STATE OF MICHIGAN

BEFORE THE MICHIGAN PUBLIC SERVICE COMMISSION

In the matter of the Application of **UPPER MICHIGAN ENERGY RESOURCES CORPORATION** requesting approval of an amended renewable energy plan to comply with Public Act 235 of 2023.	U-21813

DIRECT TESTIMONY OF DOUGLAS B. JESTER

ON BEHALF OF

ATTORNEY GENERAL DANA NESSEL AND

CITIZENS UTILITY BOARD OF MICHIGAN

June 26, 2025

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DIRECT TESTIMONY OF DOUGLAS B. JESTER FOR AGCUB
CASE NO. U-21813

I. INTRODUCTION & QUALIFICATIONS

Q. Please state for the record your name, position, and business address.

A. My name is Douglas B. Jester. I am Managing Partner of 5 Lakes Energy, a Michigan limited liability corporation, located at PO Box 869, Northport, Michigan 49670.

Q. On whose behalf is this testimony being offered?

A. I am testifying on behalf of Attorney General Dana Nessel and the Citizens Utility Board of Michigan, collectively identified as AGCUB.

Q. Please summarize your experience in the field of utility regulation.

A. I have worked for more than 30 years in utility industry regulation and related fields. My work experience is summarized in my resume, provided as Exhibit AGCUB-1 (DJ-1).

Q. Have you testified before this Commission or as an expert in any other proceedings?

A. I have previously testified before the Michigan Public Service Commission ("Commission") in the following cases:

- Case U-17473 (Consumers Energy Company Plant Retirement Securitization);
- Case U-17096-R (Indiana Michigan 2013 PSCR Reconciliation);
- Case U-17301 (Consumers Energy Renewable Energy Plan 2013 Biennial Review);
- Case U-17302 (DTE Energy Renewable Energy Plan 2013 Biennial Review);
- Case U-17317 (Consumers Energy 2014 PSCR Plan);
- Case U-17319 (DTE Electric 2014 PSCR Plan);
- Case U-17671-R (UPPCO 2015 PSCR Reconciliation);
- Case U-17674 (WEPCO 2015 PSCR Plan);

- Case U-17674-R (WEPCO 2015 PSCR Reconciliation);
- Case U-17679 (Indiana-Michigan 2015 PSCR Plan);
- Case U-17688 (Consumers Energy Cost of Service and Rate Design);
- Case U-17689 (DTE Electric Cost of Service and Rate Design);
- Case U-17698 (Indiana-Michigan Cost of Service and Rate Design);
- Case U-17735 (Consumers Energy General Rates);
- Case U-17752 (Consumers Energy Community Solar);
- Case U-17762 (DTE Electric Energy Optimization Plan);
- Case U-17767 (DTE General Rates);
- Case U-17792 (Consumers Energy Renewable Energy Plan Revision);
- Case U-17895 (UPPCO General Rates);
- Case U-17911 (UPPCO 2016 PSCR Plan);
- Case U-17911-R (UPPCO 2016 PSCR Reconciliation);
- Case U-17990 (Consumers Energy General Rates);
- Case U-18014 (DTE General Rates);
- Case U-18089 (Alpena Power PURPA Avoided Costs);
- Case U-18090 (Consumers Energy PURPA Avoided Costs);
- Case U-17911-R (UPPCO 2016 PSCR Reconciliation);
- Case U-18091 (DTE PURPA Avoided Costs);
- Case U-18092 (Indiana Michigan Power Company PURPA Avoided Costs);
- Case U-18093 (Northern States Power PURPA Avoided Costs);
- Case U-18094 (Upper Peninsula Power Company PURPA Avoided Costs);
- Case U-18095 (Wisconsin Public Service Company PURPA Avoided Costs);

- Case U-18096 (Wisconsin Electric Power Company PURPA Avoided Costs);
- Case U-18224 (UMERC Certificate of Necessity);
- Case U-18232 (DTE Renewable Energy Plan);
- Case U-18255 (DTE Electric General Rates);
- Case U-18322 (Consumers Energy General Rates);
- Case U-18406 (UPPCO 2018 PSCR Plan);
- Case U-18408 (UMERC 2018 PSCR Plan);
- Case U-18419 (DTE Certificate of Necessity);
- Case U-20072 UPPCO 2017 PSCR Reconciliation);
- Case U-20111 (UPPCO Tax Cuts and Jobs Act of 2017 Adjustment);
- Case U-20134 (Consumers Energy General Rates);
- Case U-20150 (UPPCO Revenue Decoupling Mechanism Complaint);
- Case U-20162 (DTE General Rates);
- Case U-20165 (Consumers Energy Integrated Resource Plan);
- Case U-20229 (UPPCO 2019 PSCR Plan Case);
- Case U-20276 (UPPCO General Rates);
- Case U-20350 (UPPCO Integrated Resource Plan);
- Case U-20359 (I&M 2019 General Rate Case);
- Case U-20471 (DTE Integrated Resource Plan);
- Case U-20479 (SEMCO 2019 General Rate Case);
- Case U-20561 (DTE 2019 General Rate Case);
- Case U-20591 (Indian Michigan Power Company IRP);
- Case U-20642 (DTE Gas 2020 General Rate Case);

- Case U-20649 (Consumers Electric Voluntary Green Pricing);
- Case U-20650 (Consumers Gas 2020 General Rate Case);
- Case U-20697 (Consumers Electric 2020 General Rate Case);
- Case U-20713 (DTE 2020 Voluntary Green Pricing);
- Case U-20836 (DTE Electric 2022 General Rate Case);
- Case U-20874 (Alpena Power 2022-23 EWR Plan Case);
- Case U-20875 (Consumers Energy 2022-23 EWR Plan Case);
- Case U-20876 (DTE Electric 2022-23 EWR Plan Case);
- Case U-20877 (Indiana Michigan 2022-23 EWR Plan Case);
- Case U-20878 (NSP 2022-23 EWR Plan Case);
- Case U-20879 (UPPCO 2022-23 EWR Plan Case);
- Case U-20880 (UMERC 2022-23 EWR Plan Case);
- Case U-20881 (DTE Gas 2022-23 EWR Plan Case);
- Case U-20882 (MGU Gas 2022-23 EWR Plan Case);
- Case U-20883 (SEMCO Gas 2022-23 EWR Plan Case);
- Case U-20889 (Consumers Karn Retirement Securitization);
- Case U-20963 (Consumers Energy Electric Rate Case);
- Case U-21015 (DTE Securitization Case);
- Case U-21048 (Consumers Energy 2022 PSCR Plan);
- Case U-21081 (UMERC 2021 IRP);
- Case U-21090 (Consumers Energy 2021 IRP);
- Case U-21189 (Indiana Michigan 2022 IRP);
- Case U-21193 (DTE Electric 2022 IRP);

- Case U-21224 (Consumers Energy 2022 Electric Rate Case);
- Case U-21297 (DTE Electric 2023 Rate Case);
- Case U-21377 (IM Renewable Acquisition);
- Case U-21389 (Consumers Energy 2023 Electric Rate Case);
- Case U-21540 (MGU 2024 Gas Rate Case);
- Case U-21555 (UPPCO 2024 Rate Case);
- Case U-21534 (DTE 2024 Electric Rate Case);
- Case U-21585 (Consumers 2024 Electric Rate Case);
- Case U-21654 (EWR Alternative Compliance Plan);
- Case U-21662 (DTE 2024 Renewable Energy Plan Case);
- Case U-21816 (Consumers Energy 2024 Renewable Energy Plan Case); and
- Case U-21859 (Consumers Energy Data Center Tariff Case).

Additionally, I have testified as an expert witness before the Public Utilities Commission of Nevada in Case No. 16-07001 concerning the 2017-2036 integrated resource Plan of NV Energy; and before the Missouri Public Service Commission in Case Nos. ER-2016-0179, ER-2016-0285, and ET-2016-0246 concerning residential rate design and electric vehicle ("EV") policy, revenue requirements, cost of service, and rate design. I testified before the Kentucky Public Service Commission in Case No. 2016-00370 concerning municipal street lighting rates and technologies. I testified before the Massachusetts Department of Public Utilities in Case Nos. DPU 17-05 and DPU 17-13 concerning EV charging infrastructure program design and cost recovery. Before the Rhode Island Public Utilities Commission, in case 4780, I testified concerning Advanced Metering Infrastructure and EV charging infrastructure. Before the Delaware Public Service

Commission, I testified regarding EV charging infrastructure in case 17-1094. I testified before the Georgia Public Service Commission in Case No. 4822 concerning PURPA avoided cost. I testified before the Colorado Public Utilities Commission in Cases No. 20A-0204E and 20A-195E concerning cost recovery for EV charging infrastructure. I also testified before the Minnesota Public Utilities Commission in Case No. 22-432 regarding EV charging rate design. I testified before the Public Service Commission of Wisconsin in Certificate of Public Convenience and Necessity cases 6630-CE-316 and 6630-CE-317.

I have also testified as an expert witness on behalf of the State of Michigan before the Federal Energy Regulatory Commission ("FERC") in cases relating to the relicensing of hydro-electric generation and have participated in state and federal court cases on behalf of the State of Michigan, concerning electricity generation matters, which were settled before trial.

Q. Are you sponsoring any exhibits?

A. Yes, I am sponsoring the following exhibit:

Exhibit AGCUB-1 (DJ-1):	Resume of Douglas B. Jester
Exhibit AGCUB-2 (DJ-2):	UMERC response to discovery 02-AG-CUB-16
Exhibit AGCUB-3 (DJ-3):	UMERC responses to discovery 02-AG-CUB-20 and 03-AG-CUB-30
Exhibit AGCUB-4 (DJ-4):	UMERC response to discovery 02-AG-CUB-21
Exhibit AGCUB-5 (DJ-5):	UMERC response to discovery 02-AG-CUB-13
Exhibit AGCUB-6 (DJ-6):	Tilden response to discovery AG/CUB-TM-1

Exhibit AGCUB-7 (DJ-7):	Calculation of renewable energy needed to achieve 100% clean energy for UMERC's non-Tilden customers
Exhibit AGCUB-8 (DJ-8):	CONFIDENTIAL Summary of Renewable Energy Plan proposed in this testimony
Exhibit AGCUB-9 (DJ-9):	UMERC CONFIDENTIAL response to discovery 03-AG-CUB-31

II. SUMMARY

Q. What topics are you addressing in your testimony?

A. My testimony will address the following topics:

- Michigan renewable and clean energy standards do not require terminating operations of Upper Michigan Energy Resources Corporation's ("UMERC's") RICE plants.
- UMERC's proposed battery energy storage systems are neither necessary nor appropriate for inclusion in a Renewable Energy Plan.
- UMERC included in its Amended Renewable Energy Plan renewable resources in excess of what is required to satisfy Michigan's Renewable Energy Standard.
- UMERC did not properly tailor its Amended Renewable Energy Plan to the expected life of its largest customer, the Tilden Mine. UMERC should limit owned renewable generation to 100% of energy sales to non-Tilden customers and meet the remainder of its renewable energy credit ("REC") requirements through REC purchases.
- UMERC grossly overstates the incremental cost of compliance with the Renewable Energy Standard.

- UMERC's proposed mechanism to recover the costs of its Amended Renewable Energy Plan is inconsistent with law and unreasonable.
- The Commission should find that UMERC's proposed Amended Renewable Energy Plan is neither prudent nor reasonable, and should recommend that UMERC revise its Amended Renewable Energy Plan, or else should disapprove the Amended Renewable Energy Plan.
- The Commission should approve in part, but not in whole, the projected costs of UMERC's Amended Renewable Energy Plan.

Q. Which UMERC witnesses' testimony do you discuss in your testimony?

A. I am addressing aspects of the testimony of UMERC witnesses Richard F. Stasik, Jaime Cano Lopez, Chelsey A. Biersach, and James M. Beyer.

III. OVERVIEW OF CASE

Q. What is the purpose of this case?

A. In this case the Commission is to consider whether the Amended Renewable Energy Plan presented by UMERC is reasonable and prudent and compliant with 2008 PA 295 as amended, particularly including the provisions adopted in 2023 PA 235. The Commission must also consider a plan for recovery of the reasonable and prudent projected costs of UMERC's Amended Renewable Energy Plan.

Q. What is your overall evaluation of UMERC's Amended Renewable Energy Plan as proposed in this case?

A. UMERC's Amended Renewable Energy Plan proposed in this case is unreasonable and imprudent, including as being based on false or inaccurate assumptions, includes resources and costs that are unnecessary for compliance with the Renewable Energy Standard, and fails to comply with requirements of law.

IV. UMERC'S RICE PLANTS

Q. What is the relevance of UMERC's RICE plants in this case?

A. UMERC owns and operates two power plants, the Mihm and Kuester plants, each of which consists of several reciprocating internal combustion engine ("RICE") engines fueled by natural gas. These plants provide approximately 180 MW nameplate power generation capacity and were placed in service in 2019.[1] UMERC claims in this case that "the mandates of PA 235, if not amended, will require UMERC to prematurely retire the RICE Units."[2] On that basis, UMERC proposes in this case sufficient resources to meet UMERC's capacity obligations without the RICE units and posits substantial costs for compliance with PA 235.

In furtherance of its argument, UMERC evaluates the incremental cost of compliance with the renewable energy standard by comparing the purported costs of a resource plan that meets both the renewable and clean energy standards of 2023 PA 235 with the purported costs of a resource plan in the absence of 2023 PA 235.[3]

Q. On what basis does UMERC assert that 2023 PA 235 requires the premature

[1] Direct testimony of Richard F. Stasik, 12:10-15.
[2] Direct testimony of Richard F. Stasik, 13:23-24.
[3] Direct testimony of Jaime Cano Lopez, 9:12-19.

retirement of its RICE plants?

A. For the most part, UMERC simply asserts that this is so.[4] In discovery, UMERC witness Jaime Cano Lopez was asked to "identify the clean energy requirements of PA 235 that required the existing Mihm and Kuester RICE facilities to be retired by 2040," to which they responded that "Public Act 235 establishes a clean energy standard of 80% by 2035 and 100% by 2040, Mihm and Kuester are not part of the low- or zero-carbon sources defined in PA 235, like renewables, nuclear, or fossil fuels with carbon capture."[5]

Q. Does UMERC claim that retiring its RICE plants is necessary for compliance with Michigan's renewable energy standard?

A. No. I carefully examined its Application and testimony in this case and did not find such a claim. Rather, the Company is attempting to claim retirement of the plants is necessary for its clean-energy obligations under PA 235. That claim is incorrect, as will be addressed in detail below, and further is not required or appropriate for the Company's RE Plan case.

Q. Is UMERC's assertion that 2023 PA 235 requires the premature retirement of its RICE plants correct?

A. It is not. UMERC is correct that 2023 PA 235 establishes a clean energy standard of 80% by 2035 and 100% by 2040, but that standard does not require the retirement of its RICE plants nor even prevent the construction of new RICE plants. The clean energy standard does not prohibit the operation in Michigan of power plants that are not "clean" as defined in 2023 PA 235. It requires that each electric provider supply clean energy exceeding 80%

[4] Direct testimony of Richard F. Stasik, 13:23-24, 22:5-7, and direct testimony of Jaime Cano Lopez 11:2-4,
[5] Exhibit AGCUB-2 (DJ-2) consisting of response to discovery request 02-AG-CUB-16.

of its Michigan retail sales in 2035 through 2039 and exceeding 100% of its Michigan retail sales in 2040 and thereafter.[6]

Q. Why does a requirement that an electricity provider supply 100% of its Michigan retail sales from a clean energy portfolio not imply that it cannot generate power from a resource that is not "clean" as defined in 2023 PA 235?

A. There are several ways that an electricity provider can comply with the clean energy standard and operate a resource that is not "clean" as defined in 2023 PA 235.

It is important to understand that UMERC, like other electric providers that are participants in the Midcontinent Independent System Operator's ("MISO's") energy markets, does not produce power to supply directly to its own customers. All of the power that UMERC sells to its customers is purchased by UMERC from MISO's power pool. All of the power that UMERC generates from facilities that are connected to the transmission system that MISO operates is sold to MISO. There is no quantitative connection between UMERC's sales to its retail customers and UMERC's generation. UMERC may sell to MISO's power pool generation that is either less than or more than UMERC purchases from MISO and sells to UMERC's customers.

Nothing in 2023 PA 235 prevents UMERC from generating and selling more power to MISO than it purchases from MISO for delivery to UMERC's retail customers. UMERC can continue to operate its RICE units, selling their generation to MISO under economic dispatch as UMERC currently does. UMERC's obligation under the clean energy standard

[6] 2023 PA 235, Section 51 requires a clean energy portfolio of 80% in 2035 through 2039 and 100% in 2040 and every year thereafter, while Section 3 defines a "clean energy portfolio" as the percentage of an electric provider's total retail electric sales consisting of clean energy or renewable energy.

is to sell to the MISO power pool a quantity of clean energy that equals or exceeds the portions of UMERC's retail sales that are required each year by the clean energy standard. It can do that without retiring the RICE plants.

In fact, due to the need to provide power for transmission and distribution losses, MISO market participants must in aggregate produce more power than is consumed by their customers. And, many MISO members, like UMERC does at present, purchase significantly more power from MISO to supply their retail customers than they generate and sell to MISO. In Case No. U-21600, the Commission approved a settlement of UMERC's 2025 Power Supply Cost Recovery Plan in an Order on April 24, 2025. That Plan shows that UMERC generation in 2025 will provide only about 41% of its energy requirements and the balance will be net purchases from MISO.[7] It follows by simple arithmetic that some MISO members must produce and sell to MISO more power than they buy from MISO for delivery to their customers. UMERC can be one of those MISO market participants that sells more power to MISO than it obtains from MISO to serve its customers.

Q. What are the consequences in this case of correcting UMERC's false assumption that it must prematurely retire its RICE plants in order to comply with 2023 PA 235?

A. First, this case is supposed to be about UMERC's plan to comply with the renewable energy standards in 2023 PA 235. UMERC does not claim that it needs to prematurely retire its RICE plants in order to comply with the renewable energy standard in 2023 PA

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[7] U-21600 Exhibit A-5 shows Mihm and Kester generation totaling 769,650 MWh and MISO Purchased Power of 1,111,877 MWh in 2025, so that UMERC-owned generation is about 41% of energy requirements. This fact also illustrates that UMERC need not generate significantly more than it sells in order to meet 60% of sales for the renewable energy standard.

235. Thus, any resources included in this proposed Amended Renewable Energy Plan in order to comply with the clean energy standard in 2023 PA 235 are improperly included in this plan.

Second, even if resources needed to comply with the clean energy standard but not needed to comply with the renewable energy standard of 2023 PA 235 were relevant in this case, any resources included because of the assumed premature retirement of UMERC's RICE plants are unreasonable and imprudent. The Commission should refuse the inclusion of such resources in this Amended Renewable Energy Plan.

Q. What portions of UMERC's Application in this case should be rejected because they are based on the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants?

A. Paragraph 8 of the Company's Application, including the table showing proposed wind, solar, and battery energy storage system ("BESS") resources is based on the modeling presented in the testimony of UMERC witness Jaime Cano Lopez that is in turn based on this false assumption that 2023 PA 235 requires premature retirement UMERC's RICE plants.

Paragraph 10, concerning the importance of UMERC's RICE plants, is essentially irrelevant because it is premised on the false assumption that the RICE plants must be prematurely retired to comply, though this paragraph contains no request to the Commission.

Paragraph 11 references an incremental cost of compliance that is premised on the false assumption that UMERC must retire its RICE plants due to the requirements of 2023 PA

235, though this paragraph does not recite the incremental cost of compliance. Furthermore, this paragraph acknowledges that UMERC addresses in this case its claimed cost of compliance with the clean energy standards contained in 2023 PA 235.

The Application requests the Commission to "[a]pprove UMERC's AREP as reasonable, prudent, and compliant with Act 235 and the Commission's orders in Case No. U-21568." Since the AREP is premised on the false assumption that UMERC must retire its RICE plans due to 2023 PA 235, the Commission should not grant such approval.

Q. What portions of the testimony of Richard F. Stasik in this case are wrong or irrelevant due to the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants?

A. Early in his testimony,[8] Mr. Stasik begins discussing additional renewable energy resources purportedly necessary for compliance with 2023 PA 235 based on UMERC's faulty modeling surrounding a premature retirement of its RICE plants. Most of the remainder of his testimony is based on this foundational reference and is therefore rendered wrong or irrelevant. In particular, his estimates of and comments on revenue requirements and bill impacts[9] are wrong and irrelevant. His extended discussion of UMERC's RICE units[10] is largely irrelevant in this case. Since 2023 PA 235 does not require premature retirement of UMERC's RICE units, UMERC's capacity position will not be harmed and will in fact be enhanced by UMERC's compliance with the renewable and clean energy standards in addition to UMERC's continued operation of its RICE plants. Further,

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[8] Direct testimony of Richard F. Stasik, 7:17.
[9] Direct testimony of Richard F. Stasik, 9:9 through 11:1, 13:16 through 14:3.
[10] Direct testimony of Richard F. Stasik, 18:1 through 23:2.

UMERC's advocacy for HB 4007, which Mr. Stasik discusses,[11] has been based on misrepresentations to legislators and the public premised on the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants.

Q. What portions of the testimony of Jaime Cano Lopez in this case are wrong or irrelevant due to the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants?

A. UMERC witness Jaime Cano Lopez testifies to UMERC's capacity expansion modeling to select a resource portfolio in compliance with 2023 PA 235 and a comparison of the cost of that resource portfolio to one developed assuming away 2023 PA 235. However, the scenario modeled for purposes of compliance with 2023 PA 235 is premised on the false assumption that 2023 PA 235 requires the premature retirement, by 2040, of UMERC's RICE plants.[12] Consequently the entirety of witness Cano Lopez's testimony is irrelevant and the portion of the testimony that speaks to the cost to comply with 2023 PA 235[13] is wrong. Only that portion of witness Cano Lopez's testimony that concerns UMERC's resource plan absent 2023 PA 235 is potentially valid.

Q. What portions of the testimony of Chelsey A. Biersach in this case are wrong or irrelevant due to the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants?

A. UMERC witness Biersach's testimony is unaffected by the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants.

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[11] Direct testimony of Richard F. Stasik, 23:4-19.
[12] Direct testimony of Jaime Cano Lopez, 11:1-6.
[13] Direct testimony of Jamie Cano Lopez 12:9 through 13:5.

Q. What portions of the testimony of James M. Beyer in this case are wrong or irrelevant due to the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants?

A. UMERC witness Beyer testifies to the Renewable Energy Plan surcharge calculations, forecasted revenues from those surcharges, and the cost of compliance with the requirements of 2023 PA 235, and presents proposed tariff changes to implement the surcharges. All of his testimony and Exhibits are premised on the resource plan and costs developed through the faulty modeling presented by UMERC witness Jaime Cano Lopez, in turn premised on the false assumption that 2023 PA 235 requires premature retirement of UMERC's RICE plants; they are therefore wrong. Furthermore, to the extent that these points in witness Beyer's testimony and Exhibits address compliance with the clean energy standard in 2023 PA 235 and not the renewable energy standard that is supposed to be the focus of this case, they are irrelevant.

V. BATTERY ENERGY STORAGE SYSTEMS

Q. Does UMERC propose BESS as part of its renewable energy plan in this case?

A. Yes. UMERC proposes as part of its Amended Renewable Energy Plan presented in this case, to acquire 275 MW of BESS in tranches of 125 MW in 2030, 75 MW in 2035, 50 MW in 2039, and 25 MW in 2040.[14] UMERC witness Richard F. Stasik states that UMERC includes battery energy storage systems as part of UMERC's Amended Renewable Energy Plan.[15] According to UMERC, the capital cost of BESS included in its Amended Renewable Energy Plan proposed in this case is $856.9 million, out of a total capital cost

[14] UMERC Application, p 4, para 8.
[15] Direct testimony of Richard F. Stasik, 6:8-19.

claimed by UMERC of $3,141.7 million.[16]

Q. Is a BESS a renewable energy system?

A. Notwithstanding UMERC witness Richard F. Stasik's declaration that UMERC considers it to be so, a BESS is not a renewable energy system as defined by 2023 PA 235.[17] Section 101 of PA 235 specifically addresses cost recovery for BESS in base rates.[18] Since BESS are not renewable energy systems, UMERC cannot recover the costs for BESS via its renewable energy plan and they should not be included in UMERC's renewable energy plan.

Q. If UMERC does not retire the RICE plants, does UMERC need to build BESS?

A. UMERC witness Jaime Cano Lopez presented results of capacity additions modeling absent the requirements of 2023 PA 235 and found that no BESS and no other resources would be added.[19] I can conclude from that result that UMERC has no projected need for incremental capacity through the end of the modeling period in 2045.

It is possible that BESS would be economically warranted, even if the RICE plants are not retired, by a combination of revenues from energy arbitrage and incremental capacity credits that could be sold to other MISO market participants, but the evidence presented by UMERC does not properly address that possibility because UMERC modeled both its "business as usual" scenario and its invalid renewable energy plan scenario using locational

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[16] Direct testimony of Richard F. Stasik, 8:1.
[17] See Section 11, paragraph (i) of 2023 PA 235 for the applicable definition of a renewable energy system. I offer my opinions regarding PA 235 from my experience as a witness and my involvement in the development of that legislation, and not as a legal opinion.
[18] MCL 460.1101(4).
[19] Direct testimony of Jaime Cano Lopez 12:13 through 13:5.

marginal price assumptions that do not include the effects of the renewable energy standards adopted by Illinois,[20] Michigan,[21] and Minnesota,[22] as acknowledged in a discovery response by UMERC.[23] This has the effect of lessening the potential for energy arbitrage to be modeled as beneficial compared to what is likely to actually happen, because the increased use of variable renewable generation in Illinois, Michigan, and Minnesota pursuant to their respective renewable and clean energy standards should increase the volatility of locational marginal prices in this portion of MISO. Further, the potential sale of capacity credits does not appear to have been considered in any of UMERC's analysis.[24] Since BESS cannot be approved nor BESS costs recovered through a Renewable Energy Plan, I did not undertake to provide an alternative analysis.

2023 PA 235 does include a requirement that by December 31, 2029, UMERC petition the Commission for approval of UMERC's share of a statewide goal of 2500 MW of new BESS, demonstrating compliance in an integrated resource plan filed under section 6t of 1939 PA 3. According to Commission Staff calculations Ordered by the Commission,[25] based on data available in 2025, UMERC's share of that statewide goal would be 30.6 MW,[26] which is considerably less than proposed by UMERC in this case. Since this is not an integrated resource plan case, and UMERC has not provided any analysis of BESS in

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[20] Illinois Public Act 102-0662.
[21] Michigan Public Act 235 of 2023.
[22] Minnesota 2023 House File No. 7.
[23] Exhibit AGCUB-3 (DJ-3) consisting of UMERC responses to discovery 02-AG-CUB-20 and 03-AG-CUB-30.
[24] Exhibit AGCUB-4 (DJ-4) consisting of UMERC response to discovery 02-AG-CUB-21.
[25] U-21571 Order of January 23, 2025, available at https://mi-psc.my.site.com/sfc/servlet.shepherd/version/download/068cs00000X2AMwAAN.
[26] See https://www.michigan.gov/mpsc/-/media/Project/Websites/mpsc/workgroups/2023-Energy-Legislation/2025-Statewide-Energy-Storage-Calc.pdf?rev=26b900866e1d414fb7710d7c2159af33&hash=829219ED72304EA5365F5DFEE67D11FC.

the context of a valid plan for compliance with Michigan's renewable and clean energy standards, that requirement is not relevant in this proceeding.

VI. EXCESS RENEWABLE RESOURCES

Q. Does UMERC propose in this case sufficient renewable energy resources to comply with Michigan's renewable energy standard?

A. In this case, UMERC proposes sufficient renewable energy resources to comply with an 80% clean energy standard in 2035 through 2039 and a 100% clean energy standard in 2040 and thereafter, using only renewable energy. Consequently, UMERC proposes renewable resources in excess of what is needed to comply with the renewable energy standard.

Q. Is that excess problematic in this case?

A. While it is possible, even likely, that additional renewable energy beyond what is required by the renewable energy standard in 2023 PA 235 is the most reasonable and prudent way for UMERC to satisfy the clean energy standard in 2023 PA 235, that additional renewable energy should not be included in UMERC's Amended Renewable Energy Plan in this case. 2023 PA 235 prescribes that UMERC file its clean energy plan as part of an integrated resource plan.[27] Second, UMERC has not demonstrated in this case that this is the most reasonable and prudent way to comply with the clean energy standard, which it must do in its integrated resource plan. Indeed, since UMERC has only modeled compliance with the

[27] See Section 51(2)(a) of 2023 PA 235.

clean energy standard based on the false assumption that UMERC must retire its RICE plants prematurely, UMERC has provided no viable evidence on this question.

Furthermore, any incremental cost of that incremental renewable energy should not be attributed to the renewable energy standard, as UMERC does in this case. In my opinion as a non-attorney expert, 2023 PA 235 directs that costs of compliance with the clean energy standard be recovered in a rate case as provided by 1939 PA 3, MCL 460.1 to 460.11.[28] 2023 PA 235 Sections 45 and 47 are specific to the Renewable Energy Plan.

VII. TILDEN MINE

Q. Why is the Tilden Mine of particular concern in this case?

A. The Tilden Mine is a large share of UMERC's current sales. UMERC, as it should, has included those sales in determining its obligations to provide renewable (as well as clean) energy to satisfy the renewable and clean energy standards. However, mines are expected to eventually exhaust their ore body and cease operations, which may mean that there is a temporary requirement for renewable energy credits to meet the renewable energy standard. Prudent strategies to meet temporary needs are likely different than those for long-term needs.

Q. How long is Tilden Mine expected to operate?

A. All of UMERC's testimony and Exhibits in this case make it appear that Tilden Mine will operate through 2045 and provide no indication of the status of the Tilden Mine after that. However, UMERC proposes to own renewable generation facilities that will be constructed

[28] See Section 51(1)(a) of 2023 PA 235.

in 2027, 2030, 2034, 2035, and 2040 that are cumulatively designed to supply 100% of UMERC's sales, including sales to Tilden Mine, as of 2040. Given that the expected life of both wind and solar facilities is on the order of 35 years, this means that all of UMERC's proposed renewable resources should be expected to be in production in 2062 and substantial quantities for several years thereafter.

In response to discovery, UMERC witness Chelsey Biersach reported that in this case UMERC assumed the Tilden Mine would operate through 2045.[29]

In response to discovery, the Tilden Mining Company provided a "Technical Report Summary on the Tilden Property, Michigan, USA S-K 1300 Report,"[30] which has an effective date of December 31, 2021. This report represents that Tilden LC estimates that the mine life will be 25 years,[31] consistent with its estimate of reserves[32] and plant production summary.[33] It thus appears that major operations at Tilden Mine should be expected to end by around 2045. It would therefore be imprudent for UMERC to undertake to own renewable generation systems whose expected life would be very much later than 2045 in order to meet renewable energy requirements associated with the Tilden Mine sales.

Q. What would be a prudent approach to meeting the renewable energy standard for UMERC's total sales, including the Tilden Mine, given that the Tilden Mine sales are

[29] Exhibit AGCUB-5 (DJ-5) consisting of UMERC response to discovery 02-AG-CUB-13.
[30] Exhibit AGCUB-6 (DJ-6).
[31] Exhibit AGCUB-6 (DJ-6) p 1-15.
[32] Exhibit AGCUB-6 (DJ-6) p 12-1.
[33] Exhibit AGCUB-6 (DJ-6) p 1-6, Table 1-3.

temporary?

A. I recommend that UMERC **not** own renewable energy systems or enter into long-term Power Purchase Agreements ("PPAs") that extend beyond 2045 except as needed to provide renewable energy approximating 100% of UMERC's non-Tilden sales. This positions UMERC to meet the 100% clean energy standard after Tilden closes using long-term resources, while avoiding long-term resources to meet renewable energy requirements associated with sales to Tilden Mine.

Q. What level of renewable system ownership or long-term PPA acquisition would be prudent for UMERC?

A. I prepared Exhibit AGCUB-7 (DJ-7) to address this question. Current Year Sales to Non-Tilden Retail Customers was obtained by summing the sales shown in the Public Redacted version of Exhibit A-7. Energy Credits Obtained Through Generation – Renegade was obtained from Exhibit A-4. Since a new resource is unlikely to reach commercial operation before 2030, I then calculated Energy Credits Potentially Obtained through Generation – Future Project as the difference between these beginning in 2030. Due to some load growth and the aging of the Renegade project systems, the Energy Credits Potentially Obtained through Generation – Future Projects that I show in line 5 of AGCUB-7 (DJ-7) begins at about 421 GWh and rises to 492 GWh in 2045.

In developing its proposed Amended Renewable Energy Plan, UMERC reasonably assumed that Wind generation will have a net capacity factor, the ratio of average generation to nameplate capacity, of 0.35. A 150 MW wind system would then produce approximately 460 GWh annually.

It would be prudent for UMERC to complete the Renegade solar project and to acquire or enter a long-term PPA for the power from a 150 MW wind system as part of its renewable energy plan. This would approximately meet the 100% clean energy standard for UMERC's non-Tilden sales in 2040 and thereafter for the life of these assets, which might be expected to end between 2060 and 2065. Acquisition of renewable energy systems or of long-term PPAs in greater quantities than this are likely to position UMERC with substantially more renewable energy production than it needs to comply with the clean energy standard.

Q. How should UMERC meet renewable energy requirements related to electricity sales to the Tilden Mine?

A. Generation from UMERC-owned renewable systems or from long-term PPAs chosen to match approximately 100% of electricity sales to non-Tilden customers will provide a portion of the RECs needed to satisfy the REC requirement for the Tilden load. Confidential Exhibit AGCUB-8 (DJ-8) generally follows the format of Exhibit A-4. I inserted line 10 in Confidential Exhibit AGCUB-8, compared to the format of Exhibit A-4, to show Retail Sales to Non-Tilden Customers and line 17 to show the REC requirements for non-Tilden customers. Lines 21 and 22 in Confidential Exhibit AGCUB-8 show, respectively, the generation and therefore the RECs expected to be produced by the Renegade solar project and the 150 MW wind project I recommend above as generally matching UMERC-owned generation to the requirements of non-Tilden customers. Line 23 then shows the RECs produced by Renegade and the 150 MW wind project that are in excess of the RECs required by the renewable energy standard for the non-Tilden customers. The RECs on line 23 partly meet the requirements for RECs due to electricity sales to Tilden Mine.

UMERC should meet the remaining REC requirements associated with electricity sales to the Tilden Mine through REC purchases, as allowed by 2023 PA 235. 2023 PA 235 Section 27(5)(c) allows UMERC to use RECs purchased from anywhere in MISO without the associated capacity or energy for up to 5% of REC requirements during each year through 2035. I assume that UMERC will make such purchases, and I show those quantities in line 26 of Confidential Exhibit AGCUB-8.

The remaining RECs that UMERC should purchase to meet the remaining REC requirements associated with electricity sales to Tilden Mine are shown in line 24 of Confidential Exhibit AGCUB-8. As specified in 2023 PA 235 Section 29(1), those RECs will need to be purchased from a source anywhere in Michigan, or "outside of this state but only if the electric provider includes the capacity from the renewable energy system toward meeting its resource adequacy obligations to the applicable regional transmission organization."

Since UMERC is a MISO participant, any energy produced in association with these RECs must be sold to MISO's short-term energy market, or it may be sold bilaterally to another party. UMERC currently accrues more zonal resource credits ("ZRCs") from its RICE plants than it requires to meet MISO resource adequacy requirements and sells at least some of the excess.[34] To the extent that UMERC acquires ZRCs from renewable energy systems that it owns or through PPAs, those ZRCs can be retained by UMERC and used

[34] CONFIDENTIAL Exhibit AGCUB-9 (DJ-9), UMERC CONFIDENTIAL response to discovery 03-AG-CUB-31.

toward meeting its resource adequacy obligations to MISO. This will free up additional ZRCs from UMERC's RICE plants that can be sold in the MISO capacity markets. If UMERC is efficient in its purchases of RECs bundled with energy and capacity and in selling the associated energy and excess ZRCs that it thereby acquires, the net cost of the RECs should be approximately the same as the cost of unbundled RECs.

Since these additional RECs to satisfy the renewable energy standard relate to sales to Tilden Mine, and those needs are finite, UMERC should competitively obtain most of those RECs through fixed term contracts matched to its needs. Additionally, UMERC should be concerned that sales to the Tilden Mine may not be reliable through the end of 2045, notwithstanding the findings in the "life of mine" report in Exhibit AGCUB-6 (DJ-6). Based on the temporal structure of those needs, this would suggest a term contract from 2030 through 2040 for approximately the annual REC need during the period 2030 through 2034 and another term contract for the additional amount that is needed beginning in 2035 and extending through the year that at that time seems reliable for continuing operations of the Tilden Mine. Some additional contracts may be needed to navigate the last few years of Tilden Mine operations. Given uncertainties about Tilden Mine operations and electricity demand, some caution is warranted about contracting for requirements near end of the mine's life.

Q. Do you have any basis to believe that UMERC will be able to acquire sufficient RECs to satisfy the renewable energy standard through REC purchases?

A. MISO is projecting load growth of 90 TWh between 2024 and 2030, requiring similar growth in generation. In order to comply with Michigan's renewable energy standard under the approach I described above, UMERC merely needs to ensure, through PPAs or bundled REC purchases, that about 0.3% is from renewable resources that are not providing RECs to other load-serving entities subject to binding renewable energy standards. That seems eminently achievable.

VIII. REVENUE REQUIREMENTS AND INCREMENTAL COST OF COMPLIANCE

Q. If UMERC were to follow your recommendations, what would be the renewable energy revenue requirements?

A. In Confidential Exhibit AGCUB-8, the section headed "Revenue Requirement" provides an approximation of the revenue requirements for the approach I recommended above. Line 33 shows the revenue requirements for the Renegade solar project as filed by UMERC in Revised Exhibit A-11. Line 34 shows the revenue requirements for the 150 MW Wind Project I recommended, approximated by scaling the capital costs in UMERC's Renegade model[35] to the capital costs of a 150 MW wind project proportional to the capital cost cited by UMERC for a 500 MW wind project with commercial operation in 2030,[36] and by scaling operations and maintenance costs in UMERC's Renegade model to wind based on the Fixed O&M values used in UMERC's PLEXOS model runs.[37]

Line 36 shows the cost of unbundled RECs using the $4 per REC cost that was used by UMERC in Exhibit A-4.

Line 35 applies the same $4 per REC as the net cost of RECs when acquired bundled with

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[35] See the Renegade tab in UMERC discovery response attachment 01-AG-CUB-01 JMB Workpapers.

[36] Direct testimony of Richard F. Stasik, 8:1 shows capital cost of $856.5 M for a 500 MW wind project.

[37] Fixed O&M values found in PLEXOS model inputs provided in Attachments to discovery response 02-AG-CUB-17.

energy and capacity where the energy and capacity are then sold by UMERC. There is a significant variety of contractual arrangements UMERC could make in this category, making it difficult to ascribe a gross revenue requirement. However, since the net cost of the RECs should be at approximately the market-clearing price for RECs, it is reasonable to assume that the net cost is the same as the cost of unbundled RECs. Line 39 shows the Total Revenue Requirement with the understanding that the Revenue Requirement for Bundled RECs is the net cost of the RECs.

Q. If UMERC were to follow your recommendations, what would be the incremental cost of compliance with the renewable energy standard?

A. The section of Confidential Exhibit AGCUB-8 (DJ-8) headed "Incremental Cost of Compliance" provides estimates. The Energy and Capacity Value of Renegade on line 41 is calculated as the product of MWh generated in each year from Renegade and the 2023 Schedule transfer price in Case No. U-15800, as used in UMERC Exhibit A-9 in the present case. The Energy and Capacity Value of the Future 150 MW Wind Project is computed similarly but using the 2025 Schedule transfer price in U-15800, as used in UMERC Exhibit A-9 in the present case. Line 43 shows the net cost of UMERC-owned generation each year. Lines 44 and 45 carry forward the revenue requirements from lines 36 and 37 as incremental costs of compliance, since the net cost of RECs has no avoided capacity and energy value. These incremental costs of various sources of RECs are summed in line 47 to obtain the incremental cost of compliance, while line 48 shows the incremental cost of compliance per MWh of sales.

Q. How does the incremental cost of compliance that you show compare to that proposed

by UMERC?

A. Line 50 of Confidential Exhibit AGCUB-8 (DJ-8) shows the cost of compliance proposed by UMERC in its Exhibit A-9. These are similar to my calculations of the incremental cost of compliance until 2030 and differ substantially thereafter. This difference is due to the differences in resources planned by UMERC and those I recommend. Those differences are partly due to my exclusion of BESS from the renewable energy plan, partly due to my consideration of only the renewable energy standard in this case, not the clean energy standard, and partly due to my recommendation that UMERC use term purchases of RECs for the portion of Tilden Mine load that cannot be served with RECs based on 100% renewable energy for the non-Tilden customers.

IX. COST RECOVERY

Q. How does UMERC propose to recover the cost of its Amended Renewable Energy Plan?

A. UMERC proposes to annually recover the full costs, not just the incremental costs of compliance, of its proposed plan through per-meter surcharges.[38] It allocates the full revenue requirements as shown in Exhibit A-9 to customer classes in proportion to MWh load in the class.[39] It then calculates a per-meter surcharge by dividing the revenue requirement of each customer class by the number of customers and the number of days in the year.[40] Notably, they do not propose allocating any of these costs to Power Supply Cost Recovery through transfer prices. It is thus proposing that the vast majority of its power

[38] Direct testimony of James M. Beyer, 4:9-13.
[39] Direct testimony of James M. Beyer, 4:17 through 5:12.
[40] Direct testimony of James M. Beyer, 5:13-17.

supply costs in future be recovered through fixed daily charges.

Q. How does UMERC summarize the bill impact of their plan?

A. UMERC presents the estimated monthly per-meter bill surcharges as the bill impact.[41] Notably, they do not report the corresponding reduction in kWh charges on customer bills associated with the recovery of most of their power supply costs through these fixed charges.

Q. Is this proposal consistent with 2023 PA 235?

A. Not in my opinion as a non-lawyer. 2023 PA 235 Section 45 authorizes the Commission to determine a cost recovery mechanism, subject to Section 47, that permits the electric provider to recover the incremental cost of compliance and further provides:

> (2) An electric provider's incremental cost of compliance shall be recovered through a revenue recovery mechanism that is designed consistent with the production allocation approved in the provider's most recent general rate case under section 6a of 1939 PA 3, MCL 460.6a. An electric provider may propose a revenue recovery mechanism in an amended renewable energy plan to include all or a portion of the electric provider's incremental cost of compliance in base rates. If an electric provider proposes to include all or a portion of the incremental cost of compliance in base rates, the commission shall review and approve, approve with modifications, or deny the revenue recovery mechanism proposed by the electric provider.

Section 47 provides for the calculation of the incremental cost of compliance, including subtraction from the revenue requirements of the electric provider's renewable energy plan,

> (iv) Revenue derived from the provision of renewable energy to retail electric customers subject to a power supply cost recovery clause under section 6j of 1939 PA 3, MCL 460.6j, of an electric provider whose rates are regulated by the commission. After providing an opportunity for a contested case hearing for an electric provider whose rates are regulated by the commission, the commission shall annually establish a price per megawatt hour. An electric provider whose rates are regulated by the commission may at any time petition the commission to revise the price. In setting the price per megawatt hour under this subparagraph, the

[41] Direct testimony of Richard F. Stasik, 10:3 through 11:1.

> commission shall consider factors, including, but not limited to, projected capacity, energy, maintenance, and operating costs; information filed under section 6j of 1939 PA 3, MCL 460.6j; and information from wholesale markets, including, but not limited to, locational marginal pricing. This price shall be multiplied by the sum of the number of megawatt hours of renewable energy used to maintain compliance with the renewable energy standard. The product shall be considered a booked cost of purchased and net interchanged power transactions under section 6j of 1939 PA 3, MCL 460.6j. For energy purchased by such an electric provider under a renewable energy contract, the price shall be the lower of the amount established by the commission or the actual price paid and shall be multiplied by the number of megawatt hours of renewable energy purchased. The resulting value shall be considered a booked cost of purchased and net interchanged power under section 6j of 1939 PA 3, MCL 460.6j.

UMERC does not propose to recover any costs of its Amended Renewable Energy Plan through Power Supply Cost Recovery. It also proposes to recover all costs of its Amended Renewable Energy Plan through fixed monthly charges, contrary to Section 41(2) of 2023 PA 235 which specifies that the "incremental cost of compliance shall be recovered through a revenue recovery mechanism that is designed consistent with the production allocation approved in the provider's most recent general rate case….". UMERC's most recent general rate case does not provide for recovery of production costs through monthly fixed charges.

Q. What do you recommend that the Commission do in this case regarding cost recovery for UMERC's costs of compliance with Michigan's renewable energy standard?

A. First, I recommend that the Commission require UMERC to use, for UMERC-owned resources, levelized recovery of required revenue rather than the annual revenue requirements UMERC proposes. I calculate in workpapers the levelized annual cost of the Renegade solar project to be approximately $17,560,090 and the levelized annual cost of the Future 150 MW Wind Project that I recommend to be approximately $22,460,370.

Second, I recommend that the Commission require UMERC to recover the costs of UMERC-owned resources, up to the transfer price,[42] through Power Supply Cost Recovery.

Third, I recommend that any incremental cost of compliance be allocated to classes consistent with production allocations in UMERC rate cases and recovered through volumetric rates, not monthly fixed charges.

X. RECOMMENDATIONS

Q. Please summarize your conclusions and recommendations to the Commission.

A. On behalf of AGCUB, I recommend that the Commission:

1. Find that the Amended Renewable Energy Plan presented by UMERC in this case is unreasonable and imprudent because:
    a. It falsely assumes that Michigan's clean energy standard requires premature retirement of UMERC's RICE plants.
    b. It includes storage resources not required to comply with Michigan's renewable energy standard.
    c. It includes excess renewable resources not required to comply with Michigan's renewable energy standard.
    d. It fails to consider the finite life of the Tilden Mine and the implications of that for UMERC's renewable energy strategy. UMERC proposes to acquire and own

[42] I testified in U-21662 that the Staff transfer price calculations filed in Case No. U-15800 should be modified to include the costs of carbon capture and sequestration from a combined cycle gas plant, and that proposal is now under consideration by the Commission through a Staff-led stakeholder engagement and Staff report.

resources that will be far in excess of its requirements for as much as 15 years after Tilden Mine is forecasted to close.

2. Reject UMERC's revenue requirements as requested in its Application. As a result of UMERC's inclusion of excess resources in its Amended Renewable Energy Plan, UMERC's revenue requirements for the plan grossly exceed its actual requirements.
3. Find that UMERC's proposal to recover all of the revenue requirements for its Amended Renewable Plan through monthly fixed charges is unreasonable and is contrary to law. The Commission should require UMERC to recover costs for Company-owned renewable resources as levelized annual costs to be recovered primarily through the transfer price mechanism and require that any incremental cost of compliance be allocated consistent with the allocation of other production costs in UMERC's rate cases, with recovery of production costs through energy charges and no recovery of such costs through monthly fixed charges.
4. Find that UMERC's representation of the bill impacts of its Amended Renewable Energy Plan is seriously misleading.
5. Allow recovery of the costs of the Renegade solar project through the renewable energy plan only if the costs are recovered by the annual levelized cost of the project, with any costs up to the transfer price to be recovered through Power Supply Cost Recovery. The Commission has already authorized the Renegade solar project.
6. Authorize UMERC to acquire by competitive bidding the ownership or a long-term PPA for approximately 150 MW wind generation with a commercial operation date in approximately 2030. In the event that such a wind project is not offered at commercially reasonable costs, the Commission should allow acquisition of solar resources providing

similar annual renewable energy supply. The Commission should not authorize acquisition of long-term renewable resources to meet renewable energy requirements associated with sales to the Tilden Mine, which is not forecast to be in operation beyond approximately 2045.

7. Authorize the purchase of Renewable Energy Credits to meet all UMERC REC requirements in excess of the RECs provided by UMERC-owned facilities and PPAs, in a manner consistent with the requirements of 2008 PA 295 as amended by 2023 PA 235, with recovery of those costs through Power Supply Cost Recovery.

Q. Does that complete your testimony?

A. Yes, it does.

U-21813 Attorney General's Exhibits

Exhibit AGCUB-1 (DJ-1)	Resume of Douglas B. Jester
Exhibit AGCUB-2 (DJ-2)	UMERC response to discovery 02-AG-CUB-16
Exhibit AGCUB-3 (DJ-3)	UMERC responses to discovery 02-AG-CUB-20 and 03-AG-CUB-30
Exhibit AGCUB-4 (DJ-4)	UMERC response to discovery 02-AG-CUB-21
Exhibit AGCUB-5 (DJ-5)	UMERC response to discovery 02-AG-CUB-13
Exhibit AGCUB-6 (DJ-6)	Tilden response to discovery AG-CUB-TM-1
Exhibit AGCUB-7 (DJ-7)	Calculation of renewable energy needed to achieve 100% clean energy for UMERC's non-Tilden customers
Exhibit AGCUB-8 (DJ-8)	**CONF Summary of Renewable Energy Plan proposed in this testimony**
Exhibit AGCUB-9 (DJ-9)	**CONF UMERC response to discovery 03-AG-CUB-31**

Douglas B. Jester

Personal Information

Contact Information:

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Professional experience

January 2011 – present 5 Lakes Energy

Partner

Co-owner of a consulting firm working to advance the clean energy economy in Michigan and beyond. Consulting engagements with foundations, startups, and large mature businesses have included work on public policy, business strategy, market development, technology collaboration, project finance, and export development concerning energy efficiency, smart grid, renewable generation, electric vehicle infrastructure, and utility regulation and rate design. Policy director for renewable energy ballot initiative and Michigan energy legislation advocacy. Supported startup of the Energy Innovation Business Council, a trade association of clean energy businesses. Expert witness in utility regulation cases. Developed integrated resource planning models for use in ten states' compliance with the Clean Power Plan.

February 2010 - December 2010 Michigan Department of Energy, Labor and Economic Growth

Senior Energy Policy Advisor

Advisor to the Chief Energy Officer of the State of Michigan with primary focus on institutionalizing energy efficiency and renewable energy strategies and policies and developing clean energy businesses in Michigan. Provided several policy analyses concerning utility regulation, grid-integrated storage, performance contracting, feed-in tariffs, and low-income energy efficiency and assistance. Participated in Pluggable Electric Vehicle Task Force, Smart Grid Collaborative, Michigan Prosperity Initiative, and Green Partnership Team. Managed development of social-media-based community for energy practitioners. Organized conference on Biomass Waste to Energy.

August 2008 - February 2010 Rose International

Business Development Consultant - Smart Grid

- Employed by Verizon Business' exclusive external staffing agency for the purpose of providing business and solution development consultation services to Verizon Business in the areas of Smart Grid services and transportation management services.

December 2007 - March 2010 Efficient Printers Inc

President/Co-Owner

- Co-founder and co-owner with Keith Carlson of a corporation formed for the purpose of acquiring J A Thomas Company, a sole proprietorship owned by Keith Carlson. Recognized as Sacramento County (California) 2008 Supplier of the Year and Washoe County (Nevada) Association for Retarded Citizens 2008 Employer of the Year. Business operations discontinued by asset sale to focus on associated printing software services of IT Services Corporation.

August 2007 - present IT Services Corporation

President/Owner

- Founder, co-owner, and President of a startup business intended to provide advanced IT consulting services and to acquire or develop managed services in selected niches, currently focused on developing e-commerce solutions for commercial printing with software-as-a-service.

2004 – August 2007 Automated License Systems

Chief Technology Officer

- Member of four-person executive team and member of board of directors of a privately-held corporation specializing in automated systems for the sale of hunting and fishing licenses, park campground reservations, and in automated background check systems. Executive responsible for project management, network and data center operations, software and product development. Brought company through mezzanine financing and sold it to Active Networks.

2000 - 2004 WorldCom/MCI

Director, Government Application Solutions

- Executive responsible in various combinations for line of business sales, state and local government product marketing, project management, network and data center operations, software and product development, and contact center operations for specialized government process outsourcing business. Principal lines of business were vehicle emissions testing, firearm background checks, automated hunting and fishing license systems, automated appointment scheduling, and managed application hosting services. Also responsible for managing order entry, tracking, and service support systems for numerous large federal telecommunications contracts such as the US Post Office, Federal Aviation Administration, and Navy-Marine Corps Intranet.
- Increased annual line-of-business revenue from $64 million to $93 million, improved EBITDA from approximately 2% to 27%, and retained all customers, in context of corporate scandal and bankruptcy.
- Repeatedly evaluated in top 10% of company executive management on annual performance evaluations.

1999-2000 Compuware Corporation

Senior Project Manager

- Senior project manager, on customer site with five project managers and team of approximately 80, to migrate a major dental insurer from a mainframe environment to internet-enabled client-server environment.

1995 - 1999 City of East Lansing, Michigan

Mayor and Councilmember

- Elected chief executive of the City of East Lansing, a sophisticated city of 52,000 residents with a council-manager government employing about 350 staff and with an annual budget of about $47 million. Major accomplishments included incorporation of public asset depreciation into budgets with consequent improvements in public facilities and services, complete rewrite and modernization of city charter, greatly intensified cooperation between the City of East Lansing and the East Lansing Public Schools, significant increases in recreational facilities and services, major revisions to housing code, initiation of revision of the City Master Plan, facilitation of the merger of the Capital Area Transportation Authority and Michigan State University bus systems, initiation of a major downtown redevelopment project, City government efficiency improvements, and numerous other policy initiatives. Member of Michigan Municipal League policy committee on Transportation and Environment and principal writer of league policy on these subjects (still substantially unchanged as of 2009).

1995-1999 Michigan Department of Natural Resources

Chief Information Officer

- Executive responsibility for end-user computing, data center operations, wide area network, local area network, telephony, public safety radio, videoconferencing, application development and support, Y2K readiness for Departments of Natural Resources and Environmental Quality. Directed staff of about 110. Member of MERIT Affiliates Board and of the Great Lakes Commission's Great Lakes Information Network (GLIN) Board.

1990-1995 Michigan Department of Natural Resources

Senior Fisheries Manager

- Responsible for coordinating management of Michigan's Great Lakes fisheries worth about $4 billion per year including fish stocking and sport and commercial fishing regulation decisions, fishery monitoring and research programs, information systems development, market and economic analyses, litigation, legislative analysis and negotiation. University relations. Extensive involvement in regulation of steam electric and hydroelectric power plants.
- Served as agency expert on natural resource damage assessment, for all resources and causes.
- Considerable involvement with Great Lakes Fishery Commission, including:
    - Co-chair of Strategic Great Lakes Fishery Management Plan working group

- Member of Lake Erie and Lake St. Clair Committees
- Chair, Council of Lake Committees
- Member, Sea Lamprey Control Advisory Committee
- St Clair and Detroit River Areas of Concern Planning Committees

1989-1990 American Fisheries Society

Editor, North American Journal of Fisheries Management

- Full responsibility for publication of one of the premier academic journals in natural resource management.

1984 - 1989 Michigan Department of Natural Resources

Fisheries Administrator

- Assistant to Chief of Fisheries, responsible for strategic planning, budgets, personnel management, public relations, market and economic analysis, and information systems. Department of Natural Resources representative to Governor's Cabinet Council on Economic Development. Extensive involvement in regulation of steam electric and hydroelectric power plants.

1983-present Michigan State University

Adjunct Instructor

- Irregular lecturer in various undergraduate and graduate fisheries and wildlife courses and informal graduate student research advisor in fisheries and wildlife and in parks and recreation marketing.

1977 – 1984 Michigan Department of Natural Resources

Fisheries Research Biologist

- Simulation modeling & policy analysis of Great Lakes ecosystems. Development of problem-oriented management records system and "epidemiological" approaches to managing inland fisheries.
- Modeling and valuation of impacts power plants on natural resources and recreation.

Education

1991-1995 Michigan State University
PhD Candidate, Environmental Economics
Coursework completed, dissertation not pursued due to decision to pursue different career direction.

1980-1981 University of British Columbia
Non-degree Program, Institute of Animal Resource Ecology

1974-1977 Virginia Polytechnic Institute & State University
MS Fisheries and Wildlife Sciences
MS Statistics and Operations Research

1971-1974 New Mexico State University
BIS Mathematics, Biology, and Fine Arts

Citizenship and Community Involvement

Youth Soccer Coach, East Lansing Soccer League, 1987-89

Co-organizer, East Lansing Community Unity, 1992-1993

Bailey Community Association Board, 1993-1995

East Lansing Commission on the Environment, 1993-1995

East Lansing Street Lighting Advisory Committee, 1994

Councilmember, City of East Lansing, 1995-1999

Mayor, City of East Lansing, 1995-1997

East Lansing Downtown Development Authority Board Member, 1995-1999

East Lansing Transportation Commission, 1999-2004

East Lansing Non-Profit Housing and Neighborhood Services Corporation Board Member, 2001-2004

Lansing – East Lansing Smart Zone Board of Directors, 2007-present

Council on Labor and Economic Growth, State of Michigan, by appointment of the Governor, May 2009 – May 2012

East Lansing Downtown Development Authority Board Member and Vice-Chair, 2010 – present.

East Lansing Brownfield Authority Board Member and Vice-Chair, 2010 – present.

East Lansing Downtown Management Board and Chair, 2010 – 2016

East Lansing City Center Condominium Association Board Member, 2015 – present.

Douglas Jester
Specific Energy-Related Accomplishments

Unrelated to Employment

- Member of Michigan SAVES initial Advisory Board. Michigan SAVES is a financing program for building energy efficiency measures initiated by the State of Michigan Public Service Commission and administered under contract by Public Sector Consultants. Program launched in 2010.
- Member of Michigan Green Jobs Initiative, representing the Council for Labor and Economic Growth.
- Participated in Lansing Board of Water and Light Integrated Resource Planning, leading to their recent completion of a combined cycle natural gas power plant that also provides district heating to downtown Lansing.
- In graduate school, participated in development of database and algorithms for optimal routing of major transmission lines for Virginia Electric Power Company (now part of Dominion Resources).
- Commissioner of the Lansing Board of Water and Light, representing East Lansing. December 2017 – present.

For 5 Lakes Energy

- Participant by invitation in the Michigan Public Service Commission Smart Grid Collaborative, authoring recommendations on data access, application priorities, and electric vehicle integration to the grid.
- Participant by invitation in the Michigan Public Service Commission Energy Optimization Collaborative, a regular meeting and action collaborative of parties involved in the Energy Optimization programs required of utilities by Michigan law enacted in 2008.
- Participant by invitation in Michigan Public Service Commission Solar Work Group, including presentations and written comments on value of solar, including energy, capacity, avoided health and environmental damages, hedge value, and ancillary services.
- Participant by invitation in Michigan Senate Energy and Technology Committee stakeholder work group preliminary to introduction of a comprehensive legislative package.
- Participant by invitation in Michigan Public Service Commission PURPA Avoided Cost Technical Advisory Committee.
- Participant by invitation in Michigan Public Service Commission Standby Rate Working Group.
- Participant by invitation in Michigan Public Service Commission Street Lighting Collaborative.
- Participant by invitation in State of Michigan Agency for Energy Technical Advisory Committee on Clean Power Plan implementation.
- Conceived, obtained funding, and developed open access integrated resource planning tools (State Tool for Electricity Emissions Reduction aka STEER) for State compliance with the Clean Power Plan:
  - For Energy Foundation - Michigan and Iowa
  - For Advanced Energy Economy Institute – Arkansas, Florida, Illinois, Ohio, Pennsylvania, Virginia
  - For The Solar Foundation - Georgia and North Carolina
- Presentations to Michigan Agency for Energy and the Institute for Public Utilities Michigan Forum on Strategies for Michigan to Comply with the Clean Power Plan.
- Participant in Midcontinent Independent Systems Operator stakeholder processes on behalf of Michigan Citizens Against Rate Excess and the MISO Consumer Representatives Sector, including Resource Adequacy Committee, Loss of Load Expectation Working Group, Transmission Expansion Working Group, Demand Response Working Group, Independent Load Forecasting Working Group, and Clean Power Plan Working Group.
- Expert witness before the Michigan Public Service Commission in various cases, including:

  - Case U-17473 (Consumers Energy Plant Retirement Securitization)
  - Case U-17096-R (Indiana Michigan 2013 PSCR Reconciliation)
  - Case U-17301 (Consumers Energy Renewable Energy Plan 2013 Biennial Review);
  - Case U-17302 (DTE Energy Renewable Energy Plan 2013 Biennial Review);
  - Case U-17317 (Consumers Energy 2014 PSCR Plan);
  - Case U-17319 (DTE Electric 2014 PSCR Plan);
  - Case U-17674 (WEPCO 2015 PSCR Plan);
  - Case U-17679 (Indiana-Michigan 2015 PSCR Plan);
  - Case U-17689 (DTE Electric Cost of Service and Rate Design);
  - Case U-17688 (Consumers Energy Cost of Service and Rate Design);
  - Case U-17698 (Indiana-Michigan Cost of Service and Rate Design);
  - Case U-17762 (DTE Electric Energy Optimization Plan);
  - Case U-17752 (Consumers Energy Community Solar);
  - Case U-17735 (Consumers Energy General Rates);
  - Case U-17767 (DTE General Rates);
  - Case U-17792 (Consumers Energy Renewable Energy Plan Revision);
  - Case U-17895 (UPPCO General Rates);
  - Case U-17911 (UPPCO 2016 PSCR Plan);
  - Case U-17990 (Consumers Energy General Rates); and
  - Case U-18014 (DTE General Rates);
  - Case U-17611-R (UPPCO 2015 PSCR Reconciliation);
  - Case U-18089 (Alpena Power PURPA Avoided Costs);
  - Case U-18090 (Consumers Energy PURPA Avoided Costs);
  - Case U-18091 (DTE PURPA Avoided Costs);
  - Case U-18092 (Indiana Michigan Electric Power PURPA Avoided Costs);
  - Case U-18093 (Northern States Power PURPA Avoided Costs);
  - Case U-18094 (Upper Peninsula Power Company PURPA Avoided Costs);
  - Case U-18095 (UMERC PURPA Avoided Costs);
  - Case U-18224 (UMERC Certificate of Necessity);
  - Case U-18255 (DTE General Rate Case);
  - Case U-18322 (Consumers Energy General Rate Case).
- Expert witness before the Public Utilities Commission of Nevada in
  - Case 16-07001 (NV Energy 2017-2036 Sierra Pacific Integrated Resource Plan)
- Expert witness before the Missouri Public Service Commission in
  - Case ER-2016-0179 (Ameren Missouri General Rate Case)
  - Case ER-2016-0285 (KCP&L General Rate Case)
  - Case ET-2016-0246 (Ameren Missouri EV Policy)
- Expert witness before the Kentucky Public Service Commission
  - Case 2016-00370 (Kentucky Utilities General Rate Case)
- Expert witness before the Massachusetts Department of Public Utilities in
  - Case 17-05 (Eversource General Rate Case)
  - Case 17-13 (National Grid General Rate Case)
- Coauthored “Charge without a Cause: Assessing Utility Demand Charges on Small Customers”
- Currently under contract to the Michigan Agency for Energy to develop a Roadmap for CHP Market Development in Michigan, including evaluation of various CHP technologies and applications using STEER Michigan as an integrated resource planning tool.
- Under contract to NextEnergy, authored “Alternative Energy and Distributed Generation” chapter of Smart Grid Economic Development Opportunities report to Michigan Economic Development Corporation and assisted authors of chapters on “Demand Response” and “Automated Energy Management Systems”.
- Developed presentation on “Whole System Perspective on Energy Optimization Strategy” for Michigan Energy Optimization Collaborative.
- Under contract to NextEnergy, assisted in development of industrial energy efficiency technology development strategy.

- Under contract to a multinational solar photovoltaics company, developed market strategy recommendations.
- For an automobile OEM, developed analyses of economic benefits of demand response in vehicle charging and vehicle-to-grid electricity storage solutions.
- Under contract to Pew Charitable Trusts, assisted in development of a report of best practices for electric vehicle charging infrastructure.
- Under contract to a national foundation, developed renewable energy business case for Michigan including estimates of rate impacts, employment and income effects, health effects, and greenhouse gas emissions effects.
- Assisted in Michigan market development for a solar panel manufacturer, clean energy finance company, and industrial energy management systems company.
- Under contract to Institute for Energy Innovation, organized legislative learning sessions covering a synopsis of Michigan's energy uses and supply, energy efficiency, and economic impacts of clean energy.

For Department of Energy Labor and Economic Growth

- Participant in the Michigan Public Service Commission Energy Optimization Collaborative, a regular meeting and action collaborative of parties involved in the Energy Optimization programs required of utilities by Michigan law enacted in 2008.
- Lead development of a social-media-based community for energy practitioners in Michigan at www.MichEEN.org.
- Drafted analysis and policy paper concerning customer and third-party access to utility meter data.
- Analyzed hourly electric utility load demonstrating relationship amongst time of day, daylight, and temperature on loads of residential, commercial, industrial, and public lighting customers. Analysis demonstrated the importance of heating for residential electrical loads and the effects of various energy efficiency measures on load-duration curves.
- Analyzed relationship of marginal locational prices to load, demonstrating that traditional assumptions of Integrated Resource Planning are invalid and that there are substantial current opportunities for cost-effective grid-integrated storage for the purpose of price arbitrage as opposed to traditionally considered load arbitrage.
- Developed analyses and recommendations concerning the use of feed-in tariffs in Michigan.
- Participated in Pluggable Electric Vehicle Task Force and initiated changes in State building code to accommodate installation of vehicle charging equipment.
- Organized December 2010 conference on Biomass Waste to Energy technologies and market opportunities.
- Participated in and provided support for teams working on developing Michigan businesses involved in renewable energy, storage, and smart grid supply chains.
- Developed analyses and recommendations concerning low-income energy assistance coordination with low-income energy efficiency programs and utility payment collection programs.
- Drafted State of Michigan response to a US Department of Energy request for information on offshore wind energy technology development opportunities.
- Assisted in development of draft performance contracting enabling legislation, since adopted by the State of Michigan.

For Verizon Business

- Analyzed several potential new lines of business for potential entry by Verizon's Global Services Systems Integration business unit and recommended entry to the "Smart Grid" market. This recommendation was adopted and became a major corporate initiative.
- Provided market analysis and participation in various conferences to aid in positioning Verizon in the "Smart Grid" market. Recommendations are proprietary to Verizon.

- Led a task force to identify potential converged solutions for the "Smart Grid" market by integrating Verizon's current products and selected partners. Established five key partnerships that are the basis for Verizon's current "Smart Grid" product offerings.
- Participated in the "Smart Grid" architecture team sponsored by the corporate Chief Technology Officer with sub-team lead responsibilities in the areas of Software and System Integration and Network and Systems Management. This team established a reference architecture for the company's "Smart Grid" offerings, identified necessary changes in networks and product offerings, and recommended public policy positions concerning spectrum allocation by the FCC, security standards being developed by the North American Reliability Council, and interoperability standards being developed by the National Institute of Standards and Technology.
- Developed product proposals and requirements in the areas of residential energy management, commercial building energy management, advanced metering infrastructure, power distribution monitoring and control, power outage detection and restoration, energy market integration and trading platforms, utility customer portals and notification services, utility contact center voice application enablement, and critical infrastructure physical security.
- Lead solution architecture and proposal development for six utilities with solutions encompassing customer portal, advanced metering, outage management, security assessment, distribution automation, and comprehensive "Smart Grid" implementation.
- Presented Verizon's "Smart Grid" capabilities to seventeen utilities.
- Presented "Role of Telecommunications Carriers in Smart Grid Implementation" to 2009 Mid-America Regulatory Conference.
- Presented "Smart Grid: Transforming the Electricity Supply Chain" to the 2009 World Energy Engineering Conference.
- Participant in NASPInet work groups of the North American Energy Reliability Corporation (NERC), developing specifications for a wide-area situational awareness network to facilitate the sharing and analysis of synchrophasor data amongst utilities in order to increase transmission reliability.
- Provided technical advice to account team concerning successful proposal to provide network services and information systems support for the California ISO, which coordinates power dispatch and intercompany power sales transactions for the California market.

For Michigan Department of Natural Resources

- Determined permit requirements under Section 316 of the Clean Water Act for all steam electric plants currently operating in the State of Michigan.
- Case manager and key witness for the State of Michigan in FERC, State court, and Federal court cases concerning economics and environmental impacts of the Ludington Pumped Storage Plant, which is the world's largest pumped storage plant. A lead negotiator for the State in the ultimate settlement of this issue. The settlement was valued at $127 million in 1995 and included considerations of environmental mitigation, changes in power system dispatch rules, and damages compensation.
- Managed FERC license application reviews for the State of Michigan for all hydroelectric projects in Michigan as these came up for reissuance in 1970s and 1980s.
- Testified on behalf of the State of Michigan in contested cases before the Federal Energy Regulatory Commission concerning benefit-cost analyses and regulatory issues for four different hydroelectric dams in Michigan.
- Reviewed (as regulator) the environmental impacts and benefit-cost analyses of all major steam electric and most hydroelectric plants in the State of Michigan.
- Executive responsibility for development, maintenance, and operations of the State of Michigan's information system for mineral (includes oil and gas) rights leasing, unitization and apportionment, and royalty collection.
- In cooperative project with Ontario Ministry of Natural Resources, participated in development of a simulation model of oil field development logistics and environmental impact on Canada's Arctic slope for Tesoro Oil.

Upper Michigan Energy Resources Corporation
MPSC Case No. U-21813

Response to the AG-CUB
Second Set of Discovery Requests to
Upper Michigan Energy Resources Corporation ("The Company")

02-AG-CUB-16: Refer to the testimony of Jaime Cano Lopez, 11:1-6. Please identify the clean energy requirements of PA 235 that require the existing Mihm and Kuester RICE facilities to be retired by 2040.

Response: Public Act 235 establishes a clean energy standard of 80% by 2035 and 100% by 2040. Mihm and Kuester are not part of the low- or zero-carbon sources defined in PA 235, like renewables, nuclear, or fossil fuels with carbon capture.

Response By: Jaime Cano Lopez

Date: 4/18/2025

Upper Michigan Energy Resources Corporation
MPSC Case No. U-21813

Response to the TILDEN
Second Set of Discovery Requests to
Upper Michigan Energy Resources Corporation ("The Company")

02-TM-UMERC-20. On an electronic spreadsheet with all formula intact, please provide UMERC witness James M. Beyer's development of Exhibits A-9(JMB-1), A-10 (JMB-2), A- 11 (JMB-3), and A-12 (JMB-4). Please also provide a narrative explanation of all assumptions used to produce each of these exhibits and a complete copy of all supporting documentation used to produce these exhibits.

Response: Please see response to 01-AG-CUB-01 for electronic versions of the workpapers. Specifically "01-AG-CUB-01 JMB Workpapers.xlsx (tab JMB A-11)" and "01-AG-CUB-01 Confidential Attachment.xlsx (tab JMB A-9 and JMB A-10)".

Exhibit A-9 (JMB-1) – Calculation of Daily Renewable Energy Surcharges

The calculation of the daily surcharges begins with the revenue requirement for the resources required to comply with PA 235 for each year 2026 through 2045. The revenue requirement can be found on Witness Jaime Cano Lopez's Exhibit A-4 (JCL-1).

UMERC then split its customers into classes similar to the breakout used in the Energy Waste Reduction program. The revenue requirement was then allocated to each class based on total forecasted MWh sales which can be found on Witness Chelsey Biersach's Exhibit A-7 (CB-2). The revenue requirement allocated to each class can be found on rows 28-34 of Exhibit A-9 (JMB-1).

Finally, the surcharge for each class was calculated taking the allocated costs in rows 28-34 and dividing that value by the number of customers in each customer class found in rows 20-26. This value was then divided by 365 to derive a per meter per day charge. UMERC's proposed daily surcharge by customer class can be found on rows 36-41 of Exhibit A-9 (JMB-1).

Supplemental Response: See "01-AG-CUB-01 Supplemental Attachment" for detail and support behind the calculation of the Renewable Energy Surcharges. A narrative description of the calculation can be found on Witness Beyer's Supplemental Direct Testimony page 7 row 10 through page 10 row 18.

Supplemental Response By: Jim Beyer

Date: June 5, 2025

Upper Michigan Energy Resources Corporation
MPSC Case No. U-21813

Response to the AG-CUB's
Third Set of Discovery Requests to
Upper Michigan Energy Resources Corporation ("The Company")

03-AG-CUB-30: Refer to discovery response 02-AG-CUB-20. The response merely reiterates the description in testimony of the process for developing the LMP forecast but does not provide the assumptions. Provide the assumptions used in the referenced PLEXOS zonal model to develop the LMP forecast, including the fuel price forecasts, generation additions and retirements, transmission capacity and line additions, etc., Also specify whether the scenario used to develop the LMP forecast complies with the renewable and clean energy standards of Minnesota, Illinois and Michigan.

Objection: The Company objects to this request so far as it seeks information regarding compliance with the renewable and clean energy standards of Minnesota and Illinois as such data is neither relevant nor likely to lead to the discovery of information relevant to the implementation of Michigan's renewable and clean energy standards. Notwithstanding, and without waiving this objection, UMERC responses as follows:

Response: There are no line additions. For the rest of assumptions please see U-21813 03-AG-CUB-30 attachment. Market prices were developed using a market model dataset provided by PLEXOS vendor (Energy Exemplar) that is from 2022 and does not reflect current law for RPS standards. Further, the forecast does not reflect MI RE compliance via RECs.

Objection By: Counsel

Response By: Jaime Cano Lopez

Date: May 19, 2025

Upper Michigan Energy Resources Corporation
MPSC Case No. U-21813

Response to the AG-CUB
Second Set of Discovery Requests to
Upper Michigan Energy Resources Corporation ("The Company")

02-AG-CUB-21: Refer to the testimony of Jaime Cano Lopez, 7:10-8:9. Did you also develop a forecast of capacity (ZRC) prices that is logically consistent (modeled based on the same assumptions) with the LMP forecast?

Response: No, a forecast of capacity (ZRC) prices was not developed or used in the analysis. UMERC's resource planning methodology does not rely on the market for capacity but rather solves to replace a need with a physical resource. Also, PLEXOS does not have the capability to calculate or forecast prices for ZRC.

Response By: Jaime Cano Lopez

Date: 4/18/2025

Upper Michigan Energy Resources Corporation
MPSC Case No. U-21813

Response to the AG-CUB
Second Set of Discovery Requests to
Upper Michigan Energy Resources Corporation ("The Company")

02-AG-CUB-13: Refer to the testimony of Chelsey A. Biersach, 3:20-21. Assuming that the Special Contract customer is the Tilden Mine, what assumption did you make regarding when the Tilden Mine will permanently terminate mining operations and the path of sales to this customer in the years preceding the termination of mining operations?

Response:

We assumed that Tilden Mine would operate through 2045.

Response By: Chelsey Biersach

Date: 4/18/2025

TILDEN MINING COMPANY L.C.

UPPER MICHIGAN ENERGY RESOURCES CORPORATION

MPSC CASE NO. U-21813

The Attorney General's First Discovery Request Joined by CB to Tilden Mining Company L.C.

AG/CUB-TM-1.: Provide a copy of the most recent "life of mine" report for the Tilden Mine.

Objection:

Tilden objects to this request to the extent that it seeks information neither relevant to the subject matter of this proceeding nor reasonably calculated to lead to the discovery of admissible evidence. Subject to this objection, see response below.

Response:

See the Tilden TRS Report dated February 7, 2022 attached in the file labeled "AG CUB-TM-1 Attachment (SLR Cleveland-Cliffs Tilden S-K 1300 TRS FINAL Feb 7 2022).pdf."

Objection By: Counsel

Response By: Ryan Korpela

Dated: May 6, 2025

Technical Report Summary on the Tilden Property, Michigan, USA S-K 1300 Report

Cleveland-Cliffs Inc.

SLR Project No: 138.02467.00001

February 7, 2022

Effective Date: December 31, 2021

Technical Report Summary on the Tilden Property, Michigan, USA

SLR Project No: 138.02467.00001

Prepared by
SLR International Corporation
1658 Cole Blvd, Suite 100
Lakewood, CO 80401
for

Cleveland-Cliffs Inc.
200 Public Square, Suite 3300
Cleveland, OH 44114-2544
USA

Effective Date – December 31, 2021
Signature Date - February 7, 2022

FINAL

Distribution: 1 copy – Cleveland-Cliffs Inc.
1 copy – SLR International Corporation

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1.0 EXECUTIVE SUMMARY

1.1 Summary

SLR International Corporation (SLR) was retained by Cleveland-Cliffs Inc. (Cliffs) to prepare an independent Technical Report Summary (TRS) for the Tilden Property (Tilden or the Property), located in Northern Michigan, USA. The owner of the Property, Tilden Mining Company L.C. (Tilden L.C.), is a wholly owned subsidiary of Cliffs.

The purpose of this TRS is to disclose year-end (YE) 2021 Mineral Resource and Mineral Reserve estimates for Tilden.

Cliffs is listed on the New York Stock Exchange (NYSE) and currently reports Mineral Reserves of pelletized ore in SEC filings. This TRS conforms to the United States Securities and Exchange Commission's (SEC) Modernized Property Disclosure Requirements for Mining Registrants as described in Subpart 229.1300 of Regulation S-K, Disclosure by Registrants Engaged in Mining Operations (S-K 1300) and Item 601 (b)(96) Technical Report Summary. SLR visited the Property on October 24, 2019 and January 20 to 24, 2020.

The Property includes the Tilden Mine (the Mine) and processing facility (the Plant) located approximately five miles south of the city of Ishpeming, Michigan. The Property is also immediately west of Cliffs' Empire Property, which was indefinitely idled in 2016. The Mine is a large, operating, open-pit iron mine and is unique among Cliffs' US-owned operations because the primary ore mineral at Tilden is hematite, with other minerals being martite (oxidized pseudomorph of magnetite), goethite, and siderite (iron carbonate mineral), as opposed to strictly magnetite. The Property is also unique in the world in that the hematite-dominant ore is mined at a low grade, concentrated using a selective-flocculation desliming and flotation process, and pelletized.

The Property commenced operations in 1974 under a partnership of Algoma Steel, Stelco, J&L Steel, Wheeling-Pittsburgh Steel, Sharon Steel, and The Cleveland-Cliffs Iron Company (CCIC). The property has since been at least partially in the possession of a subsidiary of Cliffs. In 2001, Cliffs acquired Algoma Steel's 45% interest in Tilden L.C. In 2017, Cliffs became the sole owner of Tilden L.C.

The open-pit operation has a mining rate of approximately 21 million long tons (MLT) of ore per year and produces 7.7 MLT of iron ore pellets per year, which are mostly shipped by freighter via the Great Lakes to Cliffs' steel mill facilities in the Midwestern USA, with some quantities shipped by rail to external customers.

1.1.1 Conclusions

Tilden has successfully produced iron ore pellets for over 47 years. The update to the Mineral Resource and Mineral Reserve does not materially change any of the assumptions from previous operations. An economic analysis was performed using the estimates presented in this TRS and confirms that the outcome is a positive cash flow that supports the statement of Mineral Reserves for a 25-year mine life.

SLR offers the following conclusions by area.

1.1.1.1 Geology and Mineral Resources

- Indicated Mineral Resources at Tilden, exclusive of Mineral Reserves, are estimated to total 135.4 MLT at a grade of 34.7% crude Fe. Inferred Mineral Resources are estimated to total 350.4 MLT at a grade of 34.7% crude Fe.
- The 2019 quality assurance and quality control (QA/QC) program as designed and implemented by Cliffs has been helpful to understand the precision and accuracy of sample analysis at the Tilden laboratory, which is used to support the assay results within the database and confirm that the database is suitable for use in estimating Indicated and Inferred Mineral Resources.
- The Tilden database is adequate for the purposes of estimating Indicated and Inferred Mineral Resources. The lack of regular QA/QC sample submissions alongside samples used to support Mineral Resources is outside of industry-standard practice, and there are several database integrity issues that require attention.
- There is a moderate to good correlation of all variables between drill and blast hole twinned samples. Correlation of iron content values decreases for samples with high silica in concentrate values. There is a potential high bias of phosphorus in concentrate values in favor of blast holes. The known bias of weight recovery (wtrec) in favor of blast hole data is not observable in the paired dataset.
- The estimated block grades reflect the local blast hole or drill hole composite value, and the trends of the different variables are as intended.

1.1.1.2 Mining and Mineral Reserves

- The Property has been in production since 1974, and specifically under 100% Cliffs operating management since 2017. Cliffs conducts its own Mineral Reserve estimations.
- Total Proven and Probable Mineral Reserves are estimated at 520.0 MLT of crude ore at a grade of 34.7% crude Fe.
- Mineral Reserve estimation practices follow industry standards.
- The Mineral Reserve estimate indicates a sustainable project over a 25-year life of mine (LOM).
- The geotechnical design parameters used for pit design are reasonable and support previous operations. Slope depressurization may be required as part of the development of the final pit walls.
- The LOM production schedule is reasonable and incorporates large mining areas and open benches.
- An appropriate mining equipment fleet, maintenance facilities, and manpower are in place, with additions and replacements estimated, to meet the LOM production schedule requirements.
- Sufficient storage capacity for waste stockpiles and tailings has been identified to support the production of the Mineral Reserve.

1.1.1.3 Mineral Processing

- The Tilden deposit is complex and requires metallurgical testing to classify materials as ore and waste. A standard flotation testing procedure has been developed for material classification, resource modeling, and concentrator feed blending.

- The capacity of the Tilden concentrator and pellet plant is 7.7 MLT per year (MLT/y) of fluxed pellets (hemflux) from hematite-dominant crude ore sources.
- The ore is amenable to autogenous grinding (AG), and the concentrator consists of eleven lines of primary autogenous mills for coarse grinding and pebble mills for fine grinding, eliminating the requirement for steel grinding media.
- Pellets are indurated using a gas- and coal-fired grate drying and preheating furnace, followed by gas- and coal-fired rotary kilns for fusing and hardening, and rotary coolers for cooling. Heat must be supplied by fuel for low-magnetite concentrates, without the benefit of the exothermic heat of reaction from magnetite oxidation to hematite during heating.
- Crude iron ore head grades feeding the Plant during 2014 to 2020 ranged from 34.4% Fe to 35.5% Fe. Iron recovery to flotation concentrates ranged from 69.6% to 74.8%, with concentrate grades averaging 62.2% to 63.7% during this period. Approximately 20.5 MLT of crude ore is processed through the concentrator annually to produce 8.9 MLT of fluxed concentrate and 7.7 MLT of fluxed pellets (hemflux).

1.1.1.4 Infrastructure

- The Property is in a historically important, iron-producing region of Northern Michigan. All the infrastructure necessary to mine and process commercial quantities of iron ore and produce and ship pellets is in place, including the Mine, concentrator, and support facilities, line power supplies, natural gas sourced from an interstate pipeline system, local supply of coal, and diesel fuel supply from Green Bay, Wisconsin.
- The Gribben Tailings Basin (GTB) is located approximately five miles southeast of the Tilden concentrator plant and nine miles from Lake Superior. The GTB is comprised of two, ring dike-type impoundments: the Gribben North Tailings Basin (GNTB), which encompasses approximately 1,350 acres, and the Gribben South Tailings Basin (GSTB), which encompasses approximately 1,100 acres.

1.1.1.5 Environment

- Tilden indicated that it maintains the requisite state and federal permits and is in compliance with all permits. Various permitting applications have been submitted to authorities and are pending authorization. Environmental liabilities and permitting are further discussed in Section 17.0.

1.1.2 Recommendations

1.1.2.1 Geology and Mineral Resources

1. Complete a reconciliation study to support the inclusion of Measured Mineral Resources at Tilden.
2. Complete additional drilling to improve the understanding of the deposit at its periphery and at depth, with a focus on low drill density areas within the 2019 LOM plan, as well as in areas with increased variability, such as the high-silica zones in the east of the Main Pit. Integrate the downhole information from the Empire and Tilden mines into a single, valid database.
3. Develop a standard operating procedure for detailed logging of drill core that captures iron speciation, alteration, mineralogy, structure, and lithology. Retain initial geological observations in drill core separately from subsequent re-interpretations based on metallurgical results or results of neighboring drill holes.

4. Undertake a study where samples are consistently taken at shorter intervals, broken by geology, to examine how the variance of the assays is affected and how the material-type designation, based on a calculation of those variables, compares against the material-type designation of longer samples. Sample intrusive material (dilution) too small to be segregated when modeling or mining as part of iron formation unit samples.
5. Continue work to define fault orientations and related alteration in the east of the Main Pit to confirm the syn-bedding and cross-cutting directions of the modeled, high-silica alteration units and investigate alternative tools to capture drill hole information, including a magnetometer and hyperspectral and x-ray fluorescence handheld devices to allow empirical measurements of magnetism (where relevant), alteration, such as clay, and iron speciation.
6. Develop and implement a robust QA/QC program at Tilden for both exploration drill hole and blast hole samples and incorporate analytical attribute data, such as grind time, starch type, and dates into the assay database, to be able to analyze results in context of changing test protocols for performance and bias.
7. Address capacity issues at the Tilden laboratory to allow the sample analysis to be completed in a timely manner and to facilitate the inclusion of QA/QC samples.

1.1.2.2 Mining and Mineral Reserves

1. Assess groundwater conditions in the immediate vicinity of the final pit through a more focused groundwater model. The results of this assessment should be input into an update of the pit slope stability analysis on sections cut through the current final pit design.

1.1.2.3 Mineral Processing

1. Continue specialized metallurgical testing to support resource modeling and mine planning and blending for the concentrator.
2. Plant operational performance including concentrate and pellet production and pellet quality continues to be consistent year over year. It is important to maintain diligence in process-oriented metallurgical testing and in plant maintenance.

1.1.2.4 Infrastructure

1. Prioritize the completion of an Operations, Maintenance, and Surveillance (OMS) Manual for the tailings storage facility (TSF) with the Engineer of Record (EOR) in accordance with Mining Association of Canada (MAC) guidelines and other industry-recognized standard guidance for tailings facilities.
2. Document, prioritize, track, and close out in a timely manner the remediation, or resolution, of items of concern noted in TSF audits or inspection reports.
3. Assess the impacts of depositing tailings in the Empire facility, and prepare the necessary design and permitting documents.

1.2 Economic Analysis

1.2.1 Economic Criteria

An un-escalated technical-economic model was prepared on an after-tax, discounted cash flow (DCF) basis, the results of which are presented in this subsection. Key criteria used in the analysis are discussed in detail throughout this TRS. General assumptions used are summarized in Table 1-1, with all pellets reported per wet long ton (WLT) pellet.

Table 1-1: Technical-Economic Assumptions
Cleveland-Cliffs Inc. – Tilden Property

Description	Value
Start Date	December 31, 2021
Mine Life	25 years
Three-Year Trailing Average Revenue	$98/WLT Pellet
Operating Costs	$66.00/WLT Pellet
Sustaining Capital Costs (after five years)	$4/WLT Pellet
Discount Rate	10%
Discounting Basis	End of Period
Inflation	0.0%
Federal Tax Rate	20%
State Tax Rate	None – Sales made out of state

Table 1-2 presents a summary of the estimated mine production over the 25 year LOM.

Table 1-2: LOM Production Summary
Cleveland-Cliffs Inc. – Tilden Property

Description	Units	Value
Run of Mine (ROM) Ore	MLT	520.0
Total Material	MLT	1,116.9
Fe Grade	%	34.7
Average Annualized Mining Rate	MLT/y	44
Maximum Annualized Mining Rate	MLT/y	62

Table 1-3 presents a summary of the estimated plant production over the 25 year LOM.

Table 1-3: LOM Plant Production Summary
Cleveland-Cliffs Inc. – Tilden Property

Description	Units	Value
ROM Material Milled	MLT	520.0
Average Annualized Processing Rate	MLT/y	20.8
Process Recovery	%	37.0
Total Hemflux Pellet	MLT	192.4
Annual Hemflux Pellet Production	MLT/y	7.7

1.2.2 Cash Flow Analysis

The indicative economic analysis results, presented in Table 1-4, indicate an after-tax Net Present Value (NPV), using a 10% discount rate, of $1,325 million at an average blended wet pellet price of $98/WLT. SLR notes that Internal Rate of Return (IRR) is not applicable, as the Property has been in operation for a number of years. Capital identified in the economics is for sustaining operations and plant rebuilds as necessary.

The economic analysis was performed using the estimates presented in this TRS and confirms that the outcome is a positive cash flow that supports the statement of Mineral Reserves.

Table 1-4: LOM Indicative Economic Results
Cleveland-Cliffs Inc. – Tilden Property

Description	US$ Millions	US$/WLT Pellet
Three-Year Trailing Revenue ($/WLT Pellet)		98
Pellet Production (MWLT)	192.4	
Gross Revenue	**18,854**	
Mining	(2,944)	15.30
Processing	(8,233)	42.79
Site Administration	(547)	2.84
General / Other Costs	(975)	5.07
Total Operating Costs	**12,698**	**66.00**
Operating Income (excl. D&A)	**6,156**	**32.00**
Federal Income Tax	(1,231)	(6.40)
Depreciation Tax Savings	209	1.09
Accretion Tax Savings	13	0.07
Net Income after Taxes	**5,146**	**26.75**
Capital	(894)	(4.65)
Closure Costs	(57)	(0.30)

Description	US$ Millions	US$/WLT Pellet
Cash Flow	4,196	21.81
NPV 10%	1,322	

1.2.3 Sensitivity Analysis

The Tilden operation is nominally most sensitive to market prices (revenues) followed by operating cost. For each dollar movement in sales price or operating cost, respectively, the after-tax NPV changes by approximately $56 million.

1.3 Technical Summary

1.3.1 Property Description

The Property is located in Marquette County in Michigan's Upper Peninsula, USA, on the Marquette Iron Range, approximately five miles south of the city of Ishpeming, Michigan at latitude 46° 29' N and longitude 87° 40' W. The Property is also immediately adjacent to Cliffs' indefinitely idled Empire Mine and processing facility. The Mine and Plant have the capacity to produce approximately 7.7 MLT of iron ore pellets annually.

Land ownership and mineral leases are held by Tilden L.C. Cliffs, through its subsidiary CCIC, owns 100% of the surface and mining rights. In addition, Cliffs owns 100% of Tilden L.C. Tilden L.C. owns 21,100 acres of surface rights and 2,470 acres of mineral leases in Marquette County.

1.3.2 Accessibility, Climate, Local Resources, Infrastructure, and Physiography

The Property can be accessed from the west through the Tilden entrance gate near the community of National Mine, located two miles south of Ishpeming on County Road 476. Alternatively, the Property can be accessed from the east through the adjacent Empire Mine. The Empire entrance gate is located on M-35, nine miles south of US Highway 41 between Marquette and Negaunee.

Michigan's Upper Peninsula has a humid continental climate, typified by large seasonal temperature differences. Summers are generally warm and humid; winters are cold and long. Precipitation in the area averages approximately 31 in. of rain and 102 in. of snow in the winter. Snowfall in the region is greatly influenced by the "lake effect" due to proximity to the Great Lakes. Many towns in the Upper Peninsula have recorded annual snowfalls in excess of 350 in., and storms can quickly reach whiteout conditions and last for days.

The operation employs a total of 967 salaried and hourly employees (including LS&I railroad staff) as of Q4 2021. The majority of the employees live within a 50 mi radius of the Property. Marquette County has an estimated population of 66,000 people.

The Property is located in a historically important, iron-producing region in Northern Michigan. All infrastructure necessary to mine and process significant commercial quantities of iron ore exist at the current time. Infrastructure items include administration buildings and offices, maintenance shops, high-voltage electrical supplies, natural gas pipelines that connect into the North American distribution system, concentrating plant, pelletizing plant, water sources, paved roads and highways, railroads for transporting raw materials and final product, port facilities that connect into the Great Lakes and towns where employees live.

The Property is within the limits of a topographic region known as the Superior Uplands, a part of the Canadian Shield. The Property features elevations ranging from approximately 1300 to 1800 ft above sea level (fasl). Topography is hilly and is dominated by glacially influenced landforms. The Property is located in the Western Upper Peninsula Ecoregion (Section IX) and characterized by a landscape featuring moraines, drumlins, lake plains, outwash channels, outwash plains, and glacially eroded bedrock ridges (Albert, 1995). Vegetation in the vicinity of Tilden is described as northern hardwood forest dominated by sugar maple, eastern hemlock, basswood, yellow birch, and sparse white pine.

1.3.3 History

Iron deposits in Northern Michigan were originally described in the early 1840s by Douglass Houghton, Michigan's first State Geologist. Exploration and mining of high-grade iron oxides began in the mid to late 1840s, including Cliffs' predecessors Cleveland Iron Company and Iron Cliffs Company, which merged in 1891 to form the CCIC. Mining was mainly focused on underground, high-grade iron deposits through the end of the Second World War, when they were almost depleted.

Extensive development of beneficiation-grade, open pit mining began, and the first commercial agglomeration (pellet) plant in the Lake Superior region started operations in 1952. Agglomeration was a relatively new process that took the concentrate from lower-grade deposits and produced pelletized product containing approximately 65% Fe.

After years of favorable experimental testing for processing of fine-grained hematite ores, the Property commenced operations in 1974 under a partnership of Algoma Steel, Stelco, and CCIC. The Property has since been at least partially in the possession of a subsidiary of Cliffs. In 2001, Cliffs acquired Algoma Steel's 45% interest in Tilden L.C. In 2017, Cliffs became the sole owner of the Tilden L.C. entity.

1.3.4 Geological Setting, Mineralization, and Deposit

The Tilden deposit is a classic example of a banded iron formation (BIF) deposit of the Superior type and is located near the base of the Negaunee Iron Formation (Negaunee IF) of the Menominee Group, within the Marquette Range Super Group. The Negaunee IF and equivalents host most of the iron deposits in Michigan. It is Proterozoic in age and sits on the southern margin of the Marquette trough.

The deposit is modeled to extend from surface to up to 2,300 ft vertical depth below and is comprised of alternating layers of iron oxides and iron-poor chert in a northwest-plunging anticline; the axial surface dips steeply north, and the hinge line plunges 30° west-northwest down the center of the Main Pit. It is fault-bounded to the south by Archean gneiss terrane; the fault contact dips steeply north and aligns with the south wall of the Main Pit at Tilden. To the east of the Tilden deposit lies the Empire deposit (a stratigraphically deeper extension of the Tilden deposit) and its historical pit. Tilden is impacted by a higher frequency and volume of intrusions and sills northward, but is open to the west, at depth, and in some areas to the north.

The iron formation facies at Tilden were locally modified by clay-silica alteration associated with faulting and intrusions, as well as by varying degrees of oxidation throughout. Some BIF units in the south were disrupted by turbidite flows, typified by lensoidal inclusions of clastic material.

The Tilden Mine is unique among Cliffs-owned operations because the primary ore mineral at Tilden is hematite, with other minerals being martite (oxidized pseudomorph of magnetite), goethite, and siderite (iron carbonate mineral), as opposed to strictly magnetite. Tilden is also unique in the world in that the hematite-dominant ore is mined at a low grade, concentrated using a selective-flocculation desliming and flotation process, and pelletized. Although some now-expended areas at Tilden did mine and magnetically recover magnetite-dominant ore prior to 2009, remaining Mineral Resources at Tilden are hematite-dominant. The adjacent (now indefinitely idled) Empire deposit hosted primarily magnetite ore, and unoxidized magnetite is variably present at Tilden.

1.3.5 Exploration

Cliffs and Tilden Mine do not maintain detailed records or results of non-drilling prospecting methods used during initial exploration activities, such as geophysical surveys, mapping, trenching, and test pits, conducted prior to Cliffs' development of the operation. No exploration work or investigations other than drilling and limited pit mapping have been conducted by Cliffs at Tilden.

The Tilden drill hole database consists of 382,605 ft of drill hole information in 578 drill holes, completed from the 1950s to 2020. Annual exploration drilling programs at Tilden have completed zero to 42 drill holes. Of the last 10 years, nine have included drill hole programs and have averaged 10 drill holes per year. Diamond, hammer, and churn drilling have all been employed at Tilden, with diamond drilling having been exclusively used since 2008.

1.3.6 Mineral Resource Estimates

A geological model was constructed by SLR considering regional mapping, drill hole logging, and blast hole analytical results, in addition to grade control modeling and flotation ore coding. Data verification included standard database verification, a review of QA/QC protocols and results, and a comparison of blast hole and exploration drill hole results.

The Tilden Mineral Resource estimate was completed by SLR using a conventional block modeling approach, defining estimation domains from wireframes built in Seequent's Leapfrog Geo (Leapfrog Geo) software and using a regular block model built and interpolated in Seequent's Leapfrog Edge (Leapfrog Edge) software. The general workflow included the creation of a geological model from mapping, drill and blast hole logging, and sampling, which were used to define discrete domains of non-iron formation and iron formation sub-units. Iron formation drill hole samples were composited, and the estimation of six variables (crude iron and magnetic iron, wtrec, and iron, phosphorus, and silica in concentrate) was completed using ordinary kriging (OK) over five passes in iron formation units, the first of which incorporated blast hole samples. Distance restriction of outlier grades was applied to selected domains and variables. Blocks were classified as Indicated or Inferred using distance-based and qualitative criterion. Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves dated May 10, 2014 (CIM (2014) definitions) were used for Mineral Resource classification. Models were depleted to December 31, 2021. Estimates were validated using standard industry techniques and were peer reviewed prior to finalization.

A detailed breakdown of the Mineral Resources exclusive of Mineral Reserves is presented in Table 1-5. Mineral Resources were defined and constrained within an open-pit shell, prepared by Cliffs and based on a US$90/LT pellet price, and meet the following cut-off grade criteria, based on existing pellet specifications and price contracts:

- ≥ 25% wtrec
- ≥ 25% crude iron content (crudefe)
- ≤ 0.07% phosphorus in concentrate (conphos)
- ≤ 6% to 8.5% silica in concentrate (consio2) (domain dependent)

The pellet cost basis for the Lerchs-Grossmann (LG) optimization is based on a dry 61.5% Fe fluxed pellet.

Table 1-5: Summary of Tilden Mineral Resources - December 31, 2021
Cleveland-Cliffs Inc. – Tilden Property

Category	Long Tons (MLT)	Crude Fe (%)	Process Recovery (%)	Wet Pellets (MLT)
Measured	-	-	-	-
Indicated	135.4	35.5	35.9	48.6
Total Measured + Indicated	**135.4**	**35.5**	**35.9**	**48.6**
Inferred	350.4	34.7	36.4	127.4

Notes:

1. Tonnage is reported in long tons equivalent to 2,240 lb.
2. Tonnage is reported exclusive of Mineral Reserves and has been rounded to the nearest 100,000.
3. Mineral Resources are estimated at cut-off grades of 25% crudefe, 25% wtrec, 0.07% conphos, and 6% consio2 to 8.5% consio2, domain dependent.
4. Mineral Resources are estimated using a pellet value of US$90/LT.
5. Pellets are reported as fluxed and wet, containing 61.5% Fe; shipped pellets contain 1.5% moisture.
6. Tonnage estimate based on estimated depletion from a surveyed topography on December 31, 2021.
7. Resources are crude ore tons as delivered to the primary crusher; pellets are as loaded onto rail cars.
8. Classification of Mineral Resources is in accordance with the S-K 1300 classification system.
9. Bulk density is assigned based on a regression equation related to crude Fe.
10. Mineral Resources are 100% attributable to Cliffs.
11. Mineral Resources are constrained within an optimized pit shell.
12. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
13. Numbers may not add due to rounding.

The Tilden operation is currently active and in full production. The SLR QP is of the opinion that with consideration of the recommendations summarized in this section, any issues relating to all relevant technical and economic factors likely to influence the prospect of economic extraction can be resolved with further work.

1.3.7 Mineral Reserve Estimate

Mineral Reserves in this TRS are derived from the current Mineral Resources. The Mineral Reserves are reported as crude ore and are based on open pit mining. Crude ore is the unconcentrated ore as it leaves the Mine at its natural *in situ* moisture content. The Proven and Probable Mineral Reserves for Tilden are estimated as of December 31, 2021 and summarized in Table 1-6.

Table 1-6: Summary of Tilden Mineral Reserves - December 31, 2021
Cleveland-Cliffs Inc. – Tilden Property

Category	Crude Ore Mineral Reserves (MLT)	Crude Ore Fe (%)	Process Recovery (%)	Wet Pellets (MLT)
Proven	3.6	35.3	36.1	1.3
Probable	516.4	34.7	37.0	191.1
Proven & Probable	520.0	34.7	37.0	192.4

Notes:

1. Tonnage is reported in long tons equivalent to 2,240 lb and has been rounded to the nearest 100,000.
2. Mineral Reserves are reported at a $90/LT wet hemflux pellet price freight-on-board (FOB) Lake Superior, based on the three-year trailing average of the realized product revenue rate.
3. Mineral Reserves are estimated at a crude ore cut-off grade of 25.0% Fe along with additional metallurgical constraints.
4. Mineral Reserves include mining dilution built into the Mineral Resource model and mining extraction losses by geometallurgical domain, which range from 4% to 30%.
5. The Mineral Reserve mining stripping ratio (waste units to crude ore units) is at 1.2.
6. Proven Mineral Reserves are crude ore that has been mined and stockpiled for processing during the LOM.
7. Process recovery is reported as the percent mass recovery to produce a wet hemflux pellet containing 61.5% Fe; shipped hemflux pellets average approximately 1.5% moisture.
8. Tonnage estimate is based on the end of year, December 31, 2021 topographic survey.
9. Mineral Reserve tons are as delivered to the primary crusher; wet hemflux pellets are as loaded onto lake freighters at Marquette, Michigan.
10. Classification of Mineral Reserves is in accordance with the S-K 1300 classification system.
11. Mineral Reserves are 100% attributable to Cliffs.
12. Numbers may not add due to rounding.

The pellet price used to perform the evaluation of the Mineral Reserves in the current mining model is US$90/LT wet hemflux pellet. This price is consistent with the Mineral Reserve price used at Cliffs' Northshore and UTAC operations and is supported by the current three-year trailing average of the realized product revenue rate of US$98/LT wet hemflux pellet. Proven Mineral Reserves consist exclusively of crude ore that has been mined and stockpiled for future processing in the LOM plan. The costs used in this study represent all mining, processing, transportation, and administrative costs including the loading of pellets into lake freighters at Marquette, Michigan.

SLR is not aware of any risk factors associated with, or changes to, any aspects of the modifying factors such as mining, metallurgical, infrastructure, permitting, or other relevant factors that could materially affect the Mineral Reserve estimate.

1.3.8 Mining Methods

The Tilden deposit is mined using conventional surface mining methods. The surface operations include:

- Overburden (glacial till) removal
- Drilling and blasting (excluding overburden)
- Loading and haulage
- Crushing and rail loading

The Mineral Reserve is based on the ongoing annual crude ore production of 20 MLT to 22 MLT producing approximately 7.7 MLT of wet hemflux pellets for domestic consumption.

Mining and processing operations are scheduled 24 hours per day, and the mine production is scheduled to directly feed the processing operations.

The current LOM plan has mining scheduled for 25 years and mines the known Mineral Reserve. The average stripping ratio is approximately 1.2 waste units to 1 crude ore unit (1.2 stripping ratio).

The final Tilden pit is a single pit approximately 2.5 mi along strike, up to 0.9 mi wide, and up to 1,980 ft deep.

The Mine's operation has a strict crude ore blending requirement to ensure the Plant receives a consistent crude ore feed. The most important characteristics of the crude ore are the crude ore iron grade and the predicted concentrate mass recovery and concentrate iron, silica, and phosphorus content. Operationally, blending is done on a shift-by-shift basis. Generally, three to four crude ore loading points are mined at one time with dispatch operators issuing real-time adjustments to meet specified crude ore blends for the Plant.

Crude ore is hauled to the crushing facility and either direct tipped to the primary crusher or stockpiled. Haul trucks are alternated to blend delivery from the multiple crude ore loading points. The crude ore stockpiles are used as an additional source for blending and production efficiency. Crushed crude ore is conveyed to a covered storage building for stockpiling prior to being fed to the concentrator. Waste rock and overburden are hauled to one of the many waste stockpiles peripheral to the pit or to the in-pit backfill.

The major pieces of pit equipment include electric drills, electric rope shovels, haul trucks, front-end loaders (FELs), bulldozers, and graders. Extensive maintenance facilities are available at the mine site to service the mine equipment.

1.3.9 Processing and Recovery Methods

The mix of magnetite and primarily hematite ores at Tilden is unique to US iron ore mines. Typical flowsheets developed for beneficiation-grade magnetite ores of the Lake Superior region were not applicable, as most of the iron oxide occurs as non-magnetic hematite, which requires fine grinding for liberation. Metallurgical research conducted in the 1960s focused on creating a process that included selective flocculation and desliming followed by cationic silica (SiO_2) flotation.

A standardized bench-scale flotation test was designed to simulate the Tilden hematite grinding and concentrating circuit. Results from the standardized bench flotation test are used to characterize rock samples as either crude iron ore or waste rock. The data are used to build a resource model and mine plan to supply a consistent blend of ore to the concentrator. Deleterious materials impacting economic extraction are observed in the flotation bench test, which may include clay minerals, quartz inclusions within iron oxide bands, fine goethite, and carbonates.

The capacity of the Tilden concentrator and pellet plant is 7.7 MLT/y of fluxed pellets from both hematite and magnetite crude ore sources. The Plant includes primary crushing, autogenous primary and secondary grinding, selective flocculation and desliming, flotation, filtration, drying, balling (agglomeration), and induration. The concentrator is designed to campaign either hematite ores or magnetite ores but not in combination.

The processing of magnetite-dominant ores at the Tilden concentrator ceased in 2009. Magnetite ore from the Tilden was delivered and processed at the Empire Mine from 2010 through 2016 when the Empire was indefinitely idled. Remaining Mineral Resources and Mineral Reserves at Tilden are processed in hematite-based flotation circuits.

Mined ore is directly dumped from haul trucks into a gyratory crusher to produce a nominal nine-inch crushed product, which is conveyed to the ore storage building ahead of the grinding circuit. Primary grinding is accomplished with eleven primary AG mills, each driven by two, 2,860 hp synchronous motors. Each primary AG mill discharges to a triple-deck screen, producing coarse pebble for pebble mill grinding media, an intermediate product that is recycled to the AG mill, and a 100% passing 2 mm product that feeds the pebble mills. The pebble mills are operated in closed circuit with cyclones to produce a final grind of 80% to 85% passing 25 microns. Caustic soda and slaked lime are added to the water circuit to control pH prior to desliming and flotation.

Starch and a dispersant are added to the slurry to selectively flocculate and depress the iron oxides while dispersing the fine silica gangue in advance of the deslime thickeners. The deslime thickener overflow, containing the waste products, is fed to the tailings thickeners, and the deslime thickener underflow is conditioned with additional starch and advanced to the flotation circuit.

The reverse flotation circuit is divided into twelve lines, which float silica from the iron minerals with an amine collector. The rougher flotation concentrate represents final upgraded iron concentrate and is advanced to the concentrate thickener. The rougher tail is scavenged in four flotation stages to remove entrained iron values. The scavenger flotation concentrates are recycled to the rougher feed, and scavenger tails are pumped to the tailings thickeners.

The iron concentrate is thickened to approximately 65% to 70% solids in the concentrate thickeners, neutralized to a pH of 7.0 using carbon dioxide, and then filtered in a series of vacuum disc filters to approximately 11.5% weight by weight (w/w) moisture content. Filtered concentrates are either sent directly to the pelletizing plant, a thermal drying circuit, or to a concentrate storage stockpile.

Fluxstone consisting of dolomite and calcite is delivered to site via truck and stored in stockpiles. The material is fed from a stockpile via apron feeders and processed in two, 15.5-ft-diameter x 30-ft-long ball mills. The fluxstone slurry is added to the iron concentrate prior to filtering to ensure homogenous mixing.

The unit processes of the pelletizing plant include concentrate drying, agglomeration or balling, sizing, and induration in a grate kiln and cooler to produce final pellets, and pellet storage and loadout.

Concentrate is conveyed from filtration or the concentrate stockpile to the balling section of the pelletizing plant. A portion of the concentrate is dried in a rotary dryer and then recombined with the concentrate feed to achieve 9.5% w/w moisture for balling. Green balls are produced in fourteen rotating balling drums operating in parallel. Bentonite clay binder is added to the balling drum feed, and green balls are discharged onto a vibrating seed screen with a two-feet-long grizzly extension for oversize removal. The screen undersize is returned to the balling drum, and the grizzly oversize is returned to the concentrate bin or diverted to outdoor storage. The seed screen product is conveyed by a reciprocating conveyor, which distributes the green balls over a grate feed belt.

The green balls enter a moving grate, which passes through 3.5 bays of updraft drying, 7.5 bays of downdraft drying, and eight bays of downdraft pre-heating and are then discharged into one of two rotary kilns. Heat for the kilns is produced with a combination of pulverized coal and/or natural gas. Product from the kiln is discharged into two rotary coolers, sufficiently cooling the pellets to be transported by conveyor.

Cooled pellets are conveyed directly to either a railroad load-out bin or to an outdoor stockpile with nominal capacity of 2 MLT. Pellets are loaded into rail cars and transported to the dock facility in Marquette, Michigan or shipped directly to customers by rail. Pellet stockpiles are screened to reduce fines using loaders feeding a portable screening plant. Pellet chips and fines from this process are sold as a secondary product.

1.3.10 Infrastructure

The Property is in a historically important, iron-producing region in the Upper Peninsula of Northern Michigan. All the infrastructure necessary to mine and process commercial quantities of iron ore is in place.

Infrastructure items include:

- The Mine, concentrator, and concentrate pelletizing facilities near Marquette, Michigan.
- The main processing facility is contained in a conventional, multi-level, insulated steel building. Mining offices and mobile equipment maintenance shops are separated from the main facility and are located on the Empire Mine property.
- Power is supplied by Upper Michigan Energy Resources (UMERC) that supplies power through the existing power grid, which is interconnected to neighboring states and is received at its substation on transmission lines owned by American Transmission Company.
- Backup diesel-powered generators are installed at several locations to operate critical equipment should main power be lost.
- Natural gas is primarily used for firing the rotary kilns at the pelletizing plant and water boilers in the concentrator. Natural gas is purchased from Encore Energy and supplied to the site via a gas pipeline owned and operated by Northern Natural Gas (NNG), which has an extensive interstate pipeline system.
- The Tilden pellet plant kilns are a dual fuel system with the ability to operate on pulverized coal, natural gas, or a combination of both.
- U.S. Oil supplies the Tilden Mine from its terminal in Green Bay, Wisconsin. The Mine has one 20,000 gal, above-ground diesel fuel tank and one 10,000 gal, underground gasoline storage tank.
- Fresh make-up water for the process is supplied from the Greenwood Reservoir, which is located approximately seven miles southwest of Ishpeming and is on the Middle Branch Escanaba River.
- Process water is primarily supplied by tailings reclaim.
- Potable water is supplied by two deep well pumps located on site.
- Paved roads and highways.
- Pellets produced at the site are shipped in rail cars by the Lake Superior & Ishpeming Railroad (LS&I), a wholly owned subsidiary of Cliffs, 22 mi to the LS&I dock in Marquette, Michigan.
- Tailings are stored in the GTB located approximately five miles southeast of the Tilden concentrator plant and nine miles from Lake Superior. The GTB is comprised of two ring dike-type impoundments: the GNTB, which encompasses approximately 1,350 acres, and the GSTB, which encompasses approximately 1,100 acres.
- Dock facilities in Marquette include 50,000 LT of pellet storage and ship loaders for loading 60,000 LT-capacity lakers that transport pellets to steel mills on the Great Lakes.
- Pellets can also be shipped using the Canadian National (CN) railroad. The CN owns and operates its own rail fleet. Currently, one customer receives direct rail deliveries by CN to Sault Ste. Marie, Ontario, Canada, a distance of 120 mi from the Property.
- Accommodations for employees.
- Local and State infrastructure also includes hospitals, schools, airports, equipment suppliers, fuel suppliers, commercial laboratories, and communication systems.

1.3.11 Market Studies

Cliffs is the largest producer of iron ore pellets in North America. It is also the largest flat-rolled steel producer in North America. In 2020, Cliffs acquired two major steelmakers, ArcelorMittal USA (AMUSA), and AK Steel (AK), vertically integrating its legacy iron ore business with steel production and emphasis on the automotive end market.

Cliffs owns or co-owns five active iron ore mines in Minnesota and Michigan. Through the two acquisitions and transformation into a vertically integrated business, the iron ore mines are primarily now a critical source of feedstock for Cliffs' downstream primary steelmaking operations. Based on its ownership in these mines, Cliffs' share of annual rated iron ore production capacity is approximately 28.0 million LT, enough to supply its steelmaking operations and not have to rely on outside supply.

The importance of the steel industry in North America and specifically the USA is apparent by the actions of the US federal government in implementing and keeping import restrictions in place. It is important for middle-class job generation and the efficiency of the national supply chain. It is also an industry that supports the country's national security by providing products used for US military forces and national infrastructure. Cliffs expects the US government to continue recognizing the importance of this industry and does not see major declines in the production of steel in North America.

Tilden L.C. ships flux pellets annually to Cliffs' steelmaking facilities in the Midwestern USA, with some quantities shipped by rail to external customers.

For cash flow projections, Cliffs uses a blended pellet revenue rate of $98/WLT Free on Board (FOB) Mine based on a three-year trailing average for 2017 to 2019. Based on macroeconomic trends, SLR is of the opinion that Cliffs' pellet prices will remain at least at the current three-year trailing average of $98/WLT or above for the next five years.

1.3.12 Environmental Studies, Permitting and Plans, Negotiations, or Agreements with Local Individuals or Groups

Tilden L.C. indicated that it presently has the requisite operating permits for the Mine and Plant and estimates that the mine life will be 25 years. Environmental monitoring during operations includes water and air quality monitoring. Closure plans and other post-mining plans are required to be prepared within two years of anticipated closure. Cliffs indicated that it conducts an in-depth review every three years to ensure that the Asset Retirement Obligation (ARO) legal liabilities are accurately estimated based on current laws, regulations, facility conditions, and cost to perform services. These cost estimates are conducted in accordance with the Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) 410. SLR is not aware of any formal commitments to local procurement and hiring; however, Cliffs indicated that it has a long-standing relationship with local vendors.

1.3.13 Capital and Operating Cost Estimates

Productive and sustaining capital expenditure estimates for the remaining life of the operation are presented in Table 1-7. The LOM capital cost forecast is shown for the next five-year period from 2022 to 2026, which totals $314.2 million and an additional $579.9 million from 2027 to the last year of mining in 2046. Total capital expenditures are estimated at $894.2 million.

Table 1-7: LOM Capital Costs
Cleveland-Cliffs Inc. – Tilden Property

Type	Values	Total	2022	2023	2024	2025	2026	2027-2046
Total	$ millions	894.2	63.5	82.9	45.7	43.8	78.3	579.9

Operating costs are based on a full run rate of flux pellets consistent with what is expected for the life of the mine. A LOM average operating cost of $66.00/WLT pellet is estimated over the remaining 25 years of the mine life and is presented by area in Table 1-8.

Table 1-8: LOM Operating Costs
Cleveland-Cliffs Inc. – Tilden Property

Description	LOM ($/WLT Pellet)
Mining	15.30
Processing	42.79
Site Administration	2.84
General/Other	5.07
Operating Cash Cost	**66.00**

Cliffs' capital and operating costs estimates are derived from annual budgets and historical actuals over the long life of the current operation. According to the American Association of Cost Engineers (AACE) International, these estimates would be classified as Class 1 with an accuracy range of -3% to -10% to +3% to +15%.

2.0 INTRODUCTION

SLR International Corporation (SLR) was retained by Cleveland-Cliffs Inc. (Cliffs) to prepare an independent Technical Report Summary (TRS) for the Tilden Property (Tilden or the Property), located in Northern Michigan, USA. The owner of the Property, Tilden Mining Company L.C. (Tilden L.C.), is a wholly owned subsidiary of Cliffs.

The purpose of this TRS is to disclose year end (YE) 2021 Mineral Resource and Mineral Reserve estimates for Tilden.

Cliffs is listed on the New York Stock Exchange (NYSE) and currently reports Mineral Reserves of pelletized ore in SEC filings. This TRS conforms to the United States Securities and Exchange Commission's (SEC) Modernized Property Disclosure Requirements for Mining Registrants as described in Subpart 229.1300 of Regulation S-K, Disclosure by Registrants Engaged in Mining Operations (S-K 1300) and Item 601 (b)(96) Technical Report Summary.

The Property includes the Tilden Mine (the Mine) and processing facility (the Plant) located approximately five miles south of the city of Ishpeming, Michigan. The Property is also immediately west of Cliffs' Empire Property, which was indefinitely idled in 2016. The Mine is a large, operating open-pit iron mine and is unique among Cliffs' US-owned operations because the primary ore mineral at Tilden is hematite, with other minerals being martite (oxidized pseudomorph of magnetite), goethite, and siderite (iron carbonate mineral), as opposed to strictly magnetite. The Property is also unique in the world in that the hematite-dominant ore is mined at a low grade, concentrated using a selective-flocculation desliming and flotation process, and pelletized.

The Property commenced operations in 1974 under a partnership of Algoma Steel, Stelco, J&L Steel, Wheeling-Pittsburgh Steel, Sharon Steel, and The Cleveland-Cliffs Iron Company (CCIC). The property has since been at least partially in the possession of a subsidiary of Cliffs. In 2001, Cliffs acquired Algoma Steel's 45% interest in Tilden L.C. In 2017, Cliffs became the sole owner of Tilden L.C.

The open-pit operation has a mining rate of approximately 21 million long tons (MLT) of ore per year and produces 7.7 MLT of iron ore pellets per year, which are mostly shipped by freighter via the Great Lakes to Cliffs' steel mill facilities in the Midwestern USA, with some quantities shipped by rail to external customers.

2.1 Site Visits

SLR Qualified Persons (QPs) visited the Property on October 24, 2019 and January 20 to 24, 2020. During the 2019 site visit, the SLR team all toured the tailings basin, plant laboratory, concentrator and pelletizing facilities plus rail pellet loadout site, and the mine offices and operational areas.

During the 2020 site visit, the SLR geologist visited the mine offices and worked with the mine geologists to update the geological and Mineral Resource block model.

2.2 Sources of Information

Technical documents and reports on the Property were obtained from Cliffs' personnel. During the preparation of this TRS, discussions were held with personnel from Cliffs:

- Kurt Gitzlaff, Director - Mine Engineering, Cliffs Technical Group (CTG)
- Michael Orobona, Principal Geologist, CTG

- Michael Koop, Lead Mine Engineer, CTG
- Scott Gischia, Director - Environmental Compliance
- Dean Korri, Director - Basin & Civil Engineering
- Sandy Karnowski, District Manager - Public Affairs
- John Elton, Senior Director - Corporate Accounting & Assistant Controller
- Tushar Mondhe, Senior Manager – Operations and Capital Finance
- Al Strandlie, Mine Geologist
- Tyson Murphy, Section Manager - Mine Engineering
- Todd Davis, Area Manager – Plant
- Kris Scherer, Tailings Engineer
- Brent Ketzenberger, Environmental Manager

This TRS was prepared by SLR QPs. The documentation reviewed, and other sources of information, are listed at the end of this TRS in Section 24.0, References.

2.3 List of Abbreviations

The U.S. System for weights and units has been used throughout this report. Tons are reported in long tons (LT) of 2,240 lb unless otherwise noted. All currency in this report is US dollars (US$ or $) unless otherwise noted.

Abbreviations and acronyms used in this TRS are listed below.

Unit Abbreviation	Definition	Unit Abbreviation	Definition
a	annum	LT/h	long tons per hour
A	ampere	µL	microliter
acfm	actual cubic feet per minute	M	mega (million); molar
bbl	barrels	Ma	one million years
Btu	British thermal units	MBtu	thousand British thermal units
d	day	MCF	million cubic feet
°F	degree Fahrenheit	MCF/h	million cubic feet per hour
fasl	feet above sea level	mi	mile
ft	foot	min	minute
ft^2	square foot	MLT/y	million long tons per year
ft^3	cubic foot	MPa	megapascal
ft/s	foot per second	mph	miles per hour
g	gram	MVA	megavolt-amperes
G	giga (billion)	MW	megawatt
Ga	one billion years	MWh	megawatt-hour
gal	gallon	MWLT	million wet long tons
gal/d	gallon per day	oz	Troy ounce (31.1035g)
g/L	gram per liter	oz/ton	ounce per short ton
g/y	gallon per year	ppb	part per billion
gpm	gallons per minute	ppm	part per million
hp	horsepower	psia	pound per square inch absolute
h	hour	psig	pound per square inch gauge
Hz	hertz	rpm	revolutions per minute
in.	inch	RL	relative elevation
in^2	square inch	s	second
J	joule	ton	short ton
kLT	thousand long tons	stpa	short ton per year
k	kilo (thousand)	stpd	short ton per day
kg/m^3	Kilogram per cubic meter	t	metric tonne
kVA	kilovolt-amperes	US$	United States dollar
kW	kilowatt	V	volt
kWh	kilowatt-hour	W	watt
kWLT	thousand wet long tons	wt%	weight percent
L	liter	WLT	wet long ton
lb	pound	w/w	weight by weight
LT	long or gross ton equivalent to 2,240 pounds	y	year
LT/d	long tons per day	yd^3	cubic yard

Acronym	Definition
AACE	American Association of Cost Engineers
AK	AK Steel
AMUSA	ArcelorMittal USA
ANSI	American National Standards Institute
ARO	asset retirement obligation
ASC	Accounting Standards Codification
ASQ	American Society for Quality
ASTM	American Society for Testing and Materials
BF	blast furnace
BFA	bench face angle
BH	bench height
BIF	banded iron formation
BLS	United States Bureau of Labor Statistics
CCD	counter-current decantation
CCIC	Cleveland-Cliffs Iron Company
CCP	Conceptual Closure Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Cost and Freight
CN	Canadian National Railroad
COA	certificates of analysis
CRIRSCO	Committee for Mineral Reserves International Reporting Standards
D&A	depreciation and amortization
DDH	diamond drill hole
DMO	Department Maintenance Office
DOSS	Dioctyl Sulfosuccinate
DRI	direct reduced iron
DSO	direct-shipping iron ore
EAF	electric arc furnace
EAP	Emergency Action Plan
EGLE	Michigan Department of Environment, Great Lakes and Energy
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EMS	environmental management system
EPA	United States Environmental Protection Agency
ESOP	Environmental Standard Operating Procedures
EOR	Engineer of Record
FASB	Financial Accounting Standards Board
FDCP	Fugitive Dust Control Plan
FOB	Free on Board
GHG	greenhouse gas

Acronym	Definition
GIM	Geoscientific Information Management
GNTB	Gribben North Tailings Basin
GPS	global positioning system
GSI	Geological Strength Index
GSSI	General Security Services Corporation
GSTB	Gribben South Tailings Basin
GTB	Gribben Tailings Basin
HBI	hot briquetted iron
HRC	hot-rolled coil
ID^2	Inverse distance squared
ID^3	Inverse distance cubed
IF	iron formation
IRA	Inter-ramp angle
IRR	internal rate of return
ISO	International Standards Organization
KEV	key economic variables
LG	Lerchs-Grossmann
LiDAR	light imaging, detection, and ranging
LMF	Laurentian Mixed Forest
LOM	life of mine
LS&I	Lake Superior & Ishpeming Railroad
MAC	Mining Association of Canada
MLT	million long tons
MR	moving range
MRCC	Midwestern Regional Climate Center
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGO	non-governmental organization
NN	nearest neighbor
NNG	Northern Natural Gas
NOAA	National Oceanic and Atmospheric Administration
NOLA	Nuclear On-Line Analyzer
NPDES	National Pollution Discharge Elimination System
NPV	net present value
OMS	Operations, Maintenance, and Surveillance
OSA	overall slope angle
QA/QC	quality assurance/quality control
QP	Qualified Person
RC	rotary circulation drilling
RCRA	Resource Conservation and Recovery Act

Acronym	Definition
ROM	run of mine
RQD	rock quality designation
RTR	risk and technology review
SDS	State Disposal System Permit
SEC	United States Securities and Exchange Commission
SG	specific gravity
SMU	selective mining unit
SQL	Structured Query Language
SPC	Statistical Process Control
SPT	standard penetration testing
TMDL	total maximum daily load
TRS	Technical Report Summary
TSF	tailings storage facility
TSP	total suspended particulates
UCS	uniaxial compressive strength
UMERC	Upper Michigan Energy Resources
USGAAP	United States General Accepted Accounting Principles
USGS	United States Geological Survey
USNRC	United States Nuclear Regulatory Commission
WTF	water treatment facility
XRF	x-ray fluorescence

3.0 PROPERTY DESCRIPTION

3.1 Property Location

The Property is located in Marquette County, in Michigan's Upper Peninsula, USA, on the Marquette Iron Range, approximately five miles south of the city of Ishpeming at latitude 46° 27' N and longitude 87° 39' W. The Property is also immediately adjacent to Cliffs' indefinitely idled Empire Mine and processing facility. Figure 3-1 shows the location of the Property.

3.2 Land Tenure

3.2.1 Mineral Titles

Land ownership and mineral leases are held by Tilden L.C., which is a wholly owned subsidiary of Cliffs. Initial acquisitions from outside parties were accomplished by CCIC over 150 years ago and moved to the various partnerships before Tilden L.C. was established.

The Property consists of approximately 2,470 acres of mineral leases from three parties. Tilden leases approximately 2,210 acres directly from its affiliate, CCIC. Tilden subleases approximately 140 acres from Empire Iron Mining Partnership, another affiliate which leases the Property from CCIC. Tilden subleases the remaining, approximately 120 acres from CCIC, which leases the Property from the Chester Company (2/3 undivided interest) and CCIC (1/3 undivided interest), as illustrated in Figure 3-2. Mineral leases include surface mining rights. Land tenure is summarized in Table 3-1.

Both Tilden subleases expire in 2061; the CCIC lease is through the life of mine (LOM). In order to maintain the mineral leases until their expiration, Tilden L.C. must continue to make minimum prepaid royalty payments each quarter and pay property taxes. When mining occurs, a royalty is due per long ton of crude ore mined or long ton of pellets produced from the crude ore mined, and payable to the respective lessors quarterly. Royalty rates per long ton fluctuate based on industry and economic indexes. Minimum prepaid royalty payments may be credited against royalties due when mining occurs. Specific terms and provisions of the mineral leases are confidential.

Figure 3-1: Location Map

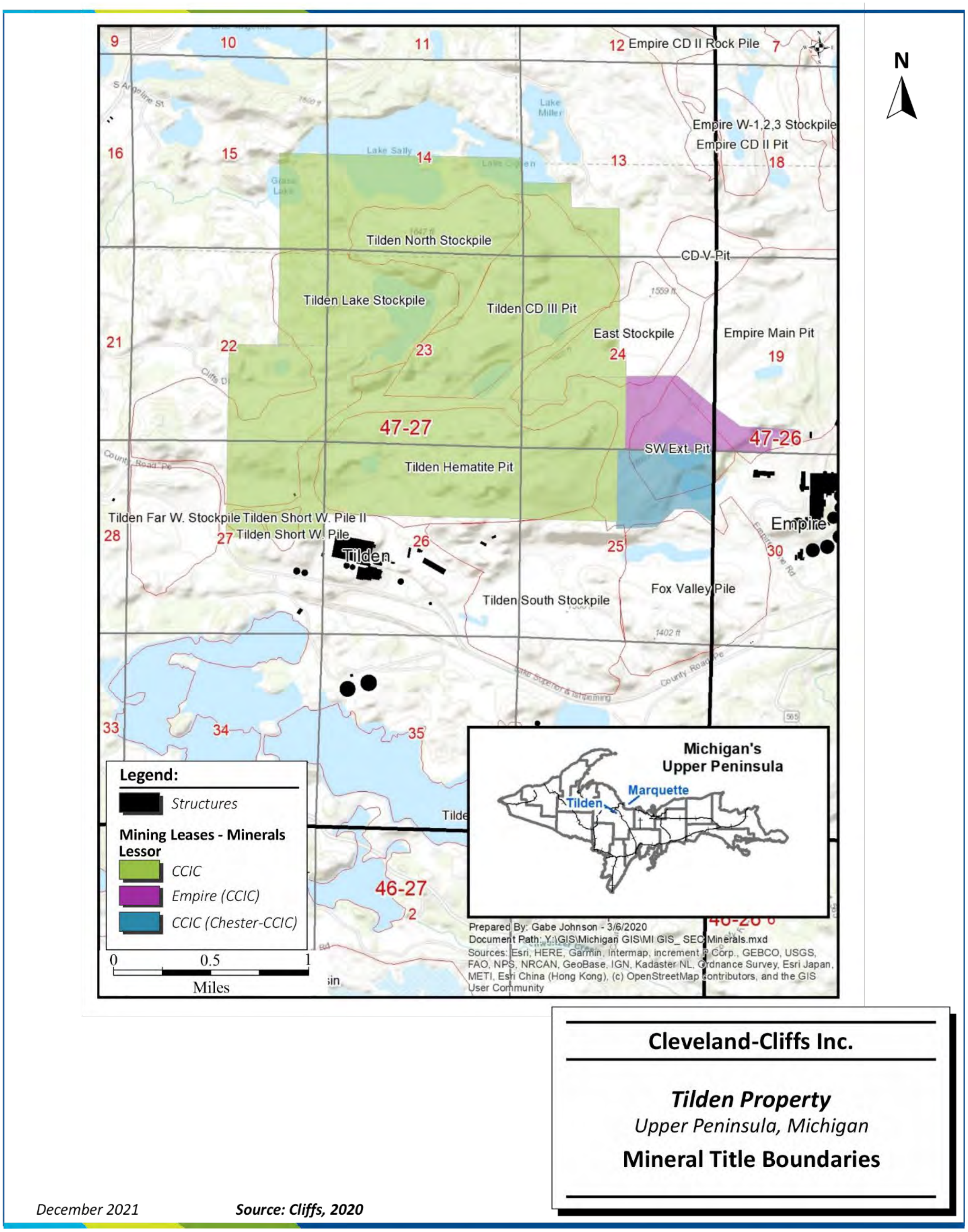


Figure 3-2: Mineral Title Boundaries

Table 3-1: Land Tenure
Cleveland-Cliffs Inc. – Tilden Property

Lease Name	Expiration Date
Empire Mining Sublease	6/1/2061
CCIC Mining Sublease	6/1/2061
CCIC Supplemental Lease	12/31/2070

3.2.2 Surface Rights

Surface rights consist of approximately 21,100 acres of owned property in and around the Mine, Plant, Greenwood Reservoir, and the Gribben Basin, as illustrated in Figure 3-3. To maintain ownership, property taxes must be paid to the local government units in Marquette County.

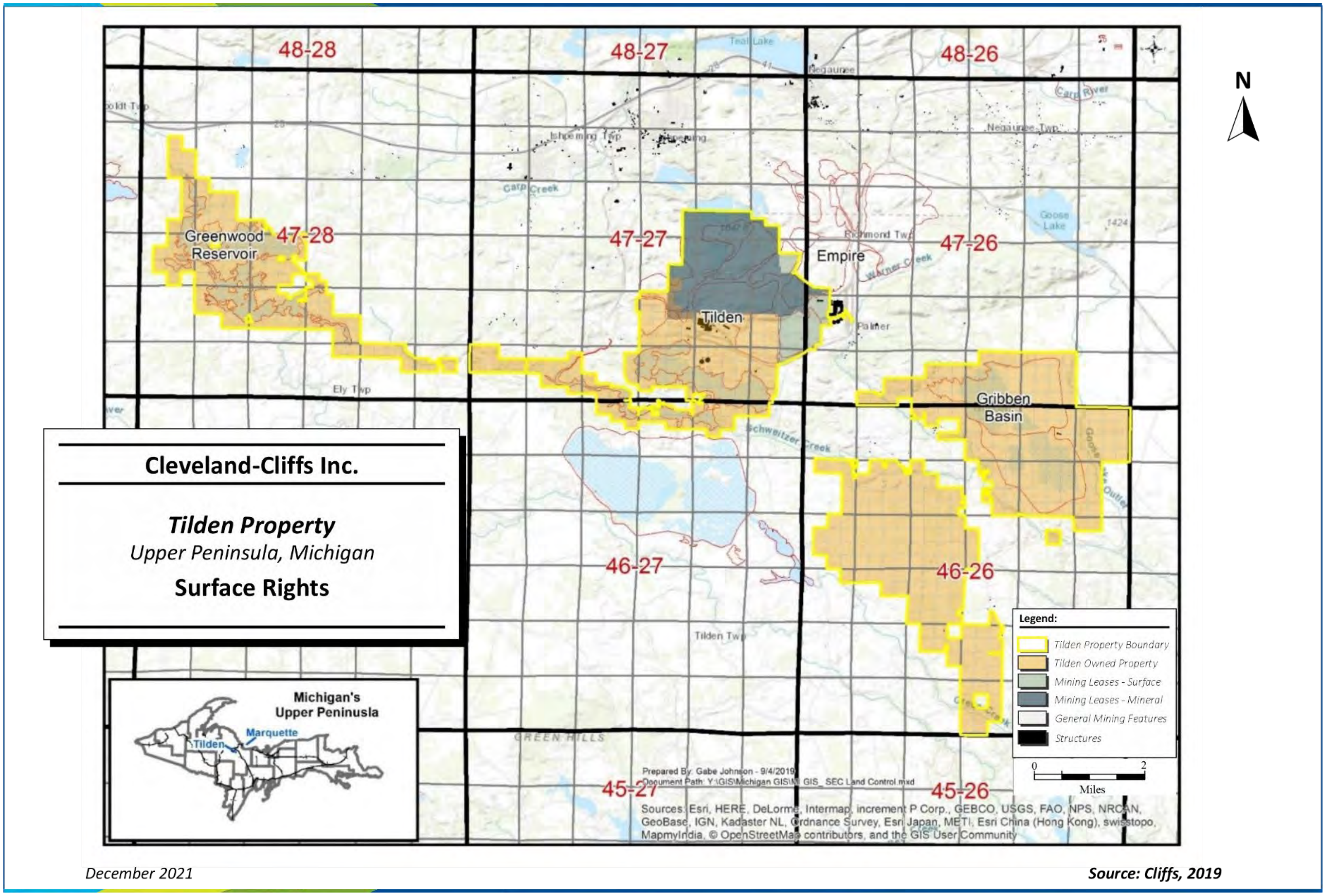


Figure 3-3: Surface Rights

3.3 Encumbrances

Tilden grants leases, licenses, and easements for various purposes including miscellaneous community land uses, utility infrastructure, and other third-party uses that encumber the Property but do not materially inhibit operations. Certain assets of Tilden L.C. serve as collateral as part of Cliffs' asset-based lending (ABL) facility. Cliffs has outstanding standby letters of credit, which were issued to back certain obligations of Tilden L.C., including certain permits and tailings basin projects. Additionally, Tilden has and may continue to enter into lease agreements for necessary equipment used in the operations of the mine.

3.4 Royalties

Reference section 3.2 for royalty information. No overriding royalty agreements are in place.

3.5 Other Significant Factors and Risks

No additional significant factors or risks are known.

SLR is not aware of any environmental liabilities on the Property. Cleveland-Cliffs Inc. has all required permits to conduct the proposed work on the Property. SLR is not aware of any other significant factors and risks that may affect access, title, or the right or ability to perform the proposed work program on the Property.

4.0 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

4.1 Accessibility

The Property is located close to the cities of Marquette, Negaunee, and Ishpeming, Michigan. The Mine can be accessed by the Tilden entrance gate near the community of National Mine, located two miles south of Ishpeming on County Road 476. Alternatively, the Property can be accessed from the east through the adjacent Empire Mine. The Empire entrance gate is located on M-35, nine miles south of US Highway 41 between Marquette and Negaunee. Sawyer International Airport, the closest public airport, is located 17 mi south of Marquette and serves the region with several flights daily to major hubs in Minneapolis, Chicago, and Detroit.

4.2 Climate

Michigan's Upper Peninsula has a humid continental climate, typified by large seasonal temperature differences. Summers are generally warm and humid; winters are cold and long. Precipitation in the area averages approximately 31 in. of rain and 102 in. of snow in the winter (Western Regional Climate Center, 2015). The average maximum and minimum temperatures are shown in Table 4-1, along with the average precipitation and snowfall. Snowfall in the region is greatly influenced by the "lake effect" due to proximity to the Great Lakes. Many towns in the Upper Peninsula have recorded annual snowfalls in excess of 350 in., and storms can quickly reach whiteout conditions and last for days (Albert, 1995).

The Property is a year-round operation and is not generally curtailed due to seasonal temperature changes or weather conditions.

Table 4-1: Ishpeming, MI Temperature and Precipitation
Cleveland-Cliffs Inc. – Tilden Property

Station 204127	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (°F)	23.2	29.6	38.5	52.9	66.0	73.8	79.6	76.1	65.8	53.9	38.0	26.6	52.2
Average Min. Temperature (°F)	5.2	10.5	17.7	29.2	40.0	48.0	54.4	52.8	44.8	35.3	23.2	11.4	31.1
Average Total Precipitation (in.)	1.5	1.3	2.0	2.7	2.7	3.0	3.4	3.5	3.7	3.7	2.3	1.9	31.4
Average Total Snow Fall (in.)	20.0	17.6	16.6	8.2	1.2	0.1	0.0	0.0	0.2	3.8	15.4	19.1	102.1
Average Snow Depth (in.)	15.0	21.0	16.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	8.0	5.0

4.3 Local Resources

Local and State infrastructure includes hospitals, schools, airports, equipment suppliers, fuel suppliers, and communication systems. The Property is located approximately five miles south of the city of Ishpeming, Michigan, nine miles southwest of Negaunee, Michigan, and 20 mi west-southwest of Marquette, Michigan. Medical facilities with trauma centers are located in the cities of Marquette and Green Bay. Table 4-2 is a list of the major population centers and the distance by road to the Property.

Table 4-2: Nearby Population Centers
Cleveland-Cliffs Inc. – Tilden Property

City/Town	Medical Center	Population 2010 Census	Mileage to Mine
Palmer, MI	n/a	449	3.5
Ishpeming, MI	ER	6,470	5.0
Negaunee, MI	n/a	4,568	9.0
Marquette, MI	Level II	21,355	20.0
Green Bay, WI	Level II and III	104,057	167

Source: U.S. Census Bureau, Google Maps

The Tilden operation employs a total of 967 salaried and hourly employees, including Lake Superior & Ishpeming Railroad (LS&I) railroad staff, as of Q4 2021. The majority of the employees live within a 50 mi radius of the Property.

4.4 Infrastructure

The Property is located in a historically important, iron-producing region in Northern Michigan. All infrastructure necessary to mine and process significant commercial quantities of iron ore exist at the current time. Infrastructure items include administration buildings and offices, maintenance shops, high-voltage electrical supplies, natural gas pipelines that connect into the North American distribution system, concentrator, pelletizing plant, water sources, paved roads and highways, railroads for transporting raw materials and final product, port facilities that connect into the Great Lakes, and towns where employees live. Additional details regarding Tilden infrastructure are provided in Section 15.0 of this TRS.

4.5 Physiography

The Property is within the limits of a topographic region known as the Superior Uplands, a part of the Canadian Shield. This region is more rugged than the eastern portion of the Upper Peninsula, as it is dominated by Precambrian volcanic rocks and Archean basement rocks that were eroded down over many glaciation events. The Tilden Mine property features elevations ranging from approximately 1,300 fasl to 1,800 fasl. Topography is hilly and is dominated by glacially influenced landforms. Tilden is located in the Western Upper Peninsula Ecoregion (Section IX) and characterized by a landscape featuring moraines, drumlins, lake plains, outwash channels, outwash plains, and glacially eroded bedrock ridges (Albert, 1995).

Vegetation in the vicinity of Tilden is described as northern hardwood forest dominated by sugar maple, eastern hemlock, basswood, yellow birch, and sparse white pine. The Western Upper Peninsula Ecoregion also contains numerous bogs, tamarack-black spruce swamps, and hardwood-conifer swamps. The bogs and wetlands include elm, green and black ash, and red and sugar maple. Upland wetlands (remnants of glacial lakebeds) support ash, red maple, pin oak, and swamp white oak, whereas acidic, boggy sites may contain boreal flora that persist in this area as outliers of the Canadian forest, including black spruce, larch (tamarack), red maple, several evergreen shrubs, and locally rare herbaceous plants that may grow on a mat of partially decomposed sphagnum moss (Sommers, 1984).

The soil profile in this part of Michigan's Upper Peninsula is dominated by spodosols and histosols. Spodosols are formed in sandy material where precipitation is sufficient to allow large amounts of water to infiltrate the soil multiple times per year. In Michigan, the spring snowmelt season produces these types of conditions. Spodosols in Northern Michigan typically form under mixed forests of maple, pine, hemlock, and birch. Because of the sandy nature of the soil, they have limited water storage capacity and are generally poor for farming. They also locally have varying horizons that may feature abundant organic matter, and aluminum and iron concentrations. Histosols are comprised mainly of organic materials and form in low wetlands or bogs with reducing conditions that allow organic material to accumulate over a longer time period as compared to spodosols (Schaetzl and Anderson, 2005).

5.0 HISTORY

5.1 Prior Ownership

The Tilden Mine officially began operation in 1974 under a partnership of Algoma Steel, Stelco, J&L Steel, Wheeling-Pittsburgh Steel, Sharon Steel, and CCIC. The Property has since been at least partially in the possession of a subsidiary of Cliffs. Notable predecessors to the current evolution of the company were the Cleveland Iron Mining Company and the Iron Cliffs Company. The latter was formed in 1865 by Samuel J. Tilden, a financier who would become the governor of New York and a contender in the 1876 presidential election.

In November 2001, Cliffs announced the planned acquisition of Algoma Steel's 45% interest in the Tilden Mine. In January 2003, Cliffs increased its ownership of the adjacent Empire Mine to 79%, which led to the combination of the Empire and Tilden mining operations before the end of that year.

On August 27, 2007, U.S. Steel purchased Stelco and with it a 15% interest in Tilden L.C. In 2017, Cliffs purchased U.S. Steel's interest, making Cliffs the sole owner of Tilden L.C.

5.2 Exploration and Development History

Iron deposits in Northern Michigan were originally described in the early 1840s by Douglass Houghton, Michigan's first State Geologist. Houghton stated that iron deposits of unknown extent were to be found near the south shore of Lake Superior. In 1844, United States Deputy Surveyor William Austin Burt observed unusual variations in his compass, which tended to behave strangely in the vicinity of certain outcrops that would later be identified as a hematite-rich banded iron formation (BIF). The first major discovery of high-grade iron oxides was in early 1845 near the present site of Negaunee, Michigan (Stiffler, 2010). The Jackson Mining Company was formed shortly thereafter in July 1845, and iron mining in Michigan officially began. The Cleveland Iron Company was formed in 1847 and began exploration for iron ores just east of Ishpeming, Michigan. In 1850, the company changed its name to the Cleveland Iron Mining Company and was granted a charter for mining, smelting, and manufacturing ores, minerals, and metals. The Iron Cliffs Company formed in 1865 and began operations at the Barnum Mine in 1867. By 1871, the Iron Cliffs Company owned a number of small, direct-ship iron mines, including a mine referred to as the Tilden. There is little information regarding the original Tilden Mine, which was focused on direct-ship ores.

Ores were shipped via the Sault Ste. Marie Ship Canal to furnaces on the lower Great Lakes starting in 1855, and tonnages gradually increased into the latter part of the 19th century. In 1891, the Cleveland-Cliffs Iron Company was founded through a merger of the Cleveland Iron Mining Company and the Iron Cliffs Company. After World War II, the underground, high-grade iron mines were almost depleted. Extensive development of low-grade, open pit mining began, and the first commercial agglomeration (pellet) plant in the Lake Superior region started operations in 1952. Agglomeration was a relatively new process that took the concentrate from lower-grade deposits and produced pelletized product containing approximately 65% Fe. The Tilden Mine opened in 1974 after years of favorable experimental testing for processing of fine-grained hematite ores.

Site-standard analytical procedures of bench-scale flotation and magnetic iron determination by a saturation magnetization analyzer (Satmagan) applied to drill core were developed prior to mining and continue to the present as described in section 8.1 of this TRS.

Early regional geologic mapping was compiled by the United States Geological Survey (USGS) (Van Hise and Leith, 1911), and more detailed quadrangle geologic mapping was completed in the mid-20th century (Gair, 1975; Simmons, 1974). Aeromagnetic surveys were first completed in the region in the 1960s and documented by the USGS (Case and Gair, 1965). Cliffs and Tilden Mine do not maintain detailed records or results of early, non-drilling prospecting methods used during initial exploration activities (ground geophysical surveys, trenching, test pits, etc.) conducted prior to Cliffs' development of the operation in the early 1970s.

5.3 Historical Mineral Reserve Estimates

As the Property has since been at least partially in the possession of a subsidiary of Cliffs, there are no historical Mineral Resource or Mineral Reserve estimates.

5.4 Past Production

The Property has produced pellets since 1974 and currently operates with a plant capacity of 7.7 MLT/y. Production has been hematite flux pellets or hematite/magnetite flux since 1994. Magnetite ores were processed from 1989 to 2009, and after 2009, remaining magnetite ores were processed at the Empire Mine prior to its indefinite idling in 2016. Table 5-1 shows the historical pellet production from the Mine and Plant since 1974.

Table 5-1: Historical Production
Cleveland-Cliffs Inc. – Tilden Property

Year	Stripping (kWLT)	Crude Ore (kWLT)			Concentrate (kWLT)			Pellets (kWLT)		
		Hem.	Mag.	Total	Hem.	Mag.	Total	Hem.	Mag.	Total
1974- 1989	0	198,998	6,305	205,303	81,688	1,991	83,679	72,442	1,796	74,238
1990- 1999	0	97,466	59,519	156,985	40,969	20,241	61,209	36,632	21,060	57,693
2000- 2009	0	139,884	40,371	180,255	59,636	15,560	75,196	55,268	15,149	70,417
2010	0	19,194	0	19,194	7,980	0	7,980	7,468	0	7,468
2011	0	20,850	0	20,850	8,374	0	8,374	7,794	0	7,794
2012	0	21,380	0	21,380	8,567	0	8,567	7,618	0	7,618
2013	0	20,114	0	20,114	7,922	0	7,922	7,485	0	7,485
2014	0	20,298	0	20,298	8,130	0	8,130	7,581	0	7,581
2015	0	19,661	0	19,661	7,998	0	7,998	7,631	0	7,631
2016	0	20,672	0	20,672	8,295	0	8,295	7,632	0	7,632
2017	0	21,007	0	21,007	8,157	0	8,157	7,650	0	7,650
2018	0	21,016	0	21,016	8,320	0	8,320	7,679	0	7,679
2019	0	21,500	0	21,500	8,312	0	8,312	7,708	0	7,708
2020	0	18,006	0	18,006	6,968	0	6,968	6,323	0	6,323
2021	0	21,482	0	21,482	8,238	0	8,238	7,365	0	7,365
TOTAL	**0**	**681,528**	**106,195**	**787,723**	**279,554**	**37,792**	**317,345**	**254,276**	**38,005**	**292,282**

6.0 GEOLOGICAL SETTING, MINERALIZATION, AND DEPOSIT

6.1 Regional Geology

Essential aspects of the regional geology in the Lake Superior region have been understood since the early 1900s, and the geologic understanding of the area has remained relatively unchanged over the years.

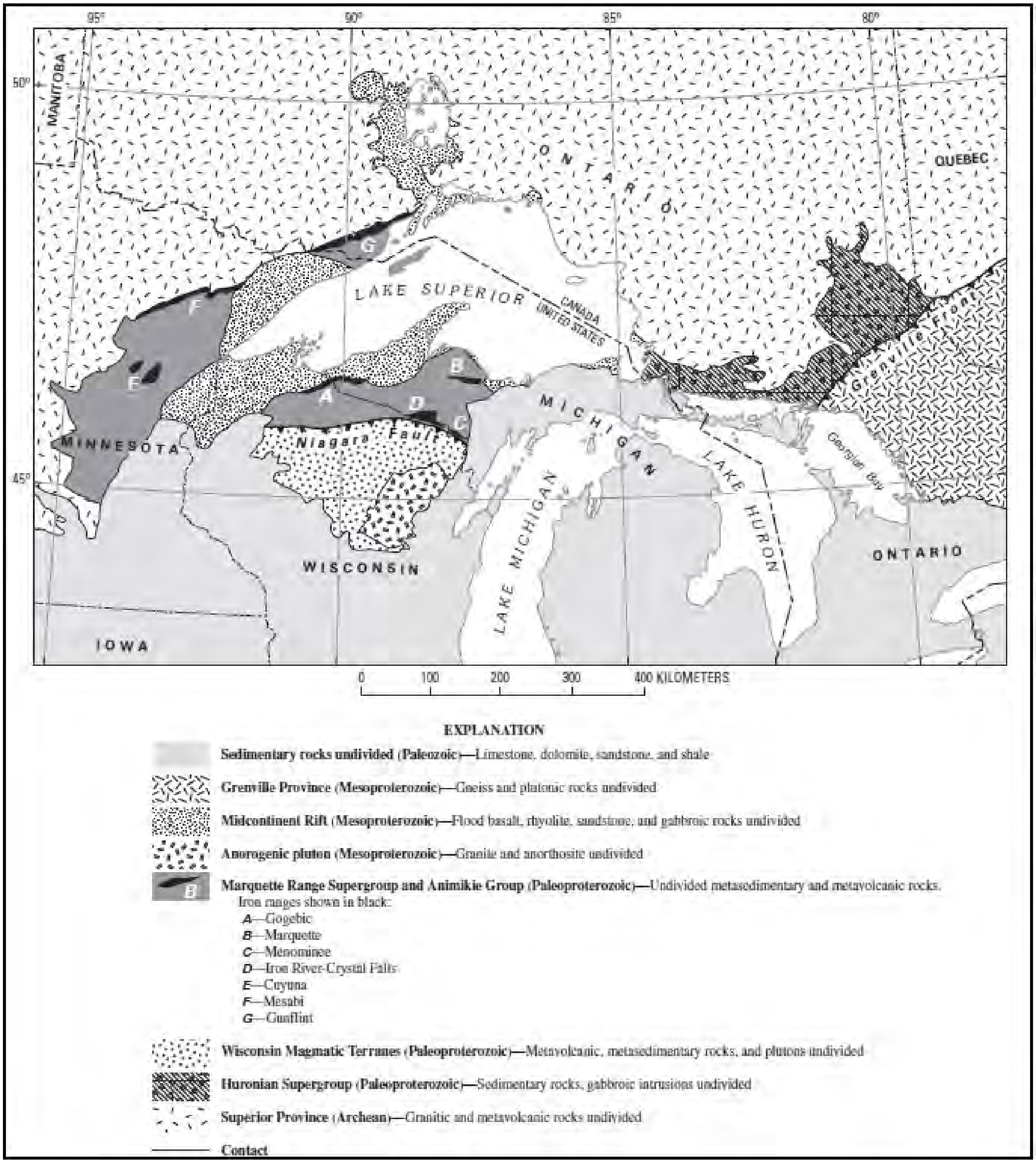
Iron ores produced within the region range from high-grade, structurally controlled "natural" or direct-shipping iron ore (DSO) bodies to more disseminated, stratigraphically controlled, low-grade iron ores that require beneficiation. The beneficiation-grade deposits are found in a sequence of Paleoproterozoic metasedimentary rocks overlying Archean granitic basement in the Lake Superior region.

The Palmer Gneiss represents the basement complex of Archean (2.6 Ga) granitic gneiss underlying a thick sequence of variably metamorphosed volcanic rocks and sedimentary rocks including iron formations hosted within several stratigraphic intervals. The principal iron formations in Northern Michigan are within the 1.9 Ga to 2.7 Ga Marquette Range Supergroup (Figure 6-1).

Paleoproterozoic rocks in the vicinity of Tilden consist of three subgroups: the Chocolay Group, the Menominee Group, and the Baraga Group. The stratigraphic sequence features shelf facies of quartzite and dolomite of the Chocolay Group underlying the Menominee Group of argillaceous rocks and the major iron formations. The Baraga Group is generally described as a volcanogenic unit of considerable thickness and complexity (Bayley and James, 1973). In the area of the Marquette Range, it comprises sequences of turbidite, graywacke, and shale along with minor iron formations. The Baraga Group is roughly equivalent to the upper stratigraphy of the Animikie Group in Minnesota. The Menominee Group is comprised of the basal Ajibik Quartzite, the Siamo Slate, the Negaunee Iron Formation (Negaunee IF), and rift-related mafic intrusive rocks. The Menominee Group contains the 1.875 Ga iron formations of economic significance and is correlative with the Animikie Group on the Mesabi Range of Minnesota (Figure 6-1), which hosts several beneficiation-grade (magnetite "taconite") mining operations.

The Menominee Group was determined to have been deposited between 1.9 Ga and 2.2 Ga by radiometric age dating (Van Schmus and Woolsey, 1975). Although the Menominee Group is stratigraphically equivalent to the Animikie Group in Minnesota, units differ dramatically from one range to the other in thickness, stratigraphic details, and facies type. Sedimentary rocks were deformed and metamorphosed during the Penokean orogeny, resulting in a wide range of metamorphic mineral assemblages and grades. The Marquette district, including the Tilden Mine, is one of the more geologically complex iron mining districts in the Lake Superior region. Orogenic transpression resulted in a relatively tight, west-plunging syncline of strata in the Chocolay and Menominee Groups (Figure 6-3). To the north, the syncline is bounded by unconformably underlying rocks older than 2.5 Ga. To the west, the syncline opens to a thick sequence of graywacke and slate within the Baraga Group (Bayley and James, 1973). In the eastern part of the syncline, the Negaunee IF can reach a thickness of 2,500 ft. The region along the fold axis of this syncline is referred to as the Marquette trough.

Regional structures include the Niagara Fault Zone, the collision zone between the Wisconsin Magmatic Terrane, the Superior craton, and the Great Lakes Tectonic Zone, which forms the boundary between Archean granite-greenstone and gneissic terranes (Sims et al., 1992). In the Marquette Range area, deformation along the Great Lakes Tectonic Zone evolved from extension and deposition (Schneider et al., 2002). The resulting fault-bounded, shallowly west-plunging, asymmetric syncline contains a series of second-order growth fault basins that define the detailed stratigraphic variations.



Source: Cannon, et al., 2007

Figure 6-1: Fe Formation Locations and Relevant Stratigraphy in the Lake Superior Region

6.2 Local Geology

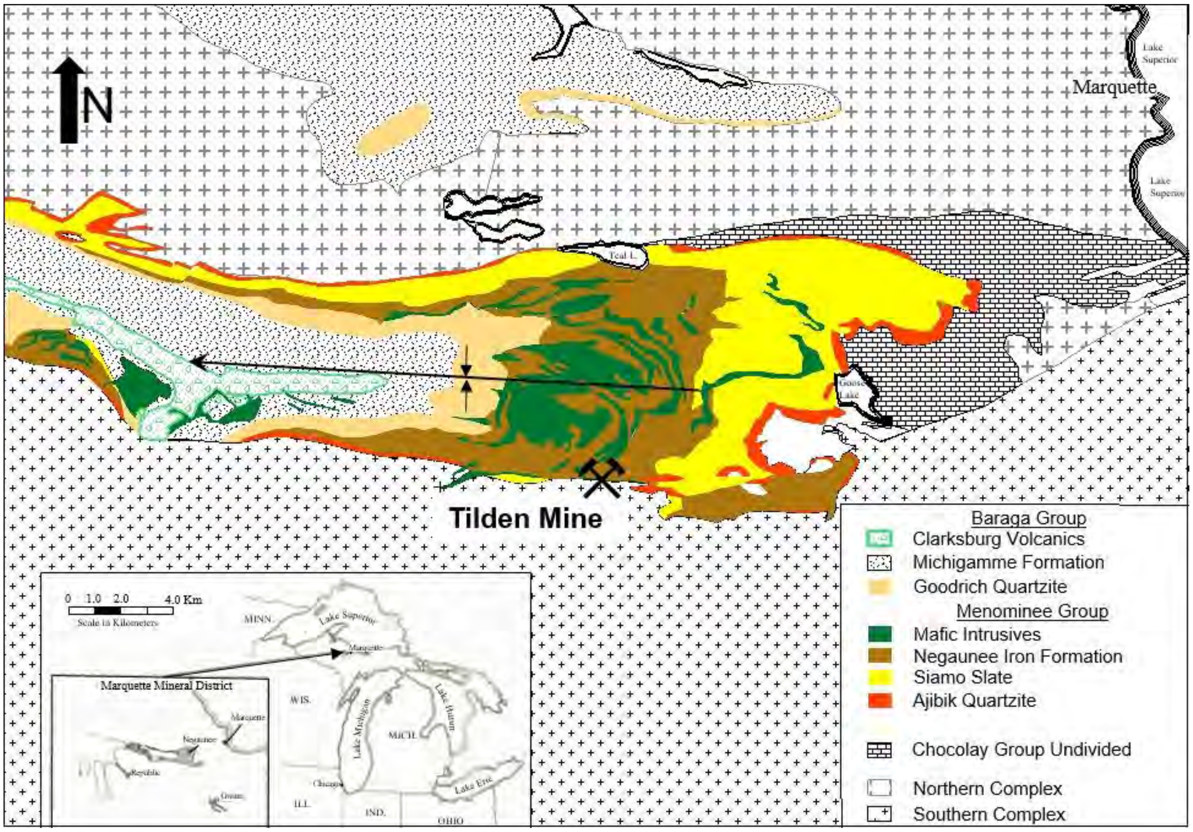
The Negaunee IF and its equivalents (Figure 6-3) host the majority of the iron deposits in Michigan. In the Marquette Range, the Negaunee IF reaches a thickness of approximately 1,300 ft. The Tilden Mine sits on the southern margin of the Marquette trough and is fault-bounded to the south by Archean gneiss terrane, alternatively referred to as the Palmer Gneiss (Figure 6-2) or the Southern Complex (Figure 6-3). There is no formal subdivision of the Negaunee IF, and stratigraphy is generally discussed in relative terms from the bottom to the top of the unit (Figure 6-2). The majority of the Negaunee IF consists of iron-rich carbonate, carbonate-silicate, or carbonate-oxide facies iron formation (James, 1954; Gair, 1975) roughly described in three zones from lowest to uppermost (Cannon, 1976). The lowest portion is interbedded at its base with the underlying Siamo Slate and consists primarily of laminated chert and siderite. The middle portion is dominated by alternating thin layers of magnetite, iron silicate minerals, and chert. Silicate minerals are dominated by minnesotaite ($(Fe^{2+},Mg)_3Si_4O_{10}(OH)_2$), stilpnomelane ($K(Fe^{2+},Mg,Fe^{3+})_8(Si,Al)_{12}(O,OH)_{27}n(H_2O)$), and quartz ($SiO_2$). The upper Negaunee IF is dominated by increasingly oxidized, hematite-jasper facies (jaspilite) iron formation. It exhibits a texture of thinly interbedded, reddish chert and hematite (Fe_2O_3) and martite, which is a pseudomorph of hematite occurring after magnetite (Bayley and James, 1973).

Two ages of mafic igneous rocks occur in the Mine: syn-sedimentary sills and associated dikes and a younger dike series of Keweenawan age (approximately 1.0 Ga) that is related to the Midcontinent Rift. The older intrusions vary from fine porphyritic to diabasic or ophitic in composition and texture and typically display chlorite-carbonate alteration assemblages, particularly in deformation zones. The iron formation is variably altered along all intrusive contacts, with the type and extent of alteration dependent on the thickness of the intrusive and the composition of the iron formation (Lukey et al., 2007).

Local structure is characterized by second-order, steeply inclined anticlines and synclines with shallow northwest and southwest plunges. Major structures include the large-scale (hundreds of feet) Main Pit anticline and a fault that marks the contact between Archean gneiss terrane and the iron formation. The fold is asymmetric, with the southern limb steeper than the northern limb, with an axial plane that dips steeply north and a hinge line that plunges 30° northwest. The fault, initially a basin-margin, listric normal fault, was reactivated and is now a reverse fault that dips approximately 65° north (Cambray, 2002). Smaller faults and folds, on a scale of one meter to 20 m, are observed in the pit to follow trends of larger, regional-scale structures. These structures tend to reflect ductile deformation in the Tilden Main Pit, where folds with sheared limbs are common (Lukey et al., 2007).

<table>
<tr><th>Eon</th><th>Group-Series-Period</th><th>Formation</th><th>Tilden Mine Chronostratigraphy</th></tr>
<tr><td rowspan="2">Phanerozoic</td><td>Quaternary</td><td>Glacial Sediments</td><td>Overburden</td></tr>
<tr><td colspan="3">Unconformity</td></tr>
<tr><td rowspan="9">Proterozoic</td><td>Keweenawan Series</td><td colspan="2">Dikes</td></tr>
<tr><td>Metadiabase</td><td colspan="2">200 Series Diabase Dikes and Sills</td></tr>
<tr><td rowspan="5">Marquette Range Supergroup – Menominee Group</td><td rowspan="5">Negaunee Iron Formation</td><td>500 Series</td></tr>
<tr><td>400 Series</td></tr>
<tr><td>300 Series</td></tr>
<tr><td>100 (Empire) Series</td></tr>
<tr><td>Empire Series</td></tr>
<tr><td></td><td colspan="2">Siamo Slate</td></tr>
<tr><td colspan="3">Palmer Fault / Unconformity</td></tr>
<tr><td>Archean</td><td colspan="3">Palmer Gneiss</td></tr>
</table>

Figure 6-2: Chronostratigraphic Column for the Tilden Mine



Source: Modified from Lukey, 2007

Figure 6-3: General Geology of the Marquette Range Supergroup and Tilden Mine Location

6.3 Property Geology

The Tilden BIF deposit forms the base of the Negaunee IF of the Menominee Group within the Marquette Range Super Group. The Tilden BIF is Proterozoic in age and sits on the southern margin of the Marquette trough. It is fault-bounded to the south by Archean gneiss terrane, with the fault contact dipping steeply north and aligning with the south wall of the Main Pit at Tilden.

The Tilden BIF is interbedded with three distinct, syn-sedimentary, mafic intrusive sills: The Summit Mountain Sill, the Suicide Sill, and the Tilden Lake Sill, as well as associated smaller dikes and sills. There is a younger dike series of Keweenawan age (approximately 1.0 Ga) that crosscuts bedding. Alteration is present along all intrusive contacts, with the type and extent of alteration dependent on the thickness of the intrusive and the composition of the iron formation (Lukey et al., 2007). Brittle fractures and late quartz veins cut all units.

Tilden is dominated by a 100 m-scale, northwest-plunging anticline. The hinge line of the anticline dips steeply north, plunges 30°NW, and runs down the center of the Main Pit. The hinge line of the anticline is mapped locally coincident with the Keweenawan Dike. The Summit Mountain Sill, locally termed the Pillar Intrusive, defines the asymmetry and orientation of the anticline. Smaller faults and folds, on a scale of one meter to 20 m, are observed in the Main Pit to follow trends of larger, regional-scale structures. These structures tend to reflect ductile deformation in the Main Pit, where folds with sheared limbs are common (Lukey et al., 2007). The orientation and geometry of bedding at Tilden is presented in Figure 6-4.

To date, there has been no formal subdivision of the Negaunee IF at Tilden, and stratigraphy is discussed in relative terms from bottom to top. A stratigraphic section, without formal names or dates, was prepared by SLR and is presented in Figure 6-5. Stratigraphically, the upward mineralogical variation is from (martite)-magnetite-carbonate-chlorite ("*Carbonate*") to (magnetite)-martite ("*Martite*") to (martite)-microplaty hematite-goethite ("*Hematite*") and represents a transition upwards from dominantly ferrous iron (Fe^{2+}) mineralogy to dominantly ferric iron (Fe^{3+}) mineralogy (Lukey et al., 2007). Some BIF units were disrupted during turbidite flows that manifest as discontinuous lenses of clastic material. Clastic lithology is most prevalent along the bottom (southern) contact with the Archean gneiss. All BIF units are ferrous iron-dominant and increase in ferric iron content upward (generally northward and westward).

6.3.1 Mineralization

The Tilden Mine is unique among Cliffs' operations because the primary ore mineral at Tilden is hematite, with other minerals including martite (oxidized pseudomorph of magnetite), goethite, and siderite (iron carbonate mineral), as opposed to strictly magnetite. Tilden is also unique in the world in that the hematite-dominant ore is mined at a low grade, concentrated using a selective-flocculation desliming and flotation process, and pelletized. Although some now-expended areas at Tilden did mine and magnetically recover magnetite-dominant ore prior to 2009, remaining Mineral Resources at Tilden are hematite-dominant. The adjacent Empire deposit hosted primarily magnetite ore, and unoxidized magnetite is variably present at Tilden.

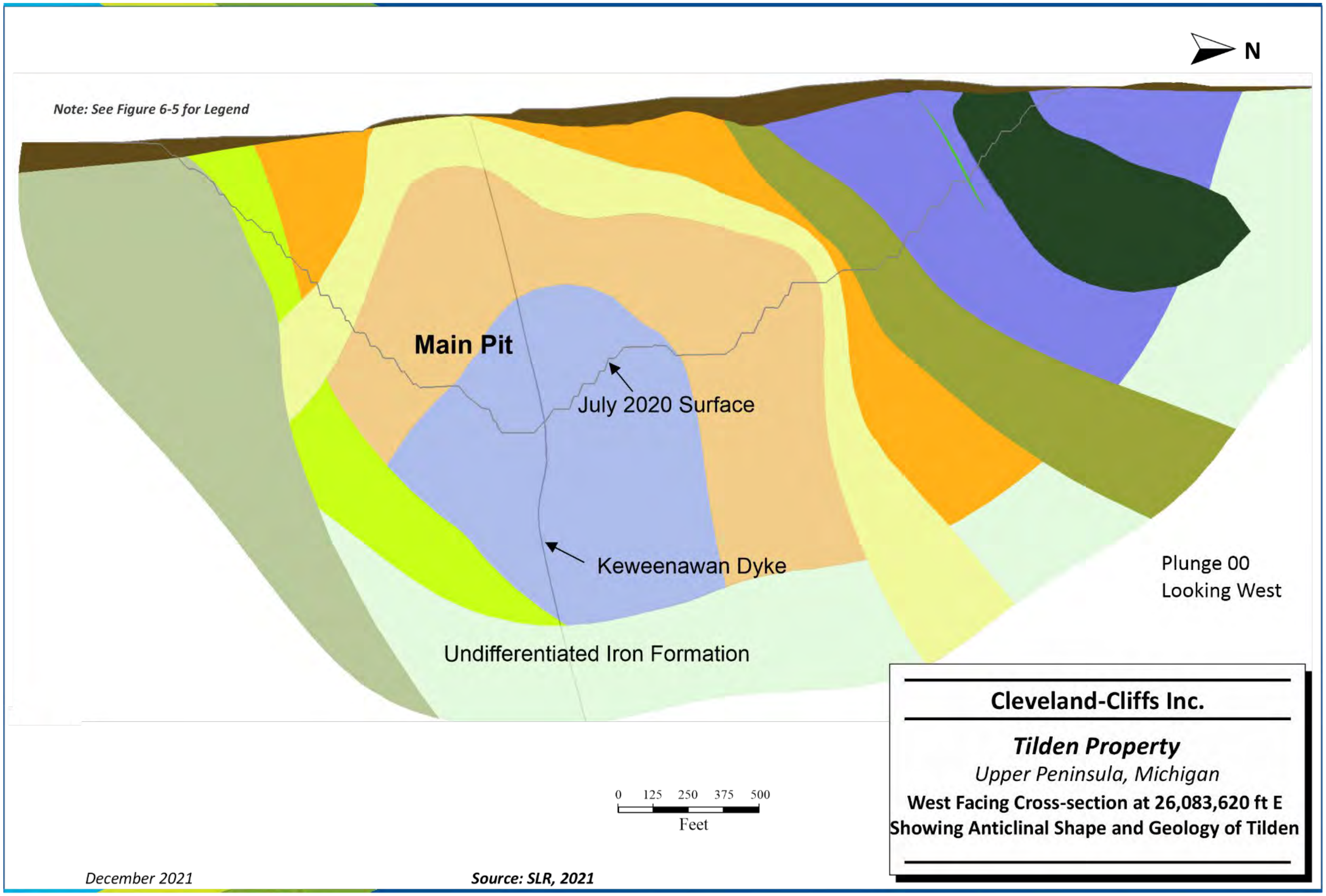


Figure 6-4: West-Facing Cross-section at 26,083,620 ft E Showing Anticlinal Shape and Geology of Tilden

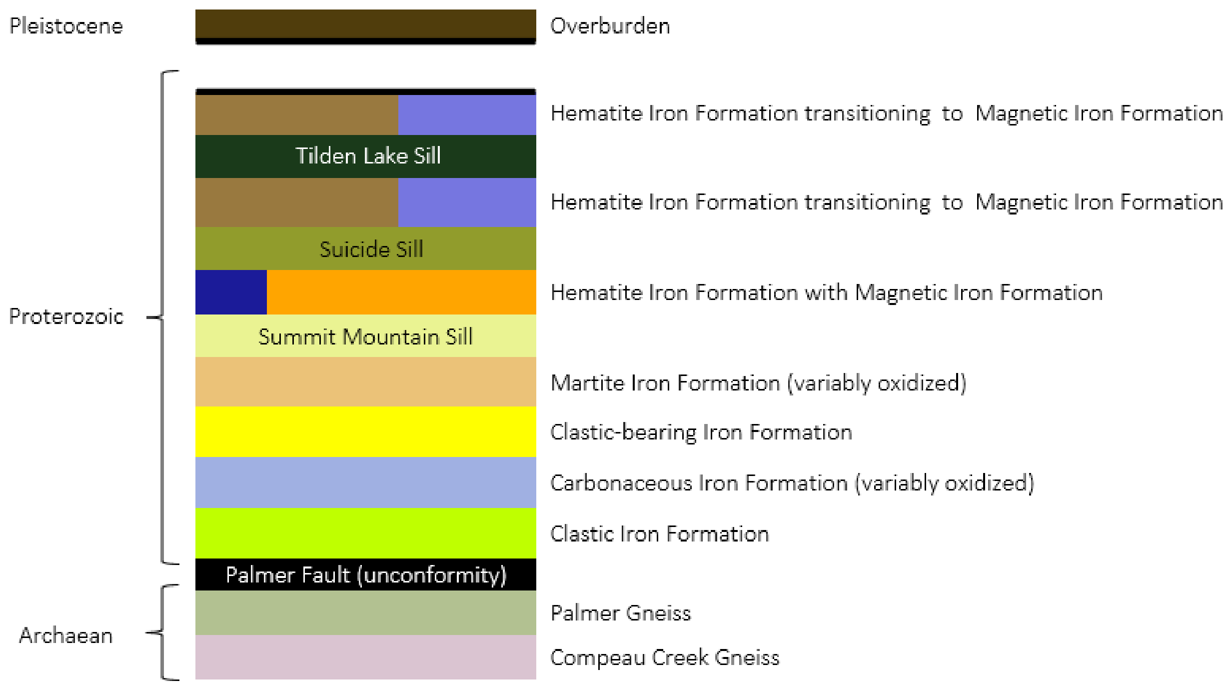


Figure 6-5: Basic Stratigraphic Section Local to Tilden

At Tilden, the Negaunee IF can be divided into five distinct facies:

- **Clastic Iron Formation (IFCL) Units**: Varying thickness of interbedded slate with laminated chert, iron silicate, and siderite. Clastics have a lower weight recovery (wtrec) due to the presence of interbedded clastic material. They are highly oxidized in the east side of the Main Pit.
- **Carbonaceous Iron Formation (IFCB) Units**: Alternating thin layers of magnetite, martite (oxidized pseudomorph of magnetite), iron silicate minerals, iron carbonate minerals and chert. Carbonate material is characterized by the presence of siderite (iron carbonate mineral), low phosphorus, and higher wtrec.
- **Martite Iron Formation (IFCH) Units**: Thicker beds of hematite-martite-chert with intervals of magnetite-carbonate. The oxidation level increases in the east and where proximal to intrusive sills.
- **Magnetic Iron Formation Units**: Magnetite domain consisting of magnetite-carbonate and magnetite-silicate-chert with variable oxidation. It is defined principally by magnetite content and is generally fresh, with some localized oxidation. At Tilden, it is found within and defines the (now expended) material of the CDIII Pit.
- **Hematite Iron Formation Units**: The oxidized equivalent of the Magnetite Iron Formation prominent in both the Empire deposit and in the east side of the Main Pit, is located stratigraphically above the Summit Mountain Sill. It is dominantly composed of hematite and chert interbeds. At Tilden, this unit has locally very high levels of silica and phosphorus in concentrate (consio2 and conphos, respectively).

The iron formation facies at Tilden have also been modified by clay-silicate alteration associated with Keweenawan faults in the east of the Main Pit, as well as varying levels of oxidation throughout.

SLR notes that these facies represent continuums of changing iron speciation and mineralogy due to both depositional environment conditions and later-stage alteration and oxidation. Clastic-bearing iron formation units are grouped by the presence of clastic material but have varying mineralogy resulting from the nature of formation – turbidite flows of varying energy levels occurring in different depositional environments and time periods that remobilized sediments characteristic of that position and incorporated transported exotic rock fragments. Drill hole logging at Tilden over time has also inconsistently represented mineralogy according to perceived importance as well as logged abundance, and the often fine-grained nature of the rock has made it difficult to define facies with confidence. SLR recommends carrying out a mineralogical study to better understand iron mineral speciation at Tilden as it relates to geology, stratigraphy, and (importantly) plant flotation, as well as continuing efforts to construct a stratigraphic section and develop a standard operating procedure for detailed logging of drill core going forward.

Tilden Mine geology is described on site using broad geological groupings as listed in Table 6-1. The primary ore-bearing and non-ore-bearing domains are further categorized based on a variety of lithological, alteration, and analytical (recoverable iron grade, deleterious element grades) parameters as well as spatial references that are used for ore control purposes. Selected geometallurgical (code1) subgroupings are shown in Figure 6-6. A full description of code1 subgroupings is included in Appendix section 27.1 Geometallurgical Domains.

Table 6-1: Geometallurgical Groupings at Tilden
Cleveland-Cliffs Inc. – Tilden Property

Group	Name	General Description
100	Lower Series	Archaean-aged, non-iron formation rocks which form the south wall of the Main Pit.
200	Intrusive Sills and Dikes	Mafic rocks which vary from diabasic to porphyritic to aphanitic. All units appear to thin to the west and south. Contacts tend to be sheared and locally oxidized. Contact metamorphism of the iron formation is minimal and, if present, results in finer-grained iron formation. Synclinal structures and intersections with dikes have focused oxidation of the iron formation
300	Main Pit Carbonate Iron Formation	Contains iron formation units stratigraphically below the CDIII footwall metadiabase and/or the East Pit hanging-wall metadiabase. Includes numerous small, mafic intrusive dikes and sills.
400	Northwest Iron Formation Domain	Stratigraphically between the CDIII/West Pit hanging-wall metadiabase and CDIII footwall. Includes numerous small dikes and sills.
500	West Iron Formation Domain	Stratigraphically above CDIII/West Pit hanging-wall metadiabase and below North Intrusive; it includes numerous dikes and one mappable intrusive body.

Code1	Lithology
Non-Iron Formation Units	
121	Compeau Creek Gneiss
121	Palmer Gneiss / South Wall Intrusive
200	Summit Mtn Sill / Pillar Intrusive
230	Suicide Sill
250	Tilden Lake Sill
260	Intrusive, Undifferentiated
999	Overburden
Clastic Iron Formation Units	
310, 480	IFCL South Wall Clastics, Low SiO2
320	IFCL East Pit Clastics, Low SiO2
Carbonaceous Iron Formation Units	
316	IFCB East Tilden Carb
317	IFCB Oxidized East Tilden Carb
340	IFCB Main Pit Carb
421	IFCB West Pit Carb

Code1	Lithology
Magnetite Iron Formation Units	
420	CDIII Pit Mag
Martite Iron Formation Units	
350	IFCH 300, Low SiO2
Hematite Iron Formation Units	
400	IFCH 400
500	IFCH 500
600	IF - Undifferentiated
Silica Altered Iron Formation Units	
321	IFCL 300, High SiO2
330	IFCH 300, High SiO2
331	IFCB 316, 317, High SiO2
370	IFCH Hi SiO2, Pillar Intrusive FW
410	IFCB Hi SiO2 Suicide Sill HW

Figure 6-6: Selected Geometallurgical (code1) Groupings and Sub-groupings at Tilden

The structural control and stratigraphic upward changes in mineralogy imply a combination of original sedimentation and post-depositional fluid alteration as the likely cause of increasing oxidation and hydration up-sequence. The four primary types of iron ores are centered on the anticlinal axis and trend upwards from Fe^{2+} and elevated magnesium (Mg), calcium (Ca), manganese (Mn), and aluminum (Al) to Fe^{3+} and decreased trace elements, but increased phosphorus content due to weathering. Bedding changes from thick (centimeter scale) to thin (millimeter scale) are indicative of varying depositional conditions and silica (SiO_2) mobilization. The presence of microplaty hematite in relatively reduced (magnetite-carbonate-chlorite) and oxidized (martite-goethite) assemblages may be indicative of deposition and/or an evolving fluid system.

6.4 Deposit Types

6.4.1 Mineral Deposit

The Tilden iron deposit is an example of a Lake Superior-type BIF deposit. These types of deposits occur worldwide, represent the largest global source of iron ore, and were deposited between 2,700 Ma and 1,800 Ma, formed by chemical precipitation in shallow waters such as continental shelves. Precipitation of iron oxides was due to low atmospheric and ocean oxygen levels resulting in increased iron content in sea water. These deposits are typically characterized by alternating layers of iron oxides and SiO_2-rich material such as cherts or SiO_2-rich sediments.

The Tilden Mine is unique among Cliffs-owned operations because the primary ore mineral at Tilden is hematite, with other minerals being martite (oxidized pseudomorph of magnetite), goethite, and siderite (iron carbonate mineral), as opposed to strictly magnetite. Tilden is also unique in the world in that the hematite-dominant ore is mined at a low grade, concentrated using a selective-flocculation desliming and flotation process, and pelletized. Although some now-expended areas at Tilden did mine and magnetically recover magnetite-dominant ore prior to 2009, remaining Mineral Resources at Tilden are hematite dominant. The adjacent (now indefinitely idled) Empire deposit hosted primarily magnetite ore, and unoxidized magnetite is variably present at Tilden.

6.4.2 Geological Model

Cliffs is using a Lake Superior-type BIF geologic model based on geologic interpretation of the Negaunee IF and its structure derived from peer-reviewed journal articles (Gair, 1975; Cannon, 1976; Lukey et al., 2007).

7.0 EXPLORATION

Cliffs and Tilden L.C. do not maintain detailed records or results of non-drilling prospecting methods used during initial exploration activities, such as geophysical surveys, mapping, trenching, and test pits, conducted prior to Cliffs' development of the operation. No materially significant exploration work or investigations other than drilling and limited pit mapping have been conducted by Cliffs at Tilden. Historical mapping compiled by the USGS prior to mining is detailed in section 5.2.

7.1 Exploration Drilling

7.1.1 Drilling Type and Extent

The Tilden drill hole database consists of 382,605 ft of drill hole information in 578 drill holes, completed from the 1950s to 2020. Annual exploration drilling programs at Tilden have completed zero to 42 drill holes. Of the last 10 years, nine have included drill hole programs and have averaged 10 drill holes per year. Diamond, hammer, and churn drilling have all been employed at Tilden, with diamond drilling having been exclusively used since 2008.

Completed drill hole collar locations are recorded by the mine surveyor using a Trimble R8 GNSS receiver and TSC3 data collector. Since the 1990s, downhole deviation surveys have been performed, initially using a crude clay impression procedure, followed by a non-magnetic reflex gyro once the technology was developed. Drill core at Tilden is generally competent and has good recovery.

A summary of the drill hole database is provided in Table 7-1 and collar locations are shown in Figure 7-1. Assay information for holes drilled in 2019 and 2020 east of the CD5 Pit area (northeast area in Figure 7-1) were not available and, as such, the CD5 area has not been included in SLR's drill hole summary. Downhole information from Empire drill holes was also not available, and the holes are excluded from the SLR Mineral Resource estimate as well as the summary in Table 7-1. SLR recommends integrating the downhole information from the Empire and Tilden mines into a single valid database.

Table 7-1: Summary of the Tilden Mine Drill Hole Database
Cleveland-Cliffs Inc. – Tilden Property

Drill Type	Unk.	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020	Total
Unknown										
No. Holes	14	-	-	-	-	-	-	-	-	14
Length (ft)	8,962	-	-	-	-	-	-	-	-	8,962
Hammer										
No. Holes	1	-	-	113	10	109	20	-	-	253
Length (ft)	790	-	-	56,508	4,179	60,991	16,360	-	-	138,828
Churn										
No. Holes	-	-	2	1	-	-	-	-	-	3
Length (ft)	-	-	554	1,401	-	-	-	-	-	1,955

Drill Type	Unk.	1950s	1960s	1970s	1980s	1990s	2000s	2010s	2020	Total
Diamond										
No. Holes	-	29	78	51	8	10	13	109	10	308
Length (ft)	-	17,471	62,948	30,352	6,430	7,120	8,589	94,987	4,964	232,860
Total No. Holes	15	29	80	165	18	119	33	109	10	578
Total Length (ft)	9,752	17,471	63,502	88,261	10,609	68,111	24,949	94,987	4,964	382,605

Notes:

1. Excludes Empire Mine drill holes.

Geology has been logged at Tilden considering five broad geologic groupings based on geological and metallurgical data, as well as approximately 30 highly specific geometallurgical domains based on geometallurgical test results, which are subsequently grouped for mine planning.

Drill core is photographed, and rock quality designation (RQD) is recorded for all drill core. Currently, Tilden drill hole logging procedures attempt to capture magnetic characteristics, alteration, mineralogy, textures, and structural information; however, the fine-grained nature of the lithologies can inhibit rock-type designation based on visual observation, and recent drill logs are generally brief. Final lithological coding is re-interpreted considering the results of metallurgical testing in the context of spatial and geometallurgical characteristics.

During 2020, Cliffs personnel digitized details of historical logs previously available in paper format only, and this information has been incorporated into the SLR modeling work. SLR recommends that detailed lithological logs that capture iron speciation, alteration, mineralogy, structure, and lithology be collected on all drill core, and recommends investigating alternative tools to capture information during initial logging, including a magnetometer and hyperspectral and X-ray fluorescence hand-held devices to allow empirical measurements of magnetism (where relevant), alteration such as clay, and iron speciation. SLR also recommends a formal separation between initial geological observations in drill core and subsequent re-interpretations based on metallurgical results or results of neighboring drill holes.

SLR notes that the density of drill hole information at Tilden decreases outside the current pit limits and recommends additional drilling within and adjacent to the LOM plan area with a focus on material at depth. SLR also recommends closer spaced drilling where the iron formation is impacted by silica alteration, or in and adjacent to areas understood to have high oxidation but defined by older drill holes with absent conphos values.

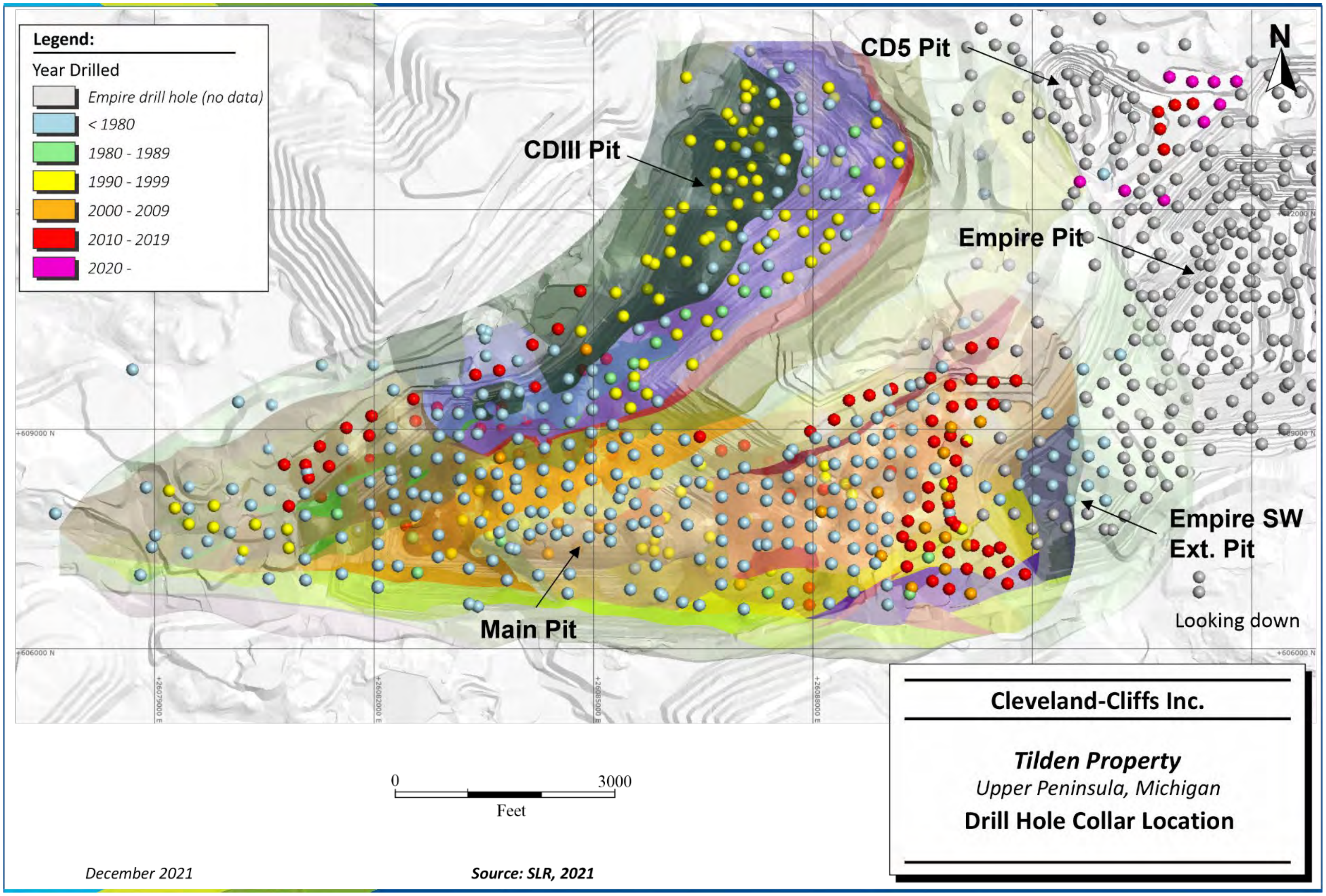


Figure 7-1: Drill Hole Collar Location

7.1.2 Procedures and Parameters

Prior to drilling, drill hole collars are located by a Cliffs geologist using a global positioning system (GPS) and marked with a wooden post.

The collar of each completed drill hole is surveyed by the mine surveyor using a Trimble R8 GNSS receiver and TSC3 data collector. The collar coordinates in Michigan State Plane for horizontal location and elevation above mean sea level are verified by the project geologist. Final collar coordinates are validated in the office by the project geologist and incorporated into Cliffs' acQuire drill hole database.

7.1.3 Downhole Survey

Downhole surveys are conducted with a REFLEX gyro MEMS tool. This downhole instrument is specifically designed for use in areas where magnetism may be an issue. Measurements are taken every 20 ft down the hole. The instrument is field calibrated using five rotations in the field stand prior to being used down a hole.

Prior to the gyroscopic technology being available, downhole deviations were determined by older techniques, primarily a clay impression procedure. Downhole surveys were not conducted on reverse circulation holes drilled up until the 1990s. Downhole surveys are not conducted on holes with depths less than 500 ft. Over 75% of the holes are vertical, with most others oriented to the south and angled from 30° to near vertical.

7.1.4 Core Handling and Security

Core is transported from the drill site to the logging facility by the project geologist or by the contracted drilling company. A Cliffs geologist ensures the following:

- The integrity of the core when taken from the core barrels to the gutter.
- Placement of core in clean, unused, waxed core boxes.
- The cores in the boxes were positioned in the correct direction and sequence when transferred from the core barrel or gutter to the core boxes, making sure there was no inversion during the transfer process.
- A wooden block in the core box at the end of each core run that has hole depth in feet at that specific point written on it in permanent marker.
- Identification on the boxes is made on the pre-printed templates located on core box tops and on the end panels of the core box tops and bottoms. This information includes the hole number, footage contained in the box (from-to), and the box number.
- Transportation of core to the onsite core storage facility for logging and sampling.

7.1.5 Sampling Methods and Sample Quality

The indicated depths on the blocks, marking core barrel runs in the boxes and the depths noted on the outside of the core boxes, are verified in contractor drill reports. Daily drill rod counts are performed by the drill contactor to verify drill depth. The final depth of the drill hole is confirmed and registered in the drill report. Hole size and final hole depth are authorized by the project geologist.

Core is photographed digitally, and photographs are archived on a local area network with a hole number and depth for future reference. These digital images are backed up daily as part of Cliffs' normal daily backup procedure described in section 8.2. Images are acquired in an environment that permits consistency in distance to core, lighting, and exposure. Core was not photographed before 2003.

Geotechnical core measurements include core recovery percentage and RQD. Data are recorded in an Excel spreadsheet for later upload into the acQuire database or directly into the acQuire database.

Geological logging of the core is done by a Cliffs geologist, digitally, using acQuire for database management. Logging includes rock type, magnetic characteristics, alteration, mineralogy, observed textures, structural information, geotechnical data, and a general geologic description. The interpreted metallurgical domain is included in the geological log. Hard copies of all completed drill logs are stored on site. Logging is completed before sampling.

The core sample intervals are marked by a Cliffs geologist, and the core is split lengthwise with a hydraulic splitter. Core has been split since 2003, with the exception of the 2017 drilling program, when core was fully consumed due to time constraints. Cliffs maintains a document listing historical core saves.

Samples are taken to represent the full height of a 45-ft mining bench, broken by geological contacts. Sample lengths are dependent on the angle of the hole, and sample beginning/end points are selected to coincide with the top and bottom of the 45-ft mining benches. The sample length is ideally the height of a mining bench at 45 ft but ranges from 5 ft to 70 ft within a defined geological domain. The average length of sample intervals at the Tilden is 40 ft. The large range in sample lengths is due to samples matching a bench width; in angled holes the distance between bench intersections is greater than 45 ft.

Core is stored within a locked warehouse at the mine site before processing and is transported to the Tilden laboratory, where it is kept within the laboratory building until processed. The Tilden Mine core storage facility is locked at all times in the absence of authorized Tilden personnel.

Each sample is labeled to include a unique identifier including the hole number, footage interval, and bag number sequence. A tag is put inside the bag, and a second tag is tied to the bag on a string. The sample number is a unique identification number (ID) that ties it to a specific drill hole and interval and which cannot be mistaken for other types of samples. Alphabetical characters identify the next sample in sequence for each hole. For example, the interval of 0 ft to 45 ft from drill hole 23679 would be sample 23679 0-45A; the next sample would be 23679 45-90B for the interval of 45 ft to 90 ft. All sample parts and splits are stored at Cliffs Technical Group (CTG) research laboratory facility.

7.1.6 Drilling, Sampling, or Recovery Factors

There are no known drilling, sampling, or recovery factors that would affect the reliability of the analytical results described in Section 9.0 of this report. Core recovery is generally very good with greater than 90% core recovered. There are localized areas where the iron formation is oxidized to varying degrees, which can impact core recovery and sample quality. Oxidized zones are associated with proximity to fault zones. Rock quality is generally very good per section 7.1.1. Localized zones of poorer rock quality exist adjacent to fault zones.

SLR understands that the practice of taking long drill core samples has been adopted to address laboratory processing constraints and recommends addressing those constraints at the Tilden laboratory. SLR recommends that Cliffs undertake a study where samples are consistently taken at 15 ft intervals, broken by geology, to examine how the variance of the assays are affected, and how the material type designation, based on a calculation of those variables, compares against the material type designation of longer samples.

The Tilden BIF is well sampled (over 90%). Unsampled intervals within the modeled BIF unit represent either BIF, intrusive, overburden, or backfill material. By length, approximately 80% of drill hole samples logged as intrusive material within the BIF (small dikes) is unsampled, and overall, drill hole intervals logged as intrusive represent approximately 3% of the total intervals within BIF units. SLR recommends sampling intrusive material too small to be modeled or segregated when mining (dilution).

7.1.7 Drilling Results and Interpretation

The drilling has taken place over more than 50 years and has defined a large iron ore deposit at Tilden. It is SLR's opinion that the drilling and sampling procedures at Tilden are adequate for use in the estimation of Mineral Resources. There are no known drilling, sampling, or recovery factors that would affect the reliability of the analytical results described in Section 8.0 of this TRS.

7.2 Geological Mapping

Geologic structures are locally digitized annually from light imaging, detection, and ranging (LiDAR) data that are draped with digital orthophotography. Fault zones are digitized on the screen and verified through field observations of bench faces. Data, including fault or joint orientations and bedding planes, are compiled and stored in Maptek Vulcan™ (Vulcan) mine planning software. The base purpose of the mapping is for monitoring of local geotechnical zones; however, the data were used where possible to inform the geologic model (see section 11.3).

7.3 Hydrogeology and Geotechnical Data

Refer to section 13.2 Pit Geotechnical and section 15.4 Tailings Disposal for this information.

8.0 SAMPLE PREPARATION, ANALYSES, AND SECURITY

8.1 Sample Preparation and Analysis

8.1.1 Sample Preparation

Sample preparation and analysis of diamond drill core and blast hole samples for use in resource estimation is conducted at the onsite Tilden laboratory. The Tilden-owned facility is accredited to International Organization for Standardization (ISO)-9001:2015 for its quality management system.

Upon receipt of samples to the Tilden laboratory, drill hole samples are oven dried, crushed to -3" in a jaw crusher and to -¼ in. in a cone crusher, then split using a Gilson SP-1 sample splitter.

A subsample from 15 lb to 50 lb is reduced to 100% passing -10 mesh with a roll crusher and then cone mixed on a five-stage, inverted cone mixer. A 50 g subsample is taken, pulverized to -100 mesh using a plate pulverizer, and further split to a 25 g sample, which is analyzed for crude iron content (crudefe); two 10 g subsamples of the crude material are used for x-ray fluorescence (XRF) and Satmagan analysis.

A second and a third 600 g subsample of material passing -10 mesh roll crusher are collected using a riffle splitter. One of the samples is archived, and the second is submitted for a bench flotation test. A procedural flow chart is shown in Figure 8-1.

8.1.2 Sample Assaying and Analytical Procedures

Samples are analyzed at the Tilden laboratory. The laboratory is not independent of Cliffs. Sample analysis includes the evaluation of head samples and the production of a flotation concentrate. The flotation concentrate fractions undergo further analysis for various properties.

The bench flotation test has been developed for and is unique to Tilden (procedure 0903Q0200, Figure 8-2). It has been customized to mimic Tilden's plant flotation cycle. It involves grinding material in a miniature rod mill for a specific time and producing a concentrate material from a mixture of sample, test water, caustic solution, and sodium hexametaphosphate (dispersant) within a Wemco flotation machine. The Tilden laboratory technician operating the machine produces six concentrate products (A to F) similar to the plant cycle, which are measured and recombined for grind analysis and to record the wtrec. Twenty-five gram subsamples of the concentrate material are submitted for analysis of iron content (confe) by titration method, magnetic iron content (magfe) using a Satmagan instrument, and SiO_2 (consio2), CaO, MgO, Mn, Al_2O_3, and P (conphos) by XRF.

The principal variables used in the determination of Mineral Resources at Tilden are confe, consio2, conphos, wtrec, and crudefe. The bench flotation test is described in more detail in Section 10.0 of this report.

Over time, several procedural changes have taken place at the Tilden laboratory, including the sample grind time, and type and amount of the starch additive during the bench flotation test. These changes have been initiated to align with changing plant procedures, incorporate new technology, and address processing delays and quality issues at the Tilden laboratory and in the mine. They have been applied to drill and blast hole samples differently, and at different times. In addition, at some point in the past, to better align wtrec results in blast hole assays with plant readings that reference natural moisture instead of the dried value from the laboratory, a standard +3% was added to the blast hole wtrec laboratory values. There is no record of the exact timing of implementation, or whether blast hole data prior to implementation was affected. The impact of these procedural changes, as well as variation in the flotation test operation by different laboratory technicians (which has a large manual component that is difficult to standardize), has not been well documented or monitored despite being long suspected of contributing to bias between sample results. Cliffs is working to enhance the sample database attributes, which would allow the impact of these changes to be better understood and quantified, as well as decouple data manipulation from original assay results. SLR strongly supports these initiatives and presents some preliminary observations in Section 9.0.

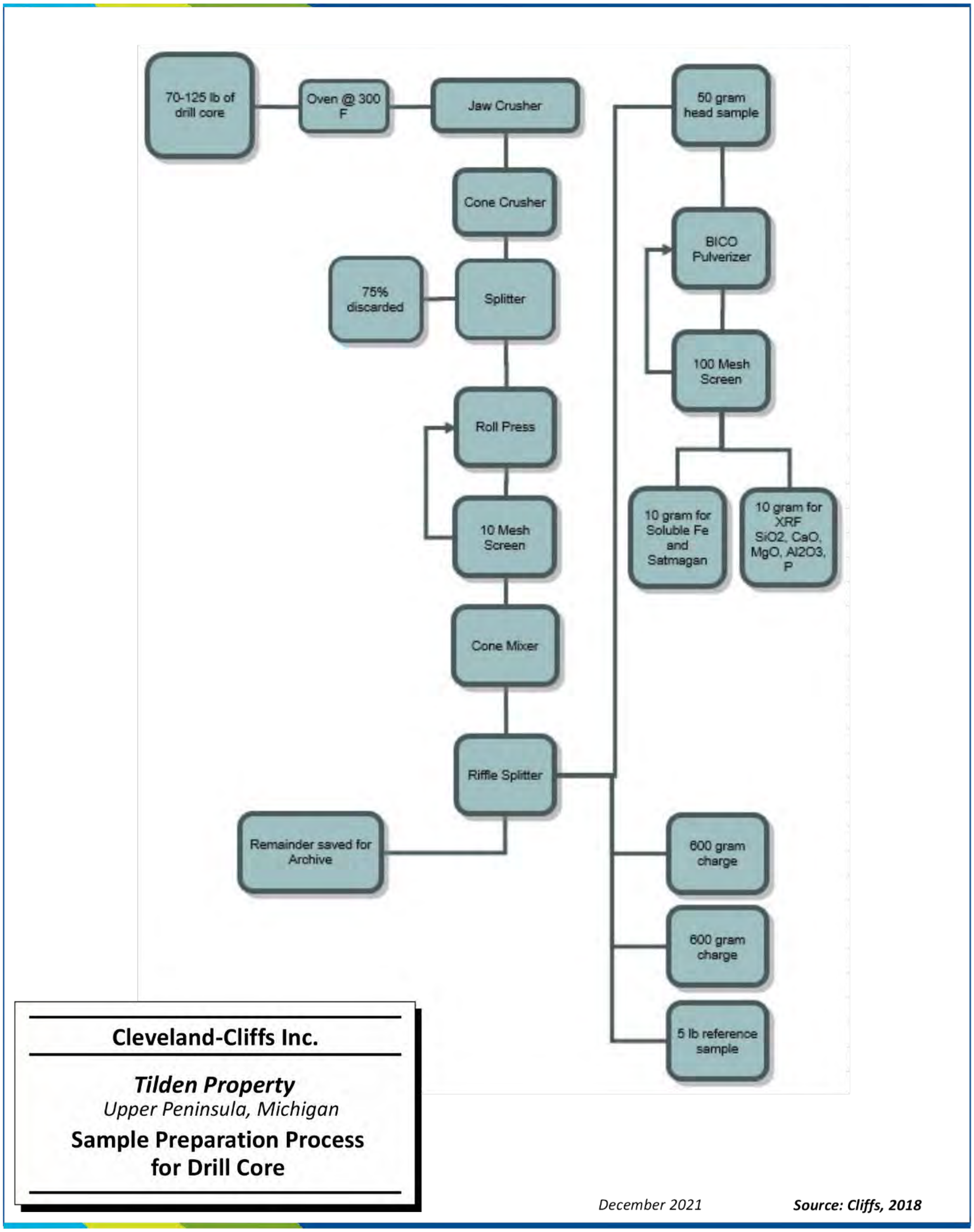


Figure 8-1: Drill Hole Sample Preparation Process

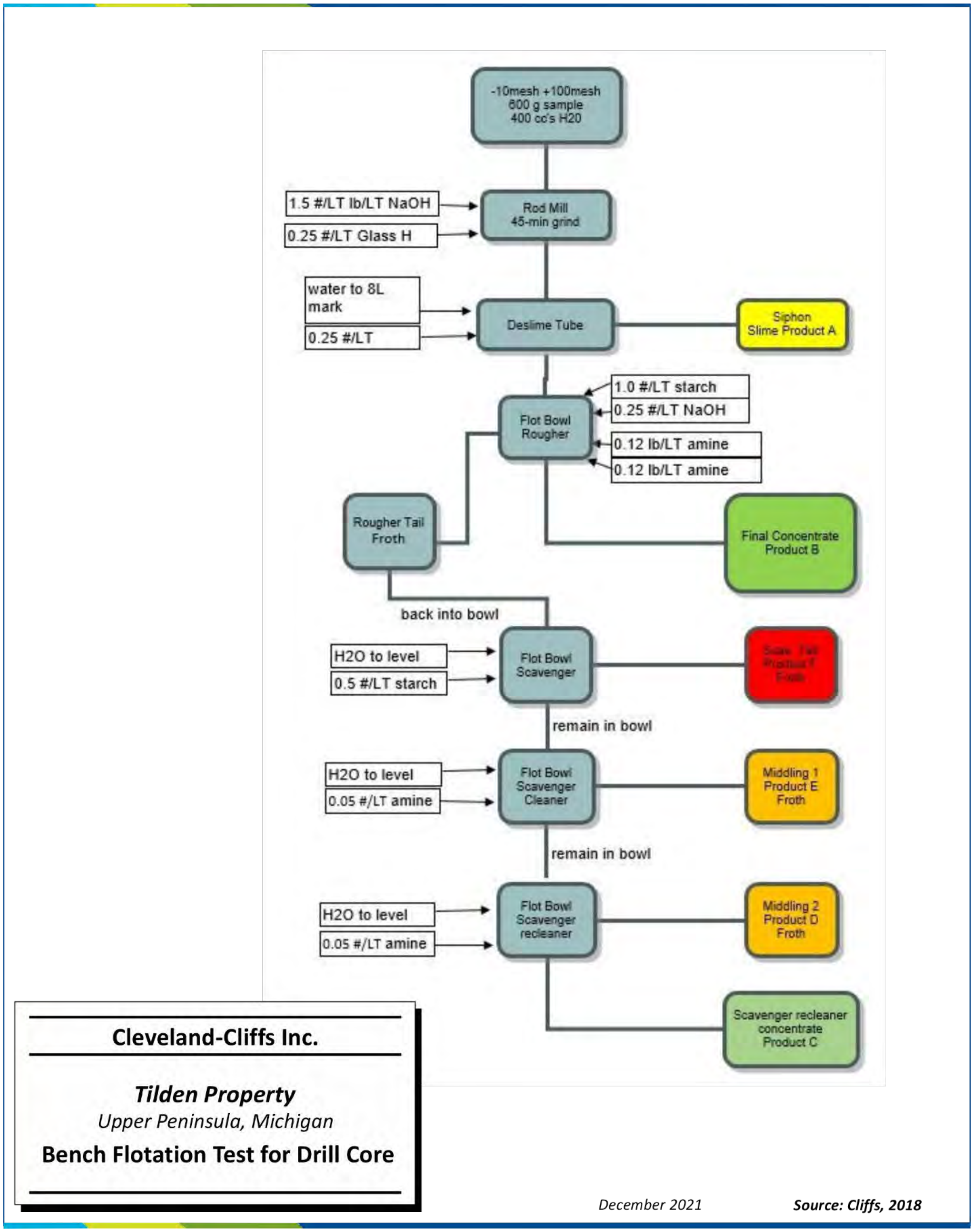


Figure 8-2: Drill Core Bench Flotation Test Process

8.1.3 Density Analysis

Tonnage factors applied at Tilden are based on density values from 116 samples tested by water immersion from four material types at the adjacent, on-strike Empire Mine (Nummela and Anderson, 1970). Bulk hand samples ranging from 10 lb to 23 lb were taken from blast patterns with a wide range in magnetic and soluble iron. These samples had a large variance in observed grain size, lithologic characteristics, and mineralogy that is found in the clastic, carbonate, and silicate facies of the Empire Mine. Samples were selected that were relatively homogeneous, visibly unfractured, and unweathered. SLR notes that no allowance was made for jointing and fracturing. While individual immersion results are tabulated on historical reports, exact spatial distribution of the samples has not been established.

The following regression calculation for iron formation was developed using crudefe:

Tonnage Factor (cubic feet per long ton) = 13.45 – (0.0792 * crudefe)

Average tonnage factors for non-iron formation material were also determined.

8.1.3.1 Validation of Tonnage Factor Equation

In 2021, the Tilden Mine Engineering Department undertook to compare the different onsite tonnage measurements, in part, to assess the validity of the tonnage factor equation. Cliffs compared the following measurements representing 2019 and 2020 mined material:

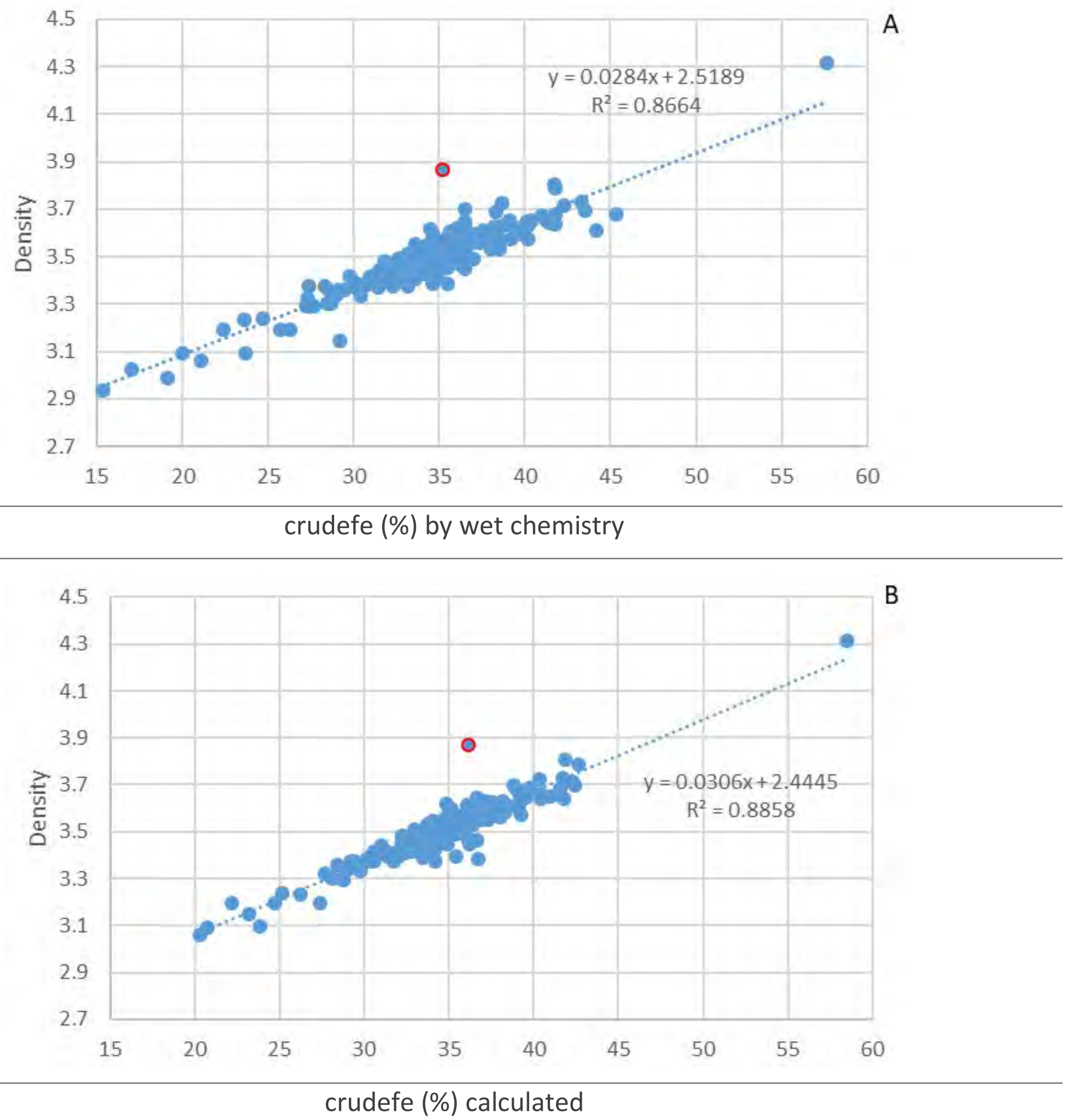
1. Reported tons from the belt scale.
2. Dispatch recorded truck tons measured by onboard payload scales.
3. Predicted tons measured from the volume of material mined multiplied by the estimated tonnage factor for each lithology.

Overall, reported tons were determined to be 1.5% higher than predicted tons, although local area differences ranged from -9% to +6%. Local variances in predicted to reported tons were explained by an overprediction of overburden in some areas, underprediction of *in situ* material (due to underreported presence of old fill ramps) in other areas, and small inaccuracies in the topography due to overflow from higher benches.

In parallel to this validation work, the geology department at Tilden and CTG undertook additional sampling work to further confirm that the regression equation developed using Empire samples, which are relatively unoxidized compared to Tilden material, is suitable for use at Tilden.

A total of 217 samples of crushed -10 mesh (coarse reject) material, representing a suite of material types, soluble iron content, and trace-element chemistry, and selected from 22 historical diamond drill holes across the Tilden pit were collected from storage for testing at CTG's laboratory. The laboratory, located in Ishpeming, Michigan, provides in-house analytical services for all of Cliffs' iron ore operations. The CTG laboratory is accredited with ASQ/ANSI ISO-9001:2015 for its system of quality management. The most recent certificate renewal was completed in 2021.

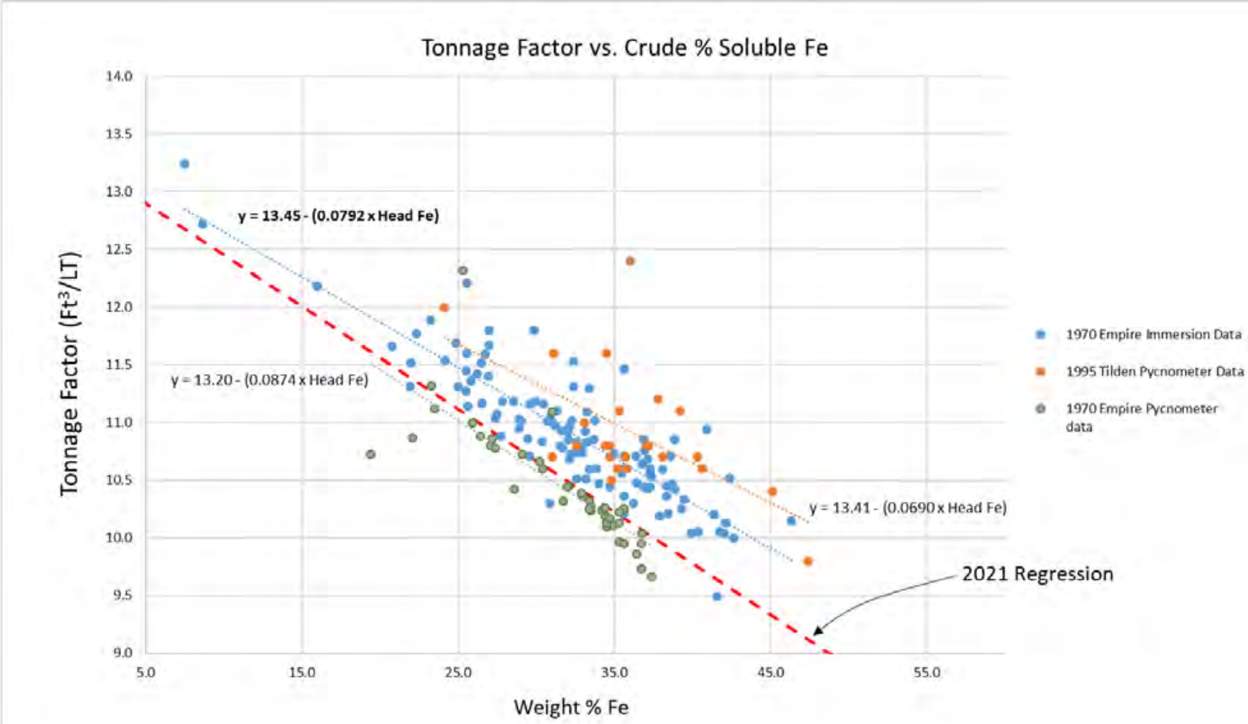
Results were plotted against crude soluble iron content (crudefe; determined using both wet chemistry and calculated methods), linear regression lines were plotted and are shown in Figure 8-3. Comparisons considering material type and trace element chemistry were also completed (not shown).



Source: Orobona (2021)

Figure 8-3: Least Squares Regression Plots of (A) Soluble Fe by Wet Chemistry versus Density and (B) Soluble Fe Weight Calculated from Bench Flotation Products versus Density

The regression model determined using Tilden's data is nearly identical to the tonnage calculation based on a similar pycnometer study conducted in 1970 for the nearby Empire Mine, and based on 41 pycnometer tests, and as expected, below the 1970 Empire immersion data defining the current tonnage factor equation (Figure 8-4).



Source: Orobona (2021)

Figure 8-4: Comparison of Empire Immersion Tonnage Factor Regression Used in Tilden Model and Other Density Studies

As the Empire and Tilden pycnometer sample regressions virtually overlap, Cliffs has presumed that a regression of Tilden sample immersion data should similarly overlap with that of Empire samples, where based on similar rock types and assuming a similar porosity. These results, alongside the volumetric analysis completed by Tilden Mine Engineering Department, support the continued use of the tonnage factor regression equation at Tilden.

8.2 Sample Security

Samples collected and submitted to the Tilden laboratory are accompanied by submission forms. There is no offsite laboratory, and samples do not leave the Tilden property.

Digital copies of drill core and blast hole analysis from the Tilden laboratory are stored in a Microsoft (MS) Access databases with restricted access and regular backups. There is a manual component in transferring data between different departments and users, and the system does not include automated checks of data validity or integrity and allows for authorized users to manipulate entries. SLR understands that Tilden is in the process of migrating to an acQuire system, which will integrate additional security and data integrity measures and is accompanied by a data verification process at the point of transition. SLR strongly supports this initiative.

8.3 Quality Assurance/Control Procedures

Quality assurance (QA) consists of evidence to demonstrate that the assay data has precision and accuracy within generally accepted limits for the sampling and analytical method(s) used in order to have confidence in a Mineral Resource estimate. Quality control (QC) consists of procedures used to ensure that an adequate level of quality is maintained in the process of collecting, preparing, and assaying the exploration drilling samples. In general, QA/QC programs are designed to prevent or detect contamination and allow assaying (analytical), precision (repeatability), and accuracy to be quantified. In addition, a QA/QC program can disclose the overall sampling-assaying variability of the sampling method itself.

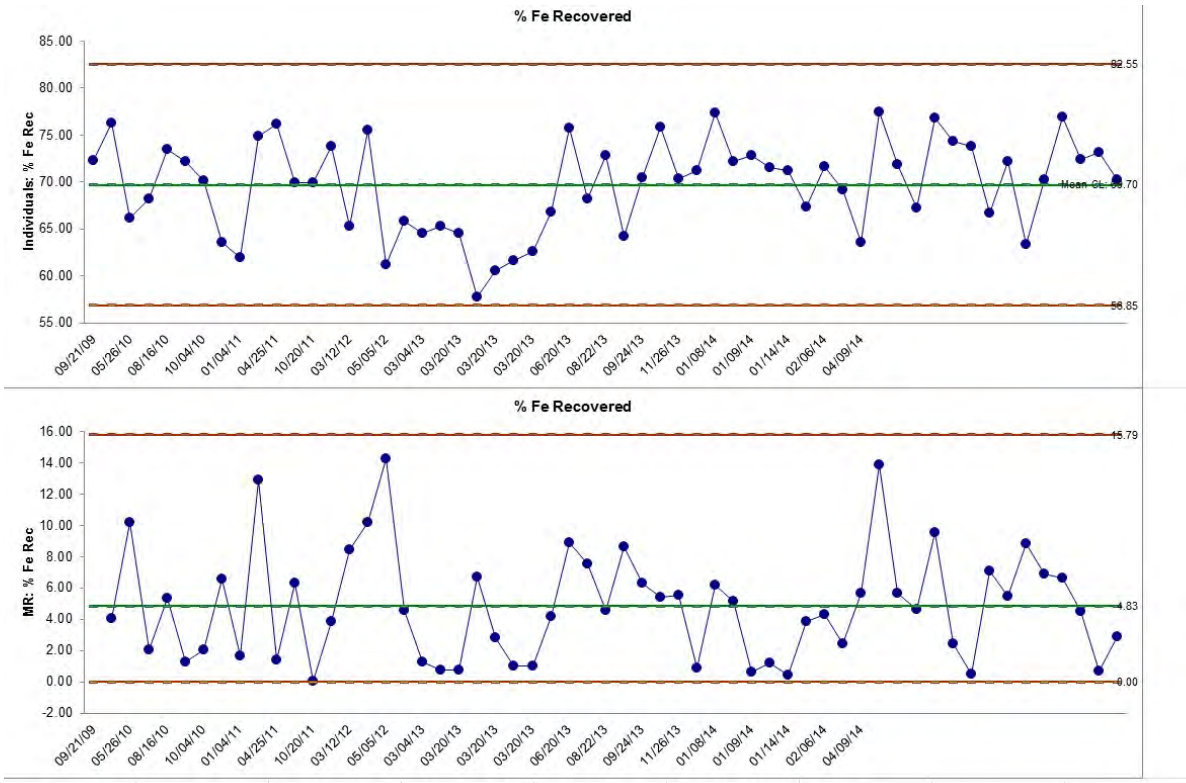
The standard operating procedure at Tilden does not prescribe the inclusion or analysis of field, coarse, or pulp duplicate samples, and no QA/QC samples are included with regularity alongside batches of exploration drill or blast hole samples. An in-house reference sample, the Martite Master Composite (the Standard), is analyzed by the Tilden laboratory monthly using the same protocols as applied to the blast holes. Results are graphed against the average grade of the dataset, evaluated considering the range of accepted values represented by three standard deviations (SD) of the entire population of data, and compared to accepted and historical values as part of the internal laboratory QA/QC program. The Standard was generated in the early 1980s and is based on a composite of material collected over different areas of the Main Pit at that time, crushed, mixed, and stored in 60 gal drums, which are split as needed into batches of approximately five hundred, 600 g samples. Due to the custom nature of the bench flotation test and associated custom equipment, check assays at external laboratories are not performed. Coarse blank reference samples are not relevant at Tilden and are not used. The Tilden laboratory internal QA/QC program includes equipment calibration and monitoring.

Two additional reference standards have been developed and are included as part of the ore control procedures. SLR understands that the associated datasets at present are quite small, and that the standards are of lower quality than the Martite Master Composite. SLR did not review the protocols or results of these reference materials.

Due to the relatively small exploration drilling and sampling programs undertaken annually at Tilden, it is difficult to include reference material alongside exploration samples at a rate that is both statistically significant, as well as representing no more than 5% of the total sample submission, which is important as the Tilden laboratory is currently operating at maximum capacity, and the bench flotation test is time consuming to complete and prioritizes grade control samples. As both drill and blast holes are analyzed at the same laboratory, and as blast holes are included in the Mineral Resource estimate in a limited capacity, SLR suggests including coarse duplicate tests at a rate of 1 in 50 with blast hole sample submissions. Although the preparation stage of these samples is not identical to exploration drill hole samples, general conclusions could likely be made by reviewing these results.

8.3.1 Metallurgical Reference Samples

Monthly Martite Master sample results are charted and tested for failures compared to previous results. An example of such control charts and test rules is illustrated in Figure 8-5.



Tests for Special Causes - Individuals: % Fe Rec								
Number of Data Points Failing Tests = 0								
Observation No.	Test 1: 1 point more than 3 Stdev from CL	Test 2: 9 points in a row on same side of CL	Test 3: 6 points in a row all increasing or all decreasing	Test 4: 14 points in a row alternating up and down	Test 5: 2 out of 3 points more than 2 Stdev from CL (same side)	Test 6: 4 out of 5 points more than 1 Stdev from CL (same side)	Test 7: 15 points in a row within 1 Stdev from CL (either side)	Test 8: 8 points in a row more than 1 Stdev from CL (either side)

Figure 8-5: Example of Control Charting of the Monthly Martite Master Composite

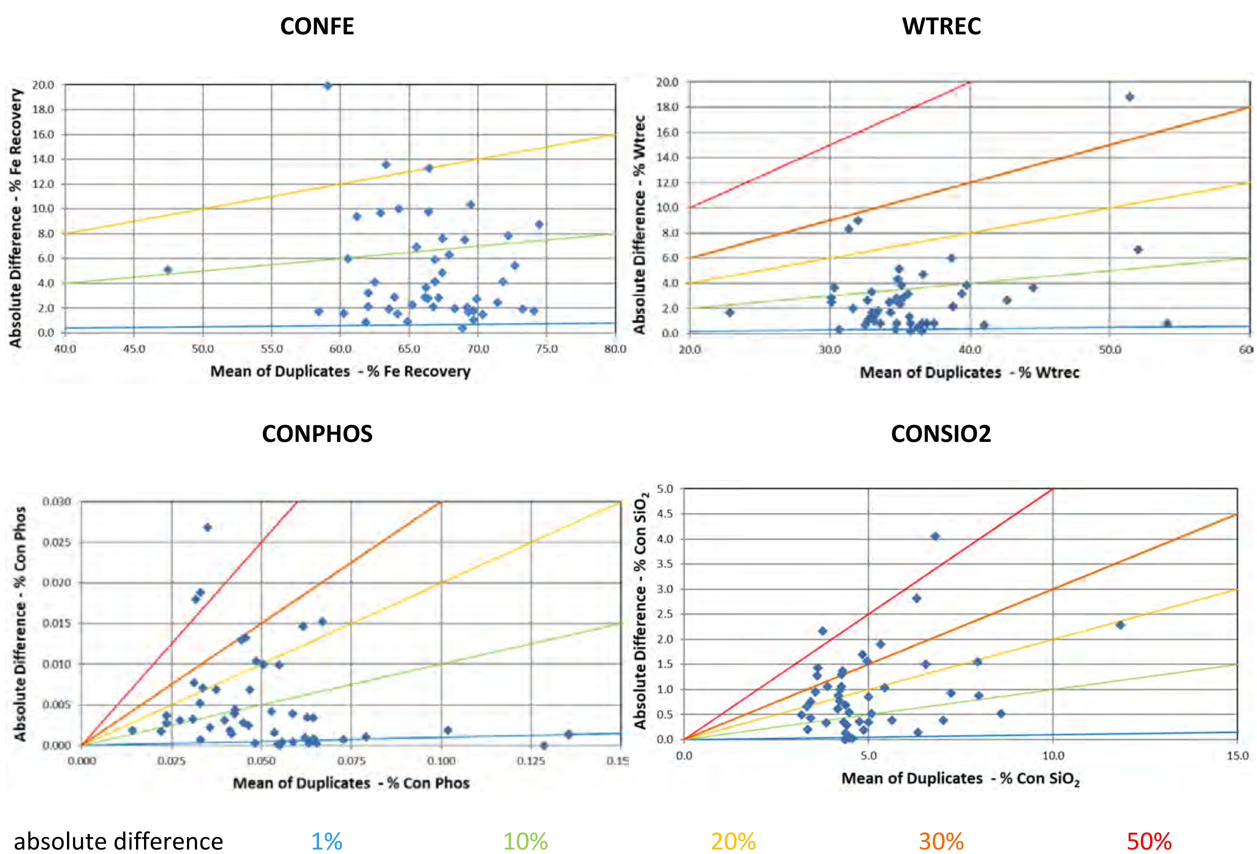
Control limits are based on the common approach for Shewhart control charts. For individual samples, control limits are Mean $_{data}$ ± 2.66 * Mean $_{moving\ range}$. For the moving range charts, control limits are 3.267 * Mean $_{moving\ range}$. In both cases, 1σ and 2σ are $^1/_3$ and $^2/_3$ of the difference between the mean(s) and control limits, respectively. This approach is commonly used in statistical process control software and narrows control limits relative to three standard deviations (SD) from the mean of the data.

When a failure is reported for a Standard test, an investigation is initiated by the Laboratory Supervisor. The QC Technician who performed the test is interviewed. If nothing out of the ordinary was observed during the bench process or analysis, then associated equipment will be checked for malfunctions using available standards and test equipment. If no equipment is found to be in error or disrepair, the Martite Standard will be run again. This could be by the same QC Technician or by another, depending on the suspected cause and resource availability. The re-test may be monitored by the Laboratory Supervisor. If the re-test results remain outside of control limits, the Laboratory Supervisor will consult with process engineers and continue re-testing and equipment evaluation. In some cases, the Laboratory Supervisor and engineers may agree that the change is due to process water, a change in reagent supply, or other change outside of the laboratory's control.

8.3.2 2019 Duplicate Sample Program

During 2019, 50 blind coarse reject samples representing approximately 6% of exploration drill hole samples since 2014 were analyzed, and results were compared to the original assay data for the key economic variables of crudefe, wtrec, and consio2, confe, and conphos. The coarse reject samples were accompanied by 10 blind Standard samples, which were analyzed using the drill hole sample procedure. Results were compiled in an internal memorandum by Cliffs' Corporate Principal Geologist, Orobona (2020).

SLR reviewed the graphs, discussions, and conclusions outlined in Orobona (2020). Figure 8-6, compiled from the Orobona 2020 report, displays graphs of the absolute difference of the coarse duplicate pairs against the mean grades of each sample pair for selected variables. In reviewing these results, all sample pairs with an absolute difference greater than 10%, 20%, and 30% were considered to have moderate, poor, and very poor precision, respectively, and the duplicate campaign results were considered together when assessing the overall precision of the variable.



Source: Orobona, 2020

Figure 8-6: Absolute Difference of Coarse Duplicate Pairs

The results point toward a higher precision of crude sample pairs (crudefe and crudephos, not shown) than concentrate samples that have undergone the bench flotation test. Little bias was noted; however, a slight positive bias was observed in the 2019 consio2 and conphos results, as compared to the original analysis. Orobona (2020) noted that a 5% positive bias was also observed in the grind of samples prior to flotation, postulating that the higher grind results may have contributed to the bias in concentrate samples. Specific conclusions derived from this program, and recommendations for future work are listed at the end of the section.

Expected values of principal variables of the Standard submitted alongside coarse duplicate sampled during 2019 are presented in Table 8-1. The expected values were calculated from the average value and SD of the 10 submitted samples. For each variable, material was considered to have failed if the variable reported outside the confidence limits of ±3SD from the expected value, or two consecutive values outside ±2SD.

Table 8-1: Expected Values of and 2019 Performance of Principal Variables of Martite Master Composite Samples
Cleveland-Cliffs Inc. – Tilden Property

Variable	Expected Value	(±2SD)	No. Failures	Observation
confe (%)	67.4	66.6 – 68.2	0	Good performance
consio2 (%)	3.8	2.7 – 4.9	0	Good performance
conphos (%)	0.0244	0.0230 – 0.0259	0	Good performance
wtrec (%)	37.5	34.2 – 40.8	0	Good performance
crudefe (%)	35.6	35.3 – 35.9	1	Inconclusive

Although all principal variable results from the Standards show acceptable agreement with the expected value, the sample size is too low for robust statistical analysis. Considering the small size of annual drilling programs at Cliffs, SLR recommends supporting the drill hole sample performance by reviewing performance of the blast hole QA/QC program. SLR recommends increasing the frequency of standard submission with blast holes at the laboratory to obtain a sample size of 25 annually.

SLR also recommends that Cliffs prepare a second reference standard, with expected values approximating the cut-off grades for deleterious variables consio2 and conphos, in order to measure the precision of results around ore delineation. SLR recommends that Cliffs target a submission rate of 25 annually (50 standards total) and submitting the Standards in random order and blind to the laboratory.

8.3.3 Conclusions and Recommendations

SLR presents the following conclusions and recommendations of the QA/QC program at Tilden:

8.3.3.1 Conclusions

- In the SLR QP's opinion, the sample preparation, analysis, and security procedures at Tilden are adequate for use in the estimation of Mineral Resources.
- The lack of regular submission of QA/QC samples alongside samples used to support Mineral Resources is outside of industry-standard practice, and improvements are warranted.
- The 2019 QA/QC program as designed and implemented by Cliffs has been helpful to understand the precision and accuracy of sample analysis at the Tilden laboratory, which is used to support the assay results within the database, and to confirm that the database is suitable for use in estimating Indicated and Inferred Mineral Resources.

- The following conclusions relate specifically to the 2019 QA/QC program results but can be applied to the assay program as a whole, with caution:
  - Good repeatability was observed between the coarse duplicates of crudefe, crudephos, and wtrec values at all grade ranges tested.
  - Very good repeatability was observed in confe duplicate pairs above 61%. Low-grade or waste samples had poor repeatability.
  - Poor repeatability of consio2 values was observed in all samples within the grade range tested (3% to 41%). Precision decreased with increasing consio2 values.
  - Moderate to poor repeatability of conphos values was observed, with 20% of samples returning an absolute difference greater than 20%. Precision was observed to improve with conphos values above 0.075%. The lowest precision was observed between sample pairs with a mean conphos value from 0.025% to 0.075%. A low bias was observed in the 2019 duplicate sample batch as compared to the original samples analyzed from 2014 to 2018.
  - Although precision of the timed grind in the rod mill is good, a high bias in the 2019 duplicate sample batch was observed, which may contribute to the bias observed in downstream concentrate sample variables.

8.3.3.2 Recommendations

1. Develop and implement a robust QA/QC program at Tilden for both exploration drill hole and blast hole samples.
2. Address the capacity issues at the Tilden laboratory to allow the sample analysis to be completed in a timely manner, and to facilitate the inclusion of QA/QC samples.
3. Include coarse duplicate samples in the drill hole and blast hole sample stream at a rate of 1 in 50, and monitor results regularly. Use the blast hole results to support small exploration drilling programs, while considering procedural differences. Create a standard operation procedure for the inclusion of field, coarse, and pulp duplicate samples and develop a set of actionable, performance-based criteria. Work closely with the laboratory to improve the precision of the bench flotation test.
4. Include field duplicate samples at a rate of 1 in 50 in the drill hole sample stream.
5. Increase the submission rate of the Standard to achieve an annual sample size of 25. Ensure submission is blind to the laboratory.
6. Develop a second reference standard with expected values approximating the cut-off grades for deleterious variables consio2 and conphos, in order to measure the precision of results around ore delineation. Submit at a rate of 25 samples annually, and ensure submission is blind to the laboratory.
7. Investigate the poor repeatability of conphos and consio2 values observed in the 2019 duplicate sample campaign, and work with the Tilden laboratory to improve precision, with focus on values within a grade range of 75% to 125% of the cut-off grades for these deleterious variables.
8. Investigate the low bias observed in the duplicate conphos data set, and review any long-term trends within the Tilden laboratory. Consider the impact of grinding.
9. Include magnetic samples in future duplicate programs that assess crude magfe content.

9.0 DATA VERIFICATION

9.1 Site Verification Work

During 2019, a data verification exercise was performed within the LOM plan area. Of the 528 drill holes in the Tilden (then) MS Access database, 25 historical and recent drill holes (4.7%) were selected for data verification.

Geologic logs from ledger books and assay results in MS Excel spreadsheets obtained directly from the Tilden laboratory were compared against the MS Access database for discrepancies in:

- Collar naming and coordinates, and downhole surveys (where available)
- Geological coding
- Analytical results

The MS Access database itself was also queried for irregular or impossible values, irregular survey deviation results, and from/to interval conformance.

Integrity issues were limited to isolated value discrepancies and minor survey differences and were corrected in the master database.

9.2 QP Verification Work

Personal inspections were carried out by SLR personnel during the site visits, including a visit to the core shack where SLR examined examples of drill core, inspected several examples of material types, and reviewed logging and sampling procedures. Visits were made to the operating Main Pit where the nature of the mineralization was observed, stockpiles of various iron formation material were inspected, and the blast hole mapping and sampling procedures were reviewed.

SLR also visited the onsite Tilden sample preparation and analysis laboratory, reviewed sample database security protocols, and participated in a tour of the Plant.

During the site visit, SLR had an opportunity to inspect the site, talk to mine and laboratory personnel, and collect relevant information for Mineral Resource estimation. In addition to personal inspections of core, SLR also spot checked material-type designations against several drill core photos.

SLR completed the following data verification procedures on the provided drill hole database:

- A search for highly unlikely or impossible values in the drill and blast hole databases. These values were removed or adjusted in the database.
- A search for missing drill holes.
- A search for duplicate or overlapping samples or drill holes.
- A comparison of flotation ore coding against original logging.
- A search for odd or irregular drill and blast hole collars, and downhole survey positions.

Unsupported data was revised or removed from the drill and blast hole datasets prior to estimation.

SLR compared drill and blast hole composite samples to examine any bias present due to changing preparation and analysis procedures over time and between the data types. Comparisons by procedure or time were not possible due to the organization of attribute data. SLR has recommended that this information be collated within an attribute database, and Cliffs is currently undertaking to do so.

In order to pair blast hole samples and drill hole composites, SLR completed a nearest neighbor (NN) estimate using a search ellipse equal to the block size of 25 ft x 25 ft x 45 ft. Blocks estimated using both data types were considered as twin pairs. Paired data was compared using scatter plots and quantile-quantile (QQ) plots, both as a whole, and by individual domains. In general, the pairs demonstrate a high degree of scatter. Basic statistics of the paired data are summarized in Table 9-1, and small differences in mean value, in favor of either blast or drill hole data, are apparent. Blast hole data appears to under-represent confe and crudefe (very slightly) values when compared to drill hole data, while conphos values appear to be over-represented in blast hole data when compared to drill hole data.

Figure 9-1 presents paired drill and blast hole samples in a scatter plot, colored by consio2 values. The scatter shows reasonable correlation, with few outliers at consio2 values below 10%. Pairs high in consio2 tend to have low concentrate grades as well as poor correlation. A small bias, in favor of drill hole results, is observed in comparing mean values of the twin pairs (62.5% versus 63.2%) and in the QQ plot (not shown). SLR notes that the bias is still observable when values below 55% confe are removed.

Table 9-1: Basic Statistics of Twinned Drill and Blast Hole Samples
Cleveland-Cliffs Inc. – Tilden Property

Variable	Source	Count	Mean (%)	CV	Min. (%)	Max. (%)
confe	BH	1,543	62.5	0.1	34.3	74.4
confe	DH	1,543	63.2	0.1	17.7	68.5
conphos	BH	775	0.043	0.596	0.006	0.221
conphos	DH	775	0.038	1.072	0.002	0.659
consio2	BH	1,543	6.9	0.9	1.1	43.4
consio2	DH	1,543	6.9	0.9	1.6	65.8
crudefe	BH	1,539	35.6	0.1	3.5	64.8
crudefe	DH	1,539	36.2	0.1	19.9	55.6
wtrec	BH	1,542	38.2	0.2	16.1	79.5
wtrec	DH	1,542	38.1	0.2	7.1	75.5

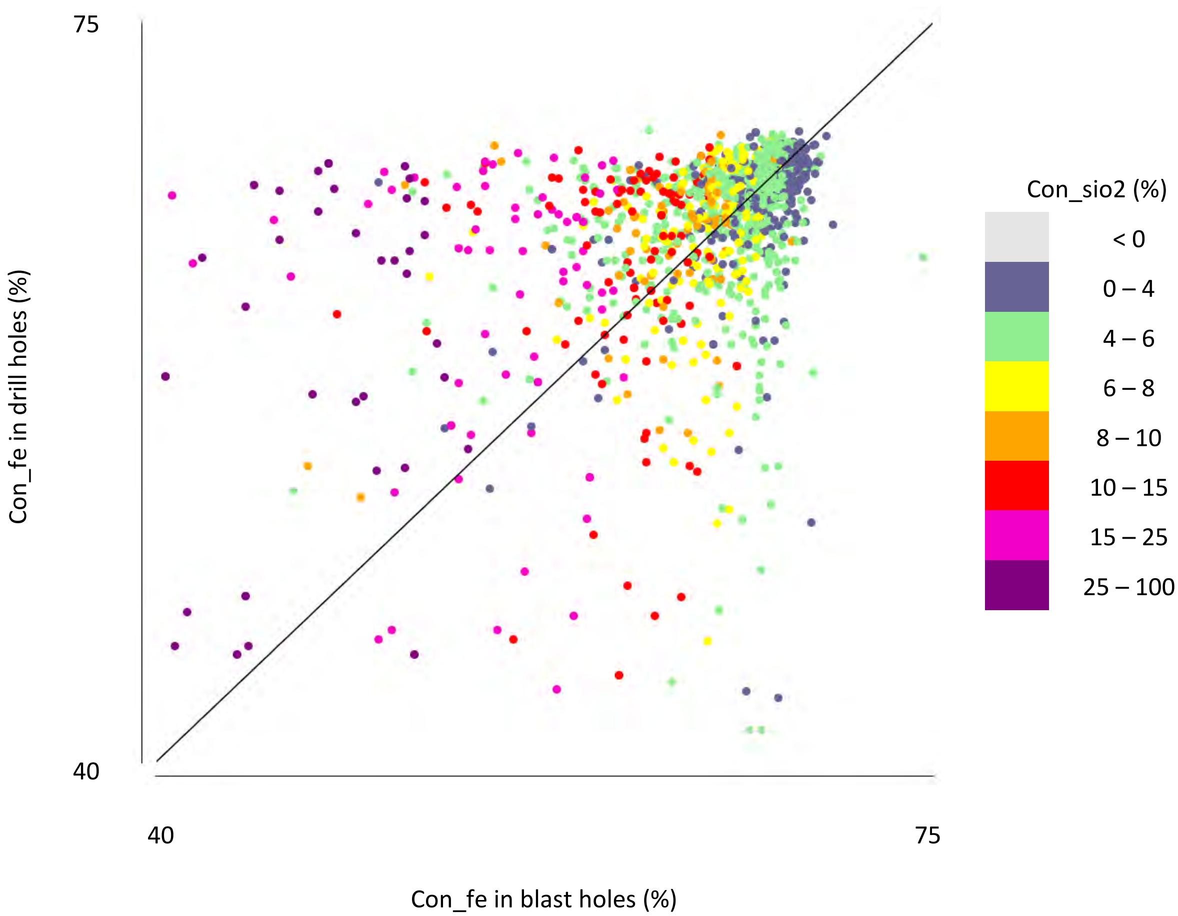


Figure 9-1: Scatter Plot of Twinned Drill and Blast Hole Sample Pairs on confe, Colored by consio2 Values

While a bias was expected in favor of blast hole data, as a standard +3% has been added to the blast hole wtrec values since an undetermined time in the past, to better align laboratory results (dried) and plant readings (natural moisture), no bias was observed. This is likely due to the linear application of the 3%, and the high degree of scatter shown overall.

The best correlation of all variables was shown between drill and blast hole crudefe (not shown). Good correlation of conphos values is also observed, despite a high bias in favor of blast hole data. A scatter plot is shown in Figure 9-2, where it is observable that pairs of conphos values in the Main Pit Carbonate domain showed poorer correlation than other domains and the highest overall bias. SLR notes that conphos variables represent the smallest sample set, due to absent conphos values from older drill holes. SLR recommends repeating this analysis once this attribute data is stored in the database, to allow filtering of older drill holes in other variables to determine if the correlation of the different variable pairs improves.

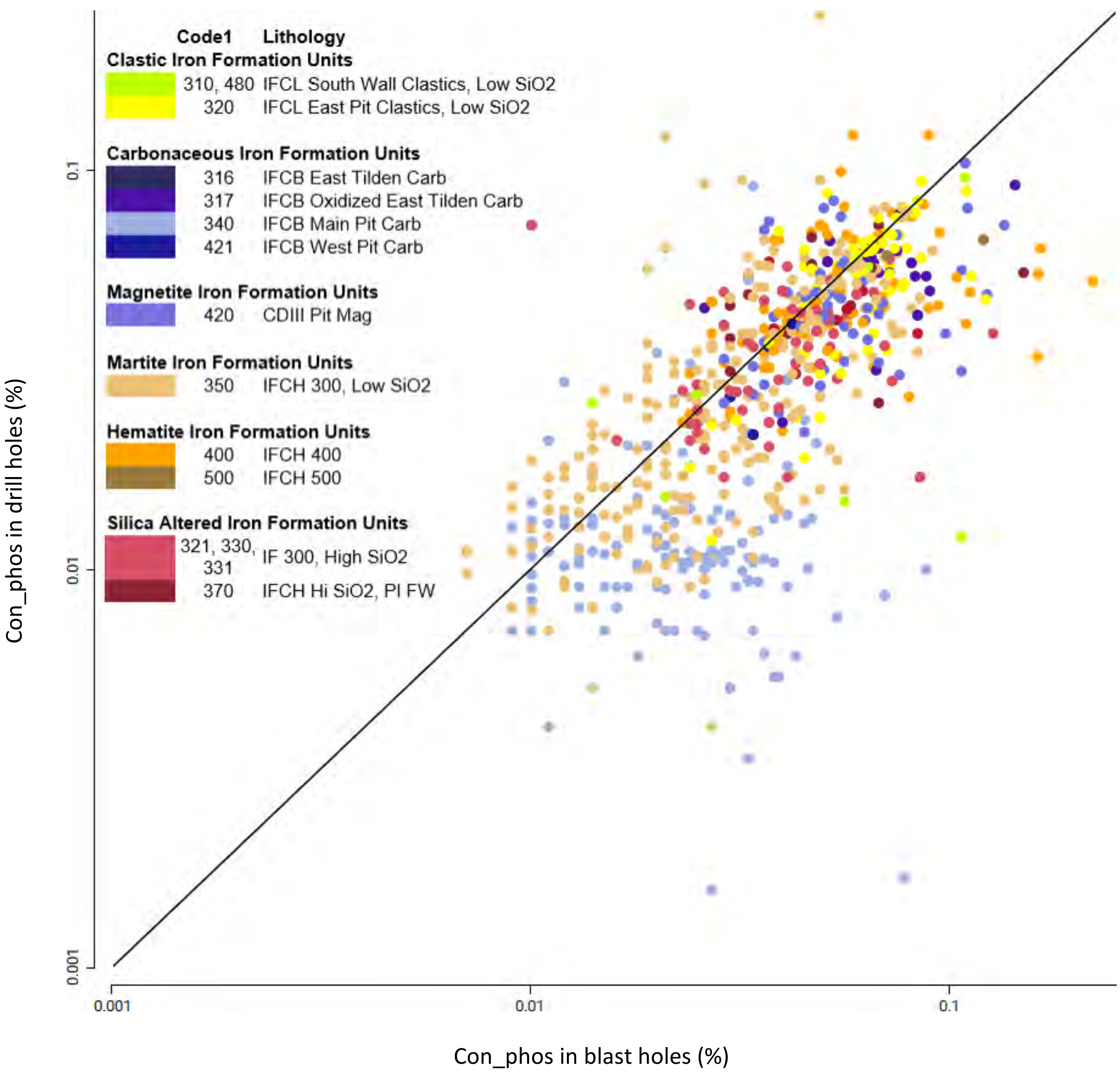


Figure 9-2: Scatter Plot of Twinned Drill Hole and Blast Hole Sample Pairs on conphos Colored by Domain

SLR offers the following conclusions regarding the drill hole and blast hole twin analysis:

- There is a moderate to good correlation of all variables between blast hole and drill hole twinned samples.
- Correlation of confe values decreases for samples with high consio2 values.
- The known bias of wtrec in favor of blast hole data is not observable in the paired dataset.
- A high bias, in favor of blast holes, is observable in the conphos variable; however, overall comparison is good.

SLR offers the following recommendations regarding the drill hole and blast hole twin analysis:

1. Repeat this analysis upon incorporation of attribute data such as year, starch type, and grind time, to determine if correlations in paired data can be improved following the removal of select data types.
2. Explore the bias observed in the conphos twinned data and continue to work with the laboratory to bring the datasets into alignment.

The QP is of the opinion that the Tilden database is adequate for the purposes of estimating Indicated and Inferred Mineral Resources.

10.0 MINERAL PROCESSING AND METALLURGICAL TESTING

10.1 Historical Metallurgical Testing and Process Design

The mix of magnetite and primarily hematite ores at Tilden is unique to US iron ore mines. Typical flowsheets developed for beneficiation-grade magnetite ores of the Lake Superior region were not applicable in that the preponderance of the iron oxide occurs as non-magnetic hematite. Ordinary methods of desliming and flotation were also unacceptable due to the fine grinding required for liberation, which would have resulted in either excessive iron unit losses or unsatisfactory concentrate grades. This necessitated the development of unique technologies for the successful processing of Tilden's iron ores.

Metallurgical research conducted in the 1960s eventually focused on creating a processing scheme that included selective flocculation and desliming followed by cationic SiO_2 flotation. During this period, a multitude of dispersants and flocculants were evaluated. Originally, sodium silicate was used, then sodium hexametaphosphate, $(NaPO_3)_6$, with corn starch as the flocculant. Currently, Tilden is using polyacrylic acid. This was followed by evaluation of various silicate flotation systems, with the ultimate selection of a cationic flotation system using amine-based silicate collectors to separate (float) the SiO_2 minerals from both hematite and magnetite.

A description of the current process and plant performance is provided in Section 14.0.

10.2 Sampling and Metallurgical Testing

10.2.1 Drill Sample Preparation and Testing

The standardized bench-scale flotation test was designed to simulate the Tilden hematite grinding and concentrating circuit. Data from the standardized bench flotation test are provided to the geologist and are used to characterize diamond drilling samples as either crude iron ore or waste rock. The data are then used to build a resource model and mine plan, with the purpose of supplying a consistent blend of ore to the concentrator. An illustration of the bench test flowsheet is provided in Figure 8-2.

10.2.2 Bench Flotation Test

The 600 g flotation test sample is ground using an 8 in. by 10 in. mild steel rod mill containing 26 rods of various diameters: two $1^1/_4$ in., eight $^3/_4$ in., four $^1/_2$ in., ten $^3/_8$ in., and two $^1/_4$ in. Total weight of the rods can range from 9,200 g to 9,500 g. Added to the mill with the flotation test sample are 400 mL of flotation test water, 0.25 lb/LT of glass H (6.4 mL of a 1 wt% solution of sodium hexametaphosphate powder), and 1.5 lb/LT caustic sodium hydroxide (1.8 mL solution, 18.7% specific gravity, 1.205 NaOH solids). The mill is placed on mill rolls designed to rotate at 54 rpm. Standard grind time is 45 min for a flotation test sample, and grinding continues uninterrupted.

Following grinding, the sample is immediately washed out of the mill and off of the rods with flotation test water. Without delay, the sample is transferred into an 8 L deslime tube, and water is added to fill the tube up to the 8 L mark. The ore slurry in the tube is mixed using 12 strokes with the plunger. pH of the slurry in the tube is measured with a pH meter; pH should be 10.0 or higher, which is typical of the normal plant circuit operating pH (generally 10.0 to 10.5). If the pH is lower than 10.0, additional NaOH solution is added in 0.25 lb/LT increments. Then the sample is re-mixed, and the pH is checked again. Additional caustic dosage(s) are recorded.

Starch is added at 0.25 lb/LT (3.0 mL solution) to the deslime tube, which is then mixed with the plunger for 30 sec. Starch type is recorded. The standard flotation test originally used Pearl starch. Since March 2015, the test now uses modified starch to match plant usage.

Sample settling time is measured. The standard settling time if Pearl starch is used is two minutes; standard settling time if modified starch is used is five minutes. If, after this time, settling is not complete, as much time as is necessary is allowed before siphoning, then actual settling time is recorded. The $^1/_2$ in. diameter siphon tube is inserted into the slurry. Siphoning occurs down to the 1 L mark on the deslime tube or one inch above the bed, whichever is higher.

Flocculant is added to the slime fraction and mixed vigorously to aid settling in a pressure filter. Slimes are pressure-filtered, then dried on a hot plate. This is the A product. To guard against contaminating a flotation test with the settling aid, the pail used to siphon the slimes is not the same pail used to empty the grinding mill.

The sample left in the tube is washed into the Pyrex glass flotation bowl of a Wemco Flot machine using flotation water. The water level is then raised up to just where the standpipe starts to change diameter. The following is added to the flotation bowl: 1.0 lb/LT starch (12.0 mL solution) and 0.25 lb/LT caustic (0.3 mL solution); the sample is left to condition with the air off for two minutes.

The first stage of rougher amine is added with a micro pipettor at the standard dosage of 0.12 lb/LT (38.2 µL) for development drill hole samples. To avoid leaving any residual amine in the pipette, the outside of the pipette is wiped off with a paper towel, with care taken not to touch the end after drawing the amine into the pipette. The end of the amine pipette is then immersed into the slurry, and amine is dispensed. Following this, the pipette is withdrawn, and the outside is wiped off with a paper towel. Air is turned on the Wemco flotation machine (operated at 1,250 rpm), which agitates the slurry and generates a froth. Froth is immediately and continuously removed using a paddle until froth generation diminishes. Then the air is shut off. Flotation water is added to the flotation bowl, as required, to maintain a constant level. A second stage of rougher amine is added, froth is removed using the paddle until it diminishes again, and the air is turned off. Any abnormal froth volume is noted. Rougher amine dosage and any non-standard reagent dosage are recorded.

The product left in the bowl is the rougher concentrate and comprises the B product. This sample is washed into a pail and saved.

Froth product from the previous step is washed back into the flotation bowl. The level is raised up to where the standpipe begins to change diameter. To the flotation bowl is added 0.5 lb/LT starch (6.0 mL solution), and the sample is left to condition with the air off for two minutes. The froth should be completely repulped while conditioning. This flotation simulates the flotation scavenger circuit.

Following conditioning, the air is turned on, and froth is removed into a pan until froth generation diminishes. The product left in the pan is the F product (the final tailing product), which is then filtered and dried on a hot plate. Amine is added to the flotation bowl at 0.05 lb/LT amine (15.93 µL solution), and the air is tuned on. Froth removed per the previous steps is Middling 1, the low-grade middling E product, which is then filtered and dried on a hot plate. Another 0.05 lb/LT amine (15.93 µL solution) is added to the flotation bowl, and the air is turned on. Froth removed comprises Middling 2, the high-grade middling D product, which is then filtered and dried on a hot plate.

The material left in the flotation bowl is concentrate recovered from the scavenger circuit. The sample is washed into a pail and filtered. This product is the C product (the scavenger flotation concentrate product), which is then filtered and dried on a hot plate.

10.2.2.1 Flotation Test, Product Sample Preparation and Assay

Weights are recorded for each of the products. Products are separately pushed through a 30 mesh screen and forty cornered on a mixing cloth or passed three times through a cone mixer. Approximately 25 g of each product are dipped out into three labeled sample envelopes for archival, soluble wet iron, and XRF analysis for % SiO_2, CaO, MgO, Mn, Al_2O_3, and % phos. An additional envelope is made for Satmagan analysis of the B product.

Half of each product by weight is placed in a separate pan for wet screen analysis. Products are combined in the pan and mixed in a cone mixer. Approximately 10 g is split from this re-composited sample and analyzed by the Microtrac for particle size distribution. The -35 µm result is recorded. Remaining re-composited sample is then wet-screened until only clear water drains from the underflow, which is discarded down the drain. The +500 mesh solids are dried and weighed, and the % -500 mesh is calculated.

10.2.2.2 Flotation Test Results

The Tilden bench float test is an approximation of anticipated plant response for the specific ore type being tested. The bench test is unique to iron ore evaluation techniques, and the actual flotation of the ore is conducted manually by an operator. Automation of the procedure is not practical. Variability in the results can be impacted by the operator. There are occasionally re-tests requested to compare results and identify retraining requirements. Extremely high concentrate SiO_2 values are indicative of interfering minerals that are usually in the form of smectite clays. These clays absorb the amine, which does not allow the amine to adhere to SiO_2 particles (interferes). Re-testing of these samples shows similar results. Flotation concentrate SiO_2 values above cut-off grade, but lower than the extremely high values associated with interfering minerals, are usually indicative of SiO_2 grain inclusions within iron oxide grains. This phenomenon is geographically associated with the Eastern end of the deposit and is hypothesized to be associated with hydrothermal alteration of the iron formation. Re-tests yield similar results. On rare occasions, a sample may be re-run with a larger dose of amine or longer mill grind time to investigate the sensitivity of the particular ore type.

10.2.3 Recovery Estimate Assumptions

It has been empirically determined over time that the bench test wtrec requires an additional 1.8 percentage point addition to match actual plant results.

10.3 Material Characterization and Classification

The flotation bench test determines whether an iron formation sample is crude ore or waste if all cut-off grade criteria are met (see Section 13.0). Crude ore samples can be further delineated as material types based on magnetic iron content and total oxides (Table 10-1). The modeled geologic domain the samples fall within is also taken into consideration when characterizing ore types.

Table 10-1: Material Type Specifications
Cleveland-Cliffs Inc. – Tilden Property

Ore Type	Head Fe	Conc. SiO_2	Total Oxides	Satmagan Head Magnetic Fe	Conc. Phos.	Davis Tube wtrec	Davis Tube Conc. SiO_2	Calculated Magnetic Fe
Hematite	>25	<6	>94	<15	<0.07			
Main Pit Carbonate	>25	<6	<94.01	>15	<0.07			
Goethite	>25	<6	>87 and <94	<15	<0.07			
Magnetite	>25	<6				>24.99	<10	>20

10.4 Factors Affecting Economic Extraction and Plant Performance

Gangue minerals impacting economic extraction are identified in the flotation bench test. These include interfering minerals (clay) that adsorb amine, resulting in concentrate SiO_2 values above cut-off values. Quartz inclusions within the iron oxide bands generally also result in bench test concentrate SiO_2 values that are above cut-off grade. Very fine goethite ore can result in potential filtering, crushing, and flotation issues. Therefore, this material is mined at very low percentages when exposed. Carbonate ore and goethite ore can impact pellet quality due to calcination of carbonate in the former and dehydration in the latter. Therefore, these ore types are mined at low percentages when exposed.

11.0 MINERAL RESOURCE ESTIMATES

11.1 Summary

A geological model was constructed by SLR considering regional mapping, drill hole logging, and blast hole analytical results, in addition to grade control modeling and flotation ore coding. Data verification included standard database verification, a review of QA/QC protocols and results, and a comparison of blast hole and drill hole results.

The EY 2020 Tilden Mineral Resource estimate was completed by SLR using a conventional block modeling approach, defining estimation domains from wireframes built in Seequent's Leapfrog Geo (Leapfrog Geo) software and using a regular block model built and interpolated in Seequent's Leapfrog Edge (Leapfrog Edge) software. The general workflow included the creation of a geological model from mapping, drill and blast hole logging, and sampling, which were used to define discrete domains of non-iron formation and iron formation sub-units. Iron formation drill hole samples were composited, and the estimation of six variables (crude iron and magnetic iron, wtrec, and iron, phosphorus, and silica in concentrate) was completed using ordinary kriging (OK) over five passes in iron formation units, the first of which incorporated blast hole samples. Distance restriction of outlier grades was applied to selected domains and variables. Blocks were classified as Indicated or Inferred using distance-based and qualitative criterion. Canadian Institute of Mining, Metallurgy and Petroleum (CIM) Definition Standards for Mineral Resources and Mineral Reserves dated May 10, 2014 (CIM (2014) definitions) were used for Mineral Resource classification. Models were depleted to December 31, 2021, with depletion predicted for September 1, 2020 to December 31, 2020. Estimates were validated using standard industry techniques and were peer reviewed prior to finalization.

A detailed breakdown of the Mineral Resources exclusive of Mineral Reserves is presented in Table 11-1. Mineral Resources were defined and constrained within an open pit shell, prepared by Cliffs and based on a US$90/long ton pellet price, and meeting the following cut-off grade criteria, based on existing pellet specifications and price contracts:

- ≥ 25% wtrec
- ≥ 25% crude iron content (crudefe)
- ≤ 0.07% phosphorous in concentrate (conphos)
- ≤ 6% to 8.5% silica in concentrate (consio2) (domain dependent)

The pellet cost basis for the Lerchs-Grossmann (LG) optimization is based on a dry 61.5% Fe fluxed pellet.

Table 11-1: Summary of Tilden Mineral Resources – December 31, 2021
Cleveland-Cliffs Inc. – Tilden Property

Category	Long Tons (Mtons)	Crude Fe (%)	Process Recovery (%)	Pellets (Mtons)
Measured	-	-	-	-
Indicated	135.4	35.5	35.9	48.6
Total Measured + Indicated	**135.4**	**35.5**	**35.9**	**48.6**

Category	Long Tons (Mtons)	Crude Fe (%)	Process Recovery (%)	Pellets (Mtons)
Inferred	350.4	34.7	36.4	127.4

Notes:

1. Tonnage is reported in long tons equivalent to 2,240 lb.
2. Tonnage is reported exclusive of Mineral Reserves and has been rounded to the nearest 100,000.
3. Mineral Resources are estimated at cut-off grades of 25% crudefe, 25% wtrec, 0.07% conphos and 6% consio2 to 8.5% consio2, domain dependent.
4. Mineral Resources are estimated using a pellet value of US$90/LT.
5. Pellets are reported as fluxed and dry, containing 61.5% Fe, shipped pellets contain 2% moisture.
6. Tonnage estimate based on estimated depletion from a surveyed topography on December 31, 2021.
7. Resources are crude ore tons as delivered to the primary crusher; pellets are as loaded onto rail cars.
8. Classification of Mineral Resources is in accordance with the S-K 1300 classification system.
9. Bulk density is assigned based on a regression equation related to crude Fe.
10. Mineral Resources are 100% attributable to Cliffs.
11. Mineral Resources are constrained within an optimized pit shell and are exclusive of Mineral Reserves.
12. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
13. Numbers may not add due to rounding.

The Tilden operation is currently active and in full production. The SLR QP is of the opinion that with consideration of the recommendations summarized in Sections 1.0 and 23.0 of this report, any issues relating to all relevant technical and economic factors likely to influence the prospect of economic extraction can be resolved with further work.

A summary of the key assumptions, parameters, and methods used for Mineral Resource estimates, including drilling database, geological model, compositing and capping, density, and variography are discussed below.

11.2 Resource Database

The Tilden drill hole database consists of 382,605 ft of drill hole information in 578 drill holes, completed from the 1950s to 2020. Assay information of holes drilled in 2019 and 2020 in the CD5 Pit area were not available and, as such, the CD5 area has not been included in SLR's Mineral Resource estimate. Down hole information from Empire drill holes were also not available and are excluded from the SLR Mineral Resource estimate. SLR recommends integrating the downhole information from the Empire and Tilden mines into a single valid database.

11.3 Geological Interpretation

Iron formation and intrusive units were modeled in Leapfrog Geo using surface mapping and drill hole logs, with consideration given to grade control modeling and flotation ore coding (code1), assay results, and noted or measured presences of magfe. Iron formation units were distinguished to a distance of 600 ft beyond drilling, beyond which were modeled as Undifferentiated Iron Formation.

Below the Summit Mountain Sill, silica alteration in BIF units was modeled to overprint the iron formation using a nominal cut-off grade of 10% consio2, and oxidation domains were modeled using a cut-off grade of 0.04% conphos, with reference to oxidation noted in drill hole logs, and code1 logging from both drill and blast holes. SLR recommends that Cliffs continue work to define fault orientation and related alteration in the east of the Main Pit to confirm the syn-bedding and cross-cutting directions of the modeled high-silica alteration domains.

Above the Summit Mountain Sill, the iron formation is highly oxidized in all areas (Hematite Iron Formation) apart from the Magnetic Iron Formation unit of the CDIII Pit, and has strong silica alteration along the more prevalent intrusive contacts. These alteration contacts were not distinguished with the exception of high-silica alteration along the hanging wall of the Suicide Sill in the CDIII Pit.

Following domain modeling, lithology units were back-coded with the most closely defined flotation ore coding. The geological model at Tilden is presented in plan and cross-section in Figure 11-1 and Figure 11-2, respectively.

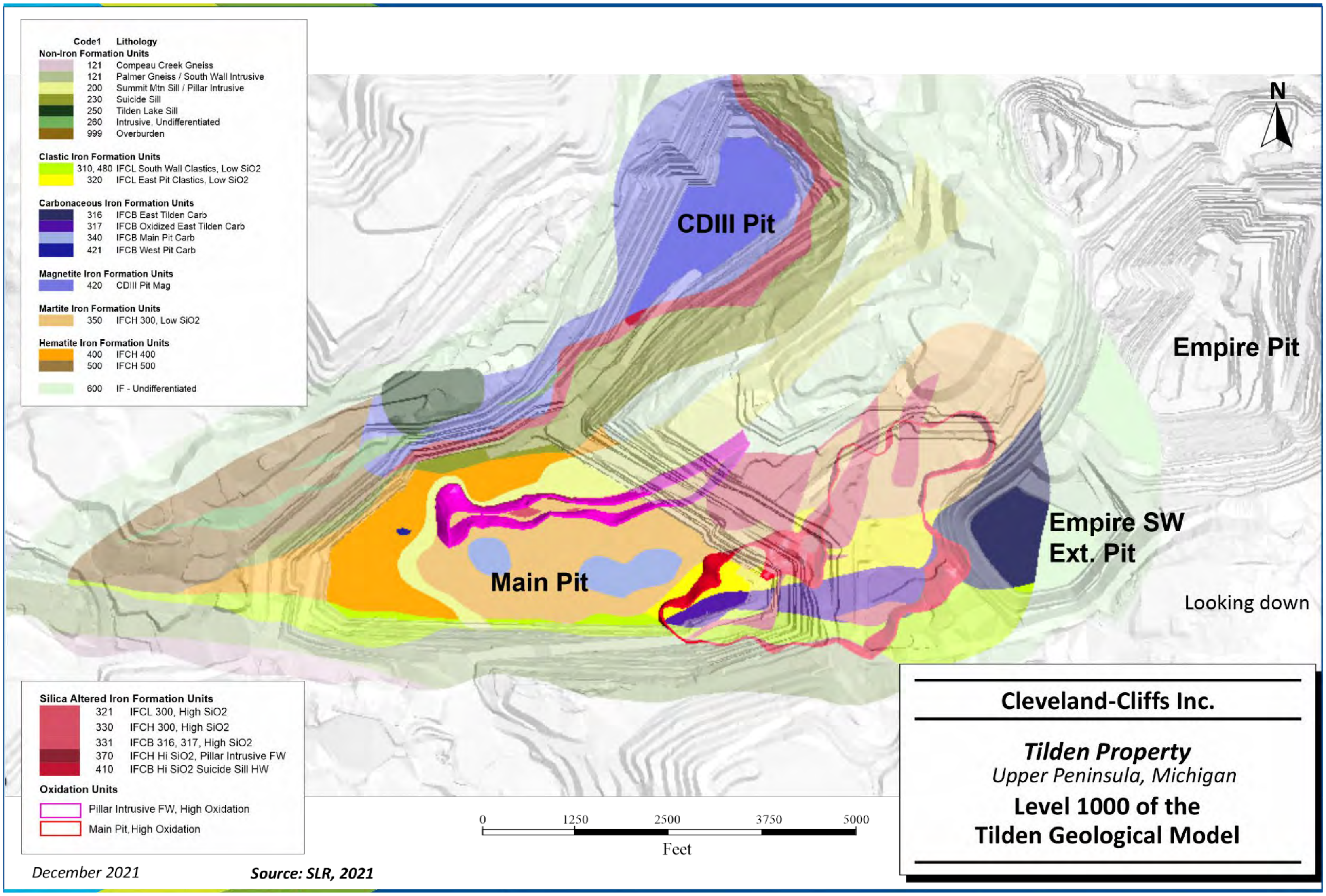


Figure 11-1: Level 1000 of the Tilden Geological Model

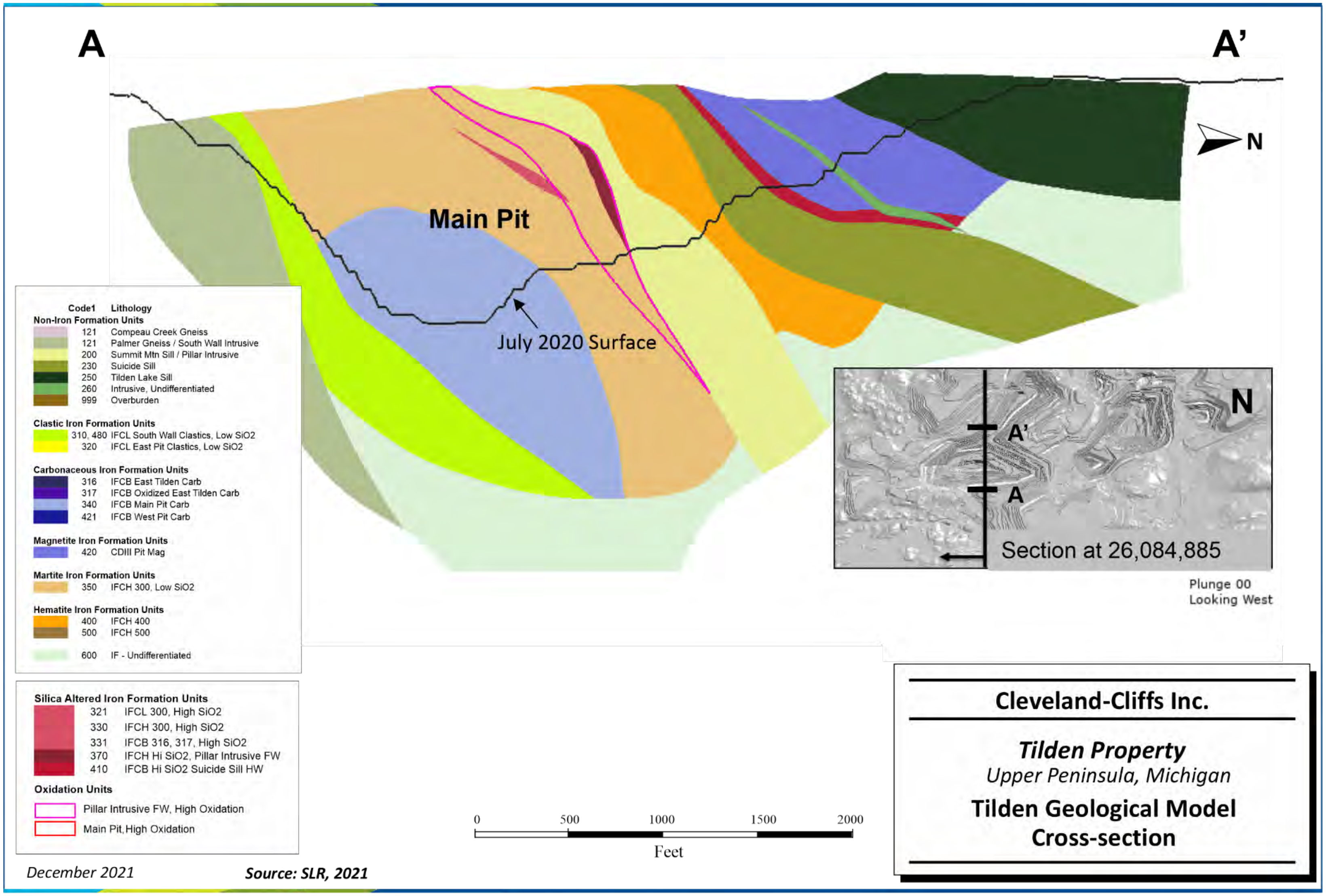


Figure 11-2: Tilden Geological Model Cross-section

11.4 Resource Assays

The length-weighted data presented in Table 11-2 is effective as of July 15, 2020, when the blast hole database was last exported and supplied to SLR. Note that within the drill hole database, there are limited samples of conphos, which was not historically included as a standard test. Samples of magfe in drill and blast holes are limited to magnetic units.

Impossible or irregular blast hole values were removed prior to estimation; SLR recommends a thorough database verification exercise to remove anomalous blast hole values from the master database.

Table 11-2: Tilden Mine Mineral Resource Database
Cleveland-Cliffs Inc. – Tilden Property

Name	Count	Length	Mean	CV	Min	Max
			Drill Hole Samples			
confe	6,652	266,450	61.80	0.10	12.39	69.51
conphos	3,572	149,646	0.04	0.73	0.00	0.66
consio2	6,660	266,830	7.35	0.90	1.30	65.83
crudefe	6,634	264,663	35.56	0.13	6.11	63.70
magfe	3,139	127,409	11.34	1.04	0.10	38.00
wtrec	6,659	266,780	37.27	0.26	4.00	90.00
			Blast Hole Samples			
confe	84,506	3,802,770	62.05	0.10	3.70	70
conphos	84,449	3,800,205	0.04	2.01	0.00	1.0
consio2	84,479	3,801,555	6.88	0.86	0.07	81.20
crudefe	86,698	3,901,410	35.30	0.51	2.00	70
magfe	15,616	702,720	26.08	0.20	0.20	45.30
wtrec	84,505	3,802,725	38.37	0.24	4.20	91.80

11.5 Compositing and Capping

No capping was applied prior to compositing.

11.5.1 Compositing

Drill hole data was composited to 45 ft, the most common sample interval length, and equal to the blast hole sample length. Unsampled intervals were ignored during compositing for the following reasons:

- To substitute null values for deleterious elements is incautious.
- To substitute null values where iron formation is unsampled is overly conservative.
- There is insufficient information to be able to assign proxy values in the assay database to small intrusive dike material within the iron formation during compositing, and the number of these samples was sufficiently small to not be expected to cause significant bias in the overall database.

A histogram of sample lengths is shown in Figure 11-3.

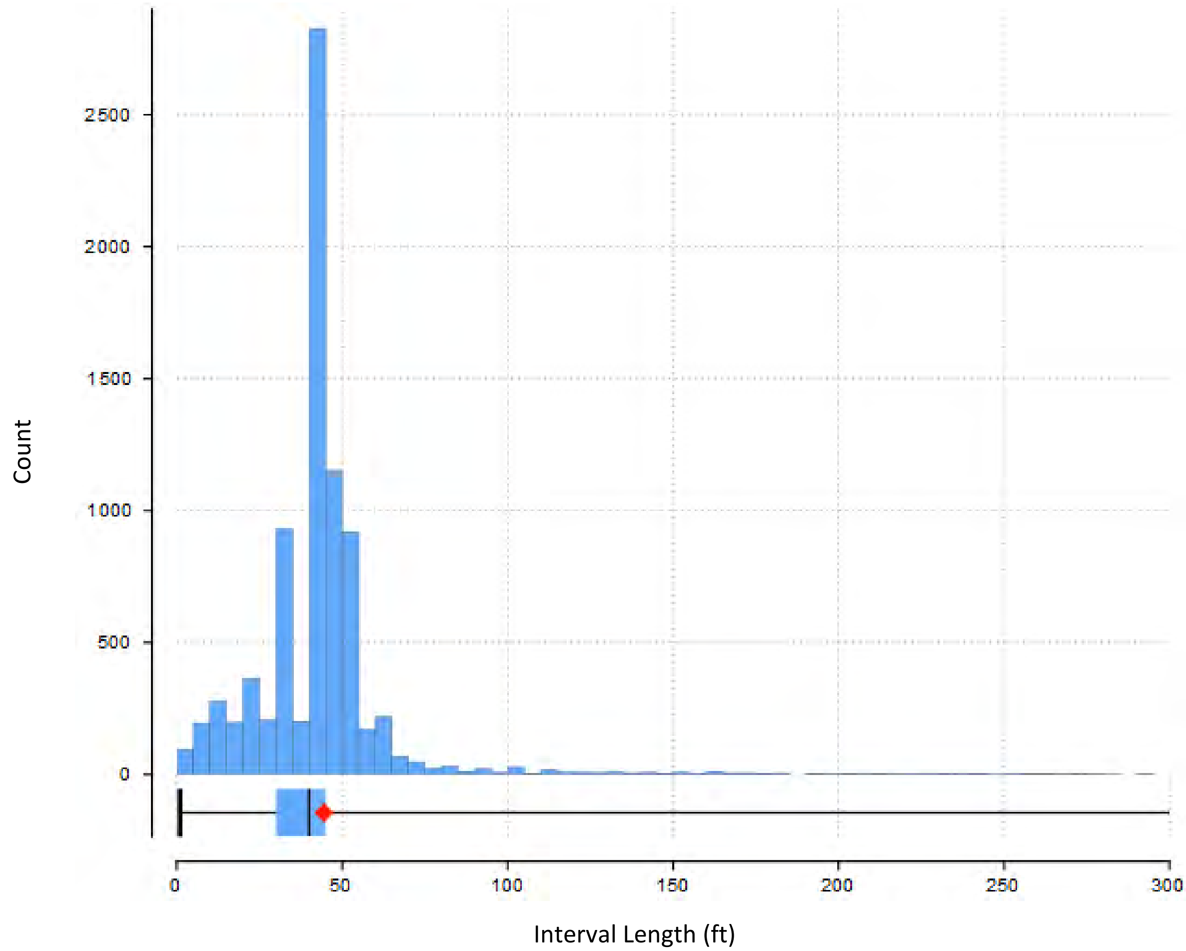


Figure 11-3: Histogram of Sample Length

Table 11-3 presents the drill and blast hole composite statistics by estimation domain. SLR notes that the blast hole samples are not composited.

Table 11-3: Tilden Mine Composite Statistics
Cleveland-Cliffs Inc. – Tilden Property

	Blast Holes					Drill Holes				
	Count	Mean (%)	CV	Min. (%)	Max. (%)	Count	Mean (%)	CV	Min. (%)	Max. (%)
IFCB Mag CDIII Pit (420)										
confe	9,779	58.86	0.12	3.70	69.90	868	60.20	0.10	29.51	68.74
conphos	9,740	0.05	0.70	0.00	1.00	436	0.05	0.46	0.01	0.34
consio2	9,761	7.64	0.71	0.98	44.82	869	6.81	0.66	1.49	31.96
crudefe	9,905	37.60	0.12	3.50	69.00	871	38.21	0.10	18.84	63.20

	Blast Holes					Drill Holes				
	Count	Mean (%)	CV	Min. (%)	Max. (%)	Count	Mean (%)	CV	Min. (%)	Max. (%)
magfe	13,708	26.14	0.19	0.20	39.10	847	22.78	0.34	0.60	37.40
wtrec	9,778	41.66	0.30	4.90	91.80	869	39.54	0.27	7.10	78.17
IFCB East Tilden Carb (316)										
confe	-	-	-	-	-	122	60.25	0.11	35.10	67.66
conphos	-	-	-	-	-	93	0.03	0.38	0.01	0.06
consio2	-	-	-	-	-	122	4.18	0.32	2.13	9.51
crudefe	-	-	-	-	-	122	32.95	0.08	24.40	42.74
magfe	-	-	-	-	-	66	7.37	1.08	0.42	25.10
wtrec	-	-	-	-	-	122	40.40	0.26	12.10	65.90
IFCB Main Pit Carb (340)										
confe	10,870	60.79	0.07	27.80	69.10	531	62.10	0.07	45.40	68.48
conphos	10,873	0.03	0.58	0.00	0.43	427	0.02	0.65	0.00	0.09
consio2	10,870	4.80	0.35	1.79	40.23	531	4.57	0.30	1.91	22.18
crudefe	11,033	34.03	0.09	7.00	62.00	531	33.73	0.09	16.60	41.37
magfe	-	-	-	-	-	423	18.40	0.40	0.30	31.87
wtrec	10,870	42.49	0.15	15.80	89.40	531	43.88	0.17	11.70	64.10
IFCB Oxidized East Tilden Carb (317)										
confe	1,348	62.70	0.06	22.10	68.70	242	64.22	0.05	39.63	68.30
conphos	1,348	0.06	0.32	0.01	0.27	210	0.06	0.65	0.02	0.40
consio2	1,348	5.25	0.77	0.07	44.12	242	4.58	0.47	2.22	22.13
crudefe	1,388	35.92	0.14	11.40	62.70	241	35.12	0.12	19.91	61.00
magfe	-	-	-	-	-	115	1.03	1.18	0.20	8.54
wtrec	1,348	37.18	0.19	14.90	77.90	242	35.86	0.20	14.97	64.40
IFCB West Pit Carb (421)										
confe	481	63.74	0.06	42.90	69.90	28	64.85	0.04	57.93	67.79
conphos	481	0.04	0.37	0.02	0.17	8	0.04	0.24	0.02	0.05
consio2	481	5.57	0.41	1.52	21.58	28	4.78	0.16	3.14	6.09
crudefe	481	39.85	0.07	30.00	55.80	28	40.86	0.05	36.17	45.10
magfe	181	28.24	0.18	6.60	35.50	20	29.11	0.13	21.95	33.60
wtrec	481	38.80	0.20	18.80	63.20	28	45.00	0.15	30.92	57.11
IFCB, Hi SiO_2, Suicide Sill HW (410)										
confe	655	58.76	0.09	29.60	68.70	148	56.59	0.10	37.10	66.95

	Blast Holes					Drill Holes				
	Count	Mean (%)	CV	Min. (%)	Max. (%)	Count	Mean (%)	CV	Min. (%)	Max. (%)
conphos	657	0.05	0.43	0.02	0.27	76	0.05	0.76	0.02	0.25
consio2	655	12.23	0.49	1.85	41.14	148	12.78	0.43	3.29	34.79
crudefe	667	38.99	0.11	8.70	48.10	148	38.10	0.08	25.90	49.68
magfe	448	28.63	0.11	15.70	35.50	162	25.50	0.30	1.10	35.10
wtrec	655	40.72	0.23	11.20	72.40	148	36.82	0.35	14.70	69.51
IFCH 300, Low SiO_2 (350)										
confe	29,277	63.76	0.08	13.70	69.70	1,781	64.91	0.05	23.29	69.48
conphos	29,252	0.03	0.60	0.00	0.71	937	0.04	0.68	0.00	0.35
consio2	29,266	6.31	0.94	0.19	65.40	1,781	5.15	0.66	1.49	42.83
crudefe	29,424	34.96	0.09	3.10	65.60	1,779	35.62	0.08	18.83	61.09
magfe	25	16.98	0.32	8.00	27.90	539	1.78	1.83	0.10	24.62
wtrec	29,277	38.64	0.19	6.20	88.00	1,780	36.73	0.19	8.04	67.17
IFCH 400										
confe	11,050	63.05	0.07	24.50	69.80	546	63.22	0.07	38.54	68.17
conphos	11,042	0.05	0.54	0.01	0.72	239	0.05	0.84	0.01	0.66
consio2	11,046	6.73	0.80	0.74	81.20	546	7.02	0.82	2.15	42.86
crudefe	11,187	37.82	0.11	3.00	66.70	546	37.94	0.08	20.21	52.69
magfe	73	26.32	0.28	6.30	35.70	133	2.25	1.78	0.10	30.00
wtrec	11,050	36.76	0.23	8.80	79.60	546	35.26	0.22	10.42	75.46
IFCH 500										
confe	2,382	59.55	0.10	17.80	68.40	626	59.80	0.10	35.44	68.40
conphos	2,378	0.09	0.51	0.01	0.89	346	0.08	0.48	0.01	0.26
consio2	2,382	8.16	0.69	0.87	45.75	626	8.42	0.73	2.00	40.76
crudefe	2,539	34.46	0.18	2.00	54.50	624	35.91	0.12	13.67	57.30
magfe	-	-	-	-	-	217	1.65	2.24	0.10	26.83
wtrec	2,382	31.13	0.31	4.20	74.10	626	34.10	0.28	5.58	63.81
IFCH, Hi SiO_2 SM Sill FW (370)										
confe	736	56.67	0.15	34.00	68.00	77	58.70	0.10	32.70	67.02
conphos	737	0.05	0.50	0.01	0.45	36	0.05	0.30	0.02	0.07
consio2	736	13.80	0.83	1.67	47.40	77	12.23	0.64	2.96	38.50
crudefe	745	35.09	0.11	11.60	58.00	77	35.51	0.10	22.50	41.54
magfe	-	-	-	-	-	27	0.89	0.75	0.20	2.23

	Blast Holes					Drill Holes				
	Count	Mean (%)	CV	Min. (%)	Max. (%)	Count	Mean (%)	CV	Min. (%)	Max. (%)
wtrec	736	41.73	0.27	16.80	87.50	77	34.54	0.26	10.50	53.27
IFCH/CL 300, Hi SiO2 (330, 321)										
confe	6,137	59.79	0.12	15.60	68.50	710	55.46	0.14	27.64	67.60
conphos	6,131	0.04	0.52	0.01	0.90	386	0.05	0.51	0.01	0.32
consio2	6,137	11.40	0.80	0.09	54.36	716	16.68	0.60	2.61	65.83
crudefe	6,189	34.41	0.09	3.60	65.80	705	34.29	0.12	10.96	49.02
magfe	-	-	-	-	-	257	1.30	1.90	0.10	21.34
wtrec	6,137	37.21	0.27	7.00	86.30	716	39.10	0.26	8.60	75.80
IFCL East Pit Clastics (320), Low SiO_2										
confe	5,302	64.01	0.06	13.60	69.30	406	64.29	0.04	47.85	68.33
conphos	5,303	0.05	0.58	0.00	1.00	279	0.05	0.34	0.01	0.11
consio2	5,300	5.05	0.72	0.69	74.50	406	5.33	0.57	1.85	29.98
crudefe	6,041	31.74	0.20	6.80	63.20	401	33.30	0.15	19.24	57.34
magfe	-	-	-	-	-	161	1.16	1.19	0.10	12.30
wtrec	5,302	34.01	0.24	9.30	77.50	406	33.98	0.23	13.80	70.75
IFCL South Wall Clastics (480, 310), Low SiO_2										
confe	2,250	63.03	0.06	25.10	69.30	342	62.30	0.08	35.50	68.77
conphos	2,256	0.05	0.80	0.00	0.65	203	0.04	0.68	0.01	0.19
consio2	2,248	6.87	0.54	0.73	35.40	342	6.27	0.57	1.88	38.91
crudefe	2,502	33.33	0.22	9.50	65.20	304	30.45	0.23	12.21	59.80
magfe	-	-	-	-	-	110	4.18	1.11	0.20	25.80
wtrec	2,250	35.40	0.29	10.50	91.70	342	30.08	0.34	8.53	80.30

11.6 Trend Analysis

Trend analysis in the form of three-dimensional contouring was completed within the BIF units of the Tilden deposit to understand overall grade distributions by spatial location and material type, to assist in variography, estimation, and validation, and – in the case of consio2 and conphos – to assist in modeling.

Trend analysis of crudefe, wtrec, and confe assumed higher continuity along bedding, with the bedding following the general trend of the Summit Mountain Sill/Pillar Intrusive.

Trend analysis of consio2 identified several syn-bedding and cross-cutting structures with high continuity associated with faults and dikes in the east of the Main Pit. Trend analysis of conphos identified a broad zone of increased oxidation (elevated conphos values) in the East Pit as well as directly adjacent to the Pillar Intrusive footwall.

11.6.1 Variography

Variography was completed for all variables in all estimation domains. Variograms were oriented in line with the most prominent domain orientation and the lowest variability determined from radial plots. In general, variogram models resembled a flattened, or oblate sphere or ellipsoid. Model distances ranged from 650 ft to 1,200 ft in the major axis, 400 ft to 700 ft in the semi-major axis, and from 200 ft to 400 ft in the minor axis direction. Variogram quality varied from good to low/moderate where based on a low number of composites within a domain, within a domain with variable orientation, or characterized using widely spaced data. A sample radial plot and variogram is presented in Figure 11-4, with variogram models listed in Table 11-4.

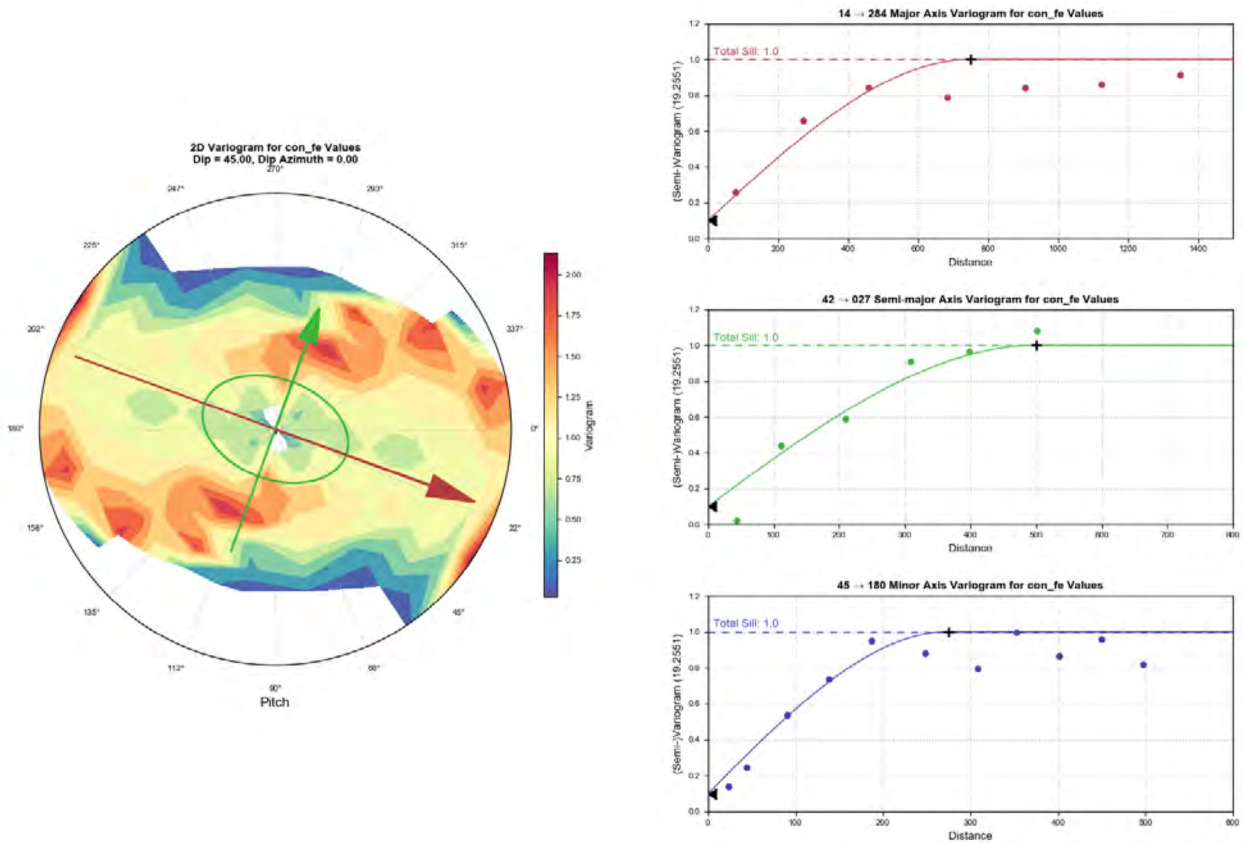


Figure 11-4: Radial Plot, Experimental Variogram and Model for confe Within IFCB Main Pit Carb (340)

Table 11-4: Tilden Variogram Models
Cleveland-Cliffs Inc. – Tilden Property

Domain	Variable	Nugget	Structure ½	Distance (ft) (Structure ½)			Trend (°)		
				Major	Semi Major	Minor	Dip	Dip Az.	Pitch
High SiO_2 Contact Al (370)	all	0.1	0.9	750	400	400	45	340	45
IFCB 340 Main Pit Carb	all	0.1	0.9	750	500	275	45	0	20
IFCB CDIII Pit (420)	all	0.1	0.9	900	600	200	50	335	0
IFCB East Tilden Carb (316)	all	0.1	0.9	600	600	200	50	300	90
IFCB Hi SiO_2, Suicide Sill HW (410)	all	0.1	0.9	900	600	200	50	335	0
IFCB Oxidized East Tilden Carb (317)	all	0.1	0.9	600	600	200	50	300	90
IFCB West Pit Carb (421)	all	0.1	0.9	750	500	275	45	0	20
IFCH 300, Low SiO_2 (350)	all	0.1	0.9	1000	700	400	45	0	50
IFCH 400	all	0.1	0.9	900	700	200	50	335	15
IFCH 500	all	0.1	0.9	900	700	200	50	335	15
IFCH/CL 300, Hi SiO_2 South (330,321)	all	0.1	0.9	1,000	700	400	45	0	50
IFCL East Pit Clastics, Low SiO_2 (320)	confe, crudefe, wtrec	0.1	0.4/0.5	350/650	250/600	200/200	35	345	65
IFCL East Pit Clastics, Low SiO_2 (320)	conphos, consio2	0.1	0.9	650	600	200	35	345	65
IFCL South Wall Clastics, Low SiO_2	all	0.1	0.9	1,000	800	200	60	0	110
300 High Oxi	conphos	0.1	0.9	1,200	800	200	60	0	180
Suicide Sill High Oxi	conphos	0.1	0.9	1,000	800	200	60	0	110

11.7 Block Model

A regularized, non-rotated block model was created in Leapfrog Edge. Block size was designed to be consistent with the Tilden site grade control model, historical models, and the mine BH (45 ft). SLR recommends exploring a larger block length in the X and Y dimensions, such as 50 ft, in subsequent updates to bring the model in line with mine selectivity. A summary of the block model setup and selected included variables is shown in Table 11-5.

Table 11-5: Summary of Block Model Setup
Cleveland-Cliffs Inc. – Tilden Property

Type	X	Y	Z
Min. Coord.	26,077,700	606,225	2,025
Max. Coord.	26,091,825	611,850	-720
Total Length	14,125	5,625	2,745
Block Size	25	25	45

Variable	Description
domain	Estimation domains
mine	Mine 2020JUL15 material flag: insitu, mined, fill, air
confe_ok	BH and DH First pass, DH subsequent
conphos_ok	BH and DH First pass, DH subsequent
consio2_ok	BH and DH First pass, DH subsequent
crudefe_ok	BH and DH First pass, DH subsequent
magfe_ok	BH and DH First pass, DH subsequent
wtrec_ok	BH and DH First pass, DH subsequent
dh_confe_ok	DH only OK est.
dh_conphos_ok	DH only OK est.
dh_consio2_ok	DH only OK est.
dh_crudefe_ok	DH only OK est.
dh_magfe_ok	DH only OK est.
dh_wtrec_ok	DH only OK est.
bh_confe_ok	BH only – estimated by crude IF domain (300, 400, 500)
bh_conphos_ok	BH only – estimated by crude IF domain (300, 400, 500)
bh_consio2_ok	BH only – estimated by crude IF domain (300, 400, 500)
bh_crudefe_ok	BH only – estimated by crude IF domain (300, 400, 500)
bh_magfe_ok	BH only – estimated by crude IF domain (300, 400, 500)
bh_wtrec_ok	BH only – estimated by crude IF domain (300, 400, 500)
tfc	13.45-(0.0792 * (crudefe_ok)) for IF, Int=12.3, Ovb=17.3
tfc_inv	1/tfc
code1	best match code for reference to site grade control codes
class	2=Indicated; 3 = Inferred

11.8 Estimation Methodology

Grade interpolation at Tilden was conducted in Leapfrog Edge using OK and hard boundaries, with progressively larger search ellipses and relaxed criteria within BIF units. The first pass used both drill and blast hole data, subsequent passes used drill hole data only. The final conphos variable estimated within the high-oxidation zones below the Summit Mountain Sill overprints the general domain-restricted conphos results. Inverse distance cubed (ID^3) and NN estimates were run in parallel for comparison and validation purposes.

Search ellipses were oriented using dynamic anisotropy based on the hanging wall and footwall of the domain boundaries, except for the high-oxidation zone in the Main Pit, which used a flat search ellipse. The initial search ellipse, which used both drill and blast hole data, was designed to capture blast hole data from three benches. The dimensions of the search ellipses in passes 2 to 4 reference the general drill hole spacing across the deposit (300 ft x 300 ft), the composite length (45 ft), and the block size. The final pass was designed to populate a small number of interstitial blocks that remained unestimated. The search strategy is detailed in Table 11-6. Estimation runs using exclusively drill and blast holes were also performed for use in reconciliation studies using the same strategy.

Table 11-6: Search Strategy
Cleveland-Cliffs Inc. – Tilden Property

Pass	Source Composites1	Search Radius (ft)	Max. Samples/Hole	Minimum Samples	Maximum Samples
General Domains					
1	BH, DH	120/120/50	-	3	8
2	DH	450/450/100	3	4	8
3	DH	900/900/200	3	4	8
4	DH	1,500/1,500/300	-	3	8
5	DH	1,500/1,500/1,500	-	3	8
High-Oxidation Domains in Main Pit, conphos only					
1	BH, DH	120/120/50	-	3	8
2	DH	450/450/100	3	4	8
3	DH	600/600/150	3	4	8
4	DH	900/900/200	-	3	8

Notes:

1. BH = blast hole; DH = drill hole

11.8.1 High-Grade Restriction

The influence of consio2 values above a threshold of 15% or 20% (domain dependent) in low-silica domains was restricted to a distance ellipse of 135 ft x 135 ft x 33 ft. At greater distances values were capped at the threshold, so as to restrict the influence of isolated high values due to small, localized faults and fractures.

11.8.2 Bulk Density

Consistent with previous models at Tilden, the following regression calculation was used to assign tonnage factors to the model:

$$\text{Tonnage Factor } (ft^3/LT) = 13.45 - (0.0792 * \text{crudefe})$$

For non-iron formation units, the following tonnage factors were assigned:

- Intrusive: 12.3
- Outlier or unestimated Iron Formation: 10.25
- Overburden: 17.3
- Backfill: 17.3

11.9 Cut-off Grade

A preliminary open-pit shell was generated using the Lerchs-Grossmann (LG) optimization method as a constraint in the preparation of the open pit Mineral Resource estimate. The open-pit shell is based on a US$90/long ton pellet price and meeting the following cut-off grade criteria, based on existing pellet specifications and price contracts:

- ≥ 25% wtrec
- ≥ 25% crudefe
- ≤ 0.07% conphos
- ≤ 6% to 8.5% consio2 (domain dependent)

The pellet cost basis for the LG optimization is based on a dry, 61.5% Fe fluxed pellet. The revenue and cost parameters for the LG optimization are presented in Table 11-7. Pit slopes applied to *in situ* material range from 33.7° to 43.8°, depending on the domain.

Table 11-7: Whittle Pit Parameters
Cleveland-Cliffs Inc. – Tilden Property

Parameter	Value
Pellet Sale Price	US$90/t pellet
Mining Cost - Depth Adjustment Factor (per 45ft bench)	US$2.52/t mined US$0.02/t mined
Milling Cost	US$9.50/t milled
Pelletizing Cost General and Administration Cost	US$11.34/t pellet US$2.72/t pellet
Sustaining Capital	US$4.33/t pellet
Mineral Royalty	US$1.80/t pellet

11.10 Classification

Definitions for resource categories used in this TRS are those defined by SEC in S-K 1300. Mineral Resources are classified into Measured, Indicated, and Inferred categories.

Classification criteria considered the spatial continuity of the different variables, and the quality and density of the samples. Final classification was assigned from wireframes built to capture areas characterized by drill hole-spacing criteria as shown in Table 11-8. This work was supported by variography, as well as a drill hole-spacing study that assigned an average distance of the three closest composite samples from neighboring drill holes to each composite. The block model was post-processed to downgrade an area of clastic material west of the Main Pit that would have otherwise met the criteria for a classification of Indicated but was missing conphos values due to historical practices that did not include conphos as a standard measurement in exploration drill hole sampling.

Table 11-8: Classification Criteria
Cleveland-Cliffs Inc. – Tilden Property

Classification Criteria	Indicated	Inferred
Drill hole Spacing (ft)	600	1,200
Extension Beyond Drilling (ft)	300	600
Extension Below Drilling (ft)	150	300

SLR recommends completing a reconciliation study to support the inclusion of Measured Mineral Resources at Tilden. SLR notes that, in general, the drill hole spacing is lower below the current topography than above, and that there is very little drilling outside of the 2019 LOM plan extents. SLR recommends additional drilling to improve the understanding of the Tilden deposit at the periphery and at depth, with a focus on low drill-density areas within the 2019 LOM plan, as well as in areas with increased variability, such as the high-silica areas in the east of the Main Pit. An overview of classification is presented in Figure 11-5.

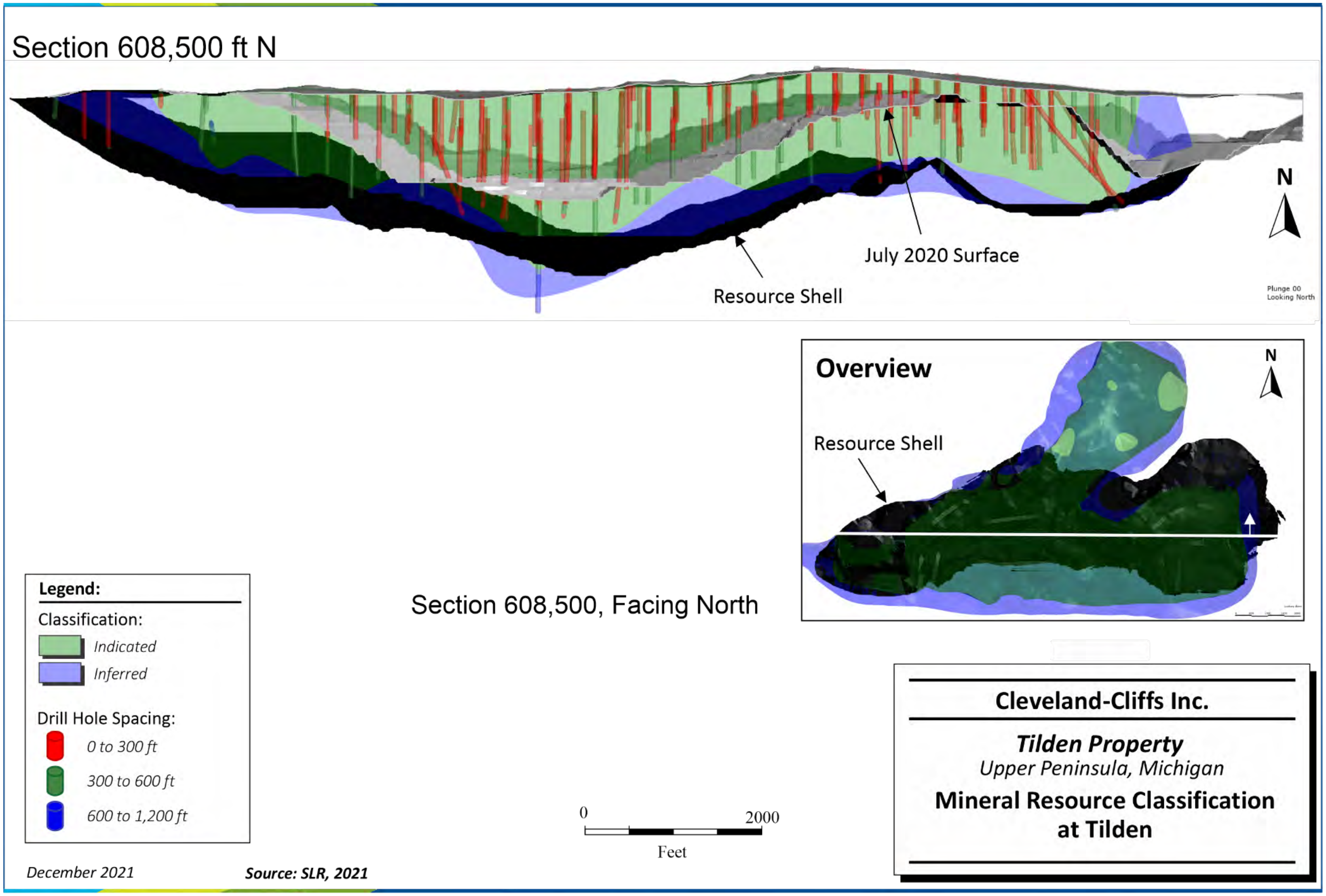


Figure 11-5: Mineral Resource Classification

11.11 Model Validation

Validation of the Mineral Resource estimate results included visual grade comparisons, reviews of block model coding, and statistical reviews of the global accuracy of the estimated variables and evaluation of the local accuracy through the preparation of swath plots (not shown) and comparative statistics (Figure 11-6). Comparative statistics between composite and block data was not reliable due to the clustered nature of the blast hole data. In place of this, the final estimated value was compared to a NN estimate, as a proxy of the declustered input data. No reconciliation with the short-term model was carried out; however, SLR understands that a comprehensive reconciliation study is currently underway.

Visual comparisons between the composites and estimated block grades were conducted on vertical sections and plan views. SLR is of the opinion that the estimated block grades reflect the local drill or blast hole composite value and that the trends displayed are as intended. Selected comparisons are shown in Figure 11-7 to Figure 11-9.

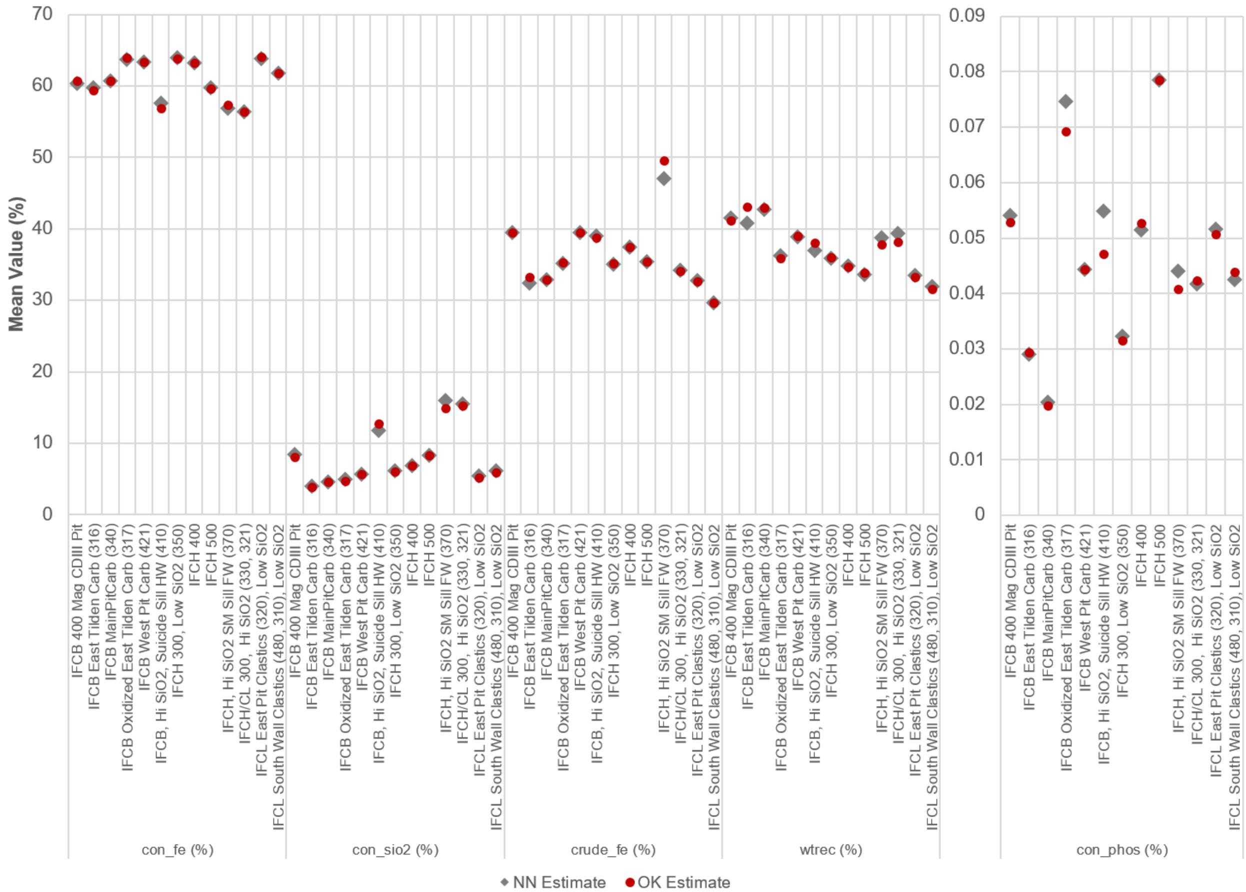


Figure 11-6: Comparison of OK and NN Estimates by Variable and Domain

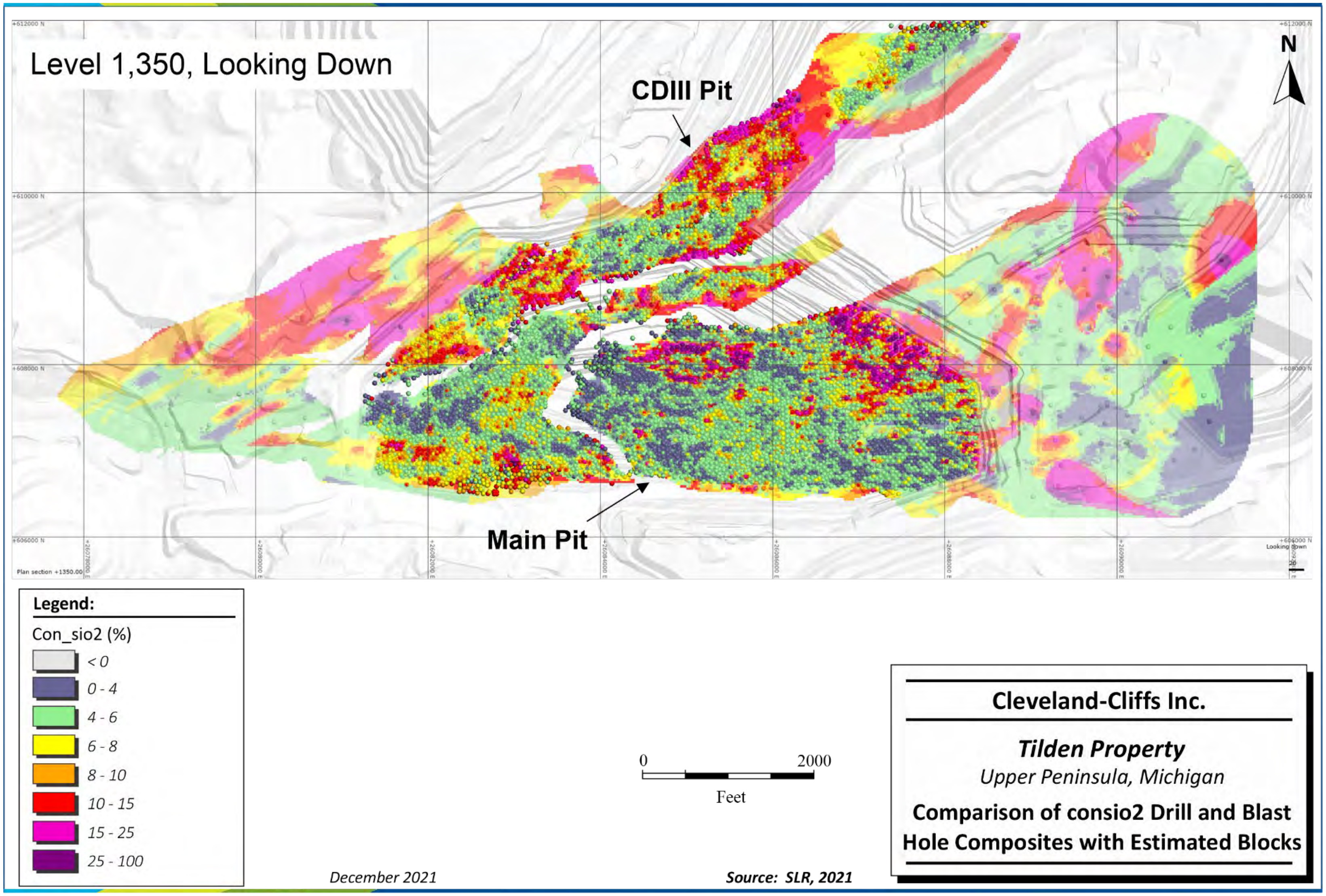


Figure 11-7: Comparison of consio2 Drill and Blast Hole Composites with Estimated Blocks

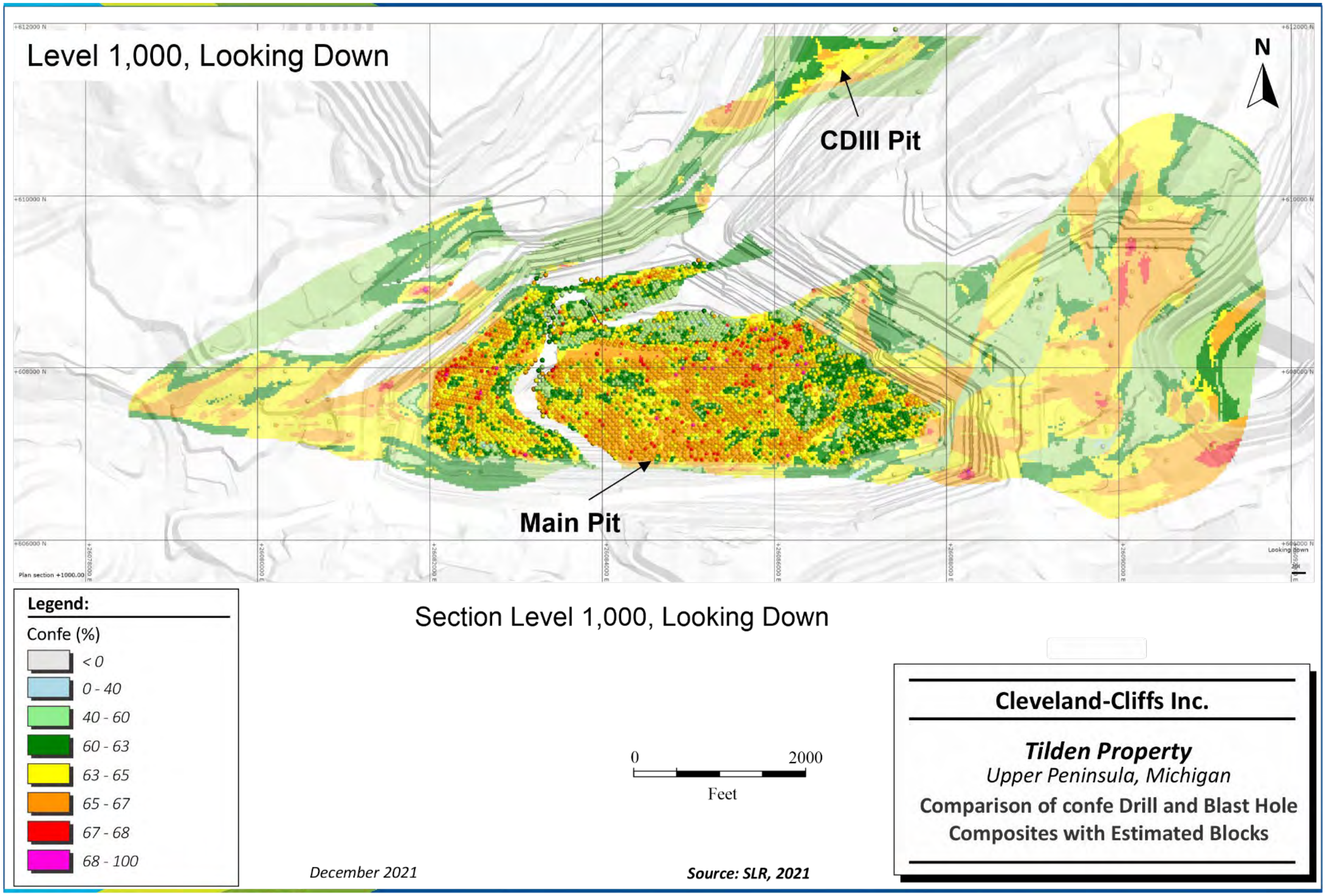


Figure 11-8: Comparison of confe Drill and Blast Hole Composites with Estimated Blocks

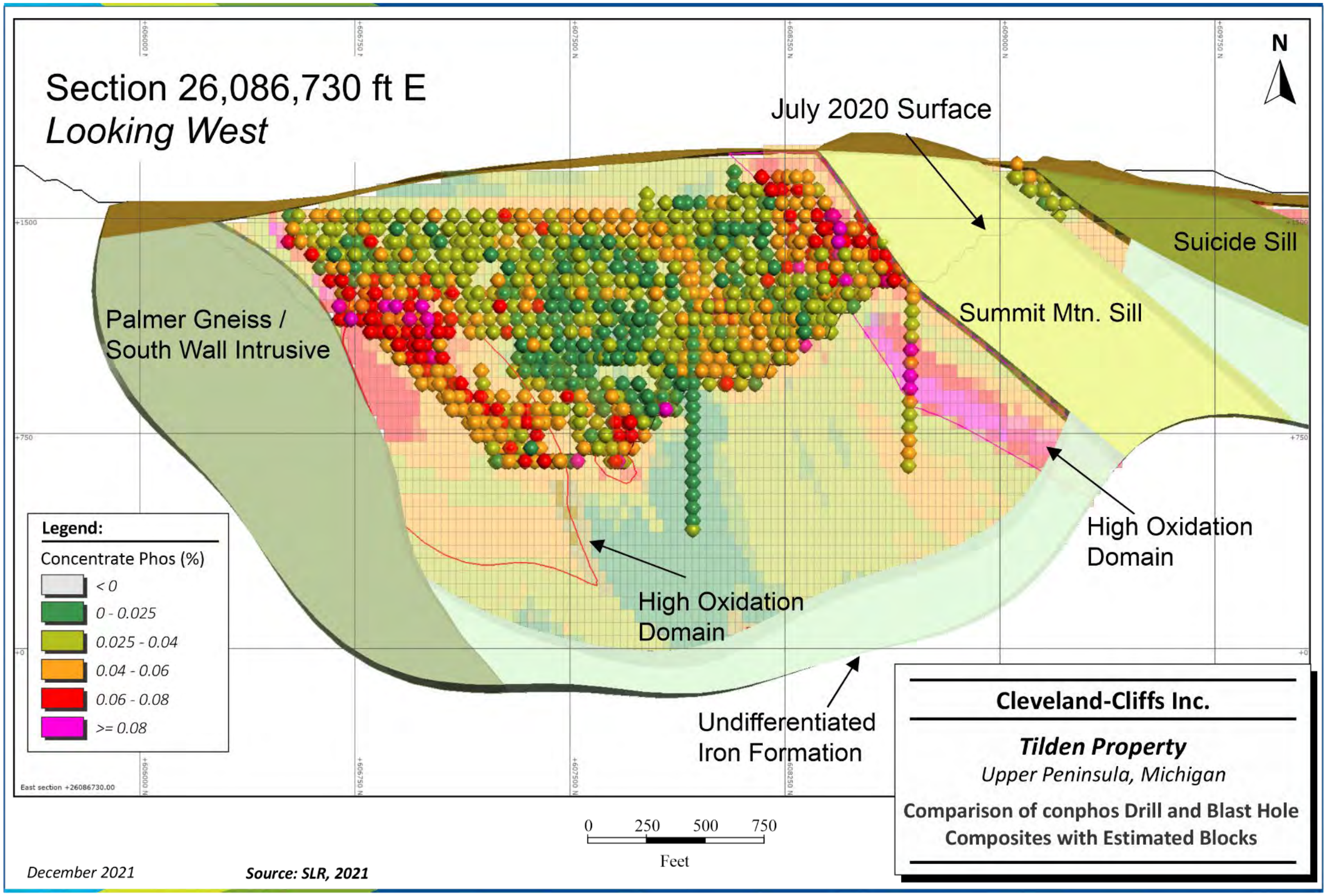


Figure 11-9: Comparison of conphos Drill and Blast Hole Composites with Estimated Blocks

11.12 Model Reconciliation

Reconciliation results comparing actual production results versus model-predicted values of crudefe confe, wtrec, consio2, and conphos for 2021 are presented in Table 11-9. Model values are represented by excavated full bench voids between quarterly topographies. A factor of 0.5 was applied to all ramp excavations, either developing them or removing them, to simulate volumetric differences. The Actual data in this reconciliation is dispatch-recorded material removed from the pit and placed directly in either the crusher or the stockpile.

The models used were the budget mine planning block models, which were modified from the geological model to account for crude ore loss and dilution.

Table 11-9: 2021 Model Reconciliation
Cleveland-Cliffs Inc. – Tilden Property

Period	Variable	Model	Actual	Variance
Q1	Crude Ore (kLT)	6,334	5,749	10.2%
	wtrec (%)	34.2	34.5	-0.8%
	crudefe (%)	38.0	37.7	0.6%
	confe (%)	63.8	64.2	-0.6%
	consio2 (%)	4.19	3.98	5.2%
	conphos (%)	0.030	0.030	0.6%
Q2	Crude Ore (kLT)	5,753	5,755	0.0%
	wtrec (%)	35.0	35.2	-0.5%
	crudefe (%)	37.8	36.8	2.9%
	confe (%)	63.8	64.5	-1.1%
	consio2 (%)	4.20	3.99	5.4%
	conphos (%)	0.036	0.031	14.9%
Q3	Crude Ore (kLT)	4,817	5,370	-10.3%
	wtrec (%)	35.2	34.7	1.6%
	crudefe (%)	38.6	36.4	6.0%
	confe (%)	63.5	63.5	0.1%
	consio2 (%)	4.44	4.15	7.1%
	conphos (%)	0.030	0.033	-6.6%
Q4	Crude Ore (kLT)	5,050	5,082	-0.6%
	wtrec (%)	35.4	34.6	2.2%
	crudefe (%)	39.2	37.6	4.3%
	confe (%)	62.8	62.7	0.2%
	consio2 (%)	4.59	4.38	4.9%
	conphos (%)	0.033	0.034	-3.8%

Period	Variable	Model	Actual	Variance
2021 Total	**Crude Ore (kLT)**	**21,953**	**21,955**	**0.0%**
	wtrec (%)	**34.9**	**34.7**	**0.5%**
	crudefe (%)	**38.4**	**37.1**	**3.3%**
	confe (%)	**63.5**	**63.7**	**-0.4%**
	consio2 (%)	**4.34**	**4.12**	**5.5%**
	conphos (%)	**0.032**	**0.032**	**1.3%**

The results indicate good overall reconciliation, with consistent slight over-prediction of consio2 values and variable conphos, as expected given the lower precision of these values as discussed in Section 8.0.

11.13 Mineral Resource Statement

A detailed breakdown of the Mineral Resources exclusive of Mineral Reserves is presented in Table 11-10. Mineral Resources defined were constrained within an optimized pit shell based on a $90/long ton pellet price and meeting the following cut-off grade criteria, based on existing pellet specifications and price contracts:

- ≥ 25% wtrec
- ≥ 25% crudefe
- ≤ 0.07% conphos
- ≤ 6% to 8.5% consio2 (domain dependent)

Table 11-10: Summary of Mineral Resources – December 31, 2021
Cleveland-Cliffs Inc. – Tilden Property

Category	Long Tons (Mtons)	Crude Fe (%)	Process Recovery (%)	Pellets (Mtons)
Measured	-	-	-	-
Indicated	135.4	35.5	35.9	48.6
Total Measured + Indicated	**135.4**	**35.5**	**35.9**	**48.6**
Inferred	350.4	34.7	36.4	127.4

Notes:

1. Tonnage is reported in long tons equivalent to 2,240 lb.
2. Tonnage is reported exclusive of Mineral Reserves and has been rounded to the nearest 100,000.
3. Mineral Resources are estimated at cut-off grades of 25% crudefe, 25% wtrec, 0.07% conphos, and 6% consio2 to 8.5% consio2, domain dependent.
4. Mineral Resources are estimated using a pellet value of US$90/LT.
5. Pellets are reported as fluxed and dry, containing 61.5% Fe, shipped pellets contain 1.5% moisture.
6. Tonnage estimate based on predicted depletion from a surveyed topography on December 31, 2021.
7. Resources are crude ore tons as delivered to the primary crusher; pellets are as loaded onto rail cars.
8. Bulk density is assigned based on a regression equation related to crude Fe.
9. Mineral Resources are 100% attributable to Cliffs.
10. Mineral Resources are constrained within an optimized pit shell and are exclusive of Mineral Reserves.

11. Mineral Resources that are not Mineral Reserves do not have demonstrated economic viability.
12. Numbers may not add due to rounding.

12.0 MINERAL RESERVE ESTIMATE

Mineral Reserves in this TRS are derived from the current Mineral Resources. Mineral Reserves are reported as crude ore and are based on open pit mining. Crude ore is the unconcentrated ore as it leaves the Mine at its natural *in situ* moisture content. The Proven and Probable Mineral Reserves for Tilden are estimated as of December 31, 2021, and summarized in Table 12-1.

Table 12-1: Summary of Tilden Mineral Reserves – December 31, 2021
Cleveland-Cliffs Inc. – Tilden Property

Category	Crude Ore Mineral Reserves (MLT)	Crude Ore Fe (%)	Process Recovery (%)	Wet Pellets (MLT)
Proven	3.6	35.3	36.1	1.3
Probable	516.4	34.7	37.0	191.1
Proven & Probable	**520.0**	**34.7**	**37.0**	**192.4**

Notes:

1. Tonnage is reported in long tons equivalent to 2,240 lb and has been rounded to the nearest 100,000.
2. Mineral Reserves are reported at a $90/LT wet hemflux pellet price freight-on-board (FOB) Lake Superior, based on the three-year trailing average of the realized product revenue rate.
3. Mineral Reserves are estimated at a crude ore cut-off grade of 25.0% Fe along with additional metallurgical constraints.
4. Mineral Reserves include mining dilution built into the Mineral Resource model and mining extraction losses by geometallurgical domain, which range from 4% to 30%.
5. The Mineral Reserve mining stripping ratio (waste units to crude ore units) is 1.2.
6. Proven Mineral Reserves are crude ore that has been mined and stockpiled for processing during the LOM.
7. Process recovery is reported as the percent mass recovery to produce a wet hemflux pellet containing 61.5% Fe; shipped pellets average approximately 1.5% moisture.
8. Tonnage estimate is based on the end of year, December 31, 2021 topographic survey.
9. Mineral Reserve tons are as delivered to the primary crusher; wet hemflux pellets are as loaded onto lake freighters at Marquette, Michigan.
10. Classification of Mineral Reserves is in accordance with the S-K 1300 classification system.
11. Mineral Reserves are 100% attributable to Cliffs.
12. Numbers may not add due to rounding.

The pellet price of US$90/LT wet hemflux pellet was used to perform the evaluation of Mineral Reserves in the current mining model. This price is consistent with the Mineral Reserve price used at Cliffs Northshore and United Taconite (UTAC) operations and is supported by the current three-year trailing average of the realized product revenue rate of US$98/LT wet hemflux pellet. Proven Mineral Reserves consist exclusively of crude ore that has been mined and stockpiled for future processing in the LOM plan. The costs used in this TRS represent all mining, processing, transportation, and administrative costs including the loading of pellets into lake freighters at Marquette, Michigan.

SLR is not aware of any risk factors associated with, or changes to, any aspects of the modifying factors such as mining, metallurgical, infrastructure, permitting, or other relevant factors that could materially affect the Mineral Reserve estimate.

12.1 Conversion Assumptions, Optimization Parameters, and Methods

Using the mine planning block model for Tilden, pit optimizations and pit designs were conducted to convert the Mineral Resources to Mineral Reserves.

In April 2021, a new mine planning block model, which forms the basis of the current Mineral Reserve estimate, was constructed for Tilden. The mine planning block model is based on the Mineral Resource block model from the January 26, 2021 geologic model (tilden_rpa_block_model_jan2021_ext_wtrec_mod.bmf) and a September 1, 2020 topographic survey projected to December 31, 2021 using actual and forecast depletion. The current Mineral Reserve estimate is reported from the mine planning block model and adjusted for the end of year, December 31, 2021 topographic survey.

Scripts executed within Vulcan add variables for economic evaluation and mine planning, assign mineral lease-holder information, and flag geotechnical zones and in-pit backfills in the mine planning block model. Scripts also assign restrictions to blocks that impact facilities areas or reside within specific geologic boundaries, assigning blocks as restricted or waste when appropriate. The resulting mine planning block model is evaluated using the pit optimization and Chronos scheduling packages in Vulcan.

Iron formations at Tilden are only initially considered as “candidate” crude ore if the stratigraphy comprises one of the following geometallurgical domains (as detailed in Sections 6.0 and 27.0 of this TRS):

- 300 Series Domains – 310, 316, 317, 320, 321, 330, 331, 340, 350, and 370.
- 400 Series Domains – 400, 410, 420, 421, and 480.
- 500 Series Domains – 500.

All other geometallurgical domains are considered to be waste.

In order to be amenable to the Tilden beneficiation process, candidate crude ore from the specified geometallurgical domains must also meet a number of metallurgical constraints as detailed in Sections 10.0 and 14.0 of this TRS and summarized in Table 12-2.

Table 12-2: Tilden Metallurgical Constraints
Cleveland-Cliffs Inc. – Tilden Property

Description	Main Pit[1]	East Pit[2]
wtrec	≧ 25%	≧ 25%
Head Iron	≧ 25%	≧ 25%
Concentrate P	≦ 0.07%	≦ 0.07%
	Concentrate Silica	
330 Domain	≦ 7.0%	≦ 6.0%
340 Domain	≦ 8.5%	≦ 8.5%
350 Domain	≦ 7.0%	≦ 6.0%
500 Domain	≦ 6.0%	≦ 6.0%
All Other Domains	≦ 7.0%	≦ 7.0%

Notes:

1. Main Pit area defined as all material west of 26,087,000 E in the Mine site coordinate system.

2. East Pit area defined as all material east of 26,087,000 E in the Mine site coordinate system.

Candidate crude ore blocks must then meet the following additional criteria to be considered crude ore blocks:

- Be classified as a Measured or Indicated Resource; Inferred Mineral Resources are considered to be waste.
- Not occur within a mining-restricted area.
- Generate a net block value greater than the cost of the block as if it were mined as waste.

The mine planning block model is based on 25 ft by 25 ft by 45 ft (XYZ) blocks. SLR notes that the block height is consistent with the mined BH dimensions of 45 ft.

Tilden practices strict grade control procedures coupled with post-blast, in-field ore and waste zone delineations. The material type assignment of each block is based on geologic domains, drilling confidence, and metallurgical results from grade control sampling.

Grade control samples are collected from blast holes with the entire 45 ft BH composited into a single sample per blast hole. This accounts for mining conditions such as small scale (i.e., not modeled) intrusive dikes, interfering mineral zones (e.g., smectite clays), or silica inclusions. With the use of this controlled ore grading system, minimal dilution is expected. Ore loss is assigned systematically within the block model on a geometallurgical domain basis using one of the following two methods: assignment based on reconciliation of operational results while mining in a specific domain, or assignment based on observed variability from exploration drilling of a specific domain. Ore loss values specific to each domain are used to convert a percentage of crude ore in the domain to waste rock. The ore loss factors applied by geometallurgical domain are as follows:

- 4% Ore Loss Domains – 310, 320, 340, 350, 370, 410, 420, 421, and 480.
- 8% Ore Loss Domains – 316, 317, and 500.
- 20% Ore Loss Domains – 400.
- 30% Ore Loss Domains – 321, 330, and 331.

Tilden has a long history of plant recovery, which is used as part of the pit optimization. The following summarizes the empirical relationship for hemflux pellet production based on crude ore tons, wtrec, and concentrate iron (Conc_Fe) content:

Wet Standard Concentrate tons = Crude Ore tons x (wtrec x DDH Discount x Plant Discount)

Wet Hemflux Pellet tons = Wet Standard Concentrate tons x ((Conc_Fe + 0.4) / Hemflux Pellet Fe)

Where:

- DDH Discount = 94.0%
- Plant Discount = 97.5%
- Hemflux Pellet Fe = 61.5%

From 2015 through 2020 the equation has reconciled within 5% annually when comparing calculated wet hemflux pellet production to actual wet hemflux pellet production. Figure 12-1 presents the variance of calculated versus actual hemflux pellets.

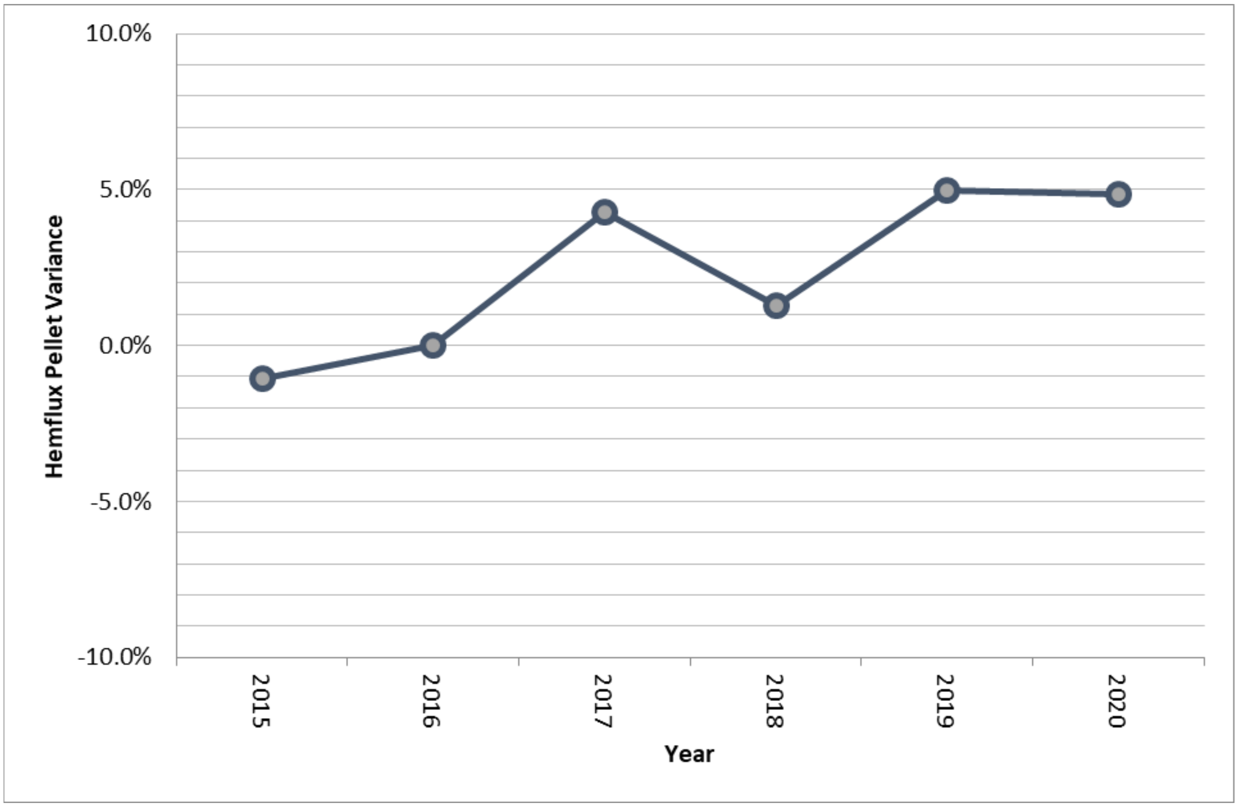


Figure 12-1: Wet Hemflux Pellet Calculated Versus Actual Production Variance

All Measured and Indicated Mineral Resources within the final designed pit that meet the above criteria are converted into Mineral Reserves. The only additional criteria for Measured Mineral Resources being converted into Proven Mineral Reserves is that the material must have already been mined and placed into stockpiles for future processing. Table 12-3 presents the criteria to convert Mineral Resource classifications to Mineral Reserve classifications.

Table 12-3: Mineral Resource to Mineral Reserve Classification Criteria
Cleveland-Cliffs Inc. – Tilden Property

Mineral Resources	Criteria for Conversion	Mineral Reserves
Measured	Mined and Stockpiled for Processing	Proven
Indicated	As Scheduled	Probable
Inferred	As Scheduled	Waste

12.2 Previous Mineral Reserve Estimates by Cliffs

Cliffs periodically updates the Tilden Mineral Reserve estimates as changes in Tilden pit development and market conditions occur. The SEC-reported Mineral Reserves for 2012 through 2020 are presented in Table 12-4. While these Mineral Reserves were not prepared under the recently adopted SEC guidelines they followed SEC Guide 7 requirements for public reporting of Mineral Reserves in the United States.

Prior to the current Mineral Reserve estimate, the most recent update to the LOM plan and Mineral Reserves was in 2019. Mineral Reserves in Cliffs' 10K filings have been updated net of depletion since.

Table 12-4: Previous Cliffs Mineral Reserves
Cleveland-Cliffs Inc. – Tilden Property

Year	Proven & Probable Crude Ore (MLT)	Process Recovery (%)	Dry Standard Equivalent Pellets (MLT)
2020[1]	585	34.3	201
2019[2]	603	34.2	206
2018[3]	324	37.6	122
2017[4]	346	37.3	129
2016[5]	368	37.1	136
2015[6]	389	36.9	144
2014[7]	584	34.2	200
2013[8]	605	34.3	207
2012[9]	625	34.3	214

Notes:

1. As of December 31, 2020; Source: Cleveland-Cliffs, Inc. 10-K Filing
2. As of December 31, 2019; Source: Cleveland-Cliffs, Inc. 10-K Filing
3. As of December 31, 2018; Source: Cleveland-Cliffs, Inc. 10-K Filing
4. As of December 31, 2017; Source: Cleveland-Cliffs, Inc. 10-K Filing
5. As of December 31, 2016; Source: Cleveland-Cliffs, Inc. 10-K Filing
6. As of December 31, 2015; Source: Cleveland-Cliffs, Inc. 10-K Filing
7. As of December 31, 2014; Source: Cleveland-Cliffs, Inc. 10-K Filing
8. As of December 31, 2013; Source: Cleveland-Cliffs, Inc. 10-K Filing
9. As of December 31, 2012; Source: Cleveland-Cliffs, Inc. 10-K Filing

Year-to-year changes to crude ore tons in Table 12-4 are primarily attributable to mining depletion. SLR notes that in 2015, significant changes to the pellet market contributed to the decrease in crude ore tons from the previous year. This trend was reversed in 2019, with crude ore tons increasing to similar levels observed prior to 2015. In 2021, a new Mineral Resource block model was prepared, which, along with mining depletion, contributes to the current decrease from the end of year 2020.

12.3 Pit Optimization

Pit optimizations were carried out for Tilden in Vulcan using the current mine-planning block model. Inputs used for the optimization were derived from actual production metrics and first principles estimation for the LOM forecast.

12.3.1 Summary of Pit Optimization Parameters

Pit optimization parameters are summarized as follows:

- Wet hemflux pellet tons = crude ore tons x (wtrec x 0.9165) x ((Conc_Fe + 0.4)/61.5)
- Base-case product average price = $90/LT wet hemflux pellets

- *In situ* rock mining cost = \$2.52/LT mined
- Incremental mining cost per bench above or below +1,575 ft elevation = \$0.02/LT/45 ft mined
- Crushing and concentrating cost = \$9.50/LT crude ore
- Pelletizing and site administration cost = \$14.06/LT wet hemflux pellets
- Replacement capital cost = \$4.33/LT wet hemflux pellets
- Royalty cost = variable based on *in situ* crude ore spatial location
- Maximum overall pit slope angle = variable by slope sector (34° to 44° for *in situ* rock, 30° in overburden)
- Pit restriction = surface infrastructure to the south (i.e., the processing facilities) with the existing southern footwall being a defined limit, existing large waste rock stockpiles to the north and northeast

12.3.2 Pit Optimization Results and Analysis

Pit optimization results are used as a guide for pit and stockpile designs. Pit optimizations were run by varying the base-case product price with a block revenue factor. The risk profile and revenue-generating potential of the deposit is evaluated by looking at the relationship between crude ore and waste rock and the associated relative discounted cash flows generated at each incremental pit (discount rate of 10% utilized for the optimization analysis).

The optimization results are summarized in Table 12-5, presenting the pit shell results from a price range of \$63.00/LT to \$90.00/LT of wet hemflux pellets. Pit shell 22 was selected as a guide for the Mineral Reserve final pit design, which is based on a wet hemflux pellet price of \$72.90/LT.

Table 12-5: Pit Optimization Results
Cleveland-Cliffs Inc. – Tilden Property

Pit Shell	Revenue Factor	Product Price (US\$/LT wet pellet)	Crude Ore (MLT)	Stripping (MLT)	Total Tons (MLT)	Stripping Ratio (W:O)	Process Recovery (%)	Wet Pellets (MLT)
11	0.70	63.00	380	187	567	0.5	37.2	141
12	0.71	63.90	390	201	592	0.5	37.1	145
13	0.72	64.80	397	210	607	0.5	37.1	147
14	0.73	65.70	409	229	638	0.6	37.1	151
15	0.74	66.60	418	242	660	0.6	37.0	155
16	0.75	67.50	444	277	721	0.6	36.7	163
17	0.76	68.40	463	303	765	0.7	36.5	169
18	0.77	69.30	478	330	807	0.7	36.5	174
19	0.78	70.20	488	350	837	0.7	36.4	178
20	0.79	71.10	495	364	859	0.7	36.4	180
21	0.80	72.00	525	449	973	0.9	36.5	191

Pit Shell	Revenue Factor	Product Price (US$/LT wet pellet)	Crude Ore (MLT)	Stripping (MLT)	Total Tons (MLT)	Stripping Ratio (W:O)	Process Recovery (%)	Wet Pellets (MLT)
22	**0.81**	**72.90**	**530**	**460**	**990**	**0.9**	**36.4**	**193**
23	0.82	73.80	538	476	1,014	0.9	36.4	196
24	0.83	74.70	547	494	1,041	0.9	36.3	199
25	0.84	75.60	553	510	1,063	0.9	36.3	201
26	0.85	76.50	560	529	1,088	0.9	36.3	203
27	0.86	77.40	563	539	1,102	1.0	36.3	204
28	0.87	78.30	565	544	1,109	1.0	36.3	205
29	0.88	79.20	573	568	1,141	1.0	36.2	208
30	0.89	80.10	576	580	1,157	1.0	36.2	209
31	0.90	81.00	578	586	1,163	1.0	36.2	209
32	0.91	81.90	580	592	1,172	1.0	36.2	210
33	0.92	82.80	584	605	1,189	1.0	36.2	211
34	0.93	83.70	588	621	1,209	1.1	36.2	213
35	0.94	84.60	590	630	1,220	1.1	36.2	214
36	0.95	85.50	591	631	1,222	1.1	36.2	214
37	0.96	86.40	592	635	1,226	1.1	36.2	214
38	0.97	87.30	592	637	1,229	1.1	36.2	214
39	0.98	88.20	594	643	1,236	1.1	36.2	215
40	0.99	89.10	596	654	1,250	1.1	36.2	216
41	1.00	90.00	599	666	1,264	1.1	36.2	217

Note:

1. Numbers may not add due to rounding.

Figure 12-2 presents an optimization pit-by-pit graph showing tonnages and relative discounted cash flow results, in addition to the selected final pit shell 22 highlighted (Revenue Factor of 0.81).

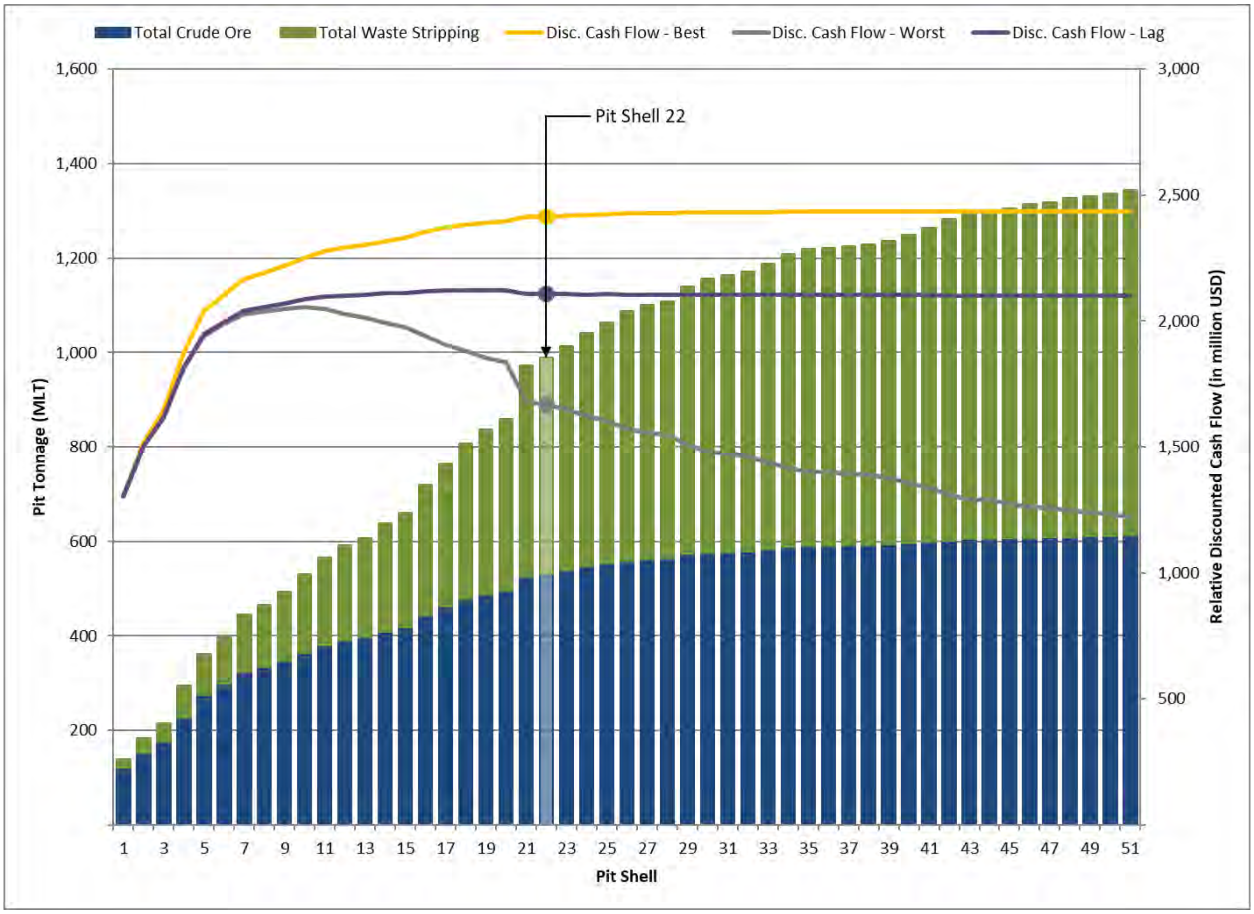


Figure 12-2: Tilden Mine Pit-by-Pit Graph

As observed in Figure 12-2, at higher pit shell numbers (i.e., higher product prices) there is limited opportunity for increased Mineral Reserves and the incremental stripping ratio increases significantly. This is a result of the overall pit size being restricted by the surface infrastructure to the south (i.e., the processing facilities) and waste rock stockpiles to the north and northeast.

Figure 12-3 superimposes the final pit shell selection (i.e., pit shell 22) footprint over top the current Tilden topography.

As observed in Figure 12-3, the final pit shell selection develops to the north and along strike of the existing pit, leaving the existing southern pit footwall slope unaltered.

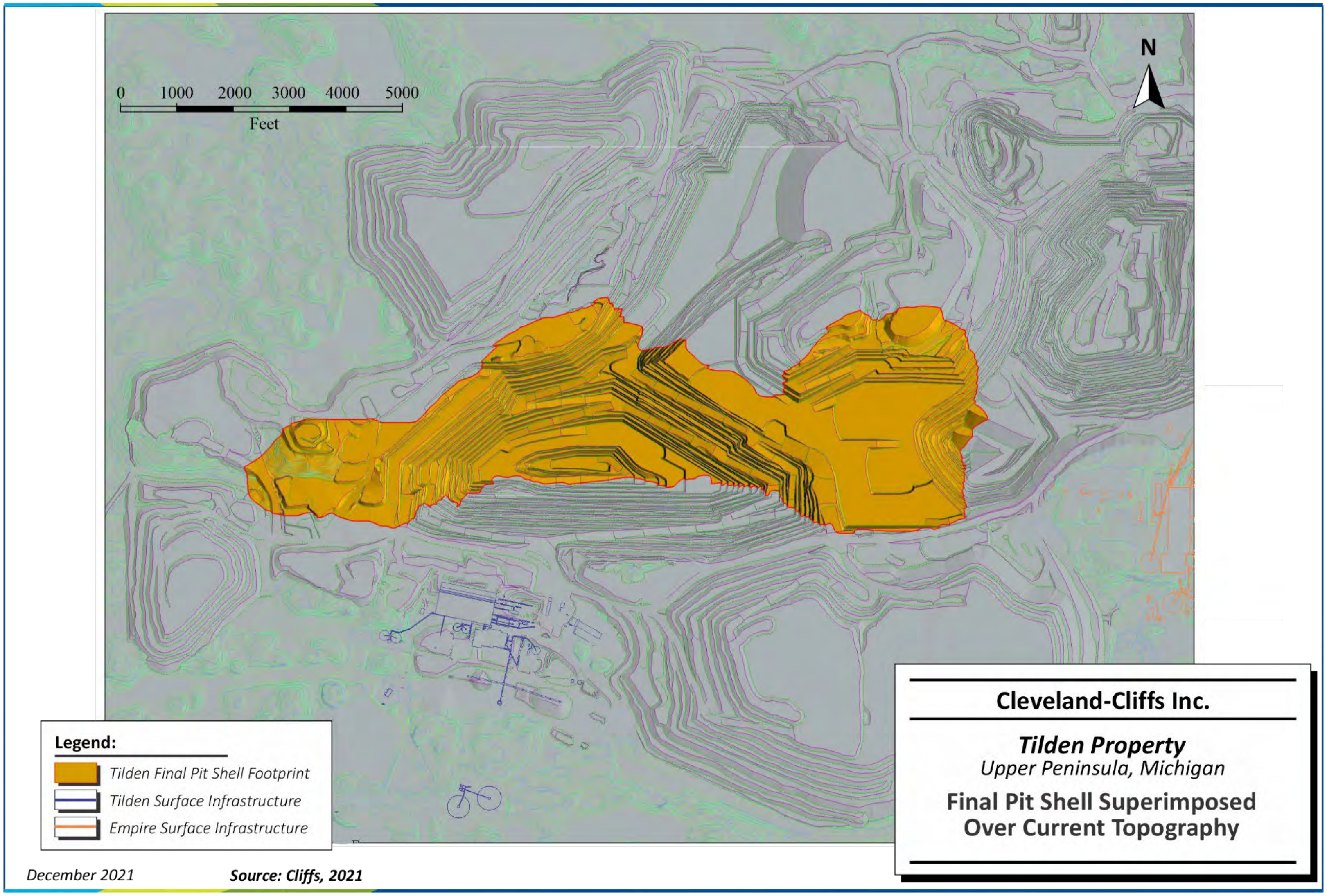


Figure 12-3: Final Pit Shell Superimposed Over Current Topography

12.4 Mineral Reserve Cut-off Grade

The Mineral Reserve cut-off grade is a combination of metallurgical constraints based on geometallurgical domains applied in order to produce a saleable product followed by verification through a break-even cut-off grade calculation. In summary, the Mineral Reserve cut-off requirements are:

- Crude ore Fe: all geometallurgical domains ≥ 25%
- Crude ore wtrec: all geometallurgical domains ≥ 25%
- Concentrate P: all geometallurgical domains ≤ 0.07%
- Concentrate SiO_2: variable by geometallurgical domain from ≤ 6.0% to ≤ 8.5%

12.5 Mine Design

The Tilden final pit design incorporates several design variables including geotechnical parameters (e.g., wall angles and bench configurations), equipment size requirements (e.g., mining height and ramp configuration), and physical mining limits (e.g., property boundaries and existing infrastructure). The following summarizes the design variables and final pit results. Further detail is provided in the preceding subsections and in Section 13.0 of this TRS.

Six separate slope sectors have been identified in the *in situ* rock. The IRA of the slope sectors varies from approximately 38° to 47°. The bench design consists of 45 ft-high mining benches, double benched to a final 90 ft BH, with a 48.5° to 66.5° BFA and 35-ft to 45-ft catch benches (CB). The majority of the final pit's south wall is an existing final wall located above slope sector 5. It was developed along the footwall of the iron formation and acts as a limit to the new final pit design.

Pit slopes in glacial overburden are designed at an average slope angle of approximately 30°.

Haul roads are incorporated with widths of 120 ft to support two-way traffic and 90 ft for one-way traffic. Ramp gradients are limited to a maximum of 10% to stay within the safe working capabilities of the trucks.

The selected final pit shell compared to the final pit design is detailed in Table 12-6. Pit design results are reported using the same topographic surface projection as the pit optimization results (i.e., as per the mine planning block model).

Table 12-6: Pit Optimization to Pit Design Comparison
Cleveland-Cliffs Inc. – Tilden Property

Pit	Crude Ore (MLT)	Crude Ore Fe (%)	Stripping (MLT)	Total Material (MLT)	Stripping Ratio (W:O)
Pit Optimization Pit Shell 22	530	34.7	460	990	0.9
Final Pit Design	513	34.7	595	1,107	1.2

Notes:

1. Comparison totals are per the Mine planning model.
2. Crude ore is *in situ* tonnage; stockpiled inventory is excluded.
3. Numbers may not add due to rounding.

Overall, the final pit design is a reasonable representation of the final pit shell guide, with the exception of the north side of the pit proximal to the existing (previously mined) CD3 pit. Additional waste stripping is required in this area to allow access to the CD3 backfill area while not impacting current Mineral Resources and preserving the future Mineral Resources to Mineral Reserve conversion potential of the area.

13.0 MINING METHODS

13.1 Mining Methods Overview

The Tilden deposit is mined using conventional surface mining methods, with surface operations including:

- Overburden (glacial till) removal
- Drilling and blasting (excluding overburden)
- Loading and haulage
- Crushing and rail loading

Tilden Mineral Reserves are based on ongoing annual crude ore production of 20 MLT to 22 MLT producing approximately 7.7 MLT of wet hemflux pellets for domestic consumption.

Mining and processing operations are scheduled 24 hours per day, and mine production is scheduled to directly feed the processing operations.

The current LOM plan has mining scheduled for 25 years and mines the known Mineral Reserve. The average stripping ratio is approximately 1.2 waste units to 1 crude ore unit (1.2 stripping ratio).

The final Tilden pit is a single pit approximately 2.5 mi along strike, up to 0.9 mi wide, and up to 1,980 ft deep.

The Tilden operation has strict crude ore blending requirements to ensure the Plant receives a consistent crude ore feed. The most important characteristics of the crude ore are the crude ore iron grade and predicted concentrate mass recovery, and Conc_Fe, silica, and phosphorus content. Operationally, blending is completed on a shift-by-shift basis. Generally, three to four crude ore loading points are mined simultaneously with dispatch operators issuing real-time adjustments to meet specified crude ore blends for the Plant.

Crude ore is hauled to the crushing facility and either direct tipped to the primary crusher or stockpiled. Haul trucks are alternated to blend delivery from the multiple crude ore loading points. Crude ore stockpiles are used as an additional source for blending and production efficiency. Crushed crude ore is conveyed to a covered storage building for stockpiling, prior to being fed to the concentrator. Waste rock and overburden are hauled to one of the many waste stockpiles peripheral to the pit or to the in-pit backfill.

Primary pit equipment includes electric drills, electric rope shovels, haul trucks, front-end loaders (FELs), bulldozers, and graders. Extensive maintenance facilities are available at the Mine to service the mine equipment.

13.2 Pit Geotechnical

13.2.1 Overview

The geotechnical parameters used for slope design are based on the 2020 slope angle study completed by Call & Nicholas Inc. (CNI) (CNI, 2020). The geotechnical and haul road construction parameters incorporated into the Tilden pit design are summarized in Table 13-1 and referenced graphically in Figure

13-1 and Figure 13-2. Double benching is practiced, involving two, 45-ft working benches to create one, 90 ft overall BH.

Table 13-1: Pit Wall Geotechnical Parameters
Cleveland-Cliffs Inc. – Tilden Property

Parameter	Unit	Sector 1	Sector 2	Sector 3	Sector 4	Sector 5	Sector 6	Overburden
IRA	Degrees	38.1	45.0	42.9	38.1	46.9	44.1	29.7
BFA	Degrees	48.5	63.5	60.0	48.5	66.5	62.0	60.0
BH	ft	90	90	90	90	90	90	45
CB	ft	35	45	45	35	45	45	53
Ramp–Width - 2 way	ft	120	120	120	120	120	120	120
Ramp–Width - 1 way	ft	90	90	90	90	90	90	90
Ramp Gradient (Maximum)	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0

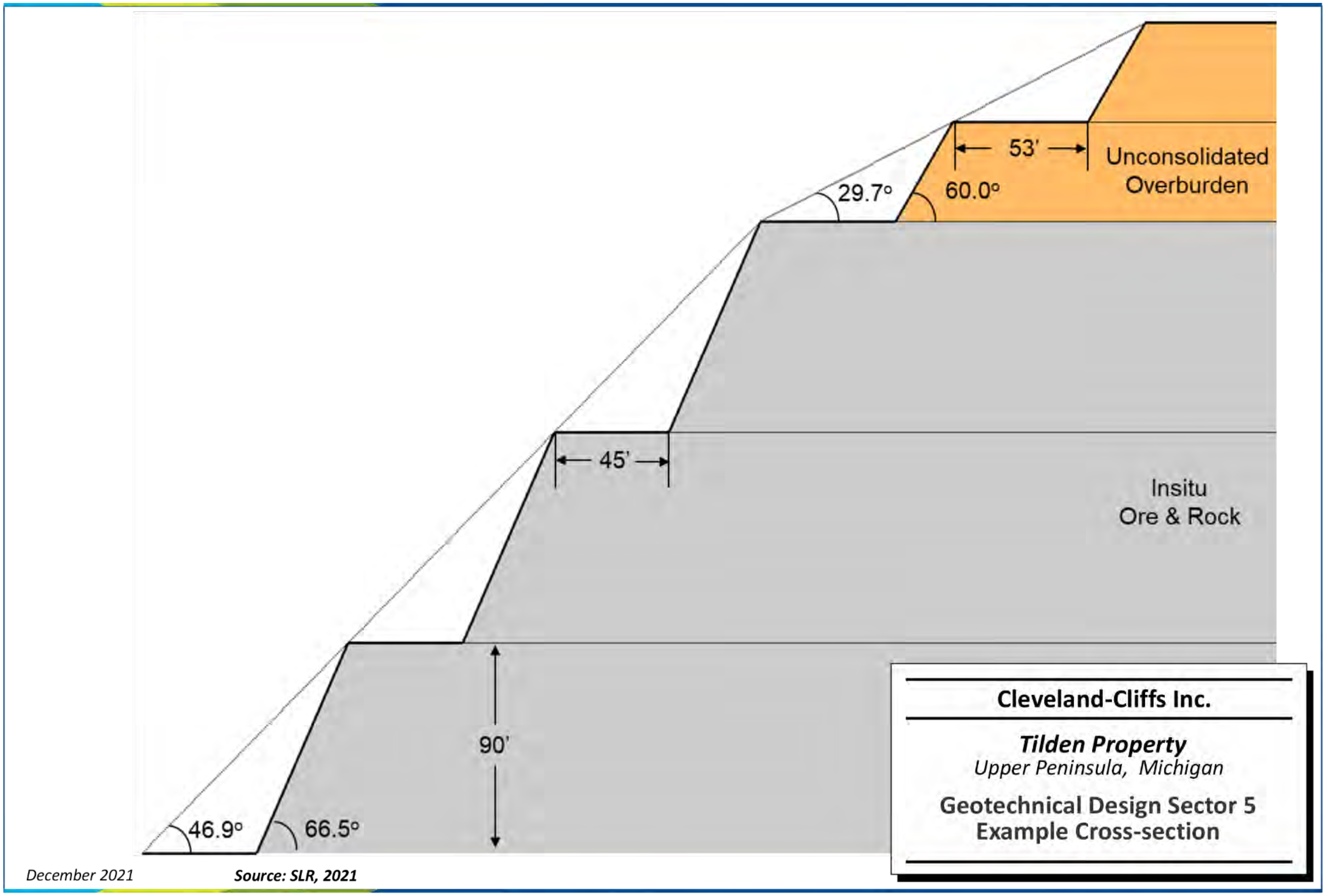


Figure 13-1: Geotechnical Design Sector 5 Example Cross-section

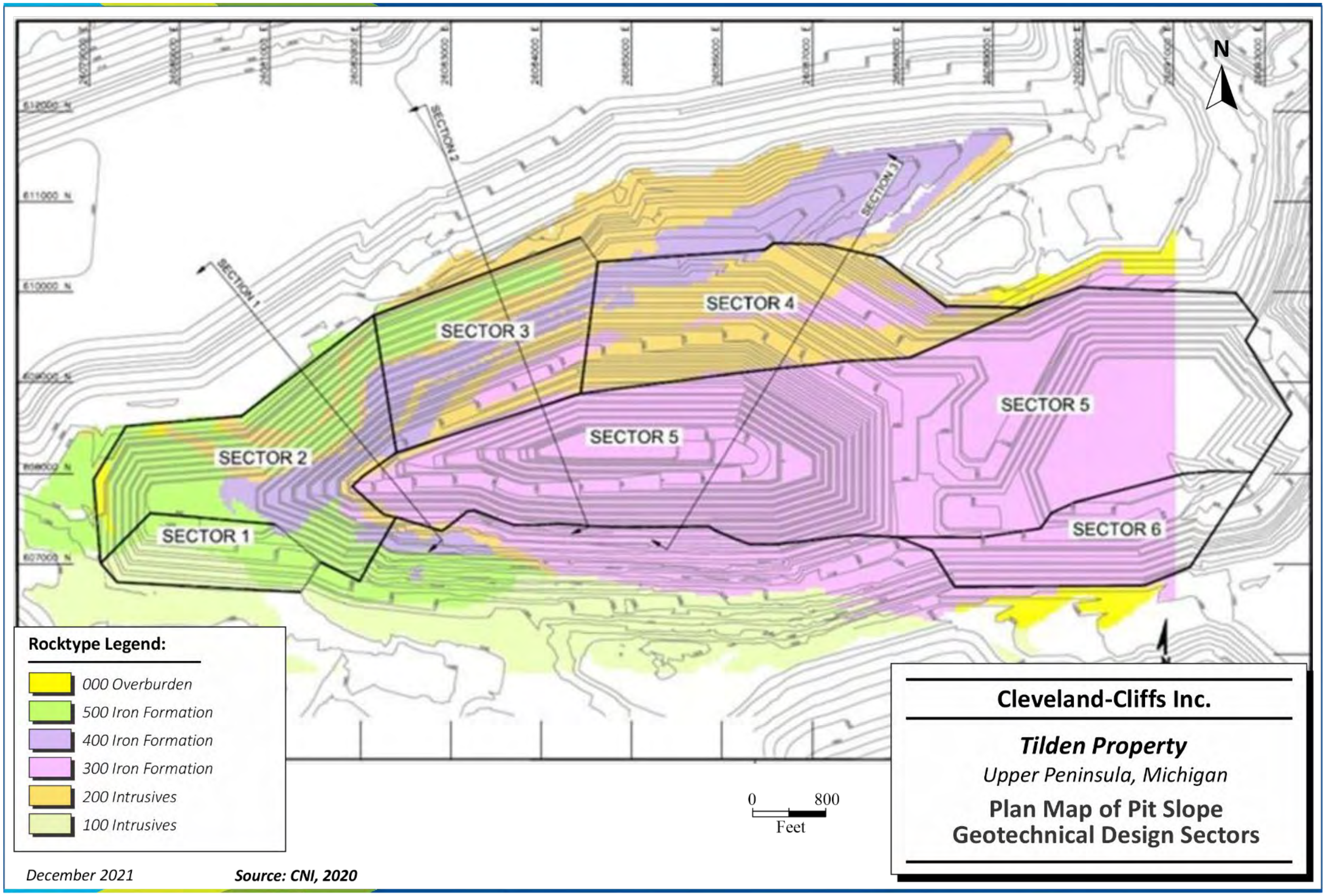


Figure 13-2: Plan Map of Pit Slope Geotechnical Design Sectors

13.2.2 Geotechnical Data

Geotechnical data includes RQD data, contained in the Tilden drill hole database, and laboratory test results of UCS, BTS, and direct shear tests on natural fractures (CNI, 2020). The tests performed are summarized in Table 13-2 and Table 13-3.

Table 13-2: Summary of UCS and BTS Test Results
Cleveland-Cliffs Inc. – Tilden Property

Rock Type	Mean UCS (psi)	Young's Modulus (psi)	Poisson's Ratio	Density (pcf)	Mean Tensile Strength (psi)	Number of Tests	
						UCS	BTS
Intrusive (200 series)	17,188	5.7E+06	0.26	176	1,939	13	21
Iron Formation (300, 400, 500 series)	23,657	1.4E+06	0.12	213.4	2,673	11	22

Source: after CNI (2020)

Table 13-3: Summary of Direct Shear Test Results
Cleveland-Cliffs Inc. – Tilden Property

Rock Type	Mean Cohesion (psi)	Standard Deviation Cohesion (psi)	Mean Friction Angle (°)	Standard Deviation Friction Angle (°)	Number of Tests
Intrusive (200 series)	4.7	4.2	19.4	4.8	13
Iron Formation (300, 400, 500 series)	5.1	4.0	34.4	3.5	11
Fault Gouge	4.0	4.0	18.9	1.6	2

Source: after CNI (2020)

Photogrammetry data, combined with cell-mapping data collected by CNI in 2010 and 2012 was used to develop a structural model. Photographs taken using an aerial drone were processed by CNI using Pix4D to create high-definition point clouds. The point clouds were then used to map joints and faults and take measurements of dip and dip direction for use in defining structural domains and for input into a slope stability assessment.

13.2.3 Rock Mass Shear Strength

Geotechnical domains have been delineated from lithological contacts, lithology block models, fault traces and fault surfaces provided by Cliffs, in addition to from previous Mineral Reserve modeling work. Lithological contacts were used to define iron formation and intrusive rock domains, which were further subdivided into separate geotechnical domains by the faults. Mohr-Coulomb shear strength parameters for the rock mass have been determined using the CNI criterion, which uses a combination of the intact rock strength and fracture shear strength weighted according to the RQD for each geotechnical domain (Table 13-4).

Table 13-4: Material Properties Used in Overall Slope Stability Analysis
Cleveland-Cliffs Inc. – Tilden Property

Cross Section	Rock Type	Geologic Domain	RQD 70% rel.	Fracture		Intact Rock		Rock Mass (crf 0.3) – US		
				Phi (°)	Coh (psi)	Phi (°)	Coh (psi)	Phi (°)	Coh (psi)	Unit Weight (lb/ft^3)
1	300 Iron Fm	-	40	34.4	5.1	44.9	3897	37.5	169	213
	200 Intrusive	2	43	19.4	4.7	44.9	2829	27.8	133	176
	400 Iron Fm	2	34	34.4	5.1	44.9	3897	37.2	145	213
	500 Iron Fm	2	35	34.4	5.1	44.9	3897	37.2	148	213
2	200 Intrusive	3	43	19.4	4.7	44.9	2829	27.8	133	176
	300 Iron Fm	3	40	34.4	5.1	44.9	3897	37.5	169	213
	200 Intrusive	6	43	19.4	4.7	44.9	2829	27.8	133	176
	400 Iron Fm	6	34	34.4	5.1	44.9	3897	37.2	145	213
	500 Iron Fm	6	35	34.4	5.1	44.9	3897	37.2	148	213
3	200 Intrusive	4	43	19.4	4.7	44.9	2829	27.8	133	176
	300 Iron Fm	4	40	34.4	5.1	44.9	3897	37.5	169	213
	400 Iron Fm	6	34	34.4	5.1	44.9	3897	37.2	145	213

Source: after CNI (2020)

Strength anisotropy is also modeled to account for strong preferential jointing in the iron formations and intrusive rocks, which reduces the shear strength of the rock mass in the direction parallel to the main structure. Anisotropic strength is calculated from a weighted average of intact rock strength (rock bridge) and fracture strength (Table 13-5).

Table 13-5: Anisotropic Material Properties Used in the Weak Direction
Cleveland-Cliffs Inc. – Tilden Property

Cross Section	Rock Type	Geologic Domain	Dip Range (°)	Type	Percentage Intact (%)	Phi (°)	Coh (psf)
1	300 Iron Fm	-	-	Joint	3.1	34.8	125.8
	200 Intrusive	2	53-38		1.9	19.9	58.4
	400 Iron Fm	2	55-39		3.1	34.8	125.8
	500 Iron Fm	2	55-39		3.1	34.8	125.8
2	200 Intrusive	3	58-42	Joint	1.9	19.9	58.4
	300 Iron Fm	3	51-35		3.1	34.8	125.8
	200 Intrusive	6	49-36		1.9	19.9	58.4

Cross Section	Rock Type	Geologic Domain	Dip Range (°)	Type	Percentage Intact (%)	Phi (°)	Coh (psf)
	400 Iron Fm	6	59-41		3.1	34.8	125.8
	500 Iron Fm	6	59-41		3.1	34.8	125.8
	200 Intrusive	4	51-35		1.9	19.9	58.4
3	300 Iron Fm	4	84-52	Joint	3.1	34.8	125.8
	400 Iron Fm	6	84-52		3.1	34.8	125.8

Source: after CNI (2020)

13.2.4 Hydrogeology and Pit Water Management

Surface water is abundant, as the Property is surrounded by natural lakes and wetlands. While water is known to be present within the rock mass, inflow of water from the pit walls has not been a significant challenge to operations.

Groundwater has been incorporated into the slope stability analysis using the results of 2D pore pressure modeling carried out by CNI based on the regional phreatic surface provided by Cliffs.

All pit dewatering that is discharged off-site must first pass through the clarifier system at the Gribben tailings basin prior to discharge via a National Pollutant Discharge Elimination System (NPDES)-permitted outfall, which has a maximum discharge rate of 25.8 million gallons per day.

Water used for dust control on roads comes from pit sumps. Overall water requirements for the Mine are detailed in section 15.10 of this TRS.

13.2.5 Stability Assessment and Slope Design

Recommended IRAs, CBs, and BFAs were derived by CNI from a survey of as-built slopes using LiDAR and drone survey data, which allowed for an assessment of achievable design parameters. The stability of the overall slope design was assessed for sections cut through the May 2019 pit surface combined with the current Mineral Reserve pit. Analysis was performed with Rocscience's Slide 2018 limit equilibrium software using the Spencer method of slices, including the modeled (regional) groundwater phreatic surface. A factor of safety (FoS) of 1.2 was chosen as the acceptance criteria for slope stability. Three sections were analysed through slope sectors 2, 3, and 4. Results indicate that final slopes in sector 4 will be stable, while sectors 2 and 3 may require some depressurization to achieve a FoS of 1.2. SLR recommends an assessment of the groundwater conditions in the immediate vicinity of the final pit through a more focused groundwater model. The results of this assessment should be input into an update of the stability analysis on sections cut through the current final pit design.

13.3 Open Pit Design

The Tilden pit design combines current site access, minimum mining width requirements, geotechnical parameters, pit optimization results, and mining limit restrictions as described previously in sections 12.5 and 13.2 of this TRS.

Table 13-6 details the contents of the final pit design adjusted for the end of year, December 31, 2021 topographic survey.

Table 13-6: Final Pit Design LOM Total - December 31, 2021
Cleveland-Cliffs Inc. – Tilden Property

Pit	Crude Ore (MLT)	Crude Ore Fe (%)	Waste Rock Stripping (MLT)	Overburden Stripping (MLT)	Total Stripping (MLT)	Total Material (MLT)	Stripping Ratio (W:O)
Tilden	516.4	34.7	586.6	13.9	600.5	1,116.9	1.2

Notes:

1. Crude ore is *in situ* tonnage, stockpiled inventory is excluded.
2. Numbers may not add due to rounding.

Figure 13-3 presents a plan view of the final pit design in addition to the final waste stockpile designs. Figure 13-4 to Figure 13-6 present example cross-sections through the final pit design.

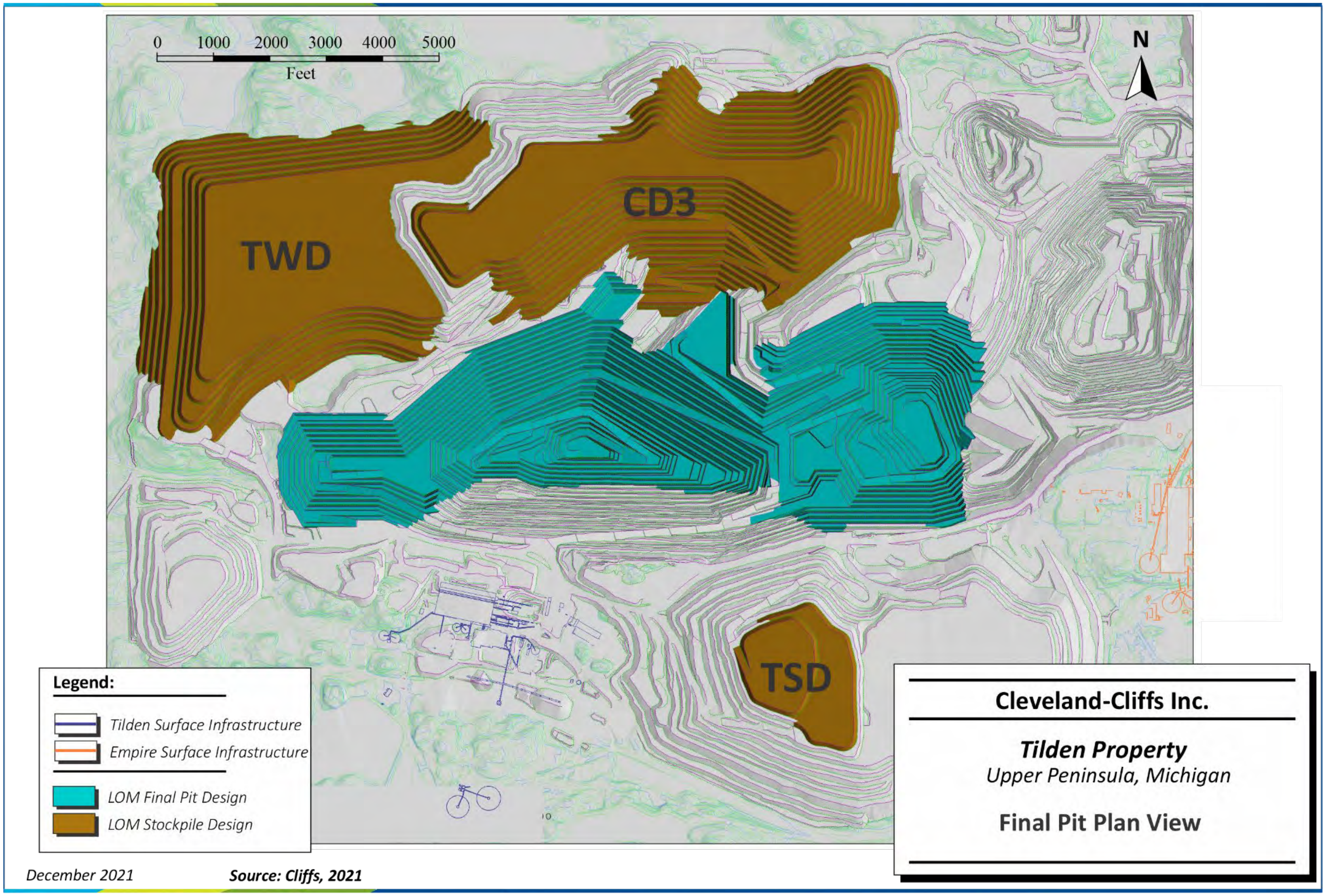


Figure 13-3: Final Pit Plan View

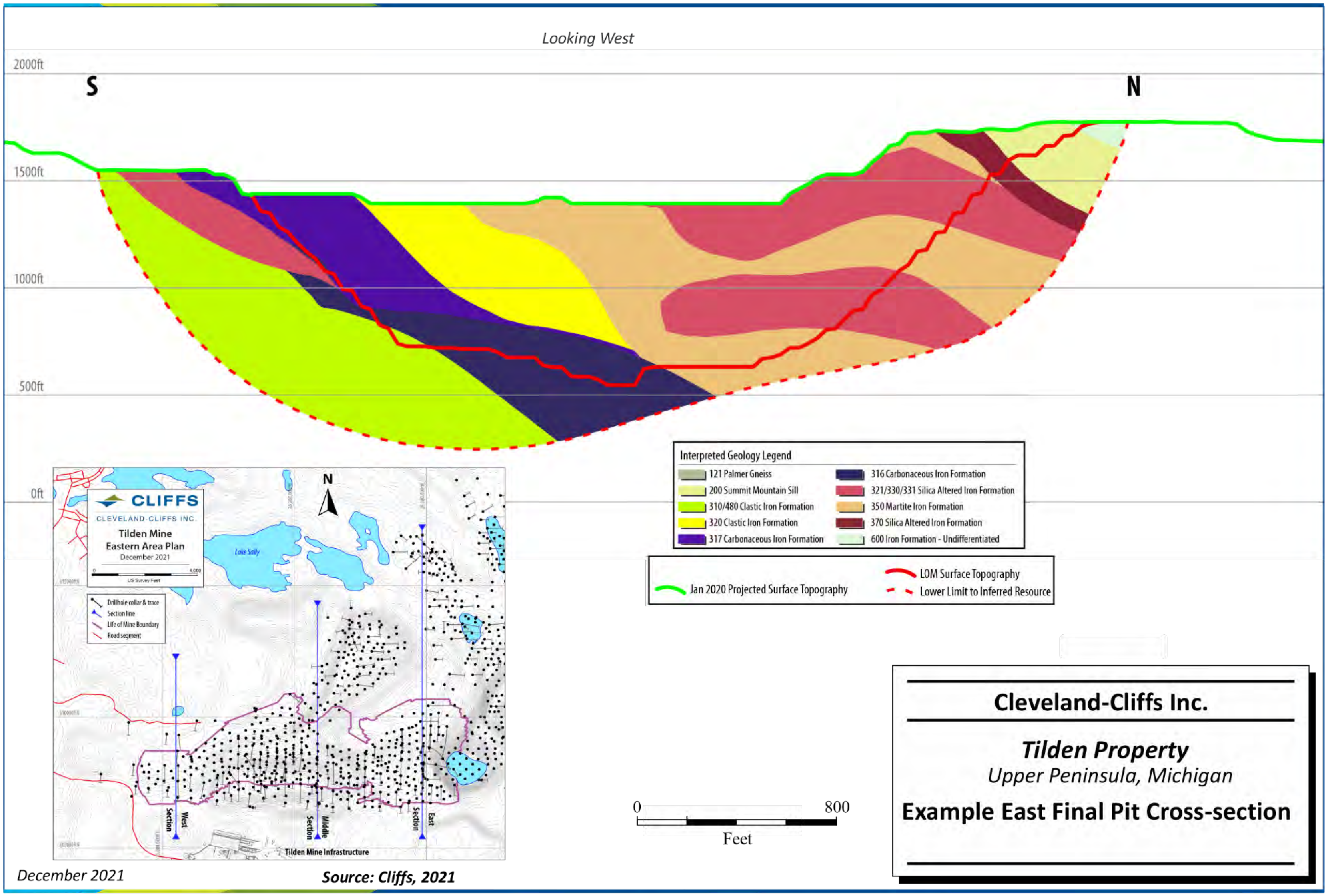


Figure 13-4: Example East Final Pit Cross-section Looking West

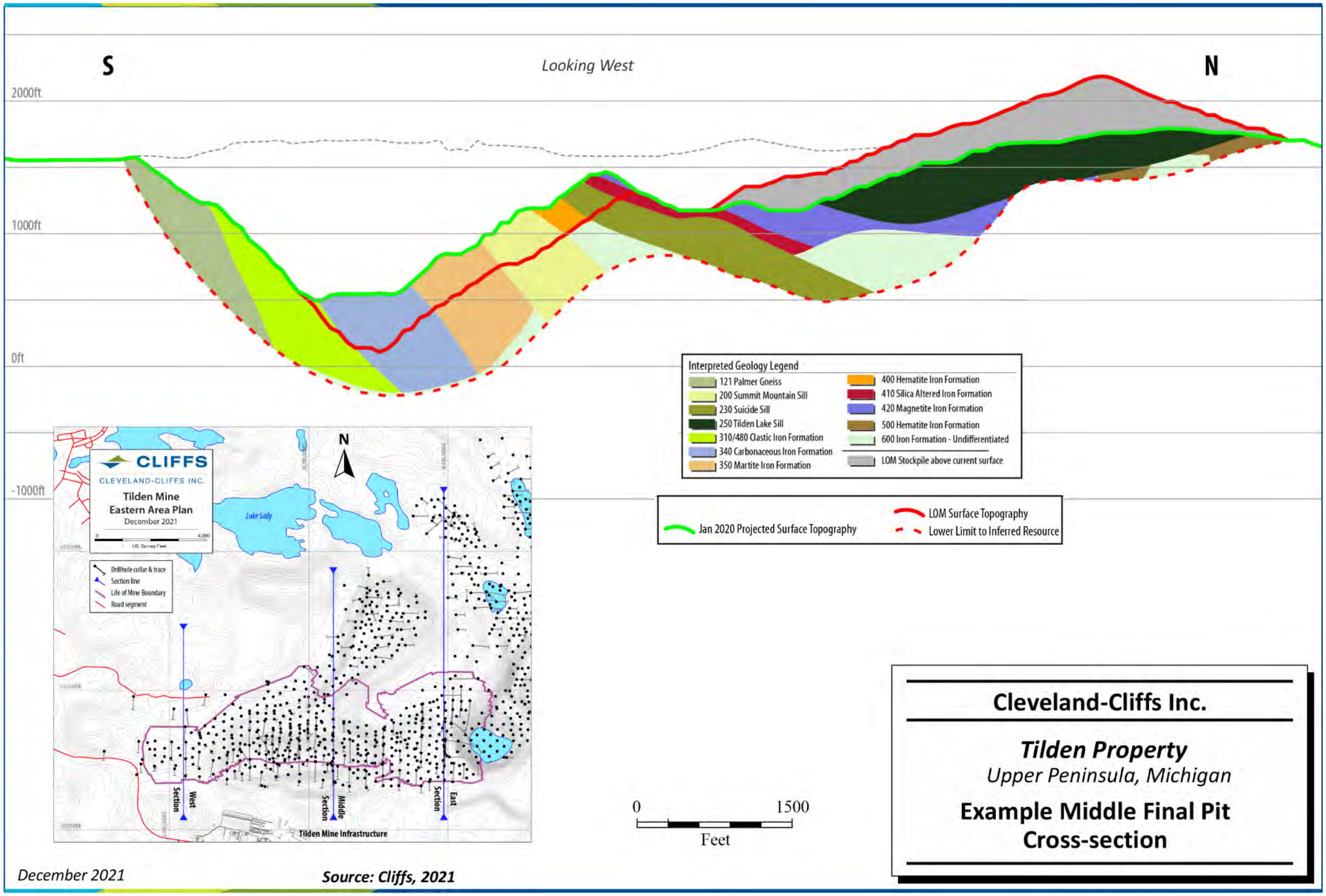


Figure 13-5: Example Middle Final Pit Cross-section Looking West

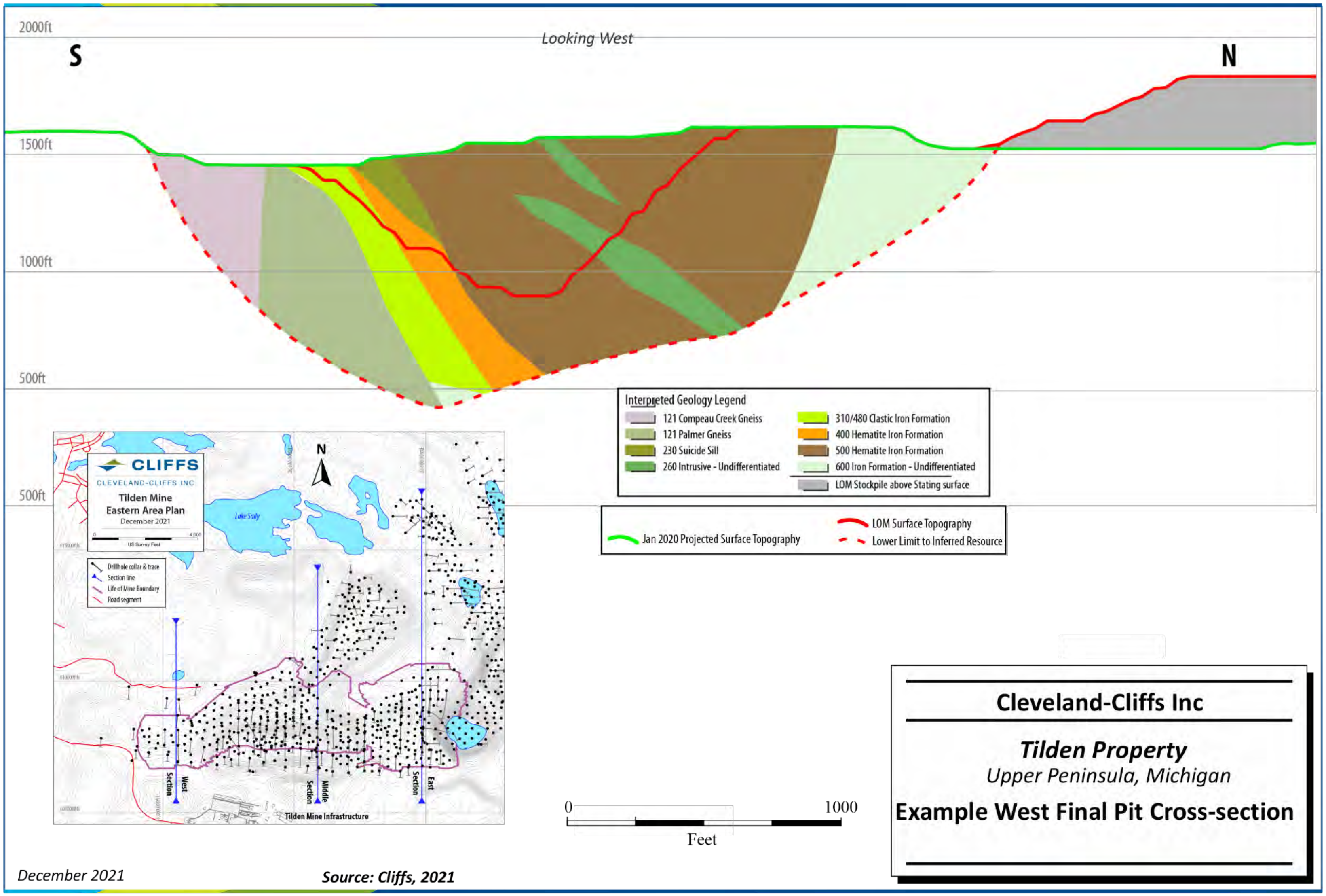


Figure 13-6: Example West Final Pit Cross-section Looking West

13.3.1 Pit Phase Design

Intermediate pit phase designs or pushbacks are included in the LOM planning. The primary objective of the phased designs is to balance waste stripping and maintain access to specific ore types for blending purposes while ensuring haulage access is maintained over the LOM. Access to crude ore, specifically 340 domain Fe carbonate, 350 domain Fe oxide, and 320 domain Fe clastic iron mineralization groups, plays a significant role in determining the pit phasing design

Designs for each mining pit phase are largely determined by effective minimum mining width and influence on access to crude ore. Pit optimization results at lower revenue factors are also used to help guide the phase development.

Design parameters for intermediate-phase walls use decreased BFAs to account for shallower wall slopes as a result of not drilling and cleaning to the final pit design parameters. Figure 13-7 presents the location of the phases within the mining area, where the surface footprint of each phase is represented by a different color.

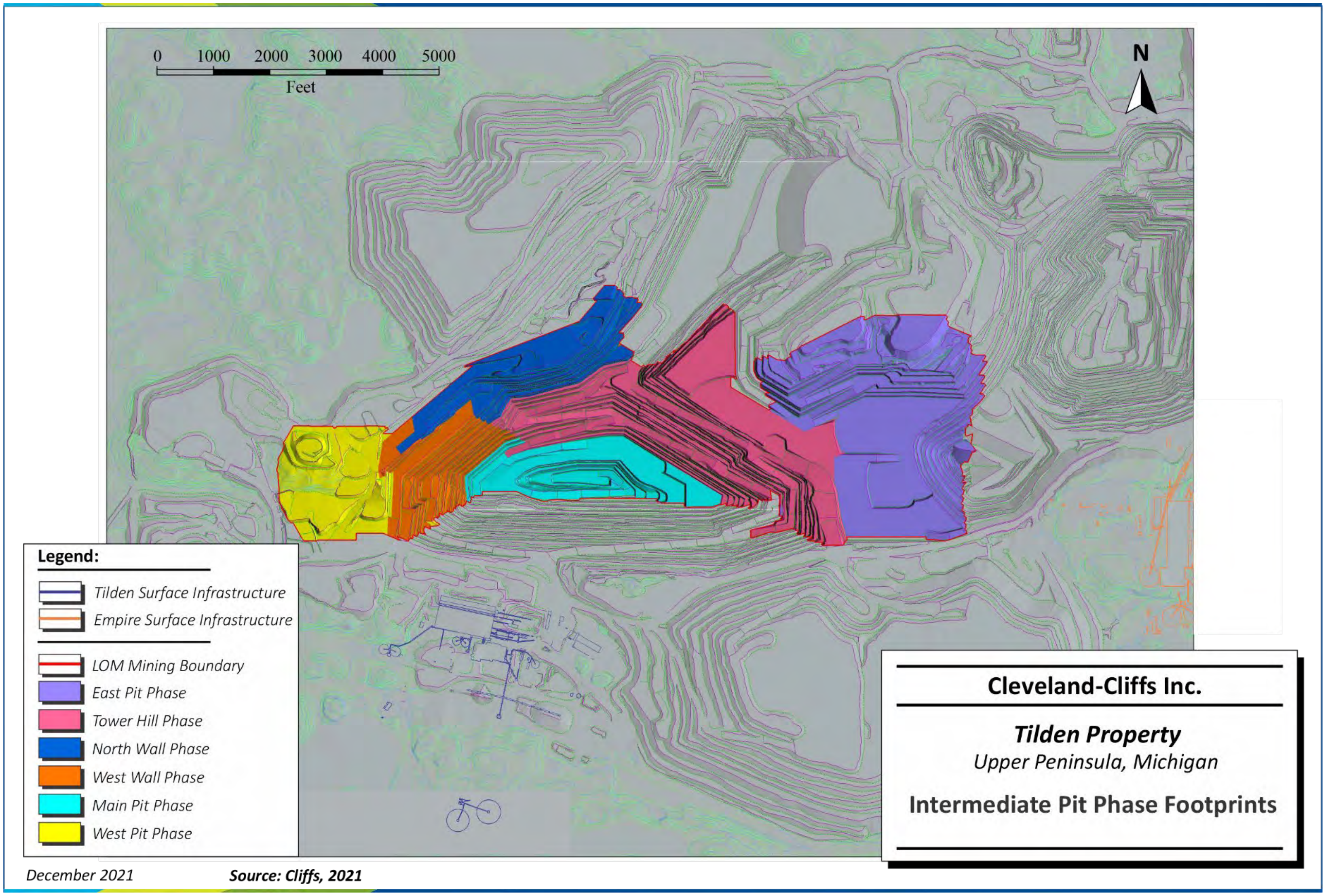


Figure 13-7: Intermediate Pit Phase Footprints

13.4 Production Schedule

13.4.1 Clearing

Before mining operations commence in new undeveloped areas, it is necessary to remove any overburden material. The primary clearing and grubbing equipment includes bulldozers, electric rope shovels, FELs, and trucks. This equipment has been successfully deployed in historical overburden clearing operations at Tilden. SLR notes there is a minimal amount of clearing and overburden removal remaining in the LOM plan, while the majority of the activity will be focused in areas of waste stockpile expansion.

13.4.2 Grade Control

A strict regiment of grade control procedures are followed at Tilden, coupled with post-blast, in-field ore and waste zone delineations to ensure a consistent crude ore feed blend for processing. As described in Sections 6.0 and 8.0 of this TRS, the local geology is well known with crude ore types geometallurgically binned into Fe oxide, Fe carbonate, Fe hydroxide, and Fe clastic mineral groups.

Grade control sampling is performed on every other production blast hole from every other row drilled in the iron formation (i.e., approximately one third of the production blast holes in the iron formation) to confirm or reclassify crude ore mineral groupings and delineate ore-waste boundaries. If the crude ore iron chemistry for the sampled blast holes is above the cut-off grade, the sample proceeds to bench flotation testing at the Tilden laboratory. The results of the bench flotation testing are entered into a database that is available to the mine engineering and geology department. This data is exported to Vulcan mine planning software, where crude ore and waste zone delineations are made, and metallurgical grade blocks are created using grade control software. Metallurgical grade blocks are utilized in short-range planning and uploaded into dispatch for crude ore blending purposes. Metallurgical data from the corresponding grade block is assigned to each truck load delivered to the primary crusher, allowing for the determination of weighted-average metallurgical qualities for specified periods.

Generally, three to four crude ore headings and/or stockpiles are mined at any one time to obtain the best crude ore blend for the Plant. Operationally, blending is completed on a shift-by-shift basis using the dispatch system for production management and data tracking. The dispatch operator is provided a blend schedule for each shift detailing the active crude ore headings and the expected specific blend percentage for each of the headings. Each production loading unit is equipped with a high-precision GPS, which, when coupled with the spatial grade blocks uploaded into the dispatch system, allows the dispatch operator to monitor progress and manage mining activities at each heading. Dispatch operators issue real-time adjustments to meet specified crude ore blends or correct for changes in pit operating conditions. As crude ore is delivered to the primary crusher, the dispatch system tracks the tonnage and associated metallurgical grades to provide a running total to the dispatch operator. Crude ore is either delivered directly to the primary crusher or is stockpiled in crude ore type-specific stockpiles for later use. Ore can be stockpiled for immediate operational reasons, planned mining sequence optimization, or to ensure future consistent ore quality.

13.4.3 Production Schedule

The basis of the production schedule is to:

- Produce approximately 7.7 MLT/y of wet hemflux pellets for the LOM:

- This production rate was selected as it represents maintaining the current production assumption throughout the LOM.
- Limit crude ore delivery to the crusher to 22 MLT/y.

- Meet the maximum and minimum metallurgical constraints for crude ore and concentrate including carbonate crude ore type blending restrictions:
  - Constrain annual crude ore blend metallurgy to:
    - Minimum Conc_Fe of 61.5% Fe.
    - Maximum concentrate phosphorus of 0.040% P.
  - Limit delivery blend of specific crude ore types to:
    - Minimum 340 carbonate crude ore blend component of 20%.
    - Maximum combined 316, 420, and 421 carbonate crude ore blend component of 10%.
- Limit total mined tons per period at approximately 62 MLT to balance the mine fleet utilization.

The production schedule is planned yearly throughout the LOM. Scheduling is by mining blocks within the pit phases. Table 13-7 presents the LOM production schedule for Tilden.

Table 13-7: LOM Production Schedule
Cleveland-Cliffs Inc. – Tilden Property

Year	Crude Ore (MLT)	Crude Ore Fe (MLT)	Stripping (MLT)	Total Tons (MLT)	Stripping Ratio (W:O)	Crude Ore Milled (MLT)	Process Recovery (%)	Wet Pellets (MLT)
2022	19.3	34.3	38.4	57.7	1.8	21.6	35.6	7.7
2023	21.3	34.6	40.7	62.0	1.9	21.3	36.1	7.7
2024	22.7	34.7	39.3	62.0	1.9	21.2	36.3	7.7
2025	22.5	34.8	39.3	61.8	1.8	21.3	36.1	7.7
2026	20.4	34.6	37.9	58.3	1.7	22.1	34.9	7.7
2027	20.2	34.9	38.5	58.7	1.8	21.5	35.8	7.7
2028	20.8	35.0	29.2	50.0	1.4	20.8	37.1	7.7
2029	20.6	35.4	29.4	50.0	1.4	20.6	37.4	7.7
2030-2034	106.6	34.8	113.4	220.0	1.1	106.6	36.2	38.5
2035-2039	101.1	35.0	98.9	200.0	1.0	101.1	38.1	38.5
2040-2044	102.1	34.2	75.4	177.5	0.7	102.1	37.7	38.5
2045 - 2046	38.8	35.1	20.1	58.9	0.5	39.8	35.1	15.3
Total	**516.4**	**34.7**	**600.5**	**1116.9**	**1.2**	**520.0**	**37.0**	**192.4**

Note:

1. Numbers may not add due to rounding.

Recent past production (2010 to current) and LOM planned production for Tilden is presented in Figure 13-8.

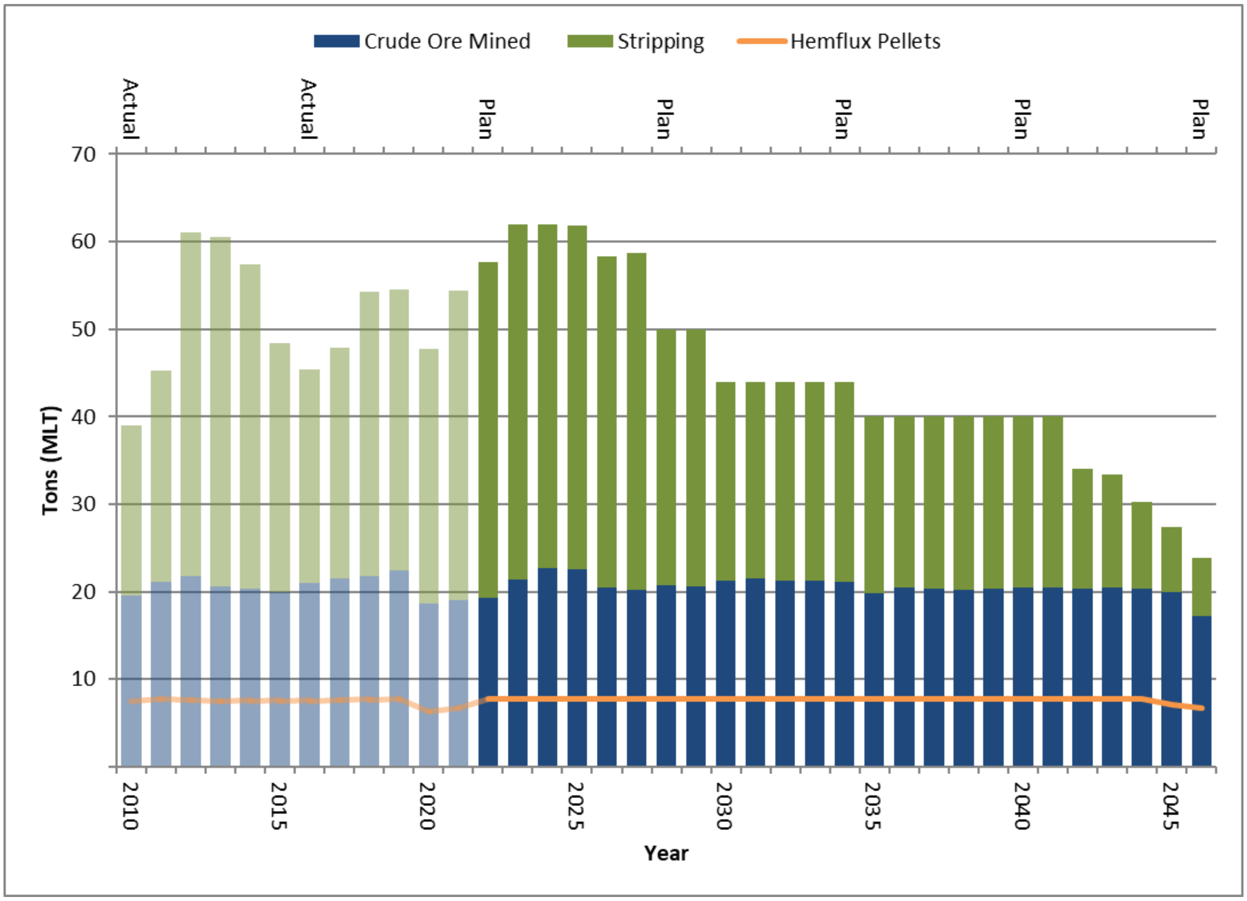


Figure 13-8: Past and Forecast LOM Production

As observed in Table 13-7 and Figure 13-8, waste stripping decreases significantly starting in 2028 and is steady or decreasing over the remaining LOM, with final-phase crude ore sources being exposed leading to decreases in required developmental stripping and overall material movement.

13.5 Overburden and Waste Rock Stockpiles

Waste rock and overburden excavated during the stripping process is placed in designated stockpiles located either around the periphery of the pit or inside the pit in designated in-pit backfills. Overburden that can be segregated is either used in concurrent reclamation activities or stockpiled for future reclamation use.

The overburden and waste rock stockpile design parameters are detailed in Table 13-8.

Table 13-8: Stockpile Parameters
Cleveland-Cliffs Inc. – Tilden Property

Parameter	Unit	Waste Rock	Overburden
OSA	degrees	22.8	20.1
BFA	degrees	36	30
BH	ft	50	50
Berm Width	ft	50	50
Ramp–Width - 2 way	ft	120	120
Ramp–Width - 1 way	ft	90	90
Ramp Gradient	%	10	10

Stripped waste rock excavated during the LOM plan will be stockpiled in either the CD3 in-pit backfill (CD3) to the north or the Tilden West Stockpile (TWD).

Overburden is segregated and if not used in concurrent reclamation activities is placed exclusively in the Tilden South Stockpile (TSD) stockpile, which was previously used as a waste rock stockpile. Stockpiled overburden material will be available for future reclamation activities.

The volumes for each stockpile are calculated using three-dimensional models created in Vulcan. Material-specific swell factors are used to convert the volumes into stockpile capacity. Table 13-9 lists the maximum design volume and storage capacity for each of the rock and overburden stockpile designs, in addition to the planned utilized capacity.

Table 13-9: Volumes and Capacities of Stockpile Designs
Cleveland-Cliffs Inc. – Tilden Property

Stockpile	Design Volume (Mft^3)	Design Capacity (MLT)	LOM Utilized Capacity (MLT)
Waste Rock Stockpiles			
CD3	6,097	339	339
TWD	6,053	337	248
Total Waste Rock Stockpiles	**12,150**	**676**	**587**
Overburden Stockpile			
TSD	437	24	14

SLR notes that there is sufficient overburden and waste rock stockpile capacity included in the LOM plan.

In addition to waste rock and overburden stockpiling activities, crude ore blending constraints require crude ore stockpiling in crude ore type-specific stockpiles. The crude ore stockpiles are active over the LOM with crude ore dispatched in and out and new accumulations of up to 3.0 MLT.

Figure 13-9 presents the full design capacities for the CD3 and TWD waste rock stockpiles and the TSD overburden stockpile.

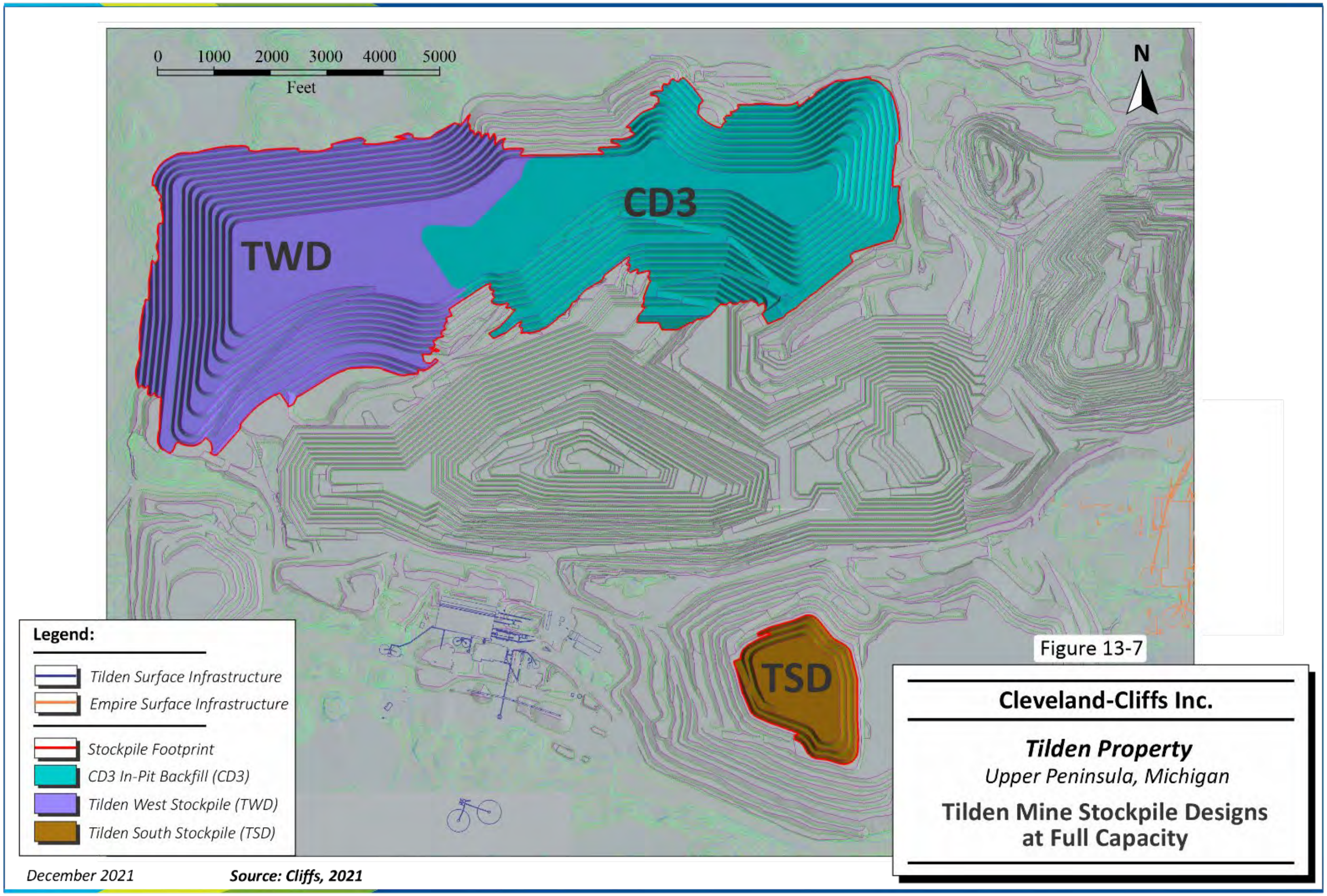


Figure 13-9: Tilden Mine Stockpile Designs at Full Capacity

In 2018, Golder Associates Inc. (Golder) assessed the current stockpiles following guidelines published by Hawley and Cunning (2017) to classify the instability hazard as either very low, low, moderate, high, or very high. All stockpiles evaluated were classified as being a low-instability hazard with the exception of the TOD stockpile (i.e., the Fox Valley overburden stockpile), which is listed as a moderate instability hazard, falling on the line differentiating moderate from low risk (Shaigetz and Cunning, 2019). SLR notes there is no additional loading of the TOD stockpile in the current LOM plan.

13.6 Mining Fleet

The primary mine equipment fleet consists of electric drills, electric cable shovels, and off-road dump trucks. In addition to the primary equipment, there are FELs, bulldozers, graders, water trucks, and backhoes for mining support. Additional equipment is on site for non-productive mining fleet tasks. The current fleet is to be maintained with replacement units as the current equipment reaches its maximum operating hours. The production equipment fleet is based on a quarterly, rolling five-year production schedule developed by the Mine.

Table 13-10 presents the existing fleet (2021/2022) and planned average major fleet requirements estimated to achieve the LOM plan.

Table 13-10: Major Mining Equipment
Cleveland-Cliffs Inc. – Tilden Property

Year	Drills	Shovels	Trucks	Loaders	Dozers	Graders
2022	4	6	17	4	7	4
2023	4	5	17	4	7	4
2024	4	5	16	4	7	4
2025-2029	4	5	18	4	7	4
2030-2034	3	5	15	2	7	4
2035-2039	3	4	15	3	7	4
2040-2044	3	3	13	4	7	4
2045-2048	3	3	10	4	7	4
Size/Payload	16 in	44 yd^3	320 ton	37 yd^3	57 yd^3	14 ft
Useful Life (hrs)	100,000	150,000	90,000	45,000	60,000	60,000
Example Unit	P&H 120A	P&H 2800	Komatsu 930E	LeTourneau L1850	CAT D11	CAT 16M

The primary loading and hauling equipment were selected to provide a good synergy between mine selectivity of crude ore and the ability to operate in variable conditions. Since crude ore is blended at the primary crusher, the loading units in crude ore do not operate at capacity.

Longer haulage distances will be realized as the open pit deepens and the waste stockpiles increase in size. As the haulage distances increase, the waste stripping ratio decreases, helping offset the need for additional haul trucks.

Extensive maintenance facilities are available at the Mine site to service the mine equipment.

13.7 Mine Manpower

The current mining manpower is summarized as follows:

- Mine operations: 237
- Mine maintenance (excluding mine crusher): 156
- Mine supervision and technical services: 40

The mine operations and mine maintenance manpower will increase/decrease proportionately with the change in haul trucks over the LOM. The additional required manpower will be sourced from local communities.

14.0 PROCESSING AND RECOVERY METHODS

14.1 Overview

Over the years, the Tilden concentrator capacity has expanded to its current nominal capacity of 7.7 MLT/y fluxed pellets from both hematite and magnetite crude ore sources. The Plant includes many unit operations standard to the industry, including, primary crushing, autogenous grinding (AG), flotation, filtering, drying, agglomeration, and induration to remove silica gangue and produce a hardened pellet. The unique feature of the Tilden concentrator is the selective flocculation and desliming process implemented prior to flotation, which successfully removes slime contaminants that would otherwise cause serious complications during subsequent stages of processing. The Tilden concentrator is designed to campaign either hematite-dominant ores or magnetite ores, but does not process both ore types simultaneously. The major difference between the hematite and magnetite circuits is the magnetite circuit includes two separate stages of magnetic separation in the grinding circuit. This section briefly describes the processes currently in use at the Plant.

The processing of magnetite ores at the Tilden concentrator ceased in 2009. Magnetite ore from the Mine was delivered and processed at the Empire Mine from 2010 through 2016 when the Empire Mine was indefinitely idled. Remaining Mineral Resources and Mineral Reserves at Tilden are processed in hematite-based flotation circuits.

14.2 Processing Methods

The process flowsheet for the hematite circuit is presented in Figure 14-1, while a list of major equipment is provided in Table 14-1.

14.2.1 Comminution

Primary crushing, which is operated and maintained by the mining department, is accomplished with a 60 in. x 109 in. Allis-Chalmers gyratory crusher operated to produce a nominal -9 in. crushed product, which is conveyed to the ore storage building ahead of the grinding circuit. Primary grinding is accomplished with eleven, 27-ft-diameter x 14.5-ft-long AG mills, each driven by two synchronous motors that have a combined output of 5,720 hp. Each primary AG mill discharges to a triple-deck screen, producing a -1.5 in. x 0.5 in. product that is used as a grinding media in the pebble mills (excess diverted to the pebble crushers or recirculated back to the primary mill), a -0.5 in. x 2 mm product that is conveyed back to the primary mill, and a -2 mm product that is advanced to the secondary pebble mills. The -2 mm discharge from each AG mill feeds two, 15.5-ft-diameter x 32-ft-long pebble mills, which are operated in closed circuit with a cluster of nine, 15-in.-diameter cyclones to produce a final grind of 80% to 85% passing 25 µm. Caustic soda and slaked lime are added to the water circuit to control pH prior to desliming and flotation.

14.2.2 Desliming

Starch and a dispersant are added to the slurry and advanced to the deslime thickeners. At this stage, the iron oxides are selectively flocculated by the starch and depressed, and the siliceous slimes are dispersed and removed. Deslime thickener overflow containing these waste products is fed to the tailings thickeners, and the settled slimes are disposed of in the tailings pond. The deslime thickener underflow is conditioned with additional starch and advanced to the flotation circuit.

14.2.3 Flotation

The flotation circuit is divided into twelve lines, each consisting of ten, 500 ft^3 rougher flotation cells, which are used to float silica-rich tailings away from the iron minerals with an amine collector. The rougher flotation concentrate represents the final upgraded iron concentrate and is advanced to the concentrate thickener. Rougher tailings are further scavenged in four stages (fifteen, 500 ft^3 flotation cells per line) of scavenger flotation to remove entrained iron values. Scavenger flotation concentrates are recycled back to the head of the rougher flotation circuit, with scavenger tailings being pumped to the tailings thickeners.

14.2.4 Dewatering

The iron concentrate is thickened to approximately 65% to 70% solids in two, 150-ft-diameter and two, 180-ft-diameter Eimco thickeners, neutralized to a pH of 7.0 using carbon dioxide and then filtered in a series of 9-ft-diameter x 8 disc vacuum disc filters to approximately 11.5% w/w moisture content. Filtered concentrates are either sent directly to the pelletizing plant, a thermal drying circuit, or to a concentrate storage stockpile.

14.2.5 Fluxstone

Fluxstone consisting of dolomite and calcite is received at Tilden via truck and stored in stockpiles. Material is fed from a stockpile via apron feeders and processed in two, 15.5-ft-diameter x 30-ft-long ball mills. The fluxstone slurry is added to the iron concentrate prior to filtering to ensure homogenous mixing.

14.2.6 Historical Magnetite Processing (1989 to 2009)

The magnetite processing circuit is similar to the hematite circuit, with the exception that when magnetite is campaigned through the concentrator, the -1.4 mm screen undersize from each AG mill is sent to low-intensity magnetic cobbing to recover the coarsely liberated magnetite. The non-magnetic cobber tail is directed to tailings. The magnetic fraction from the cobbing circuit is then directed to the secondary pebble mill grinding circuit, which is operated in closed circuit with a cluster of 15-in.-diameter cyclones. The cyclone overflow is then sent to two stages of deslime thickening. Thickener underflow from the second stage of desliming is processed in a finisher stage of low-intensity magnetic separation, with the magnetic concentrate continuing to a finisher thickener stage. Underflow from the finisher thickener is then advanced to silica flotation with amine collectors. The remaining magnetite circuit is the same as the hematite circuit.

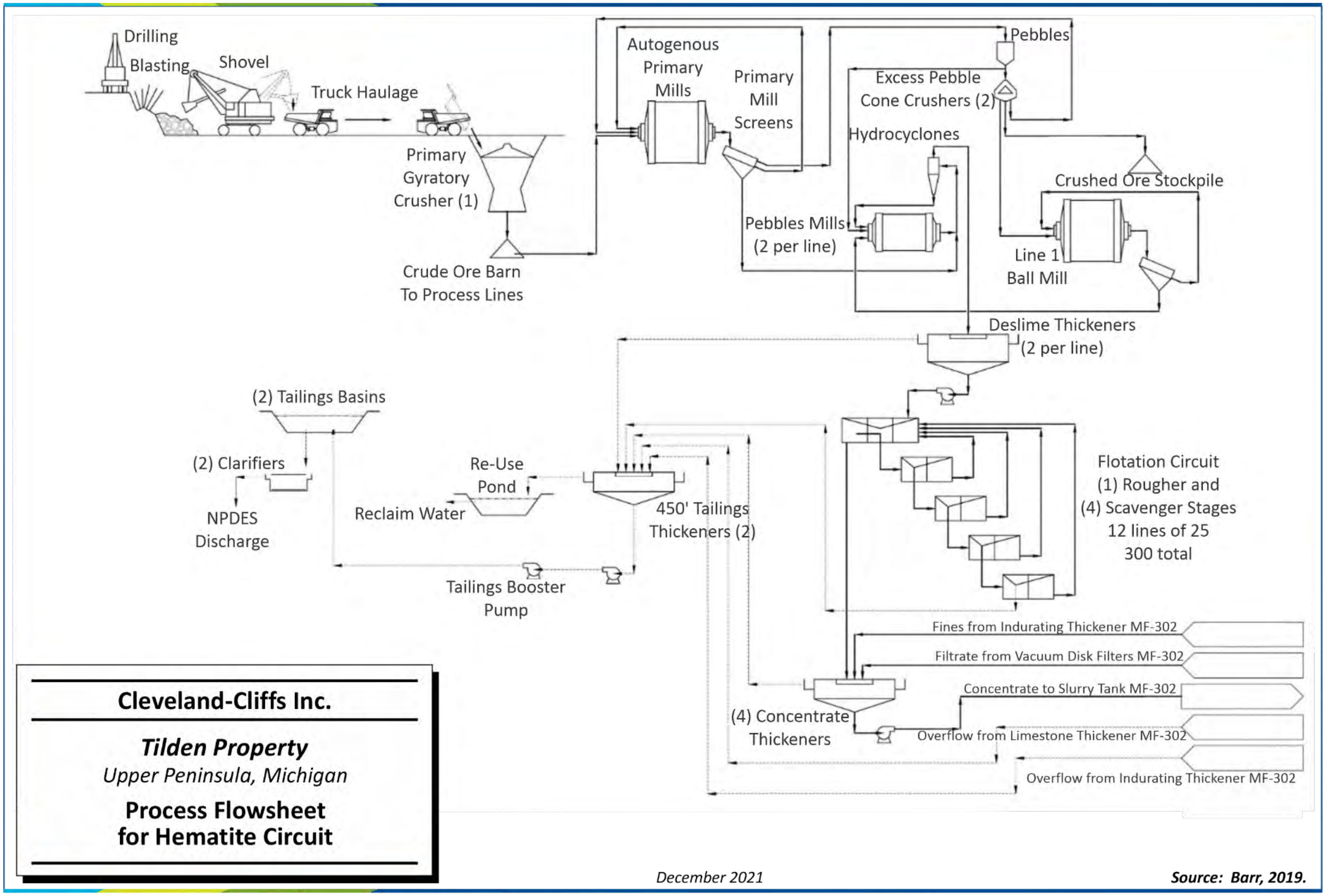


Figure 14-1: Hematite Circuit Process Flowsheet

14.3 Pelletizing Plant

The pelletizing plant unit processes include concentrate drying, concentrate agglomeration (balling), pellet hardening or induration in a grate kiln and cooler, and pellet storage and railcar loading. The pelletizing plant flowsheet is presented in Figure 14-2.

A portion of the concentrate feeding the pellet plant along with concentrate reclaimed from stockpiles is dried in a rotary dryer. The dried concentrate is combined with filtered concentrate on the agglomeration or balling feed conveyor.

14.3.1 Concentrate Agglomeration - Balling

The balling circuit is supplied with concentrate with a target moisture content of 9.5%. Balling is accomplished using fourteen, 12-ft-diameter x 33-ft-long rotary drums operated at approximately 12 rpm. Bentonite, a clay binder, is ratioed to the balling drum feed and blended on the balling drum feed belt to agglomerate the concentrate. Each drum utilizes an oscillating cutter bar, and the resulting green balls are discharged onto a vibrating seed screen with a 2-ft-long grizzly extension for oversize removal. Screen undersize is returned to the balling drum, while grizzly oversize is returned to the concentrate bin or diverted to outdoor storage. The seed screen product is conveyed by a reciprocating conveyor, which distributes the green balls over a grate feed belt.

14.3.2 Grate, Kiln, Cooler

The green balls are loaded onto a moving grates with a feed rate maintained to achieve a nominal bed depth of seven inches. The grates pass through 19 wind boxes. The green balls are subjected to 3.5 bays of updraft drying, 7.5 bays of downdraft drying, and eight bays of downdraft preheating. After traversing the length of the grates, the green balls are discharged into one of two, 25-ft-diameter x 160-ft-long rotary kilns. Heat for the kilns is produced with a combination of pulverized coal and/or natural gas. Product from the kiln is discharged into two, 10-ft-wide x 66-ft-diameter rotary coolers, sufficiently cooling the pellets to be transported by conveyor.

14.3.3 Pellet Loadout

Cooled pellets are conveyed directly to either a railroad load-out bin or to an outdoor stockpile with a nominal capacity of 2 MLT. Pellets are loaded into rail cars with 60 LT capacity in configurations of 110 cars. Pellets are transported via rail to a dock facility in Marquette, Michigan or directly to customers. Pellet stockpiles are selectively screened to reduce fines with a loader-fed, portable screening plant. Pellet chips and fines from this process are sold as secondary product.

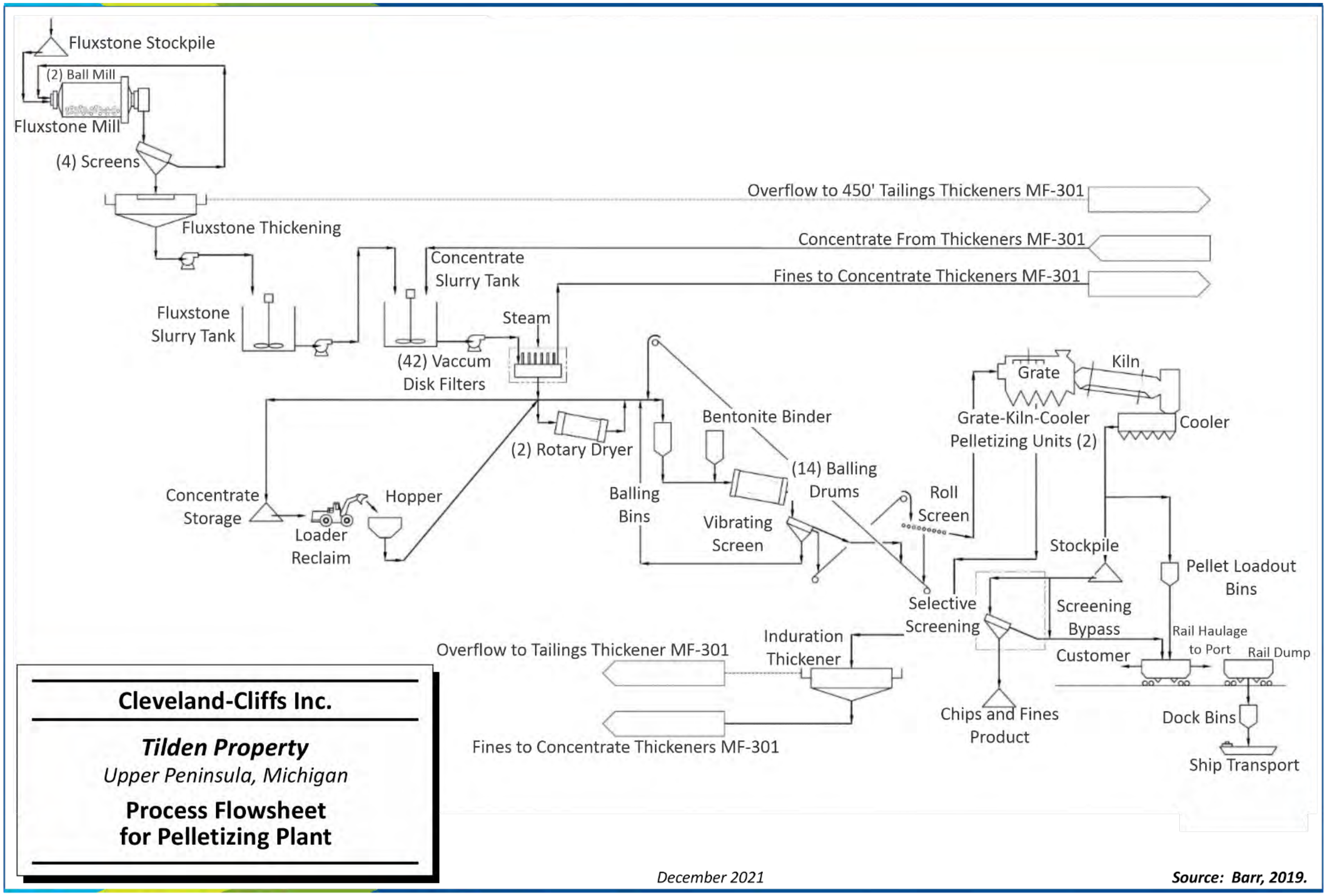


Figure 14-2: Process Flowsheet for Pelletizing Plant

14.4 Major Equipment

A list of all major processing equipment is provided in Table 14-1.

Table 14-1: Major Processing Equipment
Cleveland-Cliffs Inc. – Tilden Property

Equipment	Qty	Size	Manufacturer	Hp	Comments
Primary Gyratory Crusher	1	60 in. x 109 in.	Allis Chalmers	1000	
Apron Feeders	4	48 in. x 9 ft	Stephen-Adamson	5	
Primary Autogenous Mill	5	27 ft x 15.5 ft	Allis Chalmers	2 x 2860	Tilden 1
Primary Autogenous Mill	6	27 ft x 15.5 ft	Allis Chalmers	2 x 3100	Tilden 2
Vibrating Screen	11	Model OA-160-D	Simplicity	50	triple-deck (12.7mm x 2mm)
Pebble Crusher	2	MP-800	Nordberg	800	
Crushed Product Ball Mill	1	27 ft x 15.5 ft	Allis Chalmers	2 x 2860	Internal diameter reduced
Secondary Pebble Mill	10	15.5 ft x 30 ft	Nordberg	2860	Tilden 1
Secondary Pebble Mill	12	15.5 ft x 32 ft	Nordberg	3100	Tilden 2
Hydrocyclone	198	15 in.	Krebs		9 cyclones per pebble mill
Cobber Magnetic Separators	27	48 in. x 120 in.	Eriez		Magnetite Processing Only
Deslime Thickener	24	55 ft diameter	EIMCO	7.5	
Flotation Feed Conditioner	12	9 ft x 9 ft	Denver Equipment	15	
Finishing Magnetic Separator	27	48 in. x 120 in.	Eriez		Magnetite Processing Only
Rougher Flotation Cells	10	500 ft^3	WEMCO	40	12 banks x 10/bank
Scavenger-1 Flotation Cells	5	500 ft^3	WEMCO	40	12 banks x 5/bank
Scavenger-2 Flotation Cells	4	500 ft^3	WEMCO	40	12 banks x 4/bank
Scavenger-3 Flotation Cells	3	500 ft^3	WEMCO	40	12 banks x 3/bank
Scavenger-4 Flotation Cells	3	500 ft^3	WEMCO	40	12 banks x 3/bank
			Concentrate Dewatering		
Concentrate Thickener	2	150 ft diameter	EIMCO	7.5 + 7.5	
Concentrate Thickener	2	180 ft diameter	EIMCO	7.5 + 7.5	
Vacuum Disk Filter	42	9 ft diameter x 8 discs	EIMCO	5	
Vacuum Pump	3	12,100 ICFM@26 mm Hg	Ingersoll-Rand	500	
Vacuum Pump	14		Nash	500	
Dewatering Thickener	2	450 ft diameter	Dorr-Oliver	4 + 7.5	
Tailing Pumps	10	16 in. x 14 in.	GIW	400	Several different sizes

Equipment	Qty	Size	Manufacturer	Hp	Comments
Gribben Booster Pump	1	16 in. x 14 in.	Warman	1000	
Lamella Clarifiers	2		Veolia		
			Flux Preparation		
Flux Grinding Mill	2	15.5 ft x 30 ft	Nordberg	2520	Internal length reduced
Hydrocylones	3	15 in.	Krebs		
DSM Screens	4				
Thickener	1	55 ft diameter	Eimco	7.5 + 1	
			Plant Services		
Boiler	1	200 klb	Trane Murrey	350 fan	
Boiler	1	200 klb	Zun Boiler	350 fan	
Instrument Air Compressor	3	131/2 - 8x7	Joy	200	
Instrument Air Compressor	8	15-15x7	Joy	200	
Instrument Air Compressor	1	ZR 750	Atlas Copco	500	
Snap Blow Compressor	1	Pre-2 Series F	Ingersoll Rand		
Plant Air Compressor	1	TS-32-600	Sullair		

14.5 Plant Performance

Plant performance for 2014 to 2020 is summarized in Table 14-2 and demonstrates that crude iron ore head grades ranged from 33.4% Fe to 34.8% Fe over the period. Iron recovery to flotation concentrates on average ranged from 66.0% to 72.3%, with a concentrate grade averaging 62.5% to 63.7% during this period. Approximately 20.3 MLT (wet) of crude ore is processed through the concentrator annually to produce 8.0 MLT (wet) of fluxed concentrate and 7.5 MLT (wet) of fluxed pellets (hemflux pellet).

Table 14-2: Tilden Concentrator Performance 2014 to 2020
Cleveland-Cliffs Inc. – Tilden Property

	2014	2015	2016	2017	2018	2019	2020
Feed (LT)	20,298,301	19,660,601	20,671,866	21,006,512	21,016,286	21,500,213	18,006,414
Fe %	34.5	33.9	33.4	34.2	34.8	34.4	34.3
Flotation Conc. (WLT; Nat WR)	8,130,162	7,998,381	8,295,261	8,156,868	8,320,062	8,312,224	6,968,367
W% (Nat WR-WLT)	40.05	40.68	40.13	38.83	39.59	38.70	38.66
W% (Dry Met WR)	38.00	37.26	37.71	38.97	40.69	36.06	37.10
Fe% (Dry Met)	63.7	63.7	63.3	62.7	62.5	63.0	63.1
Fe Dist % (Dry Met)	70.2	70	71.5	71.3	72.3	66.04	68.26
Total Tailings (Dry LT; based on Met WR)	12,584,085	12,334,440	12,876,850	12,819,820	12,465,763	13,747,062	11,325,283

	2014	2015	2016	2017	2018	2019	2020
W% (Dry Met)	62.00	62.74	62.29	61.03	59.31	63.94	62.90
Fe% (Dry Met)	16.6	16.2	15.3	16	15.8	18.3	17.3
Fe Dist% (Dry Met)	29.80	30.00	28.50	28.70	27.70	33.96	31.74
Fluxstone (LT)	775,910	764,959	738,966	732,351	753,046	775,709	672,212
Fluxed Conc. (LT)	8,906,072	8,763,340	9,034,227	8,889,219	9,073,107	9,087,933	7,640,580
Pellet Plant Feed (LT)	8,907,111	8,918,098	9,002,847	8,989,704	9,068,586	9,096,377	7,489,057
Bentonite Binder (ST)	79,518	80,551	71,481	71,833	68,234	72,638	61,494
Hemflux Pellet (LT)	7,580,920	7,631,260	7,631,980	7,650,141	7,678,514	7,708,582	6,323,241

14.6 Pellet Quality

Tilden's blast furnace (BF) customers monitor the hemflux pellet physical quality parameters closely, with Tilden pellets measured against several physical and chemical properties outlined in Table 14-3.

Table 14-3: Hemflux Pellet Quality
Cleveland-Cliffs Inc. – Tilden Property

Quality Variable	Typical
% Fe	61.00
% SiO_2	4.90
% CaO	4.40
CaO/SiO_2	0.90
% MgO	1.70
% P	0.040
% Mn	0.3
% Al_2O_3	0.6
% H_2O	1.5
BT -½" Total (%)	6
BT -½" +3/8" (%)	82
BT -3/8" +¼" (%)	9
BT -¼" Total (%)	2
BT –28M (%)	0.3
AT + ¼" Total (%)	96.5
AT –28M (%)	2.7
Comp. (lbs. Avg.)	470
Comp. (% -300 lbs)	14

Quality Variable	Typical
Reducibility R40	0.93
LTD	93

SLR has reviewed yearly performance data for Tilden hemflux pellet production since 2014 and noted that Cliffs has achieved these specifications on a consistent basis during that period.

14.7 Consumable Requirements

Major consumables for the Plant operation include:

- **Carbon Dioxide**: Used to neutralize the slurry's pH prior to filtering and to lower the tails basin water's pH for management of selenium in the clarifier discharge.
- **Caustic Soda**: Used to control and maintain the process pH between 10.6 and 11.5 for effective operation of deslime and flotation.
- **Dispersant:** Added in deslime thickeners to aid with silica slime rejection.
- **Cornstarch:** Added in during desliming and flotation to reduce iron losses.
- **Starch Enhancer**: Modifier to improve process performance**.**
- **Amine:** Chemical added during flotation to selectively collect high-silica-bearing particles into froth.
- **DOSS**: Dioctyl sulfosuccinate added to aid moisture control in filtering.
- **Lime**: pH modifier for process waters, and offsets caustic soda usage.
- **Polymer Nalco**: Anionic polymer added during the concentrate thickener stage to minimize iron losses.
- **Polymer Filters**: Flocculant added in filter lines to aid with filter productivity.
- **Polymer Thickeners:** Flocculant added to tails thickeners for solids collection.
- **Dry Polymer**: Flocculant added to the concentrate thickener for slurry densification.
- **Filter bags**: Filtering consists of 42 filters comprised of 80 sectors. Each sector is covered with a bag that collects solids and allows water to pass through.
- **Ferric Chloride:** Used in the clarifier process.
- **Fluxstone**: A blend of calcite and dolomite added to the concentrate prior to filtration to create fluxed concentrate for fluxed pellet production. Delivered to site via trucks in four different classifications: summer calcite, summer dolomite, winter calcite, and winter dolomite. The winter prefix denotes coarser material than that denoted by summer, as it is used during the winter season for improved feeding to flux grinding system.
- **Grinding Balls**: Line 1 Ball Mill balls for grinding of crushed product from the secondary crusher.
- **Mill Lining**: Replaceable wear liner systems in grinding mills.
- **Bentonite**: Clay used to create green balls in balling drums for feed onto the induration grate.

Table 14-4 presents the unit rates for concentrator and pellet plant consumables.

Table 14-4: Consumables
Cleveland-Cliffs Inc. – Tilden Property

Consumable	Units (LT)	Rate
	Concentrator	
Carbon Dioxide	lb/ton Crude Feed	0.775
Carbon Dioxide-Tailings	lb/ton Crude Feed	0.4
Caustic Soda	lb/ton Crude Feed	1.25
Polyacrylic Acid	lb/ton Crude Feed	0.21
Cornstarch	lb/ton Crude Feed	0.525
Starch Enhancer	lb/ton Crude Feed	0.1
Amine	lb/ton Crude Feed	0.15
DOSS	lb/ton Crude Feed	0.28
Lime	lb/ton Crude Feed	1.5
Polymer Nalco	lb/ton Crude Feed	0.005
Polymer Filters	lb/ton Crude Feed	0.04
Polymer Thickeners	lb/ton Crude Feed	0.32
Dry Polymer	lb/ton Crude Feed	0.0024
Filter Bags	bags/ton Std Concentrate	0.0031
Ferric Chloride	lb/ton Crude Feed	0.2117
Fluxstone	LT flux/ton Std Concentrate	0.09
Grinding Balls	lb/ton Std Concentrate	0.5
Mill Lining	lb/ton Std Concentrate	0.8013
Electric Power	kWh/ton Std Concentrate	51.011
Natural Gas	MMBtu/ton Std Concentrate	0.8013
Process Fuel	MMBtu/ton Std Concentrate	0.1719
Heating	MMBtu/ton Std Concentrate	0.0098

Consumable	Units (LT)	Rate
	Pellet Plant	
Bentonite	lb/ton Pellets	19.5
Electric Power	kWh/ton Pellets	21.09
Process Fuel Kiln (Nat Gas/Coal)	MMBtu/ton Pellets	0.8707
Process Fuel Dryer (Nat Gas)	MMBtu/ton Pellets	0.0875
Heating (Nat Gas)	MMBtu/ton Pellets	0.0411

14.8 Process Workforce

Current processing headcount totals 399 and is summarized as follows:

- Plant operations – 160
- Plant maintenance – 180
- Plant supervision and technical services – 59

15.0 INFRASTRUCTURE

15.1 Roads

Primary access to the Mine is via the Tilden Mine Access Road. This road is one mile in length, connecting the mine guard gate to County Road 476 just south of National Mine. Once on the Property, the Tilden administration buildings and Plant are located 0.8 mi to the east. Mining area (pit) offices are located at the adjacent Empire Mine facility 2.75 mi to the east. Secondary access to the Mine is east of the Empire Mine facility, just north of the town of Palmer. Further details regarding local resources can be found in section 4.3.

15.2 Rail

Pellets produced at Tilden are loaded from stockpiles either by FELs or through a train load-out pocket to rail cars and are transported by the LS&I, a wholly owned subsidiary of Cliffs. Rail cars have a nominal capacity of 60 LT, with a train typically consisting of 110 cars. Average rail rates are 25,000 LT/d to the LS&I dock at Marquette, Michigan, a distance of 22 mi. LS&I owns approximately 1,000 cars and uses a mixture of owned and leased locomotives.

Pellets can also be shipped using the CN railroad. The CN owns and operates its own rail fleet. Currently, one customer receives direct rail deliveries by CN to Sault Ste. Marie, Ontario, Canada, a distance of 120 mi from the Property. The customer is responsible for the rail contract with CN. Figure 15-1 is a satellite photograph of the LS&I railway and port facilities in Marquette, Michigan.

Figure 15-1: LS&I Railroad and Port

15.3 Port Facilities

The LS&I gravity-dump pocket dock was designed in 1910 and placed in operation in 1912. The dock serves two primary purposes, to load ships with iron pellets. The dock is a 1,274-ft-long, 74-ft-tall concrete structure comprising storage pockets with 100 gravity-feed chutes on each side of the dock that are lowered for discharging pellets into the holds of Great Lakes iron ore freighters. The storage pockets are loaded from LS&I bottom-dump rail cars positioned on top of the dock. There are four parallel rail lines on top of the dock with room for positioning 200 rail cars at any one time. An automated dumper opens the clam shell bottom hatches on the cars discharging the pellets into the pockets. The storage capacity of the dock is approximately 450 rail cars including the 200 cars positioned on top of the dock. Locomotives are used to shuttle empty and loaded cars to and from the dock to keep the dock full for ship loading.

15.4 Tailings Disposal

CCIC operates the Mine in Marquette County, Michigan, which includes the Gribben Tailings Basin (GTB) located approximately five miles southeast of the Plant and nine miles from Lake Superior. The GTB is comprised of two ring dike-type impoundments: the Gribben North Tailings Basin (GNTB), which encompasses approximately 1,350 acres, and the Gribben South Tailings Basin (GSTB), which encompasses approximately 1,100 acres. Each impoundment is comprised of a perimeter dam constructed in an upstream method from an original centerline structure with a keyed core from which tailings are discharged, a Water Retention Dam, which is constructed in a modified centerline method and which the supernatant pool is typically impounded against, and the decant structure. The Mine first began producing iron ore pellets in 1974, with tailings disposed into the GNTB beginning in 1977.

The GNTB and GSTB were designed and permitted as unlined facilities, with the tailings providing a low-permeability material to reduce seepage.

Typically, a tailings slurry flow of approximately 10,000 gpm at approximately 50% solids by weight is deposited in either GNTB or GSTB. The coarser fraction of the tailings slurry typically settles out near the discharge point and forms the beach material, and the gradation of the tailings becomes progressively finer with increasing distance from the discharge point. The gradation of the tailings typically varies from a silt to a clayey silt.

GNTB and GSTB were designed to have the supernatant pools located against the WRDs, and the water levels at GSTB and GNTB are controlled using concrete decant structures. Water from the supernatant pool is not re-used in the process, but is treated and released. Water can be transferred from GNTB to GSTB or from GSTB to GNTB, or can be conveyed directly to the GTB water treatment facility (WTF) and treated using a clarification process with flow rates ranging up to 12,000 gpm before being released into the Goose Lake Outlet.

The GTB configuration is presented in Figure 15-2, and the facilities are discussed in the following sections.

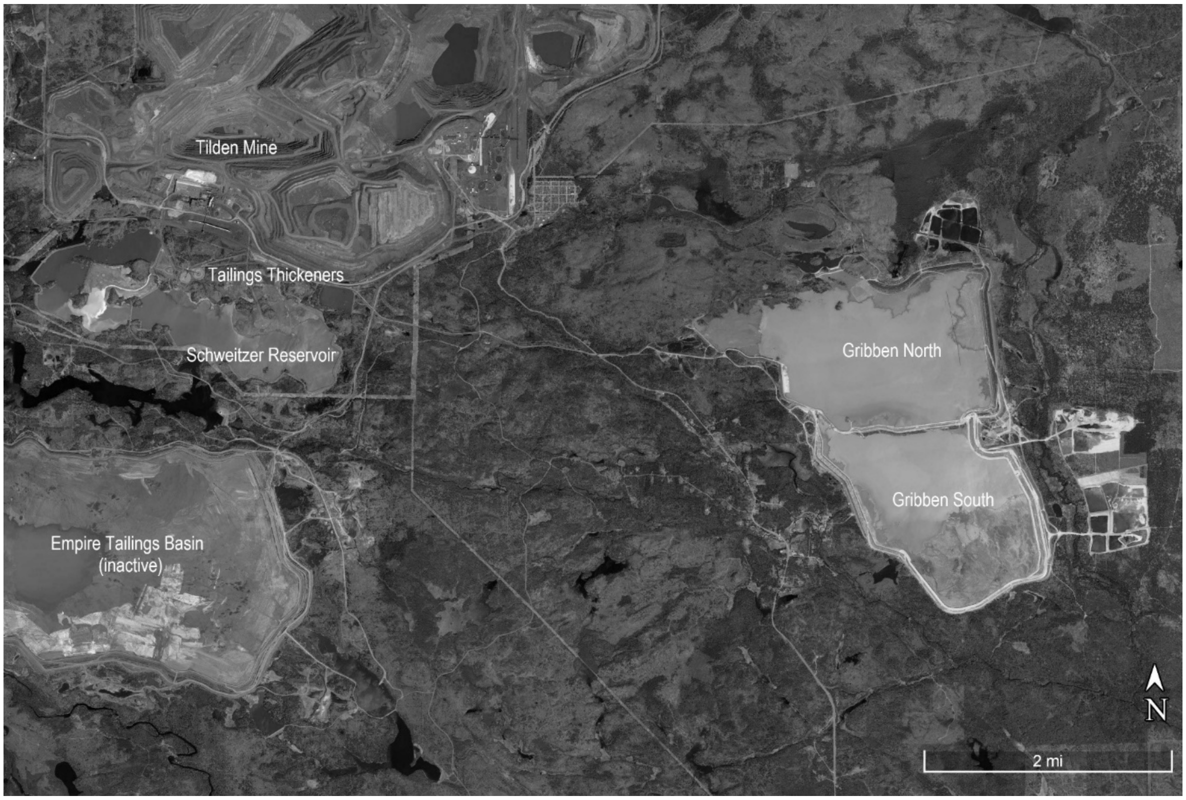


Figure 15-2: Gribben Tailings Basin

15.4.1 Facility Description

15.4.1.1 Gribben North Tailings Basin

The GNTB is located on the northern end of the tailings basin, with the southern perimeter of GNTB forming the north perimeter of GSTB. The tailings dam crest is currently approximately 5.4 mi long and at an elevation of approximately 1,331 ft. The dam is currently a maximum of approximately 130 ft high, and the ultimate height of the dam will be approximately 160 ft based on an ultimate crest elevation of 1,361 ft.

Foundation soils beneath GTB generally consist of natural, medium-dense to dense sands and silty sands that are well drained.

The original design for GNTB was developed by Harza Engineering Company (Harza). A series of connected perimeter dams were constructed to form GNTB beginning during 1976 that included a seepage cut-off core and a slurry trench or silty clay cut-off trench below the dam that was keyed into bedrock or relatively impermeable soils above the bedrock. The original perimeter dam system was constructed at that time to a crest elevation of 1,271 ft. To accommodate continued tailings storage, vertical expansions were and continue to be performed. The initial Phase 1 raise began in 1989 with construction of upstream dikes placed on previously deposited tailings beaches generally along the east perimeter. Upstream raises are typically accomplished in 10-ft-high, staged construction lifts at a 2H1V dike slope, which results in an overall composite downstream slope of approximately 6H:1V when the benches and dam crest are considered. The GNTB Water Retention Dams (areas where the pond is located adjacent to the dam) was raised in a downstream manner with a compacted tailings core to crest elevation 1,331 ft and will be raised from crest elevation 1,331 ft to 1,361 ft (1) in a modified upstream manner with sloping compacted tailings core over tailings placed in the GNTB in the area around the decant, (2) an upstream manner with a vertical compacted tailings core, and (3) an upstream manner towards between the Water Retention Dam and West Dam. The raises will be performed in 10-ft-high, staged construction lifts until the dam has a 30-ft-wide dam crest at an ultimate crest elevation of 1,361 ft, which will result in a maximum dam height of approximately 115 ft.

A buttress was constructed along the GNTB southeast corner of the dam (area immediately upgradient of the WTF) to elevation 1,278 ft in 2013, and the buttress in this general area was raised to elevation 1,292 ft in 2020 to enhance the upstream dike stability. The long-term construction design for GNTB includes vertically expanding the upstream dike and Water Retention Dam embankments along the basin perimeter to the Phase 9 crest elevation +1,361 ft (GEI, 2016).

A vertical decant structure is located along the southwest corner of the GNTB (at approximately Station 184+00), and the raises have been designed to coincide with the raising of the Upstream Dike and Water Retention Dam construction program.

Natural sand borrow material east of Goose Lake Outlet is used for the Upstream Dike and Water Retention Dam construction with the exception of the compacted tailings core within the Water Retention Dam sections. Tailings borrow material for the core sections of the Water Retention Dam is typically obtained from within the interior of the basin, in areas where the tailings material is readily accessible.

15.4.1.2 Gribben South Tailings Basin

The GSTB is located on the southern end of the tailings basin, with the northern perimeter of GSTB forming the south perimeter of GNTB. The tailings dam crest is currently approximately 4.2 mi long (not including approximately 1.3 mi of dam common to GSTB and GNTB). With a current dam crest elevation of approximately 1,310 ft (Cliffs, 2021a), the dam is currently a maximum of approximately 10 ft high. The ultimate height of the dam will be approximately 160 ft based on an ultimate crest elevation of 1,361 ft.

Foundation soils beneath GTB generally consist of natural, medium-dense to dense sands and silty sands that are well drained.

The original design for GSTB was issued by STS Consulting Ltd (STS) in 1997. Construction commenced in 1997 and was completed in 2003. Construction of the Water Retention Dam was performed to approximately elevation 1,250 ft on the east side, a decant structure to elevation 1,250 ft, and upstream dike to elevation 1,230 ft on the south and west sides. The design, construction, and operation of GSTB are very similar to GNTB. Water Retention Dams are constructed along the east perimeter of GSTB, with upstream tailings retention dikes constructed along the south and west perimeter.

To accommodate additional tailings storage, vertical expansions were and continue to be performed to a crest elevation of 1,361 ft. Upstream raises are typically accomplished with construction of upstream dikes placed on previously deposited tailings beaches, in 10-ft-high, staged construction lifts at a 2H1V dike slope. This results in an overall composite downstream slope of approximately 6H:1V when the benches and dam crest are considered. The Water Retention Dams (areas where the pond is located adjacent to the dam) are raised in a modified centerline method. This is also performed in 10-ft-high, staged construction lifts, and consists of placing an outboard and inboard set of dikes at a 2H:1V slope and hydraulically placing tailings material to form a low-permeability core between the two dikes, until the dam is at a crest elevation of 1,320 ft (GEI, 2019). The long-term construction design for GSTB includes vertically expanding the Upstream Dike and Water Retention Dam embankments along the basin perimeter to an ultimate crest elevation +1,361 ft to match the GNTB (GEI, 2019).

A vertical decant structure is located midway along the east Water Retention Dam of the GSTB, and the raises have been designed to coincide with the raising of the Upstream Dike and Water Retention Dam construction program.

Natural sand borrow material east of Goose Lake Outlet is used for the Upstream Dike and Water Retention Dam construction material, with the exception of the hydraulically placed tailings core material within the Water Retention Dam sections.

15.4.2 Design and Construction

Design of the perimeter dam to crest elevation +1,271 ft was performed by Harza. Vertical expansion above elevation +1,271 ft was designed by STS, which became part of AECOM in 2007. SLR understands that Cliffs has retained GEI Consultants, Inc. (GEI) since 2010 as the Engineer of Record (EOR) for the tailings basin. Typical EOR services include the design (i.e., volumetrics, stability analysis, water balances, hydrology, seepage cut-off design, etc.), construction and construction monitoring, inspections (i.e., annual dam safety inspections) and instrumentation monitoring data review (i.e., regularly scheduled instrumentation monitoring and interpretation), to verify that the tailings basins are being constructed and operated by Cliffs as designed and to meet all applicable regulations, guidelines, and standards. The EOR has been involved with design and construction work at GNTB since upstream dike construction began during the late 1980s and became the EOR in 1997 when working with STS.

GEI states that the slope stability Factors of Safety and the capacity to store the design storm event met the requirements for the tailings dam designs that have been completed for crest elevations for GNTB and GSTB between 1,361 ft and 1,325 ft, respectively.

During the ongoing construction of the tailings dams, field instrumentation (such as piezometers and inclinometers) are monitored as needed, and a summary is reported annually. Data that is collected is compared to thresholds set for each stage of design and reported using web-based, data visualization and an instrumentation monitoring database.

SLR understands that the current GTB provides storage for approximately 22 years of tailings, based on the current tailings production schedule, and that Cliffs plans to store the remaining seven years of tailings production in the Empire Tailings Basin that was operated from 1963 to 2016 (Cliffs, 2021b).

15.4.3 Audits

Third-party audits have been performed on the TSF by Golder in 2007 and 2012. The 2007 Golder audit would have had limited input to the GSTB as it began operations in 2006. SLR understands that Cliffs plans to engage a third party audit for the tailings basin in 2022.

SLR understands that an External Peer Review Team (EPRT) was established in 2019 as part of the tailings basin design and operations review. The EPRB is an independent group that is not associated with the day-to-day engineering activities performed by GEI or Cliffs, and it works with the EOR and Owner to review design, construction, monitoring, and risk management.

15.4.4 Inspections

During GEI's most recent inspection (GEI, 2020), GEI noted that all observations suggest the dam and dike segments are well maintained and stable, and the conclusion of the inspection report was that the systems are functioning as designed and are in good operational condition. Monitoring data was not presented.

15.4.5 Reliance on Data

SLR relies on the statements and conclusions of GEI and Cliffs and provides no conclusions or opinions regarding the stability or performance of the listed dams and impoundments.

15.4.6 Recommendations

Cliffs has been operating the Tilden Tailings Basin Cells since 1976, which is currently operating under the permit requirements of the Michigan Department of Natural Resources. Upstream tailings dam raises, such as those that have been or will be carried out by Cliffs at Tilden for the GTB vertical expansions, are typically done in low-seismic zones and can be constructed using the coarse-fraction tailings (sand) material. This type of construction approach, however, requires comprehensive communication and documentation system, careful water management, monitoring of the dam and foundation performance, and the placement of tailings material to ensure that it meets the design requirements. To address these issues, Cliffs has retained GEI as the EOR, with the EOR designation being an industry standard for tailings management, as the EOR typically verifies that the Tailings Storage Basin Cells are being constructed and operated by Cliffs as designed and meet all applicable regulations, guidelines, and standards.

Based on a review of the documentation provided, SLR has the following recommendations:

1. Prioritize the completion of an Operations, Maintenance and Surveillance (OMS) Manual for the TSF with the EOR in accordance with Mining Association of Canada (MAC) guidelines and other industry-recognized standard guidance for tailings facilities
2. Document, prioritize, track, and close out in a timely manner the remediation, or resolution, of items or concerns noted in TSF audits or inspection reports.
3. Assess the impacts of depositing tailings in the Empire facility, and prepare the necessary design and permitting documents.

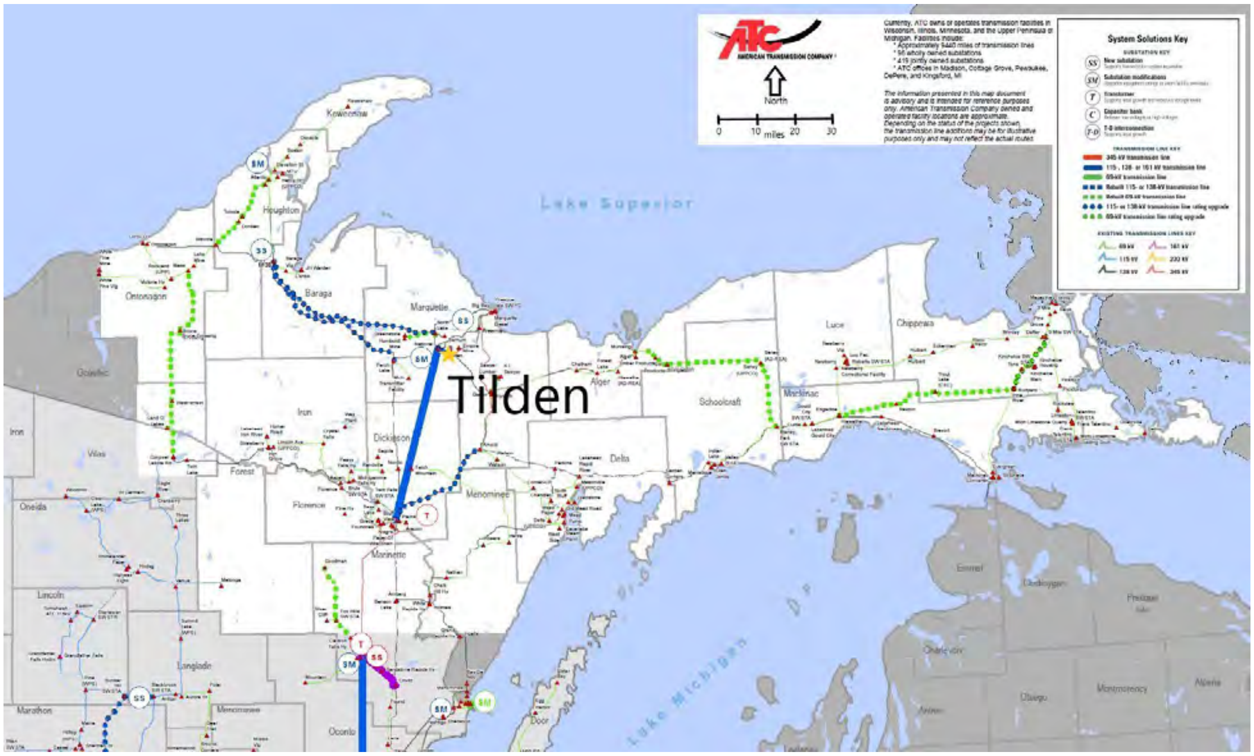
15.5 Power

Power is received at Tilden's substation on transmission lines owned by American Transmission Company. Four substation transformers have a capacity of 90 MVA and reduce voltage from 138 kV to 13.8 kV for onsite distribution.

Installed switchgear distributes 13.8 kV power to the pit and remote pumping facilities through overhead lines and to the Plant through underground ducts. In the concentrator and pelletizing plant, power is then distributed through secondary step-down transformers to the crushing, grinding, flotation, filtering, and thickening, and induration facilities at 4,160 V to 480 V, as required.

Backup diesel-powered generators are installed at several locations to operate critical equipment should main power be lost.

In August 2016, the Mine executed a 20-year special contract with the Upper Michigan Energy Resources (UMERC) that began on April 1, 2019. The electricity under that contract is supplied through the existing power grid, which is interconnected to neighboring states (Figure 15-3).

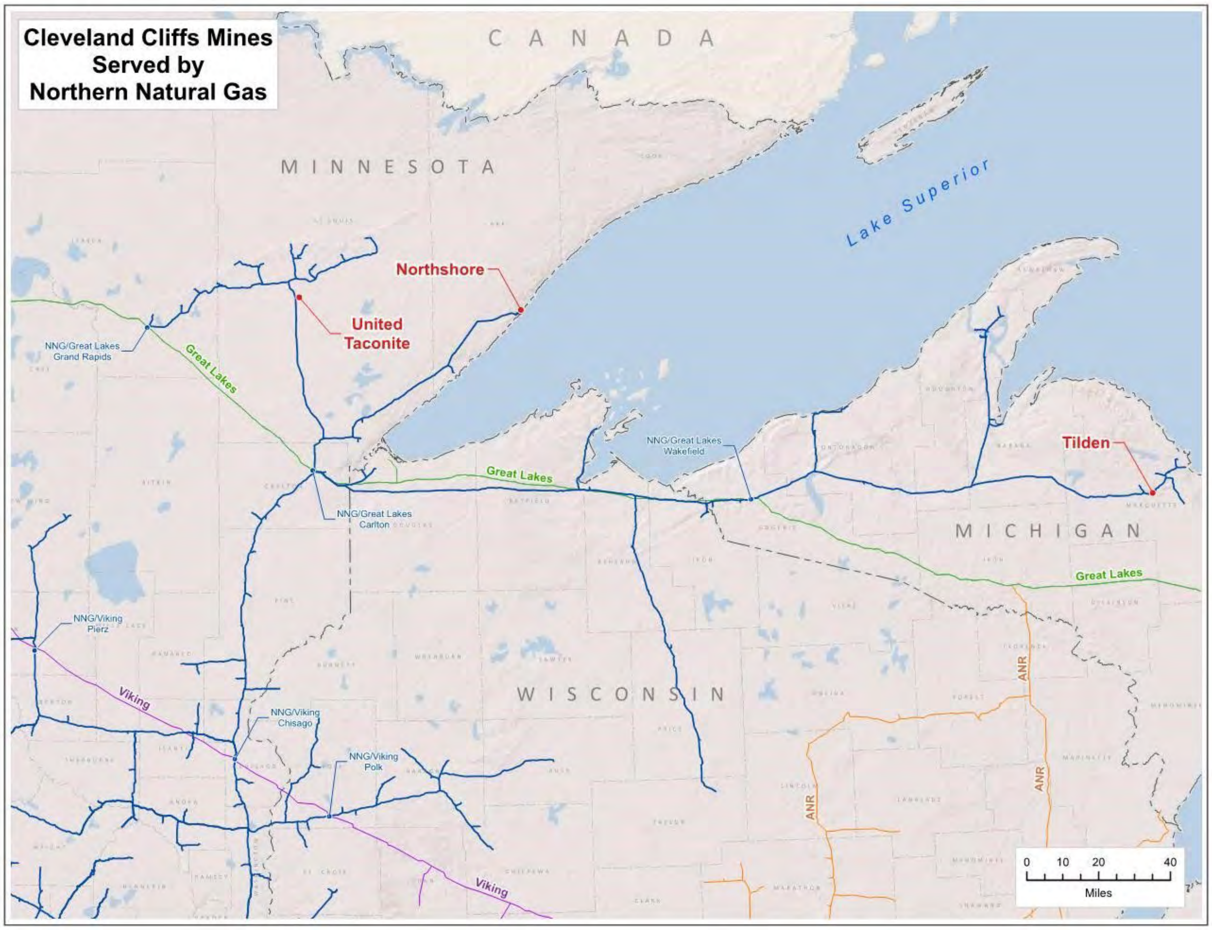


Source: American Transmission Company

Figure 15-3: Regional Electrical Power Distribution

15.6 Natural Gas

Natural gas is primarily used for firing the 160-ft rotary kilns at the pelletizing plant and water boilers in the concentrator. Natural gas is purchased from Encore Energy and supplied to the site via a gas pipeline owned and operated by Northern Natural Gas (NNG). NNG has an extensive interstate pipeline system that travels through the Midwest and is interconnected to other major interstate pipelines. Gas is delivered to a border reducing station at 575 psi. Natural gas is further reduced to 50 psi with an incoming 10-in. feed line for use in plant application. The natural gas line is buried and protected by cathodic protection. Figure 15-4 is a map of the NNG pipeline system.



Source: Northern Natural Gas Company

Figure 15-4: Regional Natural Gas Supply

15.7 Coal

The Tilden pellet plant kilns are a dual fuel system with the ability to operate on pulverized coal, natural gas, or a combination of both.

15.8 Diesel and Propane

U.S. Oil supplies the Mine from its terminal in Green Bay, Wisconsin. Tilden has one, 20,000-gal, above-ground diesel fuel tank and one, 10,000-gal, underground gasoline storage tank. Small diesel and gasoline fueling stations are used for small maintenance equipment and fleet vehicles. There is sufficient fuel supply in the region to meet the requirements of the operation.

15.9 Communications

Communications to the facility are provided by AT&T via a direct fiber connection to the Tilden facility for data/network communications. Tilden is connected to other locations such as Empire with a separate fiber line to that facility and a T1 connection to the LS&I Eagle Mills facility. Network switch connectivity is provided via gigabit connections between the various locations/buildings on the Property. Telephone connectivity is also provided by dedicated phone lines from AT&T, and the phone system is provided by Avaya.

15.10 Water Supply

15.10.1 Fresh Water

Fresh makeup water for the process is supplied from the Greenwood Reservoir. The reservoir is located approximately seven miles southwest of Ishpeming and is on the Middle Branch Escanaba River. It was constructed in 1972. The reservoir impounds 22,000 acre-ft and has a surface area of 1,400 acres. It has a 26-mi shoreline and includes 13 small islands, which add an additional 11 mi of shoreline.

Water is released from the reservoir into an after-bay, a mini reservoir downstream of the main dam, through a four-port outlet system. Water can be selected from one of the four gates from the bottom to the surface, depending on water temperature desired, or any combination of gates can be opened to obtain the desired blend.

The diversion water is conveyed by gravity through a 30-in.-diameter x 4,000-ft-long pipeline to Green Creek, which flows into the Schweitzer Reservoir, constructed in 1963 for the Empire Mine. A permanent pumping system with three pumps (one duty and two standby), pumps the fresh water 1.5 mi from the Schweitzer Reservoir to the Tilden concentrator fresh water head tank via a buried water line (Figure 15-5).

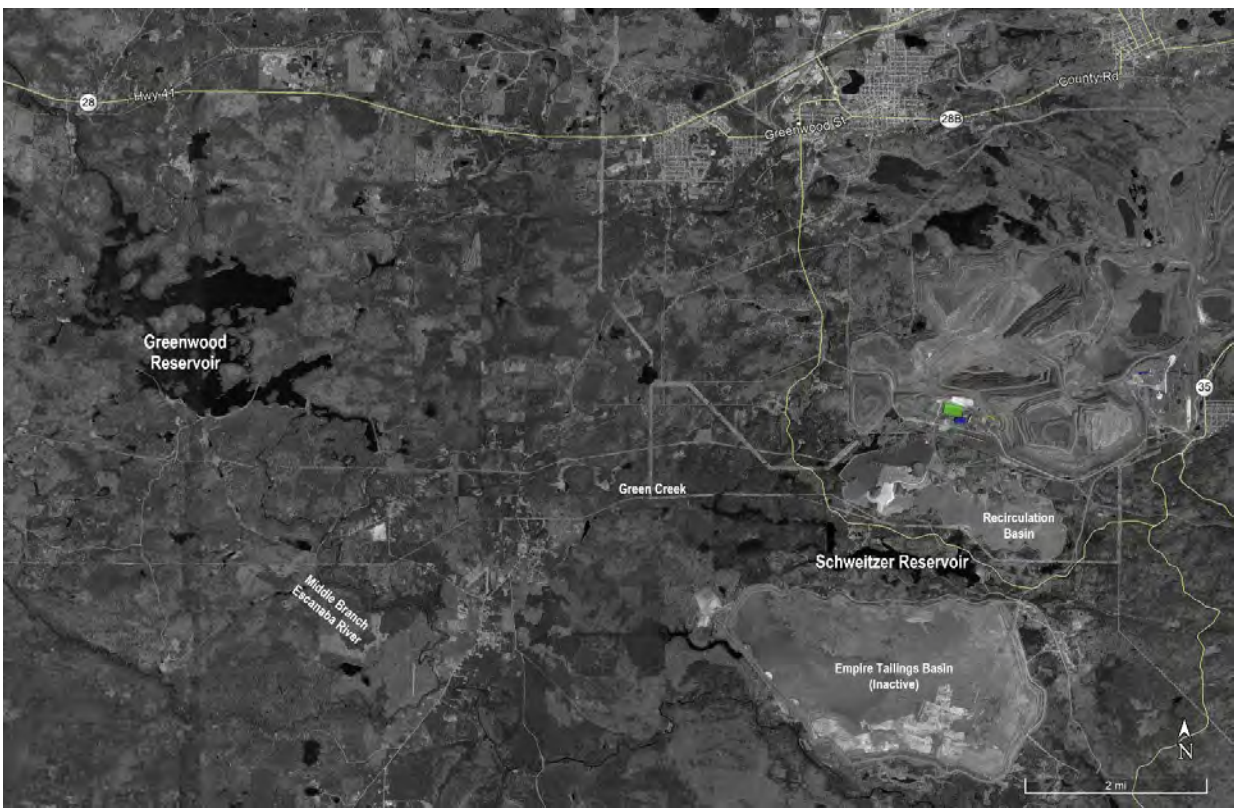


Figure 15-5: Fresh Water Supply

15.10.2 Process Water

The majority of process water requirements are met by reclaiming from the operation via tailings thickener overflow, reuse water basin, or decanting and returning from the tailings basin. Reuse basin water is a combination of excess tailings thickener overflow water and fresh water makeup to maintain level. Reuse water is pumped back to the Plant using twelve reuse pumps and boosted in pressure with seven reuse water booster pumps for Plant use.

15.10.3 Fire Water

Fire water is supplied from the fresh water head tank, which holds a minimum reserve for emergency purposes. Fire water is distributed throughout the operation both via underground piping to external buildings separated from the Plant including the Tilden truck shop, primary crusher, and fuel buildings, and via above-ground piping within the Plant. Line pressure is maintained by a small jockey pump, with full pressure supplied by an electric pump should a significant amount of water be required. A backup diesel pump is provided in the event of a power outage.

15.10.4 Potable Water

Potable water is supplied by two deep well pumps located on site. Water is pumped to a head tank with the offtake being boosted for use in the operation.

15.11 Support Facilities

The main processing facility is contained in a conventional, multilevel, insulated steel building. Mining offices and mobile equipment maintenance shops are separated from the main facility and are located on Empire Mine property. Construction of the facility was completed in 1974 for Tilden 1 and 1978 for Tilden 2. Substantial buildings separated from the main complex include the fresh water and reuse water pump houses, clarifier and reagent mixing pump house, tailings thickener pump house, and Tilden truck shop. Figure 15-6 shows a general layout of buildings near the Plant and Figure 15-7, the Empire truck shop.

Site security is provided by General Security Services Corporation (GSSC) and is managed by the Tilden Safety department.

Explosive delivery and handling is performed by contractors. There is no storage of explosives at the site.

15.11.1 Administration Buildings and Offices

Administration offices of the facility are encompassed within the Plant footprint. Sufficient office space for human resources, finance, health and safety, environmental, engineering, warehousing, plant operations, and maintenance reside in the Plant; mining, geology, mine engineering, mine operations and maintenance reside in the Empire Mine services building. Centralized support services for payroll, information technology (IT), procurement, and research are based either from Cleveland, Ohio and/or Ishpeming, Michigan. Additional finished office space is available in the Tilden truck shop if required.

15.11.2 Maintenance Shops

Mining maintenance is performed primarily at the Empire truck shop for mobile equipment. This facility is equipped with a truck wash bay and has 26 stalls with associated overhead cranes, lubrication, and parts storage. The Empire truck shop is directly connected to the mining administration building. Maintenance on drills is either performed in the field or at the Tilden truck shop. The Tilden truck shop is equipped with the bare essentials and is primarily used to provide an area out of the elements for the drill repair crew and is used as the onsite drill core logging and storage facility.

Plant maintenance is provided with work-shop space at three primary locations within the Plant footprint: concentrator, pellet plant, and main shops. Field fitting and fabricating is performed at the first two, with associated overhead cranes, welding, and cutting equipment provided. The main shop is located adjacent to the warehouse facility and provides rebuild services for primarily rotating equipment components. Large fabrication jobs are handled by an in-house fabrication shop at the Empire facility or contracted to local fabrication and machining facilities. These facilities are typically located at Calumet (114 mi northwest) or Escanaba (67 mi south-southeast).

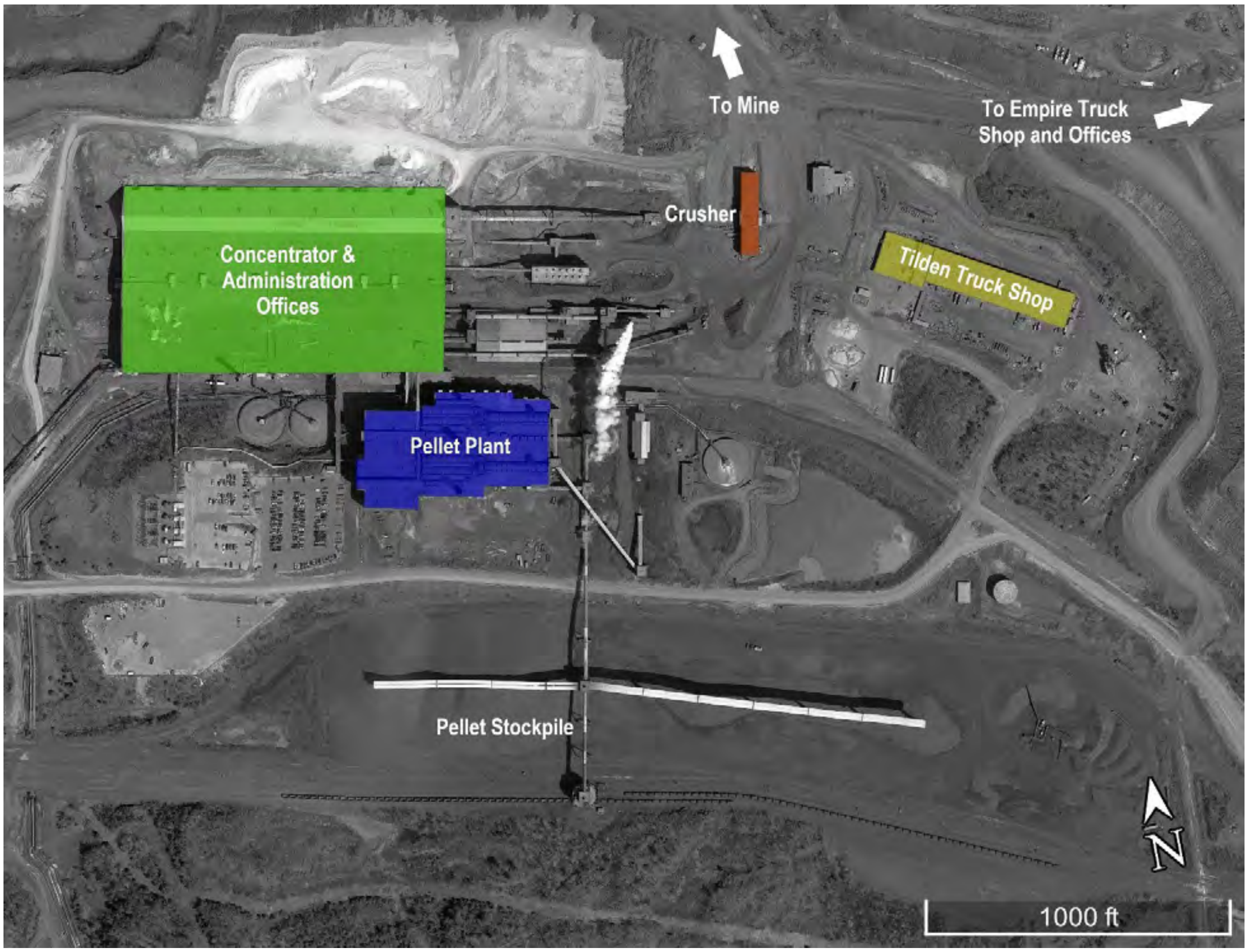


Figure 15-6: Process Plant and Administration Offices

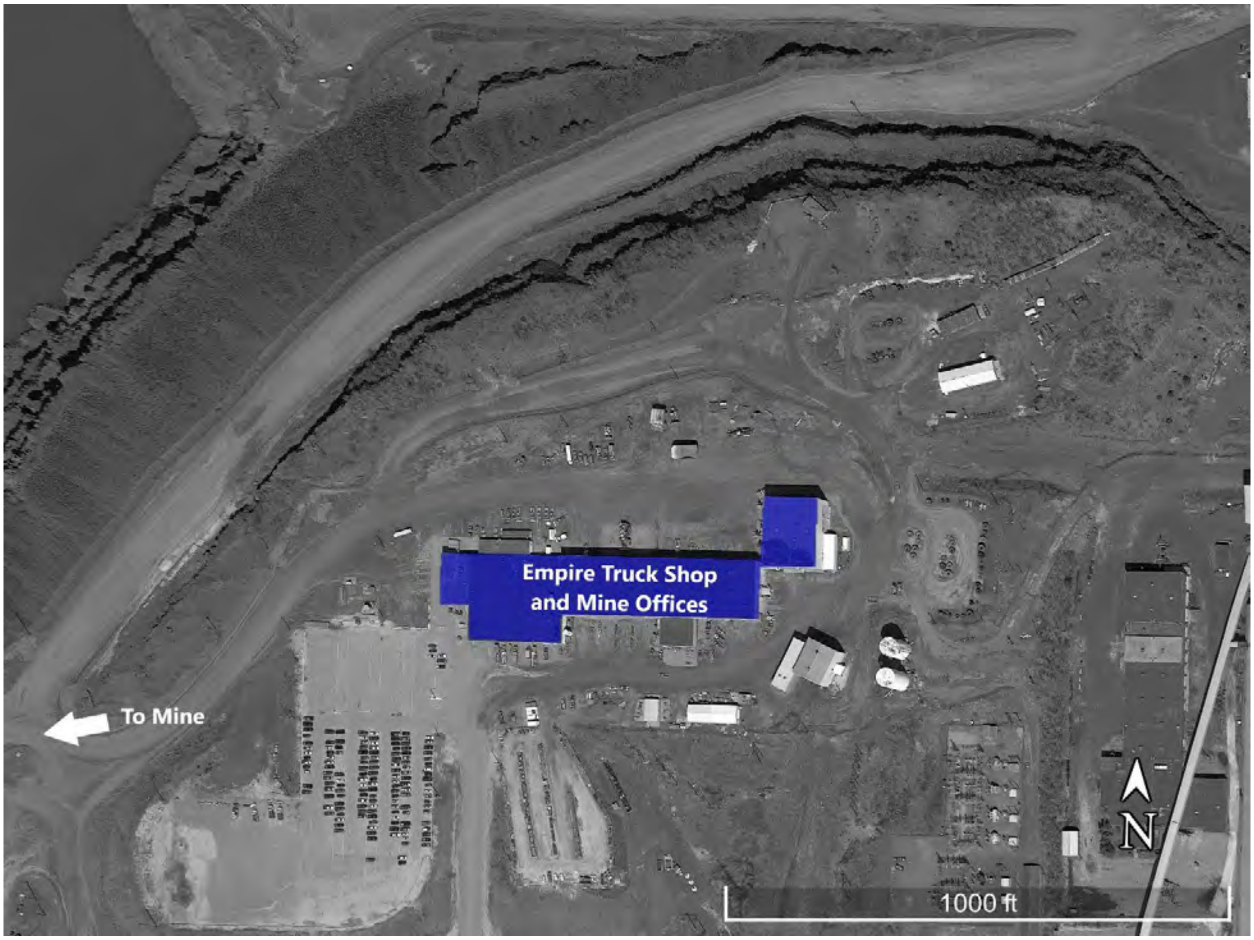


Figure 15-7: Mine Offices and Truck Shop

16.0 MARKET STUDIES

16.1 Markets

Note that while iron ore production is listed in long or gross tons (2,240 lb), steel production is normally listed in short tons (2,000 lb) or otherwise noted.

Cliffs is the largest producer of iron ore pellets in North America. It is also the largest flat-rolled steel producer in North America. In 2020, Cliffs acquired two major steelmakers, ArcelorMittal USA (AMUSA), and AK Steel (AK), vertically integrating its legacy iron ore business with steel production and emphasis on the automotive end market.

Cliffs owns or co-owns five active iron ore mines in Minnesota and Michigan. Through the two acquisitions and transformation into a vertically integrated business, the iron ore mines are primarily now a critical source of feedstock for Cliffs' downstream primary steelmaking operations. Based on its ownership in these mines, Cliffs' share of annual rated iron ore production capacity is approximately 28.0 million tons, enough to supply its steelmaking operations and not have to rely on outside supply.

In 2021, with underlying strength in demand for steel, the price reached an all time high. It is expected to remain at historically strong levels going forward for the foreseeable future. In 2020, North America consumed 124 million tons of steel while producing only 101 million tons, which is in line with the historical trend of North America being a net importer of steel. That trend is expected to continue going forward, as demand is expected to outpace supply in North America. Given the demand, it will likely be necessary for most available steelmaking capacity to be utilized.

On a *pro-forma* basis, in 2019 Cliffs shipped 16.5 million tons of finished flat-rolled steel. The next three largest producers were Nucor with 12.7 million tons, U.S. Steel with 10.7 million tons, and Steel Dynamics with 7.7 million tons. In 2019, total US flat-rolled shipments in the United States were about 60 million tons, so these four companies make up approximately 80% of shipments.

With respect to its BF capacity, Cliffs' ownership and operation of its iron ore mines is a primary competitive advantage against electric arc furnace (EAF) competitors. With its vertically integrated operating model, Cliffs is able to mine its own iron ore at a relatively stable cost and supply its BF and direct reduced iron (DRI) facilities with pellets in order to produce an end steel or hot briquetted iron (HBI) product, respectively. Flat-rolled EAFs rely heavily on bushelling scrap (offcuts from domestic manufacturing operations and excludes scrap from obsolete used items), which is a variable cost. The supply of prime scrap is inelastic, which has caused the price to rise with the increased demand. S&P Global Platts has stated the open-market demand for scrap could grow by nearly 9 million tons through 2023 as additional EAF capacity comes online, with the impact of the scrap market to continue to tighten as all new steel capacity slated to come online is from EAFs (S&P Global Platts, news release, March 18, 2021).

In addition to its traditional steel product lines, Cliffs-produced steel is found in products that are helping in the reduction of global emissions and modernization of the national infrastructure. For example, Cliffs' research and development center has been working with automotive manufacturer customers to meet their needs for electric vehicles. Cliffs also offers a variety of carbon and plate products that can be used in windmills, while it is also the sole producer of electrical steel in the United States. Additionally, in Cliffs' opinion, future demand for steel given its low CO_2 emissions positioning will increase relative to other materials such as aluminum or carbon fiber.

Cliffs is uniquely positioned for the present and future due to a diverse portfolio of iron ore, HBI, BFs, and EAFs generating a wide variety of possible strategic options moving forward, especially with iron ore. For instance, Cliffs has the optionality to continue to provide iron ore to its BFs, create more DRI internally, or sell iron ore externally to another BF or DRI facility.

The necessity for virgin iron materials like iron ore in the industry is apparent, as EAFs rely on bushelling scrap or metallics. As of 2020, EAFs accounted for 71% of the market share, a remarkably high percentage among major steelmaking nations. Because scrap cannot be consistently relied upon as feedstock for high-quality steel applications, the industry needs iron ore-based materials like those provided by Cliffs to continue to make quality steel products.

The US automotive business consumes approximately 17 million tons of steel per year and is expected to consume around or at this level over time for the foreseeable future. Cliffs' iron ore reserves provide a competitive advantage in this industry as well, due to high quality demands that are more difficult to meet for scrap-based steelmakers. As a result, Cliffs is the largest supplier of steel to the automotive industry in the United States, by a large margin.

Table 16-1 shows the historical pricing for hot rolled coil (HRC) product, Bushelling Scrap feedstock, and IODEX iron ore indices for the last five years. The table includes 2021 pricing for each index, which shows a significant increase that is primarily driven by demand.

Table 16-1: Five Year Historical Average Pricing
Cleveland-Cliffs Inc. – Tilden Property

Indices	2017	2018	2019	2020	2021	5 Yr. Avg.
US HRC ($/short ton)	620	830	603	588	1611	850
Busheling ($/gross ton)	345	390	301	306	562	381
IODEX ($/dry metric ton)	71	69	93	109	160	100

The economic viability of Cliffs' iron ore reserves will in many cases be dictated by the pricing fundamentals for the steel it is generated for, as well as scrap and seaborne iron ore itself.

The importance of the steel industry in North America, and specifically the USA, is apparent by the actions of the US federal government by implementing and keeping import restrictions in place. Steel is a product that is a necessity to North America. It is a product that people use every day, often without even knowing. It is important for middle-class job generation and the efficiency of the national supply chain. It is also an industry that supports the country's national security by providing products used for US military forces and national infrastructure. Cliffs expects the US government to continue recognizing the importance of this industry and does not see major declines in the production of steel in North America.

For the foreseeable future, Cliffs expects the prices of all three indexes to remain well above their historical averages, given the increasing scarcity of prime scrap as well as the shift in industry fundamentals both in the US and abroad.

16.2 Contracts

16.2.1 Pellet Sales

Since Cliffs' 2020 acquisition of AK and AMUSA's BF steel making facilities, Tilden L.C. ships most pellets by freighter via the Great Lakes to Cliffs' steelmaking facilities in the Midwestern USA, and some pellets by rail to external customers.

For cash flow projections, Cliffs uses a blended three-year trailing average revenue rate based on the dry standard pellet from all Cliffs' mines, calculated from the blended wet pellet revenue average of $98/WLT Free on Board (FOB) Mine as shown in Table 16-2. Pellet prices are negotiated with each customer on long-term contracts based on annual changes in benchmark indexes such as those shown in Table 16-1 and other adjustments for grade and shipping distances.

Table 16-2: Cliffs Consolidated Three-Year Trailing Average Wet Pellet Revenue
Cleveland-Cliffs Inc. – Tilden Property

Description	2017	2018	2019	3YTA
Revenue Rate ($/WLT)	88.02	105.64	99.50	98.00
Total Pellet Sales (MWLT)	18.7	20.6	19.4	19.5

SLR examined annual pricing calculations provided by Cliffs for the period 2017-2019 for external customers, namely AK. The terms appear reasonable. It should be noted that Cliffs has subsequently acquired AK and AMUSA steelmaking facilities in 2020 making the company a vertically integrated, high-value steel enterprise, beginning with the extraction of raw materials through the manufacturing of steel products, including prime scrap, stamping, tooling, and tubing.

For the purposes of this TRS, it is assumed that the internal transfer pellet price for Cliffs' steel mills going forward is the same as the $98/WLT pellet price when these facilities were owned by AK and AMUSA. Based on macroeconomic trends, SLR is of the opinion that Cliffs pellet prices will remain at least at the current three-year trailing average of $98/WLT or above for the next five years.

16.2.2 Operations

Major current suppliers for the Tilden operation include, but are not limited to, the following:

- Electrical Grid Power: Upper Michigan Energy Resources
- Natural Gas: Encore Energy Services, Inc.
- Diesel Fuel: U.S. Oil, a Division of U.S. Venture, Inc.
- Propane: UP Propane
- Pellet Rail Transport to Marquette: LS&I, a wholly owned Cliffs' subsidiary
- Pellet Rail Transport to external customers: CN Railway

17.0 ENVIRONMENTAL STUDIES, PERMITTING, AND PLANS, NEGOTIATIONS, OR AGREEMENTS WITH LOCAL INDIVIDUALS OR GROUPS

The SLR review process for Tilden included updating information that Cliffs had developed as part of its draft 2019 SK-1300 report. SLR has not had sight of or reviewed environmental studies, management plans, permits, or monitoring reports. The original and updated information included in this section is based on the information provided by the Cliffs project team.

17.1 Environmental Studies

Tilden L.C. conducted several environmental assessments for specific projects over time that have supported different aspects of its current operation. Each of those studies culminated in a determination by the relevant state and/or federal authorities to grant permits to construct and operate Tilden's facilities. The relevant historical studies are listed below. There are no environmental impact studies in process at this time.

- Empire & Tilden Mine Impact Assessment, May 2000, to support proposed wetland impacts at both mines.

Tilden has been operating for over 45 years, with baseline and other environmental studies undertaken as required to support various approvals over the site's operating history. Currently, additional environmental studies, including collecting and updating baseline information, are undertaken on an as-required basis to support new permit applications or to comply with specific permit conditions. Cliffs has indicated that all water quality-based studies site wide are being implemented per the requirements set forth in the NPDES permits

17.2 Environmental Requirements

Tilden L.C. maintains an environmental management system (EMS) that is registered to the international ISO 14001:2015 standard. The ISO standard requires components of leadership commitment, planning, internal and external communication, operations, performance evaluation, and management review. Tilden's continued registration to the ISO standard is evaluated through external auditors. ISO audits are performed as required by the registrar to maintain the umbrella certification. The last audit was completed in June 2021. Compliance audits are performed as scheduled by corporate environmental, with the last audit completed in November 2021.

The EMS *Register of Legal Requirements* is used to maintain a current listing of compliance obligations that are applicable to the site's environmental aspects. Compliance obligations are incorporated into the EMS Procedures, Work Instructions, or other operational controls such as work orders, environmental plans, and operational procedures that have been developed for the significant environmental aspects. Additionally, compliance obligations are incorporated into procedures, plans, and work orders for aspects that have not been identified as "significant" under the EMS, but where incorporation of the compliance obligations is deemed necessary to promote regulatory compliance.

17.2.1 Site Monitoring

Tilden L.C. operates through permission granted by multiple permits, which are summarized in Table 17-1. The permits contain requirements for site monitoring including air, water, waste, and land aspects of Tilden's operation. Those permit-required data are required to be maintained by the facility, and exceptions to the monitoring obligations are reportable to the permitting authority. Monitoring is conducted in compliance with permit requirements, and management plans are developed as required to outline protocols and mitigation strategies for specific components or activities. Monitoring and management programs currently undertaken in compliance with Tilden's existing permits include:

- Air Quality: Management plans including fugitive dust control plans, operation and maintenance plans, and malfunction plans; monitoring of fugitive sources and stacks, visible dust emission monitoring at the tailings facility; and greenhouse gas (GHG) emissions monitoring and reporting.
- Noise and Vibration: Blast management plans including vibration monitoring.
- Surface Water: Routine water quality sampling in receiving waters; quantity of water takings and discharges; selenium-related monitoring and management program including collection and treatment of runoff and monitoring program at nearby streams/creeks.
- Groundwater: Routine water quality sampling at the Mine's potable and monitoring wells in accordance with legal requirements; quantity of potable water takings.
- Wetlands: monitoring of nearby wetlands where a potential impact has been identified, including related to drawdown and/or discharge activities.
- Wildlife: monitoring of species in accordance with specific permit conditions.

There are no specific management plans related to social aspects in place.

In terms of compliance, Cliffs received a Notice of violation on December 17, 2020 for fugitive dust events at GTB in November/December 2020. Tilden indicated that it completed an evaluation of its FDCP and submitted a revised plan to Michigan Department of Environment, Great Lakes and Energy (EGLE) on March 8, 2021 per EGLE request.

The State and Federal government conduct regional ecologic monitoring in the vicinity of the facility operations. Two recent examples of such monitoring include:

- Environmental Protection Agency (EPA) conducted its residual risk and technology review (RTR) of the Taconite NESHAP (40 CFR 63). EPA's final rule (July 28, 2020) documents that risks from the Taconite Iron Ore Processing source category are acceptable, and the current standards provide a margin of safety to protect public health and prevent an adverse environmental effect.
- The State of Michigan conducts regional watershed monitoring to assess the overall health of waterbodies throughout the state including water quality, and macroinvertebrate and fish population diversity and health. The State may develop watershed management tools for water bodies of concern such as total maximum daily load (TMDL) plans. Tilden is not currently subject to any TMDL-based load restrictions.

17.2.2 Water

Tilden L.C.'s current NPDES permit, MI0038369, authorizes to discharge treated process wastewater and treated sanitary wastewater from the GTB to Goose Lake Outlet, which is part of the Escanaba River watershed. Cliffs indicated that Tilden is currently in compliance with all permit conditions set forth in the NPDES permit for process water discharges. Cliffs indicated these discharge outfalls have provided adequate permitted capacity to move water as necessary to support the mining process.

Selenium had been identified in the process water and stormwater runoff from the facility, causing exceedances in surface water quality standards in certain watersheds proximal to the mining operations. Capital improvements projects had been identified and implemented to achieve compliance with water quality standards in the receiving water adjacent to Tilden operations.

Tilden L.C. maintains two water use permits for operations makeup water, with adequate capacity for the facility's needs.

17.2.3 Hazardous Materials, Hazardous Waste, and Solids Waste Management

Tilden L.C. typically generates small quantities of hazardous waste and has a Small Quantity Generator status according to the federal Resource Conservation and Recovery Act (RCRA). Tilden generates other waste materials typical of any large industrial site and manages those wastes offsite through approved vendors.

17.2.4 Tailings Disposal, Mine Overburden, and Waste Rock Stockpiles

Requirements for tailings disposal are discussed in section 15.4 of this TRS. Tailings disposal is authorized by permits from the applicable regulatory authorities. See Table 17-1 for a full list of permits.

Because iron ore geology is different from some other mineralized ore bodies, acid-rock drainage is not a concern with the iron ore bodies and associated tailings in Michigan. Moreover, EPA itself describes the iron ore mining and beneficiation process as generating wastes that are "earthen in character." Chemical constituents from iron ore mining include iron oxide, silica, crystalline silica, calcium oxide, and magnesium oxide — none of which are Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) hazardous substances. The acid-neutralizing potential of carbonates in iron ore offsets any residual acid rock drainage risks, leading to pit water that naturally stabilizes at a pH of 7.5-8.5.

Tilden L.C. has implemented compliance plans to manage selenium present in the tailings basin discharge according to permit conditions. It is understood that the compliance plan has successfully managed selenium levels at or below the permit limit.

Requirements for the disposal of mine overburden and non-mineralized or lean rock are discussed in section 13.5 of this TRS. Stockpiling of these materials is authorized by permits from the applicable regulatory authorities. See Table 17-1 for a full list of permits.

17.3 Operating Permits and Status

Tilden operates through permission granted by multiple permits, which are summarized in Table 17-1.

While permitting exercises always involve varying degrees of risk due to external factors, Cliffs indicated that it has a demonstrated record of obtaining necessary environmental permits without unduly impacting the facility operational plan. Tilden is not aware of any permits/lack of permits that could lead to future operational issues.

Tilden has the following permit applications pending with a permitting authority:

- Routine renewal of Tilden's NPDES Permit with the Michigan Department of Energy, Great Lakes and Environment
- Wetland and stream impact permit for Tilden west stockpile progression (anticipated in 2022)
- Wetland and stream impact permit to support stormwater collection system upgrades (anticipated in 2022)

It is understood that all required permits are in place.

Table 17-1: List of Major Permits and Licenses
Cleveland-Cliffs Inc. – Tilden Property

Permit No	Description	Type	Jurisdiction	Agency	Status
MI0038369	NPDES Permit	NPDES	State	EGLE	Active
MI-ROP-B4885	Renewable Operating Permit (Title V)	Air	State	EGLE	Active
Permit No. 2	Part 631 Metallic Mineral	Mining	State	EGLE	Active
---	Part 35 Water Use Permit	Water Use	State	EGLE	Active
various	Wells	Well	State	EGLE / County Health Dept.	Active
4-MI-103-33- 1G-00663	Federal Explosives Permit/License	Explosives	Federal	US Dept. of Justice	Active
05-52-0032-P	Rock Stock Pile Expansion	Wetland and Stream	State	EGLE	Active
97-03-0019	Stock Pile Expansion Tilden Lake	Wetland and Stream	State	EGLE	Active
13-52-0008-P	GSTB Dike Elev 1395, Dam Elev 1300, Outlet Wks Elev 1302	Dam Safety	State	EGLE	Active
13-52-0009-P	GNTB PH 7-9 Dike construction Elev 1361	Dam Safety	State	EGLE	Active
MID083290551	Hazardous Waste Generator ID	License	State	EGLE	Active

Notes:
EGLE: Michigan Department of Environment, Great Lakes and Energy
USNRC: United States Nuclear Regulatory Commission

Regulatory issues with the potential to materially impact Tilden's current plans to address any issues related to environmental compliance and permitting are actively monitored and disclosed in Cliffs' 10-K; Part I Environment, which has discussion relevant to:

- Conductivity
- Selenium Discharge Regulation
- Evolving water quality standards for selenium and conductivity

- Definition of "Waters of the United States" Under the Clean Water Act
- Climate Change and GHG Regulation
- Regional Haze FIP Rule
- NO_2 and SO_2 National Ambient Air Quality Standards (NAAQS)
- CERCLA 108(b)
- Regulation of Discharges to Groundwater

17.4 Mine Closure Plans and Bonds

Tilden's current mine life is projected at 25 years as referenced in section 13.4 of this TRS. Michigan's Part 631 Rules (R 425.8) requires preparation of a reclamation plan that addresses a long-range look at the mining area, including consideration of reclamation, minimization of erosion and pollution, and estimated time to complete the plan. Cliffs has indicated that Tilden L.C. has developed a plan consistent with the Part 631 requirements and maintains it on file. As a matter of good mining practice, Tilden L.C. seeks to conduct progressive reclamation throughout its mining life to minimize risk and costs at closure. Tilden actively reclaims stockpiles with no further planned use, consistent with the Michigan Part 631 requirements.

Cliffs performs an annual review of significant changes to each operations Asset Retirement Obligation (ARO) cost estimates. Additionally, Cliffs conducts an in-depth review every three years to ensure ARO legal liabilities are accurately estimated based on current laws, regulations, facility conditions, and cost to perform services. These cost estimates are conducted in accordance with the Financial Accounting Standards Board (FASB) Accounting Standards Codification (ASC) 410. FASB ARO estimates comply with rules set forth by the United States General Accepted Accounting Principles (USGAAP) and the SEC, and those costs are reported as part of Cliffs' company-wide SEC disclosures. Arcadis calculated the 2020 ARO legal obligation Closure and Reclamation costs associated with project deactivation to be $52.5 million (Arcadis, 2020). The total ARO liability for Cliffs is $56.8 million; to calculate the total ARO liability, Cliffs deducts Arcadis' specified contingency value and adds Cliffs' accounting policy contingency at 15% and Cliffs' accounting policy market risk at 4%. SLR notes that there are differences between the ARO estimate and the book value calculated by Cliffs due to the long life of the operation.

Tilden L.C. indicated that it worked with a third party to develop a site-specific estimate of actual closure and reclamation cost, which considers likely approaches and techniques to close the facility consistent with the requirements of its Part 631 plan. Cliffs indicated that upon closure Tilden will implement short-term and long-term water quality treatment technologies to meet water quality standards in the receiving waters.

SLR cannot comment on adequacy of the closure costing and the closure plan based on currently available information.

17.4.1 Performance or Reclamations Bonds

Tilden currently has no outstanding performance or reclamation bonds.

17.5 Social and Community

Tilden has an agreement with Richmond and Tilden Townships to make an annual contribution to a house-washing program. The township administers the program for local homeowners through an area contractor. Cliffs indicated that this is a good faith gesture by Tilden to address any dust-related concerns in the community. Cliffs also provides access/lease agreements with organizations for public use of inactive mine lands.

Cliffs Public/Government Affairs maintains a list of stakeholders for Cliffs iron ore mine operations.

SLR is not able to verify adequacy of management of social issues and what the general issues raised are. However, it is understood that Cliffs has a positive relationship with the community, and in the event of a complaint, Cliffs would work directly with affected community members to develop a mutually acceptable resolution.

18.0 CAPITAL AND OPERATING COSTS

Cliffs' forecasted capital and operating costs estimates are derived from annual budgets and historical actuals over the long life of the current operation. According to the American Association of Cost Engineers (AACE) International, these estimates would be classified as Class 1 with an accuracy range of -3% to -10% to +3% to +15%. All unit rates are reported in WLT pellets.

18.1 Capital Costs

Capital costs were derived from current levels and work of similar scope based on the 2022 plan. Table 18-1 shows the sustaining capital cost forecast for the five year period from 2022 to 2026, which totals $314.2 million, or $8.29/WLT pellet. These costs include but are not limited to:

- $15.4 million environmental compliance
- $180.8 million in mine fleet replacements and additions
- $94.3 million in plant maintenance
- $23.7 million in plant and tailings basin operations

For the remaining LOM starting in 2027, an annual sustaining capital cost of $4/WLT pellet totaling an additional $579.9 million in expenditures is required for the remaining mine life as follows:

- $261.4 million for major fleet purchases
- $318.5 million for other sustaining capital expenditures (environmental, maintenance, etc.)

Total capital expenditures are estimated at $894.2 million, or $4.65/WLT pellet.

Table 18-1: LOM Capital Costs
Cleveland-Cliffs Inc. – Tilden Property

Type	Values	LOM	2022	2023	2024	2025	2026	2027-2046
Capital Costs								
Sustaining	$ millions	632.8	63.5	82.9	45.7	43.8	78.3	318.5
Major Fleet	$ millions	261.4						261.4
Total	$ millions	894.2	63.5	82.9	45.7	43.8	78.3	579.9
Pellet Sales								
Pellet Sales	MWLT	192.4	7.7	7.5	7.4	7.6	7.7	154.5
Unit Rates								
Sustaining	$/LT	3.29	8.25	11.10	6.16	5.73	10.17	2.06
Major Fleet	$/LT	1.36						1.69
Total	$/LT	4.65	8.25	11.10	6.16	5.73	10.17	3.75

A final closure reclamation cost of $56.8 million is estimated, with $18.9 million spent annually starting in the last year of production in 2047 and the two subsequent years.

18.2 Operating Costs

Operating costs for the LOM are based on the 2022 plan. For this period, costs are based on a full run rate of flux production consistent with what is expected for the life of the mine. At this point in time, there are no items identified that should significantly impact operating costs either positively or negatively for the evaluation period. Minor year-to-year variations should be expected based upon maintenance outages and production schedules. The 2022 Budget and LOM average operating costs over the remaining 25 years of mine life are shown below in Table 18-2.

Table 18-2: LOM Operating Costs
Cleveland-Cliffs Inc. – Tilden Property

Description	2022 ($/WLT Pellet)	LOM ($/WLT Pellet)
Mining	21.43	15.30
Processing	42.73	42.79
Site Administration	2.88	2.84
General/Other Costs	6.35	5.07
Operating Cash Cost ($/WLT Pellet)	**73.39**	**66.00**

Processing costs consist of crushing, grinding, concentrating, and pelletizing activities along with tailings basin disposal and shop allocations. Unlike Cliffs' Northshore and United operations, Tilden only includes pellet loading costs at the mine site and does not include the cost of railing pellets to Marquette port and ship loading in its operating costs. General/Other costs include production tax and royalty costs, insurance, corporate cost allocations, and other minor costs.

The Tilden operation employs a total of 967 salaried and hourly employees (including LS&I railroad staff) as of Q4 2021 consisting of 141 salaried and 826 hourly employees. The majority of the hourly employees are United Steelworkers production and maintenance bargaining unit members.

Table 18-3 summarizes the current workforce levels by department for the Property.

Table 18-3: Workforce Summary
Cleveland-Cliffs Inc. - Tilden Property

Category	Salary	Hourly	Total
Mine	40	393	433
Plant	59	340	399
General Staff Organization	28	0	28
LS&I Railroad	14	93	107
Total	**141**	**826**	**967**

19.0 ECONOMIC ANALYSIS

19.1 Economic Criteria

The economic analysis detailed in this section was completed after the mine plan was finalized. The assumptions used in the analysis are current for the time the analysis was completed (Q3 2021), which may be different than the economic assumptions defined in Sections 11.0 and 12.0 when calculating the economic pit. For this period costs are based on a full run rate of pellet production consistent with what is expected for the life of the mine.

An un-escalated, technical-financial model was prepared on an after-tax basis, the results of which are presented in this section. Key criteria used in the analysis are discussed in detail throughout this report. General assumptions used are shown summarized in Table 19-1.

Cliffs uses a 10% discount rate for DCF analysis incorporating quarterly cost of capital estimates based on Bloomberg data. SLR is of the opinion that a 10% discount/hurdle rate for after-tax cash flow discounting of large iron ore and/or base metal operations is reasonable and appropriate.

Table 19-1: Technical-Economic Assumptions
Cleveland-Cliffs Inc. – Tilden Property

Description	Value
Start Date	December 31, 2021
Mine Life	25 years
Three-Year Trailing Average Revenue	$98/WLT Pellet
Operating Costs	$66.00/WLT Pellet
Sustaining Capital (after five years)	$4/WLT Pellet
Discount Rate	10%
Discounting Basis	End of Period
Inflation	0%
Federal Income Tax	20%
State Income Tax	None – Sales made out of state

The operating cost of $66.00/WLT pellet includes royalties and State of Michigan production taxes.

The production and cost information developed for the Property are detailed in this section. Table 19-2 is a summary of the estimated mine production over the 25-year mine life.

Table 19-2: LOM Production Summary
Cleveland-Cliffs Inc. – Tilden Property

Description	Units	Value
ROM Ore	MLT	520.0
Total Material	MLT	1,116.9
Fe Grade	%	34.7
Average Annualized Mining Rate	MLT/y	44
Maximum Annualized Mining Rate	MLT/y	62

Table 19-3 is a summary of the estimated plant production over the 25-year mine life.

Table 19-3: LOM Plant Production Summary
Cleveland-Cliffs Inc. – Tilden Property

Description	Units	Value
ROM Material Milled	MLT	520.0
Annual Processing Rate	MLT/y	20.8
Process Recovery	%	37.0
Total Hemflux Pellet	MLT	192.4
Annual Hemflux Pellet Production	MLT/y	7.7

19.2 Cash Flow Analysis

The indicative economic analysis results, shown in Table 19-4, indicate an after-tax NPV, using a 10% discount rate, of $1,322 million at an average blended wet pellet price of $98/WLT. The after-tax IRR is not applicable since the Plant has been in operation for a number of years. Capital identified in the economics is for sustaining operations and plant rebuilds as necessary.

Project economic results and estimated cash costs are summarized in Table 19-4. Annual estimates of mine production and pellet production with associated cash flows are provided for years 2022 to 2026 and then by ten year groupings through the end of mine life.

The economic analysis was performed using the estimates presented in this TRS and confirms that the outcome is a positive cash flow that supports the statement of Mineral Reserves.

Table 19-4: Life of Mine Indicative Economic Results
Cleveland-Cliffs Inc. – Tilden Property

Mine Life		1	2	3	4	5	6-15	16-25	26-35
Calendar Years	**Total**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027-2036**	**2037-2046**	**2047-2056**
Reserve Base:									
Tilden Mining Ore Pellet Reserve Tons (millions)	192.4	184.7	177.2	169.8	162.2	154.5	77.5	0.0	0.0
Tonnage Data:									
Tilden Mining Total Tons Moved (millions)	1,116.9	60.0	62.0	60.5	60.6	60.0	460.0	353.8	-
Tilden Mining Crude Ore Tons Mined (millions)	520.0	21.6	21.3	21.2	21.3	22.1	209.6	202.8	-
Tilden Mining Pellet Production Tons (millions)	**192.4**	**7.7**	**7.5**	**7.4**	**7.6**	**7.7**	**77.0**	**77.5**	**-**
Inputs:									
Tilden Mining Pellet Revenue Rate ($/ton)	**98**	**98**	**98**	**98**	**98**	**98**	**98**	**98**	**-**
Tilden Mining Operating Cash Costs ($/ton)									
Mining	15.30	21.43	20.57	21.77	21.34	19.76	15.82	12.02	-
Crushing	0.80	0.87	0.69	0.81	0.80	0.80	0.80	0.80	-
Concentrating	28.02	28.58	27.49	28.95	27.98	27.98	27.98	27.98	-
Tailings Basin	-	-	-	-	-	-	-	-	-
Pelletizing and Pellet Handling	13.97	13.28	12.80	12.11	14.14	14.14	14.14	14.14	-
Site Administration	2.84	2.88	2.84	2.90	2.85	2.85	2.85	2.83	-
Production Taxes	1.03	1.03	1.06	1.06	1.02	1.02	1.02	1.02	-
Royalty	5.19	5.08	5.02	5.10	5.22	5.22	5.22	5.19	-
Insurance Charges	0.36	0.34	0.35	0.36	0.36	0.36	0.36	0.36	-
SG&A Corporate Allocation	0.02	0.46	0.00	0.00	0.00	0.00	0.00	0.00	-
General / Other Costs	(1.52)	(0.55)	(1.41)	(1.50)	(1.58)	(1.58)	(1.58)	(1.57)	-
Tilden Mining Operating Cash Cost ($/ton)	**66.00**	**73.39**	**69.42**	**71.57**	**72.13**	**70.55**	**66.60**	**62.76**	**-**
Income Statement:									
Tilden Mining Gross Revenue ($ in millions)	**18,854**	**755**	**732**	**728**	**748**	**755**	**7,546**	**7,591**	**-**
Mining	2,944	165	154	162	163	152	1,218	931	-
Crushing	154	7	5	6	6	6	62	62	-
Concentrating	5,391	220	205	215	214	215	2,154	2,167	-

Mine Life Calendar Years	Total	1 2022	2 2023	3 2024	4 2025	5 2026	6-15 2027-2036	16-25 2037-2046	26-35 2047-2056
Tailings Basin	-	-	-	-	-	-	-	-	-
Pelletizing and Pellet Handling	2,688	102	96	90	108	109	1,088	1,095	-
Site Administration	547	22	21	22	22	22	219	219	-
Production Taxes	197	8	8	8	8	8	79	79	-
Royalty	998	39	37	38	40	40	402	402	-
Insurance Charges	69	3	3	3	3	3	28	28	-
SG&A Corporate Allocation	4	4	0	0	0	0	0	0	-
General / Other Costs	(293)	(4)	(11)	(11)	(12)	(12)	(122)	(122)	-
Tilden Mining Operating Cash Cost ($ in millions)	**12,698**	**565**	**518**	**531**	**551**	**543**	**5,128**	**4,861**	**-**
Tilden Mining Operating Income (excl. Depreciation & Accretion)	**6,156**	**190**	**213**	**196**	**198**	**211**	**2,418**	**2,730**	**-**
Federal Income Taxes ($ in millions)	(1,231)	(38)	(43)	(39)	(40)	(42)	(484)	(546)	-
Depreciation Tax Savings ($ in millions)	209	5	6	7	7	7	82	94	-
Accretion Tax Savings ($ in millions)	13	0	0	0	0	0	4	8	-
									-
Tilden Mining Income after Taxes ($ in millions)	**5,147**	**157**	**177**	**164**	**165**	**176**	**2,020**	**2,287**	**-**
Other Cash Inflows & Outflows ($ in millions):									
Sustaining Capital Investments	(633)	(64)	(83)	(46)	(44)	(78)	(177)	(141)	-
Significant All Material Change Capital Additions	(261)	-	-	-	-	-	(124)	(137)	-
Mine Closure Costs (Incl. Post Closure)	(57)	-	-	-	-	-	-	-	(57)
Tilden Mining Cash Flow ($ in millions)	**4,196**	**94**	**95**	**118**	**121**	**98**	**1,718**	**2,009**	**(57)**
Tilden Mining Discounted Cash Flow ($ in millions)	**1,322**	**85**	**78**	**89**	**83**	**61**	**642**	**289**	**(4)**

19.3 Sensitivity Analysis

Project risks can be identified in both economic and non-economic terms. Key economic risks were examined by running cash flow sensitivities. The Tilden operation is nominally most sensitive to market prices (revenues) followed by operating cost as demonstrated in Table 19-5. For each dollar movement in sales price and operating cost, respectively, the after-tax NPV changes by approximately $55 million.

SLR notes that recovery and head grade sensitivity do not vary much in iron ore deposits compared to metal price sensitivity. In addition, sustaining capital expenditures amount to 5% of LOM operating costs and, therefore, do not have much impact on the viability of operating mines.

Table 19-5: NPV @ 10% Sensitivity Analysis
Cleveland-Cliffs Inc. – Tilden Property

Sales Price ($/WLT Pellet)	Operating Costs ($/WLT Pellet)					
	$81	**$76**	**$71**	**$66**	**$61**	**$56**
$83	($345)	($67)	$211	$489	$766	$1,044
$88	($67)	$211	$489	$766	$1,044	$1,322
$93	$211	$489	$766	$1,044	$1,322	$1,600
$98	$489	$766	$1,044	**$1,322**	$1,600	$1,878
$103	$766	$1,044	$1,322	$1,600	$1,878	$2,155
$108	$1,044	$1,322	$1,600	$1,878	$2,155	$2,433
$113	$1,322	$1,600	$1,878	$2,155	$2,433	$2,711
$118	$1,600	$1,878	$2,155	$2,433	$2,711	$2,989
$123	$1,878	$2,155	$2,433	$2,711	$2,989	$3,267

20.0 ADJACENT PROPERTIES

This TRS is based solely on information and data from the Tilden Property. Although Cliffs' Empire Mine is adjacent to the Tilden Property and is on care and maintenance status, the Mineral Resource and Mineral Reserves stated in this TRS are contained entirely within the Property's mineral leases, and information from other operations was not used in this TRS.

21.0 OTHER RELEVANT DATA AND INFORMATION

There is no other relevant data or information that is not discussed in this TRS.

22.0 INTERPRETATION AND CONCLUSIONS

Tilden has successfully produced iron ore pellets for over 47 years. The update to the Mineral Resource and Mineral Reserve does not materially change any of the assumptions from previous operations. An economic analysis was performed using the estimates presented in this TRS and confirms that the outcome is a positive cash flow that supports the statement of Mineral Reserves for a 25-year mine life.

SLR offers the following conclusions by area.

22.1 Geology and Mineral Resources

- Indicated Mineral Resources at Tilden, exclusive of Mineral Reserves, are estimated to total 135.4 MLT at a grade of 34.7% crude Fe. Inferred Mineral Resources are estimated to total 350.4 MLT at a grade of 34.7% crude Fe.
- The 2019 QA/QC program as designed and implemented by Cliffs has been helpful to understand the precision and accuracy of sample analysis at the Tilden laboratory, which is used to support the assay results within the database and confirm that the database is suitable for use in estimating Indicated and Inferred Mineral Resources.
- The Tilden database is adequate for the purposes of estimating Indicated and Inferred Mineral Resources. The lack of regular QA/QC sample submissions alongside samples used to support Mineral Resources is outside of industry-standard practice, and there are several database integrity issues that require attention.
- There is a moderate to good correlation of all variables between drill and blast hole twinned samples. Correlation of iron content values decreases for samples with high silica in concentrate values. There is a potential high bias of phosphorus in concentrate values in favor of blast holes. The known bias of weight recovery (wtrec) in favor of blast hole data is not observable in the paired dataset.
- The estimated block grades reflect the local blast hole or drill hole composite value, and the trends of the different variables are as intended.

22.2 Mining and Mineral Reserves

- The Property has been in production since 1974, and specifically under 100% Cliffs operating management since 2017. Cliffs conducts its own Mineral Reserve estimations.
- Total Proven and Probable Mineral Reserves are estimated at 520.0 MLT of crude ore at a grade of 34.7% crude Fe.
- Mineral Reserve estimation practices follow industry standards.
- The Mineral Reserve estimate indicates a sustainable project over a 25-year LOM.
- The geotechnical design parameters used for pit design are reasonable and support previous operations. Slope depressurization may be required as part of the development of the final pit walls.
- The LOM production schedule is reasonable and incorporates large mining areas and open benches.
- An appropriate mining equipment fleet, maintenance facilities, and manpower are in place, with additions and replacements estimated, to meet the LOM production schedule requirements.

- Sufficient storage capacity for waste stockpiles and tailings has been identified to support the production of the Mineral Reserve.

22.3 Mineral Processing

- The Tilden deposit is complex and requires metallurgical testing to classify materials as ore and waste. A standard flotation testing procedure has been developed for material classification, resource modeling, and concentrator feed blending.
- The capacity of the Tilden concentrator and pellet plant is 7.7 MLT/y of fluxed pellets (hemflux) from hematite-dominant crude ore sources.
- The ore is amenable to AG, and the concentrator consists of eleven lines of primary autogenous mills for coarse grinding and pebble mills for fine grinding, eliminating the requirement for steel grinding media.
- Pellets are indurated using a gas- and coal-fired grate drying and preheating furnace, followed by gas- and coal-fired rotary kilns for fusing and hardening, and rotary coolers for cooling. Heat must be supplied by fuel for low-magnetite concentrates, without the benefit of the exothermic heat of reaction from magnetite oxidation to hematite during heating.
- Crude iron ore head grades feeding the Plant during 2014 to 2020 ranged from 34.4% Fe to 35.5% Fe. Iron recovery to flotation concentrates ranged from 69.6% to 74.8%, with concentrate grades averaging 62.2% to 63.7% during this period. Approximately 20.5 MLT of crude ore is processed through the concentrator annually to produce 8.9 MLT of fluxed concentrate and 7.7 MLT of fluxed pellets (hemflux).

22.4 Infrastructure

- The Property is in a historically important, iron-producing region of Northern Michigan. All the infrastructure necessary to mine and process commercial quantities of iron ore and produce and ship pellets is in place, including the Mine, concentrator, and support facilities, line power supplies, natural gas sourced from an interstate pipeline system, local supply of coal, and diesel fuel supply from Green Bay, Wisconsin.
- The GTB is located approximately five miles southeast of the Tilden concentrator plant and nine miles from Lake Superior. The GTB is comprised of two, ring dike-type impoundments: the GNTB, which encompasses approximately 1,350 acres, and the GSTB, which encompasses approximately 1,100 acres.

22.5 Environment

- Tilden indicated that it maintains the requisite state and federal permits and is in compliance with all permits. Various permitting applications have been submitted to authorities and are pending authorization. Environmental liabilities and permitting are further discussed in Section 17.0.

23.0 RECOMMENDATIONS

23.1 Geology and Mineral Resources

1. Complete a reconciliation study to support the inclusion of Measured Mineral Resources at Tilden.
2. Complete additional drilling to improve the understanding of the deposit at its periphery and at depth, with a focus on low drill density areas within the 2019 LOM plan, as well as in areas with increased variability, such as the high-silica zones in the east of the Main Pit. Integrate the downhole information from the Empire and Tilden mines into a single, valid database.
3. Develop a standard operating procedure for detailed logging of drill core that captures iron speciation, alteration, mineralogy, structure, and lithology. Retain initial geological observations in drill core separately from subsequent re-interpretations based on metallurgical results or results of neighboring drill holes.
4. Undertake a study where samples are consistently taken at shorter intervals, broken by geology, to examine how the variance of the assays is affected and how the material-type designation, based on a calculation of those variables, compares against the material-type designation of longer samples. Sample intrusive material (dilution) too small to be segregated when modeling or mining as part of iron formation unit samples.
5. Continue work to define fault orientations and related alteration in the east of the Main Pit to confirm the syn-bedding and cross-cutting directions of the modeled, high-silica alteration units and investigate alternative tools to capture drill hole information, including a magnetometer and hyperspectral and x-ray fluorescence handheld devices to allow empirical measurements of magnetism (where relevant), alteration, such as clay, and iron speciation.
6. Develop and implement a robust QA/QC program at Tilden for both exploration drill hole and blast hole samples and incorporate analytical attribute data, such as grind time, starch type, and dates into the assay database, to be able to analyze results in context of changing test protocols for performance and bias.
7. Address capacity issues at the Tilden laboratory to allow the sample analysis to be completed in a timely manner and to facilitate the inclusion of QA/QC samples.

23.2 Mining and Mineral Reserves

1. Assess groundwater conditions in the immediate vicinity of the final pit through a more focused groundwater model. The results of this assessment should be input into an update of the pit slope stability analysis on sections cut through the current final pit design.

23.3 Mineral Processing

1. Continue specialized metallurgical testing to support resource modeling and mine planning and blending for the concentrator.
2. Plant operational performance including concentrate and pellet production and pellet quality continues to be consistent year over year. It is important to maintain diligence in process-oriented metallurgical testing and in plant maintenance.

23.4 Infrastructure

1. Prioritize the completion of an OMS Manual for the TSF with the EOR in accordance with MAC guidelines and other industry-recognized standard guidance for tailings facilities.
2. Document, prioritize, track, and close out in a timely manner the remediation, or resolution, of items of concern noted in TSF audits or inspection reports.
3. Assess the impacts of depositing tailings in the Empire facility, and prepare the necessary design and permitting documents.

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25.0 RELIANCE ON INFORMATION PROVIDED BY THE REGISTRANT

This report has been prepared by SLR for Cliffs. The information, conclusions, opinions, and estimates contained herein are based on:

- Information available to SLR at the time of preparation of this report,
- Assumptions, conditions, and qualifications as set forth in this report, and
- Data, reports, and other information supplied by Cliffs and other third party sources.

For the purpose of this report, SLR has relied on ownership information provided by Cliffs and verified in an email from Gabriel D. Johnson, Cliffs' Senior Manager – Land Administration dated January 20, 2022. SLR has not researched property title or mineral rights for Tilden as we consider it reasonable to rely on Cliffs' Land Administration personnel who are responsible for maintaining this information.

SLR has relied on Cliffs for guidance on applicable taxes, royalties, and other government levies or interests, applicable to revenue or income from the Tilden Mine in the Executive Summary and Section 19. As the Tilden Mine has been in operation for almost 50 years, Cliffs has considerable experience in this area.

SLR has relied on information provided by Cliffs pertaining to environmental studies, management plans, permits, compliance documentation, and monitoring reports that were verified in an email from Scott A. Gischia, Cliffs' Director – Environmental Compliance, Mining and Pelletizing, dated January 21, 2022.

The Qualified Persons have taken all appropriate steps, in their professional opinion, to ensure that the above information from Cliffs is sound.

Except for the purposes legislated under applicable securities laws, any use of this report by any third party is at that party's sole risk.

26.0 DATE AND SIGNATURE PAGE

This report titled "Technical Report Summary on the Tilden Property, Michigan, USA" with an effective date of December 31, 2021 was prepared and signed by:

Signed *SLR International Corporation*

Dated at Lakewood, CO
February 7, 2022

SLR International Corporation

27.0 APPENDIX 1

27.1 Geometallurgical Domains

For operational purposes, the Tilden Mine is divided into geometallurgical domains, as shown in Figure 6-6. The domains are based on the metallurgical response from bench-scale flotation tests and processing in the Plant. Wtrec, SiO_2 content, and crude magnetic Fe content determine the domain designation. These properties are controlled by lithology (martite, carbonate, clastic, intrusive) and ore type (flot, magnetite).

The primary economic parameters are wtrec and grade of Fe (crude) and concentrate SiO_2. Wtrec is the percentage by weight of each ton of material that reports to the concentrate following flotation. The grade of Fe and SiO_2 in the concentrate determine if the material will meet specifications for economic processing. Other factors that can affect the Plant operation and pellet quality are mineralogy as related to total oxides and loss on ignition; trace element chemistry, in particular phosphorous (P), but also manganese (Mn), magnesium oxide (MgO), calcium oxide (CaO), and alkalis; crude soluble, magnetic, and slime Fe. It should be noted that these data are essentially all based on involved bench test results that may not directly reflect the Plant response. The bench test is described in Section 10.2.2.

Brief descriptions of the individual geometallurgical domains are as following.

27.1.1 500 Northwest Domain

Stratigraphically above CDIII/West pit hanging-wall metadiabase (250) and below North Intrusive (270); it includes numerous dikes and one mappable igneous body, the West Intrusive (260);

- 550 Restricted to the Far West Extension, West Hematite domain is dominantly hematite-chert with mixed goethite, with weight recoveries around 40% and variable but elevated P. Its contact with the 530 domain is defined by a thin intrusive and metallurgical change;
- 530 Hematite-Goethite domain includes flotation ore (531) and Waste Iron Formation (WIF, 532);
    - o 531 Dominantly goethite-chert with wtrec from low-30s to mid-40s and variable, but generally high, concentrate SiO_2 and P content;
    - o 532 Oxidized martite/goethite; characterized by low wtrec, high SiO_2 and P; low head Fe indicates original Fe formation may have been carbonate facies (?). Sulfate minerals are locally common in bench faces;
- 520 Magnetite domain is dominantly magnetite-carbonate with silicate horizons. It is locally flotation and/or mag ore depending on liberation characteristics; and
- 510 Clastic interval at contact with top of the CDIII/West pit hanging-wall (250) in local (?) syncline. The 510 Clastic domain is locally flotation ore.

27.1.2 400 CDIII-West Pit Domain

Stratigraphically between the CDIII/West pit hanging-wall metadiabase (250) and CDIII footwall (230). Includes numerous small dikes and sills, the Keweenawan dike, and the West Pit Marker interval (240);

- 480 Footwall clastic zone along Main pit footwall (100). Consists of dominant martite clastics with coarse quartzite/conglomerate and interbedded martite-hematite chert;
- 470 Hanging-wall zone along base of CDIII/West pit hanging-wall metadiabase (250). It is defined as waste iron formation (WIF) due to very fine grain size and/or oxidization;
- 460 Dike domain is defined as a northeast-trending zone of chloritic dikes and associated oxidized and unoxidized Fe formation. The dikes result in a high dilution factor;
- 450 South Hematite domain in south part of CDIII and the West pit contains flotation ore of variable metallurgy and WIF. Dominantly thin-bedded, fine-grained, hematite-martite-chert, although some zones may be oxidized carbonate;
    - 451 Goethite zones within hematite domain associated with folding and faulting;
    - 452 Goethite zone along CDIII footwall, south of Keweenawan dike. Typically, high slime Fe, the goethite zone may be oxidized Carbonate (430) domain near the intersection of dike and footwall;
- 440 North hematite domain consists of fine-grained, oxidized, martite-hematite chert with numerous dikes. The boundary between this domain and the Magnetite domain (420) trends northeast and dips steeply to the south. This domain is locally flotation ore;
- 430 Carbonate domain is carbonate flotation ore with low magnetite content, high wtrec, and low concentrate grade. It is fault-bounded on north and south but apparently gradational down-dip to west to Magnetite domain (420);
- 420 Magnetite domain consists of magnetite-carbonate and magnetite-silicate-chert with variable oxidation and grain size. Boundaries are relatively sharp with other domains. The domain is generally defined by magnetite content, not ore type, so it contains potential flotation ore;
    - 421 West pit magnetite domain is an isolated (?) zone of high-grade magnetite in the west pit. It is defined by exploration drilling and blast pattern data;
    - 422 South CDIII carbonate is magnetite-carbonate flotation ore, apparently separate from the 420 and 421 domains; and
- 410 Footwall zone is defined as the magnetite-silicate body proximal to the contact with the CDIII Footwall metadiabase (230). It is typically waste or low-grade ore due to low magnetite content or poor liberation.

27.1.3 300 Main Pit Domain

Contains Fe formation units stratigraphically below the CDIII footwall metadiabase (230) and/or the East pit hanging-wall metadiabase (200). Includes numerous small, mafic intrusives;

- 370 Hanging-wall contact includes zones of erratic metallurgy along the base of the CDIII footwall (230) or East pit hanging-wall (200);
- 360 Transition zone between CDIII footwall (230) and the East pit hanging-wall (200). Consists of variably oxidized hematite Fe formation and mafic intrusives. Restricted to north side of the East pit;

- 350 Hematite-martite domain in East pit consists of various types of martite-chert. Includes intervals of magnetite-carbonate Fe formation and thin dikes. Gradational transition over 20 ft to 50 ft;
- 340 Carbonate Fe formation stratigraphically below the hematite-martite domain (350) in the East pit. Consists of martite-carbonate-chert with variable magnetite/martite content. Defined by magnetic Fe, wtrec, and total oxides. Has lower wtrec and higher concentrate grade than CDIII carbonates (430). May be magnetite ore in part;
- 330 Clay zone is defined as the intervals of Fe formation outlined as waste due to high SiO_2 from montmorillonite (or other) interference. Does not differentiate non-liberating hematite material. May be stratigraphically controlled. Includes some flotation ore within boundaries;
- 320 East pit clastics are mixed siliceous and silicate clastics and hematite Fe formation. Includes oxide and carbonate intervals. A thin dike defines the north boundary, presumably marking a fault, with the martite or carbonate domains;
    - 321 High SiO_2 zones (6% to greater than (>) 10%) in the clastic domain reflects clay and/or Fe-silicates and/or non-liberating Fe formation;
- 310 Footwall Fe formation domain consists of variably oxidized oxide Fe formation and coarse clastics. Typified by erratic metallurgy; and
- 311 Earthy fines are high grade (>50 weight (wt) rec and >50 head Fe), oxidized zones controlled by structures within the footwall domain.

27.1.4 200 Intrusive Domains

These domains are used for correlation of the Fe formation domains and structural trends and appear to be conformable at the scale of the ore body. Generally interpreted as intrusives, they consist of mafic rocks, which vary from diabasic to porphyritic to aphanitic. All units appear to thin to the west and south. Contacts tend to be sheared and locally oxidized. Contact metamorphism of the Fe formation is minimal and, if present, results in finer-grained Fe formation. Synclinal structures and intersections with dikes have focused oxidation of the Fe formation;

- 270 North intrusive is a poorly defined intrusive body at the top of the Northwest zone (500);
- 260 West intrusive is a poorly defined but mappable intrusive body within the Northwest zone (500);
- 250 The CDIII/West pit hanging-wall is a relatively easily mappable diabase marker unit, and along with the CDIII footwall (230) is one of the principle stratigraphic correlations between the CDIII pit and the Main pit;
- 240 The West pit marker is a thin but continuous intrusive unit within the CDIII/West pit stratigraphy (300). It is interpreted to extend from the Foster Lake slot through the West pit;
- 230 The top of the CDIII footwall defines the base of the CDIII/West pit domain (400), while the base defines the top of the Main pit east domain (300);
- 220 Chloritic and diabase dikes and thin sills occur in all domains. The domain includes an east-west trending, 30+ ft-thick Keweenawan dike in CDIII; and

- 200 The East pit hanging-wall is separated from the CDIII footwall (230) by the Transition zone (360) Fe formation. Along the north side of the East pit, the base of this intrusive body marks the top of the Main pit East domain (300) for mining and planning purposes.

27.1.5 100 Main Pit Footwall Domain

- This domain consists of Archean (?) metamorphic rocks that are separated from the Fe formation domains by an east-west trending, north-dipping, high-angle fault;
- 121 Chloritic schist is the dominant footwall rock type exposed within the pit and in drill holes. This rock may be the extension of the CDIII footwall horizon (230) within the fault zone; and
- 111 Granite gneiss occurs south of the chloritic schist (121) but is only poorly exposed in the pit. This domain has not been used in the drill hole codes.

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Michigan Public Service Commission
Upper Michigan Energy Resources Corporation
2025 Renewable Energy Plan
Renewable Energy Plan Summary

Line No.	(a)	(b)	(c) 2026	(d) 2027	(e) 2028	(f) 2029	(g) 2030	(h) 2031	(i) 2032	(j) 2033	(k) 2034	(l) 2035	(m) 2036	(n) 2037	(o) 2038	(p) 2039	(q) 2040	(r) 2041	(s) 2042	(t) 2043	(u) 2044	(v) 2045
1	**Sales and Requirement Calculation**																					
2	Current Year Retail Sales to Non-Tilden Retail Customers		607,403	610,318	613,248	616,192	619,149	622,121	625,107	628,108	631,123	634,152	637,196	640,255	643,328	646,416	649,519	652,636	655,769	658,917	662,080	665,258
3	**Energy Credits**																					
4	Energy Credits Obtained Through Generation - Renegade		0	200,844	200,535	198,830	197,824	196,817	196,494	194,804	193,797	192,791	192,450	190,777	189,771	188,764	188,413	171,638	171,647	171,352	177,215	172,372
5	Energy Credits Potentially Obtained Through Generation - Future Project		0	0	0	0	421,325	425,304	428,613	433,304	437,326	441,362	444,746	449,477	453,557	457,652	461,106	480,999	484,122	487,565	484,864	492,885

Exhibit AGCUB-8

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Exhibit AGCUB-9

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The undersigned certifies that a copy of the ***Public Testimony and Exhibits of Douglas Jester on behalf of the Attorney General and CUB*** was served upon the parties listed below by e-mailing the same to them at their respective e-mail addresses on the 26th day of June 2025.

Lucas Wollenzien Digitally signed by Lucas Wollenzien Date: 2025.06.26 11:26:03 -04'00'

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