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**A REVIEW  
of  
Hydrogeological Investigations  
in support of  
Draft Environmental Impact Statement  
Hudson River Valley Resorts**

**September 14, 2010**

**By  
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## THE SCOPE OF THIS REVIEW

### Per Agreement With The Town of Rosendale

The items I was asked to address are individually listed in bold italics followed by specific responses as indicated.

1) *Review of the study methodologies utilized by the applicant in conducting their investigations to determine if:*

*a) The investigations were appropriate for a potential karst area, and*

*b) Whether the methods used were sufficient to determine the presence of karst features and how such features influence the movement of surface and groundwater.*

### Response:

#### The Existence of Karst-

The applicant dismisses of presence of karst by stating that there is none. While I recognize the inherent difficulty in substantiating a negative proposition, the presence of rock units of the Devonian Helderburg Group suggest otherwise. Many of these are recognized karst formers. Several commercial caves just north of the site and famous Howe Caverns are in these same rock types. Clearly, the Rosendale and Whiteport Members of the Rondout Formation that are the “hydraulic limestones,” actually dolostones used in cement manufacture are exceptions to this rule and are not good karst formers. They are by no means the only carbonates present at the site.

The applicants state: “However, geologic features typical of a karst type terrain (natural caves, sinkholes) are not present on the site likely due to a number of factors including the mineralogy of the various members and the high degree of folding and faulting that has occurred on the site.” If folding and faulting were an impediment to karst formation we would not have many of the mapped caves in New York State and throughout the world. The DEIS includes a spring location in 5<sup>th</sup> lake, but I can find no specific description of it. Springs are features of karst aquifers

My first principles assessment that there is likely karst on the site and surrounding it in several of the karst susceptible units is supported by the observations of knowledgeable geologists who are familiar with the area. Personal communication with Dr. Kurtis Burmeister, author of the most recent geologic map of the area dismisses the contention that there is no karst in the area with photographs of one of several sinking streams, photographs of solution features in outcrop, and photos of springs. Personal communication with Dr. Stephen Marshak who mapped the area just north of the site is aware of disappearing streams and significant subsurface karst features in the Helderburg units that are stratigraphically immediately above the Rondout Formation. Mr Paul Rubin is a local geologist and former student of a respected colleague Dr. Arthur N. Palmer, a well known karst geomorphologist and hydrogeologist. Mr. Ruben has posted photographs of caves, caves containing streams, sinkholes, and sinking streams which he indicated are located on the subject property.

**Conclusion:** These factors lead me to believe that it is likely that a karst aquifer or aquifers exist at the site.

### **The utilization of appropriate investigations and methodologies-**

Tracer studies are the best and most conclusive means of understanding the characteristics and function of karst aquifers. Two dye testing episodes were presented. These both have narratives that suggest a lack of experimental rigor on several counts.

### **Dye Testing at TW-03**

The total amount of dye used is not given, nor the volume of the “tub” in which the dye was mixed, nor the total quantity of dye laden water that was released into the “grassy area”. Further, the duration and rate of the dye discharge is not given nor the duration of the “visual observations...of other water bodies” or details of what “water bodies” were observed.

I am not familiar with the YSI 360 fluorometer that was reported to have been used in this testing. Technical support personnel at YSI are equally unfamiliar with such an instrument.

One assumes that Table 9909A.DAT and TW3END.DAT refers to the discharge from TW-3 at the beginning and end of the testing, though that is not clear. The time of dye release is not indicated on these tables, nor its duration.

One assumes that BAITA.DAT refers to measurements from the bait pond, though that is not made clear. Again the time of dye release is not indicated, nor its duration. The location and means of monitoring at this location is not given, and is of no small significance.

One assumes that 4THLK.DAT refers to measurements from the Fourth Lake, though again that is not clear. Once more the time of dye release is not shown, nor its duration. The location and means of monitoring at this location is not given, and is of no small significance. One monitoring location or 42 in a lake 900 feet across with thousands of feet of shoreline is hardly definitive. If the lake discharge was measured for the indicated 6 minutes, that tells virtually nothing.

The choice of Rhodamine-WT for the purpose of testing for return of surface water to TW-3 was not a good one. The rhodamines, including Rhodamine-WT are subject to very considerable sorption losses, especially onto soils. Discharging the dye laden water onto the “grassy area” implies that infiltration through the soil was the means by which return would occur, and the means by which the dye would travel to any of the water bodies that were under visual observation. Rhodamine-WT would be unlikely to survive such flow unless there were demonstrable preferential flow paths through the soil.

I would agree that the test suggests that there were no major preferential pathways returning pumped water to the well. It is not a definitive test of return flow by other means. The test was likely terminated before this could be properly assessed.

**Conclusion:** This is not a valid or convincing test of hydraulic connection between the test site and other water bodies, given the parameters that are presented.

### **Lake Mine, Hotel Mine, and Mine 7 Dye Testing-**

The total amount of dye used is not given, nor the volume or flow of the water into which it was introduced. Unless there was some indication that the dye was not introduced into a stagnant pool, the test cannot be judged definitive in any way. There is no indication of the duration of monitoring for the dye. As presented, this is not a valid or convincing test of hydraulic connection between the mines and other water bodies.

**Conclusion:** This is not a valid or convincing test of hydraulic connection between the test site and other water bodies, given the parameters that are presented.

### **General Comments On the Dye Testing**

Dye testing into ponds and lakes is not easily accomplished and has many special considerations. Among these is the lake/pond temperature relative to groundwater. The reported dye testing was apparently accomplished in September, 2009. Specific dates are not given except for the fluorometer record in Appendix C. At this time the lake water temperature is likely at or above the mean annual value. According to the list of temperatures associated with Table 4THLK.DAT the temperature of the lakes was about 24C. At such a time, groundwater carrying dye is likely to be more dense than the lake water on two counts. First and most importantly, it is very close to the mean annual temperature, the record of Table 9909A.DAT indicates that the groundwater temperature at that time was about 11C. Second, if it is visually colored it bears the weight of the dye. Unless the dye entered the pond or lake very close to the shoreline it would likely not be visually observable and would move toward the deeper lake levels not toward the surface. It is highly unlikely that the Rhodamine-WT from these tests would have been visually observable unless dye quantities of the order of 5 pounds of 20% solution had been used.

Only a careful reconnaissance by a hydrogeologist specializing in karst can make a final judgement as to the existence of karst. Presently available information suggests that it is present. The tracer methodologies employed are in part inappropriate and are insufficient to disclose the existence of karst or other preferential pathways in the bedrock.

*2) Review of the "Hydro Geology Investigation Report" and related documents prepared by the applicant and included (in the) DEIS submitted to NYS DEC to determine if the information presented satisfied the requirements of the Final Scoping Document, available on the NYS DEC website at <http://www.dec.ny.gov/permits/54656.html>, plus any other documents the NYS DEC Region 3 representatives, as lead agency, deem necessary.*

I find the DEIS insufficient to satisfy the requirements of the Final Scoping Document that are listed below.

## **FINAL SCOPING DOCUMENT**

April 1, 2009

**C. Ground Water Resources (Page 9)**

1. The groundwater resources of the site shall be described using available literature regarding the geology and hydrology of the region and site; all on-site information collected during subsurface investigations, including geotechnical and soil borings, well drilling activities, and mine and cave investigations; and observations and mapping of surface water resources. Given that much of the area is karst terrain with underlying karst aquifer, a concerted effort must be made to detail the presence of these features and how they influence the movement of surface and ground water. (My underlining)

**Response:** No concerted and defensible effort was directed at discovering or detailing the presence of karst features in this terrane<sup>1</sup>, the attempts at dye tracing not with standing.

3. Potential areas of direct groundwater recharge shall be described and identified on a site map. (Page 10)

**Response :** Without understanding the potential for a karst aquifer at this site the true nature of the catchment cannot be known. Karst aquifers frequently transmit recharge in ways that ignore traditional surface basin boundaries. This can have both positive and negative impacts upon groundwater budgets.

5. Discuss and document the karstic characteristics of the aquifer on and adjacent to the site. Document groundwater flow and pathways in the project area using well information and dye tracer tests. If aquifer (pump) tests are conducted for potential water supply wells, they must be designed to demonstrate the lack or presence of hydraulic connection with Williams Lake. (Page 10)

**Response:** No concerted and defensible effort was directed at discovering or detailing the presence of karst aquifers in this terrane, either on or adjacent to the site. Their existence was cavalierly dismissed, in part because no sinkholes were observed. Sinkholes do not define karst aquifers. Many karst aquifers are devoid of them. At least one observer (Rubin) indicates that they do exist on the site. The present studies have not established the relationship between the test wells and the lakes.

6. Discuss potential impacts of the project on groundwater quality that may result from stormwater runoff discharges, wastewater treatment plant discharges, water treatment plant discharges, and disposal of excess fill within mine or cave areas. Discuss the movement of surface water into in the karst aquifer via sinkholes and the ultimate fate of that infiltrated water. Other sources of potential impacts to groundwater quality shall also be included, as identified. (Page 10)

**Response:** Without an understanding of the karst aquifers, if they exist at the site, one cannot assess properly the impacts of the project on groundwater. There is no recognition of karst, no proper assessment of its presence or absence, and certainly no indication of the project's influence on groundwater if karst does exist.

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<sup>1</sup> Terrane in Geological usage, unlike Terrain, includes the subsurface and its features which include aquifer characteristics.

## **D. Water Supply**

**3.** A central water supply system utilizing the existing surface water source (Williams Lake)...

**c** An estimate of the existing supply capacity based on available information sources and its general physical extent. The study must include a water budget (recharge analysis) of the study parcel and its watershed. Recharge must be estimated under normal and drought conditions and compared to estimated water demands of the project. If the sewer district(s) shall be disposing of sewage effluent off site, include the removal of that water in the water budget analysis. (Page 11)

**Response:** An estimate of the supply capacity cannot be undertaken meaningfully unless all potential lake inputs and outputs can be taken into account. Karst aquifers may control important lake inputs and conceal important losses. Such factors have not been looked for meaningfully, much less taken into account.

**4.** Central Water Supply System Using Groundwater Sources: If the water supply source will be groundwater, proposed well(s) and the supporting aquifer shall be described. (Page 11)

**Response:** Karst considerations would be important to any assessment of water supplies from groundwater, and an understanding of the effects of such withdrawals.

## **E. Wastewater / Sewage Disposal**

**7.** Discuss mitigation measures to address identified potential impacts which may include, among others, water conservation to reduce sewage flows; relocation of components to address siting constraints (including wetlands); and alternative technologies or structures. The potential mitigation measures discussed shall also include potential interconnection to, and expansion of, the Town of Rosendale municipal plant. (Page 13)

**Response:** Among the impacts of wastewater discharge are a number of karst related ones. These include losing streams flowing over karst terrane, a potential impact upon groundwater that can affect distant users.

## **G. Terrestrial and Aquatic Ecology**

**3.** Wetlands and Waterbodies

**e** Describe proposed measures that would be implemented to avoid and minimize wetland impacts. Discuss any special mitigation measures that shall be implemented to prevent soil erosion and sedimentation of wetlands during construction. Where unavoidable wetland impacts are identified, a compensatory wetland mitigation plan shall be provided that provides a rationale for the proposed mitigation. The plan shall include drawings for the proposed compensatory wetland mitigation showing its location and conceptual grading and landscaping plans. (Page 16)

**Response:** Without an appreciation for the role of any karst aquifers at the site, project impacts upon wetlands cannot be understood. Karst aquifers transmit groundwater through conduits, natural pipes, which behaviors very different from intergranular and fracture flow.

*3) Prepare recommendations, if necessary, for*

*a) Any additional steps required to adequately perform this review, including on-site field verification*

*b) Additional study and testing to be performed if the previous investigations are deemed insufficient.*

**Response:** It is my experience over 30 years as a practicing geologist and karst specialist that most engineers and many practicing geologists are unfamiliar with karst terrains and terranes. A competent specialist in karst geomorphology and hydrogeology should make a site visit and carefully assess any indicators of the presence of karst aquifers. On their recommendation, a carefully prepared tracing program may need to be undertaken which is designed to address the potential deficiencies listed above. The tracing must be designed and carried out by persons with extensive experience in this specialty. Without on-site experience it is difficult to outline more specific steps.

**General Comments**

Within the time constraints of this review it was not possible to cover all aspects of the DEIS as they relate to karst and the hydrogeology. A thorough critique of the chemical data and my perspective on their meaning was clearly beyond the scope of the possible. I have already spent considerably more time on this project than our contract has specified. Further, I had to rely not only upon my experience, but on the eyes and site specific observations of others. Similarly, there was not time to support my responses with published references, these can be described and referenced if necessary.

The photographs and documents I received from Dr. Burmeister and others are not included. Most are the work of Dr. Marshak and Mr. Rubin. I will endeavor to secure permission to include them if that is deemed desirable.

Geology in general and karst hydrogeology in particular is best done with field experience specific to a site in question. That was not in the scope of my charge, and my conclusions might be altered in some degree by such experience. That said, I am confident that the possibility of karst involvement at this site is very real. I am not a partisan in this matter except for the science that it entails. I believe I am a skeptic with an open mind, and that is essential to my definition of a scientist.