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6 January 2016

David Gisler, President
Tule Basin Water Quality Coalition
2904 West Main Street
Visalia, CA 93291

CONDITIONAL APPROVAL OF TULE BASIN WATER QUALITY COALITION GROUNDWATER QUALITY ASSESSMENT REPORT

Thank you for the 9 February 2015 submittal of the Tule Basin Water Quality Coalition (Coalition) Groundwater Quality Assessment Report (GAR), as required by Waste Discharge Requirements General Order R5-2015-0120 (General Order). The purpose of the GAR is to provide the foundational information necessary for design of the Management Practice Evaluation Program (MPEP), the Groundwater Quality Trend Monitoring Program (GQTMP), and the Groundwater Quality Management Plan(s) (GQMP).

As outlined in the enclosed staff review, the information provided generally addresses the General Order's main GAR objectives. However, additional data and information need to be collected, evaluated, and incorporated into the Coalition's conceptual hydrogeologic model as it moves forward with the MPEP, GQTMP, and the GQMP. Additionally, the high vulnerability area map did not include the area above and near Lake Success (supplemental coverage area), which has documented nitrate concentrations above the maximum contaminant level (MCL). As required by Revising Order R5-2014-0143, and discussed at the December 2014 meeting between the Coalition and staff, your high vulnerability areas must include all irrigated agricultural lands within the Coalition boundaries, including the supplemental coverage area, where nitrate concentrations have been detected above the MCL.

In order to facilitate implementation of the General Order's post-GAR groundwater requirements I am conditionally approving the Coalition's GAR. This conditional approval provides a pathway for the Coalition to address issues identified in the staff review through future work plans and the 5-year GAR update while also allowing the Coalition to expeditiously proceed with the important work of the MPEP, GQTMP, and the GQMP. **By 5 February 2016**, please submit an addendum to your high vulnerability area map that includes an assessment of the nitrate exceedances within the supplemental coverage area. All other GAR items need to be addressed in accordance with the schedule in Table 1 (enclosed).

If you have any questions, please contact Nicholas Smaira at (559) 488-4393 or by email at NicholasBassam.Smaira@waterboards.ca.gov.

Sincerely,

Clay L. Rodgers

for Pamela C. Creedon
Executive Officer

Enclosure(s) Table 1. Summary of Issues to be Addressed in Forthcoming Work Plans
Staff Review Memorandum

cc: Sue McConnell, Central Valley Water Board, Rancho Cordova
Richard Schafer, R.L. Schafer and Associates, Visalia
David De Groot, 4 Creeks Civil Engineering and Land Surveying, Visalia

Table 1
Summary of Issues to be Addressed Forthcoming Work Plans*

Staff Memorandum Item	Groundwater Quality Management Plan(s) (Due as needed)	Groundwater Quality Trend Monitoring Program (Due 6 January 2017)	Groundwater Quality Assessment Report Update (Due 6 January 2021)
1.A		X	
1.B	X	X	
1.C			X
1.D		X	
1.E		X	
1.F		X	
2.A		X	
2.B		X	
3.A		X	
3.B		X	
3.C			X
3.D		X	
4		X	
6		X	
8.A		X	
8.B			X
8.C		X	
8.D		X	
9	X	X	
10	X	X	
11		X	
12.A	X	X	
12.B		X	
12.C	X	X	
12.D	X	X	
12.E	X	X	
13		X	
14		X	
15			X
16.A	X	X	

Table 1 (Continued)
Summary of Issues to be Addressed in Forthcoming Work Plans*

Staff Memorandum Item	Groundwater Quality Management Plan(s) (Due as Needed)	Groundwater Quality Trend Monitoring Program (Due 6 January 2017)	Groundwater Quality Assessment Report Update (Due 6 January 2021)
16.B	X	X	
18.A		X	
18.B		X	

* Once an item has been addressed through the designated workplan, the information and approach required to satisfy the item must be carried forward to all future reports.

Central Valley Regional Water Quality Control Board

TO: David Sholes, CEG
Senior Engineering Geologist
Irrigated Lands Regulatory Program

FROM: Nicholas Smaira
Engineering Geologist
Irrigated Lands Regulatory Program

DATE: 6 January 2016

SUBJECT: **REVIEW OF 4 FEBRUARY 2015 GROUNDWATER ASSESSMENT REPORT FOR THE TULE BASIN WATER QUALITY COALITION**

On 9 February 2015, 4 Creeks Civil Engineering and Land Surveying submitted a Groundwater Quality Assessment Report (GAR) on behalf of the Tule Basin Water Quality Coalition (Coalition or TBWQC). The GAR provides the foundational information necessary for design of the Management Practices Evaluation Program (MPEP), the Groundwater Quality Trend Monitoring Program (GQMP), and the Groundwater Quality Management Plan (GQMP). The GAR was reviewed to determine compliance with requirements pursuant to section VIII.D.1 of Waste Discharge Requirements General Order R5-2013-0120 (General Order), section IV.A of Attachment B (Monitoring and Reporting Program) to the General Order, and the Revising Order R5-2014-0143.

California Regional Water Quality Control Board, Central Valley Region (Central Valley Water Board or Water Board) staff's review of the GAR concluded that modifications and additions are necessary to the GAR to meet the terms and conditions of the General Order; however, many of the required modifications can be included in subsequent work plans or GAR updates. Table 1 provides descriptions of the required GAR components from the General Order and Monitoring and Reporting Program and lists the section in the GAR that addresses each component. Recommended revisions/additions for incomplete items are provided below. The memorandum item numbers correspond to item numbers in Table 1. Additionally, a missing information and errata sheet for deficiencies or oversights that are contained within the GAR but are not required elements of the General Order is provided in Attachment A.

Item 1. Assessment of Readily Available, Applicable and Relevant Data and Information to Determine High and Low Vulnerability Areas.

The General Order (Section VIII.D.1) requires that the GAR provide an assessment of all readily available, applicable and relevant data and information to determine the high and low vulnerability areas where discharges from irrigated lands may result in groundwater quality degradation. While a portion of the available data was discussed in the GAR and referenced by the document, a large body of available information was not identified or evaluated. This has given rise to a variety of assumptions that have affected the interpretation of the water quality data present within and adjacent to the Coalition's boundaries. Recommended revisions include the following:

A. A discussion of the Friant-Kern Canal and its role in providing surface water to area streams and irrigation canals or water for groundwater banking/recharge is needed. Additionally, nitrate groundwater data from the irrigation district's Pump-in Program (wells discharging into the Friant-Kern Canal) should be obtained, evaluated and included in the GAR's discussion of the TBWQC's watersheds (Temporary Change in Water Quality Requirements for the Friant-Kern Canal Groundwater Pump-in Program, 2014, U.S. Department of the Interior Bureau of Reclamation, Draft Finding of No Significant Impact, October 2014, FONSI-14-043).

B. Page 9 of the GAR states in part that, "There are little, if any, lands that are irrigated within the Sierra Nevada Mountains". However, as illustrated in GAR Attachment H (Prime Farmland) and confirmed using aerial photography, irrigated pasture and citrus are present in or near Success Valley, Pleasant Valley and the Springville areas. The GAR should include water quality data and well detail information for these areas (see Fram and Belitz 2014, and Fogelman 1982).

C. The discussion of regional geology in Section IV of the GAR should be reorganized to provide the necessary regional framework that forms the basis for understanding the specific geology of the TBWQC area, and to capture the importance of the alluvial fan deposits and their relation to the hydrogeologic framework of the area (as discussed by Faunt, C.C., ed., 2009). The information on geomorphology and groundwater should be moved to their respective discussions (Geomorphic Units [page 8] and Groundwater Occurrence [page 19]). Likewise, the geologic descriptions of basement and alluvial deposits contained in the Groundwater Occurrence (page 19) and Unconsolidated Deposits (page 27) should be incorporated into the Regional Geology section or into a new section that specifically discusses the geology of the TBWQC area.

   Attachment I, Geologic Map of the TBWQC Area should be revised to more fully describe the important portions of the areas alluvial geology. According to the Geologic Map of California, Fresno and Bakersfield Sheets (complied by Matthew and Burnett 1965, and Smith 1964) the areas Quaternary age sediments consist of Qal (alluvium), Qf (fan deposits), Qb (basin deposits), and Qt (Quaternary nonmarine terrace deposits) and Qp (Pleistocene nonmarine deposits). The Qp deposits are mapped as Tulare Formation in the area of Porterville/Tule River, and Tulare/Kern River Formations in portions of Deer Creek and White River. These formations form important components of the aquifer system beneath the Coalition area.

D. The groundwater discussion in Section IV.B of the GAR should provide a clear and detailed description of the unconfined, semi-confined, and confined groundwater systems, where they exist within the TBWQC area, and the interactions between these systems (see: A Conjunctive Use Model for the Tule Groundwater Sub-Basin Area in the Southern-Eastern San Joaquin Valley, California by Ruud, N., Harter, T., and Naugle, A., 2002). This section should also include further discussion regarding the difference in the depths of well completion that exists across the Coalition's area (completed both above and below the Corcoran Clay) and how the various depths of completion may affect groundwater quality (e.g.: wells that are completed in different aquifers [shallow unconfined, deeper semi-confined and deep confined aquifers] have different sediment/groundwater chemistries; various depths of wells produce different ages of groundwater; and that groundwater intercepted by the wells represents both distinct and diffuse recharge areas).

   Section IV.B should also include a discussion/acknowledgement that well bores may provide potential preferential pathways for vertical migration between aquifers and how this may reflect on groundwater chemistry. As stated by a variety of USGS investigators (Lofgren and Klausing 1969, Williamson et al. 1987, Bertoldi et al. 1991, Burow et al. 2012), the high density of wells constructed with long perforated sections or multiple well screens provides vertical hydraulic connections within the aquifer system. The presence of tens of thousands of irrigation wells perforated at various levels (Harou and Lund 2008) has lead USGS investigators and modelers to the concept of a single heterogeneous aquifer within the Central Valley with varying vertical leakage and confinement. This concept/discussion should be carried forward into the Groundwater Recharge discussion in Section IV.C of the GAR.

E. The groundwater quality discussion in Section V of the GAR identifies the multiple sources of groundwater data used by the Coalition to evaluate water quality within the TBWQC area; however, it does not provide the actual data set or identify a method for reproducing the data set used for GAR evaluations. Access to this data set is necessary for Central Valley Water Board staff review of the GAR and to determine if all the readily available data were evaluated. Based on the review of the reference section of the GAR, it appears that a large number of relevant documents (some of which contain groundwater data that does not appear to have been included in the GAR data set) were not evaluated as part of the GAR (see Attachment B, Additional References to this memorandum).

   The GAR states in part *"...no information was available on the specific well from which the sample was taken. It was assumed that each water sample was drawn relatively from the same aquifer system"*. Although this information may not be available for many of the wells in the GAR data set, a combination of well locations, depths, screened intervals and groundwater chemistry for portions of the Coalition's area is available in literature (Fogelman 1982; Burton and Belitz 2008; Beard et al. 1994; Hilton et al. 1963; Croft and Gordon1968; Fujii and Swain 1995; Burton et al. 2012).

Evaluating groundwater quality data without knowing the depth within the aquifer from which the sample was obtained provides an incomplete picture for purposes of assigning vulnerability. While some portion (likely a large portion) of the wells may not have construction information available, where such information is available it should be utilized in the evaluation of water quality data (e.g., well construction details should be compared to the depth to groundwater maps contained in the GAR and the historical maps presented on the California Department of Water Resources website to determine potential differences between shallow and deeper groundwater quality).

Well construction in relation to the depth of first encountered groundwater is particularly important as it has been established by a variety of USGS investigators and academics that nitrate concentrations decline with depth below first encountered groundwater (Burow et al. 1998; Burow et al. 2012; Fuhrer et al. 1999, Rupert 1999). Therefore, areas for which only deep groundwater quality data are available cannot be assumed to be low vulnerability based solely on this data. Additional efforts need be made to obtain shallow groundwater quality data to comply with the requirements of the General Order (MRP Section IV. A. 2). A discussion should be developed regarding differences in shallow groundwater concentrations of constituents of concern (COC's) and deeper groundwater chemistry obtained from the same region. Any such discussion should be tied to an evaluation of the apparent age of the groundwater sampled by the USGS GAMA Wells, the depth to groundwater in these wells, and how this reflects on data interpretation.

F. The data gaps and assumptions discussion in Section V of the GAR states that

> "*Where not specified, nitrate concentrations were assumed to be in milligrams per liter. Units were assumed similar among data sets. Depth of each sample, well construction, and screened intervals were unknown for each well from which the water quality result was sampled. Quality control of sampling procedures was unknown. Analytical methods were unknown. Data sets were sorted for duplicate wells with the same parameters of latitude, longitude, result, and date. Well locations were defined by latitude and longitude, not well name. Concentrations of 0.0 were assumed as non-detects below the method detection limit.*"

The Coalition should make every effort to validate data prior to conducting any assessment of groundwater quality trends and/or vulnerability. Well depths, screened intervals, water levels, and quality assurance/quality control data are available for the majority of the USGS GAMA data sets used by the Coalition's consultant in the preparation of the GAR. Data that cannot be validated should be identified and vulnerability designations should reflect the inexact nature of these data.

Item 2. Establish Priorities for Implementation

The General Order (Section VIII.D.1) requires that the GAR establish priorities for implementation of groundwater studies within high vulnerability areas. While the GAR provides a discussion of the process for prioritization of high vulnerability areas, it does not provide the required prioritization of the Coalition's high vulnerability areas. Additionally, the proposed prioritization process does not appear to comply with the requirements of the General Order.

A. The discussion regarding the prioritization of high vulnerability areas in section VII of the GAR appears to be confusing the General Order's requirement to propose prioritization within high vulnerability areas with the General Orders requirement for the development of groundwater quality management plans (GQMP).

   A GQMP must be prepared for all high vulnerability areas identified by the GAR, regardless of the prioritization for the implementation of groundwater studies within the high vulnerability areas. The General Order does allow the Coalition to prepare a prioritization list for the order in which the Coalition would develop GQMP's (see Section I of Appendix MRP-1 of the General Order); however, this is not the high vulnerability area prioritization component required by Section VIII.D.1 of the General Order. This section of the GAR should be revised to specifically identify how the Coalition will prioritize the implementation of groundwater studies within high vulnerability areas.

B. Discussion in Section VII.A of the GAR states in part that *"As trends in Nitrate and Salts are developed, the areas with increasing trends around these communities will become the highest priority."* This statement suggests that prioritization will be partially based on results of the trend monitoring program that will be established by the Coalition following the approval of the GAR. Monitoring and Reporting Program (Section IV.E) requires the Coalition to consider the conditions identified in the GAR related to vulnerability prioritization when developing its trend monitoring network. As stated above, revisions to the GAR are needed to directly prioritize the implementation of groundwater studies within high vulnerability areas.

Item 3. Basis for Establishing Monitoring Work Plans Developed to Assess Groundwater Quality Trends

The General Order (Section VIII.D.1) requires that the GAR provide the basis for establishing workplans to assess groundwater quality trends. To address this requirement the GAR included information regarding the commodities grown in the TBWQC area, a process for prioritization (see Item 2 above), and information regarding the areas of groundwater recharge, groundwater contour maps and the locations of disadvantaged communities (see Item 8 below).

The GAR included an evaluation and statistical assessment of historical nitrate and electrical conductivity trends. Several issues including data quality concerns, the appropriateness of the selected statistical method, the execution of the calculations, and the function of the analysis as it relates to the GAR were identified during the review and are summarized below. The GAR should be revised to address these issues or propose an alternative method for the evaluation of the historical data.

A. As discussed in Item 1.E and Item 1.F above, based on the unknown nature of the data set and the assumptions made (e.g. all samples being drawn from the same aquifer system, reporting units in mg/l when not specifically identified), the data set does not appear to be of sufficient quality to support the statistical analysis performed. The Coalition should conduct a data quality assessment to determine if the data set is of the right type, quality, and quantity to support the intended use.

B. Appendix D of the GAR includes a table listing the annual mean for nitrate concentrations from samples collected within the TBWQCs area for the period of 1945 to 2015 (excluding means for: 1949, 1954, 1955, 1965, 1975, 1977, 1983, and 2015). The annual nitrate means were calculated from 13,361 total data points and ranged from .8 mg/l to 154 mg/l. However, the GAR does not provide information regarding the number of samples (n value) used to calculate each annual mean or identify if an individual well is sampled multiple times in a single year. The GAR does not include a discussion or graphical representation of the distribution of the data used to calculate the annual means. This information is needed for the review of the annual averages. Similarly, this same information is also needed for the review of the annual electrical conductivity (EC) means.

C. The historical average nitrate concentration time series included in Section V.B of the GAR does not coincide with the data presented in Appendix D of the GAR (see Attachment C to this memorandum).

D. The GAR included upper confidence level (UCL) calculations for the annual mean of nitrate and EC; however, no rationale was provided regarding the purpose for performing this statistical analysis or discussion on how the UCL results would be utilized in the GAR conclusions and recommendations. Additional discussion is needed to justify the use of the UCL, provide an interpretation of the results, and address the concerns related to the methodology listed below.

- The GAR states in part that annual mean concentrations "were used for trend analysis to reduce the number of data points and smooth out outliers in the dataset". It is unclear if this censorship of the data is appropriate since the raw data was not provided. The GAR should be revised to include the uncensored data set and provide further discussion regarding the appropriateness of data censorship as it relates to analyses performed.
- It appears that a normal distribution was assumed when calculating the UCL, even though the normality tests ran (Shapiro Wilk and Lilliefors) on the annual mean concentrations indicated that the data set was not normally distributed. Justification for this assumption is needed.
- Appendix D of the GAR includes outlier analysis (Rosner's outlier test) for the annual mean concentrations. This outlier test is labeled as *"Outlier Test for Selected*

Uncensored Variables". As indicated above, the data set used for these statistical analyses is a censored data set and it is unclear what is meant by selected uncensored variables. Further explanation is needed or this section should be revised to clearly indicate that the data set has been censored. Additionally, statistical outliers should not be removed from a data set until a specific cause for the abnormal measurements has been determined.

- The GAR does not indicate what method was used for evaluating non-detect data and it does not appear that the data set includes sufficient information regarding method detection and quantitation limits to use the tools available in ProUCL to deal with non-detect data. Further explanation of how non-detect data was managed is needed.

Item 4. Basis for Establishing Management Practices Evaluation Program (MPEP) Work Plans.

Section VII.C and D of the GAR states that the TBWQC has elected to participate in the group option for developing the Management Practice Evaluation Work Plan required under the General Order. The GAR also specifies that, *"The basis for evaluation of Groundwater Quality Management Practices will be focused on those areas within the high vulnerability areas that have a trend in degradation of Nitrate and/or Salts based upon three (3) consecutive years of data from the wells identified within the approved Groundwater Trend Monitoring Work Plan."*

The stated basis for MPEP work plans is too narrow and does not fully comply with the requirements of the Order. Specifically, Section VIII.D.2 of the General Order states, *"The overall goal of the Management Practice Evaluation Program (MPEP) is to determine the effects, if any, irrigated agricultural practices have on first encountered groundwater under different conditions that could affect the discharge of waste from irrigated lands to groundwater (e.g., soil type, depth to groundwater, aquifer and unsaturated zone physical characteristics, irrigation practice, crop type, nutrient management practice)."* As the emphasis of the MPEP is specifically related to shallow first encountered groundwater, the GAR needs to identify geographically where these data are available and evaluate these data for evidence of discharges of waste from irrigated lands. Areas and/or crop types where shallow groundwater quality appears to have been adversely impacted by agricultural operations will be subject to MPEP work plan development either solely by the Coalition, or as a coordinated group effort.

While some shallow groundwater data were reviewed and included in the Coalition's GAR and attachments, these data were not specifically identified and included in the GAR or MPEP discussions. Revisions to the GAR are necessary to identify where first encountered groundwater data are available, whether the analytical data from these areas show evidence of discharges from irrigated lands, and how the Coalition intends to incorporate this information into the development of the MPEP.

Item 6. Land Use and Management Practices Information.

Section IV.A.2 of the Monitoring and Reporting Program requires that the GAR include detailed land use information for the Coalition's area and identify the largest acreage commodity types (including the most prevalent commodities comprising up to at least 80% of the Coalitions irrigated agricultural acreage). The information provided in Section III of the GAR related to agricultural land use largely consists of regional (Tulare Lake Hydrologic Region [TLHR]) information and is not specific to the Coalition's area (the TBWQC comprises approximately 9% of the TLHR). Data obtained from DWR (2007) were used to produce a land use map for the Coalition's area that is discussed in the GAR and included as Attachment G. Land use was not provided for the Coalition's Supplemental Area as the data was reportedly sparse and unavailable.

The GAR should be revised to include the acreage of each of the crops identified as top commodities comprising up to at least 80% of the irrigated agricultural acreage within the Coalition's area. In addition, there is a significant difference in the crop acreage between Table 3 and Table 10 of the GAR. The GAR needs to be revised to either reconcile this difference or provide an explanation for why this difference exists.

Recent GIS based land use data (2014) are available from the USDA Cropland Data Layer (also called CropScape). This data source provides data coverage for the entirety of the Coalition area including the Supplemental Area. Staff recommends that the Coalition review and use CropScape in the Groundwater Quality Trend Monitoring Work Plan, as well as other future work plans.

Item 8. Groundwater Recharge

Section IV.A.2 of the Monitoring and Reporting Program requires that the GAR include information regarding groundwater recharge within the Coalition area, including the identification of areas contributing recharge to urban and rural communities where groundwater serves as a significant source of supply. Although Section IV.C of the GAR did include some information on groundwater recharge, review of this material has identified issues (detailed below) and additional information is needed. The GAR should be revised to address these issues and provide the necessary additional information.

A. The GAR should provide specific information regarding how groundwater recharge is related to the depth to groundwater maps, the recharge basin map, or the groundwater elevation map. This evaluation is an important step in identifying the areas that contribute recharge to urban and rural communities within the Coalition's area where groundwater serves as a significant source of supply. For example, the disadvantaged community of Pixley is situated over a north-south trending groundwater ridge produced by groundwater depressions positioned to the east and west of town. Recharge to Pixley groundwater wells is likely from both north and south of town. Another example can be observed at the disadvantaged community of Terra Bella. The portion of Deer Creek east of Road 256 likely provides a significant portion of recharge to the groundwater wells in Terra Bella.

B. The recharge basin map (Attachment J of the GAR) should be revised to include all recharge basins within the Coalition's area. Specifically, the map is missing Hare Pit, Lapdula Pit, County Pit, State Pit, Herchy Pit, Dennis Pit, Faure Pit, Baird Pit, Huddelston Pit, Gin Pit, School Pit, Creighton Ranch, Terry Pit, Hewett Pit, Keith Pit, Toledo Pit, and the Turnipseed Water Bank operated by the Delano-Earlimart Irrigation District. Information regarding some of these recharge basins can be found in the Lower Tule Irrigation District Prop. 2018 Engineer's Report prepared by Provost and Pritchard Consulting Group in July 2010.

C. The GAR attributes a portion of the groundwater recharge to direct seepage from irrigation canals and ditches. Information such as estimates of the seepage loss through unlined canals may be found in the local irrigation districts water management plans and should be included in the GAR. Additionally, the GAR should be revised to clearly identify the location of these recharge sources.

D. The GAR should include expanded discussion of the significance of irrigation on groundwater recharge. As discussed in *A Conjunctive Use Model for the Tule Groundwater Sub-Basin Area in the Southern-Eastern San Joaquin Valley, California* by Ruud, N., Harter, T., and Naugle, A., 2002, diffuse recharge from surface applied water can be a significant source of aquifer recharge.

Item 9. Soil Survey Information

Section II.E of the GAR provides a discussion of soil properties and qualities that are important in the design and management of irrigation systems but does not include all the required elements necessary to meet the General Order requirements. Specifically, the GAR does not discuss the soil properties that affect the potential for groundwater impacts from irrigated agriculture. These soil properties include, but are not limited to, soil hydraulic conductivity, presence or absence of a hardpan, and soil drainage class. In addition, the GAR does not discuss areas of high salinity, alkalinity and acidity within the Coalition's area. Section II.E of the GAR should be revised to include discussion to address these issues.

Item 10. Shallow Groundwater Constituent Concentrations from Existing Monitoring Networks

The GAR does not identify any shallow groundwater quality data or any information regarding existing groundwater monitoring networks (see discussion of Item 4. above). It does however identify some constituents of concern (COCs) that agricultural operations could mobilize resulting in degradation of groundwater quality (Table 9 of the GAR). Review of Table 9 shows that only one pesticide (Simazine) was identified as a COC for groundwater. Review of readily available data on pesticides in groundwater (Zhang et al. 1997, Kent et al. 2014) identified that in addition to Simazine, Atrazine, Bromacil , Cyanazine, Deethyl-atrazine (DEA), Deisopropyl-atrazine (DIA), Diaminochlorotriazine (DACT), Diuron, EPTC (S-Ethyl depropylthio-carbamate), Hexazinone, Metolachlor , Norflurazon, and 1,2-dibromo-3-chloropropane (DBCP) have been detected in Tulare County groundwater. Additional discussion and evaluation regarding the occurrence/detections of pesticides in groundwater beneath agricultural areas within the Coalition's boundaries needs to be added to the GAR.

Item 11. Information on Existing Groundwater Data Collection and Analysis Efforts

The groundwater data compilation and review must include all readily accessible information relevant to the Order on existing monitoring well networks, individual well details, and monitored parameters. For existing monitoring networks (or portions thereof) and/or relevant data sets, the third-party should assess the possibility of data sharing between the data-collecting entity, the third-party, and the Central Valley Water Board.

The GAR should be revised to provide information and discussion regarding monitoring networks used to obtain the data or the data set evaluated by the GAR. Furthermore, the GAR should include individual monitoring well construction details, identify the COCs monitored, the QA/QC methods used to validate the data, and specify which data set corresponds to specific or general geographical areas within the Coalition's boundaries (e.g., data distributed across the entire area or only a portion of the area) (see Items 1.D, 1.E, 1.F and 3.A. above).

The GAR does not assess the possibility of data sharing between the data-collecting entity, the Coalition, and the Central Valley Water Board. Given that the data sets that were identified and assessed by the GAR are primarily public agencies (e.g., GAMA, DWR) some amount of data sharing should be feasible, and therefore explored by the Coalition.

Item 12. Existing Water Quality Impacts and Vulnerable Conditions
Section IV.A.3 of the Monitoring and Reporting Program requires that the GAR identify known groundwater quality impacts for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities. Review of the GAR has identified the following concerns regarding existing groundwater quality impacts and data/information not included. The GAR should be revised to address these concerns.

A. Additional, readily available water quality data exist that have not been evaluated by the GAR (see Attachment B). These data need to be reviewed and the GAR updated to reflect the results of the new information. Additionally, Tulare County staff (Mr. Mike Hickey) was contacted by Central Valley Water Board staff regarding available nitrate groundwater data. Mr. Hickey provided a groundwater quality data base that he had complied from Tulare County records and additional data obtained from a variety of other sources. This data set shows regions of nitrate exceedances in the Springville, South Porterville, Poplar, and Strathmore areas that do not appear on the GAR's Attachment N (Nitrate Concentrations in Wells From 1945-2014). The Coalition should obtain the Tulare County database for review and inclusion into the GAR.

B. The GAR provided data on soil type, depth to groundwater, crop types, irrigation methods and a portion of COCs detected by groundwater monitoring; however, it did not provide an evaluation of those data with respect to potential impacts from irrigated agricultural operations. The GAR should provide an assessment of these variables as they relate to irrigated agricultures potential to impact groundwater quality.

   For example, the relationship between management practices, soil characteristics, and groundwater quality impacts were evaluated by Braun and Hawkins (1991). This study assessed rainfall runoff in a citrus-growing region of Tulare County, California. The study identified that a portion of the area growers were disposing of excess surface water runoff into dry wells in regions that have a shallow hard-pan soil layer. Relatively high concentrations of diuron in runoff water entering dry wells were found, ranging up to 890 micrograms per Liter (µg/L). Braun and Hawkins (1991) concluded that *"the data provide strong evidence that the widespread regional presence of diuron in ground water is at least partially attributable to contaminated runoff water entering dry wells."*

C. The introduction to Section V of the GAR states "*The principal focus of groundwater quality, to determine the vulnerability lands from irrigated agriculture operations, was on the constituents of Nitrate (NO_3) and Salts measured as Electrical Conductivity (EC).*" The Order requires that the GAR address all constituents of concern associated with agriculture. At a minimum, the HVAs also should be evaluated for areas with pesticide detections.

D. Any areas that are hydrogeologically susceptible to groundwater contamination need to be included in the HVAs, regardless of current land use or existing water quality data (e.g., areas within city limits or areas not currently having irrigated agricultural operations). Groundwater vulnerability is a measure of how easy or how hard it is for a contaminant or pollutant to reach groundwater. Natural factors (e.g., soil structure, depth to groundwater, precipitation) may make an area susceptible to groundwater impact; however, without the presence of a contaminant, even the most susceptible area is not at risk of groundwater degradation or pollution.

   Native pasture lands or areas within cities that are zoned agricultural may be situated in areas susceptible to groundwater impacts and therefore may be potentially vulnerable. These areas may at any time become irrigated agricultural properties subject to the General Order. Similarly, agricultural operations currently regulated under different Waste Discharge Requirements (e.g., dairies or food processors with croplands irrigated with wastewater), may convert to irrigated agricultural croplands subject to the General Order (e.g., leased dairy cropland may not be renewed or the dairy may go out of business and its lands converted to irrigated croplands). In order to allow new or changing agricultural operations to know at the time of their inception that they are located within a high vulnerability area subject to potential management practice restrictions, the Coalition's GAR needs to evaluate vulnerability across all areas within the Coalition's boundaries.

E. Any readily available nitrite in the data sets utilized by the GAR should be evaluated relative to the nitrite MCL (1 mg/l).

Item 13. Feasibility of Incorporating Existing Groundwater Data and Their Corresponding Monitoring Well Systems.
This information was not provided and needs to be added to the GAR; see the discussion of Item 11 above.

Item 14. Ranking of High Vulnerability Areas
This information was not provided; see the discussion of Item 2. above.

Item 15. Describe pertinent geologic and hydrogeologic information for the third-party area(s) and utilize GIS mapping applications

The discussions of regional geology and hydrogeology would be more useful with additional clarification/discussion and reorganization (see Items 1.C. and 1.D. above).

Item 16. Groundwater Vulnerability Designations

The Order requires that the GAR designate high/low vulnerability areas for groundwater where known groundwater quality impacts exist for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities. The vulnerability designations are to be made using a combination of physical properties (soil type, depth to groundwater, known agricultural impacts to beneficial uses, etc.) and management practices (e.g., irrigation method, crop type, nitrogen application and removal rates, extent of implementation, etc.). The third-party must provide the rationale for proposed vulnerability determinations. Review of the vulnerability analysis in Section VI of the GAR has identified the following concerns which need to be addressed:

A. The vulnerability designation proposed in the GAR were determined through the application of a two-dimensional vulnerability model that utilized four elements. These elements included the boundary of irrigated parcels; the boundary of surface and subsurface geologic deposits based on type of lithology as provided on the Geologic Map of the TBWQC Area (Attachment I of the GAR); the boundary of relative permeability of deposits at different depths based on particle sizes of gravel, sand, silt, and clay; and the boundary of groundwater wells with nitrate and EC levels above the regulatory threshold. Issues with this approach include the following:

  - The hydrogeologic conditions used in the GAR's two-dimensional vulnerability model consist solely of the relative permeability of the geologic units. However, the GAR does not describe how the sole use of the relative permeability of area soils layers (Attachment R.1.through R.4.) is correlated to groundwater vulnerability (GAR utilizes permeability to assign vulnerability to various depths below the ground surface [GAR Attachment S]). Permeability is only one of many factors that control vertical leaching through the unsaturated zone. Factors such as hydraulic conductivity, porosity, presence or absence of preferential pathways, amounts and timing of irrigation events, rainfall, crop type, and thickness of the vadose zone affect vertical movement in the unsaturated zone. Hydraulic gradients, groundwater pumping, aquifer material, and multiple screened intervals or the absence of proper seals affect vertical flow within the aquifer.

  - As discussed under item 12.D. above, any area that is hydrogeologically susceptible to groundwater contamination needs to be evaluated by the GAR and included in the final vulnerability designations, regardless of their current land use. This approach allows for new or changing agricultural operations to know at the time of their inception that they are within a high vulnerability area subject to potential management practice restrictions.

- The discussion of the Geologic Map layer of the vulnerability model (Attachment I) includes the following statement,

> "The contact between the alluvial boundary and the crystalline Sierran bedrock is the location for the relative change in permeability along the east boundary of the TBWQC. The alluvial boundary was overlaid onto the geologic map and marks the east boundary of vulnerable area on the map."

While Water Board staff agree that the contact between the alluvial boundary and the crystalline Sierran bedrock is the location for the relative change in permeability, it does not denote the eastern edge of groundwater vulnerability. Nitrate concentrations that exceed 45 mg/L are depicted as occurring in the granitic rock south of Springville on Attachment N (Nitrate Concentrations in Wells from 1945-2014) approximately four to five miles east of this boundary.

With regards to the western boundary, the GAR states,

> "The easternmost extent of the E-Clay marks the vertical western boundary on the geologic map. The E-Clay is assumed to be relatively impermeable, continuous, and any wells drilled through it to be properly sealed with minimal to no vertical mixing of groundwater above and below the layer. Based on these assumptions, the E-Clay is treated as a subsurface barrier to vertical flow. The vulnerability boundary on the geologic map covers 240,649-acres within the TBWQC boundary."

As previously discussed (Items 1.D and 1.E above) the assumptions made regarding well seals, and the Corcoran Clay (E-Clay) is not supported by the available data. Wells within the Coalition's boundaries are completed at widely varying depths below first encountered groundwater, have long and short screen lengths, single and multiple screened intervals, and are completed into the unconfined and semiconfined aquifers as well as beneath the Corcoran Clay. The high density of wells constructed with long perforated sections or multiple well screens provides vertical hydraulic connections within the aquifer system. The presence of tens of thousands of irrigation wells perforated at various levels (Harou and Lund, 2008) has lead USGS investigators and modelers to the concept of a single heterogeneous aquifer within the Central Valley with varying vertical leakage and confinement.

- Comparison of the GAR's Attachment R.4 (Relative Permeability 100 to 200 feet, Depth Below Ground Surface) with Attachments K (2013 Spring Depth to Groundwater Map) and N (Nitrate Concentrations in Wells 1945-2014), shows that nitrate concentrations greater than 45 mg/L have occurred at a variety of locations within the Coalitions boundaries at depths greater than 250 feet (4 miles west of Tipton, northeast of Ducor, and north of Alpaugh) and up to 350 feet near Richgrove. Similarly, regions exist outside of the area(s) designated as having permeability from 100-200 feet below ground surface where nitrate concentrations exceed 45 mg/L within this depth interval (e.g., area between Poplar and Tipton, area north of Porterville).

- The use of well nitrate and EC values only at their respective maximum contaminant levels does not provide an appropriate boundary for the vulnerability model. Areas that are at or above 50% of the MCL and with increasing trends in groundwater are not identified using this method. At a minimum, the high vulnerability areas need to include all areas where EC and Nitrate concentrations in groundwater are at 50% of the regulatory threshold (MCL) or higher and have a trend indicating a statistically significant increasing concentration. Additionally, comparison of Attachments N and O show that not all of the groundwater wells depicted have values for both nitrate and/or EC values and that there are large areas within the Coalitions boundaries that have had no wells identified (e.g., the area south of Poplar). These areas should be evaluated based on hydrogeologic characteristics (soil texture, depth to groundwater, etc.), if available, for high vulnerability area determinations. Additionally, the method used for ranking the boundary layers is not described in the GAR.

B. Two groundwater vulnerability maps are included in the Coalition's GAR, a composite high vulnerability area map (Attachment S of the GAR) and a TBWQC high vulnerability area map (Attachment T of the GAR). Review/comparison of the two maps identified the following issues:

- Only a portion of the high vulnerability area (irrigated acres) identified on the composite map was included on the TBWQC map. Instead, the TBWQC map renames a portion of these areas as Member Parcels Outside of the High Vulnerability Area. No discussion or rationale was provided for this decision (see discussion of Item 16.A above).

- Member Parcels inside the High Vulnerability Area are depicted as red in color on the TBWQC map. However, a number of red parcels are located outside of the high vulnerability area boundary depicted as a blue dashed line on this map (e.g., red parcels to the west and northwest of Terra Bella).

- Some of the areas that have nitrate concentrations above the nitrate MCL value are not included on the TBWQC map (e.g., wells around Springville or the area north of Porterville and north of W. Baker Ave.).

- The high vulnerability area boundary (blue dashed line) bisects Member parcels. This results in part of a Members land being high vulnerability and part low vulnerability (e.g., eastern and southern edges of the boundary). No rationale or discussion is provided in the GAR to justify this decision.

- Not all of the readily available groundwater data was evaluated for the preparation of these high vulnerability area maps (see Item 1.E.).

Item 18. Additional Concerns Regarding GAR Material Not Specifically Required by the General Order

Section VIII of the GAR includes information regarding the anticipated elements the Coalition will employ in the development of the Trend Groundwater Monitoring Program. Review of this section has identified concerns with the proposed elements/processes to be used for trend monitoring development that will need to be addressed in the Coalition's Trend Groundwater Monitoring Workplan.

A. The discussion of existing groundwater monitoring programs (pages 43-44 of the GAR) provides information on entities that conduct groundwater elevation monitoring within the Coalition's area. Data from these existing programs are proposed to be incorporated into the development of the Trend Monitoring Work Plan, and when possible, the Coalition proposes to include those existing wells as candidates of the TBWQC area groundwater monitoring network.

   The existing groundwater monitoring programs identified by the GAR are: Bureau of Reclamation- Friant Division; Deer Creek and Tule River Authority Groundwater Management Plan; and the California Statewide Groundwater Elevation Monitoring (CASGEM). Information regarding the types of wells (e.g., domestic wells, irrigation wells, or monitoring wells), used for groundwater elevation monitoring is not discussed in the GAR. It is unlikely that well construction details are known and/or available for the wells utilized by these programs (see discussion of Item 1.E above). Additionally, the Summary and Recommendations section of the GAR states that the groundwater monitoring well network will include the monitoring of existing wells, primarily domestic wells, within the TBWQC Boundary. It should be recognized that domestic wells are unlikely to be utilized by the existing groundwater monitoring programs cited by the GAR.

   Section IV.C of the Monitoring and Reporting Program requires that the Coalition develop a trend groundwater monitoring network that will be implemented over both high and low vulnerability areas within the Coalition's boundary and employ shallow wells (but not necessarily wells completed in the uppermost zone of first encountered groundwater). This requirement will need to be considered during the preparation of the Trend Groundwater Monitoring Workplan.

B. The Coalition's proposed methodology for establishing the Trend Groundwater Monitoring network is described as follows.

   Within the High Vulnerability Area, identify four (4) wells per Township, one (1) well in each quadrant; within the Low Vulnerability Area, identify two (2) wells per Township, one (1) well in each half of the Township. Based upon the High Vulnerability Area identified within the GAR, the total estimated number of existing wells planned to be included in the groundwater monitoring network is 72 wells.

No information or discussion is provided in the GAR regarding the basis for the number of trend wells proposed. Justification for this approach will need to be provided as part of the Trend Groundwater Monitoring Workplan.

Table 1. Components of the Groundwater Assessment Report

Item No.	Required Component	Location in GAR
GAR Objectives – MRP section IV.A.1		
1	Provide an assessment of all readily available, applicable and relevant data and information to determine the high and low vulnerability areas where discharges from irrigated lands may result in groundwater quality degradation.	Partial Sections V, VI Throughout
2	Establish priorities for implementation of monitoring and studies within high vulnerability or data gap areas.	Section VII
3	Provide a basis for establishing Monitoring Workplans developed to assess groundwater quality trends.	Partial Sections: VI.; VII.; and VIII.
4	Provide a basis for establishing Management Practices Evaluation Program (MPEP) Workplans and priorities developed to evaluate the effectiveness of agricultural management practices to protect groundwater quality.	Partial Throughout
5	Provide a basis for establishing groundwater quality management plans in high vulnerability areas and priorities for implementation of those plans.	Throughout
Required GAR Components – MRP section IV.A.2		
6	Detailed land use information with emphasis on land uses associated with irrigated agricultural operations. The information shall identify the largest acreage commodity types in the third-party area, including the most prevalent commodities comprising up to at least 80% of the irrigated agricultural acreage in the third-party area. If the third-party manages the area through sub-watershed groups, the GAR information should be developed for each sub-watershed.	Partial Section III. Attachment C, Attachment H
7	Information regarding depth to groundwater, provided as a contour map(s), if readily available. Tabulated and/or graphical data from discrete sampling events may be submitted if limited data precludes producing a contour map.	Section IV, E. Attachments: K,L,M
8	Groundwater recharge information, if readily available, including identification of areas contributing recharge to urban and rural communities where groundwater serves as a significant source of supply.	Partial Section IV, C. Attachment J
9	Soil survey information, including significant areas of high salinity, alkalinity and acidity.	Partial Section II. E. Attachments D, E
10	Shallow groundwater constituent concentrations from existing monitoring networks (potential constituents of concern include any material applied as part of the agricultural operation, including constituents in irrigation supply water [e.g., pesticides, fertilizers, soil amendments, etc.] that could impact beneficial uses or cause degradation).	Partial Section VI Attachment P
11	Information on existing groundwater data collection and analysis efforts relevant to this Order (e.g., Department of Pesticide Regulation [DPR], United States Geological Survey [USGS], State Water Board Groundwater Ambient Monitoring and Assessment [GAMA], California Department of Public Health, local groundwater management plans, etc.). This groundwater data compilation and review shall include all readily accessible information relevant to the Order on existing monitoring well networks, individual well details, and monitored parameters. For existing monitoring networks (or portions thereof) and/or relevant data sets, the	Partial Sections V, VI

	third-party should assess the possibility of data sharing between the data-collecting entity, the third-party, and the Central Valley Water Board.	
GAR Data Review and Analysis – MRP section IV.A.3		
12	Determine where known groundwater quality impacts exist for which irrigated agricultural operations are a potential contributor or where conditions make groundwater more vulnerable to impacts from irrigated agricultural activities.	Partial Section V., A.
13	Determine the merit and feasibility of incorporating existing groundwater data collection efforts, and their corresponding monitoring well systems for obtaining appropriate groundwater quality information to achieve the objectives of and support groundwater monitoring activities under this Order. This shall include specific findings and conclusions and provide the rationale for conclusions.	Not included
14	Prepare a ranking of high vulnerability areas to provide a basis for prioritization of work plan activities.	Not included
15	Describe pertinent geologic and hydrogeologic information for the third-party area(s) and utilize GIS mapping applications, graphics, and tables, as appropriate, in order to clearly convey pertinent data, support data analysis, and show results.	Partial Throughout
Groundwater Vulnerability Designations – MRP section IV.A.4		
16	The GAR shall designate high/low vulnerability areas for groundwater in consideration of high and low vulnerability definitions provided in Attachment E of the Order. The vulnerability designations will be made using a combination of physical properties (soil type, depth to groundwater, known agricultural impacts to beneficial uses, etc.) and management practices (e.g., irrigation method, crop type, nitrogen application and removal rates, extent of implementation, etc.). The third-party shall provide the rationale for proposed vulnerability determinations.	Partial Section VI Attachments S, T
Other		
17	Section 7835 of the California Geologist and Geophysicist Act states that "All geologic plans, specifications, reports, or documents shall be prepared by a professional geologist or registered certified specialty geologist, or by a subordinate employee under his or her direction. In addition, they shall be signed by the professional geologist or registered certified specialty geologist or stamped with his or her seal, either of which shall indicate his or her responsibility for them."	Included Cover Sheet
Additional Concerns		
18	Section VIII. Groundwater Quality Trend Monitoring Work plan Development	Not Required in the GAR

Attachment A
Missing Information and Errata

- Page ii paragraph four states, "To prepare a final high vulnerability area within the TBWQC boundary, groundwater vulnerability elements including irrigated lands, location of surface and subsurface geologic deposits, relative permeability of surface and subsurface deposits, and existing groundwater wells with nitrate and EC in exceedance of maximum contaminant levels." *This statement appears to be incomplete (e.g., were reviewed or evaluated appears to be needed at the end of the sentence).*

- Page 3- The Physical setting section *does not discuss the supplemental area.*

- Page 4 – The TBWQC watersheds section *does not discuss the Friant-Kern Canal and its role in supplementing irrigation water into the river systems and irrigation districts canals, and providing storm water for intentional groundwater recharge.*

- Page 19, first full paragraph contains the statement, "Loosely consolidated Miocene to Pleistocene deposits exposed in the western portion of the TBWQC area include sandstone, shale, and gravel." *Review of the Geologic Map of California, Fresno and Bakersfield Sheets did not identify any Miocene aged sedimentary deposits that crop out within the western portion of the TBWQC area.*

- Page 19, second full paragraph, second to last sentence says, "The second group are mostly non-waterbearing marine sedimentary rocks that generally contain saline water." *This sentence is contradictory; if the deposits are non-water-bearing, how can they contain saline water?*

- Page 20, second paragraph, "Within the second group are semiconsolidated to consolidated mostly non-waterbearing Cretaceous and Tertiary marine sedimentary rocks. They generally containing saline water that underlie the freshwater-bearing deposits. The water body underlying the freshwater aquifers throughout the valley is of no importance as a source of fresh groundwater. It contains connate water of poor quality except in a few places in the outcrop areas where the connate water probably has been flushed out and replaced with meteoric water." *This paragraph is confusing and consideration should be given to rewording or reworking the discussion.*

- Page 20, fourth paragraph, "The hydrogeologic groundwater conditions beneath the TBWQC area consist of no-flow on[portions] of the northern, southern, and eastern boundaries, and a general-head on the western boundary (Harter et. al., 2001). *It is unclear what this statement is attempting to convey. Attachment M (Groundwater Elevation Map) depicts groundwater flow in a variety of directions in response to areas of recharge and groundwater pumping.*

- Consideration should be given to revising the eastern portion of Figure 6 (Generalized Geologic Cross Section - TBWQA). *The area of Lake Success and the Town of Springville are shown as being underlain by 800+ feet of unconsolidated sediments.*

- Page 21, The discussion of groundwater recharge (Section C) states in the first paragraph, "Prior to development within the Central Valley, the aquifer system was under steady-state conditions in which natural recharge balanced natural discharge. By the middle of the 20th century, development had lowered and altered the groundwater flow patterns throughout the Central Valley (in addition to the Tule Subbasin). Over the years, the hydraulic head in the lower confined portion of the aquifer system has declined below the water table and the vertical hydraulic gradient has reversed. Much of the water that used to flow to discharge areas such as rivers now flows vertically downward through unconfined, semiconfined, and confining beds (USGS, 1995). Groundwater discharge now occurs mainly by evapotranspiration and discharge to streams where groundwater levels are near land surface."*It is unclear how a flow pattern can be lowered or how the hydraulic head in the lower* *confined portion of the aquifer system can decline below the water table; nevertheless thought should be given to revising and refocusing this discussion. The topic is groundwater recharge within the Coalitions boundary. How is recharge related to Attachments J-M? Likewise, the third paragraph on page 22 appears to be a series of disconnected sentences.*

- Page 25, second paragraph states, "In general, the groundwater elevation contours trend similar to the depth to groundwater contours for the Tule River. Groundwater contours diverge beneath the Tule River, indicating the Tule River is a losing stream. Groundwater elevation contours generally do not diverge beneath Deer Creek in the southwest TBWQC area, most likely a result of relatively small volumes of water normally flowing through these streams." *The conclusion that groundwater elevation contours for 2014 are not indicative of Deer Creek being a losing stream needs to be substantiated with additional discussion/data. There appears to be little if any difference between the shapes of the lines of equal groundwater elevation for the Tule River versus Deer Creek where data are available (e.g., data are not presented for the southwestern portion of the Tule River, consequently no direct comparison can be made for this area). It should also be noted that the shape of the lines of equal groundwater elevation in the vicinity of the western portion of Deer Creek are being affected by groundwater depressions due to groundwater withdrawals in the area to the north, south and west of the creek. Additionally, it should be noted that both Deer Creek and the Tule River are routinely used to convey Friant-Kern Canal waters during normal precipitation years and that seepage losses have been reported for Deer Creek (Ruud, et al., 2003; Pixley Irrigation District Resolution No. 2012 – 9 – 1).*

- Page 26, first paragraph states, "The groundwater gradient and direction of flow are generally westward across the TBWQC area with four localized depressions near Richgrove, Poplar-Cotton Center, Alpaugh, and west of Tipton. Flowlines converging to these four depressions indicate they are areas of increased groundwater pumping assuming homogenous and isotropic conditions. However, actual geologic conditions are heterogeneous and anisotropic and therefore the resulting depressions may be a combination of many factors, some of which could be water well pumping centers, geologic structural and/or stratigraphic conditions, and soil texture." *Are there any known structural or stratigraphic conditions within these localized regions that are different from the surrounding areas? No structure was discussed in the Geology section, and the stratigraphy presented is one of successive alluvial fan deposits that cannot be distinguished from each other based upon lithology. Changes in groundwater elevations of greater than 100 feet over a relatively short distance (approximately 4 to 6 miles) is most likely the result of pumping.*

- Page 27 Section G, first paragraph states, "The alluvial deposits generally increase in permeability from east to west across the TBWQC area. The soil mantle overlying the dissected uplands and crystalline bedrock along the east side of the area are relatively thin and immature. These deposits generally have low groundwater yield with relative low permeability to no permeability." *This paragraph needs additional clarification. The first sentence is a discussion alluvial deposits; the second sentence discusses a soil mantle; and third sentence is simply these deposits. Thus, the GAR is stating that the soil mantle which is presumably either residual soils or alluvial deposits have low permeability to no permeability. Is this correct? What is the relationship between the permeability of the soil mantle and the alluvial deposits in reference to the first sentence? Additionally, the conclusion that permeability generally increases from east to west is not substantiated or qualified. Is this surface soil permeability (Attachment R.1) or a general statement for Attachments R.1 through R.4 (surface to a depth of 200 feet below ground)? If it is the surface permeability, then the GAR should discuss the NRCS soil survey (Attachment D) and the associated soil permeability's provided in the series descriptions.*

- The discussion of unconsolidated deposits on page 27 provides specific thicknesses for geologic units. *What is the reference for this data?*

- Page 29, the purpose for Table 8 and the associated paragraph on hydraulic conductivity is not discussed in the GAR. *Since hydraulic conductivity is not one of the layers used by the GAR to model* *vulnerability, and hydraulic conductivity is not discussed in relation to permeability (one of the modeled layers), why is it included? The GAR should discuss the relationship between Table 7 (relative permeability) and Table 8 (vertical and horizontal hydraulic conductivities).*

- Page 31, fourth parahraph states,"The datasets used to create the nitrate concentration maps were prepared and plotted on a chart showing the historical trend of nitrate in groundwater. First, the dataset was sorted by year and then the average nitrate value was calculated for each year. Yearly averages were used for the trend analysis to reduce the number of data points and smooth out any outliers in the dataset. The maximum value was 154-mg/L, the minimum value was 0.8-mg/L, the mean value was 30.36-mg/L, and the standard deviation was 22.85-mg/L." *This paragraph raises a number of concerns regarding data manipulation used for the statistical analysis of nitrate. These issues include:*
  - *The practice of calculating the yearly averaged nitrate values to smooth out any outliers and then using this averaged value for statistical testing for outliers is not appropriate.*
  - *The use of yearly averages of nitrate data instead of using the full nitrate data set appears to negate the ProUCL software requirement for general statistics calculations (analysis title states "General Statistics for Uncensored Dataset).*
  - *The use of the Goodness-of-fit Test Statistics for Uncensored Full Data Set Without Non-Detects does not appear to be appropriate both for censored data and for the nitrate data that was deemed non-detect.*

- Page 31, fifth paragraph states, "Of the 63 data points used for the yearly averages, 51 of the data points, or 81% of the data, were less than 45-mg/L." *Consideration should be given to further breaking down this statistic. Only 19% of the yearly averages exceeded 45 mg/l nitrate; however, as stated on the following page (GAR page 32), 25% of the total data set exceeded the nitrate MCL value. How many of the total data set wells exceeded one half of the nitrate MCL value? How many of these wells had a sufficient number of samples to conduct trend analysis?*

- Page 32 contains a quote attributed to (EPA, 1992; EPA 2002a). *These documents are not referenced in the GAR's References section.*

- The discussion of electrical conductivity trends presented at the top of page 33 states, "The datasets used to evaluate EC were prepared and plotted below on FIGURE 10: HISTORICAL AVERAGE ANNUAL EC VALUES (µmhos/cm) showing the historical trend of EC in groundwater from 1950 through 2014. EC values in the immediate area of Alpaugh were extremely high (>50,000-µmhos/cm) with respect to the rest of the TBWQC area. Data values greater than 5000 µmhos/cm were not used in the statistical analysis. The datasets were sorted by year and the average nitrate value was calculated for each year. The yearly average was used for the trend analysis to reduce the number of data points and smooth any outliers in the data set. The maximum value used was 1,604-µmhos/cm, the minimum value was 271- µmhos/cm. The mean value was 561-µmhos/cm and the standard deviation was 221.8-µmhos/cm." *Similar to the problems identified with the statistical analysis for nitrate, a variety of concerns exist with the approach described for evaluation of electrical conductivity (EC). These concerns include:*
  - *Why was the Alpaugh data not included in the evaluation of the data set for potential outliers? The decision not to include this data resulted in the highest numeric value for the censored data set being 1,604 µmhos/cm. This value was subsequently deemed to be an outlier by the Rosner's outlier test.*
  - *Not using the full EC data set appears to negate the requirements for the general statistics calculations (analysis title states "General Statistics for Uncensored Dataset).*
  - *Similarly, the use of the Goodness-of-fit Test Statistics for Uncensored Full Data Set Without Non-Detects does not appear to be appropriate.*

- Table 9: Additional Water Quality Constituents provides data for constituents listed on Table 5 of the General Order. *Question regarding Table 9 include:*

    - *Why was such a wide range in sampling dates used (e,g., 2005 to 2011 for DO but 1950 to 2014 for TDS)?*
    - *Were any of the values that were over the trigger limits in wells that did not exceed the nitrate MCL value or the secondary MCL value for EC?*
    - *What is the areal distribution of the trigger limit exceedances (i.e., provide a map or figure of the exceedances). Why was simazine the only pesticide included on the table? Section IV.A.2 of the Monitoring and Reporting Program requires that the GAR provide "Shallow groundwater constituent concentrations (potential constituents of concern include any material applied as part of the agricultural operation, including constituents in irrigation supply water [e.g., pesticides, fertilizers, soil amendments, etc.] that could impact beneficial uses or cause degradation.)"*

- The fourth sentence on the top of page 37 states, "There is no description of permeability for the dissected uplands and mountain soils." *Permeability data does exist for these areas. See: Tulare County GIS Information used by 4Creeks for the Deer Creek & Tule River Authority Groundwater Management Plan Update. Also see, Croft & Gordon, 1968, Open File Report 68-67.*

- The top of page 38 contains the statement, Using the Nitrate Concentration Map, **ATTACHMENT N: NITRATE CONCENTRATIONS IN WELLS FROM 1945-2014**, a boundary was drawn around those areas where nitrates exceeded the MCL of 45-mg/l. *Why were only MCL exceedances used for the layer? What about those areas where nitrate concentrations are just below the MCL or areas with increasing trends of nitrate in groundwater?*

- Section VI.C.5 of the GAR provides an evaluation of EC exceedances across the Coalition area. *The section does not however, provide any information regarding potential sources for the high EC areas. If such information is known, it should be added to the GAR.*

- Section VII.B of the GAR states in part that the commodities identified in Table 10 of the GAR will be a focus of high priority in determining the effectiveness of management practices as part of the Management Practice Evaluation Plan. *The commodities presented on Table 10 appear to be broad categories that are insufficient for the purposes of conducting management practice evaluation (e.g., deciduous fruits and nuts). Management practices for peaches are not the same as management practices for walnuts (e.g., pests and pesticide spray timing).*

- *The following concerns are related to the GAR's attachments:*

    - *The PDF version of the Coalitions GAR does not provide the level of detail contained in the printed GAR (e.g., well designations on Attachments N and M of the PDF are not the same as those on the printed document).*
    - *The scale used for the majority of the Attachments (1 inch = 4 miles) is actually closer to one inch equals approximately 3.24 miles.*
    - *Attachment E – The colors used to distinguish between the very limited irrigation rating and the not rated designation are too close in hue to allow easy differentiation between the categories.*
    - *Attachment I – The pattern used for the Boundary of Alluvium and Corcoran Clay needs to be changed to distinguish between these two geologic units (e.g., same pattern is shown on both the east side of the valley [alluvium/rock boundary] and the western area [the eastern extent of the Corcoran Clay within the alluvium]).*
    - *Attachment J – This attachment does not identify all of the areas recharge basins (see Item 8. B.)*
    - *Attachment R.2. - The colors used to differentiate between the old alluvial-fan soils and the basin soils are too close in hue to allow easy differentiation between the categories (the diagonal pattern for the old alluvial-fan soils is not readily distinguishable).*
    - *Attachments R.3. and R.4. have incorrect references (both indicate Plate 3 of USGS Water-Supply Paper 1618; actually Plates 4 & 5 respectively).*

Attachment B
Additional References

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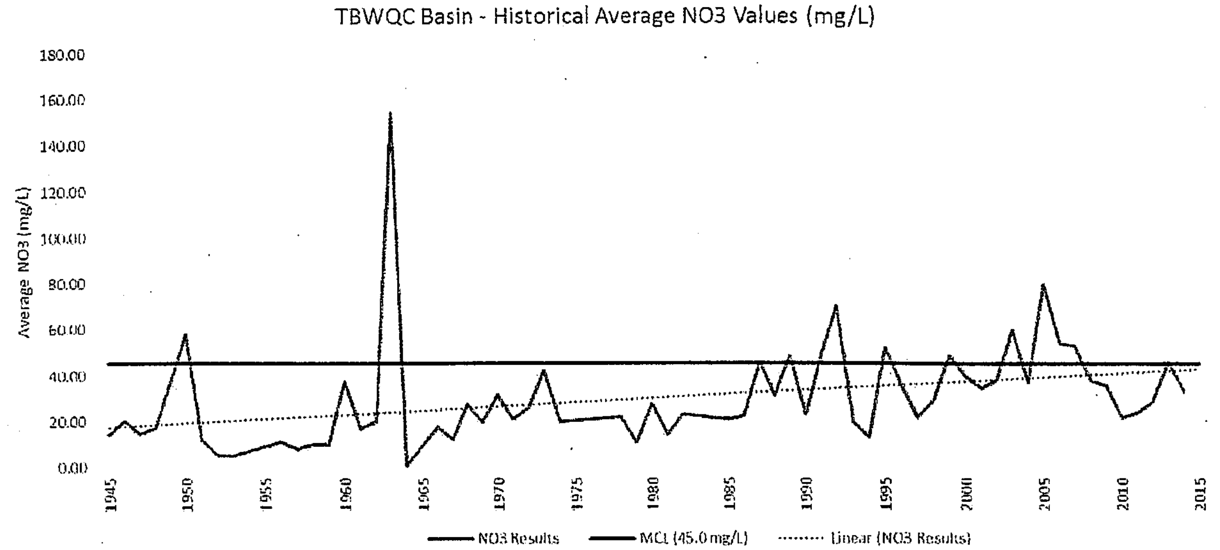
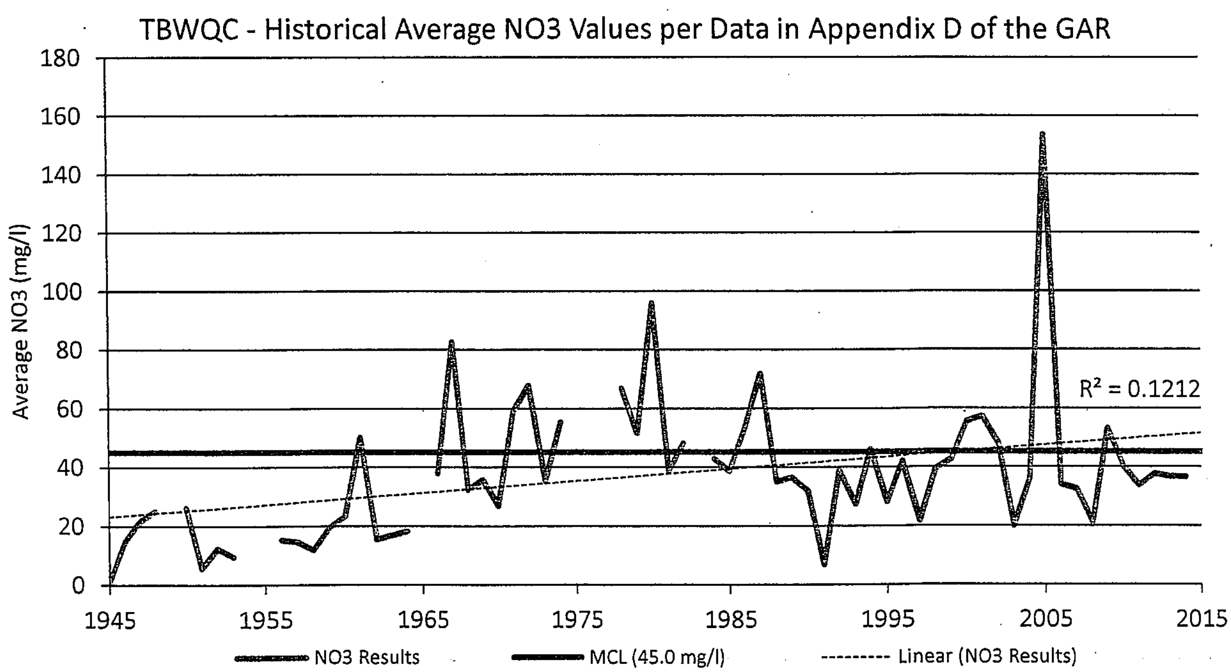
Attachment C
Comparison of GAR Times Series and GAR Appendix D Data

FIGURE 9: HISTORICAL AVERAGE ANNUAL NITRATE CONCENTRATION (mg/L)



Time series from Section V.B of the Tule Basin Water Quality Coalitions (TBWQC) groundwater quality assessment report (GAR).



Time series prepared by staff using data set from Appendix D of the GAR.