Sustainable Constructed Wetland for Pharmaceutical Waste Leachate and Groundwater Management and Treatment

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Background/Objectives. The site located in central Japan on 2 hectares of mountainous-terrain, leased land, was developed as a landfill to manage fermentation waste residue generated from a pharmaceutical operation. The waste emplaced in an unlined ravine was contained with a perimeter cement slurry/sheet pile wall and an engineered cap, and in addition provided with a leachate and methane collection and treatment system. The waste was placed on a hillside composed of fractured and weathered granite with a seasonally fluctuating groundwater table, which has been impacted due to contact with the waste. The primary chemicals of concern (COCs) in groundwater are biological oxygen demand (BOD) and chemical oxygen demand (COD) due to their potential impact on a river located approximately 200 m downgradient of the landfill, where lower levels of arsenic were also observed. The land lease will expire in 2020 and access to the landfill and associated infrastructure will be lost; thus, an alternative approach to management of leachate and impacted groundwater is desired.

Approach/Activities. Due to a desire to minimize disruption of the third-party owned landfill, treatment options evaluated consisted of mainly those requiring construction in the area downgradient of the landfill. In addition, sustainable options requiring low operation and maintenance cost were preferred. ERM conducted a comprehensive study to evaluate collection options for leachate and impacted groundwater, quantity and quality estimate by surface water and groundwater modeling, and conducted a treatability study to evaluate treatment options.

Results/Lessons Learned. Through installation of new borings and monitoring wells, ERM determined that a majority of the downgradient landfill perimeter was not providing competent containment as the cement slurry/sheet pile wall was likely keyed into weathered bedrock comprised of lightly-consolidated sand. Data from groundwater sampling and continuous water-level logging indicated that rainfall correlated with groundwater rise within the landfill and increased COCs concentrations in key wells at the site. Onsite pump-tests and infiltration tests provided data to develop and calibrate groundwater and surface water models. A constructed wetland was deemed most suitable to provide a sustainable solution for long-term leachate management than the current water treatment plant after handover of the landfill. To develop a constructed wetland solution, a detailed hydrologic study was implemented to provide data on climate, hydraulic loading rate and residence time, groundwater exchanges, evapotranspiration, and overall water balance. A biodiversity survey of the site was conducted to collect primary information on flora species richness, diversity, dominance and vulnerability status. With that, ERM developed and implemented a bench-scale demonstration study to evaluate potential substrate materials, estimate hydraulic residence time, removal rates, hydraulic conductivity, and porosity of the substrate, and to demonstrate the efficacy of two types of engineered wetlands – Free Water Surface (FWS) or subsurface flow (SSF) wetlands. A site-specific constructed wetland solution consisting of a sequential arrangement of SSF and FWS wetlands was then developed to meet the COC reduction goals, hydrologic load, and site topography and space constraints. Construction planning and permitting currently underway with the wetland construction scheduled from May through November 2019.