

# The removal of selected pharmaceuticals and personal care products by two shallow-placed soil dispersal systems

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These projects were funded by the Massachusetts Department of Environmental Protection with funds from the United States Environmental Protection Agency under a Section 319 Competitive Grant. The contents of this presentation do not necessarily reflect the views or policies of the departments mentioned, nor does the mention of any product trade name constitute an endorsement.

What we know..

## The top three pathways of pharmaceuticals into the environment

- Improper Disposal of unwanted medications
- Spreading of manure on land surfaces (veterinary pharmaceuticals)
- Excreted into wastewater and disposal (septic systems, treatment plants)

The top three concerns of wastewater disposal in general and CEC.

- Endocrine disruption
- Antibiotic/antimicrobial activity
- Direct toxicity

# Of the three concerns endocrine disruption is the highest importance.

(although there are situations where this may not be the case)

Endocrine  
Disruptors

Antibiotic Resistance

Direct Toxicity

# Why ?

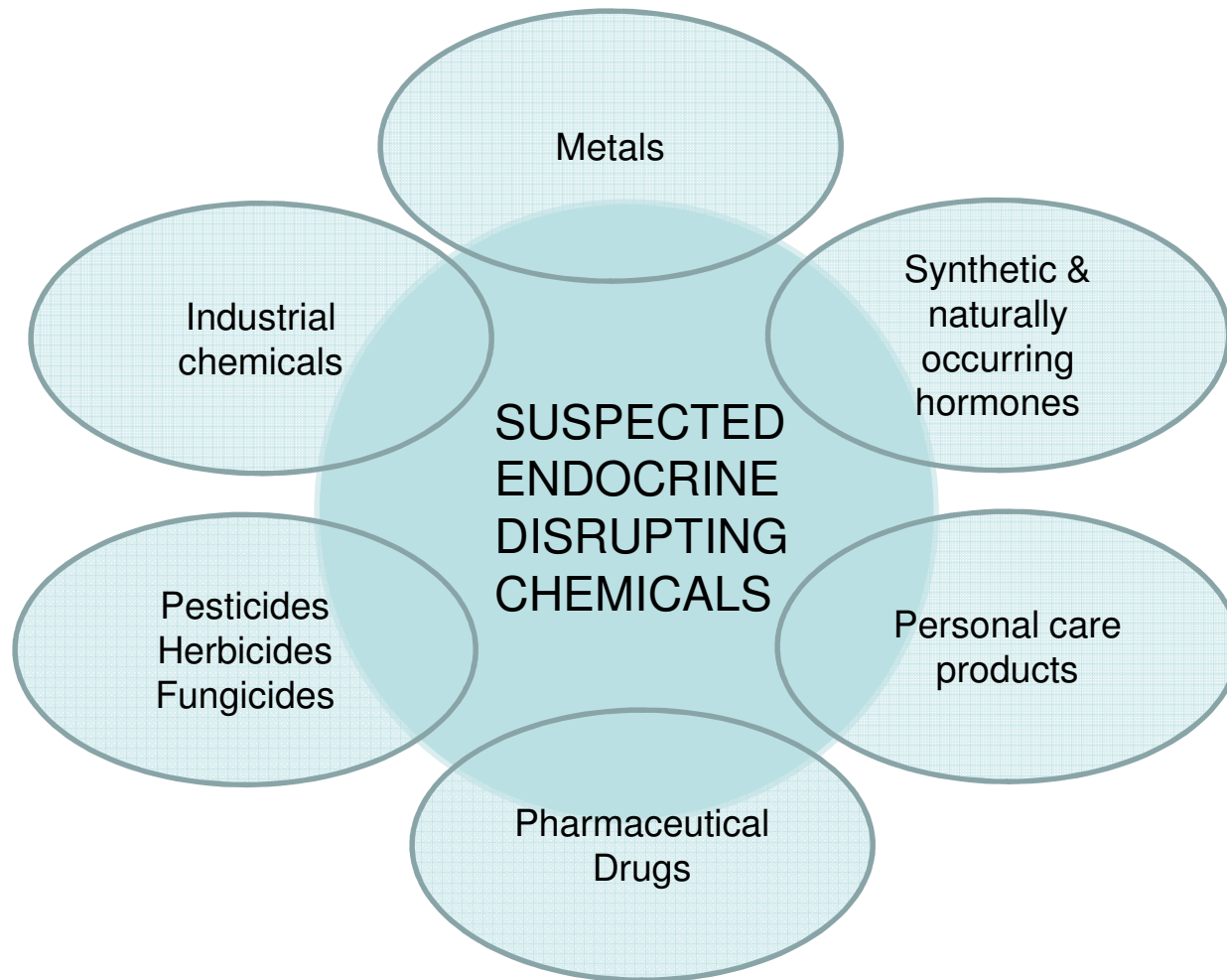
Because it turns out that you actually can fool Mother Nature.

# Estrogen

## The case in point..

*No preferred parking*





Effects of endocrine disrupting compounds that originate from wastewater disposal practices are not fully known....

Areas of needed toxicological research are many.

Long term exposure  
Low-level early embryonic exposure



As far as the  
impacts on the  
ecosystem, what we  
do know is that  
nature is one of the  
earlier purveyors of  
backward compatible  
software



*Earliest indication of the  
presence of estrogen and  
estrogen receptors*

What could  
*possibly* have in  
common with a  
minnow?

91,000 grams

Take Home

Micro-constituents  
Can have  
Macro effects

Energy physiology

More than he  
realizes !

25 grams



Endocrine function

neurological physiology

organ physiology

# Organic Wastewater Contaminants and Septic System Treatment

## Research Review Summary

Advanced treatment devices that incorporate aeration of wastewater during transit through media significantly reduce a number of CEC.(Colorado, Wisconsin, Cape Cod)

<http://www.masstc.org/library/2012/11/TheFinalWhitePaper1.pdf>

# Organic Wastewater Contaminants and Septic System Treatment

## Research Review Summary

CEC of concern still “break through” to  
sensitive receptor sites at environmentally  
relevant concentrations.(Cape Cod)

Compelling

[http://www.masstc.org/library/2012/  
11/TheFinalWhitePaper1.pdf](http://www.masstc.org/library/2012/11/TheFinalWhitePaper1.pdf)

Why would we  
think shallow soil  
placement would be  
effective ?

# Bacteria (and other microbes) - the real workhorses of the terrestrial ecosystems

## **Bacteria/gram of soil**

Billions

7-8 million

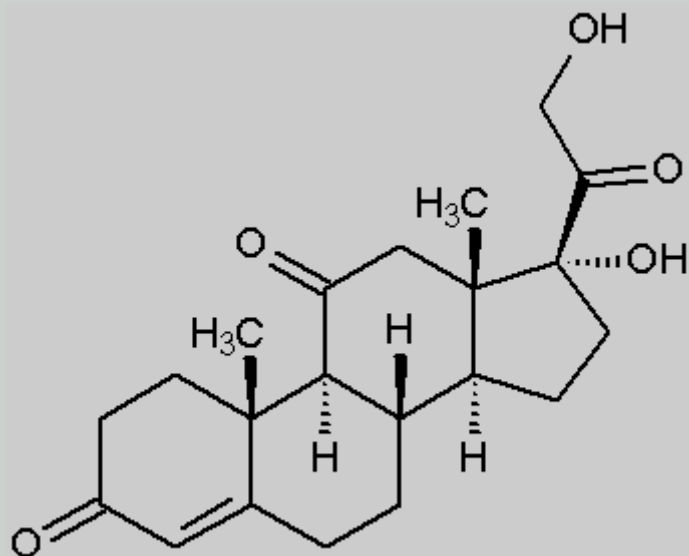
1- 2 million

400 – 500 thousand

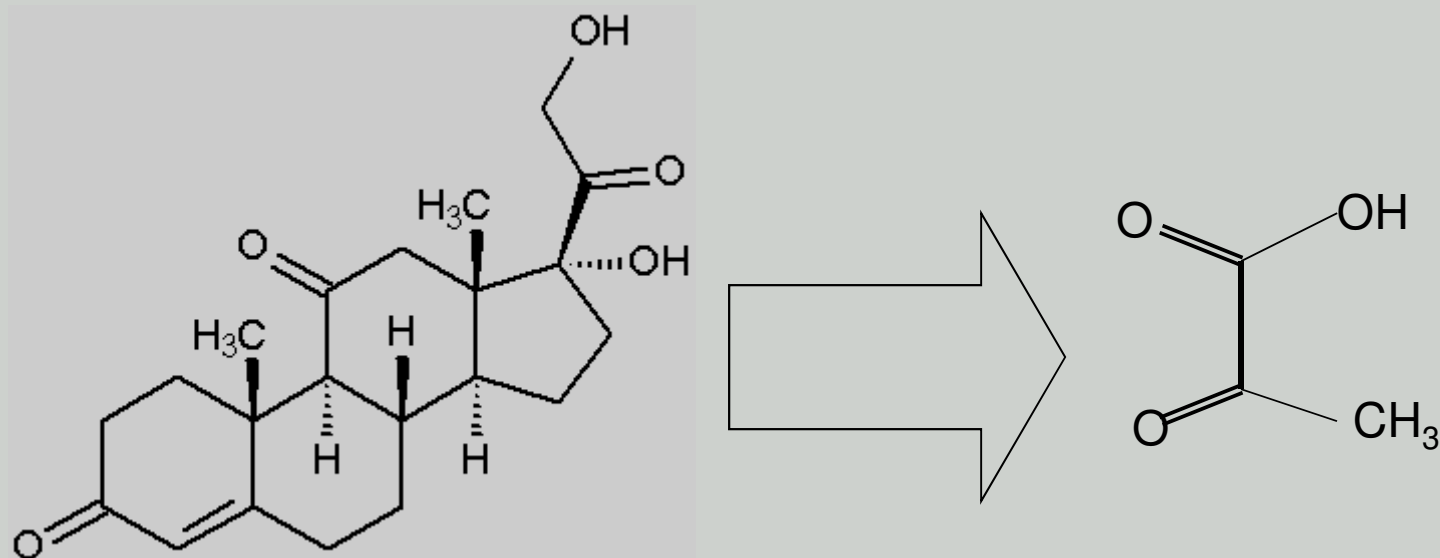
~ 10 thousand

one thousand

hundreds



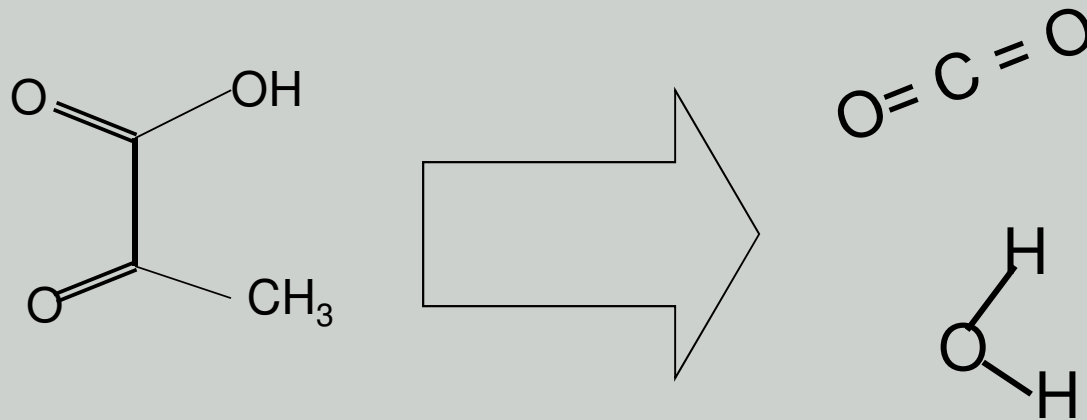
What are we hoping for?



Perhaps there are metabolic pathways of bacteria, algae, plants and fungi that can be exploited to reduce CEC to harmless byproducts.

And.....





And perhaps the environments to encourage organisms and physical conditions that promote these organisms can be engineered into onsite systems.

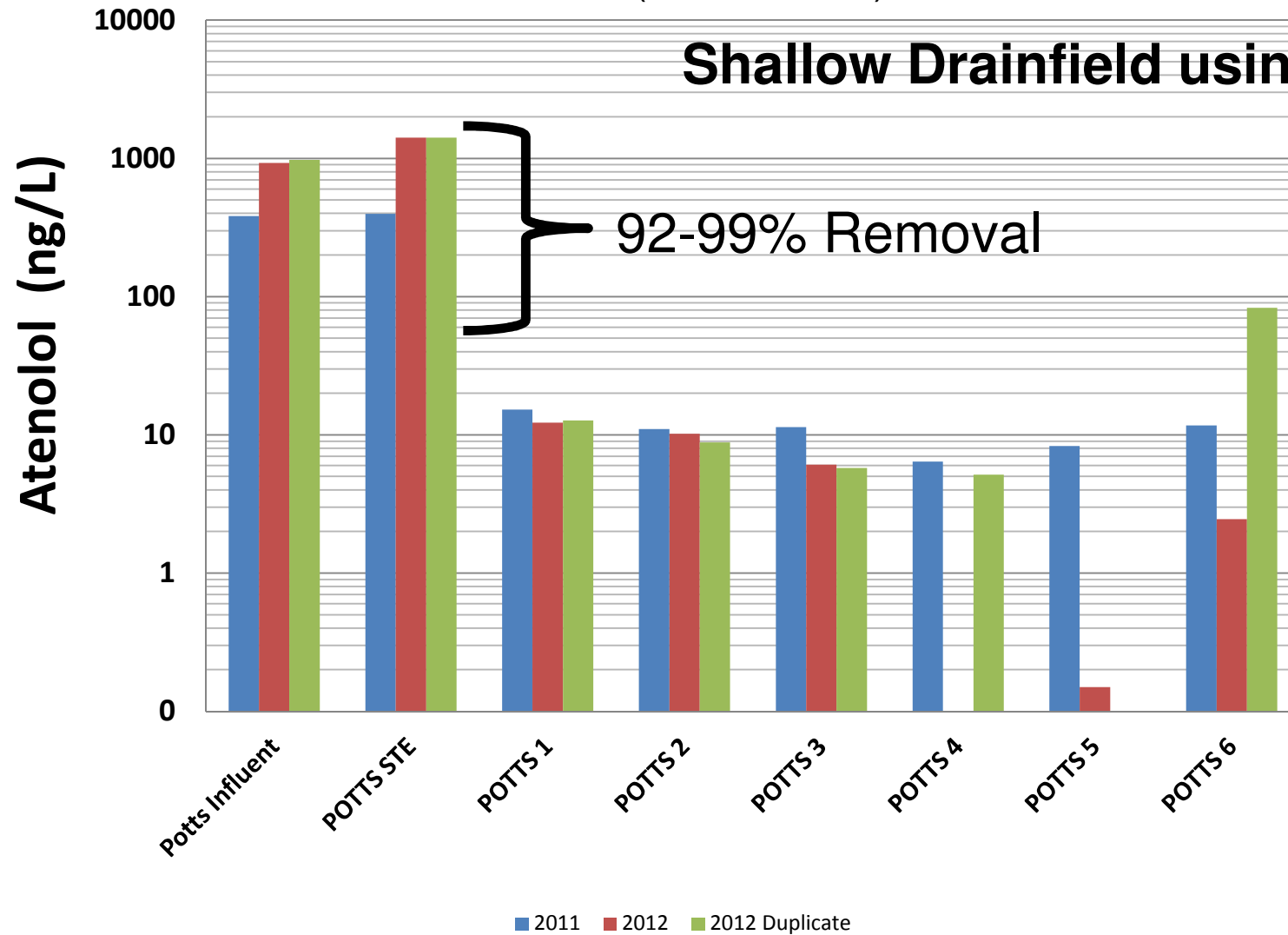
Shallow-placed septic system treatment for  
pharmaceuticals

There is  
Good News

and  
Bad News

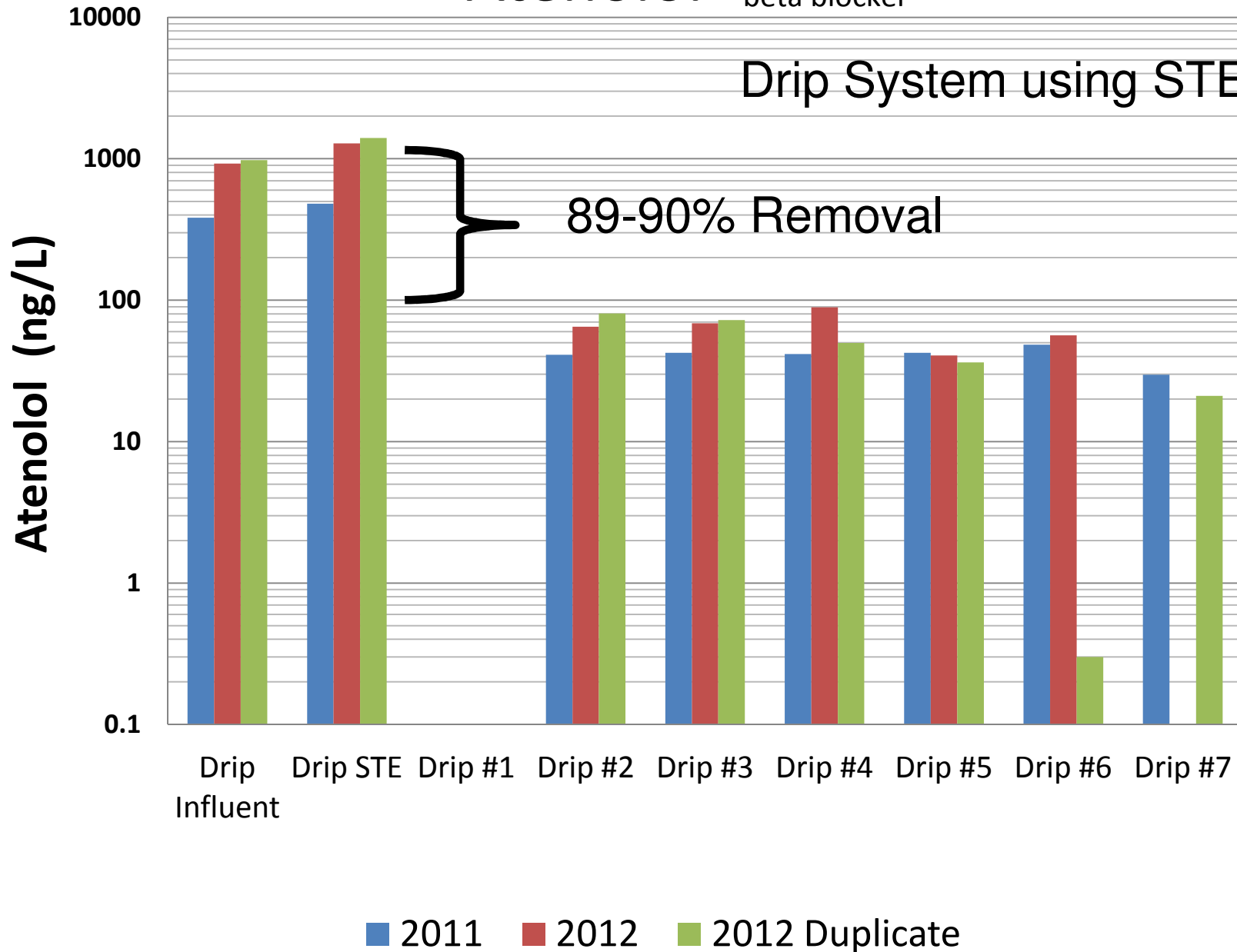
# Atenolol (beta blocker)

## Shallow Drainfield using STE

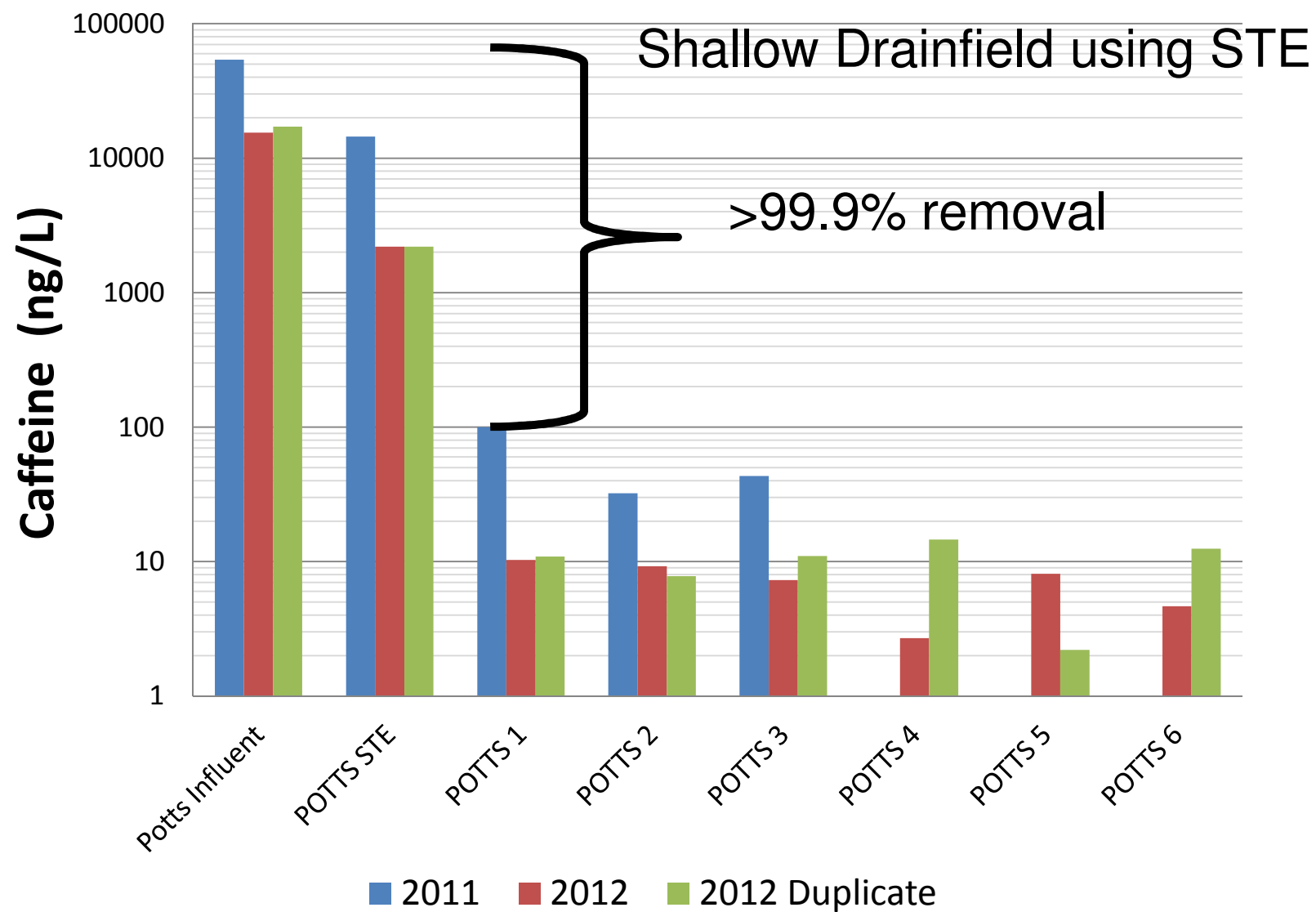


# Atenolol beta blocker

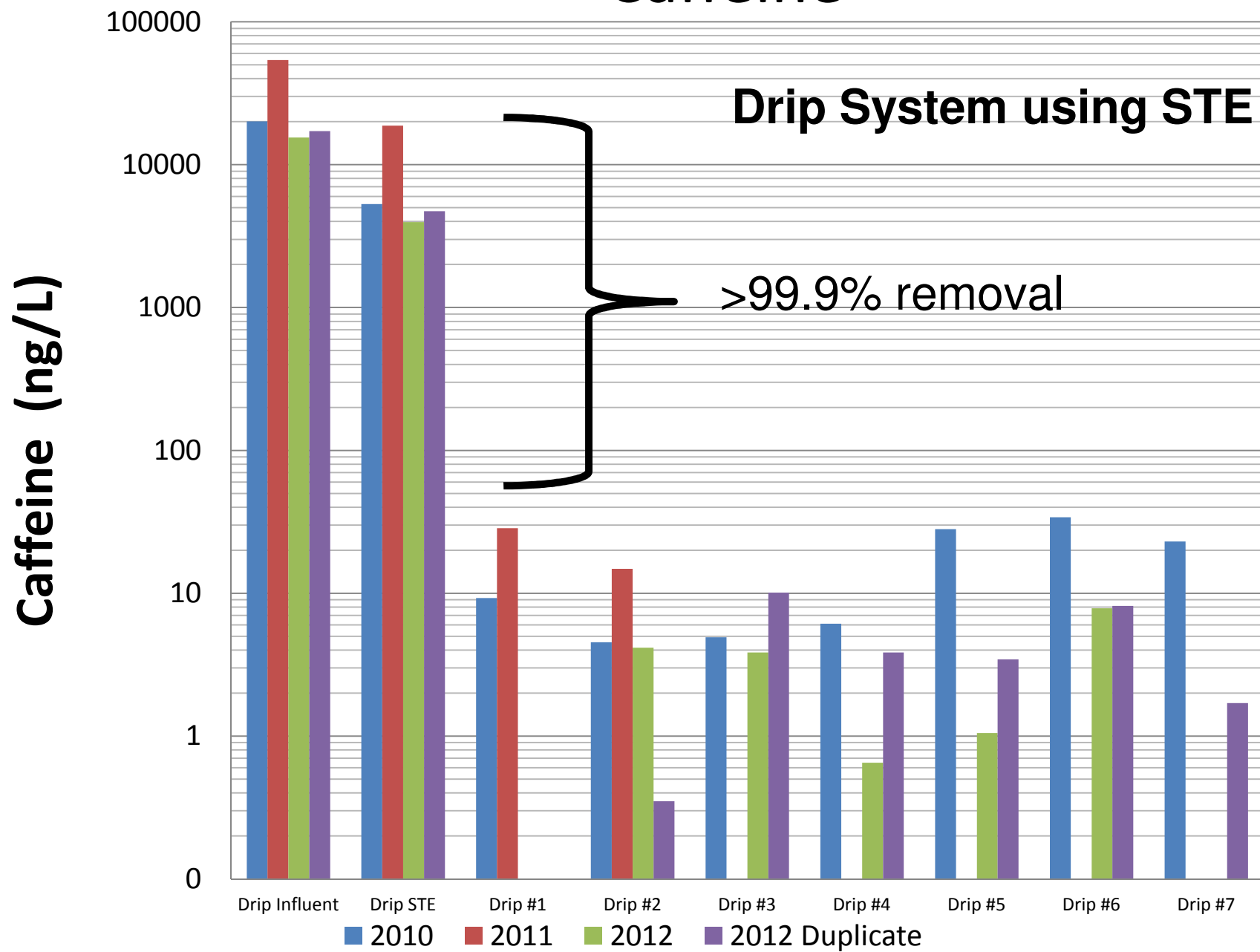
Drip System using STE



# Caffeine

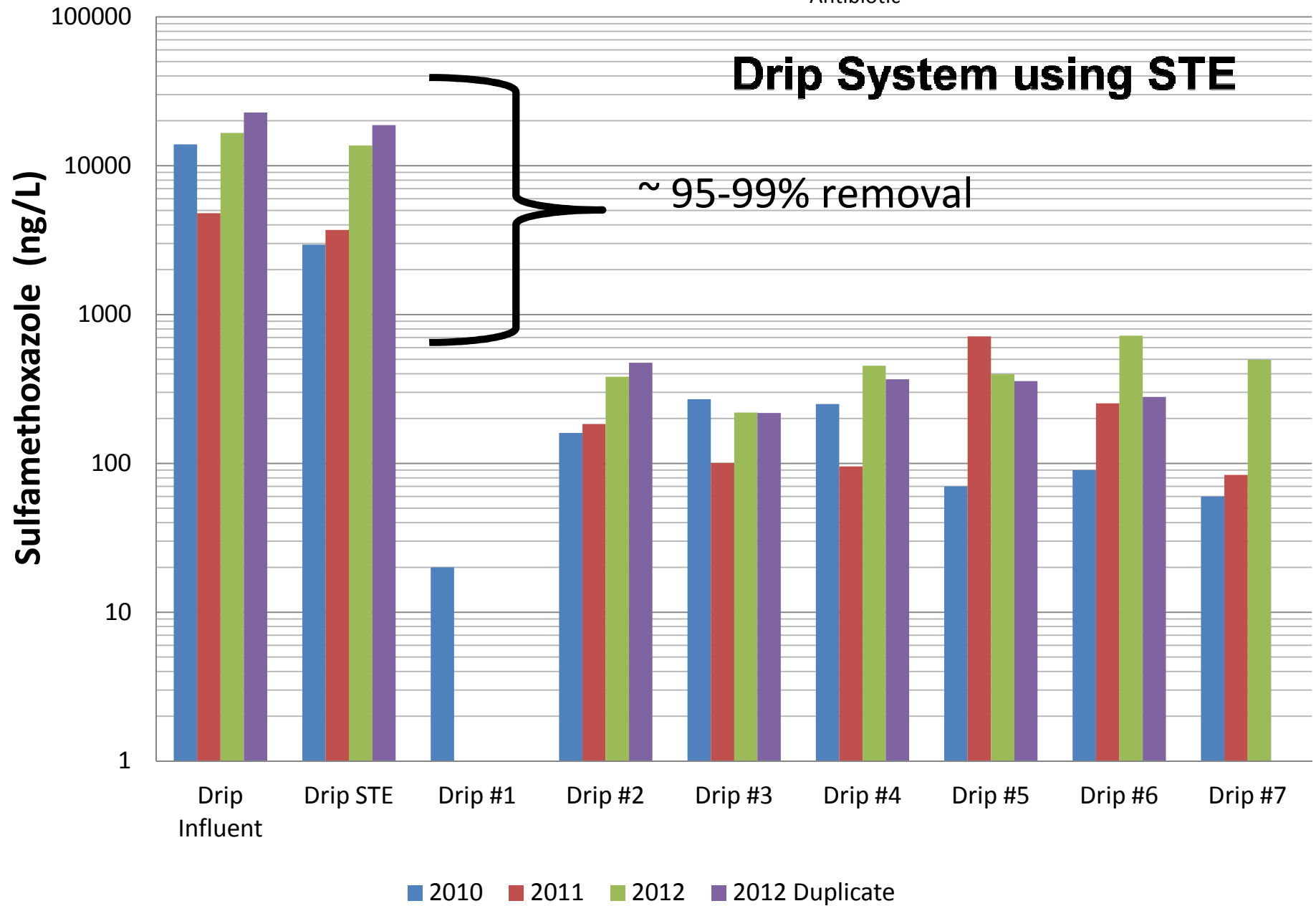


# Caffeine

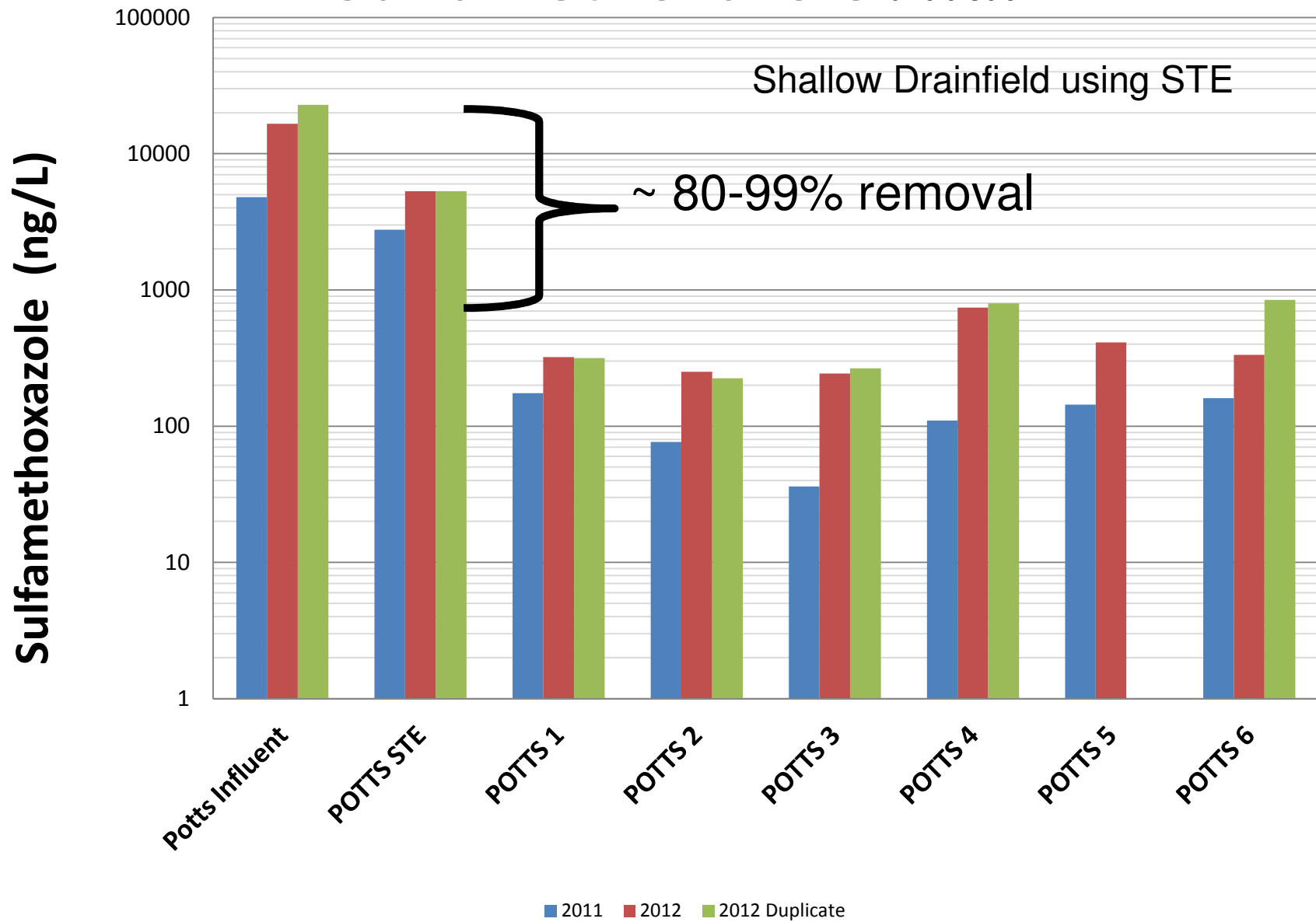


# Sulfamethoxazole

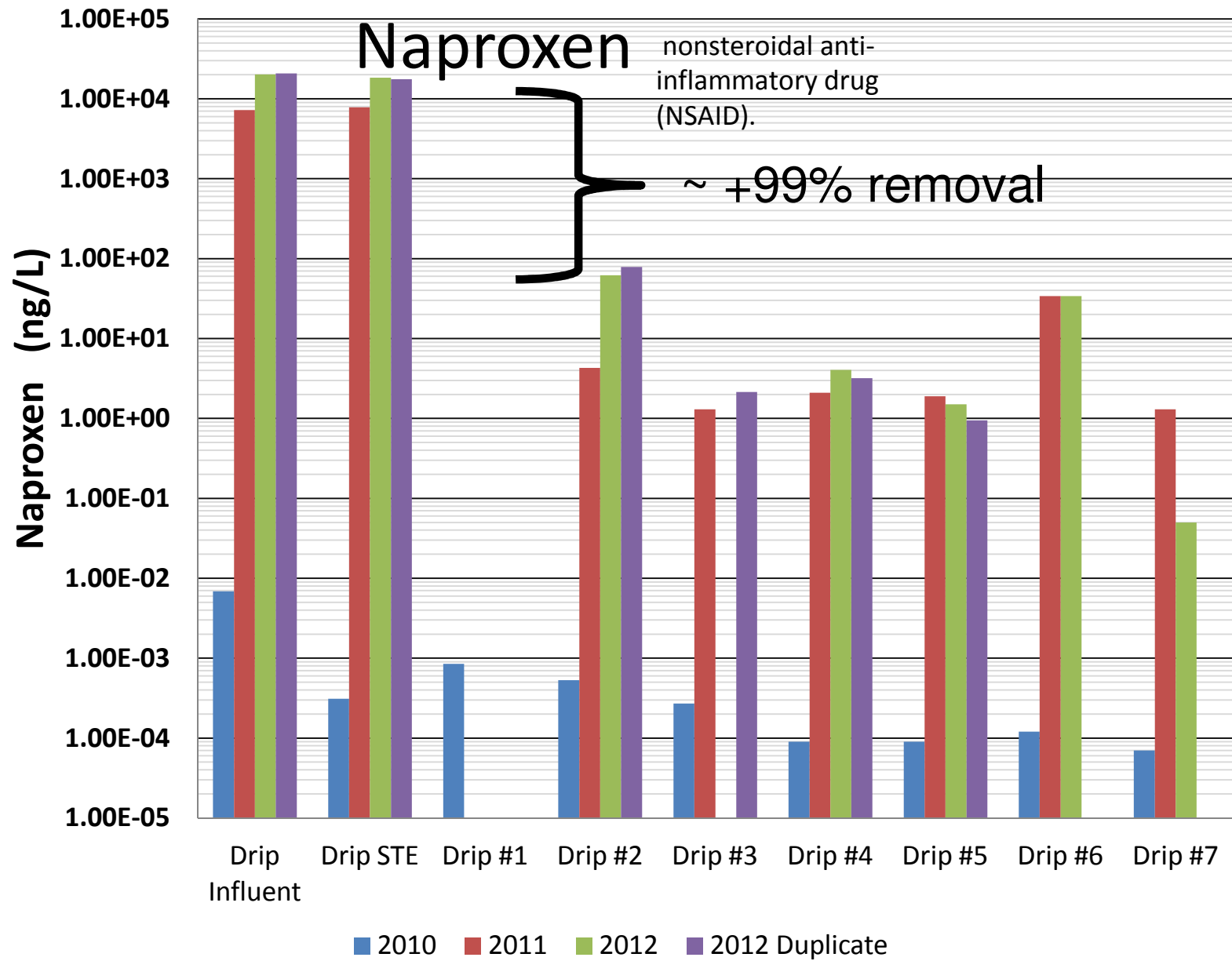
Antibiotic



# Sulfamethoxazole antibiotic



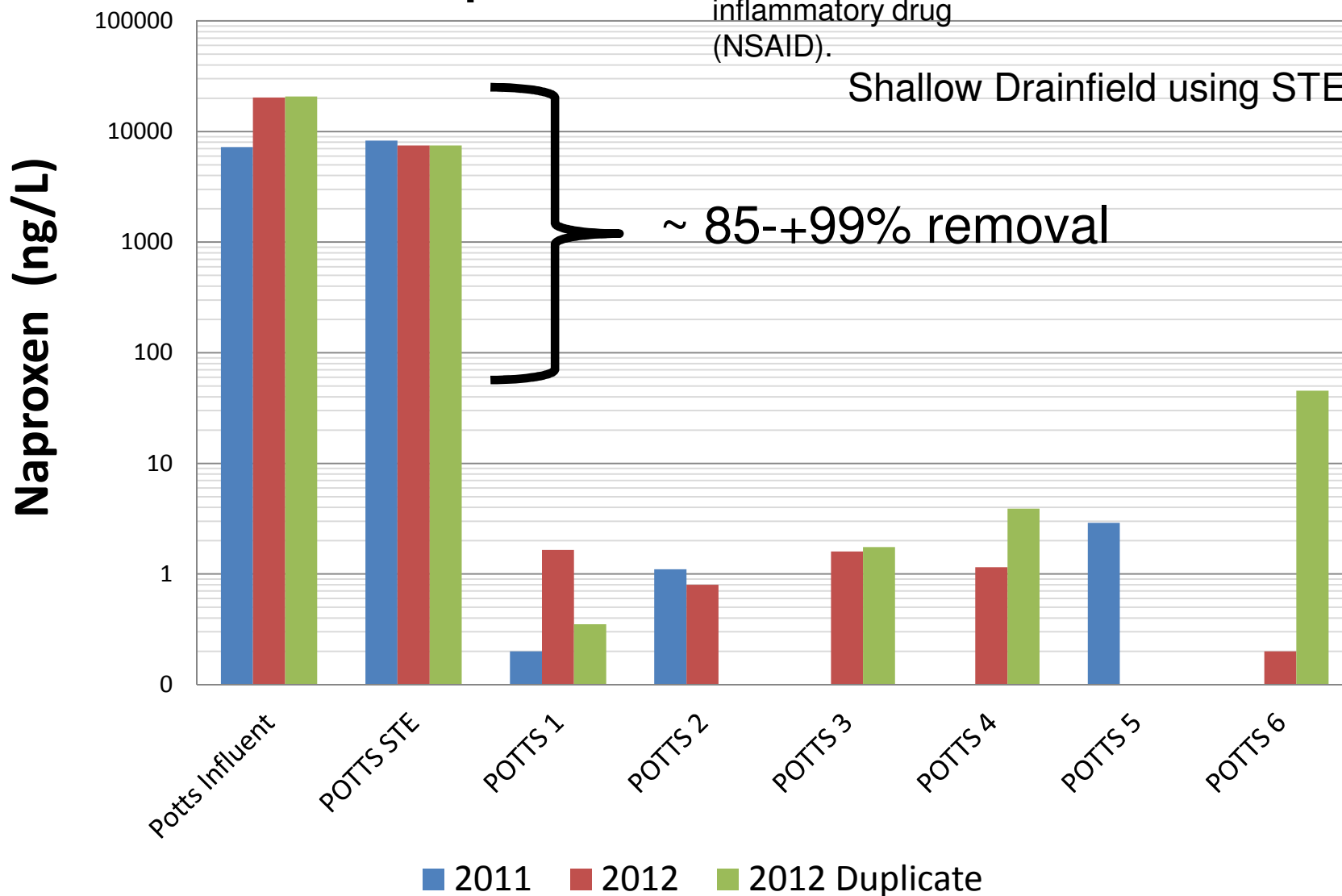




# Naproxen

nonsteroidal anti-inflammatory drug (NSAID).

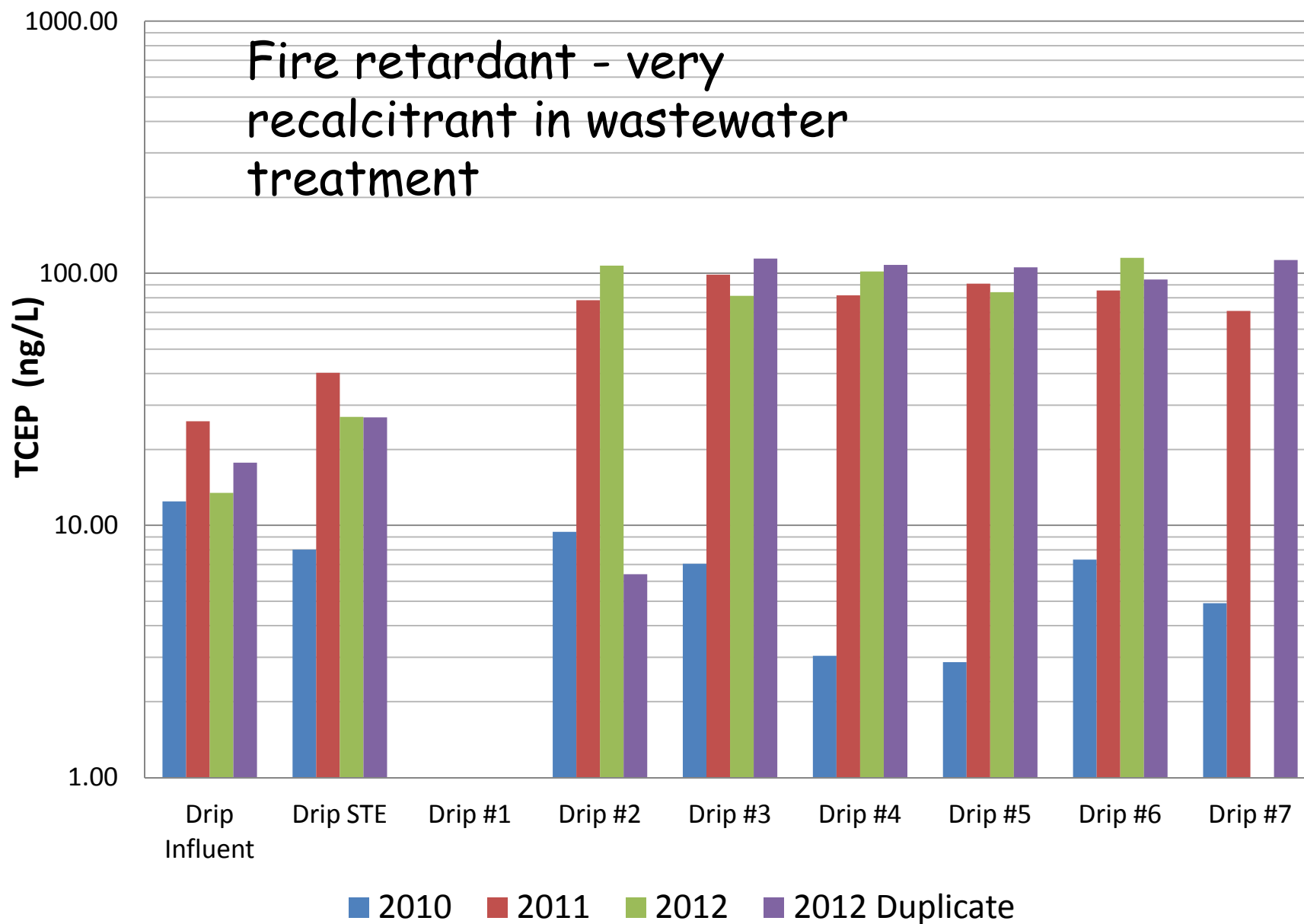
Shallow Drainfield using STE



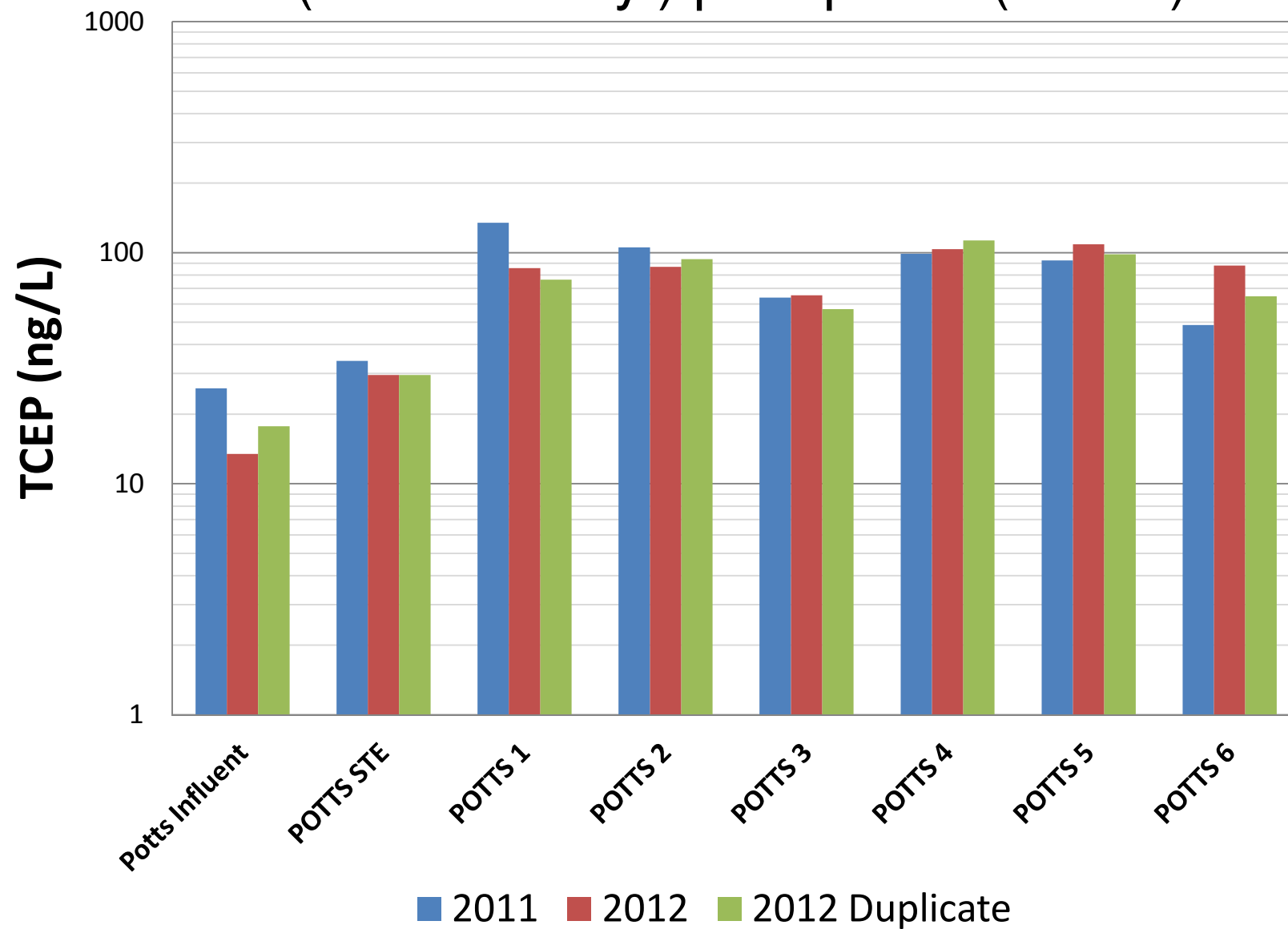
## Not so good news

There are some classes of compounds that are recalcitrant, that is they do not break down during treatment attempts.

# tris(2-chloroethyl) phosphate (TCEP)

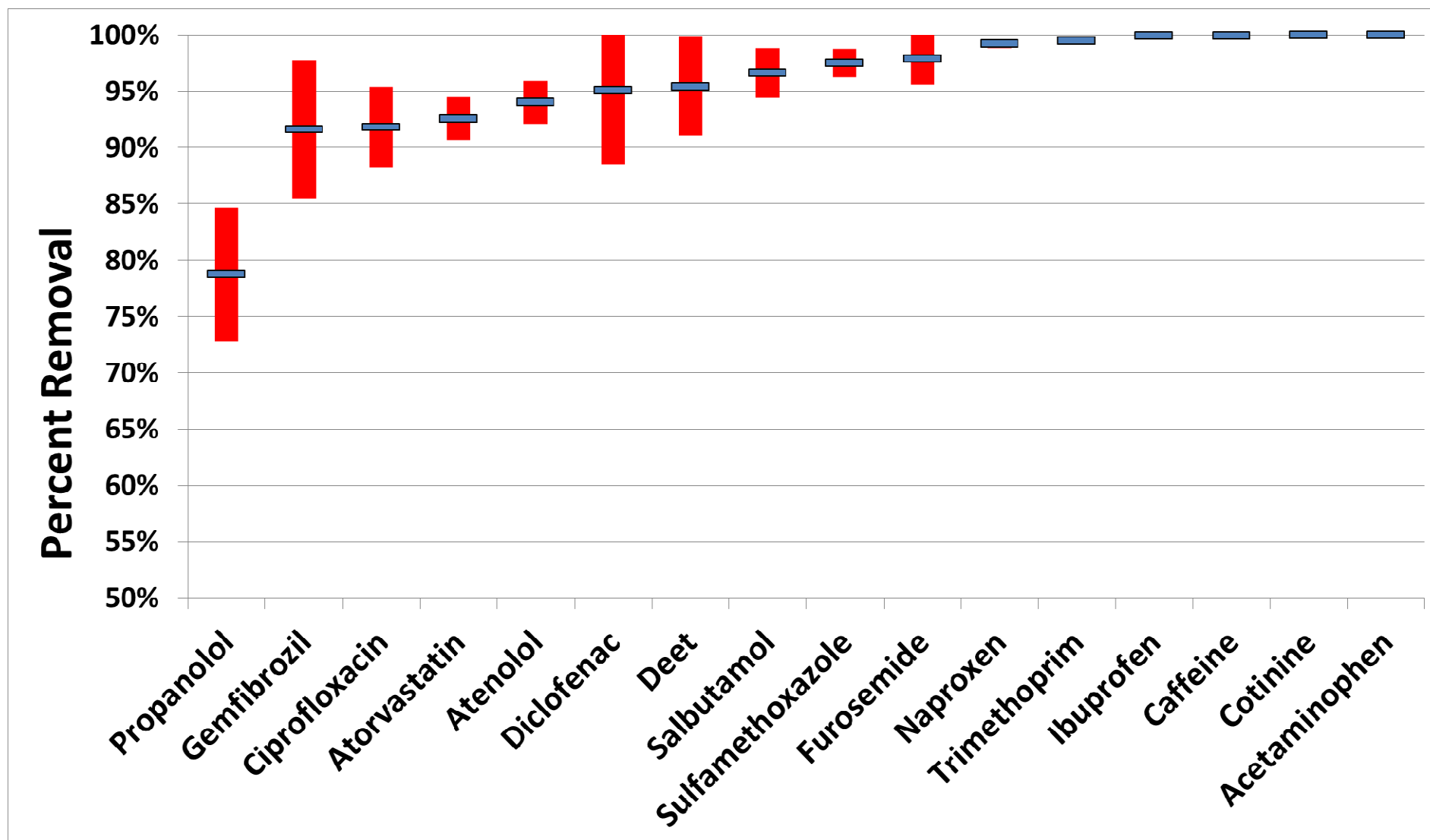


# tris(2-chloroethyl) phosphate (TCEP)

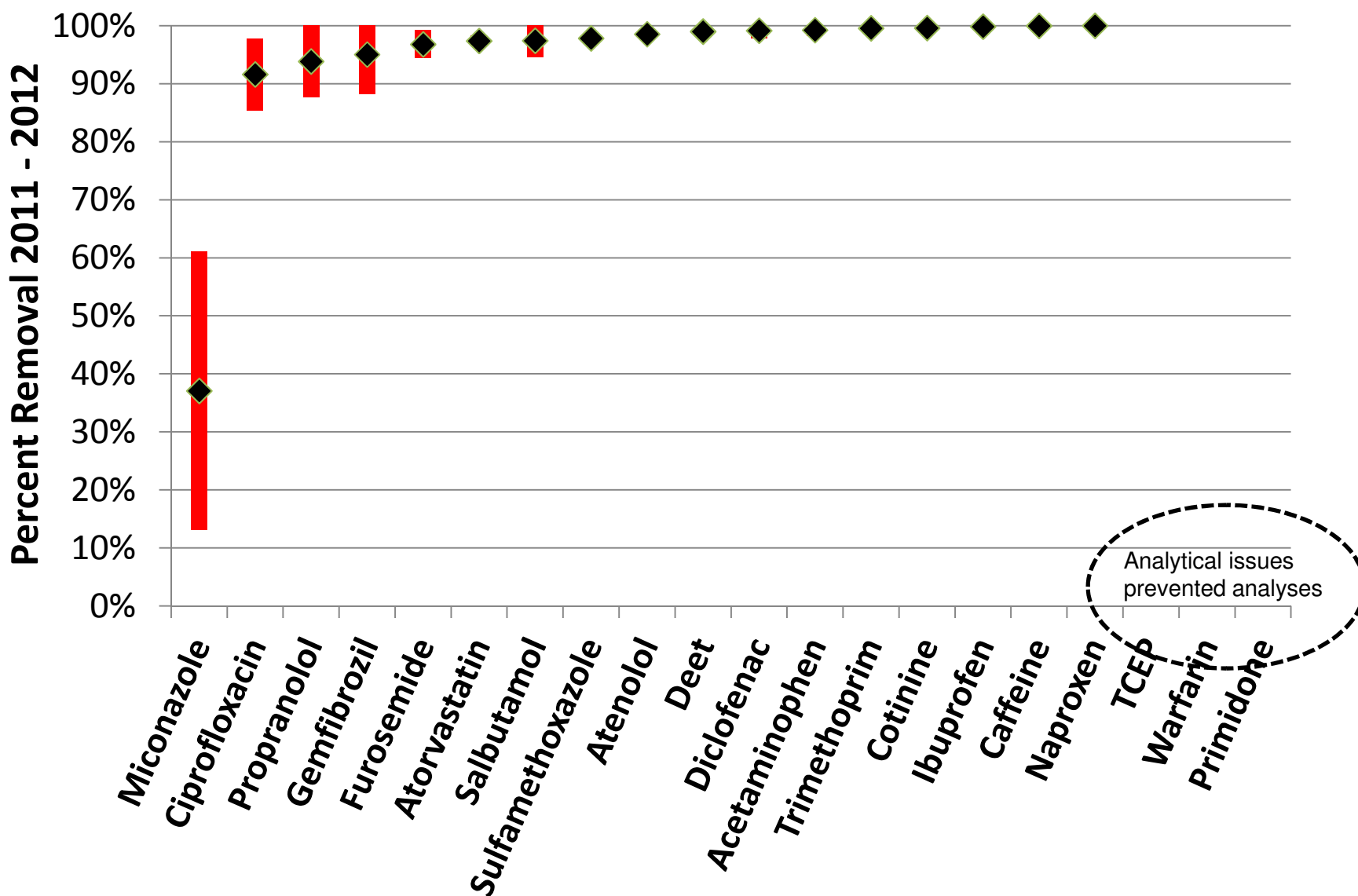


But in general.....

## Removal of selected contaminants of emerging concern by drip dispersal 2010-2012

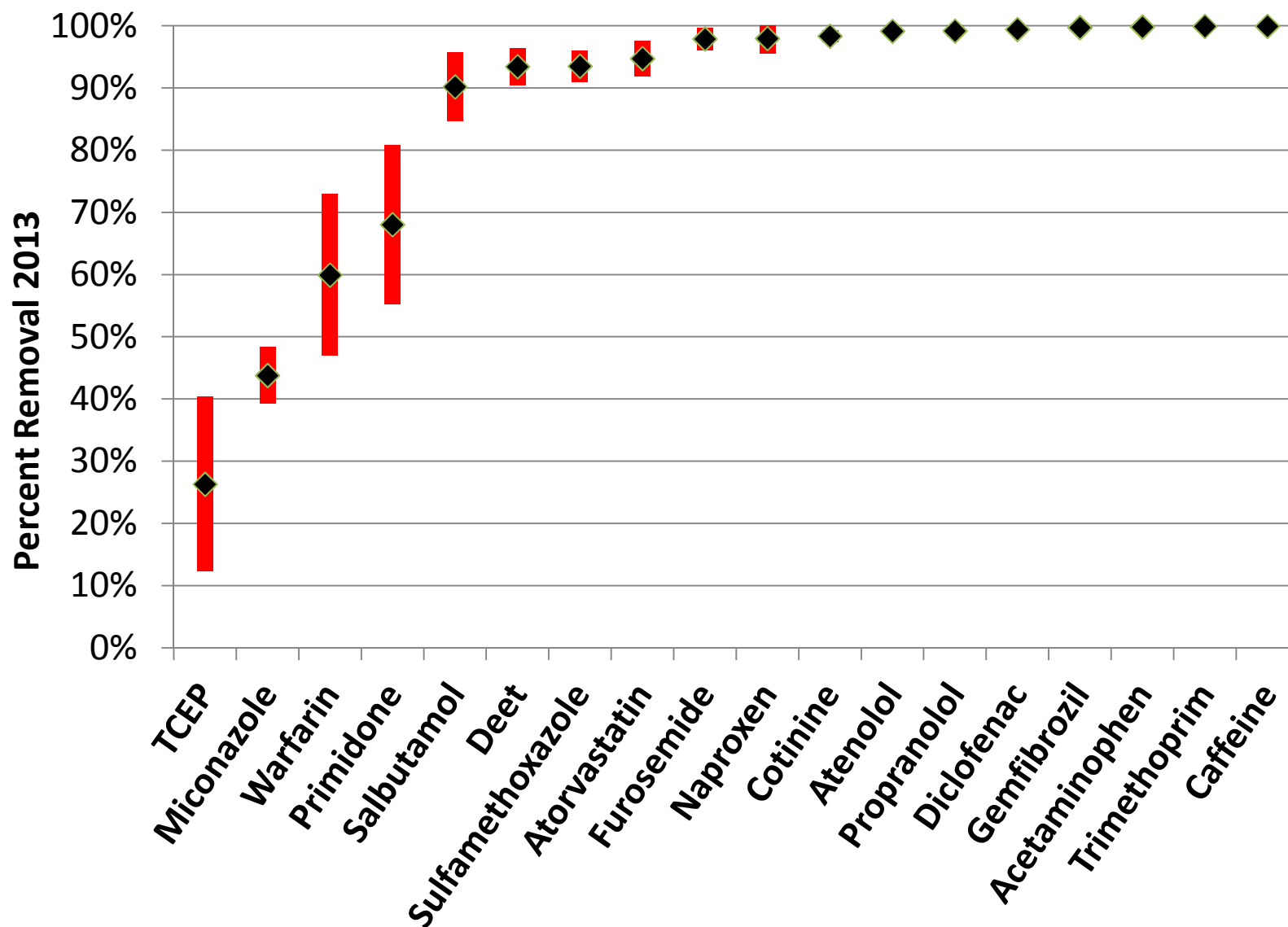


## Removal of selected contaminants of emerging concern by shallow-placed drainfields 2011-2012.

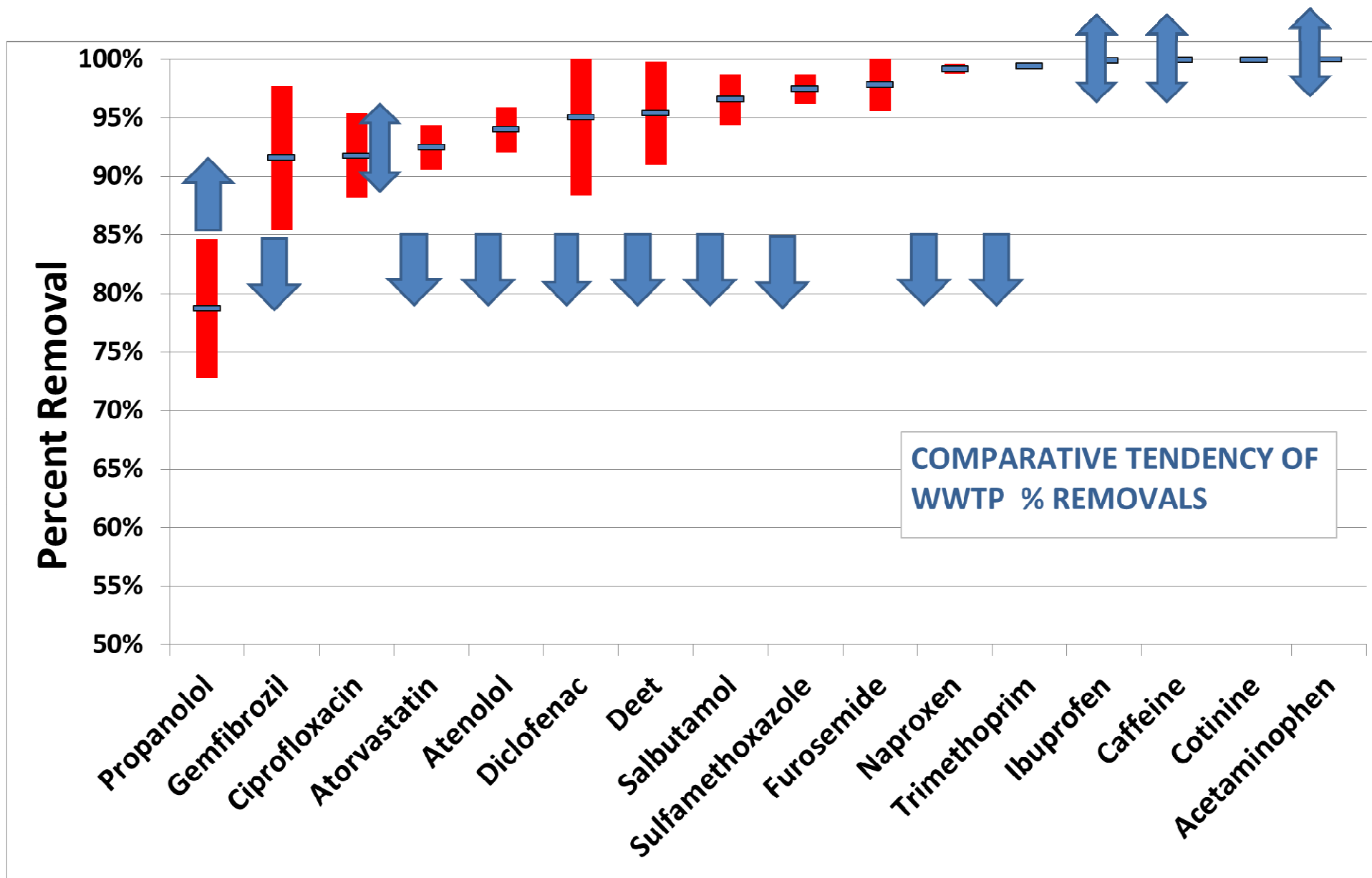




## Removal of selected contaminants of emerging concern by shallow-placed drainfields 2013.



## Removal of selected contaminants of emerging concern by drip dispersal and shallow drainfields



## Possible mechanisms for pharmaceutical removal by shallow-placed disposal fields.

- More diverse and abundant microbiology;
- Relatively long residence times in the biologically active areas (compared to for example many treatment plants);
- Adsorption onto filter media (particularly by polar molecules);
- Chemical reaction (and immobilization) within the filter media.

Is there any hope for eliminating  
TCEP and similar compounds?

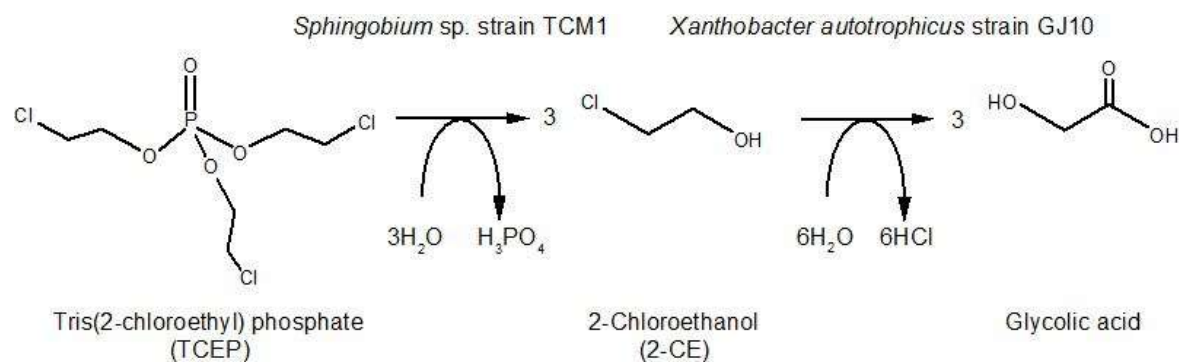
YES

CHANCE FAVORS THE PREPARED MIND

LOUIS PASTEUR

CHANCE FAVORS THE PREPARED BACTERIA

SUSAN DRACUT MONÂS



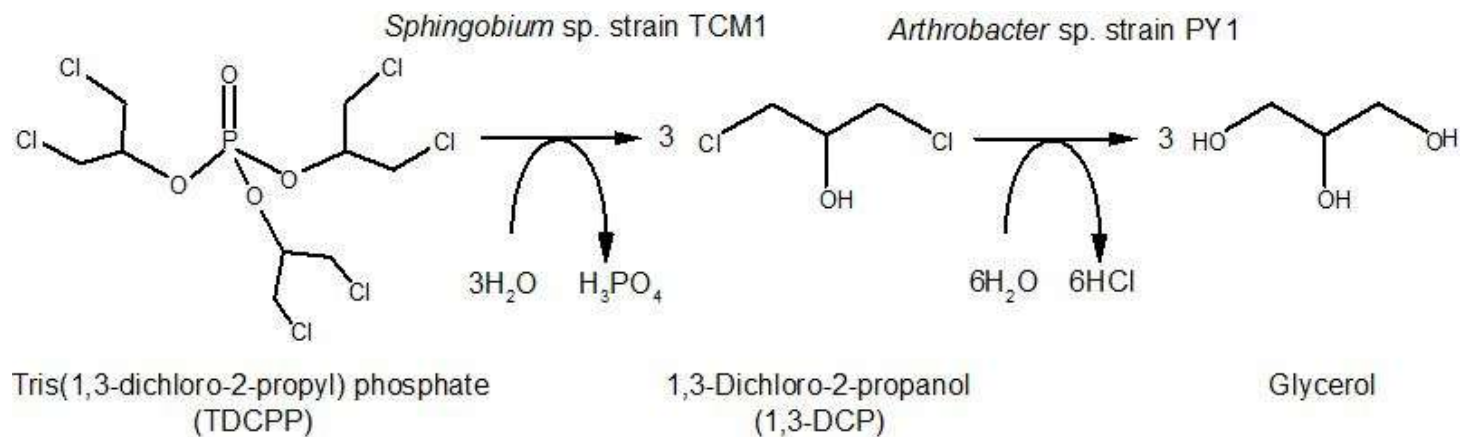
[Biochemistry, Genetics and Molecular Biology](#) » ["Environmental Biotechnology - New Approaches and Prospective Applications"](#), book edited by Marian Petre, ISBN 978-953-51-0972-3, Published: February 7, 2013 under [CC BY 3.0 license](#)

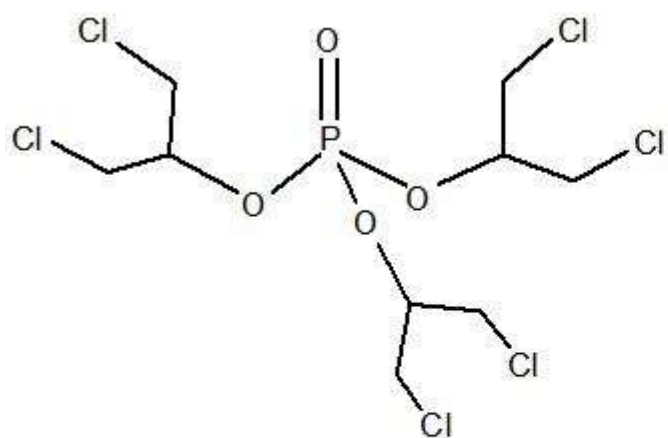
## Chapter 5

### Microbial Degradation of Persistent Organophosphorus Flame Retardants

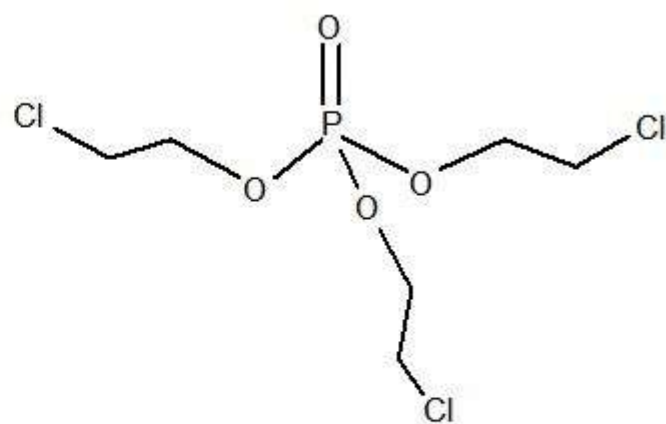
By Shouji Takahashi, Katsumasa Abe and Yoshio Kera

DOI: 10.5772/53749

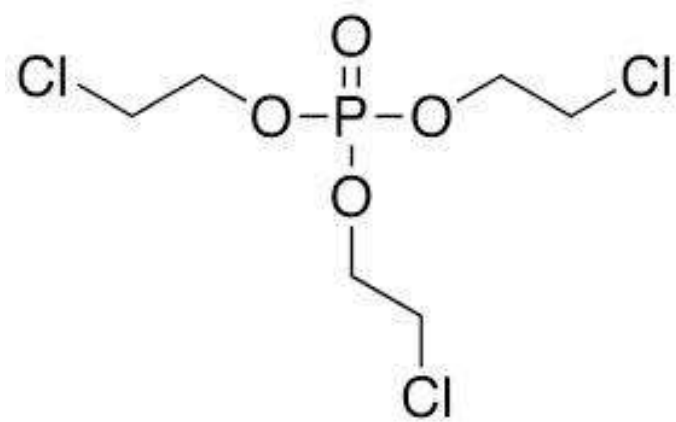




Tris(1,3-dichloro-2-propyl) phosphate  
(TDCPP)



Tris(2-chloroethyl) phosphate  
(TCEP)



# Take home messages

- Many pharmaceutical and personal care products, contain compounds that can disrupt the normal functioning of hormones in humans and wildlife.
- Although a major route for CEC entrance into the environment is wastewater disposal, the onsite septic system presents opportunity for significant treatment.
- Shallow-placed soil absorption systems remove > 90% of many CECs found in household wastewater.
- A more complete understanding of the principles of CEC removal in soils may offer opportunities to design optimization.
- A complete understanding of the range of mechanisms responsible for CEC removal in soils is not yet available.



# Questions

