FULCRUM
environmental consulting

February 8, 2023

Sent by email

John Zinza, P.E., Site Manager
Toxics Cleanup Program - Central Regional Office
Washington State Department of Ecology
1250 West Alder Street
Union Gap, Washington 98903
Email: john.zinza@ecy.wa.gov

RE: Monitoring Well 101 Replacement Work Plan
Yakima Mill Site
Agreed Order No. DE 13959

Dear John:

Thank you for the opportunity to present this Monitoring Well 101 Replacement Work Plan to install and develop a replacement for monitoring well 101 (MW-101) in the southern portion of the Yakima Mill Site. Per your request, we are providing this work plan for this element as part of the Yakima Mill Site Feasibility Study process.

All work will be completed as specified under the following documents previously approved by the Washington State Department of Ecology (Ecology) for Remedial Investigation (RI) or Feasibility Study work at the Yakima Mill Site:

- *Revised Final Remedial Investigation Work Plan*, Yakima Mill Site (aka Boise Cascade Mill Site), Barr Engineering Co. and Fulcrum Environmental Consulting, Inc, January 2019. (RIWP)
- *Revised Final Sampling and Analysis Plan, Exhibit A to Revised Final Remedial Investigation Work Plan, Yakima Mill Site,* Barr Engineering Co. and Fulcrum Environmental Consulting, Inc., January 2019. (SAP)
- *Final Project Health and Safety Plan, Remedial Investigation, Exhibit C to Revised Final Remedial Investigation Work Plan, Yakima Mill Site*, Barr Engineering Co. and Fulcrum Environmental Consulting, Inc., December 20, 2017. (PHASP)
- *Inadvertent Discovery Plan, Yakima Mill Site Remedial Investigation,* AECOM, April 16, 2019. *(IDP)*
- *Request to Complete Supplemental Groundwater Sampling – Yakima Mill Site Feasibility*, Fulcrum Environmental Consulting, Inc. and Barr Engineering Co., May 19, 2022, amended by email on May 27, 2022.

Relevant sections of the RIWP and the SAP are provided in this letter, are attached, or are incorporated by reference.

P. 509.574.0839 F. 509.575.8453
406 North 2nd Street
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Background

Monitoring well MW-101 was removed in November of 2020 during the City of Yakima's Bravo Company Boulevard project. The City of Yakima (City) agreed that any wells removed for the project that were needed to facilitate work on the Yakima Mill Site under Agreed Order No. DE 13959 would be replaced by the City. We understand that Landau Associates on behalf of the City of Yakima, has requested approval to replace MW-101, but that approval has not yet been provided and Ecology is unable to provide a timeline for approval.

The sampling of MW-101 is required under the Ecology-approved May 2022 Yakima Mill Site supplemental groundwater sampling plan. Barr Engineering Co. (Barr) and Fulcrum Environmental Consulting, Inc. (Fulcrum) have previously notified Ecology of the significant impact that the lack of groundwater sampling at a replacement well for MW-101 (MW-101R) has on the timely completion of the draft Feasibility Study. The third groundwater sampling event under the May 2022 supplemental groundwater sampling plan was scheduled to have been completed in January 2023 but has been postponed until the replacement well can be installed.

Purpose of MW-101R

In May 2022, Fulcrum and Barr requested Ecology's approval to complete additional groundwater sampling in seven monitoring wells on the Yakima Mill Site. Previous groundwater samples from these wells had a detection of bis(2-ethylhexyl)phthalate and/or pentachlorophenol in one or two sampling events completed during the RI. The concentrations of bis(2-ethylhexyl)phthalate and pentachlorophenol in these samples were slightly above their respective preliminary cleanup level (PCUL), which is set at the practical quantitation limit for these constituents, and the detections occurred typically during only one monitoring event (the November 2019 sampling event). It is believed that a quality control issue may have occurred during the November 2019 sampling/analysis event that resulted in very low semi-volatile organic compound (SVOC) concentrations occurring in a few of the samples. All of the groundwater analytical data was validated consistent with the Quality Assurance Project Plan (QAPP) (Exhibit B to the RIWP) and no evidence of a quality control issue was identified in these samples so the wells with the detectable concentrations are being resampled as part of the Feasibility Study process.

The November 2019 sample collected from MW-101 had concentrations of bis(2-ethylhexyl)phthalate and pentachlorophenol slightly above the applicable PCUL. Based on those results, sampling of a replacement well for MW-101 for bis(2-ethylhexyl)phthalate and pentachlorophenol for four consecutive quarters was included in the May 2022 supplemental groundwater sampling plan. No other contaminants of concern were found in MW-101 samples at concentrations requiring supplemental investigation.

Under the May 2022 supplemental groundwater sampling plan, groundwater sampling resumed in June 2022 on six of the seven monitoring wells included in the plan; only the replacement for MW-101 has not be sampled.

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Schedule

Installation of MW-101R is planned to occur on or about February 13, 2023. Well development will occur immediately following installation of MW-101R. Groundwater sampling will occur no sooner than 7 days following well installation as described in the SAP.

Proposed MW-101R Location

Fulcrum obtained information from the City and their consultant, Landau Associates, on the location of the vapor barrier systems installed during the City's Bravo Company Boulevard project. The vapor barriers include a clay liner and a polyethylene liner. HLA Engineering and Surveying, Inc. (HLA), under contract to Fulcrum, completed a survey on February 1, 2023 delineating the boundary of the City roadway, the boundary of the road construction easement, and the previous location of MW-101.

Installation of a replacement well at the former location of MW-101 or in the construction easement is not workable as the location would be within the roadway system planned for construction by the City in the next few years.

The approximate distance between the former location of MW-101 and the western edge of the road construction easement is about 79-feet. A field visit determined that the preferred location of MW-101R would be outside of the construction easement at a distance of about 100-feet west of the former MW-101 location. See Figure 1 for the former location of MW-101, the selected location of MW-101R, and the associated City roadway and construction easements.

The proposed location is located in proximity to municipal solid waste (MSW) associated with the Yakima City Landfill. If MSW is identified, the boring will be terminated and relocated west and/or north of the boring location to an area beyond the MSW.

Well Screen Interval

Fulcrum and Barr completed a review of groundwater elevations measured in MW-101 during the RI to determine if the well screen length for MW-101R needed to be modified from the monitoring well design (10-foot long screen) described in the RIWP. MW-101 was constructed as a 26-foot deep well (as measured from ground surface) with the well screen placed at a depth of about 15.8 feet to 25.8-feet below ground surface. Height of the riser of MW-101 was about 2.8-feet above ground surface. Water level measurements were collected as provided in the RIWP *Standard Operating Procedure – Yakima Mill Site: Measuring Static Water Level, Immiscible Layers (DNAPL and LNAPL), and Total Well Depth in Wells.* A copy of this standard operating procedure is attached. The measured groundwater levels during the RI ranged from 20.89 to 23.15-feet below the top of the riser (Table 1).

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Table 1: Groundwater Measurements in MW-101

Date [1]	Water Level (distance in feet below top of the well riser)
5/8/2019	20.89
8/16/2019	20.69
11/4/2019	22.00
1/31/2020	23.15

[1] The water levels for all YMS RI monitoring wells were measured on the same day. The day the water level measurements were collected is different than the day that groundwater samples were collected.

Based on a review of the water level measurements from the RI, the screened interval of MW-101 extended between about 2.1 and 4.5-feet above the measured water levels. There were no events in which the water level was outside of the screened interval. No modification to the length of the well screen for MW-101R is warranted.

Well Construction

Drilling and well construction will be completed by Anderson Environmental Contracting, Inc. (AEC). AEC is a licensed well driller and Washington State licensed contractor (ANDEREC005PD). AEC will submit a Notice of Intent prior to drilling. Fulcrum will have a field geologist present during all onsite activities completed by AEC. Well cuttings will be containerized and managed as provided in the RIWP.

Drilling and well construction will be completed consistent with WAC 173-160: *Minimum Standards of Construction and Maintenance of Wells* and as specified in Section 2.1.2 of the approved SAP (provided below for ease of reference):

2.1.2 Monitoring Well Installation

Monitoring wells will be installed via rotasonic drilling. All wells will be installed and decommissioned (in the case of temporary wells) by a licensed well contractor in accordance with all applicable rules and regulations and in accordance with WAC 173-160.

Water table monitoring well screens will be two-inch inner diameter (I.D.) polyvinyl chloride (PVC) pipe with a 10-foot long, continuous No. 20 slot (0.020") well screen fitted with a flat base plate and threaded female flush coupling. Riser pipe will be two-inch diameter, Schedule 40 PVC. Monitoring well construction details are provided on Figure 32.

Water table wells will be set so that the screen intersects the water table with approximately three feet above the water table and seven feet below the water table at the time of placement, adjusted for seasonal fluctuations.

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Upon completion of the borehole, the monitoring well screen and riser pipe, including an adequate number of centering guides, if needed, will be assembled without solvent or joint dressing and installed so that the screen is at the design depth, and the riser pipe extends approximately three feet above ground surface. If drilling fluid other than water has been used during borehole advancement, the drilling fluid will be flushed from the borehole by pumping potable water through the riser pipe and well screen until the return water is clear. The sand pack will be installed in a manner that will minimize segregation and ensure that the sand pack fills, as nearly as practical, the annular space between the well screen and the borehole wall to a depth of two feet above the top of the screen. Approximately two feet of bentonite chips will be added above the sandpack and hydrated. Neat cement grout will be placed above the bentonite seal by pumping under pressure through a tremie pipe. After six inches of grout has been placed in the borehole, the discharge point of the tremie pipe will be maintained three inches or more below the grout surface. Full strength grout will be placed to a depth of five feet from the ground surface. Down hole equipment will be withdrawn as necessary during the grouting process.

Each monitoring well will be finished above grade with a protective casing and a locking cap. Two to three protective posts will be placed two feet from the protective casing, symmetrically spaced approximately three feet apart.

Monitoring well logs will include location, well construction schematics, field screening observations, and soil classification data as shown in Appendix B.

See the attached Figure 32 from the SAP for the well construction design. MW-101R will be constructed consistent with Figure 32.

John Greer, Barr's Washington State licensed Geologist and Hydrogeologist for the RI, has determined that MW-101R should be installed to a depth of about 25-feet below ground surface with a screened interval from about 15 to 25-feet below ground surface, adjusted as appropriate based on the depth to the water table at the location of MW-101R at the time of well drilling.

Well Development

As provided in Section 2.1.3 of the SAP:

2.1.3 Monitoring Well Development

Monitoring wells (new and existing permanent wells; not including temporary wells) will be developed by air lifting, water jetting, surging and bailing, pumping, or a combination of these methods in accordance with the SOPs (Appendix A). The objective of monitoring well development will be to produce water with minimal turbidity (defined as < 5 nephelometric turbidity units; NTUs). This criterion may not be attainable for monitoring wells screened in fine grained soil or those with high organic content.

Monitoring well development will also be considered complete if the development criteria are not met, but at least ten well volumes have been removed. Well development techniques, purge volume, and stabilization criteria will be documented and provided in the RI Report. Samples will not be collected for laboratory analysis for at least 7 days following successful well development.

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Yakima, Washington 98901
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Monitoring well development will be completed as provided in *Standard Operating Procedure – Yakima Mill Site: Monitoring Well Development* contained in Appendix A of the SAP. The monitoring well development SOP from the SAP is attached. Any investigation derived waste (i.e., groundwater) generated during well development will be managed as described in the RIWP.

As described in the monitoring well development SOP, turbidity will be measured during well development following the *Standard Operating Procedure – Yakima Mill Site: Field Measurement of Turbidity in Water* from the SAP. The turbidity measurement SOP from the SAP is attached.

MW-101R Survey

Following installation of MW-101R, HLA will return to the site to survey the location of the well, the elevation of the top of the protective casing, the elevation of the top of the riser, and the elevation of the ground surface adjacent to the well.

Project Safety and Health

Well drilling, construction, and development will be completed consistent with the PHASP referenced in the first section of this letter. The PHASP is more than 580 pages and is not attached.

The PHASP was prepared to address the requirements in WAC 173-340-350(7)(c)(iv) and WAC 173-340-810. All site workers will have current training as specified by WAC 296-843: Hazardous Waste Operations and the PHASP.

For installation of MW-101R, the modifications shown in Table 2 will be made to the PHASP:

Table 2: PHASP Contacts

Organization	Role	Name	Phone	Email
Fulcrum	Field Team Lead	Amanda Enbysk	509.574.0839	amanda.enbysk@efulcrum.net
Fulcrum	Project Health and Safety Team Lead	Ryan Mathews	509.728.2424	rmathews@efulcrum.net
Barr Engineering	Project Manager	Alec Danielson	612.708.9883	adanielsom@efulcrum.net
AEC	Project Manager	Ron Rider	253.293.1910	ronr@aecllc.net

P. 509.574.0839 F. 509.575.8453
406 North 2nd Street
Yakima, Washington 98901
efulcrum.net

Inadvertent Discovery Plan

Well drilling will be completed under the existing IDP prepared by AECOM for the RI (referenced in the first section of this letter). The following staff will constitute the IDP contacts for the construction of MW-101R:

Table 3: IDP Contacts

Organization	Role	Name	Cell Phone	Email
Fulcrum	Field Team Lead	Amanda Enbysk	509.571.3374	amanda.enbysk@efulcrum.net
Fulcrum	Project Manager	Ryan Mathews	509.728.2424	rmathews@efulcrum.net
Barr Engineering	Project Manager	Alec Danielson	612.708.9883	adanielsom@efulcrum.net
AECOM	Qualified Archaeologist	Sarah McDaniel	360.624.4285	sarah.mcdaniel@aecom.com
AECOM	Alt. Archaeologist	Michelle Stegner	503.310.0087	michelle.stegner@aecom.com

In the evert that suspected Native American ancestral remains, funerary objects, sacred objects, or objects of cultural patrimony are discovered during the field investigation, all work will stop and the discovery will be handled as described in the IDP.

Non-Aqueous Phase Liquids

The PCUL for diesel range hydrocarbons and heavy oil range hydrocarbons were each established as 500 micrograms per liter (µg/L) in the RI, with a practical quantitation limit (PQL) of 250 µg/L.

Diesel range petroleum hydrocarbons were not identified in samples from MW-101 during the four sampling events completed during the RI. Heavy oil was reported, at a level below the PQL during two of the monitoring events. See Table 4 for a summary of the groundwater sampling results.

Table 4: Remedial Investigation Groundwater Diesel-Range Organic Results in MW-101

Date	Diesel Concentration (µg/L)	Heavy Oil Concentration (µg/L)
5/16/2019	< 50.2 U	167
8/9/2019	< 49.8 U	177
11/11/2019	< 48.6 U	< 97.2 U
2/12/2020	< 49.4 U	<97.9 U

The presence of non-aqueous phase liquid is not anticipated at the location of MW-101R. If non-aqueous phase liquid is identified during drilling, well construction will be halted, impacted materials containerized for proper characterization and disposal, and it will be determined if a new well location is required.

P. 509.574.0839 F. 509.575.8453
406 North 2nd Street
Yakima, Washington 98901
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Groundwater PCULs

PCULs were established as a part of the RI. No PCULs are proposed for change as a part the installation of MW-101R.

MW-101R Construction Documentation Report

A report will be prepared documenting the construction and development of MW-101R. The report will include a well boring log, a cross section showing well construction including top of casing, top of riser, and ground surface elevations, a description of well development, and a figure showing the surveyed well location. The report will be submitted to Ecology within 30 days of the completion of well construction and development.

Thank you for the opportunity to submit this work plan to complete the installation of MW-101R. We look forward to Ecology's approval so that well installation, development and groundwater sampling can begin as scheduled on February 13, 2023.

John Greer, Barr's Washington State licensed Geologist and Hydrogeologist for the RI has reviewed this letter and agrees with the work plan. If you have any questions, please contact me.

Sincerely,

Ryan K. Mathews, CIH, CHMM
Principal

Attachments

cc: Alec Danielson, PE; Allan Gebhard; and John Greer, PG, HG, Barr Engineering Co.
Rhonda Luke, Jennifer Lind, and Valerie Bound, Washington State Department of Ecology

P. 509.574.0839 F. 509.575.8453
406 North 2nd Street
Yakima, Washington 98901
efulcrum.net

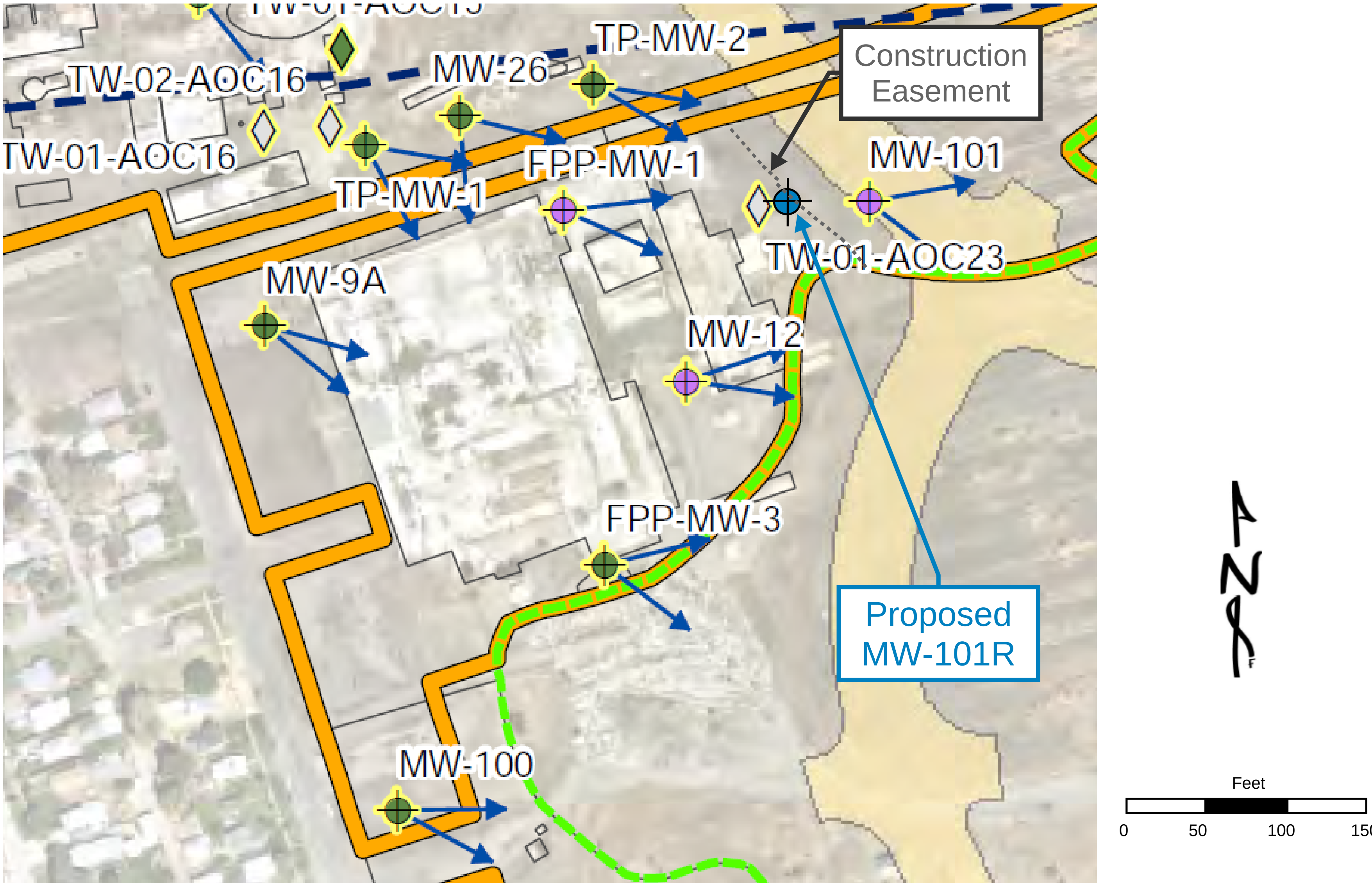

Figure background from YMS RI Figure 37 - Selected to provide monitoring network well locations.

Fulcrum Environmental Consulting, Inc.
406 North 2nd Street, Yakima, Washington 98901
p: 509.574.0839 | www.efulcrum.net

YMS MW-101R Installation Plan . RKM . 02062023

Yakima Mill Site
Feasibility Study

Proposed MW-101R Location

FIGURE
1

BARR

Standard Operating Procedure – Yakima Mill Site

Measuring Static Water Level, Immiscible Layers (DNAPL and LNAPL), and Total Well Depth in Wells

Revision 0

September 13, 2018

Approved By:

Print	Technical Reviewer Signature	Date
Alec Danielson	[signature]	9/13/18

Print	QA Manager Signature	Date
Dana Pasi	[signature]	9/13/18

Review of the SOP has been performed and the SOP still reflects current practice.

Initials:		Date:	
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Measuring Static Water Level, Immiscible Layers (DNAPL and LNAPL), and Total Well Depth in Wells

1.0 Scope and Applicability

The purpose of this Standard Operating Procedure (SOP) is to describe the procedure for measuring static water level, light non-aqueous phase liquid (LNAPL) level, dense non-aqueous phase liquid (DNAPL) level, and total well depth in a groundwater well.

The recommended procedures in this SOP should be followed unless conditions make it impractical or inappropriate to do so. Modifications should be noted in the applicable documentation and communicated to appropriate personnel. Significant changes may result in a revision or newly created SOP.

2.0 Limitations

- Decontamination of reusable equipment is required to prevent cross-contamination.

3.0 Responsibilities

Equipment Technicians are responsible to maintain equipment in working order and aid in troubleshooting equipment issues.

The role of the Project Health and Safety Team Leader is to oversee all aspects of on-site safety activities.

The Project Manager, in conjunction with the client, develops the site specific scope of work (e.g., Work Plan, SAP, etc.).

Experienced Field Technicians are responsible for the proper measurement and documentation of water levels, immiscible (does not dissolve in water) layers (DNAPL and LNAPL), and total water depth.

4.0 Safety

Barr staff is responsible for conducting all aspects of the job safely. When applicable, refer to the appropriate Project Health and Safety Plan (PHASP) to understand the hazards associated with suspected contamination, symptoms of exposure, methods to minimize exposure, personal protection equipment (PPE), and personal air monitoring required when using this SOP. Minimum protection of two pair of chemical resistant gloves (e.g., nitrile) and safety glasses with side shields should be worn to prevent sample contact with the skin and eyes. When working with liquids contaminated with corrosive materials, emergency eye flushing facilities should be available.

Consult the applicable Safety Data Sheet to review hazards and appropriate PPE to minimize exposure.

5.0 Equipment, Reagents, and Supplies

- Electronic water level indicator
- Chemical resistant gloves (e.g., nitrile)
- Oil/water interface probe

6.0 Procedure

This section below describes the procedures and equipment used for measuring static water level, LNAPL or DNAPL) level (if present), non-aqueous phase product thickness (if present), and total well depth in a groundwater well.

6.1 Calibration

The electronic water level indicator and oil/water interface probe will be tested prior to use to ensure they are functioning properly. Instruments that are not properly functioning should be tagged for inspection by the Equipment Technician or sent to the manufacturer for repair. AA or 9V batteries are normally used for a power source; spare batteries should be kept on hand.

6.2 Measurements

The water level, total depth, and immiscible layers are measured prior to well purging or sampling. For new wells, measurements should not be taken until the water level in the well has stabilized, a minimum of 48 hours after well installation and development.

Decontaminate reusable equipment per Barr's SOP 'Decontamination of Sampling Equipment'.

6.2.1 Water Level

Groundwater levels will be measured at all permanent monitoring wells on the same day prior to purging and sampling with an electronic water level indicator probe that is lowered into the well. An oil/water interface probe may also be used if oil layers may be encountered (see section below). The electronic water level indicator consists of a spool of length-marked cable, a probe attached to the end, and an indicator. When the probe comes in contact with the water, the circuit is closed, and a meter light and/or tone signals the contact.

To ensure consistent results, groundwater level measurements are made in reference to an established point (e.g., top of riser pipe). Water level measurements are made from the high side of the riser pipe unless otherwise specified. If the top of the riser appears to be level, take the readings at the north side of the riser. The depth to water is indicated by the markings on the cable. Read the water level directly off of the tape. The groundwater level should be measured three times consecutively (without completely winding up the water level indicator probe) to help ensure accuracy. Record the water level to the nearest 0.01 foot on the appropriate field sheets.

6.2.2 Total Well Depth

Determine the total well depth by lowering the water level indicator probe (or equivalent) into the well. After feeling the bottom of the well, raise and lower the water level indicator probe three times to ensure the bottom is being felt. Record the total well depth to the nearest 0.01 foot on the appropriate field sheets.

6.2.3 Immiscible Layer Thickness – Oil/Water Interface Probe

An immiscible layer may consist of LNAPL or DNAPL. LNAPL has a specific gravity less than water and is typically found floating on the water surface in a well. DNAPL has a specific gravity greater than water and tends to accumulate at the bottom of a well. An oil/water interface probe is used to measure the layer and consists of a flat measuring tape with a probe attached to the end, an indicator, and a grounding mechanism. After grounding the instrument to a metal source (well casing), determine the LNAPL or DNAPL thickness by slowly lowering the probe into the well.

6.2.3.1 LNAPL

If LNAPL (floating product) is present, a steady tone will activate. If there is no LNAPL, an intermittent tone will activate indicating the air/water interface (i.e., water level) in the well. Raise and lower the probe gently to clear product from the conductivity sensor and to determine the exact upper level of the floating product. The air/product interface level should be measured three times consecutively (without completely winding up the product level interface probe) to help ensure accuracy. Read the level of the air/product interface from the measuring tape and record to the nearest 0.01 foot.

Continue lowering the probe through the product until the original signal changes to an intermittent tone. This signals contact of the probe with water. Raise and lower the probe gently to clear product from the conductivity sensor and to determine the exact lower level of the floating product. The product/water interface should be measured three times consecutively (without completely winding up the product level interface probe) to help ensure accuracy. Read the level of the product/water interface from the measuring tape and record to the nearest 0.01 foot.

6.2.3.2 DNAPL

If there isn't any LNAPL present in the well, an intermittent tone will activate when the water level is reached. Continue lowering the probe until a steady tone is activated indicating the upper level of the DNAPL layer. Raise and lower the probe gently to clear product from the conductivity sensor and to determine the exact upper level of the DNAPL. The water/product interface level should be measured three times consecutively (without completely winding up the product level indicator probe) to help ensure accuracy. Read the level of the water/product interface from the measuring tape and record to the nearest 0.01 foot.

Continue lowering the probe through the product until coming into contact with the bottom of the well. Raise and lower the probe gently to ensure the bottom is being felt. The bottom of the well should be measured three times consecutively (without completely winding up the product level interface probe) to help ensure accuracy. Read the depth to the bottom of the well from the measuring tape and record to the nearest 0.01 foot.

6.3 Data Reduction/Calculations

The water column in the well is calculated by subtracting the measured water level from the total well depth.

The difference in the LNAPL upper level and the LNAPL lower level is the LNAPL thickness. The difference in the DNAPL upper level and the bottom of well is the DNAPL thickness.

6.4 Disposal

Waste generated by this process will be containerized for characterization and disposal in accordance with Federal, State and Local regulations.

7.0 Quality Control and Quality Assurance (QA/QC)

Not applicable.

8.0 Records

The field technician(s) will document the water level, total depth, or product level measurements on the water level data sheet and the field log data sheet for each well, if required.

Examples of common field documentation are available in Barr's "Compendium of Field Documentation". Field documentation specific to this SOP are listed below:

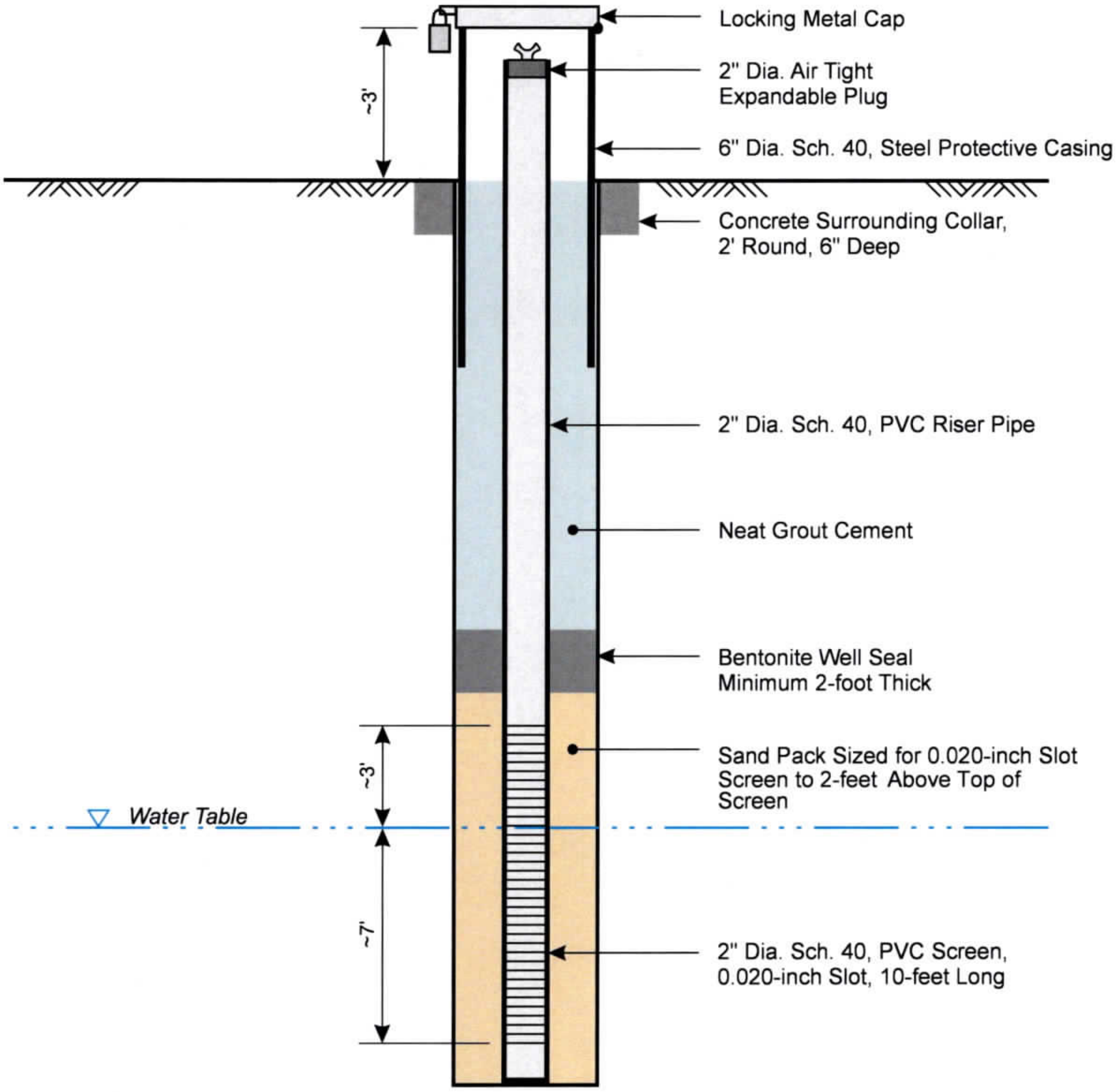
- Field Log Data Sheet
- Water Level Data Sheet

Field documentation are provided to a Barr Data Management Administrator for storage on the internal Barr network.

Other Barr SOP subjects referenced within this SOP: decontamination of sampling equipment and investigative derived waste.

9.0 References

Equipment operation manuals.



Not to Scale

P:\Mpls\47 WA\39\47391001\Workfiles\Graphics\Monitoring Well Schematic.CDR RLG 12-20-17

Figure 32

MONITORING WELL SCHEMATIC

Revised Final RI Work Plan - January 2019

Yakima Mill Site

Yakima, WA

BARR

Standard Operating Procedure – Yakima Mill Site

Monitoring Well Development

Revision 0

September 13, 2018

Approved By:

Alec Danielson	[signature]	9/13/18
Print	Technical Reviewer Signature	Date
Dana Pasi	[signature]	9/13/18
Print	QA Manager Signature	Date

Review of the SOP has been performed and the SOP still reflects current practice.

Initials:		Date:	
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Monitoring Well Development

1.0 Scope and Applicability

The purpose of this procedure is to describe how to develop new monitoring wells or redevelop existing monitoring wells that have just been installed or existing monitoring wells that may have become partially filled with sediment during use as a monitoring well. These procedures are performed with the objective of obtaining representative groundwater information and water quality samples from aquifers.

The recommended procedures in this SOP should be followed unless conditions make it impractical or inappropriate to do so. Modifications should be noted in the applicable documentation and communicated to appropriate personnel. Significant changes may result in a revision or newly created SOP.

2.0 Limitations

- Well development should be completed by an appropriately licensed or registered well contractor unless allowed by rules governing wells and borings.

3.0 Responsibilities

The role of the Health and Safety Officer is to oversee all aspects of job safety.

Experienced Field Technicians are responsible for overseeing the well development, quality control procedures, and documentation.

The well drilling contractors are responsible for the development of monitoring wells at the time of installation and have the necessary tools, equipment, chemicals, applicable licenses or registrations that may be required to perform the development work.

4.0 Safety

Barr staff is responsible for conducting all aspects of the job safely. When applicable, refer to the appropriate Project Health and Safety Plan (PHASP) to understand the hazards associated with suspected contamination, symptoms of exposure, methods to minimize exposure, personal protection equipment (PPE), and personal air monitoring required when using this SOP. Minimum protection of two pair of chemical resistant gloves (e.g., nitrile) and safety glasses with side shields should be worn to prevent sample contact with the skin and eyes. When working with liquids contaminated with corrosive materials, emergency eye flushing facilities should be available.

5.0 Equipment, Reagents, and Supplies

- Pumps (e.g., submersible or peristaltic)
- Pump discharge hose/tubing
- Bailers
- Chemical resistant gloves (e.g., nitrile)
- Water level indicator or interface probe
- Surge block (optional)
- Water quality meter (YSI Model 556, or equivalent)
- Turbidimeter

6.0 Procedure

These procedures are used to remove the fine-grained materials from a well or well bore as a result of boring or well construction. Monitoring wells must be developed to provide water free of suspended solids and to yield representative samples. Well development should result in a well that yields visibly clear groundwater.

6.1 Calibration

The water quality meter and turbidimeter will be calibrated as per the applicable Barr SOP. The meters will undergo calibration checks, at a minimum, before and after sampling. The calibration check will be documented on a calibration form (as appropriate) and/or in the field notebook. Any significant issues found during the calibration check will be noted in the field notebook and the Equipment Technicians will be notified.

6.2 Development

Successful development methods include bailing, surging, pumping/over-pumping, and jetting with water. The basic principle behind each method is to create reversals of water flow into and out of the well screen (and/or bore hole) to break-down any potential mud cake or disturbed zones where fine-grained particles may be concentrated at the borehole-formation interface, and to draw the finer materials into the well or borehole for removal. This process also helps remove fine fraction formation materials in proximity to the borehole wall, leaving behind a "natural" pack of coarser-grained materials.

6.2.1 Bailing

In relatively clean, permeable formations where water flows freely into the borehole, bailing is an effective development technique. Let the bailer fall down the well until it strikes the surface of the groundwater which produces an outward surge. Rapidly withdraw the bailer to create a drawdown and/or after the bailer hits the groundwater lower it to the bottom of the well and agitate it with rapid short strokes. Continue bailing with repeated up and down "surging motions" until water bailed from the well is free from suspended particles.

Note: During this process, if the well goes dry, stop bailing and let the well recharge before continuing.

6.2.2 Surge Block

A surge block is a tool used to break up bridging of fine grained material by inducing agitation and inducing flow into and out of the well and aquifer formation. Bridging is the tendency for particles moving towards a well under unidirectional flow (pumping) to develop a blockage that restricts subsequent particles to move into a well. Surge block is used alternately with either a pump or bailer. Let the surge block fall down the well until it strikes the groundwater surface. This creates a vigorous outward surge; rapidly retrieve the surge block. Lower the surge block to the top of the well intake and begin a pumping action with a typical stroke of approximately 3 feet and gradually work downward through the screened interval. Remove the surge block at regular intervals to discard the loosened suspended particles by either bailing or pumping. Continue the cycle of surging/bailing/pumping until satisfactory development has been attained.

6.2.3 Pumping/Over-pumping

During pumping, the groundwater flow is induced to flow into the well and the fine particulate material moves into the well and is discharged by the pump. In the case of over-pumping, the pump is operated at a rate that substantially exceeds the ability of the formation to deliver water, which results in the water level in the well dropping throughout the pumping period. Once pumping has begun, start the surging action by lowering and raising the hose/pumping apparatus through the screened interval. Bailing or bailing and surging may be combined with pumping for efficient well development. Continue pumping until such time as satisfactory development has been attained based on field observation of visibly clear water produced.

If pumping/over-pumping is completed by air lifting, the air compressor must be of an oil-less type or fitted with an oil trap capable of removing compressor oil from the air stream to avoid contaminating the well or boring.

6.2.4 High Velocity Jetting

Development by high velocity jetting may be completed with either water or air. In practice, jetting with water is typically followed by or simultaneously occurring air-lift pumping/over pumping to remove the fine materials. The jetting procedure consists of operating a horizontal water jet(s) inside of the well screen so high velocity streams of water shoot through the screen openings into the sand pack/formation. The jetting tool is worked similar to a surge block. The jetting tool ideally will have four openings located 90 degrees apart and should be worked up and down the screened interval while being rotated. At a minimum, the amount of water introduced during jetting and, if feasible, an additional 10 well volumes of water should be purged from the well.

6.3 Data Reduction/Calculations

No data reduction or calculations are associated with this procedure.

6.4 Disposal

Waste generated by this process will be containerized for characterization and disposal in accordance with Federal, State and Local regulations.

7.0 Quality Control and Quality Assurance (QA/QC)

The objective of well development is to remove fine-grained materials from the well-pack for a good hydraulic connection that provides representative aquifer conditions. This objective will be evaluated through collection of QA/QC samples for turbidity. Well development is considered complete when samples have less than 5 nephelometric turbidity units (NTUs) or when 10 well volumes have been removed.

8.0 Records

The field technician(s) will document the method of development (e.g., high velocity jetting, flushing), any deviations from this SOP, volume of water purged, and any volume of water introduced to the well.

Examples of common field documentation are available in Barr's "Compendium of Field Documentation". Field documentation specific to this SOP are listed below:

- Field Log Data Sheet

The field documents are provided to a Barr Data Management Administrator for storage on the internal Barr network.

Other Barr SOP subjects referenced within this SOP: water quality meter, turbidimeter, well recovery rate testing, and low-flow purging/sampling.

9.0 References

American Society for Testing and Materials (ASTM), D5521/D5521M-13. 2013. *Standard Guide for Development of Groundwater Monitoring Wells in Granular Aquifers.*

Environmental Protection Agency, Offices of Waste Programs Enforcement and Solid Waste and Emergency Response. 1986. *RCRA Ground-Water Monitoring Technical Enforcement Document.*

Johnson Filtration Systems. 1986. *Groundwater and Wells.*

National Water Well Association. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells.*

BARR

Standard Operating Procedure – Yakima Mill Site

Field Measurement of Turbidity in Water

Revision 0

September 13, 2018

Approved By:

Alec Danielson	Alec Danielson (signature)	9/13/18
Print	Technical Reviewer Signature	Date

Dana Pasi	Dana Pasi (signature)	9/13/18
Print	QA Manager Signature	Date

Review of the SOP has been performed and the SOP still reflects current practice.

Initials: ______	Date: ______
Initials: ______	Date: ______
Initials: ______	Date: ______
Initials: ______	Date: ______

Field Measurement of Turbidity in Water

1.0 Scope and Applicability

The purpose of this Standard Operating Procedure (SOP) is to detail the method for measuring turbidity using the Hach Model 2100P Portable Turbidimeter. This SOP applies to Field Technicians measuring turbidity in water (e.g., groundwater, surface water, waste water).

The recommended procedures in this SOP should be followed unless conditions make it impractical or inappropriate to do so. Modifications should be noted in the applicable documentation and communicated to appropriate personnel. Significant changes may result in a revision or newly created SOP.

2.0 Limitations

The Hach Model 2100P Portable Turbidimeter measures turbidity from 0.01 to 10000 nephelometric turbidity units (NTU). This method does not apply to turbid water above 10000 NTUs of turbidity.

- When taking a reading, the instrument must be placed on a level surface. It should not be held in your hand.
- Make certain that cold (temperature) sample do not "fog" the sample cell which could affect the measurement.
- Do not leave the sample cell in the cell compartment which may compress the spring inside the cell holder.
- Instrument operating temperature range = 32 to 122 °F

3.0 Responsibilities

Equipment Technicians are responsible to maintain equipment in working order and aid in troubleshooting equipment issues.

The role of the Project Health and Safety Team Leader is to oversee all aspects of on-site safety activities.

Experienced Field Technicians are responsible for the proper sample identification, collection of samples, field screening procedures, calibration and operation of the Hach Model 2100P Portable Turbidimeter, quality control procedures, and documentation.

Project staff are responsible for ordering sample containers prior to the sampling event.

4.0 Safety

The calibration standards required by this method contain formaldehyde. Staff handling these chemicals should have undergone Formaldehyde Safety Training, as appropriate, prior to operating this piece of equipment. Additionally, a formaldehyde spill kit should be readily accessible near the work area. Consult the formazine calibration standards' Safety Data Sheet to review hazards and appropriate PPE to minimize exposure.

Barr staff is responsible for conducting all aspects of the job safely. When applicable, refer to the appropriate Project Health and Safety Plan (PHASP) to understand the hazards associated with suspected contamination, symptoms of exposure, methods to minimize exposure, personal protection equipment

(PPE), and personal air monitoring required when using this SOP. Minimum protection of two pair of chemical resistant gloves (e.g., nitrile) and safety glasses with side shields should be worn to prevent sample contact with the skin and eyes. When samples may be contaminated with corrosive materials, emergency eye flushing facilities should be available.

Some of the sample containers may require the use of preservatives. Consult the applicable Safety Data Sheet to review hazards and appropriate PPE to minimize exposure.

5.0 Equipment, Reagents, and Supplies

- Hach Model 2100P Portable Turbidimeter
- StablCal primary calibration standards - <0.1 NTU, 20 NTU, 100 NTU, & 800 NTU Hach Item # 26594-05
- Gelex secondary calibration standards and 3 sample cells – Hach Item # 24641-05
- Four AA Alkaline Batteries
- Instrument manual with reference card
- Silicone oil with a dropper – Hach Item # 1269-06
- Oiling cloth – Hach Item # 47076-00
- Distilled or deionized water
- Phosphate-free detergent

6.0 Procedure

6.1 Calibration

A primary calibration standard, such as StablCal Stabilized Standards or formazin standards, should be used. Do not calibrate with Gelex Secondary Standards.

- Rinse a clean sample cell with dilution water several times. Fill the cell to the line (about 15ml) with dilution water or use StablCal <0.1 NTU standard and insert the sample cell in the cell compartment (with the diamond orientation mark facing toward the user).
- Close the lid and press I/O. Choose signal average mode option (on or off) before pressing CAL.
- Press CAL. The CAL and S0 icons will be displayed (the 0 will flash). The 4-digit display will show the value of the S0 standard for the previous calibration. If the blank was forced to 0.0, the display will be blank. Press → to get a numerical display.
- Press READ. Read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is > or = 0.5 NTU, E1 will appear when the calibration is calculated. The display will automatically increment to the next standard. Remove the cell from the cell compartment.
- The display will show the S1 (with the 1 flashing) and 20 NTU or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key. After editing, fill a clean sample cell to the line with a well-mixed 20 NTU StablCal Standard or 20 NTU formazin standard. Insert and align the sample cell into the cell compartment and close the lid.
- Press READ. The instrument will measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the compartment.

- The display will show the S2 and 100 NTU or the value of the of the S2 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key. After editing, fill a clean sample cell to the line with a well-mixed 100 NTU StablCal Standard or 100 NTU formazin standard. Insert and align the sample cell into the cell compartment and close the lid.
- Press READ. The instrument will measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the compartment.
- The display will show the S3 and 800 NTU or the value of the of the S3 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key. After editing, fill a clean sample cell to the line with a well-mixed 100 NTU StablCal Standard or 800 NTU formazin standard. Insert and align the sample cell into the cell compartment and close the lid.
- Press READ. The instrument will measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the sample cell from the compartment.
- Press CAL to accept the calibration. The instrument will return to measurement mode automatically.

6.2 Turbidity Measurement in Water Samples

- Fill a clean sample cell to the line with a well-mixed water sample taking care to hold the cell by the top. Wipe the sample cell with a lint free lab cloth to remove water spots and fingerprints.
- Apply a thin film of silicone oil to the outside of the sample cell and wipe with the lint-free cloth to ensure an even film over the entire surface of the sample cell.
- Insert and align the sample cell into the cell compartment (with the diamond orientation mark facing toward the user) and close the lid.
- Select manual or automatic range selection by pressing the RANGE key. The display will show AUTO RNG when the instrument is in automatic range selection.
- Select signal averaging mode by pressing the SIGNAL AVERAGE hey. The display will show SIG AVG when the instrument is using signal average.

  NOTE: Use signal average if the water sample causes a noisy signal (display changes constantly).
- Press READ. The instrument will measure the turbidity and store the value. Remove the sample cell from the compartment.
- Repeat.

Take a field replicate measurement every twenty (20) samples.

Analyze a calibration verification check standard at the end of the run sequence.

6.3 Corrective Action for Calibration/Field Equipment Failures

If E1 or E2 are displayed an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. If the error messages recur, calibrate using the factoryspecified standards. Press DIAG to cancel the error message (E1 or E2). To continue without repeating the calibration, press I/O twice to restore the previous calibration. If CAL? is displayed, an error may have occurred during calibration. The previous calibration may not be restored and recalibration is necessary.

6.4 Preventative Maintenance Procedures

6.4.1 Cleaning

Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or deionized water and air dry. Avoid scratching the cells.

6.4.2 Battery Replacement

The battery icon flashes when battery replacement is needed. For battery replacement/installation, remove the battery compartment cover on the instrument bottom and install the batteries with the correct polarity shown on the battery holder. Reinstall the battery compartment cover.

6.4.3 Lamp Replacement

- Use a small screwdriver to remove and install the lamp leads in the terminal block.
- Orient the instrument so it is upside down and the top faces away from you. Remove the battery cover and at least one battery.
- Remove the lamp assembly by grasping the tab on the left side of the assembly. Firmly, but gently, slide the assembly towards the rear of the instrument.
- Rotate the tab towards the nearest outside edge. The assembly should release and slip out easily.
- Back the terminal block screws partially out (1 to 2 turns) and remove the old lamp leads.
- Gently bend the wires of the new lamp assembly into an "L" shape so they fit easily into the housing. Insert the leads into the terminal screws and tighten with clockwise turns. Gently tug the wires to make sure they are connected to the terminal block.
- Hold the new lamp assembly by the tab with the lamp facing the tope (keyboard) of the instrument. Slide the small catch on the other side of the assembly into the black plastic slot (towards the nearest edge of the instrument).
- Snap the U-shaped bottom of the tab into the slot on the left side of the black plastic that holds the lamp assembly.
- With your thumb firmly slide the assembly forward until it stops. Again, pushing firmly against the tab make sure the lamp is seated correctly.
- Replace the batteries and battery cover.
- Insert the 800 NTU formazin standard into the sample cell. Press and hold READ. Then press I/O. Release the READ key after the software version number disappears from the display.
- Adjust the scattered light amplifier output by inserting a small flat-bladed screwdriver into the trimpot hole (located on the bottom). Adjust the display to read 2.5 +/-0.3 volts (2.0 volts for models that display 2100 when turned on).

- Press I/O to exit gain adjust mode.
- Perform a formazin calibration.

6.5 Preventative Maintenance Schedule:

6.5.1 Battery Life

Typically 300 tests with signal average mode off; 180 tests with signal average mode on.

6.5.2 Light Source

Lamp life typically greater than 100,000 readings.

6.6 Data Reduction/Calculations

No data reduction or calculations are associated with this procedure.

6.7 Disposal

Waste generated by this process will be containerized for characterization and disposal of in accordance with Federal, State and Local regulations.

7.0 Quality Control and Quality Assurance (QA/QC)

The QC activities described below allow the self-verification of the quality and consistency of the work.

7.1 QA/QC Samples

QA/QC samples are defined in Barr's SOP 'Collection of Quality Control Samples'.

The following QA/QC samples are not included in the SOP referenced above but should be analyzed:

- Field replicate measurements

Replicate sample measurements should be taken a minimum of one every twenty (20) project samples or one each day, whichever is more frequent.

7.2 Measurement Criteria

- Field replicate measurements criterion: ±25 relative percent difference (RPD)

8.0 Records

Examples of common field documentation are available in Barr's "Compendium of Field Documentation". Field documentation specific to this SOP are listed below:

- Field Log Data Sheet
- Meter Calibration Summary Form

Field Sampling Report, Field Log Cover Sheet, Field Log Data Sheet, and Meter Calibration Summary Forms are provided to a Barr Data Management Administrator for storage on the internal Barr network.

9.0 References

Hach Company, 2004. *Portable Turbidimeter Model 2100P Instrument and Procedure Manual.*