INNOVATIVE TECHNOLOGY EVALUATION PROGRAM REVIEW

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ITE Background

- Team established in 2000 by Impact Area Groundwater Study Program (IAGWSP)
- Voluntary efforts outside response to EPA Administrative Orders
- Mission:
  - Identify and evaluate innovative remediation technologies to address low levels of PEP-type contamination
  - Recommend technologies for implementation at contaminated sites on Camp Edwards/MMR
  - Support future application at other DoD/ARNG training installations
- Early studies predated perchlorate concerns – perchlorate added to scope of efforts in 2001

ITE Soil Treatment Experience - Explosives

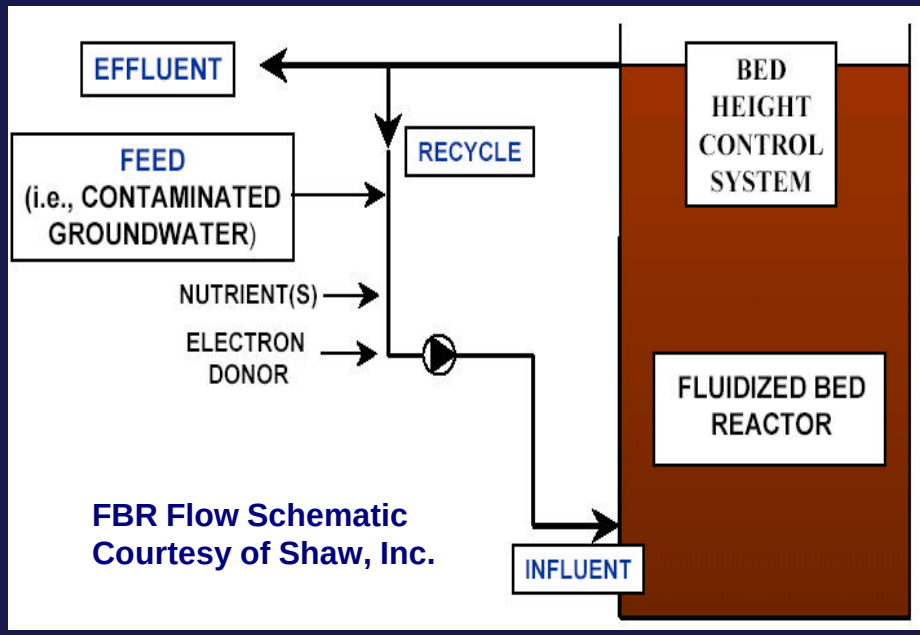
- Explosives contaminant isolation via soil washing (field scale)
  - Volume reduction of 75 – 90 %
  - Reduced volume requiring secondary treatment or off-site disposal
- Successful explosives contaminant destruction (bench scale)
  - Chemical reduction, using zero valent iron
  - Solid phase bioremediation
  - Bioslurry
  - Low temperature thermal desorption / destruction
- Lessons Learned:
  - Composting not effective on particulate form of explosives encountered at training range
  - Chemical oxidation not as successful
  - Deposition of explosives from training significantly different than explosives in process washout at manufacturing sites

Early ITE Groundwater Treatment

- Perchlorate studied but total destruction not a goal (until 2001)
- Successes
  - Cometabolic reduction (in situ) – degraded explosives, Positive indications of perchlorate degradation.
- Lessons learned
  - Chemical oxidation not effective on explosives destruction – treatment at other sites has met with varied success / failure
  - Chemical oxidation not effective on perchlorate destruction, as predicted by chemistry
  - In-situ technologies not suitable for MMR as technologies can reduce but not eliminate contamination in a cost-effective manner

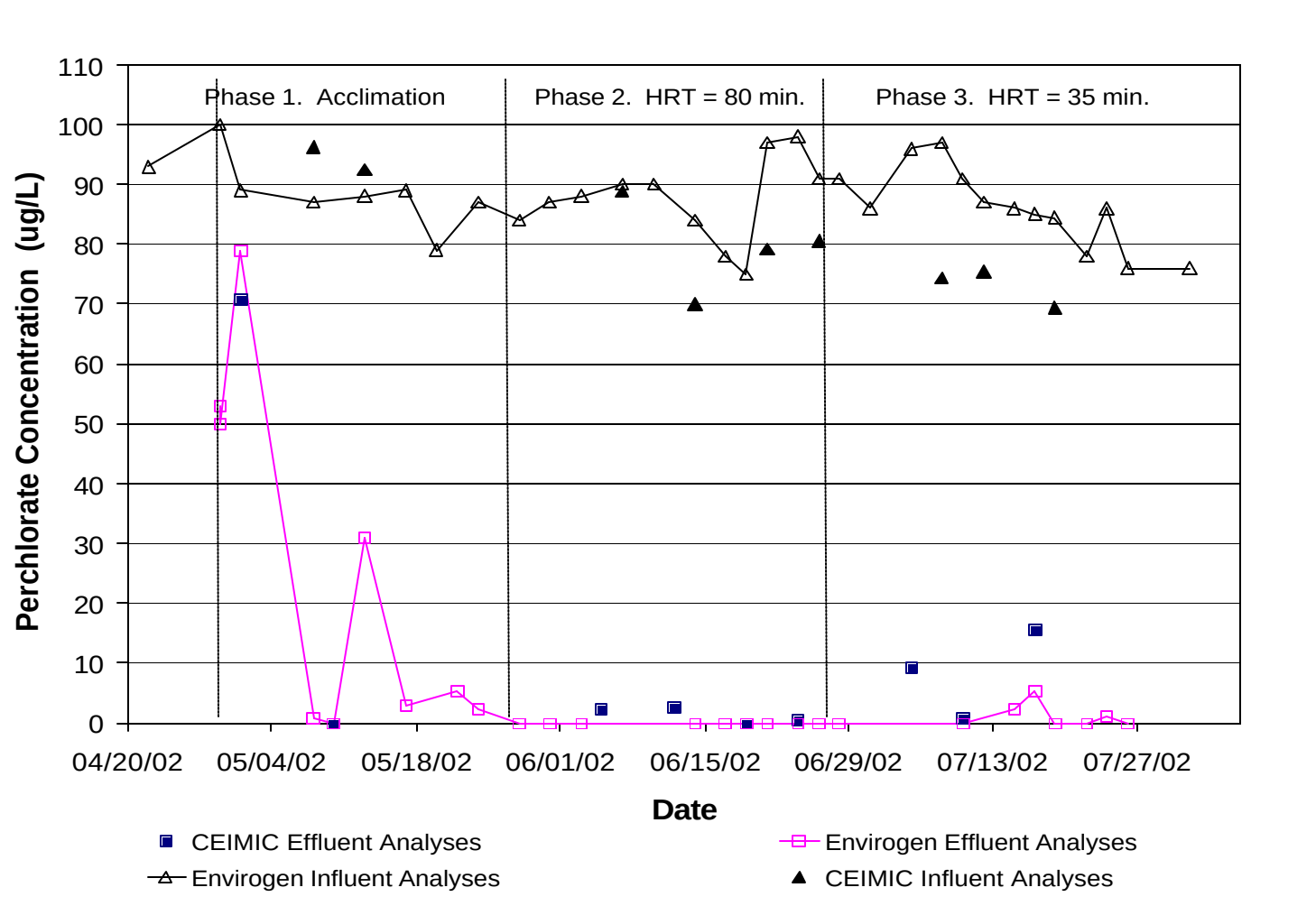
Recent ITE Groundwater Treatment Biological Fluidized Bed Reactor (BFBR)

- Study #1 (Perchlorate 100 µg/L, RDX 190 µg/L)
  - Perchlorate <1.0 µg/L, HRT = 35 min.
  - RDX <2 µg/L, HRT = 80 min.
- Study #2 (Perchlorate 3–6 µg/L)
  - Perchlorate <1.0 µg/L, HRT = 16 min.
  - Nitrate addition required when water is low in natural electron acceptors.
  - Acetic acid substrate successful. Molasses and ethanol degrade perchlorate, but not to below 1.0 µg/l.



FBR Flow Schematic
Courtesy of Shaw, Inc.

ITE Groundwater Treatment BFBR (continued)



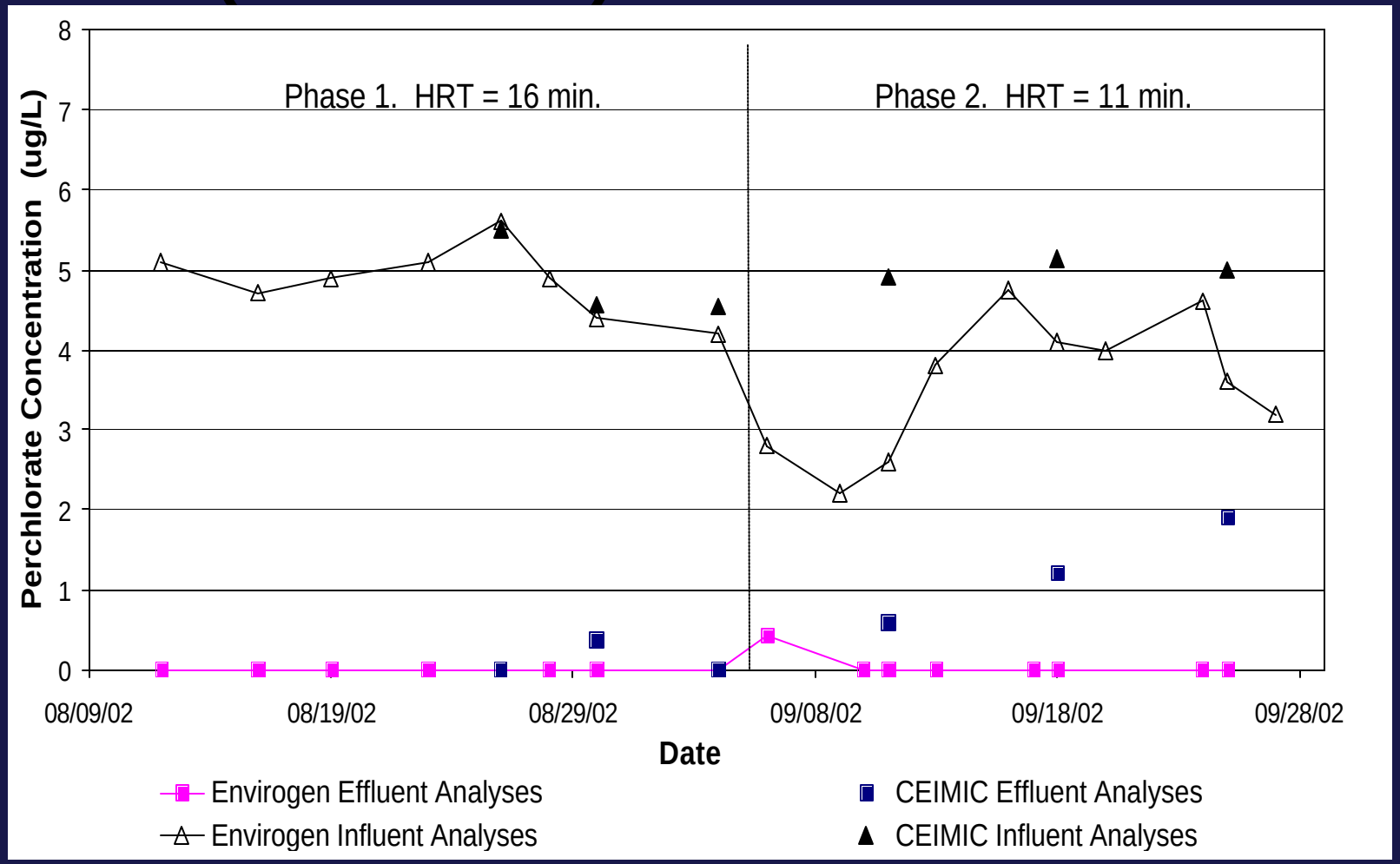
Study #1 (Perchlorate at 100 µg/L, RDX at 190 µg/L)

ITE Groundwater Treatment BFBR (continued)

RDX Concentrations on GAC			
Sample Location within Reactor	RDX - End of Phase 1 (mg/kg GAC)	RDX - End of Phase 2 (mg/kg GAC)	RDX - End of Phase 3 (mg/kg GAC)
FBR A - Top	309	4	4
FBR A - Bottom	330	3	4
FBR B - Top	590	626	784
FBR B - Bottom	728	558	545
FBR C - Top	591	558	1019
FBR C - Bottom	641	718	888
Note: Reactor A = Acetic Acid, Reactor B = Molasses, Reactor C = Control			

Study #1 (Perchlorate at 100 µg/L, RDX at 190 µg/L)

ITE Groundwater Treatment BFBR (continued)



Study #2 (Perchlorate at 3 – 6 µg/L)

ITE Groundwater Treatment Granular Activated Carbon (GAC)

Rapid Small Scale Column Tests (RSSCTs)

- Laboratory scale studies predict full-scale system performance
  - Predict how many bed volumes (BVs) of groundwater can be processed through GAC before the contaminant breaks through.
  - Estimate design hydraulic loading rates
  - Optimize empty bed contact times (EBCTs)
- RSSCT scaling per Crittenden studies (1989)
  - $EBCT_{Small\ Column} / EBCT_{Large\ Column} = D_{SC} / D_{LC}$
  - $V_{SC} / V_{LC} = (D_{LC} / D_{SC})*(Re_{SC}, min / Re_{LC})$

    (D = Diameter of particles, V = Velocity, Re = Reynolds number)
- For perchlorate studies at MMR
  - Grain size: full-scale = #8 x #30 mesh, RSSCT = #200 x #400 mesh
  - EBCT: full scale = 20 minutes, RSSCT = 0.9 minutes
  - RSSCTs can model 22 days of full scale operations in 1 day

ITE Groundwater Treatment
Granular Activated Carbon (GAC)

RSSCTs on Groundwater - Perchlorate at 1 μg/L

- Virgin Ultracarb: 30,000 BV @ 20 min EBCT

RSSCTs on Groundwater - Perchlorate at 3-6 μg/L

- Virgin Aquacarb: 24,000+ BV @ 20 min EBCT
- Virgin Aquacarb: 25,000 BV @ 7 min EBCT
- Virgin Ultracarb: 20,000 BV @ 20 min EBCT
- Virgin Ultracarb: 15,000 BV @ 5 min EBCT
- Polymer on Ultracarb: 23,000 BV @ 5 min EBCT
- Monomer on Ultracarb: 77,000+ BV @ 5 min EBCT
- Monomer on Ultracarb that had been exhausted before tailoring: 67,000 BV @ 5 – 7 min EBCT

Current Efforts – GAC & Ion Exchange Resins

- Field study completed April 2003
  - GAC treatment of perchlorate at 1 µg/L
- Field study Jan - Jul 2004 (perchlorate at 3 - 6 µg/L)
  - Type 1 Styrene Ion Exchange Resin
  - Nitrate selective Ion Exchange Resin
  - Monomer-amended GAC
- RSSCTs on perchlorate and explosives
  - GAC
  - Monomer-amended GAC
  - No Ion Exchange Resins - not effective on explosives
  - Monomer-amended GAC chased by GAC

Application of ITE Findings

- BFBR designed for Frank Perkins Road treatment system to address explosives and perchlorate
- GAC accepted by MA DEP and Town of Bourne for wellhead treatment of perchlorate
- GAC designed for Pew Road treatment system to address perchlorate at 3 – 6 μg/L
- 6-month field pilot study to determine best-value media for Pew Road treatment system (may replace GAC in future)
- USACE/NGB can evaluate technologies early in process
- ITE program has identified best value technologies to meet the needs of the on-going treatment efforts at MMR
- Technology transferable to other DoD sites