CV-SALTS Conceptual Model Summary Description

A Conceptual Model for Understanding Salts and Nitrates in the Central Valley

1. Introduction and Context

The proposed Conceptual Model is intended to provide the technical basis to unify data and modeled information from across the Central Valley into a Geographic Information System (GIS) model framework for both understanding salt and nitrate and assisting with planning and Salt and Nutrient Management Planning (SNMP) preparation. Additionally, many critical tasks needed within CV-SALTS will be accomplished through this system.

The Initial Phase will utilize basin wide data available in existing data sources to develop a high level overview of the current salt and nitrate conditions in the Central Valley. Phases 2 and 3 will use the overview as the basis to build upon and will expand the tools needed for SNMP preparation. Phase 2 will add additional information and analysis tools to support the SNMP and the final phase will support documentation for approval.

The phases and elements of the Conceptual Model[1] are integrated into the 5-Year Work plan and support policy development with high level summarized information and management planning and Basin Planning support at a more detailed level. The SNMP development will benefit from the ability to test assumptions and add more detailed information as it becomes available from local areas. This approach provides a common toolset to achieve the critical tasks for the Central Valley to comply with the appropriate requirements for Salt and Nutrient Management Plans from the State Water Resources Control Board Recycled Water Policy.

The utility of a common Conceptual Model for CV-SALTS is to have a uniform basis for determining salinity source areas and discriminating between those areas in salt balance, those areas that may be accumulating salt and those area that are net exporters of salt. Salinity management practices will need to be tailored to the circumstances in each of these areas. Conceptual models can be simple mass balances or complex numerical simulation models – each model employs key assumptions that help to quantify the important hydrologic processes that drive salinity fluxes in the watersheds. A good conceptual model is one that is technically sound, easy to explain and understand and that can be applied to the variety of land uses in the basin i.e. the conceptual model should be able to deal with dryland farming, irrigated agriculture, and managed wetlands, rural and urban land uses.

This document with the Methodology Addendum will be used to develop the Scope of work for the Initial Phase Conceptual Model (CM).

[1] Conceptual Model, as used here is intended to be a GIS based decision support tool used to summarize and illustrate the salt and nitrate status and assist in understanding of the water and salt sources in large areas of the Central Valley. Similar to a physical model of a building in design by an architect it represents the structure and appearance (data based information) but is simplified to an appropriate level for discussion and decisions.

2. Summary of the CV-SALTS Conceptual Model

This conceptual model would use existing GIS data layers, model outputs, and existing salt and nitrate source information. The concept is to summarize and aggregate water, salt, nutrients and other relevant information to appropriately high levels through GIS to allow a common level of representation and integration.

By doing this work in phases the CM would serve to drive discussion and decisions needed at each level.

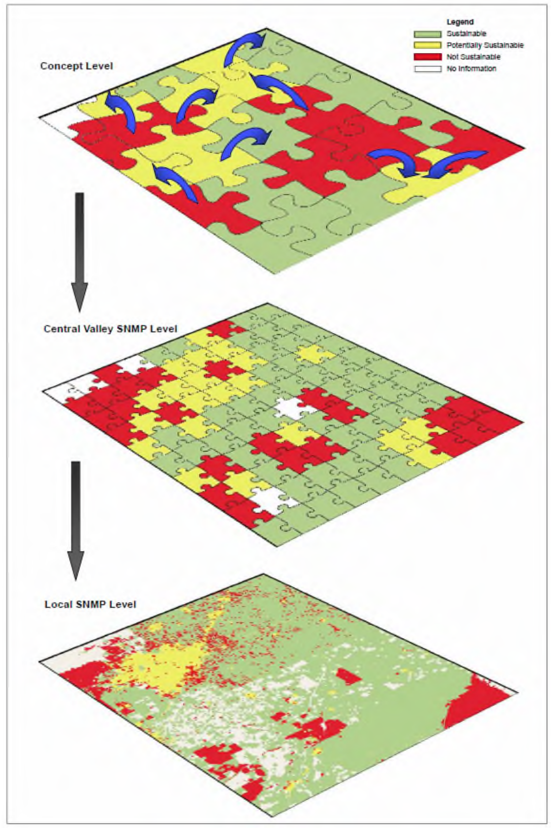

Figure 1, Full Scale figure is included in Attachment 1

Concept or Initial level, shown by the largest puzzle pieces in Figure 1, would be used for Central Valley wide discussions and decisions and policy issues (35Kft).

When a high level is completed it is expected that additional detail will be needed for the **SNMP or Analysis and Planning Level** which may be developed and summarized to fit this more detailed level, shown by the smaller puzzle pieces in Figure 1. The summary will provide appropriate information to develop a clear understanding for SNMP at more detailed level - smaller puzzle pieces (10Kft).

It will also form the basis for integrating available data from the lowest level (ground floor). This final phase for the process can incorporate current and future local planning efforts at the **Local SNMP level and support implementation** and future monitoring results.

Overall, this approach achieves the following goals:

- Identifies and uses credible water balances
- Identifies and uses best existing available data
- Answers the questions (shown in Attachment 2) at the appropriate levels needed for assessment, planning and documentation
- Facilitates cooperating groups to provide better information
- Works with existing data sets and accommodates future boundaries
- Allows assessment of impacts to local future users and downstream uses.

3. This approach is also consistent with work being done by many other studies including those on the West Side of the San Joaquin by the Bureau of Reclamation, CV-SALTS Pilot Study, and work being done for the Drinking Water Policy and Irrigated Lands efforts. The Model should clearly state what is capable of providing at each level of detail and what is not to be provided. Technical Committee Considerations and Recommendations

The Technical Committee at a meeting held on December 16, 2011, reviewed the concept and discussed it in the detail described herein. Several suggestions and recommendations were made that improve the concept. These consensus recommendations are incorporated throughout this description and outlined in the sections below.

Graphic from USGS CVHM factsheet showing the area covered by the model

Utilize CVHM[2] for water balance/equilibrium in the Central Valley. This existing geodatabase has been peer reviewed and validated and used 8500 drillers' logs to develop subsurface characteristics for most of CV. An excellent summary of the model is shown in Attachment 3 and with additional information at the link in the footnote. Datasets from this model will soon be published on the United States Bureau of Reclamation Website, and are commonly used in the Central Valley.

Use Land Use Based Estimation for primary salt sources as was done in the pilot studies, and is done in most other models for source information. DWR and others provide information that can augment existing datasets and can be used for verification.

Utilize Existing Region Wide Databases especially GIS databases for water quality and other data; some of the data that may be used includes, but is not limited to the following sources identified by the Technical Advisory Committee:

Drinking Water Policy Technical Working Group – Groundwater and water supply data from models developed for or performed under the direction of this group.

DWR Applied Water Data for Irrigated Agriculture – DWR applied water values are available and have been demonstrated to represent irrigation water usage for agriculture compared estimates based on climatic data and specific irrigation practice assumptions. This data may also be used for validation of the models.

SB X2 1 Nitrate Project – Study directed by Thomas Harter recently published reports on water quality modeled in the Tulare Lake Basin which are more detailed in areas of the Tulare Lake Basin. Included in this work, for example, are estimates of applied nitrogen by crop and locale, as well as newly available references helpful in developing such estimates.

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[2] Central Valley Hydrologic Model developed by the USGS http://pubs.usgs.gov/fs/2009/3057/ provides hydrologic water balance for surface and groundwater waters for the Central Valley; additional information is available in Attachment 3. CV2SIM is an alternative model with differing assumptions and therefor differing water balance.

Pilot Study Data Sources – Use the constituent data and appropriate model output from the West Side Reclamation Study and the CV-SALTS Salt and Nutrient Source Pilot Study Areas. Several of the pilot study input data themes have been updated and expanded to the entire Central Valley as part of modeling done for the Drinking Water Policy Technical Working Group. This dataset also includes assumptions and some limitations determined by the Knowledge Gained committee.

Dairy General Order Representative Groundwater Monitoring Results Report[3] - This information includes data developed in response to the Regional Board Dairy General Order for dairy monitoring of groundwater. This dataset covers the entire Central Valley and contains GIS layer information for several relevant needs. While these data were developed to determine priority groundwater monitoring areas, its water quality data and other physical parameters may be used for CV-SALTS. Layers include average depth to groundwater, average recharge, average soil permeability and water quality data from 1960 to 2000 for nitrate and chloride. Additional information on this dataset is available in Attachment 4.

Validate Salt and Nitrate Sources Data – Data on several major sources of salt can be used to augment or validate the information in the land use models, such as, but not limited to the following:

- Irrigation and drainage district records
- Pesticide use records from State databases to validate land and crop information
- Sales records of fertilizers and amendments from CDFA
- Animal herd size values from County Ag Commissioners
- Dairy and other significant permitted sources from the Regional Water Board
- Wastewater treatment and permitted treatment plants from Regional Water Board
- Monitoring results from the Irrigated Lands Program coalitions

Stakeholders Coordination is Key – A component of the data compilation effort will be an integrated effort with stakeholders representing important areas of the Central Valley. Engaging and having a working process to support stakeholders who have salt data and management capability is critical. This conceptual model should help encourage participants who may want to provide data for the initial phase or to provide additional or separate information after the initial work is completed. The model should provide clear, accessible summary information useful to the stakeholders in order to engage them and allow them to get something in return. If it is determined that entities have information that is critical for developing components of the phased model but they have not engaged with CV-SALTS, a formal CWC §13267 data report request may be issued by the Regional or State Board.

Initial Methodology Considerations will be discussed by the Technical Advisory Committee. These will be documented as an addendum to this document when developed. This initial methodology will assist those preparing the workplan for the CM. The final methodology will be proposed, reviewed, and approved by the Technical Committee. Additionally handling of temporal issues may be documented in the methodology addendum. Addressing temporal issues is based on data which is

[3] Dairy General Order Representative Groundwater Monitoring Results Report was developed for the Dairy General Order monitoring program and provides data in GIS format for the assessment of monitoring groundwater for Dairy CARES. Additional information is available in Attachment 4.

available and the ability of the data sources to provide models an adequate understanding to project future conditions.

Stated Assumptions and Default Values – Where information is lacking or data gaps exist, the CM will utilize predetermined default values to determine salt and nitrate loads. If reasonable default values cannot be established, it is possible that certain data gaps may not be fully addressed. Default values and the basis for these values shall be clearly stated. Data gaps not addressed by default values shall also be identified. Evaluation of additional work that would be needed to supplant the default values will be identified.

4. Development Process and Questions

This description was developed with the assistance of Technical Committee members over several Technical Committee meetings. Some questions discussed in the development of the CM were resolved by information provided by the Committee and are summarized below:

- The CM approach can accommodate the level of spatial and temporal aggregation/ disaggregation needed for CV-SNMP
- The GIS database can be used to overlay likely data sources together when aggregated
- The CM can be compatible with the data level needed for local SNMP/project assessment
- Site Specific Objective or other levels of entry can be integrated into the CM
- The CM is compatible with implementation of alternatives or archetype/prototype evaluation

5. Questions Matrix for Conceptual Model Phases

To provide a concise review of the questions to be answered and functions the CM will serve at each phase of the process, a matrix of questions was developed as is shown in Attachment 2. The matrix was reviewed by the Technical and Executive Committees and should drive the information and tools needed to complete the plan at these levels. This matrix may become part of the specifications for procurement of these services.

6. Methodology Addendum

A Methodology Addendum will be prepared by the Technical Committee documenting consensus methodological and Technical issues and assumptions to be used by those performing this work. Any issues not resolved by the committee in the addendum will be addressed and proposed in the workplan by the contractor. Elements the Addendum may address include but are not limited to:

- Critical methodology for aggregating water quality in surface and groundwater
    - Water Balance
    - Salt and Nitrate equilibrium/balance
    - Nitrogen Loss issues
    - Integration/aggregation of conflicting data
    - Minimum data quality restrictions
- Assumptions where data does not exist or for future scenarios/projections
- What level of quality is expected from each phase of the model, how will it be assessed?

- How will salt and nutrient balances be calculated from loading information?

The addendum may also consider questions for the Executive Committee, such as:

- Are there additional information needed for policy level regulatory decisions
- When should the Technical Committee or Executive Committee review progress and results?
- Are there other efforts the contractor should be aware of as they do this work?

This addendum when completed will be shown as part of this document in Attachment 5

7. Additional Development and Work Planning

The Methodology Addendum will provide specific consensus approach methodology and other technical specifics to be developed. Additionally, the documents developed by the Knowledge Gained Committee and Pilot Implementation Study should be included in the background for the development of the workplan for the Initial CM.

Some areas the work plan should cover include:

- How should areas where there is little data be handled or displayed?
- What are the areas where significant assumptions regarding data and models are required?
- What are the most likely data gaps that have a long lead time to completion?
- What limitations are there likely to be other than data?
- What process for outreach should be taken for the initial CM level? For the SNMP steps?

8. Scoping and Procurement Steps

The schedules and budgets shown below correlate to CV-SALTS Workplan and policy process goals. At this time, detailed scoping and work planning that would provide more reliable schedules and budgets to complete the desired work have not been developed. It is recognized that adequate time and resources for the work will be essential to completion of quality work products to meet program needs.

This Conceptual Plan Description review by the Technical Committee will be presented to the Executive Committee for concurrence. If acceptable, a performance based scope of work should be prepared for procurement of the initial phase work. While future phases will likely be in separate procurements, they are included here to ensure the future phases will build upon and augment the initial phase CM.

Initial Concept Phase

- Develop Work Plan, assumptions, methodology, and data sources for the initial phase of the Conceptual Model
- Upon approval, implement work plan and construct model geodatabase consistent with existing BUOS Phase I
- Select and develop tools to calculate salt and nutrient balances in conjunction with databases and other modeling tools and other efforts needed to answer matrix questions
- Data acquisition, formatting and GIS development to provide Conceptual Model
- Provide information, briefings and outreach for understanding
- Develop needs for SNMP data for levels beyond initial phase Conceptual Model

- Schedule 6-8 months
- Budget $200,000

Phase 2 – CV-SNMP- Masterplan

- Develop Work Plan, modifications and additional data sources for second level of detail
- Upon approval, implement work plan, aggregate and analyze additional data and develop additional model components such as temporal capacity forecasting etc.
- Data acquisition, formatting and GIS development to provide SNMP Level Model and efforts needed to answer matrix questions for Phase 2
- Provide information, briefings and outreach for understanding
- Develop needs for SNMP data beyond existing SNMP Level Conceptual Model (implementation etc.)
- Schedule 12-18 months
- Budget $400,000

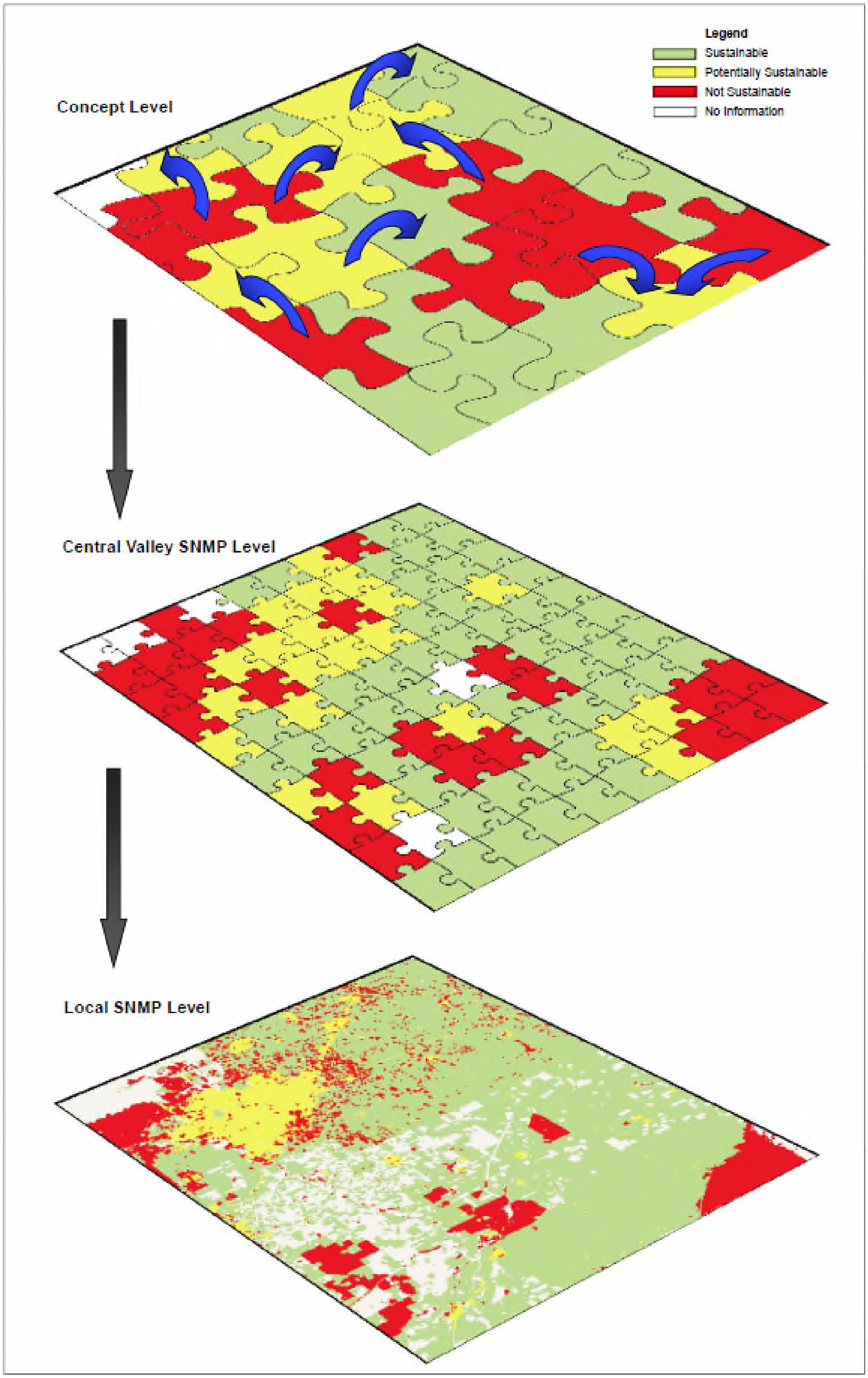
Final Phase – Local SNMP Support and Documentation

- Assessment and support for the SNMP, Implementation Plan and Documentation
- Incorporating Data from Regional SNMP
- Other Tasks
- Schedule 9 months
- Budget $100,000

9. Acknowledgements

This document includes significant contributions from the consultants working for and with CVSC members and others participating with CV-SALTS as well as work from EKI as Technical Project Manager. Assistance and feedback from the Regional Board staff and from the Committee Chair, Nigel Quinn provided significant clarifications and additions to the work to develop the concept.

Attachment 1 - Figure 1 - Conceptual Model Diagram



Attachment 2 CV-SALTS Questions Matrix for Concetual Models

#	Conceptual Model Question	Answered		
		Initial Planning	SNMP Master Plan	Local SNMP
1	Which areas/regions/subareas (?management zones?) are achieving water/salt/nitrate balance?	X	X	
2	What are the high priority areas/regions/subareas (management zones?)?	X	X	X
2	Where are the known impaired areas and/or hotspots?	X	X	X
3 & 5	Which areas/regions/subareas (management zones?) are accumulating water, salt, nitrate; and what are the rates of accumulation?	X	X	X
6	For areas/regions/subareas (management zones?) accumulating water, salt, nitrate, what is the estimated water, salt, nitrate volume/load that will accumulate over the next __ years?		X	X
3	Which areas/regions/subareas (management zones?) are depleting water, salt, nitrate; and what are the rates of depletion?	X	X	X
6	For areas/regions/subareas (management zones?) depleting water, salt, nitrate, what is the estimated water, salt, nitrate volume/load that will be depleted over the next __ years?		X	X
4	What is the water, salt, and nitrate transport pattern within the Central Valley and what are the rates of transport?	X	X	X
4, 7 & 8	What are the major sources of water, salt, and nitrate into the Central Valley; and where and at what rate do they enter the Central Valley ?	X	X	X
4	Where and at what rate do water, salt, and nitrate leave the Central Valley ?	X	X	X
11	What are the existing major data gaps?	X	X	X
12	What are the primary drivers of salts and nitrates?	X	X	X
13	How do the primary drivers result in different management practices?		X	X
14	Does seasonal variability impact salt concentrations / loading / transport?		X	X
14	Does water year type variability impact salt concentrations / loading / transport?		X	X
15	What are future water, salt, nitrate scenarios?		X	X
17	What is the assimilative capacity of each management zone?		X	X
19	How do changes in management practices effect baseline salt loads/concentrations within one or more management zones?		X	X
22	What is the rate of change for concentrations in groundwater and vadose zone?	X	X	X
24	What management areas will require a high level of regulatory oversight?	X	X	X

#	Conceptual Model Question	Answered: Initial Planning	Answered: SNMP Master Plan	Answered: Local SNMP
#	**If the above questions are answered satisfactorally, the Conceptual Model will:**			
18	Support required elements of the SNMP	X	X	X
20	Support SSALTS, initial development /refinement /impact of implementation plans		X	X
21	Support offsets, credits, trading related assessment?		X	X
26	Support BPA, CEQA, Economic, Antideg, etc.		X	
27	Support Tier 1 efforts regarding Waterbodies	X		
28	Support Tier 2 efforts regarding Standards	X	X	
29	Support Tier 3 efforts regarding Assessment		X	X
30	Support Tier 4 efforts regarding Implementation		X	X
31	Support monitoring planning and periodoc reassessment		X	X
#	**The Conceptual Model should be capable of:**			
10	Integrating additional studies by others		X	X
16	Integrating archetype and prototype efforts		X	X
23	Incorporating changes to beneficial uses and objectives (standards) and updateassimilative capacity		X	X
	Reports based on the Conceptual Model should:			
	Identify the assumptions used in the model	X	X	X
	Discuss how conservative nitrogen was assumed to be	X	X	X
	Discuss how CVHM was used to calculate loads	X	X	X
	Describe the level of confidence in the results	X	X	X
	Discuss how results were or will be validated by stakeholders impacted by the study	X	X	X

This table was reorganized and checks replaced the more detailed information which may provide additional understanding of the levels; this document is posted at:
http://cvsalinity.org/index.php/documents/doc_download/861-cv-salts-conceptual-model-qaa-matrix

Attachment 3 - Summary of the CVHM Model

The USGS Central Valley Hydrologic Model (CVHM; Faunt et al., 2009) builds on previous investigations, such as the USGS Central Valley Regional Aquifer System and Analysis (CV-RASA) project and several other groundwater studies in the Valley completed by federal, state and local agencies at different scales. The development of the CVHM comprised four major elements: (1) a comprehensive Geographic Information System (GIS) to compile, analyze and visualize data; (2) a texture model to characterize the aquifer system; (3) estimates of water budget components by numerically modeling the surface water and groundwater flow across the entire Central Valley system, including irrigated agriculture water demands and processes; and (4) simulations to assess and quantify hydrologic conditions. The CVHM professional paper is posted online; all model input and output files are also available online for use by water managers and other agencies at http://pubs.usgs.gov/pp/1766/ .

The CVHM simulates the complex hydrologic system of the Central Valley using a number of advanced components of the USGS's numerical modeling code MODFLOW-2000 (MF2K), including the Farm Process (FMP). The FMP dynamically allocates groundwater recharge and groundwater pumpage on the basis of crop water demand, surface-water deliveries, and depth to the water table. This approach is particularly useful in the Central Valley where private groundwater pumping for irrigation is not metered. Irrigation water requirements are calculated from consumptive use, effective precipitation, groundwater uptake by plants, and on-farm efficiency. The FMP links with other MF2K Packages, including the Streamflow Routing Package (SFR1) to facilitate the simulated conveyance of surface-water deliveries. If surface-water deliveries are insufficient to meet irrigation requirements, the FMP invokes simulated groundwater pumping. The FMP uses specified irrigation efficiencies to calculate irrigation return flow.

The CVHM simulates groundwater and surface water flow, irrigated agriculture, land subsidence, and other key processes in the Central Valley between October 1961 and September 2003 on a monthly basis. This model is discretized horizontally into 20,000 model cells of 1-mi^2 areal extent, and vertically into 10 layers ranging in thickness from 50 to 1,800 ft. The texture model was used to estimate hydraulic conductivity for every cell in the model. Land subsidence, an important consequence of intense groundwater pumpage in susceptible aquifer systems, especially in the San Joaquin Valley, is simulated using the SUB Package. Intra-borehole flow, an important mechanism for vertical flow within and between hydrogeologic units in parts of the valley, is simulated using the Multi Node Well (MNW) package.

Web Link http://pubs.usgs.gov/fs/2009/3057/pdf/fs20093057.pdf

Attachment 4 – Description of Dairy Cares Datasets

Technical Approach Used to Identify Hydrogeologically Sensitive Regions along with Salt and Nitrate Impacts to Shallow Groundwater in the Central Valley

On May 3, 2007, the Central Valley Regional Water Quality Control Board (CVRWQCB) adopted *Waste Discharge Requirements General Order No. R5-2007-0035 for Existing Milk Cow Dairies* (General Order). The General Order regulates waste discharges to land at the majority of 1,429 existing dairies of all sizes and imposes significantly more stringent requirements than in the past. The CVRWQCB has proceeded with implementation of the General Order by issuing directives, under California Water Code Section 13267, to individual dairies that require the installation of groundwater monitoring wells. In October 2009, and parallel to these activities, Dairy Cares submitted a proposal to the CVRWQCB Executive Officer for the development of a collaborative plan that would allow representative groundwater monitoring networks to satisfy the alternative groundwater monitoring method recognized by the General Order.

An integral part of implementing the representative groundwater monitoring program was the development and implementation of a technical approach to identify a high priority, hydrogeologically sensitive geographic region in the Central Valley within which to initiate the representative groundwater monitoring approach. The method incorporates analysis of existing groundwater quality data to identify 1) where high groundwater nitrogen and salt concentrations occurred historically, 2) where increasing salt and nitrate concentrations are indicated, and 3) the hydrogeologic areas where changes in groundwater quality are most likely to be quickly detected in response to modified (improved) management practices.[4]

The cooperating members of the dairy industry (particularly Dairy Cares) who funded this technical work have agreed to share the results of their analysis with the Central Valley Salinity Coalition.

TECHNICAL APPROACH

The technical approach employed to identify hydrogeologically sensitive regions in the Central Valley included the use and organization of readily available pertinent data, utilization of spatial analyses which use a Geographic Information System (GIS) database and mapping tool, and also application of non-spatial analyses. The methodology was developed with the recognition that existing groundwater quality conditions are the result of historical processes. The methodology incorporates parameters that are either widespread (e.g., groundwater quality data, whole farm nitrogen balance) or were derived via extensive data collection, analysis, and scaled averaging by others (e.g., recharge to groundwater, depth to groundwater, soil survey information). Therefore, the methodology places little significance on any individual data point. Instead, it places emphasis on regional comparisons.

[4] The method described in the *Report of Results* (LSCE, 2010) also utilized dairy farm locations and herd densities to help identify areas of high groundwater nitrogen and salt concentrations thought to be substantially attributable to dairy operations and where changes in water quality are most likely to be detected quickly due to the recent adoption of improved dairy waste management practices. However, the existing groundwater quality data spanning the period from the 1960s through the late 2000s makes the groundwater quality observations in the Central Valley relevant to other salt and nutrient sources as well.

Data Components

Seven data components were considered for purposes of identifying high priority areas relative to dairy land use and waste management effects, including:

- Dairy locations and population densities of dairy cows
- Non-dairy land use information
- Depth to groundwater
- Recharge to groundwater
- Soil survey information
- Shallow groundwater nitrate and salt concentrations
- Whole farm nitrogen balance

These data components included the compilation and analysis of data for the entire Central Valley. Those data components relative to the broader interest for salt and nutrient management planning and prioritization of areas of interest (i.e., data components 2 through 6) are further described below. The technical approach and additional discussion of the individual data components, including the benefits and limitations of each data type, is provided in the *Report of Results* (LSCE, 2010).

Non-Dairy Land Use Information

Rationale

Human activities associated with certain land uses unrelated to dairies have been identified as potentially contributing to nutrient and salinity increases in groundwater, including non-dairy agriculture, ranches, and other livestock operations. Consideration of non-dairy land use types is useful in the evaluation of the proportional non-dairy contribution to existing groundwater conditions.

Sources

- USGS's CVHM
- DWR
- USDA National Agricultural Statistics Service (NASS)[5]

Data Description

The U.S. Geological Survey's (USGS) Central Valley Hydrologic Model (CVHM) (Faunt, 2009) includes model input files with extensive land use information.[6] In addition, the California Department of Water Resources (DWR) gathers and compiles land use information on a county-wide basis. This information is available for some counties but inter-county differences exist between land use categorization, scales and mapping accuracy, and the times of the mapping efforts. USDA NASS maintains annual records by county on livestock herd sizes.

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[5] Data accessed December 1, 2009 at http://www.nass.usda.gov:80/Statistics_by_State/California/index.asp

[6] CVHM's land use input files are a comprehensive source of information as they were compiled from many different sources such as California Department of Water Resources (DWR), USGS Geographic Information Retrieval and Analysis System (GIRAS), and USGS North American Land Class Data.

Depth to Groundwater

Rationale

The depth to first encountered groundwater gives an indication of the thickness of the unsaturated zone. The thickness of the unsaturated zone can give an indication of the comparative sensitivity of groundwater to surface water percolation. For example, a thin unsaturated zone may be expected to provide less protection for groundwater resources than a thick unsaturated zone, which provides greater opportunity for natural attenuation to occur (other variables constant). The thickness of the unsaturated zone can also provide an indication of the relative travel time of vertical unsaturated flow to reach groundwater. Therefore, the depth to groundwater is an important component within the framework of the proposed methodology. Areas of higher priority would include areas where the depth to groundwater is relatively shallow and groundwater is more sensitive to surface activities.

Sources

- USGS's CVHM
- DWR

Data Description

Hydraulic head output files from CVHM and DWR's mapped contours of equal depth to first encountered groundwater (identified as the unconfined aquifer).

Recharge to Groundwater

Rationale

The rate of recharge represents the link between surface water, irrigation/applied water, precipitation, and groundwater and gives an indication of aquifer vulnerability to surface percolation. Under certain assumptions and a given constituent concentration, the rate of recharge determines the constituent's mass loading rate to groundwater. For example, an area of low groundwater recharge is expected to be less vulnerable to contamination from surface water percolation than an area of high recharge (other variables constant). Therefore, knowledge of the vertical flux to groundwater is a useful component within the framework of the proposed methodology.

Source

- USGS's CVHM

Data Description

Vertical flux output files from CVHM[7]. These data were manipulated to achieve a database of DWR-defined subregional areas and their average rate of recharge per year on a decadal basis (1960s to 2000).

[7] In hydrologic wet years, recharge of excess applied irrigation water is estimated to be approximately 2 times greater than stream losses. In hydrologic dry years, this ratio is amplified to approximately 6:1 (Faunt, 2009). The proportional magnitude of recharge from irrigation to groundwater demonstrates the enormous influence of irrigated agriculture on groundwater resources in the Central Valley.

Soil Survey Information

Rationale

Soil survey information includes soil textural data that can be related to the soil's permeability. Farming practices may vary according to soil type, and soil permeability plays a key role affecting irrigation practices and efficiencies, the potential for leaching, and the availability of oxygen in shallow groundwater, which affects the fate of nitrogen components. Therefore, soil survey information was used to complement recharge rates simulated with CVHM.

Source

- Natural Resources Conservation Service's (NRCS) Soil Survey Geographic Database (SSURGO)[8]

Data Description

Compilation of extensive, detailed soil descriptions, which were generally to a maximum depth of 6 feet. 512 soil textural classes were organized according to their relative permeability and abundance in the vertical soil profile into 3 permeability categories.

Shallow Groundwater Nitrate and Salt Concentrations

Rationale

Information on shallow groundwater nitrate and salt concentrations gives an indication of existing groundwater conditions at a moment in time. The evaluation of existing conditions is a key component of the proposed methodology because it provides a relative measure of potential groundwater quality impacts associated with historical land uses and management practices.

Sources

- USGS National Water Information System (NWIS) including its Groundwater Ambient Monitoring and Assessment (GAMA) Priority Basins Project (implemented by the California State Water Resources Control Board [SWRCB]).
- SWRCB GeoTracker, including the newly available GeoTracker GAMA (Beta version) groundwater quality download option to spreadsheet.
- CVRWQCB

Data Description

USGS groundwater quality data are provided on-line and can be searched, for example, by region, date, constituent (e.g., nitrate and total dissolved solids), and total well depth.

SWRCB GeoTracker GAMA (Beta version) contains groundwater monitoring records from SWRCB/RWQCB, the GAMA domestic well program, USGS GAMA, Lawrence Livermore National Laboratory (LLNL) GAMA, California Department of Pesticide Regulation (DPR), DWR, and Electronic Data

[8] Data accessed March 2, 2010 at http://soildatamart.nrcs.usda.gov/

File (EDF) submittals from regulated facilities. These data were recently made available on-line. Data can be searched, for example, by region, date, and constituent (e.g., nitrate and total dissolved solids). The Report of Results (LSCE, 2010) includes maps showing decadal nitrate and chloride results spanning the time frame from the 1960s to the 2000s.

CVRWQCB data are composed of maximum nitrate concentration analytical results reported for non-barn domestic wells and on-site production wells (2007 and 2008) that were submitted by individual dairies to the CVRWQCB (Fresno and Sacramento offices) in response to the General Order.

High Priority Area Selection for RMP Phase 1

Based on the above criteria, the *Report of Results* (LSCE, 2010) recommended that the representative groundwater monitoring be initiated in Stanislaus and Merced Counties (i.e., from the Stanislaus River in the north and the Chowchilla River in the south) between the San Joaquin River and Highway 99. This area is referred to as the high priority area, and is characterized by predominantly coarse-grained, highly permeable soils, and shallow depths to groundwater.

Following approval of the RMP Workplan (LSCE, 2011)[9], the first phase of the RMP is now underway with administration by the nonprofit organization, the Central Valley Dairy Representative Monitoring Program (CVDRMP), formed in 2010 to conduct and manage the RMP and comprised of approximately 1200 member dairies. The CVDRMP is presently in the process of creating a comprehensive sustainable dairy farming plan (SDFP). Components of the SDFP provide for rigorous peer review of RMP data collection, analyses, and interpretations, by two technical advisory committees, stakeholder input, and ongoing identification of research, extension and consulting needs, and funding sources necessary to support those needs.

REFERENCES

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[9] The RMP Workplan (Monitoring and Reporting Workplan and Monitoring Well Installation and Sampling Plan; LSCE, 2011).

Attachment 5 – Committee Methodology Addendum

To be attached when completed