Work Plan

Att5_LGA12_MCCSD_WrkPln_1of1

Project Scope

MCCSD is proposing to complete an assessment of water quality risks for the Mendocino Headlands Aquifer for the water users within the District. This work will include an assessment of known and potentially contaminating activities that may impact the aquifer's sustainability to act as a public water supply. The study area includes the Mendocino area as shown on Figure 5-1.

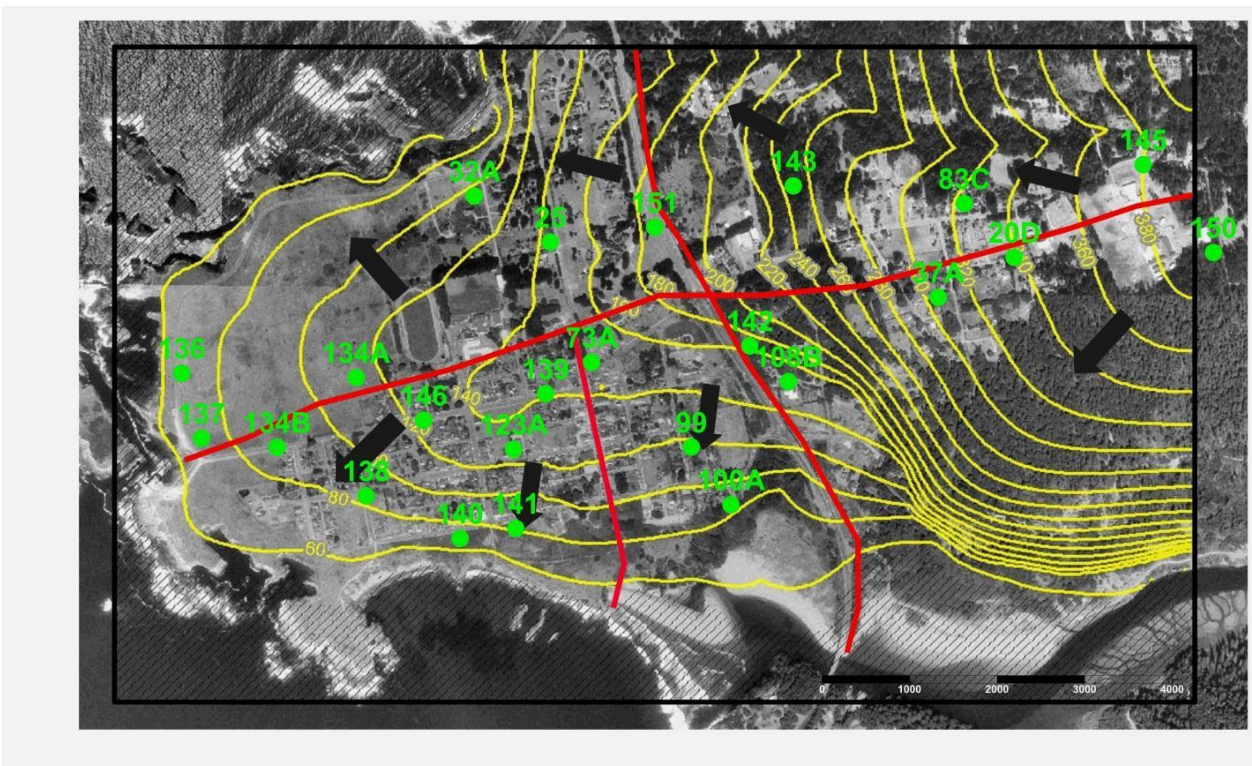

Figure 5-1 – Study area map showing location of proposed monitoring wells in context with typical groundwater potentiometric map showing flow direction. Red lines indicate the different flow subareas for the Mendocino Headland.

GWMP Goals and Objectives

In 1990, Mendocino City Community Services District (MCCSD) developed a Groundwater Management Plan (GWMP) to manage and protect the groundwater resources within its boundaries for the common good of all present and potential users. The District has made significant improvements to its GWMP since 1990. The District's initial groundwater management efforts focused on water conservation and regulating groundwater extraction to prevent aquifer overdraft or depletion. In 1996, MCCSD developed a District-wide monitoring program to monitor groundwater elevations and changes in groundwater storage. In 1997, a recycled water system was constructed to help limit potable groundwater withdrawals for irrigation. Later GWMP improvements in 2002 included developing a geographic information system (GIS) and a numerical groundwater model. The Board of Directors used these analytical tools as a foundation for groundwater management decision-making. The Mendocino Groundwater Model was used to improve the GWMP with the development of a Water Shortage Contingency Plan. The development of the GIS, Mendocino Groundwater Model, and Water Shortage Contingency were funded with LGA grants.

The District's GWMP has the following Goals and Objective:

GWMP GOALS

- Promote water conservation
- Limit groundwater withdrawals to prevent aquifer overdraft
- Manage Mendocino's groundwater supply during drought
- Ensure groundwater quality is protected
- Develop groundwater management programs that serve as a foundation for groundwater management decision-making

GWMP OBJECTIVES

- Implement effective administrative procedures for groundwater extraction permitting
- Develop a representative updatable numerical groundwater model to provide a comprehensive overview of Mendocino's hydrogeology
- Regularly monitor groundwater elevations and quality in the Mendocino Headlands Aquifer
- Conserve groundwater through Recycled Water and Water Conservation Programs
- Utilize the Water Shortage Contingency Plan to help prevent aquifer depletion during drought conditions

The current grant Project is designed to advance the GWMP goal of ensuring groundwater quality is protected and the objective to regularly monitor both groundwater elevations and groundwater quality in the aquifer. The proposed project is entirely consistent with the goals and objectives of the MCCSD GWMP. The GWMP was developed to ensure a viable groundwater resource for beneficial uses to provide a reliable and safe water supply. The 2012 GWMP does not address groundwater quality, so the groundwater quality assessment project will fill that gap. However, this assessment is clearly at the heart of the GWMP goals and objectives. The local well owners want to understand if the potential impacts of the various contaminants in the local water supply. Based on identifying and prioritizing these threats, the District will have an important tool for near and long-term planning to mitigate against these potential impacts.

Project Purpose, Goals and Objectives

- **Project Purpose**

The purpose of the project work is to provide MCCSD with projections of the potential future risks to water quality to allow for long-term planning to ensure that the region maintains a sustainable groundwater supply. The results of the work will also be provided for use in the update of MCCSD's Groundwater Management Plan.

- **Project Goals and Objectives Designed to Improve the GWMP**

The groundwater quality assessment project will be presented in graphic display using geographic information system (GIS) tools for both public outreach and policy planning by MCCSD. Decisions of aquifer storage, enhancement and protection will rely on this effort as a common starting point in the future. The Project Goals include:

1. Develop a baseline of water quality based on sampling groundwater for a range of regulated drinking water constituents in Mendocino.
2. Develop an inventory and assessment of potentially contaminating activities within the District.
3. Assess the potential threat of the various contributing activities to the water users in the MCCSD area.
4. Develop a water quality monitoring plan with recommendations of where new monitoring wells are needed as "sentry wells."

Project tasks and sub-tasks support one or more of the project goals listed above, and each task description that follows describes its project objective and how it will be met. The GWMP will be improved by the proposed groundwater quality assessment, and the GWMP goal to "Ensure groundwater quality is protected" and the GWMP objective to regularly monitor groundwater quality in the aquifer will be achieved.

Project Tasks

There are six Project Tasks:

1. Task 1 Water Quality Sampling
2. Task 2 Groundwater Threat Assessment
3. Task 3 Groundwater Model Update
4. Task 4 Groundwater Protection Plan
5. Task 5 Technical Report
6. Task 6 Project Coordination, Meetings and Presentation

Task 1 – Water Quality Sampling

The primary objective of Task 1 is to develop a baseline set of water quality data for the Mendocino area for water quality and an inspection/sanitary survey of District wells. Water quality samples from MCCSD monitoring wells that are used for groundwater levels monitoring will be sampled to develop a baseline of water quality. Depth to water data is currently measured in these wells on a monthly basis. Monitoring wells will be sampled for general constituents and potential water quality contaminants including nitrates, bacteria, metals, and various chemicals used as fuels, solvents and other commonly used contaminants of concern. Monitoring wells would be sampled twice, once in the spring during high groundwater conditions and once in the late summer during low groundwater conditions. Prior to water quality sampling, property owners will be notified that water quality samples will be collected in April and July 2013.

Subtask 1.1: Sampling and Analysis Plan

This subtask is to finalize the sampling and analysis plan for the twenty-four selected wells. The plan will describe quality assurance/quality control on sample collection and analysis. Groundwater sampling will be in accordance with the Kennedy/Jenks' Standard Operating Guideline for Groundwater Sampling (Exhibit 1 at the end of this document).

Sampling for developing the water quality baseline is planned for the 24 wells used by the District for groundwater management. These wells are accessible to the District and provide coverage for the entire District. The distribution of these wells includes locations near developed areas which may have water quality impacts, and locations in undeveloped areas that can be used for control to determine natural background water quality. Figure 5-1 shows the location of the 24 wells that are proposed to be sampled for Task 1.

Subtask 1.2: Groundwater Quality Sampling

This subtask is to implement the Sampling and Analysis Plan developed above. Groundwater will be purged from the monitoring wells prior to sampling to obtain samples representative of aquifer conditions. Field parameters pH, temperature, and electrical conductivity will be measured and recorded during purging to document stabilization in accordance with Kennedy/Jenks' Standard Operating Guideline for Groundwater Sampling (Exhibit 1) for Field Measurement of pH, Temperature, and Conductivity .

Purge water from the sampled wells will either be distributed on the ground at the well site or transported to the wastewater treatment plant for disposal. Table 5-1 below provides the depth intervals within each well which will be analyzed.

Following purging, groundwater samples will be collected into containers provided by a state-certified laboratory, labeled, kept in a chilled cooler, and delivered to the laboratory under chain-of-custody procedures. The laboratory will follow their normal turnaround time and internal quality assurance/quality control (QA/QC) procedures during the analysis.

Analysis will include the key drinking water parameters that will indicate the presence of potential water quality impacts including general minerals, nitrates, bacterial, VOCs, fuel hydrocarbons and oxygenates indicator contaminants. These include the following:

- VOCs by EPA Method 524.2, includes PCE, TCE, MTBE and fuel hydrocarbons
- Primary Inorganics - Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Fluoride, Mercury, Nickel, Selenium, Thallium, Lead, and Vanadium
- Hexavalent Chromium by EPA Method 218.6
- Nitrate and Nitrite (as N)
- Secondary Standards (Color, Odor, Turbidity, Surfactants (MBAS), Copper, Iron, Manganese, Silver, Zinc, Aggressive Index Calculation, Sulfate, Chloride, pH, Specific Conductance, Total Dissolved Solids, Total Hardness Calculation, Calcium, Magnesium, Sodium, Total Alkalinity ($CaCO_3$), Hydroxide Alkalinity, Carbonate Alkalinity, Bicarbonate Alkalinity)
- Total and Fecal Coliform

Table 5-1 – Well construction and groundwater information for proposed monitoring wells. Locations are shown on Figure 5-1.

MCCSD Well Number	Well Depth (feet)	Casing Type	Average Depth to Water (ft)
20D	--	8' steel, 5" PVC	9.2
151	150	5" PVC	40.1
25	115	5" PVC	34.1
32A	128	4", 10ga	24.3
123A	215	5" PVC	14.2
134A	35	2' concrete	14.4
134B	25.5	2' concrete	12.8
136	150	4" PVC	13.7
137	150	4" PVC	18.7
138	150	4" PVC	23.7
140	100	5" PVC	7.0
141	100	5" PVC	7.3
146	150	4" PVC	28.9
139	150	5" PVC	15.7
73A	206	5" PVC	18.3
142	150	4" PVC	12.0
99	175	5" PVC	38.1
100A	--	4' concrete	8.4
108B	240	5" PVC	6.6
143	150	4" PVC	7.9
37A	65	5" PVC	14.3
83C	35	5" PVC	0.6
145	100	4" PVC	5.1
150	150	5" PVC	3.2

Subtask 1.3: Groundwater Quality Sampling Report

An interim technical memorandum will be provided after each sampling event to document the field sampling activities. This will be a concise report to document field procedures performed during the event, provide field data sheets to verify stabilization parameters and other key sampling parameters, and provide the laboratory results. Analysis of the analytical data will be performed during Tasks 2, 3 and 4.

Task 2 – Groundwater Threat Assessment

The principal objective for this project task is to develop a GIS-based tool to evaluate the vulnerability to groundwater wells, and to develop an inventory and assessment of potentially contaminating activities within the District. The groundwater threat assessment, based on a source–pathway–receptor approach, would be developed. A modified version of the DRASTIC methodology developed by the US Environmental Protection Agency will used to map the intrinsic and specific threats to groundwater quality. The GIS based analysis will enable MCCSD to screen and rank the relative vulnerability of the local groundwater to contamination and estimate the financial vulnerability to groundwater production infrastructure posed by groundwater contamination.

Subtask 2.1 – Data Compilation

This Task 2 includes collection and compilation of available groundwater well water quality data and other pertinent information from local water agencies, Potentially Responsible Parties (PRPs), regulatory bodies and other sources that may have bearing on the future sustainability of the basin. The information compiled in Task 2 will be compiled in a Geographic Information System (GIS) that will be utilized in subsequent tasks and form the foundation of the assessment of water quality risks.

- ***Groundwater Cleanup Activities –*** compile available data from prior and existing groundwater remediation activities within the District. Water quality data and analysis will be used to help understand the types of contaminants present in the District. The information will also be incorporated into the groundwater model.

- ***Potential Contaminating Activities (PCAs)*** - collect data consistent with the existing Drinking Water Source Assessment Program (DWSAP) data on potential contaminating activities (PCAs). Updated business listings will be obtained that will provide information on regional commercial and industrial activity in the District in a GIS shape file format. Updated Leaking Underground Storage Tank data will also be obtained from the State Water Resources Control Board (SWRCB) and imported into the GIS.

- ***Domestic Well Construction Information -*** The purpose of this task is to develop and import into the GIS a database query of all active and standby public supply wells in the basin. The data will be obtained from MCCSD. The dataset will include attributes of average annual pumping for each well and top and bottom of perforated interval elevations to help prioritize wells during the GIS queries to determine where the greatest threats exist.

- ***Contaminants of Concern -*** The purpose of this task is to conduct basic research to identify potential groundwater contaminants that are currently or may emerge as a concern in the future for the basin. The basic approach will be to review USEPA and California Department of Public Health information for constituents in water that are being considered for drinking water regulatory standards (e.g., hexavalent chromium) or contaminants that are currently unregulated.

Subtask 2.2 – Assess Water Quality Threats

The purpose of this subtask will be to identify near-term water quality risks. It is the combination of a potential source of contamination related to the human activities and use of land for various purposes and the existence of pathways through the subsurface to the aquifer that ultimately creates the potential threat of groundwater contamination.

The objective of the PCA Analysis is to compile a comprehensive database of potentially contaminating activities in the Study Area and to develop a technically-sound and scientifically-defensible ranking of those activities. Data for this study are obtained from various public and private sources. Many data sources are necessary to characterize PCA threat because groundwater contamination from human activities arises from many origins. The use of multiple PCA-threat factors improves the overall results of the analysis.

The PCA Analysis is an accounting of human activities at the ground surface, and identifies potential sources of contamination that will be used for this part of the groundwater quality threat assessment. PCAs are defined as human activities at the ground surface that are actual or potential sources of microbiological and chemical contaminants to groundwater. The basis for the relative threat is based on the Drinking Water Source Area Protection Plan from the California Department of Public Health.

The PCA analysis will be based only on the likelihood of the occurrence of surface contamination. The groundwater is dependent on the properties characterized by pathway for surface contaminants to reach the hydrogeologic setting of the area. The DRASTIC method will be used to determine the probability that a contaminant may infiltrate downward through the soil, vadose zone, and saturated zone finally reaching the aquifer. Because it is neither practical nor feasible to obtain quantitative evaluations of these intrinsic mechanisms from a regional perspective, it is necessary to look at the broader physical parameters which incorporate the many transport processes.

The DRASTIC system will be developed as a relatively inexpensive, straight-forward tool for planners, managers, and administrators to evaluate the relative sensitivity of areas 100 acres or greater to groundwater contamination. The DRASTIC system assumes a pollutant that is introduced at the ground surface, is carried to groundwater by areal recharge from precipitation, and has a similar mobility to that of recharge water. No consideration is given to unique chemical and physical properties of a contaminant that may influence the fate and transport of the contaminant with respect to groundwater recharge.

The DRASTIC method was developed by the USEPA. DRASTIC is an acronym standing for the seven hydrogeologic variables considered in the method. These variables include the following:

- **D**epth to Water,
- Net **R**echarge,
- **A**quifer Media,
- **S**oil Media,
- **T**opography,
- **I**mpact of Vadose Zone, and
- Aquifer Hydraulic **C**onductivity.

The DRASTIC system has been used to produce groundwater sensitivity maps in many parts of the United States. To calculate a DRASTIC score, each of the seven variables is divided into a numerical range to allow for relative comparisons. A description of each DRASTIC feature and the included processes is provided below.

To weight the relative significance of each of the seven hydrogeologic variables in DRASTIC each variable is then multiplied by a weighting factor. To calculate a final DRASTIC index score, the weighted values for each variable is added according to the equation below:

DRASTIC Index score = (5)D + (4)R + (3)A + (2)S + (1)T + (5)I +(3)C

where, upper-cased letters = DRASTIC variable

number in parentheses = weighting factor assigned to variable

As shown in the formula below, the most significant variables (Depth to Water and Impact of Vadose Zone) are assigned weighting factors of 5, and the least significant weighting factor (Topography) is assigned a weighting factor of 1. The weighting factors are not changed from the traditional DRASTIC approach. The results of the DRASTIC analysis are mapped onto the regional grid.

An evaluation of potentially contaminating activities (PCA) and a regional-scale evaluation of soils, geology and groundwater characteristics used for the DRASTIC analysis are proposed. These will be combined to evaluate the potential threat to groundwater quality. These factors conservatively predict the potential for groundwater contamination associated with human activity. To assess the potential threat of groundwater contamination, a comprehensive database of PCAs in the study area will be developed and a scientifically-defensible ranking of these activities will be conducted using the PCA/DRASTIC analysis.

Subtask 2.3 – Prepare Threat Assessment Mapping

Because the potential threat of groundwater contamination is a function of both the potential pathway for contamination to reach the groundwater and the presence of a potential source of contamination, the PCA and DRASTIC analyses were considered together to define the potential threat to groundwater quality. The potential threat of groundwater contamination will be determined by merging the individual GIS layers and mapping the PCA and DRASTIC results onto the regional grid. The potential threat rankings were determined by a systematic, reproducible procedure to minimize subjectivity.

GIS layers from each risk category will be analyzed to identify a) wells at risk to water quality impacts, and b) areas of undeveloped groundwater that are at high risk of degraded groundwater quality. Tabular results will be prepared documenting each existing water supply well, the associated risk level, and response activity over the assessment period. This effort will identify those first wells in the basin potentially subject to permitting restrictions resulting from potential contamination threat.

The District has conducted a survey of District wells. The goal is to develop a GIS database and maps of which locations use wells that meet current state and county well standards. For those that do not, we would develop a survey to assess the potential vulnerability of the well to surface contamination sources. In particular, we would want to identify those locations that use the very old, large diameter hand-dug wells. These wells typically have limited surface and annular seal protection and are particularly vulnerable to contamination from surface sources.

The maps and tabular results will be used in future groundwater management planning activities and will assist with identification of low-risk future well sites, and possible monitoring programs for existing wells.

Task 3 – Groundwater Model Update

The objective of Task 3 is to use the existing Mendocino Headlands groundwater model to delineate potential flowpaths through the aquifer to better understand the flowpaths that potential contaminants would take.

Subtask 3.1 – Update Existing Groundwater Model

Task 3 will include an update to the existing Mendocino groundwater model developed for the District in 2004 and used for the Water Shortage Contingency Plan and later groundwater assessments. The model will be updated with data since the last update in 2009 and compare the simulation results to measured groundwater elevations.

In 2008, the model was upgraded to MODFLOW-SURFACT to provide capability to evaluate resaturation of sediments. MODFLOW-SURFACT is based on the United States Geological Survey (USGS) version of MODFLOW, but contains additional mathematical solvers and options that are well suited to simulating shallow groundwater systems found at the Site. The model was constructed and run in the graphical user interface *Groundwater Vistas 5* (ESI, 2007). The use of the industry-standard modeling code MODFLOW SURFACT along with a commercial processor supports future usability of the model.

Modifications will be limited to changes in magnitude and distribution of aquifer parameters and boundary conditions, but not structural changes to how the model is constructed. The objective is to make a percentage improvement in the residual difference between measured and simulated groundwater elevations. The task will update the model with new data from 2008 through 2012 using the MCCSD groundwater management database that includes:

- Groundwater elevation data from monitoring well network
- Precipitation
- Water demand estimates
- Locations of any new pumping wells that have been installed since 2003

This is considered a model validation step where a calibrated model is compared to additional measured groundwater elevation data after the calibration period. The model results will be assessed using similar techniques as used in the May 2004 model report. A table similar to Table 11 in the 2004 Report will be developed. The consultant will evaluate how the model performed and, if necessary, provide recommendations on how to improve the model.

Task 3.2 – Aquifer Flowpath Analysis

The purpose of this subtask is to use the particle tracking code MODPATH and the flow and transport code MT3D in conjunction with the existing MODFLOW-based Mendocino Headlands groundwater model to simulate the movement of possible contamination based on a flow system.

The flowpath evaluation will be conducted using MODPATH, which is a particle tracking code developed by USGS to be run in conjunction with MODFLOW. MODPATH considers flow by advection and dispersion, but does not consider chemical reactions or retardation. Application requires defining particles within the groundwater model. MODPATH calculates the flow path and time length of travel for each defined particle. MODPATH will be used to evaluate the direction and the travel time for various parts of the Mendocino Headlands aquifer. The MODPATH analysis evaluates a two-year travel distance as appropriate for this analysis. For the particle tracking analysis, a ring of ten (10) particles will be placed around each injection well. The particle tracking will evaluated forward in time to evaluate the flowpaths as a result of the injection.

The transport code MT3D, which is coupled directly with MODFLOW, will be used to analyze the attenuation factor of potentially contaminating activities. This analysis required an evaluation of mixing and movement of the effluent in the aquifer. The discharge from a potentially contaminating activity will be set to a concentration of 100 approximating that it is composed of 100 percent liquid effluent products. MT3D will be then used to calculate the mixing and movement of the discharged effluent in the shallow aquifer as a percentage of the initial source strength. This is important to evaluate the potential risk of contamination to the drinking water supply.

This subtask includes the simulation of one baseline scenario and up to five (5) additional model scenarios in the vicinity of the potential high risk areas. The five scenarios will be developed after the analysis of the data from Tasks 1 and 2. The simulations will evaluate horizontal migration from high risk areas to downgradient wells; specifically to evaluate the time of impact to existing and planned production wells. These model runs are intended to predict: 1) the modeled distribution of nitrate and chloride within the model domain; and 2) time dependent changes in water quality in production wells. The vertical transport if any is likely due to induced downward groundwater gradient by ongoing pumping from the upper marine terrace deposits into the lower fractured bedrock aquifer.

Task 3.3 –Assessment of Flowpath Analysis

The purpose of the flowpath analysis is to simulate the movement of particles under the various aquifer and climatic conditions (e.g. wet, average and drought years). This will be used to identify those areas at the threat of potential contamination from known or potentially contaminating activities identified in Task 2. This will provide the technical basis for the groundwater vulnerability analysis and developing the groundwater protection plan in Task 4.

The results of the modeling will be documented with a series of maps, graphs and hydrographs to show potential flowpaths, relative percentage of the source strength, the relative change in the volumetric and mass balance for the different scenarios.

Task 4 –Groundwater Protection Plan

The objective for developing the Groundwater Protection Plan is to categorize and prioritize the identified water quality threats and potentially contaminating activities found during the completion of Tasks 1, 2 and 3, and to evaluate practices related to salt and nutrient management. It will be critical to distinguish between historical mismanagement and current practices early in the Groundwater

Protection Plan and to acknowledge that localized degradation sources may be out of the District's control.

Subtask 4.1 – Groundwater Vulnerability Analysis

The integration of these water quality threat assessment mapping and model flowpath analysis will be used to assess groundwater pollution risks and identify areas to prioritize in terms of groundwater monitoring and, if necessary, restriction on use.

This task will also develop a table identified as a Water Supply Risk Matrix to provide a summary of the findings above. This master table will be a vulnerability matrix for the sustainability of threatened and impaired groundwater resources. The matrix will relate each water-quality vulnerability factor and impacted facility to the estimated cost impact and number of years until vulnerability is significant.

Subtask 4.2 – Evaluate Potential Economic, Resource and Environmental Impacts

This subtask will quantify the cost of maintaining a high-quality, safe groundwater supply to the domestic water users within the Mendocino area. The three principal areas of impacts potentially caused by water-quality degradation that will be considered in this effort are (1) economic impacts, (2) water resources impacts, and (3) regional environmental impacts.

- Economic Impacts – A conceptual cost estimate will be developed to upgrade existing wells that do not meet current state and county well standards to those standards. Various alternatives will be evaluated such as well replacement, well treatment or alternative water supply. It is anticipated that there will be a substantial number of these wells. The objective of developing an aggregate cost is to help quantify the issue. The costs will quantify the potential economic impact to the Mendocino residents. Wells in the MCCSD area are privately owned, but the results of these analyses could be used to help secure funding for needed upgrades.

- Water Resources Impacts – This analysis will be performed using the Task 2 GIS shapefiles and Task 3 model analysis to identify the areas that are most vulnerable to contamination. The percent area will be a conservative analysis because it will represent the potential well site locations that are available. The evaluation will be broken down to show which District areas are most susceptible to future water quality issues.

- Environmental Resource Considerations – The task will develop a list of local resources that may be at risk for potentially reduced access to good quality groundwater due to the vulnerability of that portion of the aquifer.

This subtask will provide recommendations for increasing awareness of the resource protection necessary to sustain the high-quality groundwater supply critical to meeting the local objectives. This work will not estimate life cycle costs, increased/decreased operation and maintenance costs or other recurring costs, but instead will present order of magnitude impacts based on the two resource management scenario.

The results of this subtask is to compile the findings developed above into a summary table presenting each factor, estimated cost impact and number of years until risk is significant. The matrix will provide a single set of summary tables presenting a range of possible outcomes.

Subtask 4.3 – Develop Groundwater Protection Plan

The Groundwater Protection Plan will address the key issues identified in the approach and will integrate the elements discussed in the preceding work plan tasks. There are essentially two parts to the Groundwater Protection Plan: (1) recommendation of best management practices, and (2) development of a groundwater monitoring program.

Existing water quality data and the review of existing monitoring efforts will guide the development of a monitoring program. The objective of the monitoring plan will be to facilitate ongoing data collection (location, frequency, responsibility). A work plan that presents a streamlined approach for utilizing existing data and filling in gaps, if any, will be developed. The characterization of the aquifer and evaluation of the potential for groundwater degradation will provide the basis for the initial scoping of the plan.

For best management practices, this task will provide recommendations increasing awareness of the resource protection necessary to provide for the sustainable high quality groundwater supply in Mendocino. Best management practices may include:

- Monitor changing water quality for early indicators of problems
- Well head protection considerations for existing and future well siting activities
- Additional groundwater analysis and monitoring in the vicinity of any identified existing water quality issues identified during this study.
- Collaborative opportunities working with potential responsible parties and stakeholders to manage or mitigate identified water quality issues.

Based on the vulnerability analysis, a groundwater protection plan will be developed for planning to regularly monitor groundwater quality going forward, and to provide guidelines on future well installation, and provide a plan on how to address water quality concerns for wells that are not currently up to well standards.

Task 5 – Technical Report

A concise technical report will be prepared that documents the work completed in Tasks 1 through 4. The report will succinctly present the project findings as well as recommended actions for the Groundwater Protection Plan. Task 5 will include developing a draft report for review and production of the final technical report to MCCSD and DWR, as per specifications in the grant funding agreement. MCCSD will maintain an electronic library of the report, mapping, GIS shapefiles, and groundwater model input and output datasets.

Subtask 5.1 – Draft Technical Summary Report

This task includes preparation of a draft technical report to document the work completed in Tasks 2 through 5. The report will also include consolidated findings and any recommended actions in response to the water quality risk assessment. The deliverables will include a draft report for review in a workshop setting to prioritize findings.

Subtask 5.2 – Final Technical Summary Report

A final report will be produced and distributed to MCCSD and DWR as specified in the grant funding agreement. MCCSD will maintain an electronic library of the report, mapping, shapefiles and groundwater model data input and output sets for use by interested parties moving forward.

Task 6 – Project Coordination, Meetings and Presentation

Task 6 provides general project management efforts required to organize the project team, assign and control work, prepare and submit invoices, and report progress to DWR. The work in this task includes developing and maintaining schedules, project status meetings, and compliance with Quality Assurance/Quality Control (QA/QC) procedures. Time is included for one Project Coordination Meeting and a Stakeholder Outreach Meeting at the conclusion of the Project in Mendocino. Senior staff not directly involved in the project work shall provide QA/QC review of key aspects and provide independent peer review. The objective of this task is to ensure that QA/QC procedures are followed, to discuss potential problems, to review and evaluate alternatives, and to confirm the schedule for internal review of work products.

Subtask 6.1 – Project Management

The objective of this task is to provide program supervision and coordination of the project team(s) for the duration of the work to ensure timely and successful project completion. The work in this task includes developing and maintaining schedules, project status meetings, and compliance with Quality Assurance/Quality Control (QA/QC) procedures. This effort is further described to include the following discrete elements.

Subtask 6.2 – Project Coordination

The purpose of this task is to schedule and conduct project coordination with MCCSD project team members, and DWR. It is assumed that project coordination teleconferences will be completed quarterly, for a total of four (4) teleconferences over the project duration. The teleconferences will include a study “kickoff” introductory teleconference before the water quality sampling for Task 1, a project mid-point teleconference to provide a progress update for Tasks 2 and 3, and a project findings meeting to discuss the results of the meeting before the completion of the technical report.

Kennedy/Jenks uses the C&CR to validate the project concept and criteria being used early with an independent group of experts. This review shall provide the project manager with the opportunity to review the project concept with the consultant team and gain input and contributions to enhance the execution of work. The review focus shall be on technical and value engineering solutions and suggestions for the project team.

Subtask 6.3 – Stakeholder Outreach

The results of the water quality assessment and groundwater protection plan will be presented to the District Board during a public meeting in Mendocino. The objective of this subtask is to provide outreach to a broader group of project stakeholders.

Project Deliverables

The DWR will be kept current on District Progress with DWR quarterly reports and interim project deliverables. A final comprehensive report will document all completed work and summarize information included in the interim reports.

Project Deliverables include:

1. Quarterly Progress Reports
2. Groundwater Quality Sampling Report after each sampling event
3. Interim Task 1-4 Technical Report with Groundwater Protection Plan recommendations.
4. Final Comprehensive Report

Progress and Performance Evaluation

The objectives of each task are identified in the Work Plan, and are specific and measurable, which will permit a formative evaluation to access initial and ongoing project activities. Project progress and performance may be evaluated through quarterly DWR progress reports and interim task reports.

A summative evaluation will be used to measure project outcomes following completion of the grant Project. The Final Comprehensive Report will discuss stated goals and task objectives that were achieved by the Project.

CEQA Compliance

Following notification of a grant award, MCCSD will submit a CEQA Categorical Exemption under Sections 15262, 15301, and 15306 (Exhibit 1). The CEQA documents will be submitted to the State Clearing House and the Mendocino County Recorder’s Office for posting in January 2013.

No other applicable environmental permit or any other regulatory approval is required for the Project.

Kennedy/Jenks
Standard Operating Guideline
Groundwater Sampling

Exhibit 1

Introduction

This Standard Operating Guideline (SOG) provides the procedures typically followed by Kennedy/Jenks Consultants personnel during the collection of groundwater samples from monitoring wells. Groundwater sampling from temporary boreholes (e.g., grab groundwater samples collected from direct push borings) is not addressed by this SOG. This SOG provides guidance on procedures that are generally consistent with standard practices used in environmental sampling. Federal, state and/or local regulatory agencies may require groundwater sampling procedures that differ from those described in this SOG and/or may require additional procedures. As guidance, this SOG does not constitute a specification of requirements for groundwater sampling. Deviations from, and additions to, the procedures described herein may be appropriate based on project-specific sampling objectives, site-specific conditions, and/or regulatory requirements. The user of this SOG should modify the sampling procedures used, as appropriate, to conform to the project-specific requirements and then document such deviations from this SOG in the project-specific documentation of groundwater sampling activities.

This SOG does not address Quality Assurance/Quality Control (QA/QC) procedures for groundwater sampling in detail. While some general QA/QC procedures are addressed, project-specific QA/QC procedures should be developed and presented in a Quality Assurance Project Plan (QAPP), field sampling and analysis work plan, or other project- or activity-specific document.

This SOG contains the following sections:

- Field Equipment/Material
- Typical Procedures for Monitoring Well purging and Groundwater Sampling
- Stabilization Criteria for Adequacy of Monitoring Well Purging
- Typical Procedures for Groundwater Sampling using Passive Diffusion Bags (PDBs)
- Quality Control Guidance
- Investigation-Derived Waste (IDW) Management
- References

Field Equipment/Materials

Material/equipment typically required for the collection of groundwater samples from monitoring wells may include:

- Electric water-level monitoring probe
- Multi-phase interface monitoring probe

- Bladder pump, peristaltic pump, pre-cleaned, disposable, 2- or 4-inch bailers with disposable cord, inertial pump, submersible pump, passive diffusion bags or other suitable apparatus for purging the well and sampling
- Flexible discharge tubing [polyethylene (PE), Teflon™, or similar]
- Purge water collection container
- Multi-parameter water quality meter (temperature, pH, specific conductance, redox potential)
- Turbidity meter
- Flow-through cell
- Nitrocellulose filters (if conducting field filtering)
- Sample containers (laboratory-supplied) with appropriate preservatives
- Additional chemical preservatives (if necessary)
- Watch or stopwatch
- Sample labels, pens, field logbook, or other appropriate field forms (e.g., groundwater purge and sample forms, chain-of-custody forms), and access agreements and third-party sample receipts (if warranted)
- Previous purging and sampling data for monitoring wells to be sampled, including water levels, purging parameters, and laboratory analysis results.
- Monitoring well boring and construction log (including wellhead elevation survey and reference point information)
- Personnel and equipment decontamination supplies
- Sample shipping and packaging supplies
- Personal protective equipment as specified in the Health and Safety Plan (HASP).

Typical Procedures for Monitoring Well Purging and Groundwater Sampling

1. **Pre-Purging Data Collection and Purging Equipment Placement.** Record the data and information collected during this procedure on a groundwater purge and sample form. Perform the following prior to groundwater sampling:
   a. Calibrate the multi-parameter water quality meter, prior to beginning sampling and as necessary based on field conditions, in accordance with the instructions in the manufacturer's operation manual. Note that it may be appropriate to keep a written log of the calibration procedures and an instrument maintenance with the instrument.
   b. Examine the monitoring well to be sampled and associated protective surface enclosure for any structural damage, poorly fitting caps, and leaks into the inner casing. If notable conditions exist, they should be recorded on the sampling log for the well so that any necessary follow-up corrective actions can be planned and implemented.
   c. Record an initial measurement of the depth to water. Calculate the volume of water in the well casing if wetted-casing-volume-based purging is to be used to remove the so-called "stagnant water" from the well prior to sampling. The volume of water in the

wetted well casing should be calculated using the formula: V = (π r^2) x L where r is one half of the inner diameter of the well casing/screen and L is the length of wetted casing/screen (calculated by subtracting the depth to water from the total well depth). Total well depth should not be measured at the start of a sampling event (due to the potential to cause turbidity). Measure the total well depth after sample collection. Note that some regulatory agencies require that the calculated “stagnant water” volume include the water contained in the pores space of the wetted portion of the monitoring well filter pack in addition to the casing/screen. If this is a requirement, it should be defined in the project-specific sampling requirements.

d. If light non-aqueous phase liquid (LNAPL) is potentially present, measure the depth and thickness of the LNAPL and the static water level using a multiphase interface monitoring probe. Use one of the following devices for purging:

a. Bladder pump: adjust the pump intake at a depth approximately equal to the middle or just slightly below the middle of the well screen interval or water column unless another position is justified based on site-specific conditions.

b. Peristaltic pump: place the pump intake at a depth equal to the approximate middle or just slightly above the middle of the well screen interval or water column unless another position is justified based on site-specific conditions. Note: If degassing of water is occurring when sampling with a peristaltic pump, alternative types of sampling equipment should be used for volatile organic compound (VOC) or volatile petroleum hydrocarbon (VPH) sample collection.

c. Inertial pump: place the pump intake at a depth approximate to the middle or just slightly below the middle of the well screen interval or water column unless another position is justified based on site-specific conditions. Note: Some studies suggest that the use of inertial pumps for purging and/or sampling may produce a low bias when collecting samples for VOC and VPH analyses. This should be considered along with regulatory requirements when selecting an inertial pump for purging and/or sampling.

d. Submersible pump: place the pump intake at a depth approximate to the middle or just slightly below the middle of the well screen interval unless another position is justified based on site-specific conditions.

e. Pre-cleaned or disposable bailers. Note: The use of bailers for low-flow purging/sampling is not appropriate.

f. Another suitable purging/sampling device may be selected for use depending upon project requirements.

2. **Monitoring Well Purging and Sampling.** When purging of a monitoring well prior to sampling is appropriate and/or required, purge the well using either (a) wetted-casing-volume-based purging or (b) low-flow purging as described in the following sections. If a well exhibits evidence of slow recharge, or produces excessively silty water, etc., the well may need to be redeveloped.

   a. Wetted-casing-volume-based purging.

      (1) Establish a purging rate to pump or bail approximately three wetted-casing volumes of groundwater without dewatering the well.

      (2) If using a pump, set-up the discharge tubing, flow-through cell, water quality meter, and purge water collection container. If turbidity is measured, collect the sample for turbidity measurement after groundwater passes through the flow-through cell in the

vial provided with the turbidity meter. If using a bailer, maintain a clean plastic container next to the well for collecting observation samples. Begin purging the well.

(3) At the beginning of purging and periodically thereafter, record the following information and water quality parameters/observations on the groundwater purge and sample form: As guidance, field parameters may be measured after one purge volume is removed and every ½ purge volume thereafter.

- Date and time
- Purge volume and/or flow rate
- Water depth
- Temperature
- pH
- Specific conductance
- Dissolved oxygen
- Oxidation-reduction potential (ORP)
- Other observations as appropriate (turbidity, color, presence of odors, sheen, etc).

(4) Continue purging until water quality parameters have stabilized (refer to "Stabilization Criteria for Adequacy of Monitoring Well Purging" below) and/or a minimum of three wetted-casing volumes of water have been removed from the well. If a well purges dry, let it recover to 80 percent of original water column, then sample. If the well takes a very long time to recover (i.e., longer than 2 hours), try to sample the well at the end of day or first thing the next day.

(5) Collect the sample in pre-cleaned sample containers suitable for the laboratory analyses to be performed.

(6) If sampling using a bailer, use a bottom-emptying device or other technique to avoid sample agitation. If the collected water is very turbid, or a bottom-emptying bailer is not used, properly transfer the water from the bailer into the appropriate sample containers. Be careful to avoid agitating the sample. When sampling for VOCs, turn the bottle upside down after filling the container to identify possible headspace. If bubbles are present, top off the sample container or resample.

b. Low-flow purging and sampling.

(1) Place the pump intake at a depth equal to the approximate middle or just slightly above the middle of the well screen interval or water column or otherwise as dictated by well-specific soil stratigraphy and project-specific requirements. For example, it may be appropriate that the pump intake be set opposite to any preferential flow pathways (i.e., zones of higher permeability).

(2) Place an electronic water-level indicator probe in the well, approximately 0.5 to 3 inches below the piezometric surface. If available, a transducer of sufficient accuracy can also be used to measure depth to water when purging.

(3) Connect the pump discharge tube to a flow-through cell housing a water quality parameter probe.

(4) Activate the pump for purging at a flow rate ranging from approximately 0.1 to 0.5 liters per minute (L/min) or other flow rate as dictated by project-specific and/or site-specific requirements. (Note: Some regulatory agencies may require specific

flow rates). Determine the flow rate by timing the rate at which the flow-through cell is filled.

(5) During purging, monitor the water level in the well to evaluate potential drawdown. The goal is to minimize drawdown to less than approximately 4 inches. If drawdown is observed (especially rapid drawdown at the beginning of purging), decrease the pumping rate.

(6) Measure water quality parameters at approximately 3- to 5-minute intervals during purging. Continue purging until water quality parameters have stabilized (refer to “Stabilization Criteria for Adequacy of Monitoring Well Purging” below)

(7) Immediately after purging, collect the sample in pre-cleaned sampled containers suitable for the laboratory analyses to be performed using the same flow rate that was used during purging unless it is necessary to decrease the rate to minimize aeration or turbulent filling of sample containers. If sampling for VOCs or VPH reduce the flow rate to 0.1 L/min or less.

3. **Sampling with LNAPL Present in a Monitoring Well.** Wells containing LNAPL are typically not sampled for dissolved phase constituents in groundwater due to the potential for entrainment of LNAPL in the aqueous sample matrix. If such sampling is required, and purging is not required, make sure the pump intake is placed in the upper 2 feet of water column and collect the samples without purging in a manner that reduces the potential for mixing of the groundwater sample with air or LNAPL. If groundwater sampling is required from wells containing LNAPL for the purposes of characterizing VOCs, and purging is required, purge the well prior to sampling unless or until LNAPL becomes entrained in the sampling apparatus. If LNAPL will likely become entrained in the groundwater, the sample should be collected without purging. If LNAPL becomes entrained in the sampling apparatus then the sampling effort for VOCs should be aborted.

4. **Field Filtering Groundwater Samples.** Groundwater sample filtering and/or preservation should be performed in accordance with the requirements of the analytical method being specified and any other project-specific requirements. For example, samples collected for dissolved metals are typically filtered using a 0.45 µm filter.

5. **Sample Collection Considerations.** When multiple analyses will be performed, collect the samples in order of decreasing sensitivity to volatilization (i.e., VOC samples first and metals last). When sampling for VOCs, turn the sample container upside down after filling to identify possible headspace. If bubbles are present, top off the sample bottle or resample (do not reuse bottles, especially if they have been pre-preserved by the vendor or laboratory). If possible, the pump should not be moved or turned off between purging and sampling; however, the pump may need to be turned off for a very brief period (as a practical matter) so field personnel can handle samples and minimize the potential for water to splash on the ground surface. The ground surface should be protected from incidental splashing, especially if water from the well would be considered a hazardous waste for disposal purposes.

6. **Monitoring Wells with Slow Recharge.** If a well purges dry, let it recover to 80 percent of original water column, then sample. If the well takes a very long time to recover (i.e., longer than 2 hours), try to sample the well at the end of day or first thing the next day.

7. **Sample Container Filling and Shipping.** Fill the appropriate containers for the analyses to be requested and ensure that the required label information is completely and accurately filled in. Follow sampling packaging, shipping, and chain-of-custody procedures (see applicable SOG).

8. **Decontamination.** Follow personnel and equipment decontamination procedures (see applicable SOG).

Stabilization Criteria for Adequacy of Monitoring Well Purging

Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EPA 2001) states that "with respect to groundwater chemistry, an adequate purge is achieved when pH, specific conductance, and temperature of groundwater have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). Wells should be considered stable when the criteria listed in the following table have been met for pH, specific conductance, temperature, and turbidity. Attempts should also be made to stabilize ORP and dissolved oxygen.

Field Parameters	Stabilization Criteria for Three or More Consecutive Readings	Notes
pH	Difference between three or more consecutive readings is within ±0.2 units	–
Temperature	Difference between three or more consecutive readings is constant	–
Specific Conductance	Difference between three or more consecutive readings is within ±3%	–
Turbidity	Difference between three or more consecutive readings is within ±10% or three consecutive readings below 10 NTUs	Generally, turbidity is the last parameter to stabilize. Attempts should be made to achieve stabilization; however, this may not be possible. It should be noted that natural turbidity in groundwater may exceed 10 NTUs. If turbidity is greater than 50 NTU, redevelopment of the well may be warranted.
ORP	Difference between three or more consecutive readings is within ±20mV	Very sensitive. Attempts should be made to achieve stabilization; however, due to parameter sensitivity this may not be possible.
Dissolved Oxygen	Difference between three or more consecutive readings is within ±10% or ±0.2 milligrams per liter (mg/L), whichever is greater	Very sensitive. Attempts should be made to achieve stabilization, especially when collecting samples of VOC analysis; however, due to parameter sensitivity this may not be possible.

Attempts should be made to achieve the stabilization criteria. Because of geochemical heterogeneities in the subsurface environment, stabilization of field parameters during purging may not always be achievable. If field parameter measurements do not indicate stabilization, continued conventional purging may be required until a minimum of three wetted-casing volumes have been removed. During low-flow purging of a well containing a large volume of casing water, it may be practical to discontinue low-flow purging and proceed with sampling if field parameters have not stabilized within a reasonable period. This judgment must be made on a site-specific/project-specific basis.

Quality Control Guidance

Follow the quality control requirements specified in the Quality Assurance Project Plan (QAPP), project-specific field sampling and analysis work plan, and/or project-specific regulatory requirements, as applicable. The following may be used as guidelines.

1. Approximately one duplicate sample should be obtained for each sampling event or for each batch of samples (a batch is typically defined as 20 samples). Collect duplicate samples immediately after the original samples are collected. Purging is not performed between original sample collection and collection of duplicate samples. Original and duplicate samples are collected sequentially, without appreciable delay between collection cycles. Duplicate samples are to be submitted to the laboratory blind (i.e., not identified as a duplicate sample).
2. Typically, at least one type of field blank sample (rinsate or transfer) should be collected per day of water sampling. All field blank samples are to be collected, preserved, labeled, and treated like any other sample. Field blank samples are to be sent blind to the laboratory (i.e., not identified as a field blank). Record in the field notebook the collection of any blank sample (rinsate, transfer, trip). The types of field blank samples are discussed below.
    a. Rinsate blank samples. If rinsate field blank samples are required, prepare the sample by pouring deionized water over, around, and through the various reusable sampling implements contacting a natural sample. Rinsate blanks need not be collected when dedicated sampling equipment is used for purging and sampling the well. Rinsate blank samples are to be analyzed for the same parameters as the environmental samples.
    b. Transfer blank samples. Transfer blank samples are routinely prepared when no rinsate blank samples are collected. (The purpose of a transfer blank sample is to monitor for entrainment of contaminants into the sample from existing atmospheric conditions at the sampling location during the sample collection process.) A transfer blank sample is prepared by filling a sample container(s) with distilled or deionized water at a given sampling location. Transfer blank samples are to be analyzed for the same parameters as the environmental samples.
    c. Trip blank samples. Trip blank samples are submitted for VOC analysis to monitor for possible sampling contamination during shipment as volatile organic samples are susceptible to contamination by diffusion of organic contaminants through the Teflon-faced silicone rubber septum of the sample vial. Trip blank samples are prepared by the laboratory by filling VOA vials from organic-free water and shipped with field sample containers. Trip blank samples accompany the sample bottles through collection and shipment to the laboratory and are stored with the samples. It is suggested that a trip blank sample be included in each cooler of samples submitted for VOC analysis.

Investigation-Derived Waste (IDW) Management

Purge water is to be contained onsite in an appropriate labeled container for disposition by the client unless other project-specific procedures are defined. Other investigation-derived wastes, such as personal protective equipment, are to be properly handled and disposed. Preferably, PPE IDW should also be containerized and left onsite for disposal by the client. As a matter of practice, any waste, or potential waste, generated onsite, should remain onsite. Refer to the IDW SOG.

References

ASTM. 1999. Designation: D 6452 - 99. Standard Guide for Purging Methods for Wells Used for Ground-Water Quality Investigations. Copyright ASTM, West Conshocken, PA.

ASTM International. 2002. Designation D 6771 – 02. Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations. Copyright ASTM International, West Conshocken, PA.

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