REMEDIATION AT AGFA-GEVAERT, BELGIUM

40,000 t soil; >99,5 % concentration reduction; complete biological treatment (soil, water and air)

Marijke Van Camp, Lars Van Passel

1. Site description - History

Site description

Agfa-Gevaert – fine chemicals

Chemical production: equipment

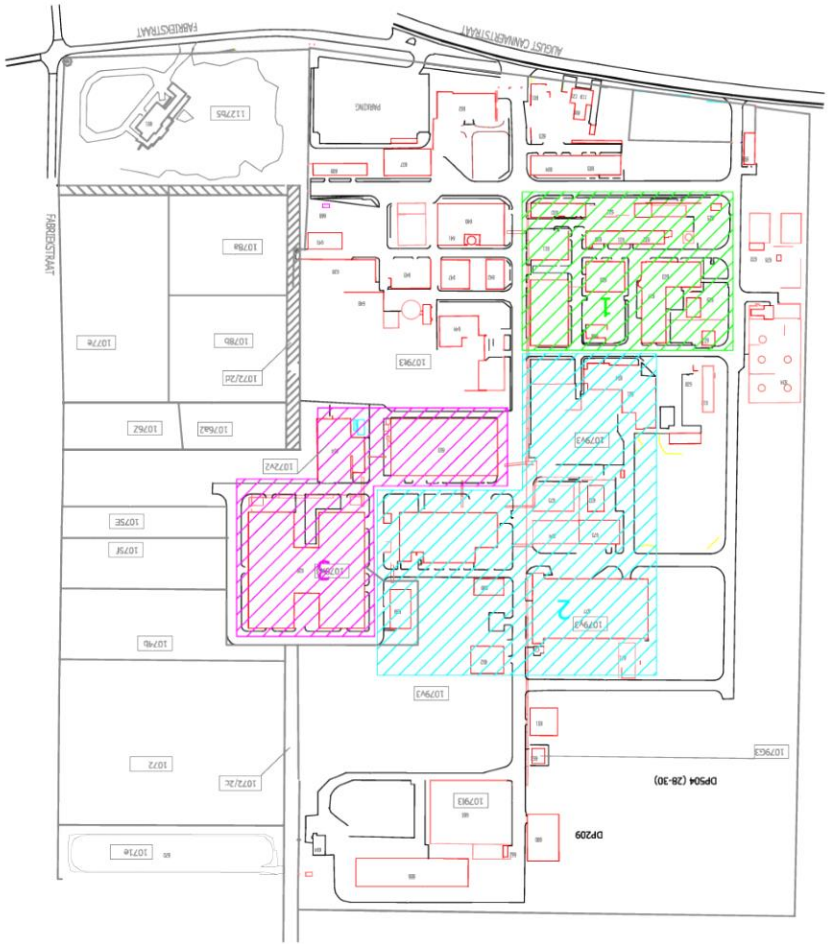
Agfa’s mission

Emission-free installations

- Prevent emission of chemicals to the environment
- Protect operators against toxic products
- Protect the environment against uncontrolled emissions

Site History

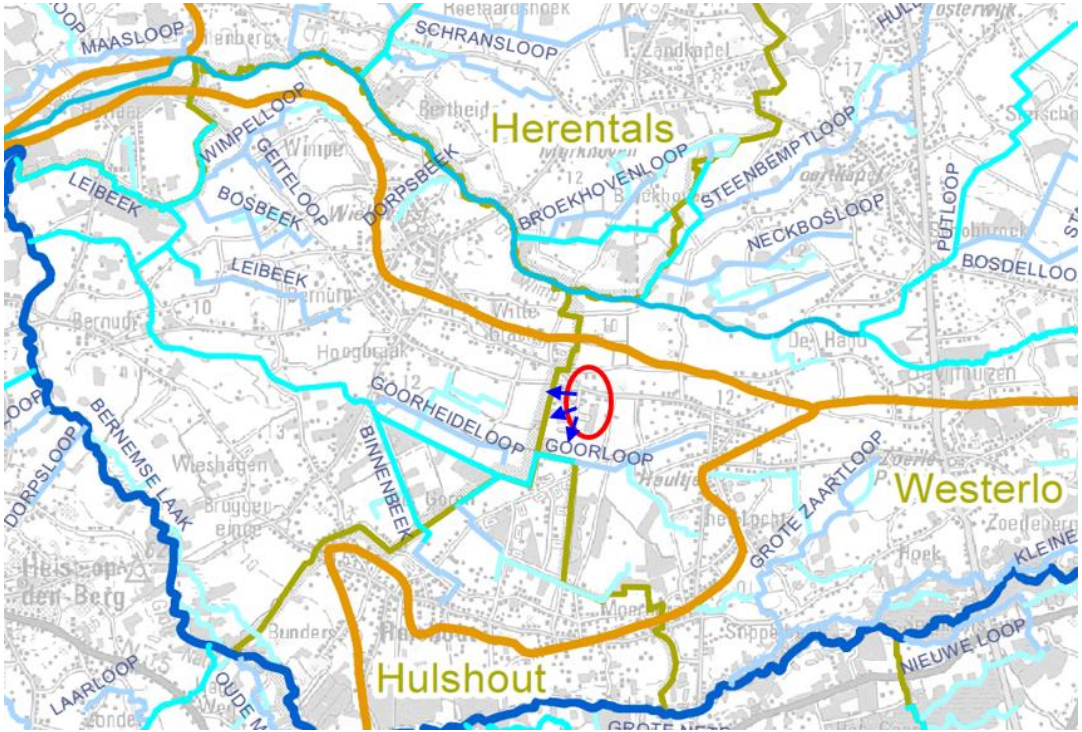
- 1928: start production of nitrocellulose on the site in Westerlo
- 1951: stop production nitrocellulose; start production cellulose-tri-acetaat
- 1965: start production toner
- 1970: start production developer
- 1973: start production chemicals for photographic materials
- 1996: stop production cellulose-tri-acetaat
- 2000: sale of production toner and developer -> Xeikon



2. Conceptual Site Model

General site characteristics

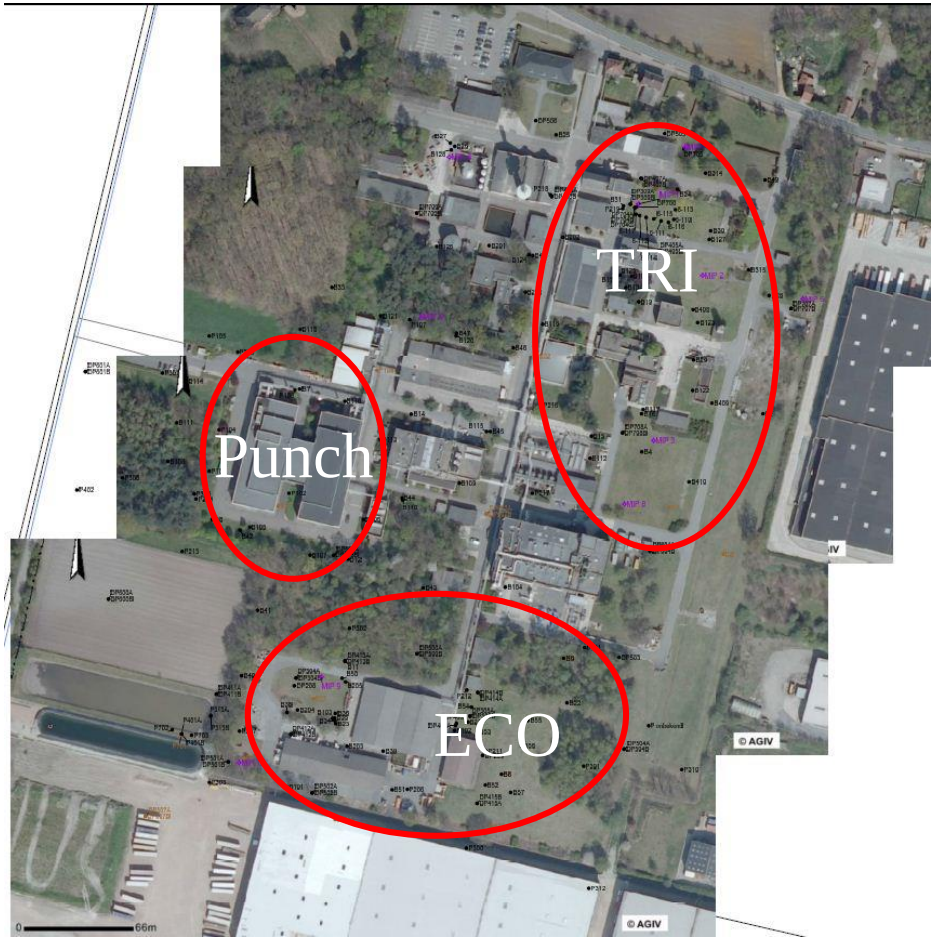
- Groundwater flow direction W–SW
- Geology:
  - 0–50 m: sand, aquifer (formation of Diest/Berchem)
  - 50–110 m: clay, low permeability (formation of Boom)
- Infiltrating soil
- Annual groundwater fluctuations of 1 to 1.5 m



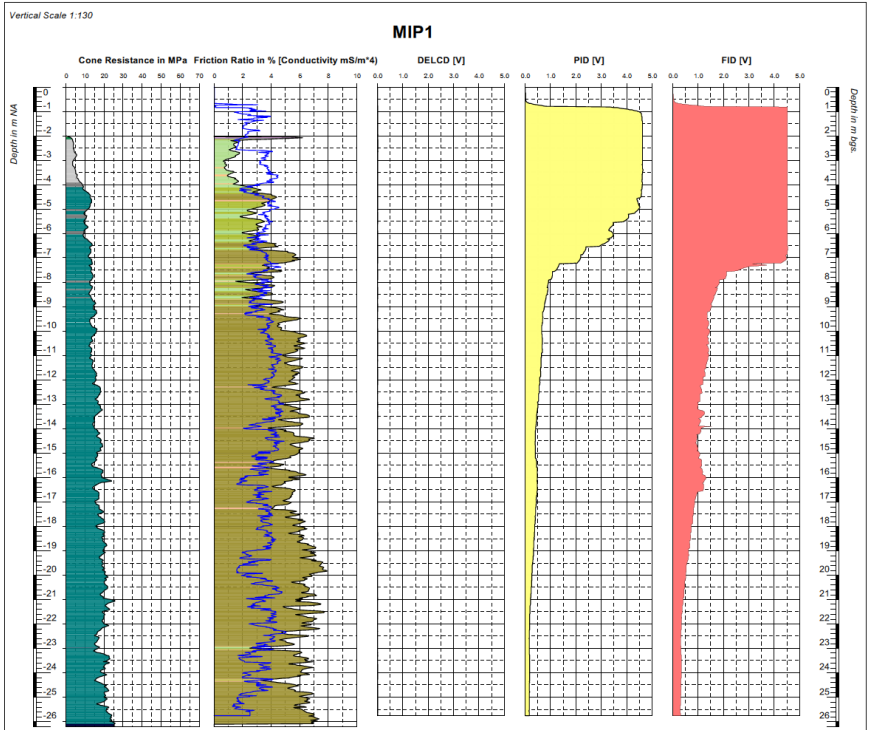
Overview of contaminated zones

Complex soil and groundwater contamination

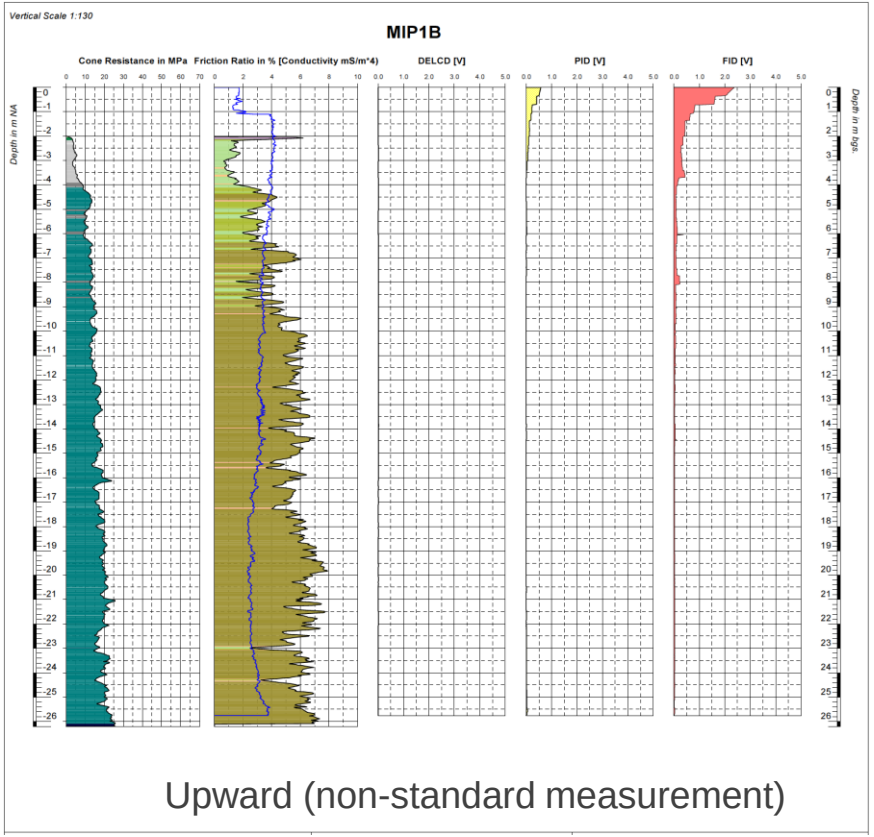
- 3 zones with different origin and different composition:
  - Zone ECO (former waste processing, storage of lime sludge, open ditch)
  - Zone Punch (former iron oxide dump)
  - Zone TRI (former tri-acetate production)



Remedial investigation - MIP



Downward (standard measurement)



Upward (non-standard measurement)

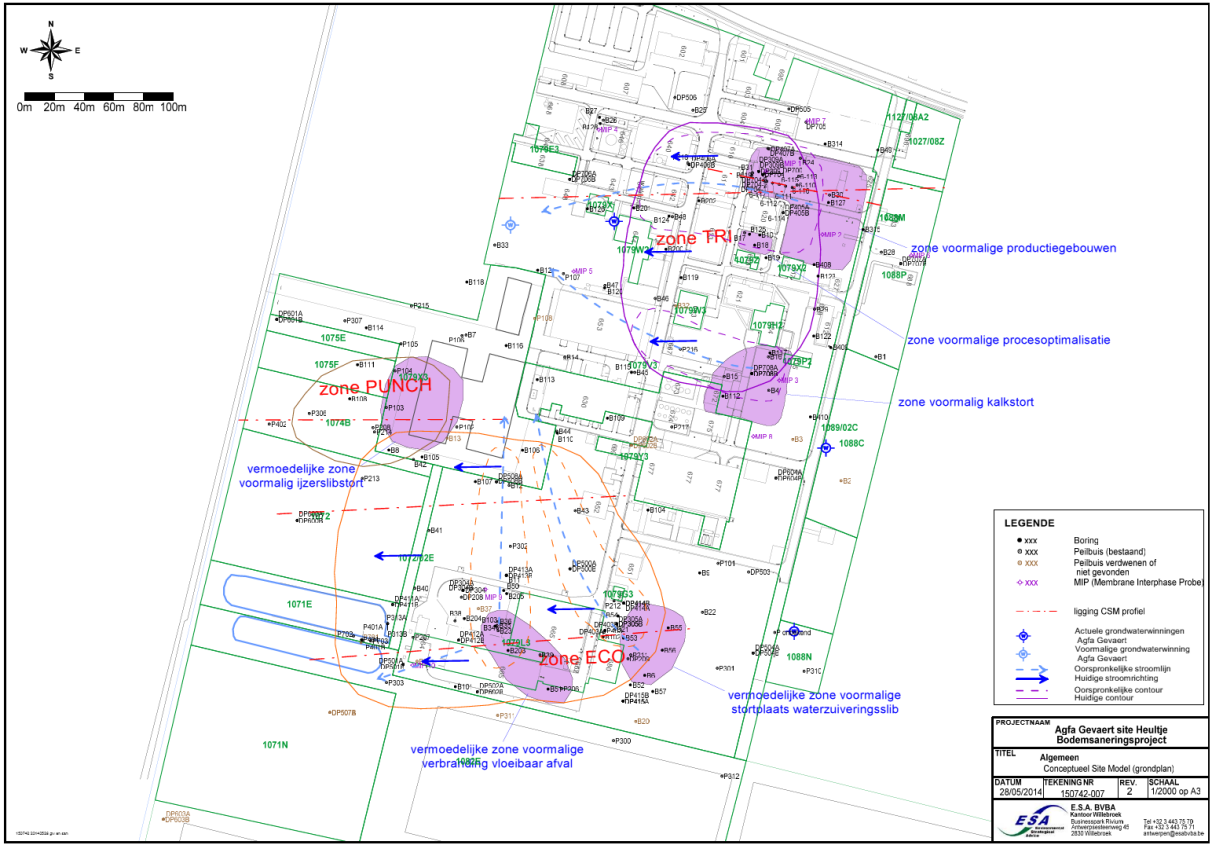
Remedial investigation – calculation mass area TRI

Total mass (adsorbed + water phase + NAPL) via soil concentration

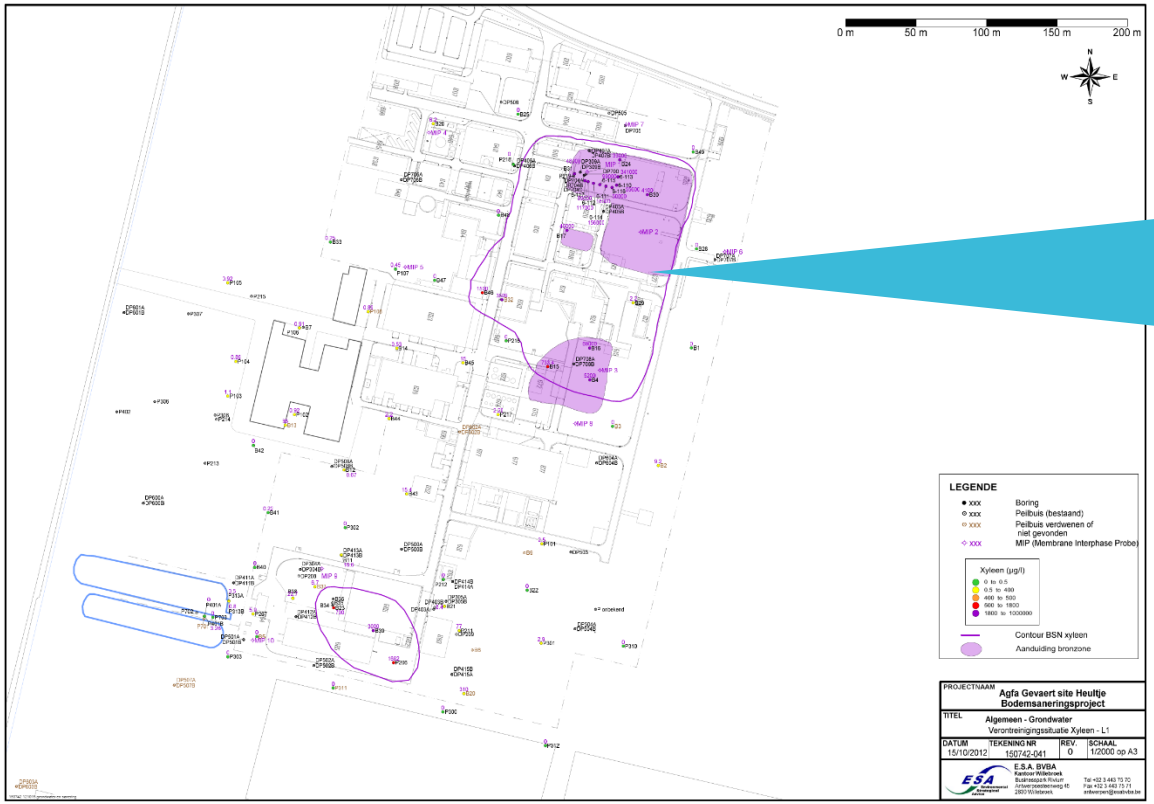
Portion of NAPL in total mass via distribution over soil phases using fugacity capacity constants and solubility as max pore water concentration

Massaberekening zone TRI										
Grond	**Berekening obv gemeten grondconcentraties**									
Tri production area (Tri 1)			4478	m²						
	soortelijk gewicht		1800	kg/m³						
					L11	L12	L13	totaal		
			ds (kg ds/kg)		85.3%	82.1%	84.1%			
			laagdikte (m)		1	1	1.5			
	Naam monster	Laag	B		T	E	X	BTEX		
	B24 (0-3)	L11	<0.05		<0.05	<0.05	0	0		
	B408 (0.7-0.9)	L11	<0.1		<0.1	<0.1	0	0		
	B314 (0.3-0.8)	L11	<0.1		<0.1	<0.1	<0.1	0		
	DP704 (0.5-0.7)	L11	<0.050		<0.050	1.5	26.65	28.15		
	Cgr gemiddeld	L11	0.025		0.025	1.5	26.65	28.15		
	Massa	L11	0.2		0.2	10.3	183.2	193.9	kg	
	B24 (0-3)	L12	<0.05		<0.05	<0.05	0	0		
	B30 (1-3)	L12	<0.05		95	180	1660	1935		
	B31 (1-3)	L12	<0.05		3.4	200	420	623.4		
	B315 (1-1.4)	L12	<0.1		<0.1	0.1	0.13	0.23		
	DP309 (1.2-1.4)	L12	<0.1		2.8	136	344	482.8		
	DP704 (1-1.2)	L12	0.077		12.9	1040	3862	4914.977		
	DP704 (1.5-1.7)	L12	0.329		24.8	1770	7100	8895.129		
	Cgr gemiddeld	L12	0.13533333		27.78	665.2	2677.2	3370.261		
	Massa	L12	0.9		183.8	4402.0	17716.6	22303.3	kg	
	B24 (0-3)	L13	<0.05		<0.05	<0.05	0	0		
	B30 (1-3)	L13	<0.05		95	180	1660	1935		
	B31 (1-3)	L13	<0.05		3.4	200	420	623.4		
	DP704 (2-2.2)	L13	0.492		33.3	1580	3691	5304.792		
	Cgr gemiddeld	L13	0.18066667		43.9	653.333333	1923.667	2621.064		
	Massa	L13	1.8		446.4	6643.2	19560.2	26651.6	kg	
	Totale massa		2.9		630.4	11055.5	37460.0	49149	kg	
			0.0%		1.3%	22.5%	76.2%			
	Vermoedelijke massa NAPL gemeten als grondverontreiniging									
	Naam monster	Laag	B		T	E	X	BTEX		
	Cgr gemiddeld	L12	0.03533333		18.78	606.2	2423			
	Massa	L12	0.2		124.3	4011.6	16034.4	20170.5	kg	
	Cgr gemiddeld	L13	0		34.5	614.833333	1802.367			
	Massa	L13	0.0		350.8	6251.7	18326.8	24929.3	kg	
	Totale massa		0.2		475.1	10263.3	34361.2	45100	kg	

CSM – plan view



Xylenes in shallow groundwater 1.5–7 m

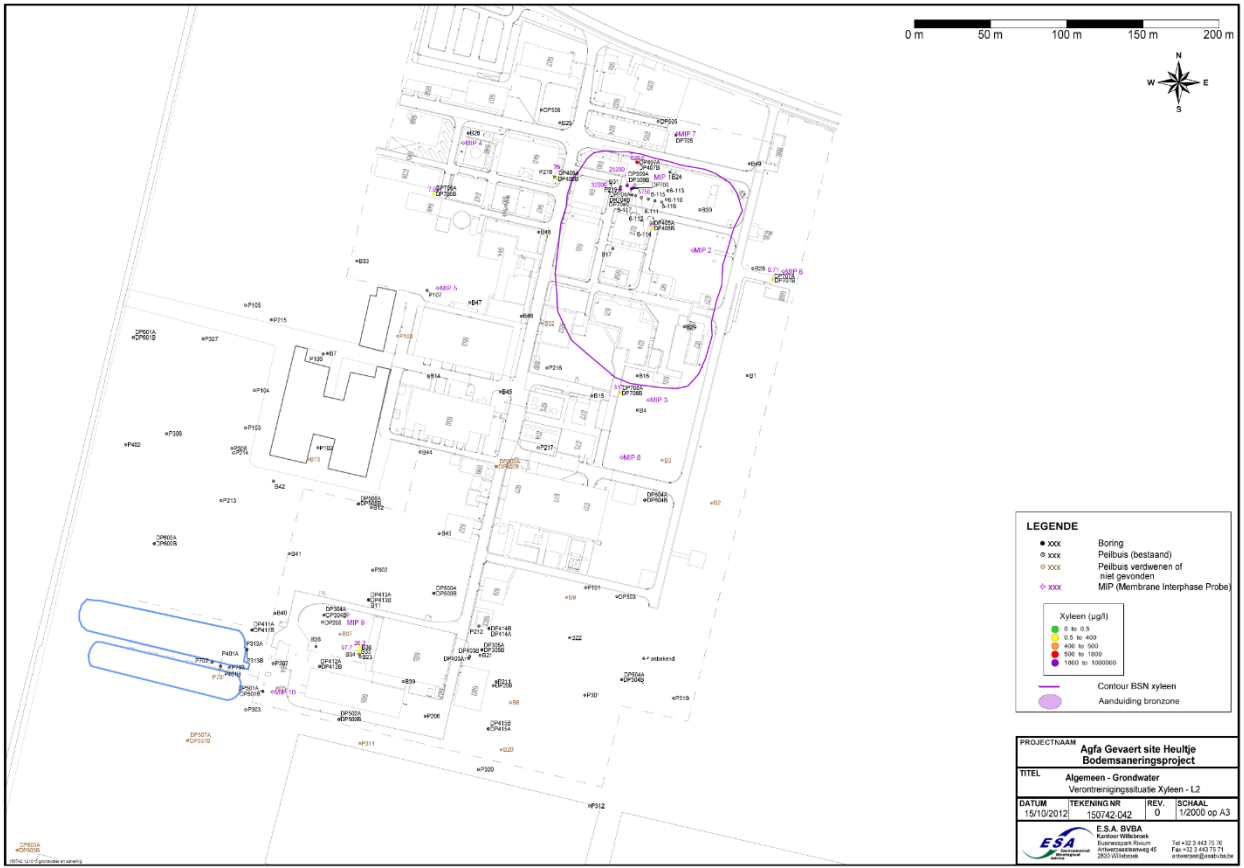


Several source areas

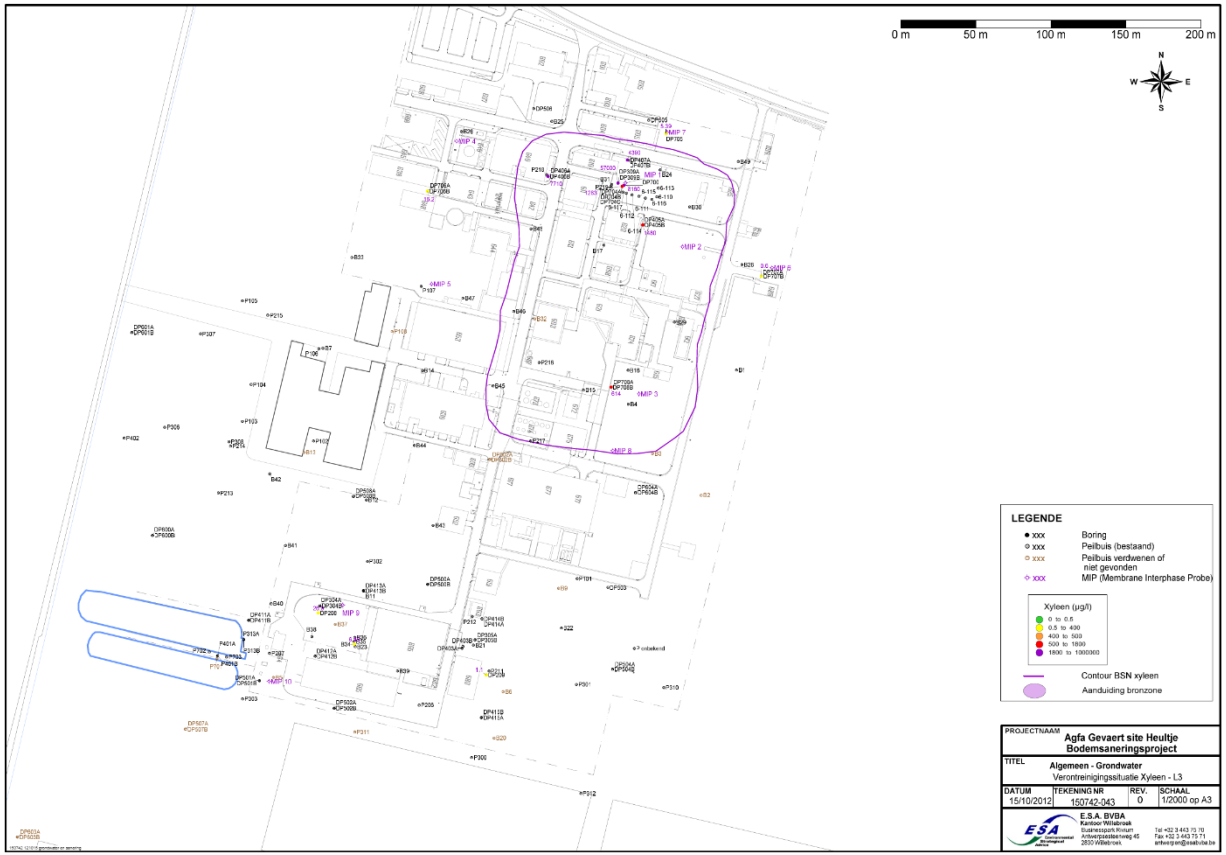
Contamination:

- **80% xylenes, 20% ethylbenzene, traces of benzene**
- **LNAPL results in a strong contamination of the shallow groundwater (to 5-m depth)**

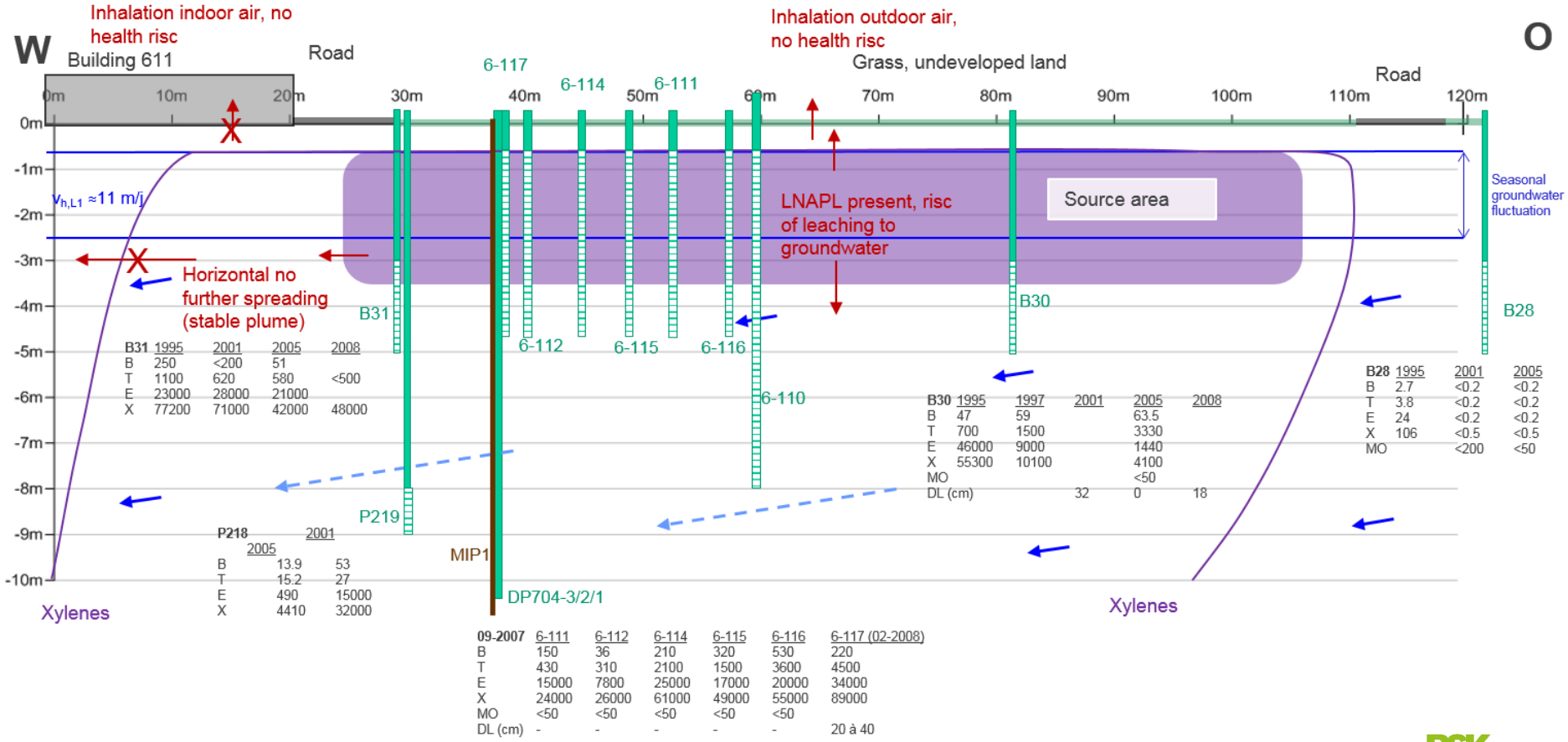
Xylenes in groundwater 7-16 m



Xylenes in groundwater 16-26 m



CSM – TRI source area



B31	1995	2001	2005	2008
B	250	<200	51	
T	1100	620	580	<500
E	23000	28000	21000	
X	77200	71000	42000	48000

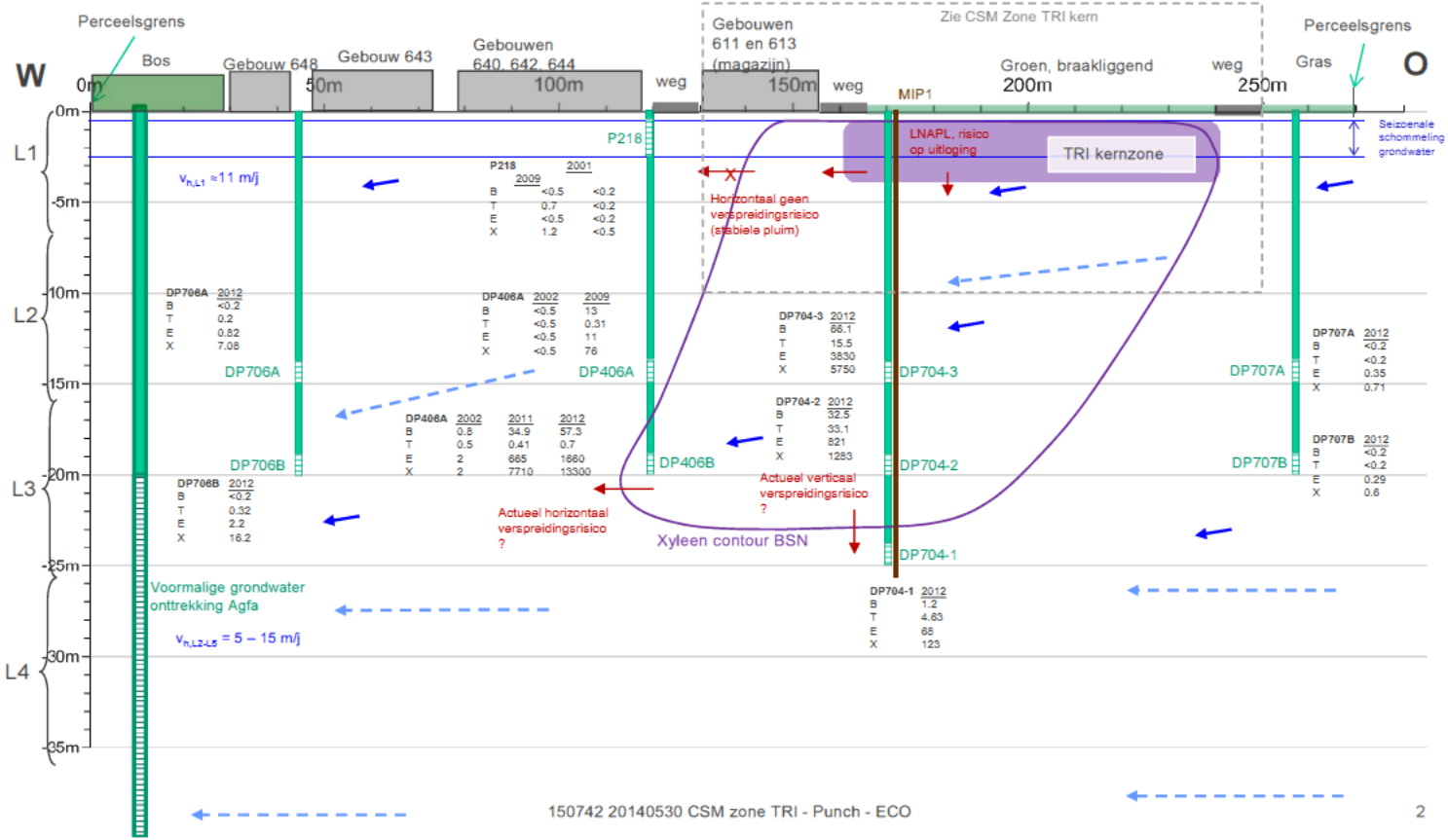
B30	1995	1997	2001	2005	2008
B	47	59		63.5	
T	700	1500		3330	
E	46000	9000		1440	
X	55300	10100		4100	
MO				<50	
DL (cm)			32	0	18

B28	1995	2001	2005
B	2.7	<0.2	<0.2
T	3.8	<0.2	<0.2
E	24	<0.2	<0.2
X	106	<0.5	<0.5
MO		<200	<50

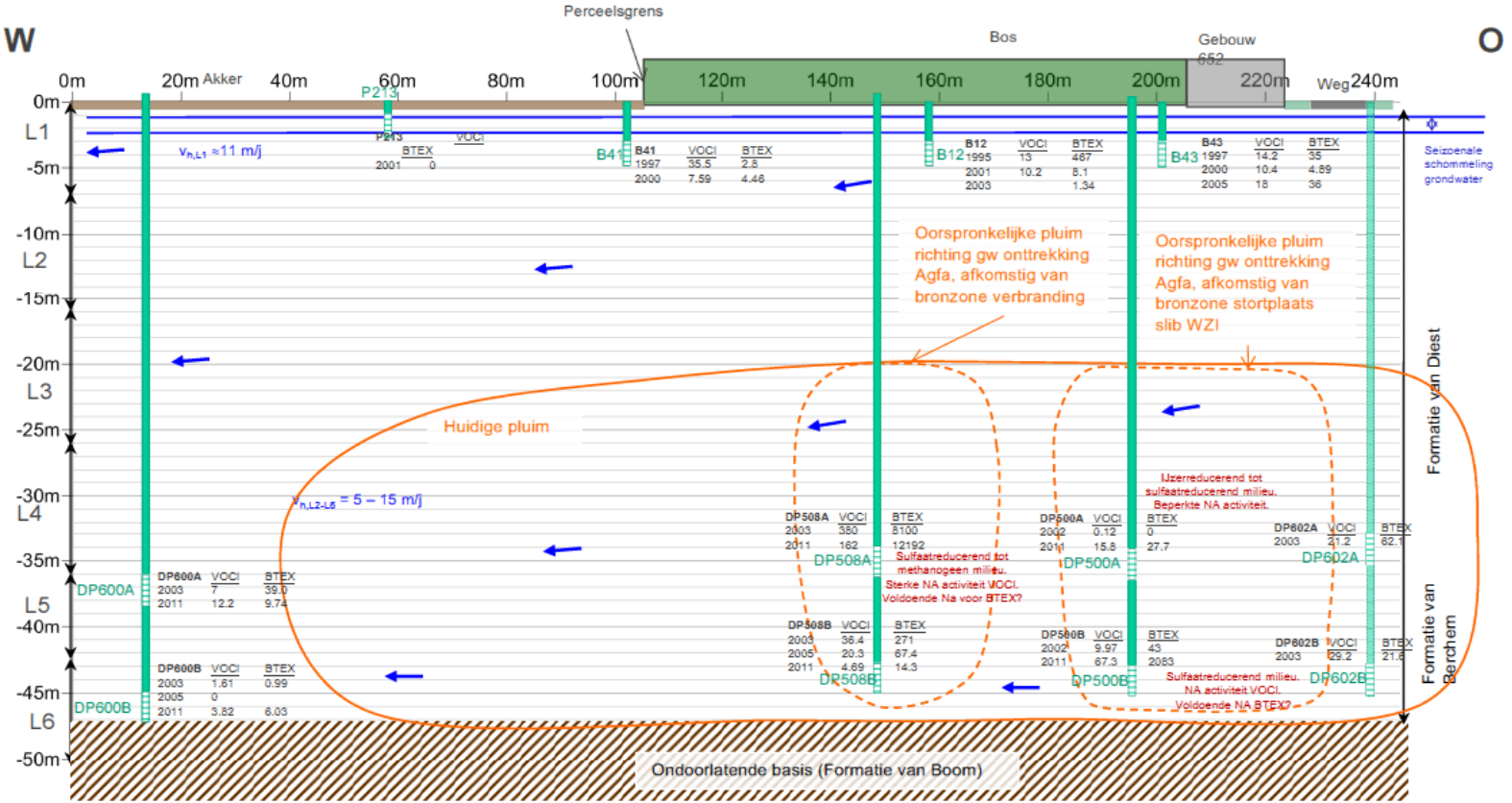
P218	2001	2005
B	53	13.9
T	27	15.2
E	15000	490
X	32000	4410

09-2007	6-111	6-112	6-114	6-115	6-116	6-117 (02-2008)
B	150	36	210	320	530	220
T	430	310	2100	1500	3600	4500
E	15000	7800	25000	17000	20000	34000
X	24000	26000	61000	49000	55000	89000
MO	<50	<50	<50	<50	<50	
DL (cm)	-	-	-	-	-	20 à 40

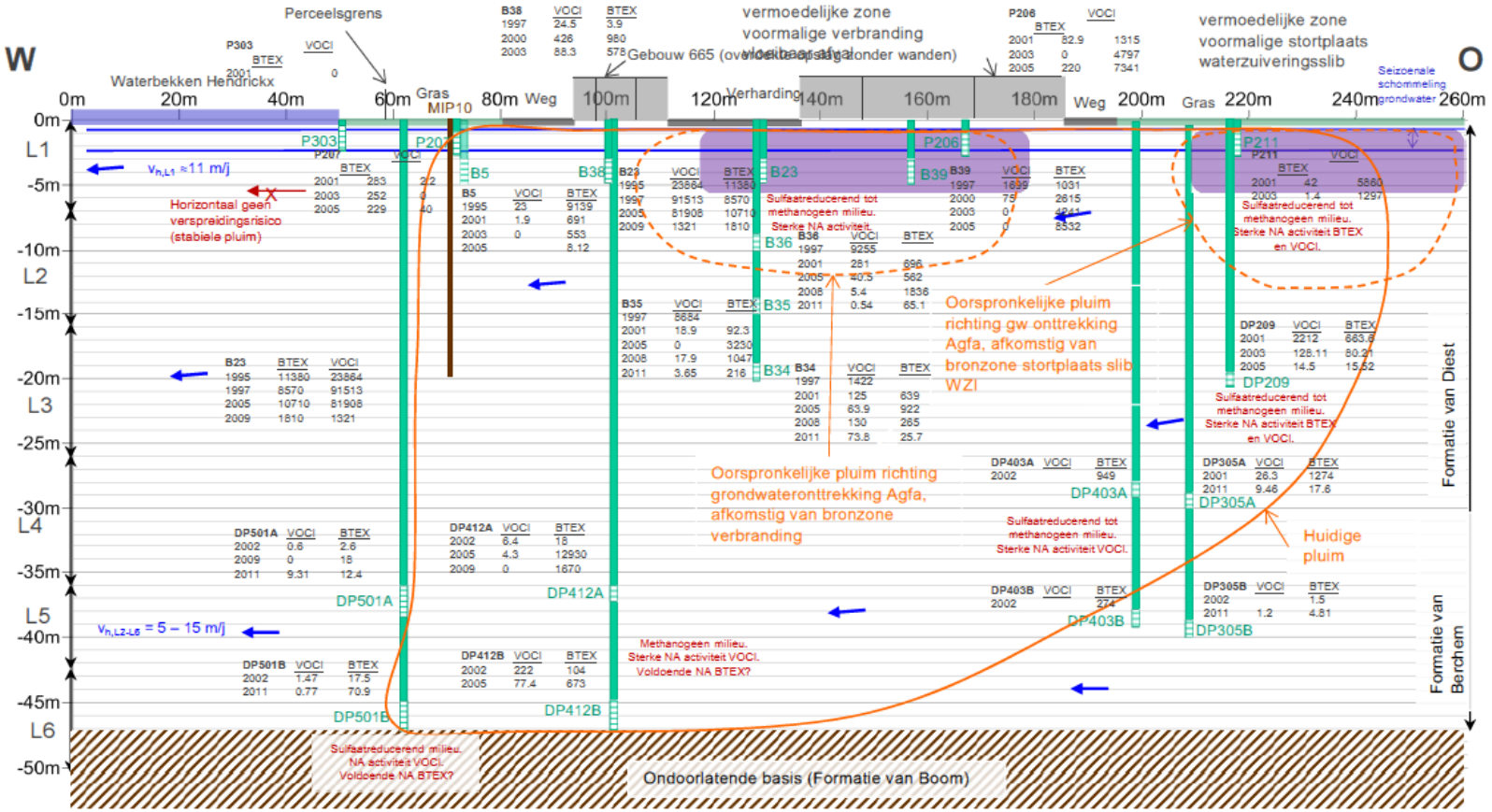
CSM – TRI area plume



CSM – ECO area, North



CSM – ECO area, South



2. Remediation goals

Remediation goals

Phase	Contaminants	Initial C	Target C	Reduction	Remediation goal
Soil	Ethylbenzene	4,110 mg/kg	80,2 mg/kg	80%	No risks
	Xylenes	27,850 mg/kg	379 mg/kg	80%	No risks
Ground water	Ethylbenzene	34,000 µg/L	4,560 µg/L	80% (stable plume)	No risks
	Xylenes	89,000 µg/L	5,320 µg/L	80% (stable plume)	No risks
NAPL	-	32 cm	0 cm	100%	No risks
Causes for residual contamination:			Presence of buildings and installations		

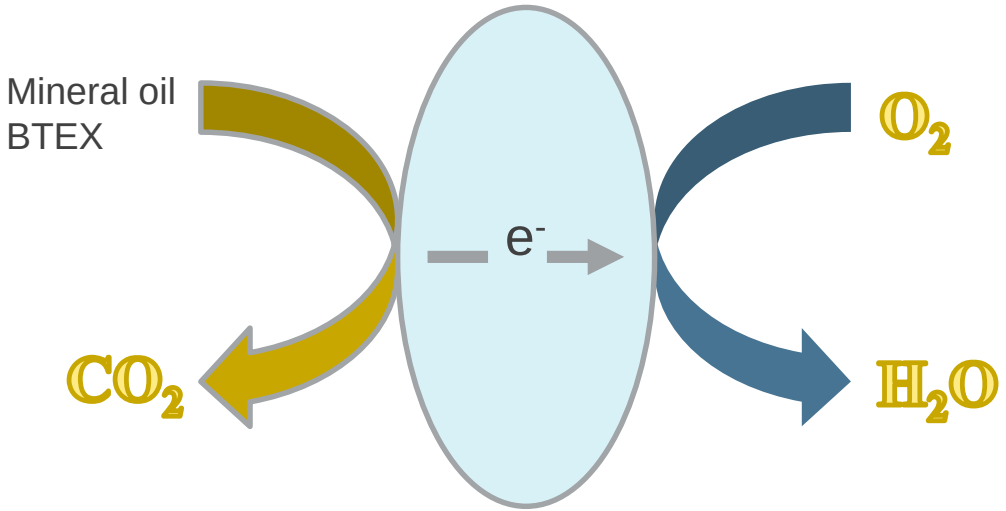
3. Remediation concept

Aerobic biological degradation process

Electron donor
(usually carbon source)

Bacteria

Electron acceptor
(respiratory)



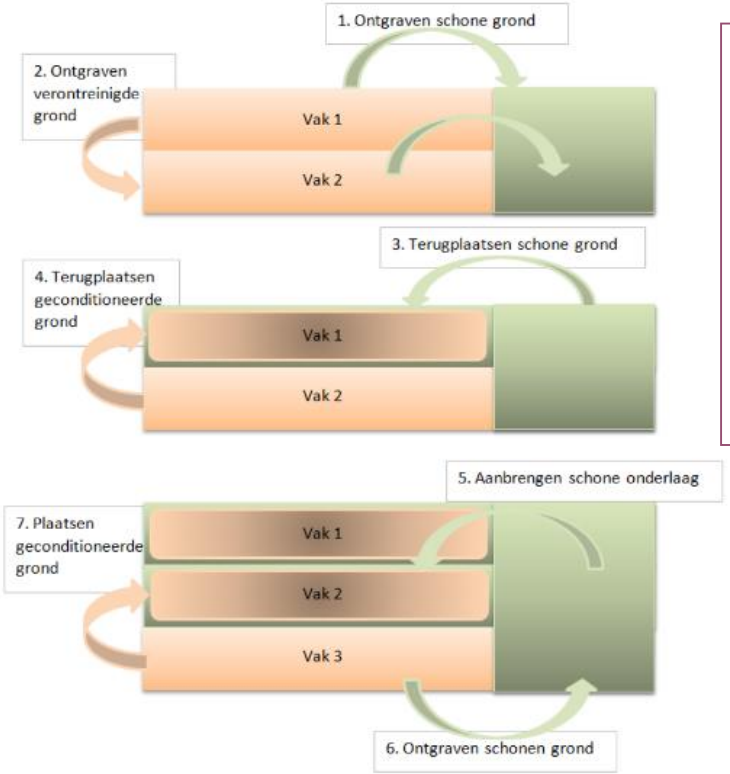
Nutrients (nitrogen, phosphate)

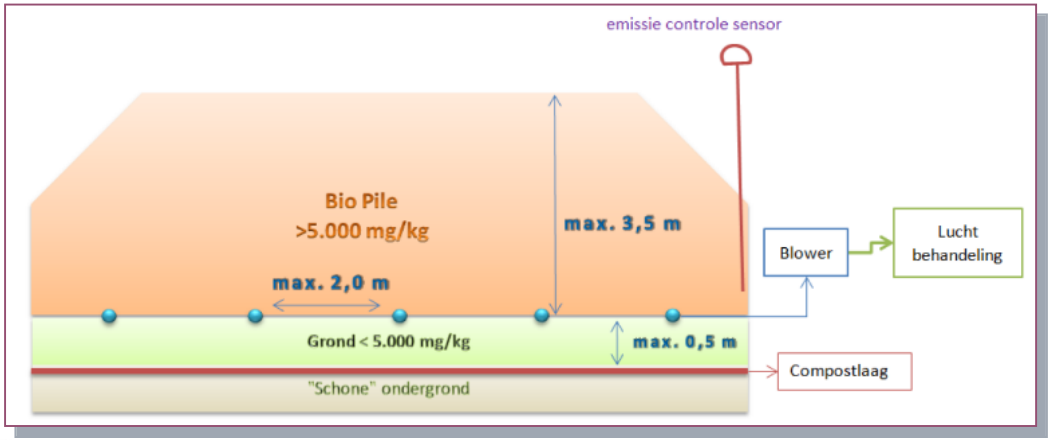
Remediation concept

- Biological soil, groundwater and air treatment
  - Combination of on-site soil treatment and in-situ groundwater treatment
  - Stimulate indigenous biodegradative bacteria and facilitate their aerobic degradation of contaminants
- Key aspects:
  - Collaboration with different partners
  - Sustainability (CO_2 footprint)
  - Control of health and safety risks for this Seveso site
  - Cost efficient/management of risks

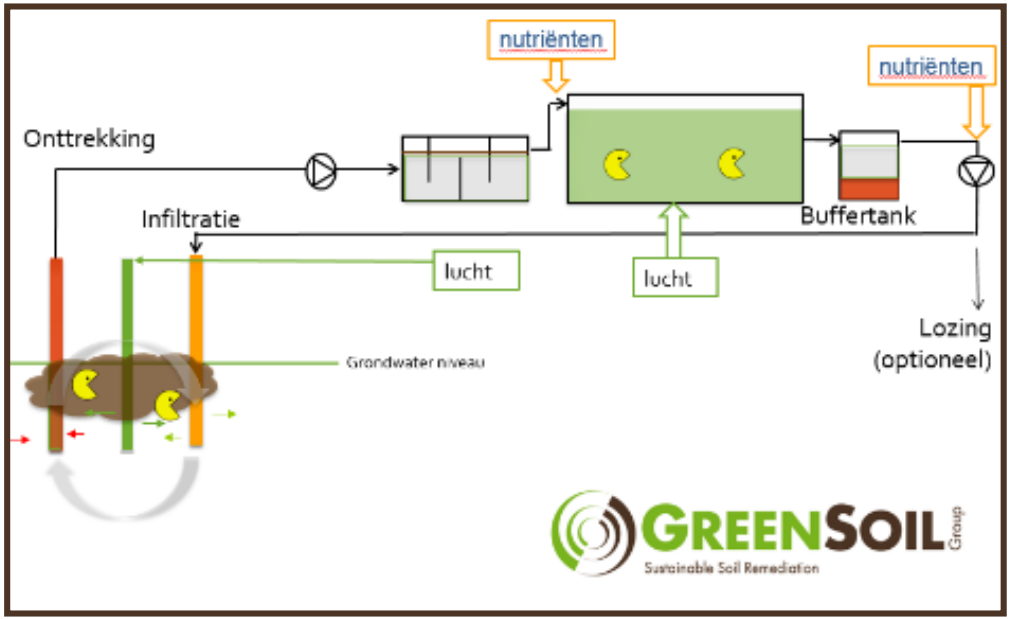
4. Engineering

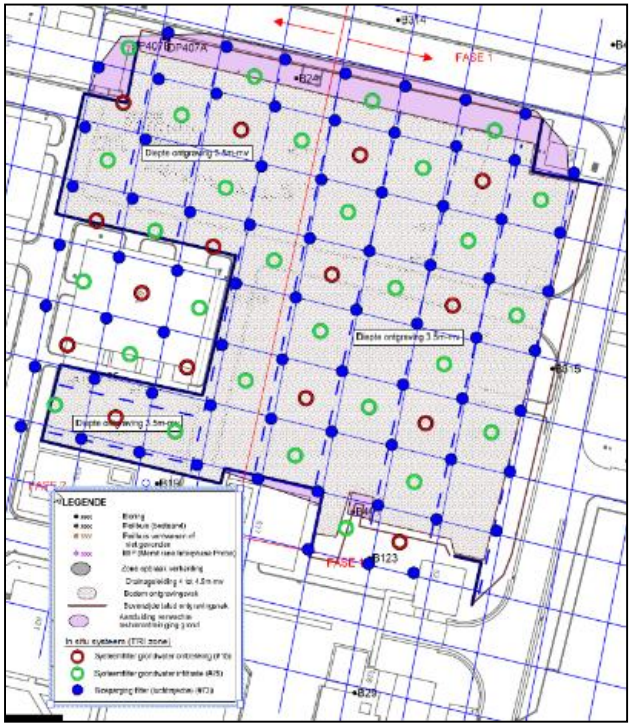
Excavation and on-site treatment (0–3.5 m bgl)





In-situ remediation (3.5–10 m bgl)





Biological air treatment

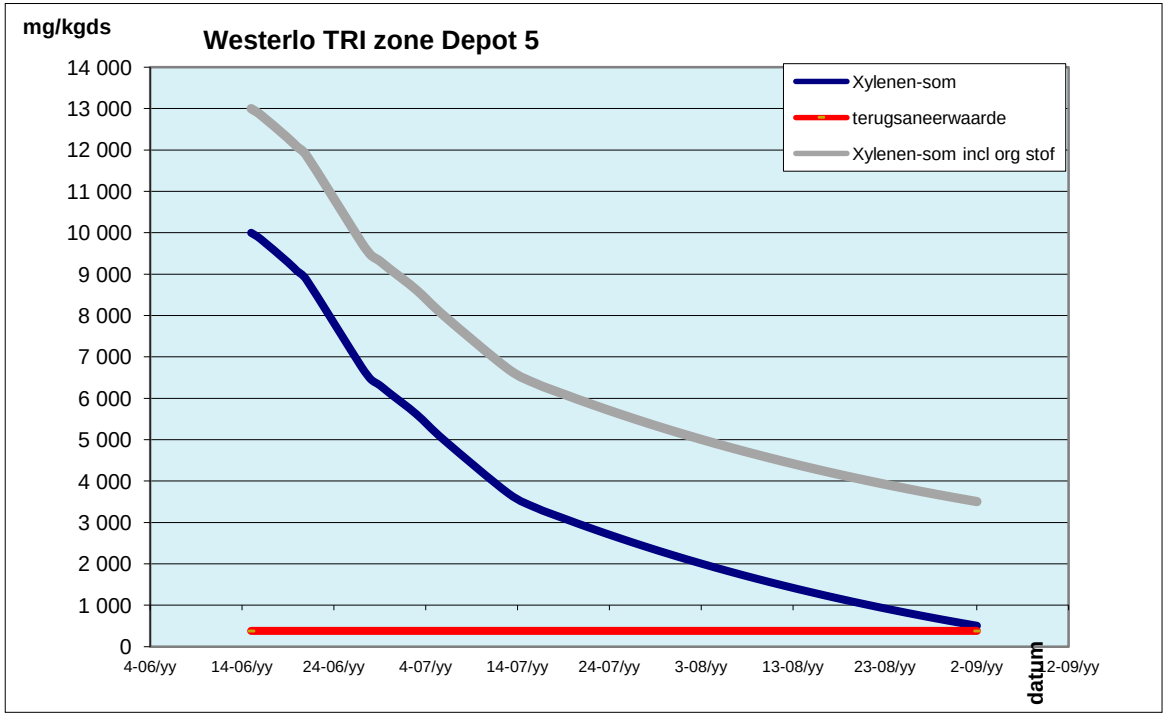
Bioscrubber

GREENSOIL Group
Sustainable Soil Remediation

5. Soil treatment

Progress monitoring and results

Soil treatment progress



- CO_2
- Xylenes (ppm)
- Temperature (10–45°C)

Results treatment progress

Locatie TRI:

ORD-1-4	Date	tijd (d)	Benzeen	Tolueen	Ethylb	Xyleen (som)	BTEX	Toetsing TSW
Sample 1	17-3-2017	0	0,16	23	510	1500	2033,16	NOK
Sample 2	9-5-2017	53	<	0,28	98	380	478,28	NOK
Sample 3	1-6-2017	76	0	1,1	3,1	90	94,2	OK

ORD-5	Date	tijd (d)	Benzeen	Tolueen	Ethylb	Xyleen (som)	BTEX	Toetsing TSW
Sample 1	20-6-2017	0	<	2,1	520	660	1182,1	NOK
Sample 2	10-7-2017	20	<	2,1	190	270	462,1	NOK
Sample 3	8-9-2017	80	<	0,05	13	20	33,05	OK

ORD-6	Date	tijd (d)	Benzeen	Tolueen	Ethylb	Xyleen (som)	BTEX	Toetsing TSW
Sample 1	7-7-2017	0	<	0,9	240	640	880,9	NOK
Sample 2	8-9-2017	63	<	<	1,1	15	16,1	OK

ORD-7	Date	tijd (d)	Benzeen	Tolueen	Ethylb	Xyleen (som)	BTEX	Toetsing TSW
Sample 1	13-7-2017	0	0,52	72	1700	4100	5872,52	NOK
Sample 2	8-9-2017	57	<	0,9	82	370	452,9	NOK
Sample 3	21-9-2017	70	<	<	7,5	12	19,5	OK

6. Conclusions

Progress monitoring and results

Conclusion

Advantages of on-site biological treatment:

- >98% of contamination is degraded biologically on site; almost no waste mass is generated
- High performance for soil, water and air treatment
- No transport of contaminated soil on the roads -> 23,000 m^3 = 1500 transports through small villages and city centres
- No sludge from the groundwater purification plant that needs to be dumped on a landfill -> all contamination is reduced to CO_2

➔ Minimises waste flows, limits emissions to ambient air, treatment of airflows

➔ Lower energy usage

➔ Smaller carbon footprint (10%)

➔ Minimises impacts on neighbours and surroundings

Thank you

RSK

SAFEGUARDING YOUR
BUSINESS ENVIRONMENT