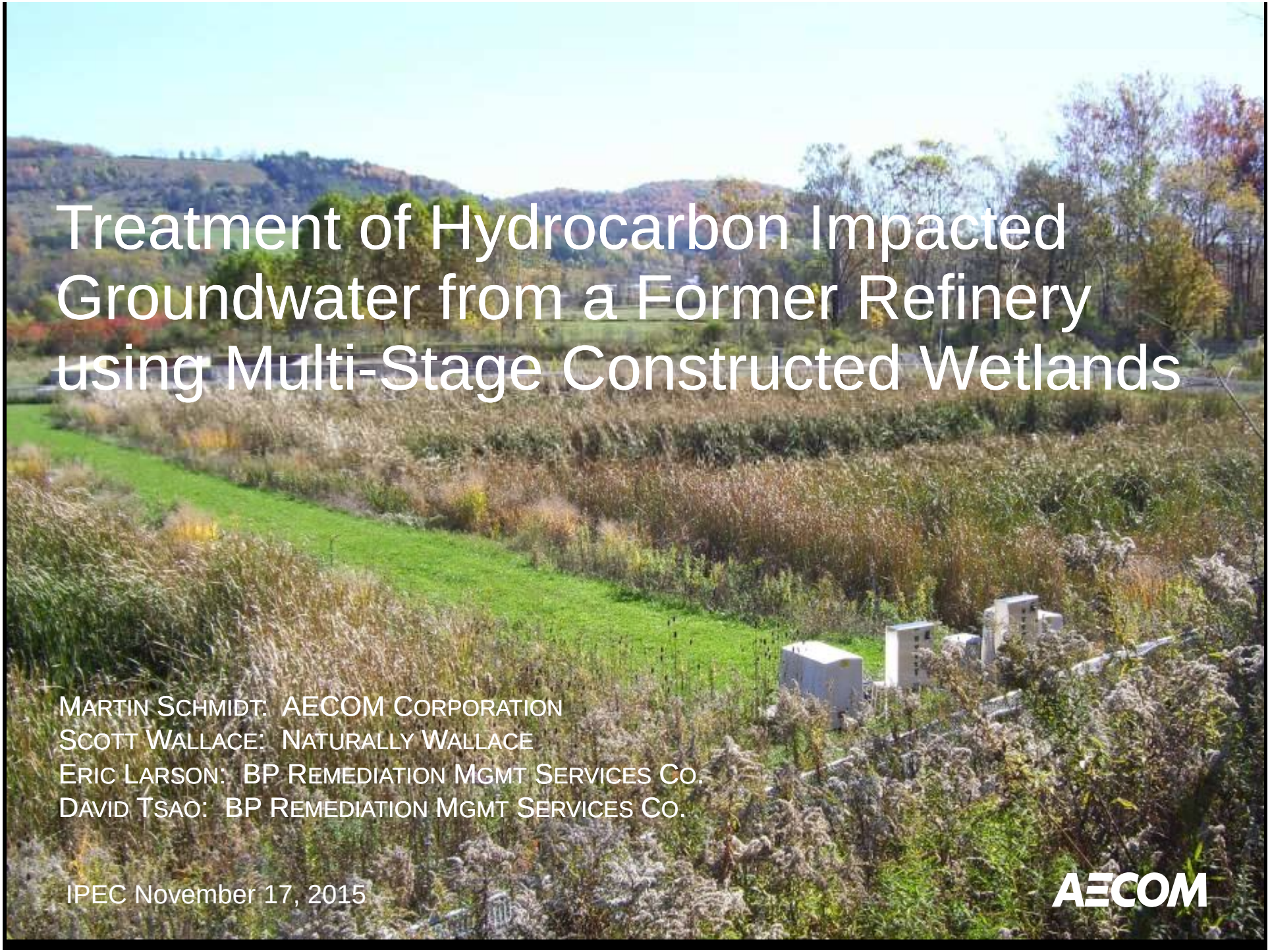
Treatment of Hydrocarbon Impacted Groundwater from a Former Refinery using Multi-Stage Constructed Wetlands



MARTIN SCHMIDT: AECOM CORPORATION
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IPEC November 17, 2015

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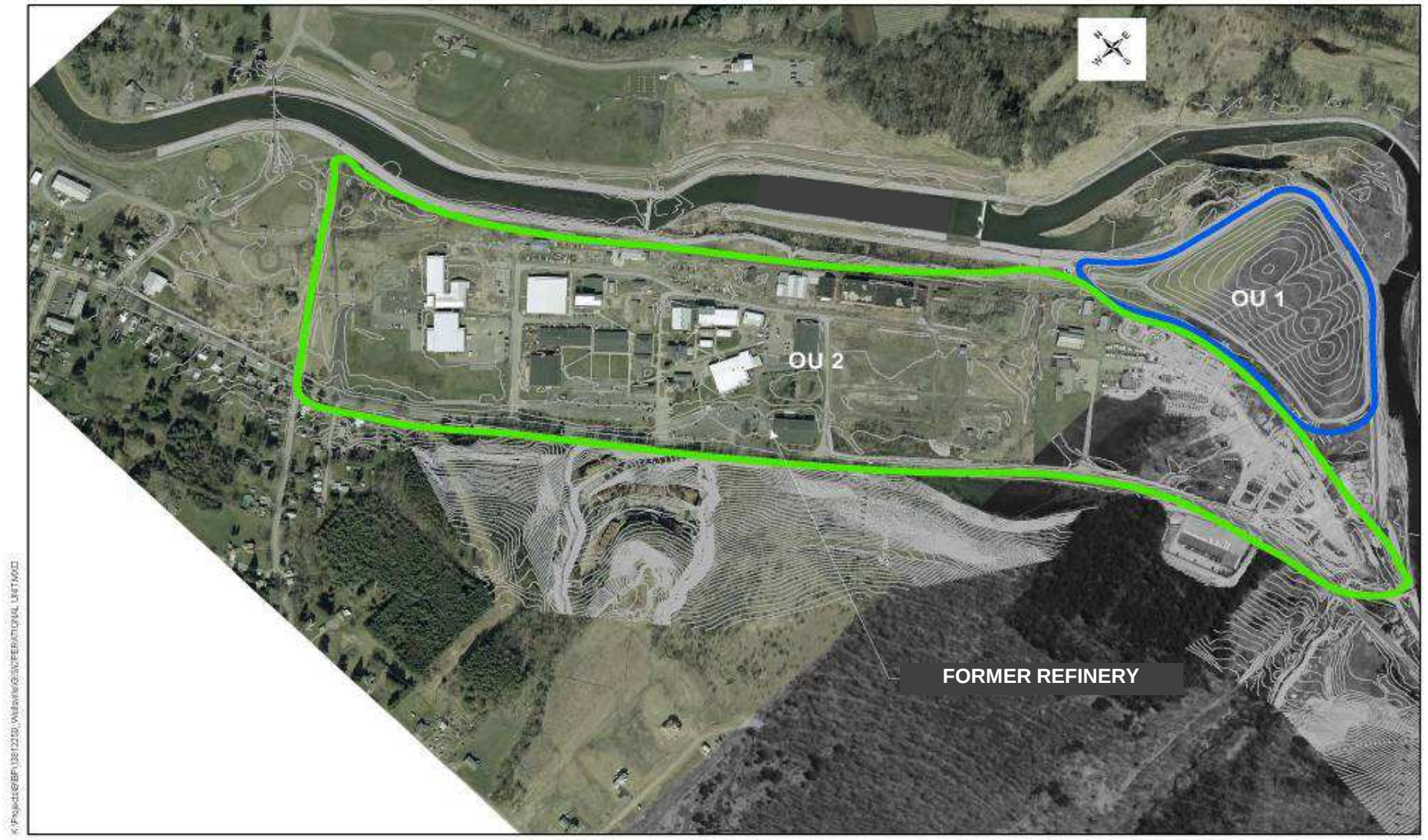
Objectives

- Provide overview of multi-stage constructed wetland groundwater treatment system design and operation
- Summarize operating conditions
- Discuss treatment efficiency and Lessons Learned

Site Background Information

- Location
  - Northwest New York State
  - Former Refinery now occupied by SUNY campus
  - 110 acre site adjacent to approx. major river
  - Majority of site within 100 yr. floodplain
  - Former Operations included: ASTs, Process Areas and Landfill

Site Layout



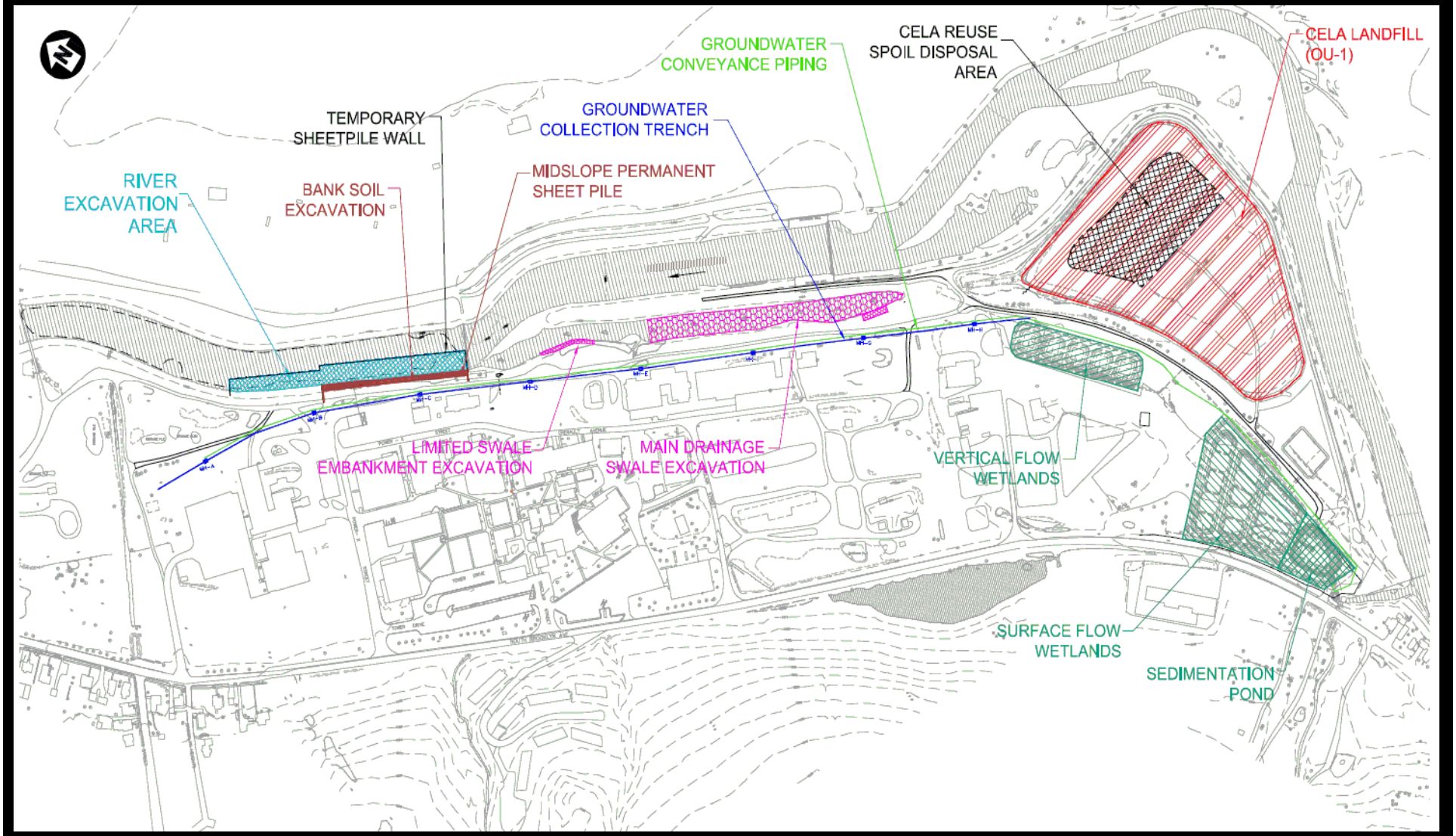
Project History / Regulatory History

- Project History
  - 1901 to 1958 : Operated as refinery
  - 1958 : Second major fire destroyed refinery
  - 1968 : SUNY begins operation
  - 1983 : Placed on National Priority List
    - Record of Decisions (1985 and 1991)
    - Operable Unit 1 : Central Elevated Landfill Area
    - Operable Unit 2 : Site Wide Subsurface Groundwater
  - 1985 – ongoing : Investigation, Design, Remediation of OU 1 and OU 2

Project History / Regulatory History

- Operable Unit 2 : Site Wide Groundwater
  - 1990s: Air Sparge/Soil Vapor Extraction
  - 1999 – 2008: Groundwater extraction from 3 recovery wells / treatment using GAC
  - 2008 -present: Groundwater extraction:
    - 8 large diameter collection sumps
    - 3,000-ft interceptor trench
    - Water treatment using multi-stage constructed wetlands
  - 2012 - present: Site Remediation Complete / Long-Term OM&M

Operable Unit 2: Remedial Design Components



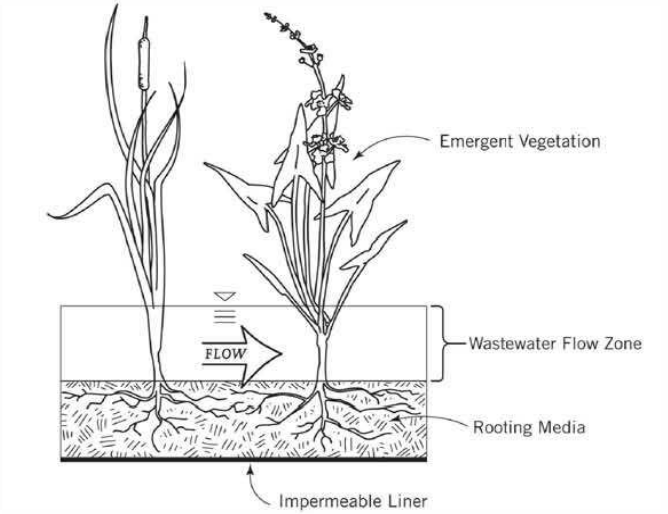
Multi-Stage Constructed Wetland Treatment System

- Basis of Design:
  - Constituents of Interest (COI) include (volatile, semi – volatile organics, and metals)
  - Multi-stage aerobic process using cattails to remove organics and metals from groundwater
  - Existing topography facilitates hydraulic profile gradient
  - Limited O&M, except for iron solids management
  - Design flow rate : 80-150 gpm, 14 day retention time

Multi-Stage Constructed Wetland Treatment System

- Design Components
  - Cascade Aerators (4 corrugated culverts)
  - Sedimentation Pond (1 pond)
  - Surface Flow Wetlands (3 ponds)
  - Aeration basins in Surface Flow Wetlands to facilitate removal of organics during winter months
  - Vertical Flow Wetlands (5 ponds)
  - Splitter box structures to divert flow to wetland ponds
  - Gate valves to control water level / flow rate in Surface / Vertical Flow Wetlands

Wetland Process Schematic



FROM GROUNDWATER COLLECTION TRENCH

CASCADE AERATOR

SEDIMENTATION POND

SEDIMENTATION POND

SURFACE FLOW WETLANDS

VERTICAL FLOW WETLANDS

TO MAIN DRAINAGE SWALE OUTFALL 001

MAIN DRAINAGE SWALE OUTFALL 001

WATER LEVEL CONTROL BERM POND

PROPOSED NEW OUTFALL

MAIN DRAINAGE SWALE

Construction of Wetland Treatment System

- Sequence of Work Completed
  - September 2008: Wetlands constructed
  - December 2008: Initial Start-Up, limited plantings
  - May 2009: Supplemental plantings
  - June 2010-2015: Iron Solids Removal (Sedimentation Pond Cleanout)
  - October 2011: Construction of Water Level Control Berm constructed
  - June 2012: Installation of muskrat exclusion fencing

Cascade Aerators

- Purpose :
  - Oxidize metals (Fe, Mn) and allow precipitate to settle out
  - Gas exchange for organic compound removal

- Design Features :
  - Divides flow equally from conveyance line discharge and splitter structure
  - 4 - 18 inch diameter, corrugated metal culverts
  - Discharges into sedimentation pond

Cascade Aerators 2011

Sedimentation Pond

- Purpose:
  - Allow settling of oxidized metal precipitates
  - Periodic removal of iron sludge for drying/disposal
  - Place in onsite drying beds / offsite disposal
- Design Features:
  - 60 mil lined pond, rip rap edges, concrete bottom
  - 18,000 sq. ft.
  - 248,000 gallons
  - Discharges to surface flow wetlands via gravity feed drain
- Sludge Drying Beds:
  - 4 concrete basins, 60-mil-lined, sand drainage filter system, periodic removal

Sedimentation Pond 2015

Open Water, Surface Flow Wetlands (SFW)

- Purpose :
  - Aeration to remove volatile and semi-volatile organic compounds
  - Biodegradation to remove organic compounds
  - Supplemental metals precipitation and filtering of suspended solids
- Design Features :
  - 3 pond structures, each having :
    - 3 aeration basins (4-5 ft. water depth)
    - 2 benches for microbial and plant rhizosphere development (2-3 ft. water depth)
  - 91,000 sq. ft.
  - Combined 598,500 gallons;
  - 60 mil lined pond bottom/slopes, soil benches, vegetated edges
  - Discharges to vertical flow wetlands via gravity feed drain and weir gates
  - Benches planted with cattails (Typha angustafolia)

Surface Flow Wetlands 2011

Muskrat Exclusion Fence

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Open Water, Vertical Flow Wetlands

- Purpose:
  - Restoration of alkalinity lost from metal precipitation
  - Supplemental suspended solids removal
  - Supplemental biodegradation
- Design Features:
  - 5 pond structures, each having :
    - 1 passive limestone gravel aeration basin
    - Gravel surface planted for microbial growth/rhizosphere development
    - 60 mil lined bottom/slopes, vegetated edges
    - Discharges to outfall 001 via siphon drains, pulsation
  - 29,000 sq. ft.
  - Combined 179,500 gallons
  - Limestone beds planted with cattails

Vertical Flow Wetlands 2015

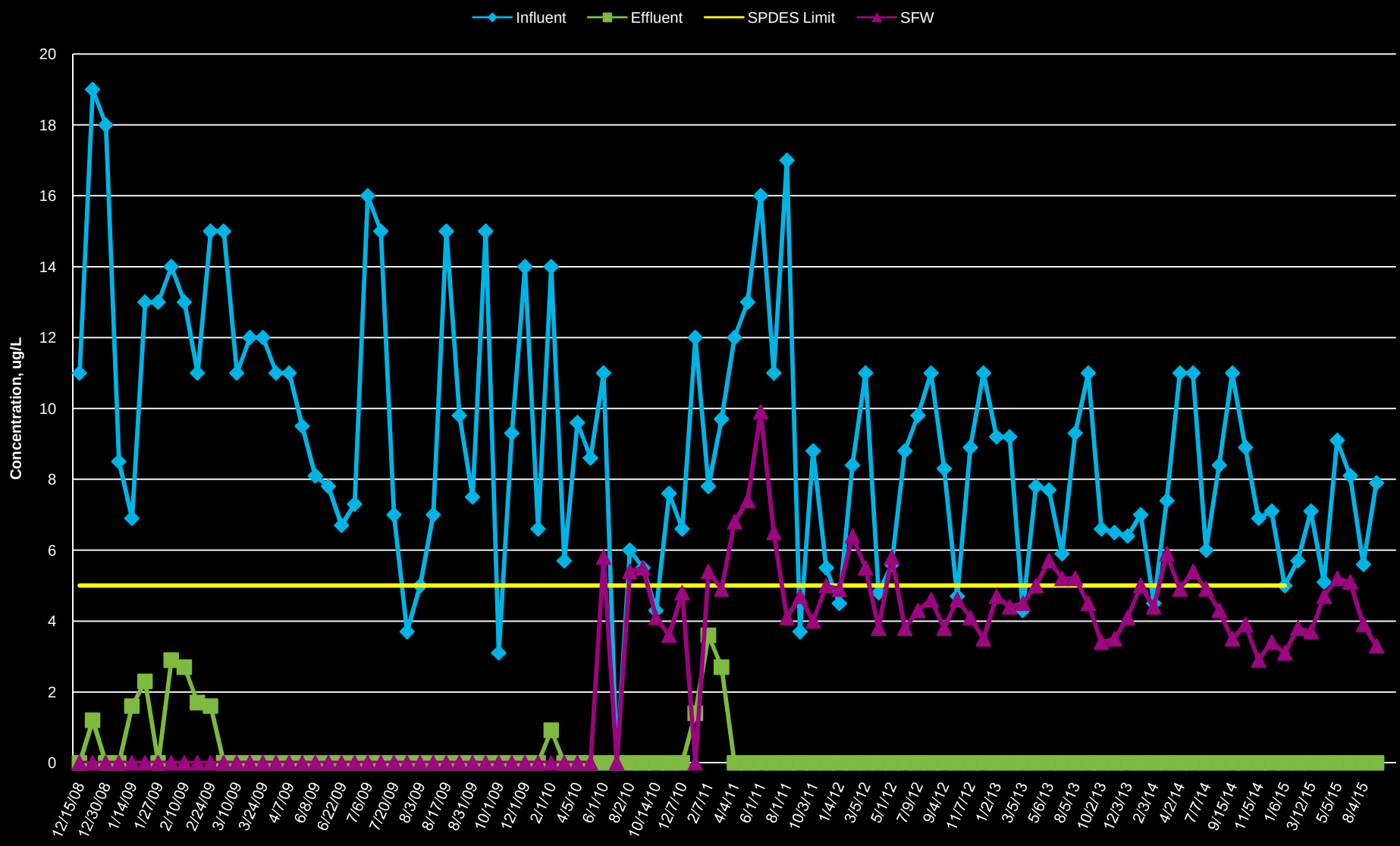
Treatment Efficiency Results
2008 - September 2015

- Summary of Data Trends
  - Influent concentrations:
    - VOCs: Benzene 5-20 ppb; Ethylbenzene 2-35 ppb; Toluene 3-10 ppb; Xylene 5-25 ppb
    - SVOCs: Nitrobenzene: 2,000 – 12,000 ppb; Aniline: 50-1,600 ppb
    - Metals: Iron: 20 – 43 ppm; Manganese 3-7 ppm

Treatment Efficiency Results
2008 - September 2015

- Summary of Data Trends
  - Effluent concentrations significantly reduced:
    - VOCs: Non-Detect
    - SVOCs: Non Detect
    - Metals: Iron above ND, winter 2010/2011 and sporadic; Manganese above ND initially, winter 2010 / 2011, summer 2012 - 2015
  - Since 2008 approx. 450 million gallons of groundwater treated

Benzene Results



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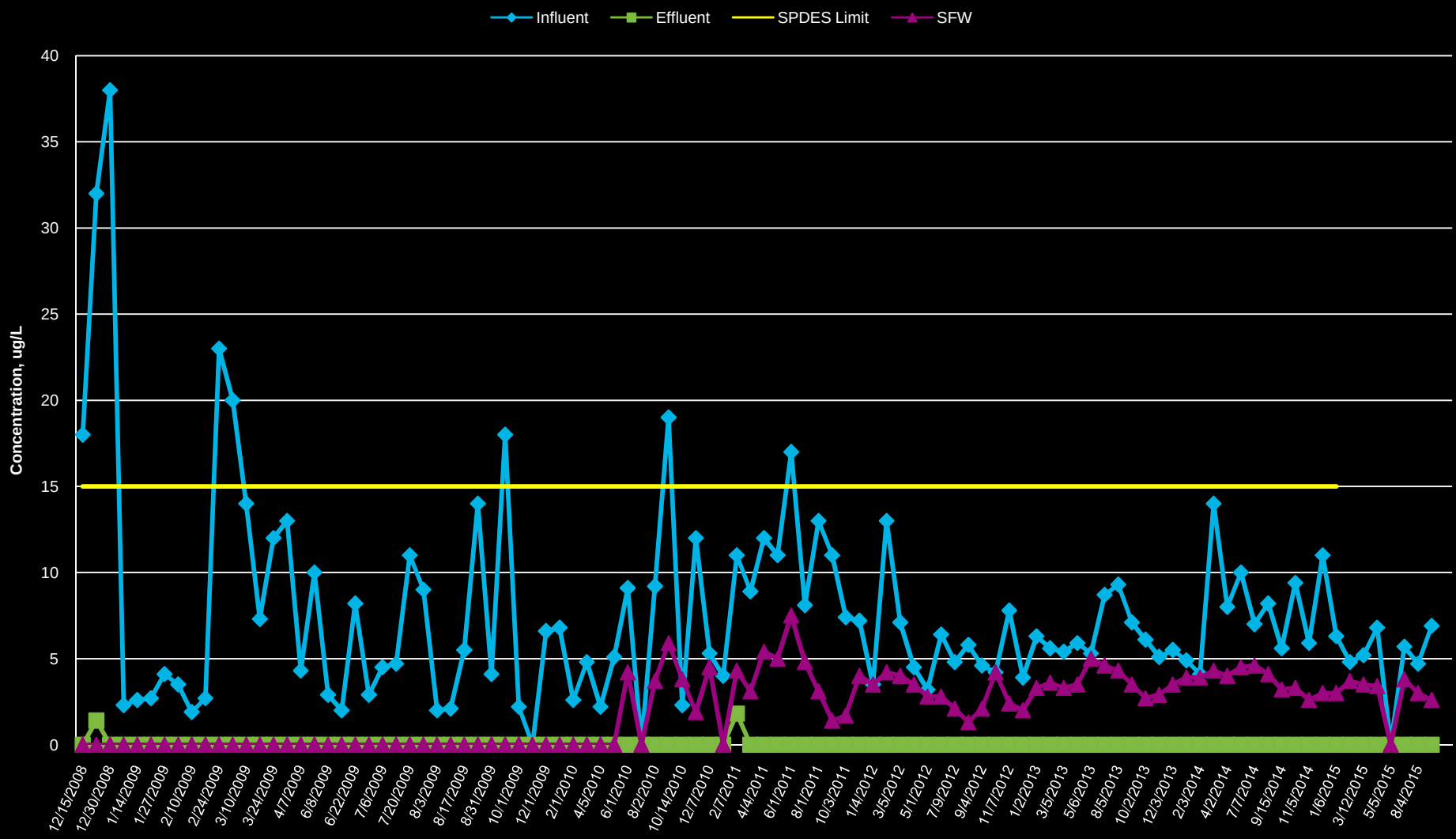
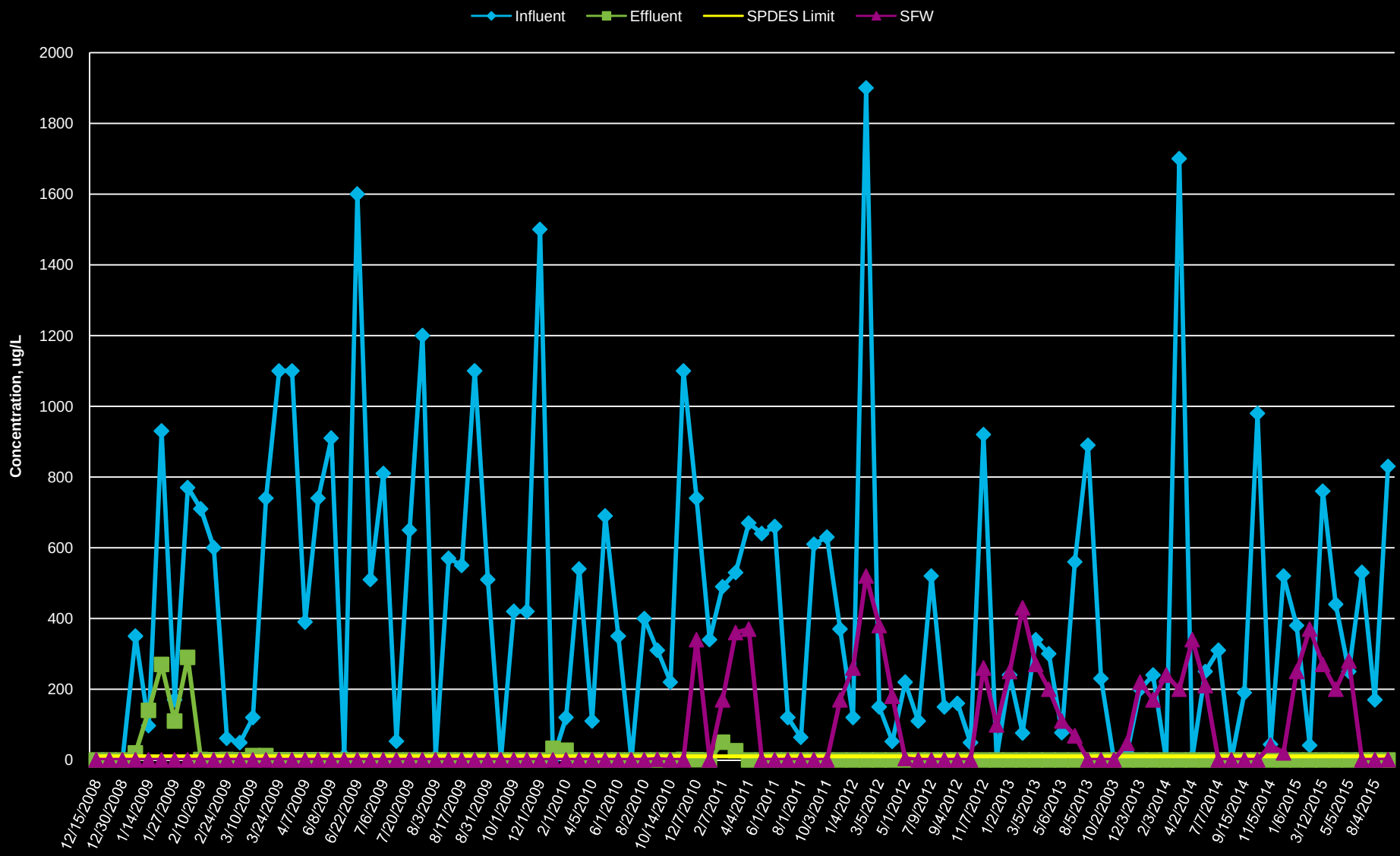
Xylene Results



Aniline Results



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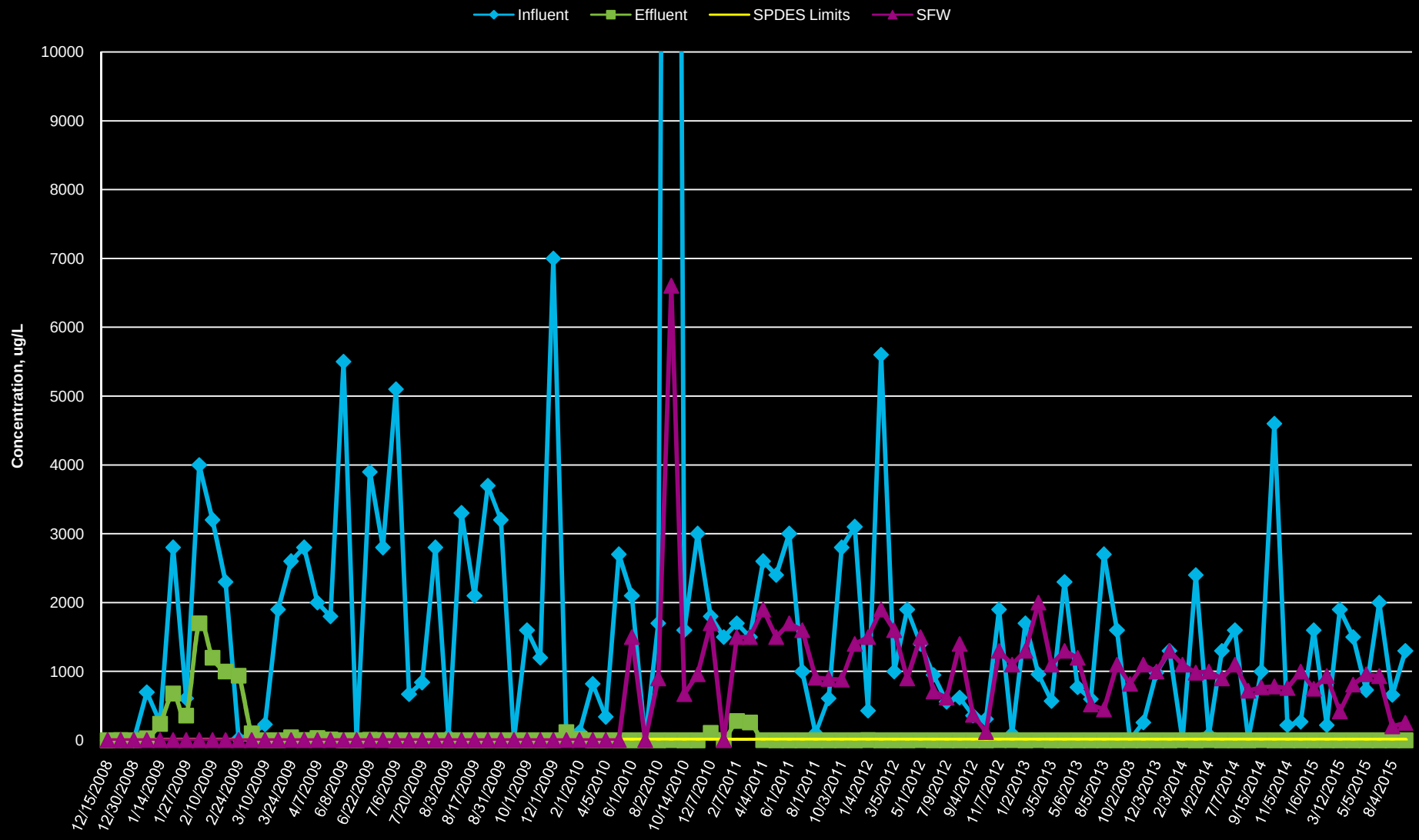
Nitrobenzene Results



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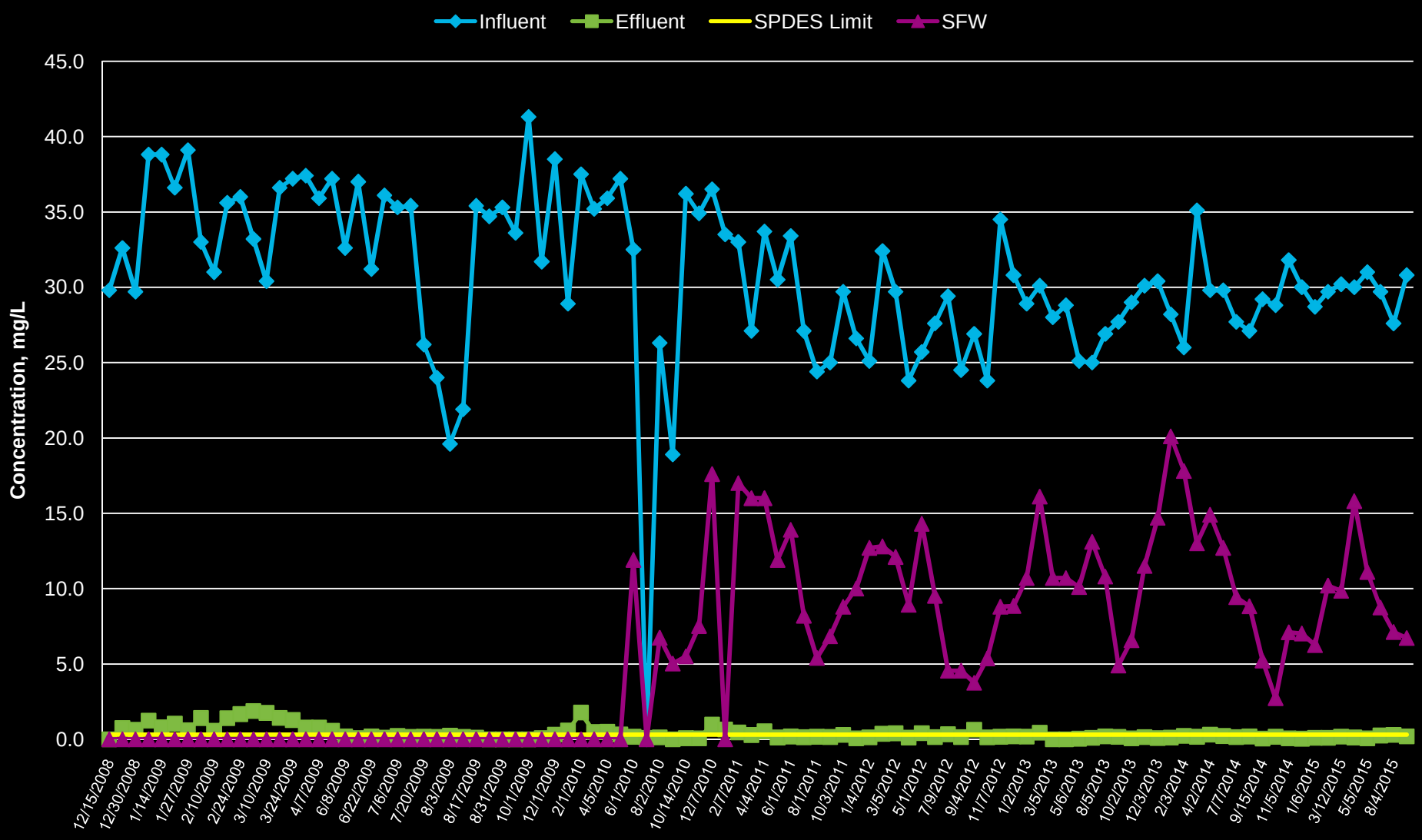
Iron Results



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Conclusions and Lessons Learned

- Wetland treatment system effectively treats VOCs, SVOCs, and Metals
  - Influent
    - VOCs display decreasing trends
    - SVOCs display stable to decreasing trends
    - Metals display stable trends, naturally occurring at background concentrations above limit
  - Effluent
    - VOCs, SVOCs non detect
    - Metals vary seasonally, near NPDES Limit
- Winter operation requires augmentation using pond aeration system (SFW)

Conclusions and Lessons Learned

- Transplanting cattails more efficient than root stock plantings
- Muskrat Mitigation Program to include exclusion fencing / annual trapping / hut removal
- Highly cost-effective system, low carbon foot print, very sustainable long-term solution
- Iron solids removal is long-term O&M issue (annual)
- ROD requires site groundwater discharge to meet MCLs
- Operation of multi-state wetland treatment system expected for additional 30+ years
- Site reclassified as Class 4 (Properly remediated as specified in ROD)

Q & A

Thank you,