



June 24, 2015

Rachel Lee
Strand Engineering
910 West Wingra Drive
Madison, WI 53715

**Re: ACTIFLO® Pilot Study Proposal – Tertiary Phosphorus Application
Waukesha, WI**

Dear Rachel,

Please find the following pilot proposal and data package for ACTIFLO® pilot testing. This proposal summarizes set-up requirements for the pilot unit and includes an agreement for the cost of pilot testing.

As per the attached documents, the cost for pilot testing is \$7,500 per week excluding transportation. This cost includes pilot plant specialists to run the pilot unit and rental cost of the equipment. The transportation of the pilot unit is estimated to be an additional \$8,000 roundtrip. Only the actual shipping costs will be billed so this could be reduced based on the location from where the pilot unit is shipped. Total cost of a two week pilot study with estimated shipping costs is \$23,000. If additional weeks are anticipated or needed, please add \$7,500 for each additional week.

The price excludes sales and/or use taxes. The Customer agrees to provide the necessary tax exemption certificate for sales tax exemption within 30 days after receipt of a pilot agreement executed by all parties. Furthermore, the Customer accepts responsibility for all applicable state and local sales taxes as Kruger is not registered to collect or remit state sales and/or use taxes.

The proposed testing period is to be determined. I. Kruger Inc. reserves pilot studies on a first come, first serve basis. Please sign page 2 and 9 in the proposal and return the attached agreement along with the Customer's Sales Tax Exemption Certificate to reserve a testing period.

If you have any questions on this package, or other requirements for preparation, please do not hesitate to contact me at (919)653-4572.

Sincerely,

Andy Szekeress
Regional Manager

Cc: Robert Clay, Rich Dimassimo, Drew Bostian, Tom Perry – I. Kruger Inc.
Rob Szekeress - Peterson and Matz



DEMONSTRATION TEST AGREEMENT

THIS DEMONSTRATION TEST AGREEMENT (this "Agreement") is made as of the 27th day of October 2014, by and between I. Kruger Inc., ("KRUGER") and Waukesha WWTP ("Customer").

1. KRUGER has submitted to the Customer, dated October 27th, 2014 (the "Proposal", a copy of which is appended hereto as Attachment A) concerning the use of a mobile ACTIFLO[®] Pilot Unit (the "Unit") at Waukesha WWTP located in the City of Waukesha, State of Wisconsin (the "Facility"), and Customer desires to accept the Proposal on the terms and conditions herein set forth.

2. KRUGER shall at all times maintain ownership of the Unit, but shall make the Unit available at the Facility for a 2 week period, mutually acceptable to KRUGER and the Customer, for the completion of a demonstration test (the "Demonstration") as described in the Proposal. The Customer shall provide, at its sole cost and expense, the personnel, services and other support items necessary to completion of the Demonstration, as described in the Proposal. In consideration for making the Unit available for the Demonstration, the Customer shall pay to KRUGER the sums set forth in the Proposal.

3. KRUGER'S provision of the Unit for completion of the Demonstration shall be subject to all of the terms and conditions set forth in Attachment B hereto, each of which are incorporated by reference as if fully set forth herein. The provisions of Attachment B shall survive the expiration or earlier termination of this Agreement. Initially capitalized words and phrases used in Attachment B without definition shall have the meanings ascribed to such words and phrases in this Agreement.

4. This Agreement may be executed in two or more counterparts, each of which shall be deemed to be an original, but all of which together shall be deemed to be one and the same instrument. Any written notice or other written information to be communicated pursuant to or in connection with this Agreement shall be delivered by reputable overnight courier or certified mail, return receipt requested, to the addresses appearing on the signature page of this Agreement.

IN WITNESS WHEREOF, the parties hereto have caused their duly authorized representatives to execute and deliver this Agreement as of the day and year first above written.

Facility Legal Name

I. Kruger Inc. d/b/a
KRUGER

By: _____
Print Name:

By: _____
Print Name:

Title: _____

Title: _____

Address: _____

Address: 4001 Weston Parkway
Cary, NC 27513



ATTACHMENT A

ACTIFLO[®] Technical Proposal

For

**Waukesha WWTP
Waukesha, WI**

The information or data contained in this proposal is proprietary to Kruger and should not be copied, reproduced, duplicated, or disclosed to any third party, in whole or part, without the prior written consent of Kruger. This restriction will not apply to any information or data that is available to the public generally.

June 24, 2015



I) INTRODUCTION

An ACTIFLO® demonstration unit will be used to carry out the pilot study at the Waukesha WWTP. The purpose of the pilot study will be to investigate performance, provide operational data and develop treatment experience with a primary goal of phosphorus removal.

II) THE ACTIFLO® PROCESS

ACTIFLO® is a high rate clarification process that combines two water treatment technologies: ballasted flocculation and plate settling. Microsand in the system promotes flocculation and acts as a weighted structure to produce a very dense floc with a high settling velocity.

Coagulant, such as alum or ferric chloride, is introduced into the influent raw water to destabilize the colloids. With the addition of polymer as flocculent aid, the destabilized particles are attached to microsand in the system by polyelectrolyte bridging. Clarified water is collected in troughs located above the settling plates, while the settled microsand/sludge slurry is continuously pumped to hydrocyclones. Sludge and microsand particles are separated by the centrifugal force in the hydrocyclones. The lighter sludge is discharged while the heavier sand is injected by gravity into the system.

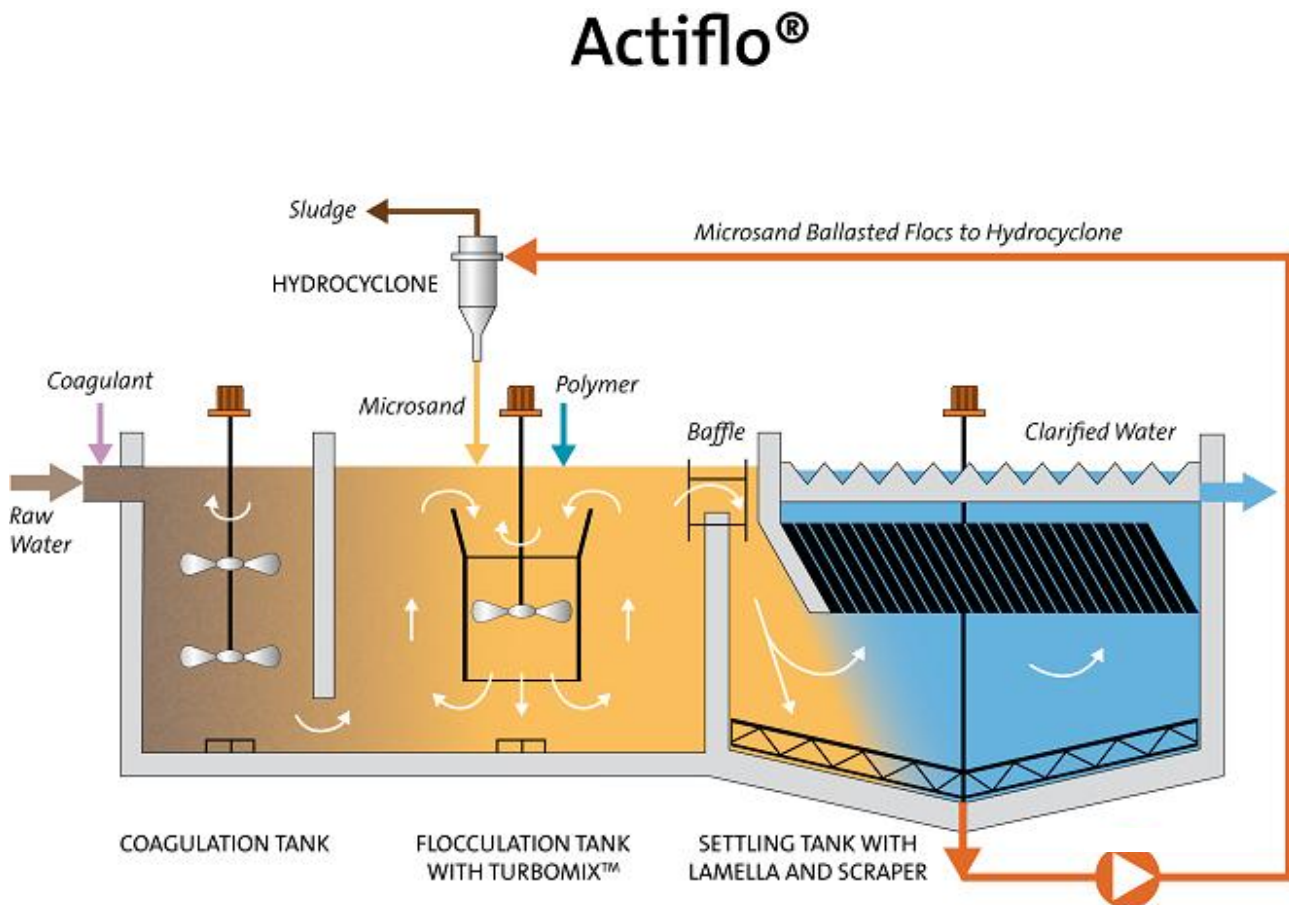


Figure 1: The ACTIFLO® Process



III) THE ACTIFLO[®] PILOT UNIT SPECIFICATIONS

A) Equipment – Trailer Number 007

The ACTIFLO[®] pilot unit contains the following equipment:

- One (1) 15 HP submersible raw water feed pump with VFD control
- Two (2) coagulation tanks equipped with two (2) coagulation tank mixers
- One (1) maturation tank equipped with one (1) maturation tank mixer and one (1) draft tube
- One (1) manual set of basket strainers
- One (1) tube/plate settling module
- One (1) rubber-lined sand recirculation pump
- One (1) hydrocyclone (U-3)
- One (1) magnetic flow meter for continuous monitoring of raw water flow
- One (1) magnetic flow meter for continuous monitoring of sand recirculation rate
- Two (2) pH meters for raw water pH and coagulated water pH
- Two (2) turbidimeters in-line for raw and settled water turbidities (Make: HACH Optiquant)
- Two (2) dry/emulsion polymer makeup tanks, with mixers
- Two (2), variable speed, polymer feed pumps
- One (1) coagulant chemical storage tank
- One (1), variable speed, coagulant feed pump
- One (1) pH adjustment chemical storage tank, with mixer
- One (1), variable speed, pH adjustment feed pump
- One (1) MCC
- One (1) PLC based control panel

B) Technical Specifications

Dimensions:

Dimensions: 53' in length by 8.0' in width by 13.5' in height

Weight: 39,000 lbs (empty); 60,000 lbs (full)

Capacity:

Nominal Flow: 202 gpm @ 32 gpm/ft²

Maximum Flow: up to 310 gpm @ 50 gpm/ft²

• **Hydraulic Connections:**

INFLUENT:

Kruger Provides:

- One (1) raw water submersible pump, VFD controlled. The pump is 3' D x 3' H and weighs ~ 300 lbs and has a 70 foot power cord that is plugged into the pilot unit.
- 100 feet of 4" hose with male and female camlock connections.
- The pilot unit has one 4" female camlock raw water inlet connection (located on driver's side of trailer towards the front)
- The submersible pump has a 4" male camlock discharge.



Client Provides:

- Equipment (backhoe, bobcat, forklift, etc.) to remove the raw water pump from the back of the pilot unit and place it in the raw water source.
- If the location of the influent pump is greater than 100 feet (including depth of influent water basin) from the influent pump electrical connection (middle of trailer on the passenger side), the client will need to supply additional cable and junction box to extend the power cable of the pump.
- If the location of the influent pump is greater than 100 feet away from the pilot unit (including depth of influent water basin) additional flexible hose with 4" male camlock and female camlock fittings must be supplied.

PROCESS SLUDGE:**Kruger Provides:**

- 50 feet of 4" hose with male and female camlock connections.
- One (1) 4" female camlock discharge connection (located on driver's side of trailer towards the rear). The pilot unit process sludge is approximately 20 gpm at 0.1 – 0.5% solids. The process sludge is gravity discharged with approximately 5 feet of head.

Client Provides:

- Additional 4" rigid hose (if needed) to run the sludge from the pilot unit to the sludge discharge site.
- Since the process sludge is gravity discharged it may need to be pumped to the sludge discharge site. If this is the case the client will need to supply a catch container and trash/sludge pump with float system.

EFFLUENT:**Kruger Provides:**

- 50 feet of 6" hose with male and female camlock connections.
- One (1) 6" female camlock connection (located on driver's side of trailer over the rear axle).
- The pilot unit process settled water discharge is approximately 200 gpm with approximately 10 feet of head.

Client Provides:

- Additional 6" rigid hose (if needed).
- The process settled water is gravity discharged and may need to be pumped to the discharge site. If this is the case the client will need to supply a catch container and discharge pump with a float system capable of handling the peak flow needed for the test.

SERVICE WATER:**Kruger Provides:**

- One (1) garden hose connection (located on driver's side of trailer towards the front) and 100' of garden hose.
- The service water will supply water to the office sink and polymer batch system.

Client Provides:

- Pressurized potable water and a connection.



LABORATORY SINK AND CHEMICAL TANK DRAIN:

Kruger Provides:

- 50 feet of 2" hose with male and female camlock connections.
- One (1) 2" male camlock connection (located on the driver's side of the trailer towards the front).
- The pilot unit laboratory sink and chemical drain water discharge is intermittent flow with approximately 4 feet of head.

Client Provides:

- Additional 2" rigid hose (if needed).
- The laboratory sink and chemical drain is gravity discharged and may need to be pumped to the discharge site. If this is the case the client will need to supply a catch container and discharge pump with a float system capable of handling the peak flow needed for the test. It could also be easily combined with effluent or sludge if these items are also being pumped.

• Foundation Preparation:

Kruger Provides:

- Two crank-down jack stands, which are attached to the pilot unit near the front of the trailer.

Client Provides:

- A level surface on asphalt, concrete, or well packed gravel which will support 60,000 lbs (the weight of the pilot unit when filled with water).
- Pieces of 2" x 10" or 2" x 12" for jack support.

• Electrical:

Kruger Provides:

- 70-foot, 480 Volt, 150 Amp electrical supply cable.
- The electrical cable is 1/0 AWG mining grade cable.
- The electrical cable connection to the pilot trailer is a quick connect Hubbell plug located on the passenger side of the trailer towards the middle.
- The electrical cable connection for the customer's end is consists of three (3) 3f wires and a ground. The diameter of the cable is 1.72 inches.

Client Provides:

- A 480-volt, 150 Amp service and an electrician who will hard wire the cable to the supply. The client will need to supply any additional cable that is needed to reach the power supply.

• Miscellaneous:

One or two personnel will be needed intermittently on the first two days and the last day to assist with connecting and disconnecting hose.

Kruger has a 400 lb submersible pump, with a 70' power cable and 70' of hose available to supply the raw water to the trailer, which is stored in rear of the trailer and is accessible by the trailer's rear bay doors. Special arrangements must be made to unload the pump and lower it into the water source.



C) Equipment and Services Provided by Kruger

- One ACTIFLO® demonstration unit with equipment and instruments as per Section III.
- At least 1 operator working typical first shift hours and 40 hours per week.
- Unless special arrangements are made in advance, the Kruger operator will need to leave the job site by noon each Friday.
- All polymers (floc. aids)
- Microsand (silica sand)
- A summary of operational results approximately 30 days after the last set of data has been received.

D) Equipment and Services Provided by Client

- Independent laboratories analysis and payment for their services.
- Complete responsibility for, and ownership of all effluents and sludge disposal from the ACTIFLO® pilot unit.
- Utilities: potable water and a 480V, 150 Amp electrical supply.
- Additional Influent Pipe and pump cable if needed.
- Additional Backwash/Emergency Overflow discharge pipe and storage if needed.
- Additional Chemical tank drain pipe if needed.
- Additional Effluent pipe if needed.
- Clean, level and accessible site.
- All chemicals (including coagulants and any pH adjustments) and disposal of excess chemicals.
- Manpower and assistance hooking up and disassembling the pilot unit.
- Operation assistance over the weekends, if necessary.
- A vehicle to move the pilot unit trailer if it is necessary to relocate testing sites during the study.

E) Protocol, Data and Visitation

- Both the client/engineer and Kruger must agree upon pilot study protocol prior to the start of the pilot study.
- Kruger reserves the right to all data collected (including ACTIFLO® running conditions and laboratory samples) by the client/engineer or Kruger. All data shall be shared between the client/engineer and Kruger at the time that the data is collected or available.
- Kruger reserves the right to use any collected data in their marketing program.
- Kruger reserves the right to bring visitors to the pilot unit throughout the course of the pilot study.

IV) RECOMMENDED LABORATORY ANALYSIS

It is recommended that the Client/Engineer perform the following lab analysis on collected grab samples:

Influent Water and Clarified Water:

- Total Phosphorus
- Ortho Phosphorus

Kruger will need a rush turnaround on analytical samples collected during the optimization phase. Please verify detection limits with outside analytical labs to ensure they are in the range for your application.



Agreement for ACTIFLO® Pilot Testing

Client: Waukesha WWTP

Location: Waukesha, WI

Date of Testing: Availability for a 2 week pilot study to be determined.

Cost of Testing: \$7,500 per week (A week being defined as typical first shift hours, forty hours per week, excluding weekends and holidays).

Freight Cost: \$8,000 (Estimated as coming from Cary, NC and going back to Cary, NC). This will be billed as the actual freight cost.

Total Cost: The total cost of a 2-week pilot study (one day to set up & one day to disassemble) with estimated shipping cost will be \$23,000.

Payment Terms: Billing to be at the completion of pilot testing with payment due net thirty (30) days.

Tax Exemption: The Customer agrees to provide the necessary tax exemption certificate for sales tax in advance of a pilot agreement executed by all parties.

Conditions: All of the conditions as stated in the Demo Test Agreement, Pilot Study Specifications and Proposal package (Attachment A, specifically Section IV c-e) and the attached Standard Terms and Conditions (Attachment B) are acceptable to both parties.

Agreed Upon and Accepted By:

I. Kruger Inc.
4001 Weston Parkway
Cary, NC 27513

By: _____

By: _____

Date: _____

Date: _____

P.O. # _____



Pre-Arrival Checklist for the ACTIFLO® Pilot Plant

- ☐ The 480V, 150 Amp electric supply*for each unit is hooked up and an electrician is scheduled to be on site the morning of the trailer's scheduled arrival.
- ☐ A suitable site* is available and prepared for arrival. Trailer jack supports (pieces of 2" x 10" or 2" x 12") are on site and available for use.
- ☐ Equipment is on site to move and lower the submersible pumps*. Personnel to operate the equipment are available.
- ☐ Enough 4" PVC pipe or 4" rigid hose is available to run the waste sludge* to the selected disposal location.
- ☐ 4" influent piping or hose* is on site and prepared to hook up.
- ☐ 6" Effluent piping* is on site and ready to hook up. A suitable effluent disposal location is chosen.
- ☐ Potable service water (garden hose connections) is available.*
- ☐ All chemicals* (except flocculant aid polymer) which will be used should be readily available and delivered to the pilot day tanks.
- ☐ Personnel* are scheduled to be on site to assist with hook up of the pilot plant.

* These items are fully detailed in the technical specification section.

Please sign and return this list to Kruger. The ACTIFLO® pilot plant will be delivered after the receipt of this document.

Engineer _____/_____/_____
 print here sign here date

Client _____/_____/_____
 print here sign here date



ATTACHMENT B TERMS AND CONDITIONS

1. **General.** (a) At all times during the term of this Agreement the Unit shall remain the personal property of KRUGER and shall not, by accession or otherwise, become a fixture or part of the real property at the Facility. At the conclusion of the Demonstration, the CUSTOMER shall permit KRUGER access to the Facility for the time period necessary for KRUGER to remove the Unit. (b) The CUSTOMER shall procure all licenses, permits and approvals necessary to the performance of any Demonstration and shall be responsible for complying with all laws and regulations of governmental authorities and agencies affecting any such Demonstration, including without limitation, rules and regulations concerning safety and environmental matters. Notwithstanding the provisions of paragraph 1 (b) herein, KRUGER shall be responsible for any violation of law, rule or regulation caused by the Unit or KRUGER employees.

2 **Confidentiality; Ownership of Results.** All results, information, data, procedures, formulas, compilations, methods, techniques and processes, whether in writing or otherwise, relating to the Unit or any Demonstration ("Information") shall be received and maintained in confidence by the CUSTOMER, and/or any of its consultants or engineers, and shall not (with the exception of a lawful order of a court of competent jurisdiction or as required to be disclosed by CUSTOMER to any governmental agency in connection with its efforts to obtain any permits, licenses or approvals) be disclosed, directly or indirectly, by any such recipient, except to those of their employees who need to receive such information to enable the CUSTOMER to evaluate the results of any Demonstration. The CUSTOMER shall not, nor shall it permit its consultants or engineers to use or permit the use of any of such Information for any purpose other than to evaluate the results of and Demonstration. All Information, including results, data, discoveries, inventions, and improvements, whether or not patentable or copyrightable, any and all expressions of computer programs, manuals, data bases and all forms of computer hardware, firmware and software, conceived, made, first reduced to practice, or developed by either party arising out of the conduct of any Demonstration shall be the sole and exclusive intellectual property of KRUGER with respect to any and all countries, their territories and possessions.

3. **Warranty.** Kruger warrants the unit is free from defects in workmanship and materials. If CUSTOMER gives Kruger prompt written notice of breach of this warranty within 2 months from delivery (the "warranty period"), Kruger shall, at its sole option and as customer's sole remedy, repair or replace the subject parts or refund the rental price therefore. Kruger's warranty is conditioned on CUSTOMER's (a) operating and maintaining the unit in accordance with Kruger's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Kruger. Kruger's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Kruger). Other than the warranties contained herein, no warranties, including but not limited to, warranties regarding performance or warranties of merchantability or fitness for a particular purpose, have been given or shall be implied herein regarding the unit, the information, any demonstration or the results of any demonstration.

4. **Indemnification.** KRUGER shall indemnify, defend and hold harmless CUSTOMER from and against any and all claims, demands, actions and causes of action, including without limitation, claims on account of personal injury, including death, or damage to or loss of tangible property of third parties to the extent caused by the negligent or other wrongful acts or omissions of KRUGER. CUSTOMER shall indemnify, defend and hold harmless KRUGER from and against any and all claims, demands, actions and causes of action, including without limitation, claims on account of personal injury, including death, or damage to or loss of tangible property of third parties to the extent caused by the negligent or other wrongful acts or omissions of CUSTOMER.

5. **Limitation of Liability.**

(a) Except for the obligation of Kruger and CUSTOMER to indemnify each other for any personal injury or third party property damage claims pursuant to paragraph 4, the aggregate liability of either party, including without limitation for or with respect to their affiliates and employees, arising out of or in connection with the Agreement, any Demonstration or the Unit, including without limitation liability based upon or arising from indemnification or contribution, breach of contract or warranty, strict liability, negligence or other tort, or any other legal or equitable theory, shall not exceed the greater of (i) the amount paid by the CUSTOMER to KRUGER for the Demonstration; or (ii) \$50,000.

(b) Notwithstanding anything to the contrary herein, in no event shall either party be liable to the other for consequential, incidental, indirect, special, exemplary or punitive damages of any kind, or for loss of profits, revenues or product, or loss of use of any property (whether by shutdown, operation at less than capacity or otherwise), regardless of whether any of the foregoing damages are based directly or indirectly upon indemnification or contribution, breach of contract, strict liability, negligence or other tort, or any other legal theory or equitable claim.

6. **General Provisions.** The Agreement, together with the Attachments thereto, represents the entire agreement between the parties with respect to the subject matter thereof, and supersedes all prior negotiations, purchase orders, representations or agreements, whether written or oral. The Agreement and these terms and conditions may not be amended except by mutual written agreement of KRUGER and the Customer. No course of performance or failure to strictly enforce any term shall be construed as a waiver thereof. Waiver of any term shall not constitute a waiver of any other term or a continuing waiver. The Agreement, including its Attachments, shall be binding on the parties' respective successors and assigns; provided that the CUSTOMER may not assign, delegate or permit any other transfer thereof without KRUGER'S prior written consent. The Agreement and its Attachments shall be governed by and construed in accordance with the laws of the State of North Carolina, without regard to its conflict of laws provisions.



Attachment C - Sampling and Analytical Protocol for Tertiary P Removal Pilot Study Evaluations

Purpose: Ensure proper sampling technique and choice of laboratory analytical method

Sampling	<ul style="list-style-type: none"> ▪ If P concentrations are expected to be ≤ 0.1 mg P/L (in any form) sample bottles must be glass (no preservative). If plastic bottles are used, there is a possibility of adsorption of P onto plastic surface causing a false low in the results. Request acid rinsed glassware sample bottles. ▪ If P concentrations are expected to be > 0.1 mg P/L (in any form) plastic sample bottles are considered acceptable. ▪ Do not use separate sample bottles for TP, dissolved P, ortho-P (if multiple bottles are used (when very low P concentrations are present, these bottles, in effect, can be considered multiple samples ▪ If only TP is to be measured, the sample can be preserved with 1 mL of HCl/L
Sample storage	Store immediately in cooler at 4 °C
MDL	If P concentrations are expected to be ≤ 0.1 mg P/L (in any form) MDL should be at least as low as 0.005 mg/L
PQL	For samples expected to be ≥ 0.01 mgP/L, the lab PQL should be equal to or less than 0.01 mgP/L. Any data reported below the laboratory PQL must be qualified
Interferences	<ul style="list-style-type: none"> ▪ Iron, the presence of iron can affect the results due to consumption of reducing agent (note: if SM4500PF is used, the interference from iron of up to 50 mgFe³⁺/L can be tolerated) ▪ Nitrite ▪ Turbidity ▪ Color
Sample preservative	Sample bottles must not contain acid preservative if P forms are to be measured. Acid preserved bottles are acceptable if only TP is to be measured (this is not typically the case in most pilot studies)
Analytical Method	<ul style="list-style-type: none"> ▪ If P concentrations are expected to be ≤ 0.1 mg P/L (in any form) the Method of choice is <u>Standard Methods SM4500P E or F</u>, which is the <u>Ascorbic Acid Reduction Method</u>. In this test O-P reacts with the molybdate reagent forming phosphomolybdic acid; ascorbic acid is added as the reducing agent forming a blue color. ▪ If P concentrations are expected to be > 0.1 mg P/L either <u>Standard Methods SM4500P E or F</u> or <u>EPA Method 365.3</u> are acceptable



Glossary:

Reactive Phosphorus: phosphates (mostly ortho-P) that respond to colorimetric tests without preliminary acid hydrolysis (or oxidative digestion) of the sample. Can occur in both dissolved and suspended forms.

Ortho-Phosphorus (O-P): inorganic PO₄

Total Phosphorus (TP): the sum of all P components (soluble reactive P + soluble organic P + particulate P).

Method Blank: pure lab water to which all digestion chemicals are added and then digested. Measurement should be below detection limit result for the analyte.

Spiked Recovery: adding a known concentration aliquot (the spike) to the sample (sample matrix in this case = water sample) and measuring the result. Measuring recovery of the spike determines method efficiency. Spike recovery is measured in percent and calculated (concentration measured in spiked sample/concentration spiked into sample prior to analysis) x 100.

Interferences: Analytes within the sample matrix that affect the measurement of desired analyte. The purpose of doing matrix spikes is to reveal interference because of matrix effects. If the results of analysis of a standard in a given batch are within the limits on a control chart, analytical bias and precision are in control. If the matrix spike in that same batch comes out way below the desired recovery (e.g. 50%), it means only one thing ... the matrix has interfered with the analysis.

IDL (Instrument Detection Limit) is the lowest limit that the instrument can detect. It is determined on samples which have not gone through any sample preparation steps.

MDL (Method Detection Limit) is similar to an IDL, but is based on samples which have gone through the entire sample preparation scheme prior to analysis. EPA defines the method detection limit as, "the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte." It is, in effect, a calculated value based on statistical analysis of sample runs (see Attachment A). In general, all MDLs are defined in terms of a multiple of the *standard deviation* of measurements on blank specimens or on specimens that have been spiked with very low concentrations of the analyte of interest.

PQL (Practical Quantitation Limit) The lowest measured value that can be quantified within specified limits of precision and accuracy. Normally 3 to 10 times the MDL and is considered the lowest concentration that can be accurately measured, as opposed to just detected. This is always greater than the detection limit. Ask the laboratory to disclose their relative standard deviation or long term precision on lab check standards. The PQL is often 5 x MDL.

DLs are actually determined by analysis of replicate low-level samples or blanks. This information gives the variation in instrument response at levels near the detection limit, from which 99% confidence limits are calculated from the standard deviation.

Precision: Precision refers to the reproducibility of replicate results about a mean which is not necessarily the true value. Replicate analysis is the primary means of evaluating data variability or precision.



Coefficient of Variation (CV): The coefficient of variation is used most often when the size of the standard deviation (s) changes with the magnitude of the mean. Coefficient of variation (CV), also called relative standard deviation (RSD), is defined:

$$CV = RSD = (s / \bar{y}) \times 100\%$$

- \bar{y} = mean of replicate analyses
- s = sample standard deviation
- y_i = measured value of the i th replicate
- \bar{y} = mean of replicate analyses
- n = number of replicates

Sample standard deviation and coefficient of variation are used when there are at least three replicate measurements.

