Construction of a Relational Database for Analyzing Water Levels

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This report describes the structure and use of a relational database built using Microsoft Access from data retrieved from the USGS's Ground Water Site Inventory Database. The database and related spreadsheets were used to prepare hydrographs, lists of interpolated water levels for use as target heads in modeling, and in the preparation of water level and water level decline maps.

A central table contains one record about each well. Another table stores water level measurements. Supporting tables store geologic formation information, well construction details, and output results that take too long to generate as queries.

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Introduction

The work described in this report was performed as part of a groundwater modeling study of Southwest Kansas on the Dakota Project at KGS. This database evolved to fulfill the needs of modelers for easy retrieval of wells by formation, for water level hydrographs, and construction of water level maps and water level datasets.

The original data for this database came from the US Geological Survey's Ground Water Site Inventory (GWSI) database, from both the Lawrence, Kansas and the Lakewood, Colorado offices of the Water Resources Division. (The author wishes to especially acknowledge the assistance of Christi Hansen at the Lawrence office in understanding the GWSI database.)

The primary data was obtained by querying the GWSI database for well data in western Kansas and eastern Colorado. Each query was designed to avoid multiplication of records. As the data were obtained, they were imported into a Microsoft Access relational database. This required eliminating duplicate and pseudo-duplicate records, converting missing-value codes into nulls, and converting the data into a relational database format. The design and use of the resulting database is the primary topic of this report.

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Objectives

The objectives, as well as the database, evolved over time. The original goal was simply to produce water level maps in a particular formation at a particular time. The final products of the database included:

1. well hydrographs (this also involved a Microsoft Excel spreadsheet for graphing and Microsoft Word for printing summary sheets), and catalogues of well hydrographs
2. point water levels at a particular time for contouring/gridding
3. as above, but limited by formation

4. point data at particular times as target heads in modeling

A variety of queries for extracting subsets of the data were written. Forms for viewing well summary data along with well details, such as a water levels, or formation picks, or well construction details were developed.

It should be noted that storing water levels and other information about wells is not an objective in the construction of the database: storing data is necessary, but not an objective. The design/construction of a database must proceed from the goals to the methodology, not vice versa.

Table Structure

Ultimately, this database required a number of related tables, shown in Figure 1. For each well, there is a record (or row or entry) in the tblSiteLocation table, because wells are the principal entity in this database. All other tables in this database are explicitly related to the wells data. For each well, there might be zero, one, or many water levels, which are stored in the WaterLevels table: this is shown with the one-to-many connecting line from tblSiteLocation to WaterLevels.

The principal table is tblSiteLocations, in which each record describes a single well. The primary key of this table is SiteSerialNumber, which is an arbitrary number assigned to a well. It does not encode counties, location, formation, owner's name, or anything else: it is just a serial number. Other fields include primary aquifer (derived from the tblFormationPicks table), location (Legal description, longitude-latitude, and the Dakota Project's Lambert coordinates), total depth, site use, water use, and the range of dates observed in this well. tblSiteLocation is a subset of the original GWSI wells listing, eliminating wells lacking elevations, water levels, or known dominant aquifer.

This database also contains a number of auxiliary tables containing water levels, formation picks, and well construction details. All other tables are in one-to-many relationships with tblSiteLocation.

Table tblSiteFormationPicks stores geological formation picks. For each formation in each well (some wells, really), this table contains the SiteSerialNumber and sequence counter, an AquiferCode, formation top and bottom, and whether the formation is a contributing formation or not. A single well might have one, fifteen, or zero entries in the tblSiteFormationPicks table, but will have only one entry in tblSiteLocation. The formation picks are from USGS GWSI database. The contributing field was combined from two possible fields indicating whether a formation is contributing.

Table WaterLevels contains information about groundwater heads and was the central purpose of this database. Its fields are SiteSerialNumber, Date_BestGuess, Head_BestGuess and DayOfYear. As might be expected from the names, the date and head were somewhat ambiguous in the original GWSI database: head and date could each be stored in two different fields. Date_BestGuess and Head_BestGuess represent a best guess at when the water level measurement was taken and what the depth to water was. The USGS GWSI database stores elevation and depth to water. Because the primary purpose of this database was to prepare groundwater level maps, the depth-to-water measurements were converted to water level above mean sea level by subtracting the depth to water from the well elevation. Only wells for which elevations were available were included in this database.

Table WaterLevels_INTERPOLATED contains information about interpolated water levels. These water levels were interpolated from the observed water levels by finding the nearest winter water levels before and after the target date, and linearly interpolating between them. This interpolation was done by a basic subroutine run from a form in the data base: View Site Locations_CanInterpolateToDate. This form allows the user to select a subset of the wells for which to perform the interpolation and a target date. It relies on two parameter queries to find the winter water levels, and another parameter query to retrieve the water levels (qdfPARAMFindFirstWinterWLBeforeDate, qdfPARAMFindFirstWinterWLAfterDate, and qdfPARAMFindWaterLevelBySerialNumberAndDate). It uses only winter water levels to avoid the irrigation-induced, short-term fluctuations seen in summer water levels. Winter is defined as the period from 30 November to 30 March of each year.

Two other tables contain information about well construction. CasingDetails and WellOpenings contain information about the casing string and the slots/screen, respectively. These tables are largely empty.

There are several other tables in the database that are not relevant to this discussion. These include

1. x WaterLevels_INTERPOLATED_AND_ALTERED, which contains hand-smoothed water levels for use as modeling targets,
2. x tblInterpolatedWaterLevelSUMMARY2, which contains a crosstab summary of interpolated water levels
3. tblFontList and zWHEATtblThemes for use with the WHEAT Electronic Mapping package
4. zDataEncyclopedia Recordsets and zDataEncyclopedia Fields which contain the enhanced data dictionary (or data encyclopedia) describing this database

Descriptions of the main tables and their fields follow the database diagram.

Main structure of Water Levels Database

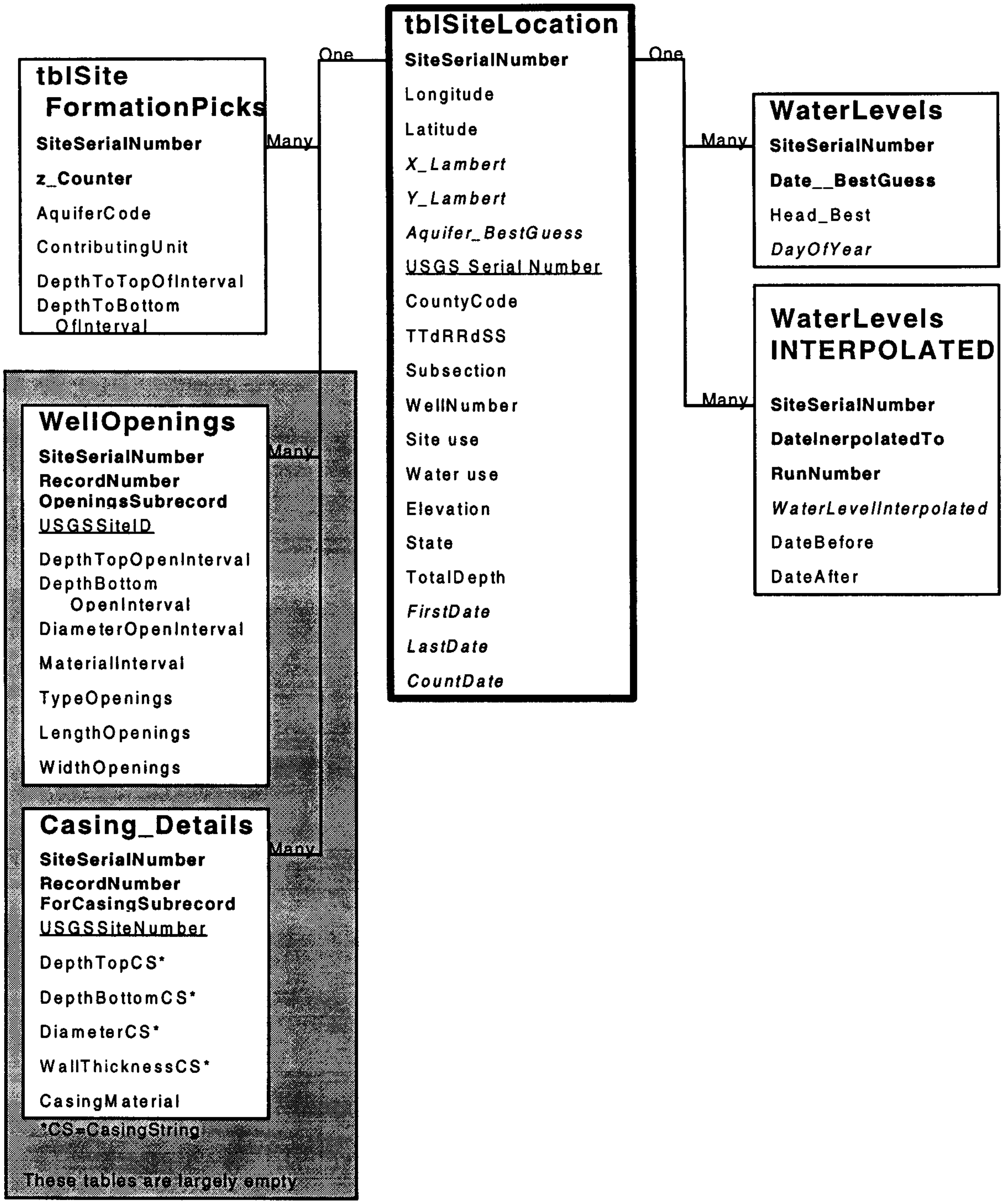


Figure 1 Structure of the Water Levels Database

The large bold type is for table names, the smaller type is for fields. Bold indicates that the field is part of a primary key, italic indicates calculated fields, and underlining indicates that it could be used as an a primary key, but is not.

Fields in tblSiteLocations

Name	Description	DataType
SiteSerialNumber	KGS Assigned Serial Number	Integer*4
Longitude	Longitude from USGS SiteID	Real*4
Latitude	Latitude from USGS SiteID	Real*4
X_Lambert	Easting in Dakota Projection	Real*4
Y_Lambert	Northing in Dakota Projection	Real*4
Aquifer_BestGuess	Best Guess at the Primary Contributing Aquifer, based on several fields	Text
USGS_Site_Number_As_Text	LatLongWellNum 15 characters Original USGS SiteID, but cannot be used as a number due to size.	Text
County code	FIPS County Code	Integer*2
TTdRRdSS	USPLSS location in TTdRRdSS format, like 02S13W23	Text
Subsection	BLM Style ACBD quartering	Text
Well Number	A sequence number for a well. Not used	Integer*4
Site use	Use of site.	Text
Water use	Use of the water.	Text
Elevation	Elevation in feet	Real*4
State	State abbreviation	Text
TotalDepth	Total depth of well	Real*4
FirstDate	First Date in WaterLevels	Date
LastDate	Last Date in WaterLevels	Date
CountDate	Number of Dates in WaterLevels	Date

Fields in tblSiteFormationPicks

Name	Explanation	DataType
SiteSerialNumber	KGS Assigned Serial Number	Integer*4
AquiferCode	USGS Aquifer Code, like 121OGLL	Text
Contributing unit	P for contributing unit, S for Secondary Unit, N for non-contributing, U for unknown	Text
Depth to top of interval	Top of formation	Real*4
Depth to bottom of interval	Bottom of formation	Real*4
z_Counter	Used as part of primary key. No other purpose	Integer*4

Fields in WaterLevels

Name	Explanation	DataType
SiteSerialNumber	KGS Assigned Serial Number	Integer*4
Date__BestGuess	Date of measurement. Comes from more than one field in the input data	Date
Head_Best	Elevation-DepthToWater. DTW may have come from several different fields.	Real*4
DayOfYear	Calculated day of year. Stored because DayOfYear calculations are very slow	Integer

Fields in WaterLevels_INTERPOLATED

Name	Explanation	DataType
SiteSerialNumber	KGS Well Serial Number	Integer*4
DateInterpolatedTo	Date the interpolation is for	Date
WaterLevel Interpolated	Interpolated water level. Linear interpolation of first preceding and first succeeding winter water levels	Real
DateBefore	Preceding winter water level date	Date
DateAfter	Succeeding winter water level date	Date
RunNumber	Arbitrary run number. Can be dropped.	Integer*4

Fields in Casing Details

Name	Explanation	DataType
SiteSerialNumber	KGS Assigned Serial Number	Integer*4
USGSSiteNumber	USGS LongLatNum SiteID	Text
RecordNumberFor CasingSubrecord	A sequence number for this record	Integer*4
DepthTopCasing	Depth to top of this casing interval	Real*4
DepthBottomCasing	Depth to bottom of this casing interval	Real*4
DiameterCasing	Diameter of this casing interval	Real*4
WallThicknessCasing	Thickness of this casing interval	Real*4
CasingMaterial	Material from which the casing in this interval was made	Text

Fields In WellOpenings

Name	Explanation	DataType
USGSSiteID	USGS LongLatNum SiteID	Text
SiteSerialNumber	KGS Assigned Serial Number	Integer*4
RecordNumber OpeningsSubrecord	A sequence number for this opening interval	Integer*4
DepthTopInterval	Depth to top of these "slots"	Real*4
DepthBottomInterval	Depth to bottom of these "slots"	Real*4
DiameterInterval	Diameter of the casing in this interval	Real*4
MaterialInInterval	Material in this interval	Text
TypeOpenings	Type of openings: slots, screen, open hole	Text
LengthOpenings	Length of slots	Real*4
WidthOpenings	Width of slots	Real*4

Example Queries

As pointed out earlier, the purpose of a database is not to store data, it is to retrieve and display data. Some of the queries developed in the course of this investigation are included here. Others were *ad hoc* queries of little interest to anyone other than the investigator, but were left in the database as potentially interesting examples of query design: these were renamed to start with xmplQDF, such as xmplQDF Get wells listed, which is a query that retrieves summary data from tblSiteLocations about a set of wells listed in the query.

Three queries get information from tblSiteLocations about wells whose primary aquifer is a particular aquifer and which have more than one water level: these are qdfCenozoicWells, qdfDakotaWells, and qdfMesozoicWells for the Cenozoic formations, for the Dakota formation, and for the Mesozoic formations.

The query qdfPARAMGetLastWaterLevelInTimeRange is a parameter query that takes two parameters, a beginning and an ending date, that define the time range of interest. It returns only the SiteSerialNumber, Date, and Head. The parameter query qdfPARAMGetLastWaterLevelInTimeRangeInFormation is based on qdfPARAMGetLastWaterLevelInTimeRange and tblSiteLocations, and retrieves the last water level in a user-specified time range in a user-specified formation.

The queries PARAMqdf FindCasingDetailsBySerialNumber,
PARAMqdf FindFormationPicksBySiteSerialNumber,
PARAMqdf FindInterpolatedAlteredWaterLevelsBySerialNumber,
PARAMqdf FindInterpolatedWaterLevelsBySerialNumber,
PARAMqdf FindOpenIntervalDetailsBySerialNumber,
PARAMqdf FindSiteDetailsBySerialNumber, and
PARAMqdf FindWaterLevelsBySiteSerialNumber are all used by the form/program frmSiteDescription WRITE SUMMARY FILES to produce summary data files for importing into an Excel spreadsheet for producing a well hydrograph catalogue of user-specified subset of wells.

The parameter queries qdfPARAMFindFirstWinterWLAfterDate, qdfPARAMFindFirstWinterWLBeforeDate, and qdfPARAMFindWaterLevelBySerialNumberAndDate are used in the water level interpolation. The parameter queries qdfPARAMFindFirstWLAfterDate and qdfPARAMFindFirstWLBeforeDate are not presently used in water level interpolation, but do allow the fast retrieval of water levels before or after a specific date without the winter requirement.

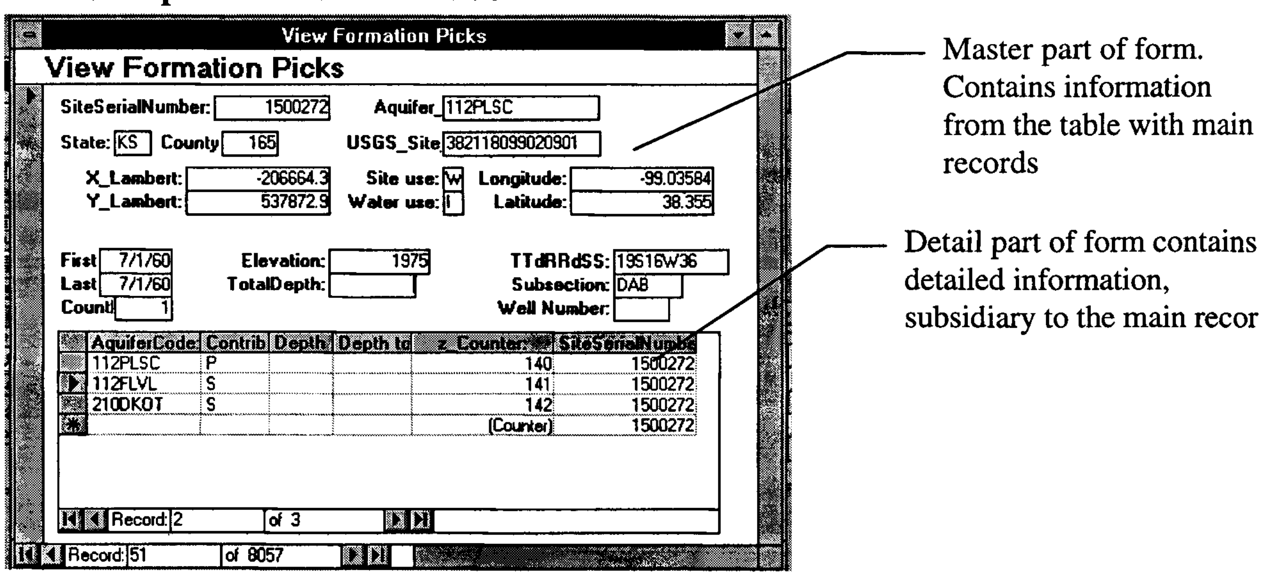
Example Forms

While queries are useful for selecting subsets of data and combining data from different tables, viewing data, particularly master-detail relationships, is best done with forms, which are like small programs for viewing, entering, or manipulating data. This database includes a number of forms for viewing and manipulating data

A number of forms and subforms are used for master details viewing of the database including

1. frmShowWaterLevelsWithoutGraph and frmSUBShowWaterLevelDetails
2. frmMAINViewFormationPicks and frmSUBViewFormationPicks
3. frmMAINViewOpenIntervals and frmSUBOpenIntervalDetails
4. z frmShowWaterLevels UsedToGraph (no longer graphs for some reason, but Excel was better for this anyway)

Figure 2 An Example of a Master-Detail Form



The database also includes three main forms that perform actions. One is frmSiteDescription WRITE SUMMARY FILES, which generates text files summarizing a well, including the site description, the water levels, the formation picks, the interpolated water levels, and the well construction details. These files are designed to be read into a spreadsheet, where the data can be graphed or a spreadsheet macro can be used to produce summary sheets for wells. These well hydrographs were analyzed to determine whether wells were subject to confined or unconfined conditions and whether certain areas should be represented as constant head boundaries.

Another action form is frm View Site Locations_CanInterpolateToDate, which was used for linearly interpolating water levels to a user specified date. This program works by finding the first winter water level preceding and the first winter water level succeeding the date specified, finding the corresponding water levels, and linearly interpolating between them to estimate the water level at the user-specified time.

The form xmpl_frmInterpolatedWaterLevels_byDate_byAquifer_WRITE_DXF can be used to produce a DXF file of interpolated water levels for a user specified date and formation.

For all three forms, the source code is commented. The reader is advised to read the Microsoft Access programmer's guide (Building Applications) to become familiar with Access Basic programming and the forms section in the User's Manual before trying to understand how these programs work.

Hydrographs and Well Summaries Using Excel and Word

A spreadsheet used for a variety of analysis and display functions was developed to go along with this database. The spreadsheet was developed in Microsoft Excel, and produces well summary sheets in Microsoft Word.

The water level catalogue spreadsheet performs a number of functions, including importing the well summary text files generated by the database, graphing the water levels and winter water levels, controlling WHEAT Electronic Mapper to produce index maps of the well location and copying this onto the spreadsheet, and producing well summary sheets. An example summary sheet is included in this report.

To produce a catalogue of water levels, there are several steps.

1. Perform winter water level interpolation using frm View Site Locations_CanInterpolateToDate, once for each date wanted. It is best not to try getting a subset of wells for the interpolation: subset later.
2. Export the information about each well into text files with frmSiteDescription WRITE SUMMARY FILES Select a subset of wells by using the filter property of the form (see the Access User's Manual or Getting Started manual.) The text box labeled Write Files To: is where the name of a directory is entered; this can be a new a directory, and writing to a new directory is recommended. This will generate a set of files named SiteSerialNumber.TXT, like 1501417.txt. Once this is done, it might be a good idea to create a set of subdirectories containing thirty or so wells each so that the spreadsheets aren't too big and don't crash the computer.
3. Open the spreadsheet and import the text files using z01_OpenTextFilesALLAndAddToCurrentWorkbook. (All succeeding steps assume that a water level catalogue spreadsheet containing the data is open to run the routines.)
4. Select all the worksheets and set the format for the USGS Site ID to "0" to get integer output, and make that column much wider. Add a tall-skinny copy (rather than a short-wide) copy of the well summary data with z02_CopyAndTransposeSiteDataALL.
5. Graph the water levels and winter water levels using z03_GraphWholeNotebook.

6. Classify water levels and mark for possible hand-smoothing using z04_ClassifyALLWaterLevelGraphs and add the classification to the graphs with z05_AddInterp_ALLSheets
7. Optional: Add location maps using E-Map and z06_PasteLocationMapALL. Before doing this, make sure that E-MAP is open and has the whole map area displayed, showing the desired basemap features, and that Save Copy of Map in Memory has is checked. It will probably be necessary to change the AppActivate line in PasteLocMap_AsBitmap to match the caption of E-MAP.
8. Optional: Hand smooth using FindNextSheetToAlterWaterLevels to move to the next sheet to hand-smooth the water levels, perform smoothing by some means and store them next to the interpolated water levels, then add the altered water levels to the graph using z08_AddALTEREDWaterLevelsALL. They can be written to a text file for importing back into the database using z09_WriteInterpolatedWaterLevelsToFile. The water level interpretations can be written to text files for import back into the database using z10_WriteWLInterpALLToFile
9. Produce water levels catalog using z11_CreateReportALL. Make sure that all non-essential applications have been turned off, all toolbars hidden, and anything else that frees up system resources has been done before doing this.

As with the action forms in the database, the potential programmer is advised to read the Excel Visual Basic User's Guide to become familiar with the object programming model before trying to read the macros/programs/routines. Most of the routines are based on macros generated by recording a series of actions. The zALL... series routines generally are based on a sweep through all worksheets in the current workbook and perform some action for each sheet or each chart, usually a routine that was originally based on a recorded macro.

Acknowledgments

The author would like to thank Christi Hansen of the USGS DWR-Lawrence, Jim Mitchell, Al MacFarlane, Martin Smith, and numerous other KGS employees for their advice and assistance in preparing this database.

List of Queries

qdfFindDakotaWellsWithMoreThan5Obs
Find all Dakota wells with more than 5 water level observations.
SELECT DISTINCTROW tblSiteLocations.* FROM tblSiteLocations WHERE ((tblSiteLocations.Aquifer_BestGuess = "210dkot" Or tblSiteLocations.Aquifer_BestGuess="211dkot") AND (tblSiteLocations.CountDate>5));

qdfFindLastPre-1970WaterLevelForMesozoicWells
Gets the last water level before March 1, 1970 for all Mesozoic Wells. Makes use of Mesozoic formation codes beginning with 2. Fairly complex grouping and criteria.
SELECT DISTINCTROW tblSiteLocations.SiteSerialNumber, Last(tblSiteLocations.X_Lambert) AS X_Lambert, Last(tblSiteLocations.Y_Lambert) AS Y_Lambert, Last(tblSiteLocations.Aquifer_BestGuess) AS Aquifer_BestGuess, Last(tblSiteLocations.[Site use]) AS [Site use], Last(tblSiteLocations.[Water use]) AS [Water use], Last(WaterLevels.Head_Best) AS Head_Best, Last(WaterLevels.Date__BestGuess) AS Date__BestGuess FROM tblSiteLocations INNER JOIN WaterLevels ON tblSiteLocations.SiteSerialNumber = WaterLevels.SiteSerialNumber WHERE ((WaterLevels.Date__BestGuess<=#03/1/70#)) GROUP BY tblSiteLocations.SiteSerialNumber HAVING (((Last(tblSiteLocations.Aquifer_BestGuess)) Like "2*"));

The PARAMqdfFind... queries are used by the Well Summary form/program.

PARAMqdf FindSiteDetailsBySerialNumber

Gets the summary data in tblSiteLocations for a well given its SiteSerialNumber

```
PARAMETERS SiteSerialNumberToFind Long;
SELECT DISTINCTROW tblSiteLocations.*
FROM tblSiteLocations
WHERE ((tblSiteLocations.SiteSerialNumber=[SiteSerialNumberToFind]));
```

PARAMqdf FindWaterLevelsBySiteSerialNumber

Gets water levels for a well, given its SiteSerialNumber

```
PARAMETERS SiteSerialNumberToFind Long;
SELECT DISTINCTROW WaterLevels.Date__BestGuess AS [Date],
    WaterLevels.Head_Best AS Head, WaterLevels.DayOfYear
FROM WaterLevels
WHERE ((WaterLevels.SiteSerialNumber=[SiteSerialNumberToFind]))
ORDER BY WaterLevels.Date__BestGuess;
```

PARAMqdf FindInterpolatedWaterLevelsBySerialNumber

Gets the interpolated winter water levels for a well, given its SiteSerialNumber

```
PARAMETERS SiteSerialNumberToFind Long;
SELECT DISTINCT WaterLevels_INTERPOLATED.DateInterpolatedTo,
    WaterLevels_INTERPOLATED.WaterLevelInterpolated
FROM WaterLevels_INTERPOLATED
WHERE
    ((WaterLevels_INTERPOLATED.SiteSerialNumber=[SiteSerialNumberToFind]))
ORDER BY WaterLevels_INTERPOLATED.DateInterpolatedTo;
```

PARAMqdf FindInterpolatedAlteredWaterLevelsBySerialNumber

Finds the hand-smoothed water levels for a well, given its SiteSerialNumber

```
PARAMETERS SiteSerialNumberToFind Long;
SELECT DISTINCTROW [x
    WaterLevels_INTERPOLATED_AND_ALTERED].DateInterpolatedTo, [x
    WaterLevels_INTERPOLATED_AND_ALTERED].WaterLevelInterpolated, [x
    WaterLevels_INTERPOLATED_AND_ALTERED].Modified
FROM [x WaterLevels_INTERPOLATED_AND_ALTERED]
WHERE (([x
    WaterLevels_INTERPOLATED_AND_ALTERED].SiteSerialNumber=[SiteSerialNu
    mberToFind]))
ORDER BY [x WaterLevels_INTERPOLATED_AND_ALTERED].DateInterpolatedTo;
```

PARAMqdf FindFormationPicksBySiteSerialNumber
Gets the list of formation picks for well, given its serial number.
PARAMETERS SiteSerialNumberToFind Long; SELECT DISTINCTROW tblSiteFormationPicks.AquiferCode AS Formation, tblSiteFormationPicks.[Contributing unit], tblSiteFormationPicks.[Depth to top of interval], tblSiteFormationPicks.[Depth to bottom of interval] FROM tblSiteFormationPicks WHERE ((tblSiteFormationPicks.SiteSerialNumber=[SiteSerialNumberToFind])) ORDER BY tblSiteFormationPicks.z_Counter;

PARAMqdf FindCasingDetailsBySerialNumber
Gets all the casing details for a well, given the SiteSerialNumber
PARAMETERS SiteSerialNumberToFind Long; SELECT DISTINCTROW Casing_Details.DepthTopCasingString, Casing_Details.DepthBottomCasingString, Casing_Details.DiameterCasingString, Casing_Details.WallThicknessCasing, Casing_Details.CasingMaterial FROM Casing_Details WHERE ((Casing_Details.SiteSerialNumber=[SiteSerialNumberToFind])) ORDER BY Casing_Details.RecordNumberForCasingSubrecord;

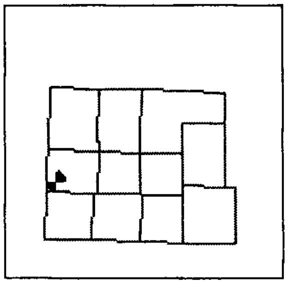
PARAMqdf FindOpenIntervalDetailsBySerialNumber
Gets the open intervals (screen, slots, open hole...) for a well given its SiteSerialNumber
PARAMETERS SiteSerialNumberToFind Long; SELECT DISTINCTROW WellOpenings.DepthTopOpenInterval, WellOpenings.DepthBottomOpenInterval, WellOpenings.DiameterOpenInterval, WellOpenings.MaterialInInterval, WellOpenings.TypeOpenings, WellOpenings.LengthOpenings, WellOpenings.WidthOpenings FROM WellOpenings WHERE ((WellOpenings.SiteSerialNumber=[SiteSerialNumberToFind])) ORDER BY WellOpenings.RecordNumberOpeningsSubrecord;

qdfPARAMGetLastWaterLevelInTimeRange
Gets water level and date of the last water level in a user specified time range for each well. Requires two dates. Returns SiteSerialNumber, Date__BestGuess, and Head_Best.
PARAMETERS DateBefore DateTime, DateAfter DateTime; SELECT DISTINCTROW WaterLevels.SiteSerialNumber, Last(WaterLevels.Date__BestGuess) AS Date__BestGuess, Last(WaterLevels.Head_Best) AS Head_Best FROM WaterLevels WHERE ((WaterLevels.Date__BestGuess>=[DateBefore] And WaterLevels.Date__BestGuess<=[DateAfter])) GROUP BY WaterLevels.SiteSerialNumber;

A parameter query based on another parameter query and a table.

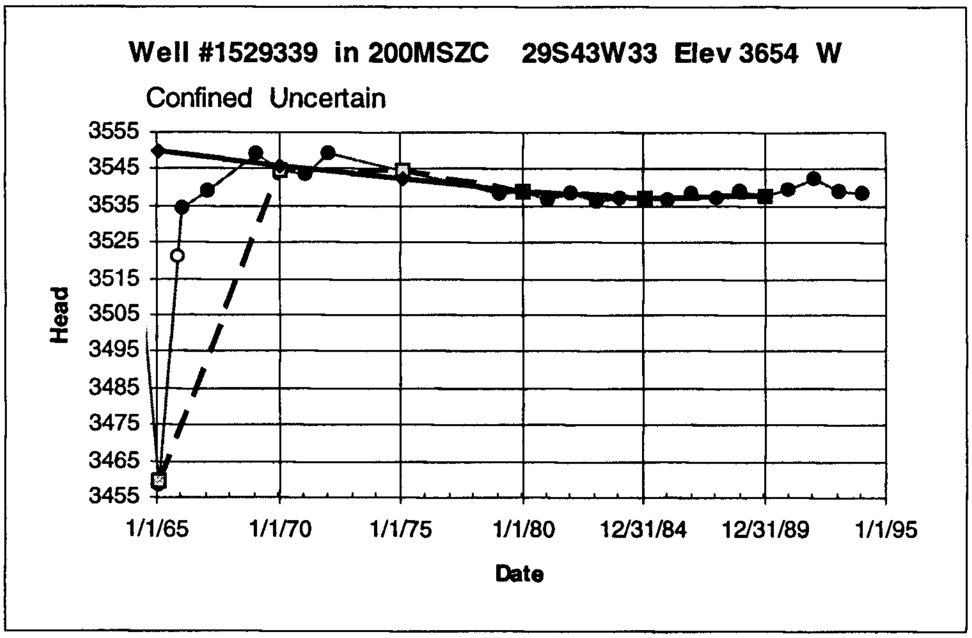
qdfPARAMGetLastWaterLevelInTimeRangeInFormation
Gets site information and the last water level in a time range, given the formation of interest (including wildcard matches), the start and the end of the time range.
PARAMETERS [Aquifer Wildcard] Text; SELECT DISTINCTROW tblSiteLocations.*, qdfPARAMGetLastWaterLevelInTimeRange.Date__BestGuess, qdfPARAMGetLastWaterLevelInTimeRange.Head_Best FROM tblSiteLocations INNER JOIN qdfPARAMGetLastWaterLevelInTimeRange ON tblSiteLocations.SiteSerialNumber = qdfPARAMGetLastWaterLevelInTimeRange.SiteSerialNumber WHERE ((tblSiteLocations.Aquifer_BestGuess Like [Aquifer Wildcard]));

Example: Well 1529339



X_Lambert	-1074293
Y_Lambert	240711.4
Aquifer_BestGuess	200MSZC
USGS_Site_Number_As_Text	372840102014101
County code	187
TTdRRdSS	29S43W33
Subsection	CDB
Well Number	
Site use	W
Water use	I
Elevation	3654
State	KS
TotalDepth	
FirstDate	11/15/59
LastDate	1/4/94
CountDate	28

SiteSerialNumber	1529339
Longitude	-102.0281
Latitude	37.47778



Formation	Contributing unit	Depth to top of interval	Depth to bottom of interval
200MSZC	P		

DepthTopOpenInterval	DepthBottomOpenInterval	DiameterOpenInterval	MaterialInInterval
N/A			N/A

DepthTopCasingString	DepthBottomCasingString	DiameterCasingString	WallThicknessCasing
N/A			N/A

Figure 2 Example of Water Level Catalog Spreadsheet Ouput to MSWord.

Kansas Geological Survey
Open-file Report

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