



Professional Services Task Order

Task Order Number: 1

In accordance with Professional Services Agreement contract, with the
City of Fortuna and GHD Inc., dated 1/28/2021
the City of Fortuna hereby requests and authorizes the service to be performed on the
project described below:

Project: NPDES Compliance Project: Land Disposal Contaminate Transport Analysis

Specific Work Requested:

Perform a transient groundwater contaminant transport analysis to support the
City's new summertime discharge location for CIP 0171. See attached scope for details.

Not to Exceed Amount: \$118,200

Consultant Signature: _____ Date: _____

Authorized Signature: _____ Date: _____

Our ref: 12559007

December 17, 2021

Brendan Byrd
City of Fortuna
621 11th Street
Fortuna
California, 95540

Scope of Services for Wastewater Land Disposal Groundwater Contaminate Transport Analysis

Dear Mr. Byrd

The City of Fortuna has a compliance schedule in its North Coast Regional Water Quality Control Board (Regional Board) waste discharge permit (WDR) R1-2017-0005 and Time Schedule Order (TSO) R1-2017-0026, which require that the City prepare a number of technical reports to address disposal and treatment issues.

The City is pursuing winter discharge to Strongs Creek as currently permitted, and summertime land application of treated effluent when discharge to surface water is not permitted. Under previous scopes, GHD helped identify candidate land application sites and completed preliminary investigations including monitoring wells, test pits, permeability testing, and preliminary groundwater analysis. The City installed seven groundwater monitoring wells that were logged by GHD staff. The City has periodically measured groundwater elevations and has completed limited water quality testing. A Seasonal Land Disposal Site Evaluation was completed and provided to the Regional Board in December 2019. In the summer of 2021, the Regional Board provided comments, and requested additional analysis to confirm the proposed summertime effluent percolation will not degrade the groundwater. The next phase of work includes collection of additional water quality data, analysis of results, and updates to the Seasonal Land Disposal Site Evaluation Report.

GHD will provide assistance to the City in completing an update to the Seasonal Land Disposal Site Evaluation which will require a detailed assessment of transport of wastewater parameters. Nine constituents of concern were identified during a preliminary assessment and refined based on discussions with the Regional Board. Justin McSmith, from the North Coast Regional Board has stated that the City should investigate “any constituent the City has detected in your effluent which is above background for the aquifer and/or more than half of the groundwater Water Quality Objective (WQO) as a starting point.” GHD has used this as the basis for determining which constituents should be evaluated. These parameters include the following:

- Ammonia Nitrogen, Total
- Nitrite Nitrogen, Total
- Nitrate Nitrogen, Total
- Chloride
- Conductivity¹

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- Sodium
- Total Dissolved Solids¹
- Total Coliform¹
- Turbidity¹

A preliminary approach implemented by GHD used analytical applications of Darcy's law, which indicated that the effluent discharge may negatively affect water quality for several constituents. From the previous analysis GHD understands that a more detailed transient model is required to fully represent the groundwater conditions that would be present with the seasonal disposal of treated wastewater effluent.

In November 2021 the Humboldt County Groundwater Sustainability Agency (GSA) published a first draft of the Eel River Valley Basin Groundwater Sustainability Plan (GSP) that included the development of an integrated groundwater surface water model (the Model). The Model was based on a detailed hydrogeologic conceptual model (HCM) of the Eel River Valley Basin (ERVB) that characterized the geologic setting, soil characteristics, principal aquifers and aquitards, general water quality, and surface water bodies significant to the basin. In other words, the HCM provides a summary of the hydrology, geology, and hydrogeology of the ERVB and organizes it in a framework to understand the general hydrogeologic characteristics of the groundwater flow system that formed the basis of model construction.

The existing ERVB Model is discretized into finite-difference rows and columns with minimum finite-difference grid spacing of 1,000 feet by 1,000 feet and discretized vertically into six (6) model layers. This horizontal and vertical discretization was implemented to provide sufficient resolution for its intended purpose:

- Supporting the development of the water budget in the Basin
- Supporting the establishment of sustainable management criteria
- Supporting identification and development of potential projects and management actions to address undesirable results (if needed)
- Supporting the refinement of the monitoring network

The ERVB Model was calibrated under transient conditions for the period between 2000 and September 2020 (i.e., end of Water Year 2020) in a two-stage approach: first matching simulated to observed surface water flows and stage elevations, then matching simulated to observed groundwater elevations. Based on the calibration results the model is suitable for application towards its intended purpose.

GHD proposes using the ERVB Model as the basis for developing a refined groundwater contaminant transport model that is focused on the area of interest so that it can be used for contaminant transport analysis of the nine identified constituents of concern. The primary reason for developing a refined groundwater contaminant transport model is that the relatively course 1,000 feet by 1,000 feet discretization of the ERVB will result in numerical dispersion of constituents of concern. Numerical dispersion occurs because the advective dispersion equation is solved at the center of each active finite-difference model cell using finite-difference methods and represents mass throughout the entirety of the model cell, which means that a model cell downgradient of the contaminant front will show concentrations even when the actual front has not actually reached the midpoint of the model cell. This form of distance-related numerical dispersion can be reduced by refining the model discretization (i.e., increasing the numbers of rows, columns, and layers in the finite-difference grid). The development of a refined site-scale model will reduce numerical dispersion and the application of ERVB Model will support the specification of boundary conditions and aquifer units consistent with regional conditions.

The updated Seasonal Land Disposal Site Evaluation Report that supports the Treatment Work Plan for Next Steps and the City's next WDR will rely heavily on the ability to make reasonable predictions of potential future parameter migration in groundwater. The integrated groundwater surface water model developed for the GSP represents the best starting point for developing a three-dimensional contaminant transport model to obtain

¹ The monitoring parameters conductivity, total coliform, and turbidity are expected to be related to total dissolved solids. This will provide a simplification and a reduction of the total number of transport scenarios to undertake.

scientifically defensible estimates of parameter migration from the City's proposed effluent land application site, located across the Eel River from the wastewater plant. These model results will support discussions with the Regional Board and updates of the Report of Waste Discharge (RWD), State-required Form 200 (Form 200), and Conceptual Design Documents (if required).

Purpose and Objectives

The initial modeling work will modify the existing integrated groundwater surface water model so that it has sufficient resolution in the Area of Interest to represent contaminant migration from the City's proposed effluent land application site (Land Application Area). The modified model will then be applied to conduct contaminant transport simulations from the Land Application Area under the influence of regional flow conditions and irrigation pumping. It is expected that it will take several summer land application cycles for groundwater concentrations to approach a steady-state (i.e., a stable peak concentration)². The results of the contaminant migration simulations will be reviewed for potential elevated concentrations at nearby observation locations including irrigation wells.

GHD will provide assistance to the City in completing the following deliverables in compliance with the City's WDR from the Regional Board:

- Groundwater Contaminant Transport Analysis
- Summary Memorandum and Recommendations on Next Steps

Based on the tasks below:

Scope of Services

Task 1: Groundwater Contaminant Transport Analysis

The proposed Scope of Services associated with modifying the existing ERVB Model and applying it to contaminant migration simulations involves the tasks described below.

Sub-task 1.1: Groundwater Quality Data Compilation and Review

This task will involve the compilation and review of groundwater and effluent water quality data collected. The Effluent water quality data will be based on City-provided data including the expected effluent concentrations associated with the treatment plant upgrades and the groundwater data from the monitoring wells near the Land Application Area. These groundwater quality data will be reviewed and compiled into a digital format suitable for input into the modified model.

Sub-task 1.2: Data Interpretation and Incorporation into Existing HCM

Developing an HCM is the process by which data describing field conditions are assembled in a systematic way to describe groundwater flow and contaminant transport processes at a site. Model application of the existing Model did not involve contaminant transport and as such groundwater quality information collected for the Land Application Area will need to be interpreted and incorporated into the existing understanding of the groundwater flow system.

² The steady-state condition may be difficult to identify due to the variable climatic conditions implemented in the existing Model and several model simulations may be required to identify the period of simulation time required to reach steady-state conditions under uniform climatic conditions.

Transport mechanisms such as advection, dispersion, sorption/retardation, and mass loss for each of the nine constituents will be evaluated. Each of these are described as follows:

- **Advection:** Advection is the bulk movement of a fluid through a geologic medium and is the primary transport mechanism in the ERVB. The advection mechanism is governed by Darcy's Law, which determines groundwater flow velocity, accounting for hydrogeologic characteristics (hydraulic gradient, hydraulic conductivity, and porosity), of the aquifer.
- **Dispersion:** Dispersion is a transport mechanism by which solutes or compounds spread along the groundwater flow path. Dispersion results from two basic processes, molecular diffusion and mechanical mixing. Molecular diffusion is a process where solutes move from zones of higher concentrations to zones of lower concentrations. The driving force of this movement is kinetic activity at the molecular level. Mechanical dispersion occurs due to the variability (heterogeneity) in pore-space groundwater velocities that act to spread or mix a solute in an aquifer. The primary aquifer characteristics that cause this mixing are variable frictional forces in pore channels, variations in pore channel geometry, and pore channel branching. Dispersion/spreading of solutes during groundwater flow results in dilution of solute pulses and attenuation of concentration peaks. This dilution/attenuation effect is accounted for in the transport equation by applying longitudinal and transverse dispersivity coefficients in a 3D domain.
- **Sorption/Retardation:** Sorption describes the interaction of contaminants with a solid through partitioning between the dissolved and the solid phase. Sorption causes a contaminant to move at a velocity that is slower than the mean pore water velocity by a factor referred to as the retardation factor.
- **Mass Loss:** Mass loss describes the process of geochemical conversion through processes such as nitrification. These processes can be described by governing equations of multi-component reactive transport in groundwater in the presence of multiple electron acceptors. Further mass loss can be accounted for through plant uptake when the compound being simulated is a plant nutrient.

Each of these transport mechanisms will be evaluated and incorporated into the HCM.

Land application rates will affect recharge to groundwater and corresponding hydraulic gradients and groundwater flow directions in the immediate area of the Land Application Area. Land application rates therefore also will be incorporated into the existing HCM.

Sub-task 1.3: Model Rediscretization

The model rediscretization will extend to areas where constituents may potentially migrate within the upper quaternary alluvium. The rediscretization will involve redefining the existing Model into a sub-domain over the area of interest by adding additional rows and columns in the horizontal directions and additional model layers in the vertical direction to minimize distance-related numerical dispersion during contaminant transport simulations. GHD anticipates that this rediscretization can be implemented through telescopic mesh refinement that will generate a localized and refined model in the area of interest (i.e., between Eel and Salt Rivers). Where the model grid is redefined into a sub-domain area of interest, the existing Model's aquifer properties, surface water feature attributes, and groundwater inflow conditions will be utilized.

GHD also anticipates that modifications to the existing Model's simulation period (i.e., the time discretization) also will need to be updated to ensure enough time is simulated for peak contaminant concentrations to reach steady-state conditions. As described in the Introduction the existing model spans from 2000 through to the end of Water Year 2020 (i.e., September 2020). It is possible that this is not enough time for peak concentrations to reach steady-state conditions and additional simulation time will need to be added. The additional time will be added by assigning climatic conditions from 2000 through 2020 to the end of the initial model simulation period, generating two repeating 20-year periods.

Sub-task 1.4 Contaminant Migration Simulations

The rediscretized model will be used to conduct solute transport simulations of ammonia nitrogen, nitrite nitrogen, nitrate nitrogen, chloride, conductivity, sodium, total dissolved solids, total coliform, and turbidity. As

described in Footnote 1 the monitoring parameters conductivity, total coliform, and turbidity are expected to be related to total dissolved solids and this will provide a simplification and a reduction of the total number of transport scenarios to model. As a result, application of the model will involve simulating solute transport of seven constituents.

Levels of each of these contaminants in wastewater will be applied as recharging conditions to the groundwater flow system near the Land Application Area. Concentrations in the leachate will be based on the most recently available water quality data available prior to model start-up. The simulation results will be reviewed for potential contaminant concentrations migrating from the Land Application Area towards the Eel River and other nearby wells. The results of the contaminant migration simulations will be reviewed for potential elevated concentrations (relative to applicable water quality standards) at nearby observation locations including known agricultural wells and the Eel River to evaluate the effect of the City's land application of wastewater on beneficial uses for surface and ground waters.

GHD anticipates meeting with the City (see Sub-task 1.6) to provide preliminary simulation results at which point the City can consult on additional model scenarios to evaluate (up to three). For example, if a constituent exceeds a water quality standard at the current application rate/concentration, the model could be re-run to determine the rate/concentration that could be discharged in the effluent to not exceed the water quality standards to inform treatment design.

Sub-task 1.6: Model Documentation and Presentations

The rediscritization of the Model will be presented in a preliminary summary meeting with the City and in a model report prepared consistent with industry guidelines and standards on groundwater model documentation such as ASTM Standard Designation D5718-13 (2013) "*Standard Guide for Documenting a Ground-Water Flow Model Application*". Modeling results will be presented in graphical and tabular formats as appropriate to clearly summarize the HCM, computer hydrogeologic model development/rediscritization, and simulation results. GHD will clearly identify all assumptions applied in the model development.

Task 1 Deliverables:

- Preliminary model simulation results
- Revised model simulation results (up to three)
- Contaminant Transport Model Report
- Presentation materials

Task 1 Items Provided by the City:

- Water quality data (groundwater wells and effluent) results in MS Excel based tabular form
- Groundwater Elevation monitoring data results in MS Excel based tabular form

Task 2: Summary Memorandum and Recommendations for Next Steps

Based on the results from the HCM simulations and direction from the City, GHD will provide the City with a memorandum summarizing the results from the HCM simulations and present GHDs recommended next steps. The next steps will include; remaining documentation needed to meet the WDRs, updates needed for the engineering plans for Land Application disposal and/or treatment plant upgrades, and coordination expected with the Regional Board.

Task 2 Deliverables:

- Summary Memorandum

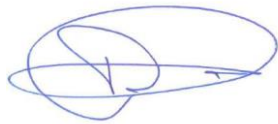
Estimated Cost and Schedule

Table 1 presents GHD's cost estimate for the proposed Tasks presented in the Scopes of Services outlined above. The estimate of the total cost for modifying the existing Model so that it is suitable for contaminant transport simulations and applying the updated Model for those contaminant transport simulations is \$118,200. GHD is prepared to commence the Scope of Services upon receipt of approval to proceed.

Table 1: Cost Estimate

Task	Budget
Task 1 – Groundwater Contaminate Transport Analysis	
Task 1.1 – Groundwater Quality Data Compilation and Review	\$4,200
Task 1.2 – Data Interpretation and Incorporation into Existing HCM	\$6,500
Task 1.3 – Model Rediscretization	\$22,000
Task 1.4 – Contaminant Migration Simulations	\$42,500
Task 1.5 – Model Documentation and Presentations	\$36,500
Task 2: Summary Memo	\$6,500
TOTAL	\$118,200

Regards



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