

# Reply to “Open Letter to Governor Andrew Cuomo and the NYSDEC on the Safety of Continued Salt Mining under Lake Cayuga”

July 21, 2017

The Honorable Andrew M. Cuomo  
Governor of the State of New York  
The Capitol  
Albany, NY 12224

Dear Governor Cuomo:

The recent open letter from Prof. Lawrence Cathles to you raises a number of interesting and informative points that are said to contradict CLEAN’s finding that the DEC Negative Declaration for Cargill’s Cayuga Mine/Shaft #4 should be rescinded.<sup>1</sup> We agree with much of what Cathles says; however, we disagree with the logic he uses to support the Negative Declaration. Part of the problem is that Cathles apparently misunderstands the SEQRA threshold that separates an EIS process from a Negative Declaration:

- (1) To require an EIS for a proposed action, the lead agency must determine that the action *may* include the potential for at least one significant adverse environmental impact.
- (2) To determine that an EIS will not be required for an action, the lead agency must determine either that there will be no adverse environmental impacts or that the identified adverse environmental impacts will not be significant.<sup>2</sup>

Thus, an EIS is required if there *may* be the potential for at least one significant adverse environmental impact; no EIS is required if there *will* be no adverse environmental impacts or that such impacts *will* not be significant. While this is part of the misunderstanding, we believe there are many other crucial links in Cathles’ logic that don’t hold up well to closer scrutiny.

## **Salinization risk from mine flooding and subsequent collapse/closure**

Weaknesses in the letter’s logic are most evident in what Cathles says under the heading “Flaws in the Technical Arguments for Reversal,” subheading “Lake Salinification.” Speaking of the risk that mine flooding would dissolve unmined salt, and that the salty water would then be squeezed out into Cayuga Lake as the mine closed or collapsed, he says “This risk was not quantified. When quantified, it largely disappears.” While Cathles’ quantification of the risk is on the right track, he does not show that the risk “largely disappears.” On the contrary, his risk

---

<sup>1</sup> DEC has issued a Negative Declaration under the State Environmental Quality Review Act (SEQRA) and its implementing regulations (6 NYCRR Part 617). A Negative Declaration is a determination that an Environmental Impact Statement (EIS) will not be required for a given action. Cayuga Lake Environmental Action Now (CLEAN) has stated that the Negative Declaration should be rescinded and that an EIS process needs to be conducted.

<sup>2</sup> 6 NYCRR 617.7(a), emphasis added.

calculations show why, under DEC's own policies and rules, the SEQRA negative declaration must be rescinded and an EIS process must be initiated.

Cathles provides three examples, using time constants of 100, 200, and 500 years for exponential rates of mine collapse. These examples show Cayuga Lake salinity increasing by as much as 175 ppm, 100 ppm, and 45 ppm, respectively, from brine being squeezed out of the mine. Based on these results, he argues that "even if the mine flooded and collapsed in the worst fashion conceivable, the salinity risk to Lake Cayuga would be small, and this small salinity increase could be reduced or eliminated if that were deemed desirable." His assertion that his calculated salinity risks to Lake Cayuga "would be small" is inconsistent with federal and state laws, rules, and policies on both Clean Water and environmental review. Without going into full detail here, it is important to recognize that there are federal and state requirements for water quality standards and Water Quality-Based Effluent Limits (WQBELs); that New York has a statewide antidegradation policy for water quality;<sup>3</sup> and that, even though there are no federal or state designated limits for sodium in drinking water,<sup>4</sup> the NYS Health Department advises that "Water containing more than 20 mg/L of sodium should not be used for drinking by people on severely restricted sodium diets."<sup>5</sup> Given these environmental and public health considerations, and given the SEQRA EIS requirements, there can be no plausible argument that salinity discharges resulting in lakewide salinity peaks such as 175 ppm, 100 ppm, or 45 ppm are so insignificant that they should escape environmental review. The correct vehicle for such a review is an EIS process.

Cathles states not only that "the salinity risk to Lake Cayuga would be small" but also that "this small salinity increase could be reduced or eliminated if that were deemed desirable." An EIS process is also the appropriate vehicle for assessing mitigating measures that could reduce or eliminate salinity increases. At one point in his letter, Cathles correctly notes that "Flooding of the mine would be a disaster to Cargill and its employees," and we certainly agree. In its assessment and balancing of various interests, an EIS must include impacts to the company and employees.

Cathles argues that his own calculations provide bounding upper limits on salinization of Cayuga Lake, but this is not true. He correctly notes that other input values (such as ~10 years rather than 18.2 years for Cayuga Lake residence time) may lower the calculated salinity; however, his own salinity calculations are too low for a given mine volume due to offsetting factors that he

---

<sup>3</sup> See September 9, 1985 *Organization and Delegation Memorandum Number 85-40*. For the Great Lakes System, this statewide policy is supplemented by implementation guidance in TOGS 1.3.9 (see <http://www.dec.ny.gov/chemical/23853.html>).

<sup>4</sup> Sodium (Na) is one of the elements in salt (NaCl). About 39% of the weight (or concentration) of salt is sodium; about 61% is chlorine. A concentration of 20 mg/L sodium corresponds to 20 ppm sodium and corresponds to approximately 51 ppm salt.

<sup>5</sup> See [www.health.ny.gov/regulations/nycrr/title\\_10/part\\_5/subpart\\_5-1\\_tables.htm](http://www.health.ny.gov/regulations/nycrr/title_10/part_5/subpart_5-1_tables.htm). Note that the additional sodium associated with Cathles' calculated salinity increases would be in addition to current sodium levels in the lake. Bolton Point Municipal Water System's *2017 Drinking Water Quality Report* indicates that up to 39 mg/L sodium was detected in water drawn from Cayuga Lake.

failed to take into account. His calculations need to be corrected for the density of saturated brine (this would raise his calculated Cayuga Lake salinity increase by about 20%) and for the fact that the given mine volume will increase when fresh water floods the mine and dissolves additional salt (thus raising his calculated salinity by an additional 18% or so<sup>6</sup>). Furthermore, ongoing salinization is not necessarily capped by the volume of fresh water that floods the mine and is then expelled. Ongoing percolation of fresh water through a partially collapsed mine may continue to dissolve salt and cause long-term brine impacts, limited mainly by the supply of unmined salt, analogous to the upwelling salinity experienced in the Tully Valley.<sup>7</sup> Even more significantly, Cathles' salinity calculations are lakewide averages, but brine squeezed out of a flooded mine would enter the southern part of the lake, perhaps in the vicinity of Taughannock State Park. Such a salinity discharge from the mine would experience poorer flushing efficiency than a discharge nearer the north end of the lake, and the localized discharge would create substantial salinity gradients within the lake, with peak values near the discharge being substantially higher than lakewide averages. In any case, while there may be too many variables to allow an exact calculation of the salinity risk to Cayuga Lake due to mine flooding, Cathles' calculations should be regarded as working approximations rather than upper limits.

### **Risk of mine flooding through Shaft #4 during its reaming process**

Cathles goes on to discuss the risk of mine flooding that CLEAN has identified as a concern during the reaming of Shaft #4. His cross-sectional diagram provides a clear illustration of many of the relevant features, the only major discrepancy being the orange-shaded aquiclude that is shown overlapping the Onondaga/Oriskany contact. In the text of his letter he refers to, and thus apparently recognizes, the Onondaga/Oriskany contact as a permeable or water-transmissive unconformity, so its blockage by the orange-shaded aquiclude may just be an artifact of his drawing.

What seems to be missing in Cathles' discussion of the risk of mine flooding is a good understanding of fracture flow, meaning the secondary porosity which is highly locally variable (on the order of inches or feet) in the sedimentary bedrock of the Finger Lakes region. Fractures are pervasive in the region's bedrock, but a given fracture's ability to transmit groundwater is highly variable, depending on 1) the width or aperture of the fracture and 2) whether it's interconnected with other fractures. Fracture aperture is important because flow varies with the third power of the aperture – so that tripling the aperture of a narrow fracture, for example, would accommodate 27 times greater flow than in the narrow fracture – but such relationships only matter when fractures are sufficiently interconnected to form a completed pathway for groundwater flow through bedrock. Such completed pathways typically pass through a

---

<sup>6</sup> P. Bérest, B. Brouard, and B. Feuga, *Dry Mine Abandonment*, Solution Mining Research Institute (SMRI) Technical Conference Paper, Wichita, KS, Spring 2004 (<http://www.brouard-consulting.com/sites/default/files/smri-wichita.pdf>), p. 6. The increase in mine volume due to salt dissolution will be 18% if the mine is flooded with fresh water or may be somewhat lower if the mine is flooded with saline water. The increase in the calculated salinity of Cayuga Lake will be the same, on a percentage basis, as the increase in mine volume due to salt dissolution.

<sup>7</sup> For example, see W.M. Kappel, *The hydrogeology of the Tully Valley, Onondaga County, New York—An overview of research, 1992–2012*, USGS Open-File Report 2014–1076 (2014).

combination of wide and narrow fractures, with the narrowest fractures effectively throttling and limiting the flow.

Speaking of the unconformable Onondaga/Oriskany contact and the fault which may intersect Corehole 18, Cathles says “The permeability might vary laterally within these features, but the low permeability measured by the Corehole shows that at least parts of these surfaces are not especially permeable.” We agree but fail to see the logic. As indicated above, fracture flow is extremely variable over short distances, so the fact that the relatively small diameter Corehole did not intercept highly transmissive fractures provides little guidance about whether a 14-foot or 18-foot shaft would do so.<sup>8</sup> This uncertainty has been acknowledged by Cargill’s consultant RESPEC.<sup>9</sup> RESPEC would probably not conclude that this uncertainty encompasses Retsof-scale inflow rates, nor do we consider such high inflow rates likely – *but the probability is not zero. This is the type of high-consequences, low-probability event that would typically meet the threshold for review within an EIS process.* Further testing is needed in order to characterize the fracture networks in the vicinity of Corehole 18 and to provide a better understanding of the risk.

Part of the concern about mine flooding during the reaming of Shaft #4 is the *completed flow pathway* to the Corehole 18/Shaft #4 location from the valley fill aquifers that are supplied by Cayuga Lake. This means that a virtually unlimited supply of lake water is available to flood the mine, limited only by the narrowest fracture apertures that exist along the completed flow pathway. It is unclear whether Cathles fully recognizes this. He notes that “the standing water level in Corehole #18 is 100 ft below lake level which suggests a flow connection to the mine workings 20,000 ft (~4 miles) away,” but he doesn’t specifically acknowledge in the text of his letter that this standing water level indicates *an existing flow connection from the valley fill aquifers of Cayuga Lake*. This vast supply of water, limited only by the throttling effect of narrow apertures which may gradually or suddenly enlarge (e.g., by gradual erosion or sudden displacement of rock chips), amplifies the risk of mine flooding during the reaming of Shaft #4.

### **Low permeability and hydraulic isolation versus transmissive fracture flow**

Cathles finds that the standing water level in Corehole 18 (~100 feet below lake level) “suggests lower rather than higher inflow to Shaft #4, and confirms the hydrologic isolation of the Cayuga

---

<sup>8</sup> The diameter of Corehole 18 varies with depth, ranging from about 10.75 inches at the surface to 3.78 inches in the lower portion. See especially RESPEC, *Cargill Deicing Technology Lansing Mine, Corehole #18 Stratigraphic Test Hole, Installation and Data Collection*, Topical Report RSI-2381, November 2013, Fig. 2-1. The intended inside diameter of Shaft #4 is apparently 14 feet, with a concrete shaft with 12” walls centered in the 18-foot reamed hole. RESPEC’s estimation of groundwater inflow rates assumed an 18-inch diameter for the borehole that will be the initial enlargement of Corehole 18, and assumed 18 feet for the reamed shaft diameter. *Ibid.*, pp. 35-38.

<sup>9</sup> According to RESPEC, “The actual inflow rates are suspected to be somewhat greater because the larger diameters of the borehole and shaft are likely to intersect a more permeable feature (e.g., fracture) than the small-diameter corehole intercepted.” RESPEC, *op. cit.* p. 38. Cathles himself recognizes this, at least in part (“...testing of Corehole #18 showed low permeability, but it is feared that nearby faults with much greater permeability that were not encountered by the test drill hole could be encountered by the wider 14 ft diameter shaft”), but it is unclear whether he intended this statement to include commonly occurring *fractures* in addition to relatively uncommon *faults*.

mine.” He also says that “The standing level 100 ft below lake level and the low inflow to the mine confirm the low permeability suggested by this geology.”

His claim of hydraulic isolation is contradicted by the isotopic composition of a groundwater sample collected from Corehole 18 that indicated the presence of meteoric (post 1960) water at the Onondaga/Oriskany contact at a depth of 1,490 ft. This very relevant finding is not mentioned in his comments, as it would void his hydraulic isolation claim.

It is the operation of the Cargill mine shafts approximately four (4) miles to the south of Corehole 18, or leakage into the mine workings, that drained the potentiometric level at the Onondaga/Oriskany aquifer to approximately 100 ft below the lake level. There is no explanation for that low water level other than the impact from the prolonged shaft or mine inflows. This also serves as indirect evidence of the hydraulic continuity of the Onondaga/Oriskany aquifer between Corehole 18 and the existing shafts to the south (down-dip). Beyond that, the presence of meteoric water in Corehole 18 attests to the hydraulic continuity of the Onondaga/Oriskany aquifer in the northerly (up-dip) direction where the meteoric water can be sourced, either at the Onondaga/Oriskany subcrop below the lake or to the outcrop area.

The regional extent of this Onondaga/Oriskany aquifer is corroborated further by the fact that this discrete aquifer was the major source of bedrock groundwater that flooded the Retsof Mine.<sup>10</sup> As mine subsidence opens/increases bedding plane separations (apertures), the flow increases dramatically owing to the cubic law that states that the flow is proportional to the third power of the fracture aperture.

Given the potential impact of future subsidence at the proposed Shaft #4 on the flow along transmissive bedding separations, an inflow estimate to the Shaft that is based on a pumping test conducted in Corehole 18 likely grossly underestimates an actual future inflow from the Onondaga/Oriskany aquifer.

In addition, the shaft inflow estimate by Cargill does not include any water inflows from the upper 590 ft of the hole that was completed using air-rotary drilling and then cased-off. Available data from nearby supply wells indicates the presence of at least two bedrock water-bearing units within this interval. A yield of 60 gpm is reported for the Koplinka-Loehr bedrock supply well. The same water-bearing unit is intercepted by the 187 ft deep Ross Road bedrock well. A 225 ft deep Oursler bedrock supply well located near the lake terminates at an approximate elevation of 200 ft msl and appears to be completed into the other, deeper water bearing zone. The proposed construction of Shaft #4 will cross-connect not only these two upper bedrock units (cased-off in Corehole 18) but also the Onondaga/Oriskany aquifer with the mine level; however, RESPEC assumed no inflows from these upper units in their shaft inflow estimates.

---

<sup>10</sup> R.M. Yager, T.S. Miller, W.M. Kappel, P.E. Misut, C.D. Langevin, D.L. Parkhurst, and M.P. deVries, *Simulated Flow of Groundwater and Brine from a Flooded Salt Mine in Livingston County, New York, and Effects of Remedial Pumping on an Overlying Aquifer*, USGS Open-File Report 2011–1286 (ver. 1.1, August 23, 2012), Fig. 2.

Cargill's consultants used a simplistic concept of a uniform groundwater flow in the bedrock in the Site vicinity. They downplayed or ignored the evidence of a dominant role of bedding-parallel groundwater flow, with relatively few transmissive bedding fractures acting as discrete aquifers extending for large distances. Cargill's claim that drawdowns in transmissive bedrock units will be limited to "a few hundred feet" underestimates the actual distance of drawdown impacts along the bedding by an order of magnitude. The existing meager observations, including the low potentiometric level of the Onondaga/Oriskany aquifer in Corehole 18, indicate current drawdown impacts in this aquifer due to mine inflows over an area some 10 miles in diameter from the existing shafts. The addition of Shaft #4 will not only increase and enlarge the existing drawdown in this aquifer but will also significantly lower the water levels in the area supply wells in the upper bedrock aquifers.

In addition to such drawdown, there is also a concern that a prolonged and enhanced drainage by addition of Shaft #4 will result in upwelling and up-dip flow of saline water into the fresh water bedrock aquifers in the area.

All of these issues should be reviewed and addressed in the context of an EIS process.

### **Whether mining under lakes is riskier than mining under land**

Cathles' statements that mining under lakes is not riskier than under the land, and that there would be no negative consequences such as those experienced at Retsof because the Cayuga salt mine is overlain by a lake, are simply not accurate.<sup>11</sup> These statements, apparently meant to minimize environmental impacts if the Cayuga mine is rapidly flooded, do not serve their intended purpose. They reflect an incomplete understanding of actual hydrogeologic conditions, which was one of the major factors behind the Retsof collapse.

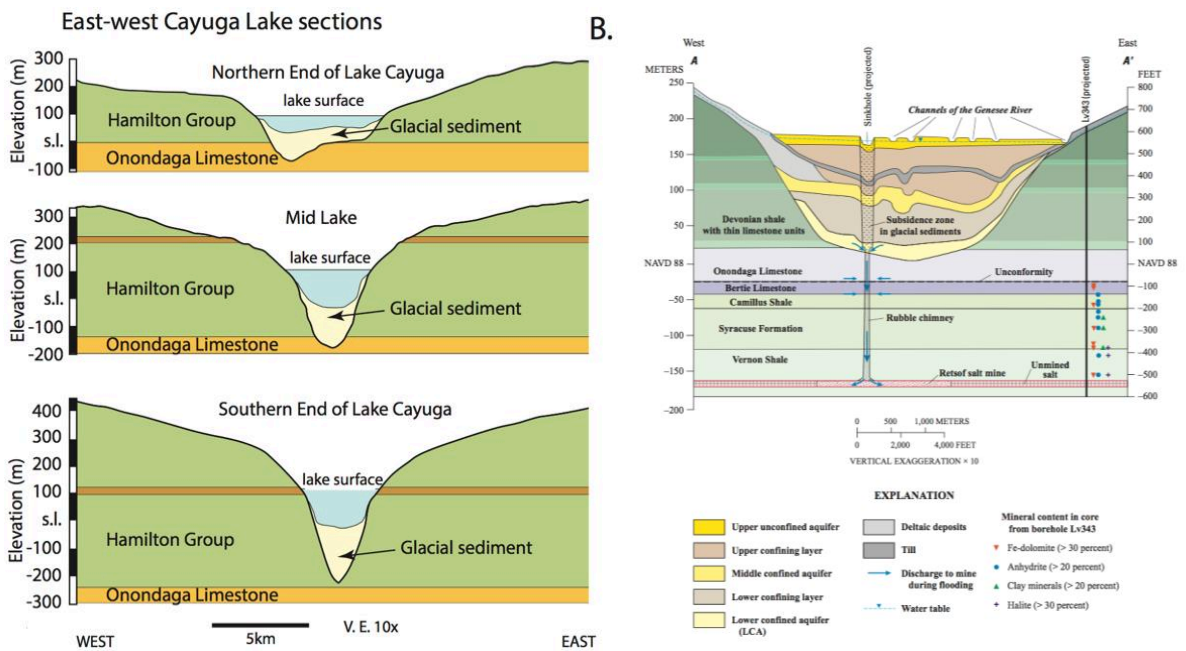
The catastrophic flooding of the Retsof Mine occurred following a roof collapse in a portion of the mine located below a glacially scoured valley/trough filled with glacial sediments. The latter hosts a lower confined aquifer and a low-permeability confining unit above it. The lower confined aquifer acted as a large water reservoir that provided the primary source of uncontrollable inflows that flooded the Retsof mine. If a mine roof collapse occurred outside the buried valley and thus away from this huge Retsof valley reservoir, the water inflow rate would have been an order of magnitude lower, giving a chance to control the flooding.

The catastrophic flooding of the Retsof mine in the buried valley can serve as a good analog for the Cayuga mine portion under the lake with one exception: An upper portion of glacial sediments at the Cayuga mine is replaced by lake water. Other than that, the hydrogeologic settings and conditions of these two valleys are similar. The lower confined aquifer in the Cayuga valley would still provide the primary source of water in case of catastrophic mine flooding. The presence of confining units between the lower aquifer and the lake water limits

---

<sup>11</sup> As an example of a catastrophic mine collapse under a lake in a somewhat different geologic setting, consider the Lake Peigneur disaster in Louisiana in 1980 when a Texaco drill rig on Lake Peigneur drilled into the Diamond Crystal Salt Mine beneath the lake. According to Wikipedia, "The resultant whirlpool sucked in the drilling platform, eleven barges, many trees and 65 acres (26 ha) of the surrounding terrain" ([https://en.wikipedia.org/wiki/Lake\\_Peigneur](https://en.wikipedia.org/wiki/Lake_Peigneur)).

any significant hydraulic connection between the lower confined aquifer and the lake to the sides of the buried valley. Thus, the lake itself would provide a secondary, delayed source of mine flooding water during the flooding and much of the post-flooding period.



**Left Figure:** East-West Cayuga Lake sections from *Technical requirements needed to approve construction of Shaft #4 in the Cayuga Salt Mine, New York State* by Dr. John K. Warren (after Mullins et al., 1995).

**Right Figure:** Stratigraphic section A-A' depicting rubble chimney above collapsed room in salt mine, Livingston County, N.Y. from *Brine Migration from a Flooded Salt Mine in the Genesee Valley, Livingston County, New York: Geochemical Modeling and Simulation of Variable-Density Flow*, Richard M. Yager et al. 2009.

Cathles' suggestion that water level would not drop after the flooding because "the local water level is pinned to lake level" is based on an incorrect conceptualization of the flooding mechanism in the context of site-specific hydrogeology. The potentiometric level in the lower confined aquifer (the primary water reservoir) would surely drop in the case of the Cayuga mine flooding, as it is pinned to the mine cavity more than to the lake level. The Retsof flooding resulted in a large drop of potentiometric levels and salinization of the bedrock and the lower confined aquifers over a very large area that extended for many miles from the two collapsed mine areas. However, as reported by USGS studies, the upper water-table aquifer was not impacted except in the vicinity of the collapse sinkholes.

Based on the Retsof mine analog, a catastrophic flooding of the Cayuga mine can be expected to produce an extensive drop of potentiometric heads and salinization of the lower confined aquifer.

The confined aquifer beneath the City of Ithaca at the head of the buried Cayuga valley would likely be impacted by the head drop and salinization.

Whereas it's true that most of the post-collapse surficial damage would occur beneath the lake, Cayuga mine flooding accompanied by pillar dissolution would produce other serious environmental consequences that are not included in Cathles' comments. Subsidence along the sides of the lake valley would modify the current lake shoreline. Localized lake encroachment onto subsiding lakeshore properties currently 10 to 15 ft above the lake level may occur adjacent to mine collapse areas, as suggested by the Retsof case. Upland land along the side of the valley and above upland portions of the existing mine would also be impacted by accelerated subsidence. According to the so-called "angle of draw" used by Cargill's consultants, the landscape likely to be impacted by subsidence east and west of the lake shores opposite the mine (essentially from the Ithaca Yacht Club at the south and Cayuga Power Plant to the north) would extend roughly one-quarter mile east and west of the lake shores.<sup>12</sup> There is also a question of impact due to methane gas releases triggered by a mine collapse and flooding.

These various issues should be included in the EIS process.

### **Salient points that Cathles' letter mentions only in passing, or not at all**

Important points that Cathles' letter mentions only in passing, or not at all, include thinning bedrock, horizontal stress, effects of mine subsidence on fracture aperture enlargement, penetration of glacially driven meltwater/groundwater toward and into the salt, etc.

**Thinning bedrock.** The term "Carbonate Beam" is used to describe the layers of relatively strong, stable carbonate rock above the salt beds in the Finger Lakes region. It refers to the strata between the top of the Cherry Valley Formation and the base of the Bertie Formation. Its thickness in Corehole 18 is about 382 feet; however, the valley of Cayuga Lake has been carved down into the bedrock by glaciers, thus drastically thinning the Carbonate Beam under the lake. Ferguson & Warren's recent report to CLEAN raises the concerns that such thinning "will result in more unstable geological conditions for the mining operations" and that, along the thalweg of the glacial valley of the lake, as little as 80 feet of geological section remains above the Evaporite Section. As described by Ferguson and Warren, "This would mean that the carbonate beam has been eroded out and only weaker shales of the Camillus Formation now sit above the evaporite unit. The evaporite unit contains the ore level salt layer currently exploited in the Cayuga Salt Mine, as well as younger salt layers and their remnants above. The lack of a carbonate beam facilitates groundwater entry and salt dissolution. This in turn would likely weaken and destabilise the rock roof to a mine working below such an eroded beam."<sup>13</sup> This thinning bedrock issue is well known to DEC and to the John T. Boyd Company which serves as a consultant to DEC on mining issues. For example, Boyd's 2015 review of Cargill's 2014 annual report to DEC says that "Condition 9.b. [of Cargill's permit] requires investigations and reports on the adequacy of the thin rock overburden where the solid rock overburden is thinner,

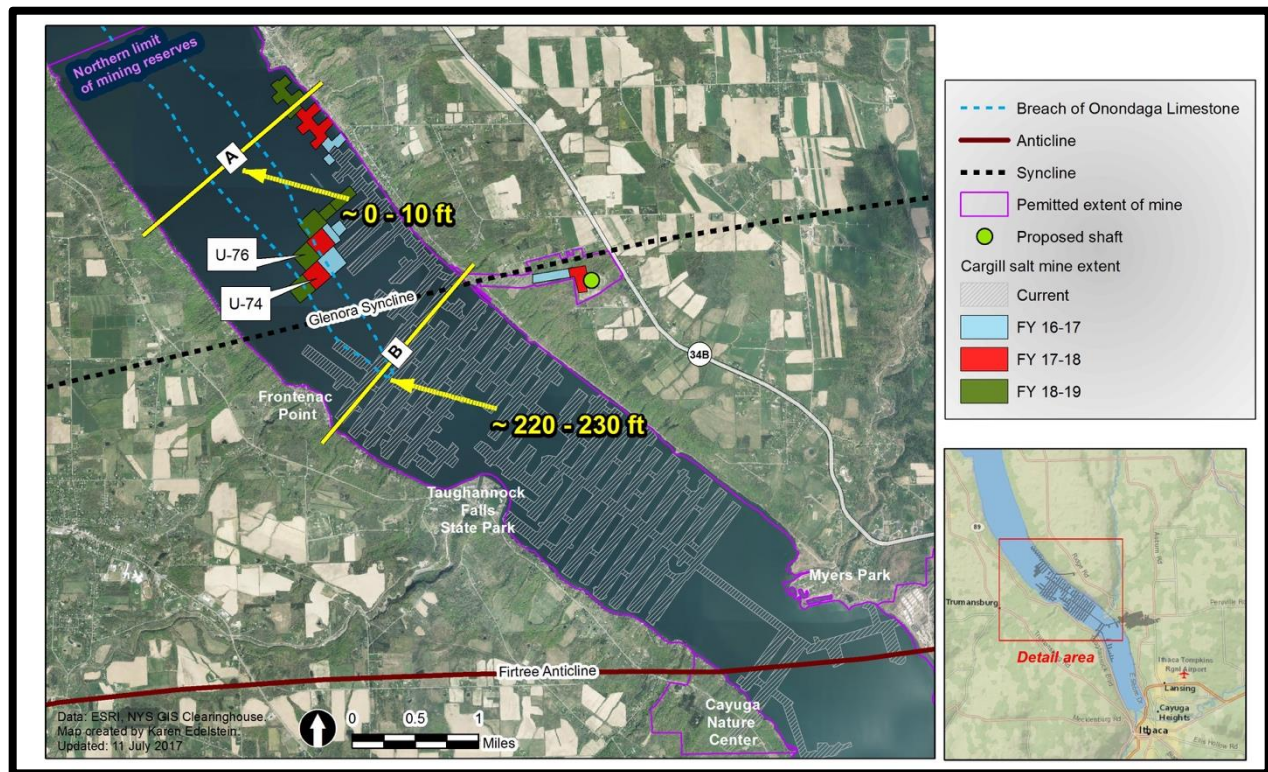
---

<sup>12</sup> Assuming 35° angle of draw.

<sup>13</sup> A. Ferguson and J.K. Warren, *Salt Mining and Possible Future Problems in the Cayuga Lake Region: Integration of public-domain seismic with known salt geology*, report to CLEAN, July 2017.



the glacial till and lake sediments thicken and lake depth increases. The thin rock overburden and Frontenac Point Anomaly may overlap. *The Additional investigations have not been performed*, and mining in this area should be avoided until reviewed and approved by the NYSDEC.”<sup>14</sup> The same wording, including the statement that “The Additional investigations have not been performed,” appears a year later in Boyd’s 2016 review of Cargill’s 2015 annual report.<sup>15</sup> This delay of a year or longer indicates that the recognized issue of thinning bedrock is not receiving the attention it needs. It should be part of the EIS process for Shaft #4 and the mine.



### Carbonate Beam Thickness Over Cayuga Salt Mine

Showing transect of Profiles A and B, the trend of the Glenora Syncline and a zone of glacial downcutting into the Onondaga Limestone.

**Regional horizontal tectonic stress.** Cathles does not adequately refute the issue of major horizontal forces at depth and how such forces are known to fracture rock in valley bottoms

<sup>14</sup> Letter dated March 18, 2015 (re: “Annual Report Review – 2014”) from Vincent A. Scovazzo of John T. Boyd Company to Matthew Podniesinski of DEC, p. 3 (emphasis added).

<sup>15</sup> Letter dated January 29, 2016 (re: “Annual Report Review – 2015”) from Vincent A. Scovazzo of John T. Boyd Company to Matthew Podniesinski of DEC, pp. 2-3.

above such a mine, thereby threatening the competence and permeability of the roof rock.<sup>16</sup> In general, there are various rock mechanics factors that make mining in buried valley settings more collapse-prone and riskier than in upland areas. Cathles also dismisses the potential for a thrust fault to affect permeability and fracture flow within a larger proposed shaft excavation, as compared to the limited and poorly documented core data from Corehole 18. Horizontal stress and its effects need to be part of the EIS process.

**Effects of mine subsidence on fracture aperture enlargement.** Subsidence is an ongoing process that continually increases the transmissivity of groundwater flow pathways in bedrock above a mine. A water inflow estimate of 4 to 6 gpm, for example, can be expected to increase over time due to subsidence. This process causes sagging of the overlying bedrock strata and increases the apertures of bedding plane separations above the mined-out salt bed. In accordance with the cubic law, such aperture increases will result in disproportionately high increases of potential flowrates, by orders of magnitude, within a bedrock portion that was originally quite tight. When this area of subsidence-enhanced permeability connects with the virtually unlimited water source in the buried valley and the Lake, the resulting water inflow rates may become uncontrollable.<sup>17</sup> The effects of mine subsidence on fracture apertures and resulting fracture flow need to be part of the EIS process.

**Penetration of glacially driven meltwater/groundwater toward and into the salt.** In their recent report to CLEAN, Ferguson and Warren review the evidence for glacial meltwater and groundwater being pumped or driven downward, to depths of hundreds of meters, as documented in the Michigan and Appalachian Basins and other locations worldwide. Cyclical processes of glacial advance, loading, retreat, and rebound provide the driving force for this type of deep penetration of relatively fresh water – and the consequences are particularly important where the penetrating water reaches salt beds. Evidence for such penetration can include collapse breccias (with satin spar associations) and other salt dissolution features/textures. The concern for the Cargill mine is greatest at the thinnest (thalweg) bedrock locations where the relatively weak and fractured Camillus Shales (80-100 ft thickness) provide the only separation between Cayuga Lake's valley-fill aquifers and the salt beds of the Syracuse Formation. These are the most likely locations where glacially driven penetration of undersaturated meltwater/groundwater may have occurred. Such penetration may have already 1) enhanced/enlarged fracture pathways through the Camillus and 2) dissolved some of the underlying salt beds, thereby leaving pockets of brine and/or collapse breccias in the Syracuse. None of these outcomes can be safely left undetected if mining is being done in deeper salt beds within the Syracuse. The main implications are

---

<sup>16</sup> For example, see G.M. Molinda, K.A. Heasley, D.C. Oyler, and J.R. Jones, *Effects of Horizontal Stress Related to Stream Valleys on the Stability of Coal Mine Openings*, U.S. Bureau of Mines, Report of Investigations 9413 (1992). On horizontal stress generally, including numerous regional examples, see R. Young presentation at June 13, 2017 CLEAN public meeting in Ithaca.

<sup>17</sup> These sentences are quoted from p. 4 of the May 1, 2017 from Brian Eden of Tompkins County Environmental Management Council letter to Matthew Marko et al. of DEC Region 7.

pathways for fluid flow, possible brine inclusions, and loss of mechanical strength in the bedrock/salt beds above the mine.<sup>18</sup>

It is not clear whether DEC and John T. Boyd Company are aware of the growing geological recognition of glacially driven penetration of undersaturated meltwater/groundwater; however, *they are apparently aware of well data relevant to the Cargill Mine*. Boyd's 2015 review of Cargill's 2014 annual report refers to a RESPEC report that said "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."<sup>19</sup>

While the presence of brine on top of and within Salina Group beds is relatively well documented in the northern part of Cayuga Lake,<sup>20</sup> the suggested or documented presence of brine in the immediate vicinity of the Cargill mine at the Frontenac Point Anomaly<sup>21</sup> seems to be relatively new information whose interpretation and resolution are not readily apparent.<sup>22</sup> This information, combined with methods identified by Ferguson and Warren for expert recognition of meltwater/groundwater penetration<sup>23</sup> and additional testing that may be needed, should be part of the EIS process.

## Conclusion

Considered separately, each of the many issues identified above satisfies the EIS criterion for an action that "may include the potential for at least one significant adverse environmental impact." Considered together, there is overwhelming evidence that the EIS criterion is met. We respectfully disagree with Cathles on this point.

In closing, we also believe that Cathles may have misunderstood CLEAN's position on the necessity of conducting an EIS. According to Cathles,

---

<sup>18</sup> See Ferguson and Warren, *op. cit.*

<sup>19</sup> Letter dated March 18, 2015 (re: "Annual Report Review – 2014") from Vincent A. Scovazzo of John T. Boyd Company, *op. cit.*, p. 12 (and see also pp. 2 and 15).

<sup>20</sup> W.M. Goodman, D.J. Gnage, and P.H. Smith, *The Saline Water Belt Marginal to Bedded Salt Deposits of the Silurian Salina Group, Western New York State: A Possible Glacial "Pocket" Aquifer*, Rochester Committee for Scientific Information Bulletin #333, October 2011. All three authors are/were associated with RESPEC.

<sup>21</sup> The Frontenac Point Anomaly is associated with the disturbed salt zone which lies along the west shore of Cayuga Lake immediately west of the current mined footprint of the Cargill mine. It is reportedly "a graben-like structure" that "appears to contain at least one deeply penetrating, near vertical fault that affects the salt interval," apparently with 100 ft vertical displacement. See John T. Boyd Company, *Review of the Mined Use Plan, Cayuga Mine, Cargill, Inc.*, report no. 2499.4, prepared for DEC, February 2002, p. 6, where these descriptions are attributed to a RESPEC report.

<sup>22</sup> For example, there appears to be no further discussion in the letter dated January 29, 2016 (re: "Annual Report Review – 2015") from Vincent A. Scovazzo of John T. Boyd Company, *op. cit.*

<sup>23</sup> For example, expert examination of core or high-resolution core photos from Corehole 18. See Ferguson and Warren, *op. cit.*

The CLEAN logic, expressed explicitly at the information session, is that denial of permission to drill Shaft #4 would preclude (for ventilation and safety reasons) extension of the mine to the north, and this would be a good thing because mining to the north may be riskier...

In our understanding, he should have said:

The CLEAN logic, expressed explicitly at the information session, is that denial of permission to drill Shaft #4 would preclude (for ventilation and safety reasons) extension of the mine to the north *unless and until an appropriate EIS process is conducted*, and this would be a good thing because mining to the north may be riskier...

The italicized words, *unless and until an appropriate EIS process is conducted*, make an enormous difference. As outlined above, the risks are real but poorly quantified. Cathles' letter was a small but very incomplete step toward quantifying the risks. The appropriate way to proceed is to follow SEQRA, rescind the Negative Declaration, and initiate an EIS process.

While we are generally familiar with EIS processes under Part 617 (SEQRA) and consider such a process to be applicable and necessary, we have also participated in proceedings under Part 624 and suggest that a Part 624 hearing process (issues conference/adjudicatory hearing) may be applicable as well, not only for the proposed Modification #3 of Mined Land Reclamation Permit 0-9999-00075/00001 but also for renewal of the existing permit if/when applied for. In our understanding, a Part 624 hearing process may be invoked as follows:

The determination to hold an adjudicatory public hearing shall be based on whether the department's review raises substantive and significant issues relating to any findings or determinations the department is required to make pursuant to the Environmental Conservation Law, including the reasonable likelihood that a permit applied for will be denied or can be granted only with major modifications to the project because the project, as proposed, may not meet statutory or regulatory criteria or standards. In addition, *where any comments received from members of the public or other interested parties raise substantive and significant issues relating to the application, and resolution of any such issue may result in denial of the permit application, or the imposition of significant conditions thereon, the department shall hold an adjudicatory public hearing on the application.*<sup>24</sup>

In this letter we have raised substantive and significant issues relating to the application(s) for Modification #3 and renewal (if/when applied for) of Permit 0-9999-00075/00001. Many of these issues are new; they have not been considered previously in the context of this permit. Based on our brief review of the existing and proposed permit conditions, we believe significant additional permit conditions would be needed to resolve the substantive and significant issues we have raised here.

---

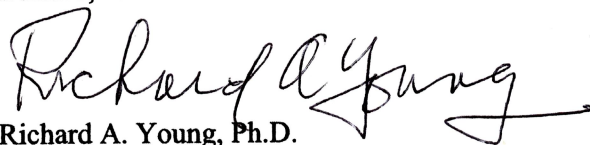
<sup>24</sup> 6 NYCRR 621.8(b), emphasis added.

From a broader perspective, you – in your role as Governor – are in charge of the two executive branch agencies, namely DEC and the Office of General Services, whose permits/permissions currently allow and set certain restrictions on salt mining under Cayuga Lake. As Governor, you may be able to improve the interagency cooperation, whether through hearings or other measures, that would ensure long-term protection of Cayuga Lake and the many benefits it provides. We hope you would also take advantage of any opportunity to work jointly with the legislative branch on this important matter.

Sincerely,



Raymond C. Vaughan, Ph.D., P.G.  
Geologist  
Buffalo, NY



Richard A. Young, Ph.D.  
Emeritus Distinguished Service Professor of Geological Sciences  
SUNY Geneseo



Andrew Michalski, Ph.D., CGWP, P.G.  
Hydrogeologist  
South Plainfield, NJ

cc: Eric Schneiderman, Attorney General  
Basil Seggos, Commissioner, DEC  
Matthew Marko, Regional Director, Region 7, DEC  
Paul D'Amato, Regional Director, Region 8, DEC