EG&G MOUND-21-04-04-02--9607080102

Document Control No. _____

Environmental Restoration Program

OPERABLE UNIT 1
GROUNDWATER PROCESS OPTIONS
SUPPLEMENTAL COST ESTIMATE

MOUND PLANT
MIAMISBURG, OHIO

February 1995

Final
(Revision 0)

U.S. Department of Energy
Ohio Field Office

EG&G Mound Applied Technologies

1. INTRODUCTION

The purpose of this report is to present supplemental cost estimate information for groundwater treatment options at Operable Unit 1 (OU1), Mound Plant, Miamisburg, Ohio. The cost estimates contained in this report were prepared in accordance with Ohio Environmental Protection Agency Engineering Guide #46, 5 December 1983. When possible, multiple written vendor quotes were solicited to support the cost estimates. Cost estimates for four process options are presented: (1) cascade aeration (2) air stripper with free exhaust (3) air stripper with secondary activated carbon VOC (volatile organic carbon) capture on the vapor phase, and (4) UV/Oxidation.

2. SYSTEM PARAMETERS

To provide consistency among vendor quotes for the various process options, standard treatment parameters were developed from the OU1 Remedial Investigation Report (Final version, May 1994) and the OU1 Feasibility Study Report (Draft Final, August 1994). Information from these reports was summarized and is presented in Table 1. This information was provided to each vendor solicited. To aid the vendors in preparation of quotations, simplified design statements and process flow block diagrams were prepared for each process option. These statements along with approximate removal efficiencies and drawings can be found in Appendix A. Vendor quotations are contained in Appendices B through E.

3. COST EFFECTIVENESS DATA FOR CONTROL SYSTEM OPTIONS

Cost-effectiveness data are presented in Tables 2 and 3. Supporting capital cost and annualized cost tables are contained in Appendices B through E. The data are evaluated for removal of VOC contaminants from the vapor stream and groundwater stream in accordance with Ohio EPA Engineering Guide #46. A service life of 20 years was chosen for each process option. This report differs from the Feasibility Study Report (FS) in that the FS used an economic life of 30 years to determine the present value of various options where this report uses estimated service life to determine annualized costs. An interest rate of 7 percent is used in each case to be consistent with OSWER Directive 9355.3-20.

Table 2 presents the cost effectiveness data for reduction of air emissions. The data show that the cascade aeration and air stripper with free exhaust options create, rather than remove, the air emissions. The air stripper costs more and emits more VOCs to the air than the cascade aerator. The incremental cost to use an air stripper with secondary activated carbon VOC capture is large at

$160,000 per 1,000 lb. VOC collected. Further, UV oxidation provides little added benefit for an additional $450,000 per 1,000 lb. VOC collected.

Table 3 presents analogous cost effectiveness information for reduction of surface water emissions. Cascade aeration is shown to provide some benefit for moderate cost. None of the remaining options provide significantly more benefit; but, they are substantially more expensive.

TABLE 1 GROUNDWATER CONCENTRATIONS AND TREATMENT PARAMETERS
Mound Plant
Miamisburg, Ohio

Compound	Average Concentration (µg/L)
Volatile Organic Compound	
1,2-cis-dichloroethane (DCE)	274
1,2-*trans*-DCE	3.2
Tetrachloroethane (PCE)	125
Tetrachloromethane (carbon tetrachloride)	3.4
1,1,1-trichloroethane (1,1,1-TCA)	0.7
Trichloroethene (TCE)	86
Trichlorofluoromethane	5.4
Trichloromethane (chloroform)	43
Chloroethane (vinyl chloride)	3.6
Total Organic Carbon (TOC)	5,000
BOD	0
Total Suspended Solids	0
Dissolved Inorganics	
Cd	0.80 U
Ca	176,000
Cr	0.94 U
C	1.4 U
Fe	341
Pb	2.1
Mg	56,450
Mn	228
Hg	0.1U
Ni	58
Ag	1.02 U
Zn	181
Chloride	267,000
Nitrate	1,000
Sulfate	122,000

U = Not detected at the limit shown

Treatment Parameters

Inlet groundwater flow rate = 200 L/min
Treatment objective = All VOCs less than 5 µg/L
Groundwater temperature = 20 °C
Groundwater pH = 6.75-7.25
Groundwater specific conductance = 800-1500 µmhos/cm
Groundwater alkalinity = 203.5 to 429.5 mg/L

TABLE 2 OHIO EPA ENGINEERING GUIDE #46
COST-EFFECTIVENESS DATA FOR CONTROL SYSTEM OPTIONS
FOR REDUCTION OF AIR EMISSIONS
Mound Plant
Miamisburg, Ohio

Control System	[1]Emission Reduction (1000 lb/year)	Annualized Control Costs ($/year)	[2]Cost-Effectiveness, Annualized Control Costs per 1000 Pounds Collected ($/1000 lb)	Incremental Emission Reduction (1000 lb/year)	Incremental Annualized Control Costs ($/year)	Incremental Cost Effectiveness, Annualized Control Costs per 1,000 Pounds Collected ($/1000 lb)
No Treatment of Groundwater	0	0	0	---	---	---
Cascade Aeration	(-0.042)	2,300	(-55,000)	(-0.042)	2,300	(-55,000)
Air Stripper with Free Exhaust	(-0.13)	53,000	(-410,000)	(-0.088)	51,000	(-580,000)
Air Stripper with Secondary Activated Carbon VOC Capture on Vapor Phase	+0.11	91,000	+830,000	+0.24	38,000	+158,000
UV/Oxidation	+0.13	100,000	+770,000	+0.02	9,000	+450,000

[1]Total VOC Air Emission Reduction with positive numbers indicating decrease in emissions.
[2]In the present analysis, emissions foregaone are considered collected.

TABLE 3 OHIO EPA ENGINEERING GUIDE #46
COST EFFECTIVENESS DATA FOR CONTROL SYSTEM OPTIONS
FOR REDUCTION OF SURFACE WATER EMISSIONS
Mound Plant
Miamisburg, Ohio

Control System	[1]Emission Reduction (1000 lb/year)	Annualized Control Costs ($/year)	[2]Cost-Effectiveness, Annualized Control Costs per 1000 Pounds Collected ($/1000 lb)	Incremental Emission Reduction (1000 lb/year)	Incremental Annualized Control Costs ($/year)	Incremental Cost Effectiveness, Annualized Control Costs per 1,000 Pounds Collected ($/1000 lb)
No Treatment of Groundwater	0	0	0	---	---	---
Cascade Aeration	0.042	2,300	55,000	0.042	2,300	55,000
Air Stripper with Free Exhaust	0.13	53,000	410,000	0.088	51,000	580,000
Air Stripper with Secondary Activated Carbon VOC Capture on Vapor Phase	0.13	91,000	700,000	See Note 2	38,000	See Note 2
UV/Oxidation	0.13	100,000	770,000	See Note 2	9,000	See Note 2

[1]In the present analysis, emissions foregone are considered collected.
[2]No incremental change in emission reduction to surface water is achieved for any subsequent treatment technology. Each technology removes approximately 100% of the VOC contaminants with increasing costs.

APPENDIX A

SYSTEM DESCRIPTIONS

Cascade Aerator (Figure A-1) - (Removal efficiency: water 35%, vapor 0%)

Typically used as an effective means of oxygenating large flows of waste water, this process option is also used for the removal of VOCs from groundwater. The process is a simple and very low cost option. The groundwater is pumped to the top of an inclined plane, where it cascades by gravity down a transversely corrugated surface. The resulting turbulence enhances the mass exchange of volatile contaminants from the liquid to the vapor phase. Desorption coefficients (overall mass transfer) are generally one order of magnitude larger for packed columns. Tests show rates greater than 60 (conservatively assumed to be 35% for the system being considered here) percent are possible with reasonable treatment surface lengths and angles of inclination. Cascade aeration is only partially effective for removing volatile chemicals with a Henry's Law constant of less than 50 atmospheres. Pretreatment of the feed water is not necessary. Vapor phase treatment may be applied to this system as described below for air strippers; but, at significant extra cost.

Air Stripping with Free Exhaust (Figure A-2) - (Removal efficiency: water 99.98%, vapor 0%)

Air Stripping is a mass transfer process where volatile contaminants are removed from liquids, such as groundwater, by forcing air through the liquid. Air stripping is commonly performed onsite using a packed tower that works on the principle of countercurrent flow. The contaminated water would flow downward through the packing while the air would flow upward and would be exhausted through the top. Other types of air strippers include the low profile tray and multi-cell air stripper. These units diffuse air through a chamber of flowing water to achieve mass transfer. Pretreatment is not necessary.

Air Stripping with Secondary Activated Carbon VOC Capture on the Vapor Phase (Figure A-3) - (Removal efficiency: water 99.98%, vapor 90%)

As described above, an air stripper exhausts volatile contaminants to the atmosphere. To comply with applicable regulations, an emissions control device may be required to remove the volatile contaminants from the air stream and then exhaust the clean air. Air emission control devices include a vapor-phase granular activated carbon (GAC) adsorber bed and a catalytic oxidizer. Pretreatment is not necessary.

UV/Oxidation (Figure A-4) - (Removal efficiency: water 100%, vapor 100%)

UV/oxidation treatment involves the use of hydrogen peroxide and ultraviolet light to photo-oxidize organic contaminants. Groundwater would be pumped into holding tanks and hydrogen peroxide added to begin destruction of organics. Ultimately, the VOCs are destroyed resulting in the generation of carbon dioxide, water and halide ions. During the process, hydrogen chloride emission control is necessary.

CASCADE AERATION UNIT

DIMENSIONS: 4' WIDE, 100' LONG, 25' HIGH (4:1 SLOPE)

EQUIPMENT LIST: CASCADE AERATOR – FORM WORK AND CONCRETE
FOUNDATION
REINFORCING STEEL

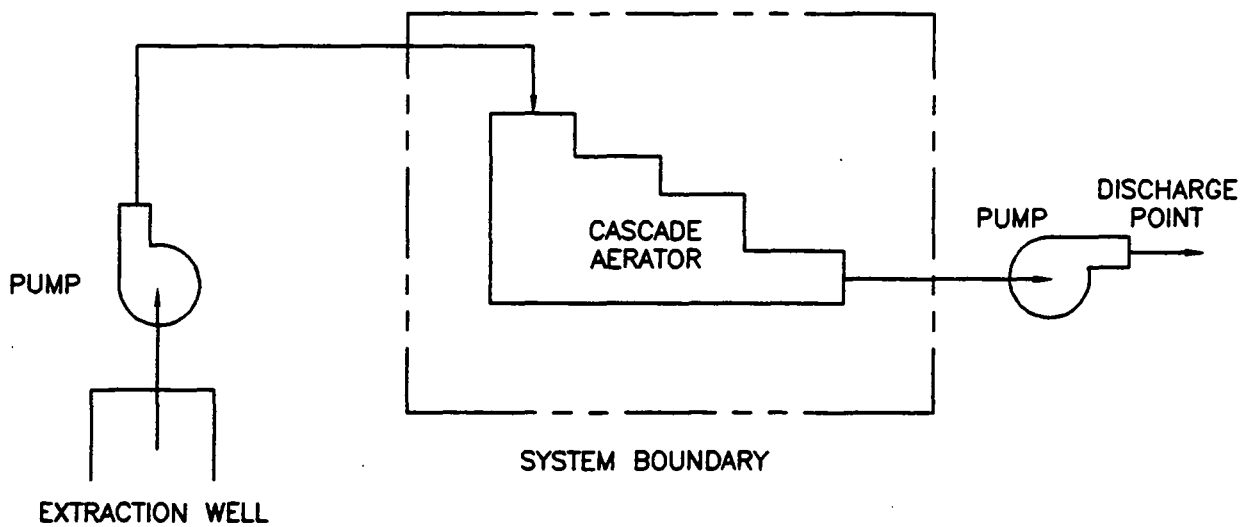

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FIGURE A-1

WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

CASCADE AERATION UNIT

MOUND PLANT
Miamisburg, Ohio

AIR STRIPPER WITH SECONDARY ACTIVATED CARBON VOC CAPTURE

DIMENSIONS: TOWER 22'H X 2'DIA.
664cfm AIR FLOW
53gpm WATER FLOW
CARBON UNIT (2) 1600lb

EQUIPMENT LIST: EQUALIZATION TANK
FEED PUMP AND PIPING
AIR STRIPPING TOWER FOUNDATION & BLOWER
2 – CARBON BEDS
BOILER AND PIPING
CHILLER AND PIPING
CONDENSER AND PUMP
DECANTER, PIPING AND PUMPS (2)

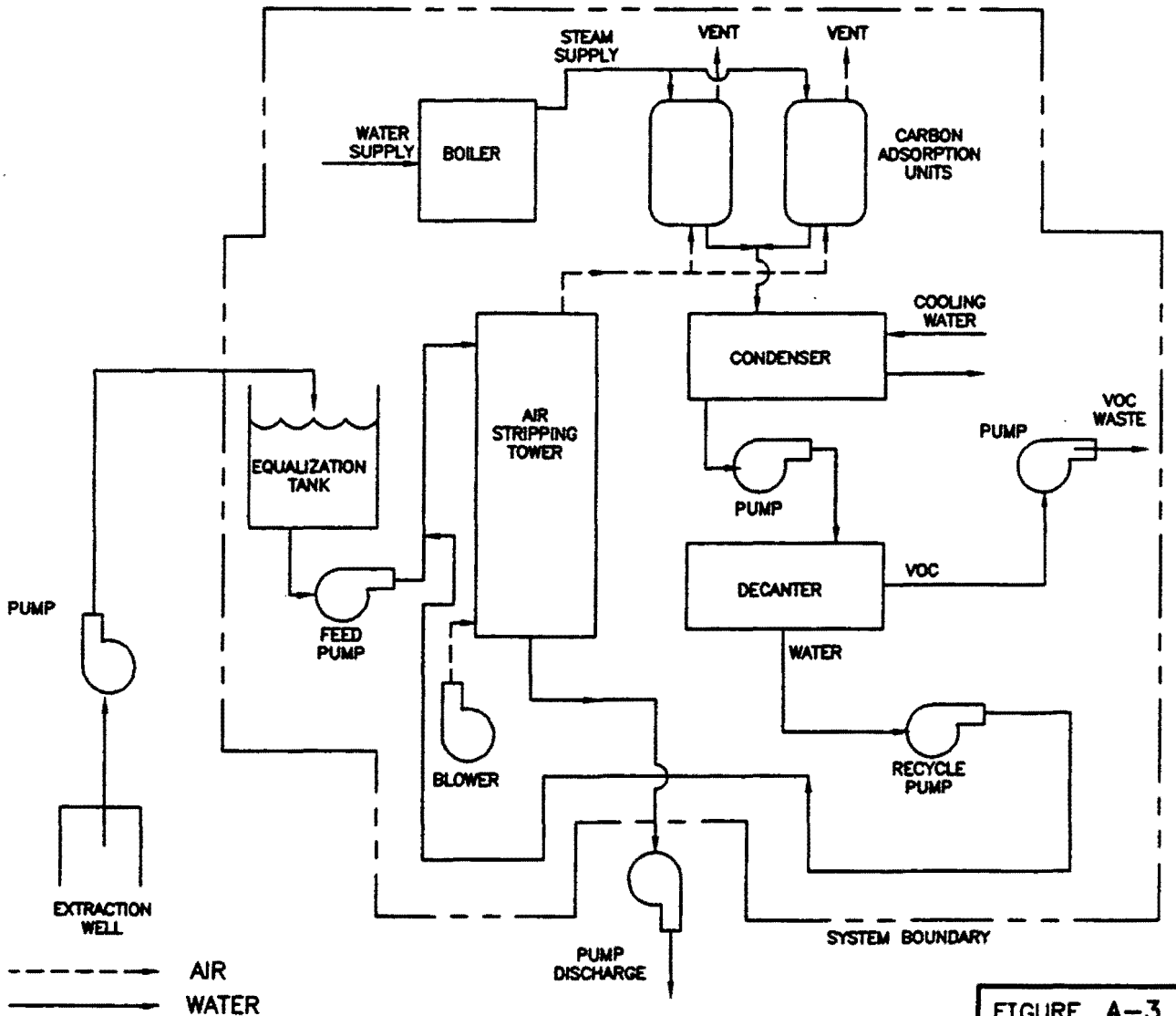

FIGURE A-3

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WESTON MANAGERS DESIGNERS/CONSULTANTS

Three Hawthorn Parkway
Vernon Hills, Illinois
60061

AIR STRIPPER WITH SECONDARY ACTIVATED CARBON VOC CAPTURE
MOUND PLANT
Miamisburg, Ohio

AIR STRIPPER WITH FREE EXHAUST

DIMENSIONS: TOWER 22'H X 2'DIA.
664cfm AIR FLOW
53gpm WATER FLOW
675gal EQUALIZATION TANK

EQUIPMENT LIST: AERATION TANK AND BLOWER
FEED PUMP AND PIPING
AIR STRIPPING TOWER,
FOUNDATION & BLOWER

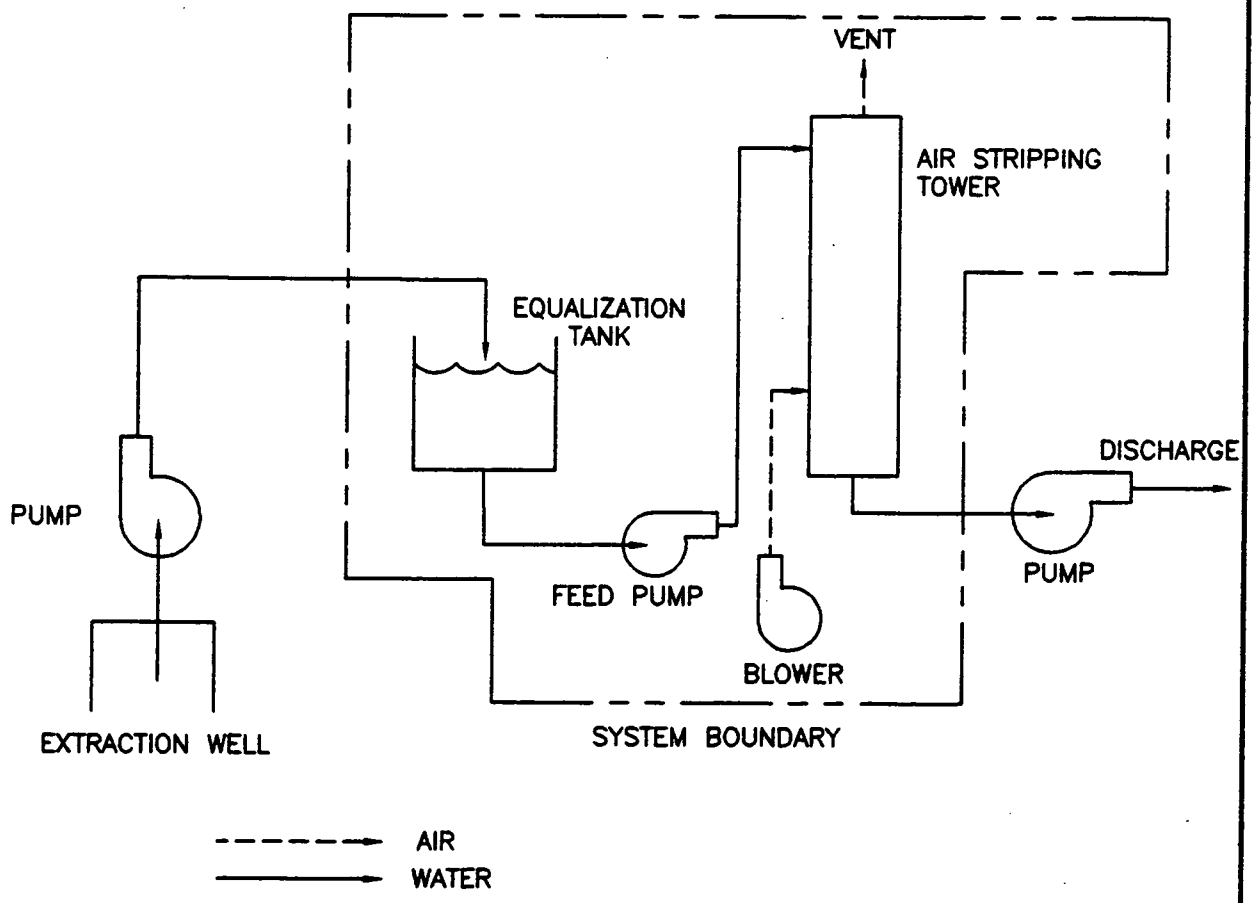

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FIGURE A-2

WESTON MANAGERS DESIGNERS/CONSULTANTS
Three Hawthorn Parkway
Vernon Hills, Illinois
60061

AIR STRIPPER WITH FREE EXHAUST

MOUND PLANT
Miamisburg, Ohio

UV/OXIDATION UNIT

DIMENSIONS: 90 kw UNIT (3–30kw REACTORS)

EQUIPMENT LIST: EQUALIZATION TANK
PUMP AND PIPING
UV/OXIDATION REACTOR UNIT
PEROXIDE FEED UNIT

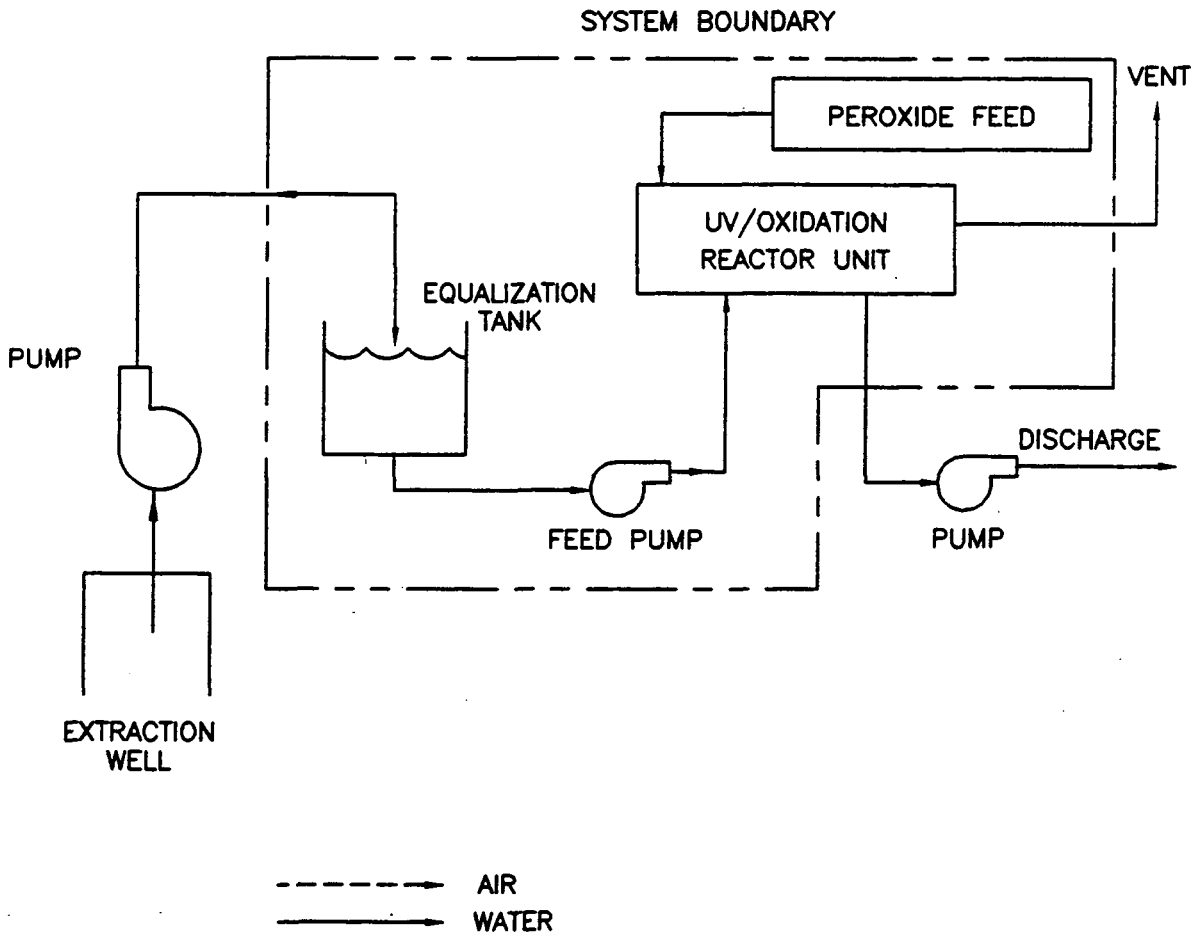

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FIGURE A–4

WESTON MANAGERS DESIGNERS/CONSULTANTS	Three Hawthorn Parkway Vernon Hills, Illinois 60061	UV/OXIDATION UNIT MOUND PLANT Miamisburg, Ohio

APPENDIX B

CASCADE AERATOR

TABLE B.1 CAPITAL COSTS - CASCADE AERATOR
OHIO EPA ENGINEERING GUIDE #46
Mound Plant
Miamisburg, Ohio

Cost Item	Computation Method			Cost in Dollars	
Direct costs					
Purchased equipment:					
Basic equipment (A)	Purchased cost of control device			2,620	
Auxiliary equipment (B)	Purchased cost of auxiliaries			0	
Total equipment costs (A + B)	Total of above (A + B)			2,620	
	(Average cost factor) x	(Adjustment factor)* x	(A + B)		
Instruments/controls	(0.10)	(0)	(2,620)	None	
Taxes (unless exempt)	(0.05)		(2,620)	Exempt	
Freight	(0.05)	(1)	(2,620)	131	
Base price (C)	Subtotal of above plus (A+B)				2,800 (C)
	(Average cost factor) x	(Adjustment factor)* x	(C)		
Foundations/supports	(0.4)		(2,800)	1,120	
Erection/handling	(0.14)	(1)	(2,800)	392	
Electrical	(0)		(2,800)	0	
Piping	(0)		(2,800)	0	
Insulation	(0)		(2,800)	0	
Painting	(0)		(2,800)	0	
Site preparation[b]	Estimate (0) x (0)		(2,800)	0	
Facilities/buildings[b]	Estimate (0) x (0)		(2,800)	0	
Total installation costs (D)	Subtotal of above				1,500 (D)
TOTAL DIRECT COSTS (E)	Base price (C) + installation cost (D)				4,300 (E)
Indirect costs	(Average cost factor) x	(Adjustment factor)* x	(C)		
Installation costs, indirect:					
Engineering/supervision	(0.05)	(0.5)	(2,800)	70	
Construction field expenses	(0.1)	(0.5)	(2,800)	140	
Construction fee	(0.10)	(1)	(2,800)	280	
Start-up	(0.01)		(2,800)	28	
Performance test	(0.10)		(2,800)	280	
Model study	(0)	(1)	(2,800)	0	
Contingencies	(0.30)	(1)	(2,800)	840	
TOTAL INDIRECT COSTS (F)	Total of above indirect costs				1,600 (F)
TOTAL CAPITAL COSTS (G)	Direct costs (E) + indirect costs (F)				5,900 (G)

*Absence of parenthesis in the adjustment factor column means no such factor is available.

[b]Costs for these items are unrelated to equipment costs (C) and are developed independently on an individual item basis. General estimates for these items can be modified with cost adjustment factors. Case specific estimates are entered directly in the cost column.

TABLE B.2 ANNUALIZED COSTS - CASCADE AERATOR
OHIO EPA ENGINEERING GUIDE # 46
Mound Plant
Miamisburg, Ohio

Cost Item	Computation Method	Cost in Dollars
Direct operating costs		
Operating labor:		
Operator	15 $/hr x 12 hr/yr	180 [a]
Supervision	15/% of operator labor cost	27
Operating materials	None	
Maintenance	15 $/hr x 24 hr/yr	360 [b]
Labor	100% of maintenance labor	360
Materials		
Replacement Parts	$100 Annually Estimated	100
Labor	100% of replacement parts cost	100
Utilities		
Electricity	0 $/kWh x 0 kWh/yr	0
Fuel oil	0 $/gal x 0 gal/yr	0
Gas	0 $/10^{3}ft^3 x 0 10^{3}ft^3/yr	0
Water	0 $/10^3 gal x 0 10^3 gal/yr	0
Steam	0 $/10^3 lb x 0 10^3 lb/yr	0
Other (specify)	As required	0
Waste disposal	0 $/ton x 0 tons/yr	0
Wastewater treatment	0 $/10^3 gas x 0 10^3 gals/yr	0
TOTAL DIRECT OPERATING COSTS (A)	Subtotal of above	$1,100 (A)
Indirect operating (fixed) costs		
Overhead	80% of O/M labor costs (a + b)	432
Property tax	1% of capital costs (5,900)*	59
Insurance	1% of capital costs (5,900)*	59
Administration	2% of capital costs (5,900)*	118
Capital recovery	CRF 0.0944 (at 7%, 20 yrs) x (5,900)*	557
TOTAL FIXED COSTS (B)	Subtotal of above	$1,200 (B)
Credits		
Project recovery	0 $/ton x 0 tons/yr	(0)
Heat recovery	0 $/10^6 Btu x 0 10^6 Btu/yr	(0)
TOTAL CREDITS (minus C)	Subtotal of above	(0)
TOTAL ANNUALIZED COSTS (D)	(A + B) minus (C)	$2,300

*Total capital costs (G) from Table B.1)

WESTON MANAGERS DESIGNERS/CONSULTANTS

SHEET 1 of 3 (20) 4

CLIENT/SUBJECT DOE/Mound - Cascade Aerator W.O. NO. 05376-051-002

TASK DESCRIPTION OU1 - Treatment Cost Analysis TASK NO. 0100

PREPARED BY R. Gabriel DEPT 642 DATE 12-15-94

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY

DEPT _____ DATE _____

Cascade aerator:

4 ft wide and 100 ft long. It will be placed on a slope 100 ft long and 25 ft in height (4:1).

Form work (From Means Building Construction Cost Data 1994 p. 87)

Edge forms to 6" high, on grade $2.26/LF

LF = 2(4ft) + 2(100ft) = 208 LF

208 LF × $2.26/LF = $470.08

CIP Concrete (From Means Building Construction Cost Data 1994 p 99)

Slab on grade 6" thick no reinforcement, not including forms

$1.81 SF

SF = 4ft × 100ft = 400 SF

400 SF × $1.81 SF = $724

CLIENT/SUBJECT DCE / Merrimack - Cascade Aerator W.O. NO. 05376-051-002

TASK DESCRIPTION O.U.1 - Treatment Cost Analysis TASK NO. 0100

PREPARED BY R. Gabriel DEPT 642 DATE _____ | APPROVED BY

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____ | DEPT _____ DATE _____

Reinforcement

Welded Wire Fabric (From Means Building Construction Cost Data, 1994 p 95)

Rolls 6×6 - 2/16 $29/CSF where CSF = hundred SF

$$CSF = \frac{400 SF}{100} = 4 CSF$$

$$4 CSF \times \$29/CSF = \$116$$

Capital Cost

Total Direct Capital Cost doubled due to sloping surface

$$2 \times [\$470 + \$724 + \$116] = \$2620$$

Indirect Capital Costs

Engineering and Design	(10% TDC)	= $262
Contingency Allowance	(20% TDC)	= $524
License/permit costs	(1% TDC)	= $26
		$812

Total Capital Costs

$2620 + $812 $3432

WESTON MANAGERS DESIGNERS/CONSULTANTS

SHEET 3 of 34

CLIENT/SUBJECT DOE/Mound - Cascade Aerator W.O. NO. 05376-051-002

TASK DESCRIPTION OU1 - Treatment Costs Analysis TASK NO. 0100

PREPARED BY R. Gabriel DEPT 642 DATE

MATH CHECK BY DEPT DATE

METHOD REV. BY DEPT DATE

APPROVED BY

DEPT DATE

Annual O & M

Assumed twice the power consumption of the extraction well system.

Power for 2 pumps for one year

2 ½ HP motors

1 HP = 0.7457 kW

$2 \times \frac{1}{2} hp \times \frac{0.7457 kw}{Hp} = 0.7457 kW$

$0.7457 kw \times \frac{24 hrs}{day} \times \frac{365 day}{year} \times \frac{\$.06}{kW \cdot hr} = \$ 391.94$

$2 \times \$392 = \$784$

Maintenance Reserve and Contingency Cost

Use 1% of Capital Cost = $.01 \times \$3432 = \$34.32$

Total Annual O & M =

$\$784 + \$34 = \$818$

CLIENT/SUBJECT DOE/Mound - Cascade Aerator W.O. NO. 05376-057-002

TASK DESCRIPTION 001 - Treatment cost Analysis TASK NO. 0100

PREPARED BY _____ DEPT _____ DATE _____

MATH CHECK BY _____ DEPT _____ DATE _____

METHOD REV. BY _____ DEPT _____ DATE _____

APPROVED BY _____ DEPT _____ DATE _____

Present Value of the 30-yr O&M cost

$$P = U\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

P = present value

U = uniform cost

n = number of periods

i = interest rate

n = 30 years

i = 3.2% (anticipated escalation rate for out year 1996, Pearman 1994)

U = $818

$$P = \$818\left[\frac{(1+.032)^{30} - 1}{.032(1+.032)^{30}}\right]$$

P = $15,626.48

Present or Total Value

Total Capital Cost + PV of 30-yr O&M = $19,058

APPENDIX C

AIR STRIPPER WITH FREE EXHAUST

TABLE C.1 CAPITAL COSTS - Air Stripping Tower
Ohio EPA Engineering Guide #46
Mound Plant
Miamisburg, Ohio

Cost Item	Computation Method			Cost in Dollars	
Direct costs					
Purchased equipment:					
Basic equipment (A)	Purchased cost of control device			25,202	
Auxiliary equipment (B)	Purchased cost of auxiliaries			0	
Total equipment costs (A + B)	Total of above (A + B)			25,202	
	(Average cost factor) x	(Adjustment factor)[a]	x (A + B)		
Instruments/controls	(0.10)	(0)	(25,202)	Included	
Taxes (unless exempt)	(0.05)		(25,202)	Exempt	
Freight	(0.05)	(1)	(25,202)	1,260	
Base price (C)	Subtotal of above plus (A + B)				$27,000 (C)
	(Average cost factor) x	(Adjustment factor)[a]	x (C)		
Foundations/supports	(0.08)		(27,000)	2,160	
Erection/handling	(0.14)	(2)	(27,000)	756	
Electrical	(0.04)		(27,000)	1,080	
Piping	(0.02)		(27,000)	540	
Insulation	(0.02)		(27,000)	540	
Painting	(0.01)		(27,000)	270	
Site preparation[b]	Estimate (0) x (0)		(27,000)	0	
Facilities/buildings[b]	Estimate (0) x (0)		(27,000)	0	
Total installation costs (D)	Subtotal of above				$5,300 (D)
TOTAL DIRECT COSTS (E)	Base price (C) + installation cost (D)				$32,000 (E)
Indirect costs	(Average cost factor) x	(Adjustment factor)[a]	x (C)		
Installation costs, indirect:					
Engineering/supervision	(0.05)	(1.5)	(27,000)	2,025	
Construction field expenses	(0.10)	(1)	(27,000)	2,700	
Construction fee	(0.10)	(1)	(27,000)	2,700	
Start-up	(0.02)		(27,000)	540	
Performance test	(0.10)		(27,000)	2,700	
Model study	(0.03)	(1)	(27,000)	810	
Contingencies	(0.30)	(1)	(27,000)	8,100	
TOTAL INDIRECT COSTS (F)	Total of above indirect costs				$20,000 (F)
TOTAL CAPITAL COSTS (G)	Direct costs (E) + indirect costs (F)				$52,000 (G)

[a]Absence of parenthesis in the adjustment factor column means no such factor is available.
[b]Costs for these items are unrelated to equipment costs (C) and are developed independently on an individual item basis. General estimates for these items can be modified with cost adjustment factors. Case specific estimates are entered directly in the cost column.

TABLE C.2 ANNUALIZED COSTS - Air Stripper with Free Exhaust
Ohio EPA Engineering Guide #46
Mound Plant
Miamisburg, Ohio

Cost Item	Computation Method	Cost in Dollars
Direct operating costs		
Operating labor:		
Operator	15 $/hr x 730 hr/yr	10,950 [a]
Supervision	15/% of operator labor cost	1,643
Operating materials	None	
Maintenance	15 $/hr x 416 hr/yr	6,240 [b]
Labor	100% of maintenance labor	6,240
Materials		
Replacement Parts	$1,000 Annually	1,000
Labor	100% of replacement parts cost	1,000
Utilities		
Electricity	0.06 $/kWh x 83,000 kWh/yr	4,980
Fuel oil	0 $/gal x 0 gal/yr	0
Gas	0 $/10^{3}ft^3 x 0 10^{3}ft^3/yr	0
Water	0 $/10^3 gal x 0 10^3 gal/yr	0
Steam	0 $/10^3 lb x 0 10^3 lb/yr	0
Other (specify)	As required	0
Waste disposal	0 $/ton x 0 tons/yr	0
Wastewater treatment	0 $/10^3 gas x 0 10^3 gals/yr	0
TOTAL DIRECT OPERATING COSTS (A)	Subtotal of above	$32,000 (A)
Indirect operating (fixed) costs		
Overhead	80% of O/M labor costs (a+b)	13,752
Property tax	1% of capital costs (52,000)*	520
Insurance	1% of capital costs (52,000)*	520
Administration	2% of capital costs (52,000)*	1,040
Capital recovery	CRF 0.0944 (at 7%, 20 yrs) x (52,000)*	4,909
TOTAL FIXED COSTS (B)	Subtotal of above	$21,000 (B)
Credits		
Project recovery	0 $/ton x 0 tons/yr	(0)
Heat recovery	0 $/10^6 Btu x 0 10^6 Btu/yr	(0)
TOTAL CREDITS (minus C)	Subtotal of above	(0)
TOTAL ANNUALIZED COSTS (D)	(A + B) minus (C)	$53,000

*Total capital costs (G) from Table C.1)

Remedial Systems, Inc.

56 Leonard Street
Foxboro, MA 02035-2929
(508) 543-1512
FAX (508) 543-7485

February 3, 1995

Gopa Nair
Roy F. Weston, Inc.
3 Hawthorn Pkwy - Ste 400
Vernon Hills, IL 60061-1450

Tel: 708-918-4000
Fax: 708-918-4055

Subject: RSI Quotation # **SYS-02-0395-IL**

Dear Gopa,

Remedial Systems Inc. (RSI) is pleased to present the following quotation for the above referenced project.

Item 1: (1) - RSI **Air Stripping Tower** designed to meet the following conditions:

Flowrate (gpm)	53
Water Temp (°F)	68

Chemical	Infl (ppb)	Effl (ppb)	Rem %	lbs/day
TCE	86	5	94.19	0.05
PCE	125	5	96	0.08
1,2 DCE	274	5	98.18	0.17
Vinyl Chloride	3.6	1	72.22	0
Total	488.6	16	96.73	0.3

Tower Diameter	24 inches
Overall Height	16 feet
Pack Height	10 feet
3.5" Packing	
Blower	230V, 1 PH, TEFC motor

1 HP

This equipment includes visual cleanout port, inlet piping, liquid distributor, packing supports, heavy duty top flange, demister, outlet discharge, instrumentation, blower, sight glass, high level sump switch, blower fail safe switch, and packing.

$ 9,950.00

Item 2: (1) - **Equalization Tank**, 500 gallon capacity, complete with 3-level switch array for transfer pump control.

$ 1,995.00

Item 3: (1) - **Transfer Pump**, TPE-10751, close coupled, end suction, capable of 53 gpm @ 25 feet TDH, 3/4 HP, 230V, 1 PH, TEFC motor.

$ 545.00

Item 4: (1) - **Control Panel,** model RSI-1001, capable of operating and controlling one (1) Water Table Depression Pump, and a complete Air Stripper System. (NEMA 4 weathertight enclosure)

List Price: **$ 1,750.00 each**
See Applicable Discount below

Item 5: (1) - **Optional Telemetry Module**. With this option, the user may remotely monitor and operate the site from an IBM-PC compatible computer equipped with a phone modem. The user will have information on all analog and digital inputs, outputs, cycle timers, and run times of each output in the system.

List Price: **$ 2,495.00 each**
See Applicable Discount below

Item 6: (2) - **VP-1500LP** Vapor Phase Carbon Vessel, constructed of mild steel with a high quality two layer epoxy interior coating and a hard enamel finish exterior.

Max. Flowrate	1,500	cfm
Max. Pressure	3	psig
Max. Temp.	125	°F
Width / Depth	42	inches
Height	84	inches

Inlet / Outlet	6	" NPT
Virgin Carbon	1,500	lbs
Shipping Weight	1,900	lbs
Est. Reactiv. Cost	$ 1440	
Est.Disposal Cost	$ 600	

$ 6,950.00 each

Item 7: (1) - **Bag Filter**, model FTB-00220, carbon steel construction, 0-220 gpm flow range, supplied with six (6) spare filter bags.

$ 1,395.00

- F.O.B. Factory
- Delivery: 5-6 weeks, after approval of drawings
- Terms: (subject to credit approval)
  25 % Upon Approval of Engineering Drawings
  25 % Prior to shipment, Balance Net 30 days

Offer Valid for 90 days

RSI warranty and conditions of sale enclosed

If you have any additional questions, please do not hesitate to contact me.

Sincerely,

Brendan Boulerice

Brendan Boulerice

BAB
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APPENDIX D

AIR STRIPPER WITH SECONDARY ACTIVATED CARBON VOC CAPTURE ON VAPOR PHASE

TABLE D.1 CAPITAL COSTS - Air Stripping Tower with Secondary Activated Carbon VOC Capture on Vapor Phase
Ohio EPA Engineering Guide #46
Mound Plant
Miamisburg, Ohio

Cost Item	Computation Method			Cost in Dollars	
Direct costs					
Purchased equipment:					
Basic equipment (A)	Purchased cost of control device			37,202	
Auxiliary equipment (B)	Purchased cost of auxiliaries			50,000	
Total equipment costs (A + B)	Total of above (A + B)			87,202	
	(Average cost factor) x	(Adjustment factor)[a] x	(A + B)		
Instruments/controls	(0.10)	(0)	(87,202)	Included	
Taxes (unless exempt)	(0.05)		(87,202)	Exempt	
Freight	(0.05)	(1)	(87,202)	4,630	
Base price (C)	Subtotal of above plus (A+B)				$92,000 (C)
	(Average cost factor) x	(Adjustment factor)[a] x	(C)		
Foundations/supports	(0.08)		(92,000)	7,360	
Erection/handling	(0.14)	(0.5)	(92,000)	6,880	
Electrical	(0.04)		(92,000)	3,680	
Piping	(0.02)		(92,000)	1,840	
Insulation	(0.02)		(92,000)	1,840	
Painting	(0.01)		(92,000)	920	
Site preparation[b]	Estimate (0) x (0)		(92,000)	0	
Facilities/buildings[b]	Estimate (0) x (0)		(92,000)	0	
Total installation costs (D)	Subtotal of above				$22,000 (D)
TOTAL DIRECT COSTS (E)	Base price (C) + installation cost (D)				$114,000 (E)
Indirect costs	(Average cost factor) x	(Adjustment factor)[a] x	(C)		
Installation costs, indirect:					
Engineering/supervision	(0.05)	(1.5)	(92,000)	6,900	
Construction field expenses	(0.10)	(1)	(92,000)	9,200	
Construction fee	(0.10)	(1)	(92,000)	9,200	
Start-up	(0.02)		(92,000)	1,840	
Performance test	(0.10)		(92,000)	9,200	
Model study	(0.03)	(1)	(92,000)	2,760	
Contingencies	(0.30)	(1)	(92,000)	27,600	
TOTAL INDIRECT COSTS (F)	Total of above indirect costs				$67,000 (F)
TOTAL CAPITAL COSTS (G)	Direct costs (E) + indirect costs (F)				$180,000 (G)

[a]Absence of parenthesis in the adjustment factor column means no such factor is available.
[b]Costs for these items are unrelated to equipment costs (C) and are developed independently on an individual item basis. General estimates for these items can be modified with cost adjustment factors. Case specific estimates are entered directly in the cost column.

TABLE D.2 ANNUALIZED COSTS - Air Stripping Tower With Secondary Activated Carbon VOC Capture on Vapor Phase Ohio EPA Engineering Guide #46 Mound Plant Miamisburg, Ohio

Cost Item	Computation Method	Cost in Dollars
Direct operating costs		
Operating labor:		
Operator	15 $/hr x 880 hr/yr	13,200 [a]
Supervision	15/% of operator labor cost	1,980
Operating materials	None	
Maintenance	15 $/hr x 774 hr/yr	11,610 [b]
Labor	100% of maintenance labor	11,610
Materials		
Replacement Parts	$1,500 Annually	1,500
Labor	100% of replacement parts cost	1,500
Utilities		
Electricity	0.06 $/kWh x 91,000 kWh/yr	5,460
Fuel oil	0 $/gal x 0 gal/yr	0
Gas	0 $/10^{3}ft^3 x 0 10^{3}ft^3/yr	0
Water	0 $/10^3 gal x 0 10^3 gal/yr	0
Steam	0 $/10^3 lb x 0 10^3 lb/yr	0
Other (specify)	As Required	0
Waste disposal	9.500 $/ton x 0.05 tons/yr	475
Wastewater treatment	0 $/10^3 gas x 0 10^3 gals/yr	0
TOTAL DIRECT OPERATING COSTS (A)	Subtotal of above	$47,000 (A)
Indirect operating (fixed) costs		
Overhead	80% of O/M labor costs (a+b)	19,848
Property tax	1% of capital costs (180,000)*	1,800
Insurance	1% of capital costs (180,000)*	1,800
Administration	2% of capital costs (180,000)*	3,600
Capital recovery	CRF 0.0944 (at 7%, 20 yrs) x (180,000)*	16,992
TOTAL FIXED COSTS (B)	Subtotal of above	$44,000 (B)
Credits		
Project recovery	0 $/ton x 0 tons/yr	(0)
Heat recovery	0 $/10^6 Btu x 0 10^6 Btu/yr	(0)
TOTAL CREDITS (minus C)	Subtotal of above	(0)
TOTAL ANNUALIZED COSTS (D)	(A + B) minus (C)	$91,000

*Total capital costs (G) from Table D.1)

APPENDIX E

UV/OXIDATION

TABLE E.1 CAPITAL COSTS - UV/OXIDATION
OHIO EPA ENGINEERING GUIDE # 46
Mound Plant
Miamisburg, Ohio

Cost Item	Computation Method			Cost in Dollars	
Direct costs					
Purchased equipment:					
Basic equipment (A)	Purchased cost of control device			125,000	
Auxiliary equipment (B)	Purchased cost of auxiliaries			1,700	
Total equipment costs (A + B)	Total of above (A + B)			126,700	
	(Average cost factor) x	(Adjustment factor)[a] x	(A + B)		
Instruments/controls	(0.10)	(1.2)	(126,700)	15,204	
Taxes (unless exempt)	(0.05)		(126,700)	EXEMPT	
Freight	(0.05)	(1.0)	(126,700)	6,335	
Base price (C)	Subtotal of above plus (A+B)				$150,000 (C)
	(Average cost factor) x	(Adjustment factor)[a] x	(C)		
Foundations/supports	(0.08)		(150,000)	12,000	
Erection/handling	(0.14)	(0.5)	(150,000)	10,500	
Electrical	(0.08)		(150,000)	12,000	
Piping	(0.01)		(150,000)	1,500	
Insulation	(0.01)		(150,000)	1,500	
Painting	(0)		(150,000)	0	
Site preparation[b]	Estimate (0) x (0)		(150,000)	0	
Facilities/buildings[b]	Estimate (0.05) x (1)		(150,000)	7,500	
Total installation costs (D)	Subtotal of above				$45,000 (D)
TOTAL DIRECT COSTS (E)	Base price (C) + installation cost (D)				$200,000 (E)
Indirect costs	(Average cost factor) x	(Adjustment factor)[a] x	(C)		
Installation costs, indirect:					
Engineering/supervision	(0.10)	(1.5)	(150,000)	22,500	
Construction field expenses	(0.10)	(1)	(150,000)	15,000	
Construction fee	(0.10)	(1)	(150,000)	15,000	
Start-up	(0.10)		(150,000)	15,000	
Performance test	(0.10)		(150,000)	15,000	
Model study	(0.10)	(1)	(150,000)	15,000	
Contingencies	(0.30)	(1)	(150,000)	45,000	
TOTAL INDIRECT COSTS (F)	Total of above indirect costs				$140,000 (F)
TOTAL CAPITAL COSTS (G)	Direct costs (E) + indirect costs (F)				$340,000 (G)

[a]Absence of parenthesis in the adjustment factor column means no such factor is available.
[b]Costs for these items are unrelated to equipment costs (C) and are developed independently on an individual item basis. General estimates for these items can be modified with cost adjustment factors. Case specific estimates are entered directly in the cost column.

TABLE E.2 ANNUALIZED COSTS - UV/OXIDATION
OHIO EPA ENGINEERING GUIDE # 46
Mound Plant
Miamisburg, Ohio

Cost Item	Computation Method	Cost in Dollars
Direct operating costs		
Operating labor:		
Operator	15 $/hr x 730 hr/yr	10,950 [a]
Supervision	15/% of operator labor cost	1,643
Operating materials	0.78 $/1,000 gal x 28,000 (1,000 gal/yr)	21,087
Maintenance	Factory maintenance $4,000/yr	4,000 [b]
Labor		NA
Materials		
Replacement Parts	Included in operating materials	NA
Labor	100% of replacement parts cost	NA
Utilities		
Electricity	0.06 $/kWh x 77,417 kWh/yr	4,485
Fuel oil	0 $/gal x 0 gal/yr	0
Gas	0 $/$10^3 ft^3$ x 0 $10^3 ft^3$/yr	0
Water	0 $/$10^3$ gal x 0 10^3 gal/yr	0
Steam	0 $/$10^3$ lb x 0 10^3 lb/yr	0
Other (specify)	As required	0
Waste disposal	0 $/ton x 0 tons/yr	0
Wastewater treatment	0 $/$10^3$ gas x 0 10^3 gals/yr	0
TOTAL DIRECT OPERATING COSTS (A)	Subtotal of above	$42,000 (A)
Indirect operating (fixed) costs		
Overhead	80% of O/M labor costs (a+b)	11,960
Property tax	1% of capital costs (340,000)*	3,800
Insurance	1% of capital costs (340,000)*	3,800
Administration	2% of capital costs (340,000)*	6,800
Capital recovery	CRF 0.0944 (at 7%, 20 yrs) x (340,000)*	32,096
TOTAL FIXED COSTS (B)	Subtotal of above	$58,000 (B)
Credits		
Project recovery	0 $/ton x 0 tons/yr	(0)
Heat recovery	0 $/$10^6$ Btu x 0 10^6 Btu/yr	(0)
TOTAL CREDITS (minus C)	Subtotal of above	($)
TOTAL ANNUALIZED COSTS (D)	(A + B) minus (C)	$100,000

*Total capital costs (G) from Table E.1)

ULTROX

A Division of Zimpro Environmental, Inc.

2435 South Anne Street
Santa Ana, CA 92704-5308
Phone: 714 545-5557
Fax: 714 557-5396

March 2, 1994

Randall Gabriel
Roy F. Weston
Suite 800
6501 Americas Parkway, N.E.
Albuquerque, NM 87110-1517

Dear Mr. Gabriel:

Please find attached budget capital and O&M costs for the ULTROX• UV/Oxidation system estimated to meet your client's groundwater treatment requirements. Because UV/Oxidation destroys different compounds with different levels of efficiency, we are basing our estimates on experiences with similar contaminants.

To provide more complete data and a firm price quotation, we recommend a laboratory treatability study. This would allow us to subject the targeted compounds to a variety of oxidation variables and determine the optimum, cost effective dosing needed to reach your required target concentrations. I have enclosed our laboratory fee schedule for your consideration.

Should you require any further information or clarification, please give me a call.

Sincerely,
ULTROX

William S. Hinebaugh
National Sales Manager

WSH/gkr
enc: Budget Quote & Fee Schedule

BUDGET CAPITAL AND O&M COSTS FOR THE ULTROX® UV/OXIDATION SYSTEM

I. PARAMETERS

PARAMETERS	CONCENTRATION (ug/l)	GOAL (ug/l)
1,2-DCE	640	SDWA MCL
Vinyl Chloride	4.5	"
Tetrachloroethene	270	"
TCE	210	"
Trichloromethane	130	"

II. UV/OXIDATION SYSTEM COMPONENTS

A. OXIDATION REACTOR
   1. ONE F-650

B. OZONE GENERATOR
   1. 7 LB/DAY OZONE GENERATOR

C. OZONE GENERATOR AIR PREPARATION SYSTEM
   1. COMPRESSOR
   2. AIR DRYER (-70°F DEWPOINT)
   3. AIR FILTER

D. HYDROGEN PEROXIDE FEED SYSTEM
   1. CHEMICAL METERING PUMP (0.5 GPH)
   2. CALIBRATION CYLINDER
   3. PUMP STAND

E. VAPOR TREATMENT
   1. D-TOX™/DECOMPOZON™ CATALYTIC OZONE/VOC DESTRUCTION UNIT

F. POWER CONTROL UNIT
   1. PROGRAMMABLE LOGIC AUTOMATIC CONTROL UNIT

III. ASSUMPTIONS

A. FLOW RATE = 20.0 GPM

B. ELECTRICAL COSTS = $0.06/KWH

C. H_2O_2 COSTS = $0.70/LB

D. REPLACEMENT COSTS PER LAMP = $60 (lamp life = 1.2 yrs.)

IV. COSTS

A. TOTAL BUDGET CAPITAL COST*: $ 195,000

B. TOTAL BUDGET O&M COSTS**: $ 0.87/1000 GALLONS

* Capital costs are estimated FOB Santa Ana, CA and do not include installation, start up or training. More detailed information will be required for integration into full-scale system design.

** O&M costs include electrical power costs, H_2O_2 costs, and amortized UV lamp replacement costs.

ULTROX

STANDARD TERMS AND FEE SCHEDULE FOR LABORATORY TREATABILITY AND PILOT PLANT STUDIES

LABORATORY TREATABILITY STUDIES (Santa Ana, CA)

$700/day with a five day minimum

Analytical work at an independent laboratory will be billed at cost plus 20%

FIELD PILOT PLANT STUDIES

Models P-75

$2,650/week, with a one week minimum

Models P-325, P-650, P-675

$3,100/week, with a one week minimum

D-TOX CF-1 with G-14 lb/day ozone generator	$2,500/week
D-TOX CF-1 with G-28 lb/day ozone generator	$2,800/week

An Ultrox field engineer will be provided at a charge of $2,400 (plus travel and living expenses) for the first five working days on site. A per diem charge of $575.00 (plus travel and living expenses) will be invoiced for each additional day an Ultrox field engineer is required. Rates for extended rental periods, i.e. greater than four weeks, will be quoted upon request.

A credit of 50% on up to 4 weeks laboratory work and pilot plant work will be given for purchase of an ULTROX® system purchased within six months of test completion. The credit does not apply to charges for living, travel and freight expenses or field engineer's time, or for analytical charges at an independent laboratory.

TERMS

- Payable upon receipt of invoice
- Invoices for laboratory tests are issued upon completion of tests or on a monthly basis for extended laboratory studies.
- Freight charges for shipment of samples and/or pilot plant units to and from Santa Ana, CA, are the customer's responsibility.
- Invoices for pilot plant rentals are issued on a monthly basis.
- First week's pilot plant rental due with purchase order.
- One third (1/3) payment due with purchase order on laboratory studies.
- Charges commence on the day the unit arrives at client's facility until it is returned to Santa Ana, CA. Federal holidays, Saturdays and Sundays that the unit is in transit are not billed to our clients.
- Any damage to the unit above normal operating wear is the responsibility of the customer.
- Actual travel and daily living expenses for Ultrox field engineers are billed to the customer.
- Prices are subject to change without notice.
- All samples will be returned to client after testing is completed.

Prices effective 4/1/91

130 Royal Crest Court
Markham, Ontario
Canada L3R 0A1

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Solarchem

FACSIMILE NO. : (708) 918-4055

NO. OF PAGES : 8

DATE : Feb 6, 1995

TO : Gopa Nair

FROM : Rob Abernethy