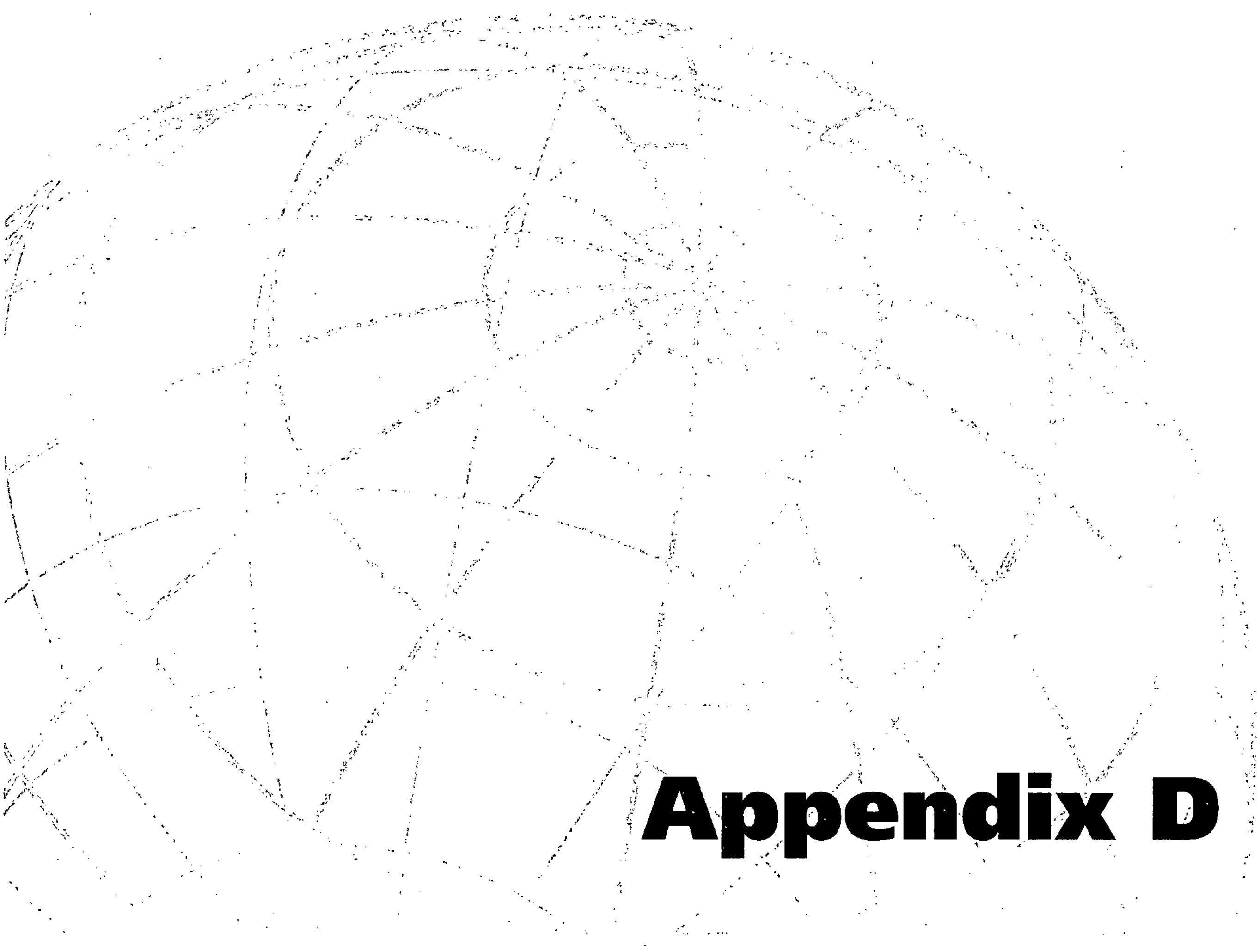

Appendix D

Appendix D

D. GROUNDWATER TREATMENT

D-1 Precipitation Holding/Equalization Tank Sizing
D-2 Evaluation of Scaling Factor
D-3 Groundwater Treatment Systems - Summary Tables for Groundwater Conditions
D-4 Capital and Operating Cost Quotes
- Metals Treatment Quotation: Lancy/US Filter
- Metals Treatment Quotation: Koch Membrane Systems
- Metals Treatment Quotation: Osmonics
- UV/Chemical Oxidation Quotation: Solarchem
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D-5 Point of Use System
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D-1 Precipitation Holding/Equalization Tank Sizing

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1 of 1
Subject	Rationale for Alternative #4 -	Comptd. By	S. Czarniecki	Date	09/13/96
Detail	On-site Leachate Treatment System	Ck'd. By	D. Peters	Date	09/13/96

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Leachate/groundwater treatment systems were originally sized based on 50 and 200 gpm flow rates in the Draft FS. Sizing for the current Alternative #4 treatment system (5 gpm) will be revised as follows.

Assumed scaling factor for 5 gpm system from the 50 gpm system - 0.4

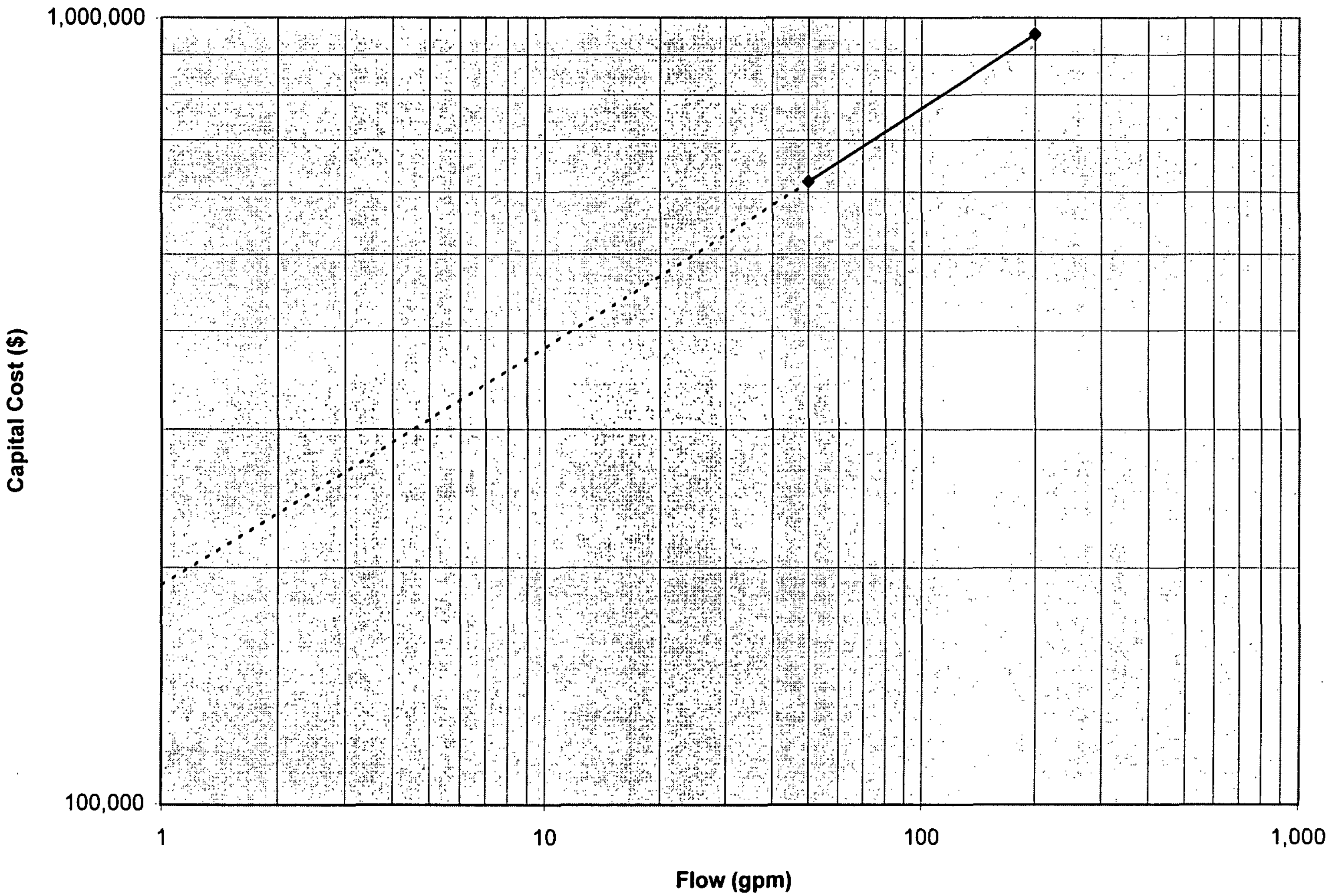
As knowledge of system retention time is usually desired, the initial holding tank size will be calculated.

	50 gpm	5 gpm
Precipitation Holding/Equalization Tank	12,000 gal	4,800 gal
	Selected tank size:	5,000 gal
	This results in a holding time of	17 hrs

All other pieces of equipment will be scaled from respective vendor quotations.

D-2 Evaluation of Scaling Factor

Flow vs. Capital Cost



D-3 Groundwater Treatment Systems - Summary Tables for Groundwater Conditions

TABLE D-1: GROUNDWATER CONDITIONS FOR THE 5 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b)			PRELIMINARY REMEDIATION GOAL
	Average	Maximum		
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	13	22		
Sulfide (mg/L)	0	0		
Aluminum	2,100	9,220	*	
Antimony	0	0	*	6
Arsenic	0	0	*	
Barium	510	2,120	*	
Beryllium	2	9	*	4
Cadmium	2	5	*	5
Chromium	0	0	*	100
Cobalt	63	295	*	
Copper	0	0	*	
Iron	286,675	1,370,000	*	
Lead	37	174	*	15
Manganese	8,200	14,700	*	900
Mercury	0.11	0.20	*	
Nickel	5	14	*	100
Vanadium	15	65	*	
Zinc	210	133	*	
Dieldrin	0.000	0.000		
2-Methylnaphthalene	0	0		
4-Chloro-3-methylphenol	0	0		
4-Methylphenol	0	0		
Pentachlorophenol	0	0		1
bis(2-Ethylhexyl)phthalate	50	230		6
1,1-Dichloroethane	3	2		
1,1-Dichloroethene	0	0		
1,2-Dichloroethene(total)	3	1		70
4-Methyl-2-pentanone	0	0		
Acetone	0	0		
Benzene	0	0		5
Carbon Disulfide	3	3		
Chloroethane	6	8		
Ethylbenzene	2	2		
Toluene	19	50		
Trichloroethene	0	0		
Vinyl Chloride	0	0		2
Acrylamide	0	0		0.02 (c)
N,N-DMF	0	0		
Hardness (mg/L)	79	214		
pH	6.5	7.1		
Total Organic Carbon (mg/L)	26	50		
Biochemical Oxygen Demand (mg/L)	9	51		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

TABLE D-2: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	9	48		
Sulfide (mg/L)	1	4		
Aluminum	12,616	98,281	*	
Antimony	0	0	*	6
Arsenic	2	9	*	
Barium	210	695	*	
Beryllium	2	13	*	4
Cadmium	4	36	*	5
Chromium	21	136	*	100
Cobalt	21	82	*	
Copper	37	324	*	
Iron	91,571	396,140	*	
Lead	40	180	*	15
Manganese	2,633	10,361	*	900
Mercury	0.11	0.29	*	
Nickel	24	112	*	100
Vanadium	20	133	*	
Zinc	625	6,520	*	
Dieldrin	0.043	0.003		
2-Methylnaphthalene	4	4		
4-Chloro-3-methylphenol	4	4		
4-Methylphenol	8	64		
Pentachlorophenol	12	3		1
bis(2-Ethylhexyl)phthalate	11	59		6
1,1-Dichloroethane	13	195		
1,1-Dichloroethene	4	2		
1,2-Dichloroethene(total)	30	645		70
4-Methyl-2-pentanone	5	27		
Acetone	20	415		
Benzene	10	27		5
Carbon Disulfide	13	77		
Chloroethane	16	77		
Ethylbenzene	14	64		
Toluene	31	156		
Trichloroethene	4	4		
Vinyl Chloride	30	610		2
Acrylamide	141	202		0.02 (c)
N,N-DMF	177	1,273		
Hardness (mg/L)	151	621		
pH	7.1	11.9		
Total Organic Carbon (mg/L)	44	200		
Biochemical Oxygen Demand (mg/L)	12	112		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

TABLE D-3
SUMMARY OF CAPITAL AND OPERATING COSTS
BASED ON QUOTES PROVIDED BY VENDORS

Treatment/Vendor	Flow Rate (gpm)	Capital Cost	Operating Cost ($ / 1K gal)[A]
Inorganic Precipitation/	50	$500,000	–
US Filter	200	$800,000	–
Inorganic Removal via	5	$254,000	–
UF and RO/	50	$643,000	–
Koch Membrane	200	$1,681,000	–
Inorganic Removal via RO/	50	$175,000	–
Osmonics	200	$470,000	–
Organics Removal via	50	$80,000	$0.90
UV-Oxidation/	200	$175,000	$0.90
Solarchem			
Organics Removal via	50	$250,000	$101,200 [B]
UV-Oxidation/	200	$675,000	$366,000 [B]
Peroxidation Systems			
Organics Removal via	50	$218,000	$0.75
UV-Oxidation/	200	$333,000	$0.34
Ultrox			

Notes:

A – Operating cost data not included in US Filter, Koch, or Osmonics quotes.

B – Value given is annual operating cost ($ / yr).

D-4 Capital and Operating Cost Quotes

- Metals Treatment Quotation: Lancy/US Filter
- Metals Treatment Quotation: Koch Membrane Systems
- Metals Treatment Quotation: Osmonics
- UV/Chemical Oxidation Quotation: Solarchem
- UV/Chemical Oxidation Quotation: Peroxidation Systems
- UV/Chemical Oxidation Quotation: Ultrox

- Metals Treatment Quotation: Lancy/US Filter
  Design Basis: 50 gpm System
  Process Description
  Equipment List: 50 gpm System
  Design Basis: 200 gpm System
  Equipment List: 200 gpm System
  Operating Requirements
  Budgetary Prices and Delivery Schedule
  Terms and Conditions
  System Drawings
  Sludge Calculations
  Price Breakout by Equipment
  M&E Quotation Request

U.S.FILTER
UNITED STATES FILTER CORPORATION

THE . . F & EDDY, INC.
JUN 4 1993
RECEIVED

LANCY™
SYSTEMS & EQUIPMENT
181 THORN HILL ROAD
WARRENDALE, PA 15086-7527
TEL: 412-772-0044
FAX: 412-772-1360

June 3, 1993

Metcalf and Eddy
30 Harvard Mill Square
Wakefield, Massachusetts 01880
(617) 246-5200

Attention: Mr. Sean Czarniecki

Reference: Rose Hill, Rhode Island Groundwater/Leachate Project

Subject: Budgetary Proposal to Provide Groundwater Treatment Equipment

Dear Mr. Czarniecki:

United States Filter Corporation is pleased to supply this budgetary proposal regarding the above-referenced project.

We are providing unit process descriptions for a groundwater treatment system to address metals treatment. We have also included an overall conceptual flow diagram which depicts our treatment concept. We feel very confident that the treatment levels required for metals can be achieved with the proposed unit operations. Ultraviolet/oxidation equipment shall also be incorporated into the system and shall be supplied by others. The following design information is being provided for two system alternatives.

With the equalization tank with level controls provided in this system, we feel confident that the system can perform effectively with incoming flow rates as low as 5 gpm.

ALTERNATE NO. 1 - 50 GPM SYSTEM

- ***Design Basis***

Parameter	*Average Influent*	*Effluent Requirements*
Ammonia, mg/l	9	
Sulfide, mg/l	1	
Aluminum, µg/l	12,616	
Antimony, µg/l	0	
Arsenic, µg/l	2	
Barium, µg/l	210	
Beryllium, µg/l	2	1
Cadmium, µg/l	4	5
Chromium, µg/l	21	100

ALTERNATE NO. 1 - 50 GPM SYSTEM

Design Basis (Continued)

Parameter	***Average Influent***	***Effluent Requirements***
Cobalt, µg/l	21	
Copper, µg/l	37	
Iron, µg/l	91,571	
Lead, µg/l	40	15
Manganese, µg/l	2,633	3,650
Mercury, µg/l	0.11	
Nickel, µg/l	24	100
Vanadium, µg/l	20	
Zinc, µg/l	625	
Dieldrin, µg/l	0.043	
2-Methylnaphthalene, µg/l	4	
4-Chloro-3-methylphenol, µg/l	4	
4-Methylphenol, µg/l	8	
Pentachlorophenol, µg/l	12	
bis(2-Ethylhexyl)phthalate, µg/l	11	
1,1-Dichloroethane, µg/l	13	
1,1-Dichloroethene, µg/l	4	
1,2-Dichloroethene (total), µg/l	30	
4-Methyl-2-pentanone, µg/l	5	
Acetone, µg/l	20	
Benzene, µg/l	10	
Carbon Disulfide, µg/l	13	
Chloroethane, µg/l	16	
Ethylbenzene, µg/l	14	
Toluene, µg/l	31	
Trichloroethene, µg/l	4	
Vinyl Chloride, µg/l	30	
Acrylamide, µg/l	141	
N,N-DMP, µg/l	177	
Hardness, mg/l	151	
pH, standard units	7.1	
Total Organic Carbon, mg/l	44	
BOD, mg/l	12	

- ***Process Description***

Equalization

The 50 gpm groundwater shall be transferred (by others) to a 12,000-gallon holding/equalization tank. The holding tank shall have a cover and shall be exhausted to a vapor phase carbon adsorber. This tank shall provide approximately 4 hours retention time. This tank shall serve as a reservoir to provide a continuous feed to the groundwater treatment system. Additionally, this tank shall help to minimize variations of influent groundwater characteristics. Design flow of the system shall be 50 gpm. Should the influent flow rate be less (down to 5 gpm expected), the equalization tank and transfer pumping shall serve to cycle flow through the system on a high level tank demand. The unit operations employed in this system can be idle or automatic recirculation when no flow conditions exist.

Metals Precipitation

The proposed groundwater treatment system maximizes the use of gravity to transfer the wastewater from one reactor to the next. Due to the logistics of the system, lift stations will be necessary to transfer the groundwater to the system. Pumping is also utilized to facilitate the transfer of sludge within the sludge handling system.

The groundwater flows into each reactor where the agitator used produces a mixing pattern that ensures rapid blending of the treatment chemicals and wastewater. The wastewater exits each reactor through a specially designed outlet box which directs the flow from the tank bottom up to the outlet and prevents short-circuiting of untreated wastewater through the reactor.

The proposed system utilizes solid-state instrumentation which is capable of reliably automating the addition of treatment chemicals. The models used have a meter display, proportional chemical feed capabilities, and are housed in a NEMA-12 enclosure.

Metals Precipitation (Continued)

The groundwater shall be transferred from the equalization tank to the first reaction compartment of the Lancy™ Econo-Treat. This compartment shall be lined with 3/16-inch PVC to protect the steel from the acidic groundwater. Transfers shall be accomplished by duplex centrifugal pumps operated by level controls mounted in the equalization tank. (Pumps and level controls supplied by U.S. Filter.) After entering the treatment system, the groundwater will be pH adjusted to acidic conditions (~4) in the first-stage reactor. Sulfuric acid will be used to maintain the pH at approximately 3 to 4 and a coagulant of ferrous sulfate shall be added. Chemical additions will be controlled by solid-state instrumentation to optimize chemical additions/consumption.

The sulfuric acid feed system shall be a metering pump which feeds acid directly from the day tank. The coagulant feed system shall consist of a FRP tank, mixing agitator and metering pump.

The groundwater in the first reaction compartment shall flow by gravity to the second reaction compartment where it will be neutralized to a pH of 9.5 to 10 with caustic in the second-stage reaction compartment. Caustic additions will be controlled by solid-state instrumentation.

The neutralized groundwaters shall continue to flow by gravity into the flocculation compartment and then into the solids separator compartment. A liquid polymer will be added in the floc compartment to aid the settling of the precipitated solids in the solids separator. Both the caustic and polymer feed systems shall be a metering pump which feeds chemicals directly from dedicated day tanks.

After the solid/liquid phases have been separated in the solids separator compartment, the clarified supernatant shall flow by gravity to a lift station for transfer to the sand filter.

<u>Note</u>: The metals precipitation unit shall be covered and exhausted to the vapor phase carbon adsorber.

The accumulated sludge in the solids separator will be periodically transferred to a sludge thickener for further dewatering.

The thickened sludge will undergo a final dewatering in a plate and frame type of filter press where the solids content is expected to reach approximately 25 to 30 percent by weight. The pressed sludge will then be discharged for proper disposal.

Sand Filtration

The liquid phase of the groundwater shall then be directed to a continuous backwash, upflow sand filter for further removal of suspended matter. It is anticipated that particles greater than 11 μm shall be removed to <10 mg/l.

UV / Oxidation / Carbon Adsorption

We believe reduction of the organic compounds would be addressed in this scope of work. If Metcalf and Eddy feels carbon adsorption polishing is required to meet the organic limits after UV oxidation, then we suggest placement of carbon adsorption units after UV/oxidation. pH adjustments for both UV/oxidation and carbon adsorption should also be addressed. These unit operations are not included in our quotation.

Sorption Filter System

To address the polishing of metals to discharge limits, U.S. Filter proposes placement of a Lancy™ Sorption Filter after organics treatment.

Groundwater to be processed by the sorption filter is first collected in the integral reaction module where the pH is elevated and a sulfide reagent is added. This addition ensures that a small amount of free soluble sulfide will be maintained.

The waste will then gravity flow to the sorption filter retention tank. This tank permits continuous operation of the system while obtaining the maximum use of media, as described below.

From the retention tank, the wastewater is pumped to the filter bodies where it is filtered through a proprietary reactive media which performs two functions. First, it filters out the fine, colloidal metal sulfide precipitates formed in the reaction module and secondly, it adsorbs any residual soluble metals and unreacted sulfides remaining in solution. These two features conspire to produce an extremely high effluent quality.

This unit maximizes media use in a unique way. As the soluble particulate metal sulfides are filtered out, the pressure drop increases across the filter. When this pressure differential reaches a predetermined level, the media is automatically bumped off the filter fingers and recoated thereby exposing new open filtration sites. This bump/recoat cycle is not started until the retention tank reaches a low level at which time automatic valves are activated which shut off the feed of waste to the filter. At this time, the solution in the filter system is recycled back through a separate precoat tank until the media is recoated on the filter fingers.

While the filter precoats, the incoming waste is accumulated in the retention tank. After the precoat cycle is completed, the automatic valves are actuated again to permit the processing of the accumulated wastewater.

After exiting the filter, the wastewater is directed to a final pH adjustment module prior to discharging due to the elevated operating pH of the sorption filtration process.

The treated groundwater shall then be routed, via a lift station, to an effluent hold tank. The effluent hold tank may be used as a chemical make-up water supply, and, if necessary, the effluent may be reprocessed back through the system should effluent quality not be met. (This event may occur during start-up and shut-down operations.)

Effluent Monitoring System

The treated groundwater shall pass through a flow monitor/totalizer prior to discharge.

- ***Equipment List - 50 GPM System***

Item No.	*Description*

1-1 EQUALIZATION TANK
Lancy Model No. 50-49120-1

* 12,000-gallon capacity, vertical, cylindrical FRP tank
* Flanged drain connection
* Dip tube
* Tie-down lugs

TRANSFER PUMP
Lancy Model No. 50-2224-050/50-11

* Duplex, FRP constructed horizontal, centrifugal pumps
* 50 gpm capacity
* 210-gallon capacity, vertical, cylindrical FRP tank
* Pump level controls
* High level alarm
* 230/460-VAC, 3-Phase, TEFC motors

FLOW METER AND RECORDER

VAPOR PHASE CARBON ADSORBER

1-2 LANCY™ ECONO-TREAT UNIT
Lancy Model No. ET120-B-L

* Carbon steel fabricated unit
* First-stage PVC sheet lined pH adjustment compartment
* Second-stage neutralization compartment
* Third-stage flocculation compartment
* Solids separator compartment with integral corrugated plate interceptor pack(s) and solids collection hopper
* Access ladder and platform
* Exterior coat of chemically-resistant paint
* Reaction compartment agitators
* Automatically controlled sludge withdrawal pump
* Flanged sludge withdrawal connection
* Adjustable effluent trough and flanged effluent nozzles

- ***Equipment List - 50 GPM System (Continued)***

<u>*Item No.*</u>	<u>*Description*</u>
1-2	LANCY™ ECONO-TREAT UNIT (Continued)

* Chemical supply tanks
* Chemical supply tank agitators
* Chemical feed pumps
* Electrical control system--to control electrically-operated components that are included with the Econo-Treat such as metering pumps, process controllers, agitators and the sludge withdrawal timers and pump
* The unit and the chemical support equipment will be prewired and prepiped at our plant. However, due to shipping limitations, some re-assembly will be required.

ADDITIONAL ACID FEED PUMP
Lancy Model No. 50-5111-000

* One positive displacement metering pump
* 0-18 gph output capacity
* Polypropylene head, check valves and diaphragm
* Suction hose and strainer
* Totally enclosed drive
* Anti-syphon valve
* Dial-knob capacity adjustment

1-3 LIFT STATION
Lancy Model No. 50-2224-050/50-11

* Duplex, FRP constructed horizontal, centrifugal pumps
* 50 gpm capacity
* 210-gallon capacity, vertical, cylindrical FRP tank
* Pump level controls
* High level alarm
* 230/460-VAC, 3-Phase, TEFC motors

- ***Equipment List - 50 GPM System (Continued)***

Item No.	*Description*
1-4	SAND FILTER

* 42-gallon per minute capacity wastewater filter at less than 50 ppm solids
* FRP constructed vertical cylindrical unit
* Inlet connection and riser tubes
* Distribution hood
* Self-cleansing sand bed
* Overflow weir
* Airlift pipe
* Central reject compartment
* Gravity washer/separator
* Reject effluent/filtrate weir
* Continuous upflow/backwash design

1-5	LANCY™ SORPTION FILTER SYSTEM

* 80 gpm maximum capacity
* Skidded modular unit
* ~10 ft-6 in. long by 7 ft wide by 12 ft-6 in. high
* 1,100-gallon reactor tank with agitator
* Sulfide and pH controller
* Sample center
* 1,200-gallon retention tank
* 350-gallon precoat tank with agitator
* Duplex filter feed pumps
* One stainless steel filter body
* Stainless steel filter fingers
* Valves and level controls
* Electrical control panel
* 200-gallon caustic tank with agitator and feed pump
* 150-gallon sulfide tank with agitator and feed pump
* Prewired and prepiped unit
* Operator platform and ladder

- ***Equipment List - 50 GPM System (Continued)***

Item No.	*Description*
1-6	pH ADJUSTMENT MODULE Lancy Model No. 50-4406-1

* 600-gallon capacity, vertical, cylindrical FRP tank
* Outlet box
* Flanged nozzles
* Agitator
* Agitator mounting bracket
* pH controller, cables, electrode, electrode holder and holder mounting bracket

1-7	LIFT STATION Lancy Model No. 50-2221-050/50-11

* Duplex, cast iron constructed horizontal, centrifugal pumps
* 50 gpm capacity
* 210-gallon capacity, vertical, cylindrical FRP tank
* Pump level controls
* High level alarm
* 230/460-VAC, 3-Phase, TEFC motors

1-8	EFFLUENT HOLD TANK Lancy Model No. 50-49120-1

* 12,000-gallon capacity, vertical, cylindrical FRP tank
* Flanged drain connection
* Dip tube
* Tie-down lugs

TRANSFER PUMPS
Lancy Model No. 50-2221-050/50-10

* Duplex, cast iron constructed horizontal centrifugal pumps
* 50 gpm capacity
* Pump level controls
* High level alarm
* 230/460-VAC, 3-Phase, TEFC motors

- ***Equipment List - 50 GPM System (Continued)***

Item No.	Description
1-9	LANCY™ EFFLUENT MONITOR Lancy Model No. 75-9712-01120

The unit includes:

* Open channel flow measuring device with analog flow percentage meter, digital display totalizer and strip chart recorder.

* pH control with analog display meter, recorder, electrode and electrode holder, pH control selector switches for acid/alkaline adjustment complete with dry contacts to operate chemical feed pumps and agitators. (Pumps and agitators not provided.)

* Pneumatically operated composite sampler and a digital display sample counter. The sampler can be activated manually, on a timed basis or flow proportionally.

* An indoor/outdoor 12-gauge steel epoxy coated insulated enclosure with lifting lugs.

* Thermostatically controlled heating and ventilation.

* Instrument panel lighting.

* 117-VAC duplex convenience outlets mounted above the front and rear panels.

* Full sized front and rear lockable access doors.

* Refrigerator with a 5-gallon composite sample bottle which will contain up to 378 50-ml samples.

- ***Equipment List - 50 GPM System (Continued)***

Item No.	*Description*
	EFFLUENT MONITORING TANK Lancy Model No. EMT-50
	* 50 gpm capacity tank * V-notch weir box * Polypropylene construction * Stilling well/transducer mounting bracket * Influent baffle * Flanged effluent nozzle
1-10	SLUDGE THICKENER Lancy Model No. 50-7135-30
	* 3,500-gallon capacity, vertical, cylindrical FRP tank * Conical bottom * Internal baffles * Overflow nozzle * Flanged bottom nozzle
	SLUDGE WITHDRAWAL PUMP Lancy Model No. 50-6211-08-10
	* One air-operated diaphragm pump * Cast iron construction * Neoprene elastomers * 110 gpm capacity at 100 psi * 2-inch NPT suction connection * 2-inch NPT discharge connection

- ***Equipment List - 50 GPM System (Continued)***

Item No.	*Description*
1-11	FILTER PRESS

* 5 cu ft filter cake capacity
* 1.26-inch cake thickness
* 100 psi filtration capacity
* Center feed
* Four corner filtrate discharge connection
* Painted steel skeleton
* Woven polypropylene filter cloth
* Automatically operated closure
* Plate shifter

TWO DUMP CARTS

1-12 FILTRATE LIFT STATION
Lancy Model No. 50-2221-110/50-11

* Duplex, cast iron constructed horizontal, centrifugal pumps
* 110 gpm capacity
* 550-gallon capacity, vertical, cylindrical FRP tank
* Pump level controls
* High level alarm
* 230/460-VAC, 3-Phase, TEFC motors

- ***Equipment List - 50 GPM System (Continued)***

Item No.	*Description*
1-13	ELECTRICAL CONTROL PANEL

An electrical control panel (ECP) shall be provided to house the circuitry for the equipment items described in this proposal necessary for a complete and operable system and shall consist of the following:

* NEMA-12 enclosure
* Motors less than 1/2 HP--designed for 115-VAC, 60-Hertz service
* Motors 1/2 HP or greater--designed for 230/460, 3-Phase, 60-Hertz service
* Single-phase transformer
* Main panel disconnect switch (for complete system shutdown)
* Numbered terminal strips
* Fuse protection (all circuits)
* Motor starters with overload heaters (all 3-Phase)

Note: Motor disconnects for each piece of equipment or motor to be provided by the installer.

ALTERNATE NO. 2 - 200 GPM SYSTEM

- ***Design Basis***

Parameter	*Average Influent*	*Effluent Requirements*
Ammonia, mg/l	11	
Sulfide, mg/l	1	
Aluminum, µg/l	14,277	
Antimony, µg/l	10	
Arsenic, µg/l	2	
Barium, µg/l	136	
Beryllium, µg/l	2	1
Cadmium, µg/l	3	5
Chromium, µg/l	17	100
Cobalt, µg/l	18	
Copper, µg/l	47	
Iron, µg/l	60,644	
Lead, µg/l	32	15
Manganese, µg/l	2,305	3,650
Mercury, µg/l	0.10	
Nickel, µg/l	27	100
Vanadium, µg/l	20	
Zinc, µg/l	348	
Dieldrin, µg/l	0.020	
2-Methylnaphthalene, µg/l	3	
4-Chloro-3-methylphenol, µg/l	2	
4-Methylphenol, µg/l	8	
Pentachlorophenol, µg/l	6	
bis(2-Ethylhexyl)phthalate, µg/l	4	
1,1-Dichloroethane, µg/l	7	
1,1-Dichloroethene, µg/l	3	
1,2-Dichloroethene (total), µg/l	14	
4-Methyl-2-pentanone, µg/l	2	
Acetone, µg/l	21	
Benzene, µg/l	5	
Carbon Disulfide, µg/l	11	
Chloroethane, µg/l	8	
Ethylbenzene, µg/l	7	

ALTERNATE NO. 2 - 200 GPM SYSTEM

Design Basis (Continued)

Parameter	*Average Influent*	*Effluent Requirements*
Toluene, µg/l	21	
Trichloroethene, µg/l	2	
Vinyl Chloride, µg/l	14	
Acrylamide, µg/l	64	
N,N-DMP, µg/l	84	
Hardness, mg/l	86	
pH, standard units	6.9	
Total Organic Carbon, mg/l	28	
BOD, mg/l	7	

- ***Process Description***

  The unit operations for the 200 gpm alternative are similar to those described in Alternate No. 1 with the exception of modular pH adjustment and flocculation units to accommodate the higher flow rates instead of a Lancy™ Econo-Treat Unit.

- ***Equipment List - 200 GPM System***

Item No.	*Description*
2-1	EQUALIZATION TANK

2-1 EQUALIZATION TANK

* SuperBlue® glass-fused-to-steel tank
* 50,000-gallon capacity

TRANSFER PUMP
Lancy Model No. 50-2224-200/50-10

* Duplex, FRP constructed horizontal centrifugal pumps
* 200 gpm capacity
* Pump level controls
* High level alarm
* 230/460-VAC, 3-Phase, TEFC motors

FLOW METER AND RECORDER

2-2 pH ADJUSTMENT MODULES (2 Required)
Lancy Model No. 50-4424-1

* 2,400-gallon capacity, vertical, cylindrical FRP tank
* Outlet box
* Flanged nozzles
* Agitator
* Agitator mounting bracket
* pH controller, cables, electrode, electrode holder and holder mounting bracket

2-3 FLOCCULATION MODULE
Lancy Model No. 50-4506-3

* 600-gallon capacity, vertical, cylindrical FRP tank
* Outlet box
* Flanged nozzles
* Agitator
* Agitator mounting bracket

- ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
2-4	CHEMICAL DAY TANKS (4 Required) Lancy Model No. 50-5463-100 * 960-gallon capacity, vertical, cylindrical, FRP tank * Agitator * Agitator mounting bracket * Partial cover and exhaust collar * Dip tube for metering pump
	CHEMICAL FEED PUMPS Lancy Model No. 50-5151-000 * Five positive displacement metering pumps * 0-18 gph output capacity * Polypropylene head, check valves and diaphragm * Suction hose and strainer * Totally enclosed drive * Anti-syphon valve * Dial-knob capacity adjustment
2-5	SOLIDS SEPARATOR Lancy Model No. 6112-240-2 * 240 gpm flow rate * Twelve CPI packs (proprietary design--FRP construction) * 1/4-inch carbon steel fabrication * Chemical-resistant paint (exterior) * 103 sq ft of settling surface area (Per 60-degree pack) * Flanged sludge withdrawal connection * Flanged effluent connection * Adjustable weir trough

• ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
	SLUDGE WITHDRAWAL PUMPS (2 Required) Lancy Model No. 50-6211-04-10 * Air-operated diaphragm pumps * Cast iron construction * Neoprene elastomers * 55 gpm capacity at 100 psi * 1-1/2-inch NPT suction connection * 1-1/4-inch NPT discharge connection
2-6	LIFT STATION Lancy Model No. 50-2224-200/50-11 * Duplex, FRP constructed horizontal, centrifugal pumps * 200 gpm capacity * 1,000-gallon capacity, vertical, cylindrical FRP tank * Pump level controls * High level alarm * 230/460-VAC, 3-Phase, TEFC motors
2-7	SAND FILTER * 228-gallon per minute capacity wastewater filter at less than 50 ppm solids * Steel constructed vertical cylindrical unit * Inlet connection and riser tubes * Distribution hood * Self-cleansing sand bed * Overflow weir * Airlift pipe * Central reject compartment * Gravity washer/separator * Reject effluent/filtrate weir * Continuous upflow/backwash design

• ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
2-8	SORPTION FILTER SYSTEM

* 240 gpm capacity
* Skidded modular units
* 31.5 ft long by 21 ft wide by 12.5 ft high
* 3,300-gallon reactor tank with agitator
* Sulfide and pH controller
* Sample center
* 3,600-gallon retention tank
* 1,050-gallon precoat tank with agitator
* Duplex filter feed pumps
* One stainless steel filter body
* Stainless steel filter fingers
* Valves and level controls
* Electrical control panel
* 600-gallon caustic tank with agitator and feed pump
* 450-gallon sulfide tank with agitator and feed pump
* Prewired and prepiped unit
* Operator platform and ladder

2-9	pH ADJUSTMENT MODULE Lancy Model No. 50-4424-1

* 2,400-gallon capacity, vertical, cylindrical FRP tank
* Outlet box
* Flanged nozzles
* Agitator
* Agitator mounting bracket
* pH controller, cables, electrode, electrode holder and holder mounting bracket

• ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
2-10	LIFT STATION Lancy Model No. 50-2224-200/50-11 * Duplex, FRP constructed horizontal, centrifugal pumps * 200 gpm capacity * 1,000-gallon capacity, vertical, cylindrical FRP tank * Pump level controls * High level alarm * 230/460-VAC, 3-Phase, TEFC motors
2-11	EFFLUENT HOLD TANK * SuperBlue® glass-fused-to-steel tank * 50,000-gallon capacity TRANSFER PUMPS Lancy Model No. 50-2221-200/50-10 * Duplex, cast iron constructed horizontal centrifugal pumps * 200 gpm capacity * Pump level controls * High level alarm * 230/460-VAC, 3-Phase, TEFC motors

- ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
2-12	LANCY EFFLUENT MONITOR Lancy Model No. 75-9712-01120

The unit includes:

* Open channel flow measuring device with analog flow percentage meter, digital display totalizer and strip chart recorder.

* pH control with analog display meter, recorder, electrode and electrode holder, pH control selector switches for acid/alkaline adjustment complete with dry contacts to operate chemical feed pumps and agitators. (Pumps and agitators not provided.)

* Pneumatically operated composite sampler and a digital display sample counter. The sampler can be activated manually, on a timed basis or flow proportionally.

* An indoor/outdoor 12-gauge steel epoxy coated insulated enclosure with lifting lugs.

* Thermostatically controlled heating and ventilation.

* Instrument panel lighting.

* 117-VAC duplex convenience outlets mounted above the front and rear panels.

* Full sized front and rear lockable access doors.

* Refrigerator with a 5-gallon composite sample bottle which will contain up to 378 50-ml samples.

• ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
	EFFLUENT MONITOR TANK Lancy Model No. EMT-200 * 200 gpm capacity tank * V-notch weir box * Polypropylene construction * Stilling well/transducer mounting bracket * Influent baffle * Flanged effluent nozzle
2-13	SLUDGE THICKENERS (2 Required) Lancy Model No. 50-7150-30 * 5,000-gallon capacity, vertical, cylindrical FRP tank * Conical bottom * Internal baffles * Overflow nozzle * Flanged bottom nozzle SLUDGE WITHDRAWAL PUMPS (2 Required) Lancy Model No. 50-6211-15-10 * Air-operated diaphragm pumps * Cast iron construction * Neoprene elastomers * 200 gpm capacity at 100 psi * 3-inch NPT suction connection * 3-inch NPT discharge connection

* ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
2-14	FILTER PRESS

* 20 cu ft filter cake capacity
* 1.26-inch cake thickness
* 100 psi filtration capacity
* Center feed
* Four corner filtrate discharge connection
* Painted steel skeleton
* Woven polypropylene filter cloth
* Automatically operated closure
* Plate shifter

2-15 FILTRATE LIFT STATION
Lancy Model No. 50-2221-230/50-11

* Duplex, cast iron constructed horizontal, centrifugal pumps
* 230 gpm capacity
* 1,000-gallon capacity, vertical, cylindrical FRP tank
* Pump level controls
* High level alarm
* 230/460-VAC, 3-Phase, TEFC motors

- ***Equipment List - 200 GPM System (Continued)***

Item No.	*Description*
2-16	ELECTRICAL CONTROL PANEL An electrical control panel (ECP) shall be provided to house the circuitry for the equipment items described in this proposal necessary for a complete and operable system and shall consist of the following:

* NEMA-12 enclosure
* Motors less than 1/2 HP--designed for 115-VAC, 60-Hertz service
* Motors 1/2 HP or greater--designed for 230/460, 3-Phase, 60-Hertz service
* Single-phase transformer
* Main panel disconnect switch (for complete system shutdown)
* Numbered terminal strips
* Fuse protection (all circuits)
* Motor starters with overload heaters (all 3-Phase)

Note: Motor disconnects for each piece of equipment or motor to be provided by the installer.

Note: Unless otherwise specified herein, ventilation, interconnecting piping, wiring, conduit, supports, fittings, valves, etc. between U.S. Filter equipment items and/or customer equipment is to be provided by others.

If you require installation prices for the above listed equipment, we would be happy to submit a proposal for the complete installation of this equipment.

ESTIMATED OPERATING REQUIREMENTS

The following are rough estimates of chemical usage and must be confirmed by conducting a treatability study. These estimates are for equipment quoted only and does not include options or equipment supplied by others.

	50 gpm System	200 gpm System	Unit Cost
• ***Chemical Usage***			
Caustic	~300 lbs/day	~1,200 lbs/day	~$300/2,000 lbs
Sulfuric Acid	~480 lbs/day	~1,900 lbs/day	~$75/2,000 lbs
Ferrous Sulfate	~315 lbs/day	~1,260 lbs/day	~$160/2,000 lbs
Polymer	~.6 lbs/day	~2.5 lbs/day	~$5.75/lb
Sodium Sulfide	~7.5 lbs/day	~30 lbs/day	$29/100 lbs
Sorption Filter Media	~6 lbs/day	~25 lbs/day	$3.50/lb
• ***Make-Up Water***	1,000 gals/day	4,000 gals/day	~$.002/gal
• ***Sludge***	14 cu ft/day at 25% dry solids	~50 cu ft/day at 25% dry solids	~$200/ton

- ***Electrical Requirements*** - 480-VAC, 3-Phase power.

  Electrical usage estimate: Alternate No. 1 - 40 Kw-Hr
  Alternate No. 2 - 100 Kw-Hr

  Note: These are theoretical estimates which do not account for mechanical efficiencies.

- ***Manpower*** - Assume 2 operators, 8 hours/day (including UV/oxidation)
- ***Maintenance*** - Assume 1% of facility price/yr
- ***Space Requirements***

  Alternate No. 1 - 50 gpm System — 50 ft long by 50 ft wide by 20 ft high
  Alternate No. 2 - 200 gpm System — 60 ft long by 50 ft wide by 20 ft high

Note: Sludge estimate is based upon assumption of 100 ppm TSS (assumes all metals are soluble) and iron additions of 60 ppm $FeSO_4$ as Fe.

TREATABILITY STUDIES

As you know, we have not had the opportunity to analyze and process representative samples of your waste in our treatability laboratory. While we have ample reason to believe that the proposed system will provide satisfactory treatment, U.S. Filter reserves the right to perform such tests prior to formal acceptance of your order. If you wish, we can perform the treatability work immediately for a fee of $7,500, which would be credited against your purchase order for the proposed system.

ENGINEERING SERVICES

U.S. Filter would provide the following engineering services for the proposed groundwater treatment system:

- Piping and instrumentation diagram(s)
- Electrical drawing(s)
- Equipment layout drawing(s)
- Operating manual consisting of operating instructions, equipment specifications and process descriptions for the major subsystems
- Equipment maintenance manual which includes itemized data sheets for all equipment components
- Visit by a U.S. Filter engineer to client's facility during engineering phase

Note: All copies described above are in triplicate.
Additional copies may be obtained at cost.

START-UP SERVICES

U.S. Filter would provide 5 man-days of start-up services on a portal-to-portal basis. These services normally include the following:

- Pre-start-up checkout/troubleshooting for all equipment
- Supervision of system start-up
- Instruction of operating personnel in system maintenance and operation

Additional days of start-up requested by the client would be charged at our standard per diem rate of $550 per 8-hour working day, on a portal-to-portal basis, plus all out-of-pocket travel and living expenses which would be invoiced as a separate item at net cost.

BUDGETARY PRICES

- ***Alternate No. 1 - 50 gpm System***

  U.S. Filter would supply equipment item Nos. 1-1 through 1-13, engineering and start-up services as described herein for approximately
  FIVE HUNDRED THOUSAND DOLLARS..............................$500,000.00.

- ***Alternate No. 2- 200 gpm System***

  U.S. Filter would supply equipment item Nos. 2-1 through 2-16, engineering and start-up services as described herein for approximately
  EIGHT HUNDRED THOUSAND DOLLARS............................$800,000.00.

EQUIPMENT WARRANTY

U.S. Filter would warrant all equipment for a maximum period of 12 months from date of shipment. This warranty would cover all defects in materials or workmanship.

The pH/ORP electrodes are warranted for 30 days from the start-up date, or 6 months from the shipping date, whichever occurs first.

SHIPPING SCHEDULE

Shipment of equipment is quoted F.O.B. shipping point and is anticipated to be ready for shipment 12 to 14 weeks following return of approval drawings. Approval drawings would be issued approximately 4 weeks after acceptance of a purchase order.

Freight would be prepaid and invoiced at time of equipment shipment.

APPENDIX

- Drawing No. A-1
- Literature

CONFIDENTIALITY AGREEMENT

This information is confidential and contains proprietary information. It is not to be disclosed to a third party without the consent of United States Filter Corporation.

U.S. Filter shall be most interested in providing further information to you as needed, and ultimately, we hope that we can work with you on this project. Please do not hesitate to call if we can be of further service to you.

Sincerely,

UNITED STATES FILTER CORPORATION

Deborah M. Buckley

Deborah M. Buckley
Groundwater Market Manager

cc:

Authorized Representative
Global Technologies, Inc.
2 Gordon Street
Simsbury, Connecticut 06070
(203) 651-0255

U.S. FILTER, INC. WARRENDALE, PENNSYLVANIA

TERMS AND CONDITIONS OF SALE
(Systems)

ACCEPTANCE BY U.S. FILTER, INC. WARRENDALE, PENNSYLVANIA (HEREINAFTER "SELLER") OF THE PURCHASER'S PURCHASE ORDER OR OTHER OFFER TO PURCHASE IS EXPRESSLY MADE CONDITIONAL UPON THE PURCHASER'S ASSENT TO ANY TERMS AND CONDITIONS HEREIN WHICH DIFFER FROM, OR ARE ADDITIONAL TO, THOSE IN PURCHASER'S OFFER. THE TERMS AND CONDITIONS HEREIN ARE AN INTEGRAL PART OF ANY OFFER TO SELL BY SELLER, AND THE PURCHASER'S ACCEPTANCE OF SUCH OFFER IS EXPRESSLY LIMITED TO AND CONDITIONED UPON THE EXCLUSIVE APPLICABILITY THERETO OF THESE TERMS AND CONDITIONS.

Terms. Unless otherwise stated herein, prices are F.O.B. point of shipment and payment terms are net thirty (30) days from date of Seller's invoice. Each incremental shipment of equipment and/or materials shall be invoiced at time of shipment in an amount proportional to that of the total contract price. Purchaser shall incur interest at the rate of one and one-half percent (1.5%) per month or the highest rate permitted by applicable law, whichever is less, on amounts not paid in accordance with terms of sale. The price offered is based on shipment of the equipment as stipulated in the proposal. If the shipment schedule is delayed as a result of Purchaser's activities, such as delay in return of approval drawings, inspection, etc., a price adjustment of 2% of the purchase price for each month of delay will be added to the purchase price.

Extra Charges. Unless specified otherwise on the face of Seller's Sales Order Acknowledgement Form, the price to Purchaser does not include installation, erection or service, or any accessory, supportive or associated materials. Seller shall make such reasonable additional charges as it determines in the event it agrees to changes or modifications in said specifications.

Credit. All contracts and orders are subject to credit approval by Seller. If Seller, in its sole judgment, has reasonable grounds for insecurity with respect to due performance by Purchaser, Seller may demand different terms of payment from those specified herein and may demand assurance of Purchaser's due performance. Any such demand may be oral or in writing and Seller may, upon the making of such demand, stop production and suspend shipments hereunder. If within the period stated in such demand Purchaser fails or refuses to agree to such different terms of payment or fails or refuses to give adequate assurance of due performance, Seller may, at its option, treat such failure or refusal as a repudiation of the portion of this order which has not been fully performed or may resume production and may make shipment under reservation of possession or of a security interest and may demand payment against tender of documents of title.

Delivery Delays. Unless a firm delivery date is stated on the face of Seller's Sales Order Acknowledgement Form, shipment dates are approximate, and delivery made within a reasonable time thereof shall be deemed full performance of this aspect of Seller's obligations hereunder. Seller shall not be liable for any delays in performance due to causes beyond Seller's reasonable control or beyond the control of its suppliers which prevents or impedes manufacture, supply or delivery by Seller or such suppliers, including without limitation acts of God, accidents to machinery, differences with workmen, strikes, labor shortages, fires, floods, inadequate or reduced supply or excessive cost of suitable raw materials, delays in transportation or lack of transportation facilities, priorities required or requested by the Federal or any State government or any subdivision or agency thereof or granted for the benefit, directly or indirectly, of any of them, delays in transportation or lack of transportation facilities, restrictions imposed by Federal or State laws or rules or regulations thereunder.

Warranty. Seller warrants that the goods to be supplied hereunder will conform to the description on the face of the Sale Order Acknowledgement Form or applicable document there referenced; that it will convey good title thereto; that such goods will be delivered free from any lawful security interest or other lien or encumbrance unknown to Purchaser; and that such goods will be free from defects in material and workmanship provided that such warranty of freedom from defects in material and workmanship shall extend only for a period of twelve months from the date of installation or for a period of eighteen months from the date of shipment, whichever is shorter, and that Purchaser gives Seller notice of any such defect within thirty (30) days after Purchaser discovers or should have discovered such defect. *Seller makes no warranty that the goods shall be merchantable or fit for any particular purpose. Seller makes no warranty, express or implied, except such as is expressly set forth herein.* Seller shall not be liable for any incidental or consequential damages for any breach of warranty, Seller's liability and Purchaser's exclusive remedy being expressly limited to Seller's choice of (a) the repair of defective goods; (b) the replacement thereof with conforming goods at F.O.B. Purchaser's plant; or (c) the repayment of the purchase price. Replacement of defective goods or repayment of the purchase price therefor will be made only upon return of the defective goods which may be returned at the cost of Seller only after inspection by Seller and receipt by Purchaser of definite shipping instructions from Seller.

Seller makes no warranty whatsoever with respect to goods manufactured by third parties. Warranties with respect to such goods are limited to those offered by such suppliers which are transferable.

A warranty of performance when given by Seller shall be in addition to the warranties provided in the preceding paragraphs hereof. Purchaser's exclusive remedies with respect to any failure of the goods to meet any performance guarantees shall be limited, at Seller's option, to (i) acquiring full ownership of the goods upon payment of ninety percent (90%) of the purchase price, if agreed to by Seller, or (ii) relinquishing ownership and possession of the goods and having Seller refund any payment already made by Purchaser toward the purchase price. In the latter case, the expense for removing the goods from the premises of the Purchaser shall be negotiated by the parties.

Patents. Seller agrees to indemnify Purchaser, its successors and assigns, against all judgments, decrees and reasonable costs (except where the goods sold hereunder are machines, in which event, against court assessed damages and costs) resulting from infringement of any United States Letters Patent covering (a) standard commercial compositions offered for sale generally by Seller at the time of acceptance by it of this order; or (b) standard commercial forms, shapes or constructions offered for sale generally by Seller at the time of acceptance by it of this order, to the extent that such compositions, forms, shapes or constructions are supplied hereunder. Purchaser agrees, for goods delivered under this order, to indemnify Seller, its successors and assigns, against all judgments, decrees and costs resulting from infringement of any United States Letters Patent to the extent that such infringement arises from designs, specifications or instructions furnished or expressly or implicitly required by Purchaser and different from the matters embraced by (a) and (b) of the preceding sentence. Neither party shall be entitled to indemnification under this clause as to any claim of infringement concerning which it does not give to the other party prompt notice in writing upon learning thereof and full opportunity, at the expense of such other party, to defend and dispose of such claim of infringement. The sale of the goods covered by this order shall not grant to Purchaser any right or license of any kind under any patent owned or controlled by Seller or under which Seller is licensed, but the foregoing shall not be understood to limit in any way the right of Purchaser to use and sell such goods, in the event that such goods as sold hereunder are covered by any such patent.

Subsidiaries and Affiliates. This order may be performed and all rights hereunder against Purchaser may be enforced, in whole or in part, by Seller or by its parent corporation or any one or more of the corporations subsidiary to or affiliated with Seller.

Waiver. No provision hereof and no breach of any provision shall be deemed waived by reason of any previous waiver of such provision or of any breach thereof.

Cancellation by Purchaser. If an order is cancelled before engineering and/or production has begun, and before Seller has incurred obligations for items such as materials or components, Purchaser shall pay a cancellation charge equal to 15% of the total purchase price as liquidated damages and not as a penalty; for any order that is cancelled subsequent to that time, Purchaser shall pay a cancellation charge equal to Seller's costs for materials, labor, engineering, shop overhead, and charges made by its suppliers, plus 25% of the total purchase price as liquidated damages and not as a penalty.

Indemnity. Purchaser shall release, hold harmless, indemnify and defend Seller from and against any loss, liability, claims, suits and costs caused by, arising out of, or relating to the design of goods supplied hereunder or the design of the packages or containers in which they are shipped, if such goods, packages or containers are made in compliance with Purchaser's design or specifications.

Taxes. Purchaser shall pay to Seller, in addition to the purchase price of the goods, any other tax, however denominated or measured, imposed on property, or upon its construction, inventory, or upon the manufacture, storage, sale, transportation, importation, delivery, use, or consumption of goods sold to Purchaser.

Insurance. Risk of loss for all goods sold pursuant hereto passes to Purchaser upon shipment. Claims for loss or damage in transit shall be made by Purchaser directly with the carrier. Purchaser shall make all claims for factory shortage within five (5) days of receipt of goods, and failure to do so shall constitute a waiver of Purchaser's right to make any such claims. Purchaser shall furnish at its own expense adequate insurance protecting goods sold pursuant hereto against loss or damage by fire or other causes from time of shipment until full and complete payment has been made.

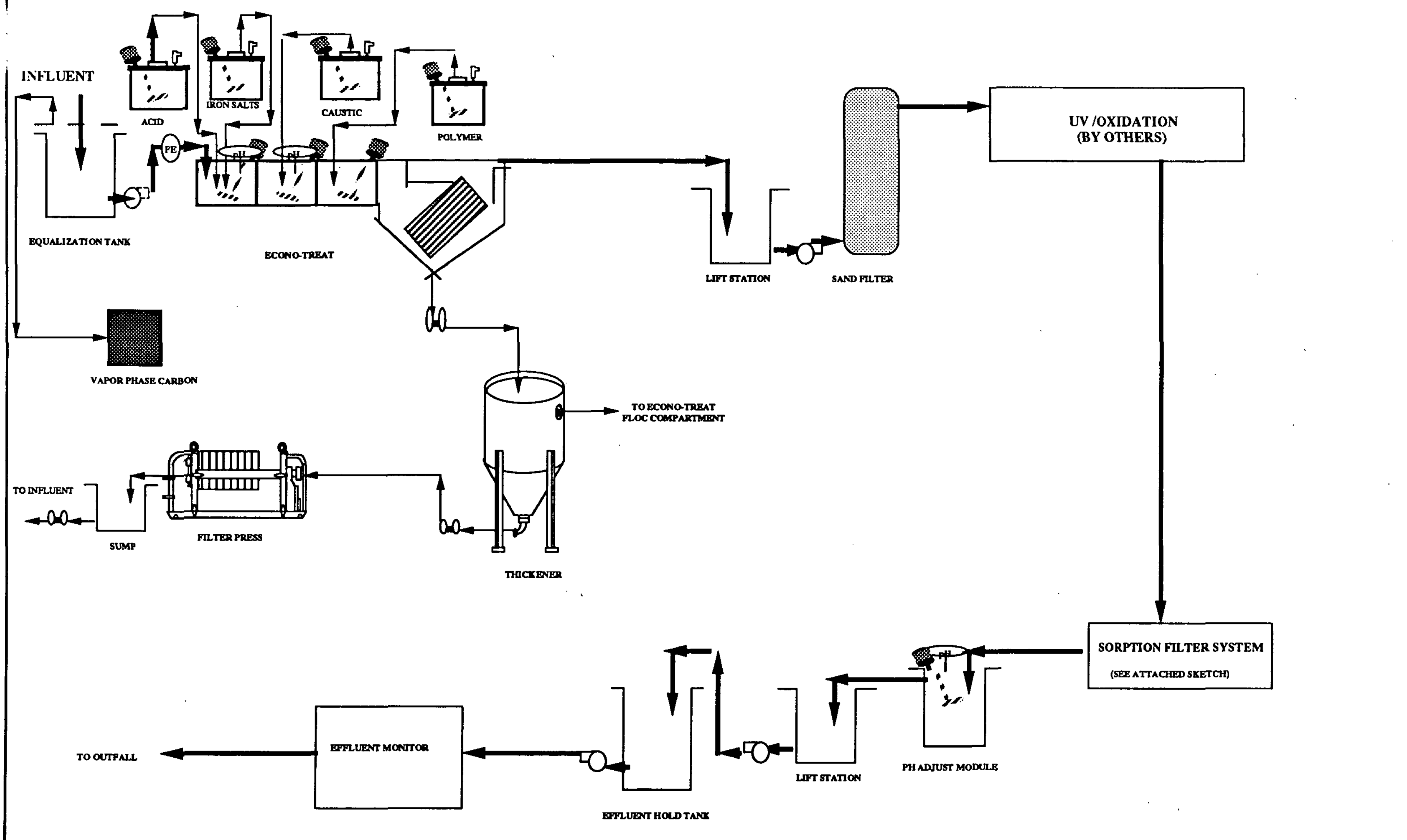
Security Interest. Until such time as Seller has received payment in full for equipment sold pursuant hereto, Seller shall have a security interest herein. Purchaser agrees to extend such reasonable cooperation as Seller may require, including the execution of financing statements or other documents, in order for said security interest to be perfected as against third parties. In the event of default by Purchaser, Seller shall have available all rights at law or equity to a secured seller, including the right to enter upon the premises where such equipment shall be located for purposes of removing same, or rendering it inoperative, and all such rights shall be cumulative.

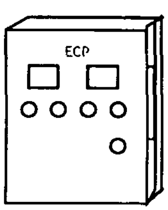
Miscellaneous. When ASME code vessels are supplied, certification by an inspector commissioned by the National Board of Boiler and Pressure Vessel Inspectors shall irrefutably establish conformance of the vessel to the applicable section of the ASME Boiler and Pressure Vessel Code, Latest Edition. Seller will not be responsible for meeting state and local codes or ordinances or other special codes unless the details of these codes are specified in the specifications and are specifically accepted by Seller. All illustrations, drawings, etc., accompanying Seller's proposal show approximate dimensions only and are not binding in detail unless stated to be by Seller. All drawings pertaining to the goods are supplied to Purchaser solely for the limited purpose of permitting Purchaser to install, operate and maintain the goods. They are confidential and except for the purpose above specified, shall not be copied, exhibited or furnished to others without the prior written consent of Seller.

Entirety of Agreement. The terms and conditions contained herein constitute the entire agreement of the parties, and neither party shall be bound by any oral or written understanding not expressly included herein. No valid and binding contract shall exist until such time as the Sale Order Acknowledgement Form is accepted by the Purchaser. No modification or alteration in these terms and conditions shall be effective except by means of a writing duly executed on behalf of both parties, and expressly purporting to amend the terms and conditions.

Governing Law. These terms and conditions shall be governed by and construed in accordance with the laws of the Commonwealth of Pennsylvania, excluding rules relating to choice or conflicts of law.

APPENDIX





Drawn	Date
DMB	6/3/93
Checked	
Approved	
Scale	NONE

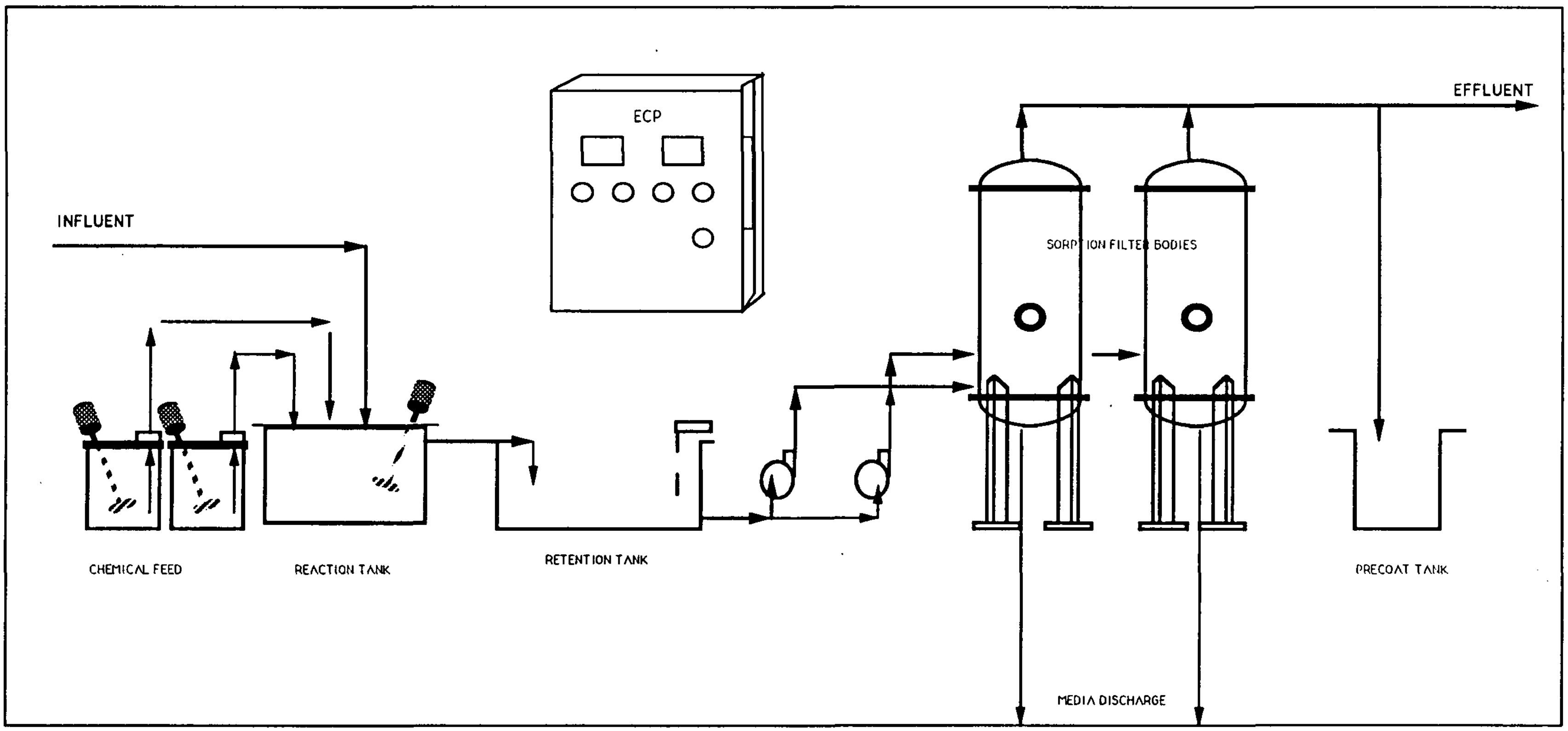
USF

Title: GROUNDWATER TREATMENT SYSTEM-CONCEPTUAL FLOW DIAGRAM

Client: METCALF& EDDY - ROSE HILL LANDFILL SUPERFUND SITE

US FILTER CORPORATION, INC.

Sheet 1 of 1 | Project No. 5040-21 | Drawing No. A-1 | Rev 0


ECP
EFFLUENT
INFLUENT
SORPTION FILTER BODIES
CHEMICAL FEED
REACTION TANK
RETENTION TANK
PRECOAT TANK
MEDIA DISCHARGE

PREPARED BY: DM Buckley | CLIENT: METCALF & EDDY | **U.S. FILTER/ WARRENDALE**

CHECKED BY: ______ | PROJECT NO.: 5040-21

DATE: 5/5/93 REV.: ______ | SHEET: 1 OF 1 | DRAWING NO.:

SUBJECT: Sludge Calculations

GIVEN FLOW: 200 gpm

Al = 142 mg/L

Fe = 60.6 mg/L

Mn = 2.3 mg/L

ASSUME TSS = .5 (Fe) + 100 mg/L

∴ TSS = 130 mg/L

$$\left[\left(\frac{142\text{ mg Al}}{L} \times \frac{78\ Al(OH)_3}{27\text{ mg Al}}\right)^{(410)} + \left(\frac{60.6\text{ mg Fe}}{L} \times \frac{1.93\text{ mg } Fe(OH)_3}{1\text{ mg}}\right)^{(116.9)} + \left(2.3\text{ mg Mn} \times \frac{2.32\text{ mg } Mn(OH)_2}{1\text{ mg Mn}}\right)^{(5.336)}\right.$$

$$\left. + \left(\frac{130\text{ mg TSS}}{L}\right)\right] \times 200\text{ gpm} \times .012 = 1590\ \#/\text{DAY SOLIDS}$$

$$.012 \approx \frac{3.78\,l}{gal} \times \frac{lb}{454 \times 10^{3}\,mg} \times \frac{1440\,min}{D}$$

THICKENER

$$\frac{1590\ \#}{DAY} \times \frac{1}{.03 \times 8.59} = 6168\ \text{GAL/DAY @ 3\% DRY SOLIDS}$$

∴ USE (1) 10,000 GAL THICKENER

FILTER PRESS

$$\frac{1590}{DAY} \times \frac{1}{.30 \times 81.1} = 65.35\ FT^3/DAY$$

@ 30% DRYNESS / 4 PRESSES/DAY = 16.3 FT^3/PRESS

∴ USE 20 FT^3 PRESS

FOR 50 GPM ⇒ ROUGH ESTIMATE WILL BE 1/4 SIZE OF 200 GPM SYSTEM

∴ USE 3000 THICKENER

5 FT^3 PRESS

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-10

DATE: 6/22/93

SUBJECT: Rose Hill FS - GW treatment by precipitation.

M&E ENGINEER: S. Czarniecki

OUTSIDE PARTY: Debbie Buckley - U.S. Filter 412 772-1298

MADE CALL (X)

REC'D CALL ( )

COMMENTS	SUMMARY OF CONVERSATION:
	She will fax me by end-of-day Thursday breakout of costs for individual components - even though prices change if a component is replaced.

CC:

M&E FORM NO. 196 (9/78)

U.S. FILTER
UNITED STATES FILTER CORPORATION

LANCY™ SYSTEMS AND EQUIPMENT
181 THORN HILL ROAD
WARRENDALE, PA 15086
TEL. 412-772-0044
FAX 412-772-1360

FAX TRANSMITTAL

Date: 6/23/93 Page 1 of 1

To: Mr. Sean Czarnicki Company: Metcalf & Eddy

Location: Wakefield, Mass

Fax: 617/245-6293 Telephone: 617/246-5200

From: Debbie Buckley

cc: Tom Whalen

Dear Sean:

Per your request, US Filter is providing breakout prices for equipment items as presented in our June 3, 1993 proposal for the Rose Hill, RI GW/Leachate Project. As I eluded to on the telephone, these prices would not include the services required to develop these equipment items into a system; such as: site visit, start up, treatability, master control panel, system engineering, project management, etc. Prices presented are for equipment supply only. These are, again, budget prices.

Alt 1	Sorption Filter System	$ 135,000
	ET, Thickener, Filter Press	$ 162,000
	Sand Filter	$ 25,000
Alt 2	Sorption Filter System	$ 225,000
	ET, Thickener, Filter Press	$ 210,000
	Sand Filter	$ 55,000

Sincerely, D. Buckley

M&E Metcalf & Eddy
An Air & Water Technologies Company

004609-0018-010-001

May 24, 1993

Ms. Deborah M. Buckley
Groundwater Market Manager
U.S. Filter, Inc.
181 Thorn Hill Road
Warrendale, PA 15086-7527

Subject: **Contract No. 68-W9-0036**
Work Assignment No. 18-1LA5
Rose Hill Regional Landfill Superfund Site, South Kingstown, Rhode Island
Request for Quotation on Equipment, Services and Budgetary Costs - Treatment of Contaminated Groundwater

Dear Ms. Buckley:

Metcalf & Eddy (M&E) is currently finalizing the Feasibility Study (FS) for treatment of contaminated groundwater at the Rose Hill Landfill site. As previously discussed, this groundwater is contaminated with weak, municipal landfill leachate. M&E has identified precipitation as an appropriate method for removing the inorganic compounds-of-concern (COCs).

As you have already supplied me with a conceptual process design, an updated quotation describing suggested equipment, services and budgetary costs should be based on the following assumptions:

1) quotations are needed for two different systems; groundwater concentrations are shown in Attachment A for the 50 gpm system (Alternative 4) and Attachment B for the 200 gpm system (Alternative 5).
2) treatment goals are listed in each attachment by compound; for the inorganic compounds, please identify any compounds that <u>may not meet goals</u>.
3) organics will be treated by a UV/Chemical oxidation system after inorganics removal.
4) assume a water temperature of 55 degrees F.
5) 50 gpm flowrate may be as low as 5 gpm (conditions shown in Attachment C); will your system still operate effectively ?
6) treated water discharges to recharge wells or to river.
7) identify operations and maintenance services necessary for your proposed system.
8) identify the make & model of your proposed system; please include copies of brochures, drawings and specifications that you may not have already provided to me.
9) assume budgetary costs accuracy for equipment, f.o.b.

10) identify any other potential pretreatment or special conditions that you feel may be necessary for proper operation.

Your quotations are needed by the end-of-day Friday, June 4, 1993. Thank you for your assistance with this project. If you have any questions, please do not hesitate to contact me at TEL (617) 246-5200, extension 4811 or by FAX at (617) 245-6293.

Very truly yours,

METCALF & EDDY, INC.

Sean Czarniecki

Sean Czarniecki
Engineer II,
Industrial & Hazardous Waste Division

Attachments
cc: D. Peters
WA#18-1LA5
Contract File

ATTACHMENT A: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	9	48		
Sulfide (mg/L)	1	4		
Aluminum	12,616	98,281	*	
Antimony	0	0	*	6
Arsenic	2	9	*	
Barium	210	695	*	
Beryllium	2	13	*	1
Cadmium	4	36	*	5
Chromium	21	136	*	100
Cobalt	21	82	*	
Copper	37	324	*	
Iron	91,571	396,140	*	
Lead	40	180	*	15
Manganese	2,633	10,361	*	3,650
Mercury	0.11	0.29	*	
Nickel	24	112	*	100
Vanadium	20	133	*	
Zinc	625	6,520	*	7,300
Dieldrin	0.043	0.003		
2-Methylnaphthalene	4	4		
4-Chloro-3-methylphenol	4	4		
4-Methylphenol	8	64		
Pentachlorophenol	12	3		1
bis(2-Ethylhexyl)phthalate	11	59		4
1,1-Dichloroethane	13	195		
1,1-Dichloroethene	4	2		
1,2-Dichloroethene(total)	30	645		70
4-Methyl-2-pentanone	5	27		
Acetone	20	415		
Benzene	10	27		5
Carbon Disulfide	13	77		
Chloroethane	16	77		
Ethylbenzene	14	64		
Toluene	31	156		
Trichloroethene	4	4		
Vinyl Chloride	30	610		2
Acrylamide	141	202		0.02 (c)
N,N-DMF	177	1,273		
Hardness (mg/L)	151	621		
pH	7.1	11.9		
Total Organic Carbon (mg/L)	44	200		
Biochemical Oxygen Demand (mg/L)	12	112		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

ATTACHMENT B: GROUNDWATER CONDITIONS FOR THE 200 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (µg/L) except where noted at left			
Ammonia (mg/L)	11	30		
Sulfide (mg/L)	1	7		
Aluminum	14,277	76,745	*	
Antimony	10	46	*	6
Arsenic	2	7	*	
Barium	136	445	*	
Beryllium	2	9	*	1
Cadmium	3	25	*	5
Chromium	17	94	*	100
Cobalt	18	53	*	
Copper	47	215	*	
Iron	60,644	218,437	*	
Lead	32	154	*	15
Manganese	2,305	8,391	*	3,650
Mercury	0.10	0.22	*	
Nickel	27	93	*	100
Vanadium	20	115	*	
Zinc	348	3,135	*	7,300
Dieldrin	0.020	0.001		
2-Methylnaphthalene	3	2		
4-Chloro-3-methylphenol	2	2		
4-Methylphenol	8	56		
Pentachlorophenol	6	1		1
bis(2-Ethylhexyl)phthalate	4	21		4
1,1-Dichloroethane	7	89		
1,1-Dichloroethene	3	1		
1,2-Dichloroethene(total)	14	293		70
4-Methyl-2-pentanone	2	12		
Acetone	21	329		
Benzene	5	13		5
Carbon Disulfide	11	57		
Chloroethane	8	37		
Ethylbenzene	7	29		
Toluene	21	121		
Trichloroethene	2	2		
Vinyl Chloride	14	276		2
Acrylamide	64	92		0.02 (c)
N,N-DMF	84	600		
Hardness (mg/L)	86	330		
pH	6.9	9.8		
Total Organic Carbon (mg/L)	28	125		
Biochemical Oxygen Demand (mg/L)	7	58		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 µg/L standard assuming that this is the detection limit.

ATTACHMENT C: GROUNDWATER CONDITIONS FOR 5 GPM FLOW RATES

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	13	22		
Sulfide (mg/L)	0	0		
Aluminum	2,100	9,220	*	
Antimony	0	0	*	6
Arsenic	0	0	*	
Barium	510	2,120	*	
Beryllium	2	9	*	1
Cadmium	2	5	*	5
Chromium	0	0	*	100
Cobalt	63	295	*	
Copper	0	0	*	
Iron	286,675	1,370,000	*	
Lead	37	174	*	15
Manganese	8,200	14,700	*	3,650
Mercury	0.11	0.20	*	
Nickel	5	14	*	100
Vanadium	15	65	*	
Zinc	210	133	*	7,300
Dieldrin	0.000	0.000		
2-Methylnaphthalene	0	0		
4-Chloro-3-methylphenol	0	0		
4-Methylphenol	0	0		
Pentachlorophenol	0	0		1
bis(2-Ethylhexyl)phthalate	50	230		4
1,1-Dichloroethane	3	2		
1,1-Dichloroethene	0	0		
1,2-Dichloroethene(total)	3	1		70
4-Methyl-2-pentanone	0	0		
Acetone	0	0		
Benzene	0	0		5
Carbon Disulfide	3	3		
Chloroethane	6	8		
Ethylbenzene	2	2		
Toluene	19	50		
Trichloroethene	0	0		
Vinyl Chloride	0	0		2
Acrylamide	0	0		0.02 (c)
N,N-DMF	0	0		
Hardness (mg/L)	79	214		
pH	6.5	7.1		
Total Organic Carbon (mg/L)	26	50		
Biochemical Oxygen Demand (mg/L)	9	51		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

- Metals Treatment Quotation: Koch Membrane Systems
  System Drawings and Specifications
  M&E Quotation Request

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KOCH MEMBRANE SYSTEMS INC

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25 June 1993

Sean Czarniecki,
Engineer
METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880

Subject: South Kingston, Rhode Island

Dear Mr. Czarniecki:

To confirm our telephone conversation yesterday, we are pleased to submit budgetary estimates for the three applications you are considering for feasibility studies. All systems are based on standard KSM design and include:

UF Systems (Except UF 158 which is standard except for piping). 304 SS retentate piping, PVC permeate piping. Feed pump, rack with circ. pump piping and controls. CIP station with dual tanks. NEMA 12 steel control panel with manual controls.

RO Systems (Except once-through which has manual controls). 316 SS retentate piping, PVC permeate piping. Feed and booster pumps, rack with circ. pump piping and controls. Feed/CIP station with single tank. NEMA 12 steel control panel with semi-auto controls.

5 GPM Capacity

UF 1622 S/S once-through, mod-batch w/72 1" FEG tubes	$ 72,000.00
RO 1/6 8" SW once-through, mod-batch w/6 BW modules	$182,000.00
Total:	$254,000.00

50 GPM Capacity

UF 1622RM S/S F&B mod-batch w/736 1" FEG tubes	$260,000.00
RO 2x4/6 SIS 8" SW continuous w/48 BW modules	$383,000.00
Total:	$643,000.00

200 GPM Capacity

4 - UF 1622RM S/S F&B mod-batch w/2640 1" FEG tubes	$827,000.00
RO 4x8/6 SIS 8" SW continuous w/192 BW modules	$854,000.00
Total:	$1,681,000.00

850 Main Street ☐ Wilmington, MA 01887-3388 U.S.A. ☐ TEL. (508) 657-4250 ☐ FAX (508) 657-5208 ☐ TWX 710 347 6537

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Agents and Associates in more than 20 Countries

Sean, I have included some info on our standard UF systems. The R/O information is unavailable at this time. Please refer to the attached Process and Operating Summary for a description of a modified batch cycle. Thank you for your interest in KOCH MEMBRANE SYSTEMS. If you have any questions, or require any additional information, please do not hesitate to call me.

Very Truly Yours,

Tony

Anthony J. MacDonald
KOCH MEMBRANE SYSTEMS, INC.
Northeast Regional Sales Engineer

AJMd:bal
Enclosures

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Terms and Conditions

Abcor

1. TIME LIMIT. All quotations are valid for a period of sixty (60) calendar days.

2. FOB POINT. Prices included herein are FOB point of manufacture. Transportation and insurance charges, if required, to be prepaid by Koch Membrane Systems, Inc., (hereinafter referred to as "KMS"), will be invoiced at actual cost to the Purchaser. Claims for shortages in shipment shall be deemed waived unless made in writing to KMS within ten (10) days after delivery.

3. PAYMENT TERMS. Payments will be made in accordance with the specified payment schedule. All payments are due net thirty (30) days from date of invoice. If in the judgement of KMS, the financial position of the purchaser does not justify the terms of payment specified, KMS may require full or partial payment prior to shipment of the goods. Purchaser agrees to furnish KMS with the required credit information. Payments for all export shipments will be in accordance with the specified payment schedule included herein by way of a confirmed, irrevocable letter of credit established in favor of KMS on a USA bank to be designated by KMS. This letter of credit is to be established at the time of award of an order. All costs associated with the letter of credit will be for the Purchaser's account.

4. TAXES. Federal, state or local sales and/or use taxes are not included in the price set forth herein.

5. WARRANTY. KMS warrants that all goods manufactured by KMS, except membranes, shall be free from defects in material and workmanship; provided, however, that this warranty shall be limited to goods found to be defective within a period of one (1) year from initial use or fifteen (15) months from the date of shipment, whichever expires first. Except as may otherwise be provided, MEMBRANES ARE SOLD AS IS. This warranty does not cover Purchaser furnished/specified equipment and/or Purchaser furnished materials. Resale products shall carry only the warranty offered by the original manufacturer.

The sole and exclusive remedy of the Purchaser for any liability of KMS of any kind, including (a) warranty, express or implied whether contained in the terms and conditions hereof or in any terms additional or supplemental hereto, (b) contract, (c) negligence, (d) tort, or (e) otherwise, is limited to the repair or replacement, FOB point of manufacture, by KMS of those goods which an examination reveals to be defective during the warranty period, or at KMS' option to refund to purchaser the money paid to KMS for such goods. Purchaser and KMS may mutually agree to acceptance of the goods "as is" with an agreed upon reduction in price. Before KMS undertakes any obligation to remedy defects, the Purchaser must give KMS written notice of its claim and return the defective goods after receipt of shipping instructions from KMS to return such goods. Purchaser will ship the goods to KMS, freight prepaid, and KMS will return the goods to Purchaser, freight collect. All goods returned for repair or replacement pursuant to this section are to be packaged in accordance with the instructions received.

In no event, shall KMS incur any obligation to repair or replace goods which are determined by KMS to be defective due to customer misuse, or due to use not in accordance with specified operating conditions, and operating and maintenance instructions. KMS retains the option to witness the operation of the goods to verify operating conditions. KMS shall not incur any obligation hereunder with respect to goods, which are repaired or modified in any way by the Purchaser without KMS prior written approval. Installation by the Purchaser during regular intervals of normal maintenance of parts supplied by KMS shall not constitute such modification.

EXCEPT FOR THE EXPRESS WARRANTY STATED HEREIN, KMS DISCLAIMS ALL WARRANTIES WITH RESPECT TO THE GOODS, INCLUDING ANY AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE.

6. CONFIDENTIAL INFORMATION. The information, drawings, plans and specifications being furnished by KMS have been developed at KMS' expense and shall not be used or disclosed by Purchaser for any purpose other than to install, operate, and maintain the goods supplied hereunder.

7. DELIVERIES. The delivery date(s) quoted are based on KMS' best estimate of a realistic time when delivery to the carrier will be made, and are subject to confirmation at time of acceptance of any resulting order. KMS reserves the right to make either early shipment or partial shipments and invoice Purchaser accordingly.

8. EXCUSABLE DELAYS. KMS shall not be liable for loss, damages, detention or delays resulting from causes beyond its reasonable control or caused by but not limited to strikes, restrictions of the United States Government, or other governments having jurisdiction, delays in transportation, inability to obtain necessary labor, materials, or manufacturing facilities.

9. PATENTS. The Purchaser shall indemnify and hold KMS harmless against any expense or loss or other damage resulting from infringement of patents or trademarks arising from KMS' compliance with any designs, specifications or instructions of the Purchaser.

10. TITLE AND RISK OF LOSS OR DAMAGE. Risk of loss and/or damage shall pass to the Purchaser upon delivery of the goods to the F.O.B. point. Title shall pass to the Purchaser upon receipt of final payment by KMS.

11. INSTALLATION/FIELD SERVICE. Installation of goods furnished hereunder shall be by the Purchaser, unless otherwise agreed to in writing.

Field service will be provided on a per diem basis upon written authorization by the Purchaser and will be at the rates in effect at the time such services are provided unless otherwise agreed to in writing. Field service at the jobsite to diagnose equipment problems will be provided on a per diem basis at the then current rates.

12. CANCELLATION. Cancellation of any order must be by written notice to KMS and will be subject to cancellation charges.

13. LAWS, CODES, AND STANDARDS. Except as expressly stated herein, the price and schedule included herein are based on United States laws, codes, and standards in effect as of the date of this order. Should such laws, codes, and standards change and increase or decrease the cost of performing the work or impact the schedule, KMS will advise Purchaser of such. Purchaser and KMS shall mutually agree to any modification to the order resulting from such change.

14. CONSEQUENTIAL DAMAGES/LIMIT OF LIABILITY. KMS shall not in any case whatsoever be liable for special, incidental, indirect or consequential damages of any kind. In no case shall KMS' liability exceed the amount paid to KMS by the Purchaser for the specific goods giving rise to such liability. Purchaser agrees to indemnify and hold KMS harmless from and against all liabilities, claims and demands of third parties of any kind relating to the goods and their use arising after shipment of the goods.

15. MODIFICATION. No modification or waiver of any part of this agreement shall be valid unless it is in writing and signed by an authorized representative of the Purchaser and KMS.

16. ASSIGNMENT. This agreement may not be transferred or assigned by operation of law or otherwise, without the prior express written consent of KMS. Any transfer or assignment of any rights, duties or obligations hereunder without such consent shall be void.

17. EXPORT SALES. No provision of this agreement shall be construed to require KMS to export or deliver any technical information, data and/or equipment if such export or delivery is then prohibited or restricted by any law or regulation of the U.S. Government.

18. INSURANCE. Upon the request by Purchaser, KMS will provide a Certificate of Insurance evidencing the following types of insurance:

Workers' Compensation	Statutory	
Employer Liability	$100,000.00	
Comprehensive General Liability	$1,000,000.00 Combined Single Limit for BI & PD	$1,000,000.00 Aggregate
Comprehensive Auto Liability & Physical Damage	$1,000,000.00 Combined Single Limit for BI & PD	$1,000,000.00 Aggregate

19. GOVERNING LAW. All matters involving the validity, interpretation and application to this agreement shall be controlled by the laws of the Commonwealth of Massachusetts, United States of America.

20. HEADINGS. The headings used throughout are for administrative convenience only and shall be disregarded for the purpose of construing and enforcing this agreement.

21. ENTIRE AGREEMENT. Purchaser by acceptance of KMS' offer does acknowledge and agree to the terms and conditions contained herein. Only representations, promises, conditions or understandings subsequently reduced to writing and signed by an authorized representative of each party shall be binding upon either party.

SECTION II. PROCESS AND OPERATING SUMMARY

The soluble oil or water waste treatment process begins with waste collection in an equalization tank (figure II.1). The equalization tank should have a minimum capacity of one working day unless the waste flow is highly variable, in which case a larger tank will be required. The equalization tank is to be equipped to remove, essentially completely, free oil and settleable solids. A skimming device for surface oil and sophisticated separator (e.g. API, coalescing, etc.), may be employed to remove free oil and/or suspended solids.

The waste is then transferred to a process tank (volume usually equal to 1/2 to 1 day's capacity). The withdrawal line from the equalization tank should be at least two feet off the bottom so that the settled solids will not be transferred into the process tank. The transfer pump will depend on the type of operation employed, i.e. "batch" concentration or "modified batch" concentration.

BATCH CONCENTRATION

For this operation the process tank is filled and the wastewater is circulated between the process tank and the KOCH ultrafilter. The soluble oil or water will slowly be concentrated as the clear water discharges to the sewer during the ultrafiltration cycle. Cleaning is performed between cycles or at the end of several cycles, depending on need. Two process tanks can be used to facilitate the continual processing of batches and waste collection.

MODIFIED-BATCH CONCENTRATION CYCLE

The modified-batch cycle is similar to a batch cycle except during the initial phase of the cycle (4-5 days) the process tank is kept full with fresh feed to minimize the oil concentrate of its contents. This is accomplished by using level controls to activate the transfer pump.

Following this phase, flow to the process tank is stopped by overriding the level controls. The wastewater remaining in the process tank is "batch" concentrated to the maximum oil content achievable. The final concentrate is then discharged to a holding tank for ultimate disposal and the system is cleaned for the subsequent week's operation. This phase of the cycle, i.e. batch concentration and cleaning, is normally performed in a single day.

PROCESS TANK HEATING:

The normal operating temperature range for ultrafiltration is $80^{O}F$-120^{O}. If the influent waste temperature is significantly below $80^{O}F$, heating may be required.

Koch Membrane Systems, Inc., 850 Main Street, Wilmington, Massachusetts 01887-3388 ■ Tel. (508) 657-4250 ■ TWX 710 347 6537 ■ FAX (508) 657-5208

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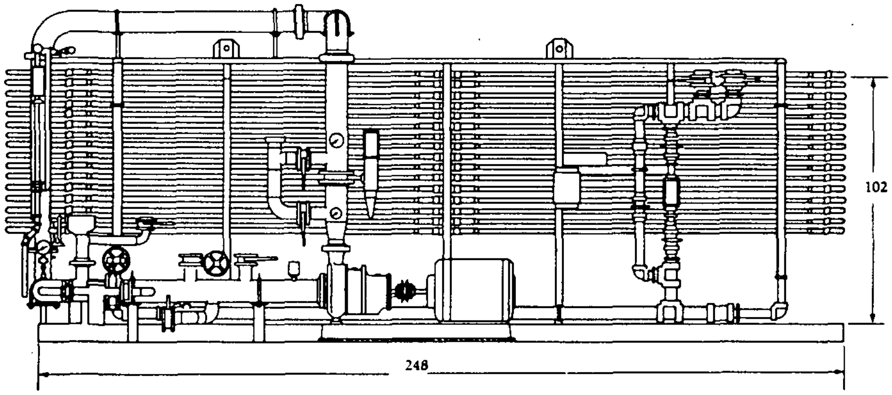
Abcor

UF-1200 RM SYSTEM FOR TREATING INDUSTRIAL WASTEWATER

Koch Membrane Systems' UF-1200 RM (rack mount) ultrafiltration wastewater treatment system is designed for treating a variety of liquid wastes.

The system is capable of treating volumes from 34,000 gallons per day (128,700 liters per day) to 176,800 gallons per day (669,260 liters), depending on the stream:



UF-1200 RM Daily Capacity		
Typical coolant oily waste, high parts per million (i.e. 5,000-50,000 PPM initial oil and grease concentration)	Chemical and low parts per million waste (i.e. less than 5,000 PPM solids concentration	Fine particle separation (metal hydroxides, pigments)
34,000 gallons per day (128,700 liters per day)	81,600 gallons per day (308,890 liters per day)	176,800 gallons per day (669,260 liters per day)

BENEFITS	SPECIAL FEATURES
• Simple, one-step operation saves labor costs	System operation is semi-automatic requiring virtually no operator attention
• Eliminates cost of pretreatment	No pretreatment necessary. No chemicals to store or mix
• Lowers hauling costs	System reduces spent coolant and other waste volume by as much as 98%, minimizing amount to be disposed of. Plus, system generates no additional sludge
• Saves Energy	System operates at low pressure
• Rugged, versatile, easily serviced and replaced	Standard NEMA frame and TEFC motors

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Agents and Associates in more than 20 Countries

4/90

Standard Equipment

- 544 Abcor® tubular membranes, with 1200 square feet (111.5M²) of membrane area
- One ultrafiltration stage with:
  - One circulation pump and motor - 100 HP, 1020 gpm (3860 lpm)
  - Pressure gauges for manifold inlet/outlet
  - Pressure switches with audible-visual alarm and automatic shutdown for low pressure at circulation pump suction and high pressure at membrane module inlet
  - High temperature switch with audible-visual alarm and automatic shutdown of circulation pump
  - Temperature indicator
  - Permeate glass-tube rotameter
  - Entrance piping Y-connection and screens for convenient manual insertion and removal of spongeballs for mechanical cleaning during chemical cleaning
  - Air vent and vacuum breaker assembly
- One Cleaning Tankage Sub-assembly, including:
  - 600 gallon (2270 liter) tank
  - Temperature indicator in tank
  - Steam sparger system with a temperature control valve
- One Cleaning Pump Package Sub-assembly, including:
  - One cleaning pump and motor - 15 HP, 300 gpm (1135 lpm)
  - Pressure gauge for cleaning pump discharge
  - Pressure switch with audible-visual alarm and automatic shutdown for low pressure at cleaning pump discharge
  - High temperature switch with audible-visual alarm and automatic shutdown on cleaning pump suction
- All valves, piping, and wiring
- One free standing local control panel

DIMENSIONS

Length:	21 feet	(6.4M)
Width:	10 feet	(3M)
Height:	9 feet	(2.7M)
Oper. Wt.:	13,250 lbs.	(6,010Kg)
Ship Wt.:	10,525 lbs.	(4,775Kg)

ULTRAFILTRATION

Ultrafiltration (UF) is a low pressure (10-150 PSI [1.4 -21.7 KPA]) membrane process for separating suspended solids and high molecular weight dissolved materials from liquids.

Fluid flows across the membrane surface at high velocity. This cross-flow characteristic differs from the perpendicular flow of ordinary filtration, where a "cake" builds up on the filter surface requiring frequent filter replacement or cleaning. Cross-flow prevents filter-cake buildup, resulting in high filtration rates that can be maintained continuously.

Ultrafiltration is a proven, reliable, simple (one-step), treatment process that requires minimum energy and minimum operator attention.

MEMBRANES

Koch manufactures Abcor® membranes, the most rugged and reliable available for industrial wastewater treatment. Membranes are available in a broad range of molecular weight cutoffs. Koch engineers will study your stream then recommend the best membrane for treating your system.

The UF-1200 RM comes equipped with membranes in tubular form. The benefits are as follows:

- They are easy to clean and require no flow reversal, which weakens membranes.
- Superior, more chemically resistant polymer selection and rugged design means these membranes will last two to three times longer than others.

START-UP, TRAINING AND SERVICE

Koch's Technical Service Department will start up your system and train operators in how to run the system. You will receive an in-depth operating manual, in addition to training. Service engineers are available to help you with system operation at any time during the life of the equipment.

Koch's Technical Service Department is committed to making sure your system operates efficiently day after day. Simply call, and one of our Tech Service engineers will help you optimize performance of your system.

THE KOCH DIFFERENCE

Koch doesn't just sell you membranes and systems. Our technical staff studies your specific wastewater problem, conducts feasibility tests if necessary, specifies and designs the right membrane and system for your needs, then works with you to ensure that our products perform as promised.

Find out more by calling or writing today. Let Koch show you how you too can take advantage of the simplest, most economical approach to treating wastewater.

KOCH
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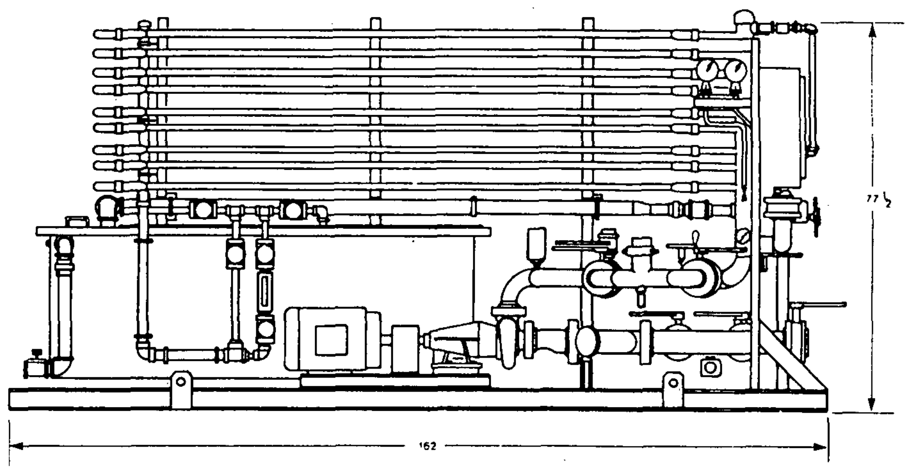
Abcor

UF-158 SYSTEM FOR TREATING INDUSTRIAL WASTEWATER



Koch Membrane Systems' UF-158 ultrafiltration wastewater treatment system is designed for both pilot and demonstration applications and for use as a fully operational system for treating a variety of liquid wastes.

The system is capable of treating volumes from 4,500 gallons per day (17,035 liters per day) to 23,400 gallons per day (88,580 liters), depending on the stream:

UF-158 Daily Capacity		
Typical coolant oily waste, high parts per million (i.e. 5,000-50,000 PPM initial oil and grease concentration)	Chemical and low parts per million waste (i.e. less than 5,000 PPM solids concentration	Fine particle separation (metal hydroxides, pigments)
4,500 gallons per day (17,035 liters per day)	10,800 gallons (40,880 liters per day)	23,400 gallons per day (88,580 liters per day)

BENEFITS	SPECIAL FEATURES
• Simple, one-step operation saves labor costs	System operation is semi-automatic requiring virtually no operator attention
• Eliminates cost of pretreatment	No pretreatment necessary. No chemicals to store or mix
• Lowers hauling costs	System reduces spent coolant and other waste volume by as much as 98%, minimizing amount to be disposed of. Plus, system generates no additional sludge
• Saves Energy	System operates at low pressure
• Rugged, versatile, easily serviced and replaced	Standard NEMA frame and TEFC motors

KOCH
KOCH MEMBRANE SYSTEMS INC

850 Main Street ☐ Wilmington, MA 01887-3388 U.S.A. ☐ TEL. (508) 657-4250 ☐ FAX (508) 657-5208

ABCOR Division of KOCH International (UK) Ltd., Stafford, England ☐ ABCOR Division of KOCH International GmbH, Düsseldorf, West Germany ☐ ABCOR Division of KOCH International S.A.R.L., Paris, France

Agents and Associates in more than 20 Countries

Standard Equipment

- 72 Abcor® tubular membranes with 158 square feet ($14.6M^2$) of membrane area
- Centrifugal circulation pumping system, 15 HP, 270 gpm (1025 lpm)
- Feed temperature gauge
- Two pressure gauges
- High temperature switch interlocked to circulation pump
- Low pressure switch interlocked to circulation pump
- Audible-visual alarms for high temperature and low pressure switches
- Permeate line direct reading flowmeter
- All valves, piping and internal wiring
- Cleaning tank and associated piping
- Control panel
- Spongeballs (1 dozen) for mechanical cleaning. Semi-automatic operation
- Koch liquid detergent (5 gallons [19 liters])

DIMENSIONS

Length:	14 feet (4.2M)
Width:	4 feet (1.2M)
Height:	7 feet (2.1M)
Oper. Wt.:	5,125 lbs. (2,325Kg)
Ship. Wt.:	4,825 lbs. (2,190Kg)
Voltage:	230/460 VAC, 3 phase, 60 Hz

ULTRAFILTRATION

Ultrafiltration (UF) is a low pressure (10-150 PSI [1.4 -21.7 KPA]) membrane process for separating suspended solids and high molecular weight dissolved materials from liquids.

Fluid flows across the membrane surface at high velocity. This cross-flow characteristic differs from the perpendicular flow of ordinary filtration, where a "cake" builds up on the filter surface requiring frequent filter replacement or cleaning. Cross-flow prevents filter-cake buildup, resulting in high filtration rates that can be maintained continuously.

Ultrafiltration is a proven, reliable, simple (one-step), treatment process that requires minimum energy and minimum operator attention.

MEMBRANES

Koch manufactures Abcor® membranes, the most rugged and reliable available for industrial wastewater treatment. Membranes are available in a broad range of molecular weight cutoffs. Koch engineers will study your stream then recommend the best membrane for treating your system.

The UF-158 comes equipped with membranes in tubular form. The benefits are as follows:

- They are easy to clean and require no flow reversal, which weakens membranes.
- Superior, more chemically resistant polymer selection and rugged design means these membranes will last two to three times longer than others.

START-UP, TRAINING AND SERVICE

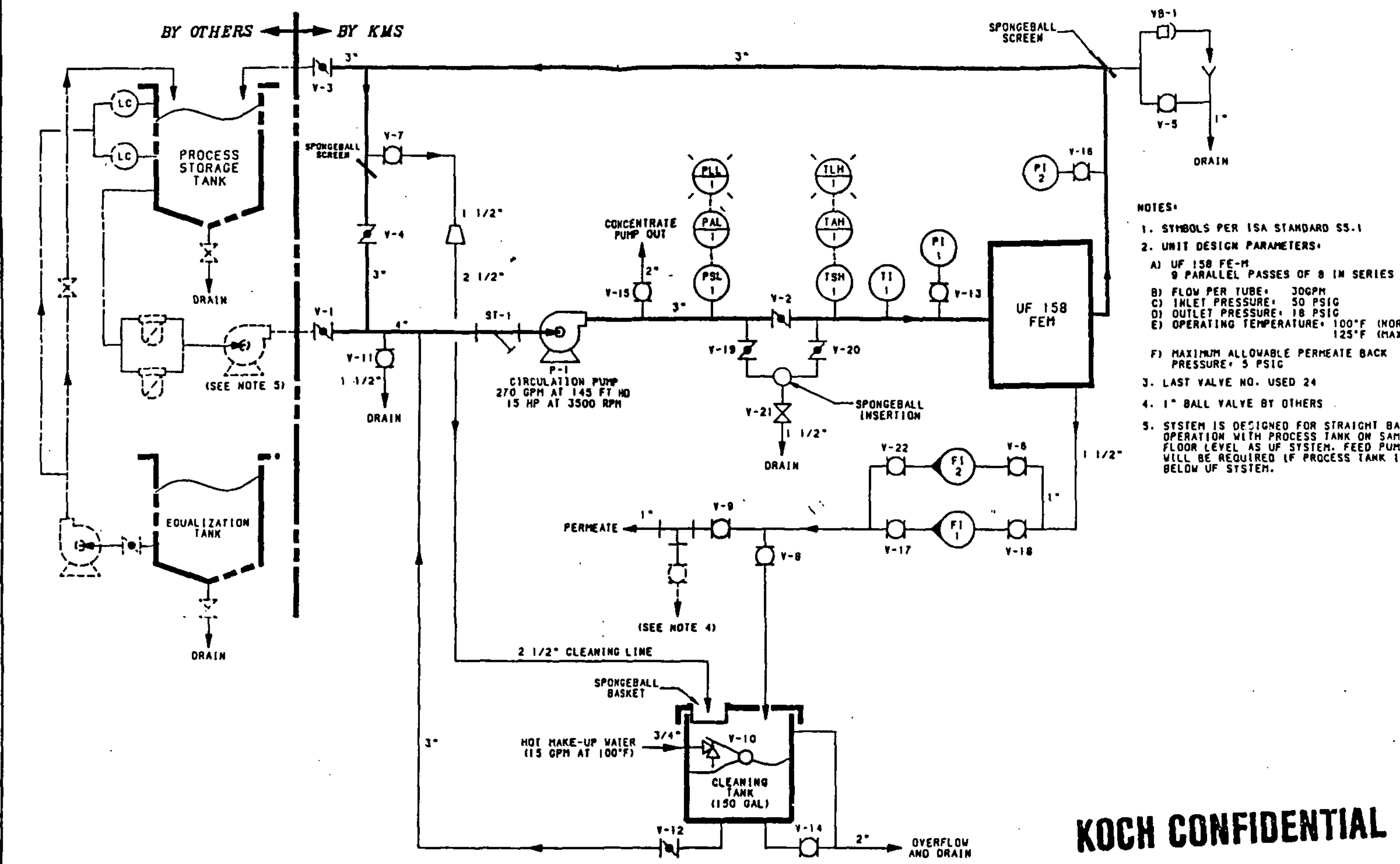
Koch's Technical Service Department will start up your system and train operators in how to run the system. You will receive an in-depth operating manual, in addition to training. Service engineers are available to help you with system operation at any time during the life of the equipment.

Koch's Technical Service Department is committed to making sure your system operates efficiently day after day. Simply call, and one of our Tech Service engineers will help you optimize performance of your system.

THE KOCH DIFFERENCE

Koch doesn't just sell you membranes and systems. Our technical staff studies your specific wastewater problem, conducts feasibility tests if necessary, specifies and designs the right membrane and system for your needs, then works with you to ensure that our products perform as promised.

Find out more by calling or writing today. Let Koch show you how you too can take advantage of the simplest, most economical approach to treating wastewater.



NOTES:

1. SYMBOLS PER ISA STANDARD S5.1
2. UNIT DESIGN PARAMETERS:
   - A) UF 158 FE-M 9 PARALLEL PASSES OF 8 IN SERIES
   - B) FLOW PER TUBE: 30GPM
   - C) INLET PRESSURE: 50 PSIG
   - D) OUTLET PRESSURE: 18 PSIG
   - E) OPERATING TEMPERATURE: 100°F (NORMAL) 125°F (MAXIMUM)
   - F) MAXIMUM ALLOWABLE PERMEATE BACK PRESSURE: 5 PSIG
3. LAST VALVE NO. USED 24
4. 1" BALL VALVE BY OTHERS
5. SYSTEM IS DESIGNED FOR STRAIGHT BATCH OPERATION WITH PROCESS TANK ON SAME FLOOR LEVEL AS UF SYSTEM. FEED PUMP WILL BE REQUIRED IF PROCESS TANK IS BELOW UF SYSTEM.

KOCH CONFIDENTIAL

REVISIONS

SYM	DESCRIPTION	APPROVAL	DATE
A	APPROVED & RELEASED		
D	REDRAWN ON CAD	AMP	4-14-89
E	RELOCATED TSH-1 PER ECO F649	[illegible]	7-10-90

SEPARATE PARTS LIST: YES ☐ NO ☒

APPLICATION

USED ON

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
ANGLES, ±
FRACTIONS, ±
DECIMALS, .XX± .XXX±

MATERIAL:

FINISH:

	NAME	DATE
DRAWN	R. J.	4-14-89
CHECKED	AMP	4-14-89
ENGINEER		
PROJ APP		
MICROFILM		
PROJ NO.		
MADE FROM		

KOCH
KOCH MEMBRANE SYSTEMS INC
850 Main Street Wilmington, Ma. 01887
Abcor MEMBRANES

TITLE: UF-158 FE-M O/W SYSTEM FLOW SCHEMATIC (15 HP 3500 RPM)

KMS PART NO. SIZE C 5388-5017 REV. E

SCALE SHEET OF

M&E Metcalf & Eddy
An Air & Water Technologies Company

004609-0018-010-001

June 17, 1993

Mr. Anthony J. MacDonald
Sales Engineer
Northeast Region
Koch Membrane Systems, Inc.
850 Main Street
Wilmington, Massachusetts 01887-3388

Subject: **Contract No. 68-W9-0036**
Work Assignment No. 18-1LA5
Rose Hill Regional Landfill Superfund Site,
South Kingstown, Rhode Island
Request for Quotation on Equipment, Services and Budgetary Costs - Treatment of Contaminated Groundwater using Membrane Filtration

Dear Mr. MacDonald:

Metcalf & Eddy (M&E) is currently finalizing the Feasibility Study (FS) for treatment of contaminated groundwater at the Rose Hill Landfill site. This groundwater is contaminated with weak, municipal landfill leachate. M&E has identified reverse osmosis as an appropriate method for removing the inorganic compounds-of-concern (COCs). I attended your seminar in Newton this morning and feel that your company has the perfect background to assist us on this project.

I am requesting a quotation describing suggested equipment, services and budgetary costs should be based on the following assumptions:

1) quotations are needed for two different systems; groundwater concentrations are shown in Attachment A for the 50 gpm system (Alternative 4) and Attachment B for the 200 gpm system (Alternative 5).
2) treatment goals are listed in each attachment by compound; for the inorganic compounds, please identify any compounds that may not meet goals.
3) organics will be treated by a UV/Chemical oxidation system after inorganics removal; if you feel this should be placed prior to reverse osmosis due to organics affecting the membrane, please state this.
4) assume a water temperature of 55 degrees F.
5) 50 gpm flowrate may be as low as 5 gpm; will your system still operate effectively? This will probably require semi-batch processing.
6) treated water discharges to recharge wells or to river.
7) identify operations and maintenance services necessary for your proposed system.
8) identify the make & model of your proposed system; please include copies of brochures, drawings and specifications.
9) assume budgetary costs accuracy for equipment, f.o.b.

10) identify any other potential pretreatment or special conditions that you feel may be necessary for proper operation.

Based on my understanding of today's seminar, I am assuming that you would perform a precipitation followed by ultrafiltration, and then polish the stream using reverse osmosis. It would be appreciated if costs for the system were broken down into those three steps. I would also assume that you would employ modified batch processing to reduce the volume of waste to be disposed of. An approximate volume of this waste generated would be helpful. As this is a closed landfill, there is currently no equipment (i.e. tanks) available for use. These would need to be included in the system. I understand that without a pilot test, the membrane costs will be very rough, but since this is a feasibility study, we cannot perform such a test.

Your quotations are needed by the end-of-day Thursday, June 24, 1993. Thank you for your assistance with this project. If you have any questions, please do not hesitate to contact me at TEL (617) 246-5200, extension 4811 or by FAX at (617) 245-6293.

Very truly yours,

METCALF & EDDY, INC.

Sean Czarniecki

Sean Czarniecki
Engineer II,
Industrial & Hazardous Waste Division

Attachments
cc: D. Peters
WA#18-1LA5

ATTACHMENT A: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	9	48		
Sulfide (mg/L)	1	4		
Aluminum	12,616	98,281	*	87
Antimony	0	0	*	6
Arsenic	2	9	*	
Barium	210	695	*	
Beryllium	2	13	*	1
Cadmium	4	36	*	5
Chromium	21	136	*	100
Cobalt	21	82	*	
Copper	37	324	*	
Iron	91,571	396,140	*	1,000
Lead	40	180	*	15
Manganese	2,633	10,361	*	45
Mercury	0.11	0.29	*	
Nickel	24	112	*	100
Vanadium	20	133	*	
Zinc	625	6,520	*	7,300
Dieldrin	0.043	0.003		
2-Methylnaphthalene	4	4		
4-Chloro-3-methylphenol	4	4		
4-Methylphenol	8	64		
Pentachlorophenol	12	3		1
bis(2-Ethylhexyl)phthalate	11	59		4
1,1-Dichloroethane	13	195		
1,1-Dichloroethene	4	2		
1,2-Dichloroethene(total)	30	645		70
4-Methyl-2-pentanone	5	27		
Acetone	20	415		
Benzene	10	27		5
Carbon Disulfide	13	77		
Chloroethane	16	77		
Ethylbenzene	14	64		
Toluene	31	156		
Trichloroethene	4	4		
Vinyl Chloride	30	610		2
Acrylamide	141	202		0.02 (c)
N,N-DMF	177	1,273		
Hardness (mg/L)	151	621		
pH	7.1	11.9		
Total Organic Carbon (mg/L)	44	200		
Biochemical Oxygen Demand (mg/L)	12	112		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

ATTACHMENT B: GROUNDWATER CONDITIONS FOR THE 200 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (µg/L) except where noted at left			
Ammonia (mg/L)	11	30		
Sulfide (mg/L)	1	7		
Aluminum	14,277	76,745	*	87
Antimony	10	46	*	6
Arsenic	2	7	*	
Barium	136	445	*	
Beryllium	2	9	*	1
Cadmium	3	25	*	5
Chromium	17	94	*	100
Cobalt	18	53	*	
Copper	47	215	*	
Iron	60,644	218,437	*	1,000
Lead	32	154	*	15
Manganese	2,305	8,391	*	45
Mercury	0.10	0.22	*	
Nickel	27	93	*	100
Vanadium	20	115	*	
Zinc	348	3,135	*	7,300
Dieldrin	0.020	0.001		
2-Methylnaphthalene	3	2		
4-Chloro-3-methylphenol	2	2		
4-Methylphenol	8	56		
Pentachlorophenol	6	1		1
bis(2-Ethylhexyl)phthalate	4	21		4
1,1-Dichloroethane	7	89		
1,1-Dichloroethene	3	1		
1,2-Dichloroethene(total)	14	293		70
4-Methyl-2-pentanone	2	12		
Acetone	21	329		
Benzene	5	13		5
Carbon Disulfide	11	57		
Chloroethane	8	37		
Ethylbenzene	7	29		
Toluene	21	121		
Trichloroethene	2	2		
Vinyl Chloride	14	276		2
Acrylamide	64	92		0.02 (c)
N,N-DMF	84	600		
Hardness (mg/L)	86	330		
pH	6.9	9.8		
Total Organic Carbon (mg/L)	28	125		
Biochemical Oxygen Demand (mg/L)	7	58		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 µg/L standard assuming that this is the detection limit.

ATTACHMENT C: GROUNDWATER CONDITIONS FOR 5 GPM FLOW RATES

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	13	22		
Sulfide (mg/L)	0	0		
Aluminum	2,100	9,220	*	87
Antimony	0	0	*	6
Arsenic	0	0	*	
Barium	510	2,120	*	
Beryllium	2	9	*	1
Cadmium	2	5	*	5
Chromium	0	0	*	100
Cobalt	63	295	*	
Copper	0	0	*	
Iron	286,675	1,370,000	*	1,000
Lead	37	174	*	15
Manganese	8,200	14,700	*	45
Mercury	0.11	0.20	*	
Nickel	5	14	*	100
Vanadium	15	65	*	
Zinc	210	133	*	7,300
Dieldrin	0.000	0.000		
2-Methylnaphthalene	0	0		
4-Chloro-3-methylphenol	0	0		
4-Methylphenol	0	0		
Pentachlorophenol	0	0		1
bis(2-Ethylhexyl)phthalate	50	230		4
1,1-Dichloroethane	3	2		
1,1-Dichloroethene	0	0		
1,2-Dichloroethene(total)	3	1		70
4-Methyl-2-pentanone	0	0		
Acetone	0	0		
Benzene	0	0		5
Carbon Disulfide	3	3		
Chloroethane	6	8		
Ethylbenzene	2	2		
Toluene	19	50		
Trichloroethene	0	0		
Vinyl Chloride	0	0		2
Acrylamide	0	0		0.02 (c)
N,N-DMF	0	0		
Hardness (mg/L)	79	214		
pH	6.5	7.1		
Total Organic Carbon (mg/L)	26	50		
Biochemical Oxygen Demand (mg/L)	9	51		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

- Metals Treatment Quotation: Osmonics
  M&E Quotation Request

OSMONICS, INC.

5951 Clearwater Drive
Minnetonka, Minnesota 55343-8990 USA
(15 miles west of Minneapolis airport)
Phone: 612/933-2277
Fax: 612/933-0141 • Telex: 29-0847

WATER PURIFICATION, FLUID HANDLING, FILTRATION AND SEPARATION SPECIALISTS SINCE 1969

June 16, 1993

Mr. Sean Czarniecki
METCALF & EDDY
30 Harvard Mill Square
Wakefield, MA 01880

Re: Budgetary Information on MPE Contract Number 68-W9-0036

Dear Sean:

Thank you for your interest in Osmonics and our products. We are pleased to provide information on reverse osmosis (RO).

Based on the water analyses provided, it appears that reverse osmosis could be viable in conjunction with other technologies. To make membrane technology feasible, extensive pretreatment would be required to precipitate many of the constituents prior to further concentration by the RO. Liquids with low osmotic pressure and Langelier Saturation Index (LSI) less than zero may allow an RO to operate with recoveries as high as 75%. For your applications, this could provide concentrate flows as low as 12.5 gpm and 50 gpm. This reduced volume could then be sent to an evaporator for further treatment.

A budget number for RO's for these systems would be 145,000-175,000 for a 50-gpm feed and 350,000-470,000 for the 200-gpm feed. Osmonics is also involved with media filters and ozone among other equipment. Ozone could be used as an oxidant to assist precipitation as well as destruction of bacteria.

Typical equipment for an RO includes:

<u>CHF DELUXE RO MACHINE</u>

SEPA® Membrane
OSMO® Sepralators
PVC or 304SS Sepralator Housings
Variable Recovery
Thermal Cut-Out Switch (set at 105°F)
Concentrate Flow Meter
Permeate Flow Meter
Primary/Final Pressure Gauges
5-Micron HYTREX® Prefilter Cartridge and Housing
TONKAFLO® Multi-Stage Centrifugal Pump
UNI pH Monitor
Conductivity Meter
PVC, 304SS or 316SS Piping. "L" grades would also be available.

cont...

Enclosed are pages detailing RO as well as an Osmonics Family Product Binder which contains information on the various product lines we offer. Please call us at 612/933-2277 if there are any questions.

Sincerely,

OSMONICS, INC.

Alan T. Rivers
Application Engineer
Engineered Products & Systems

ATR/pc

Encl: Family Product Binder
A Historical Perspective of UF and RO Membrane Development
Engineering Memo #13

cc: Mr. Harold S. Gooding, Sales Engineer, Engineered Products & Systems, OSMONICS, INC.

M&E Metcalf & Eddy
An Air & Water Technologies Company

004609-0018-010-001

May 24, 1993

Mr. Harold S. Gooding
Sales Engineer
Engineered Products & Systems
Osmonics
5951 Clearwater Drive
Minnetonka, Minnesota 55343

Subject: **Contract No. 68-W9-0036**
Work Assignment No. 18-1LA5
Rose Hill Regional Landfill Superfund Site
South Kingston, Rhode Island
Request for Quotation on Equipment, Services and Budgetary Costs - Treatment of Contaminated Groundwater using Reverse Osmosis

Dear Mr Gooding:

Metcalf & Eddy (M&E) is currently finalizing the Feasibility Study (FS) for treatment of contaminated groundwater at the Rose Hill Landfill site. As previously discussed, this groundwater is contaminated with weak, municipal landfill leachate. M&E has identified reverse osmosis as an appropriate method for removing the inorganic compounds-of-concern (COCs).

A quotation describing suggested equipment, services and budgetary costs should be based on the following assumptions:

1) quotations are needed for two different systems; groundwater concentrations are shown in Attachment A for the 50 gpm system (Alternative 4) and Attachment B for the 200 gpm system (Alternative 5).
2) treatment goals are listed in each attachment by compound; for the inorganic compounds, please identify any compounds that <u>may not meet goals</u>.
3) organics will be treated by a UV/Chemical oxidation system after inorganics removal.
4) assume a water temperature of 55 degrees F.
5) 50 gpm flowrate may be as low as 5 gpm (conditions shown in Attachment C); will your system still operate effectively ?
6) treated water discharges to recharge wells or to river.
7) identify operations and maintenance services necessary for your proposed system.
8) identify the make & model of your proposed system; please include copies of brochures, drawings and specifications that you may not have already provided to me.
9) assume budgetary costs accuracy for equipment, f.o.b.

30 Harvard Mill Square, Wakefield, MA 01880
Mailing Address: PO Box 4043, Woburn, MA 01888-4043
617-246-5200 FAX 617-245-6293

10) identify any other potential pretreatment or special conditions that you feel may be necessary for proper operation.

Your quotations are needed by the end-of-day Friday, June 4, 1993. While looking at your sizing calculations, I noticed that the aluminum concentration you used was an order of magnitude too high. I was also wondering if the ratio of $Mn(OH)_2$ to Mn is actually 2.32. These items may affect the size of equipment you have selected for us and I would appreciate it if you could take a quick look at them again.

Thank you for your assistance with this project. If you have any questions, please do not hesitate to contact me at TEL (617) 246-5200, extension 4811 or by FAX at (617) 245-6293.

Very truly yours,

METCALF & EDDY, INC.

Sean Czarniecki

Sean Czarniecki
Engineer II,
Industrial & Hazardous Waste Division

Attachments
cc: D. Peters
WA#18-1LA5

Mr. Frank Estill
Global Technologies, Inc.
2 Gordon Street
Simsbury, CT 06070

ATTACHMENT A: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	9	48		
Sulfide (mg/L)	1	4		
Aluminum	12,616	98,281	*	← 87
Antimony	0	0	*	6
Arsenic	2	9	*	
Barium	210	695	*	
Beryllium	2	13	*	1
Cadmium	4	36	*	5
Chromium	21	136	*	100
Cobalt	21	82	*	
Copper	37	324	*	
Iron	91,571	396,140	*	1,000
Lead	40	180	*	15
Manganese	2,633	10,361	*	~~3,650~~ 45
Mercury	0.11	0.29	*	
Nickel	24	112	*	100
Vanadium	20	133	*	
Zinc	625	6,520	*	7,300
Dieldrin	0.043	0.003		
2-Methylnaphthalene	4	4		
4-Chloro-3-methylphenol	4	4		
4-Methylphenol	8	64		
Pentachlorophenol	12	3		1
bis(2-Ethylhexyl)phthalate	11	59		4
1,1-Dichloroethane	13	195		
1,1-Dichloroethene	4	2		
1,2-Dichloroethene(total)	30	645		70
4-Methyl-2-pentanone	5	27		
Acetone	20	415		
Benzene	10	27		5
Carbon Disulfide	13	77		
Chloroethane	16	77		
Ethylbenzene	14	64		
Toluene	31	156		
Trichloroethene	4	4		
Vinyl Chloride	30	610		2
Acrylamide	141	202		0.02 (c)
N,N-DMF	177	1,273		
Hardness (mg/L)	151	621		
pH	7.1	11.9		
Total Organic Carbon (mg/L)	44	200		
Biochemical Oxygen Demand (mg/L)	12	112		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

ATTACHMENT B: GROUNDWATER CONDITIONS FOR THE 200 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	GROUNDWATER CONCENTRATIONS (b) Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	11	30		
Sulfide (mg/L)	1	7		
Aluminum	14,277	76,745	*	87
Antimony	10	46	*	6
Arsenic	2	7	*	
Barium	136	445	*	
Beryllium	2	9	*	1
Cadmium	3	25	*	5
Chromium	17	94	*	100
Cobalt	18	53	*	
Copper	47	215	*	
Iron	60,644	218,437	*	1,000
Lead	32	154	*	15
Manganese	2,305	8,391	*	~~3,650~~ 45
Mercury	0.10	0.22	*	
Nickel	27	93	*	100
Vanadium	20	115	*	
Zinc	348	3,135	*	7,300
Dieldrin	0.020	0.001		
2-Methylnaphthalene	3	2		
4-Chloro-3-methylphenol	2	2		
4-Methylphenol	8	56		
Pentachlorophenol	6	1		1
bis(2-Ethylhexyl)phthalate	4	21		4
1,1-Dichloroethane	7	89		
1,1-Dichloroethene	3	1		
1,2-Dichloroethene(total)	14	293		70
4-Methyl-2-pentanone	2	12		
Acetone	21	329		
Benzene	5	13		5
Carbon Disulfide	11	57		
Chloroethane	8	37		
Ethylbenzene	7	29		
Toluene	21	121		
Trichloroethene	2	2		
Vinyl Chloride	14	276		2
Acrylamide	64	92		0.02 (c)
N,N-DMF	84	600		
Hardness (mg/L)	86	330		
pH	6.9	9.8		
Total Organic Carbon (mg/L)	28	125		
Biochemical Oxygen Demand (mg/L)	7	58		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

ATTACHMENT C: GROUNDWATER CONDITIONS FOR 5 GPM FLOW RATES

ANALYTE (a)		GROUNDWATER CONCENTRATIONS (b) Average	Maximum	PRELIMINARY REMEDIATION GOAL
		all in (μg/L) except where noted at left		
Ammonia (mg/L)		13	22	
Sulfide (mg/L)		0	0	
Aluminum	*	2,100	9,220	87
Antimony	*	0	0	6
Arsenic	*	0	0	
Barium	*	510	2,120	
Beryllium	*	2	9	1
Cadmium	*	2	5	5
Chromium	*	0	0	100
Cobalt	*	63	295	
Copper	*	0	0	
Iron	*	286,675	1,370,000	1,000
Lead	*	37	174	15
Manganese	*	8,200	14,700	~~3,650~~ 45
Mercury	*	0.11	0.20	
Nickel	*	5	14	100
Vanadium	*	15	65	
Zinc	*	210	133	7,300
Dieldrin		0.000	0.000	
2-Methylnaphthalene		0	0	
4-Chloro-3-methylphenol		0	0	
4-Methylphenol		0	0	
Pentachlorophenol		0	0	1
bis(2-Ethylhexyl)phthalate		50	230	4
1,1-Dichloroethane		3	2	
1,1-Dichloroethene		0	0	
1,2-Dichloroethene(total)		3	1	70
4-Methyl-2-pentanone		0	0	
Acetone		0	0	
Benzene		0	0	5
Carbon Disulfide		3	3	
Chloroethane		6	8	
Ethylbenzene		2	2	
Toluene		19	50	
Trichloroethene		0	0	
Vinyl Chloride		0	0	2
Acrylamide		0	0	0.02 (c)
N,N-DMF		0	0	
Hardness (mg/L)		79	214	
pH		6.5	7.1	
Total Organic Carbon (mg/L)		26	50	
Biochemical Oxygen Demand (mg/L)		9	51	

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

- UV/Chemical Oxidation Quotation: Solarchem
  Cost Estimates
  Performance Specification
  System Drawings
  M&E Quotation Request

Solarchem

May 25, 1993

Mr. Dan Peters
Metcalf and Eddy, Inc.
P O Box 4043
Woburn, MA
01888-4043

As a follow up to our recent telephone conversation, I am writing to provide a cost estimate to treat your groundwater with our **Rayox**® UV/Oxidation system.

Solarchem has a strong experience base in the treatment of contaminated wastewater and groundwater, with commercial **Rayox**® installations treating between 2 gpm and 600 gpm of water with the following contaminants:

- BTEX, MTBE for the oil and gas industry
- PCP, Phenols, PAH's for the wood treating industry
- Chlorinated Solvents (TCE, PCE) for the chemical industry
- NG, TNT, DNT for the explosives industry

Details on the treatment of these and other contaminants are given in the enclosed brochure and technical papers. Of particular interest to you may be the technical papers, where our experience treating various VOCs is outlined.

Features and advantages of the **Rayox**® Second Generation UV/Oxidation process include:

- *Destruction of up to 99.999+% of contaminants* - no transfer of toxic material from one medium to another.
- *Proprietary Solarchem UV lamps* - significantly enhanced output in the region of the UV spectrum where virtually all organic contaminants are most photochemically active gives inherently lower operating costs from simultaneous oxidation/photolysis of organics.
- *Transmittance Controller* - a proven and effective wiper mechanism prevents fouling of the UV lamp, which increases system efficiency and eliminates the need for a metals pretreatment system or shutdown for cleaning.
- *ENOX catalysts* - proprietary reagents and processes can reduce capital costs and enhance performance.
- *Programmable Logic Controller (PLC)* - maintains automatic, failsafe, unattended operation, reduces operator time and costs, and adds flexibility for variable flow rates or future additions. A PLC also allows use of a message window for easy diagnostics, and a modem and telephone dialer for easy servicing and remote monitoring.

130 Royal Crest Court
Markham, Ontario
Canada, L3R 0A1
Telephone: (416) 477 - 9242
Facsimile: (416) 477 - 4511

7320 Smoke Ranch Road
Las Vegas, Nevada 89128
USA
Telephone: (702) 255 - 7055
Facsimile: (702) 255 - 7280

Solarchem

Cost Estimate:

Based on our extensive experience treating organics in groundwater we estimate that to treat to the performance specifications attached as Table 1, the following system will be required:

Alternative 4 (50 gpm)

1 x 30 kW **Rayox**® UV/Oxidation System

Capital Investment $ 80,000

Alternative 5 (200 gpm)

4 x 30 kW **Rayox**® UV/Oxidation System

Capital Investment $ 175,00

Including:

- **Rayox**® reactors and power supplies
- Peroxide Delivery System
- Catalyst Delivery System
- System Controller (PLC)
- Operation Manual
- Heat Exchanger

For your reference, I have attached drawings showing dimensions of a 1 x 30 kW and a 4 x 30 kW **Rayox**® skid and the peroxide delivery system.

Based on $0.05 per kWh for electrical power in your area, and market rates for H_2O_2, the following are typical operating costs:

	$/1000USG
Electrical Power	$ 0.50
Replacement UV Lamps	0.25
Hydrogen Peroxide	0.15
Total Operating Costs	$ 0.90

Solarchem

Other information pertinent to this estimate is as follows:

- Normal delivery is 12-16 weeks.
- Leasing terms can be arranged.
- Solarchem warrants the performance of the system indefinitely, as well as the materials and workmanship of its equipment for a period of one year after installation date.
- Periodic maintenance contracts are available. Normal maintenance includes daily logging of system parameters and approximately 4 hours/month of maintenance.
- Solarchem offers 48 hour emergency service to any point in North America.
- Delivery, site preparation and installation are not included.
- If the flow is decreased to 5 gpm, a temperature rise of 40F would occur through a 30 kw reactor. This will not effect the treatment by our system but may require a heat exchanger to cool the water prior to open water discharge.

Design Test - The Next Practical Step

Due to the potential variability of groundwater streams, your stream should be tested by Solarchem engineers in order to design the optimum utilization of UV reactors, H_2O_2, catalysts and pH, and in order to confirm our budget estimate.

To perform a Design Test, we require 1 x 55 gallon drum of representative water along with recent analysis of the water and your discharge requirements. This large volume of water means we can do tests on batches of 7 gallons each, allowing a more reliable scale-up to a commercial system.

You will receive a Design Test report which summarizes:

- our assessment of the **Rayox**® treatment alternatives evaluated
- a confirmation of the capital investment and operating costs to meet the treatment specification
- a process flow schematic of the proposed least cost system
- a firm delivery schedule for a commercial system, subject to confirmation at time of order
- a warranty statement of system performance to the agreed specifications

Solarchem

The cost for a design test is $5,000 not including outside analyses, if necessary. Please note that the $5,000 fee will be applied as a credit towards the purchase of a full-scale system. Solarchem offers assistance for the transportation of water from the client's facilities to our Markham laboratories.

I trust that this letter has provided the information you were looking for. Please call me if you have any questions or wish to arrange for a design test.

Yours sincerely,

SOLARCHEM ENVIRONMENTAL SYSTEMS
per:

Rob Abernethy

Rob Abernethy, P.Eng.
Technical Sales Representative

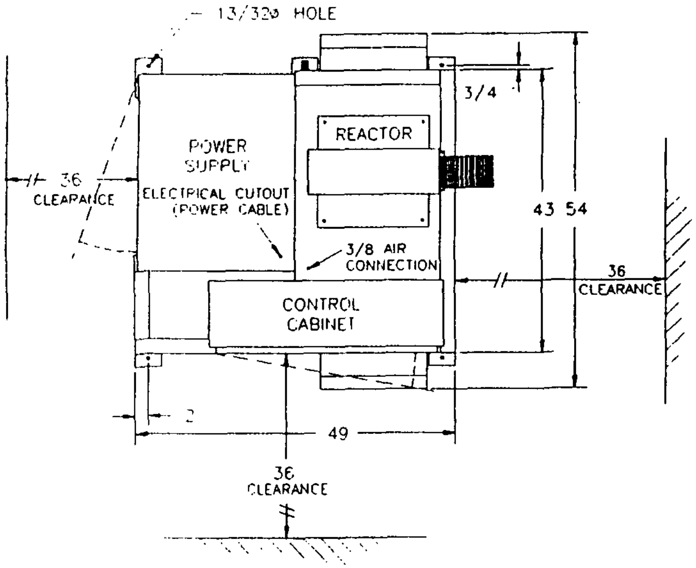
RA/ps
60.M.

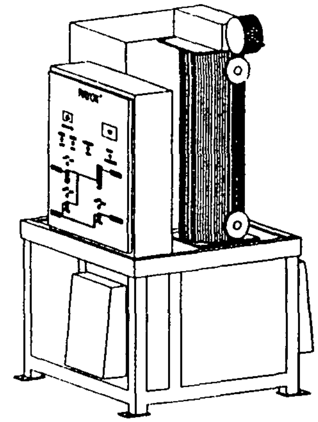
TABLE 1

Rose Hill Groundwater
Treatment Performance Specification

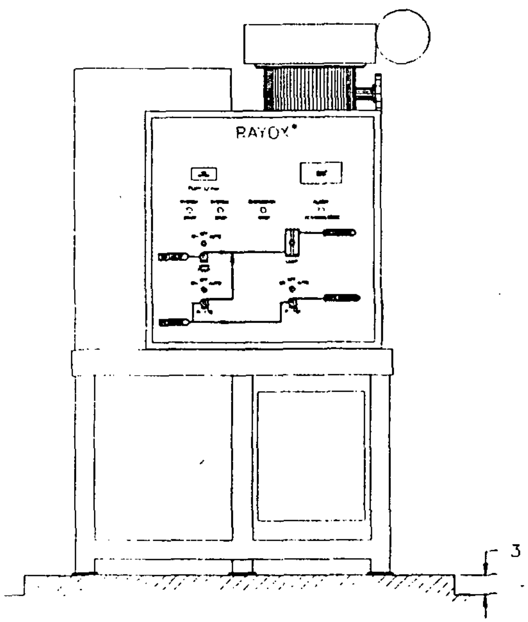
	Contaminant	Influent (ppb)	Effluent (ppb)	Flow Rate (gpm)
Alternative 4	Acrylamide	202	2	50
Alternative 5	Acrylamide	92	2	200

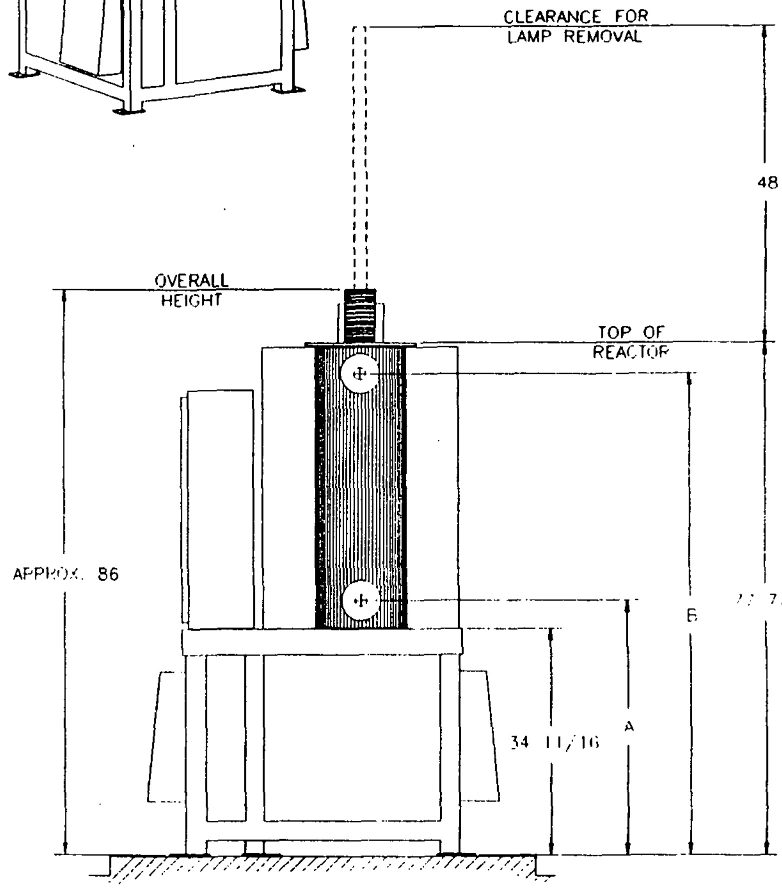
* Acrylamide is the rate limiting contaminant. All of the other organic contaminants will be well below their remediation goals when acrylamide reaches it's remediation good.





PORT SIZE	APPROX. A	APPROX. B
1	38 1/4	74
1 1/2	39	73 1/4
2	39	73 1/4
3	39	73 1/4





REVISIONS

REV	DESCRIPTION	DATE	APPV'D
A	ECO 00144 – [illegible]	[illegible]	
B			
C			
D			
E			

NOTES:

1. APPPOX. WEIGHT 1600 lbs
2. REFER TO PIPING DRAWING FOR REACTOR NOZZLE ORIENTATION AND PIPING.
3. MINIMUM 36" CLEARANCE REQUIRED FOR MAINTENANCE ACCESS AS SHOWN
4. UNIT TO BE MOUNTED ON 3" RAISED CONCRETE SLAB.

FINISH:

MATERIAL:

DIMENSIONS IN INCHES unless otherwise specified
TOLERANCES unless otherwise specified

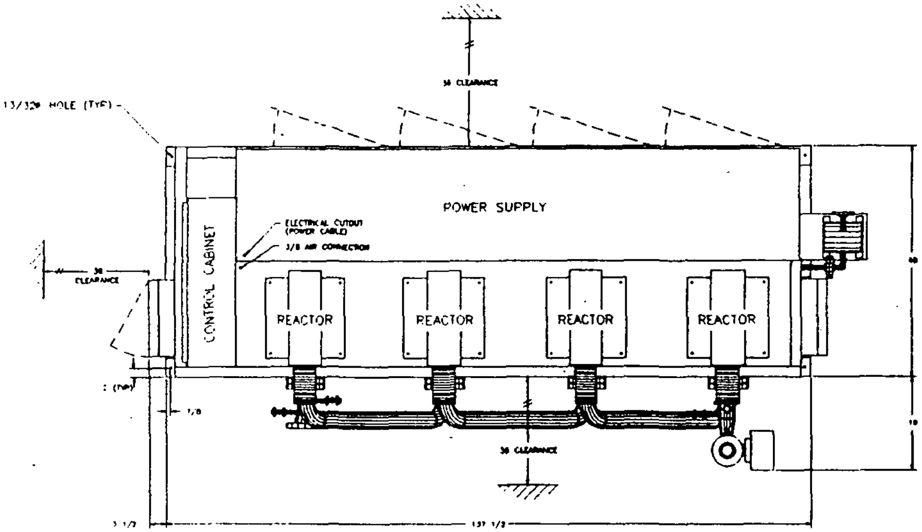
ANGULAR	± 0°30'	DECIMAL 2 PLACES	± [illegible]
FRACTIONAL	± 1/32	DECIMAL 3 PLACES	± [illegible]
DECIMAL 1 PLACE	± .015	DECIMAL 4 PLACES	± [illegible]

	NAME	SIGN	DATE
DRAFT	T. G. R.		[illegible]
DESIGN			
CHECK			
APPR			

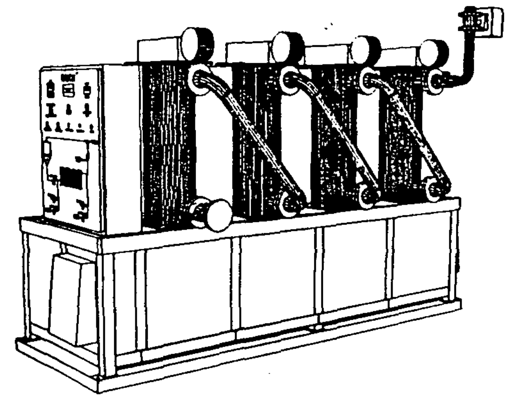
Solarchem

TITLE: RAYOX 30 kW REACTOR OUTLINE DETAIL

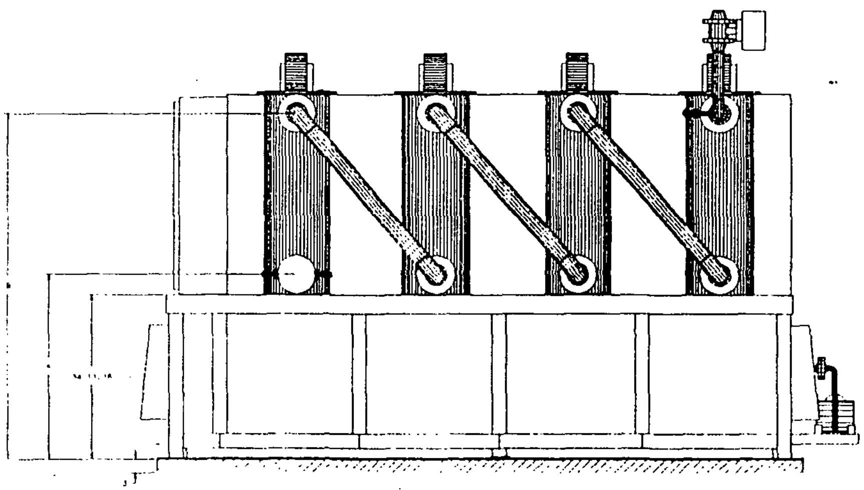
SCALE	DWG. No.	REVISION
NONE	000-RD-000111	A



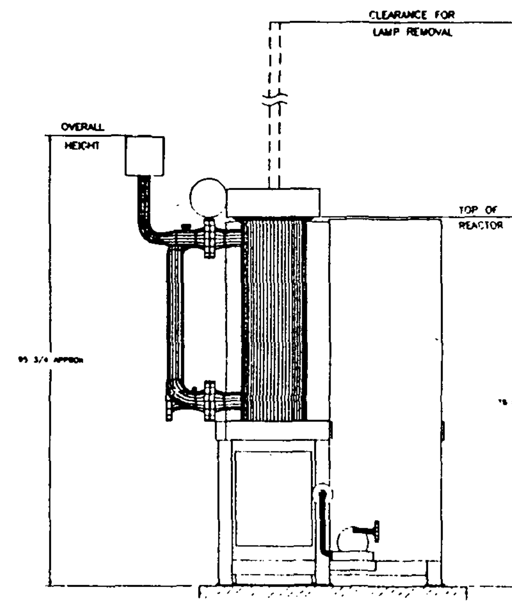
PLAN



ISOMETRIC VIEW



FRONT ELEVATION



SIDE ELEVATION

REVISIONS

REV	DESCRIPTION	DATE	APPV'D
A			
B			
C			
D			
E			

NOTES:

1. APPROX. WT. = 2800 lbs. REFER TO PIPING DRAWING FOR REACTOR NOZZLE ORIENTATION AND PIPING.
2. MINIMUM 36" CLEARANCE REQUIRED FOR MAINTENANCE ACCESS AS SHOWN.
3. UNIT TO BE MOUNTED ON 3" CONCRETE SLAB.

PORT SIZE	APPROX. A	APPROX. B
1	38 1/4	74
1 1/2	39	73 1/4
2	39	73 1/4
3	39	73 1/4

FINISH:

MATERIAL:

DIMENSIONS IN INCHES unless otherwise specified
TOLERANCES unless otherwise specified

ANGULAR	± 0°30'	DECIMAL 2 PLACES	± .017
FRACTIONAL	± 1/32	DECIMAL 3 PLACES	± .008
DECIMAL 1 PLACE	± .015	DECIMAL 4 PLACES	± .0005

	NAME	SIGN	DATE
DRAFT	JMB		[illegible]
DESIGN			
CHECK			
APPR			

Solarchem
40 WEST WILMOT ST
RICHMOND HILL
ONTARIO
L4B 1H8

TITLE: RAYOX 4×30kW REACTOR OUTLINE DETAIL

SCALE: NONE | DWG No: 000-RD-000193 | REVISION:

WA # 18-1LAS
File Copy

Metcalf & Eddy
An Air & Water Technologies Company

May 19, 1993

Mr. Robert Abernethy
Sales Engineer
Solarchem Environmental Systems
130 Royal Crest Court
Markham, Ontario, Canada L3R 0A1

Subject: **Request for Quotation on Equipment, Services and Budgetary Costs - Treatment of Contaminated Groundwater using UV/Chemical Oxidation, Rose Hill Regional Landfill Superfund Site, South Kingstown, Rhode Island**

Dear Mr. Abernethy:

Metcalf & Eddy (M&E) is currently finalizing the Feasibility Study (FS) for treatment of contaminated groundwater at the Rose Hill Landfill site. This groundwater is contaminated with weak, municipal landfill leachate. M&E has identified treatment using ultra-violet/chemical oxidation technology as the most appropriate method for removing the organic compounds-of-concern (COCs).

A quotation describing suggested equipment, services and budgetary costs should be based on the following assumptions:

1) quotations are needed for two different systems; groundwater concentrations are shown in Attachment A for the 50 gpm system (Alternative 4) and Attachment B for the 200 gpm system (Alternative 5).
2) treatment goals are listed in each attachment by compound; for the organic compounds, please identify any compounds that <u>may not meet goals</u>.
3) suspended solids and metals pretreatment system will have removed the compounds noted by asterisk prior to entering the UV/Chemical oxidation system.
4) assume a water temperature of 55 degrees F.
5) 50 gpm flowrate may be as low as 5 gpm; will your system still operate effectively ?
6) treated water discharges to recharge wells or to river.
7) identify operations and maintenance services necessary for your proposed system.
8) identify the make & model of your proposed system; please include copies of brochures, drawings and specifications.
9) assume budgetary costs accuracy for equipment, f.o.b.
10) identify any other potential pretreatment or special conditions that you feel may be necessary for proper operation.

30 Harvard Mill Square, Wakefield, MA 01880
Mailing Address: PO Box 4043 Woburn, MA 01888-4043
617 [illegible] FAX 617-245-6293

Your quotations are needed by the end-of-day Wednesday, May 26, 1993. Thank you for your assistance with this project. If you have any questions, please do not hesitate to contact me at TEL (617) 246-5200, extension 4272 or by FAX at (617) 245-6293.

Very truly yours,

METCALF & EDDY, INC.

Daniel P. Peters

Daniel P. Peters, P.E., ChE
Project Engineer,
Industrial & Hazardous Waste Division

Attachments
cc: S. Czarniecki
WA#18-1LA5

ATTACHMENT A: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	9	48		
Sulfide (mg/L)	1	4		
Aluminum	12,616	98,281	*	
Antimony	0	0	*	6
Arsenic	2	9	*	
Barium	210	695	*	
Beryllium	2	13	*	1
Cadmium	4	36	*	5
Chromium	21	136	*	100
Cobalt	21	82	*	
Copper	37	324	*	
Iron	91,571	396,140	*	
Lead	40	180	*	15
Manganese	2,633	10,361	*	3,650
Mercury	0.11	0.29	*	
Nickel	24	112	*	100
Vanadium	20	133	*	
Zinc	625	6,520	*	7,300
Dieldrin	0.043	0.003		
2-Methylnaphthalene	4	4		
4-Chloro-3-methylphenol	4	4		
4-Methylphenol	8	64		
Pentachlorophenol	12	3		1
bis(2-Ethylhexyl)phthalate	11	59		4
1,1-Dichloroethane	13	195		
1,1-Dichloroethene	4	2		
1,2-Dichloroethene(total)	30	645		70
4-Methyl-2-pentanone	5	27		
Acetone	20	415		
Benzene	10	27		5
Carbon Disulfide	13	77		
Chloroethane	16	77		
Ethylbenzene	14	64		
Toluene	31	156		
Trichloroethene	4	4		
Vinyl Chloride	30	610		2
Acrylamide	141	202		0.02 (c)
N,N-DMF	177	1,273		
Hardness (mg/L)	151	621		
pH	7.1	11.9		
Total Organic Carbon (mg/L)	44	200		
Biochemical Oxygen Demand (mg/L)	12	112		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

ATTACHMENT B: GROUNDWATER CONDITIONS FOR THE 200 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	11	30		
Sulfide (mg/L)	1	7		
Aluminum	14,277	76,745	*	
Antimony	10	46	*	6
Arsenic	2	7	*	
Barium	136	445	*	
Beryllium	2	9	*	1
Cadmium	3	25	*	5
Chromium	17	94	*	100
Cobalt	18	53	*	
Copper	47	215	*	
Iron	60,644	218,437	*	
Lead	32	154	*	15
Manganese	2,305	8,391	*	3,650
Mercury	0.10	0.22	*	
Nickel	27	93	*	100
Vanadium	20	115	*	
Zinc	348	3,135	*	7,300
Dieldrin	0.020	0.001		
2-Methylnaphthalene	3	2		
4-Chloro-3-methylphenol	2	2		
4-Methylphenol	8	56		
Pentachlorophenol	6	1		1
bis(2-Ethylhexyl)phthalate	4	21		4
1,1-Dichloroethane	7	89		
1,1-Dichloroethene	3	1		
1,2-Dichloroethene(total)	14	293		70
4-Methyl-2-pentanone	2	12		
Acetone	21	329		
Benzene	5	13		5
Carbon Disulfide	11	57		
Chloroethane	8	37		
Ethylbenzene	7	29		
Toluene	21	121		
Trichloroethene	2	2		
Vinyl Chloride	14	276		2
Acrylamide	64	92		0.02 (c)
N,N-DMF	84	600		
Hardness (mg/L)	86	330		
pH	6.9	9.8		
Total Organic Carbon (mg/L)	28	125		
Biochemical Oxygen Demand (mg/L)	7	58		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

- UV/Chemical Oxidation Quotation: Peroxidation Systems
  50 gpm System
  200 gpm System
  M&E Quotation Request

May 26, 1993

Mr. Daniel P. Peters, P.E., ChE
Metcalf & Eddy
30 Harvard Mill Square, Box 4043
Woburn, MA 01888-4043

RE: **perox-pure™** Treatment Estimate for Contaminated Groundwater from the Rose Hill Regional Landfill Superfund Site in South Kingston, Rhode Island
Proposal #NAO-93071-16484-PN01

Dear Mr. Peters:

Thank you for your interest in the **perox-pure™** Process. As requested, we have prepared this preliminary estimate for **perox-pure™** Process treatment of the water described in Attachments A & B. The figures quoted are preliminary only and are subject to change.

perox-pure™ SYSTEM

Peroxidation System Inc's **perox-pure™** system is a complete skid mounted ultraviolet (UV), hydrogen peroxide (H_2O_2) system with all required controls. Only a minimal foundation with containment dike, electrical and plumbing connections are necessary. Over 80 systems are in use in North America and Europe. Many of our customers use the **perox-pure™** Process at multiple plant locations.

The unique difference between the **perox-pure™** organic destruction process and other systems is its ability to actually destroy organics to non-detectable levels, thus eliminating the generation of by-product wastes or air discharges to handle or treat.

In contrast to treatment by liquid phase activated carbon, **perox-pure™** doesn't require solids handling, transport and potential liability. Compared to the complexities of air stripping with vapor phase treatment **perox-pure™** is simple, straight forward and doesn't require an air permit or vapor monitoring.

If circumstances dictate the desirability of using the **perox-pure™** Process along with other technologies, we are prepared to offer the total system.

INVESTMENT AND OPERATING COSTS

The **perox-pure™** treatment system estimated to treat the anticipated flow and organic loading is presented below.

	Case A	Case B
Equipment Capital Investment	$200-250,000	$600-675,000
Installation/Start-up	$8,500	$12,500
Maintenance Parts (est. @ 8% of Capital)	$18,000/yr.	$51,000/yr.
Hydrogen Peroxide (est. @ $0.65/lb. 50%)	$12,300/yr.	$31,300/yr.
Power (est. @ $0.06/kWh)	$70,900/yr.	$283,600/yr.

Peroxidation Systems Inc.
5151 E. Broadway, Suite 600 Tucson, Arizona 85711 602-790-8383 FAX 602-790-8008

Please note this preliminary estimate does not include site preparation, pretreatment or post-treatment equipment, if any, freight, taxes, special permits or on-site equipment handling. Normal delivery is 12-16 weeks after receipt of order.

PROCESS ASSESSMENT

Due to the variability of treatment costs depending on the physical and chemical characteristics of the water, a more definitive estimate will require a process feasibility evaluation in our Tucson facility. For this evaluation we would need 15 gallons of water, depending on pretreatment requirements, if any. These test results would enable us to more accurately select the appropriate unit size and "firm up" our estimate. The cost for this testing is $3,500, plus analytical.

SUMMARY

The **perox-pure™** Process offers the advantages of a proven, cost-effective treatment system that creates no air emissions or generation of secondary waste products.

Your Area Sales Manager, Mr. Mike Donaway of PSI's Cranford, New Jersey office, would be happy to discuss any questions you have, as well as how to take the next step in your evaluation of **perox-pure™** technology, and can be reached at (908) 276-0044.

Thank you very much for your continued interest in our products and services!

Sincerely yours,

Norman Olson

Norman A. Olson
Applications Specialist

NAO:cw
Enclosures

cc: Mike Donaway, PSI

ATTACHMENT A: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum	PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left		
Ammonia (mg/L)	9	48	
Sulfide (mg/L)	1	4	
Aluminum	12,616	98,281	*
Antimony	0	0	* 6
Arsenic	2	9	*
Barium	210	695	*
Beryllium	2	13	* 1
Cadmium	4	36	* 5
Chromium	21	136	* 100
Cobalt	21	82	*
Copper	37	324	*
Iron	91,571	396,140	*
Lead	40	180	* 15
Manganese	2,633	10,361	* 3,650
Mercury	0.11	0.29	*
Nickel	24	112	* 100
Vanadium	20	133	*
Zinc	625	6,520	* 7,300
Dieldrin	0.043	0.003	
2-Methylnaphthalene	4	4	
4-Chloro-3-methylphenol	4	4	
4-Methylphenol	8	64	
Pentachlorophenol	12	3	1
bis(2-Ethylhexyl)phthalate	11	59	4
1,1-Dichloroethane	13	195	
1,1-Dichloroethene	4	2	
1,2-Dichloroethene(total)	30	645	70
4-Methyl-2-pentanone	5	27	
Acetone	20	415	
Benzene	10	27	5
Carbon Disulfide	13	77	
Chloroethane	16	77	
Ethylbenzene	14	64	
Toluene	31	156	
Trichloroethene	4	4	
Vinyl Chloride	30	610	2
Acrylamide	141	202	0.02 (c)
N,N-DMF	177	1,273	
Hardness (mg/L)	151	621	
pH	7.1	11.9	
Total Organic Carbon (mg/L)	44	200	
Biochemical Oxygen Demand (mg/L)	12	112	

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

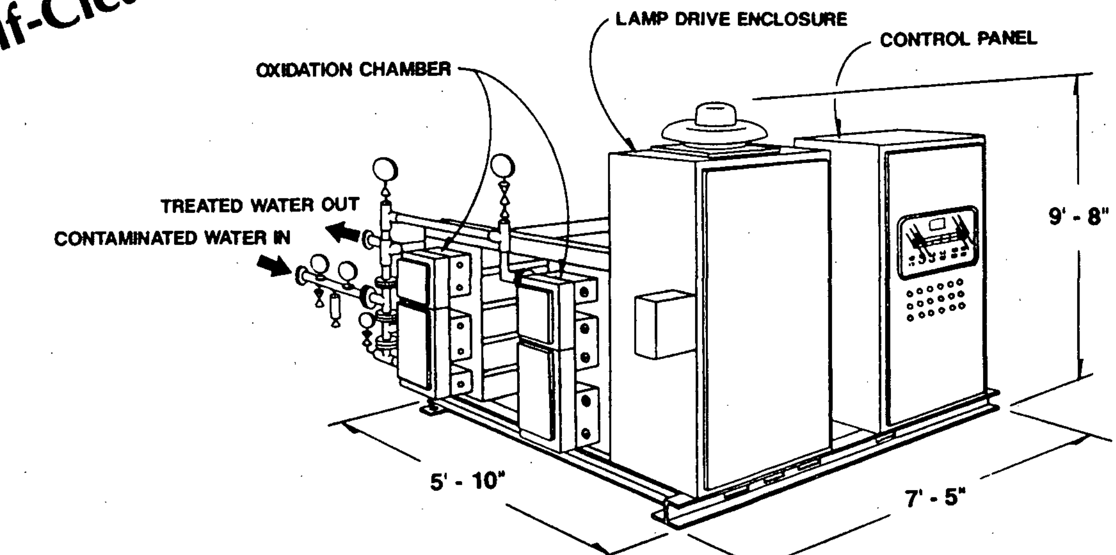
perox-pure™

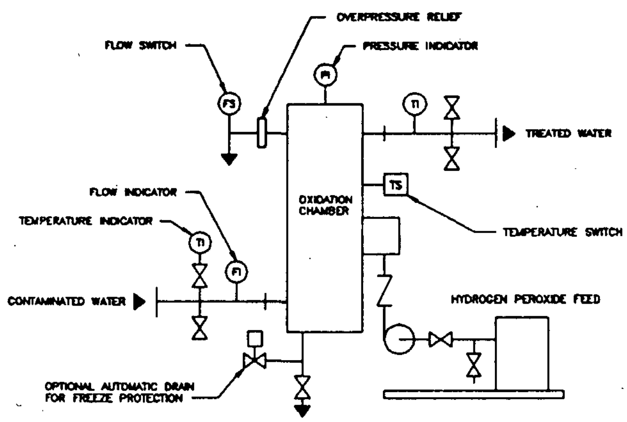
ORGANIC DESTRUCTION PROCESS

Now Self-Cleaning

MODULAR TREATMENT SYSTEM

MODEL S-135





SPECIFICATIONS	Model S-135	
Flow Rate: Maximum	200 gpm	350 gpm
Connections:	150# Flange	150# Flange
Inlet:	3"	4"
Outlet:	3"	4"
Power Supply:	3 pH/60Hz/480V, 135KW	
Electrical Encl.:	NEMA 3R	
Material - Wetted Parts:	Quartz, Fluorpolymers	
External Parts:	Enameled Steel	
Weight - Shipping:	5400 lbs.	
Operating:	6300 lbs.	

The **perox-pure**™ chemical oxidation system consists of modular, skid-mounted equipment designed to treat water contaminated by dissolved organic compounds. Bench-scale process evaluations will determine pretreatment requirements (if any) and the oxidation time necessary for the desired treatment level. Full-scale oxidation chamber volume, UV requirements and oxidant dosage are then selected.

The **perox-pure**™ system incorporates corrosion resistant fluorocarbon-lined oxidation chambers and horizontally mounted medium pressure UV lamps. Indicators are provided to monitor performance of each lamp. A sequential hydrogen peroxide addition feature provides easy process optimization for maximum economy. In addition, a patented tube cleaning device maximizes performance and minimizes maintenance time. The cleaning device is automatic and self propelled, requiring no external actuating mechanism or sliding shaft seals. Other design features include shop-wired and tested control panels interlocked with personnel and process safety features to shut-off power and display the cause at preset conditions. Installation is quick and easy.

The **perox-pure**™ system and its components are covered by numerous issued and pending patents.

Peroxidation *Systems Inc.*

5151 E. Broadway, Suite 600 Tucson, Arizona 85711 602-790-8383 FAX 602-790-

ATTACHMENT B: GROUNDWATER CONDITIONS FOR THE 200 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	11	30		
Sulfide (mg/L)	1	7		
Aluminum	14,277	76,745	*	
Antimony	10	46	*	6
Arsenic	2	7	*	
Barium	136	445	*	
Beryllium	2	9	*	1
Cadmium	3	25	*	5
Chromium	17	94	*	100
Cobalt	18	53	*	
Copper	47	215	*	
Iron	60,644	218,437	*	
Lead	32	154	*	15
Manganese	2,305	8,391	*	3,650
Mercury	0.10	0.22	*	
Nickel	27	93	*	100
Vanadium	20	115	*	
Zinc	348	3,135	*	7,300
Dieldrin	0.020	0.001		
2-Methylnaphthalene	3	2		
4-Chloro-3-methylphenol	2	2		
4-Methylphenol	8	56		
Pentachlorophenol	6	1		1
bis(2-Ethylhexyl)phthalate	4	21		4
1,1-Dichloroethane	7	89		
1,1-Dichloroethene	3	1		
1,2-Dichloroethene(total)	14	293		70
4-Methyl-2-pentanone	2	12		
Acetone	21	329		
Benzene	5	13		5
Carbon Disulfide	11	57		
Chloroethane	8	37		
Ethylbenzene	7	29		
Toluene	21	121		
Trichloroethene	2	2		
Vinyl Chloride	14	276		2
Acrylamide	64	92		0.02 (c)
N,N-DMF	84	600		
Hardness (mg/L)	86	330		
pH	6.9	9.8		
Total Organic Carbon (mg/L)	28	125		
Biochemical Oxygen Demand (mg/L)	7	58		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

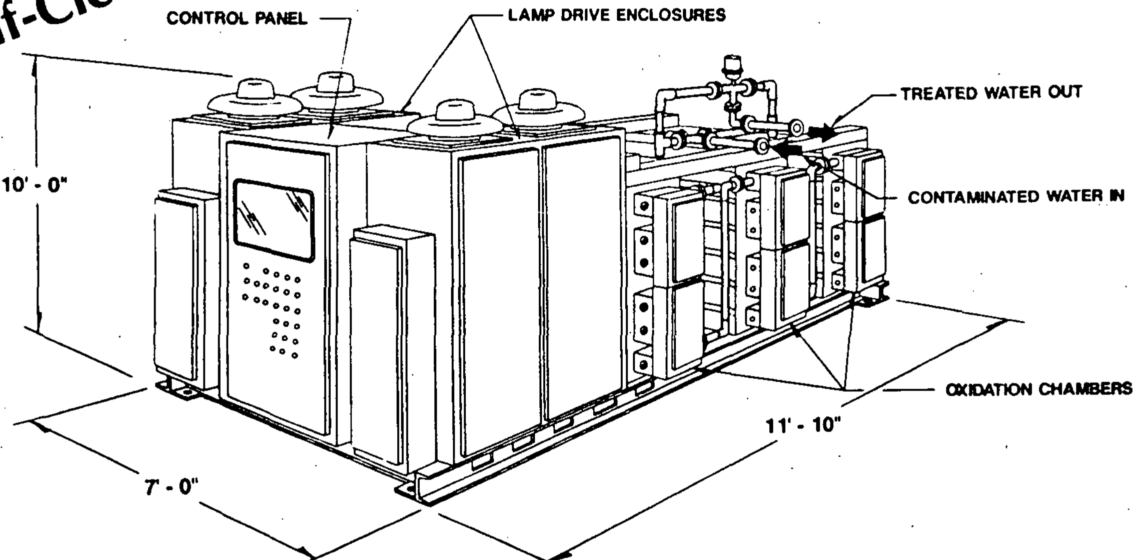
perox-pure™

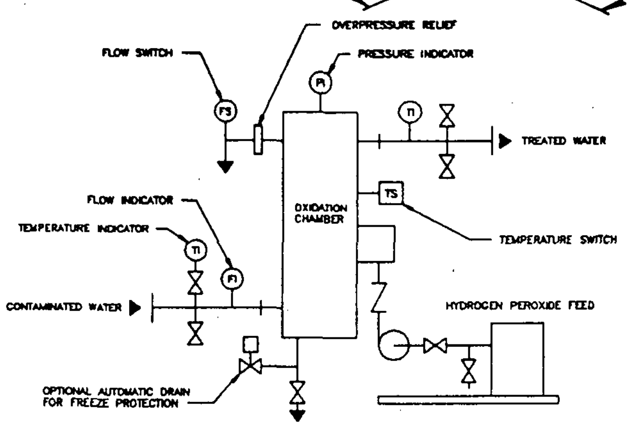
ORGANIC DESTRUCTION PROCESS

Now Self-Cleaning

MODULAR TREATMENT SYSTEM

MODEL E-540





SPECIFICATIONS	Model E-540	
Flow Rate: Maximum	200 gpm	1500 gpm
Connections:	150# Flange	150# Flange
Inlet:	3"	8"
Outlet:	3"	8"
Power Supply:	3 pH/60Hz/480V, 540KW (2 @ 270 KW)	
Electrical Encl.:	NEMA 3R	
Material - Wetted Parts:	Quartz, Fluoropolymers	
External Parts:	Enameled Steel	
Weight - Shipping:	21000 lbs.	
Operating:	23800 lbs.	

The **perox-pure™** chemical oxidation system consists of modular, skid-mounted equipment designed to treat water contaminated by dissolved organic compounds. Bench-scale process evaluations will determine pretreatment requirements (if any) and the oxidation time necessary for the desired treatment level. Full-scale oxidation chamber volume, UV requirements and oxidant dosage are then selected.

The **perox-pure™** system incorporates corrosion resistant fluorocarbon-lined oxidation chambers and horizontally mounted medium pressure UV lamps. Indicators are provided to monitor performance of each lamp. *A sequential hydrogen peroxide addition feature provides easy* process optimization for maximum economy. In addition, a patented tube cleaning device maximizes performance and minimizes maintenance time. The cleaning device is automatic and self propelled, requiring no external actuating mechanism or sliding shaft seals. Other design features include shop-wired and tested control panels interlocked with personnel and process safety features to shut-off power and display the cause at preset conditions. Installation is quick and easy.

The **perox-pure™** system and its components are covered by numerous issued and pending patents.

Peroxidation Systems Inc.

[illegible] 85711 602-790-8383 FAX 602-790-8008

WA # 18 - 1LAS
File Copy

M&E Metcalf & Eddy

An Air & Water Technologies Company

May 19, 1993

Mr. Norman A. Olson
Application Specialist
Peroxidation Systems, Inc.
5151 East Broadway, Suite 600
Tucson, AZ 85711

Subject: **Request for Quotation on Equipment, Services and Budgetary Costs - Treatment of Contaminated Groundwater using UV/Chemical Oxidation, Rose Hill Regional Landfill Superfund Site, South Kingstown, Rhode Island**

Dear Mr. Olson:

Metcalf & Eddy (M&E) is currently finalizing the Feasibility Study (FS) for treatment of contaminated groundwater at the Rose Hill Landfill site. This groundwater is contaminated with weak, municipal landfill leachate. M&E has identified treatment using ultra-violet/chemical oxidation technology as the most appropriate method for removing the organic compounds-of-concern (COCs).

A quotation describing suggested equipment, services and budgetary costs should be based on the following assumptions:

1) quotations are needed for two different systems; groundwater concentrations are shown in Attachment A for the 50 gpm system (Alternative 4) and Attachment B for the 200 gpm system (Alternative 5).
2) treatment goals are listed in each attachment by compound; for the organic compounds, please identify any compounds that may not meet goals.
3) suspended solids and metals pretreatment system will have removed the compounds noted by asterisk prior to entering the UV/Chemical oxidation system.
4) assume a water temperature of 55 degrees F.
5) 50 gpm flowrate may be as low as 5 gpm; will your system still operate effectively ?
6) treated water discharges to recharge wells or to river.
7) identify operations and maintenance services necessary for your proposed system.
8) identify the make & model of your proposed system; please include copies of brochures, drawings and specifications.
9) assume budgetary costs accuracy for equipment, f.o.b.
10) identify any other potential pretreatment or special conditions that you feel may be necessary for proper operation.

30 Harvard Mill Square, Wakefield, MA 01880
Mailing Address PO Box 4043, Woburn, MA 01888-4043
617 246-5200 FAX 617-245-6293

Your quotations are needed by the end-of-day Wednesday, May 26, 1993. Thank you for your assistance with this project. If you have any questions, please do not hesitate to contact me at TEL (617) 246-5200, extension 4272 or by FAX at (617) 245-6293.

Very truly yours,

METCALF & EDDY, INC.

Daniel P. Peters

Daniel P. Peters, P.E., ChE
Project Engineer,
Industrial & Hazardous Waste Division

Attachments
cc: S. Czarniecki
WA#18-1LA5

ATTACHMENT A: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	9	48		
Sulfide (mg/L)	1	4		
Aluminum	12,616	98,281	*	
Antimony	0	0	*	6
Arsenic	2	9	*	
Barium	210	695	*	
Beryllium	2	13	*	1
Cadmium	4	36	*	5
Chromium	21	136	*	100
Cobalt	21	82	*	
Copper	37	324	*	
Iron	91,571	396,140	*	
Lead	40	180	*	15
Manganese	2,633	10,361	*	3,650
Mercury	0.11	0.29	*	
Nickel	24	112	*	100
Vanadium	20	133	*	
Zinc	625	6,520	*	7,300
Dieldrin	0.043	0.003		
2-Methylnaphthalene	4	4		
4-Chloro-3-methylphenol	4	4		
4-Methylphenol	8	64		
Pentachlorophenol	12	3		1
bis(2-Ethylhexyl)phthalate	11	59		4
1,1-Dichloroethane	13	195		
1,1-Dichloroethene	4	2		
1,2-Dichloroethene(total)	30	645		70
4-Methyl-2-pentanone	5	27		
Acetone	20	415		
Benzene	10	27		5
Carbon Disulfide	13	77		
Chloroethane	16	77		
Ethylbenzene	14	64		
Toluene	31	156		
Trichloroethene	4	4		
Vinyl Chloride	30	610		2
Acrylamide	141	202		0.02 (c)
N,N-DMF	177	1,273		
Hardness (mg/L)	151	621		
pH	7.1	11.9		
Total Organic Carbon (mg/L)	44	200		
Biochemical Oxygen Demand (mg/L)	12	112		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

ATTACHMENT B: GROUNDWATER CONDITIONS FOR THE 200 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (μg/L) except where noted at left			
Ammonia (mg/L)	11	30		
Sulfide (mg/L)	1	7		
Aluminum	14,277	76,745	*	
Antimony	10	46	*	6
Arsenic	2	7	*	
Barium	136	445	*	
Beryllium	2	9	*	1
Cadmium	3	25	*	5
Chromium	17	94	*	100
Cobalt	18	53	*	
Copper	47	215	*	
Iron	60,644	218,437	*	
Lead	32	154	*	15
Manganese	2,305	8,391	*	3,650
Mercury	0.10	0.22	*	
Nickel	27	93	*	100
Vanadium	20	115	*	
Zinc	348	3,135	*	7,300
Dieldrin	0.020	0.001		
2-Methylnaphthalene	3	2		
4-Chloro-3-methylphenol	2	2		
4-Methylphenol	8	56		
Pentachlorophenol	6	1		1
bis(2-Ethylhexyl)phthalate	4	21		4
1,1-Dichloroethane	7	89		
1,1-Dichloroethene	3	1		
1,2-Dichloroethene(total)	14	293		70
4-Methyl-2-pentanone	2	12		
Acetone	21	329		
Benzene	5	13		5
Carbon Disulfide	11	57		
Chloroethane	8	37		
Ethylbenzene	7	29		
Toluene	21	121		
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Vinyl Chloride	14	276		2
Acrylamide	64	92		0.02 (c)
N,N-DMF	84	600		
Hardness (mg/L)	86	330		
pH	6.9	9.8		
Total Organic Carbon (mg/L)	28	125		
Biochemical Oxygen Demand (mg/L)	7	58		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

- UV/Chemical Oxidation Quotation: Ultrox
  Parameters Basis
  System Components: 50 and 200 gpm
  Costs and Assumptions
  M&E Quotation Request

ULTROX

A Division of Resources Conservation Company

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

May 26, 1993

METCALF & EDDY, INC.
JUN 1 1993
RECEIVED

Mr. Daniel P. Peters, P.E., ChE
Metcalf & Eddy
30 Harvard Mill Square
Wakefield, MA 01880

Dear Mr. Peters:

Please find attached budget capital and O&M costs for the ULTROX® UV/Oxidation system estimated to meet your groundwater treatment requirements at the Rose Hill Regional Landfill Superfund Site in South Kingston, Rhode Island. Because UV/Oxidation destroys different compounds with different levels of efficiency, we are basing our estimates on experiences with similar contaminants.

With respect to your questions, I have itemized responses below:

1. Budget quotations are attached.

2. Ultrox equipment is expected to meet treatment objectives for all organic compounds where Preliminary Remediation Goals are provided.

3. Budget quotation assumes pretreatment for solids and metals are provided by others.

4. Water temperature of 55°F is assumed.

5. The Ultrox® systems quoted are capable of operation at lower flow rates. Individual banks of lamps can be turned off and ozone generators can be turned down to save on operating costs when flows are lower.

6. Systems can accommodate any discharge requirements

7. UV lamps must be replaced after one year of continuous operation. Oxidant dosage settings are checked once per day (2 minutes).

8. Makes and models of equipment are listed in attached budget quotation. Brochures are sent by mail with original. Ultrox systems are not "off the shelf" systems. Each set of drawings is a portion of a complete documentation package provided with each system. A sketch is provided as an example of a layout. A set of specifications is prepared for a full scale system proposal, but not as part of budgetary quotations.

9. Budgetary cost estimates are expected to be +/- 25%. Estimates are based on FOB Santa Ana, CA.

10. No other pretreatment is required for the Ultrox® systems.

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. Himebaugh
National Sales Manager

WSH/gkr
enc: Budget Quote & Fee Schedule

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

I. PARAMETERS

50 GPM System

PARAMETERS	CONCENTRATION (ug/l)	GOAL (ug/l)
PCP	12	1
bis(2-ethylhexyl)phthalate	11	4
1,2-DCE	30	70
Benzene	10	5
Vinyl Chloride	30	2
Acrylamide	141	0.02

200 GPM SYSTEM

PARAMETERS	CONCENTRATION (ug/l)	GOAL (ug/l)
PCP	6	1
bis(2-ethylhexyl)phthalate	4	4
1,2-DCE	14	70
Benzene	5	5
Vinyl Chloride	14	2
Acrylamide	64	0.02

II. UV/OXIDATION SYSTEM COMPONENTS

50 GPM SYSTEM

A. OXIDATION REACTOR
   1. F-1300

B. OZONE GENERATOR
   1. 21 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

200

~~50~~ GPM SYSTEM

A. OXIDATION REACTOR
   1. F-1300
   2. C-5000

B. OZONE GENERATOR
   1. 50 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. ELECTRICAL COSTS = $0.06/KWH

B. H_2O_2 COSTS = $0.70/LB

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

IV. COSTS

<u>50 GPM SYSTEM</u>

A. TOTAL BUDGET CAPITAL COST*: $ 218,000

B. TOTAL BUDGET O&M COSTS**: $0.75/1000 GALLONS

<u>200 GPM SYSTEM</u>

A. TOTAL BUDGET CAPITAL COST*: $ 333,000

B. TOTAL BUDGET O&M COSTS**: $0.34/1000 GALLONS

* Capital costs are estimated FOB Santa Ana, CA and do not include installation, start up or training. These cost calculation require detailed requirements for integrating into the remediation program.

** 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

WA # 18-1LA5
File Copy

Metcalf & Eddy

An Air & Water Technologies Company

May 19, 1993

Mr. William Heimbaugh
Manager of Marketing & Sales
Ultrox International
2435 South Ann Street
Santa Anna, CA 92714

Subject: **Request for Quotation on Equipment, Services and Budgetary Costs - Treatment of Contaminated Groundwater using UV/Chemical Oxidation, Rose Hill Regional Landfill Superfund Site, South Kingstown, Rhode Island**

Dear Mr. Heimbaugh:

Metcalf & Eddy (M&E) is currently finalizing the Feasibility Study (FS) for treatment of contaminated groundwater at the Rose Hill Landfill site. This groundwater is contaminated with weak, municipal landfill leachate. M&E has identified treatment using ultra-violet/chemical oxidation technology as the most appropriate method for removing the organic compounds-of-concern (COCs).

A quotation describing suggested equipment, services and budgetary costs should be based on the following assumptions:

1) quotations are needed for two different systems; groundwater concentrations are shown in Attachment A for the 50 gpm system (Alternative 4) and Attachment B for the 200 gpm system (Alternative 5).
2) treatment goals are listed in each attachment by compound; for the organic compounds, please identify any compounds that <u>may not meet goals</u>.
3) suspended solids and metals pretreatment system will have removed the compounds noted by asterisk prior to entering the UV/Chemical oxidation system.
4) assume a water temperature of 55 degrees F.
5) 50 gpm flowrate may be as low as 5 gpm; will your system still operate effectively ?
6) treated water discharges to recharge wells or to river.
7) identify operations and maintenance services necessary for your proposed system.
8) identify the make & model of your proposed system; please include copies of brochures, drawings and specifications.
9) assume budgetary costs accuracy for equipment, f.o.b.
10) identify any other potential pretreatment or special conditions that you feel may be necessary for proper operation.

Your quotations are needed by the end-of-day Wednesday, May 26, 1993. Thank you for your assistance with this project. If you have any questions, please do not hesitate to contact me at TEL (617) 246-5200, extension 4272 or by FAX at (617) 245-6293.

Very truly yours,

METCALF & EDDY, INC.

Daniel P. Peters

Daniel P. Peters, P.E., ChE
Project Engineer,
Industrial & Hazardous Waste Division

Attachments
cc: S. Czarniecki
WA#18-1LA5

ATTACHMENT A: GROUNDWATER CONDITIONS FOR THE 50 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b)		PRELIMINARY REMEDIATION GOAL
	Average	Maximum	
	all in (μg/L) except where noted at left		
Ammonia (mg/L)	9	48	
Sulfide (mg/L)	1	4	
Aluminum	12,616	98,281	*
Antimony	0	0	* 6
Arsenic	2	9	*
Barium	210	695	*
Beryllium	2	13	* 1
Cadmium	4	36	* 5
Chromium	21	136	* 100
Cobalt	21	82	*
Copper	37	324	*
Iron	91,571	396,140	*
Lead	40	180	* 15
Manganese	2,633	10,361	* 3,650
Mercury	0.11	0.29	*
Nickel	24	112	* 100
Vanadium	20	133	*
Zinc	625	6,520	* 7,300
Dieldrin	0.043	0.003	
2-Methylnaphthalene	4	4	
4-Chloro-3-methylphenol	4	4	
4-Methylphenol	8	64	
Pentachlorophenol	12	3	1
bis(2-Ethylhexyl)phthalate	11	59	4
1,1-Dichloroethane	13	195	
1,1-Dichloroethene	4	2	
1,2-Dichloroethene(total)	30	645	70
4-Methyl-2-pentanone	5	27	
Acetone	20	415	
Benzene	10	27	5
Carbon Disulfide	13	77	
Chloroethane	16	77	
Ethylbenzene	14	64	
Toluene	31	156	
Trichloroethene	4	4	
Vinyl Chloride	30	610	2
Acrylamide	141	202	0.02 (c)
N,N-DMF	177	1,273	
Hardness (mg/L)	151	621	
pH	7.1	11.9	
Total Organic Carbon (mg/L)	44	200	
Biochemical Oxygen Demand (mg/L)	12	112	

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

(c). Goal is significantly below normal analytical detection limits; evaluate potential to meet 2 μg/L standard assuming that this is the detection limit.

ATTACHMENT B: GROUNDWATER CONDITIONS FOR THE 200 GPM SYSTEM

ANALYTE (a)	GROUNDWATER CONCENTRATIONS (b) Average	Maximum		PRELIMINARY REMEDIATION GOAL
	all in (µg/L) except where noted at left			
Ammonia (mg/L)	11	30		
Sulfide (mg/L)	1	7		
Aluminum	14,277	76,745	*	
Antimony	10	46	*	6
Arsenic	2	7	*	
Barium	136	445	*	
Beryllium	2	9	*	1
Cadmium	3	25	*	5
Chromium	17	94	*	100
Cobalt	18	53	*	
Copper	47	215	*	
Iron	60,644	218,437	*	
Lead	32	154	*	15
Manganese	2,305	8,391	*	3,650
Mercury	0.10	0.22	*	
Nickel	27	93	*	100
Vanadium	20	115	*	
Zinc	348	3,135	*	7,300
Dieldrin	0.020	0.001		
2-Methylnaphthalene	3	2		
4-Chloro-3-methylphenol	2	2		
4-Methylphenol	8	56		
Pentachlorophenol	6	1		1
bis(2-Ethylhexyl)phthalate	4	21		4
1,1-Dichloroethane	7	89		
1,1-Dichloroethene	3	1		
1,2-Dichloroethene(total)	14	293		70
4-Methyl-2-pentanone	2	12		
Acetone	21	329		
Benzene	5	13		5
Carbon Disulfide	11	57		
Chloroethane	8	37		
Ethylbenzene	7	29		
Toluene	21	121		
Trichloroethene	2	2		
Vinyl Chloride	14	276		2
Acrylamide	64	92		0.02 (c)
N,N-DMF	84	600		
Hardness (mg/L)	86	330		
pH	6.9	9.8		
Total Organic Carbon (mg/L)	28	125		
Biochemical Oxygen Demand (mg/L)	7	58		

Notes:

(a). Asterisk denotes compounds that will be handled by the metals treatment system.

(b). Concentrations for metals are "total" and not dissolved values.

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D-5 Point of Use System

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-10

DATE: 5/18/93

SUBJECT: Rose Hill FS Home RO units

M&E ENGINEER: S. Czarniecki

OUTSIDE PARTY: Mark Goldstein
Osmonics 413 567-6660
Engineering Products Services - District Mngr.

MADE CALL ( )

REC'D CALL (X)

COMMENTS

SUMMARY OF CONVERSATION:

He manufactures the membranes for the home RO units, but doesn't sell the systems. He'll send me a list of distributors.

Generally, you'll see 3 filter housings; a sediment filter, a carbon filter, and a second carbon filter to ensure all chlorine is out (which would hurt the membrane). The RO filter is across the top of those 3 housings and there is a bladder tank on the side which is connected to the faucet. The system may cost ~$1000 and produce 20-30 gal/day.

He'll take a look at the parameters I fax to him (413-567-6720) and let me know if he sees any problems.

CC:

M&E FORM NO. 196 (9/78)

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. ____________ DATE: 9/12/96

SUBJECT: Rose Hill - Point-of-Use Treatment Systems Equipment + Installation Costs

M&E ENGINEER: N. Bergeron OUTSIDE PARTY: Jeff Ford

MADE CALL (X) (508) 462-6938

REC'D CALL ( )

COMMENTS	SUMMARY OF CONVERSATION:
	Discussed point-of-use treatment systems with Jeff. Budget estimate of capital cost for each unit (media filtration followed by activated carbon) based on a house with 4 to 5 residents: $2,000. Estimate for installation: $500.

CC:

M&E FORM NO. 196 (9/78)

Table D-4: Groundwater Conditions for Residential Systems

ANALYTE	GROUNDWATER CONCENTRATIONS[a]	
	Average	Maximum
	all in (μg/L) except where noted at left	
Sulfide (mg/L)	1.6	3.8
Aluminum	74.6	552
Antimony	6.17	14.05
Arsenic	1	2
Barium	6.81	44.3
Calcium	8,430	23,400
Copper	13	78
Iron	5,300	81,000
Lead	2	7
Magnesium	1,760	4,580
Manganese	790	3,100
Mercury	0.11	0.46
Nickel	6.47	10.5
Potassium	1,170	7,470
Sodium	42,400	891,000
Zinc	13.0	165
Dieldrin	0.05	0.06
Endrin Aldehyde	0.05	0.1
Endrin Ketone	0.05	0.1
4-Methylphenol	7.9	63
1,1-Dichloroethane	0.74	3.1
Acetone	3	5
Benzene	0.59	2.5
Bromodichloromethane	0.64	2.5
Carbon Disulfide	1.3	12
Chloroethane	0.7	5
Ethylbenzene	0.60	2.5
Toluene	0.73	4.1
Trichloroethene	0.6	2
o-Xylene	0.5	0.8
trans-1,2-Dichloroethene	0.5	0.5
N,N-DMF	23	25
Biochemical Oxygen Demand (mg/L)	2.1	22
Hardness (mg/L)	33.12	67.45
Total Organic Carbon (mg/L)	3.37	17.7
pH	6.6	8.3

Notes:

[a] Concentrations are based only on detections found during residential RI sampling (M&E, 1994). Values used for non-detected analytes are one-half the detection limit. Concentrations for metals are "total" and not dissolved values.

D-6 Sludge Volume Evaluation

TABLE D-5: SLUDGE VOLUME FROM PRECIPITATION - 5 gpm

ITEM	DESCRIPTION/ EQUATION	VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
PURPOSE:	Worksheet calculates hydroxide sludge production for selected metals. Thickener and filter press sizing are also included.		Developed by: Checked by:	S. Czarniecki N. Bergeron	*Version:* *Jun-16-93* *Sep-6-96*
REFERENCES:	Metcalf & Eddy, Inc., Wastewater Engineering – Treatment, Disposal, and Reuse, 3rd Edition, McGraw-Hill, Inc., New York, NY, 1991.	U.S. Filter, Inc., Warrendale, PA; Conceptual Process Design for Metals Treatment, May 10, 1993.			
PROCEDURE FOR USE:	1)Input metals, hydroxides and their respective molar masses. 2)Input feed concentrations. 3)If necessary, change assumed specific gravities for sludge and solids for the thickener and filter press, respectively.	4) If necessary, change assumed solids percentages for the thickener and filter press.			
ASSUMPTIONS:	1)Excess waters are not attached to hydroxides unless the user includes them both in formula and molar mass.	2) Various assumptions stated below.			

TABLE D-5: SLUDGE VOLUME FROM PRECIPITATION - 5 gpm

ITEM	DESCRIPTION/ EQUATION		VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
A. INPUT VARIABLES:						
1. Molar Mass of Metals in Feed Stream						
MET1	Major metal ions which will be removed by precipitation, plus TSS, which creates conservative value.	Al	27	mg/mol	27	lb/lbmol
MET2		Fe	56	mg/mol	56	lb/lbmol
MET3		Mn	55	mg/mol	55	lb/lbmol
MET4		TSS	--	mg/mol	--	lb/lbmol
2. Molar Mass of Hydroxides Formed						
HYD1	Hydroxides formed in precipitation process. TSS does not form hydroxide.	Al(OH)3	78	mg/mol	78	lb/lbmol
HYD2		Fe(OH)3	107	mg/mol	107	lb/lbmol
HYD3		Mn(OH)2	89	mg/mol	89	lb/lbmol
HYD4		TSS	--	mg/mol	--	lb/lbmol
3. Concentrations of Metals in Feed Stream						
CONC1	For MET1		2.1	mg/L	1.75E-05	lb/gal
CONC2	For MET2		287	mg/L	2.40E-03	lb/gal
CONC3	For MET3		8.2	mg/L	6.84E-05	lb/gal
CONC4	For MET4: TSS value assumed in this case since it was not analyzed for. Assumed 100 mg/L plus half of Fe concentration (U.S. Filter).		244	mg/L	2.04E-03	lb/gal
4. Feed Stream Flow Rate						
FLOW	Input flow rate of feed stream.		18.93	L/min	5	gal/min

TABLE D-5: SLUDGE VOLUME FROM PRECIPITATION - 5 gpm

ITEM	DESCRIPTION/ EQUATION	VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
B. OUTPUT QUANTITIES: 1. Sludge Mass: SM	= [CONC1 * (HYD1/MET1)]+[CONC2 * (HYD2/MET2)]+...+[CONCn] where CONCn is the TSS concentration	811.71	mg/L solids	6.77E-03	lb/gal solids
2. Sludge Mass Per Day: SMPD	= SM * FLOW * 60 min/hr * 24 hr/day	2.21E+07	mg/day solids	48.77	lb/day solids
C. THICKENER SIZING: 1. Sludge sp. gr. SLSG	Assumed value from M&E, 1991, p773 - range 1.005-1.05 - and assumption from U.S. Filter	1.03		1.03	
2. Sludge Dry Solids Fraction SLDSF	Percentage assumed - U.S. Filter	3.00%		3.00%	
3. Sludge Volume Per Day SLVPD	= SMPD / SLDSF / (SLSG * refden) where refden is either 8.34 lbs/gal or 1E+6 mg/L	715.99	L/day @ SLDSF dry solids	189.26	gal/day @ SLDSF dry solids

TABLE D-5: SLUDGE VOLUME FROM PRECIPITATION - 5 gpm

ITEM	DESCRIPTION/ EQUATION	VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
D. FILTER PRESS SIZING:					
1. Sludge Solids sp. gr. SLSSG	Assumed value from M&E, 1991, p868 - range 1.2-2.2 - and assumption from U.S. Filter	1.3		1.3	
2. Filter Cake Solids Fraction FCSF	Percentage assumed - U.S. Filter	30.00%		30.00%	
3. Filter Cake Volume Per Day FCVPD	= SMPD / FCSF / (SLSSG * refden2) where refden2 is either 62.43 lbs/ft^3 or 1E+9 mg/m^3	0.06	m^3/day @ FCSF solids	2.00	ft^3/day @ FCSF solids

TABLE D-6: SLUDGE VOLUME FROM PRECIPITATION - 50 gpm

ITEM	DESCRIPTION/ EQUATION	VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
PURPOSE:	Worksheet calculates hydroxide sludge production for selected metals. Thickener and filter press sizing are also included.	Developed by: Checked by:		S. Czarniecki C. McLane	*Version: Jun-16-93* *July-13-93*
REFERENCES:	Metcalf & Eddy, Inc., Wastewater Engineering – Treatment, Disposal, and Reuse, 3rd Edition, McGraw-Hill, Inc., New York, NY, 1991.	U.S. Filter, Inc., Warrendale, PA; Conceptual Process Design for Metals Treatment, May 10, 1993.			
PROCEDURE FOR USE:	1) Input metals, hydroxides and their respective molar masses. 2) Input feed concentrations. 3) If necessary, change assumed specific gravities for sludge and solids for the thickener and filter press, respectively.	4) If necessary, change assumed solids percentages for the thickener and filter press.			
ASSUMPTIONS:	1) Excess waters are not attached to hydroxides unless the user includes them both in formula and molar mass.	2) Various assumptions stated below.			

TABLE D-6: SLUDGE VOLUME FROM PRECIPITATION - 50 gpm

ITEM	DESCRIPTION/ EQUATION		VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
A. INPUT VARIABLES:						
1. Molar Mass of Metals in Feed Stream						
MET1	Major metal ions which will be removed by precipitation, plus TSS, which creates conservative value.	Al	27	mg/mol	27	lb/lbmol
MET2		Fe	56	mg/mol	56	lb/lbmol
MET3		Mn	55	mg/mol	55	lb/lbmol
MET4		TSS	--	mg/mol	--	lb/lbmol
2. Molar Mass of Hydroxides Formed						
HYD1	Hydroxides formed in precipitation process. TSS does not form hydroxide.	Al(OH)3	78	mg/mol	78	lb/lbmol
HYD2		Fe(OH)3	107	mg/mol	107	lb/lbmol
HYD3		Mn(OH)2	89	mg/mol	89	lb/lbmol
HYD4		TSS	--	mg/mol	--	lb/lbmol
3. Concentrations of Metals in Feed Stream						
CONC1	For MET1		12.6	mg/L	1.05E-04	lb/gal
CONC2	For MET2		91.6	mg/L	7.64E-04	lb/gal
CONC3	For MET3		2.6	mg/L	2.17E-05	lb/gal
CONC4	For MET4: TSS value assumed in this case since it was not analyzed for. Assumed 100 mg/L plus half of Fe concentration (U.S. Filter).		146	mg/L	1.22E-03	lb/gal
4. Feed Stream Flow Rate						
FLOW	Input flow rate of feed stream.		189.28	L/min	50	gal/min

TABLE D-6: SLUDGE VOLUME FROM PRECIPITATION - 50 gpm

ITEM	DESCRIPTION/ EQUATION	VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
B. OUTPUT QUANTITIES: 1. Sludge Mass: SM	= [CONC1 * (HYD1/MET1)]+[CONC2 * (HYD2/MET2)]+...+[CONCn] where CONCn is the TSS concentration	361.63	mg/L solids	3.02E-03	lb/gal solids
2. Sludge Mass Per Day: SMPD	= SM * FLOW * 60 min/hr * 24 hr/day	9.86E+07	mg/day solids	217.30	lb/day solids
C. THICKENER SIZING: 1. Sludge sp. gr. SLSG	Assumed value from M&E, 1991, p773 - range 1.005-1.05 - and assumption from U.S. Filter	1.03		1.03	
2. Sludge Dry Solids Fraction SLDSF	Percentage assumed - U.S. Filter	3.00%		3.00%	
3. Sludge Volume Per Day SLVPD	= SMPD / SLDSF / (SLSG * refden) where refden is either 8.34 lbs/gal or 1E+6 mg/L	3189.85	L/day @ SLDSF dry solids	843.20	gal/day @ SLDSF dry solids

TABLE D-6: SLUDGE VOLUME FROM PRECIPITATION - 50 gpm

ITEM	DESCRIPTION/ EQUATION	VALUE	SI UNITS	EQUIVALENT VALUE	U.S. UNITS
D. FILTER PRESS SIZING:					
1. Sludge Solids sp. gr. SLSSG	Assumed value from M&E, 1991, p868 - range 1.2-2.2 - and assumption from U.S. Filter	1.3		1.3	
2. Filter Cake Solids Fraction FCSF	Percentage assumed - U.S. Filter	30.00%		30.00%	
3. Filter Cake Volume Per Day FCVPD	= SMPD / FCSF / (SLSSG * refden2) where refden2 is either 62.43 lbs/ft^3 or 1E+9 mg/m^3	0.25	m^3/day @ FCSF solids	8.92	ft^3/day @ FCSF solids

D-7 Development of Disposal Costs

Project	Rose Hill FS	Acct. No.	4609-18-10-10	Page	1 of 1
Subject	Sludge Calcs	Comptd. By	S. Czarniecki	Date	6/15/93
Detail	Disposal Costs	Ck'd. By	C. McLane	Date	7/13/93

200 gpm

28.7 ft^3/day filter cake - say 30 ft^3/day

solids sp. gr. = 1.3

30 ft^3/day (1.3)(62.43 lb/ft^3) = 2435 lb/day

50 gpm

8.9 ft^3/day filter cake - say 9 ft^3/day

9 (1.3)(62.43) = 730 lb/day

Assuming $200/ton (See U.S. Filter Proposal)

200 gpm $200/2000 lb × 2435 lb/day = $243.50/day × day/288 (1000 gal) = $0.84/1000 gal

50 gpm " × 730 lb/day = $73/day × day/72 (1000 gal) = $1.01/1000 gal

D-8 Development of Chemical Requirements for Precipitation

Project Rose Hill FS | Acct. No. 460T-18-10-10 | Page 1 of 1
Subject GW/Leachate Treatment | Comptd. By S Czarniecki | Date 6/15/93
Detail Chemical Requirements/Elec. | Ck'd. By C. McLane | Date 7/13/93

50 gpm - 72000 gal/day   200 gpm - 288000 gal/day

From US Filter Proposal:

Caustic
50 gpm: $300/2000 lbs × 300 lbs/day = $45/day × day/72(1000 gal) = $0.63/1000 gal ✓
200 gpm (Use as check): $300/2000 lbs × 1200 lbs/day = $180/day × day/288(1000 gal) = $0.63/1000 gal ✓

Sulfuric Acid
50 gpm: $75/2000 lbs × 480 lbs/day = $18/day × day/72(1000 gal) = $0.25/1000 gal

Ferrous Sulfate
50 gpm: $160/2000 lbs × 315 lbs/day = $25.20/day × day/72(1000 gal) = $0.35/1000 gal ✓

Polymer
50 gpm: $5.75/lb × 0.6 lb/day = $3.45/day × day/72(1000 gal) = $0.05/1000 gal ✓

Sodium Sulfide
50 gpm: $29/100 lbs × 7.5 lbs/day = $2.18/day × day/72(1000 gal) = $0.03/1000 gal

Sorption Filter Media
50 gpm: $3.50/lb × 6 lbs/day = $21/day × day/72(1000 gal) = $0.29/1000 gal ✓

Total = $1.60/1000 gal

Electricity assume usage is per day
50 gpm - 40 Kw-H/day × $0.07/Kwhr (assumed) = $2.80/day × day/72(1000 gal) = $0.04/1000 gal
200 gpm 100 Kw-H/day × $0.07/Kwhr = $7/day × day/288(1000 gal) = $0.02/1000 gal

NONREPRODUCIBLE GRID FORM 145
METCALF & EDDY, ENGINEERS

Appendix E

Appendix E

E. LANDFILL GAS COLLECTION AND TREATMENT

E-1 Landfill Gas Generation Rate Calculation: Scholl Canyon Model
E-2 Perimeter Gas Flowrate Calculations: Johnson Equation
E-3 Gas Composition Calculations
E-4 Enclosed Landfill Gas Flare Calculations
- Vendor Quotation: John Zink Company
- Auxiliary Fuel Requirements

E-5 Additional Landfill Gas Collection System Calculations - Draft FS
E-6 Photocatalytic Oxidation Calculations

E-1 Landfill Gas Generation Rate Calculation: Scholl Canyon Model

ROSE HILL SOLID WASTE LANDFILL
GAS GENERATION RATE CALCULATION
METHOD 1: SCHOLL CANYON FIRST ORDER KINETIC MODEL

VERSION: AUG-08-96
Checked by: Sean Czarniecki 08/26/96

FORMULA:

$$Q = 2 \bullet [k \bullet L \bullet R\,[\exp(-k \bullet (t - lag))]]$$

[Source: Methane Generation & Recovery from Landfills. Emcon Associates. 1982]

Incorporates: New Stationary Source Performance Standards for Municipal Solid Waste LFs FR 9905, Vol. 61, No. 49, March 12, 1996
(Formula is multiplied by 2 since it is for methane generation and CH_4 is assumed to be 50% of LFG)

WHERE:

Q = landfill gas generation rate @ time t (ft^3 LFG / yr)
L = potential methane gas generation capacity of refuse (ft^3 CH_4 / ton)
R = annual refuse acceptance rate in landfill (tons)
k = methane production rate (1 / yr)
t = time since refuse placement (yr)
lag = time to reach conditions suitable for methane production (yr)

INPUT PARAMETERS:

L =	5,447	Year closed =	1982		tons MSW
k =	0.05	Current year =	1996	Avg. refuse 1967–1970:	18,667
lag =	2	Time since closure =	14	Avg. refuse 1971–1975:	10,889
				Avg. refuse 1976–1977:	24,000
				Avg. refuse 1978–1982:	20,400

L and k are EPA default values.

Total MSW disposed (tons) 279,113
Total MSW disposed (Mg) 253,164

YEAR	TIME SINCE REFUSE PLACEMENT	GENERATION RATE 1996
1968	28	2.77E+06
1969	27	2.91E+06
1970	26	3.06E+06
1971	25	1.88E+06
1972	24	1.97E+06
1973	23	2.08E+06
1974	22	2.18E+06
1975	21	2.29E+06
1976	20	5.32E+06
1977	19	5.59E+06
1978	18	4.99E+06
1979	17	5.25E+06
1980	16	5.52E+06
1981	15	5.80E+06
1982	14	6.10E+06
1983	–	0.00E+00
1984	–	0.00E+00
1985	–	0.00E+00
1986	–	0.00E+00
1987	–	0.00E+00
1988	–	0.00E+00
1989	–	0.00E+00
1990	–	0.00E+00
1991	–	0.00E+00
1992	–	0.00E+00
1993	–	0.00E+00
TOTAL	**1996 LF GAS PRODUCTION**	5.77E+07 ft^3 LFG / yr
		5.18E+04 cm^3 LFG / s

This area determines the contribution towards the 1996 LFG generation rate. No refuse was placed after 1982, so there is no contribution from waste placed after that date.

ROSE HILL SOLID WASTE LANDFILL
GAS GENERATION RATE CALCULATION
METHOD 1: SCHOLL CANYON FIRST ORDER KINETIC MODEL (continued)

TOTAL ANNUAL LFG PRODUCTION OVER TIME: ESTIMATED PROJECTIONS

Year	Estimated Annual LFG Production (ft^3 / yr)	Time Since Landfill Closure (years)
1996	5.77E+07	14
1997	5.49E+07	15
1998	5.22E+07	16
1999	4.97E+07	17
2000	4.73E+07	18
2001	4.49E+07	19
2002	4.28E+07	20
2003	4.07E+07	21
2004	3.87E+07	22
2005	3.68E+07	23
2006	3.50E+07	24
2007	3.33E+07	25
2008	3.17E+07	26
2009	3.01E+07	27
2010	2.87E+07	28
2011	2.73E+07	29
2012	2.59E+07	30

E-2 Perimeter Gas Flowrate Calculations: Johnson Equation

ROSE HILL SOLID WASTE AREA
LANDFILL GAS VOLUMETRIC FLOWRATE CALCULATION

Purpose:	This spreadsheet calculates landfill gas flowrates collected from extraction wells under vacuum using the Johnson equation for steady flow in a confined vadose zone.	Developed by:	K. Campbell	Run Date:	08/16/96
		Checked by:	S. Czarniecki	Date:	08/23/96

The Johnson equation is shown below and in Attachment A, copied from *A Practical Approach to the Design, Operation, and Monitoring of In Situ Soil–Venting Systems*, Groundwater Monitoring Review, Johnson et al., Spring 1990.

$$\text{Flowrate } (cm^3/s) = \pi * K_g/\mu_g * P_w * [(1-(P_{atm}/P_w)^2)/\ln(R_w/R_I)]$$

INPUT PARAMETERS:

Air Viscosity, μ_a =	1.75E−04 g/cm•s	0°C [Bennett & Meyers, 1982, App. 9 – Attached]
Landfill Gas Viscosity, μ_{lfg} =	1.18E−04 g/cm•s	0°C Avg. of CH_4 & CO_2 [Bennett & Meyers, 1982]
Mix Fraction Air, X_a =	0.8	Assumed
Mix Fraction Landfill Gas, X_{lfg} =	0.2	$1 - X_a$
Mixed Gas Viscosity, μ_g =	1.63E−04 g/cm•s	$\mu_a * X_a + \mu_{lfg} * X_{lfg}$
Soil Hydraulic Conductivity, K =	5.80E−03 cm/s	Sand [USEPA, 1994, p.30]
Water Viscosity, μ_w =	1.307E−02 g/cm•s	@ 10°C [CRC 68th, p. F−39]
Water Density, rho_w =	9.997E−01 g/cm^3	@ 10°C [CRC 68th, p. F−10]
Gravitational Acceleration, Ag =	9.81E+02 cm/s^2	
Vent Well Diameter, d =	15.24 cm	6 in. diameter
Depth to Confining Layer, b =	661 cm	22 ft. avg. well depth (btw. 20−25 ft.)
Atmospheric Pressure, P_{atm} =	1.01E+06 g/cm•s^2	
Linear Distance Along rose Hill Road, m =	540 m	Estimate from maps

CALCULATION:

Hydraulic Intrinsic Permeability, K_i = (Soil Gas Permeability, K_g)	7.733E−08 cm^2	$K \cdot \mu_w / rho_w \cdot Ag$ [Fetter, 1988, p.78]

INDIVIDUAL WELL FLOWRATE TO ESTABLISH RADIUS OF INFLUENCE

VACUUM APPLIED AT WELL		RADIUS OF INFLUENCE, R						
(in. water)	(cm water)	304 cm 10 ft	608 cm 20 ft	912 cm 30 ft	1,216 cm 40 ft	1,520 cm 50 ft	1,824 cm 60 ft	3,048 cm 100 ft
		(cm^3/s)						
4	10.2	5,357	4,509	4,127	3,893	3,729	3,605	3,296
5	12.7	6,678	5,621	5,145	4,853	4,648	4,494	4,108
10	25.4	13,440	11,313	10,354	9,767	9,356	9,044	8,269
15	38.1	20,291	17,080	15,632	14,746	14,124	13,654	12,484
17	44.0	23,505	19,785	18,108	17,081	16,361	15,817	14,461
20	50.8	27,233	22,923	20,981	19,791	18,957	18,326	16,755
25	63.5	34,271	28,847	26,402	24,905	23,856	23,062	21,085

FLOWRATE OF SYSTEM

VACUUM APPLIED AT WELL		TOTAL NUMBER OF WELLS BASED ON RADIUS OF INFLUENCE ABOVE						
(in. water)	(cm water)	103	52	35	26	21	18	11
		(cm^3/s)						
5	12.7	6.88E+05	2.92E+05	1.80E+05	1.26E+05	9.76E+04	8.09E+04	4.52E+04
10	25.4	1.38E+06	5.88E+05	3.62E+05	2.54E+05	1.96E+05	1.63E+05	9.10E+04
15	38.1	2.09E+06	8.88E+05	5.47E+05	3.83E+05	2.97E+05	2.46E+05	1.37E+05
17	44.0	2.42E+06	1.03E+06	6.34E+05	4.44E+05	3.44E+05	2.85E+05	1.59E+05
20	50.8	2.81E+06	1.19E+06	7.34E+05	5.15E+05	3.98E+05	3.30E+05	1.84E+05
25	63.5	3.53E+06	1.50E+06	9.24E+05	6.48E+05	5.01E+05	4.15E+05	2.32E+05

Notes:

Flowrate of 3.83E+05 chosen because a 40 ft radius of influence and 38.1 cm (15 in) water vacuum is sufficient to prevent landfill gas migration beyon collection system. A total of 26 perimeter extraction wells would be required for a 40 ft radius of influence.

tures accidentally released to the environment. There are more sophisticated equations for predicting vapor concentrations in soil systems based on equilibrium partitioning arguments, but these require more detailed information (organic carbon content, soil moisture) than is normally available. If a site is chosen for remediation, the residual total hydrocarbons in soil typically exceed 500 mg/kg. In this residual concentration range most of the hydrocarbons will be present as a separate or "free" phase, the contaminant vapor concentrations become independent of residual concentration (but still depend on composition), and Equation 1 is applicable (Johnson et al. 1988). In any case, it should be noted that these are estimates only for vapor concentrations at the start of venting, which is when the removal rates are generally greatest. Contaminant concentrations in the extracted vapors will decline with time due to changes in composition, residual levels, or increased diffusional resistances. These topics will be discussed in more detail.

Under Ideal Vapor Flow Conditions (i.e., 100 – 1000 scfm Vapor Flow Rates), Is This Concentration Great Enough to Yield Acceptable Removal Rates?

Question 2 is answered by multiplying the concentration estimate C_{est}, by a range of reasonable flow rates, Q:

$$R_{est} = C_{est}\, Q \qquad (2)$$

Here R_{est} denotes the estimated removal rate, and C_{est} and Q must be expressed in consistent units. For reference, documented venting operations at service station sites typically report vapor flow rates in the 10 – 100 scfm range (Hutzler et al. 1988), although 100 – 1000 scfm flow rates are achievable for sandy soils or large numbers of extraction wells. At this point in the decision process what is still being neglected is that vapor concentrations decrease during venting due to compositional changes and mass transfer resistances. Figure 4 presents calculated removal rates R_{est} [kg/d] for a range of C_{est} and Q values. C_{est} values are presented in [mg/L] and [ppm_{CH4}] units, where [ppm_{CH4}] represents methane-equivalent parts-per-million volume/volume (ppm_v) units. The [ppm_{CH4}] units are used because field analytical tools that report [ppm_v] values are often calibrated with methane. The [mg/L] and [ppm_{CH4}] units are related by:

$$[\text{mg/L}] = \frac{[ppm_{CH4}] * 16000\ \text{mg-}CH_4\text{/mole-}CH_4 * 10^{-6}}{(0.0821\ \text{l-atm/}^{\circ}\text{K-mole}) * (298\ \text{K})} \qquad (3)$$

For field instruments calibrated with other compounds (i.e., butane, propane), [ppm_v] values are converted to [mg/L] by replacing the molecular weight of CH_4 in Equation 3 by the molecular weight [mg/mole] of the calibration compound.

Acceptable or desirable removal rates $R_{acceptable}$, can be determined by dividing the estimated spill mass M_{spill}, by the maximum acceptable cleanup time τ:

$$R_{acceptable} = M_{spill}/\tau \qquad (4)$$

For example, if 1500kg (≈ 500 gal) of gasoline had been spilled at a service station and it was wished to

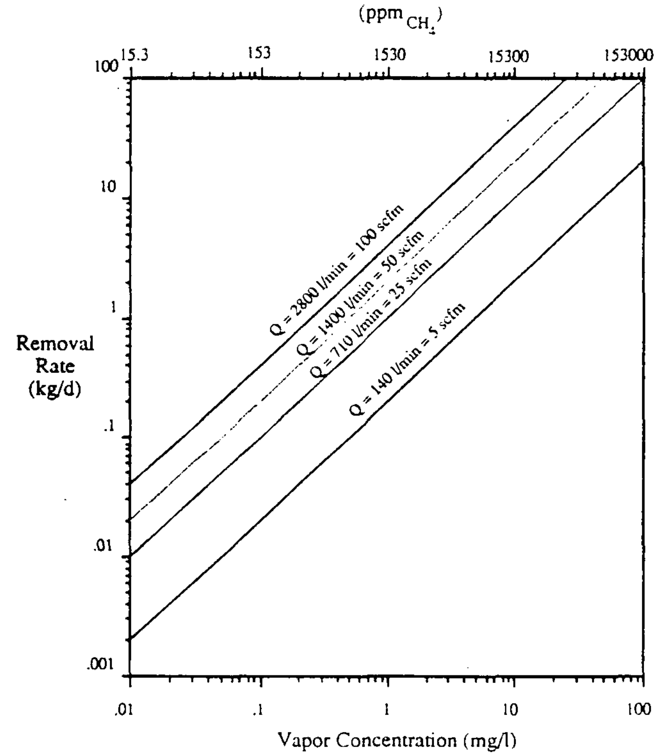


Figure 4. In situ soil-venting removal rate dependence on vapor extraction rate and vapor concentration.

complete the cleanup within eight months, then $R_{acceptable}$ = 6.3 kg/d. Based on Figure 4, therefore, C_{est} would have to average >1.5 mg/L (2400 ppm_{CH4}) for Q=2800 l/min (100 cfm) if venting is to be an acceptable option. Generally, removal rates <1 kg/d will be unacceptable for most releases, so soils contaminated with compounds (mixtures) having saturated vapor concentrations less than 0.3 mg/L (450 ppm_{CH4}) will not be good candidates for venting, unless vapor flow rates exceed 100 scfm. Judging from the compounds listed in Table 1, this corresponds to compounds with boiling points (T_b)>150 C, or pure component vapor pressures <0.0001 atm evaluated at the subsurface temperature.

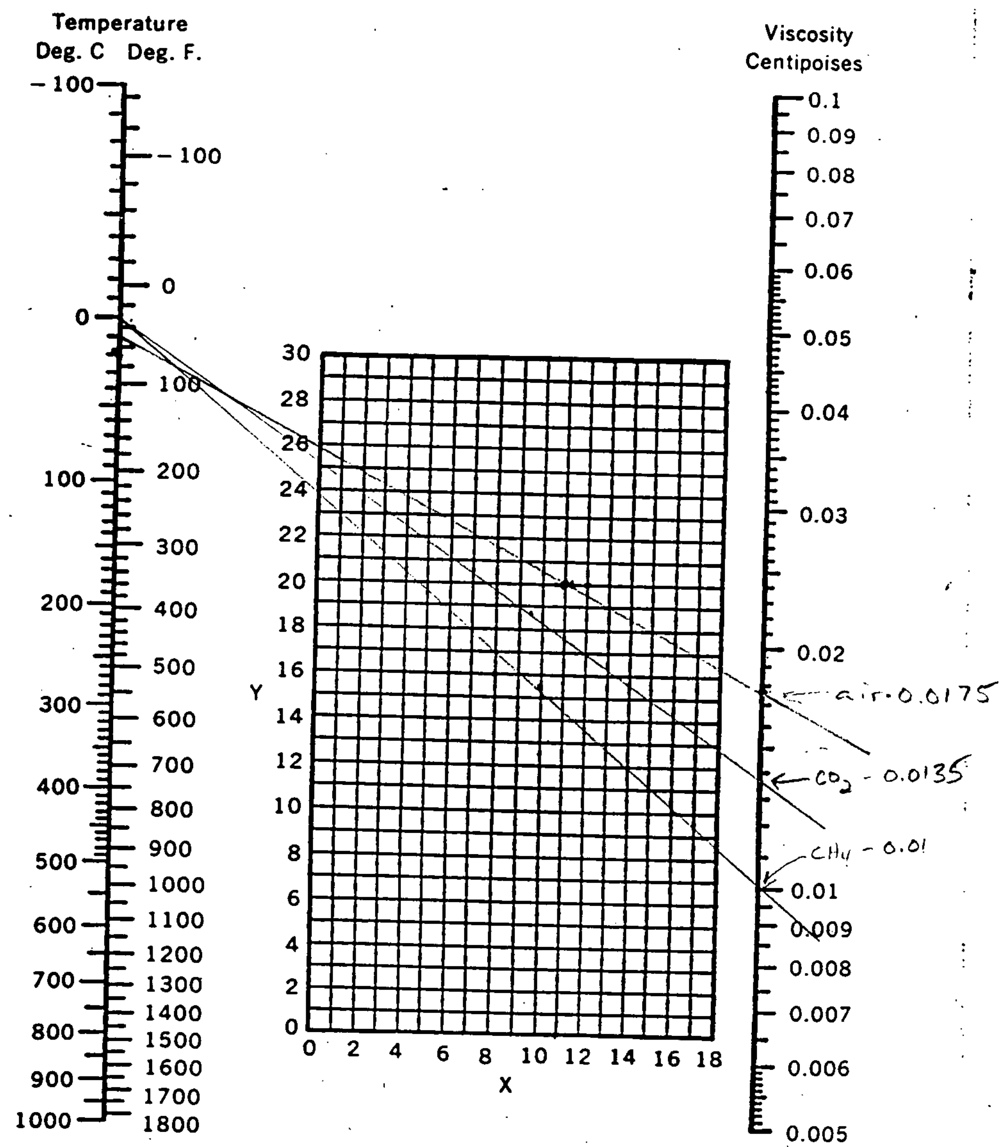
What Range of Vapor Flow Rates Can Realistically Be Achieved?

Question 3 requires that realistic vapor flow rates for the site-specific conditions be estimated. Equation 5, which predicts the flow rate per unit thickness of well screen Q/H [cm^3/s], can be used for this purpose:

$$\frac{Q}{H} = \pi \frac{k}{\mu} p_w \frac{[1 - (P_{Atm}/P_w)^2]}{\ln(R_w/R_I)} \qquad (5)$$

where:

- k = soil permeability to air flow [cm^2] or [darcy]
- μ = viscosity of air = 1.8 x 10^{-4} g/cm-s or 0.018 cp
- P_w = absolute pressure at extraction well [g/cm-s^2] or [atm]
- P_{Atm} = absolute ambient pressure ≈ 1.01 x 10^6 g/cm-s^2 or 1 atm
- R_w = radius of vapor extraction well [cm]
- R_I = radius of influence of vapor extraction well [cm].



Viscosities of gases and vapors at 1 atm; for coordinates, see table on previous page.

M

·lpy, Btu/lb	
Vaporization λ	Sat. vapor H_y
1075.8	1075.8
1074.1	1077.1
1071.3	1079.3
1068.4	1081.5
1065.6	1083.7
1062.7	1085.8
1059.9	1088.0
1057.1	1090.2
1054.3	1092.3
1051.5	1094.5
1048.6	1096.6
1045.8	1098.8
1042.9	1100.9
1040.1	1103.1
1037.2	1105.2
1031.6	1109.5
1025.8	1113.7
1020.0	1117.9
1014.1	1122.0
1008.2	1126.1
1002.3	1130.2
996.3	1134.2
990.2	1138.1
984.1	1142.0
977.9	1145.9
971.6	1149.7
970.3	1150.4
965.2	1153.4
958.8	1157.0
952.2	1160.5
945.5	1164.0
938.7	1167.3
931.8	1170.6
924.7	1173.8
917.5	1176.8
910.1	1179.7
902.6	1182.5
894.9	1185.2
887.0	1187.7
879.0	1190.1
870.7	1192.3
862.2	1194.4
853.5	1196.3
844.6	1198.1
835.4	1199.6
826.0	1201.0
816.3	1202.1
806.3	1203.1
796.0	1203.8
785.4	1204.3
774.5	1204.6

Steam," by Joseph H. Keenan and
he permission of the authors and

APPENDIX 9

VISCOSITIES OF GASES†

No.	Gas	X	Y	No.	Gas	X	Y
1	Acetic acid	7.7	14.3	29	Freon-113	11.3	14.0
2	Acetone	8.9	13.0	30	Helium	10.9	20.5
3	Acetylene	9.8	14.9	31	Hexane	8.6	11.8
4	Air	11.0	20.0	32	Hydrogen	11.2	12.4
5	Ammonia	8.4	16.0	33	$3H_2 + N_2$	11.2	17.2
6	Argon	10.5	22.4	34	Hydrogen bromide	8.8	20.9
7	Benzene	8.5	13.2	35	Hydrogen chloride	8.8	18.7
8	Bromine	8.9	19.2	36	Hydrogen cyanide	9.8	14.9
9	Butene	9.2	13.7	37	Hydrogen iodide	9.0	21.3
10	Butylene	8.9	13.0	38	Hydrogen sulfide	8.6	18.0
11	Carbon dioxide	9.5	18.7	39	Iodine	9.0	18.4
12	Carbon disulfide	8.0	16.0	40	Mercury	5.3	22.9
13	Carbon monoxide	11.0	20.0	41	Methane	9.9	15.5
14	Chlorine	9.0	18.4	42	Methyl alcohol	8.5	15.6
15	Chloroform	8.9	15.7	43	Nitric oxide	10.9	20.5
16	Cyanogen	9.2	15.2	44	Nitrogen	10.6	20.0
17	Cyclohexane	9.2	12.0	45	Nitrosyl chloride	8.0	17.6
18	Ethane	9.1	14.5	46	Nitrous oxide	8.8	19.0
19	Ethyl acetate	8.5	13.2	47	Oxygen	11.0	21.3
20	Ethyl alcohol	9.2	14.2	48	Pentane	7.0	12.8
21	Ethyl chloride	8.5	15.6	49	Propane	9.7	12.9
22	Ethyl ether	8.9	13.0	50	Propyl alcohol	8.4	13.4
23	Ethylene	9.5	15.1	51	Propylene	9.0	13.8
24	Fluorine	7.3	23.8	52	Sulfur dioxide	9.6	17.0
25	Freon-11	10.6	15.1	53	Toleune	8.6	12.4
26	Freon-12	11.1	16.0	54	2,3,3-Trimethylbutane	9.5	10.5
27	Freon-21	10.8	15.3	55	Water	8.0	16.0
28	Freon-22	10.1	17.0	56	Xenon	9.3	23.0

Coordinates for use with figure overleaf.

† By permission, from J. H. Perry (ed.), "Chemical Engineers' Handbook," 5th ed., pp. 3–210 and 3–211.

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 020617-0011

DATE: Aug. 15, 1997

SUBJECT: Rose Hill Landfill FS – Perimeter & Internal LFG Control Systems : Solid Waste Area

M&E ENGINEER: Daniel Peters

OUTSIDE PARTY: Fred Rice, Pres. F.C. Rice & Co., Inc. 15 Heather Lane, Hampton, NH & TEL (603) 929-1771 FAX

MADE CALL (✓) 8:30, 13:00

REC'D CALL (✓) 12:30

COMMENTS	SUMMARY OF CONVERSATION:
	8:30 Called & left message for Fred re: Rose Hill Landfill — key issue internal vs. perimeter landfill gas collection system
	12:30, 13:00 Called Fred back
Fred concerned that we may use more propane than we expect (Fred not aware of the alternate flare design) →	• Fred's primary concern is the potential for over-estimation of the gas generation rate using the EPA default coefficients; this may cause an O&M impact for combusting the perimeter gas stream in the flare
	• Fred recommended eliminating the perimeter extraction well system and replacing it with an upgraded internal system as follows:
	– change well spacing from 200-ft (center to center) to 100-ft (center to center)
	– locate internal well system ~50 ft in from refuse limit along perimeter areas w/migration problems
	– internal well layout should be in a uniform, checkerboard pattern

CC: Sean Czarniecki; J. Osborn
Barb Weir
Deb Simone

RAC WA# 007-RICO-01A5

M&E FORM NO. 196 (9/78)

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. ______

DATE: Aug. 15, 1997

SUBJECT: ______

M&E ENGINEER: ______

OUTSIDE PARTY: Fred Rice

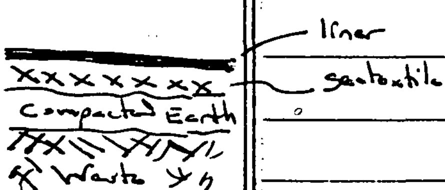
MADE CALL ( )

REC'D CALL ( )

COMMENTS

SUMMARY OF CONVERSATION:

- I discussed w/ Fred that residences along Rose Hill Road were very close to the Solid Waste Area fill... did he think an internal system alone would be sufficient to prevent migration? Fred felt it would
- Fred suggested some additional design features which should be added to the internal LFG collection system:
  - add a liner to act as a barrier along Rose Hill Road in conjuction w/ internal system
  - do not have a sand vent layer under the L.F. cap (will short-circuit LFG wells); instead use a geotextile to avoid damaging liner & add compacted earth onto waste



  - add a ring main system w/ branches of 4 to 5 wells on each branch to allow partial shutdown of collection system
  - header pipe should be placed above the liner w/ 18" minimum cover to prevent freezing of LFG condensate

Comments: above liner To ~~prevent~~ monitor pipe settlement

CC:

M&E FORM NO. 196 (9/78)

E-3 Gas Composition Calculations

The feed gas streams which will be collected for treatment have different compositions based on the location and type of collection system utilized. Each process technology evaluated requires knowledge of the feed stream(s) methane composition for permitting and combustion purposes.

Internal LFG Stream

The total landfill gas generated [from SCHOLLRE.wk1] is 5.18E+04 cm^3/s or 110 cfm
Assuming 70% of this amount is collected by the Internal system, 3.63E+04 cm^3/s or **77 cfm**
would have been collected in 1996.

The composition of this stream is assumed to be 50% Methane and
50% Carbon Dioxide

Perimeter Gas Stream

The total gas collected from the Perimeter system [from JOHNSON.wk1] is 3.83E+05 cm^3/s or **812 cfm**
This includes air and LFG generated by the landfill.
Assuming 30% of the total landfill gas generated is collected by the perimeter system, this value is
1.55E+04 cm^3/s or 33 cfm
This amounts to 4% of the perimeter gas stream.

The composition of this portion of the stream is assumed to be 50% Methane and
50% Carbon Dioxide

The remaining 96% of the stream is assumed to be air at a composition of 21% Oxygen and
79% Nitrogen

Therefore, the composition of the perimeter gas stream is calculated to be
2% Methane
2% Carbon Dioxide
20% Oxygen
76% Nitrogen

Compositions for the blending of the two streams are calculated on COMPOSIT.wk1.

ROSE HILL SOLID WASTE LANDFILL
GAS COMPOSITIONS

VERSION: AUG-26-96

Checked by: Sean Czarniecki 08/26/96

file: COMPOSIT.WK1

Input Values:

Qair – from worksheet for Johnson Equation

Qgas – from worksheet from the Scholl Canyon Model; for a conservative estimate – see also Gamma model

Qair =	3.83E+05	cm^3/s	Total gas (air & LFG) collected from perimeter system [from JOHNSON.wk1]
Qgas =	5.18E+04	cm^3/s	Total landfill gas generated [from SCHOLLRE.wk1]
Assume	70%		of Qgas is collected by the internal system
Therefore,	30%		of Qgas is collected by the perimeter system
This equals	1.55E+04	cm^3/s	
and is	4%		of Qair
Therefore,	3.68E+05	cm^3/s	is assumed to be air without landfill gas (Q_a)

$Vlfg = Q_a + Qgas$ = 4.20E+05 cm^3/s

0.4197 m^3/s

Composition of gas:

Assuming:	Q_a is	21%	Oxygen and
		79%	Nitrogen
	Qgas is	50%	Methane and
		50%	Carbon Dioxide

$Q\ CH_4$ =	Qgas *	50%		=	2.59E+04	cm^3/s	0.0259 m^3/s
$Q\ CO_2$ =	Qgas *	50%		=	2.59E+04	cm^3/s	0.0259 m^3/s
$Q\ N_2$ =	Q_a *	79%		=	2.91E+05	cm^3/s	0.2906 m^3/s
$Q\ O_2$ =	Q_a *	21%		=	7.72E+04	cm^3/s	0.0772 m^3/s
Check:			Total		4.20E+05	cm^3/s	0.4197 m^3/s

$YlfgCH_4$ =	$Q\ CH_4/Vlfg$	=	0.0618
$YlfgCO_2$ =	$Q\ CO_2/Vlfg$	=	0.0618
$YlfgN_2$ =	$Q\ N_2/Vlfg$	=	0.6924
$YlfgO_2$ =	$Q\ O_2/Vlfg$	=	0.1841
Check:			1.0000

Non-combustion LFG treatment processes (such as photocatalytic oxidation) which do not treat methane will produce the following amounts of methane:

Feed Gas

Total landfill gas (1996) [from SCHOLLRE.wk1] 110 cfm = 1.83 cfs = 0.052 m^3/s

Assume all methane will be captured by either the internal system or the perimeter system.

The landfill gas composition is assumed to be

50% methane

50% carbon dioxide

Therefore, the flow of methane through a non-combustion treatment process is approximately

CH4FLOW = 55 cfm = 0.91 cfs = 0.026 m^3/s

Density of 20°C air: 0.00121 g/cm^3 = 0.075 lb/ft^3 [ref: CRC, 1987]

Density of 0°C methane: 0.00072 g/cm^3 = 0.045 lb/ft^3 = CH4DENSITY [ref: Perry & Green, 1984]

Assume that temperature will not greatly impact density.

The colder temperature methane density provides a more conservative mass value.

Amount of methane out of treatment process:

CH4FLOW x CH4DENSITY = 2.46 lb/min = 147 lb/hr = 3,537 lb/day

LEL calculations

From COMPOSIT.wk1 gas composition calculations, the combination of the internal & perimeter gas streams will result in an approximate methane concentration of 6.18%

The LEL of methane is 5% by volume.

Therefore, dilution air will need to be added at some point along the treatment process so that explosions are averted.

E-4 Enclosed Landfill Gas Flare Calculations

- Vendor Quotation: John Zink Company
- Auxiliary Fuel Requirements

- Vendor Quotation: John Zink Company

JOHN ZINK
A KOCH INDUSTRIES COMPANY

International Headquarters
P.O. Box 21220
Tulsa, Oklahoma 74121-1220
918/234-1900

July 17, 1997

Metcalf & Eddy
30 Harvard Mill Square
Wakefield, MA 01880

Attention: Sean Czarniecki

Subject: Landfill Gas Flare System for the Rose Hill Regional Landfill
John Zink Proposal Number BF 3746

Dear Mr. Czarnieki,

Thank you for your recent inquiry into John Zink Biogas Flare products. We appreciate the opportunity to assist you with the flare portion of your project. As the leading supplier of landfill gas flare equipment throughout the world, John Zink Company is pleased to offer our field proven **ZTOF** Enclosed Flare System for your application.

With over 300 installations nationwide, John Zink has the expertise and resources to ensure your flare project is successful. We can provide skid packages for your system that will result in a lower installed cost while limiting the installation time and hassle.

We have offered a number of options in our proposal to allow you to customize your system to meet your particular needs. After you have reviewed this proposal, please let us know if there are any additional options you would like to pursue.

Emission compliance (present or future) is another benefit of John Zink enclosed flares. With high destruction of the waste hydrocarbons, John Zink Enclosed Flares are also low in NOx and CO emissions. John Zink flares have consistently passed local and federal emissions tests.

We look forward to working with you on this project, and if you require any additional information please do not hesitate to contact me at (918) 234-1884.

Best Regards,

JOHN ZINK COMPANY

Tim Locke
Business Team Leader
Biogas Flare Group

TABLE OF CONTENTS

I. TECHNICAL SUMMARY

A. DESIGN CRITERIA

Flare Gas Stream

Type:	Internal LF Gas	Perimeter LF Gas
Composition:	50 % CH_4 (maximum) 50 % CO_2, air, inerts	2% CH4; 2% CO2 Remainder Air
Lower Heating Value:	455 BTU/SCF	18 BTU/SCF
Temperature:	100 °F	100°F
Flow Rate:	80 SCFM	810 SCFM
Waste Heat Release:	2.2 MMBtu/hr (maximum)	

NOTE: *Assist gas is not required for the above flow rates and compositions. However, if these vary, then natural gas assist may be required.*

Mechanical

Design Wind Speed:	100 mph
Ambient Temperature:	-20 °F to 120 °F
Electrical Area:	non-hazardous
Elevation:	sea level (14.7 psia)

Unit Design

Smokeless Capacity:	100%
Pressure Drop:	< 8" w.c. through flare and flame arrestor
Operating Temperature:	1400 °F - 1800 °F (2000 °F shutdown)
Retention Time:	0.7 seconds at 1800 °F (minimum)

NOTE: *Low methane concentrations may require auxiliary fuel to initiate combustion and maintain temperature.*

Utilities

Pilot Gas (Intermittent):	22 SCFH propane at 7-10 psig
Compressed Air:	Required for Condensate Injection System (optional)
Electricity:	460 V, 3 ph, 60 Hz for blower control (including step-down transformer for control system components) 110 V, 1 ph, 60 Hz for control system components
Fired (Auxiliary) Fuel:	None based on the flows given above. However, if the methane concentration or flow rates vary, natural gas assist may be required.

Expected Flue Gas

Operating Temperature	1600°F	1800°F
CO_2 Volume %	7.0	8.1
H_2O Volume %	8.2	9.2
N_2 Volume %	72.6	71.8
O_2 Volume %	12.2	10.9

Emission Range (Design Flow)[1]

Operating Temperature	1600°F	1800°F
Overall Destruction Efficiency[2]	98%	99%
NOx, lb / MMBtu[3]	0.06	0.08
CO, lb / MMBtu[4]	0.20	0.15

(1) Expected emission rates at lower operating temperatures are available upon request.

(2) Typical sulfur containing compounds are expected to have greater than 98% oxidation efficiency.

(3) Excludes NOx from fixed nitrogen.

(4) Excludes CO contribution present in landfill gas.

NOTE: *Projected emissions are based on field tests of operating units and the HHV of the landfill gas. Destruction efficiency, NOx, and CO emissions shown are valid for combustion of landfill gas only. These expected emissions are the same for the simultaneous combustion of landfill gas and condensate injection within the specified design range for typical MSW condensate. A condensate composition analysis is required to verify specific expected emission.*

B. EQUIPMENT DESCRIPTION

Item 1, ZTOF Enclosed Flare Assembly

- 3'-6" diameter x 30' overall height, 1/4" A-36 carbon steel vessel.
- 2" layer of A.P. Green (or equal) ceramic fiber refractory mounted on Inconel pins and keepers. (2400 °F hot face refractory). The surface layer of 1" 8# refractory is overlapped both horizontally and vertically for additional protection.
- Burner Management System for landfill gas application.
    - Burner manifold assembly with flanged inlet connection. Individually flanged burner connections allow easy servicing.
    - **V-Mix™** biogas burner with stainless steel anti-flashback tips for high temperature corrosion resistance and maximum flame stability through the full range of design flow rates.
    - Perimeter gas distribution manifold for direct injection into the base of the enclosed flare.
    - **Tru-Lite™** ignitor assembly for use during start-up cycles. This externally mounted pilot provides easy operation and can be removed for maintenance without entering the vessel.
- Bolted blade combustion air damper(s). Opposed blade design provides 5:1 air turndown control. Galvanized finish and stainless steel press-fit bearings ensure smooth, long term operation. A special proprietary lower burner chamber design minimizes direct radiation on the damper for maximum service life.

  NOTE: *Removal of these bolted blades allows access to the lower flare burner chamber and eliminates the need for a separate manway.*

- Four (4) 4" NPT sample ports at 90° apart located 1/2 stack diameter from the flare top for accurate emission testing.

  NOTE: *These ports can be accessed by use of a temporary device such as power-lift vehicle or permanent ladder and platform equipment. Refer to the options sections for ladder and platform selection.*

- Three (3) thermocouple connections at various elevations for temperature monitoring.
- Exterior protection using SSPC-SP-6 sandblast and Sherwin Williams Zinc Clad I coating system, gray-green color, 2 1/2 - 3 mils DFT for superior corrosion protection at shell temperatures to 750 °F.
- AISC designed continuous base plate for high wind stability.
- Lifting lugs to assist in erection.

- Thermocouple conduit mounting brackets.
- Galvanized personnel protection screen located on lower portion of st:.ck to prevent contact with the vessel surface. Additional screenings is available fc r upper stack instrument locations. See Ladder and Platform options for details.

Item 2, <u>Control System</u>

Control Station Assembly

- Self-Supporting Steel Rack
- Flare Control Panel with 110V items enclosed in a separate panel for electrical safety including:
  - Allen Bradley SLC-500 programmable logic controller.
  - Honeywell UDC 3000 temperature controller for automati: temperature control.
  - Honeywell UDC 2000 temperature indicator for stack mounted high temperature shutdown thermocouple.
  - One (1) flame scanner relay.
  - Four (4) ammeter(s) for landfill gas blower motors (200% scale).
  - Four (4) hourmeter(s) for landfill gas blower motors.
  - Two (2) "manual-off-automatic" blower selector switch(es).
  - Indicating lights:

a.	Panel power ON	e.	Flame proved
b.	Purging	f.	Low stack temper: ture (shutdown)
c.	Purge complete	g.	High stack temper:.ture (shutdown)
d.	Pilot gas ON	h.	Flame failure (shu:down)

- Main power supply disconnect.
- Power transformer to step-down 460V, 3 ph, 60 Hz service to 110 V, 1 ph, 60 Hz for use as required by control components.
- Motor Starter Panel.
  - Four (4) landfill gas blower motor starter(s).
  - One (1) stack mounted purge blower motor starter.
- Other Rack Mounted Components.
  - Pilot gas train including pressure regulator, fail-closed shutdown valves, manual block valve and pressure indicator.
  - 15A convenience outlet (duplex) with weatherproof cover.
  - 100W high pressure sodium security light with manual switch and photocell.

- Appropriate items will be enclosed in weatherproof (NEMA 4) panels.
- The control station assembly will be pre-piped and wired in our UL approved shop and function tested simulating actual operations.

Stack Mounted Controls

- One (1) combustion air damper to control the operating temperature. Damper with automatically controlled louvers are provided with the automatic temperature control feature.
- Ignition panel assembly including transformer, pilot spark electrode ignition timer and ignition wire. Enclosure is stack mounted for easy access to the pilot assembly.
- One (1) self-checking flame scanner.
- One (1) purge air blower.
- One (1) high temperature shutdown thermocouple.
- Two (2) temperature monitoring thermocouples with location based on specific flow conditions.

Automatic Temperature Control

- Flue gas temperature is automatically controlled by adjusting the air flow into the unit. Lower waste gas flows or lower methane concentrations will automatically close the inlet air louvers. The control loop consists of a thermocouple and temperature indicator/controller and electrically operated actuator(s) on the air louvers. Included with this option is the enhanced automatic start-up feature which includes additional timers, relays, and controls to allow the air damper to open to a preset position, for a flare warm-up, before returning to modulating temperature control. This feature allows more air into the stack during start-up when a stack is cold and lacking draft, thereby minimizing any smoke at start-up.

Miscellaneous Accessories

- Three (3) operating manuals with essential operating instructions, appropriate vendor literature on instrumentation, and drawings combined in a three ring binder.

Item 3, Flare System Accessories

- 400 ft of thermocouple extension wire.
- One (1) gallon of field touch-up paint.

C. OPTIONAL EQUIPMENT

Item 4, Inlet Flame Arrester

- Two (2) 3" Varec Model 5010 Flame Arrester with aluminum housing and aluminum internals. Internal elements can be cleaned without removing the flame arrester body from the pipe.

Item 5, ZMS Moisture Separator

- Two (2) 3'-0" O.D. x 6' Tall moisture separator with flanged inlet and outlet, drain connection, level gauge, stainless steel mesh pad for moisture collection, and a flanged top for accessibility and maintenance. The vessel will be constructed of carbon steel and coated internally with a phenolic painting system to protect the vessel from the corrosive landfill gas. The exterior of the vessel will be prepared with an SSPC-SP-6 sandblast, primed with an epoxy primer, and coated with enamel.

Item 6, Automatic Inlet Valve With Pneumatic Actuator

- Two (2) 3 " Xomox Pliaxseal High Performance Butterfly Valve, ANSI 150 lb with carbon steel body, 316 stainless steel disk, PTFE seat with Bettis pneumatic fail-closed actuator, three-way solenoid valve, speed control valve and auxiliary switches. This valve can be actuated by nitrogen cylinders (not included) or by 100 psig compressed air if available.

Item 7, Flow Meter

- Two (2) FCI Thermal Mass Flow Meter Assembly with 316 stainless steel probe for 3/4" NPT mounting. The output of this meter can be wired to Optional Item 8 to provide for continuous flow monitoring.

Item 8, Chart Recorder

- One (1) Honeywell model DR4500T Digital Circular Chart Recorder. The circular chart recorder is a microprocessor based recorder which draws its own chart as it records data. User can design the chart to match specific applications. The recorder will have two (2) inputs with options for up to four (4) inputs. All inputs are 4-20 mA. With this option the Honeywell controller will be provided with an optional output signal allowing the recorder and controller to read the same temperature from the thermocouple. Additionally, the recorder is capable of totalizing the system flow.

Item 9, Autodialer

- One (1) Raco Verbatim automatic dialer with four (4) digital inputs. This unit is voice programmable and capable of dialing up to 16 telephone numbers in the event of an alarm condition (e.g., flame failure, high-temperature shutdown, etc.). At an additional cost, this unit can also process analog signals (e.g., flare operating temperature, system flow rate, etc.) and provide this information when accessed remotely via telephone.

Item 10, *Underwriters Laboratories* Classification

- John Zink Company is dedicated to ensuring the highest level of quality and safety standards in its products. This performance level is reflected in all products and provides the capability to apply the UL listing symbol for Industrial Control Panels on motor starters and a UL classification symbol on Flare Control Panels. This option is provided for applications requiring Underwriters Laboratories Certification.

Item 11, Ladder

- Galvanized ladder for access to thermocouples. Equipment includes ladder, rails, two (2) safety belts, and personnel protection screening behind the ladder and around the thermocouple ports. A lockable gate, for preventing unauthorized access, can be added for an additional price.

Item 12, Service Platform

- Galvanized 360° service platform for accessing the stack sample connections, designed per OSHA requirements. A continuous band of personnel protection screening around the sample ports is included with this option.

Item 13, Hinged Damper

- One of the manual dampers may be hinged in order to provide easy access to the bottom of the flare stack for inspection and maintenance of the burners.

Item 14, Control Panel Weather Hood

- This fabricated steel hood is designed to limit the panel's exposure to the elements. It provides approximately 4' of overhang to the front and 2' to the rear. The hood is painted to match the rest of the control panel rack and comes with a fluorescent light assembly for enhanced visibility of the panel components at night. This hood is painted to match the control panel rack.

Item 15, Top-Coat Finish

- Sherwin Williams Kem High Temperature 881A001 Gray with 700C418 catalyst coated 1-2 mils DFT. This coat is applied over the standard Sherwin Williams Zinc Clad I primer to provide an enhanced finish with superior corrosion protection up to 500 °F.

Item 16, Flare Base Ring Template

- One (1) enclosed flare base ring template constructed of 1/4" carbon steel plate to assist in setting and installing the anchor bolts in the field. The template is match-drilled with the actual baseplate and shipped in 1 to 4 marked pieces, depending on the size of the flare stack.

Item 17, Landfill Gas Blower

- Two (2) Lamson or Hoffman landfill gas blowers sized for the interior gas stream of 80 scfm.
- Two (2) Lamson or Hoffman landfill gas blowers sized for the perimeter gas stream of 810 scfm.

Item 18, Condensate Injection System

- ? (?) stack-mounted condensate injection guns. Each gun is capable of disposing of up to 1 GPM of condensate. Each gun can be removed from service for maintenance purposes or to minimize air consumption without removing the compressed air or condensate piping.
- A flare stack condensate injection gun port for each condensate injection nozzle.
- AISC designed skid with galvanized grating.
- One (1) air compressor complete with particulate filters.
- Two (2) pneumatic condensate pumps.
- One (1) 550 gallon high-density cross-linked polyethylene condensate storage tank with level control.
- Controls (mounted in control station panel, see Item 2) complete with lights, switches, and PLC logic for safe operation of the condensate injection system.
- All components fully piped and assembled within the skid boundaries.

Item 19, Blower Skid Assembly

- One heavy duty AISC designed skid with galvanized grating.
- ??? (?) ?? HP landfill gas blower(s).
- Fully supported 304 stainless steel waste gas piping.
- ??? (?) manual butterfly valves for blower inlet and outlet.
- ??? (?) flexible expansion joints for blower inlet and outlet.
- ??? (?) check valve for blower outlet.
- Two (2) five gallon propane tanks for intermittent ignition fuel supply.
- All piping, wiring, and conduit within the skid boundaries will be factory installed.

D. OPERATION

The following is a brief outline of the system start-up and operating sequence.

System start-up begins with a timed air purge cycle to evacuate any fugitive hydrocarbons from the flare enclosure. After purge is completed, the pilot is lit. Upon proving the pilot flame with the flame scanner, the waste gas valve is opened and the waste gas blower is started allowing flow to the flare enclosure. This allows use of the waste gas for system warm-up.

After the waste gas valve is opened, the pilot gas shuts off after a timed delay to limit utility gas usage. If a flame is still sensed on the main burner the system will continue operation, if not, it will shutdown on flame failure.

In the automatic mode, the above sequence automatically starts when power is supplied. If the unit shuts down for any reason except high stack temperature, the automatic mode will allow the unit to attempt to purge and restart for a specified time period. A remote signal is sent if the unit fails to restart. Units can be operated in the manual mode which requires an operator at the flare to start and restart the system using a push-button sequence. If the unit shuts down for any reason, operator assisted restart is required.

The unit temperature is set by adjusting the air dampers (manually or automatically). Opening the dampers reduces the flue gas temperature by adding quench air

Due to the presence of an open flame, the flare assembly should be located in a "non-hazardous" electrical area.

II. COMMERCIAL

A. BUDGET PRICING

Item	*Description*	*Total*
1	One (1) ZTOF Enclosed Flare System	
2	Control System	
3	Accessories	$90,000
	OPTIONS	
4	Two (2) Inlet Flame Arrester	Included
5	Two (2) Moisture Separator	$18,000
6	Two (2) Automatic Inlet Valve	$3,000
7	Two (2) Flow Meter	$ 7,000
8	One (1) Digital Circular Chart Recorder	$ 3,300
9	One (1) Autodialer	$ 3,300
10	*Underwriters Laboratories* Classification	$ 1,500
11	One (1) Ladder	$ 3,500
12	One (1) Service Platform	Upon Request
13	One (1) Hinged Damper	$ 800
14	Control Panel Weather Hood	$ 2,000
15	Top-Coat Finish	$ 3,000
16	One (1) Flare Base Ring Template	$ 900
17	Four (4) Landfill Gas Blowers	$60,000
18	One (1) Condensate Injection Skid	Upon Request
19	One (1) Blower Skid Assembly	Upon Request
20	(2) Consecutive Days of Field Start-up and Training	$ 3,500
21	Estimated Freight	$5,000

B. TERMS AND CONDITIONS

Prices are F.O.B. point of manufacture Skiatook, Oklahoma and do not include foreign, federal, state, local sales, excise or other use taxes. Freight charges are not included in the pricing unless specifically noted otherwise.

All pricing contained herein is based on and contingent upon John Zink Standard Terms and Conditions of Sale attached and made part of this offering.

Prices are firm for acceptance for thirty (30) days and for the quoted delivery. Should shipment be delayed past the quoted delivery by acts of Buyer or its agents, the quoted price will be subject to escalation based upon appropriate material and labor indexes.

Should delivery be delayed past the quoted delivery by acts of Buyer or its agents, vendor shall have the right to invoice and be paid for materials on hand, fabrication performed and services rendered.

PAYMENT TERMS: Terms of payment will be 100% net thirty (30) days after invoicing as follows:

25% Upon issuance of drawings
25% Upon receipt of major materials
25% Upon completion of one-half the fabrication
25% Upon notification of readiness for shipment

A guaranteed form of payment acceptable to John Zink, such as an irrevocable letter of credit on a major United States bank may be required.

C. WARRANTY

John Zink Company warrants only new products manufactured by John Zink against workmanship and/or materials under normal and proper use. Please refer to John Zink Standard Terms and Conditions of Sale (attached) for conditions and limitations.

D. DELIVERY SCHEDULE

Based on a release to purchase major materials at the time a purchase order number is issued, John Zink Company will maintain the following delivery schedule:

Submittals for Approval:	4 - 6 weeks after receipt of order
Fabrication:	10 - 12 weeks after receipt of approved drawings

Overall schedule will be based on time required for drawing approval. Improved schedules may be arranged to meet specific project requirements.

E. OTHER CONDITIONS

Shipping

Shipping will be via common carrier. Portions of the unit will be shipped loose to reduce shipping costs and damage to the unit.

Spare Parts

Due to the custom designed nature of this package, a spare parts price listing is to be submitted with the certified drawing package. Partial lists for equipment parts can be made available on request.

Change Orders

John Zink Company has based pricing on the inquiry design information. In the event of process changes, we reserve the right to alter our equipment design in order to maintain safe engineering practices.

If additions or deletions are required after an order is received, a price summary will be submitted to the customer's office for approval. The Engineering Change Order (ECO) will include charges for drafting and engineering changes, material and labor changes, freight and administration costs. Change orders must be approved by the client and returned to John Zink prior to beginning additional work.

Equipment dimensions, sizes and subvendor selections offered in this proposal are subject to change after the design is finalized.

Field Service

Start-up and training services are included as listed above. Additional services are offered according to attached John Zink Company Technical Assistance Agreement.

F. GENERAL SCOPE OF WORK

John Zink Company will furnish the labor, materials, equipment and tools necessary to fabricate the proposed system.

General construction bolts, nuts, washers, gaskets and other bolts/fixings associated with the connecting and assembly of equipment supplied by John Zink are included.

The following items are not included in this proposal:

- Detailed fabrication drawings are the proprietary property of John Zink Company. Customer drawings include the necessary dimensions, nozzle placements, structural details, and other data required to assemble the equipment.
- All civil works. John Zink will supply the data necessary to design such civil works by providing loadings for equipment.
- Erection of equipment or installation of piping or instruments. John Zink can supply turnkey installations on many projects.
- The supply or installation of fireproofing materials, personnel protection, heat tracing, external insulation, electrical/thermocouple wire, conduit, piping, bolts, gaskets, and finish paint unless specifically noted.
- Obtainment of permits, licenses, and approval by and from authorities to install and operate this equipment.
- Any additional cost incurred for fees and/or the preparation of drawings, forms and/or data for approval by state or local agencies of the design of the system.
- Automatic compliance with state, local or municipal codes unless specifically reviewed. All equipment is designed to applicable national codes and standards.
- Please note that John Zink Company has numerous units operating in many states and is knowledgeable in dealing with various regulatory authorities.

III. ATTACHMENTS

A. Standard Terms and Conditions

B. Technical Assistance Agreement

KOCH ENGINEERING COMPANY, INC.
JOHN ZINK COMPANY.

International Headquarters
11920 East Apache
Tulsa, Oklahoma 74121-1220
Phone: 918/234-2783
Facsimile: 918-234-1986

Tim Locke
Business Team Leader
Biogas Flare Group

TELEFAX TRANSMITTAL MESSAGE

DATE:	July 22, 1997
TO:	Sean Czarniecki
COMPANY:	Metcalf & Eddy, Inc.
FAX NUMBER:	(617)245-6293
TOTAL PAGES:	2
REFERENCE:	***Quotation Clarifications***
COPIES:	D. Ryan (610-252-6161)

IF MISSENT, PLEASE TELEPHONE 918 234-2783. THIS MESSAGE IS BEING SENT FROM 918 234-1986.

In response to your recent questions on our previously submitted proposal, please find the following:

1. A lower temperature on the perimeter gas will have no impact on the proposed flare system or utility consumption.
2. Yes, 100% of the oxygen in the perimeter gas is being utilized for combustion. However, in addition to the perimeter gas, quench air will be required at a rate of approximately 450 scfm at 1600°F and approximately 560 scfm at 1500°F stack temperature. Based on a 3'-6" O.D. stack with 2" of insulation and ¼" wall thickness, the velocity at 1600°F will be 11.5 fps and at 1500°F will be 11.9 fps (these values are plus or minus 15% due to the stack heat losses).
3. Basically, the industry standard is to guarantee a 98% DRE for NMOC's in landfill gas when measured as a common compound, such as Hexane. This is due to the difficulty of measuring a number of different compounds on the inlet and outlet, which are typically in the very small ppm range. This analysis may not show a 98% DRE of each and every compound, but when averaged, the 98% DRE will be met.
4. Generally on a 3.5' diameter flare, it will take approximately 1.5 MMBtu/Hr to maintain an operating temperature of 1500° to 1600°F. It does not matter if this heat duty is the result of the landfill gas or an assist gas.
   4a. *Natural gas heating value - 1000 Btu/Scf*
   Propane heating value - 2316 Btu/Scf

4b. As stated above, we will need approximately 1.5 MMBtu/Hr to maintain an operating temperature of 1500°F to 1600°F, either from the landfill gas or from an assist gas. Based on 50% methane, 1.5 MMBtu/Hr equates to 55 scfm of landfill gas. However, as the landfill gas flow rate decreases, typically so does the methane concentration. Therefore, higher flow rates will be required to maintain temperature as the methane decreases. One way to minimize assist gas consumption in the future would be to operate the flare on a timer, set for several hours a day or several days a week. This way, while the flare was down, the landfill gas would build up allowing larger flows to the flare while is was in operation and could minimize or possibly eliminate the need for assist gas.

I hope that this has addressed you questions. If you would like further information, please feel free to call our local representative, David Ryan at (610)252-6[illegible]60 or myself at (918)234-2783.

Regards,

JOHN ZINK COMPANY,
a division of Koch Engineering Company, Inc.

Tim Locke
Business Team Leader
Biogas Flare Group

KOCH ENGINEERING COMPANY, INC.
JOHN ZINK COMPANY.

International Headquarters
11920 East Apache
Tulsa, Oklahoma 74121-1220
Phone: 918/234-2783
Facsimile: 918-234-1986

Tim Locke
Business Team Leader
Biogas Flare Group

TELEFAX TRANSMITTAL MESSAGE

DATE:	August 4, 1997
TO:	Sean Czarniecki
COMPANY:	Metcalf & Eddy
FAX NUMBER:	(617)245-6293
TOTAL PAGES:	1
REFERENCE:	*Pilot Gas Consumption*
COPIES:	D. Ryan

IF MISSENT, PLEASE TELEPHONE 918 234-2783. THIS MESSAGE IS BEING SENT FROM 918 234-1986.

In response to your pilot gas usage question, I would guess that a flare system in normal operation will be started and stopped once or twice a month, with the pilot going through the following sequence:

The pilot will initially try to light for 10 seconds, if at this point the pilot is not lit, the system will shut down. If the pilot does light, then the system allows 5 seconds for a blower to start, then the inlet block valve starts opening and can take up to 30 seconds to open fully. Once the valve has been proven fully open by the valve open limit switch, the pilot will remain on for an additional 15 seconds. After that time, the pilot is shut off. If after the 15 seconds the main flame is lit, the pilot remains off, if the main flame is not proven, the pilot ignition sequence starts over. Therefore, the pilot is on for a maximum of 60 seconds every time the unit starts.

I have attached a pilot gas consumption chart for your convenience. If you have any further questions or comments, please feel free to call David Ryan, our local sales representative, at (610)252-6210 or myself at (918)234-2783.

Regards,

AUG 04 '97 11:26AM JZ FLARES 9182341986

Pilot Usage

Propane Bottle Information

Cylinder Size (gallon)	O.D. (in)	Height (in)	Volume (ft^3)	Fuel Weight (lbs)	Capacity (SCF)	Weight (lbs)
5			0.766	20	108	
100			15.313	400	2167	

Pilot Fuel	Operating Pressure (PSIG)	Pilot Firing Rate (SCFH)	Avg. Pilot Run Time (Sec)	Pilot usage per start-up (SCF)	# of start-ups/ 5 gal.	# of start-ups/ 100 gal.
Propane	10	22.000	60	0.367	295	5910
Natural Gas	15	45.000	60	0.750	144	2889

Metcalf & Eddy
An Air & Water Technologies Company

July 10, 1997

Mr. Tim Locke
Biogas Flare Group
John Zink Company
11920 East Apache
Tulsa, Oklahoma 74116

Subject: **Request for Preliminary Sizing and Budget Quotation - Enclosed Landfill Gas Flare; Rose Hill Regional Landfill Superfund Site, South Kingstown, Rhode Island**

Dear Mr. Locke:

Metcalf & Eddy (M&E) is currently finalizing the Feasibility Study (FS) for the Rose Hill Regional Landfill site in South Kingstown, RI. One of the FS alternatives includes treatment of landfill gas (LFG) utilizing an enclosed flare. Previous contact with your company regarding this project has been made on two occaisions. The first was a similar request made to Mr. David Ryan on February 17, 1993. The second was a phone discussion which you and I had on June 3, 1997. M&E is interested in obtaining a preliminary LFG flare sizing and budgetary equipment cost quotation to use for the lastest version of the FS.

As previously discussed, there are two gas streams anticipated, an Internal LFG stream and a dilute Perimeter Gas stream. Previously, these streams were assumed to be combined prior to combustion. However, due to the anticipated gas stream compositions (see below), the amount of auxiliary fuel required to sustain combustion of the LFG contaminants was found to be quite large. The costs associated with the auxiliary fuel has caused much concern with those that will be paying the O&M costs. Therefore, an alternative design which reduces the O&M costs is desired. As we discussed, by keeping the Perimeter Gas separated from the Internal LFG prior to entering the flare, auxilary fuel costs should be reduced.

Please develop preliminary flare sizing based on the following assumptions:

1) Internal LFG flow rate: 80 cfm, 50% CH_4 by volume, 50% CO_2
2) Perimeter gas flow rate: 810 cfm, 2% CH_4 by volume, 2% CO_2, balance air
3) Flare combustion temperature: 1,500 °F
4) There will not be a building available to place the equipment in

Please include the following items in your quotation:

1) System Requirements:

- flare dimensions (diameter, height)
- combustion and quench air flowrates required
- stack velocities (if possible)

2) Budgetary equipment costs (+50%, -30% accuracy), including blower costs (2 for each gas stream)

3) Construction Items:
   - estimated lead time for flare delivery
   - utility requirements
   - instrumentation requirements
   - foundation requirements/weight loads

4) Operations & Maintenance items:
   - start-up support needed
   - expected lifetimes of major equipment
   - auxiliary fuel needed*
   - pilot fuel needed*
   - annual O&M labor required
   - maintenance equipment and spare parts

5) Installation cost multipliers (freight, taxes, installation) if known

* Please calculate for both propane and natural gas and present heating value assumptions.

Your quotations are needed by the end-of-day Friday, July 18, 1997. Thank you for your assistance with this project. If you have any questions, please do not hesitate to contact me at TEL (617) 224-6811 or by FAX at (617) 245-6293.

Very truly yours,

METCALF & EDDY, INC.

Sean Czarniecki

Sean Czarniecki, P.E., ChE
Project Engineer

cc: File

M&E Metcalf & Eddy

Metcalf & Eddy, Inc.

30 Harvard Mill Square P.O. Box 4071
Wakefield, Massachusetts 01880-5371

FAX Number: 617/245-6293

TELECOPIER TRANSMITTAL SHEET

Date: 7-10-97

PLEASE DELIVER AT ONCE TO:

Name: Mr. Tim Locke

Location: John Zink Company

FAX Number if not M&E: 918-234-1986

From: Sean Czarniecki Ext: 6811

Please make copies and deliver to the following additional people:

Additional Information/Message:

TOTAL Number of pages being transmitted (including this cover): 3

**PLEASE TELEPHONE THE MAILROOM
IF YOU DO NOT RECEIVE THE CORRECT NUMBER OF PAGES - 617/224-6296 or 6298**

FOR WAKEFIELD USE ONLY:

DO YOU WANT ORIGINAL BACK? YES ☒ NO ☐

JOB NO. 020617-0011 DEPT NO. 2114

Project	Rose Hill	Acct. No.	020617-0011	Page	1 of 2
Subject	Flare Quotation	Comptd. By	S. Czarniecki	Date	7/21/97
Detail		Ck'd. By		Date	

Tim,

Thanks for your quotation. I have a few more questions:

(1) You have the Gas Stream Temperatures at 100°F. We can see that for the internal stream, but the perimeter would probably be lower. Does this change anything? We don't think it will, but thought we'd ask.

(2) Is the perimeter gas being used as combustion air? What is the amount of combustion air the flare will be using? These questions need to be answered so that I can calculate the stack discharge velocity - I need to perform dispersion modeling. If you can give me the velocity, my life would also be made easier, although it is not difficult to calculate.

(3) We generally anticipate approximately 98% DRE for our organic contaminants. Based on existing literature, this may vary depending on the compound. Do you have a standard list of compounds that we could compare our list to check our assumptions? Vinyl chloride is our major contaminant and we assume a conservative 95% DRE. Any comments?

(4) Based on the flows I gave you, we don't need aux. fuel. However, the LFG production is decreasing. I've attached the projected flows for Internal Gas (assume Perimeter Gas remains the same). ~~What is your low~~ It appears that approximately 2 MMBtu/hr will be the low point prior to aux. fuel being required. Is this correct?

(4a) What are the heating values you utilize for propane and natural gas?

(4b) How much aux. fuel do you anticipate being required based on the flows presented?

Thank you for you time in this matter. You can either contact me by fax 617-245-6293 or phone 617-224-6811.

Sean Czarniecki

Project	Rose Hill	Acct. No.	020617-0011	Page	2 of 2
Subject	Flare Quotation	Comptd. By	S. Czarniecki	Date	7/21/97
Detail		Ck'd. By		Date	

Projected Internal Gas Stream Flows

	SCFM
1996	80
1997	73
1998	69
1999	66
2000	63
2001	60
2002	57
2003	54
2004	51
2005	49
2006	46
2007	44
2008	42
2009	40
2010	38
2011	36
2012	34

End of Operation

- Auxiliary Fuel Requirements

Project	Rose Hill Feasibility Study	Acct. No.	020617 - 0011	Page	1 of 2
Subject	Alternative Flare	Comptd. By	S. Czarniecki	Date	25-Jul-97
Detail	Auxiliary Fuel	Ck'd By	B. Weir	Date	28-Jul-97

P:\NE\ROSEHILL\FS\APPX-E\FLARE.XLS

Using LFG production values from the Scholl-Canyon model results and assumptions listed below, we calculate the future auxiliary fuel needs.

Year	Time Since LF Closure (years)	Annual LFG Production (ft^3 / yr)	Annual LFG Production (cfm)	Internal LFG Production (cfm)	Heating Value (Btu/hr)	Assist Heat (Btu/hr)	Natural Gas (scfm)	Propane (scfm)
1996	14	5.77E+07	110	77	2.10E+06	0.00E+00	0.0	0.0
1997	15	5.49E+07	104	73	2.00E+06	0.00E+00	0.0	0.0
1998	16	5.22E+07	99	70	1.90E+06	0.00E+00	0.0	0.0
1999	17	4.97E+07	95	66	1.81E+06	0.00E+00	0.0	0.0
2000	18	4.73E+07	90	63	1.72E+06	0.00E+00	0.0	0.0
2001	19	4.49E+07	86	60	1.63E+06	0.00E+00	0.0	0.0
2002	20	4.28E+07	81	57	1.55E+06	0.00E+00	0.0	0.0
2003	21	4.07E+07	77	54	1.48E+06	2.13E+04	0.4	0.2
2004	22	3.87E+07	74	52	1.41E+06	9.34E+04	1.6	0.7
2005	23	3.68E+07	70	49	1.34E+06	1.62E+05	2.7	1.2
2006	24	3.50E+07	67	47	1.27E+06	2.27E+05	3.8	1.6
2007	25	3.33E+07	63	44	1.21E+06	2.89E+05	4.8	2.1
2008	26	3.17E+07	60	42	1.15E+06	3.48E+05	5.8	2.5
2009	27	3.01E+07	57	40	1.10E+06	4.05E+05	6.7	2.9
2010	28	2.87E+07	55	38	1.04E+06	4.58E+05	7.6	3.3
2011	29	2.73E+07	52	36	9.91E+05	5.09E+05	8.5	3.7
2012	30	2.59E+07	49	35	9.43E+05	5.57E+05	9.3	4.0
						Total	51.17	22.09

Assumptions

Flare will operate until 30 years beyond landfill closure, which was 1982.

The Internal LFG stream remains at 50% methane and 50% carbon dioxide and is 70% of the total LFG production.

The Perimeter LFG stream volume and composition remains constant over time.

The Internal LFG stream has a Lower Heating Value of 455 Btu/scf [Ref: John Zink Co., 1997]

1.5 MMBtu/hr are requred to maintain an operating temperature of 1500 to 1600°F [Ref: John Zink Co., 1997]

Natural gas heating value - 1000 Btu/scf   Propane heating value - 2316 Btu/scf [Ref: John Zink Co., 1997]

METCALF & EDDY

Worst case total aux. fuel occurs if flare is operated 24 hrs/day. However, intermittent operation utilizing a timer may reduce or eliminate the need for aux. fuel. This would only occur if the perimeter system was found to be unnecessary in the future. Calculations below assume present day costs and 24 hr operation.

Natural Gas

51.17 cfm = 2.69E+07 cf total — Using 1997 as a basis, 15 years of operation gives an annual O&M

$0.79 /cf = $21,246,642 total — cost for natural gas as $1,416,443

[Cost Ref: Providence Gas Telecommunication - Attached]

Propane

22.09 cfm = 1.16E+07 cf total — Using 1997 as a basis, 15 years of operation gives an annual O&M

$0.02 /cf = $232,249 total — cost for propane as $15,483

[Cost Ref: Star Gas Telecommunication - Attached]

Natural Gas Line Installation

M&E reviewed the location of a natural gas line while performing aux. fuel cost calculations. The nearest gas line is located approximately 4,700 ft from the proposed flare location, at the intersection of Broad Rock Road and Saugatucket Road. [Providence Gas Telecommunication - Attached] Providence Gas Co. also provided an approximate cost of $22/ft for connection to a gas main.

This results in an installation cost of approximately $103,400 to install a natural gas line.

Based on the costs provided above, propane appears to be the best fuel for the flare at the Rose Hill site.

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 020617

DATE: 7/23/97

SUBJECT: Rose Hill Landfill
Gas Utility Location

M&E ENGINEER: N. Bergeron

OUTSIDE PARTY: Cindy
Providence Gas – Drafting Dept.
(401) 272-5040 x514

MADE CALL (X)

REC'D CALL ( )

COMMENTS	SUMMARY OF CONVERSATION:
11:00	I asked if Rose Hill Rd. had a gas line. Cindy looked it up and left a message that Rose Hill Rd. had no record of a gas line.
11:30	I called back to find out where the nearest gas line was. Cindy left a message that Mooresfield Road and Broad Rock Road had gas lines.
1:30	I called Cindy back to see if there was a gas line at the intersection of of Broad Rock Road and Saugatucket Road. Cindy verified that there was a gas line at this intersection.

CC:

M&E FORM NO. 196 (9/78)

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 020617

DATE: 7/23/97

SUBJECT: Rose Hill Landfill Feasability
Natural Gas Cost

M&E ENGINEER: N. Bergeron

OUTSIDE PARTY: Russ
Providence Gas
(401) 831-8806

MADE CALL (X)

REC'D CALL ( )

COMMENTS	SUMMARY OF CONVERSATION:
	Cost for natural gas:
	\$0.79/ft^3

CC:

M&E FORM NO. 196 (9/78)

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 020617

DATE: 7/23/97

SUBJECT: Rose Hill Landfill
Gas Utility Installation Cost

M&E ENGINEER: N. Bergeron

OUTSIDE PARTY: Lynn Moorer
Providence Gas - Marketing
(401) 272-5040 x 528

MADE CALL (X)

REC'D CALL ( )

COMMENTS

SUMMARY OF CONVERSATION:

I called to find a unit cost for gas line installation. Lynn referenced a chart for installation of a 2" main in a paved road. Chart only went up to 500' length:

For 500' → total cost = $11,000.

Using this the unit cost = $22/ft.

CC:

M&E FORM NO. 196 (9/78)

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 020617

DATE: 7/25/97

SUBJECT: Rose Hill Landfill
Propane Gas Price

M&E ENGINEER: N. Bergeron

OUTSIDE PARTY: Don
Star Gas
(401) 294-9547

MADE CALL ( )

REC'D CALL (X)

COMMENTS

SUMMARY OF CONVERSATION:

Don called with a propane price. He would charge $0.25/gal over the CELKIRK (sp? - a propane price index) He checked over the last 12 months and came up with an average CELKIRK price of $0.68/gal. He said that this past year was the highest in ten years (so its a conservative est.) This would give a price of $0.81/gal. Dividing by 36.4 ft³/gal yields a propane price of $0.02/ft³.

CC:

M&E FORM NO. 196 (9/78)

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 020617-0011

DATE: 7/28/97

SUBJECT: Rose Hill Landfill Flare
Propane Cost

M&E ENGINEER: N. Bergeron

OUTSIDE PARTY: Tom Ames
Suburban Propane

MADE CALL (X)

REC'D CALL ( )

COMMENTS	SUMMARY OF CONVERSATION:
	I asked Tom for a unit cost for propane. He said that for large volumes of propane he would be down around $0.12 to $0.15/gallon of propane above the CELKIRK (sp.?) price. CELKIRK is an index or cost baseline in the propane industry.

CC:
S. Czarniecki

M&E FORM NO. 196 (9/78)

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 020617-0011

DATE: 8/7/97

SUBJECT: Rose Hill Landfill Flare Propane Tank

M&E ENGINEER: S. Czarniecki

OUTSIDE PARTY: Don Andreozzi
Star Gas
401-294-9547 Fax 401-294-1465

MADE CALL ( )

REC'D CALL (X)

COMMENTS

SUMMARY OF CONVERSATION:

1:15

I told Don that we are looking for a cost on a propane tank. He said the tank is free with the propane purchase. We just have to determine the best size based on our needs. He asked what our usage will be & I explained that I have it in cfm. He needed gallons, so I said I would fax a graph for him. He thinks ~ 1000 to 2000 gal tank.

I asked what codes we will need to follow - he said NFPA 58 will require that the tank is 25 ft from any building or property line.

1:45

Don said he would suggest the 1st 4 years using a single 1000 gal tank and then adding another after that. Peak operation will be ~160 gpd (1120 gal/wk) so he would fill them once a week. If you go over 2000 gal in size new rules kick in.

The size is 16 ft long & about 40" in diameter. You need 3 ft between tanks. If you use a concrete pad, they will put down patio blocks. If you fence it in, you need two gates so no one gets trapped.

CC:
B. Weir
S. McCarron

E-5 Additional Landfill Gas Collection System Calculations - Draft FS

Project: Rose Hill FS — Acct. No. 9699-18-16-16 — Page 1 of 3
Subject: Perimeter Collection System — Comptd. By DTC — Date 6/1/93
Detail: — Ck'd. By [illegible] — Date 7/14/93

USE EQUATION DEVELOPED BY JOHNSON TO SIMULATE PERFORMANCE OF PERIMETER GAS EXTRACTION SYSTEM

$$\frac{Q}{H} = \pi \frac{k}{\mu} P_w \frac{1-(P_{ATM}/P_w)^2}{\ln(R_w/R_I)} \quad *$$

k = SOIL PERMEABILITY (cm^2)
μ = VISCOSITY OF AIR g/cm-s
P_w = ABSOLUTE PRESSURE AT EXTRACTION WELL [$g/cm\text{-}s^2$]
P_{ATM} = ABSOLUTE AMBIENT PRESSURE
R_w = RADIUS OF VAPOR EXTRACTION WELL
R_I = RADIUS OF INFLUENCE OF VAPOR EXTRACTION WELL

ATTACHED WORKSHEETS 1) INPUT PARAMETERS, 2) SOLUTIONS TO EQUATION AT DIFFERENT RADIUS' OF INFLUENCE AND EXTRACTION VACUUMS

ASSUME: RADIUS OF INFL. = 40 ft *
EXTRACTION VACUUM = 18 in H_2O

FLOW RATE = 18,800 cm^3/s [FROM 3/3]

= 40 cfm/well

NUMBER OF WELLS ALONG ROSE HILL ROAD:

ASSUME OVERLAP = 1/4 R_I

= 26 WELLS

TOTAL FLOW RATE:

40 cfm/well * 26 wells = 1,040 cfm

SAY 1,000 cfm

* SOURCE: JOHNSON, P.C. A PRACTICAL APPROACH TO THE DESIGN, OPERATION, AND MONITORING OF IN-SITU SOIL VENTING SYSTEMS. GROUNDWATER MONITORING REV. VOL. 10 NO. 2.. SPRING 1990.

METCALF & EDDY, ENGINEERS

NONREPRODUCIBLE GRID FORM 145

ROSE HILL SOLID WASTE LANDFILL: PERIMETER GAS EXTRACTION SYSTEM
VOLUMETRIC FLOWRATE CALCULATION
SOLUTION USING JOHNSON EQUATION FOR STEADY FLOW IN CONFINED VADOSE ZONE

INPUT PARAMETERS:

Air Viscosity, ua =	1.71E-04	g/cm•s
Air Density, rhoa =	1.29E-03	g/cm³
Landfill Gas Viscosity, ulfg =	1.21E-04	g/cm•s
Landfill Gas Density, rholfg =	1.35E-03	g/cm³
Mix Fraction Air, Xa =	0.5	
Mix Fraction Landfill Gas, Xlfg =	0.5	
Mixed Gas Viscosity, ug =	1.46E-04	g/cm•s
Mixed Gas Density, rhog =	1.32E-03	g/cm³
Soil Hydraulic Conductivity, K =	5.80E-03	cm/s
Water Viscosity, uw =	1.791E-02	g/cm•s
Water Density, rhow =	9.997E-01	g/cm³
Gravitational Acceleration, Ag =	9.81E+02	cm/s²
Gas Specific Gravity, gamma =	0.001	
Molecular Weight Air, MWa =	28	g/mol
ular Weight Landfill Gas, MWlfg =	30	g/mol
Molecular Weight Mix, MWg =	29	g/mol
Soil Porosity, n =	0.3	
Engineering Gas Constant, R =	8.314E+07	g•cm²/°K•mol•s²
Temperature, T =	10	°C
Vent Well Diameter, d =	20.32	cm
Depth to Confining Layer, b =	450	cm
Atmospheric Pressure, Patm =	1.01E+06	g/cm•s²
stance Along Rose Hill Road, m =	540	m
stance Along Entrance Road, m =	184	m
stance Along Northern Road, m =	184	m

CALCULATION:

draulic Intrinsic Permeability, ki =K*uw/rhow*Ag cm²
ki = 1.054E-07 cm²

Soil Gas Conductivity, Kg = K*uw*rhog/rh cm/s
Kg = 9.342E-04 cm/s

Soil Gas Permeability, kg = Ki cm²
kg = 1.054E-07 cm²

Storage Coefficient, Ss = Ag*MWg/R*T 1/cm
Ss = 3.626E-07 1/cm

Assume Radius of Infl. of 40 ft.

SOLUTION OF JOHNSTON EQUATION–FLOWRATE AT WELL TO ESTABLISH RADIUS OF INFLUENCE, R, AT FIXED VACUUM PRESSURE

APPLIED VACUUM AT W (om water	(g/om–s^2)	FLOW AT WELL (om^3/s)	304 om 10 ft	608 oi 20 ft	912 om 30 ft	1216 o 40 ft	1520 om 50 ft	1824 om 60 ft	3048 om 100 ft
10.2	1.000E+06		6032	5010	4559	4284	4094	3950	3594
12.7	9.976E+05	3355	7520	6246	5683	5341	5103	4924	4481
25.4	9.851E+05	6710	15135	12571	11438	10750	10271	9910	9018
38.1	9.727E+05	10065	22650	18879	17268	16230	15507	14962	13615
44.0	9.669E+05	11623	26469	21985	20003	18800	17962	17331	15771
50.8	9.602E+05	13420	30668	25473	23176	21783	20812	20081	18273
63.5	9.478E+05	16774	38593	32055	29165	27412	26190	25270	22995

Assume Drawdown at Well = 18 in = 44 cm H_2O

TOTAL FLOW RATE (om^3/s)

(om water	(g/om–s^2)							
NUMVER OF WELLS		103	52	35	26	21	18	11
12.7	9.976E+05	7.745E+05	6.433E+05	5.853E+05	5.501E+05	5.256E+05	5.072E+05	4.615E+05
25.4	9.851E+05	1.559E+06	1.295E+06	1.178E+06	1.107E+06	1.058E+06	1.021E+06	9.289E+05
38.1	9.727E+05	2.354E+06	1.955E+06	1.779E+06	1.672E+06	1.597E+06	1.541E+06	1.402E+06
50.8	9.602E+05	3.159E+06	2.624E+06	2.387E+06	2.244E+06	2.144E+06	2.068E+06	1.882E+06
63.5	9.478E+05	3.975E+06	3.302E+06	3.004E+06	2.823E+06	2.696E+06	2.603E+06	2.369E+06

E-6 Photocatalytic Oxidation Calculations

ACIDGAS.XLS

Data from Appendix D in the Remedial Investigation Report (M&E, 1994) was used for contaminant concentrations in the Solid Waste Area. Presented below are conversion calculations for ppbv to mg/m^3, followed by conversion of these concentrations to account for dilution by air that will also be drawn in during gas extraction (the sample data are for "pure" landfill gas, and must be adjusted to account for the air collected by the perimeter and internal collection systems). Contaminants shown were selected by risk assessment personnel.

Locations sampled: SG-SW(13+300)-12
SG-SW(11+500)-05
SG-SWD(13+300)-12
SG-SW(03+300)-06

Conversion from ppbv to mg/m^3: [from spreadsheet SUMMA.WK1, 8/14/96, prepared by S. Czarniecki]

Based on 760 torr (1 atm.) barometric pressure at 25°C and where 24.45 = molar volume in liters

mg/m^3 = (ppbv * gram molecular weight of substance) / (24.45 * 1000)

Conversion to account for dilution by extracted air:

Assumptions and Calculations:

1. The air does not contain any of the contaminants of concern.
2. The volumetric flow rate of air without landfill gas is 368,000 cm^3/s
   [from calculation by S. Czarniecki dated 8/26/96, spreadsheet COMPOSIT.WK1]
3. The volumetric flow rate of air + landfill gas = total influent to photocatalytic oxidation unit
   = 420,000 cm^3/s
4. Therefore the volumetric flow rate of landfill gas = 420,000 - 368,000
   = 52,000 cm^3/s
5. Concentration of contaminant in influent gas (air + landfill gas) = concentration in landfill gas x [landfill gas flow rate/(air + landfill gas flow rate)] = concentration x 52,000/420,000

ACIDGAS.XLS

Contaminants:	MW	Landfill Gas Concentrations Maximum Detection (ppbv) [1]	(mg/m³)	Photocatalytic Oxidation Unit Influent Concentrations Maximum Detection (ppbv) [1]	(mg/m³)
Benzene	78.1	2,500	8.0	310	0.99
1,1-Dichloroethene	**97**	**8,100**	**32**	**1,003**	**3.98**
cis-1,2-Dichloroethene	**97**	**5,900,000**	**23,000**	**730,476**	**2,848**
trans-1,2-Dichloroethene	**97**	**6,700**	**27**	**830**	**3.29**
Ethylbenzene	106.2	5,800	25	718	3.12
Methylene Chloride	**84.9**	**19,000**	**66**	**2,352**	**8.17**
Toluene	92.1	62,000	230	7,676	28.48
Trichloroethene	**131.4**	**5,700**	**31**	**706**	**3.79**
Vinyl Chloride	**62.5**	**1,200,000**	**3,100**	**148,571**	**383.81**
m,p-Xylene	106.2	9,400	41	1,164	5.06
o-Xylene	106.2	2,500	11	310	1.34
Carbon Disulfide	76.1	280	0.87	35	0.11
Dichlorodifluoromethane	**120.9**	**22,000**	**110** [2]	**2,724**	**13.62**
1,1-Dichloroethane	**99**	**34,000**	**140**	**4,210**	**17.33**
4-Methyl-2-pentanone	100.2	1,600	6.6	198	0.81
1,1,2,2-Tetrachloroethane	**167.9**	**0** *	**0**	**0**	**0**
1,1,1-Trichloroethane	**133.4**	**1,900**	**10**	**235**	**1.28**
1,2,4-Trimethylbenzene	120.2	500	2	62	0.30
1,3,5-Trimethylbenzene	120.2	870	4.3	108	0.53
Acetone	58.1	0 *	0	0	0
1,2,4-Trichlorobenzene	**181.5**	**0** *	**0**	**0**	**0**

ACIDGAS.XLS

Major Components of Influent Gas to the Photocatalytic Oxidation System are: Methane, Carbon Dioxide, Nitrogen, and Oxygen

The percentages (by volume) of these gases [from spreadsheet COMPOSIT.WK1, dated 8/26/96, prepared by S. Czarniecki] are:

Percent by volume Methane (CH_4):	6.18
Percent by volume Carbon Dioxide (CO_2):	6.18
Percent by volume Nitrogen (N_2):	69.24
Percent by volume Oxygen (O_2):	18.41

Relative Humidity and Temperature of Influent Gas to the Photocatalytic Oxidation System:

Given the source of the gas, it is assumed that the relative humidity will approach 100% and the temperature will not drop below 10° C.

DESTRUCTION AND REMOVAL EFFICIENCIES:

For the purpose of estimating acid gas production, 100% destruction of chlorinated VOCs in the influent gas stream is assumed.

It is further assumed that the percentages of HCl and Cl_2 formed will be the same for each chlorinated VOC and will be as follows:

6.7% of the total chlorine atoms formed will go to HCl;

93.3% of the total chlorine atoms formed will go to Cl_2.

These values are based on values provided by KSE, Inc. for the photocatalytic oxidation of vinyl chloride.

Notes:

* Not detected in solid waste area SUMMA canister samples, but were chemicals of concern in RI report (M&E, 1994)

(1) Maximum of four samples. Duplicate samples not averaged prior to identifying maximum.

(2) Shows as 100 mg/m^3 on analytical sheet possibly due to calculation at different temperature.

ACIDGAS.XLS

Chlorinated VOCs:

	MW	No. Cl atoms	Influent to Photocatalytic Units: Concentration (ppbv)	Influent to Photocatalytic Units: Flow (gmoles/s)	Effluent from Photocatalytic Units: Cl production assuming 100%DRE (g-atoms/s)
1,1-Dichloroethene	97	2	1,003	1.88E-05	3.76E-05
cis-1,2-Dichloroethene	97	2	730,476	1.37E-02	2.74E-02
trans-1,2-Dichloroethene	97	2	830	1.56E-05	3.11E-05
Methylene Chloride	84.9	2	2,352	4.41E-05	8.82E-05
Trichloroethene	131.4	3	706	1.32E-05	3.97E-05
Vinyl Chloride	62.5	1	148,571	2.79E-03	2.79E-03
Dichlorodifluoromethane	120.9	2	2,724	5.11E-05	1.02E-04
1,1-Dichloroethane	99	2	4,210	7.89E-05	1.58E-04
1,1,2,2-Tetrachloroethane	167.9	4	0	0.00E+00	0.00E+00
1,1,1-Trichloroethane	133.4	3	235	4.41E-06	1.32E-05
1,2,4-Trichlorobenzene	181.5	3	0	0.00E+00	0.00E+00

CALCULATIONS:

Total influent gas flow rate = 420,000 cm^3/s (STP) x 1 gmole/22,400 cm^3 = 18.75 gmoles/s

VOC Flow (gmoles/s) = VOC concentration (ppbv) x 1 /1,000,000,000 x total influent gas flow rate (gmoles/s)

Cl production (g-atoms/s) = VOC flow (gmoles/s) x no. Cl atoms

ACIDGAS.XLS

Chlorinated VOCs:	Effluent from Photocatalytic Units HCl @ 6.7% of Cl atoms (gmoles/s)	Cl2 @ 93.3% of Cl atoms (gmoles/s)	Convert to lb/hr HCl (lb/hr)	Cl2 (lb/hr)
1,1-Dichloroethene	2.52E-06	1.75E-05	7.28E-04	9.86E-03
cis-1,2-Dichloroethene	1.84E-03	1.28E-02	5.30E-01	7.18E+00
trans-1,2-Dichloroethene	2.08E-06	1.45E-05	6.02E-04	8.16E-03
Methylene Chloride	5.91E-06	4.12E-05	1.71E-03	2.31E-02
Trichloroethene	2.66E-06	1.85E-05	7.69E-04	1.04E-02
Vinyl Chloride	1.87E-04	1.30E-03	5.39E-02	7.31E-01
Dichlorodifluoromethane	6.84E-06	4.76E-05	1.98E-03	2.68E-02
1,1-Dichloroethane	1.06E-05	7.36E-05	3.06E-03	4.14E-02
1,1,2,2-Tetrachloroethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,1,1-Trichloroethane	8.87E-07	6.17E-06	2.56E-04	3.47E-03
1,2,4-Trichlorobenzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TOTALS:	0.00205	1.43E-02	0.5935	8.038

CALCULATE CONCENTRATIONS OF HCl and Cl_2 IN EXIT GAS (Assumes change in total moles of gas is negligible):

HCl: 0.00205 gmoles/s / 18.75 gmoles/s total gas flow x 1,000,000 = 109.52 ppmv

Cl_2: 0.0143 gmoles/s / 18.75 gmoles/s total gas flow x 1,000,000 = 762.53 ppmv

CALCULATIONS:

HCl (gmoles/s) = total Cl atoms (g-atoms/s) x 0.067

Cl_2 (gmoles/s) = total Cl atoms (g-atoms/s) x 0.933 x 1 gmole Cl_2/2 g-atoms Cl

HCl (lb/hr) = HCl (gmoles/s) x 3,600 s/hr x 36.45 g/gmoles x 1 lb/454 g

Cl_2 (lb/hr) = Cl_2 (gmoles/s) x 3,600 s/hr x 70.9 g/gmole x 1 lb/454 g

To determine if the treatment systems will be considered major sources by Rhode Island Air Pollution Control Rule #9, we must estimate the annual emissions of VOCs and NOx.

"Major stationary source" means any stationary source of air pollutants which emits or has the potential to emit 50 tons/yr or more of VOCs or NOx or 100 tons/yr of any other regulated air pollutant.

VOCs

Utilizing data from SUMMA.wk1, we assume that all contaminants detected are VOCs and that worst case treatment would allow 100% emissions. The total LFG concentration would be = 26,845 mg/m^3

From SCHOLLRE.wk1, the LFG production is = 0.0518 m^3/s

Therefore, without treatment, the total VOCs leaving the landfill = 1,391 mg/s
= 96,677 lb/yr
= 48 ton/yr

This shows that any treatment system utilized will not be a major source for VOCs.

NOx

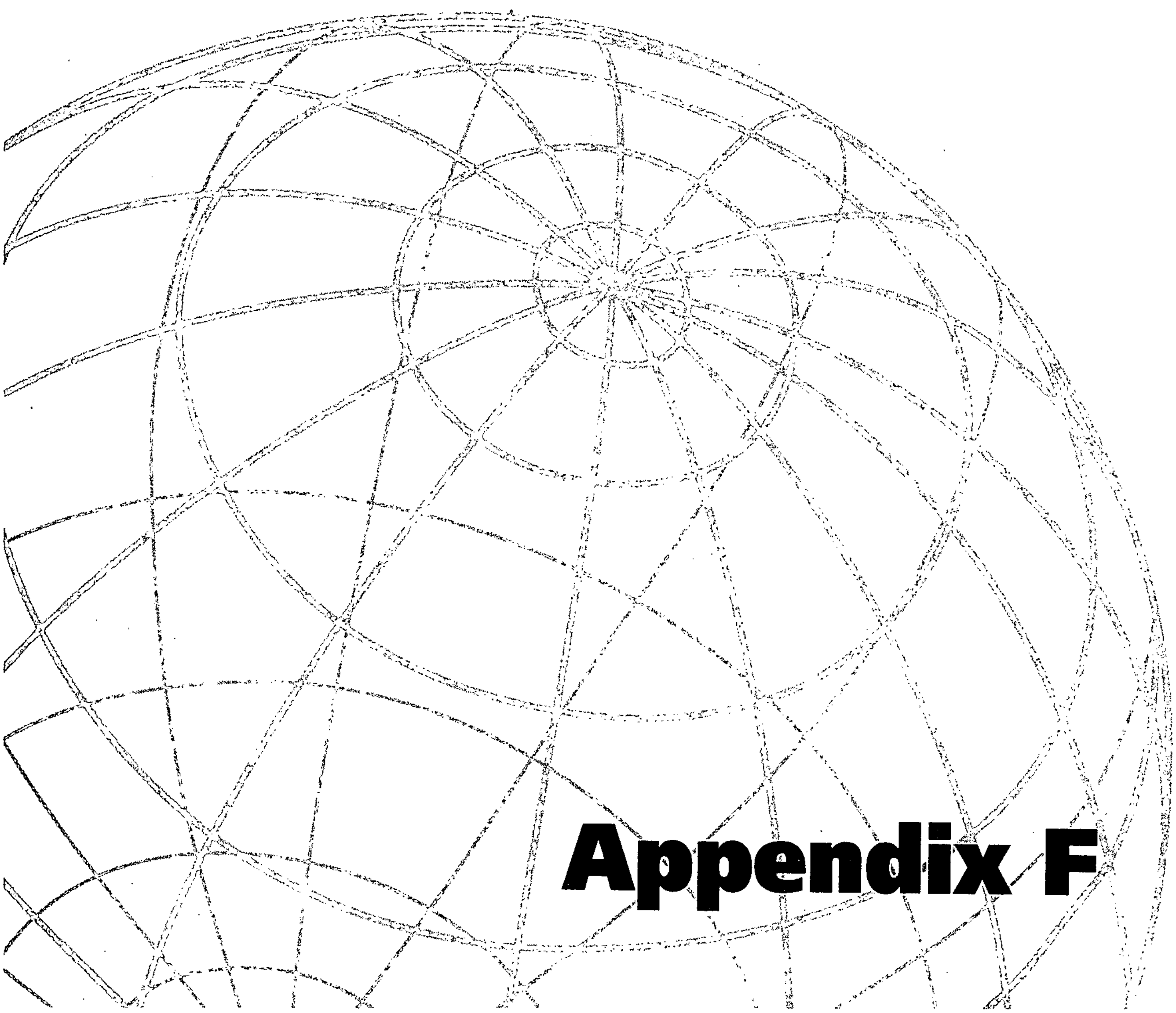
Flare operation is anticipated to produce more NOx than photocatalytic oxidation, since photocatalytic oxidation is a non-thermal treatment. From vendor quotations, NOx production at 1600°F is estimated to be 0.06 lb/MMBtu. The vendor also requires 1.5 MMBtu/hr of heating value for operation from 1500 to 1600°F.

For one year, NOx production is estimated at 788 lb/yr
= 0.4 ton/yr

This shows that the flare will not be a major source for NOx.

Any Other Regulated Pollutant

If Methane is considered a regulated pollutant under the definition of a major source, then any non-combustion treatment system becomes a major source (see GAS_COMP.xls).



Appendix F

Appendix F

F. AMBIENT AIR DISPERSION

F-1 Area Source Modeling - Risk Assessment

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1 of 1
Subject	Air Modeling	Comptd. By	S. Czarniecki	Date	08/14/96
Detail	SUMMA Canister Concentrations	Ck'd. By	J. Young	Date	08/14/96

C:\RH\AIR\ISCST3\SUMMA.WK1

SUMMA.WK1

Data from Appendix D in the Remedial Investigation Report (M&E, 1994) was used for contaminant concentrations in the Solid Waste Area. Attachment A presents these results as well as a map showing sampling locations. Presented below is conversion calculations for ppbv to mg/m^3. Contaminants shown were selected by risk assessment personnel.

Locations sampled: SG-SW(13+300)-12
SG-SW(11+500)-05
SG-SWD(13+300)-12
SG-SW(03+300)-06

Conversion from ppbv to mg/m^3:

Based on 760 torr (1 atm.) barometric pressure at 25°C and where 24.45 = molar volume in liters

mg/m^3 = (ppbv * gram molecular weight of substance) / (24.45 * 1000)

Contaminants:	MW	Maximum Detection (ppbv)[1]	(mg/m^3)
Benzene	78.1	2,500	8.0
1,1-Dichloroethene	97	8,100	32
cis-1,2-Dichloroethene	97	5,900,000	23,000
trans-1,2-Dichloroethene	97	6,700	27
Ethylbenzene	106.2	5,800	25
Methylene Chloride	84.9	19,000	66
Toluene	92.1	62,000	230
Trichloroethene	131.4	5,700	31
Vinyl Chloride	62.5	1,200,000	3,100
m,p-Xylene	106.2	9,400	41
o-Xylene	106.2	2,500	11
Carbon Disulfide	76.1	280	0.87
Dichlorodifluoromethane	120.9	22,000	110 [2]
1,1-Dichloroethane	99	34,000	140
4-Methyl-2-pentanone	100.2	1,600	6.6
1,1,2,2-Tetrachloroethane	167.9	0 *	0
1,1,1-Trichloroethane	133.4	1,900	10
1,2,4-Trimethylbenzene	120.2	500	2
1,3,5-Trimethylbenzene	120.2	870	4.3
Acetone	58.1	0 *	0
1,2,4-Trichlorobenzene	181.5	0 *	0

Notes:

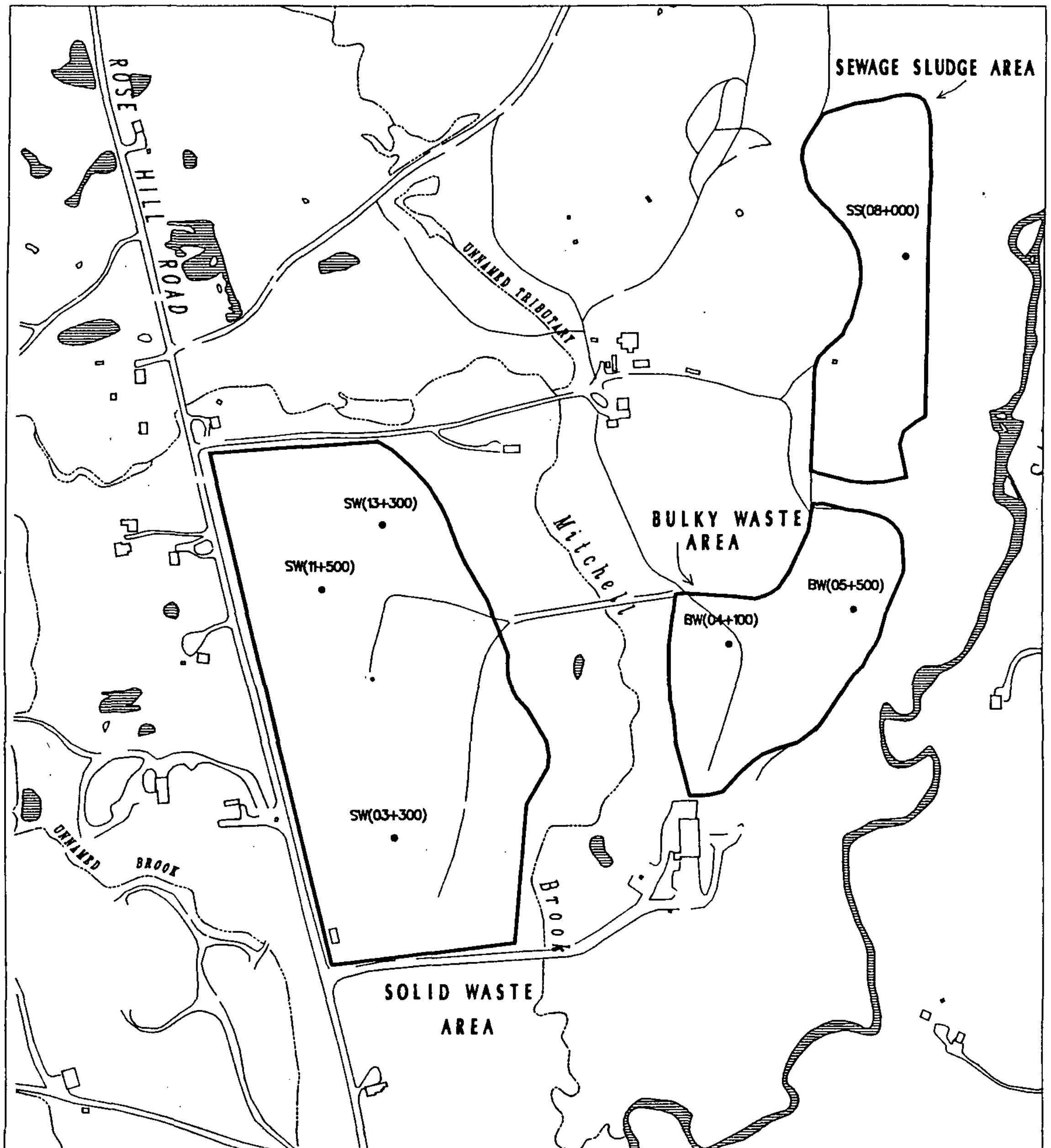
* Not detected in solid waste area SUMMA canister samples, but were chemicals of concern in RI report (M&E, 1994)

(1) Maximum of four samples. Duplicate samples not averaged prior to identifying maximum.

(2) Shows as 100 mg/m^3 on analytical sheet possibly due to calculation at different temperature.

Metcalf & Eddy, Inc.

ATTACHMENT A



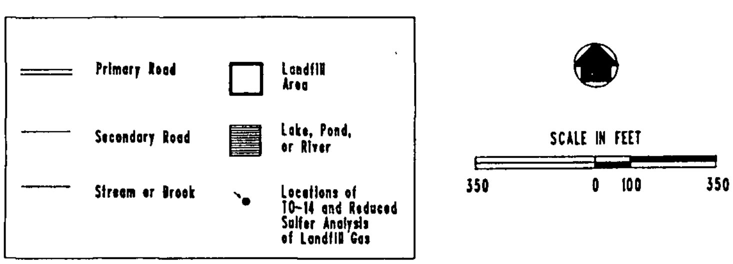


FIGURE 2-28

TO-14 and Reduced Sulfur Analysis Sampling Locations

ROSE HILL REGIONAL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

Volatile Analysis of SUMMA Canisters
(ppbv)

SITE: ROSE HILL REGIONAL LANDFILL
SAS NO.: 7165A SDG NO.: SA1401

TRAFFIC REPORT NUMBER:			SA1401		SA1402		SA1403		SA1404		SA1405		SA1406	
M&E SAMPLE ID:			SG-SS(08+000)-12		SG-BW(04+100)-06		SG-BW(05+500)-12		SG-SW(13+300)-12		SG-SW(11+500)-05		SG-SWD(13+300)-12	
COMPOUND	CRQL	MW		mg/m3		mg/m3		mg/m3		mg/m3		mg/m3		mg/m3
Dichlorodifluromethane	5	120.9	8 U	0.04	282 J	1.39	5200	26	12000 J	59	9200	45	22000 J	100
Freon 114	5	170.9	8 U	0.06	360 U	2.5	330 U	2.3	40000 U	300	280 J	2.0	140000 U	980
Chloromethane	5	50.5	8 U	0.02	360 U	0.74	330 U	0.68	40000 U	80	1400 J	2.9	140000 UJ	290
Vinyl Chloride	5	62.5	8 U	0.02	5500 D	14	470	1.2	490000 A	1300	400000 D	1000	1200000	3100
Bromomethane	5	95	8 U	0.03	360 U	1.4	330 U	1.3	40000 U	200	1800 U	7.0	140000 U	540
Chloroethane	5	64.5	8 U	0.02	740 J	1.9	670	1.8	6600 J	17	1800 U	4.7	140000 U	370
Trichlorofluoromethane	5	137.4	8 U	0.05	230 J	1.3	28 J	0.16	40000 U	200	250 J	1.4	140000 U	790
1,1-Dichloroethene	5	97	8 U	0.03	78 J	0.31	23 J	0.091	5600 J	22	3800	15	8100 J	32
Carbon Disulfide	5	76.1	8 U	0.03	360 U	1.1	330 U	1.0	40000 U	100	280 J	0.87	140000 U	430
Freon 113	5	187.4	8 U	0.06	14 J	0.11	330 U	2.5	40000 U	300	31 J	0.24	140000 U	1100
Acetone	5	58.1	34	0.08	560 J	1.3	330 U	0.78	40000 U	90	1800 U	4.3	140000 U	330
Methylene Chloride	5	84.9	0.6 J	0.002	260 J	0.90	680	2.4	8000 J	30	2400	8.3	19000 J	66
trans-1,2-Dichloroethene	5	97	8 U	0.03	75 J	0.30	28 J	0.11	3600 J	14	1000 J	4	6700 J	27
1,1-Dichloroethane	5	99	8 U	0.03	1700 J	6.9	510	2.1	22000 J	89	3900	16	34000 J	140
cis-1,2-Dichloroethene	5	97	8 U	0.03	4400 A	17	1200	4.8	2300000 A	9100	1800000 D	7100	5900000 J	23000
2-Butanone	5	72.1	8 U	0.02	740 J	2.2	590 A	1.7	40000 U	100	1800 U	5.3	140000 U	410
Chloroform	5	119.4	8 U	0.04	360 U	1.8	330 U	1.6	40000 U	200	1800 U	8.8	140000 U	680
1,1,1-Trichloroethane	5	133.4	8 U	0.04	310 J	1.7	330 U	1.8	1900 J	10	230 J	1.3	140000 U	760
Carbon Tetrachloride	5	153.8	8 U	0.05	360 U	2.3	330 U	2.1	40000 U	300	45 J	0.28	140000 U	880
Benzene	5	78.1	8 U	0.03	920 J	2.9	95 AJ	0.30	2500 J	8.0	620 J	2.0	140000 U	450
1,2-Dichloroethane	5	99	8 U	0.03	360 U	1.5	330 U	1.3	40000 U	160	1800 U	7.3	140000 U	570
Trichloroethene	5	131.4	8 U	0.04	570 J	3.1	700 A	3.8	2700 J	14	5700	31	140000 U	750
1,2-Dichloropropane	5	113	8 U	0.04	360 U	1.7	330 U	1.5	40000 U	200	1800 U	8.3	140000 U	650
Bromodichloromethane	5	163.9	8 U	0.05	360 U	2.4	330 U	2.2	40000 U	300	1800 U	12	140000 U	940
2-Chloroethyl Vinyl Ether	5	106.6	8 U	0.04	360 U	1.6	330 U	1.4	40000 U	200	1800 U	7.8	140000 U	610
cis-1,3-Dichloropropene	5	111	8 U	0.04	360 U	1.6	330 U	1.5	40000 U	200	1800 U	8.2	140000 U	630
4-Methyl-2-pentanone	5	100.2	8 U	0.03	360 U	1.5	330 U	1.3	1600 J	6.5	1800 U	7.4	140000 U	570
Toluene	5	92.1	8 U	0.03	9100 A	34	5700	21	22000 J	83	19000	71	62000 J	230
trans-1,3-Dichloropropene	5	111	8 U	0.04	360 U	1.6	330 U	1.5	40000 U	200	1800 U	8.2	140000 U	630
1,1,2-Trichloroethane	5	133.4	8 U	0.04	360 U	2.0	330 U	1.8	40000 U	200	1800 U	9.8	140000 U	760
Tetrachloroethene	5	165.8	8 U	0.06	130 J	0.88	200 J	1	40000 U	300	1200 J	8.1	140000 U	950
Dibromochloromethane	5	208.3	8 U	0.07	360 U	3.1	330 U	2.8	40000 U	300	1800 U	15	140000 U	1200
1,2-Dibromomethane	5	173.9	8 U	0.06	360 U	2.6	330 U	2.3	40000 U	300	1800 U	13	140000 U	990
2-Hexanone	5	100.2	8 U	0.03	360 U	1.5	330 U	1.3	40000 U	200	1800 U	7.4	140000 U	570
Chlorobenzene	5	112.6	8 U	0.04	360 U	1.7	330 U	1.5	40000 U	200	1800 U	8.3	140000 U	640
Ethylbenzene	5	106.2	2 J	0.01	2800 J	12	1300	5.6	40000 U	200	3000	10	140000 U	610
m,p-Xylene	5	106.2	4 J	0.02	5600 J	24	750	3.3	40000 U	200	5600	24	140000 U	610
o-Xylene	5	106.2	2 J	0.01	1500 J	6.5	160 J	0.69	40000 U	200	1000 J	4	140000 U	610
Styrene	5	104.2	8 U	0.03	1100 J	4.7	250 J	1.1	40000 U	200	1800 U	7.7	140000 U	600
Bromoform	5	252.8	8 U	0.08	360 U	3.7	330 U	3.4	40000 U	400	230 J	2.4	140000 U	1400
1,1,2,2-Tetrachloroethane	5	167.9	8 U	0.06	360 U	2.5	330 U	2.3	40000 U	300	1800 U	12	140000 U	960
1,3,5-Trimethylbenzene	5	120.2	0.6 J	0.003	310 J	1.5	61 AJ	0.30	870 J	4.3	150 J	0.74	140000 U	690
1,2,4-Trimethylbenzene	5	120.2	1 J	0.005	470 J	2.3	160 J	0.78	40000 U	200	220 J	1.1	140000 U	690
1,3-Dichlorobenzene	5	147	8 U	0.05	360 U	2.2	330 U	2.0	40000 U	200	1800 U	11	140000 U	840

Volatile Analysis of SUMMA Canisters
(ppbv)

SITE: ROSE HILL REGIONAL LANDFILL
SAS NO.: 7165A SDG NO.: SA1401

TRAFFIC REPORT NUMBER:			SA1401		SA1402		SA1403		SA1404		SA1405		SA1406	
M&E SAMPLE ID:			SG-SS(08+000)-12		SG-BW(04+100)-06		SG-BW(05+500)-12		SG-SW(13+300)-12		SG-SW(11+500)-05		SG-SWD(13+300)-12	
COMPOUND	CRQL	MW		mg/m3		mg/m3		mg/m3		mg/m3		mg/m3		mg/m3
1,4-Dichlorobenzene	5	147	8 U	0.05	360 U	2.2	330 U	2.0	40000 U	200	1800 U	11	140000 U	840
Benzyl Chloride	5	126.6	8 U	0.04	360 U	1.9	330 U	1.7	40000 U	200	1800 U	9.3	140000 U	720
1,2-Dichlorobenzene	5	147	8 U	0.05	360 U	2.2	330 U	2.0	40000 U	200	1800 U	11	140000 U	840
1,2,4-Trichlorobenzene	5	181.5	8 U	0.06	360 U	2.7	37 J	0.27	40000 U	300	1800 U	13	140000 U	1000
Hexachlorbutadiene	5	260.8	8 U	0.09	360 U	3.8	29 J	0.31	40000 U	400	1800 U	19	140000 U	1500
DILUTION FACTOR:			1.642110		73.12241		66		7887.555		357.7192		28219.79	
RECEIPT PRESSURE (in Hg):			5.5		2.5		2		4.5		7.5		1.5	
FINAL PRESSURE (psi):			5		5		5		5		5		5	
SAMPLE VOLUME:			1000		20		25		0.2		5		0.05	
DATE SAMPLED:			05/07/92		05/08/92		05/11/92		05/12/92		05/12/92		05/12/92	
DATE ANALYZED:			05/20/92		05/20/92		05/21/92		05/20/92		05/21/92		05/22/92	
REMARKS:														

Footnotes:
- CRQL - Contract Required Quantitation Limits.
- J - Quantitation is approximate due to limitations identified in the quality control review .
- U - Value reported is the sample detection limit.
- R - Value is rejected.
- UJ - Sample detection limit is approximate due to limitations identified in the quality control review.
- D - Quantitation is from a diluted sample result.
- DJ - Quantitation is from a diluted sample result, but should be considered estimated due to limitations identified in the quality control review.
- A - Quantitation is the average of two diluted analysis results.
- AJ - Quantitation is the average of two diluted analysis results, but should be considered estimated due to limitations identified in the quality control review.

SITE: ROSE HILL REGIONAL LANDFILL
SAS NO.: 7165A SDG NO.: SA1

TRAFFIC REPORT NUMBER:			SA1407		SA1408	
M&E SAMPLE ID:			SG-SW(03+300)-06		SG-EB(05-011)-0	
COMPOUND	CRQL	MW		mg/m3		mg/m3
Dichlorodifluromethane	5	120.9	210	1.0	0.3 J	0.001
Freon 114	5	170.9	160 U	1.1	6 U	0.04
Chloromethane	5	50.5	160 UJ	0.33	6 U	0.01
Vinyl Chloride	5	62.5	1200	3.1	6 U	0.02
Bromomethane	5	95	160 U	0.62	6 U	0.02
Chloroethane	5	64.5	450	1.2	6 U	0.02
Trichlorofluoromethane	5	137.4	32 J	0.18	0.1 J	0.0006
1,1-Dichloroethene	5	97	10 J	0.04	6 U	0.02
Carbon Disulfide	5	76.1	38 J	0.12	6 U	0.02
Freon 113	5	187.4	160 U	1.2	0.3 J	0.002
Acetone	5	58.1	160 U	0.38	6 U	0.01
Methylene Chloride	5	84.9	200	0.7	6 U	0.02
trans-1,2-Dichloroethene	5	97	22 J	0.087	6 U	0.02
1,1-Dichloroethane	5	99	53 J	0.21	6 U	0.02
cis-1,2-Dichloroethene	5	97	380	1.5	0.4 J	0.002
2-Butanone	5	72.1	160 U	0.47	6 U	0.02
Chloroform	5	119.4	160 U	0.78	6 U	0.03
1,1,1-Trichloroethane	5	133.4	160 U	0.87	0.2 J	0.001
Carbon Tetrachloride	5	153.8	160 U	1.0	6 U	0.04
Benzene	5	78.1	820	2.6	6 U	0.02
1,2-Dichloroethane	5	99	160 U	0.65	6 U	0.02
Trichloroethene	5	131.4	84 J	0.45	6 U	0.03
1,2-Dichloropropane	5	113	160 U	0.74	6 U	0.03
Bromodichloromethane	5	163.9	160 U	1.1	6 U	0.04
2-Chloroethyl Vinyl Ether	5	106.6	160 U	0.70	6 U	0.03
cis-1,3-Dichloropropene	5	111	160 U	0.72	6 U	0.03
4-Methyl-2-pentanone	5	100.2	160 U	0.65	6 U	0.02
Toluene	5	92.1	5500 A	21	0.6 J	0.002
trans-1,3-Dichloropropene	5	111	160 U	0.72	6 U	0.03
1,1,2-Trichloroethane	5	133.4	160 U	0.87	6 U	0.03
Tetrachloroethene	5	165.8	84 J	0.57	0.1 J	0.0007
Dibromochloromethane	5	208.3	160 U	1.4	6 U	0.05
1,2-Dibromomethane	5	173.9	160 U	1.1	6 U	0.04
2-Hexanone	5	100.2	160 U	0.65	6 U	0.02
Chlorobenzene	5	112.6	160 U	0.74	6 U	0.03
Ethylbenzene	5	106.2	5800 A	25	6 U	0.03
m,p-Xylene	5	106.2	9400 A	41	6 U	0.03
o-Xylene	5	106.2	2500 A	11	6 U	0.03
Styrene	5	104.2	160 U	0.68	6 U	0.03
Bromoform	5	252.8	160 U	1.7	6 U	0.06
1,1,2,2-Tetrachloroethane	5	167.9	160 U	1.1	6 U	0.04
1,3,5-Trimethylbenzene	5	120.2	210	1.0	6 U	0.03
1,2,4-Trimethylbenzene	5	120.2	500	2	6 U	0.03
1,3-Dichlorobenzene	5	147	160 U	0.96	6 U	0.04

SITE: ROSE HILL REGIONAL LANDFILL
SAS NO.: 7165A SDG NO.: SA1

TRAFFIC REPORT NUMBER:			SA1407		SA1408	
M&E SAMPLE ID:			SG-SW(03+300)-06		SG-EB(05-011)-0	
COMPOUND	CRQL	MW		mg/m3		mg/m3
1,4-Dichlorobenzene	5	147	72 J	0.43	6 U	0.04
Benzyl Chloride	5	126.6	160 U	0.83	6 U	0.03
1,2-Dichlorobenzene	5	147	160 U	0.96	6 U	0.04
1,2,4-Trichlorobenzene	5	181.5	160 U	1.2	6 U	0.04
Hexachlorbutadiene	5	260.8	160 U	1.7	6 U	0.06

	SA1407	SA1408
DILUTION FACTOR:	32.18325	1.304736
RECEIPT PRESSURE (in Hg):	5	-0.81442
FINAL PRESSURE (psi):	5	5
SAMPLE VOLUME:	50	1000
DATE SAMPLED:	05/13/92	05/11/92
DATE ANALYZED:	05/22/92	05/20/92
REMARKS:		

Footnotes:
- CRQL - Contract Required Quantitation Limits.
- J - Quantitation is approximate due to limitations identified in the quality control review
- U - Value reported is the sample detection limit.
- R - Value is rejected.
- UJ - Sample detection limit is approximate due to limitations identified in the quality control review.
- D - Quantitation is from a diluted result.
- DJ - Quantitation is from a diluted result, but should be consider estimated due to limitations identified in the quality control review.
- A - Quantitation is the average of diluted analysis results.
- AJ - Quantitation is the average of diluted analysis results, but considered estimated due to li identified in the quality cont

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1 of 1
Subject	Air Modeling	Comptd. By	S. Czarniecki	Date	08/09/96
Detail	ISCST3 Solid Waste Area Grid	Ck'd. By	R. Porter	Date	08/26/96

C:\RH\AIR\ISCST3\SOLGRID.WK1

Metcalf & Eddy, Inc.

SOLGRID.WK1

The FS Solid Waste Area was drawn onto the modeling grid from previous efforts (M&E, 1993) and area source squares were drawn to cover the area. See Attachment A for the numbered squares.

Historically, the source-to-receptor distance for area sources was required to be greater than the length of one side of a respective area source square to have valid results. With ISCST3, this is not the case. Attachment B is text from the User's Guide for ISC3 which describes that the only restriction is that sources with side length less than 3 meters should be used with caution near receptors. In the Rose Hill case, the smallest receptor has a length of 15 meters, so this does not apply.

Grid squares on Attachment A are 50 ft on each side = 15.24 m

	Southwest Corner			Input for model (all values in meters) Values are the X, Y coords. times square length			
Square	X	Y	Length	X	Y	Length	Area (m^2)
1	8	35	7	121.92	533.40	106.68	11,381
2	15	35	6	228.60	533.40	91.44	8,361
3	9	30	5	137.16	457.20	76.20	5,806
4	14	32	3	213.36	487.68	45.72	2,090
5	17	32	3	259.08	487.68	45.72	2,090
6	20	33	2	304.80	502.92	30.48	929
7	20	32	1	304.80	487.68	15.24	232
8	21	32	1	320.04	487.68	15.24	232
9	14	31	1	213.36	472.44	15.24	232
10	14	30	1	213.36	457.20	15.24	232
11	15	25	7	228.60	381.00	106.68	11,381
12	10	25	5	152.40	381.00	76.20	5,806
13	11	22	3	167.64	335.28	45.72	2,090
14	14	22	3	213.36	335.28	45.72	2,090
15	17	23	2	259.08	350.52	30.48	929
16	22	25	2	335.28	381.00	30.48	929
17	19	19	6	289.56	289.56	91.44	8,361
18	17	21	2	259.08	320.04	30.48	929
19	12	17	5	182.88	259.08	76.20	5,806
20	17	19	2	259.08	289.56	30.48	929
21	17	17	2	259.08	259.08	30.48	929
22	19	14	5	289.56	213.36	76.20	5,806
23	13	14	3	198.12	213.36	45.72	2,090
24	16	14	3	243.84	213.36	45.72	2,090
25	14	12	2	213.36	182.88	30.48	929
26	16	9	5	243.84	137.16	76.20	5,806
27	21	11	3	320.04	167.64	45.72	2,090
						Total ->	90,580 m^2

Emission Rate (g / m^2-s) to be used in model

Landfill Gas Production	=	0.0518	m^3/s	See Attachment C
Landfill Area	=	90,580	m^2	See Total Above

Vinyl chloride is expected to be the most significant contaminant in the air, so modeling will be based on its conc.

Contaminant Concentration		3,100,000	$\mu g/m^3$	From SUMMA.WK1
	=	3	g/m^3	
Contaminant Emission Rate	=	1.77E-06	g/m^2-s	Conc. * Rate / Area

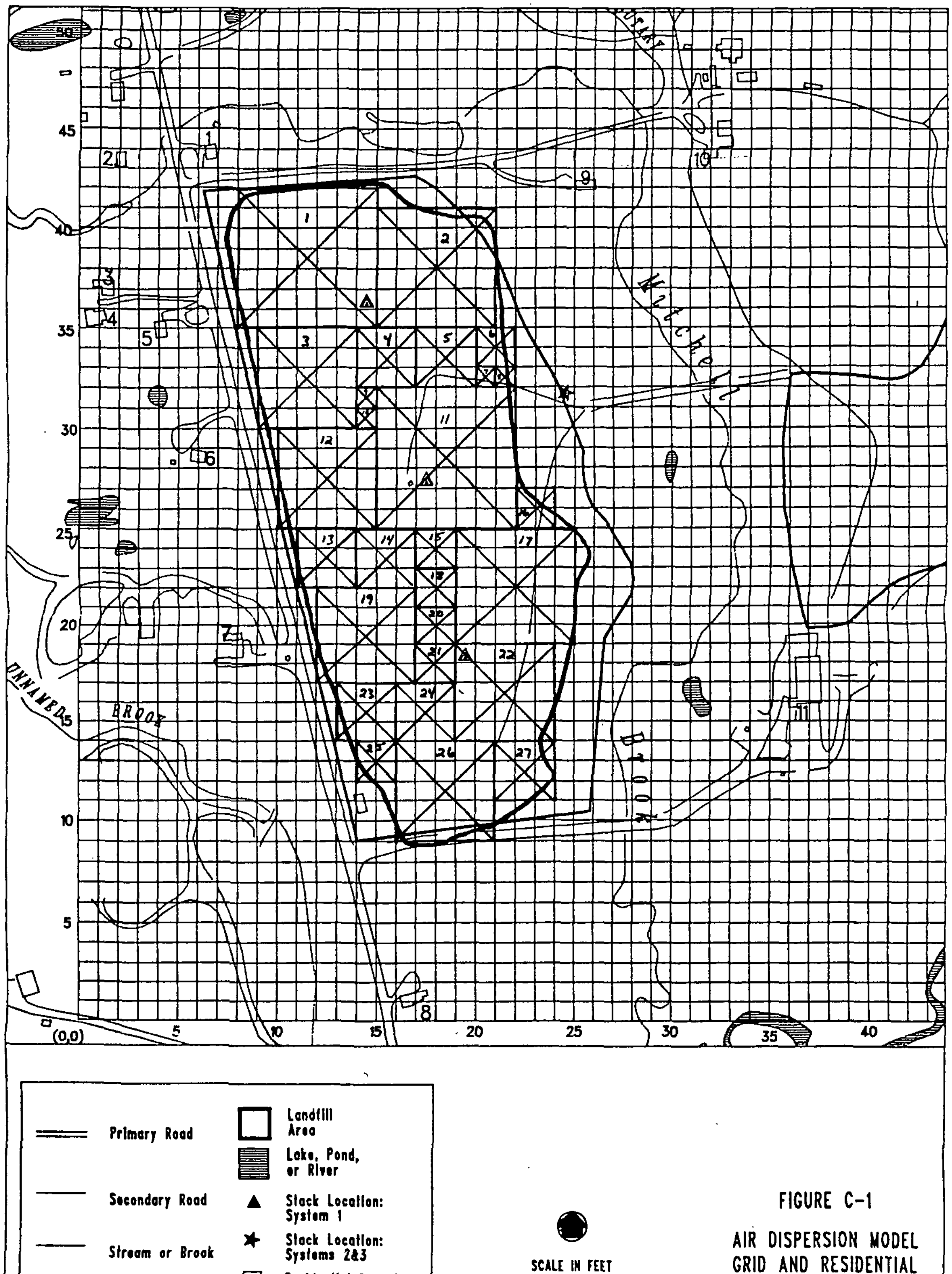


FIGURE C-1

AIR DISPERSION MODEL GRID AND RESIDENTIAL RECEPTOR LOCATIONS

ROSE HILL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

ATTACHMENT A

1 block = 15.24m (50 ft)

ATTACHMENT B

Q_A = area source emission rate (mass per unit area per unit time)

K = units scaling coefficient (Equation (1-1))

V = vertical term (see Section 1.1.6)

D = decay term as a function of x (see Section 1.1.7)

The Vertical Term is given by Equation (1-50) or Equation (1-54) with the effective emission height, h_e, being the physical release height assigned by the user. In general, h_e should be set equal to the physical height of the source of emissions above local terrain height. For example, the emission height h_e of a slag dump is the physical height of the slag dump.

Since the ISCST algorithm estimates the integral over the area upwind of the receptor location, receptors may be located within the area itself, downwind of the area, or adjacent to the area. However, since σ_z goes to 0 as the downwind distance goes to 0 (see Section 1.1.5.1), the plume function is infinite for a downwind receptor distance of 0. To avoid this singularity in evaluating the plume function, the model arbitrarily sets the plume function to 0 when the receptor distance is less than 1 meter. As a result, the area source algorithm will not provide reliable results for receptors located within or adjacent to very small areas, with dimensions on the order of a few meters across. In these cases, the receptor should be placed at least 1 meter outside of the area.

SOURCE: "USER'S GUIDE FOR THE INDUSTRIAL SOURCE COMPLEX (ISC3) DISPERSION MODELS, VOLUME II - DESCRIPTION OF MODEL ALGORITHMS," EPA-454/B-95-003b, USEPA, Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Research Triangle Park, North Carolina, September 1995.

ATTACHMENT C

ROSE HILL SOLID WASTE LANDFILL
GAS GENERATION RATE CALCULATION
METHOD 1: SCHOLL CANYON FIRST ORDER KINETIC MODEL

VERSION: AUG-08-96
Checked by: Sean Czarniecki 08/26/96

FORMULA:

$Q = 2 \cdot [k \cdot L \cdot R [\exp(-k \cdot (t-lag))]]$

[Source: Methane Generation & Recovery from Landfills. Emcon Associates, 1982]

Incorporates: New Stationary Source Performance Standards for Municipal Solid Waste LFs FR 9905, Vol. 61, No. 49, March 12, 1996
(Formula is multiplied by 2 since it is for methane generation and CH_4 is assumed to be 50% of LFG)

WHERE:

Q = landfill gas generation rate @ time t (ft^3 LFG / yr)
L = potential methane gas generation capacity of refuse (ft^3 CH_4 / ton)
R = annual refuse acceptance rate in landfill (tons)
k = methane production rate (1 / yr)
t = time since refuse placement (yr)
lag = time to reach conditions suitable for methane production (yr)

INPUT PARAMETERS:

L =	5,447	Year closed =	1982	Avg. refuse 1967–1970:	18,667
k =	0.05	Current year =	1996	Avg. refuse 1971–1975:	10,889
lag =	2	Time since closure =	14	Avg. refuse 1976–1977:	24,000
				Avg. refuse 1978–1982:	20,400

L and k are EPA default values.

YEAR	TIME SINCE REFUSE PLACEMENT	GENERATION RATE 1996
1968	28	2.77E+06
1969	27	2.91E+06
1970	26	3.06E+06
1971	25	1.88E+06
1972	24	1.97E+06
1973	23	2.08E+06
1974	22	2.18E+06
1975	21	2.29E+06
1976	20	5.32E+06
1977	19	5.59E+06
1978	18	4.99E+06
1979	17	5.25E+06
1980	16	5.52E+06
1981	15	5.80E+06
1982	14	6.10E+06
1983	–	0.00E+00
1984	–	0.00E+00
1985	–	0.00E+00
1986	–	0.00E+00
1987	–	0.00E+00
1988	–	0.00E+00
1989	–	0.00E+00
1990	–	0.00E+00
1991	–	0.00E+00
1992	–	0.00E+00
1993	–	0.00E+00
TOTAL	1996 LF GAS PRODUCTION	5.77E+07 ft^3 LFG / yr
		5.18E+04 cm^3 LFG / s

This area determines the contribution towards the 1996 LFG generation rate. No refuse was placed after 1982, so there is no contribution from waste placed after that date.

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1 of 1
Subject	Air Modeling	Comptd. By	S. Czarniecki	Date	08/09/96
Detail	ISCST3 Receptors	Ck'd. By	R. Porter	Date	08/26/96

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RECEPTOR.WK1

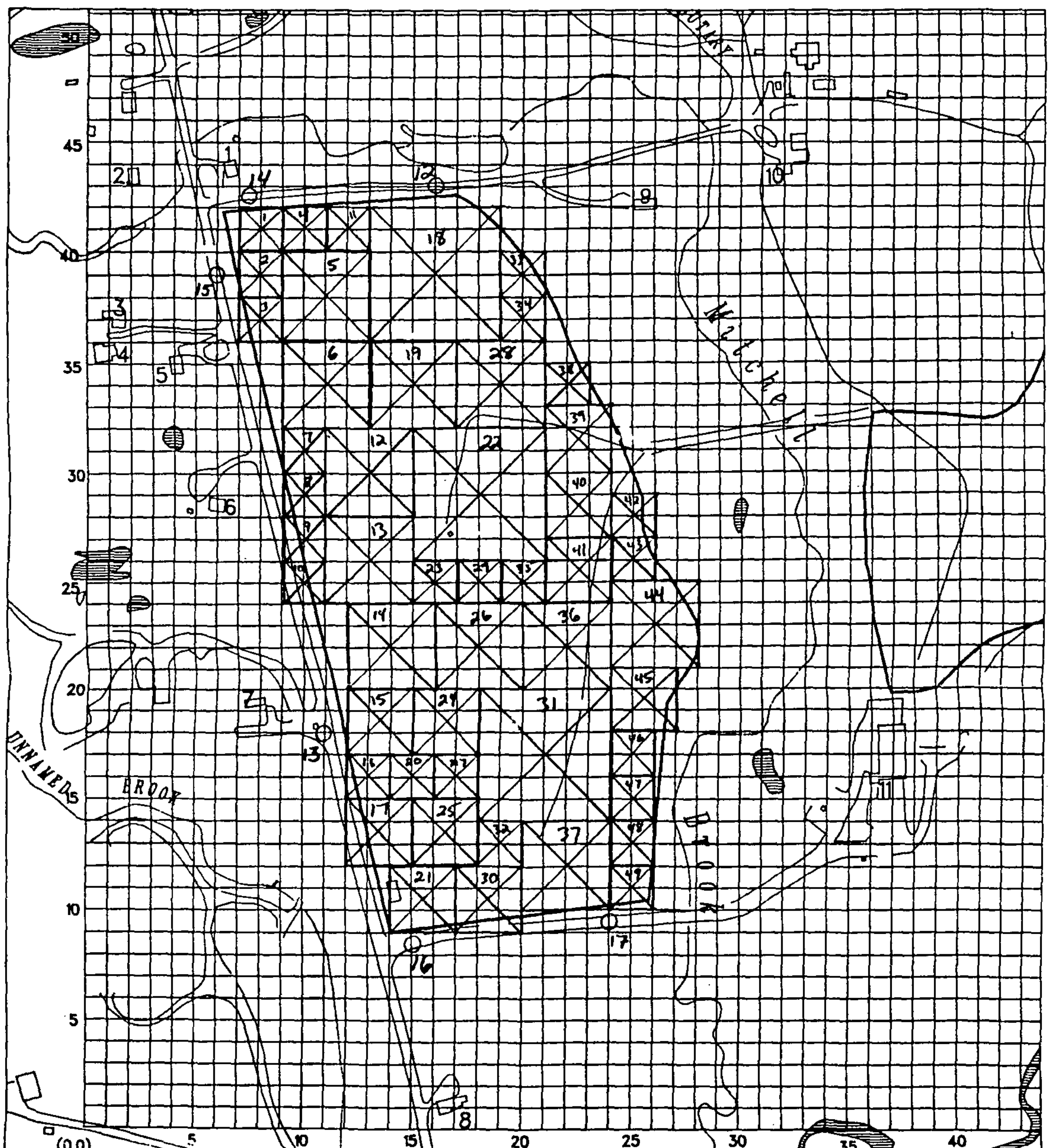
From a previous modeling effort (6/95), residential receptors and road/driveway receptors were designated. See Attachment A for these locations on the modeling grid.

RECEPTOR LOCATIONS:

Grid squares on Attachment A are 50 ft on each side = 15.24 m

Input for model (all values in meters)
Values are the X, Y coords. times square length

Receptor #	X	Y	X	Y
1	6.5	44	99.06	670.56
2	2	43.5	30.48	662.94
3	1.5	37	22.86	563.88
4	1	35.5	15.24	541.02
5	4	35	60.96	533.40
6	6	28.5	91.44	434.34
7	8	19.5	121.92	297.18
8	17	1	259.08	15.24
9	25.5	42	388.62	640.08
10	32	44	487.68	670.56
11	37	16	563.88	243.84
12	16	43	243.84	655.32
13	11	18	167.64	274.32
14	7.5	42.5	114.30	647.70
15	6	39	91.44	594.36
16	15	8.5	228.60	129.54
17	24	9.5	365.76	144.78



Primary Road

Secondary Road

Stream or Brook

Landfill Area

Lake, Pond, or River

O Road/Driveway Receptor

[9] Residential Receptor

Receptor 11 is Non-Residential: Transfer Station

SCALE IN FEET

250 0 100 250

FIGURE 1

AIR DISPERSION MODEL GRID AND RESIDENTIAL RECEPTOR LOCATIONS

ROSE HILL LANDFILL

SOUTH KINGSTOWN, RI

METCALF & EDDY

ATTACHMENT A

(Ignore area source squares)

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1 of 1
Subject	Air Modeling	Comptd. By	S. Czarniecki	Date	08/14/96
Detail	Model Runs Performed & Results	Ck'd. By	R. Porter	Date	08/26/96

C:\RH\AIR\ISCST3\RESULTS.WK1

RESULTS.WK1

The most recent meteorological data available on EPA's SCRAM electronic bulletin board for the Rose Hill Regional Landfill area was 1991. Surface data utilized was from the NOAA weather station at T.F. Green Airport in Providence, Rhode Island (#14765). Mixing height data utilized was from the weather station located in Chatham, Massachusetts (#14684), the closest station with mixing height data.

ISCST3 model runs were performed for the years 1987, 1988, 1989, 1990 and 1991 to determine maximum residential receptor concentration impacts resulting from Solid Waste Area landfill gas emissions. All runs were performed with the landfill assumed to be at the same elevation as the receptors (worst case). Runs were also performed in 1989 and 1991 with the landfill elevation at 5.2 meters above the receptors (average landfill height is approximately 17 feet above the surrounding area as shown on topographic maps) to show the difference between emissions from two different elevations.

A contaminant emission rate of 1.77E−09 g/m^2−s was used in the model (based on a vinyl chloride concentration of 3,100 $\mu g/m^3$) rather than the 1.77E−06 g/m^2−s calculated in SOLGRID.WK1. This does not change the way model results are applied proportionally to all of the contaminants of concern.

Year ->	1987	1988	1989	1989	1990	1991	1991
Landfill El. (m)	0	0	0	5.2	0	0	5.2
Receptor #	Modeled Concentration Based on Input of 3,100 $\mu g/m^3$						
1	0.00217	0.00186	0.00204	0.00128	0.00204	0.00155	0.00098
2	0.00088	0.00072	0.00086	0.00069	0.00090	0.00069	0.00054
3	0.00094	0.00069	0.00097	0.00073	0.00100	0.00095	0.00068
4	0.00091	0.00066	0.00095	0.00072	0.00097	0.00095	0.00069
5	0.00165	0.00120	0.00168	0.00109	0.00165	0.00161	0.00099
6	0.00250	0.00175	0.00253	0.00157	0.00235	0.00246	0.00144
7	0.00268	0.00182	0.00270	0.00175	0.00241	0.00280	0.00171
8	0.00173	0.00135	0.00169	0.00132	0.00134	0.00224	0.00153
9	0.00337	0.00405	0.00426	0.00268	0.00388	0.00418	0.00254
10	0.00163	0.00201	0.00215	0.00171	0.00200	0.00221	0.00174
11	0.00236	0.00234	0.00215	0.00172	0.00185	0.00219	0.00171
12	0.00740	0.00874	0.00865	0.00313	0.00795	0.00752	0.00260
13	0.00503	0.00355	0.00506	0.00221	0.00447	0.00528	0.00220
14	0.00351	0.00311	0.00335	0.00148	0.00334	0.00259	0.00116
15	0.00250	0.00189	0.00246	0.00123	0.00245	0.00223	0.00103
16	0.00447	0.00327	0.00443	0.00213	0.00364	0.00502	0.00226
17	0.00735	0.00653	0.00646	0.00250	0.00549	0.00743	0.00279

Notes:
Outlined values are maximum modeled concentrations for respective receptors.
Receptors #1 through 11 are nearby residences and the transfer station.
Receptors #12 through 17 are locations on roadways and driveways along the landfill perimeter.
Attachment A presents an example of model input/output. Attachment B presents receptor output for all runs.

Conclusions:
Ground 0 results were all higher than the release height of 5.2 meters.
Maximum modeled concentrations out of the five years will be used to determine contaminant concentrations at respective receptors.

ATTACHMENT A

```
** Rosehill - ISCST3
** Area emissions from the Solid Waste Area
** Ground 0 (Landfill assumed same level as receptors - worst case)
** 1991 data - most recent data out of the years of
**             data available
** Vinyl chloride emissions (Concentration = 3,100 ug/m^3)

CO STARTING
   TITLEONE  ROSEHILL - SOLID WASTE AREA EMISSIONS - ISCST3
   MODELOPT  DFAULT  CONC  RURAL
   AVERTIME  PERIOD
   TERRHGTS  FLAT
   POLLUTID  UNIT
   RUNORNOT  RUN
CO FINISHED

SO STARTING

**  SOLID WASTE AREA (FS Version - 8/96)
**  x, y, and z coordinates, respectively (m)

SO LOCATION     SQUARE1     AREA        121.92    533.40        0.
SO LOCATION     SQUARE2     AREA        228.60    533.40        0.
SO LOCATION     SQUARE3     AREA        137.16    457.20        0.
SO LOCATION     SQUARE4     AREA        213.36    487.68        0.
SO LOCATION     SQUARE5     AREA        259.08    487.68        0.
SO LOCATION     SQUARE6     AREA        304.80    502.92        0.
SO LOCATION     SQUARE7     AREA        304.80    487.68        0.
SO LOCATION     SQUARE8     AREA        320.04    487.68        0.
SO LOCATION     SQUARE9     AREA        213.36    472.44        0.
SO LOCATION     SQUARE10    AREA        213.36    457.20        0.
SO LOCATION     SQUARE11    AREA        228.60    381.00        0.
SO LOCATION     SQUARE12    AREA        152.40    381.00        0.
SO LOCATION     SQUARE13    AREA        167.64    335.28        0.
SO LOCATION     SQUARE14    AREA        213.36    335.28        0.
SO LOCATION     SQUARE15    AREA        259.08    350.52        0.
SO LOCATION     SQUARE16    AREA        335.28    381.00        0.
SO LOCATION     SQUARE17    AREA        289.56    289.56        0.
SO LOCATION     SQUARE18    AREA        259.08    320.04        0.
SO LOCATION     SQUARE19    AREA        182.88    259.08        0.
SO LOCATION     SQUARE20    AREA        259.08    289.56        0.
SO LOCATION     SQUARE21    AREA        259.08    259.08        0.
SO LOCATION     SQUARE22    AREA        289.56    213.36        0.
SO LOCATION     SQUARE23    AREA        198.12    213.36        0.
SO LOCATION     SQUARE24    AREA        243.84    213.36        0.
SO LOCATION     SQUARE25    AREA        213.36    182.88        0.
SO LOCATION     SQUARE26    AREA        243.84    137.16        0.
SO LOCATION     SQUARE27    AREA        320.04    167.64        0.

**  Emission rate (g/m^2-s), release height (m), length of square (m)

SO SRCPARAM     SQUARE1      1.77E-09       0.0     106.68
SO SRCPARAM     SQUARE2      1.77E-09       0.0      91.44
SO SRCPARAM     SQUARE3      1.77E-09       0.0      76.20
SO SRCPARAM     SQUARE4      1.77E-09       0.0      45.72
SO SRCPARAM     SQUARE5      1.77E-09       0.0      45.72
SO SRCPARAM     SQUARE6      1.77E-09       0.0      30.48
SO SRCPARAM     SQUARE7      1.77E-09       0.0      15.24
SO SRCPARAM     SQUARE8      1.77E-09       0.0      15.24
SO SRCPARAM     SQUARE9      1.77E-09       0.0      15.24
SO SRCPARAM     SQUARE10     1.77E-09       0.0      15.24
SO SRCPARAM     SQUARE11     1.77E-09       0.0     106.68
SO SRCPARAM     SQUARE12     1.77E-09       0.0      76.20
SO SRCPARAM     SQUARE13     1.77E-09       0.0      45.72
SO SRCPARAM     SQUARE14     1.77E-09       0.0      45.72
SO SRCPARAM     SQUARE15     1.77E-09       0.0      30.48
SO SRCPARAM     SQUARE16     1.77E-09       0.0      30.48
SO SRCPARAM     SQUARE17     1.77E-09       0.0      91.44
SO SRCPARAM     SQUARE18     1.77E-09       0.0      30.48
SO SRCPARAM     SQUARE19     1.77E-09       0.0      76.20
SO SRCPARAM     SQUARE20     1.77E-09       0.0      30.48
SO SRCPARAM     SQUARE21     1.77E-09       0.0      30.48
SO SRCPARAM     SQUARE22     1.77E-09       0.0      76.20
SO SRCPARAM     SQUARE23     1.77E-09       0.0      45.72
SO SRCPARAM     SQUARE24     1.77E-09       0.0      45.72
SO SRCPARAM     SQUARE25     1.77E-09       0.0      30.48
SO SRCPARAM     SQUARE26     1.77E-09       0.0      76.20
SO SRCPARAM     SQUARE27     1.77E-09       0.0      45.72

SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE GRIDPOLR POL STA
RE GRIDPOLR POL ORIG   375. 480.
RE GRIDPOLR POL DIST   50. 100. 150. 200. 250. 300. 350. 400. 450.
RE GRIDPOLR POL DIST   500. 550. 600. 650. 700. 750. 800. 850. 900.
**RE GRIDPOLR POL DIST   950. 1000. 1050. 1100. 1150. 1200. 1300.
**RE GRIDPOLR POL DIST   1400. 1500. 1600. 1700. 1800. 1900. 2000.
**RE GRIDPOLR POL DIST   2100. 2200. 2300. 2400. 2500. 2600. 2700.
**RE GRIDPOLR POL DIST   2800. 2900. 3000. 3100. 3200. 3300. 3400.
**RE GRIDPOLR POL DIST   3500. 3600. 3700. 3800. 3900. 4000. 4100.
**RE GRIDPOLR POL DIST   4200. 4300. 4400. 4500. 4600. 4700. 4800.
```

```
**RE GRIDPOLR POL DIST   4900. 5000. 5100. 5200. 5300. 5400. 5500.
**RE GRIDPOLR POL DIST   5600. 5700. 5800. 5900. 6000. 6100. 6200.
**RE GRIDPOLR POL DIST   6300. 6400. 6500. 6600. 6700. 6800. 6900.
**RE GRIDPOLR POL DIST   7000. 7100. 7200. 7300. 7400. 7500. 7600.
RE GRIDPOLR POL GDIR   8    0.  45.
RE GRIDPOLR POL END

**  Discreet Receptors
**  x, y coordinates (m)

** Receptor #1
RE DISCCART         99.06    670.56
** Receptor #2
RE DISCCART         30.48    662.94
** Receptor #3
RE DISCCART         22.86    563.88
** Receptor #4
RE DISCCART         15.24    541.02
** Receptor #5
RE DISCCART         60.96    533.40
** Receptor #6
RE DISCCART         91.44    434.34
** Receptor #7
RE DISCCART        121.92    297.18
** Receptor #8
RE DISCCART        259.08     15.24
** Receptor #9
RE DISCCART        388.62    640.08
** Receptor #10
RE DISCCART        487.68    670.56
** Receptor #11
RE DISCCART        563.88    243.84
** Receptor #12
RE DISCCART        243.84    655.32
** Receptor #13
RE DISCCART        167.64    274.32
** Receptor #14
RE DISCCART        114.30    647.70
** Receptor #15
RE DISCCART         91.44    594.36
** Receptor #16
RE DISCCART        228.60    129.54
** Receptor #17
RE DISCCART        365.76    144.78

RE FINISHED


ME STARTING

** 1989 - worst case at receptors
**   INPUTFIL  lprov89.bin  unform
**   ANEMHGHT  20. FEET
** SURFACE DATA FROM 1989 at Providence was utilized. MIXING FROM CHATHAM.
**   SURFDATA  14765  1989  SURFNAME
**   UAIRDATA  14684  1989  UAIRNAME

** 1991 - most recent data available
   INPUTFIL  lprov91.bin  unform
   ANEMHGHT  20. FEET
** SURFACE DATA FROM 1991 at Providence was utilized. MIXING FROM CHATHAM.
   SURFDATA  14765  1991  SURFNAME
   UAIRDATA  14684  1991  UAIRNAME

ME FINISHED

OU STARTING
   RECTABLE  ALLAVE FIRST
OU FINISHED

**********************************
*** SETUP Finishes Successfully ***
**********************************
```

```
**MODELOPTs: CONC                          RURAL  FLAT          DFAULT

                                        ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  -- SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
           1. Final Plume Rise.
           2. Stack-tip Downwash.
           3. Buoyancy-induced Dispersion.
           4. Use Calms Processing Routine.
           5. Not Use Missing Data Processing Routine.
           6. Default Wind Profile Exponents.
           7. Default Vertical Potential Temperature Gradients.
           8. "Upper Bound" Values for Supersquat Buildings.
           9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates PERIOD Averages Only

**This Run Includes:    27 Source(s);       1 Source Group(s); and     161 Receptor(s)

**The Model Assumes A Pollutant Type of:  UNIT

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of PERIOD Averages by Receptor
         Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =      6.10 ;    Decay Coef. =   0.0000      ;    Rot. Angle =      0.0
                 Emission Units = GRAMS/SEC                                   ;  Emission Rate Unit Factor =    0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: RHfs12.INP                               ;  **Output Print File: RHfs12.OUT
```

**MODELOPTs: CONC RURAL FLAT DFAULT

*** AREA SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC /METER**2)	COORD (SW CORNER) X (METERS)	Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	X-DIM OF AREA (METERS)	Y-DIM OF AREA (METERS)	ORIENT. OF AREA (DEG.)	INIT. SZ (METERS)	EMISSION RATE SCALAR VARY BY
SQUARE1	0	0.17700E-08	121.9	533.4	0.0	0.00	106.68	106.68	0.00	0.00	
SQUARE2	0	0.17700E-08	228.6	533.4	0.0	0.00	91.44	91.44	0.00	0.00	
SQUARE3	0	0.17700E-08	137.2	457.2	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE4	0	0.17700E-08	213.4	487.7	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE5	0	0.17700E-08	259.1	487.7	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE6	0	0.17700E-08	304.8	502.9	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE7	0	0.17700E-08	304.8	487.7	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE8	0	0.17700E-08	320.0	487.7	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE9	0	0.17700E-08	213.4	472.4	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE10	0	0.17700E-08	213.4	457.2	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE11	0	0.17700E-08	228.6	381.0	0.0	0.00	106.68	106.68	0.00	0.00	
SQUARE12	0	0.17700E-08	152.4	381.0	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE13	0	0.17700E-08	167.6	335.3	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE14	0	0.17700E-08	213.4	335.3	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE15	0	0.17700E-08	259.1	350.5	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE16	0	0.17700E-08	335.3	381.0	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE17	0	0.17700E-08	289.6	289.6	0.0	0.00	91.44	91.44	0.00	0.00	
SQUARE18	0	0.17700E-08	259.1	320.0	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE19	0	0.17700E-08	182.9	259.1	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE20	0	0.17700E-08	259.1	289.6	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE21	0	0.17700E-08	259.1	259.1	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE22	0	0.17700E-08	289.6	213.4	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE23	0	0.17700E-08	198.1	213.4	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE24	0	0.17700E-08	243.8	213.4	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE25	0	0.17700E-08	213.4	182.9	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE26	0	0.17700E-08	243.8	137.2	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE27	0	0.17700E-08	320.0	167.6	0.0	0.00	45.72	45.72	0.00	0.00	

**MODELOPTs: CONC RURAL FLAT DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12
	SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24
	SQUARE25, SQUARE26, SQUARE27,

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: POL   ; NETWORK TYPE: GRIDPOLR ***

*** ORIGIN FOR POLAR NETWORK ***
X-ORIG =   375.00 ; Y-ORIG =   480.00 (METERS)

*** DISTANCE RANGES OF NETWORK ***
(METERS)

50.0,	100.0,	150.0,	200.0,	250.0,	300.0,	350.0,	400.0,	450.0,	500.0,
550.0,	600.0,	650.0,	700.0,	750.0,	800.0,	850.0,	900.0,		

*** DIRECTION RADIALS OF NETWORK ***
(DEGREES)

360.0,	45.0,	90.0,	135.0,	180.0,	225.0,	270.0,	315.0,

**MODELOPTs: CONC RURAL FLAT DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(99.1,	670.6,	0.0,	0.0);	(30.5,	662.9,	0.0,	0.0);
(22.9,	563.9,	0.0,	0.0);	(15.2,	541.0,	0.0,	0.0);
(61.0,	533.4,	0.0,	0.0);	(91.4,	434.3,	0.0,	0.0);
(121.9,	297.2,	0.0,	0.0);	(259.1,	15.2,	0.0,	0.0);
(388.6,	640.1,	0.0,	0.0);	(487.7,	670.6,	0.0,	0.0);
(563.9,	243.8,	0.0,	0.0);	(243.8,	655.3,	0.0,	0.0);
(167.6,	274.3,	0.0,	0.0);	(114.3,	647.7,	0.0,	0.0);
(91.4,	594.4,	0.0,	0.0);	(228.6,	129.5,	0.0,	0.0);
(365.8,	144.8,	0.0,	0.0);				

**MODELOPTs: CONC RURAL FLAT DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1
```

NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: lprov91.bin FORMAT: UNFORM
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14684
NAME: SURFNAME NAME: UAIRNAME
YEAR: 1991 YEAR: 1991

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	IPCODE	PRATE (mm/HR)
91	1	1	1	121.0	4.12	267.6	5	453.1	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	2	128.0	3.60	267.0	5	504.8	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	3	154.0	3.60	267.0	5	556.4	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	4	123.0	3.60	266.5	5	608.1	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	5	113.0	3.09	265.9	6	659.8	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	6	12.0	2.57	264.3	6	711.5	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	7	105.0	3.09	265.4	6	763.2	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	8	133.0	3.60	265.9	5	131.6	152.8	0.0000	0.0	0.0000	0	0.00
91	1	1	9	137.0	1.54	268.7	4	297.1	314.8	0.0000	0.0	0.0000	0	0.00
91	1	1	10	131.0	3.09	270.9	3	462.7	476.8	0.0000	0.0	0.0000	0	0.00
91	1	1	11	84.0	2.57	271.5	3	628.3	638.9	0.0000	0.0	0.0000	0	0.00
91	1	1	12	86.0	3.09	272.6	3	793.9	800.9	0.0000	0.0	0.0000	0	0.00
91	1	1	13	63.0	3.09	273.1	3	959.4	963.0	0.0000	0.0	0.0000	0	0.00
91	1	1	14	329.0	4.63	273.1	3	1125.0	1125.0	0.0000	0.0	0.0000	0	0.00
91	1	1	15	2.0	4.63	273.1	4	1125.0	1125.0	0.0000	0.0	0.0000	0	0.00
91	1	1	16	4.0	6.17	272.6	4	1125.0	1125.0	0.0000	0.0	0.0000	0	0.00
91	1	1	17	1.0	5.14	270.9	5	1120.4	1035.9	0.0000	0.0	0.0000	0	0.00
91	1	1	18	17.0	2.57	270.9	6	1114.5	919.5	0.0000	0.0	0.0000	0	0.00
91	1	1	19	54.0	2.57	269.8	6	1108.5	803.0	0.0000	0.0	0.0000	0	0.00
91	1	1	20	47.0	2.57	269.3	6	1102.5	686.6	0.0000	0.0	0.0000	0	0.00
91	1	1	21	50.0	1.00	268.7	7	1096.5	570.2	0.0000	0.0	0.0000	0	0.00
91	1	1	22	352.0	1.00	268.7	7	1090.6	453.8	0.0000	0.0	0.0000	0	0.00
91	1	1	23	160.0	1.03	268.7	7	1084.6	337.4	0.0000	0.0	0.0000	0	0.00
91	1	1	24	150.0	2.57	268.7	6	1078.6	221.0	0.0000	0.0	0.0000	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.
360.00	0.00795	0.00639	0.00492	0.00350	0.00245	0.00179	0.00136	0.00106	0.00C
45.00	0.00571	0.00393	0.00290	0.00225	0.00181	0.00149	0.00125	0.00105	0.00C
90.00	0.00556	0.00389	0.00287	0.00219	0.00173	0.00139	0.00115	0.00097	0.00C
135.00	0.00699	0.00561	0.00431	0.00328	0.00254	0.00200	0.00161	0.00132	0.001
180.00	0.01106	0.02486	0.03234	0.01764	0.01493	0.01157	0.00561	0.00354	0.002
225.00	0.02062	0.03689	0.03668	0.03448	0.02780	0.00465	0.00256	0.00173	0.001
270.00	0.03437	0.03669	0.03531	0.03104	0.00515	0.00203	0.00118	0.00078	0.00C
315.00	0.01822	0.03413	0.03331	0.02633	0.00731	0.00309	0.00165	0.00100	0.00C

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 500.00	550.00	600.00	650.00	700.00	750.00	800.00	850.00	900.
360.00	0.00072	0.00061	0.00053	0.00046	0.00041	0.00037	0.00034	0.00031	0.00C
45.00	0.00078	0.00069	0.00061	0.00055	0.00050	0.00045	0.00041	0.00038	0.00C
90.00	0.00072	0.00063	0.00056	0.00050	0.00045	0.00040	0.00037	0.00033	0.00C
135.00	0.00095	0.00082	0.00072	0.00063	0.00057	0.00051	0.00046	0.00042	0.00C
180.00	0.00190	0.00153	0.00127	0.00108	0.00094	0.00082	0.00074	0.00067	0.00C
225.00	0.00096	0.00077	0.00063	0.00054	0.00046	0.00040	0.00035	0.00032	0.00C
270.00	0.00043	0.00035	0.00029	0.00025	0.00022	0.00020	0.00018	0.00016	0.00C
315.00	0.00051	0.00039	0.00032	0.00026	0.00022	0.00019	0.00017	0.00015	0.00C

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00155	30.48	662.94	0.00069
22.86	563.88	0.00095	15.24	541.02	0.00095
60.96	533.40	0.00161	91.44	434.34	0.00246
121.92	297.18	0.00280	259.08	15.24	0.00224
388.62	640.08	0.00418	487.68	670.56	0.00221
563.88	243.84	0.00219	243.84	655.32	0.00752
167.64	274.32	0.00528	114.30	647.70	0.00259
91.44	594.36	0.00223	228.60	129.54	0.00502
365.76	144.78	0.00743			

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

GROUP ID		AVERAGE CONC	RECEPTOR (XR, YR, ZELEV, ZFLAG)				OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	0.03689 AT (	304.29,	409.29,	0.00,	0.00)	GP	POL
	2ND HIGHEST VALUE IS	0.03669 AT (	275.00,	480.00,	0.00,	0.00)	GP	POL
	3RD HIGHEST VALUE IS	0.03668 AT (	268.93,	373.93,	0.00,	0.00)	GP	POL
	4TH HIGHEST VALUE IS	0.03531 AT (	225.00,	480.00,	0.00,	0.00)	GP	POL
	5TH HIGHEST VALUE IS	0.03448 AT (	233.58,	338.58,	0.00,	0.00)	GP	POL
	6TH HIGHEST VALUE IS	0.03437 AT (	325.00,	480.00,	0.00,	0.00)	GP	POL

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

**MODELOPTs: CONC RURAL FLAT DFAULT

*** Message Summary : ISCST3 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 766 Informational Message(s)

A Total of 219 Calm Hours Identified

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** ISCST3 Finishes Successfully ***
****

ATTACHMENT B

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00217	30.48	662.94	0.00088
22.86	563.88	0.00094	15.24	541.02	0.00091
60.96	533.40	0.00165	91.44	434.34	0.00250
121.92	297.18	0.00268	259.08	15.24	0.00173
388.62	640.08	0.00337	487.68	670.56	0.00163
563.88	243.84	0.00236	243.84	655.32	0.00740
167.64	274.32	0.00503	114.30	647.70	0.00351
91.44	594.36	0.00250	228.60	129.54	0.00447
365.76	144.78	0.00735			

1987 - Ø meters

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8784 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00186	30.48	662.94	0.00072
22.86	563.88	0.00069	15.24	541.02	0.00066
60.96	533.40	0.00120	91.44	434.34	0.00175
121.92	297.18	0.00182	259.08	15.24	0.00135
388.62	640.08	0.00405	487.68	670.56	0.00201
563.88	243.84	0.00234	243.84	655.32	0.00874
167.64	274.32	0.00355	114.30	647.70	0.00311
91.44	594.36	0.00189	228.60	129.54	0.00327
365.76	144.78	0.00653			

1988 – Ø meters

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00204	30.48	662.94	0.00086
22.86	563.88	0.00097	15.24	541.02	0.00095
60.96	533.40	0.00168	91.44	434.34	0.00253
121.92	297.18	0.00270	259.08	15.24	0.00169
388.62	640.08	0.00426	487.68	670.56	0.00215
563.88	243.84	0.00215	243.84	655.32	0.00865
167.64	274.32	0.00506	114.30	647.70	0.00335
91.44	594.36	0.00246	228.60	129.54	0.00443
365.76	144.78	0.00646			

1989 - 0 meters

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00128	30.48	662.94	0.00069
22.86	563.88	0.00073	15.24	541.02	0.00072
60.96	533.40	0.00109	91.44	434.34	0.00157
121.92	297.18	0.00175	259.08	15.24	0.00132
388.62	640.08	0.00268	487.68	670.56	0.00171
563.88	243.84	0.00172	243.84	655.32	0.00313
167.64	274.32	0.00221	114.30	647.70	0.00148
91.44	594.36	0.00123	228.60	129.54	0.00213
365.76	144.78	0.00250			

1989 - 5.2 meters

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00204	30.48	662.94	0.00090
22.86	563.88	0.00100	15.24	541.02	0.00097
60.96	533.40	0.00165	91.44	434.34	0.00235
121.92	297.18	0.00241	259.08	15.24	0.00134
388.62	640.08	0.00388	487.68	670.56	0.00200
563.88	243.84	0.00185	243.84	655.32	0.00795
167.64	274.32	0.00447	114.30	647.70	0.00334
91.44	594.36	0.00245	228.60	129.54	0.00364
365.76	144.78	0.00549			

1990 - 0 meters

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00155	30.48	662.94	0.00069
22.86	563.88	0.00095	15.24	541.02	0.00095
60.96	533.40	0.00161	91.44	434.34	0.00246
121.92	297.18	0.00280	259.08	15.24	0.00224
388.62	640.08	0.00418	487.68	670.56	0.00221
563.88	243.84	0.00219	243.84	655.32	0.00752
167.64	274.32	0.00528	114.30	647.70	0.00259
91.44	594.36	0.00223	228.60	129.54	0.00502
365.76	144.78	0.00743			

1991 - Ø meters

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.00098	30.48	662.94	0.00054
22.86	563.88	0.00068	15.24	541.02	0.00069
60.96	533.40	0.00099	91.44	434.34	0.00144
121.92	297.18	0.00171	259.08	15.24	0.00153
388.62	640.08	0.00254	487.68	670.56	0.00174
563.88	243.84	0.00171	243.84	655.32	0.00260
167.64	274.32	0.00220	114.30	647.70	0.00116
91.44	594.36	0.00103	228.60	129.54	0.00226
365.76	144.78	0.00279			

1991 - 5.2 meters

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1	of	1
Subject	Air Modeling	Comptd. By	S. Czarniecki	Date	08/14/96		
Detail	Results Table	Ck'd. By	R. Porter	Date	08/26/96		

C:\RH\AIR\ISCST3\RESTABLE.WK1

RESTABLE.WK1

The attached table presents modeled concentrations of analytes of concern at the Site. The maximum modeled concentrations from RESULTS.WK1 were used to proportionally determine the analytes' concentration at various receptors. Some analytes were not detected in landfill gas SUMMA canister sampling, but are noted due to detections in ambient air at residences.

MODELED CONCENTRATIONS OF LANDFILL GAS CONTAMINANTS AT RESIDENTIAL RECEPTORS, ROSE HILL REGIONAL LANDFILL SUPERFUND SITE SOLID WASTE AREA – AREA SOURCE MODELING

Maximum Modeled Concentration Based on 3,100 ($\mu g/m^3$) ->		0.00217	0.00090	0.00100	0.00097	0.00168	0.00253	0.00280	0.00224	0.00426	0.00221
		Concentration ($\mu g/m^3$)									
	SUMMA	Receptor #									
	Max ($\mu g/m^3$)	1	2	3	4	5	6	7	8	9	10
Acetone	0	0	0	0	0	0	0	0	0	0	0
Benzene	8,000	0.0056	0.0023	0.0026	0.0025	0.0043	0.0065	0.0072	0.0058	0.011	0.0057
Carbon Disulfide	870	0.00061	0.00025	0.00028	0.00027	0.00047	0.00071	0.00079	0.00063	0.0012	0.00062
Dichlorodifluoromethane	110,000	0.077	0.032	0.035	0.034	0.060	0.090	0.099	0.079	0.15	0.078
1,1-Dichloroethane	140,000	0.098	0.041	0.045	0.044	0.076	0.11	0.13	0.10	0.19	0.10
1,1-Dichloroethene	32,000	0.022	0.0093	0.010	0.010	0.017	0.026	0.029	0.023	0.044	0.023
cis-1,2-Dichloroethene	23,000,000	16	6.7	7.4	7.2	12	19	21	17	32	16
trans-1,2-Dichloroethene	27,000	0.019	0.0078	0.0087	0.0084	0.015	0.022	0.024	0.020	0.037	0.019
Ethylbenzene	25,000	0.018	0.0073	0.0081	0.0078	0.014	0.020	0.023	0.018	0.034	0.018
4-Methyl-2-pentanone	6,600	0.0046	0.0019	0.0021	0.0021	0.0036	0.0054	0.0060	0.0048	0.0091	0.0047
Methylene Chloride	66,000	0.046	0.019	0.021	0.021	0.036	0.054	0.060	0.048	0.091	0.047
1,1,2,2-Tetrachloroethane	0	0	0	0	0	0	0	0	0	0	0
Toluene	230,000	0.16	0.067	0.074	0.072	0.12	0.19	0.21	0.17	0.32	0.16
1,2,4-Trichlorobenzene	0	0	0	0	0	0	0	0	0	0	0
1,1,1-Trichloroethane	10,000	0.0070	0.0029	0.0032	0.0031	0.0054	0.0082	0.0090	0.0072	0.014	0.0071
Trichloroethene	31,000	0.022	0.0090	0.010	0.0097	0.017	0.025	0.028	0.022	0.043	0.022
1,2,4-Trimethylbenzene	2,000	0.0014	0.00058	0.00065	0.00063	0.0011	0.0016	0.0018	0.0014	0.0027	0.0014
1,3,5-Trimethylbenzene	4,300	0.0030	0.0012	0.0014	0.0013	0.0023	0.0035	0.0039	0.0031	0.0059	0.0031
Vinyl Chloride	3,100,000	2.2	0.90	1.0	0.97	1.7	2.5	2.8	2.2	4.3	2.2
m,p-Xylene	41,000	0.029	0.012	0.013	0.013	0.022	0.033	0.037	0.030	0.056	0.029
o-Xylene	11,000	0.0077	0.0032	0.0035	0.0034	0.0060	0.0090	0.0099	0.0079	0.015	0.0078

MODELED CONCENTRATIONS OF LANDFILL GAS CONTAMINANTS AT RESIDENTIAL RECEPTORS, ROSE HILL REGIONAL LANDFILL SUPERFUND SITE
SOLID WASTE AREA – AREA SOURCE MODELING

Maximum Modeled Concentration Based on 3,100 ($\mu g/m^3$) –>		0.00236	0.00874	0.00528	0.00351	0.00250	0.00502	0.00743
	SUMMA Max ($\mu g/m^3$)	Concentration ($\mu g/m^3$) Receptor #						
		11	12	13	14	15	16	17
Benzene	8,000	0.0061	0.023	0.014	0.0091	0.0065	0.013	0.019
Acetone	0	0	0	0	0	0	0	0
Carbon Disulfide	870	0.00066	0.0025	0.0015	0.0010	0.00070	0.0014	0.0021
Dichlorodifluoromethane	110,000	0.084	0.31	0.19	0.12	0.089	0.18	0.26
1,1–Dichloroethane	140,000	0.11	0.39	0.24	0.16	0.11	0.23	0.34
1,1–Dichloroethene	32,000	0.024	0.090	0.055	0.036	0.026	0.052	0.077
cis–1,2–Dichloroethene	23,000,000	18	65	39	26	19	37	55
trans–1,2–Dichloroethene	27,000	0.021	0.076	0.046	0.031	0.022	0.044	0.065
Ethylbenzene	25,000	0.019	0.070	0.043	0.028	0.020	0.040	0.060
4–Methyl–2–pentanone	6,600	0.0050	0.019	0.011	0.0075	0.0053	0.011	0.016
Methylene Chloride	66,000	0.050	0.19	0.11	0.075	0.053	0.11	0.16
1,1,2,2–Tetrachloroethane	0	0	0	0	0	0	0	0
Toluene	230,000	0.18	0.65	0.39	0.26	0.19	0.37	0.55
1,2,4–Trichlorobenzene	0	0	0	0	0	0	0	0
1,1,1–Trichloroethane	10,000	0.0076	0.028	0.017	0.011	0.0081	0.016	0.024
Trichloroethene	31,000	0.024	0.087	0.053	0.035	0.025	0.050	0.074
1,2,4–Trimethylbenzene	2,000	0.0015	0.0056	0.0034	0.0023	0.0016	0.0032	0.0048
1,3,5–Trimethylbenzene	4,300	0.0033	0.012	0.0073	0.0049	0.0035	0.0070	0.010
Vinyl Chloride	3,100,000	2.4	8.7	5.3	3.5	2.5	5.0	7.4
m,p–Xylene	41,000	0.031	0.12	0.070	0.046	0.033	0.066	0.098
o–Xylene	11,000	0.0084	0.031	0.019	0.012	0.0089	0.018	0.026

Notes:

1) ISCST3 model utilized.
2) Receptors #1 through 10 are nearby residences.
   Receptors #11 is the transfer station.
   Receptors #12 through 17 are locations on roadways and driveways along the landfill perimeter.
3) Modeling assumptions are presented in RECEPTOR.WK1, SOLGRID.WK1, SUMMA.WK1 and RESULTS.WK1.

C:\RH\AIR\ISCST3\TABLE1.WK1

F-2 Point Source Modeling - Flare

FLARE.WK1

ISCLT3 dispersion modeling from a flare will be performed using the same concentrations as for the area source modeling – see SUMMA.WK1. The flare burns landfill gas collected in the Solid Waste Area. The modeling will be based on a vinyl chloride concentration of 3,100 mg/m^3.

The ISCLT3 model was used for flare dispersion modeling to determine if the more time-consuming ISCST3 runs would be needed. Since ISCLT3 models a five-year average of meteorologic data, peak values may not be presented. However, the flare properties are expected to reduce the impacts significantly so that further short-term modeling will be unnecessary.

The receptors and flare stack location are presented on Attachment A. Coordinates for the receptors have been presented in RECEPTOR.WK1 for the area source modeling. The coordinates for the flare stack are:

Grid squares on Attachment A are 50 ft on each side = 15.24 m

			Input for model (all values in meters) Values are the X, Y coords. times square length	
	X	Y	X	Y
Flare	24.5	31.5	373.38	480.06

Emission Rate (g / s)

Assuming 100% capture of the landfill gas:		
Using a landfill gas generation rate of	0.0518 m^3 / s	see SOLGRID.WK1
and a vinyl chloride concentration of	3,100 mg / m^3	
We get	0.16 g / s	
Assuming a conservative 95% destruction efficiency, the model input becomes	0.0080 g / s	coming out of the flare.

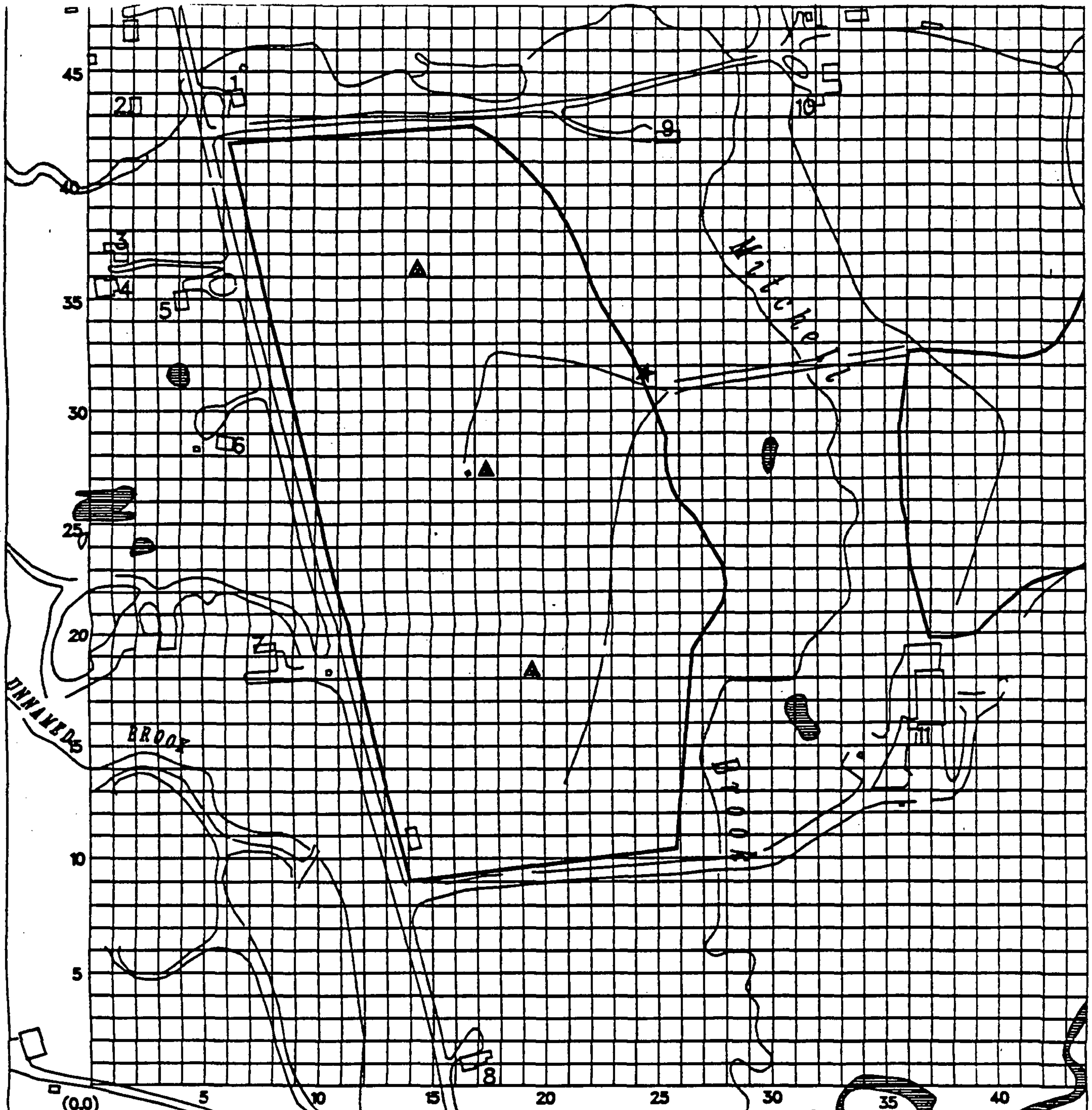
Other Flare Input Parameters

From John Zink Co. quotation (see Appendix E),

Stack Height	9.14 m	=	30 ft
Gas Exit Temperature	1,089 K	=	1,500 °F
Gas Exit Velocity	3.63 m / s	=	11.9 ft/s
Stack Diameter (ID)	0.95 m	=	3.125 ft

Other Assumptions

Rural dispersion parameters were used.
Flat terrain was assumed since area receptors were below 1/2 the stack height.



Primary Road		Landfill Area	
		Lake, Pond, or River	
Secondary Road	▲	Stack Location: System 1	
Stream or Brook	★	Stack Location: Systems 2&3	
	9	Residential Receptor	

Receptor 11 is Non-Residential: Transfer Station

SCALE IN FEET

250 0 100 250

ATTACHMENT A

~~FIGURE C-1~~

AIR DISPERSION MODEL GRID AND RESIDENTIAL RECEPTOR LOCATIONS

ROSE HILL LANDFILL
SOUTH KINGSTOWN, RI

METCALF & EDDY

LTRESULT

The ISCLT3 model uses joint frequency distributions of wind speed class, by wind direction sector, and by stability category, known as STAR summaries (for STability ARray). Seasonal and annual STAR data for the NOAA weather station at T.F. Green Airport, Providence, Rhode Island (#14765), spanning the dates of October 1, 1987 and September 30, 1992, was obtained for use as input in this model. Included in the data are seasonal and annual frequencies of wind speed and direction.

An average ambient air temperature of 50°F for the area was calculated from data collected at Providence, Rhode Island (NOAA, 1991). Mixing layer heights were calculated using data available on EPA's SCRAM Bulletin Board System for Chatham, Massachusetts (#14684), the closest weather station with mixing height data. The mixing height calculation cited (USEPA, 1992) was used to estimate mixing height data by stability class.

Discreet Receptor Results

Receptor #	Modeled Concentration Based on Input of 3.100 mg/m³ (µg/m³)
1	0.001116
2	0.001180
3	0.001441
4	0.001582
5	0.001464
6	0.001929
7	0.003314
8	0.008029
9	0.002287
10	0.004735
11	0.012546
12	0.000868
13	0.003739
14	0.001059
15	0.001076
16	0.004787
17	0.014067

Notes:
Receptors #1 through 11 are nearby residences and the transfer station.
Receptors #12 through 17 are locations on roadways and driveways along the landfill perimeter.

Maximum Modeled Concentration

The maximum modeled concentration is 0.014654 µg/m³
and is located in the southern direction of the flare stack, approximately 350 meters from the stack.

Model input/output is presented as Attachment A.

ATTACHMENT A

```
** Rosehill - ISCLT3
** Point source emissions from an alternative flare burning landfill gas
**    from the Solid Waste Area
** 1987-1992 meteorological data
** Vinyl chloride emissions (Concentration = 3,100 mg/m^3)

CO STARTING
  TITLEONE  ROSEHILL - ALT. FLARE EMISSIONS - ISCLT3
  MODELOPT  DFAULT  CONC  RURAL
  AVERTIME  ANNUAL
  TERRHGTS  FLAT
  POLLUTID  VYCL
  RUNORNOT  RUN
CO FINISHED

SO STARTING

** FLARE FOR SOLID WASTE AREA

SO LOCATION   STACK1  POINT     373.38   480.06     0.

** Emission rate (g/s), stack height (m), gas temp (K),
**    gas velocity (m/s), stack diameter (m)

SO SRCPARAM   STACK1   0.0080  9.14  1089.  3.63  0.95

SO SRCGROUP ALL
SO FINISHED


RE STARTING
RE GRIDPOLR POL STA
RE GRIDPOLR POL ORIG  375. 480.
RE GRIDPOLR POL DIST  50. 100. 150. 200. 250. 300. 350. 400. 450.
RE GRIDPOLR POL DIST  500. 550. 600. 650. 700. 750. 800. 850. 900.
** RE GRIDPOLR POL DIST  950. 1000. 1050. 1100. 1150. 1200. 1300.
** RE GRIDPOLR POL DIST  1400. 1500. 1600. 1700. 1800. 1900. 2000.
** RE GRIDPOLR POL DIST  2100. 2200. 2300. 2400. 2500. 2600. 2700.
RE GRIDPOLR POL DIST  2800. 2900. 3000. 3100. 3200. 3300. 3400.
RE GRIDPOLR POL DIST  3500. 3600. 3700. 3800. 3900. 4000. 4100.
RE GRIDPOLR POL DIST  4200. 4300. 4400. 4500. 4600. 4700. 4800.
** RE GRIDPOLR POL DIST  4900. 5000. 5100. 5200. 5300. 5400. 5500.
** RE GRIDPOLR POL DIST  5600. 5700. 5800. 5900. 6000. 6100. 6200.
RE GRIDPOLR POL GDIR  8   0. 45.
RE GRIDPOLR POL END

** Discreet Receptors
** x, y coordinates (m)

** Receptor #1
RE DISCCART       99.06    670.56
** Receptor #2
RE DISCCART       30.48    662.94
** Receptor #3
RE DISCCART       22.86    563.88
** Receptor #4
RE DISCCART       15.24    541.02
** Receptor #5
RE DISCCART       60.96    533.40
** Receptor #6
RE DISCCART       91.44    434.34
** Receptor #7
RE DISCCART      121.92    297.18
** Receptor #8
RE DISCCART      259.08     15.24
** Receptor #9
```

```
RE DISCCART      388.62   640.08
** Receptor #10
RE DISCCART      487.68   670.56
** Receptor #11
RE DISCCART      563.88   243.84
** Receptor #12
RE DISCCART      243.84   655.32
** Receptor #13
RE DISCCART      167.64   274.32
** Receptor #14
RE DISCCART      114.30   647.70
** Receptor #15
RE DISCCART       91.44   594.36
** Receptor #16
RE DISCCART      228.60   129.54
** Receptor #17
RE DISCCART      365.76   144.78

RE FINISHED


ME STARTING
  INPUTFIL  TEST.DAT FREE
  ANEMHGHT  20. FEET
** Stardata from 1987 through 1992 at Providence was utilized.
  SURFDATA  14765  1987  PROVIDENCE
  UAIRDATA  14765  1987  PROVIDENCE

**          - AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -
**
**             STAB   STAB   STAB   STAB   STAB   STAB
**             CAT 1  CAT 2  CAT 3  CAT 4  CAT 5  CAT 6
**             -----  -----  -----  -----  -----  -----

  AVETEMPS ANNUAL  283.2  283.2  283.2  283.2  283.2  283.2


**                 - MIXING LAYER HEIGHT (METERS) -
**           S
**           T  WS     WS     WS     WS     WS     WS
**      SEAS A  CAT 1  CAT 2  CAT 3  CAT 4  CAT 5  CAT 6
**      ---- B  -----  -----  -----  -----  -----  -----

  AVEMIXHT  ANNUAL 1 .142E+04 .142E+04 .142E+04 .142E+04 .142E+04 .142E+04
  AVEMIXHT  ANNUAL 2 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03
  AVEMIXHT  ANNUAL 3 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03
  AVEMIXHT  ANNUAL 4 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03
  AVEMIXHT  ANNUAL 5 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05
  AVEMIXHT  ANNUAL 6 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05
ME FINISHED

OU STARTING
  RECTABLE  INDSRC
  MAXTABLE  10 INDSRC
OU FINISHED

***********************************
*** SETUP Finishes Successfully ***
***********************************
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** MODEL SETUP OPTIONS SUMMARY ***

- -

**Model Is Setup For Calculation of Average CONCentration Values.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses NO plume DEPLETION.

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
1. Final Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Default Wind Profile Exponents.
5. Default Vertical Potential Temperature Gradients.
6. "Upper Bound" Values For Supersquat Buildings.
7. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates 1 STAR Average(s) for the Following Months: 0 0 0 0 0 0 0 0 0 0 0 0
Seasons/Quarters: 0 0 0 0
and Annual: 1

**Model Assumes 1 STAR Summaries In Data File for the Averaging Periods Identified Above

**This Run Includes: 1 Source(s); 1 Source Group(s); and 329 Receptor(s)

**The Model Assumes A Pollutant Type of: VYCL

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of Long Term Values by Receptor (RECTABLE Keyword)
Model Outputs Tables of Maximum Long Term Values (MAXTABLE Keyword)

**Misc. Inputs: Anem. Hgt. (m) = 6.10 ; Decay Coef. = 0.0000 ; Rot. Angle = 0.0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = 0.10000E+07
Output Units = MICROGRAMS/M**3

**Input Runstream File: rhflare3.inp ; **Output Print File: rhflare3.out

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STACK1	0	0.80000E-02	373.4	480.1	0.0	9.14	1089.00	3.63	0.95	NO	

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	STACK1 ,

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

*** ORIGIN FOR POLAR NETWORK ***
X-ORIG = 375.00 ; Y-ORIG = 480.00 (METERS)

*** DISTANCE RANGES OF NETWORK ***
(METERS)

50.0, 100.0, 150.0, 200.0, 250.0, 300.0, 350.0, 400.0, 450.0, 500.0,
550.0, 600.0, 650.0, 700.0, 750.0, 800.0, 850.0, 900.0, 2800.0, 2900.0,
3000.0, 3100.0, 3200.0, 3300.0, 3400.0, 3500.0, 3600.0, 3700.0, 3800.0, 3900.0,
4000.0, 4100.0, 4200.0, 4300.0, 4400.0, 4500.0, 4600.0, 4700.0, 4800.0,

*** DIRECTION RADIALS OF NETWORK ***
(DEGREES)

360.0, 45.0, 90.0, 135.0, 180.0, 225.0, 270.0, 315.0,

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

(99.1,	670.6,	0.0,	0.0);	(30.5,	662.9,	0.0,	0.0);
(22.9,	563.9,	0.0,	0.0);	(15.2,	541.0,	0.0,	0.0);
(61.0,	533.4,	0.0,	0.0);	(91.4,	434.3,	0.0,	0.0);
(121.9,	297.2,	0.0,	0.0);	(259.1,	15.2,	0.0,	0.0);
(388.6,	640.1,	0.0,	0.0);	(487.7,	670.6,	0.0,	0.0);
(563.9,	243.8,	0.0,	0.0);	(243.8,	655.3,	0.0,	0.0);
(167.6,	274.3,	0.0,	0.0);	(114.3,	647.7,	0.0,	0.0);
(91.4,	594.4,	0.0,	0.0);	(228.6,	129.5,	0.0,	0.0);
(365.8,	144.8,	0.0,	0.0);				

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** AVERAGE SPEED FOR EACH WIND SPEED CATEGORY ***
(METERS/SEC)

1.50, 2.50, 4.30, 6.80, 9.50, 12.50,

*** WIND PROFILE EXPONENTS ***

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

*** AVERAGE AMBIENT AIR TEMPERATURE (KELVIN) ***

	STABILITY CATEGORY A	STABILITY CATEGORY B	STABILITY CATEGORY C	STABILITY CATEGORY D	STABILITY CATEGORY E	STABILITY CATEGORY F
ANNUAL	283.2000	283.2000	283.2000	283.2000	283.2000	283.2000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** AVERAGE MIXING LAYER HEIGHT (METERS) ***

ANNUAL

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY A	1420.0000	1420.0000	1420.0000	1420.0000	1420.0000	1420.0000
STABILITY CATEGORY B	944.0001	944.0001	944.0001	944.0001	944.0001	944.0001
STABILITY CATEGORY C	944.0001	944.0001	944.0001	944.0001	944.0001	944.0001
STABILITY CATEGORY D	944.0001	944.0001	944.0001	944.0001	944.0001	944.0001
STABILITY CATEGORY E	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000
STABILITY CATEGORY F	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: TEST.DAT FORMAT: FREE
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14765
NAME: PROVIDENCE NAME: PROVIDENCE
YEAR: 1987 YEAR: 1987

ANNUAL: STABILITY CATEGORY A

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

ANNUAL: STABILITY CATEGORY B

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00025000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00038000	0.00000000	0.00009000	0.00000000	0.00000000	0.00000000
112.500	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00050000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00050000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00016000	0.00009000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00025000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00016000	0.00009000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: TEST.DAT FORMAT: FREE
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14765
NAME: PROVIDENCE NAME: PROVIDENCE
YEAR: 1987 YEAR: 1987

ANNUAL: STABILITY CATEGORY C

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00047000	0.00130000	0.00296000	0.00019000	0.00000000	0.00000000
22.500	0.00025000	0.00037000	0.00065000	0.00000000	0.00000000	0.00000000
45.000	0.00005000	0.00037000	0.00046000	0.00000000	0.00000000	0.00000000
67.500	0.00097000	0.00028000	0.00028000	0.00009000	0.00000000	0.00000000
90.000	0.00007000	0.00056000	0.00009000	0.00000000	0.00000000	0.00000000
112.500	0.00024000	0.00028000	0.00028000	0.00000000	0.00000000	0.00000000
135.000	0.00048000	0.00056000	0.00074000	0.00000000	0.00000000	0.00000000
157.500	0.00003000	0.00028000	0.00083000	0.00000000	0.00000000	0.00000000
180.000	0.00094000	0.00176000	0.00139000	0.00000000	0.00000000	0.00000000
202.500	0.00042000	0.00093000	0.00074000	0.00000000	0.00000000	0.00000000
225.000	0.00026000	0.00046000	0.00120000	0.00000000	0.00000000	0.00000000
247.500	0.00048000	0.00139000	0.00269000	0.00009000	0.00000000	0.00000000
270.000	0.00071000	0.00157000	0.00296000	0.00000000	0.00000000	0.00000000
292.500	0.00044000	0.00102000	0.00269000	0.00000000	0.00000000	0.00000000
315.000	0.00039000	0.00065000	0.00278000	0.00000000	0.00000000	0.00000000
337.500	0.00028000	0.00056000	0.00167000	0.00000000	0.00000000	0.00000000

ANNUAL: STABILITY CATEGORY D

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00274000	0.01083000	0.03380000	0.03593000	0.00694000	0.00074000
22.500	0.00192000	0.00639000	0.01417000	0.00981000	0.00102000	0.00019000
45.000	0.00171000	0.00630000	0.01167000	0.00824000	0.00102000	0.00037000
67.500	0.00084000	0.00565000	0.00833000	0.00546000	0.00019000	0.00000000
90.000	0.00091000	0.00426000	0.00704000	0.00259000	0.00000000	0.00000000
112.500	0.00089000	0.00194000	0.00380000	0.00157000	0.00000000	0.00000000
135.000	0.00052000	0.00231000	0.00333000	0.00093000	0.00009000	0.00000000
157.500	0.00138000	0.00500000	0.00583000	0.00222000	0.00019000	0.00000000
180.000	0.00186000	0.00796000	0.02130000	0.01157000	0.00148000	0.00037000
202.500	0.00093000	0.00454000	0.01204000	0.01167000	0.00296000	0.00120000
225.000	0.00171000	0.00528000	0.01343000	0.02065000	0.00491000	0.00185000
247.500	0.00123000	0.00343000	0.01519000	0.02694000	0.00315000	0.00074000
270.000	0.00139000	0.00509000	0.02194000	0.03037000	0.00380000	0.00111000
292.500	0.00040000	0.00426000	0.01907000	0.04454000	0.01315000	0.00222000
315.000	0.00051000	0.00324000	0.01435000	0.04204000	0.01157000	0.00167000
337.500	0.00114000	0.00454000	0.01491000	0.02833000	0.00667000	0.00102000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: TEST.DAT FORMAT: FREE
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14765
NAME: PROVIDENCE NAME: PROVIDENCE
YEAR: 1987 YEAR: 1987

ANNUAL: STABILITY CATEGORY E

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00000000	0.00630000	0.01019000	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.00102000	0.00111000	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.00148000	0.00074000	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00231000	0.00028000	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.00111000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00056000	0.00009000	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00093000	0.00028000	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00204000	0.00111000	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.00954000	0.00500000	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00546000	0.00380000	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00509000	0.00546000	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00593000	0.00694000	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00583000	0.01806000	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00389000	0.01981000	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00565000	0.01685000	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00583000	0.01074000	0.00000000	0.00000000	0.00000000

ANNUAL: STABILITY CATEGORY F

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00110000	0.00593000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00026000	0.00083000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00028000	0.00120000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00094000	0.00074000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00072000	0.00046000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00040000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00094000	0.00065000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00110000	0.00157000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00291000	0.00491000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00140000	0.00454000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00168000	0.00565000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00220000	0.01037000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00148000	0.01287000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00132000	0.01194000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00151000	0.00898000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00166000	0.00824000	0.00000000	0.00000000	0.00000000	0.00000000

SUM OF FREQUENCIES, FTOTAL = 0.98123

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00
360.00	0.000000	0.000199	0.001988	0.003866	0.005395	0.006399	0.006853	0.006999	0.006955
45.00	0.000000	0.000458	0.003213	0.005600	0.007099	0.007782	0.007855	0.007655	0.007325
90.00	0.000000	0.000538	0.004246	0.007640	0.009916	0.011059	0.011306	0.011106	0.010691
135.00	0.000000	0.000849	0.006059	0.010438	0.012939	0.013843	0.013681	0.013068	0.012284
180.00	0.000000	0.000600	0.005180	0.009551	0.012606	0.014231	0.014654	0.014490	0.014013
225.00	0.000000	0.000115	0.001199	0.002337	0.003240	0.003809	0.004047	0.004109	0.004063
270.00	0.000000	0.000041	0.000446	0.000934	0.001393	0.001736	0.001924	0.002017	0.002044
315.00	0.000000	0.000033	0.000338	0.000645	0.000907	0.001092	0.001190	0.001235	0.001245

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 500.00	550.00	600.00	650.00	700.00	750.00	800.00	850.00	900.00
360.00	0.006796	0.006574	0.006320	0.006054	0.005790	0.005531	0.005282	0.005047	0.004825
45.00	0.006942	0.006547	0.006163	0.005800	0.005462	0.005150	0.004862	0.004599	0.004358
90.00	0.010180	0.009640	0.009107	0.008600	0.008127	0.007685	0.007278	0.006905	0.006562
135.00	0.011460	0.010660	0.009915	0.009234	0.008618	0.008060	0.007558	0.007106	0.006697
180.00	0.013380	0.012683	0.011977	0.011290	0.010637	0.010024	0.009454	0.008925	0.008438
225.00	0.003951	0.003803	0.003638	0.003466	0.003294	0.003127	0.002967	0.002815	0.002672
270.00	0.002027	0.001981	0.001919	0.001847	0.001771	0.001693	0.001616	0.001542	0.001470
315.00	0.001230	0.001200	0.001161	0.001118	0.001073	0.001027	0.000982	0.000938	0.000897

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - ALT. FLARE EMISSIONS - ISCLT3 ***
07/24/97
*** *** 11:10:49
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 2800.00	2900.00	3000.00	3100.00	3200.00	3300.00	3400.00	3500.00	3600.00
360.00	0.001556	0.001494	0.001436	0.001381	0.001330	0.001283	0.001237	0.001195	0.001155
45.00	0.001302	0.001248	0.001198	0.001152	0.001109	0.001068	0.001030	0.000994	0.000960
90.00	0.002065	0.001983	0.001906	0.001834	0.001767	0.001703	0.001644	0.001588	0.001535
135.00	0.001904	0.001825	0.001751	0.001682	0.001618	0.001558	0.001501	0.001448	0.001398
180.00	0.002265	0.002164	0.002070	0.001984	0.001904	0.001828	0.001758	0.001692	0.001630
225.00	0.000713	0.000681	0.000650	0.000623	0.000597	0.000573	0.000550	0.000529	0.000509
270.00	0.000415	0.000397	0.000380	0.000364	0.000350	0.000336	0.000323	0.000311	0.000300
315.00	0.000277	0.000265	0.000255	0.000245	0.000236	0.000227	0.000219	0.000211	0.000204

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - ALT. FLARE EMISSIONS - ISCLT3 ***
07/24/97
*** *** 11:10:49
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 3700.00	3800.00	3900.00	4000.00	4100.00	4200.00	4300.00	4400.00	4500.00
360.00	0.001117	0.001081	0.001047	0.001015	0.000985	0.000956	0.000928	0.000902	0.000877
45.00	0.000928	0.000898	0.000869	0.000842	0.000817	0.000792	0.000769	0.000747	0.000726
90.00	0.001485	0.001437	0.001393	0.001350	0.001310	0.001272	0.001235	0.001201	0.001168
135.00	0.001351	0.001306	0.001264	0.001224	0.001187	0.001151	0.001117	0.001085	0.001054
180.00	0.001572	0.001517	0.001465	0.001416	0.001370	0.001326	0.001285	0.001246	0.001208
225.00	0.000490	0.000473	0.000456	0.000441	0.000426	0.000412	0.000399	0.000386	0.000374
270.00	0.000289	0.000279	0.000269	0.000261	0.000252	0.000244	0.000236	0.000229	0.000222
315.00	0.000198	0.000191	0.000185	0.000179	0.000174	0.000169	0.000164	0.000159	0.000155

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - ALT. FLARE EMISSIONS - ISCLT3 ***
07/24/97
*** *** 11:10:49
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 4600.00	4700.00	4800.00
360.00	0.000853	0.000830	0.000809
45.00	0.000706	0.000687	0.000669
90.00	0.001136	0.001106	0.001077
135.00	0.001025	0.000997	0.000970
180.00	0.001173	0.001139	0.001107
225.00	0.000363	0.000352	0.000342
270.00	0.000216	0.000210	0.000204
315.00	0.000151	0.000146	0.000143

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - ALT. FLARE EMISSIONS - ISCLT3 ***
07/24/97
*** *** 11:10:49
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.001116	30.48	662.94	0.001180
22.86	563.88	0.001441	15.24	541.02	0.001582
60.96	533.40	0.001464	91.44	434.34	0.001929
121.92	297.18	0.003314	259.08	15.24	0.008029
388.62	640.08	0.002287	487.68	670.56	0.004735
563.88	243.84	0.012546	243.84	655.32	0.000868
167.64	274.32	0.003739	114.30	647.70	0.001059
91.44	594.36	0.001076	228.60	129.54	0.004787
365.76	144.78	0.014067			

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE MAXIMUM 10 ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

RANK	CONC	AT	RECEPTOR (XR,YR) OF TYPE	RANK	CONC	AT	RECEPTOR (XR,YR) OF TYPE
1.	0.014654	AT	(375.00, 130.00) GP	6.	0.013843	AT	(587.13, 267.87) GP
2.	0.014490	AT	(375.00, 80.00) GP	7.	0.013681	AT	(622.49, 232.51) GP
3.	0.014231	AT	(375.00, 180.00) GP	8.	0.013380	AT	(375.00, -20.00) GP
4.	0.014067	AT	(365.76, 144.78) DC	9.	0.013068	AT	(657.84, 197.16) GP
5.	0.014013	AT	(375.00, 30.00) GP	10.	0.012939	AT	(551.78, 303.22) GP

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** Message Summary : ISCLT3 Model Execution ***

--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 0 Informational Message(s)

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** ISCLT3 Finishes Successfully ***
****

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1	of	1
Subject	Air Modeling	Comptd. By	S. Czarniecki	Date	08/22/96		
Detail	Flare Results Table	Ck'd. By	R. Porter	Date	08/26/96		

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RESTABLT.WK1

The attached table presents modeled concentrations of analytes of concern at the Site for dispersion from a flare. The maximum modeled concentrations from LTRESULT were used to proportionally determine the analytes' concentration at various receptors. Some analytes were not detected in landfill gas SUMMA canister sampling, but are noted due to detections in ambient air at residences.

Metcalf & Eddy, Inc.

MODELED CONCENTRATIONS OF LANDFILL GAS CONTAMINANTS AT RESIDENTIAL RECEPTORS, ROSE HILL REGIONAL LANDFILL SUPERFUND SITE
SOLID WASTE LANDFILL - POINT SOURCE MODELING - FLARE

Maximum Modeled Concentration Based on 3,100 (mg/m^3) ->		1.12E-03	1.18E-03	1.44E-03	1.58E-03	1.46E-03	1.93E-03	3.31E-03	8.03E-03	2.29E-03	4.74E-03
		Concentration (µg/m^3)									
	SUMMA	Receptor #									
	Max (µg/m^3)	1	2	3	4	5	6	7	8	9	10
Acetone	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	8,000	2.88E-06	3.05E-06	3.72E-06	4.08E-06	3.78E-06	4.98E-06	8.55E-06	2.07E-05	5.90E-06	1.22E-05
Carbon Disulfide	870	3.13E-07	3.31E-07	4.04E-07	4.44E-07	4.11E-07	5.41E-07	9.30E-07	2.25E-06	6.42E-07	1.33E-06
Dichlorodifluoromethane	110,000	3.96E-05	4.19E-05	5.11E-05	5.61E-05	5.19E-05	6.84E-05	1.18E-04	2.85E-04	8.12E-05	1.68E-04
1,1-Dichloroethane	140,000	5.04E-05	5.33E-05	6.51E-05	7.14E-05	6.61E-05	8.71E-05	1.50E-04	3.63E-04	1.03E-04	2.14E-04
1,1-Dichloroethene	32,000	1.15E-05	1.22E-05	1.49E-05	1.63E-05	1.51E-05	1.99E-05	3.42E-05	8.29E-05	2.36E-05	4.89E-05
cis-1,2-Dichloroethene	23,000,000	8.28E-03	8.75E-03	1.07E-02	1.17E-02	1.09E-02	1.43E-02	2.46E-02	5.96E-02	1.70E-02	3.51E-02
trans-1,2-Dichloroethene	27,000	9.72E-06	1.03E-05	1.26E-05	1.38E-05	1.28E-05	1.68E-05	2.89E-05	6.99E-05	1.99E-05	4.12E-05
Ethylbenzene	25,000	9.00E-06	9.52E-06	1.16E-05	1.28E-05	1.18E-05	1.56E-05	2.67E-05	6.48E-05	1.84E-05	3.82E-05
4-Methyl-2-pentanone	6,600	2.38E-06	2.51E-06	3.07E-06	3.37E-06	3.12E-06	4.11E-06	7.06E-06	1.71E-05	4.87E-06	1.01E-05
Methylene Chloride	66,000	2.38E-05	2.51E-05	3.07E-05	3.37E-05	3.12E-05	4.11E-05	7.06E-05	1.71E-04	4.87E-05	1.01E-04
1,1,2,2-Tetrachloroethane	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Toluene	230,000	8.28E-05	8.75E-05	1.07E-04	1.17E-04	1.09E-04	1.43E-04	2.46E-04	5.96E-04	1.70E-04	3.51E-04
1,2,4-Trichlorobenzene	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,1,1-Trichloroethane	10,000	3.60E-06	3.81E-06	4.65E-06	5.10E-06	4.72E-06	6.22E-06	1.07E-05	2.59E-05	7.38E-06	1.53E-05
Trichloroethene	31,000	1.12E-05	1.18E-05	1.44E-05	1.58E-05	1.46E-05	1.93E-05	3.31E-05	8.03E-05	2.29E-05	4.74E-05
1,2,4-Trimethylbenzene	2,000	7.20E-07	7.61E-07	9.30E-07	1.02E-06	9.45E-07	1.24E-06	2.14E-06	5.18E-06	1.48E-06	3.05E-06
1,3,5-Trimethylbenzene	4,300	1.55E-06	1.64E-06	2.00E-06	2.19E-06	2.03E-06	2.68E-06	4.60E-06	1.11E-05	3.17E-06	6.57E-06
Vinyl Chloride	3,100,000	1.12E-03	1.18E-03	1.44E-03	1.58E-03	1.46E-03	1.93E-03	3.31E-03	8.03E-03	2.29E-03	4.74E-03
m,p-Xylene	41,000	1.48E-05	1.56E-05	1.91E-05	2.09E-05	1.94E-05	2.55E-05	4.38E-05	1.06E-04	3.02E-05	6.26E-05
o-Xylene	11,000	3.96E-06	4.19E-06	5.11E-06	5.61E-06	5.19E-06	6.84E-06	1.18E-05	2.85E-05	8.12E-06	1.68E-05

MODELED CONCENTRATIONS OF LANDFILL GAS CONTAMINANTS AT RESIDENTIAL RECEPTORS, ROSE HILL REGIONAL LANDFILL SUPERFUND SITE
SOLID WASTE LANDFILL - POINT SOURCE MODELING - FLARE

Maximum Modeled Concentration Based on 3,100 (mg/m³) ->		1.25E-02	8.68E-04	3.74E-03	1.06E-03	1.08E-03	4.79E-03	1.41E-02	1.47E-02
		Concentration (μg/m³)							
	SUMMA	Receptor #							Maximum
	Max (μg/m³)	11	12	13	14	15	16	17	Receptor
Benzene	8,000	3.24E-05	2.24E-06	9.65E-06	2.73E-06	2.78E-06	1.24E-05	3.63E-05	3.78E-05
Acetone	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbon Disulfide	870	3.52E-06	2.44E-07	1.05E-06	2.97E-07	3.02E-07	1.34E-06	3.95E-06	4.11E-06
Dichlorodifluoromethane	110,000	4.45E-04	3.08E-05	1.33E-04	3.76E-05	3.82E-05	1.70E-04	4.99E-04	5.20E-04
1,1-Dichloroethane	140,000	5.67E-04	3.92E-05	1.69E-04	4.78E-05	4.86E-05	2.16E-04	6.35E-04	6.62E-04
1,1-Dichloroethene	32,000	1.30E-04	8.96E-06	3.86E-05	1.09E-05	1.11E-05	4.94E-05	1.45E-04	1.51E-04
cis-1,2-Dichloroethene	23,000,000	9.31E-02	6.44E-03	2.77E-02	7.86E-03	7.98E-03	3.55E-02	1.04E-01	1.09E-01
trans-1,2-Dichloroethene	27,000	1.09E-04	7.56E-06	3.26E-05	9.22E-06	9.37E-06	4.17E-05	1.23E-04	1.28E-04
Ethylbenzene	25,000	1.01E-04	7.00E-06	3.02E-05	8.54E-06	8.68E-06	3.86E-05	1.13E-04	1.18E-04
4-Methyl-2-pentanone	6,600	2.67E-05	1.85E-06	7.96E-06	2.25E-06	2.29E-06	1.02E-05	2.99E-05	3.12E-05
Methylene Chloride	66,000	2.67E-04	1.85E-05	7.96E-05	2.25E-05	2.29E-05	1.02E-04	2.99E-04	3.12E-04
1,1,2,2-Tetrachloroethane	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Toluene	230,000	9.31E-04	6.44E-05	2.77E-04	7.86E-05	7.98E-05	3.55E-04	1.04E-03	1.09E-03
1,2,4-Trichlorobenzene	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1,1,1-Trichloroethane	10,000	4.05E-05	2.80E-06	1.21E-05	3.42E-06	3.47E-06	1.54E-05	4.54E-05	4.73E-05
Trichloroethene	31,000	1.25E-04	8.68E-06	3.74E-05	1.06E-05	1.08E-05	4.79E-05	1.41E-04	1.47E-04
1,2,4-Trimethylbenzene	2,000	8.09E-06	5.60E-07	2.41E-06	6.83E-07	6.94E-07	3.09E-06	9.08E-06	9.45E-06
1,3,5-Trimethylbenzene	4,300	1.74E-05	1.20E-06	5.19E-06	1.47E-06	1.49E-06	6.64E-06	1.95E-05	2.03E-05
Vinyl Chloride	3,100,000	1.25E-02	8.68E-04	3.74E-03	1.06E-03	1.08E-03	4.79E-03	1.41E-02	1.47E-02
m,p-Xylene	41,000	1.66E-04	1.15E-05	4.95E-05	1.40E-05	1.42E-05	6.33E-05	1.86E-04	1.94E-04
o-Xylene	11,000	4.45E-05	3.08E-06	1.33E-05	3.76E-06	3.82E-06	1.70E-05	4.99E-05	5.20E-05

Notes:

1) ISCLT3 model utilized.
2) Receptors #1 through 10 are nearby residences.
   Receptors #11 is the transfer station.
   Receptors #12 through 17 are locations on roadways and driveways along the landfill perimeter.
   Maximum Receptor is the maximum modeled concentration located in the southern direction from the flare stack, approximately 350 meters away.
3) Modeling assumptions are presented in RECEPTOR.WK1, SUMMA.WK1, FLARE.WK1 and LTRESULT.

F-3 PRG Exceedances

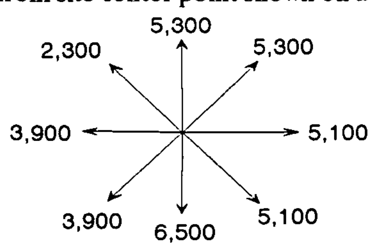
Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1 of 1
Subject	Air Modeling PRG Exceedances	Comptd. By	S. Czarniecki	Date	08/21/96
Detail	Area Sources	Ck'd. By	R. Porter	Date	08/26/96

C:\RH\AIR\EXCEED.WK1

Utilizing ISCST3 model runs, the extent of PRG exceedances for vinyl chloride was determined. The PRG (Preliminary Remediation Guideline) utilized was 0.03 $\mu g/m^3$. As with model runs performed for risk assessment purposes, five runs were performed to cover the years 1987 to 1991. A site center point was selected (shown on Attachment A) and a polar grid was used to define distances that annual average dispersion concentrations were above PRGs. Although meteorologic data for ISCST3 is for every 10 degrees, just to get an approximation of the extent of impact, results were only determined for every 45 degrees. Maximum distances in each direction from the five years are presented below. 1991 results had many of the maximum distances and the model output for this year is presented as Attachment B. The extent of PRG exceedence was assumed to be halfway between the last distance above the PRG and the next distance below the PRG.

Vinyl Chloride

Meters from site center point shown on attached figure:



Meters	Miles
2,300	1.4
3,900	2.4
5,100	3.2
5,300	3.3
6,500	4.0

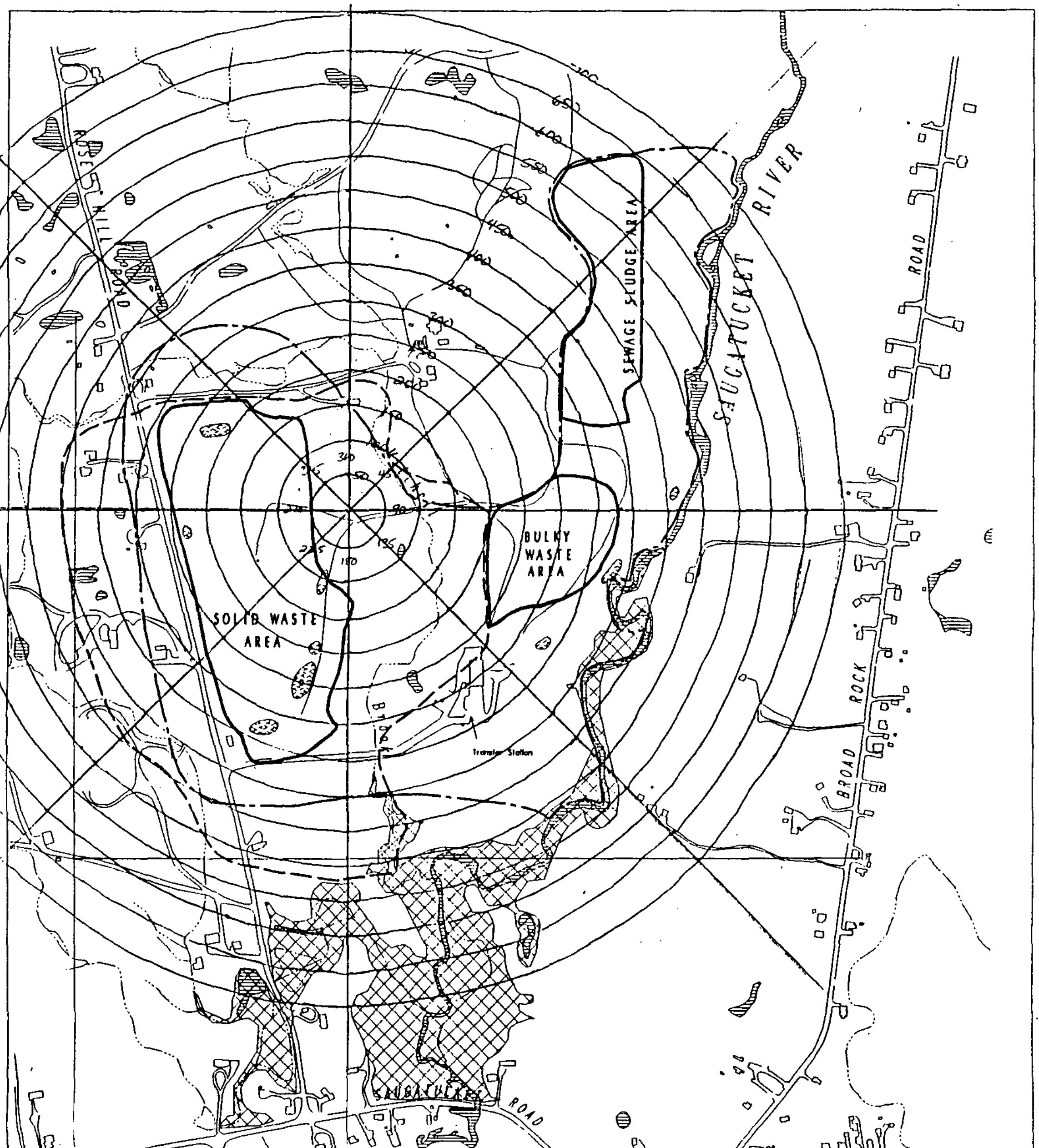
Other Compounds

Other compound impact concentrations may be determined proportionally from the vinyl chloride results and then compared to respective PRGs to see if impacts are extended at all. By determining what each compound's concentration would be at vinyl chloride's PRG, we can say if impacts are extended.

Analyte	SUMMA Maximum Concentration ($\mu g/m^3$)	PRG	Model Result Corresponding to Vinyl Chloride = 0.03
Vinyl Chloride	3,100,000	0.03	0.03
1,1-Dichloroethene	32,000	0.1	0.00030
Benzene	8,000	0.3	0.00007
1,1,2,2-Tetrachloroethane	0 *	0.04	Not Applicable

* Not detected in SUMMA canister landfill gas samples

Since a modeled concentration of 0.03 $\mu g/m^3$ vinyl chloride corresponds to other analyte concentrations which are way below respective PRG's, vinyl chloride defines the extent of impacts.



LEGEND

- Primary Road
- Secondary Road
- Stream or Brook
- Limit of GA Non-Attainment GW Classification
- Limit of GW PRG Exceedance
- Limit of Waste Placement and Limit of GB GW Classification Area
- Lake, Pond, or River
- Area of Leachate Breakout
- 100-Year Flood Plain

500 0 500
SCALE IN FEET

FIGURE [redacted]

[redacted]

AIR MODELING BASE POINT

ROSE HILL LANDFILL

SOUTH KINGSTOWN, RI

METCALF & EDDY

ATTACHMENT A

ATTACHMENT B

```
** Rosehill - ISCST3
** Area emissions from the Solid Waste Area
** Ground 0 (Landfill assumed same level as receptors - worst case)
** 1991 data
** PRG Exceedance Run
** Vinyl chloride emissions (Concentration = 3,100,000 ug/m^3)

CO STARTING
   TITLEONE  ROSEHILL - SOLID WASTE AREA EMISSIONS - ISCST3
   MODELOPT  DFAULT  CONC  RURAL
   AVERTIME  PERIOD
   TERRHGTS  FLAT
   POLLUTID  UNIT
   RUNORNOT  RUN
CO FINISHED

SO STARTING

**  SOLID WASTE AREA (FS Version - 8/96)
**  x, y, and z coordinates, respectively (m)

SO LOCATION     SQUARE1     AREA        121.92    533.40       0.
SO LOCATION     SQUARE2     AREA        228.60    533.40       0.
SO LOCATION     SQUARE3     AREA        137.16    457.20       0.
SO LOCATION     SQUARE4     AREA        213.36    487.68       0.
SO LOCATION     SQUARE5     AREA        259.08    487.68       0.
SO LOCATION     SQUARE6     AREA        304.80    502.92       0.
SO LOCATION     SQUARE7     AREA        304.80    487.68       0.
SO LOCATION     SQUARE8     AREA        320.04    487.68       0.
SO LOCATION     SQUARE9     AREA        213.36    472.44       0.
SO LOCATION     SQUARE10    AREA        213.36    457.20       0.
SO LOCATION     SQUARE11    AREA        228.60    381.00       0.
SO LOCATION     SQUARE12    AREA        152.40    381.00       0.
SO LOCATION     SQUARE13    AREA        167.64    335.28       0.
SO LOCATION     SQUARE14    AREA        213.36    335.28       0.
SO LOCATION     SQUARE15    AREA        259.08    350.52       0.
SO LOCATION     SQUARE16    AREA        335.28    381.00       0.
SO LOCATION     SQUARE17    AREA        289.56    289.56       0.
SO LOCATION     SQUARE18    AREA        259.08    320.04       0.
SO LOCATION     SQUARE19    AREA        182.88    259.08       0.
SO LOCATION     SQUARE20    AREA        259.08    289.56       0.
SO LOCATION     SQUARE21    AREA        259.08    259.08       0.
SO LOCATION     SQUARE22    AREA        289.56    213.36       0.
SO LOCATION     SQUARE23    AREA        198.12    213.36       0.
SO LOCATION     SQUARE24    AREA        243.84    213.36       0.
SO LOCATION     SQUARE25    AREA        213.36    182.88       0.
SO LOCATION     SQUARE26    AREA        243.84    137.16       0.
SO LOCATION     SQUARE27    AREA        320.04    167.64       0.

**  Emission rate (g/m^2-s), release height (m), length of square (m)

SO SRCPARAM     SQUARE1     1.77E-06      0.0     106.68
SO SRCPARAM     SQUARE2     1.77E-06      0.0      91.44
SO SRCPARAM     SQUARE3     1.77E-06      0.0      76.20
SO SRCPARAM     SQUARE4     1.77E-06      0.0      45.72
SO SRCPARAM     SQUARE5     1.77E-06      0.0      45.72
SO SRCPARAM     SQUARE6     1.77E-06      0.0      30.48
SO SRCPARAM     SQUARE7     1.77E-06      0.0      15.24
SO SRCPARAM     SQUARE8     1.77E-06      0.0      15.24
SO SRCPARAM     SQUARE9     1.77E-06      0.0      15.24
SO SRCPARAM     SQUARE10    1.77E-06      0.0      15.24
SO SRCPARAM     SQUARE11    1.77E-06      0.0     106.68
SO SRCPARAM     SQUARE12    1.77E-06      0.0      76.20
SO SRCPARAM     SQUARE13    1.77E-06      0.0      45.72
SO SRCPARAM     SQUARE14    1.77E-06      0.0      45.72
SO SRCPARAM     SQUARE15    1.77E-06      0.0      30.48
SO SRCPARAM     SQUARE16    1.77E-06      0.0      30.48
SO SRCPARAM     SQUARE17    1.77E-06      0.0      91.44
SO SRCPARAM     SQUARE18    1.77E-06      0.0      30.48
SO SRCPARAM     SQUARE19    1.77E-06      0.0      76.20
SO SRCPARAM     SQUARE20    1.77E-06      0.0      30.48
SO SRCPARAM     SQUARE21    1.77E-06      0.0      30.48
SO SRCPARAM     SQUARE22    1.77E-06      0.0      76.20
SO SRCPARAM     SQUARE23    1.77E-06      0.0      45.72
SO SRCPARAM     SQUARE24    1.77E-06      0.0      45.72
SO SRCPARAM     SQUARE25    1.77E-06      0.0      30.48
SO SRCPARAM     SQUARE26    1.77E-06      0.0      76.20
SO SRCPARAM     SQUARE27    1.77E-06      0.0      45.72

SO SRCGROUP ALL
SO FINISHED

RE STARTING
RE GRIDPOLR POL STA
RE GRIDPOLR POL ORIG    375. 480.
RE GRIDPOLR POL DIST    200. 400. 600. 800. 1000.
RE GRIDPOLR POL DIST    1200. 1400. 1600. 1800. 2000. 2200. 2400.
RE GRIDPOLR POL DIST    2600. 2800. 3000. 3200. 3400. 3600. 3800.
RE GRIDPOLR POL DIST    4000. 4200. 4400. 4600. 4800. 5000. 5200.
RE GRIDPOLR POL DIST    5400. 5600. 5800. 6000. 6200. 6400. 6600.
RE GRIDPOLR POL DIST    6800. 7000. 7200. 7400. 7600. 7800. 8000.
RE GRIDPOLR POL GDIR    8     0.  45.
RE GRIDPOLR POL END
```

```
RE FINISHED

ME STARTING

** 1991
   INPUTFIL  lprov91.bin  unform
   ANEMHGHT  20. FEET
** SURFACE DATA FROM 1991 at Providence was utilized. MIXING FROM CHATHAM.
   SURFDATA  14765  1991  SURFNAME
   UAIRDATA  14684  1991  UAIRNAME

ME FINISHED

OU STARTING
   RECTABLE  ALLAVE FIRST
OU FINISHED

***********************************
*** SETUP Finishes Successfully ***
***********************************
```

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** MODEL SETUP OPTIONS SUMMARY ***

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

-- SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION. DDPLETE = F
**Model Uses NO WET DEPLETION. WDPLETE = F
**NO WET SCAVENGING Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
1. Final Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Use Calms Processing Routine.
5. Not Use Missing Data Processing Routine.
6. Default Wind Profile Exponents.
7. Default Vertical Potential Temperature Gradients.
8. "Upper Bound" Values for Supersquat Buildings.
9. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates PERIOD Averages Only

**This Run Includes: 27 Source(s); 1 Source Group(s); and 320 Receptor(s)

**The Model Assumes A Pollutant Type of: UNIT

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of PERIOD Averages by Receptor
Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)

**NOTE: The Following Flags May Appear Following CONC Values: c for Calm Hours
m for Missing Hours
b for Both Calm and Missing Hours

**Misc. Inputs: Anem. Hgt. (m) = 6.10 ; Decay Coef. = 0.0000 ; Rot. Angle = 0.0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = 0.10000E+07
Output Units = MICROGRAMS/M**3

**Input Runstream File: RHfs25.INP ; **Output Print File: RHfs25.OUT

**MODELOPTs: CONC RURAL FLAT DFAULT

*** AREA SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC /METER**2)	COORD (SW CORNER) X (METERS)	Y (METERS)	BASE ELEV. (METERS)	RELEASE HEIGHT (METERS)	X-DIM OF AREA (METERS)	Y-DIM OF AREA (METERS)	ORIENT. OF AREA (DEG.)	INIT. SZ (METERS)	EMISSION RATE SCALAR VARY BY
SQUARE1	0	0.17700E-05	121.9	533.4	0.0	0.00	106.68	106.68	0.00	0.00	
SQUARE2	0	0.17700E-05	228.6	533.4	0.0	0.00	91.44	91.44	0.00	0.00	
SQUARE3	0	0.17700E-05	137.2	457.2	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE4	0	0.17700E-05	213.4	487.7	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE5	0	0.17700E-05	259.1	487.7	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE6	0	0.17700E-05	304.8	502.9	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE7	0	0.17700E-05	304.8	487.7	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE8	0	0.17700E-05	320.0	487.7	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE9	0	0.17700E-05	213.4	472.4	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE10	0	0.17700E-05	213.4	457.2	0.0	0.00	15.24	15.24	0.00	0.00	
SQUARE11	0	0.17700E-05	228.6	381.0	0.0	0.00	106.68	106.68	0.00	0.00	
SQUARE12	0	0.17700E-05	152.4	381.0	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE13	0	0.17700E-05	167.6	335.3	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE14	0	0.17700E-05	213.4	335.3	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE15	0	0.17700E-05	259.1	350.5	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE16	0	0.17700E-05	335.3	381.0	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE17	0	0.17700E-05	289.6	289.6	0.0	0.00	91.44	91.44	0.00	0.00	
SQUARE18	0	0.17700E-05	259.1	320.0	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE19	0	0.17700E-05	182.9	259.1	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE20	0	0.17700E-05	259.1	289.6	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE21	0	0.17700E-05	259.1	259.1	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE22	0	0.17700E-05	289.6	213.4	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE23	0	0.17700E-05	198.1	213.4	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE24	0	0.17700E-05	243.8	213.4	0.0	0.00	45.72	45.72	0.00	0.00	
SQUARE25	0	0.17700E-05	213.4	182.9	0.0	0.00	30.48	30.48	0.00	0.00	
SQUARE26	0	0.17700E-05	243.8	137.2	0.0	0.00	76.20	76.20	0.00	0.00	
SQUARE27	0	0.17700E-05	320.0	167.6	0.0	0.00	45.72	45.72	0.00	0.00	

**MODELOPTs: CONC RURAL FLAT DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12
	SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24
	SQUARE25, SQUARE26, SQUARE27,

**MODELOPTs: CONC RURAL FLAT DFAULT

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

*** ORIGIN FOR POLAR NETWORK ***
X-ORIG = 375.00 ; Y-ORIG = 480.00 (METERS)

*** DISTANCE RANGES OF NETWORK ***
(METERS)

200.0,	400.0,	600.0,	800.0,	1000.0,	1200.0,	1400.0,	1600.0,	1800.0,	2000.0,
2200.0,	2400.0,	2600.0,	2800.0,	3000.0,	3200.0,	3400.0,	3600.0,	3800.0,	4000.0,
4200.0,	4400.0,	4600.0,	4800.0,	5000.0,	5200.0,	5400.0,	5600.0,	5800.0,	6000.0,
6200.0,	6400.0,	6600.0,	6800.0,	7000.0,	7200.0,	7400.0,	7600.0,	7800.0,	8000.0,

*** DIRECTION RADIALS OF NETWORK ***
(DEGREES)

360.0,	45.0,	90.0,	135.0,	180.0,	225.0,	270.0,	315.0,

**MODELOPTs: CONC RURAL FLAT DFAULT

*** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
(1=YES; 0=NO)

```
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
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NOTE: METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE FIRST 24 HOURS OF METEOROLOGICAL DATA ***

FILE: lprov91.bin FORMAT: UNFORM
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14684
NAME: SURFNAME NAME: UAIRNAME
YEAR: 1991 YEAR: 1991

YEAR	MONTH	DAY	HOUR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	IPCODE	PRATE (mm/HR)
91	1	1	1	121.0	4.12	267.6	5	453.1	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	2	128.0	3.60	267.0	5	504.8	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	3	154.0	3.60	267.0	5	556.4	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	4	123.0	3.60	266.5	5	608.1	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	5	113.0	3.09	265.9	6	659.8	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	6	12.0	2.57	264.3	6	711.5	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	7	105.0	3.09	265.4	6	763.2	24.0	0.0000	0.0	0.0000	0	0.00
91	1	1	8	133.0	3.60	265.9	5	131.6	152.8	0.0000	0.0	0.0000	0	0.00
91	1	1	9	137.0	1.54	268.7	4	297.1	314.8	0.0000	0.0	0.0000	0	0.00
91	1	1	10	131.0	3.09	270.9	3	462.7	476.8	0.0000	0.0	0.0000	0	0.00
91	1	1	11	84.0	2.57	271.5	3	628.3	638.9	0.0000	0.0	0.0000	0	0.00
91	1	1	12	86.0	3.09	272.6	3	793.9	800.9	0.0000	0.0	0.0000	0	0.00
91	1	1	13	63.0	3.09	273.1	3	959.4	963.0	0.0000	0.0	0.0000	0	0.00
91	1	1	14	329.0	4.63	273.1	3	1125.0	1125.0	0.0000	0.0	0.0000	0	0.00
91	1	1	15	2.0	4.63	273.1	4	1125.0	1125.0	0.0000	0.0	0.0000	0	0.00
91	1	1	16	4.0	6.17	272.6	4	1125.0	1125.0	0.0000	0.0	0.0000	0	0.00
91	1	1	17	1.0	5.14	270.9	5	1120.4	1035.9	0.0000	0.0	0.0000	0	0.00
91	1	1	18	17.0	2.57	270.9	6	1114.5	919.5	0.0000	0.0	0.0000	0	0.00
91	1	1	19	54.0	2.57	269.8	6	1108.5	803.0	0.0000	0.0	0.0000	0	0.00
91	1	1	20	47.0	2.57	269.3	6	1102.5	686.6	0.0000	0.0	0.0000	0	0.00
91	1	1	21	50.0	1.00	268.7	7	1096.5	570.2	0.0000	0.0	0.0000	0	0.00
91	1	1	22	352.0	1.00	268.7	7	1090.6	453.8	0.0000	0.0	0.0000	0	0.00
91	1	1	23	160.0	1.03	268.7	7	1084.6	337.4	0.0000	0.0	0.0000	0	0.00
91	1	1	24	150.0	2.57	268.7	6	1078.6	221.0	0.0000	0.0	0.0000	0	0.00

*** NOTES: STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 200.00	400.00	600.00	800.00	1000.00	1200.00	1400.00	1600.00	1800.
360.00	3.50428	1.06471	0.52834	0.33612	0.24064	0.18522	0.14856	0.12257	0.103
45.00	2.25204	1.05082	0.61277	0.41099	0.29876	0.22945	0.18325	0.15117	0.127
90.00	2.19441	0.97241	0.55607	0.36674	0.26229	0.19913	0.15745	0.12918	0.109
135.00	3.28477	1.32423	0.71831	0.45986	0.32066	0.23944	0.18892	0.15518	0.130
180.00	17.63867	3.54185	1.27310	0.73789	0.50461	0.36945	0.28659	0.23117	0.191
225.00	34.48327	1.72571	0.63402	0.35467	0.23771	0.17712	0.14066	0.11556	0.097
270.00	31.03635	0.77989	0.29168	0.17617	0.12619	0.09950	0.08323	0.07197	0.063
315.00	26.32699	0.99803	0.31562	0.16638	0.10970	0.07866	0.05922	0.04642	0.037

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 2000.00	2200.00	2400.00	2600.00	2800.00	3000.00	3200.00	3400.00	3600.
360.00	0.08873	0.07730	0.06812	0.06061	0.05439	0.04922	0.04490	0.04121	0.038
45.00	0.11053	0.09709	0.08624	0.07730	0.06984	0.06361	0.05833	0.05375	0.049
90.00	0.09527	0.08447	0.07579	0.06862	0.06258	0.05749	0.05313	0.04932	0.045
135.00	0.11250	0.09820	0.08673	0.07732	0.06948	0.06294	0.05744	0.05273	0.048
180.00	0.16233	0.14005	0.12268	0.10877	0.09740	0.08799	0.08012	0.07348	0.067
225.00	0.08322	0.07227	0.06353	0.05638	0.05045	0.04547	0.04127	0.03771	0.034
270.00	0.05706	0.05184	0.04757	0.04399	0.04095	0.03832	0.03605	0.03407	0.032
315.00	0.03161	0.02708	0.02359	0.02083	0.01860	0.01676	0.01523	0.01394	0.012

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 3800.00	4000.00	4200.00	4400.00	4600.00	4800.00	5000.00	5200.00	5400.
360.00	0.03522	0.03277	0.03060	0.02867	0.02693	0.02538	0.02397	0.02269	0.021
45.00	0.04621	0.04310	0.04034	0.03786	0.03563	0.03362	0.03179	0.03012	0.028
90.00	0.04299	0.04036	0.03801	0.03589	0.03397	0.03224	0.03065	0.02920	0.027
135.00	0.04506	0.04192	0.03914	0.03667	0.03445	0.03246	0.03066	0.02903	0.027
180.00	0.06279	0.05844	0.05461	0.05120	0.04817	0.04545	0.04298	0.04075	0.038
225.00	0.03197	0.02963	0.02757	0.02575	0.02413	0.02267	0.02136	0.02018	0.019
270.00	0.03073	0.02931	0.02801	0.02683	0.02575	0.02476	0.02384	0.02298	0.022
315.00	0.01188	0.01104	0.01030	0.00965	0.00906	0.00854	0.00807	0.00764	0.007

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 , SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19, SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 5600.00	5800.00	6000.00	6200.00	6400.00	6600.00	6800.00	7000.00	7200.
360.00	0.02045	0.01947	0.01857	0.01773	0.01696	0.01624	0.01558	0.01496	0.014
45.00	0.02720	0.02591	0.02472	0.02362	0.02260	0.02166	0.02078	0.01997	0.019
90.00	0.02664	0.02550	0.02446	0.02348	0.02258	0.02174	0.02095	0.02022	0.019
135.00	0.02620	0.02496	0.02382	0.02277	0.02180	0.02090	0.02007	0.01929	0.018
180.00	0.03686	0.03516	0.03359	0.03215	0.03081	0.02957	0.02842	0.02735	0.026
225.00	0.01814	0.01725	0.01643	0.01568	0.01499	0.01435	0.01376	0.01321	0.012
270.00	0.02144	0.02074	0.02009	0.01948	0.01890	0.01836	0.01784	0.01736	0.016
315.00	0.00689	0.00657	0.00627	0.00599	0.00573	0.00550	0.00528	0.00507	0.004

**MODELOPTs: CONC RURAL FLAT DFAULT

*** THE PERIOD (8760 HRS) AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): SQUARE1 , SQUARE2 , SQUARE3 , SQUARE4 , SQUARE5 , SQUARE6 , SQUARE7 ,
SQUARE8 , SQUARE9 , SQUARE10, SQUARE11, SQUARE12, SQUARE13, SQUARE14, SQUARE15, SQUARE16, SQUARE17, SQUARE18, SQUARE19,
SQUARE20, SQUARE21, SQUARE22, SQUARE23, SQUARE24, SQUARE25, SQUARE26, SQUARE27,

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF UNIT IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 7400.00	7600.00	7800.00	8000.00
360.00	0.01385	0.01335	0.01288	0.01244
45.00	0.01850	0.01784	0.01721	0.01663
90.00	0.01889	0.01828	0.01771	0.01717
135.00	0.01791	0.01729	0.01670	0.01615
180.00	0.02542	0.02454	0.02372	0.02295
225.00	0.01222	0.01178	0.01136	0.01097
270.00	0.01646	0.01605	0.01565	0.01528
315.00	0.00470	0.00454	0.00438	0.00423

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** THE SUMMARY OF MAXIMUM PERIOD (8760 HRS) RESULTS ***

** CONC OF UNIT   IN MICROGRAMS/M**3   **

GROUP ID		AVERAGE CONC		RECEPTOR (XR,	YR,	ZELEV,	ZFLAG)	OF TYPE	NETWORK GRID-ID
ALL	1ST HIGHEST VALUE IS	34.48327	AT (	233.58,	338.58,	0.00,	0.00)	GP	POL
	2ND HIGHEST VALUE IS	31.03635	AT (	175.00,	480.00,	0.00,	0.00)	GP	POL
	3RD HIGHEST VALUE IS	26.32699	AT (	233.58,	621.42,	0.00,	0.00)	GP	POL
	4TH HIGHEST VALUE IS	17.63867	AT (	375.00,	280.00,	0.00,	0.00)	GP	POL
	5TH HIGHEST VALUE IS	3.54185	AT (	375.00,	80.00,	0.00,	0.00)	GP	POL
	6TH HIGHEST VALUE IS	3.50428	AT (	375.00,	680.00,	0.00,	0.00)	GP	POL

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

**MODELOPTs: CONC   RURAL FLAT   DFAULT

*** Message Summary : ISCST3 Model Execution ***

--------- Summary of Total Messages --------

```
A Total of          0 Fatal Error Message(s)
A Total of          0 Warning Message(s)
A Total of        766 Informational Message(s)

A Total of        219 Calm Hours Identified

   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***

   ********   WARNING MESSAGES   ********
              ***  NONE  ***

   ************************************
   *** ISCST3 Finishes Successfully ***
   ************************************
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F-4 Basement Ambient Air Correlation

TABLE F-1. BASEMENT AMBIENT AIR CORRELATION WORKSHEET

PURPOSE:	Worksheet calculates the average concentration of vinyl chloride in ambient (i.e. household) air based on a direct correlation with concentration of indicator methane gas;	Developed by: Daniel Peters, M&E Version: *Jun-08-93* Checked by: D. Murray Date: *Jun-08-93* Run Date: *Jun-08-93*
REFERENCES:	1)Roy F. Weston, Inc., analytical sampling results received on May 25, 1993 for February to March '93 sampling periods.	2)U.S. EPA, 1993; Letter from D. Tagliaferro (EPA) to S. Alfred, Town Manager, South Kingstown, RI, dated May 17, 1993 with attached Weston memorandum describing site visit, testing and installation of methane monitors in residential basements.
PROCEDURE FOR USE:	1)Specify instrument detection limit of methane analyzer, Cch4_DL, in ppmv.	2) Observe the resultant concentration of vinyl chloride ($\mu g/m^3$) in basement indoor air.
ASSUMPTIONS:	1)Data from Reference (1) utilized. 3)A mathematical correlation of the form: LOG (vinyl chloride conc.) versus the methane concentration was found to best fit the data as a linear function.	2)Only points where both vinyl chloride and methane were above analytical quantitation limits were used.

TABLE F-1. BASEMENT AMBIENT AIR CORRELATION WORKSHEET

A. INPUT VARIABLES	Location	Date Sampled	Comments	Vinyl Chloride (μg/m³)	Methane (ppmv)	Vinyl Chloride (ppbv)	Methane (mg/m³)
1. Vinyl Chloride Concentrations:	121 Rose Hill Road	18-Feb-93		0.51 U	100 U	0.20 U	66 U
		11-Mar-93		0.51 U	100 U	0.20 U	66 U
a. Residential Basement Air: SUMMA™ Cannister Data Data Source (1)	220 Rose Hill Road	18-Feb-93	SA3126	4.09	850	1.60	558
		18-Feb-93	SA3127	4.09	800	1.60	525
		18-Feb-93	SA3128	1.30	100 U	0.51	66 U
		25-Feb-93		4.09	910	1.60	597
		04-Mar-93		5.62	890	2.20	584
		11-Mar-93		25.56	2,500	10.00	1,641
Note: "U" is the analytical quantitation limit.		18-Mar-93		40.89	2,500	16.00	1,641
		25-Mar-93		53.67	2,500	21.00	1,641
		25-Mar-93	Duplicate	56.22	2,500	22.00	1,641
	235 Rose Hill Road	11-Mar-93		28.11	2,700	11.00	1,772
	278 Rose Hill Road	18-Feb-93		1.25	100 U	0.49	66 U
		25-Feb-93	SA6903	0.51 U	100 U	0.20 U	66 U
		25-Feb-93	SA6904	0.51 U	100 U	0.20 U	66 U
		04-Mar-93		2.53	100 U	0.99	66 U
		11-Mar-93		1.56	100 U	0.61	66 U
		25-Mar-93	SA6935	0.51 U	100 U	0.20 U	66 U
		25-Mar-93	SA6936	0.51 U	100 U	0.20 U	66 U
	294 Rose Hill Road	25-Feb-93		0.51 U	100 U	0.20 U	66 U
		18-Mar-93		0.51 U	100 U	0.20 U	66 U
	320 Rose Hill Road	04-Mar-93		0.51 U	100 U	0.20 U	66 U
		25-Mar-93		0.51 U	100 U	0.20 U	66 U

TABLE F-1. BASEMENT AMBIENT AIR CORRELATION WORKSHEET

A. INPUT VARIABLES (continued)	Location	Date Sampled	Comments	Vinyl Chloride ($\mu g/m^3$)	Methane (ppmv)	Vinyl Chloride (ppbv)	Methane (mg/m^3)
a. Residential Basement Air: SUMMA™ Cannister Data (continued)	339A Rose Hill Road	18-Feb-93		0.51 U	100 U	0.20 U	66 U
		11-Mar-93		0.51 U	100 U	0.20 U	66 U
	339BRose Hill Road	25-Feb-93		0.51 U	100 U	0.20 U	66 U
		18-Mar-93		0.51 U	100 U	0.20 U	66 U
	349 Rose Hill Road	18-Feb-93		0.51 U	100 U	0.20 U	66 U
		25-Feb-93		0.51 U	100 U	0.20 U	66 U
		04-Mar-93		0.77	100 U	0.30	66 U
		04-Mar-93	Duplicate	0.72	100 U	0.28	66 U
		11-Mar-93		0.51 U	100 U	0.20 U	66 U
		18-Mar-93		0.51 U	100 U	0.20 U	66 U
		25-Mar-93		0.51 U	100 U	0.20 U	66 U
	364 Rose Hill Road	04-Mar-93		0.51 U	100 U	0.20 U	66 U
		25-Mar-93		0.51 U	100 U	0.20 U	66 U

TABLE F-1. BASEMENT AMBIENT AIR CORRELATION WORKSHEET

A. INPUT VARIABLES (continued)	Location	Date Sampled	Comments	Vinyl Chloride (μg/m³)	Methane (ppmv)	Vinyl Chloride (ppbv)	Methane (mg/m³)
	Presented for Comparison Purposes only;						
b. Residential	220 Rose Hill Road	04-Mar-93		2.50	100 U	0.98	66 U
Outside Ambient							
Air: SUMMA™	278 Rose Hill Road	25-Feb-93		0.51 U	100 U	0.20 U	66 U
Cannister Data		11-Mar-93		4.34	100 U	1.70	66 U
Data Source (1)		18-Mar-93		0.66	100 U	0.26	66 U
		25-Mar-93		0.51 U	100 U	0.20 U	66 U
	339A Rose Hill Road	04-Mar-93		2.45	100 U	0.96	66 U
		11-Mar-93		1.89	100 U	0.74	66 U
		25-Mar-93		0.51 U	100 U	0.20 U	66 U
	339B Rose Hill Road	25-Feb-93		0.51 U	100 U	0.20 U	66 U
		18-Mar-93		0.51 U	100 U	0.20 U	66 U
2. Methane Analyzer Detection Limit:	Standard combustion sensor operating in 0-100% LEL of CH4 range; Source: (2)						
Cch4_DL	"Alarm" limit of 2% of the LEL for CH4			1,000	ppmv CH4	656	mg CH4/m³ air
B. INTERIM CALCULATIONS:	Correlation of Vinyl Chloride versus Methane			Vinyl Chloride, Cvc (μg/m³)	Methane, Cch4 (ppmv)	Log(Cvc) "y-value"	Cch4 "x-value"
1. Selected Data Points	Only data points with detected levels of both vinyl chloride and methane used; no outside ambient air data was used in the correlation.			4.09	850	0.6116	850
				4.09	800	0.6116	800
				4.09	910	0.6116	910
				5.62	890	0.7499	890
				25.56	2,500	1.4075	2,500
				40.89	2,500	1.6116	2,500
				53.67	2,500	1.7297	2,500
				56.22	2,500	1.7499	2,500
				28.11	2,700	1.4489	2,700

TABLE F–1. BASEMENT AMBIENT AIR CORRELATION WORKSHEET

B. INTERIM CALCULATIONS: (continued) 2. Linear Regression	Regression Output:			
	Constant	0.1744	"Y–intercept"	Comment: Linear regression using LOTUS 2.4 DATA/REGRESSION commands
	Std Err of Y Est	0.1476		
	R Squared	0.9271		
	No. of Observations	9		
	Degrees of Freedom	7		
	X Coefficient(s) 5.55E–04		"slope"	
	Std Err of Coef. 5.88E–05			
C. OUTPUT CALCULATIONS: 1. Correlation Equation	Correlation Equation of the form: Log(Cvc) = m•(Cch4) + b ; alternatively			
Cvc	$= 10^{[m \cdot (Cch4) + b]}$			
	Where:			
Cvc	Concentration of vinyl chloride in air ($\mu g/m^3$)			
Cch4	Concentration of methane in air (ppmv)			
m	"slope" of the line		5.55E–04 ---	---
b	"y–intercept" of the line		0.1744 ---	---
2. Resultant Vinyl chloride Concentration				
Cch4_DL	Methane Analyzer Detection Limit (from above)		1,000 ppmv CH4	656 mg CH4/m^3 air
Cvc_@DL	Vinyl Chloride Concentration at methane analyzer detection limit.		5.36 $\mu g/m^3$	2.18 ppbv

F-5 Point Source Modeling: Non-Combustion Technology

Non-combustion LFG treatment processes (such as photocatalytic oxidation) require dispersion modeling to determine if PRGs are exceeded off-site.

Feed Gas

Internal LFG + Perimeter Gas = 890 cfm = 14.8 cfs = 0.42 m^3/s

Ambient Temperature = 293 K

Stack Diameter

A reasonable stack diameter must be selected based on the gas flow:

Diam. (ft)	Diam. (m)	Area (ft^2)	Velocity (ft/s)	Velocity (m/s)	
0.5	0.15	0.20	75.5	23.0	
1	0.30	0.79	18.9	5.76	This will be used to be conservative, but a faster velocity would be desireable to avoid stack tip downwash.

This does not account for any process constraints, such as back pressure.

Emission Rate

Vinyl chloride will be assumed to be the limiting compound, even for photocatalytic oxidation.
Assuming the process is photocatalytic oxidation, the range of DREs is 95 to 98%.

Inlet concentration = 148,571 ppbv MW = 62.5
= 380 mg/m^3
= 0.38 g/m^3

Inlet mass rate = 0.16 g/s

DRE	Emission Rate (g/s)
95%	7.98E-03
98%	3.19E-03

Beginning with a stack height of 20 ft = 6.1 m

We will try the 98% run and see what results in ISCLT3.

Maximum discreet receptor conc. = 0.039 $\mu g/m^3$

Maximum grid receptor conc. = 0.088 $\mu g/m^3$ This receptor is located on site.

PRG = 0.03 $\mu g/m^3$

Trying with a stack height of 30 ft = 9.14 m (still 98% DRE) [Output - Attachment A]

Maximum discreet receptor conc. = 0.025 $\mu g/m^3$

Maximum grid receptor conc. = 0.042 $\mu g/m^3$ This receptor is also located on site. There are 5 total impacts greater than the PRG. If non-thermal treatment is utilized, various stack designs would need to be considered as well as designation of appropriate site boundaries (usually fencelines) to ensure PRGs are achieved.

```
** Rosehill - ISCLT3
** Point source emissions from a non-combustion source treating LFG
**    from the Solid Waste Area
** 1987-1992 meteorological data
** Vinyl chloride emissions

CO STARTING
  TITLEONE  ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3
  MODELOPT  DFAULT  CONC  RURAL
  AVERTIME  ANNUAL
  TERRHGTS  FLAT
  POLLUTID  VYCL
  RUNORNOT  RUN
CO FINISHED

SO STARTING

** PHOTOCAT FOR SOLID WASTE AREA

SO LOCATION   STACK1  POINT     373.38   480.06    0.

** Emission rate (g/s), stack height (m), gas temp (K),
**    gas velocity (m/s), stack diameter (m)

SO SRCPARAM   STACK1   0.00319  9.14  293.  5.76  0.3048

SO SRCGROUP ALL
SO FINISHED


RE STARTING
RE GRIDPOLR POL STA
RE GRIDPOLR POL ORIG  375. 480.
RE GRIDPOLR POL DIST  50. 100. 150. 200. 250. 300. 350. 400. 450.
RE GRIDPOLR POL DIST  500. 550. 600. 650. 700. 750. 800. 850. 900.
** RE GRIDPOLR POL DIST  950. 1000. 1050. 1100. 1150. 1200. 1300.
** RE GRIDPOLR POL DIST  1400. 1500. 1600. 1700. 1800. 1900. 2000.
** RE GRIDPOLR POL DIST  2100. 2200. 2300. 2400. 2500. 2600. 2700.
RE GRIDPOLR POL DIST  2800. 2900. 3000. 3100. 3200. 3300. 3400.
RE GRIDPOLR POL DIST  3500. 3600. 3700. 3800. 3900. 4000. 4100.
RE GRIDPOLR POL DIST  4200. 4300. 4400. 4500. 4600. 4700. 4800.
** RE GRIDPOLR POL DIST  4900. 5000. 5100. 5200. 5300. 5400. 5500.
** RE GRIDPOLR POL DIST  5600. 5700. 5800. 5900. 6000. 6100. 6200.
RE GRIDPOLR POL GDIR  8   0.  45.
RE GRIDPOLR POL END

** Discreet Receptors
** x, y coordinates (m)

** Receptor #1
RE DISCCART       99.06    670.56
** Receptor #2
RE DISCCART       30.48    662.94
** Receptor #3
RE DISCCART       22.86    563.88
** Receptor #4
RE DISCCART       15.24    541.02
** Receptor #5
RE DISCCART       60.96    533.40
** Receptor #6
RE DISCCART       91.44    434.34
** Receptor #7
RE DISCCART      121.92    297.18
** Receptor #8
RE DISCCART      259.08     15.24
** Receptor #9
```

```
RE DISCCART      388.62   640.08
** Receptor #10
RE DISCCART      487.68   670.56
** Receptor #11
RE DISCCART      563.88   243.84
** Receptor #12
RE DISCCART      243.84   655.32
** Receptor #13
RE DISCCART      167.64   274.32
** Receptor #14
RE DISCCART      114.30   647.70
** Receptor #15
RE DISCCART       91.44   594.36
** Receptor #16
RE DISCCART      228.60   129.54
** Receptor #17
RE DISCCART      365.76   144.78

RE FINISHED


ME STARTING
  INPUTFIL  TEST.DAT FREE
  ANEMHGHT  20. FEET
** Stardata from 1987 through 1992 at Providence was utilized.
  SURFDATA  14765  1987  PROVIDENCE
  UAIRDATA  14765  1987  PROVIDENCE

**          - AMBIENT AIR TEMPERATURE (DEGREES KELVIN) -
**
**            STAB   STAB   STAB   STAB   STAB   STAB
**            CAT 1  CAT 2  CAT 3  CAT 4  CAT 5  CAT 6
**            -----  -----  -----  -----  -----  -----

  AVETEMPS ANNUAL  283.2  283.2  283.2  283.2  283.2  283.2


**              - MIXING LAYER HEIGHT (METERS) -
**           S
**           T  WS     WS     WS     WS     WS     WS
**       SEAS A  CAT 1  CAT 2  CAT 3  CAT 4  CAT 5  CAT 6
**       ---- B  -----  -----  -----  -----  -----  -----

  AVEMIXHT  ANNUAL 1 .142E+04 .142E+04 .142E+04 .142E+04 .142E+04 .142E+04
  AVEMIXHT  ANNUAL 2 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03
  AVEMIXHT  ANNUAL 3 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03
  AVEMIXHT  ANNUAL 4 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03 .944E+03
  AVEMIXHT  ANNUAL 5 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05
  AVEMIXHT  ANNUAL 6 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05 .100E+05
ME FINISHED

OU STARTING
  RECTABLE  INDSRC
  MAXTABLE  10 INDSRC
OU FINISHED

***********************************
*** SETUP Finishes Successfully ***
***********************************
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** MODEL SETUP OPTIONS SUMMARY ***

- -

**Model Is Setup For Calculation of Average CONCentration Values.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses NO plume DEPLETION.

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
1. Final Plume Rise.
2. Stack-tip Downwash.
3. Buoyancy-induced Dispersion.
4. Default Wind Profile Exponents.
5. Default Vertical Potential Temperature Gradients.
6. "Upper Bound" Values For Supersquat Buildings.
7. No Exponential Decay for RURAL Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates 1 STAR Average(s) for the Following Months: 0 0 0 0 0 0 0 0 0 0 0 0
Seasons/Quarters: 0 0 0 0
and Annual: 1

**Model Assumes 1 STAR Summaries In Data File for the Averaging Periods Identified Above

**This Run Includes: 1 Source(s); 1 Source Group(s); and 329 Receptor(s)

**The Model Assumes A Pollutant Type of: VYCL

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
Model Outputs Tables of Long Term Values by Receptor (RECTABLE Keyword)
Model Outputs Tables of Maximum Long Term Values (MAXTABLE Keyword)

**Misc. Inputs: Anem. Hgt. (m) = 6.10 ; Decay Coef. = 0.0000 ; Rot. Angle = 0.0
Emission Units = GRAMS/SEC ; Emission Rate Unit Factor = 0.10000E+07
Output Units = MICROGRAMS/M**3

**Input Runstream File: RHNONC1.INP ; **Output Print File: RHNONC1.OUT

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
STACK1	0	0.31900E-02	373.4	480.1	0.0	9.14	293.00	5.76	0.30	NO	

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID	SOURCE IDs
ALL	STACK1 ,

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** GRIDDED RECEPTOR NETWORK SUMMARY ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

*** ORIGIN FOR POLAR NETWORK ***
X-ORIG = 375.00 ; Y-ORIG = 480.00 (METERS)

*** DISTANCE RANGES OF NETWORK ***
(METERS)

50.0, 100.0, 150.0, 200.0, 250.0, 300.0, 350.0, 400.0, 450.0, 500.0,
550.0, 600.0, 650.0, 700.0, 750.0, 800.0, 850.0, 900.0, 2800.0, 2900.0,
3000.0, 3100.0, 3200.0, 3300.0, 3400.0, 3500.0, 3600.0, 3700.0, 3800.0, 3900.0,
4000.0, 4100.0, 4200.0, 4300.0, 4400.0, 4500.0, 4600.0, 4700.0, 4800.0,

*** DIRECTION RADIALS OF NETWORK ***
(DEGREES)

360.0, 45.0, 90.0, 135.0, 180.0, 225.0, 270.0, 315.0,

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** DISCRETE CARTESIAN RECEPTORS ***
(X-COORD, Y-COORD, ZELEV, ZFLAG)
(METERS)

```
(   99.1,   670.6,    0.0,    0.0);    (   30.5,   662.9,    0.0,    0.0);
(   22.9,   563.9,    0.0,    0.0);    (   15.2,   541.0,    0.0,    0.0);
(   61.0,   533.4,    0.0,    0.0);    (   91.4,   434.3,    0.0,    0.0);
(  121.9,   297.2,    0.0,    0.0);    (  259.1,    15.2,    0.0,    0.0);
(  388.6,   640.1,    0.0,    0.0);    (  487.7,   670.6,    0.0,    0.0);
(  563.9,   243.8,    0.0,    0.0);    (  243.8,   655.3,    0.0,    0.0);
(  167.6,   274.3,    0.0,    0.0);    (  114.3,   647.7,    0.0,    0.0);
(   91.4,   594.4,    0.0,    0.0);    (  228.6,   129.5,    0.0,    0.0);
(  365.8,   144.8,    0.0,    0.0);
```

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** AVERAGE SPEED FOR EACH WIND SPEED CATEGORY ***
(METERS/SEC)

1.50, 2.50, 4.30, 6.80, 9.50, 12.50,

*** WIND PROFILE EXPONENTS ***

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY	WIND SPEED CATEGORY					
CATEGORY	1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

*** AVERAGE AMBIENT AIR TEMPERATURE (KELVIN) ***

	STABILITY CATEGORY A	STABILITY CATEGORY B	STABILITY CATEGORY C	STABILITY CATEGORY D	STABILITY CATEGORY E	STABILITY CATEGORY F
ANNUAL	283.2000	283.2000	283.2000	283.2000	283.2000	283.2000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** AVERAGE MIXING LAYER HEIGHT (METERS) ***

ANNUAL

	WIND SPEED CATEGORY 1	WIND SPEED CATEGORY 2	WIND SPEED CATEGORY 3	WIND SPEED CATEGORY 4	WIND SPEED CATEGORY 5	WIND SPEED CATEGORY 6
STABILITY CATEGORY A	1420.0000	1420.0000	1420.0000	1420.0000	1420.0000	1420.0000
STABILITY CATEGORY B	944.0001	944.0001	944.0001	944.0001	944.0001	944.0001
STABILITY CATEGORY C	944.0001	944.0001	944.0001	944.0001	944.0001	944.0001
STABILITY CATEGORY D	944.0001	944.0001	944.0001	944.0001	944.0001	944.0001
STABILITY CATEGORY E	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000
STABILITY CATEGORY F	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000	10000.0000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: TEST.DAT FORMAT: FREE
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14765
NAME: PROVIDENCE NAME: PROVIDENCE
YEAR: 1987 YEAR: 1987

ANNUAL: STABILITY CATEGORY A

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

ANNUAL: STABILITY CATEGORY B

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00025000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00038000	0.00000000	0.00009000	0.00000000	0.00000000	0.00000000
112.500	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00038000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00050000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00050000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00016000	0.00009000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00025000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00016000	0.00009000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00013000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: TEST.DAT FORMAT: FREE
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14765
NAME: PROVIDENCE NAME: PROVIDENCE
YEAR: 1987 YEAR: 1987

ANNUAL: STABILITY CATEGORY C

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00047000	0.00130000	0.00296000	0.00019000	0.00000000	0.00000000
22.500	0.00025000	0.00037000	0.00065000	0.00000000	0.00000000	0.00000000
45.000	0.00005000	0.00037000	0.00046000	0.00000000	0.00000000	0.00000000
67.500	0.00097000	0.00028000	0.00028000	0.00009000	0.00000000	0.00000000
90.000	0.00007000	0.00056000	0.00009000	0.00000000	0.00000000	0.00000000
112.500	0.00024000	0.00028000	0.00028000	0.00000000	0.00000000	0.00000000
135.000	0.00048000	0.00056000	0.00074000	0.00000000	0.00000000	0.00000000
157.500	0.00003000	0.00028000	0.00083000	0.00000000	0.00000000	0.00000000
180.000	0.00094000	0.00176000	0.00139000	0.00000000	0.00000000	0.00000000
202.500	0.00042000	0.00093000	0.00074000	0.00000000	0.00000000	0.00000000
225.000	0.00026000	0.00046000	0.00120000	0.00000000	0.00000000	0.00000000
247.500	0.00048000	0.00139000	0.00269000	0.00009000	0.00000000	0.00000000
270.000	0.00071000	0.00157000	0.00296000	0.00000000	0.00000000	0.00000000
292.500	0.00044000	0.00102000	0.00269000	0.00000000	0.00000000	0.00000000
315.000	0.00039000	0.00065000	0.00278000	0.00000000	0.00000000	0.00000000
337.500	0.00028000	0.00056000	0.00167000	0.00000000	0.00000000	0.00000000

ANNUAL: STABILITY CATEGORY D

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00274000	0.01083000	0.03380000	0.03593000	0.00694000	0.00074000
22.500	0.00192000	0.00639000	0.01417000	0.00981000	0.00102000	0.00019000
45.000	0.00171000	0.00630000	0.01167000	0.00824000	0.00102000	0.00037000
67.500	0.00084000	0.00565000	0.00833000	0.00546000	0.00019000	0.00000000
90.000	0.00091000	0.00426000	0.00704000	0.00259000	0.00000000	0.00000000
112.500	0.00089000	0.00194000	0.00380000	0.00157000	0.00000000	0.00000000
135.000	0.00052000	0.00231000	0.00333000	0.00093000	0.00009000	0.00000000
157.500	0.00138000	0.00500000	0.00583000	0.00222000	0.00019000	0.00000000
180.000	0.00186000	0.00796000	0.02130000	0.01157000	0.00148000	0.00037000
202.500	0.00093000	0.00454000	0.01204000	0.01167000	0.00296000	0.00120000
225.000	0.00171000	0.00528000	0.01343000	0.02065000	0.00491000	0.00185000
247.500	0.00123000	0.00343000	0.01519000	0.02694000	0.00315000	0.00074000
270.000	0.00139000	0.00509000	0.02194000	0.03037000	0.00380000	0.00111000
292.500	0.00040000	0.00426000	0.01907000	0.04454000	0.01315000	0.00222000
315.000	0.00051000	0.00324000	0.01435000	0.04204000	0.01157000	0.00167000
337.500	0.00114000	0.00454000	0.01491000	0.02833000	0.00667000	0.00102000

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** FREQUENCY OF OCCURRENCE OF WIND SPEED, DIRECTION AND STABILITY ***

FILE: TEST.DAT FORMAT: FREE
SURFACE STATION NO.: 14765 UPPER AIR STATION NO.: 14765
NAME: PROVIDENCE NAME: PROVIDENCE
YEAR: 1987 YEAR: 1987

ANNUAL: STABILITY CATEGORY E

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00000000	0.00630000	0.01019000	0.00000000	0.00000000	0.00000000
22.500	0.00000000	0.00102000	0.00111000	0.00000000	0.00000000	0.00000000
45.000	0.00000000	0.00148000	0.00074000	0.00000000	0.00000000	0.00000000
67.500	0.00000000	0.00231000	0.00028000	0.00000000	0.00000000	0.00000000
90.000	0.00000000	0.00111000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00000000	0.00056000	0.00009000	0.00000000	0.00000000	0.00000000
135.000	0.00000000	0.00093000	0.00028000	0.00000000	0.00000000	0.00000000
157.500	0.00000000	0.00204000	0.00111000	0.00000000	0.00000000	0.00000000
180.000	0.00000000	0.00954000	0.00500000	0.00000000	0.00000000	0.00000000
202.500	0.00000000	0.00546000	0.00380000	0.00000000	0.00000000	0.00000000
225.000	0.00000000	0.00509000	0.00546000	0.00000000	0.00000000	0.00000000
247.500	0.00000000	0.00593000	0.00694000	0.00000000	0.00000000	0.00000000
270.000	0.00000000	0.00583000	0.01806000	0.00000000	0.00000000	0.00000000
292.500	0.00000000	0.00389000	0.01981000	0.00000000	0.00000000	0.00000000
315.000	0.00000000	0.00565000	0.01685000	0.00000000	0.00000000	0.00000000
337.500	0.00000000	0.00583000	0.01074000	0.00000000	0.00000000	0.00000000

ANNUAL: STABILITY CATEGORY F

DIRECTION (DEGREES)	WIND SPEED CATEGORY 1 (1.500 M/S)	WIND SPEED CATEGORY 2 (2.500 M/S)	WIND SPEED CATEGORY 3 (4.300 M/S)	WIND SPEED CATEGORY 4 (6.800 M/S)	WIND SPEED CATEGORY 5 (9.500 M/S)	WIND SPEED CATEGORY 6 (12.500 M/S)
0.000	0.00110000	0.00593000	0.00000000	0.00000000	0.00000000	0.00000000
22.500	0.00026000	0.00083000	0.00000000	0.00000000	0.00000000	0.00000000
45.000	0.00028000	0.00120000	0.00000000	0.00000000	0.00000000	0.00000000
67.500	0.00094000	0.00074000	0.00000000	0.00000000	0.00000000	0.00000000
90.000	0.00072000	0.00046000	0.00000000	0.00000000	0.00000000	0.00000000
112.500	0.00040000	0.00000000	0.00000000	0.00000000	0.00000000	0.00000000
135.000	0.00094000	0.00065000	0.00000000	0.00000000	0.00000000	0.00000000
157.500	0.00110000	0.00157000	0.00000000	0.00000000	0.00000000	0.00000000
180.000	0.00291000	0.00491000	0.00000000	0.00000000	0.00000000	0.00000000
202.500	0.00140000	0.00454000	0.00000000	0.00000000	0.00000000	0.00000000
225.000	0.00168000	0.00565000	0.00000000	0.00000000	0.00000000	0.00000000
247.500	0.00220000	0.01037000	0.00000000	0.00000000	0.00000000	0.00000000
270.000	0.00148000	0.01287000	0.00000000	0.00000000	0.00000000	0.00000000
292.500	0.00132000	0.01194000	0.00000000	0.00000000	0.00000000	0.00000000
315.000	0.00151000	0.00898000	0.00000000	0.00000000	0.00000000	0.00000000
337.500	0.00166000	0.00824000	0.00000000	0.00000000	0.00000000	0.00000000

SUM OF FREQUENCIES, FTOTAL = 0.98123

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3 *** 07/25/97
*** *** 17:53:17
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 50.00	100.00	150.00	200.00	250.00	300.00	350.00	400.00	450.00
360.00	0.001672	0.017388	0.024827	0.023700	0.020707	0.017853	0.015468	0.013542	0.011969
45.00	0.001196	0.015115	0.021416	0.020187	0.017456	0.014919	0.012849	0.011197	0.009862
90.00	0.002165	0.022853	0.030629	0.028651	0.025014	0.021691	0.018943	0.016719	0.014891
135.00	0.001960	0.022937	0.030237	0.027823	0.023994	0.020597	0.017831	0.015612	0.013805
180.00	0.001797	0.028700	0.042012	0.039669	0.034009	0.028661	0.024289	0.020811	0.018029
225.00	0.000728	0.009491	0.014851	0.014265	0.012184	0.010150	0.008488	0.007177	0.006140
270.00	0.000700	0.005708	0.008627	0.008248	0.007037	0.005867	0.004918	0.004173	0.003585
315.00	0.000818	0.004644	0.005854	0.005304	0.004452	0.003710	0.003132	0.002687	0.002338

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3 *** 07/25/97
*** *** 17:53:17
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 500.00	550.00	600.00	650.00	700.00	750.00	800.00	850.00	900.00
360.00	0.010665	0.009569	0.008635	0.007833	0.007136	0.006522	0.005985	0.005512	0.005094
45.00	0.008764	0.007847	0.007069	0.006403	0.005828	0.005321	0.004878	0.004490	0.004147
90.00	0.013361	0.012059	0.010939	0.009965	0.009114	0.008355	0.007687	0.007097	0.006573
135.00	0.012308	0.011047	0.009973	0.009048	0.008245	0.007536	0.006916	0.006370	0.005887
180.00	0.015776	0.013925	0.012387	0.011092	0.009993	0.009046	0.008230	0.007522	0.006903
225.00	0.005311	0.004640	0.004089	0.003632	0.003249	0.002923	0.002645	0.002405	0.002197
270.00	0.003115	0.002734	0.002421	0.002160	0.001940	0.001751	0.001590	0.001450	0.001329
315.00	0.002059	0.001831	0.001641	0.001481	0.001344	0.001224	0.001120	0.001029	0.000950

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3 *** 07/25/97
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION |	DISTANCE (METERS)								
(DEGREES) |	2800.00	2900.00	3000.00	3100.00	3200.00	3300.00	3400.00	3500.00	3600.00
360.00 |	0.000987	0.000936	0.000889	0.000847	0.000808	0.000771	0.000738	0.000707	0.000678
45.00 |	0.000803	0.000761	0.000723	0.000689	0.000657	0.000628	0.000600	0.000575	0.000551
90.00 |	0.001303	0.001236	0.001175	0.001119	0.001068	0.001021	0.000977	0.000936	0.000898
135.00 |	0.001143	0.001084	0.001030	0.000981	0.000936	0.000894	0.000855	0.000819	0.000786
180.00 |	0.001246	0.001180	0.001120	0.001065	0.001015	0.000969	0.000926	0.000885	0.000848
225.00 |	0.000378	0.000358	0.000339	0.000322	0.000307	0.000293	0.000279	0.000267	0.000256
270.00 |	0.000236	0.000224	0.000212	0.000202	0.000192	0.000184	0.000175	0.000168	0.000161
315.00 |	0.000180	0.000171	0.000162	0.000155	0.000147	0.000141	0.000135	0.000129	0.000124

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3 *** 07/25/97
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION |	DISTANCE (METERS)								
(DEGREES) |	3700.00	3800.00	3900.00	4000.00	4100.00	4200.00	4300.00	4400.00	4500.00
360.00 |	0.000650	0.000625	0.000601	0.000579	0.000558	0.000538	0.000520	0.000502	0.000486
45.00 |	0.000529	0.000509	0.000489	0.000471	0.000454	0.000438	0.000423	0.000409	0.000396
90.00 |	0.000862	0.000829	0.000797	0.000768	0.000740	0.000715	0.000690	0.000667	0.000646
135.00 |	0.000754	0.000725	0.000697	0.000671	0.000647	0.000624	0.000603	0.000583	0.000564
180.00 |	0.000813	0.000781	0.000750	0.000722	0.000695	0.000670	0.000647	0.000625	0.000604
225.00 |	0.000245	0.000235	0.000226	0.000217	0.000209	0.000201	0.000194	0.000187	0.000181
270.00 |	0.000154	0.000148	0.000142	0.000137	0.000132	0.000127	0.000122	0.000118	0.000114
315.00 |	0.000119	0.000114	0.000110	0.000106	0.000102	0.000098	0.000095	0.000091	0.000088

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3 *** 07/25/97
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** NETWORK ID: POL ; NETWORK TYPE: GRIDPOLR ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 4600.00	4700.00	4800.00
360.00	0.000470	0.000455	0.000441
45.00	0.000383	0.000371	0.000359
90.00	0.000625	0.000605	0.000587
135.00	0.000546	0.000528	0.000512
180.00	0.000584	0.000565	0.000547
225.00	0.000175	0.000169	0.000164
270.00	0.000110	0.000107	0.000103
315.00	0.000086	0.000083	0.000080

*** ISCLT3 - VERSION 96113 *** *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3 *** 07/25/97
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1 ***

*** DISCRETE CARTESIAN RECEPTOR POINTS ***

** CONC OF VYCL IN MICROGRAMS/M**3 **

X-COORD (M)	Y-COORD (M)	CONC	X-COORD (M)	Y-COORD (M)	CONC
99.06	670.56	0.003199	30.48	662.94	0.002617
22.86	563.88	0.003602	15.24	541.02	0.003883
60.96	533.40	0.004555	91.44	434.34	0.007127
121.92	297.18	0.008958	259.08	15.24	0.010342
388.62	640.08	0.022810	487.68	670.56	0.016100
563.88	243.84	0.019502	243.84	655.32	0.006207
167.64	274.32	0.010437	114.30	647.70	0.003481
91.44	594.36	0.003501	228.60	129.54	0.008562
365.76	144.78	0.024700			

*** ISCLT3 - VERSION 96113 ***   *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3   ***
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE MAXIMUM 10 ANNUAL AVERAGE CONCENTRATION VALUES FOR SOURCE: STACK1
***

** CONC OF VYCL IN MICROGRAMS/M**3 **

RANK	CONC	AT	RECEPTOR (XR,YR) OF TYPE	RANK	CONC	AT	RECEPTOR (XR,YR) OF TYPE
1.	0.042012	AT	(375.00, 330.00) GP	6.	0.028700	AT	(375.00, 380.00) GP
2.	0.039669	AT	(375.00, 280.00) GP	7.	0.028661	AT	(375.00, 180.00) GP
3.	0.034009	AT	(375.00, 230.00) GP	8.	0.028651	AT	(575.00, 480.00) GP
4.	0.030629	AT	(525.00, 480.00) GP	9.	0.027823	AT	(516.42, 338.58) GP
5.	0.030237	AT	(481.07, 373.93) GP	10.	0.025014	AT	(625.00, 480.00) GP

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

*** ISCLT3 - VERSION 96113 ***   *** ROSEHILL - NON-COMBUSTION EMISSIONS - ISCLT3   ***
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*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** Message Summary : ISCLT3 Model Execution ***

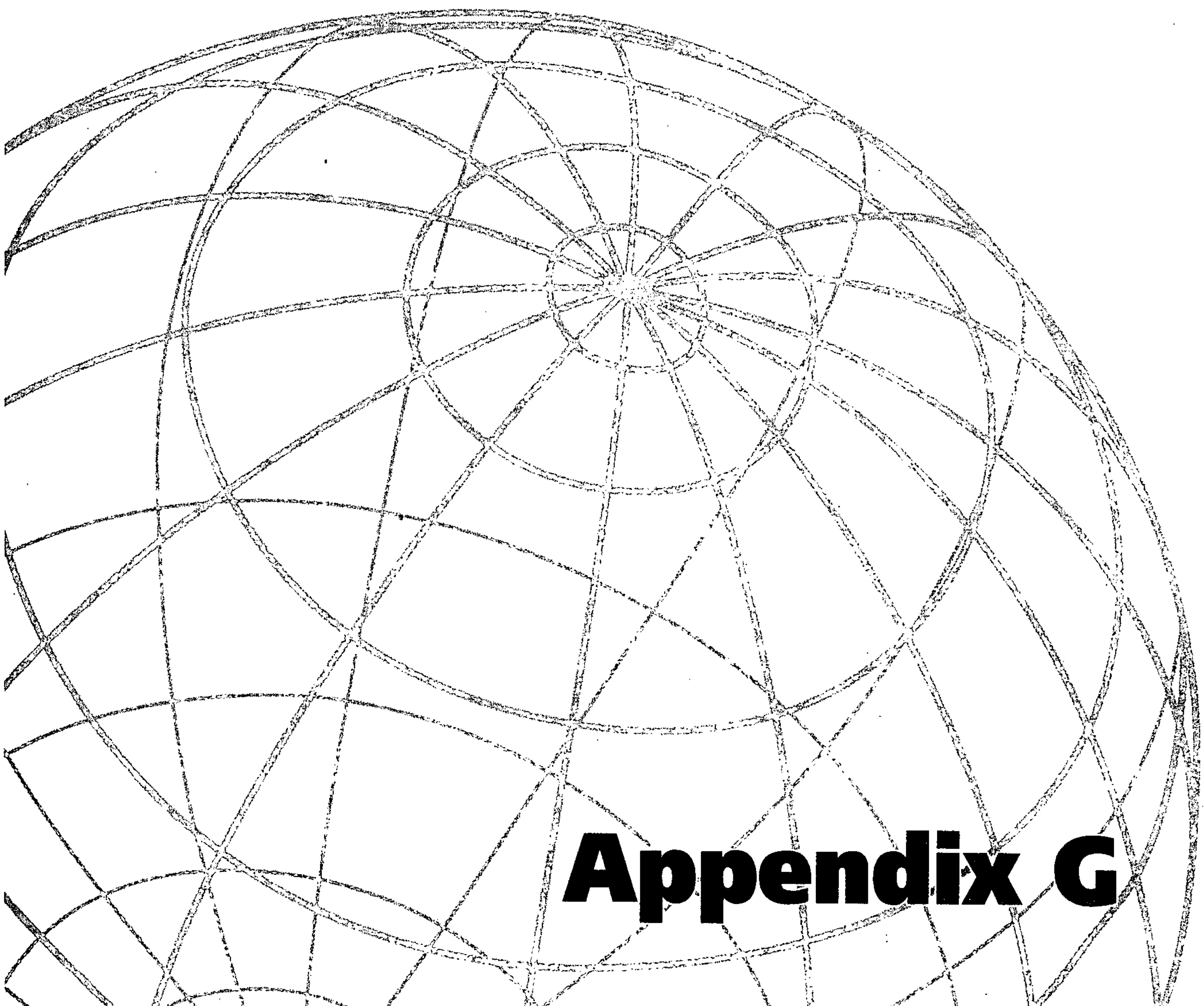
--------- Summary of Total Messages --------

A Total of 0 Fatal Error Message(s)
A Total of 0 Warning Message(s)
A Total of 0 Informational Message(s)

******** FATAL ERROR MESSAGES ********
*** NONE ***

******** WARNING MESSAGES ********
*** NONE ***

****
*** ISCLT3 Finishes Successfully ***
****



Appendix G

G. COST CALCULATIONS

G-1 Summary of Costs - Alternatives #1 through #5

TABLE G-1. SUMMARY OF COSTS, ALTERNATIVE # 1

Version: November 6, 1997 SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)			
1.0	GRADING & SITE PREP.: SOLID WASTE AREA		0
2.0	CAPPING: SOLID WASTE AREA		0
3.0	GRADING & SITE PREP.: BULKY WASTE AREA		0
4.0	CAPPING: BULKY WASTE AREA		0
5.0	LANDFILL MINING		0
6.0	PERIMETER WETLANDS MITIGATION		0
7.0	INTERNAL LF GAS COLLECTION SYSTEM		0
8.0	PERIMETER LF GAS COLLECTION SYSTEM		0
9.0	LF GAS TREATMENT PLANT		0
10.0	GW DEPRESSION SYSTEM: COLLECTION		0
11.0	LEACHATE COLLECTION SYSTEM		0
12.0	50 GPM WATER TREATMENT PLANT		0
13.0	5 GPM WATER TREATMENT PLANT		0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST		88
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA		0
16.0	INSTITUTIONAL CONTROLS	+	0
	TOTAL DIRECT CAPITAL COST		88
	REMEDIAL DESIGN ALLOWANCE		5
	CONTINGENCY	+	19
	TOTAL CAPITAL COSTS		$111
ANNUAL COSTS (Present Value in $1,000's)			
17.0	ENVIRONMENTAL MONITORING: ANNUAL		2,880
18.0	LANDFILL GAS COLLECTION AND TREATMENT		0
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM		0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM		0
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS	+	0
	TOTAL DIRECT ANNUAL COST		2,880
	CONTINGENCY		576
	TOTAL ANNUAL COSTS		$3,456
TOTAL COST OF ALTERNATIVE (in $1,000's)			$3,568

TABLE G-2. SUMMARY OF COSTS, ALTERNATIVE # 2

Version: November 6, 1997 SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)			
1.0	GRADING & SITE PREP.: SOLID WASTE AREA		71
2.0	CAPPING: SOLID WASTE AREA		0
3.0	GRADING & SITE PREP.: BULKY WASTE AREA		0
4.0	CAPPING: BULKY WASTE AREA		0
5.0	LANDFILL MINING		0
6.0	PERIMETER WETLANDS MITIGATION		0
7.0	INTERNAL LF GAS COLLECTION SYSTEM		0
8.0	PERIMETER LF GAS COLLECTION SYSTEM		0
9.0	LF GAS TREATMENT PLANT		0
10.0	GW DEPRESSION SYSTEM: COLLECTION		0
11.0	LEACHATE COLLECTION SYSTEM		0
12.0	50 GPM WATER TREATMENT PLANT		0
13.0	5 GPM WATER TREATMENT PLANT		0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST		88
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA		0
16.0	INSTITUTIONAL CONTROLS	+	127
	TOTAL DIRECT CAPITAL COST		285
	REMEDIAL DESIGN ALLOWANCE		17
	CONTINGENCY	+	60
	TOTAL CAPITAL COSTS		$363
ANNUAL COSTS (Present Value in $1,000's)			
17.0	ENVIRONMENTAL MONITORING: ANNUAL		2,880
18.0	LANDFILL GAS COLLECTION AND TREATMENT		0
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM		0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM		0
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS	+	22
	TOTAL DIRECT ANNUAL COST		2,902
	CONTINGENCY		580
	TOTAL ANNUAL COSTS		$3,482
TOTAL COST OF ALTERNATIVE (in $1,000's)			$3,845

TABLE G-3a. SUMMARY OF COSTS, ALTERNATIVE # 3a

Version: November 6, 1997 SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)			
1.0	GRADING & SITE PREP.: SOLID WASTE AREA		100
2.0	CAPPING: SOLID WASTE AREA		2,442
3.0	GRADING & SITE PREP.: BULKY WASTE AREA		48
4.0	CAPPING: BULKY WASTE AREA		864
5.0	LANDFILL MINING		0
6.0	PERIMETER WETLANDS MITIGATION		4
7.0	INTERNAL LF GAS COLLECTION SYSTEM		681
8.0	PERIMETER LF GAS COLLECTION SYSTEM		338
9.0	LF GAS TREATMENT PLANT		338
10.0	GW DEPRESSION SYSTEM: COLLECTION		0
11.0	LEACHATE COLLECTION SYSTEM		0
12.0	50 GPM WATER TREATMENT PLANT		0
13.0	5 GPM WATER TREATMENT PLANT		0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST		94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA		50
16.0	INSTITUTIONAL CONTROLS	+	88
	TOTAL DIRECT CAPITAL COST		5,047
	REMEDIAL DESIGN ALLOWANCE		303
	CONTINGENCY	+	1,070
	TOTAL CAPITAL COSTS		$6,420
ANNUAL COSTS (Present Value in $1,000's)			
17.0	ENVIRONMENTAL MONITORING: ANNUAL		3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT		2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM		0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM		0
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS	+	0
	TOTAL DIRECT ANNUAL COST		5,838
	CONTINGENCY		1,168
	TOTAL ANNUAL COSTS		$7,005
TOTAL COST OF ALTERNATIVE (in $1,000's)			$13,425

TABLE G-3b. SUMMARY OF COSTS, ALTERNATIVE # 3b

Version: November 6, 1997 SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)			
1.0	GRADING & SITE PREP.: SOLID WASTE AREA		100
2.0	CAPPING: SOLID WASTE AREA		2,442
3.0	GRADING & SITE PREP.: BULKY WASTE AREA		48
4.0	CAPPING: BULKY WASTE AREA		864
5.0	LANDFILL MINING		0
6.0	PERIMETER WETLANDS MITIGATION		4
7.0	INTERNAL LF GAS COLLECTION SYSTEM		681
8.0	PERIMETER LF GAS COLLECTION SYSTEM		338
9.0	LF GAS TREATMENT PLANT		445
10.0	GW DEPRESSION SYSTEM: COLLECTION		0
11.0	LEACHATE COLLECTION SYSTEM		0
12.0	50 GPM WATER TREATMENT PLANT		0
13.0	5 GPM WATER TREATMENT PLANT		0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST		94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA		50
16.0	INSTITUTIONAL CONTROLS	+	88
	TOTAL DIRECT CAPITAL COST		5,154
	REMEDIAL DESIGN ALLOWANCE		309
	CONTINGENCY	+	1,093
	TOTAL CAPITAL COSTS		$6,556
ANNUAL COSTS (Present Value in $1,000's)			
17.0	ENVIRONMENTAL MONITORING: ANNUAL		3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT		2,475
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM		0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM		0
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS	+	0
	TOTAL DIRECT ANNUAL COST		5,526
	CONTINGENCY		1,105
	TOTAL ANNUAL COSTS		$6,631
TOTAL COST OF ALTERNATIVE (in $1,000's)			$13,187

TABLE G-4a. SUMMARY OF COSTS, ALTERNATIVE # 4a

Version: November 6, 1997 | SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)			
1.0	GRADING & SITE PREP.: SOLID WASTE AREA		100
2.0	CAPPING: SOLID WASTE AREA		2,442
3.0	GRADING & SITE PREP.: BULKY WASTE AREA		48
4.0	CAPPING: BULKY WASTE AREA		864
5.0	LANDFILL MINING		0
6.0	PERIMETER WETLANDS MITIGATION		40
7.0	INTERNAL LF GAS COLLECTION SYSTEM		681
8.0	PERIMETER LF GAS COLLECTION SYSTEM		338
9.0	LF GAS TREATMENT PLANT		338
10.0	GW DEPRESSION SYSTEM: COLLECTION		0
11.0	LEACHATE COLLECTION SYSTEM		99
12.0	50 GPM WATER TREATMENT PLANT		0
13.0	5 GPM WATER TREATMENT PLANT		507
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST		94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA		50
16.0	INSTITUTIONAL CONTROLS	+	88
	TOTAL DIRECT CAPITAL COST		5,689
	REMEDIAL DESIGN ALLOWANCE		341
	CONTINGENCY	+	1,206
	TOTAL CAPITAL COSTS		$7,236
ANNUAL COSTS (Present Value in $1,000's)			
17.0	ENVIRONMENTAL MONITORING: ANNUAL		3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT		2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM		0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM		1,519
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS	+	0
	TOTAL DIRECT ANNUAL COST		7,357
	CONTINGENCY		1,471
	TOTAL ANNUAL COSTS		$8,828
TOTAL COST OF ALTERNATIVE (in $1,000's)			$16,064

TABLE G-4b. SUMMARY OF COSTS, ALTERNATIVE # 4b

Version: November 6, 1997 SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)		
1.0	GRADING & SITE PREP.: SOLID WASTE AREA	100
2.0	CAPPING: SOLID WASTE AREA	2,686
3.0	GRADING & SITE PREP.: BULKY WASTE AREA	46
4.0	CAPPING: BULKY WASTE AREA	0
5.0	LANDFILL MINING	2,652
6.0	PERIMETER WETLANDS MITIGATION	40
7.0	INTERNAL LF GAS COLLECTION SYSTEM	681
8.0	PERIMETER LF GAS COLLECTION SYSTEM	338
9.0	LF GAS TREATMENT PLANT	338
10.0	GW DEPRESSION SYSTEM: COLLECTION	0
11.0	LEACHATE COLLECTION SYSTEM	99
12.0	50 GPM WATER TREATMENT PLANT	0
13.0	5 GPM WATER TREATMENT PLANT	507
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST	94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA	50
16.0	INSTITUTIONAL CONTROLS +	88
	TOTAL DIRECT CAPITAL COST	7,717
	REMEDIAL DESIGN ALLOWANCE	463
	CONTINGENCY +	1,636
	TOTAL CAPITAL COSTS	$9,816
ANNUAL COSTS (Present Value in $1,000's)		
17.0	ENVIRONMENTAL MONITORING: ANNUAL	3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT	2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM	0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM	83
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS +	0
	TOTAL DIRECT ANNUAL COST	5,921
	CONTINGENCY	1,184
	TOTAL ANNUAL COSTS	$7,105
TOTAL COST OF ALTERNATIVE (in $1,000's)		$16,922

TABLE G-5a. SUMMARY OF COSTS, ALTERNATIVE # 5a

Version: November 6, 1997 SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)			
1.0	GRADING & SITE PREP.: SOLID WASTE AREA		100
2.0	CAPPING: SOLID WASTE AREA		2,442
3.0	GRADING & SITE PREP.: BULKY WASTE AREA		48
4.0	CAPPING: BULKY WASTE AREA		864
5.0	LANDFILL MINING		0
6.0	PERIMETER WETLANDS MITIGATION		40
7.0	INTERNAL LF GAS COLLECTION SYSTEM		623
8.0	PERIMETER LF GAS COLLECTION SYSTEM		338
9.0	LF GAS TREATMENT PLANT		338
10.0	GW DEPRESSION SYSTEM: COLLECTION		152
11.0	LEACHATE COLLECTION SYSTEM		99
12.0	50 GPM WATER TREATMENT PLANT		1,348
13.0	5 GPM WATER TREATMENT PLANT		0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST		94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA		50
16.0	INSTITUTIONAL CONTROLS	+	88
	TOTAL DIRECT CAPITAL COST		6,624
	REMEDIAL DESIGN ALLOWANCE		397
	CONTINGENCY	+	1,404
	TOTAL CAPITAL COSTS		$8,426
ANNUAL COSTS (Present Value in $1,000's)			
17.0	ENVIRONMENTAL MONITORING: ANNUAL		3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT		2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM		4,006
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM		0
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS	+	0
	TOTAL DIRECT ANNUAL COST		9,844
	CONTINGENCY		1,969
	TOTAL ANNUAL COSTS		$11,813
TOTAL COST OF ALTERNATIVE (in $1,000's)			$20,239

TABLE G-5b. SUMMARY OF COSTS, ALTERNATIVE # 5b

Version: November 6, 1997 SENSITIVITY: BASE

CAPITAL COSTS (in $1,000's)			
1.0	GRADING & SITE PREP.: SOLID WASTE AREA		100
2.0	CAPPING: SOLID WASTE AREA		2,686
3.0	GRADING & SITE PREP.: BULKY WASTE AREA		46
4.0	CAPPING: BULKY WASTE AREA		0
5.0	LANDFILL MINING		2,652
6.0	PERIMETER WETLANDS MITIGATION		40
7.0	INTERNAL LF GAS COLLECTION SYSTEM		623
8.0	PERIMETER LF GAS COLLECTION SYSTEM		338
9.0	LF GAS TREATMENT PLANT		338
10.0	GW DEPRESSION SYSTEM: COLLECTION		152
11.0	LEACHATE COLLECTION SYSTEM		99
12.0	50 GPM WATER TREATMENT PLANT		1,348
13.0	5 GPM WATER TREATMENT PLANT		0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST		94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA		50
16.0	INSTITUTIONAL CONTROLS	+	88
	TOTAL DIRECT CAPITAL COST		8,653
	REMEDIAL DESIGN ALLOWANCE		519
	CONTINGENCY	+	1,834
	TOTAL CAPITAL COSTS		$11,006
ANNUAL COSTS (Present Value in $1,000's)			
17.0	ENVIRONMENTAL MONITORING: ANNUAL		3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT		2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM		4,006
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM		0
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS	+	0
	TOTAL DIRECT ANNUAL COST		9,844
	CONTINGENCY		1,969
	TOTAL ANNUAL COSTS		$11,813
TOTAL COST OF ALTERNATIVE (in $1,000's)			$22,819

G-2 Detailed Costs - Alternative #1

DETAILED COST TABLE: ALTERNATIVE # 1 SENSITIVITY: BASE

ITEM		UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:					
1.0	GRADING & SITE PREP.: SOLID WASTE AREA				
1.1	Clearing and Grubbing	acre	335.00	0	0
1.2	Silt Fencing	lf	2.00	0	0
1.3	Drainage Ditches	lf	0.36	0	0
1.4	Detention Basins	cy	4.00	0	0
1.5	Fence 8' Chain Link	lf	15.00	0	0
Total					0
2.0	CAPPING: SOLID WASTE AREA				
2.1	Vegetation	sy	0.35	0	0
2.2	Topsoil: 6"	sy	3.50	0	0
2.3	Cover Layer: 18"	cy	12.00	0	0
2.4	Drainage Layer: Composite	sy	3.60	0	0
2.5	Geomembrane	sf	0.43	0	0
2.6	Low Permeability Layer: 12"	cy	8.00	0	0
2.7	Protective Layer: 6"	cy	12.00	0	0
2.8	Wetlands Replacement	acre	50,000	0	0
Total					0
3.0	GRADING & SITE PREP.: BULKY WASTE AREA				
3.1	Clearing and Grubbing	acre	335.00	0	0
3.2	Silt Fencing	lf	2.00	0	0
3.2	Drainage Ditches	lf	0.36	0	0
3.4	Detention Basins	cy	4.00	0	0
3.5	Fence 8' Chain Link	lf	15.00	0	0
Total					0
4.0	CAPPING: BULKY WASTE AREA				
4.1	Vegetation	sy	0.35	0	0
4.2	Topsoil: 6"	sy	3.50	0	0
4.3	Cover Layer: 18"	cy	12.00	0	0
4.4	Drainage Layer: Composite	sy	3.60	0	0
4.5	Geomembrane	sf	0.43	0	0
4.6	Low Permeability Layer: 12"	cy	8.00	0	0
4.7	Gas Vent Layer: Composite	sy	3.60	0	0
4.8	Passive Gas Vents	lf	196.00	0	0
Total					0
5.0	LANDFILL MINING				
5.1	Waste Removal and Segregation	cy	9.00	0	0
5.2	Scrap Metal Transport	cy	5.00	0	0
5.3	Transport Non-recyclables to Solid Waste Area	cy	1.50	0	0
5.4	Backfill With Reclaimed Soil	cy	2.15	0	0
5.5	Backfill With Clean Fill	cy	11.00	0	0
5.6	Vegetation	sy	0.35	0	0
5.7	Miscellaneous Allowances	ls	97,000	0	0
5.8	Scrap Metal Revenue	lb	0.02	0	0
5.9	Supervision & Monitoring Labor	day	300.00	0	0
Total					0
6.0	PERIMETER WETLANDS MITIGATION				
6.1	Wetlands & Buffer Zone replacement	ls	80,000	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE # 1 SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	0	0
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	0	0
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	0	0
7.3b	8" HDPE Header Pipe, buried	lf	23.60	0	0
7.3c	6" HDPE Header Pipe, buried	lf	18.50	0	0
7.3d	"Blueboard" thermal insulation	lf	1.50	0	0
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	0	0
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	0	0
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	0	0
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	0	0
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	0	0
7.5	Condensate Piping	lf	5.00	0	0
7.6	Condensate Pump Stations	ea	50,000	0	0
7.7	Condensate Storage Tank Allowance	ea	25,000	0	0
Total					0
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	0	0
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	0	0
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	0	0
8.3b	6" HDPE Header Pipe, buried	lf	18.50	0	0
8.3c	"Blueboard" thermal insulation	lf	1.50	0	0
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	0	0
8.4	Valves & Appurtenances	ea	2000.00	0	0
Total					0
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	0	0
9.2	Electricity Service	lf	14.00	0	0
9.3	Water Service	lf	5.00	0	0
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	0	0
9.5	Enclosed Flare and Appurtenances	ea	179,400	0	0
9.6	Foundation: 18" Structural Slab	cy	350.00	0	0
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	0	0
9.8	Fence 8' Chain Link	lf	15.00	0	0
Total					0
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	0	0
10.2	Pump Electrical	lf	4.00	0	0
10.3	Pump Station	ls	75,000	0	0
10.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	0	0
11.2	Pump Electrical	lf	4.00	0	0
11.3	Pump Station	ls	50,000	0	0
11.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE # 1 SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	0	0
12.5	Instrumentation	ls	58,300	0	0
12.6	Foundation: 18" Structural Slab	cy	350.00	0	0
12.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
12.8	Discharge Line	lf	8.00	0	0
12.9	Groundwater Injection Wells	ea	9,000	0	0
12.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	0	0
13.5	Instrumentation	ls	20,289	0	0
13.6	Foundation: 18" Structural Slab	cy	350.00	0	0
13.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
13.8	Discharge Line	lf	5.00	0	0
13.9	Groundwater Injection Wells	ea	9,000	0	0
13.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	0	0
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					88
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	0	0
Total					0
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	0	0
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	0	0
Total					0
	TOTAL DIRECT CAPITAL COST				88
	REMEDIAL DESIGN ALLOWANCE @ 6%				5
	CONTINGENCY @ 20%				19
	TOTAL CAPITAL COSTS				111

DETAILED COST TABLE: ALTERNATIVE #		1		SENSITIVITY:		BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:				Annual Quantity	Duration Req'd (yrs)	Net Present Value (1)
17.0	ENVIRONMENTAL MONITORING: ANNUAL					
17.1	Five Year Review	ea	25,000	0.20	30	85
17.2	Cap Inspection and Reporting	ea	2500	0	0	0
17.3	Groundwater Monitoring	sample	1,740	51	30	1,511
17.4	SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5	Ambient Air Monitoring	sample	1,690	10	15	184
17.6	Soil Gas Monitoring	sample	83	94	15	85
TOTAL						2,880
18.0	LANDFILL GAS COLLECTION AND TREATMENT					
18.1	O&M Labor:					
18.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
18.1b	Overtime @ 10%	hr	65	0	0	0
18.1c	Supervisory @ 10%	hr	75	0	0	0
18.1d	Administrative Costs	ls	4,000	0	0	0
18.2	Equipment Repair/Replacement	ls	56,476	0	0	0
18.3	Electricity Usage Internal System Blower	kWhr	0.07	0	0	0
18.4	Elec. Usage Perimeter System Blower	kWhr	0.07	0	0	0
18.5	Condensate Transportation: Internal System	gal	0.35	0	0	0
18.6	Condensate Transportation: Perimeter System	gal	0.35	0	0	0
18.7	Condensate Disposal: Internal System	gal	1.44	0	0	0
18.8	Condensate Disposal: Perimeter System	gal	1.44	0	0	0
18.9	Auxiliary Fuel Usage	cf	0.02	0	0	0
18.10	Photocatalytic Oxidation O&M	ls	27,816	0	0	0
TOTAL						0
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1	O&M Labor:					
19.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
19.1b	Overtime @ 10%	hr	65	0	0	0
19.1c	Supervisory @ 10%	hr	75	0	0	0
19.1d	Administrative Costs	ls	4,000	0	0	0
19.2	Feed Chemicals	1,000 gal	2.00	0	0	0
19.3	Equipment Repair/Replacement	ls	42,276	0	0	0
19.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
19.5	Electricity Usage: Treatment	1,000 gal	1.65	0	0	0
19.6	Diposal of Residuals	1,000 gal	1.01	0	0	0
TOTAL						0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1	O&M Labor:					
20.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
20.1b	Overtime @ 10%	hr	65	0	0	0
20.1c	Supervisory @ 10%	hr	75	0	0	0
20.1d	Administrative Costs	ls	4,000	0	0	0
20.2	Feed Chemicals	1,000 gal	0.70	0	0	0
20.3	Equipment Repair/Replacement	ls	14,967	0	0	0
20.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
20.5	Electricity Usage: Treatment	1,000 gal	0.55	0	0	0
20.6	Diposal of Residuals	1,000 gal	0.35	0	0	0
Total						0

DETAILED COST TABLE: ALTERNATIVE #		1		SENSITIVITY:		BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	0	0	0
Total						0
	TOTAL PRESENT COST					2,880
	CONTINGENCY @ 20%					576
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					3,456
	TOTAL COST (in $1,000's)					3,568

Notes:

1) Net Present Value costs were calculated using the following formula:

$$NPV_{(\$1,000's)} = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-3 Detailed Costs - Alternative #2

DETAILED COST TABLE: ALTERNATIVE #		2		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:					
1.0	GRADING & SITE PREP.: SOLID WASTE AREA				
1.1	Clearing and Grubbing	acre	335.00	0	0
1.2	Silt Fencing	lf	2.00	0	0
1.3	Drainage Ditches	lf	0.36	0	0
1.4	Detention Basins	cy	4.00	0	0
1.5	Fence 8' Chain Link	lf	15.00	4,700	71
Total					71
2.0	CAPPING: SOLID WASTE AREA				
2.1	Vegetation	sy	0.35	0	0
2.2	Topsoil: 6"	sy	3.50	0	0
2.3	Cover Layer: 18"	cy	12.00	0	0
2.4	Drainage Layer: Composite	sy	3.60	0	0
2.5	Geomembrane	sf	0.43	0	0
2.6	Low Permeability Layer: 12"	cy	8.00	0	0
2.7	Protective Layer: 6"	cy	12.00	0	0
2.8	Wetlands Replacement	acre	50,000	0	0
Total					0
3.0	GRADING & SITE PREP.: BULKY WASTE AREA				
3.1	Clearing and Grubbing	acre	335.00	0	0
3.2	Silt Fencing	lf	2.00	0	0
3.2	Drainage Ditches	lf	0.36	0	0
3.4	Detention Basins	cy	4.00	0	0
3.5	Fence 8' Chain Link	lf	15.00	0	0
Total					0
4.0	CAPPING: BULKY WASTE AREA				
4.1	Vegetation	sy	0.35	0	0
4.2	Topsoil: 6"	sy	3.50	0	0
4.3	Cover Layer: 18"	cy	12.00	0	0
4.4	Drainage Layer: Composite	sy	3.60	0	0
4.5	Geomembrane	sf	0.43	0	0
4.6	Low Permeability Layer: 12"	cy	8.00	0	0
4.7	Gas Vent Layer: Composite	sy	3.60	0	0
4.8	Passive Gas Vents	lf	196.00	0	0
Total					0
5.0	LANDFILL MINING				
5.1	Waste Removal and Segregation	cy	9.00	0	0
5.2	Scrap Metal Transport	cy	5.00	0	0
5.3	Transport Non-recyclables to Solid Waste Area	cy	1.50	0	0
5.4	Backfill With Reclaimed Soil	cy	2.15	0	0
5.5	Backfill With Clean Fill	cy	11.00	0	0
5.6	Vegetation	sy	0.35	0	0
5.7	Miscellaneous Allowances	ls	97,000	0	0
5.8	Scrap Metal Revenue	lb	0.02	0	0
5.9	Supervision & Monitoring Labor	day	300.00	0	0
Total					0
6.0	PERIMETER WETLANDS MITIGATION				
6.1	Wetlands & Buffer Zone replacement	ls	80,000	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE #		2		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	0	0
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	0	0
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	0	0
7.3b	8" HDPE Header Pipe, buried	lf	23.60	0	0
7.3c	6" HDPE Header Pipe, buried	lf	18.50	0	0
7.3d	"Blueboard" thermal insulation	lf	1.50	0	0
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	0	0
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	0	0
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	0	0
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	0	0
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	0	0
7.5	Condensate Piping	lf	5.00	0	0
7.6	Condensate Pump Stations	ea	50,000	0	0
7.7	Condensate Storage Tank Allowance	ea	25,000	0	0
Total					0
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	0	0
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	0	0
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	0	0
8.3b	6" HDPE Header Pipe, buried	lf	18.50	0	0
8.3c	"Blueboard" thermal insulation	lf	1.50	0	0
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	0	0
8.4	Valves & Appurtenances	ea	2000.00	0	0
Total					0
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	0	0
9.2	Electricity Service	lf	14.00	0	0
9.3	Water Service	lf	5.00	0	0
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	0	0
9.5	Enclosed Flare and Appurtenances	ea	179,400	0	0
9.6	Foundation: 18" Structural Slab	cy	350.00	0	0
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	0	0
9.8	Fence 8' Chain Link	lf	15.00	0	0
Total					0
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	0	0
10.2	Pump Electrical	lf	4.00	0	0
10.3	Pump Station	ls	75,000	0	0
10.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	0	0
11.2	Pump Electrical	lf	4.00	0	0
11.3	Pump Station	ls	50,000	0	0
11.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE #		2		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	0	0
12.5	Instrumentation	ls	58,300	0	0
12.6	Foundation: 18" Structural Slab	cy	350.00	0	0
12.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
12.8	Discharge Line	lf	8.00	0	0
12.9	Groundwater Injection Wells	ea	9,000	0	0
12.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	0	0
13.5	Instrumentation	ls	20,289	0	0
13.6	Foundation: 18" Structural Slab	cy	350.00	0	0
13.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
13.8	Discharge Line	lf	5.00	0	0
13.9	Groundwater Injection Wells	ea	9,000	0	0
13.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	0	0
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					88
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	0	0
Total					0
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	11	88
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	4	39
Total					127
	TOTAL DIRECT CAPITAL COST				285
	REMEDIAL DESIGN ALLOWANCE @	6%			17
	CONTINGENCY @	20%			60
	TOTAL CAPITAL COSTS				363

DETAILED COST TABLE: ALTERNATIVE # 2 SENSITIVITY: BASE

ITEM		UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:				Annual	Duration	Net Present
17.0	ENVIRONMENTAL MONITORING: ANNUAL			Quantity	Req'd (yrs)	Value (1)
17.1	Five Year Review	ea	25,000	0.20	30	85
17.2	Cap Inspection and Reporting	ea	2500	0	0	0
17.3	Groundwater Monitoring	sample	1,740	51	30	1,511
17.4	SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5	Ambient Air Monitoring	sample	1,690	10	15	184
17.6	Soil Gas Monitoring	sample	83	94	15	85
TOTAL						2,880
18.0	LANDFILL GAS COLLECTION AND TREATMENT					
18.1	O&M Labor:					
18.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
18.1b	Overtime @ 10%	hr	65	0	0	0
18.1c	Supervisory @ 10%	hr	75	0	0	0
18.1d	Administrative Costs	ls	4,000	0	0	0
18.2	Equipment Repair/Replacement	ls	56,476	0	0	0
18.3	Electricity Usage Internal System Blower	kWhr	0.07	0	0	0
18.4	Elec. Usage Perimeter System Blower	kWhr	0.07	0	0	0
18.5	Condensate Transportation: Internal System	gal	0.35	0	0	0
18.6	Condensate Transportation: Perimeter System	gal	0.35	0	0	0
18.7	Condensate Disposal: Internal System	gal	1.44	0	0	0
18.8	Condensate Disposal: Perimeter System	gal	1.44	0	0	0
18.9	Auxiliary Fuel Usage	cf	0.02	0	0	0
18.10	Photocatalytic Oxidation O&M	ls	27,816	0	0	0
TOTAL						0
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1	O&M Labor:					
19.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
19.1b	Overtime @ 10%	hr	65	0	0	0
19.1c	Supervisory @ 10%	hr	75	0	0	0
19.1d	Administrative Costs	ls	4,000	0	0	0
19.2	Feed Chemicals	1,000 gal	2.00	0	0	0
19.3	Equipment Repair/Replacement	ls	42,276	0	0	0
19.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
19.5	Electricity Usage: Treatment	1,000 gal	1.65	0	0	0
19.6	Diposal of Residuals	1,000 gal	1.01	0	0	0
TOTAL						0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1	O&M Labor:					
20.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
20.1b	Overtime @ 10%	hr	65	0	0	0
20.1c	Supervisory @ 10%	hr	75	0	0	0
20.1d	Administrative Costs	ls	4,000	0	0	0
20.2	Feed Chemicals	1,000 gal	0.70	0	0	0
20.3	Equipment Repair/Replacement	ls	14,967	0	0	0
20.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
20.5	Electricity Usage: Treatment	1,000 gal	0.55	0	0	0
20.6	Diposal of Residuals	1,000 gal	0.35	0	0	0
Total						0

DETAILED COST TABLE: ALTERNATIVE # 2 SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	4	15	22
Total						22
	TOTAL PRESENT COST					2,902
	CONTINGENCY @ 20%					580
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					3,482
	TOTAL COST (in $1,000's)					3,845

Notes:

1) Net Present Value costs were calculated using the following formula:

$$\text{NPV } (\$1{,}000\text{'s}) = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-4 Detailed Costs - Alterntive 3a

DETAILED COST TABLE: ALTERNATIVE # 3a SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:					
1.0	GRADING & SITE PREP.: SOLID WASTE AREA				
1.1	Clearing and Grubbing	acre	335.00	22.9	8
1.2	Silt Fencing	lf	2.00	4,400	9
1.3	Drainage Ditches	lf	0.36	1,240	0
1.4	Detention Basins	cy	4.00	3,025	12
1.5	Fence 8' Chain Link	lf	15.00	4,700	71
Total					100
2.0	CAPPING: SOLID WASTE AREA				
2.1	Vegetation	sy	0.35	110,836	39
2.2	Topsoil: 6"	sy	3.50	110836	388
2.3	Cover Layer: 18"	cy	12.00	55,418	665
2.4	Drainage Layer: Composite	sy	3.60	110,836	399
2.5	Geomembrane	sf	0.43	997,524	429
2.6	Low Permeability Layer: 12"	cy	8.00	36,945	296
2.7	Protective Layer: 6"	cy	12.00	18,473	222
2.8	Wetlands Replacement	acre	50,000	0.1	5
Total					2,442
3.0	GRADING & SITE PREP.: BULKY WASTE AREA				
3.1	Clearing and Grubbing	acre	335.00	7.4	2
3.2	Silt Fencing	lf	2.00	2,200	4
3.2	Drainage Ditches	lf	0.36	1,100	0
3.4	Detention Basins	cy	4.00	484	2
3.5	Fence 8' Chain Link	lf	15.00	2,600	39
Total					48
4.0	CAPPING: BULKY WASTE AREA				
4.1	Vegetation	sy	0.35	35,816	13
4.2	Topsoil: 6"	sy	3.50	35,816	125
4.3	Cover Layer: 18"	cy	12.00	17,908	215
4.4	Drainage Layer: Composite	sy	3.60	35,816	129
4.5	Geomembrane	sf	0.43	322,344	139
4.6	Low Permeability Layer: 12"	cy	8.00	11,939	96
4.7	Gas Vent Layer: Composite	sy	3.60	35,816	129
4.8	Passive Gas Vents	lf	196.00	100	20
Total					864
5.0	LANDFILL MINING				
5.1	Waste Removal and Segregation	cy	9.00	0	0
5.2	Scrap Metal Transport	cy	5.00	0	0
5.3	Transport Non-recyclables to Solid Waste Area	cy	1.50	0	0
5.4	Backfill With Reclaimed Soil	cy	2.15	0	0
5.5	Backfill With Clean Fill	cy	11.00	0	0
5.6	Vegetation	sy	0.35	0	0
5.7	Miscellaneous Allowances	ls	97,000	0	0
5.8	Scrap Metal Revenue	lb	0.02	0	0
5.9	Supervision & Monitoring Labor	day	300.00	0	0
Total					0
6.0	PERIMETER WETLANDS MITIGATION				
6.1	Wetlands & Buffer Zone replacement	ls	80,000	0	4
Total					4

DETAILED COST TABLE: ALTERNATIVE # 3a SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	36	153
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	900	176
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	500	14
7.3b	8" HDPE Header Pipe, buried	lf	23.60	3,780	89
7.3c	6" HDPE Header Pipe, buried	lf	18.50	2,890	53
7.3d	"Blueboard" thermal insulation	lf	1.50	7,170	11
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	20	6
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	22	6
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	1	2
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	15	24
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	1	6
7.5	Condensate Piping	lf	5.00	3,020	15
7.6	Condensate Pump Stations	ea	50,000	2	100
7.7	Condensate Storage Tank Allowance	ea	25,000	1	25
Total					681
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	26	111
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	572	112
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	3,210	89
8.3b	6" HDPE Header Pipe, buried	lf	18.50	260	5
8.3c	"Blueboard" thermal insulation	lf	1.50	3,470	5
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	26	11
8.4	Valves & Appurtenances	ea	2000.00	3	6
Total					338
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	4,222	23
9.2	Electricity Service	lf	14.00	1,600	22
9.3	Water Service	lf	5.00	1,600	8
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	1	60
9.5	Enclosed Flare and Appurtenances	ea	179,400	1	179
9.6	Foundation: 18" Structural Slab	cy	350.00	111	39
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	0	0
9.8	Fence 8' Chain Link	lf	15.00	400	6
Total					338
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	0	0
10.2	Pump Electrical	lf	4.00	0	0
10.3	Pump Station	ls	75,000	0	0
10.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	0	0
11.2	Pump Electrical	lf	4.00	0	0
11.3	Pump Station	ls	50,000	0	0
11.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE # 3a SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	0	0
12.5	Instrumentation	ls	58,300	0	0
12.6	Foundation: 18" Structural Slab	cy	350.00	0	0
12.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
12.8	Discharge Line	lf	8.00	0	0
12.9	Groundwater Injection Wells	ea	9,000	0	0
12.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	0	0
13.5	Instrumentation	ls	20,289	0	0
13.6	Foundation: 18" Structural Slab	cy	350.00	0	0
13.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
13.8	Discharge Line	lf	5.00	0	0
13.9	Groundwater Injection Wells	ea	9,000	0	0
13.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	125	6
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	1	50
Total					50
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	11	88
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	0	0
Total					88
	TOTAL DIRECT CAPITAL COST				5,047
	REMEDIAL DESIGN ALLOWANCE @ 6%				303
	CONTINGENCY @ 20%				1,070
	TOTAL CAPITAL COSTS				6,420

DETAILED COST TABLE: ALTERNATIVE # 3a SENSITIVITY: BASE

ITEM		UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:				Annual	Duration	Net Present
17.0	ENVIRONMENTAL MONITORING: ANNUAL			Quantity	Req'd (yrs)	Value (1)
17.1	Five Year Review	ea	25,000	0.20	30	85
17.2	Cap Inspection and Reporting	ea	2500	4	30	170
17.3	Groundwater Monitoring	sample	1,740	51	30	1,511
17.4	SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5	Ambient Air Monitoring	sample	1,690	10	15	184
17.6	Soil Gas Monitoring	sample	83	94	15	85
TOTAL						3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT					
18.1	O&M Labor:					
18.1a	Operator @ 1/2 shift/wk	hr	49	1,040	15	555
18.1b	Overtime @ 10%	hr	65	104	15	74
18.1c	Supervisory @ 10%	hr	75	104	15	85
18.1d	Administrative Costs	ls	4,000	1	15	44
18.2	Equipment Repair/Replacement	ls	56,476	1	15	615
18.3	Electricity Usage Internal System Blower	kWhr	0.07	36,291	15	28
18.4	Elec. Usage Perimeter System Blower	kWhr	0.07	108,872	15	83
18.5	Condensate Transportation: Internal System	gal	0.35	5,059	15	19
18.6	Condensate Transportation: Perimeter System	gal	0.35	53,348	15	201
18.7	Condensate Disposal: Internal System	gal	1.44	5,059	15	79
18.8	Condensate Disposal: Perimeter System	gal	1.44	53,348	15	837
18.9	Auxiliary Fuel Usage	cf	0.02	774,034	15	168
18.10	Photocatalytic Oxidation O&M	ls	27,816	0	0	0
TOTAL						2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1	O&M Labor:					
19.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
19.1b	Overtime @ 10%	hr	65	0	0	0
19.1c	Supervisory @ 10%	hr	75	0	0	0
19.1d	Administrative Costs	ls	4,000	0	0	0
19.2	Feed Chemicals	1,000 gal	2.00	0	0	0
19.3	Equipment Repair/Replacement	ls	42,276	0	0	0
19.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
19.5	Electricity Usage: Treatment	1,000 gal	1.65	0	0	0
19.6	Diposal of Residuals	1,000 gal	1.01	0	0	0
TOTAL						0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1	O&M Labor:					
20.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
20.1b	Overtime @ 10%	hr	65	0	0	0
20.1c	Supervisory @ 10%	hr	75	0	0	0
20.1d	Administrative Costs	ls	4,000	0	0	0
20.2	Feed Chemicals	1,000 gal	0.70	0	0	0
20.3	Equipment Repair/Replacement	ls	14,967	0	0	0
20.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
20.5	Electricity Usage: Treatment	1,000 gal	0.55	0	0	0
20.6	Diposal of Residuals	1,000 gal	0.35	0	0	0
Total						0

	DETAILED COST TABLE: ALTERNATIVE # 3a		SENSITIVITY:		BASE	
	ITEM	UNIT	UNIT COST ($ / unit)	QUANTITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	0	0	0
Total						0
	TOTAL PRESENT COST					5,838
	CONTINGENCY @ 20%					1,168
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					7,005
	TOTAL COST (in $1,000's)					13,425

Notes:

1) Net Present Value costs were calculated using the following formula:

$$NPV_{(\$1,000's)} = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-5 Detailed Costs - Alternative 3b

DETAILED COST TABLE: ALTERNATIVE # 3b SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:					
1.0	GRADING & SITE PREP.: SOLID WASTE AREA				
1.1	Clearing and Grubbing	acre	335.00	22.9	8
1:2	Silt Fencing	lf	2.00	4,400	9
1.3	Drainage Ditches	lf	0.36	1,240	0
1.4	Detention Basins	cy	4.00	3,025	12
1.5	Fence 8' Chain Link	lf	15.00	4,700	71
Total					100
2.0	CAPPING: SOLID WASTE AREA				
2.1	Vegetation	sy	0.35	110,836	39
2.2	Topsoil: 6"	sy	3.50	110836	388
2.3	Cover Layer: 18"	cy	12.00	55,418	665
2.4	Drainage Layer: Composite	sy	3.60	110,836	399
2.5	Geomembrane	sf	0.43	997,524	429
2.6	Low Permeability Layer: 12"	cy	8.00	36,945	296
2.7	Protective Layer: 6"	cy	12.00	18,473	222
2.8	Wetlands Replacement	acre	50,000	0.1	5
Total					2,442
3.0	GRADING & SITE PREP.: BULKY WASTE AREA				
3.1	Clearing and Grubbing	acre	335.00	7.4	2
3.2	Silt Fencing	lf	2.00	2,200	4
3.2	Drainage Ditches	lf	0.36	1,100	0
3.4	Detention Basins	cy	4.00	484	2
3.5	Fence 8' Chain Link	lf	15.00	2,600	39
Total					48
4.0	CAPPING: BULKY WASTE AREA				
4.1	Vegetation	sy	0.35	35,816	13
4.2	Topsoil: 6"	sy	3.50	35,816	125
4.3	Cover Layer: 18"	cy	12.00	17,908	215
4.4	Drainage Layer: Composite	sy	3.60	35,816	129
4.5	Geomembrane	sf	0.43	322,344	139
4.6	Low Permeability Layer: 12"	cy	8.00	11,939	96
4.7	Gas Vent Layer: Composite	sy	3.60	35,816	129
4.8	Passive Gas Vents	lf	196.00	100	20
Total					864
5.0	LANDFILL MINING				
5.1	Waste Removal and Segregation	cy	9.00	0	0
5.2	Scrap Metal Transport	cy	5.00	0	0
5.3	Transport Non-recyclables to Solid Waste Area	cy	1.50	0	0
5.4	Backfill With Reclaimed Soil	cy	2.15	0	0
5.5	Backfill With Clean Fill	cy	11.00	0	0
5.6	Vegetation	sy	0.35	0	0
5.7	Miscellaneous Allowances	ls	97,000	0	0
5.8	Scrap Metal Revenue	lb	0.02	0	0
5.9	Supervision & Monitoring Labor	day	300.00	0	0
Total					0
6.0	PERIMETER WETLANDS MITIGATION				
6.1	Wetlands & Buffer Zone replacement	ls	80,000	0	4
Total					4

DETAILED COST TABLE: ALTERNATIVE # 3b SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	36	153
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	900	176
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	500	14
7.3b	8" HDPE Header Pipe, buried	lf	23.60	3,780	89
7.3c	6" HDPE Header Pipe, buried	lf	18.50	2,890	53
7.3d	"Blueboard" thermal insulation	lf	1.50	7,170	11
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	20	6
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	22	6
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	1	2
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	15	24
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	1	6
7.5	Condensate Piping	lf	5.00	3,020	15
7.6	Condensate Pump Stations	ea	50,000	2	100
7.7	Condensate Storage Tank Allowance	ea	25,000	1	25
Total					681
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	26	111
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	572	112
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	3,210	89
8.3b	6" HDPE Header Pipe, buried	lf	18.50	260	5
8.3c	"Blueboard" thermal insulation	lf	1.50	3,470	5
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	26	11
8.4	Valves & Appurtenances	ea	2000.00	3	6
Total					338
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	4,222	23
9.2	Electricity Service	lf	14.00	1,600	22
9.3	Water Service	lf	5.00	1,600	8
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	1	60
9.5	Enclosed Flare and Appurtenances	ea	179,400	0	0
9.6	Foundation: 18" Structural Slab	cy	350.00	111	39
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	1	286
9.8	Fence 8' Chain Link	lf	15.00	400	6
Total					445
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	0	0
10.2	Pump Electrical	lf	4.00	0	0
10.3	Pump Station	ls	75,000	0	0
10.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	0	0
11.2	Pump Electrical	lf	4.00	0	0
11.3	Pump Station	ls	50,000	0	0
11.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE # 3b SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	0	0
12.5	Instrumentation	ls	58,300	0	0
12.6	Foundation: 18" Structural Slab	cy	350.00	0	0
12.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
12.8	Discharge Line	lf	8.00	0	0
12.9	Groundwater Injection Wells	ea	9,000	0	0
12.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	0	0
13.5	Instrumentation	ls	20,289	0	0
13.6	Foundation: 18" Structural Slab	cy	350.00	0	0
13.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
13.8	Discharge Line	lf	5.00	0	0
13.9	Groundwater Injection Wells	ea	9,000	0	0
13.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	125	6
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	1	50
Total					50
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	11	88
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	0	0
Total					88
	TOTAL DIRECT CAPITAL COST				5,154
	REMEDIAL DESIGN ALLOWANCE @	6%			309
	CONTINGENCY @	20%			1,093
	TOTAL CAPITAL COSTS				6,556

DETAILED COST TABLE: ALTERNATIVE #		3b	SENSITIVITY:		BASE
ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:			Annual	Duration	Net Present
17.0 ENVIRONMENTAL MONITORING: ANNUAL			Quantity	Req'd (yrs)	Value (1)
17.1 Five Year Review	ea	25,000	0.20	30	85
17.2 Cap Inspection and Reporting	ea	2500	4	30	170
17.3 Groundwater Monitoring	sample	1,740	51	30	1,511
17.4 SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5 Ambient Air Monitoring	sample	1,690	10	15	184
17.6 Soil Gas Monitoring	sample	83	94	15	85
TOTAL					3,051
18.0 LANDFILL GAS COLLECTION AND TREATMENT					
18.1 O&M Labor:					
18.1a Operator @ 1/2 shift/wk	hr	49	1,040	15	555
18.1b Overtime @ 10%	hr	65	104	15	74
18.1c Supervisory @ 10%	hr	75	104	15	85
18.1d Administrative Costs	ls	4,000	1	15	44
18.2 Equipment Repair/Replacement	ls	56,476	0	0	0
18.3 Electricity Usage Internal System Blower	kWhr	0.07	36,291	15	28
18.4 Elec. Usage Perimeter System Blower	kWhr	0.07	108,872	15	83
18.5 Condensate Transportation: Internal System	gal	0.35	5,059	15	19
18.6 Condensate Transportation: Perimeter System	gal	0.35	53,348	15	201
18.7 Condensate Disposal: Internal System	gal	1.44	5,059	15	79
18.8 Condensate Disposal: Perimeter System	gal	1.44	53,348	15	837
18.9 Auxiliary Fuel Usage	cf	0.02	774,034	15	168
18.10 Photocatalytic Oxidation O&M	ls	27,816	1	15	303
TOTAL					2,475
19.0 GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1 O&M Labor:					
19.1a Operator @ 1/2 shift/wk	hr	49	0	0	0
19.1b Overtime @ 10%	hr	65	0	0	0
19.1c Supervisory @ 10%	hr	75	0	0	0
19.1d Administrative Costs	ls	4,000	0	0	0
19.2 Feed Chemicals	1,000 gal	2.00	0	0	0
19.3 Equipment Repair/Replacement	ls	42,276	0	0	0
19.4 Electricity Usage: Collection	kWhr	0.07	0	0	0
19.5 Electricity Usage: Treatment	1,000 gal	1.65	0	0	0
19.6 Diposal of Residuals	1,000 gal	1.01	0	0	0
TOTAL					0
20.0 LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1 O&M Labor:					
20.1a Operator @ 1/2 shift/wk	hr	49	0	0	0
20.1b Overtime @ 10%	hr	65	0	0	0
20.1c Supervisory @ 10%	hr	75	0	0	0
20.1d Administrative Costs	ls	4,000	0	0	0
20.2 Feed Chemicals	1,000 gal	0.70	0	0	0
20.3 Equipment Repair/Replacement	ls	14,967	0	0	0
20.4 Electricity Usage: Collection	kWhr	0.07	0	0	0
20.5 Electricity Usage: Treatment	1,000 gal	0.55	0	0	0
20.6 Diposal of Residuals	1,000 gal	0.35	0	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE #		3b		SENSITIVITY:		BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	0	0	0
Total						0
	TOTAL PRESENT COST					5,526
	CONTINGENCY @	20%				1,105
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					6,631
	TOTAL COST (in $1,000's)					13,187

Notes:

1) Net Present Value costs were calculated using the following formula:

$$NPV\ (\$1{,}000\text{'s}) = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-6 Detailed Costs - Alternative #4a

DETAILED COST TABLE: ALTERNATIVE #		4a		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:					
1.0	GRADING & SITE PREP.: SOLID WASTE AREA				
1.1	Clearing and Grubbing	acre	335.00	22.9	8
1.2	Silt Fencing	lf	2.00	4,400	9
1.3	Drainage Ditches	lf	0.36	1,240	0
1.4	Detention Basins	cy	4.00	3,025	12
1.5	Fence 8' Chain Link	lf	15.00	4,700	71
Total					100
2.0	CAPPING: SOLID WASTE AREA				
2.1	Vegetation	sy	0.35	110,836	39
2.2	Topsoil: 6"	sy	3.50	110836	388
2.3	Cover Layer: 18"	cy	12.00	55,418	665
2.4	Drainage Layer: Composite	sy	3.60	110,836	399
2.5	Geomembrane	sf	0.43	997,524	429
2.6	Low Permeability Layer: 12"	cy	8.00	36,945	296
2.7	Protective Layer: 6"	cy	12.00	18,473	222
2.8	Wetlands Replacement	acre	50,000	0.1	5
Total					2,442
3.0	GRADING & SITE PREP.: BULKY WASTE AREA				
3.1	Clearing and Grubbing	acre	335.00	7.4	2
3.2	Silt Fencing	lf	2.00	2,200	4
3.2	Drainage Ditches	lf	0.36	1,100	0
3.4	Detention Basins	cy	4.00	484	2
3.5	Fence 8' Chain Link	lf	15.00	2,600	39
Total					48
4.0	CAPPING: BULKY WASTE AREA				
4.1	Vegetation	sy	0.35	35,816	13
4.2	Topsoil: 6"	sy	3.50	35,816	125
4.3	Cover Layer: 18"	cy	12.00	17,908	215
4.4	Drainage Layer: Composite	sy	3.60	35,816	129
4.5	Geomembrane	sf	0.43	322,344	139
4.6	Low Permeability Layer: 12"	cy	8.00	11,939	96
4.7	Gas Vent Layer: Composite	sy	3.60	35,816	129
4.8	Passive Gas Vents	lf	196.00	100	20
Total					864
5.0	LANDFILL MINING				
5.1	Waste Removal and Segregation	cy	9.00	0	0
5.2	Scrap Metal Transport	cy	5.00	0	0
5.3	Transport Non-recyclables to Solid Waste Area	cy	1.50	0	0
5.4	Backfill With Reclaimed Soil	cy	2.15	0	0
5.5	Backfill With Clean Fill	cy	11.00	0	0
5.6	Vegetation	sy	0.35	0	0
5.7	Miscellaneous Allowances	ls	97,000	0	0
5.8	Scrap Metal Revenue	lb	0.02	0	0
5.9	Supervision & Monitoring Labor	day	300.00	0	0
Total					0
6.0	PERIMETER WETLANDS MITIGATION				
6.1	Wetlands & Buffer Zone replacement	ls	80,000	1	40
Total					40

DETAILED COST TABLE: ALTERNATIVE #		4a		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	36	153
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	900	176
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	500	14
7.3b	8" HDPE Header Pipe, buried	lf	23.60	3,780	89
7.3c	6" HDPE Header Pipe, buried	lf	18.50	2,890	53
7.3d	"Blueboard" thermal insulation	lf	1.50	7,170	11
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	20	6
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	22	6
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	1	2
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	15	24
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	1	6
7.5	Condensate Piping	lf	5.00	3,020	15
7.6	Condensate Pump Stations	ea	50,000	2	100
7.7	Condensate Storage Tank Allowance	ea	25,000	1	25
Total					681
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	26	111
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	572	112
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	3,210	89
8.3b	6" HDPE Header Pipe, buried	lf	18.50	260	5
8.3c	"Blueboard" thermal insulation	lf	1.50	3,470	5
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	26	11
8.4	Valves & Appurtenances	ea	2000.00	3	6
Total					338
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	4,222	23
9.2	Electricity Service	lf	14.00	1,600	22
9.3	Water Service	lf	5.00	1,600	8
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	1	60
9.5	Enclosed Flare and Appurtenances	ea	179,400	1	179
9.6	Foundation: 18" Structural Slab	cy	350.00	111	39
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	0	0
9.8	Fence 8' Chain Link	lf	15.00	400	6
Total					338
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	0	0
10.2	Pump Electrical	lf	4.00	0	0
10.3	Pump Station	ls	75,000	0	0
10.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	2,100	11
11.2	Pump Electrical	lf	4.00	2,100	8
11.3	Pump Station	ls	50,000	1	50
11.4	Shallow Drain Piping & Installation	lf	40.00	750	30
Total					99

DETAILED COST TABLE: ALTERNATIVE #		4a		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	0	0
12.5	Instrumentation	ls	58,300	0	0
12.6	Foundation: 18" Structural Slab	cy	350.00	0	0
12.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
12.8	Discharge Line	lf	8.00	0	0
12.9	Groundwater Injection Wells	ea	9,000	0	0
12.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	1	214
13.5	Instrumentation	ls	20,289	1	20
13.6	Foundation: 18" Structural Slab	cy	350.00	200	70
13.7	Structure: 20' Pre-engineered Building	sf	50.00	3,600	180
13.8	Discharge Line	lf	5.00	500	3
13.9	Groundwater Injection Wells	ea	9,000	2	18
13.10	Fence 8' Chain Link	lf	15.00	150	2
Total					507
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	125	6
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	1	50
Total					50
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	11	88
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	0	0
Total					88
	TOTAL DIRECT CAPITAL COST				5,689
	REMEDIAL DESIGN ALLOWANCE @	6%			341
	CONTINGENCY @	20%			1,206
	TOTAL CAPITAL COSTS				7,236

DETAILED COST TABLE: ALTERNATIVE # 4a SENSITIVITY: BASE

ITEM		UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:				Annual	Duration	Net Present
17.0	ENVIRONMENTAL MONITORING: ANNUAL			Quantity	Req'd (yrs)	Value (1)
17.1	Five Year Review	ea	25,000	0.20	30	85
17.2	Cap Inspection and Reporting	ea	2500	4	30	170
17.3	Groundwater Monitoring	sample	1,740	51	30	1,511
17.4	SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5	Ambient Air Monitoring	sample	1,690	10	15	184
17.6	Soil Gas Monitoring	sample	83	94	15	85
TOTAL						3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT					
18.1	O&M Labor:					
18.1a	Operator @ 1/2 shift/wk	hr	49	1,040	15	555
18.1b	Overtime @ 10%	hr	65	104	15	74
18.1c	Supervisory @ 10%	hr	75	104	15	85
18.1d	Administrative Costs	ls	4,000	1	15	44
18.2	Equipment Repair/Replacement	ls	56,476	1	15	615
18.3	Electricity Usage Internal System Blower	kWhr	0.07	36,291	15	28
18.4	Elec. Usage Perimeter System Blower	kWhr	0.07	108,872	15	83
18.5	Condensate Transportation: Internal System	gal	0.35	5,059	15	19
18.6	Condensate Transportation: Perimeter System	gal	0.35	53,348	15	201
18.7	Condensate Disposal: Internal System	gal	1.44	5,059	15	79
18.8	Condensate Disposal: Perimeter System	gal	1.44	53,348	15	837
18.9	Auxiliary Fuel Usage	cf	0.02	774,034	15	168
18.10	Photocatalytic Oxidation O&M	ls	27,816	0	0	0
TOTAL						2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1	O&M Labor:					
19.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
19.1b	Overtime @ 10%	hr	65	0	0	0
19.1c	Supervisory @ 10%	hr	75	0	0	0
19.1d	Administrative Costs	ls	4,000	0	0	0
19.2	Feed Chemicals	1,000 gal	2.00	0	0	0
19.3	Equipment Repair/Replacement	ls	42,276	0	0	0
19.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
19.5	Electricity Usage: Treatment	1,000 gal	1.65	0	0	0
19.6	Diposal of Residuals	1,000 gal	1.01	0	0	0
TOTAL						0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1	O&M Labor:					
20.1a	Operator @ 1/2 shift/wk	hr	49	1,040	30	868
20.1b	Overtime @ 10%	hr	65	104	30	115
20.1c	Supervisory @ 10%	hr	75	104	30	133
20.1d	Administrative Costs	ls	4,000	1	30	68
20.2	Feed Chemicals	1,000 gal	0.70	2,628	30	31
20.3	Equipment Repair/Replacement	ls	14,967	1	30	255
20.4	Electricity Usage: Collection	kWhr	0.07	7,258	30	9
20.5	Electricity Usage: Treatment	1,000 gal	0.55	2,628	30	25
20.6	Diposal of Residuals	1,000 gal	0.35	2,628	30	16
Total						1,519

DETAILED COST TABLE: ALTERNATIVE #	4a			SENSITIVITY:		BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	0	0	0
Total						0
	TOTAL PRESENT COST					7,357
	CONTINGENCY @ 20%					1,471
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					8,828
	TOTAL COST (in $1,000's)					16,064

Notes:

1) Net Present Value costs were calculated using the following formula:

$$NPV_{(\$1,000's)} = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-7 Detailed Costs - Alternative 4b

DETAILED COST TABLE: ALTERNATIVE # 4b SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:					
1.0	GRADING & SITE PREP.: SOLID WASTE AREA				
1.1	Clearing and Grubbing	acre	335.00	22.9	8
1.2	Silt Fencing	lf	2.00	4,400	9
1.3	Drainage Ditches	lf	0.36	1,240	0
1.4	Detention Basins	cy	4.00	3,025	12
1.5	Fence 8' Chain Link	lf	15.00	4,700	71
Total					100
2.0	CAPPING: SOLID WASTE AREA				
2.1	Vegetation	sy	0.35	121,920	43
2.2	Topsoil: 6"	sy	3.50	121920	427
2.3	Cover Layer: 18"	cy	12.00	60,960	732
2.4	Drainage Layer: Composite	sy	3.60	121,920	439
2.5	Geomembrane	sf	0.43	1,097,276	472
2.6	Low Permeability Layer: 12"	cy	8.00	40,640	325
2.7	Protective Layer: 6"	cy	12.00	20,320	244
2.8	Wetlands Replacement	acre	50,000	0.1	5
Total					2,686
3.0	GRADING & SITE PREP.: BULKY WASTE AREA				
3.1	Clearing and Grubbing	acre	335.00	7	2
3.2	Silt Fencing	lf	2.00	2,200	4
3.2	Drainage Ditches	lf	0.36	0	0
3.4	Detention Basins	cy	4.00	0	0
3.5	Fence 8' Chain Link	lf	15.00	2,600	39
Total					46
4.0	CAPPING: BULKY WASTE AREA				
4.1	Vegetation	sy	0.35	0	0
4.2	Topsoil: 6"	sy	3.50	0	0
4.3	Cover Layer: 18"	cy	12.00	0	0
4.4	Drainage Layer: Composite	sy	3.60	0	0
4.5	Geomembrane	sf	0.43	0	0
4.6	Low Permeability Layer: 12"	cy	8.00	0	0
4.7	Gas Vent Layer: Composite	sy	3.60	0	0
4.8	Passive Gas Vents	lf	196.00	0	0
Total					0
5.0	LANDFILL MINING				
5.1	Waste Removal and Segregation	cy	9.00	114,000	1,026
5.2	Scrap Metal Transport	cy	5.00	37,500	188
5.3	Transport Non-recyclables to Solid Waste Area	cy	1.50	30,900	46
5.4	Backfill With Reclaimed Soil	cy	2.15	45,600	98
5.5	Backfill With Clean Fill	cy	11.00	50,000	550
5.6	Vegetation	sy	0.35	35,816	13
5.7	Miscellaneous Allowances	ls	97,000	1	97
5.8	Scrap Metal Revenue	lb	0.02	3.00E+07	600
5.9	Supervision & Monitoring Labor	day	300.00	114	34
Total					2,652
6.0	PERIMETER WETLANDS MITIGATION				
6.1	Wetlands & Buffer Zone replacement	ls	80,000	1	40
Total					40

DETAILED COST TABLE: ALTERNATIVE # 4b SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUANTITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	36	153
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	900	176
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	500	14
7.3b	8" HDPE Header Pipe, buried	lf	23.60	3,780	89
7.3c	6" HDPE Header Pipe, buried	lf	18.50	2,890	53
7.3d	"Blueboard" thermal insulation	lf	1.50	7,170	11
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	20	6
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	22	6
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	1	2
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	15	24
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	1	6
7.5	Condensate Piping	lf	5.00	3,020	15
7.6	Condensate Pump Stations	ea	50,000	2	100
7.7	Condensate Storage Tank Allowance	ea	25,000	1	25
Total					681
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	26	111
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	572	112
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	3,210	89
8.3b	6" HDPE Header Pipe, buried	lf	18.50	260	5
8.3c	"Blueboard" thermal insulation	lf	1.50	3,470	5
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	26	11
8.4	Valves & Appurtenances	ea	2000.00	3	6
Total					338
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	4,222	23
9.2	Electricity Service	lf	14.00	1,600	22
9.3	Water Service	lf	5.00	1,600	8
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	1	60
9.5	Enclosed Flare and Appurtenances	ea	179,400	1	179
9.6	Foundation: 18" Structural Slab	cy	350.00	111	39
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	0	0
9.8	Fence 8' Chain Link	lf	15.00	400	6
Total					338
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	0	0
10.2	Pump Electrical	lf	4.00	0	0
10.3	Pump Station	ls	75,000	0	0
10.4	Shallow Drain Piping & Installation	lf	40.00	0	0
Total					0
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	2,100	11
11.2	Pump Electrical	lf	4.00	2,100	8
11.3	Pump Station	ls	50,000	1	50
11.4	Shallow Drain Piping & Installation	lf	40.00	750	30
Total					99

DETAILED COST TABLE: ALTERNATIVE #		4b		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	0	0
12.5	Instrumentation	ls	58,300	0	0
12.6	Foundation: 18" Structural Slab	cy	350.00	0	0
12.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
12.8	Discharge Line	lf	8.00	0	0
12.9	Groundwater Injection Wells	ea	9,000	0	0
12.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	1	214
13.5	Instrumentation	ls	20,289	1	20
13.6	Foundation: 18" Structural Slab	cy	350.00	200	70
13.7	Structure: 20' Pre-engineered Building	sf	50.00	3,600	180
13.8	Discharge Line	lf	5.00	500	3
13.9	Groundwater Injection Wells	ea	9,000	2	18
13.10	Fence 8' Chain Link	lf	15.00	150	2
Total					507
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	125	6
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	1	50
Total					50
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	11	88
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	0	0
Total					88
	TOTAL DIRECT CAPITAL COST				7,717
	REMEDIAL DESIGN ALLOWANCE @	6%			463
	CONTINGENCY @	20%			1,636
	TOTAL CAPITAL COSTS				9,816

DETAILED COST TABLE: ALTERNATIVE # 4b SENSITIVITY: BASE

ITEM		UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:				Annual	Duration	Net Present
17.0	ENVIRONMENTAL MONITORING: ANNUAL			Quantity	Req'd (yrs)	Value (1)
17.1	Five Year Review	ea	25,000	0.20	30	85
17.2	Cap Inspection and Reporting	ea	2500	4	30	170
17.3	Groundwater Monitoring	sample	1,740	51	30	1,511
17.4	SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5	Ambient Air Monitoring	sample	1,690	10	15	184
17.6	Soil Gas Monitoring	sample	83	94	15	85
TOTAL						3,051
18.0	LANDFILL GAS COLLECTION AND TREATMENT					
18.1	O&M Labor:					
18.1a	Operator @ 1/2 shift/wk	hr	49	1,040	15	555
18.1b	Overtime @ 10%	hr	65	104	15	74
18.1c	Supervisory @ 10%	hr	75	104	15	85
18.1d	Administrative Costs	ls	4,000	1	15	44
18.2	Equipment Repair/Replacement	ls	56,476	1	15	615
18.3	Electricity Usage Internal System Blower	kWhr	0.07	36,291	15	28
18.4	Elec. Usage Perimeter System Blower	kWhr	0.07	108,872	15	83
18.5	Condensate Transportation: Internal System	gal	0.35	5,059	15	19
18.6	Condensate Transportation: Perimeter System	gal	0.35	53,348	15	201
18.7	Condensate Disposal: Internal System	gal	1.44	5,059	15	79
18.8	Condensate Disposal: Perimeter System	gal	1.44	53,348	15	837
18.9	Auxiliary Fuel Usage	cf	0.02	774,034	15	168
18.10	Photocatalytic Oxidation O&M	ls	27,816	0	0	0
TOTAL						2,787
19.0	GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1	O&M Labor:					
19.1a	Operator @ 1/2 shift/wk	hr	49	0	0	0
19.1b	Overtime @ 10%	hr	65	0	0	0
19.1c	Supervisory @ 10%	hr	75	0	0	0
19.1d	Administrative Costs	ls	4,000	0	0	0
19.2	Feed Chemicals	1,000 gal	2.00	0	0	0
19.3	Equipment Repair/Replacement	ls	42,276	0	0	0
19.4	Electricity Usage: Collection	kWhr	0.07	0	0	0
19.5	Electricity Usage: Treatment	1,000 gal	1.65	0	0	0
19.6	Diposal of Residuals	1,000 gal	1.01	0	0	0
TOTAL						0
20.0	LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1	O&M Labor:					
20.1a	Operator @ 1/2 shift/wk	hr	49	1,040	1	48
20.1b	Overtime @ 10%	hr	65	104	1	6
20.1c	Supervisory @ 10%	hr	75	104	1	7
20.1d	Administrative Costs	ls	4,000	1	1	4
20.2	Feed Chemicals	1,000 gal	0.70	2,628	1	2
20.3	Equipment Repair/Replacement	ls	14,967	1	1	14
20.4	Electricity Usage: Collection	kWhr	0.07	7,258	1	0
20.5	Electricity Usage: Treatment	1,000 gal	0.55	2,628	1	1
20.6	Diposal of Residuals	1,000 gal	0.35	2,628	1	1
Total						83

DETAILED COST TABLE: ALTERNATIVE # 4b SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	0	0	0
Total						0
	TOTAL PRESENT COST					5,921
	CONTINGENCY @ 20%					1,184
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					7,105
	TOTAL COST (in $1,000's)					16,922

Notes:

1) Net Present Value costs were calculated using the following formula:

$$NPV\ (\$1{,}000's) = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-8 Detailed Costs - Alternative 5a

DETAILED COST TABLE: ALTERNATIVE #		5a	SENSITIVITY:	BASE
ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:				
1.0 GRADING & SITE PREP.: SOLID WASTE AREA				
1.1 Clearing and Grubbing	acre	335.00	22.9	8
1.2 Silt Fencing	lf	2.00	4,400	9
1.3 Drainage Ditches	lf	0.36	1,240	0
1.4 Detention Basins	cy	4.00	3,025	12
1.5 Fence 8' Chain Link	lf	15.00	4,700	71
Total				100
2.0 CAPPING: SOLID WASTE AREA				
2.1 Vegetation	sy	0.35	110,836	39
2.2 Topsoil: 6"	sy	3.50	110836	388
2.3 Cover Layer: 18"	cy	12.00	55,418	665
2.4 Drainage Layer: Composite	sy	3.60	110,836	399
2.5 Geomembrane	sf	0.43	997,524	429
2.6 Low Permeability Layer: 12"	cy	8.00	36,945	296
2.7 Protective Layer: 6"	cy	12.00	18,473	222
2.8 Wetlands Replacement	acre	50,000	0.1	5
Total				2,442
3.0 GRADING & SITE PREP.: BULKY WASTE AREA				
3.1 Clearing and Grubbing	acre	335.00	7.4	2
3.2 Silt Fencing	lf	2.00	2,200	4
3.2 Drainage Ditches	lf	0.36	1,100	0
3.4 Detention Basins	cy	4.00	484	2
3.5 Fence 8' Chain Link	lf	15.00	2,600	39
Total				48
4.0 CAPPING: BULKY WASTE AREA				
4.1 Vegetation	sy	0.35	35,816	13
4.2 Topsoil: 6"	sy	3.50	35,816	125
4.3 Cover Layer: 18"	cy	12.00	17,908	215
4.4 Drainage Layer: Composite	sy	3.60	35,816	129
4.5 Geomembrane	sf	0.43	322,344	139
4.6 Low Permeability Layer: 12"	cy	8.00	11,939	96
4.7 Gas Vent Layer: Composite	sy	3.60	35,816	129
4.8 Passive Gas Vents	lf	196.00	100	20
Total				864
5.0 LANDFILL MINING				
5.1 Waste Removal and Segregation	cy	9.00	0	0
5.2 Scrap Metal Transport	cy	5.00	0	0
5.3 Transport Non-recyclables to Solid Waste Area	cy	1.50	0	0
5.4 Backfill With Reclaimed Soil	cy	2.15	0	0
5.5 Backfill With Clean Fill	cy	11.00	0	0
5.6 Vegetation	sy	0.35	0	0
5.7 Miscellaneous Allowances	ls	97,000	0	0
5.8 Scrap Metal Revenue	lb	0.02	0	0
5.9 Supervision & Monitoring Labor	day	300.00	0	0
Total				0
6.0 PERIMETER WETLANDS MITIGATION				
6.1 Wetlands & Buffer Zone replacement	ls	80,000	1	40
Total				40

DETAILED COST TABLE: ALTERNATIVE # 5a SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	36	153
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	900	176
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	500	14
7.3b	8" HDPE Header Pipe, buried	lf	23.60	3,780	89
7.3c	6" HDPE Header Pipe, buried	lf	18.50	2,890	53
7.3d	"Blueboard" thermal insulation	lf	1.50	7,170	11
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	20	6
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	22	6
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	1	2
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	15	24
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	1	6
7.5	Condensate Piping	lf	5.00	1,470	7
7.6	Condensate Pump Stations	ea	50,000	1	50
7.7	Condensate Storage Tank Allowance	ea	25,000	1	25
Total					623
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	26	111
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	572	112
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	3,210	89
8.3b	6" HDPE Header Pipe, buried	lf	18.50	260	5
8.3c	"Blueboard" thermal insulation	lf	1.50	3,470	5
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	26	11
8.4	Valves & Appurtenances	ea	2000.00	3	6
Total					338
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	4,222	23
9.2	Electricity Service	lf	14.00	1,600	22
9.3	Water Service	lf	5.00	1,600	8
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	1	60
9.5	Enclosed Flare and Appurtenances	ea	179,400	1	179
9.6	Foundation: 18" Structural Slab	cy	350.00	111	39
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	0	0
9.8	Fence 8' Chain Link	lf	15.00	400	6
Total					338
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	1,550	12
10.2	Pump Electrical	lf	4.00	1,550	6
10.3	Pump Station	ls	75,000	1	75
10.4	Shallow Drain Piping & Installation	lf	40.00	1,450	58
Total					152
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	2,100	11
11.2	Pump Electrical	lf	4:00	2,100	8
11.3	Pump Station	ls	50,000	1	50
11.4	Shallow Drain Piping & Installation	lf	40.00	750	30
Total					99

DETAILED COST TABLE: ALTERNATIVE #		5a		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	1	614
12.5	Instrumentation	ls	58,300	1	58
12.6	Foundation: 18" Structural Slab	cy	350.00	500	175
12.7	Structure: 20' Pre-engineered Building	sf	50.00	9,000	450
12.8	Discharge Line	lf	8.00	500	4
12.9	Groundwater Injection Wells	ea	9,000	5	45
12.10	Fence 8' Chain Link	lf	15.00	150	2
Total					1,348
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	0	0
13.5	Instrumentation	ls	20,289	0	0
13.6	Foundation: 18" Structural Slab	cy	350.00	0	0
13.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
13.8	Discharge Line	lf	5.00	0	0
13.9	Groundwater Injection Wells	ea	9,000	0	0
13.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	125	6
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	1	50
Total					50
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	11	88
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	0	0
Total					88
	TOTAL DIRECT CAPITAL COST				6,624
	REMEDIAL DESIGN ALLOWANCE @	6%			397
	CONTINGENCY @	20%			1,404
	TOTAL CAPITAL COSTS				8,426

DETAILED COST TABLE: ALTERNATIVE #	5a		SENSITIVITY:		BASE
ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:			Annual	Duration	Net Present
17.0 ENVIRONMENTAL MONITORING: ANNUAL			Quantity	Req'd (yrs)	Value (1)
17.1 Five Year Review	ea	25,000	0.20	30	85
17.2 Cap Inspection and Reporting	ea	2500	4	30	170
17.3 Groundwater Monitoring	sample	1,740	51	30	1,511
17.4 SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5 Ambient Air Monitoring	sample	1,690	10	15	184
17.6 Soil Gas Monitoring	sample	83	94	15	85
TOTAL					3,051
18.0 LANDFILL GAS COLLECTION AND TREATMENT					
18.1 O&M Labor:					
18.1a Operator @ 1/2 shift/wk	hr	49	1,040	15	555
18.1b Overtime @ 10%	hr	65	104	15	74
18.1c Supervisory @ 10%	hr	75	104	15	85
18.1d Administrative Costs	ls	4,000	1	15	44
18.2 Equipment Repair/Replacement	ls	56,476	1	15	615
18.3 Electricity Usage Internal System Blower	kWhr	0.07	36,291	15	28
18.4 Elec. Usage Perimeter System Blower	kWhr	0.07	108,872	15	83
18.5 Condensate Transportation: Internal System	gal	0.35	5,059	15	19
18.6 Condensate Transportation: Perimeter System	gal	0.35	53,348	15	201
18.7 Condensate Disposal: Internal System	gal	1.44	5,059	15	79
18.8 Condensate Disposal: Perimeter System	gal	1.44	53,348	15	837
18.9 Auxiliary Fuel Usage	cf	0.02	774,034	15	168
18.10 Photocatalytic Oxidation O&M	ls	27,816	0	0	0
TOTAL					2,787
19.0 GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1 O&M Labor:					
19.1a Operator @ 1/2 shift/wk	hr	49	1,040	30	868
19.1b Overtime @ 10%	hr	65	104	30	115
19.1c Supervisory @ 10%	hr	75	104	30	133
19.1d Administrative Costs	ls	4,000	1	30	68
19.2 Feed Chemicals	1,000 gal	2.00	26,280	30	895
19.3 Equipment Repair/Replacement	ls	42,276	1	30	720
19.4 Electricity Usage: Collection	kWhr	0.07	14,516	30	17
19.5 Electricity Usage: Treatment	1,000 gal	1.65	26,280	30	738
19.6 Diposal of Residuals	1,000 gal	1.01	26,280	30	452
TOTAL					4,006
20.0 LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1 O&M Labor:					
20.1a Operator @ 1/2 shift/wk	hr	49	0	0	0
20.1b Overtime @ 10%	hr	65	0	0	0
20.1c Supervisory @ 10%	hr	75	0	0	0
20.1d Administrative Costs	ls	4,000	0	0	0
20.2 Feed Chemicals	1,000 gal	0.70	0	0	0
20.3 Equipment Repair/Replacement	ls	14,967	0	0	0
20.4 Electricity Usage: Collection	kWhr	0.07	0	0	0
20.5 Electricity Usage: Treatment	1,000 gal	0.55	0	0	0
20.6 Diposal of Residuals	1,000 gal	0.35	0	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE # 5a SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUANTITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	0	0	0
Total						0
	TOTAL PRESENT COST					9,844
	CONTINGENCY @ 20%					1,969
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					11,813
	TOTAL COST (in $1,000's)					20,239

Notes:

1) Net Present Value costs were calculated using the following formula:

$$NPV_{(\$1,000's)} = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-9 Detailed Costs - Alternative 5b

DETAILED COST TABLE: ALTERNATIVE #		5b		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
CAPITAL COSTS:					
1.0	GRADING & SITE PREP.: SOLID WASTE AREA				
1.1	Clearing and Grubbing	acre	335.00	22.9	8
1.2	Silt Fencing	lf	2.00	4,400	9
1.3	Drainage Ditches	lf	0.36	1,240	0
1.4	Detention Basins	cy	4.00	3,025	12
1.5	Fence 8' Chain Link	lf	15.00	4,700	71
Total					100
2.0	CAPPING: SOLID WASTE AREA				
2.1	Vegetation	sy	0.35	121,920	43
2.2	Topsoil: 6"	sy	3.50	121920	427
2.3	Cover Layer: 18"	cy	12.00	60,960	732
2.4	Drainage Layer: Composite	sy	3.60	121,920	439
2.5	Geomembrane	sf	0.43	1,097,276	472
2.6	Low Permeability Layer: 12"	cy	8.00	40,640	325
2.7	Protective Layer: 6"	cy	12.00	20,320	244
2.8	Wetlands Replacement	acre	50,000	0.1	5
Total					2,686
3.0	GRADING & SITE PREP.: BULKY WASTE AREA				
3.1	Clearing and Grubbing	acre	335.00	7	2
3.2	Silt Fencing	lf	2.00	2,200	4
3.2	Drainage Ditches	lf	0.36	0	0
3.4	Detention Basins	cy	4.00	0	0
3.5	Fence 8' Chain Link	lf	15.00	2,600	39
Total					46
4.0	CAPPING: BULKY WASTE AREA				
4.1	Vegetation	sy	0.35	0	0
4.2	Topsoil: 6"	sy	3.50	0	0
4.3	Cover Layer: 18"	cy	12.00	0	0
4.4	Drainage Layer: Composite	sy	3.60	0	0
4.5	Geomembrane	sf	0.43	0	0
4.6	Low Permeability Layer: 12"	cy	8.00	0	0
4.7	Gas Vent Layer: Composite	sy	3.60	0	0
4.8	Passive Gas Vents	lf	196.00	0	0
Total					0
5.0	LANDFILL MINING				
5.1	Waste Removal and Segregation	cy	9.00	114,000	1,026
5.2	Scrap Metal Transport	cy	5.00	37,500	188
5.3	Transport Non-recyclables to Solid Waste Area	cy	1.50	30,900	46
5.4	Backfill With Reclaimed Soil	cy	2.15	45,600	98
5.5	Backfill With Clean Fill	cy	11.00	50,000	550
5.6	Vegetation	sy	0.35	35,816	13
5.7	Miscellaneous Allowances	ls	97,000	1	97
5.8	Scrap Metal Revenue	lb	0.02	3.00E+07	600
5.9	Supervision & Monitoring Labor	day	300.00	114	34
Total					2,652
6.0	PERIMETER WETLANDS MITIGATION				
6.1	Wetlands & Buffer Zone replacement	ls	80,000	1	40
Total					40

DETAILED COST TABLE: ALTERNATIVE #		5b		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
7.0	INTERNAL LF GAS COLLECTION SYSTEM				
7.1	Vault, Gauges, Fittings and Other Costs	well	4,250	36	153
7.2	Screen, Casing and Other Well Footage Costs	lf	196.00	900	176
7.3	Header Pipe: HDPE				
7.3a	10" HDPE Header Pipe, buried	lf	27.60	500	14
7.3b	8" HDPE Header Pipe, buried	lf	23.60	3,780	89
7.3c	6" HDPE Header Pipe, buried	lf	18.50	2,890	53
7.3d	"Blueboard" thermal insulation	lf	1.50	7,170	11
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	ea	310.00	20	6
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	ea	250.00	22	6
7.4	Valves & Appurtenances				
7.4a	Buried butterfly isolation valves: 10"	ea	2000.00	1	2
7.4b	Buried butterfly isolation valves: 8"	ea	1600.00	15	24
7.4c	LANDTEC GEM-500 LFG analyzer	ls	6395.00	1	6
7.5	Condensate Piping	lf	5.00	1,470	7
7.6	Condensate Pump Stations	ea	50,000	1	50
7.7	Condensate Storage Tank Allowance	ea	25,000	1	25
Total					623
8.0	PERIMETER LF GAS COLLECTION SYSTEM				
8.1	Vault, Gauges, Fittings and Other Costs	well	4,250	26	111
8.2	Screen, Casing and Other Well Footage Costs	lf	196.00	572	112
8.3	Header Pipe: HDPE				
8.3a	10" HDPE Header Pipe, buried	lf	27.60	3,210	89
8.3b	6" HDPE Header Pipe, buried	lf	18.50	260	5
8.3c	"Blueboard" thermal insulation	lf	1.50	3,470	5
8.3d	HDPE Tees 10" x 10" x 6", installed & buried	ea	430.00	26	11
8.4	Valves & Appurtenances	ea	2000.00	3	6
Total					338
9.0	LF GAS TREATMENT PLANT				
9.1	Access Roads	sy	5.56	4,222	23
9.2	Electricity Service	lf	14.00	1,600	22
9.3	Water Service	lf	5.00	1,600	8
9.4	Internal & Perim. Coll. System Blowers & Motors	ls	60,000	1	60
9.5	Enclosed Flare and Appurtenances	ea	179,400	1	179
9.6	Foundation: 18" Structural Slab	cy	350.00	111	39
9.7	Photocatalytic Oxidation and Appurtenances	ls	286,000	0	0
9.8	Fence 8' Chain Link	lf	15.00	400	6
Total					338
10.0	GW DEPRESSION SYSTEM: COLLECTION				
10.1	Buried Piping	lf	8.00	1,550	12
10.2	Pump Electrical	lf	4.00	1,550	6
10.3	Pump Station	ls	75,000	1	75
10.4	Shallow Drain Piping & Installation	lf	40.00	1,450	58
Total					152
11.0	LEACHATE COLLECTION SYSTEM				
11.1	Buried Piping	lf	5.00	2,100	11
11.2	Pump Electrical	lf	4.00	2,100	8
11.3	Pump Station	ls	50,000	1	50
11.4	Shallow Drain Piping & Installation	lf	40.00	750	30
Total					99

DETAILED COST TABLE: ALTERNATIVE #		5b		SENSITIVITY:	BASE
	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY	COST ($1,000's)
12.0	50 GPM WATER TREATMENT PLANT				
12.1	Not Used				
12.2	Not Used				
12.3	Not Used				
12.4	Equipment	ls	613,500	1	614
12.5	Instrumentation	ls	58,300	1	58
12.6	Foundation: 18" Structural Slab	cy	350.00	500	175
12.7	Structure: 20' Pre-engineered Building	sf	50.00	9,000	450
12.8	Discharge Line	lf	8.00	500	4
12.9	Groundwater Injection Wells	ea	9,000	5	45
12.10	Fence 8' Chain Link	lf	15.00	150	2
Total					1,348
13.0	5 GPM WATER TREATMENT PLANT				
13.1	Not Used				
13.2	Not Used				
13.3	Not Used				
13.4	Equipment	ls	213,500	0	0
13.5	Instrumentation	ls	20,289	0	0
13.6	Foundation: 18" Structural Slab	cy	350.00	0	0
13.7	Structure: 20' Pre-engineered Building	sf	50.00	0	0
13.8	Discharge Line	lf	5.00	0	0
13.9	Groundwater Injection Wells	ea	9,000	0	0
13.10	Fence 8' Chain Link	lf	15.00	0	0
Total					0
14.0	ENVIRONMENTAL MONITORING: CAPITAL COST				
14.1	Piezometer Installation	lf	50	125	6
14.2	Soil Gas Probe Construction	ea	2,500	35	88
Total					94
15.0	DECONTAMINATION AREA - TREATMENT PLANT AREA				
15.1	Decon Station Allowance	ls	50,000	1	50
Total					50
16.0	INSTITUTIONAL CONTROLS				
16.1	GW Access Restrictions: Legal Fees	lot	8,000	11	88
16.2	Alt. Water Supply Contingency: Municipal Water	house	2,885	0	0
16.3	Alt. Water Supply Contingency: Point-of-Use	house	2,500	0	0
16.4	LFG Control Contingency	house	9,808	0	0
Total					88
	TOTAL DIRECT CAPITAL COST				8,653
	REMEDIAL DESIGN ALLOWANCE @	6%			519
	CONTINGENCY @	20%			1,834
	TOTAL CAPITAL COSTS				11,006

DETAILED COST TABLE: ALTERNATIVE #	5b		SENSITIVITY:		BASE
ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
ANNUAL COSTS:			Annual	Duration	Net Present
17.0 ENVIRONMENTAL MONITORING: ANNUAL			Quantity	Req'd (yrs)	Value (1)
17.1 Five Year Review	ea	25,000	0.20	30	85
17.2 Cap Inspection and Reporting	ea	2500	4	30	170
17.3 Groundwater Monitoring	sample	1,740	51	30	1,511
17.4 SW/Sediment Monitoring	sample	2,710	22	30	1,015
17.5 Ambient Air Monitoring	sample	1,690	10	15	184
17.6 Soil Gas Monitoring	sample	83	94	15	85
TOTAL					3,051
18.0 LANDFILL GAS COLLECTION AND TREATMENT					
18.1 O&M Labor:					
18.1a Operator @ 1/2 shift/wk	hr	49	1,040	15	555
18.1b Overtime @ 10%	hr	65	104	15	74
18.1c Supervisory @ 10%	hr	75	104	15	85
18.1d Administrative Costs	ls	4,000	1	15	44
18.2 Equipment Repair/Replacement	ls	56,476	1	15	615
18.3 Electricity Usage Internal System Blower	kWhr	0.07	36,291	15	28
18.4 Elec. Usage Perimeter System Blower	kWhr	0.07	108,872	15	83
18.5 Condensate Transportation: Internal System	gal	0.35	5,059	15	19
18.6 Condensate Transportation: Perimeter System	gal	0.35	53,348	15	201
18.7 Condensate Disposal: Internal System	gal	1.44	5,059	15	79
18.8 Condensate Disposal: Perimeter System	gal	1.44	53,348	15	837
18.9 Auxiliary Fuel Usage	cf	0.02	774,034	15	168
18.10 Photocatalytic Oxidation O&M	ls	27,816	0	0	0
TOTAL					2,787
19.0 GW/LEACHATE COLLECTION & TREATMENT: 50 GPM					
19.1 O&M Labor:					
19.1a Operator @ 1/2 shift/wk	hr	49	1,040	30	868
19.1b Overtime @ 10%	hr	65	104	30	115
19.1c Supervisory @ 10%	hr	75	104	30	133
19.1d Administrative Costs	ls	4,000	1	30	68
19.2 Feed Chemicals	1,000 gal	2.00	26,280	30	895
19.3 Equipment Repair/Replacement	ls	42,276	1	30	720
19.4 Electricity Usage: Collection	kWhr	0.07	14,516	30	17
19.5 Electricity Usage: Treatment	1,000 gal	1.65	26,280	30	738
19.6 Diposal of Residuals	1,000 gal	1.01	26,280	30	452
TOTAL					4,006
20.0 LEACHATE COLLECTION & TREATMENT: 5 GPM					
20.1 O&M Labor:					
20.1a Operator @ 1/2 shift/wk	hr	49	0	0	0
20.1b Overtime @ 10%	hr	65	0	0	0
20.1c Supervisory @ 10%	hr	75	0	0	0
20.1d Administrative Costs	ls	4,000	0	0	0
20.2 Feed Chemicals	1,000 gal	0.70	0	0	0
20.3 Equipment Repair/Replacement	ls	14,967	0	0	0
20.4 Electricity Usage: Collection	kWhr	0.07	0	0	0
20.5 Electricity Usage: Treatment	1,000 gal	0.55	0	0	0
20.6 Diposal of Residuals	1,000 gal	0.35	0	0	0
Total					0

DETAILED COST TABLE: ALTERNATIVE # 5b SENSITIVITY: BASE

	ITEM	UNIT	UNIT COST ($ / unit)	QUAN-TITY		COST ($1,000's)
21.0	INSTITUTIONAL CONTROLS: ANNUAL COSTS					
21.1	Groundwater Access Restrictions (Not Used)					
21.2	Contingency: Municipal Water(Annual Water Bill)	house	712	0	0	0
21.3	Contingency: Point-of-Use (Annual Inspections)	house	750	0	0	0
21.4	LFG Control Contingency (Annual Inspections)	house	500	0	0	0
Total						0
	TOTAL PRESENT COST					9,844
	CONTINGENCY @ 20%					1,969
	TOTAL ANNUAL COSTS (Present Value in $1,000's)					11,813
	TOTAL COST (in $1,000's)					22,819

Notes:

1) Net Present Value costs were calculated using the following formula:

$$\underset{(\$1{,}000\text{'s})}{NPV} = A_o \cdot \frac{1 - (1 + i_{INF})^N / (1 + i_{DF})^N}{(i_{DF} - i_{INF})}$$

where:

A_o = (Unit cost) · (Annual quantity)

N = duration of annual cost (years)

i_{DF} = discount factor or rate

i_{INF} = inflation rate

G-10 Unit Cost Development and General Assumptions - All Alternatives

GENERAL ASSUMPTIONS

ITEM	QUANTITY	UNIT
Monitoring and Operating Period	30	YR
Inflation Rate	3	%
Discount Rate, Average Sensitivity	7	%
Discount Rate, Low Sensitivity	5	%
Discount Rate, High Sensitivity	9	%

UNIT COST DEVELOPMENT ITEM		UNIT COST ($ / unit)	UNIT
GRADING & SITE PREP.: SOLID WASTE AREA			
1.1 Clearing & Grubbing			
Use Brush Mowing: Light Density - Modified to use $45/hr labor, 17% OH&P		$335	/ acre
[Means Heavy Construction Cost Data, 1997, p.41]			
Quantity: Use acreage of disposal area; Table 2-13	22.9 acres		
1.2 Silt Fencing			
Silt Fence, Polypropylene, ideal conditions		$2.00	/ ft
[M&E estimate, 1997]			
Quantity: Approximate perimeter of disposal area, measured from figures	4,400 ft		
1.3 Drainage Ditches			
Cut drainage Ditch-Common Earth, 1' deep		$0.36	/ ft
[Means, p.59]			
Quantity: Measured from figures	1,240 ft		
1.4 Detention Basins			
Detention Basins #1 and #2			
Excavation: Backhoe, hydraulic, crawler mtd., 1 cy capacity; 75 cy/hr		$4.00	/ cy
[M&E estimate, 1997]			
Quantity: Basin volumes in Appendix B — Basin #1	1,500 cy		
Add 50% capacity — Basin #2	1,525 cy		
1.5 Fence: 8' Chain Link			
Total Bare Cost		$15.00	/ ft
[M&E estimate, 1997]			
Quantity: Approximate, measured from figures	4,700 ft		
CAPPING: SOLID WASTE AREA			
[Increase all capping material quantities by 10% for Alternatives #4b & #5b due to waste placement from Bulky Waste Area]			
2.1 Vegetation			
Air seeding with mulch & fertilizer		$0.35	/ sy
[Basis: Danbury, CT Landfill, 1997]			
Quantity: Size of disposal area	110,836 sy		
2.2 Topsoil: 6"			
Spread conditioned topsoil 6" deep, 300 Hp dozer			
Total Bare Cost		$3.50	/ sy
[Basis: Danbury, CT Landfill, 1997]			
Quantity: Size of disposal area	110,836 sy		
2.3 Cover Layer: 18"			
Select granular fill borrow cost [M&E estimate, 1997]		$12.00	/ cy
Compaction, 18" with roller, 4 passes			
Backfilling 300' haul, sand & gravel			
Quantity: Size of disposal area x depth	55,418 cy		
2.4 Drainage Layer: Composite			
Drainage composite; hydr. conductivity = 10 cm/s		$3.60	/ sy
[Carmo Environmental Systems, Inc., 1997]			
Quantity: Size of disposal area	110,836 sy		

UNIT COST DEVELOPMENT ITEM			UNIT COST ($ / unit)	UNIT
2.5 Geomembrane				
60 mil LLDPE installed			$0.43	/ sf
[Polyflex, Lou Jacobsen]				
Quantity: Size of disposal area		997,524 sf		
2.6 Low Permeability Layer: 12"				
Silt/Sand; hydr. conductivity = 1 x 10^{-4} cm/s			$8.00	/ cy
[M&E Estimate, 1997]				
Quantity: Size of disposal area		36,945 cy		
2.7 Protective Layer: 6"				
Select granular fill borrow cost	[M&E estimate, 1997]		$12.00	/ cy
Compaction, 6" with roller				
Backfilling 300' haul, sand & gravel				
Quantity: Size of disposal area x depth		18,473 cy		
2.8 Emergent Wetlands Replacement (1993 dollars)				
Assume similar to reference			$50,000	/ acre
[Figure 1, King and Bohlen, 1994]				
Quantity: Emergent Wetland on Figures, GIS measured		0.1 acres		
GRADING & SITE PREP.: BULKY WASTE AREA				
3.1 Clearing & Grubbing				
See 1.1			$335	/ acre
Quantity: Use acreage of disposal area; Table 2-13		7.4 acres		
3.2 Silt Fencing				
See 1.2			$2.00	/ ft
Quantity: Approximate perimeter of disposal area, measured from figures		2,200 ft		
3.3 Drainage Ditches				
See 1.3			$0.36	/ ft
Quantity: Measured from figures		1,100 ft		
3.4 Detention Basins				
Detention Basin #3				
Excavation: Backhoe, hydraulic, crawler mtd., 1 cy capacity; 75 cy/hr			$4.00	/ cy
[M&E estimate, 1997]				
Quantity: Basin volume in Appendix B	Basin #3	484 cy		
Add 50% capacity				
3.5 Fence: 8' Chain Link				
See 1.5			$15.00	/ ft
Quantity: Approximate, measured from figures		2,600 ft		
CAPPING: BULKY WASTE AREA				
4.1 Vegetation				
See 2.1			$0.35	/ sy
Quantity: Size of disposal area		35,816 sy		
4.2 Topsoil: 6"				
See 2.2			$3.50	/ sy
Quantity: Size of disposal area		35,816 sy		

UNIT COST DEVELOPMENT ITEM			UNIT COST ($ / unit)	UNIT
4.3 Cover Layer: 18"				
See 2.3			$12.00	/ cy
Quantity: Size of disposal area x depth		17,908 cy		
4.4 Drainage Layer: Composite				
See 2.4			$3.60	/ sy
Quantity: Size of disposal area		35,816 sy		
4.5 Geomembrane				
See 2.5			$0.43	/ sf
Quantity: Size of disposal area		322,344 sf		
4.6 Low Permeability Layer: 12"				
See 2.6			$8.00	/ cy
Quantity: Size of disposal area		11,939 cy		
4.7 Gas Vent Layer: Composite				
See 2.4			$3.60	/ sy
Quantity: Size of disposal area x depth		35,816 sy		
4.8 Passive Gas Vents				
Vent Installation			$196	/ ft
See 7.2				
Quantity: 10 penetrating cap at 10' deep; Table 4-3		100 ft		
LANDFILL MINING				
5.1 Waste Removal and Segregation				
[Appendix A]			$9	/ cy
Quantity: Estimated Bulky Waste Area Vol.; Table 2-13		114,000 cy		
5.2 Scrap Metal Transport				
[Appendix A]			$5	/ cy
Quantity: Estimated Volume; Appendix A		37,500 cy		
5.3 Transport Non-recyclables to Solid Waste Area				
[Appendix A]			$1.50	/ cy
Quantity: Estimated Volume; Appendix A		30,900 cy		
5.4 Backfill With Reclaimed Soil				
[Appendix A]			$2.15	/ cy
Quantity: Estimated Volume; Appendix A		45,600 cy		
5.5 Backfill With Clean Fill				
Fill consisting of common earth	[M&E estimate, 1997]		$11.00	/ cy
Quantity: Assumed Volume; Appendix A		50,000 cy		
5.6 Vegetation				
See 2.1			$0.35	/ sy
Quantity: Size of disposal area		35,816 sy		

UNIT COST DEVELOPMENT ITEM				UNIT COST ($ / unit)	UNIT
5.7 Miscellaneous Allowances					
	[Appendix A]				
	Hazardous Waste Disposal	$10,000 ls			
	Dewatering System	$50,000 ls			
	Health & Safety Training, Equipment	$37,000 ls			
	Total	$97,000 ls			
				$97,000	/ ls
Quantity: One lump sum		1 ls			
5.8 Scrap Metal Revenue					
	[Appendix A]			$0.02	/ lb
Quantity: Appendix A; 37,500 cy metal x 800 lb/cy		30,000,000 lb			
5.9 Supervision & Monitoring Labor					
	[Appendix A; assumption]			$300	/ day
Quantity: Appendix A; 114,000 cy @ 1,000 cy/day		114 days			
PERIMETER WETLANDS MITIGATION					
6.1 Wetlands & Buffer Zone replacement					
Assume similar to reference				$80,000	/ acre
	[Figure 1, King and Bohlen, 1994]				
Quantity: Estimated for each Alt.	Alt. #1	0.00 acres			
from figures	Alt. #2	0.00 acres			
	Alt. #3a/3b	0.05 acres			
	Alt. #4a	0.50 acres			
	Alt. #4b	0.50 acres			
	Alt. #5a	0.50 acres			
	Alt. #5b	0.50 acres			
INTERNAL LF GAS COLLECTION SYSTEM					
7.1 Vault, Gauges, Fittings and Other Costs					
Cost Per Well:					
	Precast Concrete Vault & Hatch Door Installed	$3,625 per well	[M&E estimate, 1997]		
	LANDTEC 2" Accu-Flo 200 Vertical Wellhead	$325 per well	[Landfill Control Technolgies]		
	Well Head Installation	$300 per well	[M&E estimate, 1997]		
	Total Cost	$4,250 per well			
				$4,250	/ well
Quantity: Number of wells; Section 3.1.8.3		36 wells			
7.2 Screen, Casing and Other Well Footage Costs					
[Source: Final Report Evaluation of LFG Migration Barrier Systems, M&E, 1993]					
	11" O.D. boring for 4" well	$110 per foot	[ENVEST]		
	Assume 2/3 of well depth is screened, 1/3 is unscreened				
	4" PVC, Schedule 40 well screen	$25 per foot	[ENVEST]		
	x 2/3 =	$17 per foot			
	4" PVC, Schedule 40 well casing	$22 per foot	[ENVEST]		
	x 1/3 =	$7 per foot			
	Well Filter Pack	$44 per foot	[ENVEST]		
	x 2/3 =	$29 per foot			
	Total Direct Cost	$163 per foot			
	Add 20% Overhead & Profit	$196 per foot		$196	/ ft
Quantity: Number of wells x assumed depth of 25 ft		900 ft			

UNIT COST DEVELOPMENT ITEM				UNIT COST ($ / unit)	UNIT
7.3 Header Pipe: HDPE					
Refer to the attached sketches for basis of quantities.					
7.3a	10" HDPE Header Pipe, buried	[M&E estimate, 1997]		$27.60	/ ft
	Quantity:		500 ft		
7.3b	8" HDPE Header Pipe, buried	[M&E estimate, 1997]		$23.60	/ ft
	Quantity:		3,780 ft		
7.3c	6" HDPE Header Pipe, buried	[M&E estimate, 1997]		$18.50	/ ft
	Quantity: 23 wells w/10' connectors (230'), 3 wells w/120' connectors (360'), 6 branch sections (2,300')		2,890 ft		
7.3d	"Blueboard" thermal insulation				
	1" thick by 3' wide	[M&E estimate, 1997]		$1.50	/ ft
	Quantity: Add 7.3a through 7.3c		7,170 ft		
7.3e	HDPE Tees 8" x 8" x 8", installed & buried	[M&E estimate, 1997]		$310	/ ea
	Quantity:		20 total		
7.3f	HDPE Tees 6" x 6" x 6", installed & buried	[M&E estimate, 1997]		$250	/ ea
	Quantity:		22 total		
7.4 Valves & Appurtenances					
Refer to back-up attachments for 7.3					
7.4a	Buried butterfly isolation valves: 10" Header pipeline, 10"	[M&E estimate, 1997]		$2,000	/ ea
	Quantity:		1 total		
7.4b	Buried butterfly isolation valves: 8" Header pipeline, 8"	[M&E estimate, 1997]		$1,600	/ ea
	Quantity:		15 total		
7.4c	LANDTEC GEM-500 LFG analyzer	[Landfill Technologies, 1997 - attached]		$6,395	/ ls
	Quantity:		1 ls		
7.5 Condensate Piping					
Assume 1" HDPE Line	[M&E estimate, 1997]			$5.00	/ ft
Quantity: Refer to backup for 7.3: Alts #3a to 4b			3,020 ft		
	Alts #5a & 5b (GW piping used for some)		1,470 ft		
7.6 Condensate Pump Stations	[M&E estimate, 1997]			$50,000	/ ea
Quantity: Refer to backup for 7.3: Alts #3a to 4b			2 ea		
	Alts #5a & 5b		1 ea		
7.6 Condensate Storage Tank Allowance	[M&E estimate, 1997]			$25,000	/ ea
Quantity: One required			1 ea		
PERIMETER GAS COLLECTION SYSTEM					
8.1 Vault, Gauges, Fittings and Other Costs	See 7.1			$4,250	/ well
Quantity: Number of wells			26 wells		
8.2 Screen, Casing and Other Well Footage Costs	See 7.2			$196	/ ft
Quantity: # of wells x assumed depth of 22 ft			572 ft		

UNIT COST DEVELOPMENT ITEM					UNIT COST ($ / unit)	UNIT
8.3 Header Pipe: HDPE						
Refer to Item 7.3 for basis of quantities.						
8.3a	10" HDPE Header Pipe, buried		[M&E estimate, 1997]		$27.60	/ ft
		Quantity:		3,210 ft		
8.3b	6" HDPE Header Pipe, buried		[M&E estimate, 1997]		$18.50	/ ft
		Quantity: 26 wells w/10' connectors				
				260 ft		
8.3c	"Blueboard" thermal insulation					
		1" thick by 3' wide	[M&E estimate, 1997]		$1.50	/ ft
		Quantity: Add 8.3a to 8.3b		3,470 ft		
8.3d	HDPE Tees 10" x 10" x 6", installed & buried					
			[M&E estimate, 1997]		$430	/ ea
		Quantity:		26 total		
8.4 Valves & Appurtenances						
Refer to back-up for 7.4						
	Buried butterfly isolation valves, header pipeline, 10"					
			[M&E estimate, 1997]		$2,000	/ ea
		Quantity:		3 total		
LF GAS TREATMENT PLANT						
9.1 Access Roads						
8" gravel depth, based on $25/cy					$5.56	/ sy
	[M&E estimate, 1997]					
Quantity: Measured from figs (1900) x 20 ft wide				4,222 sy		
9.2 Electricity Service						
[Source: Approximately Danbury LF, 1997]					$14.00	/ ft
Quantity: Measured from figures				1,600 ft		
9.3 Water Service						
Assume 1" HDPE Line						
	[M&E estimate, 1997]				$5.00	/ ft
Quantity: Measured from figures				1,600 ft		
9.4 Internal and Perimeter Collection System Blowers & Motors						
Blower sizes based on gas stream flows						
Installation costs assumed to be included with Item 9.5					$60,000	/ ls
	[John Zink Quotation, Appendix E]					
Quantity: 2 blowers w/backups in one lump sum				1 ls		

UNIT COST DEVELOPMENT ITEM		UNIT COST ($ / unit)	UNIT
9.5 Enclosed Flare and Appurtenances [John Zink Quotation, Appendix E]			
	Totals		
Enclosed Flare/Controls/Accessories w/Two Inlet Flame Arresters	$90,000		
2 Moisture Separators	$18,000		
2 Automatic Inlet Valves	$3,000		
2 Flow Meters	$7,000		
1 Chart Recorder	$3,300		
1 Autodialer	$3,300		
1 Ladder	$3,500		
1 Hinged Damper	$800		
1 Control Panel Weather Hood	$2,000		
1 Top-Coat Finish	$3,000		
6 Days of Field Construction, Start-Up & Operational Support	$10,500		
Estimated Freight	$5,000		
Installation/Erection [Danbury LF, 1997]	$30,000		
	$179,400	$179,400	/ ea
Quantity: One unit	1 ea		
9.6 Foundation: 18" Structural Slab [M&E estimate, 1997]		$350	/ cy
Quantity: Measured from figures (50x40)	111 cy		
9.7 Photocatalytic Oxidation and Appurtenances [Appendix A; Range: $75,000 to $350,000; use $286000]		$286,000	/ ls
Quantity: One lump sum	1 ls		
9.8 Fence: 8' Chain Link See 1.5		$15.00	/ ft
Quantity: Approximate, measured from figures	400 ft		
GW DEPRESSION SYSTEM: COLLECTION			
10.1 Buried Piping Assume 2" HDPE Line; submersible pump station located at NW corner of Solid Waste Area (condensate also transferred through this pipe) [M&E estimate, 1997]		$8.00	/ ft
Quantity: Measured from figures	1,550 ft		
10.2 Pump Electrical Electrical Utility Service to pumps, buried direct [M&E estimate, 1997]		$4.00	/ ft
Quantity: Measured from figures	1,550 ft		
10.3 Pump Station [M&E estimate, 1997]		$75,000	/ ls
Quantity: One lump sum	1 ls		
10.4 Shallow Drain Piping & Installation Trenching & Gravel Backfill; 4' wide, 12' deep [M&E estimate, 1997]		$40.00	/ ft
Quantity: Measured from figures	1,450 ft		

UNIT COST DEVELOPMENT ITEM		UNIT COST ($ / unit)	UNIT
LEACHATE COLLECTION SYSTEM			
11.1 Buried Piping			
Assume 1" HDPE Line; submersible pump station located near MW-03 well cluster		$5.00	/ ft
See 9.3			
Quantity: Measured from figures	2,100 ft		
11.2 Pump Electrical			
See 10.2		$4.00	/ ft
Quantity: Measured from figures	2,100 ft		
11.3 Pump Station			
[M&E estimate, 1997]		$50,000	/ ls
Quantity: One lump sum	1 ls		
11.4 Shallow Drain Piping & Installation			
See 10.4		$40.00	/ ft
Quantity: Measured from figures	750 ft		
50 GPM WATER TREATMENT PLANT			
12.1 Not Used			
12.2 Not Used			
12.3 Not Used			
12.4 Equipment			
[9/16/96 calculation attached]		$613,500	/ ls
Quantity: One lump sum	1 ls		
12.5 Instrumentation			
[9/16/96 calculation attached]		$58,300	/ ls
Quantity: One lump sum	1 ls		
12.6 Foundation: 18" Structural Slab			
See 9.7		$350	/ cy
Quantity: Measured from figures (150x60)	500 cy		
12.7 Structure: 20' Pre-engineered Building			
[M&E estimate, 1997]		$50.00	/ sf
Quantity: Measured from figures (150x60)	9,000 sf		
12.8 Discharge Line			
See 10.1		$8.00	/ ft
Quantity: Measured from figures	500 ft		
12.9 Groundwater Injection Wells			
[M&E estimate, 1997]		$9,000	/ ea
Quantity: Assumed	5 ea		
12.10 Fence: 8' Chain Link			
See 1.5		$15.00	/ ft
Quantity: Approximate, measured from figures	150 ft		
5 GPM WATER TREATMENT PLANT			
13.1 Not Used			
13.2 Not Used			
13.3 Not Used			

UNIT COST DEVELOPMENT ITEM		UNIT COST ($ / unit)	UNIT
13.4 Equipment			
[9/16/96 calculation attached]		$213,500	/ ls
Quantity: One lump sum	1 ls		
13.5 Instrumentation			
[9/16/96 calculation attached]		$20,289	/ ls
Quantity: One lump sum	1 ls		
13.6 Foundation: 18" Structural Slab			
See 9.7		$350	/ cy
Quantity: Measured from figures (150x60)*0.4	200 cy		
13.7 Structure: 20' Pre-engineered Building			
See 12.7		$50.00	/ sf
Quantity: Measured from figures (150x60)*0.4	3,600 sf		
13.8 Discharge Line			
See 11.1		$5.00	/ ft
Quantity: Measured from figures	500 ft		
13.9 Groundwater Injection Wells			
See 12.9		$9,000	/ ea
Quantity: Assumed	2 ea		
13.10 Fence: 8' Chain Link			
See 1.5		$15.00	/ ft
Quantity: Approximate, measured from figures	150 ft		
ENVIRONMENTAL MONITORING: CAPITAL COST			
14.1 Piezometer Installation			
[M&E Estimate, 1997]		$50	/ ft
Quantity: 5 under SW Area cap at 25' deep; Table 4-3	125 ft		
14.2 Soil Gas Probe Construction		$2,500	/ ea
[M&E Estimate, 1997]			
Quantity: Section 4.1.1.1 & Table 4-3	35 ea		
DECONTAMINATION AREA - TREATMENT PLANT AREA			
15.1 Decon Station Allowance			
[M&E Estimate, 1997]		$50,000	/ ls
Quantity: Assumed	1 ls		
INSTITUTIONAL CONTROLS			
16.1 GW Access Restrictions: Legal Fees			
Assumed one-time labor per lot		$8,000	/ lot
12 hrs @ $65/hr			
32 hrs @ $110/hr			
20 hrs @ $150/hr			
Misc. Expeditures @ $700			
Quantity: 11 potential lots	11 lots		
16.2 Alt. Water Supply Contingency: Municipal Water			
Assumed hook-up fee from water main to residential user		$2,885	/ house
[Jan '93 assumption upgraded to '97 dollars by ENR cost indices]			
Quantity: None at this time	0 houses		

UNIT COST DEVELOPMENT ITEM			UNIT COST ($ / unit)	UNIT
16.3 Alt. Water Supply Contingency: Point-of-Use				
Point-of-Use Treatment System (F.O.B.) [Appendix D]	$2,000 ls			
Plus Engineering/Installation (Appendix D: $500)			$2,500	/ house
Quantity: None at this time		0 houses		
16.4 LFG Control Contingency				
methane sensors: number req'd	2			
unit cost	$1,500 each			
instrumentation/controls allowance	$1,500 LS			
blower(s)/fan(s) number req'd	1			
unit cost	$500 each			
piping & mechanical allowance	$1,000 LS			
slab vents number req'd	5			
unit cost	$500 each			
	$8,500 per house			
[Jan '93 assumptions upgraded to '97 dollars by ENR cost indices]			$9,808	/ house
Quantity: 4 potential houses		4 houses		
ENVIRONMENTAL MONITORING: ANNUAL				
17.1 Five Year Review				
[Assumed]			$25,000	/ ea
Annual Quantity: Once every 5 years		0.20 ea		
17.2 Cap Inspection and Reporting				
Assumed labor per quarterly event			$2,500	/ ea
6 hrs @ $60/hr				
24 hrs @ $85/hr				
Misc. Exp. @ $100				
Annual Quantity: Quarterly		4 ea		
17.3 Groundwater Monitoring - Sample Collection and Analyses				
[9/16/96 calculation attached]			$1,740	/ sample
Annual Quantity: [9/16/96 calc.] - All Alts. but 4b & 5b		51 samples		
Alternatives #4b & #5b include a few more locations:				
Year 1: 46 locations, 4 times per year		184 samples		
Years 2-30: 24 locations, 2 times per year		1,392 samples		
QA/QC @ 10% of total:		158 samples		
		1,734		
Annual Quantity: Over 30 years		58 samples		
17.4 SW/Sediment Monitoring				
[9/16/96 calculation attached]			$2,710	/ sample
Annual Quantity: [9/16/96 calculation attached]		22 samples		
17.5 Ambient Air Monitoring				
[9/16/96 calculation attached]			$1,690	/ sample
Annual Quantity: [9/16/96 calculation attached]		10 samples		
17.6 Soil Gas Monitoring				
[9/16/96 calculation attached]			$83	/ sample
Annual Quantity: [9/16/96 calculation attached]		94 samples		

UNIT COST DEVELOPMENT ITEM			UNIT COST ($ / unit)	UNIT
LANDFILL GAS COLLECTION AND TREATMENT				
18.1 O&M Labor				
	[Source: PSG, Inc.]			
18.1a	Operator @ 1/2 shift/wk		$49	/ hr
	Annual Quantity:	1,040 hrs		
18.1b	Overtime @ 10%		$65	/ hr
	Annual Quantity:	104 hrs		
18.1c	Supervisory @ 10%		$75	/ hr
	Annual Quantity:	104 hrs		
18.1d	Administrative Costs		$4,000	/ ls
	Annual Quantity: One lump sum	1 ls		
18.2 Equipment Repair/Replacement				
	[9/16/96 calculation attached]		$56,476	/ ls
Annual Quantity: One lump sum per year		1 ls		
18.3 Electricity Usage Internal System Blower				
	Assume $0.07 / kWhr & 5 Hp		$0.07	/ kWhr
Annual Quantity: 5 Hp x 0.7457 kW/Hp @ 90% efficiency x				
	24 hrs/day x 365 days/yr	36,291 kWhr		
18.4 Electricity Usage Perimeter System Blower				
	Assume $0.07 / kWhr & 15 Hp		$0.07	/ kWhr
Annual Quantity: 15 Hp x 0.7457 kW/Hp @ 90% efficiency x				
	24 hrs/day x 365 days/yr	108,872 kWhr		
18.5 Condensate Transportation: Internal System				
[Source: Final Report Evaluation of LFG Migration Barrier Systems, M&E, 1993]				
	5,000 gal per trip @	$1,500 per trip	$0.35	/ gal
	(Updated from Jan. 1993 to 1997 costs by ENR indices)			
Annual Quantity: 77 cfm x 125/million cf (Section 3.1.8.2)		5,059 gal		
	Flow from Appendix E			
18.6 Condensate Transportation: Perimeter System				
	See 18.5		$0.35	/ gal
Annual Quantity: 812 cfm x 125/million cf (Section 3.1.8.2)		53,348 gal		
	Flow from Appendix E			
18.7 Condensate Disposal: Internal System				
[Source: Final Report Evaluation of LFG Migration Barrier Systems, M&E, 1993]			$1.44	/ gal
	(Updated from Jan. 1993 to 1997 costs by ENR indices)			
Annual Quantity: See 18.5		5,059 gal		
18.8 Condensate Disposal: Perimeter System				
	See 18.7		$1.44	/ gal
Annual Quantity: See 18.6		53,348 gal		
18.9 Auxiliary Fuel Usage				
	[Appendix E]		$0.02	/ cf
Annual Quantity: [Appendix E] - Basis 15-year average		774,034 cf		
18.10 Photocatalytic Oxidation Operations & Maintenance				
Includes electricity, bulb & catalyst replacement				
	[Appendix A; Range: $900 to $4,500 per month; use $2,318]		$27,816	/ ls
Annual Quantity: One lump sum		1 ls		

UNIT COST DEVELOPMENT ITEM			UNIT COST ($ / unit)	UNIT
GW/LEACHATE COLLECTION & TREATMENT: 50 GPM				
19.1 O&M Labor				
	[Source: PSG, Inc.]			
19.1a	Operator @ 1/2 shift/wk		$49	/ hr
	Annual Quantity:	1,040 hrs		
19.1b	Overtime @ 10%		$65	/ hr
	Annual Quantity:	104 hrs		
19.1c	Supervisory @ 10%		$75	/ hr
	Annual Quantity:	104 hrs		
19.1d	Administrative Costs		$4,000	/ ls
	Annual Quantity: One lump sum	1 ls		
19.2 Feed Chemicals				
	[9/16/96 calculation attached]		$2.00	/ 1,000 gal
Annual Quantity: 50 gpm		26,280,000 gal		
19.3 Equipment Repair/Replacement				
	[9/16/96 calculation attached]		$42,276	/ ls
Annual Quantity: One lump sum per year		1 ls		
19.4 Electricity Usage: Collection				
	Assume $0.07 / kWhr		$0.07	/ kWhr
Assume 2 submersible pumps @ 1 Hp each				
Annual Quantity: 2 x 1 Hp x 0.7457 kW/Hp x				
	24 hrs/day x 365 days/yr @ 90% motor effic.	14,516 kWhr		
19.5 Electricity Usage: Treatment				
	[9/16/96 calculation attached]		$1.65	/ 1,000 gal
Annual Quantity: 50 gpm		26,280,000 gal		
19.6 Disposal of Residuals				
	[9/16/96 calculation attached]		$1.01	/ 1,000 gal
Annual Quantity: 50 gpm		26,280,000 gal		
LEACHATE COLLECTION & TREATMENT: 5 GPM				
20.1 O&M Labor				
	[Source: PSG, Inc.]			
20.1a	Operator @ 1/2 shift/wk		$49	/ hr
	Annual Quantity:	1,040 hrs		
20.1b	Overtime @ 10%		$65	/ hr
	Annual Quantity:	104 hrs		
20.1c	Supervisory @ 10%		$75	/ hr
	Annual Quantity:	104 hrs		
20.1d	Administrative Costs		$4,000	/ ls
	Annual Quantity: One lump sum	1 ls		
20.2 Feed Chemicals				
	[9/16/96 calculation attached]		$0.70	/ 1,000 gal
Annual Quantity: 5 gpm		2,628,000 gal		
20.3 Equipment Repair/Replacement				
	[9/16/96 calculation attached]		$14,967	/ ls
Annual Quantity: One lump sum per year		1 ls		

UNIT COST DEVELOPMENT ITEM			UNIT COST ($ / unit)	UNIT
20.4 Electricity Usage: Collection				
Assume $0.07 / kWhr			$0.07	/ kWhr
Assume 1 submersible pump @ 1 Hp				
Annual Quantity: 1 x 1 Hp x 0.7457 kW/Hp x				
24 hrs/day x 365 days/yr @ 90% motor effic.		7,258 kWhr		
20.5 Electricity Usage: Treatment				
[9/16/96 calculation attached]			$0.55	/ 1,000 gal
Annual Quantity: 5 gpm		2,628,000 gal		
20.6 Disposal of Residuals				
[9/16/96 calculation attached]			$0.35	/ 1,000 gal
Annual Quantity: 5 gpm		2,628,000 gal		
INSTITUTIONAL CONTROLS: ANNUAL COSTS				
21.1 Groundwater Access Restrictions				
Not Applicable				
21.2 Contingency: Municipal Water (Annual Water Bill)				
Water Supply Rate	$3.00 per 1,000 gal	[Town of S. Kingstown & United Water Co. rates]		
Water Usage Rate	130 gal per person per day	[M&E Wastewater Engr, 3rd. Ed., Table 2-1, 1991]		
Household Size:	5 persons			
Water Charges			$712	/ house
Annual Quantity: None at this time		0 houses		
21.3 Contingency: Point-of-Use (Annual Inspections)				
Assumed Maintenance Allowance [1996]			$750	/ house
Annual Quantity: None at this time		0 houses		
21.4 LFG Control Contingency (Annual Inspections)				
Assumed Maintenance Allowance [1996]			$500	/ house
Annual Quantity: 4 potential houses		4 houses		

METCALF & EDDY, INC.

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	of
Subject	Capital Costs --	Comptd. By	D. Peters/S. Czarniecki	Date	September 16, 1996
Detail	Back-up Detail for Unit Costs	Ck'd. By		Date	

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	QUANTITY	COMMENTS
12.4	**EQUIPMENT (INSTALLED) - 50 gpm PLANT**	**ls**	**$613,500**	**1**	**See detailed breakdown below**
12.41	UV/Chemical Oxidation system (F.O.B.)				See Appendix D for detailed quotes
	Vendor quotations:				
A.	Solarchem Environmental Systems; Markham, ONT Canada	ls	$80,000	1	30 kW Rayox™
B.	Ultrox; Santa Ana, CA	ls	$218,000	1	F-1300 system
C.	Peroxidation Systems, Inc. Tucson, AZ	ls	$250,000	1	Model S-135
		Estimated Unit Cost:	$218,000		
12.42	Installation of UV/chemical oxidation system	Estimated Unit Cost:	$8,500	1	Based on Peroxidation Quote
12.43	Design/treatability Testing for UV/chem. system	ls	$10,000	1	Vendor quotes + A/E fees
12.44	Metals precipitation system (F.O.B.)				See Appendix D for detailed quotes
	Vendor quotations:				
A.	U.S. Filter/Lancy Systems & Equipment Warrendale, PA	ls	$365,000	1	
		Estimated Unit Cost:	$365,000		
12.45	Installation of metals precipitation system	hours	$30.00	400	estimated allowance
		Estimated Unit Cost:	$12,000		
12.46	Membrane polishing system for metals treatment (F.O.B.)	Not Included in Final FS			
12.47	Installation of membrane polishing system	hours	$30.00	0	estimated
		Estimated Unit Cost:	$0		allowance
12.5	**INSTRUMENTATION - 50 gpm PLANT**	**ls**	**$58,300**	**1**	**see detail below**
12.51	estimated @ 10.0% of process equipment F.O.B. cost	ls	$21,800	1	UV/chem.
		ls	$36,500	1	metals precip.
		ls	$0	0	membrane polish.

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	1 of 1
Subject	Cost Backup	Comptd. By	S. Czarniecki	Date	09/13/96
Detail	On-site Leachate Treatment System	Ck'd By	D. Peters	Date	09/13/96

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Leachate/groundwater treatment systems were originally sized based on 50 and 200 gpm flow rates in the Draft FS. Sizing for the current leachate treatment system (5 gpm) will be revised as follows.

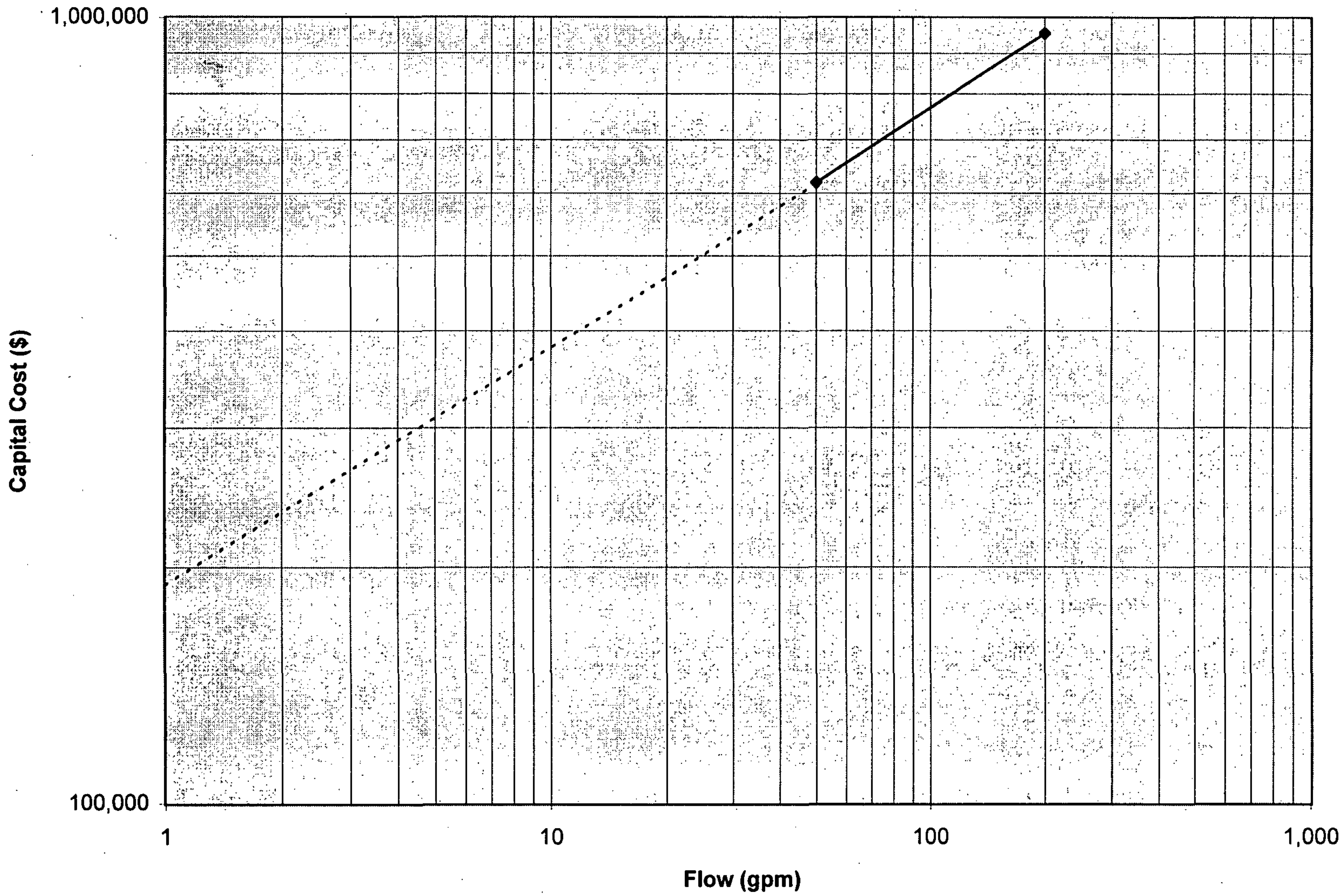
Assumed scaling factor for 5 gpm system from the 50 gpm system - 0.4

As knowledge of system retention time is usually desired, the initial holding tank size will be calculated.

	50 gpm		5 gpm
Precipitation Holding/Equalization Tank	12,000 gal		4,800 gal
		Selected tank size:	5,000 gal
		This results in a holding time of	17 hrs

All other pieces of equipment will be scaled from respective vendor quotations.

Flow vs. Capital Cost



METCALF & EDDY, INC.

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	of
Subject	Capital Costs --	Comptd. By	D. Peters/S. Czarniecki	Date	September 16, 1996
Detail	Back-up Detail for Unit Costs	Ck'd. By		Date	

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	QUANTITY	COMMENTS
13.4	**EQUIPMENT (INSTALLED) - 5 gpm PLANT**	**ls**	**$213,500**	**1**	See attached graph
	SCALE DOWN FACTOR (Use this factor to reduce 50 gpm costs)		34.8%		5 gpm cost/ 50 gpm cost
13.41	UV/Chemical Oxidation system (F.O.B.)	Estimated Unit Cost:	$75,865		
13.42	Installation of UV/chemical oxidation system	ls	$2,958	1	
13.43	Design/treatability Testing for UV/chem. system	ls	$3,480	1	
13.44	Metals precipitation system (F.O.B.)	Estimated Unit Cost:	$127,021		
13.45	Installation of metals precipitation system	hours Estimated Unit Cost:	$30.00 $4,176	139	
13.46	Membrane polishing system for metals treatment (F.O.B.)	Not Included in Final FS			
13.47	Installation of membrane polishing system	hours Estimated Unit Cost:	$30.00 $0	0	
13.5	**INSTRUMENTATION - 5 gpm PLANT**	**ls**	**$20,289**	**1**	**see detail below**
13.51	estimated @ 10.0% of process equipment F.O.B. cost	ls ls ls	$7,586 $12,702 $0	1 1 1	UV/chem. metals precip. membrane polish.

METCALF & EDDY, INC.

Project	Rose Hill FS	Acct. No.	4609-18-10-11	Page	of
Subject	Operations & Maintenance Costs --	Comptd. By	S. Czarniecki	Date	September 16, 1996
Detail	Back-up Detail for Unit Costs	Ck'd. By	D. Peters	Date	September 24, 1996

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ITEM NO.	DESCRIPTION		UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
17.3	**GROUNDWATER MONITORING**		**samples**	**$1,740**	**51**	Annualized over first 30 years
17.31	Number of Quarterly Samples:	Basis:	4 times per year sampling frequency			
	Well Locations - See Table 4-2		43 well locations (at left)			Year 1 total:
	Same as RI		Estimated		172	172 samples
	First Year Only		Annual Qty:			
17.32	Number of Semi-Annual Samples:	Basis:	2 times per year sampling frequency			
	Well Locations - See Table 4-2		21 well locations			
	Same as RI					
	Years 2-30					Years 2-30 total:
			Estimated		42	1,218 samples
			Annual Qty:			
17.33	Number of QA/QC Samples:	Basis:	10% of the collected samples over 30 years			
			sub-total - upgradient + site:		1,390	
			Estimated		139	
			Annual Qty:			
17.34	Analytical Sample Cost:	Basis:				
	Analyses (U.S. EPA - CLP protocol) --					
	TCL organics: volatiles		sample	$200	1	
	TCL organics: semi-volatiles		sample	$400	1	
	TAL inorganics: metals		sample	$250	1	
	-validation allowance		sample	$250	1	
			Estimated Unit Cost:	$1,100		
17.35	Sample Collection Cost:	Basis:	6 man-hours per sample			
	collection labor		hours	$65.00	6	
	misc. costs (shipping, equipment,etc)		sample	$250.00	1	
			Estimated Unit Cost:	$640		Qty · $/unit

METCALF & EDDY, INC.

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
17.4	**SW/SEDIMENT MONITORING**	**samples**	**$2,710**	**22**	Annualized over first 30 years
17.41	Number of Quarterly Samples:				
	Basis:	4 times per year sampling frequency			
	Locations - See Table 4-2	18 locations			Year 1 total:
	Same as RI	Estimated Annual Qty:		72	72 samples
	First Year Only				
17.42	Number of Semi-Annual Samples:				
	Basis:	2 times per year sampling frequency			
	Locations - See Table 4-2	9 locations			Years 2-30 total:
	Same as RI	Estimated Annual Qty:		18	522 samples
	Years 2-30				
17.43	Number of QA/QC Samples:				
	Basis:	10% of the collected samples over 30 years			
		sub-total - upgradient + site:		594	
		Estimated Annual Qty:		59	
17.44	Analytical Sample Cost:				
	Basis:	Assume analytical costs are the same for SW/Sed			
	Analyses ---				
	TCL organics: volatiles	sample	$200	2	
	TCL organics: semi-volatiles	sample	$400	2	
	TAL inorganics: metals	sample	$250	2	
	-validation allowance	sample	$250	2	
		Estimated Unit Cost:	$2,200		
17.45	Sample Collection Cost:				
	Basis:	4 man-hours per sample			
	collection labor	hours	$65.00	4	
	misc. costs (shipping, equipment,etc)	sample	$250.00	1	
		Estimated Unit Cost:	$510		Qty · $/unit

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
17.5	**AMBIENT AIR MONITORING**	**samples**	**$1,690**	**10**	Annualized over first 15 years
17.51	Number of Quarterly Samples:				
	Basis:	4 times per year sampling frequency			
	Locations - See Table 4-3	6 locations (at left)			Year 1 total:
	Year 1 Only	Estimated Annual Qty:		24	24 samples
17.52	Number of Semi-Annual Samples:				
	Basis:	2 times per year sampling frequency			
	Locations - See Table 4-3	4 locations (at left)			
	Years 2-15	Estimated Annual Qty:		8	Years 2-15 total: 112 samples
17.53	Number of QA/QC Samples:				
	Basis:	10% of the collected samples over 20 years			
		sub-total - upgradient + site:		136	
		Estimated Annual Qty:		14	
17.54	Analytical Sample Cost:				
	Basis:				
	Analyses ---				
	TO-14 organics: volatiles	sample	$400	1	
	H2S & sulphur compounds	sample	$220	1	
	methane	sample	$50	1	
	-validation allowance	sample	$250	1	
		Estimated Unit Cost:	$920		
17.55	Sample Collection Cost:				
	Basis:	8 man-hours per sample			
	collection labor	hours	$65.00	8	
	misc. costs (shipping, equipment,etc)	sample	$250.00	1	
		Estimated Unit Cost:	$770		Qty · $/unit

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
17.6	**SOIL GAS MONITORING**	**samples**	**$83**	**94**	Annualized over first 15 years
17.61	Number of Quarterly Samples: Basis: Locations - See Table 4-3 Year 1 Only	4 times per year sampling frequency 2 points per well (deep, shallow) 35 locations (at left) Estimated Annual Qty:		280	a) Source: M&E, 1993. Year 1 total: 280 samples
17.62	Number of Semi-Annual Samples: Basis: Locations - See Table 4-3 Years 2-15	2 times per year sampling frequency 2 points per well (deep, shallow) 18 locations (at left) Estimated Annual Qty:		72	Years 2-15 total: 1,008 samples
17.63	Number of QA/QC Samples: Basis:	10% of the collected samples over 15 years sub-total - upgradient + site: 1,288 Estimated Annual Qty:		129	
17.64	Sample Collection Cost: Basis: collection labor misc. costs (shipping, equipment,etc)	0.5 man-hours per sample hours sample Estimated Unit Cost:	 $65.00 $50.00 $83	 0.5 1	assumes use of hand-held instru-struments only. Qty · $/unit

ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
18.2	**EQUIPMENT REPAIR/ REPLACEMENT**	ls	**$56,476**	1	**See detailed breakdown below**
18.21	Internal LFG collection system:				
	Basis:	25%	of the equipment on a		M&E estimate;
	Processes requiring replacement --	15	year replacement schedule		
	7.1 Vault, Gauges, Fittings	ea	$8,145	128	
	7.2 Well footage costs	lf	$195	3,200	
	7.3 Header Pipe	lf	$51	10,000	
	7.4 Lateral Pipe	lf	$51	1,280	
	7.5 Condensate Piping	lf	$14	3,000	
	7.6 Condensate Holding Tanks	ea	$44,119	2	
		sub-total ($/unit·qty·%):	=	$592,870	
		Estimated Unit Cost:	$39,525		staight line depreciation (÷ yr replaced)
18.22	Perimeter LFG collection system:				
	Basis:	25%	of the equipment on a		M&E estimate
	Processes requiring replacement --	15	year replacement schedule		
	8.1 Vault, Gauges, Fittings	ea	$8,145	26	
	8.2 Well footage costs	lf	$195	390	
	8.3 Header Pipe	lf	$51	1,700	
	8.4 Lateral Pipe	lf	$51	260	
	8.5 Condensate Piping	ea	$14	1,700	
	8.6 Condensate Holding Tanks	ea	$44,119	2	
		sub-total ($/unit·qty·%):	=	$124,870	
		Estimated Unit Cost:	$8,325		staight line depreciation (÷ yr replaced)
18.23	LFG Treatment System:				
	Basis:	100%	of the equipment on a		M&E estimate;
	Processes requiring replacement --	15	year plant replacement		
	9.4 Internal Collection System Blower & Motor	ls	$14,194	1	Costs from prior sections
	9.5 Perimeter Collection System Blower & Motor	ls	$30,200	1	
	9.8 Flare and Appurtenances:	ls	$85,000	1	
		sub-total ($/unit·qty·%):	=	$129,394	
		Estimated Unit Cost:	$8,626		staight line depreciation (÷ yr replaced)

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
19.2	**FEED CHEMICALS - 50 gpm PLANT**	**1,000 US gal**	**$2.00**	**26,280**	**See detailed breakdown below**
19.21	UV/Chemical Oxidation system Vendor quotations for Hydrogen Peroxide:				See Appendix D for detailed quotes
A.	Solarchem Environmental Systems; Markham, ONT Canada	1,000 US gal	$0.15	---	
B.	Ultrox; Santa Ana, CA	1,000 US gal	$0.75	---	includes H2O2 & UV lamp replacement as well as electricity
C.	Peroxidation Systems, Inc. Tucson, AZ	1,000 US gal	$0.47	---	
		Estimated Unit Cost:	$0.40		
19.22	Metals precipitation system Vendor quotations:				
A.	U.S. Filter Warrendale, PA	1,000 US gal	$1.60	---	Includes: caustic, sulfuric acid, ferrous sulfate, polymer, sodium sulfide, sorption filter media
		Estimated Unit Cost:	$1.60		

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
19.3	**EQUIPMENT REPAIR/ REPLACEMENT**	**ls**	**$42,276**	**1**	**See detailed breakdown below**
19.31	Groundwater/Leachate collection system:				
	Basis:	25%	of the equipment on a		M&E estimate
	Processes requiring replacement --	15	year replacement schedule		
	10.1 Buried Piping	lf	$51	1610	
	10.2 Submersible pump	ea	$7,922	2	
	10.3 Drain Piping & Installation	lf	$51	2090	
		sub-total ($/unit·qty·%):	=	$51,136	
		Estimated Unit Cost:	$3,409		staight line depreciation (÷ yr replaced)
19.32	50 gpm Treatment System:				
	Basis:	100%	of the equipment on a		M&E estimate
	Processes requiring replacement --	15	year replacement schedule		
	12.41 UV/Chemical Oxidation system	ls	$218,000	1	Costs from prior sections
	12.44 Metals precipitation system	ls	$365,000	1	
		sub-total ($/unit·qty·%):	=	$583,000	
		Estimated Unit Cost:	$38,867		staight line depreciation (÷ yr replaced)
19.5	**ELECTRICITY USAGE - 50 gpm PLANT**	**1,000 US gal**	**$1.65**	**26,280**	**See detailed breakdown below**
19.51	Electricity usage for UV/Chemical oxidation system Vendor quotations:				Adjusted to $0.07/kWh
A.	Solarchem Environmental Systems; Markham, ONT Canada	1,000 US gal	$0.70	---	
B.	Ultrox; Santa Ana, CA	1,000 US gal	$0.75	---	includes H2O2 & UV lamp replacement as well as electricity
C.	Peroxidation Systems, Inc. Tucson, AZ	1,000 US gal	$3.15	---	
		Estimated Unit Cost:	$1.50		
19.52	Additional plant electrical usage estimated @ 10.0% of UV/chem costs	1,000 US gal	$0.15	---	Based on Peroxidation Quote

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ITEM NO.	DESCRIPTION	UNIT	UNIT COST ($/unit)	ANNUAL QUANTITY	COMMENTS
19.6	**DISPOSAL OF RESIDUALS - 50 gpm PLANT**	**1,000 US gal**	**$1.01**	**26,280**	**Unit Price Based on Feed Water**
19.61	Sludge generation & disposal	1,000 US gal	$1.01	---	M&E estimate based on calculations in Appendix D
20.2	**FEED CHEMICALS - 5 gpm PLANT**	**1,000 US gal**	**$0.70**	**2,628**	
	SCALE DOWN FACTOR (Use this factor to reduce 50 gpm costs)		34.8%		See Capital Costs
20.21	UV/Chemical Oxidation system	estimated:	$0.14		
20.22	Metals precipitation system	total:	$0.56		
20.3	**EQUIPMENT REPAIR/ REPLACEMENT**	**ls**	**$14,967**	**1**	
20.31	Leachate collection system:				
	Basis:	25%	of the equipment on a		
	Processes requiring replacement --	15	year replacement schedule		
	10.1 Buried Piping	lf	$51	900	
	10.2 Submersible pump	ea	$7,922	1	
	10.3 Drain Piping & Installation	lf	$51	640	
		sub-total ($/unit·qty·%):	=	$21,616	
		Unit Cost:	$1,441		
20.32	5 gpm Treatment System:	Estimated Unit Cost:	$13,526		
20.5	**ELECTRICITY USAGE - 5 gpm PLANT**	**1,000 US gal**	**$0.55**	**2,628**	
20.51	Electricity usage for UV/Chemical oxidation system	Estimated Unit Cost:	$0.52		
20.53	Additional plant electrical usage estimated @ 5.0% of UV/chem costs	1,000 US gal	$0.03	---	
20.6	**DISPOSAL OF RESIDUALS - 5 gpm PLANT**	**1,000 US gal**	**$0.35**	**2,628**	
20.61	Sludge generation & disposal	1,000 US gal	$0.35	---	

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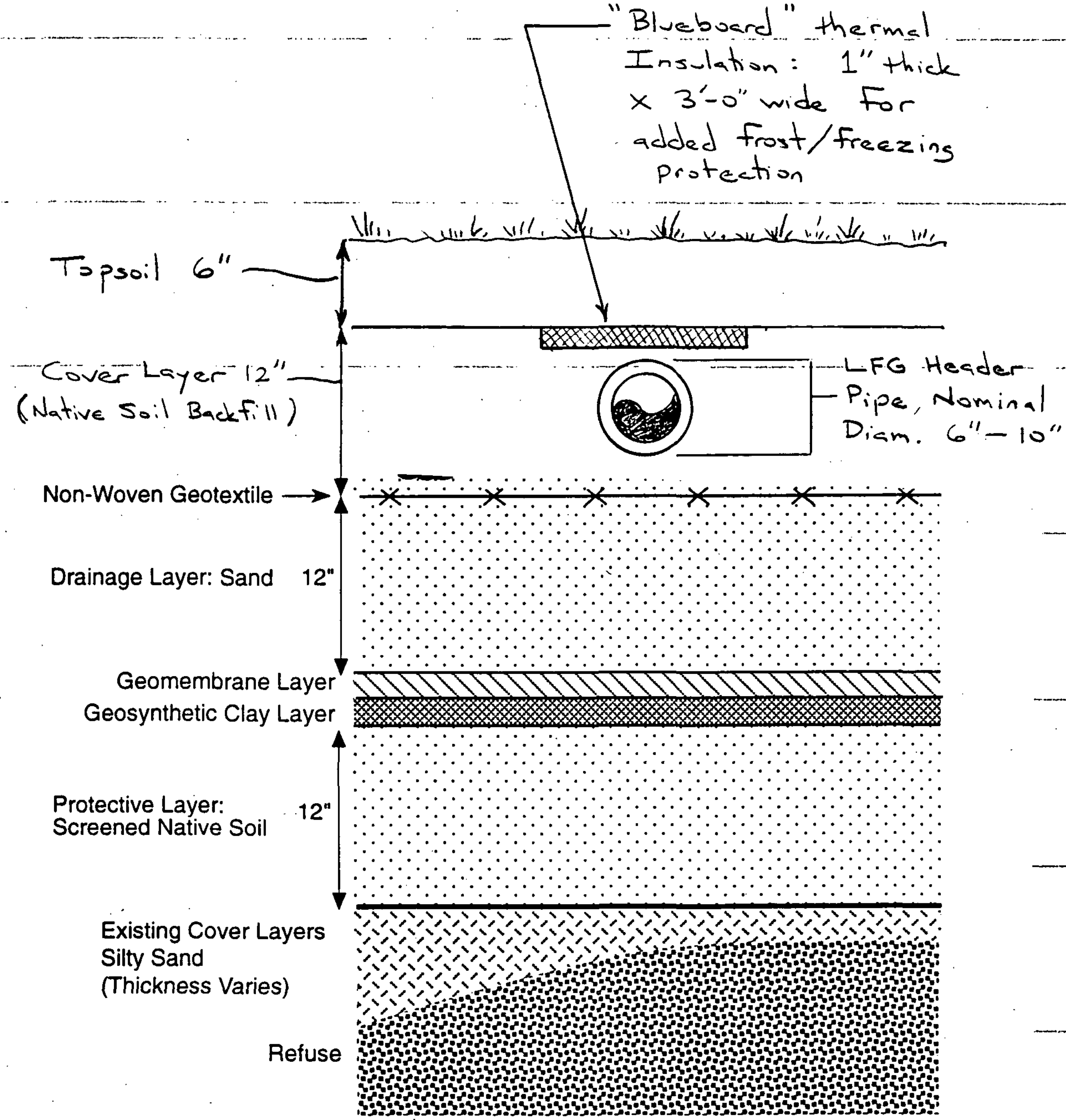
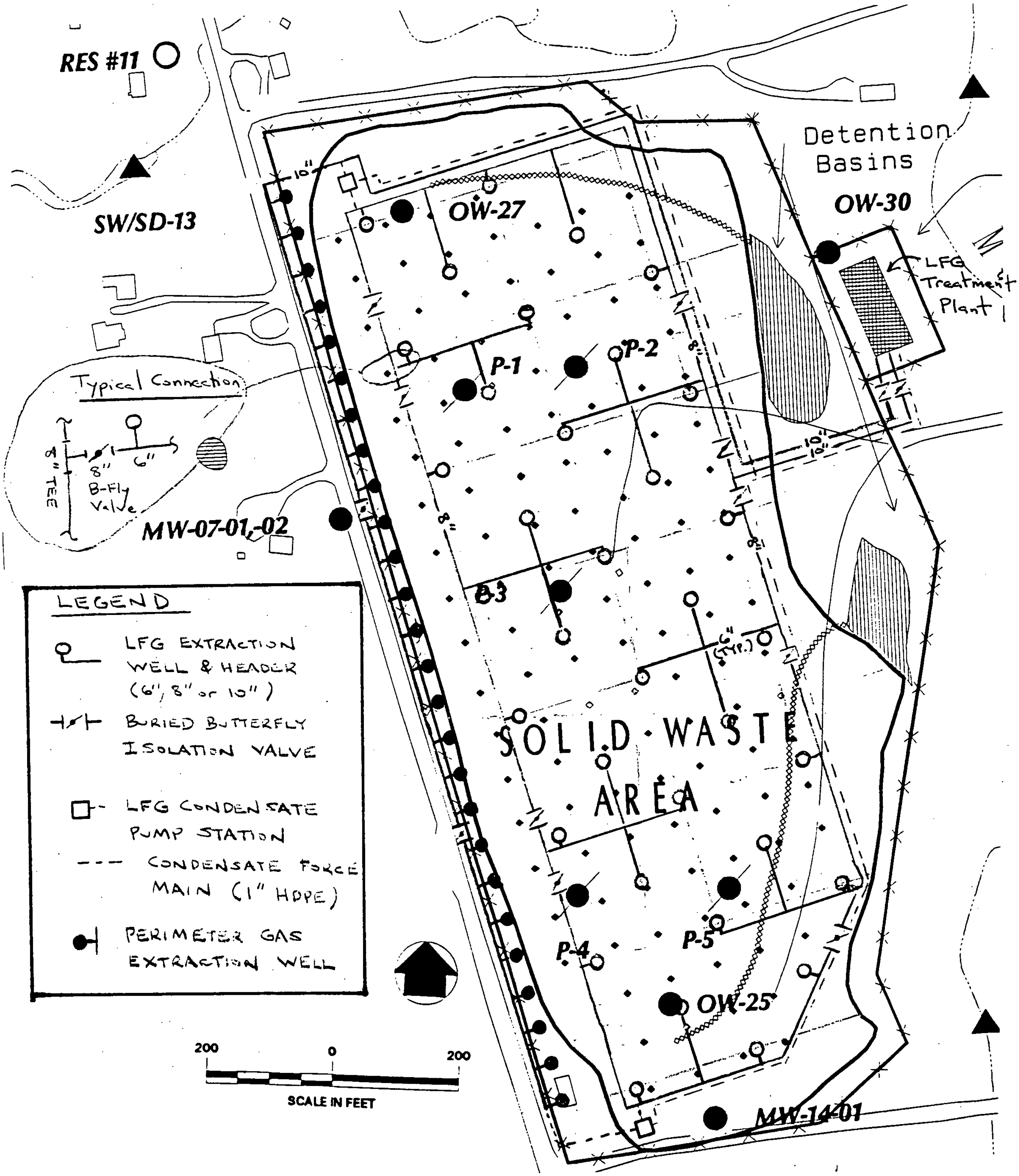
INTERNAL LFG COLLECTION SYSTEM – SOLID WASTE AREA

Item 7.3 Header Pipe : HDPE

Trench Detail – Buried HDPE header pipe (above synthetic liner)





INTERNAL LFG COLLECTION SYSTEM - SOLID WASTE AREA ITEM 7.3 HEADER PIPE : HDPE

METCALF & EDDY

LANDTEC
LANDFILL CONTROL TECHNOLOGIES

Facsimile Transmission

To: Dan Peters
Company: Metcalf & Eddy
Fax No: 781-245-6293
From: Dick Dooly
Date: October 22, 1997
Page: 1 of 7
Re: GEM-500 and Accu-Flo Wellhead Bulletins

Dan:

Here are the bulletine we discussed. Again, list pricing for the GEM-500 is $6,395.00, which includes hoses, filters, soft case, software diskette and cable. List price for the 2" vertical Accu-Flo wellhead with gate valve, quantity of 36, is $325.00 each. We will be faxing you a quote for these items, plus the additional GEM-500 accessories that we discussed.

If you have any further questions, please call our Northeastern Regional Sales Representative, John Johnson, at (800) 390-7745. He's located in Danascus, MD. If you have questions regarding this fax or the quotation, please contact me at (909) 430-3571.

Regards,

Dick Dooly
LANDTEC Sales

LANDFILL CONTROL TECHNOLOGIES
633 W. 5th Street, Los Angeles, CA 90071-2006 (213) 895-5353 (800) 821-0496 fax: (213) 895-5866

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METERING/INSTRUMENTATION
Gas Extraction Monitor

LANDTEC®
Landfill Control Technologies

GEM-500® Integrates Nine Landfill Gas Field Instruments with On-Board Computer

Versatile Analyzer Simplifies LFG Monitoring and Control

The GEM-500 was specifically designed by Landfill Control Technologies (LANDTEC) for use on landfills to monitor landfill gas (LFG) migration control systems, gas extraction systems, flares, migration probes, LEL levels, subsurface fires, and more.

The light-weight, portable unit integrates nine field instruments with an on-board computer. The versatile monitor provides landfill technicians with an array of analysis and computation functions. The results can be stored, printed and later down-loaded to a personal computer to provide error-free data management.

Multi-Functional Features

The GEM-500 automatically samples and analyzes the methane, carbon dioxide and oxygen content of landfill gas. The easy to read LCD screen shows the results as percentages of CH_4, CO_2, O_2 and "balance" gas (typically nitrogen). The GEM-500 also calculates and displays gas flow rate, Btu content, temperature, pressures and LEL (Lower Explosive Limit).

In addition, the user can recall prior data stored at up to 500 monitoring points for contrast with current data. Alarms can easily be set for methane and oxygen.

The GEM-500 can automatically calculate gas flow rates, adjusted to standard temperature and pressure (STP). The results can be displayed in either Imperial (USA) or SI (metric) units.

LANDTEC'S versatile GEM-500 can be used with Orifice plate and Pitot tube meters, but most effectively on LANDTEC's Accu-Flo™ wellheads, which incorporates a built-in precalibrated gas flow meter and quick-connect sample ports.

The Accu-Flo™ wellhead and GEM-500 were designed to work together to expedite the time required to sample and adjust LFG wellheads.

Rugged, User-Friendly Design

The GEM-500 is an all-weather, self-contained portable monitor which uses a self-compensating infrared gas analyzer, rechargeable power supply for all day use, an internal sample pump capable of drawing a gas sample at up to 70" vacuum. WC.

An easy to follow, on-screen menu guides the operator through the sampling process which can be completed in less than a minute. I.D. codes allow the user to store and recall prior measurements for each monitoring point. Preset maintenance codes can be used to note field work required. The stored data can be later retrieved for viewing or down-loaded to a personal computer for use in a database.

Time Saving Conveniences

Users will readily appreciate the built-in, time-saving conveniences provided by the GEM-500 instead of fumbling with data sheets, temperature gauges, flow meters, methane/oxygen/carbon dioxide analyzers, pressure gauges, calculators and other field equipment, the GEM-500 provides it all, and more, in an easy to carry light-weight case.

LANDTEC's Family of Landfill Products

The GEM-500 is part of a family of products developed by LANDTEC for the solid waste industry. These products are based on over a decade of corporate operating and regulatory experience at multiple client sites by LANDTEC's parent, Pacific Energy along with years of field proven reliability and experience.

 Corporate Headquarters 633 West Fifth Street, Suite 4900, Los Angeles, California 90071-2006 U.S.A.
Phone (213) 895-5353, (800) 821-0496, Fax (213) 895-5886

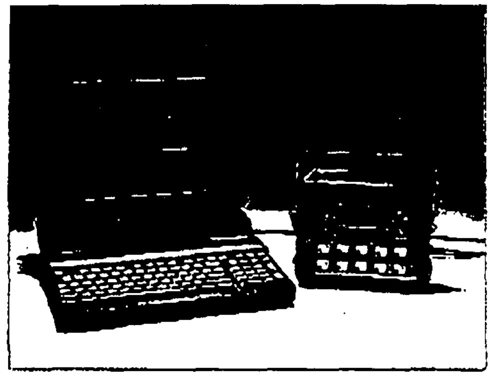
LANDTEC's GEM-500® Analyzer Provides a Convenient Link Between Your Landfill Data and Office Computer

Key GEM-500 Features:

Multi-Functional Analyzer...provides automatic sampling and analysis of gas composition (% by volume CH_4 (100% & LEL), CO_2, O_2 and % remaining gas-balance), temperature, pressures. Also calculates gas flow rates as well as Btu rates.
Diverse Field Applications...monitors migration control systems, gas extraction systems, flares, migration probes, temperatures, and more.
Light-Weight Compact Size...is easy to carry. Weighs less than five pounds.
Quick Analysis...completes sampling and displays gas analysis and flow results in usually less than one minute.
Infrared Gas Analyzer...provides high-tech accurate measurements of methane (CH_4), and carbon dioxide (CO_2).
Reference Beam...provided by infrared analyzer for self compensation.
Durable Oxygen Sensor...provided by the galvanic cell principle, unaffected by other gases such as CH_4, CO_2, or H_2S.
User Friendly On-Screen Menu...guides the user step-by-step through all functions and options available.
PC Data Downloading...provided by RS232 interface with optional software.
Data Storage/Retrieval...stores prior measurements taken for each monitoring point, over 500 monitoring points total.
Prior Date Recall...allows user to recall prior data for each monitoring point.
Methane Analysis...displayed as either $\%CH_4$ by volume or LEL (Lower Explosive Limit).
Durable Construction...built of strong, durable plastic material suitable for harsh landfill environments. Sealed tactile keyboard.
All Weather Use...designed to operate in hot/wet weather extremes from 14°F to 104°F. Weather tight case.
Built-in Adjustable Alarms...allows user to set alarm limits for CH_4 and O_2.
Rechargeable Batteries...provides all day field use.
Battery Check...monitors battery life remaining.
Monitoring Point I.D. Codes...provides alphanumeric identification of monitoring points for data storage and recall.
Maintenance Codes...allows user to note typical maintenance needs using eight preset or eight user defined maintenance codes.
Date/Time Stamp...recorded for all stored data.
Imperial vs. SI Units...displays measurements in Imperial (USA) or SI (metric) units.
Interfaces to LANDTEC Data Management Software...which provides statistical management and reporting of LFG data.
Multiple Flow Meter Analysis...supported to calculate gas flow rates from Accu-Flo™ wellheads, Orifice plates and Pitot tubes.

From: Landfill Field Data

To: Computerized Data Management



Quality Landfill Gas Management Begins with Accurate Field Data Correctly Recorded and Quickly Retrieved

GEM-500 Packs Nine LFG Instruments and Computer into Five Pound Case

The highly accurate and reliable GEM-500 provides field technicians with the most commonly used LFG instrumentation, linked to an on-board computer for quick data calculations, storage and retrieval – all within a compact, all weather case the size of a dictionary.

The GEM-500 was designed by LANDTEC to support the ever-increasing instrumentation requirements of LFG monitoring. The multi-functional unit expedites the analysis and storage of field data. Software allows easy downloading of stored data to a personal computer for further analysis and reporting.

Couple the GEM-500 with a LANDTEC Accu-Flo™ landfill gas wellhead, and field monitoring becomes more accurate and more efficient. With the GEM-500 and Accu-Flo™ combination, you can forget about carrying analyzers for methane, carbon dioxide and oxygen. You can also eliminate handling high and low pressure and temperature sensors, Pitot tube, Orifice plate or other cumbersome flow meters, vacuum pump, flow calculator and data sheets.

GEM-500 Specifications

	Sensor Range Imperial	Resolution Imperial
Methane-CH_4	0-100%	0.1%
Carbon dioxide-CO_2	0-60%	0.1%
Oxygen-O_2	0-25%	0.1%
Pressures (diff)	0-10" W.C.	0.01" H_2O
(static)	0-100" W.C.	0.1" W.C.

GEM-500™ Typical Accuracy

Concentration	% CH_4 by Volume	% CO_2 by Volume	% O_2 by Volume
5% (LEL CH_4)	±0.3%	n.a.	±0.25%
75%	±1.9%	±3.0%	n.a.

Additional Information

Technical information is available on the GEM-500 including product specifications and user instructions. Information is also available on LANDTEC's family of integrated landfill gas/liquid management products including: wellheads, well-bore seals, knock-outs, instrumentation, condensate/leachate treatment, flares and landfill gas management software.

LANDTEC also provides technical and educational literature on specific landfill subjects and issues. Please call our toll free telephone number (800) 821-0496 (8 a.m. - 5 p.m. Pacific Time) for additional information and placement on our mailing list.

SWANA MEMBER

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LANDTEC®
LANDFILL CONTROL TECHNOLOGIES

Accu-Flo™

Series: 150, 200, 300

WELLHEAD
Landfill Gas Control
Patent #5,458,006

Choose Accu-Flo™ Wellheads for Optimum Landfill Gas Control, Accuracy and Dependability

Accu-Flo™ Helps Prevent LFG Migration, LFG Emissions & Subsurface Fires

Landfill owners and operators will appreciate Accu-Flo's™ proven design that meets the special requirements of landfill gas (LFG) recovery for environmental compliance or energy production.

Accu-Flo™ wellheads, developed by Landfill Control Technologies (LANDTEC) provide operators with the gas extraction control necessary to meet more restrictive environmental and safety regulations thus preventing unnecessary and costly violations. Accu-Flo™ helps maximize gas recovery, minimize surface emissions and subsurface migration, helps control hot spots and prevent subsurface fires.

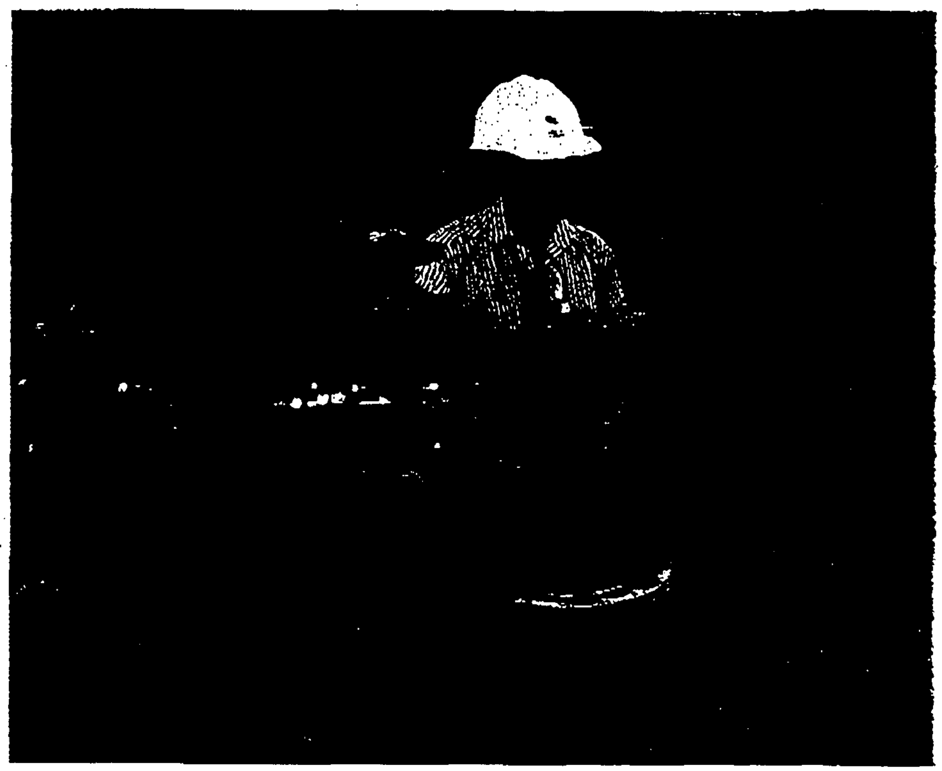
Simplified Data Collection

Accu-Flo™ simplifies the complexity of measuring wellhead data by incorporating key built-in features including a LFG flow measuring device, gas temperature gauge, quick-connect gas sample ports and a flow control gate valve.

The patented design also helps expedite the time required to obtain key wellhead data and determine necessary flow adjustments using either standard field instrumentation or LANDTEC's GEM-500 unit which integrates the function of nine field instruments and a computer into one compact, portable, light weight, simple to operate unit.

Quick and Versatile Installation

The prefabricated Accu-Flo™ assembly is factory tested and is shipped ready for immediate installation – eliminating the cost and uncertainties of field fabricated units. Accu-Flo™ models are available for installation above or below ground on vertical wells or horizontal branch laterals in flows ranging from 1 to over 500 ACFM. The compact patented design allows for installation in small 18" x 24" x 16" vaults.



LANDTEC's Family of Compatible Components

Accu-Flo™ wellheads are one in a group of LANDTEC's family of products designed to work together in an integrated landfill gas management program with other proven LANDTEC products including: well-bore seals, knock outs, pump stations, instrumentation, condensate/leachate treatment, and landfill gas management software.

The versatile GEM-500 is designed to interact with Accu-Flo™ wellheads. The unit analyzes and records the methane, carbon dioxide and oxygen composition of the gas stream, measures static and differential pressures, as well as gas temperature. It calculates Btu content, Btu flow rate, and gas flow rates. One keystroke stores all the measured information from each well which can then be down-loaded to a personal computer.

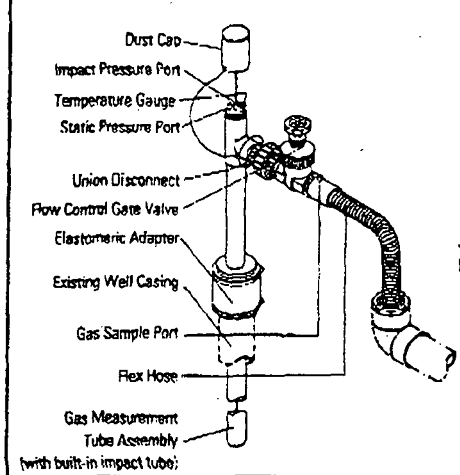
LANDTEC's Approach to Solving Specific Needs

All LANDTEC products are designed to serve the specific needs of the solid waste industry. These products are based on a decade of corporate operating experience applying landfill gas management principles at multiple client sites and sites operated by LANDTEC's parent, Pacific Energy. LANDTEC products are backed by a clear and unconditional warranty that our customers can depend upon.

 Corporate Headquarters 633 West Fifth Street, Suite 4900, Los Angeles, California 90071-2006 U.S.A.
Phone (213) 895-5353, (800) 821-0496, Fax (213) 885-5866

Accu-Flo™ Offers Time-Saving, Multi-Functional Wellheads at Less Than Field Fabrication Prices

Vertical – Accu-Flo well casing configuration



Key Accu-Flo™ Features:

Gas Flow Meter (impact tube design)... The gas measuring assembly incorporates a pre-positioned and modified impact tube within a pre-calibrated measurement tube (Accu-Flo™ body). The assembly extends into a well casing or branch lateral to provide installation compactness.

Temperature Gauge... Provides gas flow temperature required for calculating accurate gas flow rates and detecting subsurface fires.

Gas Pressure Ports... Provides quick-connect, positive sealing convenience when taking impact tube, static and differential pressure measurements.

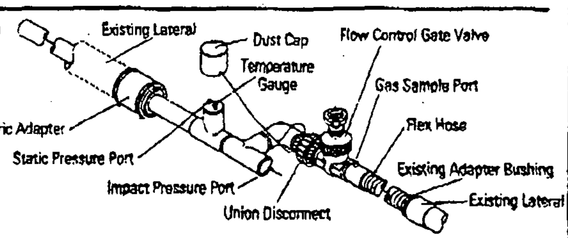
Flow Control Gate Valve... Provides controlled throttling of gas flow and positive shut-off. Incorporates durable PVC construction and inert seal materials.

Gas Sample Port... Provides convenient, quick-connect gas sampling port immediately downstream of the flow control gate valve.

Adapter Bushing... Provides versatile mounting utilizing standard fittings or convenient Accu-Flo™ adapter kits.

Union Disconnect... Provides convenient removal of Accu-Flo™ assembly for inspection or periodic maintenance.

Horizontal – Accu-Flo lateral configuration



Flow Accuracy and Reliability

The Accu-Flo™ system is designed to operate in the wet, abrasive environment typical of landfill gas and still provide exacting control and accurate flow measurements with high dependability and repeatability.

A patented feature of the Accu-Flo™ design is the pre-calibrated gas measurement tube assembly (Accu-Flo™ body) which extends into a standard vertical or horizontal well casing or branch lateral, creating a compact installation.

The measurement tube assembly houses a modified stainless steel impact tube specifically designed by LANDTEC for harsh landfill gas applications. Pressure differential readings between the impact tube and measurement tube are used to calculate flow.

To help protect the impact tube from condensate and particulate clogging, common with conventional designs, Pitot tubes and Orifice ports, LANDTEC uses an enlarged total pressure port opening and a separate protected static pressure port. Also, pre-calibration of the measurement tube with a pre-positioned impact tube eliminates the need to take time-consuming traverse measurements normally required for accuracy.

SWANA MEMBER NSWMA

An involved and contributing member of the Solid Waste Association of North America and the National Solid Waste Management Association.

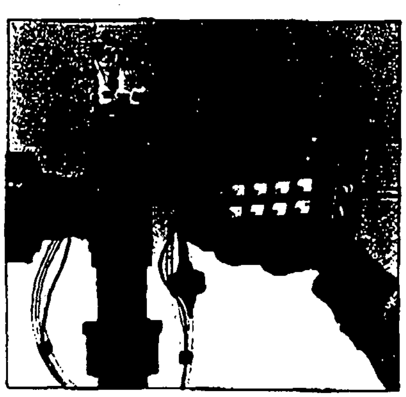
Key Accu-Flo™ Benefits

- Compact size
- Easy installation and maintenance
- Built-in gas flow measurement
- Built-in flow control gate valve
- Quick connect measurement ports
- High accuracy and repeatability of measurements
- Durable Materials: Sch. 80 PVC or PE housing and couplings, stainless steel impact tube, and polypropylene fittings, Elastomer couplings and PVC Flexible interconnects.

Standard Accu-Flo™ Models

Model Size/Dia. Inches		Flow Rate SCFM	Pressure Drop (Inches H_2O)
150	1.5"	0 - 50+	0.1 - 1.5
200	2.0"	5 - 75+	0.1 - 3.5
300	3.0"	10 - 500+	0.1 - 11.5

Specify vertical or horizontal design. Optional adapter kits are available for well casings up to 8" in diameter.



Expedite LFG Measurements with Accu-Flo™ and GEM-500

LANDTEC - Ready To Help You

At LANDTEC we take pride in the quality and experience built into our products. We are equally proud of our warranty and technical support which back these products. As a Pacific Energy company, with a diversity of operating and regulatory experience in gas recovery, we can help you provide practical solutions to your landfill requirements.

Please call our toll free West Coast number 1-800-821-0496 (8 a.m. - 5 p.m.) and ask for a sales engineer to discuss your landfill needs. We're here to help.

Additional Information

Technical information is available on the Accu-Flo™ wellhead including product specifications, installation instructions and drawings.

Additional product information is available on well-bore seals, knock-outs, pump-stations, instrumentation, condensate/leachate treatment, flares and landfill gas management software.

LANDTEC also has technical and educational literature available on specific landfill subjects and issues. Please call for additional information and/or to be placed on our mailing list.

LANDTEC®
Landfill Control Technologies
(800) LANDTEC

Northwest Sales Office
(213) 895-5621, (213) 895-5866 FAX
Southwest Sales Office
(213) 895-5625, (213) 895-5866 FAX
Northeast Sales Office
(703) 425-9894, (703) 425-6026 FAX
Southeast Sales Office
(404) 869-0102, (404) 869-0103 FAX

Printed on Recycled Paper

LANDTEC®
LANDFILL CONTROL TECHNOLOGIES

PRODUCT SPECIFICATIONS

Accu-Flo™

Series: 150, 200, 300

WELLHEAD
Landfill Gas Control
Patent #5,458,006

Accu-Flo™ Description

The patented Accu-Flo™ series wellhead is a prefabricated gas flow control system developed specifically for installation on landfill gas (LFG) management systems. The assembly incorporates a built-in gas flow meter, gas temperature guage, quick-connect gas sample and pressure ports, and flow control gate valve. Models are available for installation above or below ground, on vertical wells or horizontal branch laterals, and for flow rates ranging from one to over 500 cfm (cubic feet per minute). Adapter kits are available for installing Accu-Flo™ wellheads on a multitude of gas well casings or laterals.

Landfill Gas Flow Measurements at Wellheads

Step A – The following measurements should be taken directly at the wellhead using appropriate instrumentation.

- Static Pressure – measure s.p. range, 0-100" W.C., 0.1 resolution.
- Differential Pressure – measure d.p. range, 0-10" W.C., 0.01 resolution.
- Gas Temperature – read built-in thermometer, degrees Fahrenheit, 2.0 resolution.
- Gas Composition – use any port to extract a gas sample of analysis.

Step B – Calculate gas flow volume (SCFM) using one of the following methods:

- Use LANDTEC Chart: Velocity Pressure vs. Flow provided with each wellhead.
- Use LANDTEC GEM-500 (Gas Extraction Monitor) for automatic gas sampling, pressure measurements, analysis, and flow calculations.
- Use LANDTEC's proprietory equations

Accu-Flo™ Maintenance

Accu-Flo™ wellheads are designed to provide maintenance free operation. The quick-connect ports are threaded for easy inspection or replacement. The union disconnect allow convenient removal of the Accu-Flo™ assembly for periodic inspection. The built-in impact tube is mounted to a standard PVC plug for easy removal. Removal of the plug also allows operators to "sound" a gas well to determine the approximate liquid depth within the well casing.

Primary Accu-Flo™ Features and Components

Gas Flow Meter: (Gas Measurement Tube assembly) incorporates a prepositioned, impact tube within a precalibrated (lab certified) measurement tube assembly (Accu-Flo™ body). Assembly can extend into the well casing to provide installation compactness.

Flow Control Gate Valve: Designed for full flow with minimal pressure droo or throttled flow, non-rising stem, positive shut-off gas flow, PVC materials, and a polypropylene wedge.

Impact Tube: Pre-positioned within the gas measurement tube assembly. Mounted to a threaded PVC plug. Stainless steel construction. Design incorporates an enlarged pressure port and a separate static pressure port to protect the tube from particulate and condensate clogging common with conventional Pitot designs used in LFG applications.

Gas Pressure Ports and Sample Port: Provide quick-connect convenience when taking gas samples and impact tube static/differential pressure readings required for calculating gas flow rates. Constructed of polypropylene with Viton seals for positive sealing. Threaded fittings are easily removed for inspection or replacement.

Temperature Gauge: Indicates gas flow temperature on a scale ranging from 0° to 220°F with ±2°F accuracy. Stainless steel probe, plastic water tight dial cover and a recalibration nut. Easily removed from quick-connect fitting for inspection, or other use of fitting.

Flex hose: A 5' long flexible "PVC spa hose" is provided, with all Accu-Flo™ models to connect the outlet of the Accu-Flo™ wellhead to an existing LFG laterial or header.

Dust Cover: Protects sample ports and temperature gauge from the sun and landfill elements.

Accu-Flo™ Compatible Instrumentation and LANDTEC Products

Landfill Control Technologies (LANDTEC) distributes or manufactures the following products that can be used with Accu-Flo™ wellheads:

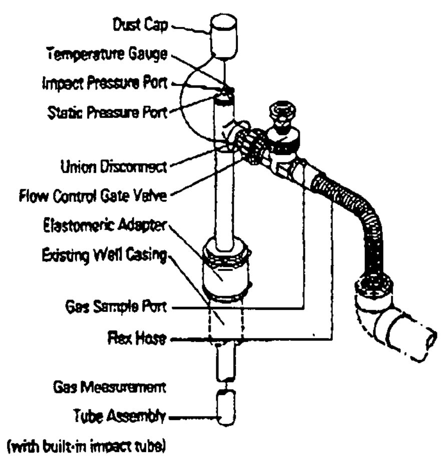
- ***LANDTEC* GEM-500 (Gas Extraction Monitor)** – incorporates nine landfill gas instruments with on-board computer. Data can be downloaded to PC.
- ***LANDTEC* WBS-100™ (Well Bore Seal)** – dense PVC sheeting provides durable, impermeable membrane seal around well casing to prevent well-bore air intrusion and LFG emissions.

TABLE 1
Accu-Flo™ Model Specifications

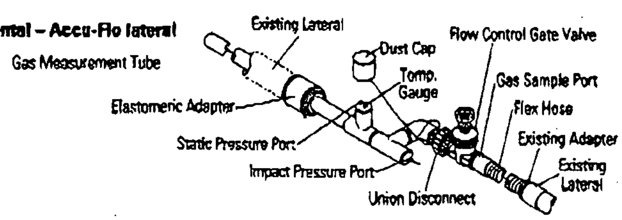
Style	Model No.	Recommended Flow Range C.F.M.	Pressure Drop Flow Range Inches of H_2O	Dimensions A x B	Actual Weight (lbs.)	Shipping Weight (lbs.)
1.5" Vertical	150V	1 Thru 50	0.1 Thru 1.5	16" x 54"	9.6	10.0
1.5" Horizontal	150H	1 Thru 50	0.1 Thru 2.1	10" x 61"	12.3	13.0
2" Vertical	200V	5 Thru 75	0.1 Thru 3.2	16" x 55"	11.6	12.0
2" Horizontal	200H	5 Thru 75	0.1 Thru 3.5	10" x 61"	12.5	13.0
3" Vertical	300V	10 Thru 500	0.1 Thru 11.5 +	23" x 62"	37.5	38.0*
3" Horizontal	300H	10 Thru 500	0.1 Thru 19.0 +	13" x 71"	46.4	47.0*

V = Vertical H = Horizontal *Includes 3" valves shipped separately, weight 22 lbs.
To order basic wellhead without flow measurement element add "NF" to model number.

Vertical – Accu-Flo well casing configuration



Horizontal – Accu-Flo lateral



Accu-Flo™ Wellhead Shipment and Installation

Shipment: Accu-Flo™ wellheads are shipped as a complete assembly, plus separate flex hose (glued fitting).

Installation: Accu-Flo™ wellheads (vertical and horizontal) are installed on top of or extend into 2" through 8" well casing or laterals. Accu-Flo™ wellheads are typically installed on a well casing or branch lateral by using appropriate reducer bushings, couplings, flanges, gaskets and bolts (as required and provided by others) – or by using LANDTEC Installation Adapter Kits.
No special tools are required. Assembly and installation of an Accu-Flo™ wellhead typically takes less than an hour.

Vault Installation: All Accu-Flo™ models can be installed below ground in a vault. Because the patented Accu-Flo™ body can extend into a well casing, installation for models 150 and 200 wellheads can be in vaults as small as 18" x 24" x 16" deep.

Warranty

LANDTEC products are backed by a clear and unconditional warranty. It guarantees that for twelve months after delivery, the product will operate properly and meet design specifications, or we will repair or resolve the problem to the customer's satisfaction, otherwise we will provide a complete refund of the purchase price. Our warranty reflects our commitment to our products and customers.

Accu-Flo™ Product Selection/Order Instructions

To select the proper Accu-Flo™ models and Adapter Kits for a gas collection system, determine:
1) Model Style: Select the "installation style" required for each model, either: **(V) vertical style or (H) horizontal style.**
2) Model Size: Select the "model size" required for each wellhead to meet the design flow and pressure drop requirements by using Table 1 – Accu-Flo™ Model Specifications. Full range pressure drop charts are available upon request for each model:
Model no's. 150V, 150H, 200V, 200H, 300V, 300H.
3) Optional Adapter Kits: To order Adapter Kit, specify well casing size and type (either slip or flange).

Elastomeric Adapter Kit contains: Elastomeric Coupling, Concentric Bushing and Stainless Steel Clamps.

Flange Kit contains: Elastomeric Adapter Kit, Van Stone Flange, Neoprene Gasket and Bolt Kit.

Please call our toll-free number (800) LANDTEC and ask for a Sales Engineer to assist you.

LANDTEC Products, Support Services and Spare Parts

LANDTEC provides full technical support for our products. A spare parts list is provided with each product. Additional information can be obtained on products including: product short and long form CSI specifications, installation instructions and CAD drawings. LANDTEC products are designed to work together in an integrated landfill gas management program with other products which include: wellheads, well-bore seals, knockouts, pump stations, flares, condensate/leachate treatment, field instruments and landfill gas management software.

For additional information or placement on our mailing list, please call our toll free West Coast number (800) 821-0496 (8 a.m. - 5 p.m. PST) and ask for a sales engineer to discuss your landfill needs.

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Northeast Sales Office
(703) 425-9894, (703) 425-6026 FAX
Southeast Sales Office
(404) 869-0102, (404) 869-0103 FAX

Project Acct. No. Page of
Subject Comptd. By Date
Detail Ck'd. By Date

Sean: Cost indices used to upgrade from '93 to '97 dollars

ENR Construction Cost Sept.'97 Index Value
= 5850.69

ENR Construction Cost Jan.'93 Index Value
= 5070.66

Ratio Used = $\frac{5850.69}{5070.66}$ = 1.15383

DP

NONREPRODUCIBLE GRID FORM 145

METCALF & EDDY, ENGINEERS

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-10

DATE: 5/20/93

SUBJECT: Air Monitoring

M&E ENGINEER: D. Abrahamson

OUTSIDE PARTY: Alexis Merideth / Eric Wanager
Air Toxics Limited
(916) 638-9892

MADE CALL (X)
REC'D CALL ( )

COMMENTS

SUMMARY OF CONVERSATION:

What are options for Perimeter Ambient Air monitoring at Rose Hill
Options Depend on Cost, ~~and~~ Detection Limits and Timeliness Required
- Canisters or Sorbents
- On-Site GC
- Optical Remote Sensing

Optical remote sensing is new and experimental and probably expensive
On site ~~GC~~ alternate GC is also probably expensive ~~and~~ and expensive but is very timely
Canisters are the ~~one~~ conventional method but have a long turnaround time
Eric will send me a brochure describing capabilities
Summa Canister Sampling Costs
$270/Sample
$50/Methane
$50/Summa Canister Rental
$50/Flow Control Meter
$420/Sample

CC:

M&E FORM NO. 196 (9/78)

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-9 DATE: 5/20/93

SUBJECT: Air Monitoring at Rose Hill During Remediation

M&E ENGINEER: David Carbonneau OUTSIDE PARTY: Bill Phillips

MADE CALL ( ) Anderson Equipment

REC'D CALL ( ) 1(800) 241-6898

COMMENTS	SUMMARY OF CONVERSATION:
	Anderson furnishes ~~two~~ whole air sampling packages
	87-100 24 hour controlled sampler
	Price is $7,150 requires canisters but
	no other significant operational costs -
	excluding sampling
	Only real time monitors that they provide is for
	particulate
	High vol samplers are more appropriate for pesticides
	and PCB's

CC:

M&E FORM NO. 196 (9/78)

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 1609-18-10-10

DATE: 5/20/93

SUBJECT: Rose Hill Sampling Cost Analytical

M&E ENGINEER: D Carbonneau

OUTSIDE PARTY: Ed Lawler
NET Cambridge Division

MADE CALL ( )

REC'D CALL ( )

COMMENTS

SUMMARY OF CONVERSATION:

Budget Rough Costs For Analytical Work

	List	Discount	Deep Discount
524.2 For Volatiles	300	270	235
TAL Metals	250	230	220
SW-846	450	410	

Do not need many semi-volatile parameters - not much of a discount for limited number of parameters

Acrylamide will either come out with the VOA's in 524.2 or the Semi's in SW-846

CC:

M&E FORM NO. 196 (9/78)

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-10

DATE: 6/2/93

SUBJECT: Rose Hill Cap Cost

M&E ENGINEER: David Carbonneau

OUTSIDE PARTY: Russell Wells
Gundell Lining Systems Inc.
1(800)435-2008

MADE CALL ( )

REC'D CALL ( )

COMMENTS

SUMMARY OF CONVERSATION:

• Cap. Gundell VLT 50 mil
• 1.5 Million SF
$0.56/SF Installed - Assume Union Labor
50% Labor 50% Material

Polyfelt (TS500) $0.52/SY

Health & Safety Premium
Level C 25%
Level D 50%

CC:

M&E FORM NO. 196 (9/78)

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-10

DATE: 6/2/93

SUBJECT: Rose Hill Cap Cost : Geomembrane

M&E ENGINEER: D. Garrounean

OUTSIDE PARTY: Shawn B. McGrath
James Clem Corporation
(410) 712-8402

MADE CALL ( )

REC'D CALL ( )

COMMENTS

SUMMARY OF CONVERSATION:

Budgetary Quote for Geomembrane
Assume: - 36 Acres (1.5 million SF)
- Superfund Site
- Claymax 500SP

Material Cost To R.I. = $0.45/sf
(Includes Freight)

Installation Cost = $0.10/sf to $0.15/sf

Total Installed Cost = $0.60/sf (Includes Overhead and Profit)

Maximum Friction ~~angle~~ angle on Textured VLDPE/Geomembrane Interface = 27°

Strength of stitching reinforcing bentonite = 500psf.

CC:

M&E FORM NO. 196 (9/78)

M&E
METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-10

DATE: June 22, 1993

SUBJECT: Rose Hill FS – Cost Detail: Property Aquisition

M&E ENGINEER: Daniel Peters

MADE CALL (✓) 9:30

REC'D CALL ( )

OUTSIDE PARTY: South Kingstown, RI – Town Hall, P.O. Box 31, 180 High Street Wakefield, RI 02879

COMMENTS

SUMMARY OF CONVERSATION: TEL (401) 789-9331
~~FAX (401) 789-5280~~

9:30 I talked with the Town Assessor re: the following –

1) What is the Tax rate for South Kingstown?
$27.31 / $1,000 property value

2) What is the average housing price in South Kingstown?
unknown, local realtor may know

CC:

M&E FORM NO. 196 (9/78)

METCALF & EDDY, INC.

TELECON MEMORANDUM

JOB NO. 4609-18-10-10

DATE: June 22, 1993

SUBJECT: Rose Hill FS - Cost Detail: Property Acquisition

M&E ENGINEER: Daniel Peters

OUTSIDE PARTY: Ms. Ginny Kearns, Hallmark Realty, 235 Main Street Wakefield, RI 02879

MADE CALL (✓) 10:00

REC'D CALL ( )

COMMENTS

SUMMARY OF CONVERSATION: TEL (401) 783-9611

10:00 I talked with Ginny Kearns, a local realtor in South Kingstown re: average residential prices

- the price can vary significantly ($80,000 - $500,000) depending on area; average price ~~$~~ not known
- I talked w/ Ginny re: prices in the Kingston & Mooresfield districts of South Kingstown .... she will send some information to M&E ("Guide to Homes"); I will follow-up with questions once received.

- site not mentioned → I discussed this project only as an "Engineering Study"

CC:

M&E FORM NO. 196 (9/78)