YUKON ENERGY MINES & RESOURCES

Yukon Quartz Mining Sector GHG Target Baseline Study

PRESENTATION TO STAKEHOLDERS

MAY 1, 2024

PRESENTED BY:

STUART VAN BIBBER, Partner
BERT CHEN, Principal Consultant
NIKOLETT KOVACS, Managing Consultant

Sustainability is our business

Contents

Glossary of Terms

CH_4 – Methane or natural gas, a significant greenhouse gas, created from decomposition of organic matter.

CO_2 – Carbon dioxide, the largest greenhouse gas by mass, created as a byproduct of combustion processes.

CO_2e – Carbon dioxide equivalent, utilized when all greenhouse gases are calculated on a combined basis on global warming potential of each gas, converted to carbon dioxide equivalents.

GJ – Gigajoule, a measurement of energy, equivalent to 278 kilowatt-hours.

GHG – Greenhouse gas, the grouping of airborne emissions most responsible for atmospheric warming. For the purposes of this study, only carbon dioxide, methane and nitrous oxide are considered.

kWh/MWh – Kilowatt-hour/Megawatt-hour, the average amount of electric power consumed within an hourly period. i.e. a 10-watt lightbulb turned on for one hour would consume 0.01 kWh, or 0.00001 MWh.

Metric ton/mt – 1,000 kilograms (kg) = 1,000,000 grams (g) – all measurements in this study referencing tons are in metric tons.

N_2O – Nitrous oxide, a significant greenhouse gas, created as a byproduct of combustion processes.

Scope 1 Emissions – Direct source emissions, e.g. fuel usage from directly operated vehicles and machinery.

Scope 2 Emissions – Indirect source emissions, e.g. emissions from generation of electricity by electric utility purchased and consumed by company's structures and machinery on-site.

Scope 3 Emissions – Indirect emissions from value chain, e.g. emissions from transportation of employees to arrive on-site, and emissions of delivery vehicles from site to end customer.

SEDAR – System for Electronic Data Analysis and Retrieval, the Canadian publicly-traded company disclosure and reporting database, of which each stakeholder would have provided reports to in the past due to their publicly-traded status that is commonplace in the mining industry.

Yukon Government EMR – The relevant departments and staff within the territorial government that have been engaged on this scope of work – in this case largely confined to the Energy, Mines and Resources Energy Branch.

Background and Scope

FOR QUARTZ AND PLACER MINING SECTOR EMISSIONS BASELINES

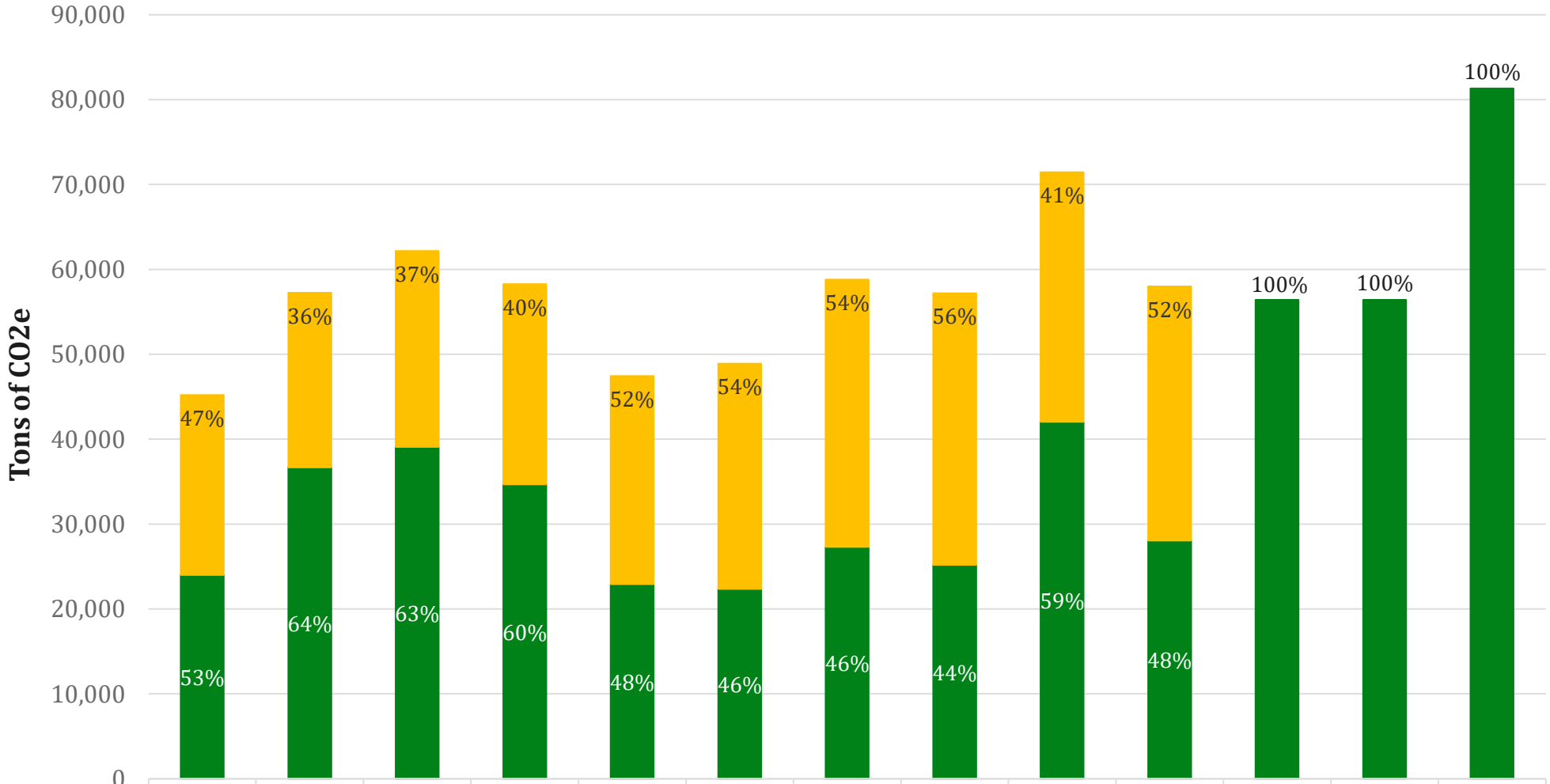
Introduction

As specified within the Request for Proposal (RFP-2023-3-2431 - Yukon Mining Greenhouse Gas Emissions Intensity Target Baseline Study 2023), the Government of Yukon (YG) has contracted Environmental Resource Management Canada (ERM) to work with mining industry representatives and YG to determine baselines against which to measure greenhouse gas emissions intensity from quartz and placer mining going forward.

The scope of work included:

1. Cataloguing and quantifying annual energy use since 2010, or since the opening of applicable mines;
2. Cataloguing and quantifying energy saving initiatives and infrastructure investments made since 2010, or since the opening of applicable mines to reduce emissions;
3. Determining how emissions intensity should be calculated and reported and what data will be needed for reporting;
4. Proposing 2023 baselines considering differences in mining operation types, outputs, and lifecycle;
5. Calculating progress to reduce emissions that a company may have undertaken since 2010, i.e., what per cent reductions in emissions has occurred as a result of these works when applied to 2023; and
6. Suggesting a method to compare emissions intensity between mines, including placer mines and potential future quartz mines.

Total Scope 1 Emissions for Quartz and Placer



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Placer	21,199	20,587	23,067	23,570	24,524	26,550	31,497	32,018	29,388	29,932	Not available for 2020 – 2022		
Quartz	24,012	36,660	39,098	34,680	22,925	22,349	27,293	25,181	42,041	28,058	56,402	56,423	81,313

Yearly totals of GHG emissions for both Quartz and Placer emissions were stacked into bar chart for comparison.

Methodology and Analysis

FOR QUARTZ SECTOR

Project Approach

1. Developing the Research Framework

- Developing a methodology for an intensity-based baseline for the mining sector in Yukon
- Confirming key methodological assumptions (e.g. types of GHG emissions, energy sources, relevant operating mines) with the Yukon Government
- Confirming what data is available (e.g. Reported fuel use data/production data)
- Developing an information request form for applicable mines (see Appendix A)

2. Information Collection and Engagement

- Sending the information collection form to participating operating mines
- Conducting interviews with operating mines and other interested stakeholders to support information collection and validate the baseline development methodology

3. Analysis and Reporting

- Analyzing the publicly available data and data from participating operating mines
- Emissions cataloguing
- Developing an excel based model to illustrate the proposed baseline
- Reporting

Additional information on these steps is provided in the following slides

Developing the Research Framework (1/3)

The proposed methodology for calculating the baseline included:

1. Taking a total inventory of all direct fuel, electricity and indirect fuel consumed:

    - Direct Scope 1 emissions for each operating mine by different types of fuel – gasoline, diesel and propane have different intensities for CO_2, CH_4 and N_2O per litre. These three fuels are commonly consumed by vehicles, mining machinery, generators and on-site heating. Therefore, a uniform amount of GHGs would need to be calculated from the total volume of fuel consumed.

    - Indirect Scope 2 and Scope 3 emissions for each applicable operating mine, including all upstream emissions from production and transport of goods/employees required by the stakeholder to conduct business, as well as emissions from downstream, with the distribution of the final metal mined to end consumers.

        - Scope 2 and 3 emissions were only able to be partially inventoried, and are excluded from the final baseline.

2. Using standardized CO_2 emissions factors and each volume of fuel consumed, based on NRCan Emissions Factors.

    - Conversion of CH_4 and N_2O to CO_2e with NRCan Global Warming Potentials.

3. Estimating consumption sources from major equipment and facilities on site to inform potential sources of efficiencies going forward.

Developing the Research Framework (2/3)

Proposed methodology (continued):

4. Dividing the total emissions from fuel consumed during ore production and establishing a baseline intensity in metric tons of applicable GHG per metric ton of ore (see next slide for additional information).

- Due to the differing end-metals from the quartz mining process of each stakeholder (e.g. Victoria Gold and Minto producing gold, and Keno Hill producing silver) and the different yields inherent within the native rock at each site, it was determined that unprocessed ore that has been excavated, would be the most uniform output from each mine.
- Unprocessed ore measured by weight is accessible from SEDAR annual report filings.
- Developing an inventory of existing energy efficiency programs or non-emitting energy sources being developed, or planned for future development, by each applicable operating mine; in an effort to account for each stakeholder's efforts to reduce emission intensity at each mine site.

Excluded from the proposed methodology:

- Scope 1 emissions that were too difficult to measure due to lack of inventory accounting, or negligible GHG emissions, were excluded from total emissions. This includes fuels and hydrocarbons beyond gasoline, diesel and propane that were untracked, as well as explosives.
- Scope 2 emissions from electrical power consumption from the Yukon Integrated System.
- The Scope 3 emissions that were able to be determined result from transport of material and personnel to-and-from the mine site within the boundaries of Yukon Territory. Further emissions from beyond territorial boundaries were excluded for this methodology.

Developing the Research Framework (3/3)

Basic Formula per mine

Based on previous experience, ERM proposed that an intensity-based baseline would require total emissions from Scope 1 emissions to be divided by volumetric total output of unprocessed ore mined, effectively the metric tons of earth/rock excavated by each mine.

$$\frac{TE = Total\ Scope\ 1}{Ore = Unprocessed\ Ore\ Mined}$$

Components of the Formula

The numerator and denominator are broken down as follows, with further clarification on the applicability within each year of operation, with the average for all mines to form the baseline.

$$\frac{TE = Net\ Diesel, Gasoline, Propane}{Ore = Gross\ Unprocessed\ Ore\ Mined = (Waste\ Rock + Ore\ sent\ for\ processing)}$$

Formula for Industry Wide Annual Average

$$\frac{Mine\ 1\ TE^{2010} + Mine\ 2\ TE^{2010} + \ldots}{Mine\ 1\ Ore^{2010} + Mine\ 2\ Ore^{2010} + \ldots}, \quad \frac{Mine\ 1\ TE^{2011} + Mine\ 2\ TE^{2011} + \ldots}{Mine\ 1\ Ore^{2011} + Mine\ 2\ Ore^{2011} + \ldots}, \ldots$$

With the average in each year for the combined operating mines, the intensity-based baseline can then be determined by the change from year-to-year from the period 2010 to 2022.

Information Collection and Engagement

FOR QUARTZ SECTOR

Information Collection and Engagement (1/4)

A summary of key questions and comments raised during the engagement process is provided below, where ERM provided responses those are noted.

Companies with active mines were sent an information collection document (see Appendix A) where key staff were interviewed to support information collection and understand questions and concerns regarding the proposed baseline methodology.

Additional stakeholder groups were included in the consultation process, where their feedback was sought on our proposed baseline development methodology.

Questions and comments on data collection:

- Publicly available reporting (e.g. SEDAR annual reports) should be leveraged to minimize the reporting burden on companies.
- Do non-operational mines need to provide data at this time?
  - Response: No, we are engaging with non-operating mines to inform companies what future data may be required and support them in preparing for data collection in the future.
  - Data for non-operating mines will be sourced from previous filings to the Yukon Government.

Questions and comments related to Scope 2 emissions characterization:

- Separating Scope 1 energy consumption and Scope 2 emissions will be important to differentiate as there is a large opportunity to decrease Scope 2 GHGs and that needs to be understood separately.
  - Response: The proposed methodology will be useful as Scope 2 emissions are separated out which will help inform the next steps of this work with forward looking GHG projections through reduced emissions from avoided fuel use to electrical power.

Information Collection and Engagement (2/4)

A summary of key questions and comments raised during the engagement process is provided below, where ERM provided responses those are noted.

Questions and comments related to operational variability and the use of unprocessed ore in the baseline calculation:

- Context is important when comparing different mines. For example, newer modern mines have less opportunity for GHG reductions compared to older less efficient mines and it is challenging to make comparisons between mines.
- There are differences between mines processes and production, are these being accounted for?
  - Response: Yes, we are using unprocessed ore to enable a fair and equitable comparison across different mining operations and factoring in the different processes.
- How did you come up with the use of unprocessed ore as the baseline denominator and is this an accepted methodology used in other jurisdictions?
  - Response: Unprocessed ore is being proposed to ensure mines that produce different products (e.g. gold, silver etc.) can be compared. Use of unprocessed ore, in calculating intensity baseline targets, can be more accurate when participating mines provide a list of their different equipment. The purposes of listing types of equipment is to further differentiate the differences between each mining company (e.g. not all mining companies use exactly the same type of and number of equipment).
- If the intensity is based on unprocessed ore, how do you fairly evaluate recognizing you can have variability at the start and end of mining projects?
  - Response: We are only requesting fuel consumption production numbers from the first year of full production. If a mine is using a development or exploration status to forgo revenue and process at a later date it is a business decision that we will not include in our study.

Information Collection and Engagement (3/4)

A summary of key questions and comments raised during the engagement process is provided below, where ERM provided responses those are noted.

Questions and comments regarding target setting:

- How will you determine targets between future mines and currently active mines given the dependence on access to hydroelectricity?
  - Response: We are not developing targets during this phase of work but will note that our methodology separates Scope 1 and Scope 2 emissions, where Scope 2 emissions depends on the location of the mine site. Discrepancies between mines with various activities and locations will be taken into account.
- It is important that the right targets are set and that they are reasonable and meet reality including for remote sites.
- Will the baseline be used to calculate the GHG reduction target for industry?
  - Response: Target setting is not part of this phase of work by ERM but we envision the Yukon Government using this baseline along with knowledge of the varying operations' equipment and processes to set a target.

Information Collection and Engagement (4/4)

A summary of key questions and comments raised during the engagement process is provided below, where ERM provided responses those are noted.

Other comments and questions:

- Future mines need to be incentivized to come up with the best technologies which will require a partnership with YG including infrastructure investment.
- Recognizing the focus of this work is on the quartz sector, concern was expressed regarding GHG baseline development for the placer sector, including lack of engagement and site visits to understand unique operational differences.
  - Response: ERM is engaged with the KPMA on this scope of work and any methodologies proposed for the placer sector.
- Recognizing this is a global issue governments should consider expanding the boundaries of what emission reduction projects are included outside the Yukon (e.g. strategic supply chain opportunities related to procuring equipment with low carbon footprints)
  - Response: Scope 3 supply chain emissions are important especially from a corporate Environmental, Social and Governance (ESG) perspective, but for this contract, the focus is stopping at the Yukon / British Columbia / Alaska / Northwest Territories border as the target appears to need to be territorially limited to align with Yukon's *Our Clean Future Strategy*.
- Within the placer industry members have a strong reuse/recycling approach with equipment, how will that be factored in?
  - Response: Question has been noted and tabled for future reference; however, Placer is not a focus of this study. For the quartz mines this should be factored in regarding the consumption of diesel and other fuels. If a mine is using older equipment the equipment can be looked at to see what drives the discrepancy and an average may be considered.
- Government investment in the electrical grid will be required to enable emissions reduction activities.

Analysis and Reporting

SUMMARY OF FINDINGS

Analysis

ERM collected all information into a model to calculate total emissions (*TE*) and divided by unprocessed ore mined (*Ore*) and generated a dynamic chart that can display the intensity-based baseline for each mine and each type of GHG, and combined figures per year. The following analytical steps were completed:

1. Inventorying all Scope 1 fuel volumes and resulting GHG emissions of carbon dioxide, methane, and nitrous oxide.
2. Performing a calculation using a standardized GHG emissions factor for each volume of fuel consumed based on NRCan Emissions Factors and Global Warming Potentials.
3. Multiplying the total inventory of all net energy and electrical consumption (including onsite generation) by the local grid emissions factor provided by the Yukon Government.
4. Compiling a total inventory of unprocessed ore produced in each year of full operation.
5. Dividing the total GHG emissions by the annual unprocessed ore production, to calculate the baseline intensity for the applicable year of mine operation.

Data Sources

To complete the emissions cataloguing process, our methodology utilized a variety of both non-publicly available and publicly available information.

Non-Publicly available information

- Annual fuel consumption volumes
  – from Yukon Government Minerals Emissions Data
- Contains annual diesel, gasoline and propane consumption volumes for each of the included stakeholders
- Annual electricity consumption volumes*
  – from completed questionnaires
- Annual Yukon location-based electricity emissions factors*
  – from Yukon Government Community-Specific Emissions Factors
- Annual Scope 3 emissions (for transport only within Yukon Territory)*
  – from completed questionnaires
- Mine operating status by year
  – from Yukon and completed questionnaires

Publicly available information

- Historical and current fuel emissions factors
  – from Natural Resources Canada – annual emissions reports
- Fuel consumption average volumes for type of equipment/vehicle*
  – from Canada trucking industry average, aircraft manufacturer specifications
- Annual unprocessed ore mined
  – from SEDAR annual reports

*Not included in intensity-based baseline calculation.

Example of Data Sources for a sample year

Required Data	Data	Data Source
Scope 1: Diesel [L]		Yukon
Scope 1: Diesel [mtCO_2/L]		NRCan
Scope 1: Diesel [mtCO_2]		Calculation
Scope 1: Gasoline [L]		Yukon
Scope 1: Gasoline [mtCO_2/L]		NRCan
Scope 1: Gasoline [tCO_2]		Calculation
Scope 1: Propane [L]		Yukon
Scope 1: Propane [mtCO_2/L]		NRCan
Scope 1: Propane [mtCO_2]		Calculation
Gross Scope 1 Emissions [mtCO_2]		**Calculation**
Scope 3: Diesel [Total km/yr]		Questionnaire
Scope 3: Diesel Tractor Trailer [Avg L/100km]		Industry Avg
Scope 3: Diesel [mtCO_2/L]		NRCan
Scope 3: Diesel [mtCO_2]		Calculation
Scope 3: Gasoline [Total km/yr]		Questionnaire
Scope 3: Gasoline Light Truck [Avg L/100km] [Total km/yr]		Questionnaire
Scope 3: Gasoline [mtCO_2/L]		NRCan
Scope 3: Gasoline [mtCO_2]		Calculation
Scope 3: Aviation Fuel [Total 200 nm trips/yr]		Questionnaire
Scope 3: Aviation Fuel ATR-42 300 [Avg tCO_2/200nm]		Manufacturer
Scope 3: Aviation Fuel [mtCO_2/L]		NRCan
Scope 3: Aviation Fuel [mtCO_2]		Calculation
Gross Scope 3 Emissions [mtCO_2]		**Calculation**
Gross Total Emissions [mtCO_2]		**Calculation**
Gross Metric Tons Mined		**SEDAR**

Summary of Findings: Baselines

Based on the analysis, a baseline with three segments is evident due to the non-overlapping operational state of the three mines from the period 2010 to 2022. The intensity-based baseline is discussed primarily through the lens of carbon dioxide, the largest GHG by volume.

The vast majority of emissions are coming from diesel fuel use

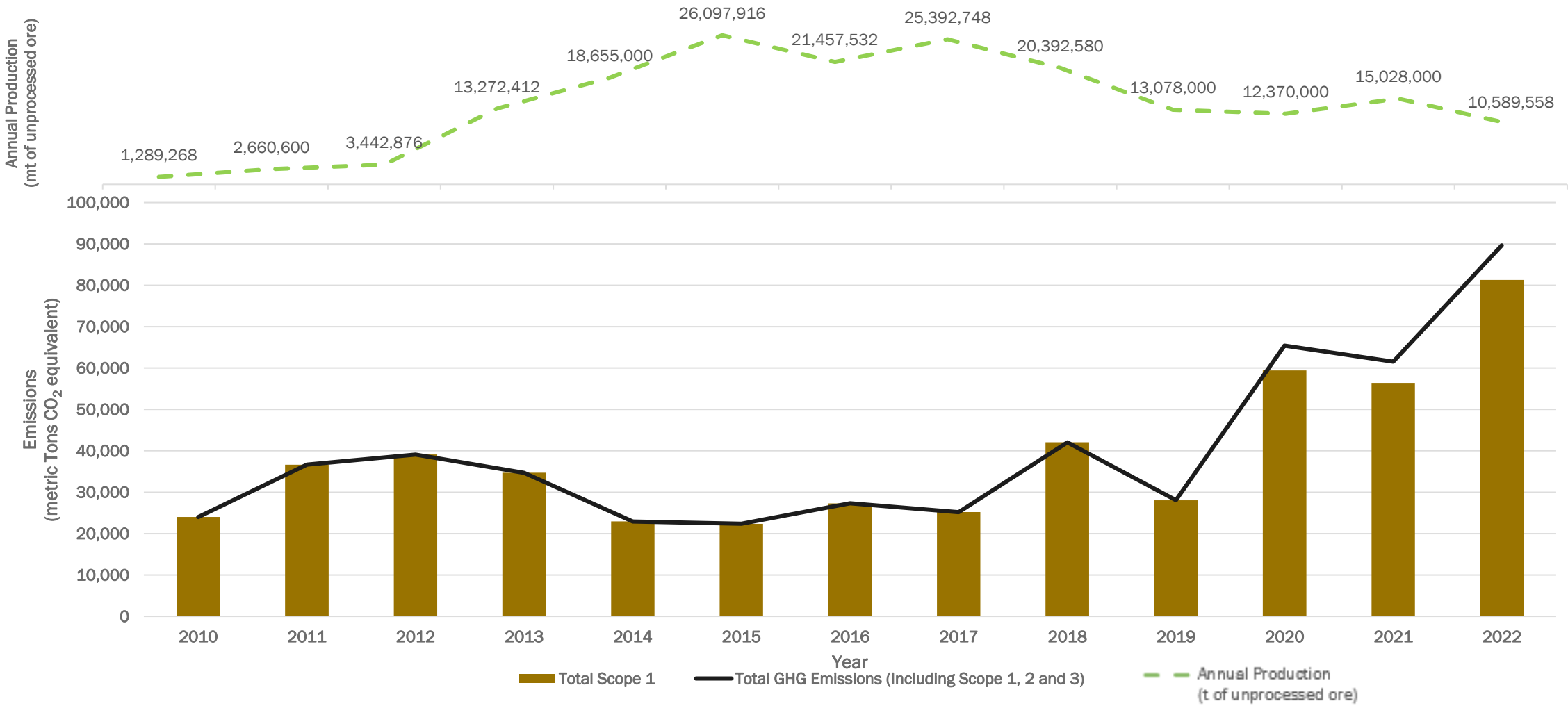
- From a volumetric perspective, total emissions from the three quartz mines during years of full operation, fluctuated between 24,000 $mtCO_2e$ in 2010 to 42,000 $mtCO_2e$ in 2018.
- The commencement of full operation of an additional mine saw emissions increase from 59,000 $mtCO_2e$ in 2020 to 81,000 $mtCO_2e$ in 2022, equal to a 37% increase.
- Associated emissions from fuel use for methane (CH_4) saw corresponding percentage changes due to volumes of fuel consumed, with approximately 3 $mtCH_4$ emitted in 2022.
- Due to the lower emissions factors for nitrous oxide (N_2O) in diesel fuel in the period post-2018, due to Government of Canada clean fuel standards, the total tons of N_2O emitted from the mines reduced from 5.5 mtN_2O in 2012 to less than 1.0 mtN_2O in 2022. (Appendix B – Slide 29)

A steady reduction since 2010 due to closure of legacy mines and underground operations with higher emissions

- Emissions from 2010 to 2013 averaged above 50 $kgCO_2e$ /mt of unprocessed ore, attributed to the underground operations of silver mining. This is more than 15x higher than the average from 2020 to 2022 between 4 and 8 $kgCO_2e$ /mt of unprocessed ore.
- Operations from legacy mines showed a consistent intensity between 15 and 20 $kgCO_2e$/mt of unprocessed ore from 2010 to 2018.

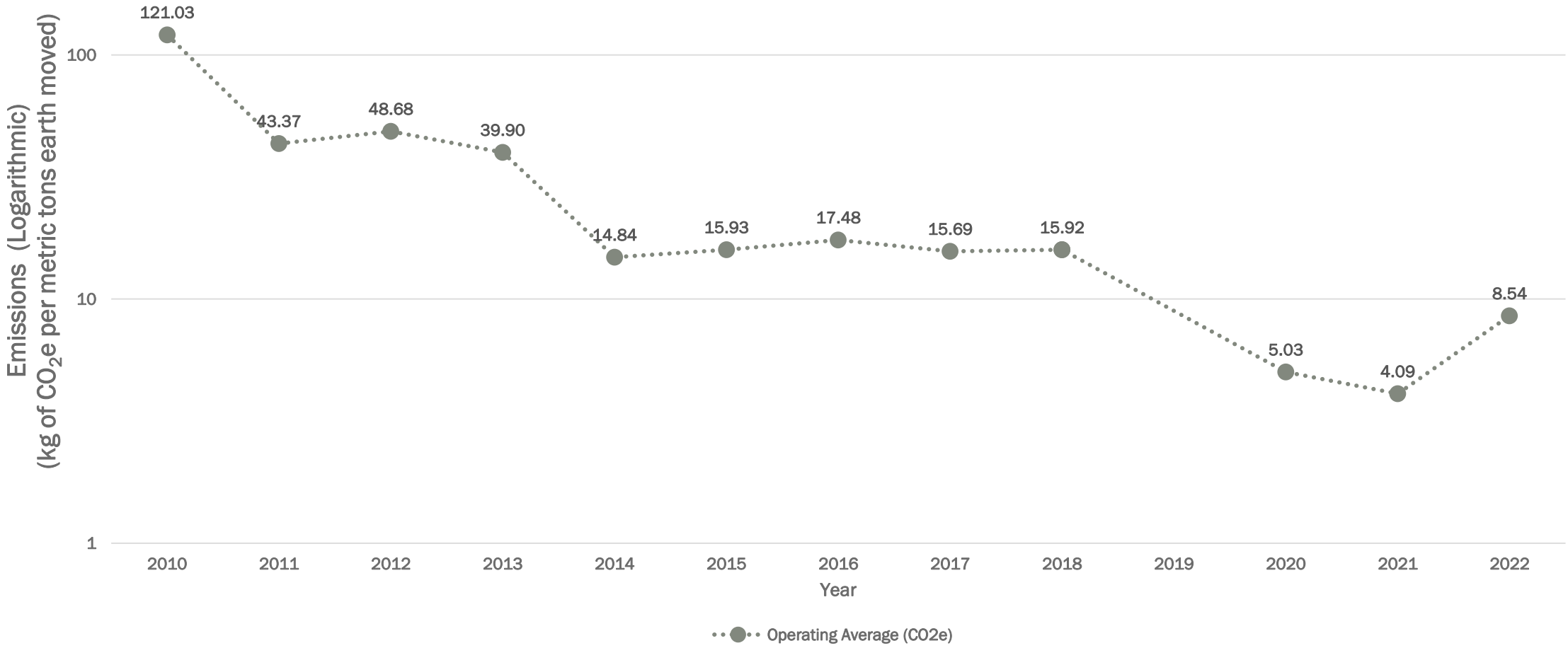
2010 to 2022 Gross CO_2e Emissions

The following graph shows the total carbon dioxide equivalent emissions from Scope 1 and Total GHGs for all three mines during years of full operation.



2010 to 2022 CO_2e Intensity for All Operating Mines

The following graph shows the total carbon dioxide emissions intensity for all three mines during years of full operation.



Summary of Findings

Differences between mines are largely attributable to the nature of their physical operations and ultimately the yield and volume of unprocessed ore at each site.

Open-pit versus Underground

- Emissions can be significantly higher due to the required additional energy for ventilation, construction/maintenance of tunnels and hauling of waste rock for an underground mining operations.
- Open-pit operations that require less energy for ventilation, dewatering and construction/maintenance of tunnels, can account for a lower intensity of fuel usage.

Type of Metal/Mineral mined

- Additional tons of ore and waste rock mined to match a similar financial value to that of other metals and minerals, will increase the emissions intensity

Age of mine

- Modern, energy-efficient machinery powered by electrical grid connection result in a lower intensity than mines with an older commencement date using legacy equipment and processes.

Fuel efficiency

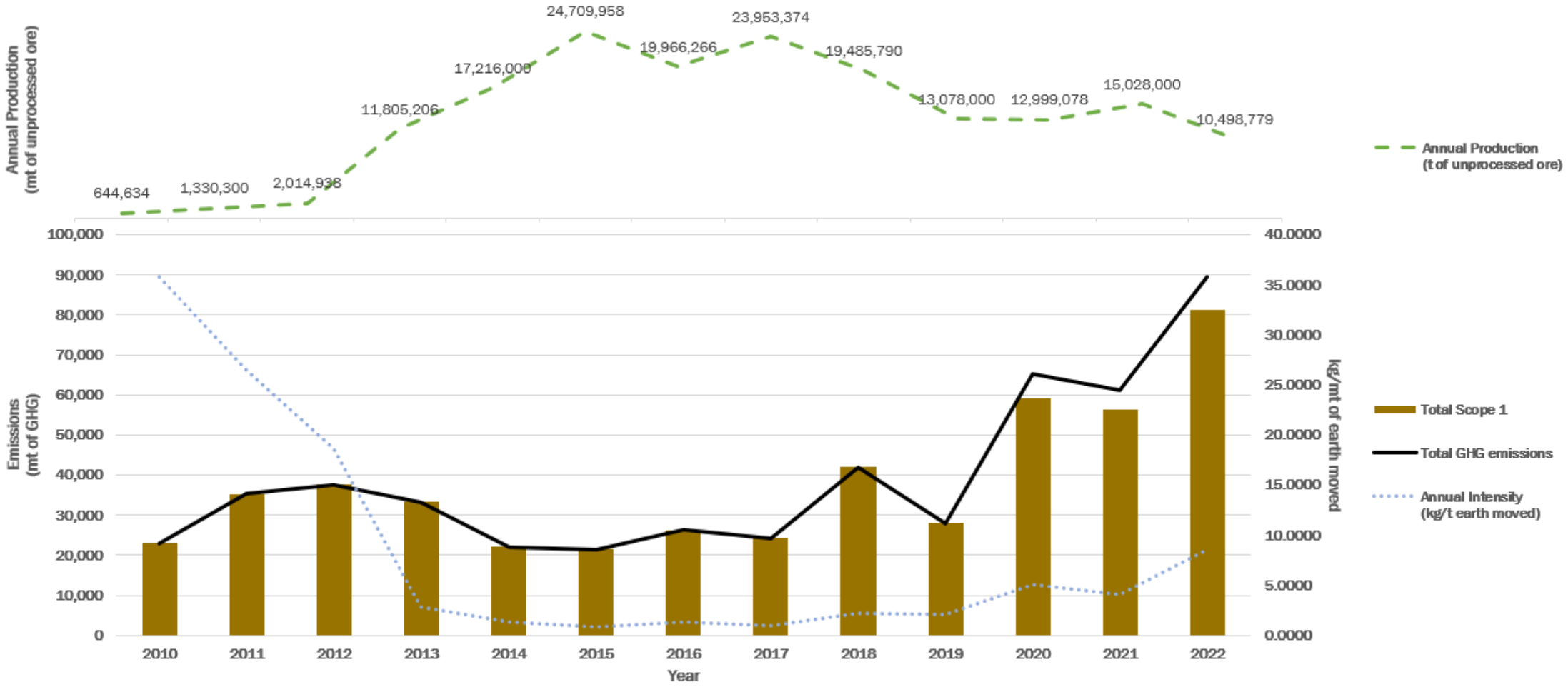
- Overtime, emissions per unit of fuel have decreased due to emissions factors published by NRCan and correspondingly, the actual emissions from the production of fuel and each unit's inherent emissions through combustion.

Appendix A

2010 – 2022 SPECIFIC GHG EMISSIONS INTENSITY GRAPHS

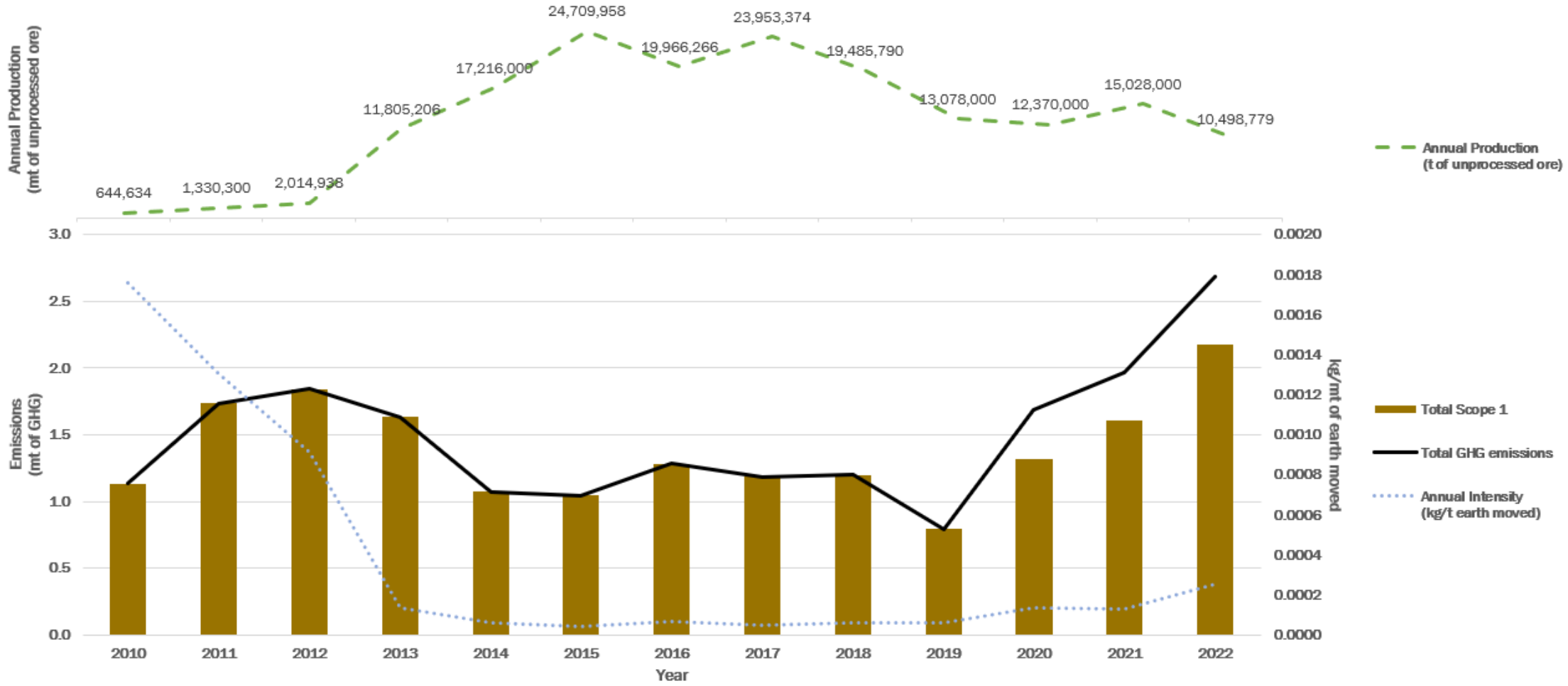
2010 to 2022 Gross CO_2 Emissions

The following graph shows the total carbon dioxide emissions from Scope 1 for all three mines during years of full operation.



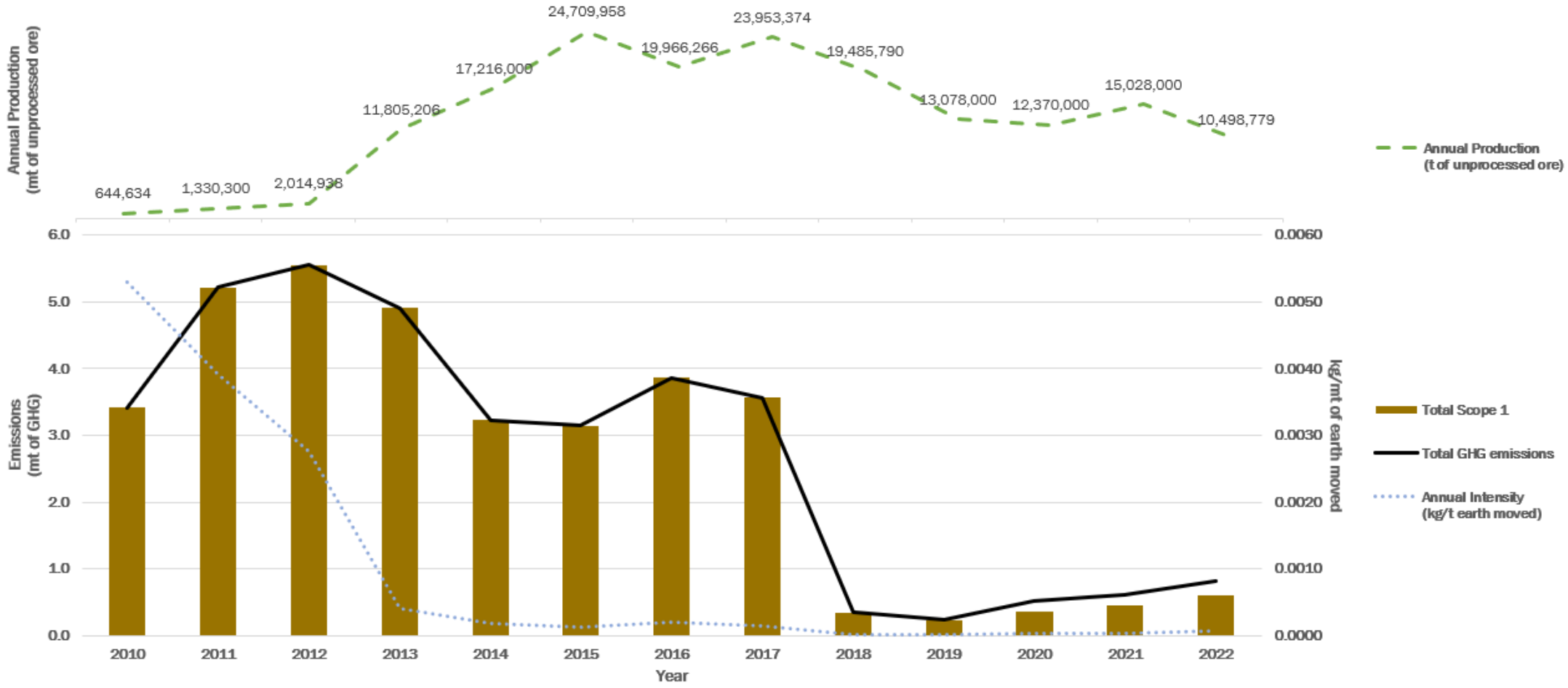
2010 to 2022 Gross CH_4 Emissions

The following total methane emissions from Scope 1 for all three mines during years of full operation is displayed below.



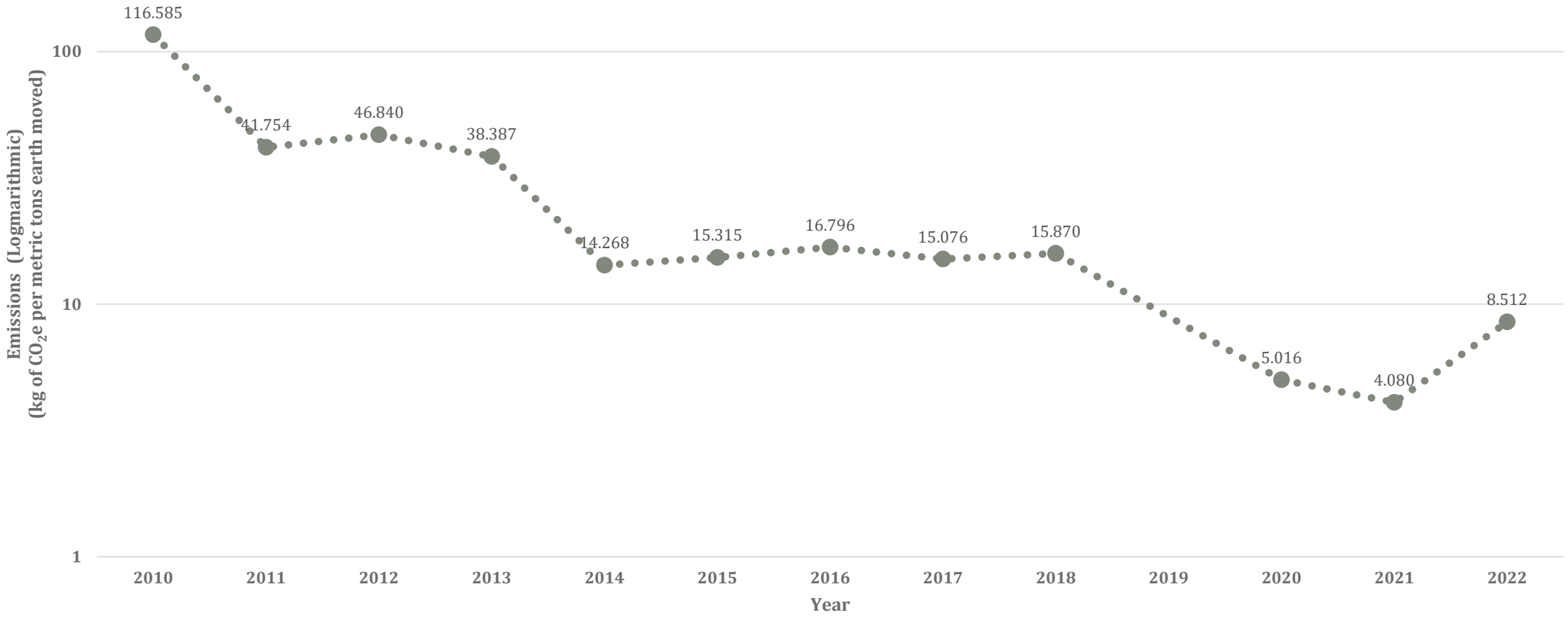
2010 to 2022 Gross N_2O Emissions

The following total nitrous oxide emissions from Scope 1 for all three mines during years of full operation is displayed below.



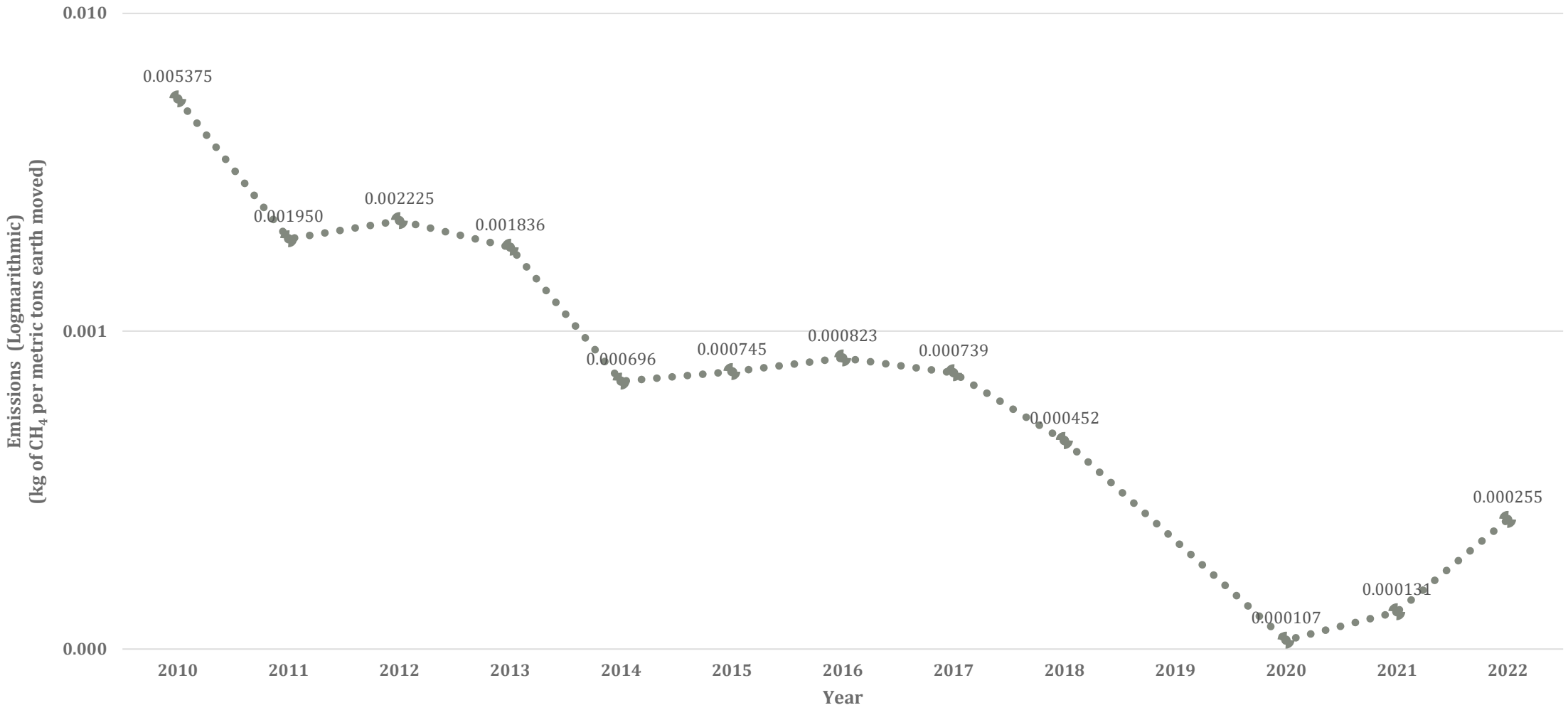
2010 to 2022 CO_2 Intensity for All Operating Mines

The following graph shows the total carbon dioxide emissions for all three mines during years of full operation.



2010 to 2022 CH_4 Intensity for All Operating Mines

The following graph shows the total methane emissions for all three mines during years of full operation.



2010 to 2022 N_2O Intensity for All Operating Mines

The following graph shows the total nitrous oxide emissions for all three mines during years of full operation.