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Oakland, CA 94612

Mr. Ron Duncan
General Manager, Soquel Creek Water District
On behalf of Santa Cruz Mid-County Groundwater Agency Executive Staff
PO Box 1550
Capitola, CA 95010-1550

September 2, 2016

Subject: Groundwater Model Update and Scope for Fiscal Year 2016-2017

Dear Mr. Duncan:

This letter provides an update on the Santa Cruz Mid-County Basin groundwater model that HydroMetrics WRI is developing for the Santa Cruz Mid-County Groundwater Agency (MGA) and includes scope and cost estimate for continued development of the model this fiscal year (2016-2017). We have been developing the model under the work plan approved by the Soquel-Aptos Basin Implementation Group (BIG) on March 25, 2015 with subsequent schedule revisions. This letter proposes re-prioritizing and revising items in the work plan to meet schedule and budget constraints. Below is a general update and summary of the need to change the work plan with a cost estimate that includes revisions to work plan tasks.

GROUNDWATER MODEL UPDATE

The model will use the U.S. Geological Survey (USGS) model code GSFLOW (Markstrom et al., 2008) that is a fully integrated watershed-groundwater model. The new regulations for Groundwater Sustainability Plans set surface water-groundwater models as a technical standard, and DWR staff has provided positive feedback on MGA's choice to use GSFLOW. GSFLOW will combine the Precipitation-Runoff Modeling System (PRMS) model for surface watersheds with a MODFLOW groundwater model. To date, we have developed working versions of the PRMS watershed model and MODFLOW subsurface groundwater model and are scheduled to integrate them into GSFLOW by the end of this month.

We have held two Technical Advisory Committee (TAC) meetings. The first meeting focused on the subsurface groundwater model construction. The second meeting was

held on August 24, and focused on watershed model construction. The reprioritization of work plan items proposed here were also discussed at this second meeting.

After integrating each model into GSFLOW, we are scheduled to calibrate the GSFLOW model to groundwater levels in October, evaluate groundwater management alternatives with the model by January 2017, and evaluate those management alternatives with a climate change scenario by March 2017.

SCHEDULE CONSTRAINTS

MGA member agencies Soquel Creek Water District (SqCWD) and City of Santa Cruz (City) require the model to be developed and calibrated on schedule in order to be used for evaluating supplemental supply options. SqCWD will use the model for its environmental review of groundwater replenishment with advanced water purification, and the City will use the model to evaluate its top recommended projects: Water Transfers for In-lieu Recharge and Aquifer Storage Recovery (ASR) using treated surface water.

The model will support SqCWD's environmental review of a project to inject advanced purified water. This injection is designed to recover and maintain groundwater levels in the basin. The environmental review includes an Environmental Impact Report, permitting, and salt and nutrient anti-degradation analysis. The schedule for this work requires project evaluation with the calibrated model by December 2016, and project evaluation under a climate change scenario by February 2016. The SqCWD Board is scheduled to consider a scope of work for modeling support of this environmental review on September 6.

The model will help the City evaluate both in-lieu recharge options, ASR, and combinations of in-lieu and ASR. The City's consultants will develop the model scenarios by December 2016.

The County of Santa Cruz will receive a Proposition 1 grant from the state that will include funds for using the model to assess the relative impacts of various classifications of municipal and non-municipal groundwater pumping on basin conditions. The grant schedule lists completion of this work in September-October 2017.

RE-PRIORITIZED WORK PLAN ITEMS

Given the above schedule constraints, we proposed to the TAC that several items in the work plan be postponed and added to the model after the model is used to evaluate groundwater management alternatives for the MGA, groundwater replenishment with advanced water purification for SqCWD, and in-lieu recharge and ASR scenarios for the City. These postponed items depend on the use of recently-developed capabilities for the GSFLOW software. Newly developed capabilities will take longer to implement and are more likely to result in delays as implementation issues arise. The three items we propose for postponement are:

1. Water Use Module in PRMS. Subtask 2.5 of the work plan states that "return flow occurs at the surface and can both recharge the basin or flow to streams so this source of water needs to be added to the PRMS model of the surface system." A newly developed water use module for PRMS appears to be the best option for accomplishing this. The TAC also encouraged us to explore whether use of the module was necessary. One of the primary motivations for including this capability is to support the County's Proposition 1 analysis of relative impacts from various water use classifications, but the schedule for that analysis allows more time for re-consideration and implementation. In the interim, the model will assume that return flow is added directly to groundwater recharge.
2. Seawater Interface Package, SWI2. Work plan Subtask 4.6 is to implement seawater interfaces in the Aromas and Purisima aquifer units using the SWI2 package. Under an agreement with SqCWD and using funding from the MGA (work plan Subtask 4.5), the USGS has added the SWI2 package to the GSFLOW code but requires a working version of the GSFLOW model to test it. Effects of groundwater management alternatives and other scenarios on seawater intrusion risk can be evaluated based on coastal groundwater level results prior to this package being implemented.
3. Downscaled climate change scenarios. Work plan Subtask 5.1 states that the "USGS will downscale four future climate scenarios (LOCA AR5) at daily time steps to the resolution of the model grid." After the USGS provided gridded data for historical climate to HydroMetrics WRI (Subtask 2.4), we recognized the difficulties in using the gridded data in PRMS and decided that we would use specific PRMS capabilities to distribute climate parameters for historical climate and any climate change scenarios to the model grid. Our subconsultant, Huntington Hydrologic, has provided a proposal to downscale global climate models to PRMS, but the USGS has recommended using either the Priestly-Taylor or Penman-Monteith formulation for potential evapotranspiration when using global climate projections. These evapotranspiration formulations have

only recently been added to PRMS. The TAC provided a recommendation for developing a climate change scenario for initial analysis that does not require downscaling and should not need a different evapotranspiration formulation. This approach categorizes years from historical climate as representative of climate change if extended over a longer period of time; the attached cost estimate reflects this approach.

Re-prioritizing these work plan items will facilitate meeting the schedule for providing the MGA, SqCWD, and City with model results to evaluate groundwater management alternatives and supplemental supply options by early 2017.

BUDGET OVERVIEW

ADDITIONAL EFFORT FOR WORK THROUGH FISCAL YEAR 2015-2016

For tasks worked on through fiscal year 2015-2016, we expended more budget than estimated by the work plan. The two main contributors to exceeding our estimation are as follows:

1. For Task 2: developing the PRMS watershed model, HydroMetrics WRI and our subconsultant, Huntington Hydrologic, took on developing the climate inputs for PRMS after we decided against using gridded data sets provided by the USGS (Subtask 2.4). This included trying different climate distribution options in PRMS, different climate data sets, and testing the new potential evapotranspiration formulations in PRMS. Following a suggestion from the TAC, we are continuing to refine the rainfall distribution in the model.
2. Task 3: developing the MODFLOW subsurface model, took much more effort than anticipated to model the geology of the Basin, particularly adding cells representing shallow alluvium and Terrace deposits on top of outcrops of dipping geologic units. This complex geology also contributed to issues when adding pumping well data and assigning boundary conditions.

The attached budget lists the Work Plan estimates for each task and the amount expended through fiscal year 2015-2016. It also identifies items completed before July 2016.

REVISED U.S. GEOLOGICAL SURVEY AGREEMENT

As discussed above, the scope to provide future climate scenarios downscaled to the GSFLOW model grid has been removed from the USGS' scope. As a result, the joint funding agreement between USGS and SqCWD has been amended. The joint funding

agreement now totals $60,030 with matching funds of $6,268 to cover the USGS's review role and implementation and testing of SWI2 in GSFLOW. Cost to SqCWD now is $53,762, to be reimbursed by the MGA. It should be noted that the USGS is not allowed to have a joint funding agreement directly with the MGA because there are private representatives on the MGA Board. The estimated total amount billed to the agreement in fiscal year 2015-2016 is $6,800, so the approximate MGA budget to fund the agreement in this fiscal year is $47,000. $70,000 was included in the MGA budget for the USGS.

COST ESTIMATE FOR PRIORITY TASKS THROUGH MARCH 2017

The attached cost estimate includes level of effort from July 2016 on subtasks that are priorities through March 2017 and excludes level of effort on the re-prioritized subtasks. It also excludes evaluation of predictive uncertainty (Subtask 5.4) and the final model report (Task 6) in order to keep our cost estimate to approximately $239,000.

Evaluation of predictive uncertainty is an advanced analysis that is not required to meet scheduling constraints for member agency uses of the model. The final model report is planned to document the additional re-prioritized capabilities after they are added. The MGA can use draft technical memorandums that will be produced on the model (Subtask 4.7) and groundwater management alternative evaluations (Subtask 5.5) and reviewed by the TAC to guide its planning in advance of a final report.

The $239,085 budget represents the initial $216,000 budgeted for the HydroMetrics WRI team for this fiscal year, plus $23,000 of USGS budget in excess of the remaining amount on that funding agreement. It should be noted that when providing the $216,000 budget estimate for our work this fiscal year, we projected that we would have expended a total of approximately $330,000 of the planned budget in the work plan through last fiscal year; the actual expenditure through last fiscal year was $27,000 less than that estimate. Therefore, using some of the USGS budget does not represent an increase in budget allocated for HydroMetrics WRI work.

The $70,000 funded by the County's Prop 1 grant is not included in the cost estimate. Additional budget will be required to implement all the re-prioritized items discussed above.

BUDGET FOR NEW TAC MEMBER

Subtask 1.4 is added to the cost estimate to provide compensation to Balance Hydrologics Senior Principal, Barry Hecht, who has been added to the TAC. We wanted to add a surface water expert to the TAC and John Ricker of the County

recommended Mr. Hecht for his experience with stream-aquifer interactions. As a private consultant, Mr. Hecht should be compensated for his time. This is common practice for private consultants who serve on TACs. Although compensation to Balance Hydrologics will be executed via our contract, Balance is not our subconsultant and we will not have control over Mr. Hecht's advice.

Robert Marks of Pueblo Water Resources is also a member of the TAC and is compensated by the City of Santa Cruz. Andy Fisher (UC Santa Cruz), Bruce Daniels (Soquel Creek Water District Board President and PhD in hydroclimatology), and Brian Lockwood (Pajaro Valley Water Management Agency) are volunteering their time on the TAC.

PROJECT TEAM UPDATE

There have been changes to our project team since the work plan was submitted.

For HydroMetrics WRI, Derrik Williams and Cameron Tana will remain Technical Lead and Project Manager, respectively. Georgina King, a Principal Hydrogeologist with HydroMetrics WRI who led the previous recharge study of the Soquel-Aptos area using PRMS, has increased her role working with PRMS aspects of the model.

Sean Culkin, Senior Hydrogeologist with HydroMetrics WRI, has been working on the subsurface model and assisting Cameron with project management. Sean is a Certified Hydrogeologist in California and has over eight years of experience in water resources, environmental, and geotechnical consulting, with an emphasis on quantitative hydrogeology and groundwater modeling.

Justin Huntington of Huntington Hydrologic and also Desert Research Institute will continue to be a subconsultant. His main role going forward under this scope will be developing packages for GSFLOW integration.

Please let me know if you have any questions. Derrik Williams will attend the September 15 MGA Board meeting and will be available to address any questions.

Sincerely,

Cameron Tana, Vice President
HydroMetrics Water Resources Inc.

Cc: Ralph Bracamonte, Central Water District
Rosemary Menard, City of Santa Cruz
John Ricker, County of Santa Cruz

Cost Estimate for Scope of Professional Services to Mid County Basin Groundwater Model Fiscal Year 2016-2017 through March 2017

	HydroMetrics WRI Hours							Huntington Hydrologic						
	Derrik Williams	Cameron Tana	Georgina King	Sean Culkin	Staff	Admin	Mike Cloud	Justin Huntington	Staff	Cost	ODC	BIG Work Plan Total	Expended before FY 16-17	FY 16-17 Total
Tasks	Technical Lead	Project Manager	Land Use Analysis Lead/PRMS Modeler	Groundwater Modeler	Hydrologist/ Modeler/GIS	Office Support	Geologist	PRMS/GSFLOW Expert	Watershed Modeler					
Rates per hour	$195	$175	$165	$155	$115	$60	$150	$138	$110	($)	($)	($)	($)	($)
Task 1 Scoping Effort														
BIG Work Plan Cost Estimate	*22*	*64*	*12*	*0*	*6*	*0*	*0*	*0*	*0*	*$ 18,070*	*$ 450*	*$ 18,970*	*$ 25,246*	
1.1 Scoping Meetings (assume 2)	*Complete before FY 16-17*													
1.2 Draft Memorandum on Potential Model Uses	*Complete before FY 16-17*													
1.3 Develop Work Plan and Revise Cost and Schedule	*Complete before FY 16-17*													
1.4 Additional TAC Member Compenation	0	0	0	0	0	0	0	0	0		$ 8,920			$ 8,920
Task 1 Subtotal												*$ 18,970*	*$ 25,246*	*$ 8,920*
Task 2 Develop Model of Surface System														
BIG Work Plan Cost Estimate	*59*	*126*	*156*	*136*	*244*	*0*	*0*	*126*	*132*	*$ 132,540*	*$ 1,144*	*$ 134,234*	*$ 98,193*	
2.1 Define Model Grid for Groundwater Model	*Complete before FY 16-17*													
2.2 Refine Model Grid for PRMS and Define Stream/Subwatershed Network	*Complete before FY 16-17*													
2.3 Compile Land Surface Data from Sub-Watershed Based PRMS	*Complete before FY 16-17*													
2.4 Climate Data for PRMS	2	8	40	4	0	0	0	16	8	$ 12,090	$ -			$ 12,090
2.5 Land Use Analysis for Water Use and Return Flow	2	12	56	8	8	0	0	4	0	$ 14,440	$ -			$ 14,440
2.5.1 Implement PRMS Water Use Module to Simulate Return Flow	*Postpone to after January 2017 or develop alternative (funded by County Prop 1 Grant)*													
2.6 Draft Technical Memo and Review of PRMS Inputs	0	16	20	8	0	0	0	20	4	$ 10,530	$ 200			$ 10,730
2.7 Construct Grid-Based PRMS for GSFLOW	0	4	20	4	0	0	0	16	24	$ 9,460	$ -			$ 9,460
2.8 Calibrate PRMS	2	16	12	8	32	0	0	4	0	$ 10,640	$ -			$ 10,640
Task 2 Subtotal												*$ 134,234*	*$ 98,193*	*$ 57,360*
Task 3 Develop Model of Sub-surface System														
BIG Work Plan Cost Estimate	*64*	*112*	*32*	*316*	*100*	*0*	*70*	*25*	*8*	*$ 101,678*	*$ 200*	*$ 102,078*	*$ 164,118*	
3.1 Develop Sub-surface Hydrogeologic Structure	*Complete before FY 16-17*													
3.2 Define Boundary Conditions	2	8	0	32	0	0	0	0	0	$ 6,750	$ -			$ 6,750
3.3 Develop Pumping Time Series	0	4	8	24	8	0	0	0	0	$ 6,660	$ -			$ 6,660
3.4 Draft Technical Memos and Review of MODFLOW Inputs	2	12	0	24	16	0	0	0	0	$ 8,050	$ 200			$ 8,250
3.5 Compile Groundwater Level Calibration Data	*Complete before FY 16-17*													
3.6 Create Recharge Package Based on HRU Based PRMS	4	4	24	10	0	0	0	0	0	$ 6,990	$ -			$ 6,990
3.7 Roughly Calibrate Subsurface MODFLOW	8	12	*0*	60	0	0	0	8	0	$ 14,060	$ -			$ 14,060
Task 3 Subtotal												*$ 102,078*	*$ 164,118*	*$ 42,710*
Task 4 Develop Integrated Model of Surface and Sub-surface Systems														
BIG Work Plan Cost Estimate	*92*	*200*	*0*	*436*	*60*	*0*	*0*	*138*	*0*	*$ 132,415*	*$ 1,782*	*$ 134,197*	*$ 15,803*	
4.1 Implement SFR and UZF Package	2	4	0	16	0	0	0	42	0	$ 9,345	$ -			$ 9,345
4.2 Create GSFLOW	4	8	4	16	0	0	0	30	0	$ 9,445	$ -			$ 9,445
4.3 Draft Technical Memo and Review of GSFLOW Integration	*Combine with 4.7 Memo and Review*													
4.4 Calibrate GSFLOW	8	40	0	80	100	0	0	16	0	$ 34,660	$ -			$ 34,660
4.5 Implement SWI2 Code in GSFLOW (coordinate with USGS)	1	4	0	12	0	0	0	0	0	$ 2,755	$ -			$ 2,755
4.6 Incorporate Density Dependence for Seawater Intrusion	*Postpone to after January 2017*													
4.7 Draft Technical Memo and Review of GSFLOW	8	20	0	40	24	0	0	32	0	$ 18,420	$ 200			$ 18,620
4.7.1 Review of GSFLOW with SWI2	*Postpone to after January 2017*													
Task 4 Subtotal												*$ 134,197*	*$ 15,803*	*$ 74,825*
Task 5 Model Simulations														
BIG Work Plan Cost Estimate	*52*	*140*	*0*	*276*	*0*	*0*	*0*	*4*	*0*	*$ 69,690*	*$ -*	*$ 69,690*	*$ -*	
5.1 Develop Climate Change Scenario Based on Historical Record	4	16	20	8	32	0	0	0	0	$ 11,800	$ -			$ 11,800
5.1.1 Develop Additional Climate Change Scenario Such as GCM Downscaling	*Postpone to after January 2017*													
5.2 Evaluate Groundwater Management Alternatives and Scenarios	4	20	0	32	60	0	0	0	0	$ 16,140	$ -			$ 16,140
5.3 Run Alternatives with Climate Change Scenario Based on Historical Record	2	12	16	16	40	0	0	4	0	$ 12,760	$ -			$ 12,760
5.3.1 Run Selected Alternatives with Additional Climate Change Scenarios	*Postpone to after January 2017*													
5.4 Evaluate Predictive Uncertainty for Preferred Alternative	*Postpone to after January 2017*													
5.5 Draft Technical Memo and Review of Model Simulations	8	16	8	36	24	0	0	4	0	$ 14,570	$ -			$ 14,570
Task 5 Subtotal												*$ 69,690*	*$ -*	*$ 55,270*
Task 6 Final Model Report														
BIG Work Plan Cost Estimate	*14*	*28*	*14*	*56*	*24*	*16*	*4*	*0*	*0*	*$ 20,900*	*$ -*	*$ 20,900*		
6.1 Final Draft Report	*Postpone to after January 2017*													
6.2 Final Report	*Postpone to after January 2017*													
Task 6 Subtotal												$ 20,900	$ -	$ -
TOTAL												***$ 480,069***	***$ 303,360***	***$ 239,085***

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