DRAFT

Methodologies for Determining Ambient Groundwater Quality, Trends, Assimilative Capacity and Best Quality Attained Since 1968

Primer for June 18, 2015 Presentation

The presentation will begin with a brief overview of previous work of the Initial Conceptual Model (ICM) in Phase I and follows with a description of updates to the groundwater quality database that was completed as part of Phase II work. This will lead into the Salt and Nitrate Management Plan (SNMP) work currently being performed in Phase II for the entire Region 5 area and the development of methodologies for assessing ambient groundwater quality, trends, and assimilative capacity for Management Zones of various sizes/scales. As part of the LWA Team, Luhdorff & Scalmanini, Consulting Engineers (LSCE) has developed a matrix that provides a blueprint summary of potential methodology options for:

- determining data adequacy,
- ambient conditions,
- groundwater quality trends,
- assimilative capacity,
- best attained water quality since 1968, and
- historical water quality.

As part of the Phase II Task 5 work, a detailed methodologies section will be included as an appendix to the SNMP and will provide detailed examples of the various methodologies outlined in the matrix for various Management Zone scales.

Draft policy considerations and questions relating to Management Zones and the application of the methodologies are interspersed in the presentation slides and are summarized at the end of the presentation, and below. It is planned that these questions will be discussed the afternoon of June 18 following the morning presentation.

A key focus of the methodology presentation is to demonstrate the importance of spatially resolved groundwater quality at a range of scales, including much smaller than those used in the ICM that was developed in Phase I to a scale similar to an ICM Initial Analysis Zones (IAZ). The ICM in Phase I used an aggregated approach for analyses that were calculated for 22 IAZs covering the Central Valley floor, ranging in size from 280 to 1,650 square miles, with the average size around 900 square miles. The June 18 presentation will compare an aggregated approach to a spatially resolved approach, where ambient groundwater quality and assimilative capacity are calculated over a grid with a resolution of less than 0.1 square mile per grid cell. The approach demonstrates that while an aggregated approach may result in no assimilative capacity when the domain is considered as a whole, a spatially resolved approach is able to show that within the domain there are areas where assimilative capacity exists.

The following list briefly touches upon the different scales of analyses that are used for illustration:

- the smallest scale of a treatment plant (0.15 sq. miles),
- the treatment plant vicinity (using an area of 5 miles around the treatment plant)
- an irrigation district (Alta Irrigation District), and
- the largest scale of the entire AID Model Area (1,500 sq. miles)

A discussion of the methodologies used to determine ambient groundwater quality and assimilative capacity for each of these scales is presented. Also planned are brief discussions of historical water quality and methods for determining the best water quality attained since 1968. In addition, trends at the local and regional scale will be discussed, including the use of past water quality trends to predict changes in assimilative capacity. At a future presentation, a groundwater flow and transport model will be used to illustrate other tools that can be used to assess salt and nitrate management approaches and their effectiveness, including estimation of future assimilative capacity.

June 18, 2015 General Presentation Outline

PHASE II TASK 3 GROUNDWATER QUALITY DATA

- Brief review of groundwater quality dataset compiled during Phase II

RECYCLED WATER POLICY AND SNMP

- Components and relationship to methods
- Summary of preliminary results and relationship to SNMP

METHODOLOGIES

- **Scales of analysis for various management zones**
  - *WWTP*
  - *WWTP Vicinity*
  - *Alta Irrigation District (AID)*
  - *AID Model Area*

What is a Management Zone?

- **Methods for determining**
  - *Data adequacy*
  - *Ambient groundwater quality*
  - *Trends*
  - *Assimilative capacity*
  - *Best groundwater quality attained since 1968*
  - *Historical groundwater quality*

What Data are Available to Determine Groundwater Quality?

- **Data availability and adequacy**
  - Data characteristics (temporal and spatial gaps, construction info, accurate locations)
  - Categorizing wells as shallow and deep

What is a Hydrologic Zone?

- **Spatial Scales**
  - Different scales of analysis from local treatment plant to regional scale.
  - Areal and vertical hydrologic zones

How Are Groundwater Quality Trends Calculated?

- **Visual trend analysis**
  - Plot time series of well data by region, by areal and vertical hydrologic zones
  - Wells with long periods of record or “representative wells”

- **Statistical trends**
  - Parametric and Non-parametric tests
  - Regional Kendall Test

How are Ambient Water Quality and Assimilative Capacity Calculated?

- **Calculating ambient water quality and assimilative capacity (see also last page of this document for definition of assimilative capacity)**
  - Interpolation to obtain spatially distributed estimated concentrations
  - Volume weighting vertical hydrologic zones
  - Calculating assimilative capacity
  - Predicting changes in assimilative capacity using trend analysis

What Is the Approach for Determining Historical Groundwater Quality and Best Groundwater Quality Attained Since 1968?

- **Establishing spatially distributed best water quality attained since 1968**
  - Define
  - Methodology used to select wells
- **Establishing historical water quality**
  - Define
  - Discuss methodology

SUMMARY OF ICM/PHASE II GROUNDWATER QUALITY FOR SNMP

- Recycled water policy and SNMP methods
- ICM and prototype results, along with Archetype results

SUMMARY OF POLICY CONSIDERATIONS/QUESTIONS

- Policy considerations and questions related to Management Zones and Methods interspersed in presentation and summarized at end of presentation
- The draft questions are planned to be discussed June 18th (afternoon) following the morning presentation

Summary of Draft Policy Considerations and Questions

(Policy numbers are in order of occurrence in presentation;
order below is suggested for Policy Committee discussion purposes)

Policy Question No.	Policy Question	Background on Issues	Potential Options for Consideration	Recommendation for Discussion
3	What is recommended to define the "shallow" part of the aquifer system (i.e., the depth [across the MZ] of part of the aquifer system that provides actual or probable beneficial use)?	The ICM analysis involved use of a 20-year vertical travel distance to define the depth of the shallow part of the aquifer system. This approach was developed to be consistent with the definition of assimilative capacity provided in the ICM. Since the ICM, the Policy Committee has been exploring additional aspects of the Management Zone concept, including "volume weighted averaging" of the production zone. It would be useful to the development of the Preliminary Draft SNMP to discuss this Policy Question.	a. Alta archetype approach where the uppermost zone of production is assessed using USGS CVHM information (related to depth of top of wells' perforated intervals and likely depth of upper zone of groundwater production) b. 20-year vertical travel distance (similar to ICM approach) c. Local hydrogeologic conditions and well construction and/or other approaches d. All of the above; describe options in the Appendix on SNMP Guidance	Option "b" served a useful purpose to meet the objectives of the ICM. The Alta approach, "a", offers an explicit example of an approach to identifying the shallow zone in the context of a part of the aquifer system that is something other than first encountered groundwater that will be a useful example to include in the Appendix on SNMP Guidance. However, other options such as "c" should also be considered, if sufficient rationale is provided by the Management Zone Entity.
4	What is recommended to define the depth of the "Production Zone"?	The depth of the production zone of groundwater supplies may vary a lot in any given Management Zone. The production zone was	a. Alta archetype approach where the depth of the production zone assessed using USGS CVHM	The Alta approach, "a", offers an explicit example of an approach to identifying the production zone in the context of a part of the aquifer

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		not a concept that was addressed at the time of the ICM. It would be useful to the development of the Preliminary Draft SNMP to discuss this Policy Question.	information (related to a survey of driller's logs and their depth to the bottom of wells' perforated intervals and likely depth of the groundwater production zone) b. Local hydrogeologic conditions and well construction and/or other approaches c. All of the above; describe options in the Appendix on SNMP Guidance	system that has been typically completed by production wells without being the deepest ever completed to date nor the deepest part of the system that could in the future be developed for water supply purposes. This approach will be useful to include as an example in the Appendix on SNMP Guidance. However, other options such as "c" should also be considered, if sufficient rationale is provided by the Management Zone Entity.
1	How should the areas (basins and/or watersheds) outside the Central Valley Floor in Region 5 be handled for purposes of the SNMP?	The Preliminary Draft SNMP will include *preliminary* ICM results on the IAZ scale for the Central Valley Floor (i.e., this analysis was done using the older dataset and was on the aggregated scale). The AID archetype and ICM prototypes are the only areas with higher resolution ambient groundwater quality and assimilative capacity results in the entire Region 5. Additionally, while the Phase II Draft SNMP included an update of the groundwater database, the scope for Phase II does not include	a. Address the area outside the Central Valley Floor qualitatively with information in the Appendix on SNMP Guidance. b. Do more analysis with data developed as part of Phase II (Task 3) and also cover additional factors in the Appendix on SNMP Guidance. (This work is outside of the current scope and budget)	With the concept that the SNMP for Region 5 serve as a programmatic basis for basins and subbasins in the region, it is recommended that a reconnaissance level of analysis of groundwater conditions be completed for the area outside the Central Valley Floor (option a). Additionally, given the concepts of the Management Zone that have been further explored since the ICM, including part of the AID archetype work, it is recommended that the updated groundwater data compiled as part of Phase II/Task 3 be utilized

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		finalizing the ambient groundwater quality for the IAZs or the assimilative capacity (i.e., there is no scope for completing work for the shallow , deep, or production zones within the Central Valley Floor with the improved and updated groundwater quality database). Additionally, there are currently no analyses scoped to characterize groundwater quality conditions outside the Central Valley Floor. Since the Preliminary Draft SNMP is scoped to address all of Region 5, it is also important to consider what is currently scoped to be included in this document. It is important that the Policy Committee discuss the content that will satisfy the Recycled Water Policy for the SNMP for Region 5.		to provide a refined default basis of groundwater quality conditions for the Central Valley Floor, including for the "shallow", "deep" and "production zones". (See also the Recommendation below for Policy Question 5.)
2	What is recommended to address the uncertainty associated with incomplete datasets?	Data available for a Management Zone area are likely to include some degree of uncertainty and other limitations. For example, for the Alta Irrigation District	a. Use only wells with well construction information (smaller dataset) b. Use all available data (larger dataset)	Based on the Alta Irrigation District Archetype approach, it appears that analysis of the data represented by both options "a" and "b" is useful as it demonstrates the relative

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		Archetype, many wells with water quality data do not have well construction information such that the water quality can be attributed to the appropriate representation of the aquifer system. It is important that the Policy Committee discuss how this wide range of conditions on dataset sufficiency/availability should be considered in the SNMP, particularly the Appendix for Guidance on SNMPs.	c. Consider a hybrid approach	differences that may exist in the Management Zone due to the uncertainty associated with the larger data set and also the smaller dataset. Once such uncertainty is identified, this can also inform additional steps needed to refine the understanding of the ambient water quality, trends, assimilative capacity, and any long-term projections of assimilative capacity. Such steps may include (but are not limited to) identification of additional well construction information necessary to make existing water quality data more meaningful, identification of additional water quality data (from existing wells), design of the Management Zone monitoring network (and/or other coordinated monitoring network arrangements), etc.
5	Would it be beneficial for the Management Zone concept to use the aggregate scale for permit flexibility, while using the higher resolution analysis for informed management	The ICM preliminary assimilative capacity results for the IAZs are on an aggregated scale; in many cases this resulted in no assimilative capacity. The archetype analysis with the	a. Use the IAZ aggregated scale results, i.e., the ICM 20-year vertical travel distance for the shallow zone and preliminary assimilative capacity results.	The ICM analysis and the preliminary results served a useful purpose for the intended "30,000" foot scale of analysis and understanding general conditions and concerns associated with the Central Valley Floor. However, at the

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	decisions?	higher resolution scale demonstrates additional flexibility (opportunity for assimilative capacity) when compared to the aggregated scale. The higher resolution approach is also important as a tool for allocating assimilative capacity and managing ongoing assessment of assimilative capacity. It is important that the Policy Committee discuss the potential implications to the many areas that will have no assimilative capacity for TDS and/or nitrate if the Phase II SNMP uses only the aggregated scale preliminary results for assimilative capacity for the IAZs, which are for the 20-year vertical travel distance only (shallow zone).	b. Provide additional higher resolution analysis for the SNMP, including the higher resolution volume-weighted Production Zone approach. (This is outside of the current scope and budget)	outset of the SNMP work, multiple levels of analysis were envisioned (i.e., 3-scales of resolution for the SNMP process). It was identified by the Policy Committee at the conclusion of the ICM work that higher resolution detail would ultimately be more meaningful and would provide local and regional entities more flexibility than the preliminary aggregate scale results provided by the Initial Analysis Zone approach. It is recommended that the additional level of high resolution detail (option b) that would serve as the preliminary default for the IAZ areas be developed to offer flexibility until such time as more detail is needed for specific projects. The additional analysis would include higher resolution detail for the shallow zone (as described above), deeper zone (i.e., difference between the production zone and shallow zone), and the volume-weighted production zone). This information would be more responsive to the requirements of the Recycled Water Policy by: 1) providing more detail on ambient water quality for the

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				components of the Management Zone concept under development by CV-SALTS, 2) providing an improved default for local and regional entities, 3) refining the assimilative capacity such that many areas would have more permitting flexibility, 4) providing a better basis for future management of salt and nitrate, 5) informing the design of the monitoring program for the Central Valley, and 6) addressing groundwater quality conditions for areas outside the Central Valley Floor to the extent feasible (where there is currently no such provision for such analysis).

Green shading indicates “no new action”; this is part of current scope for SNMP.

Yellow shading indicates this is new and requires additional scope and budget.

SWRCB Recycled Water Policy Assimilative Capacity

Recycled Water Policy 9. c. (1)

> "For compliance with this subparagraph, the available assimilative capacity shall be calculated by comparing the mineral water quality objective with the average concentration of the basin/sub-basin, either over the most recent five years of data available or using a data set approved by the Regional Water Board Executive Officer. In determining whether the available assimilative capacity will be exceeded by the project or projects, the Regional Water Board shall calculate the impacts of the project or projects over at least a ten year time frame."

Essentially this means:

> **Water Quality Objective** (concentration units) **- Ambient GW Quality** (concentration units)**= Assimilative Capacity** (concentration units)
>
> **Example:**
>
> **10 mg/L NO3-N - 4 mg/L NO3-N = 6 mg/L NO3-N**

SWRCB Recycled Water Policy -- Explicit definition of assimilative capacity not provided, i.e., non-specific with respect to which part of the aquifer system ambient or baseline water quality is computed, and correspondingly, for which part of the aquifer system assimilative capacity applies.

Assimilative Capacity (Defined in ICM):

- Amount of a constituent that can be discharged to the aquifer system (esp. that part of the aquifer system that provides actual or probable beneficial uses) without exceeding WQ standards and/or Basin Plan WQ objectives.
- Additionally describes the difference between the WQ standards/objectives and avg. ambient shallow GW quality in the basin/subbasin/IAZ (where shallow does not necessarily mean the uppermost part of the saturated zone directly at the water table, rather "shallow" means the part of the aquifer system that provides actual or probable beneficial uses).