PONDS 3.2 TECHNICAL MEMO

Date: December 7, 2007
Re: **Using PONDS for Dewatering Analysis**

The following technical memo outlines the use of the PONDS 3.2 Refined Method software to perform a dewatering analysis to determine the following:

- The extent of the groundwater mound drawdown impact

- The groundwater baseflow from groundwater seepage into the excavation

In PONDS, a dewatered excavation (or borrow pit) is modeled as a pond whose discharge structure elevation is set to the controlled water elevation during dewatering.   The groundwater is then allowed to infiltrate (through background seepage) into the pond and is discharged through a control structure.

In order to model the dewatering, a suitable hydrograph must be chosen.   The PONDS Baseflow hydrograph is generally used with the fluctuation in the ambient groundwater table generally set to a very small number to simulate static ambient groundwater conditions.

The Baseflow Hydrograph

For the baseflow hydrograph there is no direct inflow (from runoff) into the pond.   Instead, a uniform recharge is applied to the ground surface outside the pond, sufficient to raise the groundwater table from the specified starting elevation (such as seasonal low groundwater table) to the final groundwater elevation (such as the seasonal high groundwater table) over a specified period of time, as depicted in Exhibit 1 below.   This rise in groundwater table will induce baseflow groundwater infiltration from the soil into the pond, depending on the elevation of the pond relative to the low and high water levels, and the elevations of any discharge structures.

For a dewatering analysis, the change in groundwater table elevation (dH) is usually set to a very small value, but could also be set to some other value if seasonal groundwater fluctuations (for example) are to be modeled.

By using the baseflow hydrograph with a very small change in ambient groundwater table, we are essentially simulating a zero-inflow/zero-recharge hydrograph. PONDS must have a non-zero hydrograph in order to execute, and a baseflow hydrograph approaches the zero-inflow/zero-recharge conditions as long as dH is very small.
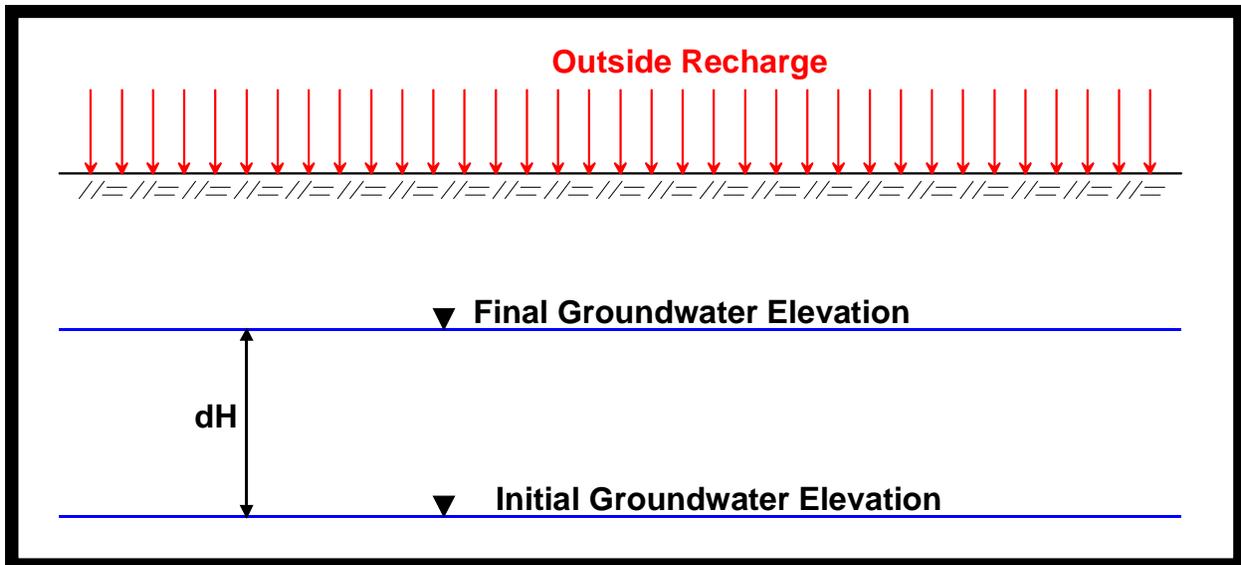
Exhibit 1.   Example of Outside Recharge in Baseflow Hydrograph

In Exhibit 1 above, the outside recharge, as calculated internally by PONDS, is as follows:

Recharge Rate = dH x n / dT

where:

dH is the desired change in groundwater elevation

n is the fillable porosity of the soil

dT is the desired length of time over which the change in groundwater elevation occurs

Groundwater Mound Profile

By default, the option for saving the groundwater mound profiles in PONDS is turned off in order to decrease the size of the PONDS data files. For a dewatering analysis, the groundwater mound profile should be turned on. This can be done by accessing the following menu sequence:

      Options ➜ Advanced Modflow Options...

This will open the Modflow Options dialog box, as shown in Exhibit 2 below. The groundwater mound output flag must be activated in order for PONDS to save the groundwater mound profile.
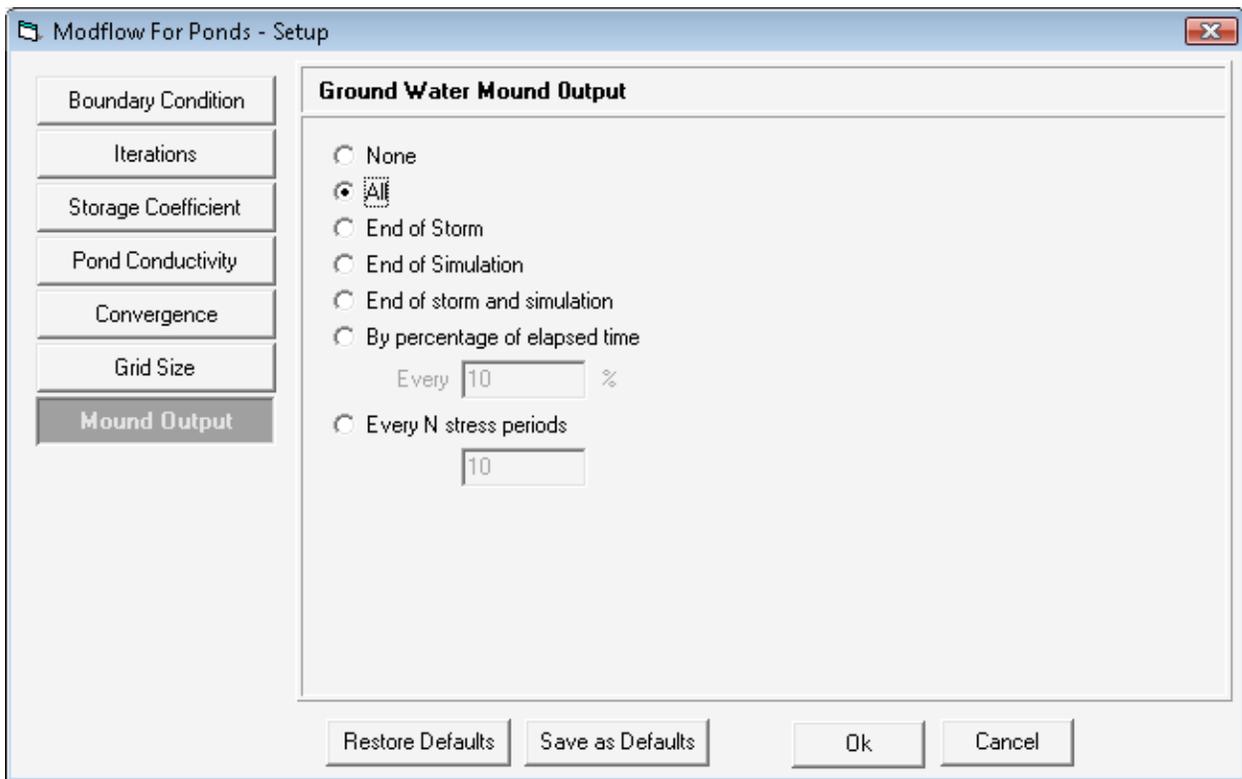
Exhibit 2.   Advanced Modflow Options, Groundwater Mound Output Flag

Example Problem

A borrow pit (approximately 2.5 acres in size) will be excavated over a period of 90 days. The dewatering will be performed in two stages using sock drains.

Exhibit 3 below shows a schematic of the equivalent pond.
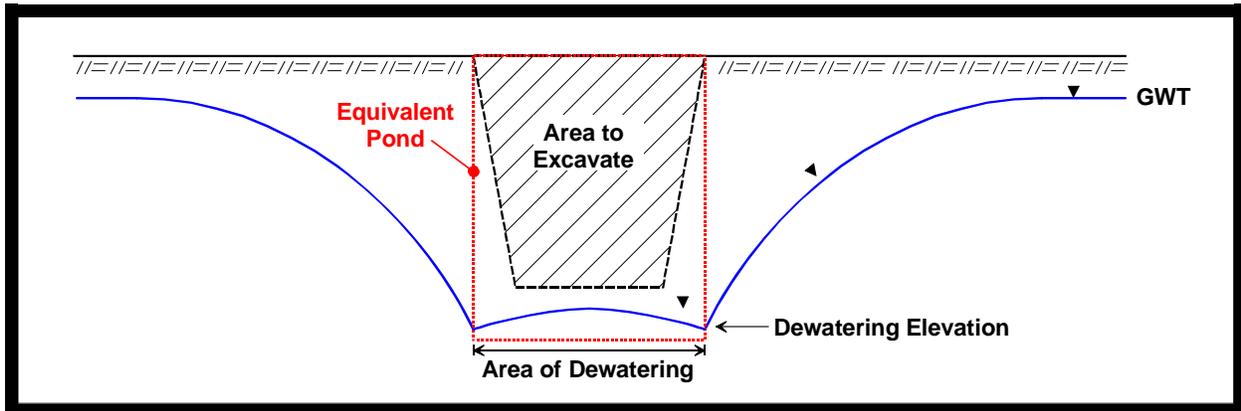
Exhibit 3.   Schematic for Dewatering Example

As seen in Exhibit 3, the equivalent pond for the dewatering analysis does not correspond exactly to the excavation, but instead corresponds to the footprint of the dewatered area.

The following data are given:

> Equivalent Length, L = 700 ft
> Equivalent Width, W = 150 ft
> Base of Excavation = +70 ft NGVD
>
> Ground Surface = +100 ft NGVD
> Water Table = +95 ft NGVD
> Base of Aquifer = +65 ft NGVD
>
> Horizontal Conductivity, kh = 5 ft/day
> Porosity, n = 25%

Dewatering will be performed using sock drains, which will be modeled as a 6-inch orifice. Dewatering will occur in two stages:

> Stage 1, sock drains at +80 ft NGVD from 0 to 45 days
> Stage 2, sock drains at +68 ft NGVD from 45 to 90 days

Note that the groundwater will be controlled at two feet below the bottom of the excavation in the final dewatering stage.

During dewatering, water will be coming out of the soil voids within the area to be excavated, i.e., the pond itself is not an open area with a porosity of 1.0 but is soil with a porosity of n (25% in this example). Therefore, the stage vs area data used in PONDS (which are used to calculate the stage vs storage relationship of the pond) should be corrected as follows:

Area = width x length x soil porosity = 700 ft x 150 ft x 0.25 = 26,250 ft

The following screen shots demonstrate the required data input in PONDS.

Exhibit 4 below shows the Aquifer Data parameter entry.
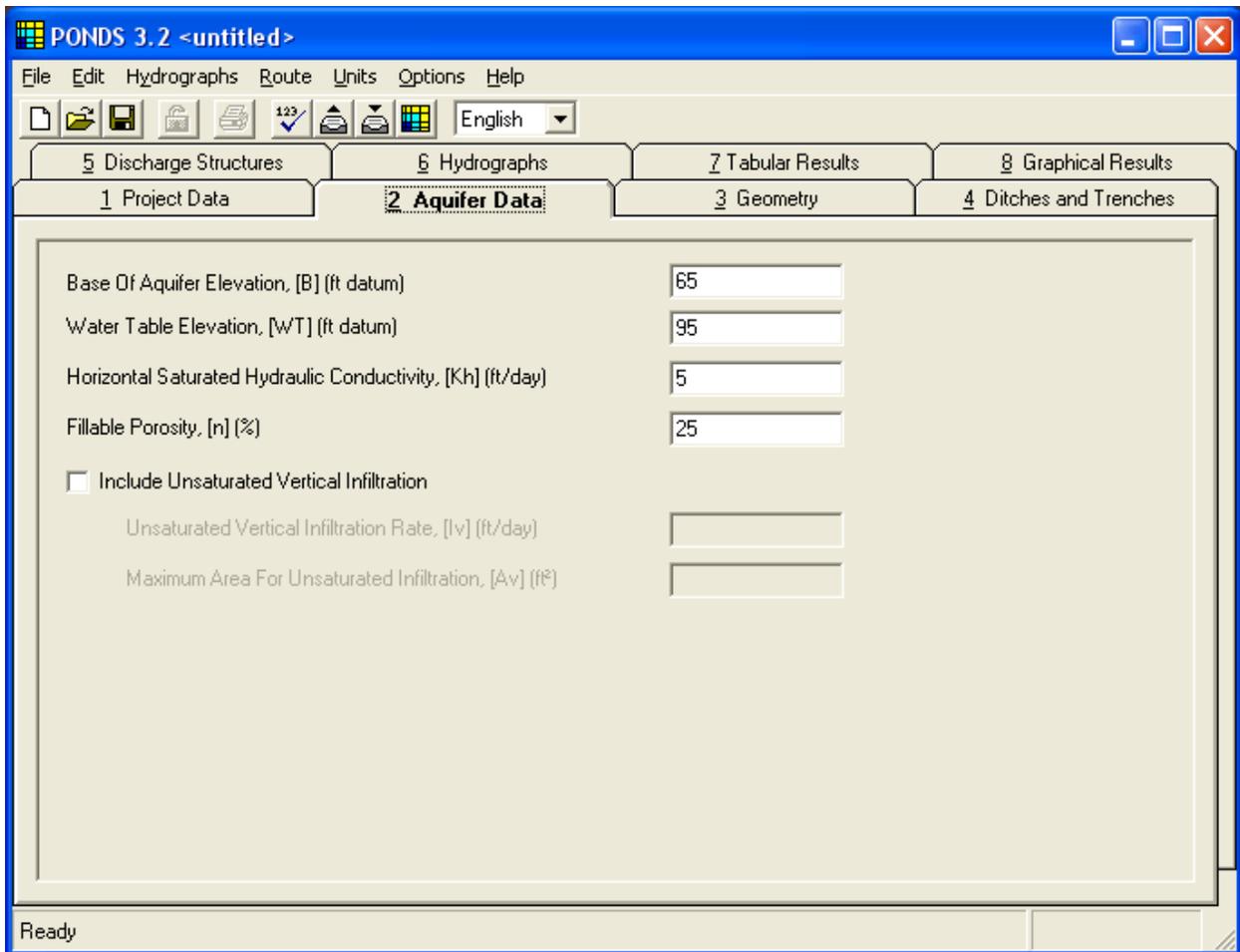
Exhibit 4.   Aquifer Data

Exhibit 5 shows the Geometry Data input parameters. Note that the pond bottom elevation is set at some finite distance below the dewatering control elevation, which was specified to be +68 ft (second stage of dewatering). The actual distance between the control elevation and pond bottom is not critical, as long as the pond bottom is below the control elevation. Also note that the areas in the stage vs area data have been adjusted (as noted previously) since the water in the excavation is assumed to be coming from the soil voids during dewatering, and not from an open pond.
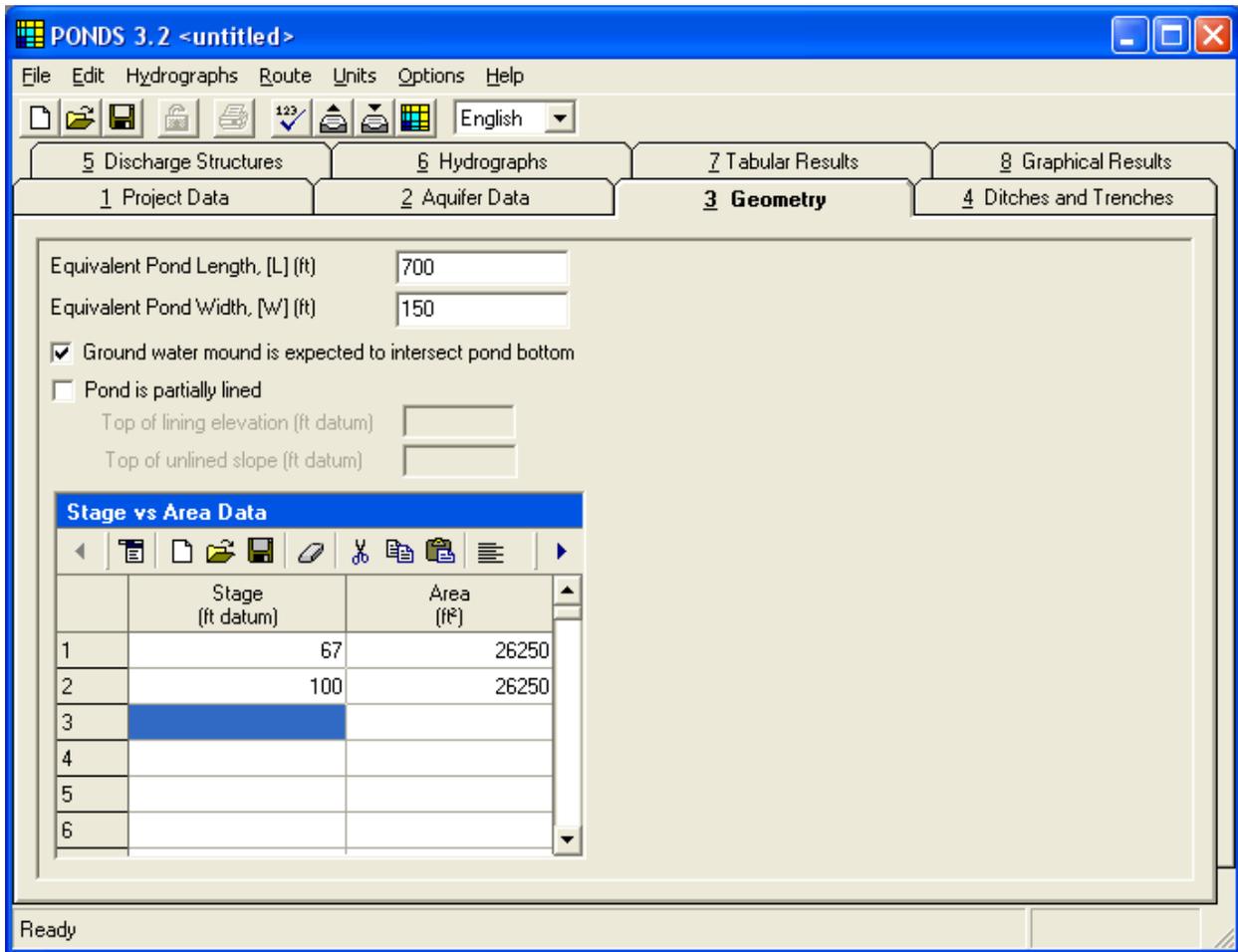
Exhibit 5.   Geometry Data

The dewatering will be simulated using a time variant orifice, which allows the control elevation to be lowered for each stage of the dewatering, as shown in Exhibit 6 below. A 6 inch circular orifice will have an area of 0.1963 ft^2.
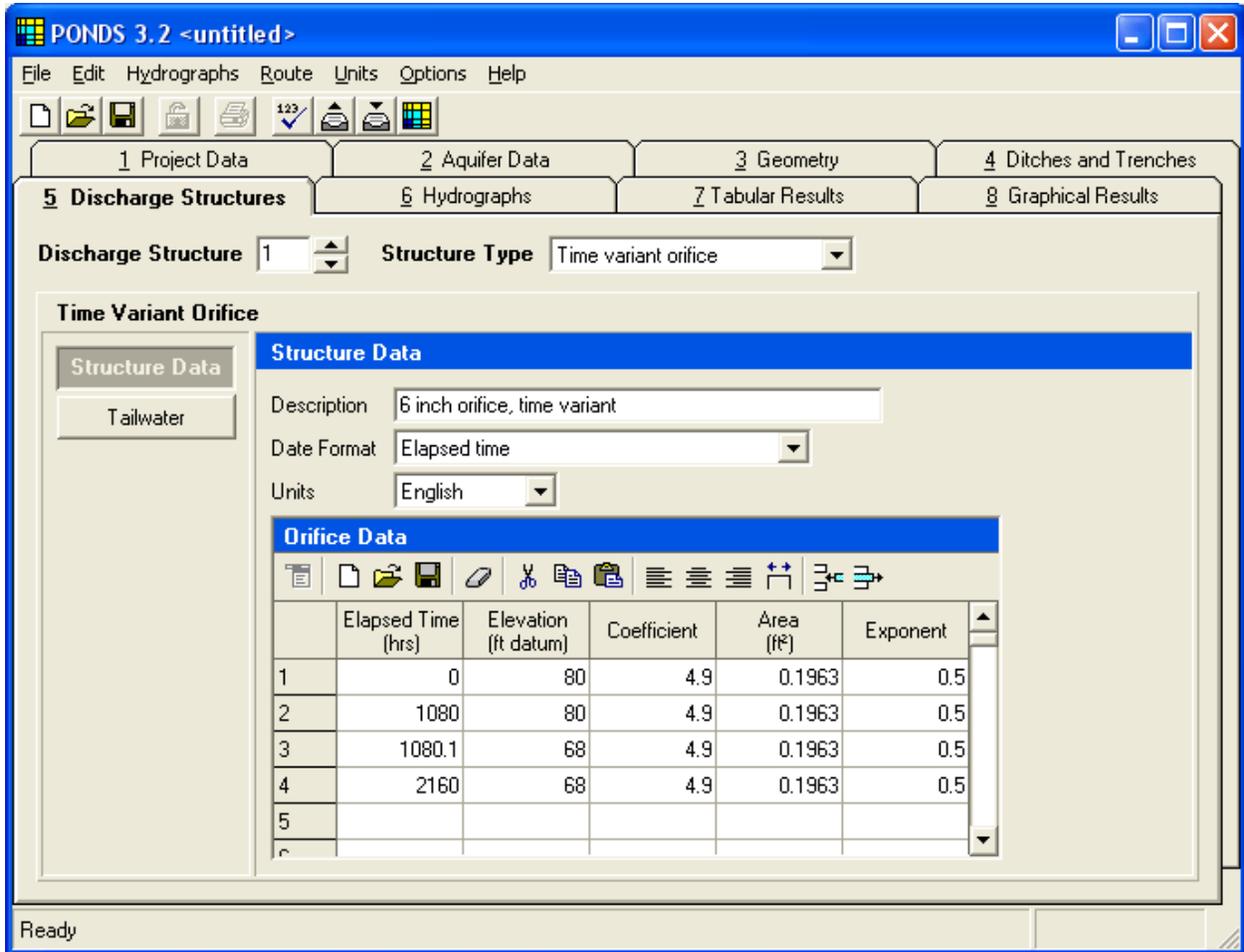
Exhibit 6.   Discharge Structure Data

A baseflow hydrograph is utilized as shown in Exhibit 7 below, with a very small change in groundwater table to approximate a static groundwater condition (at a large distance from the excavation). The duration of the hydrograph has been set to 90 days, and has been broken into 180 half-day increments. (Note: it is generally desirable to use a large number of short time increments as opposed to a small number of large time increments.)
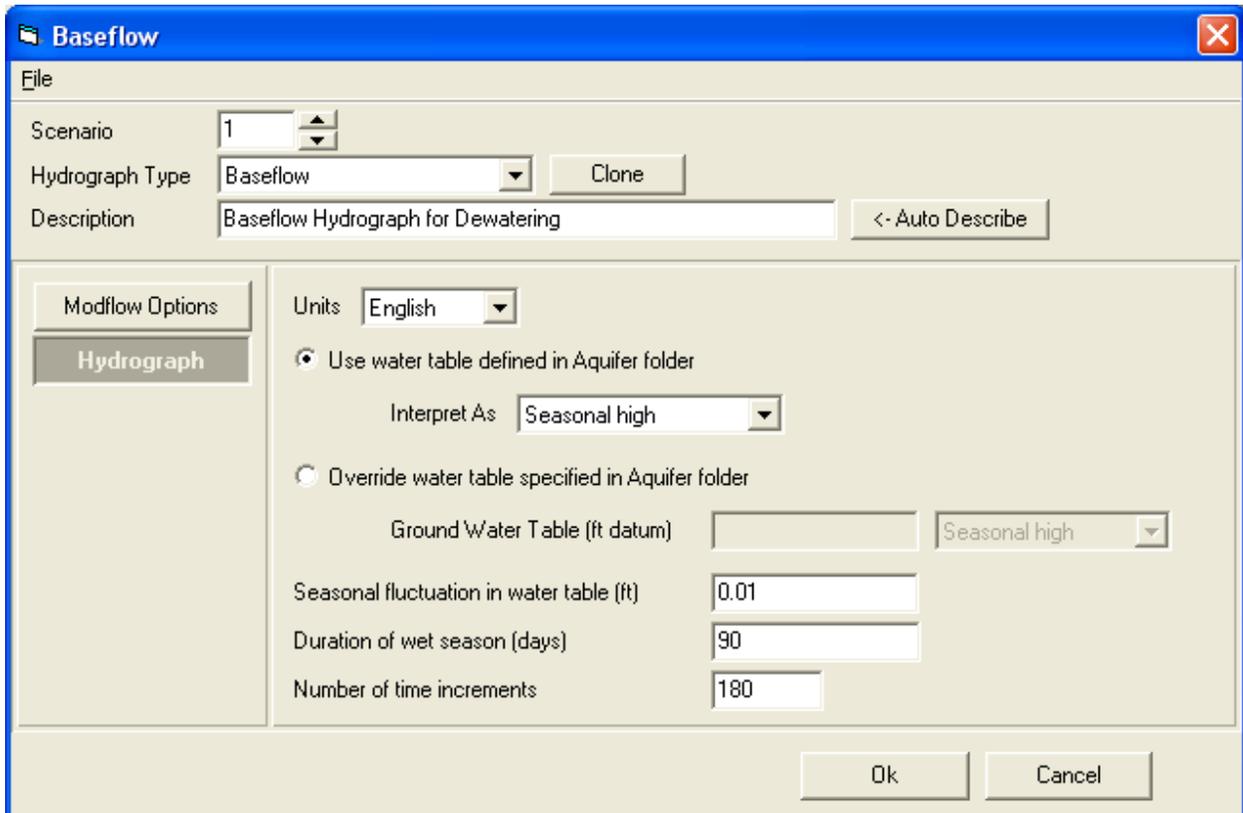
Exhibit 7.   Baseflow Hydrograph

The discharge rates through the orifice are available in tabular and graphical format. Exhibit 8 below shows a plot of the discharge rate and the water level in the pond. Note that the peaks in the discharge rate at the beginning of each dewatering stage are due to water coming out of the soil within the pond/excavation itself. Once the pond has drained, the discharge rates represent the water flowing into the pond from groundwater infiltration. The infiltration rates represent the groundwater baseflow flowing into the pond from the soils outside of the pond. Once the pond itself has drained, the infiltration rate should be equal to the discharge rate, but with opposite signs.
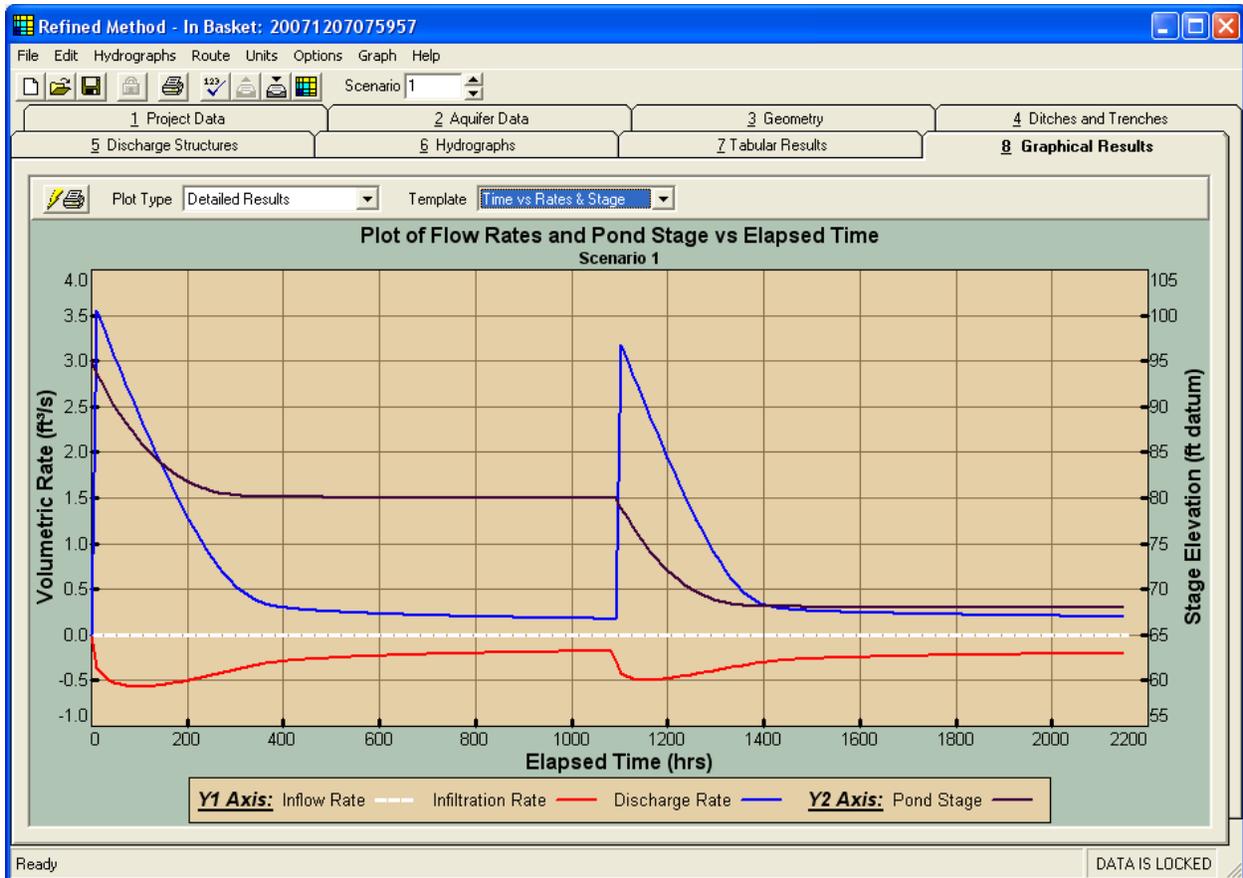

Exhibit 8.   Plot of discharge rate and stage

Provided that the Modflow Options have been set to allow saving the groundwater mound data (as discussed previously) the groundwater mound can be plotted to determine the extent of the drawdown impact at the end of the excavation period, as shown in Exhibit 9 below.
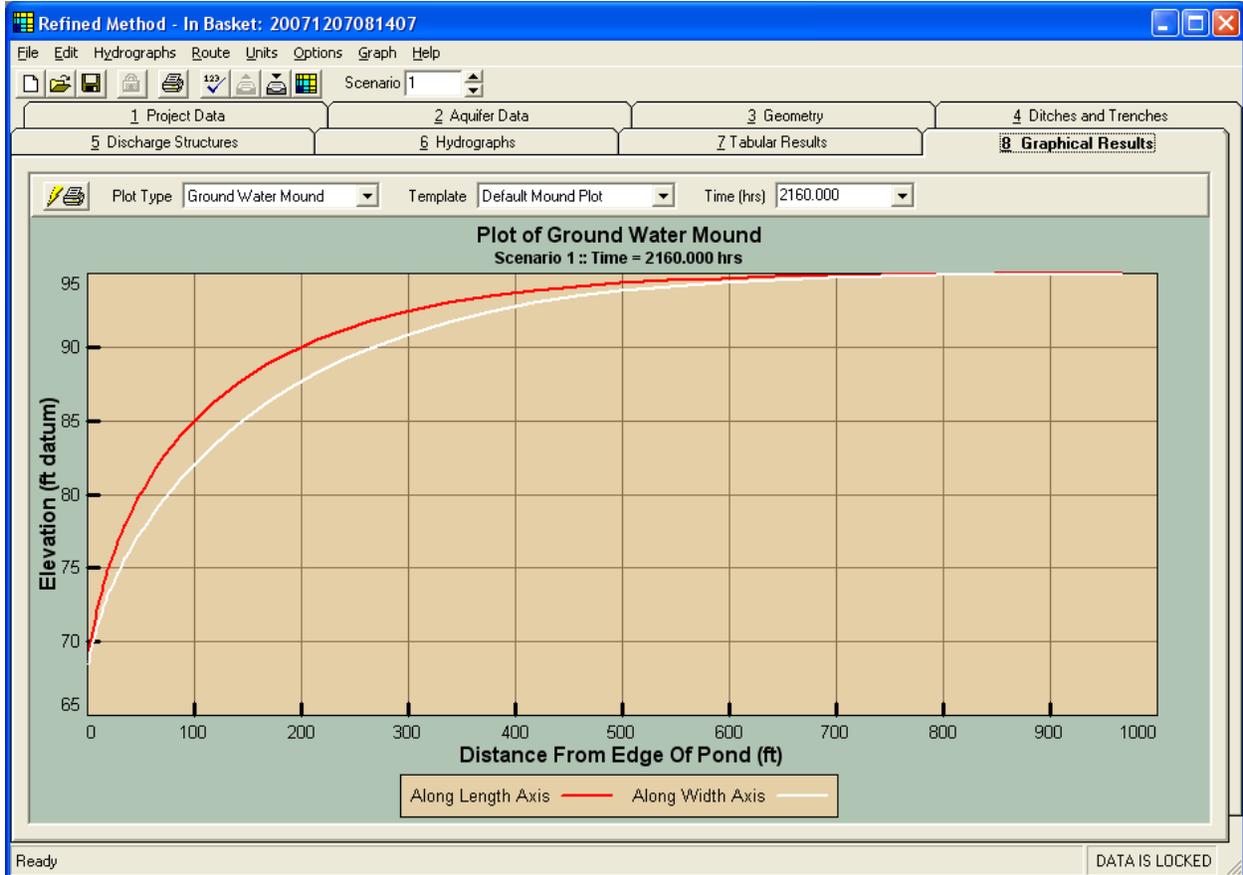

Exhibit 9. Plot of Groundwater Mound