

## Cost Summary Sheet

(information from the Remediation Information Management Systems (RIMS) Sept. 1997)

Comparing SVE, SVE with off-gas treatment, and bioventing costs for an example site

Item	COST, \$		
	SVE	SVE with off-gas tmt	bioventing
Pilot test	7500	10,000	10,000
Design and permits	5000	7,500	5,000
system installation	14,500	19,000	16,000
start-up	3000	6,000	4,000
operation - 1 yr	43,300	148,000	48,800
total 1st year costs	73,300	191,000	83,800
Remediation Time	400 d	400 d	500 d

**Bioventing** <\$10/m<sup>3</sup> including pilot test, full scale installation, 2 yrs operation and maintenance  
 electricity \$280 / mo  
 <11,000 m<sup>3</sup> contamination; \$10 to \$30 per m<sup>3</sup>; operation and maint ~\$1-\$3 / m<sup>3</sup> / yr  
 Biological Treatment ex-situ: composting \$190/cy

### Phytoremediation:

\$10,000 / acre planting  
 total remediation with maintenance, monitoring, and verification \$60K-\$100K/acre  
 \$80 / cy or \$105/m<sup>3</sup>  
 sunflowers and radioactive waste \$2-\$6 / 1000 gallons water  
 many plants have an effective rooting depth approx. 50 cm (look at specific for actual depth)

### Soil flushing - in situ treatment of inorganics and radioactive, also VOCs, fuel, pesticides

must capture "flushing" water  
 add alcohol, ethanol, methanol, etc. into contaminated area  
 cost \$1.4M / hectare (\$0.57M / acre to \$7.5M / acre); \$90 - \$990 / m<sup>3</sup>; \$65 - \$750 / cy  
 cost is higher for smaller site, lower permeability soils, or heterogeneous soil

### Horizontal well drilling - depth is a limiting factor

\$75 to \$500 / ft with well and well screen length, and subsurface lithology affecting cost.  
 depth >40 to 50' \$200/ft; depth less than 40 ft, approx. \$50 / ft  
 example: drill 2 horizontal wells 30' deep, 500' long  
 7" diameter pipe-based wire wrapped screen and low carbon steel riser pipe  
 Lengths up to 760 ft, borehole up to 17.5 inch diameter  
 at one site, to achieve same influence zone would need 224 vertical wells or just 5 horizontal well  
 each 400-1200 ft long

### Iron reactive barrier wall

\$440 - \$500 / ton of iron; installation \$2.5K TO \$8K / L / min flow  
 operation and maintenance \$1.30 to \$5.20 / 1000 L water  
 example sites: TCE contam: wall 12 m long x 3.6 m deep x 1.2 m wide;  
 Vinyl Chloride contam: 3.2 m wide x 3.2 m thick x 8.2 m deep  
 DCE: 45 m long x 5.5 m deep x 0.6 m wide  
 total wall construction cost \$720K, \$400K, \$2.1M, \$435K; average approx. \$420K

### Cement-Based Stabilization / Solidification

ex-situ cement lock technology \$30-\$40 /ton; concrete enveloping solns \$100 - \$200 /metric ton  
 in-situ GeoCon using proprietary chemicals to form a cement-like mass  
 demonstrated for PCBs, PCP, refinery waste, chlorinated and nitrogen hydrocarbons  
 used >40 sites for a total of >1 M cy of soil  
 inorganics and radioactive compounds reduce the demobilization efficiency down to 95%  
 work for depths <150 ft, and augers <12' diameter  
 auger supported by crane, 15 rpm blades with reagents and water mixed in, typical 36" dia

decreases soil permeability 4 orders of magnitude to  $10^{-6}$  cm/s, increase volume 9-50%  
 weathering and freeze-thaw may be a concern  
 with 4-augers process rate 18-45 metric tons / hr, \$111 / ton (\$122/metric ton),  
 1 auger \$194/ton; with new larger equipment \$15/ton; typical \$40-\$50/cy;

**Perma-fix Environmental Services**

- on site, ex-situ for hazardous, radioactive, or mixed wastes  
 2 steps: add chemical treatment of waste, then add stabilizing chemicals  
 200,000 drums of waste treated in 30 states; inc. 22,000 lb radioactive thorium nitrate  
 35 barrels/day; \$150 - \$200 / barrel; \$200 / ton bulk radioactive waste

**Polymer-Based Solidification / Stabilization**

PCBs, oil and grease, and halogenated hydrocarbons decrease the durability of final ss waste  
 STC Remediation ex-situ \$190-\$330 / cy, 50,000 cy contam material treated, full scale  
 reagent \$80 - \$153 / cy depending on organic content  
 processing \$40 - \$175 / cy  
 labor 9 - 14% of total cost  
 analytic 4-12% of total cost  
 STC Remed. in-situ at 1 site: drill rig and slurry, several hundred cy/d treated

**vitrification**

ExSitu Plasma Vitrification, \$/ton		In Situ Plasma Vitrification*, \$	
site preparation	37-56	capital, 10 yr proj	0.5M
equipment	100-180	drilling	0.5M
start-up	250-405	electricity	0.6M
labor	208-914	labor	0.9M
supplies	20-20	maintenance	0.3M
consumables	110-183	TOTAL	2.8M (\$130/ton)
fac mod, repair, etc	32-58		
TOTAL	757 - 1816		

\* site 1 acre, 10' deep, 5 megawatt mobile plasma system  
 in-situ radioactive waste \$250-\$400 / ton; municipal waste \$50 / ton; soil (non-waste) \$30-\$80/ton

**Joule-heated vitrification**

electrical resistance heating, electrical current passed through treatment material  
 in situ : 9 cells; \$1300/yd<sup>3</sup> for 5' deep cells, \$770/cy for 15' deep cells; \$660/dy for 20' deep cells  
 \$350-\$450 / ton haz waste ; \$400 - \$550 / ton rad waste  
 dry vs. wet soil changes cost \$55 to \$77 / metric ton

	970 cy site	3200 cy site	4400 cy site
	\$ / cy		
site preparation	51	18	13
permitting	27	9	7
equipment	190	98	83
start-up and fixed	260	130	110
labor	250	150	130
consumables/supplies	80	61	52
utilities	180	170	160
residual waste shipping/handling	34	26	23
analytic services	52	19	14
facilities modification and maintenance	170	86	59
demobilization	37	13	9
TOTAL, \$/ton *	1300	770	660

wet soil density 1.8 tons per cubic yard  
 ex-situ joule-heated vitrification: \$131 - \$267/ dry ton waste treated