ENVIRONMENTAL SERVICES GUIDE

SAB INTERNATIONAL TECHNOLOGY ENTERPRISES, INC.
1240 Bayshore Highway, Suite 305
Burlingame, California 94010
(415) 348-5505 • FAX (415) 347-4571

TABLE OF CONTENTS

OUR UNIQUE PRODUCTS

SITE has three patented chemical formulations which are used to remediate contaminated soil. The chemicals are: Landtreat, Petroxy, and Ensol.

LANDTREAT

Landtreat is used in the soil remediation processes for both organic and metal contamination. Essentially, Landtreat is a synthetic polysilicate with bulk properties similar to those of talc. Its expanded surface area yields extraordinary adsorptive and catalytic properties, and its silicate matrix contains Frankel defects created by a high temperature vacuum process.

PETROXY

Petroxy, containing hydrogen peroxide, is an oxidizing agent used with Landtreat for the fast remediation of organically contaminated soil.

ENSOL

Ensol is a water based polymer which reacts with metals over a wide pH range in contaminated soil. The reaction forms insoluble metal silicates as Ensol binds the dissolved metals on contact into the soil matrix. Ensol contains both sodium silicate and a proprietary chelating agent.

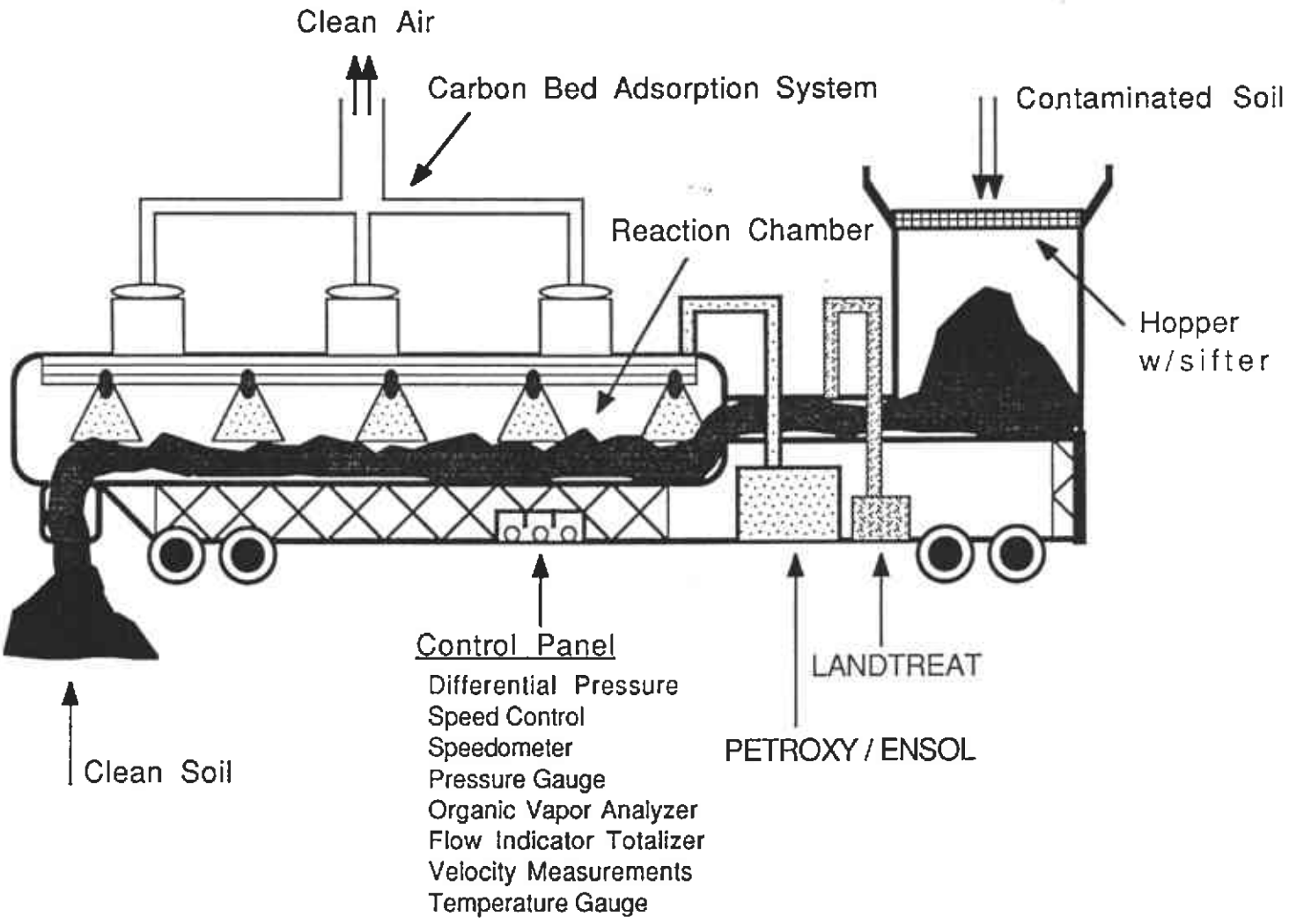
MOBILE ENVIRONMENTAL TREATMENT SYSTEM (METS)

SITE's soil decontamination process is carried out in the patented Mobile Environmental Treatment System (METS). The uniquely developed METS is capable of continuously treating soils contaminated with hazardous compounds. A single METS can treat up to 300 cubic yards of soil per day.

The METS process is carried out at ambient temperatures and does not generate any hazardous emissions or by-products. Contaminated soil is placed in the METS hopper (see figure, next page). Landtreat is then added to the soil. The soil/Landtreat mixture is introduced into one end of a partially enclosed chamber, which is equipped with mixing paddles mounted on a central auger. A nozzle spray system discharges Petroxy or Ensol toward the contaminated soil mixture. Once complete adsorption of the chemicals onto Landtreat's catalytic surface is achieved, the remediating reactions take place. The treated soil expelled from the METS is expected to meet or exceed regulatory standards after the first cycle. If this is not achieved, the soil is recycled for additional treatment.

The METS is equipped with a variety of controls and safety features. Settings which regulate the nozzle spray system, the Landtreat feeder, and the central auger rate can be adjusted to accommodate different site-specific conditions. Also, to ensure that no volatiles are discharged into the atmosphere, an exhaust fan continuously draws air from the reaction chamber into carbon filters. A monitoring device attached to the filters sounds an alarm when the concentration of volatiles in the air reaches 10 ppm. This indicates that the carbon beds have been exhausted and need replacing.

Mobile Environmental Treatment System (METS)



SOIL REMEDIATION - FUEL HYDROCARBON CONTAMINATION

SITE's method for remediating fuel hydrocarbon contamination from soil utilizes Landtreat and Petroxy to oxidize and destroy the contamination. The process is applicable to: gasoline, diesel fuel, kerosene, and solvents such as alcohols, aldehydes, and ketones. Contamination levels in the tens of thousands ppm can be reduced to below the level of detection (less than 1 ppm).

The process consists of mixing Landtreat, Petroxy, and the contaminated soil in the METS. The Frankel defects in Landtreat become active sites where Petroxy and the the fuel hydrocarbon components can be adsorbed. The active sites facilitate Petroxy decomposition to singlet oxygen, a highly reactive species which attacks saturated alkenes as well as unsaturated and aromatic compounds. Landtreat resorbs the intermediate decomposition products. The partially broken down compounds are attacked continuously until essentially complete decomposition to carbon dioxide and water is achieved. The general reaction sequence can be written as follows, where R is an alkyl, branched, or straight-chained organic:

1. RCH_2CH_3 + Landtreat --------> RCH_2CH_3 (adsorbed)

2. Petroxy + Landtreat --------> Petroxy (adsorbed)

3. Petroxy (adsorbed) --------> H_2O (desorbed) + O (desorbed)

4. 2 O + RCH_2CH_3 (adsorbed) --------> H_2O + RCH_2COH (adsorbed)

5. O + RCH_2COH (adsorbed) --------> RCH_2COOH (adsorbed)

6. 2 O + RCH_2COOH (adsorbed) --------> H_2O (desorbed) + CO_2(desorbed) + RCOH (adsorbed)

Aromatic structures, such as benzene and its derivatives, undergo ring opening first, and then follow the above sequence. Steps four (4) through six (6) continue until complete degradation is achieved.

The end result of this remediation process is a clean soil which can be used as backfill or taken to a Class III (sanitary) landfill. The client's future liability is eliminated. Total Petroleum Hydrocarbon (TPH) and Benzene-Toluene-Xylene-Ethylbenzene (BTXE) levels are guaranteed to be reduced below designated site action levels. By-products of the reaction between Petroxy and the hydrocarbons are carbon dioxide and water, while Petroxy and Landtreat produce basic calcium carbonate/bicarbonate which is naturally present in soil. All of the reaction products are non-toxic and non-hazardous.

Our technology has successfully treated over one million cubic yards of hydrocarbon-contaminated soil on over 300 separate sites. Demonstrations have been performed for Mobil Oil, Texaco, and the California Department of Health Services, among others.

SOIL REMEDIATION - OTHER ORGANIC CONTAMINATION

SITE's Landtreat/Petroxy process is also applicable to a host of other organic contaminants. The list includes: halogenated hydrocarbons, chlorinated hydrocarbons, ethylene dibromide (EDB), polychlorinated biphenyls (PCB), pentachlorophenyls (PCP), phenolic compounds such as cresylic acid, dioxins, and related pesticides.

The treatment of soils with these contaminants is a chemical oxidization process essentially the same as the Landtreat/Petroxy method of destroying volatile fuel hydrocarbons, with the addition of an ultraviolet radiation source:

1. PETROXY $\xrightarrow[\text{LANDTREAT}]{\text{UV}}$ 2 OH

2. C H X $\xrightarrow[\text{LANDTREAT \& UV}]{\text{OH}}$ $CO_2 + H_2O$ + HX (Hydrogen halide)

3. $2\,HX + CaO \longrightarrow CaX_2 + H_2O$

4. $CO_2 + 2\,CaO + H_2O \longrightarrow CaCO_3.Ca(OH)_2$

   (present in LANDTREAT) Basic Calcium Carbonate

The end product is a clean soil with contamination reduced to site action levels or below detection level (BDL). Ninety-five percent reduction is normally accomplished in approximately 15 days. In the event that the desired clean-up level is not reached after the first treatment, the cycle is repeated. Our technology has successfully remediated approximately 25,000 cubic yards on over 35 separate sites which contained contaminants in the above list.

SOIL REMEDIATION - HEAVY METAL CONTAMINATION

SITE's method for remediation of soil contaminated with heavy metals utilizes Landtreat and Ensol to fixate the soluble metals on contact into the soil matrix. The process is applicable to almost all types of heavy metals. Even high solubility levels (in the tens of thousands ppm) can be reduced to below the Soluble Threshold Limit Criteria (STLC) standards established by the Resource Conservation and Recovery Act (RCRA).

The process consists of mixing Landtreat, Ensol, and the contaminated soil into the METS. Sodium silicate, a component of Ensol, reacts with soluble metals under alkaline conditions to produce hydroxide-silicate complexes. These complexes then react with Ensol's chelating agent. The reaction is rapid and essentially irreversible due to the low solubility and high stability of the metal hydroxide-silicate complex. The chelating agent is an organic polymer containing heteroatoms with free electron pairs. Each molecule contains several active sites along its polymeric backbone and each active site has two pairs of free electrons for metal bonding. Two active sites on the same or adjacent polymer molecule will react with each ion, forming a total of four coordinate covalent bonds with the metal ion. These bonds are very stable and will not dissociate even under acidic conditions, such as those used in the California WET (Waste Extraction Test) and the E.P. Toxicity Test.

The last step of the fixation process involves further solidifying the chelated metal hydroxide-silicate complexes through the use of Landtreat. Landtreat, as an insoluble polysilicate with large adsorptive capability and an active surface area, retains the excessive chelating agent on its surface to prevent any future leaching of metals from the soil. The following equations summarize the chemical reactions which take place in SITE's metal fixation process:

1. $MeX_2 + Na_2SiO_2 + \text{Chelating agent (Ensol)} + H_2O$
   ----------> $[Me(OH)_2.SiO_2.\text{Chelating agent}] + 2NaX$

2. $3MeO.Ie_2O_3 + 6H_2O$ ----------> $3MeO.Ie_2O_3.6H_2O$

3. $[Me(OH)_2.SiO_2.\text{Chelating agent}] + \text{Landtreat} + H_2O$
   ----------> $[wMeO \cdot xIe_2O_3 \cdot yH_2O \cdot zSiO_2 \cdot$
   Chelated metal hydroxide silicates]

Where Me: divalent metals
X: monovalent anions
Ie: ion exchanger

The final product of the fixation process is a chemically inert, non-leachable, multi-bound metal silicate complex which meets the requirements of the USEPA's E.P. Toxicity Test, the California WET test, and the RCRA standards for non-hazardous waste. Our chemical fixation increases soil volume by an almost negligible 2%, significantly less than the average 40% increase in volume associated with physical solidification and encapsulation methods. The treated soil can be reused on-site or sent to a Class III (sanitary) landfill. Over ninety-nine percent reduction in solubility has been achieved at over 50 sites containing approximately 30,000 cubic yards of soil. The process has been demonstrated before the California Department of Health Services.

SOIL REMEDIATION - MIXED WASTE SITES

For soil contaminated with organics as well as heavy metals, SITE's Petroxy and Ensol processes can be used in sequence to provide complete remediation of mixed wastes such as leaded gasoline, leaded motor oil, etc.

First Landtreat is thoroughly mixed with the contaminated soil in the METS. Petroxy is added to destroy any organic wastes through its oxidizing mechanisms. The soil is then recycled through the METS, where Ensol is applied to fixate the heavy metals. The end result is a clean soil remediated of both types of contaminants. SITE guarantees the reduction of TPH and BTXE to below designated site action levels, and the reduction of STLC to meet E.P. Toxicity, California WET, and RCRA requirements. Soil may be left on-site or taken to a Class III landfill ending future liability.

GROUNDWATER TREATMENT

The contamination of our water supply is a growing problem which parallels the contamination of our soil. A host of toxic and hazardous materials have found their way into thousands of our nation's groundwater systems. As a solution to this concern, SITE extends its soil decontamination process to groundwater remediation when necessary.

Against organic contamination, Petroxy can be utilized as an oxidizing agent. Against heavy metal contamination, Ensol is applied as a precipitating agent. Both processes may be supplemented by air stripping, carbon absorption, reverse osmosis, or Radio Frequency Destruction (RFD), depending on variable site conditions and requirements.

PERMITS

Permitting requirements vary in accordance with the lead regulatory agency and site-specific conditions. SITE assumes responsibility for obtaining and maintaining all necessary permits and authorizations relating to its processes of remediation and operation of equipment. To date, our treatment services have been performed under site-specific permits from the USEPA's Superfund Program, the California Department of Health Services, the Los Angeles County Department of Health Services, the Los Angeles City Department of Public Works, the Los Angeles Regional Water Quality Control Board, the Santa Ana Regional Water Quality Control Board, the Orange County Health Care Agency, the Riverside County Health Department, and the South Coast Air Quality Management District.

SAB INTERNATIONAL TECHNOLOGY ENTERPRISES, INC.
1240 Bayshore Highway, Suite 305
Burlingame, California 94010
(415) 348-5505 • FAX (415) 347-4571

February 1990

REFERENCES

The following is a list of references for SITE's soil remediation technology. To date, this technology has been performed under SITE's sister company, Ensotech. Please refer to this latter name when consulting the sources below.

Mr. Jonathan Tuck
Dames & Moore
(415) 896-5858

Mr. Michael Dorfman, Purchasing Director
Burbank Unified School District
(818) 846-7121

Mr. Ralph Edwards
Mobil Oil
(818) 953-2517 ext. 2569

Mr. K. Rivani
Vice President, City Management Corp.
(former Project Manager, General Motors
Environmental Cleanup Division)
(313) 841-5800 ext. 274

Ms. Lorna Kirby
California Department of Health Services
(Reviewed demonstration of heavy metals decontamination)
(916) 855-7892

METAL FIXATION STUDY

	Untreated Soil			Soil Treated with Ensol/Landtreat*	
METAL	TTLC mg/kg	STLC mg/l	STLC Limit mg/l	STLC mg/l	TTLC mg/kg
Cadmium	132	10.3	1	<0.06	102
Copper	3620	341	25	<0.2	2800
Lead	1002	100	5	0.31	460
Nickel	2590	160	20	0.21	2100
Zinc	9330	762	250	88	8705
Silver	6985	570	5	<0.2	1800
Mercury	276	5.7	0.2	0.29 (0.08)	190
Cobalt	4550	458	80	1.4	4300
Chromium (Tri)	22860	1088	560	556 (170)	20150
Chromium (Hex)	2100	46	5	<0.1	1990

* Patented treatment chemicals.

( ) Parentheses indicate a lower concentration resulting from an additional dosage of Ensol.

Note: This table shows the reduction in solubility levels for different metals achieved by SITE's fixation process. These results are from synthetically constituted, mid-density, silty sand soils. Comparable levels of decontamination can be expected in similar soil types.