Form 9-1366
(Oct. 2005)

U.S. Department of the Interior
U.S. Geological Survey
Joint Funding Agreement

Customer #: **Pending FY16**
Agreement #: **16WNWA30034**
Project #: **Pending**
TIN #: 91-6001492
Fixed Cost Agreement ☑ **Yes** ☐ **No**

FOR
WATER RESOURCES INVESTIGATIONS

THIS AGREEMENT is entered into as of the **14TH** day of **December 2015**, by the U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR, party of the first part, and the **City of Redmond**, party of the second part.

1. The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation a **fixed-price agreement for evaluation of potential impacts to groundwater quality related to the shallow undefined aquifer located within the Redmond-Bear Creek Valley Groundwater Management area and the Upper Sammamish River Valley,** herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50; and 43 USC 50b.

2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) includes In-Kind Services in the amount of **$ N/A**.

   by the party of the first part during the period
   (a) **$0.00** **DECEMBER 14, 2015 to DECEMBER 30, 2016**

   by the party of the second part during the period
   (b) **$13,000** **DECEMBER 14, 2015 to DECEMBER 30, 2016**

   (c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.

   (d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.

3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.
4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.
5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.
6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.
7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

8. The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.
9. USGS will issue billings utilizing Department of the Interior Down Payment (Bill) Request (form DI-1040). Billing documents are to be rendered **SEMI-ANNUALLY**. Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof, that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983).

U.S. Geological Survey
United States
Department of the Interior

Name of Customer
City of Redmond

USGS Point of Contact

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Signatures

By Cynthia Barton Date 11-9-15

Name: **Cynthia Barton, Ph.D., L.G., L.H.G.**
Title: **Center Director, USGS Washington Water Science Center**

By MCBarton for Date 12/10/15

Name: John Marchione
Title: Mayor

Signatures

By_____
Date_____

Name:
Title:

By_____
Date_____

Name:
Title:

CITY OF REDMOND GROUNDWATER MODEL – TECHNICAL ADVISORY

SCOPE OF WORK

This scope of work outlines the technical advisory role in the development of a new and defensible numerical groundwater model of the Redmond alluvial aquifer to replace the model developed in 1997. This new model will be used to evaluate potential impacts to groundwater quality and quantity primarily related to the shallow unconfined aquifer located mostly within the Redmond-Bear Creek Valley Groundwater Management Area and the Upper Sammamish River Valley with focus on the groundwater/surface-water interactions and determining impacts to water quantity from temporary dewatering projects and construction of structures into the aquifer.

Primary objectives of this study are to build a groundwater model that can be used to evaluate risks for a variety of potential threats and to evaluate redelineation of current Wellhead Protection Zones (WHPZ) using best available science.

Secondary objectives of this study include:

1. The analysis of long term water availability;
2. Evaluation of aquifer characteristics and risk associated with contaminant fate and transport of a variety of potential pollutants; and
3. Interaction of the uplands with the aquifer.

MAJOR TASKS

Task 1 – Conceptual Site Model Development (CSM) Technical Advisory

This task includes the technical advisory role in the development of the Conceptual Site Model (CSM). The CSM is a simplified theoretical model of the system of interest which:

- Identifies the major hydrogeologic and physical processes occurring within the selected model domain;
- Establishes the interactions of the various processes; and
- Serves as the conceptual basis for numerical model development.

In addition to acting as the basis for the development of the numerical model, the CSM supports the identification of missing data (i.e., data gaps) and the identification of sampling locations where additional data should be collected.

The scope of this task includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the Conceptual Site Model and ultimately inform the CSM technical memorandum.

Task 2 – Numerical Model Planning & Design Technical Advisory

The scope of these tasks includes the technical advisory role in addressing plan and design for the accurate construction of the three-dimensional numerical grid structure. It includes the following subtasks:

Task 2a – Model Domain/Grid Design/Boundary Condition Attribution

The scope of this task includes contributions in a technical advisory capacity on:

1. Determination of appropriate lateral boundaries (i.e., model domain) best suited to achieve the overall modeling objectives,
2. Determination of appropriate vertical and horizontal grid spacings consistent with modeling objectives and physical features (e.g., pumping wells),
3. Association of hydrostratigraphic unit (HGU) contact elevations with grid layers, and
4. Identification of the type of location of critical boundary conditions at the margins of the model domain.

Task 2b – Definition of Hydrogeologic Parameter Values

The scope of this task will include providing technical expertise in the identification of the mean and reasonable upper and lower bounds for critical hydrogeologic parameter values that will be used in establishing and calibrating the numerical groundwater model. Primary aquifer properties include transmissivity, hydrostratigraphic unit thicknesses and contact elevations, hydraulic conductivity, anisotropy, streambed conductance, storativity and effective porosity.

Task 2c – Recharge Estimation

This scope will include providing technical expertise on the estimate of spatially and temporally variable recharge over the entire domain of the numerical model. Given that the large majority of the water entering the assumed model domain is derived from precipitation-based recharge, it is critically important that defensible estimates of recharge are made. This task will also include contributing to the establishment of the appropriate methodologies for recharge estimation given the specific conditions and processes near the City of Redmond.

Task 2d – Definition of Climate/Land Use Scenarios

This scope of work will include providing technical expertise on defining the climate change and land use scenarios the City will use in the predictive modeling phase of work, following the calibration & validation of the numerical model. Examples of scenarios which may be modeled include, but are not limited to:

- A variety of future climate scenarios;
- Future land use changes;
- Changes or additions to current production well pumping locations;
- Frequencies and withdrawal rates;
- Changes to stormwater infiltration systems which impact aquifer recharge; and
- Water supply usage increases or decreases.

Task 2e – Definition of Calibration & Validation Plans & Targets

The scope of this task will include providing technical expertise on the identification of the preliminary strategies and methodologies to be used to calibrate and validate the numerical groundwater model and to establish targets and general ranges of acceptability by which model calibration and validation will be assessed for completeness.

Technical advisory contributions will be made on the development of model planning and design including input on the following:

1. Descriptions of the general process anticipated to reach model calibration (e.g., steady state modeling followed by transient modeling);
2. The tools which will be used to achieve calibration (e.g., manual calibration and automated parameter estimation);
3. The identification of calibration and validation targets (e.g., measured groundwater elevations, overall water balance, streamflow, reach-specific gains/losses in surface streams etc.);
4. The identification of discrete time periods for both calibration and validation; and
5. The establishment of appropriate quantitative target ranges that will be used in conjunction with qualitative calibration targets to determine when calibration has been achieved and whether the model has been validated sufficient for use in predictive modeling.

The scope of all subtasks within this task includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the groundwater model development and ultimately inform the Model Planning and Design technical memorandum.

Note: Given the complexities and natural systems and the actions required to model them, often planned calibration/validation plans will need to change and adapt through the process of model calibration and validation.

Task 5 – Data Gaps Analysis Technical Advisory

This scope of work includes providing technical expertise on the comparison of the existing set of environmental data with that determined as being necessary as a result of CSM development and numerical modeling planning documents. This comparison will identify any missing environmental data (i.e., data gaps) which would be necessary to fill prior to completion of model calibration and validation.

The scope of this task also includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the groundwater model and ultimately inform the Data Gaps Analysis technical memorandum. The Memorandum will provide recommendations for additional environmental data acquisition to support numerical modeling and provide specific locations/frequencies for its collection.

Task 6 – Numerical Model Construction/Calibration/Validation Technical Advisory

The scope of this task will include acting in a technical advisory role and contributing to decision on the construction, calibration and validation of the numerical model the deviate from the Model Planning and Design technical Memorandum. Contributions may include deviations from the planned construction of the numerical MODFLOW grid and supporting model components, calibration using manual processes and PEST-based automated methods, and validation of the numerical model after successful calibration has been achieved.

The scope of this task includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the groundwater model construction, calibration, and validation and ultimately inform the Model Construction Report.

Task 7 – Predictive Modeling Technical Advisory

The scope of predictive modeling tasks include all modeling activity completed after model validation (i.e., when there is agreement that the numerical model is of adequate accuracy to make future predictions). Predictive simulations include fulfilling the primary objectives of the overall study which are to build a groundwater model that can be used to evaluate risks for a variety of potential threats and to evaluate redelineation of current Wellhead Protection Zones (WHPZ) using best available science.

In addition, predictive simulations will address secondary objectives of the overall study which include:

1. The analysis of long-term water availability;
2. Evaluation of aquifer characteristics and risk associated with contaminant fate and transport of a variety of potential pollutants; and
3. Interaction of the uplands with the aquifer.

Task 7a – Dewatering Impacts Modeling

The scope of this task includes technical advisory contributions to the numerical simulation of dewatering test cases for temporary and permanent dewatering systems. Dewatering activities will be modeled by the City of Redmond Consultant Team to examine how dewatering system pumping rates, durations, areal extents, and distances from pumping wells all potentially affect the achievability of current and future target production volumes at City production wells. The technical advisory role may include contributions on:

- Defining high and low water scenarios with established dewatering test cases to determine impacts on the aquifer;
- Scenarios with multiple dewatering projects occurring simultaneously in close proximity;
- Evaluation of pumping rate, duration, and drawdown triggers for impacts to supply well production and aquifer sustainability; and
- Developing simplified methods to evaluating future dewatering projects for impacts on supply wells.

The scope of this task includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the predictive modeling and ultimately inform the Dewatering Impacts Report.

Task 7b – Wellhead Protection Zone Delineation

The scope of this task includes technical advisory contributions on the use of the predictive model to delineate Wellhead Protection Zone (WHPZ) boundaries using appropriate buffers/safety factors that account for model uncertainty and non-hydrogeologic considerations such as long-term land use plans and jurisdictional boundaries in accordance with Department of Health guidelines (6 month, 1 year, 5 year, and 10 year times of travel).

The scope of this task includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the predictive modeling and ultimately inform the WHPZ Delineation Report to document modeled WHPZ boundaries.

Task 7c – Risk Assessment/Modeling

The scope of this task includes technical advisory role on the development of tools and initial evaluations of the travel time through the unsaturated zone and groundwater for spills of chemicals that have varying mobility and toxicology. The effort under this task will focus primarily on adapting and applying an existing tool developed by GSI for identifying and evaluating contaminant risks to municipal water supplies in urban settings. This risk assessment tool – ChemRisk – evaluates localized risk inside wellhead protection zones as a function of spatial variations in aquifer characteristics and the specific transport properties and toxicity of one or more chemical constituents associated with a potential source of contamination.

The scope of this task includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the predictive modeling and ultimately inform the Risk Assessment Report.

Task 7d – Water Availability Modeling

The scope of this task includes technical advisory role on predictive modeling to assess the ability of the aquifer and the City's wellfield to provide a reliable source of water under a variety of scenarios. Availability will be assessed for the City's future use of groundwater (i.e., wellfield operations, seasonal and annual groundwater supply needs), use by others (including the impact of dewatering systems), and background changes locally inside the City and across the watershed (land use, natural recharge [climate change], large-scale artificial recharge). Contributions will be made to the City's Consultant Team to develop a variety of scenarios to explore with the model, using multi-year simulations to evaluate potential changes in the aquifer and at City supply wells.

The scope of this task includes participation in regularly scheduled (tentatively identified as monthly) project progress and decision review workshops. As a technical advisor to the project, contributions will be made to decisions that impact the integrity and validity of the predictive modeling and ultimately inform the Long-Term Water Availability Modeling Results Report.

MILESTONES

The following project milestones will have associated completion dates and provide tracking for timely implementation of the project schedule:

1. Collaborative Workshop 1: CSM/Data Gaps Workshop
2. Collaborative Workshop 2: Model Calibration/Validation Results Workshop
3. Collaborative Workshop 3: Predictive Model Preliminary Results Workshop

DELIVERABLES

Project deliverables will include documentation of contributions to the groundwater model planning and development via email communications. Communications will be disseminated within two weeks of workshop dates to prevent project delays.