Modelling how dewatering impacts affects migration of contaminants from a nearby landfill

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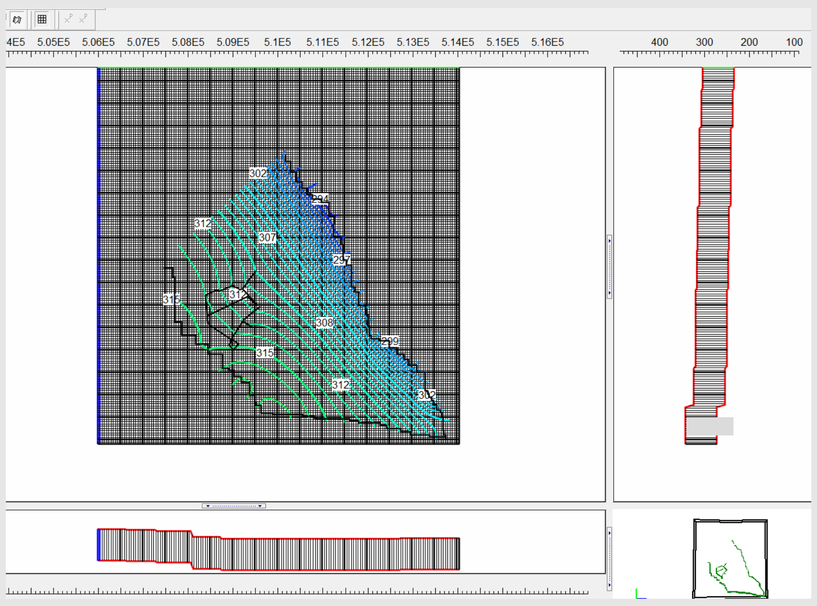
Abstract:

Following the construction of a new development in Central Asia, potential impacts of groundwater contamination and risks to flow during and after construction needed to be understood. A single layer steady state groundwater model was constructed to simulate the possible impacts arising from excavation. There is an unlined landfill close to the site and groundwater levels are shallow and maintained through drainage ditches. The groundwater model was used to assess the impacts of the development on groundwater levels, groundwater flooding and contaminant migration from the nearby landfill. MODFLOW and MODPATH were used to assess the impacts. The simulation of groundwater heads demonstrated that drainage ditches were exerting a local control on groundwater heads and that the movement of contaminants from the landfill site is predominantly directed along a particular drainage ditch. The dewatering scenario demonstrated contaminants from the landfill follow a similar flowpath to baseline, but with a greater volume of contaminant flowing towards the site. Under steady-state conditions, contaminants were not simulated to reach the site within 10 years and dewatering is unlikely to exceed months during construction. Therefore, the risk of contamination impacting construction is low. Changes to the drainage ditches did not adversely affect the hydrogeological conditions.

(Institution of Mechanical Engineers, 2023)

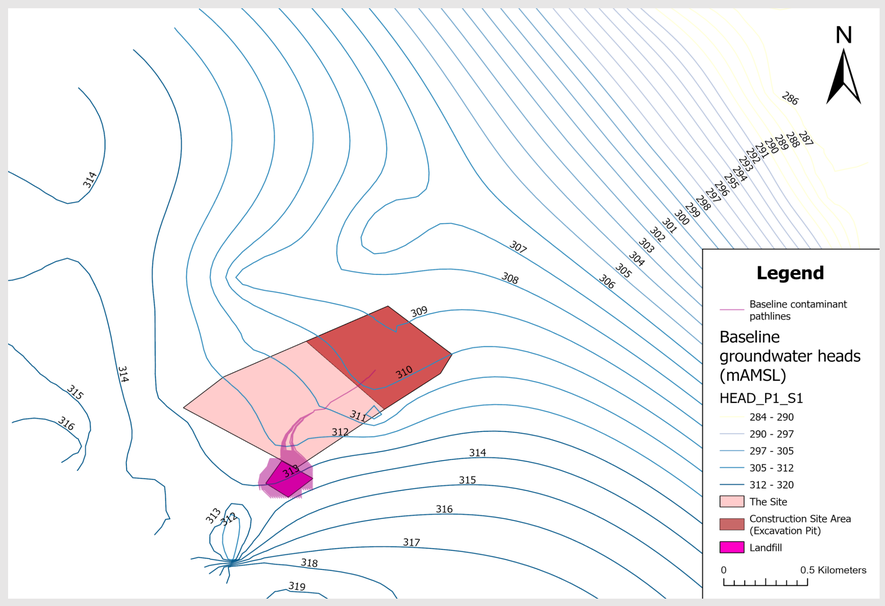
Model Construction

The groundwater model is a steady-state model (with a single stress period and timestep) that incorporates the site and is bounded by two canals to the south and west and east and by a no-flow boundary to the north. The aquifer is represented as a single layer with a thickness of 70m. Drain cells were used to represent several drainage ditches present within the site. Recharge was estimated based on a single recharge model and a constant value was applied across the model area. A value for the hydraulic conductivity of the aquifer was established from a falling head test conducted as part of a previous ground investigation on site.

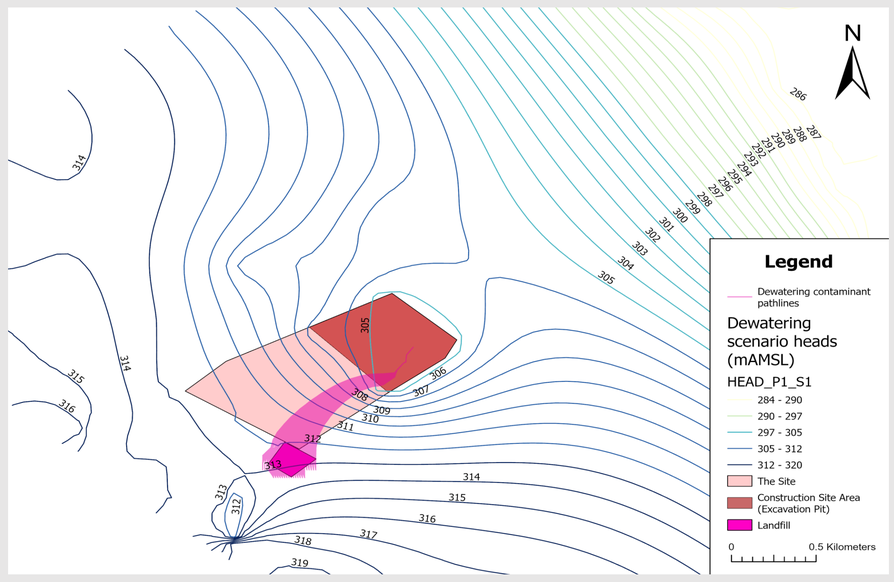


Modelled Groundwater Heads and Contaminant Plumes

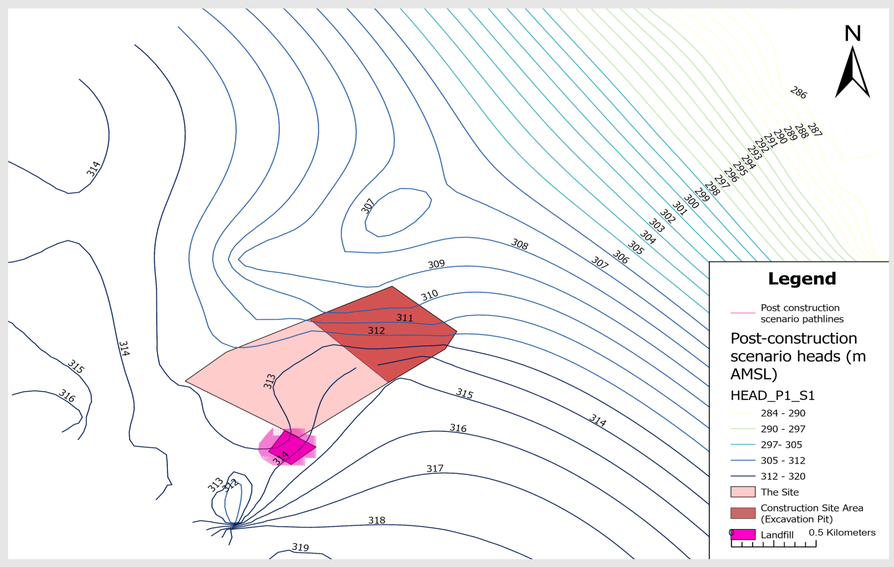
Baseline Scenario



Dewatering Scenario



Post-Construction Scenario



Results

Baseline Scenario

- Groundwater heads varied between 309-313m Above Mean Sea Level (AMSL)
- Groundwater flowing towards the north-east
- Drainage ditches exert a local control on groundwater heads
- Movement of contaminants from landfill along one drainage ditch (V-P-9) towards the construction area.

Dewatering Scenario

- Groundwater heads varied between 305-312m Above Mean Sea Level (AMSL)
- Groundwater from southern area of site directed towards construction site area (groundwater head 305m AMSL) due to dewatering concentrated in this area
- Average foundation depth is 4.4m and the average surface elevation is 311.11m AMSL within the construction area, the groundwater heads are required to be below 306.7mAMSL.
- Contaminant movement from landfill similar to baseline, expect for a greater volume in this scenario.
- Contaminant is not simulated to reach site within 10 years, therefore low risk.

Baseline Scenario

- Groundwater heads varied between 310-314m Above Mean Sea Level (AMSL)
- Contaminant restricted to the landfill site and south-eastern edge of site

Assumptions and Uncertainties:

Lack of groundwater head data (only groundwater strike during drilling is available and may not be representative of groundwater head)

Hydraulic conductivity is limited to two falling head tests and therefore only one value has been applied across the model, when there could be more vertical and lateral differentiation that isn't currently accounted for.

Lack of groundwater chemistry data near the landfill to allow for fate and transport modelling of contaminants to the Site and/or the public well. Currently only one particle tracking has been modelled to show the path of contaminant migration.