

2021 ANNUAL REPORT REVIEW

CAYUGA MINE, CARGILL, INC.

Seneca and Tompkins Counties, New York

Prepared For

**NEW YORK STATE DEPARTMENT OF
ENVIRONMENTAL CONSERVATION**

By

John T. Boyd Company

Mining and Geological Consultants

Pittsburgh, Pennsylvania, USA



Report No. 2499.008

MAY 2022



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May 5, 2022
File: 2499.008

New York State Department of Environmental Conservation
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625 Broadway, Third Floor
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Attention: Mr. Matthew Podniesinski
Chief, Resource Development Section
Bureau of Resource
Management & Development

Subject: 2021 Annual Report Review
Cayuga Mine, Cargill, Inc.
Seneca and Tompkins Counties, New York

Ladies and Gentlemen:

At the request of the New York State Department of Environmental Conservation (NYSDEC), Dr. Vincent Scovazzo, Executive Consultant – Geotechnical, of John T. Boyd Company (BOYD) reviewed the Annual Report for the Cayuga Mine signed by Shawn G. Wilczynski. The signed cover letter¹ file, report, and supporting data were provided via the secured Intranet website.

On February 15, 2006, Mr. Steven M. Potter, then the Director, Bureau of Resource Management & Development, NYSDEC, requested that BOYD review all documents, digital data, and annual reports received by BOYD starting with the 2006 Annual Report.

¹ Wilczynski, Shawn G., 2022, Annual Report for Mine File #709-3-29-0052; Cayuga Salt Mine Permit ID#0-9999-00075-00001, File: Cargill DEC annual report for Jan - Dec 2021 (3).docx, Cargill Salt letter to Matthew Podniesinski, New York State Department of Environmental Conservation, March 28.

The received documents were reviewed for their adherence to conditions of the revised Permit². Section 12.8 of the revised permit limits cost for review of annual reports by Consulting Services to \$15,000. BOYD is providing the Consulting Services for this annual review. It is noted that “Funding relating to permit modifications or alterations requiring consultant review shall not be capped due to the varying nature of potential future applications. Cargill shall fund the cost of the annual meeting/underground inspections, and will share the cost of joint inspections with American Rock Salt Co., LLC.”

Discussion of Annual Report

The Permit has several conditions that affect the Annual Report and its review including:

Condition 9

Condition 9.a.

Condition 9.a. requires investigation into the disturbed salt zone to be completed and submitted before mining proceeds into the area. Based upon the additional seismic survey and consultant reports, Cargill will maintain the planned 1,000 ft setback around the Frontenac Point Anomaly. Further investigation is to be completed and submitted to the Department for review and approval prior to mining within this 1,000 ft buffer.

Condition 9.b.

Condition 9.b. requires investigations and reports on the adequacy of the thin rock overburden where the solid rock overburden is thinner, the glacial till and lake sediments thicken, and lake depth increases. The thin rock overburden and Frontenac Point Anomaly may overlap.

The required additional investigations and reports have been performed for Anomaly C. Undermining of Anomaly C will be completed using a large pillar configuration rather than the more yielding production pillar typically used at the Cayuga Mine. Cargill has agreed that no additional mining will occur under Anomaly E and no mining will occur under Anomaly D and the Frontenac Point Anomaly. Additional investigations and reports will need to be undertaken for Anomalies A and B, and mining in these areas should be avoided until reviewed and approved by the NYSDEC.

² New York State Department of Environmental Conservation, Region 7, 2007, “Permit” DEC ID 0-9999-00075, expiration December 31, 2012, December 31, Modification # I Effective Date: November 8, 2013.

The 2020 Annual Report notes the inclusion of reports by ESG that were in the Intralinks data set:

- ESG Solutions, “Seismic Data Processing Results and Health Analysis Report for Cayuga Monitoring System,” prepared for Cargill Salt Division, covering 12 months of 2021. Cargill notes in the annual report that “The Cayuga Mine operates a micro-seismic monitoring network which now has over 120 geophones and covers over 6 square miles of mine workings. The data from this system is reviewed daily in-house, by Engineering Seismology Group (ESG), and is reviewed weekly by RESPEC. This data indicates the mine is behaving as expected and is stable.”

Condition 15.a.

Condition 15.a. requires an Annual Report to be submitted by Cargill in response to 15.a. sub-conditions (1) through (8) and Condition 15.b. through g. These conditions and Cargill’s responses are summarized below.

Condition 15.a.(1)

Condition 15.a.(1) requires the inclusion of the Mine Manager’s signed certification that “... all mining related activities...were in conformance with this permit and the approved plans, or that variances have been reported and managed.”

A certification was included on page 2, Section 15.a.(1) and the certification was signed by Mr. Shawn G. Wilczynski, Mine Manager, on March 28, 2022. This certification notes “...to the best of my knowledge, conducted during the reporting period from January 1st of 2021 through December 31st of 2021 were in conformance with the DEC Permit # 0-9999-00075/00001 and the approved plans. No variances occurred and none were reported.”

Condition 15.a.(2)

Condition 15.a.(2) requires “A summary of all non-routine mining incidents as defined in Special Conditions Part b. ...” Condition 15.b. defines non-routine as “incidents during mining, processing, or other mine related activities that may adversely affect mine stability, ground and surface water or other natural resources, or the health, safety, welfare or property of the general public.” During a meeting held on August 17, 2004, among Cargill, NYSDEC, and BOYD, it was agreed that statements will be included in the Annual Report “to point out known, encountered, or discovered geologic and geotechnical anomalies and mine action to address such anomalies.”

Cargill included a statement in the Annual Report page 2, Section 15.a.(2) that “[t]he Cayuga Mine is not aware of any non-routine incidents associated with the mining,

processing, or other mine related activities that would have adversely affected any of the following:

- Mine stability
- Ground and surface water
- Natural resources
- Health, safety, welfare or property of the general public”

Condition 15.a.(3)

Condition 15.a.(3) requires “[a]n updated Mining Plan Map depicting the current extent of mining activities, and the proposed advancement of the working face for the subsequent three years.” At the August 2004 meeting, it was agreed that in addition “[a] mine map showing instrumentation location and type and shore line...” will be included in the Annual Report.

Cargill included a statement in the Annual Report, page 2, Section 15.a.(3) that “[t]he Cayuga Mine is currently operating in the northern region of the mine. Active mining is located in panels U-78, U-82, U-84, and U-86.” Mine maps as electronic files were supplied by Cargill through Intralinks to fulfill this condition. Included maps were:

- Adobe Acrobat® file 3yr mine plan Model (1).pdf, “Cayuga Mine, 3 Yr Mine Plan” March 21, 2022. This file contained a map shows the planned extent of mining through 2025.

The supplied maps show the extent of mining, proposed mine plan and shorelines of Cayuga Lake.

Condition 15.a.(4)

Condition 15.a.(4) requires the annual report to include a “summary of in situ measurements of rock mechanics required by Part f. of this Special Condition.”

Condition 12.f. requires the measurement and collection of in situ rock mechanics data “in accordance with the approved Mined Land Use Plan.” The data are to include “plots of relevant graphs. ...” Furthermore, “[e]xceptions to anticipated trends in rock behavior shall be noted and explained. ...”

At the August 2004 meeting, it was agreed that “[a]ll rock mechanics data” would be incorporated in the Annual Report, “including, but not limited to, all instrumentation readings and observations from the initial readings to present. Data for subsidence, closure, and extensometers are to be provided electronically. These electronic files are to include raw and processed data, graphs, and explanations of any inconsistencies and

anomalous readings including reasons for abandonment, reinstallation, etc., along with applicable observation in the vicinity of the instrument such as floor heave, water inflow, etc. Future reports are to contain comment on whether, in the opinion of Cargill, the instrument readings support or conflict with prior stability models especially in areas employing new mine, panel, or main configurations.”

Closure Measurements

Cargill included a statement in the Annual Report on page 2, Section 15.a.(4) that “Evaluations of the convergence data indicate that overall no unusual trends have been identified and the mine is behaving as expected. There continues to be a few slight anomalies, which while showing elevated closure rates, are still well below industry norms and not elevated enough to be of a concern to global stability. These areas are being monitored more closely and have been outfitted with additional electronic instrumentation to help gather more data.”

Closure measurements can be evaluated to indicate possible instability in three ways:

1. By studying the graphs of the rate of closure over time. The shape of these graphs indicates areas of instability, areas of concern, and areas of stability. Mr. Petersen of Rocktec Solutions (Cargill geotechnical consultant) has evaluated the closure in this manner in the past.
2. By establishing trigger values for total closure. This method is applicable in harder, less viscous rock, but is not applicable for the Cayuga Mine, as stable closure in salt will continue until the openings are closed.
3. By establishing trigger values for long-term closure rates. Since this is not being completed by the other investigators, BOYD applied such trigger rates in its evaluation of the closure readings.

Closure rate data are significant because they offer insight into the collapses and the inundation of the Retsof Mine. Sustained closure rates of 15 in./year or less were measured in stable areas of the Retsof Mine, while in the failure areas, closure was regularly measured with sustained rates over 230 in./year with onset of failure around 600 in./year. Although Retsof and Cayuga mines have different overburden and material properties, in the general sense, a comparison seems warranted for a relative indicator of stability.

BOYD reviewed the 306 closure stations read during the reporting period (6 more than last year). No Level 4 readings were reported.

None of these 306 closure stations showed readings that exceeded 230 in./year. Table 1 lists the top 9 measured closure rates in 2021 for areas of recent mining, defined as

areas within 1,000 ft of the advance face that occurred since November of 2020. Typically, BOYD reports the Top 10 closure measurements but only 9 closure station readings were reported in the Annual Report.

Table 1. Top 9 Closure Rates in Areas of Recent Mining

Station	Closure Rate (in./yr)	Time Since Installation (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
U78PIN#3	1.338	63	0.231	1.338	1st Reading
U86PIN#2	0.699	381	0.474	0.699	2nd Reading
U81PIN#2	0.596	784	0.940	0.596	2nd Reading
U82PIN#1	0.434	1,392	6.254	0.361	
U88PIN#1	0.384	865	1.981	0.148	
U78PIN#4	0.273	955	1.867	0.273	1st Reading
U82PIN#4	0.209	741	0.875	0.148	
U81PIN#3	0.168	1,967	1.780	0.168	
U82PIN#5	0.166	904	1.444	0.166	4th Reading

These rates are lower than the comparable rates for 2019 by an average of 0.260 inches/year. These rates decreased over time, showing that the ground is stable or stabilizing.

Table 2 provides the top 10 closure rates away from recent mining activity. These results do not include data from panel U-12, as this panel's closure rates are analyzed separately and shown in Table 3.

Table 2. Top 10 Closure Rates Away from Recent Mining (Excluding Panel U-12)

Station	Closure Rate (in./yr)	Time Since Installation (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
U40BPIN#8	0.775	7,208	31.24	0.587	
U40BPIN#14	0.673	7,068	29.37	0.642	
W1PIN#4	0.667	13,465	21.95	0.636	
NW2PIN#44	0.591	5,760	20.27	0.521	
NW3PIN#68	0.586	802	7.22	0.430	
U60PIN#26	0.579	3,684	14.16	0.579	
NW3PIN#50	0.539	1,344	7.81	0.394	
U40BPIN#2	0.529	7,319	23.33	0.491	
NW3PIN#56	0.514	1,461	8.18	0.514	
NW2PIN#50	0.512	5,621	18.47	0.405	

These top 10 rates away from recent mining are lower than the comparable rates for 2020 by an average of 0.025 inches/year, and they are spread throughout the mine. Stations in the NW3 Mains are being impacted in mining in nearby panels. Three high closure rates occurred in NW-3 mains and three more occurred in the U40B Panel. All stations showed slowing closure rates.

Table 3. Top 10 Closure Rates in Panel U-12

Station	Closure Rate (in./yr)	Time Since Installation (days)	Total Measured Closure (in.)	Latest Closure Rate (in./yr)	Notes
U12PIN#91	6.205	609	2.89	0.315	-
U12PIN#93	2.190	609	1.87	0.296	water in bottom pin
U12PIN#94	1.825	616	0.75	0.000	-
U12PIN#102	1.582	7333	25.27	0.313	72.1 73%, last week frozen
U12PIN#14	0.730	11863	21.97	0.295	71.9F, 60%
U12PIN#100A	0.639	48	0.05	0.365	-
U12PIN#61	0.626	12678	15.67	0.348	-
U12PIN#28	0.574	11674	28.10	0.258	-
U12PIN#103	0.495	7402	13.48	0.330	-
U12PIN#61A	0.495	1072	1.58	0.417	-

A zone of concentrated high closure rates is in panel U-12, that has experienced anomalous mine closure rates, especially since 2018. Closure rates in 2021 for the U-12 panel have decreased over 2020 by an average of 0.370 inches/year. All top ten station's rates have decreased an average of 1.24 inches/year.

Extensometers Results

Cargill included a statement in the Annual Report on page 2, Section 15.a.(4) that "Roof sag and wall expansion, measured with extensometers, is also monitored as conditions warrant, and is reviewed internally and externally as well. This data indicates the mine is behaving as expected."

Twenty five (25) extensometers (providing 31 measurements) were read at least once in 2021 (three more extensometers than in 2020). Extensometers were installed in various manners including vertically into the roof; at low angle (near horizontal); at an angle that resulted in the extensometer being installed over the pillars; and horizontally into pillars. Typically, these data are further complicated by the various rod and bay lengths, but these lengths were not always reported. (Bay length is the length difference between rods except for the first bay which is the length of the shortest rod.) Nevertheless, BOYD attempted to ascertain anomalies within these data.

Like previous reviews, BOYD evaluated the rate measured as strain per year. Using RESPEC's 1995 Cargill salts values:

$$\begin{aligned} \text{Dilation Limit} & J_2^{0.5}/I_1 = 0.36 \\ \text{Creep Rate} & \dot{\epsilon}^c = 8.3 \times 10^{-30}(\Delta\sigma)^{5.9} \end{aligned}$$

BOYD assessed the stress state to estimate that a strain rate greater than

8×10^{-3} (-/yr) is needed for destructive dilation. No calculated strain rate exceeded this standard.

Consultant Reports Concerning Conditions 15.a.(4)

The following consultant reports were available on Intralinks:

- ESG Solutions, 2021, Seismic Data Processing Results and Health Analysis Report for Cayuga Monitoring System, prepared for Cargill Salt Division, covering 12 months from January 2021 to December 2021.

These monthly reports show seismic events concentrating down the center of the lake, including concentrations above U-40B and U-12 panels. These reports are also discussed in section Condition 9.b. above.

Condition 15.a.(5)

Condition 15.a.(5) requires the Annual Report include a “summary of subsidence monitoring data required by Part e. of this Special Condition.” Condition 12.e. requires “[s]ubsidence monitoring shall be conducted in accordance with the approved subsidence monitoring plan contained within the approved Mine Land Use Plan.” Furthermore, “[e]xceptions to the trends shall be noted and explained...” Points applicable to this condition were agreed upon at the August 2004 meeting and are noted above under Condition 15.a.(4).

Cargill included a statement in the Annual Report, page 3, Section 15.a.(5) that “Surface subsidence measurements continue to be performed in accordance with the Mined Land Use Plan. A traditional survey was completed in 2020 for the for the west shoreline, east shoreline, Town of Lansing, and #4 Shaft area. All results were well within expected ranges. In November of 2021, Cargill facilitated completion of a subsidence survey using LIDAR technology to establish a baseline for future comparisons”

No subsidence data file was included in the data set on Intralinks. Cargill noted³ that Cayuga Mine has contracted with a survey company to perform a baseline LiDAR survey. This survey will extend 2,500ft beyond the extension of the planned mine. Cargill has already set surface control points and the LiDAR flyover will be completed in November (after the leaves have fallen). BOYD expects to review these data when they are provided.

³ 2020 discussion with Andrew Bannister, Senior Mine Engineer – Salt, Cayuga Mine

Condition 15.a.(6)

Condition 15.a.(6) requires the inclusion of “[i]nformation regarding the source and volume of any water inflow into the mine, and the disposition of such water.” At the August 2004 meeting, it was agreed that a discussion about water disposal in Level 4 would be included in the Annual Report, noting: “Updates of Level 4 filling including data on shore line advance.” However, in 2012 it was noted that “Access to view the pond is not possible due to ground conditions.”

Section 15.a.(6) of the Annual Report, notes that “Most the water is directed to a settling pond located on the 4-level of the mine. The water is then pumped from the settling pond to abandoned areas at the far west end of 4-level as well as to various areas of the active mine for dust control. Water labeled as Other Inflows is fully saturated and is stored in various abandoned areas on the 6 Level of the mine.”

A data file with water volume calculations was not included in the data set on Intralinks.

Cargill lists the following water flows in the Annual Report:

- Production Shaft (#1 shaft) - 23 gallons per minute (gpm).
- Ventilation Shaft (#2 shaft) - Less than 1 gpm.
- Service Shaft (#3 shaft) - 1 gpm.
- ED Plant Concentrate discharge - 1 gpm.
- Other inflows - 4 gpm.
- Total Water Inflow = 30 gpm.

Condition 15.a.(7)

Condition 15.a.(7) requires the inclusion of “[a] summary of all other monitoring data required under the terms of this permit or Department SPDES permit issued to Cargill.”

Discussions on December 2, 2021 limited SPDES data given to BOYD to summary type. Cargill included a statement in the Annual Report page 3, Section 15.a.(7) that “For the 2021 calendar year there was no exceedance of the SPDES limits for the storm water outfalls.”

Section 15.a.(7) of the Annual Report, notes that “For the 2021 calendar year there were no exceedance events of the SPDES limits for the storm water outfalls. All outfall sample data was uploaded into the EPA NetDMR website.” These data are to be reviewed by NYSDEC. Discussion on June 6, 2019, suggests that direct reporting requirements of SPDES data to the State of New York renders this requirement moot.

Condition 15.b. and c.

Condition 15.b and c. addresses Mine Safety and Health Administration (MSHA) reporting involving non-routine mining incidents as defined in Condition 15.b. Condition 15.c. requires Cargill to submit “all correspondence with the Mine Safety and Health Administration involving non-routine mining incidents...”

Cargill includes a statement in section 15.b. of the Annual Report that “[t]here were no incidents meeting the guidelines for notification as identified in section 15.a.(2).” and section 15.c. of the Annual Report that “[t]he Cayuga Mine has not received any citations or correspondence from MSHA regarding non-routine mining incidents as identified in section 15.a.(2).” The Annual Report does not note reports or letters from MSHA concerning any non-routine mining incidents.

Condition 15.d.

Condition 15.d. addresses reporting requirements “Prior to undertaking any material change in the approved mining methods or techniques ... Cargill shall submit to the Department a description of such modification ...” This condition does not require the reporting to occur in the Annual Report.

Cargill notes in section 15.d. that “[t]he mining methods used at the Cayuga Mine have not been changed in the last year.”

Condition 15.g.

Condition 15.g. addresses the reporting and recording of citizen complaints.

Cargill includes a statement in section 15.g. of the Annual Report that “Cargill maintains a written record of citizen complaints that is available to the Department upon request.” This response does not fulfill the condition for documentation in the annual report.

Site Visit

A site visit to discuss these findings among NYSDEC, Cargill, and BOYD is scheduled for June 16, 2022. The following should be addressed and discussed:

- Map showing active mine areas.
- Map showing locations of conversion stations and extensometers.
- Maps showing closure and closure rates.

- Map showing water and brine storage locations and planned locations. Map to show roof and shoreline locations.
- U12, U24, U40B, and NW2 closures.
- Form of subsidence data to be given to BOYD.
- Consultant Reports.

In-mine observation of U-12 and NW2 and NW3 mains is recommended during the site visit.

Please contact us if you require additional information or if we may be of further service.

Respectfully submitted,

JOHN T. BOYD COMPANY

By:



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