the site (Shaw, 2008); however, a 100-foot thickness is hydraulically conservative and most representative of that portion of the Chicot Aquifer impacted by dissolved phase PCE. Moreover, PCE contamination appears to be limited to the upper portion of the aquifer that is impacted by the screened interval of homeowner wells (typically less than 50 feet). However, the model was also run with vertical saturated thickness of 200 feet; these results are discussed in Section 7.0.

6.2 Wells

Initially, the model simulated six hypothetical extraction wells; these six were chosen merely as a starting point from which capture could be evaluated. The wells are assumed to be screened 50 feet into the aquifer and to pump at a constant rate. Ideally, residential wells would also be included, even in this simple model. However, uncertainty in the geographic location, screened interval, pumping rate, and whether the homeowner had connected to the EPA/TCEQ waterline summed to a considerable quantity of unknown information that was not available for use in the model. Therefore, the residential wells were excluded and only the effect of hypothetical extraction wells is modeled. Furthermore, PCE already exists in that portion of the aquifer, as evidenced by contaminated residential wells; hence capture of groundwater must encompass this zone regardless of whether or not residential wells are operational.

6.3 Constant-Head Boundaries

The model is two-dimensional and represents flow in the Chicot Aquifer only. The upper boundary of the model grid is simulated as a free-surface boundary to simulate the water table within the Chicot Aquifer. The free-surface elevation is varied during the simulation period and is calculated during the solution of the model (McDonald and Harbaugh, 1988).

All boundaries of the model domain are treated as constant hydraulic head boundaries. The constant-head boundaries simulate the observed horizontal gradient of approximately 0.003 ft/ft at the site. Heads at the northwest end of the model were set to 100 feet; heads at the southeast end of the domain were set to 95 feet, thus producing a gradient of 0.003 ft/ft. Hydraulic heads along the other boundaries varied uniformly from 100 to 95 feet. The exact hydraulic head values will not change the model results; for the purpose of this analysis, they could actually have been any value provided the 0.003 ft/ft gradient is maintained. A value of 100 feet is high enough to not permit model cells to go “dry” over the vertical thickness of the grid during drawdown (capture) simulations.

6.4 Other Hydraulic Parameters

The Chicot Aquifer is a heterogeneous unit consisting of fluvial-deltaic deposits of gravel, sand, silt, and clay (Kasmerek and Strom, 2002). Hydraulic conductivity values range from 14 to 35 feet per day in the Chicot Aquifer within Harris County (Young et al., 2006). The spatial

distribution of hydraulic conductivity within the model domain is treated as uniformly homogenous and isotropic. To account for uncertainty, hydraulic conductivity values of 5, 20, and 50 feet per day were modeled.

Porosity is uniformly 0.25 across the domain; this value is in the mid-range of values for a sandy medium (Carsell and Parrish, 1988).

7.0 Results

Table 1 summarizes whether or not complete capture was observed in each of the scenarios simulated. Initially, six extraction wells were simulated in the model. The six wells were placed around the site, with emphasis on the most contaminated areas considered when choosing location. A variety of pumping rates were modeled, with the goal of obtaining the lowest possible pumping rate that (1) does not dry up model cells and (2) still captures flowpaths within the contaminated zones. These criteria were met with a uniform pumping rate at five wells of 20 gallons per minute (each extraction well is screened 50 feet into the aquifer). A pumping rate of 25 gallons per minute is required at one well placed west of Jones Road and south of Tower Oaks Boulevard for the scenarios of a 100-foot aquifer thickness and a hydraulic conductivity of 20 feet per day. Four wells in the southern area of the site required pumping rates of 25 gallons per minute in order to achieve adequate capture of the contamination plume for an aquifer thickness of 200 feet and a hydraulic conductivity of 20 feet per day. Particles were released from each well and tracked backwards to a boundary in order to show capture zones.

The hydraulic conductivity at the site has not been measured by slug tests or aquifer tests; a number of such tests would be performed prior to completing the design of any remediation system. To account for this uncertainty, the effects of pumping under a range of hydraulic conductivities are considered. Figure 8 depicts changes in the gradient and capture zone under a hydraulic conductivity of 50 feet per day with an aquifer thickness of 100 feet. Figures 9 and 10 show results when the conductivity is 20 and 5 feet per day, respectively, for the 100-foot aquifer thickness scenario. Figures 11 through 13 illustrate changes in the gradient and capture zone under the hydraulic conductivities of 50, 20, and 5 feet per day with an aquifer thickness of 200 feet.

A hydraulic conductivity of 50 feet per day results in little drawdown beyond the area immediately adjacent to a well for both the 100- and 200-foot aquifer thicknesses (Figures 8 and 11). There are only very minor differences between the results for a 100-foot aquifer thickness and a 200-foot aquifer thickness with a hydraulic conductivity of 50 feet per day. The capture zone for each well is somewhat narrow, and gaps through which PCE might migrate are clearly present in the overall capture zone. If the conductivity were in fact 50 feet per day or higher, then two to three additional pumping wells would be required to produce hydraulic

capture of the plume. Conversely, a conductivity of 5 feet per day results in a significant amount of drawdown and a capture zone that encompasses the current plume and adjacent areas for both aquifer thicknesses simulated (Figures 10 and 13). The cone of depression (e.g., the amount of drawdown observed over an area) for the 200-foot-thick aquifer is shallower than for the 100-foot-thick aquifer, resulting in a less drawdown at the pumping wells. The decrease in the amount of observed drawdown is because a greater aquifer thickness results in a higher transmissivity; water more easily moves through the 200-foot-thick aquifer than through the 100-foot-thick aquifer under a hydraulic conductivity of 5 feet per day. Transmissivity is a measure of the amount of water that can be transmitted horizontally through a unit width of aquifer under a unit hydraulic gradient. Transmissivity is estimated by multiplying the aquifer thickness and the aquifer hydraulic conductivity.

If the average conductivity at the site is actually 5 feet per day and the aquifer thickness is 100 feet, then a lower pumping rate could be used and still produce adequate capture. Gradients close to the wells are steep and a considerable amount of uncontaminated water would end up being piped to any treatment system.

Figures 9 and 12 (20 feet per day) represents the mid-range that is close to the average conductivity reported by Young et al. (2006). The results from the 100-foot aquifer thickness scenario show that capture can be achieved with five wells pumping continuously at 20 gallons per minute and a sixth well (north of Jones Road and south of Tower Oaks Boulevard) pumping at 25 gallons per minute. The 200-foot aquifer thickness results in a higher aquifer transmissivity and therefore a smaller amount of drawdown observed at each well. With an aquifer thickness of 200 feet, the capture zone is narrower than it is in the 100-foot aquifer scenario and there are apparent gaps through which the PCE may migrate in the overall capture zone. In order to fully capture the PCE plume, additional pumping wells would be required.

Two additional pumping wells were added to the 200-foot aquifer thickness scenario with a hydraulic conductivity of 20 feet per day. Figure 14 depicts the change in the gradient and capture zone for this scenario; the results for this scenario show adequate capture of contaminated groundwater. Four of the eight wells have a pumping rate of 20 gallons per minute and the remaining four wells have pumping rates of 25 gallons per minute (Figure 14). This is the most reasonable scenario and the one recommended when determining the costs of a potential treatment system.

8.0 Summary and Conclusions

A simple model was constructed to evaluate the effect of a pump and treat system on the Chicot Aquifer at the Jones Road site. Because no site-specific hydraulic conductivity data exist for the site, literature values were used. Well locations were chosen based on the distribution of PCE

without considering the political or legal logistics of drilling a large extraction well on private property. The model also does not consider the hydraulic effect of residential wells, some of which have been shut down at this time as some homeowners have connected to a PWS pipeline. If these data and sufficient funding to develop a sophisticated model of the site were available, a scenario to examine would be using existing residential wells as extraction wells. In this scenario, it is likely that far fewer new extraction wells would need to be drilled.

The model results presented here are basic and derived from a noncalibrated model. However, the data are sufficient to determine the cost of constructing a pump and treat system that includes four wells screened 50 feet into the Chicot Aquifer that pump at a continuous rate of 20 gallons per minute per well, and four identical wells that pump at 25 gallons per minute. Site-specific aquifer and pump tests would be required prior to completing the design of a remediation system.

9.0 References

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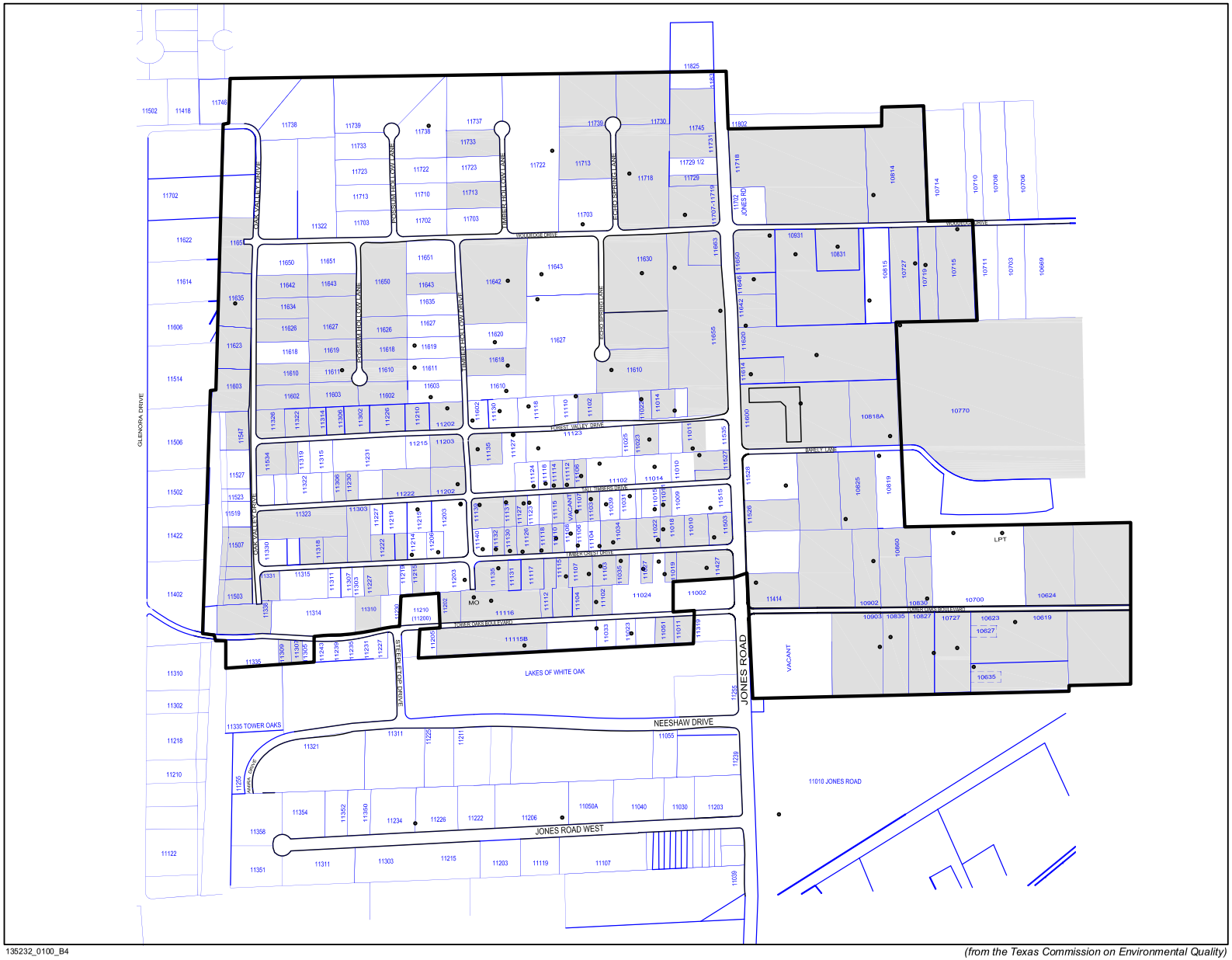
Figures



LEGEND

- Final waterline service area boundary
- Property boundary
- Approximate private well location
- Signed agreement received by TCEQ as of January 1, 2008

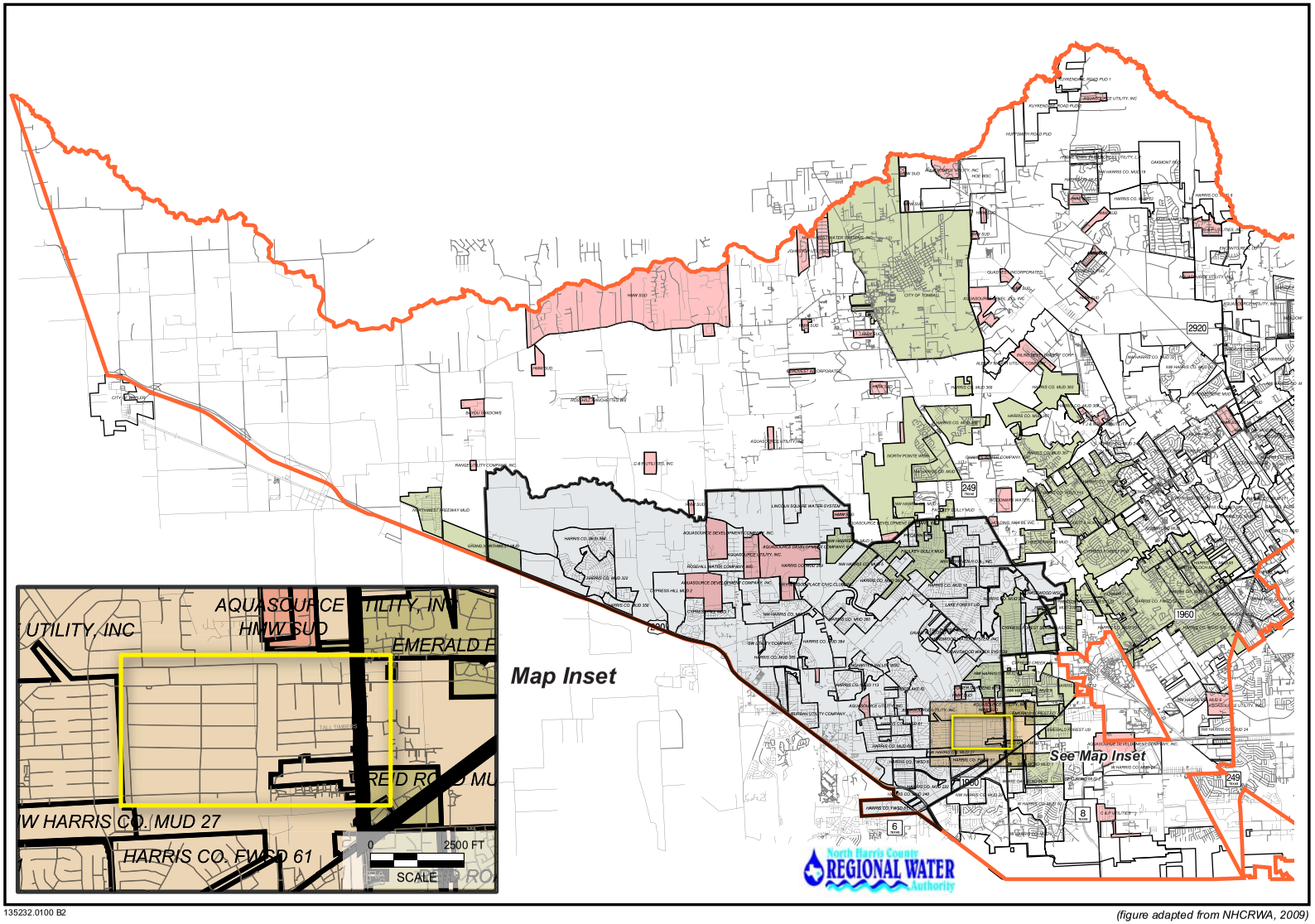
0 250 500 FT

SCALE

Figure 1
Jones Road Site
Water Line Service Area

135232_0100_B4

(from the Texas Commission on Environmental Quality)



LEGEND

- Voting District No. 1
- North Harris County Regional Water Authority Boundary
- Jones Road Site Vicinity
- Road
- Water District
- Certificate of Convenience and Necessity

July 2002

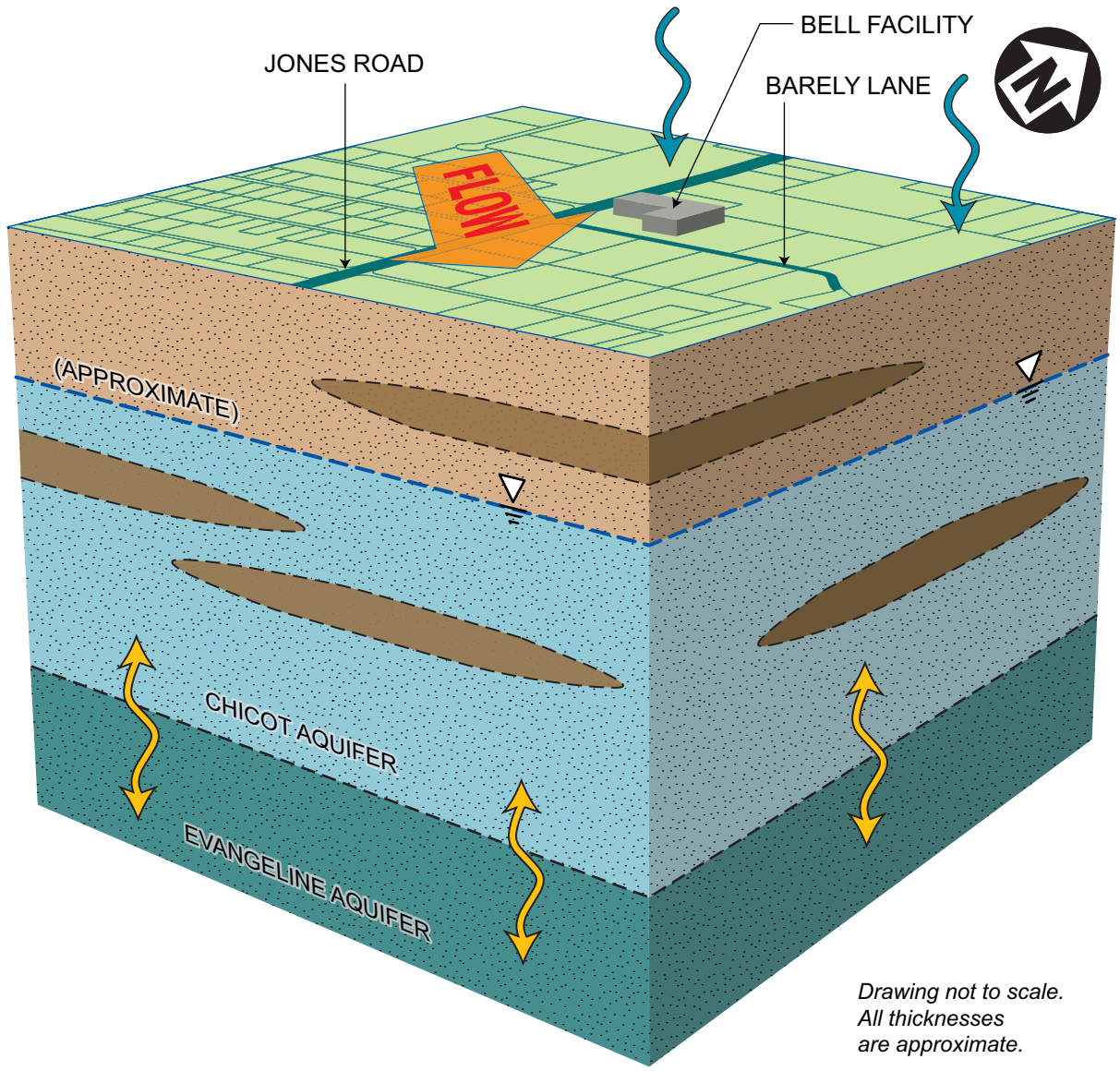
0 10000 20000 FT

SCALE

Figure 2
Map Showing Neighboring Water Districts and Municipal Utility Districts (MUDs) around Jones Road Site

135232.0100 B2

(figure adapted from NHCRWA, 2009)

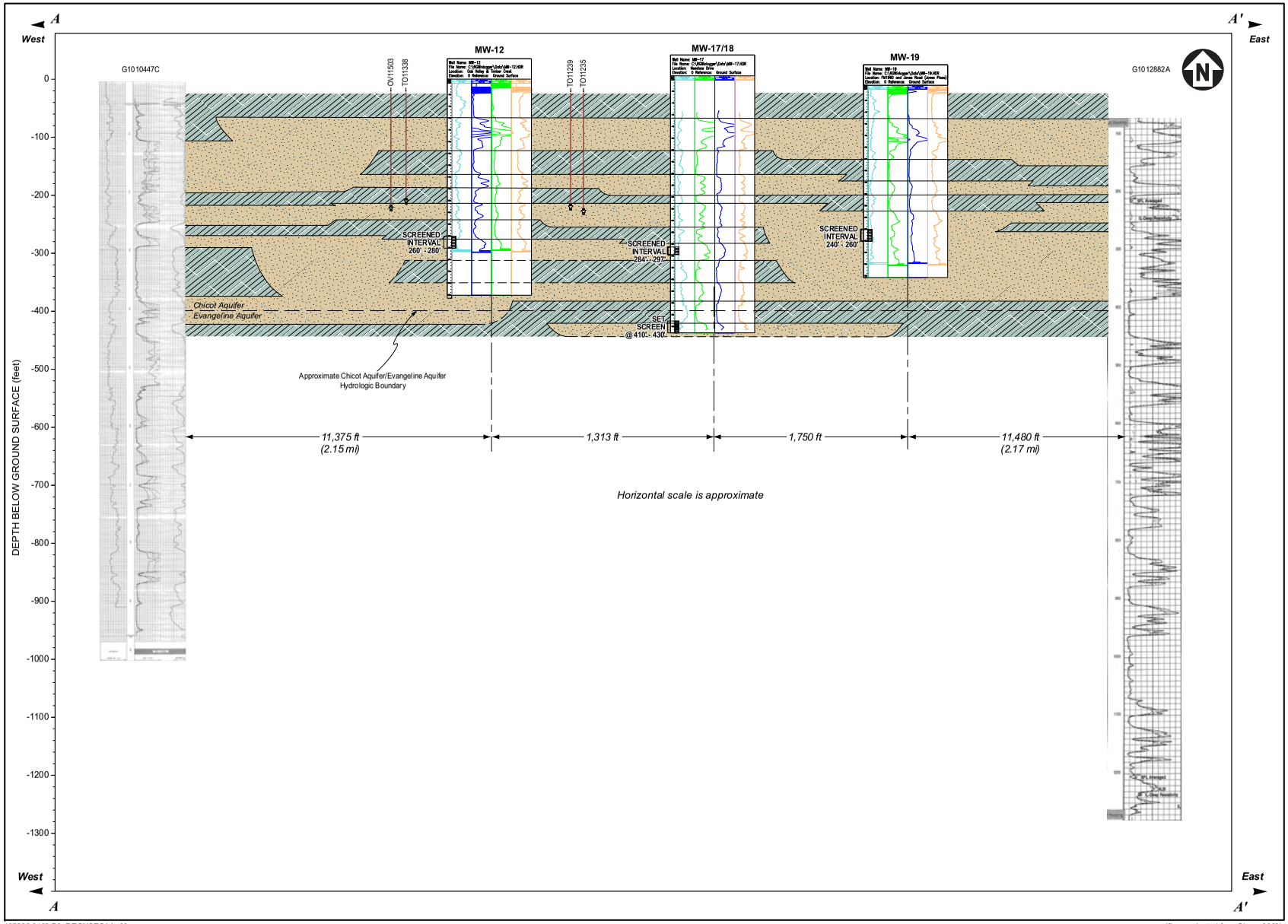


LEGEND

- Approximate water table
- Approximate boundary
- Water table elevation
- Unsaturated aquifer conditions
- Saturated aquifer conditions
- Low permeability
- Leaky aquifer zone
- Aquifer recharge from northern outcropping of Chicot Aquifer
- Approximate direction of regional groundwater flow

Figure 3
Illustration of the Conceptual Site Model
Jones Road Groundwater Plume Superfund Site
Houston, Texas

135232_0100_A1_SIT-MODL



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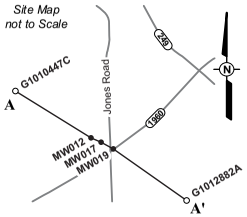
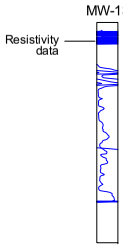


EXPLANATION



LITHOLOGY GRAPHICS

- Sand
- Clay
- Lithology Boundary
- Approximate Lithology Boundary
- PCE Concentration < 0.5 ppb In Groundwater
- PCE Concentration Not Sampled
- Well Screen

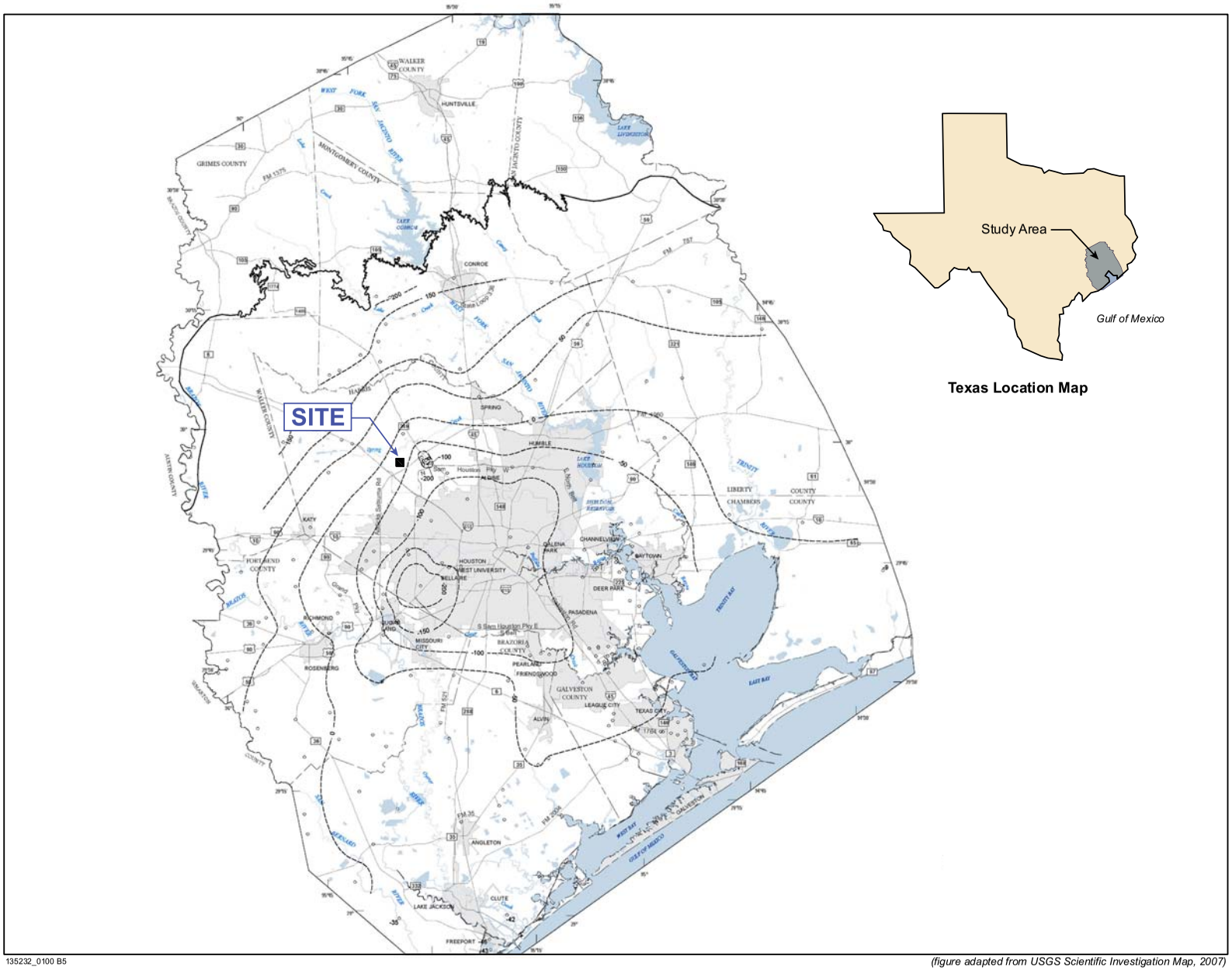
0 — 100

Vertical Scale (feet)

Figure 4
Stratigraphic Cross Section A-A'

135232.0100 B3_REGXSECAA_08

(figure adapted from Shaw, 2009)



Texas Location Map

LEGEND

- - - 50 - - - Water-level contour—Shows altitude at which water level would have stood in tightly cased well. Contour intervals 50 and 100 feet. Datum is NGVD 29

——— Boundary of study area

——— Updip limit of Chicot aquifer (Baker, 1979; University of Texas, Bureau of Economic Geology, 1968)

-9 ○ Data point—Well in which water-level altitude (shown where data too sparse for contours). One point can represent more than one well

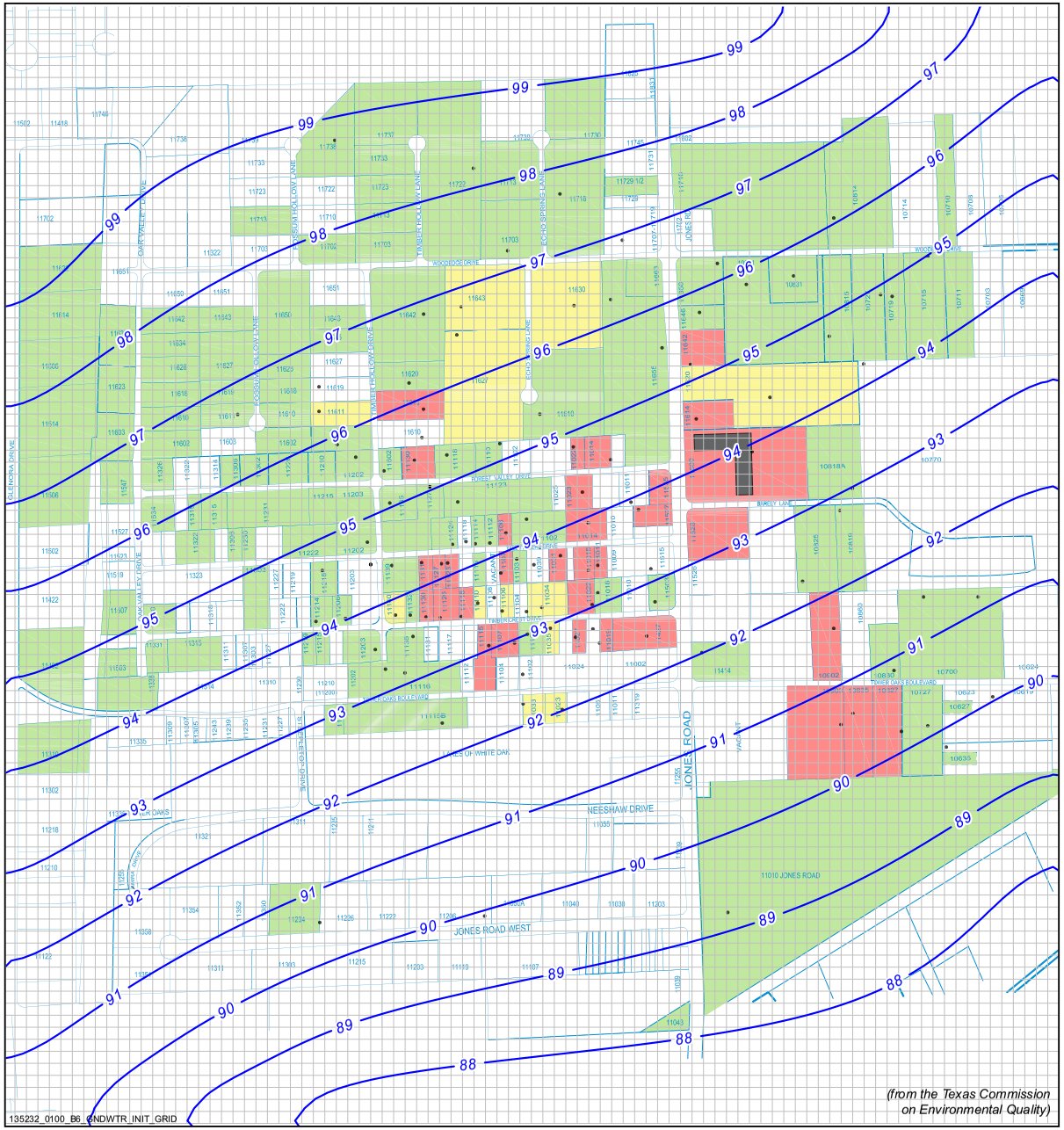
N

0 10 20 MI
SCALE

Figure 5
Approximate Regional Groundwater Levels in the Chicot Aquifer, Houston/Galveston Region, Texas
January–March 2007
Harris County, Texas

135232_0100 B5

(figure adapted from USGS Scientific Investigation Map, 2007)



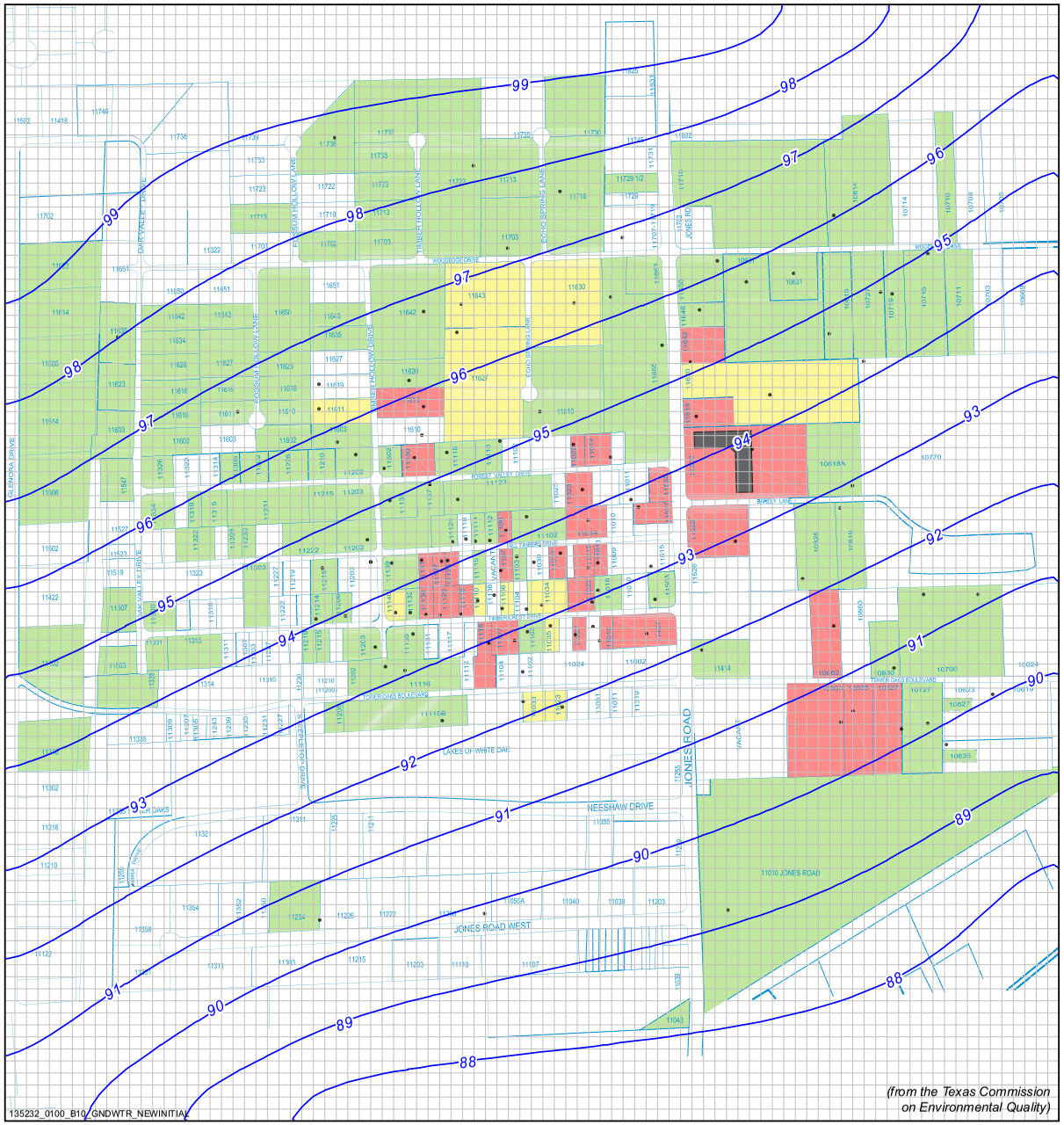
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Hydraulic head
- Model grid

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 6
Initial Conditions
100-foot Aquifer Thickness



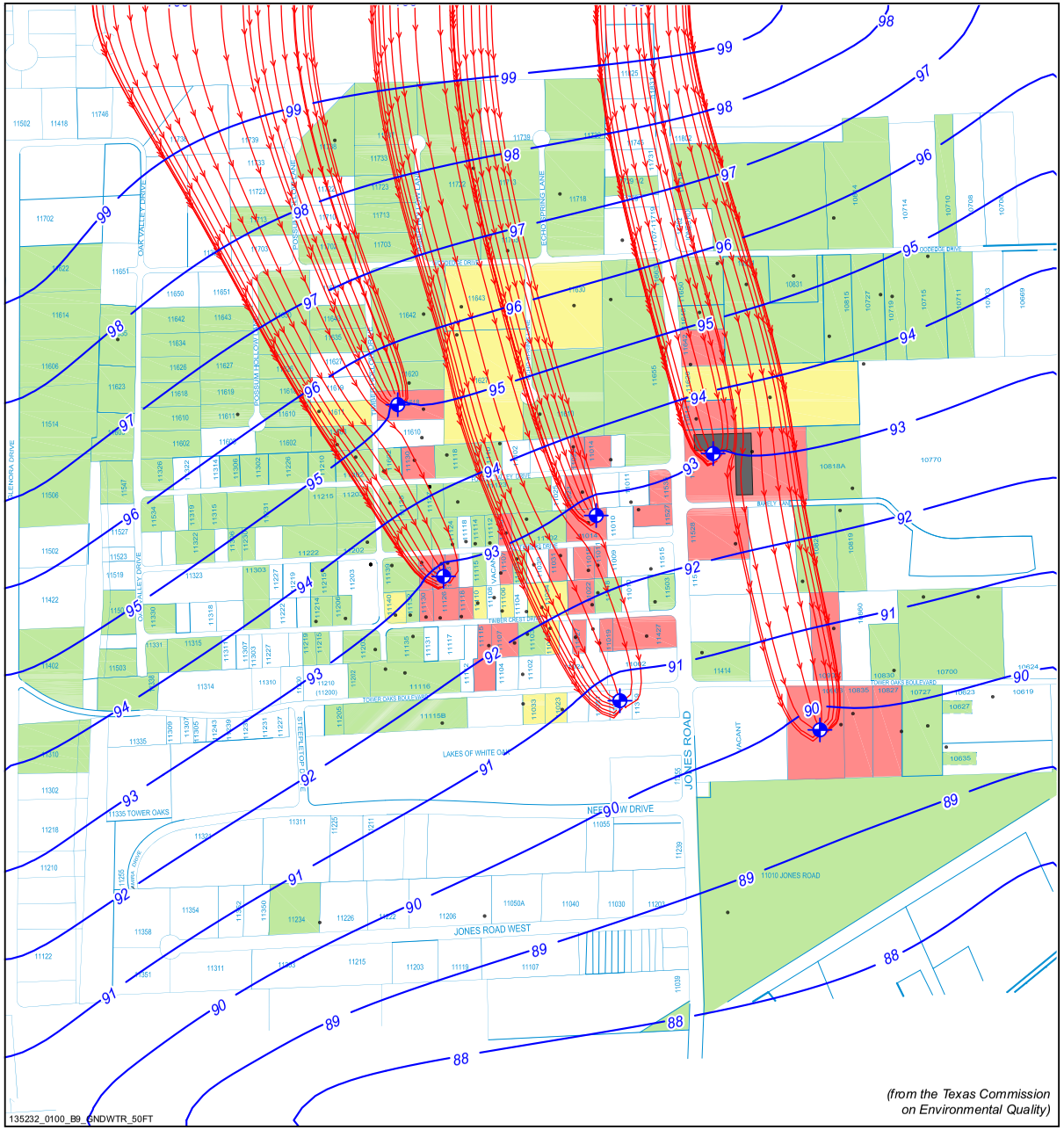
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Hydraulic head
- Model grid

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 7
Initial Conditions
200-foot Aquifer Thickness



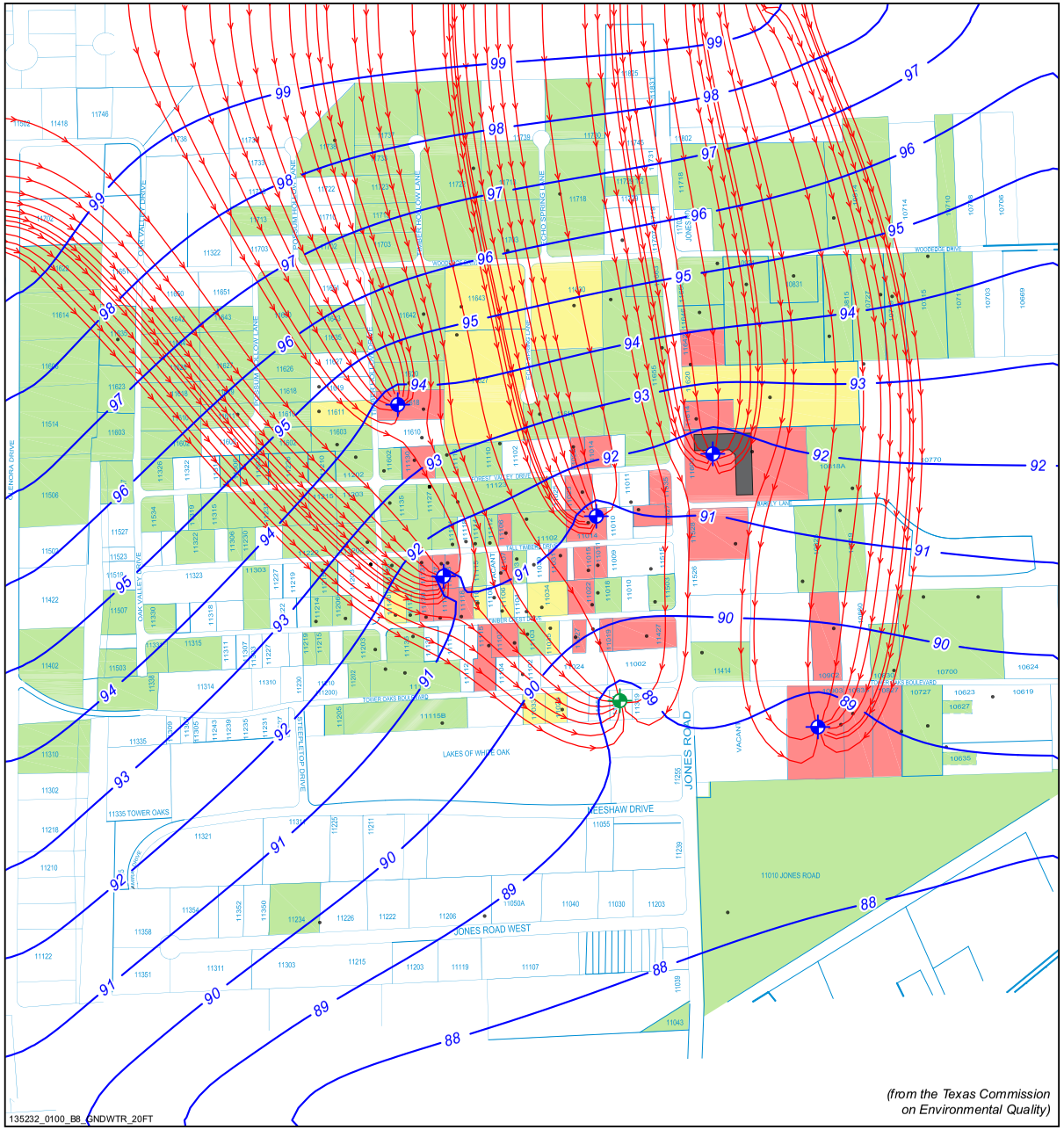
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Proposed Extraction well (20 gpm)
- Hydraulic head
- Particle tracks showing direction of groundwater flow
- gpm Gallons per minute

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 8
Capture Zones for
50 feet/day
Hydraulic Conductivity
100-foot Aquifer Thickness



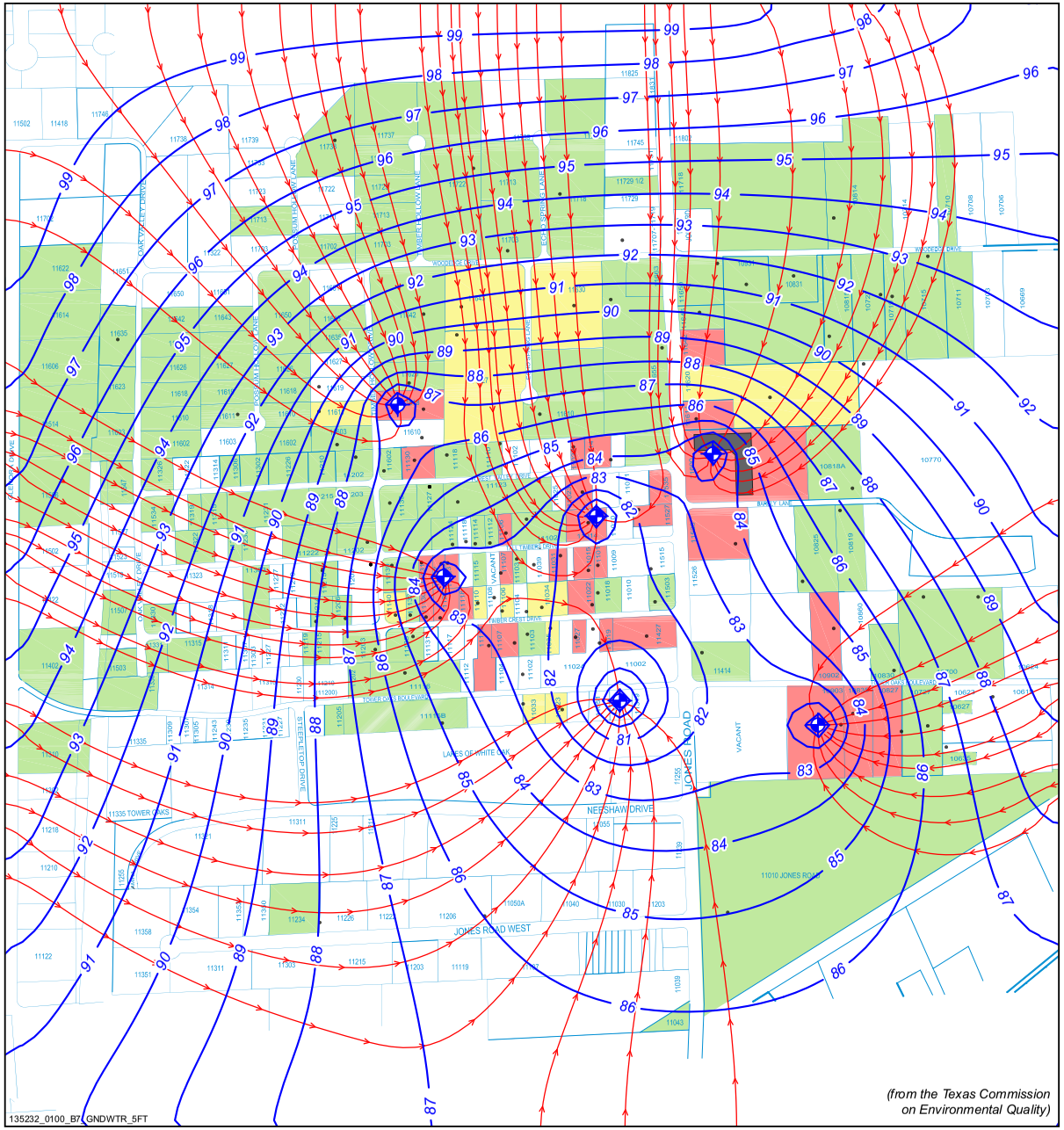
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Proposed Extraction well (20 gpm)
- Proposed Extraction well (25 gpm)
- Hydraulic head
- Particle tracks showing direction of groundwater flow
- gpm Gallons per minute

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 9
Capture Zones for
20 feet/day
Hydraulic Conductivity
100-foot Aquifer Thickness



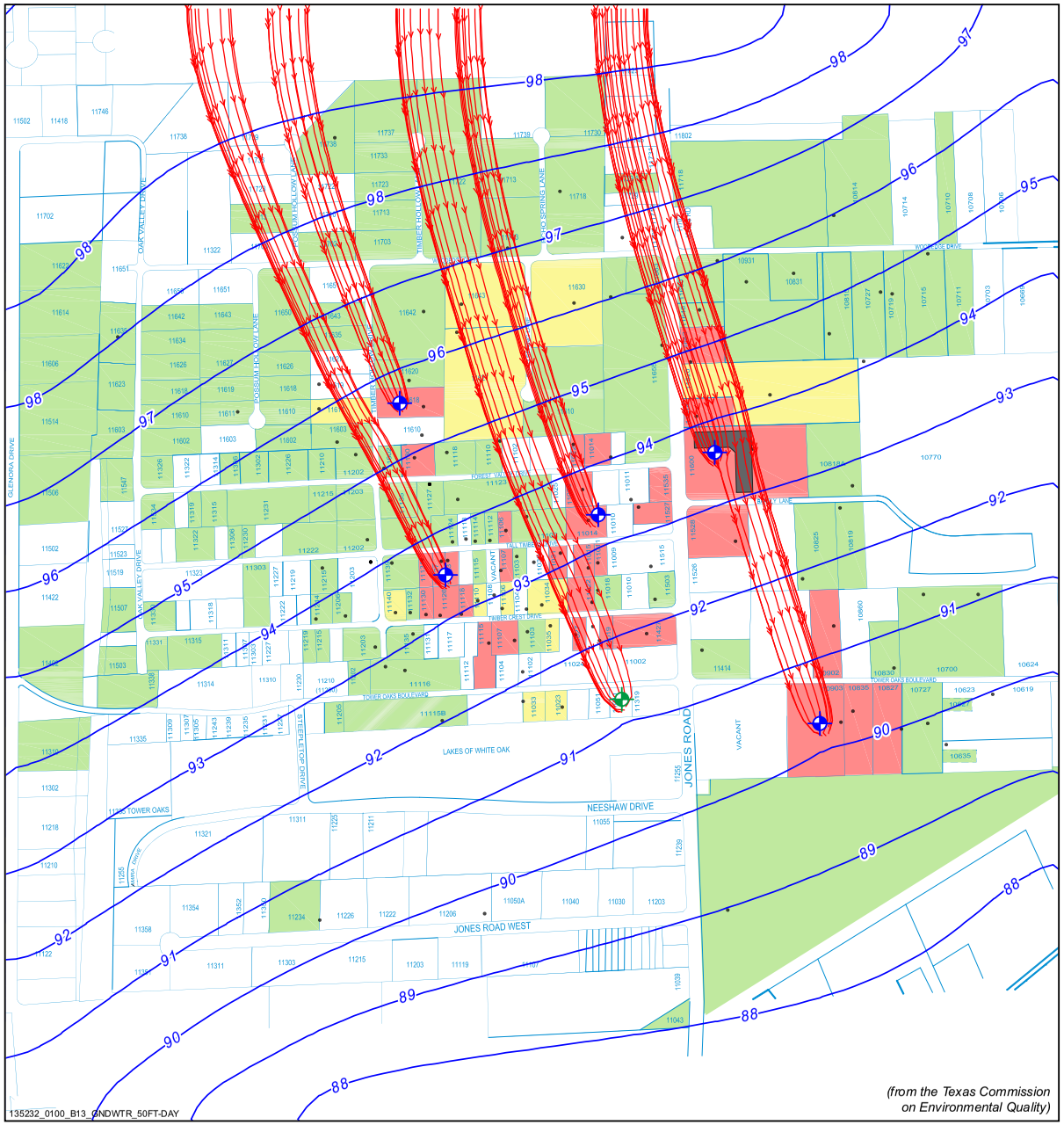
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Proposed Extraction well (20 gpm)
- Hydraulic head
- Particle tracks showing direction of groundwater flow
- gpm — Gallons per minute

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 10
Capture Zones for
5 feet/day
Hydraulic Conductivity
100-foot Aquifer Thickness



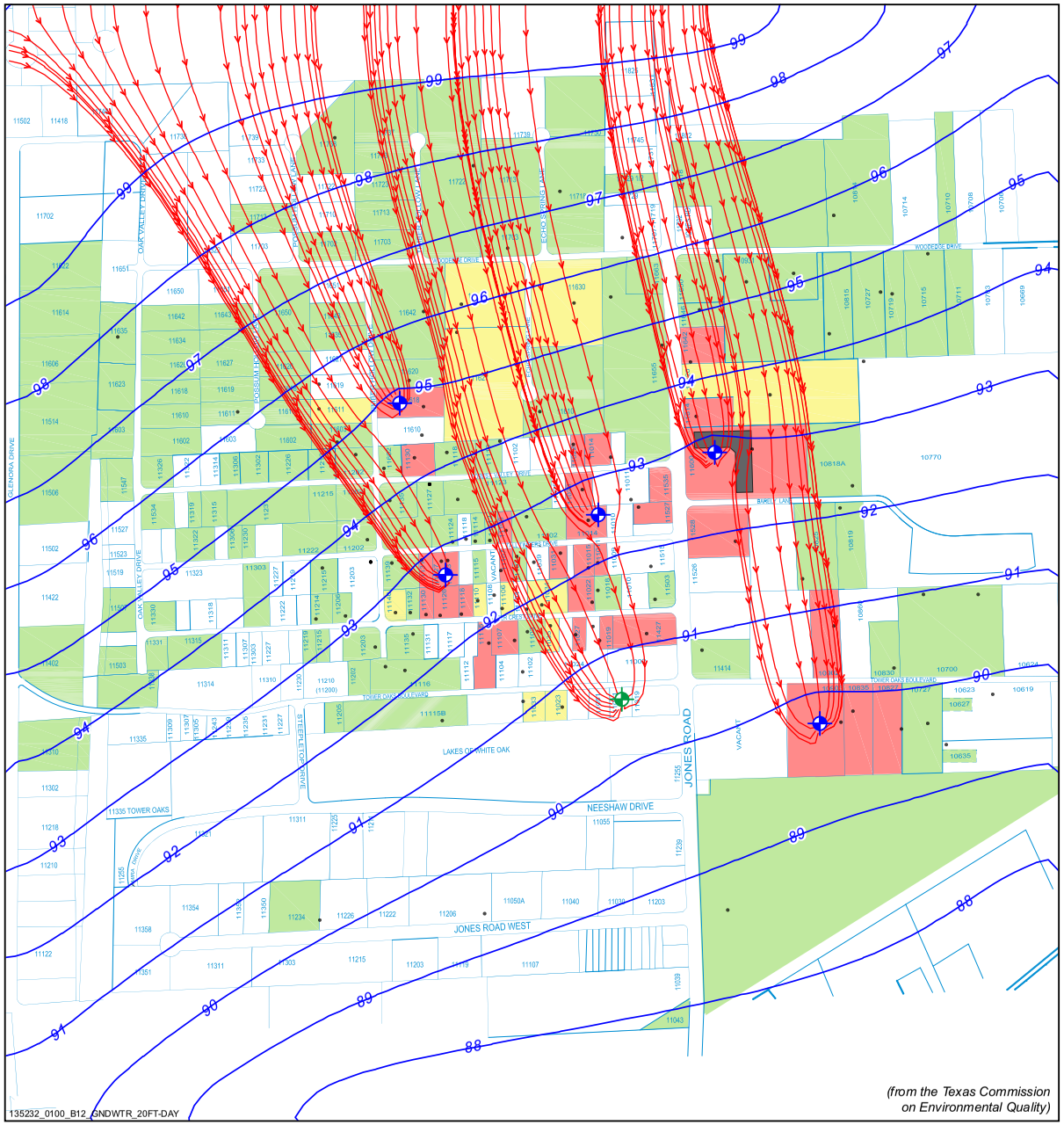
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Proposed Extraction well (20 gpm)
- Proposed Extraction well (25 gpm)
- Hydraulic head
- Particle tracks showing direction of groundwater flow
- gpm Gallons per minute

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 11
Capture Zones for
50 feet/day
Hydraulic Conductivity
200-foot Aquifer Thickness



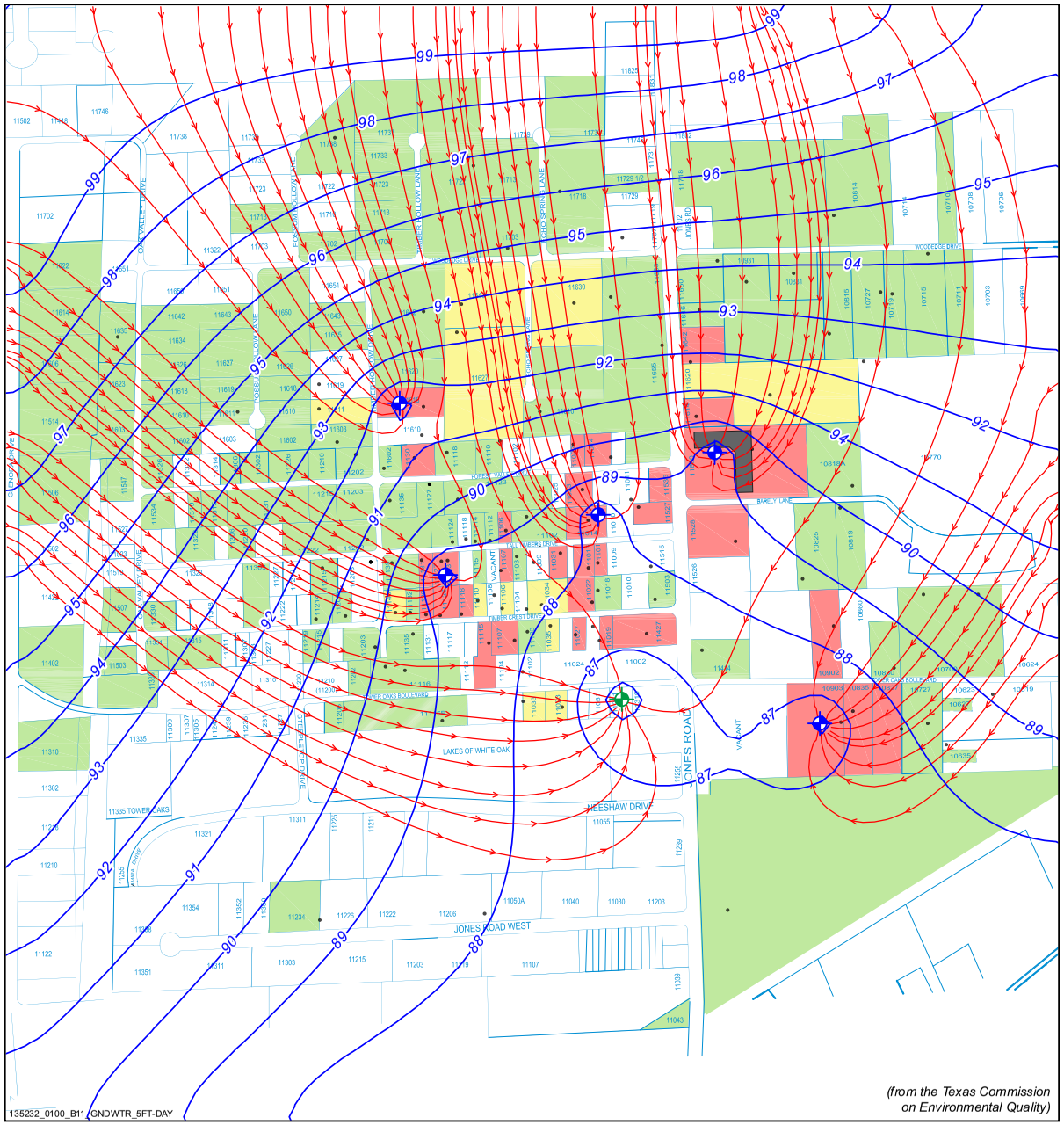
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Proposed Extraction well (20 gpm)
- Proposed Extraction well (25 gpm)
- Hydraulic head
- Particle tracks showing direction of groundwater flow
- gpm — Gallons per minute

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 12
Capture Zones for
20 feet/day
Hydraulic Conductivity
200-foot Aquifer Thickness



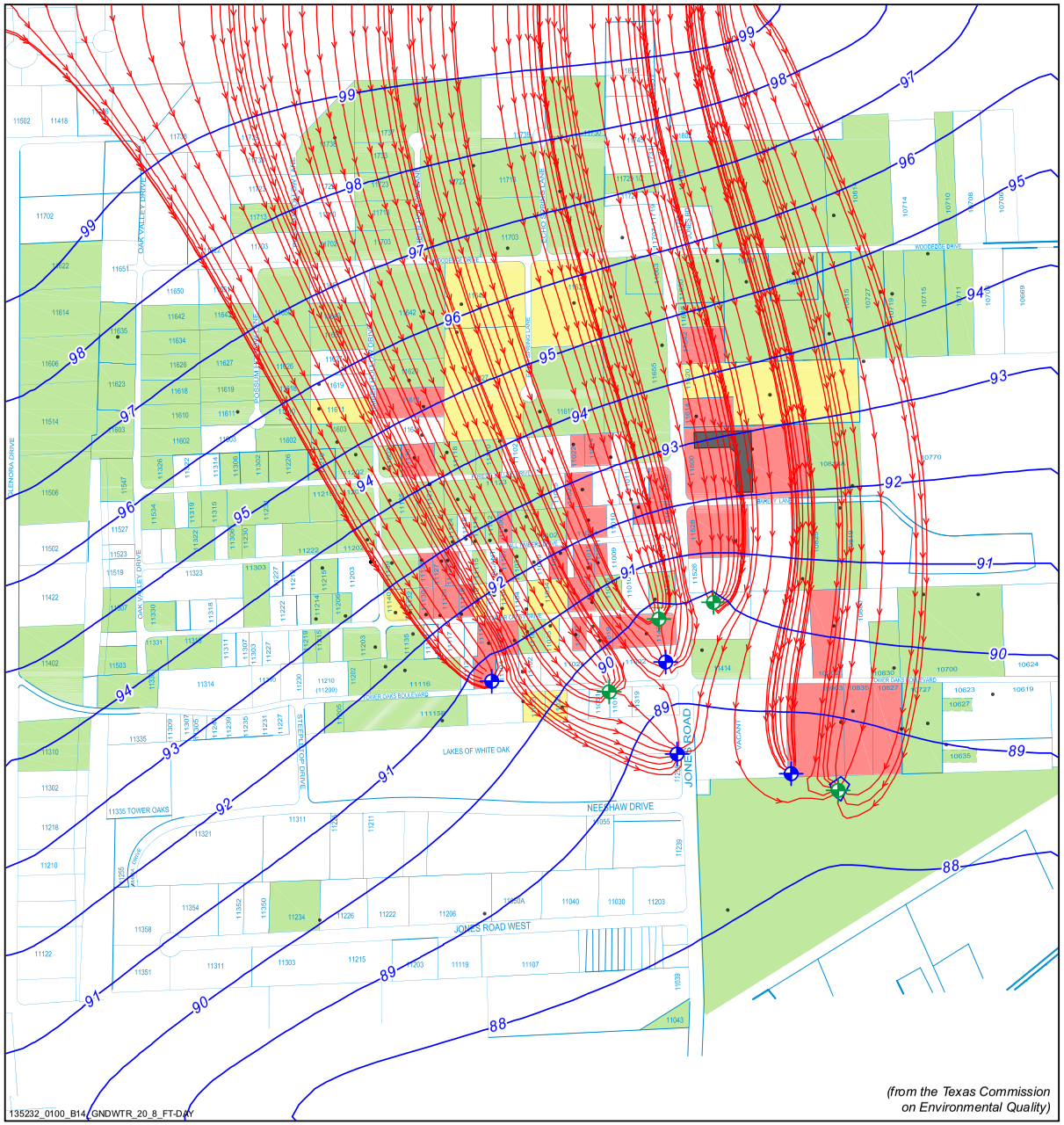
EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Proposed Extraction well (20 gpm)
- Proposed Extraction well (25 gpm)
- Hydraulic head
- Particle tracks showing direction of groundwater flow
- gpm — Gallons per minute

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 13
Capture Zones for
5 feet/day
Hydraulic Conductivity
200-foot Aquifer Thickness



EXPLANATION

- Property boundary
- Approximate private well location
- Not sampled
- PCE < 0.5ppb (Quantitation limit)
- PCE >= 0.50ppb to <= 5.0ppb
- PCE > 5.0ppb (MCL)
- Bell Facility: 11600 Jones Road
- Proposed Extraction well (20 gpm)
- Proposed Extraction well (25 gpm)
- Hydraulic head
- Particle tracks showing direction of groundwater flow
- gpm Gallons per minute

Notes:
Sample results from November 2007

0 250 500 FT
SCALE

Figure 14
Capture Zones for 8 Pumping Wells and a Hydraulic Conductivity of 20 feet/day in an Aquifer Thickness of 200 feet

Table

Table 1
Summary of Capture Zone Model Results
Jones Road Site

Aquifer Hydraulic Conductivity	Aquifer Thickness (ft)	Number of Pumping Wells Simulated		Total gpm	Complete Capture of Contamination?
		20 gpm	25 gpm		
K = 50 ft/day	100	6	0	120	Yes
	200	5	1	125	No
K = 20 ft/day	100	5	1	125	Yes
	200	5	1	125	No
	200	3	5	185	Yes
K = 5 ft/day	100	6	0	120	No
	200	5	1	125	Yes

ft = *Foot (feet).*
gpm = *Gallons per minute.*
K = *Hydraulic conductivity.*

Appendix C

Cost Estimates

Comparison of Source Area and Deep Groundwater Plume Costs				
	Source Area	**Deep**		
	Soil and	**Groundwater**		
Category	**Groundwater**	**Plume**	**Totals**	**NPV @ 7%**
Alternative 1 - No Action				
Capital	No Costs for Alternative 1			
Periodic				
O&M				
Totals				
Alternative 2 - In-Situ Treatment				
Capital	$127,136	$508,544	$635,680	$635,680
Periodic	$388,896	$835,584	$1,224,480	$1,115,379
O&M	$317,886	$1,271,544	$1,589,430	$958,609
Totals	$833,918	$2,615,672	$3,449,590	$2,709,669
Alternative 3 - Hydraulic Containment w/ Pump & Treat				
Capital	$563,612	$2,254,448	$2,818,060	$2,818,060
Periodic	$28,896	$115,584	$144,480	$114,778
O&M	$668,646	$2,674,584	$3,343,230	$1,734,822
Totals	$1,261,154	$5,044,616	$6,305,770	$4,667,661
Alternative 4 - In Situ Enhanced Pump & Treat				
Capital	$599,708	$2,398,832	$2,998,540	$2,998,540
Periodic	$388,896	$835,584	$1,224,480	$1,115,379
O&M	$668,646	$2,674,584	$3,343,230	$1,734,822
Totals	$1,657,250	$5,909,000	$7,566,250	$5,848,742
Range of Costs				
	Source Area Soil and Groundwater		**Deep Groundwater Plume**	
	Minimum	**Maximum**	**Minimum**	**Maximum**
Capital	$127,136	$599,708	$508,544	$2,398,832
Periodic	$28,896	$388,896	$115,584	$835,584
O&M	$317,886	$668,646	$1,271,544	$2,674,584
Totals	$833,918	$1,657,250	$2,615,672	$5,909,000

Alternative 1 - No Action

01.01

Alternative 2 - In-Situ Treatment	Unit Cost	Units	Total
02.01 Project Management (O&M)	20,500	30	615,000
02.02 Hydraulic Testing (Capital)	146,000	1	146,000
02.10 Install Monitor Wells (Capital)	309,200	1	309,200
02.20 Pilot Study for Selecting In Situ Methods (Capital)	155,000	1	155,000
02.30 Remedial Design (Capital)	25,480	1	25,480
02.32 Apply ISCO Chemicals (Periodic)	180,000	2	360,000
02.38 Apply Yearly Bioaugmentation (Periodic)	180,000	4	720,000
02.40 Groundwater Sampling - Sampling (O&M)	29,520	27	797,040
02.45 Groundwater Sampling - Reporting (O&M)	6,570	27	177,390
02.80 5 Year Project Reviews (Periodic)	24,080	6	144,480
			3,449,590

Alternative 3 - Hydraulic Containment w/ Pump & Treat	Unit Cost	Units	Total
03.01 Project Management (O&M)	20,500	30	615,000
03.02 Hydraulic Testing (Capital)	146,000	1	146,000
03.09 Install Monitor Wells (Capital)	264,200	1	264,200
03.10 Install Extraction Wells (Capital)	588,120	1	588,120
03.11 Install Injection Wells (Capital)	588,120	1	588,120
03.15 Pilot Study for Air Stripping (Capital)	60,000	1	60,000
03.16 Remedial Design (Capital)	41,020	1	41,020
03.20 Install GW Treatment System (Capital)	1,130,600	1	1,130,600
03.26 Operation of Treatment System (O&M)	58,460	30	1,753,800
03.40 Groundwater Sampling - Sampling (O&M)	29,520	27	797,040
03.45 Groundwater Sampling - Reporting (O&M)	6,570	27	177,390
03.80 5 Year Project Reviews (Periodic)	24,080	6	144,480
			6,305,770

Alternative 4 - In Situ Enhanced Pump & Treat	Unit Cost	Units	Total
04.01 Project Management (O&M)	20,500	30	615,000
04.02 Hydraulic Testing (Capital)	146,000	1	146,000
04.09 Install Monitor Wells (Capital)	264,200	1	264,200
04.10 Install Extraction Wells (Capital)	588,120	1	588,120
04.11 Install Injection Wells (Capital)	588,120	1	588,120
04.15 Pilot Study for Air Stripping (Capital)	60,000	1	60,000
04.17 Remedial Design (Capital)	66,500	1	66,500
04.20 Install GW Treatment System (Capital)	1,130,600	1	1,130,600
04.26 Operation of Treatment System (O&M)	58,460	30	1,753,800
04.30 Pilot Study for Selecting In Situ Methods (Capital)	155,000	1	155,000
04.32 Apply ISCO Chemicals (Periodic)	180,000	2	360,000
04.38 Apply Yearly Bioaugmentation (Periodic)	180,000	4	720,000
04.40 Groundwater Sampling - Sampling (O&M)	29,520	27	797,040
04.45 Groundwater Sampling - Reporting (O&M)	6,570	27	177,390
04.80 5 Year Project Reviews (Periodic)	24,080	6	144,480
			7,566,250

Feasibility Study Report - Jones Road Groundwater Plume

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount

01 Alternative 1 - No Action

The No Further Action alternative constitutes the absence of any remedial actions. Under this alternative, no measures would be taken to address soil or groundwater contamination, and no measures would be taken to prevent human exposure to them. No Further Action is considered in this evaluation as a baseline for comparison to all other potential remedial actions, as required by the NCP.

01.01

100.000	***HOME LABOR***			
E392	Project Manager	0.00 hour	140.00 /hour	0
	HOME LABOR			*0*
	0.00 Labor hours			
01.01			0.00 **/ls**	**0**

01 Alternative 1 - No Action 0

Alternative 2 - In Situ Treatment
Jones Road Groundwater Plume Federal Superfund Site

		Unit Cost	Units	Total
02.01	Project Management (O&M)	20,500	30	615,000
02.02	Hydraulic Testing (Capital)	146,000	1	146,000
02.10	Install Monitor Wells (Capital)	309,200	1	309,200
02.20	Pilot Study for Selecting In Situ Methods (Capital)	155,000	1	155,000
02.30	Remedial Design (Capital)	25,480	1	25,480
02.32	Apply ISCO Chemicals (Periodic)	180,000	2	360,000
02.38	Apply Yearly Bioaugmentation (Periodic)	180,000	4	720,000
02.40	Groundwater Sampling - Sampling (O&M)	29,520	27	797,040
02.45	Groundwater Sampling - Reporting (O&M)	6,570	27	177,390
02.80	5 Year Project Reviews (Periodic)	24,080	6	144,480

Year	02.01	02.02 to 30	02.32	02.38	02.40 / 45	02.80	Year Totals
1	$20,500	635,680	$180,000	$180,000	$144,360		$1,160,540
2	$20,500		$180,000	$180,000	$144,360		$524,860
3	$20,500			$180,000	$72,180		$272,680
4	$20,500			$180,000	$72,180		$272,680
5	$20,500				$72,180	$24,080	$116,760
6	$20,500				$36,090		$56,590
7	$20,500				$36,090		$56,590
8	$20,500				$36,090		$56,590
9	$20,500				$36,090		$56,590
10	$20,500				$36,090	$24,080	$80,670
11	$20,500				$36,090		$56,590
12	$20,500				$36,090		$56,590
13	$20,500				$36,090		$56,590
14	$20,500				$36,090		$56,590
15	$20,500				$36,090	$24,080	$80,670
16	$20,500						$20,500
17	$20,500						$20,500
18	$20,500						$20,500
19	$20,500						$20,500
20	$20,500				$36,090	$24,080	$80,670
21	$20,500						$20,500
22	$20,500						$20,500
23	$20,500						$20,500
24	$20,500						$20,500
25	$20,500				$36,090	$24,080	$80,670
26	$20,500						$20,500
27	$20,500						$20,500
28	$20,500						$20,500
29	$20,500						$20,500
30	$20,500				$36,090	$24,080	$80,670
Total	$615,000	$635,680	$360,000	$720,000	$974,430	$144,480	$3,449,590
NPV @ 7%	$272,192	$635,680	$348,224	$652,377	$686,417	$114,778	$2,709,669
C, P, O&M	O&M	C	P	P	O&M	P	

Category	Source Area	Deep Groundwater Plume		Totals	Subtotals	NPV @ 7%
Capital	$127,136	$508,544		$635,680	C	$635,680
Periodic	$388,896	$835,584		$1,224,480	P	$1,115,379
O&M	$317,886	$1,271,544		$1,589,430	O&M	$958,609
	$833,918	$2,615,672	$3,449,590	$3,449,590		$2,709,669

Item	Description	Takeoff Qty	Unit Cost	Total Amount

02 Alternative 2 - In-Situ Treatment

The In-Situ Treatment alternative includes institutional controls to prevent groundwater use, prevent new wells in the plume, and require better construction for deeper wells. Activities include applying in-situ chemical oxidation treatment to both soil and shallow groundwater in the source area, and applying in-situ bioaugmentation to the deep groundwater wells. Assume 50 wells are in the area requiring sampling to evaluate progress of natural attenuation, plume limits, and appropriateness of institutional control boundaries. In addition to the above sampling 20 wells will be sampled additionally for MNA parameters. Yearly report are required for submission of sample results and inspection / enforcement results. A 5-year Project Reviews is required.

02.01 Project Management (O&M)

Activity is project management for project performance, interface with regulators, interface with public, procurement, billing.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
100.000	***HOME LABOR***			
E392	Project Manager	80.00 hour	140.00 /hour	11,200
E422	Proposals Specialist / CAD	30.00 hour	72.00 /hour	2,160
N112	Administrative Assistant	120.00 hour	47.00 /hour	5,640
	HOME LABOR			*19,000*
	230.00 Labor hours			
440.000	***SUBCONTRACTS***			
E100	Meeting Displays and Handouts	1.00 ls	1,000.00 /ls	1,000
	SUBCONTRACTS			*1,000*
700.000	***OTHER DIRECT COSTS***			
B200	Meeting Facility Rental	1.00 ls	500.00 /ls	500
	OTHER DIRECT COSTS			*500*
	02.01 Project Management (O&M)		20,500.00 **/ls**	**20,500**
	1.00 /ls		30 years	**615,000**
	230.00 Labor hours	6900.00		

02.02 Hydraulic Testing (Capital)

Hydraulic testing (slug test) of shallow and deep wells to determine hydraulic conductivities.
Additionally, screen depths of 20 selected wells will be determined by downhole well logging.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
440.000	***SUBCONTRACTS***			
D001	Slug Testing of shallow wells (<50 ft bgs)	3.00 ea	2,000.00 /ea	6,000
D002	Slug Testing of deep wells (>50 ft bgs)	10.00 ea	4,000.00 /ea	40,000
D003	Determine unknown well screen depths	20.00 ea	5,000.00 /ea	100,000
	SUBCONTRACTS			*146,000*
	02.02 Hydraulic Testing (Capital)		146,000.00 **/ls**	**146,000**

02.10 Install Monitor Wells (Capital)

Monitor wells are needed to characterize groundwater in the depth range between 50 and 200 feet.
No monitor wells are screened in this depth interval, and very few water wells are screened this shallow.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	50.00 hour	100.00 /hour	5,000
E262	Engineer 2	50.00 hour	84.00 /hour	4,200
	CONSTRUCTION MANAGEMENT			*9,200*
	100.00 Labor hours			

Item	Description	Takeoff Qty	Unit Cost	Total Amount
440.000	***SUBCONTRACTS***			
D004	Mobilization	4.00 ea	10,000.00 /ea	40,000
D005	Install Monitor Wells	4.00 ea	60,000.00 /ea	240,000
D006	Demobilization	4.00 ea	5,000.00 /ea	20,000
	SUBCONTRACTS			*300,000*
	02.10 Install Monitor Wells (Capital)		309,200.00 **/ls**	**309,200**
	4.00 ea			
	100.00 Labor hours	100.00		

02.20 Pilot Study for Selecting In Situ Methods (Capital)

Activity is the pilot study to select the most effective in situ method to apply to the source area groundwater and the deep groundwater plume. Estimated activities include:

ISCO field trials for three chemical mix / delivery combinations.
Biostimulation application at one well in deep zone.
Bioaugmentation application at one well in deep zone.
Pilot Study Report

440.000	***SUBCONTRACTS***			
D006	ISCO field trials	1.00 ls	100,000.00 /ls	100,000
D007	Biostimulation field trial	1.00 ls	20,000.00 /ls	20,000
D008	Bioaugmentation field trial	1.00 ls	20,000.00 /ls	20,000
D009	Pilot Study Report	1.00 ls	15,000.00 /ls	15,000
	SUBCONTRACTS			*155,000*
	02.20 Pilot Study for Selecting In Situ Methods (Capital)		155,000.00 **/ea**	**155,000**
	1.00 ls			

02.30 Remedial Design (Capital)

Activity is remedial design for the application of In Situ treatment to shallow and deep groundwater.

100.000	***HOME LABOR***			
E392	Project Manager	40.00 hour	140.00 /hour	5,600
E373	Project Engineer	80.00 hour	105.00 /hour	8,400
E262	Engineer 2	80.00 hour	84.00 /hour	6,720
E422	Proposals Specialist / CAD	40.00 hour	72.00 /hour	2,880
N112	Administrative Assistant	40.00 hour	47.00 /hour	1,880
	HOME LABOR	280.00 Labor hours		*25,480*
	02.30 Remedial Design (Capital)		25,480.00 **/ls**	**25,480**
	1.00 /ls			
	280.00 Labor hours	280.00		

02.32 Apply ISCO Chemicals (Periodic)

Activity is the initial application of chemical products to promote in-situ chemical oxidation to source area groundwater
The ISCO for the groundwater remediation will be dispersed by injection around MW-1 and MW-6 - 8 temporary injection wells (150,000 per application) 2 applications separated by a year

440.000	***SUBCONTRACTS***			
D014	Mobilization	1.00 ls	20,000.00 /ls	20,000
D015	Apply Chemical Oxidation to Shallow GW	1.00 ls	150,000.00 /ls	150,000
D016	Demobilization	1.00 ls	10,000.00 /ls	10,000
	SUBCONTRACTS			*180,000*

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
	02.32 Apply ISCO Chemicals (Periodic)		180,000.00 **/ea**	**180,000**
	1.00 ls		2 Events	**360,000**

02.38 Apply Yearly Bioaugmentation (Periodic)

Activity is apply of bio-augmentation chemicals to ten existing unused water wells. Assume each application has a cost of $10,000 per well, or $100,000 per year. Applications will be required for 4 years. Materials to outfit well are assumed at $6,500 per well.

440.000	***SUBCONTRACTS***			
D014	Mobilization	1.00 ls	10,000.00 /ls	10,000
D025	Apply Bioaugmentation Chemicals to Existing Wells	10.00 ea	10,000.00 /ea	100,000
D050	Equipment for Chemical Injection per well	10.00 ea	6,500.00 /ea	65,000
D016	Demobilization	1.00 ls	5,000.00 /ls	5,000
	SUBCONTRACTS			*180,000*
	02.38 Apply Yearly Bioaugmentation (Periodic)		180,000.00 **/ea**	**180,000**
	1.00 ls		4 Events	**720,000**

02.40 Groundwater Sampling - Sampling (O&M)

Monitoring schedule is quarterly for 2 years, semiannually for 3 years, once a year for 10 years, and every 5 years after that for a total of 27 sampling events. Assume 50 wells. Activity is per sampling event.

100.000	***HOME LABOR***			
E392	Project Manager	10.00 hour	140.00 /hour	1,400
	HOME LABOR			*1,400*
	10.00 Labor hours			
120.000	***FIELD LABOR***			
E262	Engineer 2	50.00 hour	84.00 /hour	4,200
H212	Laborer 2	80.00 hour	39.00 /hour	3,120
	FIELD LABOR			*7,320*
	130.00 Labor hours			
200.000	***SHAW EQUIPMENT***			
V13	Pick-Up Truck with Fuel	4.00 day	75.00 /day	300
	SHAW EQUIPMENT			*300*
	32.00 Equipment hours			
250.000	***MOBILIZATION / DEMOBILIZATION***			
E210	Mobilization	1.00 ls	500.00 /ls	500
E220	Demobilization	1.00 ls	500.00 /ls	500
	MOBILIZATION / DEMOBILIZATION			*1,000*
300.000	***MATERIAL***			
	includes air compressor and sample pump rental plus disposable tubing for each well			
E100	Misc Sampling Supplies	1.00 ea	1,500.00 /ea	1,500
	MATERIAL			*1,500*
400.000	***ANALYTICAL***			
A001	Analytical (VOCs)	50.00 ea	250.00 /ea	12,500
A002	Analytical (VOCs) QC samples	6.00 ea	250.00 /ea	1,500
A003	Analytical (MNA Parameters)	20.00 ea	200.00 /ea	4,000

Item	Description	Takeoff Qty	Unit Cost	Total Amount
	ANALYTICAL			*18,000*
	02.40 Groundwater Sampling - Sampling (O&M)		29,520.00 **/ea**	**29,520**
	1.00 /ea		27 Events	**797,040**
	140.00 Labor hours	3,780.00		
	32.00 Equipment hours	864.00		

02.45 Groundwater Sampling - Reporting (O&M)

One report for each sampling event.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
100.000	***HOME LABOR***			
E373	Project Engineer	40.00 hour	105.00 /hour	4,200
E392	Project Manager	10.00 hour	140.00 /hour	1,400
N112	Administrative Assistant	10.00 hour	47.00 /hour	470
	HOME LABOR			*6,070*
	60.00 Labor hours			
440.000	***SUBCONTRACTS***			
E110	Reproduction/Shipping Small Report	10.00 ea	50.00 /ea	500
	SUBCONTRACTS			*500*
	02.45 Groundwater Sampling - Reporting (O&M)		6,570.00 **/ea**	**6,570**
	1.00 ea		27 Events	**177,390**
	60.00 Labor hours	1,620.00		

02.80 5 Year Project Reviews (Periodic)

The assumptions in this activity are identical to similar activities in earlier alternatives.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
100.000	***HOME LABOR***			
E373	Project Engineer	60.00 hour	105.00 /hour	6,300
E392	Project Manager	60.00 hour	140.00 /hour	8,400
E422	Proposals Specialist / CAD	20.00 hour	72.00 /hour	1,440
N112	Administrative Assistant	20.00 hour	47.00 /hour	940
	HOME LABOR			*17,080*
	160.00 Labor hours			
440.000	***SUBCONTRACTS***			
E100	Meeting Displays and Handouts	1.00 ls	5,000.00 /ls	5,000
E110	Reproduction/Shipping Small Report	10.00 ea	50.00 /ea	500
	SUBCONTRACTS			*5,500*
700.000	***OTHER DIRECT COSTS***			
B200	Meeting Facility Rental	1.00 ls	1,500.00 /ls	1,500
	OTHER DIRECT COSTS			*1,500*
	02.80 5 Year Project Reviews (Periodic)		24,080.00 **/ea**	**24,080**
	1.00 ea		6 Events	**144,480**
	160.00 Labor hours	960.00		

02 Alternative 2 - In-Situ Treatment 3,449,590

970.00 Labor hours	13,640.00	
32.00 Equipment hours	864.00	

Alternative 3 - Hydraulic Containment with Pump and Treat
Jones Road Groundwater Plume Federal Superfund Site

		Unit Cost	Units	Total
03.01	Project Management (O&M)	20,500	30	615,000
03.02	Hydraulic Testing (Capital)	146,000	1	146,000
03.09	Install Monitor Wells (Capital)	264,200	1	264,200
03.10	Install Extraction Wells (Capital)	588,120	1	588,120
03.11	Install Injection Wells (Capital)	588,120	1	588,120
03.15	Pilot Study for Air Stripping (Capital)	60,000	1	60,000
03.16	Remedial Design (Capital)	41,020	1	41,020
03.20	Install GW Treatment System (Capital)	1,130,600	1	1,130,600
03.26	Operation of Treatment System (O&M)	58,460	30	1,753,800
03.40	Groundwater Sampling - Sampling (O&M)	29,520	27	797,040
03.45	Groundwater Sampling - Reporting (O&M)	6,570	27	177,390
03.80	5 Year Project Reviews (Periodic)	24,080	6	144,480

Year	03.01	03.02 / 20	03.26	03.40	03.45	03.80	Year Totals
1	$20,500	$2,818,060	$58,460	$118,080	$26,280		$3,041,380
2	$20,500		$58,460	$118,080	$26,280		$223,320
3	$20,500		$58,460	$59,040	$13,140		$151,140
4	$20,500		$58,460	$59,040	$13,140		$151,140
5	$20,500		$58,460	$59,040	$13,140	$24,080	$175,220
6	$20,500		$58,460	$29,520	$6,570		$115,050
7	$20,500		$58,460	$29,520	$6,570		$115,050
8	$20,500		$58,460	$29,520	$6,570		$115,050
9	$20,500		$58,460	$29,520	$6,570		$115,050
10	$20,500		$58,460	$29,520	$6,570	$24,080	$139,130
11	$20,500		$58,460	$29,520	$6,570		$115,050
12	$20,500		$58,460	$29,520	$6,570		$115,050
13	$20,500		$58,460	$29,520	$6,570		$115,050
14	$20,500		$58,460	$29,520	$6,570		$115,050
15	$20,500		$58,460	$29,520	$6,570	$24,080	$139,130
16	$20,500		$58,460				$78,960
17	$20,500		$58,460				$78,960
18	$20,500		$58,460				$78,960
19	$20,500		$58,460				$78,960
20	$20,500		$58,460	$29,520	$6,570	$24,080	$139,130
21	$20,500		$58,460				$78,960
22	$20,500		$58,460				$78,960
23	$20,500		$58,460				$78,960
24	$20,500		$58,460				$78,960
25	$20,500		$58,460	$29,520	$6,570	$24,080	$139,130
26	$20,500		$58,460				$78,960
27	$20,500		$58,460				$78,960
28	$20,500		$58,460				$78,960
29	$20,500		$58,460				$78,960
30	$20,500		$58,460	$29,520	$6,570	$24,080	$139,130
Total	$615,000	$2,818,060	$1,753,800	$797,040	$177,390	$144,480	$6,305,770
NPV @ 7%	$272,192	$2,818,060	$776,213	$561,458	$124,959	$114,778	$4,667,661
C, P, O&M	O&M	C	O&M	O&M	O&M	P	

Category	Source Area	Deep Groundwater Plume		Totals	Subtotals	NPV @ 7%
Capital	$563,612	$2,254,448		$2,818,060	C	$2,818,060
Periodic	$28,896	$115,584		$144,480	P	$114,778
O&M	$668,646	$2,674,584		$3,343,230	O&M	$1,734,822
	$1,261,154	$5,044,616	$6,305,770	$6,305,770		$4,667,661

Item	Description	Takeoff Qty	Unit Cost	Total Amount

03 Alternative 3 - Hydraulic Containment w/ Pump & Treat

The Hydraulic Containment with Pump and Treat alternative includes institutional controls to prevent groundwater use, prevent new wells in the plume, and require better construction for deeper wells, as well as installation of a pump and treat system to remove PCE from groundwater. The groundwater treatment system will consist of a carbon based water treatment system with air strippers. The system will be housed in a pre-engineered metal building for security and weather protection. Sampling will be required in 50 wells to evaluate hydraulic containment and progress of pump and treat system, plume limits, and appropriateness of institutional control boundaries.

03.01 Project Management (O&M)

Activity is project management for project performance, interface with regulators, interface with public, procurement, billing.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
100.000	***HOME LABOR***			
E392	Project Manager	80.00 hour	140.00 /hour	11,200
E422	Proposals Specialist / CAD	30.00 hour	72.00 /hour	2,160
N112	Administrative Assistant	120.00 hour	47.00 /hour	5,640
	HOME LABOR			*19,000*
	230.00 Labor hours			
440.000	***SUBCONTRACTS***			
E100	Meeting Displays and Handouts	1.00 ls	1,000.00 /ls	1,000
	SUBCONTRACTS			*1,000*
700.000	***OTHER DIRECT COSTS***			
B200	Meeting Facility Rental	1.00 ls	500.00 /ls	500
	OTHER DIRECT COSTS			*500*
	03.01 Project Management (O&M)		20,500.00 **/ls**	**20,500**
	1.00 /ls		30 years	**615,000**
	230.00 Labor hours	6900.00		

03.02 Hydraulic Testing (Capital)

Hydraulic testing (slug test) of shallow and deep wells to determine hydraulic conductivities.
Additionally, screen depths of 20 selected wells will be determined by downhole well logging.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
440.000	***SUBCONTRACTS***			
D001	Slug Testing of shallow wells (<50 ft bgs)	3.00 ea	2,000.00 /ea	6,000
D002	Slug Testing of deep wells (>50 ft bgs)	10.00 ea	4,000.00 /ea	40,000
D003	Determine unknown well screen depths	20.00 ea	5,000.00 /ea	100,000
	SUBCONTRACTS			*146,000*
	03.02 Hydraulic Testing (Capital)		146,000.00 **/ls**	**146,000**

03.09 Install Monitor Wells (Capital)

Monitor wells are needed to characterize groundwater in the depth range between 50 and 200 feet.
No monitor wells are screened in this depth interval, and very few water wells are screened this shallow.

Item	Description	Takeoff Qty	Unit Cost	Total Amount
120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	50.00 hour	100.00 /hour	5,000
E262	Engineer 2	50.00 hour	84.00 /hour	4,200
	CONSTRUCTION MANAGEMENT			*9,200*
	100.00 Labor hours			

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
440.000	***SUBCONTRACTS***			
D004	Mobilization	1.00 ea	10,000.00 /ea	10,000
D005	Install Monitor Wells	4.00 ea	60,000.00 /ea	240,000
D006	Demobilization	1.00 ea	5,000.00 /ea	5,000
	SUBCONTRACTS			*255,000*
	03.09 Install Monitor Wells (Capital)		264,200.00 **/ls**	**264,200**
	4.00 ea			
	100.00 Labor hours	100.00		

03.10 Install Extraction Wells (Capital)

Activity is installation of 6 extraction wells, assumed 250 LF depth each

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	180.00 hour	100.00 /hour	18,000
E262	Engineer 2	180.00 hour	84.00 /hour	15,120
	CONSTRUCTION MANAGEMENT			*33,120*
	360.00 Labor hours			
440.000	***SUBCONTRACTS***			
D009	Mobilization	1.00 ea	10,000.00 /ea	10,000
D010	Install Extraction Wells	6.00 ea	90,000.00 /ea	540,000
D011	Demobilization	1.00 ea	5,000.00 /ea	5,000
	SUBCONTRACTS			*555,000*
	03.10 Install Extraction Wells (Capital)		588,120.00 **/ls**	**588,120**
	6.00 ls			
	360.00 Labor hours	360.00		

03.11 Install Injection Wells (Capital)

Activity is installation of 6 extraction wells, assumed 250 LF depth each

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	180.00 hour	100.00 /hour	18,000
E262	Engineer 2	180.00 hour	84.00 /hour	15,120
	CONSTRUCTION MANAGEMENT			*33,120*
	360.00 Labor hours			
440.000	***SUBCONTRACTS***			
D009	Mobilization	1.00 ea	10,000.00 /ea	10,000
D010	Install Injection Wells	6.00 ea	90,000.00 /ea	540,000
D011	Demobilization	1.00 ea	5,000.00 /ea	5,000
	SUBCONTRACTS			*555,000*
	03.11 Install Injection Wells (Capital)		588,120.00 **/ls**	**588,120**
	6.00 ls			
	360.00 Labor hours	360.00		

03.15 Pilot Study for Air Stripping (Capital)

Activity is the pilot study to select the most effective air stripping unit for operating to treat extracted groundwater.
Estimated activities include:

Field trials for Air Stripping unit.
Pilot Study Report

Item	Description	Takeoff Qty	Unit Cost	Total Amount
440.000	***SUBCONTRACTS***			
D006	Air Stripping Field Trials	1.00 ls	50,000.00 /ls	50,000
D009	Pilot Study Report	1.00 ls	10,000.00 /ls	10,000
	SUBCONTRACTS			*60,000*
	03.15 Pilot Study for Air Stripping (Capital)		60,000.00 **/ea**	**60,000**
	1.00 ls			

03.16 Remedial Design (Capital)

Activity is remedial design for the Air Stripping groundwater treatment system.

100.000	***HOME LABOR***			
E392	Project Manager	80.00 hour	140.00 /hour	11,200
E373	Project Engineer	120.00 hour	105.00 /hour	12,600
E262	Engineer 2	120.00 hour	84.00 /hour	10,080
E422	Proposals Specialist / CAD	60.00 hour	72.00 /hour	4,320
N112	Administrative Assistant	60.00 hour	47.00 /hour	2,820
	HOME LABOR	440.00 Labor hours		*41,020*
	03.16 Remedial Design (Capital)		41,020.00 **/ls**	**41,020**
	1.00 /ls			
	440.00 Labor hours	440.00		

03.20 Install GW Treatment System (Capital)

Activity is installation of a groundwater treatment system. Assumptions:
* One system will be used for each side of the project.
* The groundwater treatment system will consist of an air stripper water treatment system with carbon polishing.
* The system will be housed in a pre-engineered metal building for security and weather protection.

120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	200.00 hour	100.00 /hour	20,000
E262	Engineer 2	100.00 hour	84.00 /hour	8,400
	CONSTRUCTION MANAGEMENT			*28,400*
	300.00 Labor hours			
440.000	***SUBCONTRACTs***			
D005	Install Recovery Piping	10,000.00 lf	35.00 /lf	350,000
D015	Jack and Bore Pipe Under Roadways	6.00 ea	7,500.00 /ea	45,000
D025	Installation of System	2.00 ls	350,000.00 /ls	700,000
D057	GW System - Startup Testing	12.00 months	600.00 /month	7,200
	SUBCONTRACTs			*1,102,200*
	03.20 Install GW Treatment System (Capital)		1,130,600.00 **/ls**	**1,130,600**
	1.00 /ls			
	300.00 Labor hours	300.00		

03.26 Operation of Treatment System (O&M)

Activity is operation of Treatment System. Assumptions:
* Operating crew will be two persons - system will be designed to operate unattended.
* Weekly checks and adjustment - 2 hrs.
* Monthly Minor maintenance - 8 hrs.
* Annual Major maintenance - 24 hrs. (Field Supervisor included)

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
120.000	***ATTENDED OPERATIONS***			
E292	Field Supervisor	24.00 hour	100.00 /hour	2,400
H212	Laborer 2	220.00 hour	39.00 /hour	8,580
E262	Engineer 2	220.00 hour	84.00 /hour	18,480
	ATTENDED OPERATIONS			*29,460*
	464.00 Labor hours			
440.000	***SUBCONTRACTs***			
D050	Operate GW System - Electricity	1.00 yrs	15,000.00 /yr	15,000
D055	Operate GW System - Chemicals	1.00 yrs	5,000.00 /yr	5,000
D060	Operate GW System - Repairs	1.00 yrs	9,000.00 /yr	9,000
	SUBCONTRACTs			*29,000*
	03.26 Operation of Treatment System (O&M)		**58,460.00 /yr**	**58,460**
	1.00 /yrs		30 Events	**1,753,800**
	464.00 Labor hours	13,920.00		

03.40 Groundwater Sampling - Sampling (O&M)

Monitoring schedule is quarterly for 2 years, semiannually for 3 years, once a year for 10 years, and every 5 years after that for a total of 27 sampling events. Assume 50 wells. Activity is per sampling event.

100.000	***HOME LABOR***			
E392	Project Manager	10.00 hour	140.00 /hour	1,400
	HOME LABOR			*1,400*
	10.00 Labor hours			
120.000	***FIELD LABOR***			
E262	Engineer 2	50.00 hour	84.00 /hour	4,200
H212	Laborer 2	80.00 hour	39.00 /hour	3,120
	FIELD LABOR			*7,320*
	130.00 Labor hours			
200.000	***SHAW EQUIPMENT***			
V13	Pick-Up Truck with Fuel	4.00 day	75.00 /day	300
	SHAW EQUIPMENT			*300*
	32.00 Equipment hours			
250.000	***MOBILIZATION / DEMOBILIZATION***			
E210	Mobilization	1.00 ls	500.00 /ls	500
E220	Demobilization	1.00 ls	500.00 /ls	500
	MOBILIZATION / DEMOBILIZATION			*1,000*
300.000	***MATERIAL***			
	includes air compressor and sample pump rental plus disposable tubing for each well			
E100	Misc Sampling Supplies	1.00 ea	1,500.00 /ea	1,500
	MATERIAL			*1,500*
400.000	***ANALYTICAL***			
A001	Analytical (VOCs)	50.00 ea	250.00 /ea	12,500
A002	Analytical (VOCs) QC samples	6.00 ea	250.00 /ea	1,500
A003	Analytical (MNA Parameters)	20.00 ea	200.00 /ea	4,000
	ANALYTICAL			*18,000*

Item	Description	Takeoff Qty	Unit Cost	Total Amount
	03.40 Groundwater Sampling - Sampling (O&M)		29,520.00 **/ea**	**29,520**
	1.00 /ea		27 Events	**797,040**
	140.00 Labor hours	3,780.00		
	32.00 Equipment hours	864.00		
03.45	**Groundwater Sampling - Reporting (O&M)**			
	One report for each sampling event.			
100.000	***HOME LABOR***			
E373	Project Engineer	40.00 hour	105.00 /hour	4,200
E392	Project Manager	10.00 hour	140.00 /hour	1,400
N112	Administrative Assistant	10.00 hour	47.00 /hour	470
	HOME LABOR			*6,070*
	60.00 Labor hours			
440.000	***SUBCONTRACTS***			
E110	Reproduction/Shipping Small Report	10.00 ea	50.00 /ea	500
	SUBCONTRACTS			*500*
	03.45 Groundwater Sampling - Reporting (O&M)		6,570.00 **/ea**	**6,570**
	1.00 ea		27 Events	**177,390**
	60.00 Labor hours	1,620.00		
03.80	**5 Year Project Reviews (Periodic)**			
	The assumptions in this activity are identical to similar activities in earlier alternatives.			
100.000	***HOME LABOR***			
E373	Project Engineer	60.00 hour	105.00 /hour	6,300
E392	Project Manager	60.00 hour	140.00 /hour	8,400
E422	Proposals Specialist / CAD	20.00 hour	72.00 /hour	1,440
N112	Administrative Assistant	20.00 hour	47.00 /hour	940
	HOME LABOR			*17,080*
	160.00 Labor hours			
440.000	***SUBCONTRACTS***			
E100	Meeting Displays and Handouts	1.00 ls	5,000.00 /ls	5,000
E110	Reproduction/Shipping Small Report	10.00 ea	50.00 /ea	500
	SUBCONTRACTS			*5,500*
700.000	***OTHER DIRECT COSTS***			
B200	Meeting Facility Rental	1.00 ls	1,500.00 /ls	1,500
	OTHER DIRECT COSTS			*1,500*
	03.80 5 Year Project Reviews (Periodic)		24,080.00 **/ea**	**24,080**
	1.00 ea		6 Events	**144,480**
	160.00 Labor hours	960		
03	**Alternative 3 - Hydraulic Containment w/ Pump & Treat**			**6,305,770**
	2614.00 Labor hours	28740.00		
	32.00 Equipment hours	864.00		

Alternative 4 - In Situ Enhanced Pump and Treat
Jones Road Groundwater Plume Federal Superfund Site

		Unit Cost	Units	Total
04.01	Project Management (O&M)	20,500	30	615,000
04.02	Hydraulic Testing (Capital)	146,000	1	146,000
04.09	Install Monitor Wells (Capital)	264,200	1	264,200
04.10	Install Extraction Wells (Capital)	588,120	1	588,120
04.11	Install Injection Wells (Capital)	588,120	1	588,120
04.15	Pilot Study for Air Stripping (Capital)	60,000	1	60,000
04.17	Remedial Design (Capital)	66,500	1	66,500
04.20	Install GW Treatment System (Capital)	1,130,600	1	1,130,600
04.26	Operation of Treatment System (O&M)	58,460	30	1,753,800
04.30	Pilot Study for Selecting In Situ Methods (Capital)	155,000	1	155,000
04.32	Apply ISCO Chemicals (Periodic)	180,000	2	360,000
04.38	Apply Yearly Bioaugmentation (Periodic)	180,000	4	720,000
04.40	Groundwater Sampling - Sampling (O&M)	29,520	27	797,040
04.45	Groundwater Sampling - Reporting (O&M)	6,570	27	177,390
04.80	5 Year Project Reviews (Periodic)	24,080	6	144,480

Year	04.01	04.02-20,30	04.26	04.32	04.38	04.40	04.45	04.80	Year Totals
1	$20,500	$2,998,540	$58,460	$180,000	$180,000	$118,080	$26,280		$3,581,860
2	$20,500		$58,460	$180,000	$180,000	$118,080	$26,280		$583,320
3	$20,500		$58,460		$180,000	$59,040	$13,140		$331,140
4	$20,500		$58,460		$180,000	$59,040	$13,140		$331,140
5	$20,500		$58,460			$59,040	$13,140	$24,080	$175,220
6	$20,500		$58,460			$29,520	$6,570		$115,050
7	$20,500		$58,460			$29,520	$6,570		$115,050
8	$20,500		$58,460			$29,520	$6,570		$115,050
9	$20,500		$58,460			$29,520	$6,570		$115,050
10	$20,500		$58,460			$29,520	$6,570	$24,080	$139,130
11	$20,500		$58,460			$29,520	$6,570		$115,050
12	$20,500		$58,460			$29,520	$6,570		$115,050
13	$20,500		$58,460			$29,520	$6,570		$115,050
14	$20,500		$58,460			$29,520	$6,570		$115,050
15	$20,500		$58,460			$29,520	$6,570	$24,080	$139,130
16	$20,500		$58,460						$78,960
17	$20,500		$58,460						$78,960
18	$20,500		$58,460						$78,960
19	$20,500		$58,460						$78,960
20	$20,500		$58,460			$29,520	$6,570	$24,080	$139,130
21	$20,500		$58,460						$78,960
22	$20,500		$58,460						$78,960
23	$20,500		$58,460						$78,960
24	$20,500		$58,460						$78,960
25	$20,500		$58,460			$29,520	$6,570	$24,080	$139,130
26	$20,500		$58,460						$78,960
27	$20,500		$58,460						$78,960
28	$20,500		$58,460						$78,960
29	$20,500		$58,460						$78,960
30	$20,500		$58,460			$29,520	$6,570	$24,080	$139,130
Total	$615,000	$2,998,540	$1,753,800	$360,000	$720,000	$797,040	$177,390	$144,480	$7,566,250
NPV @ 7%	$272,192	$2,998,540	$776,213	$348,224	$652,377	$561,458	$124,959	$114,778	$5,848,742
C, P, O&M	O&M	C	O&M	P	P	O&M	O&M	P	

Category	Source Area	Deep Groundwater Plume					Totals	Subtotals	NPV @ 7%
Capital	$599,708	$2,398,832					$2,998,540	C	$2,998,540
Periodic	$388,896	$835,584					$1,224,480	P	$1,115,379
O&M	$668,646	$2,674,584					$3,343,230	O&M	$1,734,822
	$1,657,250	$5,909,000	$7,566,250				$7,566,250		$5,848,742

Item	Description	Takeoff Qty	Unit Cost	Total Amount

04 Alternative 4 - In Situ Enhanced Pump & Treat

Alternative 4 is in situ enhancement to the pump and treat system. This alternative includes
1.) institutional controls to prevent groundwater use, prevent new wells in the plume, and require better construction for deeper wells,
2.) installation of a pump and treat system to remove PCE from groundwater,
3.) application of in-situ chemical oxidation treatment to soil and shallow groundwater in the source area, and
4.) application of in-situ bioaugmentation to deep groundwater.
The groundwater treatment system will consist of a carbon based water treatment system with air strippers. The system will be housed in a pre-engineered metal building for security and weather protection. Sampling will be required in 50 wells to evaluate hydraulic containment and progress of pump and treat system, plume limits, and appropriateness of institutional control boundaries.

04.01 Project Management (O&M)

Activity is project management for project performance, interface with regulators, interface with public, procurement, billing.

100.000	***HOME LABOR***				
E392	Project Manager	80.00 hour	140.00 /hour		11,200
E422	Proposals Specialist / CAD	30.00 hour	72.00 /hour		2,160
N112	Administrative Assistant	120.00 hour	47.00 /hour		5,640
	HOME LABOR				*19,000*
	230.00 Labor hours				
440.000	***SUBCONTRACTS***				
E100	Meeting Displays and Handouts	1.00 ls	1,000.00 /ls		1,000
	SUBCONTRACTS				*1,000*
700.000	***OTHER DIRECT COSTS***				
B200	Meeting Facility Rental	1.00 ls	500.00 /ls		500
	OTHER DIRECT COSTS				*500*
	04.01 Project Management (O&M)		20,500.00 **/ls**		**20,500**
	1.00 /ls		30 years		**615,000**
	230.00 Labor hours	6900.00			

04.02 Hydraulic Testing (Capital)

Hydraulic testing (slug test) of shallow and deep wells to determine hydraulic conductivities.
Additionally, screen depths of 20 selected wells will be determined by downhole well logging.

440.000	***SUBCONTRACTS***				
D001	Slug Testing of shallow wells (<50 ft bgs)	3.00 ea	2,000.00 /ea		6,000
D002	Slug Testing of deep wells (>50 ft bgs)	10.00 ea	4,000.00 /ea		40,000
D003	Determine unknown well screen depths	20.00 ea	5,000.00 /ea		100,000
	SUBCONTRACTS				*146,000*
	04.02 Hydraulic Testing (Capital)		146,000.00 **/ls**		**146,000**

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
04.09	**Install Monitor Wells (Capital)**			
	Monitor wells are needed to characterize groundwater in the depth range between 50 and 200 feet. No monitor wells are screened in this depth interval, and very few water wells are screened this shallow.			
120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	50.00 hour	100.00 /hour	5,000
E262	Engineer 2	50.00 hour	84.00 /hour	4,200
	CONSTRUCTION MANAGEMENT			*9,200*
	100.00 Labor hours			
440.000	***SUBCONTRACTS***			
D004	Mobilization	1.00 ea	10,000.00 /ea	10,000
D005	Install Monitor Wells	4.00 ea	60,000.00 /ea	240,000
D006	Demobilization	1.00 ea	5,000.00 /ea	5,000
	SUBCONTRACTS			*255,000*
	04.09 Install Monitor Wells (Capital)		264,200.00 **/ls**	**264,200**
	4.00 ea			
	100.00 Labor hours	100.00		
04.10	**Install Extraction Wells (Capital)**			
	Activity is installation of 6 extraction wells, assumed 250 LF depth each			
120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	180.00 hour	100.00 /hour	18,000
E262	Engineer 2	180.00 hour	84.00 /hour	15,120
	CONSTRUCTION MANAGEMENT			*33,120*
	360.00 Labor hours			
440.000	***SUBCONTRACTS***			
D009	Mobilization	1.00 ea	10,000.00 /ea	10,000
D010	Install Extraction Wells	6.00 ea	90,000.00 /ea	540,000
D011	Demobilization	1.00 ea	5,000.00 /ea	5,000
	SUBCONTRACTS			*555,000*
	04.10 Install Extraction Wells (Capital)		588,120.00 **/ls**	**588,120**
	6.00 ls			
	360.00 Labor hours	360.00		
04.11	**Install Injection Wells (Capital)**			
	Activity is installation of 6 extraction wells, assumed 250 LF depth each			
120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	180.00 hour	100.00 /hour	18,000
E262	Engineer 2	180.00 hour	84.00 /hour	15,120
	CONSTRUCTION MANAGEMENT			*33,120*
	360.00 Labor hours			
440.000	***SUBCONTRACTS***			
D009	Mobilization	1.00 ea	10,000.00 /ea	10,000
D010	Install Injection Wells	6.00 ea	90,000.00 /ea	540,000
D011	Demobilization	1.00 ea	5,000.00 /ea	5,000
	SUBCONTRACTS			*555,000*

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
	04.11 Install Injection Wells (Capital)		588,120.00 **/ls**	**588,120**
	6.00 ls			
	360.00 Labor hours	360.00		

04.15 Pilot Study for Air Stripping (Capital)

Activity is the pilot study to select the most effective air stripping unit for operating to treat extracted groundwater.
Estimated activities include:
Field trials for Air Stripping unit.
Pilot Study Report

440.000	***SUBCONTRACTS***			
D006	Air Stripping Field Trials	1.00 ls	50,000.00 /ls	50,000
D009	Pilot Study Report	1.00 ls	10,000.00 /ls	10,000
	SUBCONTRACTS			*60,000*
	04.15 Pilot Study for Air Stripping (Capital)		60,000.00 **/ea**	**60,000**
	1.00 ls			

04.17 Remedial Design (Capital)

Activity is remedial design for the Air Stripping groundwater treatment system, and
remedial design for the application of In Situ treatment to shallow and deep groundwater.

100.000	***HOME LABOR***			
E392	Project Manager	120.00 hour	140.00 /hour	16,800
E373	Project Engineer	200.00 hour	105.00 /hour	21,000
E262	Engineer 2	200.00 hour	84.00 /hour	16,800
E422	Proposals Specialist / CAD	100.00 hour	72.00 /hour	7,200
N112	Administrative Assistant	100.00 hour	47.00 /hour	4,700
	HOME LABOR	720.00 Labor hours		*66,500*
	04.17 Remedial Design (Capital)		66,500.00 **/ls**	**66,500**
	1.00 /ls			
	720.00 Labor hours	720.00		

04.20 Install GW Treatment System (Capital)

Activity is installation of a groundwater treatment system. Assumptions:
* One system will be used for each side of the project.
* The groundwater treatment system will consist of an air stripper water treatment system with carbon polishing.
* The system will be housed in a pre-engineered metal building for security and weather protection.

120.000	***CONSTRUCTION MANAGEMENT***			
E292	Field Supervisor	200.00 hour	100.00 /hour	20,000
E262	Engineer 2	100.00 hour	84.00 /hour	8,400
	CONSTRUCTION MANAGEMENT			*28,400*
	300.00 Labor hours			
440.000	***SUBCONTRACTs***			
D005	Install Recovery Piping	10,000.00 lf	35.00 /lf	350,000
D015	Jack and Bore Pipe Under Roadways	6.00 ea	7,500.00 /ea	45,000
D025	Installation of System	2.00 ls	350,000.00 /ls	700,000
D057	GW System - Startup Testing	12.00 months	600.00 /month	7,200
	SUBCONTRACTs			*1,102,200*

Item	Description	Takeoff Qty	Unit Cost	Total Amount
	04.20 Install GW Treatment System (Capital)		1,130,600.00 **/ls**	**1,130,600**
	1.00 /ls			
	300.00 Labor hours	300.00		

04.26 Operation of Treatment System (O&M)

Activity is operation of Treatment System. Assumptions:
* Operating crew will be two persons - system will be designed to operate unattended.
* Weekly checks and adjustment - 2 hrs.
* Monthly Minor maintenance - 8 hrs.
* Annual Major maintenance - 24 hrs. (Field Supervisor included)

120.000	***ATTENDED OPERATIONS***			
E292	Field Supervisor	24.00 hour	100.00 /hour	2,400
H212	Laborer 2	220.00 hour	39.00 /hour	8,580
E262	Engineer 2	220.00 hour	84.00 /hour	18,480
	ATTENDED OPERATIONS			*29,460*
	464.00 Labor hours			
440.000	***SUBCONTRACTs***			
D050	Operate GW System - Electricity	1.00 yrs	15,000.00 /yr	15,000
D055	Operate GW System - Chemicals	1.00 yrs	5,000.00 /yr	5,000
D060	Operate GW System - Repairs	1.00 yrs	9,000.00 /yr	9,000
	SUBCONTRACTs			*29,000*
	04.26 Operation of Treatment System (O&M)		**58,460.00 /yr**	**58,460**
	1.00 /yrs		30 Events	**1,753,800**
	464.00 Labor hours	13,920.00		

04.30 Pilot Study for Selecting In Situ Methods (Capital)

Activity is the pilot study to select the most effective in situ method to apply to the source area groundwater and the deep groundwater plume. Estimated activities include:
ISCO field trials for three chemical mix / delivery combinations.
Biostimulation application at one well in deep zone.
Bioaugmentation application at one well in deep zone.
Pilot Study Report

440.000	***SUBCONTRACTS***			
D006	ISCO field trials	1.00 ls	100,000.00 /ls	100,000
D007	Biostimulation field trial	1.00 ls	20,000.00 /ls	20,000
D008	Bioaugmentation field trial	1.00 ls	20,000.00 /ls	20,000
D009	Pilot Study Report	1.00 ls	15,000.00 /ls	15,000
	SUBCONTRACTS			*155,000*
	04.30 Pilot Study for Selecting In Situ Methods (Capital)		155,000.00 **/ea**	**155,000**
	1.00 ls			

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount

04.32 Apply ISCO Chemicals (Periodic)

Activity is the initial application of chemical products to promote in-situ chemical oxidation to source area groundwater
The ISCO for the groundwater remediation will be dispersed by injection around MW-1 and MW-6 - 8 temporary injection wells (150,000 per application) 2 applications separated by a year

440.000	***SUBCONTRACTS***			
D014	Mobilization	1.00 ls	20,000.00 /ls	20,000
D015	Apply Chemical Oxidation to Shallow GW	1.00 ls	150,000.00 /ls	150,000
D016	Demobilization	1.00 ls	10,000.00 /ls	10,000
	SUBCONTRACTS			*180,000*
	04.32 Apply ISCO Chemicals (Periodic)		180,000.00 **/ea**	**180,000**
	1.00 ls		2 Events	**360,000**

04.38 Apply Yearly Bioaugmentation (Periodic)

Activity is apply of bio-augmentation chemicals to ten existing unused water wells. Assume each application has a cost of $10,000 per well, or $100,000 per year. Applications will be required for 4 years. Materials to outfit well are assumed at $6,500 per well.

440.000	***SUBCONTRACTS***			
D014	Mobilization	1.00 ls	10,000.00 /ls	10,000
D025	Apply Bioaugmentation Chemicals to	10.00 ea	10,000.00 /ea	100,000
D050	Equipment for Chemical Injection per well	10.00 ea	6,500.00 /ea	65,000
D016	Demobilization	1.00 ls	5,000.00 /ls	5,000
	SUBCONTRACTS			*180,000*
	04.38 Apply Yearly Bioaugmentation (Periodic)		180,000.00 **/ea**	**180,000**
	1.00 ls		4 Events	**720,000**

04.40 Groundwater Sampling - Sampling (O&M)

Monitoring schedule is quarterly for 2 years, semiannually for 3 years, once a year for 10 years, and every 5 years after that for a total of 27 sampling events. Assume 50 wells. Activity is per sampling event.

100.000	***HOME LABOR***			
E392	Project Manager	10.00 hour	140.00 /hour	1,400
	HOME LABOR			*1,400*
	10.00 Labor hours			
120.000	***FIELD LABOR***			
E262	Engineer 2	50.00 hour	84.00 /hour	4,200
H212	Laborer 2	80.00 hour	39.00 /hour	3,120
	FIELD LABOR			*7,320*
	130.00 Labor hours			
200.000	***SHAW EQUIPMENT***			
V13	Pick-Up Truck with Fuel	4.00 day	75.00 /day	300
	SHAW EQUIPMENT			*300*
	32.00 Equipment hours			
250.000	***MOBILIZATION / DEMOBILIZATION***			
E210	Mobilization	1.00 ls	500.00 /ls	500
E220	Demobilization	1.00 ls	500.00 /ls	500
	MOBILIZATION / DEMOBILIZATION			*1,000*

Item	Description	Takeoff Qty	Total Unit Cost	Total Amount
300.000	***MATERIAL***			
	includes air compressor and sample pump rental plus disposable tubing for each well			
E100	Misc Sampling Supplies	1.00 ea	1,500.00 /ea	1,500
	MATERIAL			*1,500*
400.000	***ANALYTICAL***			
A001	Analytical (VOCs)	50.00 ea	250.00 /ea	12,500
A002	Analytical (VOCs) QC samples	6.00 ea	250.00 /ea	1,500
A003	Analytical (MNA Parameters)	20.00 ea	200.00 /ea	4,000
	ANALYTICAL			*18,000*
	04.40 Groundwater Sampling - Sampling (O&M)		29,520.00 **/ea**	**29,520**
	1.00 /ea		27 Events	**797,040**
	140.00 Labor hours	3,780.00		
	32.00 Equipment hours	864.00		

04.45 Groundwater Sampling - Reporting (O&M)

One report for each sampling event.

100.000	***HOME LABOR***			
E373	Project Engineer	40.00 hour	105.00 /hour	4,200
E392	Project Manager	10.00 hour	140.00 /hour	1,400
N112	Administrative Assistant	10.00 hour	47.00 /hour	470
	HOME LABOR			*6,070*
	60.00 Labor hours			
440.000	***SUBCONTRACTS***			
E110	Reproduction/Shipping Small Report	10.00 ea	50.00 /ea	500
	SUBCONTRACTS			*500*
	04.45 Groundwater Sampling - Reporting (O&M)		6,570.00 **/ea**	**6,570**
	1.00 ea		27 Events	**177,390**
	60.00 Labor hours	1,620.00		

04.80 5 Year Project Reviews (Periodic)

The assumptions in this activity are identical to similar activities in earlier alternatives.

100.000	***HOME LABOR***			
E373	Project Engineer	60.00 hour	105.00 /hour	6,300
E392	Project Manager	60.00 hour	140.00 /hour	8,400
E422	Proposals Specialist / CAD	20.00 hour	72.00 /hour	1,440
N112	Administrative Assistant	20.00 hour	47.00 /hour	940
	HOME LABOR			*17,080*
	160.00 Labor hours			
440.000	***SUBCONTRACTS***			
E100	Meeting Displays and Handouts	1.00 ls	5,000.00 /ls	5,000
E110	Reproduction/Shipping Small Report	10.00 ea	50.00 /ea	500
	SUBCONTRACTS			*5,500*

Item	Description	Takeoff Qty	Unit Cost	Total Amount
700.000	***OTHER DIRECT COSTS***			
B200	Meeting Facility Rental	1.00 ls	1,500.00 /ls	1,500
	OTHER DIRECT COSTS			*1,500*
	04.80 5 Year Project Reviews (Periodic)		24,080.00 **/ea**	**24,080**
	1.00 ea		6 Events	**144,480**
	160.00 Labor hours	960		
	04 Alternative 4 - In Situ Enhanced Pump & Treat			**7,566,250**
	2894.00 Labor hours	29020.00		
	32.00 Equipment hours	864.00		

Appendix D

Mass Estimates

Appendix D
Mass Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Estimate of Mass of PCE Released from the Bell Facility

6948	pounds per year noted in the RI from the CEI
14.5	years of operation
100746	pounds potentially released if all pounds are PCE

But this was the waste liquid, likely not PCE. How much of it was PCE?
The 6948 pounds equates to 832.5 gallons of water, over 14.5 years is 12,071.25. say 12,000 gallons.
The 6948 pounds was derived from a figure of 3 gallons per day, and the assumed density was that of water.

So it was certainly not pure PCE, but how much PCE was in that liquid?
Possibilities include:

1) The measured PCE concentration from April 2002 (94.9 mg/L), or some multiple.
2) A PCE concentration that equals the maximum groundwater concentration (167 mg/L), or some multiple.
3) A PCE concentration that equals the solubility limit (200 mg/L), or some multiple of that (DNAPL)
4) A PCE concentration that would equal the estimated PCE in soil and groundwater
   (81+461+633 = 1176 pounds)
5) An arbitrary percentage of PCE, 2% by volume would be about the most that would not change the density much.
   2% = (980 + 20*1.62)/1000 32.4 grams PCE in a volume of 1 liter = 32,400 mg/L

	PCE Concentration mg/L	Volume gallons	Volume liters	PCE mg	PCE kg	PCE pounds	
1)	94.9	12,000	45420	4310358	4.31	9.50	
2)	167	12,000	45420	7585140	7.59	16.7	
3)	200	12,000	45420	9084000	9.08	20.0	
4)	11,740	12,000	45420	533230800	533	1176	match in situ estimated PCE ~0.7% PCE
5)	32,400	12,000	45420	1471608000	1472	3245	2% PCE

Comparing this range of mass to the estimated mass in the shallow source area, it becomes apparent that PCE may have been released over time in concentrations that exceeded the solubility limit, so there may have been DNAPL releases, although no DNAPL has been found at the site during soil and groundwater sampling activities.
The PCE concentration that matches the estimated PCE is < 1% PCE by volume, and would be roughly water weight.

Appendix D (continued)
Mass Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Shallow Groundwater PCE - Estimated by Well Concentrations

Well	Depth Category	Associated Area	Associated GW Volume 10 feet Thick (ft³)	million gallons	Liters	PCE µg/L	PCE kg	PCE lbs
MW-1	<50 Shallow	15079.5	37699	0.3	1067629	27900	29.79	65.68
MW-2	<50 Shallow	15079.5	37699	0.3	1067629	1070	1.14	2.52
MW-3	<50 Shallow	15079.5	37699	0.3	1067629	50.1	0.05	0.12
MW-6	<50 Shallow	15079.5	37699	0.3	1067629	167000	178.29	393.14

February 2008 values used 167000 209 461

Shallow Area Permeable Zone assumed to be on average, 10 feet thick. max total Kg total lbs

Figure 10 area within the 1,000 contour line is 60,318 square feet. use larger total

Total Area	# of Wells	Associated Area
60318	4	15079.5

Shallow Groundwater PCE - Estimated by Figure 10 Contours Ellipses

Well	Depth Category	Associated Area	Associated GW Volume 10 feet Thick (ft³)	million gallons	Liters	PCE µg/L	Average µg/L	PCE kg	PCE lbs
MW-6	<50 Shallow	0	0	0.0	0	167000			
100,000 µg/L	<50 Shallow	8155	20388	0.2	577374	100000	133500	77.08	169.96
10,000 µg/L	<50 Shallow	19759	49398	0.4	1398937	10000	55000	76.94	169.66
1,000 µg/L	<50 Shallow	32404	81010	0.6	2294203	1000	5500	12.62	27.82
ND	<50 Shallow	31832	79580	0.6	2253706	0	500	1.13	2.48

Figure 10 Contours used 167000 168 370

	MW-6	100,000	10,000	1,000	ND	max	total Kg	total lbs
Contour Area =	0	8155	27914	60318	92150		Similar, but smaller	
Associated =	0	8155	19759	32404	31832			

Appendix D (continued)
Mass Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Deep Groundwater PCE				Associated GW Volume						
Well	Side of JR	Depth Category	Thickness (ft)	Associated Area	Volume (ft^3)	million gallons	Liters	PCE µg/L	PCE kg	PCE lbs
JR11600	East	200-230	18	135333	608999	4.6	17246838	6.2	0.1069	0.2358
TO10830	East	200-230	18	135333	608999	4.6	17246838	0.5000	0.0086	0.0190
TO10835	East	200-230	18	135333	608999	4.6	17246838	29.6	0.5105	1.1257
TO10903	East	231-260	18	274250	1234125	9.2	34950420	75.3	2.6318	5.8030
BL10825	East	Unknown	91	230500	5243875	39.2	148506540	0.5000	0.0743	0.1637
JR11528	East	Unknown	91	230500	5243875	39.2	148506540	6.6	0.9801	2.1612
JR11614	East	Unknown	18	135333	608999	4.6	17246838	28.2	0.4864	1.0724
JR11620	East	Unknown	18	135333	608999	4.6	17246838	0.72	0.0124	0.0274
JR11642	East	Unknown	18	135333	608999	4.6	17246838	28	0.4829	1.0648
TO10727	East	Unknown	18	274250	1234125	9.2	34950420	0.5000	0.0175	0.0385
TO10827	East	Unknown	18	274250	1234125	9.2	34950420	5.1	0.1782	0.3930
TO10902	East	Unknown	18	274250	1234125	9.2	34950420	26.8	0.9367	2.0654
FV11022	West	<200	91	63235	1438603	10.8	40741235	57	2.3223	5.1206
TC11027	West	<200	91	63235	1438603	10.8	40741235	22.4	0.9126	2.0123
TC11107	West	<200	91	63235	1438603	10.8	40741235	39.4	1.6052	3.5395
TC11110	West	<200	91	63235	1438603	10.8	40741235	1.8	0.0733	0.1617
TC11115	West	<200	91	63235	1438603	10.8	40741235	32.3	1.3159	2.9017
TT11014	West	<200	91	63235	1438603	10.8	40741235	80.6	3.2837	7.2407
TT11039	West	<200	91	63235	1438603	10.8	40741235	0.5000	0.0204	0.0449
TT11106	West	<200	91	63235	1438603	10.8	40741235	16.3	0.6641	1.4643
TT11107	West	<200	91	63235	1438603	10.8	40741235	183	7.4556	16.4397
FV11102	West	200-230	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
JR11427	West	200-230	18	60900	274050	2.1	7761096	37.4	0.2903	0.6400
JR11527	West	200-230	18	60900	274050	2.1	7761096	110	0.8537	1.8825
TC11034	West	200-230	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
TC11103	West	200-230	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
TC11126	West	200-230	18	60900	274050	2.1	7761096	11.6	0.0900	0.1985
TH11611	West	200-230	18	60900	274050	2.1	7761096	0.34	0.0026	0.0058
TH11723	West	200-230	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086

Appendix D (continued)
Mass Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Deep Groundwater PCE					Associated GW Volume					
Well	Side of JR	Depth Category	Thickness (ft)	Associated Area	Volume (ft^3)	million gallons	Liters	PCE µg/L	PCE kg	PCE lbs
TT11011	West	200-230	18	60900	274050	2.1	7761096	67.4	0.5231	1.1534
TT11102	West	200-230	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
TT11114	West	200-230	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
ES11643	West	231-260	18	73105	328974	2.5	9316535	0.58	0.0054	0.0119
FV11014	West	231-260	18	73105	328974	2.5	9316535	103	0.9596	2.1159
FV11118	West	231-260	18	73105	328974	2.5	9316535	0.5000	0.0047	0.0103
FV11130	West	231-260	18	73105	328974	2.5	9316535	45	0.4192	0.9244
TC11019	West	231-260	18	73105	328974	2.5	9316535	22.8	0.2124	0.4684
TC11106	West	231-260	18	73105	328974	2.5	9316535	2.4	0.0224	0.0493
TH11602	West	231-260	18	73105	328974	2.5	9316535	0.5000	0.0047	0.0103
TO11024	West	231-260	18	73105	328974	2.5	9316535	25	0.2329	0.5136
TT11123	West	231-260	18	73105	328974	2.5	9316535	11	0.1025	0.2260
TT11127	West	231-260	18	73105	328974	2.5	9316535	23.3	0.2171	0.4787
ES11627	West	Unknown	91	63235	1438603	10.8	40741235	2.8	0.1141	0.2515
ES11630	West	Unknown	91	63235	1438603	10.8	40741235	0.75	0.0306	0.0674
FV11023	West	Unknown	91	63235	1438603	10.8	40741235	89.2	3.6341	8.0132
FV11110	West	Unknown	91	63235	1438603	10.8	40741235	0.5000	0.0204	0.0449
FV11123	West	Unknown	91	63235	1438603	10.8	40741235	0.5000	0.0204	0.0449
FV11202	West	Unknown	91	63235	1438603	10.8	40741235	0.5000	0.0204	0.0449
JR11503	West	Unknown	91	63235	1438603	10.8	40741235	0.5000	0.0204	0.0449
JR11535	West	Unknown	91	63235	1438603	10.8	40741235	74.7	3.0434	6.7106
JR11655	West	Unknown	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
TC11018	West	Unknown	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
TC11022	West	Unknown	18	60900	274050	2.1	7761096	9.2	0.0714	0.1574
TC11035	West	Unknown	18	60900	274050	2.1	7761096	2.5	0.0194	0.0428
TC11118	West	Unknown	18	60900	274050	2.1	7761096	6.6	0.0512	0.1129
TC11130	West	Unknown	18	60900	274050	2.1	7761096	4.2	0.0326	0.0719
TC11132	West	Unknown	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
TC11140	West	Unknown	18	60900	274050	2.1	7761096	0.4	0.0031	0.0068

Appendix D (continued)
Mass Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Deep Groundwater PCE **Associated GW Volume**

Well	Side of JR	Depth Category	Thickness (ft)	Associated Area	Volume (ft^3)	million gallons	Liters	PCE µg/L	PCE kg	PCE lbs
TH11603	West	Unknown	18	60900	274050	2.1	7761096	0.5000	0.0039	0.0086
TH11618	West	Unknown	18	73105	328974	2.5	9316535	98.5	0.9177	2.0235
TH11620	West	Unknown	18	73105	328974	2.5	9316535	0.5000	0.0047	0.0103
TO11023	West	Unknown	18	73105	328974	2.5	9316535	1.2	0.0112	0.0247
TO11033	West	Unknown	18	73105	328974	2.5	9316535	1.8	0.0168	0.0370
TT11015	West	Unknown	18	73105	328974	2.5	9316535	28.6	0.2665	0.5875
TT11031	West	Unknown	18	73105	328974	2.5	9316535	8.1	0.0755	0.1664
TT11103	West	Unknown	18	73105	328974	2.5	9316535	0.5000	0.0047	0.0103
TT11124	West	Unknown	18	73105	328974	2.5	9316535	0.43	0.0040	0.0088
TT11131	West	Unknown	18	73105	328974	2.5	9316535	25.4	0.2366	0.5218
						413.5		183	37	81
								max	total Kg	total lbs

February 2008 values used
ND values were changed to 0.5000
NS values were changed to match most recent result
Thicknesses were estimated from overall sand percentage of 60.7% times thickness of the depth category.

	Depth Category	Thickness	60.7%	Area	Wells	Associated Area	Figure
East	<200	150	91	461000	2	230500	11
East	200-230	30	18	812000	6	135333	12
East	231-260	30	18	1097000	4	274250	13
West	<200	150	91	1075000	17	63235	11
West	200-230	30	18	1218000	20	60900	12
West	231-260	30	18	1389000	19	73105	13

Wells of Unknown depths were assigned to depth categories to estimate areas and thicknesses.
Associated Areas were taken from Figures 11, 12, and 13, divided by the number of wells east/west of Jones Road.

Appendix D (continued)
Mass Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Mass of PCE in Soil Based on Figure 9.

mg/kg Contour	Contour Area ft²	Thickness ft	Volume ft³	kg of Soil	kg of PCE
500	115	50	5750	268490	134
50	900	50	45000	2101224	105
5	2400	50	120000	5603265	28
0.5	14400	50	720000	33619592	17
0.05	27000	50	1350000	63036735	3
				Totals	287 kg
					633 pounds

Crude mass estimates for PCE

37 kg	81 lbs	7%	in Deep Groundwater
209 kg	461 lbs	39%	in Shallow Groundwater
287 kg	633 lbs	54%	in Shallow Soil
533 kg	1176 lbs	100%	Estimated Total

Does this match an estimate of the PCE released?
Yes, that seems possible. It would be ~ 0.7% PCE by volume.

Appendix D (continued)
Contaminated Aquifer Thickness Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Per direction from 11-12-09 email from Marilyn Long to Russell Perry:
Estimate the thickness of sand between 50 and 300 feet bgs (the depth contaminated by VC).
The overall thickness is 250 feet (300-50).
Make estimate using geophysical logs from Figure 4A, Figure 5, and Figure 6.

Well	Sand 50 to 300	Commentary	%
G1010016A	100	Figure 4A, C1 and C2	40%
MW-11R	138	Figure 5	55%
MW-13	147	Figure 5	59%
MW-15	183	Figure 5	73%
MW-12	172	Figure 5 and Figure 6	69%
G1012097A	185	Figure 5 left side	74%
G1012740A	140	Figure 5 right side	56%
MW-17/18	172	Figure 6	69%
MW-19	186	Figure 6	74%
G1010447C	138	Figure 6 left side	55%
G1012882A	160	Figure 6 right side	64%

Average Thickness:	***156***	feet	
Percent:	62.6%		
Minimum Sand:	100	G1010016A	(-36%)
Maximum Sand:	186	MW-19	(+19%)

The average thickness of the WBU between 50 and 300 feet bgs is 156 feet.
The thickness of the WBU at individual locations is highly variable, ranging from100 to 186 feet.
The WBU thickness has been approximated by adding all the individual sand layers together.
Sand layers were deposited by fluvial deposition and are highly discontinuous across the site.
Coupled with the range of Chicot Aquifer hydraulic conductivities (14 to 35 ft/day) noted in Section 1.2.1.2, the transmissivity of the WBU from 50 to 300 feet bgs would be expected to range from 1,400 to 6,510 ft^2/day.

Appendix D (continued)
Contaminated Aquifer Thickness Estimates
Jones Road Groundwater Plume Federal Superfund Site (SUP075)
Harris County, Texas
Shaw Project Number 137226

Estimate the thickness of sand between 50 and 260 feet bgs (the interval contaminated by PCE).
The overall thickness is 210 feet (260-50).
Make estimate using geophysical logs from Figure 4A, Figure 5, and Figure 6.

Well	Sand 50 to 260	Commentary	%
G1010016A	60	Figure 4A, C1 and C2	24%
MW-11R	114	Figure 5	46%
MW-13	117	Figure 5	47%
MW-15	148	Figure 5	59%
MW-12	136	Figure 5 and Figure 6	54%
G1012097A	150	Figure 5 left side	60%
G1012740A	135	Figure 5 right side	54%
MW-17/18	162	Figure 6	65%
MW-19	146	Figure 6	58%
G1010447C	114	Figure 6 left side	46%
G1012882A	120	Figure 6 right side	48%

Average Thickness:	***127***	feet	
Percent:	60.7%		
Minimum Sand:	60	G1010016A	(-53%)
Maximum Sand:	162	MW-17/18	(+27%)

The average thickness of the WBU between 50 and 260 feet bgs is 127 feet.
The thickness of the WBU at individual locations is highly variable, ranging from 60 to 162 feet.
The WBU thickness has been approximated by adding all the individual sand layers together.
Sand layers were deposited by fluvial deposition and are highly discontinuous across the site.
Coupled with the range of Chicot Aquifer hydraulic conductivities (14 to 35 ft/day) noted in Section 1.2.1.2, the transmissivity of the WBU from 50 to 260 feet bgs would be expected to range from 840 to 5,670 ft²/day.
For PCE contaminated deep groundwater, use the same % of sand applied to depth interval:
(60.7% of 150 feet equals 91 feet for 50 to 200)
(60.7% of 30 feet equals 18 feet for 200 to 230)
(60.7% of 30 feet equals 18 feet for 231 to 260)

Appendix E

Water Usage

Location ID	**Owner**	**Date**	**Reading**	**Time Period**	**Difference**	**Monthly Average**
TO10903	Finch's Gym.	04/17/02	18,131			
		09/19/03	171,035	17 months	152904	8994
		11/11/03	316,480			
		11/13/03	323254	2 months	152219	76110
		01/22/04	468060	3 months	144806	48269
		05/05/04	654959			
		05/10/04	660781	4 months	192721	48180
		08/12/04	848257	3 months	187476	62492
		NOV 2004	1077850	3 months	229593	76531
		02/08/05	1247780	3 months	169930	56643
				Usage		
		August 04 to Feb 05		399523		
		Nov 04 to Feb 05		169930		

DATE	ES11627	mo avg	FV11014	mo avg	FV11022	mo avg	FV11023	mo avg	FV11130	mo avg	JR11427	mo avg	JR11527	mo avg
04/02/05			0		0		17321		0		0			
05/02/05														
06/02/05														
07/02/05														
08/02/05														
09/02/05													0	
10/02/05														
11/02/05														
12/02/05														
01/03/05														
02/03/05														
03/03/05														
04/03/05														
05/03/05														
06/03/05														
07/03/05														
08/03/05			140695	8793	16560	1035	74360	3565	no record		119215	7451		
09/03/05													8361	697
10/03/05			172998	16152	18273	857	84006	4823	194269	10792	137925	9355		
11/03/05			188150	15152	no record		87821	3815	204820	10551	121530	772		
12/03/05														
01/04/05														
02/04/05			225360	12403	no record		96210	2796	no record		no record		no record	
03/04/05													18801	1740
04/04/05					62219	7324	100671	2231			c 18611	8030		
05/04/05			262230	12290	62811	592	103000	2329	no record		no record		no record	
06/04/05														
07/04/05														
08/04/05			335897	24557	65930	1040	115890	4297	b 213521	967	214117	7002	53500	6940
09/04/05														
10/04/05					67798	934	121624	2867			d2233707	9795		
11/04/05			375760	13258	68620	822	123010	1386	349970	45483	239115	8333	70650	5717
12/04/05														
01/05/05														
02/05/05			408455	10898	70720	700	126220	1070	393350	14460	268820	9902	80410	3253
03/05/05														
04/05/05														
05/05/05	12170	328	451790	14445	72570	617	130290	1357	448900	18517	290200	7127	88095	2562
07/12/05	50417	38247												
08/05/05														
		16873.6765		**12211**		**1961**		**3053**		**12132**		**7843**		**2753**

a only 2 data points
b suspect this reading is in error, probably should be 313521
c suspect this reading is in error, probably dropped a digit, assumed 186110
d suspect this reading is in error, probably added a digit, assumed 233707
e flowmeter replaced 2/23/05

DATE	JR11535	mo avg	JR11614	mo avg	TC11019	mo avg	TC11022	mo avg	TC11027	mo avg	TC11103	mo avg	TC11104	mo avg
04/02/05	0													
05/02/05														
06/02/05											0		0	
07/02/05														
08/02/05														
09/02/05							0							
10/02/05			0											
11/02/05														
12/02/05														
01/03/05														
02/03/05														
03/03/05														
04/03/05														
05/03/05														
06/03/05													50492	3607
07/03/05														
08/03/05	126915	7932	15475	1548			71365	6488			100021	6251	58715	4112
09/03/05							64808	5401						
10/03/05	145083	9084	19244	1885							114678	7329		
11/03/05	155243	10160	20340	1096			92623	7086			122571	7893	69250	3512
12/03/05													no power	4074
01/04/05													no power	
02/04/05	181090	8616	no record		no record		102930	3436			no record		no power	
03/04/05							103841	911					no power	
04/04/05			27096	1351									no power	
05/04/05	no record		no record		no record		117975	7067	no record		166140	7262	no power	
06/04/05													no power	
07/04/05													no power	
08/04/05	224620	7255	33875	1695	0		129400	3808	260		193875	9245	no power	
09/04/05													no power	
10/04/05											208157	7141	no power	
11/04/05	246210	7197	36660	928	5530	1843	145330	5310	3630	1123	212640	4483	no power	
12/04/05													no power	
01/05/05													no power	
02/05/05	264800	6197	39880	1073	13740	2737	158760	4477	8330	1567	271130	19497	no power	
03/05/05													no power	
04/05/05													no power	
05/05/05	276680	3960	42640	920	24880	3713	170850	4030	11020	897	249600	6160	no power	
													SYSTEM PULLED	
		7478		**1375**		**2764**		**5339**		**1196**		**7131**		

DATE	TC11107	mo avg	TC11115	mo avg	TC11118	mo avg	TC11126	mo avg	TH11610	mo avg	TH11618	mo avg	TO10835	mo avg
04/02/05	0		0						0					
05/02/05											0			
06/02/05														
07/02/05														
08/02/05														
09/02/05														
10/02/05														
11/02/05														
12/02/05														
01/03/05														
02/03/05														
03/03/05														
04/03/05														
05/03/05														
06/03/05														
07/03/05														
08/03/05	90095	5631	66119	4132					163899	10244	135625	9042		
09/03/05									191780	27881				
10/03/05	101340	5623	76521	5201							157061	10718		
11/03/05	103780	2440	83200	6679					191880	50	163380	6319		
12/03/05														
01/04/05														
02/04/05	no record		no record		no record		no record		no record		190380	9000	no record	
03/04/05							3010		236931	18013			0	
04/04/05	122111	3666	104473	4255							210250	9935		
05/04/05	127390	5279	108700	4227	no record		5540	1265	262712	12891	213670	3420	10710	5355
06/04/05														
07/04/05														
08/04/05	145000	5870	112550	1283	no record		12132	2197	320193	19160	240040	8790	19430	2907
09/04/05				4169										
10/04/05	159540	7270	e 132550		0						265137	12548		
11/04/05	161540	2000			1030	1030	15815	1228	360960	13589	270000	4863	22440	1003
12/04/05														
01/05/05														
02/05/05	173225	3893	e 132550		3285	752	20020	1402	393340	10793	300400	10133	26370	1310
03/05/05			0							11569				
04/05/05														
05/05/05	186350	4375	e 8680	4340	5510	742	22800	927	no record		324150	7917	31570	1733
		5036				**787**		**1414**				**9004**		**2255**

DATE	TO10902	mo avg	TO10903	mo avg	TO11024	mo avg	TT11011	mo avg	TT11014	mo avg	TT11015	mo avg	TT11031	mo avg
04/02/05	1937		18131				0				0			
05/02/05														
06/02/05														
07/02/05														
08/02/05														
09/02/05									0					
10/02/05														
11/02/05													0	
12/02/05														
01/03/05														
02/03/05														
03/03/05														
04/03/05					0									
05/03/05														
06/03/05													22026	3147
07/03/05														
08/03/05	no record		115628	6094	no record		83623	5226	85614	7783	no record		29326	3650
09/03/05			171035	55407					96419	10805				
10/03/05	205578	11313			51545	8591	90247	3312			33589	1866		
11/03/05	210720	5142	323254	76110	53860	2315	95200	4953	96430	6	no record	1866	38680	3118
12/03/05														
01/04/05			468060	72403										
02/04/05	no record		no record		no record		no record		no record		no record		51700	4340
03/04/05														
04/04/05	264090	10674			62700	1768	116563	4273						
05/04/05	273520	9430	660781	48180	62940	240	121630	5067	111940	2585	no record		63030	3777
06/04/05														
07/04/05														
08/04/05	286104	4195	863700	67640	64340	467	141498	6623	141795	9952	no record		72800	3257
09/04/05														
10/04/05	300107	7002			64772	216	163626	11064						
11/04/05	304650	4543	1084430	73577	65000	228	165480	1854	137330	4232	no record		80990	2730
12/04/05														
01/05/05														
02/05/05	320155	5168	1247780	54450	67742	914	175320	3280	142970	1880	no record		86140	1717
03/05/05														
04/05/05														
05/05/05	336240	5362	1439680	63967	70510	923	184020	2900	145870	967	no record		91770	1877
		9035		**38420**		**2820**		**4974**		**4558**				**3059**

DATE	TT11106	mo avg	TT11107	mo avg	TT11123	mo avg	TT11127	mo avg	TT11131	mo avg
04/02/05			0							
05/02/05										
06/02/05										
07/02/05										
08/02/05										
09/02/05										
10/02/05										
11/02/05	0									
12/02/05										
01/03/05										
02/03/05										
03/03/05										
04/03/05										
05/03/05										
06/03/05										
07/03/05										
08/03/05	41825	4647	89189	5573						
09/03/05										
10/03/05	49843	4009	100281	5546						
11/03/05	54395	4552	106570	6289						
12/03/05										
01/04/05										
02/04/05	no record		no record							
03/04/05									0	
04/04/05	76577	4436					5312			
05/04/05	78270	1693	115740	1528			no record		14900	7450
06/04/05										
07/04/05										
08/04/05	89530	3753	134440	6233	120		23227	4479	39287	8129
09/04/05			133797	4514	0					
10/04/05										
11/04/05	103580	4683	171284	12281	4700	1527	33865	3546	62530	7748
12/04/05										
01/05/05										
02/05/05	116550	4323	201360	10025	7130	810	44760	3632	87220	9691
03/05/05						1168				
04/05/05										
05/05/05	130519	4656	232340	10327	no record		56320	3853	108910	7230
		4351		**6279**				**3924**		**7779**

AVG RES MONTHLY USAGE

17 users included in average

95822 total gallons per month

5637 average gallons per month

Previously assumed usage rates for
water line presentations
9000 gallons per month (1 house)
16000 gallons per month (house and barn)

AVG BUS MONTHLY USAGE

14 users included in average

95456 total gallons per month

6818 average gallons per month