Technical Memorandum (Final Draft)

DATE: October 20, 2020

TO: Stephanie Anagnoson
Director of Water and Natural Resources, Madera County

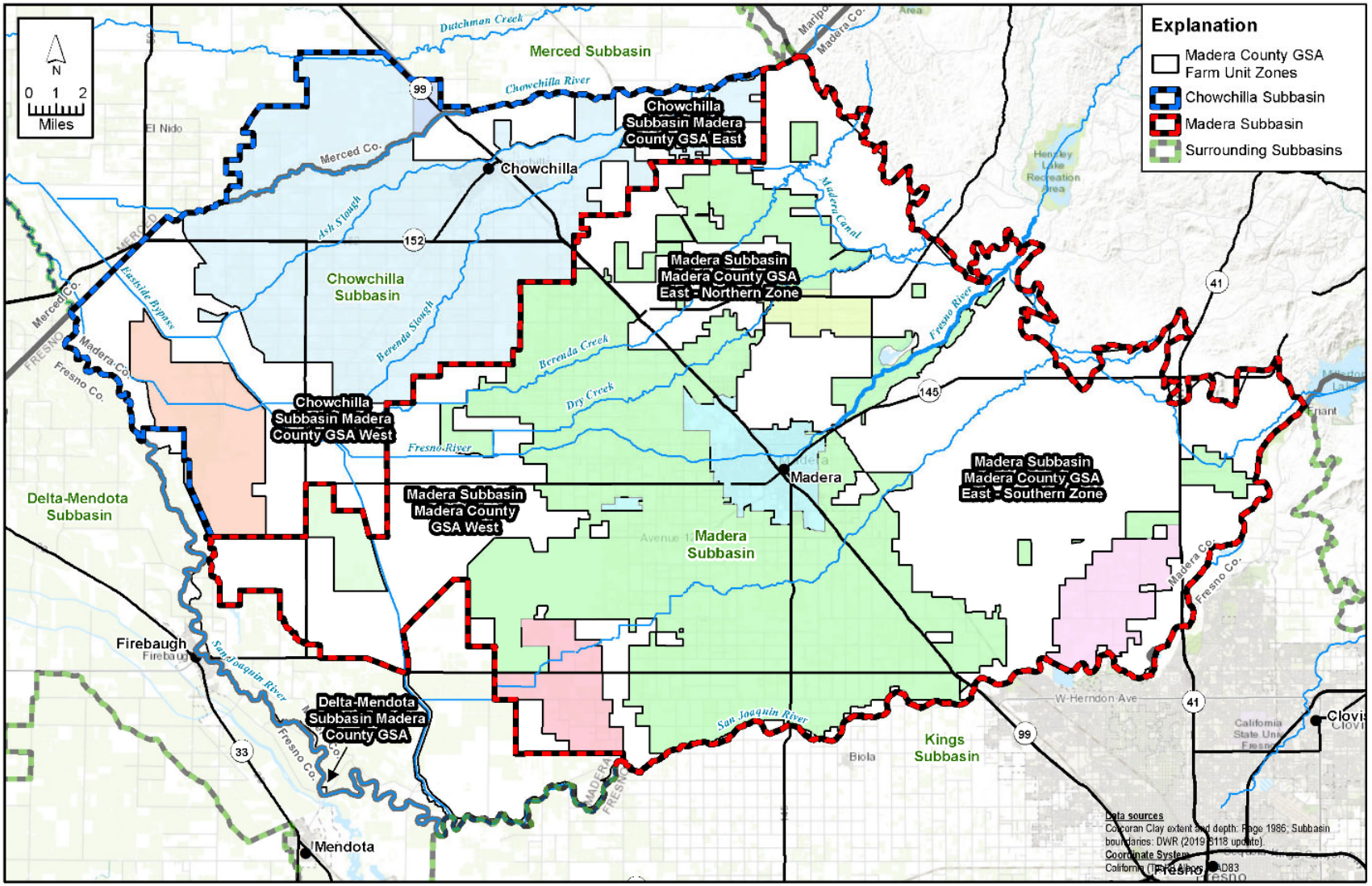
FROM: Peter Leffler (LSCE), Bryan Thoreson (DE), and Nick Watterson (LSCE)

SUBJECT: **EVALUATION OF FARM UNIT AREAS, MADERA COUNTY**

SUMMARY

To allow for both flexibility and to mimic real-world farming conditions in which resources are shared among commonly owned lands, the County GSA's per-acre, parcel-based allocations will be allowed to be shared within designated "farm units" meeting criteria defined by the Madera County GSAs. For the purpose of sharing water allocations, more than one parcel could be grouped together to form a farm unit. In order for the grouping to exist, the parcels would likely need to be owned by the same family or organization, or possibly for parcels managed by the same company, and be within the same zone on the map as indicated in **Figure 1** (Chowchilla East, Chowchilla West, Madera East north of the Fresno River, Madera East south of the Fresno River, Madera West, and Delta Mendota).

Overall, groundwater modeling suggested that the farm units should be permitted only within a specified zone. The zones take into account groundwater conditions, potential adverse effects on groundwater inflows from adjacent basins, land uses, aquifer characteristics and other considerations such as locations of concentrations of domestic wells. Given the large size of the Madera County East GSA within Madera Subbasin (and its extent from northwest to southeast), two zones of this GSA should be delineated – Madera County East GSA Northern Zone (north of the Fresno River) and Madera County East GSA Southern Zone to the south of the Fresno River (**Figure 1**). The proposed zones should serve initially to minimize likelihood for concentrated groundwater pumping (and associated groundwater depressions) in a given area along with limiting potential for causing increases in groundwater flow from adjacent subbasins as a result of the pumping distribution. Additional conditions may likely also be developed regarding the designation of parcels within specific farm units, such as whether parcels have ever been irrigated, the proximity of domestic and municipal wells, and potentially grouping of small parcels operated by designated disadvantaged owners or tenants



\\SERVER-01\Clerical\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\Figure 3 Madera County GSAs Farm Unit Zones.mxd

FIGURE 1

Madera County GSAs Farm Unit Zones

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INTRODUCTION

The Madera Joint GSP and Chowchilla GSP determined that to reach sustainability and prevent undesirable results, the Madera County GSA in both Subbasins must implement a demand management program. The Madera County GSA has identified several methods for reducing demand to achieve sustainability from 2020 to 2040. One of the methods to be used is to set an allocation of evapotranspiration of applied water (ET_{aw}). The Madera County GSA recognizes the importance of allowing flexibility to minimize the impact to Madera County growers. To provide this flexibility, the Madera County GSA desires to allow growers to define a "farm unit" within which groundwater allocation can be moved from one parcel to another parcel. However, moving water from one parcel to another could cause localized adverse impacts. The purpose of the analyses described in this Technical Memorandum (TM) are to provide guidance to the Madera County GSA with respect to how far water can be allowed to move without causing localized adverse impacts. Initially, analytical calculations were completed to estimate how fast water might physically move from the area where pumping was stopped to the area where pumping continued. After reviewing the results from the analytical calculations, a scenario was developed for a model run to evaluate potential adverse impacts. The rest of this TM describes the analytical calculations and the model scenario methodology and results, conclusions, and recommendations.

ANALYTICAL CALCULATIONS

Methodology

Groundwater flow velocities depend on the hydraulic gradient (difference in groundwater head/level per unit distance) and the characteristics of the media through which the water is moving. The analytical calculations utilized in the analysis involve calculations of groundwater flow velocities using inputs (values) for hydraulic gradient, hydraulic conductivity (K) of the aquifer media, and effective porosity (assumed equal to specific yield) of the aquifer media. Groundwater velocities are presented in units of feet per day (ft/day) or feet per year (ft/yr). The travel time between two points can then be calculated as the distance between the points divided by the groundwater velocity. The input values for groundwater velocity calculations were derived from a combination of groundwater level contour maps for various years (for hydraulic gradients) and the calibrated groundwater flow model presented in the GSPs (MCSim) for values of hydraulic conductivity (K) and effective porosity/specific yield. The analytical calculations were made for several different geographic areas in Chowchilla and Madera Subbasins and different years, which resulted in a range of values for each of the three input variables.

Results

The resulting groundwater flow velocities ranged from about 0.5 to 3 ft/day, or about 180 to 1,100 ft/yr. These calculations provide an understanding of how long it takes groundwater to move within areas of the Subbasin. The result is indicative of the slow movement of groundwater, so restricting the distances over which a parcel's water allocation would be allowed to move based on the estimated distance that groundwater may move in a year or even several years, would be very restrictive. However, these

calculations also support that need to establish farm unit zones that do not extend all the way across a Subbasin.

Numerical Groundwater Flow Model Analysis

Given the slow groundwater travel velocities estimated through the analytical calculations, the Madera County GSA decided to evaluate potential adverse impacts from implementing of a farm unit concept using the MCSim groundwater model developed and presented in the GSPs (Davids Engineering, et.al., 2020). An important concern of the Madera County GSA is subsidence in the western Chowchilla Subbasin (the area defined as the western management area in the GSP). The same concern, though to a somewhat lesser extent, exists in the Madera Subbasin. To evaluate potential undesirable effects, a scenario was developed that assumed all or most the demand management reduction occurred in the eastern Madera County GSA areas of each Subbasin.

Methodology

To simulate demand management in the GSP, crop areas were reduced (crops with lower returns had areas reduced first). The required area reduction was applied equally throughout the Madera County GSA in each Subbasin as required to reduce ET_{aw} as specified in the GSP. In other words, in the model run used to simulate the projected conditions with projects and management actions in the GSP, no area was disproportionately impacted by reduced crop areas.

To simulate a potential extreme future condition in which all pumping to satisfy the remaining ET_{aw} would occur in the western areas of each Subbasin, the necessary reduction in crop areas was applied first in the eastern areas of the Madera County GSA. In the Chowchilla Subbasin, this resulted in no irrigated area in the eastern part of the Madera County GSA by 2035. After 2035, crop area reductions began in the western part of the Madera County GSA and continued until 2040 to reach the full reduction in area necessary to reduce ET_{aw} to the level of ET_{aw} that is sustainable (per the GSP). In the Madera Subbasin, all the crop area reductions occurred in the east part of the Subbasin, and some irrigated areas were still remaining in the east when the sustainable level of ET_{aw} was reached in 2040. No irrigated crop area reduction was necessary in the western part of the Madera Subbasin.

Groundwater Model Results

Using the land use input described in the previous section, a groundwater model simulation was conducted and hydrographs were prepared for various wells in the two Subbasins, and specifically within the Madera County East and West GSAs in each Subbasin. These hydrographs showed differences between the new model run prepared for the current analysis and the GSP model run with pumping reductions uniformly distributed across Madera County GSAs. Differences in the water balance for each Subbasin were also reviewed in comparing the two model simulations.

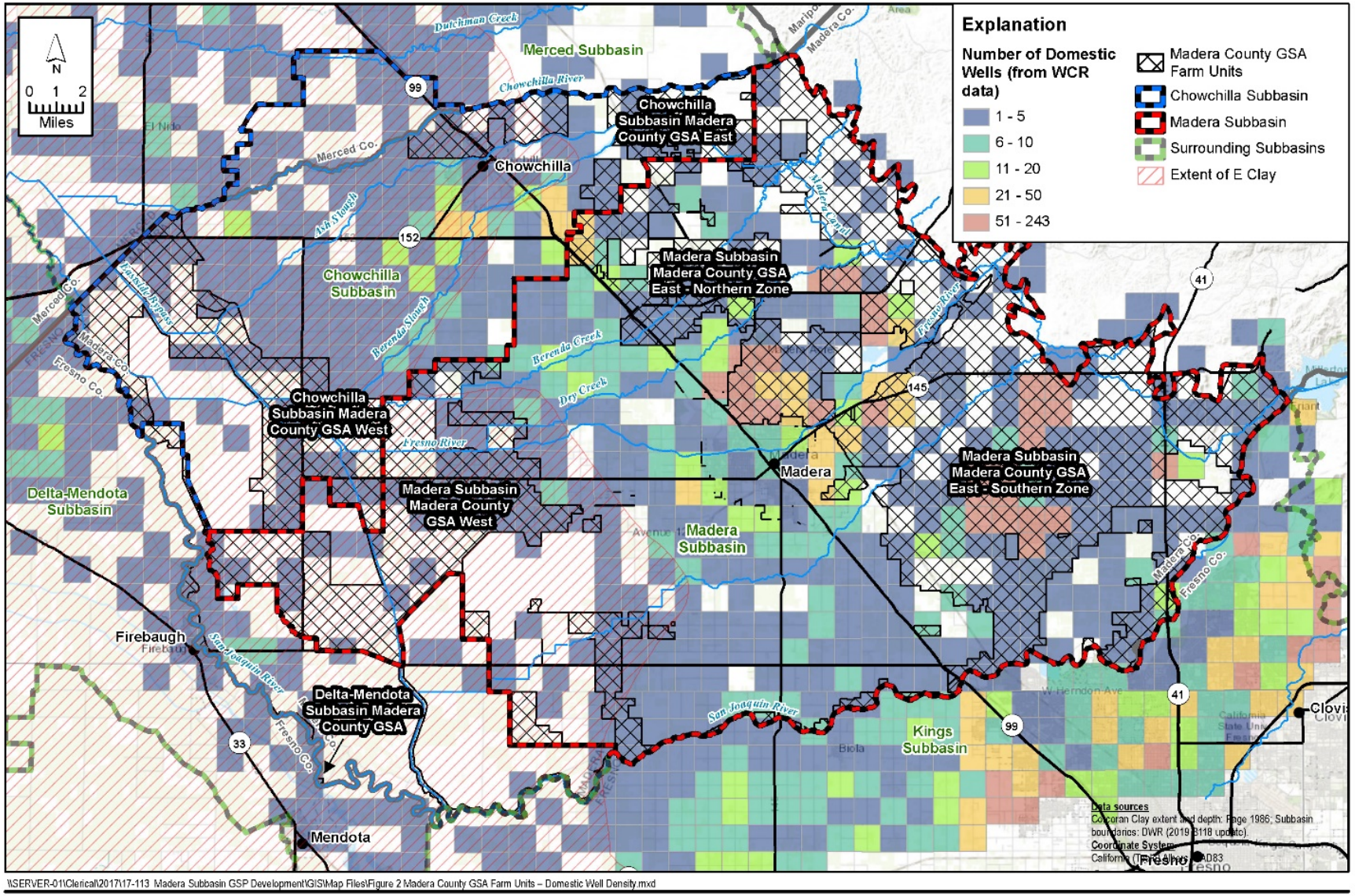
The model results generally indicated varying degrees of higher groundwater levels in Madera County East GSA (up to about 60 feet) and varying degrees of lower groundwater levels in Madera County West GSA (up to about 40 feet) in each Subbasin. The modeling results also indicated changes in subsurface inflow/outflow from adjacent subbasins, with generally greater groundwater inflow from adjacent

subbasins under the modeled farm unit scenario. Overall, the modeling results indicate that allowing farm units to move sustainable yield from the eastern areas of the Madera County GSA to the western area results in generally lower groundwater levels and increased inflows from neighboring subbasins in the western areas. These effects could lead to greater subsidence and adverse impacts. Thus, east and west farm unit zones (not the same as SGMA defined management areas) are defined to avoid SGMA undesirable results by requiring farm units to be defined within the east and west farm unit zones.

Furthermore, given the large extent from northwest to southeast of the Madera County East GSA within Madera Subbasin and other considerations such as locations of concentrations of domestic wells, especially south of the Fresno River, (see **Figure 2**), this GSA has been split into two farm units – Madera County East GSA Northern Area (north of the Fresno River) and Madera County East GSA Southern Area to the south of the Fresno River (**Figure 1**). The Fresno River serves as a natural surficial demarcation boundary between the two farm unit zones, has an narrow swath of land from another GSA (MID) running alongside and parallel to it that provides an intervening area between the two proposed farm unit zones, divides the two zones into approximately equal areas, helps to avoid potential for increased concentration of pumping in the southern portion of the Madera County East GSA that could induce more subsurface inflow from Kings Subbasin (a concern expressed in a GSP comment letter from Kings Subbasin GSAs).

DISCUSSION/CONCLUSIONS

The proposed Farm Unit zones within which farm unit groupings can be formed should serve initially to limit likelihood for concentrated groundwater pumping (and associated groundwater depressions) in a given area while also limiting potential for causing increases in lateral groundwater inflow from adjacent subbasins as a result of the pumping distribution. Technical analyses conducted for this study show that significant differences in groundwater levels can be expected if allocated groundwater pumping is concentrated in certain areas of the Subbasins. Furthermore, technical analyses show that groundwater moves relatively slowly, and it would take several years for groundwater to move from areas of less concentrated pumping to areas of more concentrated groundwater pumping within each Subbasin. The County plans to review the effects of implementing farm units on the distribution of groundwater pumping and changes in groundwater levels every five years (starting in 2025), and will make adjustments to farm unit zone boundaries in the future, if necessary.



\\SERVER-01\Clerical\2017\17-113 Madera Subbasin GSP Development\GIS\Map Files\Figure 2 Madera County GSA Farm Units – Domestic Well Density.mxd

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FIGURE 2
Madera County GSA Farm Units
Domestic Well Density

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REFERENCES

Davids Engineering, Luhdorff & Scalmanini, ERA Economics, Stillwater Sciences, and California State University – Sacramento, *Chowchilla Subbasin Groundwater Sustainability Plan*, January 2020, prepared for Chowchilla Subbasin GSP Advisory Committee.

Davids Engineering, Luhdorff & Scalmanini, ERA Economics, Stillwater Sciences, and California State University – Sacramento, *Madera Subbasin Joint Groundwater Sustainability Plan*, January 2020, prepared for Madera Subbasin Coordination Committee.

LIST OF FIGURES