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June 11, 2008
Kleinfelder Project No. 84647

Mr. Robert Kendziorski
Liquid Separation Technologies and Equipment, LLC
27405 Puerta Real, Suite 235
Mission Viejo, California 92691
robertk@lst-equip.com

Re: Case Study and Cost Analysis Report
LSTE - 10

Dear Mr. Kendziorski:

Kleinfelder, Inc. (Kleinfelder) is submitting the enclosed *Case Study and Cost Analysis Report*. Should you have any questions or require additional information regarding this report, please contact the Project Manager, Mr. W. Kent Hedges, at (512) 926-6650.

Respectfully submitted,

KLEINFELDER, INC.

W. Kent Hedges
Project Manager

enclosure

cc: Ms. Emily Anderson - ExxonMobil Oil Corporation (w/enclosure)
Mr. David Drewelow - Drewelow Remediation Equipment, Inc. (w/enclosure)
Mr. Mike Smith - Drewelow Remediation Equipment, Inc. (w/enclosure)

CASE STUDY AND COST ANALYSIS REPORT

LSTE - 10

Prepared for:

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June 11, 2008

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PURPOSE

Kleinfelder was contracted by Drewelow Remediation Equipment, Inc. (DRE) and Liquid Separation Technologies and Equipment, LLC (LSTE) to perform a cost comparison between Liquid Separation Technologies and Equipment's proprietary process (LSTE-10; a 10 gallons per minute unit) and three competing remediation technologies, with a focus on the effective remediation of specific constituents of concern including methyl-*tertiary* butyl ether (M*t*BE) and *tertiary*-butyl alcohol (*t*BA). The competing technologies included Granulated Activated Carbon (GAC), low-profile Air Stripping (AS) and ex-situ bioremediation via a Fluidized Bed Reactor (FBR). These technologies were chosen to compare with the LSTE-10 due to their popular use in the remediation of retail service stations. GAC, AS and FBR technologies are currently being used by Kleinfelder; therefore, the cost comparisons are based on actual operating experience. Specifically, costs from seven AS systems, two FBR systems and fourteen GAC systems, as well as conversations with other remediation professionals throughout Kleinfelder, are incorporated into this analysis.

Environmental consultants and equipment vendors should work cooperatively to develop an optimal remedial system design, taking into account remedial objectives and costs to construct, operate and maintain each system. In addition, system installations should be designed to minimize the long-term impact to site operations and the surrounding communities.

1.0 ANALYSIS METHODOLOGY

The goal of the analysis was to estimate a cost-per-treated-gallon of influent assuming a fixed flow rate and fixed process stream composition over one, two, five and ten years of remediation system operation; thus determining the most effective and economical remediation technology. The report and cost analysis consider the influent makeup, flow rate, capital cost of the technology, typical construction costs and periodic operations and maintenance (O&M) costs for the primary technology and all ancillary equipment. The cost-per-gallon for two, five and ten years of operation is estimated by extrapolating the one-year cost out to two, five and ten years of operation.

1.1 Concentrations and Constituents of Concern (COC)

When comparing remediation technologies, each technology will respond differently to a particular suite of contaminants, operational criteria and environmental settings. For example, GAC is better suited for the volatile aromatic contaminants such as benzene, toluene, ethylbenzene and xylene (BTEX), but is only somewhat successful with M*t*BE (an ether) and ineffective when treating *t*BA (an alcohol). On the other hand, the FBR is very effective in degrading M*t*BE and *t*BA as the microorganisms can more readily degrade these chemicals; however, FBR becomes less effective if higher concentrations of BTEX are added. Also, as contaminant concentrations and flow rates increase, the FBR becomes increasingly less effective, regardless of the contaminant(s) due to the microbes preference for a steady flow of contaminant(s).

The field test site was chosen based upon the presence of typical influent groundwater concentrations of BTEX, M*t*BE and *t*BA. In addition, polish carbon is included at the end of each treatment train due to state regulatory requirements for final carbon polish before the discharge of treated effluent. Also, two different air strippers were modeled to determine the impact of various stripper removal efficiencies on the cost-per-gallon of treated influent.

1.2 Flow Rates

For additional comparative modeling analysis in relation to field results, flow rates were divided into low, medium and high, using 2 gallons-per-minute (gpm), 5 gpm and 10 gpm, respectively. These flow rates are based on actual flow rates of existing, active systems operated by Kleinfelder. During the field test, the LSTE-10 influent flow rates varied between 5.1 and 9.8 gpm and provided data on COC removal efficiency at various flow rates. Furthermore, four concentration regimes were modeled: low, medium, high and free-product, as shown in Table 1 below (all concentrations are in parts per billion (ppb)).

Table 1

Concentrations (ppb)	BTEX	M*t*BE	*t*BA
Low Concentration	1,250	1,000	1,000
Medium Concentration	10,000	10,000	10,000
High Concentration	100,000	100,000	100,000
Free Product	2,300,000	2,300,000	2,300,000

1.3 Pressure and Temperature

In order to maximize COC removal efficiency and evaluate the LSTE-10 system controls, nozzle pressure, influent water and tower temperatures were varied during the nine-month field test. Nozzle pressure varied between 39 and 100 psig; influent water temperature varied between 68 and 95° F; and tower temperatures varied between 68 and 100° F. The analytical results for the various combinations of these parameters are summarized in Appendix A.

1.4 Sampling Protocol

Influent and effluent samples were collected at four locations: 1) from the manifold connecting the LSTE-10 to the monitoring wells (i.e., the influent) 2) from the sample port following the aeration tank 3) from the sample port on the oxidizer stack and 4) from the sample port following the separator tower (i.e., the effluent). All sampling was conducted in accordance with EPA 5030/8015M for volatile fuel hydrocarbons and EPA 8260B for BTEX and oxygenates. Samples were collected by directly filling laboratory-supplied 40-ml VOAs from the sample ports. Samples were then sealed, labeled, and placed in an ice-filled, insulated cooler pending pickup by TestAmerica, a state-certified laboratory, for analysis.

2.0 COST BREAKDOWN

Capital costs include all system components (i.e. piping, blowers, pumps, tanks, etc.) typically supporting each remediation system and are outlined in Table 2 below.

Table 2

LSTE-10 System		Cost (catox)	Cost (carbon)
	Main LSTE-10 system	$ 170,000	$ 145,000
	Polish Carbon (2- 1000 lb Carbon Vessels)	$ 2,981	$ 2,981
	Total	**$ 172,981**	**$ 147,981**
Granulated Activated Carbon (GAC) System			
	Carbon Vessels (4- 2000 lb Carbon Vessels)	$ 25,375	
	Surge Tankage (2- 200 gal poly tanks)	$ 850	
	Transfer Pump	$ 500	
	Total	**$ 26,725**	
Fluidized Bed Reactor System			
	Main Bioreactor system	$ 83,000	
	Transfer Pumps (2 pumps)	$ 1,000	
	Sacrificial Carbon (2- 500 lb Carbon Vessel)	$ 1,190	
	Polish Carbon (2 - 1000 lb Carbon Vessels)	$ 2,981	
	Total	**$ 88,171**	
Air Stripper System			
	Low Profile Air Stripper (6- tray)	$ 53,000	
	Vapor Treatment (2- 500 lb Vapor Carbon Vessels)	$ 1,250	
	Polish Carbon (2 - 1000 lb Carbon Vessels)	$ 2,981	
	Surge Tankage (2- 200 gal poly tanks)	$ 850	
	Transfer Pumps (2 pumps)	$ 1,000	
	Total	**$ 59,081**	
	Vapor Treatment (300 SCFM Catox; high conc)	$ 45,000	
	Total	**$ 102,831**	

The cost to construct a secondary containment pad is not included, as all four systems being compared require a similarly-sized pad. Ancillary equipment costs, specific to a particular system, are included in the capital cost. For example, FBR requires sacrificial carbon to decrease BTEX concentrations prior to treatment, as well as surge tanks and transfer pumps which are not part of the base system. AS system pricing is based on the use of vapor-phase carbon to treat the effluent vapor stream. However, as contaminant concentrations increase, a catalytic oxidizer may be required to treat the effluent vapor. The increased capital cost for a catalytic oxidizing unit is reflected in the high concentration regime for AS technology.

2.1 Carbon Usage

Kleinfelder operates each type of system being compared to the LSTE-10. Various flow rates and concentration combinations have been tested and compared to industry models to determine carbon adsorbtion and AS efficiency. The key factor when evaluating activated carbon as a potential treatment technology is the carbon-use rate. The Freundlich Isotherm Equation[1] was used to calculate the estimated carbon usage considering varied flow and concentration parameters and is shown as follows:

$$q = K_f C^n$$

Where: q = mass of adsorbate per dry mass of carbon [mg/g]
C = concentration of adsorbate in solution [mg/L]
K_f and n are experimentally determined parameters based on a particular adsorbate.

The Freundlich Equation parameters K_f and n were determined from the literature[2] and applied to each variation of influent concentration, as well as determining polish carbon usage rates.

All four systems require some amount of carbon, whether in the final polish stage (LSTE-10, AS, FBR) or as the primary means of COC removal (GAC). In each case, spent carbon is typically recycled and the cost for the recycling is included in the raw carbon and carbon replacement costs. One advantage of the LSTE-10 is the amount of carbon for disposal is small (polish carbon only) when compared with the other remediation technologies. The modeled costs account for the differing volumes and

[1] Treatment Technologies for Removal of M*t*BE from Drinking water, The California M*t*BE Research Partnership, February 2000

[2] Ibid

frequency of carbon replacement, including potential risk and associated disposal costs. However, the waste streams are similar, volumes are small, the carbon should be recycled, and any act of disposal typically creates a potential liability.

Vapor-phase carbon is normally used as a treatment method where air emissions are restricted. For example, where an AS is employed as a primary treatment for water, the emissions generated by the stripper can exceed the allowed emissions. Relative humidity, temperature and contaminant concentrations affect the efficiency of the vapor phase carbon when used in this capacity.

Where practicable, remediation systems are designed so that the primary treatment accomplishes the effluent requirements, thereby rendering the carbon to a backup polishing function. The two types of GAC most effective for treating groundwater are bituminous coal and coconut shell-based carbons. The coconut shell-based GACs are particularly effective in cleaner groundwater applications containing M*t*BE, BTEX, low molecular weight chlorinated organic compounds and other small, relatively difficult–to-adsorb molecules. The contaminant loading on GAC is strongly influenced by the solubility of the target compound. Most BTEX compounds load relatively well on liquid-phase GAC. However, highly soluble compounds like M*t*BE and other oxygenated gasoline additives are difficult to adsorb.

2.2 Operations & Maintenance Costs

Operations and maintenance (O&M) costs are based on a single technician visit at a rate of $70.00/hr and visit duration of three hours. Costs for replacing particulate filters, microbe feed stock, cleaning nozzles, etc. are included in the O&M costs as applicable for a specific remediation technology. Also, each remedial strategy requires a different level of preventive and corrective maintenance. Additional labor costs are factored into each strategy based on professional judgment and practical experience with these types of systems. Finally, Table 3 outlines the utility costs for each system.

Table 3

Technology	Average Monthly Power Usage (KW-hr)	Power Cost ($/KW-hr)	Annual Cost ($)	Monthly Cost ($)
LSTE-10	15,308	0.073	$13,409.81	$1,117.48
Granular Activiated Carbon	243	0.073	$212.87	$17.74
Fluidized Bed Reactor	1,568	0.073	$1,373.57	$114.46
Air Stripper (Carbon)	5,687	0.073	$4,981.81	$415.15
Air Stripper (CatOx)	11,588	0.073	$10,151.09	$845.92

3.0 OPERATIONAL RESULTS

Table 4 outlines the results of the LSTE-10 after approximately nine months of active remediation. The LSTE-10 was placed upstream of the existing GAC system to ensure compliance with the service station's Elsinore Valley Water District Publicly-Owned Treatment Works (POTW) discharge permit.

Table 4

	Run Hours	% Uptime	Total Gallons Processed	Avg TPHg Removal %	Avg M*t*BE Removal %	Avg *t*BA Removal %
March	426	81.0%	68,238	92.3%	94.1%	98.1%
April	612	85.0%	86,146	97.2%	94.5%	100.0%
May	618	95.0%	29,430*	93.4%	93.0%	100.0%
July	357	82.0%	105,386	97.4%	98.7%	100.0%
August	357	81.0%	97,161	100.0%	100.0%	100.0%
September	345	85.0%	146,918	100.0%	99.1%	100.0%
October	357	80.0%	135,374	100.0%	97.2%	100.0%
November	538	81.0%	150,344	93.7%	98.9%	100.0%
December	540	82.0%	75,400	100.0%	97.5%	100.0%

*jammed water meter due to heavy scaling

While the LSTE-10 system uptime was consistent, removal rates for all constituents of concern remained high. However, due to high water hardness and aeration, the LSTE-10 encountered calcium scale buildup in the transfer pumps and particulate filters, resulting in higher levels of maintenance than anticipated based on previous shop tests. To minimize calcium generation, mechanical de-scaling devices were added to the LSTE-10 downstream of the aeration tank.

This analysis compared remediation costs for one, two, five and ten years of operation. While environmental cases often remain open for more than five years, a single form of active remediation, particularly if it is correctly designed and operated, does not typically operate for more than five years. The length of time active remediation is necessary will depend on site-specific conditions, including: depth, distribution and concentration of the COC, soil type, depth and fluctuations in groundwater elevations and a variety of other factors. Equipment reliability and response to changes in flow rate and COC concentration can extend the remediation time by reducing system run time.

Operational 'uptime' can be one of the most important characteristics of a successful remediation system. Capital costs are distributed over the useful life of the equipment. Generally if a system has a higher uptime and can manage higher flow rates, remediation will proceed more quickly and more sites can be remediated over the effective life of the system; clearly the longer the effective equipment life, the less the impact of initial capital cost on remediation cost effectiveness. The useful equipment life must be balanced with increasing service costs as the equipment ages. The LSTE-10 equipment life is expected to be well beyond the typical four to five year system lifespan due to the quality of the parts, the simplicity of the design and the ease of replacement for the key moving parts. This is in contrast with the GAC system which is essentially assembled on site from new parts for each site, resulting in little or no recovery of capital costs for future sites. As discussed in section 4.0 below, the LSTE-10 becomes increasingly cost effective the longer the system remains on site.

Based on historical data taken from remediation equipment databases, typical system uptime for AS and FBR remediation systems is over 90%. GAC system uptime varies between 80-90% due to carbon change-out requirements. Goals of greater than 90% system uptime for all remediation systems are typical in the remediation industry.

One component of remediation which is difficult to evaluate solely on a cost basis is the risks associated with using hazardous materials, generating hazardous wastes and employee safety during system operation. Table 5 describes various risk potentials.

Table 5

	LSTE-10	GAC	FBR	AS
Hazardous Chemicals required for O&M (i.e cleaning, etc.)	None	None	M*t*BE for additional feed during colony build-up	Muriatic acid for cleaning trays
Waste material generated from O&M	Spent Carbon	Spent Carbon	Spent Carbon and Biomass	Waste Acid and Spent Carbon
Safety Concerns with operations	Potential injury during carbon change out activities.	Potential injury during carbon change out activities.	Potential injury during carbon change out activities.	Potential injury during carbon change out activities. Potential injury when handling muriatic acid.

Note: carbon change-out activities occur at a far greater rate for the GAC operation.

In conjunction with equipment lifetime, understanding system versatility is important to the success of any remediation technology. Of the four systems studied, the LSTE-10 requires the least amount of time from equipment delivery to placing the system in full-time operation. All four systems require similar containment configurations; however, once the LSTE-10 is placed in the containment, treatment can begin within one to two days. Typical AS, FBR and GAC systems require four, thirty to forty-five and two days, respectively to begin active operations due to controls system integration requirements and pre-operations testing.

Another component of versatility is the ability to treat various COCs. Based on field testing, the LSTE-10 effectively treated the typical suite of COCs including BTEX, M*t*BE and *t*BA. Conversely, AS is ineffective with *t*BA due to the compound's high solubility in water; the FBR is ineffective for oxygenates mixed with BTEX because the microbes preferentially degrade BTEX over oxygenates; and the GAC becomes more ineffective as concentrations of M*t*BE and *t*BA increase due to the adsorptive properties of carbon. While all four remediation technologies are mobile, the LSTE-10 is the system of choice to quickly begin operations and effectively process groundwater impacted with varied contaminants.

4.0 CONCLUSIONS

A total of nine scenarios were developed, focusing on two variables: influent flow rate and influent COC concentration. Table 6 shows calculated costs to treat a gallon of impacted groundwater. Based on this cost analysis, the LSTE-10 is best suited for sites where high concentrations, free product and long-term operation are expected. The capital cost of the LSTE-10 is higher than that of the other technologies compared; therefore, short-term operation of the LSTE-10 is more expensive. The economic disadvantage in the first year decreases with increased flow rate and concentration. In fact, where both flow and concentration are high, the LSTE-10 is the most cost effective, even in the first year. As the data shows, the LSTE-10 is more cost effective at increased concentrations and flow rates and the longer the term of use.

The useful lifespan for the LSTE-10, AS and FBR are similar. One major advantage of the LSTE-10 is the opportunity to use the system on multiple sites. The components of the AS and FBR are typically used for the remediation of a single site then scrapped.

There are other options for increasing the cost advantage for the LSTE-10. The LSTE-10 system could be provided as a rented unit, thereby decreasing the capital costs. Also, as the manufacturing process is refined and more LSTE systems are in use, the purchase price should decrease. Another alternative is to look at the differing markets.

As this analysis shows, the LSTE-10 is very competitive at higher flow rates; therefore, wellhead treatment might become a market segment to pursue.

As stated earlier, intangibles, such as the ability of a system to react to unexpected changes in contaminant concentrations, are not factored into the analysis. Of all systems used in this comparison, the LSTE-10 is the most capable of effectively remediating the widest range of COC mixtures. Each of the other systems has a limitation as to a particular contaminant, e.g. GAC and AS cannot treat *t*BA; FBR needs to scrub out BTEX; FBR cannot maintain a high flow rate if concentrations increase, etc.

From a safety perspective, the maintenance requirements for the LSTE-10 are much less than the other technologies resulting in reduced exposure to personnel injury. The LSTE-10's increased system operation time and response to excursions in the influent concentrations reduce the potential for plume migration and the resultant increase in potential liability when the system is not operating.

Since typical retail remediation system capital costs are between $100,000 and $150,000 and include the entire system, the LSTE-10 capital costs should be close to this range in order to be accepted by decision makers within the petrochemical community. Also, as this report outlines, there are several other advantages to the LSTE-10 over the other remediation technologies.

Both cost and performance are important when selecting the most effective remediation approach. One technology may treat all COCs within 90 days of startup, resulting in a completely "clean" site, but be too cost prohibitive or unable to be reused at another site. Another technology may be inexpensive but could take ten to fifteen years of operation to effectively "clean" the site, or has high maintenance costs or safety concerns due to inferior system components. The LSTE-10 is safe, cost-effective, and a very capable remediation technology.

The LSTE-10 has a dual-phase capability to simultaneously treat contaminated soil and groundwater; however, this cost analysis has focused on groundwater remediation. The field-test site was chosen based on the variety of COCs present in the groundwater, the high volume of treated effluent, and the ease of inserting the LSTE-10 upstream of the existing on-site treatment equipment. The field-test site has no appreciable levels of soil contamination and therefore the LSTE-10's dual-phase capabilities were not fully explored. However, based on shop tests, the LSTE-10 has the capability to effectively remediate sites expected to produce 5 gpm of groundwater and 200 SCFM of vapor. In order to fully understand the LSTE-10's ability to treat contaminated soil, Kleinfelder recommends selecting another test site which requires the simultaneous treatment of soil and groundwater.

Table 6

		Low Concentration (3,250 ppb)				Medium Concentration (30,000 ppb)			
		LST-10	Carbon-GAC	BioReactor	Air Stripper	LST-10	Carbon-GAC	BioReactor	Air Stripper
Flowrate - **LOW** (2 gpm)		2	2	2	2	2	2	2	2
Concentrations (ppb)[1]		Low(3,250)	Low(3,250)	Low(3,250)	Low(3,250)	Medium(30,000)	Medium(30,000)	Medium(30,000)	Medium(30,000)
Capital Cost[5]		$150,962.00	$26,725.00	$91,152.00	$62,062.00	$150,962.00	$26,725.00	$91,152.00	$62,062.00
Annual Costs: Carbon Change-out based on industry isotherms for COC's	Carbon Change-out	NA	$17,900.00	NA	NA	NA	$35,800.00	NA	NA
	Sacrificial Carbon[2]	NA	NA	$650.00	NA	NA	NA	$650.00	NA
	Polish Carbon	$2,800.00	NA	$2,800.00	$8,400.00	$2,800.00	NA	$2,800.00	$14,000.00
	Utilities	$6,307.20	$212.87	$1,373.57	$4,981.81	$6,307.20	$212.87	$1,373.57	$4,981.81
	General O&M[3]	$13,212.00	$12,020.00	$27,120.00	$13,512.00	$13,212.00	$12,020.00	$27,120.00	$13,512.00
Cost per Gallon Treated Water - 1 yr		**$0.165**	**$0.054**	**$0.117**	**$0.085**	**$0.165**	**$0.071**	**$0.117**	**$0.090**
Cost per Gallon Treated Water - 2 yr		**$0.093**	**$0.041**	**$0.074**	**$0.055**	**$0.093**	**$0.058**	**$0.074**	**$0.060**
Cost per Gallon Treated Water - 5 yr		**$0.050**	**$0.034**	**$0.048**	**$0.037**	**$0.050**	**$0.051**	**$0.048**	**$0.043**
Cost per Gallon Treated Water - 10 yr		**$0.036**	**$0.031**	**$0.039**	**$0.031**	**$0.036**	**$0.048**	**$0.039**	**$0.037**
		LST-10	Carbon-GAC	BioReactor	Air Stripper	LST-10	Carbon-GAC	BioReactor	Air Stripper
Flowrate - **MEDIUM** (5 gpm)		5	5	5	5	5	5	5	5
Concentrations (ppb)[1]		Low(3,250)	Low(3,250)	Low(3,250)	Low(3,250)	Medium(30,000)	Medium(30,000)	Medium(30,000)	Medium(30,000)
Capital Cost[5]		$150,962.00	$26,725.00	$91,152.00	$62,062.00	$150,962.00	$26,725.00	$91,152.00	$62,062.00
Annual Costs: Carbon Change-out based on industry isotherms for COC's	Carbon Change-out	NA	$35,800.00	NA	NA	NA	$71,600.00	NA	NA
	Sacrificial Carbon[2]	NA	NA	$650.00	NA	NA	NA	$650.00	NA
	Polish Carbon	$8,400.00	NA	$8,400.00	$19,600.00	$8,400.00	NA	$8,400.00	$33,600.00
	Utilities	$6,307.20	$212.87	$1,373.57	$4,981.81	$6,307.20	$212.87	$1,373.57	$4,981.81
	General O&M[3]	$13,212.00	$12,020.00	$27,120.00	$13,512.00	$13,212.00	$12,020.00	$27,120.00	$13,512.00
Cost per Gallon Treated Water - 1 yr		**$0.068**	**$0.028**	**$0.049**	**$0.038**	**$0.068**	**$0.042**	**$0.049**	**$0.043**
Cost per Gallon Treated Water - 2 yr		**$0.039**	**$0.023**	**$0.032**	**$0.026**	**$0.039**	**$0.037**	**$0.032**	**$0.032**
Cost per Gallon Treated Water - 5 yr		**$0.022**	**$0.020**	**$0.021**	**$0.019**	**$0.022**	**$0.034**	**$0.021**	**$0.025**
Cost per Gallon Treated Water - 10 yr		**$0.016**	**$0.019**	**$0.018**	**$0.017**	**$0.016**	**$0.033**	**$0.018**	**$0.022**
		LST-10	Carbon-GAC	BioReactor	Air Stripper	LST-10	Carbon-GAC	BioReactor	Air Stripper
Flowrate - **HIGH** (10 gpm)		10	10	10	10	10	10	10	10
Concentrations (ppb)[1]		Low(3,250)	Low(3,250)	Low(3,250)	Low(3,250)	Medium(30,000)	Medium(30,000)	Medium(30,000)	Medium(30,000)
Capital Cost[5]		$150,962.00	$26,725.00	$91,152.00	$62,062.00	$150,962.00	$26,725.00	$91,152.00	$62,062.00
Annual Costs: Carbon Change-out based on industry isotherms for COC's	Carbon Change-out	NA	$71,600.00	NA	NA	NA	$125,300.00	NA	NA
	Sacrificial Carbon[2]	NA	NA	$650.00	NA	NA	NA	$650.00	NA
	Polish Carbon	$14,000.00	NA	$14,000.00	$36,400.00	$14,000.00	NA	$14,000.00	$67,200.00
	Utilities	$6,307.20	$212.87	$1,373.57	$4,981.81	$6,307.20	$212.87	$1,373.57	$4,981.81
	General O&M[3]	$13,212.00	$12,020.00	$27,120.00	$13,512.00	$13,212.00	$12,020.00	$27,120.00	$13,512.00
Cost per Gallon Treated Water - 1 yr		**$0.035**	**$0.021**	**$0.026**	**$0.022**	**$0.035**	**$0.031**	**$0.026**	**$0.028**
Cost per Gallon Treated Water - 2 yr		**$0.021**	**$0.018**	**$0.017**	**$0.016**	**$0.021**	**$0.029**	**$0.017**	**$0.022**
Cost per Gallon Treated Water - 5 yr		**$0.012**	**$0.017**	**$0.012**	**$0.013**	**$0.012**	**$0.027**	**$0.012**	**$0.019**
Cost per Gallon Treated Water - 10 yr		**$0.009**	**$0.016**	**$0.010**	**$0.012**	**$0.009**	**$0.027**	**$0.010**	**$0.017**

[1] Mix of BTEX, *Mt*BE and *t*BA.
[2] Needed by BioReactor to remove BTEX
[3] Estimated
[4] Due to the high influent concentrations, flow is limited
[5] LST and Airstripper Usre Vapor Phase Carbon in Low, Medium, High -concentration range water and Electric Catoxs in Free Product range

Lowest $/gal in group (green)
Highest $/gal in group (red)

(table continued on next page)

Table 6 continued

		High Concentration (300,000 ppb)				Free Product on Water Table (2,300,000 ppb)			
		LST-10	Carbon-GAC	BioReactor[4]	Air Stripper	LST-10	Carbon-GAC	BioReactor	Air Stripper
Flowrate - **LOW** (2 gpm)		2	2	1.5	2	2	2	2	2
Concentrations (ppb)[1]		High(300,000)	High(300,000)	High(300,000)	High(300,000)	Free Product	Free Product	Free Product	Free Product
Capital Cost[5]		$150,962.00	$26,725.00	$91,152.00	$62,062.00	$174,712.00	NA	NA	$105,812.00
Annual Costs: Carbon Change-out based on industry isotherms for COC's	Carbon Change-out	NA	$53,700.00	NA	NA	NA	NA	NA	NA
	Sacrificial Carbon[2]	NA	NA	$650.00	NA	NA	NA	NA	NA
	Polish Carbon	$2,800.00	NA	$2,800.00	$28,000.00	$2,800.00	NA	NA	$42,000.00
	Utilities	$6,307.20	$212.87	$1,373.57	$8,961.48	$10,003.92	NA	NA	$8,961.48
	General O&M[3]	$13,212.00	$12,020.00	$27,120.00	$13,512.00	$13,212.00	NA	NA	$13,512.00
Cost per Gallon Treated Water - 1 yr		**$0.165**	**$0.088**	**$0.156**	**$0.107**	**$0.191**	**NA**	**NA**	**$0.162**
Cost per Gallon Treated Water - 2 yr		**$0.093**	**$0.075**	**$0.098**	**$0.078**	**$0.108**	**NA**	**NA**	**$0.112**
Cost per Gallon Treated Water - 5 yr		**$0.050**	**$0.068**	**$0.064**	**$0.060**	**$0.058**	**NA**	**NA**	**$0.081**
Cost per Gallon Treated Water - 10 yr		**$0.036**	**$0.065**	**$0.052**	**$0.054**	**$0.041**	**NA**	**NA**	**$0.071**
		LST-10	Carbon-GAC	BioReactor[4]	Air Stripper	LST-10	Carbon-GAC	BioReactor	Air Stripper
Flowrate - **MEDIUM** (5 gpm)		5	5	1.5	5	5	5	5	5
Concentrations (ppb)[1]		High(300,000)	High(300,000)	High(300,000)	High(300,000)	Free Product	Free Product	Free Product	Free Product
Capital Cost[5]		$150,962.00	$26,725.00	$91,152.00	$62,062.00	$174,712.00	NA	NA	$105,812.00
Annual Costs: Carbon Change-out based on industry isotherms for COC's	Carbon Change-out	NA	$125,300.00	NA	NA	NA	NA	NA	NA
	Sacrificial Carbon[2]	NA	NA	$650.00	NA	NA	NA	NA	NA
	Polish Carbon	$8,400.00	NA	$8,400.00	$70,000.00	$8,400.00	NA	NA	$106,400.00
	Utilities	$6,307.20	$212.87	$1,373.57	$8,961.48	$10,003.92	NA	NA	$8,961.48
	General O&M[3]	$13,212.00	$12,020.00	$27,120.00	$13,512.00	$13,212.00	NA	NA	$13,512.00
Cost per Gallon Treated Water - 1 yr		**$0.068**	**$0.063**	**$0.163**	**$0.059**	**$0.079**	**NA**	**NA**	**$0.089**
Cost per Gallon Treated Water - 2 yr		**$0.039**	**$0.057**	**$0.105**	**$0.047**	**$0.045**	**NA**	**NA**	**$0.069**
Cost per Gallon Treated Water - 5 yr		**$0.022**	**$0.054**	**$0.071**	**$0.040**	**$0.025**	**NA**	**NA**	**$0.057**
Cost per Gallon Treated Water - 10 yr		**$0.016**	**$0.053**	**$0.059**	**$0.038**	**$0.019**	**NA**	**NA**	**$0.053**
		LST-10	Carbon-GAC	BioReactor[4]	Air Stripper	LST-10	Carbon-GAC	BioReactor	Air Stripper
Flowrate - **HIGH** (10 gpm)		10	10	1.5	10	10	10	10	10
Concentrations (ppb)[1]		High(300,000)	High(300,000)	High(300,000)	High(300,000)	Free Product	Free Product	Free Product	Free Product
Capital Cost[5]		$150,962.00	$26,725.00	$91,152.00	$62,062.00	$174,712.00	NA	NA	$105,812.00
Annual Costs: Carbon Change-out based on industry isotherms for COC's	Carbon Change-out	NA	$250,600.00	NA	NA	NA	NA	NA	NA
	Sacrificial Carbon[2]	NA	NA	$1,300.00	NA	NA	NA	NA	NA
	Polish Carbon	$14,000.00	NA	$14,000.00	$137,200.00	$14,000.00	NA	NA	$210,000.00
	Utilities	$6,307.20	$212.87	$1,373.57	$8,961.48	$10,003.92	NA	NA	$8,961.48
	General O&M[3]	$13,212.00	$12,020.00	$27,120.00	$13,512.00	$13,212.00	NA	NA	$13,512.00
Cost per Gallon Treated Water - 1 yr		**$0.035**	**$0.055**	**$0.171**	**$0.042**	**$0.040**	**NA**	**NA**	**$0.064**
Cost per Gallon Treated Water - 2 yr		**$0.021**	**$0.053**	**$0.113**	**$0.036**	**$0.024**	**NA**	**NA**	**$0.054**
Cost per Gallon Treated Water - 5 yr		**$0.012**	**$0.051**	**$0.079**	**$0.033**	**$0.014**	**NA**	**NA**	**$0.048**
Cost per Gallon Treated Water - 10 yr		**$0.009**	**$0.051**	**$0.067**	**$0.032**	**$0.010**	**NA**	**NA**	**$0.046**

[1] Mix of BTEX, M*t*BE and *t*BA.
[2] Needed by BioReactor to remove BTEX
[3] Estimated
[4] Due to the high influent concentrations, flow is limited
[5] LST and Airstripper Usre Vapor Phase Carbon in Low, Medium, High -concentration range water and Electric Catoxs in Free Product range

Lowest $/gal in group
Highest $/gal in group

5.0 LIMITATIONS

Kleinfelder has strived to perform the services for this project in accordance with standard practice in this geographic region and time. This report may be used only by DRE and LSTE and only for the purposes stated, within a reasonable time from its issuance, but in no event later than one (1) year from the date of the report. All information gathered by Kleinfelder is considered confidential and will be released only upon written authorization by DRE or LSTE or as required by law. Non-compliance with any of these requirements by DRE or LSTE or anyone else, unless specifically agreed to in advance by Kleinfelder in writing, will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and DRE and LSTE agree to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.

Regulations and professional standards applicable to Kleinfelder's services are continually evolving. Techniques are, by necessity, often new and relatively untried. Different professionals may reasonably adopt different approaches to similar problems. As such, our services are intended to provide DRE and LSTE with a source of professional advice, opinions and recommendations. Our professional opinions and recommendations are based on our limited number of field observations and tests, collected and performed in accordance with the generally accepted engineering practice that exists at the time and may depend on, and be qualified by, information gathered previously by others and provided to Kleinfelder by DRE and/or LSTE. Consequently, no warranty or guarantee, expressed or implied, is intended or made.

APPENDIX A

Operations Data Between March and December 2007

Summary of Analytical Results											
Sample Date	**Sample ID**	**Sample Time**	**Machine Run Time**	**Nozzle Pressure (psig)**	**Process Water Flow rate (gpm)**	**Process Water Temp. °F**	**Tower Temp °F**	**Influent Effluent Removal %**	**TPHg (ppb)**	**MTBE (ppb)**	**TBA (ppb)**
3/9/2007	IQC 1102	12:00	271. hrs	100. psig	8.6 gpm	80. °F	80. °F	Influent	320. ppb	840. ppb	
								Effluent	77. ppb	38. ppb	
								Removal %	75.94%	95.48%	ND
3/13/2007	IQC 1460	12:15	362. hrs	80. psig	7.7 gpm	94. °F	93. °F	Influent	570. ppb	1000. ppb	
								Effluent		22. ppb	
								Removal %	100.00%	97.80%	ND
3/14/2007	IQC 1705	12:15	370. hrs	90. psig	9.22 gpm	88. °F	92. °F	Influent	390. ppb	970. ppb	51. ppb
								Effluent		25. ppb	
								Removal %	100.00%	97.42%	100.00%
3/14/2007	IQC 1705	17:20	370. hrs	80. psig	9.3 gpm	94. °F	90. °F	Influent	440. ppb	1300. ppb	50. ppb
								Effluent		21. ppb	
								Removal %	100.00%	98.38%	100.00%
3/15/2007	IQC 1705	10:00	390. hrs	80. psig	9.5 gpm	78. °F	82. °F	Influent	700. ppb	1600. ppb	62. ppb
								Effluent		60. ppb	
								Removal %	100.00%	96.25%	100.00%
3/15/2007	IQC 1862	13:06	390. hrs	70. psig	9.7 gpm	92. °F	90. °F	Influent	960. ppb	1400. ppb	160. ppb
								Effluent		21. ppb	
								Removal %	100.00%	98.50%	100.00%
3/16/2007	IQC 1862	8:36	413. hrs	70. psig	9.8 gpm	72. °F	80. °F	Influent	1000. ppb	1600. ppb	170. ppb
								Effluent	170. ppb	270. ppb	41. ppb
								Removal %	83.00%	83.13%	75.88%
3/16/2007	IQC 2055	12:25	413. hrs	60. psig	9.6 gpm	95. °F	100. °F	Influent	410. ppb	1500. ppb	13. ppb
								Effluent	31. ppb	74. ppb	
								Removal %	92.44%	95.07%	100.00%
3/17/2007	IQC 2055	6:30	434. hrs	63. psig	9.8 gpm	74. °F	75. °F	Influent	430. ppb	1500. ppb	13. ppb
								Effluent	120. ppb	180. ppb	
								Removal %	72.09%	88.00%	100.00%
3/17/2007	IQC 2055	9:40	434. hrs	51. psig	9.7 gpm	78. °F	80. °F	Influent	620. ppb	1400. ppb	53. ppb
								Effluent	39. ppb	57. ppb	
								Removal %	93.71%	95.93%	100.00%
3/18/2007	IQC 2055	7:30	458. hrs	50. psig	9.8 gpm	72. °F	72. °F	Influent	400. ppb	1500. ppb	16. ppb
								Effluent	100. ppb	310. ppb	
								Removal %	75.00%	79.33%	100.00%
3/18/2007	IQC 2055	10:20	458. hrs	40. psig	9.8 gpm	76. °F	78. °F	Influent	530. ppb	1500. ppb	74. ppb
								Effluent	31. ppb	43. ppb	
								Removal %	94.15%	97.13%	100.00%
3/19/2007	IQC 2055	10:00	482. hrs	39. psig	9.5 gpm	72. °F	74. °F	Influent	380. ppb	980. ppb	62. ppb
								Effluent		37. ppb	
								Removal %	100.00%	96.22%	100.00%
3/28/2007	IQC 3238	15:40	640. hrs	80. psig	8.7 gpm	84. °F	84. °F	Influent	370. ppb	770. ppb	19. ppb
								Effluent		35. ppb	
								Removal %	100.00%	95.45%	100.00%
3/31/2007	IQC 3238	15:40	697. hrs	81. psig	8.7 gpm	74. °F	74. °F	Influent	370. ppb	1300. ppb	29. ppb
								Effluent		29. ppb	
								Removal %	100.00%	97.77%	100.00%

(Table continues on next page)

Operations Data Table Cont.

Summary of Analytical Results											
Sample Date	**Sample ID**	**Sample Time**	**Machine Run Time**	**Nozzle Pressure (psig)**	**Process Water Flow rate (gpm)**	**Process Water Temp. °F**	**Tower Temp °F**	**Influent Effluent Removal %**	**TPHg (ppb)**	**MTBE (ppb)**	**TBA (ppb)**
4/1/2007	IQC 3238	15:40	720. hrs	80. psig	7.1 gpm	78. °F	78. °F	Influent	420. ppb	1300. ppb	25. ppb
								Effluent		30. ppb	
								Removal %	100.00%	97.69%	100.00%
4/2/2007	IQC 3238	15:40	744. hrs	78. psig	6.2 gpm	80. °F	86. °F	Influent	420. ppb	1300. ppb	25. ppb
								Effluent		30. ppb	
								Removal %	100.00%	97.69%	100.00%
4/3/2007	IQC 3238	15:40	765. hrs	93. psig	5.1 gpm	82. °F	80. °F	Influent	760. ppb	1300. ppb	
								Effluent	33. ppb	27. ppb	
								Removal %	95.66%	97.92%	ND
4/17/2007	IQC 1680	10:30	1098. hrs	65. psig	NOTE 1	91. °F	88. °F	Influent	320. ppb	1100. ppb	
								Effluent		35. ppb	
								Removal %	100.00%	96.82%	ND
4/27/2007	IQD 3000	11:20	1309. hrs	54. psig	NOTE 1	90. °F	90. °F	Influent	290. ppb	770. ppb	
								Effluent		55. ppb	
								Removal %	100.00%	92.86%	ND
5/3/2007	IQE 377	14:50	1332. hrs	97. psig	8.7 gpm	72. °F	72. °F	Influent	460. ppb	680. ppb	14. ppb
								Effluent	59. ppb	75. ppb	5.3 ppb
								Removal %	87.17%	88.97%	62.14%
5/7/2007	IQE 804	17:00	1428. hrs	97. psig	8.7 gpm	72. °F	72. °F	Influent	640. ppb	1100. ppb	
								Effluent	38. ppb	120. ppb	
								Removal %	94.06%	89.09%	ND
5/14/2007	IQE 1493	9:15	1593. hrs	85. psig	NOTE 1	74. °F	74. °F	Influent	700. ppb	1400. ppb	
								Effluent		25. ppb	
								Removal %	100.00%	98.21%	ND
5/21/2007	IQE 2541	10:30	1761. hrs	82. psig	NOTE 1	68. °F	68. °F	Influent	350. ppb	640. ppb	34. ppb
								Effluent	32. ppb	11. ppb	
								Removal %	90.86%	98.28%	100.00%
5/29/2007	IQE 2986	11:00	1950. hrs	80. psig	6.23 gpm	74. °F	72. °F	Influent	73. ppb	740. ppb	
								Effluent		5.6 ppb	
								Removal %	100.00%	99.24%	ND
7/3/2007	IQG0233	7:00		85. psig	6. gpm	75. °F	80. °F	Influent	140. ppb	810. ppb	
								Effluent		8.8 ppb	
								Removal %	100.00%	98.91%	ND
7/12/2007	IQG1036	7:00	2359. hrs	75. psig	NOTE 1	80. °F	80. °F	Influent	350. ppb	940. ppb	
								Effluent		9. ppb	
								Removal %	100.00%	99.04%	ND
7/23/2007	IQG2228	0:00	2525. hrs	90. psig	NOTE 1	80. °F	80. °F	Influent	390. ppb	910. ppb	12. ppb
								Effluent	30. ppb	17. ppb	
								Removal %	92.31%	98.13%	100.00%

(Table continues on next page)

Operations Data Table Cont.

Summary of Analytical Results

Sample Date	Sample ID	Sample Time	Machine Run Time	Nozzle Pressure (psig)	Process Water Flow rate (gpm)	Process Water Temp. °F	Tower Temp °F	Influent Effluent Removal %	TPHg (ppb)	MTBE (ppb)	TBA (ppb)
8/7/2007	IQH0607	0:15	2749. hrs	65. psig	5.6 gpm	72. °F	70. °F	Influent	190. ppb	.28 ppb	
								Effluent			
								Removal %	100.00%	100.00%	ND
9/4/2007	IQI0225	7:00	3001. hrs	90. psig	8.5 gpm	91. °F	91. °F	Influent	340. ppb	.23 ppb	
								Effluent			
								Removal %	100.00%	100.00%	ND
9/18/2007	IQI1710	9:00	3117. hrs	72. psig	8.2 gpm	71. °F	71. °F	Influent	280. ppb	680. ppb	
								Effluent		12. ppb	
								Removal %	100.00%	98.24%	ND
10/2/2007	IQJ0316	9:30	3365. hrs	76. psig	8.1 gpm	73. °F	74. °F	Influent	150. ppb	490. ppb	
								Effluent		15. ppb	
								Removal %	100.00%	96.94%	ND
10/24/2007	IQJ2704	11:00	3555. hrs	65. psig	8.6 gpm	72. °F	74. °F	Influent	170. ppb	460. ppb	
								Effluent		12. ppb	
								Removal %	100.00%	97.39%	ND
10/30/2007	IQJ3192	8:00	3699. hrs	71. psig	7. gpm	74. °F	72. °F	Influent	500. ppb	1100. ppb	
								Effluent		6.2 ppb	
								Removal %	100.00%	99.44%	ND
11/6/2007	IQK0722	14:15	3757. hrs	92. psig	6.5 gpm	68. °F	68. °F	Influent	180. ppb	490. ppb	
								Effluent	34. ppb	1.3 ppb	
								Removal %	81.11%	99.73%	ND
11/19/2007	IQK2251	10:55	4019. hrs	91. psig	5. gpm	71. °F	71. °F	Influent	240. ppb	550. ppb	
								Effluent		8.9 ppb	
								Removal %	100.00%	98.38%	ND
11/26/2007	IQK2770	10:55	4184. hrs	60. psig		60. °F	60. °F	Influent	180. ppb	430. ppb	
								Effluent		6.4 ppb	
								Removal %	100.00%	98.51%	ND
12/3/2007	IQL0378	9:15	4352. hrs	60. psig	8.6 gpm	54. °F	51. °F	Influent	120. ppb	310. ppb	
								Effluent		6.2 ppb	
								Removal %	100.00%	98.00%	ND
12/10/2007	IQL1289	8:45	4505. hrs	70. psig	8.6 gpm	52. °F	52. °F	Influent	130. ppb	310. ppb	
								Effluent		9.2 ppb	
								Removal %	100.00%	97.03%	ND