

Recommendation

Werra / Weser River Water Protection and Potash Production

- Executive Summary -

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The salt controversy and the work of the ROUND TABLE

For more than a hundred years the Werra river valley on the border between the regional states (*Länder*) of Hesse and Thuringia has been a centre of potash mining in Germany. For this structurally weak region, the economic capacity and the jobs offered by potash production are vitally important.¹ While ongoing improvements in production technologies have significantly reduced environmental impacts over the last two decades, the salinization of the Werra and Weser rivers and the underground injection of saline effluent continue to pose problems – for nature, for residents, and for users of water bodies.

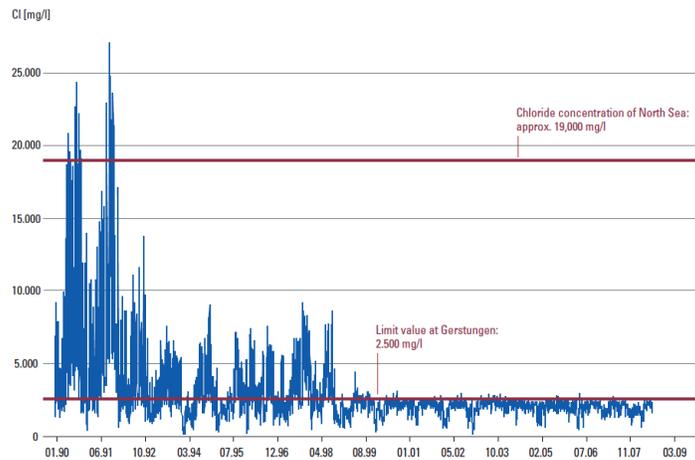


Fig. 1: Chloride concentration at Gerstungen from 1990 to May 2008

On account of the legal requirements for the protection of groundwater and surface water, especially the European Water Framework Directive, and in view of the widespread discontent with the state of the Werra and Weser rivers, action is needed: certain objectives must be met in the short-term while binding steps have to be implemented in order to achieve certain other objectives by 2027 at the latest. In view of the delicate balance between implementation of the Water Framework Directive on the one hand and the regional economic importance of potash production in the Werra river valley, in 2007 the state parliaments of Hesse and Thuringia decided to establish the ROUND TABLE on "Werra/Weser River Water Protection and Potash Production" in order to develop proposals for solutions through consensus. "Its aims are to provide a consolidated and objective basis for debate on improving the quality of the receiving waters – the Werra and Weser rivers – and achieving sustainable production patterns, to create confidence and acceptance, and to develop proposals for viable solutions." (quote from the declaration of establishment).

From March 2008 to February 2010 the ROUND TABLE members worked on such solutions. The participants comprised representatives of the municipalities bordering the rivers, environmental organizations and fisheries associations, citizens' action groups, the unions, the chambers of industry and commerce, the company K+S AG,² the *Länder* of Thuringia, Hesse, North-Rhine/Westphalia, Lower Saxony and Bremen as well as the Federal Environment Ministry BMU (Fig. 2).

¹ Currently potash production in the region provides nearly 8500 jobs. According to the present state of geological knowledge, potash deposits in Hesse and Thuringia are sufficient for a further 55 years at current production levels (source: Public law agreement on a general framework for sustainable potash production in Hesse and Thuringia [Öffentlich-rechtliche Vereinbarung über einen Gesamtrahmen zur nachhaltigen Kaliproduktion in Hessen und Thüringen]).

² Formally, K+S Aktiengesellschaft [limited company]. The K+S group includes K+S KALI GmbH, which operates potash mining operations in the Werra river valley. For simplicity the abbreviation "K+S" is used in this document.

ROUND TABLE “Werra/Weser River Water Protection and Potash Production”

Allocation of seats on the ROUND TABLE:	Seats
Business and labour (incl. local government of site areas)	
K+S	1
Trade unions/employees	2
Business (Chamber of Commerce and Industry)	1
Local communities near sites	1
Associations and initiatives for water protection	
Environmental and citizens' groups	4
Fisheries' associations	2
Leisure and tourism	1
Neighbourhood representation	
Local authorities of neighbourhood areas (excl. site areas)	3
Weserbund (Weser Alliance)	1
District authorities	3
Länder and federal government	
Länder and federal authorities	6

Fig. 2: Allocation of seats on the ROUND TABLE

Under the chairmanship of Prof. Dr. Hans Brinckmann and with scientific guidance provided by Prof. Dr. Dietrich Borchardt and Dr. Sandra Richter (both of Helmholtz Centre for Environmental Research – UFZ in Magdeburg) and other experts, the ROUND TABLE held a total of 16 meetings and 13 related working group meetings on specific topics and adopted on 9 February 2010 the recommendation documented on page 12.

The work of the ROUND TABLE may be divided into three phases:

1. Following the initial clarification of the ROUND TABLE’s composition and remit, the first task was to establish the situation: what quantities of saline tailings and wastewater are arising, what effect are these having on the aquatic ecosystem, what degradation and treatment processes does K+S use?
2. In the second step the ROUND TABLE examined the many measures and technical processes under debate for solving the problem of the saline effluent in the context of the state-of-the-art in potash production. Measures that appeared particularly suitable were selected and examined in greater depth according to a uniform assessment matrix. In parallel to this the ROUND TABLE defined its own objectives in regard to the quality of the receiving waters of the Werra and the Weser.
3. On the basis of this the ROUND TABLE produced scenarios comprising realistic combinations of actions. The various scenarios were compared with one another and the recommendation drawn up on this basis.

Parallel to this, the ROUND TABLE discussed current developments: in late 2008 K+S agreed to introduce an extensive package of measures. This would make it possible to halve the quantity of saline wastewater to be disposed of, and likewise the amount of salt. At that same time, however, the Environment Ministry of Hesse announced that the practice employed to date, of deep well discharge of liquid tailings, must cease. In February 2009 the *Länder* of Hesse and Thuringia and K+S signed a public law agreement on a general framework for sustainable potash production in Hesse and Thuringia. It is recorded in this agreement that in 2009 K+S must also produce an overall strategy for the reduction of environmental impacts and a detailed integrated action plan for the implementation of the overall strategy.

Salt on the Werra

Extracting the salt

In the Werra river valley, potash salts are extracted primarily for the manufacture of agricultural fertilizers. Today K+S KALI GmbH occupies fourth place in the global potash market. To manufacture its products, crude salt must be obtained from a depth of some 700 metres and then industrially processed. Crude salt contains not only potash salt but also common salt and magnesium salts in varying compositions. Separating the crude salt into its constituent parts involves complex process engineering. Which process can be used depends on the composition of the raw salt and on the required characteristics of the product. Each year some 21 million tonnes of crude salt are brought to the surface at the three Werra salt extraction sites.³ About 78% (16 million tonnes) of the crude salt obtained accrues as residue. 12 million tonnes in solid form (salt waste), 4 million tonnes in solution in water (saline effluent); the latter also contains the water of crystallization released from the carnallite (6%).



Fig. 3: Potash mining sites on the Werra and Fulda: Wintershall (WI), Hattorf (HA), Unterbreizbach (UB) and Neuhof (NE)

Only 16% of the material extracted is sold as part of a product; this amounts to 3.4 million tonnes per year (Fig. 4).

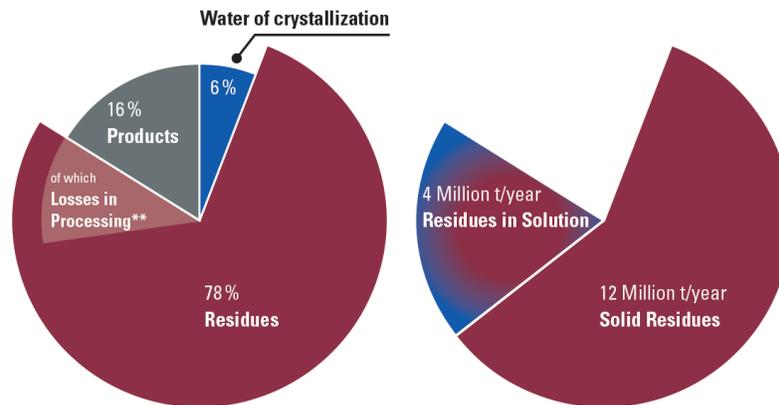


Fig. 4: Mass balance (extracted crude salt and residues)

While the 12 million tonnes of solid residue is almost entirely stockpiled (about 10% is returned to the mine as backfill), half of the 4 million tonnes of residue in solution enters the Werra. The other half is injected into deep geological layers.

³ Base year for this and subsequent data is 2006. Figures are rounded.

Salt and water

The task of the ROUND TABLE is to reduce the salt load of the Werra and Weser and of the groundwater and to bring about the sustainable disposal of production residues, while preserving jobs and manufacturing. To achieve this, the target status of the waters first had to be clarified. Various approaches can be taken:

> Legal provisions: what are the limit values and what levels of water quality are prescribed by German and European law?

> Technical considerations: what salt loads or concentrations in the receiving waters are acceptable for various requirements – such as human use or nature conservation?

How much salt is there in the water?

The salt dissolved in the effluent in aqueous solution separates out into positively charged ions (mainly sodium, potassium, magnesium and calcium) and negatively charged ions (mainly chloride and sulphate). When assessing water quality, the concentrations and proportions of these ions are of particular importance. Contamination levels in the Werra have fallen significantly in recent years. With the closure of industrial plant in Thuringia and due to major investments in the remaining Thuringian facility at Unterbreizbach, the chloride load at Gerstungen has dropped significantly. By introducing a salt load control centre at the three locations of the Werra facility, it was also possible to equalize the chloride concentration to a high degree. The introduction of the dry ESTA® process already led to a reduction in saline effluent at the Hessian locations in the 1980s. Since 2000 the maximum value – set as early as 1943 – of 2500 milligrams of chloride per litre at Gerstungen has largely been maintained.

Nevertheless, the ecology of the Werra beneath the saline effluent discharge points continues to be characterized by salt. In addition to direct discharge of saline effluent, what are known as diffuse emissions of saline effluent also occur from below ground into the Werra – and into the groundwater. Problems are caused not only by today’s discharges of saline wastewater into the Werra. Saline wastewater that has been stored underground over the decades is rising to the surface in concentrated form, together with the naturally occurring salt water. Since this salt water also enters the Werra, at times when the water level is low these diffuse emissions alone can cause the chloride limit value of 2500 milligrams per litre at Gerstungen to be reached or even exceeded. And in certain local areas, particularly close to geological fault zones, salt water can find its way into groundwater storeys that flow into fresh water – via displaced formation water, via “mixed water” (formation water mixed with saline effluent disposed of underground) and via the saline effluent injected underground. Even after underground injection is discontinued – the permission granted by the Kassel district commissioner for the injection of saline effluent into the plate dolomite layer expires in November 2011 – such salt water contamination will occur.

Legal provisions

The German Federal Water Act (Wasserhaushaltsgesetz, WHG) requires, in line with the European Water Framework Directive, that all waters achieve a “good chemical” and “good ecological status” for surface waters and a “good chemical” and “good quantitative” status for groundwater bodies by 2015 (Article 4(1) WFD). Any degradation of surface waters or groundwater should be prevented.

The Federal Water Act prescribes the greatest reduction of pollutant content in effluents achievable by state-of-the-art means, where permission is granted for use of the water bodies. The Water Framework Directive strengthens the water-related, combined approach in Germany: a discharge of pollutants to a body of water is thus assessed in terms of both emissions (on the side of the discharging industrial facility) and ambient levels (on the side of the receiving water). No legally prescribed limit values exist for

salt; these are established by the *Länder* on a case-by-case basis. A reference value for a “good ecological status” is considered here to be 200 mg/l chloride.

Towards good status

Salt loading is not the only problem for the Werra. Only when the emissions of other substances (e.g. nutrients from agriculture and sewage treatment) are reduced in addition to salt, and the structure and linear continuity of water bodies are improved, can the intended improvement in ecological status be reached. There is thus also the need for measures to reduce such further pressures and impacts on water bodies. These activities are set out in the programmes of measures of the *Länder* for implementing the Water Framework Directive. Implementation of the recommendation of the ROUND TABLE should therefore be embedded in a broader strategy.

Owing to the complexity of the pressures and impacts the *Länder* do not regard “good status” in the Werra and Weser as being entirely attainable by 2015. Nor can the salt problem be solved so quickly. However, postponement is not abandonment; the objective of bringing the Werra to a “good status” must then be achieved by 2021, or by 2027 at the latest. Only if this is entirely impossible can “less stringent environmental objectives” be defined for individual sections of water bodies.

Objectives / Ecological requirements for the Werra and Weser and for the groundwater

With regard to salt contamination of the Werra and Weser the ROUND TABLE has prepared a proposal for evaluating water quality. This proposal was developed in the context of the current situation of the waters, existing legal requirements for water protection and the measures now being undertaken for improving water quality. From the point of view of aquatic ecology, limit values for potassium, magnesium and chloride should also be set for future discharge situations (see Table 1).

Table 1: Value ranges of salt loading for chloride, potassium and magnesium and their biological significance. Values specific for the Werra and Weser taking the interactions between chloride, potassium and magnesium into consideration (as 90th percentile values).

Grade	Description	Chloride (mg/l)	Potassium (mg/l)	Magnesium (mg/l)
I	Natural background levels	≤ 75	≤ 5	≤ 20
II	Value ranges for conditions conducive to near-natural biotic communities	75 to 300	5 to 20	20 to 30
III	Value ranges for communities in which sensitive species or particular components of the community are absent	300 to 1000	20 to 80	30 to 100
IV	Value ranges for communities in which more robust species or particular components are absent	1000 to 2500	80 to 150	100 to 180
V	Value range for communities characterized by salt loading	> 2500	> 150	> 180

For evaluating the improvements to be achieved in the individual sections of Werra and Weser the 90th percentile values are used. The majority of the ROUND TABLE considers it a precondition for protecting the groundwater that the underground injection of saline effluent be discontinued as soon as possible and not later than 2020.

Possible solutions

Technological potential

For permission to discharge effluent into the receiving waters at all, K+S must employ “best available techniques” (“Stand der Technik” in German terms). The ROUND TABLE has taken into consideration the existing technological potentials for the prevention and recovery of waste, and thus the full extent of the relevant “best available techniques”. Thus, in its recommendation disposal is only envisaged for such residues that cannot currently be prevented. The technology continues to develop, however. It follows that the technological potential must be regularly examined and realised in future. But how are these potentials to be established? The ROUND TABLE has analysed what producers worldwide are doing. Relevant studies of the competent authorities were taken into consideration. The authoritative EU document on handling mining waste⁴ establishes that the processing of crude salts into potash leaves over 78% as waste in solid or liquid form. This is of the same order of magnitude as occurs at the facilities of K+S. The EU reference document contains no further-reaching proposals on best available techniques with better yields.

From 70 separate measures to an overall solution

In developing its recommendation the ROUND TABLE examined extensive scenarios arising from the various combinations of individual measures.

The ROUND TABLE examined all the methods for solving the problem (measures) that arose in the discussion. Priority was given to source control measures aiming at prevention and recovery. However, the individual measures must work and must make sense. Measures are considered useful and practical if they are proven to be **effective**, are **technically** and **legally feasible** and do not lead to **disproportionate ecological (waste, energy) or economic costs**. These measures are taken into consideration in the scenarios. Those that do not meet the criteria mentioned above were not further considered by the ROUND TABLE.

The ROUND TABLE distinguishes three groups of measures:

- | *Measures for the optimization of operations and production that minimise waste production and wastewater formation (prevention and recovery)*
- | *Measures for the local disposal of unavoidable production residues*
- | *Measures for the disposal of unavoidable production residues at a remote location*

Measures for the optimization of operations and production

These include measures to optimize operations and production such as a deep-freeze systems and changing the wet production of kieserite to the dry ESTA® process at the Hattorf site, further development of the flotation at Wintershall, installing a caustic potash concentration system at Unterbreizbach and various minor operational steps.

With these measures, all scenarios show a significant reduction in salt content by 2015 from previously approx. 4 million tonnes of salt in solution per year to about half this amount. The ROUND TABLE

⁴ BREF 25 – “Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities” – of January 2009. The document on best available technology for potash extraction issued by the German Federal Environment Agency (UBA) on the basis of Directive 2008/1/EC on integrated pollution prevention and control of 15 January 2008 (the IPPC Directive) corresponds to the BREF in its July 2004 version.

recommendation assumes that permission will be granted for each of the individual measures in this package, but this must still be checked with the responsible *Länder* authorities.

Measures for the local disposal of production effluents

A central measure for K+S for local disposal is the planned new integrated saline wastewater control system (NIS). The NIS includes further use of the plate dolomite – for ion exchange, for temporary storage and for a stronger return flow. From late 2015 this should be load-neutral and with reduced volumes. Between 2011 (expiry of current permission for underground injection) and 2015 K+S plans to continue underground injection in the context of the NIS in such a way that more saline effluent is stacked underground than is returned. The quantity is to be steadily reduced. In all scenarios examined by the ROUND TABLE the implementation of NIS is included as a variant. Since the NIS is however prone to risks concerning its long-term feasibility and, alongside its use of underground storage, is still based on continuing discharge into the Werra, albeit at reduced levels, the other variants examine the consequences for the Werra and Weser if NIS is not implemented.

Measures for the disposal of production wastewater at a remote location

Subject to the measures taken by K+S, significantly less saline effluent will be produced in future. This saline effluent need not necessarily be discharged directly into the Werra. By disposing of the effluent away from the production sites, lower down the river, the quality of the water in the Werra and Weser can be substantially improved.

In evaluating the feasibility of a pipeline the following questions must be addressed:

- | Is a pipeline that discharges into the North Sea or the Weser legally viable?
- | Is it purposeful in ecological terms?
- | Would it be economically tolerable/reasonable for the company?
- | And not least, is there a common political will at the *Länder* and federal levels that would assure the rapid implementation of such a large infrastructural measure?

The ROUND TABLE has examined a pipeline to the Weser and to the North Sea. Potentially suitable discharge points lie in the Weser below larger tributaries, thus below the confluences of the Diemel, Werre or Aller. And in the North Sea the Innenjade or the region north-east of the East Frisian Islands as far as the Exclusive Economic Zone (EEZ) offer comparatively good conditions.

The finding of commissioned expert studies was that no legal provision is evident that prohibits the discharging of salt water into the Weser and the North Sea in principle, even though many questions of detail are still to be explored. It should be possible to find a permissible route for the pipeline, since it can be combined with existing pipelines over long distances and must cross a relatively small number of protected zones. Considering the large improvement for the Werra and Weser compared to the relatively small environmental impact caused by the construction of the pipeline, the pipeline appears to be ecologically purposeful with all of the discharge variants considered. The costs are – from a first estimate – of the order of 500 million euros. The construction and operation of such a pipeline is conditional on the common political will of politicians, the authorities and civil society groups.

Developing the scenarios

The ROUND TABLE links practical measures to particular scenarios. A RECOMMENDATION for the favoured action strategy is drawn from these. All scenarios are based on methods that clearly serve the purpose of prevention and recovery and that satisfy the criteria stated above. They are compatible with the overall strategy of K+S (Overall strategy for reduction of environmental impact [Gesamtstrategie zur Verminderung von Umweltbelastungen], K+S, October 2009).

The ROUND TABLE has defined the following scenarios:

SCENARIO I *“Prevention, optimization and discharge into the Werra”*:

Abatement using the measures prioritized by the ROUND TABLE for prevention and recovery. Unavoidable quantities of salt and effluent will continue to be discharged into the Werra. It is assumed for the future that additional measures to improve processes or for the disposal of the remaining residues will be examined and, where appropriate, implemented.

- | Variant Ia: Scenario I with implementation of the new integrated saline effluent control system
- | Variant Ib: Scenario I without implementation of the new integrated saline effluent control system; temporary arrangement for underground injection until 2015
- | Variant Ic: Scenario I without implementation of the new integrated saline effluent control system; cessation of underground injection in 2011

SCENARIO II *“Prevention, optimization and discharge into the Weser”*:

Abatement using the measures prioritized by the ROUND TABLE. In the medium term, unavoidable quantities of salt and effluent are carried by pipeline to the Weser. It is assumed for the future that additional measures to improve processes or for the disposal of the remaining residues will be examined and, where appropriate, implemented.

SCENARIO III *“Prevention, optimization and discharge into the North Sea”*:

Abatement using the measures prioritized by the ROUND TABLE whereby unavoidable volumes of salt and effluent are carried by pipeline, in the medium term, to the North Sea. Unlike scenarios I and II, mainly only measures to improve processes are relevant here for the future.

- | Variant IIIa: Scenario III with implementation of the new integrated saline effluent control system (by 2020)
- | Variant IIIb: Scenario III without implementation of the new integrated saline effluent control system; temporary arrangement for underground injection until 2015

Evaluation of the Scenarios

Modelling the environmental impacts and quality of the waters

In evaluating the scenarios the expected environmental impacts are of central importance. The ROUND TABLE has therefore developed its own projection model for salt contamination in the Werra and Weser. The model is used to calculate the concentrations (as 90th percentile values) for chloride, potassium and magnesium that will occur under the future hydrological regime of the Werra and Weser under various assumptions. The concentrations of salt ions calculated represent the conditions for aquatic biology and thus also the ecological status (c.f. Table 1, the colour codes specified there are used in the following Figures).

The projection model not only takes the quantities of discharged saline effluent into consideration but also examines the flow rates on different days in the Werra and Weser and possible changes as a result of climate change. For statements to be made about the concentrations that occur under different flow rate conditions, the projection model was tested for three different years: an extremely dry year (1976), in which the highest concentrations can be expected, a year with extremely high flows (1987) and an average year (1999).

Additionally, the diffuse emissions from underground and their predicted decline when discharge and underground injection are ceased (Hessian State Agency for Environment and Geology: “Assessment of chloride contamination in the Werra through diffuse emissions for the scenario after cessation of saline effluent discharge and injection of saline effluent” [“Einschätzung der Chloridbelastung der Werra durch diffuse Einträge für das Szenario nach Einstellung der Salzabwassereinleitung und der Versenkung von Salzabwässern”]) are considered. Even if K+S were to do away with saline effluent discharges altogether, the Werra would remain saline for a long time owing to the diffuse emissions from below ground. A reduction should however be assumed when the underground injection is reduced or discontinued.



Fig. 5: 90th percentile values for chloride in the water bodies of the Werra and Weser – current status, (colour codes c.f. Table 1)

Possible variations in concentrations in the Werra are indicated when discharges cease. Following a stop to discharges there would be – given lower average contamination levels – larger fluctuations in concentration in the river sections between Tiefenort and Gerstungen affected by diffuse emissions than is the case today. This will reduce in the longer term.

Effects of the scenarios

Scenario I “Prevention, optimization and discharge into the Werra”

Implementation of the abatement measures prioritized by the ROUND TABLE will lead to a significant reduction in salt loads and thus also in saline wastewater production. The reduction in volume of the saline effluent to be discharged under scenario Ia leads – against the background of the expiring authorization for underground injection – to significantly better ecological conditions being achieved in the Werra and Weser. But there remain concentrations in large sections of the rivers that are classifiable in the lower value ranges, i.e. in ranges in which salt loads have an increasing biological impact.

It would be incorrect to assume a breach of the Water Framework Directive, since it would be possible to claim a deadline extension for achieving “good status”. If the new integrated saline effluent control system is not implemented (scenarios 1b and 1c) there would however be a substantial increase in concentration of salt ions in the Werra and also in the Weser, particularly if no above-ground storage volume is available for matching discharge levels with streamflow rates and salt concentrations. Here it would be necessary to observe the prohibition of degradation under the Water Framework Directive. On the other hand is the advantage that exploitation of the plate dolomite will end in the foreseeable future (2011 or 2015), thus protecting the groundwater from being further affected by underground injection activities. Investment costs to K+S for the implementation of the optimization measures including the NIS are estimated at about 360 million euros. Operating costs have not yet been established.

Further studies are being carried out at K+S that may reveal additional reduction potential in the near future. Some of the measures for short- to medium-term implementation could, assuming successful realization, possibly be applied at other locations too.

Scenario II “Prevention, optimization and discharge into the Weser”

By transporting the saline effluent remaining after implementation of scenario I to the Weser, a significant improvement would be obtained in the quality of the aquatic ecological system in the Werra; however, owing to the diffuse emissions that may be expected to continue for a long period yet, the “good status” prescribed by the Water Framework Directive will still not be achieved.

As regards the salt concentrations expected, the basis for achieving “good status” under implementation of scenario II in a greater or lesser number of sections of the Weser would be established – depending on how far north the discharge point is chosen. Discharge of saline effluent into the Weser must be controlled in proportion to streamflow and requires an accordingly large pipeline diameter and probably the construction of basins for interim storage.

As regards the use of the plate dolomite and long-term disposal strategies, it is the case that (analogous to scenario I) either the plate dolomite will continue to be used for an indeterminate time, whereby a legal examination of the permissibility of this use must be performed,



Fig. 6: 90th percentile values for chloride in the water bodies of the Werra and Weser – scenario 1a, (colour codes c.f. Table 1)



Fig. 7: 90th percentile values for chloride in the water bodies of the Werra and Weser – 2027 – scenario II, (colour codes c.f. Table 1)

or degradations are to be expected in the status of the Weser. It is possible that by implementing elements of the NIS a solution can be found for a reduced use of the plate dolomite and thus of the groundwater.

Extra to the investment costs of some 360 million euro required for implementing the optimization measures is the cost of transporting the saline effluent to the Weser. According to a feasibility study commissioned by the ROUND TABLE, the investment costs for this are between 125 and 510 million euros, depending on the discharge point chosen (net, confidence interval $\pm 25\%$, as at October 2009).

Scenario III “Prevention, optimization and discharge into the North Sea”

By transporting the saline effluent remaining after implementation of scenario I to the North Sea, a significant improvement – compared to discharging the effluent into the Weser – would be obtained in the Weser over a river length of more than 300 km in addition to the quality improvement gained in the Werra. Only in this scenario can value ranges be obtained over almost the entire course of the Weser for the relevant salt ions that make possible the “good status” as set out in the Water Framework Directive in regard to salt contamination. The North Sea pipeline could be operated continually without additional storage capacity, since no streamflow-dependent control of discharge is necessary.

Only in this scenario can the use of plate dolomite as a temporary store and as an ion buffer be discontinued when the pipeline is in operation, without this leading to an increased contamination of the Werra and Weser.

Depending whether underground injection is discontinued in 2015 or only after the pipeline is in operation, the continued discharge of saline effluent may result in a short-term increase in salt concentrations in the Werra and Weser.

In addition there may be the possibility of long-term disposal of tailings piles/tailings water and a further accelerated reduction of diffuse emissions through the return and draining off of saline effluent injected in the past. However, this option requires additional detailed studies.

The costs that arise for transporting the effluent to the North Sea in addition to the investment costs required for the implementation of the optimization measures of about 360 million euros are, according to the feasibility study, of the order of 460 to 510 million euros (net, confidence interval $\pm 25\%$, as at October 2009).



Fig. 8: 90th percentile values for chloride in the water bodies of the Werra and Weser – 2027 – scenario IIIa, (colour codes c.f. Table 1)

Through the abatement measures alone, carried out applying the state-of-the-art under scenario I, no significant reduction in contamination of the Werra and Weser will be achieved. By transporting the saline effluent remaining after implementation of scenario I to the Weser (scenario II), a significant quality improvement in the aquatic ecosystem of the Werra would be achieved. Scenario III leads, by contrast, to an extensive and lasting reduction of pressure on the Werra and the Weser and also on the groundwater.

The ROUND TABLE recommendation in brief

The name of the ROUND TABLE on “Werra/Weser River Water Protection and Potash Production” (German title: RUNDER TISCH “Gewässerschutz Werra/Weser und Kaliproduktion”) points to the two sides of the issue: on the one hand there is the production of a valuable raw material which generates employment and added value, on the other hand there are major environmental impacts. For more than a hundred years the Werra river valley on the border between the regional states (Länder) of Hesse and Thuringia has been a centre of potash mining in Germany. While ongoing improvements in production technologies have significantly reduced environmental impacts, the salinization of the Werra and Weser rivers and the underground injection of salt effluent continue to pose problems – for nature, for residents, and for users of water bodies. On account of the legal requirements for the protection of groundwater and surface water, especially the European Water Framework Directive, and in view of the widespread discontent with the state of the Werra and Weser rivers, action is needed: certain objectives should be met in the short-term while binding steps should be taken to achieve certain other objectives by 2027 at the latest.

In 2007, the state parliaments of Hesse and Thuringia decided to establish the ROUND TABLE on “Werra/Weser River Water Protection and Potash Production”: “Its aims are to provide a consolidated and objective basis for debate on improving the quality of the receiving waters – the Werra and Weser rivers – and achieving sustainable production patterns, to create confidence and acceptance, and to develop proposals for viable solutions.” (quote from the declaration of establishment).

Since March 2008 the ROUND TABLE members have been working on such solutions. The participants comprise representatives of the municipalities bordering the rivers, environmental organizations and fisheries associations, citizens' action groups, the unions, and the chambers of industry and commerce, working jointly with the company K+S AG*, the Länder of Thuringia, Hesse, North-Rhine/Westphalia, Lower Saxony and Bremen as well as the Federal Environment Ministry BMU. Under the chairmanship of Prof. Dr. Hans Brinckmann and with scientific guidance provided by Prof. Dr. Dietrich Borchardt (Helmholtz Centre for Environmental Research – UFZ in Magdeburg) and other experts, the ROUND TABLE held a total of 16 meetings to discuss the issues and adopted the present recommendation on 9 February 2010. The discussions which led to this recommendation were constructive, if at times controversial. Where consensus could not be reached, minority votes are given as footnotes in the text.

The ROUND TABLE recommendation is based on safeguarding potash production and the associated employment and, in conjunction with further measures taken by the Weser river basin commission, will deliver sustainable improvement of the environmental situation. The recommendation includes the following measures and procedural stages:

1. The ROUND TABLE recommends that all measures for sustainable waste management be designed in such a way that production and employment are safeguarded in the long-term and that water pollution (Werra and Weser rivers, groundwater) is reduced to the best possible extent.⁵
2. The ROUND TABLE recommends that local disposal of the unavoidable saline waste water arising from the production of potassium salt and from the tailings piles by way of discharge into the Werra river and by underground injection be discontinued as soon as possible and by 2020 at the latest.⁶

⁵ Note in the minutes by members Körzell (DGB), Nothhelfer (IGBCE), Dr. Schmidt (Hersfeld-Rothenburg), Ernst (Unterbreizbach), Orth (Philippsthal), Krauser (Wartburgkreis) and Mayer (Hesse): Should the continued production of potassium salts and the associated employment be at risk due to the implementation of the pipeline failing on one of the test criteria (legal, technical, economic, ecological) or being delayed due to no fault of K+S, the undersigned consider it to be acceptable, primarily on socio-economic grounds, to continue to discharge into the Werra, in line with the provisions of water resources law, the saline effluent remaining after all reasonably achievable mitigation and recovery efforts have been made.

⁶ Members Gunkel, Meier and Brauneis (representing environmental and conservation organizations in Thuringia, Lower Saxony and Hesse respectively), Wemheuer (district assembly of Lower Saxony), Hix (representing the “Save the Werra” citizens’

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3. The ROUND TABLE recommends that the best available technical capabilities at the Werra site for the effective mitigation and recovery of residues from potash production be implemented as soon as possible in order to reduce the quantity of saline effluent by approximately 50%. The following technical measures should be operational by 2015 at the latest:
 - Construction of a facility for deepfreezing caustic potash solution at the Hattorf site,
 - Further development of the kieserite flotation process at the Wintershall site,
 - ESTA® plant at the Hattorf site,
 - Construction of a caustic potash concentration system at the Unterbreizbach site.
4. The ROUND TABLE considers it necessary that K+S continue to monitor the relevant state-of-the-art of mitigation and recovery of residues from potash production and, when it becomes applicable, to implement such technology without delay in order to increase yields obtained from the raw material extracted from the mines, reduce the quantity of saline effluent, optimize the utilization of underground cavities, and reduce the amount of solid tailings to be disposed of and thus curb the growth of tailings piles and the quantity of runoff.
5. The ROUND TABLE recommends that a pipeline be constructed to take the remaining saline effluent generated after the implementation of the above measures to an ecologically acceptable discharge point in the North Sea area and thus ensure disposal while sustainably reducing the environmental impact on groundwater and surface waters. K+S should immediately start to plan the construction of a pipeline and should present a feasible plan of implementation by the end of 2010. The Länder involved should be tasked with ensuring that the plan of implementation is legally and politically viable and that planning approval can be obtained swiftly across Land boundaries.^{7, 8}
6. For the transition period until the termination of discharge and underground injection of saline effluent from potash production and from the tailings piles, and until such time as the pipeline will be operational by 2020 at the latest, the ROUND TABLE recommends that in cooperation with K+S and the Länder all technical and legal opportunities be utilized towards achieving a gradual reduction of saline effluent discharge into the Werra river. The same should hold for underground injection. The new integrated saline effluent control system (NIS) developed by K+S should be developed further and an assessment should be made of the potential this technology offers in the interim to contribute to an improved quality of receiving waters until such time as the pipeline becomes operational.
7. The ROUND TABLE recommendation is based on expert deliberations which have been accepted by a majority of the members and which are set out in the following chapters. The recommendation pursues the implementation of Scenario III (operational optimization and construction of pipeline towards the North Sea), the preconditions and impacts of which have been subjected to a comprehensive assessment, and which will ensure the sustained improvement of Werra and Weser river water quality as well as of the groundwater.
8. The ROUND TABLE recommends that the Länder of Thuringia, Hesse, North-Rhine/Westphalia, Lower Saxony, and Bremen as well as the Federal Government and K+S give, as soon as possible, a strong signal of their commitment to follow the ROUND TABLE recommendation in order to demonstrate that they are willing to work on long-term solutions.

It is the view of the majority of members that the ROUND TABLE has generated a sufficient technical and scientific decision-making basis and has publicly documented this. On this basis, the ROUND TABLE

action group) and Reimuth (representing the fisheries associations of Hesse) welcome the final discontinuation of underground injection in Thuringia and consider underground injection of saline effluent in Hesse acceptable at most until 2015.

⁷ The fisheries associations in Lower Saxony reject the construction of a pipeline and discharge into the Weser river and the North Sea.

⁸ The Land of Lower Saxony fundamentally rejects the conveyance of effluent to a discharge point further downstream and into the North Sea. In view of the estimated costs of a pipeline amounting to at least 500 million Euros, the Land of Lower Saxony considers a further reduction at source to be viable, and sees far more potential for source reduction than is targetted by the 360 million Euro investment programme decided upon by K+S.

recommends with 20 votes in favour⁹, 3 votes against, and no abstentions to pursue a comprehensive, systemic solution comprised of measures to reduce and recover production waste through further operational optimization, measures to dispose of unavoidable waste on a local and supra-local basis, and additional assessments. The recommendation includes proposals for an interlocking schedule of individual measures and implementation in pursuit of a comprehensive solution effective over the long-term as well as transparent, in-process monitoring of the stages of implementation.

The ROUND TABLE recommendation is based on technical, ecological and economic studies and takes its orientation from the legal concepts of appropriateness and proportionality. Its implementation will make an important contribution to securing employment in the potash-producing region of Hesse and Thuringia and will secure the production of fertilizers and other substances in the long-term. The ROUND TABLE considers the expenditure required for the construction and operation of the pipeline overall in macro-economic terms to be in keeping with the concept of proportionality, given the benefits accruing to society at large from the improvement of the water quality of the Werra and Weser rivers and also bearing in mind the planned public expenditure on watercourse rehabilitation to be incurred by the Länder that are members of the Weser river basin commission. However, the ROUND TABLE is not in a position to provide an appraisal of the micro-economic appropriateness at present or at a point in the future when the pipeline becomes operational.

A long-term improvement of groundwater and surface water quality is achievable from 2020 onwards at the latest. From that time onwards it will once again be possible for freshwater communities to establish in the Werra and Weser rivers and the conditions for the utilization of the rivers (in particular fisheries and extraction of drinking water) will improve. However, for these improvements to materialize, in tandem with implementation of the ROUND TABLE recommendation other pressures on the rivers must be reduced, as outlined in the management plan produced by the Weser river basin commission. The ROUND TABLE is aware of the fact that the implementation of its recommendation rests fundamentally, but not solely, with K+S. Development approval procedures must be completed, political support is needed and there is a possibility of court cases.

⁹ Two additional members who were not in a position to attend the meeting at which the vote was taken declared their agreement with the recommendation