Innovative Design Approach for Mitigating Landfill Gas: A Landfill Post-Closure Mixed-Use Development Case Study

Omer Uppal (ouppal@langan.com), Matthew Ambrusch, Nadira Najib, and Angelo Falabella
(Langan Engineering, Parsippany, NJ, USA)
Jeff Ludlow (Langan Engineering, San Francisco, CA, USA)
Chris Glenn (Langan Engineering, Oakland, CA, USA)
Stewart Abrams and Imtiyaz Khan (Langan Engineering, Lawrenceville, NJ, USA)
Greg Corcoran (Geosyntec, San Diego, CA, USA)
Murray Fredlund (SoilVision Systems, Ltd., Saskatoon, SK, Canada)

Background/Objectives. Langan Engineering and Geosyntec Consultants have partnered to provide the environmental and geotechnical engineering and consulting required to develop a closed landfill in the San Francisco Bay Area, California. This mega-project requires compliance with numerous local, regional and state regulatory agencies to re-purpose over 200 acres of landfill to a new mixed-use development that will include retail, commercial and residential land use. With methane levels as high as 50% by volume (10 times the lower explosive limit), the ability to design a methane collection system that will protect human health and the environment for the life of the development is a must when obtaining regulatory approvals. This presentation will focus on the environmental and geotechnical constraints confronted when developing a former landfill, and on the innovative design strategies used to overcome these obstacles. The inherent risks associated with developing landfills will be discussed, along with certain site-specific challenges (i.e., seismic activity and the site's end-use) that had to be considered when developing the methane mitigation system design. This presentation will also introduce attendees to the capabilities and benefits of innovative pilot testing techniques and three-dimensional (3D) pneumatic modeling, and will demonstrate the key roles they played in developing an effective methane mitigation strategy.

Approach/Activities. In order to design an effective landfill gas (LFG) collection system, a month long pilot study and subsequent 3D pneumatic air-flow computational modeling were performed to determine key design parameters of the required LFG collection and mitigation system. Data collected during the pilot test was used as input to a 3D computational pneumatic model, SVAIRTM (SoilVision Systems, Ltd.). The 3D pneumatic model was used to simulate the LFG flow field in the refuse and determine the correlation between applied vacuum and LFG extraction flow rate at the test well and the resultant subsurface pneumatic parameters (i.e., subsurface vacuum propagation, LFG flow rate, LFG velocity vectors, and pore volume exchanges) at varying distances from the test well. Pneumatic modeling allowed for the incorporation of varying site conditions (i.e., the site's future architectural, structural, and geotechnical features) and predicted the effects of refuse settlement, seismic activity, proposed development constraints (i.e., piles and other structural elements), and fluctuating LFG generation rates and barometric pressures on the proposed LFG system's operation. The proposed system's key design parameters included methane generation rates, radius of influence (ROI) of the LFG extraction wells, number and spacing of LFG extraction wells, and the required LFG extraction flow rates and vacuums. The model allows the prediction of system performance at any spatial point in the landfill at any given time to evaluate whether the system will be protective of human health and the environment for the life of the proposed development. This state-of-the-art modeling, as far as Langan is aware, has never been applied on the scale and to the level of detail being performed for this project.

Results/Lessons Learned. Numerous regulatory agencies reviewed the conceptual LFG

collection system design that relied heavily on the analytical outputs of the pneumatic modeling. The ability to model and demonstrate results observed during the pilot test activities and subsequently translate those results into a demonstration of the anticipated effectiveness of the proposed full-scale LFG collection system was crucial for the acceptance of the conceptual design. 3D pneumatic modeling is an extremely effective tool which can be utilized for a number of applications and has the ability to provide not only design refinement and certainty, but also significant cost savings.