RockWare Consulting – A Case Study

2/14/22

In 2019, RockWare was contracted by a client directed by a state agency to help with the modeling and visualization of a groundwater contamination plume based on well data dating back to the mid-1980s. This project involved the creation of numerous contour maps, cross-sections, fence diagrams, volumetric computations, and animations depicting lithology, stratigraphy, hydraulic conductivities, groundwater pathways, and contaminant concentrations.

Initially, the project was based on incomplete historic data from multiple sources. In addition, data from groundwater monitoring wells was, and still is, being added to the project database on an ongoing basis. The challenge was to frequently create three-dimensional “snapshots” of the data in order to identify bad or missing historical data and to monitor the plume migration to facilitate the identification of optimal locations for additional monitor and recovery wells. In other words, the task was to repeatedly perform a complex series of steps involving modeling and visualizations as the data and the project dimensions continued to be changed.

To streamline the processing, the steps involved in automating the modeling and visualizations were added to a RockWorks Playlist (Figure 1). By doing so, all of the data could be re-processed with a single click every time the data was changed. These steps included the creation of;

- a series of base maps depicting major features, prohibited drilling boundaries, well locations, etc.,
- an upper constraining grid surface based on high-resolution LIDAR data,
- a 3D display of underground stormwater drainage pipes,
- a 3D terrain model (Figure 2A),
- 3D lithology and stratigraphy striplogs,
- a 3D bedrock surface model,
- a maximum water level surface model,
- a lithology block model (Figure 2B),
- a hydraulic conductivity model based on the lithology model,
- a BPI (Boolean Permeable/Impermeable) model based on the hydraulic conductivities,
- a truncated BPI model based on the maximum water level surface model,
- 25 annual contaminant (dioxane) models based on the time-based water samples and constrained by the BPI model,
- 25 annual 3D dioxane concentration striplogs,
- annual highest dioxane level grid models,
- depth to dioxane >7.2ppb, >280ppb, >1,900ppb grid models,
- production/remediation well location maps,
- annual 3D diagrams depicting 7.2, 280, and 1,900ppb isoshells,
- proposed monitor and recovery well maps,
- 3D lithologic fence diagrams (Figure 2C),
- 3D maximum ground water level fence diagrams,
- a 2D groundwater contamination animation from 1986 to 2019 (Figures 2D & 3),
- a 3D isoshell animation 1986-2020 (Figure 2E), and
- a 3D lithology cutaway animation.

As with any project, the lateral and vertical extents of the area changed as more data became available. In addition, the resolution (i.e., voxel dimensions) of the models also changed. These models were used to create cross-sections with superimposed borehole striplogs so that the client could QA/AC the data in an iterative fashion. This process was repeated until the client was satisfied with the quality of the data and the models. The addition of new data involved a similar iterative process.

A high-resolution LIDAR surface grid (Figure 2A) was used to constrain the upper extents of the models. A satellite image of the site was subsequently draped over the LIDAR-based surface grid (Figure 2D) to provide a better spatial understanding the of the plume extents.

An automated limiting-polygon tool was used to limit the annual contamination models based on the wells that were sampled during the associated time frame. For example, the extents of the 1990 model is smaller than the 1995 model because the 1990 model was based on fewer monitor wells.

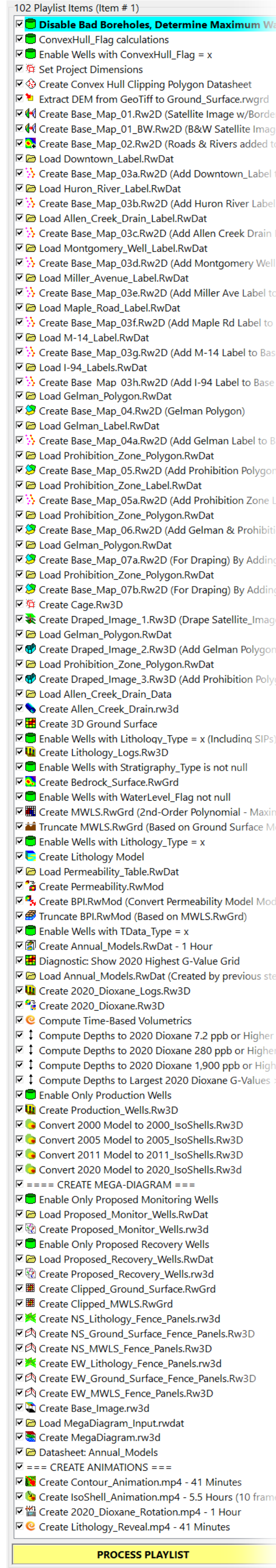

Figure 1

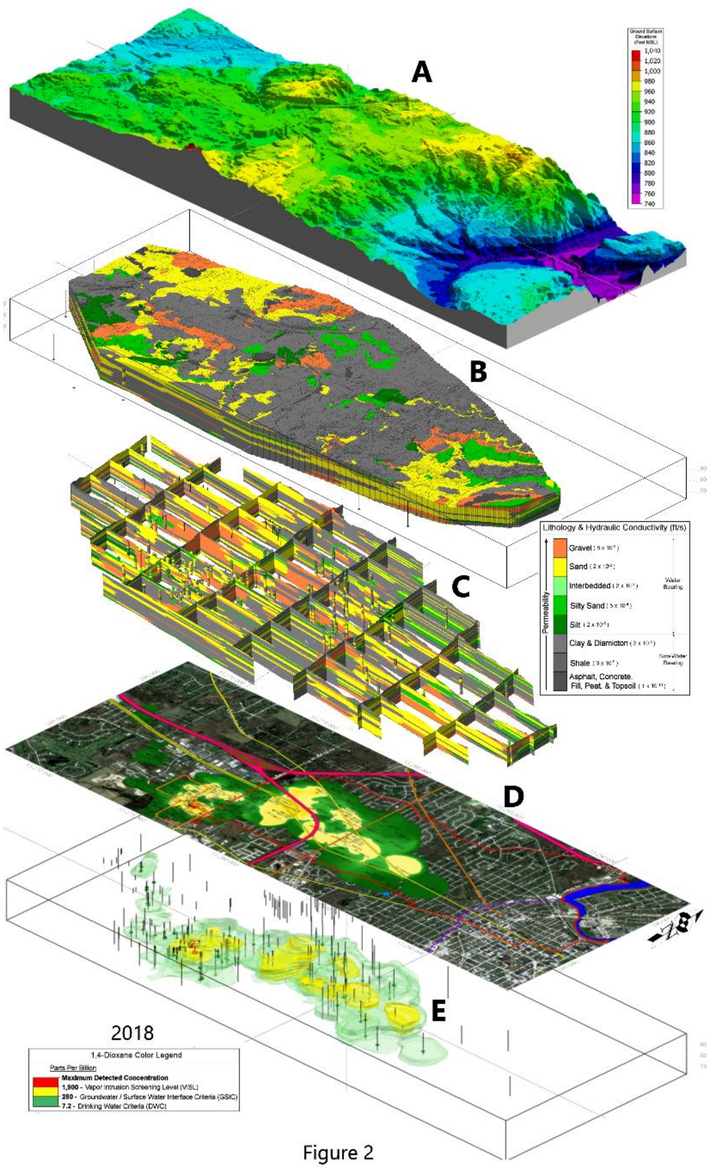

Figure 2

Hydraulic conductivities were assigned to each of the lithology types in order to create a hydraulic conductivity model. This model was then filtered to create a Boolean (true/false) model which was subsequently used to constrain the annual contamination models.

A maximum water level surface was created to serve as an upper confining surface for the geochemical modeling. Bedrock data, as determined by a seismic survey and a handful of wells, was also supplied by the client to act as a lower confining surface.

Tables and graphs were created to show the annual changes in the contaminant volumetrics based on three cutoff levels; 7.2ppb for drinking water, 280ppb for groundwater/surface water, and 1,900ppb for vapor intrusion screening level. These graphs provided a quantitative, non-spatial alternative to the time-based 3D animations in terms of showing the historical dissipation of the contamination.

Over the course of the project additional items (e.g., adding sub-sites) were added to the Playlist resulting in a list that currently contains over 248 different items. The playlist was crucial in both time management and QA/QC. Instead of having to go through each individual step as data was updated, the workflow now only consisted of updating the data and running the playlist.

Based on this case study as well as other consulting projects, the benefits of the RockWorks Playlist capability include;

- **self-documenting automation** that eliminates the tedium and error-prone repetition of opening, adjusting, and executing individual program menus,
- an **audit trail** that can be used to refresh a user's memory,
- a detailed record of all steps, algorithms used, and other menu settings suitable for use during the discovery process during **litigation**,
- a **turn-key deliverable** to clients (such as ours) who want to be able to process future data,
- a **strategy for processing other sites** without being forced to start from scratch, and
- a tool that can be used by **entry-level geoscientists** that was designed by senior-level geologists.

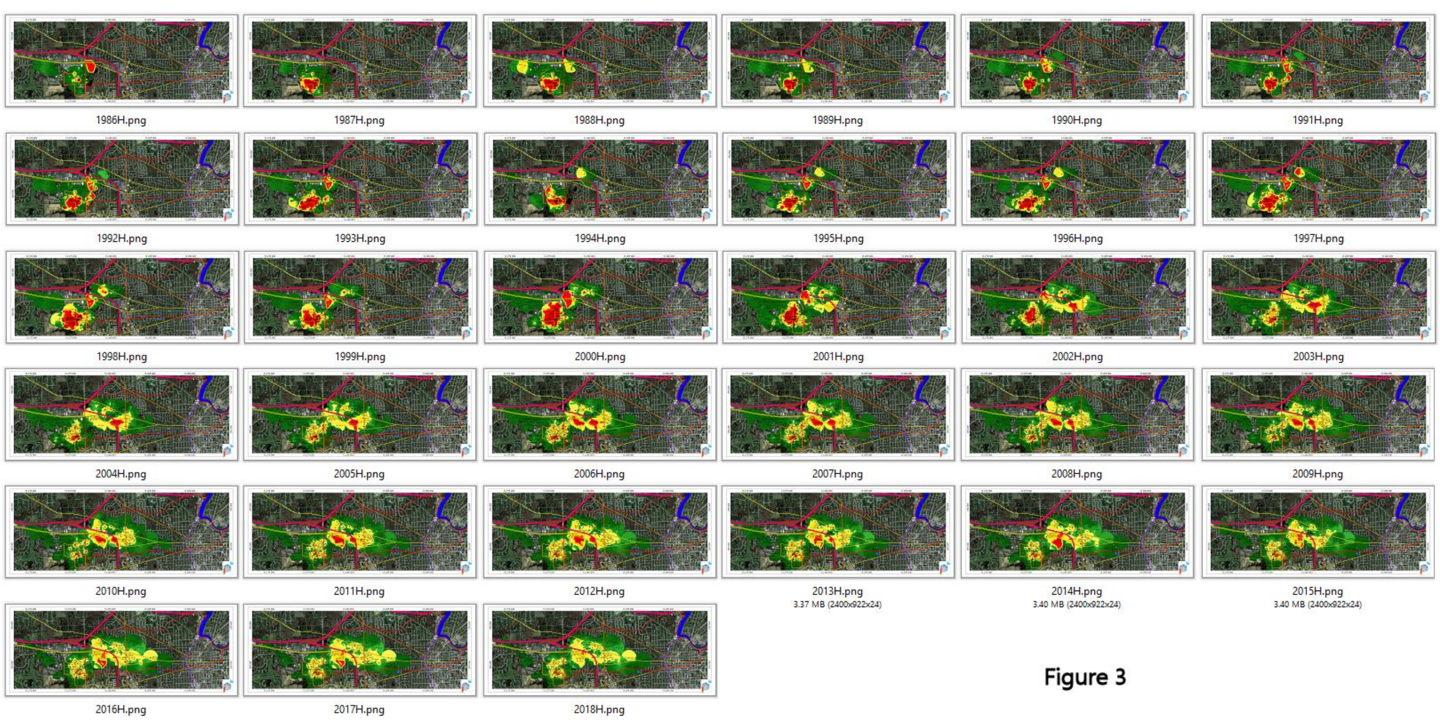

Figure 3