

STATE OF NEW YORK
SUPREME COURT : COUNTY OF TOMPKINS

In the Matter of the Application, CAYUGA LAKE ENVIRONMENTAL ACTION NOW (CLEAN), an Unincorporated Association by President JOHN V. DENNIS, and LOUISE BUCK, BURKE CARSON, JOHN V. DENNIS, WILLIAM HECHT, HILARY LAMBERT, ELIZABETH and ROBERT THOMAS, and KEN ZESERSON

Petitioners,

**AFFIDAVIT OF
RAYMOND C.
VAUGHAN IN
SUPPORT OF
PETITION**

For a Judgment Pursuant to Article 78 of the New York Civil Practice Laws and Rules

vs.

Index No.

THE NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION, and CARGILL INCORPORATED

Respondents.

State of New York,
County of Erie, ss.:

RAYMOND C. VAUGHAN, being duly sworn, deposes and says:

1. I am a Professional Geologist (NY license no. 258) and Environmental Scientist with a Ph.D. in Geology from SUNY Buffalo. I am very familiar with the State Environmental Quality Review Act (SEQRA) as a result of my service on the Town of Hamburg Conservation Advisory Board (1980-1999) where I and other members regularly conducted SEQRA reviews of proposed projects referred to us by the Town Board and/or Planning Board. My familiarity with SEQRA was reinforced during the twelve years I was employed as an Environmental Scientist at the NYS Attorney General's Office (2000-2012). My knowledge of geology is a combination of education

and experience, including extensive work at the NYS Attorney General's Office on the evolving evidence of brine migration and associated long-term impacts from the 1994 salt mine collapse in Retsof, Livingston County, NY. My CV is attached as Exhibit A.

2. I have reviewed the Cayuga Salt Mine permit, Modification # 1, effective 2/12/2021, especially its § 9 which imposes a new condition that "No mining shall occur under the Frontenac Point Anomaly. No mining or mining activities shall be conducted within 1000 feet of the Frontenac Point Anomaly." I find that this requirement is ambiguous because *it fails to distinguish between two substantially different definitions of the Frontenac Point Anomaly (FPA)* that Respondents and their consultants have utilized within the past five years. Given the protective intent of this new requirement, and given my understanding of the need for applying such a protective requirement to the FPA, I find that the new requirement's ambiguity renders it unprotective.

3. According to DEC's Notice of Intent for the Cargill Salt Mine permit modification:

New Condition 9 - Frontenac Point Anomaly [-] recognizes that Cargill performed additional investigations of the disturbed salt zone located near the west shore of the lake in the northern extended mineral lease area described in current permit condition 9.a. The disturbed salt area is now termed the Frontenac Point Anomaly (FPA). By letter, Cargill has agreed to not mine under the FPA and to maintain a minimum 1000-foot setback from the FPA for all mining activities. The new condition memorializes the letter and the commitment not to mine under the FPA and maintain the minimum 1000-foot setback as part of the permit.

DEC, *Notice of Intent to Modify*, July 29, 2020.

4. In fact, the new condition cannot "memorialize" either Cargill's letter or the commitment not to mine under the FPA and maintain the minimum 1000-foot setback. Cargill's letter is not listed in § 3 along with other approved plans, requiring

strict conformance, that have been submitted by the applicant or applicant's agent as part of the permit application. Thus, while new condition § 9 may not be entirely unenforceable, the phrases "under the FPA" and "1000-foot setback" have no clear meaning in the absence of a clear definition of the FPA and the 1000-foot setback line that encloses it.

5. In order to be protective, the modified permit would need to specify the applicable 1000-foot setback. Are *both* definitions of the FPA covered by § 9, meaning that the 1000-foot setback line encloses both versions of the FPA? Or does the setback line enclose only one version of the FPA – and, if so, what is the rational basis for applying the mining restrictions to only one and not both versions of the FPA?

Faulting: the FPA and its two conflicting definitions

6. The FPA is recognized by DEC, and by DEC's consultant Boyd, as a structural feature of concern for the Cayuga Salt Mine, particularly involving "the global stability of the mine, the potential inundation of the mine thus affecting the safety of the miners, and the potential of adversely affecting Cayuga Lake." Boyd 2018 letter at 2. The FPA is evidently a fault (*id.* at 1-6 and 9) and has been represented in two different ways on maps provided by Respondents. One version of the FPA depicts it as a generalized oval while another shows it as a slightly curving *line* that represents the FPA. The linear version is seen in Exhibits B and C; the generalized oval is seen in the Boyd 2018 letter, Exhibit D, at 4. (The map in the Boyd 2018 letter, as created by Boyd, is mostly a copy of a 2010 map but also includes the generalized FPA oval added by Boyd.)

7. Evidence that the FPA is a substantial fault includes information that Boyd provided to DEC in 2002. Boyd reported that the FPA, then called the "disturbed area," appeared to be "a graben-like structure with a vertical displacement of approximately 100

ft” (id. at 2). A few years later, based on seismic studies, RESPEC suggested “that the anomaly is a deep penetrating, nearly vertical, east-west-trending fault” (id. at 5).

8. Representing the FPA as a linear feature is more geologically plausible than representing it as a generalized oval because faults are generally linear features.

Relatively thin bedrock above the mine: Anomalies A, B, C, D, and E

9. A 2010 report by Willott – referenced in the Boyd 2018 letter but not released in its entirety under FOIL – is important because it identified the five areas of deep gouge known as Anomalies A through E. These “anomalies” of thin rock overburden are recognized as a concern (see Boyd 2018 letter at 1-10) because they are places where ancient glaciers gouged/scoured relatively deeply into the bedrock, creating what are now thin spots in the bedrock above the mine. In some of these thin spots, the layers of sturdy carbonate rock that provide crucial support for the mine roof are extremely thin or absent. Moreover, the places where ancient glaciers gouged/scoured relatively deeply are not entirely restricted to Anomalies A-E. In the 2010 Willott map shown in the Boyd 2018 letter, Exhibit D at 4, the elongated “Area where the rock overlying the limestone is very thin” encompasses not only Anomalies A-E but also the intervening areas beneath Cayuga Lake.

10. Comparison of the maps in Exhibits B, C, and D shows the linear configuration of the FPA skirting Anomaly D and passing through the thin-bedrock area between Anomalies D and E. Here, even if not elsewhere, mine integrity faces a combined risk from faulting and thin bedrock.

11. Expert evaluation on behalf of Respondents has reportedly led to a belief that “the anomalies represent erosion of bed rock that extends into the Helderberg limestone. The group could not discount faulting beneath the anomalies and confirmed

that the FPA represents a fracture in the limestones but there was no convincing evidence of lower limestones collapse due to salt solutioning.” See Boyd 2018 letter at 5.

Source of the FPA maps in Exhibits B, C, and D

12. The Boyd 2018 letter, Exhibit D at 4, is the source for the oval version of the FPA. The basis for Boyd’s use of an oval to represent the FPA, and his placement of the oval, remain unclear.

13. The linear version of the FPA, while less frequently shared with the public than the generalized oval version, is seen on the two maps – actually two versions of the same map – provided to CLEAN under FOIL and attached hereto as Exhibits B and C. CLEAN has given me no specific information on the source of this map, and in my best understanding no such information has been provided to CLEAN. Despite this lack of specific information, I can draw certain conclusions from the maps themselves.

14. The black-and-white version of the map in Exhibit B is accompanied by emails transmitting the map among DEC and Boyd staff in 2016; these provide limited context. The color version of the map in Exhibit C has no such evidence of how/when it was created or transmitted but includes a page number (2), a caption (“Figure 1-1. Mine Map of the Cayuga Mine Northern Reserves”) and markings (RSI- 2099-15-006 and RSI-2099-15-053) that suggest that the map is from a report.

15. See also the subject line (“RESPEC update”) of the emails in Exhibit B. RESPEC is a well-known geologic consulting company in South Dakota that has performed work for Cargill relating to the Cayuga Mine. The aforementioned markings on the map (RSI- 2099-15-006 and RSI-2099-15-053) are of the same general format as markings that RESPEC typically attaches to figures and illustrations in its reports. Based on the foregoing, including the word “update” in the subject line, the map is likely from a

RESPEC report that was prepared for Cargill and completed in 2016. I cannot be more specific because CLEAN has given me no additional information on the map source(s) beyond what's shown in Exhibits B and C. Furthermore, as noted above, it is my understanding that no specific information on the source(s) has been released under FOIL or otherwise provided to CLEAN.

Possible evolution of Respondents' understanding of the configuration of the FPA

2010 DEC letter

16. In a 2010 letter not released under FOIL in its entirety, Steve Army of DEC "affirmed and agreed that Cargill's suggested stand-off of 1,000 ft around the FPA, where no mining will be permitted, is reasonable." This quote from Steve Army's letter is known from the Boyd 2018 letter at 3. Steve Army's letter should be made available in full so that the reasoned basis for DEC's agreement with the 1000-foot FPA standoff or setback can be independently evaluated, especially in relation to DEC and Cargill's then-current understanding of the FPA and its configuration.

17. Note that Respondents' recognition or understanding of the linear configuration of the FPA is several years later than Steve Army's 2010 letter. See especially the emails dated October 2016 in Exhibit B that forwarded the linear-configuration map with "update" in the subject line and "FYI" ("For Your Information") in the body of one of the emails. Information forwarded as an "update," and accompanied by an "FYI" tag, is normally understood to be new information not already known to the recipient(s). On this basis, Respondents' recognition or understanding of the linear configuration of the FPA dates from 2016, several years after the above-quoted DEC letter from Steve Army that "affirmed and agreed that Cargill's suggested stand-off of 1,000 ft around the FPA, where no mining will be permitted, is reasonable." No explanation has been provided why a 1000-foot standoff or setback, already recognized

as protective, would not have been applied to the linear configuration of the FPA when it came to be recognized in 2016.

2013 RESPEC report

18. As additional geologic background, consider the following overview from a 2013 report prepared by Cargill's consultant RESPEC:

Bedrock structures at the Cayuga Mine include folds, faults, and joints. The most prominent feature is the Fir Tree Point Anticline, which is the major east-west trending fold whose axis crosses Cayuga Lake between Myers Point and Portland Point. The smaller-scale structures observed in the mine at the #1 Salt, the #4 Salt, and the #6 Salt levels are related to regionally extensive tectonic deformation that produced the Fir Tree Point Anticline and even larger folds to the south.

Smaller-scale folds and faults occur on the limbs and in the core of the Fir Tree Point Anticline. The extreme relief on the #4 salt bed is related to buckling in the core of the larger fold. The well-known thrust fault in the Tully Limestone in the quarry above the mine occurs along the crest of the fold. Faults are also known to occur on the limbs of the fold at the Onondaga Limestone level based on well control and can also be clearly observed in seismic data....

Salt Structure. No evidence of faulting was noted in the seismic reflection data north of the Frontenac Point Anomaly. In addition, structural contour maps in Figures 3-4 through 3-8, for the #6 Salt, the base of the #4 Salt (Salina E), the top of the salt sequence (Salina F), the top of the Camillus shale, and the top of the overlying carbonates all appear relatively simple.

In Corehole #18, the banding in the #6 salt is near-horizontal. There is some inclination of bedding in the #4 and #3 Salts. Dips as high as 60 degrees are noted but do not appear to be representative of large intervals within the sequence. Compressional deformation of the salt beds by internal shortening (i.e., thickening) appears to be responsible for the inclined strata in the #4 and #3 salt beds.

Log sections for the F1 Salt (#4 Salt) in the Zeifle #1, Dunkle, and Champion wells also suggest some tectonic deformation in the region surrounding the Northern Reserves. The typical bedding sequence for the F salts is disrupted, the interval appears thicker, and the F1 Salt is less pure (see Figure 3-6).

RESPEC, Cargill Icing Technology Lansing Mine, Corehole #18 Stratigraphic Test Hole Installation and Data Collection, Topical Report RSI-2381 (November 2013), at 26-27.

19. The above-quoted overview by RESPEC acknowledges folds, faults, and joints at the mine, with “No evidence of faulting...noted in the seismic reflection data north of the Frontenac Point Anomaly” – but the geographic reach of this latter conclusion remains vague as long as the FPA remains poorly bounded. Note particularly that RESPEC’s November 2013 interpretation should be regarded as a work in progress, as indicated by Respondents’ recognition or understanding of the linear configuration of the FPA being a few years later than this RESPEC report. See especially the aforementioned emails dated October 2016 in Exhibit B that forwarded the linear-configuration map with “update” in the subject line and “FYI” in the body of one of the emails. On this basis, Respondents’ recognition or understanding of the linear configuration of the FPA dates from 2016, a few years after the above-quoted 2013 RESPEC interpretation. No explanation has been provided why a 1000-foot standoff or setback, already recognized as protective, would not have been applied to the linear configuration of the FPA when it came to be recognized in 2016.

2018 Boyd letter


20. The Boyd 2018 letter, Exhibit D, is two years later than the 2016 recognition of the linear configuration of the FPA but shows only the generalized oval, not the linear version. While this might suggest that the linear configuration had been superseded or refuted by new investigation between 2016 and 2018, no such evidence has been presented or mentioned. Boyd’s silence on this matter in the otherwise informative 2018 letter is not convincing evidence that the linear configuration has been ruled out. Boyd’s statement that “Faulting was not detected” (id. at 10) is in the context of a drilling investigation of Anomaly C, not the FPA.

21. Partway through the Boyd 2018 letter, it pivots away from the purely mechanical strength of thinned bedrock at the scour anomalies to the question of whether

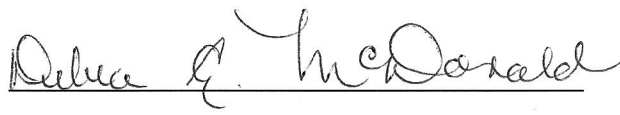
bedrock strength is further compromised by water penetration. The Boyd letter (op. cit. at 7-9) discusses a drilling investigation of Anomaly C, reporting generally positive results but with minimal emphasis on the limitations of the drilling investigation and without providing a clear line of reasoning on the original bedrock-strength issue. The issue continues to need independent evaluation. For example, the Boyd letter fails to mention any analysis being conducted on the salt crystallography of salt cores produced during the drilling investigation.

22. In summary, protective measures are needed for the FPA, and such measures need to be applied to the best-demonstrated location of the FPA. If different tests or expert interpretations point to different locations for the FPA, such protective measures need to be applied to each such location. The importance of this can be traced to the known risks posed by *thinning bedrock* and *faulting*. These are two individually important risk factors, both of which are known to be associated with the FPA, and *each* of which poses a risk to mine stability and integrity. The existence of these risk factors is not in dispute. The associated level of risk cannot be established precisely, yet there is general agreement that protective measures such as a 1000-foot setback or standoff are warranted. The need for such protective measures is based partly on lessons learned from the 1994 roof collapse, and the subsequent complete flooding and abandonment, of the Akzo salt mine in Retsof, Livingston County, NY. At the time of its collapse, the Akzo mine had been in operation for about a century and was the largest salt mine in North America.

This affidavit is based on information available to me at this time. Should additional information become available, I reserve the right to determine the impact, if any, of the new information on my opinions and conclusions and to modify or supplement this affidavit if necessary.



Sworn to before me this 7 day of June 2021.



Notary Public, State of New York

DEBRA A. McDONALD
NOTARY PUBLIC, STATE OF NEW YORK
REG. No. 01MC5030288
QUALIFIED IN ERIE COUNTY
My Commission Expires July 11, 2022

EXHIBIT A

RAYMOND C. VAUGHAN, Ph.D., P.G.
534 Delaware Avenue • Buffalo, NY 14202 • (716) 332-7113
rcvaughan9@gmail.com

Professional Geologist/Environmental Scientist/Consultant with specialties in geology, hydrogeology, physical chemistry, thermodynamics, public policy, technical communication, numerical methods and programming, environmental testing, site remediation, development of soil cleanup standards, chemical fate and transport, Great Lakes protection, aquatic invasive species policy and ballast water management technology, wetlands protection, climate change and carbon sequestration, bioassay and analytical methods, nuclear waste policy and technology, and research and development. Eight U.S. patents.

PROFESSIONAL EXPERIENCE

Consultant to Sierra Club Atlantic Chapter, 2017-2020

Geologist/Environmental Consultant, 2017-2020

- Review and interpretation of radiological test results from Hakes and Chemung landfills

Consultant to Cayuga Lake Environmental Action Now (CLEAN), 2017-present

Geologist/Environmental Consultant, 2017-present

- Reviewing Finger Lakes salt mining issues as part of geological support team

Consultant to Environmental Protection Dept. of Seneca Nation of Indians, 2016

Geologist/Environmental Consultant, 2016

- Report on large data set of radiological test results for several sets of soil samples

University at Buffalo, Department of Geology, 2015

Adjunct Assistant Professor, Fall 2015

- Created and taught graduate course, GLY 606, Environmental and Legal Issues in Geology

Consultant to Seneca Lake Pure Waters Association, 2014-2018

Geologist/Environmental Consultant, 2014-2018

- Report preparation and participation in Issues Conference on LPG storage proposal
- Ongoing support and consultation with scientific/legal team for preparation of legal briefs

New York State Attorney General's Office, Environmental Protection Bureau, Buffalo, NY, 1999-2012

Environmental Scientist, 2000-2012

Environmental Intern, 1999-2000

- Investigation and assessment of environmental issues
- Case preparation and other scientific consultation with experts
- Litigation support and interagency scientific consultation on mercury emission standards
- Affiant in mercury emissions case, *New Jersey v. EPA*, 517 F.3d 574 (D.C. Cir. 2008)
- Litigation support and interagency scientific consultation on aquatic invasive species
- Site characterization and remediation support for sites in New York State
- Design and execution of groundwater testing

- Head measurement and potentiometric surface mapping
- Groundwater modeling
- Design and execution of soil and sediment testing
- Integration of stratigraphic & structural data w/test results (esp. for assessing contaminant migration)
- Monitoring of well drilling and logging
- Pumping-test interpretation
- Interpretation of other testing and modeling results
- Development and application of soil contamination standards
- Review and interpretation of various reports submitted to Attorney General's Office
- Geologic characterization and interpretation of a major salt mine collapse
- Assessment of groundwater contamination from manure spreading
- Assessment of groundwater impacts from mining
- Assessment of potential impacts from oil & gas exploration
- Field investigation, record review, and interagency consultation on wetlands protection
- Consultation with environmental organizations on issues of mutual interest
- Participation in Great Lakes Binational Toxics Strategy

Graphic Controls Corporation, Buffalo, NY, 1976-1998

Senior Research Technician, 1981-1998

Research Technician, 1976-1981

- Development of electrode products including Quikset, Q-Trace, and Meditrace
- Development of silver/silver chloride and graphite inks and conductive substrates
- Development of hydrogels and conductive adhesives
- Design and construction of prototype equipment for coating, curing, and printing
- Product and component testing; development of test methods

Carborundum Company, Niagara Falls, NY, 1965-1975

Research Technician

- Development of boron nitride ceramic fibers and high-temperature polymer fibers
- Development of processes for converting fibers to various textile forms

EDUCATION/AFFILIATIONS

NYS Professional Geologist License No. 258

Ph.D., Geology, University at Buffalo, 2008

B.S., Math and Astronomy, Empire State College, 1975

Massachusetts Institute of Technology, 1962-1964

Member, Buffalo Association of Professional Geologists

Member, Clean Air Coalition of Western New York

Steering Committee, Coalition on West Valley Nuclear Wastes, 1978-2006

Member, West Valley Citizen Task Force, 1997-present

Member, Town of Hamburg Conservation Advisory Board, 1980-1999

Board of Directors, Western New York Land Conservancy, 1991-2002

Board of Managers, Buffalo Society of Natural Sciences, 2011-2020 and 2021-present

Board of Directors, Nature Sanctuary Society of Western New York, 2013-present

SELECTED PUBLICATIONS/PRESENTATIONS

R.C. Vaughan (editor and coauthor), *'Low-Level' Radioactive Waste: The Siting Process in New York State*, 3rd ed., Norwich, NY, 1990.

R.C. Vaughan, K. McGoldrick, C. Kent, J. Rauch, B. Cain, G. Mathe, and B. Stephan, *Geology Reports of the Coalition on West Valley Nuclear Wastes*, East Concord, NY, 1994.

R.C. Vaughan, "Fending Off Orthodoxy with Ink and Umbrage: Church and State Controversy in Western New York, 1815-1837," presented at Conference on New York State History, Buffalo, 1998.

R.C. Vaughan, "State Options for Controlling Aquatic Invasive Species in the Great Lakes," *National Environmental Enforcement Journal* **18**, 3 (2003).

R.C. Vaughan, "Ranking the Bioassay TEFs and REPs," poster presented at Dioxin 2003 conference, Boston; published in *Organohalogen Compounds* **60**, 165 (2003).

R.C. Vaughan, T.D. Wood, D.J. Higbee, J.R. Olson, and Y. Tondeur, "Chromatographic Separation Strategy for Isolating and Characterizing Compounds with High Bioassay Response," presented at Dioxin 2005 conference, Toronto; published in *Organohalogen Compounds* **67**, 208 (2005).

R.C. Vaughan, "The West Valley Nuclear Site within the Cattaraugus Creek watershed," Cattaraugus Creek Watershed Summit, Concord Town Hall, Springville, NY, October 3, 2006.

R.C. Vaughan, testimony on site decommissioning on behalf of West Valley Citizen Task Force, before U.S. Nuclear Regulatory Commission, Rockville, MD, 2006, available at www.nrc.gov/reading-rm/doc-collections/commission/tr/2006/20061211.pdf.

R.C. Vaughan, "Applying an Effect-Directed Strategy to the Search for Unrecognized Toxic Chemicals," presented at Great Lakes Binational Toxics Strategy Integration Workgroup meeting, Windsor, Ontario, February 2007; presentation slides available at <http://archive.epa.gov/bns/web/pdf/vaughan022107.pdf>.

R.C. Vaughan, "Due Process, Morgan's Disappearance, and American Antimasonry in Historical Context," presented at International Conference on the History of Freemasonry, Edinburgh, Scotland, 2007.

R.C. Vaughan, *Methods and Programs for Inverse Modeling of Underdetermined Sets of Gravity Data*, Ph.D. thesis, Department of Geology, University at Buffalo, 2007.

F. Zagorski and R.C. Vaughan, "New York's 401 Certification of EPA's Vessel General Permit (VGP)," presented at Great Lakes Aquatic Nuisance Species Panel Meeting, Grand Island, NY, 2009.

R.C. Vaughan, "Zoar Valley geology, uncertain timing of gorge incision, and comparison to the Niagara Gorge," presented at Nature Sanctuary Society of Western New York annual banquet, Buffalo, 2010.

R.C. Vaughan, "Stemming the Tide of Aquatic Invasive Species: Efforts of the Office of the New York State Attorney General," presented at SUNY ESF, Syracuse, 2010.

R.C. Vaughan, "Nuclear Power: Can it help solve the problem of climate change?," presented at University of Pittsburgh at Bradford's Nuclear Forum, Bradford, PA, 2011.

R.C. Vaughan, "NRC's recent and ongoing activities to authorize nuclear waste reprocessing," presented at West Valley Citizen Task Force meeting, West Valley, NY, 2011; presentation slides available at http://www.westvalleyctf.org/2011_Materials/09/2011-09-28_Vaughan_reprocessing_presentation.pdf.

R.C. Vaughan, "The Unfinished West Valley Experience at the Back End of the Nuclear Fuel Cycle, 1960-present," presented at Council of State Governments/Blue Ribbon Commission public meeting, Boston, 2011.

R.C. Vaughan and R. Newberry, "Is There a Distinctive Form of Great Lakes Humor? The Western New York Perspective," presented at Conference on New York State History, Niagara University, Lewiston, NY, 2012.

R.C. Vaughan, "The Nuclear Dilemma: No Good Place to Put the Waste," presented at St. Bonaventure University, St. Bonaventure, NY, 2013.

R.C. Vaughan, J. Sullivan, and C. Osterhoudt, "The Geology of Zoar Valley and the Cattaraugus Creek Watershed," *Nature Sanctuary Society of WNY Monograph in the Natural Sciences*, Vol. I, January 2013.

R.C. Vaughan, "West Valley site history, cleanup status, and role of the West Valley Citizen Task Force," presented at National Transportation Stakeholders Forum (U.S. Department of Energy/Council of State Governments), Buffalo, 2013.

R.C. Vaughan, "Henry J. Raymond & His Family," presented at Burnett Family Reunion, Southboro, MA, 2013.

R.C. Vaughan, "NFBS [Niagara Frontier Botanical Society] Leaders Speak at Spring Meeting," *Nature Preserves* **14**, no. 2 (April 2014), 2-3.

R.C. Vaughan, "Geologic History of the Niagara Escarpment," Appendix G of Western New York Land Conservancy, *Niagara Escarpment Legacy Project* (2014), available at pp. 83-93 of <http://wnylc.org/site/wp-content/uploads/2014/05/Appendices-Niagara-Escarpment-Legacy-Project-May-2014.pdf>.

R.C. Vaughan, "The Buffalo Skyway: Can CNU's Bad Boy Become a Beautiful Elevated Linear Park?," presented at 22nd Congress for the New Urbanism, Buffalo, 2014; available at https://www.youtube.com/watch?v=2_PRoEQLbIk.

R.C. Vaughan, "Tom Diggins on the Ecology of the Zoar Valley Gorge," *Nature Preserves* **14**, no. 3 (August 2014), 7-8.

R.C. Vaughan, "Departure of the Fair Train (Strates Shows) from Hamburg, NY, August 2014, after the Erie County Fair," video (length 8:40), 2014, available at <https://www.youtube.com/watch?v=kYOVA0tl-Pc>.

R.C. Vaughan, "Split-sample testing strategy to assess risk from dioxin/furan deposition," poster presented at Air Pollution Workshop, UB Department of Epidemiology and Environmental Health, Buffalo, 2014.

R.C. Vaughan, "West Valley site history, cleanup status, and role of the West Valley Citizen Task Force," presented to BSA Troop 652, Ellicottville, NY, 2014.

R.C. Vaughan, "NSSWNY Fall Membership Meeting: Ken Roblee on Western New York's Herptiles," *Nature Preserves* **14**, no. 4 (November 2014), 4-5.

R.C. Vaughan, "Industrial stack testing principles and methods," presented to Air Pollution Applications class, GEG 480/616, Buffalo State College, 2014.

R.C. Vaughan, "Mercury deposition from coal-fired power plant emissions, and the use of a simple computer model to predict downwind deposition," presented to Air Pollution Applications class, GEG 480/616, Buffalo State College, 2014.

R.C. Vaughan, "An air pollution episode involving residential exposure to a poorly characterized chemical," presented to Air Pollution Applications class, GEG 480/616, Buffalo State College, 2014.

R.C. Vaughan, "The Hemlock Woolly Adelgid: How You Can Become Part of the Solution," *Nature Preserves* **15**, no. 1 (February 2015), 4-5.

R.C. Vaughan, "Identity and Fate of Capt. John Dalzell and His Sons," *The Scottish Genealogist* **62**, 4-22 (March 2015).

R.C. Vaughan, "Geologic Issues for LP Gas Storage in Seneca Lake Salt Caverns," presented at Rochester Committee for Scientific Information public meeting, Rochester, NY, April 7, 2015.

R.C. Vaughan, "The Big Impact of a Tiny Product: Sam Mason's Work against Microbeads / Local, State Governments Issue Bans," *Nature Preserves* **15**, no. 3 (August 2015), 1-3.

R.C. Vaughan, "The History of Zoar Valley: NSSWNY Fall Lecture Explores the Rich Past of a Local Treasure," *Nature Preserves* **15**, no. 4 (December 2015), 1-3.

R.C. Vaughan, "Several prominent and representative residents of 331 Franklin Street, Buffalo, NY," 7-page report presented/summarized at public hearing on three City of Buffalo Landmark applications, Common Council Chambers, Buffalo City Hall, April 14, 2016.

R.C. Vaughan, "Biology: A Short Overview of Radiation, Radioactive Contamination, and Effects," presented at SNI Cattaraugus Community Wellness Center, Irving, NY, April 22, 2016.

R.C. Vaughan, "Cattaraugus Creek: A Story of Flowing Water and the Geology of the Channel It Flows Through," presented at SNI Cattaraugus Community Wellness Center, Irving, NY, April 22, 2016.

R.C. Vaughan, "NSSWNY Spring Membership Lecture: Dr. Wayne Gall on Lyme Disease and Other Tick-Borne Diseases," *Nature Preserves* **16**, no. 2 (April 2016), 4-5.

R.C. Vaughan, "Cattaraugus Creek: A Story of Flowing Water and the Geology of the Channel It Flows Through," presented at West Valley Citizen Task Force meeting, West Valley, NY, April 27, 2016.

S. Parwulski, D. Bauer, and R.C. Vaughan, "Renewing Our Connections to Nature: Dave Bauer's Call to Engage Children in Nature," *Nature Preserves* **16**, no. 4 (November 2016), 1-3.

R.C. Vaughan, "Messinger Woods: WNY's Emergency Room for Wildlife," *Nature Preserves* **17**, no. 2 (April 2017), 4-5.

R.C. Vaughan, "Endangered: The Rusty Patched Bumble Bee (*Bombus affinis*)," *Nature Preserves* **17**, no. 2 (April 2017), 10-11.

R.C. Vaughan, "Unresolved geologic questions for salt mining under Cayuga Lake," presented at Cayuga Lake Environmental Action Now (CLEAN) public meeting, Ithaca, NY, June 13, 2017.

R.C. Vaughan, "Climate & intense rainfall events: Can they be predicted well enough to support cleanup decisions for the West Valley nuclear waste site?," presented at American Meteorological Society, Western New York Chapter meeting, Buffalo State College, June 20, 2017.

R.C. Vaughan, "Erosion Modeling Issues that Need Attention and Sensitivity Analyses," presented at West Valley Citizen Task Force meeting, West Valley, NY, June 28, 2017.

R.C. Vaughan, "Ken Parker on Landscaping with Local Native Plants," *Nature Preserves* **17**, no. 3 (August 2017), 4-5.

R.C. Vaughan, "Jay Burney on the Buffalo Outer Harbor and Times Beach Nature Preserve," *Nature Preserves* **17**, no. 4 (November 2017), 1-2.

R.C. Vaughan, "Unresolved Issues for Disposal of Radium-bearing Wastes at Hakes Landfill," presented at Sierra Club/CCAC Public Meeting, Campbell, NY, February 10, 2018, available at <https://www.youtube.com/watch?v=8YuC6cHWd3A>.

R.C. Vaughan, "Controlling Aquatic Invasive Species in Ships' Ballast Water: A New York State perspective," presented at Nature Sanctuary Society of Western New York Spring membership meeting, Amherst, NY, March 4, 2018.

R.C. Vaughan, "Scoping: An important early step in the environmental review process that will guide cleanup decisions for buried waste at the West Valley nuclear waste site," presented at public meeting on scoping issues, Springville Center for the Arts, Springville, NY, March 11, 2018.

R.C. Vaughan, "Geology of the Cattaraugus Creek watershed and West Valley nuclear waste site," presented at public meeting on scoping issues, Crane Branch Library, Buffalo, March 15, 2018.

R.C. Vaughan, "A Likely Story: The Niagara Escarpment and Gorge," presented at Buffalo Geological Society meeting, April 6, 2018.

R.C. Vaughan, "Restoring the Niagara Gorge: Dave Spiering's Firsthand Look at the Transformation Process of One of Western New York's Most Significant Natural Areas," *Nature Preserves* **18**, no. 3 (August 2018), 1-3.

R.C. Vaughan, "Two Presentations on Invasive Species at the March Membership Meeting," *Nature Preserves* **18**, no. 3 (August 2018), 8-10.

R.C. Vaughan, "Paddling the Thelon: Ellen Gendreau's Northern Adventure," *Nature Preserves* **18**, no. 4 (November 2018), 1-4.

R.C. Vaughan, C. Konieczny, M.P. Wilson, and J.C. Swift, "Exploring the Geologic History of Zoar Valley through Research at Alexander Preserve," *Nature Preserves* **19**, no. 1 (February 2019), 17-22.

R.C. Vaughan, "Expert overview of poorly characterized impacts from salt mining under Cayuga Lake," presented (as part of joint presentation by R. Lippes, S. McCloud, and R.C. Vaughan) at Water Law II symposium, Cornell Law School, Ithaca, NY, March 22, 2019.

R.C. Vaughan, "Robbyn Drake: Exploring New Funding Options for the Society," *Nature Preserves* **19**, no. 2 (April 2019), 3.

R.C. Vaughan, "Tales to Be Told around a Campfire: Gerry Rising Looks Back at His Many Years Afield," *Nature Preserves* **19**, no. 3 (August 2019), 1-3.

R.C. Vaughan and A.O. James, *Vision for Skyway Corridor and relocated NY Route 5 highway*, Part 2 Technical Submission to the Competition to Re-Imagine the Buffalo Skyway Corridor, August 16, 2019 (61-page report and four presentation boards; one of nine finalist entries in the Competition sponsored and administered by New York State/Empire State Development).

R.C. Vaughan, "Conservationist in Chief: Judi Geer on Theodore Roosevelt and his Conservation Legacy," *Nature Preserves* **19**, no. 4 (November 2019), 1-3.

R.C. Vaughan and M.P. Wilson, "An Update on Geology Research at the William P. Alexander Preserve," *Nature Preserves* **19**, no. 4 (November 2019), 3.

R.C. Vaughan, "Evidence of High Levels of Radium and Radon in Hakes and Chemung Landfills," Sierra Club/CCAC webinar (part of joint presentation by D.O. Carpenter and R.C. Vaughan), March 28, 2020, available at <https://youtu.be/vhY48XfwQI>.

R.C. Vaughan, "Algonquin Wildlife Research: Patrick Moldowan Delivers Spring Membership Lecture," *Nature Preserves* **20**, no. 2 (April 2020), 1-3.

EXHIBIT B

Lucidi, Christopher M (DEC)

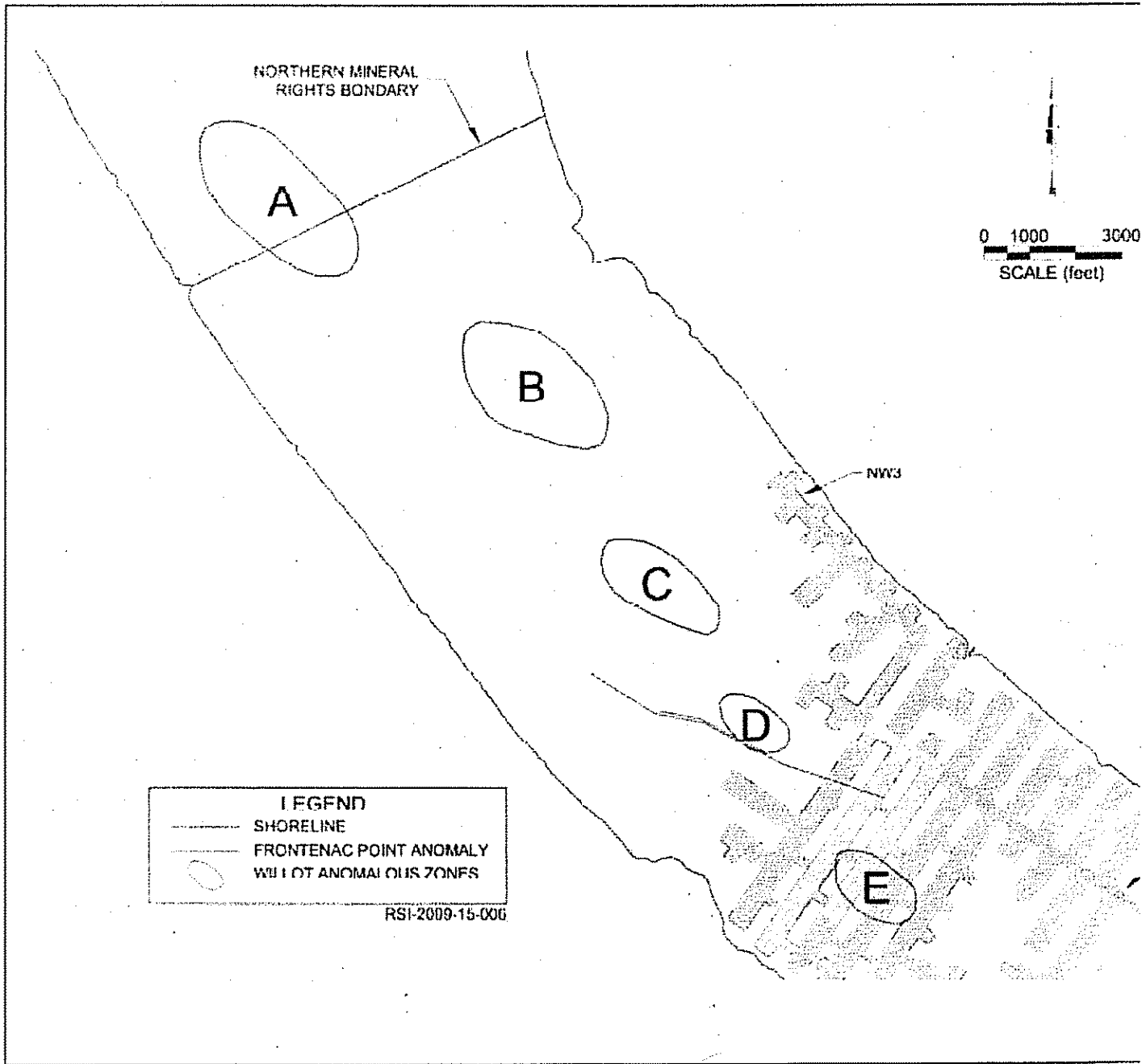
From: Army, Steve (DEC)
Sent: Monday, October 24, 2016 11:24 AM
To: Podniesinski, Matthew J (DEC); Rodriguez, Simone S (DEC); Lucidi, Christopher M (DEC); McKelvey, Christopher J (DEC)
Subject: Fw: RESPEC update

FYI.

Steven M. Army
Region 8 Mining Program Supervisor
Office: 585-226-5372
Cell: 585-319-1012
Fax: 585-226-6323

From: [BOYD COMPANY]Vincent A. Scovazzo <v-scovaz@jtboyd.com>
Sent: Thursday, October 20, 2016 12:53 PM
To: Army, Steve (DEC)
Subject: RE: RESPEC update

ATTENTION: This email came from an external source. Do not open attachments or click on links from unknown senders or unexpected emails.



Vincent A. Scovazzo PhD, PE, PG
 Director of Geotechnical Services
 John T. Boyd Company
 307 Riverwood Street
 Richland, WA 99352

509 627 1190

From: Army, Steve (DEC) [mailto:steve.army@dec.ny.gov]
Sent: Thursday, October 20, 2016 9:02 AM
To: [BOYD COMPANY]Vincent A. Scovazzo
Subject: RE: RESPEC update

EXHIBIT C

RSI-2099-15-053

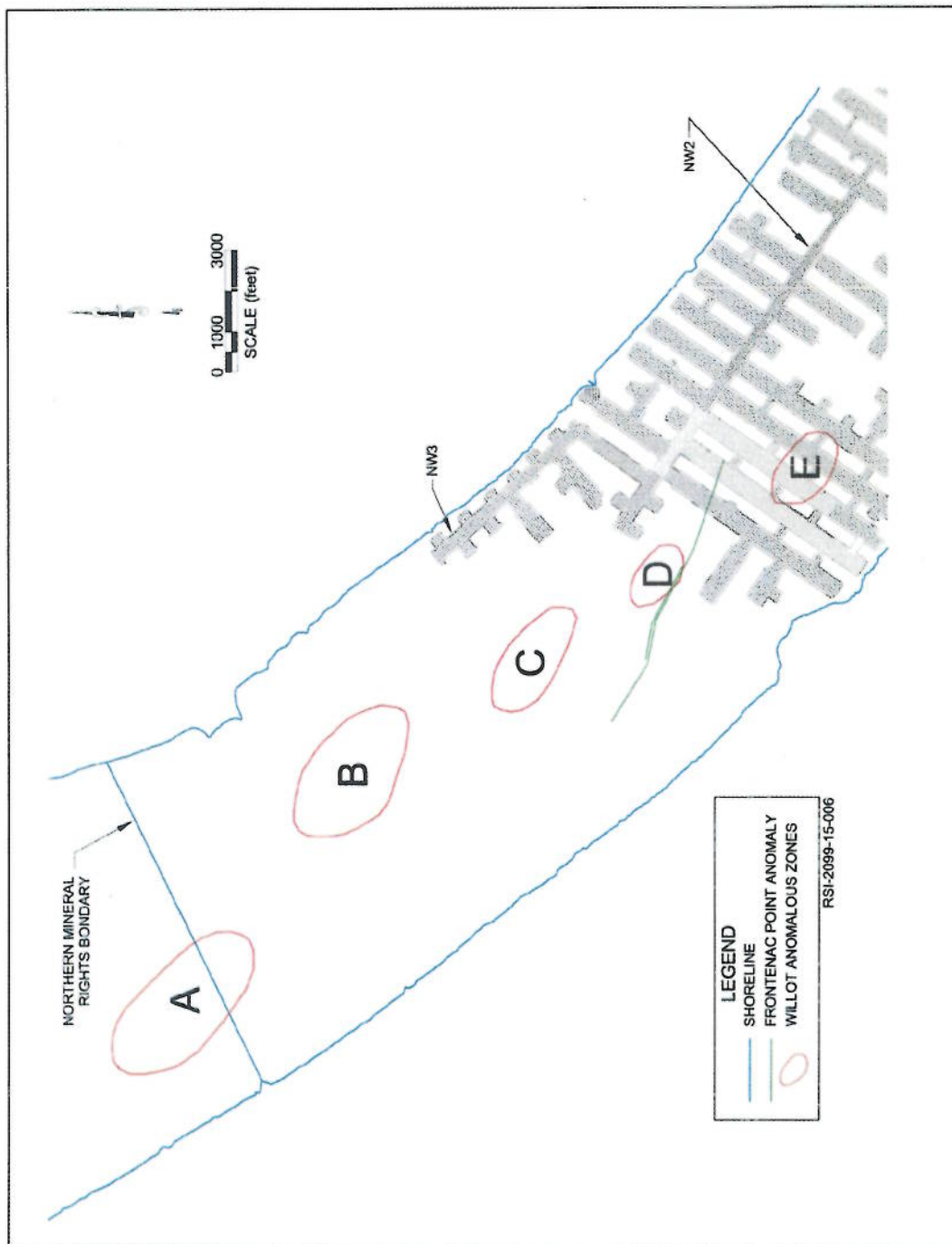


Figure 1-1. Mine Map of the Cayuga Mine Northern Reserves.

EXHIBIT D

**John T. Boyd Company**

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James W. Boyd

President and CEO

John T. Boyd II

Managing Director and COO

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Vice Presidents

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February 22, 2018

File: 2499.004

New York State Department of Environmental Conservation
 Bureau of Resource Management & Development
 Division of Mineral Resources
 625 Broadway, Third Floor
 Albany, NY 12233-6500

Attention: Mr. Matthew Podniesinski
 Director, Bureau of Resource Development
 and Reclamation

Subject: Scour and Frontenac Point Anomalies
 Cayuga Mine, Cargill Deicing Technology, Inc.
 Seneca and Tompkins Counties, New York

Gentlemen:

At the request of the New York State Department of Environmental Conservation (NYSDEC), John T. Boyd Company (BOYD) has summarized the progress of research and engineering design in reference to overburden anomalies in the northern reserves of the Cayuga Mine of Cargill Deicing Technology.

BOYD became aware of what was then called the "disturbed salt area" and now known as the Frontenac Point Anomaly (FPA) during meetings with the staff at the Cayuga Mine who expressed a concern about mining north. During one of the initial meetings David Plumeau forwarded a report by Stearns & Wheler and Syracuse University¹ which reported on a seismic study of Cayuga Lake. This paper is the first to present a seismic survey of the lake and noted that the deepest glacial scour of the bed rock occurred one third of the way up the lake from Ithaca where the bedrock is eroded to 1,175 ft below lake level. They note that the scouring is likely controlled by the Onondaga Limestone.

¹ Hinchley, Edward J., H.T. Mullins, and A. Hine, 1991, Seismic Stratigraphy and Depositional History of Cayuga Lake, Geologic Society of America Special Paper - The Origin and Evolution of the New York Finger Lakes.

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After the review of this paper, BOYD noted that the FPA is located at the intersection of two defined linears that corresponds to joint swarms identified by Engelder and Geiser²; joint swarm Ia that strikes north-south and joint swarm II that strikes east-west and parallels the regional folding. The lake bottom generally parallels joint swarm Ib. This location is just north of the kimberlite dykes swarm (Ithaca Kimberlites³) that parallels joint swarm Ia and may be a contributing factor to poor mining conditions in the southern extent of the Cayuga Mine.

In 1998, BOYD⁴ wrote a letter to the NYSDEC about the FPA and both the NYSDEC and BOYD became mindful of this disturbed zone. Concerns focused on the global stability of the mine, the potential inundation of the mine thus affecting the safety of the miners, and the potential of adversely affecting Cayuga Lake. Cargill agreed to avoid the disturbed area until further study was completed.

After further study of the FPA, BOYD⁵ reported in 2002 to NYSDEC that the disturbed area appeared to be a graben-like structure with a vertical displacement of approximately 100 ft and that further investigations are needed before mining could proceed into this zone.

NYSDEC Response

The NYSDEC added the following conditions to the 2003 mine permit:

- Special Conditions 18 – Cargill shall conduct further investigations of the disturbed salt zone, identified by seismic survey and shown on No.6 Salt structure contours (top of salt), which may exist near the west shore of the lake in the northern extended mineral lease area. Mine projections show that present plans are to extract this area sometime between 2016 and 2020. Further investigation of this disturbance needs to be completed and submitted to the Department for review before mining proceeds in this area.
- Special Conditions 19 – Cargill shall conduct further investigations and report on the adequacy of the thin rock overburden at the northern extent of the mineral lease area

² Engelder, Terry and Peter Geiser, 1980, On the use of regional joint sets as trajectories of paleostress fields during the development of the Appalachian Plateau, New York, Journal of Geophysical Research, Volume 85, Issue B11, Pages 6319–6341, 10 November.

³ Mahlburg Kay, Suzanne, William T. Snedden, Brayton P. Foster, and Robert W. Kay, 1983, Upper Mantle and Crustal Fragments in the Ithaca Kimberlites, The Journal of Geology, Volume 91, Number 3, May.

⁴ Scovazzo, Vincent A., 1998, Meeting of December 19, 1997, Cayuga Mine, Cargill Salt, letter to C. B. McGranahan, New York State Department of Environmental Conservation, John T Boyd Company project number 2499.2, January 5.

⁵ Scovazzo, Vincent A. and Russell P. Moran, 2002, Review of the Mined Land Use Plan, Cayugs Mine, Cargill, Inc., prepared for New York Department of Environmental Conservation, John T. Boyd Company Report No. 2499.4, February.

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where the solid rock overburden becomes thinner where the glacial till and lake sediment thickens and lake depth increases and where mining is proposed for this area after 2030. This condition must be thoroughly analyzed for stability by Cargill and reviewed by the Department before mining proceeds in this area.

These conditions are repeated in the presently enforced permit as 9.a. and 9.b.

In 2009, Boyd / PetroSearch⁶ further defined the lake scour and identified five areas of deep gouge that were labeled as anomalies A through E within the continuous scour. One of these anomalies (Anomaly E) had already been undermined without affecting the mine's global stability. Since the anomalies are located in the northern mine reserve, Anomalies A through D would then require additional study before mining below these anomalies would be permitted. If these studies determined that mining will not adversely affect global stability or adversely affect Cayuga Lake, it would follow that mining between these anomalies will also have no adverse effects.

On December 24, 2010, NYSDEC⁷ affirmed and agreed that Cargill's suggested stand-off of 1,000 ft around the FPA, where no mining will be permitted, is reasonable. NYSDEC noted that if further consideration is to be given to this distance, additional information will need to be submitted to the Department for review and approval.

On March 13, 2015, BOYD and the NYSDEC recognized that mining options at the Cayuga Mine were becoming limited and would cause Cargill to develop northward and possibly require mining under the scour anomalies (A through E). It was decided that

⁶ Willott, Richard, 2010, Geophysical Progress Report, Analysis of the Frontenac Point Anomaly, Cayuga Mine, for Cargill Salt Division, Boyd / PetroSearch Project #20101017, August 3, 2010.

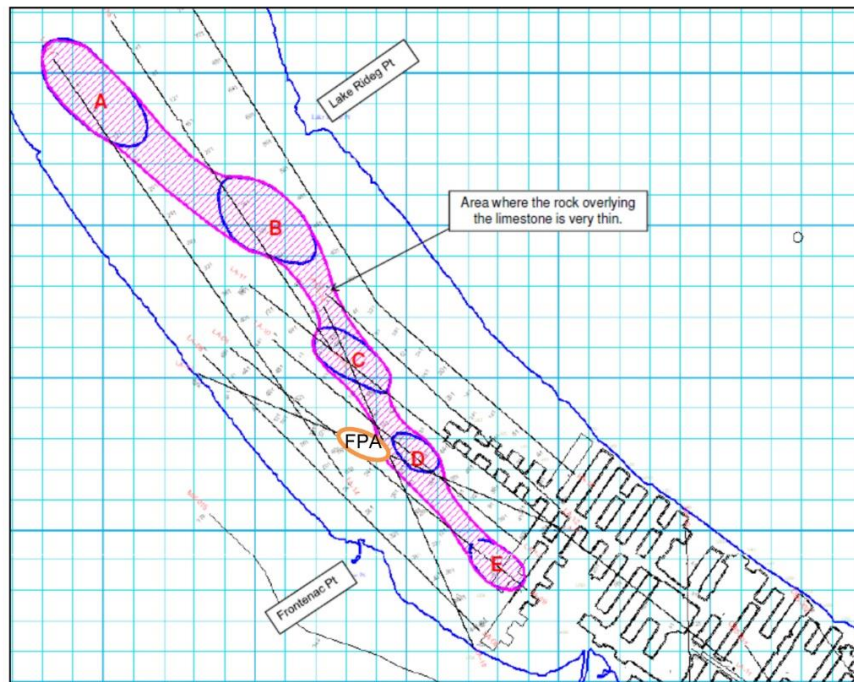
⁷ Army, Steven M., 2010, Cayuga Salt Mine MF#70052, New York State Department of Environmental Conservation letter to Russell S. Givens, Cayuga Mine, December 24.

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BOYD and the NYSDEC would emphasize in discussions with Cargill that investigations of the FPA and all scour anomalies should quickly move forward.



Scour Anomalies A through E as Identified by Willott⁶, the FPA Placed on Figure by BOYD

Further Seismic Studies by Cargill

In 1994, Cargill purchased a 1984 commercially available seismic survey from GeoData Corporation to further understand the geologic setting of the Cayuga Mine. GeoData reprocess the data and the interpretation was completed by Sear-Brown Group. In 1995, Cargill hired Bay Geophysical to complete extensive seismic surveys of the southern half of the Cayuga Lake. These data were processed by GeoData and interpreted by Sear-Brown Group. The results of the 1995 survey were considered good to poor but adequate to identify the mine location. In 1996, Cargill hired Duncan Exploration, Inc. to complete a land based survey. These data were processed by GeoData and interpreted by Sear-Brown Group. These studies showed the FPA and a lake scour.

Two additional lake seismic studies were completed in 2009 and 2016 to define the depth, location, and geology of the anomalies. In addition, the 1995 and 1997 data were reanalyzed because of advancement in software. In 2009, Cargill hired Walker Marine Seismic for a lake seismic survey; these data were processed by CGG Veritas and interpreted by Boyd / PetroSearch and RESPEC, which further defined possible limestone fracturing and the extent of the FPA.

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In 2016, Bay Geophysical was again hired to complete a cross lake survey; these data were processed by Sterling Seismic Services and interpreted by Corona Consulting and RESPEC, which further defined the anomalies.

These seismic studies have been evaluated by Dr. William Goodman (RESPEC and Sear-Brown), John Clark (Corona Consulting), Richard Willott (Boyd / PetroSearch), and John Schneider (RESPEC). It was reported⁸ that this group believes that the anomalies represent erosion of bed rock that extends into the Helderberg limestone. The group could not discount faulting beneath the anomalies and confirmed that the FPA represents a fracture in the limestones but there was no convincing evidence of lower limestones collapse due to salt solutioning.

Boyd / PetroSearch reported on the 2009 study defining the five scour anomalies (A through E) noting that the C and D anomalies show a "... maximum disturbance, where the upper salts may be leached, and the overlying carbonates broken and discontinuous."

Cargill Engineering Studies of the Anomalies

Cargill, in their letter to BOYD⁹ notes. "...work has begun on re-evaluating the geologic anomaly previously identified on seismic lines north of Frontenac Point. At this time, development mining has stopped in the NW-2 mains..."

In 2007, RESPEC addressed the FPA¹⁰ calling it a "suspected geological structure" and this anomaly was identified by a seismic study located approximately 2,400 ft north of Frontenac Point. Based on seismic studies, RESPEC suggested that the anomaly is a deep penetrating, nearly vertical, east-west-trending fault.

Of interest to RESPEC was Seismic Line 7, located on the west side of the lake that may show that the anomaly likely penetrates the Syracuse Formation. There is a down warping of the strata on both sides of the anomaly extending up through the lower half of the glacial till and is reminiscent of a collapse due to salt-dissolution.

⁸ Plumeau, David, 2017, Memorandum, Assessment of the Feasibility of Mining Beneath the "C" Anomaly, Cargill Deicing Technology, Cayuga Mine, to Vince Scovazzo, John T. Boyd Company, October.

⁹ Plumeau, David, 2007, untitled letter to Vincent A. Scovazzo, John T. Boyd Company, February 20.

¹⁰ DeVries, Kerry L., Paul E. Nelson, Leo L. Van Sambeek, William M. Goodman, 2007, Mine Stability Assessment, Cargill Deicing Technology, Cayuga Mine, Lansing, New York, RESPEC Topical Report RSI-1913, prepared for Cargill Deicing Technology, January.

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RESPEC recommended that Cargill complete a floor elevation survey of NW2 and surrounding production panels that may indicate if a fault is near and possibly represents the FPA. Also, a face-drilling program was recommended to characterize the anomaly before mining the salt below the anomaly.

RESPEC cautioned that brine may be associated with the FPA and that as the anomaly is approached, the vertical distance between the salt and the base of the groundwater-saturated rock is likely to decrease. RESPEC notes that the NW2 mains at the time were close to the valley axis where the overlying carbonates will thin to less than 130 ft and recommended that the mains be shifted to the east. This shift has been completed by Cargill.

In 2014 RESPEC¹¹ noted "Well data in the northern part of the Cayuga Lake Valley have determined that brine is present on top of and in between beds in the Salina Group. The Frontenac Point Anomaly may reflect the southern extent of water infiltration." RESPEC opined that the planned 1,000 ft buffer around the FPA should prevent a hydraulic connection with the mine. Further, "As the mine progresses north, micro-seismic monitoring to detect anomalies and drilling in advance of the faces to detect an increase in moisture or presence of water is recommended as a precaution."

In 2016 RESPEC¹² designed large pillars for the C Anomaly that would reduce shear in the overlying salts and reduce shear to insignificant levels in the limestones.

Mr. Petersen¹³ noted that due to the theory "... that the abnormal closure in U12, U40B and perhaps U24 could be due to hydraulic pressure within the de-stressed zone of the yield pillar panel design, it was wisely decided not to use the YPP (yield pillar panel) design to mine the northern reserves where the potential for high pressure/high volume aquiferic water in conjunction with large geological anomalies could bring water too close to the mining horizon. The concern being that the YPP design creates a low stress (destressed) zone above that panel that attracts higher pressure fluids in the rock strata, which given a geological conduit will flow into the de-stressed zone resulting in abnormal panel closure."

¹¹ DeVries, Kerry L., William M. Goodman, and Cody A. Vining, 2014, Mine Stability Assessment, Cargill Deicing Technology, Cayuga Mine, Lansing, New York, RESPEC Topical Report RSI-2371, prepared for Cargill Deicing Technology, April.

¹² DeVries, Kerry, 2016, Large Pillar Design, RESPEC, September 15. As Large Pillar Design 9-19-16 V2.pdf last modified on September 20, 2016.

¹³ Petersen, Gary, 2016, Cayuga Mine, Thoughts on Mining the Northern Reserves, prepared for David Plumeau, Cargill Deicing Technology, RockTec Solutions, August 27.

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In addressing the big pillar design of RESPEC to undermine C Anomaly, Petersen continues “The big pillar design doesn’t create a de-stressed zone above the panel, making it a much better design for potential water pressure situations.” Thus “... the potential for developing a leak is much lower ...” and “We know from experience that the big pillar design is prone to shear the roof along the roof/pillar contact out over the room and in some cases results in a rather large roof fall.”

In reference to a set of yield pillars that will result in the three entry access to the large pillar area Mr. Petersen notes “The load transfer from the YPP initially goes to the edge of the adjacent big pillar and creates a relatively high peak load along the edge of the pillar ... which can cause roof shears to develop rather quickly.”

Large roof falls at pillar edge and roof shear at the YPP – big pillar transition, as discussed by Mr. Petersen, are local events and not a factor in, or represent, global instability.

Drilling Investigation of Anomaly C

Several Investigators, including BOYD, RESPEC, and the group that evaluated the 2009 and 2016 seismic studies, had recommended drilling Anomaly C to verify assumptions and to clarify conditions. BOYD noted to Cargill that some of the questions about the anomalies could be clarified including:

- Whether or not a brine layer existed within the #4 Salt and the immediate roof.
- If water or brine exists, whether or not it is under pressure suggesting a connection to the lake or groundwater.
- Determine if a fault exists.
- Verify the thickness of the salt to show that solutioning did not occur or was minimal.
- Determine if down warping exists.

This planned drilling program was developed by Cargill and presented to NYSDEC and BOYD.

Mr. Plumeau⁸ presented the results of this drilling program to BOYD in 2017. In his words “Although the computer modeling suggests there is no risk of large pillar mining under the C anomaly, Cargill chose to do advanced drilling to verify that there was no water present at a level 260’ above the mine horizon in the footprint of the C anomaly. The drill hole was angled up into the #4 salt bed then deflected horizontally. That region is well above the expected de-stressed strata created by large pillar mining. The drill

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hole and side tracks covered the length and width of the C anomaly as defined by lake seismic work.”

Before drilling commenced into the 4 Salt, the holes were shut-in and the wellhead and the casing was successfully tested to 1,500 psi and held at 1,200 psi.

After each drilling day, the drill hole was allowed to drain for about 25 to 30 minutes and then sealed. When checked in the morning, the hydraulic head would be about 75 ft (32.5 psi). At day’s end, the hole was allowed to drain for 45 minutes, and the following morning pressure rise was noted to be insignificant.

After drilling was completed, the holes were shut in (i.e., sealed) and the pressure checked every week. Mr. Plumeau noted that “There has been zero pressure increase when shut-in.” “Opening the valve at the collar results in zero discharge of gas or brine—it is a dry hole.”

“... drilling totaled over 8,000 lineal feet and has undulations and side tracks vertically up and down, and horizontally.” For long-term monitoring, Cargill plans to install micro-seismic geophones in the hole and leave it open. Cargill will place a barrel under the collar of the hole and a conductivity meter will be placed in the barrel to monitor water discharge. If water enters the barrel, the meter will alert Cargill that the hole is draining water.

The hole was developed by REI Drilling Inc.¹⁴ during March and September 2017 and “... installed one (1) multi-lateral directionally drilled borehole for exploration of the projected C Anomaly. REI drilled an exploratory borehole laterally within the 4 Salt seam to verify continuity of salt and the presence or lack of water in the formation. The borehole originated from H2 crosscut within U72 in the Number 6 Salt Bed and directionally drilled up to the 4 Salt seam. Five (5) roof tags and two (2) floor tags were drilled within the main borehole. Additionally, three (3) branches were drilled to the C Anomaly estimated extent.”

¹⁴ Schumacher, Forrest, 2017, Report of Directional Drilling for Exploration of the C Anomaly at Cargill’s Cayuga Mine, to Alex Greenblatt, Cargill Deicing Technology, REI Drilling Inc., October 16.

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Drilling description:

Depth (ft)	Diameter (inches)		Notes
	Hole	Casing	
162	12.75	8	Centralizers, grouted
540	6.75	4	
8,494	3.8	open hole	

The total depths achieved in each branch of the drilling program were:

Branch Name	Total Depth (ft)
Main Branch	3,570
Branch #1	3,875
Branch #2	3,894
Branch #3	3,364

Drilling hole direction and hole location was maintained by a non-magnetic directional drilling motor and a DDMS survey tool that measures orientation.

“Drilling did not encounter any anomalous conditions within the 4 Salt, which was verified by monitoring drill cuttings, gamma counts from the survey tool, and measuring shut-in pressures at the wellhead.”

“The 4 Seam thickness was estimated by drilling corresponding roof and floor tags (side-tracks) at boreholes depths of 3,166 ft (roof), 3,228 ft (floor), 3,530 ft (floor), and 3,549 ft (roof). REI estimates salt thickness of 48 ft and 32 ft at depths of 3,020 ft DT and 3,370 ft DT respectively. Gamma counts ... show continuity of salt in all lateral portions of the borehole.” BOYD notes that at the nearby Borehole 18, the 4 Salt was 48 ft thick.

Conclusions

After reviewing the data presented to BOYD by Cargill, BOYD recommended that Cargill be permitted to mine under the C Anomaly using RESPEC's large pillar design, but not under the other scour anomalies or the FPA. It is BOYD's opinion that the 1,000 ft no-mining buffer should remain around the FPA and that mining under the Anomaly D and the FPA not be permitted because of the close proximity of these two anomalies. Mining under the A and B anomalies will require additional investigation specific to those anomalies and be reviewed and evaluated by BOYD and the NYSDEC before progressing.

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BOYD arrived at this conclusion because the seismic surveys defined the extent of the C Anomaly, RESPEC designed a large pillar configuration to reduce stress in the 4 Salt and carbonates, and the drilling program showed:

- No brine or water was under pressure in the 4 Salt.
- Brine in the 4 Salt and its roof was not present in any significant quantities.
- Faulting was not detected.
- The 4 Salt was of expected thickness thus salt solutioning was minimal or did not occur.
- Down warping was either not present or minimal.

BOYD and the NYSDEC will monitor mining progress and the global stability under the C Anomaly by review and analysis of:

- Water/brine discharge from the C Anomaly exploration hole which may indicate if a connection develops between the 4 Salt or roof to groundwater or lake.
- Closure stations which will allow insight into opening behavior.
- Visual observation of mine conditions.
- Results from the Cayuga Mine micro-seismic monitoring system which will show activities within the overburden above the 6 Salt.

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

Respectfully submitted,

JOHN T. BOYD COMPANY

By:



Vincent A. Scovazzo
Director of Geotechnical Services

Copy to:

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