2022 Americas Site Solutions Technology Transfer Conference

Title: Striving Towards Sustainable Ecological Habitat through Groundwater Modeling and Remote Sensing

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Key Topic: Modeling

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Client Name: Rio Tinto Alcan and Rusal

Project Name: QAL RDA Priorities – Groundwater Modeling

Project Location: Gladstone, Queensland, Australia

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ABSTRACT

Background/Objectives:

Queensland Alumina Limited operates one of the world's largest alumina refineries since the 1960s in Gladstone, Queensland, Australia. The bauxite residue commonly referred to as "red mud", is a by-product of alumina production, red mud is neutralized using seawater prior to disposal in engineered red mud dams (RMDs) located adjacent to ecologically preserved habitat in the Great Barrier Reef Marine Park on Boyne Island. The decanting water from the RMDs is impacting the habitats with increasing salinity and has been a concern since around 2007. As the RMD levels continue to increase, groundwater levels and flux through and out of the RMD facility also will evolve. Ramboll's goal is to understand environmental impacts and protect sensitive habitats through groundwater modeling and remote monitoring techniques. The groundwater model was developed to test various mitigation approaches (a combination of engineering subsoil drains and cut-off walls) to reduce the potential flux impact on preserved areas and to initiate an assessment of these potential future conditions. The purpose of the study is to assist the client to rapidly and more frequently assess the changing vegetation conditions and to provide mitigation solutions.

Approach/Activities:

The groundwater model refinement process started with a base model developed by the firm GHD. However, the model run time was over four hours, and hence, found not suitable to test over fifty potential remedial designs. Thus, a simplified model with less than five minutes of run time was developed for the site. In this endeavor, a detailed 3D geologic model was developed using GeoScene3D software to support the conceptual site model. The transient groundwater model was calibrated for the site conditions that existed between 2009 to 2021. After the model calibration, various potential future scenarios were tested and compared to the field data to evaluate the impact on surrounding habitats. For each case scenario, the model predicted changes in groundwater elevations from 2022 to 2182. The mitigation options were evaluated, and recommendations were provided for the best-case scenario. The data processing for approximately 200 years of model output for over fifty model scenarios was not possible without automation. Thus, several python scripts were developed to automate the workflow and for the visualization of modeling results. Ramboll's Galago team analyzed current and historical high-resolution aerial and satellite imagery to determine sitewide trends related to vegetation health and dieback via a deep learning model. The model can be applied as new imagery becomes available, providing additional monitoring between ground surveys.

Results/Lessons Learned:

The combination of groundwater modeling and remote sensing analysis provides a more sustainable and cost-effective approach to support site investigation and monitoring activities at the site. The combined approach is applied in an accurate, defensible, and repeatable manner across large areas, enabling the client to implement remedial plans more efficiently and effectively. The developed

groundwater model is a robust and efficient tool to test numerous potential scenarios with different combinations of mitigation measures. The python scripts are scalable and provide value in presenting results to the client and other stakeholders. The deep learning model provides a path towards more frequent remote vegetation monitoring. Overall, the remote sensing analysis gives an additional line of evidence of the complex vegetation trends, including the impact of a recent drought on vegetation health and dieback. By collaborating with various multidisciplinary teams within Ramboll across the globe, we can bring new technology and innovation to projects and experience the rewards of true teamwork.

Aspect of Work that Relates to Sustainability:

The project provides a sustainable solution to preserve the ecological preserve located adjacent to the Great Barrier Reef Marine Park. The groundwater model and remote sensing assessment serve as a primary decision-making tool for the client and stakeholders to test various mitigation approaches to reduce the potential flux impact on preserved areas and local communities.