PFC Remediation at a Fire Extinguisher Manufacturing Site

Felix Tamms

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Contents

– Site Description
– Contamination Situation
– Remediation Thresholds
– Remediation Techniques
– Remediation Activities
– Conclusions
Site Description

- **Fire Training Area**
- **Meadow**
- **Pond**

Approximately 200 m distance.
Site Description

Fire Training Area (ca. 1.000 m²)

Pond on neighboring property (ca. 700 m²)
Site Description / Site History

– Until 1945: Agricultural Use
– Since 1953: Fire Extinguisher Factory
– Until 2007: Manufacturing and Testing of Fire Extinguishers

Fire Training in the 1970s
Contamination Situation

– 2008: Detection of elevated PFC concentrations in sewage sludge

– 2009: Detection of elevated PFC concentrations in soil, groundwater, surface water, and waste water at the site and on two neighboring properties

– 2012: Designation of two main remediation zones during preparation of the remedial concept:

1) the onsite Fire Training Area, and
2) one Pond on the neighboring downgradient property
Contamination Situation

- Main impact by PFC in soil at the Fire Training Area
- Discharge via the groundwater in the quaternary aquifer
- Influenced by a surficial drainage system in the neighboring meadow
- Entry into the neighboring downgradient Pond
- Discharge of the PFCs in the waste water via the onsite sewer system

General Groundwater Flow Direction
Definition of Remediation Thresholds

Challenges:

- Different Check Values for different single compounds of the group of PFCs
- Different Check Values in different countries / states
- Low (Drinking-) water action values vs. relatively high soil action values
- Approximately factor 10 between soil values and leachate values

Agreed Remediation Thresholds:

<table>
<thead>
<tr>
<th>Medium</th>
<th>Threshold</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>100 µg/kg</td>
<td>Sewage Sludge (MUNLV)</td>
</tr>
<tr>
<td>Groundwater</td>
<td>5.0 µg/l</td>
<td>Drinking Water (LANUV)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precautionary: total PFC</td>
</tr>
<tr>
<td>Waste Water</td>
<td>1.0 µg/l</td>
<td>total PFC</td>
</tr>
<tr>
<td></td>
<td>0.3 µg/l</td>
<td>PFOA + PFOS</td>
</tr>
</tbody>
</table>
Remediation Techniques

1) Soil:
   - Excavation of source areas and reconstruction with sealing and securing

2) Groundwater:
   - Pump & Treat downgradient of source areas
   - Additional securing of the source areas by water collection

3) Sewer System:
   - Removal of residuals inside the sewer lines using water flushing
Remedial Activities – Fire Training Area

- Excavation planning based on intensive preliminary investigations

Cross Section B-B'/
Schnitt B-B'

- Maximum PFC in Soil: 9,500 µg/kg
- Maximum PFC in Groundwater: 50 µg/l
- Highly impacted soil was excavated in segments
Impacted soil was excavated in segments, base sampling, analyses, and if necessary, additional excavation (to approximately 1.5 m)
Remedial Activities – Fire Training Area

- Demolition of surface utilities (disposal)
- Backfill / sealing of pit base (Geomembrane)
- Installation of circumferential drainage system (connection to existing separator)
- Prevention of surficial discharge via the slope onto the neighboring meadow
- Reconstruction of surface including surface water discharge into the sewer line
Remedial Activities – Pond

- Excavation planning based on intensive preliminary investigations

- Maximum PFC in Soil: 5,000 µg/kg
- Maximum PFC in Water: 16 µg/l
- Highly impacted soil was excavated depth orientated (Sediment)
- Soil with high organic content cannot be landfilled!
Remedial Activities – Pond

- Clearance of the area, work site preparation (temporary access road, etc.)

- Excavation of pond sediments (separation based on preliminary investigation results and organic content)

- Backfill of pit base above the groundwater level with clean soil

- Sealing of pit base (Geomembrane)

- Installation of circumferential drainage system (securing) and connection to the existing water treatment plant of the drainage water from the meadow)
Remedial Activities – Pond

- Professional Landscaping and Gardening
- Elimination of direct contact pathway: impacted soil / surface water - human
- Elimination of future recontamination by potentially impacted groundwater
Remedial Activities – Sewer System

– Flushing the sections of the onsite sewer system between the former Fire Training Area and the transfer point to the public sewer system

– The flushing water was collected, sampled, and disposed of properly

– By these different measures, a significant reduction of PFC concentrations in waste water has been achieved (currently, PFC values in the range of discharge limits)
Challenges:

- PFCs are highly soluble and not degradable
- PFCs can be analyzed exclusively in the laboratory (not visual / olfactory)
- Different Check Values for different compounds of the group of PFCs
- Different Check Values in different countries / states
- Low (Drinking-) water action values vs. relatively high soil action values
- Approximately factor 10 between soil values and leachate values
- Migration pathways via surface water, groundwater, sewer systems, and drainage systems
- Landfilling (Selection of transportation company and landfill site)
Conclusions

Recommendations:

• Intensive preliminary investigations of soil and groundwater in the source areas required
• Examination of potential downgradient migration pathways and accumulation areas (Water, Soil, Sediment)
• Investigation of the onsite sewer system
• Cross-check investigations (offsite) also recommended (upgradient impact also possible by private user)
• Disposal (landfilling / incineration)
Thank You

Felix Tamms
Project Manager, Soil & Groundwater
T +49 201 68501-19
M +49 172 6180535
felix.tamms@aecom.com

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