



European Remediation Technologie

*Let us do it
together!*

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www.e-r-t.net





**Used as anaerobic biobarriers
for VOCs**



CARUS®



European Remediation Technology

TOPICS

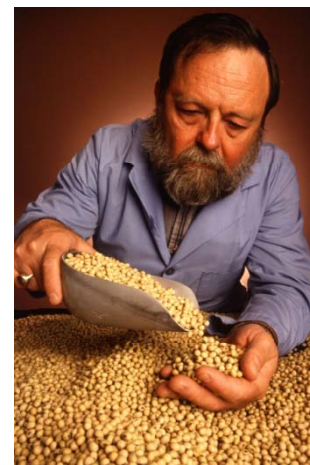
- **What are CAP18[®] and CAP18-ME[®]?**
- CAP18[®] biobarrier reference projects

Topics

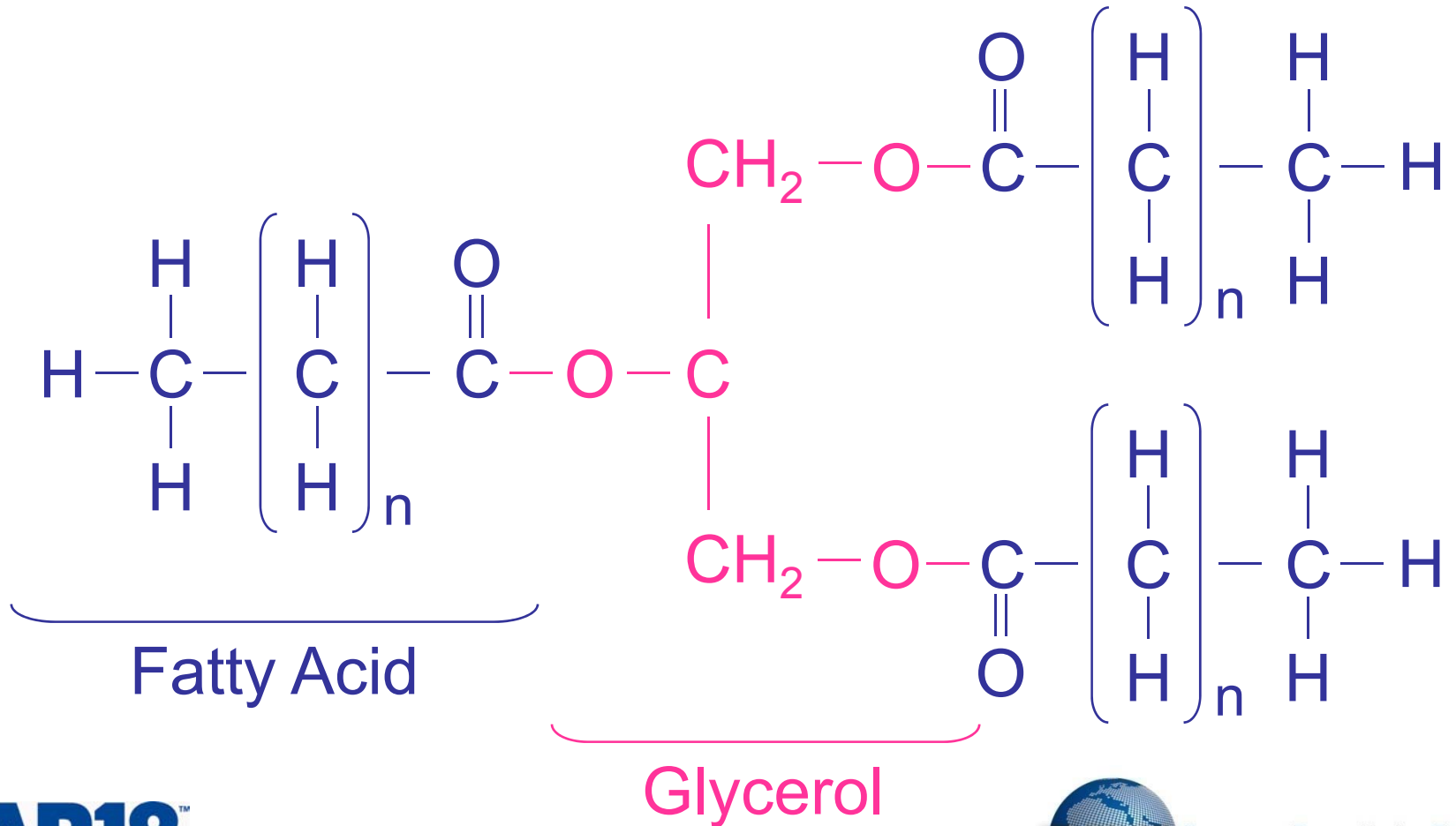
- How CAP18® Works
 - What is CAP18®
 - Composition
 - Hydrolysis
 - Beta oxidation
 - Inhibition of methane production
- CAP18® Advantages
 - Lower cost
 - Easier application
 - Better hydrogen efficiency
 - Very long lifetime
- CAP18® Disadvantages
 - Hard water

What is CAP18®

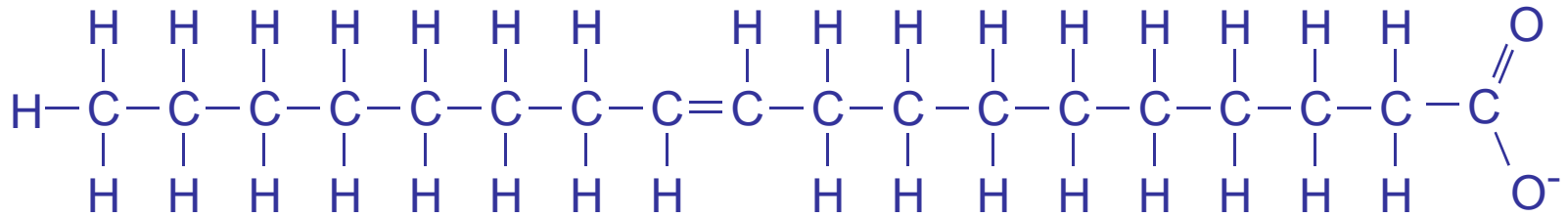
- Food-grade, slightly viscous liquid
- Refined from natural vegetable oil
- Specifically designed for bioremediation
 - Chlorinated solvents (PCE, TCE, TCA)
 - Nitrate, Explosives & Perchlorate
- Concentrates the C18 unsaturated fatty acids



Vegetable Oils are Comprised of Triacylglycerols

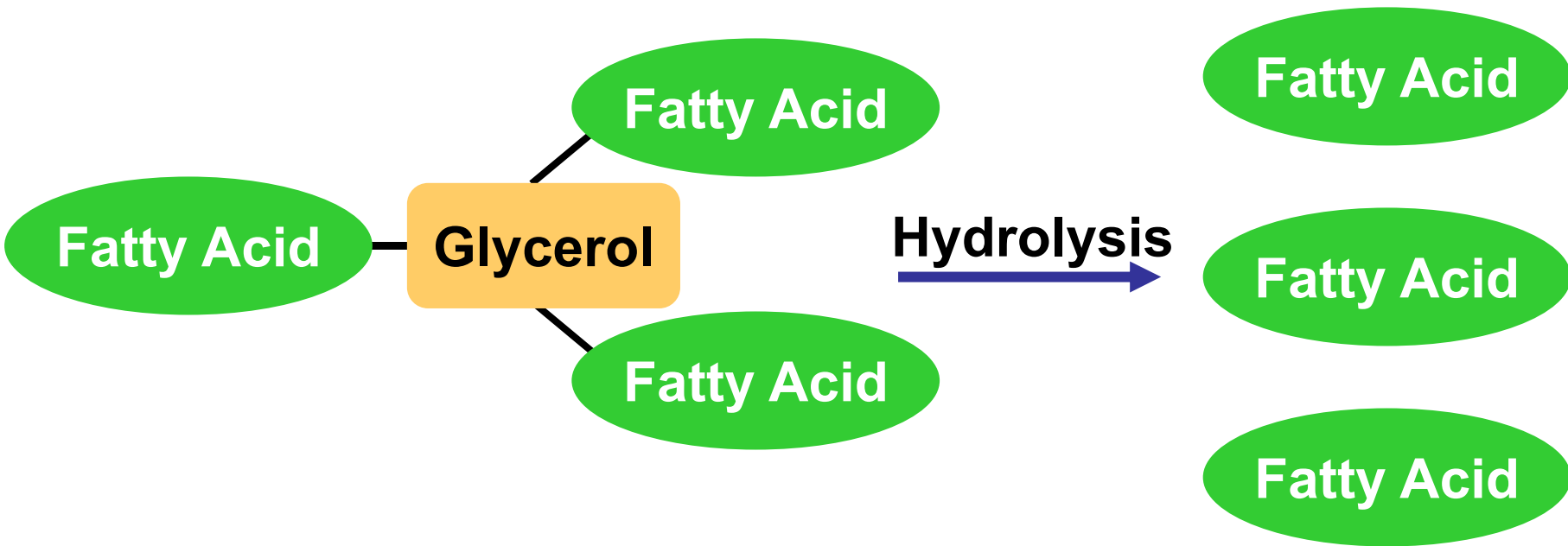


CAP18® Fatty Acids are Primarily C-18 Unsaturated Acids

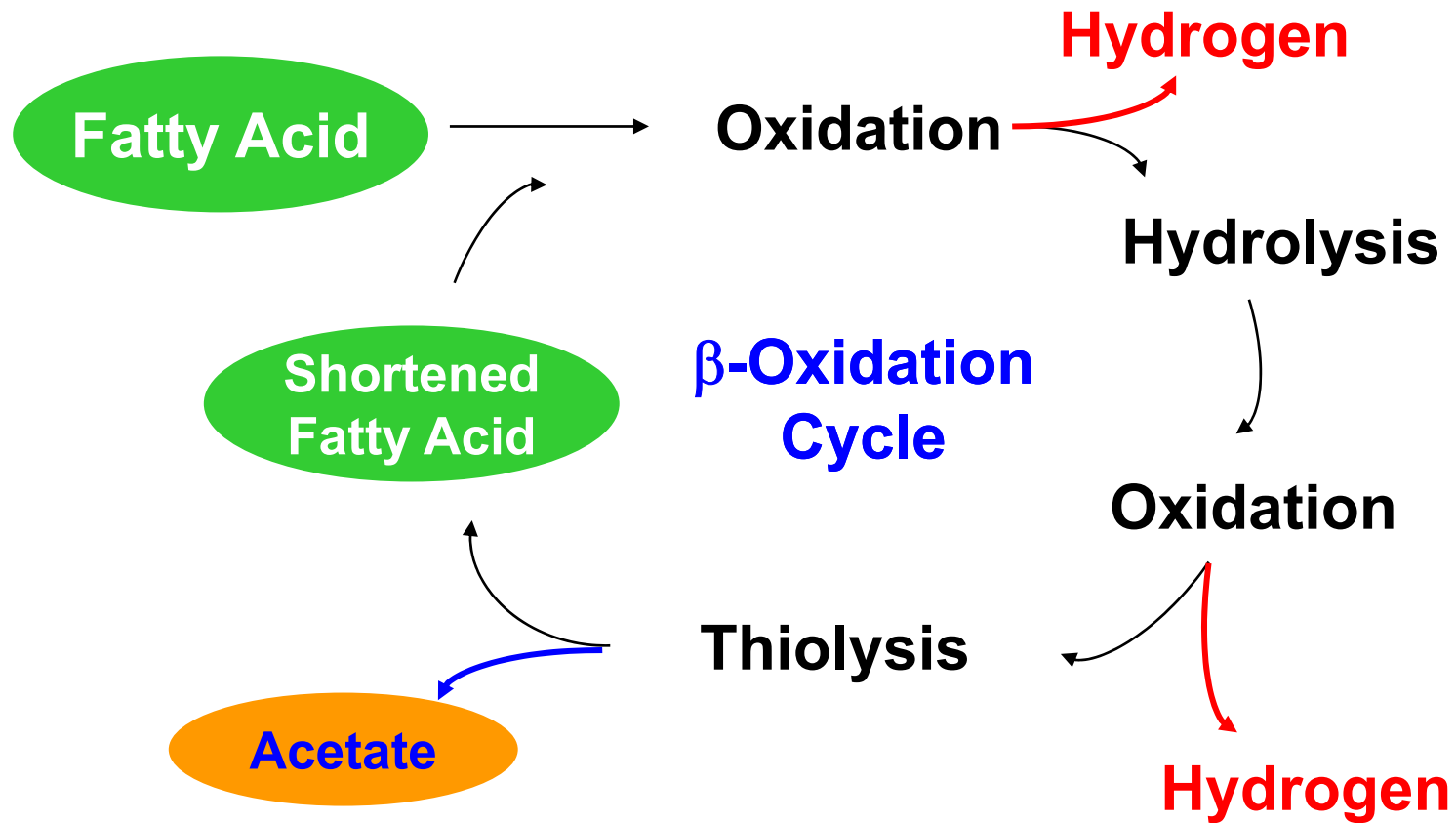


Oleic Acid (C18:1)

In Aquifers, the Triacyglycerols Hydrolyze to Release Free Fatty Acids

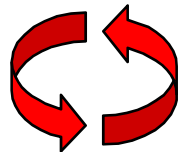
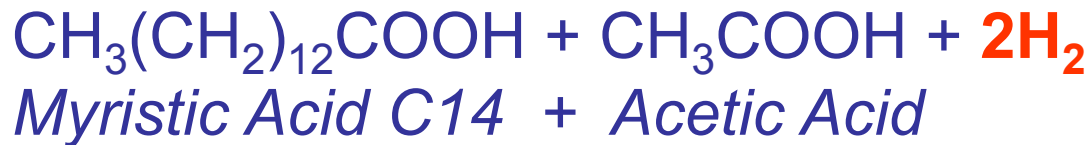
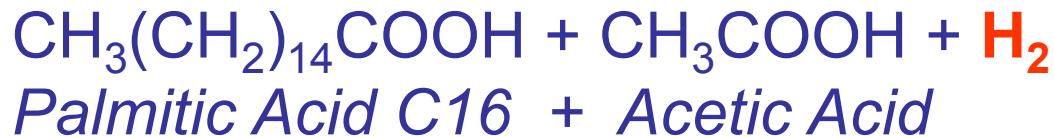
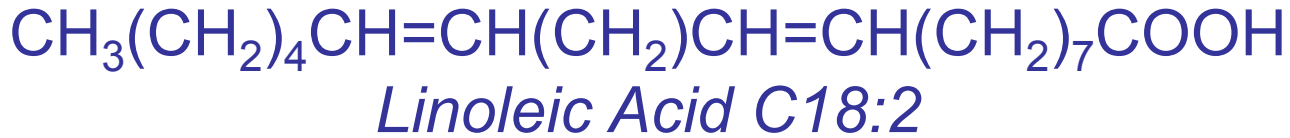


Fatty Acids are Metabolized by Beta (β) Oxidation



Ultimate Production: 13-17 H₂ (26-34 electrons)

β -Oxidation



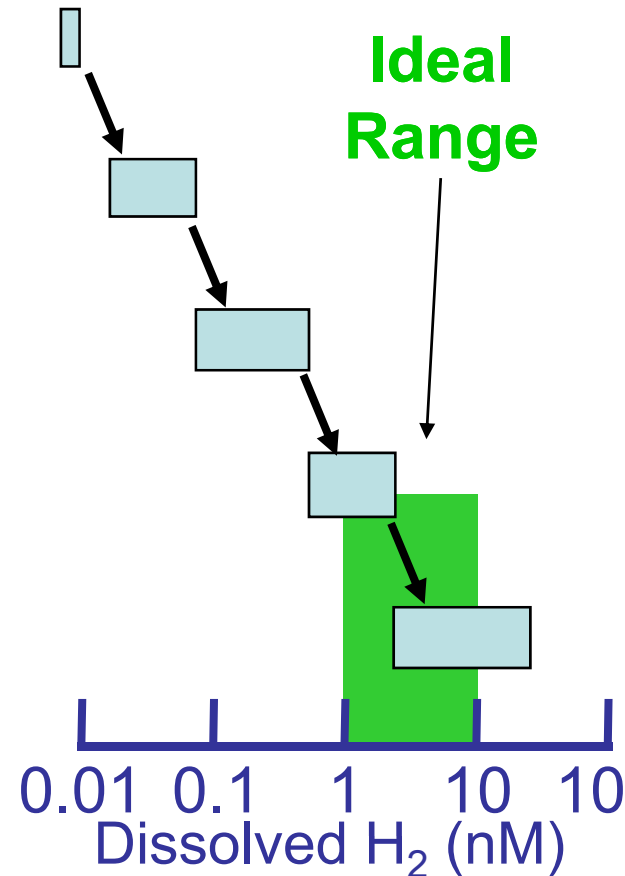
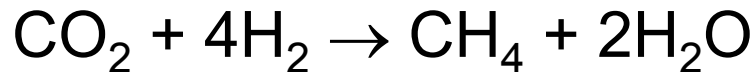
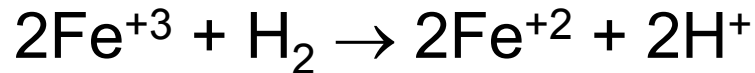
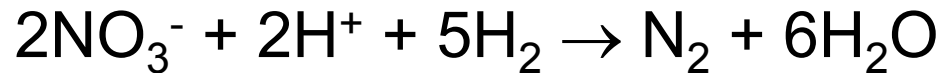
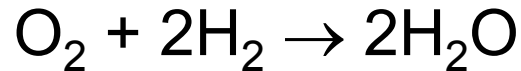
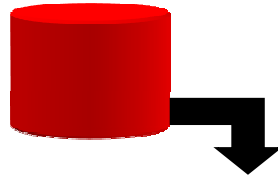
6 Additional Cycles



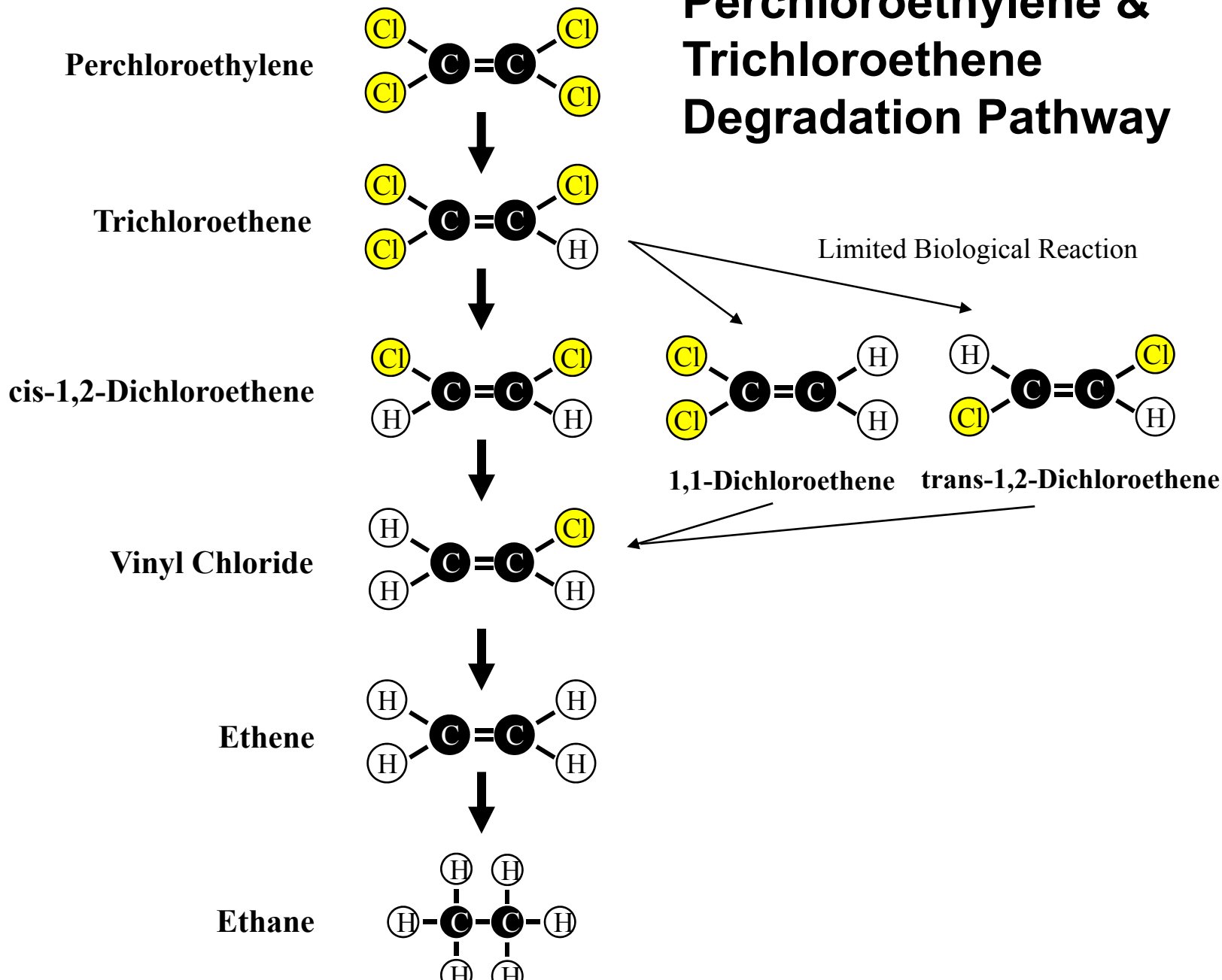
Ultimate Production: 9 molecules of Acetic Acid
15 molecules of H_2

“Footrace for Hydrogen”







Hydrogen
Reservoir



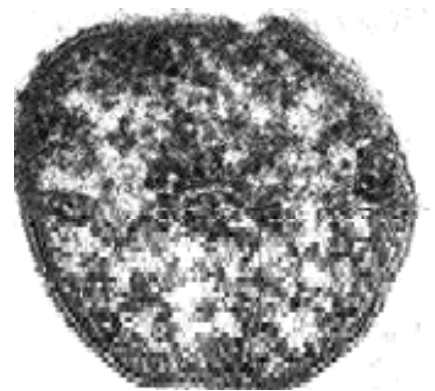
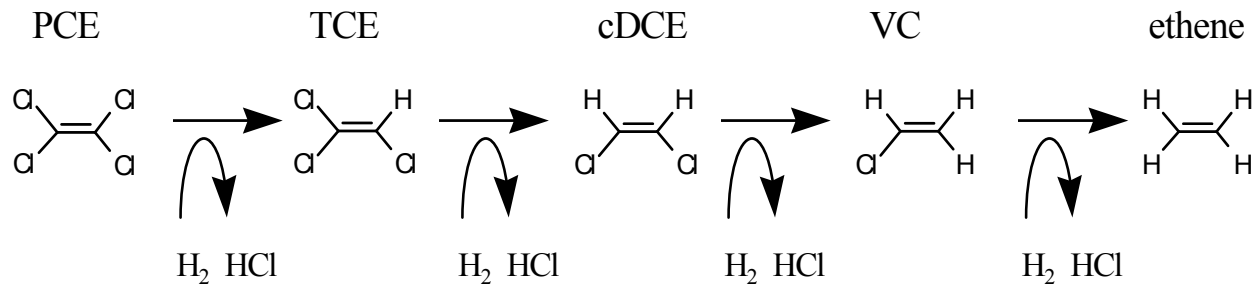
Perchloroethylene & Trichloroethene Degradation Pathway



All Bacteria are Not the Same

<u>Bacterial species</u>	PCE	TCE	DCE	VC	Ethene
<i>Dehalococcoides</i>					
<i>Dehalospirillum</i>					
<i>Desulfuromonas</i>					
<i>Dehalobacter</i>					
<i>Desulfitobacterium</i>					
<i>Desulfomonile</i>					

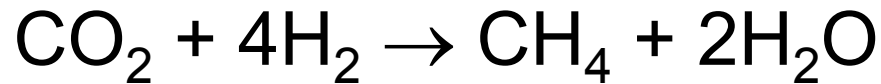
Dehalococcoides ethenogenes Maymó-Gatell *et al.* 1997 Science 276:1568-1571



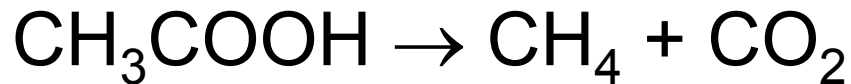
Methanogenesis

Two Pathways

Hydrogenotrophic Methanogenesis



Aceticlastic Methanogenesis



Responsible for 65-80% of Methane Production
INHIBITED BY C18:1 AND C18:2 FATTY ACIDS

Topics

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CAP18[®] is Easier to Apply

Ease of
Application

CAP18[™] Lactate

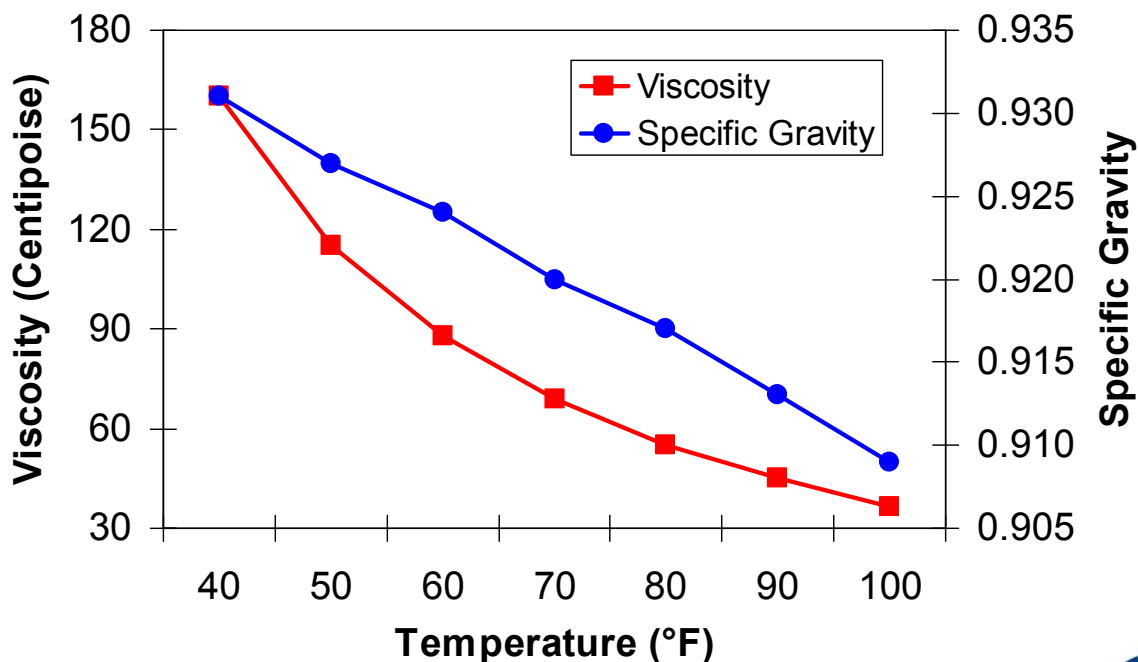
Molasses

HRC HRC-X

No Heating
No Recirculation
No Emulsification

Recirculation
Multiple Injections

High Pressure
Viscous
Needs Heating





EVV215 60

MIL LABO EVV LA2

Cap18
Fijne deegvervalsing
DB

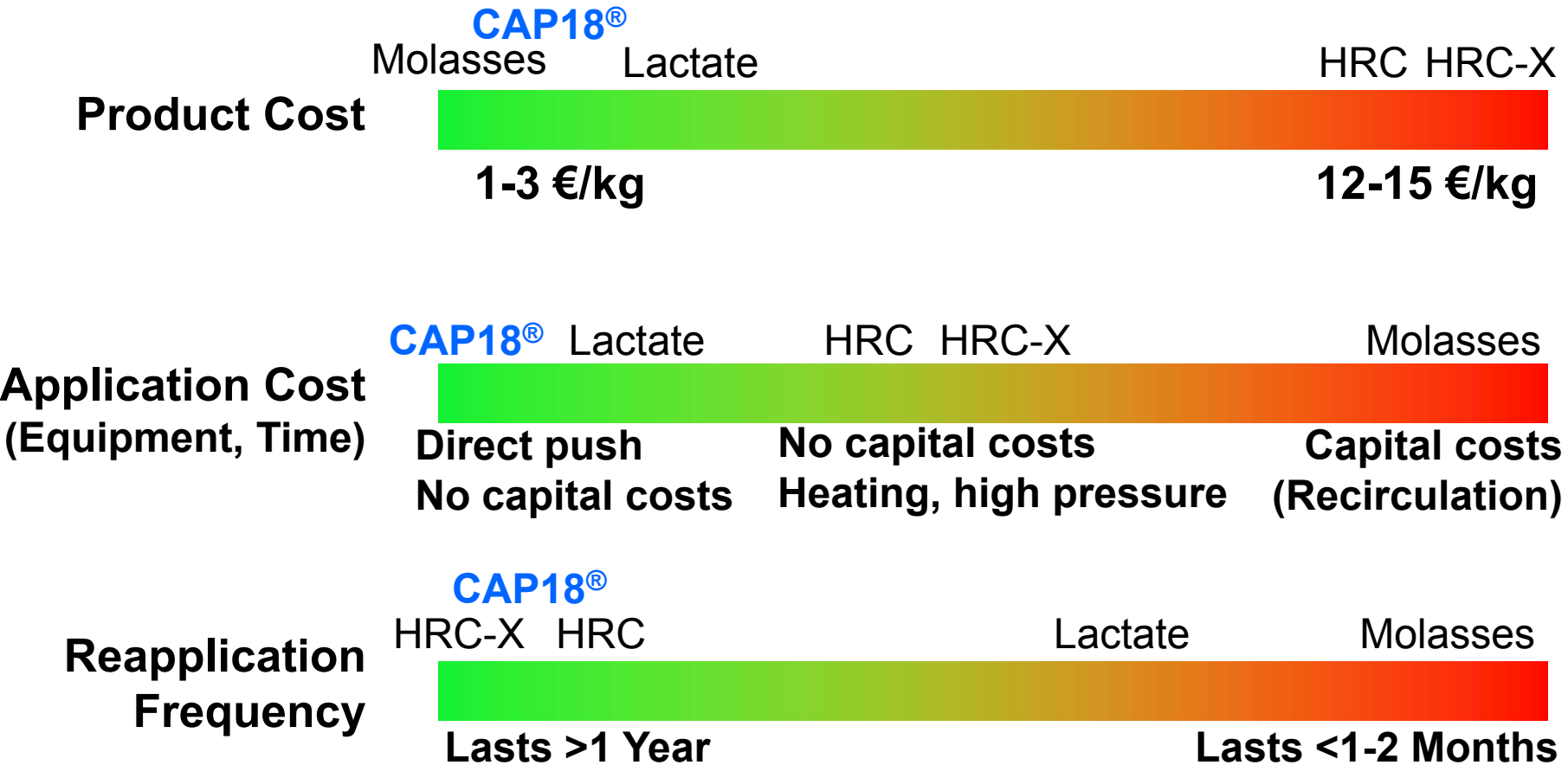
1000



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CAP18[®] is More Cost Effective

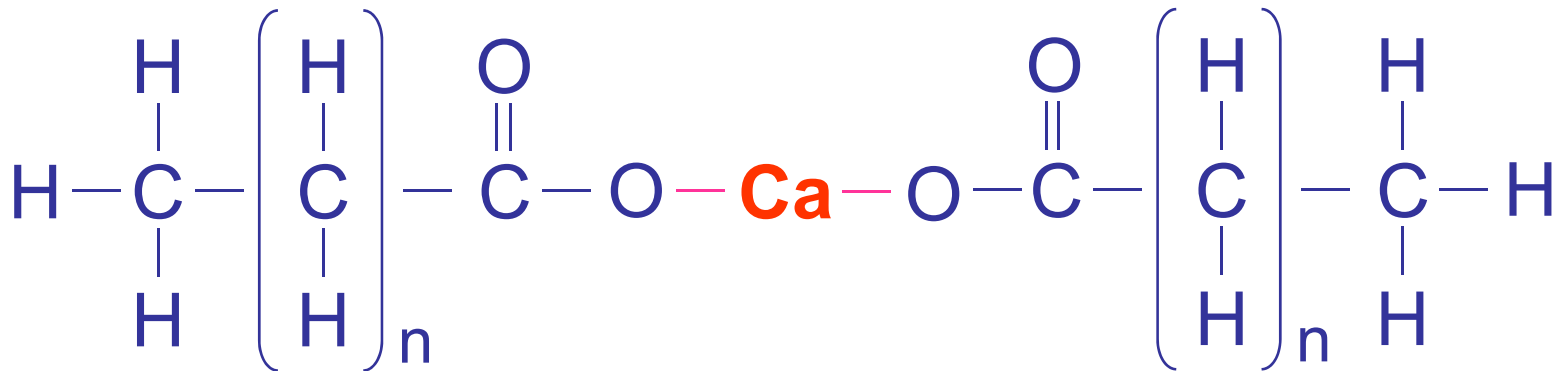


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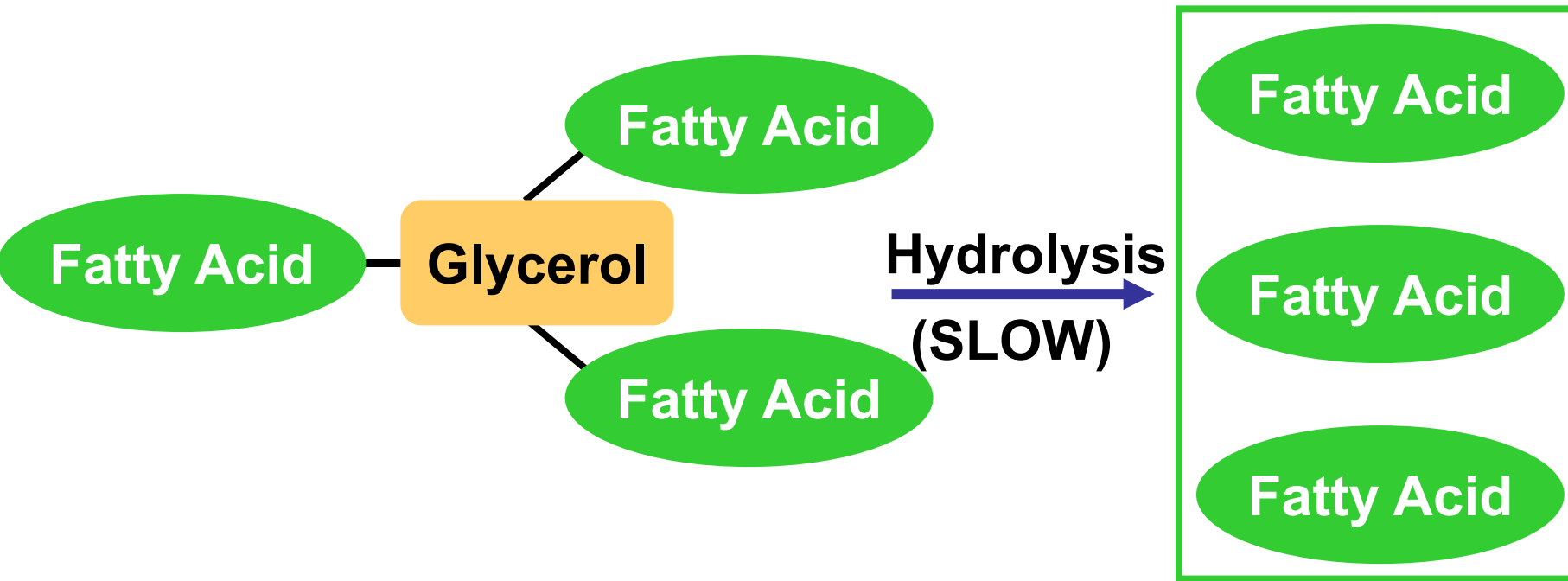
Calcium Precipitation

*Same effect that hard water has on soap & detergent
soap scum formation – insoluble precipitate*



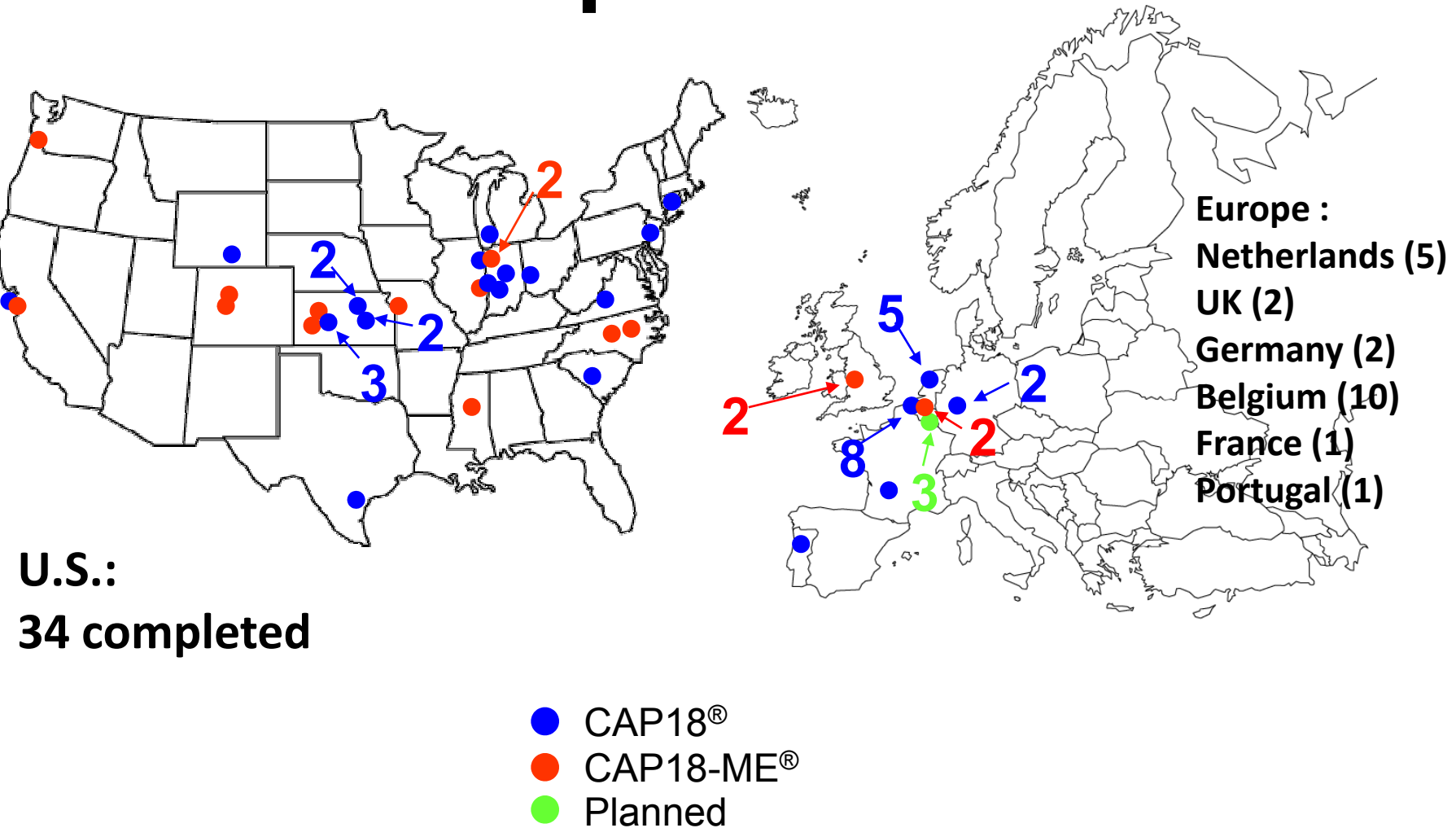
CALCIUM OLEATE

What is CAP18-ME®?



- Limitation of CAP18® is slow initial release
- Addition of methyl esters of fatty acids
- Provides fatty acids immediately to microbes
- Preserves long lifetime of CAP18®

Completed Sites



TOPICS

- What are CAP18[®] and CAP18-ME[®]?
- **CAP18[®] biobarrier reference projects**

Reference projects

- **CAP18[®] biobarrier project in Haute-Garonne(F)**
- **CAP18[®] biobarrier project in Kansas(USA)**
- **CAP18[®] biobarrier project in Santa Clara(USA)**
- **CAP18[®]-biobarrier project in East-Flanders(B)**

CAP18[®] biobarrier project Haute Garonne(F)

Site specific conditions :

- ***Pollution*** : VOCs, maximum concentrations :
 - PCE = 250 µg/L
 - TCE = 3.600 µg/L
 - Cis = 520 /L
 - VC = 10 µg/L
- ***Geology*** : sand with big boulders
- ***Aquitard*** : rock layer at ca.5,5 m-bg
- ***Groundwater*** : ca.3,5 m-bg
- ***Groundwater velocity*** : 10 m/day!!!
- ***Grondwater direction*** : W to NE and SE

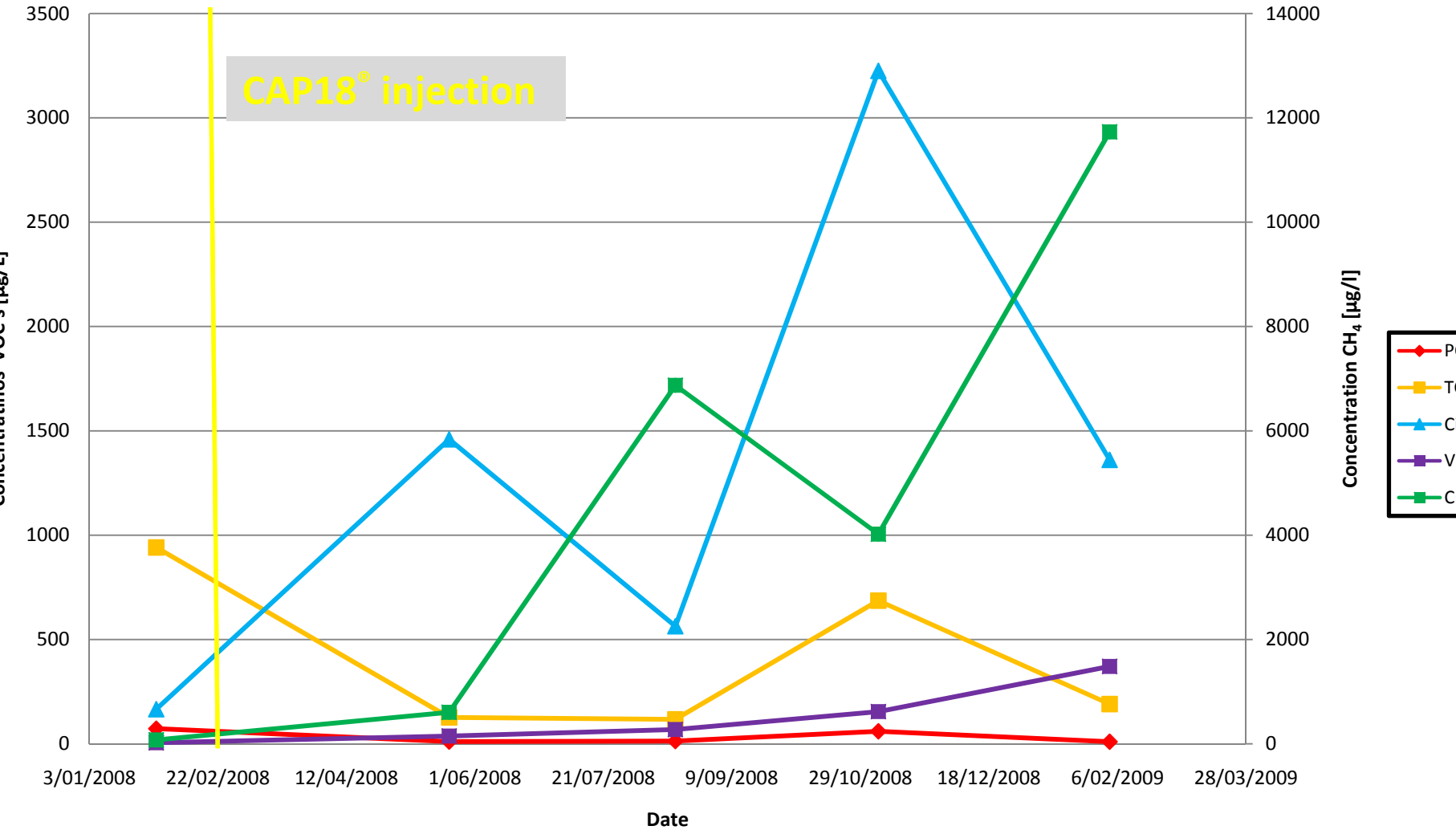
CAP18[®] biobarrier project Haute Garonne(F)

CAP18[®] approach :

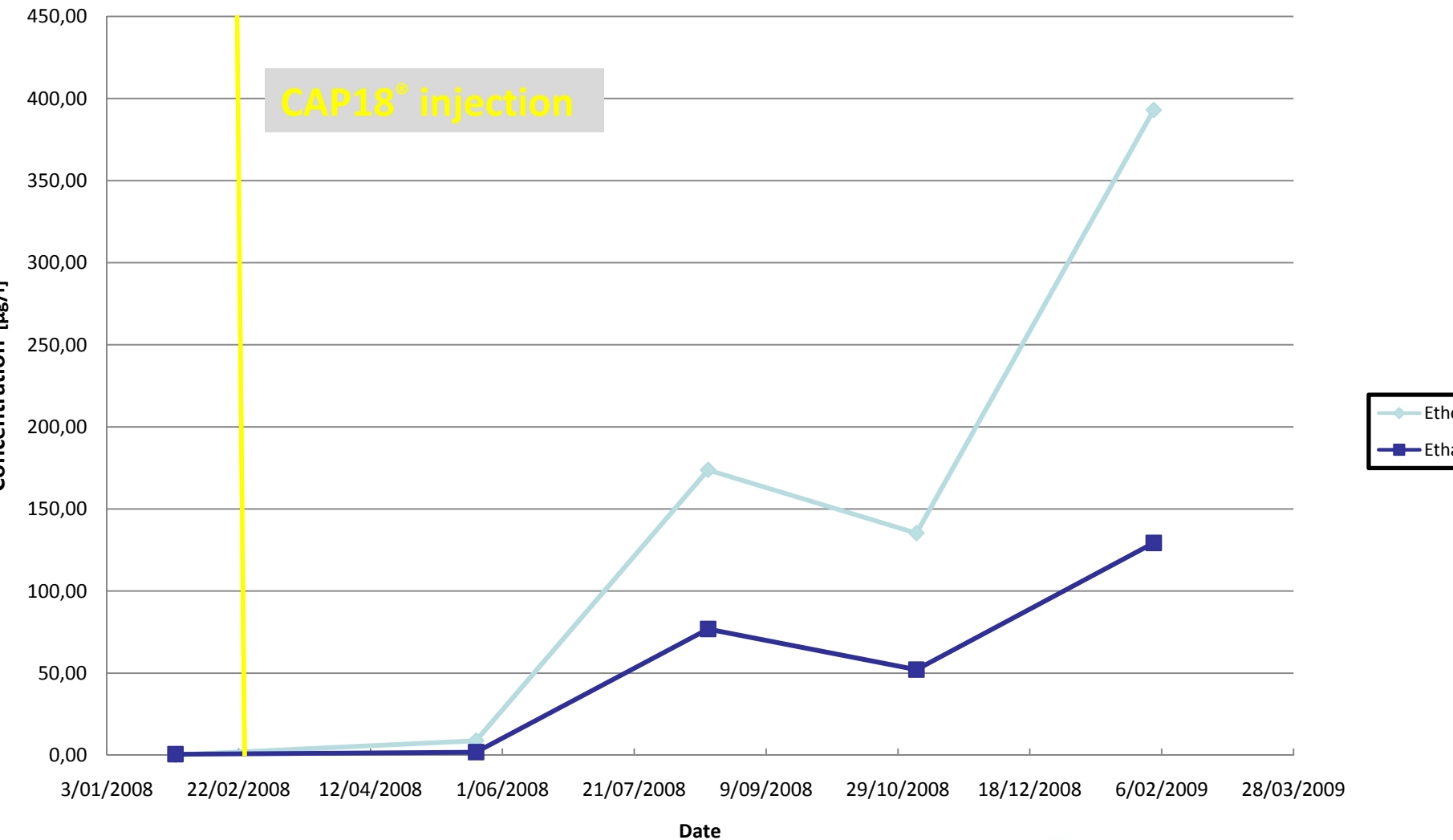
CAP18[®] injections via FIXED injectors :

*February 2008 : 8.280 kg CAP18[®] divided into
9 injectors.*

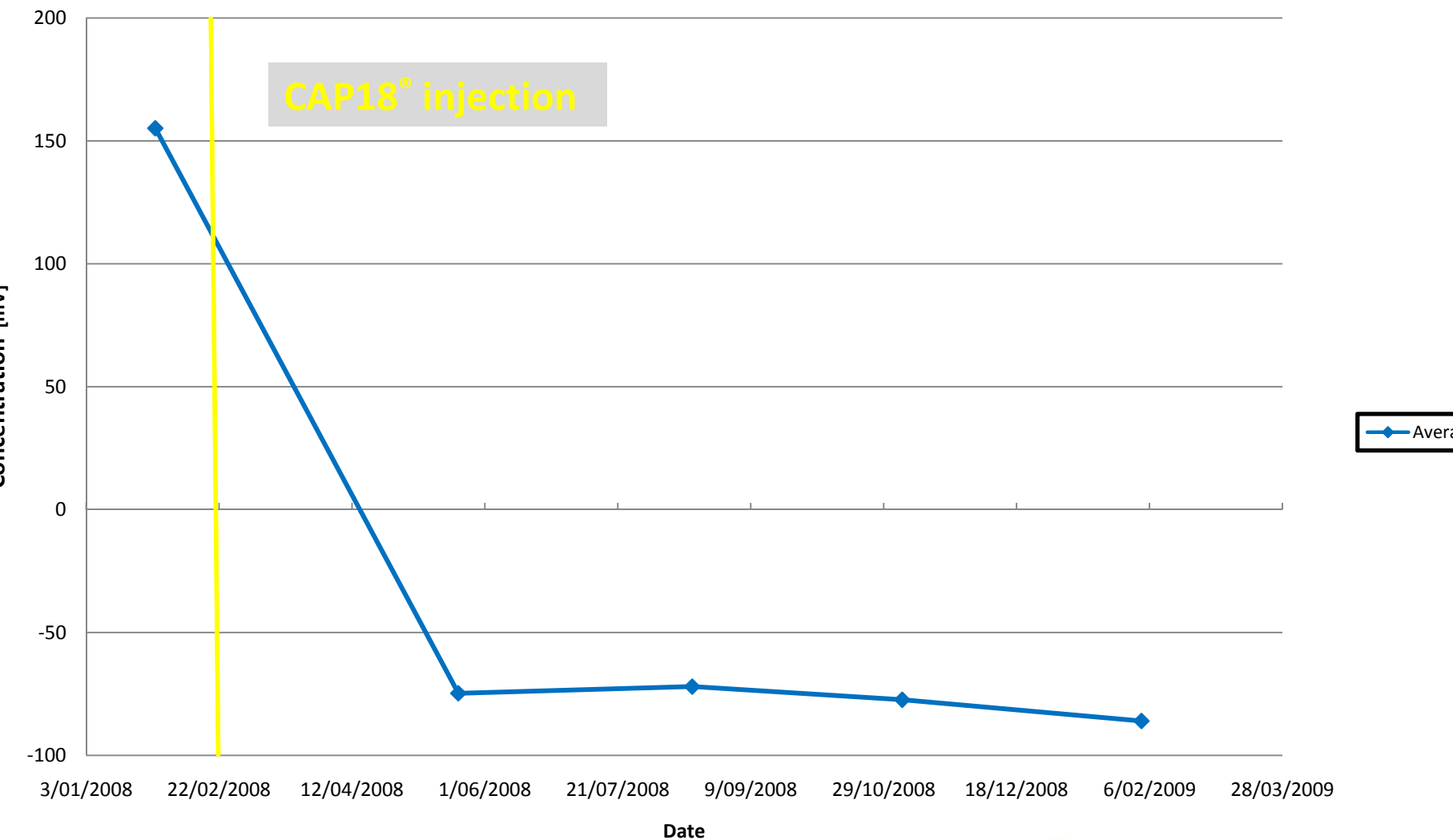
Average VOC- and CH₄-concentrations



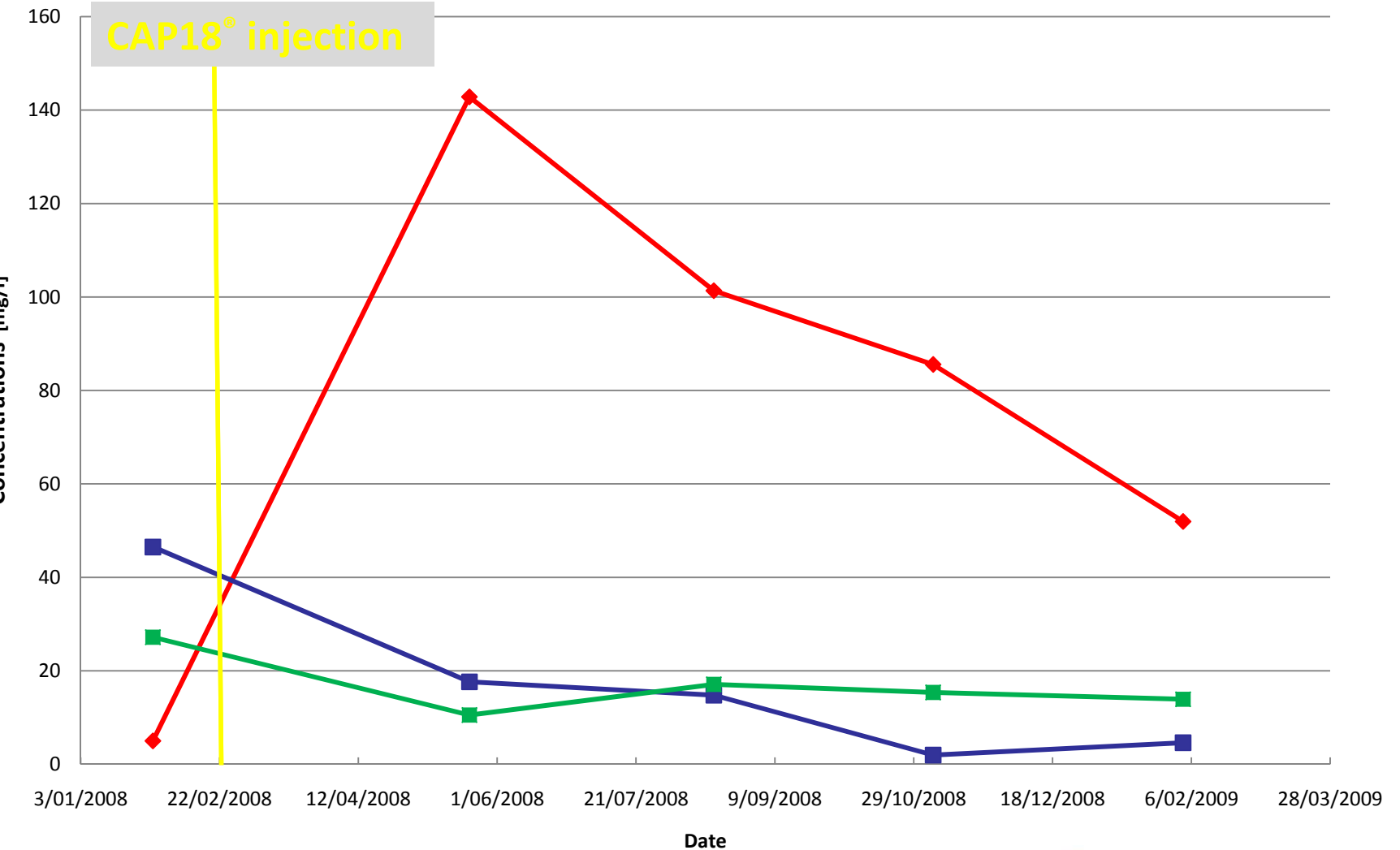
Average ethene and ethane concentrations



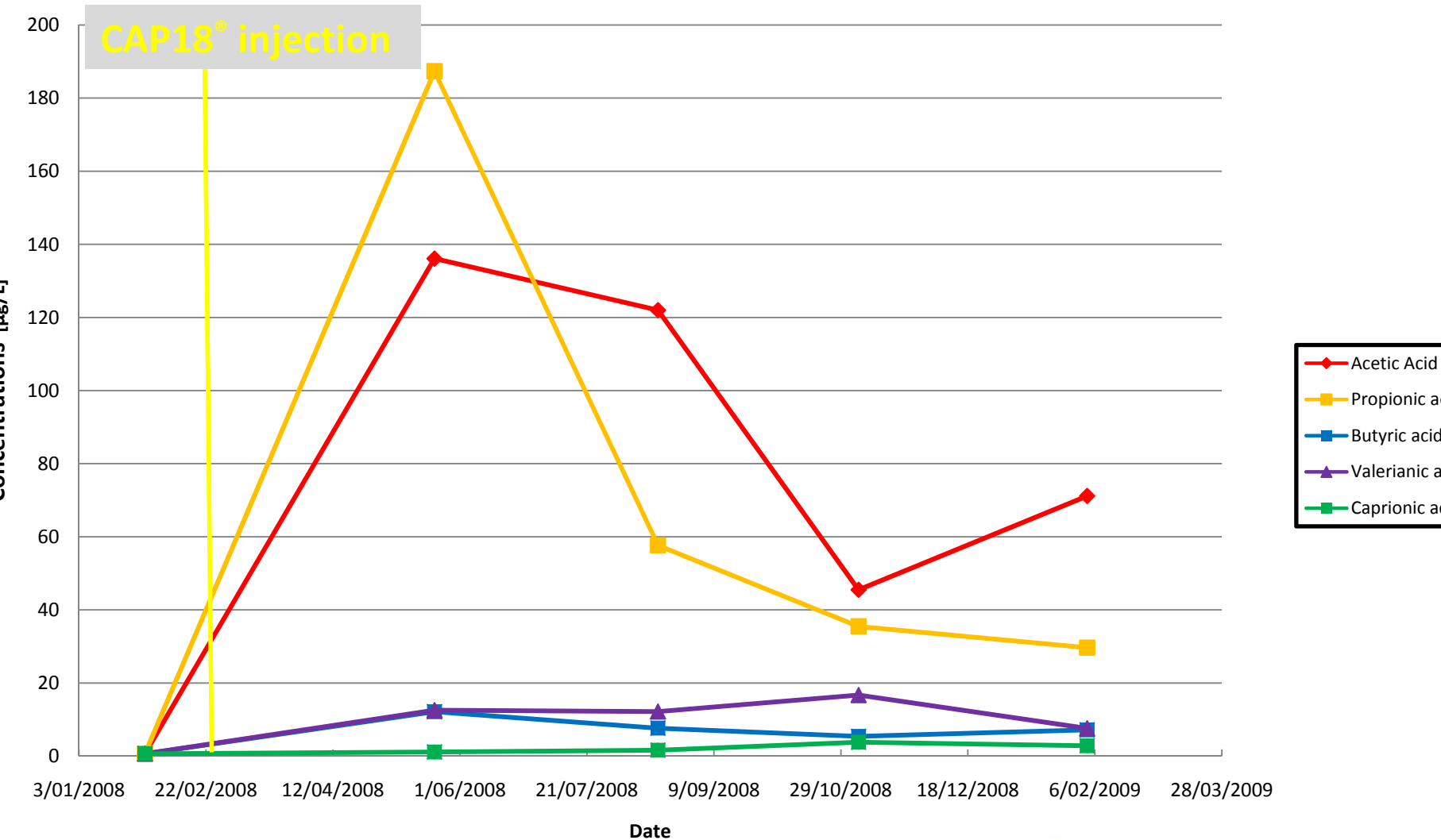
Oxidation-reduction potential



Average TOC-, NO₃- en SO₄-concentrations



Average fatty acid concentrations



Reference projects

- CAP18[®] biobarrier project in Haute-Garonne(F)
- CAP18[®] biobarrier project in Kansas(USA)
- CAP18[®] biobarrier project in Santa Clara(USA)
- CAP18[®]-biobarrier project in East-Flanders(B)

CAP18[®] biobarrier project Kansas(USA)

Site specific conditions :

- ***Pollution*** : VOCs, max concentration TCE = 300 µg/L.
- ***CAP18[®] pilot (August 2005)*** :
 - *14 injectors;*
 - *Injection of 2.300 kg CAP18[®]*
- ***CAP18[®] full scale*** :
 - *May 2007 : 8.500 kg CAP18[®](pink dots)*
 - *July 2007 : 58.000 kg CAP18[®](blue dots)*

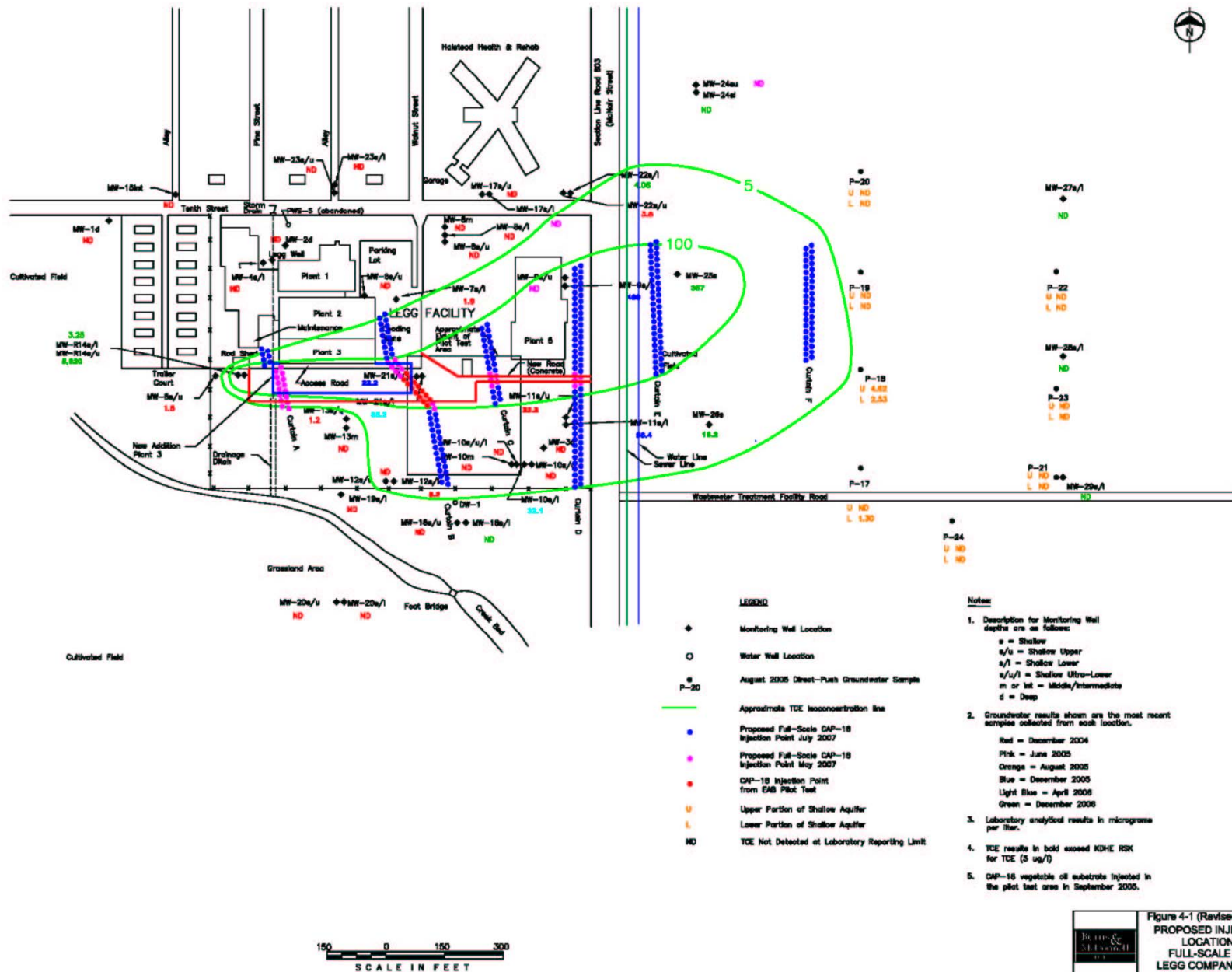


Figure 4-1 (Revised 4/17/07)
 PROPOSED INJECTION
 LOCATIONS
 FULL-SCALE EAB
 LEGG COMPANY, INC.
 HALSTEAD, KANSAS

Reference projects

- CAP18[®] biobarrier project in Haute-Garonne(F)
- CAP18[®] biobarrier project in Kansas(USA)
- CAP18[®] biobarrier project in Santa Clara(USA)
- CAP18[®]-biobarrier project in East-Flanders(B)

CAP18[®] biobarrier project Santa Clara(USA)

Site specific conditions :

- ***Pollution*** : VOCs, max concentration TCE = 900 µg/L.
- ***CAP18[®] pilot (January 2007)*** :
 - *Length pilot barrier : 140 m;*
 - *Depth to be treated : 4,5 and 7,5 m-bg*
 - *Injection of 14.000 kg CAP18[®]*
- ***CAP18[®] full scale*** :
 - *Multiple barrier system : 450.000 kg CAP18[®]*

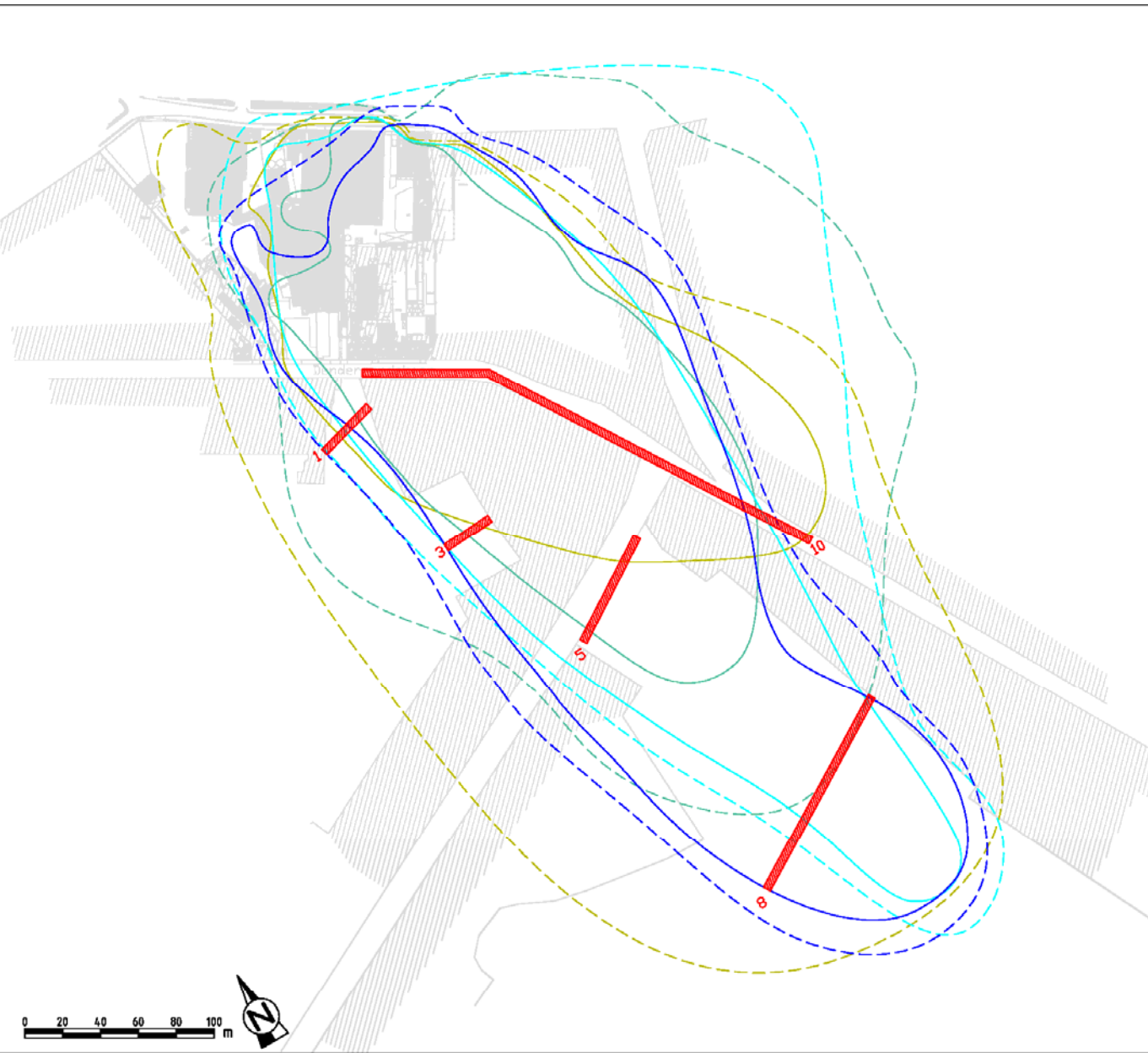
Reference projects










- **CAP18[®] biobarrier project in Haute-Garonne(F)**
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CAP18[®]-biobarrier project E-FL(B)

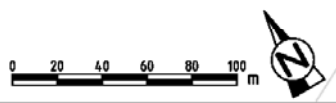
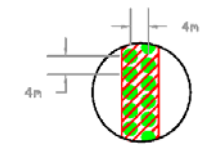
Site specific conditions(CAPISCO[™]) :

- ***Pollution(plume) :*** VOCs, max concentration Cis = 21.000 µg/L en VC = 540 µg/L.
- ***Source approach:***
 - *Fenton's pilot(April 2009) and Fenton's full scale(fall 2009)*
 - *After treatment with CAP18-ME[®](spring 2010) : 85.000 kg*
- ***Plume approach (fall 2009) :***
 - *Multiple CAP18[®]-barrier system : in total 5*
 - *Depth to be treated : 9 m, from 4 till 13 m-bg*
 - *Circa 250 injectors;*
 - *Injection of 90.000 kg CAP18[®]*



-  barrière
-  Conc VC in LQS >80% BSN
-  Conc Cis in LQS >80% BSN
-  Conc Tri in LQS >80% BSN
-  Conc Per in LQS >80% BSN
-  Conc VC in LQS AW
-  Conc Cis in LQS AW
-  Conc Tri in LQS AW
-  Conc Per in LQS AW

CAP18™-Barrièredesign



9/08/2007	
Site.dwg	
A3	9240 Z618
<p>CAP18™ FS Design</p> <p>Barrières 1,3,5,8 en 10</p>	
<p>SCHAAL: 1:2000</p>	
<small>Doelbeheer / Owner</small> Dhr Haghebaert	<small>Tekenaar</small> J. Soenen
<p>E.R.T. European Remediation Technologies www.e-r-t.net</p>	

Questions?



Stijn Haghebaert