

Dispersion of de-icing chemicals to the areas along the runways at Oslo Airport Gardermoen

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Operating of airports in cold winter climate may affect the local environment



To evaluate the risk of contamination of local water bodies, information on the following processes are important:

1. Dispersion of chemicals from aircraft and runway de-icing

Were

How much

2. Snowmelting on frozen ground:

Infiltration

Surface runoff to watercourses

The main goal is to avoid negative effects on the environments

Oslo Airport Gardermoen

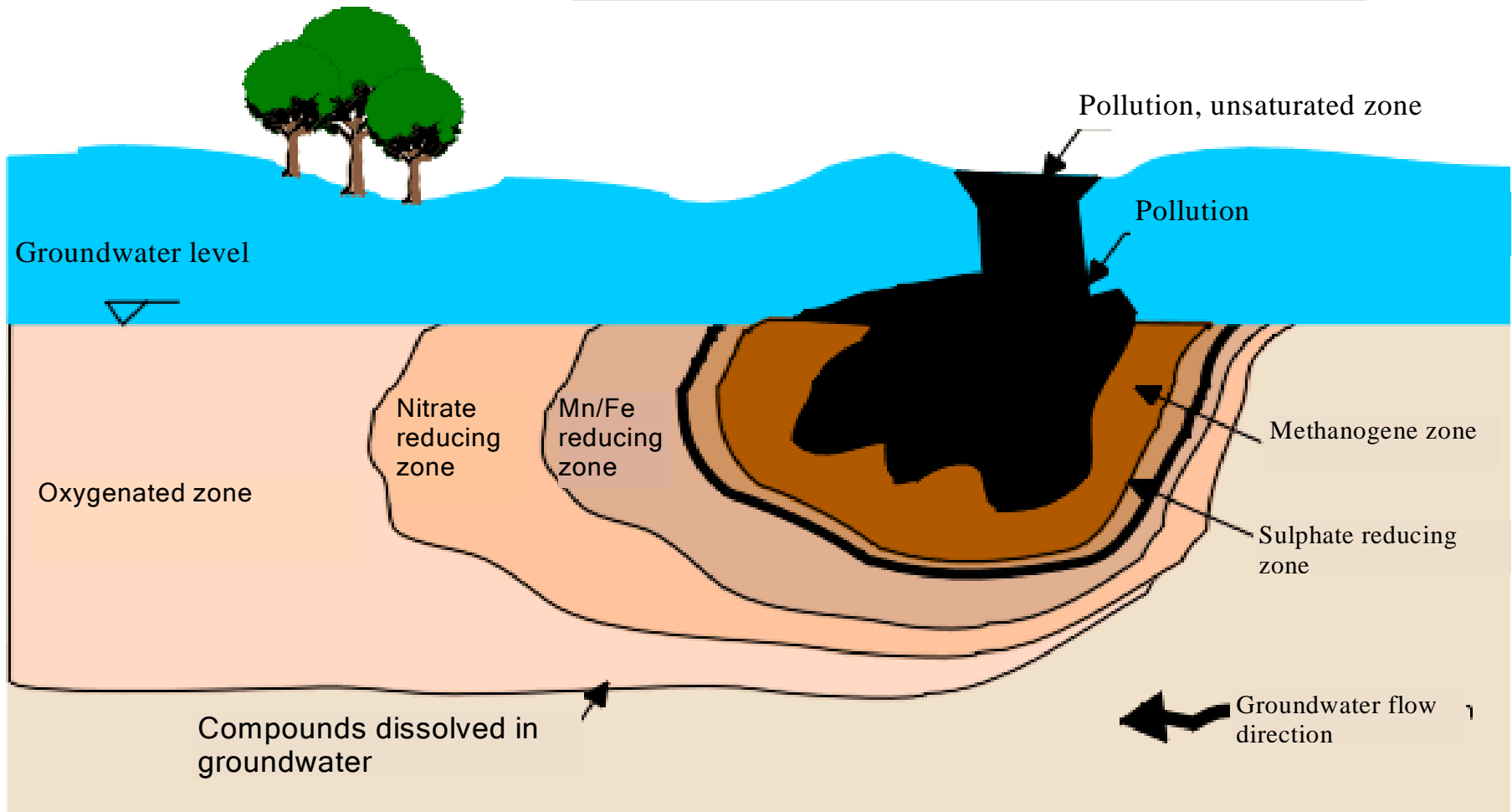
- **Located on the largest unconfined groundwater aquifer in Norway**
- **Cold winter climate**
- **De-icing of aircrafts and runway systems**



Requirement from the pollution authority:

- **Not affect the groundwater balance**
- **Not affect the groundwater quality**
- **Not affect the natural erosion processes in the ravine system**
- **Not affect the surrounding waterresources**

De-icing chemical in the Groundwater



R&D project 1994 – Present :

Dispersion of de-icing chemicals

Infiltration / surface run-off

Degradation in the unsaturated zone

Degradation in the groundwater(saturated zone)

Long time effects in the groundwater

Effects in local streams (water courses)

De-icing at Oslo Airport Gardermoen



Runway de-icing:

Potassium Formiate; 200 – 360 tonn (100 % F) per winter season to the runway systems

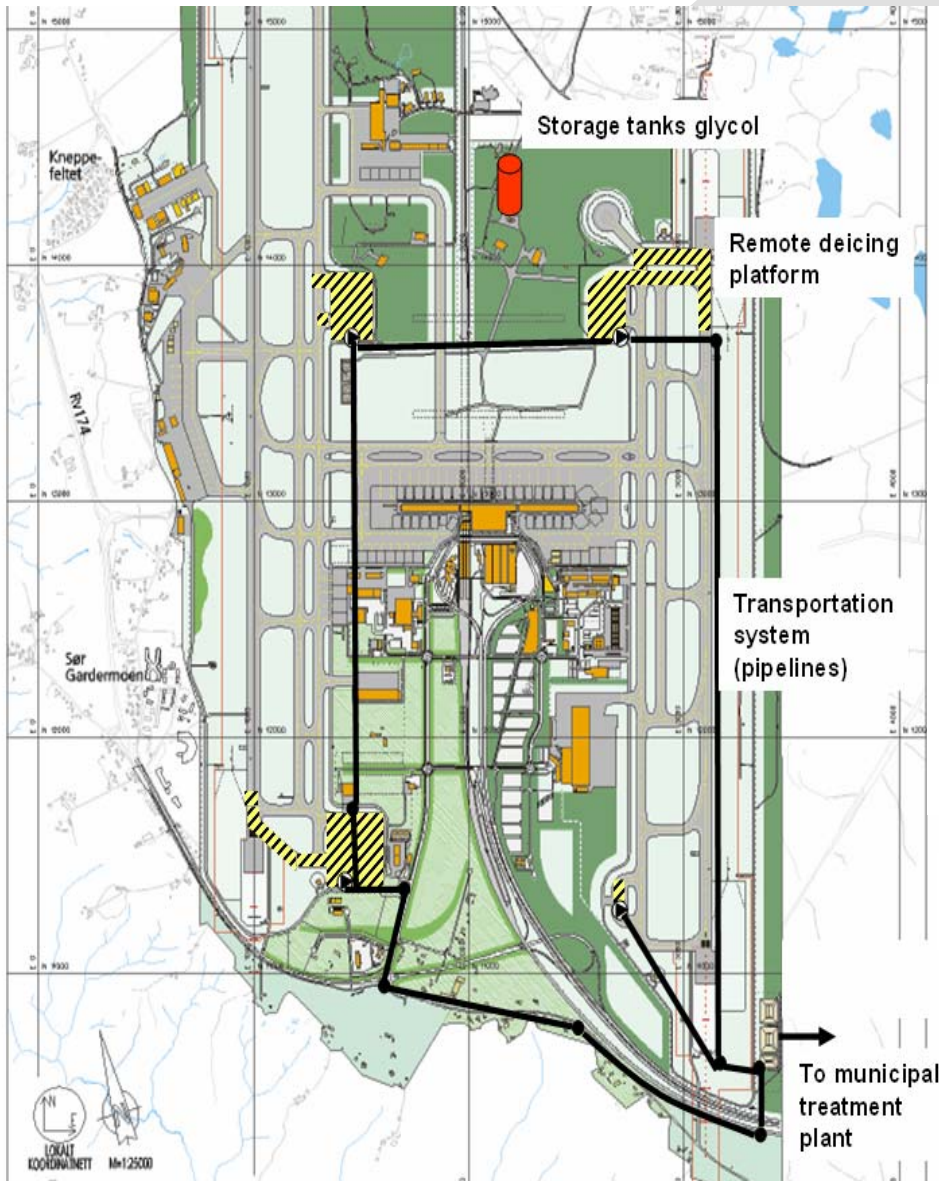


Aircraft de-icing:

- Propylen glycol (1000-2000 tonn 100 % PG per winter season)
- 8000 -12000 De-icing operations
- 80% Type I 20% Type 2

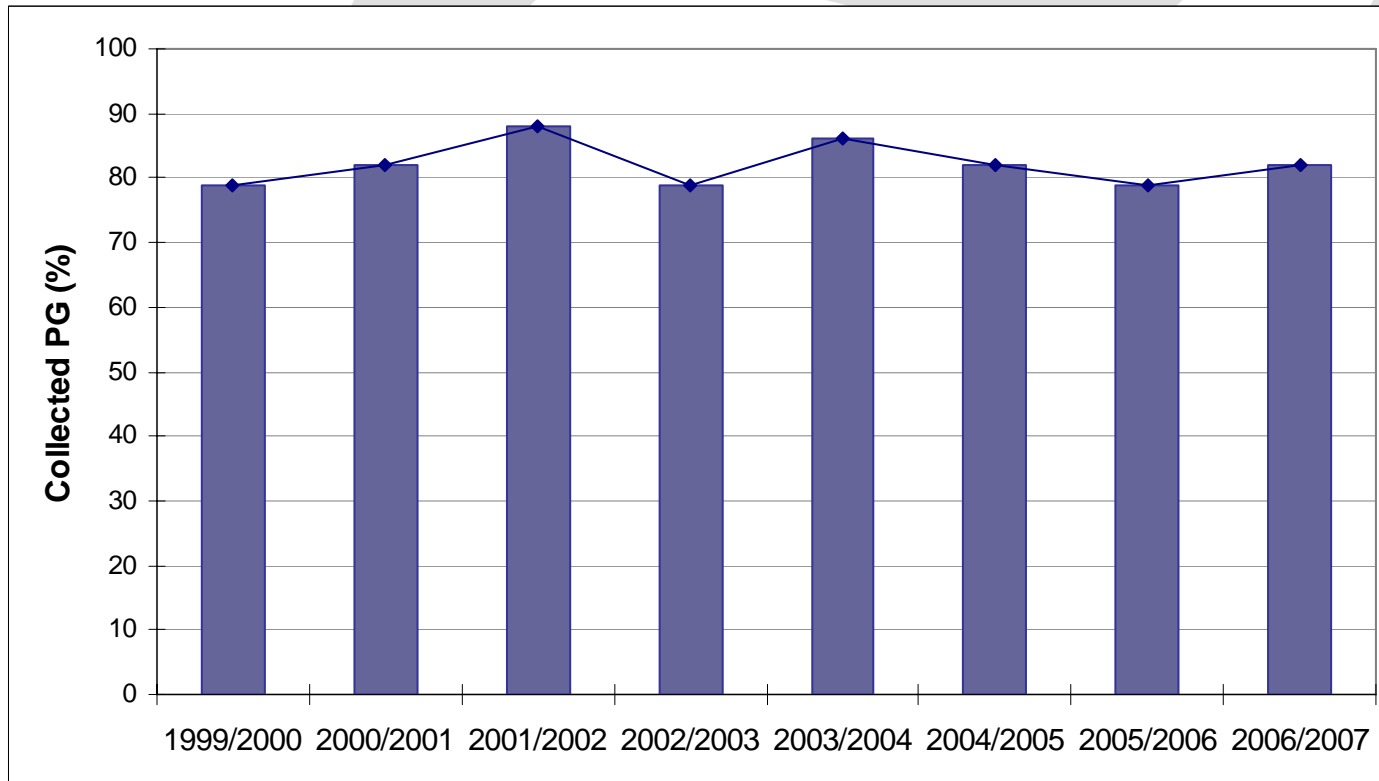
1. Dispersion of de-icing chemicals

Oslo Airport with remote de-icing platforms and drainage system

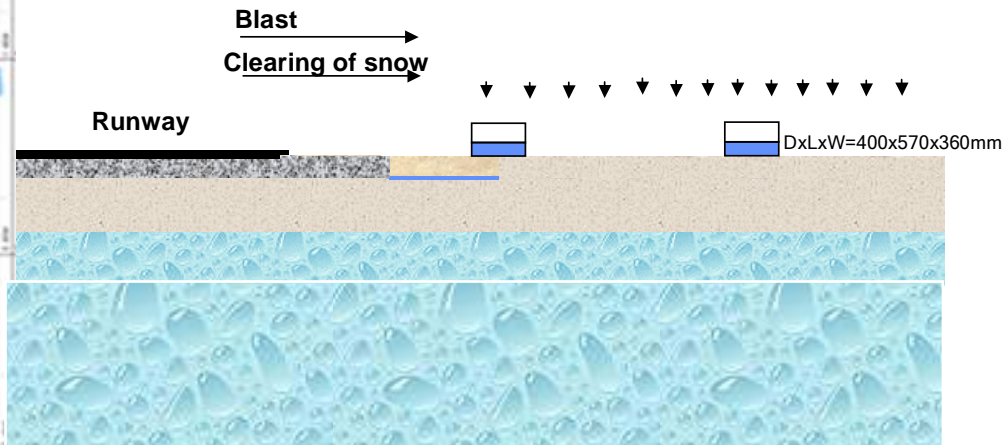
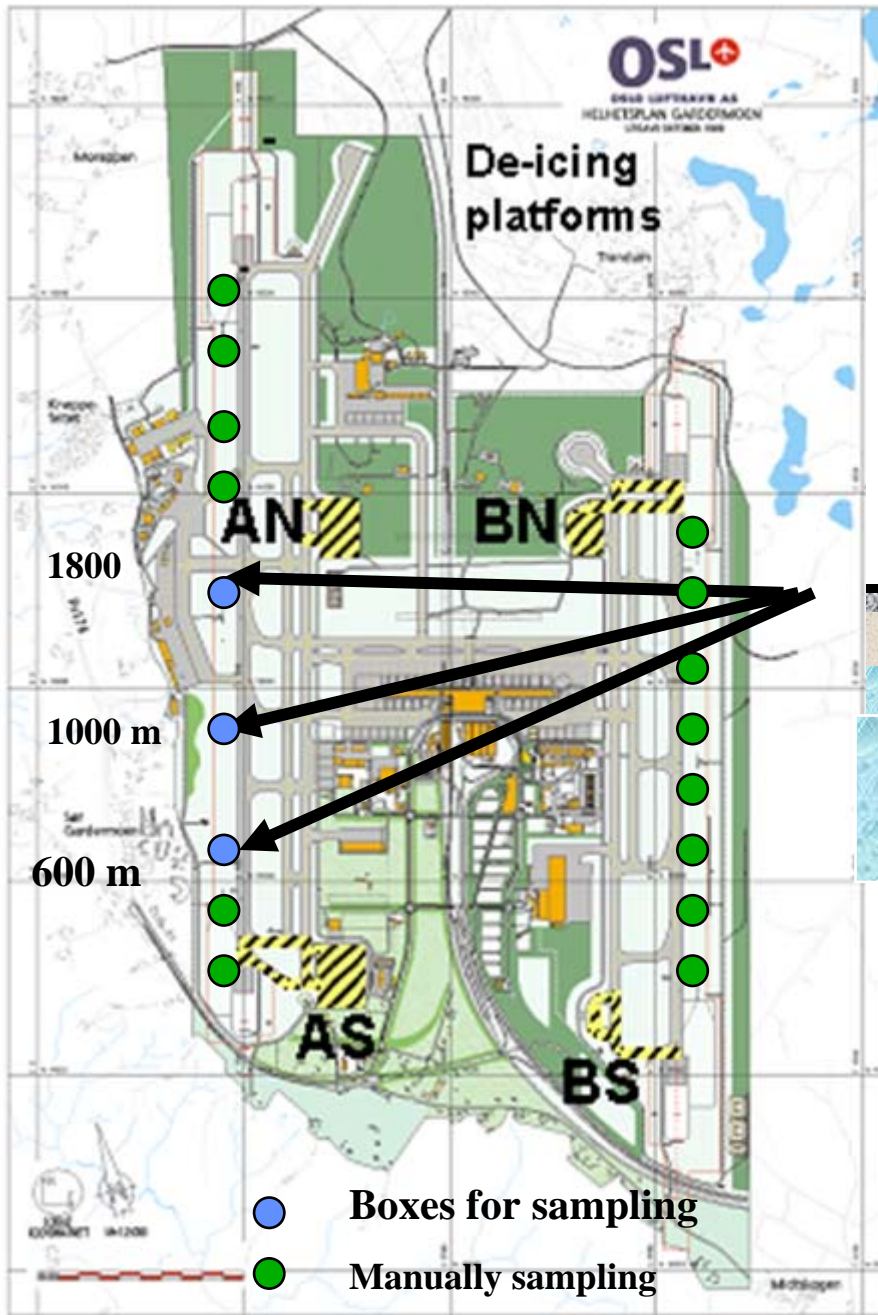


- **80 % is collected**
- **10 % is dispersed inside the airport**
- **10 % is following the aircrafts outside the airport**

Total collected PG in drain system at Gardermoen as percentage of consumption of PG at de-icing platforms, for winter seasons 1999/2000 through 2006/2007.

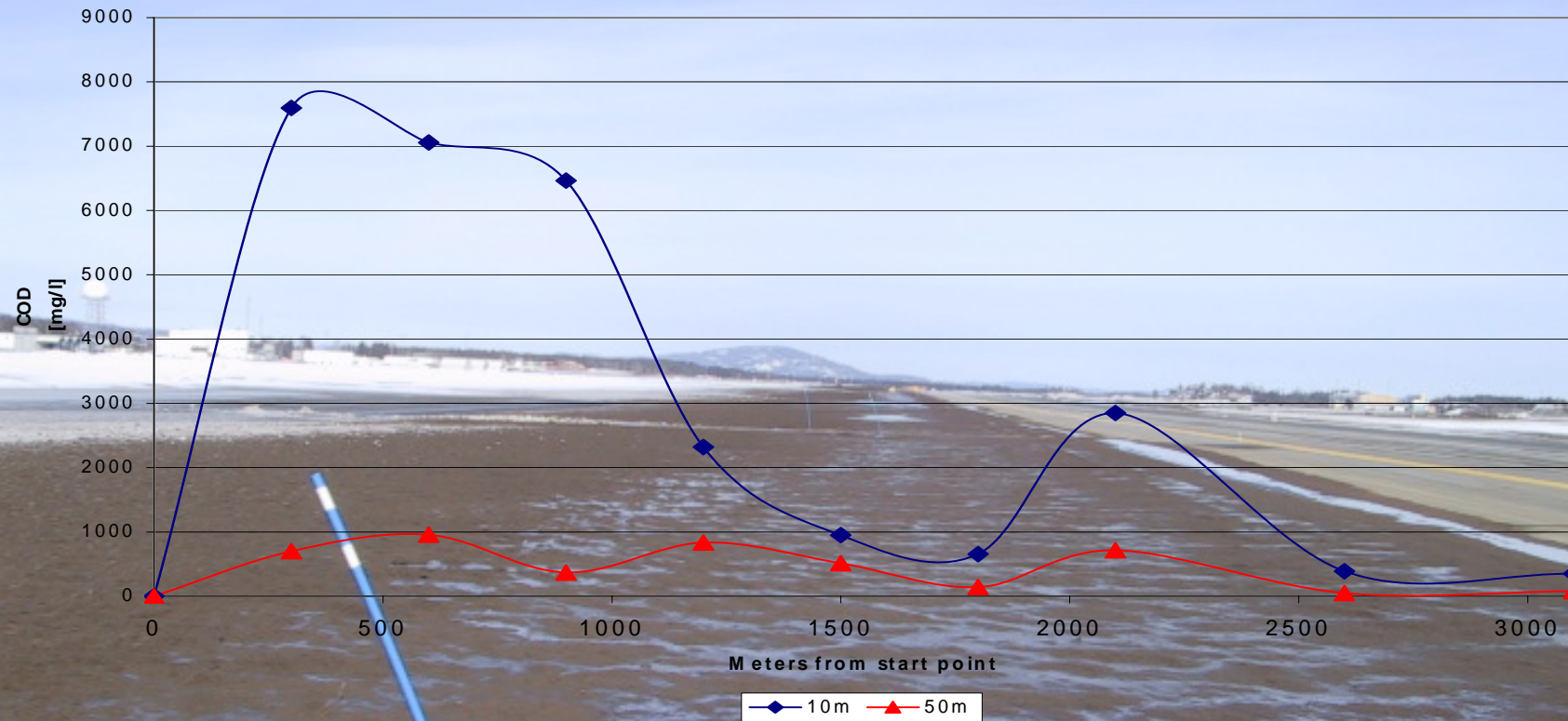


Monitoring of the dispersion of de-icing chemicals 1999 - Present



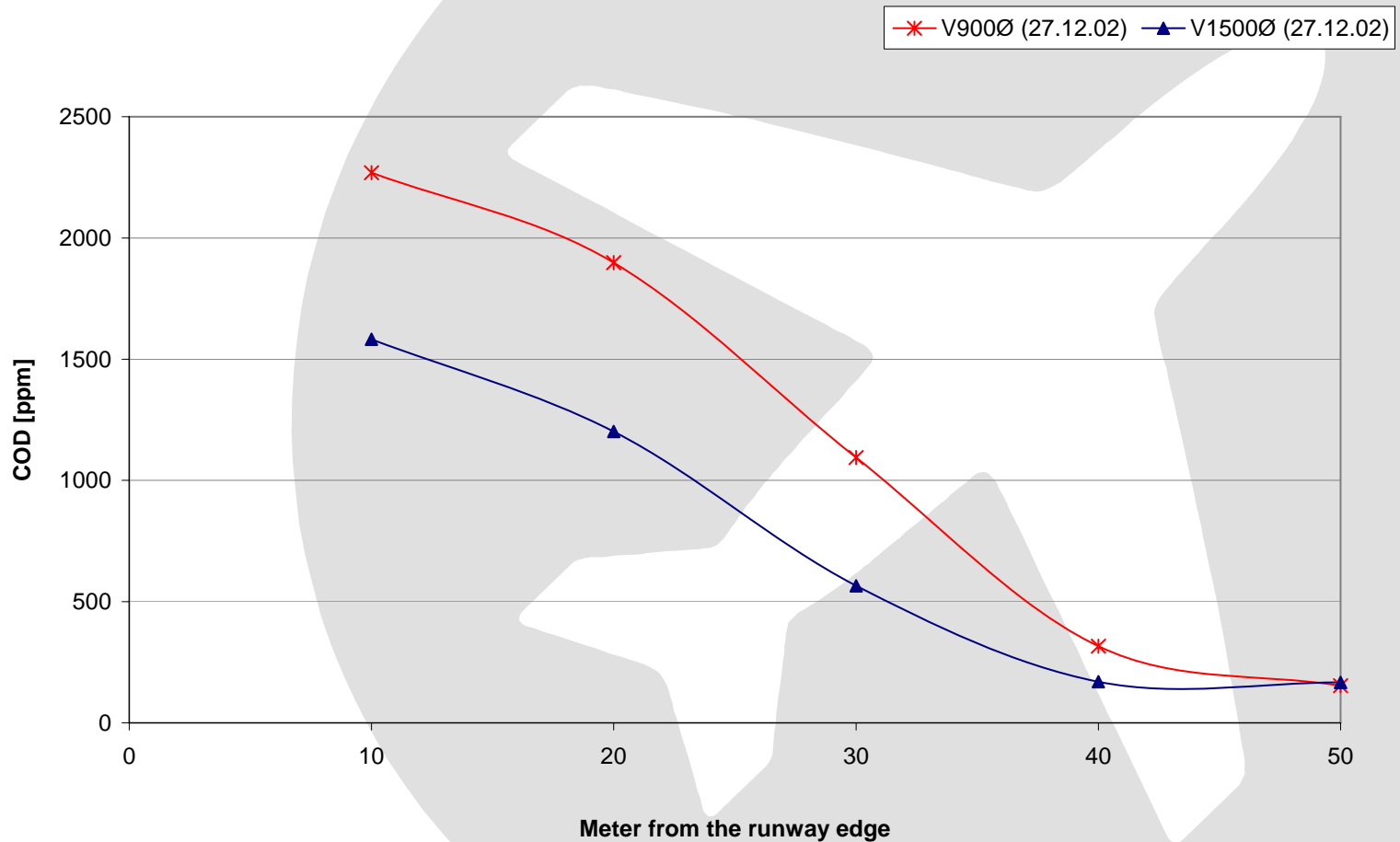
COD load in snow along western runway

Sample 10 m and 50 m from runway 02.12.2002

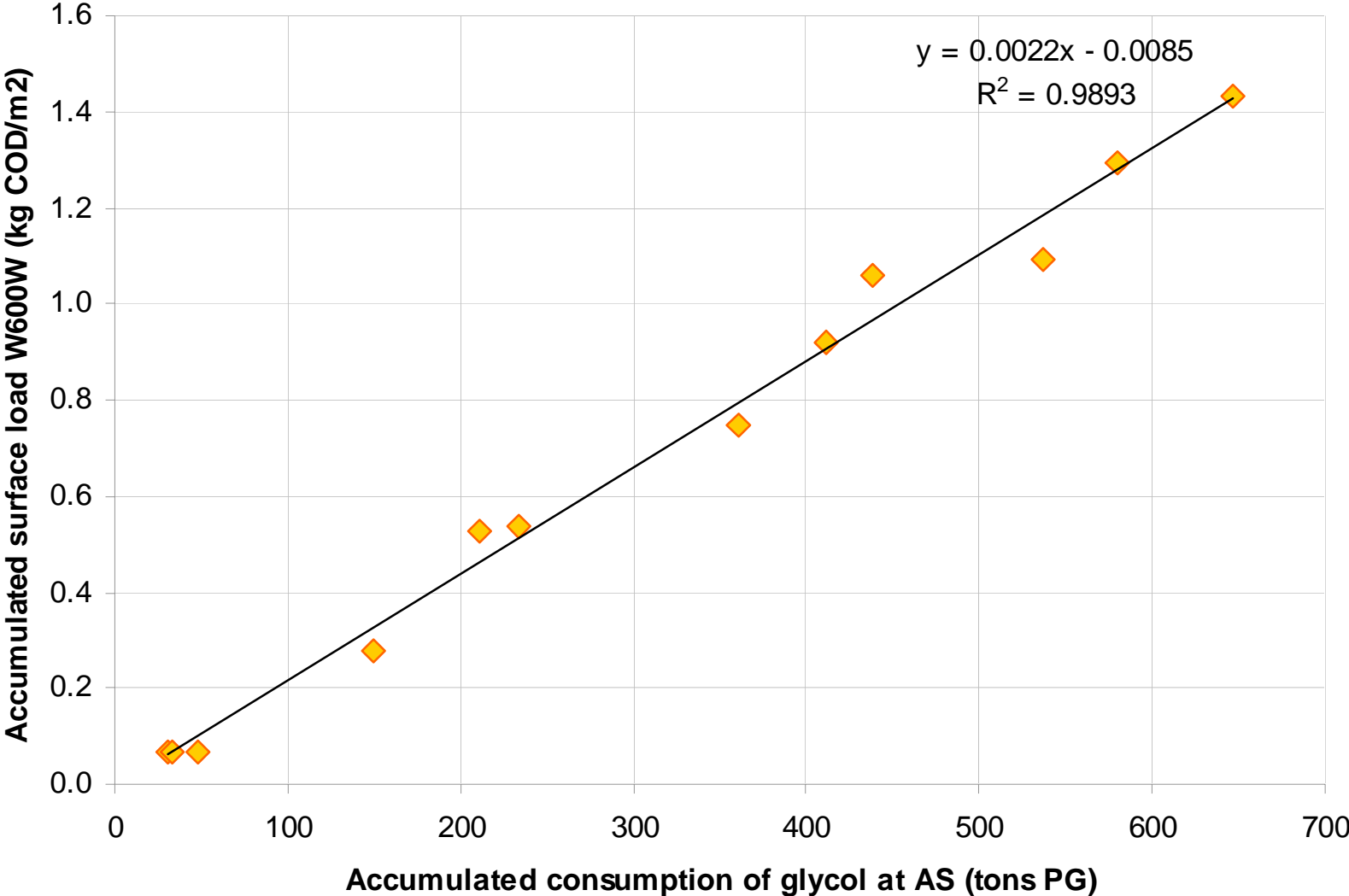


Load: < 3 kg COD/m² pr winter season

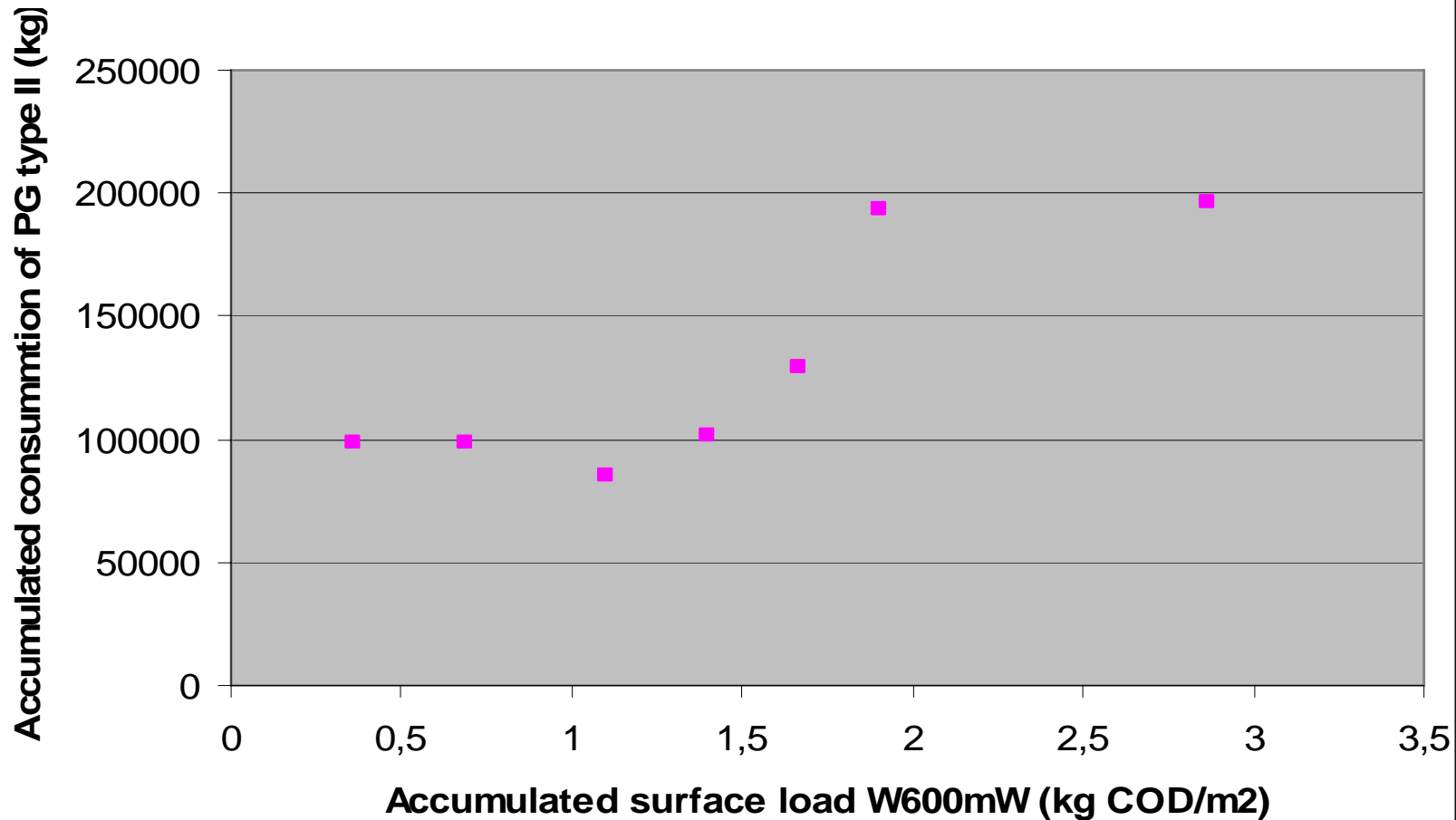
Concentration of COD in snow in two profiles perpendicular to the runway edge, 900 m and 1500 m after runway start position.



Organic load at W600W, winter season 2000/2001



Accumulated yearly surface load as function of accumulated consumption of PG Type II



Type I / Type II - Calculation of dye

$$\frac{\%PG}{\%dye} = \frac{C_{PG}}{C_{dye}} \Rightarrow C_{dye} = \frac{C_{PG} * \%dye}{\%PG}$$

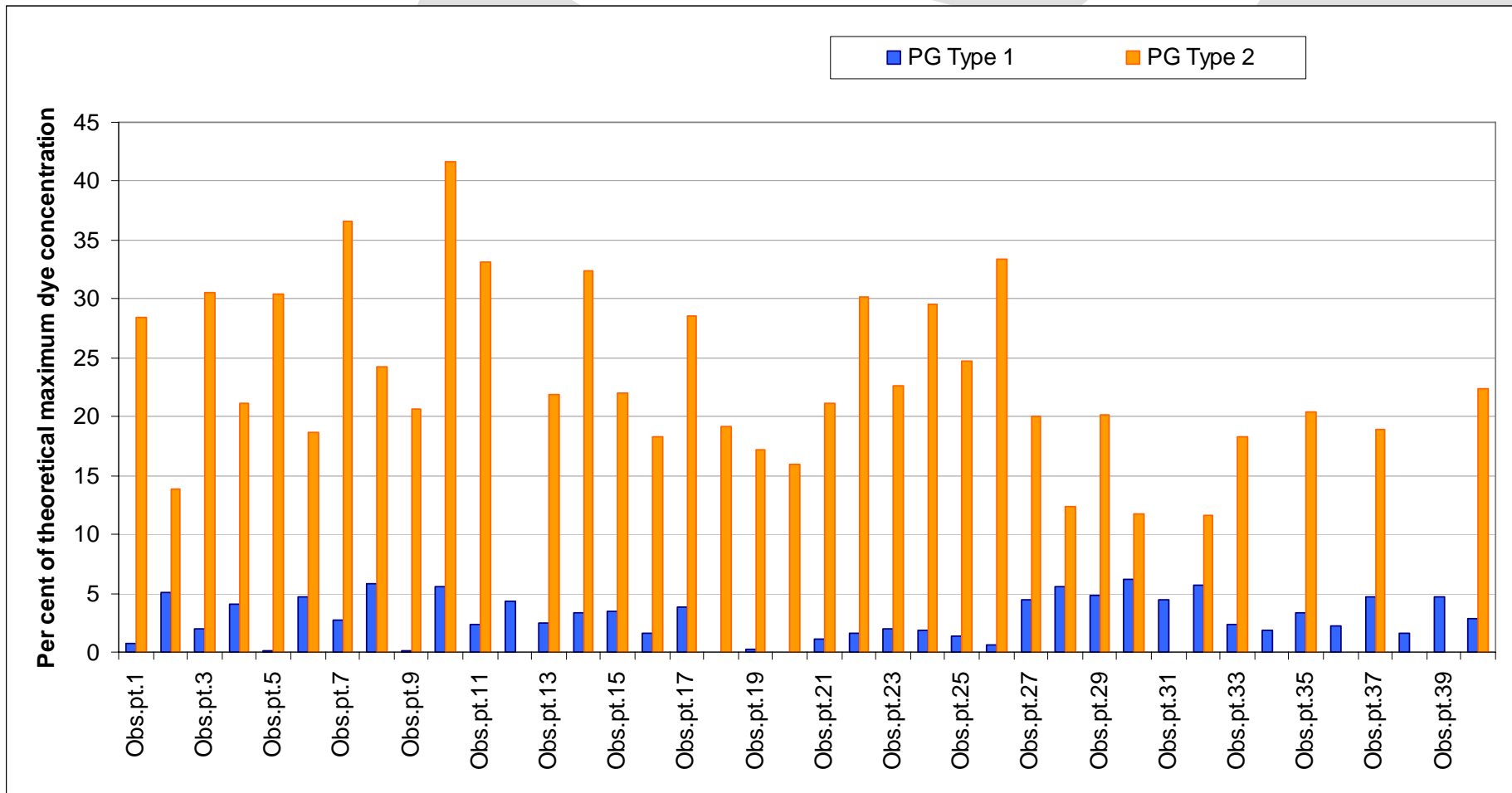
$\%PG$ is the percentage of PG in de-icing fluid (known value, different for type 1 and type 2)

$\%dye$ is the percentage of dye in de-icing fluid (known value, different for type 1 and type 2)

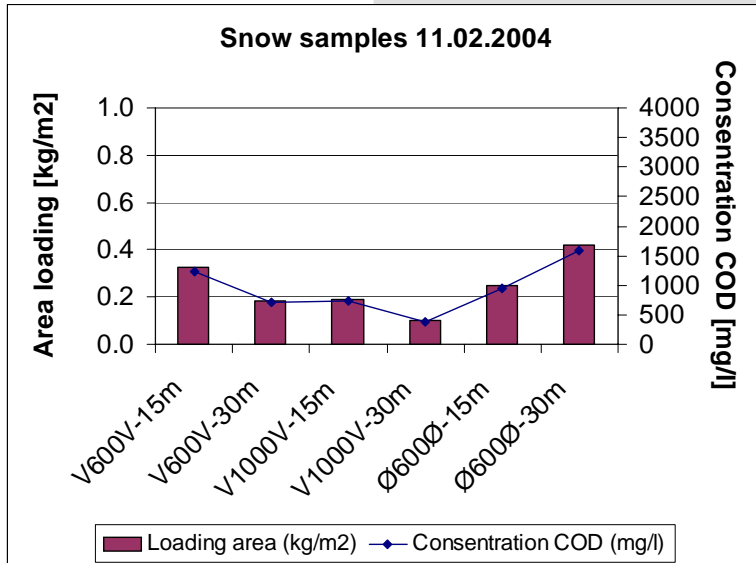
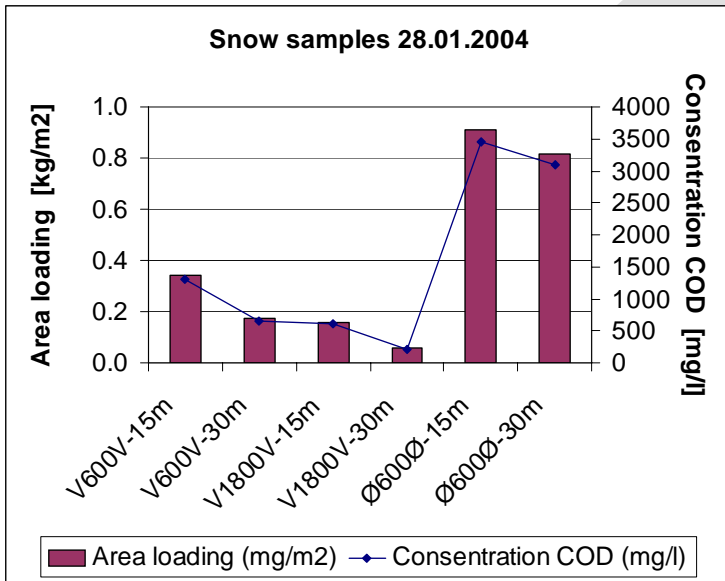
C_{PG} is the observed concentration of PG in snow at each observation point and time

C_{dye} is the maximum theoretical concentration of the dye at each observation point and time

Relative amount of type 1 and type 2 dyes retrieved in snow at 40 observation points along the runways, related to the theoretical maximum dye concentration (type 1 or type 2) in this point at the time of observation for 2005/2006 and 2006/2007.



Melting of de-icing chemicals in snow

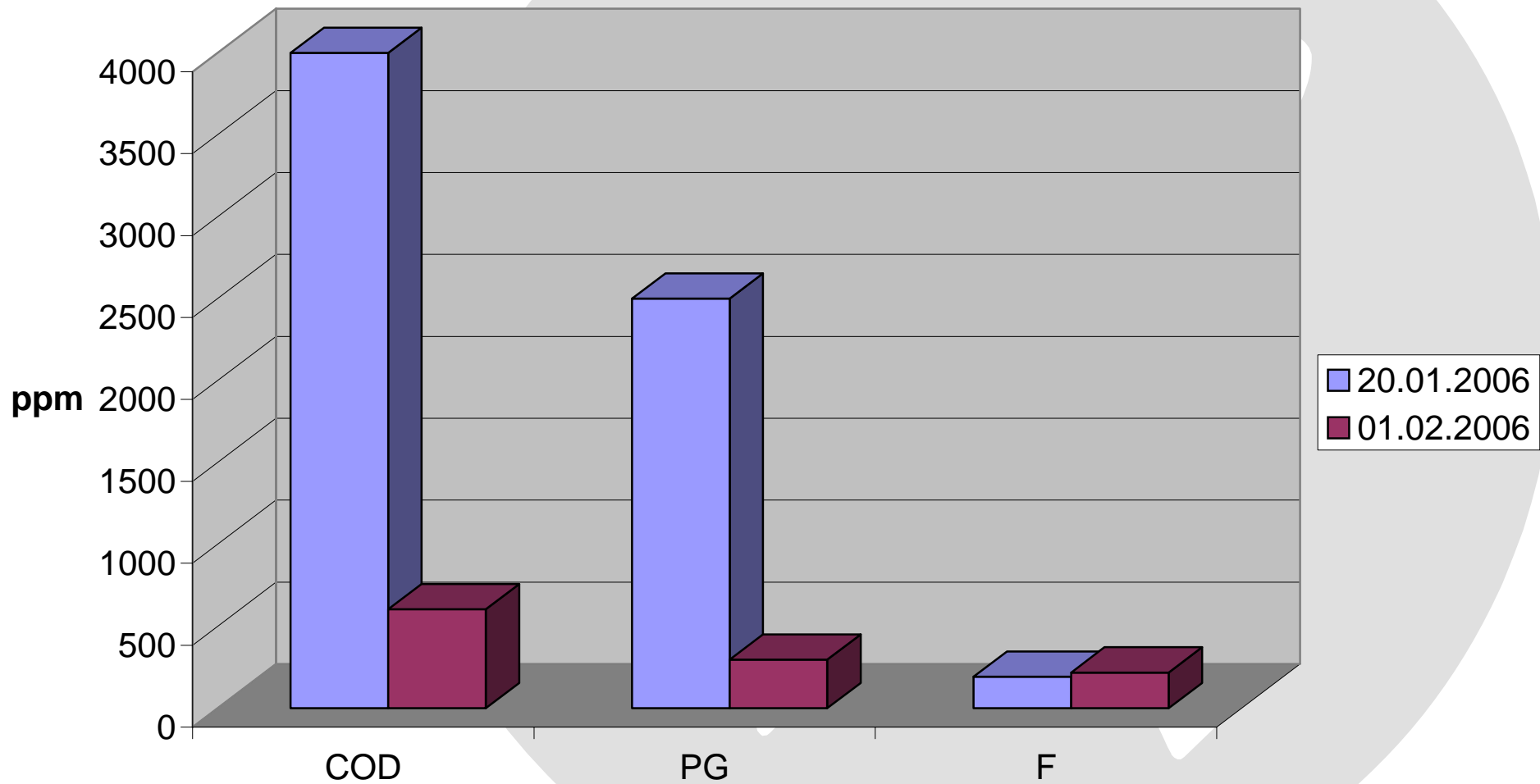


> 75 % of COD has melted out along eastern runway



> 10 % of COD has melted out along western runway

De-icing chemicals in snow January 2006



2. Infiltration / surface run-off



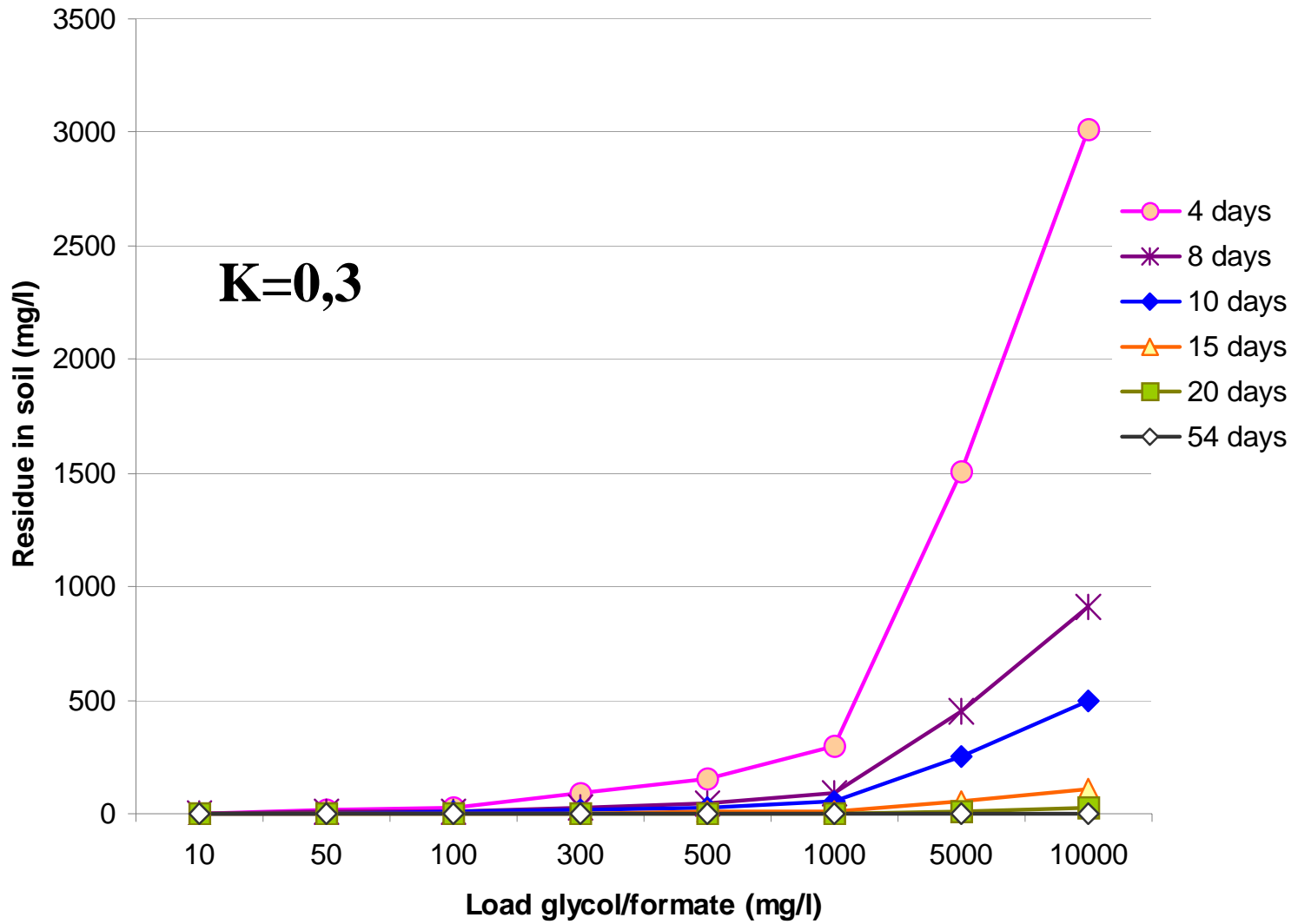
1st order degradation equation, de-icing chemicals

$$C(t) = C(t_0)e^{-kt}$$

$C(t)$ = concentration of de-icing chemical in soil after a given retention time, t

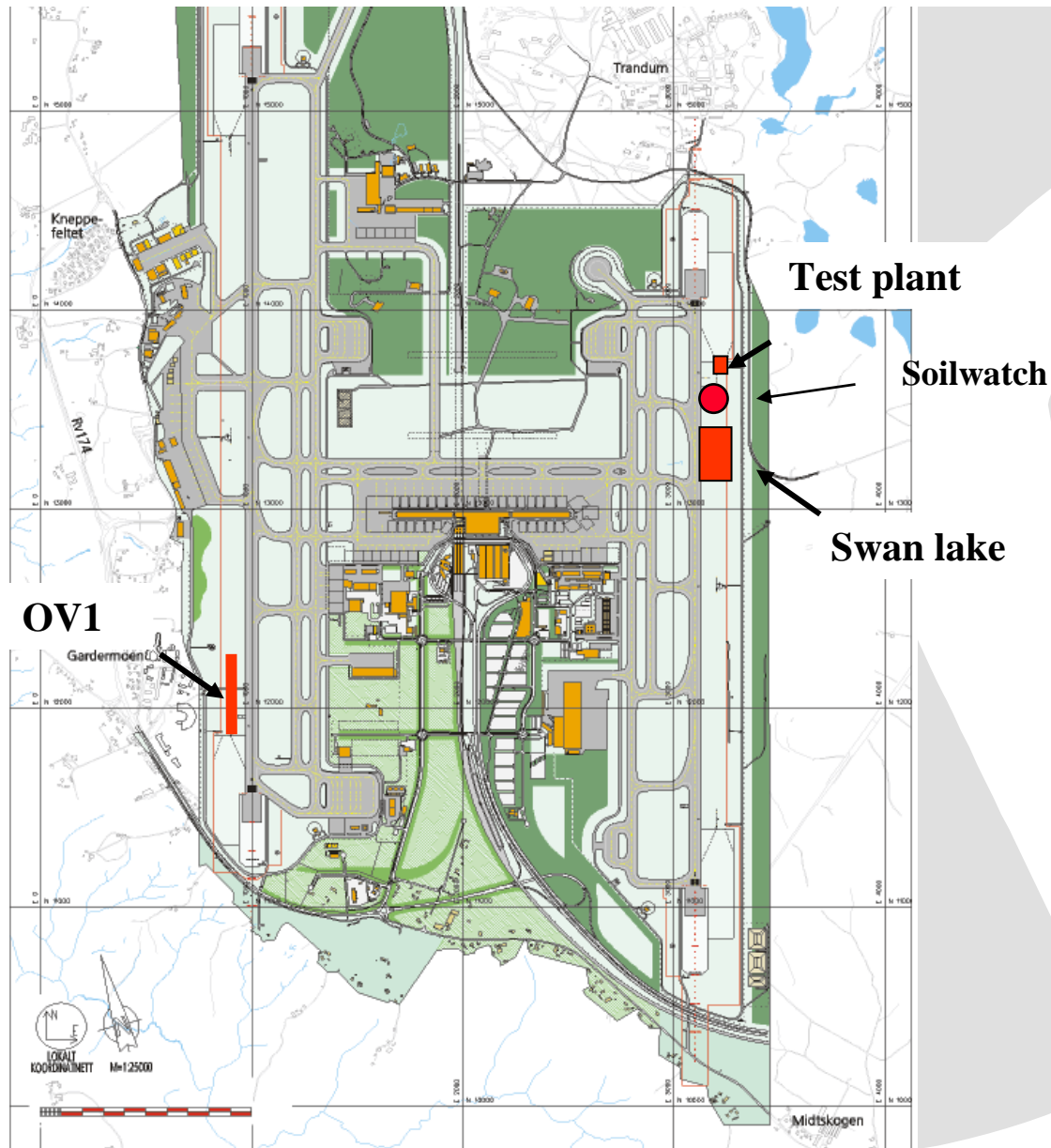
$C(t_0)$ = initial concentration of de-icing chemicals infiltrating into the soil

k = degradation coefficient



Infiltration processes :

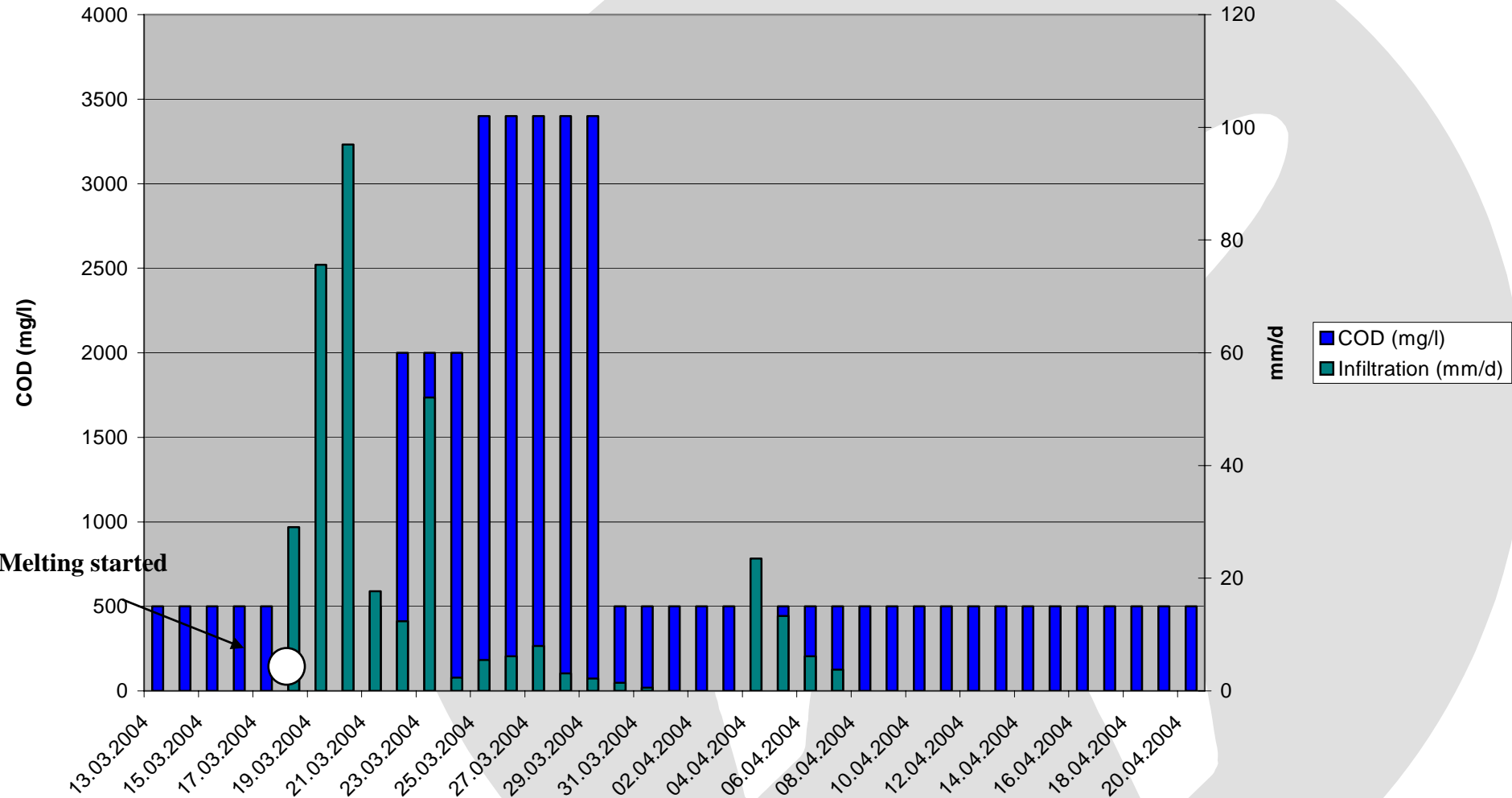
Main results from 4 different studies



Area for testing of infiltration close to the runway



Infiltration of water and COD



Infiltration amount = 100 mm/d



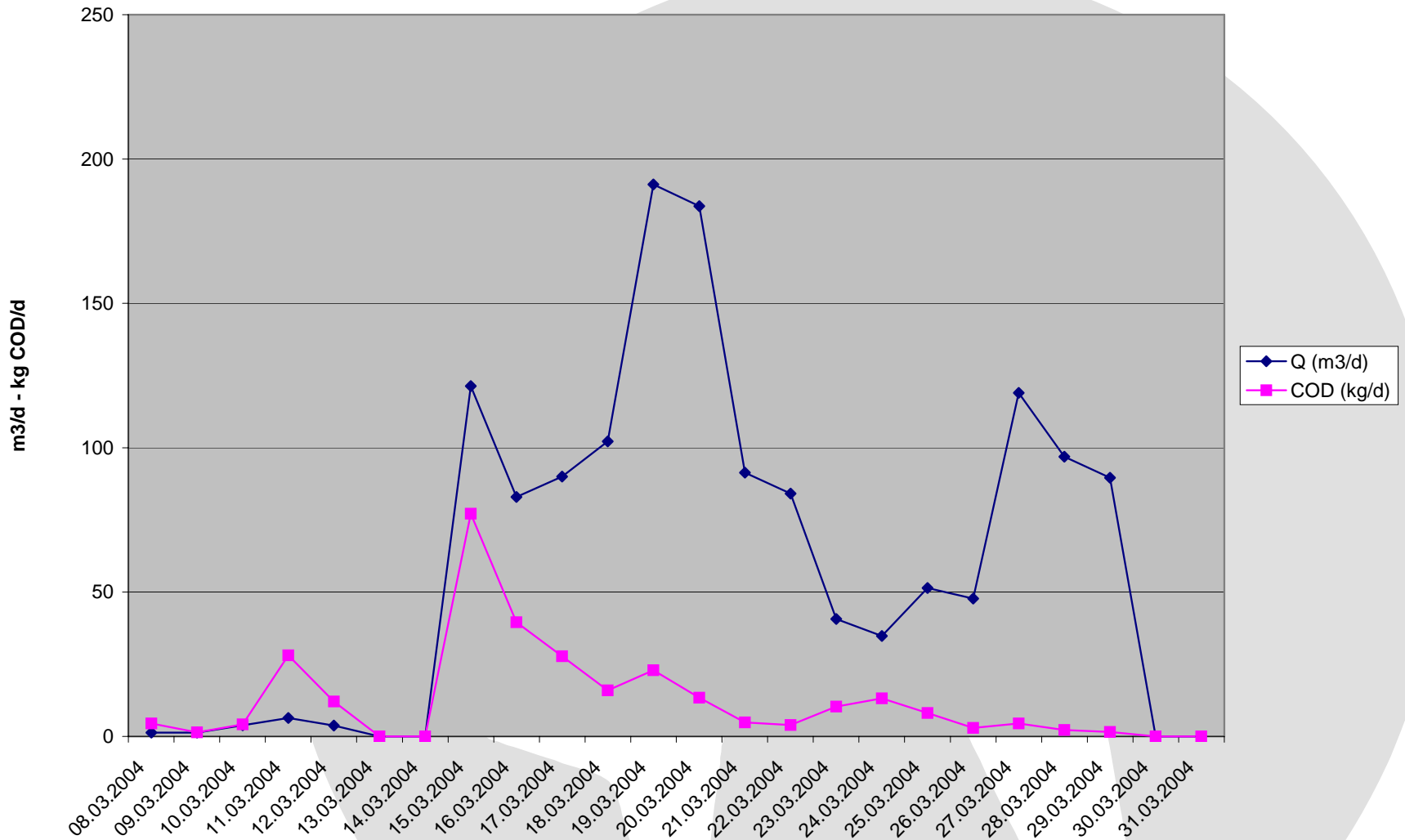
Rate = 0,7 m/d





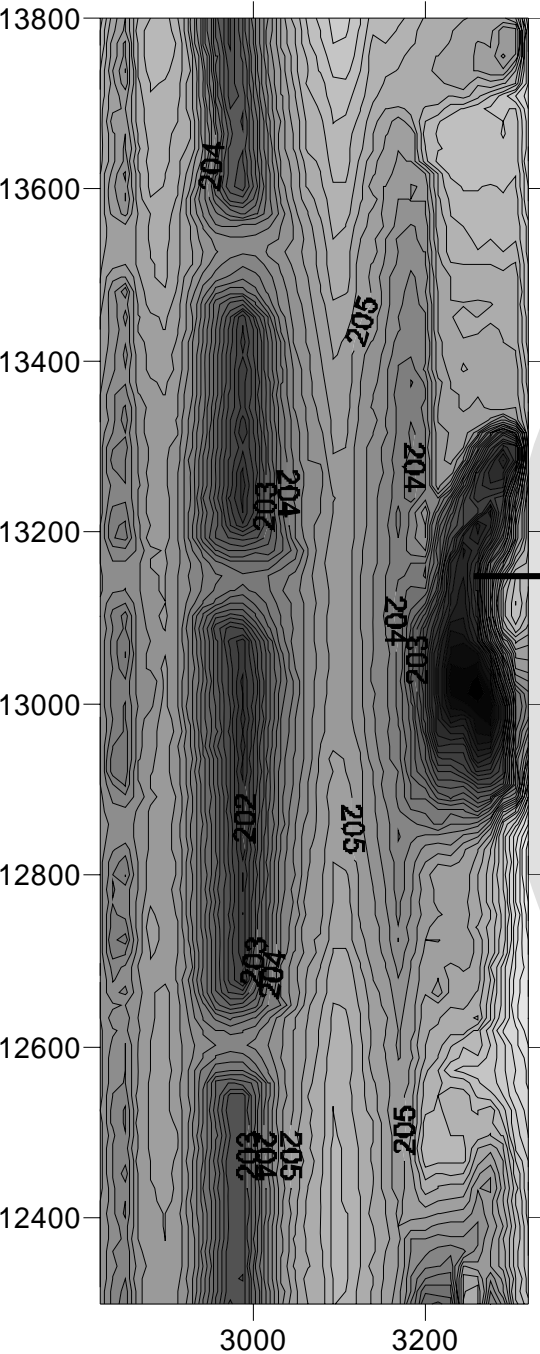
OV1



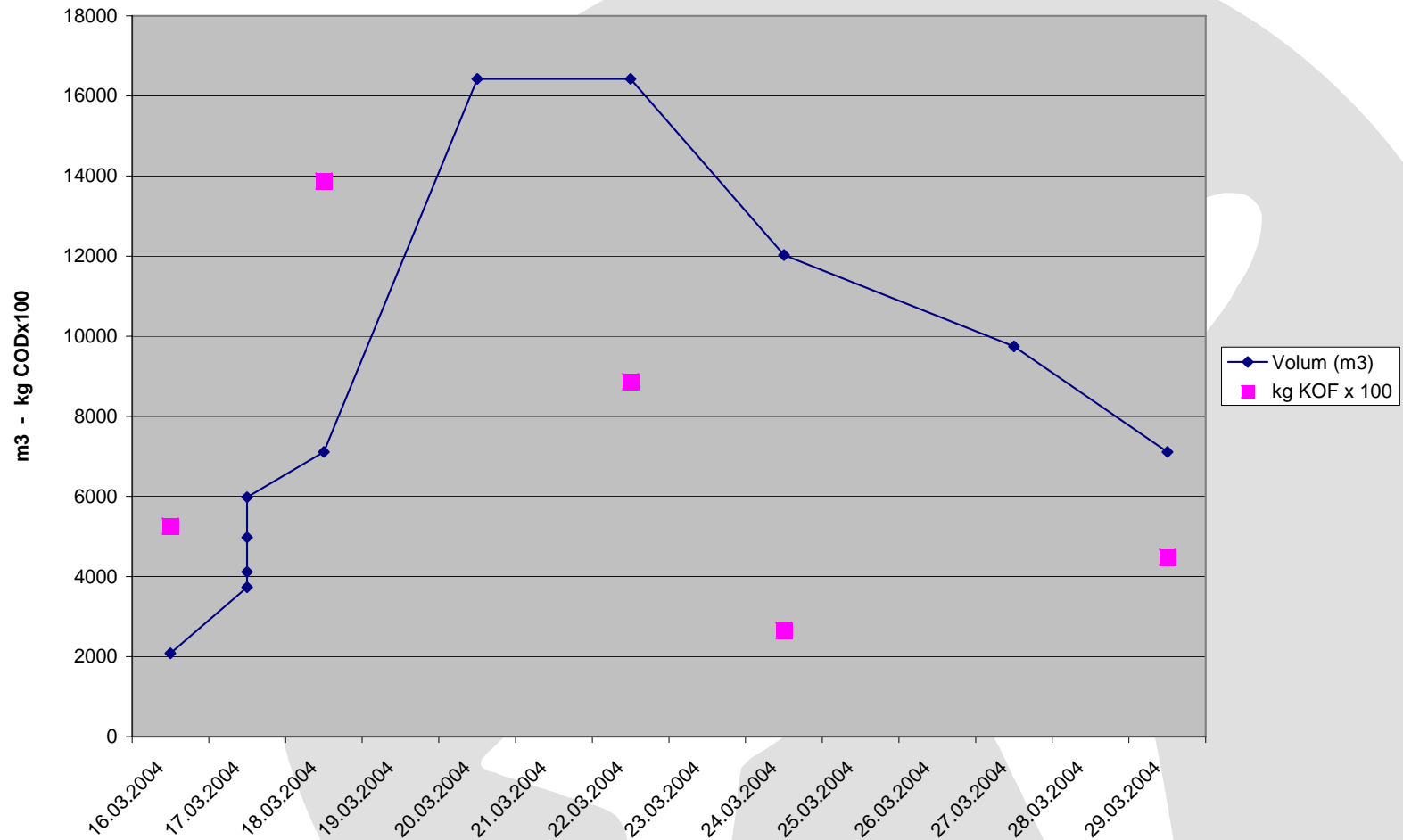


About < 2 % of the spreaded COD has been transported to the system

Swan lake



Run-off from the green area to the Swan lake

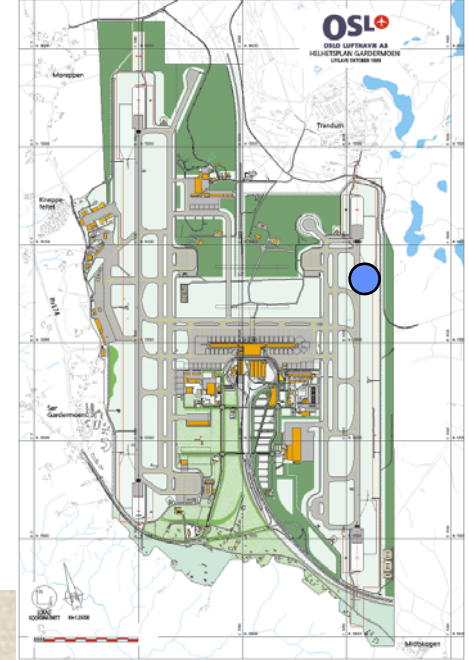
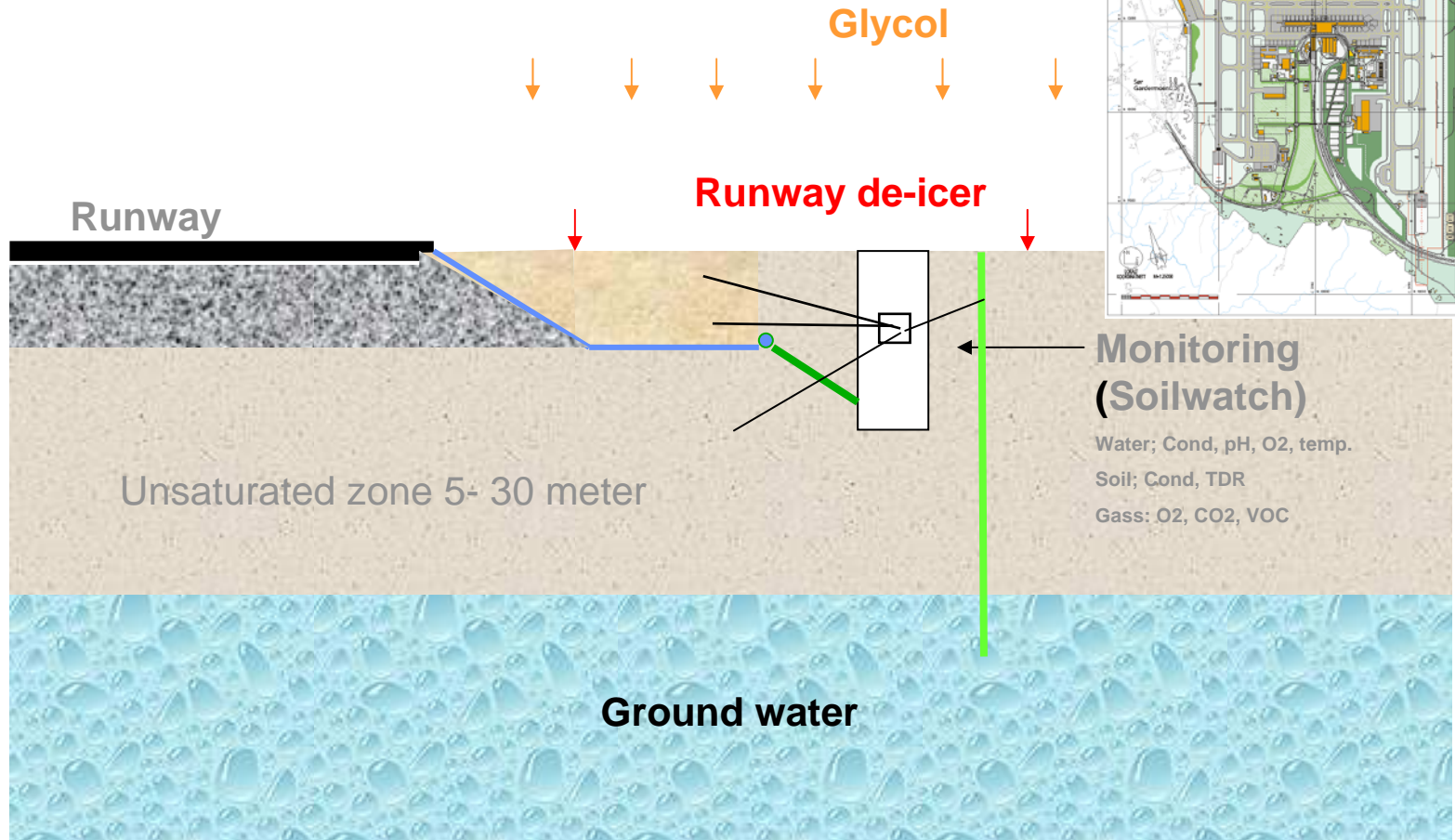


About 2 % of the loaded COD and 70 % of the melt-water has been transported to the Swan lake



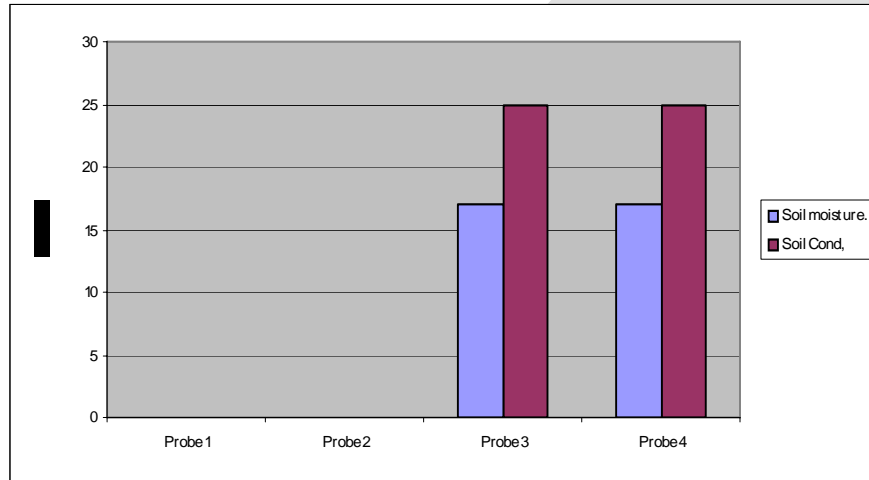
About 98 % of the spreaded COD has been infiltrated in the area along the runway

SOILWATCH



Response time for a front of melt water at 2.5 m deep

Februar 2003

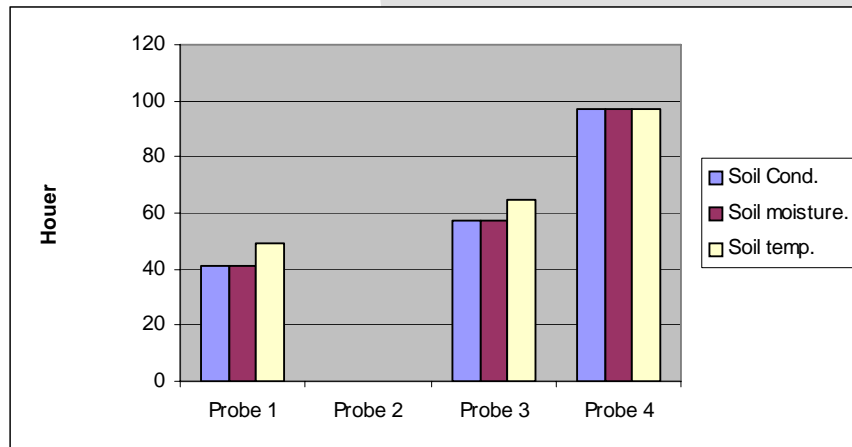


Infiltration takes place in ca 50 % of the area along the runway

Meltwater front reach 2,5 m deep after 15 houers

→ Rate. 4 m/d

Mars 2003

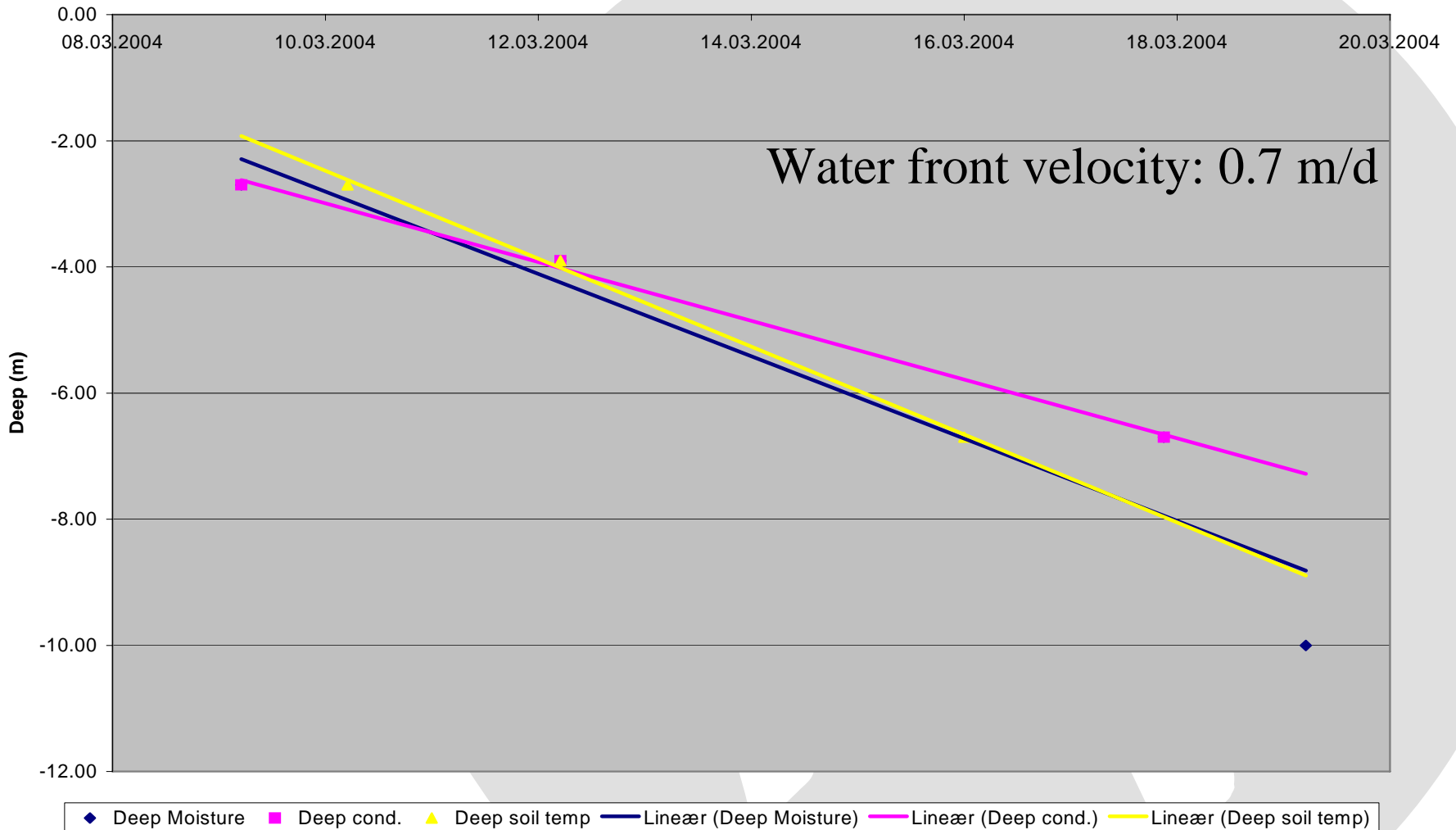


Infiltration take place in about 75 % of the area

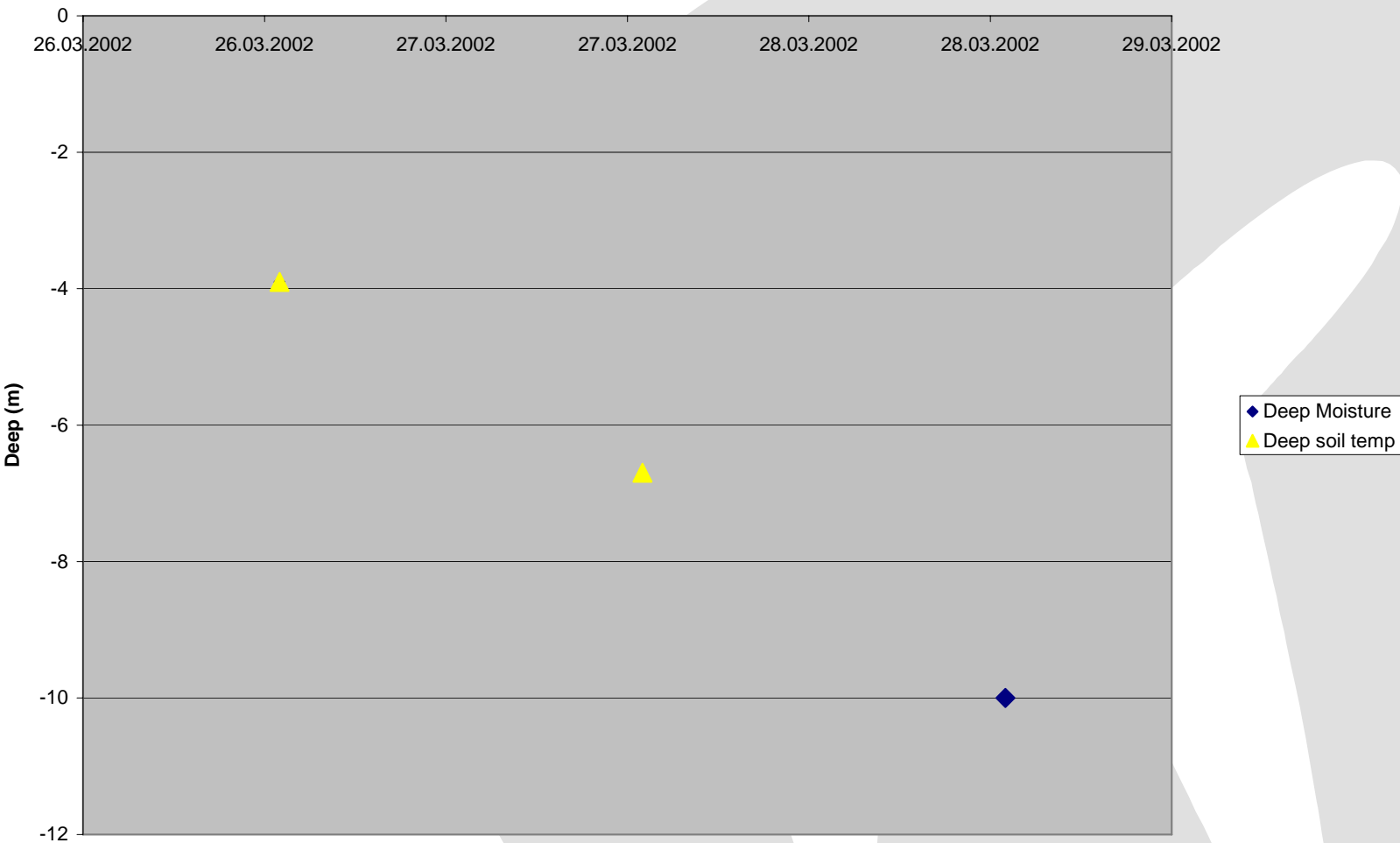
Melting front reach 2,5 m deep after 40, 60 and 100 hours

Effective infiltration area change with time

Infiltration rate Mars 2004



Infiltration rate mars 2002



Water front velocity: 3 m/d →

Simulated Infiltration amount: 250 mm/d



Summary:

1. **High dispersion of de-icing chemicals to green areas along runways**
 - 100 – 200 tonns of PG (170 – 340 tonns as COD) 10 %**
 - 200 – 360 tonns of Formiate (70 – 122 tonns as COD) 100 %**
 - Type II (Anti-icing chemicals)**
 - < 10.000 ppm COD in the snow**
 - < 3 kg COD/m² pr season**
2. **De-icing chemicals melt out of the snow and infiltrat in the frozen top soil**
3. **> 98 % of the de-icing chemicals infiltrates the areas along the runway - also in frozen soil.**
 - Challenge for the ground and groundwater**
4. **Infiltration in frozen soil occur only in part of the area. Area change with time**
5. **Infiltration amount (> 150 mm/d) and rate (> 4 m/d) can be high, specially when the soil is frozen**

Situation Oslo airport at present

