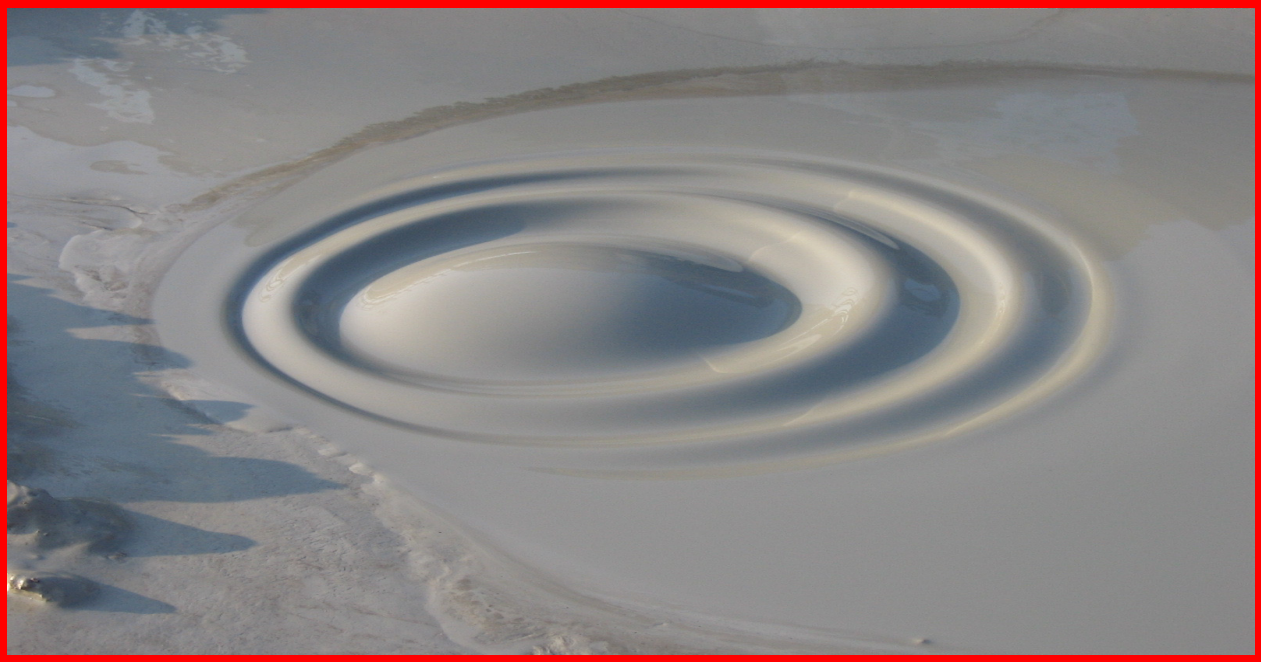
DCA Technical Information No. 4

Recovery and disposal of drilling cuttings and fluids from HDD operations

Current legislation and recommended procedures

November 2019



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Foreword

In recent years the “recovery and disposal of drilling cuttings and fluids from horizontal directional drillings” has become more and more complex throughout Europe. In Germany the HDD industry faced serious problems, when in 2015 the federal state Lower-Saxony passed a decree stating very clearly that cuttings and drilling muds will be classify as waste and they would be subject to Germany's Federal Circular Economy Act.

Other federal states, for instance, Baden-Württemberg, have meanwhile followed this initiative. Cuttings and drilling mud are hence to be recovered and disposed properly and safely as mineral waste. According to the current legal opinion, cuttings or drilling mud from horizontal directional drillings may only be disposed on agricultural land, as was common practice on many locations and projects in the past, if certain exceptional preconditions are fulfilled (the decree by Baden-Württemberg goes as far as to categorically ban it). It should be noted that the Lower-Saxon decree does not produce any new legislation but repeats and clarifies legislation already in force.

The consequences of the decree for the HDD industry are:

- Immediate uncertainty with respect to the legally compliant recovery and disposal of cuttings and drilling fluid;
- Great uncertainty with respect to the calculation of recovery costs, given that the definite point of disposal / recovery may usually be determined only after specific laboratory analyses;
- Increased waste treatment costs due to long transport routes and limited number of disposal locations;
- Creation of “regional or company-specific local solutions” instead of global ones.

It was against this backdrop that the DCA founded Task Group 1: Disposal of Cuttings and Drilling Mud from Horizontal Directional Drillings in the spring of 2016. The aim was to study the challenges for the industry with regard to the recovery and disposal of cuttings and drilling mud arising from the decree and to develop suitable recommendations for action or universal guidelines / minimum standards.

The task group was composed of representatives of drilling companies, clients, manufacturers of machinery, recycling experts and consultancy firms – as it is relevant to the entire HDD industry that the progress:

- remains economically viable;
- remains environmentally friendly;
- can meet all legal requirements; and
- is feasible and calculable.

Furthermore, fair conditions of competition must be ensured, and contractual responsibilities clarified.

The task group has met regularly since it was set up. It primarily worked on the following topics:

- Examination and interpretation of the NMU decree;
- Identification of the state of play in waste treatment;
- Familiarisation with existing waste legislation;
- Considerations about waste reduction and savings potential;
- Establishment of possible recovery and disposal routes for cuttings and drilling mud.

In addition, talks were held with ministries (Lower-Saxon environment and economics ministries), associations etc. to discuss proposed waste treatment solutions and the related legal requirements.

The task group also reviewed a study by Dr R. Kögler from Uplengen of November 2016 on the handling of drilling mud and cuttings from horizontal directional drillings. The study was commissioned by Dekena Bohrtechnik GmbH from Stedesdorf, EWE Netz GmbH Oldenburg, the company Graalmann GmbH from Westoverledingen, the Oldenburg-East Frisian water association Brake and Schulte-Perk GmbH from Saterland-Strücklingen. The study's results and preliminary recommendations were discussed by the task group and served as a source of inspiration for its work on the topic.

Most of the following accounts apply to the German national judicial area, which however is based on European legislation. Therefore, general information, process explanations and most of the recommendations should easily be derived and transferred to European HDD business.

The following report points out the most important facts about waste legislation that need to be taken into account. It includes comments on the responsibilities of the project partners, information on sampling and transportation, indications on possible and legally compliant recovery and disposal routes as well as recommendations on organisational and contractual waste treatment provisions both contractors and clients.

Aachen, November 2019.

Drilling Contractors Association – DCA Europe

Inhaltsverzeichnis:

1 Key facts about waste legislation and the initial legal situation regarding the recovery and disposal of cuttings and drilling fluid

1.1 Waste law

“Waste law” is defined as the entirety of all legal rules regulating the management, transport, recovery and disposal and any other handling of waste matter.

At European level, the primary piece of legislation in the area of waste management is the Waste Framework Directive (Directive 2008/98/EC). It outlines basic concepts as well as legal criteria regarding waste management. The German Act to Promote Circular Economy and Safeguard the Environmentally Compatible Management of Waste, or Circular Economy Act (KrWG), is based largely on the EU directive.

The Circular Economy Act is complemented and specified by a series of secondary legislations, e.g.:

- Ordinance on the European Waste Catalogue (AVV)
- Ordinance on the Documentary Evidence of Recycling and Disposal (NachwV)
- Landfill Ordinance (DepV)
- Ordinance on Supplementing Building Materials (AbfKlärV)
- Substitute Building Material Ordinance
- Ordinance on Bio-Wastes (BioAbfV)
- Regional Waste Study Group (LAGA M20 – 2004)

It should be noted that the LAGA M20 alone has no legal authority, but can regulate, for instance, by decree or disposition.

Germany's federal states can pass more specific rules and regulations in the form of state laws and ordinances or state-specific decrees or by the municipal governments.

There are also overlaps with other legal fields, above all soil protection law, which is regulated mainly by the Federal Soil Protection Act and the Federal Soil Protection and Contaminated Sites Ordinance. An amendment to the Federal Soil Protection Act and a related harmonisation with waste law in the form of what is called a “framework ordinance” are currently being prepared.

1.2 The concept of waste

In accordance with Section 3 (1) of the Circular Economy Act, all substances or objects that are only a by-product of a production process and which the holder discards, intends or is required to discard are defined as waste. Furthermore, a distinction is made between waste that is recovered and waste for disposal.

Exempt from waste law under Circular Economy Act are by-products that are produced in the manufacture of another substance or product and meet the following criteria:

- Further use of the substance (at the place of its production) needs to be certain
- No pre-processing other than normal industrial practice is necessary for this,
- The substance is produced as an integral part of the production process; and
- Further use is lawful (the substance or object fulfils all relevant product, environmental and health-protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts)

A substance ceases to be waste if it meets the following criteria under Section 5 of the Circular Economy Act:

- It will undergo a recovery operation;
- It will be commonly used for a specific purpose;
- A market or demand exists for it;
- It fulfils certain technical and legal requirements;
- Its use is safe for the general public and the environment.

1.3 Waste management

With regard to waste management, Section 6 of the Circular Economy Act proposes the following hierarchy of waste management activities:

1. Prevention;
2. Preparing for re-use,
3. Recycling,
4. Other use, especially recovery and backfilling operations,
5. Disposal

Based on this hierarchy, the waste management measure should take priority that best guarantees the protection of human health and the environment.

1.4 Assessment of drilling fluid and cuttings under waste law

The decrees by the Lower-Saxon Ministry for the Environment, Energy and Climate Protection (NMU) of 7 August 2015 and 29 August 2016 clarifiy that drilling mud and cuttings classify as (mineral) waste under the Circular Economy Act, because they were not the intendend final product of a production process and their holder intends to discard them. Other German federal states, for instance, Baden-Württemberg, agree with this assessment.

The following waste codes shall be used in accordance with the German Ordinance on the European Waste Catalogue (AVV) (see also European List of Waste (LoW)):

• AVV 01 05 04	Freshwater drilling muds and wastes
• AVV 01 05 06*	Drilling muds and other drilling wastes containing hazardous substances
• AVV 01 05 08	Chloride-containing drilling muds and wastes
• AVV 01 05 99	Wastes not otherwise specified

2 Legal basis for the responsibilities of those involved in the project, sampling and the transport of drilling mud and cuttings

2.1 Responsibility for waste products

Under the Circular Economy Act (Section 7(2)), producers and holders of waste are obliged to recover and dispose of their mineral wastes properly and safely. Both parties are liable, if they fail to meet their obligation of proper waste management could have fines or even prosecution imposed upon them.

Waste producers are original producers (any natural or legal person whose activities produce waste, i.e., in construction projects usually the client) and secondary waste producers (any natural or legal person who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of such waste). A waste holder is defined as any natural or legal person who has physical control over such waste (in construction projects usually the company executing the project).

As a waste producer, the client is obliged to recover and dispose of mineral waste properly and safely. This obligation ceases only after the recovery or disposal is completed. The contractor is also obliged to ensure proper and safe recovery and disposal. Client and contractor can both be held legally liable for failing to meet their recovery or disposal obligations.

Producers and holders of waste may commission third parties to fulfill their obligations. The commissioned third parties must provide the necessary documentation (e.g. certified waste management certificates). Such commissioning shall not affect the responsibility of the waste producer for fulfilment of the relevant obligations until the recovery or disposal is finally and properly completed. Physical control over such waste and hence the status of waste holder may be transferred from one company (e.g. a HDD company) to another entity (e.g. a waste management company) during the period of a construction project.

2.2 Sampling of the used drilling fluid

The used drilling fluid consists of solid and fluid components. With regard to regulations on representative sampling, the Landfill Ordinance (DepV) and Part III of the 20th notification of the Regional Waste Study Group, LAGA M20, (sample taking and analytics) refer to the guideline LAGA PN 98. This guideline also recommends taking samples from moving waste streams.

Given that LAGA PN 98 is explicitly designed for solid and compact wastes, it may only be used as an indication when sampling unconditioned drilling mud.

This means that an assessment of the solid components, or rather the cuttings, in accordance with LAGA M20 is possible. There are no suitable guidelines on the sampling and classification of the liquid phase of the drilling fluid. LAGA M20 is therefore only used as a reference. On this basis, the results of the sampling should be examined individually.

2.3 Transport of used drilling mud / cuttings

As previously mentioned, when transporting drilling fluids and cuttings off site, the used material will be classified as waste.

A distinction is made between commercial and non-commerical transportation of waste. Commercial transportation is defined as the transportation of waste in the context of economic enterprises and as a permanent activity that is carried out with the purpose of generating income. Waste transportation qualifies as non-commercial if the main purpose of the activity is not the collection, transport, trading or dealing in waste, but the transportation of waste for other purposes. This may be the case of HDD companies transport used drilling mud or cuttings themselves.

In accordance with the Circular Economy Act, non-hazardous and hazardous wastes may only be transported by Certified Waste Management Companies (Entsorgungsfachbetriebe) or transportation companies which have the necessary reliability, knowledge and expertise. The criteria for the reliability are essentially regulated by the Ordinance on the Notification and Permission Procedure for Waste Collectors, Transporters, Brokers and Dealers (AbfAEV). The implementation of the criteria is monitored by technical supervisory organisations in accordance with Section 56(5) of the Circular Economy Act or a Community of Certified Waste Management Companies recognised in accordance with Section 56(6) of the Circular Economy Act.

In general, all commercial waste transports must be properly marked (with two reflective, white panels or “A signs”).

Transboundary (across-state-border) movements of waste are governed by Regulation (EC) No 1013/2006 on Shipments of Waste. Depending on the destined operation (disposal / recovery), the classification of waste in accordance with the waste lists under the regulation and depending on rules and regulations in the states involved, the transboundary movement of wastes is subject either to general information requirements or to a notification procedure.

Notification is required for shipments within the European Union of hazardous wastes and wastes destined for disposal. During the notification procedure, an approval for the intended transport must be requested from the competent authorities. The transboundary movement may only be carried out, if all authorities approve.

2.4 Information on criteria for waste acceptance at landfills and waste water treatment plants

Compact wastes with an organic matter content of < 5 % wt% may be disposed of at any certified landfill site. However, they must respect the allocation values of the respective landfill site class, defined in the annex of the German Landfill Ordinance (DepV).

There are five classes of landfills:

- DK 0 – Landfill for inert waste (mineral wastes with low-levels of pollution);
- DK I – Landfill for non-hazardous waste (with very low levels of organic components);
- DK II – Landfill for non-hazardous waste (with low levels of organic components);
- DK III – Landfill for hazardous waste;
- Underground storage.

Investigations into the disposal of the liquid phase of the used drilling mud, or rather, the residual water (i.e., product after additional centrifugal treatment) at waste water treatment plants after the recycling process have shown that there is no universal legal provision or regulation. Any landfill site may decide individually whether they accept drilling mud or residual water and which criteria and parameter need to be met on the basis of their specific assessment and operating conditions.

3 Description of possible recovery and disposal routes and difficulties with practical implementation

3.1 Formal recovery procedure

As noted above, waste has to be treated (i.e. recovered or disposed of) properly and safely. Recovery is deemed to take place properly, if it is performed in compliance with existing provisions of public law. The recovery of waste is deemed to take place safely, if no impairment of the public interest is expected, no accumulation of harmful substances occurs within the substance cycle and if there are no adverse effects on an interest that is eligible for protection (human health, soil or ground water) are expected.

Generally, three testing stages have to be passed through when recovering drilling mud or cuttings:

1. Functional and formal assessment of the recovery. The recovery measure, i.e., the application or use of drilling fluid or cuttings as installation material, has to be necessary and other materials have to be thereby replaced as installation material. Regulatory planning and application requirements need to be met by the recovery.

2. Assessment of the functional suitability of the waste. The drilling fluid to be used and the cuttings need to have the characteristics required for recovery in terms of building physics (e.g. shear strength, frost resistance). When waste is recovered as soil-like material, it needs to be ensured that the natural soil functions (e.g. water retention capacity, soil aeration) are maintained or improved.
3. Assessment of the waste safety. It needs to be ensured that the recovery of waste does not have adverse effects on an interest that is eligible for protection, for example, because of increased levels of pollutants.

3.2 Previous practice of soil-like application

The long-established practice of spreading used drilling muds on agricultural land and the use of cuttings for backfilling do usually not constitute, as was clarified by the aforementioned decree by the Lower-Saxon Environment Ministry, proper disposal in accordance with Section 3 (22) of the Circular Economy Act.
Yet, soil-like recovery (e.g. backfillng of excavated material, creation of a layer of rooted soil) is still generally, i.e. theoreticall, possible. When applied to rooted soil, proof must be provided beforehand that the necessary measures and the soil functions listed in Germany's Soil Protection Act will be substantially improved or maintained. Additionally, the levels of pollutants in the material must not exceed the precautionary levels under the Soil Protection Act.

Spreading or backfilling drilling mud and cuttings in cropped soil has to be previously cleared with the competent soil protection authority in each individual case.

When recovering waste by backfilling excavations or in landscapes away from built structures, proof must be provided that the material fulfils the function of the natural subsoil and is suitable in terms of building physics. The requirements with regard to pollutant levels are set out individually by each federal German state (in Lower Saxony and Bremen, for instance, meeting the requirements of a material class for backfilling and installation LAGA Z0 or Z0*).

Given that the aforementioned case-specific evidence is extremely difficult to obtain and that the costs and efforts for obtaining such evidence are disproportionately high and the process is impossible to complete in a timely manner, a soil-like recovery of drilling mud and cuttings should generally be avoided in horizontal directional drillings as a disposal route in accordance with of the Soil Protection Act.

Recovering drilling mud and cuttings by using them as fertilisers is currently not possible under German fertiliser legislation either, because drilling muds and cuttings do neither qualify as technical fertilisers, soil improvers, culture mediums, nor plant additives and wastes must generally not be used as fertiliser. As a result, alternative recovery and disposal routes have to be sought for both for drilling muds and cuttings.

3.3 Outline of recovery methods in relation to the waste hierarchy

As described in section 2, the Ciricular Economy Act stipulates that the following hierarchy has to be applied to waste management:

Prevention ► Re-use ► Recyclling ► Disposal

The following sub-sections lay out the specific options and framework conditions for implementing each hierarchy level in horizontal directional drillings.

3.3.1 Prevention

Given that the use of drilling fluid and the production of cuttings are an integral part of any horizontal drilling process, measures can only be taken to minimise waste, not to prevent it.

During the design and engineering phase of the works waste reduction can be achieved by

- Shortening the drilling length;
- Reducing the pipe diameter as far as the intended use allows.

Of course, potential implications of these changes need to be taken into account. Reducing the drilling length, for instance, could mean that the missing segment has to be layed utalising another construction method, which might have similar or even more far-reaching ecological and economic consequences.

Applied during the detailed engineering and execution phase, the following measures may lead to a reduction in the recovery volume of drilling mud and cuttings:

- Determination of the borehole diameter on the basis of a minimum overcut required for the drilling;
- Keeping the mud factor (ratio of required mud volume to excavated soil volume) as small as possible when determining the pump rate and drilling speed in order to trasport as much solid material while using as little drilling mud as possible;
- Limiting the maximum pump rate and avoiding pumping phases without or with a reduced penetration rate in order to prevent washout of the borehole.

More importantly, however, the drilling plan needs to be adjusted to the parameters required for the drilling. Conflicting waste reduction measures could compromise the successful execution of the drill and / or entail other ecological or economic repercussions, e.g. mud break-outs at the surface area, drying out of the borehole.

3.3.2 Re-use / recovery after reconditioning

Re-use / recovery may be understood as the reconditioning of the drilling mud and cuttings. The reclycled drilling mud may then be re-used as an additive either in the same or another drilling project.

The separated cuttings are usually recovered as substitute bulding materials directly or after treatment by a certified waste management company.

Recycling units for HDD drilling fluids are complex devices with different separation stages for varying sizes of material. In order to be universally applyable to different geologies, the output rate needs to be sufficient even if not all separation stages are equally applied. There are three possible ways to operate a recycling unit.

a) Temporarily directly at the borehole

This option is a standard procedure for what is called large-scale drills. When the drilling project has a certain scope, operating a recycling unit at the borehole becomes indispensable, for economic reasons alone. The following comparison, however, shows that using recycling units is not technically and economically viable in all HDD projects.

Favourable aspects:

- The re-use leads to a reduction of the total waste recovery volume and the need for fresh drilling fluid (water, bentonite and possibly other additives). The larger the dimension of the project (borehole volume and required drilling fluid volume), the more beneficial the use of a recycling unit.

Unfavourable aspects:

- A larger site installation area is required to include a recycling unit;
- In operation, a recycling unit needs to be adjusted to match the specific geology, for instance, by testing different sieves on the shakers, before it can operate efficiently. 'Efficient' means that the unit has sufficient capacity to achieve the mud rate required for the drilling process (remaining sand content < 0.5–1 %) while generating separated cuttings that are dry enough to allow proper disposal. The smaller the drilling dimension (borehole volume and required drilling fluid volume), the more likely that level of efficiency is not achieved or achieved too late;
- Two, possibly different, recovery and disposal routes need to be worked out for the remaining mud and the separated cuttings after the drill is completed;
- Suction vehicles or temporary pump lines are necessary to transfer the mud exiting at the pipe site into the recycling unit which is located at the rig site;
- Greater manpower and logistical efforts are required for transporting, setting-up / dismantling and operating a recycling unit.

b) Temporarily at a central place within the construction site

This option is useful when a number of smaller drillings need to be executed at a similar time and place and if a temporary recycling directly at the borehole would require excessive efforts.

Other favourable aspects:

- Aggregation of several separate drills where recycling at the borehole would be inefficient into one efficient central recycling operation.

Other unfavourable aspects:

- Extensive efforts to tansport the mud from the borehole to the recycling unit and the reconditioned mud from the recycling unit back to the drilling rig.
- Mixing the drilling fluids from different drills with different geologies may compromise the efficiency of the recycling unit or the re-usability of the reconditioned mud.

c) Permanently on site

A stationary recycling unit may be operated, for instance, on premises of the HDD company. The profitable operation of such a unit can be achieved, if a certain number of drilling rigs operate more or less regularly in the nearer vicinity and the capacity of the recycling unit is utilised.

Other favourable aspects:

- Using permanently installed or existing infrastructure (e.g. connection to power supply, access roads, approved interim storage facilities, operating and maintenance staff) can help achieve regular and cost-effective operation.

Other unfavourable aspects:

- Operating a permanent recycling unit requires an authorisation under the Federal Immission Control Act (BImSchG);
- The capacity of the unit must be permanently utilised.

► The feasibility and economic viability of operating a recycling unit depends largely on the project specifics and is not easily predictable. Operating a central recycling unit may be economically viable only when separating the recycling and disposal routes of cuttings and drilling mud, and when re-using the reconditioned drilling mud is not possible due to insufficient quality and / or due to excessive transportation and reconditioning costs.

► The scope of works which the assessment of the economic viability should be based on is determined by the planned borehole volume (number of drills starting from the same drilling site, borehole diameter, borehole length) and the geological conditions. Rock drillings, for instance, require high pump rates at relatively low rates of penetration, so that a huge mud volume is required. In conclusion, it can only be said that for economic reasons the scope of works in large-scale drilling projects (i.e., using rigs with a pulling force of more than 40 t) generally requires the use of recycling units.

3.3.3 The use of centrifuges

In addition to using a recyclling unit, which separates the drilling fluid from cuttings it has picked up from the subsoil up to a size of > 20 µm, a centrifuge may be applied, in order to be able to separate even smaller grain particles. This may be necessary when drilling in very cohesive / clayey grounds, in order to be able to re-use the drilling fluid after reconditioning.
Otherwise the drilling fluid will become increasingly thicker (increase in density). Furthermore, a centrifuge is usually required as an important part of a recycling unit, if it is used at smaller rigs (approx. < 30 t pull force). The high-pressure pumps of those drill rigs are much less resistant to wear and require the remaining sand content to be significantly <0,5%, which can only be achieved with centrifuges.
When applying an optional flocculation system ahead of the centrifuge, it is possible to separate even very fine particles and hence the bentonite from the drilling fluid by flocculation. What remains is residual water which contains no significant solid matter and might only, if at all, be turbid.

This separation method may raise the possibility of recovering the residual water in a local wastewater treatment plant, possibly even by discharging the water directly via sewage as to avoid road haulage. Discharging the water into water plants/ courses may also require approval.

It it not possible, however, to lay down universal criteria or parameter for the recovery of residual water that need to be met in order to be able to recover such water in waste water treatment plants. Every plant operates under different working conditions. This requires a case-by-case analysis on the basis of specific laboratory tests of the residual water. Both the recovery in waste water treatment plans and the discharge into water courses involve inspection and authorisation costs and related processing times all of which is usually only worthwhile for permanently operated recycling plants or long-term projects.

3.3.4 Recovery / disposal without recycling

Some recovery and disposal routes apart from land filling or the handover to certified waste management companies that might seem convenient at first often fail due to a lack of time to clear them with the competent authorities in time leading up to the project. Even when there would be enough time before works commence, it is still not possible because authorisations of recovery and disposal routes are usually granted on the basis of specific samples, which can only be taken during project execution.

The analysis of the sample(s) which is followed by a proposal of a recovery site suitable for the respective material and the consultations with the competent authorities before a decision is made may take several weeks. Especially for small-scale drillings with execution time is one to no more than a few days, this procedure is not workable. Furthermore, the cost of identifying and clarifying such recovery and disposal routes are out of all proportion to the actual drilling cost.

Therefore, for a great number of small-scale drillings, the only time and cost-effective option is to recover the drilling fluid directly (without reconditioning) via certified waste management companies. There are different types of direct recovery that certified waste management companies on the market offer:

- Acceptance with declaration anaylsis
  Some waste management companies may only accept waste upon presentation of a declaration analysis. In that case, the waste has to be kept and collected (i.e., in sufficiently large pits, reservoirs or containers) on site until the analysis result becomes available – a task that shoud not be underestimated. While the waste is stored, the reservoirs, containers etc. have to be mainained in accordance with safety regulations.

- Acceptance without declaration analysis
  Other waste management companies may accept waste without prior declaration analysis under the precondition that an organoleptic test at the borehole shows no irregularities. The declaration analysis is carried out or commissioned by the certified waste management company after waste acceptance. One major advantage is that the waste can directly be transported off site without being initially collected and stored on site.

4 Conclusion

As the above remarks suggests, there is unfortunately no recommendable, ideal approach to handling used drilling fluid and cuttings that can be applied universally in every region. Recovery or disposal routes have to be examined on a case-by-case basis for each drilling project. The recovery options, the relative cost of determining a suitable recovery and disposal route, the eligibility for approval and finally the (financial) recovery costs dependent on:

- The location of the drilling site (federal state, municipality, competent authority / case officer);
- The total amount of waste matter (dimension of the drilling or number of drills within one construction project);
- The mass flow rate (volume or tonnage per day) which results from the penetration rate and which the certified waste management company has to be able to process;
- Possibly linking up with other construction projects in the same region;
- Information about and contact to local waste management companies and disposal points;
- Physicochemical properties of the waste matter (determined by subsoil, fluid components, mixing water and possibly dry matter content of the cuttings when using a recycling unit);
- The equipment, experience and philosophy of a HDD company with respect to the use of mud recycling units.

The great number and partial interdependence of those largely project-specific variables makes it very hard and sometimes even impossible for HDD companies to determine an equally workable, legally sound and even economically attractive disposal route in the time leading up to a drilling project and calculating the costs when preparing an offer. Only an HDD company based in the vicinity of a drilling project may have the possibilities to gain sufficient information about possible disposal routes through their existing networks and experience.

Furthermore, it needs to be pointed out that dealing with the subject of waste recovery and disposal today requires such complex expert knowledge and expertise in environmental and waste disposal technology that HDD companies usually do not have and probably cannot efficiently acquire and maintain. The competence of HDD companies lies in drilling technology and it should remain their priority of expertise in order to be able to guarantee safe and quality execution of drilling projects.

5 Recommendations for action

All recovery and disposal routes described in section 4 are applied in HDD construction projects today. Unfortunately, it must be pointed out that there are still a few contractors that illegally discharge drilling fluids on agricultural land. Sometimes clients are aware and remain silent. In general, both HDD companies and clients should have a common interest in:

a) Making sure that HDD projects are executed in line with all legal requirements. This also includes the recovery and disposal of drilling fluid and cuttings. As waste producer and waste holder respectively, both parties are responsible for proper recovery and disposal. Failure to comply may constitute a criminal offence and in some cases have severe consequences for those involved. Globally, such violations may tarnish the reputation of the HDD process which is actually an environmentally friendly procedure. The industry is hence underminding one of their primary selling points – not only at the expense of the contracted HDD companies, whose business heavily depends on it, but also at the expense of network operators, whose construction projects are often eligible for approval and economically viable only through HDD.

b) Keeping a reasonable balance between the costs for the recovery and disposal of mud and cuttings and the drilling costs. Excessive waste management costs will discourage the use of HDD in pipe laying projects and could in turn prevent an entire utility line project from being realised.

c) Ensuring fairness and transparency regarding the responsibility for determining the appropriate waste management route and for covering the costs. Assigning the responsbililty to either contractor or client unilaterally may create an uncalculable overburden on one of the parties which might be even further aggrevated by giving the other party incentives. Currently, some disposal operations are remunerated entirely based on efforts for which the respective operators must provide evidence. As a result, for instance, sometimes very small amounts of waste are being transported over very long distances to be disposed of, causing disproportionately high costs. This is at odds with the aforementioned principle b). On the other hand, unilateral responsibility may put such an immense economic pressure on the HDD company that they neglect the regularity of the recovery or disposal and might hence disregard principle a).

So how can these principles be put into practice? The main challenge results from the fact that a certain type and quantity of drilling fluid, both determined by the HDD company, that can be previously specified is mixed with the subsoil which is made availabe by the client and cannot be sufficiently specified beforehand has to be recovered and disposed of later.

For the HDD company this means that, without specific sampling (in situ) and laboratory tests, they can often not clarify and determine the disposal route beforehand. The effort it takes to assess several different disposal options for different scenarios is usually out of proportion for one project. Another problem might be a lack of cooperation and interest by the certified waste management companies given that they run the risk of ultimately being awarded a contract for only a small amount of waste. The client, on the other hand, has no or only limited influence on the amount of the used drilling fluid and its properties. Yet, the client has the possibility, for instance, to ask for the data sheets of the fluid products to approve them and make certain requirements (e.g. approval of products only upon presentation of a clearance certificate and classification in accordance with LAGA Z0 etc.). Usually a locally established pipeline operator with connections, the client has better access to and knowledge about local disposal points. Given that the client constantly or at least repeatedly commissions HDD works in their network area or on their pipelines, the client could combine amounts of wastes from different projects that are executed by different contractors and discuss and negotiate these combined amounts with the certified waste management companies.

By bringing waste together and creating bigger loads, the client strengthens their negotiating position. They attract a much greater interest by the waste management companies than several different HDD companies who ask for offers on small quantities during their calculating phases. As waste management companies have to set up and maintain appropriate storage containers or reservoirs at least for accepting drilling muds, some of them take no interest in individual requests. Collecting regulary produced amounts of waste throughout the year, however, will usually generate much stronger interest. Differential prices for different amounts per year would be a possibility to ease the burden of fixed costs.

After illustrating the advantages, a client has in the disposal process, the potential advantages and powers of intervention of the contractor / HDD company need to be examined. Apart from the composition of the fresh drilling fluid (perhaps taking into account requirements by the client, see above), the HDD company has significant control over the amounts. The pump volume, the number of reaming operations or the use of recycling technology, all have an influence on the quantities of drilling fluid applied and on the quantitiy of mud (and cuttings) to be recovered / disposed of. These parameters are generally all determined by the HDD company.

In the DCA's opinion, this provides a beneficial oppertunity to efficiently combine the aforementioned powers of intervention. We call it the "Danish model", as it is frequently applied in Denmark. The project developer names one or several waste management companies or disposal points with whom they have made agreements. The waste treatment fees are directly paid to the waste management companies by the project developer. The HDD company must include the costs for transporting the mud / cuttings from the construction site to the disposal point in the tender price. This procedure results in the following scenarios and advantages:

- With their planned projects in mind, the project developer may clarify the disposal routes for larger amounts of waste with enough time ahead and for a long-term perspective and conclude agreements with certified waste management companies.
- Given their high profile / reputation / company size, they are in a better position and have greater leverage in negotiations with the certified waste management companies than the HDD company.
- In the context of the planning permission, they have already had contact with the competent authorities and can clarify waste treatment questions with the authorities early on, if required.
- They can be certain and have control over proper, i.e., legally conform, waste treatment.
- As the HDD company will cancel handling and speculation charges and risk premiums, the project developer will benefit from lower drilling costs and better conditions offered by the certified waste management
  companies for bigger and more regular waste quantities.
- Being responsible for paying the transporting costs, the HDD company is keen to keep waste quantities low.
- To reduce the amounts of waste for transport and to minimise the necessary amounts of fresh fluid, the HDD company will assess in their own interest, whether the use of a recycling unit is beneficial, also by evaluating the economic efficiency for each project.
- By settling the recovery and disposal route beforehand, the HDD company can shift their focus on ensuring a safe, high-quality and swift execution of the drilling, concentrating on their core business.
- The tenders for HDD work by different contractors will become more comparable given that the aforementioned speculation charges and risk premiums are no longer necessary and that the quality of waste treatment is assured.
- If HDD companies can or want to offer alternative, more economical disposal routes (e.g. via in-house waste treatment plants, re-use of drilling fluid / cuttings in other construction projects), they could do so through alternative proposals. The client can assess the proposals objectively by evaluating both the price advantage and quality (within the meaning of regularity) and decide whether such an alternative proposals should be accepted.
- It will ensure fair competition between HDD contractors. Due to low transportation costs, the advantage of local players remains preserved.

Of course, individually tailored versions of the model described above could be tested and adapted, if necessary. It could be beneficial for clients, for instance, to outsource the settling and determination of disposal routes to external service providers (e.g. engineering consultancies specialised in environmental and waste disposal technology or certified waste management companies that act as waste brokers), instead of doing it themselves.

The last presented model is most suitable, in the DCA's view, to reconcile the competences and the possibilities of the responsible parties efficiently, which helps make the project an economic success and create fair conditions for contractor and client. Additionally, it sustains and further strengthens the market position of HDD as a cost-effective and eco-friendly pipe laying technology.

6 Glossary

Abbreviation	Term
AbfKlärV	Ordinance on Supplementing Building Materials
AbfAEV	Ordinance on the Notification and Permission Procedure for Waste Collectors, Transporters, Brokers and Dealers
AVV	Ordinance on the European Waste Catalogue
BauGB	Federal Building Code
BaustellV	Construction Site Ordinance
BBodSchG	Federal Soil Protection Act
BBodSchV	Federal Soil Protection and Contaminated Sites Ordinance
BImschG	Federal Immission Control Act
BioAbfV	Ordinance on Bio-Wastes
i.e.	That is to say
e.g.	For example
DepV	Landfill Ordinance
DIN	Any of a series of technical standards originating in Germany
EC	European Community
KrWG	Circular Economy Act
LAGA 2004 TR Boden	Regional Waste Study Group, Requirements for the Material Recovery of Mineral Wastes: Part II: Technical Rules for Recovery, 1.2 Soil Material (TR Soil)
LAGA 1997 TR Bauschutt	Regional Waste Study Group, Requirements for the Material Recovery of Mineral Residues / Wastes – Technical Rules
LAGA M20	Regional Waste Study Group; Requirements for the Material Recovery of Mineral Wastes
LAGA PN 98	Regional Waste Study Group; Guidelines on How to Handle Physical, Chemical and Biological Examinations in the Context of Waste Recovery / Disposal
NachwV	Ordinance on the Documentary Evidence of Recycling and Disposal
NMU	Ministry for the Environment, Energy and Climate Protection of the State of Lower Saxony
t	tonnes

7 Terminology

Waste producers and holders

In accordance with the KrWG, waste producers and waste holders have the obligation to ensure proper and safe recovery, i.e. recycling or disposal, of wastes.

A **waste producer** is generally the client / property owner.

A **waste holder** in accordance with Section 3 (9) of the KrWG is any natural or legal person who has physical control over waste, hence usually the contractor.

The legal obligation of the contracted construction company is assumed only when transportating waste off site. In accordance with the KrWG, by transporting the waste, the contractor becomes a waste holder. As waste holder, the contractor must ensure together with the waste producer that waste is recovered properly **in line with the requirements set by the waste producer**. The status of waste procuder remains unaffected by the change of possession. For the KrWG is designed to maintain the status of waste producer until proper completion of waste recovery. Only the status of waste holder may change over the course of the disposal chain.

Waste recovery and waste disposal

If the reclaimed material (accumulated soil or mineral construction waste) qualifies as waste under KrWG, it needs to be treated. The KrWG defines waste treatment as recovery or disposal operations, including the preparation prior to recovery or disposal (Section 3 (22) KrWG).

Recovery within the meaning of Section 3 (26) KrWG is defined as any operation the principal result of which is waste within the plant or in the wider economy serving a useful purpose, either by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function. Priority is hence given to the ‘substitutional effect’ of the waste treatment chain.

Disposal within the meaning of Section 3 (26) of the KrWG is any operation that does not constitute recovery. The focus with waste for disposal lies on eliminating its potential danger. As a result, safely storing such waste at a properly authorized landfill in line with the requirements under the Landfill Ordinance is usually the only option.

According to the system proposed by the KrWG, waste recovery takes priority over waste disposal. This means that waste should primarily be recovered. Only if recovery is not possible may waste be disposed of.

The suitability of a recovery measure depends on the pollutant content of the waste. If waste qualifies as “hazardous waste” due to its pollutant content, special obligations apply under the KrWG. According to Section 9 (2) of the KrWG, the mixing, including the dilution, of hazardous waste with other categories of hazardous waste or with other types of waste is not permissible. In the following document, the term **waste treatment** (German: Entsorgung) within the meaning of Section 3 (22) of the KrWG will be used in connection with material that is to leave the construction site, regardless of whether it will be recovered or disposed of.

Substitute building materials

Substitute building materials comprise the costs for scaffolding, formworks and shoring. They are usually used several times and any related material costs are not factored into the construction work. They include standardised and non-standardised parts made of wood, steel and other materials.

Construction lot

The term construction lot refers to a subsection of a construction project. It is defined by quantitative or technical aspects. The tasks connected with one lot are assigned to a contractor.

Construction waste

From practical experience, the term construction waste or mineral rubble refers to all soil materials containing more than 50 vol.% of mineral impurities, concrete (see AVV 17 01 01) from road construction works and demolitions, bricks (AVV 17 01 02), tiles, bricks and ceramics (AVV 170103), and mixtures of that materials (AVV 17 01 07 and 17 01 06*), which are produced in the demolition or reconstruction of buildings or components. If the construction waste contains > 5 vol.% of non-mineral impurities, the material is classified as mixed construction waste ((AVV 17 09 04 and possibly 17 09 03*).

Construction site

A construction site under the Construction Site Ordinance (BaustellV) is the place where a construction project is executed, where one or several physical structures are built, modified or demolished at the behest of a client and the necessary preparatory and closing works are performed.
The construction site consists of the area designated for the structure and the areas used during the construction phase for site installation. Taken together they make up the construction site.
A construction project that comprises several structures in the same spatial and temporal context which are planned and executed together does usually constitute a construction site. Even if a construction project is split in different construction lots, there is usually a construction site involved.

Soil material

In accordance with Section 2 (1) of the **BBodSchV**, soil material (see AVV 17 05 04 bzw. 17 05 03*) is defined as material from soils within the meaning of Section 2 (1) of the BBodSchG and their original geology, including topsoil (in German: "Mutterboden"), which is excavated, displaced or processed in the context of construction works or other significant changes to the ground surface.
LAGA 2004 defines **soil material** within the meaning of their technical regulation as material from soils within the meaning of Section 2 (1) of the BBodSchG and their original geology, excluding, however, topsoil. These soils (AVV 17 05 04 without topsoil) are suitable for the recovery in technical structures when meeting the specifications of LAGA.
Specification: Soil material which contains < 10 vol.% of mineral impurities is usually treated als soil.
Within the meaning of this paper, alongside surface layers (without topsoil) soil materials in accordance with waste legislation include:

a) Natural subsoils consisting of unconsolidated and hard rock in accordance with DIN 4022-1 / DIN EN ISO 14688-1 / DIN EN ISO 14689-1;
b) Backfilling materials from unstabilised upper layers of roads (layers without binding materials) that consist of mechanically processed natural unconsolidated and hard rock and do not fit the definition of composite soils (i.e. it may contain no more than 10 vol.% of impurities, like asphalt or concrete, resulting from the excavation process);
c) Backfilling materials from roadbeds (e.g. embankments) or anti-noise fences, consisting of the rocks listed under a) and b);
d) Soils in accordance with a) to c) containing up to 10 Vol.% of mineral impurities;
For the assessment of soil material (except for topsoil), please consult the Regional Waste Study Group's (LAGA) Technical Rules on the "Requirements for the Material Recovery of Mineral Wastes: Part II: Technical Rules for Recovery, 1.2 Soil Material (TR Soil)" of 5 November 2004.

Root penetration of soils (surface layers)

The soil area penetrable by roots (see AVV 17 05 04 or 20 02 02) is the soil layer which plant roots can penetrate into depending on the natural local conditions (see Section 2 no. 11 of the BBodSchV). It usually includes the humic surface layer, or topsoil ("Mutterboden" within the meaning of Section 202 BauGB) and the subsurface layer, as far as it penetrated or penetrable by roots.
Topsoil (humic surface layer) is not suitable for the treatment methods laid out in the "Technical Rules for the Recovery of Soil Material" **(LAGA 2004)** and must accordingly **not be tested**.
Topsoil may be recovered by spreading it onto or backfilling it onto a soil area penetrable by roots or by creating a soil area penetrable by roots, while taking into account the requirements under Section 12 of the BBodSchV. **DIN 19731** (on the recovery of soil material) defines surface layers as the upper part of the mineral soil (solum) that contains quantities of humus and soil organisms depending on the soil formation and whose dark colour usually contrasts with the lighter subsurface layers.
In accordance with Section 202 of the BauGB, any topsoil which is excavated during the construction or alteration of physical structures, or in the course of any other major changes to the surface of the earth, must be preserved in a usable condition and protected from destruction or wasteful disposal.
During construction works, surface layers have to be excavated separatey while keeping the natural soil functions intact, which means that it has to be stored and backfilled while preventing further compaction and water logging.

In accordance with Section 12 (2) (2) of the BBodSchV, the interim storage of soil material during the construction or alteration of physical structures or operational plants is not subject to this Section (Requirements to the spreading and backfilling of materials onto or into the ground), if the soil material is re-used at its place of origin.
For the assessment of the soil area penetrable by roots, please consult the Federal Soil Protection and Contaminated Sites Ordinance (BBodSchV), the Federal Soil Protection Act (BBodSchG) as well as the enforcement guideline on Section 12 of the BBodSchV.

Inert waste
Inert waste is waste that comprises mineral waste, that does not undergo any significant physical, chemical or biological transformation, that does not dissolve, burn or otherwise react physically or chemically, that does not biodegrade, that does not adversely affect other materials with which it comes into contact in a manner that could lead to detrimental impact on human health or on the environment. The total leachability and pollutant content of the waste, as well as the ecotoxicity of the leachate, must be insignificant, and in particular may not endanger the quality of surface or ground water.

Storage / interim storage of materials
If materials which are temporarily not needed (up to one year of storage time), but are to be backfilled at a later time, are stored away from the construction site, the competent local building supervisory authority needs to be consulted to clarify, whether a planning permission or an authorisation under the Federal Immission Control Act (BImSchV) have to be applied for. In general, authorisation under BImSchV is required, if more than 100 tonnes of non-hazardous waste or 1 tonne of hazardous waste are to be stored for more than one year. In individual cases, provisional storage sites / site installation areas (temporary storage facilities for up to one year of storage time) may be applied for at the competent authority. In general, the storage of non-contaminated materials on site does not require a permit.

Notification procedure
The transboundary movement of waste which is not included on the "green list" is subject to the **notification procedure**. This also applies to waste that is subject authorisation.

Organoleptic test
Soil analysis or sampling via sense organs. This includes an assessment of appearance (colour, body and texture, macroscopic content) and smell. For work safety reasons, the taste of soil is usually not assessed. The organoleptic soil test is usually the first task on site. In contaminated locations, it often forms the decision-making basis for chemical analyses.

In situ sampling
Taking samples immediately on site, in the original location.

Reconditioning
Processing for re-use

Shear strength
Shear strength is the resistance of a solid state body to shear forces. It describes the maximum shear stress a body can sustain before shearing, i.e. the tangential force acting on the fracture plane.

Technical structures
Technical structures are defined by the Regional Waste Study Group on Waste (LAGA M 20) as:
Physical structures that are connected with the ground and which are made from construction products and / or mineral waste and serve technical functions. This includes especially roads, walkways, transport facilities, industrial and commercial sites (superstructures and substructures), including related earthworks (e.g. anti-noise fences and screens), buildings (including substructures).
For the recovery of waste in technical structures, please consult "LAGA 2004 TR Boden", "LAGA 1997 TR Bauschutt" or rules and regulations of the respective German federal state.

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