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UNDERGROUND TEST AREA PROJECT PHASE I DATA ANALYSIS TASK

VOLUME II

POTENTIOMETRIC DATA DOCUMENTATION PACKAGE

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1.3.1 Subtask Purpose and Scope

The potentiometric surface, as defined by water levels observed in wells, is a measure of the driving energy that causes water to move through transmissive geologic media. Potentiometric data may be used in three ways during the development of a groundwater flow model. First, observed water levels are used during the groundwater flow model calibration, verification, and validation processes for comparison with water levels simulated by the model. Second, the observed water levels are used to develop potentiometric maps to help define flow directions which are also used during the calibration process. Third, the data help define the model boundaries, based on the potentiometric maps. Thus, the purpose of the Potentiometric Data Subtask is the compilation of potentiometric data within the selected area of investigation.

The scope of this subtask is to evaluate water level and spring data within the investigation area to help define the boundaries of the NTS regional groundwater flow system, the groundwater flow directions, and to provide a data set for use during the flow model development.

1.3.2 Subtask Objectives

The objectives of the Potentiometric Data subtask are to:

- Collect, compile, and qualify existing and newly-acquired depth-to-water and ancillary data within the area of investigation.
- Evaluate the temporal trends in these data and identify a subset that is representative of predevelopment, steady-state conditions for use in the model calibration.
- Provide a set of water level data, indicating the location of the measurement point, average water level elevation, variance, and the hydrostratigraphic unit (HSU) or HSUs represented.
- Prepare maps of hydraulic head distribution to determine groundwater divides and flow-line boundaries of the basin and to determine which geologic units significantly affect flow.

1.3.3 Subtask Approach

The general subtask approach includes the following steps:

- Compile and qualify new and available depth-to-water and ancillary data.
- Extract historical water level data subset representative of natural undisturbed groundwater flow system conditions.

7.2 *Uncertainty Analysis*

The two variables used to calculate the hydraulic head are depth-to-water (DTW) and land surface elevation (LSE) (Equation 5-1). Thus, the uncertainty associated with a mean hydraulic head value at a given site stems from three main sources of errors: the error associated with estimating the land surface elevation, the error associated with depth-to-water measurements, and the error associated with reducing the temporal water level measurements to a mean value.

The USGS database provides an estimate of the land surface elevation accuracy based on the method used including topographic maps or surveying, which provides better accuracies. These estimates are only gross indicators of the potential error based on the method of estimation. For the purposes of this task, they are assumed to represent the errors on land surface elevations for sites reported in the NWIS database. These errors range between 0 and 70 meters (m) (0 and 230 feet [ft]). The LSE errors for other sites are unknown.

It is assumed that the error on depth-to-water measurements is dependent only on the method used. Human errors arising from different operators may not be estimated here and will be neglected. Based on the USGS procedures, different methods are used depending on the depths to be measured. For depth-to-water measurements taken in shallow wells (7.6 to 30.5 m [25 to 100 ft]) using the wireline method, the steel tape or the electric tape, the accuracies range between ± 0.01 to 0.1 foot. For measurements in intermediate-depth wells (30.5 to 305 m [100 to 1,000 ft]) made using the steel and electric tapes, the accuracies range between ± 0.1 and 0.5 foot. For deep wells (305 to 914 m [1,000 to 3,000 ft]), the accuracy of depth-to-water measurements made using the wireline method is approximately 0.5 foot. In summary, the error associated with the depth-to-water measurements is generally less than 0.5 foot.
When averaging measurements, the error associated with taking individual depth-to-water measurements is included within the fluctuations of the hydrograph.

The hydrograph error is dependent on the site under consideration and may be estimated from the hydrograph variance. For flow model calibration purposes, estimates of the variances associated with the hydraulic head values, rather than errors, are used to weigh the hydraulic heads. Thus, a discussion of the variances is presented next.

As shown by Equation 5-1, the hydraulic head value is derived from land surface elevation and depth-to-water measurements, which are independent variables. Thus, the variance of the average hydraulic head value may be expressed as the sum of the variances of the two independent variables, i.e:

$$F^2_{\overline{H}} = F^2_{LSE} + F^2_{DTW} \tag{7-2}$$

Where:

$F^2_{\overline{H}}$ = Variance associated with the average hydraulic head, in meters squared;
F^2_{LSE} = Variance associated with the land surface elevation, in meters squared; and
F^2_{DTW} = Hydrograph variance of "consistent" measurements, in meters squared.

An alternate way to express the variance associated with the mean hydraulic head value obtained from multiple water level measurements is the variance of the sample mean, as follows:

$$F^2_{\overline{H}} = F^2_{LSE} + \frac{F^2_{DTW}}{n} \tag{7-3}$$

Where:

$F^2_{\overline{H}}$ = Variance the average hydraulic head, in meters squared;
F^2_{LSE} = Variance associated with the land surface elevation, in meters squared;
F^2_{DTW} = Hydrograph variance of "consistent" measurements, in meters squared.; and
n = Number of historical water level measurements used to calculate the average.

For each site, only one measurement or estimate of the land surface elevation is available. This single measurement is accompanied by an estimated accuracy that is dependent on the method used. For example, for land surface elevations estimated from topographic maps, the accuracy is equal to half of the contour interval used. The variance of the land surface elevation may be estimated from the land surface accuracy, assuming that the accuracy represents the error on the estimate with a 95 percent confidence level, and is, therefore, equal to two standard deviations. Thus, the variance associated with the land surface elevation is estimated as follows:

$$\sigma^2_{LSE} = (0.5 *)LSE)^2 \tag{7-4}$$

Where:

σ^2_{LSE} = Variance associated with land surface elevation, in meters squared; and
) LSE = Accuracy (Error) of land surface elevation measurement, in meters.

For sites having a single measurement of depth-to-water, temporal variances are unknown for such sites and were assigned a "999" code value in the database. Thus, the total variance is unknown and also is assigned a “999" code. For springs, the variance of the land surface elevation is used as the total hydraulic head variance. A total hydraulic head variance value of 100 square meters is recommended for all hydraulic head values assigned a “999" code. This variance is equivalent to an estimated error of +/- 20 meters or plus or minus two standard deviations, with a 95 percent confidence level.

7.3 Effective Open Interval Definition

Well construction data were used to define the well open interval to identify the hydrostratigraphic unit or units associated with each site for which water level measurements were available.

Detailed well construction data are stored in the ER database. The open interval of each completion zone is the construction data of primary interest. The term "open interval" refers to any type of opening through which water may flow freely from the rock formation into the borehole. Examples of open intervals include open borehole (uncased) or the intervals in which well screens and perforated casing are gravel packed. Types of well construction data needed for well hydrostratigraphic unit assignment are limited and include the following for each site:

Total depth (TD)
Depth to top of first open interval
Depth to bottom of first open interval