Vertex Environmental Inc.

Optimizing Groundwater Treatment for Complex Construction Sites: 2 Case Studies

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Agenda

- Introduction
- What are the challenges with groundwater treatment at construction sites?
- Why bench scale testing?
- Case Study #1: Metals Pre-Treatment for STM discharge
- Case Study #2: Metals Pre-Treatment for SANI discharge

Introduction

- **Vertex Environmental Inc.**
  - Specialty Remediation Contractor
- **Nathan Lichti, B.A.Sc., P.Eng.**
  - Environmental Engineer
  - University of Waterloo
- **Mahshid Jannati, M.A.Sc., EIT.**
  - Masters in Wastewater Treatment
  - McMaster University

What are the challenges with Groundwater Treatment at Construction Sites?

1) Municipal Requirements
2) Contaminants & Heavy Metals
3) Site Constraints

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Discharge Options

3 Types of Discharge (based on end receiver):

Sanitary Sewer Discharge

Sewer Discharge Permit from Municipality (usually upper tier)
Timeline: 1-6 months

Storm Sewer Discharge

Sewer Discharge Permit from Municipality (usually lower tier)
Timeline: 1-6 months

Natural Environment Discharge

Environmental Compliance Approval (ECA) and/or Environmental Sector Registry (EASR) from Province
Timeline: 2-4 weeks

Toronto Timeline

Groundwater generally going to Storm Sewers – no testing or cost

Groundwater shifted from STM to SANI – with testing & cost

Groundwater shifting back towards STM / Watertight – with treatment

Watertight

2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
$0/m³			$1.97/m³	$2.07/m³	$2.17/m³	$2.25/m³	$2.32/m³	$2.36/m³	$2.43/m³	$2.50/m³

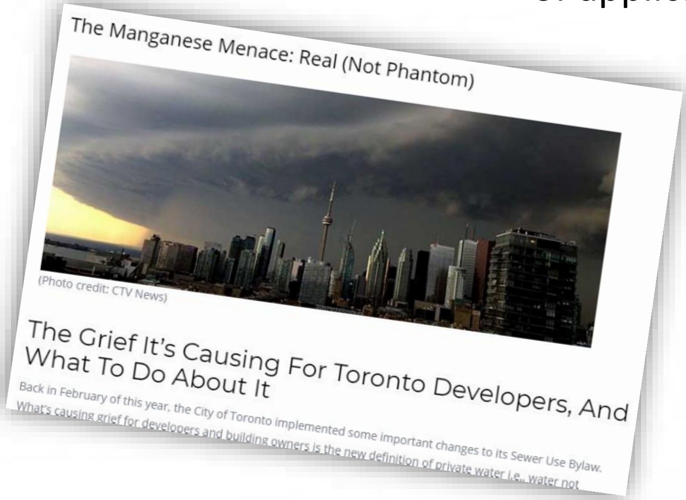
TW Studying issue of Construction Water into storm sewers and combined sewers

TW Recommends that New Constructions Divert Water from Storm

Vertex Manganese Menace Newsletter

TW requires all SANI applicants to evaluate Watertight/STM as part of application

By-Law Amendment passed that defines Groundwater & Stormwater as "Private Water" that needs to be metered/sampled under SDA


The Manganese Menace: Real (Not Phantom)

(Photo credit: CTV News)

The Grief It's Causing For Toronto Developers, And What To Do About It

Back in February of this year, the City of Toronto implemented some important changes to its Sewer Use Bylaw. What's causing grief for developers and building owners is the new definition of private water i.e., water not

Foundation Drainage rule prohibits long-term discharge of "Private Water" to sewer system under most circumstances

STM = Storm Sewer
SANI = Sanitary Sewer
TW = Toronto Water

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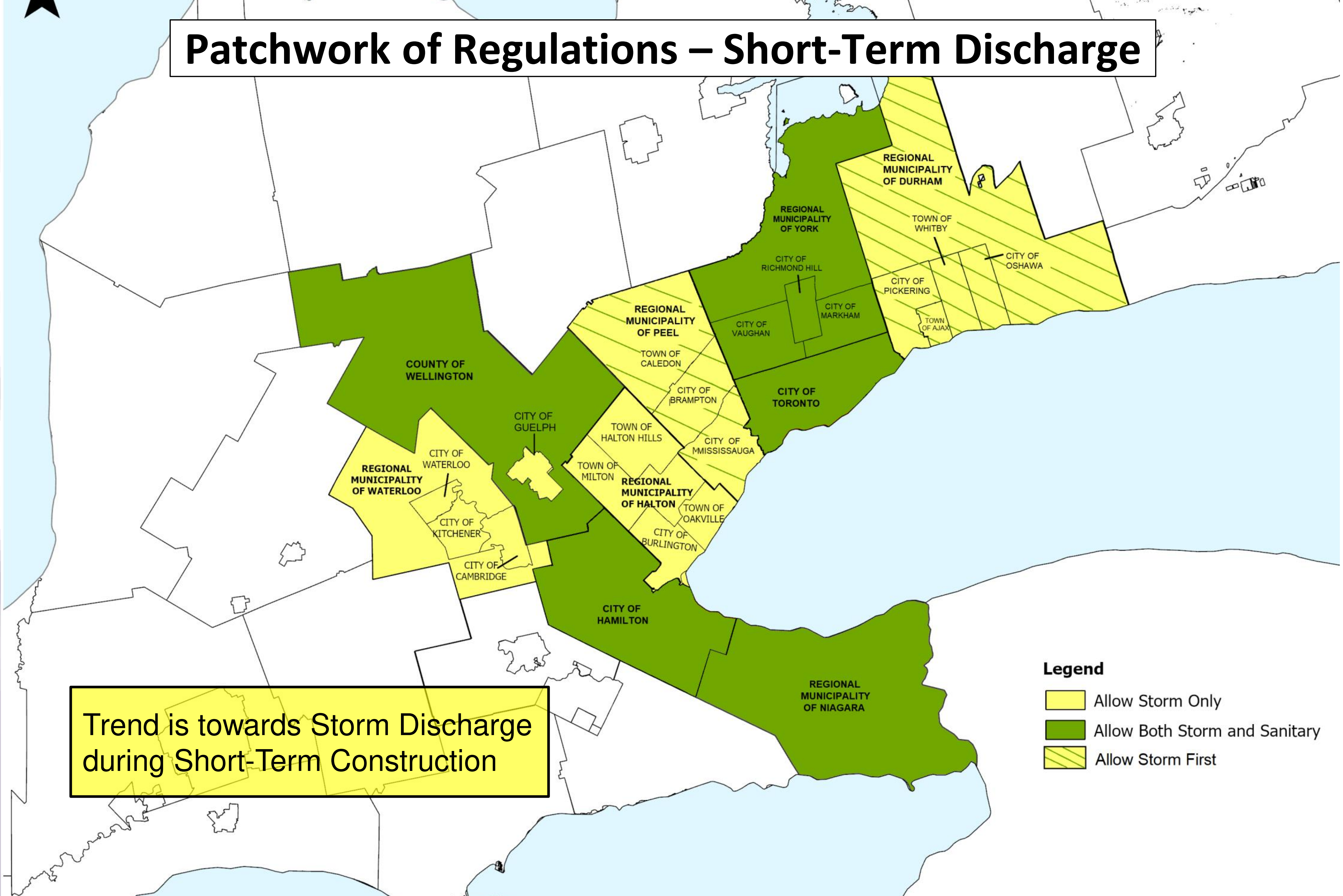
Patchwork of Regulations – Short-Term Discharge



Trend is towards Storm Discharge during Short-Term Construction

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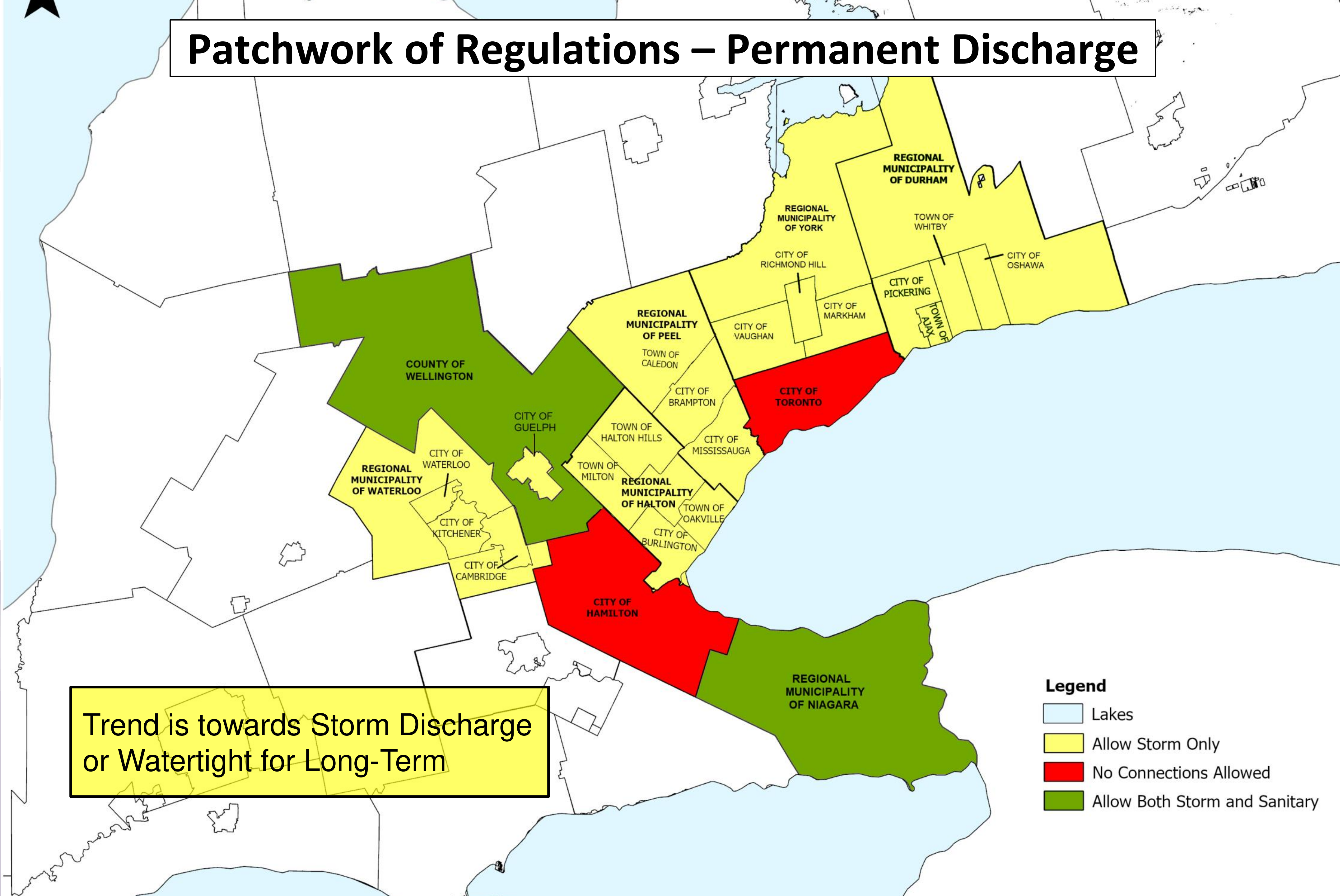
Patchwork of Regulations – Permanent Discharge



Trend is towards Storm Discharge or Watertight for Long-Term

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What are the challenges with Groundwater Treatment at Construction Sites?

1) Municipal Requirements
2) Contaminants & Heavy Metals
3) Site Constraints

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Typical Contamination?

Naturally Occurring Contamination

Suspended Solids

Naturally Occurring Metals

Contamination is Relative

Manganese (Mn) Standards:

In-Place Under Building

Mn Std = No Standard

SANI Sewer to Treatment Plant

Mn Std = 5,000 ug/L

Storm Sewer to River

Mn Std = 50 ug/L

Drinking Water

Mn Std = 50 ug/L

Note: SANI & STM standards based on Toronto Sewer Use By-Law 861.
Drinking Water based on Ontario Drinking Water Quality Standards.
No MECP Table 3 standard for Manganese left In-Place Under Building.

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How Extensive is the Problem?

- Compiled results from 43 construction sites in Toronto
- Based on Hydrogeological Reports (prepared by 13 different consultants)
- Top 5 naturally occurring contaminants below:

Parameter	Average Conc	SANI Std	% Sites > SANI	STM Std	% Sites > STM
TSS	2,657 mg/L	350 mg/L	26%	15 mg/L	81%
Total Manganese	1,573 ug/L	5,000 ug/L	7%	50 ug/L	93%
Total Zinc	155 ug/L	2,000 ug/L	0%	40 ug/L	35%
Total Phosphorus	1,835 ug/L	10,000 ug/L	5%	400 ug/L	30%
Total Copper	49 ug/L	2,000 ug/L	0%	40 ug/L	23%

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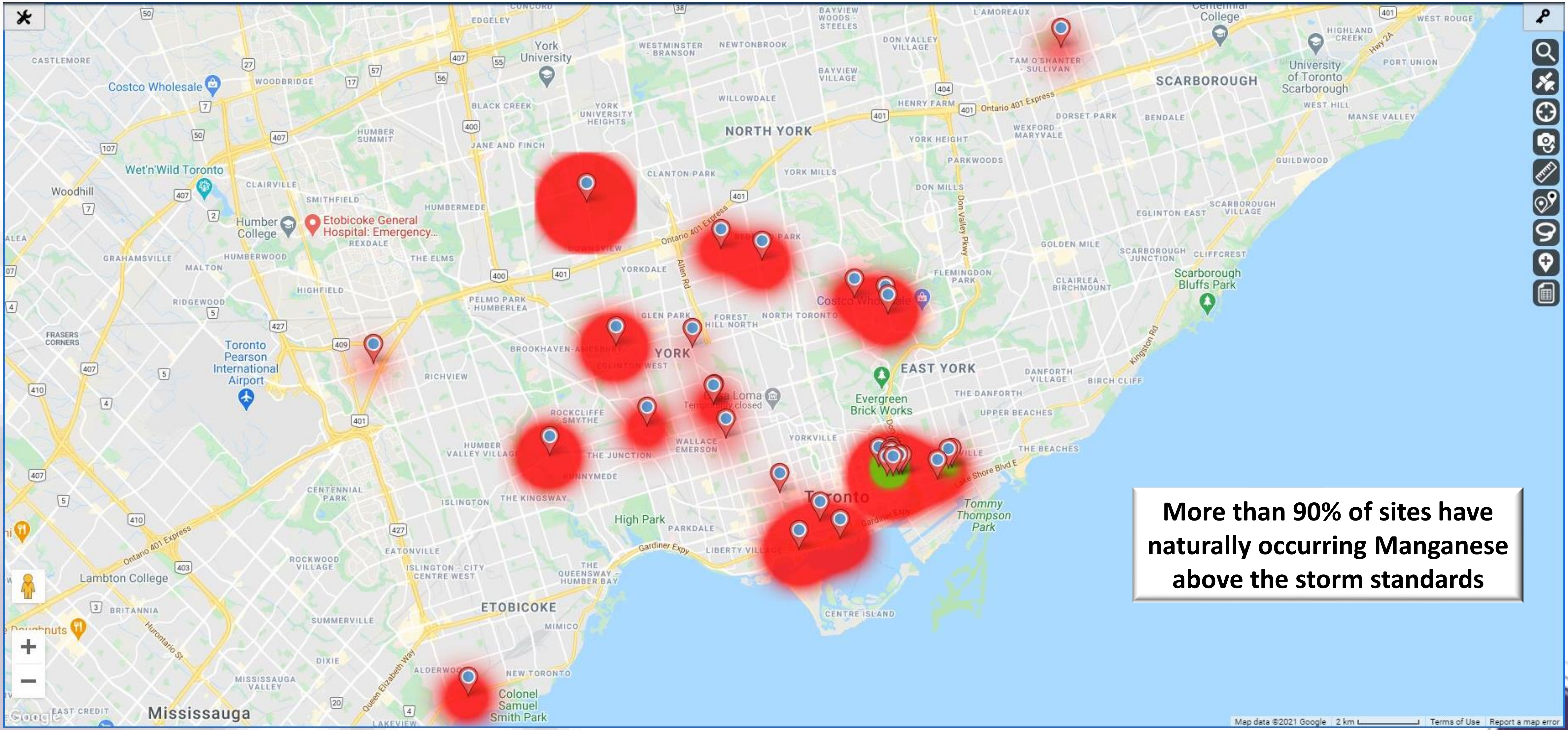
Manganese Storm Exceedances



More than 90% of sites have naturally occurring Manganese above the storm standards

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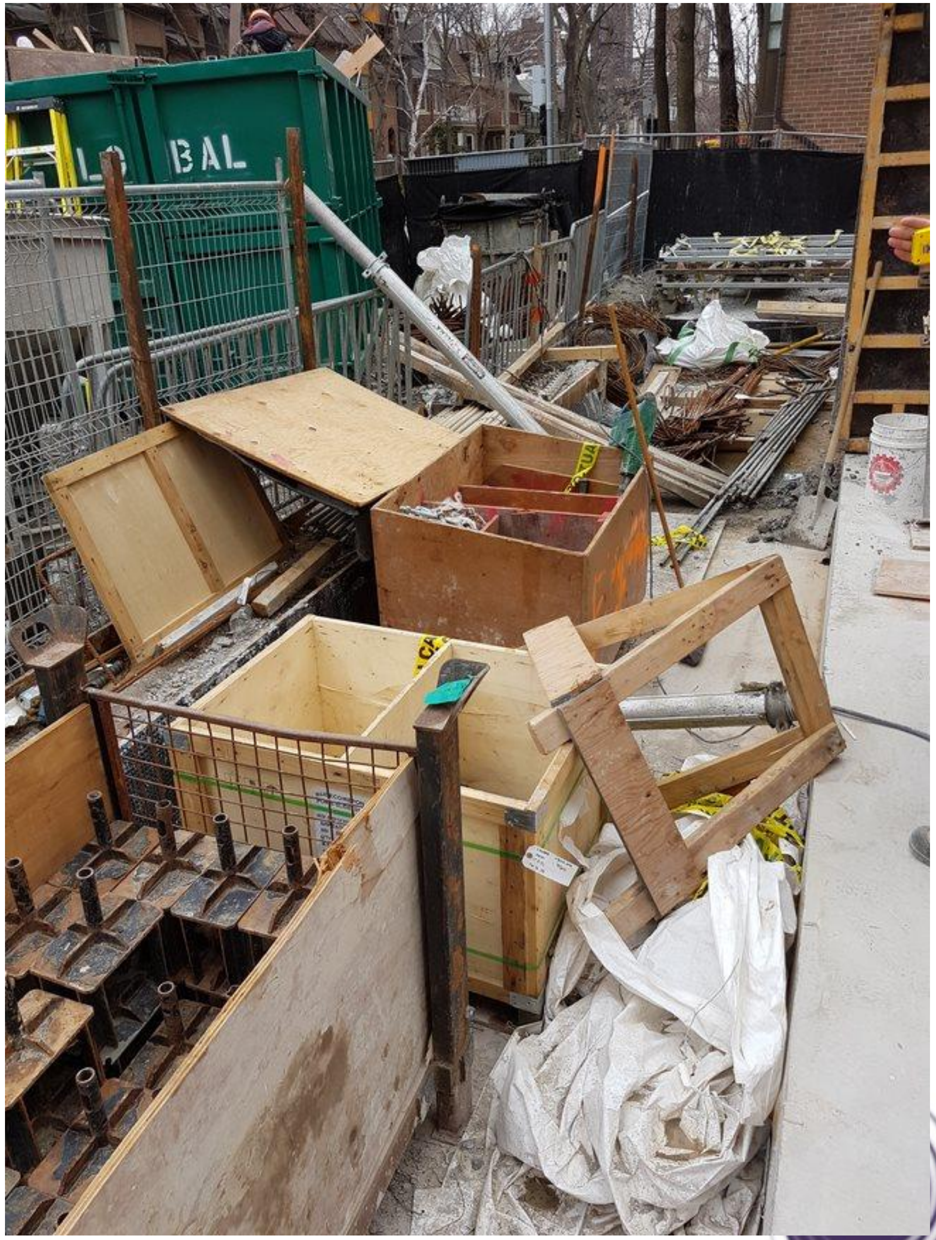
What are the challenges with Groundwater Treatment at Construction Sites?

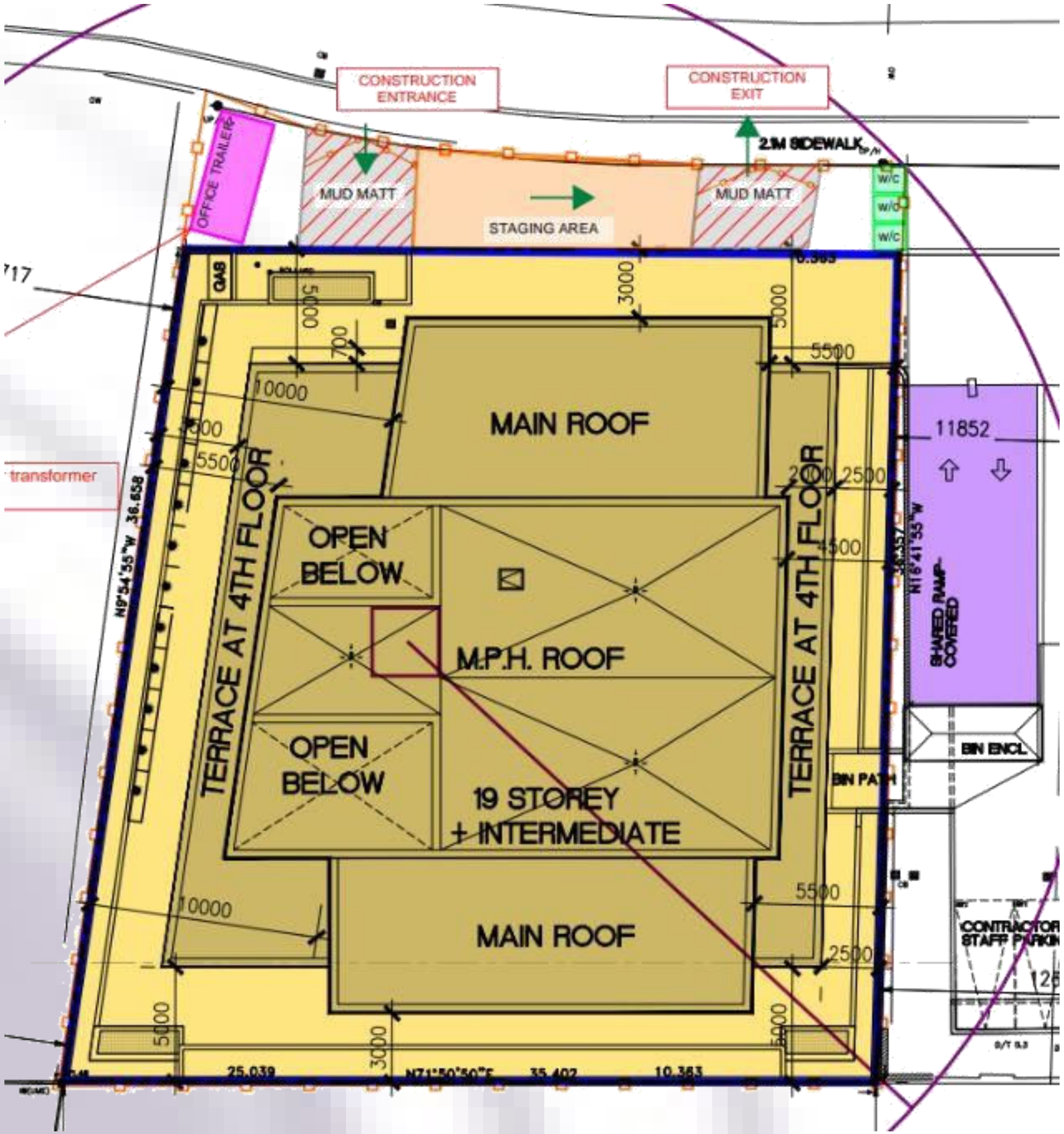
1) Municipal Requirements
2) Contaminants & Heavy Metals
3) Site Constraints

Space – typical brownfield site

Space – typical construction site

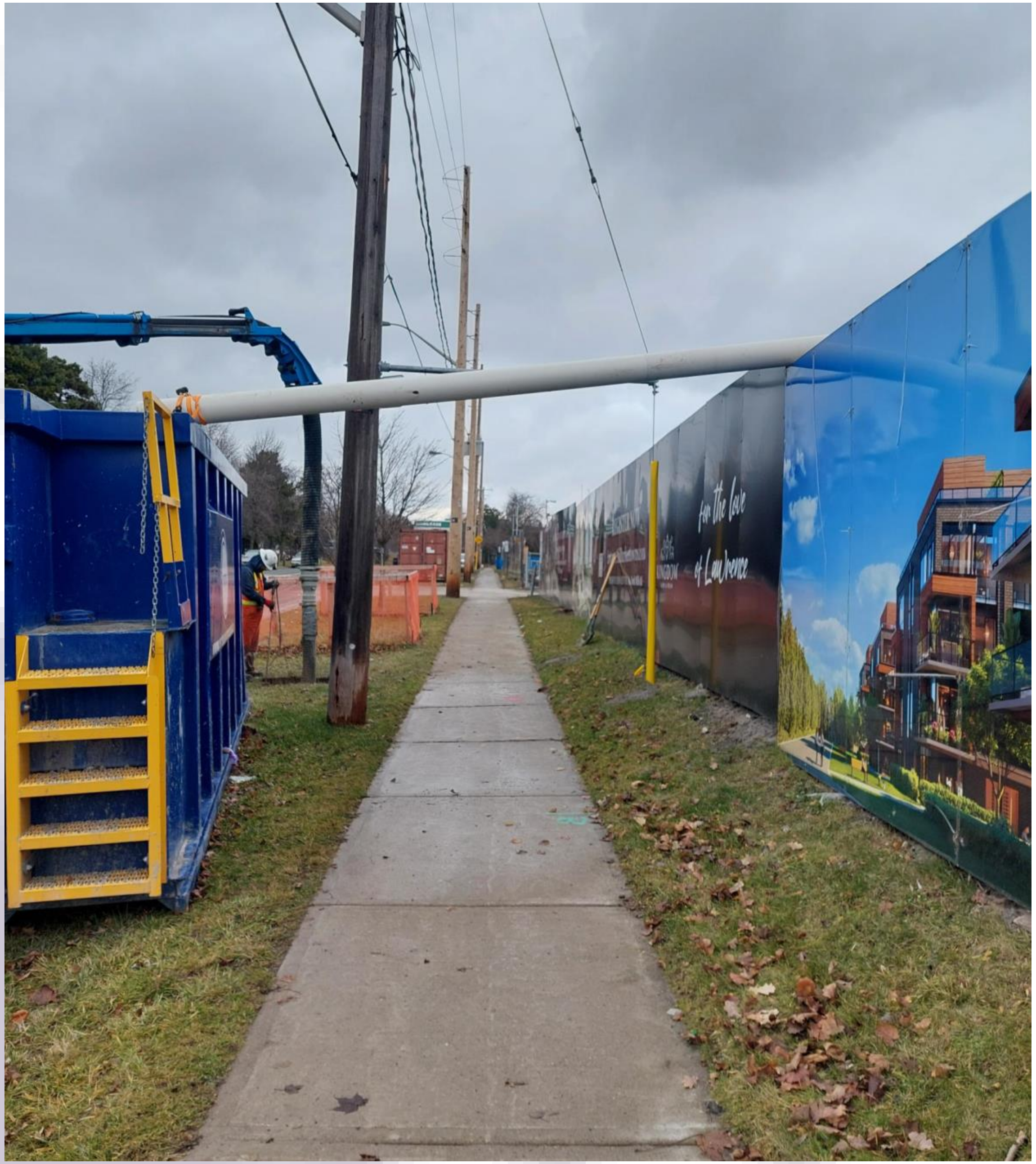


Space



- Property-boundary-to-property-boundary construction typical
- CM plans prepared before dewatering & water treatment contract tendered
- Need flexibility for install/operation

Space



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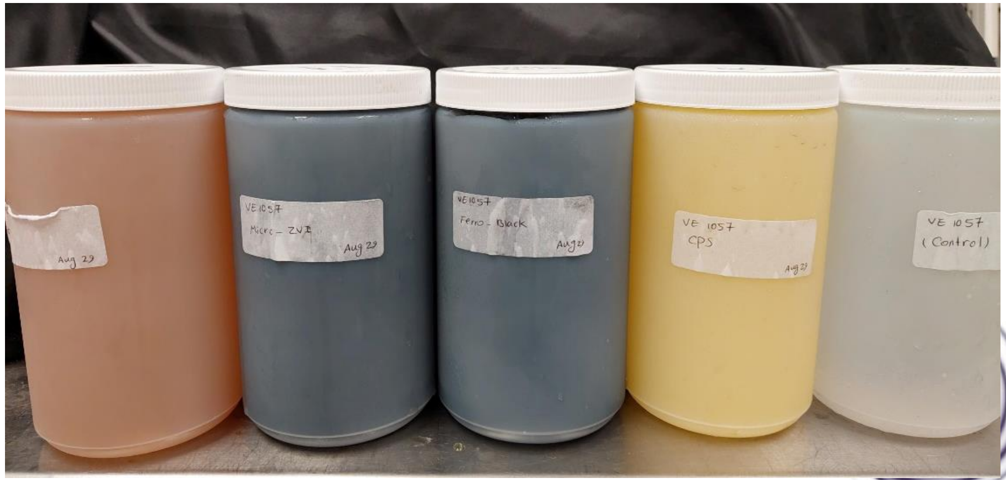
DANGER


Mastercraft

Why Bench Scale Testing?!

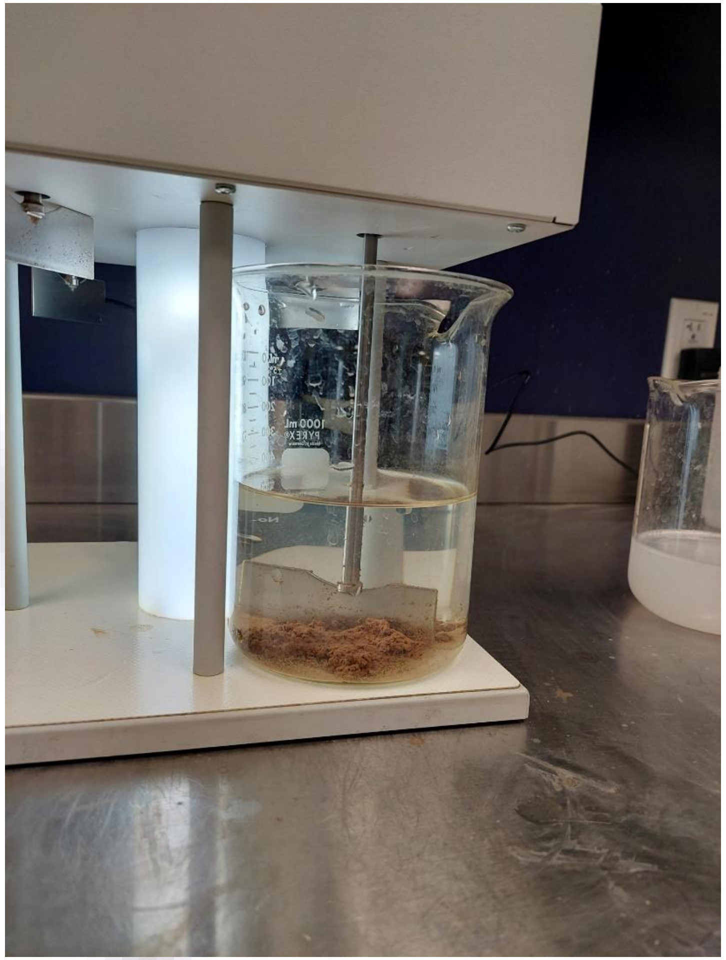
Why Bench Scale Testing?

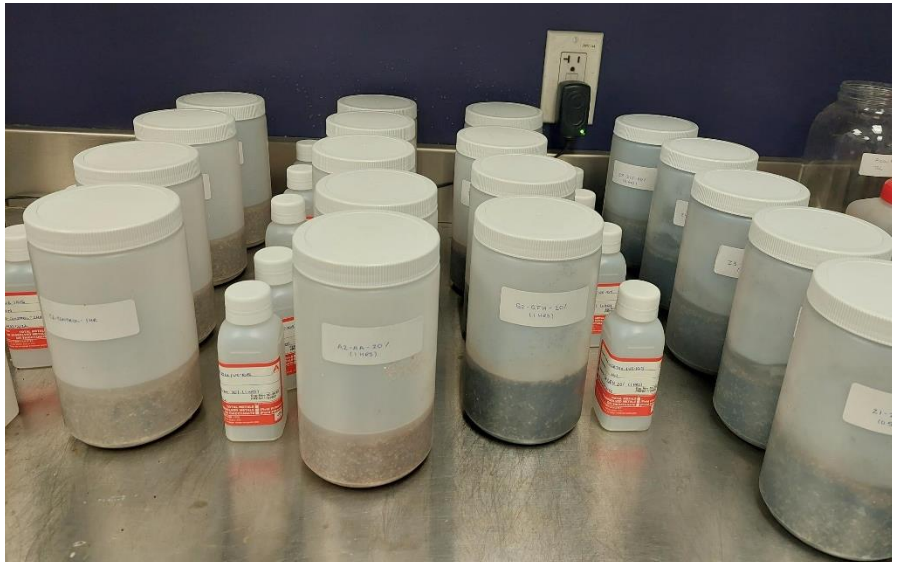
- Multiple Contaminants → Treatment Train
- Multiple Options → Optimize for Site-specific constraints

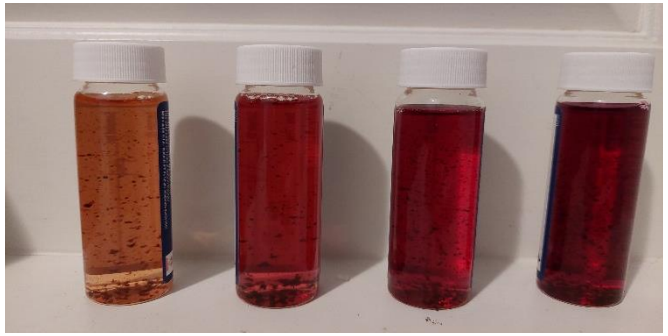


Why Bench Scale Testing?

- Used to refine full-scale treatment approaches
- Small-scale, multi-variable, low-cost testing







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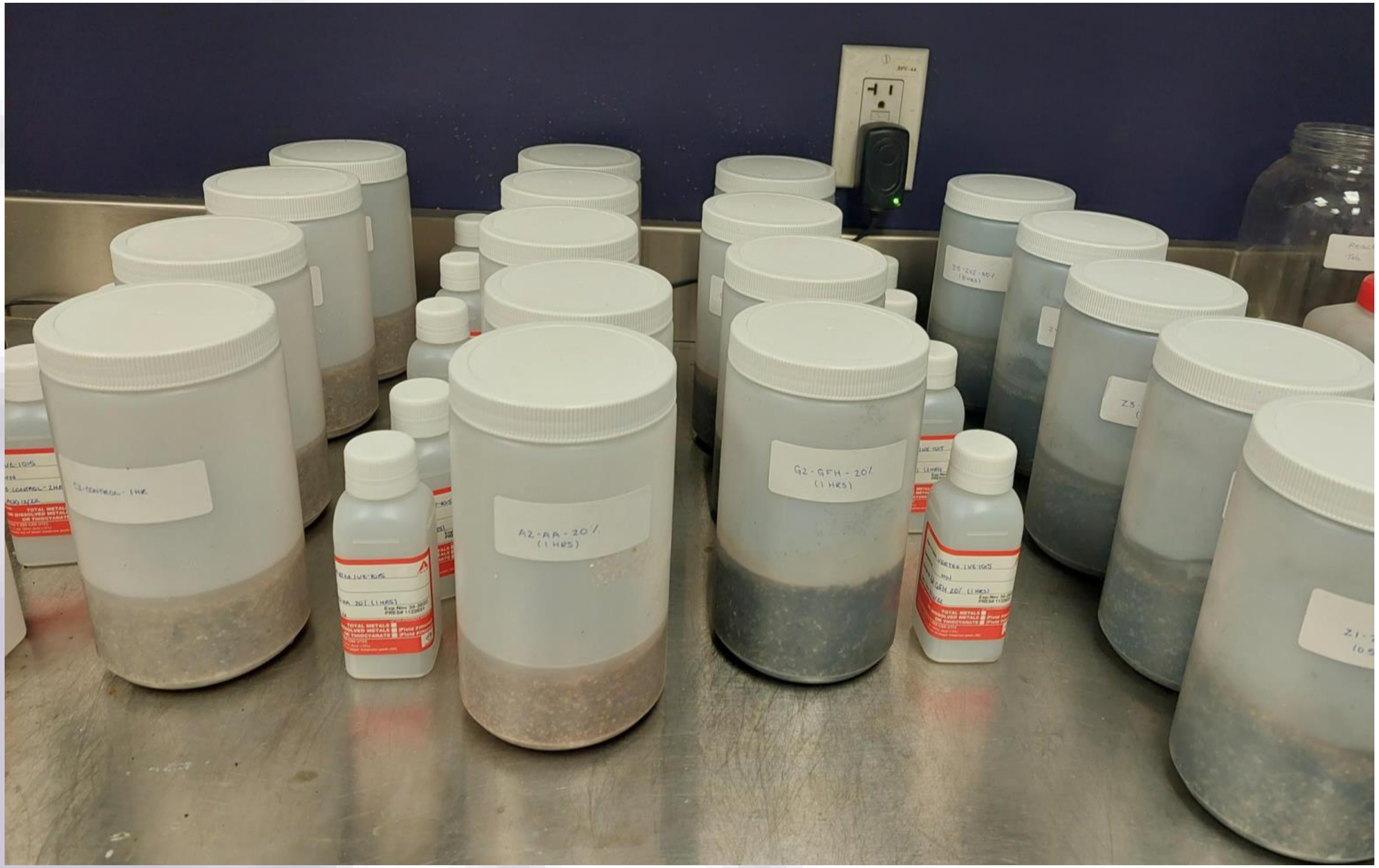
How to Bench-Scale Test?

- Static reactors → 1 bucket (20 L) of site water
- Flow through columns → 1 tote (200-1000 L) site water



Bench Test Cost-Benefits

Significant cost savings over project life-time:

- **Specifications:** oversized vessels costs $$$ per month in rental fees
- **Amendment Selection:** incorrect media selections costs $$$ per extra media change
- **Backwash Costs:** hauling backwash can cost \$150/m^3 vs. ~\$2.50/m^3, if backwash can be pre-treated for discharge to SANI stds
- **Schedule Delays:** water treatment systems (without bench-testing) often must resolve issues during systems install stage which can cause delays to overall construction schedule

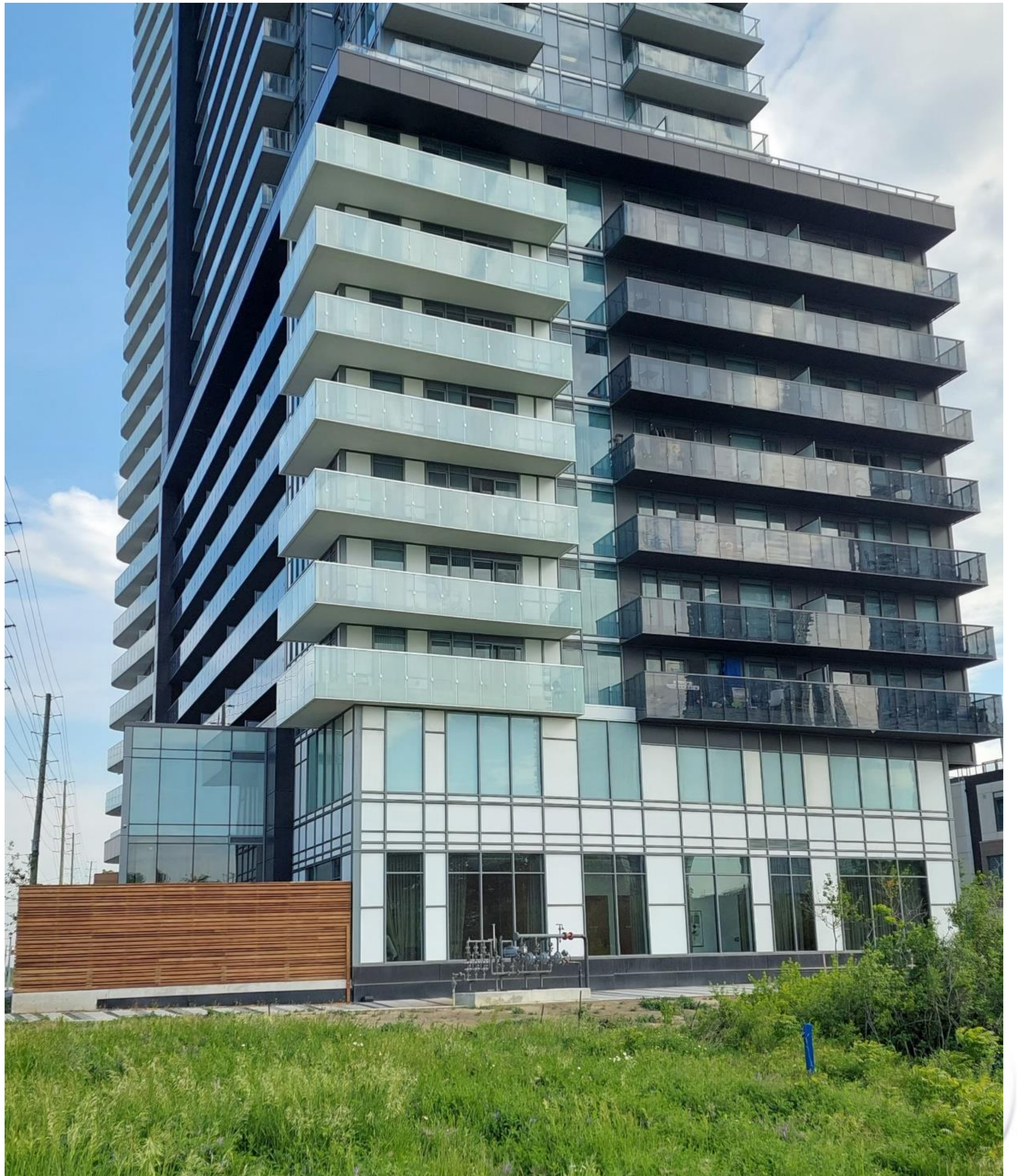
Case Study #1:

Metals Pre-Treatment for STM Discharge

Case Study #1

Site Background:

- New Construction in Vaughan/York Region
  - SANI discharge during construction
  - STM discharge over building lifetime
- Contaminants of Concern:
  - Total **Manganese**: 180 ug/L avg (150 ug/L STM Std)
  - Total **Zinc**: 165 ug/L avg (40 ug/L STM std)
- Site Conditions:
  - Flowrate: 245,000 L/day
  - Allotted location: triangular space in U/G

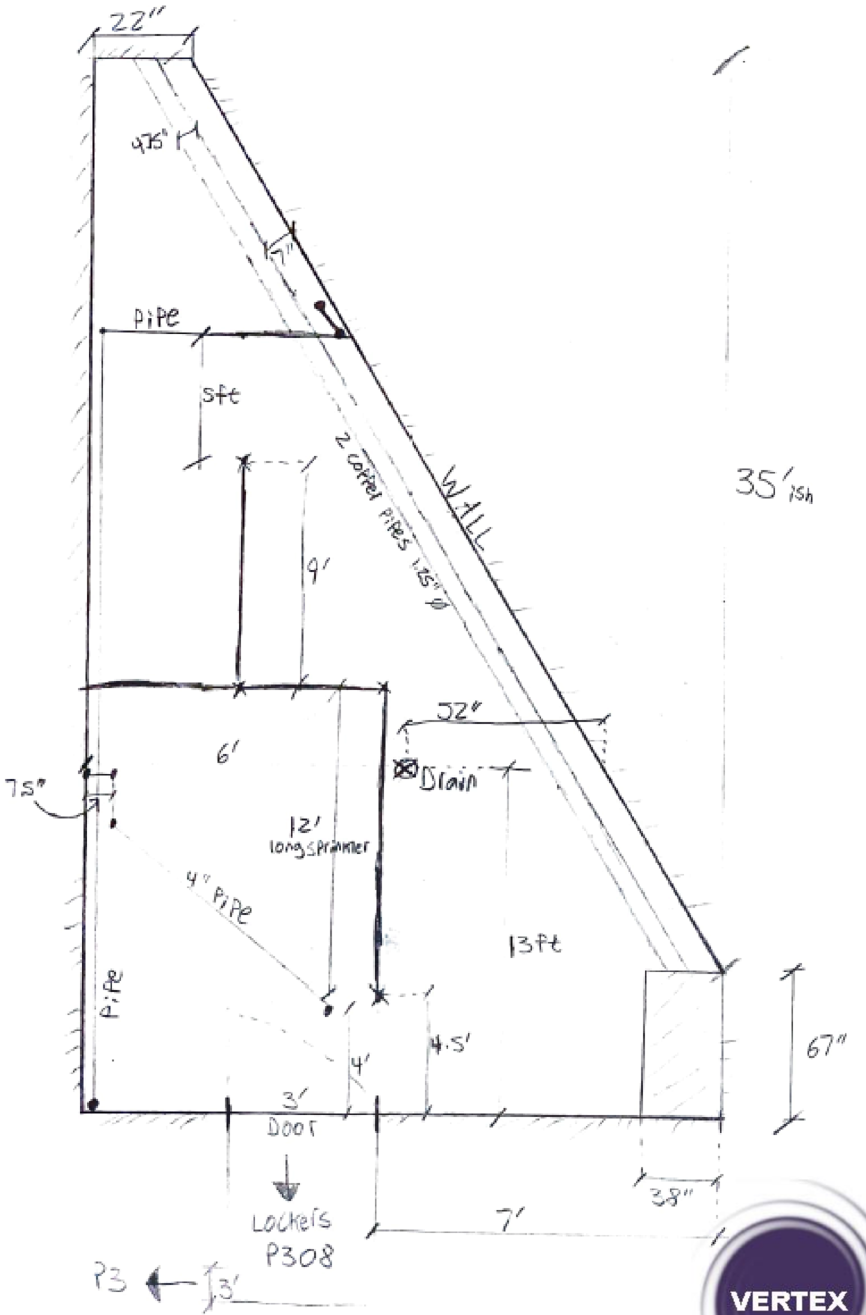


Bench Test Objectives:

1) Evaluate filtration efficacy for various treatment media
2) Evaluate loading capacity and backwash frequency

Case Study #1

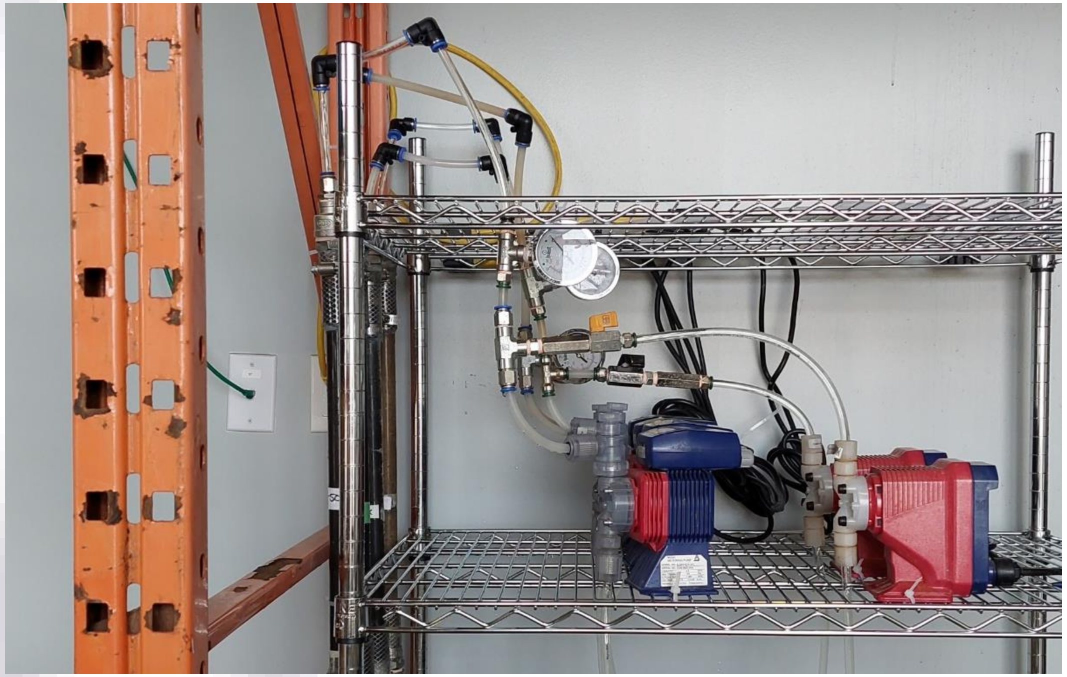
Significant space constraints



Bench Test Design

Four (4) Column Test studies:

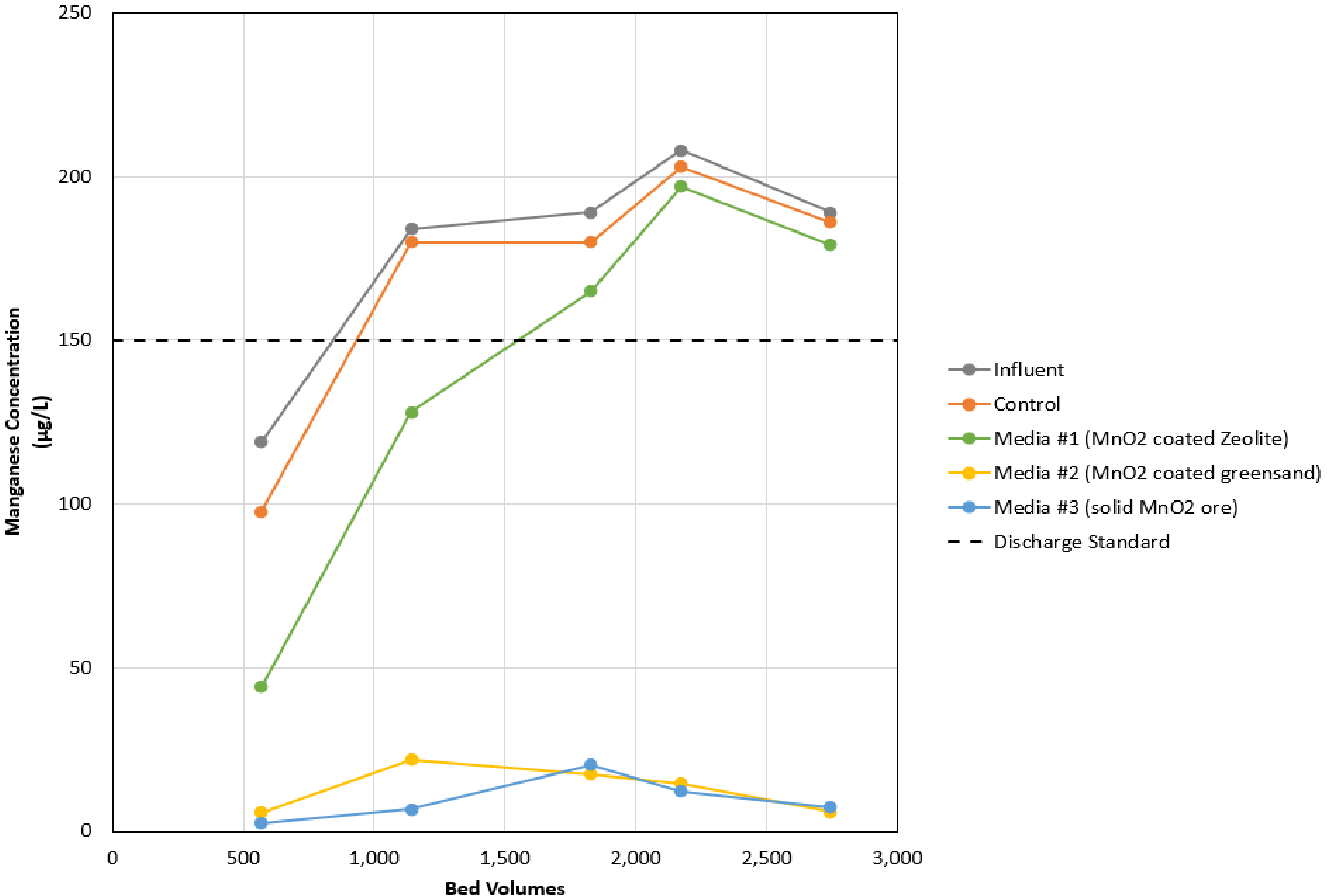
- Stage #1 – Manganese Removal:
  - Treatment Media #1 (MnO_2 coated zeolite)
  - Treatment Media #2 (MnO_2 coated greensand)
  - Treatment Media #3 (solid MnO_2 ore)
  - Control Column (silica sand)
- Stage #2 – Zinc Removal (using column effluents):
  - Treatment Media #4 (Activated Alumina)



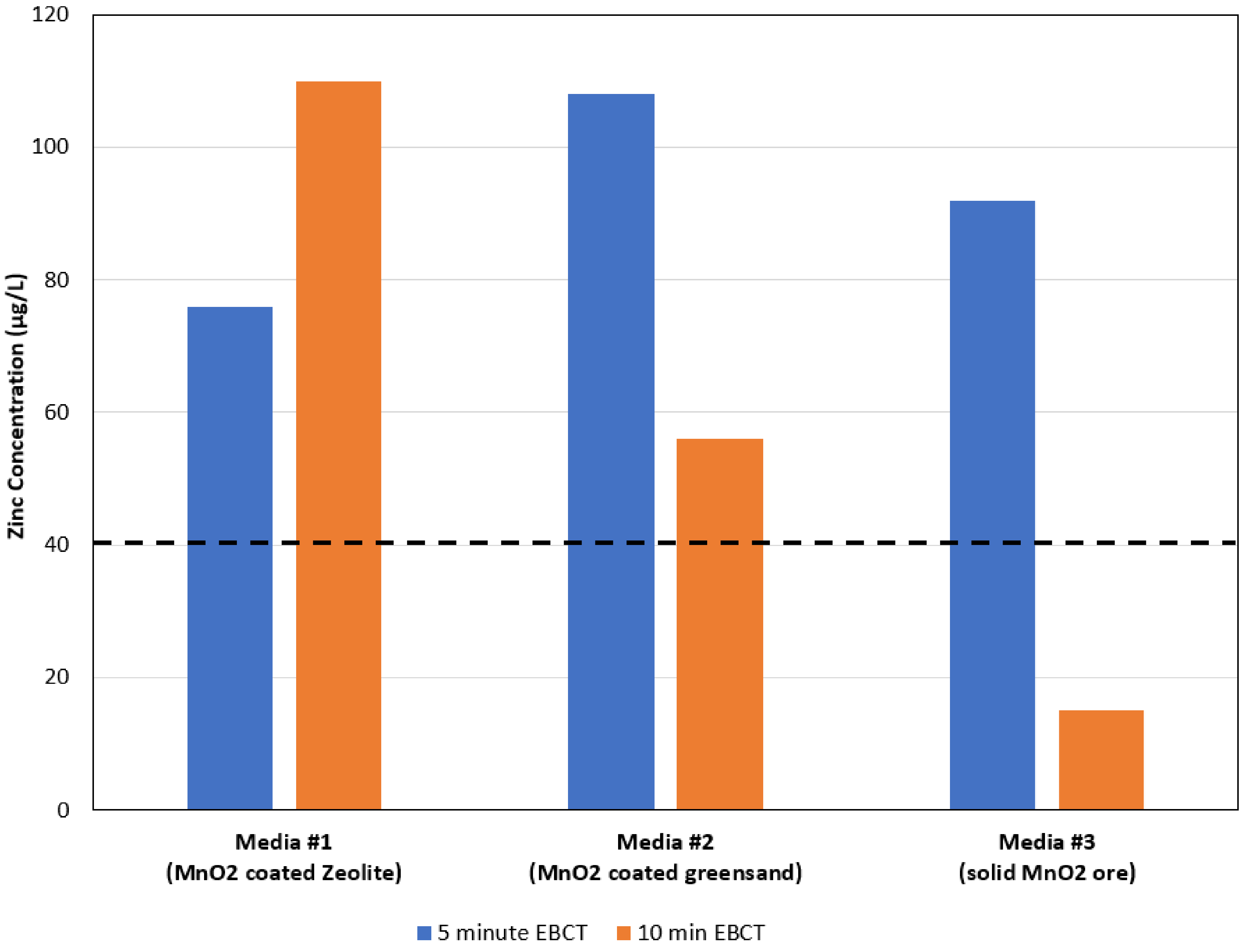
Design Parameters:

- Media pre-conditioning
- Mn influent spiking
- EBCT = 5 to 10 min
- Column materials

Mn Removal Results from Test Columns



Zn Removal Results using Activated Alumina



Bench-Test #1 – Results

Bench Test Results:

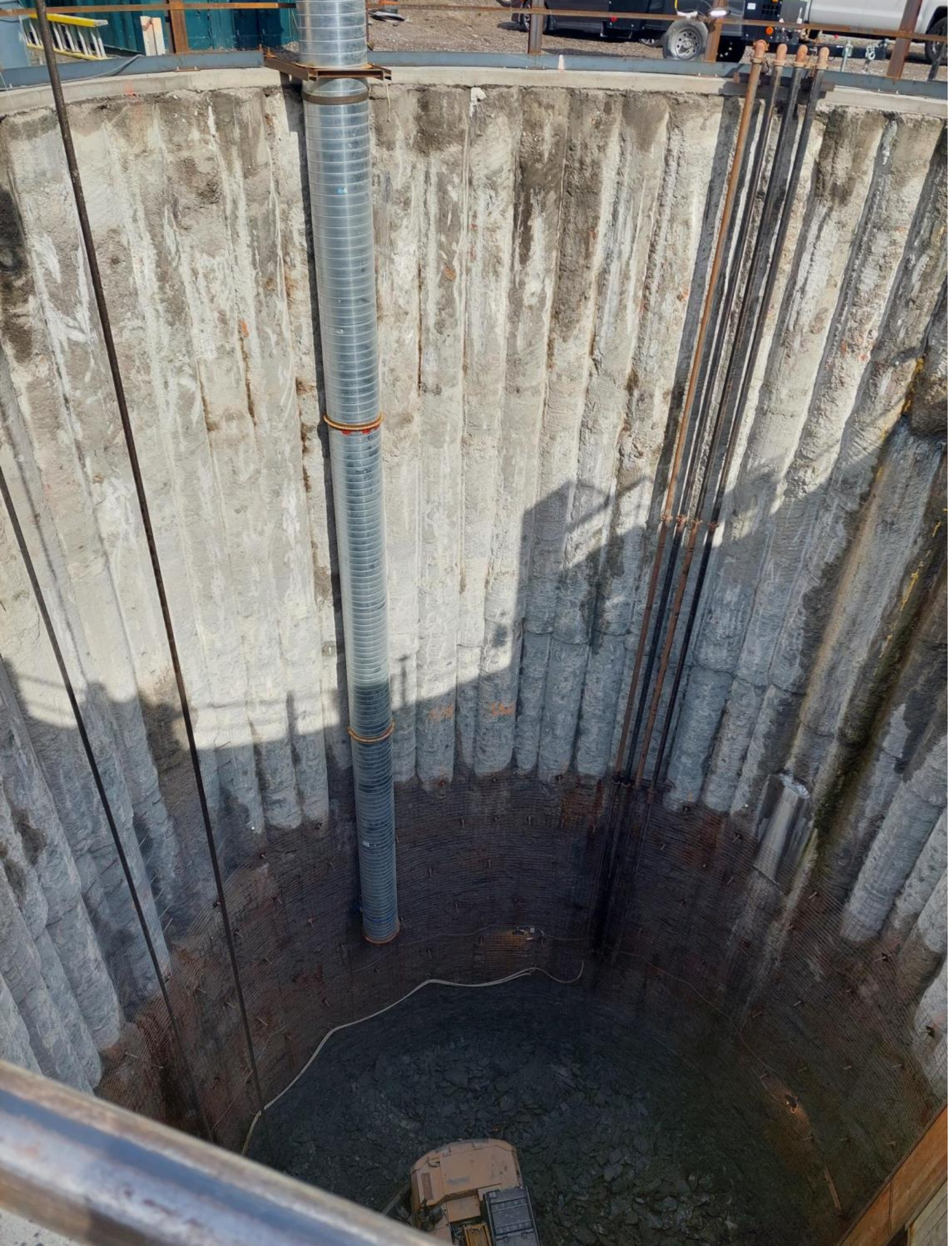
- Control column results similar to influent → minimal loss mechanisms
- Treatment Media #2 and #3 were both effective at removing dissolved Mn
- Activated Alumina was effective at removing Zn at the higher EBCT
- Treatment Train selected:

  1) Treatment Media #3 (solid MnO_2 ore)

  2) Activated Alumina (media)
- Met objectives to treat to STM and minimize backwash volumes

Case Study #2

Metals Pre-Treatment for SANI Discharge



Case Study #2

Site Background:

- Utility Tunnelling Project (12 km length) in Toronto
- SANI discharge agreement during construction

Site Conditions:

- Design Flowrate: 400,000 L/day
- **Total Manganese**: influent = 35,000 ug/L
- Toronto Sanitary Standard: 5000 ug/L

Bench-Test Objectives:

- Evaluate manganese removal using different treatment methods (ion exchange media, oxidants, possibly RO)
- Minimize backwash volume generation → hauling cost
- Select the most efficient and cost-effective method

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Iterative Bench-Test

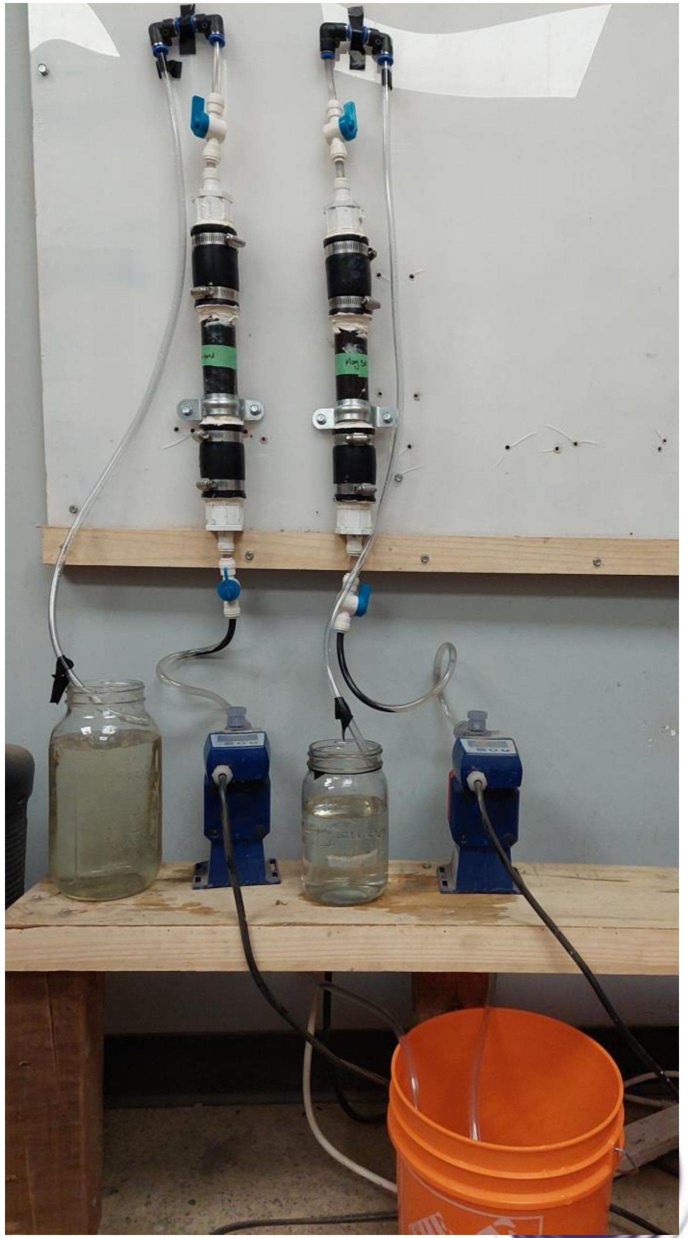
Iteration #1:

1. Influent Sampling
2. Oxidation with Chlorine
3. Filtration (1 uM bag filter)
4. Ion exchange media

- Media #1 (solid MnO2 ore)
- Media #2 (MnO2 coated greensand)

Step	Mn Concentration (ug/L)
Influent	34,400
Oxidation & Filtration	34,400
Media #1	107
Media #2	1,760

Results promising however… Backwash disposal fees for ion-exchange process >$100k/mo



Iterative Bench-Test

Iteration #2:

1. Influent Sampling
2. pH adjustment
   - Increase from 6.3 to 9.0
3. Oxidation with Chlorine
4. Filtration (1 uM bag filter)
5. Ion exchange media

- Media #1 (solid MnO2 ore)
- Media #2 (MnO2 coated greensand)

Step	Mn Concentration (ug/L)
Influent	34,400
pH adjustment, Oxidation & Filtration	20,700
Media #1	405
Media #2	420

Results promising however…
Still not achieving objective without significant backwash generation

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Iterative Bench Test Designs

Iteration #3:

1. Influent Sampling
2. pH adjustment
   - Increase from 6.3 to 9.0
3. Oxidation with Aeration
   - 10 min duration
4. Oxidation with Chlorine
5. Filtration (1 uM bag filter)

Step	Mn Concentration (ug/L)
Influent	31,900
pH adjustment	18,000
Aeration	8,490
Oxidation & Filtration	517

Finally…
Objective achieved without backwash

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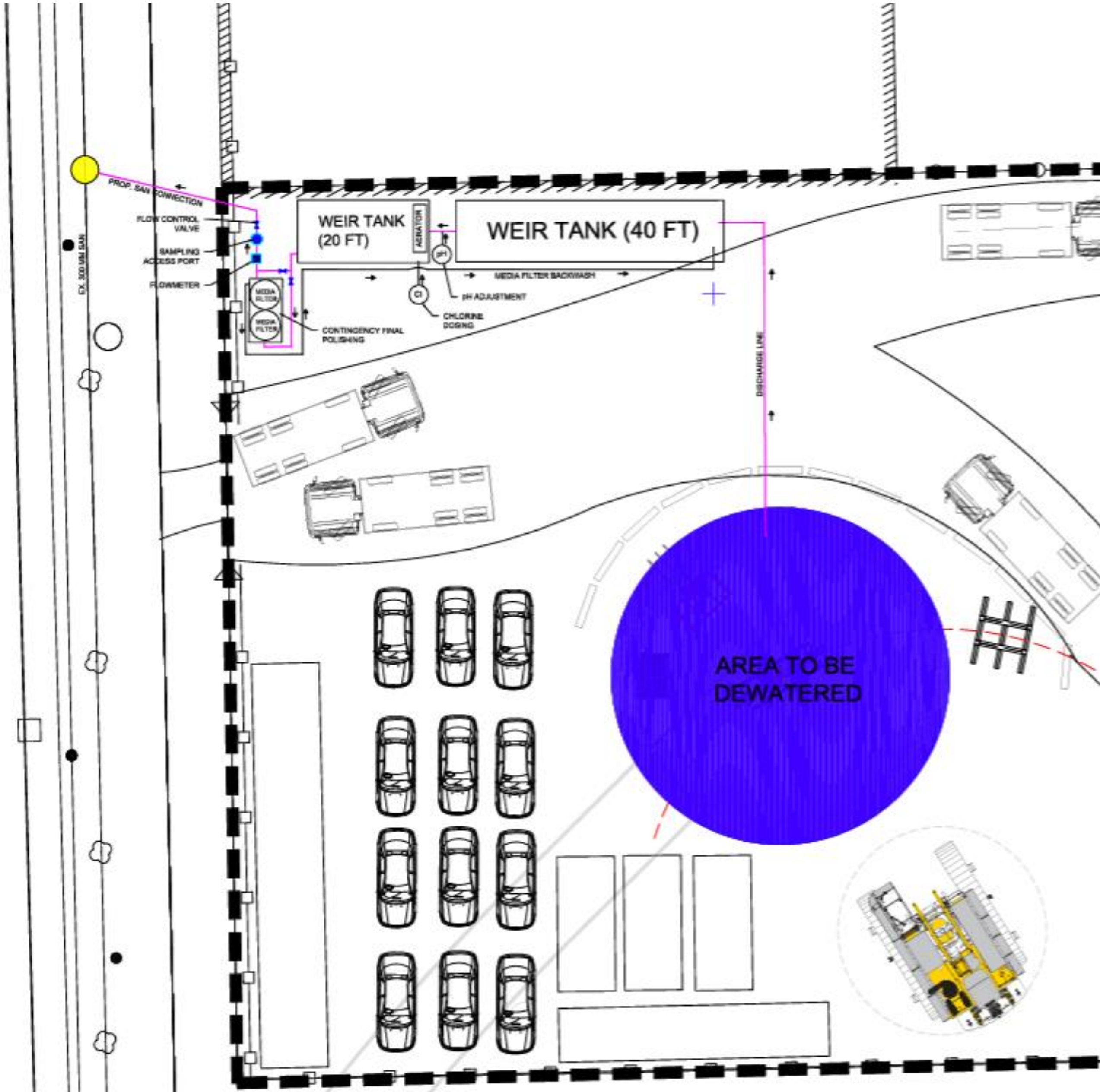
Bench Test #2 – Results

Bench Test Results:

- High concentrations Mn can be treated through a combination of oxidation/filtration and/or ion exchange methods
- Bench testing with actual site water allowed for accurate evaluation of performance and compatibility with specific groundwater conditions
- Optimized treatment train successfully eliminated the requirement for backwashing, leading to significant cost reductions and space savings



Lessons Learned

Bench-Test advantages for Construction Sites:

- Proof of concept for discharge objectives
- Evaluation of site-specific geochemistry / conditions without delaying schedule
- Optimization of groundwater treatment train to minimize space and cost

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Thank you!

Questions?

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