Attachment 5- Workplan

Humboldt Bay Municipal Water District Groundwater Study

DWR Local Groundwater Assistance Grant Program, P84 LGA 2012 Application

BMS Electronic File: “Att5_LGA12_HBMWD_WrkPln_1of1”

Humboldt Bay Municipal Water District

Groundwater Study Workplan

July 2012

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1.0 INTRODUCTION

Humboldt Bay Municipal Water District (HBMWD) is located in Humboldt County and serves the Humboldt Bay region, which is the most heavily populated and developed part of Humboldt County. HBMWD was established in 1956 to provide domestic and industrial water to various municipal agencies and industrial water users.

HBMWD manages groundwater resources within the Mad River Basin and is contracted to provide wholesale drinking water to the cities of Eureka, Arcata and Blue Lake, as well as the Community Services Districts of McKinleyville, Fieldbrook/Glendale, Humboldt and Manila. In addition, HBMWD serves a limited amount of retail and industrial customers through its filtered water system. The total current population served by HBMWD is approximately 88,000 people. HBMWD currently delivers an average of approximately 12 million gallons per day (MGD) with a peak daily use of approximately 16.5 MGD and a peak instantaneous use of approximately 20 MGD through five (5) Ranney collectors (Collectors 1, 1A, 2, 3, and 4), herein referred to individually or as Collectors, adjacent to the Mad River. The Ranney collectors draw water from an aquifer 100 feet below the Mad River and have a known peak sustained capacity of 17.1 MGD.

HBMWD's Ranney collectors are the heart of the water delivery system and are critical to HBMWD's mission of providing reliable, high quality drinking water to their customers. The Collectors are currently over 50-years old and the summer time peak instantaneous demand exceeds their capacity. Peak daily demand is also fast approaching the Collector's maximum capacity. Replacement of laterals is necessary to HBMWD primarily to meet current and future contracted demands. If the installation of replacement and new laterals provides an additional supply it will be an additional benefit, but is not the primary purpose.

HBMWD has undertaken a systematic approach to assess the condition of the collectors and plan for their replacement as well as maintain and increase their capacity. In the mid-1990's, HBMWD established goals to develop information for the longevity of the system and to look for ways to increase system yield.

Video inspections of the collectors in 1996 and again in 2002 for Collector 2 showed that the existing carbon steel laterals are coated with calcification nodules and the wall thickness of the screens has seriously degraded. Some of the laterals had already collapsed. The rehabilitation of Collector 2, though removal of the calcification and cleaning of the screens in 2005, improved the production and decreased the drawdown in the caisson slightly, but was ultimately deemed not a cost effective project. The decision was made to pursue installation of new laterals in the existing Collectors to replace the aging laterals to potentially increase production. Toward this end, an initial groundwater model was developed in 2005 to determine locations within the aquifer in the vicinity of the existing Collectors that could provide additional capacity. This model was used in the development of the HBMWD's Groundwater Management Plan (GWMP). The model was also used in conjunction with HBMWD's strategic planning to develop and guide the Capital Improvement Plan (CIP) for the Collectors.

In 2008 HBMWD updated the initial groundwater model of the area near Collector 3 in preparation for adding new laterals. The groundwater model was integral in the selection of the location for the new laterals in Collector 3 (elevation and direction). The installation of the new laterals at Collector 3 was completed in 2012 and was successful as the capacity at the collector was increased from approximately five (5) MGD to ten (10) MGD and draw down and turbidity reduced. Despite the success in capacity increases, the project identified gaps in the groundwater model. One of the gaps is mapping of the bedrock surface. Two of the laterals installed in Collector 3 hit bedrock outcroppings that were unknown and the laterals had to be terminated at approximately half of the desired length. Detailed stratigraphic information is not available in the vicinity of Collectors 1, 1A, 2, and 4.

While the initial work on the 2005 and 2008 groundwater model met the GWMP goal of improving understanding of basin hydrology, further work is needed. The 2008 groundwater model identified data gaps that need to be addressed to continue the Ranney Collector Rehabilitation program cost-effectively. The proposed groundwater study will build upon the previous information obtained from the 2012

Collector 3 lateral replacement project and historical stratigraphic information to refine HBMWD's understanding of the hydrogeologic conditions in the aquifer serving the Collectors. Of particular interest are aquifer parameters (the depth of the bedrock surface, aquifer dimensions, and hydraulic conductivity) influencing the system design for the rehabilitation of the HBMWD Collectors.

HBMWD proposes to complete a groundwater study. The Groundwater Study will include:

- Perform mapping though monitoring well installation and geophysics of the bedrock around Collectors 1, 1A, 2, and 4
- Update and refine the previously developed groundwater model with additional data near Collectors 1, 1A, 2, and 4 not included in previous groundwater modeling efforts
- Complete a final evaluation to determine the potential yields from Collectors 1, 1A, 2, and 4
- Develop recommendations regarding a Collector for lateral replacement under the broader Ranney Collector Rehabilitation program being developed in the CIP

2.0 GROUNDWATER SCOPE OF WORK

The following tasks will be completed in order to gain a better understanding of the subsurface conditions influencing groundwater near the HBMWD's Ranney Collectors.

Task 1- Monitoring Wells Installation

Data gaps exist in the understanding of groundwater aquifers in the vicinity of HBMWD Collectors 1, 1A, 2, and 4. Additional aquifer characterization will provide useful data in refining the groundwater model. The proposed geologic investigation will begin with review of existing data and background information collected by HBMWD. A total of four (4) soil borings will be installed in the vicinity of Collectors 1, 1A, 2, and 4 to a depth of approximately 100 feet below ground surface (bgs). A monitoring well will be installed in each borehole following exploration to the desired depth. The proposed locations of the monitoring wells are shown on Figure 2 (attached). The exact location of the proposed wells will be determined following review of historical stratigraphic data.

The execution of the work shall be by competent workmen and shall be performed under the direct supervision of an experienced well driller. The drilling method shall prevent the collapse of formation material against the well screen and casing during installation of the borings and monitoring wells. Any drilling fluid additive used shall be inorganic in nature, but be phosphate free. Grease or oil on drill rods, casing, or auger joints is not permitted. The drill rig shall be free from leaks of fuel, hydraulic fluid, and oil which may contaminate the borehole, ground surface or drill tools.

The monitoring wells will be installed using a sonic drill rig. The borings and monitoring well shall be drilled straight, plumb, and circular from top to bottom. During construction of the monitoring wells, precautions shall be used to prevent tampering with the well or entrance of foreign material. Runoff shall be prevented from entering the borings and monitoring wells during construction. If there is an interruption in work, such as overnight shutdown or inclement weather, the well opening shall be closed with a watertight uncontaminated cover. The cover shall be secured in place or weighted down so that it cannot be removed except with the aid of the drilling equipment or through the use of drill tools.

The total depths and screen intervals for the proposed monitoring wells will be based on the depth of the existing lateral well screens in the aquifer. Table A, below, presents the depth of the existing laterals at each Collector:

Table A: HBMWD Ranney Collector Lateral Depth

Ranney Collector	Surface Elevation (feet msl)	Lateral Elevation (feet msl)	Lateral Elevation (feet bgs*)
1	23.0	-38.7	61.7
1A	40.5	-30	70.5
2	25.0	-62	87.0
3	30.0	-30.9	60.9
4	35	-37	72

*bgs- below ground surface

The monitoring wells will be developed (by surging and pumping) and surveyed. Following monitoring well development, a series of 24-hour pump tests utilizing various different pumping scenarios will be completed. The full scope for the monitoring well installation is described in the subtasks below.

Task 1.1- Pre-Field Work Activities

The following activities will be completed prior to the monitoring well installation:

- A geologist will confirm the data gaps and compile the information on site plans to aid in finalization of the location of the proposed monitoring wells and geophysics transects.
- The monitoring well installation will comply with California Environmental Quality Act (CEQA) requirements.
- A monitoring well installation permit will be obtained from the Humboldt County Division of Environmental Health (HCDEH). The HCDEH will be notified of the proposed field activities at least five (5) days in advance.
- The site and proposed monitoring well locations will be pre-marked in white paint per Underground Services Alert (USA) specifications approximately 72-hours prior to the start of the monitoring well installation. Notification to USA will be completed a minimum of 48-hours prior to the start of monitoring well installation activities.

Site Specific Health and Safety Plan

A Site Specific Health and Safety Plan (SSHASP) will be prepared to minimize the threat of serious injury to workers engaged in monitoring well installation activities while performing site work under this workplan. Onsite personnel will conduct tailgate safety meetings at the start of each workday. A tailgate safety meeting will be completed as new personnel arrives onsite. A copy of the SSHASP will be accessible onsite during working hours.

Task 1.2- Soil Boring Installation

The soil borings will be installed using a sonic drill rig. Soil borings will be installed to a proposed total depth of approximately 100 feet bgs. Soil borings will be continuously cored to the anticipated proposed depth of approximately 100 feet bgs. A registered geologist will describe soil from each boring according to American Society for Testing and Materials (ASTM) D2488-09a, *Description and Identification of Soils*. Soil color will be described according to a Munsell Soil Color Chart. A log of the stratigraphic data collected from each soil boring will be prepared.

Task 1.3- Monitoring Well Installation

The monitoring wells will be installed by a licensed C-57 drilling contractor in conformance with California Water Code (CWC) Sections §13700 through §13806. A minimum standard for the construction and demolition of wells is specified in California Department of Water Resources (DWR) Bulletins 74-81 and 74-90, which will be followed by HBMWD. The proposed monitoring wells will be constructed of four (4)-inch diameter blank and screened polyvinyl chloride (PVC) well casing. The total depth and screen intervals for each of the proposed monitoring wells are based on the existing Collector laterals and identified in Table B (below):

Table B: Proposed Monitoring Well Screen Intervals

Proposed Monitoring Well	Proposed Location	Proposed Screen Interval (feet bgs)
1	Near Collector 1A	50 to 70
2	Near Collector 2	65 to 85
3	Near Collector 2	65 to 85
4	Near Collector 4	50 to 70

Blank casing pipe, well screens, and joint couplings shall be of compatible materials throughout each well. The inside diameter of any temporary casing used shall be sufficient to allow accurate placement of the screen, riser, filter pack, seal, and grout. After the well screen and blank casing have been set, the approved filter pack shall be constructed around the screen by filling the entire space between the screen and the wall of the hole in with filter pack material. A tremie pipe shall be lowered to the bottom of the well between the borehole and screen. The tremie pipe shall be arranged and connected, at the surface of the ground, so that water and filter material, fed at uniform rates, are discharged as the filter material fills the borehole from the bottom up.

The monitoring wells will be constructed with approximately 20 feet of four (4)-inch PVC with a screen size of 0.040-inch factory-slotted well screen. A uniform filter pack of Cemex #2/12 washed silica sand will be placed within the annular space from approximately two (2) feet above the top of the screen interval to the bottom of the screen interval. A four (4)-foot thick seal of hydrated bentonite pellets will be placed over the filter pack, a surface/sanitary seal of cement will be placed to within one (1) foot of the surface and finished with one (1) foot of concrete.

The new monitoring wells will be protected by above grade stovepipes set in concrete and expandable well plugs with a locked cap. The horizontal location and top of casing and ground surface elevations at each new monitoring well were surveyed as described below.

Monitoring Well Development

The new wells will be developed a minimum of 72-hours after installation of the sanitary seal. Monitoring well development will be completed by the drilling contractor. The monitoring wells will be developed per CWC Sections §13700 through §13806.

The well shall be developed until the water pumped from the well is substantially free from fines, and until the turbidity is less than five (5) nephelometric turbidity units (NTUs). Developing equipment shall be of an approved type and of sufficient capacity to remove all cutting fluids, sand, rock cuttings, and any other foreign material. The well shall be thoroughly cleaned from top to bottom before beginning the well tests. Development shall be performed using only mechanical surging, over pumping, or jetting, or a combination thereof in accordance with ASTM D5521. At the time of development of any well, the well shall be free of drawdown or surcharge effects due to pump testing, developing, or drilling at another location.

Monitoring Well Survey

Top-of-casing (TOC) and ground surface elevations will be surveyed to the nearest 0.01 foot above mean sea level (msl) relative to the North American Vertical Datum of 1988 (NAVD88). Horizontal well locations will be surveyed relative to State Plane Coordinate System in degrees latitude/longitude to seven (7) decimal places relative to the North American Datum of 1983 (NAD83).

Task 1.4- Bedrock Outcrop and Seep Mapping

A registered geologist will complete site reconnaissance to identify bedrock outcrops and seep faces present in the vicinity of Collectors 1, 1A, 2, and 4. The latitude and longitude of the location of bedrock outcrops and seeps will be mapped using a hand-held Trimble unit. Bedrock outcrop and groundwater seep locations will be incorporated into data assessment and revision of the groundwater model.

Task 1.5 Aquifer Characterization and Pump Testing

The existing Collectors and the new monitoring wells will be used to gather depth to groundwater and drawdown levels during various pumping scenarios to aid in model calibration. HBMWD Collectors 1, 1A, 2, 3, and 4 will be utilized as pumping wells.

A temporary pump (submersible or jet type) with a capacity sufficient to deliver the required pumping rate will be utilized in the pump test. The pumping rate will be determined following the monitoring well installation The pump shall be connected to the pump controls by a three-wire drop line. Piping for the well drop line shall be either polyethylene plastic pipe conforming to ASTM D2239 or galvanized steel pipe conforming to ASTM A53/A 53M. The pump shall operate on either 230 volts, 60 Hertz (Hz) or three-phase power. The motor shall be of sufficient size to operate the pump under the maximum operating conditions without exceeding its rating. Pump shall be equipped with necessary controls to provide for automatic operation of the pump. The pump and motor unit shall be no larger than three (3)-inches in diameter at any point.

This test should be used to verify that the well is developed properly and will produce the required yield. The test pump should be capable of a range of pumping rates, varying from about 50 percent to about 200 percent of the design capacity of the well.

An eight (8)-hour step-drawdown capacity test shall be run with the pumping rate and drawdown at the pump well and observation wells recorded every 30 seconds during the first five (5) minutes after starting the pump; then every five (5) minutes for an hour; then every 20 minutes for two (2) hours. From this point on, readings will be taken at hourly intervals, until the water level stabilizes.

Monitoring wells shall be read on the same schedule as the pumping location(s). During the step-drawdown test, the pumping rate shall be increased in steps at regular, two (2)-hour intervals. Specific capacity shall be measured for each step. The test shall begin at the rate of the expected capacity of well and maintained throughout the duration of the step interval. The well shall be "step" tested at rates of approximately 1/2, 3/4, 1, and 1 1/2 times the design capacity of the well. If this capacity cannot be maintained for the test period, the capacity test shall be terminated and the test hole drilled deeper or relocated as directed. When the pump is shut off, water level readings shall be taken during the rebound period for the same intervals of time as the drawdown test. Capacity testing parameters will be finalized following the monitoring well installation.

Task 1 Deliverables

- Boring and monitoring well construction logs
- Pump test field data sheets
- Site map with identification of bedrock outcrops and groundwater seeps
- Latitude, longitude, and elevation of the ground surface and top of casing at each monitoring well

Task 2- Geophysical Investigation

A seismic reflection and resistivity survey will be completed to measure the thickness, depth, and configuration of the geological layers of aquifer around Collectors 1, 1A, 2, and 4. This information will be used in refinement of the conceptual groundwater model, the establishment of bedrock locations, and design of the installation of new laterals. The geophysical investigation will be completed by a licensed geophysical company with a registered professional geo-physics license.

Seismic Reflection Equipment

The seismic reflection equipment used during this investigation would likely consist of a 72-channel Geometrics StrataVisorNZII 24-bit seismic data recorder (StrataVisor), 40-hertz (Hz) vertical geophones and cables, and accessories. A Geometrics PRS-1 “Urban Seismic” swept impact source or a 20-lb sledgehammer will be used as the seismic p-wave source. The electrical resistivity imaging (ERI) equipment used during this investigation will consist of an Advanced Geosciences, Inc. SuperStingR8/IP automated resistivity system with associated cabling, power and associated accessories, and processing software to interpret the data.

Task 2.1- Geophysical Field Work
Prior to direct current (DC) electrical resistivity data acquisition, the geophysics crew will use a survey chain to establish six (6) transects. The approximate location of each transect is shown on Figure 2 (attached). It is anticipated that transects will bisect each of the Collectors to define the aquifer thickness at approximate 30, 60, and 90-degree angles to each collector. Each line will have an electrode spacing of approximately four (4) meters and will have a length of up to 120 meters (space permitting). Once the stakes are established, the resistivity cable with passive electrodes will be attached to each stake with a rubber band to form the electrical circuit.

It is anticipated that data from the six (6) seismic and six (6) electrical resistivity transects will be collected at the site, where (depending on site restrictions) each seismic array will consist of a linear, "broadside T" or a cross-pattern array of 72-channels with geophones spaced at five (5)-foot intervals.

Task 2.2- Geophysical Report
Once the field data is collected, the data will be processed and analyzed. A geophysical final report will be complied with descriptions of the methods used and locations of the installed transects. The reflection sections with interpreted features of interest and key reflectors will be provided for each line of data acquired. The resistivity data will be used to create a color-contoured model section for each transect that represents the subsurface materials. The geophysical final report will contain cross-sectional profiles of each of the transect locations showing depths of various lithological layers and top of bed rock. Conclusions from the geophysical final report will be included in the groundwater model.

Task 2 Deliverables

- Final Transects Map
- Final Geophysical Report

Task 3- Groundwater Modeling
HBMWD developed a groundwater model that it uses to assist in managing and optimizing water production. The groundwater model is a management and design tool to assess actual or speculative aquifer and water quality impact scenarios under various pumping conditions. The groundwater model will be utilized to analyze the installation of new laterals in the existing Collectors, optimize lateral locations, and understand the interaction/interference between Collectors.

The HBMWD groundwater model is a MODFLOW-based hydrologic modeling system, MODFLOW-SURFACT (MODFLOW). This model was specifically developed to ensure meaningful results and predictive capability in the regions where the interactions between the surface and groundwater are closely coupled such as near the HBMWD Collectors on the Mad River. MODFLOW combines fully integrated hydrologic water quality subsurface flow and transport capabilities with Graphic Information Systems (GIS) capabilities under a graphical user interface.

The refinement of the groundwater model for the Mad River basin near the Collectors will build upon the existing model and incorporate the results of the proposed monitoring well installation, pump testing, and geophysical investigation. Subsurface bedrock boundaries and site hydrologic conditions will be defined by geologic and geophysical investigations. Monitoring well lithological data and pump test data will be used during model calibration and validation.

The modeling methodology used for the aquifer parameters and scenarios analyzed will be reported in the Groundwater Study Report. Recommendations will be made with respect to the location and total length of proposed laterals to be installed in Collectors 1, 1A, 2, and 4. This information will then be utilized to move into the next phase, design of new lateral installation, which is not included in this proposed workplan.

Task 3.1- Model Update

The new data will help refine the model domain and discretization. The previous model domain covered an area approximately 5,800 feet by 2,600 feet with 100-foot grid spacing that decreased to a finer resolution of between approximately 25 and approximately 50 feet approaching the Collectors. It is anticipated that with new data, the updated model domain will be able to cover an area over four (4) times as large, measuring approximately 11,000 feet by 6,000 feet with grid spacing of 50 feet that decreases to within approximately five (5) feet and approximately 25 feet approaching the Collectors.

The vertical extent of the existing model is comprised of the Holocene River Channel deposits, ranging from the ground surface to the boundary bedrock. This hydrologic unit is divided into eight (8) separate layers in the model to simulate the various zones of the Mad River and the two (2) tiers of laterals present within Collectors. It is anticipated that the vertical layering of the model will not be changed appreciable, but the new geophysical data will allow refinement of the depth of the bedrock surface, updating the bottom boundary condition of the model, particularly around the Collectors, where it will have the most influence on the predictive capability of the model.

Task 3.2- Model Calibration

Once the model is refined with the new subsurface and geophysical data, it will be calibrated and validated through a series of simulations with known and prescribed conditions. During calibration, system parameters will be adjusted to minimize the difference between model outputs and measured values. After the model is calibrated under multiple flow conditions, it will be used as a predictive groundwater management tool. To assure the highest quality and most reliable groundwater model, the completed model will be independently reviewed by a 3rd party sub-consultant.

Task 3.3- Model Scenarios

The work on Collector 3 showed new laterals can improve yield while reducing drawdown. The results of the proposed groundwater study will identify improvement options for the other Collectors, meeting the GWMP goals of enhancing the reliability of groundwater in the area and helping to ensure the long-term availability of high quality groundwater. HBMWD is committed to providing a long-term source of high quality potable water for the residents of Humboldt County. As such, the GWMP is a living document which serves as a tool for strategic planning to assist in balancing strategic planning of capital improvements with protection of the groundwater resource.

Various scenarios will be analyzed with the groundwater model to:

- Estimate the increase in individual and collective capacity possible from the Collector(s).
- Simulate interactions between Collectors 1 and 1A and Collectors 2 and 4.
- Make recommendations for installation of new laterals

Drawdown

To evaluate the impacts on drawdown due to various pumping rates the model will be used to simulate drawdown in the aquifer. The model will simulate drawdown for a given pumping rate. The simulated pumping rate will then be increased and a new drawdown level determined. These results will be used to create pumping rate drawdown curves for various lateral configurations. Several configurations will be simulated: existing lateral configuration with the pump stations pumping separately, 400 feet of additional laterals for Collector 1 with Collectors 1 and 1A pumping together, and 400 feet of additional laterals for Collectors 2 and 4 (each), with each collector pumping separately and concurrently. The interactions between the various configurations will be analyzed and recommendations regarding configurations which yield the most efficient pumping and overall production scenario will be provided.

Individual Collector Capacity

One of the other goals of this groundwater study will be to estimate the maximum individual capacities of each of the Collectors. Pumping rates at Collectors 1, 1A, 2, 3, and 4 will be systematically increased to estimate the maximum individual capacity. Extraction capacity at each collector is limited by two main constraints, the minimum submergence requirement of the pump’s bowl assemblies and increased turbidity at increased drawdown levels. Turbidity is introduced to the groundwater system by creating localized regions of higher vertical infiltration rates. For continued production of high quality groundwater it is advantageous to maintain horizontal flow into the laterals/Collectors. As pumping rates increase, drawdown near the Collectors cause increased vertical flow potential. Vertical flow velocities become the main limiting factor for groundwater production. The model will be used to simulate this flow velocity. Pumping rates will be increased until flow velocities exceed recommended velocities. The anticipated maximum aquifer production rate for each collector will be determined.

Total Collector Capacity
In addition to the individual collector capacity evaluations, a separate analysis will be conducted to estimate the collective capacity of the Collectors. It is critical to consider interference between the Collectors, which is caused when the zones of capture or cones of depression of the collectors overlap. The velocity vectors developed by the model are useful in visualizing the zone of capture and potential interference between pumping of the Collectors. Modeling and operational results indicate that portions of the laterals closer to the pump station caisson wall have a cumulative effect of increasing drawdown near the pump station. This situation could be mitigated by installing fewer but longer laterals (if possible) to achieve the total lateral replacement length. Additionally, laterals could be installed with the screen intervals starting at approximately 15 feet or more away from the caisson wall using regular pipe for the first section in order to reduce velocities near the caisson. The installation and length of this blank pipe will be varied and analyzed with the model. Well interference is very important from an operational perspective since overlapping zones of capture lead to diminishing returns with respect to extraction rates. Once zones begin to overlap, less water is available collectively per unit of energy invested due to interference between the wells. Total extraction from wells experiencing interference is less than the sum of the wells' extraction potential when operating independently. From an energy perspective, it is preferable to operate wells individually or at extraction rates that do not lead to well interference. However, during periods of high demand, it might be necessary to run the wells at high extraction rates with some level of interference. Therefore, the model will be run to estimate maximum pumping rates capable from Collectors 1, 1A, 2, 3, and 4 without exceeding the minimum submergence criterion.

Task 3 Deliverables

- Model calibration results in graphical form
- Third Party Model review summary
- Graphical results from modeled scenarios

Task 4- CEQA Compliance/Permitting

Task 4.1 CEQA Compliance
Activities that will require CEQA compliance are the drilling and installation of the monitoring wells. It is anticipated that a Categorical Exemption will be completed and Notice of Exemption filed by HBMWD for these efforts, which is what HBMWD has done previously on similar efforts.

Task 4.2 Agency Consultation
Consultation with the United States Army Corps of Engineers (USACE), California Department of Fish & Game (Fish & Game), and National Marine Fisheries Service will be completed for approval of monitoring wells that are located below the high water line of the Mad River.

Task 4 Deliverables

- Notice of Exemption stamped by the County Recorder
- Meeting minutes and correspondence with permitting agencies

Task 5- Stakeholder and Local Public Agency Coordination
Throughout the development of the groundwater study, reports will be made on the progress to the HBMWD Board and the public at regularly scheduled HBMWD Board meetings. In addition, preliminary findings will be discussed at quarterly meetings with the HBMWD's municipal customers. Upon completion of the groundwater study, a final public meeting will be held at a regularly scheduled HBMWD

Board meeting to present the results of the study and recommendations for the next phase of Collector rehabilitation.

Task 5.1 Regular Project Updates

Throughout the development of the groundwater study, reports will be made on the progress to the HBMWD Board and the public at regularly scheduled HBMWD Board meetings. In addition, preliminary findings will be discussed at quarterly meetings with the HBMWD's municipal customers.

Task 5.2 Final Public Presentation

Upon completion of the groundwater study, a final public meeting will be held at a regularly scheduled HBMWD Board meeting to present the results of the study and recommendations for the next phase of Collector rehabilitation.

Task 5 Deliverables

- Copies of presentations made to the HBMWD Board of Directors (Electronic PDF)
- Copy of Final Public Presentation (Electronic PDF)

Task 6- QA/QC / Project Management

At the start of the project, a Quality Assurance/Quality Control (QA/QC) Plan will be developed. The QC checks for this project are anticipated to occur at the following points:

- Prior to the performance of field work: The results of the background document review and proposed locations of the monitoring wells and geophysical transects will be evaluated and agreed to by senior review prior to the performance of this work.
- Upon receipt of field data: The preliminary field data will be summarized and reviewed by registered geologists to ensure anomalous data is identified, flagged, and corrected by collection of new data (if possible) prior to inclusion in the groundwater model.
- Upon completion of the groundwater model analysis: The groundwater model and output will be reviewed along with the assumptions and assigned parameter characteristics.
- Upon completion of the Draft Groundwater Study Report: The final draft report will be reviewed internally by senior licensed engineers and registered geologists. A draft report will be presented to HBMWD staff for review prior to finalization.

QA/QC procedures are further described in Attachment 8, Quality, of this DWR Local Groundwater Assistance (LGA) Grant application.

Task 6 Deliverables

- QA/QC Plan

Task 7- Final Groundwater Study Preparation

The Final Groundwater Study will also meet the requirements of the Grant Final Report. The Study will include an executive summary, a comparison of planned schedule in the Grant Agreement and actual timeline and explanation of the differences; a discussion of major problems that occurred in meeting the project goals and objectives how they were resolved. The Study will also contain a detailed description and analysis of project results including whether the purposes of the Project have been met, a summary of the costs incurred, and disposition of funds disbursed.

Task 7.1- Prepare Draft Groundwater Study

A Draft Groundwater Study will be completed by HBMWD. The Draft Groundwater Study will be reviewed by HBMWD prior to finalization. Comments generated from the HBMWD review will be incorporated prior to finalization of the document.

Task 7.2 Presentation
Following HBMWD review of the Groundwater Study, a presentation discussing the work will be prepared for HBMWD Board of Directors, stakeholders, and local agencies. The presentation will serve to educate HBMWD stakeholders and local agencies on the aquifer supporting the local water supply, refinement of the groundwater model through the additional data collected, and recommendations for Collector rehabilitation.

Task 7.3 Final Groundwater Study
Following presentation of the Draft Groundwater Study to the HBMWD Board of Directors, stakeholders, and local agencies, the document will be finalized. Comments generated from the stakeholder and local agency presentation will be included in the final report.

Task 7 Deliverables

- Final Groundwater Study
- Presentation to the HBMWD Board, stakeholders, and public agencies

Task 8- Grant Administration

Task 8.1- Labor Compliance Plan
A Labor Compliance Plan will be completed for administration of the grant funds.

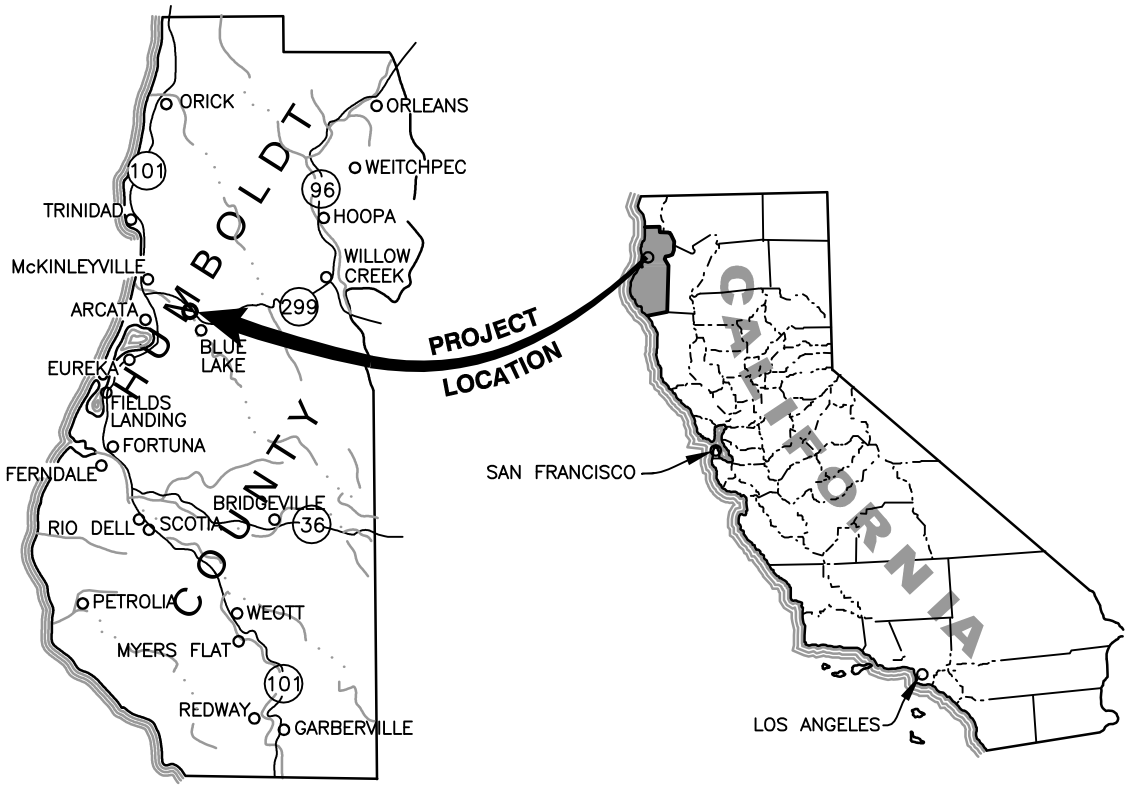
Task 8.2 Grant Reporting
Regular progress reports will be submitted via electronic mail to the DWR's Project Manager. The progress report will include a brief description of the work performed, Grantees activities, milestones achieved, accomplishments during the reporting period, and problems encountered in the performance of the work. The submission will also include the reimbursement request for work completed. The reimbursement request will always be accompanied by the progress report, and will include DWR's standard templates and required data for submission of invoices.

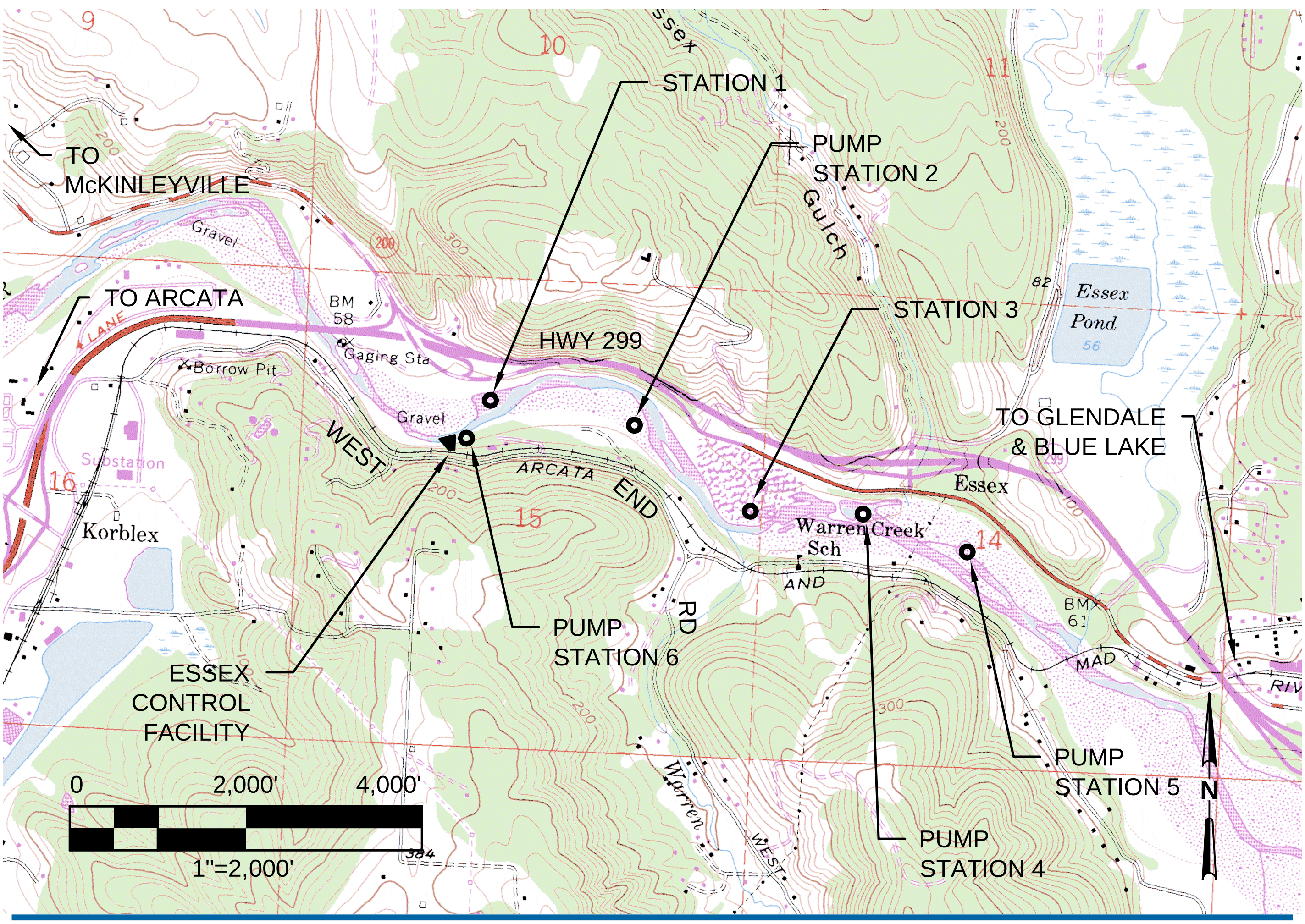
Task 8.3 Coordinate with Grant Manager
Throughout administration of the proposed groundwater study, HBMWD will coordinate with the DWR representative identified as the Manager for the grant. HBMWD will communicate regularly with the DWR Grant Manager to ensure requirements of the funding are met.

Task 8 Deliverables

- LGA Grant Progress Reports
- LGA Grant Reimbursement Request
- Labor Compliance Plan
- Grant Final Report

Figures





HUMBOLDT BAY MUNICIPAL WATER DISTRICT

LOCAL GROUNDWATER ASSISTANCE GRANT

GHD

LOCATION & VICINITY MAP

Job Number	0105511020
Revision	
Date	7-2012

Figure 1

718 Third Street Eureka California 95501 USA **T** 1 707 443 8326 **F** 1 707 444 8330 **W** www.ghd.com

Plot Date: 9 July 2012 - 9:05 AM Cad File No: G:\01055 HBMWD\01055-11-020 DWR-GroundwaterGrantAssist\06-CAD\Figures\0105511020Figure1.dwg

LEGEND:

PROPOSED GEOPHYSICAL-TRANSECTS

PROPOSED GROUNDWATER MONITORING WELLS

HUMBOLDT BAY MUNICIPAL WATER DISTRICT
LOCAL GROUNDWATER ASSISTANCE GRANT

GHD

GROUNDWATER STUDY
PROPOSED MONITORING WELL LOCATIONS
AND GEOPHYSICAL TRANSECTS

Job Number 0105511020
Revision
Date 7/2012

Figure 2

718 Third Street Eureka California 95501 USA **T** 1 707 443 8326 **F** 1 707 444 8330 **W** www.ghd.com

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Appendix A
Standard Operating Procedures (SOPs)

GHD Inc.

STANDARD OPERATING PROCEDURES
for
MONITORING WELL INSTALLATION IN THE UNCONFINED AQUIFER

1. Objective

To provide an accepted method for the installation of monitoring wells in the unconfined aquifer for sites impacted with chemical contaminants.

2. Background

Monitoring wells are installed in accordance with the California Well Standards (Bulletin 74-90) and the appropriate lead agency guidelines.

Careful consideration should be given to the specific gravity of the contaminants of concern and screening the upper or lower portion of the aquifer.

Except where otherwise required, GHD only utilizes disposable polyethylene bailers to collect groundwater samples.

3. Personnel Required and Responsibilities

Professional Geologist: A Professional Geologist (PG) is responsible for ensuring that the monitoring well is properly installed and oversee the logging of the monitoring well and for ensuring that field personnel have been trained in the use of this procedure.

Staff Geologist: A staff geologist (SG) has 0.5 to 5 years experience logging borings and installing monitoring wells. The SG is responsible for complying with the procedure, installing the well, collection of samples, containerization of samples, and documentation. The SG will call into the PG with proposed well construction, soils and contaminant data to obtain approval prior to well installation.

4. Equipment Required

- Level D Safety Equipment
- Boring Log form / Munsell Soil Charts
- Sample containers - provided by the laboratory
- En Core® Sampler Set and sample containers
- Sample labels/Indelible marker
- Disposal gloves
- Ice chest with ice
- Unified Soil Classification System Guide

5. Procedure

- Prior to drilling the monitoring well boring GHD will obtain all required permits. A Site-Specific Safety Plan detailing site hazards, site safety, and control will be prepared prior to any field work. At least 48 hours prior to drilling Underground Services Alert (USA) will be notified of the planned work.

- Prior to installing a monitoring well, log the boring and sample according to GHD's Standard Operating Procedures for *Soil and Water Sampling from a Boring.*

- Use a PID during the drilling and sampling activities to screen for the presence of Volatile Organic Compounds (VOCs).

- Use a hollow-stem rotary auger drill rig set up with a 9-inch auger to complete the well drilling and to assist in the well installation.

- Extend the well borings at least 10 feet into the aquifer under investigation. At a minimum, obtain soil samples by driving an 18- or 24-inch long split spoon sampler continuously for the first well and at 5-foot intervals for the other wells. Retain one 6-inch sample tube from each 5-foot interval for possible submittal to the analytical laboratory. Collect soil samples at the soil-water interface, at notable changes in lithology, and in areas of observed chemical contaminant impact.

- For the laboratory analysis of <u>non-VOCs</u>, obtain soil samples in clean brass tubes during the drilling as part of the monitoring well installation process. Cap the 6-inch tube of soil selected for laboratory analysis with aluminum foil or Teflon tape and plastic caps; label and store samples in a cooler, on ice. Transport the soil samples to a state-certified analytical laboratory under chain-of-custody documentation. Handle soil samples that will be selected for laboratory analysis in accordance with GHD's Standard Operating Procedures for *Soil and Water Sampling from a Boring*.

- For the laboratory analysis of <u>VOCs</u>, soil samples will be collected with a split spoon sampler or direct-push sample barrel that is not lined with any sleeves. Soil will be scraped away using a clean trowel or other device to get to the interior of the sample. As per EPA Method 5035, a new disposable En Core® Sampler will be in the En Core® handle. Three clean En Core® sample tubes will be driven into the soil and filled completely to avoid air space. The En Core® sample tube will be retracted from the soil and capped with the locking cap, and inserted in the provided envelope. Each envelope will be labeled with the job number, the sample identification, date and time of collection, the sampler's name, and the analyses required. Each set of three En Core® samples will then be placed in an ice chest (chilled to 4°C) until delivered to a state-certified laboratory under strict chain-of-custody documentation, where they will weigh and preserve each sample within 48-hours of collection.

A fourth sample will be collected for laboratory screening, by driving a pre-cleaned container, such as a glass jar or a brass tube into the soil, capping it with Teflon or aluminum sheeting, and tight-fitting plastic caps.

A clean set of En Core® samplers and brass tube will then be driven into the soil until each are completely full.

- Classify soil types and log under the Unified Soil Classification System using the ASTM Visual Manual Procedure (D 2488-84) and Munsell Soil Color Charts. Field screen the soil headspace within a sealed sample bag, using a portable Organic Vapor Meter. GHD uses a photo-ionization detector (PID) to assess relative concentrations of volatile constituents in the soil samples, and also to monitor the breathing zone.

- Include the lithology, moisture, density, colors and depth sample identification, PID measurements and well construction details on the boring logs as appropriate. Include the boring logs generated from the field activities in the Report of Investigation.

- If a clay layer is encountered, perform continuous sampling to assess its thickness. A clay aquitard shall not be penetrated more than 3 feet. If cross contamination of aquifers is possible, use conductor casings and packers, as appropriate to maintain groundwater quality.

- Depending on the season during the drilling activities (high water table season or low water table season), the screened interval should be placed to allow for fluctuations in the water table. The screened casing should be placed about 5-feet above the anticipated high water table, and should extend a maximum of 15 feet below the water table.

- The last page of this SOP illustrates the Typical Monitoring Well Construction Detail.

- Use two-inch diameter schedule 40-PVC, flush-threaded well screen and install through the hollow-stem augers. If the soils are stiff enough to open hole the boring, then make sure centralizers are installed on the outside of the casing every 10-feet.

- Slowly install a uniform filter pack from the bottom of each boring to a depth of 6 inches and preferably 1-foot above the top of the well screen. This step is imperative because if the sand is poured too quickly, it may bridge. The bridging can also cause the well casing to move upward. If this happens and the well bridge cannot be broken, remove the well casing and auger out all the sand and reinstall.

- Use a clean, weighted tape measure to ensure proper placement of the sand and that sand always stays in the auger. This prevents any possible cave ins.

- Use Lonestar #2/16, or #2/12 Monterey sand or equivalent with a 0.010-inch slot or 0.020-inch slot screen. The screen size is dependent on the lithology. If the saturated soil consists of coarser material, then 0.020-inch slot with #3 Lonestar Sand (or equivalent) should be used.

- Place a minimum 1-foot thick seal of **hydrated** bentonite pellets over the filter pack. Grout the remainder of the boring with a cement/bentonite slurry not exceeding 5 percent bentonite to 1 foot below the ground surface. The top of the PVC casing will be approximately 2 inches below grade. Slide slip cap over the top of the casing.

- Place empty Lonestar sandbags around the casing to ensure no clods of dirt fall into the boring until ready to place the surface seal.

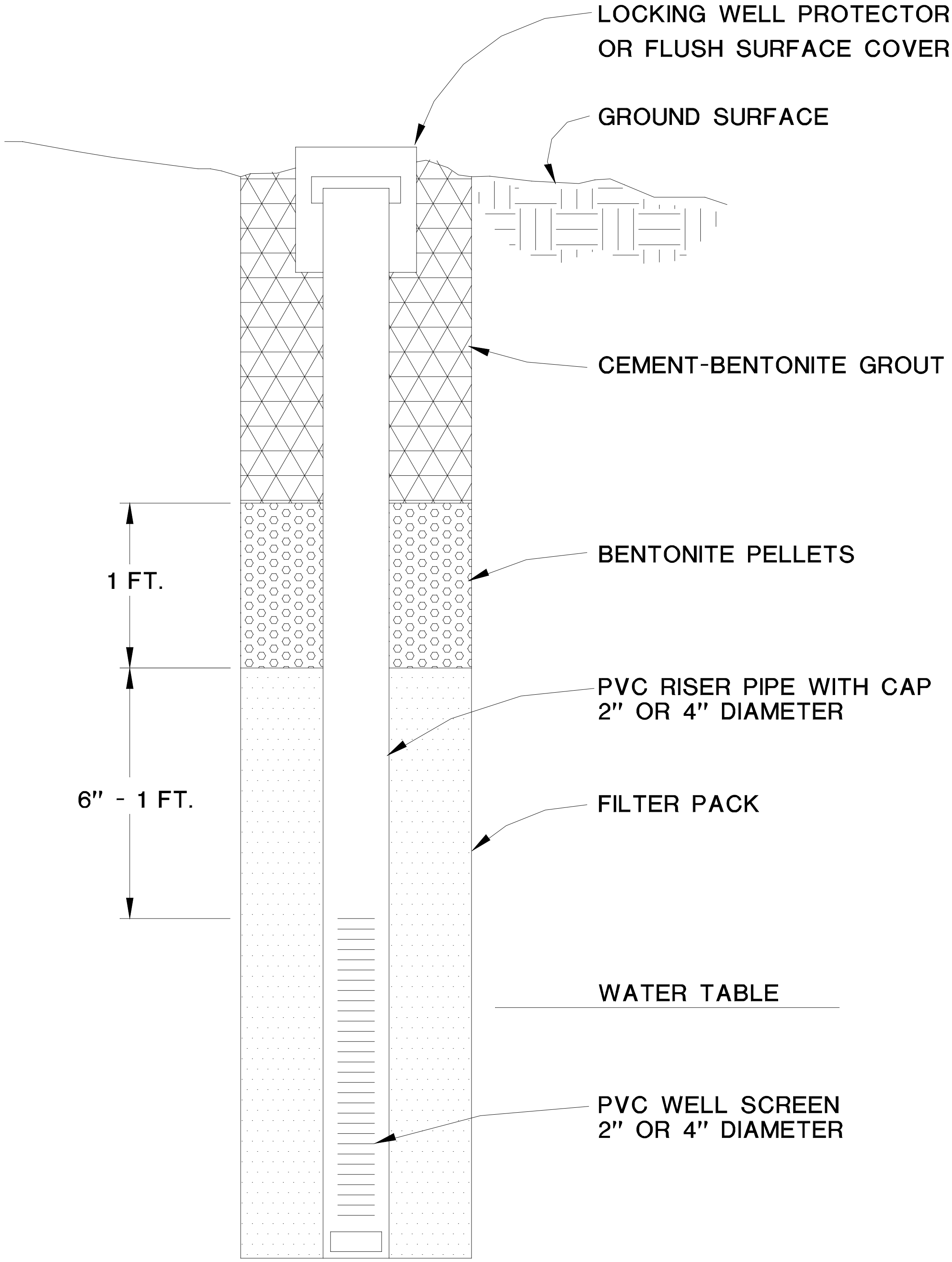
- Protect the wells by 8-inch minimum to a 12-inch maximum, flush-mounted traffic boxes set in concrete, with locking well caps. The top of the traffic boxes will be set above grade with a gently sloping concrete rim. The monitoring well identification number should be scribed into the concrete rim before it completely sets.

- Refer to other SOPs for development and sampling the wells.

- A depth to water measurement should be collected after the sample is collected. The measurement and time shall be documented in the logbook.

- Upon completion of the well installation, each well will be closed and secured by replacing the well cap, securing the lock and bolting down the lid of the flush-mounted traffic box. Ensure the box does not sink in the wet concrete.

- Properly drum or dispose of used gloves and any other PPE gear, after each use.



TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM

NOT TO SCALE

GHD Inc.

STANDARD OPERATING PROCEDURES
for
SOIL BORING INSTALLATION

1.0 Objective

To establish procedures for sampling soil and water from using a hand auger or direct push tools to install soil borings.

2.0 Background

During subsurface investigations it is necessary to obtain discrete soil and water samples from below the ground surface. This SOP establishes the procedures for collecting soil and groundwater samples from borings using hand tools on projects requiring near-surface data.

3.0 Personnel Required and Responsibilities

Project Manager: The Project Manager (PM) is responsible for ensuring that field personnel have been trained in the use of these procedures and for verifying that drilling water and soil sampling activities are performed in compliance with this SOP.

Project Scientist: The responsible professional in charge of the field work must determine the exact location and depth of each boring, and decide on the sampling interval. The project scientist must collect samples; prepare them for transport to the laboratory, and record lithologic and other observations. The Project Scientist is responsible for complying with this SOP.

4.0 Equipment Required

- Hand auger kit or direct push boring tools
- Core drill and power supply if boring to be installed through hard surface
- Split spoon sampler or direct push sample barrel
- Brass or stainless steel sample liners and plastic end caps
- Soil sampling jars
- Aluminum foil or Teflon sheeting
- Decontamination equipment
- Containers for decontamination rinseate
- Disposable gloves
- Sample labels
- Field guide for logging boreholes
- Munsell color charts
- Putty knife
- Boring logs
- Photoionization detector (PID)

- Ice/ice chest
- Sealable plastic storage bags
- Indelible marker that will not transfer volatile compounds to sampling container.

5.0 Procedure

Borings will be installed using hand augers, or small diameter pushrods. Borings will extend to the groundwater surface or deeper as specified by the project requirements. Typically, soil samples will be obtained either continuously, or at a minimum of 5-foot intervals for lithologic logging, on site field screening, and potential chemical analyses. Additional soil samples will be obtained at any notable changes in lithology and at any obvious areas of contamination.

- Soil samples will be collected in a hand auger, split spoon sampler or direct-push sample barrel lined with clean brass or stainless steel sleeves. A six-inch interval of the sample will be capped with aluminum foil or Teflon sheeting and plastic end caps, labeled, wrapped in a plastic storage bag and stored in a cooler, on ice. Sample numbers and depths will be noted on the boring logs.
- The remaining sample will be used for color and soil type classification using the Unified Soil Classification System and Munsell color charts. A portion of each sample will be field-screened with a photo-ionization detector. Results of classification and field screening will be recorded on the boring logs.
- Sample equipment will be decontaminated in an Alconox detergent solution and rinsed in deionized or tap water between sampling intervals.
- If a hydropunch sampler is to be used to collect water samples, borings will terminate at the groundwater surface. A hydropunch-type groundwater sampling device will be lowered into the hollow stem augers or the drive casing, and driven three to four feet into the aquifer. Groundwater will be allowed to flow into the hydropunch.
- If a hydropunch type sampler is not used, the boring will be extended 3 to 5 feet into the aquifer. The augers or drive casing will be pulled back to allow for water to enter the boring. If caving of the bore hole occurs, temporary PVC casing may be lowered into the drive casing or hollow stem augers prior to retraction of the drive casing.
- Groundwater will be sampled using a small diameter stainless steel or disposable polyethylene bailer.
- Groundwater samples will be transferred from the bailer to appropriate size/type containers with the appropriate preservatives, as required by the project needs. Precautions will be taken to avoid capturing air bubbles in the samples. Sample containers will be labeled, wrapped in plastic bags and stored in a cooler, on ice. The water samples will be transported to a State-certified laboratory for the appropriate chemical analyses.
- Soil borings will be closed by filling to 6 inches below the surface with bentonite or a cement/bentonite grout mixture, not exceeding 5% bentonite.