Introduction
The main source of groundwater pollution in the Kabul basin is the infiltration of untreated wastewater. Hence, this presentation “General options for groundwater protection” should give an overview of the different dimensions and possibilities of sanitation with respect to groundwater protection.

Scales in Sanitation
The conventional system for industrialised counties is off-site treatment: it’s convenient for the users; they are not responsible for the operation and maintenance of the facilities - but it is quite expensive. In rural areas and in most developing countries on-side sanitation is common. Facilities need to be operated by the users; but it is of low costs in investment and operation. To fill the gap between these possibilities: Community based sanitation consists of low-tech and low-cost facilities. In convenience and costs it lies between the other systems.

On-site vs. off-site sanitation
The main selection criteria for on-site or off-site sanitation are population density and water volume. High population density and high water volume are leading to off-site systems. Low population density leads to on-site sanitation. About water consumption we discuss next.

Off-site Treatment
Off-Site sanitation consists of a sewer network and a centralised wastewater treatment plant. The construction of a sewer network needs high investments. About 65% of the total investments are required for the sewers.

If in-house tab-water is supplied, the water demand often is much higher than 100 l/d per capita. A minimum of about 30 l is used for flush toilet.

In Germany for example we use water saving installations (poor flush toilets...), and we have an average water demand of 130 l/d per capita. On the other hand: In some regions in India water consumption is told to be about 250 l/d per capita. High water consumption in developing counties often depend on pipe leakages or tab leakages.

Benefits of a centralised wastewater system:
- high removal of organic matter, nutrients and pathogen bacteria
- good adapted to urban areas
- space required for WWTP (0.5 - 2 sqm/person)
- good controllabilty

Disadvantages:
- high cost in investment and operation
- requires highly skilled personal
- materials are often not locally available
- high water demand - for the operation of a sewer network high water consumption is required to prevent sewer clogging.
- energy and large machinery necessary
Scales in sanitation
In opposite to a conventional off-site system Community Based Sanitation means the catchment and treatment of wastewater from a block of flats or a small district.

Community based sanitation
It consists of a simplified sewerage and a small treatment plant - that requires no or just little energy.

Septic Tank
A septic tank is an example for a small wastewater treatment plant within a community based sanitation system. The aim of a septic tank is to separate suspended soils and floating sludge from the wastewater. The removal of organic matter in such systems is told be 30 - 50 %. Also parts of pathogen bacteria should be removed in septic tanks it should be more or less the same value. Both are strongly depending on the retention time.

There are currently some septic tanks operating in Kabul. Establishment of post treatment would upgrade the current situation.

Constructed wetland
A simple and effective post-treatment system is a constructed wetland. A constructed wetland is a soil filter. Plants are responsible for the aeration of the soil. Soil filters can also be operated without plants. Wetlands achieve a high removal of pathogen bacteria, organic matter and nutrients. If there is a natural decline in the topography this system can work without energy.

Benefits of Community based sanitation systems
- The sewer network is much simpler and lower-cost, than that of a centralised system.
- Also the costs in operating such a system are low, because in most cases no energy is required.
- No highly skilled personal is necessary for operation.
- The basic technology allows reliable operation.
- A significant reduction of pollutant output.

Disadvantages of Community based Sanitation Systems
- It needs several treatment plants - each of them need to be operated.
- The high demand in space could be a problem in urban areas.

Common on-site sanitation
On-site sanitation is effective when no tab-water is available.

On-site sanitation
In most cases solids are separated from liquids. Solids can be dehydrated and used as fertiliser in agriculture as practised in Kabul, known as nightsoil collection. Greywater from bath and kitchen needs a minimum of treatment.
On-site sanitation
From the groundwater point of view dry on-site sanitation is the safest way in sanitation. In opposite to a simple pit-latrine, this is a tight container witch collects solids. This can be installed inside or outside the house. Ventilation against odours and prevention of fly breeding are essential for those systems.

On-site sanitation
One main advantage of this system is that solids - which contain nearly all relevant pathogen bacteria - are not dissolved in water and therefore the most important access for the pathogen bacteria to the groundwater and therefore to the people is cut off.

To specify this: pathogen bacteria benefit from water, because on one hand they need moisture to survive. On the other hand water is the means of transport for the pathogen bacteria to reach the groundwater. A leaky sewer pollutes the groundwater in exactly the same way.

When there is no water used to flush, there also is no water leading the pathogen bacteria into the groundwater. Small amounts of fluid are detained in the unsaturated zone above the groundwater.

Benefits of on-site sanitation
- low cost
- small water demand
- no sewer network
- reliable techniques
- no energy necessary
- no groundwater contamination by pathogen bacteria

Disadvantages of on-site sanitation
- no control of performance
- needs maintenance by users
- large space required
- therefore it is not well adapted to densely populated areas

Conclusions
Currently the groundwater quality is strongly affected by wastewater infiltration. A rapid implementation of a system that cuts off pollution paths for pathogen bacteria and suspended organic matter to the groundwater is essential for the health of the Kabul inhabitants.

The installation of a sophisticated wastewater system will need decades.

This means that an intermediate solution is required. In the Micro Rayon already sewer network exists, but the treatment plant is not working. A fast reconnection would upgrade the current situation.

If treated wastewater can be used for irrigation, treatment can be easier and cheaper without disadvantages for health and environment.

The energy-, time- and space-effective nutrient removal is not necessary.