PeCOD® COD Analysis

COD Results in 15 Minutes

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Introduction

- COD and BOD
- Standard Method (Dichromate)
- New PeCOD® COD Method (Photo-Electrochemistry)
- Comparison of COD Methods
- PeCOD Applications
- Conclusion

About MANTECH

- Manufacturer of laboratory instrumentation solutions:
  - Automated multi-parameter
  - Titration
  - Biochemical Oxygen Demand (BOD)
  - Chemical Oxygen Demand (COD)

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COD and BOD

- Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are **ubiquitous measurements of overall water quality.**
- Among the most diagnostic parameters for the determination of water quality in natural waterways and waste streams.
- COD measures the equivalent amount of oxygen required to chemically oxidize the organic compounds in water
- BOD measures the equivalent amount of oxygen required to biologically (microbes) oxidize the organic compounds in water

COD and BOD

- The standard BOD test requires five days to complete - unable to provide continuous monitoring of organic load.
- COD is often used for BOD screening.
- Both involve a 2 step process:

  Step 1 - Oxidation of organic matter

  Step 2 - Measurement of extent of oxidation

Standard COD Method (Dichromate)

- Uses hazardous chemicals (dichromate, concentrated acid, mercury) to oxidize organic carbon in water into CO_2 and H_2O.
- Samples are digested at 150°C, 2-3 hour process with cooling time
- The oxygen demand is determined by the amount of oxidant consumed, using a spectrophotometer or titration method.
- Overall measurement uncertainty, ≈ ±20-30 %

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PeCOD® COD Analysis

- PeCOD is a new technology which measures soluble COD in various water samples.
- Directly measures photocurrent/charge originating from the oxidization of the organic contamination in a test sample.
- A UV-activated nanoparticle TiO2 (titanium dioxide) photocatalyst coupled to an external circuit.
- High Oxidation Potential (3.2eV) vs (1.6eV) for Dichromate

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PeCOD® COD Analysis

Overcomes many of the problems encountered by existing COD analysis methods

- Fastest available method – results in only 15 minutes
- Does not use dichromate or other hazardous reagents
- Can be used by all operations staff
- Excellent BOD screening tool

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- “The new approach for measuring chemical oxygen demand by photo-electrochemical measurement eliminates the use of corrosive (H_2SO_4), carcinogenic ($K_2Cr_2O_7$), toxic (HgSO4) and irritant (Ag_2SO_4) chemicals for the analysis of chemical oxygen demand.
- Analysis time was significantly reduced and the method detection limit was 1 mg/L O_2.”

  Vasile Furdui, Ph.D. Research Scientist, Ministry of the Environment and Climate Change.

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Simplified Analysis Approach

Easy to use, “click and go” interface menu for all operations – analysis, calibration, flushing.

Small unit footprint requires minimal bench space (235 x 375 mm) and is light weight (5 kg).

Enhanced software package enables additional functionality, parameter sampling and reporting.

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Nanotechnology based approach

- Patented sensor consists of a UV-activated TiO2 (titanium dioxide) photocatalyst
- Powerful oxidizing potential of TiO2 gives a true measure of COD
- COD analysis method of Ontario Ministry of Environment (method E3515)
- COD analysis can now be done by any operations staff member

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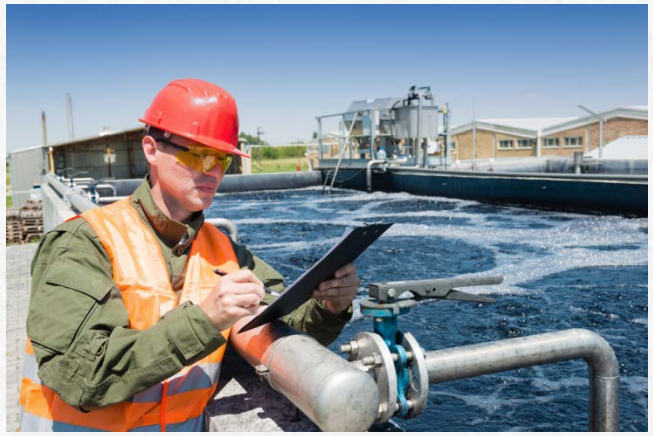
PeCOD® Applications



Municipal

- Incoming COD monitoring
- In-plant COD monitoring
- Wet weather events
- Discharge compliance
- Potable water analysis

Industrial

- In-plant COD monitoring
- Process optimization
- Discharge compliance
- Fine avoidance

Laboratory

- COD analysis
- Multi-parameter
- Speed and accuracy
- Safety of employees

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- “We moved from the COD vials to the PeCOD® primarily because it allowed us to run our process more efficiently and further adjustments to our process could be made up to ten times a day. With the COD vials, only 3 or 4 adjustments could be made. This increase in efficiency, not to mention the added benefit that we're no longer using carcinogenic chemicals to test for COD.
- We have also seen a reduction in cost of consumables and waste disposal.”

  Mark Westhorpe, Analytical Shift Leader, Vertellus Specialty Materials based in the United Kingdom.

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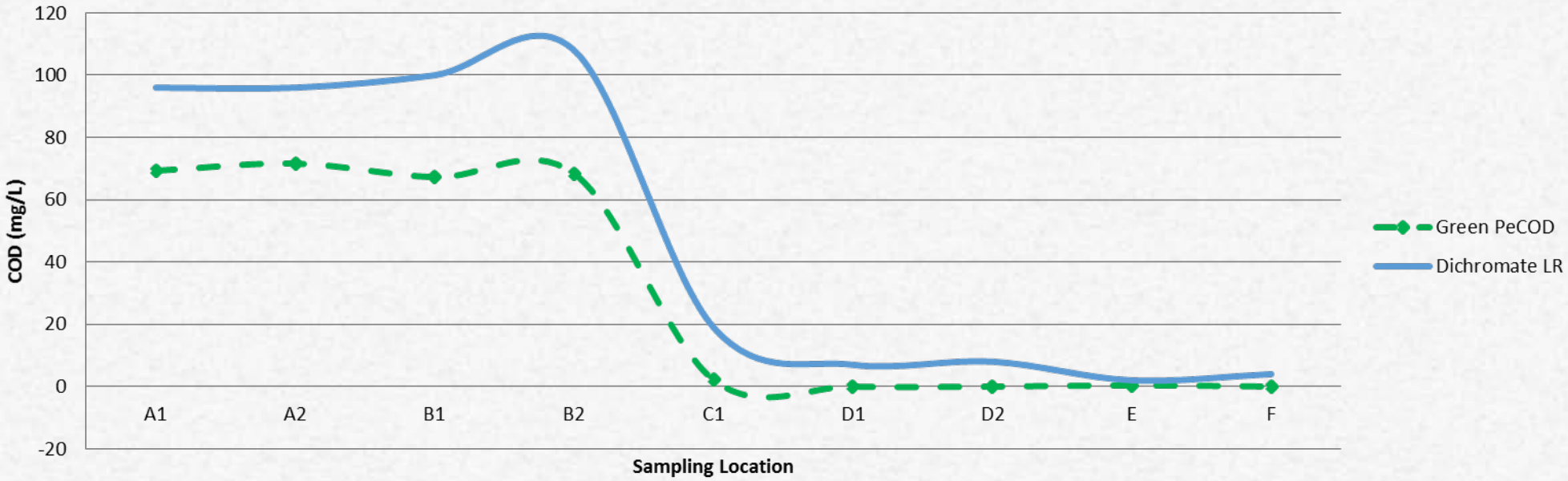
City of Guelph WWTP



Plot of PeCOD COD (green range) and dichromate COD (low range vials) for various filtered waste water samples from various sampling locations (round 2 of testing).

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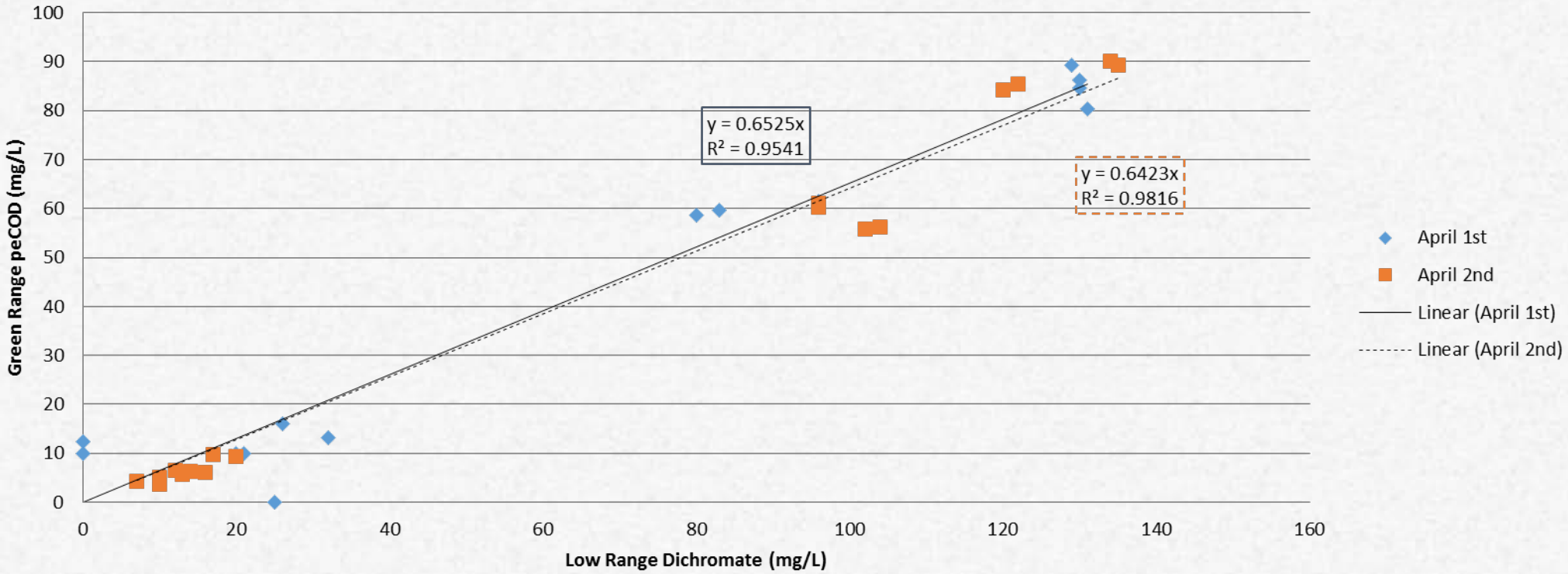
Strong Correlation for Waste Water



Scatter plot of PeCOD COD (green range) and dichromate COD (low range vials) for various filtered waste water samples.

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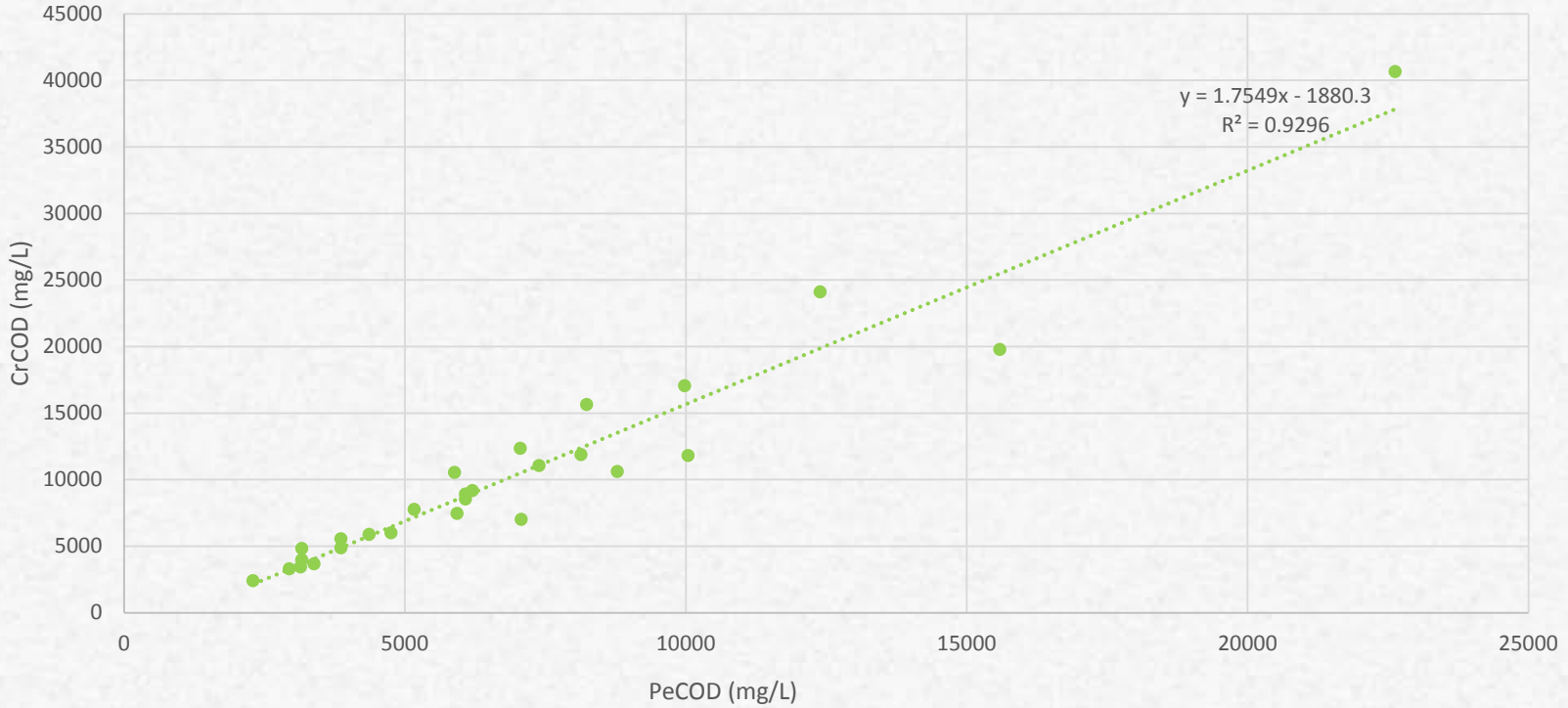
Strong Correlation for Waste Water



Scatter plot of PeCOD COD (red range) and dichromate COD for treated effluent samples analyzed by Clean Harbors (waste treatment facility)

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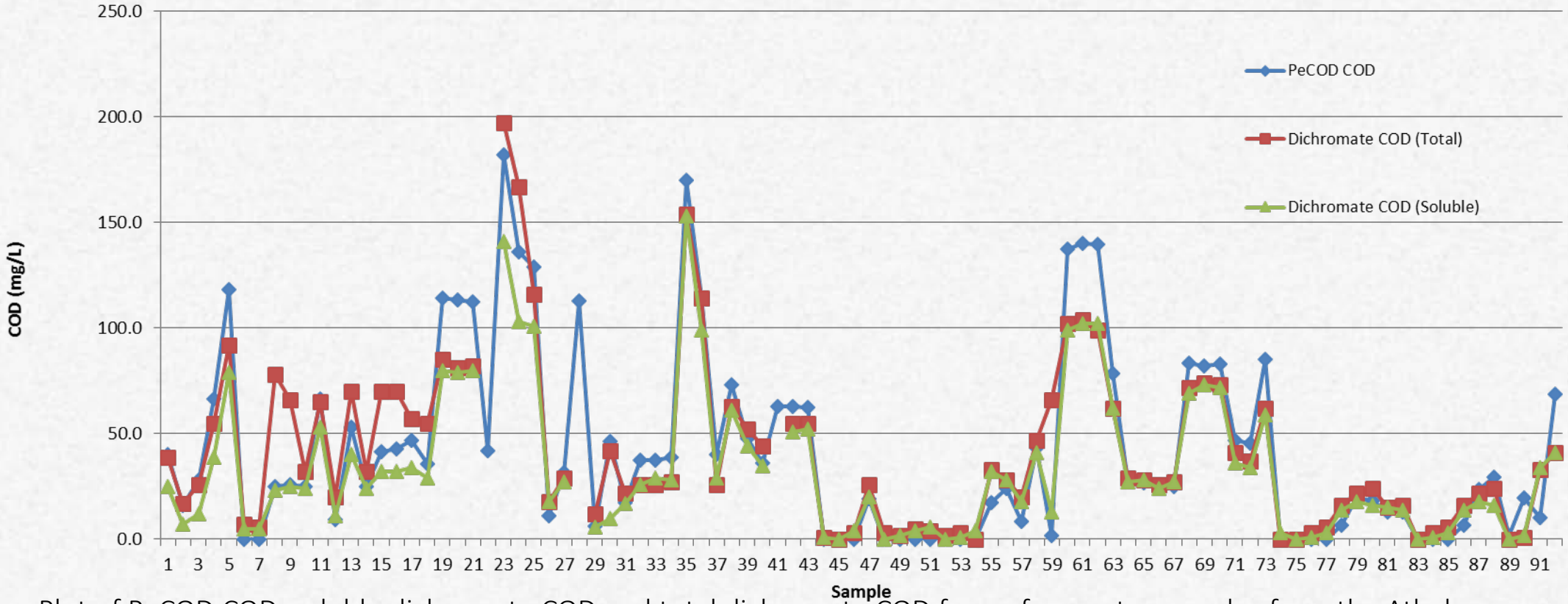
Effective Surface Water Monitoring



Plot of PeCOD COD, soluble dichromate COD and total dichromate COD for surface water samples from the Athabasca watershed in Alberta, Canada.

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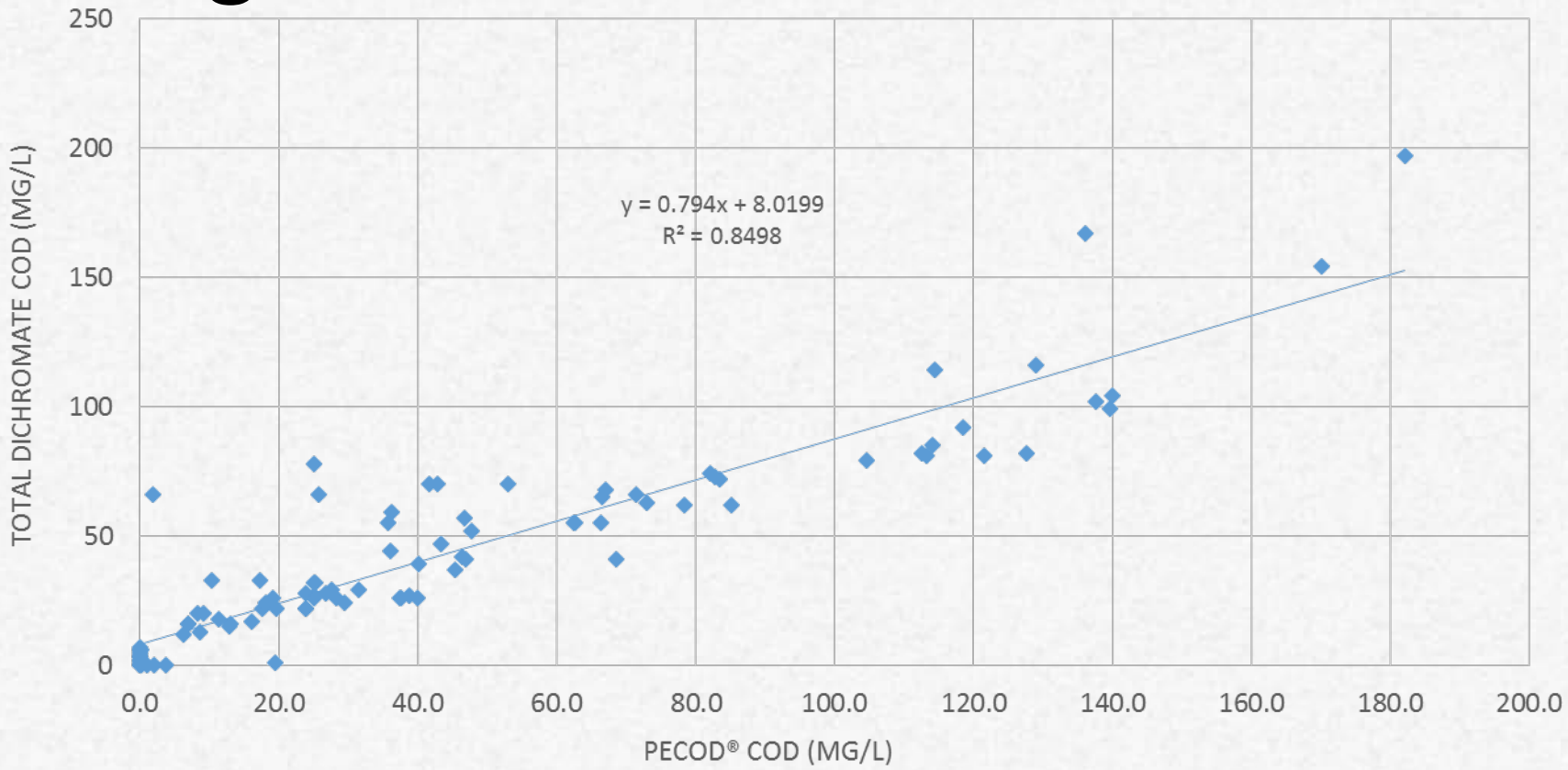
Strong Correlation for Surface Water



Scatter plot of PeCOD COD against total dichromate COD for surface water samples from the Athabasca watershed in Alberta, Canada.

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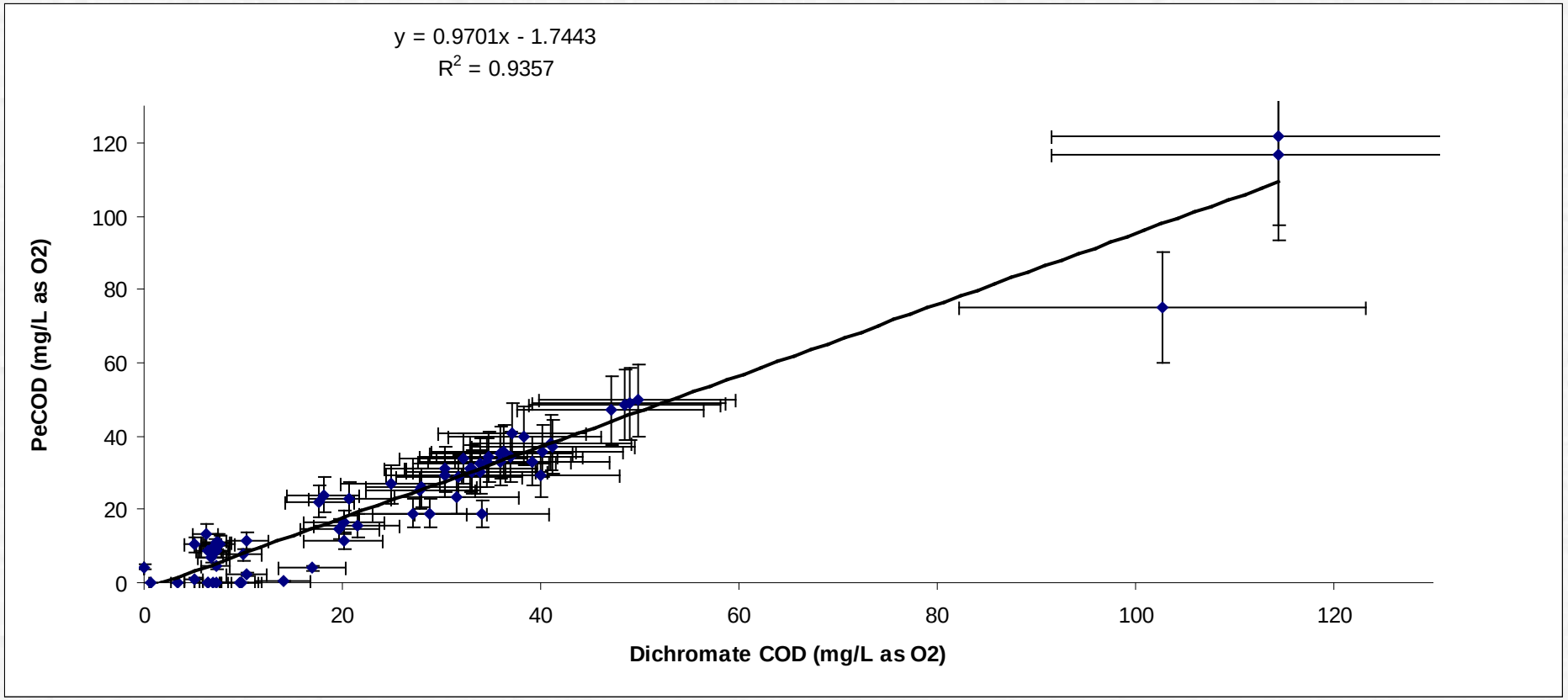
Strong Correlation for Surface Water



Scatter plot of PeCOD COD (green range) and dichromate COD for 68 surface water samples analyzed by the MOE

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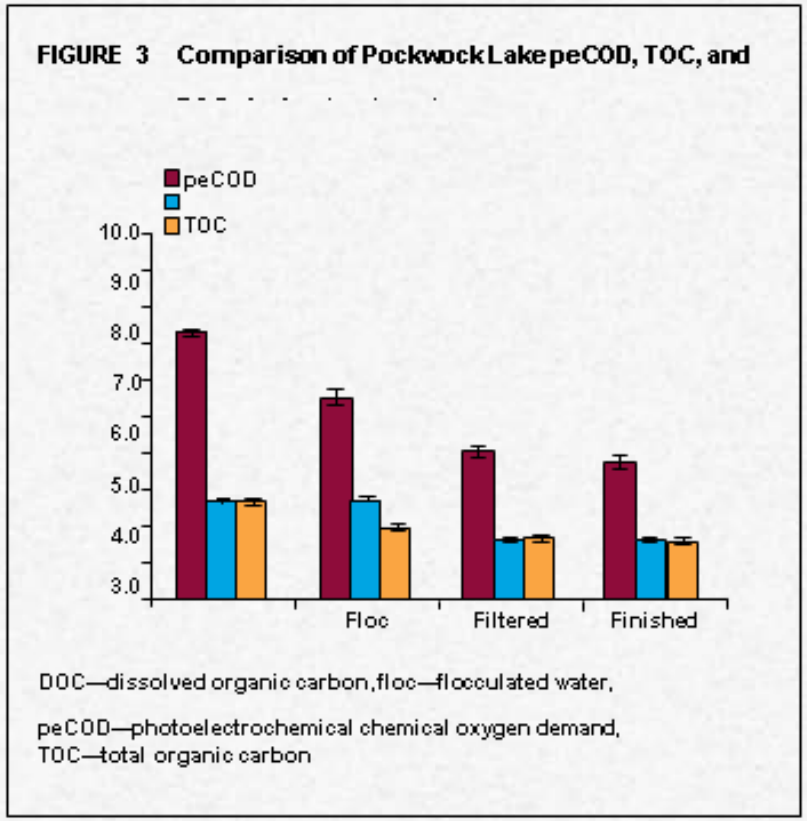
More Effective Potable Water Analysis

- Dalhousie University study
- With PeCOD® analysis, removal of NOM is approximately 3.5x greater vs use of traditional surrogates such as TOC and DOC
- PeCOD® has expanded resolution, even when NOM removal is small
- Significant advantage of a rapid response time for analysis results
- Ideal for processes such as biofiltration and advanced oxidation that require more understanding of NOM removal



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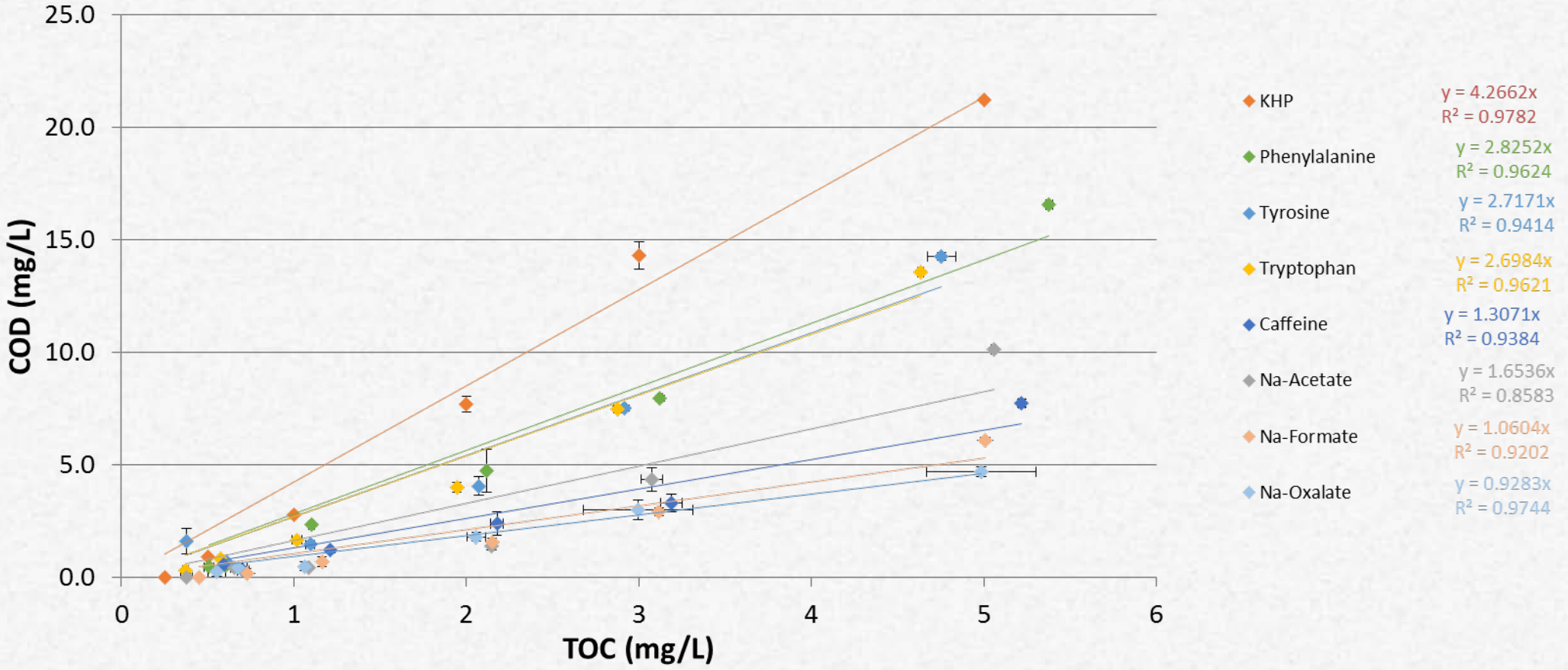
Strong Correlation for Potable Waters



Scatter plot of PeCOD COD (blue range) and TOC for various reference compounds analyzed by Dalhousie University

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Conclusion

- Overcomes the weaknesses of traditional COD analysis
  - Results in only 15 minutes
  - No use of dichromate or harmful reagents
  - Easy to use system for all operations staff
- Nanotechnology provides more accurate measure of COD
- Excellent screening tool for BOD and high potential for NOM
- Recognized and used by the Ontario Ministry of Environment

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