Streamlined Treatment Option for Remediation of Commingled Perchlorate and Explosives in Groundwater

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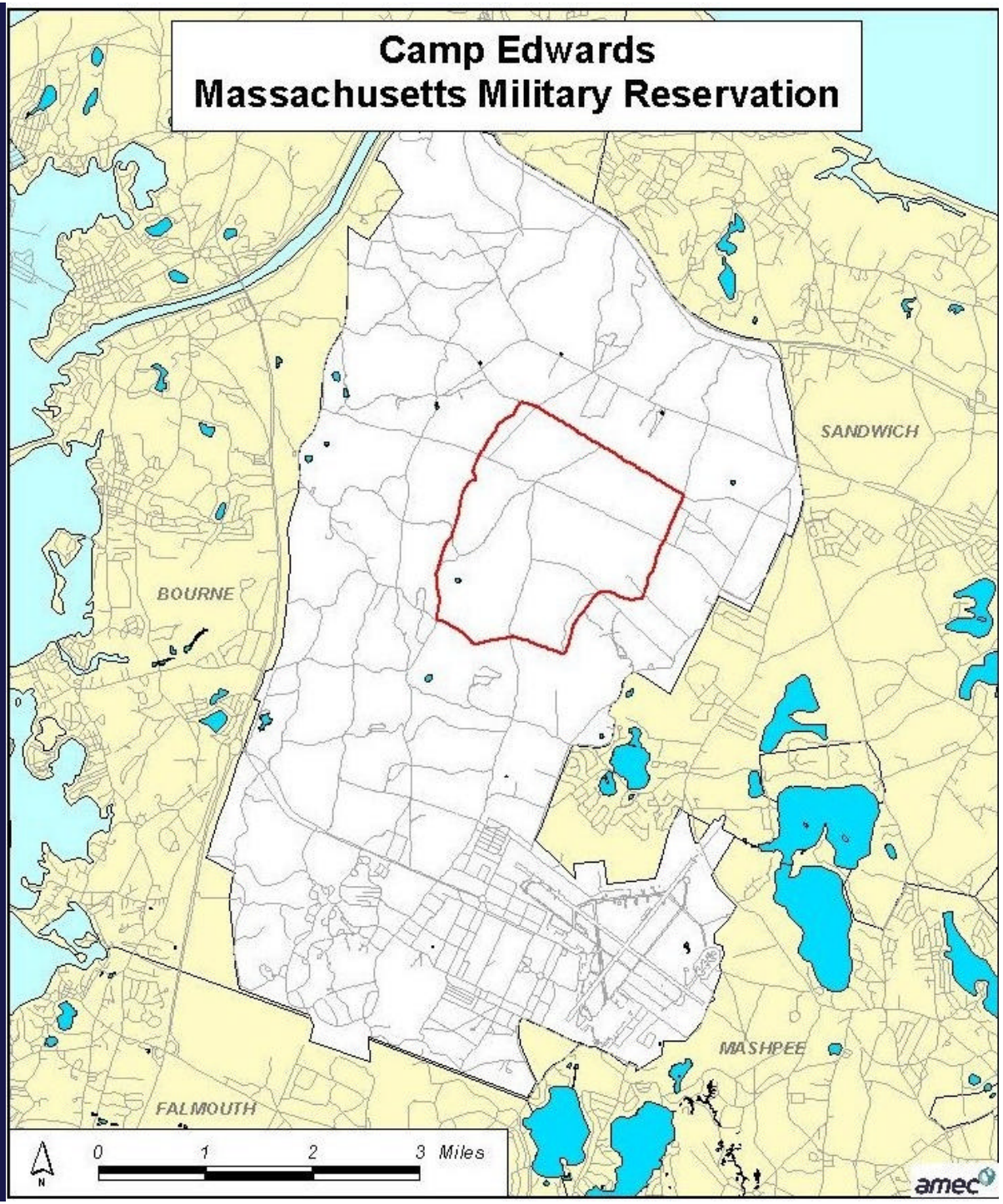
Camp Edwards

- 15,000 acres on Cape Cod
- Impact Area and Training Ranges used for target practice and range training operations since 1940s



ITE Mission

- Identify and evaluate innovative remediation technologies to address low levels of explosives and perchlorate contamination
- Recommend technologies for implementation at contaminated sites on Camp Edwards/MMR
- Support future application at other DoD/ARNG training installations

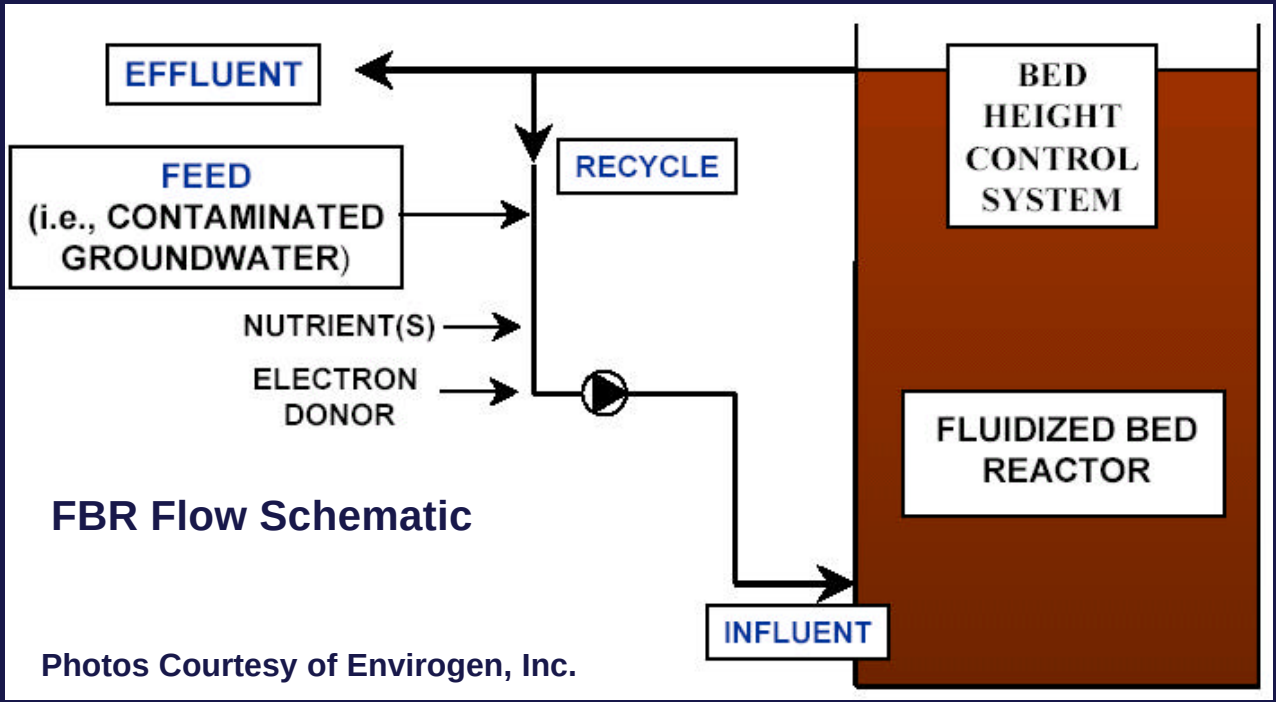
Fluidized Bed Reactor (FBR) Evaluation

- Can FBR systems remediate low concentrations of perchlorate ?
- Can FBR systems concurrently degrade explosives as well as perchlorate ?
- Can a single FBR replace traditional lead-lag arrangement of FBR and GAC ?

Fluidized Bed Reactor (FBR)

Ex Situ Fluidized Bed Reactor (FBR) - Envirogen

- Uses GAC as substrate for microbial growth
- Demonstrated at Aerojet site in California



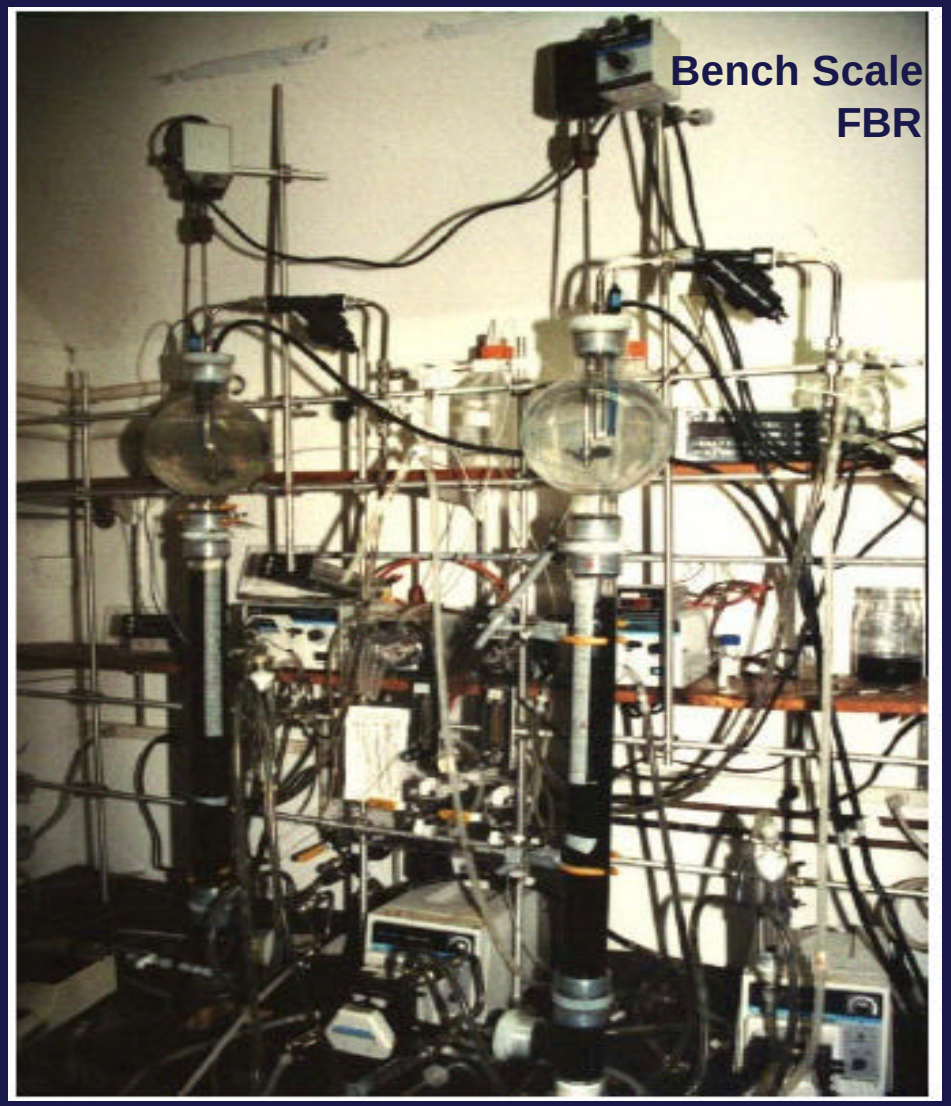
FBR Flow Schematic

Photos Courtesy of Envirogen, Inc.

FBR Treatability Study – Set up

- Initial concentrations in groundwater were 190 ug/L RDX and 100 ug/L perchlorate
- Lab scale columns loaded with GAC
- FBR #1 fed acetic acid, a simple organic substrate
- FBR #2 fed molasses, a complex organic substrate
- FBR #3 was a control (no substrate or nutrients)
- Each column fed groundwater until perchlorate effluent concentrations approached influent concentrations meaning GAC saturated with perchlorate

FBR Treatability Study – Set up



- Photo courtesy of Envirogen

FBR Treatability Study – Phase 1

Phase 1 - Acclimation

- FBRs #1 and #2 inoculated with naturally occurring bacteria already acclimated to each of the nutrient substrates
- Inoculated to accelerate study
- Operated until acclimated for destruction of perchlorate as demonstrated by effluent < 5 ug/L

FBR Treatability Study – Phase 2

Phase 2 – Operation

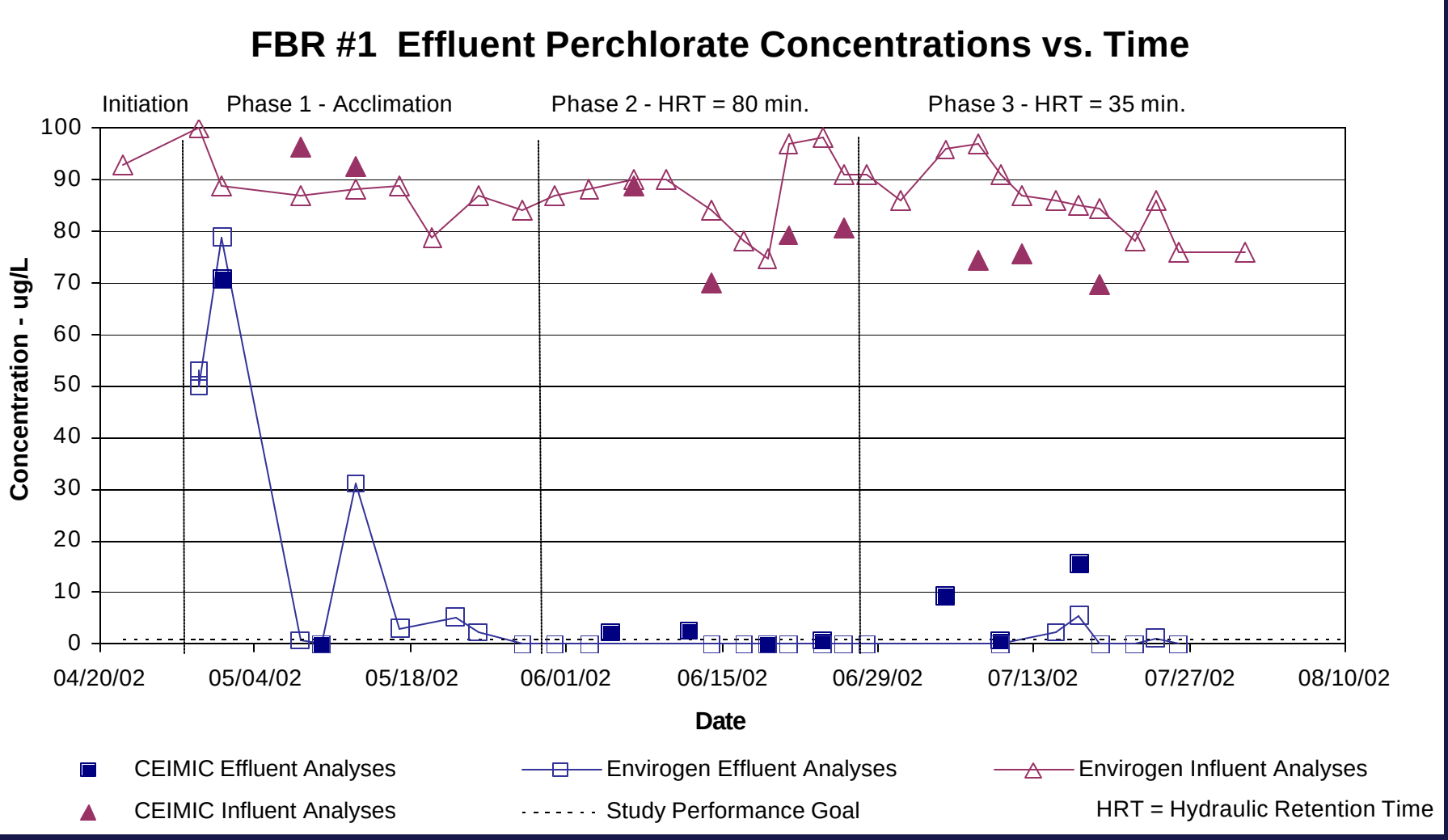
- Operated at excess organic substrate feed rates for degradation of perchlorate and explosives
- Set at hydraulic retention time (HRT) of 80 minutes
- Operated for one month and achieved perchlorate effluent < 1.5 ug/L in FBR #1

FBR Treatability Study – Phase 3

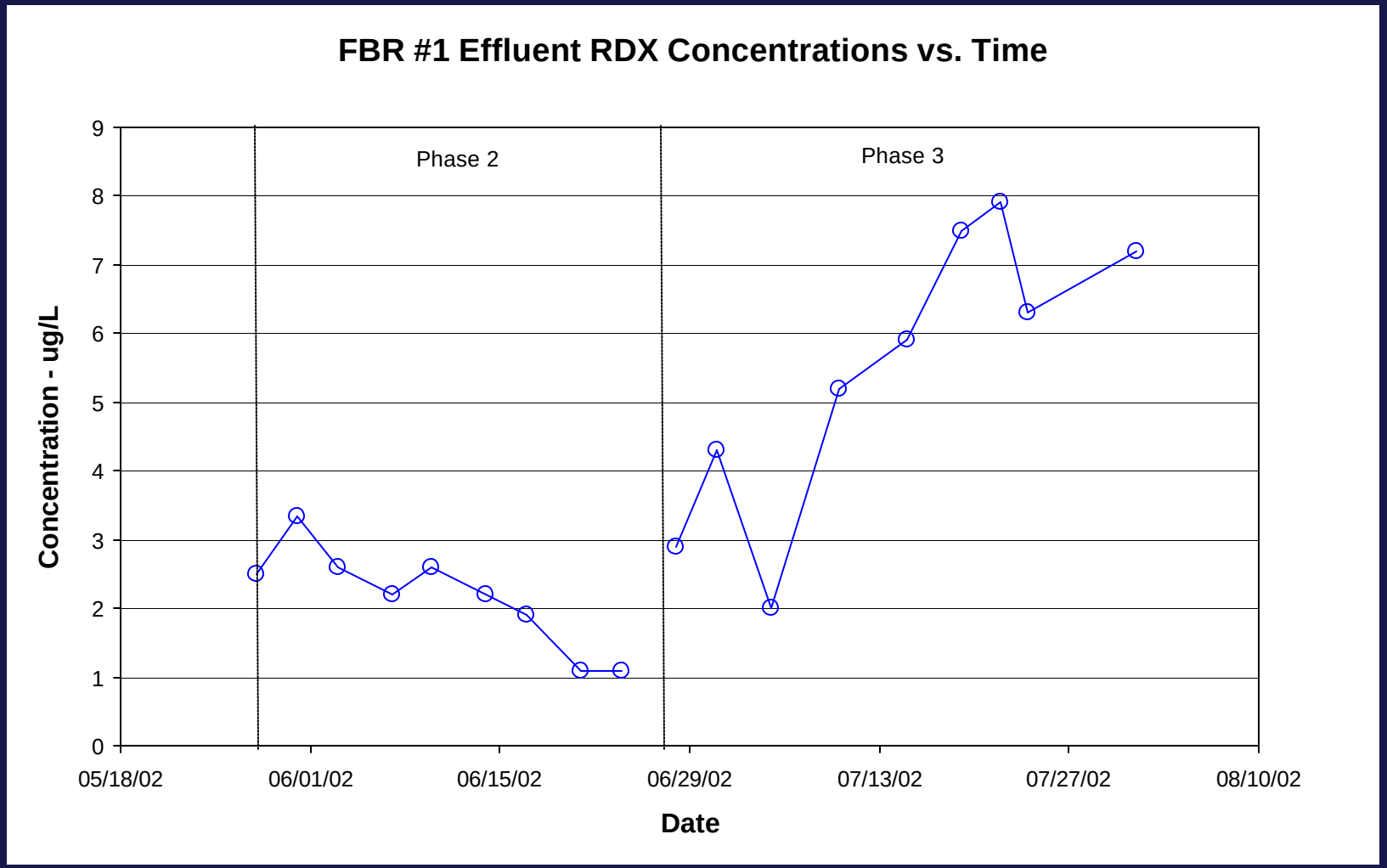
Phase 3 – Improve System Performance

- Sustained FBR #1 perchlorate effluent < 1.5 ug/L
- Reduced organic feed rate by half
- Optimize for degradation of perchlorate and RDX

FBR Treatability Study Results



FBR Treatability Study Results



FBR Treatability Study Conclusions

- Success with acetic acid fed FBR (FBR #1)
- Field-equivalent HRT of 80 minutes
  - Perchlorate reduced from 100 ug/L < 1.5 ug/L
  - RDX reduced from 190 ug/L to < 2 ug/L
- HRT of 35 minutes
  - Perchlorate reduced to < 1.5 ug/L
  - RDX could be removed by secondary GAC unit

FBR Treatability Study Conclusions

- The molasses fed FBR (FBR #2) degraded perchlorate and RDX, but did not meet study performance goals
- RDX that sorbed to the GAC in FBR #1 (acetic acid) was consistently 2 orders of magnitude lower than in FBR #2 and FBR #3 (control). This tells us that the biologically active film on the GAC in FBR #1 was effective at destroying a significant amount of sorbed RDX
- Bottom line = FBR can perform as a stand alone alternative to traditional lead-lag multiple step treatment trains for perchlorate and explosives

ITE - Moving Forward

- Results support design of treatment systems for concurrent removal of explosives and perchlorate
- Army/NGB considering FBR to treat commingled RDX and perchlorate in groundwater at Camp Edwards
- Potential application for the central portion of the groundwater plume underlying Demolition Area 1
- ITE team continues to evaluate GAC and IX Resins with respect to treatment of low concentrations of perchlorate and explosives in groundwater