Appendix E

Executive Administrator's Comments on Draft Report

ATTACHMENT 1

TEXAS WATER DEVELOPMENT BOARD
Review of the Draft Final Report: Contract No. 2001-483-379
" Draft Groundwater Availability of the Southern Ogallala Aquifer in Texas and New Mexico Numerical Simulations Through 2050"

DRAFT REPORT TECHNICAL / ADMINISTRATIVE COMMENTS:

DRAFT REPORT – TABLE OF CONTENTS

1. No comments

DRAFT REPORT – REPORT TITLE

1. Report title should read " Groundwater Availability Model of the Southern Ogallala Aquifer in Texas and New Mexico: Numerical Simulations Through 2050".

   Edit made.

DRAFT REPORT – ABSTRACT

1. The second sentence should read "…and it updates other **availability** models," instead of available models.

   Edit made.

DRAFT REPORT – INTRODUCTION

1. No comments

DRAFT REPORT – STUDY AREA

1. Page 5: Please mention evaporation and include a map of evaporation (see RFP Attachment 1, page 4/40).

   Evaporation map is now included (Figure 10) and report has been amended.

2. Page 5: Please include a map of the physiographic provinces (see RFP Attachment 1, page 4/40).

   Physiographic map is now included, (Figure 4).

3. Figure 3: Please mention source of population data.

   Edit made on Figure 3.

4. Figure 6: Please mention source of soils data.

   Edit made on Figure 7.

5. Figure 7: Please mention source of precipitation data.

   Edit made on Figure 8.

6. Figure 7: Please indicate units for precipitation data.

   Units already on figure.

7. Physiography and Climate section: Please include a map and discussion of average net lake evaporation.

   Map (Figure 10) and discussion provided.

8. Physiography and Climate section: Please include a discussion of evapotranspiration.

   Discussion of evapotranspiration provided in Discharge section.

9. Figure 9: Please mention source of geologic data. Although included in the legend, there does not appear to be 'Paleogene sedimentary rocks' or 'Neogene sedimentary rocks' on the map. Unclear how the terminology on the figure relates to the stratigraphic column or the text. Please provide a clearer geologic map that relates to the text and stratigraphic column.

   The figure and text have been amended.

10. Figure 9: Please indicate units for thickness data.

    Edit made; units are feet.

11. Figure 15: "Olgallala" should be Ogallala

    Edit made.

12. Figure 16: This figure doesn't print well in black and white and Ogallala is spelled wrong.

    Edits made.

DRAFT REPORT – PREVIOUS WORK

1. Page 22, last paragraph of "SB1 Regional Water Planning Model," line 3: "that" should be "than"

   Edit made.

DRAFT REPORT – HYDROGEOLOGIC SETTING

1. Figure 17: Please add the Ruppel (1983) and Howard and Williams (1972) references to the reference list at the end of the report.

   References added.

2. Page 25, 4th paragraph: 'Osterkamp and other, 1987' versus 'Osterkamp and Wood (1987)' in the reference list. Please verify reference.

   Sources verified. Osterkamp and Wood is correct reference.

3. Page 25, 5th bulleted item: Please include Gutentag (1981) in the reference list at the end of the report.

   Reference added.

4. Page 25, Structure: Is the structure in Figure 18 and discussed in the section the bottom of the Ogallala Formation or the Ogallala aquifer (= High Plains aquifer)?

   Bottom of Ogallala aquifer, which is equivalent to the High plains aquifer.

5. Figure 19: Unclear what 'DBS&A hydrograph available' means. There do not appear to be any solid dots on the figure.

   DBS&A Hydrograph wells notation removed on Figure 21.

6. Water Levels and Regional Groundwater Flow: Please include maps of aquifer (saturated) thickness for the three potentiometric surfaces.

   Not required in scope of work.

7. River, Streams, Springs, and Lakes: Please include plots of representative stream-flow gages and a map of gage locations, if any.

   Added Figures 34 and 35 and associated write up.

8. Hydraulic Conductivity: Please include a discussion of vertical variations of hydraulic conductivity.

   Added requested write up.

9. Hydraulic Conductivity: Please include a discussion of horizontal anisotropy.

   Added requested write up.

10. Discharge: Please include a discussion of discharge to streams/lakes.

    Added requested write up.

11. Pages 42-43: Please discuss whether rejected recharge is considered in the model. (see RFP Attachment 1, page 7/40).

    Added requested write up.

12. Page 48: Discuss large-scale anisotropy of horizontal hydraulic conductivity caused by distribution shown in Figure 33. (see RFP Attachment 1, page 8/40)

    Added requested write up.

13. Page 51: Include at least a couple of spring flow hydrographs (see RFP Attachment 1, page 26/40, xviii).

    Insufficient information for plotting spring flow hydrographs. Flow information documented in Table 2.

DRAFT REPORT – CONCEPTUAL MODEL OF GROUNDWATER FLOW

1. The conceptual model diagrams (Figures 40a & b) indicate that the Upper Dockum Group "red beds" form the base of the Ogallala aquifer. Previous investigators and models on the Southern High Plains (SHP) have recognized that water-bearing strata in hydraulic continuity with the Ogallala Formation should be considered part of the High Plains aquifer. However, it is unclear from the text and figures in the report whether or not the entire Cretaceous subcrop has been included as part of the High Plains aquifer in the

GAM (i.e., if model cells in the area underlain by Cretaceous have been extended to the base of the Cretaceous). If the entire Cretaceous subcrop is included and values of hydraulic conductivity for initial input to the model were calculated as a weighted average of hydraulic conductivity of both the Ogallala Formation and the Cretaceous section (as described on page 49), the hydraulic conductivity values of the dynamic section of the aquifer (i.e., the Ogallala section) will be significantly modified. Since sensitivity analyses indicate that the model is most sensitive to hydraulic conductivity (along with recharge), it is imperative that conductivity values accurately represents the conductivity of the aquifer. (external comment)

Text has been amended to clarify this issue. Only a portion of the Cretaceous subcrop (as interpreted in previous studies) is included in the model.

DRAFT REPORT – MODEL DESIGN

1. Page 68, Model Design, Layers and Grid: Please mention the projection parameters and the grid origin coordinates.

   Provided in Figure 45.

2. Page 69, Model Parameters, 6th paragraph: Please clarify that although pumping was reduced in low transmissivity cells, 100% of pumping volume was preserved.

   Clarification added.

DRAFT REPORT – MODELING APPROACH

1. Page 73: Discuss how this model will match up with Ogallala North model (Dutton et al., 2000). (see RFP Attachment 1, page 13/40).

   Discussion added.

2. Include a map of the grid. Consider doing what the BEG did: show 10 cell by 10 cellblocks. Then show one 10 x 10 block magnified with all of the cells in it. This way readers can see the orientation and extent of the grid. This will also allow you to explain that you extended the grid to the east so that the Dockum aquifer could be added at a later date.

   Two new figures were added to illustrate the model grid (figs. 45 and 46). Discussion added.

DRAFT REPORT – STEADY-STATE MODEL

1. Figures 44 and 57: Show locations of observation wells. (see RFP Attachment 1, page 26/40, xxviii) Locations of observed water levels are plotted in Figure 21 and Figure 23.

   Locations of observation wells are plotted on Figures 21 and 23, and a note to that effect is included on the figures. There are too many data points in some locations to plot them on the cited figures - the water level contours would be too obscured.

2. Pages 80 and 96: Please include detailed tables of the water budget for the calibration and predictive simulations listing (1) recharge, (2) natural discharge (3) cross-formational flow, (4) well discharge, (5) changes in storage etc. The tables should include budgets for steady state, 1980, 1990, 2000, 2010, 2020, 2030, 2040, and 2050. (see RFP Attachment 1, pages 15/40 and 17/40).

   Requested water budgets have been added as tables in the report.

3. Page 80: Please include a table or figure depicting results of hydraulic head sensitivity analysis.

   Table 4 added.

4. Page 77: Please also report the Mean Absolute Error.

   Mean absolute error reported.

5. Page 83, Figure 50a: Y-axis label should be flux at springs (not average difference in simulated head).

   Figure corrected.

6. Water Budget, page 80: Please include a detailed water budget for the steady-state model.

   Water budget table included.

7. Figure 50: It appears that the Y-axis of the top plot is incorrectly identified.

   Figure corrected.

8. Figure 50: The variations in the lines for drain conductance and recharge of the bottom plot appear unusual. These plots generally do not show reversals of slope. Please check that the data represented in the plot is correct.

   Calculations were checked and figure was redone - there was an error in the draft report figure.

DRAFT REPORT – TRANSIENT MODEL

1. Please include a detailed water budget for:
   - steady-state
   - beginning of calibration period
   - the drought of the calibration period
   - end of the calibration period
   - end of the verification period
   - end of 2000, 2010, 2020,2030,2040, and 2050.

   Requested water budgets have been added as tables in the report

3. Page 84: Please give RMS for fitting hydrographs (see RFP Attachment 1, page 15/40).

   RMS for hydrographs is provided and documented.

4. Page 100: Please include a figure depicting hydrograph sensitivity to specific yield (see RFP Attachment 1, page 16/40).

   Figure 68 added.

5. Page 94, Figure 58: Legend label for 100 – 150 ft is mislabeled as 10 – 150 ft.

   Legend corrected.

6. Page 96, 1st paragraph: Please change '138.651 ac-ft' to '138,651 ac-ft.'

   Edit made.

7. Page 91, first paragraph: Verb "are" has been omitted from second sentence. Should read "…statistics for 1980 **are** similar to those for …"

   Edit made.

8. Page 93, first paragraph, last sentence: Please leave out second occurrence of "are."

   Edit made.

9. According to the report under the Transient Model component, 80 wells were used for model verification; specifically Gaines County well #2624307 has a simulated hydrograph value which some 50 feet below the observed hydrograph level. Why is there is such a large difference between these values? Does this not in fact show that these values, at least in Gaines County's case, are off? (external comment).

   Calibration results are documented and discussed in the report, and were discussed during several SAF meetings.

10. Additionally, again under the Transient Model component, 80 wells were used for model calibration, which is represented as figures Gaines 1, 2, 3, and 4 in appendix D. The average of these wells has a simulated hydrograph value some 55 feet below the observed hydrograph level. Again, as you can see these values are substantially different from what are observed. At what point are these observed values being used in this model and how can it be considered accurate if the figures are consistently off by some 50 feet particularly if we have a saturated thickness of say 150 feet? (external comment)

    Calibration results are documented and discussed in the report, and were discussed during several SAF meetings.

11. The difference in simulated vs. observed heads on numerous model runs was frequently 25 to 50 feet (occasionally up to 100 feet). It is unclear why model input parameters were not adjusted to improve model correlation to actual conditions. (external comment)

    Calibration results are documented and discussed in the report, and were discussed during several SAF meetings. Close matches between observed and simulated water levels can not be obtained in all areas unless detailed adjustments to model input parameters are made, for which there is no basis other than matching water levels. The TWDB does not want to develop "over-calibrated" models.

12. It is unclear why model input parameters were not adjusted to reduce the number of model cells that went dry. Comparison of actual data to Year 2000 simulations confirms that the numerous cells that are drying (as well as flooding) do not represent actual aquifer conditions. (external comment)

    This issue is discussed in the report in the Transient Calibration section.

13. Why does the model show rising water levels in Dawson County? Recently, monitor wells have indicated declining water levels. (external comment).

    Water levels have been rising away outside of irrigated areas, and declining within or near irrigated areas. The model replicates these general trends.

14. Monitor wells 27-07-901 and 28-26-206 in the northern and southern portions of the Dawson County, respectively, would make better observation wells for model calibration than the the two that were selected. (external comment)

    These two wells were added as observation wells and are included in Appendix D.

15. A model that will give the amount of water in storage based on the change in water levels from year to year would be helpful. Will this model do that? (external comment)

    Yes, on a regional basis and over the long term. For county by county annual calculations, other methods or tools may be more appropriate.

DRAFT REPORT – PREDICTIONS

1. Page 102: Were monthly stress periods used for final 10 years of each scenario? (See RFP Attachment 1, page 17/40).

    Yes, and the text has been amended.

1. Pages 102 and C-3: Please say more about the source of predictive pumping data (see RFP page 17/40 "using RWPG water demand projections under average and drought-of –record conditions").

    Text has been amended.

2. Predictions: Please provide discussion on the effects of water-level declines/rises on environmental resource.

    Additional section has been added.

DRAFT REPORT – LIMITATIONS OF THE MODEL

1. Page 134, second paragraph, last sentence: Please add the word "to" before phrase "be average values…"

    Edit made.

DRAFT REPORT – RECOMMENDED FUTURE IMPROVEMENTS

1. No comments

DRAFT REPORT – SUMMARY AND CONCLUSIONS

1. No comments

DRAFT REPORT – ACKNOWLEDGMENTS

1. No comments

DRAFT REPORT – REFERENCES

1. No comments

DRAFT REPORT – APPENDICES – PART A

1. Time lag for irrigation return flow (Appendix A) utilized calculations based on soil types; however, soil types are appropriate only for soils and paleosols and are not representative of the majority of the sediment profile on the southern high plains.

    The word "soil" has been replaced with "sediment".

DRAFT REPORT – APPENDICES – PART B

1. No comments

DRAFT REPORT – APPENDICES – PART C

1. No comments

DRAFT REPORT – APPENDICES – PART D

1. No comments

The following figures are not readable when photocopied in black and white (see RFP Attachment 1 page 25/40, "figures shall be designed such that a black and white photocopy is readable"):

Figure 3
Figure 4
Figure 5
Figure 6
Figure 11
Figure 12
Figure 22
Figure 34
Figure 41
Figure 46
Figure 47
Figure 48
Figure 58
Figure 59
Figure 60
Figures 63, 64, 65, 66, 67
Figures 68, 69, 70, 71
Figures 72, 73, 74, 75, 76, 77, 78, 79, 80
Figures 81, 82, 83, 84, 85, 86, 87, 88, 89, 90,91, 92, 93, 94, 95

Each of these figures were recreated and black and white copy tested to ensure their readability when reprinted.

DRAFT REPORT – REVIEW OF SOURCE DATA

OGLL_s GAM Review – Part B: Project Data

Did we get all of the data files we requested? NO
Is the data organized in the way we requested? NO

Introduction:

It is imperative that enough source data to completely rebuild the groundwater model from scratch and reproduce all report figures and tables (should it be necessary) be received. In other words, if a new model grid resolution and/or orientation is needed, there should be sufficient data to create a new model for the study area. Moreover, there should be enough data to regenerate any or all of the intermediate derivative data with updated information. This source and intermediate derivative data should be organized under the SRCDATA folder/directory according to the guidelines set forth in Attachments 1 & 2 of the RFP. An empty directory tree structure was provided to facilitate the organization of the project data. The empty directory tree structure is available for download in zip format at http://www.twdb.state.tx.us/gam/resources/gam_tree.zip.

It is also required that all final model parameter and variable/stress data be delivered in a database format that can easily be referenced to each and every model grid cell. In other words, there should be enough cell-referenced data to regenerate all or update any individual cell value of the required MODFLOW or PMWIN input files. The file format of these databases may be in Excel 97, Access 97, or in an ESRI GIS format compatible with ArcView 3.2 or ArcInfo 7.21. Each sheet, table, or coverage should be attributed with the appropriate model grid cell-reference information as set forth in Attachments 1 & 2 of the RFP. These data sets should be organized under the GRDDATA folder directory and with in the appropriate sub-folders/directories. The GRDDATA OUTPUT folder and its sub-folders/directories may be omitted or left empty.

Finally, the actual MODFLOW 96 and PMWIN 5.0 formatted files for both INPUT and OUTPUT must be organized as set forth in Attachments 1 & 2 of the RFP. Separate folders/directories must be used for 1) the calibrated steady-state model files; 2) the calibrated transient model files; 3) the verification transient model files; 4) and each of the decadal transient predictive model simulation run files.

All required data, model inputs and outputs, and GIS files have been provided as requested. Some specific comments are provided below, but each item is not addressed individually.

Review Summary:

The data provided by the OGLL_s contractor is mostly incomplete but somewhat unorganized. Many of the geographic features in the draft report are not included in the data CDs such as roads, cities, counties, streams, reservoirs, playas, target calibration wells, regional geologic structures, Cretaceous extent, surficial geology, soil types, topography, population density, groundwater conservation districts, lines of geologic cross-section(s), landuse (original), various water-use pumping maps, ibounds, specific yield, recharge maps, top of aquifer, thickness of Ogallala sediments, thickness of Cretaceous sediments, etc. More information on source and derivative data used to estimate recharge and return flows is needed.

The contractor must follow the requirements as set forth in Attachments 1 & 2 of the RFP. It is therefore required that the contractor resubmit the project data after reading and understanding Attachments 1 & 2 of the RFP. Furthermore, all GIS data appears to be correct NAD83 Datum but listed as NAD27 datum within the metadata. Finally, all Access databases may be in wrong version since reviewer was unable to open any of them in Access 97. All Access databases must be in Access 97 format.

DRIVE:\OGLL_s\grddata\input\hydraul
The shape coverage is not referenced to row, column, and/or cell_id. This coverage belongs under srcdata folder. The metadata file is incomplete and requires Data_Abstract, Attributes, Attribute_Descriptions, and Attributes_Domain.

Metadata file was expanded and the files were moved to the OGLL_s/scrdata/subhyd folder.

Model Cells folder contains accurate information for this area.
DRIVE:\OGLL_s\grddata\input\ibnd
NO DATA FOUND – model cell referenced ibound data should go here.
DRIVE:\OGLL_s\grddata\input\stress\ststate\drns
NO DATA FOUND – model cell referenced drain package parameters should go here.
DRIVE:\OGLL_s\grddata\input\stress\ststate\evt
NO DATA FOUND – model cell referenced ET package parameters should go here.
DRIVE:\OGLL_s\grddata\input\stress\ststate\rech
NO DATA FOUND – model cell referenced recharge package parameters should go here.
DRIVE:\OGLL_s\grddata\input\stress\ststate\res
NO DATA FOUND – model cell referenced reservoir package parameters should go here if applicable.
DRIVE:\OGLL_s\grddata\input\stress\ststate\strm
NO DATA FOUND – model cell referenced streamflow-routing package parameters should go here if applicable.
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NO DATA FOUND – model cell drain package parameters should go here.
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NO DATA FOUND – model cell referenced ET package parameters should go here.
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NO DATA FOUND – model cell referenced recharge package parameters should go here.
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DRIVE:\OGLL_s\grddata\input\struct
NO DATA FOUND – model cell referenced structure data such as tops and bottoms of each model layer should go here.
DRIVE:\OGLL_s\modflow\modfl_96\input\ststate
These files are acceptable.
DRIVE:\OGLL_s\modflow\modfl_96\input\trans
These files are acceptable.
DRIVE:\OGLL_s\modflow\pmwin_50\input\ststate
NO DATA FOUND
DRIVE:\OGLL_s\modflow\pmwin_50\input\trans
Borehole files for calibration not found. These files must be included under this folder. Remainder of files acceptable.
DRIVE:\OGLL_s\modflow\pmwin_50\refdxf
OK … contains county, model bndy, and rivers.

DRIVE:\OGLL_s\scrdata\bndy
Census 2000 data missing for New Mexico are of model. The metadata for census does not match with coverage (some fields have no values) and reference is made to landuse/landcover relation to census tract polygons in metadata but no such relation exists in coverage. Also missing population density.

Census 2000 date from New Mexico was not used as approved by the TWDB and therefore is not present as a coverage. Metadata file has been updated. The population density is included in these files and is indicated as such. The tx_censusblocks_2000.shp file has an attribute field derived by DBS&A described in the metadata. The two 1990 files have the pop_90_sqmile filed which was already present in the source data.

Model grid and study area coverages appear to be acceptable.

Need to include basin and county boundary coverages as well as roads, groundwater conservation districts, and city boundaries.

DRIVE:\OGLL_s\scrdata\clim
Contoured precipitation coverage OK but also require the source point data used to interpolate contour coverage.

DRIVE:\OGLL_s\scrdata\cnsv
The irrigated shape file is not the same as described by metadata. The metadata must be updated to fit manipulated irrigated coverage and correct coverage for metadata file should be added. Landuse coverage has also been manipulated from its original form and requires original landuse data as well as manipulated coverage provided. Grid referenced recharge information is in wrong directory.

DRIVE:\OGLL_s\scrdata\geol
Insufficient or no metadata for the point and polygon sand fraction coverages. Remainder of lithologic data acceptable.
No coverages of regional geologic structures, Cretaceous extent, surficial geology? No cross-sections used in study?

The maps of regional geological structures and surficial geology included in the report (Figures 9 and 17), the cross sections presented in Figures 11 and 12, and the Cretaceous subcrop map (Figure 13) were prepared as graphics files for the purpose of conveying required information in the report. These information were not needed as GIS coverages for the purposes of model construction or analysis.

DRIVE:\OGLL_s\scrdata\geom
NO DATA FOUND – DEMs, physiography, and any other geomorphologic data should go here

DEMs were moved to this folder and physiography was added here.

DRIVE:\OGLL_s\scrdata\geop
NO DATA FOUND – Landsat data should go here along with any other geophysical data.

Landsat data was moved to this folder.

DRIVE:\OGLL_s\scrdata\soil
The coverage has no soil attributes. Instead the coverage is an intermediate derivative coverage for recharge and has only recharge attributes without the actual soils source data. Greater detail is needed for the processing of the recharge coverage that is provided within the readme or metadata file.
No coverage of soils data?

Recharge metadata description was expanded and STATSGO data was added to this folder.

DRIVE:\OGLL_s\scrdata\subhyd
The metadata implies that several sources were used to develop the aquifer base yet only the resultant contours are provided in the coverage. The point source data must be provided as well as interpreted data for the aquifer base. Top of aquifer must be provided or referenced to another directory (ie. DEM location) No coverage of aquifer thickness or saturated thickness?

The digitized files that were used to create the aquifer base were added to a subfolder called aquifer_base_source and the metadata was updated to note this. A reference file is provided here noting that the DEM was used as the top of aquifer and that it can be found in the OGLL_s\scrdata\geom directory.

Hydraulic data is acceptable.

Water level data is acceptable but needs readme/metadata file.

Water level shapefile metadata files exist as: water_level_1990.txt, water_level_2000.txt and water_level_pre_devt.txt. The ogll_s_Waterlevels.MDB file has an associated .txt file as well.

Need source and intermediate derivative coverages used to spatially distribute pumpage data.

Need coverage of specific yield and porosity if available.

Not available. Specific yield based on hydraulic conductivity zones as used in the model.

Need point coverage of calibration target boreholes and hydrographs.
DRIVE:\OGLL_s\scrdata\surhyd
The only coverage is for springs. The metadata references associations to landuse but none was found in the attribute table. Further explanation is needed regarding how data was transformed into GAM coordinates. Missing coverage data for streams, reservoirs, and playas.
DRIVE:\OGLL_s\scrdata\tran
NO DATA FOUND – no roads or transportation features submitted in report?

DRAFT REPORT – OGALLALA SOUTH – EDITORIAL COMMENTS

Page ii: Please list Appendices in Table of Contents.

Edit made.

Page 19, Figure 15 caption: Ogallala is misspelled.

Edit made.

Page 21, Figure 16 caption: Ogallala is misspelled.

Edit made.

Page 91, 1st paragraph, last line: "….for 1980 are similar to those …." ("are" is missing).

Edit made.

Page 118, last 2 paragraphs: Suggest moving sentence "In addition …… by Amosson and others (Appendix B)" to the beginning of the next paragraph.

Not changed.

Page A-6, top of page: "preferential flow", "pre" is missing.

Edit made.

Page A-10, Figure 6 caption: The last sentence is incomplete.

Edit made.

Page B-8, Table 2: The numbers in the top two rows are not centered.

Edit made.

Page B-16, Figure 5: Nothing is plotted in this figure?

Figure corrected.

It is difficult to differentiate the color scale on some figures (for example, the blue scale for the ranges of 200 to 350 feet on Figure 58). It would be most helpful to the end users if distinct color scales would be used. (external comment)

Color figures were edited and tested for black and white photocopy readability.