BIOTECH RESTORATIONS

Bioremediation of Sites Impacted by Persistent Organic Pollutants

What’s the big problem?

This is the big problem

One Million Polluted Sites Nationwide

Why is Remediation Important?

- Persistent chemical pollutants pose a real human health and environmental risk
- Chemicals released into soils can remain toxic for decades or longer
- The cost of conventional cleanup continues to increase and stifles economic development
- The potential for attached liability discourages business from occupying a deed restricted vs remediated property

Restoring abandoned, polluted properties to productive use and, eliminating legacy pollutants is a top priority with every city

Every city or town has one of these

Or several of these

Or these

- For nearly a century, the default approach to any site cleanup was to excavate the polluted soil and haul the soil to one of hundreds of landfills.
  - Some landfills were permitted, many were not..

- Today, only a handful of permitted landfills will accept soils that contain listed or hazardous wastes.
  - Solvents
  - High levels of petroleum hydrocarbons
  - Pesticides
  - PCBs
  - Disposal costs can be as high as $1,000 ton

- On-site Capping has become popular
  - Wastes are consolidated, buried and covered to prevent exposure.
  - Cap and containment cell must be maintained
  - Cap area is deed restricted
  - Liability remains

- Most polluted sites remain polluted, abandoned and a blight on the community because the site's cleanup costs exceed the property's clean market value

So why Bioremediation ?

- Bioremediation is the lowest cost remedial approach to restoring a polluted site to safe and productive reuse.

Bioremediation

- Converts pollutants to harmless byproducts (CO_2 + H_2O)
- Cleaner than conventional cleanup
- Utilizes sustainable materials for cleanup
- Restores the soil's natural balance
- Is carbon neutral
- COSTS 30% TO 70% LESS

Transforming this

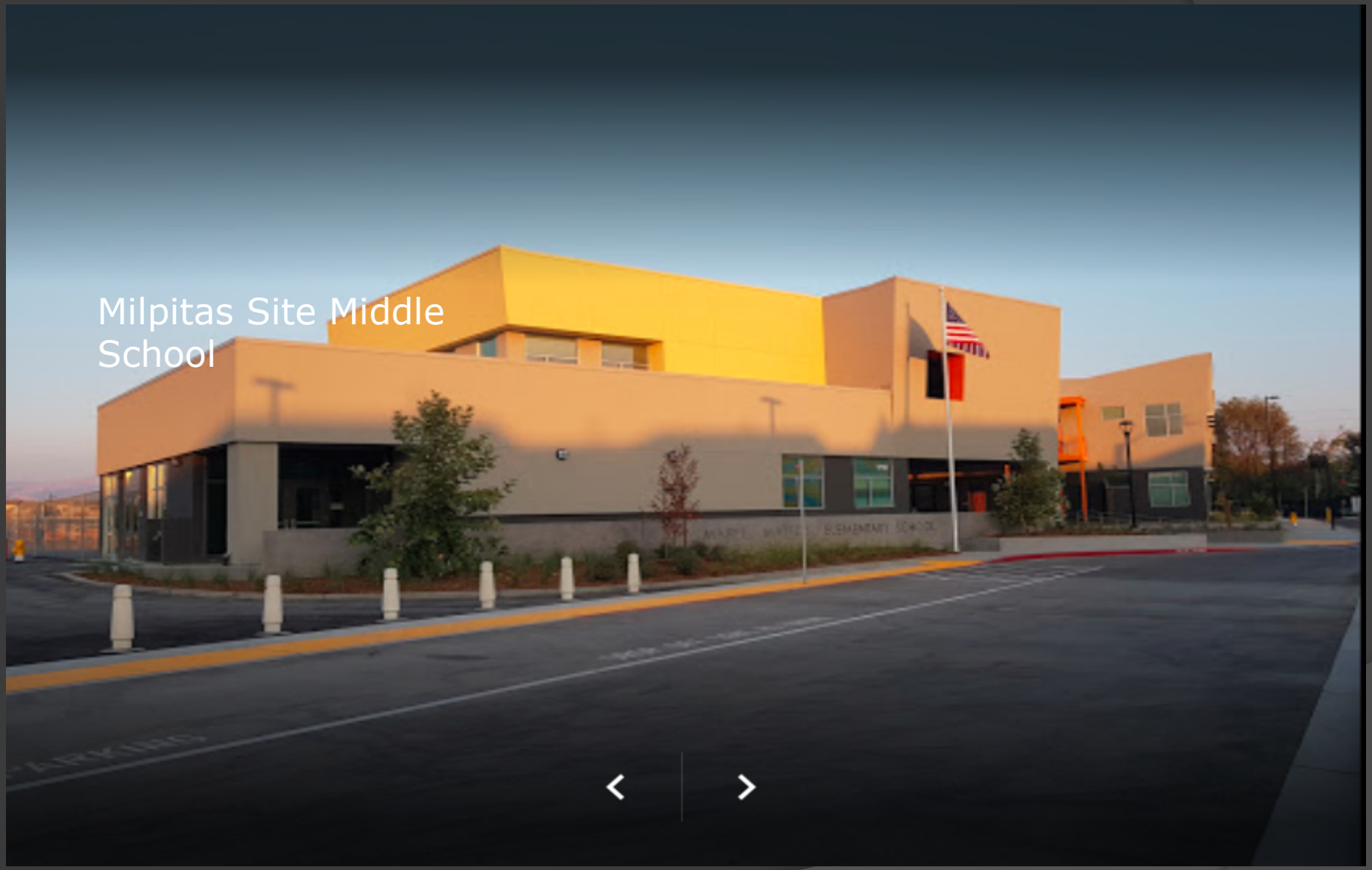
Into this

And this

Former Fertilizer Site, Palmetto FL.

New 225 Unit Apartment Complex

Milpitas School District California
16,400 cy of PCB soil treatment completed


Milpitas Site Middle School

Jacksonville Shipyards and Metropolitan Park

Future Shipyards

What is Bioremediation

- the use of naturally occurring or cultured microorganisms to consume and break down environmental pollutants, in order to clean up a polluted site

1 tablespoon of soil = 5 billion bacteria

Five Components to Bioremediation

- Soil Nutrients
  - Nitrogen, compost, manure
- Water
  - Soil moisture maintained at 25%
- Air
  - Aerobic treatments, soils must be turned
- Temperature
  - > 37º F
- Time
  - 4 weeks to 4 months

Soil sampling and analysis

Soil conditioning

Ex-situ & In-Situ treatments

Water is critical

So is Soil Organic Matter

Cultural attitudes vary

Butt, if you can get it, use it

Adding organic carbon is an essential part of bioremediation

Why ?

- 90% of soil carbon has been depleted
- soil carbon is essential for microbial growth, reproduction and pollutant destruction
- manure and compost are excellent sources of readily available carbon
- Manure and compost are the definition of renewable and sustainable resources

Tilling or turning the soil every 10 days

Turn the dirt

5 Steps to Bioremediation

1. Test the soil
2. Breakup the soil to the depth of the pollutant impact
3. Surface apply and incorporate manure, nitrogen, calcium carbonate (ag lime)
4. Cultivate and irrigate the treated soil weekly
5. Maintain a pH between 7 and 8.5.

Why are some chemicals resistant to natural attenuation or bioremediation?

Chemical pollutants prevent the soil bacteria from producing reductive enzymes that will degrade the pollutants

Environmental Microbiology 101

- Microbial genes express protein messenger signals
- Messenger signals support all physiological functions
- Enzyme production is a physiological function
- Bacteria must secrete enzymes to reduce available organic carbon for mineralization (growth) & reproduction
- Chemical pollutants impair the capacity of bacterial genes to express messenger proteins for enzyme secretion

Gene Signaling

The ability to manipulate gene performance through the substitution of an analogous protein set

A BioBlend treatment overrides the pollutant induced impairment, restores gene function and promotes elevated enzyme production even in the presence of the inhibiting pollutant

Bioremediation does not utilize genetically altered or genetically modified microorganisms

What is BioBlend ?

- Organic proteins that restore gene function
- Blended into safe, non-toxic organic compounds developed for each site's unique chemistry/biology
- Sustain elevated indigenous microbial activity
- Promote enzymatic reduction under aerobic and anaerobic conditions

How is BioBlend Applied

- Surface applied and incorporated for on site, in-situ/ex-situ land farming
- Deep mixing into vadose zone soil
- Broadcast spray with incorporation
- Drench treatment

MORGAN HILL CA. LAND FARMING

TABLE 1

LABORATORY ANALYSIS OF SURFICIAL SOIL SAMPLES FOR ORGANOCHLORIDE PESTICIDES – 0.5 FOOT

Borello Property – 10063.E
Morgan Hill, California
March 25, 2004

Sample ID	Depth (feet)	Toxaphene (µg/Kg)	DDT (µg/Kg)	DDE (µg/Kg)	DDD (µg/Kg)	Endosulfan II (µg/Kg)	g-Chlordane (µg/Kg)	a-Chlordane (µg/Kg)	Dieldrin (µg/Kg)
B1-0.5	0.5	**1,600**	**100**	**310**	<20	<20	<20	<20	**58**
B2-0.5	0.5	**1,800**	**39**	**350**	**34**	**20**	**27**	<20	**120**
B3-0.5	0.5	**1,700**	**110**	**450**	**25**	**22**	<20	<20	**80**
B4-0.5	0.5	**1,600**	**100**	**400**	**24**	**21**	<20	<20	**90**
B5-0.5	0.5	**2,100**	**160**	**580**	**28**	**23**	<20	<20	**160**
B6-0.5	0.5	**2,200**	**150**	**560**	**26**	**25**	<20	<20	**190**
B7-0.5	0.5	**1,200**	**80**	**260**	<20	**22**	<20	<20	**62**
B8-0.5	0.5	**1,200**	**66**	**270**	<20	<20	<20	<20	**72**
B9-0.5	0.5	**1,300**	**63**	**240**	<20	<20	<20	<20	**130**
B10-0.5	0.5	**2,500**	**100**	**620**	**38**	**23**	<20	<20	**370**
B11-0.5	0.5	**1,800**	**120**	**420**	**25**	**24**	<20	<20	**120**
B12-0.5	0.5	**1,900**	**120**	**500**	**26**	**22**	<20	<20	**80**
B13-0.5	0.5	**2,100**	**140**	**470**	**20**	**25**	<20	<20	**97**
B14-0.5	0.5	**1,800**	**75**	**220**	**22**	**22**	<20	<20	**41**
B15-0.5	0.5	**1,500**	**91**	**300**	**23**	**21**	**20**	<20	**52**
B16-0.5	0.5	**2,600**	**190**	**610**	**37**	**30**	**28**	<20	**170**
B17-0.5	0.5	**2,000**	**140**	**540**	**28**	**25**	<20	<20	**150**
B18-0.5	0.5	**1,500**	**75**	**340**	**21**	**23**	<20	<20	**130**
B19-0.5	0.5	**1,800**	**110**	**390**	**21**	<20	<20	<20	**160**
B20-0.5	0.5	**2,200**	**180**	**600**	**32**	**26**	<20	<20	**140**
B21-0.5	0.5	**1,900**	**93**	**460**	**25**	<20	**27**	<20	**110**
B22-0.5	0.5	**2,100**	**120**	**450**	**<20**	**23**	**39**	**54**	**140**
B23-0.5	0.5	**1,700**	**120**	**330**	**24**	<20	**21**	<20	**80**
B24-0.5	0.5	**6,200**	**270**	**980**	<100	<100	**150**	**200**	**400**
B25-0.5	0.5	**2,100**	**170**	**360**	**25**	**24**	**28**	<20	**140**
PRGs[1]	*0.39*	*440*	*1,700*	*1,700*	*2,000*	*370,000*	*1,600*	*1,600*	*30*

DDT = 1,1,1-trichloro-2,2-bis-(p-chlorophenyl)ethane using EPA Method 8080.
DDE = 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene using EPA Method SW846 8080.
mg/Kg = Milligrams per kilogram, equivalent to parts per million (ppm).
µg/Kg = Micrograms per kilogram, equivalent to parts per billion (ppb).
< = Less than laboratory detection limit.
1 = EPA Region IX Preliminary Remediation Goals, October 1, 2002.

TABLE 1

LABORATORY ANALYSIS OF CONFIRMATION SOIL SAMPLES FOR ORGANOCHLORIDE PESTICIDES – 0.5 FOOT
Borello Property – 10063.E1
Morgan Hill, California
July 25, 2005

Sample ID	Depth (feet)	Toxaphene (µg/Kg)	DDT (µg/Kg)	DDE (µg/Kg)	DDD (µg/Kg)	Endosulfan II (µg/Kg)	g-Chlordane (µg/Kg)	a-Chlordane (µg/Kg)	Dieldrin (µg/Kg)
CB1-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB2-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB3-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB4-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	**1.3**
DCB4-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB5-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB6-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
DCB6-0.5	0.5	**130**	**9.4**	**38**	<1	<1	<1	<1	***73***
CB7-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB8-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB9-05	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB10-05	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB11-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB12-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	**1.2**
CB13-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	**1.4**
CB14-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
DCB14-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB15-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB16-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
DCB16-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB17-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB18-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB19-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB20-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB21-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	**1.8**
CB22-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB23-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB24-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
CB25-0.5	0.5	<50	<1	<1	<1	<1	<1	<1	<1
Average	---	***52.7***	***1.28***	***2.27***	***<1***	***<1***	***<1***	***<1***	***3.54***
PRGs	---	*400**	*1,700*	*1,700*	*2,000*	*370,000*	*1,600*	*1,600*	*25**

DDT = 1,1,1-trichloro-2,2-bis-(p-chlorophenyl)ethane using EPA Method 8080.
DDE = 1,1-dichloro-2,2-bis(p-chlorophenyl)ethylene using EPA Method SW846 8080.
mg/Kg = Milligrams per kilogram, equivalent to parts per million (ppm).
µg/Kg = Micrograms per kilogram, equivalent to parts per billion (ppb).
< = Less than laboratory detection limit.
CB6-0.5 = Confirmation soil sample.
DCB6-0.5= Duplicate confirmation soil sample.
PRGs = EPA Region IX Preliminary Remediation Goals, October 15, 2004.
* = Site Specific PEA Remediation Goals determined in the RAW.

Targeted list of pollutants

- Petroleum hydrocarbons (gasoline, diesel, fuel oil, jet fuel/avgas, crude and refined oils)
- Aldrin, chlordane, dieldrin, DDT (inc. DDD/DDE), endrin, heptachlor, hexachlorobenzene, mirex, toxaphene, PCBs, dioxins, furans (the dirty dozen)
- Other organic chemical compounds not specified

Bioremediation

- Lower cost than conventional cleanup
- Proven effective for a wide range of organic chemical pollutants
- Easily performed with standard equipment
- Sustainable with a low carbon footprint
- Restorative
- Eliminates liabilities

Questions ?


Thank You
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