

## **State of the Practice in Geothermal Well Design and Installation – Common Problems and Lessons Learned**

John Kastrinos and Paul Ormond, Haley & Aldrich Inc.; Reidar Bomengen, Boart Longyear

Alternative energies are receiving a lot of attention from developers and the public, in response to concerns of climate change, and a renewed interest in reducing our oil dependency. Consistent with this trend, the number of ground-source heat pump systems (so-called geothermal systems) has increased dramatically in the New England region in the past few years, and many new systems are in the planning stages.

The “track-record” of these systems is regrettably mixed, with some systems in need of extensive, costly repairs within a short time following startup, leading to disputes and claims. This paper presents case studies with our interpretation of the likely causes of these problems, including corrosion by saline waters, encrustation, and bio-fouling. In general, the state-of-the-practice in geothermal design suffers from a lack of understanding of well design, aqueous geochemistry and changes that occur under pumping conditions (such as air entrainment and the resultant precipitation of metal oxides). The paper also describes recurrent problems related to drilling methods that result in a failure to reach design depth due to high inflows from bedrock fracture zones. When wells fall short of the design depth, groundwater must be pumped to waste in order to maintain thermal efficiency.

Unless these problems can be addressed through proper design, geothermal technology in the northeast may gain a reputation of being an unreliable alternative-energy source.

System failures such as the case studies described in this paper could be avoided through a multi-disciplinary approach that uses the skills, knowledge and experience of drillers, scientists and engineers with backgrounds in well design and hydrogeology.

John R. Kastrinos, P.G., has over twenty years of experience as a hydrogeologist with Haley & Aldrich, Inc. He graduated from Dickinson College in 1983 with a B.S. in Geology and from Penn State University in 1985 with an M.S. in Environmental Pollution Control. His work has been applied to diverse projects, including groundwater supply development, contaminant fate and transport, seepage analysis for tunnels and deep excavations, construction dewatering design, and litigation support in all of these areas of the practice. Mr. Kastrinos is an American Institute of Hydrology (AIH) certified professional hydrogeologist (PHG) and a Pennsylvania Professional Geologist (PG).

Paul F. Ormond, P.E. has worked for over eight years with Haley & Aldrich on a wide variety of infrastructure and real estate development projects. Mr. Ormond routinely works in an “integrated” role, managing projects’ geotechnical, environmental, and permitting issues concurrently. Project experience includes design, specification and construction of a wide variety of trenchless methods and foundation systems. Mr. Ormond is also experienced with permitting, environmental soil and groundwater issues, and is currently involved in several geothermal evaluation, design, and implementation projects.

Reidar Bomengen has been employed by Boart Longyear (formerly DL Maher) for over 19 years. The firm is a full service drilling contractor locally based in North Reading. Currently, as a project manager, his duties involve all aspects of new source development within both unconsolidated and bedrock aquifers. His responsibilities include the supervision of drilling operations, well site selection, pump test design and analysis, well design and report preparation. He is a licensed New Hampshire Professional Geologist and an IGSHPA certified installer. He graduated from University of Lowell with a B.S. in Environmental Science\Geology.