Draft Commission Regulation's amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards lead in ammunition and fishing tackle

TECHNICAL NOTE on Annex XVII to Regulation (EC) No 1907/2006: Appendix [X] Entry 63 Conditions for the application of the derogation in paragraph 25

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This note responds to the request of FITACS to provide to European authority's risk-management measures that shall be in place for outdoor sports shooting ranges to be authorised by Member States pursuant to paragraphs 25 of Annex XVII to Regulation (EC) No 1907/2006, appendix [X] Entry 63: surface water management.

Reference File

File detail	
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Project number :	75-001
Status :	Technical note
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Reference number:	ATS/PAR/25/75-001: FITASC - Technical Note - Dr Jean-Louis SEVEQUE - March 2025 V0
Report title:	Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards lead in ammunition - Technical note on Annex XVII to Regulation (EC) No 1907/2006: Appendix [X] Entry 63 - Conditions for the application of the derogation in paragraph 25
Report date:	21 March 2025

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1. Documents

This technical note has been prepared based on the following documents :

EUROPEAN COMMISSION

Brussels, XXX
[…](2025) XXX draft

COMMISSION REGULATION (EU) …/…

of XXX

amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards lead in ammunition and fishing tackle

(Text with EEA relevance)

EUROPEAN COMMISSION

Brussels, XXX
[…](2025) XXX draft

ANNEX

ANNEXES

to the

Commission Regulation (EU) .../... of XXX

amending Annex XVII to Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) as regards lead in ammunition and in fishing tackle

1. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Official Journal L 327, 22/12/2000 P. 0001 - 0073.
2. Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council.

2. Initial data

2.1. The context

On 16 July 2019, the European Commission asked the European Chemicals Agency (ECHA) to prepare a dossier (Annex XV dossier) to address the concerns regarding human health and the environment posed by lead and lead compounds in ammunition, including gunshot used in terrains other than wetlands and bullets used both in wetlands and in terrains other than wetlands.

On 24 March 2021, ECHA published the Annex XV dossier in which it concluded that lead in ammunition poses a risk to the environment and human health, to vulnerable populations such as children that is not adequately controlled and that needs to be addressed on a Union-wide basis. Lead accumulation at sports-shooting ranges can result in the leaching of lead-polluted surface water into local watercourses and may affect groundwater, potentially poisoning people, livestock and wildlife.

During the preparation of the dossier, FITACS and other parties discussed with ECHA, and later with the European Commission, demonstrating that for outdoor shooting ranges for clay target shooting, lead and lead compounds can be managed to prevent impacts on the environment and to avoid human health risks. In February 2025, the European Commission published its draft proposal on the restriction on lead ammunition. In accordance with demonstration made, and following FITACS demand, the European Commission suggested a derogation from the ban on the use of lead gunshot for sports shooting, on condition that specific risk management measures are implemented at sports shooting ranges:

“Appendix [X] - Entry 63 - Conditions for the application of the derogation in paragraph 25

This Appendix lays down the risk-management measures that shall be in place for outdoor sports shooting ranges to be authorised by Member States pursuant to paragraphs 25, point (a) and 37, point (a).

Risk-management measures for use of gunshot in outdoor sports shooting ranges

The following risk-management measures shall be present in outdoor sports shooting ranges where gunshot is discharged:

(a) at least two of the following lead-containment measures:

- *one or more walls.*
- *one or more berms or banks made of soil, gravel, sand or other appropriate material.*
- *one or more nets or shot curtains.*
- *surface covering.*

(b) recovery of spent lead shot at least every 3 years and upon cessation of activity of the outdoor sports shooting range.

(c) monitoring and, where necessary, treatment of the gunshot-impact areas to ensure that they have a pH of between 6.5 and 8.5, to minimise lead migration into soil and water. Compliance with those pH values shall be verified at least once every six months.

(d) containment, monitoring and, where necessary, treatment of drainage water (including surface water run-off) from gunshot-impact areas to ensure compliance with the environmental quality standard for lead specified under Directive 2000/60/EC.

(e) a ban on any agricultural use within the site’s boundaries.

(f) records of compliance with the conditions in this paragraph.”

The following pages present potential solutions to answer to point c (managing pH of the soils) and d (managing of surface water).

2.2. Regulatory obligations

The point (d) asks for the containment, the monitoring and, where necessary, treatment of drainage water (including surface water run-off) from gunshot-impact areas to ensure compliance with the environmental quality standard for lead specified under Directive 2000/60/EC. This Directive said since water is not a commercial product like any other but, rather, a heritage which must be protected, defended and treated as such, environmental quality standards in the field of water policy must be defined.

This is the purpose of the Directive 2008/105/EC of the European parliament and of the council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council. The aim of this Directive is to set out environmental quality standards (EQSs) for the presence in surface water[1] of certain substances or groups of substances identified as priority pollutants because of the significant risk they pose to or via the aquatic environment. As mentioned above, these standards are in line with the strategy and objectives of the European Union's water framework Directive (Directive 2000/60/EC).

The Directive sets EQSs for priority substances and pollutants. These substances include the metals cadmium, lead, mercury and nickel, and their compounds; benzene; polyaromatic hydrocarbons; and several pesticides. Several of these priority substances are classed as hazardous. The EQSs in Directive 2008/105/EC are limits on the concentration of the priority substances and other pollutants in water (or biota[2]), i.e. thresholds which must not be exceeded if a good chemical status is to be met. There are two types of water standard.

1. A threshold for the average concentration of the substance concerned calculated from measurements over a 1-year period. The purpose of this standard is to ensure protection against long-term exposure to pollutants in the aquatic environment.
2. A maximum allowable concentration of the substance concerned, i.e. the maximum for any single measurement. The purpose of this standard is to ensure protection against short-term exposure, i.e. pollution peaks.

The EQSs are different for:

- Inland surface waters (rivers and lakes).
- Other surface waters (transitional, coastal and territorial waters).

In our present discussion, EQSs for lead and its compounds are:

[1] Surface water = rivers, lakes, transitional waters and coastal waters. Surface waters also include territorial waters as far as chemical status is concerned.

[2] Biota = the animal and plant life of a given habitat or region.

ANNEX I

ENVIRONMENTAL QUALITY STANDARDS FOR PRIORITY SUBSTANCES AND CERTAIN OTHER POLLUTANTS

PART A: ENVIRONMENTAL QUALITY STANDARDS (EQS)

AA : annual average;

MAC : maximum allowable concentration.

Unit : [µg/l]

(1)	(2)	(3)	(4)	(5)	(6)	(7)
(20)	Lead and its compounds	7439-92-1	7,2	7,2	not applicable	not applicable

Table 1 : environmental quality standard (EQS) for lead in surface water

Columns 4 and 5 of the table: for any given surface water body, applying the AA-EQS means that, for each representative monitoring point within the water body, the arithmetic mean of the concentrations measured at different times during the year does not exceed the standard.

The calculation of the arithmetic mean, the analytical method used and, where there is no appropriate analytical method meeting the minimum performance criteria, the method of applying an EQS must be in accordance with implementing acts adopting technical specifications for chemical monitoring and quality of analytical results, in accordance with Directive 2000/60/EC.

It could also be stated that it exists another standard for lead, from the directive 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption. The Directive 98/83/EC on the quality of water intended for human consumption (water for human consumption, WFHC) has been a relevant legal tool to ensure the quality of WFHC in the European Union. The objective of this directive, set out in Article 1, was to "protect human health from the harmful effects of contamination of WFHCs by guaranteeing their health and cleanliness". After nearly 3 years of negotiations between the European authorities (European Commission, Council of the European Union, European Parliament), a new drinking water directive was published on 23 December 2020 in the Official Journal of the European Union (annex 1). For lead and its compound, the target is set to 10 µg/l until 12 January 2036 (see table 2).

ANNEX I

MINIMUM REQUIREMENTS FOR PARAMETRIC VALUES USED TO ASSESS THE QUALITY OF WATER INTENDED FOR HUMAN CONSUMPTION

Part B

Chemical parameters

Parameter	Parametric value	Unit	Notes
Lead	5	µg/l	The parametric value of 5 µg/l shall be met, at the latest, by 12 January 2036. The parametric value for lead until that date shall be 10 µg/l.
			After that date, the parametric value of 5 µg/l shall be met at least at the point of supply to the domestic distribution system. For the purposes of point (b) of the first subparagraph of Article 11(2), the parametric value of 5 µg/l at the tap shall apply.

Table 2 : lead concentration in water for human consumption

3. Management systems for surface water

3.1. Lead geochemistry

Lead (Pb) is a chemical element with the atomic number 82, belonging to group 14 (Carbon group) of the periodic table. Lead is a dense metal with a density of 11,34 g/cm³, making it significantly heavier than most common metals. It is soft and malleable, and when freshly cut, lead appears bluish white, but it quickly tarnishes to a dull grey due to oxidation: this is the property we look at to implement risk-management measures since Lead is resistant to corrosion[3], as it forms a protective oxide layer when exposed to air or basic water or soil.

Metallic lead is released into the environment at shooting ranges during their service life. Each pathway is site-specific and may or may not occur at any individual range. If lead particles or dissolved lead can be moved by storm water runoff (horizontal migration), dissolved lead cannot migrate through soils to ground water (vertical migration): all known measurements made on lead in soils have shown that migration of lead is about few centimetres and cannot migrate *per descensum* to underground water, excepted of course in flooding area.

Like most chemical elements, the mobility of lead is mainly controlled by its speciation in aqueous phase and by adsorption / desorption and / or dissolution / precipitation processes. The role of certain parameters such as the pH, the redox potential, the mineralogical composition of the soil and the presence of ligands or colloids in soil will be decisive as illustrated with the following figure.

[3] Chemical corrosion of lead is very slow. When a lead particle is brought into contact with the atmosphere, corrosion is limited by the rapid formation of a layer of lead oxide or lead carbonate on the surface of the particle.

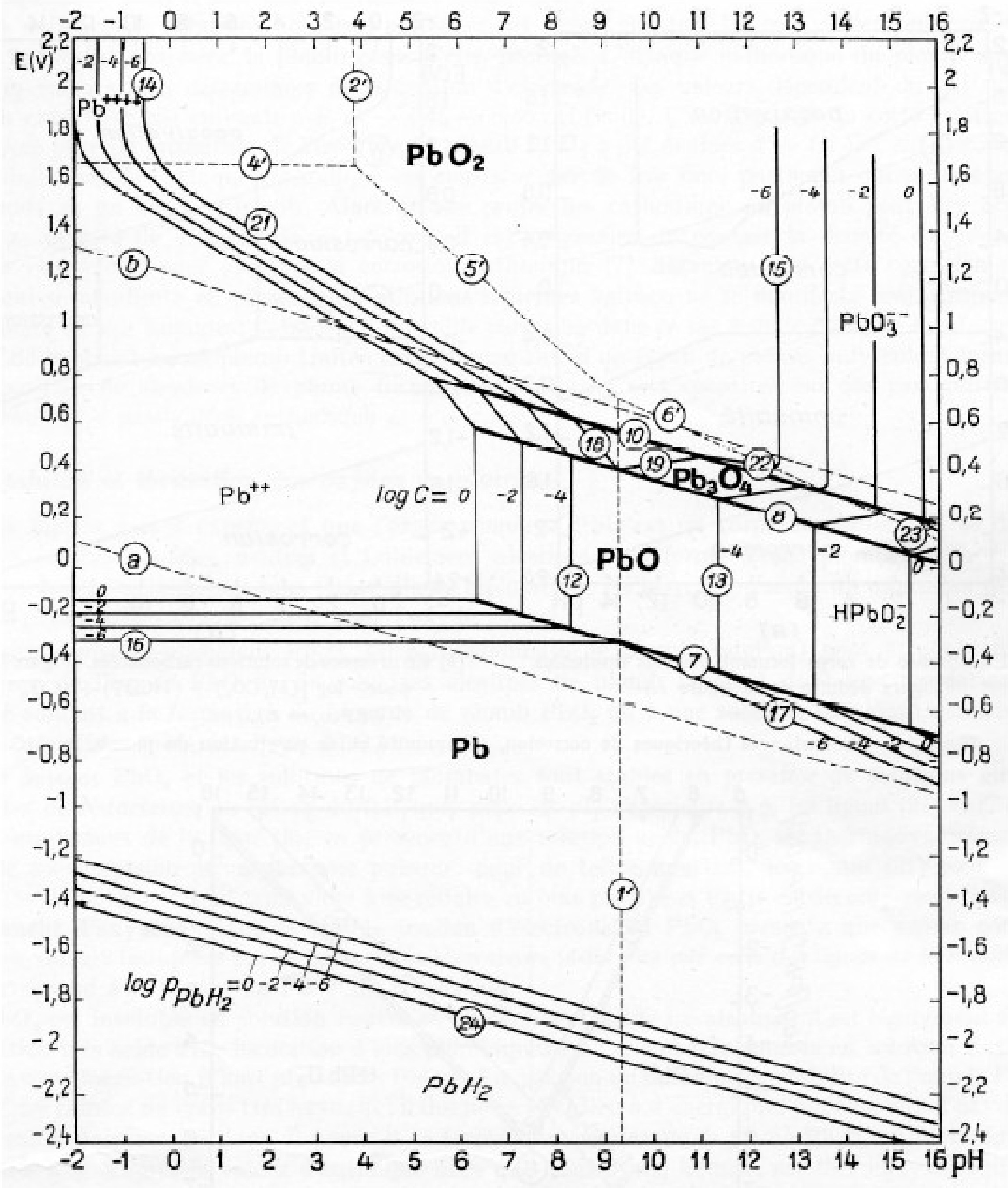

Figure 1 : Eh-pH diagram of the lead-water system at 25°C

In fact, speciation calculations have shown that when lead is dissolved in natural water, it is the carbonate complexes that predominate for pH values above 6.5, and the dissolved ion Pb^{2+} ion for pH lower than 6.

On this basis, what could be the different management systems to implement to fulfil requirements from EU ?

3.2. Management solutions for treatment of drainage water

Water management at a shooting range means the minimisation of the amount of water getting into contact with pollutants, the controlled collection of water with pollutant content, and its redirection into monitoring and, if necessary, treatment. The principle is, depending on the conditions of the area, water from the gunshot-impact area is directed via open or underground drains into a sedimentation or infiltration water treatment system.

Therefore, as mentioned above, the derogation should depend on the presence, in the shooting range where the sports shooting takes place, of appropriate risk management measures, both to ensure lead containment and to limit the release of lead. The solution to implement is only dedicated to gunshot-impact area and is therefore strongly site-specific. The obligation to contain, monitor and, where necessary, treat drainage water (including surface water run-off) from gunshot impact area must be done according to one of these two options, again from a site-specific point of view:

1. Water treatment by filtration.
2. Water treatment by sedimentation.

3.2.1. Initial state: pH of the soil

Before studying these two options, it must be recalled that the first aspect to know is the pH of the soil of the gunshot-impact area. If this area is not impervious (which is commonly the case), all the rainwater will mainly percolate the soil toward the water table. If lead shots are on the surface, a part will migrate as particulate matter downward due to high density of lead, and other part will be dissolves and may be transferred to underground water is pH is under acidic conditions. Thus, it is required first to implement pH monitoring and, where necessary, treatment of soil.

The pH of the soil must be monitored and, where necessary, treatment of the gunshot-impact area must be applied to ensure that they have a pH of between 6.5 and 8.5 to minimise lead migration into soil and water. In this pH range, lead mobility is minimal, and the soil does not need to be treated in curative mode but can be treated in preventive mode. Knowing that the pH of a natural soil does not exceed 8.5, control by decreasing the pH is not necessary.

Compliance with those pH values shall be verified at least once every six months[4].

The pH can be increased by liming the soils, i.e. by adding lime, mainly composed of limestone. Limestone reduces acidity. Soil liming has the added benefit of increasing soil stability. The frequency of liming will depend mainly on the type of soil:

- For sandy soil: frequent, even annual inputs to limit leaching (carrying particles into depth).
- For clay soil: possible application every 5 years at most. It is important to avoid delaying these intakes for too long, a frequency of 2 to 3 years seems optimal.

[4] Point (c) of Entry 63 - Conditions for the application of the derogation in paragraph 25.

Liming can, via pH control, be very effective in reducing lead solubility and shifting the lead management problem from dissolved to particulate phases, which can be controlled more easily (see next sub clauses). Lime is readily available in all countries where soil acidity is an agricultural problem, inexpensive and easily applicable with standard farm equipment. Optimal use of limestone may require a mixture of powdered and crushed limestone in proportions determined by site conditions[5].

An alternative option to liming is phosphating. Lead phosphates are the most insoluble forms of lead in soils and can be rapidly formed in the presence of lead and available phosphate. Thus, the hydrogen phosphate ion HPO_4^{-2} gives with the Pb^{2+} ion a white precipitate of lead phosphate:

$$3\ Pb^{2+} + 4\ HPO_4^{-2} \rightarrow \underline{Pb_3(PO_4)_2}\downarrow + 2\ H_2PO_4$$

Commercially available, finely ground phosphate rocks have been used as phosphate fertilizers for years. Among the phosphate minerals, apatites [$Ca_5(PO_4)_3$] are by far the most abundant. Hydroxyapatite with the formula $Ca_{10}\ (PO_4)_6\ (OH)_2$ is effective in removing divalent metal ions such as lead and has previously been used for wastewater treatment. As with lime, optimal use of phosphates would require a mixture of powder and crushed rock in proportions determined by site-specific conditions.

The main conclusion is, managing the pH of the soil, no groundwater monitoring is required. This monitoring is not required for the application of the derogation in paragraph 25. The derogation concerns only surface water, as indicated in (b): "*containment, monitoring and, where necessary, treatment of drainage water (including surface water run-off) from gunshot-impact areas to ensure compliance with the environmental quality standard for lead specified under Directive 2000/60/EC*." The management of groundwater is described in the Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration.

The aim of environmental quality standards (EQS) is to achieve good surface water chemical status, not underground water chemical status.

3.2.2. Water collection

One of the problems sometimes encountered is when the soil can no longer absorb rainwater or melted snow, or when the soil is clayish, the excess water will run off the surface of the soil until it meets drainage channels to wash it away. Soil, soil slope and soil cover are important determinants of soil erosion. Topsoil can be lost and deep runoff channels created to transport lead out of the limits of the shooting range.

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[5] E.A. Engineering, Science, and Technology, Inc. - Lead Mobility at Shooting Ranges prepared for SAAMI, 5 January 1996, 50 pages.

The first step is the need for collecting water from the target area. For site with low water permeability, water can be collected from gunshot-impact area in a controlled manner with open ditches and underground drainage, and directed to collecting system and, if necessary, treatment. For site with high water permeability, collecting water from gunshot-impact area with open ditches is difficult, as the water is absorbed into the soil, excepted when rain fall is so intense you can have temporally flooding.

As already mentioned, the need for water management in these areas is assessed on a case-by-case basis. But in all cases, the collection of runoff water requires that a system has been constructed, allowing the water to be directed into a drainage system. The water is directed from the drainage system to collecting system and, if necessary, treatment in a controlled manner.

3.2.3. Water treatment by filtration

By promoting the penetration of runoff water into the soil, surface soil erosion and lead migration can be reduced. Vegetation can slow down flow and promote infiltration. However, the main concern must be to prevent the migration of lead into groundwater.

The filtration system could be a shallow depression and wide width, which promotes water storage and their infiltration. In dry weather, it is a totally accessible space. This system could be grassed and/or planted with trees, shrubs and humidity-tolerant perennials and drought (e.g., willows, helophytes, grasses...). The filtration system could also be a narrow depression with slopes marked. It facilitates the evacuation of water. His slopes do not allow the reception of cash tree. The collected water can be treated by filtration in a well. A well made from concrete rings and a prefabricated plastic well are examples of suitable treatment wells. All joints and pass-throughs must be built to be watertight.

All systems are designed with a screening system at the inlet to capture gunshots. For the purification method to be as effective as possible, the water should flow through crushed limestone of varying coarseness from the bottom to the top to increase the pH of the water flowing from them (reducing the mobility of the lead). The granular size of the crushed adsorption material is between 1 to 2 mm and its hydraulic conductivity is around 10^{-4} m/s to 10^{-5} m/s.

A water treatment containing sand, limestone or gravel, and incorporating a drainage pipe, can be particularly effective. It requires virtually no maintenance, but requires periodic removal of residues, contaminated sand or limescale renewal to ensure a permanent flow (minimal pressure drop). After filtration, the water can be discharged into the environment as surface water or absorbed into the soil, depending on the soil conditions in the area. The acceptable quality level of water discharged into the soil, or a body of water must be check for the assessment of the need for pollutant management at shooting ranges. The quality level of the discharged water should be in accordance with EQSs.

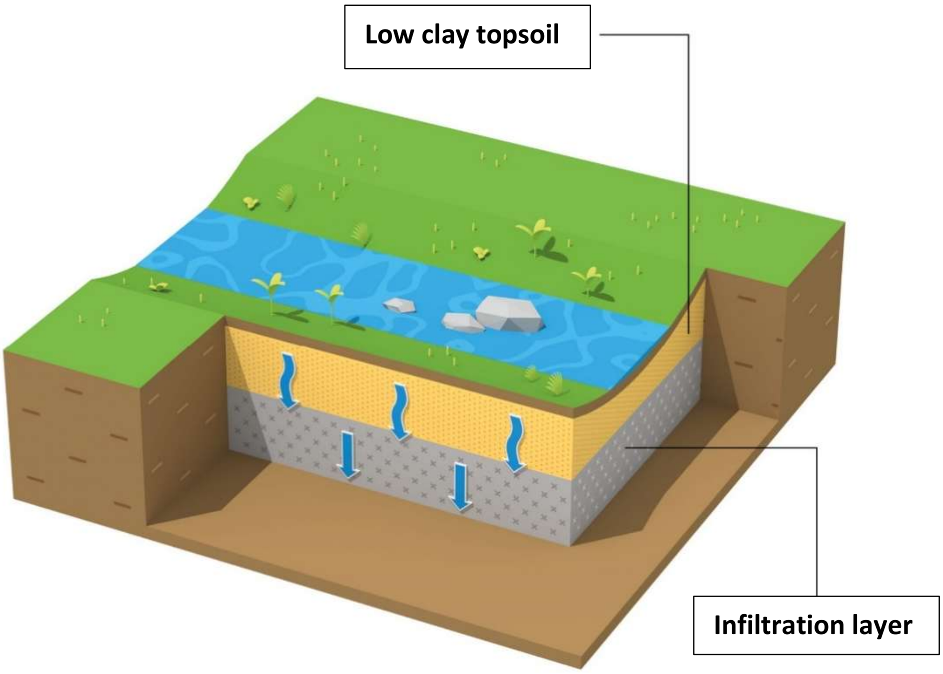

Figure 2 : infiltration system for runoff water management

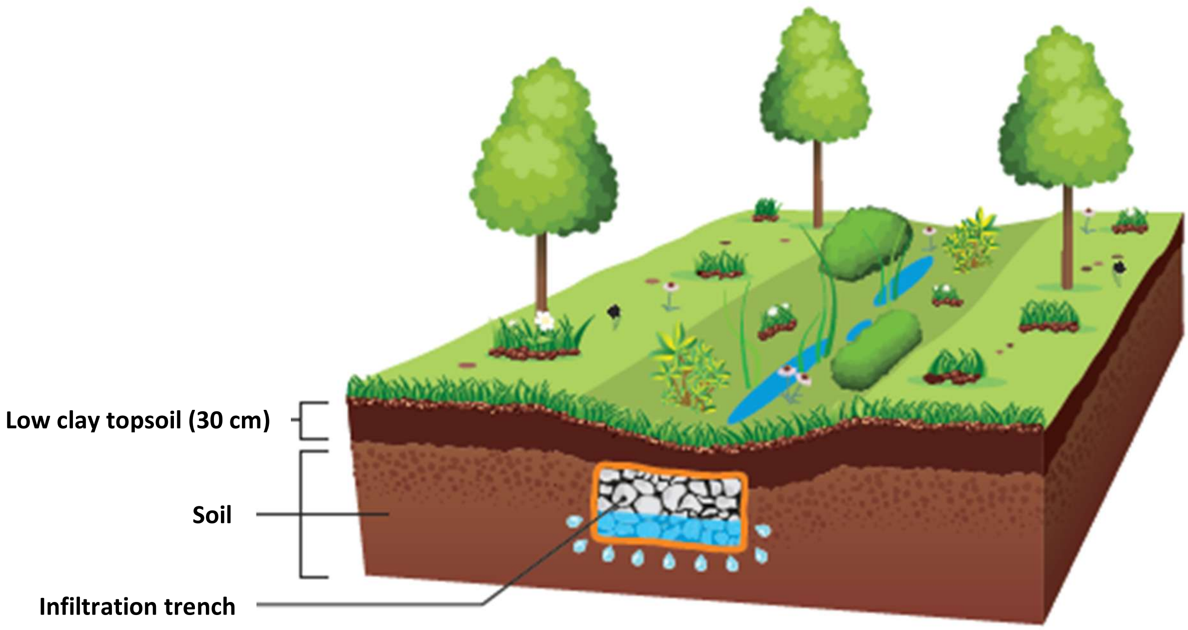

Figure 3 : combined infiltration systems for runoff water management

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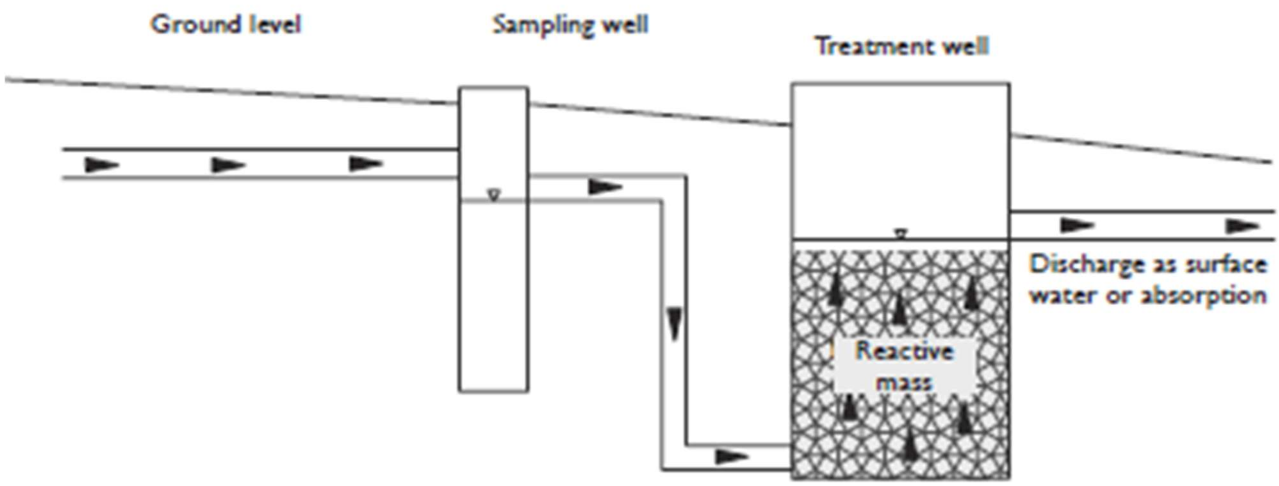

Figure 4 : Drawing in principle of a filtration well
(from Best Available Techniques (BAT) - Management of the Environmental Impact of Shooting Ranges – Ministry of Finnish environment 4/2014)

As a conclusion, filtration is well suited to the water treatment at shooting ranges. It is a good way to raise awareness about stormwater management. It is wildly used for the management of rainfall water in residential zone. The price to create such a site-specific system is affordable.

3.2.4. Water treatment by sedimentation

It has already been demonstrated that a significant amount of the migrating pollutant emissions in the surface waters from shooting ranges is bonded with fine matter. Their spread can be effectively limited by sedimentation.

After creating small trench that brings any runoff water collected to a pellet trap located just before the sedimentation, the system can be implemented in a well, basin or a system of ditches. A sedimentation system is a device designed to isolate solid particles carried with runoff water, allowing heavy particles to settle to the bottom under the effect of gravity, thus producing “purified” water. Treatment is carried out at least by settling, before evaporation and/or overflow or infiltration into the water table.

The operating principle is simple: runoff water is accumulating in the basin (could also be a buried plastic tank or a two-part concrete ring well), then slowly evacuated using a drain or overflow, the solid phase (earth + lead particles) is thus retained according to the principle of settling, which implies that the bottom of the basin is watertight. A basin can also be built directly in the channel of a ditch, with crushed limestone of varying coarseness, to increase the pH of the water flowing from them (reducing the mobility of the lead) to settle the suspended fine matter.

The settling basin must be located at a lower point of the site, to ensure that the whole system works by gravity. It is therefore necessary to check the altimetry of connection, the correspondence between the water supply of the outlet and the receiving environment (public network, hydraulic superficial environment, etc.). It is strongly advised not to install lift pumps for runoff water management that require maintenance.

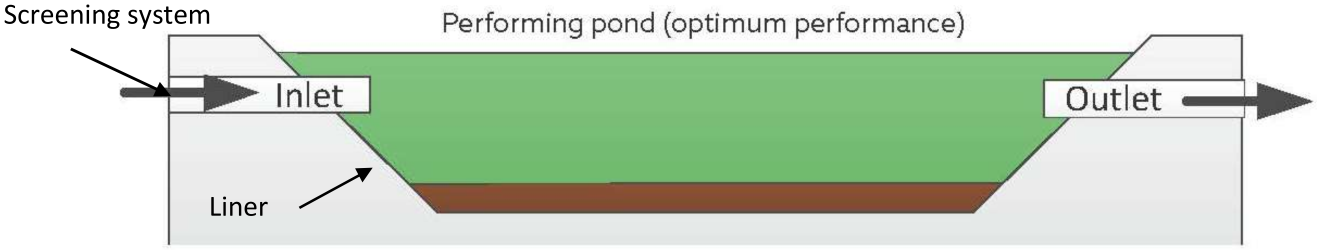

Figure 5 : settling basin for runoff water management

The upstream rainwater collection and the recharge of the basin are carried out by a "screening" system, floating traps, and a protection to prevent any intrusion into the pipes. Periodic cleaning of the concentrated lead deposit and its disposal in licensed facilities may be required. In addition, it will be necessary to ensure that the lead content of the effluent does not exceed the legal limits. The quality level of the discharged water should be in accordance with EQSs.

Settling basin is wildly used, for example stormwater treatment is an important environmental issue for motorways. During rainy episodes, water runs off the motorway in abundance. Therefore, rainwater collection systems channel it to dedicated basins. They have two main functions: to prevent flooding of motorway downstream and to clean up the water that falls on the tracks. The settling basins store water and gradually return it to the natural environment. Water can be loaded with hydrocarbons, brake particles or heavy metals from the guardrails. These elements will be trapped inside the basin.

As a conclusion, sedimentation is also well suited to the water treatment at shooting ranges. It is also a good way to raise awareness about stormwater management. The price to create such a site-specific system is acceptable.

3.3. Conclusion

Water management at a shooting range means the minimisation of the amount of water getting into contact with pollutants, the controlled collection of water with pollutant content, and its redirection into monitoring and, if necessary, treatment.

First step is to control the pH of the soil of the gunshot-impact area. The pH of the soil must be controlled and, where necessary, treatment of the gunshot-impact area must be applied to ensure that the pH of the soil is between 6.5 and 8.5, to minimise lead migration into soil and water.

Second step is to determine the volume of stormwater that needs to be stored to size the treatment system. The method used is "the rainfall method": choice of rainfall event as reference, determination of the leakage rate, and calculation of the volume of water to be stored for a discharge. This sizing must be made by a specialist.

Third step is to choose the water treatment system. The principle is that, depending on the conditions of the area (site-specific), water from the gunshot-impact area is directed via open or underground drains into a sedimentation or infiltration water treatment system.

Implementing containment measures, such as particle traps or filtration systems, is easy to do to intercept pollutants before they spread. Thus, the easy way to fulfil EU demand for the application of the derogation in paragraph 25 is:

1. Check the pH of the soil of the gunshot-impact area. If pH is between 6.5 and 8.5, nothing to do. If pH is below 6.5, liming or phosphating of soil is required.
2. Find the lower point of the site, downstream of the gunshot-impact area. Collect runoff waters to one and unique outlet. Install the containment measure (filtration or sedimentation water treatment) with the characteristics given above.
3. From one time per year to one time each 5 years, maintain the system and check the pH of water before water discharge in the environment. The quality level of the discharged water should be in accordance with EQSs.

Sedimentation and filtration are well suited to the water treatment at shooting ranges. Of course, the replacement interval of the filtration mass depends on the quality of the percolating water and on the site-specific conditions. And of course, the final price depends on the depth of the well, of the basin, the length of the pipelines, and the materials chosen. But in all cases, the price to create such a system is affordable.

4. Runoff water treatment for shooting ranges

4.1. Introduction

Short study of the different shooting ranges over the world shown 90% are with a low slope, and 10% have a steeper slope. Knowing even more that other studies have shown water treatment by filtration is most effective to prevent release of dissolved and particle heavy metals. The treatment of runoff waters by filtration offers several advantages over sedimentation, particularly in the context of a shotgun range, where runoff may contain heavy metal residues (lead, copper, antimony).

1. Better Pollutant Retention

- Filtration: effectively captures fine particles and dissolved pollutants (heavy metals, gunpowder residues, hydrocarbons).
- Sedimentation: primarily effective for coarse particles, less efficient at removing dissolved pollutants.

2. Reduced Risk of Pollutant Release

- Filtration: filter media (sand, activated carbon, zeolites) trap pollutants and limit their re-release into the environment.
- Sedimentation: deposited particles may be resuspended during heavy rainfall or if maintenance is inadequate.

3. Long-Term Efficiency

- Filtration: can be customized with specific filter materials to target certain pollutants (e.g., calcareous material to lower lead mobility).
- Sedimentation: requires frequent sludge removal and may lose effectiveness if not properly maintained.

4. Smaller Footprint

- Filtration: can be implemented in compact filter units, reducing space requirements.
- Sedimentation: requires large settling basins to ensure sufficient retention time.

5. Better Protection of Receiving Environments

- Filtration: improves water quality before discharge, minimizing soil and groundwater contamination.
- Sedimentation: may allow dissolved pollutants to pass through, leading to long-term environmental accumulation.

As a conclusion, at a shooting range, where heavy metal contamination is a major concern, filtration treatment is more effective than sedimentation. It provides better retention of fine particles and dissolved pollutants while reducing the risk of pollutant release into the environment. Therefore, the following proposals are made for runoff water treatment at shooting ranges.

4.2. Shooting ranges with low slope

Our proposed solution is to install a drainage system, perpendicular to the general direction of surface water flow, in the gunshot-impact area. The following figure illustrates the concept. The final design of the drainage system is site-specific, and more specifically weather specific. The drainage system must consider rainfall to determine the number of collection ditches and the frequency of rainfall and thunderstorms to size the depth and width of the ditches.

The ditches will be built as follows:

1. A trench will be dug. But the filtration system first requires an estimate of the maximum water flow from the gunshot-impact area to determine the width and depth of the trench. The dimension must be well determined to since the contact time between the adsorptive material in the filtration trench and the water flowing into the trench must be at least several minutes, may be more (site-specific conditions).
2. The trench is then filled with limestone of medium size. The purpose of this layer of limestone is to increase the pH of the water from neutral to basic, thus causing the precipitation of dissolved lead in the lead carbonate water, and water-soluble metals become tightly bonded to it.

   The thickness of the layer of adsorptive calcareous material in the filter must be no less than 0.4 m but no more than 1.0 m. If the adsorptive material layer is too thin, it may reduce the effectiveness of the water purification, and if the layer is too thick, it may reduce the water permeability of the filtration trench.

Note that depending on the dissolved lead concentration in runoff water, the adsorptive material should be other than limestone. For example, it could be ferric hydroxide pellets suitable for lead and other metals removal.

3. Above this layer of crushed limestone, sand will be poured. The water directed into the filtration trench must contain as little solid material as possible, as it may clog the filter and significantly reduce its service life. For this reason, we suggest protecting the top surface of the trench with a sand layer at least 30 cm deep.

   The sand will allow rainwater to infiltrate to the dissolved lead neutralization zone while serving as a retention for lead beads and other particles that will be carried away by runoff water.

Figure 6 : conceptual design of runoff water filtration for shooting range with low slop

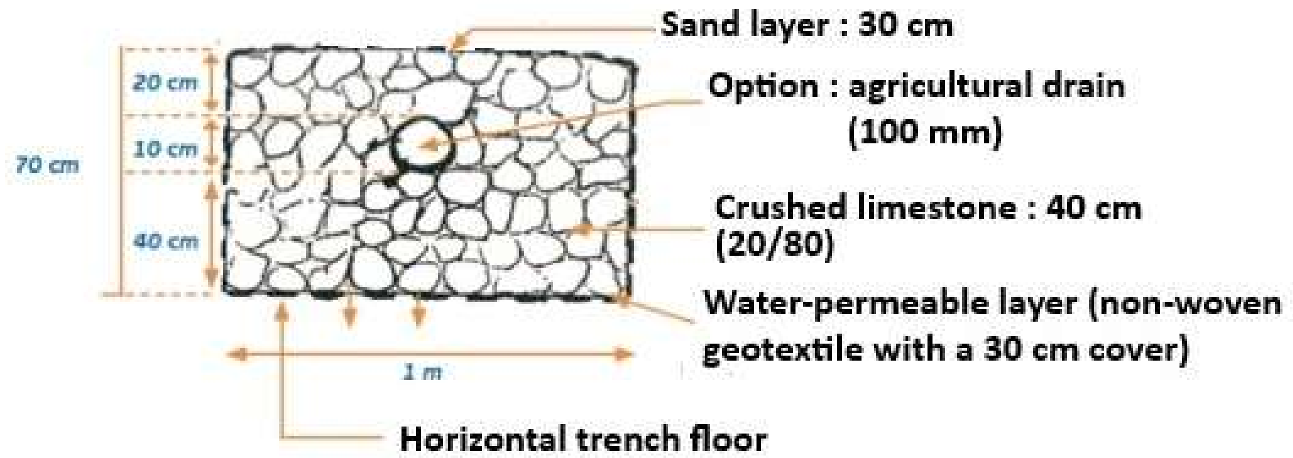

Figure 7 : conceptual design of a filtration trench

4.3. Shooting range with steeper slope

The difference between the two cases is only the slope. For low slope, runoff water will move slowly while for steeper slope, the runoff water flows faster and could accumulate at the low point of the site. Also, a drainage system such as the one presented above will be ineffective, the water will run off the sand of the trenches, very little will percolate this sand: potentially contaminated water and lead particle will not be captured.

And so, to solve the question, it is necessary to put a single trench at the low point of the site, directly downstream of the gunshot-impact area. As before, the design will be the same, namely a non-woven geotextile, an adsorbent material such as crushed limestone and a layer of sand, with or without agricultural drain.

And as mentioned previously, the size of this unique filtration trench is site-specific and weather specific. The drainage system must consider rainfall to size the depth and width of the filtration system. The surface area of the filtration system must be large enough for the desired flow and the hydraulic conductivity must be the average between a low value to promote infiltration and a higher value to increase the water-solid draining contact time.

4.4. Conclusion

The infiltration runoff water treatment for sport shooting ranges depends only on two major factors: the slope of the gunshot-impact area and the weather (quantity and frequence of rainfall). Of course, as previously mentioned, it is first required to check the pH of the soils in gunshot-impact area and adjust it, if necessary (6.5 - 8 pH units). And to facilitate infiltration of runoff water, it is recommended to vegetate the area, with grass for example.

Once the two main parameters have been mastered, the design of the runoff water treatment system by infiltration can be designed and implemented. The cost comprises the preparation of the plan, its implementation and maintenance. Maintenance is an important aspect.

The maintenance need depends to a great degree on the amount of solids amassed in the gunshot-impact area. The larger the amount of amassed solids, the more often the water treatment system needs to be dredged. A recommended basic principle is to regularly empty the trenches by dredging every 2 to 5 years. It may be necessary to dredge the gunshot-impact area more extensively at intervals of around ten years, removing limestone to put "fresh" one.

The migration of pollutants from the gunshot-impact area subjected to pollutant load into the soil and further into the groundwater can be managed through runoff water treatment. For sport shooting ranges, the proposed method is based on infiltration after capture of solid particles and precipitation/adsorption of the dissolved lead. To ensure the effectiveness of the system, an initial study on rainfall must be done, knowing the slope of the gunshot-impact area, to design the system.

The final cost to implement the runoff water treatment is affordable and depends on site-specific conditions.

Technical note, written at Berneuil-en-Bray, 21 March 2025.

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