DHI CASE STORY

DECOMMISSIONING A FORMER NUCLEAR WEAPONS MANUFACTURING FACILITY

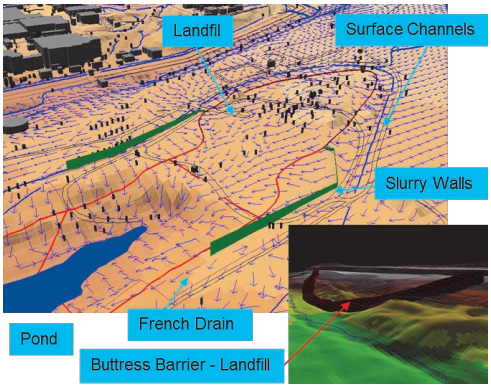
Modelling groundwater-surfacewater interactions in a semi-arid region

A nuclear weapon parts manufacturing facility in Colorado, USA, on the Rocky Flats Environmental Technology Site (RFETS) was successfully converted into a wildlife refuge in 2005. The highly industrial site had undergone substantial surface and sub-surface modifications. The remediation and closure required a detailed understanding of the complex natural hydrologic system. We applied our integrated hydrological knowledge coupled with our modelling expertise to the challenge. Using the MIKE SHE modelling platform, we developed a detailed surfacewater and groundwater interaction model. With the help of this model, we were able to assess contamination pathways and identify and justify the preferred water management and rehabilitation options.

RFETS – A NETWORK OF WATER COMPLEXITIES

For many years, the U.S. Department of Energy (DOE) operated a nuclear weapon parts manufacturing facility at the RFETS, located in semi-arid Golden, Colorado. The facility was ultimately closed in 2005 and converted into a National Wildlife Refuge. The closure and rehabilitation of the site was to be achieved through a major rehabilitation program at a cost of USD 10 billion.

Hydrologic conditions at RFETS exhibit strongly coupled surfacewater-groundwater interaction. The hydrology is further complicated by the industrial surface drainage modifications and extensive existing subsurface infrastructure. It was necessary to ensure that the proposed wildlife refuge was sustainable. As such, it was critical to thoroughly understand the effects of the site closure and develop appropriate rehabilitation options for the site hydrology and water balance. The rehabilitation and closure plan was designed to improve the environmental conditions for the wildlife.



Simulation of surface drainage to identify contamination pathways

SUMMARY

CLIENT

Kaiser-Hill, LLC

CHALLENGE

- Complex hydrologic conditions in a semi-arid area
- Strongly coupled surface water-groundwater interaction
- Significant radionuclide and industrial contamination
- Extensive infrastructure below ground infrastructure

SOLUTION

- Integrated hydrologic model of surface water and groudwater interaction
- Creation of a substantial digital database and GIS
- Community engagement and dialogue with stakeholders
- Recomendation of site closure and rehabiliation design

VALUE

- Acceptance of the study results by stakeholders and regulators
- Enhanced knowledge of semi-arid areas
- Enabling sustainability of the proposed wildlife refuge
- Extensive knowledge of the water system at RFETS
- Improved ability to manage water at RFETS

LOCATION/COUNTRY

Golden, Colorado, U.S.A

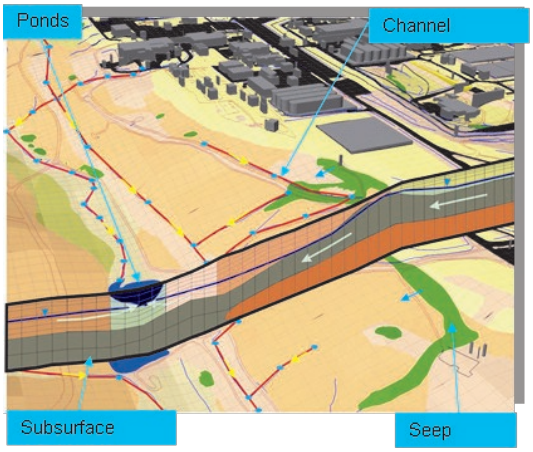
WE CREATE AN INTEGRATED SURFACEWATER-GROUNDWATER INTERACTION MODEL

Using our MIKE SHE modelling platform, we developed a fully integrated hydrologic model of the surface-subsurface flow system. To support model development, we constructed a detailed digital database and Geographical Information System (GIS). We developed several coupled sub-scale integrated models site-wide to better understand and parameterise the complex system flow dynamics. We used the model primarily to assess system response to wet- and dry-year climate impacts for different proposed site-closure land configuration designs. The final model included:

- changes to the site topography
- site drainage routing
- operation and design of the final surface reservoir system
- hundreds of miles of subsurface utility corridors and storm and sanitary drains

OUR RESULTS ARE WIDELY REVIEWED, SCREENED AND ACKNOWLEDGED

Our modelling work and presentations to stakeholders dramatically changed the understanding and perceptions within both the public and responsible agencies of groundwater flows, surfacewater flows and how they interact at RFETS. Our assessments were successfully peer-reviewed in detail by several different nationally recognised expert panels. Results were presented to various agencies – Environmental Protection Agency (EPA), State Health Department, U.S. Fish and Wildlife Service and DOE to name a few. We also presented the results to a range of concerned citizen groups overseeing the site closure. Thus, in addition to our technical expertise, we were able to support our client by facilitating dialogues with stakeholders and regulators.



Groundwater–surfacewater interaction model mesh

DEVELOPING OTHER PERIPHERAL MODELS TO CATER TO ADDRESS SPECIFIC CONCERNS

Working closely with several geotechnical experts, we also developed localised, high-resolution flow models of two former industrial landfills. This was done to better understand coupled water dynamics in these areas for both current and future closure designs. Once developed and calibrated, we used the models to evaluate the integrated hydrologic response to different closure designs. These included modified vegetation, soil configurations, topography and surface drainages.

Furthermore, we developed localised, high-resolution MIKE SHE surface-groundwater flow models for seven former deep-basement nuclear manufacturing structures. These models were constructed to address several concerns identified by federal and state agencies. These concerns primarily included improving the fundamental understanding of surface-groundwater flow and contaminant transport dynamics surrounding the buildings for both current and alternative closure configurations and typical and extreme annual and event-level climate sequences.

These model results were used to predict future conditions and changes in flow through:

- surfacewater ponds
- stream discharge
- potential seep areas and discharge rates
- drain flow
- 3D groundwater flow
- integrated contaminant transport

They were also used to evaluate several engineered systems to control groundwater and surfacewater flows.

Using our group expertise in water governance and policy development, we were able to inform stakeholders such as attorneys, consultants, citizen groups and various federal and state regulators on management options. This broad capability was acknowledged and appreciated by government agencies such as U.S. Fish and Wildlife Services, US EPA and State Public Health departments.

The combination of in-depth technical expertise coupled with water governance and policy development within DHI was crucial in gaining acceptance of the approach to site rehabilitation.

Based on our modelling approach, the regulators and the concerned citizens accepted our client's hopes for the proposed closure configurations.

OUR ASSESSMENT APPROACH PROVED EXTREMELY USEFUL!

Our modelling results were used to:

- Make critical decisions on future operation and maintenance of surface reservoirs
- Assess impacts to radioactive contaminant plume migration and surfacewater discharge areas
- Modify land surface topography and drainage
- Support detailed studies on wetland design and sustainability for different climate regimes

We continue to participate in post-closure model validation efforts, which confirm model predictions.

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