VIA ELECTRONIC MAIL

June 29, 2012

Mr. James Cagle
Nu-West Industries
Conda Phosphate Operations
3010 Conda Road
Soda Springs, ID 83276

Re: Addendum to the Work Plan for Additional Requirements
Administrative Order on Consent for Nu-West CPO Facility
Docket No. RCRA-10-2009-0186

Dear Jim:

WSP Environment & Energy LLC (WSP) prepared this addendum to the Work Plan for Additional Requirements, dated July 11, 2011, to address comments provided by the U.S. Environmental Protection Agency (EPA) in a series of communications concerning the drilling and geophysical logging approach for six (6) boreholes to be installed in the vicinity of the seismic survey transects. The locations and depths for proposed boreholes were provided in a report titled Seismic Survey Results, Nu-West Industries, Inc., Conda Phosphate Operations (WSP January 26, 2012). The methodologies for drilling, groundwater grab sampling, geophysical logging, monitoring well installation, and groundwater monitoring were presented and subsequently revised in the following communications:

- letters from WSP to Nu-West dated May 8, June 4, June 7, and June 22, 2012
- conference calls between Nu-West and EPA on May 1, May 31, June 5, June 14, and June 15, 2012
- letters from EPA to Nu-West dated June 11and June 27, 2012
- emails from EPA to Nu-West dated May 31 and June 15, 2012

The methodologies presented below were developed in consultation with Boart Longyear (Boart), the new drilling firm on this project (previous firm, WDC Exploration & Wells (WDC) ceased operations) The methodologies reflect Boart's experience and capabilities, and as such, certain elements of the methodology have been revised.

Borehole Locations and Objectives

Figure 1 shows the six proposed borehole locations in the vicinity of the seismic survey transects (A-27 through A-32). At each location, multiple boreholes will be drilled and up to three monitoring wells will be installed. The monitoring wells are intended to evaluate the following zones: 1) the surficial sediment/basalt interface; 2) the first water-bearing zone within the basalt sequence; and, 3) the second water-bearing zone within the basalt sequence.

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Borehole Drilling Procedures

The following revised borehole drilling, geophysical logging, and monitoring well procedures are applicable to the A-27 through A-32 locations in the vicinity of the seismic survey transects. For any conflict in procedures found elsewhere in the Work Plan for Additional Requirements, the procedures in this section shall apply.

Two drilling methods are included in the revised approach, (i) air rotary using a down-the-hole-hammer (DTHH) with simultaneous casing advancement (hereafter referred to as advanced casing air rotary) and (ii) air rotary without simultaneous casing advancement (hereafter referred to as direct air rotary).

Soil-Bedrock Interface Evaluation

Up to two boreholes will be advanced in each of the six locations (A-27 through A-32) using minimum 8-inch diameter advanced casing or direct air rotary drilling methods to assess water at the soil/basalt bedrock interface. The boreholes will be located approximately 20 feet apart and will be advanced sequentially, completing the evaluation and well or casing installation or borehole abandonment at the first location before moving to the second location. The boreholes will be advanced to seven (7) feet below the top of basalt bedrock, which is assumed to be between approximately 10 to 30 feet below ground surface (bgs); however, the actual depth to top of bedrock will be identified during drilling at each location. If advanced casing or driven casing air rotary drilling method is used to maintain an open borehole through the soil overburden, the casing will be removed from the borehole or retracted to at least three (3) feet above the soil-bedrock interface to prevent restricting groundwater flow into the borehole before monitoring for the appearance of groundwater.

Upon reaching the target depth, the drill string will be removed from the borehole and the total depth will be measured. If loose soil or rock has collapsed into the bottom of the borehole and prevents measurement of the water level, the borehole will be cleaned out using the drill bit. The process to clean out the borehole will be repeated as necessary, and any efforts to clean out the borehole and observations regarding the occurrence of groundwater will be documented, recording the timing of each cleaning cycle and the volume of water produced each cycle. Upon removal of the drill string from a clean borehole, a temporary 4-inch diameter Schedule 40 polyvinyl chloride (PVC) casing with a 10-foot long 0.020-inch slotted screen will be installed to monitor for the appearance of groundwater for at least 45 minutes, recording the depth observed at 15 minute intervals while monitoring for the appearance of water.

If a water column of at least 0.75 feet (9 inches) is present in the temporary PVC casing after 45 minutes, a grab sample will be collected using either an inertial pump, peristaltic pump, or bottom-filling polyethylene bailer in accordance with WSP revised standard operating procedure 3 (Enclosure A). The sample will be analysed for field parameters including pH, conductivity, temperature, and turbidity using a multi-parameter water quality meter (e.g., Horiba U-52). Additional analyses will be conducted using Hach portable colorimeter (DR/890) and field test kits for nitrate (Hach method 8039), sulfate (Hach method 8051), and orthophosphate (Hach method 8114 or 8048). The Hach procedure descriptions for each method are included as Enclosure B. The multi-parameter water quality meter will be calibrated daily for pH, conductivity, and turbidity in accordance with the manufacturer's recommendations. An accuracy check will be performed daily for the Hach test kits using the Standard Solution Method as described in the procedure descriptions (Enclosure B). The calibration and accuracy

check records will be documented. Spent field test kit reagent and tested groundwater samples will be managed as investigation-derived waste.

Following the grab sampling, an attempt will be made to purge the temporary PVC casing dry by removing the volume calculated to be present in the borehole observed after grab sampling. Groundwater recharge to the borehole following purging will be observed for another 45 minutes as described above.

If groundwater in the temporary PVC casing recharges to at least 0.75 feet of water or remains static during the purge and grab sampling, a monitoring well will be installed in the borehole and screened across the soil-bedrock interface from three (3) feet above the top of bedrock to seven (7) feet below the top of bedrock. If the water level meets the 0.75-foot threshold prior to 45 minutes, the well installation will proceed.

If less than 0.75 feet of water is observed during the initial 45-minute observation period or if less than 0.75 feet of water recharges during the second 45-minute observation period, a soil-bedrock interface monitoring well will not be installed. The borehole will either be abandoned with hydrated bentonite chips or a conductor casing will be installed for the bedrock borehole drilling as described below.

Monitoring wells installed at the soil-bedrock interface will be constructed using 4-inch diameter, flush-threaded Schedule 40 polyvinyl chloride (PVC) casing and 0.020-inch slotted screen with a bottom end cap. The PVC casing will be fitted with a single centralizer at the bottom of the screened interval to ensure that the well is centered in the borehole. The annular space will be backfilled with a clean graded sand to create a filter pack extending a minimum of two (2) feet above the top of the screen. If the screened interval is submerged, a surge block will be used to settle the filter pack before placement of the annular seal. Additional sand will be placed in the well annulus to compensate for any settling that occurred as a result of the surging process until the filter pack is stabilized at two (2) feet above the screen top. A minimum 3-foot thick bentonite seal will be placed on top of the filter pack (after completion of surging) and consist of bentonite chips or pellets hydrated in place. The remaining annular space will be sealed with a bentonite-cement slurry grout containing no more than 5% bentonite per Idaho Administrative Rules for well construction. The slurry grout will be placed in the borehole using a tremie pipe to approximately three (3) feet bgs.

Lithologic and groundwater observations at the soil-bedrock interface, including the depth to the top of bedrock, depth to water measurements, grab sampling results, and well construction information will be communicated to EPA at the conclusion of each day during the soil-bedrock interface evaluation.

On June 7 and 8, 2012, initial borehole drilling at the A-27 location included a soil-bedrock interface evaluation at two adjacent boreholes advanced to 18 and 19.8 feet bgs. The top of basalt bedrock was observed at 11 and 13 feet, respectively, and less than 0.75 feet of water was observed in each borehole. As such, conductor casing was installed in both boreholes in preparation for bedrock drilling as described below. In order to complete the assessment of the soil-bedrock interface at the A-27 location, one additional borehole will be advanced using the procedure described above. If groundwater conditions are not met to install a soil-bedrock interface monitoring well, the borehole will be sealed in accordance with the Idaho Administrative Rules for well construction.

Bedrock Borehole Drilling and Vertical Groundwater Profiling

At each of the six locations, two boreholes will be installed to evaluate bedrock groundwater; one borehole with a monitoring well screened at the initial bedrock water-bearing zone and one borehole with a monitoring well screened in a deeper water-bearing zone which is at least 20 feet below the bottom of the screened interval for the shallow well. The bedrock boreholes will be initially constructed with a conductor casing installed to 10 feet below the top of bedrock to case off perched groundwater. The boreholes will be advanced using nominal 16-inch diameter direct air rotary drilling methods for installation of the nominal 10-inch diameter steel conductor casing, which will be grouted into place.

Within the deep bedrock boreholes, vertical groundwater profiling and borehole geophysical logging will be conducted, followed by monitoring well installation in a deeper water-bearing zone. The other bedrock borehole will be advanced for monitoring well installation in a shallow water-bearing zone.

The deep borehole drilling will utilize nominal 8-inch diameter advanced casing air rotary drilling methods. Observations during drilling will include lithology of cuttings, advancement rate, depth of first strike of groundwater, and rate of groundwater production during drilling. Once the borehole reaches the first saturated zone in the basalt, groundwater grab samples will be collected at 10-foot intervals to a depth of approximately 60 feet below first strike of groundwater. For the first (uppermost) ten foot interval within the saturated zone, the borehole will be developed by injecting compressed air through the drill string to blow out the borehole and remove any water initially added during the drilling process. Once it is certain that any added water has been removed (i.e., the borehole is “making water”) the drill string will be removed and a volume of water equivalent to approximately three (3) borehole volumes with be removed using either an inertial pump, peristaltic pump, submersible pump, or bottom-filling stainless steel or polyethylene bailer. To facilitate water coming into the borehole it may be necessary to retract the advanced casing several feet. For subsequent sampling intervals the bottom ten feet of the borehole will be sealed off by removing the drill string and retracting the advanced casing approximately 11 feet and deploying an inflatable packer assembly equipped with an electric submersible pump installed through the advanced casing. The packer will be inflated against the borehole wall below the bottom of the advanced casing. A pump will be used to extract three (3) borehole volumes of water (e.g., for an 8-inch diameter hole 10 feet deep, one borehole volume equals approximately 26 gallons) After development at each sampling interval the water level in the borehole will be observed for approximately 20 minutes, or until conditions are relatively stable (i.e. water levels are no longer rising).

Grab samples will be collected using an inertial pump, peristaltic pump, submersible pump, or bottom-filling polyethylene bailer in accordance with WSP revised SOP 3 (Enclosure A). The sample will be analyzed for field parameters including pH, conductivity, temperature, and turbidity using a multi-parameter water quality meter (e.g., Horiba U-52). Additional analyses will be conducted using Hach portable colorimeter (DR/890) and field test kits for nitrate (Hach method 8039), sulfate (Hach method 8051), and orthophosphate (Hach method 8114 or 8048). The Hach procedures for each method to be followed are included as Enclosure B. The multi-parameter water quality meter will be calibrated daily for pH, conductivity, and turbidity in accordance with the manufacturer’s recommendations. An accuracy check will be performed daily for the Hach test kits using the Standard Solution Method as described in the procedure descriptions (Enclosure B). The calibration and accuracy check records will be documented.

Spent field test kit reagent and tested groundwater samples will be managed as investigation-derived waste.

Advancement of the deep borehole will continue to a total depth of approximately 60 feet below the first strike of groundwater, stopping in 10 foot increments for development and grab sampling using the procedure described above. In the event that no additional water-bearing zones are identified within 60 feet of the first strike of groundwater, the borehole will be advanced until a second water-bearing zone is identified.

Lithologic observations, the occurrence and relative yield of water-bearing zones, and the results of groundwater profiling will be communicated to EPA at the conclusion of each borehole during the drilling and vertical groundwater profiling.

Bedrock Borehole Geophysical Logging

In the deep bedrock borehole, downhole geophysical logging will be conducted after the borehole is advanced to the target depth. Geophysical logging will include natural gamma, neutron porosity, and gamma-gamma-density logs run through the advanced casing. The drilling observations and geophysical logging results will be reviewed to assess the potential for borehole collapse and identify zones likely to collapse. Key criteria for likely collapse within the basalt sequence include identification of interflow zones greater than approximately 10 feet in thickness characterized by intensely weathered basalt or scoria cuttings, the presence of sedimentary cuttings that correlate to the depth of prominent deflections in the geophysical logs, or notable changes in the rate of groundwater production during drilling. If the boreholes encounter the bottom contact of the basalt sequence and the underlying sedimentary sequence, likelihood of collapse will be based on the lithology and total thickness of the sedimentary sequence encountered in the borehole.

If borehole collapse occurs or likely collapse zones are identified, the bottom of the advanced casing will be raised to a competent zone underlying the likely collapse zone, and an acoustic televiewer and caliper log will be acquired for the open portion of the borehole below the advanced casing. The casing will then be raised to the next competent zone, and additional acoustic televiewer and caliper log data will be collected in the newly exposed portion of the borehole. In this manner, a nearly continuous acoustic televiewer and caliper log will be collected even if portions of the borehole are prone to collapse, while minimizing the risk of losing a geophysical logging tool.

The results of borehole geophysical logging will be communicated to EPA at the conclusion of logging at each borehole.

<u>Bedrock Monitoring Well Installation and Development</u>

The screened intervals for monitoring wells installed in both the shallow and deep bedrock boreholes will be determined in consultation with EPA and based on a review of data collected from the deep boreholes, including drilling observations, first strike and static water levels measured in the boreholes and nearby monitoring wells, the results of vertical groundwater profiling, and the results of geophysical logging. The screened interval for the shallow bedrock borehole will correspond to the first water-bearing zone. The screened interval for the deep bedrock borehole will correspond to the second water-bearing zone and be at least 20 feet below the bottom of the screened interval in the shallow bedrock borehole. As such, the

shallow bedrock monitoring well may be dry during periods of lower groundwater elevations, but the deeper bedrock monitoring well will be screened in a perennially saturated water-bearing zone such that it yields water at all times. WSP requests that EPA respond within 24 hours regarding proposed screen intervals.

The monitoring wells will be constructed using 4-inch diameter, flush-threaded Schedule 40 polyvinyl chloride (PVC) casing and 0.020-inch slotted screen with a bottom end cap. The screen lengths will be 20 feet. The PVC casing will be fitted with centralizers every 20 feet to ensure that it remains plumbed and aligned in the borehole during installation. The annular space will be backfilled with a clean sand filter pack installed via a tremie pipe to a minimum of two (2) feet above the top of the screen. A surge block will be used to settle the filter pack before placement of the annular seal. Additional filter pack material will be placed in the annular space to compensate for settling of the pack material as a result of the surging process until pack is stabilized at two (2) feet above the screen top. A minimum 3-foot thick bentonite seal will be placed on top of the sand pack (after completion of surging) and consist of either bentonite chips or pellets or a bentonite slurry installed via tremie pipe, depending on the height of the water column above the screened interval and the depth below ground surface. The remaining annular space will be sealed with a bentonite-cement slurry grout containing no more than 5% bentonite per Idaho Administrative Rules for well construction. The slurry grout will be placed in the borehole using a tremie pipe to approximately three (3) feet bgs.

The groundwater monitoring wells will be developed consistent with the requirements in EPA's Monitoring Well Development Guidelines for Superfund Project Managers dated April 1992. Groundwater monitoring wells will be developed no sooner than 24 hours after the placement of the bentonite-cement slurry grout seal. Well development will utilize a submersible pump and surge block, if necessary, to purge groundwater, until the development water is relatively free of suspended sediment and turbidity stabilizes to 20 nephelometric turbidity units (NTUs). If turbidity does not attain 20 NTUs, Nu-West will inform EPA and discuss next steps. During development, temperature, pH, specific conductance, and turbidity will be monitored using a multi-parameter water quality meter, and drawdown will be monitored using an electronic water-level meter. Submersible pumps will be decontaminated before each use.

The locations and elevations of the monitoring wells will be surveyed by an Idaho-licensed professional surveyor. For each monitoring well, the top of PVC casing and ground surface will be surveyed relative to the Idaho East Zone State Plane Coordinate System (North American Datum of 1983 (NAD83)) and the North American Vertical Datum of 1988 (NAVD88). Horizontal locations will be surveyed to the nearest 0.1 feet and vertical locations to the nearest 0.01 feet.

Monitoring Well Groundwater Sampling

The new wells will be sampled a minimum of two weeks after installation and development. If possible, the sampling will be conducted in conjunction with a semi-annual monitoring event. Low-flow purging and sampling techniques will be used in accordance with WSP revised SOP 3 and EPA low-flow sampling guidance (EPA 1996). Before initiating the sampling activities, each well will be uncapped and allowed to stand for a minimum of 15 minutes while the water level in the well equilibrates with the atmospheric pressure. The depth to groundwater (to the nearest 0.01 foot) will be measured from the reference point on the north side of the inner well casing using an electronic water level meter.

Well purging will be conducted using a submersible or bladder pump capable of flow rates between 0.1 and 0.5 liter per minute. During purging, temperature, pH, specific conductance,

dissolved oxygen (DO), turbidity, and oxidation-reduction potential (ORP) will be monitored using a multi-parameter water-quality meter equipped with a flow-through cell (e.g., Horiba U-52), and drawdown will be monitored using an electronic water-level meter. Field parameters, including the water level in the well, will be recorded every 3 to 5 minutes until the parameters have stabilized with the two preceding measurements (±10 percent for temperature, turbidity, and DO; ±10 mV for ORP; ±0.1 unit for pH; ±3 percent for specific conductance; and ±0.3 foot for drawdown). Final turbidity readings should be less than 20 NTUs. If the turbidity criterion of less than 20 NTUs cannot be met, then the turbidity must be within ±5 NTUs or 10 percent, whichever is greater, for three consecutive measurements before sample collection. After these parameters have stabilized, groundwater samples will be collected for laboratory analysis of the parameters listed in the Analytical Program described below and summarized in Tables 1 and 2.

Due to the potential for stagnant water in the soil-bedrock interface monitoring wells, groundwater sampling at these locations will utilize a three well volume purge prior to sampling. Water will be withdrawn using technology appropriate for slow-recovering wells, such as an inertial pump, peristaltic pump, or bottom-filling polyethylene bailer. If a monitoring well purges dry during the removal of three well volumes, the well will be allowed to recharge for 24 hours, after which a grab sample will be collected for laboratory analysis. If insufficient water has entered the well for the full suite of analytes after 24 hours, bottle sets will be filled sequentially in the order specified in the Analytical Program described below.

All purge water generated during the monitoring well sampling activities will be contained in either DOT-compliant 55-gallon steel drums or a small polyethylene tank, and managed at the CPO facility.

Quality Assurance Requirements

Quality assurance requirements associated with groundwater sampling and analysis were described in the approved Quality Assurance Project Plan (QAPP) dated June 10, 2010. The 2010 QAPP covered all of the analytical methods identified for monitoring well groundwater sampling. A summary of quality assurance requirements from the EPA-approved QAPP are provided below. Procedures for Hach field test kits are included in Enclosure B.

Analytical Program

The following field parameters will be measured at each monitoring well location during low-flow purging: pH, temperature, specific conductance, turbidity, DO, and ORP. The ORP results will be used to calculate Eh.

Laboratory analyses for conventional chemical parameters will be performed by Accutest Laboratories Southeast located in Wheat Ridge, Colorado. Accutest Laboratories participates in the National Environmental Laboratory Accreditation Program (NELAP) and is certified by the NELAP accrediting authority in Idaho. Radiological analyses will be performed by ALS Laboratory Group located in Fort Collins, Colorado. ALS Laboratory Group holds NELAP certification and several state certifications for radiochemistry. Both Accutest and ALS are listed on IDEQ's current list of laboratories certified for drinking water analysis.

As summarized in Tables 1 and 2, analytical methods will be those specified below. Samples exhibiting gross alpha above 15 picocuries per liter (pCi/L) will be analyzed for radium 226 and radium 228.

- total dissolved solids (TDS) by Standard Method 2540C
- total suspended solids (TSS) by Standard Method 2540D
- antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, lead, magnesium, nickel, potassium, selenium, sodium, thallium, and vanadium by EPA Method 200.8 or 6010B
- chloride, fluoride, nitrate as N, nitrite as N, and sulfate by EPA Method 300.0 or 300.1
- sulfide by Standard Method 4500 S=F
- pH by Standard Method 4500 H+B
- total ammonia by EPA Method 350.1
- total phosphorous by EPA Method 365.3
- orthophosphate by EPA Method 365.1
- total nitrogen by Standard Method 4500N
- total Kjeldahl nitrogen (TKN) by EPA Method 351.2
- hardness as $CaCO_3$ by Standard Method 2340B
- total alkalinity as $CaCO_3$ by Standard Method 2320B
- bicarbonate and carbonate alkalinity as $CaCO_3$ by Standard Method 4500CO2D
- specific conductance by EPA Method 120.1
- gross alpha and gross beta by EPA Method 900.0
- radium 226 by EPA Method 903.0
- radium 228 by EPA Method 904.0

With the exception of total Kjeldahl nitrogen, total phosphorous, sulfide, and total suspended solids, all of the above stated analytical methods meet EPA's requirements for drinking water analysis. The laboratory method detection limits are compared to State of Idaho drinking water standards in Table 2. Total Kjeldahl nitrogen, total phosphorus, sulfide, and total suspended solids do not have drinking water standards – these analytes will be analyzed using accepted EPA or Standard Method analytical methods.

The chemical analytical results for the groundwater samples will be compared to the Idaho Primary and Secondary Constituent Standards for groundwater (IDAPA 58.01.11) and EPA National Primary Drinking Water Regulations Maximum Contaminant Levels (40 C.F.R. Part141).

Field QA/QC Samples

Groundwater sampling will include the collection of blind field duplicates at a ratio of 1:10 and, if necessary, equipment blanks on a daily basis. These field quality assurance/quality control samples will be collected in accordance with WSP SOP #21.

Equipment Decontamination

Decontamination of non-dedicated groundwater sampling equipment will be performed between each monitoring well, and decontaminated sampling equipment will be used for the collection of each sample. Decontamination procedures are specified in WSP SOPs #15 and #19. Decontamination will include the use of a phosphate-free detergent, such as Liquinox®.

Sample Container Requirements

Groundwater samples will be placed in new, laboratory-supplied, clean sample containers. Sample containers and preservatives will be as specified by the laboratory, in accordance with WSP SOP #2. Each sample container will be labeled with a unique label description that will include the sample identification number, date and time of sample collection, analyses to be performed, sampler's initials, and the project name and number.

Following collection, each sample will be placed in a cooler and chilled to approximately 4 degrees Celsius. Samples will be packaged and shipped according to procedures described below and chain-of-custody (COC) procedures described below.

Sample Packaging and Shipping

The lid of each sample container will be securely tightened and samples placed in re-sealable plastic bags. Samples will be placed into a sample cooler or other appropriate shipping vessel and packed carefully to minimize the potential for breakage or spilling by using packing material (e.g., bubble wrap). In no case will glass sample containers be permitted to touch each other inside the sample transportation container.

Ice in watertight re-sealable plastic bags will be placed on top of the samples and packing. If shipped by common carrier, the appropriate COC forms will accompany the samples sealed in the shipping cooler in watertight packaging. The COC forms must be dry and legible upon receipt at the laboratory.

After packing, the containers must be sealed and managed in accordance with the COC requirements listed below. If being shipped by common carrier, an appropriate completed air bill or freight bill will be taped to the outside of the container.

Chain-of-Custody Procedures

COC procedures consist of several levels of documentation, including the field logbook, the COC form, and custody seals. These documents serve as the record for tracking sample collection and transport. Once a sample is obtained, it must be maintained under COC procedures until it is in the custody of the analytical laboratory. The person collecting the sample is responsible for the custody of the sample until it is properly transferred or dispatched. WSP's standard COC forms or laboratory-supplied COC forms shall be used.

Field Logbook

The field logbook serves as official documentation of sampling activities. Field logbooks will be constructed of bound, sequentially numbered, water-resistant notepaper, and records will be kept in waterproof ink. Field personnel shall make frequent detailed entries to provide an adequate record of activities conducted during each day on site. WSP SOP #1 provides additional details of required protocol for the field log book.

Chain-of-Custody Form

A COC form will be filled out either simultaneously with the notations in the logbook or shortly after sample collection is completed for the day. The information required on the COC form

includes the project name and number; sampler's name and signature; sample numbers; sample matrix; date and time of sample collection; quantity of sample containers; analyses required; and custody sequence.

If the samples are being shipped by common carrier, the COC form will include the carrier air bill number in lieu of a custody signature from a courier employee. In this event, the COC form will be packed in a cooler with the laboratory samples in a re-sealable plastic bag. One copy of the COC form will be retained by the sampler. The sender's copy of the air bill will be affixed to this copy of the COC form and will become a part of the COC documentation. The original COC form will remain with the samples during shipment. The receiving laboratory will be instructed to sign the COC form and return one copy with the analytical data package. The original COC form will remain with the samples until their ultimate disposal.

Custody Seals

To complete custody procedures for shipping, each sample cooler or container will be sealed with custody seals that are to be signed and dated by the shipper. The custody seal is a label with adhesive backing that is sealed over the container latch or across the closure point. If broken during transit, the sample custody has been compromised, which indicates potential tampering during transit. If unbroken, the integrity of the samples is assumed to have been maintained.

Proposed Schedule

A schedule has been developed indicating the start date for the borehole drilling in the vicinity of the Cooling Ponds (Figure 2). Field activities are tentatively scheduled to resume during the week of July 9, 2012, pending EPA approval of this Addendum to the Work Plan for Additional Requirements. The schedule, which is in calendar days, assumes that activities will occur in succession and will continue as weather/field conditions permit. The schedule includes Nu-West review of investigation results followed by submittal to EPA for review and approval.

Reporting

The scope of work described in this Addendum includes ongoing communication with EPA regarding the observations and field activities. This includes daily summaries of drilling conditions and borehole summaries of groundwater profiling and geophysical logging results. Proposed screened intervals for monitoring wells will be determined in consultation with EPA. The compiled results of the investigation including groundwater monitoring well sampling results will be provided to EPA at the conclusion of the field season and incorporated with the results of other investigations being conducted at the Nu-West CPO facility.

The drilling observations and groundwater sampling results will be incorporated into an updated conceptual site model for groundwater flow and contaminant distribution. The updated conceptual site model will also incorporate sampling results for the existing groundwater monitoring program; results for soil, sediment, and surface water sampling; lithologic and geochemical observations from borehole drilling and downhole geophysical logging; and groundwater elevation measurements and groundwater yield data from well gauging and well sampling.

If you require additional information or have any questions regarding the scope of work described in this letter, please do not hesitate to contact us.

Sincerely,

James P. Bulman
Executive Vice President

JPB:rlo
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cc: P. Scott Burton (Hunton & Williams LLP)

Enclosures

Figures

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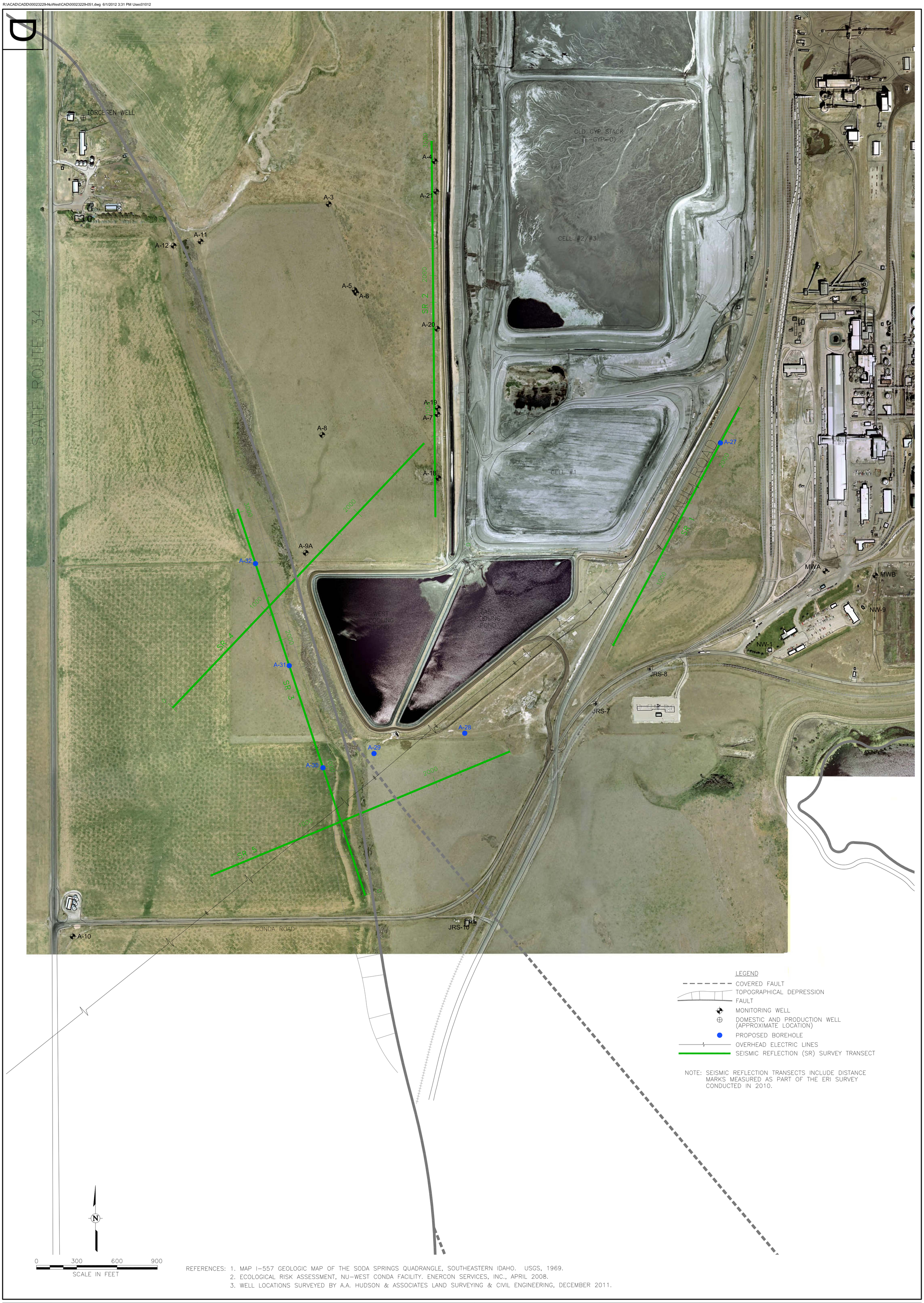

REFERENCES:
1. MAP I-557 GEOLOGIC MAP OF THE SODA SPRINGS QUADRANGLE, SOUTHEASTERN IDAHO. USGS, 1969.
2. ECOLOGICAL RISK ASSESSMENT, NU-WEST CONDA FACILITY. ENERCON SERVICES, INC., APRIL 2008.
3. WELL LOCATIONS SURVEYED BY A.A. HUDSON & ASSOCIATES LAND SURVEYING & CIVIL ENGINEERING, DECEMBER 2011.

Drawing Number 00023229-051

Figure 1

WSP

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SEISMIC SURVEY TRANSECTS AND PROPOSED BOREHOLE LOCATIONS

NU-WEST CPO FACILITY
SODA SPRINGS, IDAHO

DRAWN BY	EGC	
CHECKED	TAH	6/1/12
APPROVED		

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SEAL

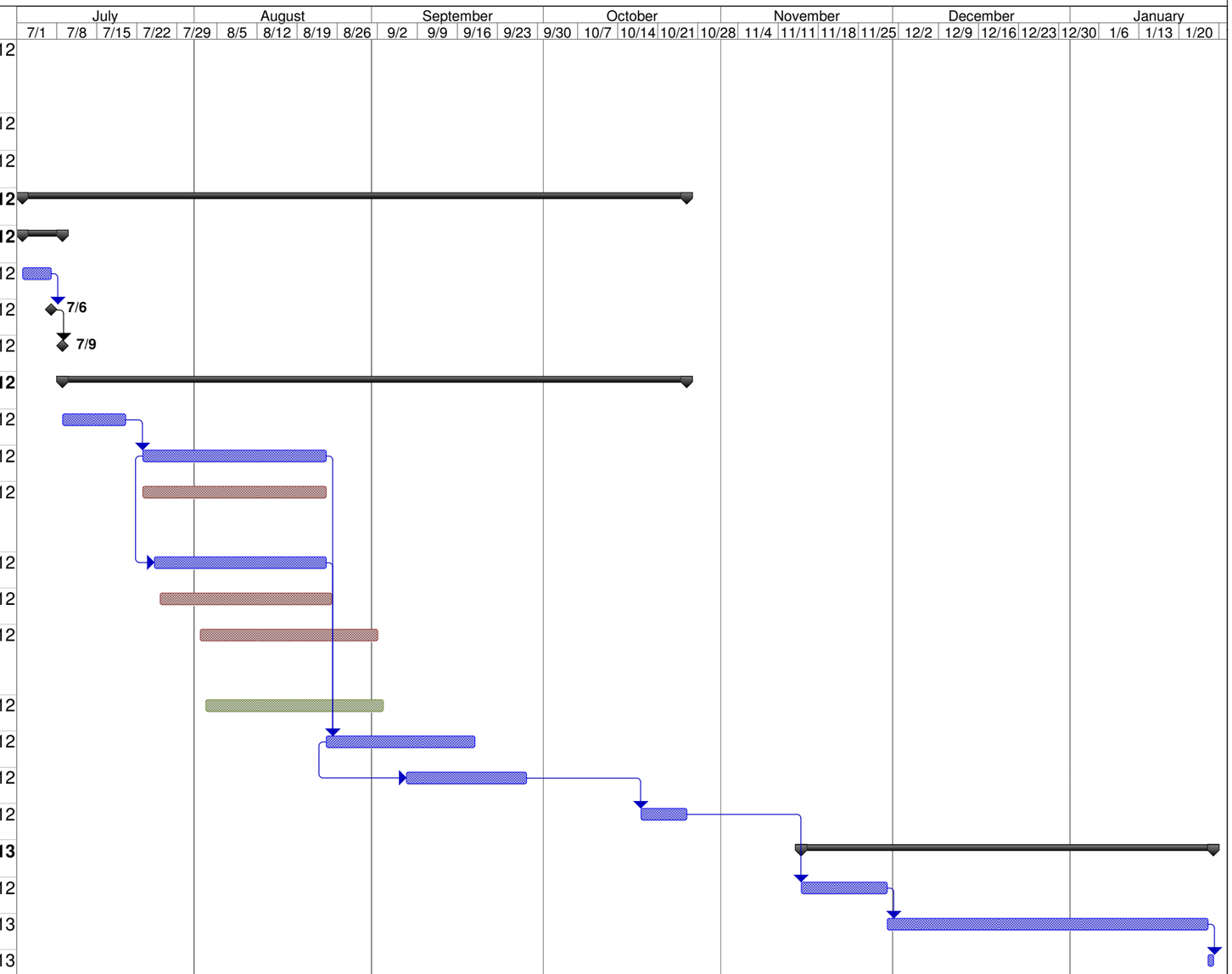
DATE

REVISIONS

REV	DESCRIPTION		
1	Revised:	Chkd:	Appr.:
2	Revised:	Chkd:	Appr.:
3	Revised:	Chkd:	Appr.:

Figure 2
Project Schedule
Seismic Survey Borehole Installation
Nu-West CPO Facility
Soda Springs, Idaho

Task Name	Start	Finish
Addendum to Work Plan for Additional Requirements Submitted to EPA	Fri 6/22/12	Fri 6/22/12
EPA Review and Comment Work Plan	Fri 6/22/12	Fri 6/29/12
EPA Approval of Work Plan	Fri 6/29/12	Fri 6/29/12
Work Plan Implementation	**Mon 7/2/12**	**Thu 10/25/12**
Preparation for Field Work	**Mon 7/2/12**	**Mon 7/9/12**
Subcontractor Procurement (incl. final scope adjustments)	Mon 7/2/12	Fri 7/6/12
Issue Notice to Proceed to Subcontactors	Fri 7/6/12	Fri 7/6/12
Drilling Contractor on Site	Mon 7/9/12	Mon 7/9/12
Boring/Monitoring Well Installation and Sampling	**Mon 7/9/12**	**Thu 10/25/12**
Soil/Bedrock Interface Evaluation	Mon 7/9/12	Thu 7/19/12
Bedrock Borehole Drilling and Vertical Groundwater Profiling	Mon 7/23/12	Thu 8/23/12
Provide Results of Bedrock Borehole Drilling and Vertical Groundwater Profiling to EPA	Mon 7/23/12	Thu 8/23/12
Bedrock Borehole Geophysical Logging	Wed 7/25/12	Thu 8/23/12
Provide Results of Geophysical Logging to EPA	Thu 7/26/12	Fri 8/24/12
Provide Recommendations for Monitoring Well Screened Intervals to EPA	Thu 8/2/12	Sat 9/1/12
EPA Review, Comment, and Approval	Fri 8/3/12	Sun 9/2/12
Bedrock Monitoring Well Installation	Fri 8/24/12	Tue 9/18/12
Monitoring Well Development	Fri 9/7/12	Thu 9/27/12
Monitoring Well Sampling	Thu 10/18/12	Thu 10/25/12
Data Evaluation and Reporting	**Thu 11/15/12**	**Fri 1/25/13**
Data Evaluation	Thu 11/15/12	Thu 11/29/12
Report Preparation	Fri 11/30/12	Thu 1/24/13
Report Submittal	Fri 1/25/13	Fri 1/25/13



Nu-West CPO
Soda Springs, Idaho
2012

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Progress	
Split		External Tasks		Inactive Summary		Manual Summary		Deadline	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

Tables

Table 1
Groundwater Sampling and Analytical Program
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Sample Location	Monitored Zone (e)	Metals (a)	General Chemistry (b)	Radiological Parameters (c)	Field Parameters (d)
Cooling Pond Area Monitoring Wells					
A-27	Soil-Bedrock	1	1	1	1
A-27	Shallow	1	1	1	1
A-27	Deep	1	1	1	1
A-28	Soil-Bedrock	1	1	1	1
A-28	Shallow	1	1	1	1
A-28	Deep	1	1	1	1
A-29	Soil-Bedrock	1	1	1	1
A-29	Shallow	1	1	1	1
A-29	Deep	1	1	1	1
A-30	Soil-Bedrock	1	1	1	1
A-30	Shallow	1	1	1	1
A-30	Deep	1	1	1	1
A-31	Soil-Bedrock	1	1	1	1
A-31	Shallow	1	1	1	1
A-31	Deep	1	1	1	1
A-32	Soil-Bedrock	1	1	1	1
A-32	Shallow	1	1	1	1
A-32	Deep	1	1	1	1

a/ Samples will be field filtered for dissolved phase metals listed in Table 2.

b/ The general chemistry parameters will include Chloride, Fluoride, Nitrate, Nitrite, Total Nitrogen, Total Kjeldahl Nitrogen, Orthophosphate, Total Phosphorous, Sulfate, Sulfide, TDS, TSS, pH, Hardness ($CaCO_3$), Alkalinity, Ammonia (total), Alkalinity (bicarbonate and carbonate), and Specific Conductance.

c/ The initial radiological parameters include total and dissolved gross alpha radiation. Based on the results, additional testing for radium-226 and radium-228 may be performed.

d/ Field parameters include pH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation/reduction potential (ORP).

e/ Soil-Bedrock corresponds to the soil/ bedrock interface;
Shallow corresponds to the first water-bearing zone within the bedrock aquifer;
Deep corresponds to the second water-bearing zone within the bedrock aquifer

Table 2
Groundwater Sample Analytical Methods
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Analytes	Test Method (b)	Method Detection Limit (mg/l)	Laboratory Reporting Limit (mg/l)	EPA Maximum Contaminant Level (c) (mg/l)	Idaho Groundwater Standard (d) (mg/l)	Sample Criteria (e) Container	Quantity (ml)	Preservative	Holding Time
Dissolved Metals (mg/l)									
Antimony	SW-846 6010B	0.0045	0.006	0.006	0.006	P	500	4^oC; HNO_3 <2 S.U.	6 months
Arsenic	SW-846 6010B	0.0054	0.01	0.01	0.01	P	500	4^oC; HNO_3 <2 S.U.	6 months
Barium	SW-846 6010B	0.005	0.2	2	2	P	500	4^oC; HNO_3 <2 S.U.	6 months
Beryllium	SW-846 6010B	0.001	0.004	0.004	0.004	P	500	4^oC; HNO_3 <2 S.U.	6 months
Cadmium	SW-846 6010B	0.001	0.005	0.005	0.005	P	500	4^oC; HNO_3 <2 S.U.	6 months
Calcium	SW-846 6010B	0.1	1	NS	NS	P	500	4^oC; HNO_3 <2 S.U.	6 months
Chromium	SW-846 6010B	0.002	0.01	0.1	0.1	P	500	4^oC; HNO_3 <2 S.U.	6 months
Lead	SW-846 6010B	0.002	0.005	0.015	0.015	P	500	4^oC; HNO_3 <2 S.U.	6 months
Magnesium	SW-846 6010B	0.1	5	NS	NS	P	500	4^oC; HNO_3 <2 S.U.	6 months
Nickel	SW-846 6010B	0.0023	0.04	NS	0.209	P	500	4^oC; HNO_3 <2 S.U.	6 months
Potassium	SW-846 6010B	0.1	10	NS	NS	P	500	4^oC; HNO_3 <2 S.U.	6 months
Selenium	SW-846 6010B	0.0034	0.01	0.05	0.05	P	500	4^oC; HNO_3 <2 S.U.	6 months
Sodium	SW-846 6010B	1	20	NS	NS	P	500	4^oC; HNO_3 <2 S.U.	6 months
Thallium	EPA 200.8	0.00016	0.00125	0.002	0.002	P	500	4^oC; HNO_3 <2 S.U.	6 months
Vanadium	SW-846 6010B	0.0009	0.05	NS	NS	P	500	4^oC; HNO_3 <2 S.U.	6 months
General Chemistry (mg/l)									
Chloride	EPA 300	1	2	NS	250	P	250	4^oC	28 days
Fluoride	EPA 300	0.1	0.2	NS	4	P	500	4^oC	28 days
Nitrate as N	EPA 300	0.05	0.1	10	10	P, G	1,000	4^oC; H_2SO4 <2 S.U.	28 days
Nitrite as N	EPA 300	0.05	0.1	1	1	P	1,000	4^oC	48 hours
Total Nitrogen	SM18 4500N	0.21	0.46	NS	NS	P	500	4^oC; H_2SO4 <2 S.U.	28 days
Total Kjeldahl Nitrogen	EPA 351.2	0.05	0.1	NS	NS	P	1,000	4^oC; H_2SO4 <2 S.U.	28 days
Orthophosphate	EPA 365.1	0.009	0.1	NS	NS	P (f)	500	4^oC	48 hours
Total Phosphorous	EPA 365.3	0.009	0.1	NS	NS	P	100	4^oC; H_2SO4 <2 S.U.	28 days
Sulfate	EPA 300	1	2	NS	NS	P	500	4^oC	28 days
Sulfide	SM4500S=F	0.6	1	NS	NS	P, G	500	4^oC; NaOH+Zn acetate >9 S.U.	7 days
TDS	SM2540C	10	100	NS	500	P	100	4^oC	7 days
TSS	SM2540D	4	10	NS	NS	P	100	4^oC	7 days
pH (S.U.)	SM4500 H+B	0.01	0.01	NS	6.5 to 8.5	P	100	4^oC	immediate
Hardness ($CaCO_3$)	SM2340B	4	4	NS	NS	P	500	4^oC; HNO_3 <2 S.U.	6 months
Alkalinity (total)	SM19 2320B	2.5	5	NS	NS	P	1000	4^oC	14 days
Ammonia (total)	EPA 350.1	0.05	0.1	NS	NS	P	500	4^oC; H_2SO4 <2 S.U.	28 days
Alkalinity (bicarbonate and carbonate)	SM18 4500CO2D	5	5	NS	NS	P	1000	4^oC	14 days
Specific Conductance	EPA 120.1	NA	1	NS	NS	P	1000	4^oC	28 days

Table 2
Groundwater Sample Analytical Methods
Nu-West Industries, Inc.
Conda Phosphate Operations Facility
Soda Springs, Idaho

Analytes	Test Method (b)	Method Detection Limit (mg/l)	Laboratory Reporting Limit (mg/l)	EPA Maximum Contaminant Level (c) (mg/l)	Idaho Groundwater Standard (d) (mg/l)	Sample Criteria (e) Container	Quantity (ml)	Preservative	Holding Time
Radiological Parameters (pCi/l)									
Gross alpha	EPA 900	3 piC/l	NS	15 pCi/l	15 piC/l	P	5 liters	HNO_3 < 2 S.U.	6 months
Gross beta	EPA 900	4 piC/l	NS	4 mrem/yr	15 piC/l	P	5 liters	HNO_3 < 2 S.U.	6 months
Radium 226 and 228	EPA 903.0/904.0	1 piC/l	NS	5 pCi/l	5 pCi/l	P	5 liters	HNO_3 < 2 S.U.	6 months

a/ mg/l = milligrams per liter; NS = not applicable or standard not developed; ml = milliliter; P = plastic; G = glass; oC = degrees Celsius; HNO3 = nitric acid; H2SO4 = sulfuric acid; NaOH+Zn acetate = sodium hydroxide plus zinc acetate; HCl = hydrochloric acid; S.U. = standard units; TDS = total dissolved solids; µg/l = micrograms per liter; pCi/l = picoCuries per liter; TDS will be analyzed for groundwater only.
b/ SW-846 source: EPA. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (1986, as updated and revised).
SM source: American Public Health Association. Standard Methods for Examination of Water and Wastewater (1998, as updated and revised).
EPA sources:
EPA. Methods for Chemical Analysis of Water and Waste. EPA 600/4-70-020 (1983, as updated and revised).
EPA. EPA Prescribed Procedures for Measurement of Radioactivity in Drinking Water. EPA 600 4-80-032 (1980, as updated and revised).
c/ National Primary Drinking Water Regulations, Title 40, Part 141, Appendix A, Regulated Contaminants. EPA (March 2010).
d/ Idaho Groundwater Quality Rule, Idaho Administrative Code IDAPA 58.01.11, Numerical Ground Water Quality Standards, Primary and Secondary Standards.
e/ Accutest Laboratories.
f/ Filter within 15 minutes of sampling.

Enclosure A – Revised Standard Operating Procedure 3

Revised Standard Operating Procedure – 3

Groundwater Sampling

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3 Groundwater Sampling Procedures

3.1 Scope and Application

This groundwater sampling procedure is designed to ensure that collected groundwater samples will be representative of groundwater present in the aquifer or target formation and that the groundwater samples have not been altered or contaminated by the sampling and handling procedures. These procedures can be applied to permanently, or temporarily, installed monitoring wells, temporary wells constructed using “direct-push” techniques, wells with installed plumbing, remedial groundwater treatment systems, and excavations where groundwater is present. The topics detailed in this Standard Operating Procedure (SOP) include equipment and supply selection, equipment construction materials, and purging and sampling techniques.

3.2 Acronym List

bgs	below ground surface
C	Celsius
CID	casing inside diameter
DI	deionized
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DTW	depth to water
Eh	redox potential
HASP	Health and Safety Plan
L/min	liters per minute
LNAPL	light non-aqueous phase liquid
mg/l	milligrams per liter
mV	millivolts
NAPL	non-aqueous phase liquid
NTU	Nephelometric Turbidity Unit
ORP	oxygen reduction potential
pH	hydrogen ion activity
PID	Photoionization Detector
PPE	Personal Protective Equipment
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedure
SU	Standard Units
TD	total depth
TOC	top of casing
µm	micron

µS/cm	microsiemens per centimeter
VOCs	volatile organic compounds

3.3 Materials

- Field notebook
- Personal Protective Equipment (PPE)
- Groundwater monitoring data log forms
- Well key(s), as needed
- Adjustable wrench or manhole wrench
- Plastic sheeting
- Air quality monitoring equipment (e.g., photoionization detector [PID]), as needed
- Flashlight or mirror
- Electronic water level indicator or interface probe
- Pump or bailers, tubing, and associated lanyard materials
- Water quality meter(s) with calibration reagents and standards
- Field test kits, as needed
- Pocket knife or scissors
- Deionized (DI) water
- Power supply, as needed
- Buckets or drum(s) for water storage
- Sample bottles, labels, indelible markers, and clear tape

3.4 Compulsory Prerequisites and Background Information

Before conducting field activities, review the site Health and Safety Plan (HASP) and determine the proper level of PPE. The reader is encouraged to read this entire SOP before beginning any onsite activities. This SOP is designed to provide the user with a general outline for conducting groundwater sampling and assumes the user is familiar with basic field procedures, such as recording field notes, utility location, sample shipment procedures, sample collection and quality assurance procedures, equipment decontamination, and investigation derived waste management procedures. This SOP does not cover the development of a sampling and analysis plan, nor does it cover the selection of analytical procedures, or evaluation of the analytical results. These topics require a significant amount of planning and are more appropriately addressed in a site-specific work plan.

Before sampling, be sure to review the project specific work plan or Quality Assurance Project Plan (QAPP) and any applicable state and federal guidelines or sampling procedures. Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques. As possible, monitoring wells or borings should be sampled by starting with the

upgradient (or clean locations) and proceeding downgradient (in the order from least to most contaminated locations) for the remaining monitoring wells or borings.

3.5 Equipment Selection Considerations

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. Additional supplies such as reagents, preservatives, and field measurement equipment are often necessary.

3.5.1 Pump Selection

Groundwater sampling is accomplished by using in-place plumbing and dedicated pumps or by using portable pumps/equipment when dedicated systems are not present. In selecting groundwater purging and sampling equipment, give consideration to:

- the depth of the well
- the depth to groundwater
- the volume of water to be evacuated
- the sampling and purging technique
- the analytes of interest

Sampling equipment will usually consist of peristaltic pumps, variable speed electric submersible pumps, bladder pumps, inertial lift pumps, or bailers.

Restrictions and Precautions:

- Follow all manufacturer's instructions for assembly, operation, and maintenance specific to your equipment
- For wells where the water level is below the limit of suction (approximately 25 feet to 30 feet below ground surface, bgs), and/or where there is a large volume of water to be purged, a peristaltic pump should not be used
- Purging and sampling with an inertial lift pump (e.g., polyethylene tubing with a bottom check valve) are performed by oscillating the tubing at the intake depth to drive a column of water to the surface. Inertial lift pumps cause a surging action that may cause increased turbidity, loss of volatiles, aeration, and degassing of samples. These pumps can be used when collecting non-sensitive samples; however, should not be used for volatile organic compounds (VOCs) or gas-sensitive samples. A peristaltic pump may be attached to the sample tubing and used to pump water to the surface
- VOCs and extractable organics should not be sampled with a peristaltic pump unless a vacuum jug or gravity method is employed and the method was previously approved
- Bailers may also be used for purging in appropriate situations; however, their use is discouraged by many programs. Because bailers have been shown to increase turbidity while purging and sampling, bailers should be avoided when sampling for trace element, metal, polychlorinated biphenyls, and pesticide constituents. Bailers, if improperly used, may also strip VOCs from the water column being sampled
- Bailers with a controlled flow bottom when should be used when collecting volatile organic samples

- Before use, install a check valve at the end of the purge tubing to prevent backflow
- Pump housing and tubing parts must be compatible with the analytes of interest. Parts can be composed of various materials, usually polyvinyl chloride (PVC), Teflon, polyethylene, polypropylene, and stainless steel, or other non-inert materials; be sure to use non-metallic or stainless steel tubing if sampling for metals
- Electrical cords and any cabling must be sealed in Teflon, polyethylene, or polypropylene, or be stainless steel
- Lanyard material must be non-reactive, non-leachable material (e.g., cotton twine, nylon, stainless steel, Teflon coated, polyethylene, or polypropylene; stainless steel, Teflon coated, polyethylene and polypropylene lanyards may be decontaminated for future use

3.5.2 Groundwater Indicator Parameter Monitoring Equipment

WSP regularly conducts field testing for the following in-situ or field-collected parameters: groundwater level elevation, hydrogen ion activity (pH), specific conductance (conductivity), temperature, dissolved oxygen (DO), oxygen reduction potential (ORP), and turbidity. Field testing is usually conducted due to the unstable nature of these parameters; laboratory determinations will likely not be representative of field conditions.

3.5.2.1 pH

pH is a measure of the effective concentration (or activity) of hydrogen ions and is expressed as the negative base-10 logarithm of the hydrogen-ion activity in moles per liter. Uncontaminated groundwater typically exhibits a pH ranging from 5 to 9 Standard Units (SU). Changes in pH from background may indicate the presence of groundwater contamination or that existing contamination has spread and can be very useful in identifying well construction or maintenance problems.

3.5.2.2 Specific conductance

Specific conductance, or conductivity, measures the ability of water to conduct an electric current. It is generally reported in microsiemens per centimeter (µS/cm), as natural waters commonly exhibit specific conductance well below 1 µS/cm. Total dissolved solid concentrations may be approximated from specific conductance data; high readings may indicate contamination, especially if the readings are elevated compared to background. Alternatively, elevated specific conductance may indicate inadequate well development, grout contamination, or an inadequate grout seal.

3.5.2.3 Temperature

Temperature is not necessarily an indicator of groundwater chemical stabilization, and is generally not very sensitive in distinguishing between stagnant casing water and formation water. Nevertheless, temperature is important for data interpretation. For example, stabilized temperature readings that are representative of typical groundwater conditions help demonstrate that the sample was collected in a manner that minimized exposure to elevated temperature variations, e.g., heating from the electric motor of a submersible pump. Elevating

the temperature of a sample may result in loss of VOCs or the progression of chemical reactions that may alter the sample quality in an undesirable manner.

3.5.2.4 DO

DO has been demonstrated to be a reliable indicator of the chemical stabilization of purge water under most groundwater purging and sampling circumstances. Concentrations of DO in groundwater generally range from 1 to 4 milligrams per liter (mg/l) and should only be measured with a flow-through cell. Relatively low DO concentrations (< 1 mg/l) in groundwater may indicate the biodegradation of organic contaminants, including VOCs. DO is a good indicator when sampling for VOCs, because erratic or elevated DO readings may reflect procedures that are causing excessive agitation and aeration of the ground water being drawn from the well and subsequent loss of VOCs. Artificially aerated groundwater may also adversely affect dissolved metals analyses.

3.5.2.5 ORP

ORP is a numerical index of the intensity of the oxidizing or reducing conditions within an aqueous solution such as ground water. Oxidizing conditions are indicated by positive potentials and reducing conditions are indicated by negative potentials. ORP measurements are generally expressed in millivolts (mV). The ORP of natural (uncontaminated) groundwater typically ranges from +500 to -100 mV. Groundwater contaminated with organic compounds generally exhibits depressed ORP values compared to background conditions and may exhibit ORP values as low as -400 mV. ORP must be measured with a flow-through cell and may not be an appropriate stabilization parameter for some groundwater conditions.

3.5.2.6 Turbidity

Turbidity, which is the visible presence of suspended mineral and organic particles in a ground water sample, can be useful to measure during purging. Relatively high or erratic measurements may indicate inadequate well construction, development or improper sampling procedures, such as purging at an excessive rate that exceeds the well yield. Purging and sampling in a manner that produces low-turbidity water is particularly important when analyzing for total metals, which may exhibit artificially elevated concentrations in high-turbidity samples. Generally, the turbidity of in-situ groundwater is very low (at or below 10 Nephelometric Turbidity Units, NTUs); however, some groundwater zones may have natural turbidity higher than 10 NTUs.

The groundwater indicator parameters selected for field testing should be determined by the project team. Field testing of groundwater indicator parameters should be conducted with cleaned, calibrated equipment. The following procedures should be followed and all observations and measurements recorded in the field book.

- Select water quality monitoring equipment that meets the project's data quality objectives and applicable regulatory requirements for field testing measurements

- Record manufacturer name, model number, and identifying number such as a serial number for each instrument
- Follow the manufacturer's instructions for assembly, operation, calibration, and maintenance specific to your equipment
- Ensure that all equipment is in proper working condition, not damaged, and that batteries are properly charged before using the equipment for field testing measurements
- Calibration of instruments should occur in the field, as close to the time of use as possible and, at least, be at the frequency suggested by the manufacturer
- Although water quality monitoring equipment may vary in configuration or operation, project specific calibration requirements must be met
- Document the time, date, and instrument reading of acceptable calibration and calibration verification for each instrument unit and field test or analysis, linking this record with affected sample measurements
- Document the date of receipt, expiration date, date of first use for all standards and reagents, grade and concentration (or other value) for the standard in the appropriate measurement units
- Thoroughly rinse the instrument with DI water and fresh standards or reagents when calibrating or verifying the calibration or when taking sample measurements. For in-situ measurements, ensure adequate flushing of the instrument with fresh sample water prior to taking measurements. Residual remaining on the instrument may affect the measurement
- If calibration fails to meet criteria, follow the manufacturer's instructions for corrective action to correct instrument performance; record discontinuation of equipment due to non-compliance with calibration failure

3.5.3 Field Measurements of Groundwater Indicator Parameters

Indicator parameters are measured in the field to evaluate well stabilization during purging, provide information on general ground water quality, evaluate well construction, or indicate when well maintenance is needed. Indicator parameter data also may be helpful in evaluating the presence of groundwater contamination.

After calibrating the groundwater quality monitoring equipment, follow the manufacturer's instructions to select the display for readings the necessary geochemical parameters. Field testing measurements should be collected in accordance with the purge and sampling schedules provided in Sections 3.8 and 3.9. The following procedures should be followed and all observations and measurements recorded in the field book.

- Collection of field parameters should be completed within 15 minutes of sample collection
- Immerse the probe in a flow-through cell, sample cup or beaker, or at the desired depth in the well or borehole, and wait for stabilization of the reading before recording the measurement
- If collecting field measurements ex-situ, agitate or swirl the sample during the stabilization period
- Specific conductance is sensitive to temperature. If the meter is equipped with manual temperature compensation, adjust the conductivity meter to the water temperature per manufacturer's instructions. If the water temperature varies significantly from 25°Celcius (C), measure the temperature with a calibrated device, record the temperature, and correct for temperature according to the manufacturer's specifications
- ORP meters may present redox potential (Eh) values; depending on the desired results, conversion between ORP and Eh may be necessary

- ***DO and ORP readings must be obtained in a manner in which the sample is not exposed to air prior to the measurement (e.g., flow-through cell).***

Record all field-testing measurement data, to include the following:

- Project name and location
- Date and time of measurement or test (including time zone, if applicable)
- Source and location of the measurement or test sample (e.g., monitoring well identification number, outfall number, station number or other description)
- Analyte or parameter measured
- Measurement or test sample value
- Reporting units
- Initials or name of analyst performing the measurement
- Unique identification of the specific instrument unit(s) used for the test(s)

3.6 Set-Up Procedures

Once the equipment and supplies have been selected, gathered, and calibrated, prepare for groundwater sampling. As the following steps are completed, note all observations and measurements on the groundwater monitoring data log.

- Verify locations of wells or borings, media to be sampled, and analytes
- Record the approximate ambient air temperature, precipitation, wind, tidal conditions, and other field conditions the field book. In addition, any site-specific conditions or situations that could potentially alter the ground water samples or water level measurements should be recorded
- Inspect well for soundness of protective casing and surface ground seal
- Survey around the base of the well and wellhead with a PID, as necessary
- Remove the well cover and all standing water around the top of the well casing before opening the well cap
- New plastic sheeting should be placed on the ground surface around the well or boring to prevent contamination of the pumps, hoses, lanyards, etc., in the event they accidentally come into contact with the ground surface or, for some reason, they need to be placed on the ground during the purging event; keep the plastic as clean as possible and replace as necessary
- Unlock and carefully remove well cap, if present
- Survey well casing with a PID, as necessary
- Survey breathing zone to ensure that the level of PPE is appropriate
- Position fuel powered equipment downwind and at least 10 feet from the well head or boring. Make sure that the exhaust faces downwind

3.7 Groundwater Level and Depth Measurement Procedures

The measurement of the groundwater level in a well is frequently conducted in conjunction with groundwater sampling to determine the “free” water surface. This potentiometric surface measurement can be used to establish groundwater direction and gradients. Groundwater level and well depth measurements are needed to determine the volume of water in the well casing

prior to purging the well for sampling purposes. The following procedures should be followed and all observations and measurements recorded in the field book.

- Measure and record the height of the top of the well riser above the ground; if well is a flush mount, measure and record the top of the well riser below the ground surface
- Measure the casing inside diameter (CID) and record in inches
- From the top of the casing (TOC) at the surveyor's mark, if present, measure the depth to water (DTW) to the nearest 0.01-foot with an electronic water level indicator (record in feet below TOC); if no mark is present, mark a location with a metal file or indelible marker on the north side of the casing for future reference
  - All DTW measurements must be made and recorded to the nearest 0.01 foot
  - Water level measurements from boreholes, piezometers, or monitoring wells used to define the water table or a single potentiometric surface should be collected within less than 24 hours. In certain situations, water level measurements should be made within a shorter interval, if possible:
    - Aquifers influenced by tides, recent precipitation, barometric pressure, river stage, bank storage, impoundments and/or unlined ditches, intermittent pumping of production, irrigation, or supply wells
- Total depth (TD) of the well or boring should not be conducted immediately before purging and sampling; as possible, delay purging and sampling activities for at least 24 hours after TD measurement or for a time sufficient to meet the purge stabilization criterion for turbidity. Alternately, measure TD after sample collection
  - All TD measurements must be made and recorded to the nearest 0.1 foot
  - Because of tape buoyancy and weight effects encountered in deep wells with long water columns, it may be difficult to determine when the tape end is touching the bottom of the well. Sediment in the bottom of the well can also make it difficult to determine total depth. Care must be taken in these situations to ensure accurate measurements
  - As a cautionary note, when measuring TD with an electronic water level indicator, measure and add the length of the probe beneath the circuit closing electrodes to the depth measured to obtain the true TD
- Inspect water surface in the well or boring; use flashlight if necessary. Note any observable floating product (light non-aqueous phase liquids; LNAPLs) and sinking free product layer (dense non-aqueous phase liquids; DNAPLs). Measure the thickness of the LNAPL and/or DNAPL layer using an appropriate interface gauging probe or a weighted tape coated with the appropriate reactive indicator paste for the suspected NAPL. DO NOT PURGE OR SAMPLE GROUNDWATER IN A WELL CONTAINING LNAPL. NAPL sampling is discussed in Section 3.9

3.8 Groundwater Purging

Purging is the process of removing stagnant water from a well, immediately prior to sampling, causing its replacement by groundwater from the adjacent formation that is representative of actual aquifer conditions.

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity. The intent of proper purging is to stabilize the groundwater level and minimize the hydraulic stress to the hydrogeologic formation. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging completion criteria.

In order to determine when a well has been adequately purged, geochemical parameters should be monitored, at a minimum, the pH, specific conductance and turbidity of the groundwater removed during purging and, in the case of permanent monitoring wells, the volume of water removed should be observed and recorded. Document and report the following, as applicable:

- Purging rate
- Drawdown in the well, if any
- Pump or tubing intake placement.
- Length and location of the screened interval

There are several purging strategies that may be used, depending on specific conditions encountered for given sampling situations. Purging options detailed in this SOP are:

- Traditional Multiple Volume Purge
- Low-Flow Purge
- Temporary Well Purge

No-flow groundwater sampling techniques are discussed in Section 3.8.

3.8.1 Multiple Volume or 'Traditional' Purge

A multiple volume or 'traditional' purge involves removing a minimum of three well volumes of water before sample collection. Generally, an adequate purge is achieved when three to five volumes have been removed. The following procedures should be followed and all observations and measurements recorded in the field book.

- Calculate the volume of water in a well or boring using the following equation:

  Volume (in gallons) = $(TD - DTW)*CID^2*0.041$; where:

  TD = total depth (feet)

  DTW = depth to water (feet)

  CID = casing inner diameter (inches)

- Alternately, the volume of water in a well or boring may also be calculated by multiplying the water column height by the gallons per foot of water for the appropriate well or boring diameter:

CID	Gallons per foot of water	Gallons per foot, three water columns
0.75-inch	0.02	0.06
1-inch	0.04	0.12
1.25-inch	0.06	0.18
2-inch	0.16	0.48
3-inch	0.37	1.11
4-inch	0.65	1.98
5-inch	1.02	3.06
6-inch	1.47	4.41
12-inch	5.88	17.61

- Calculate the total volume of the pump, associated tubing and container for in-situ measurements (flow-through cell), if used, using the following equation:

  Volume (in gallons) = P + ((0.0041)*D^2*L) + fc; where:

  P = volume of pump (gallons)

  D = tubing diameter (inches)

  L = length of tubing (feet)

  fc = volume of flow-through cell (gallons)

- Install the pump or tubing to the depth prescribed in the work plan or QAPP, as dictated by the purge and sampling method
  - for wells with a completely submerged screen or if a bailer is being used, the pump, tubing or bailer should be placed above the screen at the top of the water column
  - for wells with a partially submerged screen, the pump or tubing should be placed within the middle of the saturated portion of the screened interval
- Prepare for the collection of purge water into an appropriate storage container
- Begin purging at a rate that will not cause excessive turbulence in the well; commonly less than 1 gallon per minute. Stabilization parameters should be collected every 0.5 to 1 well volume, or more frequently, record field measurements and observations of water color, suspended particulates, discoloration of casing, casing diameter and material, any unusual occurrences during sampling, and any pertinent weather details in the field book
- The minimum volume removed must be more than the volume of the pump and sampling tube capacity and the flow through cell (if used). After the minimum purge volume has been removed, review the geochemical measurements to ensure that readings have stabilized. Stabilization occurs when at least three consecutive measurements are within:

Traditional Purge Stabilization Parameters	
pH	± 0.1 SU
Specific Conductance	± 3%
Temperature	± 3%
DO	± 0.2 mg/l or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 1 NTU
ORP	± 10 millivolts (flow-through cell only)

- If the geochemical measurements have not stabilized within five volumes, it is at the discretion of the project team whether or not to collect a sample or to continue purging. If, after five well volumes, pH and conductivity have stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible, with respect to turbidity
- If drawdown is observed on initiation of pumping, reduce the pump speed and attempt to match the drawdown of the well. If the drawdown stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated
- If the well or borehole is purged dry before removing three well volumes, allow well or boring to recharge (commonly 90%) and proceed immediately to sample collection. If adequate sampling volume is available immediately upon completion of purging, the well should be sampled immediately.

If recovery exceeds 2 hours, sample as soon as sufficient volume is available, or within 3 hours of purging. If possible, sampling of wells which have a slow recovery should be scheduled so that they can be purged and sampled in the same day, after adequate volume has recovered

- Once purging is complete, proceed to sample collection, as described in Section 3.9

3.8.2 Low-Flow Purge

Low-flow purging is generally used in low permeability units, when calculated purge volumes for traditional purging are excessive, or when vertical characterization within a screened interval is desired. In-line flow-through cells equipped with water quality meters with continuous readout displays are highly recommended. The following procedures should be followed and all observations and measurements recorded in the field book.

- Calculate the total volume of the pump, associated tubing and container for in-situ measurements (flow-through cell), if used, using the following equation:

  Volume (in gallons) = $P + ((0.0041)*D^2*L) + fc$; where:

  P = volume of pump (gallons)

  D = tubing diameter (inches)

  L = length of tubing (feet)

  fc = volume of flow-through cell (gallons)

- Install the pump or tubing to the depth prescribed in the work plan or QAPP, as dictated by the purge and sampling method
  - for wells with a completely submerged screen, the open or screened interval is less than 10 feet, and the aquifer recovery rate is approximately equal to the purge rate, the intake should be placed in the middle of the screen or open interval
  - for wells with a partially submerged screen, the pump or tubing should be placed within the middle of the saturated portion of the screened interval
- Prepare for the collection of purge water into an appropriate storage container
- The pump should be started at the lowest flow volume, and adjusted higher as long as the maximum drawdown is not exceeded. Purging should not exceed 0.1 to 0.5 liters per minute (L/min)
- Water level should optimally be monitored continuously, but at a minimum, at 30 seconds to 5 minutes intervals (depending on the hydraulic conductivity of the aquifer, diameter of the well, and pumping rate) during purging. Ideally, a steady flow rate should be maintained that results in a stabilized water level (less than 0.3 feet of variation). Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. However, care should be taken to maintain pump suction and to avoid entrainment of air in the tubing. Record each adjustment made to the pumping rate and the water level measured immediately after each adjustment.
- If the recharge rate of the well is very low, care should be taken to avoid loss of pressure in the tubing line, cascading through the sand pack, or pumping the well dry. In these cases, purging should be interrupted before the water in the well reaches a level below the top of the pump. Sampling should commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

- During purging, monitor and record geochemical parameters at 30 seconds to 5 minutes intervals. Stabilization occurs once at least three equipment volumes have been purged and the following criteria have been met over three successive measurements made at least three minutes apart:

Low-Flow Purge Stabilization Parameters	
Water Level Drawdown	<0.3 feet
pH	± 0.1 SU
Specific Conductance	± 3%
Temperature	± 3%
DO	± 0.2 mg/l or 10% (flow-through cell only)
Turbidity	± 10% for values greater than 1 NTU
ORP	± 10 millivolts (flow-through cell only)

- Once purging is complete, proceed to sample collection, as described in Section 3.9.

3.8.3 Temporary Well Purge

Procedures used to purge temporary ground water monitoring wells differ from permanent wells because temporary wells are installed for immediate sample acquisition. Wells of this type may include open bedrock boreholes or standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as a direct push Wellpoint®, a Geoprobe® Screen Point 15/16 sampler or a Hydropunch® sampler. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply because stagnant water is not present. However, exposed probes that are driven through the soil to the desired water sample depth must be purged of a minimum of three probe-rod volumes of water before sampling is conducted. The longer a temporary well is in place and not sampled, the more stagnant the water column becomes and the more appropriate it becomes to apply, to the extent possible, monitoring well purging criteria to re-achieve aquifer conditions.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity conditions in these types of wells that are completed within the limit of suction are typically and routinely achieved by the use of low-flow/low stress purging techniques using variable speed peristaltic pumps.

Once purging is complete, proceed to sample collection, as described in Section 3.9.

3.9 Groundwater Sampling Techniques

Sampling is the process of obtaining, containerizing, and preserving (if required) a groundwater sample after the purging process is complete.

- Once purging is complete, field measurements performed to fulfill regulatory requirements, beyond those used to measure for stabilization, should be obtained after purging and before samples are collected for analysis
- Collect samples and associated quality assurance/quality control samples using the sampling pump operated at a maximum rate of 0.25 L/min or the rate of the purging activities to avoid agitating the water; if using a bailer, lower the bailer slowly to avoid agitating the water
- Field samples must be directly transferred from the sampling equipment to the container that has been specifically prepared for that given parameter; intermediate containers should be avoided.
- Groundwater samples should be collected in the order of the volatilization (highest ability to volatilize to the lowest). Sample for VOCs first at a rate less than 0.1 L/min, taking care to remove all air bubbles from the vial and minimize agitation
- Collect remaining organic samples then inorganic samples in the following order of volatilization sensitivity:
  - VOCs
  - Purgeable organic carbon
  - Purgeable organic halogens
  - Total organic halogens
  - Total organic carbon
  - Extractable organics
  - Total metals
  - Dissolved metals
  - Phenols
  - Cyanide
  - Sulfate and chloride
  - Nitrate and ammonia
  - Radionuclides
- If submitting samples for dissolved metals analyses or conducting field testing that use filtered samples, the sample may be field filtered (Section 3.9.1)
- Affix a sample tag or label to each sample container and complete all required information (sample number, date, time, sampler's initials, analysis, preservatives, place of collection)
- Place clear tape over the tag or label
- Samples for temperature-sensitive parameters should be preserved immediately after collection by placement into an insulated cooler maintained at a temperature of approximately 4°C
- Record sample designation, date, time, and the sampler's initials on the sample tracking form and in the field book
- Complete chain-of-custody forms with appropriate sampling information
- Complete sample packing and shipping in accordance with proper procedures

3.9.1 Groundwater Filtration Procedures

Filtered groundwater samples are sometimes used for field kit analyses and should only be collected for laboratory use after approval from the appropriate agency and/or project manager. If filtration is necessary, the following procedures should be followed and all observations and measurements recorded in the field book.

- Use a variable speed peristaltic, bladder, or submersible pump with the in-line filter fitted on the outlet end; pressurized bailers could also be used
- At the pump discharge end, attach a clean 0.45-micron (□m) filter (for organics) or 0.1-µm (for inorganics), or appropriate sized filter, to the tubing
- Turn on the pump to a rate less than 100 mL/min, hold the filter upright with the inlet and outlet in the vertical position and pump groundwater through the filter until all atmospheric oxygen has been removed and the minimum volume of water has been flushed through the filter, in accordance with the manufacturer's specifications
- Collect the filtered samples directly into the sample container from the pump-filter assembly
- If sediment is visible in the sample container after filtration, filter break-through has occurred and the sampling and filtering process should be repeated
- Disassemble the pump head and discard the tubing and filter appropriately

3.9.2 No-Flow Passive Sampling Techniques

A number of alternate sampling devices are becoming available, including passive diffusion samplers, equilibrated grab samplers, and other in-situ sampling devices. These devices may be particularly useful to sampling low permeability geologic materials, assuming the device is made of materials compatible with the analytical parameters, meet data quality objectives, and have been properly evaluated. However, the site investigator should ensure the diffusion membrane materials are selected for the contaminants of concern present at the site. Comparison tests with an approved sampling method and diffusion samplers should be completed to confirm that the method is suitable for the site. Manufacturer's specifications should be strictly followed for deployment and use of these samplers.

Equilibration time for diffusion samplers depends on the time required for the environment disturbed by deployment of the sampler to return to ambient conditions and time required by the sampler to equilibrate with the ambient water. To account for this, diffusion samplers are generally deployed a minimum of 14 days prior to sample collection. Though the sampler may be deployed for an extended period (e.g., three months or longer); the analytical results will be the average of the sample equilibration time for the analyte of concern (generally the last 1 to 4 days).

No-flow grab samplers are placed in the well before sampling and remain closed. The water is then collected when the sampler is activated. Samples are either transferred to containers at the well head or the sampler is shipped to the laboratory for analysis. Examples of equilibrated grab samples include Hydrosleeve®, Snap Sampler™, and Kemmerer Sampler.

3.10 Non-Aqueous Phase Liquid Sampling

Non-aqueous phase liquid (NAPL) is normally sampled for two reasons:

- Documentation for its existence and thickness
- Determination of the type of product so that the proper analyses can be performed to determine extent. This is only feasible for relatively recent releases as it may not be possible to identify weathered product

Disposable plastic (acrylic, clear PVC) bailers are recommended for sampling. Disposable polyethylene and polypropylene bailers are also acceptable. If a NAPL is identified in a monitoring well during the water level measurement, measure its thickness in the well.

- If the thickness of the NAPL is greater than 0.01 foot or product globules are present, collect a sample using a precleaned disposable bailer by slowly lowering a bailer and allowing the bottom to sink to 1 foot below the water surface to capture LNAPL only
- Measure the product thickness to the nearest 0.01 foot after withdrawing the bailer
- Pour a portion of the product into a glass sample container
- Follow proper sampling, packing, and shipping procedures

Before DNAPL sampling, to the extent practical, remove the full thickness of the LNAPL

- Record the quantity of LNAPL removed in the field book
- Use a peristaltic pump, inertial pump, double check valve bailer, or polyethylene tubing equipped with a bottom check valve for DNAPL sample collection
- Slowly lower the sampling equipment to the well bottom and then raise it slowly, causing as little agitation as possible
- Minimize contact of the bailer with the well casing as it is raised
- Pour a portion of the product into a glass sample container; use the bottom check valve of the bailer for transfer
- Follow proper sampling, packing, and shipping procedures

3.11 Closing Notes

At the conclusion of groundwater sampling, be sure to:

- Maintain the record of all purging and sampling observations and measurements
- Remove all temporary equipment from the well or borehole
- Decontaminate equipment and supplies
- Properly manage and dispose of all investigation derived waste

Enclosure B – Hach Field Test Kit Procedures

Methods Quick Reference Guide

The tables on the following 4 pages list test ranges, methods of analysis, and corresponding reagent set Product Numbers. The complete procedure for each test is included in the manual or CD supplied with the instrument. The ranges given are for the pre-calibrated instrument readout; higher ranges can be analyzed by sample dilution. Parameters marked "EPA" are EPA-approved, accepted, or equivalent for reporting purposes; sample pretreatment may be required on some procedures. If no reagent set is listed for a parameter, order needed reagents and supplies separately.

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Alachlor in Water		Immunoassay	10202	0.1 - 0.5 ppb, threshold	•	•	•				•	**2813000**
Alkalinity, Total (TNTplus)		Colorimetric	10239	25 - 400 mg/L	•	•						**TNT870**
Aluminum		Aluminon	8012	0.008 - 0.800 mg/L	•	•	•	•	•	•	•	**2242000**
Aluminum		Eriochrome Cyanine R	8326	0.002 - 0.250 mg/L	•	•	•					**2603700**
Aluminum (TNTplus)		Chromazurol S	10215	0.02 - 0.50 mg/L	•	•						**TNT848**
Ammonia, Nitrogen		Salicylate	8155	0.01 - 0.50 mg/L	•	•	•	•		•	•	**2668000**
Ammonia, Nitrogen (TNTplus), ULR	•	Salicylate	10205	0.015 - 2.000 mg/L	•	•						**TNT830**
Ammonia, Nitrogen	•	Nessler	8038	0.02 - 2.50 mg/L	•	•	•					**2458200**
Ammonia, Nitrogen (Test 'N Tube), LR		Salicylate	10023	0.02 - 2.50 mg/L	•	•	•	•	•			**2604545**
Ammonia, Nitrogen (TNTplus), LR	•	Salicylate	10205	1 - 12 mg/L	•	•						**TNT831**
Ammonia, Nitrogen (Test 'N Tube), HR		Salicylate	10031	0.4 - 50.0 mg/L	•	•	•	•	•			**2606945**
Ammonia, Nitrogen (TNTplus), HR	•	Salicylate	10205	2 - 47 mg/L	•	•						**TNT832**
Ammonia, Free, Nitrogen		Indophenol	10200	0.01 - 0.50 mg/L	•	•	•	•	•		•	**2879700**
Arsenic	•	Silver Diethyldithiocarbamate	8013	0.020 - 0.200 mg/L	•	•	•					**—**
Atrazine		Immunoassay	10050	0.5 - 3.0 ppb, threshold	•	•	•				•	**2762700**
Barium		Turbidimetric	8014	2 - 100 mg/L	•	•	•					**1206499**
Benzotriazole		UV Photolysis	8079	1.0 - 16.0 mg/L	•	•	•	•				**2141299**
Boron		Carmine	8015	0.2 - 14.0 mg/L	•	•	•					**—**
Bromine		DPD	8016	0.05 - 4.50 mg/L	•	•	•	•	•	•	•	**2105669**
Bromine (AccuVac)		DPD	8016	0.05 - 4.50 mg/L	•	•	•	•	•	•	•	**2503025**
Cadmium		Dithizone	8017	0.7 - 80.0 µg/L	•	•	•					**2242200**
Cadmium (TNTplus)[1]		Cadion	10217	0.02 - 0.30 mg/L	•	•						**TNT852**
Carbohydrazide		Iron Reduction	8140	5 - 600 µg/L	•	•	•	•				**2446600**
Chloramine, Mono, LR		Indophenol	10171 10200	0.04 - 4.50 mg/L	•	•	•	•	•		•	**2802246**
Chloramine, Mono (Test 'N Tube), HR		Indophenol	10172	0.1 - 10.0 mg/L	•	•	•					**2805145**
Chloride		Mercuric Thiocyanate	8113	0.1 - 25.0 mg/L	•	•	•					**2319800**
Chlorine, Free		Indophenol	10241	0.04 - 4.50 mg/L	•	•	•	•	•		•	**—**
Chlorine, Free	•	DPD	8021	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2105569**
Chlorine, Free (AccuVac)	•	DPD	8021	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2502025**
Chlorine, Free (Pour-Thru Cell)		DPD Rapid Liquid	10059	0.02 - 2.00 mg/L	•	•	•					**2556900**
Chlorine, Free (TNTplus)	•	DPD	10231	0.05 - 2.00 mg/L	•	•						**TNT866**
Chlorine, Free (Test 'N Tube)		DPD	10102	0.09 - 5.00 mg/L	•	•	•	•	•	•		**2105545**
Chlorine, Free, MR	•	DPD	10245	0.05 - 4.00 mg/L	•	•	•	•	•	•	•	**1407099**
Chlorine, Free, HR	•	DPD	10069	0.1 - 10.0 mg/L	•	•	•	•	•	•	•	**1407099**
Chlorine, Free & Total (TNTplus)	•	DPD	10232	0.05 - 2.00 mg/L	•	•						**TNT866T**
Chlorine, Total (Pour-Thru Cell), ULR	•	DPD	8370 10014	2 - 500 µg/L	•	•	•					**2563000**
Chlorine, Total	•	DPD	8167	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2105669**
Chlorine, Total (AccuVac)	•	DPD	8167	0.02 - 2.00 mg/L	•	•	•	•	•	•	•	**2503025**
Chlorine, Total (Pour-Thru Cell)		DPD Rapid Liquid	10060	0.02 - 2.00 mg/L	•	•	•					**2557000**
Chlorine, Total (Test 'N Tube)		DPD	10101	0.09 - 5.00 mg/L	•	•	•	•	•	•		**2105645**
Chlorine, Total, MR	•	DPD	10250	0.05 - 4.00 mg/L	•	•	•	•	•	•	•	**1406499**
Chlorine, Total, HR	•	DPD	10070	0.1 - 10.0 mg/L	•	•	•	•	•	•	•	**1406499**
Chlorine Demand/Requirement	•	DPD	10223	Multiple Ranges	•	•	•	•	•	•	•	**—**
Chlorine Dioxide, DPD	•	DPD/Glycine	10126	0.04 - 5.00 mg/L	•	•	•	•	•	•	•	**2770900**
Chlorine Dioxide, DPD (AccuVac)	•	DPD/Glycine	10126	0.04 - 5.00 mg/L	•	•	•	•	•	•	•	**2771000**
Chlorine Dioxide (Europe Only)		Amaranth		20 - 500 µg/L	•	•	•					**—**
Chlorine Dioxide, LR		Chlorophenol Red	8065	0.01 - 1.00 mg/L	•	•	•					**2242300**
Chlorine Dioxide, MR		Direct Reading	8345	1 - 50 mg/L	•	•	•	•				**—**
Chlorine Dioxide, HR		Direct Reading	8138	5 - 1000 mg/L	•	•	•					**—**

[1]*As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal.*

Methods Quick Reference Guide

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Chromium, Hexavalent	•	1,5 Diphenylcarbohydrazide	8023	0.010 - 0.700 mg/L	•	•	•	•			•	1271099
Chromium, Hexavalent (AccuVac)	•	1,5 Diphenylcarbohydrazide	8023	0.010 - 0.700 mg/L	•	•	•	•			•	2505025
Chromium, Hexavalent and Total (TNTplus)	•[1]	1,5 Diphenylcarbohydrazide	10218 10219	0.03 - 1.00 mg/L	•	•						TNT854
Chromium, Total		Alkaline Hypobromite Oxidation	8024	0.01 - 0.70 mg/L	•	•	•	•				2242500
Cobalt		PAN	8078	0.01 - 2.00 mg/L	•	•	•					2651600
COD, ULR		Dichromate	8000	0.7 - 40.0 mg/L	•	•						2415825
COD, LR	•	Dichromate	8000	3 - 150 mg/L	•	•	•	•				2125825
COD, HR	•	Dichromate	8000	20 - 1,500 mg/L	•	•	•	•	•			2125925
COD, HR+		Dichromate	8000	200 - 15,000 mg/L	•	•	•	•	•			2415925
COD		Manganese III	10067	30 - 1000 mg/L	•	•	•	•	•	•		2623425
COD, Mercury-Free (TNTplus), HR		Dichromate	10236	25 - 100 mg/L	•	•						TNT825
COD (TNTplus), ULR		Dichromate	10211	1 - 60 mg/L	•	•						TNT820
COD (TNTplus), LR	•	Dichromate	8000	3 - 150 mg/L	•	•						TNT821
COD (TNTplus), HR	•	Dichromate	8000	20 - 1500 mg/L	•	•						TNT822
COD (TNTplus), UHR		Dichromate	10212	250 - 15,000 mg/L	•	•						TNT823
Color		ADMI Weighted Ordinate	10048	3 - 250 units	•							—
Color, True and Apparent		Platinum-Cobalt	8025	15 - 500 units	•	•	•	•				—
Color, True and Apparent, LR		Platinum-Cobalt	8025	3 - 200 units	•	•	•					—
Copper, LR		Porphyrin	8143	1 - 210 µg/L	•	•	•	•				2603300
Copper	•	Bicinchoninate	8506	0.04 - 5.00 mg/L	•	•	•	•			•	2105869
Copper (AccuVac)		Bicinchoninate	8026	0.04 - 5.00 mg/L	•	•	•	•			•	2504025
Copper (TNTplus)[2]		Bathocuproine	10238	0.1 - 8.0 mg/L	•	•						TNT860
Cyanide		Pyridine-Pyrazalone	8027	0.002 - 0.240 mg/L	•	•	•	•	•			2430200
Cyanuric Acid		Turbidimetric	8139	5 - 50 mg/L		•	•	•	•	•		246066
DEHA (Diethylhydroxylamine)		Iron Reduction	8140	3 - 450 µg/L	•	•	•	•				2446600
Detergents (Surfactants)		Crystal Violet	8028	0.002 - 0.275 mg/L	•	•	•	•	•			2446800
Dissolved Oxygen (AccuVac), LR		Indigo Carmine	8316	6 - 800 µg/L	•	•	•	•	•			2501025
Dissolved Oxygen (AccuVac), HR		HRDO	8166	0.3 - 15.0 mg/L	•	•	•	•	•	•	•	2515025
Dissolved Oxygen (AccuVac), UHR		Ultra High Range	8333	1.0 - 40.0 mg/L	•	•	•					2515025
Erythorbic Acid (Isoascorbic Acid)		Iron Reduction	8140	13 - 1500 µg/L	•	•	•	•				2446600
Fluoride, Arsenic Free	•[3,4]	SPADNS 2	10225	0.02 - 2.00 mg/L	•	•	•	•	•		•	2947549
Fluoride, Arsenic Free (AccuVac)	•[3,4]	SPADNS 2	10225	0.02 - 2.00 mg/L	•	•	•	•	•		•	2527025
Fluoride	•[4]	SPADNS	8029	0.02 - 2.00 mg/L	•	•	•	•	•		•	44449
Fluoride (AccuVac)	•[4]	SPADNS	8029	0.02 - 2.00 mg/L	•	•	•	•	•		•	2506025
Formaldehyde		MBTH	8110	3 - 500 µg/L	•	•	•					2257700
Hardness, Total, ULR		Chlorophosphonazo Colorimetric	8374	8 - 1000 µg/L	•	•	•					2603100
Hardness, Total, ULR (Pour-Thru Cell)		Chlorophosphonazo Rapid Liquid	8374	4 - 1000 µg/L	•	•	•					—
Hardness, Ca & Mg		Calmagite Colorimetric	8030	0.05 - 4.00 mg/L	•	•	•	•	•	•		2319900
Hydrazine		p-Dimethylaminobenzaldehyde	8141	4 - 600 µg/L	•	•	•	•				179032
Hydrazine (AccuVac)		p-Dimethylaminobenzaldehyde	8141	4 - 600 µg/L	•	•	•	•				2524025
Hydroquinone		Iron Reduction	8140	9 - 1000 µg/L	•	•	•	•				2446600
Iodine DPD		DPD	8031	0.07 - 7.00 mg/L	•	•	•					2105669
Iodine DPD (AccuVac)		DPD	8031	0.07 - 7.00 mg/L	•	•	•					2503025
Iron (TNTplus)[2]	•	Phenanthroline	10229	0.2 - 6.0 mg/L	•	•						TNT858
Iron		FerroZine	8147	0.009 - 1.400 mg/L	•	•	•	•				230166
Iron (Pour-Thru Cell)		FerroZine Rapid Liquid	8147	0.009 - 1.400 mg/L	•	•	•					230149
Iron, Ferrous		1, 10 Phenanthroline	8146	0.02 - 3.00 mg/L	•	•	•	•	•	•		103769
Iron, Ferrous (AccuVac)		1, 10 Phenanthroline	8146	0.02 - 3.00 mg/L	•	•	•	•	•	•		2514025
Iron, Total		FerroMo	8365	0.01 - 1.80 mg/L	•	•	•	•	•			2544800
Iron, Total		TPTZ	8112	0.012 - 1.800 mg/L	•	•	•	•	•		•	2608799
Iron, Total (AccuVac)		TPTZ	8112	0.012 - 1.800 mg/L	•	•	•	•	•		•	2510025
Iron, Total	•	FerroVer	8008	0.02 - 3.00 mg/L	•	•	•	•	•	•	•	2105769

[1]EPA approved for Cr^{6+} only. [2]As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal.
[3]Per 40 CFR 136.6 Method Modification and Flexibility. [4]Not EPA accepted for drinking water using DR/800 Series colorimeters.

HACH® Be Right™

Methods Quick Reference Guide

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Iron, Total (AccuVac)	•	FerroVer	8008	0.02 - 3.00 mg/L	•	•	•	•	•	•	•	**2507025**
Isoascorbic Acid (Erythorbic Acid) (ISA)		Iron Reduction	8140	13 - 1500 µg/L	•	•	•	•				**2446600**
Lead		LeadTrak Fast Column Extraction 8317	8317	5 - 150 µg/L	•	•	•				•	**2375000**
Lead	•	Dithizone	8033	3 - 300 µg/L	•	•	•					**2243100**
Lead (TNTplus)*		PAR	10216	0.1 - 2.0 mg/L	•	•						**TNT850**
Manganese, LR		PAN	8149	0.006 - 0.700 mg/L	•	•	•	•			•	**2651700**
Manganese, HR	•	Periodate Oxidation	8034	0.1 - 20.0 mg/L	•	•	•	•	•	•	•	**2430000**
Mercury		Cold Vapor Mercury Concentration	10065	0.1 - 2.5 µg/L	•	•	•					**2658300**
Methylethylketoxime (MEKO)		Iron Reduction	8140	15 - 1000 µg/L	•	•	•	•				**2446600**
Molybdenum, Molybdate, LR		Ternary Complex	8169	0.02 - 3.00 mg/L	•	•	•	•	•		•	**2449400**
Molybdenum, Molybdate, HR		Mercaptoacetic Acid	8036	0.2 - 40.0 mg/L	•	•	•	•				**2604100**
Molybdenum, Molybdate (AccuVac), HR		Mercaptoacetic Acid	8036	0.2 - 40.0 mg/L	•	•	•	•				**—**
Nickel		PAN	8150	0.006 - 1.000 mg/L	•	•	•	3			•	**2651600**
Nickel	•	Heptoxime	8037	0.02 - 1.80 mg/L	•	•	•					**2243500**
Nickel (TNTplus)[1]		Dimethylglyoxime	10220	0.1 - 6.0 mg/L	•	•						**TNT856**
Nitrate, Nitrogen, LR		Cadmium Reduction	8192	0.01 - 0.50 mg/L	•	•	•	•	•	•		**2429800**
Nitrate, Nitrogen (TNTplus), LR		Dimethylphenol	10206	0.23 - 13.5 mg/L	•	•						**TNT835**
Nitrate, Nitrogen, MR		Cadmium Reduction	8171	0.1 - 10.0 mg/L	•	•	•	•				**2106169**
Nitrate, Nitrogen (AccuVac), MR		Cadmium Reduction	8171	0.1 - 10.0 mg/L	•	•	•	•				**2511025**
Nitrate, Nitrogen		UV Screening	10049	0.1 - 10.0 mg/L	•							**—**
Nitrate, Nitrogen (Test 'N Tube), HR		Chromotropic Acid	10020	0.2 - 30.0 mg/L	•	•	•	•				**2605345**
Nitrate, Nitrogen, HR		Cadmium Reduction	8039	0.3 - 30.0 mg/L	•	•	•	•	•	•	•	**2106169**
Nitrate, Nitrogen (AccuVac), HR		Cadmium Reduction	8039	0.3 - 30.0 mg/L	•	•	•	•	•	•	•	**2511025**
Nitrate, Nitrogen (TNTplus), HR		Dimethylphenol	10206	5 - 35 mg/L	•	•						**TNT836**
Nitrite, Nitrogen, LR	•	Diazotization	8507	0.002 - 0.300 mg/L	•	•	•	•	•	•		**2107169**
Nitrite, Nitrogen (AccuVac), LR	•	Diazotization	8507	0.002 - 0.300 mg/L	•	•	•	•	•	•		**2512025**
Nitrite, Nitrogen (Test 'N Tube), LR		Diazotization	10019	0.003 - 0.500 mg/L	•	•	•	•	•	•		**2608345**
Nitrite, Nitrogen (TNTplus), LR	•	Diazotization	10207	0.015 - 0.600 mg/L	•	•						**TNT839**
Nitrite, Nitrogen (TNTplus), HR		Diazotization	10237	0.6 - 6.0 mg/L	•	•						**TNT840**
Nitrite, Nitrogen, HR		Ferrous Sulfate	8153	2 - 250 mg/L	•	•	•	•				**2107569**
Nitrogen, Ammonia (see Ammonia, Nitrogen)												
Nitrogen, Total (Test 'N Tube), LR		Persulfate Digestion	10071	0.5 - 25.0 mg/L	•	•	•	•				**2672245**
Nitrogen, Total (TNTplus), LR		Persulfate Digestion	10208	1 - 16 mg/L	•	•						**TNT826**
Nitrogen, Total (TNTplus), HR		Persulfate Digestion	10208	5 - 40 mg/L	•	•						**TNT827**
Nitrogen, Total (Test 'N Tube), HR		Persulfate Digestion	10072	2 - 150 mg/L	•	•	•	•				**2714100**
Nitrogen, Total (TNTplus), UHR		Persulfate Digestion	10208	20 - 100 mg/L	•	•						**TNT828**
Nitrogen, Total Inorganic (TIN) (Test 'N Tube)		Titanium Trichloride Reduction	10021	0.2 - 25.0 mg/L	•	•	•	•	•			**2604945**
Nitrogen, Simplified TKN (TNTplus)		s-TKN	10242	0 - 16 mg/L	•	•						**TNT880**
Nitrogen, Total Kjeldahl (TKN)		Nessler	8075	1 - 150 mg/L	•	•	•	•				**2495300**
Organic Carbon, Total (See TOC)												**—**
Organic Constituents, UV-Absorbing (UV-254)		Direct Reading	10054	Varies-Units Abs/cm	•							**—**
Oxygen Demand, Chemical (See COD)												**—**
Oxygen, Dissolved (See Dissolved Oxygen)												**—**
Oxygen Scavengers (See specific compounds)												**—**
Ozone (AccuVac), LR		Indigo	8311	0.01 - 0.25 mg/L	•	•	•	•	•		•	**2516025**
Ozone (AccuVac), MR		Indigo	8311	0.01 - 0.75 mg/L	•	•	•	•	•		•	**2517025**
Ozone (AccuVac), HR		Indigo	8311	0.01 - 1.50 mg/L	•	•	•	•	•			**2518025**
PCB (Polychlorinated Biphenyls) in Soil[2]		Immunoassay	10050	1 - 50 ppm, threshold	•	•	•				•	**2773500**
pH		Colorimetric Phenol Red	10076	6.5 - 8.5 units				•	•	•	•	**2657512**
Phenols	•	4-Aminoantipyrine	8047	0.002 - 0.200 mg/L	•	•	•					**2243900**

[1]As listed, test determines soluble metal. Order Metals Prep Set TNT890 to determine total metal. [2]Requires Soil Extraction Kit. Please order Prod. No. 2775100. (Included with Pocket Colorimeter II). [3]Nickel PAN method reagent set for DR/890 is Prod. No. 2242600

Methods Quick Reference Guide

Test	EPA	Method	Number	DR 5000 Range	DR 5000	DR 3900 & DR 2800	DR 2700	DR/890	DR/850	DR/820	PC II Colorimeter	Prod. No.
Phosphonates		Persulfate UV Oxidation	8007	0.02 - 125.0 mg/L	•	•	•	•	•		•	**2429700**
Phosphorus, Reactive	•	PhosVer 3	8048	0.02 - 2.50 mg/L	•	•	•	•	•		•	**2106069**
Phosphorus, Reactive (AccuVac)	•	PhosVer 3	8048	0.02 - 2.50 mg/L	•	•	•	•	•		•	**2508025**
Phosphorus, Reactive (Test 'N Tube)	•	PhosVer 3	8048	0.06 - 5.00 mg/L	•	•	•	•	•			**2742545**
Phosphorus, Reactive		Amino Acid	8178	0.23 - 30.00 mg/L	•	•	•	•	•	•		**2244100**
Phosphorus, Reactive		Molybdovanadate	8114	0.3 - 45.0 mg/L	•	•	•	•				**2076032**
Phosphorus, Reactive (AccuVac)		Molybdovanadate	8114	0.3 - 45.0 mg/L	•	•	•	•				**2525025**
Phosphorus, Reactive (Test 'N Tube), HR		Molybdovanadate	8114	1.0 - 100.0 mg/L	•	•	•	•				**2767345**
Phosphorus, Reactive (Pour-Thru Cell), HR		Molybdovanadate Rapid Liquid	8114	0.3 - 45.0 mg/L	•	•	•					**2076049**
Phosphorus, Reactive (Pour-Thru Cell), LR	•	Ascorbic Acid Rapid Liquid	10055	19 - 3000 µg/L	•	•	•					**2678600**
Phosphorus, Reactive (TNTplus)		Molybdovanadate	10214	5.0 - 90.0 mg/L	•	•						**TNT846**
Phosphorus, Acid Hydrolyzable (Test 'N Tube)		PhosVer 3 with Acid Hydrolysis	8180	0.06 - 3.50 mg/L	•	•	•	•	•			**2742645**
Phosphorus, Total (Test 'N Tube)	•	PhosVer 3 with Acid Persulfate Digestion	8190	0.06 - 3.50 mg/L	•	•	•	•	•			**2742645**
Phosphorus, Total (Test 'N Tube), HR		Molybdovanadate with Acid Persulfate Digestion	10127	1.0 - 100.0 mg/L	•	•	•	•				**2767245**
Phosphorus, Reactive and Total (TNTplus), LR	•	Ascorbic Acid	10209 10210	0.15 - 4.50 mg/L	•	•						**TNT843**
Phosphorus, Reactive and Total (TNTplus), HR	•	Ascorbic Acid	10209 10210	1.5 - 15.0 mg/L	•	•						**TNT844**
Phosphorus, Reactive and Total (TNTplus), UHR	•	Ascorbic Acid	10209 10210	6 - 60 mg/L	•	•						**TNT845**
Potassium		Tetraphenylborate	8049	0.1 - 7.0 mg/L	•	•	•					**2459100**
Quaternary Ammonium Compounds		Direct Binary Complex	8337	0.2 - 5.0 mg/L	•	•	•					**2459200**
Selenium		Diaminobenzidine	8194	0.01 - 1.00 mg/L	•	•	•					**2244200**
Silica (Pour-Thru Cell), ULR		Heteropoly Blue	8282	3 - 1000 µg/L	•	•	•					**2553500**
Silica (Pour-Thru Cell), ULR		Heteropoly Blue Rapid Liquid	8282	3 - 1000 µg/L	•	•	•					**2678500**
Silica, LR		Heteropoly Blue	8186	0.010 - 1.600 mg/L	•	•	•	•	•			**2459300**
Silica, HR		Silicomolybdate	8185	1 - 100 mg/L	•	•	•	•			•	**2429600**
Silver		Colorimetric	8120	0.02 - 0.70 mg/L	•	•	•					**2296600**
Sulfate	•	SulfaVer 4	8051	2 - 70 mg/L	•	•	•	•	•	•	•	**2106769**
Sulfate (AccuVac)	•	SulfaVer 4	8051	2 - 70 mg/L	•	•	•	•	•	•	•	**2509025**
Sulfate (TNTplus), LR		Turbidimetric	10227	40 - 150 mg/L	•	•						**TNT864**
Sulfate (TNTplus), HR		Turbidimetric	10227	150 - 900 mg/L	•	•						**TNT865**
Sulfide	•	Methylene Blue	8131	5 - 800 µg/L	•	•	•	•	•			**2244500**
Sulfite (Europe only)		Colorimetric		0.10 - 5.00 mg/L	•	•	•					**—**
Surfactants (See Detergents)												**—**
Suspended Solids		Photometric	8006	5 - 750 mg/L	•	•	•	•	•			**—**
Tannin & Lignin		Tyrosine	8193	0.1 - 9.0 mg/L	•	•	•	•	•			**2244600**
TOC (Total Organic Carbon), LR		Direct Method	10129	0.3 - 20.0 mg/L	•	•	•	•	•			**2760345**
TOC (Total Organic Carbon), MR		Direct Method	10173	15 - 150 mg/L	•	•	•	•	•			**2815945**
TOC (Total Organic Carbon), HR		Direct Method	10128	100 - 700 mg/L	•	•	•	•	•			**2760445**
Tolytriazole		UV Photolysis	8079	1.0 - 20.0 mg/L	•	•	•	•				**2141299**
Toxicity		ToxTrak	10017	0 - 100 % inhibition	•	•	•	•	•			**2597200**
TPH in Soil[1]		Immunoassay	10050	2 - 20 ppm, threshold	•	•	•				•	**2774300**
TPH in Water		Immunoassay	10050	2 - 20 ppm, threshold	•	•	•				•	**2774300**
Trihalomethanes (THM)		THM Plus	10132	10 - 600 µg/L	•	•	•					**2790800**
Trihalomethane Formation Potential (THMFP)		THM Plus	10224	10 - 600 µg/L	•	•	•					**2790800**
Volatile Acids		Esterification	8196	27 - 2800 mg/L	•	•	•	•	•	•		**2244700**
Volatile Acids (TNTplus)		Esterification	10240	50 - 2500 mg/L	•	•						**TNT872**
Zinc	•	Zincon	8009	0.01 - 3.00 mg/L	•	•	•	•	•		•	**2429300**

[1]*Requires Soil Extraction Kit. Please order Prod. No. 2775100. (Included with Pocket Colorimeter II).*

For more information or to place an order, call 800-227-4224 or visit: www.hach.com

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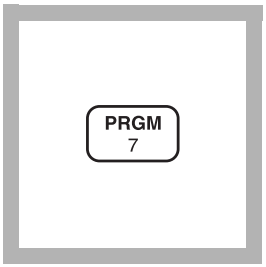
HACH®
Be Right™

NITRATE, High Range (0 to 30.0 mg/L NO_3^--N) For water, wastewater, and seawater*

Cadmium Reduction Method (Using Powder Pillows or AccuVac Ampuls)

Using Powder Pillows



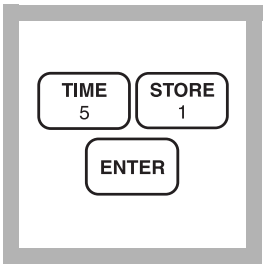
1. Enter the stored program number for high range nitrate nitrogen (NO_3^-–N) powder pillows.

Press: **PRGM**

The display will show:

PRGM ?

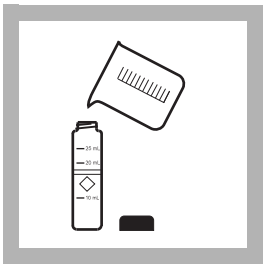
Note: *For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*



2. Press: **51 ENTER**

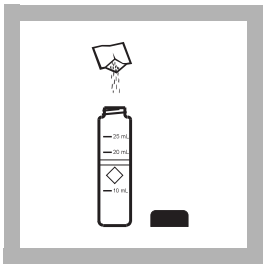
The display will show **mg/L, NO3-N** and the **ZERO** icon.

Note: *For alternate forms (NO_3), press the* **CONC** *key.*



3. Fill a sample cell with 10 mL of sample.

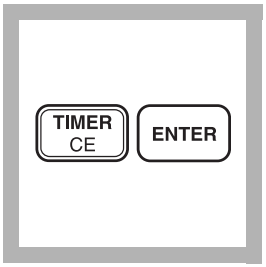
Note: *Adjust the pH of stored samples before analysis.*



4. Add the contents of one NitraVer 5 Nitrate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the sample cell.

Note: *It is important to remove all of the powder from the foil pillow. Tap the pillow until no more powder pours out.*

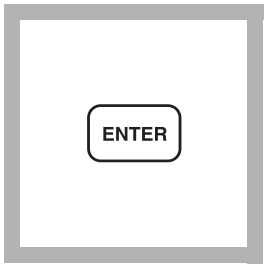
* Seawater requires a manual calibration; see Interferences.



5. Press:
TIMER ENTER

A one-minute reaction period will begin. Shake the sample cell vigorously until the timer beeps.

Note: *It is important to shake the cell vigorously. Shaking time and technique influence color development. For most accurate results, do successive tests on a standard solution and adjust the shaking time to obtain the correct result.*



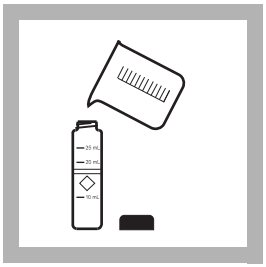
6. After the timer beeps, the display will show:
5:00 TIMER 2

Press: **ENTER**

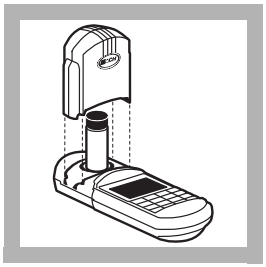
A five-minute reaction period will begin.

Note: *A deposit will remain after the reagent dissolves and will not affect test results.*

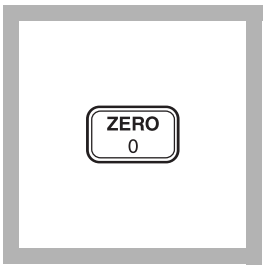
Note: *An amber color will develop if nitrate nitrogen is present.*



7. Fill another cell with 10 mL of sample (the blank). Wipe off any fingerprints or liquid.



8. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

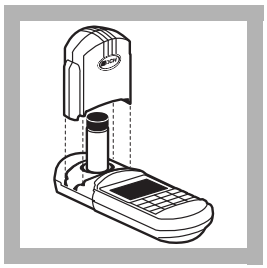


9. When the timer beeps, press **ZERO.**

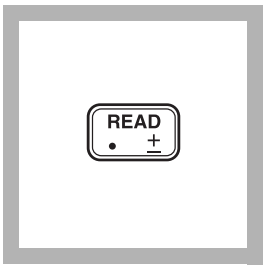
The cursor will move to the right, then the display will show:

0.0 mg/L NO3-N

Note: *If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



10. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



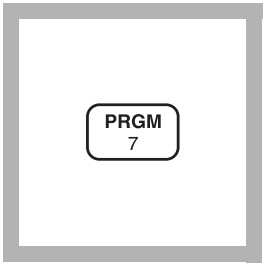
11. Press: **READ**

The cursor will move to the right, then the result in mg/L NO_3-N (or alternate form) will be displayed.

Note: *Use of the Standard Adjust feature for each new lot of reagent is highly recommended. See* Accuracy Check.

Note: *Rinse the sample cell immediately after use to remove all cadmium particles. Save the spent sample for proper hazardous waste disposal for cadmium.*

Using AccuVac Ampuls



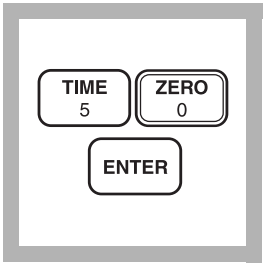
1. Enter the stored program number for high range nitrate nitrogen (NO_3^-–N) AccuVac Ampuls.

Press: **PRGM**

The display will show:

PRGM ?

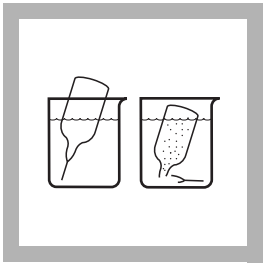
Note: *For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*



2. Press: **50 ENTER**

The display will show **mg/L, NO3-N** and the **ZERO** icon.

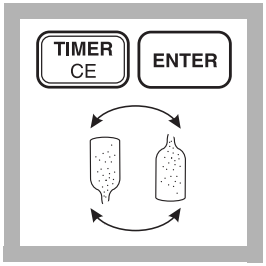
Note: *For alternate forms (NO_3), press the* **CONC** *key.*



3. Collect at least 40 mL of sample in a 50-mL beaker. Fill a NitraVer 5 Nitrate AccuVac Ampul with sample. Place a stopper over the tip of the ampul.

Note: *Keep the tip immersed while the ampul fills. The ampul will not fill completely.*

Note: *Adjust the pH of stored samples before analysis.*

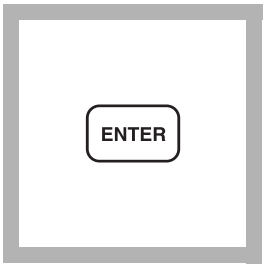


4. Press:

TIMER ENTER

A one-minute mixing period will begin. Invert the ampul repeatedly back and forth until the timer beeps. Wipe off any liquid or fingerprints.

Note: *Mixing time and technique influence color development. For most accurate results, do successive tests on a standard solution and adjust the mixing time to obtain the correct result.*



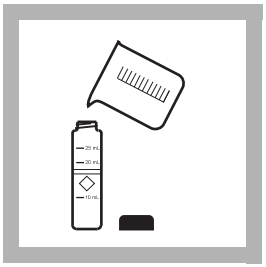
5. The display will show: **5:00 TIMER 2**

Press: **ENTER**

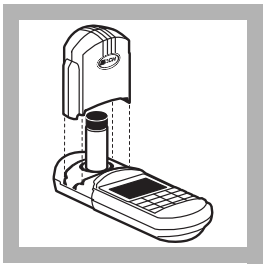
A five-minute reaction period will begin.

Note: *A deposit will remain after the reagent dissolves and will not affect results.*

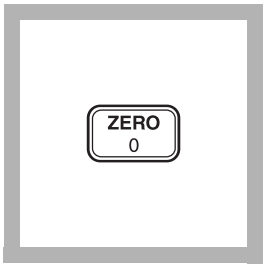
Note: *An amber color will develop if nitrate nitrogen is present.*



6. Fill a sample cell with at least 10 mL of sample (the blank).



7. When the timer beeps, place the blank in the cell holder. Tightly cover the sample cell with the instrument cap.

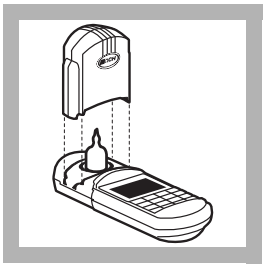


8. Press: **ZERO**

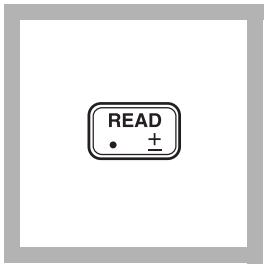
The cursor will move to the right, then the display will show:

0.0 mg/L NO3-N

Note: *If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



9. Place the AccuVac Ampul into the cell holder. Tightly cover the ampul with the instrument cap.



10. Press: **READ**

The cursor will move to the right, then the result in mg/L NO_3-N (or alternate form) will be displayed.

Note: *Use of the Standard Adjust feature for each new lot of reagent is highly recommended. See* Accuracy Check.

Note: *See Pollution Prevention and Waste Management for proper disposal of cadmium.*

Sampling and Storage

Collect samples in clean plastic or glass bottles. Store at 4 °C (39 °F) or lower if the sample is to be analyzed within 24 to 48 hours. Warm to room temperature before running the test. For longer storage periods, adjust sample pH to 2 or less with sulfuric acid, ACS (about 2 mL per liter). Sample refrigeration is still required.

Before testing the stored sample, warm to room temperature and neutralize with 5.0 N Sodium Hydroxide Standard Solution.

Do not use mercury compounds as preservatives.

Correct the test result for volume additions; see *Correction for Volume Additions* (*Section 1*) for more information.

Accuracy Check

Standard Additions Method

a) Fill three 25-mL mixing cylinders with 25 mL of sample.

b) Snap the neck off a Nitrate Nitrogen Ampule Standard, 500 mg/L nitrate nitrogen.

c) Use the TenSette Pipet to add 0.1, 0.2, and 0.3 mL of Nitrate Nitrogen Standard Solution to the three samples. Stopper and
mix thoroughly.

d) For AccuVac analysis, transfer the solutions to clean, dry 50-mL beakers. For analysis with powder pillows, transfer only 10 mL of solution to clean, dry sample cells.

e) Analyze each sample as described above. The nitrate nitrogen (NO_3^--N) concentration should increase 2.0 mg/L for each 0.1 mL of standard added.

f) If these increases do not occur, see *Standard Additions* (*Section 1*) for more information.

Standard Solution Method

Use a Hach Nitrate-Nitrogen Standard Solution, 10.0 mg/L NO_3^--N, listed under Optional Reagents as the sample and perform the procedure as described above.

Standard Adjust

To adjust the calibration curve using the reading obtained with the 10.0-mg/L standard solution, press the **SETUP** key and scroll (using the arrow keys) to the STD setup option. Press **ENTER** to activate the standard adjust option. Then enter **10.0** to edit the standard concentration to match that of the standard used. Press **ENTER** to complete the curve adjustment. See *Section 1, Standard Curve Adjustmen*t for more information. If you are using a reagent blank correction, the blank correction should be entered before the Standard Adjust value is entered.

Method Performance

Precision

In a single laboratory using standard solutions of 25.0 mg/L nitrate nitrogen (NO_3^--N) and two representative lots of reagent with the instrument, a single operator obtained a standard deviation of ±0.3 mg/L nitrate nitrogen for program #50 and ±1.7 mg/L nitrate nitrogen for program # 51.

Estimated Detection Limit

The estimated detection limit for program 50 is 0.5 mg/L NO_3^--N and 0.8 mg/L NO_3^--N for program 51. For more information on the estimated detection limit, see *Section 1*.

Interferences

Interfering Substance	Interference Levels and Treatments
Chloride	Chloride concentrations above 100 mg/L will cause low results. The test may be used at high chloride concentrations (seawater) but a calibration must be done using standards spiked to the same chloride concentration.
Ferric iron	All levels
Nitrite	All levels Compensate for nitrite interference as follows: Add 30-g/L Bromine Water dropwise to the sample in Step 3 until a yellow color remains. Add one drop of 30-g/L Phenol Solution to destroy the color. Proceed with Step 4. Report the results as total nitrate and nitrite.
pH	Highly buffered samples or extreme sample pH may exceed the buffering capacity of the reagents and require sample pretreatment.
Strong oxidizing and reducing substances	Interfere at all levels.

Summary Of Method

Cadmium metal reduces nitrates present in the sample to nitrite. The nitrite ion reacts in an acidic medium with sulfanilic acid to form an intermediate diazonium salt which couples to gentisic acid to form an amber-colored product.

Pollution Prevention and Waste Management

NitraVer 5 contains cadmium metal. Both samples and reagent blanks will contain cadmium (D006) at a concentration regulated as hazardous wastes by the Federal RCRA. Do not pour these solutions down the drain. See *Section 3* for more information on proper disposal of these materials.

REQUIRED REAGENTS & APPARATUS (Using Powder Pillows)

Description	Quantity Required Per Test	Unit	Cat. No.
NitraVer 5 Nitrate Reagent Powder Pillows	1 pillow	100/pkg	21061-69
Sample Cell, 10-20-25 mL, w/cap	2	6/pkg	24019-06

REQUIRED REAGENTS (Using AccuVac Ampuls)

NitraVer 5 Nitrate Reagent AccuVac Ampul	1 ampul	25/pkg	25110-25

REQUIRED APPARATUS (Using AccuVac Ampuls)

Beaker, 50 mL	1	each	500-41H
Stopper	1	6/pkg	1731-06

OPTIONAL REAGENTS

Bromine Water 30 g/L	29 mL*		2211-20
Nitrate Nitrogen Standard Solution, 10.0 mg/L as (NO_3^--N)	500 mL		307-49
Nitrate Nitrogen Standard Solution, 1000 mg/L as (NO_3^--N)	500 mL		12792-49
Nitrate Nitrogen Standard Solution, PourRite ampule, 500 mg/L as NO_3^--N, 2 mL	20/pkg		14260-20
Phenol Solution	29 mL		2112-20
Sodium Hydroxide Standard Solution, 5.0 N	50 mL*		2450-26
Sulfuric Acid, ACS	500 mL*		979-49
Water, deionized	4 L		272-56

OPTIONAL APPARATUS

AccuVac Snapper Kit	each		24052-00
Cylinder, graduated, mixing, 25 mL	each		1896-40
Dropper, for 29-mL bottle	each		2258-00
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg		391-33
pH Meter, *sension*™*1*, portable, with electrode	each		51700-10
Pipet Filler, safety bulb	each		14651-00
Pipet, serological, 2 mL	each		532-36
Pipet, TenSette, 0.1 to 1.0 mL	each		19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg		21856-96
Pipet Tips, for 19700-01 TenSette Pipet	1000/pkg		21856-28
PourRite Ampule Breaker	each		24846-00
Thermometer, –20 to 110 °C, non-mercury	each		26357-02

For Technical Assistance, Price and Ordering

In the U.S.A. call 800-227-4224

Outside the U.S.A.—Contact the Hach office or distributor serving you.

* Contact Hach for larger sizes.

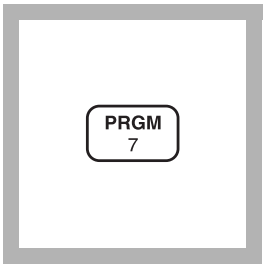
SULFATE (0 to 70 mg/L)

SulfaVer 4 Method* (Powder Pillows or AccuVac Ampuls); USEPA accepted for reporting wastewater analysis**

Using Powder Pillows

1. A User-Entered Calibration is necessary to obtain the most accurate results. See the *User Calibration* section at the back of this procedure. Program 91 can be used for process control or applications where a high degree of accuracy is not needed.

Note: *The nature of turbidimetric tests and reagent lot variation requires user calibration for best results.*

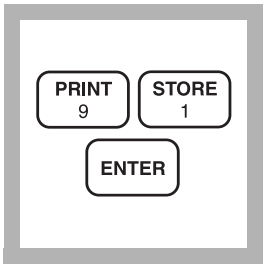


2. Enter the stored program number for sulfate (SO_4^-).

Press: **PRGM**

The display will show:

PRGM ?



3. Press: **91 ENTER** or the program number selected for a user-entered calibration.

The display will show **mg/L, SO4** and the **ZERO** icon.

4. Fill a clean sample cell with 10 mL of sample.

Note: *Filter highly turbid or colored samples. Use filtered sample in this step and as the blank.*

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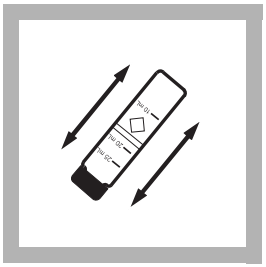
* Adapted from *Standard Methods for the Examination of Water and Wastewater.*

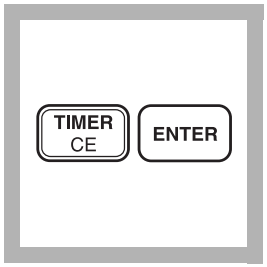
** Procedure is equivalent to USEPA method 375.4 for wastewater.



5. Add the contents of one SulfaVer 4 Sulfate Reagent Powder Pillow to the sample cell (the prepared sample). Cap the cell and invert several times to mix.

Note: *A white turbidity will develop if sulfate is present in the sample.*

Note: *Accuracy is not affected by undissolved powder.*



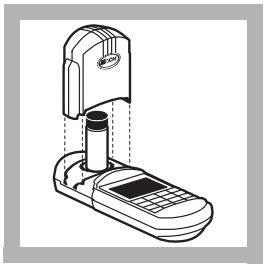
6. Press:

TIMER ENTER

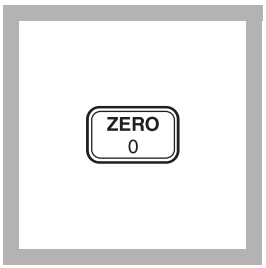
A 5-minute reaction period will begin.

Allow the cell to stand undisturbed.

7. After the timer beeps, fill a second sample cell with 10 mL of sample (the blank).



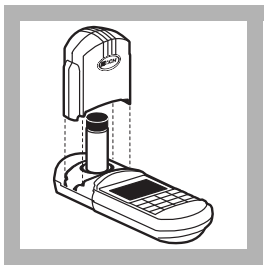
8. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



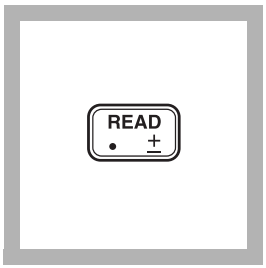
9. Press: **ZERO**

The cursor will move to the right, then the display will show:

0 mg/L SO4



10. Within five minutes after the timer beeps, place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



11. Press: **READ**

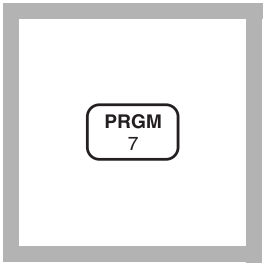
The cursor will move to the right, then the result in mg/L sulfate will be displayed.

Note: *If Program 91 is used, use of the Standard Adjust is highly recommended. See Accuracy Check.*

Note: *Clean the sample cells with soap and a brush.*

Using AccuVac Ampuls

1. A User-Entered Calibration is necessary to obtain the most accurate results. See User Calibration Section at the back of this procedure. Program 92 can be used for process control or applications where a high degree of accuracy is not needed.

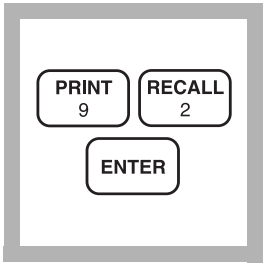


2. Enter the stored program number for sulfate (SO_4^-)-AccuVac Ampuls.

Press: **PRGM**

The display will show:

PRGM ?

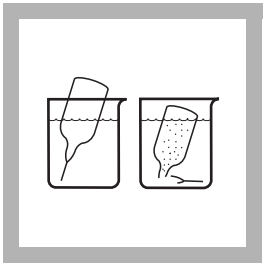


3. Press: **92 ENTER**

The display will show **mg/L, SO4** and the **ZERO** icon.

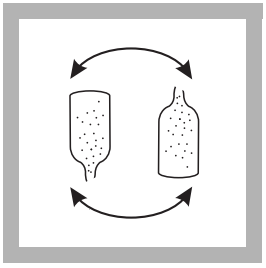
4. Fill a sample cell with at least 10 mL of sample (the blank). Collect at least 40 mL of sample in a 50-mL beaker.

Note: *Filter highly turbid or colored samples. Use filtered sample in this step and as the blank.*



5. Fill a SulfaVer 4 Sulfate AccuVac Ampul with sample.

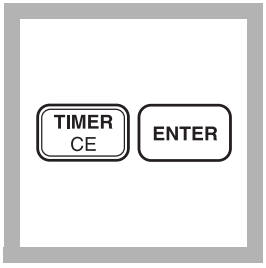
Note: *Keep tip immersed until the ampul fills completely.*



6. Quickly invert the ampul several times to mix. Wipe off any liquid or fingerprints.

Note: *A white turbidity will develop if sulfate is present.*

Note: *Accuracy is not affected by undissolved powder.*

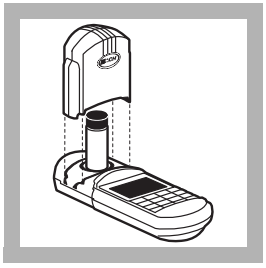


7. Press:

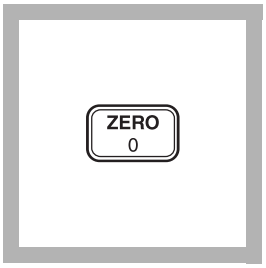
TIMER ENTER

A 5-minute reaction period will begin.

Note: *Allow the ampul to stand undisturbed.*



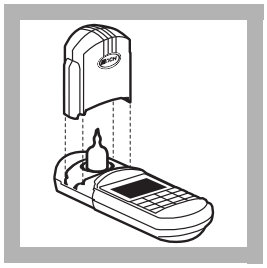
8. After the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



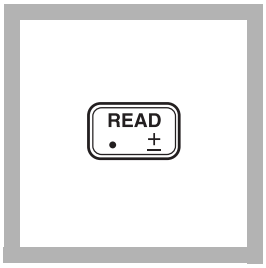
9. Press: **ZERO**

The cursor will move to the right, then the display will show:

0 mg/L SO4



10. Within five minutes after the timer beeps, place the AccuVac ampul into the cell holder. Tightly cover the sample cell with the instrument cap.



11. Press: **READ**

The cursor will move to the right, then the result in mg/L sulfate will be displayed.

Note: *If Program 92 is used, use of the Standard Adjust is highly recommended. See Accuracy Check.*

User- Entered Calibration

There are various programs to determine sulfate, each with a different level of accuracy. Best results are obtained by performing a user-entered calibration with each new lot of reagent. Programs 91 and 92 can be run when a high degree of accuracy is not needed. Use of the Standard Adjust feature will improve performance when using programs 91 and 92. It should NOT be used with a user calibration, as it will hinder performance.

Using Class A glassware, prepare standards of 10, 20, 30, 40, 50, 60, and 70 mg/L sulfate by pipetting 1, 2, 3, 4, 5, 6, and 7 mL of a 1000-mg/L sulfate standard into 100-mL volumetric flasks. Dilute to the mark with deionized water and mix well.

Zero the instrument with water. The user-entered settings for sulfate are:

Program number: #101 to 105
Wavelength: 520 nm
Resolution: 0 mg/L

See *Creating User-Entered Program* in the instrument manual for specific instructions on entering a user-entered program.

Sampling and Storage

Collect samples in clean plastic or glass bottles. Samples may be stored up to 28 days by cooling to 4 °C (39 °F) or lower. Warm to room temperature before analysis.

Accuracy Check

Standard Additions Method- Powder Pillows

a) Snap the neck off a Sulfate Standard PourRite Ampule, 1000 mg/L SO_4^{2-} .

b) Use a TenSette Pipet to add 0.1, 0.2 and 0.3 mL of standard to the three 10-mL samples. Mix thoroughly.

c) Analyze each sample as described above. The sulfate concentration should increase 10 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

Standard Additions Method- AccuVac Ampuls

a) Snap the neck off a Sulfate Standard PourRite Ampule, 2500 mg/L SO_4^{2-} .

b) Fill three 25- mL graduated cylinders with 25 mL of sample. Use a TenSette Pipet to add 0.1, 0.2 and 0.3 mL of standard to the three cylinders. Mix thoroughly. For AccuVac Ampuls, transfer to a
50-mL beaker.

c) Analyze each sample as described above. The sulfate concentration should increase 10 mg/L for each 0.1 mL of standard added.

d) If these increases do not occur, see *Standard Additions* in *Section 1* for more information.

Standard Solution Method

Check the accuracy of the test by using the Sulfate Standard Solution,
50 mg/L, listed under Optional Reagents. Or, prepare this solution by pipetting 1.0 mL of a PourRite Ampule Standard for Sulfate (2500 mg/L) into a 50-mL volumetric flask. Dilute to volume with deionized water. The final concentration is 50 mg/L sulfate. Substitute this standard for the sample and proceed with the test as described in the procedure.

Standard Adjust

Standard adjust is recommended when using stored programs 91 or 92. It **should not** be used with a user-entered calibration.

To adjust the calibration curve using the reading obtained with the
50-mg/L standard solution, press the **SETUP** key and scroll (using the arrow keys) to the STD setup option. Press **ENTER** to activate the standard adjust option. Then enter **50** to edit the standard concentration to match that of the standard used. Press **ENTER** to complete the adjustment. See *Section 1*, *Standard Curve Adjustmen*t for more information.

Method Performance

Precision

In a single laboratory, using a standard solution of 50 mg/L sulfate and two representative lots of powder pillows with the instrument, a single operator obtained a standard deviation of ±0.5 mg/L sulfate.

In a single laboratory, using a standard solution of 50 mg/L sulfate and two representative lots of AccuVac Ampuls with the instrument, a single operator obtained a standard deviation of ±3 mg/L sulfate.

Estimated Detection Limit (EDL)

The EDL for program 91 is 4.9 mg/L SO_4 and the EDL for program 92 is 3 mg/L SO_4. For more information on derivation and use of Hach's estimated detection limit, see *Section 1*.

Interferences

The following interfere at levels above those concentrations listed:

Calcium: 20,000 mg/L as $CaCO_3$	Magnesium: 10,000 mg/L as $CaCO_3$
Chloride: 40,000 mg/L as Cl^-	Silica: 500 mg/L as $CaCO_3$

Summary of Method

Sulfate ions in the sample react with barium in the SulfaVer 4 Sulfate Reagent to form insoluble barium sulfate. The amount of turbidity formed is proportional to the sulfate concentration. The SulfaVer 4 also contains a stabilizing agent to hold the precipitate in suspension.

REQUIRED REAGENTS AND APPARATUS (Using Powder Pillows)

Description	Quantity Required Per Test	Units	Cat. No.
SulfaVer 4 Sulfate Reagent Powder Pillows	1 pillow	100/pkg	21067-69
Sample Cell, 10-20-25 mL, w/ cap	2	6/pkg	24019-06

REQUIRED REAGENTS AND APPARATUS (Using AccuVac Ampuls)

SulfaVer 4 Sulfate AccuVac Ampuls	1 ampul	25/pkg	25090-25
Beaker, 50-mL	1	each	500-41H

OPTIONAL REAGENTS

Standard, Drinking Water Inorganics, F^-, NO_3^{-N}, PO_4^{-3}, SO_4^{-2}	500 mL	28330-49
Standard, Wastewater Effluent Inorganics, NH_3^{-N}, NO_3^{-N}, PO_4^{-3}, COD, SO_4^{-2}, TOC	500 mL	28332-49
Sulfate Standard Solution, 50 mg/L	500 mL	2578-49
Sulfate Standard Solution, 1000 mg/L	500 mL	21757-49
Sulfate Standard Solution, PourRite Ampule, 2500 mg/L, 10 mL	16/pkg	14252-10
Sulfate Standard Solution, PourRite Ampule, 1000 mg/L, 2 mL	20/pkg	21757-20
Water, deionized	4 L	272-56

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Cylinder, graduated mixing, 25 mL	each	20886-40
Filter Paper, folded, 12.5 cm	100/pkg	1894-57
Flask, volumetric, 50 mL, Class A	each	14574-41
Funnel, poly, 65 mm	each	1083-67
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 Pipet	50/pkg	21856-96
Pipet, volumetric, 1.00 mL, Class A	each	14515-35
Pipet, volumetric, 2.00 mL, Class A	each	14515-36
Pipet, volumetric, 3.00 mL, Class A	each	14515-03
Pipet, volumetric, 4.00 mL, Class A	each	14515-04
Pipet, volumetric, 5.00 mL, Class A	each	14515-37
Pipet, volumetric, 6.00 mL, Class A	each	14515-06
Pipet, volumetric, 7.00 mL, Class A	each	14515-07
Pipet Filler, safety bulb	each	14651-00
PourRite Ampule Breaker	each	24846-00

For Technical Assistance, Price and Ordering

In the U.S.A.—Call 800-227-4224

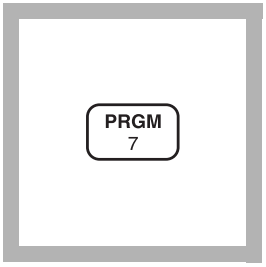
Outside the U.S.A.—Contact the Hach office or distributor serving you.

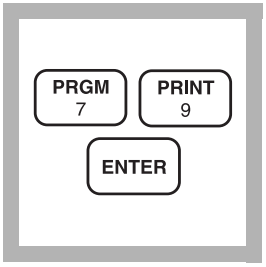
PHOSPHORUS, REACTIVE (0 to 2.50 mg/L PO_4^{3-}) For water, wastewater, seawater

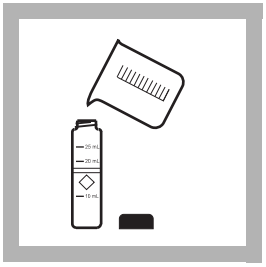
(Also called Orthophosphate) PhosVer 3 (Ascorbic Acid) Method*

(Powder Pillows or AccuVac Ampuls) **USEPA Accepted for wastewater analysis reporting****

Using Powder Pillows







1. Enter the stored program number for reactive phosphorus, ascorbic acid method.

Press: **PRGM**

The display will show:

PRGM ?

Note: *For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*

2. Press: **79 ENTER**

The display will show **mg/L, PO4** and the **ZERO** icon**.**

Note: *For alternate forms (P, P_2O_5), press the* **CONC** *key.*

3. Fill a sample cell with 10 mL of sample.

Note: *For samples with extreme pH, see* Interferences *following these steps.*

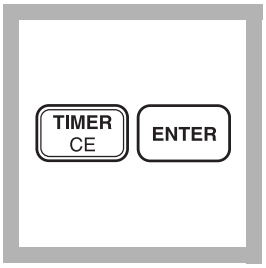
Note: *Clean glassware with 1:1 HCl. Rinse again with deionized water. Do not use detergents containing phosphates to clean glassware.*

4. Add the contents of one PhosVer 3 Phosphate Powder Pillow for 10-mL sample to the cell (the prepared sample). Shake for 15 seconds.

Note: *A blue color will form if phosphate is present.*

* Adapted from *Standard Methods for the Examination of Water and Wastewater.*

** Procedure is equivalent to USEPA method 365.2 and Standard Method 4500-PE for wastewater.



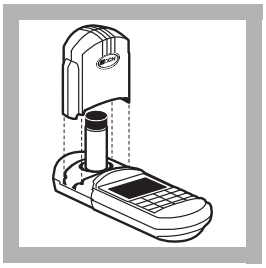
5. Press:

TIMER ENTER

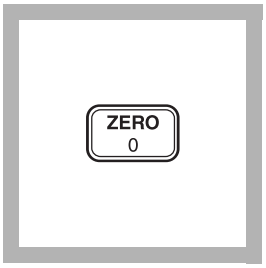
A two-minute reaction period will begin. Perform Steps 6-8 during this period.

Note: *If the acid-persulfate digestion was used, an 8-10 minute reaction period is required.*

6. Fill another sample cell with 10 mL of sample (the blank).



7. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

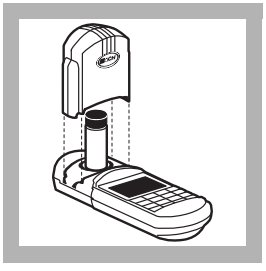


8. Press: **ZERO**

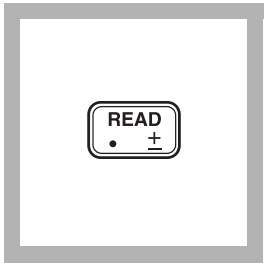
The cursor will move to the right, then the display will show:

0.00 mg/L PO4

Note: *If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



9. After the timer beeps, place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

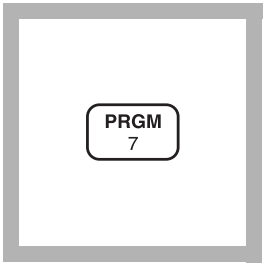


10. Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate (PO_4^{3-}) will be displayed.

Note: *Standard Adjust may be performed using a 2.0-mg/L PO_4^{3-}-standard; see Section 1.*

Using AccuVac Ampuls



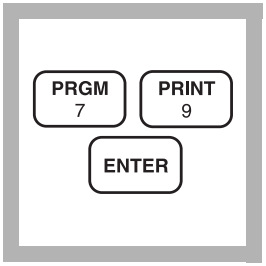
1. Enter the stored program number for reactive phosphorus-ascorbic acid method.

Press: **PRGM**

The display will show:

PRGM ?

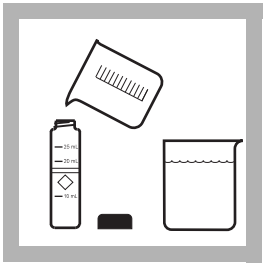
Note: *For most accurate results, perform a Reagent Blank Correction using deionized water (see Section 1).*



2. Press: **79 ENTER**

The display will show **mg/L, PO4** and the **ZERO** icon**.**

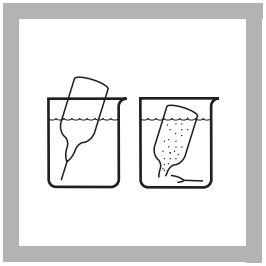
Note: *For alternate forms (P, P_2O_5), press the* **CONC** *key.*



3. Fill a sample cell (the blank) with at least 10 mL of sample. Collect at least 40 mL of sample in a 50-mL beaker.

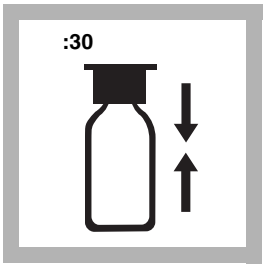
Note: *For samples with extreme pH, see* Interferences.

Note: *Clean glassware with 1:1 HCl. Rinse again with deionized water. Do not use detergent containing phosphates to clean glassware.*



4. Fill a PhosVer 3 Phosphate AccuVac Ampul with sample.

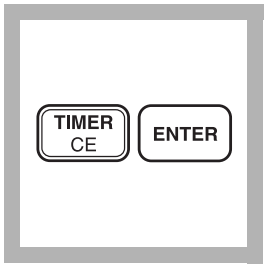
Note: *Keep the tip immersed while the ampul fills completely.*



5. Place an ampul cap securely over the tip of the ampul. Shake the ampul for about 30 seconds. Wipe off any liquid or fingerprints.

Note: *A blue color will form if phosphate is present.*

Note: *Accuracy is not affected by undissolved powder.*

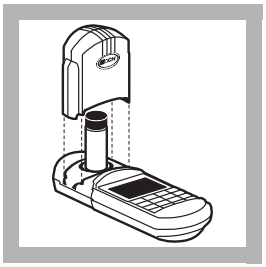


6. Press:

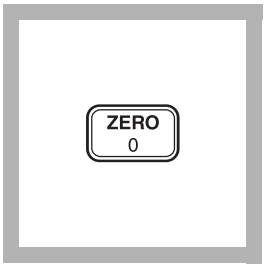
TIMER ENTER

A two-minute reaction period will begin. Perform Steps 7-8 during this period.

Note: *Use an 8-10 minute reaction period if determining total phosphorus following the acid-persulfate digestion.*



7. Place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.

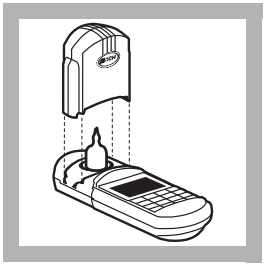


8. Press: **ZERO**

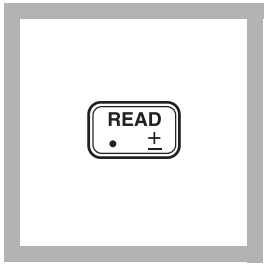
The cursor will move to the right, then the display will show:

0.00 mg/L PO4

Note: *If Reagent Blank Correction is on, the display may flash "limit". See Section 1.*



9. After the timer beeps, place the AccuVac ampul into the cell holder. Tightly cover the ampul with the instrument cap.



10. Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate (PO_4^{3-}) will be displayed.

Note: *Standard Adjust may be performed using a 2.0-mg/L PO_4^{3-} standard; see Section 1.*

Sampling and Storage

Collect sample in plastic or glass bottles that have been cleaned with 1:1 Hydrochloric Acid Solution and rinsed with deionized water. Do not use commercial detergents containing phosphate for cleaning glassware used in this test.

Analyze samples immediately after collection for best results. If prompt analysis is impossible, preserve samples for up to 48 hours by filtering immediately and storing samples at 4 °C. Warm to room temperature before testing.

Accuracy Check

Standard Additions Method

a) Fill three 25-mL graduated mixing cylinders with 25 mL of sample.

b) Snap the neck off a Phosphate PourRite Ampule Standard Solution, 50 mg/L as PO_4^{3-}.

c) Use the TenSette Pipet to add 0.1 mL, 0.2 mL, and 0.3 mL of standard, respectively, to the three mixing cylinders. Stopper each and mix thoroughly.

d) For analysis with AccuVacs, transfer solutions to dry, clean 50 mL beakers to fill the AccuVac ampules. For analysis with powder pillows, transfer only 10 mL of solution to the sample cells.

e) Analyze each standard addition sample as described in the procedure. The phosphate concentration should increase 0.2 mg/L PO_4^{3-} for each 0.1 mL of standard added.

f) If these increases do not occur, see *Standard Additions* in *Section 1*.

Standard Solution Method

Prepare a 2.0 mg/L PO_4^{3-} standard solution by pipetting 4.0 mL of Phosphate Standard Solution, 50 mg/L as PO_4^{3-}, into an acid-washed Class A 100-mL volumetric flask. Dilute to volume with deionized water. Stopper and invert to mix. Use this solution in place of the sample in the procedure to insure the accuracy of the test. The mg/L PO_4^{3-} reading should be 2.00 mg/L.

Method Performance

Precision

In a single laboratory using a standard solution of 1.00 mg/L PO_4^{3-} and two lots of reagents with the instrument, a single operator obtained a standard deviation of ±0.05 mg/L PO_4^{3-}.

In a single laboratory using a standard solution of 1.00 mg/L PO_4^{3-} and two representative lots of AccuVac ampuls with the instrument, a single operator obtained a standard deviation of ±0.03 mg/L PO_4^{3-}.

Estimated Detection Limit (EDL)

The EDL for program 79 is 0.05 mg/L PO_4. For more information on the estimated detection limit, see *Section 1*.

Interference

Interfering Substance	Interference Levels and Treatments
Aluminum	Greater than 200 mg/L
Arsenate	All levels
Chromium	Greater than 100 mg/L
Copper	Greater than 10 mg/L
Hydrogen sulfide	All levels
Iron	Greater than 100 mg/L
Nickel	Greater than 300 mg/L
Silica	Greater than 50 mg/L
Silicate	Greater than 10 mg/L
Turbidity or color	Large amounts may cause inconsistent results in the test because the acid present in the powder pillows may dissolve some of the suspended particles and because of variable desorption of orthophosphate from the particles. For highly turbid or colored samples, add the contents of one Phosphate Pretreatment Pillow to 25 mL of sample. Mix well. Use this solution to zero the instrument.
Zinc	Greater than 80 mg/L
Highly buffered samples or extreme sample pH	May exceed the buffering capacity of the reagents and require sample pretreatment. pH 2 to 10 is recommended.

Summary of Method

Orthophosphate reacts with molybdate in an acid medium to produce a Phosphomolybdate complex. Ascorbic acid then reduces the complex, giving an intense molybdenum blue color.

REQUIRED REAGENTS & APPARATUS (Using Powder Pillows)

Description	Quantity Required Per Test	Unit	Cat. No.
PhosVer 3 Phosphate Reagent Powder Pillows 10 mL sample size	1 Pillow	100/pkg	21060-69
Sample Cell, 10-20-25 mL, w/cap	2	6/pkg	24019-06

REQUIRED REAGENTS & APPARATUS (Using AccuVac Ampuls)

PhosVer 3 Phosphate Reagent AccuVac Ampuls	1 ampul	25/pkg	25080-25
Beaker, 50 mL	1	each	500-41
Cap, ampul, blue	1	25/pkg	1731-25
Sample Cell, 10-20-25 mL, w/cap	1	6/pkg	24019-06

OPTIONAL REAGENTS

Drinking Water Standard, Inorganic, F^-, NO_3^-–N, PO_4^{3-}, SO_4^{2-}	500mL	28330-49
Hydrochloric Acid Standard Solution, 6.0 N (1:1)	500 mL	884-49
Phosphate Standard Solution, 1mg/L	500mL	2569-49
Phosphate Standard Solution, PourRite ampule, 50 mg/L as PO_4^{3-}, 2 mL	20/pkg	171-20
Phosphate Standard Solution, Voluette Ampul, 50 mg/L, 10 mL	16/pkg	171-10
Sodium Hydroxide Standard Solution, 5.0 N	100 mL* MDB	2450-32
Wastewater Effluent Standard, Inorganic (NH_3–N, NO_3–N, PO_4, COD, SO_4, TOC)	500 mL	28332-49
Water, deionized	4 L	272-56

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Ampule Breaker Kit for 10-ml ampules	each	21968-00
Aspirator, vacuum	each	2131-00
Cylinder, graduated, mixing, 25 mL, tall (3 required)	each	20886-40
Filter Holder, 47 mm, 300 mL, graduated	each	13529-00
Filter, membrane, 47 mm, 0.45 microns	100/pkg	13530-00
Flask, filtering, 500 mL	each	546-49
Flask, volumetric, Class A, 100 mL	each	14574-42
pH Indicator Paper, 1 to 11 pH	5 rolls/pkg	391-33
pH Meter, *Sension™1*, portable with electrode	each	51700-10
Pipet, 2 mL serological	each	532-36
Pipet, TenSette, 0.1 to 1.0 mL TenSette Pipet	each	19700-01
Pipet Tips, for 19700-01	50/pkg	21856-96
Pipet Tips, for 19700-01	1000/pkg	21856-28
Pipet Filler, safety bulb	each	14651-00
Pipet, volumetric, Class A, 4.00 mL	each	14515-04
PourRite Ampule Breaker Kit	each	24846-00

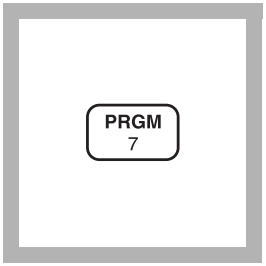
Outside the U.S.A.—Contact the Hach office or distributor serving you.

* Larger sizes available.

PHOSPHORUS, REACTIVE (0 to 45.0 mg/L PO_4^{3-}) For water and wastewater

(Also called Orthophosphate) Molybdovanadate Method*
(Reagent Solution or AccuVac Ampuls)

Using Reagent Solution

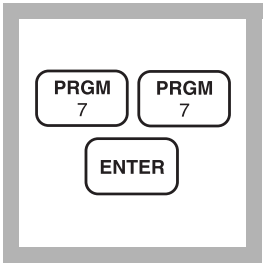


1. Enter the stored program number for high range phosphate (PO_4^{3-}) reagent solution.

Press: **PRGM**

The display will show:

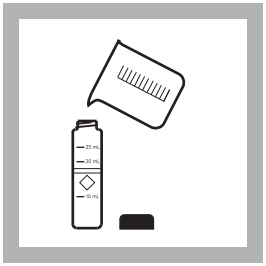
PRGM ?



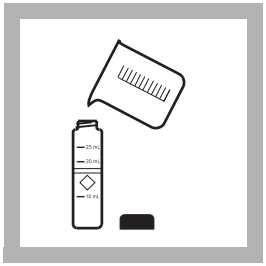
2. Press: **77 ENTER**

The display will show **mg/L, PO4** and the **ZERO** icon**.**

Note: *For alternate forms (P, P_2O_5), press the* **CONC** *key.*

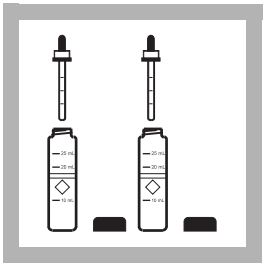


3. Fill a sample cell with 25 mL of deionized water (the blank).



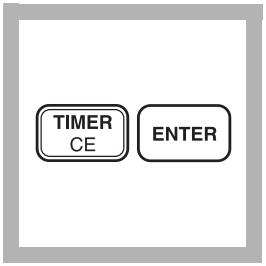
4. Fill another sample cell with 25 mL of sample (the prepared sample).

Note: *For best results, the sample temperature should be 20-25 °C.*



5. Add 1.0 mL of Molybdovanadate Reagent to each sample cell. Cap the cells and invert to mix.

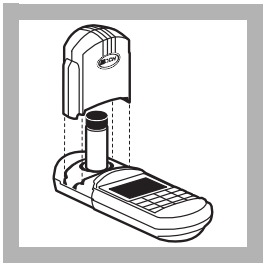
Note: *A yellow color will form if phosphate is present. A small amount of yellow will be present in the blank, because of the reagent.*



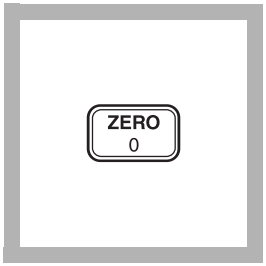
6. Press:

TIMER ENTER

A five-minute reaction period will begin.



7. After the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



8. Press: **ZERO**

The cursor will move to the right, then the display will show:

0.0 mg/L PO4

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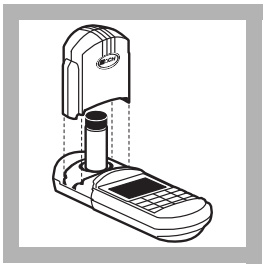
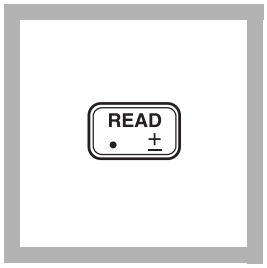
* Adapted from *Standard Methods for the Examination of Water and Wastewater.*



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.

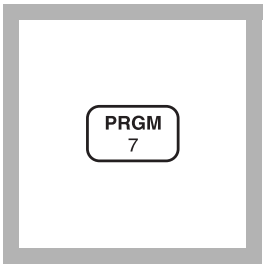


10. Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate (or alternate form) will be displayed.

Note: *Use of the Standard Adjust feature with each new lot of reagent is highly recommended. See Accuracy Check.*

Using AccuVac Ampuls

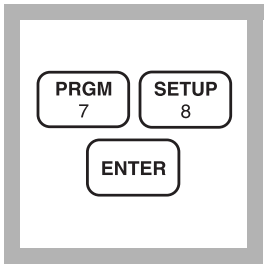


1. Enter the stored program number for high range phosphate (PO_4^{3-})-AccuVac Ampuls.

Press: **PRGM**

The display will show:

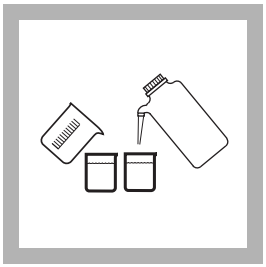
PRGM ?



2. Press: **78 ENTER**

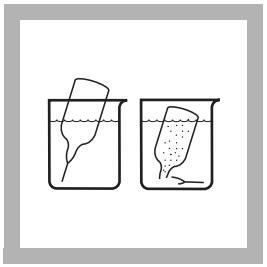
The display will show **mg/L, PO4** and the **ZERO** icon**.**

Note: *For alternate forms (P, P_2O_5), press the* **CONC** *key.*



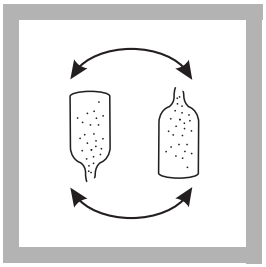
3. Collect at least 40 mL of sample in a 50-mL beaker. Pour at least 40 mL of deionized water into a second beaker.

Note: *For best results, sample temperature should be 20-25 °C.*



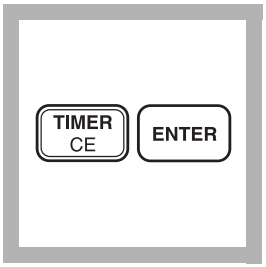
4. Fill a Molybdo-vanadate Reagent AccuVac Ampul with sample. Fill a second AccuVac Ampul with deionized water (the blank).

Note: *Keep the tip immersed while the ampul fills completely.*



5. Invert the ampul several times to mix, then wipe off any liquid or fingerprints.

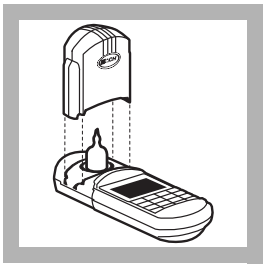
Note: *A yellow color will form if phosphate is present. A small amount of yellow will be present in the blank because of the reagent.*



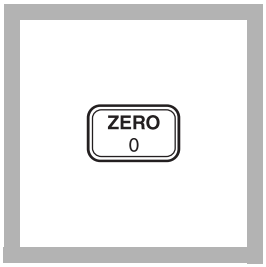
6. Press:

TIMER ENTER

A five-minute reaction period will begin.



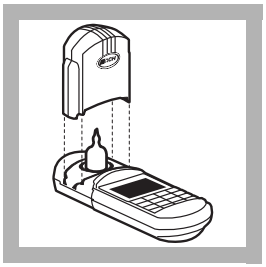
7. After the timer beeps, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap.



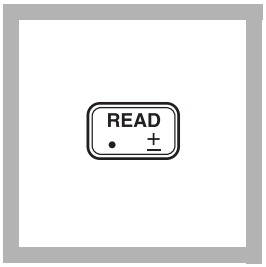
8. Press: **ZERO**

The cursor will move to the right, then the display will show:

0.0 mg/L PO4



9. Place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap.



10. Press: **READ**

The cursor will move to the right, then the result in mg/L phosphate (or alternate form) will be displayed.

Note: *Use of the Standard Adjust feature with each new lot of reagent is highly recommended. See Accuracy Check.*

Sampling and Storage

Collect samples in clean plastic or glass bottles that have been cleaned with 1:1 Hydrochloric Acid Solution and rinsed with deionized water.

Do not use a commercial detergent containing phosphate for cleaning glassware used in this test.

Analyze samples immediately for best results. If prompt analysis is impossible, preserve samples by filtering immediately and storing at 4 °C for up to 48 hours.

Accuracy Check

Standard Additions Method

a) Fill three 25-mL graduated mixing cylinders with 25 mL of sample.

b) Snap the neck off a Phosphate Voluette Ampule Standard Solution, 500 mg/L as PO_4^{3-}.

c) Use the TenSette Pipet to add 0.1 mL, 0.2 mL and 0.3 mL of standard, respectively, to the three mixing cylinders. Stopper and invert to mix well.

d) For analysis with AccuVac Ampuls, transfer the spiked samples to clean, dry 50-mL beakers to facilitate filling of the ampuls. For analysis with reagent solution, transfer the spiked samples to
25-mL sample cells.

e) Analyze each sample as described in the procedure. Each 0.1-mL addition of standard should cause an increase of 2.0 mg/L PO_4^{3-}.

f) If these increases do not occur, see *Standard Additions* (Section 1) for more information.

Standard Solution Method

Obtain a Hach Phosphate Standard Solution, 10.0 mg/L as phosphate. Using this solution as the sample, perform the phosphate procedure as described above.

Standard Adjust

To adjust the calibration curve using the reading obtained with the
10.0 mg/L standard solution, press the **SETUP** key and scroll (using the arrow keys) to the STD setup option. Press **ENTER** to activate the standard adjust option. Then enter **10.0** to edit the standard concentration to match that of the standard used. Press **ENTER** to complete the adjustment. See *Standard Curve Adjustmen*t, *Section 1* for more information.

Method Performance

Precision

In a single laboratory using a standard solution of 30.0 mg/L PO_4^{3-}, two lots of reagent, and the instrument, a single operator obtained a standard deviation of ±0.1 mg/L PO_4^{3-} for the reagent solution method and a standard deviation of ±0.2 for the AccuVac Ampul method.

Estimated Detection Limit

The estimated detection limit for program 77 is 0.3 mg/L PO_4^{3-} and
0.4 mg/L PO_4^{3-} for program 78. For more information on the estimated detection limit, see *Section 1*.

Interferences

Interfering Substances and Suggested Treatment

Interfering Substance	Interference Level and Treatment
Arsenate	Only interferes if sample is heated.
Iron, ferrous	Blue color caused by ferrous iron does not interfere if iron concentration is less than 100 mg/L.
Molybdate	Causes negative interference above 1000 mg/L.
Silica	Only interferes if sample is heated.
Sulfide	Causes a negative interference. Remove interference as follows: **1.** Measure 50 mL of sample into an erlenmeyer flask. **2.** Add Bromine Water drop-wise with constant swirling until a permanent yellow color develops. **3.** Add Phenol Solution drop-wise until the yellow color just disappears. Proceed with step 4 of the procedure (step 3 if using the AccuVac procedure).
Extreme pH or highly buffered samples	May exceed buffering capacity of reagents. See Section 1, *pH Interferences*. Samples may require pretreatment. Sample pH should be about 7.
Fluoride, thorium, bismuth, thiosulfate or thiocyanate	Cause negative interference
The following do not interfere in concentrations up to 1000 mg/L: Pyrophosphate, tetraborate, selenate benzoate, citrate, oxalate, lactate, tartrate, formate, salicylate, Al^{3+}, Fe^{3+}, Mg^{2+}, Ca^{2+}, Ba^{2+}, Sr^{2+}, Li^{+}, Na^{+}, K^{+}, NH_4^{+}, Cd^{2+}, Mn^{2+}, NO_3^{-}, NO_2^{-}, SO_4^{2-}, SO_3^{2-}, Pb^{2+}, Hg^{+}, Hg^{2+}, Sn^{2+}, Cu^{2+}, Ni^{2+}, Ag^{+}, U^{4+}, Zr^{4+}, AsO_3^{-}, Br^{-}, CO_3^{2-}, $Cl0_4^{-}$, CN^{-}, IO_3^{-}, SiO_4^{4-}.	

Summary of Method

In the molybdovanadate method, orthophosphate reacts with molybdate in an acid medium to produce a phosphomolybdate complex. In the presence of vanadium, yellow vanadomolybdophosphoric acid is formed. The intensity of the yellow color is proportional to the phosphate concentration.

REQUIRED REAGENTS AND APPARATUS (using Reagent Solution)

Description	Quantity Required Per Test		Units	Cat. No.
Molybdovanadate Reagent	2.0 mL	100 mL*	MDB	20760-32
Sample Cell, 10-20-25 mL, w/ cap	2		6/pkg	24019-06
Water, deionized	25 mL		4 L	272-56

REQUIRED REAGENTS AND APPARATUS (using AccuVac Ampuls)

Molybdovanadate Reagent AccuVac Ampuls	2	25/pkg	25250-25
Beaker, 50 mL	2	each	500-41H
Water, deionized	25 mL	4 L	272-56

OPTIONAL REAGENTS

Description	Units	Cat. No.
Bromine Water, 30 g/L	29 mL*	2211-20
Hydrochloric Acid Solution, 1:1 (6.0 N)	500 mL	884-49
Phenol Solution, 30 g/L	29 mL	2112-20
Phosphate Standard Solution, 10.0 mg/L as PO_4^{3-}	946 mL	14204-16
Phosphate Standard Solution, Voluette Ampule, 500 mg/L as PO_4^{3-}, 10 mL	16/pkg	14242-10
Sodium Hydroxide Standard Solution, 5.0 N	100 mL* MDB	2450-32
Sulfuric Acid, ACS	500 mL*	979-49
Wastewater Influent Standard, Inorganic (NH_3–N, NO_3–N, PO_4, COD, SO_4, TOC)	500 mL	28331-49

OPTIONAL APPARATUS

AccuVac Snapper Kit	each	24052-00
Ampule Breaker Kit	each	21968-00
Cylinder, graduated, 25 mL	each	508-40
Cylinder, graduated, mixing, 25-mL	each	20886-40
Dispenser, fixed volume, 1.0 mL Repipet Jr.	each	21113-02
Flask, erlenmeyer, 50 mL	each	505-41
Flask, volumetric, Class A, 50 mL	each	14574-41
pH Paper, 1 to 11 pH units	5 rolls/pkg	391-33
pH Meter, *Sension™1*, portable with electrode	each	51700-10

* Contact Hach for larger sizes.

OPTIONAL APPARATUS (continued)

Description	Units	Cat. No.
Pipet, serological, 2.0 mL	each	532-36
Pipet, TenSette, 0.1 to 1.0 mL	each	19700-01
Pipet Tips, for 19700-01 TenSette Pipet	50/pkg	21856-96
Pipet Tips, for 19700-01 TenSette Pipet	1000/pkg	21856-28
Thermometer, -20 to 110 °C	each	26357-02

For Technical Assistance, Price and Ordering

In the U.S.A.—Call 800-227-4224
Outside the U.S.A.—Contact the Hach office or distributor serving you.

The following list contains the Material Safety Data Sheets you requested. Please scoll down to view the requested MSDS(s).

Product	MSDS	Distributor	Format	Language	Quantity
2511025	N/A	Hach Company	OSHA	English	1
2509025	N/A	Hach Company	OSHA	English	1
2508025	N/A	Hach Company	OSHA	English	1
2525025	N/A	Hach Company	OSHA	English	1

Total Enclosures: 4

World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00164

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: NitraVer® 5 Nitrate Reagent
Catalog Number: 2511025

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00164
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: Toxic. Recognized carcinogen. Cumulative poison. Experimental teratogen. May cause irritation.
Date of MSDS Preparation:
Day: 05
Month: October
Year: 2007

2. COMPOSITION / INFORMATION ON INGREDIENTS

Potassium Phosphate
CAS No.: 7778-77-0
TSCA CAS Number: 7778-77-0
Percent Range: 30.0 - 40.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 7100 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable
Percent Range: < 1.0
Percent Range Units: weight / weight
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Cadmium
CAS No.: 7440-43-9

TSCA CAS Number: 7440-43-9
Percent Range: 5.0 - 10.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 225 mg/kg
LC50: Inhalation rat LC50 = 25 mg/m^3/30min
TLV: 0.01 mg/m^3
PEL: 0.005 mg/m^3
Hazard: Toxic. Recognized carcinogen. Cumulative poison. May cause irritation. Experimental teratogen.

Gentisic Acid
CAS No.: 490-79-9
TSCA CAS Number: 490-79-9
Percent Range: 5.0 - 15.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 800 mg/kg, Oral mouse LD50 = 4500 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

Magnesium Sulfate
CAS No.: 10034-99-8
TSCA CAS Number: 7487-88-9
Percent Range: 5.0 - 15.0
Percent Range Units: weight / weight
LD50: Oral mouse LDLo = 5000 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

Sulfanilic Acid
CAS No.: 121-57-3
TSCA CAS Number: 121-57-3
Percent Range: 30.0 - 40.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 12300 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: May cause irritation.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Gray powder
Odor: None
HARMFUL IF SWALLOWED OR INHALED MAY CAUSE EYE, SKIN AND RESPIRATORY TRACT IRRITATION
CONTAINS CADMIUM: CANCER HAZARD CAN CAUSE LUNG AND KIDNEY DISEASE

HMIS:
Health: 4

Flammability: 1
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.

NFPA:
Health: 3
Flammability: 1
Reactivity: 0
Symbol: Not applicable

Potential Health Effects:
Eye Contact: May cause irritiation
Skin Contact: May cause irritiation
Skin Absorption: None reported
Target Organs: None reported
Ingestion: May cause: salivation vomiting abdominal pain anemia diarrhea kidney failure central nervous system effects
Target Organs: Kidneys Reproductive system Central nervous system
Inhalation: May cause: coughing headache nausea, vomiting chest pain pneumonitis respiratory tract irritation lung damage kidney damage
Target Organs: Kidneys Reproductive system Lungs
Medical Conditions Aggravated: Pre-existing: Respiratory conditions Kidney conditions
Chronic Effects: Chronic overexposure may cause cancer kidney damage liver damage bone damage (osteosclerosis)
Cancer / Reproductive Toxicity Information:
An ingredient of this product is an OSHA listed carcinogen.
Cadmium
An ingredient of this mixture is: IARC Group 2A: Suspected Carcinogen
Cadmium
An ingredient of this mixture is: NTP Listed Group 2A: Suspected Carcinogen
Cadmium
Additional Cancer / Reproductive Toxicity Information: Contains: an experimental teratogen. In laboratory tests, when magnesium sulfate was given to pregnant rats, a sharp reduction of both the number and the weight of the offspring was observed.

Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with soap and plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Administer milk or beaten egg whites at frequent intervals. Induce vomiting using syrup of ipecac or by sticking finger down throat. Never give anything by mouth to an unconscious person. Call physician immediately.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Can burn in fire, releasing toxic vapors.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not available
Hazardous Combustion Products: Toxic fumes of: cadmium oxide sulfur oxides. phosphorus oxides carbon monoxide, carbon dioxide.
Fire / Explosion Hazards: None reported

Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment. Releases of this material may contaminate the environment.
Clean-up Technique: Avoid breathing spilled material. Sweep up material. Incinerate material at an E.P.A. approved hazardous waste facility. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate general area (50 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Product is regulated as RCRA hazardous waste.
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product. Use with adequate ventilation.
Storage: Protect from: moisture Keep away from: oxidizers powdered metals hydrazoic acid
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Use a fume hood to avoid exposure to dust, mist or vapor. Have an eyewash station nearby.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: laboratory fume hood
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: dust Wash thoroughly after handling. Protect from: moisture Keep away from: oxidizers powdered metals
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Gray powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: None
pH: 5% solution = 2.7
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: 175°C; 347°F
Specific Gravity (water = 1): 2.13

Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Slightly soluble
Acid: Slightly soluble
Other: Not determined
Metal Corrosivity:
Steel: 0.105 in/yr
Aluminum: 0.028 in/yr

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Excess moisture
Reactivity / Incompatibility: Incompatible with: oxidizers powdered metals hydrazoic acid
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: sulfur oxides phosphorus oxides cadmium oxide carbon dioxide carbon monoxide
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: Sulfanilic acid: Skin rabbit - 500 mg/24H Standard Draize - MILD, Eye rabbit - 100 mg/24H Standard Draize - MODERATE
Mutation Data: Cadmium - Cytogenetic analysis - hamster ovary 1 µmol/l; Gentisic acid - DNA Inhibition - Human Lymphocytes 1 mmol/l
Reproductive Effects Data: Cadmium: Oral male rat TDLo = 155 mg/kg - 13 weeks pre-mating - effects on newborn growth and behavior; Oral female rat TDLo = 23 mg/kg - 1-22 days after conception - blood and lymphatic system abnormalities
Ingredient Toxicological Data: Cadmium: Oral rat LD50 = 225 mg/kg, Inhalation rat LC50 = 25 mg/m^3/30 min; Sulfanilic acid Oral rat LD50 = 12300 mg/kg; Gentisic acid Oral rat LD50 = 800 mg/kg; Potassium Phosphate Monobasic Oral rat LD50 = 7100 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: D006
Special Instructions (Disposal): Incinerate material at an E.P.A. approved hazardous waste facility.
Empty Containers: Rinse three times with an appropriate solvent. Rinsate from empty containers may contain sufficient product to require disposal as hazardous waste. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:

D.O.T. Proper Shipping Name: Not Currently Regulated

--

DOT Hazard Class: NA

DOT Subsidiary Risk: NA

DOT ID Number: NA

DOT Packing Group: NA

I.C.A.O.:

I.C.A.O. Proper Shipping Name: Not Currently Regulated

--

ICAO Hazard Class: NA

ICAO Subsidiary Risk: NA

ICAO ID Number: NA

ICAO Packing Group: NA

I.M.O.:

I.M.O. Proper Shipping Name: Not Currently Regulated

--

I.M.O. Hazard Class: NA

I.M.O. Subsidiary Risk: NA

I.M.O. ID Number: NA

I.M.O. Packing Group: NA

Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply. ALSO NOTE: If the National Competent Authority declares this product an environmental hazard by Special Provision 909 (IMDG) and Special Provision A97 (IATA) the classification may be UN3077 or UN3082.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product contains Cadmium and is regulated under 29CFR Subpart Z 1910.1027. This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product contains a chemical(s) subject to the reporting requirements of Section 313 of Title III of SARA.

Cadmium

302 (EHS) TPQ (40 CFR 355): Not applicable

304 CERCLA RQ (40 CFR 302.4): Cadmium 10 lbs.

304 EHS RQ (40 CFR 355): Not applicable

Clean Water Act (40 CFR 116.4): Not applicable

RCRA: Contains RCRA regulated substances. See Section 13, EPA Waste ID Number.

C.P.S.C.: Not applicable

State Regulations:

California Prop. 65: WARNING - This product contains a chemical known to the State of California to cause cancer.

Identification of Prop. 65 Ingredient(s): Cadmium

California Perchlorate Rule CCR Title 22 Chap 33:

Trade Secret Registry: Not applicable

National Inventories:

U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).

TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Determination of nitrate

References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. NIOSH/OSHA Occupational Health Guidelines for Chemical Hazards. Cincinnati: Department of Health and Human Services, 1981. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987. List of Dangerous Substances Classified in Annex I of the EEC Directive (67/548) - Classification, Packaging and Labeling of Dangerous Substances, Amended July 1992. Sixth Annual Report on Carcinogens, 1991. U.S. Department of Health and Human Services. Rockville, MD: Technical Resources, Inc. 1991. In-house information. Technical Judgment.

Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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World Headquarters
Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00046

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: SulfaVer ® 4 Sulfate Reagent
Catalog Number: 2509025

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00046
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: Causes severe eye irritation.
Date of MSDS Preparation:
Day: 26
Month: August
Year: 2011

2. COMPOSITION / INFORMATION ON INGREDIENTS

Barium Chloride
CAS No.: 10361-37-2
TSCA CAS Number: 10361-37-2
Percent Range: 40.0 - 50.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 118 mg/kg Oral Human LDLo = 11400 µg/kg
LC50: None reported
TLV: 0.5 mg/m^3 as Ba
PEL: 0.5 mg/m^3 as Ba
Hazard: May cause irritation. Toxic.

Citric Acid
CAS No.: 77-92-9
TSCA CAS Number: 77-92-9
Percent Range: 55.0 - 65.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 6730 mg/Kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: Causes irritation.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White powder
Odor: None

CAUSES EYE IRRITATION MAY CAUSE SKIN AND RESPIRATORY TRACT IRRITATION

HMIS:

Health: 2
Flammability: 0
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.

NFPA:

Health: 2
Flammability: 1
Reactivity: 0
Symbol: Not applicable

Potential Health Effects:

Eye Contact: Causes severe irritation
Skin Contact: Causes moderate irritation
Skin Absorption: None reported
Target Organs: None reported
Ingestion: Barium compounds cause central nervous system stimulation followed by central nervous system depression. Barium compounds cause stimulation of the muscles which may result in muscle twitching, cramps and weakness; blood pressure effects; disturbance of the heart's action and respiratory paralysis. Causes: abdominal pain dizziness Can cause: paralysis of tongue limb immobility death kidney damage
Target Organs: Cardiovascular system Central nervous system Muscles Kidneys
Inhalation: Barium compounds cause central nervous system stimulation followed by central nervous system depression. Barium compounds cause stimulation of the muscles which may result in muscle twitching, cramps and weakness; blood pressure effects; disturbance in the heart's action and respiratory paralysis. Causes: abdominal pain dizziness Can cause: paralysis of tongue limb immobility death kidney damage
Target Organs: Cardiovascular system Central nervous system Muscles Kidneys
Medical Conditions Aggravated: None reported
Chronic Effects: Citric acid chronic overexposure may cause effects due to the ability of citric acid to chelate metals, which could impair the body's ability to absorb calcium and iron. Chronic overexposure may cause kidney damage
Cancer / Reproductive Toxicity Information:

This product does NOT contain any OSHA listed carcinogens.
This product does NOT contain any IARC listed chemicals.
This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: None reported

Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water. Call physician if irritation develops.
Ingestion (First Aid): Induce vomiting using syrup of ipecac or by sticking finger down throat. Give 1 tablespoon of epsom salt in a glass of water. Call physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Can burn in fire, releasing toxic vapors. During a fire, irritating and highly toxic gases may be generated by thermal decomposition.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:

Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable

Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: carbon monoxide, carbon dioxide. chlorides
Fire / Explosion Hazards: May react violently with: strong oxidizers

Static Discharge: None reported.
Mechanical Impact: None reported

Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance. Outside of the US, only persons properly qualified according to state or local regulations should respond to a spill involving chemicals.
Containment Technique: Releases of this material may contaminate the environment. Stop spilled material from being released to the environment.
Clean-up Technique: Avoid contact with spilled material. Sweep up material. Dispose of material in government approved hazardous waste facility. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Mixture contains a component which is regulated as hazardous waste in the U. S. .
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Store away from: oxidizers Protect from: moisture
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Use a fume hood to avoid exposure to dust, mist or vapor. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves In the EU, the selected gloves must satisfy the specifications of EU Directive 89/686/EEC and standard EN 374 derived from it. lab coat
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: dust Wash thoroughly after handling. Protect from: moisture Keep away from: oxidizers
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: White powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: None
pH: of a 5% solution ~ 2.0
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: ~ 124 °C (255 °F)
Specific Gravity/ Relative Density (water = 1; air =1): ~2
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Soluble
Acid: Not determined
Other: Not determined
Metal Corrosivity:

Steel: Not applicable
Aluminum: Not applicable

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Excess moisture Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers bromine trifluoride 2-furan percarboxylic acid metal nitrates metal nitrites
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: carbon dioxide carbon monoxide chlorides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: Oral rat LD50 = 680 mg/kg
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: Citric Acid: Standard Draize Test Skin rabbit 500 mg/24 hour = MODERATE. Citric Acid: Standard Draize Test Eye rabbit 750 µg/24 hour = SEVERE.
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Barium Chloride Oral rat LD50 = 118 mg/kg; Citric Acid Oral rat LD50 = 6730 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product. Mobility in soil: No data available
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: D005
Special Instructions (Disposal): Dispose of material in an E.P.A. approved hazardous waste facility.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA

I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product contains a chemical(s) subject to the reporting requirements of Section 313 of Title III of SARA.
Barium Chloride
302 (EHS) TPQ (40 CFR 355): Not applicable
304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains RCRA regulated substances. See Section 13, EPA Waste ID Number.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): Not applicable
California Perchlorate Rule CCR Title 22 Chap 33: Not applicable
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Laboratory Reagent Sulfate determination
References: TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. In-house information. Technical Judgment. Outside Testing. Vendor Information. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Patty, Frank A. Industrial Hygiene and Toxicology, 3rd Revised Edition. Volume 2. New York: A Wiley-Interscience Publication, 1981. NIOSH Registry of Toxic Effects of Chemical Substances, 1985-86. Cincinnati: U.S. Department of Health and Human Services, April, 1987.
Revision Summary: Substantial revision to comply with EU Reg 1272/2008, Reg 1907/2006 and UN GHS (ST/SG/AC.10/36/Add.3).

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

MSDS No: M00035

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: PhosVer ® 3 Phosphate Reagent
Catalog Number: 2508025

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00035
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: Causes eye burns.
Date of MSDS Preparation:
Day: 15
Month: October
Year: 2009

2. COMPOSITION / INFORMATION ON INGREDIENTS

Potassium Pyrosulfate
CAS No.: 7790-62-7
TSCA CAS Number: 7790-62-7
Percent Range: 75.0 - 85.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 2340 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: Causes eye burns.

Ascorbic Acid
CAS No.: 50-81-7
TSCA CAS Number: 50-81-7
Percent Range: 15.0 - 25.0
Percent Range Units: weight / weight
LD50: Oral rat LD50 = 11900 mg/kg
LC50: None reported
TLV: Not established
PEL: Not established
Hazard: Practically non-toxic.

Sodium Molybdate
CAS No.: 10102-40-6
TSCA CAS Number: 7631-95-0
Percent Range: 1.0 - 10.0
Percent Range Units: weight / weight
LD50: Oral rat LD_{50} = 4000 mg/kg.
LC50: Inhalation rat LC50 = > 2080 mg/m³/4 hrs
TLV: 5 mg/m³ (as Mo)

PEL: 5 mg/m³ (as Mo)
Hazard: May cause irritation.

Other components, each
CAS No.: Not applicable
TSCA CAS Number: Not applicable
Percent Range: 0.1 - 1.0
Percent Range Units: weight / weight
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: White to off-white powder
Odor: None
CAUSES EYE BURNS MAY CAUSE RESPIRATORY TRACT IRRITATION

HMIS:
Health: 3
Flammability: 1
Reactivity: 0
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 3
Flammability: 1
Reactivity: 0
Symbol: Not applicable
Potential Health Effects:
Eye Contact: Causes eye burns.
Skin Contact: No effects are anticipated
Skin Absorption: None reported
Target Organs: None reported
Ingestion: May cause: copper deficiency anemia gout loss of appetite loss of coordination listlessness diarrhea liver damage May effect enzyme activity.
Target Organs: Blood Liver
Inhalation: May cause: respiratory tract irritation Effects similar to those of ingestion.
Target Organs: Blood Liver
Medical Conditions Aggravated: Pre-existing: Eye conditions Respiratory conditions Gout
Chronic Effects: Chronic overexposure may cause copper deficiency enzyme activity effects liver damage Molybdenum poisoning signs include loss of appetite, listlessness and reduced growth rate. Excessive exposure to molybdenum compounds may cause gout and anemia.
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

This product does NOT contain any IARC listed chemicals.

This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water.
Ingestion (First Aid): Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: Can burn in fire, releasing toxic vapors.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not determined
Hazardous Combustion Products: Toxic fumes of: sulfur oxides. carbon monoxide, carbon dioxide. sodium monoxide
Fire / Explosion Hazards: None reported
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Use media appropriate to surrounding fire conditions
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Stop spilled material from being released to the environment.
Clean-up Technique: Scoop up spilled material into a large beaker and dissolve with water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled.
Special Instructions (for accidental release): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
D.O.T. Emergency Response Guide Number: None

7. HANDLING / STORAGE

Handling: Avoid contact with eyes Do not breathe dust. Wash thoroughly after handling. Maintain general industrial hygiene practices when using this product.
Storage: Store between 10° and 25°C.
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: safety glasses with top and side shields
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes Do not breathe: dust Wash thoroughly after handling.
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: White to off-white powder
Physical State: Solid
Molecular Weight: Not applicable
Odor: None
pH: of a 5% solution = 1.5
Vapor Pressure: Not applicable
Vapor Density (air = 1): Not applicable
Boiling Point: Not applicable
Melting Point: 105 °C (221 °F)
Specific Gravity (water = 1): 2.22
Evaporation Rate (water = 1): Not applicable
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: Not applicable
Aluminum: Not applicable

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures
Reactivity / Incompatibility: Incompatible with: oxidizers dyes alkalies iron copper
Hazardous Decomposition: Heating to decomposition releases: carbon dioxide carbon monoxide sulfur oxides
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: Not corrosive to skin, no erythema
Mutation Data: None reported
Reproductive Effects Data: None reported
Ingredient Toxicological Data: Potassium Pyrosulfate Oral rat LD50 = 2340 mg/kg; Sodium Molybdate Oral rat LD50 = 4000 mg/kg, Inhalation rat LC50 > 2080mg/m^3/4 hr; Ascorbic Acid Oral rat LD50 = 11.9 g/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --
No ecological data available for this product.
Ingredient Ecological Information: --
No ecological data available for the ingredients of this product.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: None
Special Instructions (Disposal): Work in an approved fume hood. Dilute material with excess water making a weaker than 5% solution. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain. Allow cold water to run for 5 minutes to completely flush the system.
Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.
NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:
D.O.T. Proper Shipping Name: Not Currently Regulated
--
DOT Hazard Class: NA
DOT Subsidiary Risk: NA
DOT ID Number: NA
DOT Packing Group: NA
I.C.A.O.:
I.C.A.O. Proper Shipping Name: Not Currently Regulated
--
ICAO Hazard Class: NA
ICAO Subsidiary Risk: NA
ICAO ID Number: NA
ICAO Packing Group: NA
I.M.O.:
I.M.O. Proper Shipping Name: Not Currently Regulated
--
I.M.O. Hazard Class: NA
I.M.O. Subsidiary Risk: NA
I.M.O. ID Number: NA
I.M.O. Packing Group: NA
Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

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15. REGULATORY INFORMATION

U.S. Federal Regulations:
O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)
E.P.A.:
S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Delayed (Chronic) Health Hazard
S.A.R.A. Title III Section 313 (40 CFR 372): This product does NOT contain any chemical subject to the reporting requirements of Section 313 of Title III of SARA.
--
302 (EHS) TPQ (40 CFR 355): Not applicable
304 CERCLA RQ (40 CFR 302.4): Not applicable
304 EHS RQ (40 CFR 355): Not applicable
Clean Water Act (40 CFR 116.4): Not applicable
RCRA: Contains no RCRA regulated substances.
C.P.S.C.: Not applicable
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): None
California Perchlorate Rule CCR Title 22 Chap 33:
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

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16. OTHER INFORMATION

Intended Use: Phosphate determination
References: TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. In-house information. Technical Judgment. Outside Testing. NIOSH/OSHA Occupational Health

Guidelines for Chemical Hazards. Cincinnati: Department of Health and Human Services, 1981. Sax, N. Irving. Dangerous Properties of Industrial Materials, 7th Ed. New York: Van Nostrand Reinhold Co., 1989. Gosselin, R. E. et al. Clinical Toxicology of Commercial Products, 5th Ed. Baltimore: The Williams and Wilkins Co., 1984. Vendor Information. Patty, Frank A. Industrial Hygiene and Toxicology, 3rd Revised Edition. Volume 2. New York: A Wiley-Interscience Publication, 1981.

Revision Summary: Updates in Section(s) 14,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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(970) 669-3050

MSDS No: M00297

MATERIAL SAFETY DATA SHEET

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Phosphorus Molybdovanadate
Catalog Number: 2525025

Hach Company
P.O.Box 389
Loveland, CO USA 80539
(970) 669-3050

Emergency Telephone Numbers:
(Medical and Transportation)
(303) 623-5716 24 Hour Service
(515)232-2533 8am - 4pm CST

MSDS Number: M00297
Chemical Name: Not applicable
CAS No.: Not applicable
Chemical Formula: Not applicable
Chemical Family: Not applicable
Hazard: Harmful if inhaled. Carcinogen. Causes eye burns.
Date of MSDS Preparation:
Day: 20
Month: April
Year: 2010

2. COMPOSITION / INFORMATION ON INGREDIENTS

Ammonium Molybdate
CAS No.: 12054-85-2
TSCA CAS Number: 12027-67-7
Percent Range: 1.0 - 5.0
Percent Range Units: weight / volume
LD50: None reported.
LC50: None reported.
TLV: 5 mg/m^3 as Mo
PEL: 5 mg/m^3 as Mo
Hazard: Toxic. May cause irritation.

Ammonium Metavanadate
CAS No.: 7803-55-6
TSCA CAS Number: 7803-55-6
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Oral rat LD50 = 160 mg/kg; Oral rat LD50 = 58,100 µg/kg
LC50: Inhalation rat LC50 = 7800 $\mu g/m^3$/4H
TLV: 0.05 mg/m^3 as V_2O_5
PEL: Ceiling 0.05 mg/m^3 as V_2O_5
Hazard: Toxic. May cause irritation.

Demineralized Water
CAS No.: 7732-18-5
TSCA CAS Number: 7732-18-5
Percent Range: 50.0 - 60.0
Percent Range Units: volume / volume
LD50: None reported
LC50: None reported
TLV: Not established

PEL: Not established
Hazard: No effects anticipated.

Other component
CAS No.: Not applicable
TSCA CAS Number: Not applicable
Percent Range: < 1.0
Percent Range Units: weight / volume
LD50: Not applicable
LC50: Not applicable
TLV: Not established
PEL: Not established
Hazard: Any ingredient(s) of this product listed as "Other component(s)" is not considered a health hazard to the user of this product.

Sulfuric Acid
CAS No.: 7664-93-9
TSCA CAS Number: 7664-93-9
Percent Range: 35.0 - 45.0
Percent Range Units: weight / volume
LD50: Oral rat LD50 = 2140 mg/kg.
LC50: Inhalation rat LC50 = 87 ppm/4 hr
TLV: 1 mg/m³ (TWA); 3 mg/m³ (STEL)
PEL: 1 mg/m³
Hazard: Causes severe burns. Harmful if inhaled. Recognized carcinogen.

3. HAZARDS IDENTIFICATION

Emergency Overview:
Appearance: Clear, yellow liquid
Odor: None
CAUSES EYE BURNS HARMFUL IF INHALED CAUSES SKIN IRRITATION

HMIS:
Health: 3
Flammability: 0
Reactivity: 2
Protective Equipment: X - See protective equipment, Section 8.
NFPA:
Health: 3
Flammability: 0
Reactivity: 2
Symbol: Water Reactive
Potential Health Effects:
Eye Contact: Causes severe burns
Skin Contact: Causes irritation
Skin Absorption: None reported
Target Organs: None reported
Ingestion: Causes: severe burns May cause: loss of coordination copper deficiency gout May effect enzyme activity. Molybdenum compounds may cause loss of coordination, enzyme activity effects, copper deficiency and gout.
Target Organs: None reported
Inhalation: Causes: severe burns May cause: difficult breathing mouth soreness teeth erosion
Target Organs: Lungs
Medical Conditions Aggravated: Pre-existing: Eye conditions Skin conditions Respiratory conditions Gout
Chronic Effects: Molybdenum poisoning signs include loss of appetite, listlessness and reduced growth rate. Excessive exposure to molybdenum compounds may cause gout and anemia. Chronic overexposure may cause erosion of the teeth enzyme activity effects copper deficiency chronic irritation or inflammation of the lungs cancer
Cancer / Reproductive Toxicity Information:
This product does NOT contain any OSHA listed carcinogens.

An ingredient of this mixture is: IARC Group 1: Recognized Carcinogen
Sulfuric Acid - The IARC evaluation was based on exposure to the mist or vapor of concentrated sulfuric acid generated during chemical processes.
This product does NOT contain any NTP listed chemicals.

Additional Cancer / Reproductive Toxicity Information: Contains: an experimental teratogen. an experimental mutagen.
Toxicologically Synergistic Products: None reported

4. FIRST AID

Eye Contact: Immediately flush eyes with water for 15 minutes. Call physician.
Skin Contact (First Aid): Wash skin with plenty of water for 15 minutes. Remove contaminated clothing. Call physician immediately.
Ingestion (First Aid): Do not induce vomiting. Give 1-2 glasses of water. Call physician immediately. Never give anything by mouth to an unconscious person.
Inhalation: Remove to fresh air. Give artificial respiration if necessary. Call physician.

5. FIRE FIGHTING MEASURES

Flammable Properties: During a fire, corrosive and toxic gases may be generated by thermal decomposition. Not Flammable, but reacts with most metals to form flammable hydrogen gas.
Flash Point: Not applicable
Method: Not applicable
Flammability Limits:
Lower Explosion Limits: Not applicable
Upper Explosion Limits: Not applicable
Autoignition Temperature: Not applicable
Hazardous Combustion Products: Toxic fumes of: ammonia nitrogen oxides. sulfur oxides.
Fire / Explosion Hazards: May react violently with: reducers
Static Discharge: None reported.
Mechanical Impact: None reported
Extinguishing Media: Dry chemical. Do NOT use water.
Fire Fighting Instruction: As in any fire, wear self-contained breathing apparatus pressure-demand and full protective gear.

6. ACCIDENTAL RELEASE MEASURES

Spill Response Notice:
Only persons properly qualified to respond to an emergency involving hazardous substances may respond to a spill according to federal regulations (OSHA 29 CFR 1910.120(a)(v)) and per your company's emergency response plan and guidelines/procedures. See Section 13, Special Instructions for disposal assistance.
Containment Technique: Absorb spilled liquid with non-reactive sorbent material. Stop spilled material from being released to the environment.
Clean-up Technique: Cover spilled material with an alkali, such as soda ash or sodium bicarbonate. Scoop up slurry into a large beaker. Dilute with a large excess of water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Flush reacted material to the drain with a large excess of water. Decontaminate the area of the spill with a soap solution.
Evacuation Procedure: Evacuate local area (15 foot radius or as directed by your facility's emergency response plan) when: any quantity is spilled. If conditions warrant, increase the size of the evacuation.
Special Instructions (for accidental release): Mixture contains a component which is regulated as a water pollutant in the U. S. . Product is regulated as RCRA hazardous waste in the U.S.
304 EHS RQ (40 CFR 355): Sulfuric Acid - RQ 1000 lbs.
D.O.T. Emergency Response Guide Number: 154

7. HANDLING / STORAGE

Handling: Avoid contact with eyes skin clothing Do not breathe mist or vapors. Wash thoroughly after handling. Use with adequate ventilation. Maintain general industrial hygiene practices when using this product.

Storage: Store between 10° and 25°C. Protect from: light Store away from: oxidizers reducers metals
Flammability Class: Not applicable

8. EXPOSURE CONTROLS / PROTECTIVE EQUIPMENT

Engineering Controls: Have an eyewash station nearby. Have a safety shower nearby. Use general ventilation to minimize exposure to mist, vapor or dust. Maintain general industrial hygiene practices when using this product.
Personal Protective Equipment:
Eye Protection: chemical splash goggles
Skin Protection: disposable latex gloves lab coat
Inhalation Protection: adequate ventilation
Precautionary Measures: Avoid contact with: eyes skin clothing Do not breathe: mist/vapor Wash thoroughly after handling. Use with adequate ventilation. Protect from: light
TLV: Not established
PEL: Not established

9. PHYSICAL / CHEMICAL PROPERTIES

Appearance: Clear, yellow liquid
Physical State: Liquid
Molecular Weight: Not applicable
Odor: None
pH: < 0.5
Vapor Pressure: Not determined
Vapor Density (air = 1): Not determined
Boiling Point: 100°C (212°F)
Melting Point: Not determined
Specific Gravity (water = 1): 1.375
Evaporation Rate (water = 1): 0.06
Volatile Organic Compounds Content: Not applicable
Partition Coefficient (n-octanol / water): Not applicable
Solubility:
Water: Soluble
Acid: Soluble
Other: Not determined
Metal Corrosivity:
Steel: 11.273 in/yr
Aluminum: Not determined

10. STABILITY / REACTIVITY

Chemical Stability: Stable when stored under proper conditions.
Conditions to Avoid: Extreme temperatures Heating to decomposition.
Reactivity / Incompatibility: May react violently in contact with: oxidizers reducers Incompatible with: metals
Hazardous Decomposition: Heating to decomposition releases toxic and/or corrosive fumes of: ammonia nitrogen oxides sulfur oxides Contact with metals may release flammable hydrogen gas.
Hazardous Polymerization: Will not occur.

11. TOXICOLOGICAL INFORMATION

Product Toxicological Data:
LD50: None reported
LC50: None reported
Dermal Toxicity Data: None reported
Skin and Eye Irritation Data: This product is not corrosive to skin. Slight to well defined erythema. Absent to slight edema. (OECD Number 404, Acute Dermal Irritation/Corrosion)
Mutation Data: Ammonium Metavanadate: DNA damage - Human lymphocytes and ovary - 200 µmol/L; Mutation in somatic cells - hamster - lung - 5 µmol/L

Reproductive Effects Data: Intraperitoneal hamster TDLo = 2820 µg/kg - Musculoskeletal abnormalities; Intraperitoneal hamster TDLo = 11280 µg/kg - Post-implantation mortality

Ingredient Toxicological Data: Sulfuric Acid: Oral rat LD50 = 2140 mg/kg, Inhalation rat LC50 = 347 ppm/1 hr; Ammonium Metavanadate: Oral rat LD50 = 58 mg/kg, Ammonium Molybdate (anhydrous): Oral rat LD50 = 333 mg/kg

12. ECOLOGICAL INFORMATION

Product Ecological Information: --

No ecological data available for this product.

Ingredient Ecological Information: Sulfuric Acid: The 48-Hour TLm in flounder is 100-300 ppm.

13. DISPOSAL CONSIDERATIONS

EPA Waste ID Number: D002

Special Instructions (Disposal): Work in an approved fume hood. Dilute to 3 to 5 times the volume with cold water. Adjust to a pH between 6 and 9 with an alkali, such as soda ash or sodium bicarbonate. Open cold water tap completely, slowly pour the reacted material to the drain. Allow cold water to run for 5 minutes to completely flush the system.

Empty Containers: Rinse three times with an appropriate solvent. Dispose of empty container as normal trash.

NOTICE (Disposal): These disposal guidelines are based on federal regulations and may be superseded by more stringent state or local requirements. Please consult your local environmental regulators for more information.

14. TRANSPORT INFORMATION

D.O.T.:

D.O.T. Proper Shipping Name: Corrosive Liquid, Acidic, Inorganic, N.O.S. (<45% Sulfuric Acid in Solution)

DOT Hazard Class: 8

DOT Subsidiary Risk: NA

DOT ID Number: UN3264

DOT Packing Group: III

I.C.A.O.:

I.C.A.O. Proper Shipping Name: Corrosive Liquid, Acidic, Inorganic, N.O.S. (<45% Sulfuric Acid in Solution)

ICAO Hazard Class: 8

ICAO Subsidiary Risk: NA

ICAO ID Number: UN3264

ICAO Packing Group: III

I.M.O.:

I.M.O. Proper Shipping Name: Corrosive Liquid, Acidic, Inorganic, N.O.S. (<45% Sulfuric Acid in Solution)

I.M.O. Hazard Class: 8

I.M.O. Subsidiary Risk: NA

I.M.O. ID Number: UN3264

I.M.O. Packing Group: III

Additional Information: There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is NOT in a set or kit, the classification given above applies. If the item IS part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III. If the item is not regulated, the Chemical Kit classification does not apply.

15. REGULATORY INFORMATION

U.S. Federal Regulations:

O.S.H.A.: This product meets the criteria for a hazardous substance as defined in the Hazard Communication Standard. (29 CFR 1910.1200)

E.P.A.:

S.A.R.A. Title III Section 311/312 Categorization (40 CFR 370): Immediate (Acute) Health Hazard Reactive Delayed (Chronic) Health Hazard

S.A.R.A. Title III Section 313 (40 CFR 372): This product contains a chemical(s) subject to the reporting requirements of Section 313 of Title III of SARA.
Ammonium compounds; Sulfuric acid (acid aerosols including mists, vapors, gas, fog, and other airborne forms of any particle size)
302 (EHS) TPQ (40 CFR 355): Sulfuric Acid 1000 lbs.
304 CERCLA RQ (40 CFR 302.4): Sulfuric Acid Ammonium vanadate 1000 lbs.
304 EHS RQ (40 CFR 355): Sulfuric Acid - RQ 1000 lbs.
Clean Water Act (40 CFR 116.4): Sulfuric acid - RQ 1000 lbs.
RCRA: Contains RCRA regulated substances. See Section 13, EPA Waste ID Number.
C.P.S.C.: The label for this product bears the signal word "POISON" because the concentration of Sulfuric Acid in the product is greater than/equal to 10%.
State Regulations:
California Prop. 65: No Prop. 65 listed chemicals are present in this product.
Identification of Prop. 65 Ingredient(s): Not applicable
California Perchlorate Rule CCR Title 22 Chap 33:
Trade Secret Registry: Not applicable
National Inventories:
U.S. Inventory Status: All ingredients in this product are listed on the TSCA 8(b) Inventory (40 CFR 710).
TSCA CAS Number: Not applicable

16. OTHER INFORMATION

Intended Use: Indicator for phosphate
References: 29 CFR 1900 - 1910 (Code of Federal Regulations - Labor). Air Contaminants, Federal Register, Vol. 54, No. 12. Thursday, January 19, 1989. pp. 2332-2983. Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Fire Protection Guide on Hazardous Materials, 10th Ed. Quincy, MA: National Fire Protection Association, 1991. In-house information. Technical Judgment. TLV's Threshold Limit Values and Biological Exposure Indices for 1992-1993. American Conference of Governmental Industrial Hygienists, 1992. IARC Monographs on the Evaluation of the Carcinogenic Risks to Humans. World Health Organization (Volumes 1-42) Supplement 7. France: 1987.

Revision Summary: Updates in Section(s) 15,

Legend:

NA - Not Applicable	w/w - weight/weight
ND - Not Determined	w/v - weight/volume
NV - Not Available	v/v - volume/volume

USER RESPONSIBILITY: Each user should read and understand this information and incorporate it in individual site safety programs in accordance with applicable hazard communication standards and regulations.

THE INFORMATION CONTAINED HEREIN IS BASED ON DATA CONSIDERED TO BE ACCURATE. HOWEVER, NO WARRANTY IS EXPRESSED OR IMPLIED REGARDING THE ACCURACY OF THESE DATA OR THE RESULTS TO BE OBTAINED FROM THE USE THEREOF.

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