CASE STUDY

Fort Hood Site
Killeen, Texas

August 2010

Prepared by
The Interstate Technology & Regulatory Council
Mining Waste Team

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FORT HOOD SITE, KILLEEN, TEXAS

1. SITE INFORMATION

1.1 Contacts

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1.2 Name, Location, and Description

New landfill located at Fort Hood, Texas.

2. REMEDIAL ACTION AND TECHNOLOGIES

To ensure the sustainable operation of a newly constructed landfill at Fort Hood during its 30-year projected operational life, the Department of the Army needed sustainable technologies to treat metals that were the contaminants of concern in the landfill leachate. A two-phase, engineered, green-treatment approach consisting of a microbial mat bioreactor (MMB) and multiple, small, containerized constructed treatment wetlands (CTWs) connected in series was evaluated at the field pilot scale. The basic conceptual design relied on the MMB to remove the bulk of the iron, manganese, and lead. The effluent from the MMB then flowed into the CTWs to remove the boron as well as additional iron, manganese, and lead. An oxidation/settling "pond" was included as the final stage of the CTWs to "polish" the treated effluent before disposal into the privately owned treatment works.

The final design used six CTW cells. Two large cells were 85" L × 56" W × 21" H, and four small cells were 48" L × 45" W × 22" H, for a total capacity of 535 gal:

Cell 1 (120 gal)—Duckweed (*Lemnaceae*)
Cell 2 (75 gal)—Cattails (*Typha latifolia*)
Cell 3 (120 gal)—Parrot feather (*Myriophyllum aquaticum*)
Cell 4 (35 gal)—Smartweed (*Polygonum hydropiperoides*)
Cell 5 (120 gal)—Bulrush (*Scripus sp.*)
Cell 6 (120 gal)—Aeration/settling

The smaller cells were enclosed in metal frames for support, and the larger did not have an external support frame. The CTW treatment train was set up as shown in Figures 2-1 and 2-2. Flow rates and residence times are shown in Table 2-1.

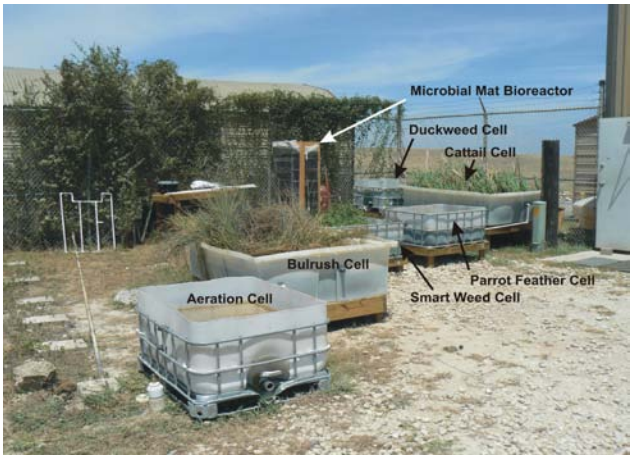


Figure 2-1. Technology design.

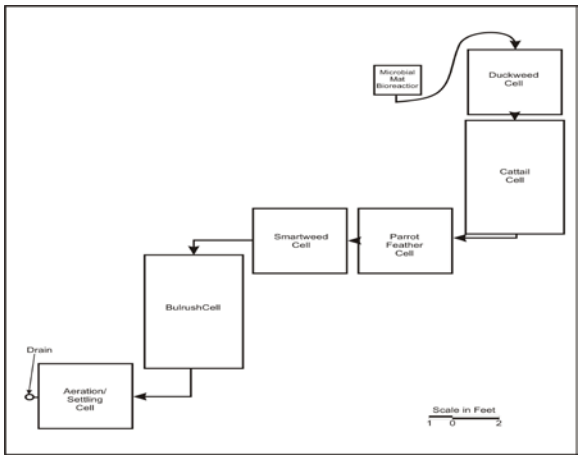


Figure 2-2. Technology overview.

Table 2-1. Flow data for pilot test

Parameter	Microbial mat bioreactor	Containerized constructed treatment wetlands
Flow rate in, gpm	2	1 gpm
Total volume treated, gal	11,520	5,760
Residence time, minutes	N/A	535
Residence time, hours	N/A	8.9

The treatment goals for the project were set as follows:

- Iron—Removal to <0.1 mg/L (1,000 μg/L)
- Boron—Removal to <0.5 mg/L (5,000 μg/L or 5 mg/L)
- All metals—≥80% removal

3. PERFORMANCE

The MMB/CTW pilot test proved the viability of a modular MMB and CTW treatment system for metals removal from water. The MMB performed quite well prior to coating of the mat surface by undissolved iron precipitates. Even after the mats were coated with the precipitates, the system was still able to achieve some of the remediation goals.

The influent iron concentrations in Fort Hood landfill leachate used in this pilot test varied widely 6,980–15,700 μg/L. Interpretation of the results of this pilot test was complicated by the fact that the influent concentration of the different metals in the untreated leachate was not consistent throughout the duration of the test. Specifically, the initial metal concentration varied with each batch of leachate supplied for treatment. Additionally, the concentration of some metals in some batches of the supplied leachate was low and below the treatment goal. Although the microbial mats were initially effective in removing >80% of the influent iron at a flow rate of 2 gpm, the bioactive mat surface was quickly overwhelmed by the deposit of precipitated iron in the influent leachate, which reduced the removal efficiency to <60% of the influent iron

concentrations (Figures 3-1 and 3-2). Because the bioreactor was overwhelmed by the suspended iron, there were few microbial mat bioactive sites available for adsorption or precipitation of manganese, lead, or boron.

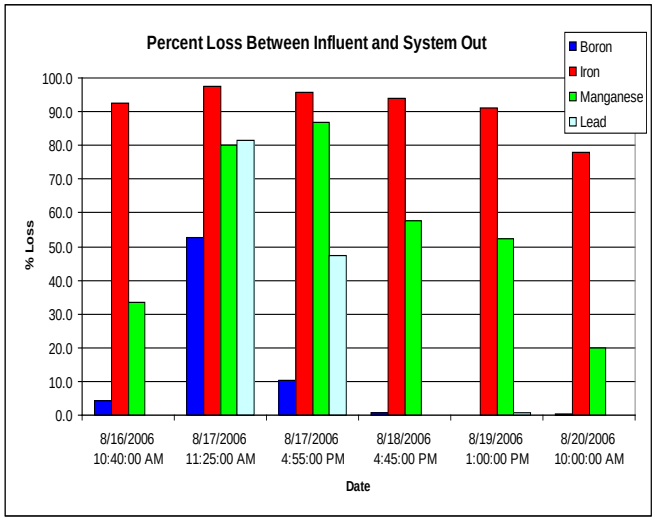
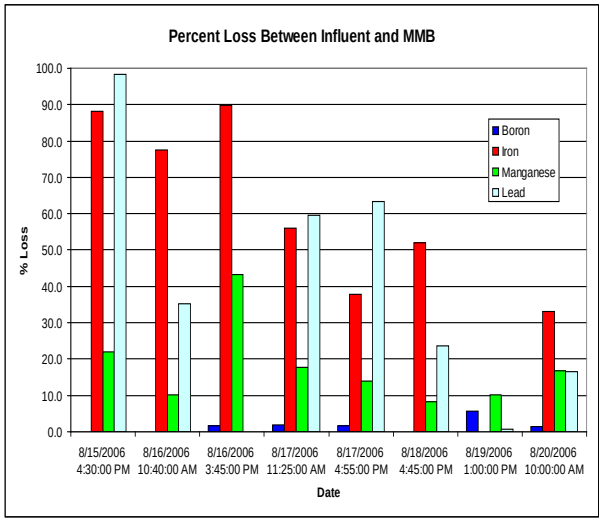


Figure 3-1. Loss of selected metals when comparing system influent and system effluent of the constructed treatment wetland. (Negative values omitted for clarity.)



Figures 3-2. Percent loss of selected metals when comparing system influent and effluent of the microbial mat bioreactor. (Negative values omitted for clarity.)

Overall the microbial mat bioreactor connected in series with the containerized treatment wetlands achieved the treatment goals (1,000 ppb) for iron. The boron levels in the landfill leachate were below the treatment goal, and so it is not possible to determine whether the MMB/CTW system can consistently remove boron to levels below the 5,000 µg/L treatment goal. The results of this pilot test highlight the need to install an iron precipitation and filtration step ahead of the modular microbial mat bioreactor. This goal can be easily accomplished by adding lime and sulfide to the influent landfill leachate and precipitating out the bulk of the iron. Pretreated landfill leachate, which contains little or no iron in suspension, should allow for optimum performance of the microbial mat bioactive surface.

A comparison of the treated effluent from the MMB and the CTW (Figures 3-1 and 3-2) indicates that the constructed treatment wetland was necessary to further remove some of the metals to the stringent compliance level. The treatment goals for iron (Table 3-1) were attainable by using the MMB alone.

Table 3-1. Treatment goals for pilot phase

Contaminant	Cleanup concentration
Iron	0.1 ppm
Boron	0.5 ppm
All other metals	80% removal

4. COSTS

- $1.35–$1.90 per 1000 gallons.
- Low concentrations (ppb) result in lower costs.
- Metals and higher contaminant concentrations result in higher costs.

5. REGULATORY CHALLENGES

None encountered.

6. STAKEHOLDER CHALLENGES

Use of treated water for irrigation water on training ranges needed regulatory approval, which could be a lengthy process.

7. OTHER CHALLENGES AND LESSONS LEARNED

The field application of a technology developed at the bench scale encounters a number of challenges when subjected to real-world conditions. The field-scale demonstration of the passive treatment of landfill leachate using microbial mats in series with multiple, containerized CTWs experienced a number of challenges, including the following:

- The variability in landfill leachate composition from one batch to the other during the field test. This was especially problematic in estimating the percent metal removed given the 9 hours residence time and the fact that the influent and effluent (treated) samples were collected for analysis at the same time.
- The leachate was supersaturated with iron, resulting in an iron precipitate sludge in the bottom of the leachate holding tanks. The precipitate was pumped into the microbial mat bioreactor and overwhelmed the bioactive surface of the microbial mats, which significantly reduced the effectiveness of the microbial mats in removing the other metals present in the leachate at smaller concentrations.
- The irregular flow between the containerized wetlands connected in series. This was later found to be due to a blockage in one pipe at breakdown of the system.
- The low biochemical oxygen demand in the leachate did not promote mat growth, as was observed at the bench scale.

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