



Sacramento Central Groundwater Authority Comprehensive Update of SCGA's Database Management System

An AB303 Project Report



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PROJECT OVERVIEW

The Hydrologic Database Management System (HydroDMS) provides an improved groundwater management tool for the Sacramento County Groundwater Authority (SCGA). The HydroDMS is a single centralized database which contains all SCGA groundwater related data. It combines the data entry and management capabilities of a typical MS Access database with powerful web-enabled tools for viewing and analyzing data. These tools can be used to monitor Basin Management Objectives (BMOs) and easily create groundwater basin management reports. HydroDMS also provides password protected web based access allowing many users with different levels of access to enter, view, and analyze the data.

This report includes a description of the HydroDMS features and tools, a description of data sources and the methodology used for updating the database, and a hydrogeological report using the HydroDMS cross section tool.

HYDRODMS FEATURES AND TOOLS

The HydroDMS is a web-based data management tool that provides a user-friendly interface that allows the SCGA to manage their water resources data. The system mimics the user's workflow process while they enter and validate water related data. The HydroDMS may be used as a stand-alone package or in conjunction with the Integrated Water Resources Information System (IWRIS).

The HydroDMS was developed with a modular design that contains data management and analysis tools to manage, analyze, and view all of SCGA's data in one Web-based application. The system has been developed to contain Web-enabled analysis tools that allow SCGA staff to easily create reports and maps for annual and/or biennial reporting.

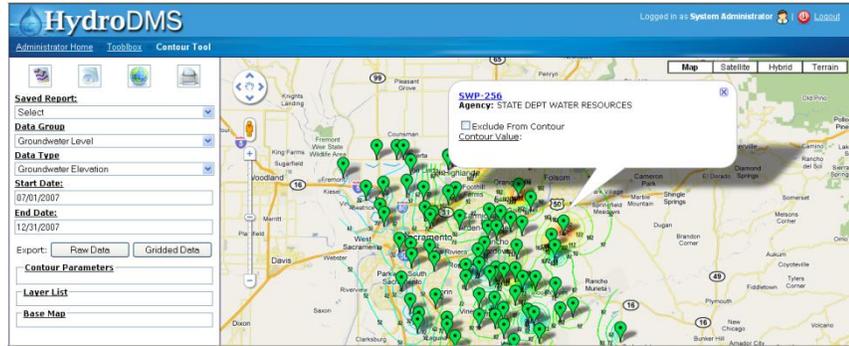


Tool and module details are provided below:

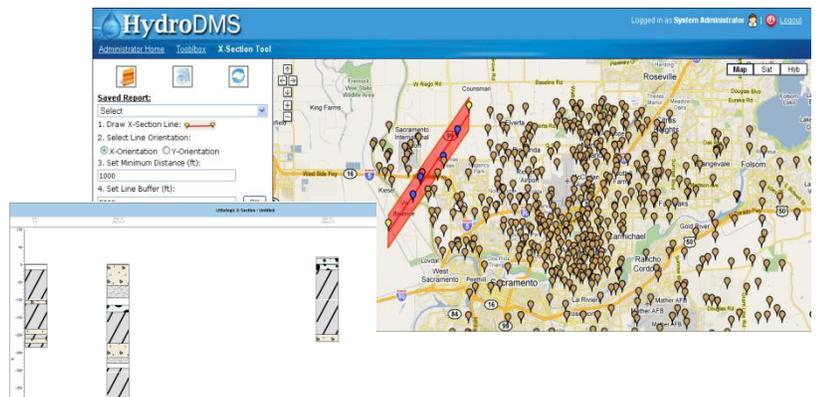
- **Account Manager** contains the tools necessary to create, edit and delete user accounts. The System Administrator may specify account types which control user access to data and analysis tools. The HydroDMS contains the following account types:
 - *System Administrator - has access to all analysis tools and modules*
 - *Power User - may enter data, import data, and view data*
 - *User - may view all validated data*

- **Database Manager** contains the following four tools:
 - **Data Entry** allows the Power User to manually enter data measurements and new site information using the customized data entry interface. The interface is integrated with Google maps for site selection and contains other validation functions to ensure error-free data entry.
 - **Data Validation** allows the System Administrator to validate the accuracy of the data after data has been entered into the HydroDMS. The tool alerts the supervisor to possible discrepancies using basic statistical analysis, color coding and alert icons, and data viewing tools. After data has been validated, it may be used in the analysis and reporting tools.
 - **Data Import** allows the Power User to import batch data using the Data Import tool by downloading the generalized template and uploading the Excel file. The template is built on-the-fly by the application to ensure changes in the database are immediately reflected in the template. The HydroDMS performs data validation functions to alert the Power User to possible errors in the data and will provide a step-by-step process for entering new sites.
 - **Data Viewer** allows the User to view all validated data in the HydroDMS. The Data Viewer makes use of Google maps and graphing tools. Data may be downloaded in Excel or CSV format from the Data Viewer interface.
- **Model Manager** contains the following two tools:
 - **Model Import** allows the Power User to upload a model output file and view upload history and model/scenario descriptions.
 - **Model Viewer** allows the User to view all model data, graph the data and download the data in Excel or CSV format.
- **Publish Manager** contains the following submodules:
 - **Publish to IWRIS** allows the System Administrator to upload a shapefile to IWRIS for publication. The System Administrator must specify a layer name and the accessibility of the layer (Restricted or Public). If the layer is Restricted, only authorized IWRIS users may view the layer and its associated data. If the layer is Public, then all IWRIS users may view the layer and its associated data.
 - **Authorize Users** provides the System Administrator with the ability to authorize specific IWRIS users to view Restricted data published to IWRIS.
- **Toolbox** contains a number of analysis tools that will provide SCGA staff with the capability to easily create reports and maps. This module contains the following tools:
 - **Report Tool** allows the System Administrator to create a custom report using an easy to use ad-hoc query builder. The Report tool displays the query in both SQL query language and Natural query language for a more advanced user. The report criteria may be saved for future use.

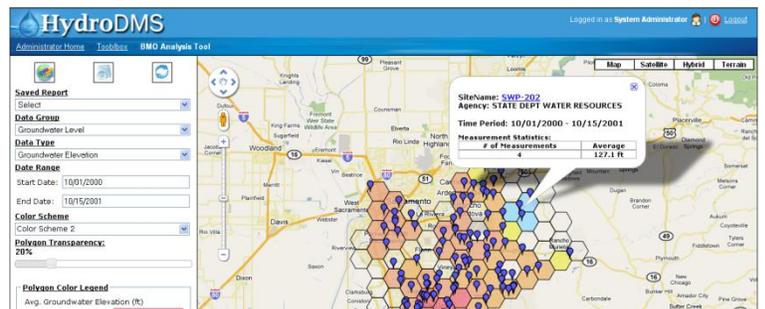
- **Contour Tool** provides an interface to create a customized contour plot of groundwater level or groundwater quality data in a Google map interface. The System Administrator may specify the contour criteria including data type, date range, and advanced contour parameters. The System Administrator may also specify the layers to be displayed on the map (County, Groundwater Basin, etc.) and upload a custom base map. The contoured data may be exported as either raw or gridded data for further analysis using ArcGIS or other applications. The contour criteria may be saved for future use.



- **Lithologic Cross Section Tool** allows the System Administrator to create a lithologic cross section report based on wells selected within a buffer zone in a Google map interface. The System Administrator must specify the lithologic cross section criteria and the wells to be displayed in the report. Additionally, lithology of individual wells may be viewed prior to report generation. The System Administrator may also specify the layers to be displayed on the map (County, Groundwater Basin, etc.) and upload a custom base map. The report may be printed and the report criteria may be saved for future use. More details on the lithology tool are discussed in the Hydrogeological Report section of the document.



- **BMO Analysis Tool** allows the System Administrator to color code the Basin Management Objective (BMO) polygons based on summary groundwater level data for the wells that are located within the specified polygons, representing various Basin Management areas. The BMO polygons are color coded based on either the groundwater level data, or whether the groundwater levels are in violation of the defined BMO levels. The report criteria may be saved for future use.



The HydroDMS has been developed on a LAMP (Linux/Apache/MySQL/PHP) platform and is currently hosted on one of WRIME's secure servers.

USER'S MANUAL

A detailed description of how to use each of the tools in the HydroDMS is documented within the HydroDMS help menu.

DATABASE UPDATE

A major part of the HydroDMS project was to update and add additional data to SCGA's previous data management system (referred to as the "Legacy Database"). Data sets that were updated include groundwater production, groundwater quality, groundwater level, and lithology data. All data was checked for accuracy and completeness before being uploaded into the HydroDMS. This section describes the data sources and methodology used for updating the data. It also includes recommendations for additional data that should be input into the HydroDMS.

MUNICIPAL PRODUCTION DATA

This section describes the source for well metadata, well location (XY) information, and production data for each municipal purveyor in the SCGA area. The main source for all municipal production data is local data from purveyors, which was collected by SCGA staff. When no local data was available, production data from other available sources was used including the Legacy Database and the SacIWRM model.

Sacramento County Water Agency (SCWA)

The main source of data for SCWA is local data obtained from SCWA staff. The list of production wells was primarily created from a shapefile received from SCWA. This list was supplemented by using SCWA's facility list spreadsheet. Metadata and XY locations for the wells were obtained from the shapefile and facility list. Well W-071 had production data, but was not included in the shapefile, so it was assigned the same XY as W-070 based on the assumed proximity of the two wells. SCWA wells were also matched up with the SacIWRM and the Legacy Database using the local SCWA well number (i.e. W-xxx). The database includes 80 SCWA wells with production data and 89 production wells total (these additional 9 wells were included because they have other types of data associated with them). Wells that were not yet in service (labeled as "undeveloped well site" or "well not outfitted") had no production data and were not included in the database.

Monthly production data from SCWA was obtained for 1990 to 2008. Data before 1990 was obtained from the Legacy Database.

Golden State Water Company (GSWC)

The main source of data for GSWC is local data obtained from GSWC via SCGA staff. Well locations and metadata for GSWC production wells were obtained from the SacIWRM model as no location information was provided by GSWC. Only wells from the GSWC Rancho Cordova facilities were included in the HydroDMS. The database includes 24 GSWC production wells.

Monthly production data from GSWC was obtained for 1997 & 1998 and 2001 to 2008. The Legacy Database only contained production data for one well (Gold Country Well). Data for this well was uploaded for 1996, 1997, 1999.

California American Water (CalAm)

The main source of data for CalAm is local data obtained from CalAm via SCGA staff. The list of production wells and well metadata was obtained primarily from the facility list provided by CalAm. Some additional CalAm wells were included from the Legacy Database. CalAm wells were matched up with the SacIWRM and the Legacy Database using the local well name. XY locations were obtained from the Legacy Database when available, and XY locations were estimated using the well address provided in the CalAm facility list when not available in the Legacy Database. Only CalAm wells in the SCGA area were included in the HydroDMS, which includes the Parkway, Rosemont, Suburban, and Sunrise (aka Security Park) facilities. The HydroDMS includes 57 wells with production data and 62 wells total (these additional 5 wells were included because they have other types of data associated with them).

Monthly production data from CalAm was obtained for 1997 to 2009. Annual production data from CalAm was obtained for 1991 to 1996. Data before 1991 was obtained from the Legacy Database.

Elk Grove Water Service (EGWS)

EGWS well metadata was obtained from EGWS via SCGA staff. EGWS wells were matched up with the SacIWRM and the Legacy Database using XY locations. The database includes 13 EGWS production wells.

No production data was obtained from EGWSC, so production data was obtained from the Legacy Database. This data was available through 1998.

Other Municipal Purveyors

The other municipal purveyors in the SCGA area are Florin County Water District (FCWD), Fruitridge Vista Water Company (FVWC), City of Sacramento, and Rancho Murrieta Community Service District (RMCSA).

RMCSA is entirely supplied by surface water and thus does not have any municipal production data. For the other three purveyors, well location, well metadata, and well production data was obtained from the Legacy Database and the SacIWRM model. FCWD has data available

through 2006, FVWC has data available through 1998, and City of Sacramento has data available through 2006.

Recommendations for Municipal Production Data

It is recommended that the following data be collected, verified, and incorporated into the HydroDMS.

- Collect EGWS data from 1999 to Present;
- Verify GSWC well locations and metadata; and
- Collect well locations and collect missing data for FCWD, FVWC, and City of Sacramento.

AGRICULTURAL AND PRIVATE PRODUCTION DATA

The two major agricultural water purveyors in the SCGA area are the Elk Grove Fish Hatchery (EGFH) and Omochumne-Hartnell Water District (OHWD). For EGFH well location, well metadata, and well production data was obtained through 1997 from the SacIWRM model. No data was available for OHWD.

The SCGA area also has many private agricultural and private rural production wells. No data is available for these wells. However, estimates of the groundwater production for these wells are available from the SacIWRM model. Estimates of groundwater production are also available for OHWD. This data is available by model subregion and is stored the HydroDMS model manager.

REMEDICATION OPERATION DATA

This section describes the source for well metadata, well location (XY) information, and remediation operations data in the SCGA area. Both production and injection data was included in the HydroDMS.

Aerojet

XY locations and metadata for Aerojet facilities was obtained primarily from the 2009 version of SacIWRM model. Aerojet XY location and metadata for wells that were not in the SacIWRM was provided by the SWRCB provided (SacIWRM has since been updated with these new data). The database includes 143 Aerojet remediation wells. The primary well identifier used in the HydroDMS for the Aerojet data is the 4 digit Aerojet well number.

Semi-daily remediation operations data for Aerojet was obtained from Aerojet for October 2004 to 2009. Monthly data before October 2004 was obtained from SacIWRM. All data was converted to gallons per minute (GPM), so that both the daily data and monthly data could be plotted together.

Boeing

XY locations and metadata for Boeing's facilities was provided by Boeing. The database includes 13 Boeing remediation wells. Boeing provided 2009 estimated production data.

Mather

XY locations and metadata for Mather's facilities was provided by Mather's environmental consultant. The database includes 47 Mather remediation wells. Mather 2009 total production data for each quarter was obtained from the quarterly Mather Groundwater Monitoring Reports. For the database, it is assumed this quarterly total pumping occurred evenly over each month.

WATER QUALITY DATA

This section describes the sources for water quality data and the methodology used for preparing the water quality data for HydroDMS.

California Department of Public Health (DPH) Public Drinking Water Database

The primary source for water quality data is the California DPH database. The DPH database contains:

- data from 1984 to 2009 for Sacramento County;
- data for all types of water including ground water, surface water, mixed supply, and wastewater;
- data for both municipal purveyors as well as Small Water Systems, defined by the DPH as systems that provide drinking water to the public with fewer than 200 service connections;
- data for 560 different water quality constituent; and
- address locations of each purveyor, but not specific XY locations for each well.

The unique well identifier in the DPH database is a 10 digit primary station code which is stored in the HydroDMS as the DPH ID. This DPH ID is inclusion in the updated database to allow for easier update of the HydroDMS in the future when new water quality data is available from the California DPH.

To Process the DPH Database the following steps were taken:

- selected only data in Sacramento County;
- selected only records from the database for raw groundwater (removed data records such as surface water, blended water, treated water, stored water in a tank, or water coming out of the tap); and
- classified the purveyors as SCGA municipal, municipal outside SCGA, and Small Water Systems.

For SCGA municipal data, the wells in the DPH database were matched with the municipal production data based on local well name and based on the DPH ID (when it was available in

the Legacy Database). In all, 168 production wells were matched and 30 wells were not matched. However, these 30 unmatched wells are labeled in the DPH database as “destroyed”, “abandoned”, “pending”, or “never constructed”, and thus all DPH data from active production wells is included in the HydroDMS.

The data for the Small Water Systems wells throughout Sacramento County was included in the HydroDMS by estimating the XY locations of wells based on the address of the purveyor. The HydroDMS includes 321 wells from small purveyors, of which 187 are in SCGA. Nine wells were not included because their purveyors address was not included in the DPH database and thus no XY location could be determined for these wells. However, these wells were all labeled as “inactive” in the DPH database.

The DPH Database also contains a STORET table which contains the name, EPA STORET number, and other characters for each of the water quality constituents. This STORET table was used to construct the water quality chemical metadata tables in the HydroDMS.

Other Sources

Water Quality data was also collected from USGS National Water-Quality Assessment (NAWQA) Program and the DWR Water Data Library Water Quality Data Reports for the Sacramento County area. The USGS database contained data for 42 sites and the DWR WDL database contained data for 52 sites.

USGS and DWR data were not included in the HydroDMS because the databases lacked well identifiers which could be used to relate the wells to other wells in the HydroDMS. Additionally, the water quality constituent characteristic tables for each of these databases were in a different format than the DPH STORET table, and it was not feasible to combine all three constituent characteristic tables into one unified metadata table.

Local data from SCWA was obtained for some SCWA production wells. However, upon inspection, this data was found to be identical to the data in the DPH database, and this local data was not included a second time in the HydroDMS.

The Legacy Database also contained limited water quality data for the SCGA area. The DPH IDs, when available in the Legacy Database, were used to help match up the DPH wells with the SCGA municipal wells. However, the actual time series water quality data was very incomplete and was not incorporated in the HydroDMS.

Recommendations for Water Quality Data

It is recommended that the following data be collected, verified, and incorporated into the HydroDMS.

- Incorporate data from the DPH database to the extended time series data table (such as sample method & lab name); and
- Incorporate data from other sources after determining a methodology for overcoming the obstacles documented above.

GROUNDWATER LEVEL DATA

This section describes the source for Groundwater Level data that was incorporated into the HydroDMS.

DWR Water Data Library (WDL) Groundwater Level Data Reports

The primary source of groundwater level data is from the DWR WDL which contains 316 wells throughout Sacramento County. Data for the entire Sacramento County was included in the HydroDMS so that groundwater level analysis such as contour generation would not be clipped at the SCGA boundary. DWR WDL data was available from 1930 to 2008. The state well ID number for each well, which is the primary well identifier used for the WDL wells, is included in the HydroDMS metadata so that the database can easily be updated as new water level data is available from the DWR WDL.

Other Sources

In the SCGA area, the Legacy Database contained water level data with a documented source of “State Department of Water Recourses”. Upon inspection, it was determined that these wells were duplicates of the WDL wells but with data only through 2006. Therefore, this data was not included in the HydroDMS.

Local groundwater level data from Aerojet and McClellan, which was collected as part of remediation activities, was available in the SacIWRM through 2004 and was incorporated into the HydroDMS. Although McClellan is not part of SCGA, it was included HydroDMS so that groundwater level analysis such as contour generation would not be clipped at the SCGA boundary.

Recommendations for Groundwater Level Data

It is recommended that the following data be collected, verified, and input into the HydroDMS.

- Collect and incorporate groundwater level data from Aerojet and other remediation operations from 2004 – present; and
- Collect and incorporate any local groundwater level data from SCGA purveyors that is not part of the WDL monitoring program.

LITHOLOGY DATA

This section describes the source and data processing methodology for lithology data that was incorporated into the HydroDMS.

The primary source of lithology data is a USGS Access database which contains digitized well log lithology data at each depth interval for selected boring logs in Sacramento County. This database contained 267 digitized well logs, of which 142 are in SCGA. The XY location and ground surface elevation for these wells was available in the USGS database.

The second source of lithology data is the DWR boring log database with approximately 16,000 scanned boring log images throughout Sacramento County. XY locations for these wells were estimated using the well township range and section. Ground surface elevation for these wells was estimated using a 30-meter DEM raster in ArcGIS.

In order to have a sufficient lithology in the HydroDMS, it was attempted to have at least three wells with lithology data for each SCGA groundwater management polygon. In order to meet this three wells per polygon goal, an additional 197 wells were selected from the DWR boring log database. The lithology data at each depth interval from the well log images was digitized. The combined 267 USGS database wells and the 197 DWR database wells were included in the HydroDMS.

The Legacy Database also contained lithology data; however, there was no well identifier in the Legacy Database that could be used to match the wells with the DWR log ID numbers from the USGS and DWR data sources listed above. Thus, the data from the Legacy Database was not incorporated into the HydroDMS because there was no way to accurately match and filter out duplicate wells.

HYDROGEOLOGICAL REPORT

DATA

The hydrogeology of the Central Basin and surrounding area in the HydroDMS is represented through boring logs, as discussed previously in the Database Update section. To support current and future needs, the data includes both standardized lithologic codes and the full description provided for each depth interval in the original data source. This allows for automated cross-section development through the HydroDMS and the coded intervals, but also maintains records of the original description for future detailed analysis.

The coding was performed on two levels. The first level of coding documents the primary lithology, using the following categories:

- Ash
- Boulders
- Clay
- Cobbles
- Gravel
- Hard pan
- Lithified materials
- Peat
- Sand
- Silt
- Top soil

- Undetermined

Where data were available, each depth interval was also coded with a secondary classification, using the following categories:

- Clayey
- Igneous
- Gravelly
- Metamorphic
- Organic
- Poorly Graded
- Sandy
- Sedimentary
- Silty
- Well Graded

HYDROGEOLOGY

To ensure the validity of the coded lithology and the validity of HydroDMS *Lithologic Cross Section Tool*, HydroDMS outputs were compared to cross sections from two published sources:

- DWR Bulletin 118-03, *Evaluation of Groundwater Resources, Sacramento County* (California Department of Water Resources, 1974); and
- *Influence of American River Incised Valley Fill on Sacramento County Hydrogeology* (Meirovitz, 2010).

Both of these sources focus on stream channel deposits (incised valley fill) as these features contain significant coarse-grained materials that can store and move much larger quantities of water than in the surrounding finer-grained materials.

Bulletin 118-3 presents a series of maps and cross sections to delineate stream channel deposits and to show the general subsurface geology of Sacramento County. The cross sections are based on three-dimensional statistical modeling of boring logs. Of the cross sections, Section D is most relevant to this work as it crosses through the Central Basin from southwest to northeast (See Figure 1). Section D is shown in Figure 2. The dark colors depict the vertical distribution of the stream channel deposits.

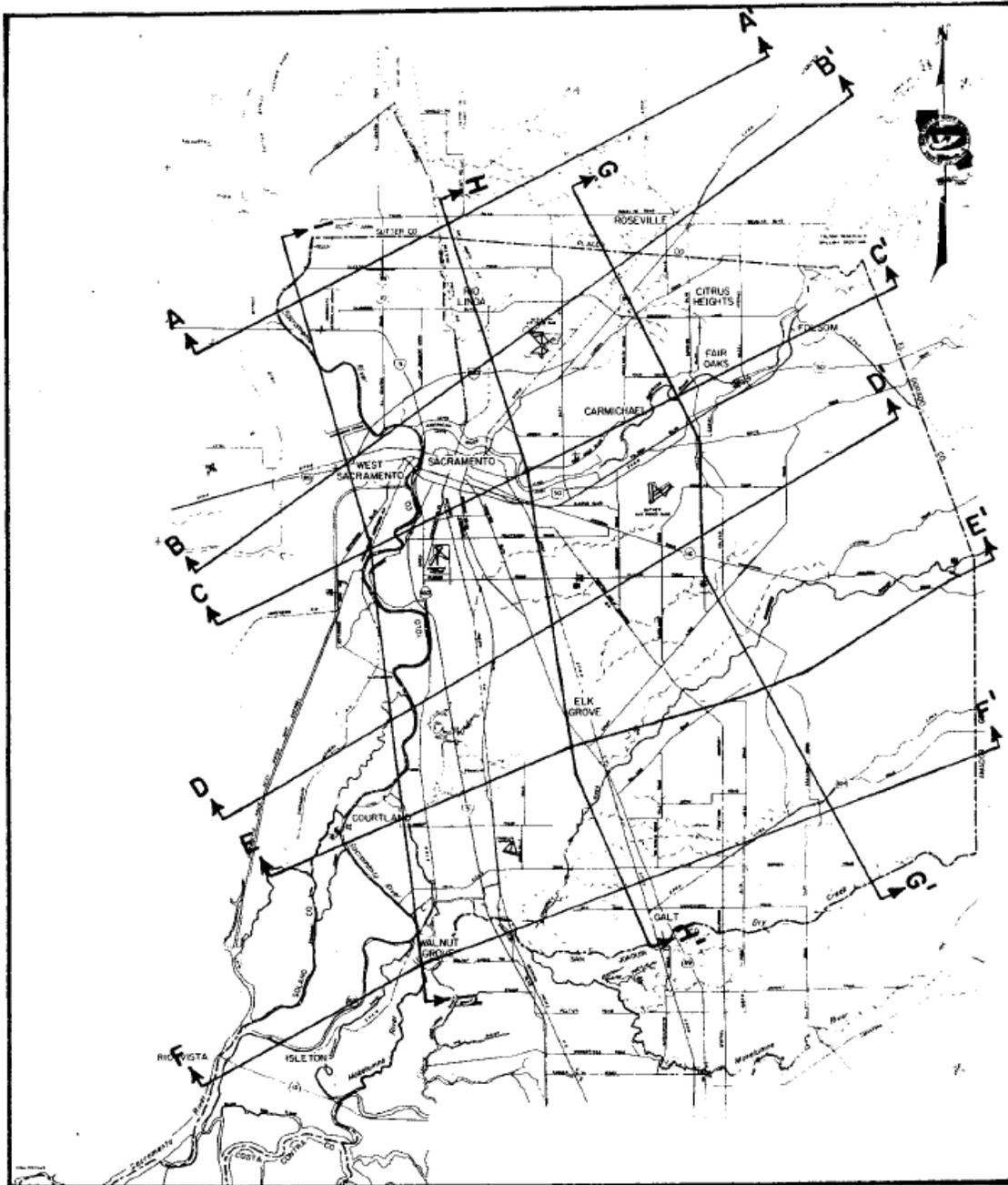


Figure 1 Location of Cross Sections D and H, DWR Bulletin 118-3

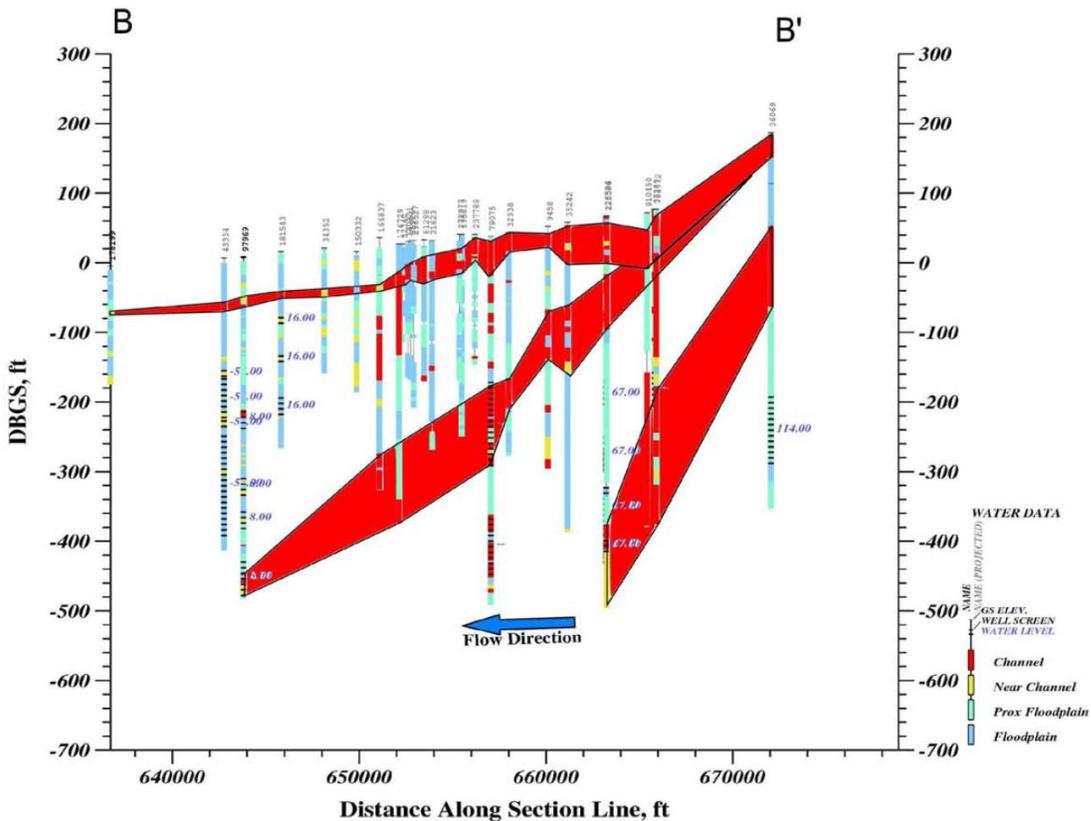


Figure 4 Section B from Meirovitz

Using the HydroDMS *Lithologic Cross Section Tool*, cross sections that follow the same horizontal orientation as the DWR Bulletin 118-3 and the Meirovitz studies were developed. Figure 5 and Figure 6 compare the output of the HydroDMS to the cross sections developed in Bulletin 118-3 and by Meirovitz, by approximately placing the HydroDMS output on the previously published reports. The placement is approximate due to limited detail on maps, thus comparisons should be considered only approximate. These comparisons show that the data in the HydroDMS generally supports the defined stream channel deposits defined in the previous reports.

In Figure 5, high permeability materials (sands, gravels, cobbles) in the HydroDMS output are compared to the Bulletin 118-3 Figure. The HydroDMS high permeability materials are highlighted with red boxes for added clarity and the boxes are angled to match the dip shown in the Bulletin 118-3 figure. Some differences between the HydroDMS and Bulletin 118-3 are likely, due to difficulty in matching the two cross sections, but the HydroDMS is generally supportive of the delineation of the stream channel deposits despite different data.

In Figure 6, high permeability materials (sands, gravels, cobbles) in the HydroDMS output are highlighted with green boxes for added clarity and compared against the channel deposits delineated by Meirovitz. Some differences are likely, again due to difficulty in matching the

two cross sections, but the HydroDMS is generally supportive of the delineation of the stream channel deposits despite different data.

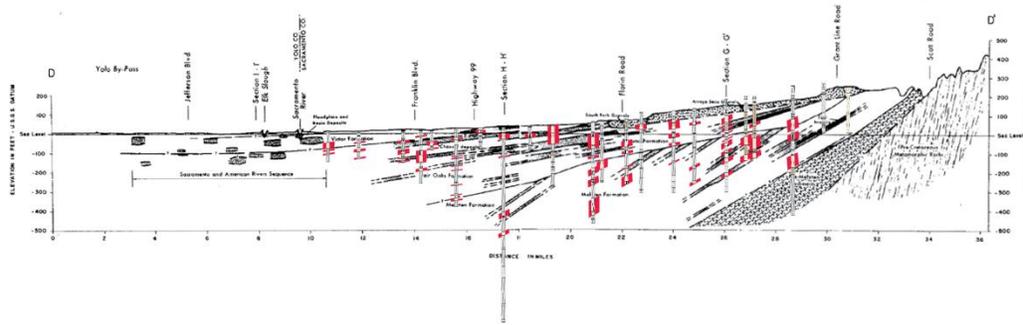


Figure 5 Comparison of DWR Bulletin 118-3 and HydroDMS Output

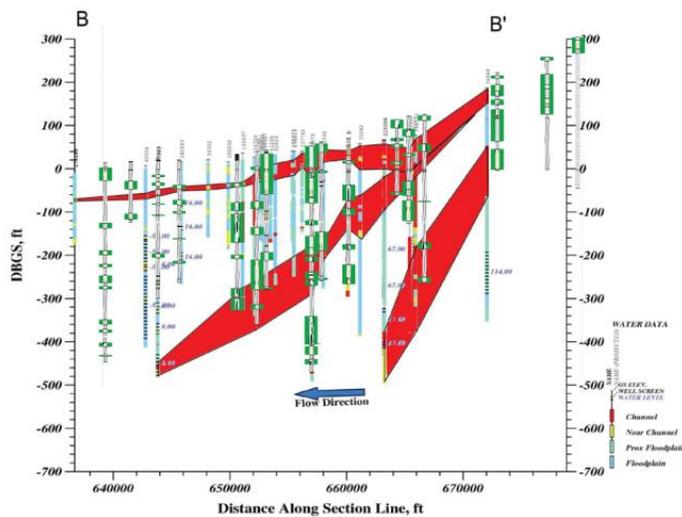


Figure 6 Comparison of Meirovitz (2010) and HydroDMS Output

The lithology data contained in the HydroDMS provides good regional coverage of the SCGA area. More detailed data may be able to be added to the HydroDMS through incorporation of the dataset developed by Meirovitz. Work will be required to obtain the data, analyze the methodology and results of the development of the dataset and, if suitable, incorporation into the HydroDMS.

WATER BUDGET

The HydroDMS can be utilized as a tool to develop water budgets for the Central Basin. The HydroDMS contains groundwater production data and estimates for basin, except for agencies

that did not report data. Once complete, these data can be combined with other outside data sources (e.g., precipitation, land use, subsurface flow) to develop a water budget estimate. At this time, the production data within the HydroDMS is not sufficiently complete to perform an accurate estimate of the water budget.

REFERENCES

- California Department of Water Resources. (1974). *Evaluation of Groundwater Resources, Sacramento County*.
- Meirovitz, C. D. (2010). *Influence of American River Incised Valley Fill on Sacramento County Hydrogeology*. MS Thesis, UC Davis, Hydrologic Sciences Graduate Group.