a. ~~Rainwater~~
b. ~~Hypolimnion~~
c. ~~Lake water~~
d. Groundwater ·
e. Lake sediments
f. ~~Acid mine drainage~~
g. Pore water of peat bogs

h. Describe in brief the formation of a hypolimnion.

(17 points)

3. Give the major speciation of nitrogen and phosphorus in the natural environments 1-7 (see Question 2) and discuss in brief their mobility.

(18 points)

4. a. Name two cosmogenic radionuclides.
    b. Name two terrestrial radionuclides
    c. Explain in brief why the half lives of terrestrial radionuclides are in the order of the age of the Earth.
    d. Radiocaesium (^{137}Cs) – a fission product – has a radioactive half-life of 30.17 years. Calculate the time it takes to reduce the initial amount of radiocaesium by 95%.

(10 points)

5. In an 80 cm deep river, ammonium release from the bed sediment occurs at a rate of 16 mg m^{-2} d^{-1}. The nitrification rate constant is 0.4 d^{-1} and the denitrification rate constant is 0.8 d^{-1}. If internal and external sources and sinks other than release from bed sediments, nitrification, and denitrification can be ignored, and the above rate parameters remain constant, the system tends to equilibrium. See for basic equations/information below.
    a. Calculate the ammonium concentration in mg l^{-1} at equilibrium
    b. Calculate the nitrate concentration in mg l^{-1} at equilibrium.
    c. Name three sources or sinks apart from direct anthropogenic sources (e.g. effluent discharges, agriculture) which may have been overlooked.

(25 points)

First-order decay:	Atomic weights
$$\frac{dC}{dt} = -kC$$ Zero-order release: $$\frac{dC}{dt} = \frac{J}{H}$$	H = 1 N = 14 O = 16

Midterm exam GEO3-4301 Soil and Water Pollution
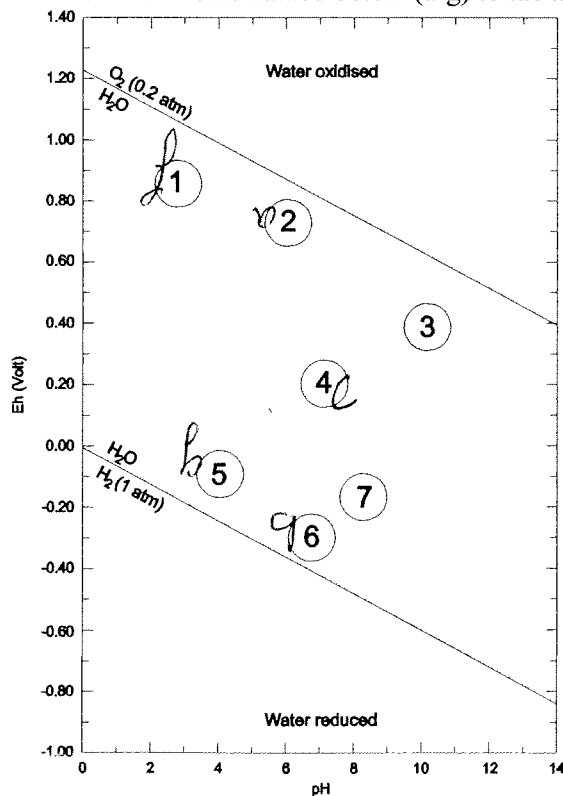## 5 January 2010 9:00 – 11:00 h

General remarks:
- This exam contains five questions.
- Please answer concisely.
- Answers in English or in Dutch are allowed.
- At the end of the examination hand in all your answer sheets.
- Write down your name or student number on all answer sheets.
- Note that after this exam, there will be an introduction to the second assignment, so please be back at 11.00 h.

1. Define the following environmental terms:
   a. Distribution coefficient
   b. Diffuse double layer
   c. Beta radiation
   d. Nitrogen fixation
   e. Internal loading
   f. Ligand
   g. Longitudinal dispersion
   h. Residence time
   i. LNAPL
   j. Heavy metals

(20 points)

2. The figure below shows a pH-Eh diagram with different natural environments. Relate the natural environments named below (a-g) to the number 1-7 in the figure.