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**MEMORANDUM**

**To:** Cosumnes Subbasin Working Group

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**Subject: Draft Technical Memorandum #1 - Data Management System Evaluation and Recommendation**  
Cosumnes Subbasin, Sacramento County, CA  
(EKI B80081.00)

EKI reviewed and evaluated Data Management System (DMS) options available to comply with the California Sustainable Groundwater Management Act (SGMA) Groundwater Sustainability Plan Regulations (GSP Regulations).<sup>1</sup> The GSP Regulations provide explicit requirements for the DMS used to support GSP preparation: *"Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin."*<sup>2</sup> Additionally, the GSP Regulations specify the format in which GSAs are to submit information to DWR as part of GSP submission and on-going annual reporting: *"both tabular and geodatabase-compatible shapefile form."*<sup>3</sup>

The options considered for the DMS to support the Cosumnes Subbasin GSP development included:

- Customized DMS using Microsoft Access and ArcGIS;
- GeoSuite Software;
- Locus Technologies Environmental Information System (EIM) software;
- Aquaveo Arc Hydro Groundwater software;
- Kisters Water Information System (WISKI);
- GEI Groundwater Well Inventory System (GWIS); and,
- Woodard & Curran Opti Data.

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<sup>1</sup> California Code of Regulations (CCR) Title 23 – Waters, Division 2 – Department of Water Resources, Chapter 1.5 – Groundwater Management, Subchapter 2 – Groundwater Sustainability Plans and Alternatives.

<sup>2</sup> CCR Title 23 §352.6.

<sup>3</sup> CCR Title 23 §352.4(c)(1).

The DMS options were evaluated against the following criteria:

- SGMA GSP Regulations;
- California Department of Water Resources (DWR) Best Management Practices (BMP) Guidance;<sup>4</sup>
- Public Availability;
- Common Use;
- Adaptability;
- Web Data Interface; and,
- Cost-Effectiveness.

Our evaluation concluded that a customized DMS using Microsoft Access and ArcGIS best meets the above criteria and current Cosumnes Subbasin GSP development scope and budget. The primary strengths for this approach include adaptability, reliance on common software, and cost-effectiveness. A detailed summary of the options considered, the ranking criterion employed, and evaluation results is attached.

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<sup>4</sup> California Department of Water Resources (2016), Monitoring Networks and Identification of Data Gaps, Best Management Practices for the Sustainable Management of Groundwater.  
[https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP\\_Monitoring\\_Networks\\_Final\\_2016-12-23.pdf](https://water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Monitoring_Networks_Final_2016-12-23.pdf).

## ATTACHMENT 1: Data Management System Evaluation and Recommendation

### 1. INTRODUCTION

To comply with (SGMA GSP Regulations and the DWR BMPs, the GSP prepared for the Cosumnes Subbasin (Basin) must include and be supported by a DMS. This Technical Memorandum reports on the review and evaluation of DMS options available to the Working Group for the Cosumnes Subbasin GSP.

As indicated in EKI's approved Work Plan, we have assumed that the initial DMS would be a straightforward set of Microsoft Access (or equivalent) and linked Geographic Information System (GIS) geodatabases, which would primarily serve to meet SGMA reporting standards while providing flexibility for future modifications and advancements. For completeness, we have also reviewed several "off-the-shelf" data management tools as potential alternatives to this customized DMS.

It is anticipated that the DMS will include both spatial and tabular data, and that the two data types will be linked through use of a GIS geodatabase. Specifically, it is anticipated that:

- **Spatial data** will generally be stored as geodatabase feature classes, shapefiles, and other georeferenced graphical formats, as appropriate. It is anticipated that such spatial data will include, but not be limited to: surficial soils and geology; topography; natural and artificial surface water features (i.e., rivers and streams, lakes, reservoirs, springs, wetlands, canals, recharge basins, etc.); wells, stream gauges, subsidence monitoring stations, and other monitoring sites, as applicable; various boundaries (i.e., basin, Groundwater Sustainability Agency [GSA], special groundwater management units or areas, Disadvantaged Community [DAC], and parcel boundaries); and,
- **Tabular data** will be stored in cross-referenced tables, and will include, but not be limited to: climate/meteorological data; hydrology/streamflow; well-specific data on groundwater levels and quality; land use/cropping data; water use information (including groundwater pumping, imports and deliveries by water suppliers); and demographic/population data.

Regardless of platform, the DMS will include quality assurance and quality control (QA/QC) checks so that data entered are valid and compatible for subsequent analyses necessary for GSP preparation and implementation. The DMS will allow for the accurate and efficient export of information for on-going GSP analysis and reporting, and readily provide for future data additions. Accordingly, Working Group and associated GSA staff will be trained on DMS use.

### 2. DMS OPTIONS

The following DMS options were evaluated herein:

- (1) **Customized DMS**, a customized application of a Microsoft Access and ArcGIS-based relational database system. The system is based on EKI's experiences with DMS applications in other basins and groundwater characterization and remediation projects for the past 15 years;

- (2) **GeoSuite Software**,<sup>5</sup> a cloud-based software developed and used for 20 years by the Danish government as a part of their groundwater management regulations and adapted specifically for SGMA;
- (3) **Locus Technologies Environmental Information System (EIM) software**,<sup>6</sup> a Mountain View-based company that has developed cloud-based groundwater data management software for environmental remediation sites, which EKI has used for over 10 years for a large multi-stakeholder federally-funded environmental remediation site;
- (4) **Aquaveo Arc Hydro Groundwater software**,<sup>7</sup> a geodatabase design for representing groundwater datasets within ArcGIS, including representations of aquifers and wells/boreholes, and temporal well data;
- (5) **Kisters Water Information System (WISKI)**,<sup>8</sup> a relational database and GIS-enabled DMS, designed for groundwater data management and used for SGMA implementation elsewhere;
- (6) **Groundwater Well Inventory System (GWIS)**, a proprietary DMS with web interface being utilized for SGMA implementation in other basins, including the North American Subbasin; and
- (7) **Opti Data**, a proprietary DMS with web interface being utilized for SGMA implementation in other basins, including the Eastern San Joaquin Subbasin. A predecessor to this system, HydroDMS, is used for groundwater management in the South American Subbasin by the Sacramento Central Groundwater Authority.

### 3. CRITERIA

As described in detail below and in Table 1, the potential DMS options have been evaluated against the following criteria:

- SGMA GSP Regulations
- DWR BMP Guidance
- Public Availability
- Common Use
- Adaptability
- Web Data Interface
- Cost-Effectiveness

#### ***SGMA GSP Regulations***

The GSP Regulations provide explicit requirements for any DMS used for GSP preparation: “*Each Agency shall develop and maintain a data management system that is capable of storing and reporting information relevant to the development or implementation of the Plan and monitoring of the basin.*”<sup>9</sup>

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<sup>5</sup> GeoSuite: <https://www.geoscene3d.com/software/geosuite>

<sup>6</sup> Locus Technologies EIM: <https://locustec.com/applications/environmental-information-management/>

<sup>7</sup> AquaVeo Arc Hydro Groundwater: <https://www.aquaveo.com/software/ahgw-archydro-groundwater-introduction>

<sup>8</sup> Kisters WISKI: <https://www.kisters.net/NA/applications/water-resources-management/groundwater/>

<sup>9</sup> CCR Title 23 §352.6.

Elsewhere in the GSP Regulations, the Data and Reporting Standards section further specifies that this relevant reporting information entails the following.<sup>10</sup>

For all monitoring sites:

- A unique site identification number and narrative description of the site location.
- A description of the type of monitoring, type of measurement taken, and monitoring frequency.
- Location, elevation of the ground surface, and identification and description of the reference point.

For wells:

- California Statewide Groundwater Elevation Monitoring (CASGEM) well identification number, or if one has not been issued, other appropriate identifying well information.
- Well location, elevation of the ground surface and reference point, including a description of the reference point.
- A description of the well use, well active/inactive status, and whether the well is a single, clustered, nested, or other type of well.
- Casing perforations, borehole depth, and total well depth.
- Well completion reports, if available.
- Geophysical logs, well construction diagrams, or other relevant information, if available.
- Identification of principal aquifers monitored.
- Other relevant well construction information, such as well capacity, casing diameter, or casing modifications, as available.

In addition to these pieces of information, the GSP Regulations also specify the format in which GSAs are to submit information to DWR as part of GSP submission and on-going annual reporting: *“both tabular and geodatabase-compatible shapefile form.”*<sup>11</sup>

The ability of a DMS to manage the information and file formats required by GSP Regulations constitutes the most fundamental criterion for consideration. As shown in Table 1, all the DMS options we evaluated fulfill this criterion.

### ***DWR Best Management Practice (BMP) Guidance***

Beyond the requirements of the GSP Regulations, the DWR has issued BMP guidance to assist in GSP development.<sup>12</sup> The *Monitoring Networks and Identification of Data Gaps Best Management Practice* document (BMP 2) provides two considerations to inform DMS selection:

- The DMS should include clear identification of all monitoring sites and a description of the quality assurance and QA/QC checks performed on the data being entered.
- Coordination of data structures between adjacent basins will facilitate data sharing and increase data transparency.

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<sup>10</sup> CCR Title 23 §352.4.

<sup>11</sup> CCR Title 23 §352.4(c)(1).

<sup>12</sup> California DWR (2016), *Monitoring Networks and Identification of Data Gaps*.

Therefore, as shown in Table 1, we evaluated the ability of each DMS option to accommodate clear site identification, QA/QC descriptions, and easy data sharing between adjacent basins. In the case of the Cosumnes Subbasin, adjacent basins are the Eastern San Joaquin Subbasin, where the Opti Data system is being used, and the South American Subbasin, where HydroDMS is used.

DWR intends to provide an update BMP 2 “as the suggested data structure is developed, as necessary.”<sup>13</sup> Therefore, the DMS may need to evolve with changes in BMP guidance. This points to the importance of adaptability, another DMS selection criterion which is discussed below.

### ***Public Availability***

All DMS options evaluated require the use of proprietary software. However, some applications can be purchased and used independently by any entity, while others are linked to private companies that develop, support, and manage their software systems. The latter category may require ongoing commitment to an outside entity with associated recurring fees, and represents an on-going cost liability for a GSA. The criterion of public availability measures the possibility of using the DMS independently and maintaining autonomy.

### ***Common Use***

The common use criterion measures how frequently the DMS software platform is used. Data transfer and analysis by multiple parties is more efficient and cost effective when they are already familiar with the basic software and system that is supporting the DMS. For example, DMS options that rely on common applications such as Microsoft Office and ArcGIS will be more desirable than options requiring specialized software, coding skills and training.

### ***Adaptability***

The DMS must be able to accommodate all data types required by GSP regulations, and other information useful for groundwater management, in both geographic and tabular forms. These data types include site information, water levels, water quality, lithology, aquifer test results, surface water flow, water use (e.g., pumpage), land use, climate, and demographics. The DMS may need to adapt as BMP guidance is refined and its functional requirements evolve.

### ***Web Data Interface***

Some DMS options include built-in information sharing with the public or approved users via a web-based interface. Without this capability, data sharing across the internet can still be made possible, but often requires hands-on interaction by GSAs responding to data requests or requires the establishment of a website where specific data are shared with the public by way of published tables, figures, shapefiles, and so forth.

### ***Cost-Effectiveness***

Different DMS options vary in the software they require. Some options utilize applications such as Microsoft Office and ArcGIS, and therefore are relatively inexpensive and commonly used. Others require the purchase or licensing of additional, specialized software.

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<sup>13</sup> California DWR (2016), Monitoring Networks and Identification of Data Gaps.

This criterion considers both the initial and ongoing cost of DMS use. Total DMS cost includes both software purchase, and/or subscription fees, and investment in development and training. A DMS using specialized software could require a significant investment of time and effort for users to build proficiency. Software and training costs will vary between DMS options. As an example, purchase of a WISKI license and training from Kisters costs approximately \$50,000, plus labor time required for GSA personnel and/or consultant to learn the system. A public web portal is available for approximately another \$25,000.

#### 4. EVALUATION

We gathered available information on seven DMS options and evaluated their suitability using the criteria summarized above and the available information for each DMS option. If a DMS met the criterion, a dot (“•”) with the equivalent of one (1) point was assigned. We assumed that all criterion have equal importance, and therefore assigned them equal weights. Table 1 shows the results of our evaluation, including the criteria and total scores of each DMS option.

**Table 1. Ranking of Data Management System Options**

Criteria	Custom DMS	Geo-Suite	EIM	Arc-Hydro	WISKI	GWIS	Opti Data
SGMA Objectives <sup>1</sup>	•	•	•	•	•	•	•
DWR BMP Guidance <sup>2</sup>	•	•	•	•	•	•	•
Publicly Available <sup>3</sup>	•	•	•	•	•		
Common Usage <sup>4</sup>	•						
Adaptability <sup>5</sup>	•	•		•	•		
Web Interface <sup>6</sup>		•	•		•	•	•
Cost-Effectiveness <sup>7</sup>	•						
Total Score	6/7	5/7	4/7	4/7	5/7	3/7	3/7

**Notes**

1. Capable of storing and reporting information relevant to GSP development, implementation, and monitoring (23-CCR §352.6).
2. Includes clear monitoring site and QA/QC description and allows coordination of data structures between adjacent basins.
3. Not based on proprietary software.
4. Familiar to public agencies.
5. Flexible and can be configured for various data types required for GSP development (for example, maps and tabular data).
6. Built-in web interface for data access.
7. Minimum start-up, training, developing and recurring costs (e.g., license subscriptions).

#### 5. RECOMMENDATION

The ranking of DMS options identified a customized DMS using Microsoft Access and ArcGIS as the option that best meets current SGMA and Working Group criteria and the current GSP scope and budget. Its main strengths over the alternatives are adaptability, commonness of software used, and cost-effectiveness. The availability of web data access is the only criterion lacking. However, the option does not preclude future development of an online GIS portal as part of GSP Implementation. The Microsoft Access and

ArcGIS DMS approach utilized in other basins has been adapted for online public access through a government hosted website.<sup>14</sup>

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<sup>14</sup> San Mateo County Office of Sustainability, "Groundwater: San Mateo Plain Subbasin," <https://www.smcsustainability.org/energy-water/groundwater/>.