Ogallala-High Plains Aquifer Protocol

A Preliminary Water Management Plan for GMD3

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Ogallala-High Plains Aquifer Management Protocol for GMD3

The 2005 state water plan asserts that Southwest Kansas Groundwater Management District No. 3 (GMD3) is responsible for determining hydrologic subunits in areas inside the district boundaries. This is in response to declines in water levels and the economic future of the water resource. The tasks described are intended to meet planning and management goals, and focus attention on refining hydrologic subunit boundaries in those areas. The subunits will be based on priority (high, medium, and low) to assist future work efforts and focus on more detailed water management strategies in higher priority areas while deferring work on the lower priority areas until a later time. A fundamental premise of this protocol is that it shall remain open to change or modification as better information is available or as changes occur in the hydrological, economical, legal or policy making process. The completion of these protocol tasks is dependent upon current and anticipated budgetary constraints determined by the GMD3 Board of Directors.

Objectives: as outlined by Ogallala Aquifer Management Advisory Committee

- Identify preliminary hydrologic subunits
    - o Identify key parameters for water resource management
    - o Identify hydrologic subunits

  Classify hydrologic subunits as high, medium, or low priority
    - o Rate of decline
    - o Time to reach selected threshold value
    - o Water Right criteria
    - o Socio-Economic Impact of declines
- Establish preliminary water management goals for high priority subunits
    - o Water Management Plans based on priority
    - o Analysis of data needed for plans
    - o Identify and develop management plan options
- Define criteria for determining success
- Define level of progress in water reduction
- Course of action if goals are not achieved
- Assistance programs for farmers to transition to dry land farming

Goals to identify, classify and manage hydrologic subunits

The planning goals are to identify hydrologic subunits for water management based on areas with relatively short time remaining to reach selected threshold water levels under present rates of withdrawal. Threshold water levels are defined as those levels where large-scale

withdrawals for irrigation would not be any lower than what is practical for that area (could vary between subunits). After identification, hydrologic subunits will be classified as high, medium, or low priority areas. The medium and low priority areas will be addressed in alternative ways or later.

After classification, management goals will be applied in high priority areas where threshold water levels are limited under the current water management. These goals will compare various water management strategies that decrease water consumption in the high priority areas.

Identification of hydrologic subunits

Hydrologic subunits should identify areas in the Ogallala-High Plains aquifer with similar hydrogeologic parameters and groundwater dynamics.

Hydrogeologic parameters are numerical and describe the hydrogeologic characteristics of an aquifer, which deal with groundwater and related geologic aspects of surface waters. Groundwater dynamics address the changes in these parameters (i.e. change in saturated thickness, change in water levels, etc.). Hydrogeologic parameters are included in the following list:

1. Water table elevation (depth to water)
2. Land Surface and Bedrock elevation
3. Aquifer storage coefficient
4. Precipitation
5. Soil type
6. Saturated Thickness
7. Withdrawal rate (projection of historic water use)
8. Aquifer discharge estimates (historic values)
9. Hydraulic Conductivity
10. Location (latitude and longitude)
11. Water Level Decline

Analytical techniques will be applied to those parameters for which adequate data is available and used to: 1) identify areas with similar parameters: and 2) adequately define planning priorities. Parameters selected for the analysis must establish a sound scientific basis for approach. Cluster analysis is one analytical technique that can be used to identify and classify areas with similar hydrogeologic parameters. The data are clustered into manageable subunits based on the eleven variables with the results represented in map form. Cluster overlaps may occur between the fringe areas and the GMD3 boundaries.

After cluster analysis, or some other computational method, has defined the subunits, a water budget computation can be applied based on spatial

distribution of similar attributes. A water budget is a technique used to describe the relative abundance of water supply in each subunit and compare the wet and dry years.

The planning criterion for identifying hydrologic subunits is to have a single value for each section (1 sq. mi.) for nine of the listed variables. This requires determining a single value from many data points for some sections. In areas where data does not exist for every section, it requires interpolation or extrapolation from adjacent areas. The legal township boundaries will not be necessarily used to define hydrologic subunits although the size (approximately 36 square miles) is expected to be the minimum size used for a subunit. To achieve the planning goal to identify hydrologic subunits it is expected that current available data will be sufficient.

Classification of hydrologic subunits

Classifying hydrologic subunits by the projected time to reach selected threshold water levels of the aquifer will be determined and quantified. Classification of high priority areas should include analysis of water right criteria, groundwater levels, water use, aquifer characteristics, well yield, aquifer discharge, and withdrawal rates. Analysis could include, for example, quantifying selected parameters in a water budget. In addition, cluster analysis could be used to further refine classification of priority areas. Definition and justification of socio-economic criteria could also be included as a secondary approach to classifying subunits. If these criteria are used then socio-economic thresholds should also be defined. For example, pumping water levels affect costs and pumping rates, which will limit the number of acres irrigated and/or crop produced.

When classifying hydrologic subunits, water rights within an area and adjacent areas should be evaluated to compare existing water rights to water supply. Then a determination can be made on the relative time remaining to reach threshold water levels. In contrast, there may be areas presently at a threshold water level where few if any water rights have a significant impact on water supply, therefore these areas should not be classified as high priority.

Density of water use and pumping rates tend to be higher within the GMD3 boundaries than in the fringe areas, due to the larger volume pumped and the greater saturated thickness. Wells inside the GMD3 boundaries may intercept groundwater flow to areas outside the GMD3 boundaries, or be dependent on groundwater flow from within the GMD3 boundaries. Determining where these interfaces occur is essential in classifying priority areas, as well as identifying management strategies that need to be coordinated between the GMD3 boundaries and the fringe area. Since the fringe areas are managed under the jurisdiction of the DWR, then GMD3

will coordinate with the DWR in developing compatible criteria for areas adjacent to the fringe areas.

Analysis of water levels can be approached from two perspectives in classifying threshold water levels; historic water level declines or historic water use rates. The historic water level declines can be projected at a continuous rate until they reach a given threshold water level. Another approach is to project historic water use rates until the volume in storage reaches a level corresponding to a given threshold water level. In both approaches the spatial variability of the aquifer characteristics (for example, storage coefficient, hydraulic conductivity, etc) are required.

Aquifer discharge is another component that can be used in classifying hydrologic subunits in the Ogallala-High Plains Aquifer region. Discharge to streams or wetlands is limited by arid climatic conditions coupled with declining water tables from aquifer withdrawal; therefore, aquifer discharge will not occur in all areas. This component of the groundwater budget typically occurs at alluvial interfaces near the fringes of the Ogallala-High Plains Aquifer formation. (Note: Inclusion of the surface elevation will address ET loss from shallow water tables). By identifying the areas where aquifer discharge occurs, an estimated base flow measurement can be taken throughout the year. Another method of estimating aquifer discharge is the application of Darcy's law. Darcy's Law requires hydraulic gradient, hydraulic conductivity, and saturated thickness for the application.

Aquifer recharge rates are variable across the Ogallala-High Plains aquifer region and include the measure of vertical and lateral movement of surface or groundwater to the aquifer system. Hydrogeologic parameters used in determining vertical movement of ground or surface water recharge rates are precipitation, soil type, and depth to water. Groundwater elevation gradients, hydraulic conductivity, and saturated thickness control lateral recharge rates. Recharge rates and withdrawal rates are often compared to determine the level of withdrawal to the amount being replenished. Areas where withdrawal rates exceed recharge will be identified and classified.

Field verification during the planning process may be required to further refine hydrologic subunits. In priority areas a more extensive data verification or, in a few instances, a targeted data collection may be necessary. However, in the water management analysis the scale of analysis would remain at 1 square mile. Current water appropriation rules for determining water availability are based on an area covered by a 2-mile circle or by township in GMD3.

Note: Coordination through with the Division of Water Resources will be necessary to ensure consistent subunit classification results throughout the Ogallala-High Plains Aquifer.

Preliminary Delineation of Aquifer Subunits in GMD3

Until better information is available the areas depicted in the map of the High Plains Aquifer as delineated in Figure 1 will be used to preliminarily classify priority ground water decline areas. This map has been adopted in the Water Conservation section of the 2005 Kansas State Water Plan (SWP). As stated in the 2005 SWP: "Figure 1 indicates the relative need for management and conservation through a priority ranking of 1-4, with 1 being the areas with a shorter estimated usable lifetime for the aquifer to support 400 gpm well yields, and having a history of higher ground water usage. Overlaying the estimated usable life of the High Plains Aquifer with the average annual reported ground water use generated the map. The estimated usable lifetime of the High Plains Aquifer is based on ground water decline trends from 1991 – 2001 and the estimated minimum saturated thickness necessary to support 400 gallons per minute pumping for 90 days (see Figure 13 in Kansas Geological Survey Open-File Report 2002-25D). The second database is the density of annual reported ground water use, average over the years 1990 – 2000, within a 5-mile radius area (see Figure 15b in Open-File Report 2002-25D). The combination of both conditions, estimated usable lifetime and the density of reported annual ground water use defined the priority zones. Areas with insufficient data and water levels for 2001 greater or equal to those in 1991 are also indicated in Figure 1." Refinements to the parameters for this analysis would be made to define subunit boundaries.

Establishing water management goals for high priority areas

In comparing water management strategies within hydrologic subunits, the threshold water level and the withdrawal rate are the variables that can be defined or controlled by water use management. A threshold water level will indicate when the annual demand on subunit water supply will change significantly, because the saturated thickness will no longer provide adequate pumping rates. Water table elevation, bedrock elevation, and hydraulic conductivity are aquifer characteristics needed to establish this threshold water level.

Withdrawal rates are a measure of the extent of development in the area and computed from water use report data available from the Kansas Department of Agriculture - Division of Water Resources (KDA - DWR) water rights information system (WRIS). By statute, water use data is collected from every authorized point of diversion that has a permit to appropriate water. The water use data can be used to identify management strategies in high priority areas, along with other data determined by GMD3 to be viable.

A list of various water use goals will be generated to establish management strategies in each high priority area. These management strategies shall

include definition of the level of progress in water use reduction, criteria for success, a course of action if goals are not achieved, and identify programs for farmers to transition to dryland.

Public meetings will be held to review the management strategies with water users in priority areas. The meetings will: 1) review analysis conducted by GMD3 and DWR; 2) receive input from the attendees on preferred strategies; and 3) determine what additional management strategies should be considered by GMD3 and DWR to achieve management goals. In addition, GMD3 will work with the Division of Water Resources (DWR), Kansas Water Office (KWO), Kansas Geological Survey (KGS), Kansas State University (KSU), other Groundwater Management Districts (GMD), and others to develop economically acceptable transition plans.

Timeline for identifying, classifying, and managing hydrologic subunits for areas inside the GMD3 Boundaries:

Planning and coordinating tasks with KGS, KWO, and key DWR personnel in identifying hydrologic subunits are targeted for completion by November 14, 2003. The tasks will interface with the state water plan and DWR objectives. Data sets compiled for this effort will be combined with KGS data sets as part of the database for the Ogallala-High Plains Aquifer management plan. Efforts on classifying hydrologic subunits will follow identification tasks (tentatively November 2004). Subsequent years will focus on establishing management strategies for implementation in high priority areas.

The following tasks are anticipated for the planning process and identification of hydrologic subunits:

- Identify and quantify key parameters for hydrologic subunits
  - Minimum rate of withdrawal
  - Trend data
  - Thresholds for sustainable management
- Review research conducted on Ogallala-High Plains Aquifer (review bibliography contents)
- Define subunits at the interfaces with DWR near the GMD3 boundaries.
- Identify areas where Ogallala-High Plains is estimated to be confined/unconfined
- Address overlap between areas inside/outside GMD3 boundaries
- Define geographic reference of management areas

Follow-up Tasks for classification of hydrologic subunits:

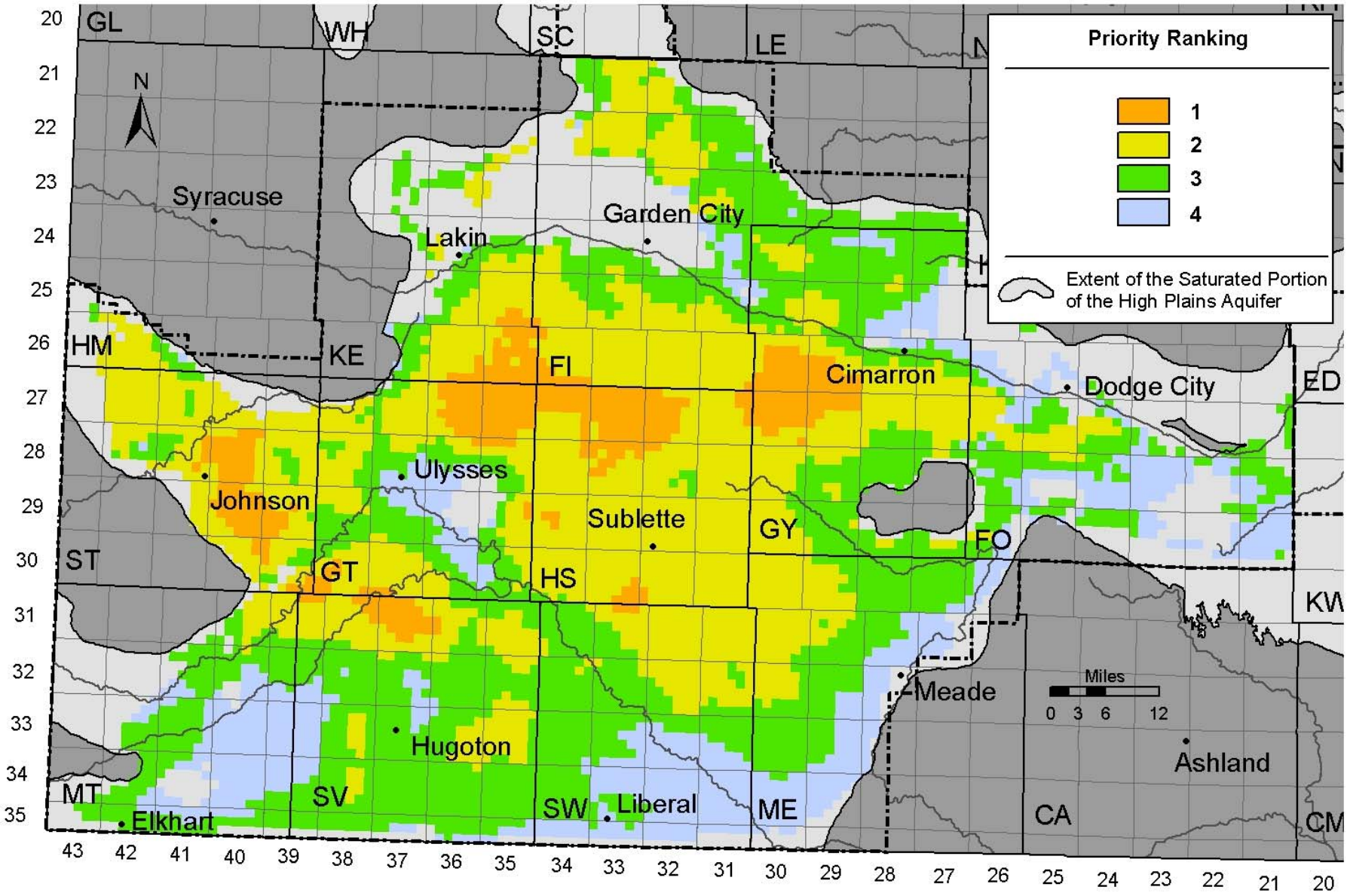
Classification and Management Strategy Tasks

- Obtain accurate point of diversion information
  - Saturated Thickness

  - Well depth
  - Depth to bedrock
- Ogallala-High Plains wells hydraulically connected to alluvium
  - Identify areas of recharge to Ogallala-High Plains
- Quantify water use by aquifer source, depth to water, type (irr, mun and vested, appropriated).
- Water Quality
- Field Verification: design and implementation of appropriate monitoring and measurement strategies.
- Water Budget
  - Establish dates to base budget
  - Identify parameters that are in agreement by all parties
- Create master database to track data compilation and analysis
  - Assist with identifying priority areas
  - Track rate of decline
  - Make information available to all parties and the general public (online)
- Establish guidelines for meetings between key personnel in DWR, KWO, KGS, KSU, GMD3, and other entities.
  - Who presents?
  - Frequency of meetings?

Figure 1

Kansas Water Plan Priority Ground Water Decline Areas
Southwest Kansas GMD #3



Note: This map is intended for planning purposes. The information presented in the map is preliminary and subject to change.