

# CASE STUDY



# GEOFEM

## Bishops Cleeve, Glos.



*"Geofem measured landfill settlement trends for the previous two years to help us assess a site's suitability for development and then provided us with a concept design for a reinforced soil platform to mitigate those settlements."*

Philip Brain, Head of Operations, Kiwa Gastec

Landfill sites can be suitable for development but there are potential hazards including land subsidence that need to be addressed. One such site on the edge of an old municipal landfill was being considered for the construction of a hydrogen plant. A combination of satellite analysis and geotechnical expertise was needed to identify a solution.

## AT A GLANCE

### THE CHALLENGE

- Ongoing landfill settlement that threatened the viability of the site was an unknown quantity and was difficult to predict accurately.
- Measuring the settlement of the site in situ would be expensive and take months to accumulate enough data to detect trends.
- The proposed hydrogen bullet tank was settlement-sensitive so a solution to mitigate differential settlements without disturbing the capping was needed.

### THE SOLUTION

- Retrospective InSAR analysis of two years of archived satellite data was used to provide settlement trends across the entire landfill.
- The settlement data and site investigation information were used to help develop a finite element analysis (FEA) model of the edge of the landfill to predict settlements of the proposed hydrogen plant.
- A reinforced soil platform was proposed to mitigate differential settlements and protect the hydrogen tank.

### THE BENEFITS

- Settlement data for the entire landfill over the previous two years was obtained for a more informed consideration of development of the site.
- This data gave confidence in the ongoing settlement predictions.
- An inexpensive solution to mitigate differential settlements was proposed in a concept design.



InSAR settlement data for the entire municipal landfill

## THE CHALLENGES

A hydrogen plant including a settlement-sensitive bullet tank were proposed to be constructed on the edge of an old municipal landfill. However, the ongoing settlements due to chemical and microbial breakdown of the waste, which are difficult to predict, threatened the viability of the site for development.

The landfill settlement could have been measured in situ but would have required expensive monitoring equipment or frequent visits to the site. It would also have taken several months to accumulate enough data to detect any trends.

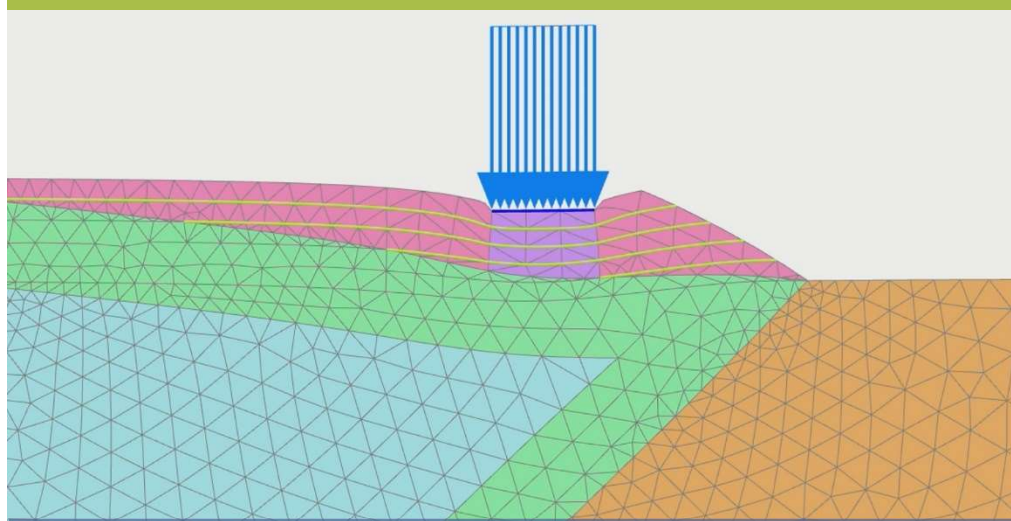
Even when the settlement trends were determined, it was likely that differential settlement would remain a potential hazard to the hydrogen plant and a solution to mitigate this without disturbing the landfill capping was needed.

## INSAR & FEA

InSAR analysis was used to measure landfill settlement over the previous two years and to detect settlement trends to help predict future behaviour and the risk of damage to the proposed hydrogen plant. This is the only technique that allows retrospective determination of ground displacement.

The existing site investigation information was studied to produce a finite element analysis (FEA) model of the edge of the landfill, the lining and capping layer as well as the natural ground. The settlement predictions of the model were validated by the InSAR-determined values.

Using our specialist expertise in the simulation of granular materials mechanically stabilised by geogrid, we simulated the construction of a reinforced soil platform to mitigate differential settlement of the hydrogen plant. The key advantage of this solution is that it did not require improvement of the landfill material nor disturbance to the all-important capping layer.



FEA model of landfill and proposed reinforced soil platform to mitigate settlements

## THE BENEFITS

For the first time, stakeholders in the municipal landfill had settlement measurements of the entire surface. This gave them valuable information regarding the current state of the facility as well as allowing development planning decisions to be taken in a more informed way.

A cost-effective solution to allow the site to be developed was identified without needing to disturb the landfill or its capping layer.



Satellite analysis with engineering insight