Appendix 7-A
Model Maintenance and Improvements for the Petaluma Valley Groundwater Sustainability Plan

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Model Maintenance and Improvements

Groundwater Sustainability Plan

Petaluma Valley

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1 Introduction

The Groundwater Sustainability Plain (GSP) for the Petaluma Valley Basin (Basin) relied on groundwater modeling to support development of historical, current, and projected water budgets, and to evaluate projected benefits from implementing Projects and Management Actions (PMA) scenarios.

The Petaluma Valley Integrated Hydrologic Model, Version 1 (PVIHM) is based on MODFLOW-OWHM, version 2, and was developed by the United States Geological Survey (USGS; citation forthcoming). Recommended model improvements that are relevant to GSP implementation will be addressed during the first five years of GSP implementation. In addition to recommended model improvements, routine model maintenance activities will also be conducted during GSP implementation. Routine model update tasks include updating the model with recent land use, groundwater pumping, and climate data, and recalibrating the model, if necessary. Finally, model predictive simulations will be updated to reflect more new information on alternative future climate scenarios and PMA planning and implementation.

All model improvements incorporated during GSP implementation will build on additional data collection and interpretation activities described in GSP Section 7. These additional data will be used to verify model inputs (Section 2.2), compare against model outputs (Section 2.3), and guide improvements to model structure (Section 3).

This appendix summarizes model improvements that are planned during the first five years of GSP implementation, including updating input data, improving the model structure, and refining the representation of projected PMAs for the 5-year GSP assessment.

2 Update Data Inputs to Model

2.1 Update Simulation Period

The PVIHM simulation period covers the period from October 1959 through September 2018. During GSP implementation, the simulation period will be extended through Water Year (WY) 2025 for the 5-year GSP update due in 2027. As part of extending the simulation period, the following data inputs will be updated and incorporated in the model:

- Land use in the Basin and surrounding watershed, which will guide changes in agricultural irrigation pumping and surface water runoff
- Rural domestic pumping rates and septic return flows
- Municipal and industrial pumping rates
- Streamflow diversion locations and rates

- Recycled water deliveries to agricultural and non-agricultural customers
- Precipitation and reference evapotranspiration
- Freshwater equivalent head in San Pablo Bay and the tidally-influenced reach of the Petaluma River
- Groundwater levels at boundaries between the Basin and Santa Rosa Plain Subbasin, and between the Basin and the Wilson Grove Formation Highlands

2.2 Verify Model Inputs Against Available Data

Several model inputs to the PVIHM are based on uncertain or limited data. During GSP implementation, these model inputs will be validated against the following additional datasets collected as part of GSP implementation. Table 1 lists datasets that will be used for model input validation.

Table 1. Model inputs to be validated against data gathered during GSP implementation

Dataset	Description	Corresponding Model Inputs to be Validated
Commercial/industrial groundwater pumping	Monthly volumes of groundwater pumping	Specified pumping rates for commercial and industrial wells in WEL package
Recycled water deliveries	Spatial and seasonal distribution of recycled water deliveries to agricultural customers	Non-routed deliveries specified in FMP package
Aquifer hydraulic properties	Hydraulic properties inferred from both existing completed aquifer testing, if any, and additional testing conducted during implementation	Discrete zones in UPW package
Non-irrigated grain acreage	Spatial extent of non-irrigated grain acreage – confirm against assumptions used in PVIHM	Irrigation status arrays in FMP package datasets

Some datasets relevant to certain model inputs may not become available or be completed during the first 5 years of GSP implementation. These data include:

- Screened intervals for agricultural irrigation and rural residential wells
- Metered irrigation pumping
- Locations and rates of surface water diversions

Any datasets relating to the three items listed above will be evaluated opportunistically, as they become available, with the understanding that the schedule of model improvements and maintenance will not be dependent on those datasets. It should be noted that amounts, locations, and depths of groundwater pumping for all water use sectors has been identified as a key data gap in Section 7 of the GSP, and will be addressed through additional data collection during GSP implementation; however, it is not anticipated that comprehensive data for all wells in the Basin will become available during the first 5 years of implementation.

2.3 Verify Model Outputs Against Available Data

Existing groundwater level, interconnected surface water, and seawater intrusion monitoring networks will be expanded during GSP implementation (GSP Section 7.2.4). Data collected from these monitoring networks will be used to check model simulation results, and provide guidance for model re-calibration planned toward the end of the first 5 years of GSP implementation.

3 Improvements to Model Structure

The following model structural improvements will be addressed during GSP implementation:

- Evaluate model sensitivity to consider surface water losses to groundwater and other losses in the watershed surrounding the Basin, and overall model conceptualization in the surrounding watershed areas
- Evaluate sensitivity of simulated GW-SW exchange and aquifer heads to hydraulic conductivity distribution along streams in model layer 1
- Revise stream diversions, simulated as semi-routed deliveries, to more closely match surface water delivery volumes simulated as non-routed deliveries, and incorporate storage if feasible
- Assess model boundary conditions, and modify as needed:
    - Review General Head Boundary (GHB) representing San Pablo Bay
        - Review consistency of GHB reference elevations between Petaluma Valley and Sonoma Valley groundwater models
        - Review sensitivity of simulated water levels in the Baylands to GHB conductance

4 Five-Year Model Update and Maintenance

The PVIHM, incorporating model updates and improvements described in Section 2 and Section 3, will be used to support the five-year update to the GSP. Depending on model simulation results, the updated model may be re-calibrated to both existing and new data collected during

GSP implementation, and will be used to update historical and current water budgets (Section 4.1), and to provide future projected water budgets and water levels for comparison against Sustainable Management Criteria (SMC; Section 4.2) and to support planning and implementation of PMAs.

As part of the five-year update to the GSP, the latest available projected climate science and data will be reviewed and considered for incorporation into the scenarios for the 2026 through 2072 projected period.

4.1 Update Historical and Current Water Budgets for Reporting

As part of the five-year update to the GSP, the model will be assessed to determine if recalibration is necessary. If necessary, recalibration will occur after completing the model update and improvement tasks described in Section 2 and Section 3. Model recalibration would entail adjusting model hydraulic properties or other model parameters to improve the goodness-of-fit between hydrologic and hydrogeologic datasets, and their model-simulated equivalents. At a minimum, datasets to be used during model calibration would include:

- Groundwater level hydrographs at Representative Monitoring Point (RMP) wells, including all new wells in the monitoring network
- Streamflow hydrographs from existing and any new stream gages

After completing model recalibration, revised simulated historical and current water budgets will be prepared through the extended simulation period (Section 2.1).

4.2 Update Future Projected Conditions

As stated in Section 7.2.6 of the GSP, the GSA plans to immediately begin implementation of Group 1 projects, including assessing water conservation and groundwater-use efficiency opportunities. As specific project details are refined, the representation of PMAs in the model will be updated so that groundwater model projections are based on updated designs of PMAs.

The recalibrated model will be used to provide future projected water budgets and groundwater levels to be compared to SMC at RMPs. Updated future projected conditions will likely vary from projections in the GSP due to the following:

- Starting head distributions will reflect groundwater responses to climate and pumping stresses through WY2025
- The model structure and calibration will be revised relative to the PVIHM
- Details of PMAs will have been further developed since GSP preparation
- Revised projected climate simulations

Predictive simulation results based on the updated and recalibrated model, with refined representation of PMAs, will then be processed to provide:

- Projected water budgets
- Projected groundwater levels relative to Sustainable Management Criteria for RMP wells
- Projected changes in exchange with interconnected surface water

5 References

Boyce, S.E., Hanson, R.T., Ferguson, I., Schmid, W., Henson, W., Reimann, T., Mehl, S.M., and Earll, M.M., 2020, One-Water Hydrologic Flow Model: A MODFLOW based conjunctive-use simulation software: U.S. Geological Survey Techniques and Methods 6-A60, 435 p., https://doi.org/10.3133/tm6a60