

Note:

This is a translation of the ESK recommendation entitled
“Bewertung der Notwendigkeit des Logistikzentrums Konrad, der Standortauswahl der BGZ und des abschließend
gewählten Standorts Würzgassen”

In case of discrepancies between the English translation and the German original, the original shall prevail.



STATEMENT of the Nuclear Waste Management Commission

Assessment of the necessity of the Konrad logistics centre, the site selection by BGZ and the finally selected Würzgassen site

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1 Introduction and task

The Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) has asked the ESK to submit a statement on the planned logistics centre for the Konrad repository (*Logistikzentrum Konrad - LoK*) at Würgassen [1]. In this context - in particular taking into account the ESK statement "Safety-related and logistical requirements for a central reception storage facility for the Konrad repository" of 26 July 2018 [2] as well as the detailed assessment study (*Bilanzierungsstudie*) of TÜV NORD EnSys GmbH & Co. KG¹ of August 2022 [3] - the necessity of the LoK and the method applied by BGZ Gesellschaft für Zwischenlagerung mbH (BGZ) for determining the site as well as the finally selected Würgassen site are assessed.

In its deliberations, the ESK also took into account other recent studies or expert opinions. These include the simulation study by NUSEC GmbH dated 20 December 2022 [4], which was prepared on behalf of BGZ, the statement by the Institute for Applied Ecology (*Öko-Institut*) on the derivation of the site recommendation "Central Reception Storage Facility Konrad" by BGZ dated 08 January 2020 [5] and the assessment by the Institute for Applied Ecology on the principal suitability of the Würgassen site for the construction and operation of a Central Reception Storage Facility Konrad (ZBL) dated 09 January 2020 [6], which were prepared on behalf of the BMUV, the "Site Recommendation for the Central Reception Storage Facility Konrad" of BGZ dated 28 August 2019 [7], the concept description for the Würgassen site of BGZ dated 2 September 2020 [8] as well as the expert opinion on the transport connection of the Konrad logistics centre at Würgassen to roads and railways prepared by RegioConsult on January 2023 [9] and commissioned by the "Atomfreies Dreiländereck e.V." (Nuclear-free Border Triangle) association. Furthermore, statements and expert opinions on the determination of flood levels [10], the possible consequences of the flood of July 2021 in the Eifel region on the design flood discharges in the Weser at the site of the logistics centre [11] and on the topics of building ground [12] and sinkholes [13, 14] were taken into account.

In addition, the ESK consulted the BGZ, the coordination office of the public sector ("Öffentliche Hand", ÖH), the Lower Saxony Ministry for the Environment, Energy and Climate Protection ("Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz", NMU), the North Rhine-Westphalia Ministry for Labour, Health and Social Affairs ("Ministerium für Arbeit, Gesundheit und Soziales des Landes Nordrhein-Westfalen", MAGS NRW) and TÜV NORD EnSys, which was commissioned by them, as well as the local political representatives and the representatives of the local citizens' initiatives on selected topics. The waste producers (BGZ and the coordination office of ÖH) were consulted on 19 January 2023 on issues relating to logistics planning and the TÜV NORD EnSys balancing study, and BGZ was consulted on issues relating to the Würgassen site. On 27 January 2023, the NMU, the MAGS NRW and TÜV NORD EnSys, which the former two had commissioned, were consulted on questions relating to the detailed assessment study by TÜV NORD EnSys. The local political representatives and the representatives of the local citizens' initiatives were consulted on 28 April 2023 on issues including the expert opinion of RegioConsult. In addition, an exchange with the regional members of the German parliament (Bundestag) took place on 27 April 2023 at their request.

¹ In the following referred to as TÜV NORD EnSys.

2 Assessment of the necessity of a logistics centre

2.1 Initial situation

2.1.1 Emplacement of waste packages in the Konrad repository

The Konrad repository has been licensed as a repository for radioactive waste with negligible heat generation for a total volume of 303,000 m³. In single-shift operation, an average of 10,000 m³ per year can be emplaced, which results in a total operating time of approximately 30 years. According to [15], there is currently already conditioned radioactive waste with a waste package volume of more than 100,000 m³ awaiting disposal in Konrad. As soon as the status "fully product-controlled" is achieved for these packages (type G2), they can be emplaced in the Konrad repository.

Emplacement is subject to various restrictions. For safety reasons, compliance with the permissible activity limits resulting from the safety analysis for specified normal operation, from the accident analysis, from the criticality safety analysis, from the analysis of the thermal influence on the host rock and from the requirements of the qualified permission issued under water law must be ensured. Further restrictions on the arrangement of individual emplacement campaigns result from the requirements for stack integrity, transport law provisions, container-design-specific requirements and any additional technical measures that may be necessary. In order to ensure storage in compliance with the licence, it is therefore necessary to optimise the arrangement of the waste packages to be emplaced in accordance with the regulations specified for this purpose in the plan approval decision. [16].

2.1.2 Situation in the existing storage facilities

Radioactive waste with negligible heat generation which is to be disposed of at the Konrad repository is currently stored at a total of 42 sites in Germany.

The dismantling of nuclear power plants in Germany will significantly increase the amount of radioactive waste with negligible heat generation in the coming years [15]. The resulting waste packages will be emplaced in the existing storage facilities or those still in the planning stage in the order in which they are produced or delivered.

The emplacement of radioactive waste in the various storage facilities takes place - mostly depending on the type of package (cylindrical packages or containers of different geometries) - in correspondingly different areas of the respective storage facility. Most storage facilities are filled according to the "last in - first out" principle.

According to the BGE, the Konrad repository is not expected to be completed before 2029. By then, part of the storage facilities will have been filled to such an extent that there will no longer be any possibility of moving waste packages around. This means that the compilation of emplacement batches for Konrad, sorted by waste package types and activities, in order to be able to comply with the above-mentioned restrictions on emplacement in the repository, will become increasingly difficult or even impossible in the storage facilities. At some sites, an expansion of storage areas will also be necessary.

2.2 Konrad transport logistics

2.2.1 Planning

Before a waste package can be registered for disposal, the conditioning, the documentation and, above all, the attainment of G2 status after completion of product control are the responsibility of the respective waste producers (AP). The then required waste pre-registration, waste registration and call-off are described in the Konrad plan approval decision (PFB Konrad) [16] but do not take into account the situation in the storage facilities. According to PFB Konrad [16], the operator of the repository carries out the preliminary campaign planning and campaign planning, has these approved by the authority and calls off the packages as they are suitable for emplacement in the repository.

Since almost all storage facilities were built and are operated according to the "last in - first out" principle, the waste packages are usually not accessible in the order in which they are called off by the operator of the repository. Therefore, at the beginning of the 2010s, it was agreed to handle the call-off logistics of the waste packages via so-called coordination centres (K-centres) and to shift a large part of the emplacement logistics to the K-centres, which in turn were to be in direct contact with the storage facility operators and the repository operator.

In cooperation with the K offices of the power utilities and public sector, the repository operator prepared the document "Konzept Abruflogistik - Endlager Konrad" (Call-of logistics concept - Konrad repository) [17].

The co-ordination between the K offices envisaged at that time was discontinued after the conclusion of the KFK² contracts and the reorganisation of responsibility in nuclear waste management. Instead of the K office for the utilities, BGZ is now centrally responsible for the disposal of all radioactive waste from the utilities and is also responsible for the central coordination of this waste.

2.2.2 Transport execution

It is planned to draw up an emplacement plan for each emplacement year in which the sequence of the waste packages to be delivered is specified, including the potential delivery dates. The operator of the repository will then call off the waste package from the waste producer eight weeks prior to the planned delivery date (rolling forecast). It must be taken into account that the waste packages take very different lengths of time to travel from the respective storage facility to the repository (e.g. Karlsruhe: 24 to 35 hours for regular goods transport; 4 to 7 hours from Würgassen). Therefore, there must be a delivery schedule at the repository that takes into account the waste producer's delivery logistics and different transport durations so that the waste packages will arrive at the repository site in the correct order.

The waste packages to be emplaced must be delivered to Konrad in the same condition in which they are to be emplaced underground (just-in-time delivery), as there are no operational buffer facilities at Konrad. The buffer hall available at Konrad serves exclusively for the elimination of problems (buffering of waste packages already in delivery that cannot be taken directly underground in the event of disruptions in the emplacement operation) or for the temporary buffering of special waste packages until all packages intended for mixed

² Commission to review the financing of the nuclear phase-out (Kommission zur Überprüfung der Finanzierung des Kernenergieausstiegs - KFK)

emplacement with the special waste packages have been delivered in full to the repository site. A logistical consolidation point for the compilation of emplacement campaigns does not exist at the Konrad site.

An emplacement campaign typically consists of many waste packages that are expected to come from different waste producers and different locations. A physical campaign formation at the Konrad site is currently neither planned from a procedural/organisational point of view, nor is it provided by the licensing documents of the plan approval procedure. From a technical and logistical point of view, the spatial conditions in the receiving area of the Konrad repository are unsuitable for such work.

The just-in-time delivery of individual waste packages from different locations is an almost unsolvable task, especially against the background of priority delivery by rail in regular goods traffic because the transport times are not only extremely long but also vary greatly (example Karlsruhe: 24 to 35 hours; example Würgassen: 4 to 7 hours). Disruptions such as line closures or train cancellations have not even been considered yet, but they probably cannot be compensated for if the strict delivery chain is maintained. In the event of changes in the emplacement sequence resulting e.g. from a disrupted delivery chain, the campaign plan officially approved by the Federal Office for the Safety of Nuclear Waste Management (BASE) would also have to be altered and resubmitted for approval, which is likely to lead to further delays.

2.3 TÜV NORD EnSys detailed assessment study

In 2022, TÜV NORD EnSys was commissioned by the German states (Länder) of Lower Saxony and North Rhine-Westphalia to prepare the so-called detailed assessment study [3] with the aim to develop a calculation tool that can be used to determine the required transport distances, radiation exposure and time needed for the delivery of all waste to the Konrad repository for various logistics chains. The aim was to identify additional aspects for the assessment of the delivery

- with and without a logistics centre as well as with a mixed variant,
- with different locations of the logistics centre,
- taking into account single-shift and double-shift operation at the Konrad repository, and
- assuming a simplified call-off regime.

After applying a calculation tool developed in the project, the study arrives at the following conclusions:

- In principle, a delivery of 303,000 m³ within 30 years is possible both with and without a logistics centre.
- The use of the logistics centre reduces transport distances and times.
- The use of the logistics centre will lead to an increase in the handling times and the exposure of the personnel as well as the exposure of the population.
- If a logistics centre is used, the storage facilities can be emptied more quickly and emplacement can be accelerated with two-shift operation at Konrad..

Following a presentation by TÜV NORD EnSys and extensive questioning as well as internal discussion, the ESK notes the following points of criticism regarding the study:

- The throughput at the Konrad site is overestimated. In the detailed assessment study, an emplacement rate of 17 transport units (TE³) per day in one-shift operation or 34 TE per day in two-shift operation is calculated. However, against the background of the overall process of call-off logistics, this emplacement rate is not necessary and is also unrealistic. For the planned emplacement volume of 10,000 m³ per year, the handling of one block train (six wagons) per day at the repository site is sufficient, which corresponds to 12 TE per day when Konrad containers are delivered.
- As regards the stocks in the various storage facilities or at the waste producers', oversimplified assumptions were made on the one hand, and on the other hand, studies (e.g. transport logistics concept of the public sector [18]) were not taken into account.
- Overall, the dose to personnel handling the radioactive waste is very low and well below the permissible limits, as shown by experience in the existing facilities. Exposure of members of the public to radioactive waste from transports is negligible, as the Konrad transport study [19] has already shown. This is not expected to change as a result of a LoK.
- The regular goods traffic timetable was not taken into account even though the plan approval decision assumes that the majority of deliveries will be made in regular goods traffic. Consequently, restrictions such as the limitation of deliveries of hazardous goods in regular goods traffic on Mondays - as trains with radioactive materials are not to be parked over the weekend - are not taken into account. Furthermore, the incompatibility of the scheduling uncertainties in regular goods transport with the delivery on the exact day at the repository site is not addressed.
- Also not taken into account are the effects of disruptions of the smallest kind in rail traffic on the emplacement rate (waste package volume/year) in the repository.
- With regard to the actually feasible emplacement rate in the Konrad repository, the fact that no emplacement operations are allowed to take place in the repository during the backfilling operation is not taken into account.
- A connection with the - depending on the delivery scenario considered - more or less strongly idealised assumptions and the very complex call-off regime is only established by the fact that a "simplified call-off regime" is assumed for the determination of the central statements. However, it is not explained what this should look like and whether it can be implemented at all within the requirements of the plan approval decision.

Taking these points of criticism into account, the ESK finds that the main conclusions of the study are not based on sufficiently complete, up-to-date and robust assumptions. The focus on the optimisation variables (time, distance, dose) in accordance with the commission must also be questioned. Therefore, the question of

³ TE (*Transporteinheit*): Transport unit consisting of a Konrad container or an exchange pallet with one to two cylindrical waste packages

the necessity and usefulness of a logistics centre cannot be answered on the basis of the detailed assessment study.

2.4 Presentation of BGZ and the NUSEC study

On behalf of BGZ, the NUSEC company has prepared a simulation study [4] for the deliveries to the Konrad repository via a logistics centre, the results of which are also compared with the results of the detailed assessment study by TÜV NORD EnSys.

In two scenarios, the simulation study compares the direct delivery of all waste intended for the Konrad repository with a delivery via the LoK with regard to the target variables

- number of rail and road transports,
- total transport kilometres covered, and
- time until complete emptying of the interim storage facilities and the LoK.

In addition, the total volume is divided in different proportions between cuboid and cylindrical waste packages in two different simulation calculations. Further assumptions for the scenarios examined are explained in Chapter 4.6 of the simulation study [4]. As a result, the study arrives at a significant reduction in all three target values for delivery via the LoK. Thus, in Simulation 1 (55 % cylindrical and 45 % cuboid containers), the storage of all waste with the LoK requires only 28 years instead of 45, and with a higher proportion of cuboid containers according to Simulation 2 (34 % cylindrical and 66 % cuboid containers) only 26 years instead of 38; all other boundary conditions were assumed to be the same.

In comparison with the results of the detailed assessment study by TÜV NORD EnSys [3], NUSEC states that some of the boundary conditions of the detailed assessment study were unrealistically chosen, but that the relative acceleration of the overall process of emplacement of all Konrad waste, with 20 to 40 % on the one hand (TÜV NORD EnSys) and 38 and 32 % on the other hand (NUSEC), correspond very well.

The ESK points out that this statement is not meaningful against the background that the NUSEC study also does not take into account any rail-route-specific parameters (e.g. regular freight timetable or specific transshipment stations) and does not assume correct load assumptions for the public sector.

In the meantime, BGZ has corrected the traffic loads downwards and has come to the conclusion that on average, only one block train (six wagons) per day and shift needs to be delivered to Konrad in order to be able to emplace the total number of packages forecast in Germany there over 30 years. The original estimate of up to ten train movements per day at the Würgassen site was too high. BGZ now assumes an average traffic volume of 2 to 3 trains and 0 to 10 road transports per day to and from the LoK (including empty transports).

The LoK reduces the number of road transports to the Konrad repository to a minimum. The ESK points out that this is advantageous for the Konrad site but does not reduce the number of road transports for the storage sites that have no railway siding since the waste packages must first be transported by road to a transshipment station before they can be transported further by rail. This should be taken into account later in the planning, which still has to be specified. According to the representative of the K office of the public sector at the 3rd

meeting of the LoK WG on 19 January 2023, the delivery transports from the public sector sites to the LoK would in each case be carried out using the same mode of transport as to the repository. Intermodal transport, i.e. transfer from road to rail at a transfer station, is not economical and does not make sense for the few road transports from the public sector facilities.

2.5 Conclusion on the necessity of a logistics centre

The necessity of a LoK should not be causally linked to or derived from the two-shift operation at Konrad as it is currently not possible to reliably estimate how much effort the emplacement of the currently targeted average 10,000 m³ waste package volume per year (12 TE/day) will actually entail, including backfill operation, periodic inspections, and maintenance measures.

Irrespective of the two-shift operation at Konrad, the ESK expects a reduction in operating time in any case if the waste is transferred to Konrad via a LoK because the possible disruptions in both the planning and the execution of the transports cannot even occur in the same form with only one site as with transports from each individual storage site. Every disruption that would lead to changes in the campaign plan means an administrative act as the competent authority has to re-examine and approve the modified campaign plan, resulting in massive disruptions in the overall operation of the repository.

If the containers are delivered from only one location (e.g. the LoK), a delivery chain that has been interrupted due to disruptions can be continued at any time after the disruption has been rectified without changing the order of the waste packages. This will not apply in the case of deliveries from various locations throughout Germany, especially not in regular goods traffic.

The ESK considers the most important advantage of the LoK to be the safe and risk-free loading of the repository with pre-sorted, precisely fitting waste packages. It is a completely different matter whether deliveries have to be planned and carried out simultaneously on schedule from different individual storage sites (incl. Land collection facilities) or whether this is done centrally from one point. This may also involve train cancellations, but then the chain would stop and continue at the next possible point in time. This would have no effect on the essentially important sequence of the waste packages at the repository site.

In the ESK's view, moreover, no unrealistic assumptions should be modelled with regard to the daily loads at the repository site that suggest that the repository can be completely filled in only 7.5 years (approach: 34 TE/day in two-shift operation) or in 15 years (approach: 17 TE/day in one-shift operation). From the ESK's point of view, the G2 waste packages cannot be provided at this frequency over a longer period of time and, in addition, some of the radioactive waste will only be produced during the progressive dismantling and will then also have to be conditioned in a manner suitable for disposal.

In summary:

- The question of the necessity and meaningfulness of a logistics centre cannot be derived from the parameters of dose, distance and time alone.
- The most important factor, namely the logistical challenges, especially in the delivery of regular goods transport and the deadline risks involved, as well as the difficulties in storage logistics ("last in - first out") and the capacity of storage facilities, have not been sufficiently taken into account so far.
- The earliest possible availability of a logistics centre as a consolidation point that decouples the independence of preparatory steps can make a decisive contribution to improving logistics and at the same time avoid the consequences of any disruptions.
- A logistics centre will contribute significantly to the robustness of the emplacement of waste packages in the Konrad repository and thus ensure that the planned 10,000 m³ per year can also be emplaced from a logistical point of view.
- Furthermore, sites producing little waste could hand it over to the logistics centre in order to reduce the large number of nuclear sites in Germany more quickly than without the LoK.
- In addition, the new building or expansion of storage facilities at different locations in different Länder could be avoided.

3 Assessment of the procedure for determining the location by BGZ

3.1 The ESK's criteria of 2018 for the LoK

From a technical and logistical point of view, *"a central reception storage facility directly at the site of the Konrad repository would have obvious advantages because the distances would be short and no public transport routes would have to be used for the transport from such a facility to the Konrad repository."*[2]. The ESK continues to be of the opinion that a central reception storage facility for the Konrad repository should only be constructed away from the repository site if this is not possible directly on site.

The implementation of a procedure for the comparison or selection of different sites, which precedes the actual licensing procedure, is not required under radiation protection law for the construction of a storage facility. The safety-related suitability of the site must be demonstrated within the framework of the licensing procedure; possible environmental impacts of the project are examined and assessed during the licensing procedure in the environmental impact assessment.

Nevertheless, the ESK welcomes the fact that BGZ has reflected about the determination of the site.

In its Statement (cf. Chapter 5 in [2]), the ESK had proposed the following criteria for the assessment of a site from a safety-related and logistical perspective:

Safety-related criteria:

- *„The site must not be located in an area endangered by flooding. When determining the probability of flooding, future developments during the expected operating period shall be taken into account.*
- *The site must not be located in an area where subsidence is likely to affect the stability of the central reception storage facility.*
- *The site should not be within the area of influence by neighbouring installations with the potential for accidents, e.g. major accident installations under the Twelfth Ordinance on the Implementation of the Federal Immission Control Act (Major Accidents Ordinance – 12th BImSchV). The area of influence is defined in accordance with the usual provisions in the respective legal field. For sites within the area of influence of installations with the potential for major accidents, a situation acceptable in terms of safety would have to be established by compensatory measures.*
- *The site must be chosen such that possible major fires in the neighbourhood cannot affect the central reception storage facility.*
- *For a site that was previously used for industrial, military or similar purposes, it must be reliably clarified that there are no more substances (e.g. explosive substances) or spatial situations (e.g. underground cavities not properly backfilled) in the subsoil that could pose a hazard to the central reception storage facility.*
- *It must be reliably clarified for the site that there are no explosives in the subsoil, e.g. from the Second World War.*
- *The site should be located in earthquake zone 0 according to DIN. This ensures that seismic influences on the safety of the facility are not to be feared without the need for more elaborate measures. Although sites in higher earthquake zones are also conceivable, here, however, a situation acceptable in terms of safety would have to be established by compensatory measures.“*

Logistical criteria:

- *„The site must be located next to a double-track railway line and, if possible, be accessible from more than one direction. Only in this way, sufficient availability for continuous rail transport will be ensured.*
- *If possible, the potential site should have either an existing railway siding or an abandoned one whose essential elements (e.g. railway line, possibility of branching off from the railway network) still exist. If a completely new railway siding would have to be built for a site or an existing one would have to be overhauled, it has to be estimated on the basis of the specific and actual conditions whether it will be possible to build a railway siding suitable for heavy loads in due time.*
- *It must be possible, with reasonable means and in due time, to connect the site to the general road network or to use a former connection. This connection must be suitable for heavy loads and must lead to a point in the general road network which allows heavy loads to be transported in several directions.*

- *The site should be no more than 150 – 200 km away from the Konrad repository in order to avoid unnecessary additional transportation. In addition, the potential for difficulties in the continuity of delivery to the Konrad repository increases strongly with increasing distance*
- *The necessary infrastructural media must be available at the site in the necessary capacity or be producible in a manageable time. This applies, in particular, to electricity, water and data lines, for which redundant connections may have to be provided.*
- *The site must be of sufficient size for the facility equipment, for the necessary spaces for the transport vehicles, including their maintenance, and for the installations required for physical protection. It will be essential to define the area required for the facility as early as possible with a view to the search for and selection of the site.*“

3.2 BGZ's approach

In [7], BGZ presents the procedure it used to identify Würgassen as a recommended location for a central reception storage facility.

Step 1 - Query of available areas:

In accordance with its mandate from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUV, formerly BMU), BGZ concentrated its search for a site for the central reception storage facility on suitable sites owned by the Institute for Federal Real Estate Tasks (BImA), Deutsche Bahn AG (DB), BVVG Bodenverwertungs- und - verwaltungs GmbH (BVVG) and real estate areas of decommissioned nuclear power plant sites in the search area (cf. p. 1 in [7]). Thus, the further selection was limited to sites owned by the Federation and the power utilities of the nuclear energy sector. Due to these ownership requirements, areas directly adjacent to the Konrad repository site were not considered in the selection procedure.

Based on the following criteria, BGZ asked the above-mentioned institutions whether any corresponding areas were available:

- *radius of up to 200 km around the Konrad repository,*
- *area greater than 30 ha,*
- *distance to the next railway track less than 10 km,*
- *distance to residential areas 300 m and*
- *no nature conservation area.*

Step 2 – Narrowing-down to a pool of potentially suitable areas:

The 28 reported sites were narrowed down to a pool of nine potentially suitable areas on the basis of a site-specific evaluation of the five criteria mentioned in Step 1. In addition, the rail and road distances to the Konrad repository were listed, but according to statements by BGZ, these were not decisive for the selection of the area pool.

In addition to the criteria mentioned explicitly, further aspects were listed in a tabular compilation of the areas as "remarks", such as the layout of the area, the presence of wetlands or the development costs of the site. These aspects were also relevant for the decision-making process.

In this step, two of three nuclear power plant sites were excluded from the further comparison: the Grohnde NPP, because the premises of the plant, which was operated until 2021, are not yet available for a logistics centre, and the Krümmel NPP, because the licensing procedure for decommissioning and dismantling has not yet been completed and the areas necessary for a central reception storage facility are not available.

Step 3 – Scoring

Among the remaining nine sites, BGZ conducted a ranking based on the "variables" of

- 1 distance to the nearest railway siding and
- 2 estimated length of the transport route to Konrad by road

with Variable 1 receiving twice the weighting as 2.

The selection of Variable 1 is justified by the fact that the time and legal risk of construction increases with increasing distance to the next railway track. Variable 2 is justified by the fact that the road offers the more sensitive transport technology but is necessary for a robust overall system of delivery logistics.

With reference to the statement of the ESK [2], BGZ states that deliveries to the Konrad repository should be mainly by rail. („Delivery to the Konrad repository could then theoretically be carried out completely by rail, which makes the delivery logistics more robust against disturbances with regard to the “just-in-time” concept.“). Therefore, it gives Variable 1 a greater weight than Variable 2 and reflects this in the calculation of the score, in which the distance to the railway siding is given a value of 1 and the length of the transport route by road is given a value of 0.5.

In this scoring, the Würgassen site is the best one.

3.3 Statements by the Institute for Applied Ecology (Öko-Institut) and RegioConsult on site selection

On Step 1 - Query of available areas:

According to RegioConsult [9] in Chapter 8 "Site search by BGZ", the focus on areas owned by BImA, DB AG, BVVG and decommissioned nuclear power plants *"also excludes suitable areas within the search area from the outset"*. Furthermore, the five selection criteria are judged to be insufficient and in contradiction to the requirements of the ESK.

On Step 2 - Narrowing-down to a pool of potentially suitable areas:

Both the criteria explicitly listed for the restriction to an area pool and the aspects that are identified as "comments" but are relevant to the decision are, in the view of the Institute for Applied Ecology [5], decisive and relevant for the decision on the site. The Institute for Applied Ecology advocates a *"soft"* interpretation of the criteria "area larger than 30 ha" and "distance to residential areas 300 m". From the point of view of the Institute for Applied Ecology, the comprehensibility of the decision-making process is hampered by the combination of criteria and comments.

The Institute for Applied Ecology [5] considers the results of the narrowing-down process for determining the area pool to be plausible, with the exception of the exclusion of the "Torgau" site, which is judged to be incomprehensible based on the explanations in the tabular presentation of BGZ. However, this has no influence on the final score.

The early exclusion of the Grohnde site is criticised in [9]. At the time of the evaluation in August 2019, it was already foreseeable that commissioning of the central reception storage facility before the end of the nuclear power plant's operating life (end of 2021) would not be realistic anyway. Therefore, the clear advantages of the Grohnde site, which has a double-track railway siding and better road access, would have to be taken into account.

On Step 3 - Scoring

Regarding the scoring, the Institute for Applied Ecology notes that a better justification of the two selected variables and their weighting would have been desirable. In addition to the scoring that includes the road distance to the Konrad repository, a scoring that includes the railway distance was carried out in [5] (under otherwise identical conditions), which leads to the same result for the first five places.

Overall, the Institute for Applied Ecology comes to the conclusion that there is room for improvement in the presentation of the decision-making process. Nevertheless, in the Institute for Applied Ecology's view, the Würgassen site is also the most suitable location according to the information available. This is supported above all by its timely availability, the fact that it is the only site with a railway siding that can be developed, and the fact that it is already used for nuclear facilities, all of which indicates its suitability from a technical and regulatory point of view.

With regard to the boundary conditions for the scoring, RegioConsult [9] criticises on the one hand the selection of the two variables and their weighting, emphasising in particular the non-consideration of the ESK's requirement of the double trackage of the railway siding. On the other hand, RegioConsult considers it inappropriate for the far-reaching decision to use an estimated distance for the evaluation.

According to [9], the double weighting of the variable railway siding cannot be justified, also in view of the probable necessity of redevelopment. If both variables were equally weighted, the Braunschweig site would be ahead of Würgassen. Furthermore, RegioConsult points out that the Grohnde site - with or without weighting of the variables - would have performed best if it had not - incorrectly - been excluded prematurely.

3.4 Conclusion on the approach to site selection

In the ESK's view, BGZ's procedure for identifying potentially suitable areas and for reducing the number of areas to a pool of nine (Steps 1 and 2 of the procedure for determining the site) is fundamentally plausible. The ESK agrees with the findings of the Institute for Applied Ecology regarding the comprehensibility of the establishment and application of the criteria in combination with the "comments" and the unfounded exclusion of the Torgau site.

The operator of the Grohnde nuclear power plant assumes that the nuclear dismantling of the nuclear power plant will take 10 to 15 years from the granting of the nuclear decommissioning and dismantling licence. Subsequently, about two years are planned for the so-called conventional demolition. The decommissioning and dismantling licence has not yet been issued. Since logistics and transport areas are needed on the site during dismantling and in order to not impede dismantling due to lack of space, the ESK does not consider the construction of the logistics centre on the site of a nuclear power plant before or in the early dismantling phase to be expedient. Nor does it make sense to wait until significant progress has been made in dismantling the NPP before constructing the logistics centre, given the intended timetable for its use. The early exclusion of the Grohnde and Krümmel sites can therefore be accepted from the ESK's point of view.

Based on the weighting of the variables (distance to the nearest railway siding and estimated length of the transport route to Konrad by road) chosen by BGZ for the scoring (Step 3 of the site selection procedure), the Würgassen site performs best because it is the only site in the area pool with a railway siding, albeit not a double-track one. If both variables were weighted equally, the Braunschweig site would perform best due to its considerably shorter distance from Konrad, followed by the Würgassen site. However, according to BGZ, the land required for the construction of a railway siding would first have to be acquired in Braunschweig or rights of use would have to be obtained, which also represents a considerable time and legal risk from the ESK's point of view.

Since none of the relevant sites has a double-track railway siding, it is up to BGZ as the applicant to provide evidence in the further procedure that the required transport frequencies can be realised with the tracks available at the Würgassen site. Based on its considerations of the transport volume that can realistically be expected (Chapter 2 of this Statement) and the comments of the Institute for Applied Ecology on the railway siding (Chapter 4 of this Statement), the ESK assumes that the goal of robust transport logistics can also be achieved with a single-track railway line.

The selected variables and their weighting do not take into account the fact that it is currently unclear whether deliveries of the waste packages to the central reception storage facility will mainly be made by rail or by road. According to BGZ's justification, the variables were derived from the considerations of transporting the packages from the logistics centre to the repository.

Since the delivery of the waste packages is not explicitly taken into account in the final scoring (Step 3), the ESK suggests that the consequences of different scenarios for the transport of the waste packages to the central reception storage facility - mainly by road or rail - should also be reflected in the further course of the planning or licensing procedure.

4 Assessment of the Würgassen site

4.1 Characterisation of the site by BGZ

In the concept report on the basic feasibility of the site-independent concept of the LoK at the Würgassen site [8], BGZ states comparatively briefly that the ESK criteria are fulfilled from a logistical and safety-related point of view [2] (cf. Chapter 3.1 of this Statement, pages 10 and 11). The ESK criteria "distance to the Konrad repository, area, railway siding, distance to the next railway line, length of the transport route to Konrad by road" were largely not presented as they were used in the site selection process. However, it was pointed out that, on the one hand, the existing railway siding must be restored and put into operation as part of the project and that, on the other hand, a connection to the public road network is given due to the previous use as a power plant site.

With regard to the natural conditions, BGZ considers the following safety-related ESK criteria to be fulfilled:

- *„The Würgassen site is not located in a flood zone. Due to its location on the River Weser, technical measures must be taken to ensure flood safety even in the event of an extreme flood.*
- *The Würgassen site is located in an area outside the seismic zones according to DIN EN 1998-1/NA, where the lowest seismic hazard exists on German territory.“*

Further safety-related ESK criteria, e.g. testing for the absence of explosive ordnance or for the contamination of the subsoil, were presented in the geotechnical site analysis [12], which was published at the same time, in addition to the actual subsoil investigation and a foundation concept as well as initial investigations of the flood risk.

In its report and presentation to the ESK on 19 January 2023, BGZ presented initial examination results on the Würgassen site from the years 2020 and 2021, which take up some of the recommendations and notes from the Institute for Applied Ecology's statement [6] (cf. Chapter 4.2 of this Statement).

With regard to logistics, two expert opinions are now available. In the rail operations programme study jointly prepared by DB Netz AG and the transport service provider DAHER for the realisation of the transport volume to/from LoK Würgassen [20], it was found that the transports are possible on the existing tracks without any restrictions on the existing public transport system. The NUSEC study [21] shows only a small additional

traffic volume for road transport with a "conservative consideration" of up to 20 lorry transports daily to and from the LoK (including empty runs) via five access routes.

Detailed derivations of the maximum flood levels [10], also taking into account possible consequences of extreme floods comparable to the Eifel flood in July 2021 [11], show that with the corresponding technical measures (elevation of the construction site at least to the elevated level of the former nuclear power plant, backfilling of the former plant trench), the selected site of the logistics centre is flood-free even in the event of a 10,000-year flood event.

In [10], the maximum flood levels at the site are derived in detail. The methods used to determine the design discharges on the basis of long-term hydrological time series with extreme-value statistical analyses and subsequent sensitivity analyses and for their transformation with water level/discharge ratios into the corresponding design water levels correspond to the state of the art in science and technology. The design water levels determined for a 100-year event are 99.5 m SL and thus 1.25 m lower than the datum level of the former nuclear power plant. For a 10,000-year flood event ($HQ_{10,000} = 2,880 \text{ m}^3/\text{s}$) with a design water level of 100.75 m SL, however, they lie 15 cm above the datum level. As a technical measure to ensure that the logistics building will be flood-free, a corresponding elevation of the foundation subsoil is proposed.

The relevance and possible consequences of a heavy-rain event similar to the flood disaster in July 2021 in the Eifel region and the Ahr valley on the design runoffs HQ_{100} and $HQ_{10,000}$ determined in [10] for the River Weser at the Würgassen site were additionally investigated [11]. It was found that due to the size, topography and geology, an application of the consequences of the flood (discharges, water levels, flooding, damage) "is not possible or only possible to a very limited extent". With the help of various extreme scenarios based on the official flood hazard maps and heavy-rain hazard information maps, river floods and heavy-rain events were considered at the site. It was found that only in the scenario of extreme heavy rainfall in the northern area of the site is flooding of localised areas to be expected. In summary, it was concluded that after assessing the influence of heavy-rainfall events on the design discharges at the site and the current status of the flood hazard maps and heavy-rainfall event maps, the determination of the design events HQ_{100} and $HQ_{10,000}$ at the site are sufficient.

Regarding the hazard assessment of the sinkhole risk, a detailed expert opinion [14] is now available in addition to a rather brief statement [13].

The basis for the assessment of the sinkhole risk in [14] was i.a. the accessible, mostly digitally available geological data (in addition to maps, also 3D sections of the subsoil) of the corresponding authorities of the three Länder as well as information on recent subsidence or uplift processes of the earth's surface from the Ground Movement Service of the Federal Institute for Geosciences and Natural Resources (BGR). In accordance with standard rules, the distance of the site to nearby historical sinkholes, the geological and tectonic structure of the subsoil and the depth of the occurrence of soluble sulphate or carbonate rocks below ground level were decisive for the assessment of the sinkhole risk:

- distance to known sinkholes is $\geq 1.5 \text{ km}$,
- none of the historical sinkholes is located in a geotectonic setting comparable to the Weser Valley,

- near-surface leachable layers are no longer present in the area of the Weser valley under consideration due to advanced erosion and the geological boundary conditions,
- the total thickness of the non-solution-sensitive layer package of the Middle and Lower Trias is at least 900 m,
- tectonic faults were not identified at the site. Major faults are mapped only 5 km northeast of the site within the Mesozoic layered package,
- the potential for (brine) water circulation in the subsurface of the site (Bad Karlshafen, brine waters in individual boreholes during pumping tests during the construction of the Würgassen nuclear power plant) is given, but a sinkhole hazard cannot be derived from this.

Based on the evaluation scale of the Lower Saxony Recommendation for the Assessment of Sinkhole Risk, [14] classifies the construction area of the site in Sinkhole Hazard Category 2 ("Soluble rocks lie at a depth at which karstification is already known locally. Sinkholes at this depth are rare. If sinkholes are known to have occurred in the vicinity at all, they are at least 300 m away from the construction site"). This classification does not result in any requirements for planning, design and construction.

4.2 Statement of the Institute for Applied Ecology on the site

In [6], the Würgassen site is assessed on the basis of the ESK criteria using the data available at the time the report was prepared. In its conclusion, the Institute for Applied Ecology points out that there is a need for further investigation of individual safety criteria in order to conclusively prove the suitability of the site from a safety-related point of view. In the view of the Institute for Applied Ecology, these investigations will *"not lead to a fundamental exclusion of the suitability of the Würgassen site"* and can also be carried out as part of the licensing procedure.

According to [6], the ESK criteria of "available area", "infrastructure and media" and "road access" are fulfilled at the Würgassen site. However, with regard to the road network, it is recommended that environmental assessments for the use of access roads be carried out as part of the licensing procedure and that it be established how high the actual additional traffic volume will be.

The logistical requirement of a "railway siding" by the ESK is also considered to be fulfilled. The ESK requirement for "double track" was not considered fulfilled. However, according to the Institute for Applied Ecology, double-tracking is not relevant for safety, but is intended to ensure the "just-in-time" deliveries to Konrad through sufficient availability and robustness against potential disruptions. Depending on the concrete demand for transport capacities (in comparison with the available capacities of the railway siding), a single-track line could also be sufficient for the transport volume of the LoK. Overall, it was concluded that the connection to the railway network is conceivable in principle but has not yet been demonstrated.

With regard to the "flood-free location", it was concluded that with the currently prevailing natural conditions, the site is not completely free of floods. However, due to the structural design (elevation of the site) and the previous use of the nuclear power plant premises, it is assumed that a flood-free location for the logistics

centre can be achieved through appropriate structural measures (elevation of the site, backfilling of the canal that was used for the physical protection of the power plant).

In this context, the Institute for Applied Ecology suggests taking into account the additional effort required for building embankments to ensure flood safety, both in terms of time and money, and, if necessary, compensating for potential retention areas in the event of extreme flooding.

Due to the geological subsoil with karstable and leachable Permian layers beneath the approximately 600-m-thick sandstones, clays and siltstones of the Trias, "subsidence" cannot be ruled out in principle according to [6]. However, it is assumed that potential subsidence that could affect the stability of the central reception storage facility has already been investigated at the site as external hazards in the safety analyses of existing facilities (storage facilities). According to [6], the suitability for the logistics centre from the point of view of safety against subsidence is presumably given in view of the knowledge available at that time, but has yet to be demonstrated in detail.

From the point of view of the Institute for Applied Ecology, further open issues for a final clarification of the safety suitability of the site are:

- final results of investigations on installations with the potential for accidents in the vicinity of the site,
- assessment of possible fire risks due to the timber storage and
- freedom from explosives.

4.3 Comments on the site from RegioConsult and from the citizens' initiative "BI Lebenswertes Bördeland und Diemeltal e. V."

RegioConsult [9] states in their expert opinion that essential ESK criteria (double track, transport links (both road and rail), freedom from flooding and subsidence, although not explained in detail) cannot be met for the Würgassen site. RegioConsult considers the existing transport network in particular to be logistically unsuitable. In connection with logistics, RegioConsult [9] points out various deficits in the expert opinions on road and rail access to the Würgassen site.

Regarding road transports, these are in particular:

- incorrect determination of the existing traffic volume,
- considerable distance to the nearest motorway junctions, and
- unsuitable passages due to downhill gradients and tight curves.

Regarding rail transports, these are in particular:

- lack of examination of the condition and possible need for rehabilitation of the tracks and bridges,
- known accident history on the line and at unguarded railway crossings and resulting need for retrofitting to crossings with barriers,
- sufficient road safety cannot be guaranteed in the future.

In addition, RegioConsult [9] considers the ESK criterion "flood-free location" as not fulfilled. On the basis of a current flood hazard map (HQ Extreme) it is shown that such floods reach as far as the railway line and "thus there is a danger of the railway line being underwashed". In addition, the area planned for the logistics centre building would be flooded by up to one metre. With reference to the expert opinion on the determination of flood levels [10], reference is made to the higher maximum flood discharge there ($HQ_{10,000} = 2,880 \text{ m}^3/\text{s}$) compared to HQ extreme of the administrative district of Detmold with $2,332 \text{ m}^3/\text{s}$, and at the same time it is demanded that in [10] the flooding of up to 1.0 m over large parts of the area should be taken into account. RegioConsult sees a major argument for the unsuitability of the Würgassen site in the forecasts of the Weser Flood Action Plan (North Rhine-Westphalia), which assume complete flooding of the entire right bank of the Weser in the oxbow, including the power plant site, up to the Land border in the event of a disaster.

Similar to RegioConsult, the citizens' initiative "BI Lebenswertes Bördeland und Diemeltal e. V." also pointed out at the hearing on 28 April 2023 [22] that the demand for "double tracks" had not been met and that the single-track railway line was in a poor state of preservation (bridges). Equally comparable is the claim that a "flood-free location" does not exist at the Würgassen site. Here, too, the flooded areas at the site for a 100-year event (HQ 100) and for an extreme event were shown on the basis of the official flood hazard maps and heavy-rain hazard maps, and reference was also made to the flooding scenario from the Weser Flood Action Plan (North Rhine-Westphalia):

- "Right Weser side up to the Land border completely flooded,
- entire village, the former power plant site and campsites affected, and
- access road (L550) incl. power plant site flooded".

In addition, the failure to take into account the numerous water level marks of the historical extreme floods (Magdalen flood of 1342, flood events of 1513 and 1682) for the determination of $HQ_{10,000}$ was criticised. In addition, the high-flood and alluvial clays [12] should have been included in the determination of the extreme discharges as evidence of flooding.

In addition to RegioConsult, BI Lebenswertes Bördeland und Diemeltal e. V. explained the reasons why the ESK criterion "no subsidence" was not met [22]. First, an excerpt of the subsoil map of North Rhine-Westphalia from 1978 was used to show that the site is located in an area with possible ground subsidence. In addition, reference was made to the various historical sinkholes in the immediate vicinity of the site and to a potential hazard from "deep salinar karst".

4.4 Conclusion on the suitability of the Würgassen site

From the point of view of the ESK, the characterisation of the site by BGZ is comprehensible and plausible. This is particularly the case now that the need for further investigation of individual safety criteria, as called for by the Öko-Institut, has been largely met by corresponding expert opinions.

The ESK agrees with the assessment of the Institute for Applied Ecology regarding the realisation of rail transports from the LoK to the Konrad repository on a single-track line. In view of the reduced load assumptions presented by BGZ, the ESK also believes that there is no longer any need for a double-track connection.

With regard to transport logistics that are as trouble-free as possible, the ESK considers it necessary to review the points raised by RegioConsult. Since heavy-duty transports were also carried out by the Würgassen nuclear power plant, the ESK does not expect any insurmountable obstacles. However, it should be clarified in a timely manner what effort may still be required for a robust transport infrastructure.

The ESK considers the proof of the absence of floods at the LoK, determined according to the state of the art in science and technology, to be comprehensible and plausible. Due to the many missing parameters of the river basin at that time (e.g. size, watercourse, topography, land use), there is still no scientifically recognised method for transferring very old water level marks, e.g. from the Magdalen flood in 1342, into corresponding water level-discharge relationships. With the extreme-value statistics that has been compiled, these maximum levels should be covered.

The ESK proposes to take into account the additional effort for fills in terms of time and money and to compensate for originally flooded areas that served as retention areas in case of extreme floods.

On the basis of the expert opinions submitted, the ESK considers safety against subsidence with a classification of the building ground in the sinkhole hazard category 2 to be fulfilled.

5 Summarising assessment

Necessity of a logistics centre

From the ESK's point of view, a logistics centre (LoK) is necessary for optimised delivery to the Konrad repository.

The ESK considers the most important advantage of a LoK to be the safe and risk-free filling of the repository with pre-sorted, precisely fitting waste packages.

The earliest possible availability of a logistics centre as a consolidation point that decouples the dependencies of preparatory steps can make a decisive contribution to improving logistics and at the same time avoid the consequences of disruptions.

By the time the Konrad repository is commissioned, some of the storage facilities will have been filled to such an extent that there will no longer be any shunting possibilities for waste packages. This means that the compilation of emplacement batches for Konrad sorted by waste package types and activity inventories in the storage facilities will become increasingly difficult or even impossible, especially since many storage facilities are operated according to the "last in - first out" principle.

Furthermore, sites with only a small amount of waste could hand it over to the logistics centre in order to reduce the large number of nuclear sites in Germany more quickly than without the LoK. In addition, the construction or expansion of storage facilities at different sites in different federal Länder could be avoided.

Irrespective of the question of a one-shift or two-shift operation of the repository, the ESK expects a shortening of the operating time if the waste is transported to Konrad via a LoK because possible disruptions of the

transports with effects on the sequence and thus the approved campaign planning of the delivered waste packages cannot occur in the first place if transports arrive from only one site, as is the case with transports from many individual interim storage sites.

Procedure for site selection

From the ESK's point of view, BGZ's procedure for identifying potentially suitable sites and for reducing the number of sites to a pool of nine (Steps 1 and 2 of the site selection procedure) is fundamentally plausible. The variables selected in the scoring (Step 3) and their weighting take particular account of the transport of the waste packages from the logistics centre to the repository. The ESK suggests that in the further course of the planning and licensing procedure, the consequences of different scenarios for transporting the waste packages to the LoK - mainly by road or rail - should also be considered.

Based on the weighting of the variables (distance to the nearest railway siding and estimated length of the transport route to Konrad by road) chosen by BGZ for the scoring (Step 3 of the site selection procedure), the Würgassen site performs best because it is the only site in the area pool with a railway siding, albeit not a double-track one. If both variables were weighted equally, the Braunschweig site would perform best due to its considerably shorter distance from Konrad, followed by the Würgassen site. However, according to BGZ, the land required for the construction of a railway siding would first have to be acquired in Braunschweig or rights of use would have to be obtained, which also represents a considerable temporal and legal risk from the ESK's point of view.

Since none of the relevant sites has a double-track railway connection, it is up to BGZ as the applicant to provide evidence in the further procedure that the required transport frequencies can be realised with the tracks available at the Würgassen site. Based on its considerations of the transport volume that can realistically be expected and the comments of the Institute for Applied Ecology on the railway connection, the ESK assumes that the goal of robust transport logistics can also be achieved on a single-track railway line.

The ESK has maintained its view that a central reception storage facility (logistics centre) for a repository should only be constructed away from the repository site if this is not feasible directly at the repository site.

Würgassen site

From the ESK's point of view, BGZ's characterisation of the site is plausible. This is particularly the case now that the need for further investigation of individual safety criteria, as called for by the Institute for Applied Ecology, has been largely met by corresponding expert opinions.

The ESK agrees with the assessment of the Institute for Applied Ecology regarding the realisation of rail transports from the LoK to the Konrad repository on a single-track line. In view of the reduced load assumptions presented by BGZ, the ESK also believes that there is no longer any need for a double-track connection.

On the basis of the expert opinions submitted, the ESK considers both the requirement of the absence of flooding, which is achieved through technical measures, and the requirement of safety against subsidence by the classification of the building ground in the sinkhole hazard category 2 to be fulfilled.

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