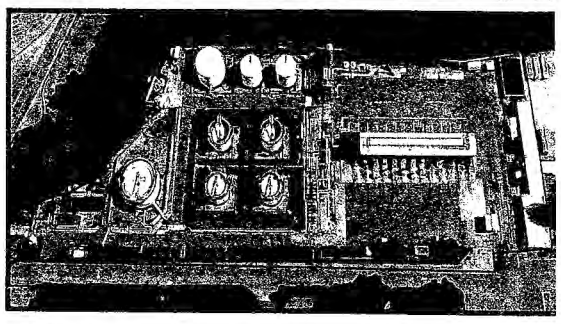
REMEDIETION PROCEDURE
REALIZATION AND TESTING OF OSM PRESIDES

DE.CO. Company:
Activities of reception, storage and petroleum products processing and mixing.



TIMELINE

On 27th of March 2001, after the detection of the groundwa ter limits exceeding (CSC - Table 1 col.B of the Annex 5 tc the Part IV Title V of the D.Lgs. 152/06 for industrial/ commercial sites) of the hydrocarbons and aromatic solvents concentration, DE.CO. proceeded with the adoption of groundwater safety measures through the installation of an hydraulic barrier.

- **03-06/2001** → ESM (Emergency Safety Measure) design and implementation: hydraulic barrier (7 wells) along the north side and Characterization plan (PdC) D.Lgs 152/06 ";

- **07/2008** → "Technical report on existing and ongoing safety emergency measures";

- **09/2008** → Integrative investigations;
  - The site has been defined as "potentially contaminated".

- **03/2009** → The "Investigation Plan" and "Risk Analysis" documents are drawn up;
  - Check about the absence of health risk for the operators present on the site as well as the risk assessment on the groundwater matrix.

- **From 09/2009 to 10/2011** → Monitoring and sampling activities;

- **11/2012** → Approval of the "Risk Analysis" document;
  - Planning of the present OSM project, and identification of all the appropriate interventions and monitoring activities. The goal is to guarantee an adequate level of safety for the people and the environment.

- **From 14/2014 to today** → The site is in OSM.

eological and hydrogeological model

ratigraphic succession of the ground:

- **Level 1)** min 0,0 - max 4,5 m g.l..: ground level (medium-coarse sand, sometimes silty, mixed with cement conglomerate, asphalt and mixed stone; maximum thickness = 3.9 m);
- **Level 2)** min 1,9 - max 7,5 m g.l.: alternating levels of silty sand, sandy silts and clayey silts with rare gravel intercalations;
- **level 3)** min 4,8 - max > 10 m g.l.: coarse sand sometimes weakly silty;
- **level 4)** min 9,0 - max > 10 m g.l.: sandy silts and clayey gray dark silt.

resence of two overlapping water tables:

rface acquifer: Static level between a minimum of about 11.0 m s.l. and a maximum of 18.5 m a.s.l. Flow direction: NW.

onfined aquifer: Static level of the under pressure stratum at an titude of about 15.0 m a.s.l.

he two aquifers are separated seamlessly by an impermeable sep- m composed of clayey limes and clays (thickness of about 2 m).

ources, routes of exposure and transport models

roundwater:

- GW-regulated Source: Benzene, Ethylbenzene, Toluene, Paraxylene, Total Hydrocarbons, Lead.
- GW-Unregulated Source: MTBE.

eep soil:

enzene, Toluene, Xylene, C> 12, C <12.

- Exposure routes:
  - Vapors volatilization from unsaturated soil and from ground water;
  - Contaminants leaching through soil to groundwater.
- Targets:
  - On-site commecial target;
  - Off-site residential target;
  - Groundwater target.

op soil:

: has not been modeled in the Risk Analysis (environmental matrix efined as not contaminated).

isk Assessment result

n acceptable health risk was determined for all the active exposure outes with respect to the groundwater source, while an unacceptale Risk Index value was found for the path of volatilisation from ie ground related to the off-site target, prudently placed at 0 m rom the boundary of the site, although to date there is no residential ettlement (or similar to that) near the depot.

OSM (Operational Safety Measure)

Operational Safety Measure: the set of interventions carried out on a site with activities in operation in order to ensure an adequate level of safety for the people and the environment, waiting further interventions of permanent safety measure or reclamation to be carried out at the cessation of activity. They also include contamination containment and control interventions.

In such cases, adequate monitoring and control plans must be set up to check the effectiveness of the solutions adopted.

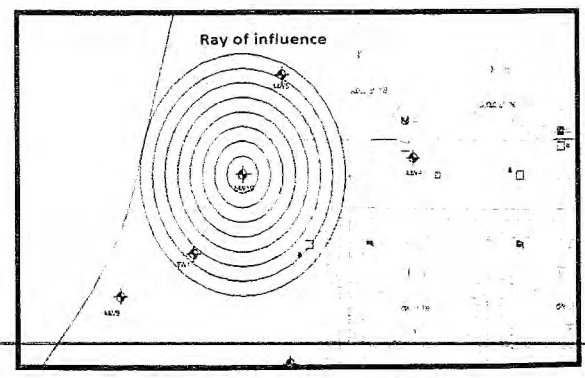
In the specific case, the present OSM project has the goal to:

- contain contamination through actions aimed at preventing the migration of the same towards sensitive environmental receptors, such as surface water (Rio Galeria) and groundwater;
- ensure compliance with the CSCs for groundwater at the Point Of Control (POC);
- reduce the concentrations detected at the POC by limiting the phenomenon of groundwater leaching;
- mitigate, through on-site interventions (assessed on the basis of monitoring results and specific field tests), the contamination present into environmental matrices in order to mitigate the risk for public health and the environment.

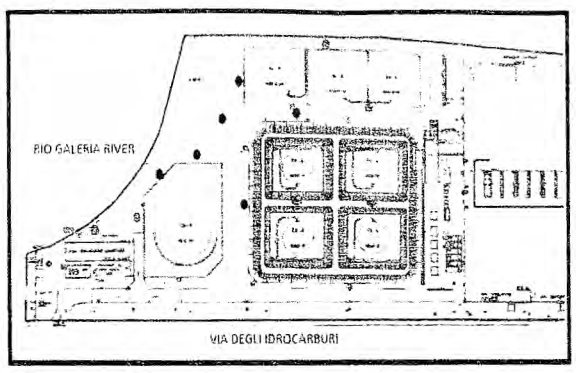
Definitively, the selected mitigation/containment technologies are:

1. **Upgrading of the current hydraulic barrier with water treatment for the reuse of the same for industrial and safety purposes of the activity;**

⇒ *Hydraulic barrier reinforcement:*
1) identification of "upgrading zones";
2) sizing of the barrier wells (ray of influence);
3) definition of technical specifications of barrier wells and revamping of pre-existing wells.
→ Post-upgrade flow rate: max. between 40 and 60 m^3/d (compared to the initial 9 ÷ 14 m^3/d).



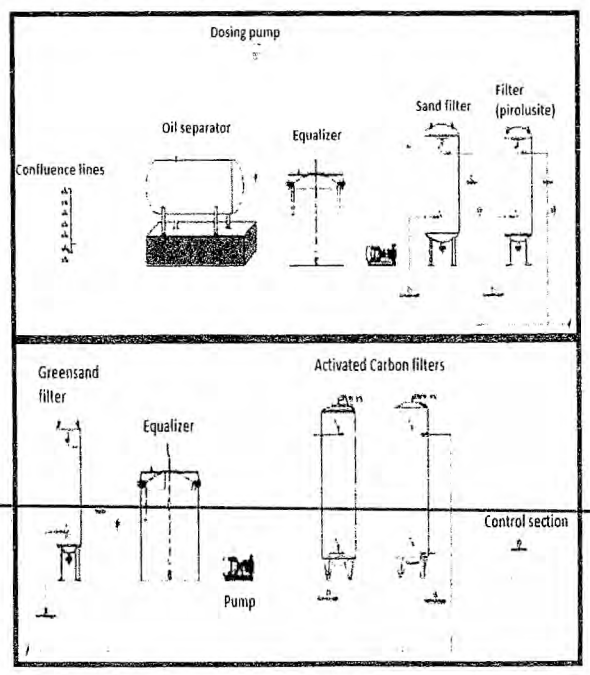
Well ray of influence detail



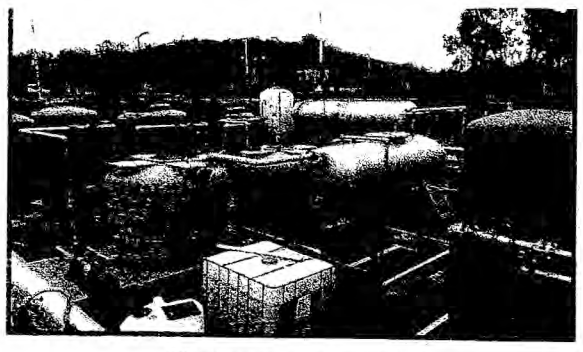
- ● *pre-existing piezometer*
- ● *pre-existing piezometer re-*
- ◎ *piezometer of new construction*
- *pre-existing piezometer integrated in the barrier*

The advantages induced by the reuse of the water pumped from the stratum can be summarized as follows:

- ◊ significant savings in the procurement, management and disposal of water resources;
- ◊ reuse of a resource otherwise treated as waste, resulting in an evident environmental damage;
- ◊ less energy consumption, energy savings and therefore lower CO_2 emissions;
- ◊ lower operating costs of the Vapor Recovery unit (greater efficiency and safety).



Water treatment plant layout



Water treatment plant detail

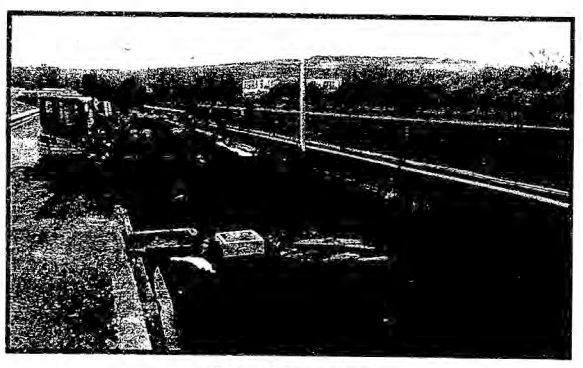
2. **Creation of a capping on the current green areas to drastically reduce the infiltration of meteoric water in the unsaturated soil (guarantee a fracture index of 1%);**

⇒ *Geomembrane (0.5 mm):* LDPE geomembrane made up with an internal high-density polyethylene (HDPE) texture which forms the reinforcement of the product; on top of the HDPE texture, on both sides, a double layer of low density polyethylene (LDPE) is hot-rolled → Permeability $k = 2.85 \times 10^{-14}$ m/sec. → Crossing time $t = S/k = 546$ years.

◊ *Protection:*
Laying of a non-woven continuous needle-punched geotextile, UV stabilized, made of 100% virgin polypropylene, with exclusion of regenerated and/or recycled fibers;

Covering soil. These sheets are placed about 30 cm deep from the ground level and covered by the excavated soil.

This is superficial soil extracted directly into site (uncontaminated) previously exposed to analysis to verify its reuse. Impermeable area: 2680 m^2.



Capping test detail

⇒ *Sub-frame monitoring system:* monitoring network consisting of a 65 mm diameter PVC drainage pipe covered with filter material to prevent clogging.The drain tube then flow into the monitoring points. Each of these points serves to monitor a surface of limited extensions allowing to punctually intervene in case the presence of water is detected.

OSM Monitoring:

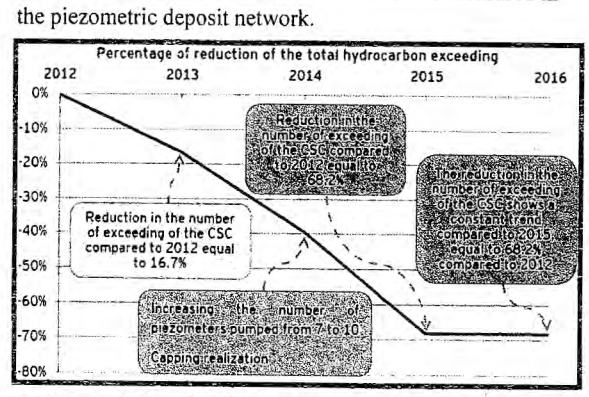
- Groundwater and surface water quality;
- Hydrogeologic;
- Water quality of treatment plant;
- Presence of gas into unsaturated soil;
- Check of the air quality.

Costs:

- Waterproofing works - capping: € 150.000,00
- Hydraulic barrier realization and enhancement: € 90.000,00
- Water treatment plant construction: € 70.000,00
- Post-operative monitoring: € 60.000,00
- Maintenance and control: € 75.000,00/per year
- Other charges: € 25.000,00

Achieved results:

- Checks carried out on the waterproofing works have given positive results regarding the capping seal against the infiltration of meteoric water;
- The monitoring on the gas survey wells and on the air quality has never highlighted any criticality;
- The upgrading of the hydraulic barrier ensured the respect for the CSCs to the compliance points and allowed consolidation of the groundwater capture front;
- The results of groundwater monitoring show a significant decrease in the concentrations of contaminants measured in the piezometric deposit network.



Relying on the results of post-operam monitoring, suitable feasibility studies can be performed to evaluate the possibility of focused interventions in the most critical areas.

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