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Estimated Climate Impacts of Proposed Twin Metals Minnesota Mine

Introduction

To understand the true potential climate impacts of the proposed Twin Metals Minnesota (TMM) project, one would have to perform an in-depth life cycle analysis of the project as proposed. Comparing the proposed mine to operating mines of similar deposit sizes, ore grades, and infrastructure components would also be helpful. Foregoing detailed, in-depth analyses, however, it is possible to make back-of-the-envelope calculations that estimate the potential greenhouse gas emissions relating to the development and operation of the proposed TMM mine. Estimates are subject to changes in energy generation sources (e.g., switching from coal to less carbon-intensive technologies), energy consumption needs by the mine, and efforts to reduce national and statewide greenhouse gas emissions. However, the estimates below provide a useful glimpse of the potential for significant contribution to ongoing climate change.

Estimated Impact of Project Power Load

Total projected power load for project, including concentrator, tailings storage facility, and mine site: 121,000 kW[1]

Twin Metals Energy Use:

$$121{,}000\ kW\ load \times \left(\frac{24\ hr}{1\ day}\right) \times \left(\frac{365\ days}{1\ year}\right) = 1{,}059{,}960{,}000\ kWh\ per\ year \times \frac{1\ year}{12\ months} = 88{,}330{,}000\ kWh\ per\ month$$

Twin Metals Annual Greenhouse Gas Emissions, measured in metric tons of CO_2-equivalent[2,3]:

$$88{,}330{,}000\ kWh\ per\ month = 1{,}722{,}892{,}085\ lb\ CO_2\ per\ year = \mathbf{781{,}491\ metric\ tons\ CO_2\text{-}e\ per\ year}$$

Annual CO_2 Emissions Equivalents:

- 1/5 of the total CO_2 released from the average U.S. coal-fired power plant for one year
- It would take a whole year for 640,000 acres of U.S. forest to sequester the same amount of carbon
- Equal to greenhouse gas emissions from adding 164,524 passenger vehicles to the roads for one year

30-Year Life-of-Mine Greenhouse Gas Emissions, measured in metric tons of CO_2-equivalent:

$$\frac{781{,}491\ \text{tons } CO_2\text{-e}}{1\ year} \times 30\ years = \mathbf{23{,}444{,}730\ metric\ tons\ CO_2\text{-}e\ over\ life\ of\ TMM\ mine}$$

Life of Mine CO_2 Emissions Equivalents:

- Equals total CO_2 emissions from 6.2 average U.S. coal-fired power plant for one year
- It would take a million acres of U.S. forests over 19 years to sequester the same amount of carbon

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[1] Duluth Metals, NI 43-101 PFS Technical Report, October 2014, p. 18-26. Available <http://www.twin-metals.com/wp-content/uploads/2012/09/TMM-Project-PFS-Technical-Report.pdf>

[2] Conversions and calculations from US Environmental Protection Agency, Power Profiler for Zip Code 55731, April 2015. Available <http://oaspub.epa.gov/powpro/ept_pack.charts#result>

[3] Conversions and calculations from US Environmental Protection Agency, Calculations and References, September 2014. Available <http://www.epa.gov/cleanenergy/energy-resources/refs.html>

- Equal to greenhouse gas emissions from adding nearly 5 million passenger vehicles to the roads for one year

Estimated Total Impact of Twin Metals Deposit Development Based on Industry Data
Total copper quantity in 4 TMM deposits: 12.35 Mt[4]
Total nickel quantity in 4 TMM deposits: 4.12 Mt[5]
Site-only energy consumption per ton copper mined: 23.1 GJ/t[6]
Site-only energy consumption per ton nickel mined: 29.5 GJ/t[7]

Greenhouse gas emissions from mining all copper in the 4 TMM deposits:

$$12.35\ Mt\ Cu \times \left(\frac{10^6\ t\ Cu}{1\ Mt\ Cu}\right) \times \left(\frac{23.1\ GJ}{1\ t\ Cu}\right) \times \left(\frac{10^3\ MJ}{1\ GJ}\right) = 285{,}285{,}000{,}000\ MJ\ energy\ used\ to\ mine\ all\ copper$$

$$285{,}285{,}000{,}000\ MJ \times 0.00008313\ {}^{\mathrm{CO_2\text{-}e\ tons}}/_{MJ} = 23{,}715{,}742\ tons\ CO_2\text{-}e = 23.7\ \mathrm{Mt\ CO_2\text{-}e}\ \text{to mine all copper}$$

Greenhouse gas emissions from mining all nickel in the 4 TMM deposits:

$$4.12\ Mt\ Ni \times \left(\frac{10^6\ t\ Ni}{1\ Mt\ Ni}\right) \times \left(\frac{29.5\ GJ}{1\ t\ Ni}\right) \times \left(\frac{10^3\ MJ}{1\ GJ}\right) = 121{,}540{,}000{,}000\ MJ\ energy\ used\ to\ mine\ all\ nickel$$

$$121{,}540{,}000{,}000\ MJ \times\ 0.00008313\ {}^{\mathrm{CO_2\text{-}e\ tons}}/_{MJ} = 10{,}103{,}620\ tons\ CO_2\text{-}e = 10.1\ \mathrm{Mt\ CO_2\text{-}e}\ \text{to mine all nickel}$$

$$(23.7\ \mathrm{Mt\ CO_2\text{-}e}\ \text{to mine all copper}) + (10.1\ \mathrm{Mt\ CO_2\text{-}e}\ \text{to mine all nickel}) = \mathbf{33.8\ Mt\ CO_2\text{-}e\ total}\ (\mathbf{excluding\ PGE})$$

Assumptions for Both Estimates
- Statewide greenhouse gas emissions per MJ of consumed energy will remain at 2012 levels over the life of the mine
- Statewide data for greenhouse gas emissions from electric power sector are similar to the Lake Country Power sources to be used by TMM
- Estimates of energy consumption per ton of metals mined presented in Farrell (2009) from extensive modeling of worldwide copper and nickel mines are applicable to TMM project specifics
- TMM mine operates 24 hours a day, 365 days a year, for 30 years
- Carbon dioxide equivalent is calculated as a common unit for all greenhouse gas emissions

[4] Edison Investment Research Limited, Duluth Metals—Buy Now, Pay Later, October 2014, p. 3.
[5] *Ibid. p. 3.*
[6] Farell, M.J., Carbon Emissions from Base Metal Mine Sites, *Mining Engineering*, April 2009, pp. 28-32, p. 29.
[7] Farell, M.J., Carbon Emissions from Base Metal Mine Sites, *Mining Engineering*, April 2009, pp. 28-32, p. 29.