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Project Site numbers will be proceeded by the following:

Municipal Brownfields - B
Superfund - HW
Spills - SP
ERP - E
VCP - V
BCP - C

932053

Geraay.

DESCRIPTION AND EVALUATION OF SUPPLEMENTAL REMEDIAL ALTERNATIVES

Stauffer Management Company
Niagara Falls Site

Re: for Trmt

- Reduce loadings to gw
- inc. philosophy of perm remedy where Feasible
- Capping = #2.9 mill
- IVES #1.3 mill
-

10/25/91 Understanding letter ...

10/31/91 initial mtg: IVES & Capping redundant AH: 10

1/13/92 2nd (expert) mtg: one well

1/92 :

demonstrate inward grad.: look @ 1, 2, 3 wells

calculated %'s removals

IVES

miss the entire point of Superfund i.e. do what is feasible.

- ☆ 11c + IVES
- ☆ Act. levels < 10ppm Soil
- ☆ Send PRAP

Surface Drainage Control · remove old sewers
· grade site
· cover with Topsoil

DNAPL OW 3-89 · Pump intermittently

(13%)

96
~~32~~
(64,000)

~~170,000 WWTP~~

$64,000 - well install
33,000 - Forcemain
~~125,000~~ - enlarge WWTP - CSP = $394,000 @100 gpm

($222,000) inc gues PumpTest

640

$49,000/year O+M

(24 gpm)

$394,000 = 100gpm

2/20/92

STAUFFER

Chosen Alt
- BR pumping
- IVES
- GRADE STE
- DNAPL

BR pumping — min. 3 wells dependent upon inward gradient control ...
- control inward gradient
- IJC 1987 50% reduct
- Contravention of standards
- Grout curtain may leak.
  NYPA now considering work at Reservoir
- Very high conc. in BR. must also look at 1986 analysis
- Latest maps present 1989 data which shows lower values to west of site

2.3 million

IVES A, B, C, T-4
- possibly only 10± yrs.

1.3 million
- Disposal area (DA's) waste source doubtful.
- Highest soil conc. are at DA's
- DEC considers DA waste as haz.
- LDR's prohibit moving DA's unless conc's can be brought down. Then must go to secure L.F.
- To place on site requires ≈ 2 yr siting procedure. RCRA impoundment
- IVES could bring conc down prior to movement of D.A's.

STAUFFER – Desc. & Eval. of Suppl. Rem. Alt's. (2/19/92)

< 200,000

± 2 min 2 wells

(11 a)
- (1) G.W. extract well
  air stripping
  Disch – Forebay
- Surface Water Controls, 6" Topsoil
- IVES A, B, C, T-4
- DNAPL

$5.1 million
46% GW
24% DNAPL
4% IVES
74% Removal

(11 b)
- (2) GW extract. wells
- Surface Water Control
- Excavate Disposal areas to "A" — 12" common fill / 6" Topsoil
- DNAPL

62% GW
24% DNAPL
2% Nat. Soil/Fill
88% Removal

(11 c)
- (3) GW extract. wells
- Surface Water Controls, 6" Topsoil
- Excavate Disposal areas to "A"
- DNAPL

70% G.W.
24% DNAPL
2% Nat Soil/Fill
96% Removal

STAUFF RECOMMEND: 11 b

DEC Recommend:
- 3 G.W.
- IVES ABC T-4
- Surface Drain Control
- DNAPL Pumping

DESCRIPTION AND EVALUATION OF SUPPLEMENTAL REMEDIAL ALTERNATIVES

Stauffer Management Company
Niagara Falls Site

FEBRUARY 1992

REF. NO. 2365 (13)

CONESTOGA-ROVERS & ASSOCIATES

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1.0 BACKGROUND

During the period from August 1989 to March 1991 an environmental Site investigation was conducted at the site of the former Stauffer Chemical Company Plant in Lewiston, New York. The data from this investigation were compiled and evaluated along with data collected during previous investigations and the results were presented in a report entitled "Final Site Investigation Report" dated April 1991.

A general summary of the conclusions of the Site investigation is presented below:

- The major chemical compounds detected in the different media at the Site are carbon disulfide, chloroform, carbon tetrachloride, trichloroethene, benzene, toluene, tetrachloroethene and methylene chloride.

- Site-related chemicals were detected in the subsurface soils at the Site. Based upon the data, it is estimated that almost all of the chemicals in the soils are located in the following areas: southwestern corner of the Site (Area T-4); the west central portion of the Site (Area A); and the two former landfills located east of the Site (Areas B and C).

- The presence of Site-related chemicals in the groundwater is generally restricted to the western half of the Site and westward towards the Niagara Gorge. The highest parameter concentrations in the groundwater were detected in the Rochester Formation at the northwestern corner of the

Site. West of the Site, the highest concentrations are reported in the deeper hydrogeologic units (Rochester, Irondequoit/Reynales).

- The majority of the chemicals transported off Site in the groundwater are transported via the Rochester Waterbearing Zone (63 percent), the Lockport Formation Upper Waterbearing Zone (14 percent) and the Lockport Formation Lower Waterbearing Zone (15 percent). Only 7.5 percent is transported in the Lockport-Rochester Waterbearing Zone and the remaining 0.5 percent is transported in the lower hydraulic units.

- Small quantities of DNAPL were identified in two of the observation wells (OW3-89) in the Rochester Formation and OW7-89 located in the overburden. The quantity of DNAPL in well OW7-89 was insufficient to obtain a sample for analyses.

- Site-related chemicals were detected in three of the surface water sampling locations adjacent to the Site.

Utilizing available data for the Site, a Risk Assessment was conducted consistent with the United States Environmental Protection Agency (USEPA) guidance document entitled "Risk Assessment Guidance for Superfund, Interim Final", December 1989. The results of the assessment indicate that the most reasonable maximum risk values for carcinogenic compounds at the Site range from 2×10^{-6} to 1×10^{-8}. The non-carcinogenic hazard index values are all below the EPA target limit of 1.0.

The highest calculated risk values were for scenarios with excavation of subsurface soils. Due to the proximity of the Site to the Niagara River and Forebay and the current and future anticipated land uses, the possibility that the groundwater downgradient of the Site will ever be used as a drinking water source is virtually non-existent. Thus, the potential exposure to chemicals in the groundwater is from the ultimate discharge of the groundwater to the Niagara River and its subsequent use and potential exposure to seeps along the Niagara Gorge. The carcinogenic and non-carcinogenic risk for these exposure scenarios is calculated to be below the target limits established by EPA.

A Feasibility Study was conducted in accordance with the following documents:

- "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA", EPA/540/G-89/400, OSWER Directive 9355.3-01, October 1988; and
- "Technical and Administrative Guidance Memorandum (TAGM) for the Selection of Remedial Actions at Inactive Hazardous Waste Sites", NYSDEC, HWR-90-4030, May 15, 1990.

The following remedial action objectives have been identified for the Site:

1. Eliminate or minimize the discharge of hazardous constituents in the groundwater to the Forebay/Niagara River.

2. Reduce concentrations of hazardous constituents within soil and groundwater with time to acceptable State and Federal levels consistent with the anticipated use of the property.
3. Minimize the potential human contact with waste constituents in soils, surface water and seeps.
4. Minimize the potential exposure of workers and nearby residents to chemicals via air pathways.
5. Minimize the need for future remediation and operation and maintenance activities.
6. Eliminate or minimize risks or impacts to natural resources.

The results of the Feasibility Study were presented in the report entitled "Feasibility Study, Stauffer Management Company, Niagara Falls Site" September 1991. A total of ten (10) Site remediation alternatives were evaluated in the Detailed Analysis included in the Feasibility Study report. Stauffer's preferred remedial alternative was Alternative 6, which included:

- treatment of soils utilizing in situ vacuum extraction;
- surface water drainage controls involving elimination of the existing stormwater sewer system, regrading and covering of the Site with clean soils;
- extraction and off-Site treatment of DNAPL from well OW3-89; and
- institutional controls for groundwater use.

This document presents a description and evaluation of three additional alternatives (11a, 11b and 11c).

2.0 ALTERNATIVE DESCRIPTIONS

Three new alternatives (Alternatives 11a, 11b and 11c) were developed for remediation at the Site. These alternatives differ in the number of groundwater extraction wells and the soil remediation technology employed. A description of each of these alternatives is presented below.

Alternative 11a

Alternative 11a includes the following components:

gw

- one groundwater extraction well (EW-2) in the southwestern corner of the Site with an estimated pumping rate of 8 gpm;
- groundwater treatment utilizing air stripping, and carbon adsorption if necessary;
- discharge of treated groundwater via outfall to the Forebay;

sw

- surface water runoff controls which include:
  - removal of the existing tile drains entering the drainage ditch along the southern perimeter of the Site,
  - removal and/or blockage of the existing storm sewer system,
  - grading of the entire Site, with the exception of the existing building foundations, to promote surface water runoff towards the south and east,
  - placing six inches of topsoil over graded areas and revegetation, and
  - discharge of water from the southern drainage ditch via the proposed outfall to the Forebay;

- treatment of subsurface soils in Areas A, B, C and T-4 utilizing in situ vacuum extraction technology; and
- extraction of DNAPL from well OW3-89 with off-Site treatment via incineration.

The components of Alternative 11a are presented on Figure 2.1.

Utilizing hydrogeologic data collected for the Site, calculations were performed to estimate the zone of capture for extraction well EW-2. The calculations are based upon the methodology presented in Todd[1], and Keely and Tsang[2]. A schematic representation of the estimated capture zone and the parameters used in the calculation is presented on Figure 2.2. An inward gradient towards the extraction well would be established over this capture zone. These calculations were based on an estimated pumping rate of 8 gpm.

Following installation of well EW-2, a pump test would be conducted to evaluate the long-term pumping rate and the zone of capture. This information would be used for the design of the groundwater extraction/treatment system.

Utilizing groundwater quality data presented in the Final Site Investigation Report and a batch flushing computer model (see Appendix F of the Feasibility Study), estimated chemical concentrations were calculated for the extracted groundwater (see Table 2.1). Figure 2.3 presents

1 Todd, D,K., Groundwater Hydrology, 2nd Edition. John Wiley & Sons (1980)
2 Keely, J.F., and Tsang, C.F., "Velocity Plots and Capture Zones of Pumping Centers for Groundwater Investigations." Groundwater, V.21, No. 6, pp.701-714 (1983).

the zone of capture for well EW-2 and the monitoring wells utilized in the determination of chemical concentrations in the extracted groundwater.

Alternative 11b

Alternative 11b includes the following components:

- two groundwater extraction wells (EW-2 and EW-3) with an estimated combined pumping rate of 16 gpm;
- groundwater treatment utilizing air stripping, and carbon adsorption if necessary;
- discharge of treated groundwater via outfall to the Forebay;
- surface water runoff controls as described previously for Alternative 11a;
- excavation of materials from the former off-Site landfill locations with chemical concentrations exceeding 10 ppm total VOCs and consolidation of these materials in Area A on Site;
- capping of Area A with 12 inches of common fill and six inches of topsoil; and
- extraction of DNAPL from well OW3-89 with off-Site treatment via incineration.

The components of Alternative 11b are presented on Figure 2.4.

Utilizing the same calculation procedures as discussed for Alternative 11a, the estimated groundwater capture zone for the two well extraction system was determined and is presented on Figure 2.5. Estimated chemical concentrations in the extracted groundwater are presented in Table 2.2.

Pump tests would be conducted on each well following installation; and the extraction system design would be modified as required to obtain an inward gradient over the calculated zone of capture as defined on Figure 2.5.

Since the capture zone includes potential soil remediation Areas A and T-4, and the mass of chemicals in these soils is very small relative to the mass of chemicals in the groundwater, additional soil remediation is not required in these areas. Materials in the former off-Site landfills with total VOC concentrations exceeding 10 ppm would be excavated and consolidated on Site in Area A. Area A would be graded and capped with a permeable soil cover (12 inches common fill and six inches of topsoil) to minimize the potential for air emissions and dermal contact with chemicals in the soils.

Alternative 11c

Alternative 11c includes the following components:

- three groundwater extraction wells (EW-1, EW-2 and EW-3) with an estimated combined pumping rate of 24 gpm;
- groundwater treatment utilizing air stripping, and carbon adsorption if necessary;
- discharge of treated groundwater via outfall to the Forebay;

- surface water runoff controls as described previously for Alternative 11a;
- soil remediation as described previously for Alternative 11b; and
- extraction of DNAPL from well OW3-89 with off-Site treatment via incineration.

The components of Alternative 11c are presented on Figure 2.6.

The estimated groundwater capture zone for the three well extraction system is presented on Figure 2.7 and estimated chemical concentrations in the collected groundwater are presented in Table 2.3.

Pump tests would be conducted on each well following installation, and the extraction system design would be modified as required to obtain an inward gradient over the calculated zone of capture as defined on Figure 2.7.

RG

w/in the Lock/Rock BR fms.

3.0 ALTERNATIVE EVALUATION

Table 3.1 presents the estimated total mass of chemicals in the groundwater, soils and DNAPL at the Site. Based upon these quantities, the relative percentages of the total mass contained in the groundwater, soils and DNAPL are estimated to be 72, 4 and 24 percent, respectively. The following evaluation presents the effectiveness of each alternative for reducing chemical constituents in the different media and meeting the remedial objectives.

It is expected that all three alternatives will be operated for at least 30 years and that groundwater SCGs will not be achieved during this time period.

A summary of the total chemicals removed from each media for Alternatives 11a, 11b and 11c is presented in Table 3.2. Alternative 11a will remove an estimated 74 percent of the total chemicals at the Site (46 percent via groundwater extraction, 24 percent via DNAPL recovery, and 4 percent via in situ vacuum extraction of soils). interesting!

Alternative 11b will remove an estimated 88 percent of the total chemicals at the Site (62 percent via groundwater extraction, 24 percent via DNAPL recovery and two percent via natural soil flushing). Any chemicals in the soils which may leach to the underlying groundwater will be collected via the groundwater collection system. The consolidation of soils with concentrations exceeding 10 ppm VOCs and subsequent cover will eliminate the accessibility of these chemicals for human contact. Infiltration of precipitation into these soils and subsequent collection in the groundwater extraction system will reduce chemical constituents in the soil.

Alternative 11c will remove an estimated 96 percent of the total chemicals at the Site (70 percent via groundwater extraction, 24 percent via DNAPL recovery and two percent via soil flushing). The chemicals in the soils would be reduced in the same manner as described for Alternative 11b above.

Alternatives 11a, 11b and 11c will satisfy the Remedial Action objectives to varying degrees, as follows:

1. Eliminate or minimize the discharge of hazardous constituents in the groundwater to the Forebay/Niagara River.
   - All three alternatives would be consistent with the spirit of the 1987 Declaration of Intent between Canada and the United States to reduce toxic releases to the Niagara River by 50 percent.

2. Reduce concentrations of hazardous constituents within soil and groundwater with time to acceptable State and Federal levels consistent with the anticipated use of the property.
   - All three alternatives would reduce chemical constituents in groundwater.
   - Alternative 11a would reduce chemical constituents in soil via vacuum extraction.
   - Alternatives 11b and 11c would reduce the chemical constituents in soil via natural flushing.

- All three alternatives would remove DNAPL as a source of chemicals to the groundwater.
- All three alternatives are not expected to achieve groundwater SCCs within a 30 year operating period.

3. Minimize the potential human contact with waste constituents in soils, surface water and seeps.
   - All three alternatives would eliminate chemicals from entering the Site storm sewers and ditches; and eliminate the potential for human contact with chemicals in the surface water runoff.
   - All three alternatives would minimize the potential for human contact with chemicals in the soil at the Site.
   - All three alternatives would minimize the potential for chemical migration to the north of the Site via groundwater flow.
   - All three alternatives will reduce the potential for human contact with chemicals in seeps by removing chemicals from the groundwater.

4. Minimize the potential exposure of workers and nearby residents to chemicals via air pathways.
   - All three alternatives would minimize the potential long-term exposure of workers and residents to chemicals via air pathways.
   - Controls would be required to minimize short-term exposure during excavation, handling and grading of soils from the former landfills for Alternatives 11b and 11c.

5. Minimize the need for future remediation and operation and maintenance activities.

   - All three alternatives address DNAPL, groundwater and soils.
   - Long-term operation and maintenance would be required for groundwater extraction and groundwater treatment operations for all alternatives.
   - Alternatives 11b and 11c remove a lesser percentage of chemicals from the soils than Alternative 11a; however, due to the relatively small volume of chemicals in the soils and existence of the groundwater extraction system, the potential need for future soil remediation in these areas is very small.

6. Eliminate or minimize risks or impacts to natural resources.

   - All three alternatives would reduce risks by reducing the chemical loading from the Site to the Forebay/Niagara River.

Cost estimates for alternatives 11a, 11b and 11c are presented on Tables 3.3, 3.4 and 3.5 respectively. The estimated total present worth costs for alternatives 11a, 11b and 11c are $5,140,000 $4,780,000 and $5,170,000 respectively.

4.0 RECOMMENDATION

As presented in Section 5.0 of the Feasibility Study, Alternative 6, which includes institutional controls for groundwater; surface water runoff drainage controls; in situ soil vacuum extraction and DNAPL recovery, is considered to be the most cost effective remedial alternative for the Site considering the relatively low carcinogenic risk levels ($\leq 6.6 \times 10^{-8}$ for Level 2 risks) associated with chemicals in the groundwater. This alternative would reduce all potential carcinogenic risks to levels less than 1.0×10^{-6}.

However, in order to meet the desired 50 percent reduction in chemical loading to the Niagara River as defined in the 1987 Declaration of Intent between Canada and the United States, it is recommended that Alternative 11b be implemented at the Site. This alternative will remove an estimated 88 percent of the chemicals at the Site and meet all of the remedial objectives. All potential carcinogenic risks will be much less than 1.0×10^{-6}. This alternative has the added benefit of not requiring installation of long-term extraction wells on property owned by others, such as EW-1 for Alternative 11C which is located on property owned by New York Power Authority, and hence Alternative 11b is much easier to implement. The small incremental reduction of total chemicals for Alternative 11c relative to Alternative 1lb (8 percent), does not justify the large increase in cost (about $0.4 million) and the increased difficulties and delays in implementation and increased operation and maintenance associated with Alternative 11c.

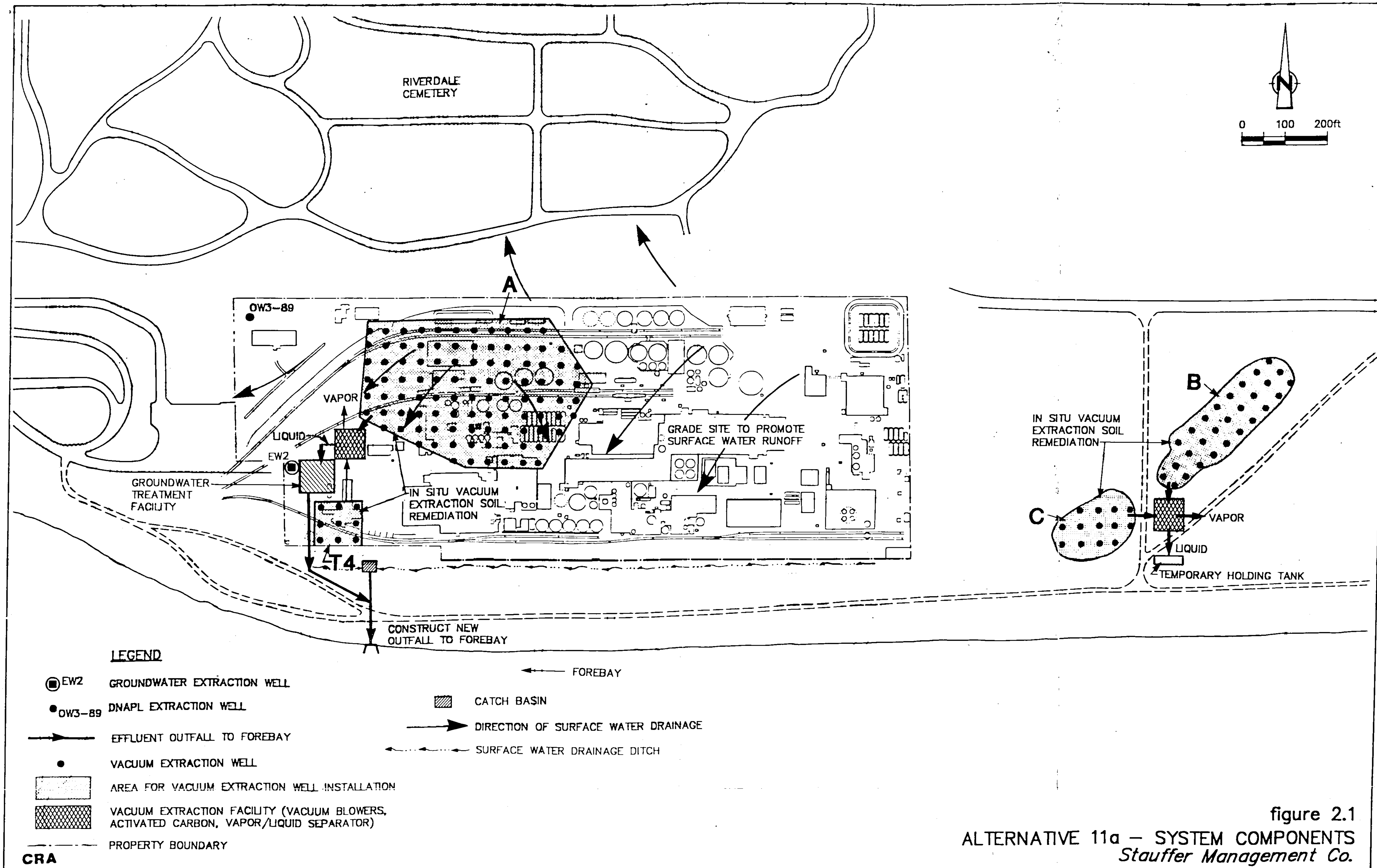

figure 2.1

ALTERNATIVE 11a – SYSTEM COMPONENTS

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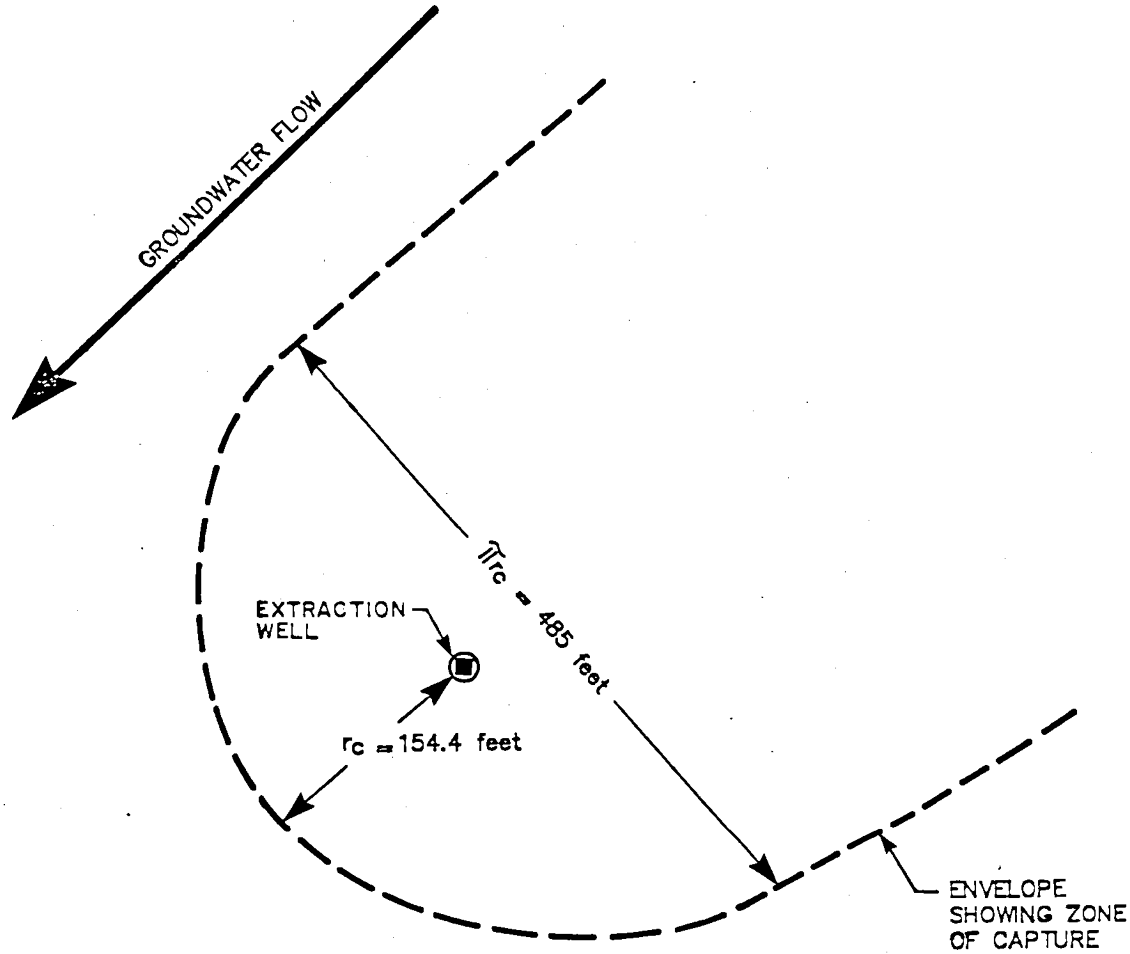
2365(13)-FEB.14/92-REV.0



$$r_c = \frac{Q^{(1)}}{2\Pi Ti}$$

r_c = distance to downgradient stagnation point (feet)

Q = pumping rate (ft^3/day) = 8 gpm 8 gpm x 1440 min/d = 11520 gpd / 7.48 gal/cf = 1540 cf/d

T = transmissivity (ft^2/day) = 52.9 ft^2/day

i = average hydraulic gradient (ft/ft) = 0.03 ft/ft

$$r_c = \frac{1540\ ft^3/day}{2\Pi\ (52.9\ ft^2/day)\ (0.03\ ft/ft)}$$

= 1540 / 9.97 = 154.5 ft.

r_c = 154.4 feet

Πr_c = maximum width of zone of capture parallel to the extraction well and perpendicular to groundwater flow

Πr_c = 485 feet

(1) Todd, D.K., Groundwater Hydrology, 2nd Edition, John Wiley & Sons, (1980)
Keely, J. F. and Tsang, C.F., "Velocity Plots and Capture Zones of Pumping Centers for Groundwater Investigations." Groundwater, V.21, No. 6, pp.701–714 (1983)

figure 2.2

SCHEMATIC DIAGRAM SHOWING ZONE OF CAPTURE

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CRA

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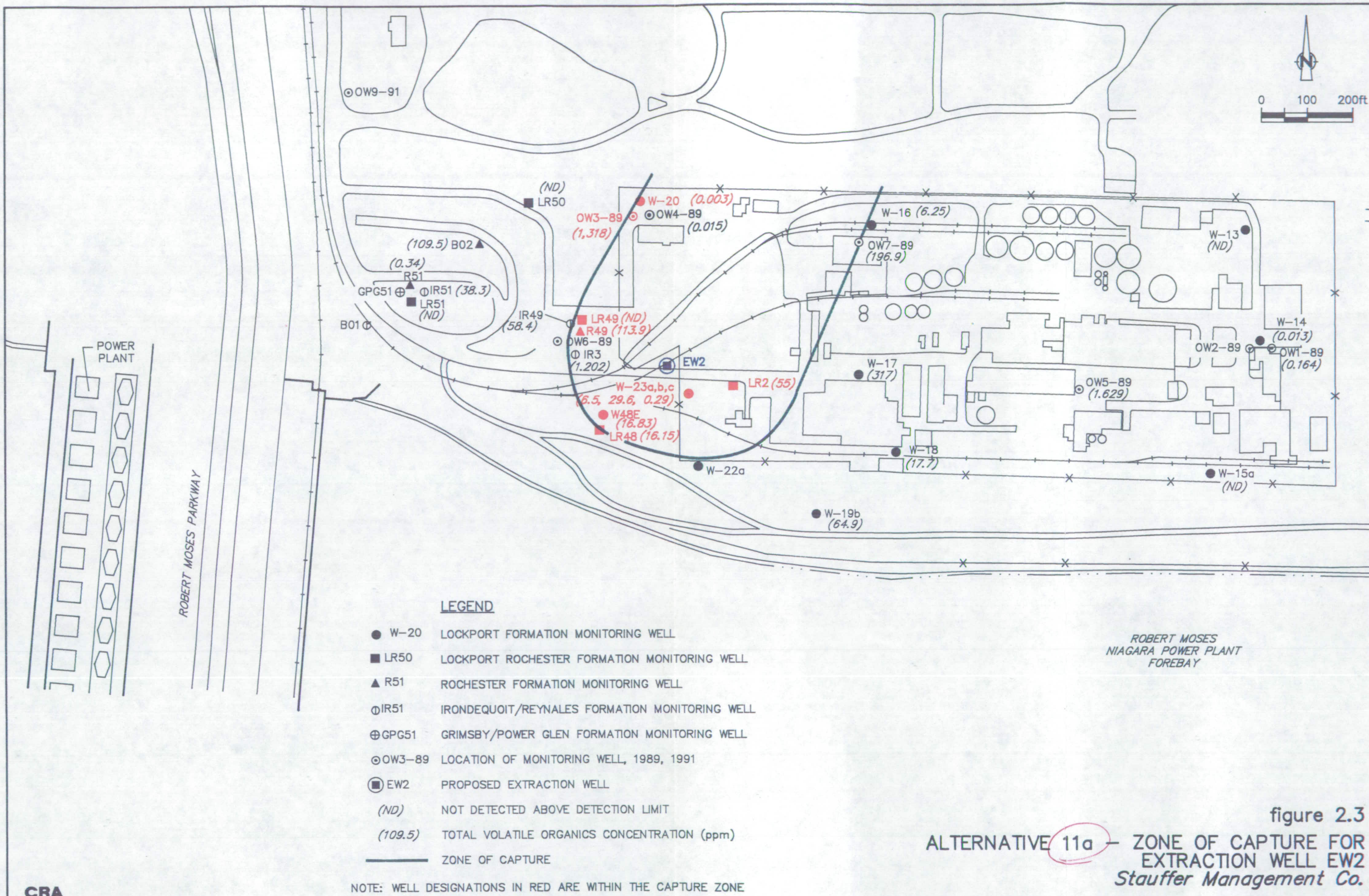

figure 2.3

ALTERNATIVE 11a – ZONE OF CAPTURE FOR EXTRACTION WELL EW2

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2365(13)–FEB.13/92–REV.0 (P–29)

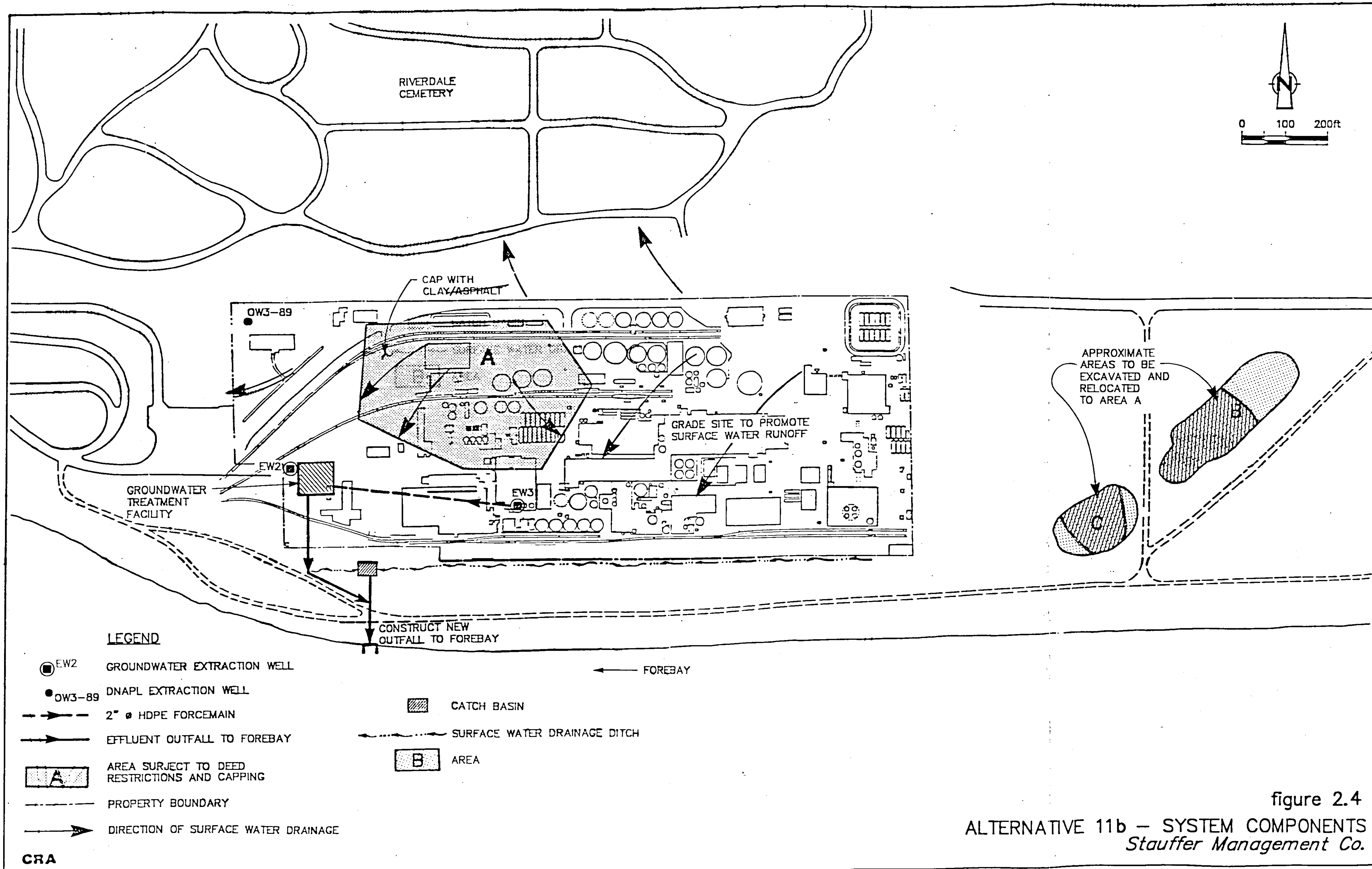

figure 2.4

ALTERNATIVE 11b – SYSTEM COMPONENTS

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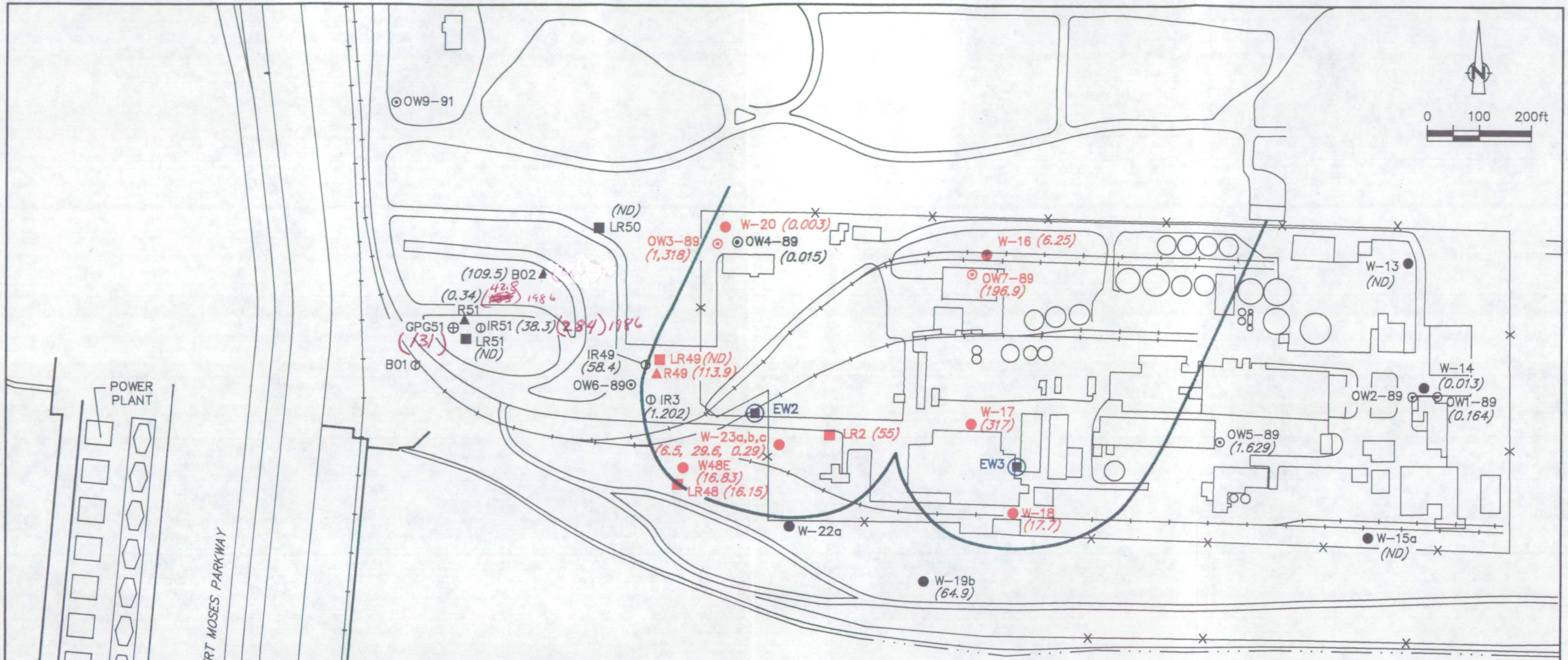
Rev 2-21-92



LEGEND

● W-20	LOCKPORT FORMATION MONITORING WELL
■ LR50	LOCKPORT ROCHESTER FORMATION MONITORING WELL
▲ R51	ROCHESTER FORMATION MONITORING WELL
⦶ IR51	IRONDEQUOIT/REYNALES FORMATION MONITORING WELL
⊕ GPG51	GRIMSBY/POWER GLEN FORMATION MONITORING WELL
⊙ OW3-89	LOCATION OF MONITORING WELL, 1989, 1991
▣ EW2	PROPOSED EXTRACTION WELL
(ND)	NOT DETECTED ABOVE DETECTION LIMIT
(109.5)	TOTAL VOLATILE ORGANICS CONCENTRATION (ppm)
———	ZONE OF CAPTURE

GPG51 (1986)

NOTE: WELL DESIGNATIONS IN RED ARE WITHIN THE CAPTURE ZONE.

CRA

2365(13)-FEB.13/92-REV.0 (P-28)

figure 2.5

ALTERNATIVE 11b - ZONE OF CAPTURE FOR EXTRACTION WELLS EW2 AND EW3

Stauffer Management Co.

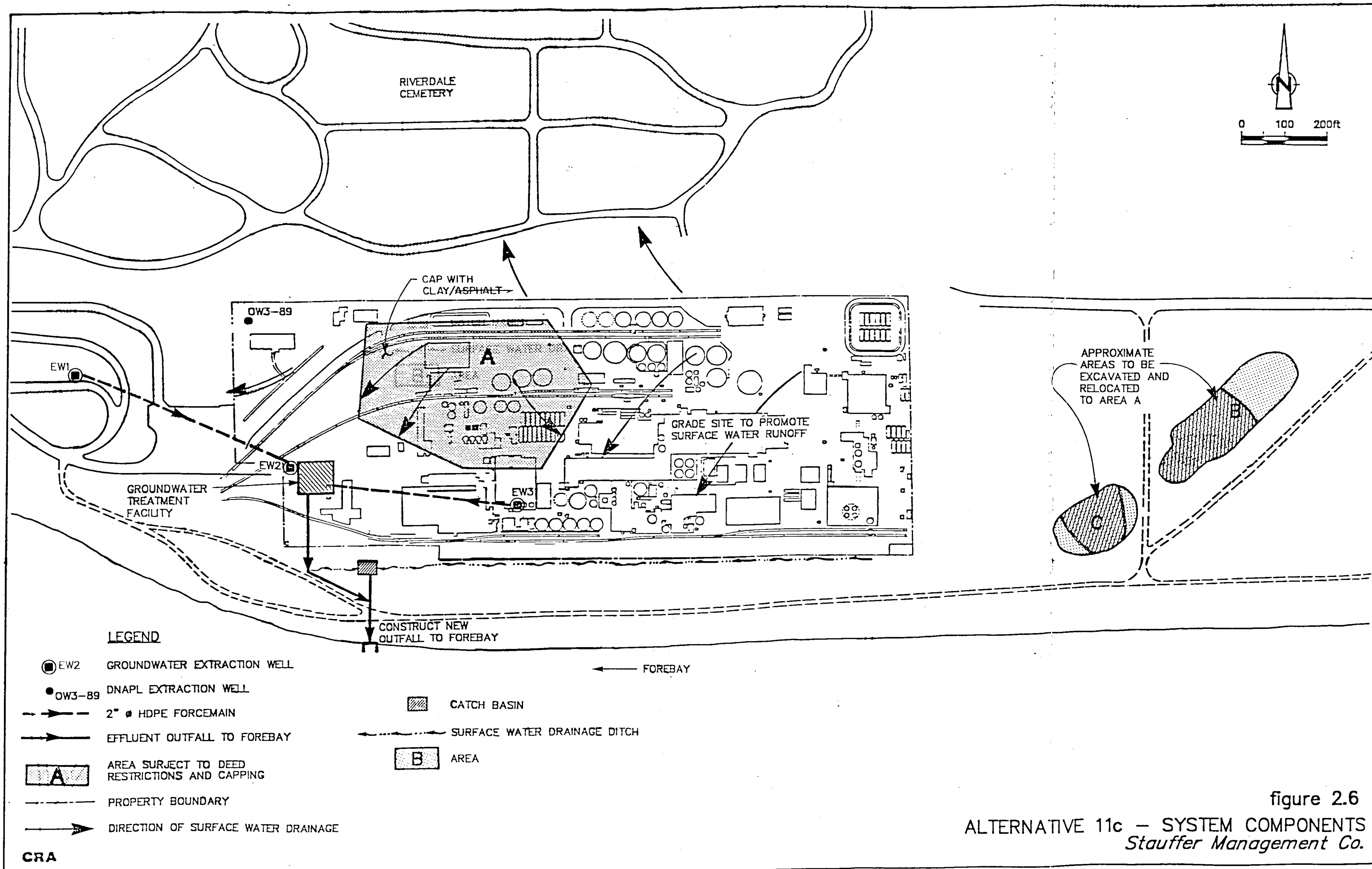


figure 2.6

ALTERNATIVE 11c – SYSTEM COMPONENTS

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Rev. 2-21-92

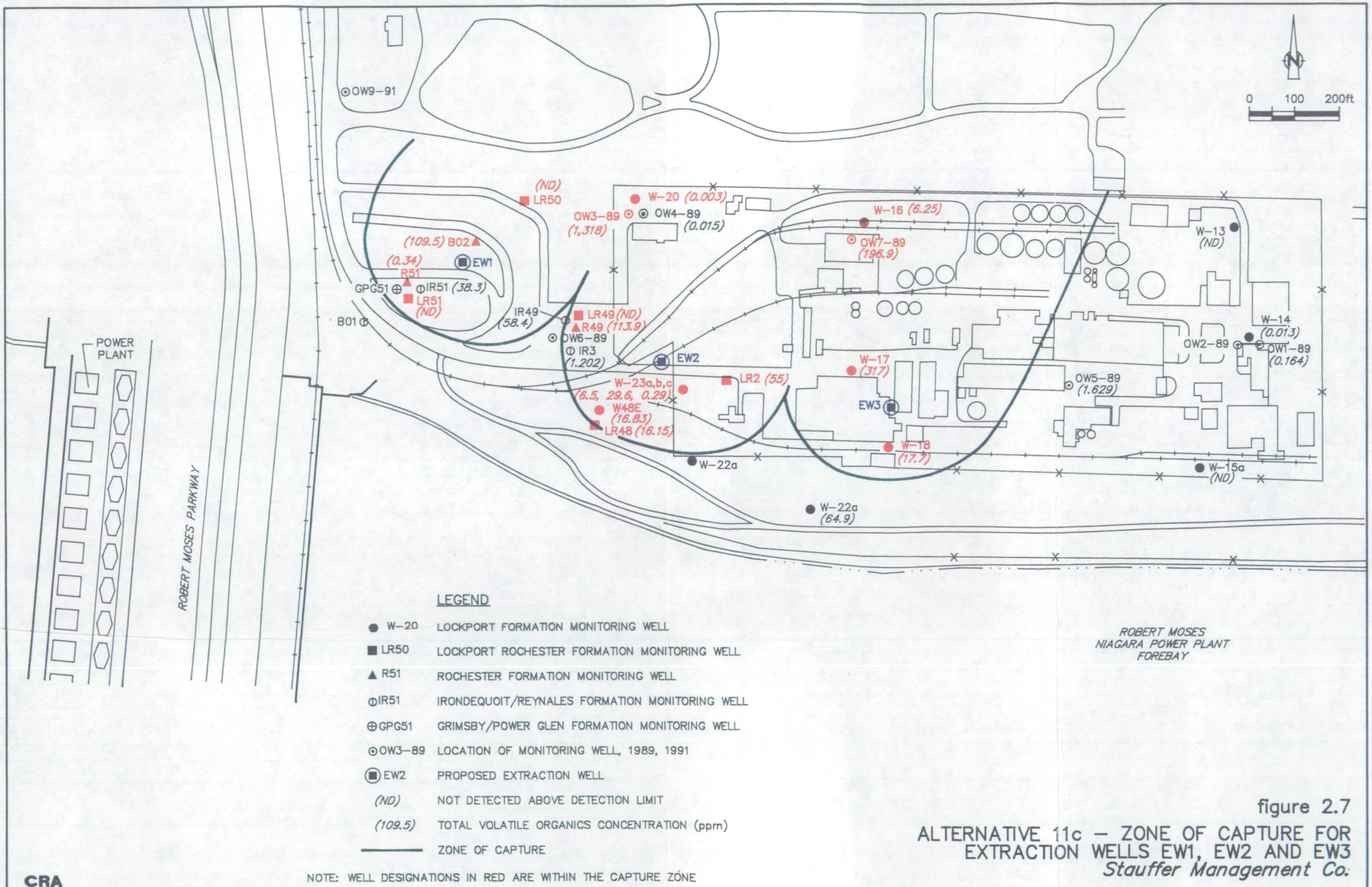

figure 2.7

ALTERNATIVE 11c – ZONE OF CAPTURE FOR EXTRACTION WELLS EW1, EW2 AND EW3

Stauffer Management Co.

2365(13)–FEB.13/92–REV.0 (P-27)

TABLE 2.1

SUMMARY OF ESTIMATED INFLUENT CONCENTRATIONS FOR ALTERNATIVE 11a
EXTRACTION WELL EW2
STAUFFER MANAGEMENT CO. SITE

Time (years)	*Carbon Disulfide (μg/L)*	*Carbon Tetrachloride (μg/L)*	*Chloroform (μg/L)*	*Methylene Chloride (μg/L)*	*Tetrachloroethene (μg/L)*	*Trichloroethene (μg/L)*	*Benzene (μg/L)*	*Toluene (μg/L)*	*Total (lbs.)*
2.5	55	15,400	23,500	13	318	216	1,250	0	3,575
5.0	1,030	6,870	50,400	1,020	152	88	326	33	5,257
7.5	232,000	219,000	49,300	99	72	36	71	26	43,910
10.0	68,600	119,000	8,220	7.2	33	15	14	15	17,185
12.5	13,500	43,500	952	0.5	16	5.9	2.6	7.8	5,086
15.0	2,230	13,200	93	0.03	7.1	2.4	0.5	3.8	1,368
17.5	330	3,620	8.2	0.01	3.3	1.0	0.08	1.8	348
20.0	46	924	0.7	<0.01	1.5	0.4	0.01	0.8	85
22.5	6	225	0.05	<0.01	0.7	0.2	<0.01	0.4	20
25.0	0.8	53	<0.01	<0.01	0.3	0.07	<0.01	0.2	5
27.5	0.09	12	<0.01	<0.01	0.1	0.03	<0.01	0.07	1
30.0	<0.01	2.7	<0.01	<0.01	0.06	<0.01	<0.01	0.03	0.2
Total (lbs.)	27,880	37,000	11,620	100	54	32	146	8	76,840

TABLE 2.2

SUMMARY OF ESTIMATED INFLUENT CONCENTRATIONS FOR ALTERNATIVE 11b
EXTRACTION WELLS EW2 AND EW3
STAUFFER MANAGEMENT CO. SITE

Time (years)	*Carbon Disulfide (µg/L)*	*Carbon Tetrachloride (µg/L)*	*Chloroform (µg/L)*	*Methylene Chloride (µg/L)*	*Tetrachloroethene (µg/L)*	*Trichloroethene (µg/L)*	*Benzene (µg/L)*	*Toluene (µg/L)*	*Total (lbs)*
2.5	267.5	7,740	11,815	172	159	108	960	0	3,720
5.0	24,765	35,935	34,200	656	376	104	264	18.0	16,900
7.5	123,700	148,250	29,570	108	297	1,508	268	18	53,300
10.0	35,865	77,500	4,890	11	186	912	102	12.5	21,000
12.5	7,013	27,950	565	0.95	106	371	28.3	7.55	6,320
15.0	1154.5	8,420	55	0.06	57.0	126	6.75	4.15	1,720
17.5	170.5	2,299	4.85	0.04	29.6	38.5	1.44	2.15	447
20.0	23.75	586	0.4	0.01	14.8	11.2	0.30	1.05	112
22.5	3.1	143	0.03	0.01	7.35	3.05	0.05	0.55	27.6
25.0	0.41	33.5	0.01	0.01	3.55	0.84	0.01	0.25	6.77
27.5	0.05	7.6	0.01	0.01	1.70	0.22	0.01	0.14	1.71
30.0	<0.01	2.7	0.01	0.01	0.06	0.01	0.01	0.03	0.5
Total lbs.	33,800	54,300	14,200	166	217	558	285	11.3	103,556

TABLE 2.3

SUMMARY OF ESTIMATED INFLUENT CONCENTRATIONS FOR ALTERNATIVE 11c
EXTRACTION WELLS EW1, EW2 AND EW3
STAUFFER MANAGEMENT CO. SITE

Time (years)	*Carbon Disulfide (µg/L)*	*Carbon Tetrachloride (µg/L)*	*Chloroform (µg/L)*	*Methylene Chloride (µg/L)*	*Tetrachloroethene (µg/L)*	*Trichloroethene (µg/L)*	*Benzene (µg/L)*	*Toluene (µg/L)*	*Total (lbs.)*
2.5	1365	5393	12877	604	106.5	72	640	0	5,540
5.0	35,677	29,890	30,900	821	255	69	483	12	25,820
7.5	86,300	101,000	20,700	134	201	1,005	402	12	55,200
10.0	24,483	52,260	3,351	13.7	126	608	146	8.3	21,310
12.5	4,752	18,779	384	1.2	72.2	247	39.2	5.0	6,390
15.0	779	5,647	37.2	0.08	38.7	84	9.2	2.8	1,740
17.5	115	1,540	3.3	0.03	20.1	26	1.96	1.4	450
20.0	16	392	0.4	0.01	10	11.25	0.31	1.1	113
22.5	2.1	95	0.03	0.01	7.4	3.0	0.05	0.55	29
25.0	0.3	22	0.01	0.01	3.6	0.84	0.01	0.25	7
27.5	0.05	7.6	0.01	0.01	1.7	0.21	0.01	0.14	3
30.0	0.01	2.7	0.01	0.01	0.06	0.01	0.01	0.03	1
Total (lbs.)	40,390	56,590	17,960	420	220	560	450	11	116,600

TABLE 3.1

DISTRIBUTION OF CHEMICALS

Medium	*Estimated Chemical Mass (lbs)*	*Percent of Total Mass (%)*
Groundwater	120,000	72
Soils	7,280	4
DNAPL	40,000*	24
	167,280	

Footnote:

* - mass of DNAPL based upon one 55-gallon drum per 2 months for 10 years and a DNAPL density of 1.5.

TABLE 3.2

SUMMARY OF ALTERNATIVE EFFECTIVENESS EVALUATION

	Alternative		
	11a	*11b*	*11c*
Groundwater			
• total mass removed (lbs)	76,800	103,500	116,600
• % of total mass in this medium removed	64%	86%	97%
Soils			
• total mass removed (lbs)	6,400*	3,600**	3,600**
• % of total mass in this medium removed	88%	50%	50%
• reduction in chemical mobility	--	Yes	Yes
DNAPL			
• total mass removed (lbs)	40,000***	40,000***	40,000***
% Removal of Total Chemical Mass at Site	74%	88%	96%

Footnotes:

* Based upon removal efficiency of 90 percent for IVES

** Based upon an estimated 50% removal of chemicals in the soils via soil flushing over a 30 year period.

*** Based upon an estimated DNAPL removal rate of one 55-gallon drum per two months for 10 years

Notes:

1. Total chemical mass in groundwater is estimated to be 120,000 lbs
2. Total chemical mass in soil is estimated to be 7,280 lbs

TABLE 3.3

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11a
ONE GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Quantity*	*Unit*		*Unit Cost*	*Cost*
Capital Costs					
1. In Situ Vacuum Extraction System (IVES)					
a) Removal and Disposal of Concrete Foundations in Areas A and T4	--	L.S.	$	--	$ 400,000
b) Pilot Study - 8 pilot IVES wells - well testing with mobile IVES unit	--	L.S.		--	180,000
c) IVES Design and Construction - 150 extraction wells - 2 vacuum blowers/manifold	--	L.S.		--	515,000 1,095,000
d) Operation and Maintenance (2 Years) - carbon - power - IVES Monitoring System	--	L.S.		--	205,000 ÷ 2 = annual 102,500
	Item 1 Subtotal				$ 1,300,000
2. Extraction Well					
a) Installation of Extraction Well (EW2)	1	Each	$	12,000	$ 12,000
b) Pump Test	--	L.S.		--	20,000
	Item 2 Subtotal				$ 32,000
3. Water Treatment System					
a) Construction of Water Treatment Facility	--	L.S.	$	--	$ 335,000
b) Forcemain Construction (2"Ø/6"Ø double wall)	450	L. ft.		51.20	23,000
c) Construct Outfall to Forebay for Discharge of Treated Water	--	L.S.		--	45,000
	Item 3 Subtotal				$ 403,000
4. Surface Water Drainage Controls					
a) Plug and Inactivate Existing Storm Sewer System	--	L.S.	$	--	$ 50,000
b) Site Grading for Surface Water Drainage Control	--	L.S.		--	450,000
	Item 4 Subtotal				$ 500,000
5. DNAPL Collection System for OW3-89 - dedicated pump, tubing, control unit and compressor	--	L.S.		--	8,000
	Item 5 Subtotal				$ 8,000
	Estimated Capital Costs				$ 2,240,000
	Engineering (20%)				448,000
	Sub-Total				$ 2,690,000
	Contingency (20%)				538,000
	Total Estimated Capital Costs (1)				$ 3,230,000

Notes:

(1) Total estimated cost has been rounded to 3 significant figures.

TABLE 3.3

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11a
ONE GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Quantity*	*Unit*	*Unit Cost*	*Cost*
<u>*Operation and Maintenance Costs*</u>				
1. Groundwater Monitoring				
a) 15 monitoring wells analyzed for SSPL compounds annually	1	Round	$ 14,000	$ 14,000
b) groundwater levels - monthly (1)	12	Round	1,500	18,000
2. Surface Water Monitoring				
- one surface water location analyzed for SSPL compounds annually	1	Round	500	500 ✓
3. Seep Monitoring				
- 7 monitoring locations analyzed for SSPL compounds annually	1	Round	4,000	4,000
4. Air Sampling of Overburden Monitoring Wells Northwest of the Site				
- 3 sample locations analyzed for SSPL compounds annually (2)	1	Round	5,200	5,200
5. Extraction System Monitoring				
a) extraction wells				
• analyze for SSPL compounds annually	1	Round	1,000	1,000
b) discharge point from treatment facility				
• analyze for SSPL compounds monthly	12	Round	1,000	12,000
6. DNAPL Collection and Off-Site Incineration	12	Month	700	8,400
7. Operation and Maintenance				
a) Water Treatment System Operation				
i) electrical	--	L.S.	--	5,000
ii) carbon (3)	--	L.S.	--	35,000
iii operation	--	L.S.	--	75,000
				115,000
8. Annual Monitoring Report	--	L.S.	--	10,000
9. Site Evaluation (every 5 years) (4)	--	L.S.	--	40,000
Estimated Annual Operation and Maintenance Costs				$ 228,000
Contingency (20%)				$ 45,600
Total Estimated Annual Operation and Maintenance Costs (5)				$ 274,000

TABLE 3.3

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11a
ONE GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Cost*
Total Present Worth	
Monitoring and Site Maintenance (discount factor of 10% for 30 years)	$ 530,000
Treatment System Operation and Maintenance (discount factor of 10% for 30 years) (6)	1,320,000
Site Evaluation (discount factor of 10% every 5 years for 30 years)	61,800
Capital Cost	3,230,000
	$ 5,140,000

Notes:

(1) Groundwater levels will be measured monthly for the first year of monitoring. For each additional year, groundwater levels will be measured annually.
(2) Air sampling will occur for the first 5 years of the 30-year monitoring program.
(3) Annual carbon cost is average annual cost for years 1 to 10 based upon the following relationship:

$$\text{carbon cost} = \text{total influent chemical mass} \times \frac{\text{100 lb carbon}}{\text{40 lb chemicals}} \times \$2$$

(4) Site evaluation will occur every 5 years during the 30-year monitoring program.
(5) Total estimated cost has been rounded to 3 significant figures.
(6) Total present worth for carbon usage based upon average annual costs for time periods 0 to 10 years, 10 to 20 years and 20 to 30 years as computed per note (3) above.

TABLE 3.4

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11b
TWO GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Quantity*	*Unit*		*Unit Cost*		*Cost*
Capital Costs						
1. Excavation of Landfill Materials and Consolidation on Site						
a) Removal and Disposal of Concrete Foundations in Area A	--	L.S.	$	--	$	400,000
b) Excavation, transportation and consolidation of landfill materials on Site	12,600	yd3		16		202,000
c) Covering Area A with 12 inches of common fill, 6 inches of topsoil	144,000	ft2		1.20		173,000
	Item 1 Subtotal				$	775,000
2. Extraction Well						
a) Installation of Extraction Well (EW2 and EW3)	2	Each	$	12,000	$	24,000
b) Pump Test	2	Each		20,000		40,000
	Item 2 Subtotal				$	64,000
3. Water Treatment System						
a) Construction of Water Treatment Facility	--	L.S.	$	--	$	420,000
b) Forcemain Construction (2"Ø/6"Ø double wall)	650	L.F.		51.20		33,300
c) Construct Outfall to Forebay for Discharge of Treated Water	--	L.S.		--		45,000
	Item 3 Subtotal				$	498,000
4. Surface Water Drainage Controls						
a) Plug and Inactivate Existing Storm Sewer System	--	L.S.	$	--	$	50,000
b) Site Grading for Surface Water Drainage Control	--	L.S.		--		450,000
	Item 4 Subtotal				$	500,000
5. DNAPL Collection System for OW3-89						
- dedicated pump, tubing, control unit and compressor	--	L.S.		--		8,000
	Item 5 Subtotal				$	8,000
	Estimated Capital Costs				$	1,850,000
	Engineering (20%)					370,000
	Sub-Total				$	2,220,000
	Contingency (20%)					444,000
	Total Estimated Capital Costs (1)				$	2,660,000

Notes:

(1) Total estimated cost has been rounded to 3 significant figures.

TABLE 3.4

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11b
TWO GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Quantity*	*Unit*	*Unit Cost*	*Cost*
Operation and Maintenance Costs				
1. Groundwater Monitoring				
a) 15 monitoring wells analyzed for SSPL compounds annually	1	Round	$ 14,000	$ 14,000
b) groundwater levels - monthly (1)	12	Round	1,500	18,000
2. Surface Water Monitoring				
- one surface water location analyzed for SSPL compounds annually	1	Round	500	500
3. Seep Monitoring				
- 7 monitoring locations analyzed for SSPL compounds annually	1	Round	4,000	4,000
4. Air Sampling of Overburden Monitoring Wells Northwest of the Site				
- 3 sample locations analyzed for SSPL compounds annually (2)	1	Round	5,200	5,200
5. Extraction System Monitoring				
a) extraction wells				
• analyze for SSPL compounds annually	1	Round	2,000	2,000
b) discharge point from treatment facility				
• analyze for SSPL compounds monthly	12	Round	1,000	12,000
6. DNAPL Collection and Off-Site Incineration	12	Month	700	8,400
7. Operation and Maintenance				
a) Water Treatment System Operation				
i) electrical	--	L.S.	--	10,000
ii) carbon (3)	--	L.S.	--	47,500
iii) operation	--	L.S.	--	85,000
				143,000
8. Annual Monitoring Report	--	L.S.	--	10,000
9. Site Evaluation (every 5 years) (4)	--	L.S.	--	40,000
	Estimated Annual Operation and Maintenance Costs			$ 257,000
	Contingency (20%)			$ 51,400
	Total Estimated Annual Operation and Maintenance Costs (5)			$ 308,000

TABLE 3.4

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11b
TWO GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Cost*
Total Present Worth	
Monitoring and Site Maintenance (discount factor of 10% for 30 years)	$ 530,000
Treatment System Operation and Maintenance (discount factor of 10% for 30 years) (6)	1,530,000
Site Evaluation (discount factor of 10% every 5 years for 30 years)	61,800
Capital Cost	2,660,000
	$ 4,780,000

Notes:

(1) Groundwater levels will be measured monthly for the first year of monitoring. For each additional year, groundwater levels will be measured annually.
(2) Air sampling will occur for the first 5 years of the 30-year monitoring program.
(3) Annual carbon cost is average annual cost for years 1 to 10 based upon the following relationship:

$$\text{carbon cost} = \text{total influent chemical mass} \times \frac{100 \text{ lb carbon}}{40 \text{ lb chemicals}} \times \$2$$

(4) Site evaluation will occur every 5 years during the 30-year monitoring program.
(5) Total estimated cost has been rounded to 3 significant figures.
(6) Total present worth for carbon usage based upon average annual costs for time periods 0 to 10 years, 10 to 20 years and 20 to 30 years as computed per note (3) above.

TABLE 3.5

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11c
THREE GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Quantity*	*Unit*	*Unit Cost*	*Cost*
Capital Costs				
1. Excavation of Landfill Materials and Consolidation on Site				
a) Removal and Disposal of Concrete Foundations in Area A	--	L.S.	$ --	$ 400,000
b) Excavation, transportation and consolidation of landfill materials on Site	12,600	yd3	16	202,000
c) Covering Area A with 12 inches of common fill, 6 inches of topsoil	144,000	ft2	1.20	173,000
	Item 1 Subtotal			$ 775,000
2. Extraction Well				
a) Installation of Extraction Well (EW1, EW2 and EW3)	3	Each	$ 12,000	$ 36,000
b) Pump Test	3	Each	20,000	60,000
	Item 2 Subtotal			$ 96,000
3. Water Treatment System				
a) Construction of Water Treatment Facility	--	L.S.	$ --	$ 460,000
b) Forcemain Construction (2"Ø/6"Ø double wall)	640	L. ft.	51.20	~~69,100~~ 33,000
c) Construct Outfall to Forebay for Discharge of Treated Water	--	L.S.	--	45,000
	Item 3 Subtotal			$ 574,100
4. Surface Water Drainage Controls				
a) Plug and Inactivate Existing Storm Sewer System	--	L.S.	$ --	$ 50,000
b) Site Grading for Surface Water Drainage Control	--	L.S.	--	450,000
	Item 4 Subtotal			$ 500,000
5. DNAPL Collection System for OW3-89				
- dedicated pump, tubing, control unit and compressor	--	L.S.	--	8,000
	Item 5 Subtotal			$ 8,000
	Estimated Capital Costs			$ 1,950,000
	Engineering (20%)			390,000
	Sub-Total			$ ~~2,340,000~~ 2296680
	Contingency (20%)			468,000
	Total Estimated Capital Costs (1)			$ 2,810,000 2,556,016

Notes:

(1) Total estimated cost has been rounded to 3 significant figures.

TABLE 3.5

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11c
THREE GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Quantity*	*Unit*	*Unit Cost*	*Cost*
Operation and Maintenance Costs				
1. Groundwater Monitoring				
a) 15 monitoring wells analyzed for SSPL compounds annually	1	Round	$ 14,000	$ 14,000
b) groundwater levels - monthly (1)	12	Round	1,500	18,000
2. Surface Water Monitoring				
- one surface water location analyzed for SSPL compounds annually	1	Round	500	500
3. Seep Monitoring				
- 7 monitoring locations analyzed for SSPL compounds annually	1	Round	4,000	4,000
4. Air Sampling of Overburden Monitoring Wells Northwest of the Site				
- 3 sample locations analyzed for SSPL compounds annually (2)	1	Round	5,200	5,200
5. Extraction System Monitoring				
a) extraction wells				
• analyze for SSPL compounds annually	1	Round	3,000	3,000
b) discharge point from treatment facility				
• analyze for SSPL compounds monthly	12	Round	1,000	12,000
6. DNAPL Collection and Off-Site Incineration	12	Month	700	8,400
7. Operation and Maintenance				
a) Water Treatment System Operation				
i) electrical	–	L.S.	--	15,000
ii) carbon (3)	–	L.S.	--	54,000
iii) operation	–	L.S.	--	95,000
				164,000
8. Annual Monitoring Report	–	L.S.	--	10,000
9. Site Evaluation (every 5 years) (4)	–	L.S.	--	40,000
	Estimated Annual Operation and Maintenance Costs			$ 279,000
	Contingency (20%)			$ 55,800
	Total Estimated Annual Operation and Maintenance Costs (5)			$ 335,000

TABLE 3.5

COST ESTIMATE FOR REMEDIAL ALTERNATIVE 11c
THREE GROUNDWATER EXTRACTION WELL ALTERNATIVE

Item	*Cost*
<u>*Total Present Worth*</u>	
Monitoring and Site Maintenance (discount factor of 10% for 30 years)	$ 549,000
Treatment System Operation and Maintenance (discount factor of 10% for 30 years) (6)	1,750,000
Site Evaluation (discount factor of 10% every 5 years for 30 years)	61,800
Capital Cost	~~2,810,000~~ 2 556 016
	~~$ 5,170,000~~ 4,916,016

<u>Notes:</u>

(1) Groundwater levels will be measured monthly for the first year of monitoring. For each additional year, groundwater levels will be measured annually.
(2) Air sampling will occur for the first 5 years of the 30-year monitoring program.
(3) Annual carbon cost is average annual cost for years 1 to 10 based upon the following relationship:

$$\text{carbon cost} = \text{total influent chemical mass} \times \frac{100 \text{ lb carbon}}{40 \text{ lb chemicals}} \times \$2$$

(4) Site evaluation will occur every 5 years during the 30-year monitoring program.
(5) Total estimated cost has been rounded to 3 significant figures.
(6) Total present worth for carbon usage based upon average annual costs for time periods 0 to 10 years, 10 to 20 years and 20 to 30 years as computed per note (3) above.