LEACHATE TREATMENT PILOT STUDY AT KANDIYOHI COUNTY LANDFILL

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and

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Overview

1. The Landfill
2. The Test
3. Test Process and results
4. The Technology
5. The Next Step
6. Questions

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Introduction

Kandiyohi County landfill is a combined municipal, C&D and organic waste lined landfill at approximately 12 mile north of City of Willmar, MN.

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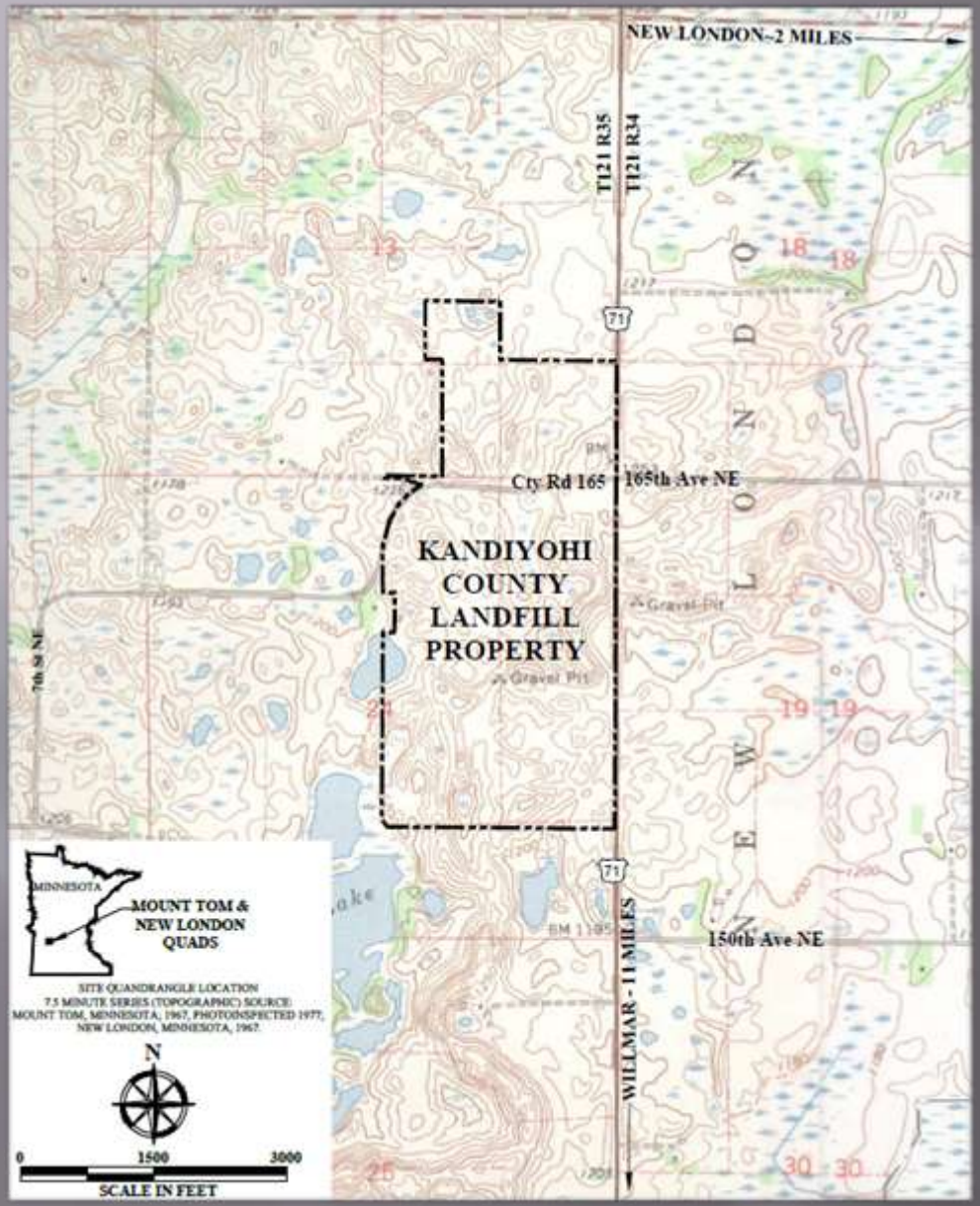
Site Location



15650 Highway 71 NE
New London, MN

270 Acre Property
11 miles North of
Willmar, Minnesota

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Site History (1970–2014)

- Ownership
  - The City of Willmar purchased the original disposal area from Elwood and Merrily Bangston in the summer of 1968, and used it as an open dump.
  - Kandiyohi County purchased that site from the City of Willmar in 1987 to continue municipal solid waste disposal activities.
- Solid Waste Disposal Permit SW-79
  - July 1972: First MPCA Permit issued
  - July 1997: C&D Landfill Separated from MSW
  - October 2016: Current Permit Expires
  - The existing facility consists of approximately 100 acres. Approximately 80 acres is for MSW, and 10 is for C&D waste disposal.

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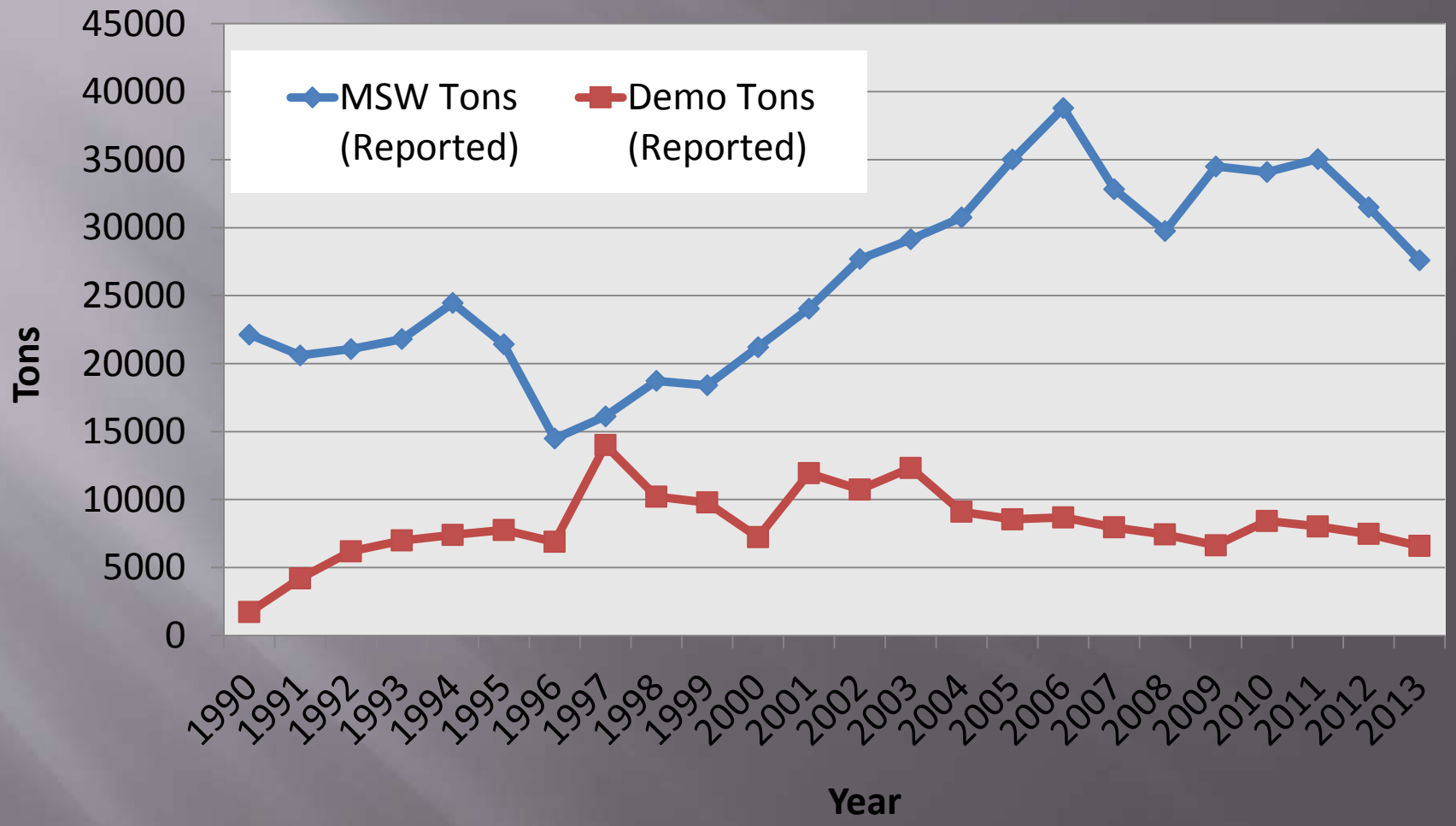
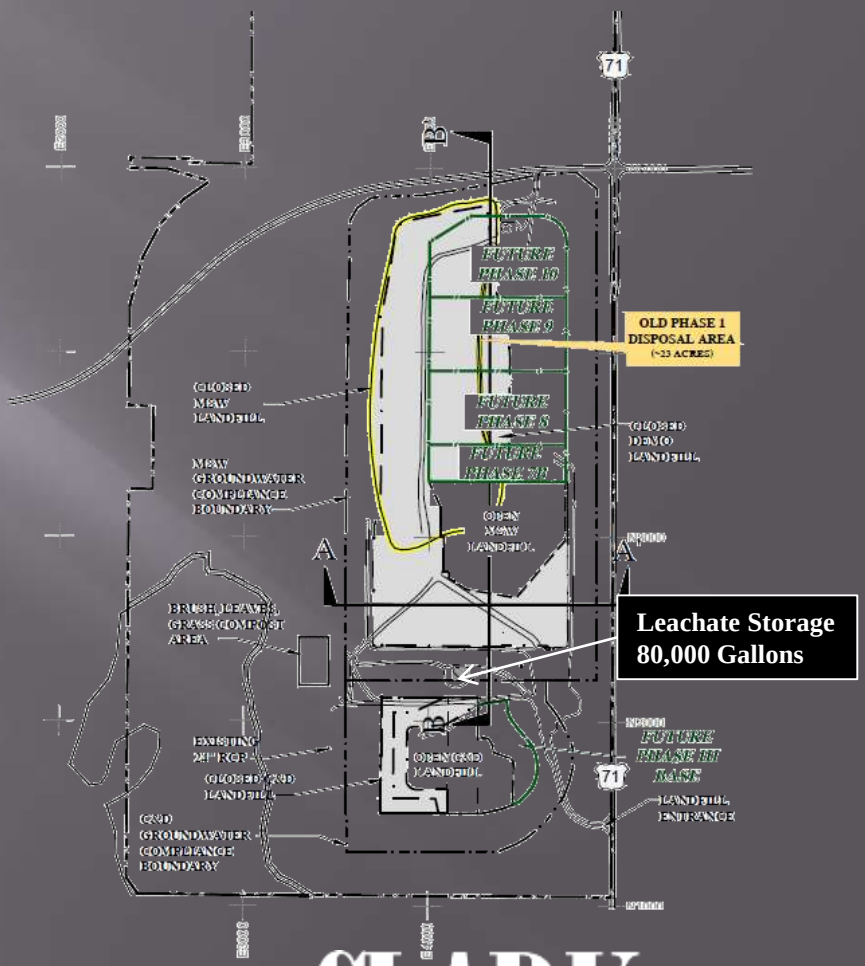
Solid Waste Disposal Rate History



Phased Development

- Old Phase I Disposal Area
  - 23 Acres unlined
  - MSW & Demo
  - Closed in 1993
- MSW Phases II-VI (A-A′)
  - 15.6 Acres lined
  - Opened in 1993
  - 10.8 Acres closed & capped
- MSW Phases 7-10 (B-B′)
  - Proposed 27.5 Acres lined
  - 8.4 Acres open (Phase 7)
  - Phases 8-10 not permitted or developed yet



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Leachate Storage/Transfer Station

- 80,000 Gallons Underground Storage
- Leachate Production at 2,500-20,000 gallons per day

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Historical Leachate Treatment Options Considered

1. Transport to Wastewater Treatment Facility (WWTF)
2. Land Spreading
3. On-Site Recirculation (Bioreactor)
4. Evaporation

Leachate Treatment Procedures Implemented

- 1993-2011
  - Transport to St. Paul Met Council WWTF (Primary)
  - Transport to Willmar WWTF (Contingency/Secondary)
- 2011-Present
  - Transport to Willmar WWTF (Primary)
  - Transport to St. Paul Met Council WWTF Contingency/Secondary)

2013 Leachate Cost Details

- 3,401,620 Gallons Transported Off-Site
  - 9,320 Gallons Per Day Average
  - 28.58 inches of precipitation reported
- 2013 Cost Breakdown
  - Trucking: $102,500
  - Treatment: $108,400
  - Leachate Quality Testing: $ 1,600

Total Cost:	**$212,500**
Cost per Gallon:	**$0.0625**

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Kandiyohi County Landfill

View west of leachate storage tank installation

NE view of leachate storage/transfer station

Transfer Station Storage Tank Pump Lines

THE TEST

Pilot Testing was conducted to evaluate the applicability of Clark's LeachBuster™ for treatment of leachate produced at Kandiyohi County Landfill, Willmar MN.

THE TEST

The test was conducted in three phases

1. Treatability Test
2. Feasibility Study
3. Engineering and Parametric Study

TREATABILITY STUDY

This is done in our labs to establish the characteristics of leachate.

In August 12, 2013 a sample of leachate was obtained from the Kandiyohi County Landfill and used to conduct the relatability test.

During this test we found that this particular leachate can be treated to produce desired effluent quality.

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FEASIBILITY STUDY

Based on the result of the treatability test, a suitable treatment procedure was established. A portable scaled down model of the LeachBuster™ was constructed and transported to the County Landfill.

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Kandiyohi County Landfill Feasibility Test

- On September 10th, 2013
  - The pilot unit was transported to the Kandiyohi County Landfill.
- On September 11th, 2013
  - The system was prepared for conducting phase I testing.
- On September 11th, 2013
  - With the presence of MPCA staff and County officials a series of tests were conducted.
  - Samples were obtained for laboratory analysis.
  - Test parameters were recorded (available for review, if required).

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Sampling and Analysis

The following Standards were used for analysis:

Parameter	Analytical Code	Analytical Method
BOD Biological Oxygen Demand 5 day	**Hach 10360 Rev 1.1**	*Hach 10360 Rev 1.1*
Total Solids	**2540B**	*SM 2540B*
Total Suspended Solids	**2540D**	*SM 2540D*
Fecal Coli (Water)	**MBIO 9222D**	*SM 9222D*
Ammonia Nitrogen	**350.1**	*EPA 350.1*
Total Kjeldahl Nitrogen	**351.2**	*EPA 351.2*
COD Chemical Oxygen Demand	**5220D**	SM 5220D
Total Phosphorus	**SM4500P-E**	*SM 4500-P E*

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Results

Highlights

- Removal of Pathogens without using disinfectants
  - E-coli <2 CFUs/100 ml
  - Fecal Coliforms < 10 CFUs/100 ml
  - No THMs or DBPs
- Removal of PFCs
- Removal of Chlorides
- Removal of Boron
- Removal VOCs

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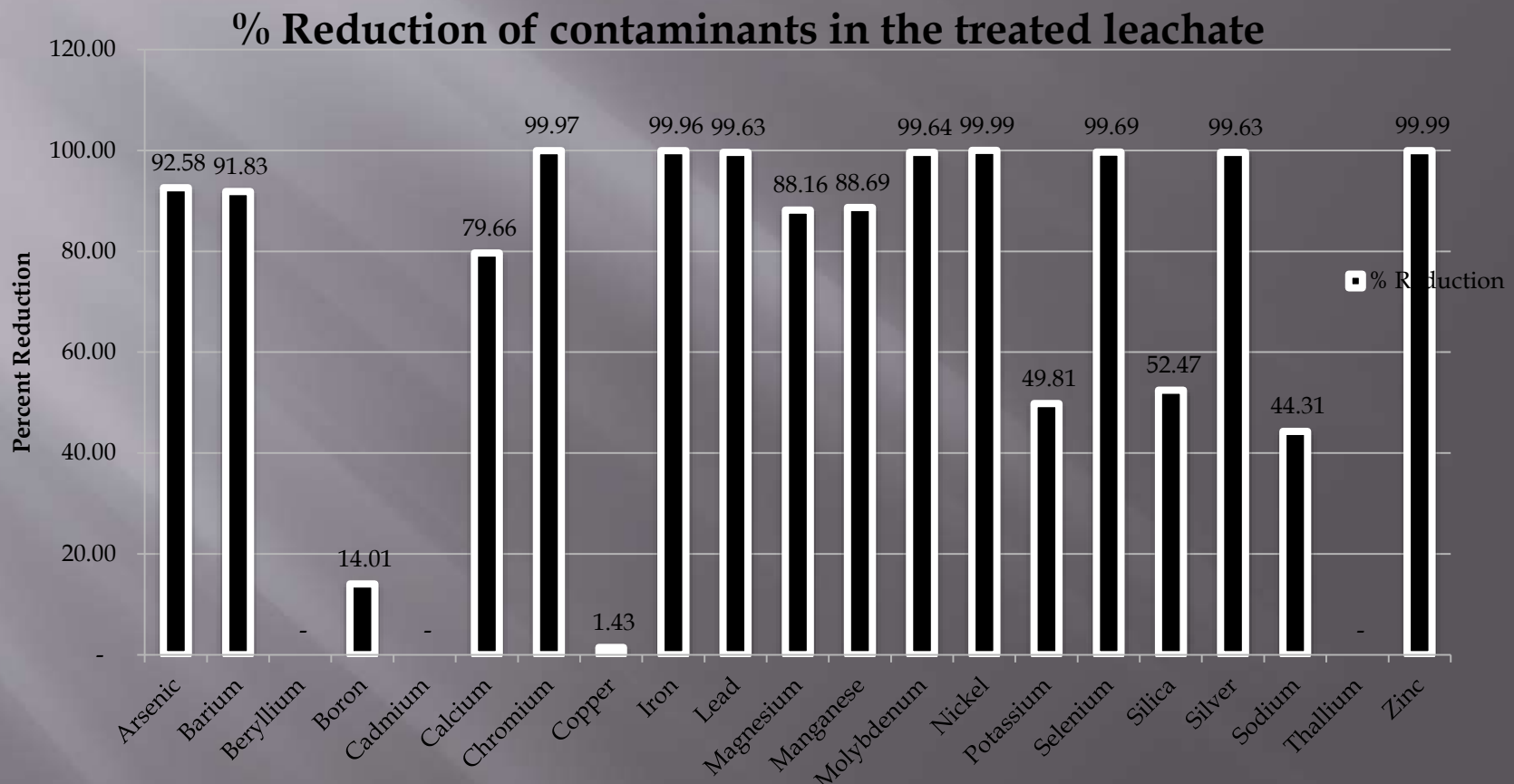
Results – ICP Metals



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Results

Raw and Treated Leachate

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ENGINEERING AND PARAMETRIC STUDY

This study was conducted to:

1. Identify design characteristics for the full scale system
2. Obtain engineering and design parameter for the full scale machine
3. Define the configurations, layout, elements and operation procedure for the final system

CHRONOLOGY OF THE EVENTS

- June 16, 2014 to June 19, 2014:
  - Transporting the testing equipment to KANDIYOHI County Landfill.
- On June 19th
  - Scientists and engineers start install and commissioned the test units.
- June 20th
  - Clean water test was conducted to evaluate the systems integrity and performance.
- June 23rd
  - Tests were commenced and continued for three weeks.
- July 3rd
  - The testing was completed and samples were sent for analysis.
- July 18th to July 28th sample results were received.

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SAMPLE ANALYSIS

About 40 sample groups were analyzed for 109 parameters generating over 4,000 data points.

- Emerging contaminants of concern such as PFCs, Boron, Chlorides etc.
- Physical indicators such as, BOD, COD, TSS, TDS, TS, Conductivity, pH etc.
- Chemical analysis of common contaminants such as P, N, NOx, NH3, Chlorides, Sulfates, Bromides etc.
- Metals assay including ICP metals such as Cd, Cr, Cu, Pb, Se, Sb, etc.
- Volatile Organic Compounds such as TCE, DCE, MEK etc.
- Biological Assay such as Fecal Coliform and E-coli bacteria

SAMPLE ANALYSIS

Effect of different parameters were evaluated:

- Physical parameters such as pH, Dissolved Oxygen Levels
- Daily variations
- Different recovery rates such as: 90%, 95%, and 97.5%

SYSTEM PERFORMANCE

Results

Results confirmed our expectations that LeachBuster™ can remove all the contaminants from leachate stream and produce an effluent quality which meets most stringent quality requirements by the local and national regulatory organizations

Contaminant levels in the effluent were substantially reduced below the limits set by HRLs, 25% of ILs, NPDES and specially the Primary National Drinking Water Standards

RESULTS

Raw Leachate

The samples were analyzed to obtain raw leachate characteristics which were as follows:

Parameter	Value
BOD (mg/l)	>14000
COD (mg/l)	>30000
pH	7-8.5
Temperature	65 to 75
Ammonia	>400
TDS (mg/l)	>5000
TSS (mg/l)	>2000
Total Coliforms (CFUs/100ml)	>7 logs

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RESULTS

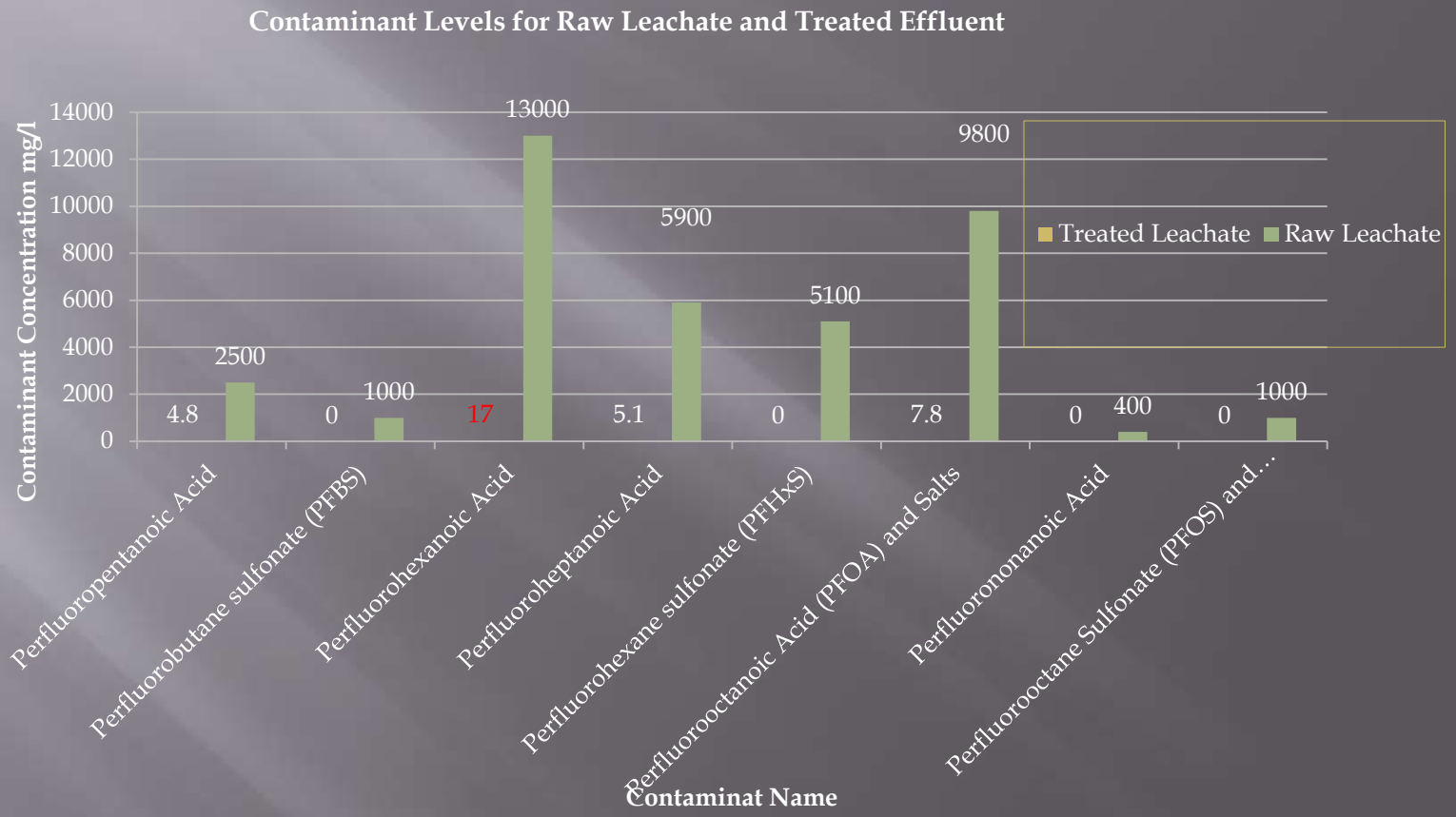
PFCs First Round

One of the major differentiating parameters of this technology is its ability to remove PFCs. The following is the influent and effluent results as compared to the regulatory limits

	Amount of contaminants in raw leachate, treated effluent and Concentrate together with ILs and HRLs.						
Analyte	Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Perfluoropentanoic Acid	2500	4.8			99.81	100	ng/l
Perfluorobutane sulfonate (PFBS)	1000	ND		7000	100.00	63	ng/l
Perfluorohexanoic Acid	13000	17			99.87	570	ng/l
Perfluoroheptanoic Acid	5900	5.1			99.91	610	ng/l
Perfluorohexane sulfonate (PFHxS)	5100	ND		7000	100.00	360	ng/l
Perfluorooctanoic Acid (PFOA) and Salts	9800	7.8		300	99.92	620	ng/l
Perfluorononanoic Acid	400	ND		300	100.00	ND	ng/l
Perfluorooctane Sulfonate (PFOS) and Salts	1000	ND		300	100.00	45	ng/l
Perfluorodecanoic Acid	ND	ND			ND	ND	ng/l
Perfluoroundecanoic Acid	ND	ND			ND	ND	ng/l
Perfluorododecanoic Acid	ND	ND			ND	ND	ng/l

RESULTS

PFCs



RESULTS

PFCs Second Round

To confirm the results another set of samples were analyzed for PFCs and results are given below.

Analyte	Standard[1]	Amount of contaminants in raw leachate, treated effluent and Concentrate together with ILs and HRLs.						
		Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Perfluoropentanoic Acid		ND	ND			ND	260	ng/l
Perfluorobutane sulfonate (PFBS)	M	680	ND		7000	100.00	160	ng/l
Perfluorohexanoic Acid		8300	10			100.00	1700	ng/l
Perfluoroheptanoic Acid		3200	ND			100.00	580	ng/l
Perfluorohexane sulfonate (PFHxS)	M	2600	ND		7000	100.00	550	ng/l
Perfluorooctanoic Acid (PFOA) and Salts	M	4500	ND		300	100.00	720	ng/l
Perfluorononanoic Acid	M	ND	ND		300	ND	ND	ng/l
Perfluorooctane Sulfonate (PFOS) and Salts	M M	1100	ND		300	100.00	150	ng/l
Perfluorodecanoic Acid		ND	ND			ND	ND	ng/l
Perfluoroundecanoic Acid		ND	ND			ND	ND	ng/l
Perfluorododecanoic Acid		ND	ND			ND	ND	ng/l

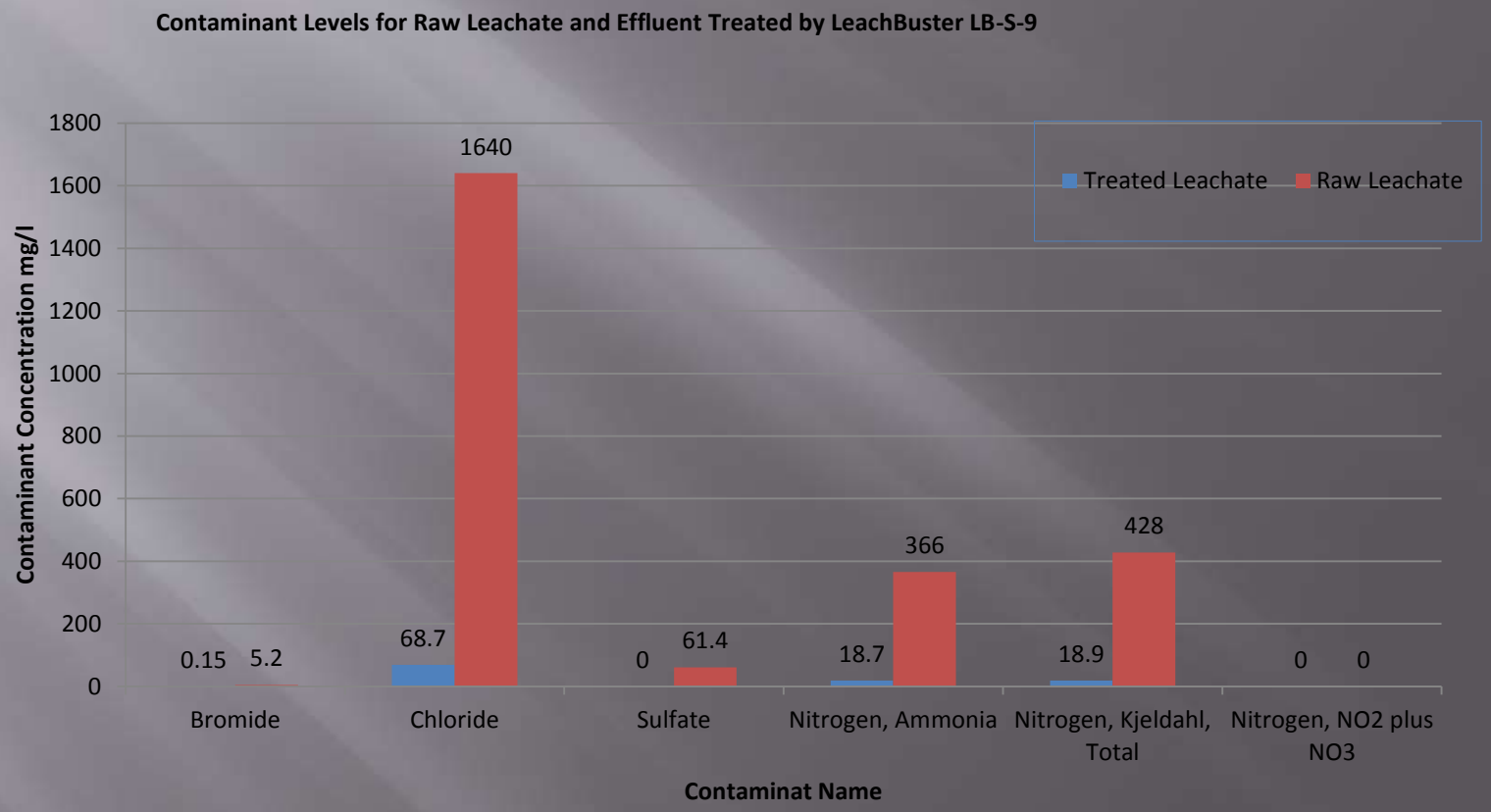
RESULTS

Salts and Selected Compounds

Analyte	Standard[1]	Amount of contaminants in raw leachate, treated effluent and Concentrate together with ILs and HRLs.						
		Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Bromide	M	5.2	0.15			97.12	4.1	mg/L
Chloride	M	1640	68.7	250		95.81	1330	mg/L
Sulfate	M	61.4	ND			100.00	49.6	mg/L
Nitrogen, Ammonia	M	366	18.7			94.89	305	mg/L
Nitrogen, Kjeldahl, Total	M	428	18.9			95.58	348	mg/L
Nitrogen, NO2 plus NO3	M	ND	ND	2500	10,000	ND	ND	mg/L

RESULTS

Salts and Selected Compounds



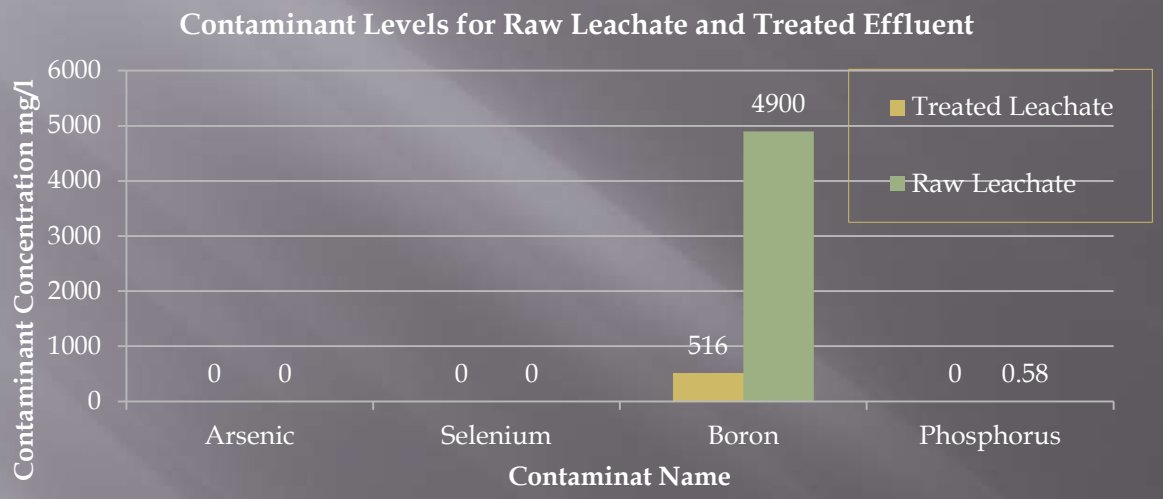
RESULTS

Metalloids

		Amount of contaminants in raw leachate, treated effluent and Concentrate together with ILs and HRLs.						
Analyte	Standard[1]	Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Arsenic	M	ND	ND	12.5		ND	ND	ug/L
Selenium	M	ND	ND	11	30	ND	21.7	ug/L
Boron	M	4900	516	250	1000	89.47	3920	ug/L
Phosphorus	M	0.58	ND			100.00	0.93	mg/L

RESULTS

Metalloids



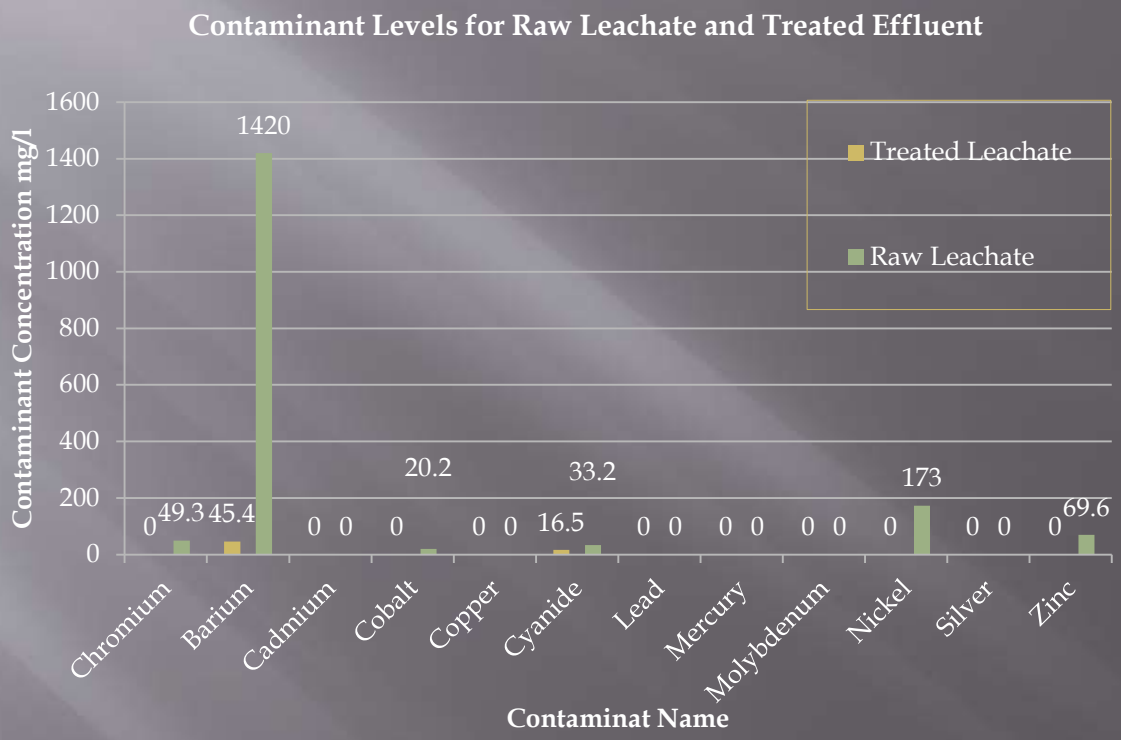
RESULTS

Metals

Analyte	Standard[1]	Amount of contaminants in raw leachate, treated effluent and Concentrate together with ILs and HRLs.						
		Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Chromium	M	49.3	ND	30		100.00	52	ug/L
Barium	M	1420	45.4	375	2,000	96.80	2290	ug/L
Cadmium	M	ND	ND	1.25		ND	ND	ug/L
Cobalt	D	20.2	ND	100		100.00	19.1	ug/L
Copper	M	ND	ND	325		ND	175	ug/L
Cyanide	D	33.2	16.5	1500		50.30	24.1	ug/L
Lead	M	ND	ND	5		ND	24.4	ug/L
Mercury	M	ND	ND	0.75		ND	ND	ug/L
Molybdenum	D	ND	ND	300		ND	ND	ug/L
Nickel	M	173	ND	38	100	100.00	151	ug/L
Silver	M	ND	ND	40	30	ND	ND	ug/L
Zinc	M	69.6	ND	50	2,000	100.00	103	ug/L

RESULTS

Metals



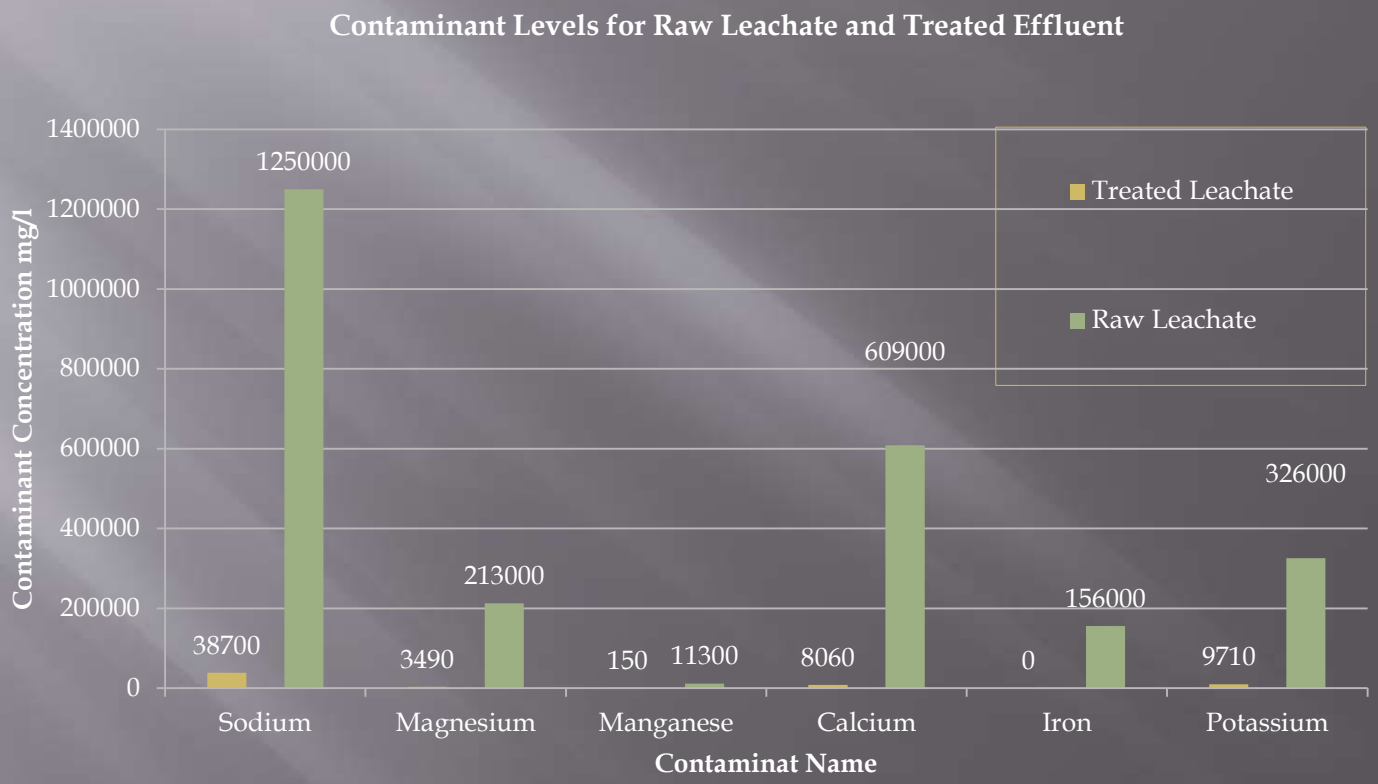
RESULTS

Non-regulated Compounds

		Amount of contaminants in raw leachate, treated effluent and Concentrate together with ILs and HRLs.						
Analyte	Standard[1]	Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Sodium		1250000	38700			96.90	1E+06	ug/L
Magnesium		213000	3490			98.36	167000	ug/L
Manganese		11300	150		300	98.67	8470	ug/L
Calcium		609000	8060			98.68	480000	ug/L
Iron		156000	ND			100.00	168000	ug/L
Potassium		326000	9710			97.02	256000	ug/L

RESULTS

Non-regulated Compounds



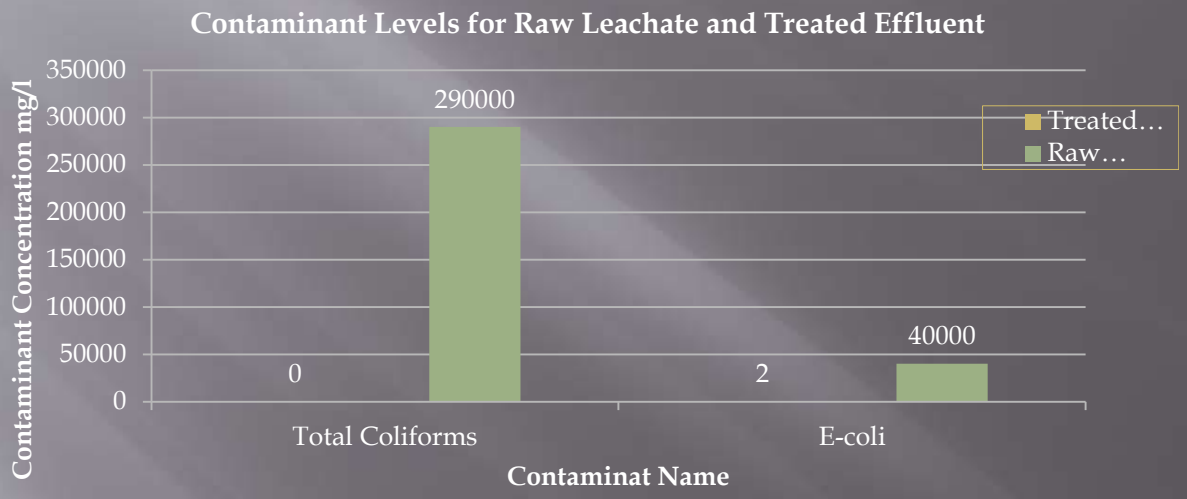
RESULTS

Pathogens

	Amount of contaminants in raw leachate, treated effluent and concentrate together with ILs and HRLs.						
Analyte	Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Total Coliforms	290,000	0	100.00		100	330000	CFU/100 mL
E-coli	400,000	<2	40		99.99	654000	CFU/100 mL

RESULTS

Pathogens



RESULTS

Physical Parameters

Analyte	Standard[1]	Amount of contaminants in raw leachate, treated effluent and concentrate together with ILs and HRLs.						
		Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Turbidity		9020	0.12			98.07	3750	NTU *
Electric Conductivity		14,000	300.7			98.46	4840	MS+
pH		7.4	7.1			-------	7.3	
Temperature		64	89			-------	90	°F

RESULTS

Volatiles, Semi-Volatiles, Polly Aromatic and other organic Compounds

Analyte	Qualifier	Raw Leachate	Treated Leachate	HAs[a]	HRLs[a]	Removal (%)	Concentrate	Units
Acetone	D	6400	853	5000		86.86	5710	ug/L
Allyl chloride		ND	ND	7.35	50	ND	ND	ug/L
Benzene		ND	ND	3		ND	ND	ug/L
Bromobenzene		ND	ND			ND	ND	ug/L
Bromochloromethane		ND	ND		10	ND	ND	ug/L
Bromodichloromethane		ND	ND		60	ND	ND	ug/L
Bromoform		ND	ND		40	ND	ND	ug/L
Bromomethane		ND	ND		10	ND	ND	ug/L
2-Butanone		ND	ND		100	ND	ND	ug/L
n-Butylbenzene		ND	ND			ND	ND	ug/L
sec-Butylbenzene		ND	ND			ND	ND	ug/L
tert-Butylbenzene		ND	ND			ND	ND	ug/L
Carbon tetrachloride		ND	ND	0.67		ND	ND	ug/L
Chlorobenzene		ND	ND	15		ND	ND	ug/L
Chloroethane		ND	ND			ND	ND	ug/L
Chloroform		ND	ND	1.3		ND	ND	ug/L
Chloromethane		ND	ND			ND	ND	ug/L
2-Chlorotoluene		ND	ND			ND	ND	ug/L
4-Chlorotoluene		ND	ND			ND	ND	ug/L
1,2-Dibromo-3-chloropropane	ND	ND			ND	ND	ug/L	
Dibromochloromethane		ND	ND			ND	ND	ug/L
1,2-Dibromoethane (EDB)		ND	ND			ND	ND	ug/L
Dibromomethane		ND	ND	0.082		ND	ND	ug/L
1,2-Dichlorobenzene		ND	ND	155	600	ND	ND	ug/L
1,3-Dichlorobenzene		ND	ND	155		ND	ND	ug/L
1,4-Dichlorobenzene		ND	ND	18.8	10	ND	ND	ug/L
Dichlorodifluoromethane		ND	ND			ND	ND	ug/L
1,1-Dichloroethane								ug/L
1,2-Dichloroethane								ug/L
1,1-Dichloroethene								ug/L
cis-1,2-Dichloroethene								ug/L
trans-1,2-Dichloroethene								ug/L
Dichlorofluoromethane								ug/L
1,2-Dichloropropane								ug/L
1,3-Dichloropropane								ug/L
2,2-Dichloropropane								ug/L
1,1-Dichloropropene								ug/L
cis-1,3-Dichloropropene								ug/L
trans-1,3-Dichloropropene								ug/L
Diethyl ether (Ethyl ether)								ug/L
Diisopropylether		ND	ND	170	50	ND	ND	ug/L
Hexachloro-1,3-butadiene		ND	ND		1	ND	ND	ug/L
Isopropylbenzene (Cumene)		ND	ND			ND	ND	ug/L
p-Isopropyltoluene		ND	ND			ND	ND	ug/L
Methylene Chloride		ND	ND			ND	ND	ug/L
4-Methyl-2-pentanone (MIBK)		ND	ND	ND	ND			ug/L
Methyl-tert-butyl ether		ND	ND			ND	ND	ug/L
Naphthalene		ND	ND		70	ND	ND	ug/L
n-Propylbenzene		ND	ND			ND	ND	ug/L
Styrene		ND	ND			ND	ND	ug/L
1,1,2-Trichloroethane		ND	ND		70	ND	ND	ug/L
1,1,2,2-Tetrachloroethane		ND	ND	0.44	2	ND	ND	ug/L
Tetrachloroethene		ND	ND	1.7	5	ND	ND	ug/L
Tetrahydrofuran	D	804	45.8	300		94.30	654	ug/L
Toluene		ND	1.9	2.1	200	ND	ND	ug/L
1,2,3-Trichlorobenzene		ND	ND			ND	ND	ug/L
1,2,4-Trichlorobenzene		ND	ND		100	ND	ND	ug/L
1,1,1-Trichloroethane		ND	ND	50	9000	ND	ND	ug/L
1,1,2-Trichloroethane		ND	ND	1.5	3	ND	ND	ug/L
Trichloroethene		ND	ND			ND	ND	ug/L
Trichlorofluoromethane		ND	ND		2,000	ND	ND	ug/L
1,2,3-Trichloropropane		ND	ND		7	ND	ND	ug/L
1,1,2-Trichlorotrifluoroethane	D	ND	200,000			ND	ND	ug/L
1,2,4-Trimethylbenzene		ND	ND		100	ND	ND	ug/L
1,3,5-Trimethylbenzene		ND	ND		100	ND	ND	ug/L
Vinyl chloride		ND	ND	0.037	10	ND	ND	ug/L
Xylene (Total)		ND	ND	110	300	ND	ND	ug/L

Example

RESULTS

Volatiles, Semi-Volatiles, Polly Aromatic and other organic Compounds

Analyte	Standard[1]	Amount of contaminants in raw leachate, treated effluent and Concentrate together with ILs and HRLs.						
		Raw Leachate	Treated Leachate	ILs[2]	HRLs[3]	Removal (%)	Concentrate	Units
Acetone	D	6490	853	5000		86.86	5710	ug/L
Allyl chloride		ND	ND	7.35	30	ND	ND	ug/L
Benzene		ND	ND	3		ND	ND	ug/L
Bromoform		ND	ND		40	ND	ND	ug/L
Bromomethane		ND	ND		10	ND	ND	ug/L
Dibromomethane		ND	ND	0.002		ND	ND	ug/L
Vinyl chloride		ND	ND	0.037	10	ND	ND	ug/L
Xylene (Total)		ND	ND	110	300	ND	ND	ug/L

Why Treat Leachate

- Confinement - One of the most important reasons for disposing the MSW in a lined landfill is "CONFINEMENT". By not treating the leachate, all the contaminants in the MSW will end up in the environment which can find its way to surface and groundwater. This defeats the purpose of confinement.

Why Treat Leachate

- Unavailability of economical treatment options such as a nearby treatment facility or suitable land for soil treatment etc.
- Inability of the treatment plants to process raw leachate and which may require some degree of pre-treatment before they would accept leachate.

Treatment Options

- Piping or trucking to a wastewater treatment plant at a substantial transportation and treatment costs.
- Construction of elaborate biological treatment systems at considerable capital and operating cost.
- Combined pond and land treatment where permitted.

Advantages of LeachBuster™

- It can treat heavily contaminated streams with high levels of solids.
- It can be installed in a small area usually >20% of the traditional treatment systems.
- It can be zoned in residential, industrial or commercial areas.

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Advantages of LeachBuster™

- Quick installation
- Minimal operator requirement
- Flexible and can treat waste streams with high variability
- Flexibility to produce effluent with different purity levels

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Advantages of LeachBuster™

- Aesthetically pleasing with no large tanks, sludge processing equipment, etc., which cannot be located within commercial, industrial or residential areas.
- Weather independent and does not require reasonably high temperatures to support biological activities such as nitrification/denitrification or bio-metabolizing
- Lack of exposure to the air and which often attract rodents, birds, parasites. Also pathogens cannot be airborne or spilled into the environment thus impacting human and animal health.

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Advantages of LeachBuster™

- Low noise and nuisance due to the lack of aeration (large blowers), clarification and pumps, etc., which can be noisy and create nuisance.
- No elaborate construction permit requirements due to the lack of soil disturbances and construction of large structures. Also may not require environmental impact studies or reviews.
- No need for highly qualified and licensed wastewater or water treatment personnel.

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Advantages of LeachBuster™

- Lack of need for monitoring and control of sophisticated parameters such as mixed liquor suspended solids (MLSS), dissolved oxygen (DO), Volatile solids (VS) and over 30 other parameters.

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Advantages of LeachBuster™

- Land Requirement

Land Requirements for Green Treatment Technologies

Technology	Area Requirement (acre/mgd)
Free Water Surface Wetlands	10
Subsurface Flow Wetlands	15
Vertical Flow Wetlands	5
Tidal Flow Wetland Living Machine®	4
Algal Ponds	25
Water Hyacinth System	5
Duckweed System	17.5
Activated sludge	0.5

Source:
August 2009 City and County of San Francisco, 2030 Sewer System Master Plan, TASK 800, TECHNICAL MEMORANDUM NO. 802, GREEN TREATMENT PLANT TECHNOLOGIES, FINAL DRAFT

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Land Requirement ?

50,000 GPD Leachate Treatment Plant

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Advantages of LeachBuster™

Proximity for the Point of Use (PoU)

Treatment plant can be placed right where it is generated and reused.

This is an example treatment plant which is located at the yard of a major hotel and the treated water is used partially for flushing toilets as well as irrigating the landscape trees and shrubs

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Model Application

Thriveable

- Generating excess economical benefit to improve the standard of living and well beings of the society and making profit.

Restorative

- Recovering and returning back to the source such as aquifer recharge etc.

Sustainable

- Recovering and reusing all the energy and water

Green

- Recovery and reuse a certain portion such as reuse of recovered energy, water for irrigation etc.

Conventional

- Some kind of recovery but not reused. ~~Waste~~water treatment and discharge to the environment etc.

Exploitive

- Is the standard practice of use and dump.

Source: Ecala Group

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Other Applications

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Other Examples

- Municipal Wastewater - Sewage

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Industrial Wastewater

Material

- Mainly industrial wastewater with organic contaminants such as brewery wastewater, vegetable and fruit canning operations, tanneries and similar industries

Revenue

- Treatment charges:- Can vary from $1.00/1000 gallons to $10/1000 gallons
- Treatment costs are assessed on the BOD, TSS and in some areas TKN load and can be substantially higher and cost prohibitive.
- Elimination of full scale wastewater treatment plant and associated capital:- Can vary from $200/ daily gallon treatment capacity (dgtc) to $500/ dgtc for example for a 10,000GPD system can cost from $2,0000,000 to $5,000,000

Very Costly site

Intangibles

- Environmental Impact:- Ground and surface water protection
- Long term liability abatement
- Aesthetics

Not a pretty site

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The System

How is it done

- It consists of a small aeration/equalization/settling tank
- A small water intake tank
- A small sludge holding tank

Clark System
500m3/day

Another Company
500m3/day

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Thank You for your attention

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Oh, forgot to mention portabilty

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Questions?

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Next Steps

Don't want to pour money down the drain?

Call Clark Engineering

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