Environmental impact assessment report compiled by

ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE VRBINA KRŠKO LILW REPOSITORY

Velenje, May 2017
supplemented in February 2018, April 2018, October 2018, March 2019

Procurer:	**Republic of Slovenia** **Gregorčičeva 20-25** **1000 Ljubljana** **by authorisation of** **ARAO, Ljubljana** **Celovška cesta 182** **1000 Ljubljana**
Contents:	**ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR THE VRBINA KRŠKO LILW REPOSITORY**
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1 INFORMATION ON ENTITY RESPONSIBLE FOR ENCROACHMENT AND ON SUBMITTED REPORT

1.1 TITLE OF PROJECT AND ITS PURPOSE

Title: LILW repository, Vrbina, Krško

Purpose: In Slovenia, which is among the countries with a nuclear programme, final disposal of low and intermediate level radioactive waste (hereinafter LILW) has not yet been regulated; therefore, a permanent radioactive waste repository needs to be arranged. With the construction of the repository, a long-term solution of the problem of LILW management will thus be established in a country where LILW is generated. For an effective, permanent and environmentally ethical and responsible solution to the issue of LILW, Slovenia must therefore ensure its safe and final disposal at an appropriate facility while taking into account international standards and achieving social and environmental acceptability.

The LILW repository in question is a **nuclear facility** intended for the permanent disposal of low and intermediate level radioactive waste[1]. In ensuring the disposal of LILW, we will take into account the generally accepted principles that radioactive waste should be managed in a way that ensures the protection of human health and the environment, does not burden future generations in any way, and where control over the safety of facilities and activities related to radioactive waste is ensured by the proper inclusion of independent administrative authorities.

The repository at the Vrbina site in the municipality of Krško is designed for permanent disposal of low and intermediate level radioactive waste generated in Slovenia.

1.2 OBLIGATIONS OF ENVIRONMENTAL IMPACT ASSESSMENT

The project "LILW repository Vrbina" falls under the Decree on categories of projects for which an environmental impact assessment is mandatory (Official Gazette of the RS, No. 51/14, 57/15, 26/17) in the following point, in accordance with Annex I Types of environmental encroachment for the following type of project:

D.II Nuclear energy D.II.6 A permanent repository of spent nuclear fuel or exclusively radioactive waste.

[1] In accordance with Article 4 of the Rules on radioactive waste and spent fuel management (JV7), LILW is:

1 low- and intermediate-level radioactive waste (hereinafter: LILW) in the management of which heat generation does not need to be considered, but they are classified into two groups:

1.1 Short-lived LILW, where the specific activity of the contained alpha emitters, having a half-life exceeding 30 years, is equal to or lower than 4,000 Bq/g in any individual package but in no case greater than 400 Bq/g on average in the overall amount of LILW;

1.2 Long-lived LILW, where the specific activity of alpha emitters exceeds the limitations applying to short-lived LILW;

All other developments[2] (plateau, including supporting embankment, exterior and landscaping arrangements, transport infrastructure and line infrastructure), which are functionally and spatially linked to the basic project "LILW repository Vrbina" are dealt with as projects owing to the basic project and are equally assessed in accordance with the substance of the aforementioned Decree, where the main emphasis in the assessment is on determining impacts and measures.

The area of the project does not encroach on a Natura 2000 area, nor on any protected areas. The area under discussion contains no natural features or areas that are important to biodiversity. The nearest protected area to the site is a Natura 2000 area (SAC Vrbina), which is at a distance from the closest point of the site of less than 1,000 m and is separated by the stream of the River Sava. As part of the environmental report, an addendum for protected areas was not necessary.

The LILW repository involves a very specific form of collection site for waste material, which given the classification of encroachments in the Rules on assessment of the acceptability of impacts of the implementation of plans and developments affecting nature in protected areas, cannot be more precisely defined.
An amendment to the Rules on assessment of the acceptability of impacts of the implementation of plans and developments affecting nature in protected areas now provides that the remote impact is determined in an area that is twice as large as the area of remote impact. In the case of the project in question, this remote impact is therefore 1,000 m. The table below shows that the remote impact is not defined for species that are typical for the closest Natura area, but exclusively for the brown bear, which according to known data for the project area is not present. According to data from the Hunting Society of Cerklje ob Krki, no brown bears have appeared in the area of Vrbina (left bank of the River Sava) for the last 30 years (letter from the president of the Hunting Society of Cerklje ob Krki).

AREA OF ENVIRONMENTAL INFRASTRUCTURE

Encroachment on nature	Direct impact	Area of direct impact (in m)	Remote impact	Area of remote impact (in m)
Arrangement of the collection site for waste material (refuse dumps, landfills and ecology islands) and waste disposal sites	ALL GROUPS	50	brown bear	500

Given the absence of brown bears in the project area in question and the nature of the waste (LILW), we may conclude with certainty that there will be no remote impact from the project in question on brown bears (since they are not present in the area) and in view of these facts no addendum for protected areas is necessary.

[2] These are considered to be projects that do not fall under mandatory assessment in accordance with the Decree on the types of environmental encroachment for which an environmental impact assessment is required and are defined in the Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško (Official Gazette of the RS No. 114/09 and 50/12).

1.3 INFORMATION ON ENTITY RESPONSIBLE FOR PROJECT

Responsible entity:	Republic of Slovenia Gregorčičeva 20-25 1000 Ljubljana by authorisation of ARAO, Ljubljana Celovška cesta 182 1000 Ljubljana
Responsible person:	Acting Director mag. Sandi Viršek

1.4 INFORMATION ON REPORT COMPILER

Company - in charge:	Eurofins ERICo Slovenija Inštitut za ekološke raziskave d.o.o.
Address:	Koroška 58, 3320 Velenje
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1.5 SUBJECT AND CONTENT OF REPORT

For the project in question prior information was obtained from the Slovenian Environment Agency (ARSO), specifically document No. 35400-566/2011-17, that for the project in question there would be a requirement, pursuant to Article 54 of the Environmental Protection Act (ZVO-1) and the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment, to produce an environmental impact assessment report. Pursuant to Article 52 of the ZVO-1, preliminary proposals for the content of the environmental impact assessment were received from the Ministry of Health, Directorate for Public Health, Ministry of the Environment and Spatial Planning, Slovenian Nuclear Safety Administration, Ministry of the Economy, Energy Directorate, Mining Section, the Nature Protection Institute and the Institute for the Protection of Cultural Heritage.
In relation to Article 52 of the ZVO-1 and in connection with Article 21 of the Local Self-Government Act, which outlines that municipalities ensure protection of the air, soil, water sources, protection against noise, provide for collection and disposal of waste and perform other environmental protection activities, ARSO obtained information on the content of the EIA from the following municipalities: Krško, Brežice, Sevnica, Laško and Šmarješke Toplice.
All the content proposed by the ministries and municipalities are incorporated into or addressed in this EIA report for the LILW repository at Vrbina, Krško, where impacts on the environment and on human health are addressed.

In the context of the call to supplement the application for environmental consent for the project in question (No. 35402-29/2017-3, of 5 February 2018) ARSO states: "On 22 July 2017 the Decree amending the Decree on the content of the report on the effects of intended activity in the environment and its method of drawing up (Official Gazette of the RS No. 40/17) entered into force. **Pursuant to Article 14 of the cited decree, the compiling of a report in procedures for obtaining environmental consent that were initiated prior to the entry into force of that decree would be governed by the Decree on the content of the report on the effects of intended activity in the environment and its method of drawing up (Official Gazette of the RS No. 36/09)."**

The purpose of drawing up the Environmental Impact Assessment Report for the LILW repository is to assess the impacts that could significantly affect the environment and human health, both in terms of the nature and characteristics of the intended activity and in terms of the features and characteristics of the environment or its parts which could be affected by the impacts of the activity.

The subject of the report is therefore the description and analysis of the intended activity affecting the environment at the time of its implementation, duration and termination in relation to the environment in which it is being placed, as well as an assessment of all possible impacts of the activity that could have significant effects on the environment: on air, water, soil, agricultural land, nature, landscape, etc. However, since the emissions of pollutants into the air, water, soil, noise emissions and the generation of waste have a significant direct or indirect impact on people and their health, one can also speak about potential environmental burdens and potential burdens on human health.

The report on environmental impacts is designed in a such a way that, based on the zero state and the results of the existing measurements and expert assessments, a finding is made of the existing situation at the site. This finding was the starting point for the assessment of changes caused by the planned activity and for the assessment of environmental impacts caused by these changes. The report provides the measures envisaged to reduce the identified impacts and a proposal to monitor the condition of the environment during construction, operation and after the abandonment of the activity.

The report addresses the following emissions and impacts on the environment and human health:

a) emission of substances into the atmosphere,
b) emission of substances into water,
c) emission of substances into the ground and agricultural surfaces,
d) environmental pollution with impacts on the nature,
e) environmental pollution with impacts on the landscape,
f) environmental pollution with waste,
g) environmental pollution with noise emissions,
h) environmental pollution with emissions of ionising radiation*,
i) environmental pollution with emissions of electromagnetic radiation,
j) environmental pollution with light,

* In certain chapters, ionising radiation is dealt with partly in points a), b) and c). The comprehensive part of the issue is addressed specifically in a separate chapter on ionising radiation both for the existing and also future state (the anticipated state after construction) and during the period of construction, operation and after abandoning the activity and thereafter.

In the area of intervention, there are no recorded cultural heritage units and no protected archaeological sites, so the activity's impact on the cultural heritage was not addressed in the EIA. Moreover in addressing the impacts of the project, we left out climate change, since the project is not a significant source of greenhouse gases and within the environmental report its impact was assessed as insignificant. At the LILW repository no activities will be pursued for which pursuant to the Decree on greenhouse gases, activities and installations for which a greenhouse gas emissions permit is required or monitoring of greenhouse gas emissions must be implemented (Official Gazette of the RS, No 55/11 and 1/13) a licence to release greenhouse gases into the atmosphere must be obtained. In the context of the existing situation we addressed odours (since the existing situation is an agricultural area), but the project is not a source of odours, so we did not address the impacts of the project in terms of increased odours in the environment. The project does not impact forest areas, since there are no such areas in the project area in question. Furthermore the project is not a source of thermal pollution, so the report leaves out the impact of the project in terms of thermal pollution.

Based on the findings, the following segments of the environment were excluded from discussion and from the impact assessment for the project:

- climate change
- odours
- thermal pollution
- cultural heritage
- forest (in the context of nature)

All the construction and technical characteristics of the project and the disposal technology are summarised in the EIA from:

- Conceptual Design (IDZ) for the LILW Repository Vrbina, Krško, project No. NRVB-B052/058-1, Rev. C, produced by the company IBE d.d., svetovanje, projektiranje in inženiring, Ljubljana, in January 2016

Inherent in the project will also be the construction of a second silo (in the event of implementation of scenario SA.2, i.e. Croatia joining the LILW repository project), so an addendum for the needs of completing the EIA was produced in the context of the Conceptual Design, addressing the solutions for the second silo:

- "Development potentials of the repository to be taken into account in elaboration of the EIA", document No.: NRVB---1P/M09B, prepared by the company IBE d.d., svetovanje, projektiranje in inženiring, Ljubljana, January 2016.

The Environmental Impact Assessment (EIA) thus addresses the disposal of all LILW waste generated in Slovenia and the construction of two silos.

Under scenario SA.2, two silos are envisaged for the disposal of the entire quantity of waste from Krško NPP and all other LILW generated in Slovenia. Under scenario SA.3, the construction of one silo is envisaged for the disposal of the Slovenian half of the waste from Krško NPP and all other LILW generated in Slovenia. Both scenarios are addressed in the confirmed Feasibility Study for the LILW repository, rev. C.

In the documents which form the basis for the Environmental Impact Assessment, the number of silos and quantity of waste are addressed as follows:

- IDZ rev. C discusses the construction of one disposal silo and disposal of half the LILW from Krško NPP and all other waste generated in Slovenia,
- Addendum to IDZ rev. C – the study "Development potentials of the repository to be taken into account in elaboration of the EIA", discusses the construction of two disposal silos and disposal of all LILW generated in Slovenia.

The Draft Safety Analysis Report, which is an annex to the Environmental Impact Assessment, addresses the entire quantity of LILW generated in Slovenia. For the area of radiation and nuclear safety, the Safety Analyses, which serve as the basis and substance of the Draft Safety Analysis Report, discuss the disposal of all waste at the disposal facility site.

With the aim of assessing the greatest possible burdening of the environment, the EIA documents discuss for the LILW repository the disposal of all LILW generated in Slovenia and the construction of two silos, and for the area of radiation loading of the environment (model research) the disposal of all LILW waste at the disposal facility site.

In addition to the IDZ and the study "Development potentials of the repository to be taken into account in elaboration of the EIA", in the EIA we also used:

- Design bases for the LILW repository Vrbina, Krško – environmental impact assessment phase, March 2018,
  and
- Draft Safety Analysis Report (osnVP) for LILW site Vrbina, Krško, April 2018, Chapters 0 - 16.

Design Bases and Draft Safety Analysis Report

The **Design Bases** constitute the starting points that must be taken into account when design solutions are being planned for the Vrbina, Krško LILW repository. The starting points include adherence to the regulatory nuclear and radiation safety requirements, standards, principles, analyses, the investor's special requirements, and so forth.
The Design Bases document is not intended to prove that the repository is safe. Under Slovenian legislation (ZVISJV) a Safety Report is compiled for the purpose of demonstrating nuclear and radiation safety. The Design Bases are annexed to this report.
According to Article 70a of the ZVISJV, an investor that intends to construct a new radiation or nuclear installation must draft design bases for the installation as part of:

- the special safety analysis compiled during the process of preparing the national spatial plan;
- the Environmental Impact Report compiled as part of the process of acquiring preliminary consent on nuclear and radiation safety and
- the safety report compiled at all subsequent stages.

The reason for drafting the Design Bases document during the phase of acquisition of environmental consent is the requirement to compile the Design Bases for the Vrbina, Krško LILW repository, which will serve as the basis for preparation of the Draft Safety Analysis Report and form part of the Environmental Impact Report, which will serve as the basis for acquisition of the preliminary consent on nuclear and radiation safety, as required under Article 65b(1) of the ZVISJV. As required under Article 40 of the JV5 rules, the Design Bases will also serve as the basis for the drafting of the project design output.

The Design Bases are drawn up as an independent document and constitute an upgrade to the previous design bases for the LILW repository at the potential location of Vrbina in the Municipality of Krško, which were drafted by IBE d.d. in 2009. Under the regulations in force, the document must be updated for acquisition of a construction permit, during construction, throughout the repository's entire service life, during any suspension of operation and during decommissioning, as well as subsequently during the long-term post-closure surveillance period, so as to show the actual state of the installation.

The Draft Safety Analysis Report is a document drawn up as part of the EIA report. In December 2011 preliminary information was obtained from ARSO regarding the content and scope of the environmental impact assessment, as facilitated by Article 52 of the ZVO (No. 35400-566/2011-17 of 27 December 2011). The information contained the proposed content and scope, as provided by the Slovenian Nuclear Safety Administration, in accordance with its powers (No. 3541-5/2011/2 of 21 December 2011). The proposal states that the content of the EIA for the LILW repository, where it relates to nuclear and radiation safety, should be formulated as a separate document in accordance with the draft practical guideline No. PS 1.03, entitled Content of safety report for the LILW repository, December 2011. The practical guideline was also issued officially in July 2012. The content of the Draft Safety Analysis Report accords with the practical guideline and the guidelines, whereby content is provided that in this stage of the project is already known and important for the assessment of nuclear and radiation safety, while the emphasis is on content that is important in terms of impact on the population and the environment.

The Design Bases and the Draft Safety Analysis Report were taken into account in formulating the Environmental Impact Report for the LILW repository in the scope of required content under the Decree on the content of report on the effects of intended activity in the environment and its method of drawing up (Official Gazette of the RS No. 36/09).
Pursuant to Article 9 of the decree, it is necessary to describe and assess the potential impacts during preparatory works or construction, use or operation, or for the duration of the activity, as well as during removal or abandonment of the activity and thereafter. The table below shows the phases of the repository covered in the assessment of all foreseen possible impacts by phase, as defined by the decree:

Phases of impact assessment under the Decree	**Phases of the repository**
Construction:	— Construction of the repository
Operation:	— Trial operation — Regular operation — Standby phase and preparation for renewed operation
Abandonment of the activity and later:	— Activities for closing the repository and its decommissioning — Phase of active long-term control and monitoring — Phase of passive long-term surveillance — Establishing unrestricted use of the physical space

1.6 SPATIAL PLANNING ACTS

1.6.1 *SPATIAL PLANNING ACTS AND LEGISLATION DEFINING LILW*

Spatial components of municipality planning documents:
- Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09),
- Decree on the detailed plan of national importance for the area of the Brežice hydroelectric plant (Official Gazette of the RS, No. 50/12),
- Ordinance on the municipal spatial plan for the municipality of Krško (Official Gazette of the RS, No. 61/15).

The tasks that Slovenia must fulfil in relation to managing radioactive waste and spent fuel are based on the legal obligations of the state, as defined in national legislation, on the obligations stemming from the legal foundations of the EU and on the obligations deriving from inter-government and international treaties, conventions and agreements to which Slovenia has acceded.

Legislation is aligned with the European acquis in the area of protection against ionising radiation and of nuclear safety, and ensures a high level of nuclear safety that includes the following areas:

- nuclear safety, including regulations and operational aspects and controlling serious accidents,
- protection against radiation and monitoring and surveillance of radiation in the environment,
- problems related to the fuel cycle and safe storage of nuclear materials, including measures to prevent the smuggling of nuclear materials,
- radioactive waste management,
- early exchange of information in the event of radiological accidents,
- decommissioning of nuclear facilities,
- nuclear responsibility of third persons.

Construction of the LILW repository is defined to the greatest extent by:

- the Feasibility Study, Rev. C, NRVB-4X/01C, IBE, Ljubljana, December 2013,
- Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09),
- Decree on the detailed plan of national importance for the area of the Brežice hydroelectric plant (Official Gazette of the RS, No. 50/12),
- Ordinance on the Spatial Planning Strategy of Slovenia (Official Gazette of the RS No. 76/2004),
- Decree on Spatial Order of Slovenia (Official Gazette of the RS No. 122/04),
- Ionising Radiation Protection and Nuclear Safety Act (ZVISJV) (Official Gazette of the RS, No. 102/04, 60/11, 74/15),
- Environmental Protection Act, ZVO-1 (Official Gazette of the RS, No. 39/06, 70/08, 108/09, 48/12, 57/12, 92/13, 56/15, 102/15 and 30/16),
- Resolution on Nuclear and Radiation Safety in the Republic of Slovenia 2013-2023 (Official Gazette of the RS, No. 56/13),
- Fund for the Financing of the Decommissioning of Krško NPP and the Disposal of RW from Krško NPP Act (Official Gazette of the RS, No. 75/94, 24/2003, 68/2008),
- Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on Regulation of the Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško NPP (BHRNEK agreement),
- Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016-2025 (Official Gazette of the RS, No. 31/16).

The **Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško** was adopted in 2009. The Decree lays down the following: planned spatial arrangements, area of the detailed plan of national importance, conditions regarding the purpose of activities, their position, size and design, conditions regarding the connection of facilities to economic public infrastructure and built public good, criteria and conditions for parcelling, conditions for integrated conservation of cultural heritage, nature conservation, protection of the environment and natural assets and protection against natural and other disasters, conditions for the protection of human health, the stage-nature of implementation of spatial planning, other conditions and requirements for the implementation of the detailed plan, permissible deviations and areas of spatial arrangements for which the spatial implementation conditions will be determined after adoption of the detailed plan.

The Decree on the detailed plan of national importance for the area of the Brežice hydroelectric plant (Official Gazette of the RS, No. 50/2012) provides in Article 47 for ensuring the safe and reliable supply of drinking water for the LILW repository and other consumers the construction of a connecting water main between the Drnovo and Brege pumping stations in a total length of 1907 m. From the Brege pumping station to the dam before Krško NPP and over the dam, the water main should be constructed or reconstructed in a total length of 2 x 1652 m. A new pipeline in a total length of 1531 m is also to be constructed south of Krško NPP to the LILW repository, serving to improve the safety of providing that repository with drinking and fire extinguishing water.[3]

In line with the **Spatial Development Strategy of Slovenia** the spatial planning entity responsible for the disposal of radioactive waste must ensure that the LILW repository site is determined in good time, and lay down all the technical conditions for execution of the LILW repository, as well as for the operation, remediation and closure of the sites of existing repositories or storage facilities.
The procedures and technical material for determining the most appropriate site for the LILW repository that have been conducted to date, and the activities as part of producing studies, have observed the provisions of the **Spatial Development Strategy of Slovenia (Official Gazette of the RS, No. 76/04)**, which sets out in chapter 2.5.1 Radioactive waste:

1. Disposal of LILW shall be ensured in the territory of the state prior to the end of the operating life of Krško NPP, in accordance with the applicable legislation applying to ionising radiation protection and nuclear safety, and the international conventions and treaties of which Slovenia is a signatory, while solutions for the permanent disposal of high-level radioactive waste (hereinafter: HLRW) are being sought with the help of the wider international community.
2. The primary areas for selection of the LILW repository site are drawn up on the basis of expert evaluation of the land in terms of suitability for LILW disposal, and are founded on criteria that determine the safety of the disposal site. Assessment of alternative sites within the primary areas is performed in accordance with international guidelines along with the assessment and evaluation of variants from the aspect of impacts on the environment and on regional and urban development, from the economic aspect, functional and technical appropriateness and in terms of public acceptability.
3. The selection of the site is carried out in a "combined" procedure, i.e. it includes professional/expert assessment and the acquisition of local site bids, and ensures a high degree of public participation.

In 2002, as a result of approximation to the European Union and of the requirement to align with the latest international recommendations, the new basic **Ionising Radiation Protection and Nuclear Safety Act** was adopted (Official Gazette of the RS, No. 67/02, 24/03, 50/03, 46/04, in 2004 standardised in the Official Gazette of the RS 102/04 as ZVISJV-UPB2, in 2011 it was

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[3] Elaboration of spatial and design output and obtaining the permit to construct the pipeline connection from the Brege pumping station over the dam before Krško NPP and south of Krško NPP to the repository, and for reconstruction of the water main from the Resa reservoir to Krško NPP is being conducted by the Municipality of Krško under a separate procedure, and is assuring the construction of both within five years of obtaining the construction permit for the repository.

recast and adopted as the Act Amending the Ionising Radiation Protection and Nuclear Safety Act or ZVISJV-C, Official Gazette of the RS, No. 60/2011); it was aligned with the European acquis in the area of ionising radiation protection and nuclear safety. This act regulates ionising radiation protection for the purpose of reducing damage to human health and the radioactive contamination of the living environment from the use of ionising radiation sources to the greatest degree possible, and at the same time of enabling the development, production and use of radiation sources and the implementation of radiation practices. The act regulates the implementation of nuclear safety measures for radiation sources intended for the production of nuclear energy and, where the use of nuclear goods is concerned, special protection measures as well.

The Act amending the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV-A), which was adopted in March 2003 (Official Gazette of the RS, No. 24/03), sets deadlines for the drafting of the national RW and SNF management programme (by the end of 2004), and deadlines for the selection and approval of a location (by 2008) and for the acquisition of an operating licence (by 2013) for the LILW repository.

The act lays down that the service life of the facility is the period in which the facility is used for the envisaged purposes. If this involves a repository, that period begins on the first disposal of waste or spent fuel into the facility, and ends on the closure of the repository.

The act further defines the supervision of implementation of the Act by competent inspectors at the authority competent for nuclear safety, the authority competent for radiation protection and the inspectorate competent for internal affairs.

Under the Ionising Radiation Protection and Nuclear Safety Act, radioactive waste is substances in gaseous, liquid or solid form, and objects or equipment that are waste products of radiation practices or intervention measures and for which no further use is anticipated, but that contain radioactive substances or are radioactively contaminated beyond clearance levels.

The Ionising Radiation Protection and Nuclear Safety Act defines the management of radioactive waste as the collection, treatment, conditioning, temporary storage and disposal of radioactive waste. A nuclear facility is a facility for the storing, processing, treating and disposal of radioactive waste.

In the chapter on ionising radiation protection, the act lays down that radioactive substances may be collected, recorded, treated, stored, finally disposed of and discharged into the human environment only in the manner and under the conditions laid down in the regulations based on this act. In 2015 the final amendments were enacted in the Act Amending the Ionising Radiation Protection and Nuclear Safety Act (UL RS, No. 74/15).

The Environmental Protection Act (ZVO-1) defines radioactive waste as waste which, owing to certain radioactive properties under the regulations on ionising radiation protection, is categorised as radioactive waste. It also states that waste is a specific substance or article in cases where the generator or other person that holds that substance or article in their possession discards, intends to discard or is obliged to discard it.

The Environmental Protection Act (ZVO-1) lays down that the management and disposal of radioactive waste is a compulsory national public environmental protection service the activities of which are ensured by the state in accordance with the regulations on commercial public services. A licence to dispose of or process radioactive materials is issued by the ministry responsible for the environment.

In the Ordinance on the Transformation of the Agency for Radwaste Management into a public utility institute, the Slovenian government determined that ARAO would conduct its activities in the legal-status form of a public utility institute, i.e. as a non-profit activity. The ordinance provides for three sources of funding for ARAO activities: the state budget, the Fund for the Financing of the Decommissioning of Krško NPP and the Disposal of RW from Krško NPP, and payments made by users of the public service/small producers (including storage) and the future radioactive waste repository. The disposal of RW and SNF from energy-producing nuclear facilities (and therefore from Krško NPP) is financed exclusively from the resources of the dedicated Fund.

The ZVISJV likewise lays down that the costs of managing RW and SNF are paid by the generator of the RW, or the holder of the RW if it took the waste over or otherwise acquired it from the generator. The Environmental Protection Act (ZVO-1) introduces the principle of liability on the part of generators of excessive environmental burden and the ‘polluter pays’ principle, under which the polluter covers all the costs of the measures prescribed to prevent and minimise pollution and environmental risk, and to eliminate the effects of pollution. The ZVISJV also lays down that the costs of managing RW are paid by the waste generator.
From the beginning of the 21st century on the commitment to ensuring nuclear and radiation safety has been underlined at the highest political level. Since 2010 this has been recorded in the fundamental standard, IAEA GSR Part 1: Governmental Legal and Regulatory Framework for Safety, ISBN:978-92-0-106410-3, ISSN 1020–525X. Although the provisions of the IAEA standards are not binding, all countries that use nuclear energy abide by them as a rule. The aforementioned standard was also the main guiding force for the **Resolution on Nuclear and Radiation Safety in the Republic of Slovenia 2013–2023**. Although Slovenia already has legislation and administrative arrangements in the area of nuclear and radiation safety, which by and large align with international standards, the Resolution fills in an outstanding gap. It represents a fundamental political guideline and commitment to nuclear and radiation safety as priority tasks alongside all other aspects of using nuclear technology and ionising radiation.
The first part of the Resolution underlines ten fundamental safety principles towards which Slovenian legislation is oriented, then it describes the main nuclear and radiation practices in the country, it describes the inclusion of Slovenian regulations in international ties in this area, the existing legislation and the organisation of state bodies, and also underlines the need for adequate personnel to ensure nuclear and radiation safety. Related to this is research and development, while particular importance is ascribed to cooperation with the public and a commitment to quality, excellence in management and to a culture of safety. Article 6.2 (Wider institutional framework) of the Resolution also addresses the operation of the ARAO agency.

Among the other laws that more broadly define the management of RW and SNF is the **Fund for the Financing of the Decommissioning of Krško NPP and the Disposal of RW from Krško NPP Act (Official Gazette of the RS, No. 75/94, 24/2003 – official consolidated text, 68/2008)**, which serves to define funds for:

- financing services provided by the Ionising Radiation Protection and Nuclear Safety Act,
- financing the preparation and implementation of projects for the safe and final disposal of spent fuel and radioactive waste from Krško NPP,
- financing the preparation and implementation of the project for the safe decommissioning of Krško NPP,
- compensation pay for limited use of the space to local communities in line with the Decree on the criteria for the determination of the compensation for limited use of space within the area of a nuclear facility (Official Gazette of the RS, No. 143/03; hereinafter: UV8).

Another especially important document is the **Agreement between the Government of the Republic of Slovenia and the Government of the Republic of Croatia on Regulation of the Status and Other Legal Relations Regarding Investment in and the Exploitation and Decommissioning of Krško NPP (BHRNEK agreement)**, which was ratified in the Slovenian National Assembly in February 2003. It provides that Krško NPP is owned by the Slovenian and Croatian electricity supply organisations, whose legal successors are ELES GEN d.o.o., Ljubljana and Hrvatska elektroprivreda d.d., Zagreb, in equal shares and equal proportions regarding the rights and obligations related to managing and exploiting the joint Krško NPP. The contracting parties state, in Article 10 of this Agreement, that the decommissioning of Krško NPP and the disposal of RW and SNF is a joint obligation, and that they will ensure an effective joint solution for decommissioning and disposal from the economic point of view and from that of environmental protection. For this reason they are to draw up the Programme for the Decommissioning of Krško NPP and the Programme for Disposal of RW and SNF from Krško NPP. In Article 11 the Parties undertake to provide financing in equal shares for the costs of formulating the decommissioning programme, the costs of its implementation and the costs of formulating the RW and SNF disposal programme.

On 22 April 2016 the National Assembly adopted the **Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016–2025 (ReNPRRO16–25)**. The Resolution serves as a basis for the fulfilment of Article 11 of Council Directive 2011/70/Euratom establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, which requires each Member State to ensure the implementation of this programme. The formulation and adoption of the national programme is therefore progressing in accordance with the Directive and the Ionising Radiation Protection and Nuclear Safety Act.

The national programme is a stand-alone document that includes the policy of managing radioactive waste and spent fuel, with programmes and specific measures to achieve the goals in implementing policy in this area.

The first chapter of the Resolution briefly describes the Slovenian nuclear programme, the legal and formal definition of radioactive waste, the valid legislation and international treaties.

The second chapter provides general goals and principles for managing radioactive waste and spent fuel, procedures for reducing generation, takeover/removal, import/export and transit of radioactive waste and spent fuel, ensuring HR and financial sources, financing the field, milestones in the programme for the 2016-2025 period, drafting of the programme to decommission the Krško nuclear power plant and the programme for disposal of radioactive waste and spent fuel from Krško NPP.

This is followed by a broad analysis of the situation in the third chapter for all types of radioactive waste and spent fuel, by specific facility, with data on the current quantities and assessments of future quantities, including radioactive waste from decommissioning. An analysis of the situation in the area of research and development addresses salient issues that relate to research and development and to education and training. Related to this is research and development work in the area of radioactive waste and spent fuel management.

Based on analysis of the situation in the area of radioactive waste and spent fuel management, and taking into account the need for timely provision of conditions for resolving problems associated with it, chapter four sets out the strategies and measures for achieving targets for all types of radioactive waste and spent fuel for the period of validity of ReNPRROG16-25 and also in the longer term. It presents 12 strategies with specific measures for achieving the targets for each individual strategy and with proposed technical measures. The deadlines, responsibility for measures and sources of financing are defined.

In addition to the valid regulations in the area of construction of facilities, the planning of a repository also needs to observe the regulations governing nuclear and radiation safety and environmental protection:

- The procedures for planning, construction, trial operation, operation and decommissioning are laid down in the Rules on factors of radiation and nuclear safety – **JV5** (Official Gazette of the RS, No. 74/16) and the Rules on the provision of safety following the commencement of operation of radiation and nuclear facilities – **JV9** (Official Gazette of the RS, No. 81/16).
- Radioactive waste management, which includes disposal, is governed by the Rules on radioactive waste and spent fuel management – **JV7** (Official Gazette of the RS, No. 49/2006).
- Clearance levels on the basis of which surveillance of radioactive materials may be waived are governed by the Decree on activities involving radiation (**UV1**, Official Gazette of the RS, No. 19/18).

INTERNATIONAL RECOMMENDATIONS, CONVENTIONS AND TREATIES

On 1 May 2004 the Republic of Slovenia became a full Member State of the European Union. From that date, the Accession Treaty, ratified by the Slovenian National Assembly on 28 January 2004 (Official Gazette of the RS – MP, 3/04), began to apply. The document on the accession conditions, which is an integral part of the Accession Treaty, also sets out financial assistance to new members in the area of the strengthening, efficiency and capacity of administrative bodies involved in nuclear safety, of technical support organisations and of public waste management agencies in the period from the date of accession to the end of 2006.

The alignment of Slovenian laws and other regulations with European Community legislation is an exceptionally complex process and one that is designed to ensure that the legislation complies with the Slovenian Constitution and with the requirements of European Union law. During the accession period, Slovenia made adjustments to its legislation and, upon joining the European Union on 1 May 2004 adopted the entirety of the European acquis, which is divided into 20 chapters. The acquis sets out directives and regulations which are binding, as well as decisions addressed to domestic legal entities.
Chapter 12 (Energy) is of particular importance for RW and SNF management, as is Chapter 15 (Environment, consumers and health protection). The first addresses nuclear energy from all its aspects, along with the supply of fuel, physical protection and operation of nuclear power plants. The second area covers nuclear safety and radioactive waste, consumer protection and health protection.

All provisions in the areas of nuclear energy production and nuclear safety are based on the 1957 Treaty Establishing the European Atomic Energy Community (EURATOM), which provides that Member States of the European Community establish uniform safety standards to protect the health of workers and of the general public and ensure that they are applied, promote research, facilitate investment, ensure the regular supply of ores and nuclear fuel, use nuclear materials only for the purposes for which they are intended, and encourage other states and international organisations to use nuclear energy for peaceful purposes.

European Union Member States are obliged to comply with the provisions of the EURATOM Treaty, particularly those relating to the supply of nuclear fuel, protection mechanisms, health and safety, and international agreements and other legislation connected with nuclear energy production and nuclear safety. To this end, the European Union has adopted numerous regulations in the form of directives, guidelines, regulations, decisions, recommendations and opinions which expand on the content of the EURATOM Treaty in more detail.

Broadly speaking, the most important of these regulations in the area of RW and SNF management are:

- Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codified text),
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom,
- Council Directive 2013/59/Euratom of 5 December 2013 laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation, and repealing Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom, The content of the Directive has been transposed into Slovenian law through the adoption of the ZVISJV-1 (Official Gazette of the RS, No. 76/17)[4],
- Council Directive 2006/117/Euratom of 20 November 2006 on the supervision and control of shipments of radioactive waste and spent fuel;
- **The Directive establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (Directive 2011/70/Euratom).**

The most important of the above-mentioned documents is indeed the **Directive establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (Directive 2011/70/Euratom).** The Directive establishes a legislative framework for ensuring the responsible and safe management of spent fuel and radioactive waste, in order to prevent the creation of excessive burdens for future generations. Its purpose is to introduce national arrangements in the Member States that provide a high level of safety in the management of spent fuel and radioactive waste and, at the same time, protect workers and the population against the dangers of ionising radiation. Equally the Directive requires Member States to ensure appropriate notification and involvement of the public in the management of spent fuel and radioactive waste.

In January 2013 the transposition table for the Directive on radioactive waste and spent nuclear fuel (Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste) was successfully

[4] Explanation from the Slovenian Nuclear Safety Administration by e-mail of 14 February 2018, regarding observance of legislation: Since the application for environmental consent was submitted in May 2017, when the ZVISJV-1 was not yet in force, the procedure of obtaining environmental consent for the LILW repository and thereby the preliminary consent regarding nuclear and radiation safety for matters related to nuclear and radiation safety would be governed by the then valid ZVISJV-D, i.e. the Ionising Radiation Protection and Nuclear Safety Act (ZVISJV; Official Gazette of the RS, No. 102/04-UPB2, 10/08-ZVO-1B, 60/11 and 74/15). The ZVISJV-1 entered into force on 6 January 2018.

transferred into the relevant database, in which the European Commission can see how Slovenia has transposed the provisions of this Directive into its national law.

Slovenia's national laws are in compliance with the Directive, for the country has a national programme of managing spent fuel and radioactive waste in the form of a resolution (**Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016-2025**) and it has a system established for issuing licences for conducting radiation practices and a system of appropriate surveillance. Equally, Slovenia has an adequate system in place for managing radioactive waste (ARAO), and has adequately addressed the issue of financing decommissioning and spent fuel and radioactive waste management (Decommissioning Fund).

It is important for each Member State to have a competent regulatory authority in the field of safe management of spent fuel and radioactive waste, which in Slovenia is the Slovenian Nuclear Safety Administration. The Directive also lays down the obligations of the holder of a licence, which in Slovenia are set out in the Ionising Radiation Protection and Nuclear Safety Act.

In addition to the standards contained in European Union legislation, Slovenia is also obliged to comply with the international conventions it has ratified and with the recommendations of the International Atomic Energy Agency (IAEA) in dealing with issues relating to radioactive waste and spent nuclear fuel.
The most important legal instruments in this area are:

- Vienna Convention on Civil Liability for Nuclear Damage of 1963;
- Convention on the Physical Protection of Nuclear Material of 1979;
- Convention on Early Notification of a Nuclear Accident of 1986;
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency of 1986;
- IAEA Incident Reporting System, ratified by the former Yugoslavia in 1987;
- Convention on Nuclear Safety of 1994;
- European Agreement Concerning the International Carriage of Dangerous Goods (ADR) of 2000;
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management of 1997 (Official Gazette of the RS-MP No. 3/99).

The Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management underlines that the entity most responsible for ensuring safety is the state, which must attend to the safe disposal of radioactive waste in its territory. The Convention also allows the safe and efficient management of RW and SNF, under certain circumstances, to be fostered by means of an agreement between states to use facilities in one of them to the benefit of others, particularly where waste originates from joint projects. The Convention also provides for a systematic safety assessment and environmental impact assessment before construction of a radioactive waste management facility, and the issuing of an operating licence based on appropriate assessments and conditional on a final decommissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements. Each contracting party must ensure that responsibility for the safety of RW and SNF management rests with the holder of the licence and that the appropriate steps are taken to ensure that each licence holder meets its responsibilities. The Convention states that it also relates to discharges and uncontrolled releases.
The common objectives of the legal instruments listed above are to attain and maintain a high level of safety in RW and SNF management, ensure the effective protection of individuals and society as a whole against the harmful effects of ionising radiation, and prevent accidents with

radiological consequences or mitigate their consequences. It should also be noted that in accordance with Slovenian law, in specific administrative procedures foreign and international standards and technical regulations may be applied, if there are no national ones available.

1.6.2 *SUMMARY OF PROVISIONS FROM THE DECREE ON THE DPN FOR LILW*

Introductory explanation on the preparation of design plans and preparation of design output

The design plans derive from the expert design bases for the variant, for which the Variant Study[5] in 2006 determined that the Vrbina site showed the highest level of suitability for construction (the design with underground silo repository units – Variant B), and which was addressed in greater detail in the Conceptual Design in 2007[6] and in the preliminary design[7] in the procedure of drafting the national spatial plan in 2009.
Optimisation of the design plans, which was aimed principally at reducing the costs of construction and operation of the repository and at the same time increasing the technical feasibility and environmental safety, began in 2010, when a significant optimisation step was taken whereby the **conditioning of LILW for disposal would not be performed at the repository, but at Krško NPP and only disposal would take place at the repository**.[8]

At the same time, with further optimisation of technological procedures for conditioning for disposal,[9] optimisation of the plans for disposal silos was carried out in 2011,[10] taking into account the recommendations of the IAEA experts.[11] These were mainly aimed at providing robust and conservatively safe construction solutions and at effective groundwater management during construction.
In 2014, the optimisation of the non-disposal part of the repository was carried out.[12] Taking into account the reduced scope of investment owing to the conditioning for disposal being performed at Krško NPP, a feasibility study[13] was produced at the end of 2013, and was confirmed by the ministry competent for infrastructure on 8 July 2014.[14] The confirmed feasibility study envisaged construction of the repository for half the LILW that would be generated at Krško NPP up until the end of the extended operating period in 2043, and in decommissioning after the end of operation, and also for the disposal of all Slovenian institutional waste.
The table below points out changes to the design bases and technical solutions between the adopted Decree on the LILW repository and the design output (IDZ, January 2016).[15] The changed technical solutions serve to cut certain practices and change the technical solutions in a

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5 Variant Study (supplemented after review), National Site Plan for the LILW Repository – Vrbina site in the Municipality of Krško, Ministry of the Environment and Spatial Planning, Spatial Planning Directorate, December 2006
6 Vrbina LILW Repository, Conceptual Design, Rev. A, project number NRVB-B052/058F (NSRAO-Vrb-IDZ 02/07), IBE, Ljubljana, June 2007
7 LILW Repository Vrbina, Krško; Preliminary Design, Rev. A, project number NRVB-B052/058; IBE, July 2009
8 Technology Development for Disposal Plans, Rev. A, IBE, Project Number NRVB-B052/069-1, Ljubljana, 2010
9 Revision and optimisation of design solutions – Disposal technology, Rev. 0, IBE, NRVB---3X/M16, Ljubljana, 2011
10 Revision and optimisation of design solutions – Disposal silos, Rev. A, IBE, NRVB---3X/M15A, Ljubljana, 2011
11 Expert Mission on Technical solutions for The Low And Intermediate Level Radioactive Waste Repository, Vrbina, Krško, IAEA TC SLO 3005; J. Pacovsky, R. Chaplow; ARAO, Ljubljana 18 – 20 January 2011 (IAEA2011)
12 Optimisation of the non-disposal part of the repository, IBE, NRVB---3X/M18, Ljubljana, 2014
13 LILW Repository Vrbina, Krško; Feasibility Study, Rev. C, NRVB-4X/01C, IBE, Ljubljana, December 2013
14 Decision approving the Feasibility Study for the LILW repository at Vrbina, Municipality of Krško, No 360-54/2014/31, 8 July 2014, Ministry of Infrastructure and Spatial Planning, Energy Directorate.
15 Preliminary Design for the LILW Repository Vrbina, Krško, No. NRVB-B052/058-1, Rev. C, IBE d.d. svetovanje, projektiranje in inženiring, Ljubljana January 2016

minimal scope within permitted deviations, which consequently increases the technical feasibility and improves the environmental safety of operation of the repository.

Projects affecting the land in question are regulated in accordance with the Decree on the DPN (Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško, Official Gazette of the RS, No. 114/09).

A review of the spatial provisions and conditions pursuant to the aforementioned Decree is set out in the table below, together with an indication of the fulfilment of conditions as part of the planned project.

Table 1: Spatial provisions relating to construction of the LILW repository and fulfilment of conditions within the project in question[16]

Arrangements under the Decree on the DPN	Observances and amendments in the Design output for the LILW repository (IDZ, January 2016)
Article 1 (basis of National Spatial Plan) (1) This Decree serves to adopt, in accordance with the Ordinance on the Spatial Planning Strategy of Slovenia (Official Gazette of the RS, No. 76/04 and 33/07 – ZPNačrt) and the Decree on the Spatial Order of Slovenia (Official Gazette of the RS, No. 122/04 and 33/07 – ZPNačrt), the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina, Municipality of Krško (hereinafter: detailed plan of national importance). (2) The detailed plan of national importance was produced by Savaprojekt d.d., Krško and Acer Novo mesto d.o.o., under order number 07180-00 of December 2009.	
Article 2 (subject of decree) (1) This Decree lays down the following: planned spatial arrangements, area of the detailed plan of national importance, conditions regarding the purpose of activities, their position, size and design, conditions regarding the connection of facilities to economic public infrastructure and built public good, criteria and conditions for parcelling, conditions for integrated conservation of cultural heritage, nature conservation, protection of the environment and natural assets and protection against natural and other disasters, conditions for the protection of human health, the stage-nature of implementation of spatial planning, other conditions and requirements for the implementation of the detailed plan, permissible deviations and areas of spatial arrangements for which the spatial implementation conditions will be determined after adoption of the detailed plan. (2) The components of the preceding paragraph are explained and presented graphically in the detailed plan of national importance, which together with the obligatory annexes is available for view at the Spatial Planning Directorate in the Ministry of the Environment and Spatial Planning and at the office competent for spatial planning in the Municipality of Krško.	
Article 3 (planned spatial arrangements) (1) The detailed plan of national importance serves to plan the provisions for a low- and intermediate-level radioactive waste repository at Vrbina, Municipality of Krško, including connections and arrangements for commercial public infrastructure. (2) The detailed plan of national importance also defines the area for	(1) Observed. (2) Not relevant.

[16] Design output and provisions of the spatial basis of the detailed plan of national importance for the LILW repository

expansion of disposal capacities, which will be arranged subject to spatial implementing conditions and, in accordance with the investor's timetable, through supplementation of this detailed plan of national importance as provided in Article 39 of this Decree.	
Article 4 (area of detailed plan of national importance) (1) The area of the detailed plan of national importance is in the Municipality of Krško, east of the Krško Nuclear Power Plant (hereinafter: Krško NPP), by the existing local road LC 191111 Krški most–Vrbina–Spodnji Stari Grad (hereinafter: local road) and the existing uncategorised road (hereinafter: Vrbina road). It covers areas on which are envisaged the siting of facilities and the arrangement of surfaces for the unimpeded use and operation of the repository. (2) The area of the detailed plan of national importance also covers sections on which for the needs of the repository reconstruction, dismantling and new construction of commercial public infrastructure will take place. (3) The area of the detailed plan of national importance comprises parcels or parts of parcels in the following cadastral municipalities: – c.m. Leskovec: 1197/100, 1197/101, 1197/102, 1197/103, 1197/104, 1197/105, 1197/106, 1197/107, 1197/108, 1197/109, 1197/110, 1197/111, 1197/112, 1197/113, 1197/114, 1197/267, 1197/378, 1197/400, 1197/401, 1197/405, 1197/415, 1197/416, 1197/417, 1197/418, 1197/419, 1197/420, 1197/421, 1197/422, 1197/423, 1197/424, 1197/425, 1197/426, 1197/427, 1197/428, 1197/429, 1197/430, 1197/431, 1197/432, 1197/433, 1197/434, 1197/44, 1197/85, 1197/91, 1197/92, 1197/93, 1197/94, 1197/95, 1197/98, 1197/99, 1198/1, 1204/17, 1205/62, 1206, 1233/3, 1233/4 and 1246/20; – c.m. Drnovo: 2103/15, 2103/74, 2103/75, 2106/2, 2106/3, 2106/49, 2106/59, 2106/6, 2106/60, 2106/7, 2106/88, 2106/89 and 2645/6; – c.m. Stari Grad: 1179/34, 1179/37, 1179/50, 1179/51, 1179/54, 1179/55, 1179/56, 1179/57, 1179/58, 1179/59, 1179/60 and 1179/61.	(1) The area of works in the north extends regarding the road and other plans to the envisaged Spodnji Stari Grad (SSG) roundabout on the Krško – Brežice regional road and regarding the sewerage connection to the envisaged connection point in the area of Spodnji Stari Grad. In the south the area of reconstruction of the local road extends to the southern boundary of the DPN. (2) Observed. (3) (1) Observed. (3) (2) Construction of sewerage for removal of wastewater partly extends beyond the DPN.
Article 5 (planned use of area of repository) (1) In the area addressed by the detailed plan of national importance, a nuclear facility shall be constructed for the permanent disposal of low- and intermediate-level radioactive waste (hereinafter: repository) generated in Slovenia. (2) The repository shall be regulated as an independent spatial entirety, within which are conducted all activities necessary for its operation and for permanent waste disposal. (3) The repository shall include an entrance section, the immediate area of the repository and vacant areas.	(1) Observed. (2) A portion of the activities, conditioning of LILW for disposal, has been shifted to Krško NPP (in accordance with the approved feasibility study, Rev. C). (3) Observed.
Article 6 (planned use of individual parts of repository) (1) Entry to the area is to be arranged in the entrance part of the repository and a repository information centre public facility (information centre) is to be built with the aim of providing informational and educational activities on the management of radioactive waste and other activities of the repository and local community. In the entrance section, parking spaces for employees and visitors as well as green surfaces and other open surfaces are to be arranged. (2) The core area of the repository, which is intended for administrative and service activities, and for the reception, processing and conditioning of waste for disposal and actual disposal, comprises: - the administrative and service section of the repository and the area for the processing and conditioning of waste for disposal; - the waste disposal area.	(1) Construction of the information centre is to be dropped. A parking area for the requirements of the repository is to be arranged in the entrance section. The scope of the project includes planned construction of an access road to the LILW repository with parking spaces for employees and visitors and all the necessary infrastructure connections to commercial public infrastructure as follows: mains water connection, medium voltage electricity connection for the new transformer station, telecommunications connection, connection to the sewers for removal of urban wastewater (faecal sewer) and a connection for the removal of rainwater (precipitation drainage) with an infiltration field. (2) Optimised (feasibility study, Rev. C). Conditioning for disposal is to be conducted at Krško NPP. Processing of LILW is to be conducted in a much reduced scope and covers only the collection and storage of secondary LILW, and handling LILW in the event of emergencies. Division of the area has been observed. The core area comprises the administrative and service section and the area for disposal. Optimised (feasibility study, Rev. C).

(3) The administrative and service section of the repository and the area for the processing and conditioning of waste for disposal shall serve for the placement of: a) administration and service facilities: - security and control centre facilities; - administrative facilities and - infrastructure, energy and service facilities; b) facilities and arrangements for the processing and conditioning of waste for disposal: - a technological facility intended for performing all procedures of processing and conditioning of waste for disposal, laboratory research, supervision of technological procedures and other necessary technological functions of the repository, with the pertaining built surface; - control pool (collection tank) for collecting and monitoring water and - other service and energy facilities and devices intended for ensuring nuclear and radiation safety at the repository. (4) Two disposal facilities (two underground silos with access shaft and inspection corridors) are to be placed in the area for waste disposal. A silo shall be completed by a hall and accompanying handling areas. Part of the waste disposal area shall be set aside for expansion of the repository's disposal capacities. For this part, in accordance with Article 39 of this Decree, spatial implementing conditions shall be laid down as part of the supplementation of this detailed plan of national importance. (5) The vacant surfaces of the repository are to be planted with trees to represent a green barrier between the repository and its surroundings.	(3) A security control centre is to be provided at the operator of the security service (external provider). Other activities are to be combined in a single facility. Optimised (feasibility study, Rev. C). The technological facility (TF), which will be intended for the storage of secondary LILW and for ensuring back up storage capacities in accordance with the JV5 Rules, Annex 3, will be constructed in two phases. The laboratory is to be dropped – a measurement room to be provided. The technological surface is to be omitted. Procedures for the processing and conditioning of waste for disposal are not to be performed at the repository. Radioactive waste ready for disposal will be delivered to the repository. (4) Observed. The access shaft will be built as part of the silo. Inspection corridors are not necessary and will be omitted. (5) Observed.
Article 7 (position and size of facilities and arrangement of repository) (1) The repository shall have a disposal capacity of 9,400 m^3 of waste generated in Slovenia. (2) The waste shall be disposed of in disposal containers, which shall in turn be placed in two disposal silos, each of which has a usable volume of 20,000 m^3 and a bottom standing at a depth of 50–60 m relative to the elevation of the embankment. The disposal silos are to be located west of the technological facility, along the southern boundary of the area addressed by the detailed plan. (3) A hall with maximum floor dimensions of 60 m × 41 m and a maximum height of 20 m shall be placed above each disposal silo prior to construction. After a silo is sealed, the hall shall be removed. (4) An information centre and parking area with approximately 40 parking spaces for employees and visitors, specifically for cars and coaches, are to be placed in the entrance section of the repository. Access is to be arranged through the reconstructed Vrbina road. (5) Facilities in the entrance section, the administrative and service part of the repository and the area for the processing and conditioning of waste for disposal shall be dimensioned and sited with the technical construction requirements and the capacities of the repository in mind, and planned as independent buildings or as groups of one or more facilities. (6) Disposal and other facilities may be sited in areas set aside for the construction of facilities. The construction boundary beyond which disposal facilities may not be sited is shown in the graphic section of this detailed plan of national importance. (7) A transparent fence shall be erected around the edge of the immediate disposal area. The waste disposal area and the facilities for the processing and conditioning of waste for disposal shall be secured by an additional fence. The height and exact location of the fences shall	 (1) Observed. In order to ensure disposal capacities, two silos will be constructed. Firstly, the first silo will be built together with other repository facilities, and the second silo will be built when there is a need for additional disposal capacities, presumably in 2048-2049. (2) Observed. (3) Observed. A hall will be built after construction of the silo. (4) Construction of the information centre is to be dropped. Information will be provided at the administration and service building and at the other ARAO facilities. In front of the security fence for the LILW repository, 32 parking spaces for employees and visitors will be laid out. Two parking spaces will be intended for persons with disability. No separate parking space for coaches is envisaged. Coach parking will be possible in the area of the car park – by the car park exit or in unoccupied spaces. (5) Observed. (6) Observed. The administrative and service building (ASB) partly extends to the repository entrance area. The ASB also in part assumes an information function, since no information building is envisaged in the entrance section under the optimisation of the repository. All structures are on surfaces demarcated for the construction of structures and within the construction site boundary. (7) Observed.

be defined in the physical security plan for the repository.	
Article 8 (design of repository facilities) (1) Facilities shall be designed in such a way that through their dimensions, capacities and selection of finishing works they meet the technological conditions and requirements, while at the same time they ensure appropriate conditions for the healthy, safe and comfortable use and work of all users and visitors. (2) Basement construction under all structures is permissible. (3) The structures and pertaining exterior arrangements are to be planned in accordance with modern principles of architectural and landscape architecture design and with the use of modern technologies and materials. The information centre shall be designed as a representative building with a main entrance facade, oriented towards the reconstructed Vrbina road or access road to the repository. The structures must have exteriors designed in a modern and simple manner and a flat roof, single pitch or double pitch with minimum pitch in view of the selected covering. In accordance with technological requirements, canopies whose design matches the principal structures are permissible. In the selection of finishing works, materials and exterior and roofing colours, account must be taken of appropriate concordance with the surroundings, with the avoidance of shiny and visually striking structures. All structures and exterior arrangements, including municipal services equipment, must be mutually coordinated in design. Their height may not exceed 20 m. (4) Facilities that will be in public use, access to those facilities and the parking area shall be designed in such a way that they do not contain built or communication obstacles that would prevent persons with reduced mobility from accessing them. (5) To ensure high-quality and integral architecture and landscape architecture, during the creation of the design for obtaining a construction permit the plans must be approved by the investor's expert commission, which must include a representative of the Municipality of Krško. The commission must comprise architects and landscape architects with at least ten years of work experience and recognised design references.	(1) Observed. (2) Observed. (3) Observed. (4) Observed (in the parking area and the public part of the administration and service building). All transport surfaces and paved areas are built in accordance with the Rules on the requirements for ensuring unhindered access to, entry to and use of buildings in general use and multi-apartment buildings (Official Gazette of the RS, 97/03). Two parking spaces for persons with disability are to be provided in the parking area. (5) Observed. An expert commission has been appointed to monitor the production of architectural and landscape architecture plans of the design input. The commission approved the architectural and landscape architecture plans of the design input in September 2015.
Article 9 (landscape and other exterior arrangements for the repository) (1) Landscape and other exterior arrangements must observe the landscape and visual characteristics of the physical environment. (2) The entrance section of the repository shall be arranged as a public area in accordance with modern principles of landscape architecture design. Shading shall be provided for the parking area through the planting of suitable native tree species. Green areas and other open surfaces in the entrance section shall be arranged as a park area, enhancing the overall image of the entrance and other sections of the repository, with special emphasis on design of the information centre surroundings. The installation of municipal services equipment that matches the design of the structures shall be ensured. (3) The planting of native trees shall be permitted in the administration and service section of the repository, taking account of the limitations owing to the need to ensure functionality of the repository and clear views on all transportation ways and handling areas. (4) Native trees shall be planted in vacant areas of the repository. Planting must enable physical control and simple maintenance, it must ensure clearance and clear views along roads and paths as well as other built surfaces. (5) The edges of flood control embankments shall be designed so as to observe the principles of landscape design. (6) A service road shall be laid out on the external side of the fence along the core area of the repository, and shall connect to the repository access road. (7) Exterior lighting at the repository shall be provided with shaded lamps and directional lighting, or a means of lighting that generates the least possible light pollution, while also satisfying the requirement for ensuring the security of the repository.	(1) Observed. (2) Observed. For the parking areas and access road native tree species are being planted for shading. (3) Observed. (4) Observed. (5) Observed. (6) Observed. (7) Observed.

Article 10 (technical design of drainage of industrial wastewater)	
(1) In areas where there are no restrictions related to protection against ionising radiation, industrial wastewater shall be collected in ditches and then as necessary appropriately treated or neutralised. After checking, wastewater that meets the criteria for urban wastewater shall be pumped to the public sewerage system for removal of urban wastewater (hereinafter: public sewers), and from there to the Vipap treatment facility, while industrial wastewater that does not meet the criteria shall be assigned to an authorized collector of such waste matter.	(1) In the area where there is no restriction related to radiation, industrial wastewater will not arise, since the conditioning of waste for disposal on-site is not envisaged and the production of filler grout has been dropped.
(2) Industrial wastewater from an area for processing and conditioning waste for disposal shall be collected at the point of generation, where the level of radioactivity shall be determined. Industrial wastewater that does not exceed the clearance criteria for radioactive substances defined by the regulations governing protection against ionising radiation, and that meets the criteria for urban wastewater, or does not exceed the approved threshold values, shall upon prior measurement of the content of radionuclides and chemical analysis, be discharged into the public sewage system, and from there to the Vipap water treatment plant.	(2) Since no processing and conditioning of waste for disposal is envisaged, the paragraph relates to the controlled part of the technological facility.
(3) Wastewater that exceeds the level referred to in the preceding paragraph or which is unsuitable in terms of chemical characteristics for discharge into the public sewers and is suitable for the production of filler grout shall be used to produce such grout for filling the empty spaces in disposal containers.	(3) No filler grout is to be produced at the repository site.
(4) Wastewater that exceeds the acceptance criteria for filler grout and is not suitable for discharge into the public sewers shall be collected and stored in a technological facility until it is removed by an authorized collector of such waste.	(4) Wastewater that exceeds the chemical threshold values will be assigned for treatment to an authorized collector of such waste. Wastewater that exceeds the radiological threshold values will be treated on-site at the repository by ARAO (using their own or hired capacities; a practice in line with the Ordinance on amendment of the ordinance on the transformation of the public enterprise Agency for Radwaste Management, Hajdrihova 2, Ljubljana, into a public service agency, Official Gazette of the RS 113/09, Article 5, paragraph one, indents one, two and three.) or will be assigned for treatment outside the repository. Such wastewater may occur only exceptionally, as a consequence of emergencies or accidents. The radiological threshold values are laid down in the operational limits and conditions (OLC), which are reference documents for the Draft Safety Analysis Report.
(5) In the area for waste disposal, water that might appear in silos shall be collected and radiologically checked. Where it exceeds the threshold values, water shall be pumped to the wastewater collection tank in the technological facility and it shall be handled in the same way as wastewater referred to in the preceding paragraph. Where water does not exceed the threshold values, upon prior chemical analysis it shall be pumped into the public sewers and from there to the Vipap treatment facility.	(5) Water that exceeds the threshold values will be handled in the same way as water referred to in paragraph (4). The Decree on DPN will apply to water that does not exceed the radiological limits.
(6) Water that might appear in the access shaft and inspection corridors shall be collected and radiologically checked. Where it exceeds the threshold values, water shall be pumped to the wastewater collection tank in the technological facility and it shall be handled in the same way as wastewater referred to in the fourth paragraph of this article. Where water does not exceed the threshold values, upon prior chemical analysis it shall be pumped into the public sewers.	(6) The access shaft and inspection corridors are being dropped.
(7) In an emergency, water from silos, the access shaft and inspection corridors shall be placed in a control pool.	(7) Observed in respect of the silo and hall and applies only in the event that the primary collection capacities (collection tank in the silo) do not suffice for the quantities of water during an emergency. The access shaft and inspection corridors are being dropped. The same as for paragraph (4).
(8) Prior to discharging, water from the control pool shall be chemically analysed, and measurements of the radionuclide content shall also be performed. Wastewater that does not exceed the threshold values shall be pumped into the public sewers and from there to the Vipap treatment facility. If it exceeds the threshold values it shall be assigned for the relevant treatment of chemical or radioactive waste.	(8) The construction of a sewer connection for removal of urban wastewater from the area of the LILW repository is planned. A public sewer system is planned from the ditch situated outside the repository security fence to the existing pumping station at Spodnji Stari Grad, from where the existing sewer runs all the way to the Vipap treatment facility. The sewer ditch outside the repository fence receives urban wastewater that meets all the criteria for discharging urban wastewater into the public sewer and then on to the Vipap treatment facility.

Article 11 (permissible modifications to existing facilities) The structures on land parcels 1197/114, 1197/420, 1197/427, 1197/429, 1197/431 and 1197/433, all c.m. Leskovec, are to be removed, if this proves necessary in later stages of planning owing to the construction of the regional road and arrangement of parking or handling areas.	This part of the detailed plan area will be arranged under the DPN for the road link from Krško to Brežice, which is being drawn up. In this way the section of the DPN for the repository that deals with the parcels referred to in Articles 11 and 12 will be rescinded. The arrangements will not affect those parcels.
Article 12 (permissible construction and design of other facilities) (1) On the facilities on parcels 1197/114, 1197/420, 1197/427, 1197/429, 1197/431 and 1197/433, all c.m. Leskovec, up until the construction of the regional road, and where no dismantling will be required for its construction, it shall be permissible to perform maintenance work, reconstruction within the limits of the existing profiles or demolition and new construction for the same activity with an appropriate gap for construction of the regional road, wherein high-quality architectural design must be ensured. It shall be permissible to perform storage activities with ancillary premises and the arrangement of double or single-pitch roofs with a minimum roofing pitch of 15 degrees, with dark colouring of the covering and light colouring of the facade. The removal and setting up of simple or uncomplicated infrastructural facilities shall also be permitted. (2) Through the modifications stated in the preceding paragraph, structures may not encroach on the area of the planned regional road.	(1) See explanation of Article 11. (2) See explanation of Article 11.
Article 13 (common provisions on public utilities infrastructure) (1) For the purpose of constructing the repository, the reconstruction, dismantling, new construction or protection of existing facilities and devices of public utilities infrastructure of national and local importance shall be permitted.	(1) Not applicable. This project involves plans to reconstruct the existing Vrbina road in a length of around 480 m, new construction of the access road in the length of around 176 m, construction of 32 new parking spaces and construction of new connections to public utility infrastructure (mains water, medium voltage power line, telecommunications, sewers for removal of urban wastewater and sewers for removal of rainwater).
(2) Facilities in the area covered by the detailed plan of national importance shall be connected to existing or planned sewerage, water supply, power, communications and gas pipeline networks. These lines shall be connected in accordance with the conditions set by the operators of the respective lines.	(2) Observed. The project involves plans to construct connections to public utility infrastructure, specifically a mains water connection, telecommunications connection, medium voltage electricity connection for supplying the new transformer station, sewer connections for removal of urban wastewater and sewers for removal of precipitation water with an infiltration field. Connection to the natural gas network at this stage is not planned.
(3) The lines shall, as far as possible, be conducted along transport and intervention areas or areas in public use.	(3) Observed. Infrastructure lines are to run along transport surfaces or surfaces in public use. The northern part of the sewer lines for removal of urban wastewater runs along mainly agricultural land, since the design took into account the route of the planned Krško – Brežice road under the PNG conceptual design.
(4) The location of facilities and devices, the route of lines and all crossings of urban services, energy and communications lines shall be mutually coordinated, taking into account adequate spacing from each other and spacing from natural or built structures. (5) The coordinated flow of construction of infrastructure lines, devices and facilities shall be ensured. (6) The construction, reconstruction and maintenance of infrastructure networks and connections of local importance shall be permitted within the boundaries of the area covered by the detailed plan of national importance in accordance with the plans of the municipality and the operators of the lines, unless they are contrary to the provisions of this	(4) Observed. (5) Observed. (6) Not applicable.

Decree and the regulation governing areas of restricted use due to nuclear facilities and on the conditions of construction.	
Article 14 (water supply network) (1) The repository shall be connected to the planned mains in the area of the reconstructed Vrbinska cesta via a water gauging shaft. (2) The planned mains shall be connected to the existing water supply network in the area of the road spur for Spodnji Stari Grad and shall run along the route of the planned Krško–Brežice regional road (hereinafter: regional road) and the reconstructed Vrbina road. (3) Sufficient flow must be ensured in accordance with the operator's terms and conditions.	(1) to (3) The design conditions (Kostak, 19 March 2015) require the envisaged connection to the LILW site to be executed at the crossroads for Spodnji Stari Grad (from line PE d 125) and the refurbishing of the existing PE d 110 to Croatia, where the connection is made. At the Kostak/ARAO/IBE meeting on 12 June 2015, it was agreed that the connection to the existing PEHD line would be made in the area of the entrance to the Waste Management Centre in Spodnji Stari Grad (CRO SSG). The measuring point, the shaft, is to be executed outside the fenced area of the LILW complex, in a permanently accessible place. The investor or operator of the LILW complex will notify the public service provider each time of the intention to fill the tank with firefighting water and will coordinate with the provider how this will be done. Construction of the water supply system in question is not expected in the medium term. A firefighting water tank is envisaged for the repository of 140 m^3. The DN 50 connection is to be made to the existing PEHD line in the area of the entrance to CRO SSG. The project includes the planned construction of a mains water connection, from the water gauging shaft which is located north of the LILW repository plateau outside the repository security fence. The connection is to be made from the water gauging shaft to the existing route of the public water main, which runs along Vrbina road. The existing water main along Vrbina road is PE100. The water main connection is planned in a length of around 42 m.
(4) In addition to the connection of the repository to the water supply network, the long-term unimpeded and safe supply of the repository and other users with drinking water will require the construction of a linking water main from the Brege pumping station to the dam, via the dam before Krško NPP and south of Krško NPP to the repository, and reconstruction of the fibre cement water main from Resa reservoir to Krško NPP. The investor shall cofinance the construction of this water supply network through payment of the municipal fees under the programme of equipment provision in a proportion necessary for the operation of the repository. Elaboration of spatial and design output and obtaining the permit to construct the pipeline connection from the Brege pumping station over the dam before Krško NPP and south of Krško NPP to the repository, and for construction of the water main from the Resa reservoir to Krško NPP is being conducted by the Municipality of Krško under a separate procedure, and it is assuring the construction of both within five years of obtaining the construction permit for the repository.	(4) Elaboration of spatial and design output and obtaining the permit to construct the pipeline connection from the Brege pumping station over the dam before Krško NPP and south of Krško NPP to the repository, and for construction of the water main from the Resa reservoir to Krško NPP will be conducted by the Municipality of Krško under a separate procedure. The Municipality of Krško will ensure construction of the two water mains within five years of obtaining the construction permit for the LILW repository. The LILW repository investor will cofinance the construction of this water supply network through payment of the municipal fees under the programme of equipment provision in a proportion necessary for the operation of the repository.
Article 15 (sewerage system for the drainage of urban wastewater) (1) The sewerage system for the entire core area of the repository shall run to the collection ditch in the administration and service section of the repository, and then to the collection ditch for sewerage in the entrance section, where the sewer line from the information centre shall join it. (2) At the ditch in the entrance section of the repository the sewerage system for the entire area of the repository shall join the public sewer, which runs gravitationally along the reconstructed Vrbina road northwest to the pumping station, and then through a pressure line north to the village of Spodnji Stari Grad, where a connection shall be made to the pumping station before the existing pressure line of the Vrbina–Krško sewer.	(1) Observed. Since the information centre is being dropped, the sewerage connection from the information centre is dropped, too. (2) Observed. Construction of a new sewer connection is planned for the removal of urban wastewater from the area of the LILW repository. From the LILW repository (ditch outside the security fence) a gravitational line is to be run to the entry/exit area of the nearby sanitary landfill of Kostak, where a new pumping station is to be built. The pumping station will be surrounded by a wire security fence. Supply of electricity to the pumping station will be provided from the nearby transformer station at the Kostak landfill. From the pumping station the wastewater will then run along the pressure line to the existing pumping station at Spodnji Stari Grad (SSG), from where the wastewater sewer runs to the Vipap treatment facility.

(3) The end point of the urban wastewater is at the Vipap treatment facility.	(3) Observed.
Article 16 (drainage of precipitation wastewater) (1) Precipitation wastewater from built surfaces in the area of processing and conditioning of waste for disposal and in the area for waste disposal shall run via control shafts or oil traps to the infiltration field, provided there is no possibility of contamination.	 (1) Observed. For the removal of precipitation water from the area of the LILW repository, drainage is to be provided with the runoff of water to its end point in the infiltration field. The infiltration field is to be provided with a minimum surface area of around 130 m^2 and a depth of 1.25 m. The infiltration field is to be sited in a green area south of the repository access road. Taking into account the envisaged infiltration volume, the connection height to the infiltration field is to be around 151.00 m above sea level, which is 1.5 m below the existing ground level. The necessary volume for standing precipitation water (anticipated standing time 10-15 minutes) is to be provided by arranging modular elements in two layers. Potentially polluted (contaminated by petroleum derivatives) precipitation water from asphalt surfaces and standing vehicles (parking area) is to be run to the infiltration field via an appropriately sized oil trap that meets legislative requirements. Drainage of the access road and pedestrian walkway will be provided through transverse drain channels and infiltration of water into the surrounding land.
(2) Where there is the possibility of contamination, precipitation wastewater shall flow to a control pool. Any possible contamination shall be determined through control measurements. Prior to discharging from the control pool to the public sewer, captured precipitation wastewater shall be chemically analysed, and measurements of the radionuclide content shall also be performed. Precipitation wastewater that does not meet the criteria for discharge into the public sewers shall be assigned for treatment or to the system for the collection and treatment of fluids.	(2) Containers will be delivered to the repository using transportation suited for driving on public roads. Drainage of precipitation water from the exterior areas of the technological section of the repository will be effected via oil traps and sewer lines ending in the infiltration field. Contamination of precipitation water is not anticipated.
(3) Precipitation wastewater from built surfaces in the administration and service section of the repository and the entrance area run via control shafts or oil traps to the infiltration field.	(3) Observed.
(4) Precipitation water runoff from roofs shall run via sand traps to the infiltration field.	(4) Observed.
(5) Precipitation water in grassy areas will drain gravitationally into the ground.	(5) Observed.
(6) Infiltration fields shall be arranged in the area of the repository outside transportation and handling areas.	(6) Observed.
Article 17 (electricity supply network) (1) For the requirements of the repository, a new transformer station shall be constructed and connected, via a high-voltage (20 kV) cable, to the transformer station at the Kostak landfill (investor Elektro Celje).	 (1) Observed. For the needs of the LILW repository, a new transformer station is to be built and supplied from the existing transformer station at Kostak landfill. From the existing Kostak landfill station to the new LILW station a medium-voltage electricity line will be run in a length of around 161 m. To power the new sewerage pumping station, a low-voltage electricity line will be run from the existing Kostak landfill.
(2) A low-voltage line supplying the pump shall be laid along the reconstructed Vrbina road from the Kostak landfill transformer station to the repository sewerage pump.	(2) Observed.
(3) A low-voltage cable connection shall be laid in the area of the repository. Low-voltage lines shall be placed outside the driving areas, or cable ducts installed with cable connections and shafts of the appropriate dimensions at locations where driving areas are planned.	(3) Observed.
Article 18 (communications network) (1) Repository facilities shall be connected to the communications	 (1) Observed.

network using the envisaged network at the entrance to Spodnji Stari Grad Collection Centre. (2) In order to ensure high-quality provision of information to local residents, especially those in the vicinity of the repository, regarding the type and quantity of waste disposed at the repository, the results of environmental monitoring and other events, the investor must cofinance the refurbishing and expansion of the existing optical network in a proportion relative to the needs of the repository to inform local residents. The Municipality of Krško is managing the design output and implementation under a separate procedure.	The telecommunications connection for the LILW repository will be provided via an optical cable that connects to the existing network in the duct at the entrance to the Kostak sanitary landfill. (2) The KLOH protocol and its implementation has been assumed by the Ministry of Infrastructure, since the investor of the arrangement is the Republic of Slovenia.
Article 19 (heating) (1) Facilities shall be heated with heating oil or natural gas, or through renewable resources. (2) For heating using natural gas, a gas pipeline of up to 4 bars pressure shall be installed.	(1) Observed. Basis for decision: Feasibility study regarding alternative energy supply systems. Heating is to be provided through air-based heat pumps. (2) The gas pipeline connection will not be carried out.
Article 20 (roads) (1) The existing local and Vrbina roads shall be entirely reconstructed between the spur for Krško NPP and the southern margin of the repository area. In the section from the Krško NPP spur to the planned connection of the reconstructed Vrbina road, they shall be converted into regional roads. From the regional road a spur shall be made to the south to Vrbina road, which shall be reconstructed with elements of a regional road. (2) Over the entire road section, between the connection for Krško NPP and the southern margin of the repository area, a two-way bicycle path shall be arranged, separated from the roadway by a green belt. In the area of the Vrbina Industrial Zone a pedestrian walkway with street lighting shall be provided. (3) The regional road and reconstruction of Vrbina road shall be carried out on a rise in the terrain that ensures safety from flood waters. The crossroads and road towards Spodnji Stari Grad and entrance to the	(1) Reconstruction of the Vrbina road as part of the LILW repository project is to be implemented from the planned SSG roundabout to the southern margin of the repository. The existing local road from the connecting spur for Krško NPP up to and including the SSG roundabout will be implemented in line with the DPN for the Krško-Brežice road link, which in the section in question the DPN for the repository will rescind. We have taken into account the repository DPN requirements on the road section from the planned SSG roundabout to the southern margin. A detailed plan of national importance is being drawn up for the road link from Krško to Brežice (hereinafter DPN Krško - Brežice bypass), which deals with the route of the new regional road from the area of the Vipap works in Krško to the shopping centre in Brežice. Part of this route runs in the area of the DPN for the LILW repository, from the roundabout at Krško NPP to the roundabout at Spodnji Stari Grad 1 with a link to Vrbina road. The course of the Krško - Brežice bypass road and all road connections to the existing public road network has not yet been finally determined and confirmed. Only a part of the reconstruction of Vrbina road in a length of 480 m is being addressed. The envisaged reconstruction of the road is to be aligned with the level of the existing public road at both ends (JP 693631 Sanitary Landfill, partly uncategorised public road). Along the reconstructed road a path for pedestrians and cyclists (2 m) will be made with a separating green belt (2 m). The reconstructed road is to be raised above the height of the existing road to a rise of 152.20 m above sea level. Raising the roadbed was determined on the basis of the Hydrological and Hydraulic Analysis / Study (project No. NRVB-B052/74, document No. NRVB---5G/03). The access road to the LILW repository will be connected to the reconstructed public road. A pedestrian pavement will be laid along the access road. The access road ends at the security fence of the LILW repository, where a parking area with 32 parking spaces will be laid out. (2) Area outside works (DPN for road link being prepared). (3) Observed. The topmost height of the road is 152.20 m above sea level.

Spodnji Stari Grad Collection Centre shall also be aligned with the elevation levels of the regional and reconstructed Vrbina roads. (4) Access to the repository shall be arranged via the new connection to the reconstructed Vrbina road. The elements of the connection road must ensure transport safety. The internal radiuses of the roads must allow for the movement of freight vehicles with trailers of the largest dimensions. Appropriate horizontal and vertical traffic signals shall be installed.	 (4) Observed.
Article 21 (urban waste disposal) (1) Urban waste shall be managed in accordance with the municipal regulations in the area of waste management. (2) A space for the collection of urban waste shall be arranged in accordance with the regulations governing waste management, such that it meets the functional, aesthetic, hygienic, technical and fire-safety conditions and does not impede or endanger transport on public surfaces. (3) The removal point for urban waste shall be spatially located and arranged in accordance with the conditions of the commercial public service provider in the Municipality of Krško.	 (1) Observed. Urban waste generated within the LILW repository complex will be collected in dedicated containers. The location for placing containers for the collection of urban waste is at the administration and service building premises, within the LILW repository security fence, where there is also a collection point for the contractor Kostak. (2) Observed. (3) Observed.
Article 22 (parcellation) (1) Parcellation shall be carried out in accordance with the presentation in the graphic part of the detailed plan of national importance on sheet 3, in which the technical elements that enable the shifting of new parcel boundaries on the ground serve to determine the cut off points of the boundary of the detailed plan. (2) Parcels defined in the detailed plan of national importance may, after works have been carried out, be divided in accordance with the established state on the basis of ownership or management, and by purpose of neighbouring areas annexed to neighbouring parcels.	 (1) Observed in the parcellation of building land for the repository. (2) Will be observed.
Article 23 (heritage conservation) (1) In carrying out all earthworks in the area of the detailed plan of national importance, constant archaeological scrutiny shall be ensured. The investor shall ensure the implementation of protective excavations of potentially uncovered finds, including all post-excavation procedures. (2) At least ten days prior to the start of works, the investor shall notify the competent regional unit of the Institute for the Protection of Cultural Heritage of Slovenia of this.	 (1) Observed. In the wider area of the envisaged construction of the LILW repository, preventive archaeological research was carried out. For investigative requirements, 108 test excavations were made in dimensions of 120 x 120 cm. The results of the archaeological tests showed that in the past the area was not settled and that there are no visible signs of human presence in this area in the past (Report on archaeological evaluation at the Vrbina site for the LILW repository, ZVKD - Novo mesto Unit, December 2006). Prior to the start of earthworks, constant archaeological scrutiny is to be ensured. (2) Observed. This will be done.
Article 24 (protection of agricultural land) (1) The investor must ensure the protection of agricultural land through appropriately organised construction and protection of land from pollution during construction of the repository. (2) In the construction of the repository the movement of construction machinery in the area of the construction site must be limited, and	 (1) Observed. Covered by the study of the arrangements for the construction site. The graphic annex “Arrangement Status” shows the area of the construction site, within which are organised dumps of earth, construction materials and the ancillary structures for the construction site. As part of the reconstruction of Vrbina road, two accesses to agricultural land will be provided. The area of construction for the urban wastewater drainage that runs through agricultural land will, after construction, be arranged so that continued agricultural activity is possible. (2) Observed. Study of the arrangements for the construction site.

existing roads are to be used for construction site transport. During construction, access to agricultural land must be maintained or ensured. No temporary structures or dumps may be placed on agricultural land, unless there are no other appropriate options. Cooperation is to be ensured with owners whose land is in temporary use. (3) During construction, fertile land shall be treated appropriately so as to preserve its fertility and quantity and to make it usable for the recultivation of damaged land. The mixing of topsoil with inorganic substrate and fertile land must be prevented. (4) On high-quality agricultural land, abandoned roads and land damaged by construction works and temporary use during construction, shall be levelled to align with the surrounding terrain, humus added and it shall be arranged as arable land. (5) The investor shall ensure the monitoring of measures implemented in relation to organisation of the construction site.	(3) Observed. (4) Observed. (5) Observed. Will be ensured (coordinator of safety and health at work).
Article 25 (fire safety) (1) Structures and the gaps between them shall be designed so as to: - prevent the spread of fire; - ensure an adequate bearing capacity of construction even in the event of fire. The necessary fire resistance shall be determined for each structure in accordance with its purpose and importance in the context of the repository and of any threat to the surroundings and the environment; - ensure access routes and intervention areas for firefighters in accordance with the valid standards; - have devices for notification of fire and alarms built in; - ensure appropriate devices and systems for extinguishing, such as an exterior and interior hydrant network, sprinkler system for certain structures and areas, hand-held extinguishers and other devices and accessories, as will be defined in the analyses of fire risk and the study of fire safety and - ensure the capture and containment of hazardous fluids that might be generated by fire. (2) Sufficient quantities of water for extinguishing shall be provided in a service facility with provision made for water supply and fire protection that comprises a fire prevention station and a tank of firefighting water and pumping station. (3) Facilities in the area for processing and conditioning of waste for disposal shall be equipped with a ventilation system, with an electricity and lightning conductor installation and appropriate systems for active fire protection, for which the prescribed sources of back up supply of electricity must be ensured. (4) In the construction of facilities, construction products shall be used that have the appropriate properties regarding resistance to fire, so that in a possible fire the requirements set out in the fire safety study and other design output are met.	(1) Observed. Fire safety study covers this. (2) Observed. (3) Observed. Conditioning of waste for disposal is not being carried out at the repository. (4) Observed.
Article 26 (protection against natural disasters) (1) All structures shall be earthquake resistant. Their design shall take into account the level of earthquake resistance to be determined by special seismic analysis for the area of this detailed plan of national importance. (2) The construction of repository facilities shall not encroach on designated Sava flood areas with a specified flow rate with a 100-year return period (Q100). (3) Waste disposal facilities and facilities and arrangements for the processing and conditioning of waste for disposal shall be constructed on an embankment with a planned elevation of 157.50 m above sea level, which will protect them from probable maximum flood (PMF). The upper edge of the silo shall be planned at an elevation of 158.50 m above sea level.	(1) Observed. Analyses conducted: Seismological analysis of the site (geological part) for the Vrbina LILW repository facility, Rev. 1, Geological Institute Ljubljana, March 2015; Seismological analysis of the site (seismological part) for the Vrbina LILW repository facility, Rev. 1, Slovenian Environment Agency, March 2015; Recommendations for seismic loading of the Vrbina LILW surface repository, Faculty of Civil and Geodetic Engineering, IKPIR, June 2015, and supplement: Seismic design parameters for the calculation of an empty silo; University of Ljubljana, Faculty of Civil and Geodetic Engineering, IKPIR, November 2015; and Seismic design requirements for low and intermediate radioactive waste repository in Slovenia, Rizzo Associates, April 2015. (2) Observed. Hydraulic analysis of the impact zone of the Vrbina LILW repository, Krško, FGG – Chair of Fluid Mechanics, August 2015. (3) In accordance with the findings of the study Determination of the final elevation for the Vrbina LILW repository, IBE, August 2015, the elevation of the plateau of facilities for disposal and processing of waste (technological plateau) is set at 155.20 m above sea level, which provides safety against flood waters from the Sava River at a flow rate of 11130 m^3/s (PMF is 7081 m^3/s) and groundwater. The upper edge of the silo is 1.3 m above the level of the plateau.

(4) The administrative and service buildings shall be constructed on an embankment with a planned elevation of 155.20 m above sea level. (5) The entrance section of the repository shall be constructed on an embankment with a planned elevation of 153.75 m above sea level. (6) A median elevation of 153.25 m above sea level is planned for the regional road and the reconstructed Vrbina road. (7) During subsequent design prior to the acquisition of a construction permit, the elevations of the embankments and roads shall be determined precisely in accordance with the results of subsequent hydrological and hydraulic studies and the flood water levels. (8) The walls of the embankments shall be reinforced as appropriate so as to ensure their stability and the safety of the facilities.	(4) Observed, safety being provided against flood waters from the Sava River at a flow rate of 11130 m^3/s. (5) Arrangement of an information centre in the entrance section has been dropped. (6) Solutions for the regional road will be governed by the detailed plan of national importance for the regional road, which is being drawn up. Reconstruction of the Vrbina road will be performed with a median elevation of 152.20 m above sea level, ensuring safety against 100-year flood water (in line with the study Determination of the final elevation for the Vrbina LILW repository, IBE, August 2015). (7) The elevations are determined in line with the studies: Hydraulic analysis of the impact zone of the Vrbina LILW repository, Krško, FGG – Chair of Fluid Mechanics, August 2015; and Determination of the final elevation for the Vrbina LILW repository, IBE, August 2015. Observed. (8) The elevation of the Vrbina road and the access road to the LILW repository is determined on the basis of the study: Vrbina, Krško LILW repository/Elevation points and access roads, No. NRVB-B052/074, produced by: IBE Ljubljana, August 2015. The elevation of the Vrbina road is set at 152.20 m above sea level. The access road then rises from that elevation to an elevation of 155.20, which is determined as the elevation of the LILW repository plateau.
Article 27 (protection of soil and groundwater) (1) In the project area soil shall be managed prudently, so as to ensure the least possible scope of its destruction and damage, the separate removal and depositing of fertile and infertile layers of soil and the use of fertile soil for recultivation and exterior arrangements. (2) Only fertile soil obtained in the area of the project shall be used for recultivation. The use of soil from other construction sites shall be prohibited, in order to prevent the introduction of exotic invasive plant species in this area. (3) Activities affecting the soil should affect the smallest possible ground surfaces. Those surfaces that will be uncovered during construction shall be recovered with grass or planted and protected from erosion. In the execution of works, appropriate protective measures shall be ensured to prevent harm to neighbouring land. (4) The surplus ploughed layer of earth shall be allocated to improve lower quality agricultural land or to balance agricultural land in the Municipality of Krško, in accordance with the instructions of the authorized expert from the agriculture and forestry chamber. Topsoil shall be removed and disposed of in such a way as to preserve its fertility and quantity. (5) The construction site shall be provided with an appropriately equipped place for storing hazardous substances with a capture vessel of adequate volume, which in possible spillages, overflow or accident enables the capture of such substances and prevents leaks into the ground and consequently into surface and groundwater. (6) Measures for protecting soil and groundwater shall comprise: - placing repository facilities in a geological area with low water permeability; - disposal of waste in impermeable repository structures, which shall be ensured through design solutions and the use of materials with the appropriate qualities; - equipping the silos for ensuring control of leakage through a drainage system, which will allow for the collection and treatment of any water that appears inside the facility, in accordance with Article 10 of this Decree; - disposal of waste in a form that retards the discharge of radionuclides into the ground and groundwater; - handling of wastewater in such a way as to prevent contamination of soil and groundwater; - the operation of disposal facilities that prevents radioactive substances entering soil and groundwater; - ensuring of an adequate seal/cover between the silo and the aquifer after the disposal of the waste and the closure of the silo; - implementing operational monitoring and active long-term	 (1) Observed. (2) Observed. (3) Observed. (4) Observed. No surplus topsoil is anticipated. In the event of surplus topsoil, the requirements of the DPN and Article 9 of the ZKZ will be heeded. (5) Observed. (6) Observed.

surveillance that includes monitoring groundwater, and - performing safety analyses serving to check the possible impact of the repository on groundwater for all periods of the repository. (7) Working machinery and transport vehicles shall be supplied with fuel only in specified areas. (8) If transport vehicles and other devices are fuelled in the area of the construction site, in transportation and other handling areas, they shall be reinforced, and on non-reinforced surfaces, mobile capture vessels shall be used. (9) In order to ensure the protection of soil, Article 29 of this Decree, which regulates protection of water, shall apply mutatis mutandis.	(7) Observed. (8) Observed. (9) Observed.
Article 28 (air protection) (1) In order to reduce negative impacts on the air, the regulations governing protection of air shall be observed. (2) Construction shall be organised and implemented in such a way as to prevent as much as possible additional air pollution, which is affected by the selection of working machinery, transport vehicles and the weather conditions during construction. The following shall be ensured: - moistening of materials, unprotected surfaces and transport routes in windy and dry weather; – the prevention of materials being dispersed from the construction site; - the cleaning of vehicles when leaving the construction site for public transport surfaces and - dust suppression protection of all construction site and public roads used for transportation.	(1) Observed. (2) Observed.
Article 29 (water protection) (1) During construction, strict protection measures and monitoring shall be implemented, along with the organisation of the construction site such that it ensures the unimpeded flow of possible high water and prevents the pollution of water that might arise from transportation, storage and use of liquid fuels and other hazardous substances. All temporary storage areas and pumping stations for fuel, oil, lubricants and other hazardous substances shall be protected against the possibility of leakage into the soil and watercourses. (2) During construction, flawless construction vehicles and machinery shall be used, and appropriate disposal of construction waste and surplus materials shall be ensured. (3) Possible contaminated precipitation wastewater from the waste disposal area and the area for the processing and conditioning of waste for disposal shall be radiologically checked and chemically analysed prior to discharge into the public sewer system. (4) Prior to discharge into the public sewer system, industrial wastewater from an area in which there are no limits regarding protection against ionising radiation shall be chemically analysed. Such wastewater shall be handled in accordance with Article 10 of this Decree. (5) All parking and transportation surfaces shall be reinforced and delimited with raised concrete kerbs so that precipitation wastewater drains from the reinforced surfaces in a controlled manner via oil traps. (6) Hazardous substances shall be stored in separate premises in such a way as to be protected from atmospheric influences. (7) In all spaces where there exists the possibility of the spillage of hazardous substances, appropriate sealing of the ground shall be ensured. (8) In the event of a spillage of hazardous substances, immediate action shall be ensured by appropriately trained workers, and the location of the spill shall be immediately remediated. (9) Regular cleaning and maintenance of the systems for removing and treating all wastewater shall be ensured. (10) With regard to the protection of water, Article 27 of this Decree, which regulates the protection of soil and groundwater, shall apply mutatis mutandis.	(1) Observed. (2) Observed. (3) Containers will be delivered to the repository using transportation suited for driving on public roads. Contamination of precipitation water is not anticipated. Drainage of precipitation water from the exterior areas of the technological section of the repository will be regulated via oil traps and drainage lines into the infiltration field. (see also Article 16 (2)) (4) Industrial wastewater in the stated area is not anticipated. (see also Article 10 (1)) (5) Observed. (6) Observed. (7) Observed. (8) Observed. (9) Observed. (10) Observed.
Article 30 (noise protection) (1) During construction, the legally defined noise levels may not be	(1) Observed.

exceeded, and the following measures to protect against noise must be applied: - use of construction machinery equipped with certificates of sound power that may not exceed the legally prescribed values; - noisy work may be performed only between 7 a.m. and 7 p.m.; - appropriate organisation of the construction site to be ensured (limitation of sonic signals, machine engines not to idle unnecessarily). (2) During operation, the same conditions as for the construction period shall apply to the performance of transportation.	(2) Observed.
Article 31 (protection against ionising and electromagnetic radiation) (1) Detailed measures to protect exposed workers and reference population groups against ionising radiation shall be defined in the environmental impact report and safety analysis report, in accordance with the regulations governing ionising radiation protection, and incorporated into construction permit acquisition projects. (2) The transformer station may not be sited in the immediate vicinity of areas in which people are present for longer periods of time. (3) The regulations governing electromagnetic radiation in the natural and living environment shall be taken into account in relation to the installation of the transformer station and the laying of medium-voltage cables.	(1) Observed. (2) Observed. (3) Observed.
Article 32 (phased implementation) (1) Arrangements set out in the detailed plan of national importance may be implemented in several phases. (2) The phases shall be functionally complete units and may be carried out and put into use separately or simultaneously.	(1) Observed. (2) Observed.
Article 33 (conditions for placement of simple and non-complex structures) In the area covered by the detailed plan of national importance, and under the regulation on areas of restricted use due to nuclear facilities and on the conditions of construction, simple and non-complex structures may be erected in accordance with the regulation governing the classification of structures with regard to the complexity and the conditions of construction of simple and non-complex structures.	(1) Not applicable.
Article 34 (monitoring and supervision of the implementation of works) (1) The investor shall ensure a programme of monitoring, including environmental monitoring, as an integral plan for monitoring and supervision in all phases during construction and operation of the repository, and also during long-term surveillance, in the scope and manner set out in the Environmental Report for the LILW Repository (produced by Geateh d.o.o., November 2006, supplemented in April 2009). Additional content of monitoring shall be defined in the environmental impact assessment report and the safety report. Reporting shall be provided to the ministry responsible for environmental protection. (2) In determining monitoring and supervision, the points of zero state measurements conducted shall apply mutatis mutandis. In sections where this is possible, monitoring and supervision shall be adapted and coordinated with other existing or envisaged national and local monitoring of the qualitative state of the environment. In the physical measurement of the state of environmental components, at least a sufficient number of points of control shall be ensured as to obtain well-founded information on the status of environmental components. The points for monitoring the status must enable the constant acquisition of data. Monitoring and supervision shall be implemented in accordance with the regulations governing environmental protection and the guidelines defined in the environmental report, and shall be defined in greater detail in the environmental impact assessment. (3) In order to establish the programme of monitoring the conditions in groundwater, in the impact zone of the repository during preparatory works and operation of the repository, sampling points shall be ensured. (4) As part of implementing the programme of monitoring the state of the environment, in addition to the sampling points under the programme of monitoring the quality of surface watercourses in	(1) Observed. (2) Observed. (3) Observed. (4) An additional sampling point is envisaged at the inflow point of the drainage channel built in accordance with the DPN for the Brežice hydroelectric plant, which flows along Vrbina road to the

Slovenia, an additional sampling point shall be set up on the section of the Sava River downstream of the repository. This point shall be determined on the basis of a field inspection and hydrological measurements.	Spodnji Stari Grad gravel pit.
(5) The design solution for removal of industrial wastewater must also cover an adequately arranged and accessible measurement point for taking samples of treated wastewater prior to its discharge into the public sewers.	(5) Observed. Sampling will be conducted in the final shaft of the sewer system in the area of the repository. The control shaft at the outflow from the LILW repository is outside the fenced repository.
(6) Control boreholes shall be made for monitoring and managing hydrological conditions in the area of the disposal units. The depth and deployment of these boreholes must ensure the monitoring of all typical hydrogeological phenomena in the area of the detailed plan of national importance. Their locations and the locations of the control boreholes made outside the area of the detailed plan of national importance shall be defined in detail in the monitoring programme.	(6) Observed. The programme of monitoring for radioactivity proposes locations and numbers of boreholes. Observed. See explanation for paragraph (5).
(7) To monitor the radioactivity of the surrounding environment, before the start of works at the repository, zero state measurements of radioactivity shall be taken. At least a year before the start of trial operation, pre-operation monitoring must be started in accordance with the identified transfer routes.	(7) Zero state measurements conducted in 2006. Will be observed.
(8) During construction, implementation of the entire construction works shall be supervised in accordance with the project design for obtaining a construction permit, including supervision of the execution of the flood protection embankment and supervision of planting.	(8) Observed.
(9) The following additional appropriate protective measures must be implemented by the investor on the basis of the results of monitoring and supervision: - additional technical and spatial solutions; - additional planting and vegetation; - remediation of damaged areas, devices or other spatial components; – change in the use of the space and – other appropriate measures (mitigation actions).	(9) Observed.
(10) Detailed provisions for monitoring the state of the environment shall be defined in the monitoring programme based on the environmental impact report and safety analysis report, in accordance with the regulations governing ionising radiation protection, and incorporated into the construction permit acquisition project design.	(10) Will be observed.
Article 35 (construction site organisation) (1) The construction site shall be arranged in the area of the detailed plan of national importance. During construction of the second silo, a portion of the vacant repository land shall be set aside for construction site facilities and arrangements.	 (1) Observed.
(2) The greatest possible levelling of earth and construction material shall be ensured in the area of the detailed plan of national importance. A portion of the surplus of non-load-bearing material may be disposed of in dumps envisaged for this purpose, as defined in municipal spatial acts. Inert material generated from the dismantling of structures shall be disposed of in accordance with the regulations governing the processing and disposal of waste.	(2) All excavated materials for the first silo will be disposed of in the area of the detailed plan of national importance for the repository, at the repository site. Excavated material in the construction of the second silo is expected to be disposed of in the ash dump (Kostak, 17978 m^2, c.m. 1316 -Stara Vas) and on parcel 2106/85, c.m. Drnovo. Owing to the time lag before construction of the second silo, only the location of the arranged dump has been addressed.
(3) In addition to all the obligations stated in preceding articles of this Decree, the investor and contractors shall ensure, during and after construction, observance of the following conditions: - roads and ways for possible detours or transportation during construction of the repository shall be properly arranged prior to the start of works, and after construction any damage remediated; - structures and infrastructure lines shall be renovated or refurbished if they are damaged during construction owing to the execution of works; - during construction, municipal service and power supply for facilities shall be provided via existing or temporary infrastructure facilities and devices; - even during construction, the repository shall be secured physically in accordance with the regulations governing the physical security of nuclear facilities, in order to ensure the security and unimpeded use of neighbouring facilities and land; - during construction, all the necessary security measures and organisation at the construction site shall be implemented, so as to prevent the pollution of water that might arise from transportation, storage and use of liquid fuels and other hazardous substances. In the event of an accident, immediate action shall be ensured by appropriately trained workers.	(3) Observed.

Article 36 (additional obligations) (1) Owing to the loss of the best agricultural land as a consequence of construction of the repository, by the time of obtaining a construction permit the methods shall be determined for compensating for lost agricultural land, specifically through cash compensation or substitute land for the owners of expropriated agricultural land, or through other appropriate measures. (2) In order to compensate for agricultural land, priority shall be given to verifying three options for compensation stemming from the study Consequences of constructing the Vrbina LILW repository on the economic viability of agricultural production (produced by the Biotechnical Faculty, University of Ljubljana, task number 134/2009, November 2009). (3) The investor shall provide compensation for loss of earnings from agricultural land that is temporarily removed from agricultural use owing to construction of the repository. (4) Prior to the start of construction, the investor must make a record of the state of existing infrastructure together with the operators. (5) During construction, contractors must ensure uninterrupted municipal service and power supply for facilities via existing infrastructure facilities and devices. (6) The investor must cover the costs of protection, movement, supervision, marking of points and routes, changes to documentation and existing infrastructure, possible damage and halting of traffic that might arise owing to implementation of the detailed plan of national importance. (7) The investor and contractor shall be liable for any damage to municipal infrastructure facilities caused by construction of the repository. (8) For any damage to road infrastructure in the Municipality of Krško the contracting authority must pay compensation, if the damage arises from construction of the repository. (9) During construction the investor must continuously inform the population about the progress of construction. (10) During construction the investor shall be responsible for implementing the programme of monitoring the state of the environment. (11) During operation of the repository the operator shall be responsible for implementing the programme of monitoring the state of the environment. (12) The investor shall commission a review of the design output for the repository, which shall be performed by an interdisciplinary review group. The results of the review must be presented to the Municipality of Krško prior to obtaining a construction permit for the repository.	(1) to (2) rescinded in 2011, ZKZ, transitional and final provisions, Article 40. Compensation will be paid for change of purpose of agricultural land, ZKZ, Article 3g-3i. (3) Observed. (4) Observed. (5) Observed. (6) Observed. (7) Observed. (8) Observed. (9) Observed. (10) Observed. (11) Observed. (12) Observed.
Article 37 (supervision) Supervision of the implementation of this Decree shall be provided by the Ministry of the Environment and Spatial Planning, Inspectorate of the Republic of Slovenia for the Environment and Spatial Planning.	Not applicable.
Article 38 (permissible deviations) (1) In the implementation of the detailed plan of national importance, deviations shall be permitted from the functional, design and technical solutions laid down in this Decree if, after further detailed examination of the security, energy, technological, geological, geomechanical, hydrological, seismic and other conditions, technical solutions are obtained that are more suitable from the security, environmental protection, geotechnical, design, technological or energy aspects, or the aspect of physical protection of the nuclear facility, whereby the spatial or environmental conditions may not be worse. (2) The deviations from the functional, design and technical solutions referred to in the preceding paragraph may not change the planned appearance of the area, may not lead to a deterioration in the working conditions in the area covered by the national spatial plan or in neighbouring areas, and may not be counter to the public good. Deviations must be agreed with authorities and organisations within the working area of which such deviations fall, and the Municipality of Krško shall be informed of them. (3) The number and size of the silos may change if it is shown, after further research and planning, that this is necessary or expedient	(1) to (6) observed. The route of the drainage system for removal of urban wastewater runs along a partly changed route from that planned in the detailed plan of national importance. In planning the route of the drainage system for removal of urban wastewater, account was taken of the planned Krško – Brežice bypass road, for which a detailed plan of national importance is being produced. The point of connection for the water main to the public water supply network is planned at the road connection to the Kostak sanitary landfill. The course of the drainage system route for removal of urban wastewater and the point of connection for the water main to the public water supply network are coordinated with the operator of the public water supply and sewerage network.

because of subsequent findings regarding the geological, geomechanical and hydrogeological characteristics of the micro-location and other technological and technical requirements for radioactive waste disposal. (4) Deviations shall be permitted from the data shown in the cartographic annexes and from the quantities defined in this Decree as a result of more precise processing of the designs and of the results of the safety analyses. (5) Changes to the routes of individual infrastructure lines and the positions of facilities, devices and connections shall be permissible for the purpose of more appropriate supply and more rational use of the space. (6) Other crossing of economic infrastructure with spatial arrangements planned in this detailed plan of national importance and not defined in this Decree may also be deemed to be permissible deviations. For each other or different solution of crossing economic infrastructure with spatial arrangements, the investor of economic infrastructure must obtain the prior consent of the investor of the spatial arrangement if it has not yet been built, or the consent of its operator after construction is completed.	
Article 39 (area of spatial arrangements for which spatial implementing conditions will be defined in supplements to this detailed plan of national importance) In the part of the area for waste disposal on parcels or parts of parcels No. 1197/85, c.m. Leskovec, and No. 2103/15, c.m. Drnovo, expansion of the disposal capacities of the repository is envisaged. For this part, spatial implementing conditions shall be laid down as part of the supplementation of this detailed plan of national importance.	Not applicable.
Article 40 (municipal spatial acts) On the day this Decree enters into force, for the area of this detailed plan of national importance the following shall be deemed to have been amended and supplemented: – Amendments to the spatial components of the long-term and medium-term plans of the Municipality of Krško (Official Gazette of the SRS, No. 7/90, and Official Gazette of the RS, No. 38/90, 8/92, 23/92, 13/94, 69/95, 11/97, 59/97, 68/97, 62/98, 8/99, 10/99, 69/99, 97/01, 71/02, 90/02, 99/02, 116/02 and 79/04) and the social plan of the Municipality of Krško for the period 1986–1990 (Official Gazette of the SRS, No. 21/87 and 25/89, and Official Gazette of the RS, No. 38/90, 8/92, 23/92, 13/94, 69/95, 11/97, 68/97, 62/98, 8/99, 10/99, 69/99, 97/01, 71/02, 90/02, 99/02, 116/02 and 79/04); – Ordinance on the spatial arrangement conditions for the area of the Municipality of Krško (Official Gazette of the RS, No. 75/96, 73/00, 101/01, 15/05 and 25/06); – Ordinance on the spatial arrangement conditions for the Industrial Zone of Vrbina (Official Gazette of the RS, No. 7/01) and – Ordinance on the location plan for Substation 400/110 kV Krško and layout of transmission lines (Official Gazette of the SRS, No. 31/87 and 34/88).	
Article 41 (entry into force) This Decree shall enter into force on the fifteenth day following its publication in the Official Gazette of the Republic of Slovenia (Official Gazette of the RS).	Not applicable.

The above table shows that the planned project work ensures adequate observance of all the relevant conditions for spatial arrangements and fulfilment of the conditions under the project in question, so the planned project is therefore in compliance with the provisions of the Decree.

1.7 OVERALL ENVIRONMENTAL IMPACT ASSESSMENT

The environmental report[17] was produced in the process of drawing up the detailed plan of national importance for the LILW repository and is a component part of the Variant Study[18]. At the same time as the environmental report, a Special Safety Analysis (SSA) was also developed in accordance with the provisions of the ZVISJV.[19] In the SSA, all factors in the area of the nuclear facility affecting nuclear safety were analysed and impacts of the repository on the population and the environment were evaluated. Both documents addressing the environmental impacts, i.e. the environmental report and SSA, are intertwined in substance and harmonised. The contents in the environmental report concerning nuclear and radiation safety are directly summarised from the SSA. The environmental report was elaborated in its final form during the final period of preparation of the Decree on DPN.

The Environmental Report which, among other things, summarised the findings of the SSA, was produced in the scope and manner that is generally prescribed for all facilities. The (environmental) impacts of the repository as a nuclear facility have already been and will continue to be addressed in detail in safety analyses in the subsequent phases of the project. Safety analyses are to be conducted in all stages of the life of the repository. The SSA represents an initial safety analysis, on the basis of which the acceptability of the spatial placement of the repository from the point of view of nuclear and radiation safety was assessed. The implementation of more detailed safety analyses for the needs of the EIA is presented in the document General Overview of the Safety Assessment Report, Issue 2.[20] Safety analyses will be repeated in the phase of obtaining a construction permit or the consent from the Slovenian Nuclear Safety Administration for the construction permit, in the phase of obtaining a permit for trial operation, and each time upon obtaining or renewal of the operating permit. For each subsequent safety analysis, more detailed data or data that is more relevant to the actual situation is used. Before starting operation, the safety analyses in the relevant report will also be submitted to the European Commission, which will give an opinion on the start of operation.[21]

In the Environmental Report, option solutions B, D, and E were analysed. The summary of the assessment focuses on the presentation of contents addressing Option B - Disposal in silos, i.e. the option which is also adopted for further consideration at the level of preparation of the Environmental Impact Report.

Evaluation of option solutions from the point of view of their environmental impacts was carried out according to the Decree laying down the content of the environmental report and on detailed procedure for the assessment of the effects of certain plans and programmes on the environment (Official Gazette of the RS, No. 73/05); in accordance with this Decree, impacts are marked with ratings from A (no impact/positive effect) to E (devastating impact).

A summary of the assessment for Option B – underground silos is given below.

[17] Environmental report for the LILW repository, Imos Geateh d.o.o., Project No. OP – 096/06, Rev. 4, April 2009; harmonised with the requirements of MOP DO SCPVO;
[18] Variant Study, National location plan for the low and intermediate level radioactive waste repository, Vrbina site in the municipality of Krško, Savaprojekt d.d. Krško and Acer d.o.o. Novo mesto, Project No. NSRAO-Vrb-ŠV/ŠV 02/06, December 2006
[19] Special safety analysis for spatial placement of the LILW repository, Vrbina site in the Municipality of Krško, DDC svetovanje inženiring d.o.o., Project No. NSRAO-Vrb-ŠV/PVA 02/06, December 2006
[20] Document designation: ARAO, EISFI-TR-(11)-15 Vol. 5, Rev. 2, October 2012
[21] In accordance with Article 37 of the EURATOM Treaty;

Findings from the environmental report:

- In the considered area, there is no **groundwater** which would be important for water supply or intended for exploitation for water supply or other similar uses. The impacts of Option B on groundwater conditions are assessed as insignificant upon implementation of mitigation measures (C). Special mitigation measures are envisaged for the handling of waste materials and construction materials that may contain hazardous substances.
- As regards the impacts on **surface waters**, the impact of the solution on the condition of the Sava River was estimated; however, the Sava River is not under the direct influence of events in the repository area. The impact of Option B on the condition of the Sava River has been assessed as insignificant.
- As regards **climate change**, it has been assessed that a minimal increase in greenhouse gas emissions in the impact area might occur; the impact is assessed as insignificant. No mitigation measures are envisaged.
- Regarding the impacts on **air quality**, it was estimated that there may be a minimal increase in the emitted quantities of pollution and consequently the concentration of pollutants in the impact area. The impact of implementation of the plan on air quality is assessed as insignificant.
- From the point of view of **noise** pollution, the solution is acceptable. During the construction and operation of the repository, measures will have to be taken to ensure that the activity will not cause an excessive burden on the environment with noise.
- Regarding the impacts on the **soil and agricultural areas**, it was found that the entire area of the Vrbina site is defined as best agricultural land in the planning acts of the Municipality of Krško. On the site itself there are landscaped fields. To reduce impacts on soil and agricultural land, specific measures will be needed (substitute land and/or provision of benefits in concluding leasing contracts with the Agricultural Land Fund and ensuring the economic management of the land in the area of the activity); however, when these measures are implemented, the above impacts will be insignificant. The implementation of the plan will destroy or permanently disable the current planned and actual use of the land in the area of the plan. The impacts have been assessed as insignificant, but that is with the implementation of mitigation measures.
- Regarding the impacts on **nature**, it was found that in the area of the plan, habitat types, plant species and less mobile animal species will be destroyed and a short-term negative impact due to increased noise levels and higher concentrations of dust might extend outside the boundaries of the plan area. The disposal units will be constructed in the Tertiary geological substrate (silt), and the access will be built through the Quaternary gravel layer. From the point of view of the impacts on biodiversity and habitat types, solution B was assessed as being more appropriate. Because of the remoteness and natural isolation, impacts are not to be expected; impacts of the plan on an ecologically important area and natural values are also unlikely. There will be no impact on protected areas and Natura 2000 sites (grade A).
- In evaluating the impacts on the **landscape**, it has been established that the planned arrangement encroaches on an area of intensive agricultural landscape with few recognisable landscape features and low landscape diversity. Landscape diversity will not be reduced by the activity. Due to a relatively short-duration impact on the landscape, Option B has been assessed as appropriate.
- Regarding the management of waste that will be generated during the construction and operation of the LILW repository, the impact of the option is insignificant.
- Given that all practices will be carried out in accordance with regulations and all quantities will be low, the **risks** for humans and the environment will be insignificant.

- Regarding **ionising radiation**, it has been found that during the construction of buildings, there will be no reception, processing or storage of radioactive waste in the repository. Therefore, there will be no radiological impact on the environment, workers or residents. Option B was assessed as appropriate. Releases of radioactive substances from the repository during normal operation, and thus the environmental impacts, will be negligible. The impact of implementation of the plan in terms of radiation has been assessed as insignificant.
- The environmental objectives of the plan in terms of impact on the **population and health** are ensuring social concern for the health of the population and control of radioactive radiation in the external environment. The Decree[22] prescribes criteria for determining areas of limited use of space due to a nuclear facility and criteria for prohibitions and restrictions on construction in areas of limited use of space. The impact of implementation of the plan on the population and health is assessed as insignificant. Option B was proposed as suitable for the implementation of the plan.

Transboundary impacts

The Act Ratifying the Convention on Environmental Impact Assessment in the Transboundary Context (MCPVO, Official Gazette of the RS, 46/1998) places a LILW repository on the list of activities under Addendum I (under point 3: "Installations solely designed for the production or enrichment of nuclear fuels, for the reprocessing of irradiated nuclear fuels or for the storage, disposal and processing of radioactive waste").

The distance of the planned LILW repository from the state borders of the neighbouring countries of Austria, Hungary and Italy (the shortest distance from the border) is as follows:

- distance from the state border with Austria is approx. 74 km;
- distance from the state border with Hungary is approx. 101 km; and
- distance from the state border with Italy is approx. 128 km.

The planned repository is to be located in the Sava river basin and is about 13 km from the border with Croatia (closest point), which is significantly less than the distance from other neighbouring countries.

In the environmental report all potential and actual impacts of the LILW repository, with consideration of mitigation measures, are insignificant - which means that even in the most unfavourable case, these cross-border impacts are insignificant or non-existent.

The conclusion of the environmental report for drawing up the detailed plan of national importance for the LILW repository is that the plan (with the implementation of mitigation measures for the protection of groundwater and agricultural land) is acceptable.

[22] Decree on areas of restricted use due to nuclear facilities and on the conditions for construction (UV 3).

Table 2: Overall assessment of impacts of implementing the plan for Option B

Security aspect	**Option B (underground silos)**
I. Groundwater	C
II. Surface waters	B
III. Climate change	B
IV. Air quality	B
V. Noise	B
VI. Soil and agricultural land	C
VII. Landscape	B
VIII. Biodiversity and habitat types	B
IX. Natural values and ecologically important areas	B
X. Protected areas and Natura 2000 sites	A
XI. Waste management	B
XII. Risk	B
XIII. Ionising radiation	B
XIV. Population and health	B
Sum of allocated points	**1 x A, 11 x B, 2 x C**

2. TYPE AND CHARACTERISTICS OF PROJECT

2.1 DESCRIPTION OF LOCATION OF PROJECT

The site of the planned LILW repository lies southeast of the town of Krško and southwest of the village of Spodnji Stari Grad, on the left bank of the River Sava on a gravel plain with the old fallow field name of Vrbina. The site and its wider impact zone are part of the Krško or Krško-Brežice plain, with the wider surroundings stretching to the local hilly parts of the Krško basin.

The site of the LILW repository lies on the margin of the alluvial plain of Krško polje at a height of between 151.69 m and 153.44 m above sea level.

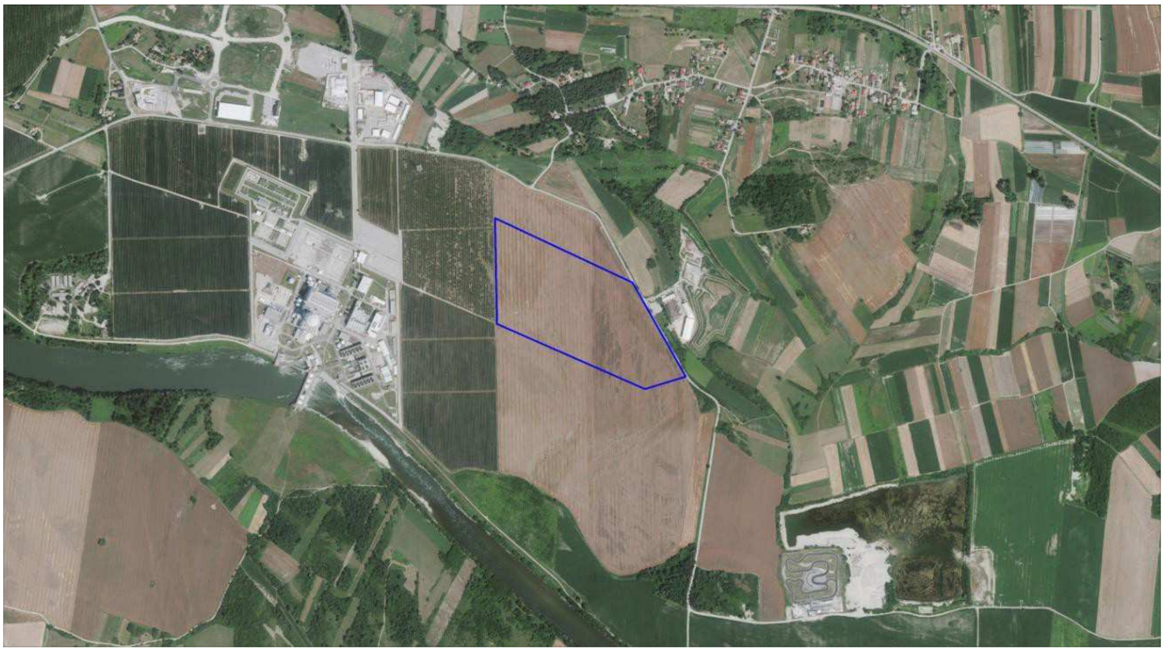

Figure 1: Illustration of the location with surroundings on a satellite image

The table below shows the parcel numbers affected by specific arrangements for the LILW repository.

Table 3: Specific arrangements as part of the project in question with parcels

	Drnovo c.m. (1320)	Leskovec c.m. (1321)	Stari Grad c.m. (1317)
REPOSITORY FACILITIES			
repository facilities	2103/85	1197/58	
INFRASTRUCTURE FACILITIES			
Vrbinska cesta road (part of a public path JP 693631 – sanitary landfill and a part of the uncategorised public road)	2106/96, 2106/105, 2106/103, 2106/98, 2103/93, 2645/15, 2645/20, 2103/92, 2645/17, 2106/99, 2106/100, 2103/89	1197/438	
Access road	2103/85, 2103/89, 2103/92		
Parking area	2103/85		

	Drnovo c.m. (1320)	Leskovec c.m. (1321)	Stari Grad c.m. (1317)
Water main connection	2103/85, 2103/89		
Existing water main – reconstruction	2103/89, 2103/92, 2103/93, 2103/91, 2645/17, 2106/100, 2106/99	1197/438	
Electrical connection	2103/85, 2103/89, 2103/92, 2103/91		
Street lighting for the Vrbina road	2106/96, 2106/105, 2103/89, 2103/92, 2103/91, 2645/17, 2106/99	1197/438	
Telecommunications connection	2103/85, 2103/89, 2103/92, 2103/91		
Sewers for the removal of urban wastewater	2103/85, 2103/89, 2103/92, 2103/93, 2106/98, 2645/15, 2645/20, 2645/19, 2106/96, 2106/95, 2106/2, 2106/106, 2106/107, 2106/277	1197/438, 1197/401	1179/71, 1179/70, 1179/68, 1179/64.
pumping station	2103/93, 2103/92, 2103/89		
Sewers for the removal of precipitation water with an infiltration field	2103/89, 2103/85		

After the adoption of the Decree on DPN for the LILW repository, construction began of a new route of the regional road from Krško to Brežice, which is the subject of a separate detailed plan of national importance. Both plans overlap in the area of the road connection to the Krško NPP. Further elaboration and drafting of the detailed plan of national importance for the aforementioned regional road has not yet been concluded. The solution presented in the Report and Conceptual Design, January 2016, shows a coordinated route of the regional road in the area of the project for both spatial arrangements, i.e. for both the LILW repository and the Krško-Brežice regional road link.
The reconstructed local road from the area of the LILW repository will be connected to the planned new route of the regional road via the southern branch of the Spodnji Stari Grad 1 roundabout (see figure below). The construction of a roundabout at Krško NPP is also planned under the proposed DPN for the new regional road connection from Krško to Brežice. The aforementioned segment of the route will be used for the transportation of the radioactive waste that is already prepared for permanent disposal at the LILW repository, where the entity responsible for the activity affecting the aforementioned construction of this segment of the road is the ministry competent for national roads. In the phase of drawing up the Conceptual Design, January 2016 for the LILW repository, a change came about in the route of the pressure pipe sewer system and under the new proposal, north of the roundabout for the new Krško - Brežice regional road a section of it runs outside the detailed plan of national importance area (shown in the figure below – the area as shown by the direction of the two-sided arrow). The area was changed owing to the placing of the new Krško to Brežice regional road.
The figure below shows the area of the project for the LILW repository under the detailed plan of national importance.

The surface area of the detailed plan of national importance amounts to: 26.3 ha
The surface area of the envisaged project zone as discussed in the EIA is smaller, amounting to: 17.5 ha Annex 1 indicates clearly the two surface areas.

Figure 1 and also several illustrations in the EIA indicate the area where the repository is sited, with the exterior arrangements (without reconstruction of Vrbina road and the sewerage system to the Libno pumping station), which covers 16.5 ha.

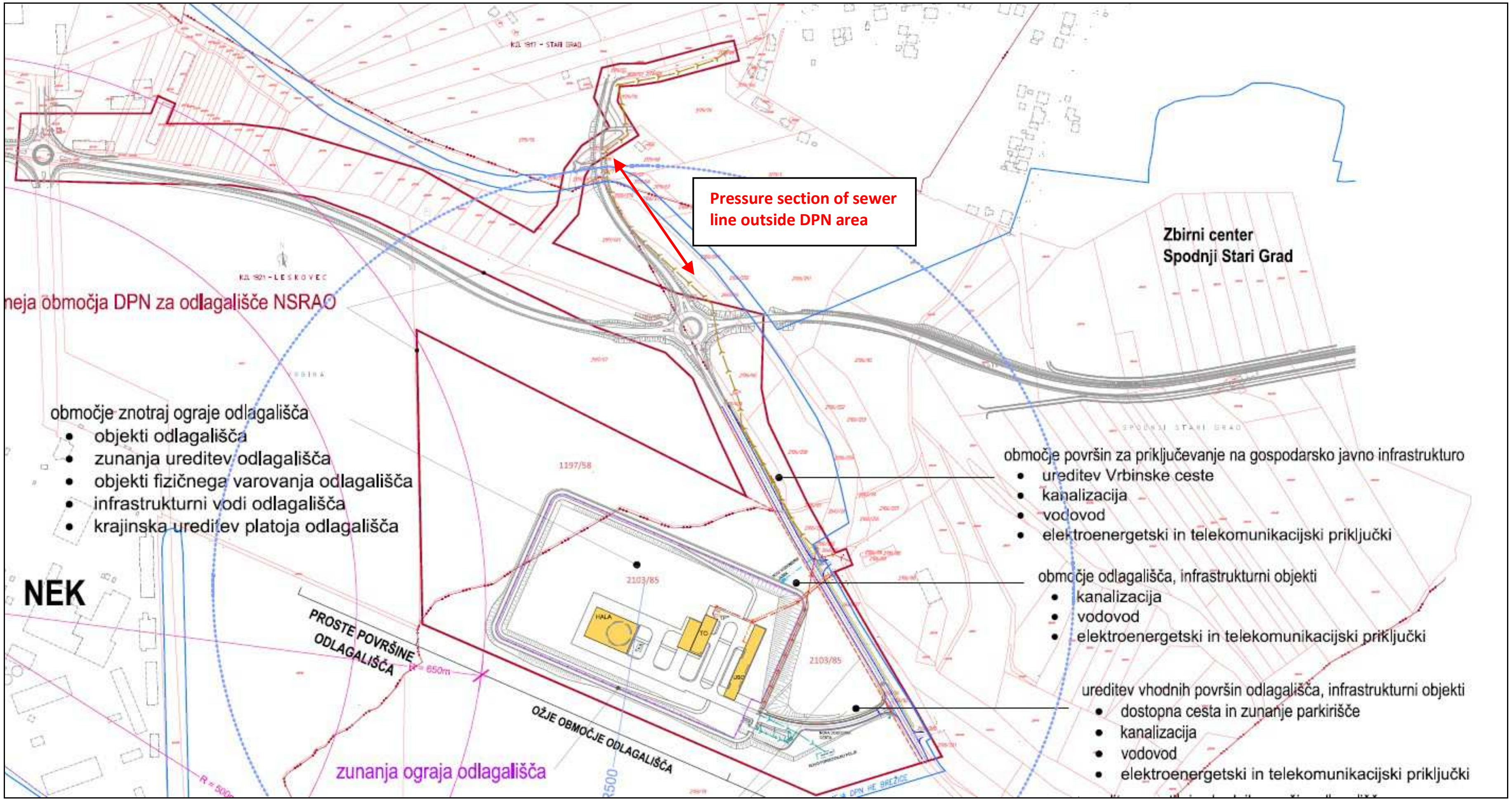

Figure 2: Area of DPN for LILW repository indicating changes to land occupation due to new route of sewers (outside DPN area)

Zbirni center Spodnji Stari Grad	Spodnji Stari Grad Collection Centre
območje površin za priključevanje na gospodarsko javno infrastrukturo	area of surfaces for connection to public utilities infrastructure
• ureditev Vrbinske ceste	• arrangement of Vrbina road
• kanalizacija	• sewerage system
• vodovod	• water supply system
• elektroenergetski in telekomunikacijski priključki	• electricity and telecommunications connections
območje znotraj ograje odlagališča	area inside repository fence
• objekti odlagališča	• repository facilities
• zunanja ureditev odlagališča	• exterior arrangement of repository
• objekti fizičnega varovanja odlagališča	• facilities for physical security of repository
• infrastrukturni vodi odlagališča	• infrastructure lines for repository
• krajinska gredifev platoja odlagališča	• landscaping of repository plateau
območje odlagališča, infrastrukturi objekti	area of repository, infrastructure facilities
• kanalizacija	• sewerage system
• vodovod	• water supply system
• elektroenergetski in telekomunikacijski priključki	• electricity and telecommunications connections
ureditev vhodnih površin odlagališča, infrastrukturni objekti	arrangement of entry areas of repository, infrastructure facilities
• dostopna cesta in zunanje parkirišče	• access road and external parking area
• kanalizacija	• sewerage system
• vodovod	• water supply system
• elektroenergetski in telekomunikacijski priključki	• electricity and telecommunications connections
zunanja ograja odlagališča	exterior fence of repository
proste površine odlagališča	vacant surfaces of repository
ožje območje odlagališča	core area of repository
meja območja DPN za odlagališče NSRAO	boundary of DPN area for the LILW repository

2.1.1 *DIRECT IMPACT AREA*

The Vrbina site lies within the Municipality of Krško, in the gravel plain area, with individual depressions formed by the former course of the Sava. The closest towns to the site are Krško and Brežice, which are located 2.5 and 5 km from the site respectively. The site is located a little over 12 km from the border with the neighbouring country Croatia. Krško NPP is situated approximately 300 m from the western edge of the site. Approximately 400 m north-east of the site is the settlement of Spodnji Stari Grad. The plain on the southern side of the site is bounded by the Sava riverbed, which is approx. 650 m from the repository site at its nearest point.

To the south of the planned activity (approx. 600 m), the construction of a reservoir of the Brežice hydroelectric plant was finished in 2017 (start of trial operation in September 2017).

To the north, the plain extends towards Libna Hill. In the east, the site is bounded by a local road leading from the settlement of Vrbina towards the south-east, i.e. towards the banks of the Sava. The wider area of the site is used for agriculture and is officially designated prime agricultural land. There are fields within the site itself and a commercial orchard at the site's far western edge.

The area in question of the detailed plan of national importance for the ARAO repository contains no particular natural features, protected areas or areas important to biodiversity. Close to the Vrbina site is an ecologically important area of the River Sava (the Sava from Radeče to the national border, EPO 63700).

The wider area is used for agriculture and is officially designated as prime agricultural land. There are fields within the envisaged site and a commercial orchard in the site's direct vicinity.
The site of construction of the LILW repository does not encroach on any water protection area. The hydrogeological structure of this site is assessed as being less challenging. The site of the project occupies retention surfaces of the floodwaters of the River Sava (area of 500 year waters and partly also 100 year waters – source: Atlas okolja, 2017).

There are no cultural heritage units listed in the area of constructing the LILW repository and no protected archaeological sites.

2.1.2 *USE OF SPACE AND LAND OWING TO PROJECT*

In the core area of the plan the following spatial use zones are in effect:

- Prime agricultural land
  The programme of conditioning agricultural land permits lowland melioration – An3, Stari Grad and commassation K11 and irrigation N1, Stara vas;
- Energy infrastructure zones[23]
  Krško NPP – Krško nuclear power plant with protective buffer zone (500, 650 and 1500 m), transmission line – 20 kV with corridor

[23] The area lies within the 500 m belt governed by the Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS No. 36/04, 103/06 and 92/14). In view of the restrictions valid under this decree, the LILW repository may be sited in an area of limited use owing to a nuclear facility.

– 110 kV above-ground transmission line
– 2x400 kV above-ground transmission line, Zagreb - Krško;

- Municipal services with infrastructure
- The closed urban waste landfill and Spodnji Stari Grad Waste Management Centre.
- The area of Cerklje airfield[24]
  Restricted use of space.

Types of activity in the core area:

- farming;
- energy activity in the area of the nuclear power plant;
- municipal services work within the closed urban waste landfill and Spodnji Stari Grad Waste Management Centre.

2.1.3 *REQUIREMENTS RELATING TO INFRASTRUCTURE PROVISION AND TRANSPORT REQUIREMENTS*

During the phases of construction and operation the LILW repository will be furnished with all the necessary infrastructure as follows:

Transport infrastructure:

- reconstruction of section of local road with path for pedestrians and cyclists (Vrbina road),
- arrangement of access road from the LILW repository to the connection with the public road and parking area for the needs of the LILW repository (including load-bearing embankment);

Infrastructure lines:

- connection to water supply network;
- connection of new pumping station for the municipal sewers to the power supply network from the Kostak landfill substation;
- connection of new substation at the LILW repository (20 kV transmission line) running from the Kostak landfill substation;
- drainage system for precipitation water run-off with infiltration field,
- drainage system for wastewater with new pumping station and flow to the Libna pumping station,
- connection to the telecommunication network.

A gas pipeline connection is not envisaged, since the facilities are to be heated using heat pumps.

Access to the area of the LILW repository is past Krško NPP along municipal road LC 191111 (Krški most–Vrbina–Spodnji Stari Grad) and then along the reconstructed public way JP693631 for the sanitary landfill.

The required infrastructure for the planned repository is described in greater detail in chapter 2.2.1.3 CONSTRUCTION OF INFRASTRUCTURE CONNECTIONS.

[24] The DPN location for the LILW repository is in an area of "controlled and restricted use" for the airfield at Cerklje ob Krki, a "controlled zone" for the Cerklje ob Krki airfield and in the wider area of controlled use for the Krško nuclear power plant.

2.1.4 *EXISTING DEVELOPMENTS IN THE AREA AND THEIR CONNECTION WITH PLANNED PROJECT*

The existing built environment that limits the area of the LILW repository comprises principally:

- an energy infrastructure area: Krško Nuclear Power Plant (NPP) with a dam on the Sava River;
- Vrbina Industrial Zone,
- the electrified Zidani Most – Dobova railway line and the settlements of Spodnji Stari Grad and Stari Grad all lie on the left bank of the River Sava,
- the closed Spodnji Stari Grad municipal waste landfill and collection centre,
- Raceland safe driving & sport driving centre – SE of Krško NPP (more than 1.5 km from the development site).

To the south of the planned activity (approx. 600 m), the construction of a reservoir of the Brežice hydroelectric plant was finished in 2017 (start of trial operation in September 2017).

According to records in the Atlas okolja (Atlas of the Environment, 2017) there are 23 house numbers within the 500 m belt, and 119 house numbers within the 1000 m belt.

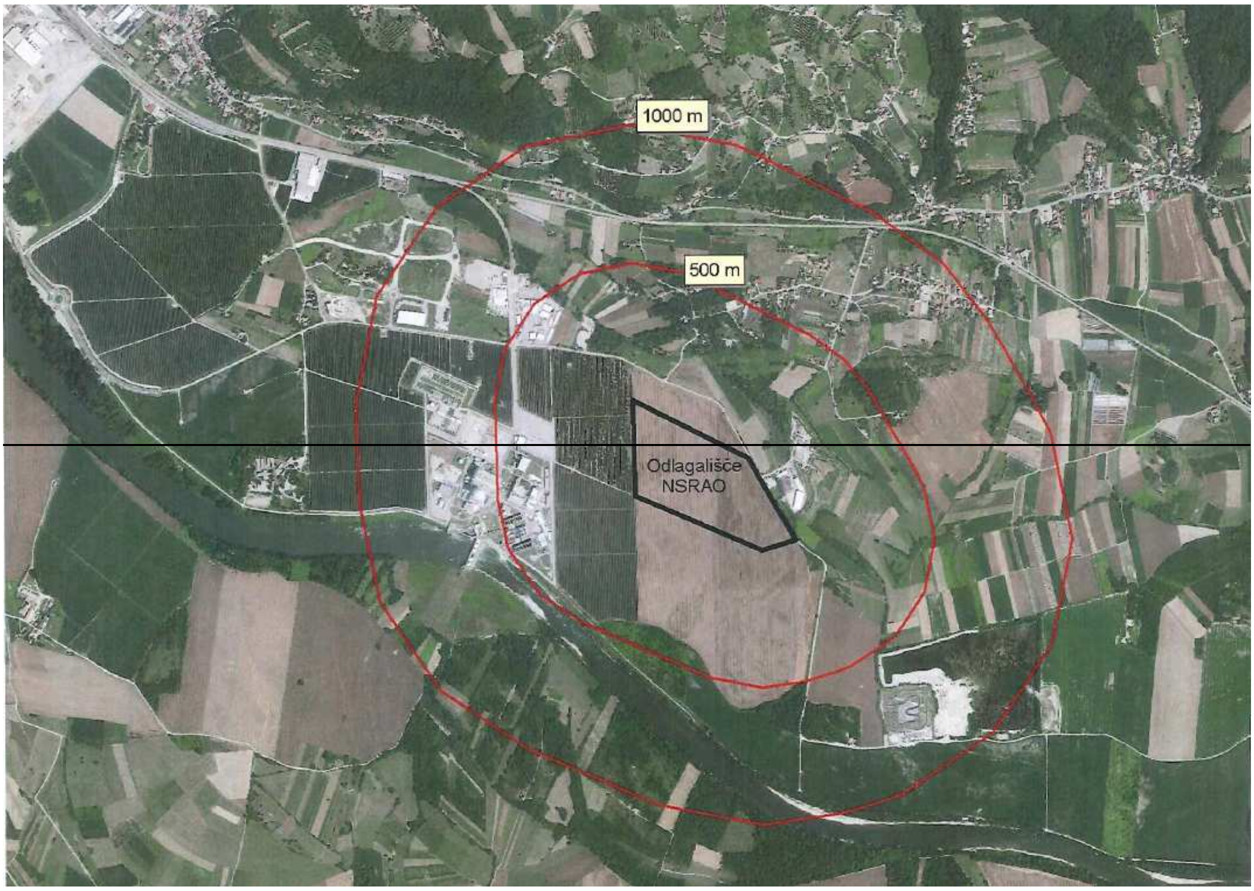

Figure 3: Areas up to 500 m and 1000 m

Odlagališče NSRAO	LILW Repository

2.1.5 *ACTIVITIES RELATED TO THE REMOVAL OR HALTING OF DEVELOPMENT OR REINSTATING THE ORIGINAL STATE AFTER HALTING DEVELOPMENT IF NECESSARY*

Upon a presumed final closure of the repository after the decommissioning of Krško NPP, the **repository decommissioning phase will take place in 2061 and closure in 2062**.

In the event of a decision on the final closure of the repository after the decommissioning of the Krško NPP, when decommissioning of Krško NPP is completed, the closing of the repository will be initiated. The activities for decommissioning of the technological facilities (first step) and the closure of the repository (second step) will be implemented on the basis of the authorisation of the competent authority[25] and will be carried out in accordance with the Programme of Decommissioning and the Programme of Closure. The decommissioning will be carried out only for technological facilities and/or for facilities in the controlled area.

Closure of the repository is the completion of all the measures that must be carried out to ensure the long-term safety of the repository.[26] Following closure, the repository will acquire the status of a closed repository for which long-term control and maintenance must be provided.[27] A decision on the status of the closed repository following its closure is issued by the Slovenian Nuclear Safety Administration along with the issuing of a decision terminating the status of the nuclear facility.[28]

Main elements of strategy and characteristics of closure:

- Following the decommissioning of non-disposal facilities at the repository, all LILW from decommissioning is placed in a disposal silo.
- An inspection is made of the radiation parameters of facilities, systems and devices (the sum of structures, systems and components, SSC) in the disposal section of the repository, which are not envisaged as being a component part of the closed and sealed silo, and preliminary decommissioning (termination of surveillance) of these SSC. The SSC that exceed the threshold values for termination of surveillance and which cannot be decontaminated will be conditioned for disposal and placed in the disposal silo.
- Disposal of LILW in the silo is concluded.
- The disposal silo is closed (empty spaces in the silo are filled, and the top slab is placed over the waste disposal casks along with a confinement barrier). The silo is drained of any seep water.
- Pumping out of seep water is terminated.
- All systems and devices are decommissioned (surveillance is terminated for them) and finally
- removed from the disposal silo excavation and hall.
- All empty spaces in the disposal silo (drainage pipes, etc.), and the machine rooms in the lower storey of the silo and in the access shaft are sealed.
- The above-ground sections of the silo and access shaft and hall above the silo are finally decommissioned
- (surveillance terminated) and dismantled.
- The flood-protection plateau on which the facilities are built is preserved.

[25] Article 79 of the ZVISJV
[26] ZVISJV, Article 3, first paragraph, point 88
[27] ZVISJV, Article 3, first paragraph, point 89
[28] ZVISJV, Article 56, first paragraph, fifth indent;

Active long-term surveillance is expected to begin in 2066, when all preparatory activities are performed for submission to surveillance and when the provider of long-term surveillance takes over the repository for management and long-term surveillance. In the period of active long-term surveillance the provider of management, long-term surveillance and maintenance of the repository will ensure, in accordance with the confirmed and valid safety report, in particular the following:

- measurements and surveillance of the radioactivity of the repository and monitoring of the environment, along with phenomena that could have a long-term impact on the state and stability and operation of individual parts of the repository;
- maintaining physical protection of the facility;
- regular maintenance works and cleaning on systems that will still be functioning, including measuring equipment;
- possible repairs and maintenance of covering, filling and service elements of the repository;
- monitoring the growth of vegetation at the repository.

Active long-term surveillance and maintenance is expected to last 50 years (2066–2116), unless another duration is determined on the basis of a safety analysis and operational experience.

When the long-term active surveillance period comes to an end, the repository will be prepared for **long-term passive surveillance.** Preparation will cover in particular:

- the removal of all equipment for the performance of measurements and other forms of active surveillance;
- the removal of the facilities that were required for active surveillance, or the handover of the facilities to unrestricted use; and
- the removal of fences or the termination of fence maintenance.

Long-term passive surveillance of the repository will primarily be carried out for:

- the storage of information on the repository;
- maintenance of ownership of the repository land;
- the presence of warning geodetic signage at the repository.

The above-ground facilities of the repository will be removed or assigned to unlimited use. The earth-filled repository plateau will remain or be removed.

Warning signs and signs of prohibition as a warning against unintended entry to the disposal facilities will be placed in the area occupied by the disposal facilities. The warning signs shall contain information on the owner of the facility, the facility type, the dangers presented by the materials disposed of at the facility, and basic information on the LILW disposed of there and its properties.

The start of long-term surveillance will signal the termination of physical protection under the Rules on the physical protection of nuclear facilities and nuclear and radioactive materials, and the transport of nuclear materials (Official Gazette of the RS No. 17/2013).

Long-term control and monitoring will last for 300 years following closure of the repository (active long-term surveillance for 50 years and passive long-term surveillance for 250 years).

At the end of passive surveillance, the repository site will pass to unrestricted use.

2.2 DESCRIPTION OF CHARACTERISTICS OF PROJECT

All the construction and technical characteristics of the project and the disposal technology are summarised in the report below from:

- Conceptual design (IDZ) for the LILW repository, Krško, project No. NRVB-B052/058-1, Rev. C, produced by the company IBE d.d., svetovanje, projektiranje in inženiring, Ljubljana, in January 2016;
- "Development potentials of the repository to be taken into account in the elaboration of the EIA", document No. NRVB---1P/M09B, prepared by the company IBE d.d., svetovanje, projektiranje in inženiring, Ljubljana, October 2015.

In addition to the IDZ and the study "Development potentials of the repository to be taken into account in elaboration of the EIA", in the EIA we also used:

- Design bases for the LILW repository Vrbina, Krško – environmental impact assessment phase, March 2018,

and

- Draft Safety Analysis Report (osnVP) for LILW site Vrbina, Krško, April 2018, Chapters 0 - 16.

The project includes the construction of a LILW repository, comprising:

1. **Repository facilities** (including exterior and landscaping arrangements):
   - Administrative and service building,
   - Technological facility (TF), phases 1 and 2,
   - Disposal facility - silo with the associated hall above it;
     - 1st silo (construction envisaged by 2020),
     - 2nd silo (construction envisaged 2048-2049),
   - Control pool and other smaller facilities.

   Exterior and landscaping arrangements cover:
     - the plateau (including load-bearing embankment),
     - municipal service, energy and telecommunications lines and facilities,
     - transport areas,
     - green areas and landscape arrangements,
     - fences and other exterior arrangement facilities.

2. **Infrastructure facilities:**
   - Transport infrastructure;
     - reconstruction of section of local road with path for pedestrians and cyclists;
     - arrangement of access road from the LILW repository to the connection with the public road and parking area for the needs of the LILW repository (including load-bearing embankment);
   - Infrastructure lines;
     - connection to water supply network;

- connection of new pumping station for the municipal sewers to the power supply network from the Kostak landfill substation;
- connection of new substation at the LILW repository (20 kV transmission line) running from the Kostak landfill substation;
- drainage system for precipitation water runoff with infiltration field;
- drainage system for urban wastewater with new pumping station and flow to the Libna pumping station;
- connection to the telecommunication network.

The LILW repository is a nuclear facility. It is designed with facilities that enable the implementation of all the activities required for the operation of the repository and permanent disposal of LILW waste.

The repository comprises spatially:

- an entrance section with vacant exterior surfaces (outside the fence of the core area),
- the core area of the repository.

In the entrance section of the repository, there is an access driveway from Vrbina road arranged outside the fence of the core area (connecting road). In the entrance section, parking areas for employees and visitors (a parking area with 32 spaces for cars) as well as green surfaces and other open surfaces are to be arranged. The vacant exterior surfaces of the repository are planted with trees to represent a green barrier between the repository and its surroundings.

The core area of the repository is intended for administration and service activities, waste takeover and disposal, and for the provision of physical security of the repository. It has a rectangular floor plan, with dimensions 318.50 m x 184.50 m (surface area of approx. 58,763 m^2).

This area includes:

- Administration and service building (ASB),
- Technological facility (TF),
- Disposal silo with a hall above the silo (Hall),
- Control pool.

The core area of the repository is fenced in and comprises a flood-protection embankment and a surface at the elevation of the natural terrain, and is divided into:

a) **a fenced controlled area**, at the elevation of 155.20 m, with the administration and service building. Access to the area is possible through the main (and only) entrance to the repository and after prior checking at the administration and service building located by the entrance in the controlled area of the repository with a fence and physical security. The area also includes an inner peripheral service road and the area with control wells at the elevation of 153.60 m;
b) **controlled area** (from the point of view of radiation protection), also on a flood-protection embankment with an elevation of 155.20 m, which protects the area from the probable maximum flood (PMF). The area represents the core of the controlled area. The project solutions enable the controlled area to cover the entire area of the technological section of the technological facility and the hall with the disposal silo, which is enclosed

with an additional, inner protective fence. This inner fence is connected to the technological facility at both ends.

Both areas are mutually connected by the main communication that runs through the entire complex of the repository, from Vrbina road to the disposal facility.
From Vrbina road to the entrance section of the repository a main access road will run in an even, gentle right curve and an even incline.
The administration and service building (ASB) and hall are to be mutually balanced by the line of the southern facade, and the ASB and technological facility (TF) balanced by the line of the northern facade. This will serve to enable the possible expansion of facilities to vacant areas of the repository. The ASB to the north and the TF to the north, south or west.
The entrance section of the core area of the repository contains an administrative and service building from which the repository will be operated and managed and associated administrative and service activities performed, along with activities to control access to and physically secure the repository, energy-related activities, fire water supply, the collection of urban waste, the storage of equipment and geological samples (cores), and a workshop.

The core of the central, controlled area of the repository is made up of the technological facility (TF) and a disposal silo with a hall (construction of the first silo 2017-2020, construction of the second silo 2048-2049). The TF is intended for the temporary storage and repair of any damaged waste containers, basic laboratory research, control of technological processes, and the remaining necessary technological and service functions of the repository as well as functions for the provision of nuclear and radiation safety. In the TF there is also a radiological entry / exit control point for the controlled area.

In accordance with the level of protection of facilities against floods, the facilities are built on a platform with an elevation height of 155.20 m. The dimensions and shape of the platform are conditioned by technological requirements, the need for disposal of material on-site and relief features that influence the flow of high (rear) waters. The repository is surrounded by an outer service road at an elevation of 153.60 m.
The eastern slope of the embankment will, for aesthetic reasons of having a gradual transition from the surrounding terrain, have a gentle incline in the entrance section (around 1:10), while the other slopes of the embankment will be a steeper, technically dictated incline (around 1:3). The slopes of the embankment are to be covered in grass.
The basic shape of the embankment is a rectangle, with a longer side parallel to the southern edge of the area. The eastern edge of the plateau is partly rotated from the main orthogonal direction of the repository itself, serving to emphasise the opening of the space between the repository and Vrbina road, while at the same time enabling a gradual transition between the orientation of structures and the incline and the direction of Vrbina road.

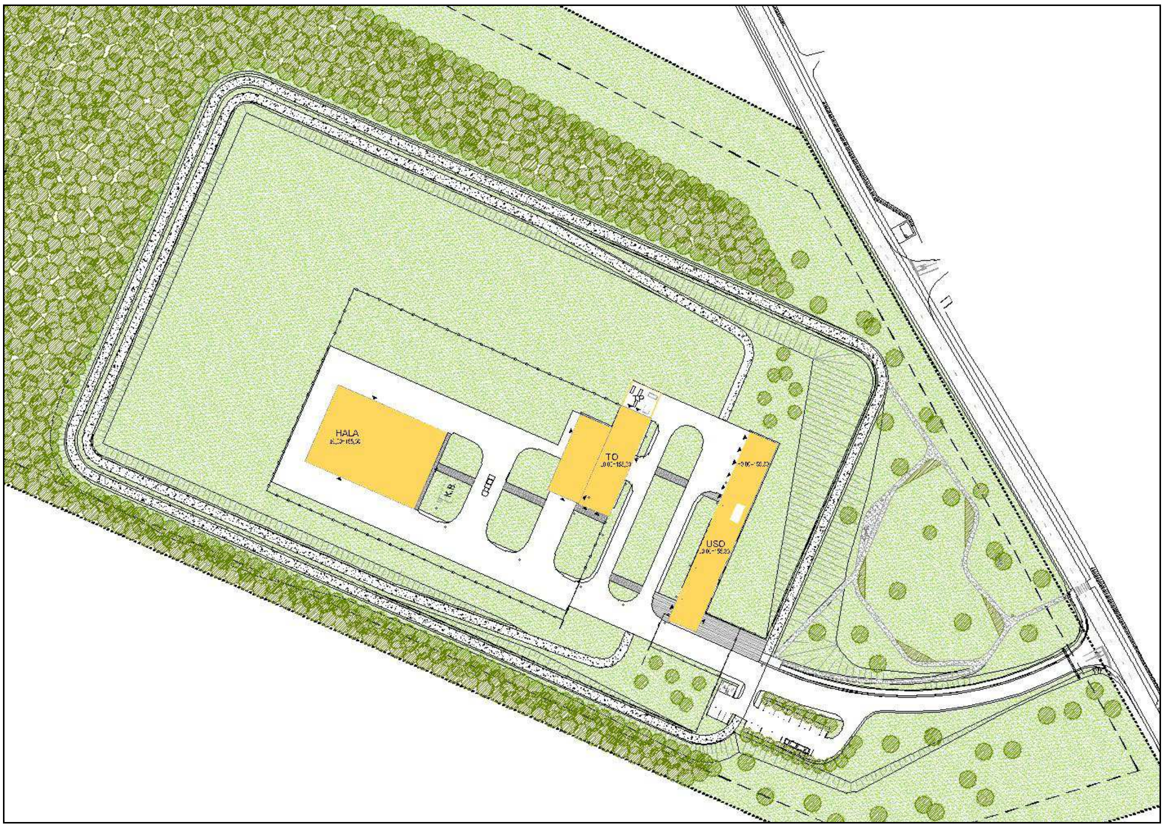

Figure 4: Entrance section and core area showing the positioning of structures

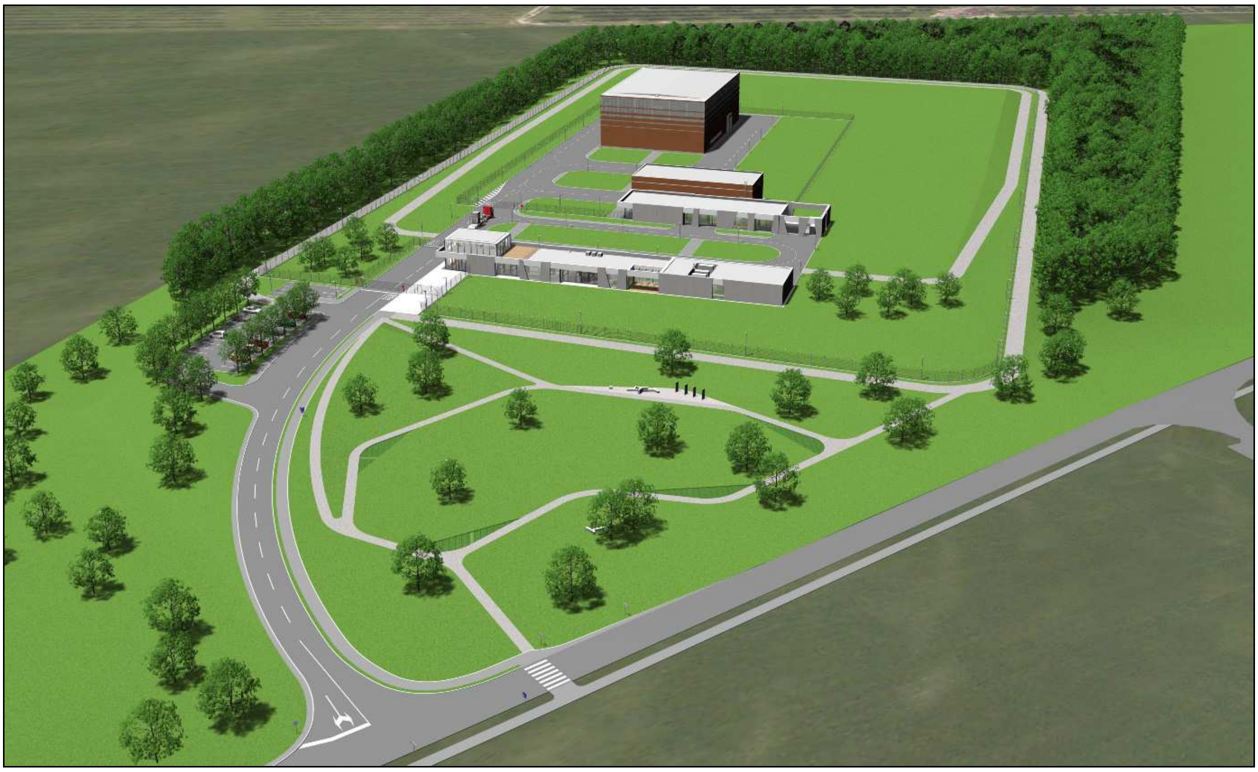

Figure 5: Visualisation of the repository

The envisaged spatial arrangement ensures adequate conditions for the safe operation of the repository (safe withdrawal of people, necessary intervals between facilities, i.e. adequate fire breaks between structures, transport and working areas for intervention vehicles, sources for adequate supply of water for firefighting, areas for vehicles to move and turn).

The planting of trees will establish a wooded area by the repository. On the eastern side the planting will be arranged in places and spread out with the aim of creating a openness of the repository to the surrounding environment.

Envisaged phases of the repository:

Under the basic scenario, construction of the repository (a single disposal silo, all technological and other facilities and associated infrastructure) is expected to take three years from the acquisition of the construction permit. A two-year period of trial operation will then commence following the acquisition of a licence for trial operation, which is a pre-condition for the acceptance of radioactive waste. At the end of the two-year trial operation period, a licence to use will be obtained; this licence is the basis for the issuing of the operating licence. The repository is expected to commence regular operations in 2022 and continue operating until 2025, when all "Slovenian" operational waste will have been disposed of. The repository will then move to the standby phase until it recommences operation in 2050. During the renewed operation, the remaining "Slovenian" operational waste generated in the Krško NPP will be disposed of in the repository, as well as the waste generated during the decommissioning of the Krško NPP up until the year 2061. In 2062, after all the waste has been disposed of and the repository decommissioned (2061), the silo and the entire repository will be closed and the long-term surveillance and maintenance of the repository will begin.

Under the expanded repository scenario, the timetable envisaged for construction, trial operation and regular operation will be identical, save for the fact that the repository will operate for three years longer and move to the standby phase in 2028. The construction of the second silo is planned for 2049 and 2050, when the repository is again ready for reception and disposal of LILW until the year 2061. In 2062, after all the waste has been disposed of and the repository decommissioned (2061), the silos and the entire repository will be closed and the long-term surveillance and maintenance of the repository will begin.

NOTE: *The above timetables are based on the documentation "Design bases for the Vrbina, Krško LILW repository – environmental impact assessment phase, Revision 2, March 2018".*

Due to time delays in the preparation of technical and other supporting documentation (Design bases, Safety Report, Environmental Impact Report), the starts of individual phases of the repository are delayed to a later implementation time, which at this time cannot be precisely defined. Given the known practice, additional time delays are also anticipated due to more complex administrative procedures for obtaining environmental consent and the procedure of transboundary assessment. However, regardless of the relative delay of the beginning of the construction phase, the estimated duration of each activity remains unchanged.

Trial operation

The purpose of the trial operation is to carry out tests of the operation of the constructed repository in order to verify and define the conformity of constructed facilities with approved design solutions and the required design conditions, and at the same time the relevance of design solutions and operating procedures which address the use of these solutions, depending on the desired functions of structures, systems and components (SSC). Containers with LILW are delivered to the repository upon the completion of tests and verifications envisaged for the phase preceding the takeover of radioactive materials at the repository. Tests and trials will be conducted at Krško NPP.

Trial operation also covers abnormal operating conditions (anomalies) and emergencies. It will be possible to remove, from the silo and from the repository, containers with waste placed in the disposal silo in the course of trial operation. Gaps between the waste containers placed in the silos in the course of trial operation will not be filled with filler grout.

Regular operation

After obtaining all permits, construction of the repository, obtaining the permit for trial operation, the two-year trial operation period and obtaining the operating licence, the LILW repository should begin full operation.

The containers will be placed in the silos from above with the help of a portal crane. It will be possible to operate the crane from the control room in the technological facility or locally with the help of a local panel. A set of cameras will be installed on the crane, the silo and the facility structure to aid lifting operations and, in particular, the positioning of containers in the disposal silo. Each silo will have capacity for 990 containers (99 containers in each of the ten disposal layers). The disposal containers will be placed alongside and on top of each other. It is assumed that there will be a gap of 20 cm between the walls of the containers. After every second layer, the gaps between the containers will be filled in and a levelling layer constructed.

In order to protect the repository against flooding, all facilities important for nuclear safety will be built on an embankment; this embankment will protect individual facilities against flooding with a suitable return period. Waste in concrete containers (final packages) will be disposed of in the silo with the help of an overhead crane. The gaps between the final packages and the silo will be filled in using a suitable material. A drainage system will also operate as part of the disposal system. During operation itself, it will collect water that could seep into the silo and then drain it in a controlled manner, thereby keeping the disposal unit dry during operation. When the silo reaches full capacity, it will be sealed.

The scenario of normal operation sets out the following course of events and processes:

- The waste is conditioned for disposal at Krško NPP and packed into final packages that meet the acceptance criteria;
- Transportation of containers to the LILW repository will be provided by Krško NPP;
- The waste is received at the repository, visual controls are conducted for the final packages and radiation is measured on the surface of the packages, and the documentation is checked;

- The disposal process continues after all the requirements have been met. The final package is transported to the roof and disposal silo, where it is unloaded using a portal crane into its predetermined position in the disposal silo,
- A drainage system is in operation in the silo during operation to collect and remove any seep water,
- After the silo has been filled (or even already during operation), the gaps between the containers and the wall of the silo are filled with backfill material. A concrete slab is placed on top of the disposal unit.
- A clay layer is then placed on top of this, providing an additional barrier between the silo and the Quaternary aquifer.

Standby phase of the repository

Repository standby phase is the operational state of the repository in which the facility is brought to a state corresponding to a longer interruption of operation and during which no disposal or other major work is carried out
at the repository.

The standby phase operational state comprises three periods:

1. preparation of the repository for the standby phase;
2. the standby phase; and
3. preparation of the repository for the re-acceptance of waste.

Preparation of the repository for the standby phase will comprise the following activities:

1. bringing waste already disposed into a state that meets nuclear and radiation requirements and the requirements of a long-term standby state. These activities are carried out in accordance with the directions laid out in safety analyses and include, in particular:
    a. the disposal of containers with low contact doses and low-activity LILW in the last (top) layer of containers;
    b. the laying of temporary (i.e. for the duration of the standby phase) or permanent layers (e.g. concrete slabs) across the last disposed layer of containers; and
    c. provision of passive and permanent drainage of water that might penetrate through the silo wall or might emerge for other reasons on the surface of waste already disposed of.
2. preparation of systems and devices for the standby phase. These activities include, in particular:
    a. conservation of devices that will not be used in the course of the standby phase, but are envisaged being used upon the re-start of the repository; and
    b. permanent or temporary removal of devices and machines that will not be used in the course of the standby phase and will be reinstalled at the repository in the course of preparations for resuming acceptance of waste (e.g. forklift, measuring equipment).
3. bringing the overall repository into a state that will ensure safe and economical standby phase operation. These activities include, in particular:
    a. decontamination of any potentially contaminated surfaces (to the maximum reasonable extent) and shielding of radiation sources to ensure the conditions to allow the area subject to radiation protection requirements to be as small and limited as possible;

b. setting up temporary additional technical security measures to allow optimisation of the extent of physical security;
c. removal of all flammable and other hazardous substances or allowing the presence of such substances only in quantities necessary for standby phase operations; and
d. release or removal, from devices that will not be used in the course of the standby phase, of water or other media that might have adverse impacts on the condition of devices and facilities through freezing, corrosion or other unfavourable effects.

Preparation of the repository for the standby phase will take one year.
Upon completion of the activities to prepare the repository for the standby phase, the repository will enter the standby phase.

In the standby phase period, as well as in the period of preparation for standby phase and period of preparation for re-start of operation, the following activities will be carried out at the repository:

- monitoring of fluence, sampling and analysis, pumping out any water seeping into the silo;
- radioactivity monitoring and other kinds of monitoring (e.g. underground water, meteorological monitoring etc.) in an (reduced) extent adequate for standby phase requirements;
- radiation protection;
- physical security;
- maintenance, inspections and surveillance; and
- administrative and service activities.

In addition to the above-listed activities, activities relating to ageing process management and operating experience feedback will also be carried out.

Preparation of the repository for the re-acceptance of waste will involve the following activities:

1. bringing the silo into a state that allows further disposal. These activities include, in particular:
   a) removal of any temporary protective layer laid over the last placed level of containers and termination of other temporary measures;
   b) verification of the condition of disposed containers, the silo wall, equalisation layer and other elements of the disposal system and assessment of their fitness for further disposal; and
   c) verification of the drainage system and bringing the drainage operation mode into the silo filling phase.
2. preparation of systems and devices for continued waste disposal. These activities include, in particular:
   a) de-conservation, inspection and testing of devices that were not used in the course of the standby phase; and
   b) reinstallation of devices that were removed in the phase of preparation for the standby phase, including their inspection and testing.
3. bringing the facility into a state that allows further acceptance of waste. These activities include, in particular:
   a) establishing appropriate zones in terms of radiation protection, including verification and installation of measuring devices, markings and access restrictions, removal of shields that were mounted for the purposes of the standby phase;

b) removal of temporary solutions relating to physical security, verification of devices and measures for the purposes of physical security in the phase of acceptance of waste;
c) provision of tools, personal protection equipment, equipment and materials for the purposes of sampling and other equipment and materials for the purposes of repository operation; and inspection, servicing and start up of all service and auxiliary devices not used in the standby phase.

Preparation of the repository for re-acceptance of LILW will take one year.

Closure of the repository

In the event of a decision on the final closure of the repository after the decommissioning of the Krško NPP, when decommissioning of Krško NPP is completed, the closing of the repository will be initiated. The activities for decommissioning of the technological facilities (first step) and the closure of the repository (second step) will be implemented on the basis of the authorisation of the competent authority and will be carried out in accordance with the Programme of Decommissioning and the Programme of Closure. The decommissioning will be carried out only for technological facilities and/or for facilities in the controlled area. Technical procedures that are an integral part of the decommissioning (decontamination, dismantling, disassembly, etc.) will also be carried out (in accordance with the closure programme) in the area of the disposal unit (silo).

Main elements of strategy and characteristics of closure:

- Following the decommissioning of non-disposal facilities at the repository, all LILW from decommissioning is placed in a disposal silo.
- A review is conducted of the radiation parameters of facilities, systems and devices in the disposal section of the repository that are not expected to be component parts of the closed and sealed silo, along with preliminary decommissioning (termination of surveillance) of these structures, systems and components (SSC). The SSC that exceed the threshold values for termination of surveillance and which cannot be decontaminated will be conditioned for disposal and placed in the disposal silo.
- Disposal of LILW in the silo is concluded.
- The disposal silo is closed (empty spaces in the silo are filled, and the top slab is placed over the waste disposal casks along with a confinement barrier). The silo is drained of any seep water.
- Pumping out of seep water is terminated.
- All systems and devices are decommissioned (surveillance is terminated for them) and finally
- removed from the disposal silo excavation and hall.
- All empty spaces in the disposal silo (drainage pipes, etc.), and the machine rooms in the lower storey of the silo and in the access shaft are sealed.
- The above-ground sections of the silo and access shaft and hall above the silo are finally decommissioned (surveillance terminated) and dismantled.
- The flood-protection plateau on which the facilities are built is preserved.

Decommissioning activities

The decommissioning of the LILW repository at Vrbina, Krško, will be carried out as a sequence of activities through which the nuclear facility will be released from active surveillance as stipulated by the Ionising Radiation Protection and Nuclear Safety Act. The activities will be divided into the following phases:

Phase 1: Procedure of application for approvals, complete with drafting the documents

- Permit for termination of operation of a nuclear facility: the content of the application is laid down in Article 27 of the JV5 Rules; the application must be submitted 2 years prior to intended termination of operation at the latest (the permit is granted by the Slovenian Nuclear Safety Administration, the SNSA).
- Permit for commencement of decommissioning of a nuclear facility: the contents of the applications are laid down in Rules JV5, Articles 28 and 29. Obtaining a construction permit for the removal of a radiation or nuclear facility, with the possibility of complete decommissioning of all systems and structures down to a “green field” will not be required, since we envisage the final state in the form of a brown field, where structures will not be removed and where this will facilitate use for industrial purposes or for implementing long-term surveillance and maintenance of the repository after closure.

Phase 2: Decommissioning

1. Monitoring the working and natural environment is conducted throughout the decommissioning of the technological facility and pertaining infrastructure in the radiologically controlled area.

2. Emptying the technological facility:
   Removal of all packages with LILW in the back up storage facility, which owing to damage in an accident in the area of the repository and consequent remediation of damage might be stored in the storage facility of the technological section of the repository, removal of secondary LILW generated in the operation of the repository and other movable technological equipment. Prior to disposal, LILW packages will be conditioned in the hall above the disposal silo in accordance with the acceptance criteria for disposal. During decommissioning, in the technological facility we anticipate the need to adapt the system of ventilation and retention of air and adapt the transportation route to the technological facility, and between that facility and the hall over the disposal silo for personnel, equipment and waste.
   Since the final inventory of the technological equipment and RW packages in the technological facility is not yet known, the precise implementing plan will be set out upon the next update of the repository project and of the programme document for decommissioning, and in the decommissioning design plan.

3. Measurements of contamination in the technological facility, system for collection of possible contaminated water, the ventilation system and implementation of the necessary decontamination:
   a) Detailed measurements of contamination will be conducted of the emptied technological facility and associated technological systems. Detailed measurements will be made of the ground, walls, ceilings, including taking smears at specific points for determining contamination.
   b) Detailed measurements of contamination will be conducted in the system for collecting and processing liquids (floor drain sump, sanitary tank, pipes, etc.), in the system for removing water from the area of the disposal units (control pool with pipes and pumps).
   c) Detailed measurements will be conducted in the ventilation system in the radiologically
   controlled section of the technological facility (filters, dampers, pipes, etc.).

If contamination is detected on the surfaces of the technological facility, in the system for the collection and processing of liquids or in the ventilation system, appropriate decontamination procedures will have to be carried out. Since the planned time of decommissioning is a very long way away, it will be necessary to use appropriate mechanical, chemical, electrical and other techniques for removing contamination from surfaces, concrete, metal, plastic and so forth that are available at the time. The waste generated from the decontamination process will have to be adequately processed and placed in appropriate containers (drums) and then conditioned for disposal in accordance with the acceptance criteria. Where decontamination is not possible for components and surfaces, equipment will have to be disassembled and facilities dismantled.

4. Dismantling of contaminated systems
   In the system for collection and treatment of liquids from the radiologically controlled part of the technological facility, on identifying contamination and failure of decontamination, the drain sump, sanitary tank and related pipes are to be dismantled. In the system for draining water from the disposal section that collects in the control pool, the pipes and pumps, along with other small equipment, will need to be dismantled. In the ventilation system within the radiologically controlled area of the technological facility, filters, dampers, piping and so forth will need to be dismantled.

   All radioactive waste generated in this way will have to be adequately separated, measurements taken of the contamination, dose rate, mass and so forth and the waste processed and conditioned for disposal in accordance with the acceptance criteria.

Phase 3: Final activities and end of decommissioning

Radiological measurements will need to be taken in the area surrounding the technological facility (at the exhaust of the ventilation system, by the control pool, by the pipes in the system for collecting and processing liquids, on the plateau by the technological system and by the transport route to the disposal silo).

A report must be drawn up about all the measurements conducted, and this must include a final overview of the radiological status.

In accordance with Article 30 of the JV5 Rules, or the then valid regulations, the facility operator will submit an application for a permit to conclude decommissioning of the repository with all the necessary annexes.

The decommissioning will be conducted and implemented by the facility operator with the help of outside contractors.

It is anticipated that additional outside contractors will be involved in:

- construction works,
- smaller-scale dismantling and disassembly,
- major decontamination work and
- conditioning waste from decommissioning for disposal.

In accordance with the legislative requirements and the system of management, working instructions will be prepared for the envisaged activities. The work will need to observe the procedures for minimising the generation of RW through the use of conditional and unconditional clearance. The detailed timetable for decommissioning will be worked out in the next updates to the programme. The entire time for decommissioning, from obtaining the permits and document preparation, decommissioning and the final activities including issuing the decision for the permit to conclude decommissioning will not be longer than one year.

Transition period for repository to long-term monitoring and maintenance
After closing the repository, it will enter the period of long-term post-closure monitoring and maintenance. During this period, the operator identifies and monitors the effectiveness of the performed activities for closure and carries out the necessary maintenance and corrective measures that bring the repository to a state appropriate for the repository to be submitted for post-closure monitoring and maintenance.

Active long-term monitoring and maintenance
After the period of transition to post-closure monitoring and maintenance, the repository should enter the period of active long-term monitoring. The active long-term monitoring begins when all preparatory activities are performed for transition to monitoring and when the competent authority or the monitoring provider takes over the repository for long-term monitoring. In the period of active long-term monitoring the provider ensures in particular:

- performance of measurements and observations,
- maintaining physical protection of the facility[29] and
- possible repairs and maintenance of control, measuring and service elements of the repository.

Passive long-term monitoring
After the end of active long-term monitoring, the repository will pass into the phase of passive long-term monitoring. The above-ground facilities of the repository will be removed or assigned to unlimited use. It is assumed that the earth-filled plateau of the repository will continue to remain at the site in the phase of passive long-term monitoring. The plateau can also be removed. Passive long-term monitoring of the repository is a form of monitoring that comprises principally:

- the storage of information on the repository;
- maintenance of ownership of the repository land;
- the presence of warning geodetic signage at the repository.

Period of unlimited use of repository site
At the end of passive surveillance, the repository site will pass to unrestricted use.

2.2.1 *CONSTRUCTION AND TECHNICAL CHARACTERISTICS OF THE PROJECT*

The area of the repository is intended for administration and service activities, waste reception and disposal, and for the provision of physical security of the repository. It has a rectangular floor plan, with dimensions 318.50 m x 184.50 m (surface area of approx. 58,763 m^2).

The following are envisaged in this area:

- Administration and service building (ASB),
- Technological facility (TF), phases 1 and 2,
- Disposal silo with a hall above the silo (Silo and Hall),
- Control pool.

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29 In accordance with IAEA SSG-29, par. 7.9 and Practical Guideline 1.03, point 11.1 fencing is deemed to be a measure of active long-term monitoring.

In accordance with the level of protection of facilities against floods, the facilities are built on a platform with an elevation height of 155.20 m. The dimensions and shape of the platform are conditioned by technological requirements, the need for disposal of material on-site and relief features that influence the flow of high (rear) waters. The repository is surrounded by an outer service road at an elevation of 153.60 m.

Within the LILW repository all activities will be carried out that are directly linked to the disposal of radioactive waste.

The envisaged placing of facilities, systems and devices ensures adequate conditions for the safe operation of the repository (safe withdrawal of people, necessary intervals between facilities, i.e. adequate fire breaks between structures, transport and working areas for intervention vehicles, sources for adequate supply of water for firefighting).

The facilities are designed to meet the technological conditions and requirements with their dimensions, capacities and selection of final machining. At the same time, special attention was devoted in the spatial arrangement of the structures and in their architectural design to their appropriate harmonisation and adaptation to the surrounding environment.

It is anticipated that the facilities will provide appropriate conditions for the healthy, safe and comfortable use, stay and work of all users of the facilities and other persons, while fulfilling all the essential requirements for buildings[30][31] (mechanical resistance and stability, fire safety, hygienic and health protection and environmental protection, safety in use, noise protection, energy saving and heat conservation).
In terms of architectural design, and especially the design of their exteriors, the repository facilities are divided into two groups:
(a) Ground-floor structures of small volume and longitudinal layout, with a varied programme:
- administration and service building and
- the ground-floor section of the technological facility.

(b) Structures of larger dimension, the same volume and without any exterior openings:
- the hall for back up storage capacities in the technological facility and
- the hall above the silo.

In general, owing to their relatively large dimensions and relative remoteness from publicly accessible points of possible observation, the facilities will be designed in a large scale with clearly delineated exterior surfaces.

Machine installations and machinery

Machine technology systems comprise: drainage of water from the area of the disposal silo, collection of wastewater in the controlled part of the repository, water main, sewerage, heating, cooling, ventilation, the hydrant network (exterior and interior).
Machine technology devices are devices for carrying out internal transport, the portal crane above the silo with a cask or container gripper and winch for auxiliary lifting, a personnel lift in the access shaft of the silo and a forklift.

[30] Act Amending the Construction Act (ZG0-1F), Official Gazette of the RS, No. 19/2015
[31] The Rules of the essential requirements for construction works that must be taken into account in determining the properties of construction products, Official Gazette of the RS, No. 9/01

The heating requirement of the administration and service building and technological facility will be serviced by using reversible heat pumps. Electricity will be used to power the reversible heat pumps. The reversible heat pumps will run on air and be able to operate at up to -20°C.
In summer the cooling requirement of the administration and service building and technological facility will be serviced by using reversible heat pumps which will be switched to the operational cooling regime.
The disposal silo and temporary hall above the silo will be passively ventilated during the period of filling. Where necessary, ventilation or the local induction of air can be provided by mobile devices that are used in poorly ventilated structures.

The access shaft of the silo will be actively ventilated. The air capture points in the depression ventilation system will be in the lower section of the silo. The exhaust will be placed on the exterior of the hall and will be radiologically monitored.

The planned controlled area in the technological facility will be actively ventilated. Exhaust from the space for decontamination, which is a part of the control point, will be controlled. In the event of exceeding the permitted emissions, the ventilated spaces will be isolated from the surrounding area by dampers. By providing differing pressure (low and high pressure) air will be moved from the area with lower possibility to the area of higher possibility of contamination. In working positions where there is a greater possibility of contamination (phase 2 of technological facility) local suction will be provided as necessary. Exhaust from the local ventilation device will be conducted via a local HEPA filter to the air outlet from the technological facility.

The machine technology systems and devices at the repository will comprise:

- System for removing water from the area of the disposal silo (R*)
- System for collection of wastewater in the controlled area of the TF (R*)
- Water supply system
- Sewerage
- Heating
- Cooling
- Ventilation (partly R)
- External hydrant network
- Internal hydrant network

* (R) denotes systems with potentially radioactive media

Where there are permanent workplaces, conditions are to be ensured for heating, cooling and ventilation pursuant to the Rules on requirements for ensuring the health and safety of workers at workplaces (Official Gazette of the RS, No. 89/1999 and 39/2005).

The following devices and installations will operate at the repository:

1. Devices for providing internal transport
   a) The portal crane above the silo with a cask or container gripper and winch for auxiliary lifting
   b) Personnel lift in the silo access shaft
   c) Forklift

The following electrical systems and installations will operate at the repository:

1. Power supply
2. Reserve power supply
3. Lightning arresters
4. Grounding
5. Lighting
6. Exterior lighting
7. Security lighting
8. Process management and monitoring
9. Radiation monitoring
10. Fire alarm system
11. Safety/access monitoring
12. Paging

Physical security of the repository

The repository is to have a security fence that marks the boundary of the controlled area with respect to physical security of nuclear facilities. As part of the Conceptual Design, a Study of Physical Security has been made.

In accordance with Article 3 of the FV1 Rules on physical protection of nuclear materials, nuclear facilities and radiation facilities, the LILW repository is a category III nuclear facility. The repository will be secured right from the start of construction.

All facilities at the repository, apart from the driveway and parking area, will be surrounded by a security fence. Within the fenced area there will be an additional fenced area that will be a radiologically controlled area. Control of access, surveillance of the repository with videocameras and other functions of physical security will be directed during the period of operation of the repository from the control centre at the administration and service building reception. The repository will also be linked to a security and surveillance centre. This centre will be at a remote location and will be provided by the outside security contractor.

Organisation of construction and timetable

The construction site will be organised in the direct vicinity, practically next to the repository. Individual dumps and construction facilities will be set up in such a way as to enable simple communication links to the envisaged facilities of the repository.

Operation of the construction site is anticipated for 10 hours a day on weekdays. During construction of the concrete diaphragm wall, the site will also operate outside regular working hours (at night, and on Saturdays, Sundays and holidays) in agreement with the investor and in line with the restrictions to be laid down in the EIA report.

Access to the construction site is envisaged by public transportation routes, past Krško NPP along municipal road
LC 191 111 and towards the Waste Collection Centre (Kostak) along the sanitary landfill public way JP1 693 631.

Preparation of the construction site also envisages removal of humus and non-bearing material, then consolidation of the working plateau with a gravel buffer.

The construction site will comprise the following main facilities
- offices;
- workshops and storage;
- dump for material and equipment;
- concrete plant;
- separation plant.

Special attention will be needed to ensure the necessary operating area to make the thick-walled concrete diaphragm for primary construction protection. This involves very heavy construction plant and installations such as silos for the preparation of bentonite, a separator of excavated material, a sedimentation basin for bentonite and pumping stations. The placement of these installations will require at least 1000 m^2 of working area, while the dump for reinforcing mesh cage will require an additional 1500 m^2. For unimpeded work around the area of excavation for the buried wall, an operating area at least 15 m wide must be provided.

To ensure unimpeded operation, the construction site will also be equipped with all the necessary municipal services infrastructure (sewerage – chemical toilets – mains water, electricity supply and so forth).

Mains water and power can be taken from the public supply network. Given the major requirement for electrical power during construction of the diaphragm, the construction site will need its own transformer substation. We envisage use of the substation that will be used as the permanent substation for the requirements of the LILW repository. In the event of the substation not meeting the needs of the construction site, at peak periods the contractor will generate additional electricity using its own generators.

Precipitation drainage will need to be channelled into open drains via appropriate oil traps. In the event of a sewer connection already being established for draining urban wastewater from the repository, it will be possible to connect the site to the public sewer.
All envisaged infrastructure will be located so as to be capable of being re-activated on any further phase of repository expansion.

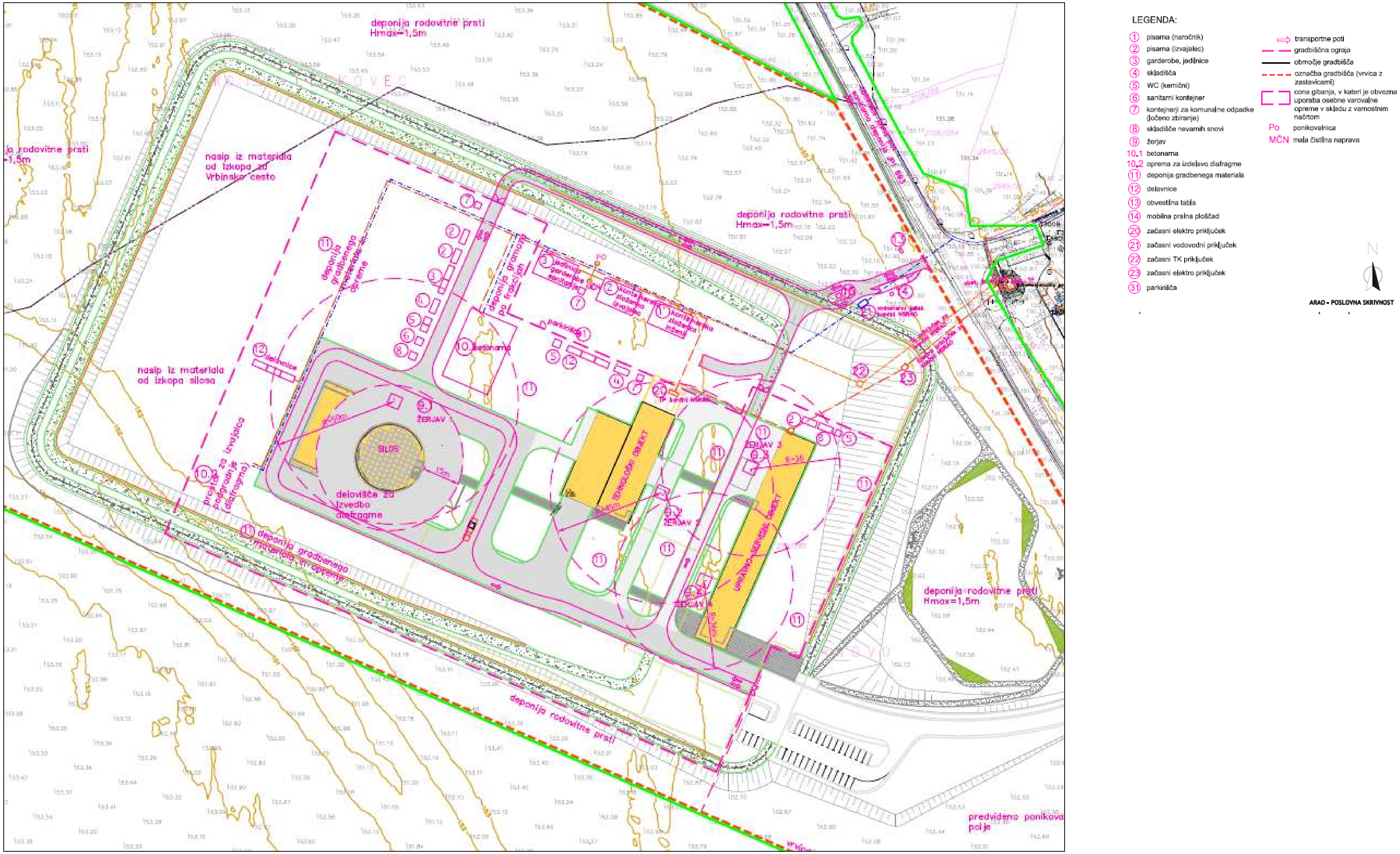

Figure 6: Construction site organisation

deponija rodovitne prsti Hmax = 1,5m	landfill of fertile soil Hmax = 1.5 m
nasip iz materiala od izkopa za Vrbinsko cesto	embankment from the material excavated for Vrbinska cesta
občinska javna pot	municipal public path
sanitarna deponija P1 693	sanitary landfill P1 693
nasip iz materiala od izkopa silosa	embankment from the material excavated for the silo
deponija gradbenega materiala in opreme	construction material and equipment landfill
delavnice	workshops
prostor za izvajalca podgradnje (diafragma)	area of the substructure contractor (diaphragm)
deponija gramoza po frakcijah	gravel landfill by fraction
jedilnica, garderobe, sanitarije	dining area (canteen), changing rooms, facilities/toilets
kontejnerska zloženka izvajalec	container complex (unit) for contractor
kontejnerska zloženka inženir	container complex (unit) for engineer
parkirišče	parking area
betonarna	concrete plant
ŽERJAV	CRANE
SILOS	SILO
delovišče za izvedbo diafragme	work site for the construction of the diaphragm
TEHNOLOŠKI OBJEKT	TECHNOLOGICAL FACILITY
UPRAVNO-SERVISNI OBJEKT	ADMINISTRATION AND SERVICE BUILDING
predvideno ponikovalno polje	infiltration field planned
LEGENDA:	KEY:
pisarna (naročnik)	office (contracting entity)
pisarna (izvajalec)	office (contractor)
garderobe, jedilnice	changing rooms, canteens
skladišča	storage facilities
WC (kemični)	chemical toilets
sanitarni kontejner	sanitary cabin
kontejnerji za komunalne odpadke (ločeno zbiranje)	containers for municipal waste (separate collection)
skladišče nevarnih snovi	storage of hazardous substances
žerjav	crane
betonarna	concrete plant
oprema za izdelavo diafragme	equipment for the construction of the diaphragm
deponija gradbenega materiala	construction material landfill
delavnice	workshops
obvestilna tabla	information board
mobilna pralna ploščad	mobile washing platform
začasni elektro priključek	temporary electrical connection
začasni vodovodni priključek	temporary water main connection
začasni TK priključek	temporary TC connection
začasni elektro priključek	temporary electrical connection
parkirišča	parking areas (car parks)
transportne poti	transport routes
gradbiščna ograja	construction site fence
območje gradbišča	area of the construction site
označba gradbišča (vrvica z zastavicami)	construction site marking (string with flags)
cona gibanja, v kateri je obvezna uporaba osebne varovalne opreme v skladu z varnostnim načrtom	movement zone where the use of personal protective equipment (PPE) is mandatory in accordance with the safety plan
ponikovalnica	sink hole
mala čistilna naprava	small wastewater treatment plant
ARAO – POSLOVNA SKRIVNOST	ARAO - TRADE SECRET

Construction of the repository is expected in the following two stages:
- construction of infrastructure facilities and
- construction of repository facilities on the flood protection plateau.

After establishing the main construction site, works will begin on the primary foundation (diaphragm) of the silo, for which including the mobilisation of equipment around 10 months are envisaged. This will be followed by other work on the silo, specifically excavation, forming the reinforced concrete construction (base slab, secondary blanket, communication section) and installation of equipment, for which around 18 months are envisaged. Creating the embankment for the second phase will begin on completion of the secondary blanket of the silo. Construction of this part of the embankment plateau will also involve the foundation construction of the temporary hall and portal crane lift. The total time needed for execution of the disposal section of the LILW repository will be around 36 months. Construction of all other facilities is lumped into the time frame for the disposal section.

Construction site surface areas for specific phases:

site area during construction of flood-protection embankment:	123,700 m^2
site area for construction of repository with first silo	repository facilities: 165,000 m^2 Infrastructure facilities: 39,500 m^2
site area for construction of second silo:	120,000 m^2

The table below gives a rough timetable showing the timeline of construction.
Construction will take around 3 years (not counting the creation of the embankment plateau).
Construction of the silo will take the longest time.
Construction will progress in stages that may also overlap:
- embankment work
- repository facilities and
- infrastructure facilities

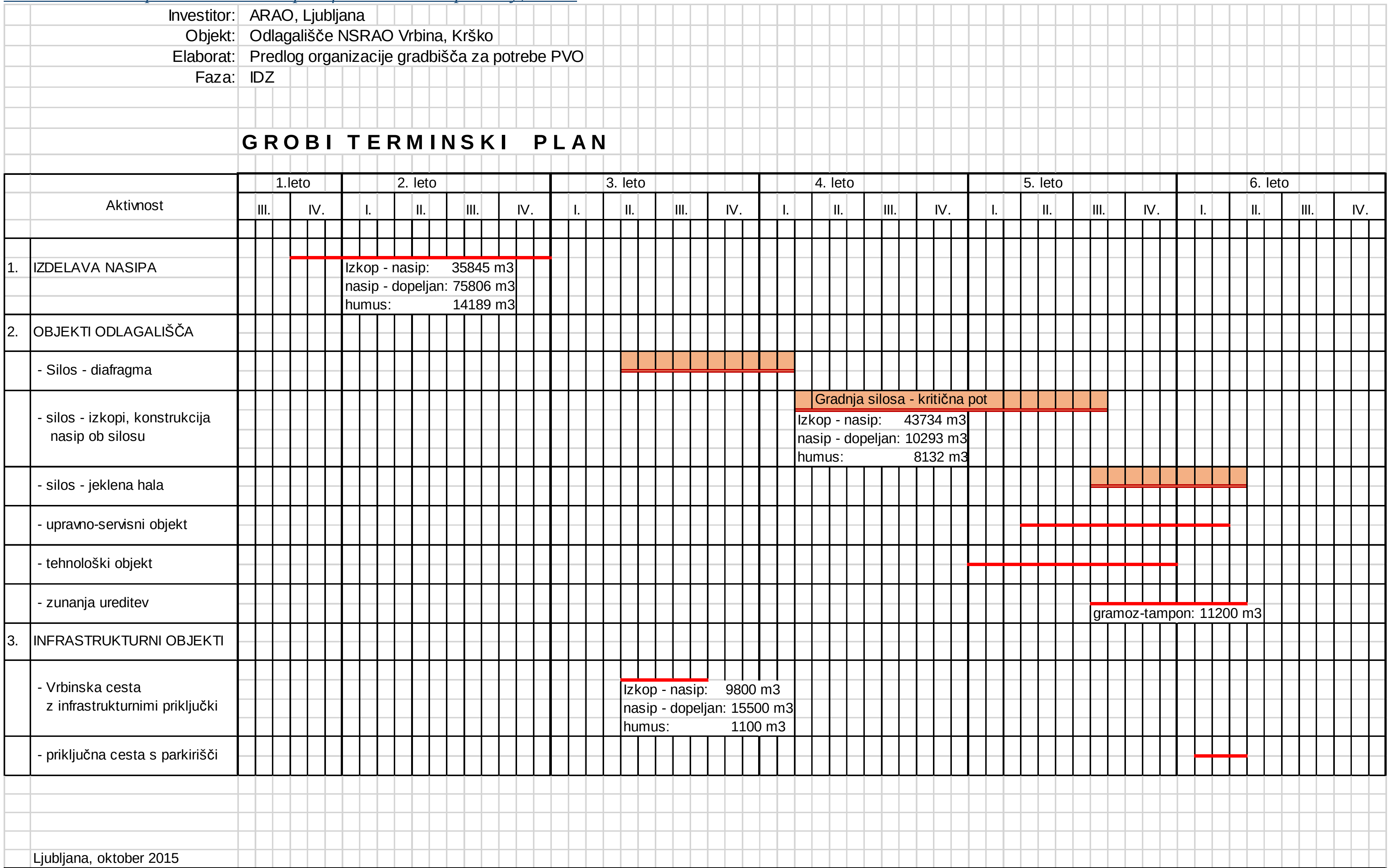

Table 4: Rough timetable of construction

Investitor: ARAO, Ljubljana	Investor: ARAO, Ljubljana
Objekt: Odlagališče NSRAO Vrbina, Krško	Facility: Vrbina Krško LILW repository
Elaborat: Predlog organizacije gradbišča za potrebe PVO	Detailed report: Proposed construction site organisation for EIA needs
Faza: IDZ	Phase: IDZ - conceptual design
GROBI TERMINSKI PLAN	ROUGH TIMETABLE
Aktivnost	Activity
1. leto	First year
2. leto	Second year
3. leto	Third year
4. leto	Fourth year
5. leto	Fifth year
6. leto	Sixth year
IZDELAVA NASIPA	EMBANKMENT WORK
Izkop – nasip: 35845 m3 nasip – dopeljan: 75806 m3 humus: 14189 m3	Excavation - embankment: 35,845 m3 embankment – additionally installed: 75,806 m3 humus: 14,189 m3
OBJEKTI ODLAGALIŠČA	REPOSITORY FACILITIES
- Silos - diafragma	- silo - diaphragm
- silos – izkopi, konstrukcija nasip ob silosu	- silo - excavations, construction of an embankment alongside the silo
Gradnja silosa – kritična pot Izkop – nasip: 43734 m3 nasip – dopeljan: 10293 m3 humus: 8132 m3	Construction of silo - critical path Excavation - embankment: 43,734 m3 embankment – additionally installed: 10,293 m3 humus: 8,132 m3
- silos – jeklena hala	- silo - steel hall
- upravno-servisni objekt	- administration and service building
- tehnološki objekt	- technological facility
- zunanja ureditev	- external arrangements (landscaping)
gramoz – tampon: 11200 m3	- gravel - buffer: 11,200 m3
INFRASTRUKTURNI OBJEKTI	INFRASTRUCTURE FACILITIES
- Vrbinska cesta z infrastrukturnimi priključki	- Vrbina road with infrastructure connections
Izkop – nasip: 9800 m3 nasip – dopeljan: 15500 m3 humus: 1100 m3	Excavation - embankment: 9,800 m3 embankment – additionally installed: 15,500 m3 humus: 1,100 m3
- priključna cesta s parkirišči	- access road with parking areas
Ljubljana, oktober 2015	Ljubljana, October 2015

2.2.1.1 CONSTRUCTION OF FLOOD-PROTECTION EMBANKMENT

For the purposes of flood protection, it is planned that all facilities of the repository will be built on an anti-flood embankment, at a height which will be safe from the maximum expected floods.

In the area of the disposal silo and the control pool, the plateau is to be constructed up to the elevation of 153.40 m above sea level. At the same time, this elevation point is also a platform for the establishment of a work site for the construction of a concrete diaphragm wall.

In the area of the non-disposal facilities (technological facility, administration and service building) a plateau will be made up to an elevation of 154.70 m above sea level. Next to the load-bearing part of the plateau, a less-load bearing part is to be arranged with the material from excavation (surface silt), approximately to the elevation of 155.00 m above sea level, which serves as the basis for a layer of humus. The finalisation of the platform up to the final elevation of 155.20 m above sea level will be carried out at the end of the construction of facilities, within the scope of external landscaping.

The plateau extends over an area of approximately 30,000 m^2. The form and size of the final embankment plateau for the LILW repository will be conditional on the size of the facilities and the related exterior arrangement, as well as on the requirements of landscape arrangements (grass surfaces, paths, inclines). All movement and operating surfaces on the plateau (transport routes, parking areas) will be arranged at the same elevation of 155.20 m above sea level, while the grassy areas in the surrounding area will be at 155.35 m above sea level. In order to meet the condition of stability in dynamic loading, the inclines of the embankment will be a minimum of 1:3, and based on design aspects they may be eased in places to an incline of 1:10.

The construction of the embankment will proceed from the level of the overgrown soil, with prior removal of approximately 30 cm of humus. The quantity of material to be removed has been estimated at around 14,200 m^3. This material will be used in the phase of constructing facilities for laying down humus and growing grass on green areas.

According to geological data from boreholes made at the silo site, under the humus layer is a sandy and silty layer 0.5 to 2 m thick. The presence of surface sand and silt in similar thicknesses is also probable in the rest of the plateau area in question. In engineering and geological terms this layer is assessed as unfavourable for the laying of foundations and excavation. The layer is in a crumbly state and therefore easily collapsible. In the area of the load-bearing embankment, this layer will therefore be completely removed. The assumed average thickness in the area in question is 1.25 m. On the ground the layer of silt and sand will be removed to its actual thickness. In the area of the less load-bearing part of the embankment the sand and silt layer will not be removed except for the humus. The quantity of material to be removed is estimated at around 35,900 m^3.

Following removal of the silt and sand layer the installation of the embankment will continue with compaction (rolling) of the embankment material in individual layers up to 50 cm thick, so that it will be possible to achieve adequate geomechanical characteristics (density, deformation modulus, load-bearing index, etc.). The quantity of material to be filled in for the load-bearing part of the embankment is estimated at around 75,800 m^3. High-quality material (dolomite, gravel) from external sources will be used for construction. The removed layer of silt and sand in the amount of 35,900 m^3 will be used for creating the non-load-bearing part of the plateau.

Before the construction of facilities, it will be necessary to remove the embankment, which will be set at an elevation of 154.70 m above sea level during the preliminary works, to the level of the foundations of the individual structures. Where necessary, depending on the results of geomechanical analysis, additional compaction or improvement of the foundation ground of the plateau will be carried out (stabilisation with cement or cement limestone mixtures, injecting of foundation ground) in the area of structure foundations that are important for nuclear and radiation safety.

2.2.1.2 CONSTRUCTION OF REPOSITORY FACILITIES WITH MAIN DESCRIPTIONS

Gross floor area of structures, greatest height and depth of structures*:

Gross floor area	Administration and service building:	1,677.05 m^2
	Technological facility: 1st phase:	872.54 m^2
	Technological facility: 2nd phase:	690.13 m^2
	Hall above silo:	2,004.52 m^2
	Silo:	789.00 m^2
	Control pool:	68.00 m^2
Maximum height of structure	Administration and service building:	8.31 m
	Technological facility: 1st phase:	5.20 m
	Technological facility: 2nd phase:	9.20 m
	Hall above silo:	18.41 m
	Silo:	- 66.20 m (max. depth of silo)

* Source of data: leading folder of PGD (Designation of repository project, NRVB---5V/01B)

DISPOSAL SILO

The entire system of the underground repository comprises the following facilities:
- Disposal silo
- Vertical access shaft (within silo)
- Seep water sump (within silo)
- Emergency fire escape.

The construction of a silo is planned on the far south-eastern edge of the repository. The repository area also enables expansion through the construction of an additional silo (repository development possibilities), see description in chapter "SECOND DISPOSAL SILO".

The silo is designed as a reinforced-concrete cylindrical structure with an internal diameter of 27.3 m and a height (depth) of 55 m, viewed from the level of the plateau to the lowest level of the bottom calotte or bottom disposal unit. The central part of the communication tract consists of stairs and a lift, while the side parts, which are somewhat irregularly pointed in shape, are used for the location of the installation lines. The communication tract ends above the level of the plateau as a small entry building with floor plan dimensions of approximately 4 x 9.5 m.

Entry to the communication tract is planned in the hall above the disposal silo. A fire escape is also envisaged from the communication tract, which via the concrete hallway enables the evacuation of people through the exit door, which opens directly into the space outside the hall.

The net floor area of the silo allows the arrangement of 99 containers at each level. The height of the facility is conceived in such a way that ten container levels, plus the planned sealing layer (reinforced concrete slab, clay), will be located below the level of the existing aquifer. For the vertical communication tract, temporary exits to the interior of the silo are planned along its height, which will facilitate access to working levels during the exploitation of the repository. As the filling of the silo progresses, these exits will gradually be put out of use/filled with concrete.

A presentation showing that the facility provides adequate capacity for the reliable implementation of the safety functions planned for during and after external and internal events is given in the existing design documentation. The design procedure and design documentation inherently included a reliability analysis.

The facility fully meets the security features. The design and intended operation of the facility is in accordance with the regulations and requirements of the administrative authorities. The design and intended operation of the facility is also in accordance with the relevant standards.

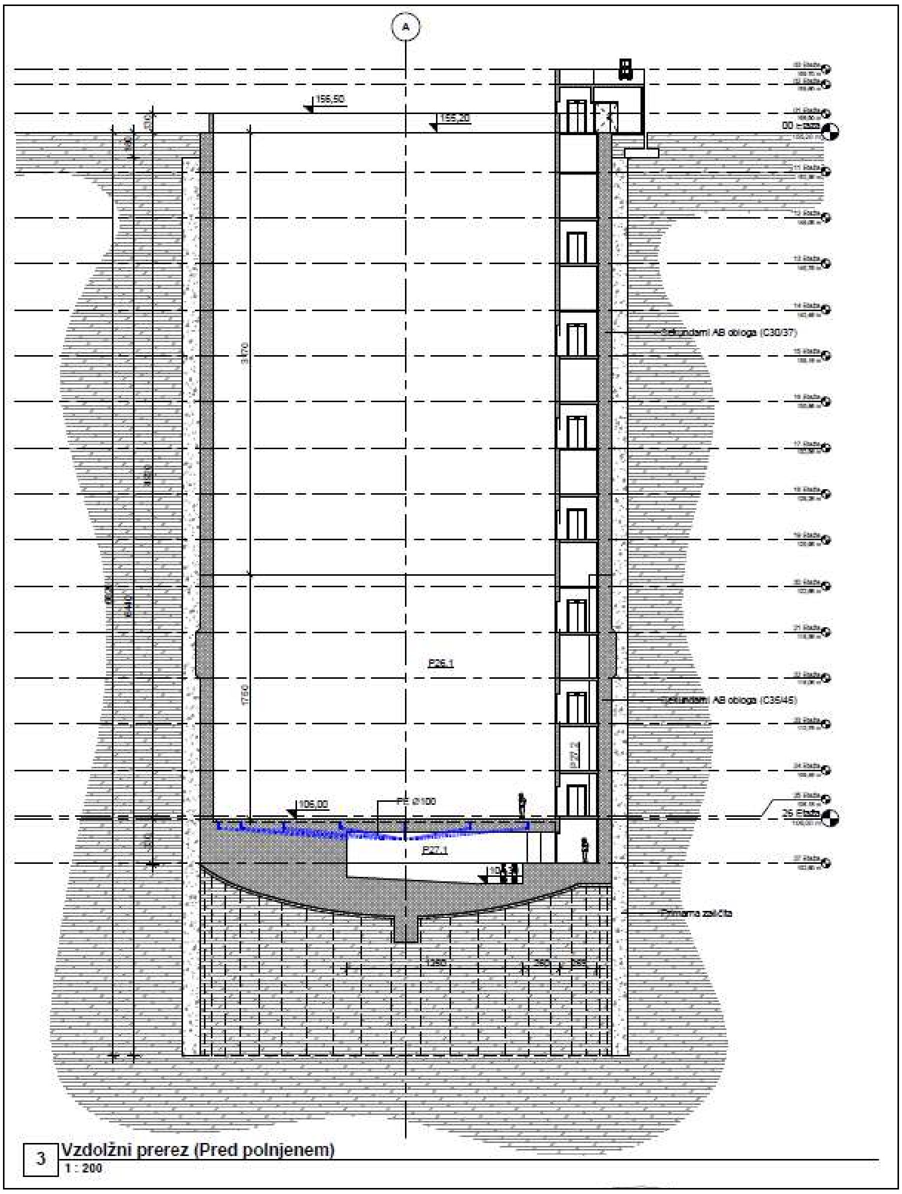

Figure 7: Longitudinal section of silo – prior to filling

Etaža	Floor
Sekundarni AB obloga (C30/37)	Secondary RC liner (C30/37)
Sekundarni AB obloga (C35/45)	Secondary RC liner (C35/45)
Primarna zaščita	Primary protection
Vzdolžni prerez (Pred polnjenjem) 1: 200	Longitudinal section (prior to filling) 1: 200

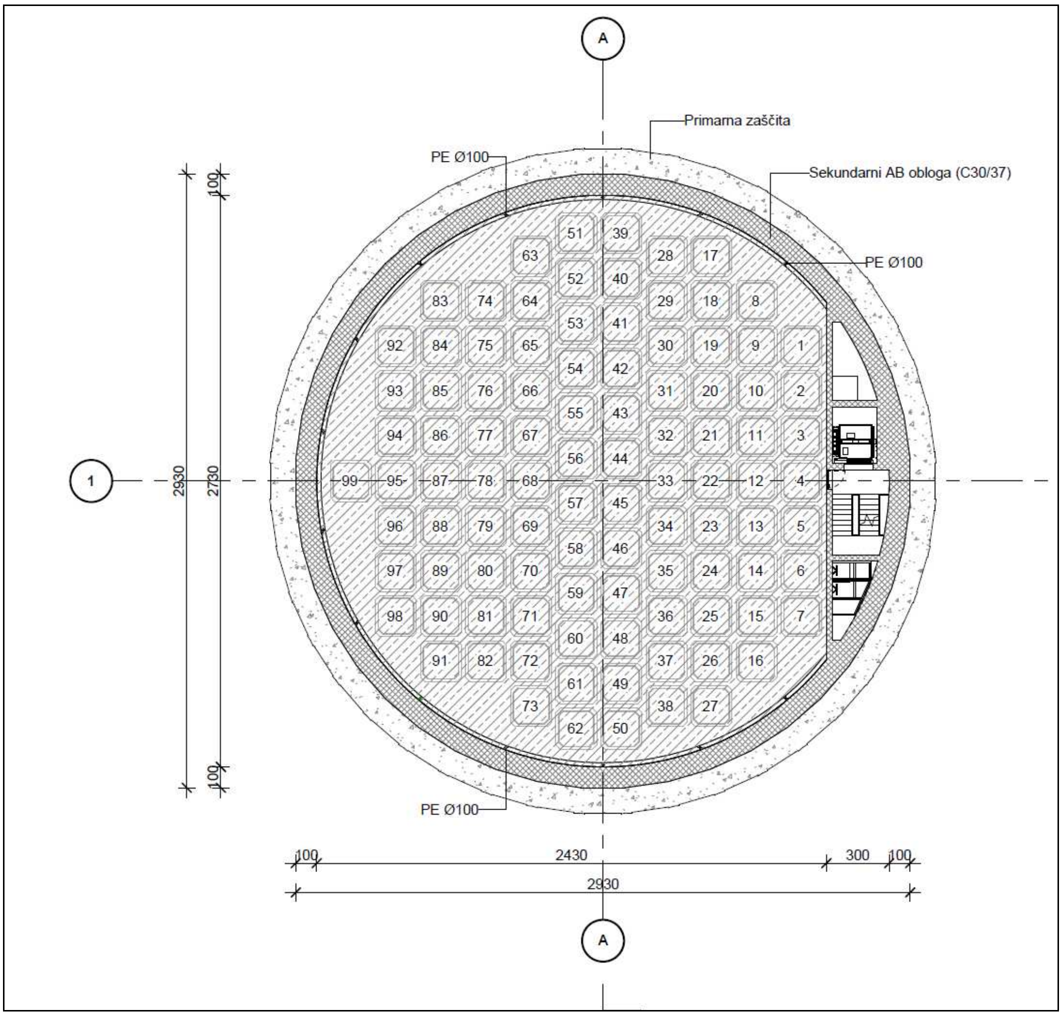

Figure 8: Filling of the silo – first phase

Primarna zaščita	Primary protection
Sekundarni AB obloga (C30/37)	Secondary RC liner (C30/37)
PE Ø100	PE Ø100

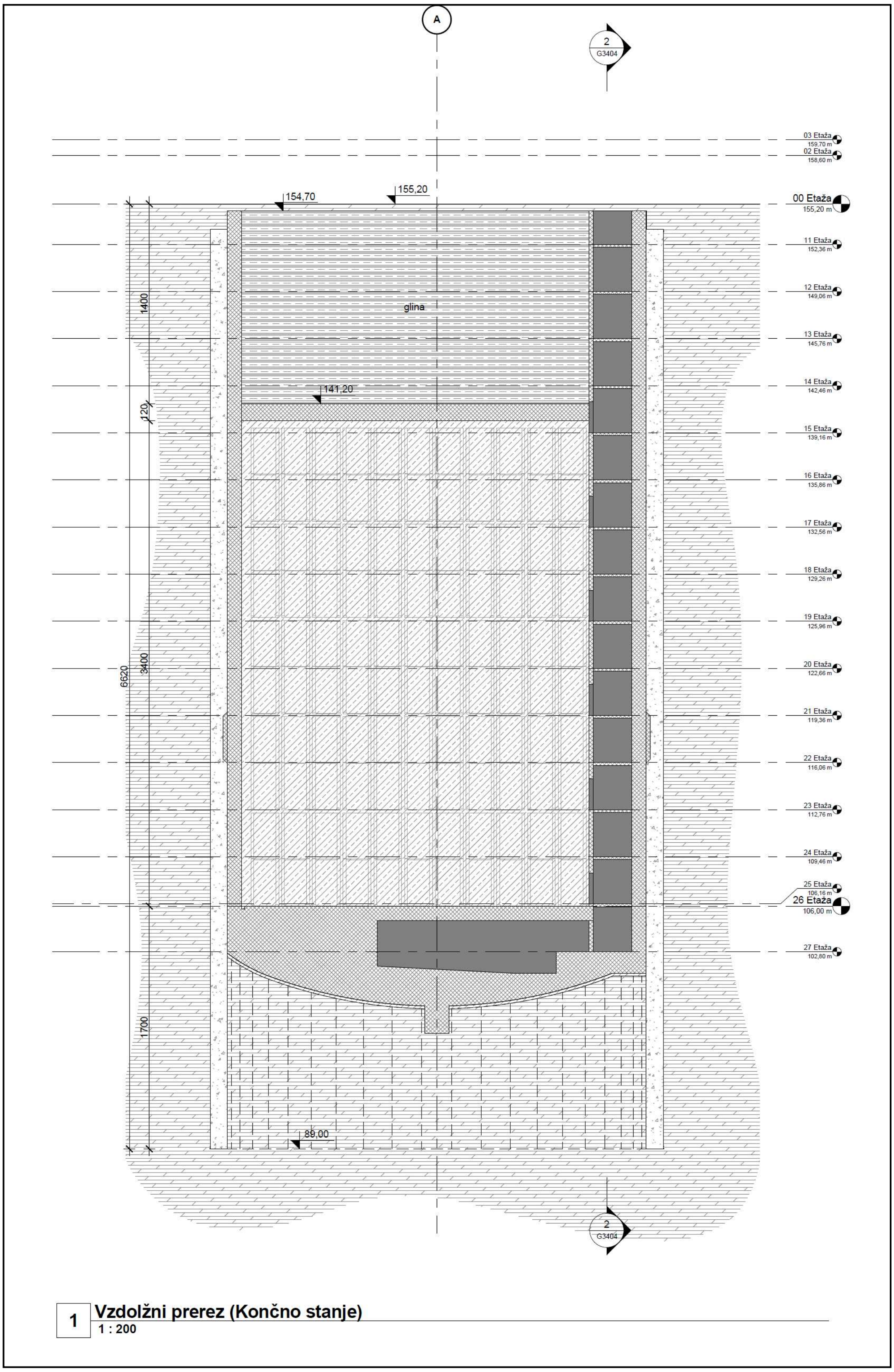

Figure 9: Silo closure concept following the end of operation

Etaža	Floor
Vzdolžni prerez (Končno stanje) 1: 200	Longitudinal section (final position) 1: 200

The silo is intended for the following:

1. to provide storage space in an appropriately sound structure in relation to the planned project events and the required durability of the structure;
2. to restrict water from reaching the disposed of waste and spreading contaminants into the environment by limiting the flow of groundwater and through favourable sorption effects;
3. to collect and retain water potentially penetrating the silo wall;
4. to provide a biological shield;
5. to provide engineered barriers that limit intrusion after closure of the repository.

The silo will be built as the second phase i.e. the secondary liner of the underground facility. In safety analyses, the silo is considered as one of the engineered barriers (besides the container and the primary LILW package).

Important content of safety analyses relating to the silo:

- regarding the primary liner the solution is taken from the preliminary design: primary liner of shotcrete, thickness 0.4 to 0.6 m with 8-metre anchors; secondary liner of 1.0 m thickness; intermediary PEHD membrane;[32] at the same time the primary liner and the PEHD membrane are not considered engineered barriers that contribute to the restriction of water flow and of the discharge of radionuclides in the safety analyses (supplementary explanation: *The solution of the primary liner from the preliminary design differs from those in the expert basis for the EIA (Conceptual Design), in terms of optimising project solutions that contribute positively to nuclear and radiation safety. For this reason the results obtained on the basis of primary design solutions represent a conservative approach and ensure that the results of the safety analyses show the maximum possible impact of the repository on humans and the environment;*
- an appropriate level of permeability of the silo wall must be provided, which however has not yet been fully reviewed;[33]
- the assumed value of the permeability of the silo wall in undegraded condition is 10^{-9} or 10^{-8} m/s for the phase without degradation, and 10^{-4} m/s in fully degraded condition;[34] and
- Two scenarios for degradation of the silo wall are discussed. In the first scenario it is assumed that the silo will remain undegraded for the first 220 years after its closure, and that it will be fully degraded in 12,700 years, while the second scenario assumes that the degradation of the silo wall (as well as the containers) begins immediately after closure. This second scenario is more conservative and was used in the analyses.[35] The degradation of the silo wall (taken into account in the degradation model used in the safety analyses), which depends on the level of carbonatisation of the concrete and which at a carbonatisation rate of 90% results in an increase in the permeability of the silo wall to 10^{-4} m/s.

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32 System description and safety functions report, NSRAO2-PCS-005-01-eng, ARAO, EISFI-TR-(11)-06 rev.2, May 2012

33 Report on initial scenarios under post-closure conditions, NSRAO2-PCS-006-01-eng, ARAO, EISFI-TR-(11)-07, Rev.1, May 2012; in Gas Generation Processes and Design Implications, NSRAO2-PCS-010-01-eng, ARAO, EISFI-TR-(11)-08, Vol.4, Rev.1, May 2012;

34 Near Field Flow Modelling Report, NSRAO2-PCS-007-01-eng, ARAO, EISFI-TR-(11)-08, Vol.1, Rev.1, May 2012

35 Evolution of the Engineered Barriers System, NSRAO2-PCS-009-01-eng, ARAO, EISFI-TR-(11)-08, Vol.3, Rev.1, May 2012

Influence of the environment

The values of geological and geomechanical parameters as well as parameters of the geological environment which may influence the underground construction, and used in the preparation of the design documentation, have been determined in the context of the following research: Main research of the geosphere and hydrosphere for the purposes of construction of a LILW repository at Vrbina, Krško carried out by a consortium of partners: IRGO Consulting d.o.o., ZAG, Geological Survey of Slovenia, Geoinženiring, National Laboratory of Health, Environment and Food, Ljubljana March 2015. The main research was complemented by targeted research, in which it was found that the soil samples are not aggressive towards concrete, that the relaxation does not significantly affect the shear strength properties of the investigated soils, and that the soil samples from the repository site do not have the potential of liquefaction with flow (Report no. P 411/15-710-3 on additional research conducted for the project Main research of the geo- and hydrosphere for the purposes of the construction of the Vrbina Krško LILW repository (after revision), ZAG, Ljubljana, November 2015).

Maximum design temperature of ambient air: Tout, max = + 38 ºC
Minimum design temperature of ambient air: Tout, min = - 25 ºC
The high-water level of the groundwater in the area of the silo is 151.25 m above sea level.

The safety functions of the silo are shown in the table below.

Safety function	Degree and method of achieving safety function
P – physical containment[36]	Water collection is ensured through capturing seep water throughout the perimeter of the silo during the operating period and by removing the seep water to the collection tank via the drainage system, which also allows continuous monitoring of the qualities and quantities of seep water. The impermeability or low permeability of the facility is ensured during the operating period and after closure of the silo by the elements of the secondary liner of the silo. The secondary liner also allows the removal of gases that accumulate in the repository after closure. The qualities of the secondary liner that ensure impermeability and the removal of gases will be defined in detail in the next phase of the project. The achievement of the safety functions will also be reassessed in the next phase of the project.
C – chemical containment[37]	The secondary liner's low pH concrete and absorbent qualities help prevent the migration of nuclides.
H – management of groundwater flow[38]	The collection tank in the silo allows the containment of all seep water and other wastewater in the lower part of the silo before pumping to the surface. The high-water level of the groundwater in the area of the silo is 151.25 m above sea level.
I – intrusion[39]	The construction of the silo ensures adequate robustness, which

36 P (physical containment): prevention of the migration of radionuclides by means of physical barriers;
37 C (chemical containment) – prevention of radionuclide migration by means of chemical barriers, using sorption and solubility limits;
38 H (hydrological): natural and man-made barriers that reduce the flow of groundwater through the repository;
39 I (intrusion) – natural and man-made barriers that reduce the likelihood or impact of human intrusion into the repository;

Safety function	Degree and method of achieving safety function
	reduces and limits the effects of explosions and the effects of other forms of intentional and unintentional actions that could constitute a threat to the strength and stability of the structure during the operating period, and limits the effects of unintentional intrusion after the closure of the repository.
S – structural stability[40]	The taking into account of the required conditions for operating and environmental loads, especially seismic, in planning and in the facility's strength analyses ensures the sufficient strength of the facility.

The facility fully meets the security features. The qualities that ensure impermeability and the removal of gases will be defined in detail in the next phase of the project.

The design and planned operation of the facility are in accordance with the regulations and requirements of the administrative authorities. The design of the facility is also in accordance with the relevant standards. A gradual approach was used when applying the standards and guidelines set out in the Design Bases.

The strength analysis primarily took into account the elastic behaviour of the structure during an earthquake. Similarly, the safety factors for earthquake loads were taken into account in accordance with special standards.

Construction of the disposal silo covers:
- construction of the underground wall (diaphragm);
- pits;
- concreting the silo wall;
- construction of other structures and installations in the silo; and
- construction (raising) the flood-protection plateau.

Underground wall (diaphragm)

The underground wall (diaphragm), a protection for the excavation of the construction pit for the silo, represents a cylindrical, massive reinforced concrete, practically impermeable structure, which in the given geological conditions was selected as the optimal solution. Excavation of the construction pit for the silo with such a means of protection is quicker and safer – with adequate conditions for drainage of water – than the options involving continuous foundation building (shotcrete, anchors).

Construction of the underground wall begins with the execution of the initial wall, which will run in an open excavation about 1.5 m below the level of the working plateau. The initial wall represents a guide to the excavator and at the same time precisely conforms to the layout of the primary and secondary panels. In order for the contacts between the panels to be at a minimum, the envisaged length of the primary panel is around 7 m, and the secondary 2.8 m, which is also the minimum width of the cutting machine. The initial wall is designed as a reinforced concrete supporting wall on either side of the envisaged initial shaft, which in ground layout form follows the layout of the primary and secondary panels. The gap between the walls is the same as the

40 S (structural stability): the use of primarily concrete barriers that ensure the structure/geometry of the repository;

thickness of the underground wall (diaphragm), which is 1.2 m. The thickness of the initial wall is about 20 cm, and it is about 1.5 m deep.

After construction of the initial wall the exterior part is filled in up to the level of the working plateau at an elevation of 153.40 m above sea level, constituting the operating area in the execution of the underground wall. Excavation of the entire ring of the underground wall runs gradually, alternating with the individual primary and secondary panels. The primary panels, which are around 7 m long, will be excavated in three steps (with mutual overlapping), while the secondary panels, whose length matches the width of the cutting machine (2.8 m) will be excavated in one step.

Excavation of the diaphragm will progress in the presence of heavy bentonite slurry, which is intended to maintain the stability of the excavation. Given that the upper part of the wall will run through an alluvial section, partial losses of slurry are possible, but this is not expected in the lower part (more than 13 m deep), since it involves practically impermeable material ($k = 10^{-7}$, 10^{-8} m/s). The properties of the heavy bentonite slurry will satisfy the conditions in situ, thereby achieving adequate sealing and filling of empty spaces in the earth.

The excavation material mixed with bentonite slurry is pumped into the separator, where it is separated from the bentonite. Further on in the cycle the bentonite is collected in a tank from which it is returned to the excavation pit. This is a partly closed circular slurry system, where the quantity is supplemented as necessary from a special installation for preparing bentonite (in the event of losses during construction of the diaphragm).

Concreting of individual panels is envisaged with the contractor under the principle of underwater concreting. With continuous concreting from the bottom up, the bentonite slurry is pushed into a sediment tank from which it is used in excavating the next panel. Each panel is concreted without interruption to its completion.

Given the relative depth of the underground wall, we envisage contact through cutting between panels. Upon completion of two neighbouring primary panels, whose clear mutual distance is 2.2 m, the secondary panel is executed by cutting into the primary panel 30 cm on each side.

Construction pit

Upon completion of the underground wall, before the start of excavation works it will be necessary to construct a security barrier in a reinforced concrete ring standing about 1.3 m high along the perimeter of the silo, as an addition to the exterior part of the initial wall or through appropriate raising of the underground wall. As part of the excavation of the upper part, the internal part of the initial wall will be removed.

The excavation works as well as all other works for the silo will progress with the assistance of a high-capacity tower crane, which will be set up directly by the silo (small arm) to provide the necessary carrying capacity. Excavations up to a depth of 13 m will be performed in the alluvial soil, then down to a final level of 89 m above sea level in the preconsolidated silt. Prior to excavation of the lower part of the alluvium, the water table will need to be pumped out.

In the area of the preconsolidated silt, especially in greater depths, in order to avoid the phenomenon of hydraulic shear it will be necessary to ease pore pressure by installing pumping wells. The construction of 7 wells is envisaged, with one in the middle of the silo and six around the perimeter at a distance of 2.5 to 3 m from the underground wall. The wells will be built at least a further 20 m below the bottom of the lowest level of excavation. The wells will be gradually shortened through progressive excavation. Given the low permeability of the silt (k $=10^{-7}$ or 10^{-8} m/s) the quantities of seep water anticipated in the drainage system are extremely small. The water pumped up from the wells will be released into the environment. Pumping will be performed until the completion of the bottom disposal unit of the secondary silo liner.

Concreting of the silo

Upon completion of the excavation of the construction pit, 20 cm of shotcrete will be sprayed onto the foundation slab, and this will serve as the concrete base. Possible seep water entering through the foundation slab will in order to eliminate flotation pressures be removed in a controlled manner to the envisaged temporary central pumping sump. We envisage a network of radial (Φ 50 mm) and central (Φ 60 mm) drainage pipes that will remove seep water from the silo foundation to the central pumping sump at the lowest point of the bottom disposal unit. Prior to being laid in a small channel dug into the silt substrate, the drainage pipes will be wrapped in geotextile in order to avoid the flushing out of fine fractions from the base substrate. Possible seep water will also be run to the aforementioned radial drainage through the vertical wall of the primary protection (thick-walled diaphragm). In the place of seepage the water will be captured by setting up halved drainage pipes, which will be affixed to the vertical wall of the silo's primary protection and run into the aforementioned floor drainage system.

A PEHD waterproof membrane will be installed on the cement lining (at the contact point of the primary and secondary liners), which will create suitable conditions (dry execution) for the construction of the reinforced-concrete structure of the bottom disposal unit of the silo.

In order to provide stability against full flotation and the ground pressures caused by the hill runoff, the ground structure is shaped like a vault or a cupola (bottom disposal unit), which has a thickness of approximately 100 cm at the critical, minimum cross-section and is built on a pre-poured layer of concrete lining.

Possible seep water during construction will be collected from the envisaged floor drainage in a temporary pumping sump, which is to be located on the bottom of the permanent drainage tank. The temporary sump of the floor drainage will function right up until completion of the complete secondary liner of the silo, when it will be possible to remove it or concrete it, since the silo construction at that time will be capable of taking on the full flotation pressure of the water. The temporary sump will be accessible through the communication tract in the silo. After removal (concreting) of the temporary pumping sump, injection of the drainage pipes in the foundation slab of the silo will be performed through the drainage pipes.

After injection of the drainages and concreting of the temporary pumping sump, the PEHD membrane will be welded to the membrane built into the foundation slab of the silo. This will be followed by concreting part of the bottom of the permanent collection tank above the temporary pumping sump. This will serve to establish waterproofing over the entire surface of the silo foundation slab.

The bottom (foundation slab) of the silo is expected to be made of solid concrete, as part of which we envisage a final (permanent) drainage tank for collecting possible seep water during exploitation of the facility.

Built into the foundation slab will also be an internal drainage system composed of a series of radially installed PEHD DN 200 drainage pipes. The pipes come together in the central section, which is the lowest point of the silo foundation slab. The drainage system's drainage pipes then lead to the collection tank.

The PEHD waterproof membrane, which is to be used as waterproofing in underground structures, will be laid on the horizontal surfaces and heat-welded together. On the pitched, vertical and ceiling surfaces it will be attached to special fastenings that will be affixed beforehand to the primary liner. Individual pieces of membrane will be heat-welded to each other. In laying the membrane, special attention will be needed in particular during the making of the secondary liner, in order to avoid mechanical damage to the membrane.

On the vertical silo walls the membrane will be affixed directly to the previously installed knobs in the concrete primary liner. Prior to laying the waterproofing membrane, visual checks will determine the state of permeability or impermeability of the primary liner. Possible places where water leaks are identified will be injected. In the event of injecting not being successful (which can happen only exceptionally), excess water will be captured and run through a drainage pipe to the drainage system pipe in the silo foundation slab. Upon completion of construction of the secondary liner of the silo, these drainage pipes will also be injected.

Concreting of the silo's secondary liner will be performed by phased panelling and concreting from the bottom up. The secondary liner will be locally thickened in the lower part with an anti-shear ring to provide protection against the flooding of the silo in the event of full hydrostatic pressure (flotation).

Other constructions and installations in the silo

Upon completion of the secondary liner of the silo, a pump will be installed in the collection tank at the bottom of the silo for possible water seeping through the secondary liner into the silo interior, which will function throughout the period of exploitation of the repository.

Any seep water from the area of the stairs, the lift well and the installation shafts will be collected at the lowest points in ground channels and removed via the area of the auxiliary installation shaft along a concrete incline to the central pumping tank.

Completion of the secondary liner of the silo will be followed by construction of the entrance booth above the pit, constituting an access building with auxiliary control point and other constructions in the silo such as landings, the lift and stairs.

Completion of the flood-protection plateau

Upon completion of the silo, the flood-protection plateau in the area of the silo, which is to be built in the phase of initial works to an elevation of 153.40 m above sea level, will be raised to a final elevation of 154.70 m, i.e. 0.5 m below the final elevation of the plateau of 155.20 m above sea level. The top layer up to the final elevation will be laid as part of the exterior arrangements. The surface area of the load-bearing part of the plateau, which is to be raised to the final elevation, will be around 9,200 m^2.

In the area outside of the load-bearing part of the plateau, a non-load bearing embankment will be installed with material from the excavation of the silo pit, to an elevation of approximately 155.00 m above sea level, which will serve as the basis for a subsequent layer of humus.

Raising the embankment will be performed with compaction (rolling) of the embankment material in individual layers up to 50 cm thick, so that it will be possible to achieve adequate geomechanical characteristics (density, deformation modulus, load-bearing index, etc.).

The quantity of material to be filled in for raising the load-bearing part of the plateau is estimated at around 21,500 m^3. High-quality material (dolomite, gravel) from external sources will be used for construction. Material from excavation of the construction pit for the silo will be used to raise the non-load-bearing part. The quantity of material to be filled in for the non-load-bearing part of the plateau is estimated at around 43,900 m^3.

SECOND DISPOSAL SILO

Construction of the second disposal silo will begin when the first silo is closed. Here we observe the scenario (record of meeting at the Agency for Radwaste Management of 19 October 2015, minutes No. NRVB-5Y8169), that following closure of the silo the hall will remain and will be used as a garage for the lift. After construction of the second silo, the hall will be moved to the new location, along with the lift.

The site of the second silo takes into consideration the condition that it be located inside the envisaged fence or road around the perimeter of the repository. We take into consideration the shifting of transportation surfaces around the hall of the second silo to the edge of the repository plateau, and also the width of the working plateau around the second silo in constructing the primary substructure (diaphragm).

The construction and operation of the second silo will observe the same regulatory requirements as for the first silo and the entire repository. Construction of the second silo will observe the same principles as in construction of the first silo, and as set out in the Conceptual Design for the first silo. These are in particular:

- design bases;
- technological and other principles;
- SAC&WAC requirements and principles;
- functionality analysis; and
- guidelines of the special commission for architecture and landscape architecture solutions regarding the placing and design of repository facilities.

Situation and placement of facilities

The second silo will be built in the core area of the repository, just like the first silo. The arrangements for all other areas of the repository remain the same as for the first silo in the Conceptual Design and are unchanged. The upper elevation of the plateau around the second silo will be the same as the elevation of the plateau around the first silo, which is 155.20 m above sea level, and the upper elevation of the silo will also be the same at 156.50 m.

A decisive factor in determining the position of the silo axis is the distance of the hall from the edge of the repository incline, which is 12 m. The distance of the first silo from the edge of the load-bearing part of the embankment is the same. Taking this condition into account, the axial distance between the silos is 73 m. In terms of method of construction (diaphragm), the distance between the silos could be smaller, but in that case we would need to remove the hall and portal crane and probably also an appropriate portion of the foundation construction.

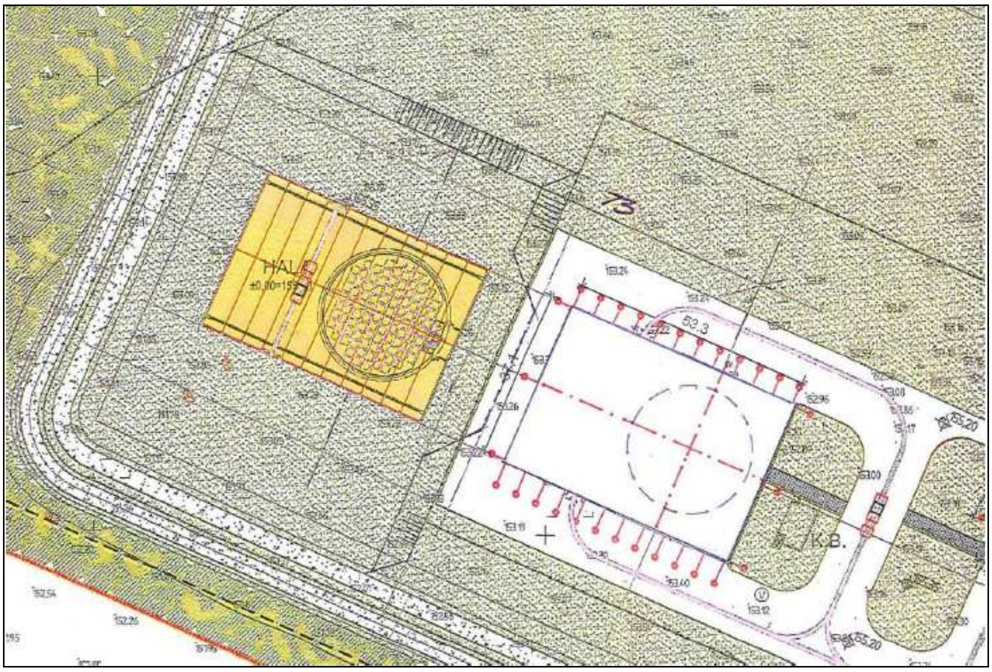

Figure 10: Area of envisaged second silo (construction in 2048 and 2049)

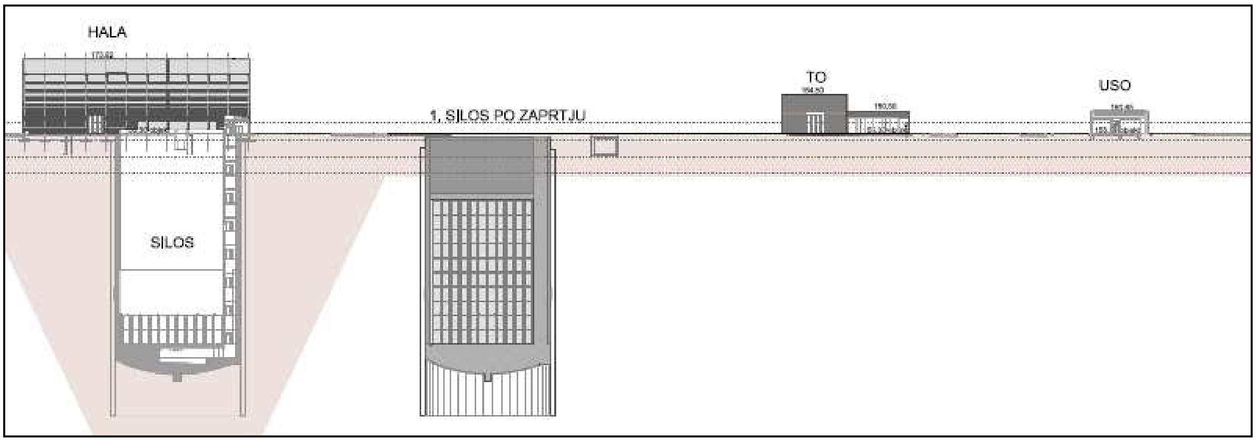

Figure 11: Location of cross-section of second silo

HALA	HALL
1. SILOS PO ZAPRTJU	1st SILO AFTER CLOSURE
TO	TF
USO	ASB
SILOS	SILO

Owing to its asymmetrical position relative to the hall, the second silo is situated close to the load-bearing part of the embankment for the first silo. The distance to the foot of the slope is about 5 m. Construction of the second silo is envisaged in the same way, i.e. implementation of primary construction planned as an underground wall (diaphragm), which would also be executed from the working plateau at an elevation of 153.40 m above sea level. The distance of the exterior edge of the diaphragm from the foot of the load-bearing part of the embankment of the first silo is around 5 m. In view of the necessary operating space around the diaphragm during its construction, with a width of around 15 m, the working plateau will extend to the area of the embankment of the first silo. The height difference between the plateau around the first silo (155.20 m) and the working plateau (153.40), amounting to 1.8 m, will need to be overcome with a temporary supporting construction such as a retaining wall or similar, set between the level of the plateau of 155.20 m above sea level.
Construction of the plateau will be executed in phases, whereby first the embankment is removed down to the lower level of the surface silt (the silt is removed entirely), then a plateau of high-quality material (outside source) is made to the level of 153.40 m, from which the diaphragm will be constructed. The plateau thus made will represent the lower level of the load-bearing embankment. The other part of the embankment from the elevation of 153.40 m to the final elevation of 155.20 m will follow after completion of the secondary blanket of the silo.
Execution of the primary (diaphragm) and secondary rings will progress exactly the same as was envisaged for the first silo.

Construction will include:
- Construction of silo:
    - Construction of the underground wall (diaphragm);
    - Excavation for the silo (use of crane);
    - Construction of silo (use of crane);
    - Embankment by the silo;
    - Hall above the silo – shifting hall from silo 1 (use of heavy lift crane);
- Exterior arrangement:
    - Municipal service lines on the plateau;
    - Transportation and pedestrian surfaces;
    - Other smaller facilities.

Material excavated from the area of the second silo will be taken away. We expect this to be infilled at the organised permanent landfill outside the area of the detailed plan of national importance (see the detailed balance of masses in the chapter on waste) that is managed by the company Kostak komunalno stavbno podjetje d.d. Krško:
- Landfill that is part of the Spodnji Stari Grad Waste Management Centre – average transport distance of around 500 m: Parcel no. 2106/85, c.m. Dronovo – 1320 and
- Ash dump – average transport distance around 2000 m: Parcels No. 105/24, 111/17, 114/8, 115/5, 115/17, 115/20, 115/21, 115/24, 115/25, 119/12, 119/14, 751/10, 751/11, 752/5, 1205/324 and 1205/326, all c.m. Stara vas – 1316.

As part of construction of the 2nd silo, the following facilities will be built (from the phase of construction of the first silo), with their purpose and size not changing, and they will remain during the construction and operation of the silo:

1. Technological facility;
2. Administration and service building;
3. Facilities for monitoring and radiological surveillance of emissions and the environment;
    a. Control pool. Without changes (the same control pool will be used for the second silo);
4. Physical security facilities
    a. Outer fence; unchanged;
5. Infrastructure lines and connections (no change).

During construction of the second silo the following facilities will be constructed for the needs of construction and operation:

3. Facilities for monitoring and radiological surveillance of emissions and the environment
    a. Additional boreholes for monitoring operation of the second silo;
4. Physical security facilities
    a. Inner fence; expanded depending on the extent of the plateau around the second silo;
5. Plateau and facilities of exterior and landscape arrangements
    a. Existing plateau to be extended;
    b. Compaction of the surfaces in the area of silo 2 construction to be carried out;
    c. Greening of surfaces around silo 2 following construction.

During operation of the second silo, the following systems to be subsequently installed:

- System for removing water from the area of the disposal silo (R);
- Drainage: extending the precipitation water drainage just for the area of the second silo, the rest to remain in its same function;
- External hydrant network; extended over the expanded plateau;
- Internal hydrant network; unchanged (Conceptual Design, January 2016).

Other envisaged repository systems are identical, and remain in their function from construction of the first silo:

- System for collection of wastewater in the radiologically controlled area of the TF (R);[41] unchanged (Conceptual Design, January 2016);
- Water supply system; unchanged (Conceptual Design, January 2016);
- Heating; unchanged (Conceptual Design, January 2016);
- Cooling; unchanged (Conceptual Design, January 2016);
- Ventilation (partly R); additional ventilation of the machine room and shaft in the silo; otherwise unchanged (Conceptual Design, January 2016);
- External hydrant network; extended over the expanded plateau;
- Internal hydrant network; unchanged (Conceptual Design, January 2016).

[41] Note: (R) denotes systems with potentially radioactive media.

Description of construction site arrangement during construction of second silo

The construction site is to be arranged pursuant to the Decree on the implementation of health and safety requirements at temporary and mobile construction sites (Official Gazette of the RS No. 83/05 and 43/11 – ZVZD-1).

The construction site will be protected as a nuclear facility in accordance with the physical security study (part of the Conceptual Design). In general the construction site will operate all weekdays for 10 hours a day. On Saturdays, Sundays and public holidays it is not expected to operate. Exceptionally the construction of the concrete diaphragm for the silo may also be performed at night, on Saturdays, Sundays and holidays, but only by special order of the investor.

Planned construction site connections

Water supply connection

- During construction of the facilities for the second silo we envisage temporary connection to the existing water gauging shaft for LILW facilities outside the fence along Vrbina road.

Electrical connection

- During construction of the repository facilities and infrastructure facilities, we envisage temporary connection to the existing substation within the fenced LILW plateau, which is located by the technological facility. In the event of the existing substation capacity not sufficing, the contractor will generate additional electricity using its own generators.

Sewerage connection

- The contractor will take care of waste sanitary water using a small treatment facility or removal to the municipal treatment facility.

Organisation of traffic communications

- Access to the construction site is envisaged along public transport communications past Krško NPP along municipal road LC 191 111 and towards the Waste Collection Centre (Kostak) along the sanitary landfill public way JP1 693 631. From the municipal road to the construction site we envisage a temporary construction site road on the north side of the LILW fence. A temporary independent entrance way is envisaged for the construction site (see the layout drawing below).

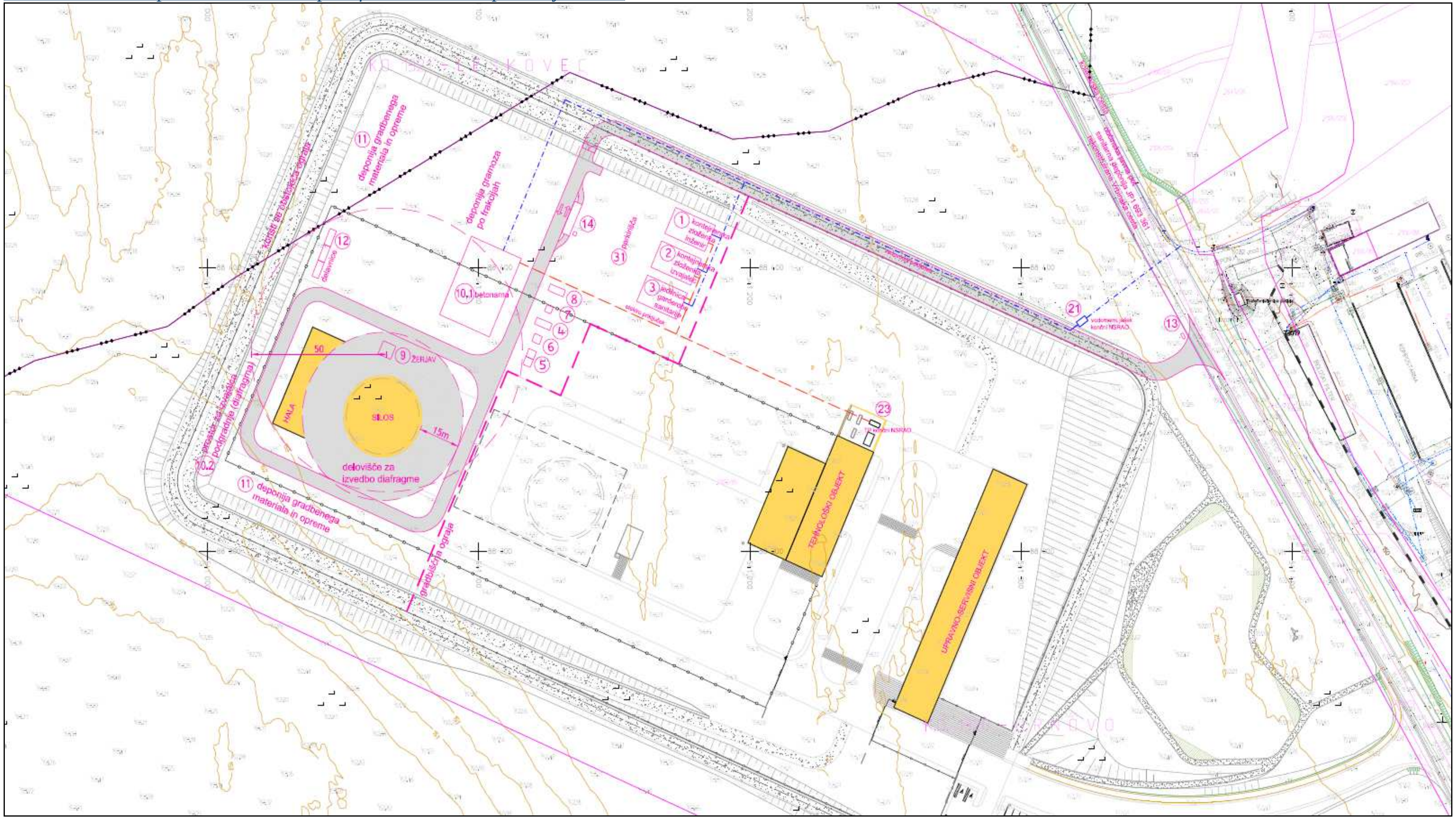

Figure 12: Arrangement of construction site in the phase of constructing the second silo

koristi se obstoječa ograja	the existing fence is used
občinska javna pot	municipal public path
sanitarna deponija P1 693	sanitary landfill P1 693
rekonstruirana Vrbinska cesta	reconstructed Vrbina road
deponija gradbenega materiala in opreme	construction material and equipment landfill
delavnice	workshops
prostor za izvajalca podgradnje (diafragma)	area of the substructure contractor (diaphragm)
deponija gramoza po frakcijah	gravel landfill by fraction
betonarna	concrete plant
parkirišča	parking areas (car parks)
kontejnerska zloženka inženir	container complex (unit) for engineer
kontejnerska zloženka izvajalec	container complex (unit) for contractor
jedilnica, garderobe, sanitarije	dining area (canteen), changing rooms, facilities/toilets
elektro priključek	electrical connection
ŽERJAV	CRANE
HALA	HALL
SILOS	SILO
delovišče za izvedbo diafragme	work site for the construction of the diaphragm
gradbiščna ograja	construction site fence
TP končni NSRAO	TP (transformer station) final for the LILW repository
TEHNOLOŠKI OBJEKT	TECHNOLOGICAL FACILITY
vodomerni jašek končni NSRAO	water gauging shaft final for the LILW repository
UPRAVNO-SERVISNI OBJEKT	ADMINISTRATION AND SERVICE BUILDING

CONSTRUCTION OF THE NON-DISPOSAL PART OF THE REPOSITORY

Construction of non-disposal facilities comprises:
improvement of the foundation ground on the plateau;
- administration and service building;
- technological facility;
- hall above the silo; and
- exterior arrangement of plateau.

Owing to the requirement for earthquake resistance of new structures, we envisage setting the foundations of the technological facility on improved ground. Improvement of the ground will be carried out during construction of the plateau through means of chemical and mechanical stabilisation, or after construction of the plateau using the technology of high-pressure injecting of a cement suspension into the ground, i.e. jet grouting. In this way in the area beneath the foundations of the TF we will ensure ground with shear characteristics that will enable safe foundations of the structure for the required accident weighting combination.

Before the start of works, a test field will be made, where alongside the appropriate procedure the characteristics of improved ground will be checked for seismic analysis. It will be necessary to measure the seismic shear wave velocity of improved ground.

Construction of non-disposal facilities will be carried out using standard construction machinery.

ADMINISTRATIVE AND SERVICE BUILDING

The administrative part of the facility will contain the premises and systems serving repository management activities, and the related service and administrative activities, as well as activities to control the intake of items, persons (personnel and visitors) and vehicles (RW-carrying and other vehicles) and to exercise surveillance of the repository.

The service part of the facility is intended for energy activities, fire water supply, collection of municipal waste, storage of equipment and geological samples (cores) and a workshop. This part of the facility contains all of the infrastructure, power supply and service areas that are important for the safe and undisturbed operation of the repository, but are not directly connected to the undisturbed operation of the technological facility itself (those areas are located directly within the technological facility).

The structure will be located by the main entrance to the protected area of the repository, north-east of the main access road, parallel to the outer perimeter fence (about 30 m from the fence). Past the structure, on its southern side, will be run the main access road, along which regular traffic will flow into the complex as well as abnormal load traffic. Since there is just one entrance to the fenced area (main access road), the administration building represents the first contact the visitor has with the core, protected area of the repository, and is at the same time the entry point to it.

The building will be located on top of the flood-protection plateau at an elevation of 155.20 m, which is raised above the surrounding terrain. Through its location on the main, front side of the repository complex, seen from the direction of arrival along the main access road to the repository, through its shape and dimensions (the building will be almost 90 m long) and through its appearance and visual exposure (raised above the surrounding terrain) it will create a kind of visual barrier and close off the repository to views from the main access road. At the same time its design, as an emphasised glass cube for controlling access to the repository does permit and enable a visual link between the 'exterior' (outside the security fence) and 'interior' (inside the fence) of the repository; the glass cube also indicates the actual entrance to the repository.

The majority of the facility is single-storey, the southern part is two-storey (G+1), while the part between axes M and O has a basement (B+G).

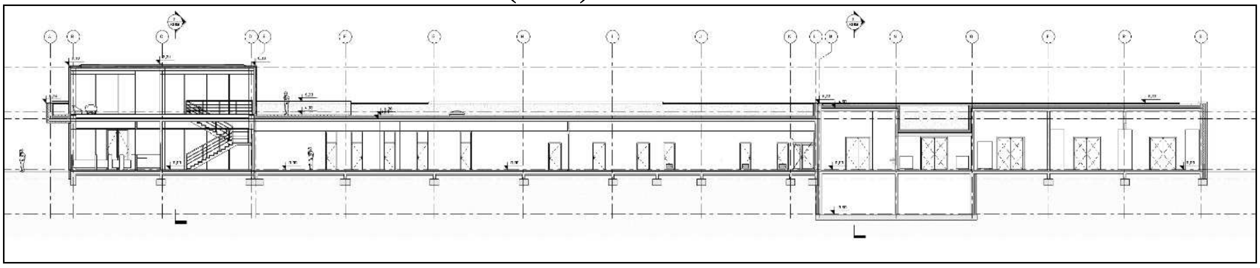

Figure 13: Longitudinal section

The floor plans of the building have dimensions of 89.55 x 13.65 m, where owing to the gradation of the exterior lines the width changes, ranging from 9.95 m to 11.85 m and then to 13.65 m.

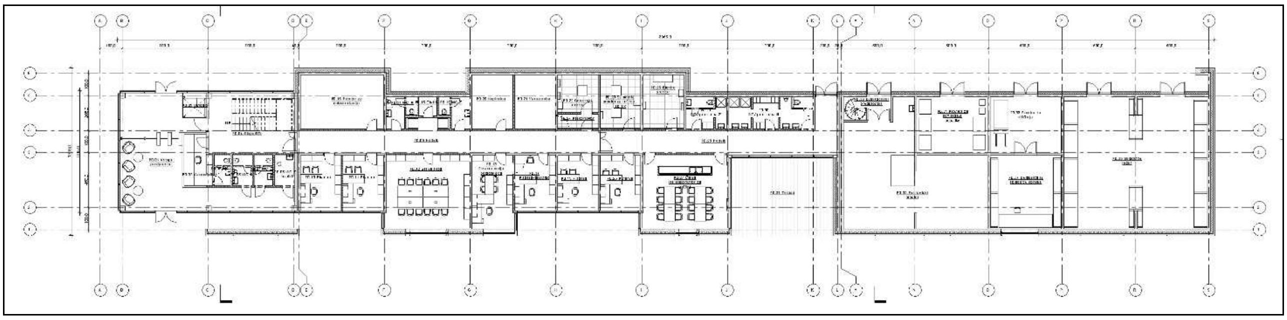

Figure 14: Ground floor plan

The building comprises three units separated from each other in construction:

- the entrance lobby with reception, security officer and spaces for visitors (axial dimensions of 14.00 x 9.15 m);
- the administrative section, housing offices, a kitchenette, common spaces (communications, service and technical spaces) and spaces for providing physical security (axial dimensions of 44.00 x 12.75 m) and
- the service section with spaces for collecting urban waste, a workshop, quick access storage, energy station, storage space for geological (core) samples and spaces for supplying water and fire protection (axial dimensions of 30.00 X 10.95 m).

The elevation of the roof cornice of the single-storey section of the building is around +5.20 m, and the height of the roof above the glass cube of the entrance lobby and reception by the entrance to the repository is around +8.20 m. The elevation ±0.00 of the structure is envisaged at 155.30 m above sea level.

Figure 15: Visualisation of administration and service building

pogled jugozahod	view from the south-west
pogled jugovzhod	view from the south-east
vzhodna fasada	eastern façade

The following sections, spaces and sets of activities are envisaged for the building:

- reception;
- administrative section;
- kitchenette;
- common areas (communications, service and technical areas);
- areas for physical security installations;
- areas for collection of urban waste;
- workshop;
- quick access storage facility;
- electrical switchboard;
- water supply and fire protection areas; and
- storage facility for geological samples (core samples).

Individual sets of activities within the building are separate from each other and represent integral units which are separate from other sets by a controlled passage.

TECHNOLOGICAL FACILITY (TF)

The technological facility (TF) is intended for the temporary storage and repair of any damaged waste containers, basic laboratory research, control of technological processes, and the remaining necessary technological and service functions of the repository as well as functions for the provision of nuclear and radiation safety. The facility is designed from a functional, structural and design standpoint to be able to be constructed in two phases.

At the same time the technological facility houses a radiological entry/exit checkpoint for the controlled area, and thus represents the entry and exit point for the access of persons to the area of the repository that is controlled in terms of safety from radiation. In this sense the TF itself, in terms of protection against radiation, is divided into a controlled and non-controlled area.

The facility is located in the central part of the repository, in the section on the boundary of the controlled area.

For the most part the building is single-storey, with the floor plan and height being distinctly divided; the eastern part of the building is lower, height 5.20 m, while the western part of the building is a 9.20 m high spacious hall with a clear height of 8.00 m, for reserve storage capacities.

The floor plan dimensions of the lower part of the building amount to around 58.00 (roof: 60.00) x 14.60 m, with the higher part of the building having floor plan dimensions of around 37.00 x 15.10 m. The southern edges of both parts of the building are mutually aligned, with the lower part of the building on the north side being around 23.00 m longer than the higher part of the building.

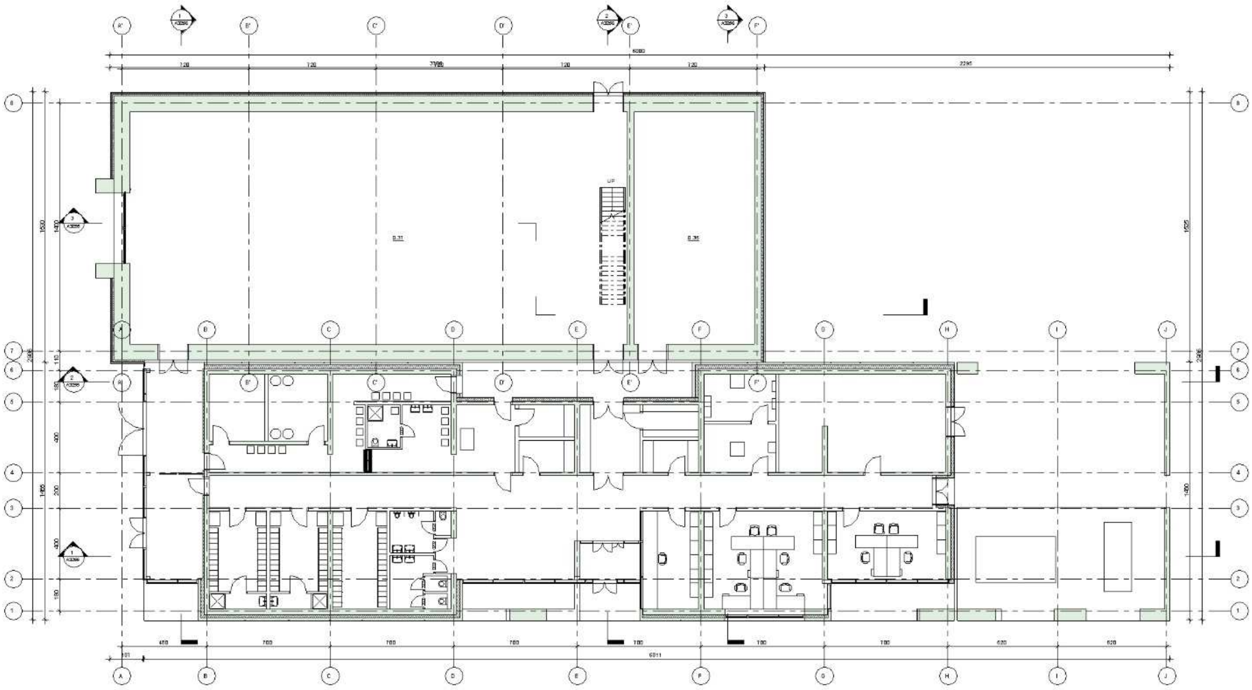

Figure 16: Ground floor plan

The elevation ±0.00 of the building is envisaged at 155.30 m. The building is founded on the ground floor level and has no basement.
The line of the northern facade of the lower part of the building is aligned with the line of the northern facade of the administration and service building

The facility is divided into several sets of activities which will be constructed in 2 phases.

Phase one:

- control point with accompanying premises,
- storage of secondary RW and measurement room,
- service, energy and technical areas serving the technological facility during Phase 1, and
- common areas and utility rooms.

Phase two:

- reserve storage capacities with hot workshop and secondary LILW storage area,
- ventilation control room and measurement room for the operational requirements during Phase 2.

The largest part of the technological facility (or main section of facility) is the hall for back up storage capacities (Phase 2). Adjoining this is the lower, eastern part of the facility, where other spaces and sets of spaces are located, supplementing and servicing it and also intended for the technological functioning of the repository (Phase 1).

The facility itself is composed of two voluminous structures: the hall for reserve storage capacities with the measurement facility and hot climate control machine room represents the main body of the facility (floor plan dimensions of 37.00 x 15.20 m and height of 9.20 m), and adjoining it on the eastern side is the body of the lower part of the facility (floor plan dimensions of 60.00 x 16.40 m and height of 5.20 m), in which are housed the office, control, service, technical, energy and common and auxiliary spaces.

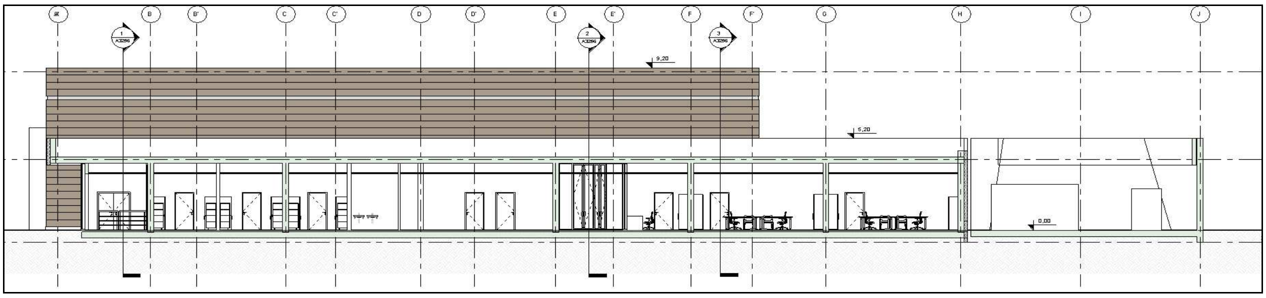

Figure 17: Longitudinal cross section – technological section with outside area

PREFABRICATED HALL ABOVE THE SILO

During the period of operation of the repository, above the disposal silo we envisage a prefabricated hall of ground plan dimensions of around 53.30 m x 37.10 m.

The structure is located in the central part of the flood protection plateau (at an elevation of +155.20 m), in the controlled area, and covers the entire footprint of the silo for disposal of LILW containers along with the necessary handling areas. The hall protects the silo and the gantry crane against weather impacts during the placing of containers.

The elevation ±0.00 of the structure is envisaged at 155.30 m. The roof space of the structure will be at a height of around 18.00 m, and the pitches of the roof at a height of around 18.45 m.

The hall will be installed as a prefabricated steel structure of zinc galvanised steel and coloured hot-rolled profiles. It will be set on strip foundations.

The design of the structure is strictly rational. It envisages 12 frames composed of two columns (HEB 500 profiles) and roof bar supports 3.80 m high, with 12 fields with tensile diagonals.

The construction grid in the longitudinal direction is 11 x 4.80 m, in the lateral direction the interval between axes is 36.40 m. The clear axial span of the frames is therefore 36.40 m, and the axial interval of individual frames (grid of frames) is 4.80 m. In the longitudinal direction the frames are connected to each other with wind bracing.

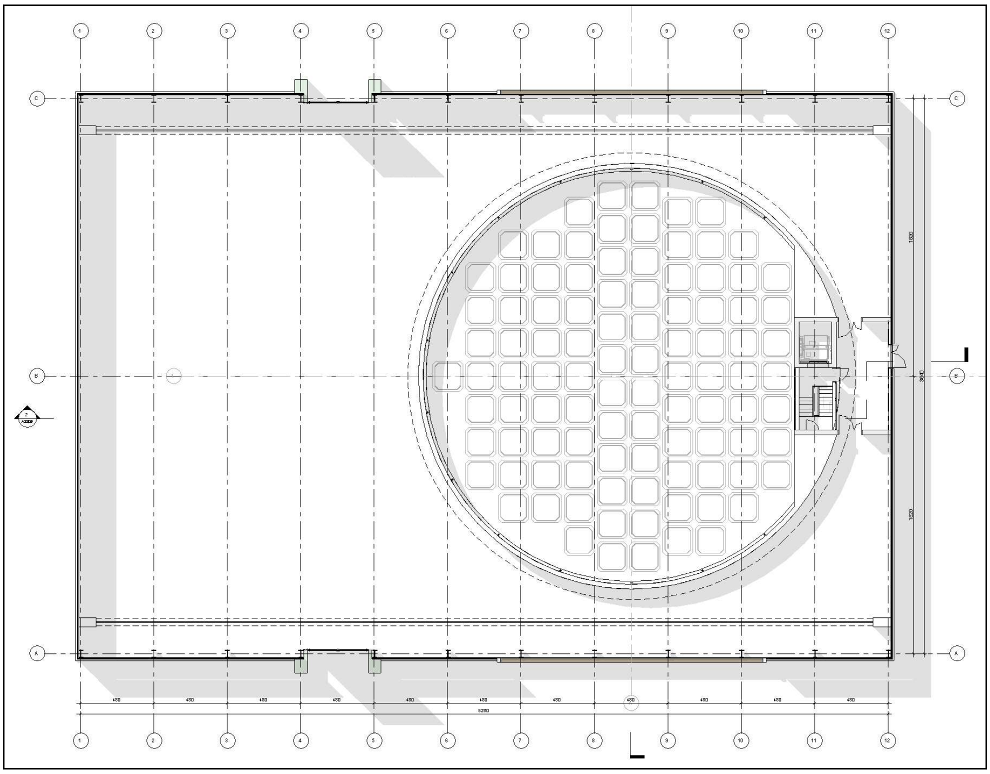

Figure 18: Hall above silo – floor plan

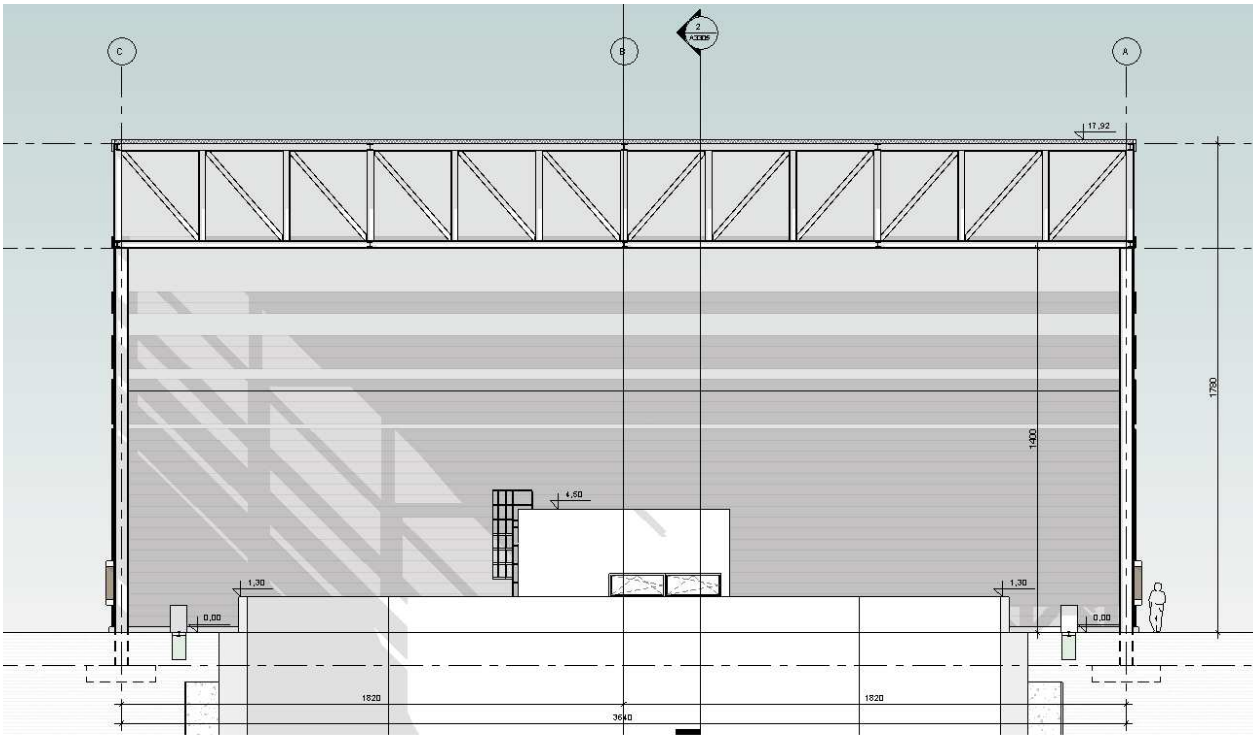

Figure 19: Hall above silo – lateral cross section

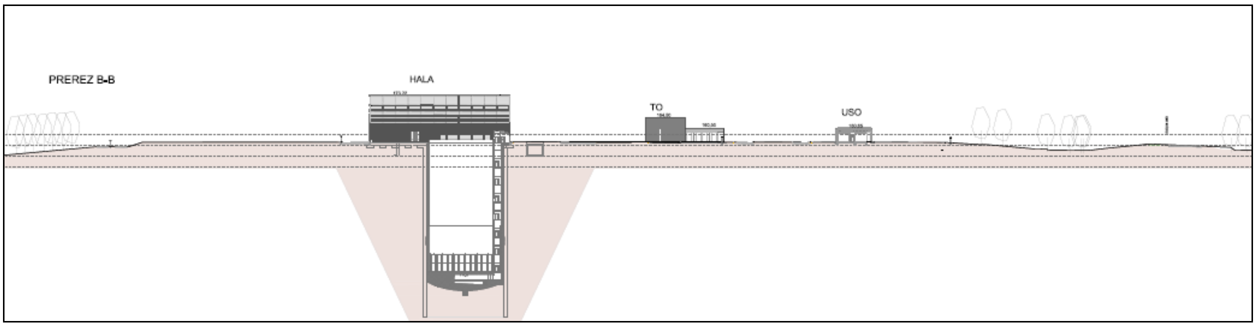

Figure 20: Illustration of hall above silo

PREREZ B-B	SECTION B-B
HALA	HALL
TO	TF
USO	ASB

The plans envisage the construction firstly of a silo for disposal of radioactive waste on the far southeast edge of the repository. The space of the repository also allows for expansion through the construction of an additional silo which in construction and technical characteristics would be identical (described below). Originally the construction of just one disposal silo has been envisaged, and all repository facilities will be constructed prior to the start of operation.

CONTROL POOL BY SILO

The control pool is to be located on the plateau of the central part of the core area, along the eastern facade of the hall above the silo.

The control pool is designed:

1. to collect industrial wastewater from the hall above the silo;
2. to collect wastewater from the silo that is not pumped directly into the sewage system;
3. to collect excess wastewater from the technological facility; and
4. to contain wastewater before being run into the sewage system or treatment.

The control pool ensures containment and collection capacities

The net volume of the control pool is 130 m^3. The total capacity of the control pool is determined on the basis of the quantity of fire water needed for two hours of operation of external hydrants at 15 l/s, or a total of 108 m^3, and the volume of the collection tank below the bottom of the repository silo, which is 20 m^3.
In the pool, water is checked for contamination before being pumped into the sewer system. The construction design is harmonised with the technological requirements. The pool is rectangular, with internal dimensions of 5.5 m x 10.0 m, with a clear height of 3.7 m. The pool is entirely covered by a reinforced concrete slab, in which openings are planned for a submersible pump, and openings for access and maintenance and for ventilation.
The bearing construction is composed of reinforced concrete side walls 40 cm thick, the covering slab 40 cm thick and the base slab 50 cm thick. The upper edge of the top slab is set at around 50 cm below ground level, which sits at 155.40 m above sea level in the area of the pool.
In order to provide protection against flotation during a PMF, the perimeter of the bottom slab is planned to be extended by 50 cm past the external walls of the pool, such that the footprint of the bottom slab is 11.80 m x 7.30 m.

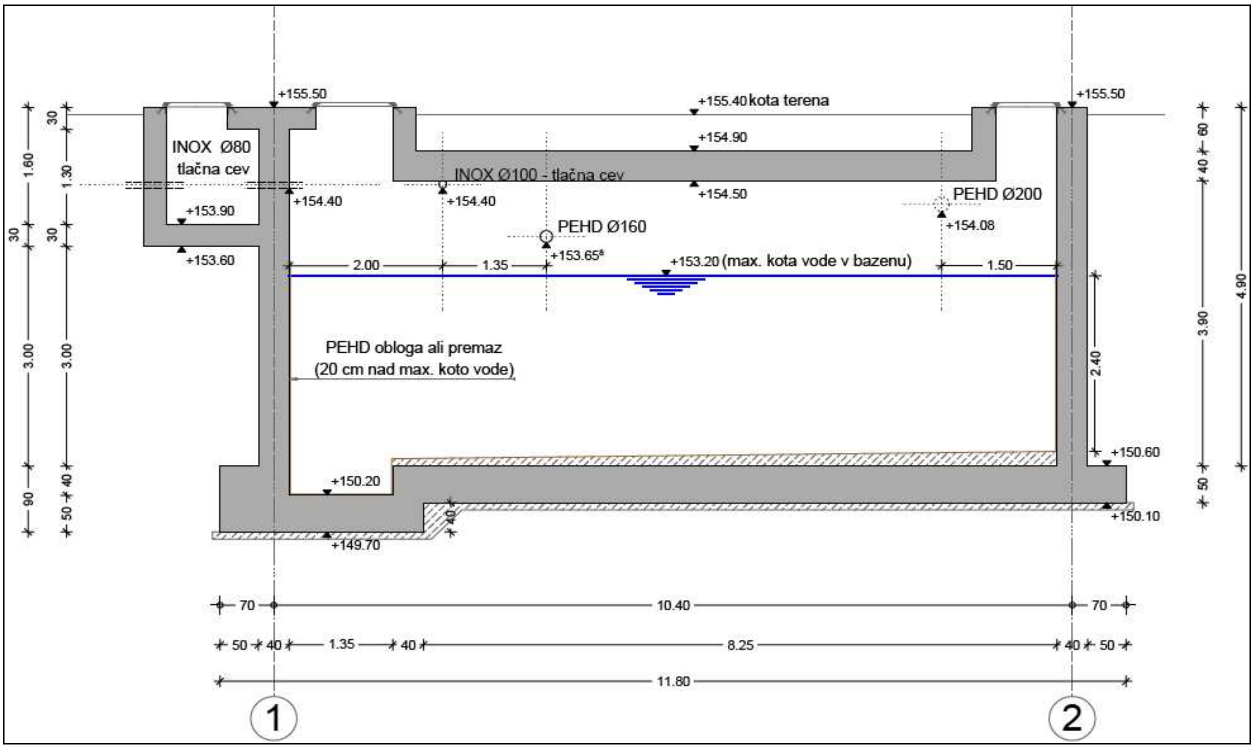

Figure 21: Control pool

INOX Ø80 tlačna cev	Inox Ø80 high-pressure pipe
INOX Ø100 – tlačna cev	INOX Ø100 – high-pressure pipe
+155.40 kota terena	+155.40 terrain elevation
PEHD Ø200	PEHD Ø200
+153.20 (max. kota vode v bazenu)	+153.20 (maximum water level in the pool)
PEHD obloga ali premaz (20 cm nad max. koto vode)	PEHD liner or coating (20 cm above the maximum water level)

In the south-eastern corner a shaft is envisaged with a valve for connection to the sewer system inserted into the wall of the pool. The internal floor plan dimensions of the sump are 1.2 x 1.2 m, and the bottom of the sump is set at a depth of 2 m below the elevation of the plateau. Concrete will be poured on the bottom of the pool at a 1.5% to 2% grade towards the sump at the south-east corner of the pool.

In order to ensure water tightness and protection of concrete surfaces from the corrosion effects of the collected water, the inside of the pool will be coated in a sealing liner resistant to chemical effects and temperatures (possible fire water) up to 50 ºC.
The walls of the control pool will be supported by a 50 cm thick reinforced concrete bottom slab, at a depth of ca 5 m below the plateau elevation (at an elevation of 150.10 m above sea level) or on land with vegetation cover.
Access to the control pool and to the valves in the ventilation shaft will be possible via access ports that will be equipped with covers, and one of the openings to the pool will also be equipped with a safety ladder (rungs). A column aerator will be installed in the ventilation port.

Functionally, the control pool is a part of the System for collection of wastewater in the area of the disposal silo, which is treated as an independent set of SSC (structures, systems and components). Water from overflows of the System for collection of wastewater in the controlled area of the TF is also fed into the control pool.

The operation of the control pool does not depend on the phase of the construction of the TF; it operates identically in both construction phases. In the event of the expansion of disposal capacity the role and operation of the control pool will remain identical. The connecting lines from the first silo and the hall, which are removed from the first silo after the filling and before the closure of the first silo, are to be replaced by connecting lines from the second silo.

The lower part of the construction of the pool is below the upper elevation of groundwater, which at the pool location is at a depth of 151.25 m above sea level. With regard to the level of the water table, Figure 23 from the document Nadgradnja hidravličnega modela_2015, Rev1-HGEM-KONČNA OBLIKA_dec2015 (Upgrade of the hydraulic model) is used, from which it follows that the level of the water table at the site of the leach field is 150.50 m above sea level, and at the site of the silo 151.25 m above sea level.

The safety functions of the control pool are shown in the table below.

Safety function	Degree and method of achieving safety function
H – management of groundwater flow[42]	The facility allows the containment of all seep water and other wastewater in the lower part of the silo before release into the sewage system or dispatching for treatment.
P – physical containment (prevention of the migration of radionuclides by means of physical barriers)	Sufficient capacities are provided for collection and containment of wastewater. The facility is impermeable and sealed.
Su – support function (not a true safety function, but provides for the implementation of the safety functions of other SSC)	The facility provides conditions for undisturbed disposal of waste. The facility provides an infrastructure for monitoring the physical and chemical properties of wastewater and for implementing the clearance procedure. The facility provides for the safe management of wastewater in the event of a fire and subsequent extinguishing using water.

The design and planned operation of the facility are in accordance with the regulations and requirements of the administrative authorities.
The control pool allows the collection of water for sampling before release into the sewage system in accordance with the requirements set out in Article 16 of JV7.

Article 10 of the Decree on the DPN (technical design of drainage of industrial wastewater) regulates the handling of industrial wastewater for the repository. The design solutions are compliant with the requirements in the Decree.

The control pool will be included in the procedures of technical observation of the repository facilities. The observation will also include monitoring of ageing processes. Monitoring of the

42 H (hydrological): natural and man-made barriers that reduce the flow of groundwater through the repository;

ageing processes will be carried out in accordance with the reference document Monitoring of Ageing Processes, NRVB---5X/29, NSRAO2-POR-026 02-08-011-003.

The requirements regarding seismic loads are set out in point 11.3 of the Design Bases. With regard to earthquake loads, the control pool is designed in accordance with the US ASCE 43-05 standard[43] assuming a lifetime of 50 years or assuming a design earthquake with a return period of 2500 years. The structure is in general planned in accordance with the Rules on the mechanical resistance and stability of buildings (Official Gazette of the RS, No. 101/05) and the national Eurocode standards.

2.2.1.3 CONSTRUCTION OF INFRASTRUCTURE CONNECTIONS

Construction of infrastructure connections will comprise the following works:

Transport infrastructure:

- reconstruction of section of local road with path for pedestrians and cyclists (Vrbina road),
- arrangement of access road from the LILW repository to the connection with the public road and parking area for the needs of the LILW repository (including load-bearing embankment);

Infrastructure lines:

- connection to water supply network;
- connection of new pumping station for the municipal sewers to the power supply network from the Kostak landfill substation;
- connection of new substation at the LILW repository (20 kV transmission line) running from the Kostak landfill substation;
- drainage system for precipitation water run-off with infiltration field,
- drainage system for wastewater with new pumping station and flow to the Libna pumping station,
- connection to the telecommunication network.

The most extensive works will involve the reconstruction of Vrbina road, as part of which it will be necessary to remove around 10,000 m^3 of material. The removed material will partly be used for creating the non-load-bearing part of the LILW repository plateau, and partly for laying humus and grass for green surfaces and for landscaping (planting) by the road and LILW facilities. The surplus fertile topsoil will be spread around the LILW facilities on the investor's land and will not be taken away.

The construction of the embankment for the road and the road itself will require the infilling of around 16,000 m^3 of material from outside sources, probably from the nearest quarry.

[43] ASCE/SEI Standard 43-05, Seismic Design Criteria for Structures, Systems and Components in Nuclear Facilities, American Society of Civil Engineers ASCE, 2005

EXTERIOR ARRANGEMENT OF REPOSITORY WITHIN THE PROTECTED AREA

The exterior arrangements involve the road connections for the repository and infrastructure lines.

Road connections

The facilities are to be connected to each other via roads.

The main transport route in the area of the repository, which we call road 1, runs along the southern section, from the entrance to the repository, i.e. the connection to the access road, to the western edge by the hall above the silo. Road 1 ends in a circular loop around the hall above the silo, thereby enabling simple movement (turning) of vehicles with heavy loads.

At the administration and service building (entrance to the repository) it is composed of a strip around the building 3.5 m wide and a strip for goods vehicle access 6.5 m wide. The total width of road 1 in this part is therefore 11 m. In this width road 1 continues to the entrance to the controlled area. There, given the turning radius of goods vehicles, it is widened slightly (13.5 m) and continues as a transport operational area around the entire structure of the hall above the silo.

In Phase 2 of construction of the Technological Facility an additional section is to be built, a spur off road 1 to the entrance to the hall for reserve storage capacity, in a width of 13 metres.

Between the administration and service building and TF is road 2, which creates a circular route between the structures. It is intended for light goods vehicles and cars, and enables adequate access to the structures for refuse and firefighting vehicles. Between the administration and service building and TF road 2 is 6 m wide.

In addition to the roads, by the structures we also envisage asphalt operational areas, surfaces for firefighting vehicles and linking and access ways.

In accordance with Article 3 of the FV1 Rules on physical protection of nuclear materials, nuclear facilities and radiation facilities, the LILW repository is a category III nuclear facility as regards physical security. The repository will be secured right from the start of construction.

All facilities at the repository, apart from the driveway and parking area, will be surrounded by a security fence. Within the fenced area there will be an additional fenced controlled area. Control of access, monitoring the situation at the repository via videocameras and other functions of physical security will be provided locally at the repository, while alarms will be connected to the remote security and surveillance centre.

On the external and internal sides of the outer security fence we envisage a perimeter gravel road. The road will be 4.00 m wide with +2 x 0.50 berms. The outer road will almost entirely be at an elevation of +153.60, except on the eastern side where it drops to the existing terrain level of +152.20. The roads have a transverse drop of 4%. Along the inner road, which runs from an elevation of +153.60 to the plateau elevation of +155.20 kerbs will be set in the grass. Water running in from the grassy incline will gradually infiltrate.

Planted areas

Areas outside the compacted surfaces will be grassed over and arranged in accordance with the requirements of the plan for the landscape architecture of the repository.

The western and northern margins of the repository will be given a forest vegetation belt stretching from the perimeter road towards the outer edge of the area. Along the southern margin the forest belt tapers into a linear strip of trees. Along the eastern margin the forest vegetation thins out into groups of trees or individual trees in the meadow. The area surrounded by the perimeter road will be grassed. Grass will also be laid on the band stretching from the outer edge of the forest surface to the northern and western edges of the area (or it will remain in use as cultivated fields). All green areas within the fence will be grassed. Trees will be planted only north and south of the administration and service building.

Figure 22: Landscape arrangements

meja območja DPN	boundary of the DPN area
meja parcele namenjene za gradnjo NSRAO	boundary of the lot intended for construction of the

	LILW repository
gradbena meja	construction boundary
LEGENDA	KEY
ASFALT	ASPHALT
MAKADAMSKE POVRŠINE	TARMACKED (UNPAVED) AREAS
TRAVA	GRASS
DREVESA	TREES
ZUNANJA OGRAJA	OUTER PERIMETER FENCE
NOTRANJA OGRAJA	INNER PERIMETER FENCE
MEJA OBDELAVE NAČRTA	BOUNDARY OF THE PLAN UNDER CONSIDERATION
LEGENDA OBJEKTOV:	KEY FOR THE FACILITIES:
HALA – HALA NAD SILOSOM	HALA - HALL ABOVE THE SILO
TO – TEHNOLOŠKI OBJEKT	TO - TECHNOLOGICAL FACILITY
USO – UPRAVNO-SERVISNI OBJEKT	USO - ADMINISTRATION AND SERVICE BUILDING
TP – TRAFO POSTAJA (obseg načrta – Infrastrukturni objekt)	TP - TRANSFORMER STATION (plan coverage - Infrastructure facilities)
K.B. – KONTROLNI BAZEN	K.B. - CONTROL POOL

INFRASTRUCTURE LINES AT THE REPOSITORY

In the area of the repository the following types of wastewater will be generated:[44]

- industrial wastewater;
- urban wastewater;
- precipitation wastewater;
- precipitation clean water.

a) Drainage of industrial wastewater

Industrial wastewater will be generated as part of radiologically controlled work in the technological facility, in the hall above the disposal silo and as runoff water in the disposal silo. Management of industrial wastewater is dealt with and described separately in the chapter on the impacts and measures regarding groundwater. This was done since the majority of industrial wastewater will be generated as runoff water that will seep through the wall of the silo and before further handling will first collect in the collection tank under the silo.

The drainage for industrial wastewater will be composed of three-layer SN12 pipe of PP and standard PE drains. The drains on the asphalt plateau will be covered with manhole covers of 40 MPa bearing capacity, in the grassy areas 15 MPa, or classes D400 and D150 in accordance with the requirements of standard EN124.

b) Drainage of urban wastewater

The outflows from toilets and washrooms in the technological facility cloakrooms and the toilets, cloakrooms, kitchenettes and so forth in the administration and service building will be connected to the urban wastewater sewers.

[44] The generation and management of wastewater are addressed with particular attention in the chapter on the impacts on groundwater.

The collection channel for this sewerage, around 170 m long, runs in asphalt road 1, from the hall above the disposal silo to the ditch before the entrance to the fenced part of the core repository area. After the connection shaft the route of this sewer line turns 90^0 and in the gravel road along the eastern fence of the repository it is channelled towards the route along Vrbina road.

The drainage for urban wastewater will be composed of PEHD pipes and standard PE drains. The drains on the asphalt road will be covered with manhole covers of 40 MPa bearing capacity, in the grassy areas 15 MPa, or classes D400 and D150 in accordance with the requirements of standard EN124.

An area is planned within the control point in the technological facility for carrying out decontamination of staff, equipped with sinks and a shower. Since there is therefore a risk of contamination (emergency in an accident), the urban wastewater from this area is not planned to be discharged directly into the public sewage system, but will be collected in a sanitary tank. The sanitary tank has a capacity of 12 m^3 and is to be located by the technological facility. The sanitary tank will be equipped with a level meter for displaying the water level in the tank. With the level meter, monitoring of the water level in the tank will be possible in the control room.

Another sanitary tank is planned for the controlled collection of used fire water for the part of the controlled radiation area of the technological facility that will be built during TF Phase 1. To this end, all areas in the controlled radiation area of the technological facility that will be built during TF Phase 1 are equipped with floor drains with siphons, and the sanitary tank will have an overflow pipe to the control pool installed.

Radiological and chemical monitoring of the collected wastewater will be carried out before the sanitary tank is emptied. If the collected wastewater does not exceed the clearance criteria and if it meets the criteria for municipal wastewater, it will be pumped into the sewer shaft using a portable submersible pump, and from there into the public sewage system or to the Vipap water treatment plant.

It will be possible to empty the tank with a vehicle (as in the collection sump). If the collected wastewater exceeds the clearance criteria, it will be treated as secondary radioactive waste. The collected contaminated wastewater will be primarily treated at the repository site (suitable treatment capacities will need to be installed at the repository) or sent to Krško NPP.

c) Drainage of precipitation wastewater

Precipitation wastewater from the asphalt surfaces will be drained through lateral and longitudinal inclines of the roadways and operational areas to the road drains and sewers for precipitation wastewater. Before connection to the main collection channel, the precipitation water is treated in two coalescing separators for mineral oils with a bypass of a capacity of 150 l/s (15l/s/ha per oil trap) and 80 l/s (15l/s/ha per oil trap).

The main collection channel for precipitation water runs parallel to the aforementioned channel for urban wastewater in asphalt road 1 from the western corner of the hall above the silo to the entrance to the repository area. This channel is 220 m long. Clean precipitation water from the roofs of structures is run directly into it via sand traps.

Precipitation water is run along the main collection channel to the connection of the drain at the entrance to the repository area (the connecting drain for the municipal sewer is also located close by).

The collection channel then continues past the outer parking area and leads to the common infiltration field covering 130 m^2, which is planned in the southeast part of the area of the repository in its entrance section.

The system for draining precipitation wastewater is envisaged with PEHD pipes.
The inflow and inspection shafts are of PE pipes with dimensions DN500 mm, DN800 mm, DN1000 mm and DN1200 mm. They will be covered with manhole covers of 40 MPa bearing capacity, or class D400 in accordance with the requirements of standard EN124.

The drains must be made in compliance with the requirements of the SIST EN 13598-2:2009 standard. A test of water tightness must be performed according to standard SIST EN 1610, which can only be carried out by an authorized organisation prior to being covered up. The requirements regarding drains and testing water tightness also apply to other types of drainage within the plan.

EXTERIOR ARRANGEMENT OF REPOSITORY OUTSIDE THE PROTECTED AREA

Vrbina road and access road with external parking area

Vrbina road is to be reconstructed from the repository access road to the planned Spodnji Stari Grad roundabout (length of 460 m). The route of the road is designed with elements of a regional road. On the affected section, along the road a two-way bicycle path will be arranged, separated from the roadway by a green belt. Reconstruction of Vrbina road will be carried out at an elevation of 152.20 m above sea level, which ensures safety from flood waters. The entrance to the Spodnji Stari Grad Collection Centre will also be aligned with the elevation level of the reconstructed Vrbina road.

The principles for the final elevation of the road are set out in the study Elevations of the repository and access road, produced by IBE in August 2015. The study states that on the basis of the calculations of the relevant catchment waters, it has been established that the elevation of the access road (152.2 m above sea level) is adequate on condition that the piping of the planned culvert between the Kostak dump (Spodnji Stari Grad) and the LILW repository, which is to be constructed as part of the Brežice hydroelectric plant project, is at least Ø 1,000 mm, instead of the currently planned Ø 800. The change to the pipe diameter in the Brežice hydroelectric project will be ensured by the investor of the repository, ARAO Ljubljana, or indeed this has already been done (as part of constructing the Brežice plant), where the piping has been provided with a diameter of Ø 1,200 mm, which is more favourable from the point of view of the drainage of hinterland floodwater!

Access to the repository will be arranged via the new intersection (access road), which will be able to take goods vehicles with trailers. An access road is planned from the reconstructed local road to the perimeter fence of the LILW repository. External parking areas are also planned for the road.

The entrance section of the repository will be arranged as a public area in accordance with modern principles of landscape design. As part of this a turning and parking area for private cars will be provided. A total of 32 parking spaces for cars are envisaged, with two spaces for disabled persons.
Shading will be provided for the parking area through the planting of native tree species. Green areas and other open spaces will be arranged as park areas. The ends/embankments will be designed so as to observe the principles of landscape design.

The reconstruction of Vrbina road will involve the incorporation of around 1,750 tons of bituminous mixture (asphalt), around 100 tons of asphalt will be used for constructing the two-way cycle path and around 710 tons of asphalt will be used for the access road to the repository and the parking area.

Water drainage from the Vrbina road carriageway will diffuse via banked verges on lower lying terrain. With regard to the provisions of the Decree on emission of substances in runoff from public roads and the nature protection conditions issued by the Ministry, for the section of the state road in question that is being reconstructed, there is no need to provide retention of precipitation water from the roadway (fewer than 12,000 cars per day). Drainage of the access road and pedestrian walkway will be provided through transverse drain channels and infiltration of water into the surrounding land.

Drainage for the car park is arranged so that water flows along the kerbs to the road drains and then through an oil separator to the infiltration field.

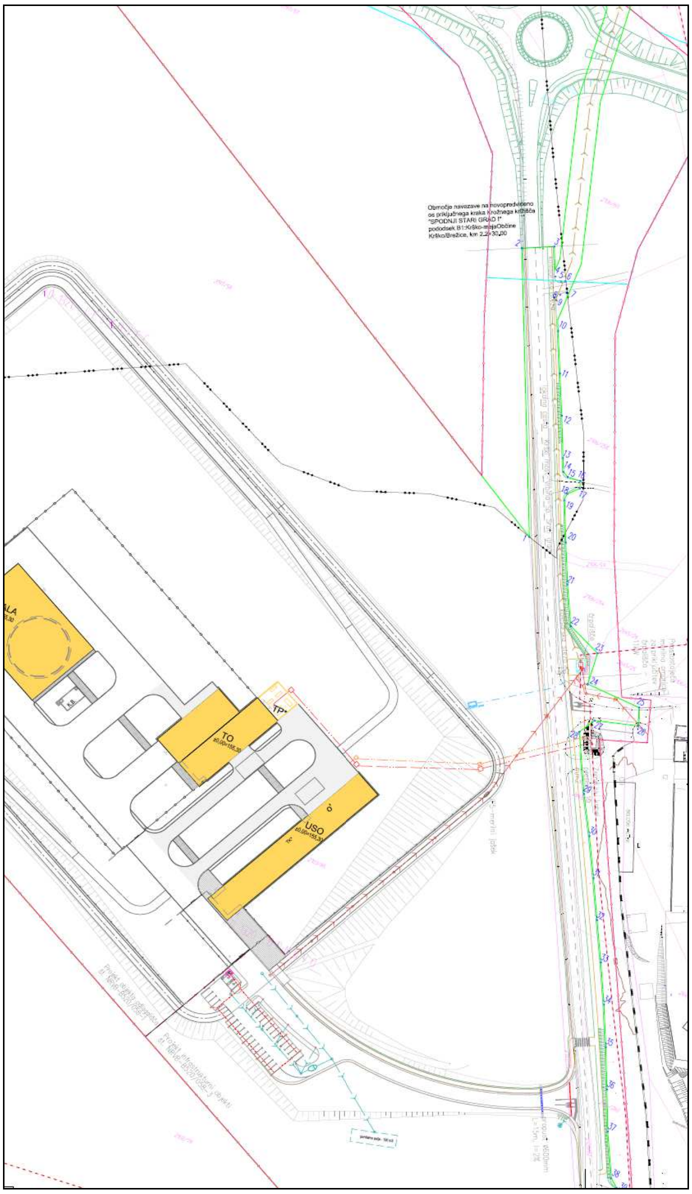

Figure 23: Vrbina road and connection of the access road to the repository entrance

An access road is planned from the reconstructed Vrbina road to the perimeter fence of the LILW repository, see illustration above. External parking areas are also planned for the road. The access road is planned to have a total width of 10.25 m with two carriageways (2 x 3.00 m) and a walkway for pedestrians and cycle path (cyclists + pedestrians) in a width of 2.00 m. In the area of the car park the road widens to 13.00 m with carriageways of 2 x 6.50 m, and continues as such to the fence gate of the repository. A total of 32 parking spaces for cars are envisaged, with two spaces for disabled persons. The parking spaces have dimensions of 2.50 m x 5.00 m, and those for the disabled are 3.5 m x 5.00 m.

Drainage of the access road and pedestrian walkway will be provided through transverse drain channels and infiltration of water into the surrounding land. Drainage for the car park is arranged so that water flows along the kerbs to the road drains.

Connection to sewerage network

The project will involve the drainage of urban water from the collection drain at the LILW repository fence to the connection to the existing public sewerage network in the Libna pumping station.

The sewer system for urban water at the LILW repository is designed to drain sanitary water from facilities and industrial water that collects in the collection tank (management of industrial wastewater is dealt with and described separately in the chapter on the impacts and measures regarding groundwater). Controls will be carried out on the industrial water collected in the tank. If it meets the conditions prescribed for release, it can be released into the public sewerage system, otherwise it will be sent to the control pool.

Because of the configuration of the terrain and the obstacles along the route, the public sewerage system is divided into:

- a free-fall section: from the LILW repository perimeter to the pump at the entrance to the Kostak municipal waste collection centre;
- a pressure section: from the pump to the connection to the existing Libna pumping station.

In order to overcome gravitational obstacles we envisage a standard pump for moving the sewage. The pumping station is envisaged in the area of the greenery and cycle path. Wastewater from the entire part of the contributing surface runs into the pumping station. The wastewater is then pumped through a pressure line to the higher lying gravitational drainage channel. Two submersible pumps are to be placed in the pump shaft and will individually meet the pumping parameters. The pumps function alternately through automatic or manual switching. One of the pumps is thus constantly in readiness in case of repairs or faults (the faulty pump can be replaced without the need to empty the drain or stop pumping). Possible breakdowns or faults are sent via the GSM modem module for alerting faults to the operator or service department.

Connection to water supply network

The route of the water supply network begins on the existing infrastructure water main on-site, which is fed from the municipal water main (on Vrbina road) and runs to the water gauging shaft which is located within the area of the LILW repository.
Mains drinking water (hereinafter also sanitary water) will be used in:

The administration and service building:

- sanitary facilities, kitchenettes, washbasins, cloakrooms etc.;
- humidifier units for ventilation and air conditioning;
- filling the firefighting water tank via float valves (only first filling, topping up owing to evaporation and cleaning out the tank).

Technological facility:

- sanitary facilities, washbasins, cloakrooms, dressing rooms, decontamination;
- humidifier units for ventilation and air conditioning.

The water supply system is designed so as to prevent the danger of contaminating drinking water owing to standing water in the pipes, and with this in mind it is separated from the firefighting water via the tank. This design enables us to keep high-quality drinking water from being polluted owing to backflow.

The water main will be high-density polyethylene pipe buried in the ground. The pipe is to be laid on a bed of fine sand. Blue PVC tape bearing the words "pozor vodovod" (warning: water mains) will be placed along the basic embankment above the axis of the pipeline.

Consumption of water from the mains supply for the needs of facilities from the public network:

- up to 3 l/s = 10.8 m^3/h = peak consumption from the mains under normal use,
- for consumption in a fire, mains water will supplement the firefighting water at a maximum rate of 4 l/s = 14.4 m^3/h,

the connection dimensions of the pipeline for facilities of the designation of repository project are envisaged as being Ø 63x5.8 (PE100 materials for the water supply system), existing dimensions of the water supply mains for connection on-site at CRO Ø110 (PE100 materials), we suggest connection to this dimension.

Connection to electricity supply network

The electric power transmission system includes network electrical installations for lighting (interior, exterior, security), lightning conductors and grounding, fire alarm system, information system (PA), management and supervision (of processes, access, radiation, safety monitoring), and a reserve power supply.

In the event of a power outage, important electrical equipment will be supplied power from a UPS with 15 minutes of autonomy. During that time a diesel generator will be started which will take over the task of supplying power to that equipment, and the remaining loads required for the normal operation of the repository.

For security purposes, the entire repository will be lit along the outer perimeter fence with lights mounted in fixtures at a height of ca 7-9 m. This part of the repository lighting will be covered in a separate plan under physical security at the repository. The interior roads inside the fences will be lit with lights mounted in fixtures approximately 6-9 m high at the edges of the roads.

Management and monitoring of all technological processes will be carried out from the control room in the technological facility. The processes will be monitored visually using cameras. All work areas and stations will be equipped with audio connections. Next to the control room there will be a server area for equipment for management and monitoring of processes, and an area for power supply equipment.

The project design addresses two electrical power connections. The first connects the repository to the power system, while the second connects the pump for sewage wastewater.

The LILW repository's electricity connections must ensure energy supply to all structures, systems and components required for operation of the repository as an independent nuclear facility. The following facilities, within which are planned individual sets of spaces, are planned:

- technological facility;

- administration and service building;
- disposal facility and
- plateau.

The electricity connections as a whole comply with the applicable technical standards and guidelines and with the requirements of Elektro Celje, which operates the electricity lines and supplies electricity to this area, as follows:
- connection to the existing transformer station;
- installation of a transformer (400 kVA) on the repository plateau;
- installation of new MV and LV cabinets;
- electricity transmission along MV lines.

Data for consent giver:

- Connection power:	1x400 kVA
- Main fuses:	1x3x600 A
- Method of offtake:	other
- Connection voltage:	20 kV

Supply of electrical power is envisaged from the existing transformer station of 20/0.4 kV of the Kostak (T927) waste landfill site, operated by Elektro Celje. A MV cell (C03) is already envisaged at the transformer station with equipment which through a 20 kV cable will supply the new transformer station at the repository. The emplacement of a standard free-standing concrete transformer station of 400 kVA power is envisaged. The location of the free-standing transformer station has been selected so as to suffice for the connection of loads in the construction phase and as a final location for the needs of repository operation.

Execution

The 20 kV supply cable from the 20/0,4 kV transformer station at the Kostak landfill will be laid in the cable ducts. We envisage 4-pipe (Φ 110 mm) cable ducts. Along the route there will also be cable shafts for the needs of laying the supply cable.

In laying MV cables in the ground or cable ducts, account will be taken of the valid SIST, IEC and VDE standards and the EMC recommendations as follows:

	local lines:	main lines:
a) minimal gaps in bundling		
- supply of extra low voltage, TC cables	0.5 m	1.0 m
- supply cables up to 1 kV	0.5 m	
- water supply, sewerage	0.5 m	1.0 m
- gas pipes	1.0 m	3.0 m
b) minimal gaps in crossing		
- supply of extra low voltage, TC cables	0.3 m	0.5 m
- supply cables up to 1 kV	0.3 m	
- water supply, sewerage	0.3 m	0.5 m
- gas pipes	0.3 m	0.5 m

Route of cables

The 20 kV supply cable from the 20/0,4 kV transformer station at the Kostak landfill for the requirements of the repository will be laid along the following route:

- from the transformer station the cable will run at a depth of around 1.2 m in the ground via the road to the cable shaft that will be located inside the repository fence. In the section where the cable will run under the road, it will be placed in a protective pipe (Φ 160 mm);
- within the repository the cable will be laid in cable ducts and cable shafts.

Equipment

The new transformer station will be located close to the new technological facility, at an elevation of +0.00, for the needs of supplying electrical power to the entire repository. The new transformer station will be composed of the transformer space with power transformer of 20/0.4 kV, 400 kVA, MV space and LV space, in which will be situated the main 0.4 kV switchboard with reactive energy compensation and 0.4 kV distributors for other users. The one-line diagram of the transformer station is shown in the drawing NRVB---5E4003. The transformer will be set on a reinforced concrete slab on tracks above a ventilation opening for the supply of fresh air, while in the section of the transformer space and in the LV space a double prefabricated floor will be laid for the cables to be run. These spaces will be fenced off with reinforced concrete walls with properly sized entrance doors and adequate openings with intake vents to capture fresh air and output vents for proper ventilation of the transformer box.

The connection between the MV side of the new power transformer and the pertaining MV transformer field will be made with a cable with polyethylene mesh insulation or insulated busbars.
The connections between the LV side of the transformer and the main LV switchboard will be made with cables in the double prefabricated floor in the LV space.

Power connection of pumping station to sewer lines

With the construction of the new repository, the entire sewerage system from all facilities will be connected to the central sewerage system (towards Spodnji Stari Grad). Owing to the differences in elevation between the new and existing sewerage systems, an underground re-pumping installation is planned on the right-hand side at the entrance to the Kostak dump. Two pumps of 5.5 kW capacity are envisaged at the pumping station.

Connection is envisaged at the Kostak landfill transformer station on the LV side. At the pumping station a free-standing metering cabinet will be set up with equipment (meter, surge protector, terminals, device for remote data transfer, etc.) for measuring consumed energy.

Connection to the telecommunication network

The LILW repository will be connected to the existing telecommunications network via a new optical cable. The new optical cable will run between the ditch at the entrance to the Kostak Krško landfill and the repository's administrative and service building. Cable ducts will be constructed along the route in the form of a PE-HD pipe (the optical cable will be laid inside the pipes).

In the area in question an existing optical cable is already installed. In the existing ditch at the entrance to the Kostak landfill there is a cable coupler from which a line runs off for the needs of the Kostak site; the existing main optical cable route continues to Raceland. A pipe of Φ50 has already been laid in the ground running along the entire route.

Execution

To install the optical network for the needs of the repository it will be necessary to run the new optical cable within the cable ducts between the ditch at the entrance to the Kostak landfill and the administration and service building. We envisage cable type and capacity TO SM 03 1x6xIIx0,4x3,5xCMAN. The cable will run all the way to the server room, where a free-standing server cupboard will be installed.

The total length of the projected optical cable is around 190 m and it comprises six fibres.

2.2.2 *BEST AVAILABLE TECHNIQUES*

A similar concept of LILW disposal in disposal silos has to date been used in several countries, e.g. in Korea, Sweden, Finland and Japan, where special attention was paid to technological solutions for optimum utilisation and distribution of underground spaces. In terms of their form, these repositories are not entirely comparable with the Slovenian repository project under discussion here. The repositories in the countries referred to above are deep geological repositories in which a substantial portion of the insulating properties are assumed by a stable geological formation. On the other hand the Vrbina Krško LILW repository is a near-surface repository in which a significant insulating role is played by the adequate conditioning of waste, the waste disposal packages and the engineered repository barriers. In 2009 a Preliminary Design was compiled for the disposal concept proposed; this was followed by a series of optimisation studies. On the basis of expert background documents, security analyses were carried out.

The solutions of the disposal technology for the LILW repository at the Vrbina, Krško site are based on established solutions around the world, on previous domestic solutions and experiences and on solutions that have been defined in the process of spatial placement of the repository in accordance with the *Programme for the drawing up of a detailed pln of national importance for the LILW repository,* and are elaborated in detail in the design output. In the elaboration of optimized solutions, the findings of the review procedures and the recommendations from domestic and foreign experts were also taken into account.

Before finalisation (Conceptual Design, January 2016), the project for the repository was subject to assessment by the IAEA expert mission,[45] and relevant opinions on the method of LILW disposal were obtained from the IAEA in the process of preparing the review of the plan for the decommissioning of the Krško NPP,[46].[47] Moreover in 2010, ARAO carried out an external

45 WATRP Review of ARAO's Documentation and Technical Programme for the Development of the Slovenian National Repository for Low- an Intermediate-Level Radioactive Waste, IAEA, 21-25 January, 2008;

46 IAEA Report on LILW Repository Mission 1&2; IAEA-TCR-04900; Developing a new iteration of decommissioning, SF and LILW Management Programmes for Krško NPP; 2009

review of the project[48,49]. One of the important common points of all reviewers was the finding that the conditioning and actual disposal of radioactive waste is complex and that technological procedures for disposal need to be optimised in the further stages of the project.

With the aim of verifying the possibilities for optimising the operation of the repository the project team for formulating the decommissioning programme for Krško NPP (Programme of NPP Krško Decommissioning and SF & LILW Disposal, revision 2, ARAO/APO) launched an initiative at the end of 2009[50] to verify the costs of operating the repository in the event of termination and idling of the repository. The issue was addressed in the study Termination of operation of the LILW repository and impacts on the cost estimate, IBE, Proj. No. NRVB-052/068, Ljubljana, 2010. At the same time, the start of the procedure for extending the operating life of Krško NPP in 2009 signalled some new circumstances that redefined the marginal conditions for implementing technological procedures and at the same time the demands to optimise these procedures. The optimisation was supposedly aimed principally at reducing the costs of construction and operation of the repository and, at the same time, increasing the technical feasibility. The optimisation was addressed in the study Technology Development for Disposal Plans, Rev. A, IBE, Project Number NRVB-B052/069-1, Ljubljana, 2010 **The study made a significant optimisation step whereby the conditioning of LILW for disposal would not be performed at the repository, but at Krško NPP and only disposal would take place at the repository.** At the same time it was determined that such significant optimisation would enable the transition to using smaller disposal containers. Regarding the quantities of decommissioning LILW that would need to be disposed of, account was taken of the data of the revised decommissioning study Preliminary Decommissioning.

The management board of Krško NPP notified ARAO of preliminary formal agreement regarding implementation of the conditioning for disposal at Krško NPP.[51] As part of the procedure of preparing for implementation of the project under discussion, in 2011 Krško NPP produced and in September 2012 supplemented a preliminary design for performing conditioning for disposal at Krško NPP (CDP).[52] The project was also listed in the Krško NPP Business Plan for 2012, and in 2014 Krško NPP obtained a construction permit for the facility in which conditioning of waste for disposal would be performed. Continuation of the procedure for investment towards the optimised variant was also approved by the Management Board of ARAO (9th regular meeting, 16 September and 6 October 2011, decision 48).

At the same time it was determined that such significant optimisation would be enabled by the transition to using smaller disposal containers. Regarding the quantities of decommissioning LILW that would need to be disposed of, account was taken of the data of the revised decommissioning study Preliminary Decommissioning Plan for Krško NPP, Rev.. 5; Siempelkamp NIS Ingenieurgesellschaft mbH, Doc.-No.: 8215/CA/F 008375 9/05, 2010.

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47 Expert Mission for Optimization of Integrated Scenarios in NEK Program - March 8-10, 2010, Čatež, Slovenia; Final Report IAEA TC SLO 3005, 24 March 2010

48 Peer Review of LILW Repository Preliminary Design, Vrbina, Krško; TECHNUM - TRACTEBEL ENGINEERING; Technical note N° P.001189.050-001.A; June 2010

49 Review of the Preliminary Design of the Vrbina Low- and Intermediate-Level Waste Repository, URS, May 2010

50 Minutes of the 8th meeting of the project team, point 3, indent 5; ARAO, 5 November 2009

51 Letter from NEK ING.DOV-219.11/7085, of 18 August 2011 (signed by the CEO of Krško NPP);

52 CDP for modification 714-AB-L: Canopy for handling equipment and consignments of radioactive freight; Krško NPP 12 September 2012. In the summer of 2013 the facility was renamed Space for handling equipment and consignments of radioactive freight (WMB).

At the same time, with further optimisation of technological procedures for conditioning for disposal,[53] optimisation of the plans for disposal silos was carried out in 2011,[54] taking into account the recommendations of the IAEA experts.[55] These were mainly aimed at providing robust and conservatively safe construction solutions and at effective groundwater management during construction. In 2014, the optimisation of the non-disposal part of the repository was carried out.[56]

Taking into account the reduced scope of investment owing to the conditioning for disposal being performed at Krško NPP, a feasibility study[57] was produced at the end of 2013, and was confirmed by the ministry competent for infrastructure on 8 July 2014.[58] The confirmed feasibility study envisaged construction of the repository for half the LILW that would be generated at Krško NPP up until the end of the extended operating period in 2043, and in decommissioning after the end of operation, and also for the disposal of all Slovenian institutional waste.

2.2.3 *TECHNOLOGICAL PROCEDURES OF DISPOSAL*

Prior to disposal, all waste will be inserted into standard disposal containers. In accordance with the acceptance criteria, controls and conditioning for disposal of stored waste packages and their insertion into disposal containers will be carried out at Krško NPP. ARAO analysed the entire inventory of Slovenia,[59] as one of the input parameters for conducting safety analyses, with the aim of confirming the operational as well as long-term safety of the LILW repository. The latest analysis of the possibility of disposing of all waste was made in 2016.[60] It was determined that the majority of waste could be safely disposed of in the envisaged repository in its existing form or with some additional processing.

LILW from Krško NPP (LILW from the operation and decommissioning of Krško NPP, along with other LILW, such as equipment that has been replaced or removed, etc.) is expected to be disposed of at the Vrbina repository. This will either constitute half of all the waste from Krško NPP or, if an agreement is reached with Croatia on the joint disposal of LILW from Krško NPP, all such waste, in accordance with the relevant international treaty. In addition to the aforementioned, other Slovenian institutional waste will be disposed of in the repository: LILW from the CSRAO in Brinje, LILW from decommissioning of the CSRAO and the TRIGA reactor, and LILW generated through the operation and closure of the repository. All the above types of waste will have to meet the acceptance criteria for disposal at the planned LILW repository in order to be disposed of at that facility.

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53 Revision and optimisation of design solutions – Disposal technology, Rev. 0, IBE, NRVB---3X/M16, Ljubljana, 2011

54 Revision and optimisation of design solutions – Disposal silos, Rev. A, IBE, NRVB---3X/M15A, Ljubljana, 2011

55 Expert Mission on Technical Solutions for The Low And Intermediate Level Radioactive Waste Repository, Vrbina, Krško, IAEA TC SLO 3005; J. Pacovsky, R. Chaplow; ARAO, Ljubljana 18 – 20 January 2011 (IAEA2011)

56 Optimisation of the non-disposal part of the repository, IBE, NRVB---3X/M18, Ljubljana, 2014

57 LILW Repository Vrbina, Krško; Feasibility Study, Rev. C, NRVB-4X/01C, IBE, Ljubljana, December 2013

58 Decision approving the Feasibility Study for the LILW repository at Vrbina, Municipality of Krško, No 360-54/2014/31, 8 July 2014, Ministry of Infrastructure and Spatial Planning, Energy Directorate.

59 “Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repository in Slovenia, EISFI Consortium, Inventory report. Report No. EISFI-TR-(11)-12 Vol.1 Rev.5, NSRAO2-WAC-002-01-eng,” EISFI Consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO), 2015.

60 Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repository in Slovenia, EISFI Consortium, Disposability Assessment Report No. EISFI-TR-(15)-06, Rev. 2. EISFI consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO), 2016.

Supervision of the process of filling disposal containers and checking the compliance of filled containers with acceptance criteria for disposal will be carried out by ARAO at Krško NPP in accordance with the written procedures. Compliance with the requirements for transportation will be checked by Krško NPP or the transporter of containers from Krško NPP to the repository. This checking will also be carried out at Krško NPP.

Set out below are all the procedures directly tied to the disposal of LILW; from transportation of LILW to the repository, recording and disposal to filling in empty spaces in the silo and in the area of the disposal units after termination of active long-term control and surveillance.

The main material flows related to the technological procedures for disposal of LILW are:

- the flow of LILW disposal containers; LILW is conditioned for disposal at Krško NPP; transportation of containers to the repository is provided by Krško NPP;
- the flow of packages with LILW; an important factor for the repository project is secondary LILW resulting from the operation and closure of the repository and generated on-site at the repository; this will be taken to Krško NPP where it will be conditioned for disposal; transportation provided by ARAO; and
- the flow of material for filling empty spaces in the disposal units.

The list above does not include smaller and less intensive flows of material that are not insignificant for the operation of the repository but are less extensive. These flows include mainly:

- samples of radioactive and other substances and materials for the operation of the measurement room;
- technological materials (drums for secondary waste, filters, etc.) and
- the supplying of the repository with materials for the operation of "non-nuclear" repository activities.
- supply and removal of materials via municipal service connections (water supply system, sewage system, etc.); and
- emissions into the air and water (into the municipal sewers or infiltration field).

The technological layout of the repository is shown in the illustration below (taken from the Conceptual Design). The layout covers all the main flows of materials, apart from the flow of construction materials needed for construction and closure of the disposal units and other repository facilities. The activities shown in the layout illustration are described below.

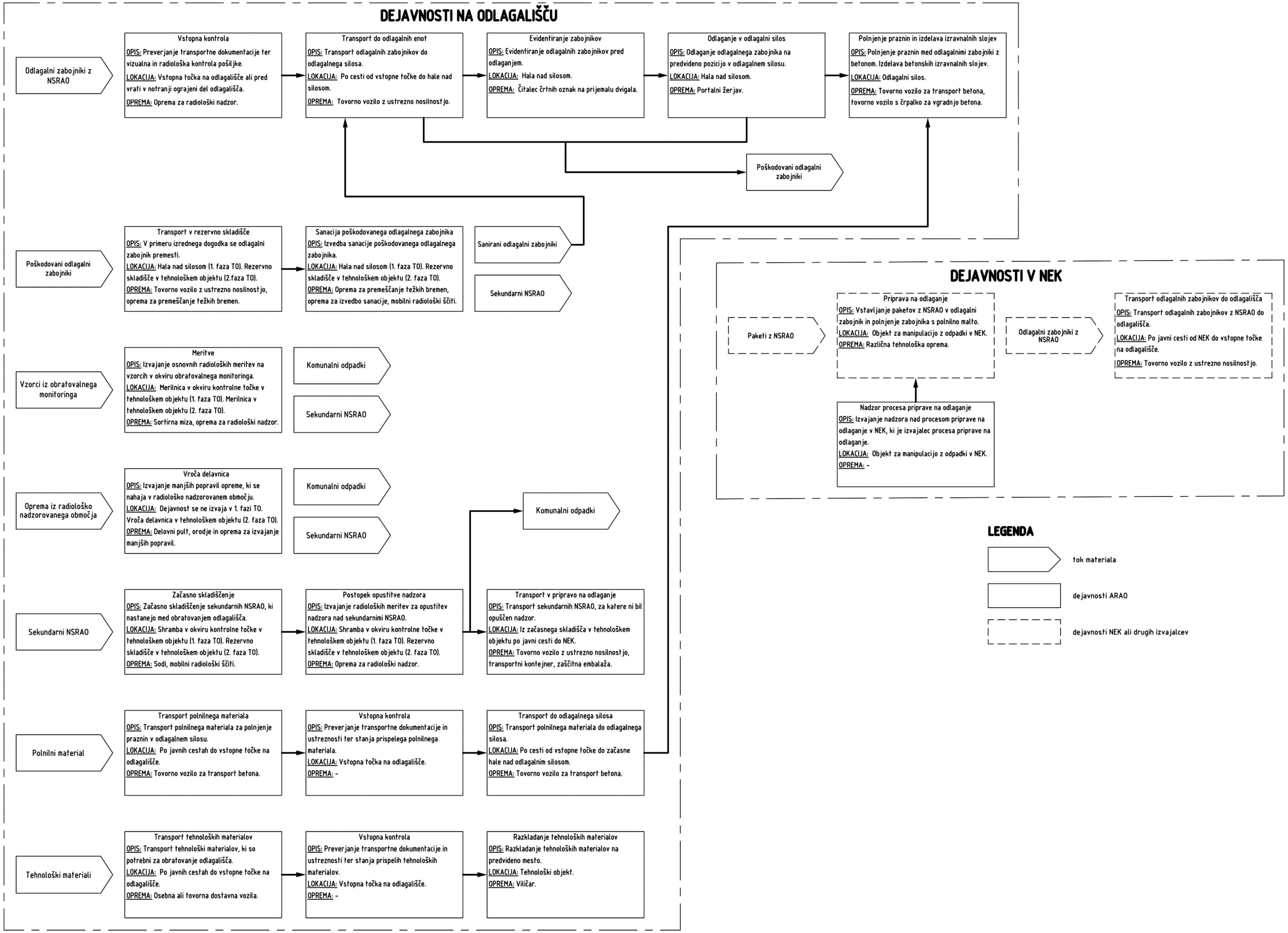


Figure 24: Technological layout of operation of the LILW repository

DEJAVNOSTI NA ODLAGALIŠČU	ACTIVITIES ON THE REPOSITORY SITE
Odlagalni zabojniki z NSRAO	Disposal containers filled with LILW
Vstopna kontrola	Entrance control
OPIS: Preverjanje transportne dokumentacije ter vizualna in radiološka kontrola pošiljke.	DESCRIPTION: Verification of transport documents, and visual and radiological control of the shipment.
LOKACIJA: Vstopna točka na odlagališče ali pred vrati v notranji ograjeni del odlagališča.	LOCATION/SITE: Entry point to the repository or in front of the doors to the internal fenced part of the repository
OPREMA: Oprema za radiološki nadzor.	EQUIPMENT: Equipment for radiological control (monitoring)
Transport do odlagalnih enot	Transportation to the disposal units
OPIS: Transport odlagalnih zabojnikov do odlagalnega silosa.	DESCRIPTION: Transportation of disposal containers to the disposal silo.
LOKACIJA: PO cesti od vstopne točke do hale nad silosom.	LOCATION/SITE: By road from the entry point to the hall above the silo
OPREMA: Tovorno vozilo z ustrezno nosilnostjo.	EQUIPMENT: Freight vehicle with the required load capacity
Evidentiranje zabojnikov	Keeping records of disposal containers
OPIS: Evidentiranje odlagalnih zabojnikov pred odlaganjem.	DESCRIPTION: Keeping records of disposal containers before disposal.
LOKACIJA: Hala nad silosom.	LOCATION/SITE: Hall above the silo
OPREMA: Čitalec črtnih oznak na prijemalu dvigala.	EQUIPMENT: Barcode reader on the lift gripper
Odlaganje v odlagalni silos	Disposal in the disposal silo
OPIS: Odlaganje odlagalnega zabojnika na predvideno pozicijo v odlagalnem silosu.	DESCRIPTION: Disposal of the disposal container to the envisaged position in the disposal silo.
LOKACIJA: Hala nad silosom.	LOCATION/SITE: Hall above the silo
OPREMA: Portalni žerjav.	EQUIPMENT: Portal crane
Polnjenje praznin in izdelava izravnalnih slojev	Filling the gaps between the containers and pouring the levelling layers
OPIS: Polnjenje praznin med odlagalnimi zabojniki z betonom. Izdelava betonskih izravnalnih slojev.	DESCRIPTION: Filling the gaps between the disposal containers with concrete. Making concrete levelling layers.
LOKACIJA: Odlagalni silos.	LOCATION/SITE: Disposal silo
OPREMA: Tovorno vozilo za transport betona, tovorno vozilo s črpalko za vgradnjo betona.	EQUIPMENT: Freight vehicle for the transportation of concrete, freight vehicle with a pump for the installation of concrete
Poškodovani odlagalni zabojniki	Damaged disposal containers
Transport v rezervno skladišče	Transportation to the reserve (backup) storage facility
OPIS: V primeru izrednega dogodka se odlagalni zabojnik premesti.	DESCRIPTION: In the event of extraordinary circumstances the disposal container is relocated.
LOKACIJA: Hala nad silosom (1. faza TO). Rezervno skladišče v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Hall above the silo (1st phase of the technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF)
OPREMA: Tovorno vozilo z ustrezno nosilnostjo, oprema za premeščanje težkih bremen.	EQUIPMENT: Freight vehicle with the required load capacity, equipment for the relocation of heavy loads
Sanacija poškodovanega zabojnika	Repair of the damaged container
OPIS: Izvedba sanacije poškodovanega odlagalnega zabojnika.	DESCRIPTION: Repair of the damaged disposal container.
LOKACIJA: Hala nad silosom (1. faza TO). Rezervno skladišče v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Hall above the silo (1st phase of the technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF)
OPREMA: Oprema za premeščanje težkih bremen, oprema za izvedbo sanacije, mobilni radiološki ščiti.	EQUIPMENT: Equipment for the relocation of heavy loads, repair equipment, mobile radiological shields
Sanirani odlagalni zabojniki	Repaired disposal containers
Sekundarni NSRAO	Secondary LILW
Vzorci iz obratovalnega monitoringa	Samples from operational monitoring
Meritve	Measurements
Opis: Izvajanje osnovnih radioloških meritev na vzorcih v okviru obratovalnega monitoringa.	Description: Performance of basic radiological measurements in samples within the scope of operational monitoring.
LOKACIJA: Merilnica v okviru kontrolne točke v tehnološkem objektu (1. faza TO). Merilnica v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Measurement room within the scope of the control point in the technological facility (1st phase of the technological facility - TF) Measurement room in the technological facility (2nd phase of the TF)
OPREMA: Sortirna miza, oprema za radiološki nadzor	EQUIPMENT: Sorting table, equipment for radiological control
Komunalni odpadki	Municipal waste
Oprema iz radiološko nadzorovanega območja	Equipment from the radiologically controlled area
Vroča delavnica	Hot workshop
OPIS: Izvajanje manjših popravil opreme, ki se nahaja v radiološko nadzorovanem območju	DESCRIPTION: Minor repairs to equipment located in the radiologically controlled area.
LOKACIJA: Dejavnost se ne izvaja v 1. fazi TO. Vroča delavnica v tehnološkem objektu (2. faza TO)	LOCATION/SITE: The activity/service is not carried out in the 1st phase of the TF. Hot workshop in the technological facility (2nd phase of the TF)
OPREMA: Delovni pult, orodje in oprema za izvajanje manjših popravil.	EQUIPMENT: Workbench, tools and equipment for performing minor repairs
Sekundarni NSRAO	Secondary LILW
Začasno skladiščenje	Temporary storage
OPIS: Začasno skladiščenje sekundarnih NSRAO, ki nastanejo med obratovanjem odlagališča.	DESCRIPTION: Temporary storage of secondary LILW which are generated during the operation of the repository.
LOKACIJA: Shramba v okviru kontrolne točke v tehnološkem objektu (1. faza TO). Rezervno skladišče v tehnološkem objektu (2. faza TO).	LOCATION/SITE: Storage within the scope of the control point in the technological facility (1st phase of the technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF).
OPREMA: Sodi, mobilni radiološki ščiti.	EQUIPMENT: Barrels, mobile radiological shields
Postopek opustitve nadzora	Control omission process
OPIS: Izvajanje radioloških meritev za opustitev nadzora nad sekundarnimi NSRAO.	DESCRIPTION: Radiological measurements for the omission of control of secondary LILW.
LOKACIJA: Shramba v okviru kontrolne točke v tehnološkem objektu (1. faza TO). Rezervno skladišče v	LOCATION/SITE: Storage within the scope of the control point in the technological facility (1st phase of the

tehnološkem objektu (2. faza TO).	technological facility - TF) Reserve storage facility in the technological facility (2nd phase of the TF).
OPREMA: Oprema za radiološki nadzor.	EQUIPMENT: Equipment for radiological control (monitoring)
Transport v pripravo na odlaganje	Transportation to preparation for disposal
OPIS: Transport sekundarnih NSRAO, za katere ni bil opuščen nadzor.	DESCRIPTION: Transportation of secondary LILW for which control was not omitted.
LOKACIJA: Iz začasnega skladišča v tehnološkem objektu po javni cesti do NEK.	LOCATION/SITE: From a temporary storage facility in the technological facility by public road to Krško NPP
OPREMA: Tovorno vozilo z ustrezno nosilnostjo, transportni kontejner, zaščitna embalaža.	EQUIPMENT: Freight vehicle with the required load capacity, transport container, protective packaging
Polnilni material	Backfill material
Transport polnilnega materiala	Transportation of backfill material
OPIS: Transport polnilnega materiala za polnjenje praznin v odlagalnem silosu.	DESCRIPTION: Transportation of backfill material for filling voids in the disposal silo.
LOKACIJA: Po javnih cestah do vstopne točke na odlagališče.	LOCATION/SITE: By public road to the entry point to the repository
OPREMA: Tovorno vozilo za transport betona.	EQUIPMENT: Freight vehicle for the transportation of concrete
Vstopna kontrola	Entrance control
OPIS: Preverjanje transportne dokumentacije in ustreznosti ter stanja prispelega materiala.	DESCRIPTION: Verification of transport documentation, fitness for continuation and state/condition of the arrived material.
LOKACIJA: Vstopna točka na odlagališče.	LOCATION/SITE: Access point to the repository
OPREMA: -	EQUIPMENT: -
Transport do odlagalnega silosa	Transportation to the disposal silo
OPIS: Transport polnilnega materiala do odlagalnega silosa.	DESCRIPTION: Transportation of the backfill material to the disposal silo.
LOKACIJA: Po cesti od vstopne točke do začasne hale nad odlagalnim silosom.	LOCATION/SITE: By road from the entry point to the temporary hall above the disposal silo.
OPREMA: Tovorno vozilo za transport betona.	EQUIPMENT: Freight vehicle for the transportation of concrete
Tehnološki materiali	Technological materials
Transport tehnoloških materialov	Transportation of technological materials
OPIS: Transport tehnoloških materialov, ki so potrebni za obratovanje odlagališča.	DESCRIPTION: Transportation of technological materials required for the operation of the repository.
LOKACIJA: Po javnih cestah do vstopne točke na odlagališče.	LOCATION/SITE: By public road to the entry point to the repository
OPREMA: Osebna ali tovorna dostavna vozila.	EQUIPMENT: Passenger (cars) or freight vehicles
Vstopna kontrola	Entrance control
OPIS: Preverjanje transportne dokumentacije in ustreznosti ter stanja prispelih tehnoloških materialov.	DESCRIPTION: Verification of transport documentation, fitness for continuation and state/condition of the arrived technological materials.
LOKACIJA: Vstopna točka na odlagališče.	LOCATION/SITE: Access point to the repository
OPREMA: -	EQUIPMENT: -
Razkladanje tehnoloških materialov	Unloading of technological materials
OPIS: Razkladanje tehnoloških materialov na predvideno mesto.	DESCRIPTION: Unloading of technological materials to the planned location.
LOKACIJA: Tehnološki objekt.	LOCATION/SITE: Technological facility
OPREMA: Viličar.	EQUIPMENT: Forklift
DEJAVNOSTI V NEK	ACTIVITIES AT Krško NPP
Paketi z NSRAO	LILW packages
Priprava na odlaganje	Preparation for disposal
OPIS: Vstavljanje paketov z NSRAO v odlagalni zabojnik in polnjenje zabojnika s polnilno malto.	DESCRIPTION: Insertion of LILW packages into the disposal container and the filling of the container with backfill mortar.
LOKACIJA: Objekt za manipulacijo z odpadki v NEK.	LOCATION/SITE: Facility for the handling of waste at Krško NPP
OPREMA: Različna tehnološka oprema.	EQUIPMENT: Various technological equipment.
Odlagalni zabojniki z NSRAO	Disposal containers filled with LILW
Transport odlagalnih zabojnikov do odlagališča	Transportation of disposal containers to the repository
OPIS: Transport odlagalnih zabojnikov z NSRAO do odlagališča.	DESCRIPTION: Transportation of the disposal containers filled with LILW to the repository.
LOKACIJA: Po javni cesti od NEK do vstopne točke na odlagališče.	LOCATION/SITE: By public road from Krško NPP to the entry point to the repository.
OPREMA: Tovorno vozilo z ustrezno nosilnostjo.	EQUIPMENT: Freight vehicle with the required load capacity
Nadzor procesa priprave na odlaganje	Control of the process of preparing for disposal
OPIS: Izvajanje nadzora nad procesom priprave na odlaganje v NEK, ki je izvajalec procesa priprave na odlaganje.	DESCRIPTION: Control of the process of preparing for disposal at NPP, which is the provider responsible for preparation for disposal.
LEGENDA	KEY
tok materiala	flow of material
dejavnosti ARAO	ARAO activities
dejavnosti NEK ali drugih izvajalcev	activities of Krško NPP or other providers

The location of the conditioning of all LILW for disposal and of dispatch (in disposal container) is Krško NPP.

Construction design of container for disposal in silo

In view of the fact that a container with reinforced-concrete walls, cover and bottom functions as a permanent radiological barrier, after the final disposal in the disposal silo, in addition to the ability to withstand and provide stability for all foreseeable loads in the phase of filling and transport before final disposal, it must also fulfil the condition of durability over its planned lifetime of 300 years as the most important and most specific requirement.

With regard to the now known conditions of the environment to which containers will be exposed after being placed in the silo, in the first phase they will be exposed to carbonatisation (in the period 2020-2061), then after filling and closing of the silo and termination of pumping water that might penetrate the silo, from 2062 on the silo and containers will gradually be saturated with groundwater.

For the majority of their lifetime, disposal containers will therefore be exposed to saturation, which must be taken into account in their design.

The Conceptual Design phase structural design document for the LILW disposal containers provides the container with functional and structural characteristics and requirements to be met by the container in all the phases of its use, from manufacture to disposal at the final repository.

The disposal containers or other packaging used for packaging LILW in the process of the processing and conditioning of LILW for disposal must be approved by the SNSA before being put into service. The SNSA is projected to approve the packaging within the context of the approval of the Safety Report.

Obtaining Slovenian technical approval

The certification of the containers will be carried out to the extent and in the manner applying to the procedure of attesting the conformity of construction products. A 1+ system will be used to assess and verify the constancy of performance of construction products pursuant to Annex V of Regulation 305/2011/EU (see Article 6(6) of the ZGPro-1). The certification of a disposal container shall be deemed to be complete when the SNSA approves the disposal container in the process of the approval of the Safety Report (Article 9(5) of the Rules on radioactive waste and spent fuel management, Official Gazette of the RS, 49/06). Technical approval is issued in accordance with the Rules on the approval of packaging for the transport of dangerous goods (Official Gazette of the RS, No. 37/02).

Requirements of regulations and standards

The special regulatory requirements are given in the chapter Compliance with special regulatory requirements. The container is also considered a construction product pursuant to the ZGPro-1 and as packaging pursuant to the ZPNB.

In connection with protection of groundwater, the sixth paragraph of Article 27 of the Decree on the DPN sets out a measure whereby waste shall be disposed of in impermeable repository structures, which shall be ensured through design solutions and the use of materials with the

appropriate qualities. This measure also applies to containers. This measure was taken into account in the design.
When designing the container, the loads on the container after disposal in the silo were taken into account, as follow from the seismic loads on the silo as set out in the Design Bases. The container is otherwise designed in accordance with the Rules on the mechanical resistance and stability of buildings (Official Gazette of the RS, No. 101/05) and the national Eurocode standards. The structure is also designed in accordance with IAEA and WENRA standards.

Characteristics of the container

A detailed list of the geometric data on the container is given in the table below.

Table 5: Geometric characteristics of the container

Parameter	**Units**	**Value**
Geometric data on the container		
External dimensions		
Width	m	1.95
Length	m	1.95
Height	m	3.3
Bevelled external edges of the walls (in both directions)	m	0.2
Internal dimensions – base of the container		
Width	m	1.49
Length	m	1.49
Internal dimensions – top of the container		
Width	m	1.55
Length	m	1.55
Height – prior to attachment of the lid	m	3.07
Height – after attachment of the lid	m	2.87
Thickness of lower plate	cm	23
Thickness of wall at the top	cm	20
Thickness of wall at the base	cm	23
Geometric data on the lid – maximum dimensions		
Width	m	1.66
Length	m	1.66
Width of the support	cm	5.5
Thickness of the lid	cm	20
Thickness of the lid above the supports	cm	20
Volume of the container		
Gross volume – external occupation of space	m^3	12.28
Net volume – after attachment of the lid	m^3	6.31
Mass		
Lid	t	1.36
Empty container with lid	t	14.92
Maximum permitted weight of a full container	t	40[61]

[61] Conceptual Design, Annex NRVB---1T3020.

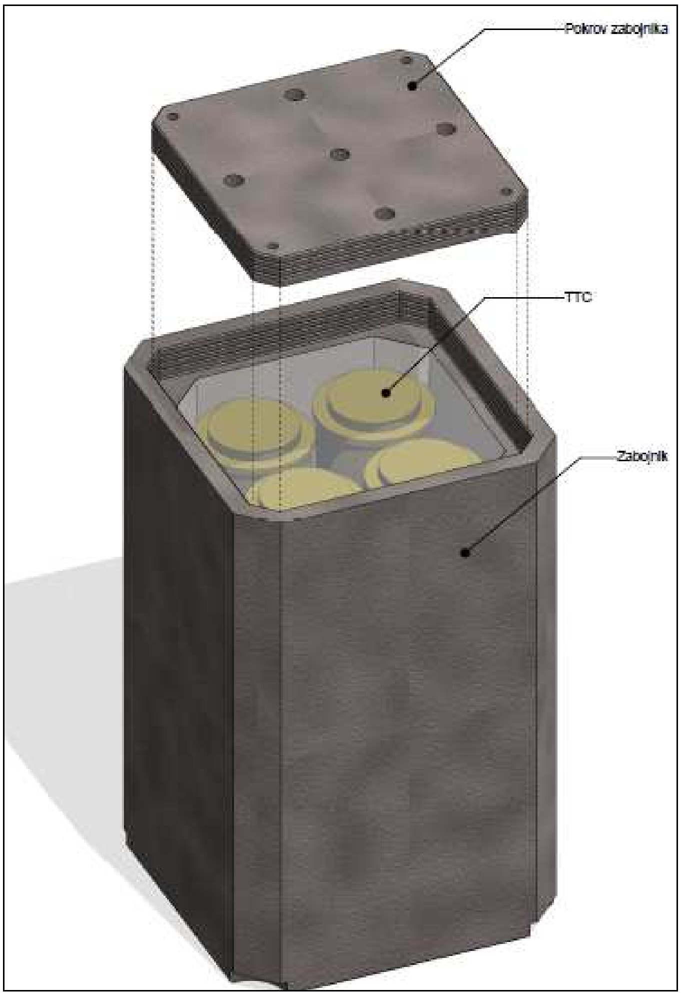


Figure 25: Diagram of the container.

Pokrov zabojnika	Container cover
TTC	TTC
Zabojnik	Container

Requirements for materials

The materials selected must ensure that the disposal container, as a reinforced-concrete barrier, will fulfil all of the key safety functions in the long term under the conditions set out in the baseline documentation.
The requirements for the individual materials are set out in Report No. E 1193/14-420-2 on the requirements for materials for RC containers at the Vrbina LILW repository (ZAG Ljubljana, May 2015), and the document Disposal container – technical description, Conceptual Design, NRVB-B052/058-1, IBE, January 2016.

The selected design of the container allows the fulfilment of all key safety functions:

- Physical retention of radionuclides or radiological shield is guaranteed with a minimum thickness of reinforced concrete walls of 20 cm.

- Chemical retention will be achieved through an appropriate chemical composition and recipe of the concrete, which will correspond to the characteristics of the waste and to chemical processes that take place in radioactive waste such that the migration of radionuclides from the container will be prevented.
- The hydraulic barrier or the prevention of water from entering the container is ensured through the use of high-performance concrete (HPC), which will be impermeable to water, but still sufficiently permeable to the gases that will form in the waste.
- Human intrusion is prevented by using a massive reinforced-concrete container with an anchored cover.
- The reinforced concrete construction also provides the required structural stability.

The container is constructed in such a way that all possible impacts and combinations of impacts are borne by the reinforced concrete structure without additional built-in steel elements. Similarly, there will be no steel elements or reinforcement on the external surfaces of the container. Along with the expanded dimensions of the concrete vertical corners, the robustness was also increased, which is particularly important for withstanding drops, and the reinforced vertical corners allow the secure fastening of the lid.
The lid is anchored to the wall of the container in each corner using bolts. Special threaded elements will be made for this purpose which will be installed in the container walls, and securely anchored using reinforcement rods. Special steel elements will also be built into the lid, which will ensure the appropriate transfer of the load into the reinforced-concrete part of the lid.
All of the steel parts will be protected with grout sealer. The container and lid will be made of high-performance concrete (HPC) and use standard reinforcement steel. The optimisation of the mechanical characteristics and required qualities of the materials will be carried out after the testing of the test containers, at which time the description of the SSC will also be amended.

The safety functions of the container are shown in the table below.

Safety function	Degree and method of achieving safety function
P – physical containment[62]	Impermeability or low permeability of the container during the period after closure is ensured through the use of reinforced-concrete box construction and sealing elements for the container lid. The construction also allows the escape of gases that accumulate in the container. The qualities of the construction that ensure impermeability and the escape of gases will be checked through testing and will be defined in detail in the next phase of the project. The achievement of the safety functions will also be reassessed in the next phase of the project.
C – chemical containment[63]	The container's low pH concrete and absorbent qualities help prevent the migration of nuclides.
H – management of groundwater flow[64]	After disposal, the container's adequately low water permeability (function P) will limit the flow of water through

[62] P (physical containment): prevention of the migration of radionuclides by means of physical barriers;
[63] C (chemical containment) – prevention of radionuclide migration by means of chemical barriers, using sorption and solubility limits;

Safety function	Degree and method of achieving safety function
	the LILW.
I – intrusion[65]	The construction of the container reduces and limits the effects of explosions and the effects of other forms of intentional and unintentional actions that could constitute a threat to safety during the operating period, and limits the effects of unintentional intrusion after the closure of the repository.
S – structural stability[66]	The container's adequate strength ensures safety during transport and transit. The qualities of the container will be checked through testing and will be defined in detail in the next phase of the project, when the achievement of the safety functions will also be reassessed. Taking into account the required conditions for operating and environmental loads, especially seismic loads after disposal, in planning and in the container strength analysis ensures the sufficient long-term strength of the disposal silo at the facility.
Sh – shielding[67]	The design solutions for the container ensure that the requirements for shielding against ionising radiation are met. The shielding qualities of the container will be checked through testing and will be defined in detail in the next phase of the project, when the implementation of the safety functions will also be reassessed.

The requirements for the individual materials are set out in Report No. E 1193/14-420-2 on the requirements for materials for RC containers at the Vrbina LILW repository (ZAG Ljubljana, May 2015).

Transportation of LILW to the repository

LILW containers will be transported from Krško NPP to the repository by road. The transportation of LILW involves the movement of hazardous goods, so transportation will require observance of the Transport of Dangerous Goods Act (Official Gazette of the RS, No. 33/06 , 41/09, 97/10 in 56/15) and pertaining regulations (particularly the Decision on the Publication of Annexes A and B to the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) (Official Gazette of the RS, No. 9/03, 66/03, 9/05, 9/07, 125/08, 97/10).

Containers will be transported on a dedicated semi-trailer which will ensure the proper fastening of the container during transport and the same position on the vehicle for all containers, with the height of the transport platform not exceeding 1m. The vehicle will transport one container at a time.

All LILW transports will be exclusively LILW consignments from a single source to the repository. There will be no interim storage, transhipment or other handling of LILW

[64] H (hydrological): natural and man-made barriers that reduce the flow of groundwater through the repository;
[65] I (intrusion) – natural and man-made barriers that reduce the likelihood or impact of human intrusion into the repository;
[66] S (structural stability): the use of primarily concrete barriers that ensure the structure/geometry of the repository;
[67] Sh (shielding): barriers that shield against radiation from radioactive waste;

containers. Prior to any dispatch of LILW to the repository, an agreement will be made between the consignor and the repository, on the extent and nature of LILW subject to shipment. The repository will not accept any containers with LILW unless approved in advance. Prior to their transport, all the LILW packages acceptable for the repository will be given a record sticker, both in numerical and barcode form. Compliance of LILW with the requirements for transportation will be checked by the transporter, who will also ensure the safety of the cargo during transport.

Acceptance of containers with LILW at the repository

A shipment containing LILW will enter the repository protected area via the entry point at the administrative and service building. Access to the entry point will be restricted by (the first) sliding gate, which will be designed as an extension of the repository outer fence. The gate opening regime will be implemented in accordance with the physical security plan. The entry point for vehicles will be divided into two driving lanes. The driving lane next to the administrative and service building (ASB) will serve mainly for inbound transport of ordinary non-radioactive waste and for outbound traffic of all vehicles, while the driving lane running parallel to the first driving lane and further away from the ASB will serve in particular for inbound transport of containers with LILW and for all abnormal loads. The driving lanes at the entry point will be separated by roadway markings and fitted with (the second) sliding doors which will delimit the entry point area and the exit into the repository site. On the arrival of a shipment, which will usually stop in front of the second sliding door, formal verification will take place of whether the acceptance of shipped LILW has been approved by the repository as well as the shipment compliance with other requirements.

Upon being confirmed as formally acceptable, the shipment will continue its way towards the entry into the controlled area.

At the time of entrance of the shipment into the repository, verification of the compliance with transport requirements, including the control of radiation parameters, will also take place. This verification will take place in particular in front of the controlled area entrance gate for vehicles, in front of the third sliding gate near the technological facility. Upon completion of verification, the vehicle will continue to the hall.

Keeping records of containers

In the hall, the vehicle will drive onto the marked position, where the container will be offloaded from the vehicle to the lift. The lift gripper will be equipped with a barcode reader to read the barcode affixed to the container. The reader will be connected to the control system in the technological facility.

Placing of containers in the disposal silo

The containers will be placed in the silos from above by means of a gantry crane with a capacity of 40 t. It will be possible to operate the crane from the control room in the

technological facility or locally with the help of a local panel. A set of cameras will be installed on the crane, the silo and the facility structure to aid lifting operations and, in particular, the positioning of containers in the disposal silo. Each silo will have capacity for 990 containers (99 containers in each of the ten disposal layers). The disposal containers will be placed alongside and on top of each other. It is assumed that there will be a gap not exceeding 20 cm between the walls of the containers. After every second layer, the gaps between the containers will be filled in and a levelling layer constructed. The procedure of placing containers in the silo is set out in detail in the technological report on internal transport (Conceptual Design, October 2015).
Water that may penetrate through the silo walls will be collected at the silo wall and channelled into the bottom section of the silo, where there will be a collection tank and pumping station.
The bottom section of the silo will be accessible via an access shaft provided in the silo secondary liner. Vertical communication in the shaft will be provided by means of a personnel lift, stairway, ventilation duct, cable trays, piping for pumping water, and a vacant vertical gap along the entire shaft height for the purposes of transporting loads by means of a 5-t capacity winch on the gantry crane.

Filling of voids in the silo

After each disposal layer is filled with disposal containers, between the container walls and between the containers and the silo wall an empty space of 500 – 600 m^3 will remain, and this will need to be filled with filler material (cement grout or concrete). After every second layer of containers the voids will be filled in.
At each second layer, across the layer of disposed of containers a levelling layer will be made from appropriate cement material.
Filling the voids and making the levelling layers will be carried out at most once a year. Works will be performed by external construction contractors using standard construction equipment under the guidance of repository staff.

Closing the disposal silo

The closed disposal silo is ready for the period of active long-term control and surveillance.

Activities following termination of operation – sealing

Following the termination of operation of the silo, all the installations and devices will be removed from the access shaft and the bottom of the silo (where the control pool with the pump will be installed), and all voids (including the drainage pipes) filled with material (cement grout or concrete). This will limit the inflow of groundwater, ensure the long-term stability of the site and prevent the destruction of the underground spaces. Works will be performed by external construction contractors under the guidance of repository staff.

Sealing will be carried out in the shortest possible time after termination of operation of the repository.

Working practices for disposing of LILW

The scope of disposal activities is presented in the form of consumption of time at individual workplaces for the disposal of one disposal container. The list is shown in the table and is important principally in terms of the estimated work efficiency of workers and the radiological load at workplaces; see the table below. The estimate does not include transport activities (performed by Krško NPP) and activities carried out following termination of repository operation. An analysis of the radiological load at presented workplaces is given in the study on safety from radiation.

Table 6: List and scope of activities for disposing of LILW

No. of workplace	Workplace	Worker (number)	Activity	Duration (hours per container)
1	Entrance to repository – reception at administrative and service building	S	Acceptance and review of transport documentation in reception (at distance of 10 m from vehicle)	0.10
		S	Vehicle security check (at distance of 1 m from vehicle)	0.05
2	Entrance control point – entry to CRA	R	Measurement of contamination and dose rate of arriving vehicle and cargo	0.10
3	Platform in hall	L / O	Placing of containers in disposal silo; – removal of container attachments on vehicle at distance of 1 m – monitoring of unloading of container at distance of 10 m	 0.15 0.05
3	Disposal silo	O	Monitoring and supervision of filling of voids between containers and construction of levelling layer (for every two layers disposed of) from top of silo or from platform in hall[68]	0.18
		E	Filling of voids between containers and construction of levelling layer from top panels of disposed of containers[69]	0.10
		O	Monitoring and guidance of installation of drainage liners for every two disposed of layers (from top of silo)[70]	0.10
		E	Placing drainage liners[71]	0.40

Key to worker abbreviations:

- S: security guard (receptionist)
- O: operator
- L: logistician
- R: radiologist (entrance and exit radiological characterisation and other radiological measurements and analysis)
- E: external contractor for construction work

In the radiologically controlled area some work will be performed that should in its scope and frequency be significantly less frequent and extensive than the work listed in the table, and the radiological load in performing this work will be very low. Among them we may count principally the taking of samples from technological procedures and from retention

68 Work monitored and directed by one worker for 36 hours, making 0.18 (36/198) hours per container. In conditions of radiation, the filling of voids and making a levelling layer is repeated five times.

69 Work performed by at least two workers in a total of 20 hours – i.e. 0.10 (20/198) hours per container.

70 Work monitored and directed by one worker for 20 hours from top of silo – i.e. 0.10 (20/198) hours per container. In conditions of radiation, the placing of a drainage liner is repeated four times. The first 7 m of liner are fixed to the wall before containers are placed in the silo.

71 Work performed by four workers at 20 hours each – total of 80 working hours – i.e. 0.40 (80/198) hours per container.

installations for fluid systems. The list also does not include maintenance work and other related work in the radiologically controlled area. Such work will be performed occasionally.

Supplementary, support and ancillary technological procedures

Storage and repair of damaged containers

In the event of the need for storage and repair or remediation of a container that was damaged during transit in the hall or during placement in the silo and the damage requires repair, in the case of the first phase of construction of the TF (before construction of the back up storage capacities) repairs can also be carried out in the hall above the silo. For the requirements of movement of containers and packages the gantry crane will be used, with devices for main and auxiliary lifting, or specially leased equipment for moving heavy loads. The container or place where the repairs will be carried out will be covered with a prefabricated shelter (tent) in order to limit the spread of contamination, and surrounded with moveable biological shields. The repairs will include: a detailed inspection of the condition of the container, which will serve as the basis for establishing compliance with the disposal acceptance criteria, repair of the damaged parts of the container (e.g. injection of sealers and other measures for repairing cracks) and, only in extreme circumstances, the placing of LILW packages into a new disposal container. The repair work will be carried out using tools, equipment and materials for carrying out construction and related works. The working shelter will be equipped with a local ventilation device with HEPA filters on the exhaust. Waste liquids will be captured locally. Moreover in the hall there are small channels for collecting spilled liquids, including firefighting water. Collected wastewater will be discharged from the channels into the control pool. All radiation measurements will be performed with hand-held portable dosimeters.

After construction of the second phase of the TF, repairs can also be made in the back up storage facility in the TF. For the needs of moving containers to the TF and within the TF, special equipment will be leased for moving heavy loads. It will also be possible to bring in heavy goods vehicles. The container or place where the repairs will be carried out will as necessary be surrounded with moveable biological shields. The storage space will be ventilated. Work that will generate dust will be performed within the TF in temporary work shelters (tents) with additional local ventilation and exhaust scrubbing. In addition to the local collection of wastewater, drainage and collection in the floor drain sump will be provided. Any excess quantities of collected wastewater will be discharged into the control pool.

Remediation procedures will also be carried out in the event of emergencies in conditioning for disposal at Krško NPP. With the aim of optimising the remediation procedures and the associated resources required (personnel, technological and measuring devices, written implementing procedures and means of work) the repository operator and Krško NPP will coordinate the approach to implementing remediation.

Storage of secondary LILW

Until the second phase of construction of the TF, secondary LILW will be generated as a result of the taking of samples of the input controls, the use of personal protection equipment, and other activities taking place within the controlled area that generate waste materials. Until the measurement that serves as the basis for clearance, these ostensibly radioactive waste materials will be stored as secondary LILW in the storage facility at the control point.[72] Waste matter will be separated and sorted upon generation and placed in PE bags. The waste bags will be stored in metal drums in the storage space. The storage space is expected to house at most at one time two full 200-litre drums and two empty drums.

The clearance procedure will be carried out periodically for stored waste matter. Measurements of radiation for the requirements of the procedure will be performed in the measurement room (1) next to the storage space. Waste matter that does not exceed the threshold values for clearance will be defined as urban waste, and the rest as secondary LILW and placed in the storage space until being submitted for conditioning for disposal at Krško NPP. In the first phase of the TF such waste is expected to amount to a maximum of one 200-litre drum annually.
After the second phase of construction of the TF is completed, an additional area for the storage of secondary LILW will be provided in the form of a reserve storage area. The net floor area of the reserve storage area will be at least 10 m^2, and the LILW packages will also be able to be stored vertically. The storage area is also designed to store secondary LILW, which will be generated primarily as a consequence of activities carried out in the facilities covered in the second phase of construction of the TF. The storage area is also designed to store contaminated equipment and contaminated empty drums. Packages with high doses will be stored with sheltering for packages with low doses or sheltering for prefabricated biological shields. The procedure for clearance will be carried out periodically for stored LILW. Substances which are not suitable for cleearance will be handed over to Krško NPP for conditioning for disposal.
Secondary LILW generated in possible remediation works in the hall will be temporarily stored in the hall (in compliance with JV7 Article 11 and JV2 Article 13).

Internal transport of secondary LILW will be performed with hand carts or hand trucks and forklifts.

Hot machine shop activities

Repairs to contaminated equipment, decontamination procedures, the sorting of waste and other work processes for the preconditioning of LILW will be performed in the hot machine shop. To this end the hot machine shop will be equipped with:
- a work counter;
- hand tools and means for performing decontamination; and
- basic tools and devices for performing assembly work and metalworking.

[72] JV7 Rules, Article 11: The holder of radioactive waste must store such radioactive waste in a storage space until it is handed over for storage or until clearance. The requirements that the storage space must meet and the conditions of storage are laid down in the regulation governing the use of radiation sources and radiation practices (JV2 Rules, Article 13).

Decontamination activities carried out on larger items (whereby a controlled atmosphere will have to be established) shall take place in a temporarily erected decontamination cabin. In the decontamination cabin and where necessary in the area of the press, a local ventilation installation will maintain appropriate negative pressure. The decontamination cabin will be equipped with local capture of leached liquids.

The hot machine shop will operate within the reserve storage space and will occupy a basic surface area (excluding the decontamination cabin) of around 10 m^2. Internal transport for the needs of the hot machine shop will be performed with hand carts and forklifts.

Laboratory practices and measurements

The measurement of swabs and other waste materials that could be radioactive, and the measurements taken during the clearance procedure will be carried out in the measurement room (measurement room 1) at the control point, which will be built during the first phase of the construction of the TF.
The larger measurement room, which will be used for:

- basic measurements of radiation;
- storing dosimeters and equipment;
- archiving active samples; and
- storage for the needs of the measurement room and preparation of samples;
- will be built during the second phase of construction of the TF (measurement room 2).

For the needs of storing dosimeters and equipment and archiving samples, storage shelves will be provided for manual placing of stored materials. Ground transport will be performed with hand carts.

Control point

Entry of people into the controlled area of the repository and exit of people from the area will proceed through a control point (Technological Facility, Phase 1). The control point will be equipped with a hand-foot monitor for performing radiological controls. A full body scan will be conducted with portable dosimeters if necessary. Equally inspection of equipment prior to removal from the CRA will be performed with hand-held dosimeters.

The control point will include an area for the aforementioned measurement room and a storage room, a changing room and area for disposal of personal safety equipment and clothing, a chemical toilet,[73] sink and shower for personal decontamination and an area for storage of personal safety equipment.

Work clothing will be cleaned in the public laundry. In the event of possible higher contamination of protective clothing, single-use protective clothing will be used.[74]

[73] The chemical toilet at the control point is the only toilet within the controlled area. In the period of intensive work filling the silo with containers and filling in the voids with filler material, owing to the relatively large distance from the control point, a temporary chemical sanitary cabin will be provided in the hall.

[74] Higher contamination could only be a consequence of an emergency or of performing special tasks (such as invasive investigation of containers) in the TF.

In the event of the controlled area being cut back to just the hall above the silo, the control point for this area will be arranged in a special space in the hall (auxiliary control point).

Process management and monitoring – control room

Management and monitoring of all technological processes will be carried out from the control room in the TF. Visual monitoring of processes in the hall will be conducted using cameras. An audio connection will be provided with the workplaces in the hall.
Next to the control room there will be a server area for equipment for management and monitoring of processes, and an area for power supply equipment.

2.2.4 *TYPES AND QUANTITIES OF MATERIALS TO BE USED*

The construction works will make use of local excavated earth, concrete, iron (reinforcement) and asphalt. The table below shows the rough quantities of materials that will be needed for construction of an individual facility.

Table 7: Rough quantities of main materials for construction of the LILW repository

Facility	**Mass of concrete, kg**	**Mass of reinforcement, kg**	**Steel (kg)**	**Mass of asphalt, kg**
Administration and service building	2,940,000	176,400		
Hall, crane track	3,696,000	184,800	260,000	
Technological facility (TF)	6,804,000	680,400		
Control pool	331,200	33,120		
Landscaping	45,820	550		1,758,000
Silo 1, diaphragm, backfill	38,418,818	1,600,784		
Silo 2, diaphragm, backfill	38,418,818	1,600,784		
Containers and filler	19,800,000	1,188,000		
Infrastructure connections	52,000	1,400		2,560,000
TOTAL (excluding 2nd silo)	**72,087,838**	**3,865,454**	**260,000**	**4,318,000**
TOTAL	**110,506,656**	**5,466,238**	**260,000**	**4,318,000**

2.2.5 *TYPE AND QUANTITY OF NECESSARY ENERGY*

The construction site will use construction machinery run on fossil fuel.

In view of the worksite and temporary facilities for making the embankment, the construction site will have the following requirements for electrical power:

-	containers 4 pieces x 5 kW =	20 kW,
-	mobile washing platform	5 kW
	Total:	25 kW x 0.7 = 17.5 kW

The connection capacity for the construction site, taking account of the simultaneous use factor (0.7) is 18 kW. The connection will be provided from the public network (option: or by means of an electricity generator via the construction site electrical cupboard).

A common construction site will be organised for the repository facilities and infrastructure facilities. The electrical power requirements are as follows:

During construction of the diaphragm in the silo:

-	Container complex	3 pieces x 10	=	30 kW
-	Containers	2 pieces x 5	=	10 kW
-	Concrete plant			150 kW
-	Small machinery and tools			approx. 5 kW
-	Lighting			10 kW
	Total:			200 kW x 0.8 = 168 kW
-	Machinery for diaphragm			500 kW
	Total:			640 kW

During construction of facilities (when diaphragm is completed):

-	Container complex	3 pieces x 10	=	30 kW
-	Containers	5 pieces x 5	=	25 kW
-	Lift (crane)	1 piece x 50	=	50 kW
-	Lift (crane)	3 pieces x 20	=	60 kW
-	circular saw	2 pieces x 10	=	20 kW
-	Welding tools	1 piece x 20	=	20 kW
-	Water pumps	4 pieces x 10	=	40 kW
-	Concrete plant			150 kW
-	Small machinery and tools			approx. 10 kW
-	Lighting			10 kW
	Total:			415 kW x 0.7 = 290 kW

Given the major requirement for electrical power, the construction site will need its own transformer substation. We envisage use of the substation that will be used as the permanent substation for the requirements of the LILW repository. The location of the substation is shown in the organisational diagram of the construction site. In the event of the substation not meeting the needs of the construction site, at peak periods the contractor will generate additional electricity using its own generators.

The table below lists the connection power of various points of consumption during regular operation.

Table 8: Points of consumption of AC voltage during regular operation

	A	B	C
FACILITIES	**Connection power of consumption point [kW]**	**Safety power supply - diesel [kW]**	**UPS power supply [kW]**
TECHNOLOGICAL FACILITY	64.00	5.00	4.00
DISPOSAL FACILITY	100.50	34.00	0.00
ADMINISTRATION AND SERVICE BUILDING	146.50	151.00	6.00
PLATEAU	58.00	12.40	0.00
TOTAL	369.00	202.40	10.00
fi	0.85	1.00	0.80
∑ TOTAL	313.65	202.40	8.00
∑∑ TOTAL (A + C)			321.65

Total consumption takes into account a 20% reserve, thus giving an overall consumption of **370 kW**.

Given the demand at the Vrbina LILW repository for UPS, the following consumption is envisaged at individual facilities:

UPS CONSUMPTION BY FACILITY	Pkon (Final cons. kW)	Note
TECHNOLOGICAL FACILITY	4.00	Technology
DISPOSAL FACILITY	0.00	
ADMINISTRATION AND SERVICE BUILDING	4.00 + 2.00	Security + communications
PLATEAU	0.00	
∑ TOTAL	10.00	

For the requirement of UPS from batteries we envisage dry batteries that will be part of the UPS set. For the supply of equipment via UPS we envisage only as much autonomy as is needed to start up the diesel and connect it to the supply system. Approximately 15 minutes of autonomy is estimated.

Heating/cooling of facilities

The heating requirement for facilities will be serviced by using reversible heat pumps. Electricity will be used to power the reversible heat pumps. The reversible heat pumps will run on air and be able to operate at up to -20°C.
In summer the cooling requirement of the premises will be serviced by using reversible heat pumps which will be switched to the cooling regime in summer.

Requirements for thermal energy for heating and ventilation in winter:

- ASB 86.8 kW
- TF, Phase 1 43.6 kW
- TF, Phase 2 94.0 kW

Requirements for thermal energy for cooling, humidifying and ventilation in summer:

- ASB excluding safe room, server and electrical spaces 74.9 kW
- ASB safe room 7.6 kW
- ASB server space 7.4 kW
- ASB server space 7.6 kW
- ASB electrical space 4.0 kW
- TF, excluding UPS and electrical space, Phase 1 38.5 kW
- TF, UPS 0.09, Phase 1 7.6 kW
- TF, electrical space 0.10, Phase 1 4.7 kW
- TF, Phase 2 0.0 kW

2.3 ENVIRONMENTAL CHARACTERISTICS OF PROJECT

2.3.1 *USE AND CONSUMPTION OF NATURAL RESOURCES*

During the construction period we are talking about the short-term consumption of natural resources, and during the period of operation about long-term consumption of natural resources.
The natural resources that the project will use during construction and operation are as follows:

- use of drinking water during the period of construction and operation;
- earth brought in for construction of the LILW repository:
  - the construction of one silo is expected to involve bringing in earth materials in a total quantity of 112,800 m^3 (of which 75,800 m^3 for construction of the embankment, 21,493 m^3 for construction of repository facilities and 15,500 m^3 for construction of infrastructure facilities);
  - construction of the second silo envisages bringing in earth materials in a total quantity of around 21,300 m^3.
- indirect consumption – such as the use of fossil fuels – petroleum in the form of fuel for installations and transport vehicles. Air heat pumps will be used for heating the facilities.

Another natural resource is the physical space in which the new project will be constructed, sited and operating.

No other requirements for natural resources are envisaged within this project.

2.3.2 *WASTE TYPES AND QUANTITIES GENERATED, AND WASTE MANAGEMENT*

DURING CONSTRUCTION

Dismantling works during the construction of the LILW repository will not be necessary, since the site of planned construction is currently agricultural land. The construction will therefore for the most part generate significant amounts of excavation materials, which will be used to landscape the area around the LILW repository facilities.

The construction of the second silo is anticipated in 2048 and 2049. The second silo will be built in the core area of the repository, southwest of the first silo. Minor dismantling work will be required. Excavated material from the area of the second silo will be removed and infilled at the organised permanent landfill outside the area of the detailed plan of national importance that is managed by the company Kostak komunalno stavbno podjetje d.d. Krško:

- landfill that is part of the Spodnji Stari Grad Waste Management Centre – average transport distance of around 500 m, parcel 2106/85, c.m. Drnovo – 1320
- ash dump – average transport distance around 2000 m, c.m. Stara vas – 1316.

CONSTRUCTION WASTE

Construction of the embankment will require fertile soil to be pushed to the edge of the construction site for re-use, excavation of the non-load-bearing sand-silt soil to a depth of about 1.5 m, and its incorporation into the non-load-bearing part of the embankment outside the area of the facility foundations.

Table 9: Quantities of earth mass in constructing the flood-protection embankment.

	Quantities
Excavation:	
Removal of fertile soil (humus)	14,189 m^3
Removal of sandy silt	35,845 m^3
Embankments:	
Embankment of excavated sandy silt	35,845 m^3
Embankment of imported load-bearing material	75,806 m^3
Applying humus	14,189 m^3

Note: All quantities are measured in their vegetation cover or inbuilt state.

All soil excavations will be used on-site to construct the embankments. The fertile soil will be used to apply humus and landscape the green areas around LILW facilities in the later stages of the project.

Repository facilities

- **Administration and service building;**
- **Technological facility;**
- **Silo**: construction of an underground wall (diaphragm), excavation for silo (use of crane), construction of silo (use of crane), embankment by silo and hall above the silo (use of heavy lift crane).
- **Other smaller facilities on the plateau;**
- **External arrangements:** municipal service lines on the plateau, transportation and pedestrian surfaces, landscaping, fences and other smaller structures.

Table 10: Outline quantities of earth mass for constructing repository facilities.

	Quantities
Excavation	
Removal of fertile soil (humus)	8,132 m^3
Excavation for the silo – diaphragm (gravel)	1,064 m^3
Excavation for the silo – diaphragm (silt)	6,149 m^3
Excavation for the silo – (gravel)	6,247 m^3
Excavation for the silo – (silt)	30,274 m^3
TOTAL:	**51,866 m^3**
Embankments	
Non-load-bearing embankment of the plateau from the material excavated for the silo	43,734 m^3
Embankment by the silo and upper layer of transportation surfaces on the plateau – gravel brought in	21,493 m^3
Applying humus	8,132 m^3

Note: All quantities are measured in their vegetation cover or inbuilt state.

The excavated material will be removed and incorporated into the embankment within the construction site. All excavated soil will be used on the construction site. The load-bearing embankment material is anticipated to be transported from the nearest quarry. The fertile soil will be used for the green areas and for landscaping (i.e. planting) around the LILW facilities.

Infrastructure facilities

Infrastructure facilities will involve the following works:

- **Transportation infrastructure – roads and parking areas:** reconstruction or arrangement of Vrbina road, arrangement of the access road to the LILW facility and external parking area.
- **Construction of infrastructure lines and connections:** drainage connections for precipitation wastewater, sewer connection for removal of urban wastewater, connection to low voltage power network, construction of connection to the mains water supply and connection to the telecommunication network.

Table 11: Outline quantities of earth mass for reconstruction of road.

	Quantities
Excavation	
Removal of fertile soil (humus)	2,400 m^3
Removal of sandy silt under the road embankment	7,400 m^3
Excavation of trench for utility lines	1,310 m^3
Dismantling and removal of asphalt on road	240 m^3
Embankments and backfilling	
Construction of plateau embankment for LILW – sandy silt	7,400 m^3
Construction of load-bearing embankment for road – imported material	7,400 m^3
Construction of embankment for road – imported material	5,300 m^3
Upper construction of road – imported material	2,800 m^3
Backfill of utility line trenches	1,310 m^3
Applying humus – infrastructural facilities	1,100 m^3
Removal and application of humus to the LILW plateau	1,300 m^3
Removal of asphalt to the organised permanent landfill	240 m^3

Note: All quantities are measured in their vegetation cover or inbuilt state.

Excavated earth will be built into the non-load-bearing part of the embankment plateau of the LILW repository. The average transportation distance is around 500 m. Load-bearing embankment material is anticipated to be transported from the nearest quarry. Fertile topsoil will be used for the green areas and for landscaping (i.e. planting) along the road and around the LILW facilities. Surplus fertile topsoil will be used for arranging the area around the LILW facilities on the investor's land and will not be taken away from the area.

Construction will take place in an area with cultivated field and grassland surfaces. During the execution of works, a variety of construction waste will be generated (waste group 17 under the waste classification list in the Decree on waste). In addition to construction waste, works will generate other waste that is not in the group with classification number 17, such as waste packaging for transportation of construction materials or construction products, waste that

may be generated from transportation or the operation of machinery and devices at the construction site and urban waste generated from workers at the site.
With regard to the Plan of managing construction waste for the Conceptual Design phase (Study No. NRVB---1P/02B), mainly the following construction waste will be generated: waste concrete, mixed construction waste, bituminous mixtures and owing to earthworks, soil and rocks.

Table 12: Type and quantity of construction waste that will be generated in the construction of the first silo and accompanying facilities and arrangements.

Waste classification number	Name of waste	Anticipated quantity (t)
17 01 01	Concrete	96.00
17 03 02	Bituminous mixtures other than those mentioned in 17 03 01	528.00
17 05 04	Earth and rocks other than those mentioned in 17 05 03	39,600.00 humus (24,721 m^3) 145,760.00 silt (80,980 m^3) 13,890.00 gravel (7,311 m^3)
17 09 04	Mixed construction waste and waste from dismantling of structures other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	840.0 bentonite slurry
TOTAL		**200,714.00**

CONSTRUCTION OF SECOND SILO

Construction of the second silo will begin after closure of the first one. Here the scenario is observed that following closure of the silo the hall will remain and will be used as a garage for the lift. After construction of the second silo, the hall will be moved to the new location, along with the lift. The second silo will be built in 2048 and 2049 in the core area of the repository, just like the first silo. The core area of the repository is a constituent part of the wider area which also comprises:

- ⇨ the entrance to the repository,
- ⇨ vacant surfaces of the repository, and
- ⇨ areas for connection to utilities infrastructure.

All additional arrangements connected to construction of the second disposal silo are envisaged within the core area of the repository, in its south-western section, west of the first disposal facility. In other parts both of the core and wider area of the repository, no changes are envisaged. According to a rough division, the new arrangements can be divided into: new repository facilities (second disposal silo and hall above the second silo), expansion of the external and municipal service arrangements and adaptation of the landscaping of the repository area within the fence in the south-western corner of the area.

Construction waste associated with the second silo can be separated into construction waste that will be generated in closing the first silo and waste that will be generated in constructing the second silo. Regardless of the number of disposal silos, after the repository ceases to operate the (last) silo will be closed and the repository decommissioned. Construction waste will be managed in line with the valid legal requirements (e.g. Plan of managing construction waste).

⇨ CONSTRUCTION WASTE THAT WILL BE GENERATED FROM CLOSING THE FIRST SILO

A scenario is envisaged where following closure of the silo the hall will remain at the location of the first silo and will be used as a garage for the lift (gantry crane). After construction of the second silo, the hall will be moved to the new location. The lift will also be moved. Prior to closing the first silo, the following will be removed from it:
1. the metal parts of the staircase, landings and other metal structural supports;
2. personnel lift;
3. machine installations including pumps and
4. electricity installations and devices.

The space left by the removed equipment will amount to several 10 m^3, and the mass from 5 to 10 t. The major portion of the equipment will be defined as waste and assigned to the authorized organisation. A smaller portion (30%) will be stored in the hall with the intention of installing it later in the second silo (e.g. personnel lift). After construction of the second silo, it will be possible to move the hall to the new silo location. It will not be possible to use the entire steel construction (approx. 220 t) in constructing the second silo. We envisage 10% of the degraded existing construction being defined as construction waste. The entire roof covering (30 t) and 20% of the facade lining (with a total mass of 65 t) will also be defined as construction waste. The hall above the silo will be of composite panelling (steel plate, mineral wool – 20 cm, waterproof membrane). The existing lift and crane tracks will also be moved to the location of the second silo. After removal of the lift and hall, the floor slab of the hall at the location of the first silo will also be removed (around 800 m^3 or 1,980 tons of RC), along with the asphalt surfaces around the former hall (1,570 m^2 or 320 t), the pertaining kerbs (170 m, 5 t), walkway slabs (190 m^2, 16 t) and fence (70 m, 14 t).

Table 13: Envisaged types and quantities of construction waste that will be generated from closing the first silo

Waste classification number	Name of waste	Waste type	Anticipated quantity	Notes
16 02	Electrical and electronic equipment waste	machine installations including pumps; and electrical installations and devices	3.5 – 7 tons	30% of the equipment will be used later for installation in the second silo (e.g. personnel lift).
17 04 05	Iron and steel	the metal parts of the staircase, landings and other metal structural supports	22 tons	After construction of the second silo, it will be possible to move the hall to the new silo location – about 198 tons of steel construction will be moved. 10% of the degraded existing construction of the hall will be construction waste.
17 09 04	Mixed construction waste and waste	reinforced concrete floor slab	1,980 tons (800 m^3)	After removal of the lift and hall, the floor

Waste classification number	Name of waste	Waste type	Anticipated quantity	Notes
	from dismantling of structures other than those mentioned in 17 09 01, 17 09 02 and 17 09 03			slab of the hall at the location of the first silo will also be removed.
17 09 04	Mixed construction waste and waste from dismantling of structures other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	roof covering, facade liner	43 tons (30 tons of roof covering, 13 tons of facade liner)	The entire roof covering (30 t) and 20% of the facade lining (with a total mass of 65 t) will also be defined as construction waste.
17 01 01	Concrete	kerbs, walkways and fence	35 tons	Kerbs (170 m), walkway slabs (190 m^2) and fence (70 m).
17 03 02	Bituminous mixtures other than those mentioned in 17 03 01	asphalt surfaces	320 tons	asphalt surfaces around the former hall

⇨ **CONSTRUCTION WASTE THAT WILL BE GENERATED FROM THE CONSTRUCTION AND CLOSING OF THE 2ND SILO**

1. **Forming the work plateau (diaphragm)**

Forming the work plateau (diaphragm) of the second silo will require the removal of the embankment to an elevation of around 153.40 m above sea level. The quantity in this section amounts to around 12,700 m^3. From this level down to an elevation of around 151.45 sand and silt will be removed from the vegetation-covered ground and replaced with high-quality materials from outside sources. The quantity of this part is estimated at around 11,500 m^3. This is a quantity based on the assumption that the thickness of the removed silt is 1.25 m. During the works, silt will be removed in its actual thickness, so the quantity may be greater or smaller than the assumption. The plateau formed in this way will serve as the basis for constructing the primary substructure (diaphragm) of the second silo. After the silo is completed, an embankment will be made of high-quality material, which will form the basis for the foundations of the hall above the silo. The quantity is estimated at around 9,800 m^3. It will be possible to incorporate around 2,700 m^3 of silt along the edge of the load-bearing part of the embankment in accordance with the profiles of the envisaged plateau at the LILW repository. In this case we envisage the removal to the external landfill of around 21,400 m^3, and later in the excavation for the silo around a further 43,800 m^3 giving a total of around 65,200 m^3. In the area of the repository it will be necessary prior to excavation of the silt embankment to remove around 2,400 m^3 of humus. Of this around 924 m^3 will be usable for later humus application. This will give a humus surplus of 1,476 m^3, which will be distributed as part of the landscaping on the investor’s land. The surplus of excavated material in the construction of the second silo will be disposed of in the permanent ash dump (Kostak, 17,978 m^2, c.m. 1316 Stara Vas) and on parcel 2106/85, c.m. Drnovo.

Table 14: Balance of materials in the area of the LILW repository (2nd silo)

DESCRIPTION	EMBANKMENTS (m^3)	EXCAVATION (m^3)
1. Plateau		
1.1 Humus		2,400
1.2 Embankment of silt		12,636
1.3 Silt in substrate		11,408
1.4 Load-bearing embankment	21,376	
1.5 Embankment of silt	2,668	
1.6 Application of humus	924	
2. Silo		
2.1 Diaphragm (gravel)		1,064
2.2 Diaphragm (silt)		6,149
2.3 Silo (gravel)		6,247
2.4 Silo (silt)		30,274
TOTAL	24,968	70,178

*All quantities are measured in their vegetation cover or inbuilt state.

2. **<u>Construction waste that will be generated from the construction and closing of the second silo</u>**

In the phase of constructing the second silo as well as during its closure, waste will be generated from the dismantling of the reinforced concrete entry way to the inner part of the silo (40 m^3), bentonite slurry for excavation for diaphragm panels (560 m^3), dismantling of the reinforced concrete parapet wall (28 m^3), dismantling of the reinforced concrete secondary blanket (45 m^3) and dismantling of the entrance structure to the silo down to the level (132 m^3). Construction waste from the construction of the second silo is expected to be disposed of in the permanent ash dump (Kostak, 17,978 m^2, c.m. 1316 Stara Vas) and on parcel 2106/85, c.m. Drnovo.

Table 15: Type and quantity of construction waste that will be generated in the phase of construction of the second silo and during its closure.

Waste classification number	**Name of waste**	**Anticipated quantity (m^3)**	**Description of generation:**
17 09 04	Mixed construction waste and waste from dismantling of structures other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	805	dismantling of the reinforced concrete entry way to the inner part of the silo, bentonite slurry for excavation for diaphragm panels, dismantling of the reinforced concrete secondary blanket and dismantling of the entrance structure to the silo down to the level

After closure of the second silo, waste will be generated from dismantling of the control pool and infrastructure lines on the plateau. Decommissioning of the repository is the procedure rendering the facility in the state of removal of its status as a nuclear facility. Decommissioning does not also signify necessarily disassembly and dismantling of nuclear facility structures. In the Vrbina LILW Repository project it is assumed that the disposal facilities and pertaining facilities (hall, platform) will be dismantled and disassembled after closure of the disposal facilities, and non-disposal facilities will be removed from the list of nuclear facilities and assigned to unlimited use.

DURING OPERATION

Regular operation

Waste will be generated in maintenance work, and owing to the presence of employees (12 jobs), urban waste will be generated. Maintenance work outside the radiologically controlled area will cover principally:

- checking the operation of devices and installations for service activities, infrastructure connections and other mechanical and electrical installations, and maintenance in accordance with the maintenance programme or manufacturer instructions (e.g. replacement of filters, seasonal start up, cleaning, etc.);
- care of green areas and planted areas;
- cleaning built surfaces and emptying sand traps;
- painting;
- inspection and servicing of vehicles;
- assembly, connection and movement of office and other equipment; and
- maintenance of lighting (replacement of bulbs) and other electrical installations and movable equipment.

Within the administration and service building there will be a storage space for spare parts for installations and equipment and for tools and accessories for performing maintenance work.

For the needs of performing minor maintenance and repairs, the administration and service building will have a workshop for:

- performing assembly and repair of mechanical and electrical devices, equipment and installations;
- basic tools for care of green areas and planted areas; and
- cleaning, testing, start up, replacement of filters and checking the operation of devices and installations for service activities and infrastructure connections in accordance with the maintenance programme or manufacturer instructions.

Waste will be generated in repairs, maintenance and cleaning. Personnel at the repository (maintenance operative) will perform just minor maintenance work. Major maintenance work will be performed by external specialised providers, either in the repository area or at the provider’s location (e.g. vehicle servicing). The maintenance provider will ensure the organisation and supervision of this work and help in implementation. In this way waste may be generated in the area of the repository and at the maintenance provider’s location outside the repository in individual repair operations. During operation, waste will be generated principally from minor maintenance work: electrical and electronic equipment waste (16 02 ..), waste batteries and accumulators (16 06 ..), content from devices for separating oil and water (13 05 ..), absorbents, filter materials, cleaning cloths and protective clothing (15 02 ..), urban waste from the maintenance of green areas: waste from gardens and parks (20 02 ..) and owing to the presence of workers separately collected fractions (except 15 01) of urban waste (20 01 ..).

The potential waste accumulated during operation and the envisaged estimated quantities per year are shown in the table below:

Table 16: Estimated quantities of waste during operation of the repository

Type of waste	LILW repository [kg/year]
13 05 Content from oil/water separators	400
15 02 Absorbents, filter materials, cleaning cloths and protective clothing	800
16 02 Electrical and electronic equipment waste	70
16 06 Batteries and accumulators	50
20 01 Separately collected fractions (except 15 01)	1,000
20 02 Waste from gardens and parks (including waste from cemeteries)	14,000

2.3.3 *TYPES AND QUANTITIES OF ENVISAGED EMISSIONS OF SUBSTANCES AND ENERGY*

Emissions into the air will be generated during construction, through exhaust gases and PM_{10} particles from means of transport and construction machinery, and as dust from worksites and transportation routes. The technological processes envisaged during operation of the LILW repository involve no major sources of air pollution.
Noise emissions will also be tied primarily to construction works and transportation, and during operation noise at the repository will be present owing to operation of the repository. Given the distance from residential buildings, the noise burden will be acceptable and anti-noise measures are not necessary.

Emissions into water will be possible during construction at all construction sites, in particular emissions of engine oil and other petroleum derivatives are possible. Machinery will use organic biodegradable oils. During operation we anticipate a minor quantity of urban wastewater owing to the presence of personnel in the repository area. Possible pollution of water may also arise in the context of industrial water, but in order to prevent this type of emission we envisage a control pool, which will collect possibly contaminated industrial water.

Emissions into the ground will be possible principally during construction (emissions of engine oil and other petroleum derivatives). Mechanised equipment will use organic biodegradable oils.

During construction, waste will be generated in the form of waste packaging, oils, wood, concrete residues, iron, earth and urban waste. During operation, urban waste will be generated in a minimal scope, and removal will be provided through the public municipal refuse collection service.

Emissions of light pollution will be present particularly during the period of operation, owing to exterior lighting, which will be installed for the needs of physical security. During construction the lighting will be short-term and specifically during construction of the diaphragm, when work during the night will be performed. Here it will be necessary to observe the Decree on Limit Values for Light Pollution of the Environment (Official Gazette of the RS, No. 81/07, 109/07, 62/10 and 46/13).

During construction in the area of the project there will be no sources of ionising radiation, while during operation and after termination of activities the effective doses at the repository fence will be significantly lower than the threshold values.

The impacts of the project in terms of emissions of pollutants into the air, water and ground and emissions of noise are addressed in greater detail later in the report in question: Chapter 5 IMPACTS OF THE PROJECT ON THE ENVIRONMENT AND HUMAN HEALTH

2.3.4 *RISKS ASSOCIATED WITH PROTECTION AGAINST ENVIRONMENTAL AND OTHER DISASTERS*

The Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment requires that in formulating an environmental impact assessment for an intended encroachment, an assessment be made of the risk or threat to the environment, or regarding the probability that an encroachment on the environment indirectly or directly in certain circumstances or in a certain time will harm the environment or life or human health, or cause destruction, damage or a critical burden on the environment, where in order to determine and evaluate the impacts of the encroachment on the environment in terms of the risk and threat of environmental disasters, account should be taken principally of the impacts associated with the use of hazardous substances, the possibility of ecological or environmental accident and the possibility of natural disasters resulting from the encroachment.

During construction

The plan of construction site organisation, which will be formulated in accordance with the regulations governing construction, will define the spaces for the temporary depositing of materials and for their preparation for use, the spaces for temporary depositing of waste, equipment, work preparations and sanitary facilities, and at the same time it will define the measures for protection of the environment during construction. With the use of technically flawless machinery and vehicles and with an adequately formulated plan of construction site organisation, along with the observance of all protection measures regarding action in the event of a spill of environmentally hazardous substances, the risk of an environmental accident or of impacts on surface and groundwater and on soil during construction is negligible or non-existent.

During operation

In respect of the Environmental Protection Act, this installation would not be classed as an installation that could cause large-scale environmental pollution (with regard to the Decree on the types of activity and installation that could cause large-scale environmental pollution, Official Gazette of the RS, No. 57/15). Under the Decree on prevention of major accidents and minimisation of their consequences (Official Gazette of the RS, No. 22/16, 30/16), the installation is not classed as an installation of lesser or greater risk to the environment owing to major accidents involving hazardous substances.

In respect of the Ionising Radiation Protection and Nuclear Safety Act, however, it was necessary to produce a Safety Report, since this involves a nuclear facility where radioactive substances will be handled.
Below we provide a summary from the Draft Safety Analysis Report, Chapter 14: Emergency preparedness (NSRAO2-POR-030-01, ARAO).

In the area of the repository certain emergencies could arise. The repository operator must be ready to act upon such events, and must maintain a state of preparedness to respond to such events. The possibility of an accident or emergency occurring must be reduced to a minimum, but in the event of one occurring, the consequences must be mitigated and conditions ensured for re-establishing normal operation.
Prior to operation of the repository, instructions or a plan of actions in case of emergency must be formulated. The basic purpose of the instructions or plan will be to plan a response and measures necessary to manage emergencies at the repository, with the aim of preventing an escalation of the emergency into a radiological accident, to limit the risk and mitigate the consequences.

The repository operator must implement all logical measures to prevent accidents.

Article 104 of the Ionising Radiation Protection and Nuclear Safety Act states that the operator of a radiation or nuclear facility must draw up a risk assessment in accordance with the act governing protection against natural and other disasters to establish whether intervention measures need to be planned for outside the area of the radiation or nuclear facility. If such measures are required, the operator must draw up a protection and rescue plan; if they are not, the operator must draw up instructions for the measures to be taken in the event of an emergency. The preparation and maintenance of a protection and rescue plan, along with implementing procedures, is the obligation, under the Rules on operational safety of radiation and nuclear facilities, of the operator of the nuclear facility, who must ensure readiness for any possible emergency.

EMERGENCY MANAGEMENT

The actions of security personnel, who will provide physical and fire safety for the LILW repository, will be discussed in the physical security plan and associated instructions for action. All plans and documents that address emergency preparedness will be mutually harmonised.
In general not every emergency involves the occurrence of a radiological accident. It could involve a reduction in radiation safety that also requires the appropriate response. Owing to the danger of an increased level of radiation or contamination of the working environment and of some parts of the repository with radioactive material as a result of an emergency, remedial measures are required.

Managing emergencies and the concept and organisation of responses through protection measures that are presented below in the EIA, are summarised from the Draft Safety Analysis Report for the Vrbina LILW, Krško, February 2018, Chapter 7 Safety analyses and Chapter 14 Emergency preparedness. The basis for the Draft Safety Analysis Report was the Design Bases for the LILW Repository at Vrbina, Krško – Environmental Impact Assessment Phase, from which we summarise the list of scenarios of normal and abnormal evolution of events during operation and after closure of the LILW repository.

The scenarios for the LILW repository have been designed in accordance with international recommendations and good practice. A more detailed description of the set of scenarios is given in the reports on the implementation of the safety analyses and recalculations, for the operating period in the Operational Safety Assessment Report for Scenarios, Models and Results of Calculations, and for the post-closure period in the Report on initial scenarios under post-closure conditions.

Scenario of normal operation and normal evolution of events following closure of the repository

Two scenarios for normal operation are developed: normal operation for the period of operation and the normal evolution of events following closure of the repository (also called a nominal scenario). These envisage that all events and processes develop in accordance with plans and that the characteristics of individual SSCs do not deviate from the plans.

The scenarios of normal operation and the normal evolution of events following closure of the repository present the following course of events and processes:

- The waste is conditioned for disposal at Krško NPP and packed into final packages that meet the acceptance criteria;
- The waste is transported to the LILW repository (the responsibility of Krško NPP, which performs the conditioning of waste for disposal);
- The waste is received at the repository, visual controls are conducted for the final packages and radiation is measured on the surface of the packages, and the documentation is checked;
- The disposal process continues after all the requirements have been met. The final package is transported to the roof and disposal silo, where it is unloaded using a gantry crane into its predetermined position in the disposal silo;
- A drainage system is in operation in the silo during operation to collect and remove any seep water;
- In the case of Scenario SA. 3, after the Slovenian half of the operational waste is disposed of, the standby phase commences as a sub-phase of operation (although without FPs being deposited).
- After the silo has been filled (or even already during operation), the voids between the containers and the wall of the silo are filled with backfill material. A concrete slab is placed on top of the disposal unit.
- A clay layer is then placed on top of this, providing an additional barrier between the silo and the Quaternary aquifer.
- After closure, the phase of active and passive surveillance of the disposal units, to last 300 years, begins.
- The engineered barriers gradually begin to degrade.

- It is assumed that there is a family residing in a village in the area around the repository (100 m) that uses a well drilled into the Quaternary aquifer for its own water supply.

The scenario of the normal evolution of events also contains several sub-scenarios:
- an alternative model of degradation of the engineered barriers, where the barriers fail in succession;
- a biosphere without a well (all water required is taken from the river);
- a biosphere in which water from the well is used to irrigate land;
- a biosphere in which water from the well is used for the watering of livestock.

Scenario of abnormal evolution of events during operation and following closure of the repository

Other possible scenarios of abnormal operation and alternate evolution of events following closure of the repository can be divided into:

Anticipated operational occurrences (abnormal operation):
- authorised dose limit exceeded;
- loss of external electricity supply;
- failure of a vehicle transporting LILW to the repository site;
- failure of a crane above the silo;
- failure of the pump in the silo and by the control pool;
- failure of the fire alarm system;
- failure of the fire protection system;
- failure of the system for recording data on LILW;
- failure of devices for measuring releases and radiological monitoring devices;
- rejection of an LILW shipment.

Scenarios of alternate evolution of events following closure of the repository can be divided into:
- early failure of artificial/engineered barriers;
- river meandering and surface erosion;
- inadvertent human intrusion
- change to the hydrological conditions.

In addition to the above, accidents are also considered. For an LILW repository, these can include:
emergency design-basis events and accidents (design-basis events):
- fire,
- dropping of a container (not possible during the standby phase);
- airplane crash (including explosion and fire);
- terrorist attack;
- earthquake (followed by operational shutdown and checking of SSCs).

Fire scenario

As a scenario, fire is treated as the consequence of several initiating events. It is divided into two sub-scenarios: The first is a fire in the technological facility and the second is a fire in the hall above the silo. The conservative assumption is that the fire engulfs packages from the most active waste flows from Krško NPP and the CSRAO. The impact of the event is assessed for workers' representatives and for the general public in this area.

Scenario of a dropped container
The scenario of a dropped container includes sub-scenarios depending on the location of the drop (in the TF or silo) and the height of the drop.
The impact of the events is assessed for workers' representatives and for the general public in this area.

Explosion scenario (airplane crash, terrorist attack)
The explosion scenario also includes the initiating events of a terrorist attack and the crashing of an airplane. In the event of a terrorist attack, it is assumed that the terrorist will circumvent the security system and place a significant quantity of explosives within the technological facility. The assumption regarding an airplane crash is that a large transport or large military airplane crashes onto a full silo (filled with containers containing the most active waste flows) that has not been definitively sealed. The doses per individual at varying distances from the explosion are estimated.

Scenario of an earthquake during operation of the repository
The scenario of an earthquake during operation of the LILW repository takes into account that anti-seismic building design is incorporated into the design of safety-related facilities. In the event of any type of earthquake during operation of the LILW repository that could lead to consequences that affect the nuclear and radiation safety of the repository, waste disposal operations must be halted, all systems checked and the appropriate measures taken.

Scenario of the early failure of the engineered barriers (post-closure earthquake)
This scenario presents a large number of potential initiating FEPs that could affect the ability to isolate radioactive waste and contain radionuclides. These FEPs incorporate the following initiating events:
- major beyond-design-basis earthquake event;
- errors in production or construction;
- anomalous operation.

The scenario of early failure is evaluated in the same way as the nominal scenario, but with the assumption of a very swift degradation of the physical characteristics of the engineered components. This begins at the end of institutional surveillance and, after one year, all the physical characteristics of the engineered barriers move to "failure" state. This conservative assumption is made on the basis of that it includes the effects of various events and processes that could affect the speed of degradation of the SSCs at the repository.

Scenario of river meandering and surface erosion
Natural forces or human activity may, in the future, lead to changes in the course of the Sava river, which could then flow over the repository. This would lead to the erosion of part of the Quaternary layer and to changes in the speed and direction of the water in the

Quaternary aquifer. From a geological point of view, it is impossible for erosion to be so strong over a period of 10,000 years that it would reach the depth of the silo and the disposed of waste. The main effect of any change in river flow is a change to the speed and direction of flow of the groundwater alongside (and through) the repository.

Scenario of inadvertent human intrusion

Given the location of the repository and the disposal concept (below the groundwater), the likelihood of inadvertent human intrusion is very low. The main possible scenario is intrusion by drilling, which could occur after the end of institutional surveillance (300 years after closure). An estimate is made of the dose sustained by the driller, as well as by a member of the general public living in the area after drilling.

Scenario of a change to the hydrological conditions

A larger number of FEPs lead to a change in regional hydrological conditions that must be accounted for in the safety assessment. These FEPs are:

- natural or anthropogenic climatic changes;
- construction of dams or other projects on the Sava;
- other indirect measures that change the behaviour of the groundwater at the site.

The key effects of these changes on the repository are a change to the direction and speed of the flow in the immediate vicinity of the repository and the Quaternary aquifer.

The impacts on employees and on members of the public from inhalation and external irradiation were estimated within the framework of the scenario. The impacts and estimated doses are set out in more detail in Chapter 5.3.10. ENVIRONMENTAL IMPACTS FROM IONISING RADIATION in this report.

Conclusions of the safety analysis for the period of operation of the LILW repository and after closure

The safety analysis for the operation of the LILW repository showed that the proposed concept and design satisfy the safety criteria and that the impact of repository during operations is within the prescribed limits. Certain assumptions were made very conservatively, and the estimated impact of the repository could therefore be even smaller subsequently, when data with less uncertainty is used.

For the scenario of normal evolution during operation, the assessment was that in no case will the dose for an employee exceed the allowed limits. The collective dose for all employees at the repository should not exceed 21.6 person-mSv/year.

In the safety analysis it was conservatively estimated that the dose for a representative member of the public at the perimeter of the repository will not exceed 5 µSv/year for the scenario of normal evolution during operation, if it is assumed that the waste is disposed of after being held in storage for five years. In the case of immediate disposal (fresh waste), the estimated dose for a member of the public at the perimeter of the repository is 11 µSv/year.

The impact of the repository for abnormal evolution scenarios was also estimated, and it was established that in this case too the impact of the repository on employees and members of the public in the worst weather conditions and the worst working conditions is lower than the required minimum reference values under European standards.

All scenarios were analysed using appropriate models, with the impact of the repository on the environment and humans being assessed. The impact on employees and the population was analysed. In the case of construction of a second silo, construction will take place after the first silo is closed, so there will be no impact on workers during construction of the second silo from waste disposed of in the first silo.
As part of the safety analyses and calculations an assessment was also made of the impact on other organisms (non-human biota). The results indicate that the impact of the repository on the organisms in question will be negligible, since the calculated doses are far below the recommended reference levels.
An assessment was also made of the impact of toxic metals mixed into the LILW and disposed of together with it. It was determined that the expected, conservatively estimated releases of toxic metals from the repository are below the prescribed limits for drinking water.

The assessment from the safety analysis is that the planned LILW repository at the Vrbina location can be operated safely, and its impact after closure on the environment and humans will be below the prescribed limits.

CONCEPT AND ORGANISATION OF RESPONSE

The response concept will be based on the classification and announcement of the danger level:

- a danger level whereby the event is brought under control entirely by ARAO staff and the safety department (unusual event);
- a danger level for which the involvement of external intervention units is envisaged.

The level of danger is determined by the person present at the event (ARAO worker or security officer). The worker determines this based on the information available.
For an effective response the repository operator will have a state of constant preparedness during and outside working hours. During the period of preparedness, one worker will be reachable by mobile telephone (a worker from the LILW repository section or a worker from the radiation protection service). The envisaged response time for a worker outside working hours is up to 60 minutes from receipt of notification of an emergency (arrival at the repository site). The state of constant preparedness is managed by the head of the repository.
In the event of a response including external intervention services (police, firefighters, ambulances), the repository head of the response will coordinate with the heads of the intervention units. In emergencies involving radioactive waste, a worker from the radiation protection department of the repository operator will participate by conducting emergency monitoring and radiation protection measures.

MONITORING RADIOACTIVITY IN AN EMERGENCY

Operational radioactivity monitoring in the area surrounding the disposal facility will be performed in accordance with the programme of radioactivity surveillance, which will be confirmed via the Safety Report for the repository. The purpose of operational monitoring is to monitor regularly for ionising radiation and radioactive contamination in the environment, which will enable immediate notification of any raised levels and an estimate of the doses from exposure to additional radiation from the repository for representatives of reference groups working in the direct vicinity of the repository.

In the event of an emergency at the repository, where there is the possibility of the event involving radioactive material, emergency monitoring will be started at the repository site, as provided in the Safety Report. The proposed emergency monitoring includes:

- monitoring for radioactivity at the location of the emergency;
- monitoring for radioactivity in the impact area of the emergency;
- monitoring for contamination of persons, equipment and objects;
- monitoring for exposure to external radiation;
- monitoring the decontamination of persons, equipment and objects.

The frequency of sampling, the duration of an individual sampling or measurement operation, the number of measurements and the locations of the measurements will be determined in accordance with the danger level and the extent of the consequences of the emergency. The locations of sampling and measurement and their scope will be determined by the repository operator's radiation protection department, and in the event of a major threat the department will consult the SNSA.

REMEDIAL MEASURES

Remedial measures in an emergency are measures to prevent environmental contamination and/or to reduce exposure of individuals to sources of radiation.
The radiation doses for individuals involved in intervention measures, including police, medical and firefighting personnel, may not exceed the doses for professionally exposed workers from sources of ionising radiation, except in cases of:

– saving life or averting a direct threat to the life or health of a large number of people;
– implementing measures that would ensure protection against a large collective dose;
– implementing measures that will prevent the onset of events with catastrophic consequences.

In any event, received doses must be as low as possible, in compliance with the ALARA principle.
The repository operator will provide personal protective equipment and technical protective means for action in an emergency and for remediation of the consequences of an emergency. A space will be provided at the repository for the storage of the above means and equipment. The repository operator will also provide equipment and technical means for remediation of the consequences of an incident. The authorities that established external organisations will be responsible for their readiness, equipment and level of training.
In the transmission of information and spoken communication, all available telecommunication and IT infrastructure will be used. Repository operator workers will use mobile telephones, stationary telephones, e-mail and the website.
Security service operatives will use mobile telephones, stationary telephones and radios.
In the event of an emergency at the repository, where there is the possibility of the event involving radioactive material, emergency monitoring at the repository site is envisaged. Emergency monitoring will cover radioactivity measurements at the radiation source, measurements of the contamination of equipment and objects and measurements in the

environment, and measurements of the exposure of the operator's workers, intervention personnel and other persons present.

Through the envisaged measures and the actual plan of operation for the repository, the environmental impacts and possible accidents, both during construction and operation and in the envisaged period of control and monitoring after closure, are reduced to the lowest possible degree and to a permissible level in accordance with the valid Slovenian legislation. (For more details see the chapter on the impacts and measures for individual components of the environment.)

2.4 LEGAL REGULATIONS OBSERVED

The regulations in the field of environmental protection that apply to the intended project:

- Environmental Protection Act (Official Gazette of the RS, No. 39/06 – official consolidated version, 49/06 – ZMetD, 66/06 – Constitutional Court Decision, 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/08, 108/09, 108/09 – ZPNačrt-A, 48/12, 57/12, 92/13, 56/15, 102/15, 30/16 and 61/17 – GZ)
- Forests Act (Official Gazette of the RS, No. 30/93, 56/99 – ZON, 67/02, 110/02 – ZGO-1, 115/06 – ORZG40, 110/07, 106/10, 63/13, 101/13 – ZDavNepr, 17/14, 24/15.9/16 – ZGGLRS and 77/16)
- Protection Against Natural and Other Disasters Act (Official Gazette of the RS, No. 51/06 – official consolidated text and 97/10)
- Construction Act (Official Gazette of the RS, No. 102/04 [official consolidated version], 14/05 – [corrigenda], 92/05 [ZJC-B], 93/05 [ZVMS], 111/05 [Constitutional Court Decision], 126/07, 108/09, 61/10 [ZRud-1], 20/11 [Constitutional Court Decision], 57/12, 101/13 [ZDavNepr], 110/13, 19/15, 61/17 [GZ], 66/17 [Constitutional Court Decision])
- Road Traffic Safety Act (Official Gazette of the RS, No. 56/08 – official consolidated text, 57/08 – ZLDUVCP, 58/09 36/10, 106/10 – ZMV, 109/10 – ZCes-1, 109/10 – ZPrCP, 109/10 ZVoz and 39/11 ZJZ-E)
- Transport of Dangerous Goods Act (Official Gazette of the RS, No. 33/06, 41/09, 97/10 and 56/15)
- Decree on environmental encroachments that require environmental impact assessments (Official Gazette of the RS, No. 51/14, 57/15 and 26/17).
- Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment (Official Gazette of the RS, No. 36/09)
- Decree on the types of activity and installation that could cause large-scale environmental pollution (Official Gazette of the RS, No. 57/15)
- Decree on types of measures for remediation of environmental damage (Official Gazette of the RS, No. 55/09)
- Rules on construction sites (Official Gazette of the RS, No. 55/08 and 54/09, as amended)
- Decree on prevention of major accidents and minimisation of the their consequences (Official Gazette of the RS, No. 22/16 and 30/16)

Air:

- Decree on national upper limits for emissions of ambient air pollutants (Official Gazette of the RS, No. 24/05, 92/07, 10/14 and 47/17)
- Decree on ambient air quality (Official Gazette of the RS, No. 09/11 and 8/15).
- Decree on the use of fluorinated greenhouse gases and ozone-damaging substances (Official Gazette of the RS, No. 60/16)
- Decree implementing Regulation (EC) on substances that deplete the ozone layer (Official Gazette of the RS, No. 57/11)

- Decree on arsenic, cadmium, mercury, nickel and polycyclic aromatic compounds in the ambient air (Official Gazette of the RS, No. 56/06)
- Decree on the emission of substances into the atmosphere from stationary sources of pollution (Official Gazette of the RS, No. 31/07, 70/08, 61/09 and 50/13)
- Decree on the prevention and reduction of particle emissions from construction sites (Official Gazette of the RS, No. 21/11)
- Rules on initial measurements and operational monitoring of the emission of substances into the atmosphere from stationary sources of pollution and on conditions for the implementation of monitoring (Official Gazette of the RS, No. 105/08)
- Rules on assessment of the quality of ambient air (Official Gazette of the RS, No. 55/11, 6/15, 5/17)
- Order on the classification of zones, agglomerations and subzones with regard to ambient air pollution (Official Gazette of the RS, No. 38/17)

Soil:

- Decree on limit values, alert thresholds and critical levels of dangerous substances in the soil (Official Gazette of the RS, No. 68/96, 41/04 – ZVO-1)
- Decree on pollution of the soil from the disposal of waste (Official Gazette of the RS, No. 34/08 and 61/11)
- Decree repealing the Decree on the limit input concentration values of dangerous substances and fertilisers in soil (Official Gazette of the RS, No. 19/17)

Water:

- Waters Act (Official Gazette of the RS, No. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14 and 56/15)
- Decree on the state of groundwater (Official Gazette of the RS, No. 25/09, 68/12 and 66/16)
- Decree on the state of surface water (Official Gazette of the RS, No. 14/09, 98/10, 96/13, 24/16)
- Decree on the emission of substances and heat in the discharge of wastewater into waters and the public sewage system (Official Gazette of the RS, No. 64/12, 64/14 and 98/15)
- Decree on the emission of substances in the discharge of landfill effluent (Official Gazette of the RS, No. 62/08)
- Decree on the emission of substances in the discharge of rainwater runoff from public roads (Official Gazette of the RS, No. 47/05)
- Decree on the discharge and treatment of municipal wastewater and rainwater runoff (Official Gazette of the RS, No. 88/11, 8.12 and 108/13)
- Ordinance on the discharge and treatment of municipal wastewater and rainwater runoff in the Municipality of Krško (Official Gazette of the RS, No. 73/12 and 84/13)
- Rules on the monitoring of groundwater (Official Gazette of the RS, No. 31/09)
- Rules on monitoring the state of surface water (Official Gazette of the RS, No. 10/09, 81/11, 73/16)
- Rules on drinking water (Official Gazette of the RS, No. 19/04, 35/04, 26/06, 92/06, 25/09, 74/15 and 51/17)

Noise:

- Decree on the limit values of noise indicators in the environment (Official Gazette of the RS, No. 43/18)
- Rules on initial assessment and operational monitoring for sources of noise and conditions for the implementation of monitoring (Official Gazette of the RS, No. 105/2008)
- Rules on measuring maximum permitted levels of noise in the residential and natural environment (Official Gazette of the SRS, No. 19/1977 and RS, No. 70/1996)
- Ordinance on the maximum permitted levels of noise for individual areas of the natural and residential environment and for residential premises (Official Gazette of the SRS, No. 29/1980, Official Gazette of the RS, No. 45/1995, 14/1999) – only those provisions governing the permitted levels of noise in premises sensitive to noise apply

- Rules on noise emissions from machinery used in the open air (Official Gazette of the RS, No. 106/02, 50/05, 49/06 and 17/11)
- Rules on the soundproofing of buildings (Official Gazette of the RS, No. 14/99, 110/02 and 10/12)
- Rules on protection of buildings against noise (Official Gazette of the RS, No. 10/12)
- Decree on the assessment and regulation of noise in the environment (Official Gazette of the RS, No. 121/04)

Light pollution:

- Decree on limit values for light pollution of the environment (Official Gazette of the RS, No. 81/07, 109/07, 62/10 and 46/13)

Waste:

- Decree on Waste (Official Gazette of the RS, No. 37/15 and 69/15)
- Decree on the management of waste arising from construction work (Official Gazette of the RS, No. 34/08)
- Decree on pollution of the soil from the disposal of waste (Official Gazette of the RS, No. 34/08 and 61/11)
- Decree on the management of packaging and packaging waste (Official Gazette of the RS, No. 84/06, 106/06, 110/07, 67/11, 18/14 and 57/15)
- Decree on the management of batteries and accumulators and waste batteries and accumulators (Official Gazette of the RS, No. 03/10, 64/12 and 93/12)
- Decree on waste oils (Official Gazette of the RS, No. 24/12)

Cultural heritage:

- Cultural Heritage Protection Act (Official Gazette of the RS, No. 16/08, 123/08, 8/11 – ORZVKD39, 90/12, 111/13 and 32/16)
- Rules on the cultural heritage register (Official Gazette of the RS, No. 66/09)
- Rules on conservation plans for renovation (Official Gazette of the RS, No. 76/10)
- Rules on lists of types of heritage and conservation guidelines (Official Gazette of the RS, No. 102/10)

Nature:

- Nature Conservation Act (Official Gazette of the RS, No. 96/04 - official consolidated text, 61/06 – ZDru-1, 8/10 – ZSKZ-B and 46/14)
- Rules on the assessment of the acceptability of impacts caused by the implementation of plans and changes to the natural environment in protected areas (Official Gazette of the RS, No. 130/04, 53/06, 38/10 and 3/11)
- Decree on types of natural values (Official Gazette of the RS, No. 52/02 and 67/03)
- Decree on protected wild animal species (Official Gazette of the RS, No. 46/04, 109/04, 84/05, 115/07, 96/08, 36/09, 102/11 and 15/14)
- Decree on protected wild plant species (Official Gazette of the RS, No. 46/04, 110/04, 115/07, 36/09 and 15/14)
- Decree on protected wild fungus species (Official Gazette of the RS 58/11)
- Decree on Special Protection Areas (Natura 2000 Areas, Official Gazette of the RS, No. 49/04, 110/04, 59/07, 43/08, 8/12, 33/13, 35/13 – corrigenda, 39/13 – Constitutional Court Decision, 3/14, 21/16)
- Decree on habitat types (Official Gazette of the RS, No. 112/03, 36/09 and 33/13)
- Decree on ecologically important areas (Official Gazette of the RS, No. 48/04, 33/13, 99/13 and 23/15)
- Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS, No. 82/02 and 42/10)
- Rules on the designation and protection of valuable natural features (Official Gazette of the RS, No. 111 /04, 70/06, 58/09, 93/10 and 23/15)
- Decree on protection forests and special purpose forests (Official Gazette of the RS, No. 88/05, 56/07, 29/09, 91/10, 1/13 and 39/15)

Ionising radiation:

- Ionising Radiation Protection and Nuclear Safety Act (Official Gazette of the RS, No. 102/04 – official consolidated text, 70/08 – ZVO-1B, 60/11 and 74/15)
- Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS, No. 36/04, 103/06 and 92/14)
- Rules on radioactive waste and spent fuel management - JV7 Rules (Official Gazette of the RS, No. 49/06)
- Rules on the monitoring of radioactivity (Official Gazette of the RS, No. 20/07 and 97/09)
- Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16)
- Rules on the obligations applying to entities conducting radiation practices and holders of ionising radiation sources (Official Gazette of the RS, No. 3/17 and 8/17)
- Decree on areas of restricted land use occasioned by a nuclear facility and the construction conditions applying to these areas (UV3, Official Gazette of the RS, No. 92/14)
- Decree on radiation activities (UV1, Official Gazette of the RS, No. 19/18)
- Decree on dose limits, radioactive contamination and intervention levels (Official Gazette of the RS, No. 18/18)
- Rules on operational safety of radiation and nuclear facilities - JV9 Rules (Official Gazette of the RS, No. 81/16)
- Resolution on the National Programme for Radioactive Waste and Spent Nuclear Fuel Management 2016-2025 (Official Gazette of the RS, No. 31/16).

Construction of the LILW repository is defined to the greatest extent by:

- Decree on the detailed plan of national importance for a low- and intermediate-level radioactive waste repository at Vrbina, Municipality of Krško (Official Gazette of the RS, No. 114/09 and 50/12)
- Ordinance on the spatial planning strategy of Slovenia (Official Gazette of the RS, No. 76/2004 and 33/07)
- Ionising Radiation Protection and Nuclear Safety Act (Official Gazette of the RS, No. 102/04 – official consolidated text, 70/08 – ZVO-1B, 60/11 and 74/15)
- Environmental Protection Act (Official Gazette of the RS, No. 39/06 – official consolidated version, 49/06 – ZMetD, 66/06 – Constitutional Court Decision, 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/08, 108/09, 108/09 – ZPNačrt-A, 48/12, 57/12, 92/13, 56/15, 102/15 and 30/16)
- Resolution on Nuclear and Radiation Safety in the Republic of Slovenia 2013-2023 (Official Gazette of the RS, No. 56/13)
- Decree on areas of restricted use due to nuclear facilities and on the conditions of construction (Official Gazette of the RS, No. 36/2004, 103/06, 92/14)
- Fund for the Financing of the Decommissioning of Krško NPP and the Disposal of RW from Krško NPP Act (Official Gazette of the RS, No. 75/94, 24/2003)
- Directive on the assessment of the effects of certain public and private projects on the environment, including those that deal with the disposal and long-term storage of radioactive waste (Directive 85/337/EEC, Directive 97/11/EC)
- Directive on informing the general public about health protection measures to be applied and steps to be taken in the event of a radiological emergency (Directive 89/618/Euratom)
- Directive on the operational protection of outside workers exposed to the risk of ionising radiation during their activities
- in controlled areas (Directive 90/641/Euratom)
- Directive on the supervision and control of shipments of radioactive waste between Member States and into and out of the Community, including procedures of compulsory notification in the event of such shipments, and strict restrictions and criteria regarding export to third countries (Directive 92/3/Euratom)

- Directive laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (Directive 96/29/Euratom)
- Directive on health protection of individuals against the dangers of ionising radiation in relation to medical exposure, and repealing Directive 84/466/Euratom (Directive 97/43/Euratom) and Directive on the control of high-activity sealed radioactive sources and orphan sources (Directive 2003/122/Euratom)
- Directive on management of spent fuel and radioactive waste (Directive 2011/70/Euratom)

3 ALTERNATIVE SOLUTIONS

In Slovenia, which is among the countries with a nuclear programme, proper provision for the final disposal of low and intermediate level radioactive waste has **not yet been made**; therefore, a permanent nuclear waste repository needs urgently to be arranged. With the construction of the repository, a long-term solution to the issue of LILW management will thus be established.

The repository at the Vrbina site in the municipality of Krško is designed for permanent disposal of low and intermediate level radioactive waste generated in Slovenia.

The selected variant of an underground silo therefore improves the method and safety of disposal, as well as radioactive waste management in the entire territory of Slovenia.

The solutions for the LILW repository at the Vrbina, Krško site are based on established solutions around the world for LILW disposal, on previous domestic solutions and experiences and on solutions that have been verified and defined in the process of spatial placement of the repository and in previously formulated phases of the repository project. The repository will be provided with all structures, systems and installations required for operation of the repository as an independent nuclear facility.

Optimisation of the design plans, which was aimed principally at reducing the costs of construction and operation of the repository and at the same time increasing the technical feasibility and environmental safety, began in 2010, when a significant optimisation step was taken whereby the **conditioning of LILW for disposal would not be performed at the repository, but at Krško NPP and only disposal would take place at the repository**.[75]

3.1 ALTERNATIVE SOLUTIONS STUDIED (AS REGARDS SITING THE PROJECT IN THE ENVIRONMENT AND THE SELECTED CONSTRUCTION, TECHNICAL AND TECHNOLOGICAL SOLUTIONS)

ALTERNATIVES FOR THE SITE OF THE LILW REPOSITORY

On the initiative of the Environment Minister, with the aim of planning and physical siting of the repository in line with the envisaged deadlines, the Programme for the preparation of the national site development plan for a LILW repository (Official Gazette of the RS, No. 128/04) was published on 30 November 2004. Based on the Programme for the preparation of the national site development plan, the formulation of the National Site Development Plan began. In the procedure of drawing up the Programme the Spatial Planning Directorate at the Ministry of the Environment held a spatial planning conference on 11 November 2004.

[75] Technology Development for Disposal Plans, Rev. A, IBE, Project Number NRVB-B052/069-1, Ljubljana, 2010

A specific feature of the procedure of drawing up a national site development plan for a LILW repository is the parallel inclusion of an expert assessment and the acquisition of local site bids, and ensuring a high degree of public participation. In order to include the local public, a local partnership was organised, while expert assessment was provided through an independent review of the material publicly unveiled in the procedure of drawing up the detailed plan of national importance. The general characteristics of the combined procedure are transparency, adaptability, and the inclusion and participation of the public while taking into account safety and environmental protection demands.

In accordance with the Programme, on 1 December 2004 all Slovenian municipalities were invited to take part in the procedure of searching for a repository site. By the deadline for submitting applications, 4 May 2005, eight municipalities had announced their intention to participate.

After prior verification of the appropriateness and coordination with municipalities, in the period **from May to October 2005 the Agency for Radwaste Management (ARAO) conducted a pre-comparative study to evaluate 12 sites in five Slovenian municipalities**. For each site a feasible variant for the repository was defined. **For the potential site of Vrbina in the municipality of Krško the variant of disposal in underground box-like cells was thus defined as appropriate. The selected combination of location/facility at the Vrbina site was evaluated in the pre-comparative study, together with the proposals at the other sites under consideration, in terms of safety, technical functionality, economy, environment, spatial planning and social dimensions.**

This led to the production in June 2005 of:

- an Assessment of the spatial aspect of potential sites for the LILW repository, produced by DDC, which looked at four sites – Vrbina, Rakovnik, Mraševski Gaj and Globoko – and an
- Expert Opinion, Evaluation of the environmental aspects of the potential sites for disposal of LILW, produced by mag. Jorg Hodalič, univ.dipl.inž.biol., in which he discussed 25 microlocations, where for each separate site he took into account the variant of an above-ground (indicated as Nadz) and variant of an underground (indicated as Podz) repository.

The Assessment of the spatial aspect of potential sites for the LILW repository gave a key assessment that the arrangement of a LILW repository in terms of amending municipal plans was least problematic at the Vrbina and Mraševski gaj sites. Despite the fact that the municipality was not favourably disposed towards the Mraševski gaj site, that site was included in the relevant study.

The Expert Opinion, Evaluation of the environmental aspects of the potential sites for disposal of LILW, discussed the following sites:

1. In the municipality of Lenart in Slovenske gorice: Črmljenšak Nadz (municipality of Lenart 1), Črmljenšak Podz (municipality of Lenart 2), Osek Nadz (municipality of Lenart 3), Osek Podz (municipality of Lenart 4) and Gašteraj Nadz & Podz (municipality of Lenart 5 + 6); together 6 microlocations.
2. In the municipality of Krško: Vrbina Nadz & Podz (municipality of Krško 1 + 2); together 2 microlocations.

3. In the municipality of Brežice: Globoko mine Nadz (municipality of Brežice 1), Globoko mine Podz (municipality of Brežice 2), Globoko Agraria Nadz & Podz (municipality of Brežice 3 + 4); together 4 microlocations.
4. In the municipality of Šmartno pri Litiji: Rakovnik Podz (municipality of Šmartno 1, which IBE calls 'Rakovnik 1'), Rakovnik DvNadz (municipality of Šmartno 2, which IBE calls 'Rakovnik 2') and Rakovnik Nadz (municipality of Šmartno 3, which IBE calls 'Rakovnik 3'); together 3 microlocations.
5. In the municipality of Sevnica: Krmelj Nadz (municipality of Sevnica 1), Krmelj Podz (municipality of Sevnica 2), Hruševaj Nadz (municipality of Sevnica 3), Hruševaj Podz (municipality of Sevnica 4), Podgorje Nadz (municipality of Sevnica 5), Podgorje Podz (municipality of Sevnica 6), Kompolje Nadz (municipality of Sevnica 7), Kompolje Podz (municipality of Sevnica 8), Čagoš Nadz (municipality of Sevnica 9) and Čagoš Podz (municipality of Sevnica 10); together 10 microlocations.

In the Expert Opinion, Evaluation of the environmental aspects of the potential sites for disposal of LILW, for the municipalities of Lenart in Slovenske gorice, Krško, Brežice, Šmartno pri Litiji and Sevnica a conclusive assessment was made that in environmental terms the following microlocations would be most appropriate for a LILW repository:

- Vrbina Nadz & Podz in the municipality of Krško between the nuclear power plant and urban waste disposal site (less demanding),
- Čagoš Podz in the municipality of Sevnica above the Krško - Sevnica road, right bank (less demanding),
- Globoko Mine Podz in the municipality of Brežice (less demanding) and
- Krmelj Podz Fortuna site (second entrance to the mine) in the municipality of Sevnica (less demanding).

In accordance with the Programme for the preparation of the national site development plan and after prior verification and coordination with the municipalities, in October 2005 a Pre-comparative Study was produced for the selection of three potential sites for the LILW repository, which weighed up and evaluated 12 potential sites in five municipalities. The three most appropriate potential sites were proposed: Vrbina in the municipality of Krško, Čagoš in the municipality of Sevnica and Globoko in the municipality of Brežice. On 17 November 2005, based on a briefing regarding the Pre-comparative Study, the Slovenian Government issued decision 35402-3/2005/5 approving continuation of the procedure of drawing up the detailed plan of national importance for the proposed three potential sites, for which a Variant Study would be made and possible variants of setting up the repository would be examined.

The aforementioned three sites earned the highest overall assessments and were identified for more detailed evaluation in the further procedure of selecting the repository site. The potential sites were identified within the municipalities of Sevnica, Krško and Brežice.
Based on the Programme and in line with the Government decision, on 11 January 2006 the Spatial Planning Directorate issued a call to those responsible for spatial planning arrangements to provide guidelines for drawing up a detailed plan of national importance for the three sites (Čagoš, Vrbina and Globoko). The call enclosed material for obtaining guidelines indicating the outline possible designs for the repository at the individual sites. In this period the programme of in situ field investigation for all three potential sites was drawn up. For the planned spatial arrangement, the competent entities responsible for spatial

planning arrangements identified in the Programme provided guidelines, and the guidelines were analysed.

ALTERNATIVE SOLUTIONS FOR THE METHOD OF DISPOSAL

In the material for obtaining guidelines and in the investigation programme, it was assumed for the potential site of Vrbina that it would be possible to construct various variants of repository facilities at the site. The original design of disposal in underground box-like disposal cells was supplemented with additional designs of disposal in buried silos, fully underground silos and tunnels and surface disposal. Expanding the possible variants for disposal was aimed mainly at formulating the most detailed and comprehensive investigation programme possible, whereby data could be obtained for the needs of planning all the potential disposal solutions. At the same time the selection of potential solutions for disposal facilities at the favourably assessed potential site of Vrbina was set out so as to ensure the possibility of developing the greatest possible number of variants. It covered the following variants:

Variant A – Disposal in buried box-like cells;
Variant B – Disposal in buried silos;
Variant C – Disposal in underground silos;
Variant D – Disposal in tunnels; and
Variant E – Surface disposal.

Activities in the area of the design concept of the repository began to be intensively implemented in May 2006 with the elaboration of the Design Bases as one of the basic starting points for design. During the formulation of the Design Bases, the Municipality of Brežice adopted a decision to withdraw the Globoko site from the procedure and to try to identify an alternative site to participate in the procedure. Since after the call for the submission of guidelines back in March 2006 the Municipality of Sevnica had already withdrawn from the procedure, the formulation of the Design Bases proceeded only for the Vrbina site. At the same time, in July 2006 work began on the **expert basis for studying variants only for the Vrbina site**. As part of the formulation of the expert basis for the Variant Study, produced in August 2006, the technical adequacy was checked for the recorded alternative solutions of repository facilities at the Vrbina site.

As part of the formulation of the expert basis for the Study of Variants, the technical adequacy was checked for the alternative solutions of repository facilities at the Vrbina site. A more detailed analysis of the existing geological data, the results of previous geological research and other factors of feasibility for the alternatives showed that all the alternative solutions for disposal facilities differed in their technical appropriateness, and that some were practically infeasible. The selection of technically appropriate variants was carried out in a professional assessment procedure by the project designer. The following variants were identified as technically appropriate:
Variant B – Disposal in buried silos;
Variant D – Disposal in tunnels;
Variant E – Surface disposal.

In December 2006, expert groundwork was carried out for the selected variants with a view to the Variant Study.
At the same time as the expert groundwork for the selected variants with a view to the Variant Study, in September 2006 expert groundwork was carried out for the special safety analysis. This period also saw the conclusion of important studies in the area of characterisation of LILW at Krško NPP and in the area of possible concepts of LILW disposal at potential sites in Slovenia.
For the needs of the Variant Study, a multilateral assessment of the acceptability of the activity was made by comparing variants from five aspects – the functional, safety, environmental, spatial and economic aspects – as well as the aspect of acceptability in the local environment.
The overall assessment of the evaluation showed that the solution with silo disposal units (Variant B) shows the highest degree of suitability for construction at the Vrbina site.

Expert groundwork for all three variants of disposal at the Vrbina site was addressed in greater detail in 2007 in the Conceptual Design. ARAO requested a review of the proposal from the IAEA, which formed a special working group for this purpose. The findings are given in the IAEA report.

For Variant B, which proved to be the most appropriate in the evaluation process and mutual comparison in the Variant Study, an amended draft national site plan was prepared, which was publicly unveiled together with the Variant Study and the environmental report. The public unveiling lasted from 1 February to 7 March 2008. As a condition for issuing an opinion on the proposed national site plan the municipality requested an independent evaluation of the results of the Variant Study and an evaluation of the acceptability of the solutions.

Creation of the investment documentation proceeded at the same time as the formulation of the expert basis and project design documentation for the LILW repository. In this way the document identifying the investment project was created in 2005, and in 2006 the economic study was produced as part of the Variant Study. The pre-investment plan was formulated in 2008.
Taking into account the guidelines of those responsible for spatial planning, the procedure of drawing up the detailed plan of national importance for the Vrbina site in the municipality of Krško involved the production of the Expert Basis for the Variant Study, the Expert Basis for the special safety analysis, the Variant Study, the Environmental Report and Special Safety Analysis.

After withdrawing the Globoko site, in 2007 the municipality of Brežice embarked on searching for new potential sites, and in February 2007 it proposed the new site of Gornji Lenart, for which in July 2007 a revised Pre-comparative Study was produced. On 23 August 2007 the Slovenian Government was briefed on the revised Pre-comparative Study and determined that the process of drawing up the detailed plan of national importance should continue at two potential sites, Vrbina and Gornji Lenart, and that for the individual proposed potential site a Variant Study should be produced to examine all possible variants of setting up a repository.

Up until May 2007 the process of physically siting the LILW repository proceeded in accordance with the Spatial Planning Act (Zakon o urejanju prostora, ZUreP-1), then after adoption of new spatial planning legislation it proceeded in accordance with the Spatial Planning Act (Zakon o prostorskem načrtovanju, ZPNačrt). The national site plan was renamed the detailed plan of national importance (DPN).
Placing the repository at the Gornji Lenart site was abandoned owing to the guidelines of the Slovenian Environment Agency, whereby the site was defined as unacceptable owing to the flood threat and reduced flood plain for the River Sava.

In line with the expert basis, in December 2007 the producer of the DPN, Acer Novo mesto d.o.o. and Savaprojekt d.d., Krško, produced a supplemented draft detailed plan of national importance, which was publicly unveiled from 1 February 2008 to 7 March 2008. A public hearing was held on 14 February 2008.

As part of the public unveiling at the headquarters of the organisation producing the DPN, in the premises of the Municipality of Krško and the Local Partnership and in the Local Communities of the town of Krško (Dolenja vas pri Krškem, Leskovec pri Krškem and Krško polje) and as part of the public hearing, the public was informed of the supplemented draft detailed plan of national importance, the environmental report and other expert bases (Variant Study, Special Safety Analysis, Conceptual Design) and made comments. In addition to the public unveiling, the public was also informed of the positions regarding the comments and suggestions from the unveiling and of the amended solutions in the DPN formulated on the basis of the adopted positions.

At the request of the Krško Municipal Council an independent review was made of the supplemented draft DPN for the LILW repository at Vrbina in the municipality of Krško, of the Environmental Report, Variant Study, Special Safety Analysis for siting the LILW repository, the Conceptual Design and other expert groundwork (Seismological Analysis of the site, a study of the regulations in the area of earthquake-proof construction and the Recommendations for the seismic loading of the near-surface LILW repository at Vrbina). The purpose of the independent review was to confirm the technical acceptability of the selected variant.

The positions regarding the public’s comments and suggestions from the public unveiling were confirmed on 30 March 2009. On 24 April 2009 the draft detailed plan of national importance was sent to the competent entities responsible for spatial planning for an opinion, including an opinion on the acceptability of the environmental impacts of the DPN.

The positive opinion of the Municipality of Krško, which was obtained on 9 July 2009, was important for the continuation of the process of drawing up the DPN. In its positive opinion the Municipality approved the siting of the repository and the social acceptability of the repository in the local environment.

In the period from May to December 2009, all the relevant opinions were obtained from those responsible for spatial planning, including opinions on the acceptability of the environmental impacts of the DPN. Based on coordination with the Slovenian Nuclear Safety Administration and the Slovenian Environment Agency’s Office of Water Management, and with the

Ministry of Agriculture, Forestry and Food, a harmonised draft detailed plan of national importance was produced in December 2009. Coordination with the Environment Agency's Office of Water Management focused on flood safety, the safety of groundwater aquifers, positioning in the geological environment and on observance of the valid legislation. An additional study entitled Consequences of constructing the Vrbina LILW repository on the economics of agricultural production was sent to the Ministry of Agriculture, Forestry and Food in November 2009.

The process of drawing up a harmonised draft detailed plan of national importance involved studying the hydrological, geological, spatial, environmental and other conditions in the area of the envisaged location and the logical heeding of comments and suggestions from the local communities. The harmonised draft detailed plan of national importance was the result of interdisciplinary work.

After confirmation on 17 December 2009 from the Environment Directorate at the Ministry of the Environment that the impacts of implementing the detailed plan of national importance on the environment were acceptable, on 30 December 2009 the Slovenian Government adopted the Decree on the detailed plan of national importance for a low- and intermediate-level radioactive waste repository at Vrbina, Municipality of Krško. The Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško was published in the Official Gazette of the RS (Official Gazette of the Republic of Slovenia) No. 114/09 of 31 December 2009, and entered into force on the 15th day after publication.

In the process of drawing up the detailed plan of national importance the following important documents were created:

- **Variant Studies**
- **Environmental Report and**
- **Special Safety Analysis**

Later the optimisation of the project solutions was performed, with the aim principally of reducing the costs of construction and operation of the repository and, at the same time, increasing the technical feasibility. A significant optimisation step was made in 2010, whereby the **conditioning of LILW for disposal would not be performed at the repository, but at Krško NPP and only disposal would take place at the repository.**

At the same time, with further optimisation of technological procedures for conditioning for disposal, **optimisation of the plans for disposal silos** was carried out in 2011, taking into account the recommendations of the IAEA experts. These were mainly aimed at **providing robust and conservatively safe construction solutions and at effective groundwater management during construction**. In 2014, the optimisation of the non-disposal part of the repository was carried out.

Taking into account the reduced scope of investment owing to the conditioning for disposal being performed at Krško NPP, a feasibility study was produced at the end of 2013, and was confirmed by the ministry competent for infrastructure on 8 July 2014. The confirmed feasibility study envisaged construction of the repository for half the LILW that would be generated at Krško NPP up until the end of the extended operating period in 2043, and in decommissioning after the end of operation, and also for the disposal of all Slovenian institutional waste.

3.2 MAIN REASONS FOR SELECTING THE EXISTING SOLUTION

The subject of all the studies of variants under the DPN that have been carried out to date has been the variants of arranging a LILW repository at the Vrbina site in the Municipality of Krško.

All the variants for the LILW repository at Vrbina have envisaged the arrangement of disposal and non-disposal facilities and all the necessary arrangements at the same site, while the differences in the variants have centred on the type of repository (surface, underground) and the construction technology. The evaluation of variants performed as part of the Variant Studies was adapted to these particularities. Thus certain aspects in the study were addressed, although there are no differences between the variants (for instance regional development impacts, part of the content relating to impacts on urban development), since it was assessed that such treatment was necessary since it could contribute to justifying the acceptability and towards seeking the best possible solution on the ground.

In the Variant Studies made in December 2006, three variants were addressed at the Vrbina site as being technically appropriate and feasible solutions:

- Variant B – Disposal in buried silos;
- Variant D – Disposal in tunnels; and
- Variant E – Surface disposal.

For these three variants the following variant studies were carried out:

1. Variant Study (supplemented after review), Folder I, 1st File: Preliminary analysis and determination of variants, compiled by ACER d.o.o. and Sava projekt d.d.
2. Variant Study (supplemented after review), Folder I, 2nd File: Evaluation and comparison of alternative solutions, compiled by ACER d.o.o. and Sava projekt d.d.
3. Variant Study (supplemented after review), Folder I, 3rd File: Proposal of most appropriate solution, compiled by ACER d.o.o. and Sava projekt d.d.
4. Variant Study, Folder I, 4th File: Report on the acceptability of the planned project in the local (social) environment, compiled by ACER d.o.o. and Sava projekt d.d.

Regarding the comparison of variants in the spatial sense the studies are specific about this not being a comparison of various sites for the spatial arrangement, but a comparison of various technological designs for the selected site.

In Variant Study, Folder I, 1st File the obligatory analyses were made in accordance with the spatial regulations of Slovenia as part of the preliminary analyses and identification of variants. The analysis of situations and desired solutions drew on key spatial planning characteristics. The analysis of development prospects highlighted the limitations associated with the nearby Krško NPP and the unattractiveness of the site for residential construction. This study provided an in-depth analysis of the guidelines, with an indication of suitable proposals in terms of observing individual guidelines. The analysis of guidelines concluded with proposals for observing the expert basis and other material and the necessary new studies and expert bases. The variants were presented in detail, so that on this basis it was possible to formulate a clear picture of the construction, operation and closure of the repository.

In Variant Study, Folder I, 2nd File the evaluation and comparison of solutions, in line with the Recommendations, was formulated whereby it drew on key data and findings from individual separate studies. **Based on the comparison and evaluation a final selection was made of the variant for a LILW repository at Vrbina with Variant B**, which in the Variant Study, Folder I, 3rd File is described in detail.

In Variant Study, Folder I, 4th File the report made a logical summarisation of the findings to date regarding acceptability of the planned arrangements in the local (social) environment.

Below we present the main findings determined in the evaluation of the aforementioned three variants.

The variants for the LILW repository at the Vrbina site (Variants B, D and E) were evaluated on the basis of principles and criteria set out for each aspect of comparison separately, and compared with each other from the following aspects:

- spatial development;
- functionality (construction and technical);
- safety (environmental protection and security);
- and the economic aspect.

In evaluating and comparing the variants, account was taken of the scale on which the variants are defined as:

5 – very suitable
4 – more suitable
3 – suitable
2 – less suitable
1 – unsuitable

In the study it was determined that in spatial planning terms there were virtually no differences between the variants, which applies particularly to regional and urban development (programme part), where all the variants were assessed as suitable. There is a minor difference between the variants only regarding the causing of major changes in spatial conditions, since Variant E causes a considerably greater impact than the other variants. This is a consequence of the fact that the repository facilities are envisaged on the surface, which during operation will mean the presence of structures of very large dimension in the physical space, where the surrounding area with the exception of the Krško NPP complex is broken up into fairly small pieces with small-scale buildings (mainly residential structures). After closure of the repository, in Variant E large tumuli will remain on the surface as a completely new landscape relief that will be created with the covering of the disposal facilities.

From the functional aspect, which is extremely complex, Variants B and E were very much equated and more suitable than Variant D, both in the technical construction and functional senses. In this part of the evaluation the variants were assessed as suitable, more suitable and less suitable. In terms of initial works, protection of water sources, dismantling of structures (not envisaged), measures on accompanying infrastructure and the seismic properties of the site, all the variants were equal, as they were regarding functional criteria – access to the land, connection to existing infrastructure – and regarding adaptability to various forms of disposal and various forms of LILW.

Major differences between the variants were apparent regarding occupation of the land, which owing to the extensive underground works would be most extensive in Variant D, and regarding earth works, which in Variants B and D are less extensive than in Variant E. Equally major differences were identified regarding the technology of construction, which in Variant D would be the most challenging and in Variant E the least challenging. The duration of repository construction would be significantly longer for Variant D than for Variants B and E, with the construction time for Variant B a little longer than for Variant E. Variant E was assessed as more suitable regarding the organisation and provision of internal transport, while Variants B and D were equal in this regard.

In the assessment concerning safety, all the variants were assessed as being pretty much equal in terms of their environmental impact. None would cause any impact on Natura 2000 areas, and for most of the areas addressed, all the variants would cause only insignificant environmental impacts, which could be reduced by just some general mitigation measures. The exception to this is the impacts on agricultural areas and soil, the reduction of which would require specific measures (replacement land, prudent management of soil), but with the implementation of these measures the impacts here would also be insignificant. Minor differences between the variants were identified only regarding the impacts on groundwater, for which reason the buried or underground Variants B and D would be less suitable (potential impacts through direct encroachment on the groundwater body), and on the landscape owing to extensive changes to the relief and changes to the physical space in Variant E, and regarding ionising radiation, where Variants B and D would be suitable, with Variant D being the best, while Variant E is assessed as less suitable.

The greatest differences between the variants were identified in the economic evaluation, especially regarding the current value of the investment costs and the costs of expansion, as well as the cost of disposing of LILW per m^3. According to these criteria, Variant D is assessed as less suitable, while Variants B and E are suitable. The variants were assessed as suitable and equal regarding the current value of operating costs.

Table 17: Overview of results of evaluating variants

	Variant B	Variant D	Variant E
I. SPATIAL ASPECT	suitable 1st - 2nd place	suitable 1st - 2nd place	suitable 3rd place
II. FUNCTIONAL ASPECT	more suitable 2nd place	suitable 3rd place	more suitable 1st place
III. SAFETY ASPECT	insignificant impacts 2nd place	insignificant impacts 1st place	insignificant impacts 3rd place
IV. ECONOMIC ASPECT	suitable 1st - 2nd place	less suitable 3rd place	suitable 1st - 2nd place

The study determined that:

- from the spatial aspect, Variants B and D are equal and Variant E is slightly worse;
- from the functional aspect Variant E is only slightly better than Variant B, while Variant D is much worse than both;
- from the safety aspect Variant D is the best, followed with minimal differences by Variant B, while Variant E is the worst, although all three cause only insignificant environmental impacts;
- from the economic aspect Variants B and E are equal, with Variant D being much worse than both.

Looking at the data on what kind of order of preference individual variants fall into for each of the four aspects of evaluation, it is clear that the variants are very much equated, and that it is not possible to spotlight any variant that is better in all aspects. While Variant D is the best in terms of safety, it is worst in the functional and especially economic aspect. Variant E is best in terms of functionality and worst in the spatial and safety aspects. Variant B is not the worst in any aspect, and in the spatial and economic aspects it is equated with the best variant.

A comparison of Variants B and E, which are very much equated, shows that Variant B has a distinct advantage over Variant E because it has been assessed as more acceptable in two very important aspects, the aspect of ionising radiation and the aspect of safety of the population, which we may highlight as key criteria in establishing the LILW repository site. In comparing the order of preference for the variants for each of the four aspects of comparison, it is clear that Variant B is more stable in the assessments and has a relatively high level of adequacy. It is not the best in any aspect, but nor is it the worst, indicating the compromise benefit of this solution in terms of all the aspects addressed.
To illustrate the above assessments by way of conclusion, we may highlight the most important findings regarding the identified advantages and weaknesses of all the variants identified in the study, and the overview of results of the evaluation of the variants.

The weaknesses and advantages identified for individual variants are set out below.
Variant B:
Advantages of Variant B:

+ favourable solution in terms of ionising radiation and safety of the population;
+ good prospects for expansion of disposal capacities;
+ few works on the surface (favourable in terms of impact on the landscape and on the physical space), but more than in Variant D and
+ disposal facilities (or at least the awnings) will be visible, after closure the relief will be unchanged except for the plateau.

Weaknesses of Variant B:

- major encroachment on the subsoil (aspect of nature protection), but less than Variant D;
- challenging construction and maintenance and
- high costs.

Variant D:
Advantages of Variant D:

+ most favourable solution in terms of ionising radiation and safety of the population;
+ lowest anticipated environmental impact;

+ fewest works on the surface (favourable in terms of impact on the landscape and on the physical space) and
+ disposal facilities are not visible.

Weaknesses of Variant D:

- very challenging construction and maintenance;
- poor prospects for expansion of disposal capacities;
- very major encroachment on the subsoil (unfavourable in terms of nature protection);
- very high costs, under one item entirely incomparable with Variants B and E and
- assessed as less suitable.

Variant E:

Advantages of Variant E:

+ good prospects for expansion of disposal capacities;
+ simple construction and maintenance;
+ established type of disposal unit and
+ lowest costs.

Weaknesses of Variant E:

- least favourable solution in terms of ionising radiation and safety of the population;
- greatest anticipated environmental impact;
- greatest surface works, facilities of very large dimensions (bad in terms of impact on the landscape and on the physical space), after closure the relief will be much changed (tumuli) and
- extensive disposal structures visible from the surrounding hills.

Based on the evaluation and the review of advantages and weaknesses of Variants B, D and E, the study found that the most appropriate Variant is B – disposal in buried silos. It should be underlined here that this involves a comparison of two different concepts of LILW disposal, specifically underground and surface repositories. While the first variant has a facility concealed deep beneath the ground (and for this reason has a somewhat higher degree of safety against ionising radiation), in the second variant the facility is on the surface (and the functioning of the repository is in sight of both the operator and the public). Analysis indicates that safety is ensured in both concepts, and the issue is more about psychology. For this reason the selection decision depends in part on the response of the public in the local environment, which will be ascertained in public discussions within the local community.

In order to more easily picture the alternatives, below we offer graphic illustrations of the individual variants.

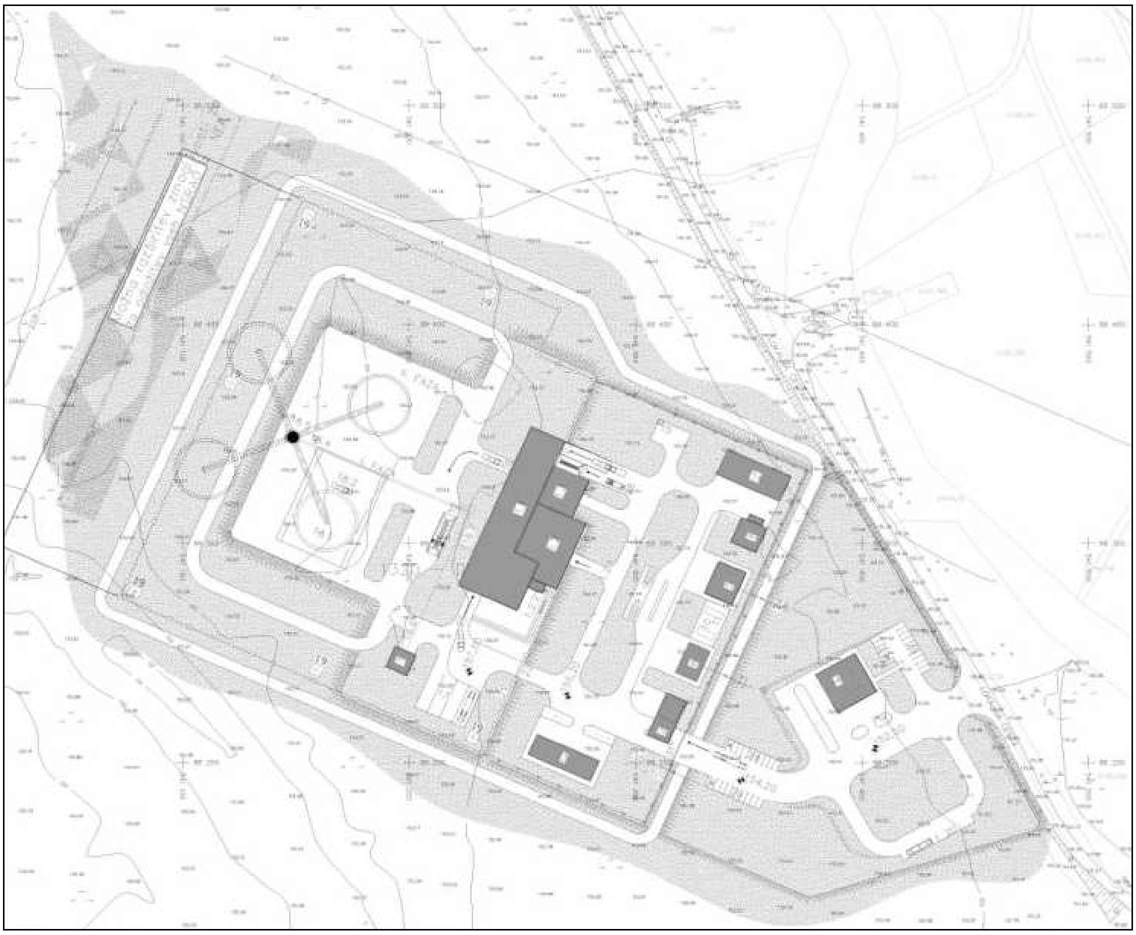


Figure 16: Variant B – Buried silo (during operation) – layout

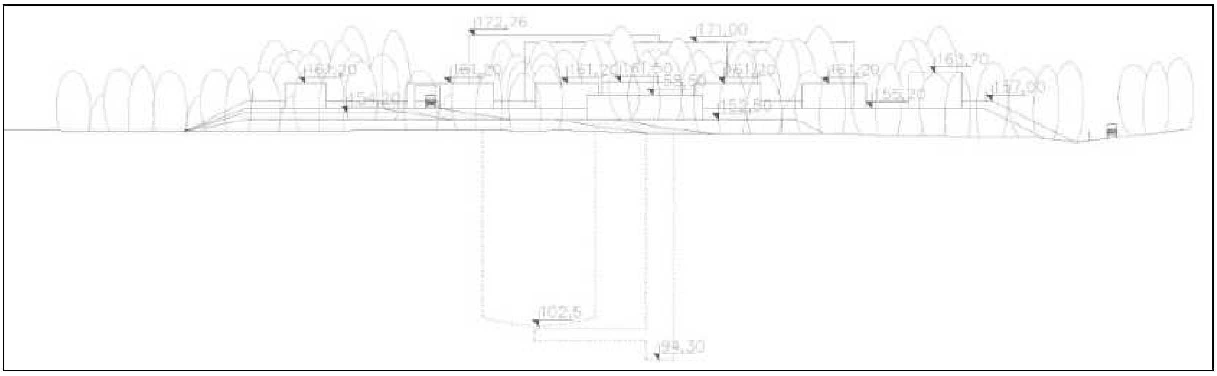


Figure 17: Variant B – Buried silo (during operation) – cross section

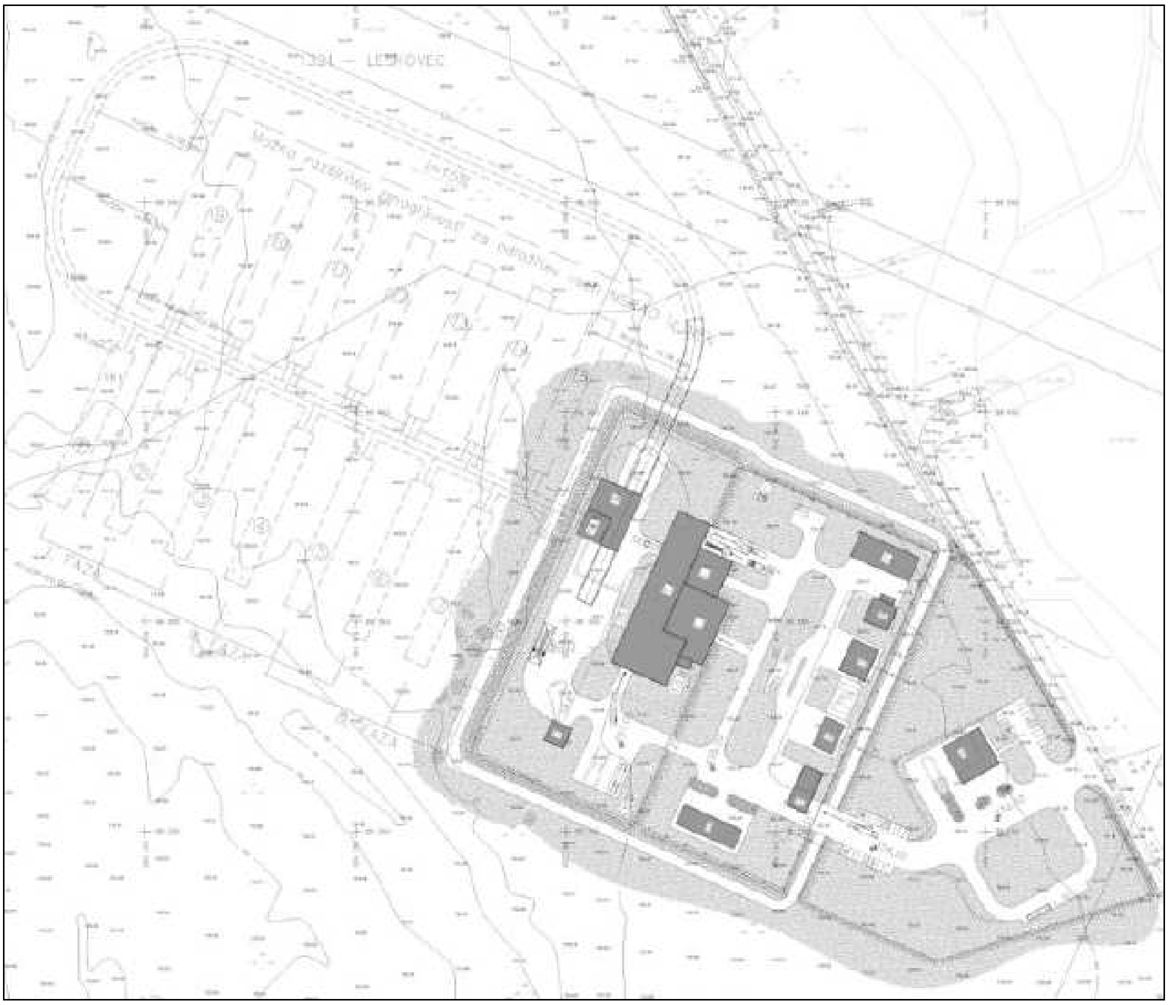


Figure 18: Variant D – Buried in tunnels (during operation) – layout

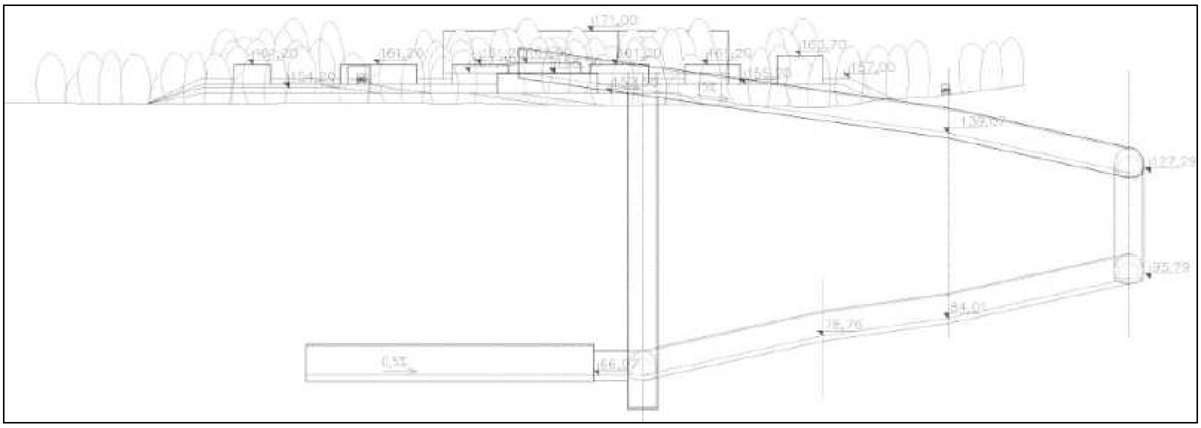


Figure 19: Variant D – Buried in tunnels (during operation) – cross section

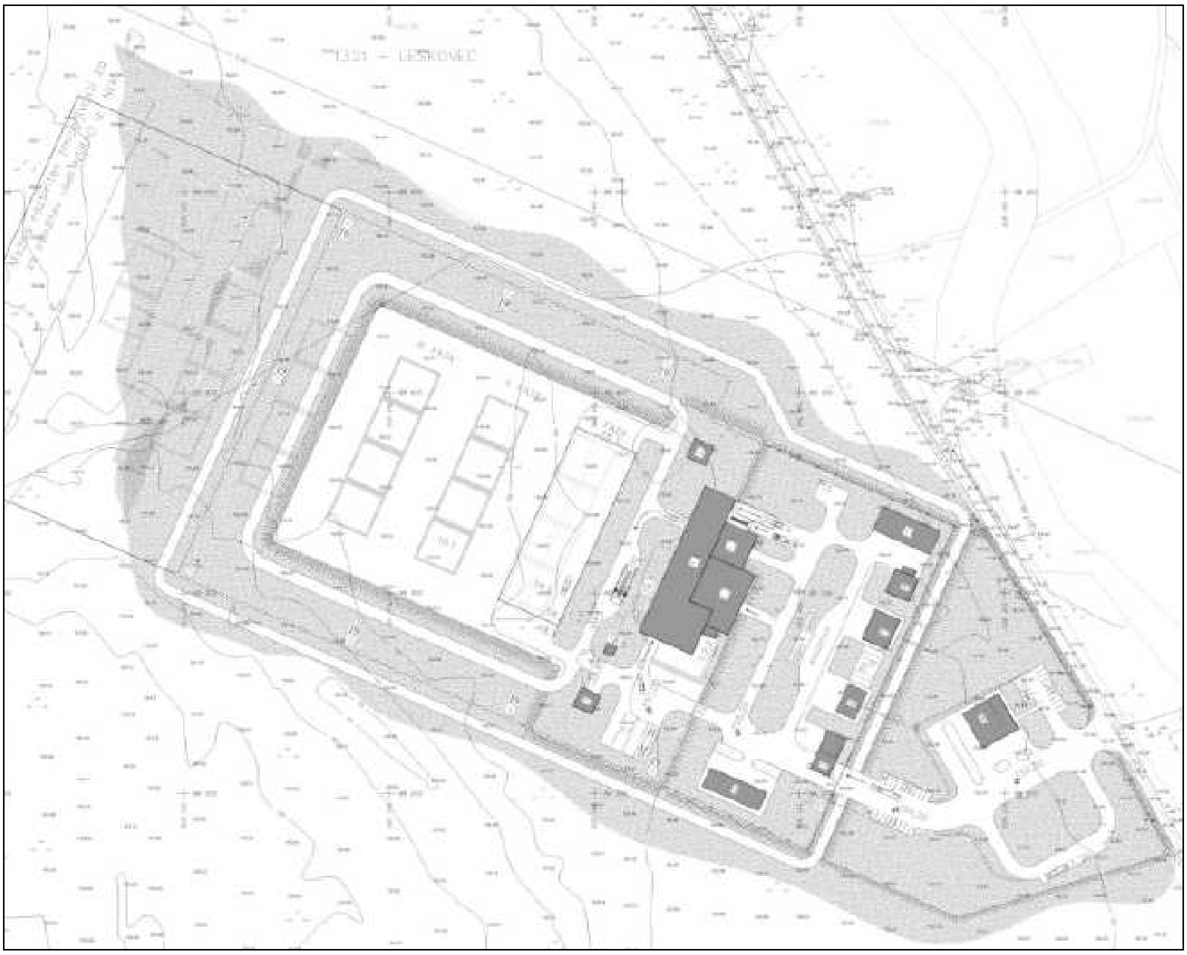


Figure 5: Variant E – Surface disposal (during operation) – layout

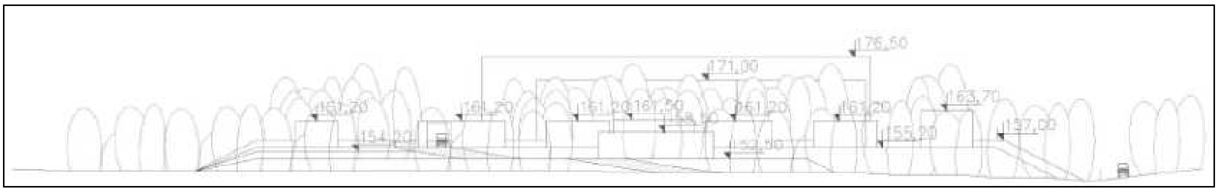


Figure 6: Variant E – Surface disposal (during operation) – cross section

<u>Proposals for further optimisation from the comprehensive environmental impact assessment phase:</u>

In the implementation of Variant B it is recommended that steps be taken to considerably reduce the anticipated negative impacts, in particular:

- checking the possibility of constructing an internal road between Krško NPP and the LILW repository, along which LILW would be transported during operation;
- non-disposal facilities will need to have high-quality urban planning and architectural design, incorporating modern design approaches. In selecting the colour of the facilities it is recommended that colour tones be used to ensure that in views from

higher ground the structures will not be very visible. Special emphasis in the design of facilities and their arrangement should be placed on the entrance area and visibly exposed parts (especially the views from Vrbina road);
- the organisation and overall expanse of the construction site should be limited to what is essential. On the margins of the construction site the preservation of farmland and its accessibility must be ensured;
- the remediation of surfaces or recultivation of areas damaged during construction should be envisaged;
- the design of the edges and slopes of the flood-protection plateau should be such as to ensure the most natural possible appearance, with gentle transitions of embankments into the existing terrain;
- planting trees as part of the exterior arrangement of the repository; the area of the information centre should be arranged as a park; in planning the planting on the margins of the landscaping area, a selection of vegetation should be ensured and planted either in a natural pattern or in regular grids, which needs to be checked and substantiated in the design; planting should be done in particular with native species; and
- all exterior arrangements should be planned in accordance with modern design approaches, which relates to the actual design, to the selection of construction materials and the selection of planting stock and small street furniture.

All measures for optimisation were taken into account in the preparation of the Conceptual Design, January 2016.

4 DESCRIPTION OF THE EXISTING STATE OF THE ENVIRONMENT

4.1 BASIC CHARACTERISTICS OF THE DEVELOPMENT SITE

The site of the planned low- and intermediate-level waste repository lies on Krško Polje, which is a gravel-filled valley covered with fields and meadows. Two major Slovenian rivers, the Sava and the Krka, flow through the area. Krško Polje is surrounded by low hills. The forest of Krakovski Gozd closes the valley to the west. In the wider sense, we are referring here to a basin which is bounded to the north by the Posavje Hills (*Posavsko hribovje*), to the south by the Gorjanci/Žumberak range, and to the west by the Kočevski Rog plateau and Suha Krajina. In the east it opens out towards Hrvatsko Zagorje. The hilly areas are covered by vineyards, orchards, arable land, meadows and deciduous forests. The valley and plain areas outside Krško Polje are covered by meadows, wetlands, deciduous forests and, to a lesser extent, arable land. There is dispersed settlement in the hilly parts of the Krško Basin, with small, nucleated village centres.

The Vrbina site lies within the Municipality of Krško, in the gravel plain area, with individual depressions formed by the former course of the Sava. The nearest towns of Krško and Brežice are located 2.5 and 5 km from the site, respectively. The site is located approximately 13 km from the border with neighbouring Croatia. Krško NPP is situated approximately 300 m from the western edge of the site. Approximately 400 m north-east of the site is the settlement of Spodnji Stari Grad. The plain on the southern side of the site is bounded by the Sava riverbed, which is approximately 650 m from the repository site at its nearest point. To the north, the plain extends towards Libna Hill. The site is bounded to the east by a local road running SE from the settlement of Vrbina, towards the bank of the Sava. The wider area of the site is used for agriculture and is officially designated prime agricultural land. There are fields within the site itself and a commercial orchard at the site's far western edge.

The core site area contains no particular natural features, protected areas or areas important to biodiversity. There are no cultural heritage units or protected archaeological sites listed in the area. The Spodnji Stari Grad Waste Management Centre is situated near the site. The land lies adjacent to the Brežice–Krško road, referred to as *Vrbinska cesta* or "the Vrbina road"

Figure 26: The Krško Polje/Brežiško Polje area

The essential characteristic of the relief of the core area is the transition from flat lowland to low hills and river terraces, which are a consequence of the action of the river Sava. The LILW repository site lies on the left bank of the Sava, at the edge of Krško Polje, an alluvial plain. The site lies at a height of between 151.69 m and 153.44 m above sea level.

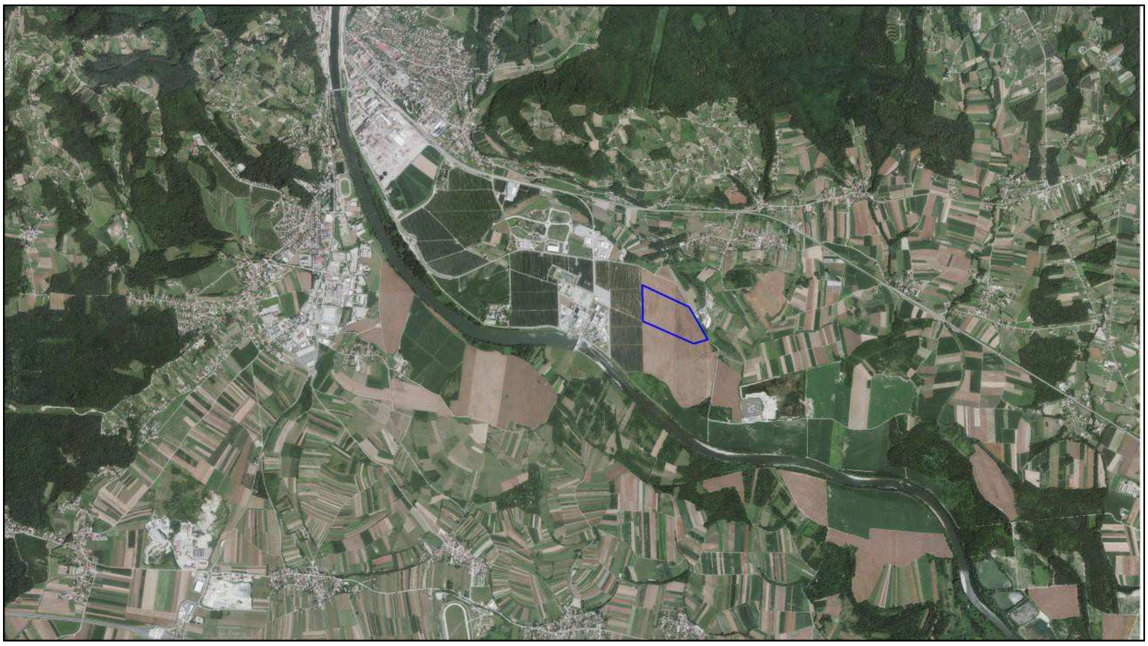


Figure 27: LILW repository site – orthophotograph of the wider surrounding area

4.1.1 *DESCRIPTION OF BASIC METEOROLOGICAL CHARACTERISTICS OF THE AREA*

Meteorological research for the Vrbina LILW repository site was conducted as part of hydrological and meteorological research regarding the siting of the repository.

In the area under examination, the quantity of precipitation declines gradually towards the east. According to data from the traditional meteorological station at Sevnica, located further west, an annual average of 1,100 mm of rain fell in the standard 30-year climatological period of 1961–1990. This figure was approx. 50 mm lower at Sremič and Gornji Lenart. The precipitation regime has distinctive orographic effects (more precipitation in hill areas), also conditioned by the microclimatic conditions. Data broken down by month shows that, on average, the precipitation regime is fairly evenly distributed, with the highest levels in June, July, August and November, and the lowest levels in January and February. The wettest summer months have, on average, around twice the amount of precipitation than the driest winter months. Precipitation is relatively heavy in the summer, which means that it comes chiefly from showers and storms. As in the rest of the country, November is another month of maximum precipitation (albeit with high year-on-year variability) – caused by autumn rain while weather fronts are crossing Slovenia. The months of heaviest precipitation are July and August. Measurements of the half-hourly quantities of precipitation show that the return period for half-hourly quantities of precipitation above 5 mm is approx. two weeks. The return periods for heavier rainfall are: approx. one month for 10 mm or more in half an hour; approx. two and a half months for 20 mm or more in half an hour; approx. six months for 30 mm or more in half an hour; and more than two years for very intense rainfall of more than 40 mm in half an hour. As part of research for the LILW repository, separate measurements were also conducted using automatic recording rain gauges in order to gather detailed information on the variability of precipitation in terms of place and time. The total quantities of precipitation show very minor differences in the quantities measured. A minute-by-minute examination of precipitation distribution shows that several regimes frequently appear: a violent beginning followed by ever calmer precipitation (usually characteristic of storms) or vice versa (light precipitation followed by gradually heavier precipitation, usually associated with frontal precipitation). Snowfall can be expected with considerable certainty in all winter months (December–February), as well as in November and March. It snows only rarely in April and only exceptionally in May. However, standard deviations show that variations between years are considerable even in winter – from fairly "green" to fairly "white". It is interesting to note how much less the variability is at Sremič: when it snows at Sremič, which is 200 m higher, it often rains down in the Sava plain. Therefore, when it snows at Sremič, the snow line is quite often somewhere between 150 and 350 m above sea level, while it is raining down in the area of the LILW repository site.[76]

Measurements from the Krško NPP automatic meteorological station have been used to estimate evaporation. Daily evaporation is calculated from evapotranspiration, where the value of the daily reference evapotranspiration is multiplied by a specific coefficient. The size of the coefficient depends on the average daily values of relative humidity and wind speed. The daily reference evapotranspiration can reach an average of 6.5 mm/day in summer and around 1 mm/day or less in winter.[66]

Relatively hot summers and relatively mild winters are characteristic of the wider Krško area. Average January temperatures are below zero and average July temperatures are almost 20°C. Frequent temperature inversions are typical of the plain; these have a significant effect on the dispersion of particles in the air. They occur mainly at night and in the morning, and usually break down before noon. Inversions are stronger in the winter months. The average height of inversions is around 90 to 110 m.[66]

The winter half of the year is the most humid, although the summer months are, on average, not very dry (average above 75% with low standard deviations). The standard deviations in daily humidity are considerably greater. This means that the air is fairly humid only rarely through the whole month; differences arise between periods, which in the monthly averages balance out the conditions between "dry" and more "humid" days (the latter frequently involving precipitation).[66]

The closest main national meteorological station is Cerklje Airfield, at a height above sea level of 154 m, lon=15.5, lat=45.9. The station is situated approx. 4.3 km south of the envisaged location of the repository at a height of 10 m above the existing terrain. Average wind speed for the period 2005–2012 was 1.8 m/s.

The figure below shows the wind rose for the period 2005–2012 (source: Slovenian Environment Agency, Meteorology Office). The numbers around the circumference of the circle indicate the relative frequency of winds from individual directions and their averaged speed. The colours indicate the relative frequency of winds in an individual speed range. Higher speed ranges can be so rare that they are not visually represented in the figure.

[76] Special safety analysis for spatial placement of the LILW repository, Vrbina site in the Municipality of Krško (Posebna varnostna analiza za umestitev odlagališča NSRAO, Lokacija Vrbina v občini Krško), December 2006. ARAO, DDC, ZDV, ZAG and Imos Geateh

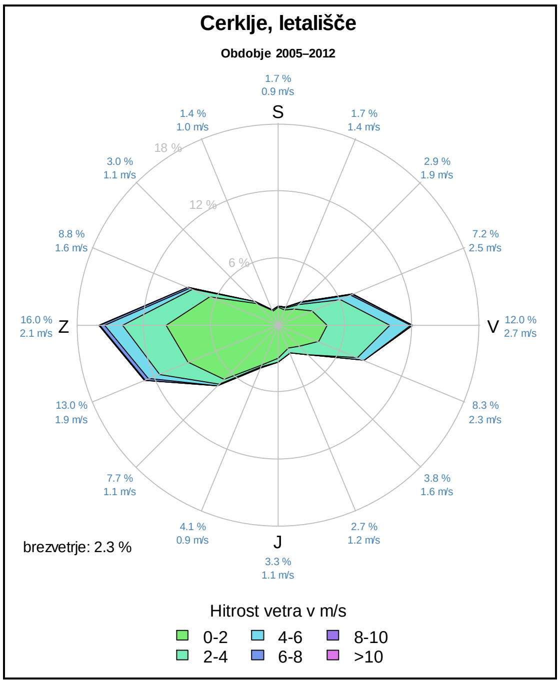


Figure 28: Wind rose for the main meteorological station at Cerklje Airfield for the period 2005–2012 (source: ARSO, Meteorology Office)

Cerklje, letališče	Cerklje, airfield
Obdobje 2005-2012	Period 2005–2012
S	N
Z	W
V	E
J	S
brezvetrje: 2.3%	no wind: 2.3%
Hitrost vetra v m/s	Wind speed (m/s)

Wind is also measured very precisely at the Krško NPP site. The wind rose (frequency from individual directions in % by associated wind speed ranges in m/s) tells us that here, as in the rest of Slovenia, south-westerly and north-easterly winds predominate and that these winds can be relatively strong (over 5 m/s), since the frequency of this speed is very low in other directions.

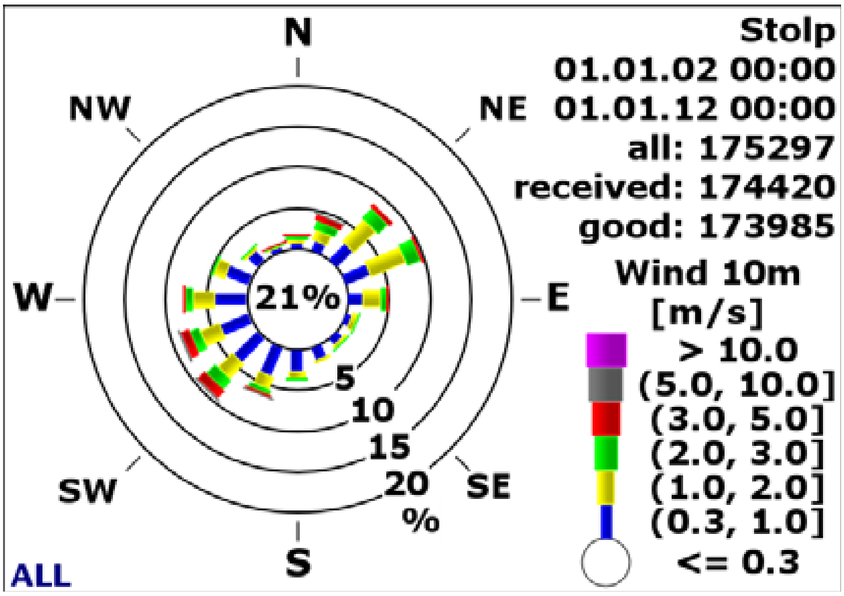


Figure 29: Wind rose at the measuring point on the Krško NPP tower 2002–2011 (source: Krško NPP USAR, Rev. 21)

A study of available solar energy in Slovenia[77] tells us that the supply of solar energy to horizontal ground in this area (without accounting for the shade provided by the hills) is around 1,230 $kWhm^{-2}$. Taking the relief into account tells us how much energy is supplied to sloping ground: slopes that face the sun receive more than slopes that do not.

[77] Sončna energija v Sloveniji [Solar Energy in Slovenia], Damjan Kastelic, Jože Rakovec, Klemen Zakšek, 2007. Založba ZRC

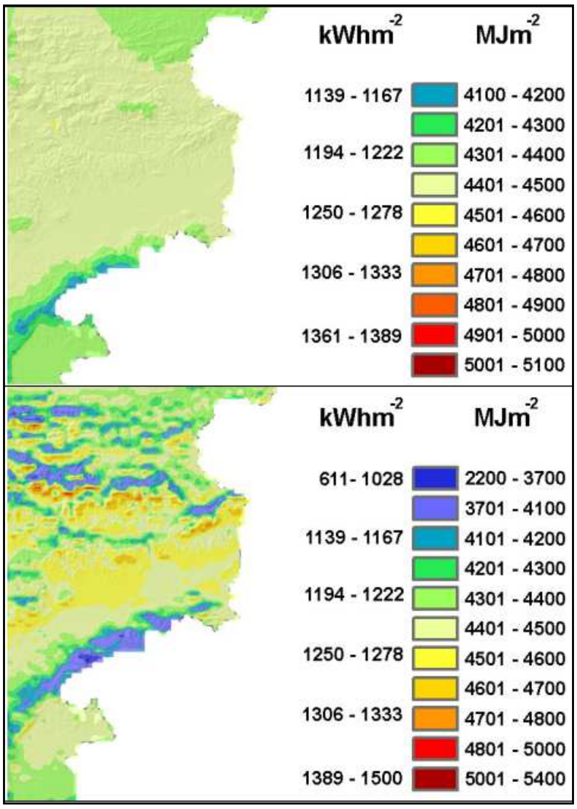


Figure 30: Annual solar radiation energy – above: on horizontal ground, without taking into account obstacles; below – taking into account relief (Kastelec et al., 2005)

4.1.2 *DESCRIPTION OF BASIC GEOLOGICAL CHARACTERISTICS OF THE AREA*

In geotectonic terms, the wider Krško area lies on the NW edge of the sinistral strike-slip Mid-Hungarian zone, near the SE margin of the Sava tectonic wedge characterised by the E–W oriented Sava folds. The principal (leading) structures in the Mid-Hungarian zone are the NE trending ("Balaton") strike-slip faults. The leading (principal) structure of this sinistral strike-slip zone is the Sveta Nedelja fault, on the southern margin of the Gorjanci mountains, and the Zagreb fault running along the southern margin of Mt Medvednica. The Sveta Nedelja fault represents a continuation of the Zagreb fault. The Orlica fault is the north-westernmost of the Balaton faults and exhibits post-Badenian sinistral strike-slip activity. It is therefore considered an external margin of the Mid-Hungarian strike-slip zone. The frequency of the Balaton faults increases from Orlica fault towards the SE.

The Krško syncline is the most prominent plicative structure in the marginal part of the Mid-Hungarian zone. According to the data from seismic and gravimetric surveys and numerous boreholes, the Krško syncline has a NE trend in the central part of the Krško Basin, turning in an E–W direction towards the west, where it approaches the SW continuation of the Orlica fault. The central and eastern parts of the Krško syncline are not parallel to the Balaton faults, since the angle between them is around 30°. Taking into account the sinistral strike-slip character of the Balaton faults, the Krško syncline may represent a "fault-flank depression" between (or related to) the Orlica and Artiče faults to the N, and the set of sub-parallel Balaton faults S of the syncline, observed in the Gorjanci Hills.[78]

The wider area around the site is represented by the Krško Basin, where Mesozoic sediments of unknown thickness lie below the Krško syncline of Tertiary sediments. The oldest Tertiary sediment is Ottnangian clay silicate-gravel with coal. Its granularity is medium to very thick. Above this is erosionally and irregularly placed solid Badenian limestone, covered in places with limestone Sarmatian resediments. These sediments are then covered in the Krško Basin by a 1,000-m-thick layer of Sarmatian fine-grained clastites (well-consolidated clayey carbonate sludge, silt, sandy silt and fine-grained sand) of Pannonian and Pontian age. The last and youngest unit of this area is a covering of Plioquaternary clastites: medium- to -thick-grained Sava gravel of differing thicknesses. The last Quaternary Sava layer is not very thick (up to 15 m).[79] The geological profiles in the area of the LILW repository site are shown in the figures below.

[78] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, Geoinženiring d.o.o., ZAG.

[79] Report on supplementary initial field and laboratory geosphere and hydrosphere research for the potential Vrbina-Krško site (Poročilo o izvedbi programa dopolnilnih začetnih terenskih in laboratorijskih raziskav geosfere in hidrosfere za potencialno lokacijo Vrbina-Krško), Rev 1, J.V. GeoZS, ZAG, Geoinženiring, IRGO, ZZVMB, 2009.

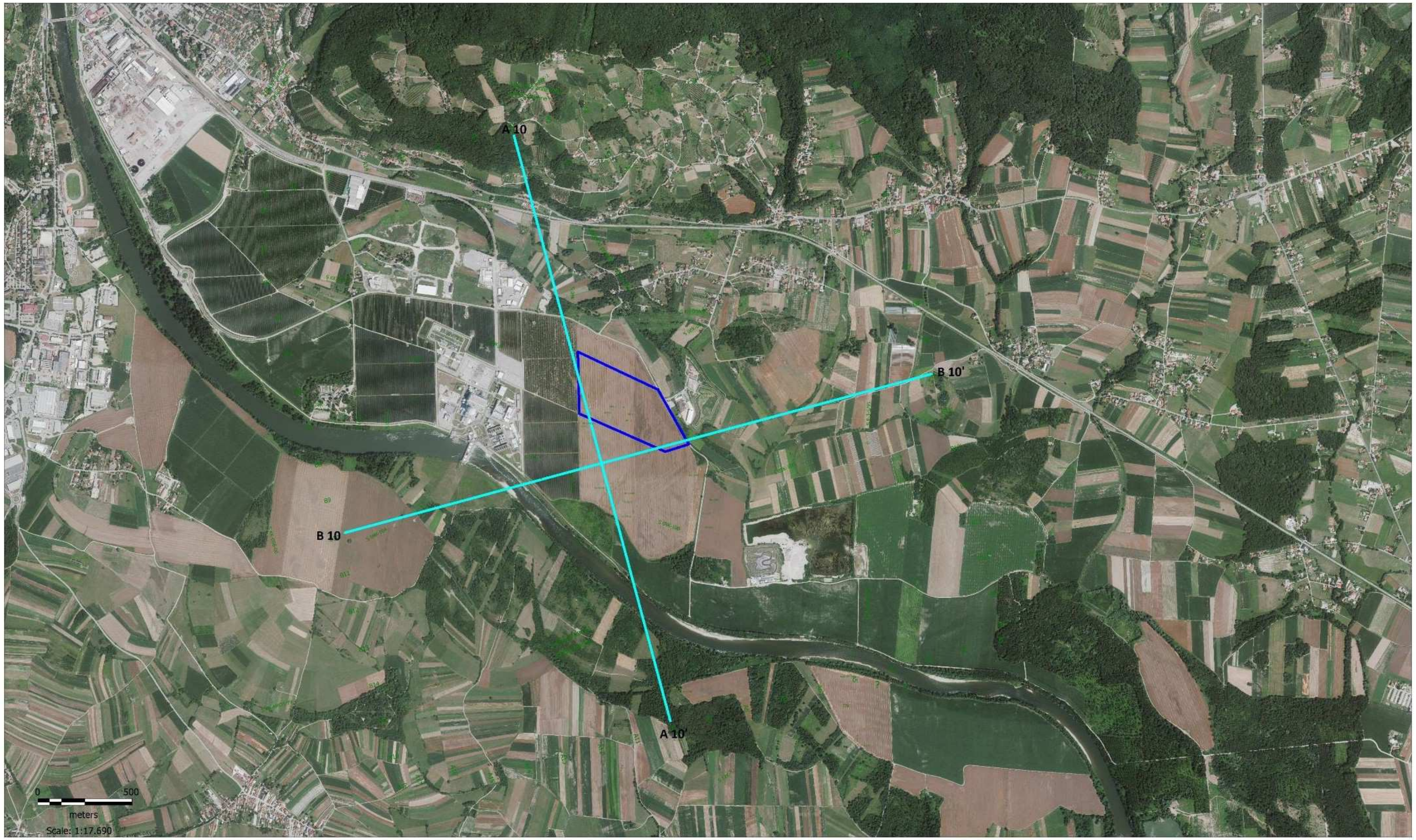


Figure 31: Locations of the geological profiles shown in the below figures

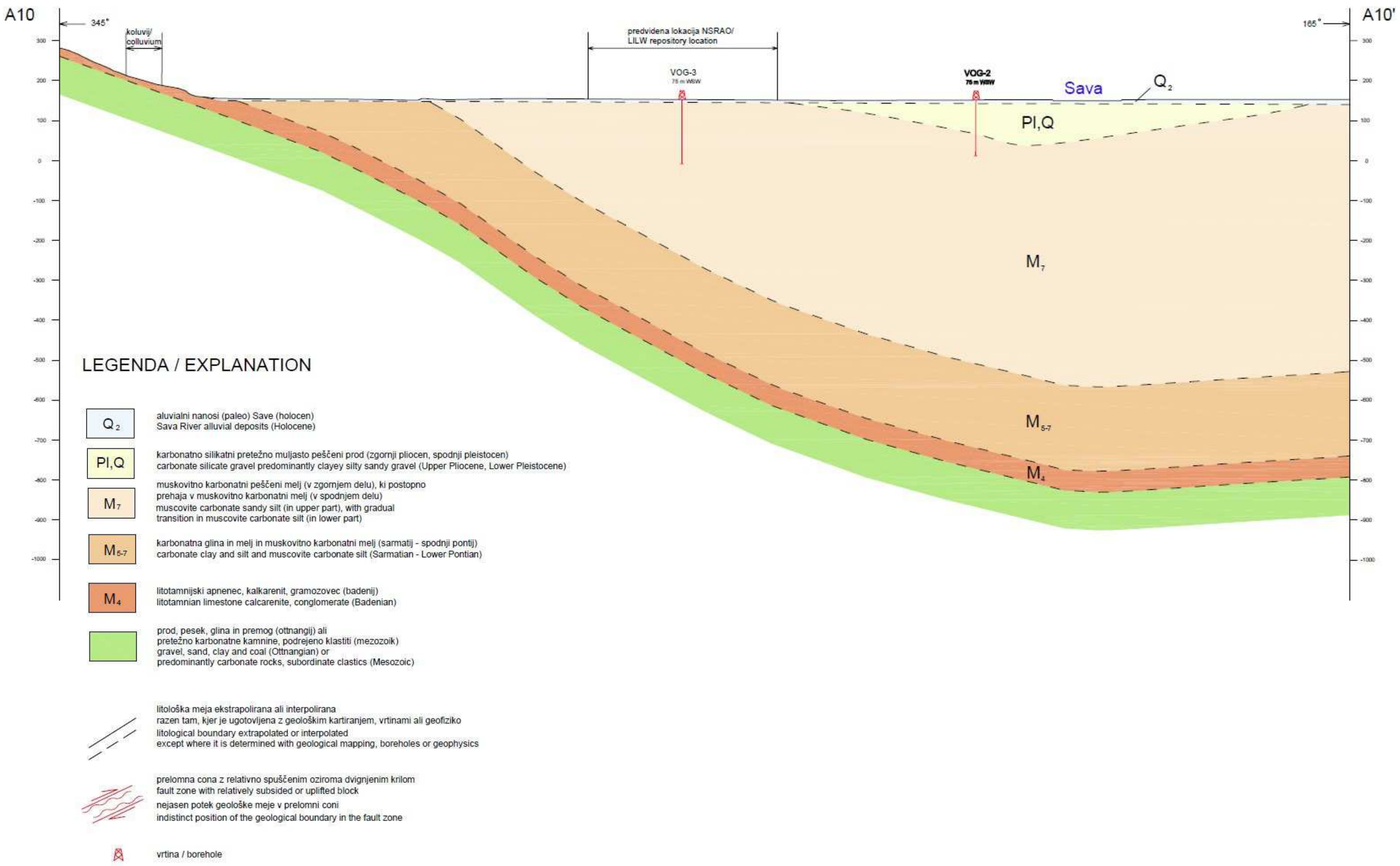


Figure 32: Geological profile of the wider area of the LILW repository site (N-S direction).

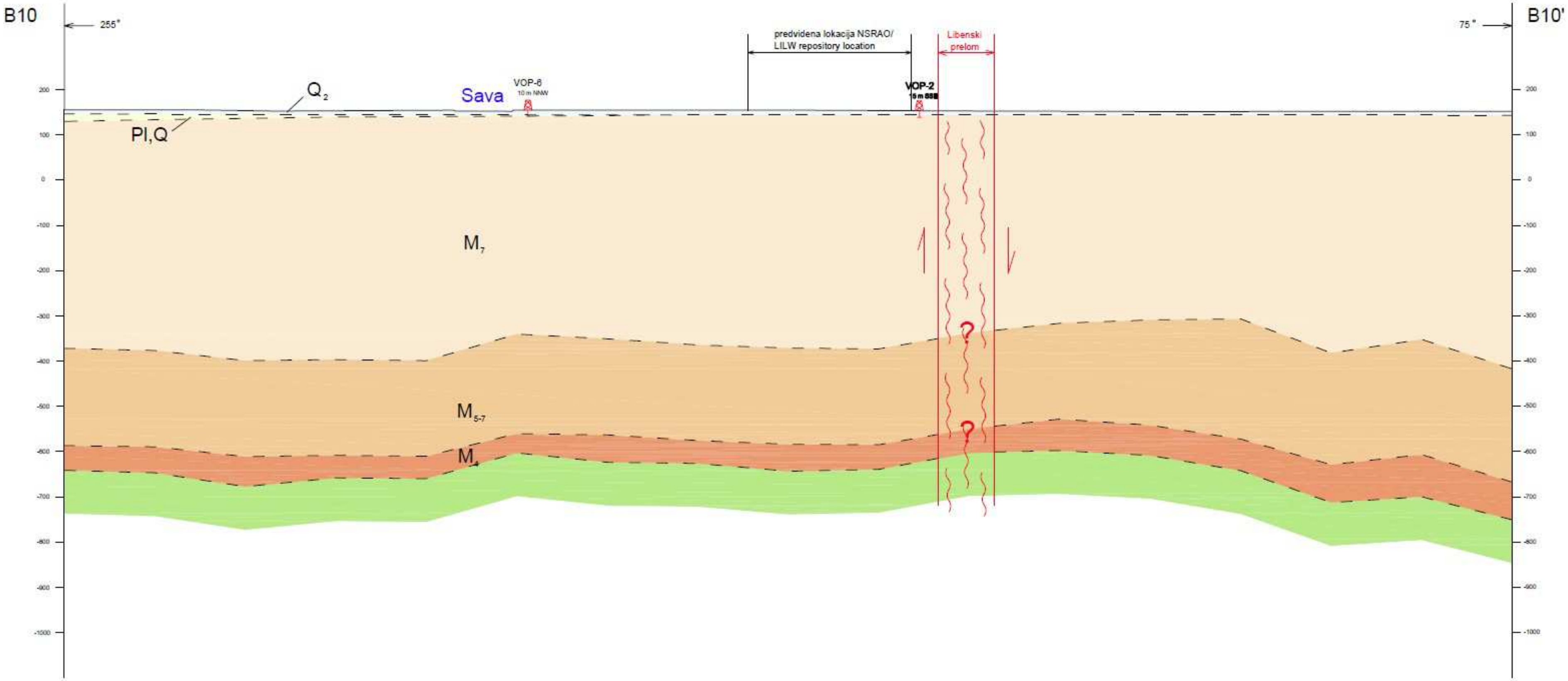


Figure 33: Geological profile of the wider area of the LILW repository site (W-E direction).

At the LILW repository site itself, the lowest horizon included in the prognosis was Ottnangian clay gravel (coloured green in the profile). Lithothamnian limestone and calcarenite (Badenian age) appear at the surface on Libna Hill, in the northern part of the area examined (M4). The carbonate clays and silts deposited on them, which transition upwards into muscovite carbonate silt, are of Sarmatian-Pannonian-Pontian age (M5-7). According to the geophysical data, the boundary between the limestone and the clastites deposited on it dips in an SSE direction (21°). This accords with the interpretation of the position of the Krško syncline, which deepens towards the ENE, in the direction of the Globoko Depression.[80] The muscovite carbonate sandy silt, which is the next lithological unit (M7), is also of Upper Pontian age. In the southern part of the profile the Tertiary sediments are covered by a Plio-Quaternary deposit of gravelly, sandy, clayey, predominantly silicate gravels that thins towards the north and then completely disappears (Pl,Q). The boundary plane is not flat, but undulating. It formed at roughly the same time as the folding of the Krško syncline and was later partly eroded. A Holocene, predominantly carbonate gravelly sandy alluvial (Sava) deposit (3–15 m thick) is situated on top of it (Q2). The composition of the gravel is not always the same. Silt and sandy silt lenses appear in places in between or above it as alluvial river sediments (overbank).[81] Plio-Quaternary deposits are not expected at the repository site itself, as none were found in any of the boreholes during the most recent phase of the research that took place at the repository site.[61]

The Artiče fault is the most significant structure outside the core area of the planned repository. Data from boreholes in the area of the Globoko mine workings show that it is cut by faults running in a roughly N–S direction. The Močnik and Sromljica faults are recorded in the seismic profile along the Krško syncline. The continuation of the Artiče fault towards the SE below the foot of Libna is highly questionable, since it has not been interpreted in the seismic profiles carried out to date, while the flexure, which is marked in the fault area, according to data from a relatively dense network of boreholes, decreases rapidly towards the SW.

The Libna anticline is a local structure. Along the Orlica fault, it is a tight fold with steep limbs, while towards the E it transitions very quickly to an open fold and is no longer detected in the area of the valley of the Močnik stream. On the basis of the various levels at which Plio-Quaternary sediments are deposited on Libna, the Libna fault is interpreted as a normal fault with a depressed E limb, while in the palaeoseismological trench we observed signs of dextral strike-slip in its fault zone. The Grič fault runs parallel to the Orlica fault and is likewise left-lateral.

The faults in the S limb of the Krško syncline are NE (“Balaton”) trending sinistral strike-slip faults with a reverse or normal component.[61]

The Tertiary sediments create a syncline structure, which runs in a WSW-ENE direction: Krško syncline. The syncline is cut through by several smaller fault lines. Regionally speaking, the most important fault is the cross-Dinaric (NW–SE) sinistral strike-slip Orlica

[80] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.
[81] Report on complementary initial field and laboratory researches of geosphere and hydrosphere for potential site Vrbina-Krško, rev.1., J.V. GeoZS, ZAG, Geoinženiring, IRGO, ZZVMB, 2009.

fault, which is presumed to have been recently active. Alongside the Orlica fault are (presumably displaced) Plio-Quaternary layers in the area of Leskovec.

The Libna fault, which runs in a NW–SE direction, lies east of the planned repository site. Its north-eastern branch is relatively subsided by approx. 50 m. The fault also partly has strike-slip characteristics. This is a fault zone over 100 m wide comprising four parallel faults that dip towards the NE and intermediate crushed and collapsed zones. The fault zone was probably active even before the Plio-Quaternary gravel was deposited, and, during or after depositing, only individual faults were reactivated. The rupture (if it is tectonic) is over 1.8 million years old.

There is no reliable evidence that the Plio-Quaternary sediments moved because of tectonic shifts along the fault. Because the palaeoseismological trench on Libna Hill was located alongside a karst sinkhole and possible deep landslides, the shifts in the Plio-Quaternary sediments were most likely caused by non-tectonic processes. There is no evidence of shifts at the Libna fault over the last 35,000 years and no recurrent shifts in the last 500,000 years, nor is there any evidence that the Libna fault is connected to any other active fault. There is no known historic seismicity connected with the Libna fault. The Libna fault shows no evidence of past or recurrent faults (e.g. major deformations and/or dislocations) across a period that would allow us to reach conclusions on future shifts on or near the surface.[82]

On the basis of recent field research completed in early 2015[63] and carried out directly on the site of the planned first disposal silo of the LILW repository, the below findings, which are key for knowledge of the micro-location, have been defined. The locations of deep boreholes on the repository site are marked on the figure below.

[82] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.

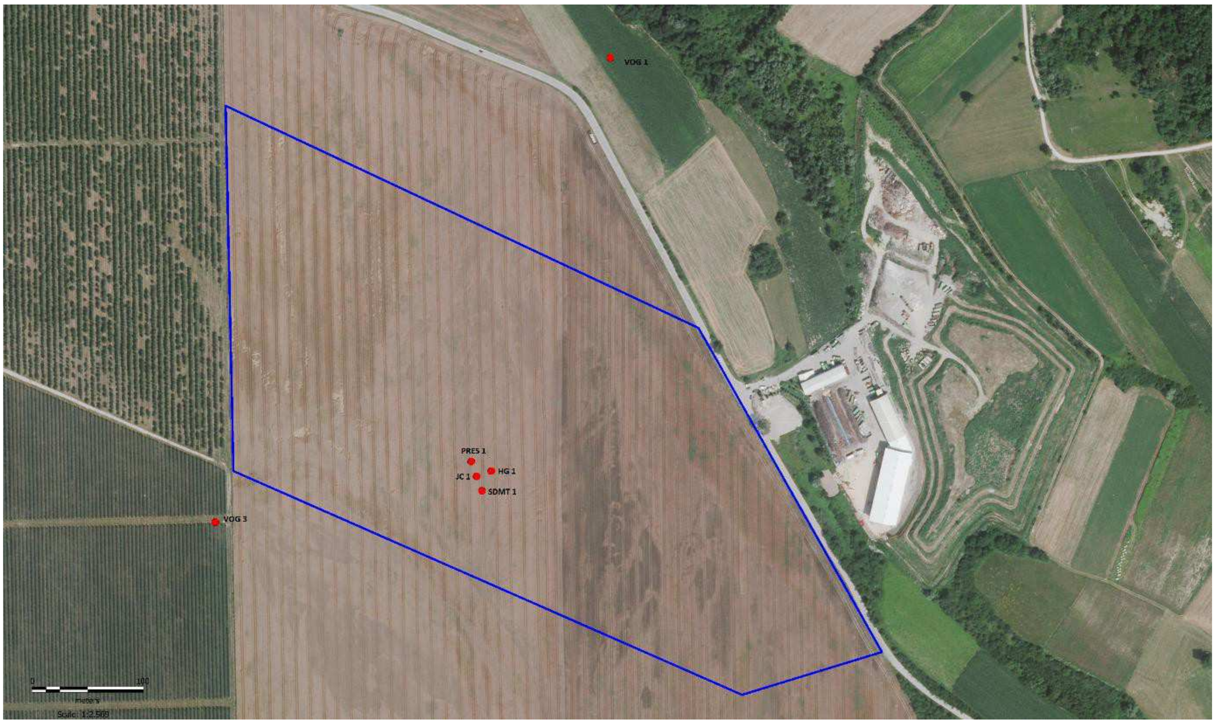


Figure 34: Locations of deep boreholes (90–170 m) on the LILW repository site and in its immediate vicinity.

The research did not reveal signs of stratification in the borehole cores. It is likewise not possible to identify precise connections between individual sections in the cores, since the transitions between individual units are gradual and therefore subjectively/arbitrarily defined. The granulometric composition varies very little along the cores, as does the colour, meaning that a thin, clearly distinguishable marker horizon that could be connected across all the boreholes is not available. One exception is the clayey silty layer in the lower part of the sequence.
With the help of well-defined peaks of natural gamma activity and downhole and crosshole data, it was nevertheless possible to connect, to a sufficient extent, individual combined packets of sandier and silty parts into a model that is concordant with expectations, i.e. a dip of the layer with an inclination of 21° in a SSE direction (see figure below).

It can be seen from the cores that stratification is not well developed/visible in these sediments. Since the repository will be located at approximately the same stratigraphic level as the excavation for the existing nuclear power plant, where stratification was clearly visible on the basis of photographs, we conclude that the situation here is similar. The entire sequence is thus developed as a parallel bedded system. The stratification planes do not represent a discontinuity but are probably the consequence of changes in grain size and, in part, structure.[83]

[83] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.

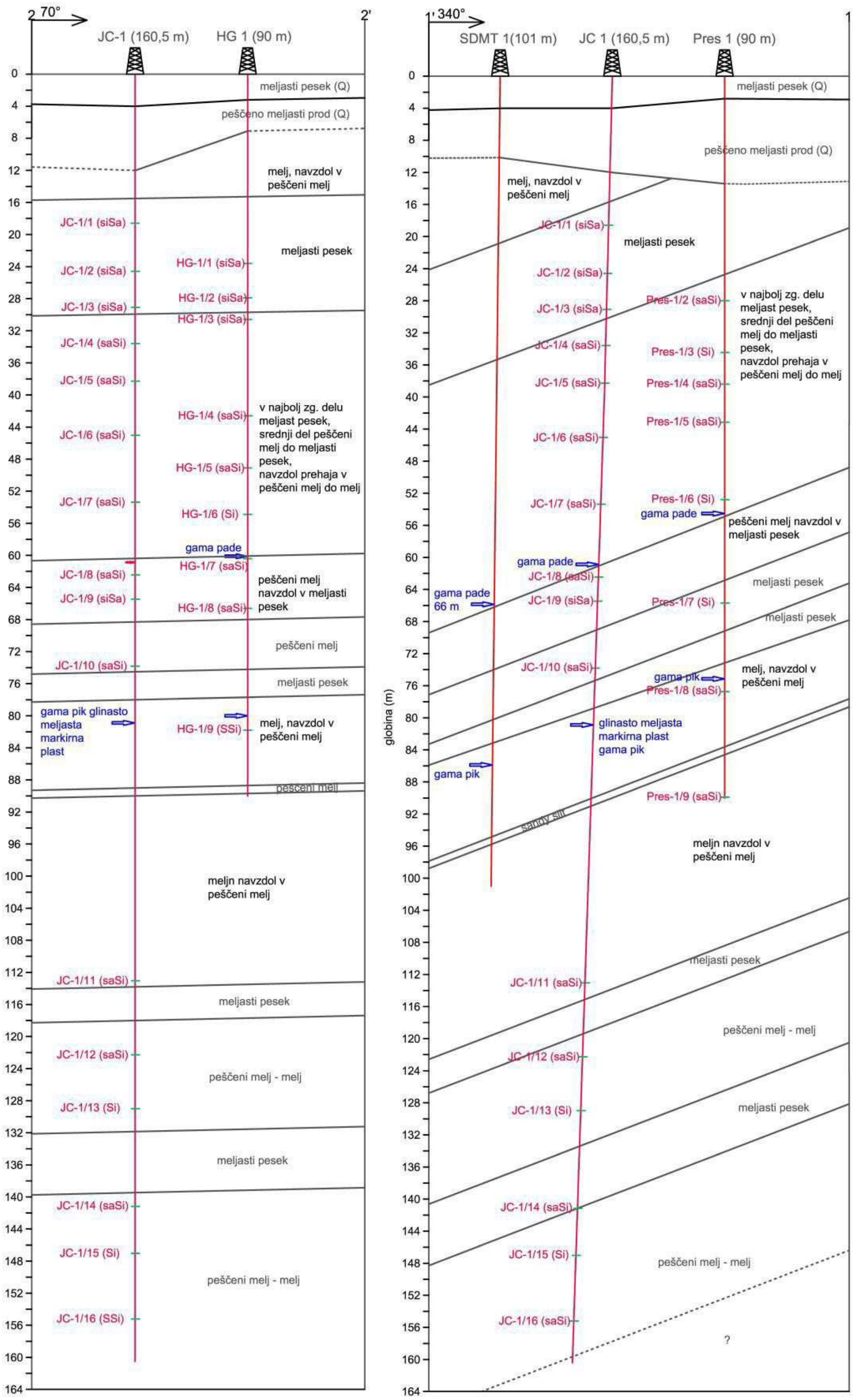
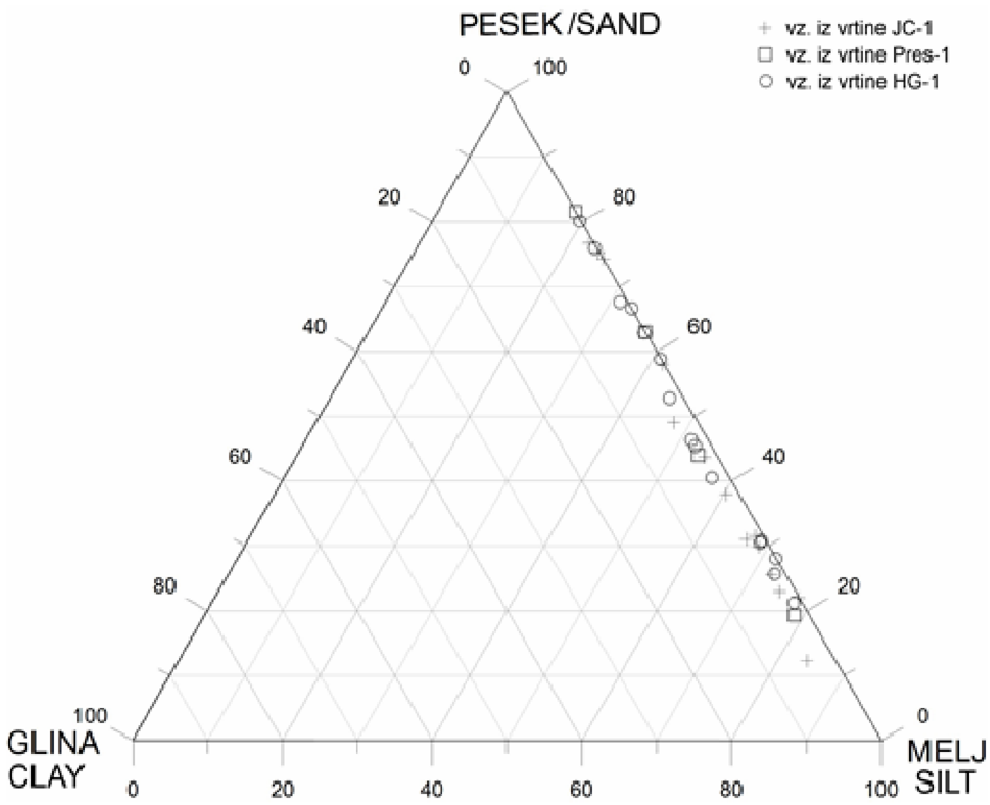


Figure 35: Lateral and longitudinal profile across boreholes at the site of the first disposal silo. The structural model shows combined packets of individual correlated sections, on the basis of an inventory and logging.

meljasti pesek (Q)	silty sand (Q)
peščeno meljasti prod (Q)	sandy and silty gravel (Q)
melj, navzdol v peščeni melj	silt, downward to sandy silt
v najbolj zg. delu meljast pesek, srednji del peščeni melj do meljasti pesek, navzdol prehaja v peščeni melj do melj	silty sand in the utmost upper part, sandy silt to silty sand in the middle part, downward transitioning to sandy silt to silt
peščeni melj navzdol v meljasti pesek	sandy silt, downward to silty sand
peščeni melj	sandy silt
gama pik glinasto meljasta markirna plast	gamma peak clayey silty marker layer
melj, navzdol v peščeni melj	silt, downward to sandy silt
peščeni melj - melj	sandy silt - silt
gama pade	gamma drop
gama pik	gamma peak

Mineralogical and petrographic studies of silt samples have shown that the granulometric structure of lithological unit M7 (Miocene sediments) is fairly monotonous and distributed on and along the line between silt and sand (see figure below), i.e. with a value ranging from around 20% to 80% of silt or sand, where those samples with above 50% of silt (19 of the total 34 samples) slightly outnumber those with a lower percentage. The clay fraction content is on average very low or non-existent, with the highest value amounting to just 3.8%.[84]



[84] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.

Figure 36: Distribution of samples of Miocene sediments from boreholes JC-1, Pres-1 and HG-1 in a ternary grain size diagram.

vz. iz vrtine JC-1	taken from the JC-1 borehole
vz. iz vrtine Pres-1	taken from the Pres-1 borehole
vz. iz vrtine HG-1	taken from the HG-1 borehole

In the light of all the data collected, it can be stated that there are no particular or salient differences between boreholes. The grain size structure indicates well-sorted silty to lightly sandy sediment. A horizon slightly sandier than the other samples was only traced above the more clearly silty part in borehole JC-1. It is represented by samples 9 (depth 65.5–65.6 m), 10 (depth 73.85–73.95 m) and, in part, 11 (depth 113.1–113.2 m). Such a horizon is not found in the other two boreholes. Samples below a depth of 52.80 m (sample 6) in borehole Pres-1 and below a depth of 54.90 m (sample 6) in borehole HG-1 are roughly comparable to the sediment from borehole JC-1 below a depth of 113 m (sample 11). This does not, however, represent a reliable distinguishing factor.

In sediments it is usual for quantities of individual mineral components to change both along the vertical and horizontally, and perfectly usual for heavy minerals to concentrate among larger grains. However, a change that could indicate a noteworthy (comparative) horizon is not perceived anywhere in the boreholes. The sediment is monotonous, without marked fluctuations in grain size and structure. When naming the sediment by grain size, silt with a somewhat changeable quantity of sand continuously appears. In terms of structure, quartz alternates with carbonates and muscovite.

X-ray studies show that the content of these minerals, particularly quartz and carbonates, is frequently very close together. For this reason, the connection of individual horizons will have to be made on the basis of field observations alone. Microscopic research shows that this could be aided by tracing layers with a similar spatial distribution of laminae or a greater concentration of dark organic detritus.

Authigenic minerals, represented by calcite, Fe-carbonates, pyrite and limonite, are extremely rare and in terms of
quantity together represent only around 1% of the total mass of the sediment. Their influence on the solidity/cementation of the sediment is therefore practically negligible.

The mineralogically unfavourable components of the sediment structure include immature organic detritus, clay minerals and pyrite. Even though a very small part of the sediment is included in preparations, the appearance of pyrite indicates a partial correlation with the quantity of organic detritus. Pyrite was not found in the near-surface part of the boreholes. The brownish colour of the sediment (presence of limonite pigment) shows that it is fully oxidised. Given the low clay minerals and pyrite content, no harmful impact in contact with concrete is to be expected.[85]

[85] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev. 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.

Geomechanics

The geological geomechanical model was based on a geological model and a comparison between the research studies, investigations and measurements performed, as well as selected data from the literature. The ground at the site is divided into five types, with each constituting a geomechanically homogeneous unit and having its own typical composition and geomechanical characteristics. The units are labelled thus: IG0, IG1a, IG1b, IG2a and IG2b.

Engineering geological unit	Age	Thickness (m)	Geological/geomechanical description and classification (UCSC/EC7)	Engineering geological mechanisms and geotechnical importance
IG0	Q	up to 0.5	Humus (HU)	The humus layer will be removed at the site of the facilities and access roads.
IG1a	Qal	0.5–2.0	Sand, silty sand (SP, SM/Sa, SISa)	This will be removed at the site of the facilities and access roads.
IG1b	Qal	2.0–11.0	Sandy and silty gravel (GP,GM/saGr, sasi Gr)	Good load-bearing layer suitable for foundations. Highly permeable. When the silo is being excavated, support will be needed and drainage provided. Suitable for incorporation.
IG2a	M5-7	11.0 -> 160.0	Silty sand and sand (SM, SM-ML/Si, saSi)	Good load-bearing layer suitable for foundations. Low permeability. When the silo is being excavated, support will be needed and drainage provided. Hydraulic fracturing of the ground possible with deeper excavations. Conditionally suitable for incorporation.
IG2b			Sandy silts and silts (ML/saSi, Si)	

The first two engineering geological units have no particular importance to the repository design process, since they will be removed from the site prior to construction and have no wider side effects. The basis for the division of the IG2 unit into two sub-units is provided by the screening analysis and the results of the CRA (Complex Reservoir Analysis): the calculated parameters of the entire and effective porosity at the depth of each borehole from the results of the core drilling, which yielded a continuous curve for the ratio between sand and silt at the depth of boreholes. The major part of the construction of the silo will take place in the IG2b unit (central part). The excavation of the topmost part of the silo will take place in the IG1b unit, followed by a shorter part (provisionally to a depth of 30 m), mainly in the IG2a unit. Construction will proceed downwards to a depth of 60 m in the IG2b unit, and the bottom of the silo will, again, mainly be in the IG2a unit.[86] The results of research into the geomechanical characteristics of the ground show that the layers have good load-bearing capacity and low permeability and are suitable for foundations. Adequate support and drainage must be provided during excavation of the silo.

4.1.3 *DESCRIPTION OF BASIC SEISMOLOGICAL CHARACTERISTICS OF THE AREA*

The fundamental structural characteristic of the Krško Basin is its syncline structure, which is responsible for the wrinkling and compression of the tectonics. The wider area around Vrbina is tectonically quite deformed. The main faults run in a NW–SE and NE–SW direction, although some run E–W. In today's tectonic stress field, with the axis of the main pressure running N–S, we can expect dextral strike-slip movement in the first, sinistral strike-slip movement in the second and reverse strike-slip movement in the third. Shifts in the faults in the N-S direction are presumed to have an important normal shift component. The most significant fault is the sinistral Orlica strike-slip fault, which is cross-Dinaric (NE–SW) in terms of direction. Neither can the Artiče fault be overlooked, despite a number of doubts as to its existence, since it was assumed to be an important source of earthquakes in the 2004 probabilistic analysis of earthquake safety for Krško NPP. According to research carried out in 2006, it could constitute an important presumed fault zone with an approximate width of 100m for the Vrbina location because of its possible course along the eastern edge of the location. The zone comprises a larger number of unconnected near-vertical or vertical faults, and is covered by tectonically undisturbed Quaternary sediments. The rupture (if it is tectonic) is over 1.8 million years old and geomorphologically expressed in the Krško Basin or north of Libna. The Libna fault is expressed south of Libna as a discontinuous structure and has a cumulative length of 4.5 km. There is no reliable evidence that the Plio-Quaternary sediments moved because of tectonic shifts along the fault. Because the palaeoseismological trench on Libna Hill was located alongside a karst sinkhole and possible deep landslides, the shifts in the Plio-Quaternary sediments were most likely caused by non-tectonic processes.[87]
According to the document "Final Report: Characterisation of the Libna Fault and Tectonic Framework of the Krško Basin",[88] the Libna fault is highly unlikely to be a fault for which the possibility exists of a break up to or close to the surface (a "capable fault"). The report also states that the safety risks connected with the Libna fault are insignificant from an engineering point of view and within the regulatory levels of concern. For this reason the current position is that, on the basis of known facts, potential shifts because of the Libna fault are not being taken into account in the planning of the repository.

The Vrbina site is located in the Krka Basin, which is one of the most seismically active areas in Slovenia, as demonstrated by historical descriptions and data (the earthquake of 29 January 1917 with an epicentre north of Brežice, a magnitude of 5.6 and an epicentre depth of

[86] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.
[87] Seismological analysis of the site for the Vrbina LILW repository facility (Izvedba seizmološke analize lokacije za objekt odlagališča NSRAO Vrbina), Rev 1, 2015. GeoZS.

[88] R. Associates, Final Report: Characterisation of the Libna Fault and Tectonic Framework of the Krško Basin, 2013.

between 6 and 13 km was the last major earthquake in the immediate vicinity of the Vrbina site) and the fact that seismic activity is fairly frequent, albeit relatively weak. The Orlica Fault, which is suspected to have been active recently, is probably the most important seismogenic structure and therefore the most important seismic source for estimating the seismic hazard in the wider area around the Vrbina site.[89]

The current seismic risk map, which is available on the Slovenian Environmental Agency website (figure below) shows that the repository site is located in an area with the requisite projected ground acceleration of 0.2g.

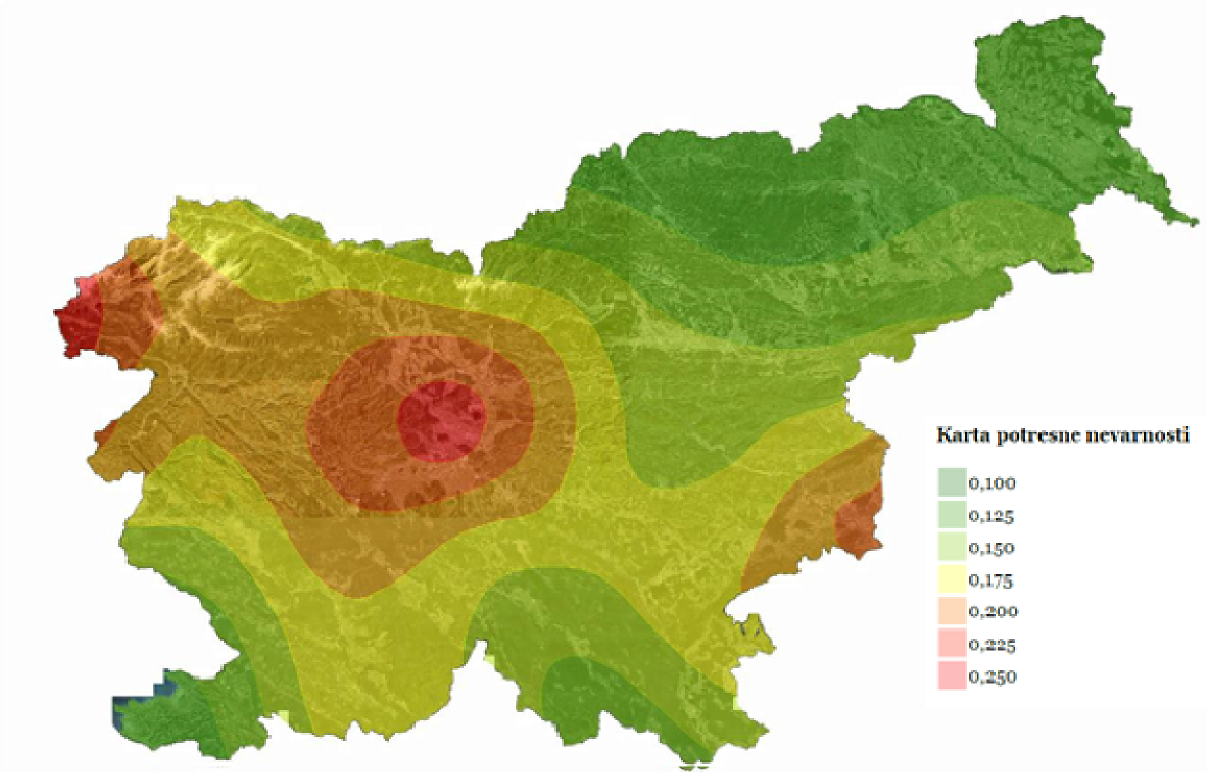


Figure 37: Seismic risk map for the area of Slovenia as a whole (Source: Slovenian Environment Agency: Environment Atlas, February 2016)

Karta potresne nevarnosti	Earthquake hazard map
0,100	0.100
0,125	0.125
0,150	0.150
0,175	0.175
0,200	0.200
0,225	0.225
0,250	0.250

Given that the LILW repository is a complex facility, the seismic risk assessment at the Vrbina site was based on the existing seismic risk assessment at the Krško NPP site. Based on this assessment and new input data from the area of the LILW repository site itself, the report Execution of seismological analysis of the site for the Vrbina LILW repository facility was

[89] Seismological analysis of the site. FGG, IKPIR, 2008.

prepared.[90] The document was prepared by the Environmental Agency of Republic of Slovenia in March 2015 and represents a support document of the final study Seismic Loading of the Near-Surface LILW Repository at Vrbina, from which the recommendations for the design of the LILW repository originate.[91] However, the study was supplemented by the determination of project seismic parameters for the calculation of an empty silo.[92] The determination of seismic loading also takes into account the findings of the study "Seismic Design Requirements for LILW Repository in Slovenia".[93]

Regarding local soil effect, the results of new field research carried out after 2008 were taken into account. Soil effect analysis was carried out using a method similar to that used in the seismic hazard analyses for the Krško NPP and in the study carried out in 2008. The methodology was slightly supplemented and expanded; in addition to the average values of the spectra of the acceleration of the soil movement at different depths, accelerograms with components in horizontal and vertical direction required for seismic analyses of the silo were also determined. Accelerograms are determined at a depth of 89 metres. The SHAKE91 program was used for the analyses. Six normalised accelerograms were taken into account as rock outcrop input motion.
The results, which relate to a rock outcrop PGA (peak ground acceleration) of 0.43 g, showed that at a greater intensity of ground motion (acceleration 0.75 g) there are no significant changes in soil effect. For this reason, the results obtained for a rock outcrop PGA of 0.43 g can be used for any major acceleration (up to 0.75 g) taking into account linear correction. For the analysis of nuclear safety related facilities, during operation, results for seismic loading of 0.43 g must be multiplied by a factor of 1.10.

Three scenarios must be taken into account for the design and execution of the silo: empty silo, half-filled silo and full silo. Different return periods are applied during the design process for a particular scenario. In all three cases, the same acceleration timelines are applied, although standardised in different ways. The absolute rock outcrop PGA values and the associated factors by which the accelerograms are to be multiplied are as follows:

- Empty silo: Return period 1,000 years, PGA = 0.36g, factor = 0.84
- Half-filled silo: Return period 1,000 years, PGA = 0.47g, factor = 1.10
- Full silo: Return period 15,000 years, PGA = 0.75g, factor = 1.75

As a result of local soil effect, ground surface accelerations increase in comparison with rock outcrop accelerations. The accelerations diminish with depth. A comparison with the Eurocode 8 spectrum has shown that the spectrum for soil type C is the most suitable for an analysis of “non-nuclear” facilities.
The proposed parameters for seismic analysis of the LILW repository facilities were obtained in a manner that took into account the previously determined local soil effects. Basic connections between the likelihood of exceeding the selected seismic impact size, the return period and the lifetime of the facility are given, as are connections between the significance

[90] ARSO, Execution of seismological analysis of the site for the Vrbina LILW repository facility, March 2015.
[91] Seismic loading of the Vrbina near-surface LILW repository (Seizmične obremenitve pripovršinskega odlagališča NSRAO Vrbina), June 2015. University of Ljubljana, FGG, IKPIR.
[92] Seismic Loading of the Near-Surface LILW Repository at Vrbina, Supplement: Seismic design parameters for the calculation of an empty silo (Projektni potresni parametri za izračun praznega silosa), November 2015. Univerza v Ljubljani, FGG, IKPIR.
[93] Rizzo Associates, Seismic Design Requirements for LILW repository in Slovenia, April 2015

factor and the return period for the location Vrbina. Of all the documents reviewed, the one most suitable for use is the US standard ASCE 43-05, which covers seismic design criteria for structures, systems and components in nuclear facilities. ASCE 43-05 can be used as a basis for the seismic design of those facilities within the scope of the Vrbina LILW repository that are nuclear safety related.
Facilities within the scope of the Vrbina LILW repository are divided into those that are nuclear safety related and those that are not. A design lifetime of 50 years is envisaged for nuclear safety related facilities, with the exception of the disposal silo after operation, for which a design lifetime of 300 years is envisaged.

It is proposed that the following seismic design parameters and processes be used in planning the LILW repository at the Vrbina location (table below):

1. Baseline data for rock outcrop seismic hazard are given in the seismic hazard study for Krško NPP,[94] while the factor of increased seismic hazard as a result of new findings (f=1.44) is given in the ARSO study.[95] According to these data, rock outcrop PGA = 0.47 g for a return period of 2,500 years and 0.75 g for a return period of 15,000 years.
2. The local soil effect for nuclear facilities (except the silo) shall be taken into account with a spectrum obtained through soil effect analysis. The spectrum for a return period of 2,500 years is shown in the figure below, while numerical values are given in the table below.
3. Non-nuclear safety related facilities shall be designed in accordance with Eurocodes. The spectrum for soil type C shall be used. The significance factor shall be 1.2.
4. Nuclear safety related facilities shall in principle be designed in accordance with the ASCE 43-05 standard, where instead of the US standards for standard facilities referred to by ASCE 43-05, European and Slovenian standards from the Eurocodes will be applied *mutatis mutandis*. An earthquake with a return period of 2,500 years shall be used as a design basis earthquake. The value 1.0 shall be taken as the design factor (DF) by which seismic loading is multiplied.
5. The disposal silo, which is nuclear safety related, shall have an “operating” period of 10 years taken into account in the phase when it is still empty. In the operational phase (disposal of waste), it shall have a design lifetime of 50 years, like the other “nuclear” facilities within the scope of the Vrbina LILW repository, and a design lifetime of 300 years following closure. For the phase in which the silo is still empty, a design basis earthquake with a return period of 1,000 years shall be taken into account for the purposes of calculations. For the operating phase, just as for the other “nuclear” facilities with a lifetime of 50 years, the design basis earthquake shall be an earthquake with a return period of 2,500 years. In the phase following closure, the design basis earthquake shall be an earthquake with a greater return period, namely 15,000 years. In the phase following closure, the disposal silo is filled completely and no longer has its upper part, so a different mathematical model of the structure is required for the analyses.
6. For each individual facility it is necessary to determine an acceptable limit state with regard to its function and the danger that a failure would represent to life and the surrounding area. Factors for the reduction of seismic loading (for nuclear facilities their values are given in ASCE 43-05) and methods of determining the capacity of individual load-bearing elements are dependent on the definition of the limit state.

[94] Revised PSHA for Krško site, PSR-NEK.2.7.2, Rev 1, 2004, FGG, IKPIR
[95] ARSO, Execution of seismological analysis of the site for the Vrbina LILW repository facility, March 2015.

7. When designing facilities according to ASCE 43-05, it is implicitly assumed that, as a result of various conservatisms in the design phase, the probability of a failure will be four times lower (0.5% over the lifetime of the facility) than the probability of exceeding the design basis earthquake (2% over the lifetime of the facility). Modern methods make it possible to estimate the actual likelihood of a failure. It is recommended that when planning facilities this likelihood be estimated with the help of fragility curves, which enable the quantitative evaluation of seismic margins. It is possible and logical to do this in the design phase.

Table 18: Overview of project parameters

Facility	Project lifecycle (years)	Return period for design earthquake (years)	Design factor (DF) Significance factor Υ_I	Effective return period for earthquake (years)	PGA values on the surface of the outcrop of solid ground (g)	Ground factor for PGA	PGA on the surface of actual grounds (g)	Specter
Silo in operation	50	2,500	DF = 1	2,500	0.47	1.16	0.55	for the site
Silo after closure	300	15,000	DF= 1	15,000	0.75	1.16	0.87	for the site
"Nuclear" facilities	50	2,500	DF= 1	2,500	0.47	1.16	0.55	for the site
"Non-nuclear" facilities	50	475	Υ_I = 1.2	800	0.24	1.15	0.28	EC8, C type of ground

Table 19: Spectrum of ground surface accelerations at the Vrbina site for the computation of nuclear safety related facilities

T [s]	0	0.01	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.5	0.6	0.7
S_{ae}[g]	0.55	0.55	0.58	0.81	1.13	1.39	1.57	1.56	1.55	1.49	1.38	1.29	1.18

T [s]	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
S_{ae}[g]	1.04	0.93	0.81	0.71	0.62	0.53	0.46	0.41	0.35	0.32	0.30	0.27	0.24

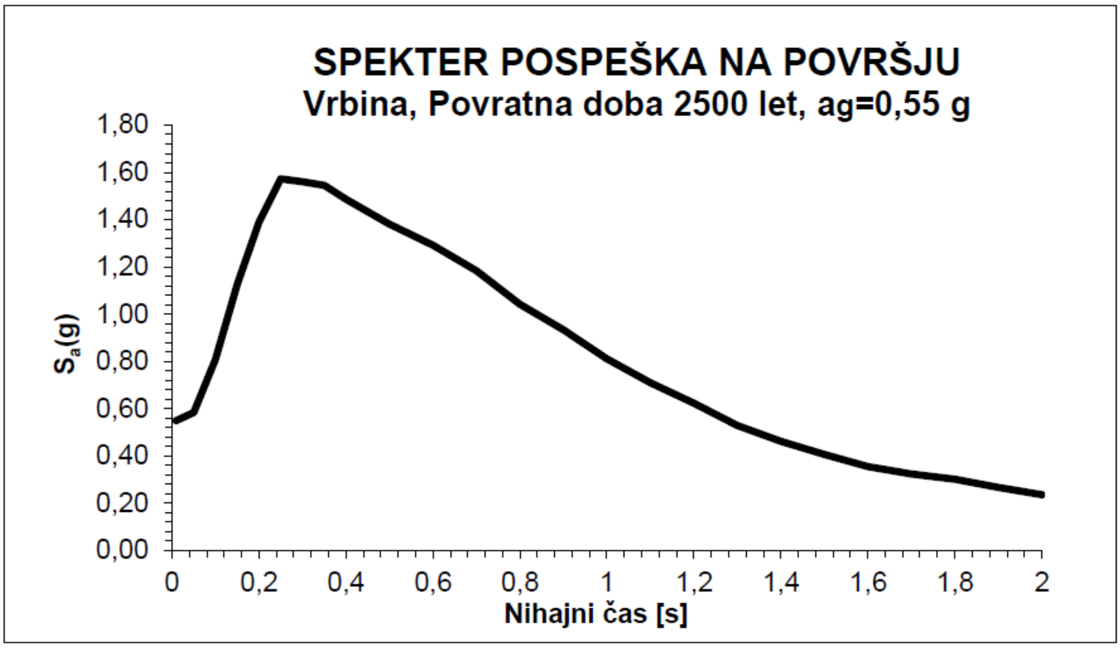


Figure 38: Spectrum of ground surface accelerations at the Vrbina site for the computation of nuclear safety related facilities.

SPEKTER POSPEŠKA NA POVRŠJU	SPECTRUM OF GROUND SURFACE ACCELERATIONS
Vrbina, Povratna doba 2500 let, ag=0,55 g	Vrbina, Return period 2,500 years, ag=0.55 g
$S_a(g)$	$S_a(g)$
Nihajni čas [s]	Oscillation period [s]

4.1.4 *DESCRIPTION OF BASIC HYDROLOGICAL AND HYDROGEOLOGICAL CHARACTERISTICS OF THE AREA*

Krško Polje is part of the basin of the river Sava, which at Krško leaves the valley along which it has made its way through the Prealpine hills and continues its way over the flat Krško Polje towards the Pannonian plains. The flat plain of Krško Polje, which descends in a series of terraces towards the rivers Sava and Krka, was created by the Sava and its tributaries with their Pleistocene and younger deposits. High water levels in the Sava cause the river to overflow on Krško Polje onto the lowest (Holocene) terrace and on the left bank to flood large areas of the Brežice part of Vrbina and, secondarily, the Krško part of Vrbina. In geological terms, the location is part of the Krško depression of the Alpine geosyncline. The permeable bedrock of the Krško Polje/Brežiško Polje area means that precipitation drains into groundwater.
The level and direction of flow of groundwater in the area of the LILW repository and its wider area depend on the hydrological regime of the Sava, aquifer recharge from the catchment area and precipitation, strata geometry and anthropogenic impacts.

The biggest watercourse in the area is the river Sava. It flows into the basin from the NW and cuts into its own Pleistocene gravel alluvial fan, creating an alluvial valley that follows the river towards the SE. The riverbed has changed or moved significantly in the past, as may be seen from the clearly visible dry channels. The lowest rate of flow of the Sava at Krško is 41 m^3/s, while the average rate of flow is approximately 281 m^3/s.

The Sava frequently floods in the wider area in question. At high water levels, when the Sava burst its banks and floods in an area up to 3 km wide, specific channel corrections form. Typical floods along the Sava are downstream of Krško, where the Sava begins to flood at medium-high discharges of 1,600 to 2,000 m^3/s.

Owing to the permeable bedrock of Krško Polje, precipitation drains into groundwater, while there are practically no streams on the surface, with the result that droughts are frequent. The Potočnica stream, which collects water from the hills north of Krško, flows into the Sava 1 km east of Vrbina.

The Struga stream is located in the immediate vicinity of the area under consideration. The channel of this stream ends on the plain or polje east of the site. The water in the stream sinks underground along the length of the Struga and rarely reaches the Sava. The Potočnica stream enters the Sava to the west of the site, while the Dolenja Vas stream (*Dolenjevaški potok*), which flows out over the surface in the area north of the village of Pesje, enters the Sava to the east of the site; when water levels are high, the latter stream empties into the Močnik stream, which flows towards the Sava.

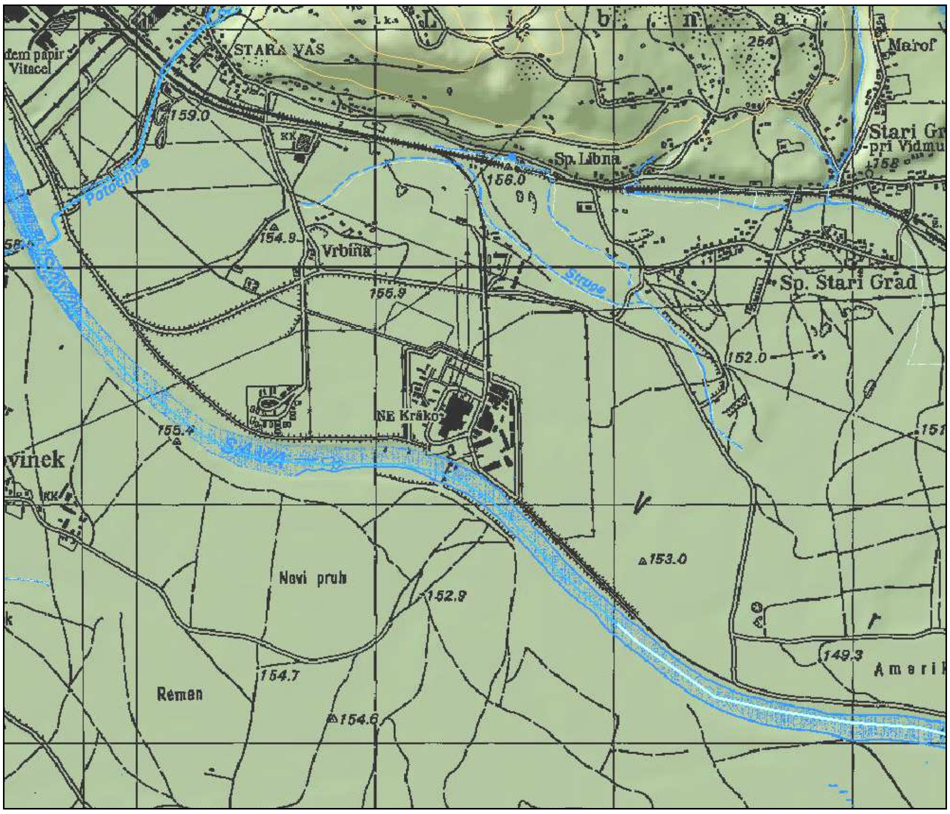


Figure 39**:** Hydrology in the wider area of the development without construction of the Brežice HPP

In order to ensure a suitable level of groundwater in the wider area of the development (construction of the Brežice HPP reservoir), a network of drainage channels has been built. These are divided into three groups:

- channels along the embankments of the Brežice HPP reservoir (on the left and right banks),
- channels in the catchment area (on the left bank),
- natural watercourses that with additional regulation function as drainage channels (Močnik, Struga)

The drainage channels along the embankments of the reservoir run along the foot of the embankments and are separated from them by a berm on which there is a multipurpose path that serves for the maintenance of both embankment and channel. As well as lowering the level of groundwater, these channels collect and drain water leaking from the reservoir through the embankment.

The channel on the left bank ("Left drainage channel") is divided into four sections, of which sections 1, 2 and 3 discharge directly into the Močnik stream, supplying it with additional quantities of water, while section 4 discharges into the existing gravel pit (see figure below). The outflow from replacement habitats NH1 and 2 (*replacement gravel pits for maintaining biodiversity in the context of Brežice HPP mitigation measures*) connects to section 3 of this channel, such that the inflow into the drainage channel dictates the water level in replacement habitats NH1 and NH2 and the existing Stari Grad gravel pit. Upstream of the connection of the outflow from NH1 and NH2, section 3 does not have a drainage function but merely drains water that may have leaked from the reservoir through the embankment and the drainage cushion below the embankment and precipitation from the slope of the embankment. A similar role is played by sections 1, 2 and 4 of the left drainage channel.

The routes of the drainage channels in the catchment on the left bank are designed in such a way as to reduce the groundwater level as effectively as possible in as wide an area of influence as possible. For the most part they run along the depressions created by old channels of the river, with the result that their depth is as shallow as possible (in some places this principle could not be applied). In order to occupy as little space as possible and for the purposes of coordination of the route with the already planned arrangements in the areas of the Vrbina business zone, the Kostak centre and the LILW repository, two sections of channel 5 are planned as an underground drainage pipe with a diameter of 80 cm and inspection shafts at 50 m intervals, with inflows and outflows fitted with gratings. Channels 4 and 5 in the area of the Evrosad orchards are likewise implemented as underground drainage pipes with a diameter of 60 cm.

Catchment drainage channels 2, 3, 4 and 5 discharge into the lake formed in replacement habitats NH1 and NH2.

Everywhere that the routes of the channels cross existing roads, paths or accesses to farmland, bridging of the channels is envisaged in the form of pipe culverts.

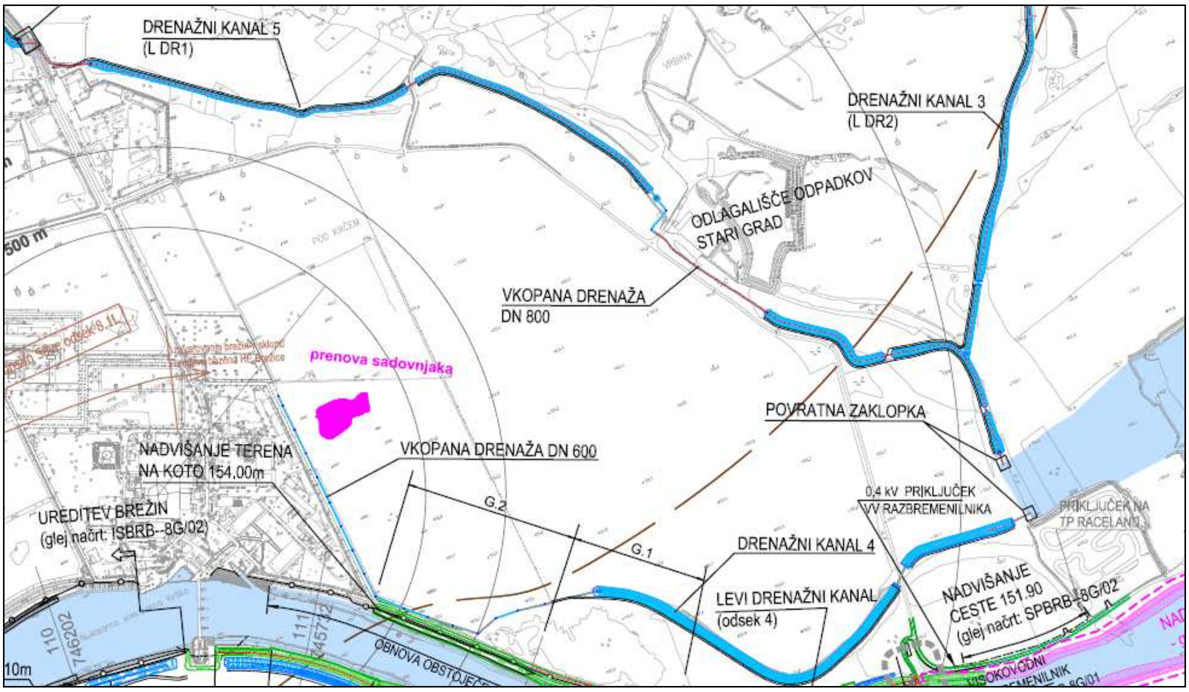


Figure 40: Regulation of the level of groundwater in the wider area of the development (including construction of the Brežice HPP)

DRENAŽNI KANAL 5 (L DR1)	DRAINAGE CHANNEL 5 (L DR1)
DRENAŽNI KANAL 3 (L DR2)	DRAINAGE CHANNEL 3 (L DR2)
ODLAGALIŠČE ODPADKOV STARI GRAD	STARI GRAD LANDFILL
VKOPANA DRENAŽA DN 899	UNDERGROUND DRAINAGE DN 899
prenova sadovnjaka	orchard renovation
POVRATNA ZAKLOPKA	RETURN FLAP
NADVIŠANJE TERENA NA KOTO 154,00 m	RAISING THE TERRAIN HEIGHT TO AN ELEVATION OF 154.00 m
VKOPANA DRENAŽA DN 600	UNDERGROUND DRAINAGE DN 600
UREDITEV BREŽIN (glej načrt: ISBRB-8G/02)	ARRANGEMENT OF BANKS (see plan: ISBRB-8G/02)
0,4 Kv PRIKLJUČEK VV RAZBREMENILNIKA	0.4 Kv CONNECTION FOR THE FLOODWAY (RELIEF CHANNEL)
PRIKLJUČEK NA TP RACELAND	CONNECTION TO THE RACELAND TRANSFORMER
DRENAŽNI KANAL 4	DRAINAGE CHANNEL 4
LEVI DRENAŽNI KANAL (odsek 4)	LEFT DRAINAGE CHANNEL (section 4)
NADVIŠANJE CESTE 151.90 (glej načrt: SPBRB-8G02)	RAISING OF THE ROAD 151.90 (see plan: SPBRB-8G02)

4.1.4.1 **Hydrogeology**

The LILW repository site lies on a plain on the left bank of the Sava. The area comprises filled meanders of streams from the Krške Gorice hills and their wetland areas, which in the past alternated with the flood plain of the Sava.

The level and direction of the groundwater around the LILW repository site and in the wider area depend on the hydrological regime of the Sava, the feeding of the aquifer (from the catchment area and from precipitation), the geometry of the layer and anthropogenic impacts. The extent of the hydrogeological layer depends on the structural conditions in the Krško Polje area, where there is a syncline oriented in the east-north-east/west-south-west direction.

Hydrogeological model and description of hydrogeological units

In the wider area of the LILW repository site, there are three hydrogeological units, namely two aquifers (Quaternary and Plioquaternary) and one aquiclude (Miocene). Hydrogeological units running deeper than the Tertiary aquiclude have not been determined.[96]

1. Quaternary aquifer

The Quaternary Krško Polje aquifer represents an alluvial fill of the Sava, consisting predominantly of gravel and sand with silt and occasional clay admixtures. The aquifer is classified as an extensive and high yielding hydrodynamically open aquifer. In the area of the site, the average thickness of the Quaternary layers is approx. 10 m, with their thickness increasing towards the south. The anisotropy of this deposit can be regarded as negligible. The levels of the groundwater in the Quaternary aquifer are connected to supply from the Sava and to inflows from the Krško hills. The direction of flow of the groundwater varies, depending on the level of the Sava. When the water level is high, the Sava feeds the repository area; however, most (97%) of the time, it drains the repository area. The direction of flow of the groundwater under prevailing water conditions is towards the south-east. This changes to the north-east during the Sava flood wave. The velocity of groundwater flow in the Quaternary aquifer is estimated to range approximately from 23 m/day to 39 m/day and it also depends on the changes in the gradient during the flood wave of the Sava River.[97]

In additional studies at the site of the disposal facility of the LILW repository, local water permeability of the Quaternary aquifer obtained on the basis of a pumping test was shown to be 1.1 x 10^{-2} m/s.[98]

2. Plio-Quaternary aquifer

The Plio-Quaternary aquifer of Krško Polje represents an alluvial fill of the Sava consisting of clay gravel and sand. The aquifer is classified as a minor aquifer with local or limited sources of groundwater. Thickness and spatial distribution of Plioquaternary gravels is related to the Krško syncline. In the core area of the potential Vrbina Krško site, these gravels do not occur, as they are situated south and south-east from the location. [99]

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[96] Report on supplementary initial field and laboratory geosphere and hydrosphere research for the potential Vrbina-Krško site (Poročilo o izvedbi programa dopolnilnih začetnih terenskih in laboratorijskih raziskav geosfere in hidrosfere za potencialno lokacijo Vrbina-Krško), Rev 1, J.V. GeoZS, ZAG, Geoinženiring, IRGO, ZZVMB, 2009.

[97] Main researches of geo- and hydrosphere for the purposes of construction of a LILW repository, Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.

[98] Hydrogeological report on pumping test carried out in borehole VOP-8, November 2015, IRGO

[99] Report on supplementary initial field and laboratory geosphere and hydrosphere research for the potential Vrbina-Krško site (Poročilo o izvedbi programa dopolnilnih začetnih terenskih in laboratorijskih raziskav geosfere in hidrosfere za potencialno lokacijo Vrbina-Krško), Rev 1, J.V. GeoZS, ZAG, Geoinženiring, IRGO, ZZVMB, 2009.

3. Miocene aquiclude

The Miocene aquiclude consists of silty-sandy, sandy-silty and silty layers. The aquiclude is qualified as geological layers without significant sources of groundwater. The measured water permeability ranges from 1.28×10^{-8} to 3.63×10^{-7} m/s. The geometric mean of the coefficient of permeability in the Miocene layers is 1.14×10^{-7} m/s. From the hydrogeological aspect, these layers can be defined as homogeneous, but with an anisotropy that is fairly variable and not dependent either on depth or on the lithological composition of the ground. The lithographic anisotropy does not exceed the value of 3. In the Miocene aquiclude, the horizontal flow component of the groundwater is less dependent on the level of the Sava. The prevailing direction of flow of groundwater is towards the south. The horizontal deviation from the prevailing direction of flow of the groundwater depending on the water level is around 25°. The greatest deviation occurs during the period of highest water levels resulting from the Sava flood wave. The horizontal gradient of flow in the Miocene aquiclude is approximately 0.002. The velocity of the groundwater is roughly four orders of magnitude lower than the velocity in the Quaternary aquifer. The anisotropy of the Miocene aquiclude has a significant effect on the route and velocity of flow of the groundwater. The flow of the groundwater in the Miocene aquiclude therefore has a significant vertical component.[100]

4.1.4.2 Direction and speed of groundwater movement

In order to determine the direction and speed of groundwater movement, a special study was prepared to analyse the data from groundwater monitoring in the wider area of the repository site. On the basis of the response of groundwater levels in individual piezometers to an induced pressure wave in the context of high water levels in the river and infiltration of precipitation, and from analysis of cross-correlation of surface water and groundwater, it is possible to roughly divide the area of the Quaternary aquifer into four segments, as follows: (1) heavily river-influenced area, (2) area at edge of Quaternary aquifer under influence of recharge from hills, (3) area in the interior of the aquifer (including in the location of the future LILW repository) and (4) area surrounding Krško NPP. The area of the Miocene aquiclude shows delayed and damped responses, as a result of the greater depths, but it is nevertheless possible to perceive a difference in responses with regard to distance from the Sava.

Within the core area, the influence of the dam at Krško NPP is highlighted. Upstream of the dam, the Sava recharges the aquifer, while directly downstream of the dam the regime changes as a result of the height difference between the reservoir and the river below the dam. From here onwards, the Sava mainly drains the aquifer. The only exception are the maximum states that occur during flood waves of the river. In these periods, the Sava also recharges the aquifer downstream of the dam.

The direction of groundwater flow in the Quaternary aquifer in the core area under consideration is towards the south/south-east in the majority of hydrological situations. Only when the water level in the Sava is high, does the direction of flow change significantly, towards the north-east, when the river also recharges the aquifer in the area below the Krško NPP dam. Such conditions only occurred in the measured period for just over 3% of the time, while for the remaining 97% of the time the river drained the aquifer. The gradient in the Quaternary aquifer in the area downstream of the repository is between 0.0024 and 0.0028 for

[100] Main researches of geo- and hydrosphere for the purposes of construction of a LILW repository, Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.

most of the year, while during the period of reversed direction of flow it is 0.0031 from the direction of the Sava towards the LILW repository.
The stability of the direction of groundwater flow is shown by the levels of groundwater in the Quaternary aquifer (see figures below).
In the low, prevailing and stable high states, the general direction of flow is from the
LILW repository towards the south/south-east. The only exception is the maximum state, where, because of the high water levels of the Sava, the river feeds the aquifer. In this brief period the direction of groundwater flow in the direct vicinity of the repository is from south-west to north-east.[101]
The vertical component of the flow in the Miocene aquiclude may be directed upwards or downwards, depending on the water level. Measurements to date show that flow in the Miocene is directed upwards 76% of the time. The influence of individual hydrogeological characteristics of the site is incorporated into the safety analyses for the LILW repository.

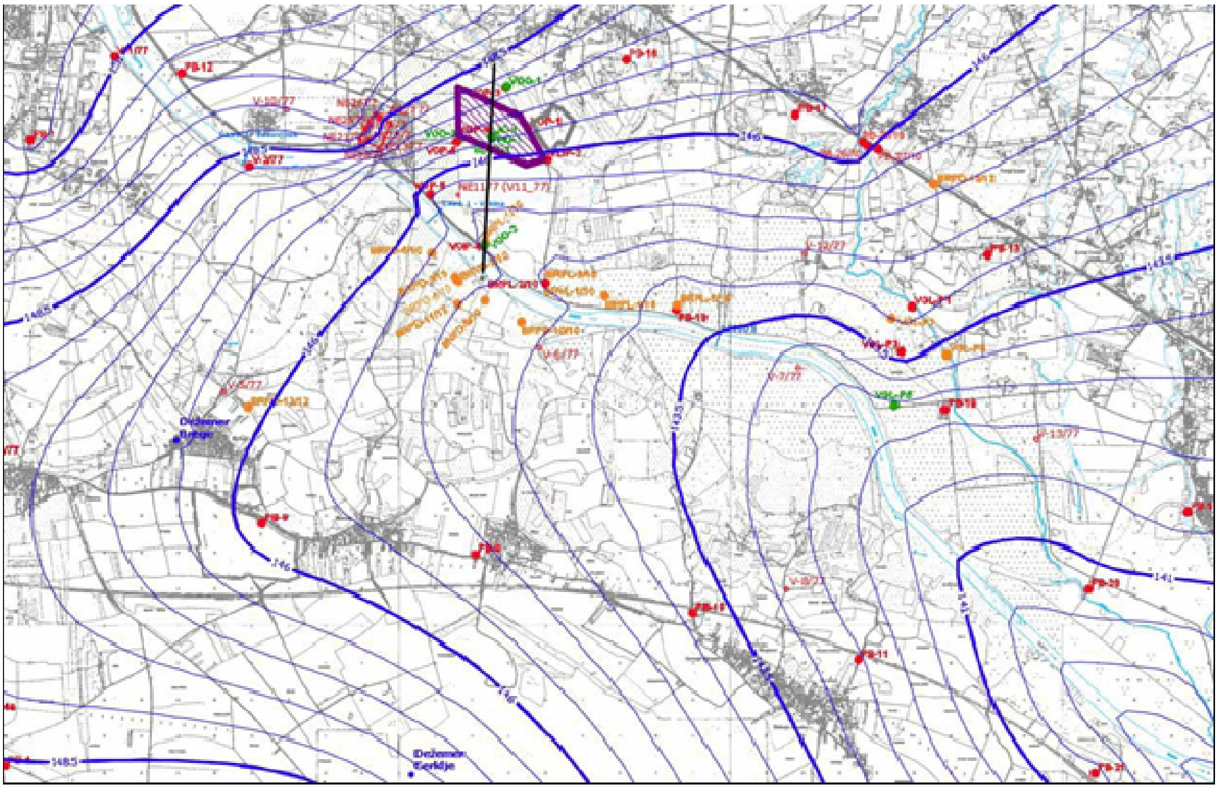


Figure 41: Map of groundwater levels in the Quaternary aquifer – low water level

[101] Upgrading of the hydrogeological interpretation of monitoring data in the wider area of the LILW repository at Vrbina in the municipality of Krško, Rev 1, 2016. IRGO Inštitut.

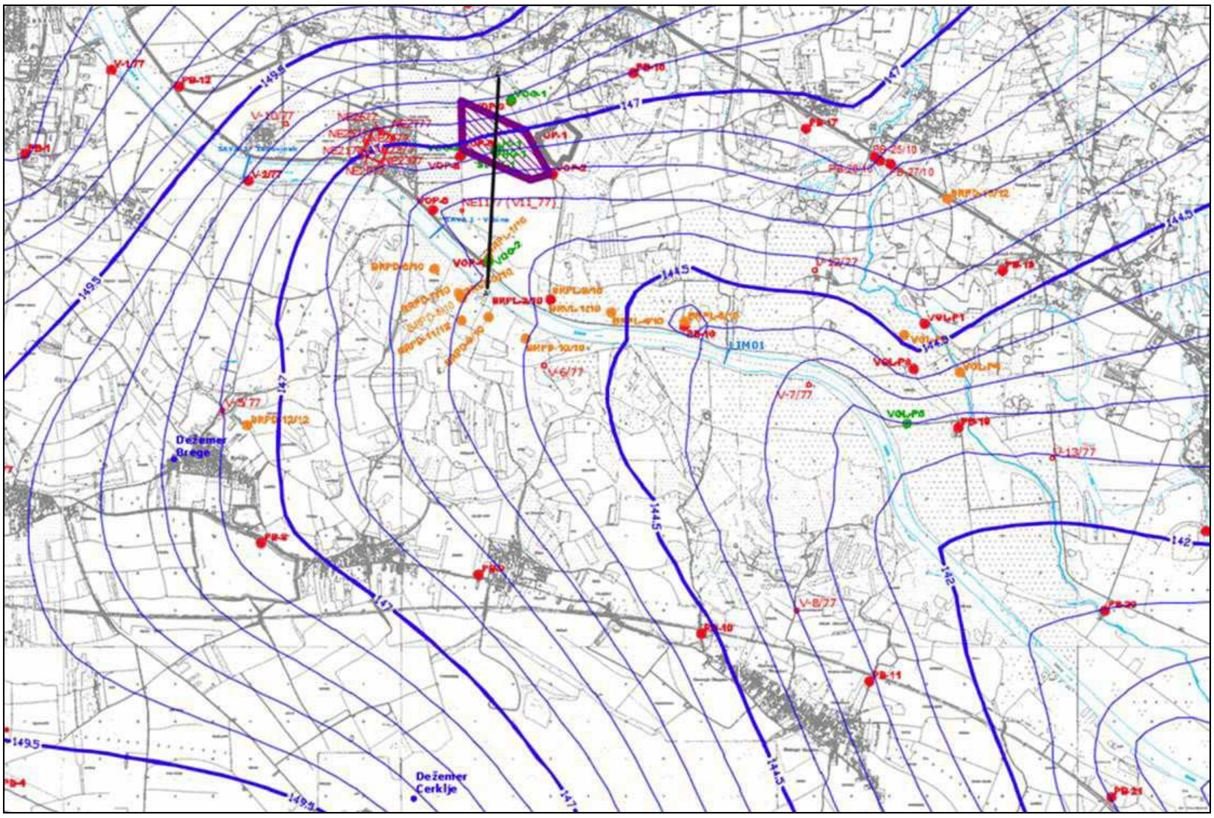


Figure 42: Map of groundwater levels in the Quaternary aquifer – prevailing water level

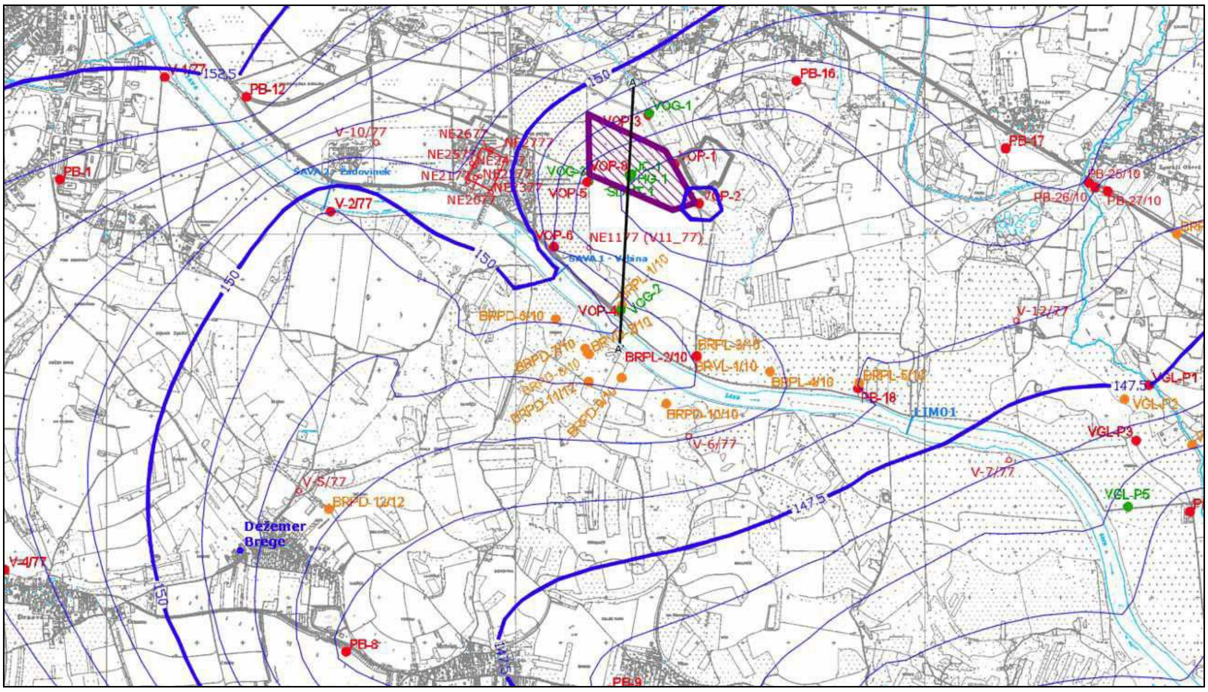


Figure 43: Map of groundwater levels in the Quaternary aquifer – maximum water level

In the Miocene aquiclude the direction of groundwater flow, which is shown in the figure below, is even more stable than in the Quaternary aquifer, and in a direction towards the south/south-west, except at times of high water, when there is a turn of approximately 25° towards the south/south-east. The size of the gradient in the Miocene is between 0.00185 and 0.0023. It should be pointed out that from the available data, as a result of the specific characteristics of the observation network, it is only possible to adequately determine the vertical component of the gradient in the Miocene. This changes between a plus value and a minus value, which means that flow can sometimes be directed upwards and sometimes downwards, depending on the water level.

Flow in the Miocene is directed upwards for 76% of the time, and for as much as 90% of the time in the new piezometers located on the site of the first disposal silo (which in all likelihood is the result of a shorter observation period). The influence of individual hydrogeological characteristics of the site is incorporated into the safety analyses for the LILW repository.

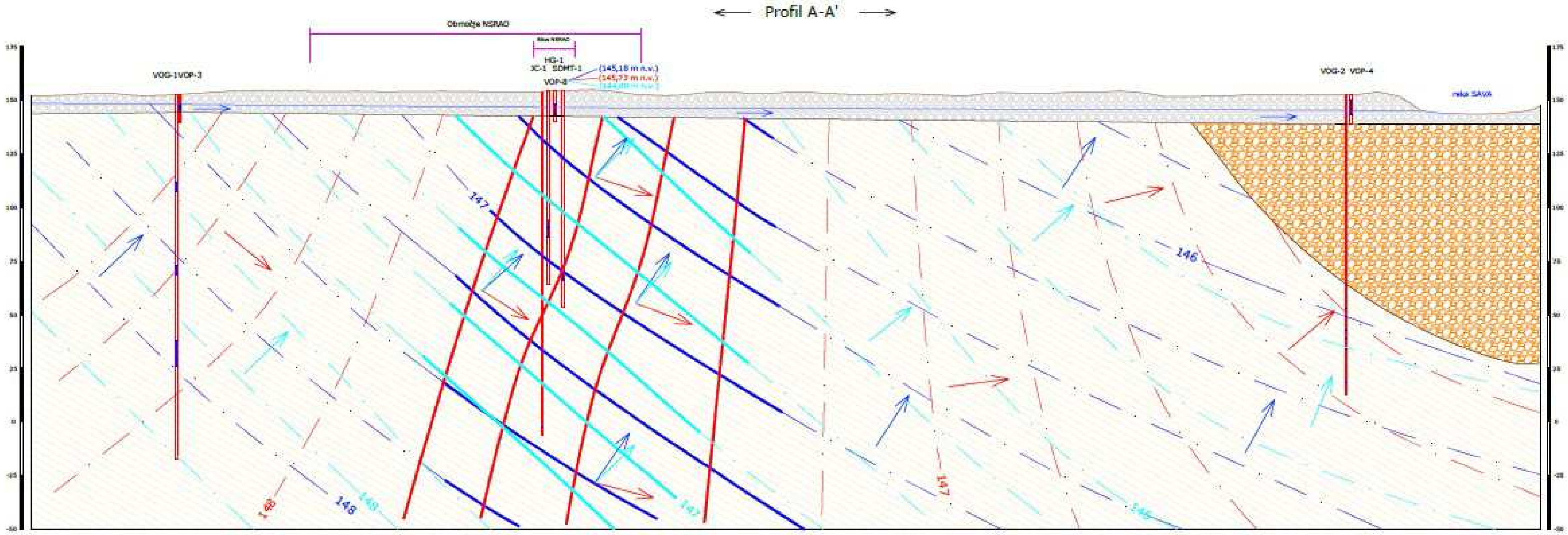


Figure 44: Direction of groundwater flow in the Miocene aquiclude. The profile (N–S direction) shows hydroisohypses for three different water levels: prevailing (dark blue), minimum (light blue) and maximum (red)

Profil A-A'	Profile A-A':
Območje NSRAO	LILW area
VOG-1 VOP-3	VOG-1 VOP-3
VOP-3	VOP-3
145,15 m n.v.	145.15 m above sea level
145,73 m n.v.	145.73 m above sea level
144,89 m n.v.	144.89 m above sea level
VOG-2 VOP-4	VOG-2 VOP-4
reka SAVA	SAVA River

4.1.4.3 **Geochemistry**

Geochemical characterisation of the geological environment was carried out in the context of the three phases of geosphere and hydrosphere field research for the needs of the Vrbina Krško LILW repository.

The results of the research show that the soil at the Vrbina site is slightly alkaline. Generally speaking, the pH value increases slightly with depth and fluctuates between 8.0 and 9.1; this accords with expectations given the mineralogical composition, the main elements of which are sodium, potassium, calcium, aluminium, magnesium, iron and manganese. There is practically no change to the levels of organic substances as one proceeds downwards and these are assessed as low. Of the trace elements, the presence of cadmium, copper, nickel, chromium, cobalt, arsenic and zinc was detected. In the soil examined, they do not exceed the immission limit values set for a particular metal. The specific surface area of the Miocene soil samples examined is low and fluctuates between 30 and 42 m^2/g. The same applies to the cation-exchange capacity, which for potential capacity in the area is between 7.5 and 8.5 cmol+/kg and for effective capacity across a slightly wider area between 6.2 and 10.6 cmol+/kg. These are values typical for the presence of the minerals illite and kaolinite. Sorption tests were carried out for the sorption of Sb^{3+}, Pb^{2+} and Zn^{2+}, and quantitative results given in the form of linear and non-linear sorption isotherms. The iron present in the soil therefore immobilises the Sb, Zn and Pb; similarly, the carbonates present immobilise the Pb. In the course of the partial dissolution and precipitation of Fe minerals and aluminosilicates, even more free sorption sites are created that could occupy the unbound cations. This means that their progress through the Miocene sediments is slowed even more. On the basis of the research conducted into leaching using distilled water as well as groundwater, it was estimated that solubility at the site was low and that the pore water is in balance with the soil (sediment). The dissolution of carbonates and other minerals present are assessed as taking place only to a small degree in natural conditions. In strongly acidic conditions, dissolution occurs, along with the associated leaching of Ca and Mn (as well as Fe and Si), with the soil showing a high buffer capacity (neutralisation capacity).

Based on a hydrological and geochemical interpretation of the results of the set of analyses conducted of groundwater and soil, the following interpretation of conditions in the groundwater in the Vrbina area is provided. The chemistry of the groundwater is linked to the extent of the aquifer structures. In terms of hydrogeochemical conditions, we can distinguish between the shallow Holocene Quaternary aquifer and the deep aquifer structures in the Miocene layers. The Holocene Quaternary aquifer is characterised by a hydrogeochemical system with a $Ca2^{+}$ - $Mg2^{+}$ - $HCO3^{-}$ water type located in the shallow aquifer, which can be defined as a hydrodynamically and thermodynamically open system. These waters are in balance with the soil CO_2. The shallow waters are, in terms of carbonate minerals, under-saturated, and the effect of non-carbonate minerals is detected in the waters. The shallow aquifer is defined as an area of transition from oxidation to reduction conditions. The waters captured from the two boreholes, which are affected by the municipal waste landfill, form a special group within the shallow aquifer. Water types Na^{+} - $Ca2^{+}$ - $HCO3^{-}$ - $SO4^{2-}$, where the ratio between the main components is not stable, is characteristic of the deep Miocene aquiclude. This water-bearing structure can be defined as a hydrodynamically closed aquifer and a thermodynamic system in which there is no direct exchange of mass with the surface. The chemistry of the groundwater here is alkaline, which is the result of the group of minerals present in the sediment. Field measurements and the results of geochemical simulations show a pH of > 8.5. The average pH values are found within the range of 9.0 < pH < 9.5. High supersaturation of the groundwater with certain potassium minerals (mica, biotite) has been detected in the deep Miocene aquifer structure; the waters are also supersaturated with carbonate minerals (dolomite, calcite). The groundwater in this structure is located in pronounced reduction conditions. Very low partial CO_2 pressure is characteristic of the deep aquifer structure, thus confirming the presence of a closed aquifer structure.[102]

4.1.4.4 **Chemical composition of groundwater**

Chemical composition and aggressiveness of groundwater

On the basis of all collected results, which include data obtained in the course of MOP/ARSO monitoring of the chemical state of groundwater, we identified two areas in the Quaternary aquifer with similar groundwater mineralisation characteristics in the wider Vrbina area:

- more richly mineralised water (with mineralisation of 500–630 mg/l), in the northern part of the repository site (more distant from the Sava), and
- less mineralised water (with mineralisation of 300–450 mg/l), in the southern part of the area.

The results of analyses of water from boreholes in the vicinity of the municipal waste dump differ from the others.

The basic components of groundwater from the Miocene layers are completely different from those in the Quaternary layers. Its mineralisation is lower. A balanced combination of calcium/sodium/magnesium cations and hydrogen carbonate anions prevails; there are also significant shares of sulphate and chloride. Increased ammonium values were also identified. Redox conditions in this water enable nitrite formation.

In waters from the Quaternary aquifer, the mineralogical composition of the water is determined by sodium/potassium/calcium/magnesium cations and hydrogen carbonate/sulphate/chloride anions. Nitrate is the only nitrogen compound to appear in these boreholes. The water in the boreholes near the municipal waste landfill also contain fluoride, which elsewhere is at the detection limit. Pesticides and heavy metals were also identified, although in permitted concentrations.

On the basis of the result for aggressive CO2 content, the water from the Miocene sediments is classified at the second level: XA2 – moderately aggressive chemical environment, or XA1 – slightly aggressive chemical environment.

The results of chemical analyses show that the waters examined derive from two hydrogeological units:

- the Quaternary gravel-sand aquifer

[102] Main geosphere and hydrosphere research for the construction of the LILW repository (Glavne raziskave geo in hidrosfere za potrebe graditve odlagališča NSRAO), Rev 1, 2015. J.V. IRGO Consulting d.o.o., GeoZS, NLZOH Maribor, geoinženiring d.o.o., ZAG.

– the Miocene silt aquiclude.

As per expectations, the samples from the two units differ significantly, which we justify using Jäckli's classification of chemical composition and a graphical representation of D'Amore's parameters. Samples from the Quaternary aquifer point to water from a carbonate aquifer, while samples from the Miocene aquiclude indicate a clastic water type with the characteristic components Na and HCO_3. Mineralisation in the Miocene aquiclude is significantly lower than in the Quaternary aquifer, except where the aquifer is subject to infiltration of surface water from the Sava with a lower level of mineralisation.

4.1.5 ***DESCRIPTION OF BASIC BIOLOGICAL CHARACTERISTICS OF THE AREA***

(biological characteristics are presented in more detail below in section: *4.4.5 ECOSYSTEMS, FLORA AND FAUNA AND THEIR HABITATS (NATURE).*

Since the site is situated in an area of intensive agriculture, the presence of endangered and protected plant species requiring protection under special protection regimes is not expected, nor are there any floristically important areas within 500 m of the site. Dry and semi-dry grasslands are present across smaller areas. However, these only occur in floristically rich form on the opposite (i.e. right) bank of the Sava.[103]
The original vegetation of the Krško Polje/Brežiško Polje area consisted of hornbeam forest with oak. The former hornbeam forests have been almost entirely cleared. Today forest covers less than 5% of the area of Krško Polje. Grasslands account for just under a fifth of the area, while fields account for almost three quarters of the total area. The area around Brežice is planted with poplar plantations. The tree community along the river is made up of different species of willow. Alders and poplars also appear in the community.

[103] Environmental report for the low- and intermediate-level radioactive waste (LILW) repository, April 2009, GEATEH.

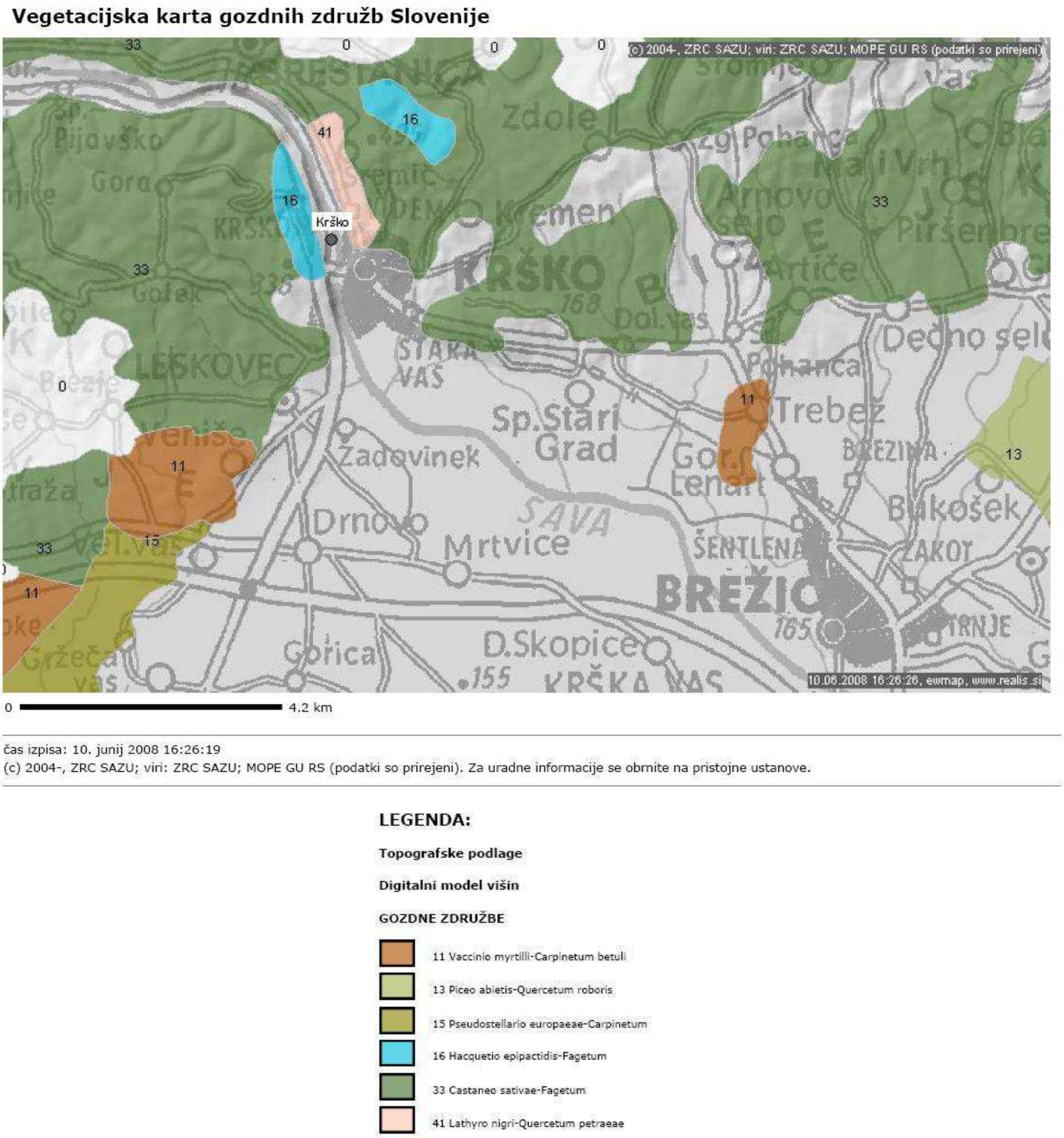


Figure 45: Plant community in the wider Krško Polje/Brežiško Polje area

Vegetacijska karta gozdnih združb Slovenije	Vegetation map of forest communities of Slovenia
čas izpisa: 10. junij 2008, 16:26:19	print-out time: 10 June 2008, 16:26:19
© 2004, ZRC SAZU; viri: ZRC SAZU; MOPE GU RS (podatki so prirejeni). Za uradne informacije se obrnite na pristojne ustanove.	© 2004, ZRC SAZU; sources: ZRC SAZU; MOPE GU RS (adapted data). Contact the responsible institutions for official information.

LEGENDA:	KEY:
Topografske podlage	Topographic bases:
Digitalni model višin	Digital elevation models
GOZDNE ZDRUŽBE	FOREST COMMUNITIES

Fauna diversity is extremely low in the core site area, since the area consists of intensively cultivated monocultural fields separated from the surroundings by natural (Sava) and man-made barriers (road, railway line with embankments).

The Krško Basin represents a varied habitat for various animal communities and offers an important habitat to numerous wild species of vertebrates and invertebrates. The former include, in particular, numerous species of birds and amphibians, while many species of mammals and fish are also present. Of the invertebrates, most is known about the butterflies and beetles. Thirty species of mammals have been recorded in the area of the Krško Basin. However, owing to migration barriers, the species variety of large mammals in the area under consideration is most likely to be relatively limited. We assume that in the area under consideration the following species are at least periodically present: southern white-breasted hedgehog (*Erinaceus concolor*), hare (*Lepus europaeus*) and various martens. Within the core area of the plan, the presence of small populations of various species of mice, voles and moles (*Talpa europaea*) may be expected.

In all likelihood there are no nesting birds in the area of the plan, although some species appear there on a regular basis.

There are potentially 43 different species of fish living in the river Sava, which runs to the south of the LILW repository site. More than 20 species of dragonflies have been observed on Krško Polje, while a smaller number of species (7) have been recorded in the area of the Stari Grad gravel pit and could potentially appear periodically in the core area under consideration. Of the invertebrates, two species of earthworms (*Lumbricus terrestris*, *Octolasion tyrtaeum*) have been recorded in the wider area and are probably also present in the core area of the repository. The presence of two species of snails (*Pagodulina sparsa*, *Cochlodina commutata*) recorded in the wider area is not expected in the area of the plan. Owing to intensive farming methods using plant protection agents, a limited presence of invertebrate species (smaller populations of the more common species) is expected. The small size of the insect population is also the reason why there are few insectivorous species of vertebrates in this area. The area of the LILW repository site does not provide a favourable living and feeding habitat for amphibious creatures. It is conjectured that individual specimens of two relatively common species, the common frog and common toad, occasionally appear in the immediate vicinity of the site. This area does not provide a favourable habitat for reptiles, with occasional appearances only by slowworms and common wall lizards. The area is not given over to livestock farming but is used for intensive feed production.[104]

4.1.6 *THE BUILT ENVIRONMENT AND THE PRESENCE OF SPECIAL MATERIAL ASSETS*

Cultural heritage consists of sources and evidence of human history and culture, irrespective of their origin, development and state of conservation (tangible, material heritage), and related cultural assets (intangible, immaterial heritage). Because of their cultural, scientific and general human value, the protection and conservation of cultural heritage are in the national interest.

With regard to Article 26 of the Cultural Heritage Protection Act (ZVKD-1, Official Gazette of the RS 16/08, 123/08, 8/11, 90/12, 111/13, 32/16), it is worth pointing out that a general archaeological conservation regime is compulsory in all interventions into earth strata, which requires the finder/site owner/developer/project manager to protect discoveries undamaged *in*

[104] Environmental report for the low- and intermediate-level radioactive waste (LILW) repository, April 2009, GEATEH

situ and immediately notify the competent unit of the Institute for the Protection of Cultural Heritage of Slovenia about the find, whereupon the latter will document the situation in accordance with the provisions of the archaeological profession.

There are **no cultural heritage units listed** in the area and **no protected archaeological sites**.

4.1.7 *TYPES AND PURPOSE OF USE OF LAND IN THE AREA*

Designated land use in the area of the planned development

The area of influence during the period of operation (area within the red contour on the figure below) measures 16.5 ha, of which, in terms of purpose of use, approximately 3.04 ha consists of “other regulated green areas”, 13.14 ha is “area of other infrastructure (T,E,O)” and 0.32 ha is “agricultural land”. In terms of categorisation of purpose of use, the majority of the LILW repository complex is classified as an area of other infrastructure (T,E,O), with only a part of it classified as green areas (source: PISO, 2017).

There are fields (monoculture cereal) within the wider area and a commercial orchard in the direct vicinity of the site (west of the LILW repository)

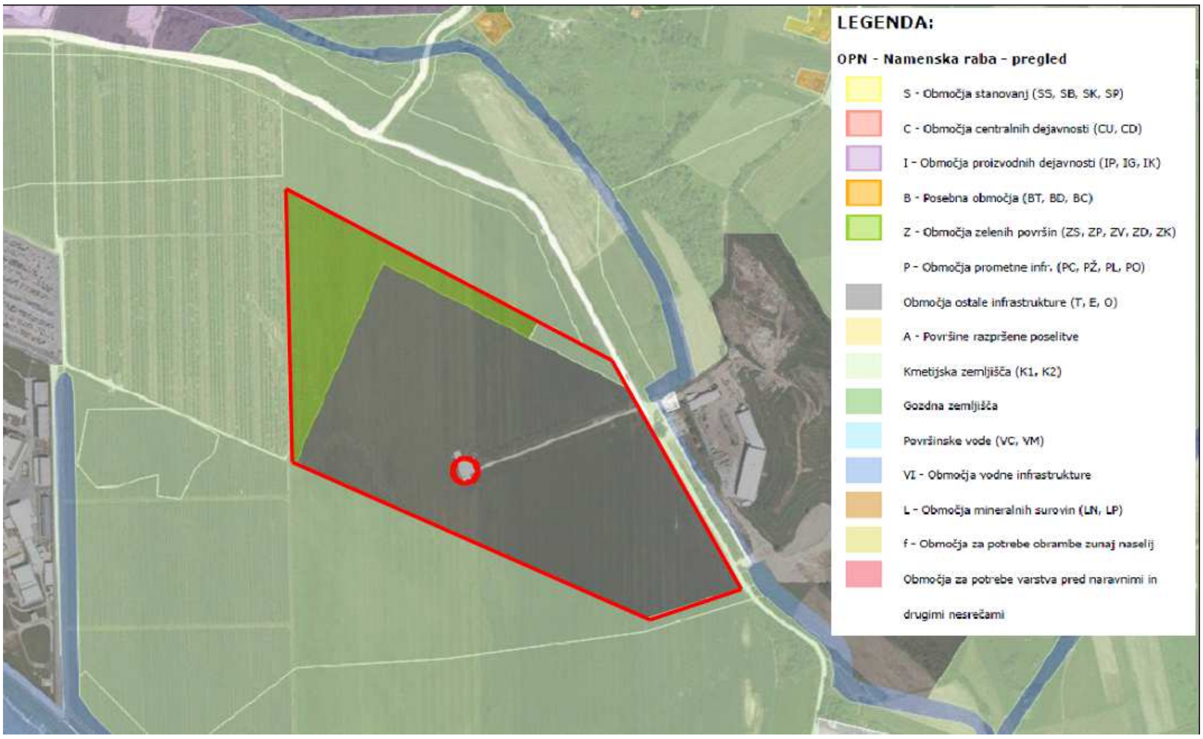


Figure 46*:* Land use in the area of the development (the red contour indicates the area of influence during operation)

LEGENDA:	KEY:

OPN – Namenska raba – pregled	OPN – Intended use – overview
S – Območja stanovanj (SS, SB, SK, SP)	S – Residential areas (SS, SB, SK, SP)
C – Območja centralnih dejavnosti (CU, CD)	C – Area of central activities (CU, CD)
I – Območja proizvodnih dejavnosti (IP, IG, IK)	I – Areas intended for manufacturing (IP, IG, IK)
B – Posebna območja (BT, BD, BC)	B – Special areas (BT, BD, BC)
Z – Območja zelenih površin (ZS, ZP, ZV, ZD, ZK)	Z – Green areas (ZS, ZP, ZV, ZD, ZK)
P – Območja prometne infr. (PC, PŽ, PL, PO)	P – Traffic infrastructure areas (PC, PŽ, PL, PO)
Območja ostale infrastrukture (T, E, O)	Other infrastructure areas (T, E, O)
A – Površine razpršene poselitve	A – Areas of dispersed settlement
Kmetijska zemljišča (K1, K2)	Agricultural land (K1, K2)
Gozdna zemljišča	Forest land
Površinske vode (VC, VM)	Surface waters (VC, VM)
VI – Območja vodne infrastrukture	VI - Water infrastructure areas
L – Območja mineralnih surovin (LN, LP)	L - Mineral raw material areas (LN, LP)
f – območja za potrebe obrambe zunaj naselij	f – Areas earmarked for defence outside settlements
Območja za potrebe varstva pred naravnimi in drugimi nesrečami	Areas for protection against natural and other disasters

Actual land use in the area of the planned development

Within the area of the plan, actual land use consists exclusively of fields and gardens (code 1100). The western part of the area of the plan borders on intensive orchards (code 1221) (Source: Actual use of agricultural land (PISO 2017).

Figure 47**:** Actual use in the area of the plan

LEGENDA:	KEY:
Dejanska raba kmetijskih in gozdnih zemljišč:	Actual use of agricultural and forest land:
Njiva, vrt, rastlinjak	Field, garden and greenhouse
Hmeljišče	Hop garden
Trajne rastline/trajni nasadi	Permanent plants/permanent plantations
Vinograd	Vineyards
Matičnjak	Root stock nursery
Intenzivni sadovnjak	Intensive orchard
Ekstenzivni oz. travniški sadovnjak	Extensive or meadow orchard
Oljčnik	Olive grove
Trajni travnik	Permanent meadows
Barjanski travnik	Bog meadow
Gozd/kmet. zemljišče, poraslo z gozdnim drevjem	Forest trees on arable/forest land
Kmetijsko zemljišče v zaraščanju	Overgrown arable land
Plantaža gozdnega drevja	Forest plantations
Drevesa in grmičevje/neobdelano kmet. zemljišče	Trees and bushes/uncultivated farmland
Pozidano in sorodno zemljišče – NE GRE ZA STAVBNA	Built and related land – DOES NOT INVOLVE BUILDING LAND

4.2 AREAS WITH A SPECIAL PROTECTION REGIME

Below we present data on conservation areas, protected areas, degraded areas and other areas in which a special legal regime has been prescribed for environmental protection, nature conservation, the protection of natural resources or the protection of cultural heritage.

4.2.1 *AREAS WITH NATURE CONSERVATION STATUS (for more details see subsection 4.4.6)*

The area of the development does not encroach on a Natura 2000 area, nor on any protected areas. The area under consideration contains no natural features or zones that are important to biodiversity. There is, however, a Natura 2000 area (SAC Vrbina) in the vicinity of the development site, an ecologically important area consisting of the Sava from Radeče to the national border (ID=63700) and, SE of the area, a valuable natural feature of local importance, namely Stari Grad–gravel pit (ID=7861).
The Special Area of Conservation designated SAC Vrbina (SI3000234) is approximately 950 metres from the area in which construction of the LILW repository is planned, at its closest point. It coincides or overlaps with the floristically richest part of the ecologically important area encompassing the Sava from Radeče to the national border.

4.2.2 *WATER PROTECTION AREAS AND WATER SOURCES*

There are no drinking water source protection zones on the development site in question.
Within the area of the development no restrictions are prescribed regarding the water regime for groundwater. Neither are there any water sources used for water supply; the nearest water source for which water protection areas have been defined is located to the west of the river Sava in the Žadovinek area, approximately 650 metres away (figure below).

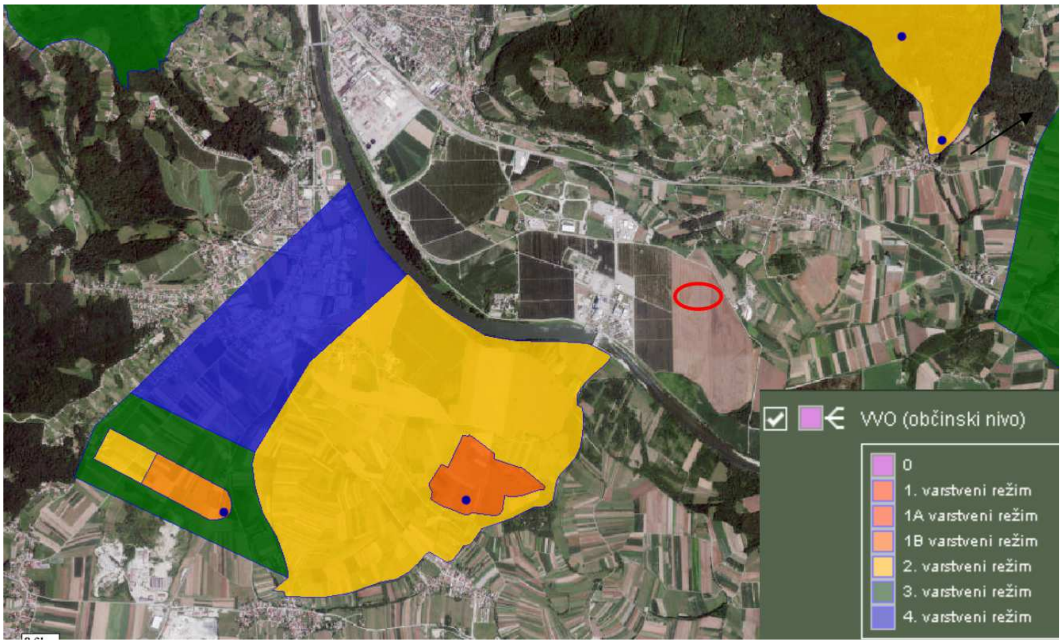


Figure 48: Water protection areas in the vicinity of the development site

VVO (občinski nivo)	VVO - water protection area (municipal level)
1. varstveni režim	protection regime 1
1A varstveni režim	protection regime 1A
1B varstveni režim	protection regime 1B
2. varstveni režim	protection regime 2
3. varstveni režim	protection regime 3
4. varstveni režim	protection regime 4

4.2.3 *AGRICULTURAL LAND*

In accordance with the applicable planned use, the best agricultural land is located in the core area of the plan (in a 500 metre circle). Within the plan of the municipality of Krško, the agricultural land conditioning programme permits lowland melioration – An3, Stari Grad and consolidation K11 and irrigation N1, Stara Vas.
In the wider area of the plan (in a 1000-metre circle) the best agricultural land is likewise situated.

The Krško Polje/Brežiško Polje area is among the priority areas for agriculture (*Ordinance on the Spatial Planning Strategy of Slovenia, Official Gazette of the RS, Nos 76/04, 33/07 – ZPNačrt and 61/17 – ZUreP-2).*

4.2.4 *PROTECTION FOREST*

There are no protection forests or forest reserves defined by the *Decree on protection forests and special purpose forests (Official Gazette of the RS, Nos 88/05, 56/07, 29/09, 91/10, 1/13, 39/15)* in the area of the development.

4.2.5 *MINERAL RESOURCES*

No mineral resources are exploited in the area of the development.
The Stari Grad gravel pit, where gravel is quarried, is located SE of the development site.

4.2.6 *CULTURAL LANDSCAPE*

Article 35 of the Nature Conservation Act (*Official Gazette of the RS, No 96/04 – official consolidated version, 61/06 – ZDru-1, 8/10 – ZSKZ-B and in 46/14*) states that a landscape is a spatially defined part of the natural environment which, as a result of animate and inanimate natural characteristics and human activity, has a specific distribution of landscape structures. Landscape diversity is the spatial structuredness of natural and anthropogenic landscape elements. Landscape diversity and those characteristics of the landscape important for the maintenance of biodiversity are conserved, developed and re-established.
Developments are planned and implemented in such a way that priority is given to conservation of those characteristics of the landscape that are important for the maintenance of biodiversity and landscape diversity.

The site of the planned development does not lie within a protected landscape/nature park or other area with a special landscape protection regime.

The key characteristics in the wider area of the Vrbina site are: plain, open farmland, the river Sava, flat forest areas, the Krško nuclear power plant (NPP).

4.3 SETTLEMENT AND LIVING CONDITIONS

All arrangements in the context of the LILW repository are planned to take place within the municipality of Krško. The total surface area of the municipality of Krško is 286 km^2.

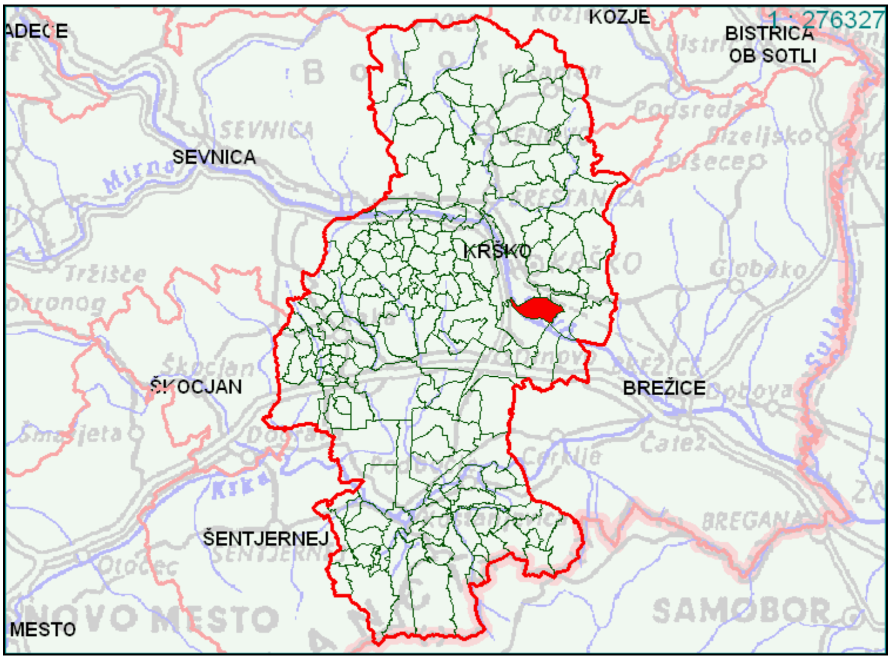


Figure 49: Municipality of Krško with Vrbina area marked

According to the most recent figures (February 2016), the population of the municipality is 25,885.[105] The area containing the LILW repository site is not settled. A pattern of dispersed construction (residential buildings and farms) is characteristic of the wider area around the repository site. The nearest settlements are Spodnji Stari Grad, lying to the NE, and Vrbina, which lies NW of the location at a distance of around 1.2 km. The nearest town is Krško, which is 2.5 km away from the site. The town of Brežice is 5 km away. The nearest large population centre is the city of Zagreb, in neighbouring Croatia, with approximately 790,000 inhabitants.[106] It lies 38 km south-east of the repository site.

The town of Krško is the economic, employment, administrative, supply, educational and cultural centre of the lower Posavje region. It lies on both banks of the river Sava, which here flows out of a long valley, in places a gorge, in the Posavje Hills, in other words between the

[105] Municipality of Krško website. [Online]. Available: http://krsko.si/7/obcina-krsko.
[106] Information on the city of Zagreb. [Online]. Available: https://hr.wikipedia.org/wiki/Zagreb.

Krško Hills in the south and the Senovo valley system in the north. South-west of the town, Krško nuclear power plant (696 MW) stands above the Vrbina floodplain.
Settlements downstream of Krško and Videm have mainly formed on the right bank of the Sava along the main Ljubljana–Zagreb road. Notwithstanding earlier planning policies aimed at the development of a conurbation, Krško and Brežice have both developed into municipal centres, each with its own urban functions, although the basis for the formation of a conurbation remains. The main impulse in this direction is without a doubt the proposed new road link between Krško and Brežice via Vrbina, which would represent a generator of development for the Krško-Brežice economic zone and the integration of the individual areas.

Brežice's spatial development is largely directed towards the north and east. An important development in the east is the town bypass, which could potentially serve as a connection to the planned Krško–Brežice road (referred to as *Vrbinska cesta* or the Vrbina road). In this sense, the present bypass would in the long term be transformed into the main route into the town, around which central services would form to supply the town's residential districts and other activities.

In 2011 the population of the Lower Posavje region was 70,167, which was an increase of just over 2% on the 2002 figure. In 2011 most of the population of the area resided in the municipality of Krško (25,867), followed by the municipalities of Brežice and Sevnica. The smallest number lived in the municipality of Kostanjevica na Krki (2,404). If we compare the figures from 2002, the trend of low population growth characteristic of the Lower Posavje region and of Slovenia as a whole is also apparent in the municipality of Brežice. By contrast, the number of people living in the municipality of Sevnica fell by just under one per cent in this period. When analysing population growth trends in the other two municipalities, account should be taken of the fact that the municipality of Kostanjevica na Krki split off from the municipality of Krško on 1 March 2006, which means that the actual population of the municipality of Krško fell by around 2,400 between 2002 and 2011. If one looks only at the population of that part of the municipality of Krško that remains part of the municipality today, one finds low population growth in the period in question, while the population of the municipality of Kostanjevica na Krki fell by just under one per cent. In summary, there was slow population growth in the Lower Posavje region and in the municipalities of Brežice and Krško (as well as in Slovenia as a whole) between 2002 and 2011, while there was slight population decline in the municipalities of Kostanjevica na Krki and Sevnica.[107]

[107] S. Založnik, Model-based demographic and social characteristics of the municipalities of the Lower Posavje region (Demografske in socialne značilnosti občin Spodnjega Posavja na osnovi modela), pp. 39–53, 2012.

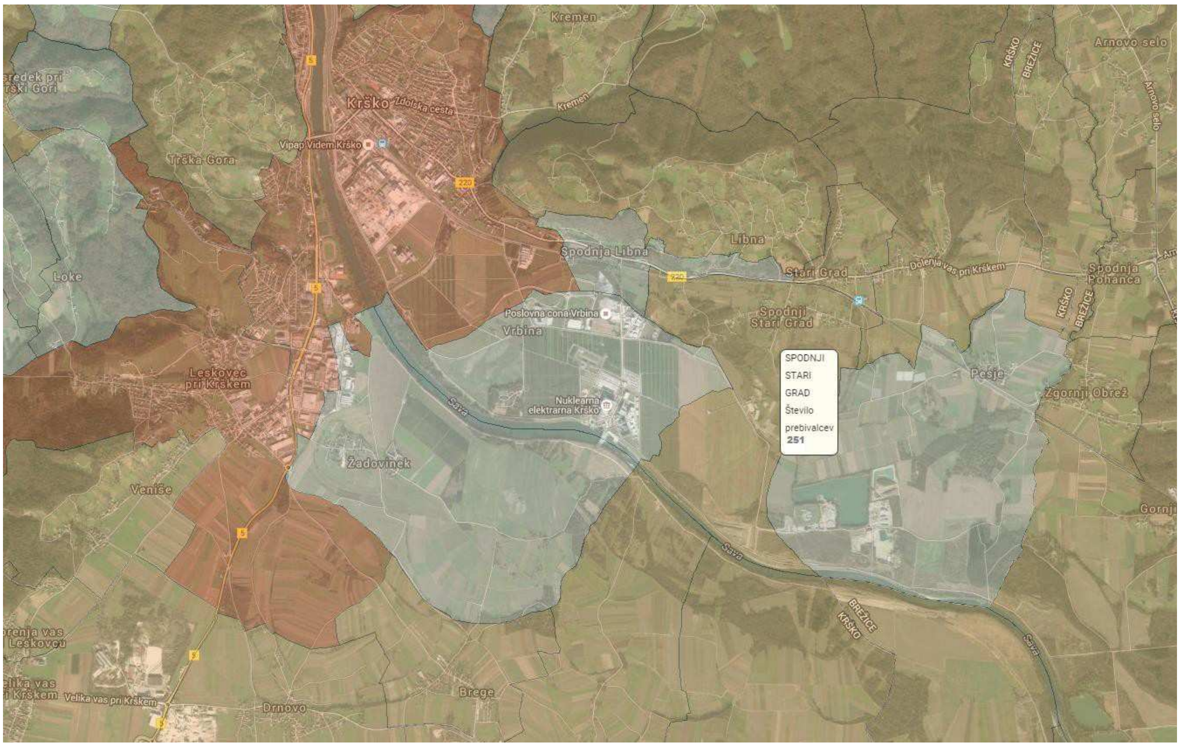


Figure 50: Settlements in the vicinity of the LILW repository site (source: Statistical Office of the Republic of Slovenia, 2017).

SPODNJI STARI GRAD *Število prebivalcev 251*	*SPODNJI STARI GRAD* *Number of inhabitants: 251*

The settlements in the vicinity of the LILW repository site are Spodnji Stari Grad and Vrbina (see figure above).[108]

According to 2017 data from the Statistical Office of the Republic of Slovenia (*http://www.stat.si/StatWeb/News/Index/6697*), 251 people live in the village of Spodnji Stari Grad, which is the closest settlement to the LILW repository site. Of this number, 39 belong to the 0–14 age group, 171 to the 15–64 age group and 41 to the 65 and over age group. According to official figures, only two inhabitants remain in Vrbina (one in the 15–65 age group and one aged over 65). The village of Spodnja Libna has 66 inhabitants, of whom 16 belong to the 0–14 age group, 38 to the 15–64 age group and 12 to the 65 and over age group.

[108] Statistical Office of the Republic of Slovenia website [online]. Available: http://www.stat.si/statweb.

4.4 DESCRIPTION OF THE EXISTING STATE AND QUALITY OF THE ENVIRONMENT

4.4.1 *AIR QUALITY AND AIR POLLUTION IN THE AREA*

4.4.1.1 Air pollution level

Air quality assessment and management is carried out throughout Slovenia in accordance with the *Decree on ambient air quality* by classifying individual areas and agglomerations as having level I air pollution level or level II air pollution:

- a zone, subzone or agglomeration is defined as having level I air pollution if the level of a pollutant exceeds limit or target values and if there is a risk that the level of pollution will exceed the alert threshold;
- an area or agglomeration is defined as having a pollution level II if the level of the pollutant in question does not exceed the limit or target value.

Classification as level I or level II pollution is determined by the minister on the basis of an air quality assessment carried out by experts from the ministry.

Under the *Decree amending the Decree on ambient air quality* (*Official Gazette of the RS* 8/15), the municipality of Krško, where the area in question is located, belongs:

- to the inland air pollution zone (code: SIC) with regard to sulphur dioxide, nitrogen dioxide, nitrogen oxides, PM_{10} and $PM_{2.5}$ particulates, benzene, carbon monoxide and benzo(a)pyrene. Extent of the area with regard to statistical regions: Pomurje and Podravje minus the City of Maribor, Koroška, Savinjska and Zasavje, central Posavje, Gorenjska, Central Slovenia and SE Slovenia minus the City of Ljubljana
- to the heavy metals zone (code: SITK) with regard to lead, arsenic, cadmium in nickel. This zone includes: Pomurje and Podravje minus the City of Maribor, Koroška minus the municipalities of Črna na Koroškem and Mežica, Savinjska and Zasavje, lower Posavje, Gorenjska, Central Slovenia and SE Slovenia minus the City of Ljubljana, Goriška, Notranjska-Karst and Coastal-Karst.

Table 20: Level of air pollution in SIC and SITK (to which the municipality of Krško belongs) with regard to the limit values set out in the *Order on the classification of zones, agglomerations and subzones with regard to ambient air pollution* (*Official Gazette of the RS* 38/17)

Zone designation	SO_2	NO_2	NO_x	PM_{10}	$PM_{2.5}$	lead	CO	benzene
SIC	II	II	II	II*	II	/	II	II
SITK	/	/	/	/	/	II	/	/

Key
II – level of contaminant below limit value
I – level of contaminant above limit value
/ – N/A
* SIC except for SIC_CE, SIC_NM, SIC_MS, SIC_ZS, SIC_KR

Table 21: Level of air pollution in SIC and SITK (to which the municipality of Krško belongs) with regard to the target values set out in the *Order on the classification of zones, agglomerations and subzones with regard to ambient air pollution* (*Official Gazette of the RS* 38/17)

Zone designation	ozone	arsenic	cadmium	nickel	benzo(a)pyrene
SIC	I	/	/	/	II
SITK	/	II	II	II	/

Key
II – level of contaminant below target value
I – level of contaminant above target value
/ – N/A

The *Decree on ambient air quality* determines lower and upper assessment thresholds for individual pollutants. If the level of pollution of an individual pollutant is below the lower assessment threshold, objective assessments or modelling are sufficient for air quality assessment, while if the levels of pollution are above the lower assessment threshold, measurements at fixed measurement sites in the individual zone or agglomeration are compulsory.

Table 22: Level of contaminants in ambient air in the SIC and SITK zones (to which the municipality of Krško belongs) with regard to the target values set out in the *Order on the classification of zones, agglomerations and subzones with regard to ambient air pollution* (*Official Gazette of the RS* 38/17)

Zone designation	***SO_2***	***NO***	***NO_x***	***PM_{10}***	***$PM_{2.5}$***	***lead***	***CO***	***benzene***	***arsenic***	***cadmium***	***nickel***	***benzo(a)pyrene***
SIC	***1***	***2***	***2***	***3***	***3***	***/***	***1***	***1***	***/***	***/***	***/***	***3***
SITK	***/***	***/***	***/***	***/***	***/***	***1***	***/***	***/***	***1***	***1***	***1***	***/***

Key
1 – below the lower assessment threshold
2 – between the lower and upper assessment thresholds
3 – above the upper assessment threshold
/ – N/A

4.4.1.2 **State of air pollution in the area of the development site**

Pollutants come from various sources and activities. The biggest contributions to the emission of pollutants come from electricity and heat production (SO_2), transport (VOCs, particles and NOx), households (VOCs) and construction. Other contributing sectors include agriculture (ammonia), waste disposal (methane) and industrial processes. All these sources are everywhere in our environment.

Ambient air quality measurements as part of the national network (DMKZ), implemented by ARSO, are not taken in the area of the development and its immediate vicinity. The closest location is Novo Mesto, which is just over 30 km to the SW as the crow flies. This measurement site is not fully representative for the area of the planned development. It is located in an urban area, for which reason the data are representative for the more densely inhabited parts of this town and thus not fully relevant for the area in which the planned development is located. The data do give us a picture of immission values in the wider area of the development.

In the past, up to 2006, Krško was included as a location (EIS Krško) in the national network of ambient air quality monitoring. Measurements of SO_2 concentrations were carried out. At this measurement site (the area of influence of the VIPAP plant) the following SO_2 concentration limits were exceeded in 2006:
- average annual concentration limit,
- average winter concentration limit,
- permitted annual exceedances of hourly concentration limit,
- permitted annual exceedances of daily concentration limit,

The VIPAP cellulose plant (Tovarna VIPAP Videm Krško d.d.) ceased operations in August 2006. With the closure of the cellulose plant, emissions of sulphur dioxide into the air significantly reduced (source: ARSO, Air-quality report for 2006).

Significant potential sources of air pollution in the direct vicinity of the development site are:
- Krško NPP (emissions into the air are discussed in more detail in the section on ionising radiation),
- the closed municipal waste landfill and the Spodnji Stari Grad Waste Management Centre,
- local traffic along the Vrbina road,
- individual furnaces during the winter in surrounding settlements,
- Raceland safe driving & sport driving centre – SE of Krško NPP (more than 1.5 km from the development site).

The table below shows the emissions of substances into the air from industrial installations that are legally required to monitor the emission of substances into the atmosphere from stationary sources of pollution within the territory of the municipality of Krško for 2015.

Table 23: Data on emissions into the air from industrial plans in the municipality of Krško for 2015.

Name of industrial plant	Location of measuring device	Contaminant	Emissions of substances from outlets (kg)	Estimated diffuse emission (kg)
VIPAP Videm Krško	Tovarniška cesta 18, Krško	- total dust - nitrogen oxides (NO and NO_2) expressed as NO_2 - carbon monoxide (CO) - organic compounds, expressed as total organic carbon (TOC) - sum of inorganic particulate matter of categories I, II and III - sum of inorganic particulate matter of category II - amount of carcinogens from danger category I - sulphur oxides (SO_2 and SO_3) expressed as SO_2	11,925.04 275,578.52 46,770.44 4,093.70 10.75 8.85 1.67 115,402.00	138.00 0 0 0 0 0 0 0
Kostak d.d.	Stari Grad landfill	- methane (NH_4) - carbon dioxide (CO_2)		102,200.00 618.900.00
Krka d.d., Krško plant	Tovarniška ulica 20, Krško	- total, expressed as HCl - total dust - nitrogen oxides (NO and NO_2) expressed as NO_2	23.42 6.14 1,159.73	0 0 0

Name of industrial plant	Location of measuring device	Contaminant	Emissions of substances from outlets (kg)	Estimated diffuse emission (kg)
		- carbon monoxide (CO) - organic compounds, expressed as total organic carbon (TOC) - dibenzofurans (PCDF)	11.61 104.83 0.05376	0 196 0
Avtoline Krško trgovina in servis d.o.o.	Bohoričeva ulica 10, Krško	- total dust	9.55	0
Ekten d.o.o.	Cesta krških žrtev 135 D	- total dust	16.00	0
Kanu inženiring d.o.o.	Veliki Podlog 999 Leskovec pri Krškem	- total dust - organic compounds, expressed as total organic carbon (TOC)	197.60 2,180.40	100.00 36,576.00
Kemokovina Krško d.o.o.	Cesta krških žrtev 137, Krško	- total dust - organic compounds, expressed as total organic carbon (TOC)	42.06 99.47	5.00 0
KIM d.o.o.	Ulica 11. novembra 49, Leskovec pri Krškem	- total dust - organic compounds, expressed as total organic carbon (TOC)	17.08	0 876.00
Metalna Senovo d.o.o.	Titova cesta 52, Senovo, Krško	- total dust	219.36	50.00
Resistene upr. d.o.o. & Co.k.d.	Žadovinek 39, Leskovec pri Krškem	- total dust - organic compounds, expressed as total organic carbon (TOC)	10.05 899.76	0 5.00
Steklarstvo Resnik Janez s.p.	Ulica mladinskih delovnih brigad 24, Leskovec pri Krškem	- organic compounds, expressed as total organic carbon (TOC)		1,152.00
Šumi bomboni d.o.o., PE Krško	Cesta 4. julija 86	- total dust	131.60	0
Willy Stadler d.o.o.	Velika vas 62 A, Leskovec pri Krškem	- organic compounds, expressed as total organic carbon (TOC)		6,235.00
TE Brestanica	Cesta prvih borcev 18, Krško	- total dust - nitrogen oxides (NO and NO_2) expressed as NO_2 - carbon monoxide (CO) - sulphur oxides (SO_2 and SO_3) expressed as SO_2	106.88 15,186.74 720.99 347.77	0 0 0 0

Source: Emissions of substances into the air from industrial installations for 2015, ARSO 2017.

Emissions from the Spodnji Stari Grad landfill for non-hazardous waste

The **landfill** has been closed since 2007. Gases are discharged into the atmosphere without preliminary treatment or combustion. No active degassing system exists at the site. The landfill has been fully remediated and grassed over. Twelve degassing units are installed at the landfill. Waste gases are the result of aerobic and anaerobic digestion of biological and other waste. The prevailing gases are methane and carbon dioxide, while trace gases include ammonia, hydrogen sulphide and other organic substances that can cause unpleasant smells. The biological processes that cause the breakdown of waste under aerobic or anaerobic conditions take place all year round, although the speed of these processes is dependent on ambient weather conditions. Part of the biological processes also take place in the covered layer of the landfill, where methane (10%) is oxidised into carbon dioxide.

Waste gases are discharged into the atmosphere, partly through degassing units but predominantly through the entire surface of the landfill. The entire surface of the landfill represents a source of diffuse emission of methane and other gaseous pollutants and particulate matter emissions (the quantity depending on ambient weather conditions and the time of year).
In October and November 2014, the National Laboratory for Health, Environment and Food (more specifically its Environment and Health Department based in Novo Mesto) carried out measurements at the landfill in accordance with the *Rules on initial measurements and operational monitoring of the emission of substances into the atmosphere from stationary sources of pollution and on conditions for the implementation of monitoring* (*Official Gazette of the RS 105/08*) and the *Decree on the landfill of waste* (*Official Gazette of the* RS 10/14). It drew up the “Report on measurements of the emission of substances into the atmosphere No 44-154/14-14OOBK of 7 January 2015”.
The findings of the report are that the total mass emitted from the landfill in 2014 was:
- 122.8 tonnes of methane
- 623.5 tonnes of carbon dioxide.

Limit values of emission of substances into the atmosphere are not prescribed.
For 2015, the values are given in the above table (Source: ARSO 2017).

Emissions from the Spodnji Stari Grad Waste Management Centre:

At the Spodnji Stari Grad Waste Management Centre, the problem of smell from the open composting plant was supposed to be addressed by means of a new project: in June 2015, according to information from the media, a new, closed composting plant fitted with biofilters was opened. This was supposed to resolve the problem of the stench that could spread from the open composting plant into the living environment of the inhabitants of the surrounding area, causing odour nuisance.
At the time of drawing up the background documents, data on emissions of substances into the air from the activities of the Waste Management Centre were not available to us. In October 2015, the Spodnji Stari Grad Waste Management Centre received an environmental permit (IPPC – number 35407-1/2013-21) from ARSO, in which the following are prescribed:
- obligations relating to operational monitoring and reporting on the emissions of substances into the atmosphere (no later than 9 months after the start of operation)
- obligations relating to first assessment, operational monitoring and reporting on noise emission

Emissions from traffic

Within the area of the planned development there are no roads or other arrangements, nor any planned transport connections, that fall within the competence of DARS d.d. For this reason there are no publicly available data on average annual daily traffic (AADT) on the local road (*Vrbinska cesta* – “the Vrbina road”), which is important for the development in question. Transport will take place along this road during the period of construction and operation of the LILW repository.
The section of road within the competence of DARS d.d. that passes closest to the planned development is the section between Krško and Spodnja Pohanca in the north (approximately

700 m away). This is a category I regional road (R1). AADT on this road was 6046 in 2011, 5571 in 2013 and 5485 in 2014 (see map below).

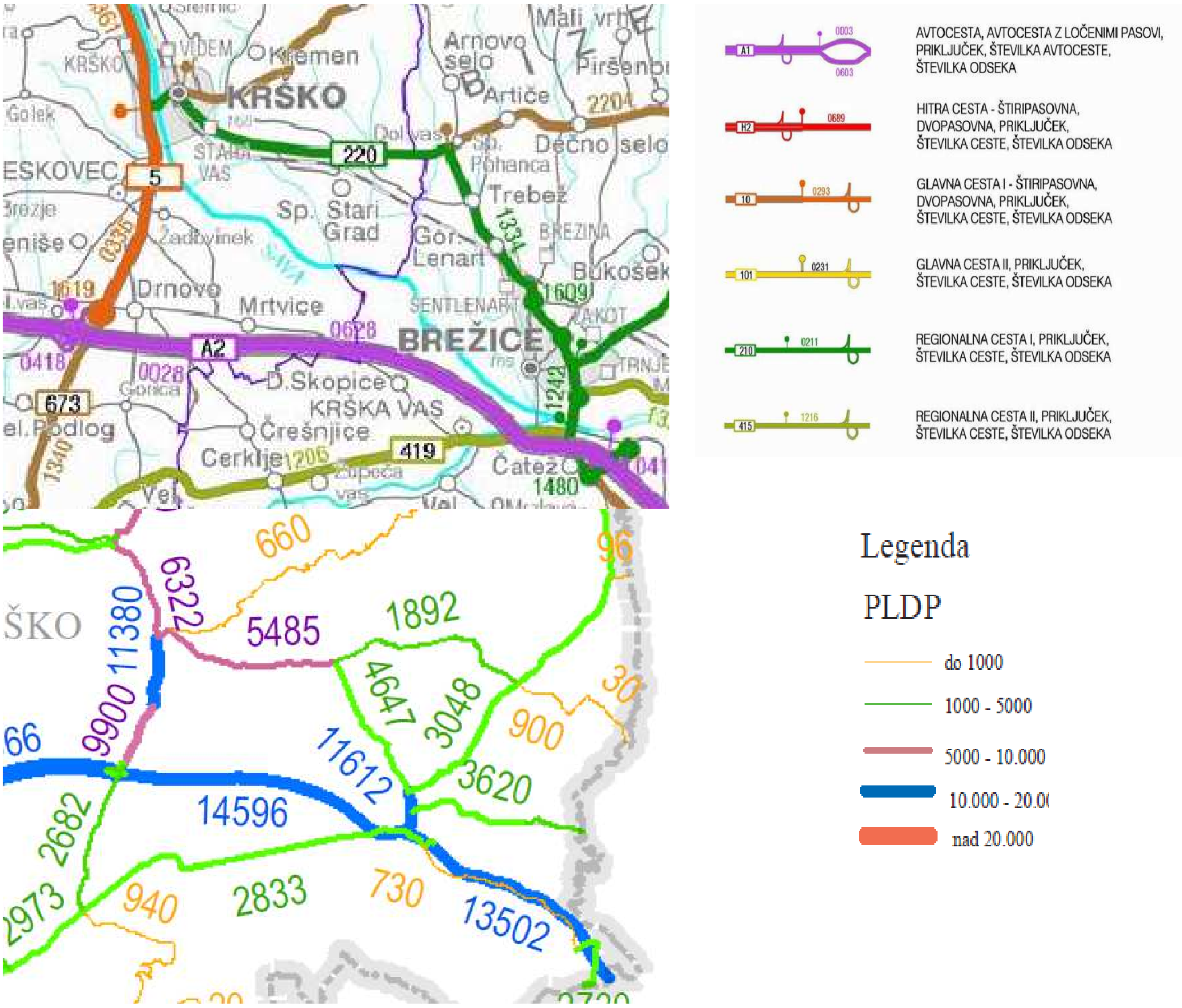


Figure 51: Detail from traffic map 2014, AADT – average annual daily traffic (source: Slovenian Roads Agency).

AVTOCESTA, AVTOCESTA Z LOČENIMI PASOVI, PRIKLJUČEK, ŠTEVILKA AVTOCESTE, ŠTEVILKA ODSEKA	MOTORWAY, MOTORWAY WITH SEPARATE LANES, ROAD JUNCTION (ACCESS), MOTORWAY NUMBER, SECTION NUMBER
HITRA CESTA – ŠTIRIPASOVNA, DVOPASOVNA, PRIKLJUČEK, ŠTEVILKA CESTE, ŠTEVILKA ODSEKA	HIGH-SPEED ROAD - FOUR LANES, TWO LANES, ROAD JUNCTION (ACCESS), ROAD NUMBER, SECTION NUMBER
GLAVNA CESTA I - ŠTIRIPASOVNA, DVOPASOVNA, PRIKLJUČEK, ŠTEVILKA CESTE, ŠTEVILKA ODSEKA	MAIN ROAD I - FOUR LANES, TWO LANES, JUNCTION (ACCESS), ROAD NUMBER, SECTION NUMBER
GLAVNA CESTA II, PRIKLJUČEK, ŠTEVILKA CESTE, ŠTEVILKA ODSEKA	MAIN ROAD II - JUNCTION (ACCESS), ROAD NUMBER, SECTION NUMBER
REGIONALNA CESTA I, PRIKLJUČEK,	REGIONAL ROAD I - JUNCTION (ACCESS),

ŠTEVILKA CESTE, ŠTEVILKA ODSEKA	ROAD NUMBER, SECTION NUMBER
REGIONALNA CESTA II, PRIKLJUČEK, ŠTEVILKA CESTE, ŠTEVILKA ODSEKA	REGIONAL ROAD II - JUNCTION (ACCESS), ROAD NUMBER, SECTION NUMBER

Legenda	Key
PLDP	AADT (average annual daily traffic)
do 1000	up to 1,000
1000 – 5000	1,000–5,000
5000 – 10.000	5,000–10,000
10.000 – 20.000	10,000–20,000
nad 20.000	over 20,000

No AADT figures are publicly available for the Vrbina road (local road), which is important for the transport of vehicles for the site of the planned development. The only data available are those obtained from ARAO (below):

Spodnji Stari Grad Waste Management Centre (source: email, 10 April 2015, Mr Zoran Omerzu):

- delivery of material: 32 goods vehicles/day
- 30 cars/day

Operating hours of the Spodnji Stari Grad Waste Management Centre:
7.00 a.m. – 8.00 p.m. (March–September)
7.00 a.m. – 6.00 p.m. (October–February)
Saturdays: 7.00 a.m. – 12.00 p.m.
Sundays and holidays: closed

Stari Grad Gravel Pit (source: e-mail, 15 May 2015, Ms Barbara Jug, manager of Kostak d.d. gravel pit and quarry):

- frequency of transports per hour during working hours (Mon–Fri) from 7.00 a.m. to 5.00 p.m. is 3 goods vehicles/hour, which amounts to a total of 30 goods vehicles/day

No other data were available at the time the "EIA-existing state" document was being prepared. On the basis of existing data, however, **we estimate that the air in the area of the planned development is not excessively polluted**. Neither is the area **defined as a brownfield site**, for which it would be necessary to prepare, adopt and implement a programme of measures to improve the quality of ambient air – Air quality plan ordinances for brownfield sites.

4.4.2 *QUALITY AND QUANTITY OF GROUNDWATER AND THE BURDEN ON THE AREA RESULTING FROM GROUNDWATER POLLUTION*

4.4.2.1 **Krško Basin groundwater body**

The construction site for the LILW repository lies within the Krško Basin groundwater body (**VTPodV_*Krška kotlina***), which includes 3 aquifer systems: Brežiško Polje with 4 measurement sites, Čateško Polje with 1 measurement site and Krško Polje with 12 measurement sites. The Krško Basin groundwater body is located in the area of the alluvial gravel fill of the river Sava between Krško and the national border at Bregana.
The Krško Basin groundwater body includes three typical aquifers.[109] The first alluvial intergranular aquifer is of Quaternary age. It consists of sand and gravel fills of the rivers Sava and Krka and their tributaries. It is extensive and local, medium to high yielding, in places low yielding. The most important part of the water body, which is used to supply the population with drinking water, is located in it. The external boundary of the water body is defined at the contact of the alluvial deposit with the pre-Quaternary margin. In places the contact is practically impermeable hydraulic boundary, while in other places a considerable difference in permeability can be detected. Since the boundary is not everywhere impermeable, we expect underground inflows from neighbouring aquifers. The boundary of the aquifer at the national border at Bregana is not of hydrodynamic character.
The second intergranular aquifer of Quaternary and Tertiary age is located below the alluvial deposits of the
rivers Sava and Krka and their tributaries. Sands and gravels appear in places in the Tertiary layers, while in places there are also limestones with fracture porosity or karst porosity. Tertiary sediments from the Bizeljsko area dip below the alluvial fill and create its substratum. There is almost no outcropping on the southern margin of the basin, since in places the rocks are already eroded down to the pre-Tertiary carbonate substratum. The aquifer is extensive and local and low to medium yielding. The hydrodynamic boundary between the first and second aquifer is represented by clay layers of low permeability, which are not deposited continuously and also have different dips. For this reason, a hydraulic connection between the two aquifers is possible, although not defined in more detail in spatial terms.
The third aquifer is a thermal karst and fracture carbonate aquifer largely consisting of Mesozoic, Triassic Dolomites. It is extensive and local and low to high yielding. The carbonate layers
are for the most part only in indirect hydrodynamic connection with the higher-lying aquifers.
The groundwater system is dependent on surface waters, geological structure, quantity and distribution of precipitation, vegetation, the size of the recharge area and other factors. The water body typically has a connection with surface waters. The river Sava represents an important hydrodynamic boundary in the alluvial aquifer, since for the most part it drains it, while also partially feeding it.
The river Krka drains the aquifer in the wider area of Krška Vas right up to the confluence with the Sava. Further upstream, it does not have a pronounced hydraulic role.
Groundwater is threatened by the same sources of pollution as surface water, and additionally by consumption for drinking water and process water supply. The biggest sources of

[109] National hydrogeological database for definition of groundwater bodies in the Republic of Slovenia, Geological Survey of Slovenia 2005 and 2006

groundwater pollution are industrial activities, agriculture (excessive and seasonally inappropriate use of artificial and animal fertilisers and plant protection products), untreated urban wastewater, illegal dumping and, along main roads, a high traffic load and potential spills of hazardous substances in the event of accidents. Agricultural and built areas account for 82.4% of the surface area of the water body. The vulnerability of the water body is assessed as being very high.
The flat plains of Krško Polje and Vrbina are filled with sand and gravel fills in which intergranular aquifers with a free groundwater level appear. In the gravel fills on the right bank of the Sava, groundwater appears continuously, while on the left bank of the Sava it appears only in places or periodically.
In the Vrbina area, the Quaternary sand and gravel fills are predominantly built of poorly granulated gravel with sand and large lenses of gravel with more sand and silt. The sand and gravel fill is covered by a silt-sand and sand-clay deposit layer of a thickness ranging from a few tens of centimetres up to 2 metres. In places this deposit layer is almost entirely eroded, while in other places, particularly in filled branches and channels, it reaches a thickness of several metres.
The main groundwater reserves are in the Quaternary aquifer of Krško Polje (right bank of the Sava), which is the most important in the Krško Basin. Groundwater is recharged from precipitation and from the Sava, with the latter accounting for between 46% and 62% of dynamic groundwater reserves.

4.4.2.2 **Chemical and quantitative status of groundwater – national monitoring**

Chemical status of groundwater – national monitoring data

The Slovenian Environment Agency (ARSO) carries out immission monitoring of water in the natural environment pursuant to the Environmental Protection Act and the Waters Act. A groundwater quality monitoring programme is prepared for each year in accordance with the Decree and Rules on groundwater monitoring, which in 2009 transposed the EU Directive on the protection of groundwater against pollution and deterioration into Slovenian legislation.

The parameters that were analysed in the context of the groundwater quality monitoring programme in 2014 were selected with regard to analyses of: results of groundwater monitoring in past years (2000–2013), results of analysis of pressures and impacts, statutory regulations and directives.

The table below shows the chemical status of groundwater in the Krško Basin in the period 2007–2014.

Table 24: Chemical status of the Krško Basin groundwater body 2007–2014 (source: ARSO)

Code VTPodV	Name VTPodV		2007	2008	2009	2010	2011	2012	2013	2014
1,003	Krško Basin	Chemical status	good	poor	poor	good	good	good	good	good
		% inadequate MM	11.1	37.5	25.0	12.5	9.1	9.1	9.1	9.1

On Krško Polje, nitrate concentrations are increasing at the Drnovo pumping station and fluctuating above the quality standard. In 2014 they exceeded the standard at Drnovo.

Concentrations of desethyl-atrazine and total pesticides at Drnovo and Brege increased from 1998 to 2005, while since 2005, when the use of atrazine was prohibited, concentrations have fallen. These two pumping stations are also polluted by desethyl-atrazine, although values have been falling since 2005.

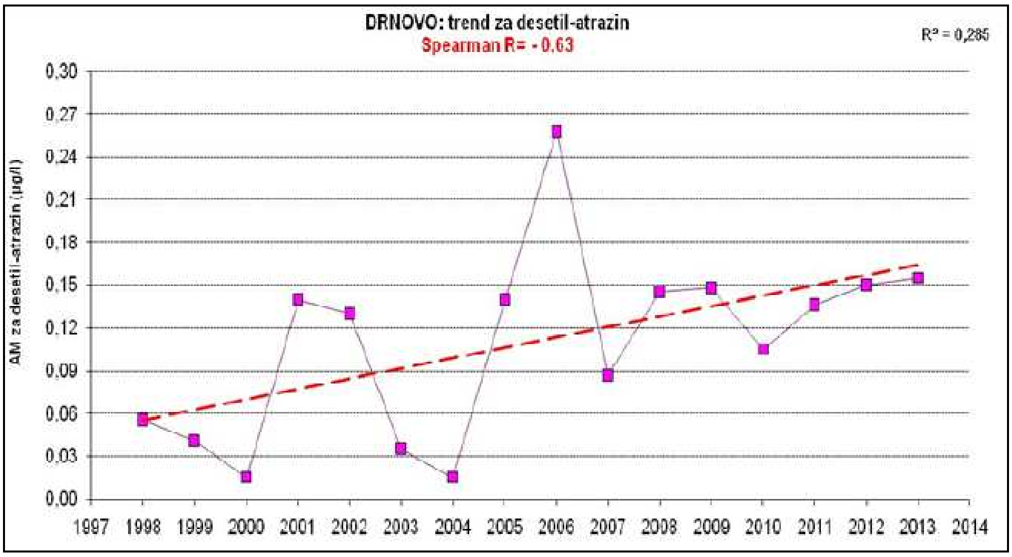


Figure 52: Drnovo, growing trend for desethyl-atrazine

DRNOVO: trend za desetil-atrazin	*DRNOVO: trend for desethyl-atrazine*
Spearman R = - 0.63	*Spearman R = -0.63*
R^2 = 0,285	*R^2 = 0.285*
AM za desetil-atrazin (µg/l)	*AM for desethyl-atrazine (µg/l)*

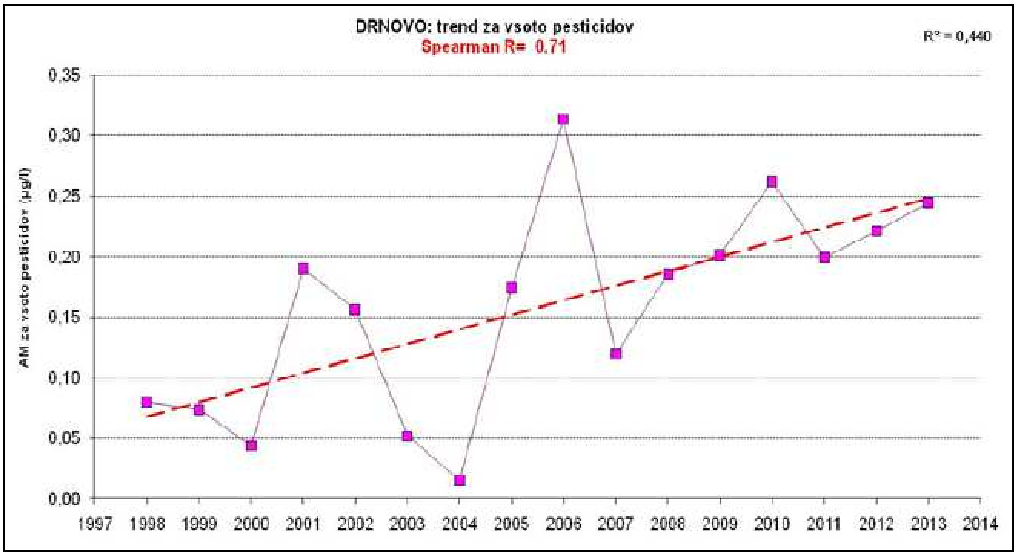


Figure 53: Drnovo, growing trend for total pesticides

DRNOVO: trend za vsoto pesticidov	DRNOVO: trend for total pesticides

Spearman R = 0.71	Spearman R = 0.71
R^2 = 0,440	R^2 = 0.440
AM za vsoto pesticidov (µg/l)	AM for total pesticides (µg/l)

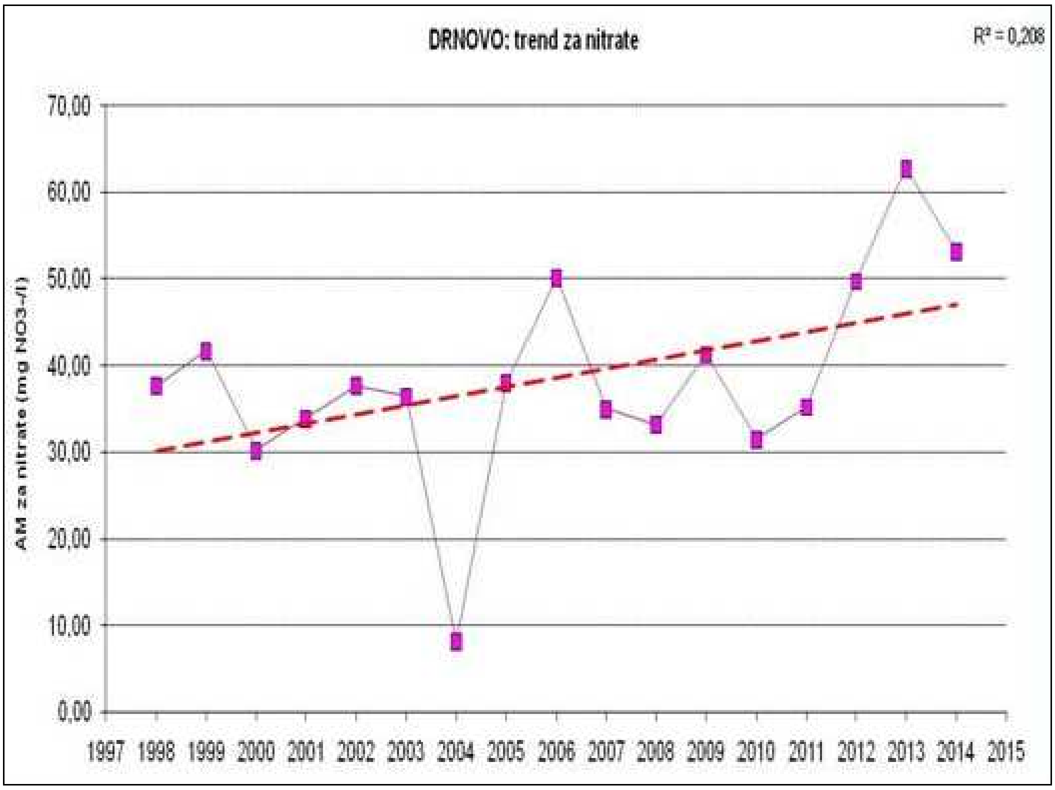


Figure 54: Drnovo, growing trend for nitrates

DRNOVO: trend za nitrate	DRNOVO: trend for nitrates
R^2 = 0,208	R^2 = 0.208
AM za nitrate (mg NO3-/l)	AM for nitrates (mg NO3-/l)

For the period 1998–2013, the results of groundwater quality monitoring for Brežiško Polje show that atrazine and desethyl-atrazine values are no longer falling but instead are fluctuating around the limit of quantification of the analytical method, while the concentration of nitrates is falling from year to year. This means that these parameters are no longer present in the groundwater of these aquifers.

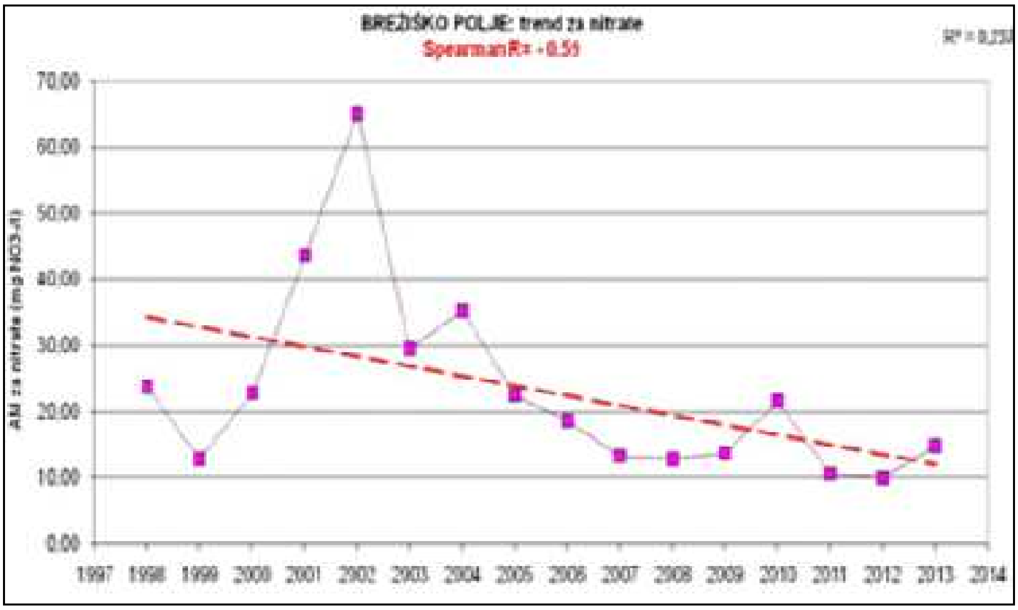


Figure 55: Brežiško Polje, falling trend for nitrates

BREŽIŠKO POLJE: trend za nitrate	BREŽIŠKO POLJE: trend for nitrates
Spearman R = - 0.59	Spearman R = -0.59
R^2 = 0,235	R^2 = 0.235
AM za nitrate (mg NO3-/l)	AM for nitrates (mg NO3-/l)

Chemical status of groundwater in the Krško Basin – national monitoring:

In 2011 a monitoring programme to determine the quantitative status of groundwater was implemented in full at the Slovenian Environment Agency. Implementation of the programme was aimed at assessing the quantitative status, as prescribed by the Decree on groundwater status (Official Gazette of the RS 25/2009). In the process of assessing the quantitative status of groundwater the following tests were carried out, as prescribed by the Decree: a water balance test, a test of the impact of groundwater abstraction on the ecological quality of surface water bodies, a test of the impact of groundwater abstraction on terrestrial ecosystems and a test of the impact of groundwater abstraction on saline or other intrusions. The groundwater quantitative status monitoring programme for 2011 was designed on the basis of selection of the optimal location for the measurement site with regard to the conceptual hydrogeological conditions of the aquifer and quantitative status assessment methodologies. The criterion of the length and continuity of the time series of past observations was also taken into account, as was the technical suitability of the facility, groundwater use and land use.

The report on groundwater quantitative status monitoring in 2011 includes an overview and comparison of the collected data with regard to the comparison period 1990–2010 and the forecast period up to 2015.
The essential condition for a good quantitative status of a groundwater body in 2011, namely that the share of measurement sites with the typical decreasing trend of the period 1990–2011 is less than 25%, was not achieved in the VTPodV_*Krška kotlina* water body.

The biggest changes in the characteristics of trends with regard to the period 1990–2010 are identified in the groundwater bodies VTPodV_1002 *Savinjska kotlina* and VTPodV_1003 *Krška kotlina*, where changes in the statistical characteristics of trends indicate a deterioration of the quantitative state.

A statistically significant decreasing trend is also shown at 10 measurement sites within the groundwater body VTPodV_1003 *Krška kotlina*, which is 12% more than in the assessment period 1990–2010. Five measurement sites along the Sava on Krško Polje (NE-0677 Vihre, NE-0777 Skopice, NE-0877 Skopice, 0152 Skopice) and Čateško Polje (M32 Čatež) show a statistically significant trend of a lowering of the groundwater level, which may presumably be linked to erosion and sedimentation processes in the channel of the Sava.

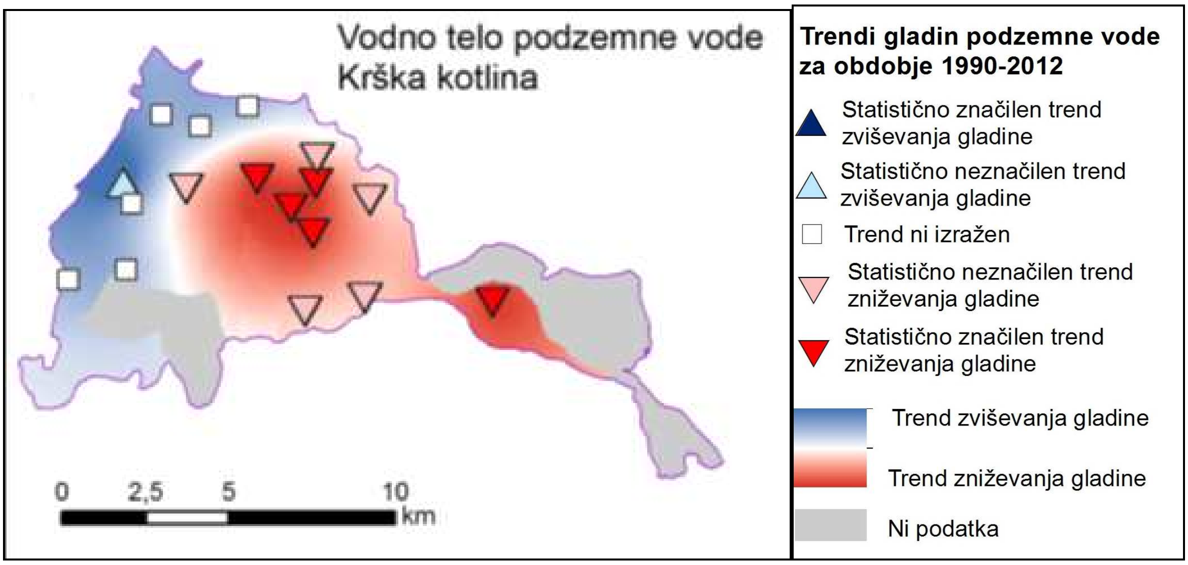


Figure 56: Quantitative status trend for the Krško Basin groundwater body

Vodno telo podzemne vode Krška kotlina	*Krško Basin groundwater body*
Trend gladin podzemne vode za obdobje 1990-2012	*Trend of groundwater levels for the period 1990–2012*
Statistično značilen trend zviševanja gladine	*Statistically significant trend of raising water levels*
Statistično neznačilen trend zviševanja gladine	*Statistically insignificant trend of raising water levels*
Trend ni izražen	*The trend is not expressed (pronounced)*
Statistično neznačilen trend zniževanja gladine	*Statistically insignificant trend of lowering water levels*
Statistično značilen trend zniževanja gladine	*Statistically significant trend of lowering water levels*
Trend zviševanja gladine	*Trend of raising water levels*
Trend zniževanja gladine	*Trend of lowering water levels*
Ni podatka	*N/A*

Groundwater level trends are shown in the tables below for the area of Brežiško Polje, measurement sites NE 0177 Vrbina, 0111 Spodnji Stari Grad, NE 1277 Pesje.

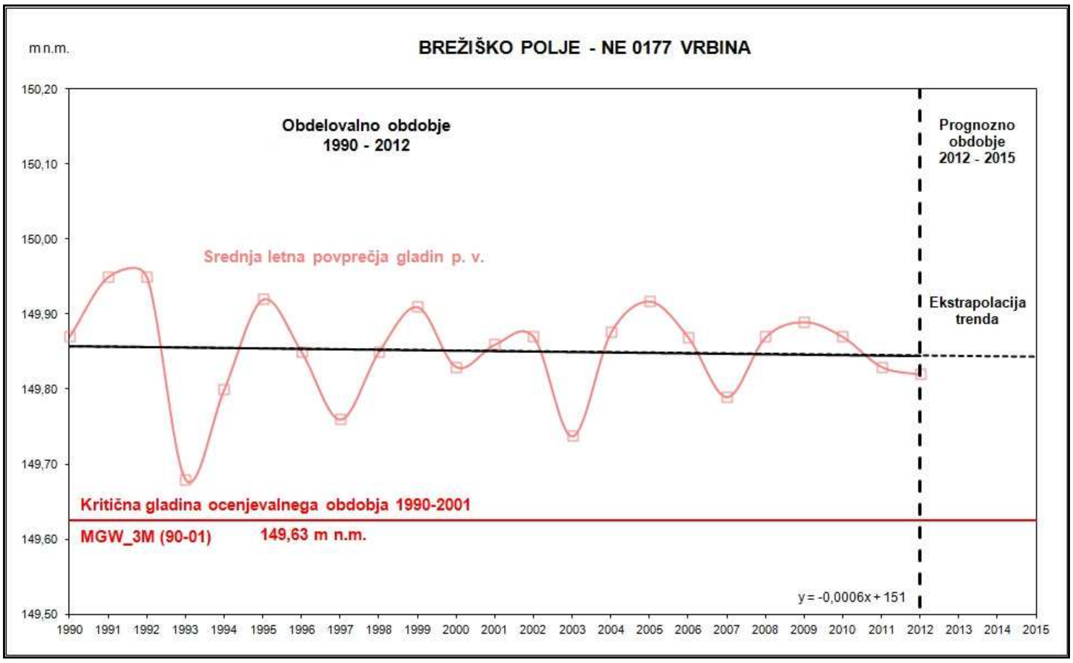


Figure 57: Trend of groundwater levels for NE 0177 Vrbina

m n.m.	m above sea level
BREŽIŠKO POLJE – NE 0177 VRBINA	BREŽIŠKO POLJE – NE 0177 VRBINA
Obdelovalno obdobje 1990-2012	Cultivation period 1990–2012
Prognozno obdobje 2012-2015	Prognosis period 2012–2015
Srednja letna povprečja gladin p.v.	Mean annual averages of water levels of groundwater
Ekstrapolacija trenda	Extrapolation of trend
Kritična gladina ocenjevalnega obdobja 1990-2001	Critical water level of the assessed period 1990–2001
MGW_3M (90-01) 149,63 m n.m.	MGW_3M (90-01) 149.63 m above sea level

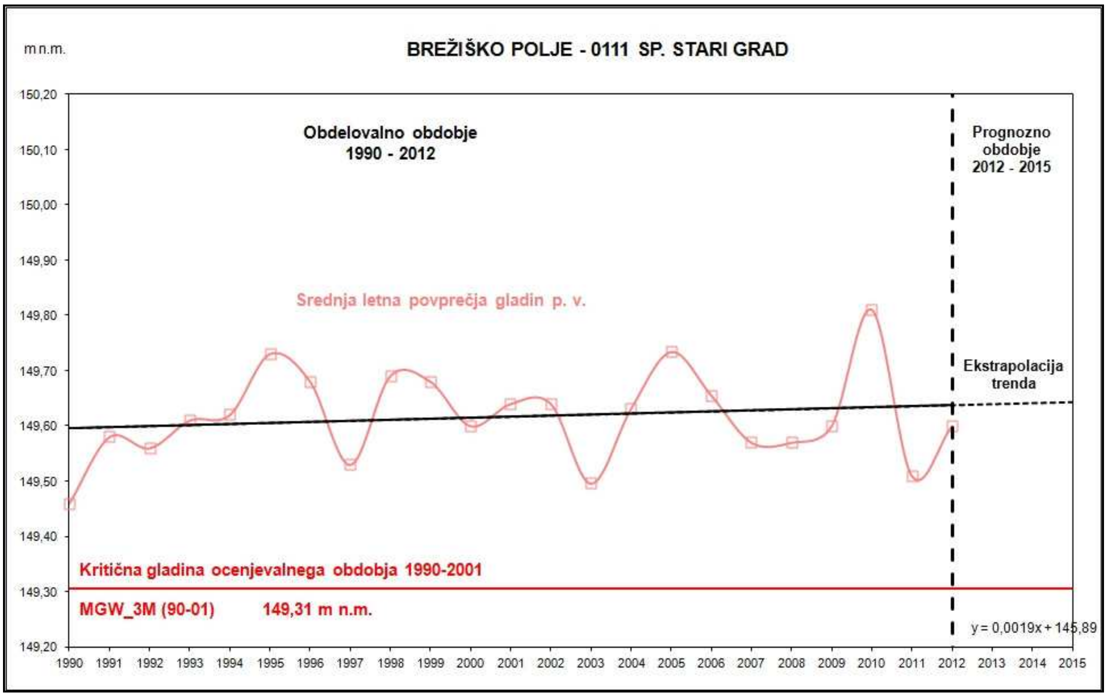


Figure 58: Trend of groundwater levels for NE 0111 Spodnji Stari Grad

m n.m.	m above sea level
BREŽIŠKO POLJE – 0111 SP. STARI GRAD	BREŽIŠKO POLJE – 0111 SP. STARI GRAD
Obdelovalno obdobje 1990-2012	Cultivation period 1990–2012
Prognozno obdobje 2012-2015	Prognosis period 2012–2015
Srednja letna povprečja gladin p.v.	Mean annual averages of water levels of groundwater
Ekstrapolacija trenda	Extrapolation of trend
Kritična gladina ocenjevalnega obdobja 1990-2001	Critical water level of the assessed period 1990–2001
MGW_3M (90-01) 149,31 m n.m.	MGW_3M (90-01) 149.31 m above sea level

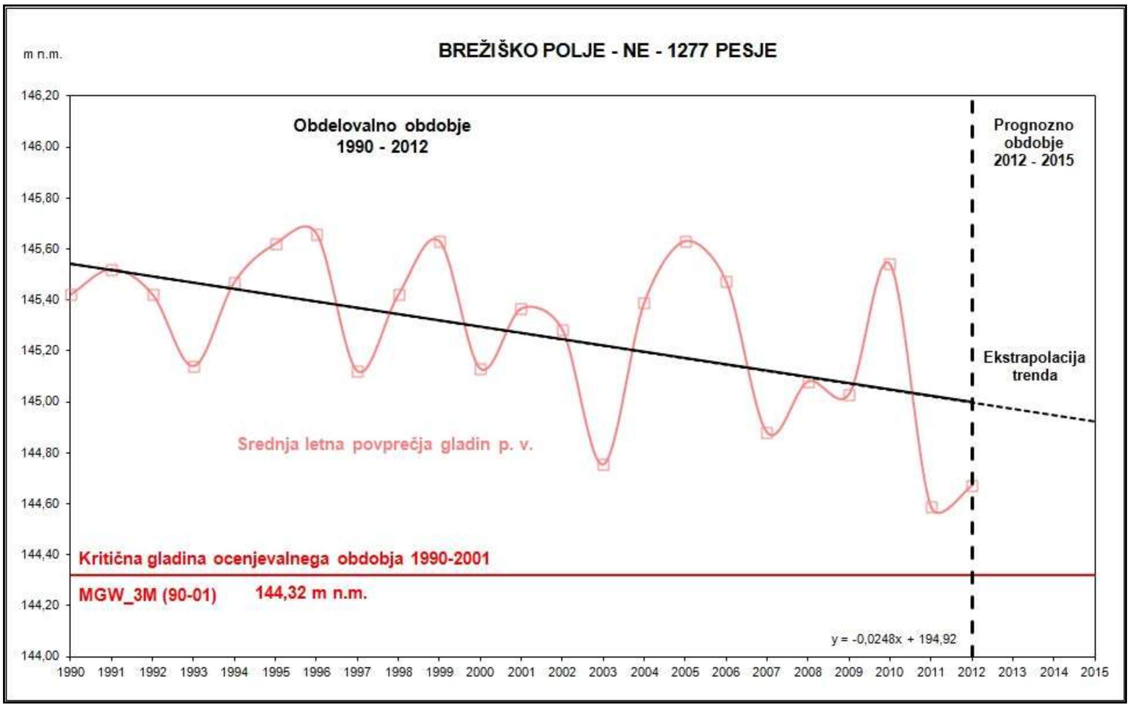


Figure 59: Trend of groundwater levels for NE -1277 Pesje

m n.m.	m above sea level
BREŽIŠKO POLJE – NE – 1277 PESJE	BREŽIŠKO POLJE – NE – 1277 PESJE
Obdelovalno obdobje 1990-2012	Cultivation period 1990–2012
Prognozno obdobje 2012-2015	Prognosis period 2012–2015
Srednja letna povprečja gladin p.v.	Mean annual averages of water levels of groundwater
Ekstrapolacija trenda	Extrapolation of trend
Kritična gladina ocenjevalnega obdobja 1990-2001	Critical water level of the assessed period 1990–2001
MGW_3M (90-01) 144,32 m n.m.	MGW_3M (90-01) 144.32 m above sea level

Alongside the impact of the level of the river Sava on groundwater, an extremely important role in aquifer recharge is played by rainwater infiltration. Average precipitation for the last 30 years amounts to around 1,044 mm at the Brege reference precipitation station (see figure below).

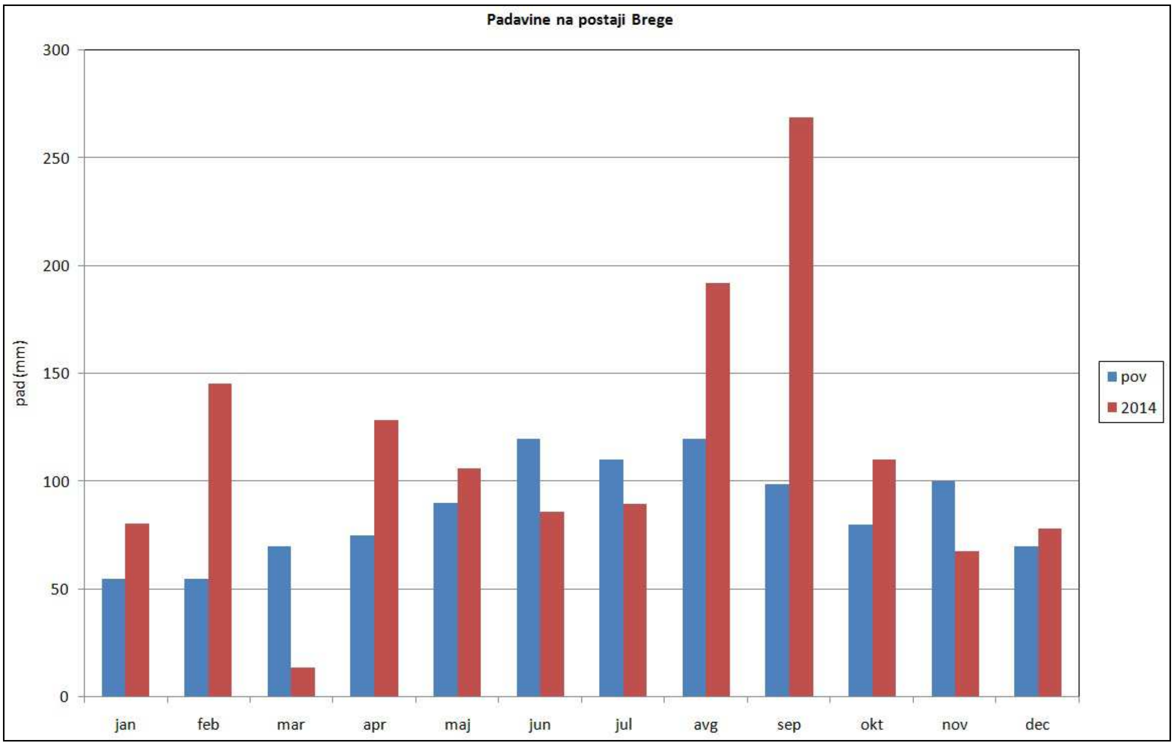


Figure 60: Average and annual precipitation at the Brege station in 2014

Padavine na postaji Brege	*Precipitation at the Brege monitoring point*
pad (mm)	*precipitation (mm)*
pov	*average*
jan	*Jan*
feb	*Feb*
mar	*Mar*
apr	*Apr*
maj	*May*
jun	*Jun*
jul	*Jul*
avg	*Aug*
sep	*Sep*
okt	*Oct*
nov	*Nov*
dec	*Dec*

Annual precipitation in 2014 was 1,376 mm, which is 31% more than the long-term average (959 mm), although it should be emphasised that precipitation was relatively unevenly distributed. The wettest months were February, August and September, while there was almost no rain in March.

4.4.2.3 **Quantitative status of groundwater – modelling data in context of Brežice HPP construction**

In order to predict the impact of construction of the Brežice HPP on the future LILW repository, the hydraulic model of the wider area of the LILW repository was upgraded

("*Upgrading the hydraulic model for the LILW repository, Rev 1, 2015. HGEM d.o.o. in GEORAZ d.o.o.*") This model takes into account all planned arrangements and measures that will affect the level of groundwater in the wider area of the LILW repository site.

The figure below shows groundwater levels in the Quaternary layer following construction of the Brežice HPP. It is evident from the model that the expected level in the Quaternary layer in the area of the repository should be between 150 m and 152 m above sea level.

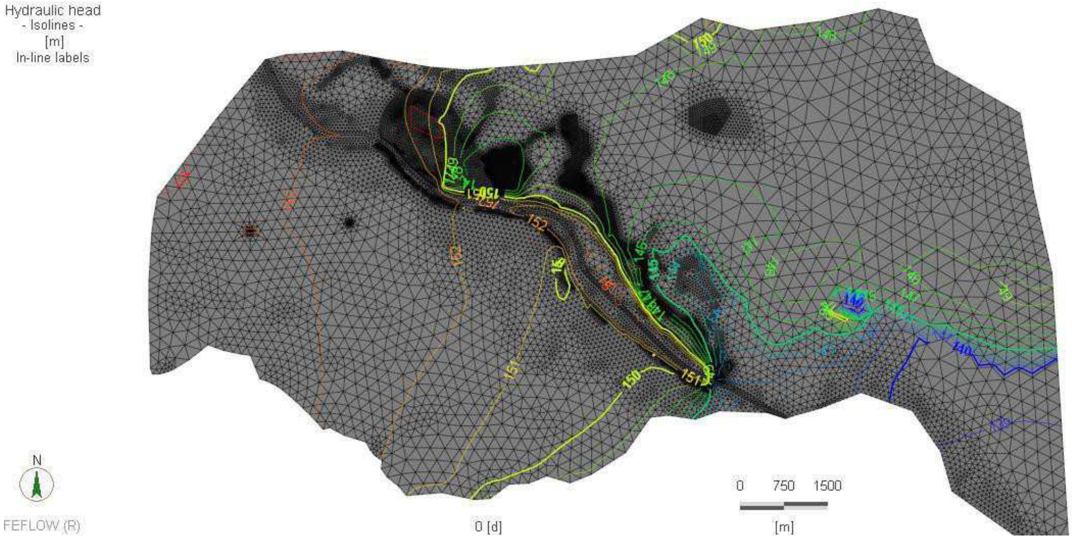


Figure 61: Impacts of the Brežice HPP on groundwater level in the Quaternary layer.

The model takes into account all planned measures to lower the level of groundwater (curtain injection, drainage measures and maintenance of the water level in the gravel pit at 146.5 m a.s.l.) **In the area of the site of the planned LILW repository, the groundwater level will rise by on average 3.8 m.**

The figure below shows groundwater levels in the Miocene layer at a depth of between 52 and 62 m below the height of the existing terrain. The model shows that pressure in the Miocene layers at these depths should likewise cause groundwater levels of between 150 and 152 m a.s.l.

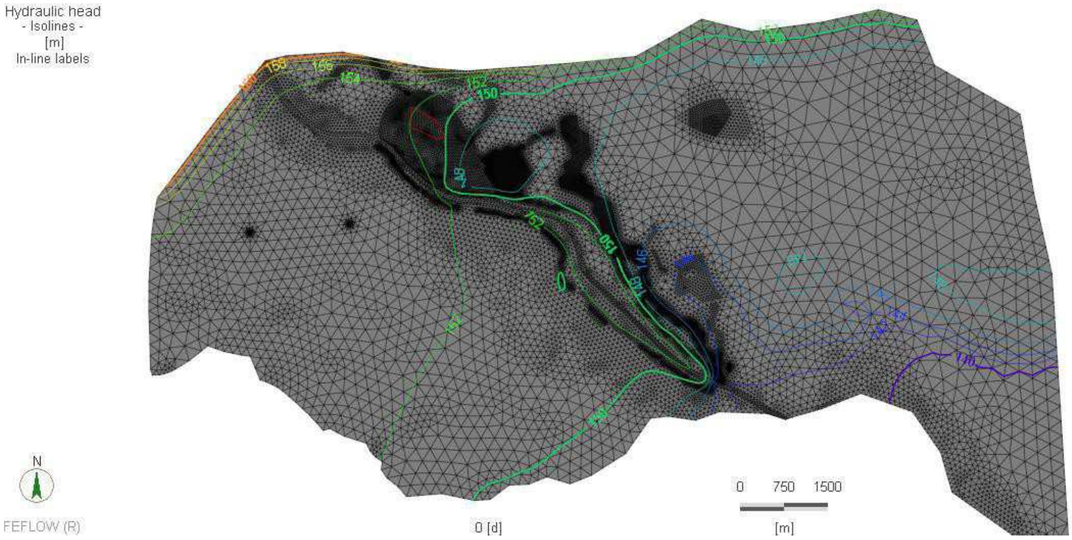


Figure 62: Impacts of the Brežice HPP on groundwater level in the Miocene layer.

The routes of the drainage channels in the catchment area (in the context of construction of the Brežice HPP) on the left bank are determined in such a way as to lower the level of groundwater as effectively as possible across as wide as possible an area of influence. For the most part they run along the depressions created by old channels of the river, with the result that their depth is as shallow as possible. This was not possible everywhere, because it was necessary to coordinate the route of the drainage channel with existing or future arrangements, and depths are considerable: for the purposes of coordination with the future arrangement of the Kostak centre, channel 5 is moved from its ideal route, with the result that in this section its depth is just under 4 m. In order to occupy as little space as possible and for the purposes of coordination of the route with the already planned arrangements in the areas of the Vrbina business zone, the Kostak centre and the LILW repository, two sections of channel 5 are planned as an underground drainage pipe with a diameter of 80 cm and inspection shafts at 50 m intervals, with inflows and outflows fitted with gratings. Drainage channel 5 is located outside the construction site of the future LILW repository and lies N and NE of it.

Owing to the stringent requirements to raise the level of groundwater in the immediate area of the Krško NPP as little as possible, the Brežice HPP project included an extension of drainage channel 4 along the eastern edge of the Krško NPP site (south of the planned site of the LILW repository), an extension of the sealing curtain from Sava profile P108 to profile P107 and the implementation of pumping wells in the yard at the Krško NPP.

4.4.2.4 Data and results of monitoring and studies of groundwater in the core site area

Below we offer data and the results of the monitoring and studies of groundwater commissioned by the developer with regard to the siting requirements of the LILW repository:

– “Upgrading of the hydrogeological interpretation of monitoring data in the wider area of the LILW repository site at Vrbina in the municipality of Krško, IRGO Inštitut, March 2016.”

The figure below shows the locations of the measurement sites for measurements of groundwater parameters in the area in question.

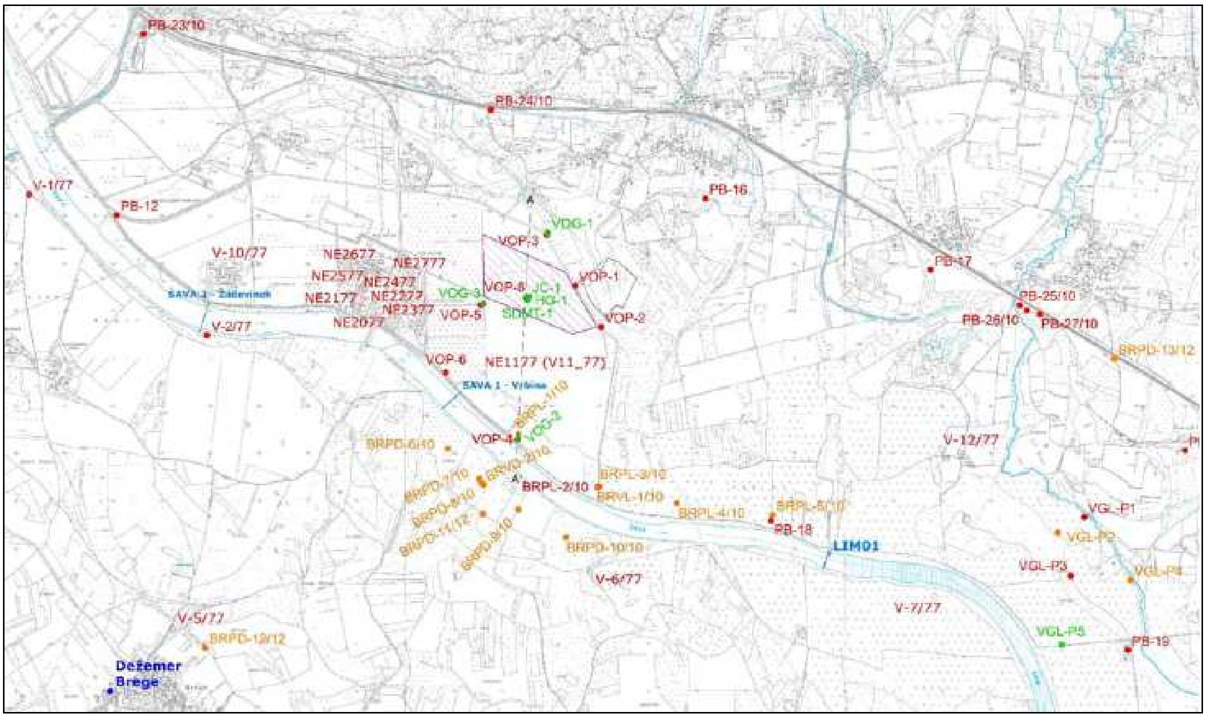


Figure 63: General map of the wider area of the future LILW repository with locations of piezometers. The black line shows the core area under consideration and the purple hatching shows the area of the future LILW repository.

The figure below shows the distribution of levels in individual piezometers in the form of a box plot (the straight line represents the range from minimum to maximum, the edge of the box represents the 25th and 75th percentiles and the square represents the median of distribution.

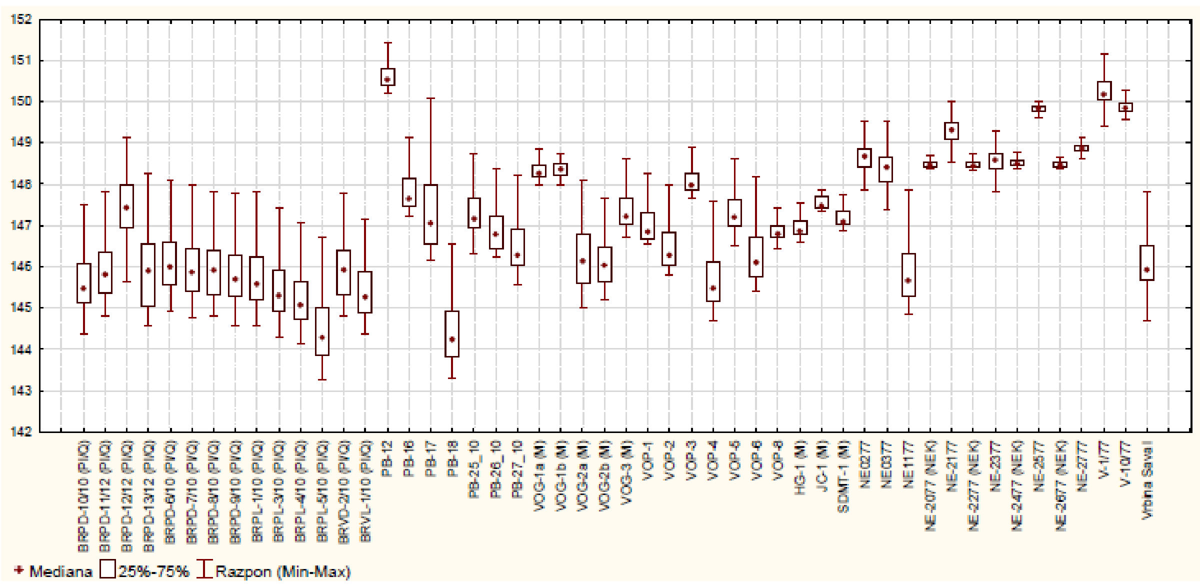


Figure 64: Box plot of distributions of levels in individual piezometers in the area under consideration

Mediana	Median
Razpon (Min-Max)	Range (Min–Max)

The range of groundwater levels in the core area in question is limited downwards by the river Sava as the drainage base of the area. The highest values of groundwater levels are linked to piezometer PB-12, which lies furthest upstream of the dam for Krško NPP. As well as this piezometer, some piezometers of the NE series in the area of Krško NPP and piezometer V-10/77 are located upstream. The Krško NPP dam has a major impact on groundwater flow in the Quaternary aquifer. This impact is further increased by the presence of a sealing curtain down to the Miocene substratum in the area of Krško NPP. The major impact of this structure on groundwater flow and levels is also apparent from the above figure, in which the large gap between the levels in the piezometers above the dam and all the other levels in the Vrbina area is clearly evident.

In general terms, we can use the data from monitoring to confirm the identified hydrogeological conditions, i.e. that groundwater levels fall along the course of the river and from the edge of the aquifer towards the river. Oscillation amplitudes are highest by the river (VOP-4 and the BRPL/D series piezometers) and reduce towards the interior of the aquifer, which is consistent with the damped oscillation of the pressure wave induced by the Sava. Water level oscillation is likewise damped in the depthwise direction, i.e. into the Miocene layers, where oscillation amplitudes are even lower (from 0.95 m in VOG-1 to 2.83 m in VOG-2). Data from the BRPL and BRPD series piezometers show that groundwater in the upper part of the Plio-Quaternary aquifer responds extremely well to induced pressure waves from the river, since the statistical data are highly comparable to data from the river Sava data at the Sava-1 measurement site.

Basic statistics of ranges of oscillations in the core area under consideration are given in tabular form in the table below.

Table 25: Basic statistics of ranges of oscillations in the core area under consideration

Piezometer	Number of measurements	Min.	Max.	Range	Mode	Median	Percentile 5	Percentile 95	Std. dev.
BRPD-10/10	15,384	144.37	151.36	6.99	145.17	145.47	144.75	147.08	0.74
BRPD-11/12	12,449	144.81	151.15	6.34	145.60	145.81	145.00	147.24	0.71
BRPD-12/12	13,484	145.66	149.12	3.46	147.33	147.43	146.45	148.66	0.70
BRPD-13/12	12,621	144.58	148.24	3.66	144.76	145.90	144.72	147.31	0.85
BRPD-6/10	15,389	144.93	151.82	6.89	145.37	146.00	145.23	147.57	0.74
BRPD-7/10	15,389	144.77	151.73	6.96	145.38	145.86	145.10	147.44	0.75
BRPD-8/10	78	144.80	148.01	3.21	145.29	145.92	144.91	147.24	0.74
BRPD-9/10	15,390	144.57	151.45	6.88	145.64	145.70	144.93	147.30	0.75
BRPL-1/10	13,920	144.58	150.91	6.33	145.16	145.58	144.80	147.35	0.81
BRPL-3/10	13,929	144.31	151.31	7	145.00	145.30	144.54	147.12	0.82
BRPL-4/10	13,827	144.13	151.26	7.13	144.94	145.07	144.35	146.84	0.80
BRPL-5/10	13,929	143.27	150.56	7.29	143.88	144.28	143.46	146.36	0.92
BRVD-2/10	78	144.81	148.01	3.2	145.62	145.92	144.91	147.23	0.73
BRVL-1/10	79	144.37	148.90	4.53	144.89	145.27	144.52	146.71	0.78
PB-12	24328	150.18	155.13	4.95	150.40	150.53	150.30	151.80	0.49
PB-16	25,360	147.24	151.61	4.37	147.42	147.64	147.33	148 98	0.56
PB-17	25,369	146.14	150.26	4.12	146.34	147.05	146.25	148.87	0.86
PB-18	21,134	143.29	151.22	7.93	143.77	144.24	143.49	146.28	0.91
PB-25/10	14,835	146.31	149.47	3.16	146.92	147.16	146.82	148.38	0.52
PB-26/10	13,771	146.23	148.80	2.57	146.34	146.78	146.32	147.86	0.49
PB-27/10	15,452	145.54	148.60	3.06	145.97	146.28	145.85	147.71	0.61
VOG-1a (VOG-1)	6,840	147.96	148.86	0.9	148.36	148.26	148.15	148.76	0.20
VOG-1b (VOG-1)	24,013	147.99	148.74	0.75	148.38	148.36	148.08	148.63	0.18
VOG-2a (VOG-2)	10,157	145.00	148.10	3.1	145.50	146.14	145.30	147.30	0.69
VOG-2b (VOG-2)	19,854	145.19	147.77	2.58	145.52	146.03	145.30	147.20	0.57
VOG-3	24,851	146.69	149.02	2.33	147.11	147.21	146.86	148.33	0.47
VOP-1	24,071	146.54	150.74	4.2	146.65	146.84	146.59	148.20	0.56
VOP-2	25,166	145.8O	151.64	5.84	145.90	146.28	145.88	147.76	0.65
VOP-3	24,057	147.65	151.12	3.47	147.85	147.97	147.76	148.99	0.42
VOP-4	24,395	144.69	152.21	7.52	145.21	145.48	144.82	147.24	0.81
VOP-5	25,921	146.52	149.86	3.34	146.96	147.20	146.81	148.46	0.54
VOP-6	25,867	145.41	150.72	5.31	145.49	146.10	145.50	147.79	0.74
VOP-8	3,694	146.43	148.06	1.63	146.72	146.79	146.50	147.66	0.31
HG-1	3,744	146.58	147.86	1.28	146.82	146.86	146.65	147.63	0.27
JC-1	3,744	147.36	147.87	0.51	147.40	147.47	147.38	147.78	0.15
SDMT-1	3,743	146.87	147.75	0.88	147.03	147.08	146.97	147.66	0.22
NE0277	25,401	147.84	151.58	3.736	148.11	148.67	148.11	149.48	0.42
NE0377	25,915	147.39	151.46	4.073	148.51	148.41	147.65	149.35	0.50
NE1177	25,915	144.85	151.07	6.22	144.94	145.66	144.97	147.42	0.79
NE-2077 (Krško NPP)	13,070	148.36	149.90	1.54	148.47	148.46	148.39	148.82	0.19
NE-2177	12,948	147.55	153.00	5.45	149.20	149.32	148.86	149.71	0.37
NE-2277 (Krško NPP)	9,296	148.32	149.90	1.58	148.41	148.44	148.34	148.91	0.24
NE-2377	13,017	147.26	152.67	5.41	148.31	148.59	148.25	149.21	0.37
NE-2477 (Krško NPP)	3,753	148.39	149.40	1.01	148.47	148.50	148.43	148.84	0.16
NE-2577	10,697	149.10	151.90	2.8	149.86	149.83	149.58	149.96	0.15
NE-2677 (Krško NPP)	13,027	148.36	149.90	1.54	148.42	148.46	148.40	148.81	0.19
NE-2777	12,903	148.42	149.99	1.57	148.83	148.87	148.77	149.54	0.25
NE-2778	440	149.41	152.71	3.3	150.04	150.18	149.81	151.23	0.45
NE-2779	301	148.85	151.00	2.15	149.84	149.84	149.61	150.49	0.28

Groundwater temperature

Continuous measurements of **groundwater temperature** are carried out in all piezometers of the core area under consideration.

Seasonal temperature fluctuation is evident, depending on the atmospheric temperature and, consequently, the temperature of infiltrated surface water (river water and precipitation). Groundwater temperature ranges in individual piezometers in the Miocene layers are relatively small, since the impact of temperature fluctuations of the atmosphere and surface water decrease with depth. Of the deep piezometers, only VOG-2, located by the Sava, shows a greater range. The piezometers in the Quaternary aquifer show wider ranges of values, with the biggest range pertaining to piezometer VOP-4. Bigger ranges in temperature measurements are also characteristic of piezometers NE0277, NE0377 and V-1/77. All these piezometers are located in the immediate vicinity of the river Sava.

Basic statistics from the set of data for groundwater temperature measurements in individual piezometers in the core area under consideration are given in the table below.

Table 26: Basic statistics of groundwater temperature measurements for the period 2010–2015 in the core area under consideration

Piezometer	Number	Minimum	Maximum	Range	Mean value	Stand. dev.
VOG-1a	51,941	12.9	15.1	0.2	12.90	0.02
VOG-1b	23,840	10.70	12.30	1.60	11.60	0.34
VOG-2a	12,054	11.90	12.20	0.30	12.00	0.10
VOG-2b	22,393	10.30	21.90	11.60	13.10	1.76
VOG-3	25,412	11.40	13.50	2.10	12.30	0.54
VOP-1	24,735	9.90	16.00	6.10	12.10	0.76
VOP-2	24,899	10.80	14.00	3.20	12.20	0.74
VOP-3	25,458	8.20	14.00	5.80	11.30	1.40
VOP-4	24,130	9.00	22.60	13.60	13.20	1.91
VOP-5	25,558	10.70	14.20	3.50	12.50	0.89
VOP-6	25,587	12.40	14.70	2.30	13.20	0.45
PB-12	25,662	10.34	14.06	3.72	12.20	1.02
PB-16	25,431	7.92	14.31	6.39	10.87	1.44
PB-17	25,447	9.11	13.55	4.44	11.19	0.99
PB-18	22,305	7.23	15.50	8.27	12.18	1.55
BRPL-1/10	15,490	12.46	15.12	2.66	12.70	0.30
BRPL-2/10	15,489	11.00	15.46	4.46	12.22	0.54
BRPL-3/10	15,483	11.78	14.65	2.87	12.05	0.37
BRPL-4/10	15,380	11.52	12.63	1.11	12.06	0.13
BRPL-5/10	15,492	10.50	15.06	4.56	11.68	0.35
VOP-8	3,409	11.80	13.00	1.20	12.20	0.33
HG-1	2,558	12.10	12.50	0.40	12.20	0.11
JC-1	3,360	12.00	13.10	1.10	12.30	0.34
SDMT-1	2,836	12.10	12.80	0.7	12.20	0.19
NE-1177	25,915	11.30	13.60	2.30	12.30	0.55
NE-2077	11,481	14.70	15.40	0.7	15.00	0.16
NE-2177	11,484	12.30	13.20	0.90	12.90	0.23
NE-2277	10,015	17.70	17.90	0.2	17.70	0.04
NE-2377	11,483	12.00	13.60	1.60	12.90	0.39
NE-2477	11,482	14.80	15.00	0.2	14.90	0.07
NE-2677	11,436	22.70	27.40	4.70	25.50	1.50
NE-2777	11,460	13.60	14.10	0.50	14.00	0.13
V-10/77	246	10.40	13.80	3.40	12.20	0.64

V-12/77	247	7.20	13.40	6.20	10.20	1.31
BRPD-10/10	13,114	11.55	11.83	0.28	11.61	0.04
BRPD-11/12	12,514	11.64	12.00	0.36	11.77	0.10
BRPD-12/12	13,561	11.73	12.18	0.45	11.90	0.09
BRPD-13/12	12,599	11.08	11.54	0.46	11.18	0.06
BRPD-6/10	15,488	11.71	13.99	2.28	12.38	0.53
BRPD-7/10	15,489	11.57	12.10	0.53	11.73	0.08
BRPD-9/10	15,495	11.54	12.16	0.62	11.70	0.07
PB-25/10	14,834	9.61	15.99	6.38	12.28	1.48
PB-26/10	13,774	9.04	15.03	5.99	11.53	1.67
PB-27/10	13,989	10.56	12.88	2.32	11.66	0.48
NE277	25,173	5.50	18.60	13.10	11.20	3.56
NE377	25,687	6.20	18.20	12.00	11.60	3.12
V-1/77	247	7.30	18.40	11.10	12.70	2.97

The piezometers in the Quaternary aquifer in the area of Krško NPP typically show a small temperature fluctuation, while the piezometers located within the sealing curtain below the facility (NE2077, NE2277, NE2477 and NE2677) show higher values. The highest temperatures were measured in piezometer NE2677,
where the temperatures deviate to the greatest extent from the others. This piezometer is located within the sealing curtain of the Krško NPP facility.

The piezometers in the Plio-Quaternary aquifer (BRPD and BRPL series) show small temperature fluctuations,
with only piezometer BRPD-6/10 showing a slightly larger range.

The lowest temperatures were measured in piezometer NE0277, which is located near the river. Low values were also measured in piezometers NE0377, V-12, V-1/77 and PB-18. Considerable fluctuation between values also occurs, which means that transfer between surface water and groundwater is relatively rapid and undamped.

Electrical conductivity of groundwater

Continuous measurements of electrical conductivity are carried out in the following piezometers within the core area: VOG-3, VOP-1, VOP-2, VOP-3, VOP-4, VOP-5, VOP-6, VOP-8, HG-1, JC-1, SDMT-1, NE2077, NE2177, NE2277, NE2377, NE2477, NE2577, NE2677 and NE2777.

On the basis of the presented measurements and measurements of **electrical conductivity of groundwater** in the Plio-Quaternary aquifer in the Vrbina area by the Sava, which were carried out during pumping tests (Vukadin, et al., 2011), it was found that the electrical conductivity of the Quaternary aquifer amounts to approximately 800 µS/cm, while the values for the Plio-Quaternary aquifer were lower: between 420 and 480 µS/cm. We can thus state that electrical conductivity in the Quaternary layers is higher than in the Plio-Quaternary layers, since in the latter predominantly silicate boulders are present, while in the Quaternary sediments we also find carbonate boulders, which are more easily dissolved and thus contribute to an increased total mass of dissolved solids and increased electrical conductivity. The lowest electrical conductivity is in Miocene silts, which are predominantly composed of silicate minerals. Nevertheless it is probably also necessary to seek the causes for such high values in the Quaternary aquifer in anthropogenic impacts (agriculture, urbanisation, etc.).

Radiological characteristics

The results of radiological measurements of groundwater from the Quaternary aquifer show the expected radiological picture of gamma emitters and Sr-90/Sr-89, which is typical of the groundwater from the Krško-Brežice area. Only concentrations of K-40 are slightly higher – a consequence of the ubiquity of potassium in the topsoil. The concentration of Ra-226 does not differ significantly from the national average in Slovenia. The concentration of Cs-137 in the samples was below the limit of detection. The results of measurements of the concentration of Sr-90/Sr-89 showed that these values are comparable to the values from measurements in samples from borehole E1 NPP and in groundwater in Croatia, while the concentration of Sr-90/Sr-89 in water supply pipes and pumps is 2–3 times lower.

The results of the measurements show a radiological picture that is typical for water pipes and pumps in the Krško-Brežice area, for all gamma emitters. Only the specific activity of Ra-226 is slightly increased. Values for tritium are in line with expectations. They are also acceptable for drinking water.

4.4.2.5 Use of groundwater in the direct vicinity of the development

There are no specially prescribed limits regarding the water regime for groundwater within the area of influence of the plan. There are no water resources in the area of the planned site that are used for water supply; the nearest water source for which water protection areas are defined is the pumping station Brege (right bank of the Sava). No water permits for groundwater use have been granted within the area of the 500-metre belt.

Figure 65: Water protection areas in the surroundings of the planned site

LEGENDA:	KEY:
Vodovarstvena območja – državni nivo	Water protection areas - national level

VVO 3	VVO 3
Vodovarstvena območja – občinski nivo	Water protection areas - municipal level
obm.	area
Vodovarstvena območja – zajetja	Water protection areas - catchments
naziv	name
Vodotoki	Watercourses

Water permits for groundwater use have not been granted in the core area, while in the wider area (up to 1 km) 5 water permits for groundwater use have been granted in the settlement of Spodnji Stari Grad (sites marked by a red triangle in the figure below).

Decision No./Responsible person/Location	Water use	Annual abstraction in m3
35537-10690/2004 ANTON PUNTAR Spodnji Stari Grad	watering	30
35537-8555/2004 PAVLA ZALOKAR Spodnji Stari Grad:	watering	30
35537-6213/2004 ŠD DOLENJA VAS Spodnji Stari Grad:	watering	30
35537-5494/2004 ALOJZ MUNIČ Spodnji Stari Grad:	watering	30
35528-162/2014 EVROSAD PROIZVODNJA Krško	Irrigation of agricultural land	45,000

Figure 66: Water permits granted, December 2017.

4.4.2.6 Existing pressures on groundwater in the area of the planned development

The following are located in the immediate vicinity of the development site:

- Spodnji Stari Grad Collection Centre (no impact on groundwater)
- closed Spodnji Stari Grad landfill for non-hazardous waste

Closed Spodnji Stari Grad landfill for non-hazardous waste

The existing landfill for non-hazardous waste in Spodnji Stari Grad began operating in 1980 and was intended for the disposal of non-hazardous waste from the municipalities of Krško and Sevnica. The landfill was closed and remediated in 2007. A waterproof cover with controlled stormwater drainage was implemented. The unsealed bottom of the landfill, which at high groundwater levels comes into contact with groundwater, is problematic.

Groundwater monitoring in the area of influence of the closed Spodnji Stari Grad landfill for non-hazardous waste

Given the results of the operational monitoring carried out every year (in the period 2007–2014) by the National Laboratory for Health, Environment and Food (NLZOH), it is possible to talk about permanent groundwater pollution, since for certain parameters the alert value is constantly exceeded. The increased concentration of herbicides in groundwater is probably also the result of intensive agriculture in the direct vicinity of the landfill (the closed landfill).

Four boreholes are used for observation (see figure below):

- piezometers V-1 and VOP-3 represent the input objects of monitoring in the high water level period
- piezometers VOP-2 and V-3 represent the output objects of monitoring in the high water level period
- piezometers V-3 and VOP-3 represent the input objects of monitoring in the low water level period
- piezometers V-1 and VOP-2 represent the output objects of monitoring in the low water level period

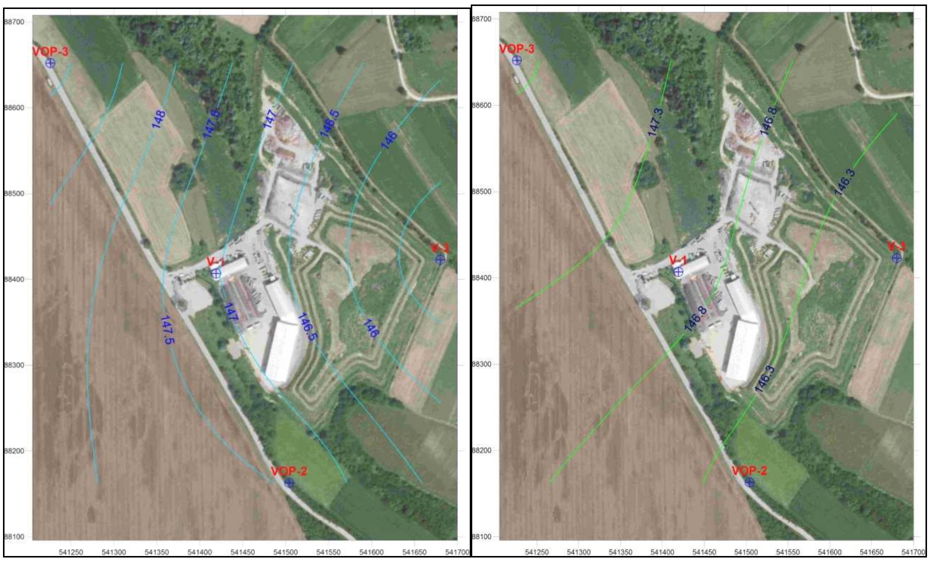


Figure 67: Observation boreholes for monitoring groundwater in the area of the closed landfill

Below we summarise just a few essential data from the annual report on operational monitoring of the closed Spodnji Stari Grad landfill, where **we can treat analyses of water from piezometer VOP-3 as a reference state for groundwater in the area of the planned LILW repository, since this piezometer is located outside the area of influence of the Spodnji Stari Grad landfill**, while the borehole of piezometer VOP-2 can be used as a reference point for the impact of the closed Spodnji Stari Grad landfill. Data on pumping and the basic characteristics of samples in 2014 are given in the table below.

Table 27: Pumping data

	BASELINE		**Area of influence**	
Measurement site	VOP-3		VOP-2	
Abstraction date	10 April 2014	18 August 2014	10 April 2014	18 August 2014
Lab. No.	2014/3170	2014/7044	2014/3173	2014/7046
Borehole diameter (cm)	11	11	11.4	11.4
Level before sampling (m)	4.71	4.5	5.83	5.84
Abstraction depth	6	6	7	8
Colour	none	none	none	none
Turbidity	clear	clear	clear	clear

	BASELINE		Area of influence	
Measurement site	VOP-3		VOP-2	
Abstraction date	10 April 2014	18 August 2014	10 April 2014	18 August 2014
Lab. No.	2014/3170	2014/7044	2014/3173	2014/7046
Smell	none	none	leachate	none

Results of measurements in a borehole outside the area of influence – VOP-3

The results of measurements of individual parameters are presented below in tabular form. Borehole VOP 3 can be considered the reference or baseline state of groundwater in the area of construction of the LILW repository.

Table 28: Results of measurements in a borehole outside the area of influence (borehole VOP-3) in all years of monitoring (2012, 2013, 2014)

Testing results			Sample	Landfill Spodnji Stari Grad - borehole VOP3					
			Date of taken sample	29 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14
External code	*Parameter*	*Norm*	*Unit*	*2012/9,487*	*2012/10,858*	*2013/6,205*	*2013/8,553*	*2014/3,170*	*2014/7,044*
	FIELD MEASUREMENTS								
1.02	Water temperature		°C	14.6	13.5	12.5	14.2	10.5	14.7
1.01	Air temperature		°C	1	0	24	11.3	5	19.3
1.0211	Appearance			clear	clear	clear	clear	clear	clear
1.03	pH			7.19	7.11	7.17	7.07	7.3	7.1
1.04	Electrical conductivity (25°C)		uS/cm	625	763	626	593	570	641
1.06	Oxygen dissolved		mg/L O2	7.8	8.3	8.6	8	8	7.9
1.0511	Oxygen-saturation		%	78	81.3	81	79	73	79
1.07	Redox potential		mV	350	520	420	360	270	390
	BASIC PARAMETERS								
1.06	Turbidity		NTU	0.13	0.13	0.17	0.11	0.64	0.12
2.01	Colour		m-1	<0.1	0.16	0.26	0.12	<0.1	<0.1
2.02	Total organic carbons (TOC)		mg/L C	0.48	2.7	0.82	0.9	0.94	1.51
2.03	Adsorbable organic halides (AOX)		*µg/L Cl*	3	2.6	3.1	4.1	4	<10
2.04	Ammonium		mg/L NH4	0.004	0.006	0.011	0.01	0.003	0.003
2.06	Sodium		mg/L Na	7.1	6.5	8.9	7.8	8.3	8.2
2.06	Potassium		mg/l K	2	2.5	2.4	2.3	2.3	2.4
2.07	Calcium		mg/l Ca	88	120	94	80	82	90
2.08	Magnesium		mg/l Mg	26	27	24	23	20	25
2.09	Iron		mg/l Fe	<0.01	<0.01	0.018	<0.01	0.037	<0.01
2.10	Hydrogen carbonates		mg/l HCO3	389	437	410	383	343	409
2.11	Nitrates	< 50	mg/l NO3	12.1	22.5	3.81	4.18	8.6	9.18
2.12	Sulphate		mg/l SO4	12.6	49.5	9.26	3.82	10.6	7.51
2.13	Chloride		mg/l Cl	9.55	14.3	13.1	2.02	10.6	6.05
2.14	Phosphates (ortho-)		mg/l PO4	0.004	0.023	0.005	0.004	<0.004	<0.004
3.362	Boron		mg/l B	0.023	0.034	0.022	0.03	0.016	0.028
	INDICATIVE PARAMETERS								
2.1611	Nitrites		mg/l NO2	<0.002	0.003	0.017	0.003	0.002	0.002
2.1612	Fluoride		mg/l F	0.41	0.3	0.34	0.073	0.34	0.27
2.1614	Bromides		mg/l Br	0.026	0.031				

Table 29: : Results of measurements in a borehole outside the area of influence (borehole VOP-3) in all years of monitoring (2012, 2013, 2014)

Testing results			Sample	Landfill Spodnji Stari Grad - borehole VOP3					
			Date of taken sample	29 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14
External code	Parameter	Norm	Unit	2012/9,487	2012/10,858	2013/6,205	2013/8,553	2014/3,170	2014/7,044
	METALS								
3.3571	Aluminium		ug/l Al	1.2	4.3	7.4	4.8	17	8.8
3.357	Antimony		ug/l Sb	0.4	0.37	0.098	0.48	0.13	0.42
3.353	Arsenic		ug/l As	0.16	0.28				
3.159	Copper		ug/l Cu	0.43	1.4	0.55	0.51	0.56	0.87
3.360	Barium		ug/l Ba	52	72	58	50	47	58
3.363	Zinc		ug/l Zn	<2	3				
3.364	Cadmium		ug/l Cd	<0.008	<0.008				
3.365	Cobalt		ug/l Co	0.15	0.32	0.27	0.27	0.26	0.33
3.367	Chromium - total		ug/l Cr	<0.1	0.36				
3.3672	Manganese		mg/l Mn	0.00034	0.00015	0.00053	0.00046	0.0041	0.00059
3.363	Molybdenum		ug/l Mo	0.4	0.34				
3.369	Nickel		ug/l Ni	0.97	2.8	1.5	1.4	2	2.2
3.370	Selenium		ug/l Se	1	1.6				
3.372	Lead		ug/l Pb	0.21	0.041				
3.373	Thallium		ug/l Tl	<0.1	<0.1				
3.374	Titanium		ug/l Ti	0.57	0.96				
3.375	Tellurium		ug/l Te	<0.1	<0.1				
3.377	Vanadium		ug/l V	0.17	0.73				
3.378	Mercury		ug/l Hg	<0.009	<0.009				
	PHENOLIC SUBSTANCES								
3.0731	Phenolic substances - total		ug/l	<2.0	<2.0				
	VOLATILE HALOGENATED HYDROCARBONS (LHH)								
3.090	Epichlorohydrin		ug/l	<1	<0.2				
	PESTICIDES								
3.612	2,6-Dichlorobenzamide	<0.1	ug/l	<0.002	<0.002				
3.112	Azinphos-methyl	<0.1	ug/l	<0.0002	<0.0002				
3.618	Azoxystrobin	<0.1	ug/l	<0.0004	<0.0004				
3.114	Bromophos-ethyl	<0.1	ug/l	<0.0004	<0.0004				
3.617	Bromopropylate	<0.1	ug/l	<0.004	<0.004				
3.63	Cyprodinil	<0.1	ug/l	<0.003	<0.003				
3.1141	Deltamethrin	<0.1	ug/l	<0.03	<0.03				
3.116	Demeton-S-methyl	<0.1	ug/l	<0.03	<0.03				
3.117	Diazinon	<0.1	ug/l	<0.0006	<0.0006				
3.1142	Dichlobenil	<0.1	ug/l	<0.03	<0.03				
3.62	Dichlofluanid	<0.1	ug/l	<0.005	<0.005				

Table 30: Results of measurements in a borehole outside the area of influence (borehole VOP-3) in all years of monitoring (2012, 2013, 2014)

Testing results			Sample	Landfill Spodnji Stari Grad - borehole VOP3					
			Date of taken sample	29 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14
External code	Parameter	Norm	Unit	2012/9,487	2012/10,858	2013/6,205	2013/8,553	2014/3,170	2014/7,044
3.118	Dichlorvos	<0.1	ug/l	<0.0009	<0.0009				
3.614	Dimethenamid	<0.1	ug/l	<0.0004	<0.0004				
3.119	Dimethoate	<0.1	ug/l	<0.0003	<0.0003				
3.120	Disulfoton	<0.1	ug/l	<0.03	<0.03				
3.121	Ethion	<0.1	ug/l	<0.03	<0.03				
3.622	Fenhexamid	<0.1	ug/l	<0.0002	<0.0002				
3.125	Fenitrothion	<0.1	ug/l	<0.0007	<0.0007				
3.69	Fentin hydroxide	<0.1	ug/l	<0.02	<0.02				
3.124	Fenthion	<0.1	ug/l	<0.0006	<0.0006				
3.1143	Fludioxonil	<0.1	ug/l	<0.03	<0.03				
3.1151	Folpet	<0.1	ug/l	<0.03	<0.03				
3.129	Phorate	<0.1	ug/l	<0.03	<0.03				
3.131	Phosalone	<0.1	ug/l	<0.0006	<0.0006				
3.133	Phosphamidon	<0.1	ug/l	<0.03	<0.03				
3.134	Phosmet	<0.1	ug/l	<0.03	<0.03				
3.627	Imidacloprid	<0.1	ug/l	<0.001	<0.001				
11	Captan	<0.1	ug/l	<0.03	<0.03				
3.616	Chlorobenzilate	<0.1	ug/l	<0.004	<0.004				
3.136	Chlorfenvinphos	<0.1	ug/l	<0.0007	<0.0007				
3.68	Chloridazon	<0.1	ug/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
3.1144	Chlorothalonil	<0.1	ug/l	<0.03	<0.03				
3.138	Chlorpyrifos-ethyl	<0.1	ug/l	<0.0007	<0.0007				
3.139	Chlorpyrifos-methyl	<0.1	ug/l	<0.0009	<0.0009				
	Kresoxim-methyl	<0.1	ug/l	<0.03	<0.03				
3.1145	Coumaphos	<0.1	ug/l	<0.03	<0.03				
3.64	Lambda-cyhalothrin	<0.1	ug/l	<0.01	<0.01				
3.141	Malathion	<0.1	ug/l	<0.002	<0.002				

3.621	Metalaxyl	<0.1	ug/l	<0.0002	<0.0002				
3.143	Methidathion	<0.1	ug/l	<0.03	<0.03				
3.65	Methiocarb	<0.1	ug/l	< 0 . 002	<0.002				
3.1148	Methoxychlor (o,p)	<0.1	ug/l	< 0 . 0 3	< 0 . 0 3				
3.1149	Methoxychlor (p,p)	<0.1	ug/l	<0.03	< 0 . 0 3				
3.144	Mevinphos	<0.1	ug/l	<0.0006	<0.0006				
3.145	Monocrotophos	<0.1	ug/l	< 0 . 003	<0.003				
3.147	Omethoat	<0.1	ug/l	< 0 . 0 1	< 0 . 0 1				
3.149	Parathion	<0.1	ug/l	<0.002	<0.002				

Table 31: Results of measurements in a borehole outside the area of influence (borehole VOP-3) in all years of monitoring (2012, 2013, 2014)

Testing results				Landfill Spodnji Stari Grad - borehole VOP3					
			Sample						
			Date of taken sample	29 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14
External code	***Parameter***	***Norm***	***Unit***	***2012/9,487***	***2012/10,858***	***2013/6,205***	***2013/8,553***	***2014/3,170***	***2014/7,044***
3.150	Parathion-methyl	<0.1	ug/l	<0.0003	<0.0003				
3.613	Pendimethalin	<0.1	ug/l	<0.0003	<0.0003				
3.623	Penconazole	<0.1	ug/l	<0.0007	<0.0007				
3.1152	Permethrin	<0.1	ug/l	<0.03	<0.03				
3.1153	Pyridafention	<0.1	ug/l	<0.03	<0.03				
3.152	Pirimiphos-methyl	<0.1	ug/l	<0.03	<**0**.03				
3.619	Pirimicarb	<0.1	ug/l	<0.003	<0.003				
3.**61**	Propiconazole	<0.1	ug/l	<0.0004	<0.0004				
3.615	Procymidone	<0.1	ug/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3.1154	Tetradifon	<0.1	ug/l	<0.03	<0.03				
3.626	Thiacloprid	<0.1	ug/l	<0.002	<0.002				
3.**611**	Triadimefon	<0.1	ug/l	<0.0009	<0.0009				
3.159	Triazofos	<0.1	ug/l	<0.0003	<0.0003				
3.624	Trifloxystrobin	<0.1	ug/l	<0.0003	<0.0003				
3.1155	Trifluralin	<0.1	ug/l	<0.03	<0.03				
3.160	Trichlorfon or Metrifonate	<0.1	ug/l	< 0 . 003	<0.003				
3.161	Vamidothion	<0.1	ug/l	<0.001	<0.003				
3.1156	Vinclozolin	<0.1	ug/l	<0.03	<0.03				
3.1421	Acetochlor	<0.1	ug/l			<0.002	<0.002	<0.002	<0.002
3.3501	Alachlor	<0.1	ug/l			<0.002	<0.002	<0.002	<0.002
3.1422	Ametrine	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.339	Atrazine	<0.1	ug/l	<0.003	0.003	<0.003	0.003	0.003	0.002
3.342	Cyanazine	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.625	Desethyl terbuthylazine	<0.1	ug/l			<0.005	<0.005	<0.001	0.001
3.142	Desethyl-atrazine	<0.1	ug/l	0.006	0.011	0.005	< 0 . 001	0.005	0.006
3.3391	Desisopropyl atrazine	<0.1	ug/l			**<0.01**	<0.**01**	0.003	0.002
	Diethyltoluamide	<0.1	ug/l	<0.003	0.004	0.004	<0.003	<0.003	<0.003
3.1423	Hexazinone	<0.1	ug/l			<0.004	<0.004	<0.004	<0.004
3.1017	S-metolachlor metabolite ESA	<0.1	ug/l	<0.005	0.019	<0.005	<0.005	0.006	<0.005
3.1016	S-metolachlor metabolite OXA	<0.1	ug/l	<0.004	0.007	<0.004	<0.004	<0.004	<0.004
3.347	Metazachlor	<0.1	ug/l			<0.002	<0.002	<0.002	<0.002
3.350	Metolachlor	<0.1	ug/l	<0.003	0.003	<0.003	<0.003	<0.003	<0.003
3.1425	Metribuzin	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.1426	Napropamide	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.1427	Prometon	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.3553	Prometryn	<0.1	ug/l	<0.003	0.003	<0.003	<0.003	<0.003	<0.003

Table 32: Results of measurements in a borehole outside the area of influence (borehole VOP-3) in all years of monitoring (2012, 2013, 2014)

Testing results				Landfill Spodnji Stari Grad - borehole VOP3					
			Sample						
			Date of taken sample	29 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14
External code	***Parameter***	***Norm***	***Unit***	***2012/9,487***	***2012/10,858***	***2013/6,205***	***2013/8,553***	***2014/3,170***	***2014/7,044***
3.3552	Propazine	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.353	Sebutilazine	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.1428	Secbumeton	<0.1	ug/l			<0.002	<0.002	<0.002	<0.002
3.338	Simazine	<0.1	ug/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
3.1429	Simetryne	<0.1	ug/l			<0.002	<0.002	<0.002	<0.002
3.1431	Terbumeton	<0.1	ug/l			<0.003	<0.003	<0.003	<0.003
3.354	Terbuthylazine	<0.1	ug/l			<0.004	<0.004	<0.004	<0.004
3.1432	Terbutryn	<0.1	ug/l			<0.004	<0.004	<0.004	<0.004
3.101	2,4,5-T	<0.1	ug/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
3.091	2,4-D	<0.1	ug/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
3.0921	2,4-DB	<0.1	ug/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
3.092	2,4-DP(dichlorprop)	<0.1	ug/l	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
3.1011	Bentazon	<0.1	ug/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
3.1013	Bromoxynil	<0.1	ug/l	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
3.1012	Dicamba	<0.1	ug/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

3.0922	Fenoprop (Silvex, 2,4,5-trichlorophenoxy)	<0.1	ug/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
3.1014	Ioxynil	<0.1	ug/l	<0.001	<0.001	<0.003	<0.001	<0.003	<0.003
3.098	MCPA	<0.1	ug/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
3.099	MCPB	<0.1	ug/l	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007
3.100	MCPP (Mecoprop)	<0.1	ug/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
3.1025	Mesotrione	<0.1	ug/l	<0.002	<0.002	<0.002		<0.002	<0.002
3.3551	Bromacil	<0.1	ug/l	<0.002	<0.002				
3.3431	Buturon	<0.1	ug/l	<0.002	<0.002				
3.343	D iuren	<0.1	ug/l	<0.002	<0.002				
3.1432	Fenuron	<0.1	ug/l	<0.002	<0.002				
3.3433	Fluometuron	<0.1	ug/l	<0.003	<0.003				
3.345	Isoproturon	<0.1	ug/l	<0.002	<0.002				
3.3434	Chlorbromuron	<0.1	ug/l	<0.003	<0.003				
3.140	Chlortoluron	<0.1	ug/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
3.3435	Linuron	<0.1	ug/l	<0.003	<0.003				
3.1424	Metamitrone	<0.1	ug/l	<0.001	<0.001				
3.349	Metobromuron	<0.1	ug/l	<0.003	<0.003				
36	Metoxuron	<0.1	ug/l	<0.003	<0.003				
3.352	Monolinuron	<0.1	ug/l	<0.003	<0.003				
3.3437	Monuron	<0.1	ug/l	<0.003	<0.003				
3.3438	Neburon	<0.1	ug/l	<0.003	<0.003				

Table 33: Results of measurements in a borehole outside the area of influence (borehole VOP-3) in all years of monitoring (2012, 2013, 2014)

Testing results			*Sample*	Landfill Spodnji Stari Grad - borehole VOP3					
			Date of taken sample	29 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14
External code	*Parameter*	*Norm*	*Unit*	*2012/9,487*	*2012/10,858*	*2013/6,205*	*2013/8,553*	*2014/3,170*	*2014/7,044*
3.1018	Amidosulfuron	<0.1	ug/l	<0.004	<0.004				
3.1019	Foramsulfuron	<0.1	ug/l	<0.004	<0.004				
3.1021	Nicosulfuron	<0.1	ug/l	<0.004	<0.004				
3.1022	Primisulfuron-methyl	<0.1	ug/l	<0.004	<0.004				
3.1023	Prosulfuron	<0.1	ug/l	<0.002	<0.002				
3.1015	Rimsulfuron	<0.1	ug/l	<0.02	<0.02				
3.1024	Triasulfuron	<0.1	ug/l	<0.003	<0.003				
3.3555	Pesticides - total	<0.5	ug/l	0.006	0.05	<0.01	<0.01	0.017	0.011
	PHTHALIC ACID ESTERS								
3.401	Butyl benzyl phthalate		ug/l	<0.1	<0.1				
3.402	Dibutyl phthalate		ug/l	<0.1	<0.1				
3.403	Diethyl phthalate		ug/l	<0.1	<0.1				
3.404	Diethylhexyl phthalate		ug/l	<0.1	<0.1				
	Dimethyl phthalate		ug/l	<0.1	<0.1				
	Dioctyl phthalate		ug/l	<0.1	<0.1				
	PHOSPHORIC ACID ESTERS								
3.162	Tributyl phosphate		ug/l	<0.004	<0.004				
	Tris(2-chloroethyl) phosphate		ug/l	<0.010	<0.010				
	Tris (chloropropyl) phosphate		ug/l	<0.005	<0.005				
	ORGANIC TIN COMPOUNDS								
3.165	Dibutyltin (DBT) compounds		ug/l	<0.05	<0.05				
3.1662	Tributyltin (TBT) compounds		ug/l	<0.03	<0.03				
3.1661	Triphenyltin (TPhT) compounds		ug/l	<0.02	<0.02				
3.166	Tetrabutyltin		ug/l	<0.01	<0.01				
	ENDOCRINE DISRUPTORS								
	Bisphenol A		ug/l	<0.11	<0.11				
	Octylphenol		ug/l	<0.005	<0.005				
	Nonylphenol		ug/l	<0.016	<0.016				
	IDENTIFICATION OF ORGANIC COMPOUNDS								
3.4111	GC-MS image			is attached		without special features		is attached	

Note: Highlighted results are results that exceed limit values from: Decree on groundwater status, Official Gazette of the RS 25/2009, Annex 2–Quality standards and threshold values

Analysis of results

Evaluation of measured values was carried out by the NLZOH in accordance with the Monitoring Programme and the Rules on the operational monitoring of groundwater pollution (Official Gazette of the RS 49/06, 114/09).
Evaluation of results obtained from measured parameters is the calculation of values for the monitoring period, the calculation of changes with regard to the baseline borehole and a comparison of changes of parameters with critical changes (alert values). On the basis of the comparison of these two values, the impact of the landfill on groundwater was estimated. A landfill has an impact on groundwater if the change of at least one basic or indicative parameter exceeds the critical change from the Monitoring Programme.
Critical changes of parameters from the Monitoring Programme were calculated in accordance with the Rules on operational monitoring of groundwater pollution (Official Gazette of the RS 49/06, 114/09). The chemical status of groundwater was estimated with regard to limit values for groundwater from the Decree on groundwater status (Official Gazette of the RS 25/09).
Water from borehole VOP-3, which is defined in the monitoring programme as the baseline borehole, is clean. It may be seen from GC/MS images that compounds present in plastics (plastificators), some compounds from the pharmaceutical industry, mineral oils and natural compounds appear in the water. None of the parameters exceeds limit values for good chemical status of groundwater. The calculation of changes of parameters for VOP-2 for 2012, 2013, 2014 compared to the baseline borehole (VOP-3) is shown in the table below.

Table 34: Calculation of changes for 2012, 2013, 2014 (baseline borehole VOP-3)

PARAMETER	UNIT	VOP-2						Used alert change
		23 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14	
		d (9,488/zero VOP-3 12)	d(10,860/zero VOP-3 12)	d(6,207/zero VOP-3 12, 13)	d(8,556/zero VOP-3 12, 13)	d(3,173/zero VOP-3 12, 13, 14)	d(7,046/zero VOP-3 12, 13, 14)	
BASIC PARAMETERS								
Total organic carbons (TOC)	*mg/L C*	*19*	843	700	933	244	223	*100*
Adsorbable organic halides (AOX)	*ug/l Cl*	*36*	*11*	525	169	106	*39*	*100*
Ammonium	*mg/L NH4*	*40*	85,300	229,900	157,500	80,900	13,540	*200*
Potassium	*mg/l K*	*491*	1,218	1,943	1,900	1,509	857	*500*
Calcium	*mg/l Ca*	*15*	92	*25*	67	*41*	*41*	*50*
Magnesium	*mg/l Mg*	*23*	135	124	124	71	58	*50*
Iron	*mg/l Fe*			1,580	660			*300*
Hydrogen carbonates	*mg/l HCO3*	*30*	94	84	87	51	*40*	*50*
Phosphates (ortho-)	*mg/l PO4*				*24*		1,060	*100*
Boron	*mg/l B*		1,750	726	726	477	323	*100*
INDICATIVE PARAMETERS								
Nitrites	*mg/l NO2*		3,540	800	620	*40*	*100*	*200*
METALS								
Aluminium	*ug/l Al*		*7*	423	*18*	261		*150*
Copper	*ug/l Cu*	*260*	1,480	*58*	*120*	*140*	*300*	*300*
Barium	*ug/l Ba*	110	545	641	607	382	221	*100*
Cobalt	*ug/l Co*		*160*	1,000	1,540	440	*160*	*300*
Manganese	*mg/l Mn*			780	1,000	1,400	710	*300*
Nickel	*ug/l Ni*	*38*	427	678	1,337	618	375	*300*
PESTICIDES								
Prometryn	*ug/l*	*20*	900	700	700	*87*	113	*100*
Diethyltoluamide	*ug/l*		5,500	2,167	6,167	400	3,500	*100*
S-metolachlor metabolite ESA	*ug/l*	*20*	108	*27*		140		*100*
Metolachlor	*ug/l*	107	633	767	1,500		227	*100*
Dimethoate	*ug/l*				127			*100*
Metalaxyl	*ug/l*				107			*100*
Thiacloprid	*ug/l*			220		*67*		*100*
Ametrine	*ug/l*			320	207	*60*		*100*
Thiamethoxam	*ug/l*		*16*		147			*100*
Terbuthylazine	*ug/l*			*47*	200			*100*
Atrazine	*ug/l*	347	767	567	900	127	107	*100*
S-metolachlor metabolite OXA	*ug/l*	*52*	140	220	180	127	147	*100*
MCPP (Mecoprop)	*ug/l*		9,900	1,367	3,300	207	2,167	*100*
2,4-DP(dichlorprop)	*ug/l*		3,660		260			*100*
2,4-D	*ug/l*		307				293	*100*
Bentazon	*ug/l*	860	11,500	900	4,700	153	1,233	*100*
Chlortoluron	*ug/l*					833	140	*100*
Tritosulfuron	*ug/l*						127	*100*
Pesticides - total	*ug/l*	2,116	34,468	6,020	12,820	2,260	5,900	*200*

Note: Meaning of "Calculation of changes" in tables: Highlighted results mean exceeded critical changes. Cells are empty if the average result in the baseline field is higher than the value of the quantification limit in the area of influence. Cells coloured yellow means that the parameter was not measured.

Of the basic parameters, the following exceed the alert limit in both samples: TOC, ammonium, potassium, magnesium and boron; AOX, hydrogen carbonates and phosphates (ortho-) exceed the alert limit in just one sample.

Of the indicative parameters, the following exceed the alert limit in both samples: barium, manganese, nickel, diethyltoluamide, atrazine, S-metolachlor metabolite OXA, bentazone, chlortoluron and pesticides – total. Aluminium, cobalt and S-metolachlor metabolite ESA only exceed it in the first sample, while metolachlor, prometryn, 2.4-D and tritosulphuron only exceed it in the second sample.

For borehole VOP-2 the results of measurements for 2012, 2013 and 2014 for those parameters that exceed limit values are shown in the table below.

Table 35: Results of measurements for 2012, 2013 and 2014 (for those parameters that exceed limit values)

Testing results			Sample	VOP2					
			Date of taken sample	29 Oct 12	4 Dec 12	17 Jul 13	1 Oct 13	10 Apr 14	18 Aug 14
External code	Parameter	Norm	Unit	2012/9,488	2012/10,860	2013/6,207	2013/8,556	2014/3,173	2014/7,046
	INDICATIVE PARAMETERS								
	PESTICIDES								
3.339	Atrazine	<0.1	ug/l	0.067	**0.13**	0.1	**0.15**	0.034	0.031
	Diethyltoluamide	<0.1	ug/l	0.017	**1.4**	**0.34**	**0.94**	0.075	**0.54**
3.350	Metolachlor	<0.1	ug/l	0.031	**0.11**	**0.13**	**0.24**	0.013	0.049
3.3553	Prometryn	<0.1	ug/l	0.018	**0.15**	**0.12**	**0.12**	0.028	0.032
3.092	2,4-DP (dichlorprop)	<0.1	ug/l	<0.006	**0.94**	0.013	0.054	<0.006	<0.006
3.1011	Bentazon	<0.1	ug/l	**0.24**	**2.9**	**0.15**	**0.72**	0.038	**0.2**
3.100	MCPP (Mecoprop)	<0.1	ug/l	0.02	**2.5**	**0.22**	**0.51**	0.046	**0.34**
3.340	Chlortoluron	<0.1	ug/l	<0.003	0.006	<0.003	0.007	**0.14**	0.036
3.3555	Pesticides - total	<0.5	ug/l	**0.53**	**8.47**	**1.53**	**3.23**	**0.59**	**1.5**

Note: Highlighted results are results that exceed limit values from: Decree on groundwater status, Official Gazette of the RS 25/2009, Annex 2–Quality standards and threshold values

When comparing values with the limit values from the Decree we find that in the case of individual samplings in borehole VOP-2 the normative values of the parameters diethyltoluamide, bentazone, MCPP (mecoprop), chlortoluron and pesticides – total for good chemical status are exceeded.

In the context of the environmental consent issued for the Brežice HPP, the developer (Infra d.o.o.) was given the obligation to undertake remediation of the Spodnji Stari Grad landfill before filling the basin. On the basis of the study "Variants of possible forms of remediation of the Spodnji Stari Grad landfill – Annex to the EIA for the Brežice HPP, January 2014, HSE Invest", Variant 2 was chosen, whereby remediation is carried out by means of a sealing diaphragm around the entire landfill down to the less permeable substratum. The system of surface drainage is modified as necessary and additional sealing of the surface is implemented with the aim of reducing penetration of stormwater into the sealed cell. According to data from boreholes in the immediate vicinity of the landfill, the permeability of the pre-Quaternary substratum is of an order of magnitude of 10^{-7}m/s, from which it may be concluded that the flow of polluted water from the cell will be relatively small, and in any case several times smaller than present-day groundwater flow through the area of the landfill. Discharges from the landfill into groundwater will consequently be significantly reduced.

With the implementation of remediation of the closed non-hazardous waste landfill, we consider that pollution in the area of influence of the landfill will be significantly reduced.

4.4.3 *QUALITY AND QUANTITY OF SURFACE WATER AND PRESSURE ON THE AREA RESULTING FROM SURFACE WATER POLLUTION*

The only major watercourse in this area is the river Sava, which is 650 metres from the planned LILW repository site at its closest point. The Sava flows from the Posavje Hills and has filled the Krško depression with gravelly deposits into which, in periods of increased erosion, it has carved its channel. The result of alternations of accumulation and erosion of gravel are clearly visible river terraces. In the past, the Sava has also changed the position of its channel, as may be observed on the ground in the form of dry riverbeds that have partly been transformed into oxbow lakes, pools, etc. Before construction of the Brežice HPP, the Sava flowed at a height of between 148 and 147 metres.

Construction of the Brežice HPP was completed in 2017. With construction of the Brežice HPP and the existing operation of Krško NPP, the following significant pressures are present in this watercourse:

- water flow regulation and morphological changes of surface water as a result of hydropower use,
- water flow regulation and morphological changes of surface water as a result of ensuring flood safety,
- water flow regulation and morphological changes of surface water,
- physical changes to channels as a result of water regulation.

When planning the Brežice HPP, the maintenance of flood safety, the nuclear and operational efficiency of Krško NPP, the maintenance of flood retention areas and international agreements regarding the flow of the river Sava were all taken into account. Following construction of the Brežice HPP, the extent of flooding is approximately the same as in the existing state (this is covered in more detail in the next section). At high water levels, floodwater will spill onto existing flood areas on both the left and right banks, so additional flood protection of settlements on both banks is also envisaged.

The Brežice HPP reservoir has the following characteristics: capacity: 19.3 million m^3; useful capacity 3.4 million m^3; water surface area: 317 ha; width at widest part: 680 m; length: 12.95 km; total length of all embankments: 13.63 km; embankment height – right bank: 1.2–8.7 m; embankment height – left bank: 2.4–9.5 m; embankment volume: 2.7 m^3.

A daily fluctuation of water levels occurs in the reservoir as a result of peak power generation. Under the terms of the concession, the maximum fluctuation of water level is set at 1.1 m. Level fluctuation could result in the banks of the reservoir being exposed to erosion (speed of fluctuation will be up to 1 m/h), so protection has been implemented in the form of stone revetments that prevent erosion.

Figure 68: HPP Brežice reservoir (2017)

NW of the planned site (at a distance of more than 2 km) is the Potočnica stream, which, however, is not in the area of influence of the plan and cannot affect conditions in the plan area. NE of the planned site is the Struga, a surface watercourse whose channel ends on the plain or polje to the east of the site under consideration. The water in the stream sinks underground along the length of the Struga and rarely reaches the Sava.

4.4.3.1 **The river Sava and floods**

The present-day channel of the Sava between Krško and the Croatian border is actually fully canalised, regulated and artificially maintained along its entire length. Regulation work on this section of the Sava began with the construction of the "Croatian railway" between Zidani Most and Zagreb (1855–1862). At first the most important concern was to retain the Sava within specific confines so that it did not represent a risk to the railway line, above all in the section at Stari Grad near Krško. Regulation work continued on this section of the Sava with interruptions of differing length for more than 100 years, while reconstruction work also took place after the Second World War. The present-day channel of the Sava partly connects formerly active meanders and has partly been dug artificially into alluvium or, in places, the rocky substratum. It is dug into the substratum at Krško and slightly south of Žadovinek, and in the section between Brežice and Mostec.

In the Vrbina area there are no specially prescribed restrictions for the Sava. The Sava is not used for water supply and no sections on the Sava are envisaged as habitats for freshwater fish species in accordance with the criteria from the Decree on surface water quality for the life of freshwater species; likewise there are no natural bathing areas on the section of the river under consideration.

The section of the Sava under consideration (from the Krško NPP facility to the town of Brežice) is a broad, open plain with large inundation surfaces. Water floods widely on the Krško Polje/Brežiško Polje, mainly on the right bank. Major hydrotechnical arrangements that reduce the natural flood area have been implemented in order to protect larger settlements along the Sava, Sevnica, Krško and Krško NPP. The safeguarding arrangements of Krško NPP prevent the Sava from flooding onto the left bank on the Krško Polje/Brežiško Polje downstream of the Potočnica stream to around 1 km downstream of Krško NPP, where the high water embankment on the left bank ends. The embankments on the left bank and the correspondingly lower heights of the terrain on the right bank of the Sava are implemented in such a way that the left bank in the corresponding section, and thus the nuclear power station, are safe up to Q_{PMF} flow rates in the Sava.

Hydrological data for the river Sava in the Krško Polje area show that the level and flow rate of the river are dependent above all on hydrometeorological conditions across the entire river basin.

The Sava has two periods of low water levels during the year. The first low water level occurs in August and continues into September. A secondary low water level occurs in winter and is less marked and with a shorter duration. On this basis, we classify the river Sava in this area as a rain-snow regime with a continental variant.
The closest gauging stations are Radeče and Čatež. Characteristic flow rates of the Sava (1961–1990) in m^3/s are shown in the table below.

Table 36: Characteristic flow rates of the Sava

	Lowest mean flow rate	**Highest mean flow rate**	**Mean flow rate**
Radeče	38.4 m^3/s	2991 m^3/s	221 m^3/s
Čatež	51.9 m^3/s	3267 m^3/s	290 m^3/s

The drainage quotient in this area is around 60%.

We can see from the above figures that the Sava has considerable fluctuations. A consequence of such conditions and the relatively low levels of the river terraces is flooding at medium-high water levels, which occur when the flow rate of the Sava is around 1,600–2,000 m^3/s.

ARSO has sent the Ministry of the Environment and Spatial Planning, Spatial Planning Directorate a document called “Correction of hydrological data and determination of a new Q_{100} for the river Sava for the profiles Radeče, Krško HPP dams and Brežice HPP dam (approx. 300 m upstream of the iron bridge)” (Document Ref. 35921-5/2011). On the basis of the changed flow curve of the Radeče gauging station, ARSO has submitted modified figures for maximum flow rates of the Sava at the Radeče gauging station for the period 1926–2000. On the basis of the values obtained through probability analysis of the modified figures, the following high water values were given for the Krško HPP and Brežice HPP profiles (both profiles have the same return water level values):

Table 37: Statistical flow rate (m^3/s) for high water levels in the section of the lower Sava under consideration

Q_{10000}	Q_{1000}	Q_{500}	Q_{100}	Q_{50}	Q_{20}	Q_{10}	Q_{5}	Q_{2}
6000	4840	4510	3750	3365	2900	2560	2190	1675

In the context of preparation of the detailed plan of national importance for the Brežice HPP and design output requirements, an extensive hybrid hydraulic model was created for the areas of Krško HPP, Brežice HPP and Mokrice HPP (Report: Hybrid hydraulic model of the area of the Brežice HPP, Institute for Hydraulic Research, University of Ljubljana, Faculty of Civil and Geodetic Engineering (FGG), Department of Fluid Mechanics with laboratory, IBE, Ljubljana, October 2011), which covers the existing situation and the situation after construction of individual hydropower plants.

Verification of the existing situation covered the following:

- establishment of a mathematical model for the existing situation,
- calibration of the mathematical model to data from field measurements and data from the physical model of the existing situation,
- calculation of complete velocity fields and depths in the channel and on flood areas for typical high water flow rates Q5-Q10,000, PMF – probable maximum flood)
- determination of flow capacity of retention areas left and right of the main channel and determination of dominant flow rates over retention areas for the existing state,
- determination of retention volumes for various high water waves or various peak flows,
- determination of delay (slowdown/acceleration) of the wave peak as a result of overflow into retention areas
- creation of flood hazard maps for the existing state.

In 2015 the model was amended for the needs of hydraulic verification of the LILW repository: "Hydraulic analysis of the impact area of Vrbina, Krško low- and intermediate level radioactive waste repository, FGG, June 2015".

The floodwater status for the existing state (without construction of the Brežice HPP) is given below for a flow rate of Q_{1000}=4840 m3/s and Q_{PMF} = 7081 m^3/s.

It can be observed from analysis of the figures that the area (the area of the planned LILW silos) is today not impacted by floodwaters right up to Q_{PMF}. The figures below offer, for the purposes of comparison, the existing flood state (without construction of the LILW repository) before and after construction of the Brežice HPP.

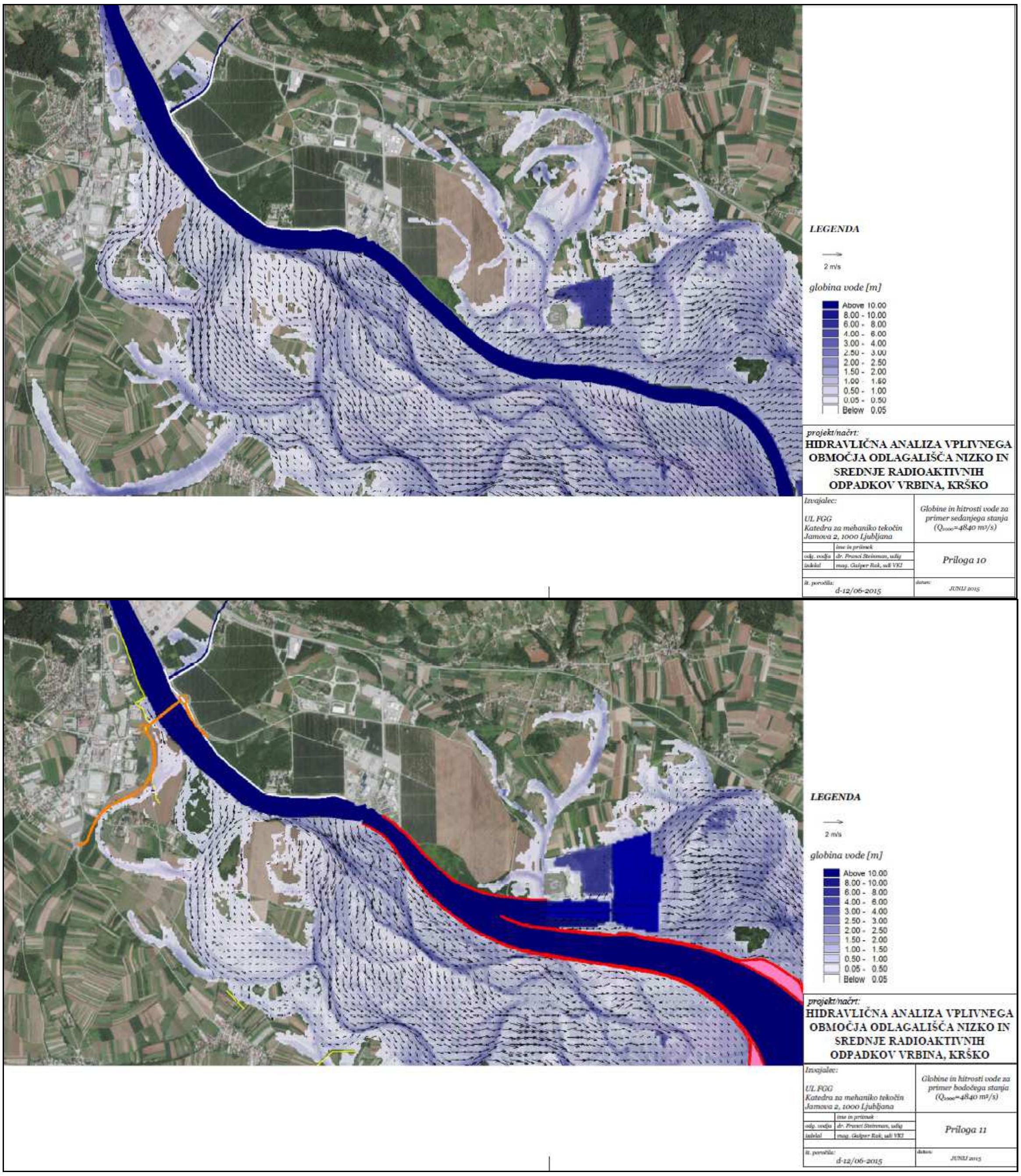
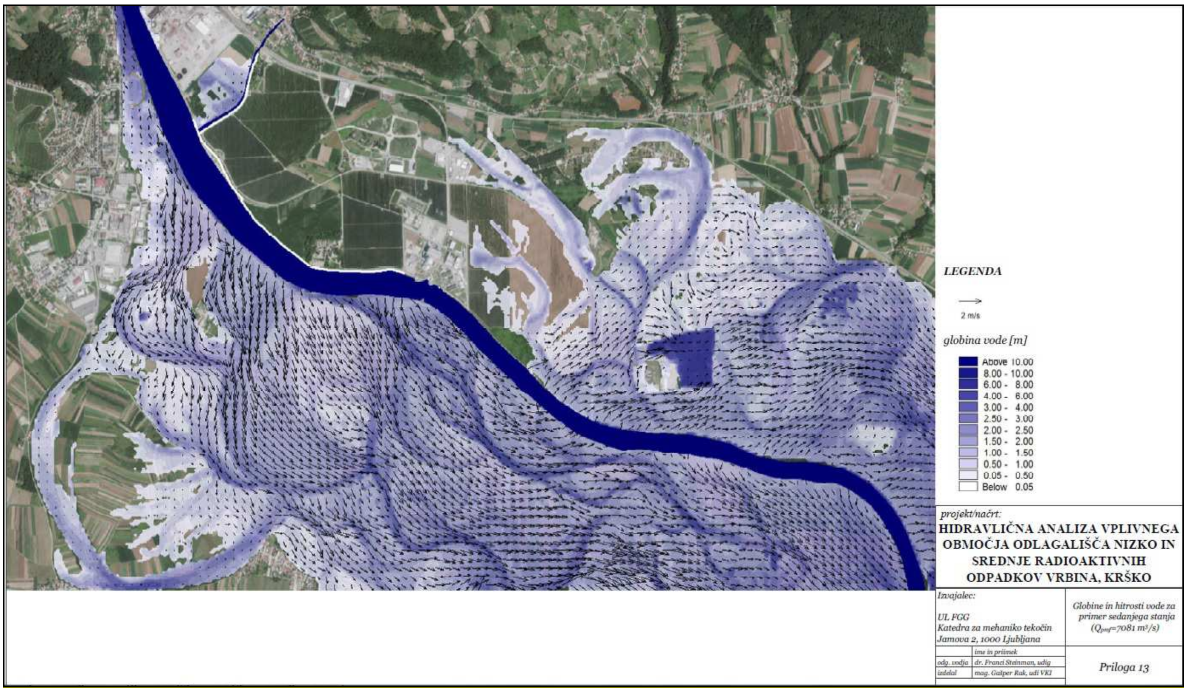


Figure 69: Flood area of the river Sava in the event of Q_{1000}

Legenda	Key
globina vode [m]	water depth [m]
projekt/načrt: HIDRAVLIČNA ANALIZA VPLIVNEGA OBMOČJA ODLAGALIŠČA NIZKO IN SREDNJE RADIOAKTIVNIH ODPADKOV VRBINA, KRŠKO	Project/plan: “HYDRAULIC ANALYSIS OF THE IMPACT AREA OF VRBINA KRŠKO LOW- AND INTERMEDIATE LEVEL RADIOACTIVE WASTE REPOSITORY”
Izvajalec: UL FGG Katedra za mehaniko tekočin Jamova 2, 1000 Ljubljana	Contractor: UL FGG Department of Fluid Mechanics Jamova 2, 1000 Ljubljana

Globine in hitrosti vode za primer sedanjega stanja (Q_{1000} = 4840 m^3/s)	Water depths and flow rates for the current situation (Q_{1000} = 4,840 m^3/s)
ime in priimek	First name and surname
odg. vodja	Responsible head
dr. Franci Steinman, udig	Dr Franci Steinman, udig
izdelal	Drawn up by
mag. Gašper Rak, udi VKI	Gašper Rak, udi VKI
št. poročila: d-12/06-2015	Report no: d-12/06-2015
Priloga 10	Appendix 10
datum: JUNIJ 2015	Date: JUNE 2015
Globine in hitrosti vode za primer bodočega stanja (Q_{1000} = 4840 m^3/s)	Water depths and flow rates for the future situation (Q_{1000} = 4,840 m^3/s)
Priloga 11	Appendix 11



Legenda	Key
globina vode [m]	water depth [m]
projekt/načrt: HIDRAVLIČNA ANALIZA VPLIVNEGA OBMOČJA ODLAGALIŠČA NIZKO IN SREDNJE RADIOAKTIVNIH ODPADKOV VRBINA, KRŠKO	Project/plan: “HYDRAULIC ANALYSIS OF THE IMPACT AREA OF VRBINA KRŠKO LOW- AND INTERMEDIATE LEVEL RADIOACTIVE WASTE REPOSITORY”
Izvajalec: UL FGG Katedra za mehaniko tekočin Jamova 2, 1000 Ljubljana	Contractor: UL FGG Department of Fluid Mechanics Jamova 2, 1000 Ljubljana
Globine in hitrosti vode za primer sedanjega stanja (Q_{pmf} = 7081 m^3/s)	Water depths and flow rates for the current situation (Q_{pmf} = 7,081 m^3/s)
ime in priimek	First name and surname

odg. vodja	Responsible head
dr. Franci Steinman, udig	Dr Franci Steinman, udig
izdelal	Drawn up by
mag. Gašper Rak, udi VKI	Gašper Rak, udi VKI
št. poročila: d-12/06-2015	Report no: d-12/06-2015
Priloga 13	Appendix 13
datum: JUNIJ 2015	Date: JUNE 2015
Globine in hitrosti vode za primer bodočega stanja (Q_{pmf} = 7081 m^3/s)	Water depths and flow rates for the future situation (Q_{pmf} = 7,081 m^3/s)
Priloga 14	Appendix 14

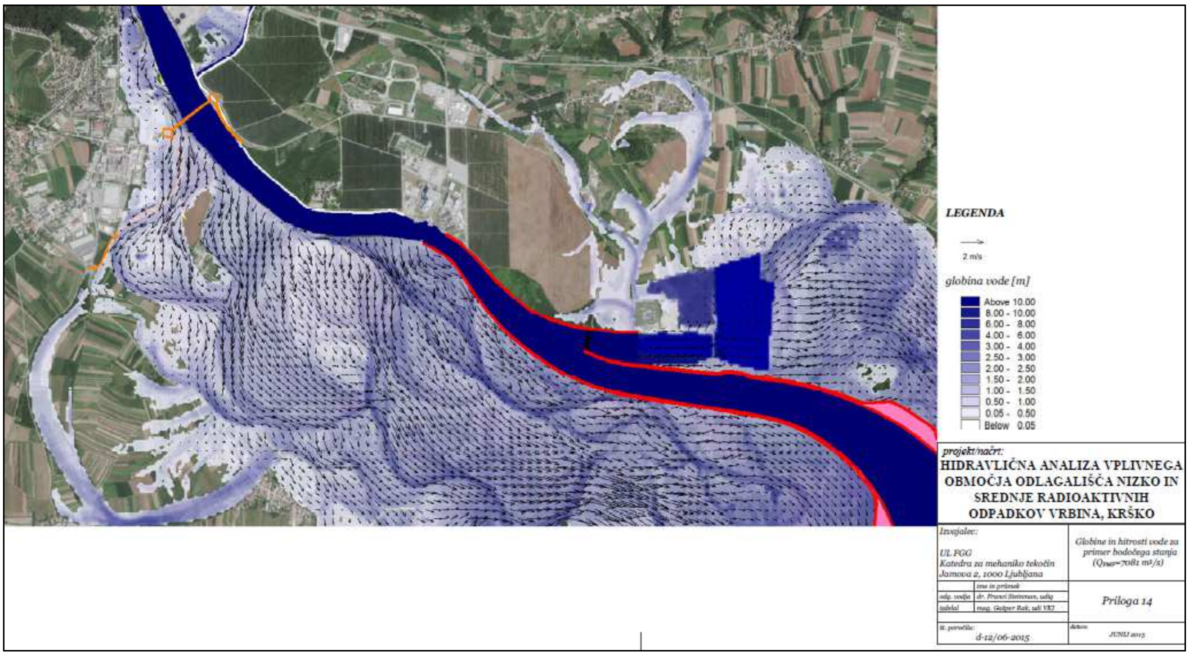


Figure 70: Flood area of the river Sava in the event of Q_{PMF}

Legenda	Key
globina vode [m]	water depth [m]
projekt/načrt: HIDRAVLIČNA ANALIZA VPLIVNEGA OBMOČJA ODLAGALIŠČA NIZKO IN SREDNJE RADIOAKTIVNIH ODPADKOV VRBINA, KRŠKO	Project/plan: "HYDRAULIC ANALYSIS OF THE IMPACT AREA OF VRBINA KRŠKO LOW- AND INTERMEDIATE LEVEL RADIOACTIVE WASTE REPOSITORY"
Izvajalec: UL FGG Katedra za mehaniko tekočin Jamova 2, 1000 Ljubljana	Contractor: UL FGG Department of Fluid Mechanics Jamova 2, 1000 Ljubljana
Globine in hitrosti vode za primer sedanjega stanja (Q_{pmf} = 7081 m^3/s)	Water depths and flow rates for the current situation (Q_{pmf} = 7,081 m^3/s)
ime in priimek	First name and surname
odg. vodja	Responsible head
dr. Franci Steinman, udig	Dr Franci Steinman, udig
izdelal	Drawn up by
mag. Gašper Rak, udi VKI	Gašper Rak, udi VKI
št. poročila:	Report no:

d-12/06-2015	d-12/06-2015
Priloga 13	Appendix 13
datum: JUNIJ 2015	Date: JUNE 2015
Globine in hitrosti vode za primer bodočega stanja (Q_{pmf} = 7081 m^3/s)	Water depths and flow rates for the future situation (Q_{pmf} = 7,081 m^3/s)
Priloga 14	Appendix 14

The figure below shows the flood area for Q10 (dark blue), Q100 (light blue) and Q500 (turquoise) annual water.

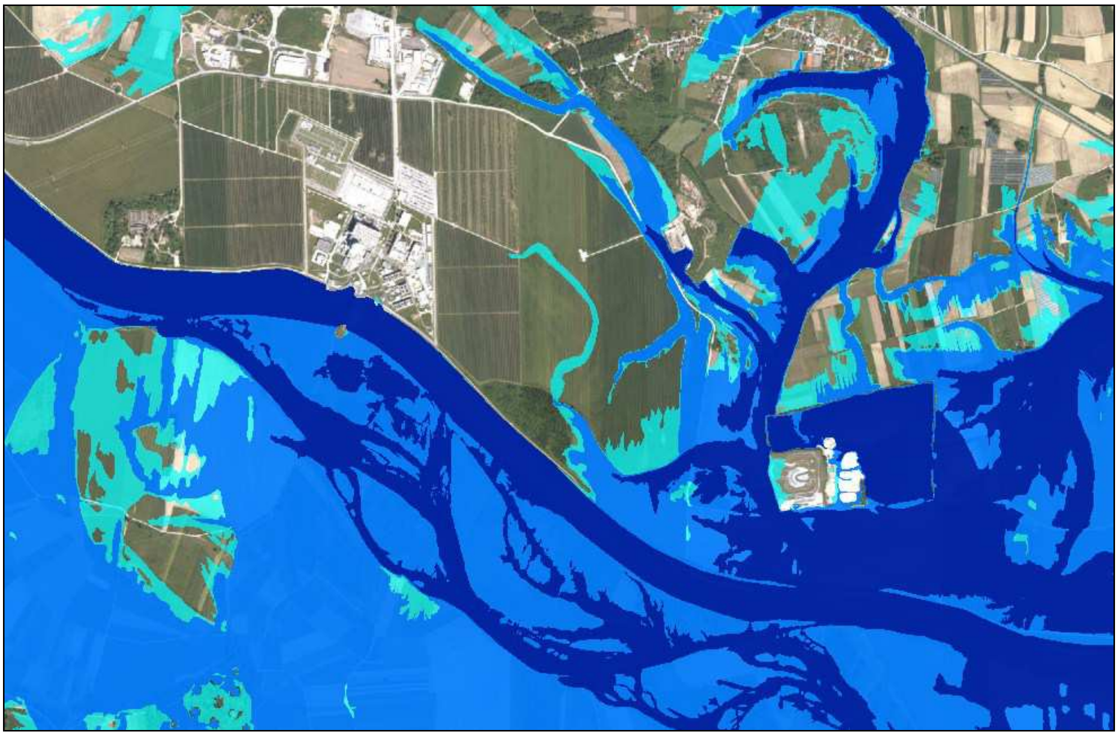


Figure 71: Size of floods in the wider area of the LILW repository site
(Source: Slovenian Environment Agency: Environment Atlas, February 2016).

4.4.3.2 Chemical and ecological status of the Sava

The chemical and ecological status of Sava in the section under consideration is affected by the presence of contaminants throughout the catchment area of the Sava, which in this case also means a considerable part of Slovenia, including the most polluted areas such as the Ljubljana and Celje Basins, and industrial areas such as Jesenice, Zagorje, Trbovlje and Hrastnik. Pollution of the watercourse is also significantly influenced by agriculture (use of animal and artificial fertilisers and plant protection products on arable land).

Chemical status

Monitoring and determination of the chemical status of watercourses in Slovenia for the period 2009–2013 took place in accordance with the Decree on surface water status (Official Gazette of the RS 14/09, 98/10, 96/13) and the Rules on monitoring surface water status

(Official Gazette of the RS 10/09, 81/11), which transpose the requirements of Directive 2008/105/EC on environmental quality standards in the field of water policy and Directive 2009/90/EC laying down technical specifications for chemical analysis and monitoring of water status. Monitoring took place in the water bodies defined by the Rules on the definition and classification of surface water bodies (Official Gazette of the RS 63/05, 26/06 and 32/11). The chemical status assessment includes the level of confidence, by which we evaluate, in a descriptive manner, the probability that the assessment reflects the actual situation. A three-point scale is given: high, medium or low.

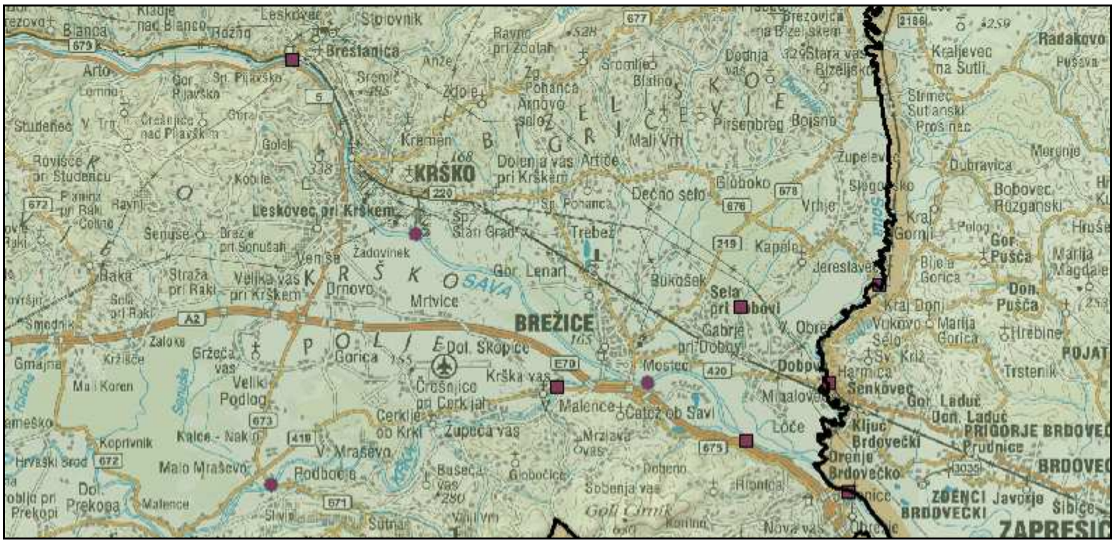


Figure 72: National measurement sites on the river Sava (source: Environment Atlas)

Environmental quality standards (EQS) for assessment of the chemical status of surface waters are set as an annual average value (AA-EQS) of the chemical status parameter in water that provides protection against long-term exposure, and as the maximum acceptable concentration (MAC-EQS) of the chemical status parameter in water that prevents the short-term consequences of pollution. Between 2009 and 2013, for the parameters mercury, hexachlorobenzene and hexachlorobutadiene, which tend to accumulate in living organisms (biota), environmental quality standards designed to ensure protection against indirect effects and secondary poisoning were also set for organisms (EQSbiota). In Slovenia, fish were defined as the most suitable organism for these three parameters.

The Decree on surface water status was amended in 2016, with amendments that transposed into national legislation the requirements of Directive 2013/39/EU amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy. Twelve new substances were added to the list of priority substances, of which six are defined as priority hazardous substances, while environmental quality standards were revised for some existing substances. As well as for mercury, hexachlorobenzene and hexachlorobutadiene, environmental quality standards for biota were newly defined for eight substances.

The figures for the period 2009–2013 were evaluated in accordance with the Decree from 2013, and were additionally evaluated with regard to the revised AA-EQS or MAC-EQS for the existing substances on the priority list. The new environmental quality standards for biota and the new substances on the list of priority substances were not taken into account in the chemical status assessment for the period 2009–2013.

The chemical status of watercourses is shown in the tables below as:

a) Chemical status of watercourses evaluated with regard to all chemical status parameters from the Decree on surface water status applying in 2013 (Official Gazette of the RS 14/09, 98/10, 96/13) or from Directive 2008/105/EEC, with the exception of mercury in biota
b) Chemical status of watercourses with regard to mercury in biota
c) Chemical status of watercourses with regard to revised environmental quality standards from the Decree amending the Decree on surface water status (Official Gazette of the RS 24/16) or Directive 2013/39/EU

Chemical status of watercourses evaluated with regard to all chemical status parameters from the Decree on surface water status applying in 2013 (Official Gazette of the RS 14/09, 98/10, 96/13) or from Directive 2008/105/EEC, with the exception of mercury in biota

Good chemical status has been established for all watercourses in Slovenia defined by the Rules on the definition and classification of surface water bodies. This chemical status assessment also evaluates hexachlorobenzene and hexachlorobutadiene content in biota. At all measurement sites where monitoring is carried out, the content of these substances was below the limit of quantification (LOQ).

The table below shows the chemical status of the river Sava in the section under consideration for the period 2009–2013 (Source: ARSO, Chemical status assessment of watercourses for the period 2009–2013, 2017).

Table 38: Chemical status assessments for the closest measurement sites to the planned construction site for the LILW repository (source: ARSO)

Name of water body	Chemical status	Level of confidence
HMWB Sava Vrhovo–Boštanj	GOOD	medium
WB Sava Boštanj–Krško	GOOD	high
WB Sava Krško–Vrbina	**GOOD**	**high**
WB Sava–border section	GOOD	high

On the basis of the results of chemical status measurements at the Brestanica, Podgračeno and Jesenice na Dolenjskem measurement sites, we find that the chemical status of the water bodies Sava Boštanj–Krško, Sava Krško–Vrbina and Sava–border section is good.

Chemical status of watercourses with regard to mercury in biota

By 2016, in conformity with the Decree on surface water status (Official Gazette of the RS 14/09, 98/10, 96/13), chemical status has been assessed on the basis of the results of analyses of 33 hazardous substances in water and three hazardous substances in biota. The biota selected in inland waters were fish (chub, brown trout, Italian chub, marble trout).

Monitoring of three hazardous substances in biota began in Slovenia in 2012, with the requirements to monitor three parameters in biota – namely mercury, hexachlorobenzene and hexachlorobutadiene – for which environmental quality standards are also defined in biota (Table 1, hereinafter: EQSbiota). These are parameters for which it is established that they accumulate in biota, which can lead to loss of habitats and biodiversity, and can also endanger human health.

The Decree amending the Decree on surface water status (Official Gazette of the RS 24/2016), introduced EQSbiota for eight additional substances, for which monitoring will begin in future monitoring programmes.
Environmental quality standards in biota (EQSbiota), the aim of which is to protect against secondary poisoning, are defined on the basis of ecotoxicological data in accordance with the European Commission's instructions on laying down EQS (European commission, 2011). Among the parameters for which EQS is set for the purpose of protecting against secondary poisoning are hexachlorobutadiene and mercury.

Measurement sites were selected so as to provide representative coverage of the entire territory of Slovenia. Mercury is transported over large distances by atmospheric deposition and in Europe is generally present in surface water biota in concentrations that exceed environmental standards for organisms. In Slovenia mercury in biota was monitored at 21 measurement sites on watercourses, both in transboundary profiles, in areas free of anthropogenic impact, and in mining areas.

Exceedances of environmental standards were recorded at 20 measurement sites across Slovenia, with the environmental standard not exceeded at just one measurement site. With regard to the measured exceedances of mercury in biota, the results of modelling of atmospheric deposition of mercury were reviewed. The quantity of atmospheric deposition of mercury in $g/km^2/year$ is the same for the entire territory of Slovenia, which means that an exceedance of Hg content in biota is to be expected in all watercourses. Accordingly, the chemical status with regard to mercury in biota was assessed as poor for all watercourses with the exception of the one body of water where the measured values did not exceed the environmental standard. The table below shows the statuses of watercourses relevant for assessment of the LILW repository development.

Table 39: Chemical status assessments (biota) for the period 2009–2013

Name of water body	Chemical status (mercury in biota)	Level of confidence
WB Sava Boštanj–Krško	POOR	low
WB Sava Krško–Vrbina	POOR	low
WB Sava–border section	POOR	high

Source: ARSO, Chemical status assessment of watercourses for the period 2009–2013, 2017.

Chemical status of watercourses with regard to revised environmental quality standards from the Decree amending the Decree on surface water status (Official Gazette of the RS 24/16) or Directive 2013/39/EU

For seven substances (anthracene, brominated diphenylethers, fluoranthene, lead, naphthalene, nickel, polycyclic aromatic hydrocarbons), Directive 2013/39 EU amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy sets revised EQS with effect from 22 December 2015 with the aim of achieving good surface water chemical status in relation to those substances by 22 December 2021. This means that for the needs of the Water Management Plans 2016–2021 it was also necessary to evaluate the substances with regard to the revised EQS and, in the event of non-achievement of good status, to envisage additional measures. Evaluation of chemical status with regard to revised MAC-EQS was carried out for all parameters, while a valuation of chemical status with regard to revised AA-EQS was carried out for all parameters except benzo(a)pyrene, where the LOD and LOQ are greater than AA-EQS. For the evaluation of surface water chemical status with regard to nickel and lead content, bioavailability was also taken into account as necessary, in accordance with the background documentation published on the ARSO website.

Evaluation of the chemical status of watercourses with regard to the revised AA-EQS and MAC-EQS showed that the chemical status of watercourses had not deteriorated as a result of stricter quality standards in anybody of water. The table below shows the status of watercourses relevant for assessment of the Mokrice HPP development.

Table 40: Evaluation of chemical status with regard to revised standards

Name of water body	**Chemical status**	**Level of confidence**
HMWB Sava Vrhovo–Boštanj	GOOD	medium
WB Sava Boštanj–Krško	GOOD	high
WB Sava Krško–Vrbina	**GOOD**	**high**
WB Sava–border section	**GOOD**	**high**

Source: ARSO, Chemical status assessment of watercourses for the period 2009–2013, 2017.

<u>Ecological status</u>

According to the definition from the EU Water Directive, ecological status is an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters. Evaluation of ecological status of surface water bodies uses the criteria from the Decree on surface water status (Official Gazette of the RS 14/09, 98/10) and the Rules on monitoring surface water status (Official Gazette of the RS 10/09, 81/11) and the background documentation relating to the amendment of the Decree on surface water status (Urbanic et al., 2013 and later revisions), which includes the results of the second phase of intercalibration (published in Commission Decision of 20 September 2013 establishing, pursuant to Directive 2000/60/EC of the European Parliament and of the Council, the values of the Member State monitoring system classifications as a result of the intercalibration exercise and repealing Decision 2008/915/EC (Official Journal of the European Union L 266/ 2013)). Ecological status is classified in five quality classes: very good, good, moderate, poor and very poor.

Assessment of ecological status takes place on the basis of:

- biological quality elements (benthic invertebrates, phytobenthos and macrophytes, fish),

- chemical and physicochemical elements that support biological quality elements (general physicochemical elements, special contaminants),
- hydromorphological elements that support biological quality elements.

Combination of the individual quality elements takes place according to the principle of “lowest result applies”, which means that the final assessment of ecological status is the worst of the assessments determined by the various quality elements. Surface water ecological status assessment represents the change in the values of biological, physicochemical and hydromorphological elements with regard to the reference status, i.e. a state that is entirely or almost entirely free of human impact.

Below we present the results of national monitoring of evaluation of ecological status of the relevant sections by years. (Source: ARSO, Results of monitoring of the ecological status of watercourses in the period 2009–2015, 2017)

Ecological status assessment is determined on the basis of:

- biological elements (benthic invertebrates, phytobenthos and macrophytes) excluding fish, since the evaluation methodology developed for these is not yet in official use,
- general physicochemical elements (nitrate, total phosphorus, BOD5),
- special contaminants.

The ecological status of rivers on the basis of phytobenthos and macrophytes is evaluated with regard to the Saprobic Index (SI), the Trophic Index (TI) and the River Macrophyte Index (RMI). Status on the basis of benthic invertebrates is evaluated with regard to the Slovenian version of the Saprobic Index (SIG3) and the Slovenian multimetric index for hydromorphological alteration/general degradation (SMEIH). Status on the basis of fish is evaluated with regard to the Slovenian fish-based assessment index for rivers (SIFAIR). The SMEIH and SIFAIR indexes have not yet been developed for all ecological types of rivers!

The SI and SIG3 indexes are used above all to evaluate the impact of pollution of water with organic substances, the TI and RMI indexes to evaluate the impact of eutrophication of water and changes to land use in the catchment area of the watercourse, and the SMEIH and SIFAIR indexes to evaluate the impact of changed hydromorphological characteristics of watercourses, dams and changes to land use.

The assessment does not include hydromorphological elements, since these are only used as confirmation in the event that a very good ecological status is determined by the other elements.

The table below shows the values of ecological status parameters for the closest measurement sites on the Sava: Brestanica and Podgračeno (source: ARSO website).

Table 41: Ecological status of the section under consideration (Source: ARSO)

Year	WB Sava Boštanj–Krško	Biological elements of quality					Chemical and physicochemical elements			
		Phytobenthos and macrophytes		Benthic invertebrates		Fish	General physicochemical elements			Special contaminants
		Saprobic status	Trophic status	Saprobic status	Hydrological changes	Gen. degr.	BPK 5	Nitrate	Total phosphorus	
2009	Brestanica						1.2	5.86	0.06	good
2010	Brestanica									very good
2011	Brestanica	0.55	0.49	0.59	0.69		4.1	6.21	0.07	very good
2012	Brestanica									good
2013	Brestanica									
2014	Brestanica									
2015	Brestanica	X	X	X	X					

Year	WB Sava Krško–Vrbina	Biological elements of quality					Chemical and physicochemical elements			
		Phytobenthos and macrophytes		Benthic invertebrates		Fish	General physicochemical elements			Special contaminants
		Saprobic status	Trophic status	Saprobic status	Hydrological changes	Gen. degr.	BPK 5	Nitrate	Total phosphorus	
2009	Podgračeno						1.3	5.54	0.04	very good
2010	Podgračeno	0.88	0.65	0.73	0.78		1.2	5.11	0.07	very good
2011	Podgračeno									very good
2012	Podgračeno									very good
2013	Podgračeno									
2014	Podgračeno						1	5.73	0.08	very good
2015	Podgračeno	1	**0.84**				1.8	6.17	0.07	very good

Key:
() - monitoring not carried out
\+ - monitoring carried out, evaluation methodology under development
x - monitoring carried out, too few organisms/indicator taxa present for evaluation

The table below shows the assessment of ecological status by individual water bodies for the period 2009–2015 (source: ARSO, 2017)

Table 42: Joint evaluation of ecological status of individual water bodies for the period 2009–2015 (Source: ARSO)

Water body	Biological elements of quality					Chemical and physicochemical elements				**Hydromorphological elements**	Ecological state, ecological potential	LEVEL OF CONFIDENCE
	Phytobenthos and macrophytes		Benthic invertebrates		Fish	General physicochemical elements			Special contaminants			
	Saprobic status	Trophic status	Saprobic status	Hydrological changes	Gen. degr.	**BPK5**	Nitrate	Total phosphorus				
Sava Boštanj–Krško	***MODERATE***	***MODERATE***	***MODERATE***	***GOOD***	***no methodology***	***GOOD***	***VERY GOOD***	***GOOD***	***GOOD***	***not required***	***moderate***	***high***
Sava Krško–Vrbina	***VERY GOOD***	***GOOD***	***GOOD***	***GOOD***	***no methodology***	***VERY GOOD***	***VERY GOOD***	***VERY GOOD***	***GOOD***	***not required***	***good***	***high***
Sava border section	***GOOD***	***GOOD***	***GOOD***	***GOOD***	no methodology	***VERY GOOD***	***GOOD***	***VERY GOOD***	***GOOD***	***not*** required	***good***	high

In the light of the results of national monitoring, the ecological status of the whole of the lower Sava (from Boštanj to the border with Croatia) is generally moderate to good. Problems include both organic pollution, where values are, however, very close to the limit values for good status (0.6) and trophicity. Hydromorphological pressure is also a problem at Vrhovo.

4.4.3.3 Surface water pollution in the area

In the area of the municipality of Krško there is a completed sewage network to which 13,000 people are connected (47% of the population of the municipality). This network is connected to the Vipap treatment plant. The settlements of Drnovo, Brege, Mrtvice, Vihre, Žadovinek and part of the town of Krško itself are equipped with a public sewage system. The treatment plant for Krško and the surrounding area operates in conjunction with the treatment plant for treating industrial wastewater in the context of the Vipap factory. The treatment process for industrial wastewater takes place separately. The principal characteristics of the plant are: total capacity 180,000 PE or 160,000 PE for the aerobic biological part of the treatment plant alone (of which the biological load of urban wastewater from the town of Krško and the surrounding area is 16,000 PE, or approximately 10% of the capacity of the aerobic part of the treatment plant).

Table 43: Treatment plants discharging into the Sava in the wider region in 2011 (source: ARSO)

Name of urban wastewater treatment plant	Treatment plant operator	Size (PE)	Gauss-Krüger Y coordinate	Gauss-Krüger X coordinate	Annual quantity of treated sewage (1000 m^3/year)	Level of treatment	Treatment effect – COD (%)	Treatment effect – phosphorus (%)	Treatment effect – nitrogen (%)
VIPAP	VIPAP VIDEM KRŠKO D.D.	180000	538415	89586	3990.4	Tertiary	94.6	93.63	88.77

Table 44: Industrial plants discharging into the Sava in the wider region (source: ARSO)

Industrial plant operator	Name of plant	Type of discharge	Watercourse	Name of treatment plant	Parameter	Annual quantity discharged (kg/year)
GORENJE SUROVINA, D.O.O.	GORENJE SUROVINA PE KRŠKO	Discharge into a collection system not leading to a treatment plant			AOX Copper BOD5 TOC Zinc COD Nickel Lead Iron Mercury	0.009197 0.084649 102.144 2.3986 0.969968 203.431 0.005464 0.216551 21.09116 0.000357
IGM SAVA D.O.O.	IGM SAVA D.O.O.	Discharge directly into the environment	into a watercourse		TOC	0.3044
KRŠKO NUCLEAR POWER PLANT	KRŠKO NUCLEAR POWER PLANT	Discharge directly into the environment	river SAVA		BOD5 COD	1067341 417

Industrial plant operator	Name of plant	Type of discharge	Watercourse	Name of treatment plant	Parameter	Annual quantity discharged (kg/year)
OMV SLOVENIJA D.O.O.	OMV BS & AP KRŠKO	Discharge into a collection system not leading to a treatment plant			AOX BOD5 TP TOC COD Sulphate Surfactant	0.083444 97.956 1.4512 3.9908 330.148 36.28 1.814
RESISTEC UPR D.O.O. & CO. K.D.	RESISTEC UPR D.O.O. & CO. K.D.	Discharge into a collection system not leading to a treatment plant			Aluminium TP chromium	0.05549 26.0624 0.0179
ŠUMI BONBONI D.O.O.	ŽITO ŠUMI D.O.O., KRŠKO	Discharge into a collection system leading to a treatment plant		VIPAP	Ammonium BOD5 TN TP TOC COD Sulphate Heavy volatile lipophilic substances	19.65 31047 224.272 12.1568 21934.64 65913.96 204.36 1577.764
VIPAP VIDEM KRŠKO D.D.	VIPAP VIDEM KRŠKO D.D.	Discharge directly into the environment	Sava		AOX BOD5 TP TN TOC Zinc COD	384.8437 28425.39 10357.69 464.9735 97.90385 649.4436 427134.3

Existing pressures on surface water in the core area of the development

Krško Nuclear Power Plant (NPP), which causes direct pressures on the river Sava, is located within the core area of the planned development.
Krško NPP lies on the left bank of the Sava, south-east of the town of Krško. It has been operating commercially for more than 35 years. The power plant generates 5 billion kWh of electricity annually, which represents around 40% of total electricity generated in Slovenia. In terms of standard criteria of nuclear safety and stability of operation, the plant is ranked in the top 25% of operating nuclear power plants around the world.
The environmental permit (No. 35441-103/2006-24) and water permit (No. 35536-31/2006-16) for Krško NPP prescribe constant measurement of temperatures, flow rates and oxygen concentration in the water of the Sava. Measurements are carried out with the help of an automatic measuring system. Krško NPP implements all prescribed measurements of temperatures, flow rates and oxygen concentration in the water of the Sava, along with monthly measurements of biological and chemical oxygen demand.

– **Hydrological impact**

Krško NPP has no impact on the flow rate of the river Sava, since all water offtake is returned to the river after some 10 metres. Under the current water permit, Krško NPP is permitted to take 850,000,000 m^3 from the Sava each year, where the restriction of a total volumetric flow rate of 27.6 m^3/s applies. The 2002 water permit did not prescribe the total offtake quantity of water from the Sava, while the volumetric flow rate of offtake was limited to 26 m^3/s (in the case of a flow rate in the Sava of over 100 m^3/s) plus 1.6 m^3/s for safety water supply, which the client is always permitted to take.

- **Impact on biodiversity**

In 1997 a detailed analysis of the Sava was carried out after 15 years of operation of Krško NPP and monitoring of abiotic and biotic changes in the river Sava, which gave an assessment of the impact of Krško NPP on the Sava – biological status and thermal impact. It was found that thermal impacts on biological communities are not observable, while trophic relations between individual organisms in the ecosystem have remained as they were before the discharge of cooling waters, therefore there has been no degradation of the river ecosystem in the Krško–Brežice section as a result of thermal loading of the river with cooling waters from Krško NPP.

- **Thermal loading**

Krško NPP uses large quantities of water from the Sava for cooling purposes, so thermal loading is the biggest negative impact on the river Sava. With regard to the baseline situation in the current environmental permit (the 2002 water permit), no temperature changes have occurred ($T_{i,h,s}$ = 34 °C and dT=3K remain the same). Changes of the values of these parameters did occur in the actual process of obtaining the environmental permit, but in the main this was the result of a different interpretation of data between ARSO and Krško NPP. Of key importance is the fact that the final state and the initial state do not differ.
It is, however, necessary to highlight a change in the limit emission share (LES), which increased from 0.95 (in 2002) to a value of 1 (from 2010 onwards). It should be emphasised that this is a legal change deriving from the “Decree on the emission of substances and heat in the discharge of wastewater into waters and the public sewage system” and not a consequence of the application to issue an environmental permit to Krško NPP. This change to the LES represents the share of heat that Krško NPP can emit into the Sava, whereby the temperature of the Sava does not increase by more than 3 K.

Chemical composition of surface waters in the area of development – ARAO study

The hydrological conditions of the Struga stream (see figure below) are dependent on the quantity of precipitation. It is therefore considered that conditions in the stream at times of increased temperatures could be significantly worse than conditions at the time that sampling was carried out. The changeable conditions were the consequence of precipitation, which is also reflected in periodic increases in organic matter content. The same finding applies to ammonium and phosphorous compounds. Similar load dynamics occur with chloride and sulphate, and with heavy metals, although these loads are insignificant in terms of their absolute value.

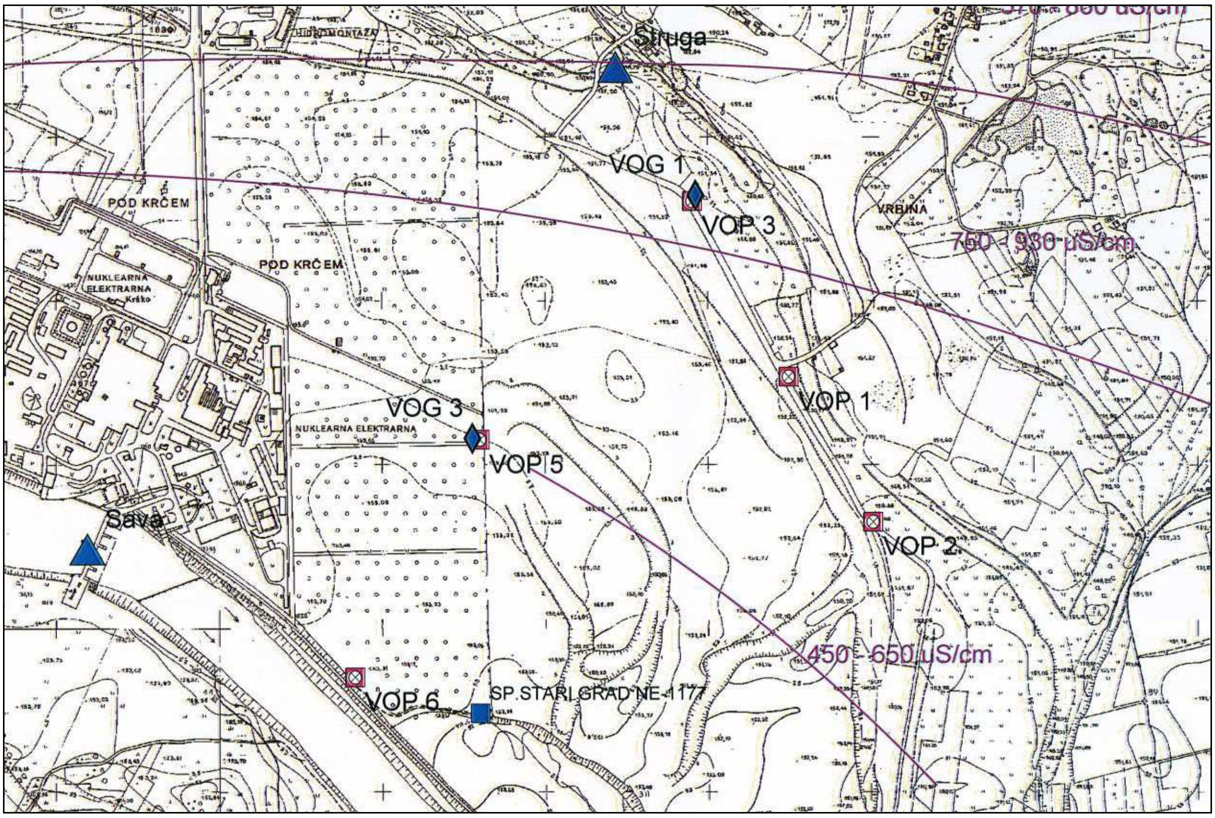


Figure 73: Sampling locations on the Sava and the Struga stream are marked with blue triangles.

The presence of organic halogen compounds, expressed as adsorbable organic halogens, was not detected in the Struga stream; by contrast, a very high organic halogen compound content was detected in the Sava, for which reason quality standards for the river Sava are not met. The presence of mineral oils, pesticides, compounds from the polycyclic aromatic hydrocarbon (PAH) group was not detected in either the Struga or the Sava. Volatile halogenated and aromatic hydrocarbons were not present either.

Surface water samples from the Struga and Sava belong to the Ca-Mg-HCO3 hydrochemical facies under Jäckli's classification and are similar to the carbonate water type under D'Amore's parameters.[110]

4.4.4 *SOIL QUALITY AND CHARACTERISTICS, SOIL POLLUTION IN THE AREA AND AGRICULTURAL LAND*

4.4.4.1 **Ground relief in the area of the development**

The relief in the Vrbina location is level, with a few local small depressions, the remains of the former course of the Sava. This area of Krško Polje consists of a gravel deposit of the Sava of an estimated thickness of 10 metres and, below it, silt and silty clay of Pliocene age.

[110] Report on supplementary initial field and laboratory geosphere and hydrosphere research for the potential Vrbina-Krško site (Poročilo o izvedbi programa dopolnilnih začetnih terenskih in laboratorijskih raziskav geosfere in hidrosfere za potencialno lokacijo Vrbina-Krško), Rev 1. J.V. GeoZS, ZAG, Geoinženiring, IRGO, ZZVMB, 2009

In terms of its geological characteristics, taking into account available data, the location was assessed as less complex. The essential characteristic of the relief of the core area is the transition from flat lowland to low hills and river terraces, which are a consequence of the action of the river Sava.
The LILW repository site lies on the left bank of the Sava, on the edge of the alluvial plain of Krško Polje, which lies at a height of between 100 and 200 metres above sea level. The site itself lies at a height of between 151.69 and 153.44 metres above sea level (existing situation).

4.4.4.2 **Soil type and use in the area of the development**

Soil is a sensitive system of the environment and represents the basis for food production. It also acts as a buffer system between sources of pollution (emissions from traffic, potential minor spills of harmful substances) and aquifer systems (groundwater and surface waters).
Fertile eutric brown soil has developed on the ice-age predominantly limestone gravel deposits of the Sava, which is a favourable basis for agriculture (maize, potatoes). Soil directly along the Sava is alluvial soil – fluvisol. Alluvial poorly developed soil is found along the Sava as far as Brestanica and on both sides of the Sava east of Žadovinek and the village of Vrbina. Alluvial brown soils are found SE of the town of Krško as far as the village of Vrbina and around Spodnji Stari Grad
Analysis of available graphical data has shown that soils in the wider area along the river Sava consist for the most part of an alluvial soil system. One of the main ecological characteristics of the soils is that they represent a high-quality agricultural area in which categories of greater value for crop production appear. On the other hand, the pedosequence on gravel and sand represents an interesting and important construction area, since gravel and sand, as a raw materials resource, enable rapid construction in this ecologically vulnerable part of the physical environment.
Naturally conserved soils only represent a small part within the plan implementation site. Anthropogenically modified soils – i.e. agricultural land – predominate. The surfaces in the area under consideration are defined in municipal planning documents as prime agricultural land. It is clear from information on actual land use, that a very large proportion of this land in the wider area is actually represented by fields.
Another important characteristic of the region are flood plains in the Krško Polje/Brežiško Polje area, where the Sava, the Krka, the Sotla and their tributaries flood. Periodic flooding in the area in which agricultural production takes place further increase the erosion effect. In the area of permanent occupation of the soil as a result of construction of the repository, the soil number is mainly greater than 55 (see the section on Agriculture).

Designated land use in the area of the planned development
There are fields within the site itself (cereal monoculture) and a commercial orchard in the immediate vicinity of the site. In terms of designated land use, the majority of the complex is classified as an area of other infrastructure (T,E,O), with only part of it classified as green areas (source: PISO, 2015).

Actual land use in the area of the planned development

Within the area of the plan, actual land use consists exclusively of fields and gardens (code 1100). The western part of the area of the plan borders on intensive orchards (code 1221) (Source: Actual use of agricultural land (Piso, 2015)
.

4.4.4.3 Soil pollution in the area

Soil in the wider area of the development is under pressure from agriculture, industrial and manufacturing sources and urban and traffic sources. Both indirect and direct sources of pollution are present, as are diffuse, point and line sources of pollution.

In terms of soil pollution from agriculture (so-called biotechnical pollution), the use of plant protection products and mineral fertilisers particularly stand out. Soil pollution can also be the consequence of improper use of slurry, the use of contaminated composts and other soil additives, irrigation (watering) with contaminated water, and similar. Nevertheless, not every fertilisation or every use of herbicides means pollution of the soil. Intensive agriculture using mineral fertilisers and plant protection products and slurry application represent a source of soil pollution and, consequently, pollution of surface waters and groundwater.
The predominant component of environmental pollution from industry, urban areas and traffic (so-called non-biotechnical pollution) is, typically, diffuse soil pollution which is indirect and airborne. Industrial emissions (discharges into the air), gases and dust particles from power plants and landfills are present, as are flue gases from individual combustion plants and emissions from traffic. A consequence of airborne pollution is polluted soil and vegetation, not only locally but also over a greater distance from the pollution source. In places soil pollution can also be the result of contaminated floodwaters.

Since there is agricultural land in the area of the planned development, we consider that agricultural soil pollution predominates. This pollution can be further divided in accordance with several criteria, as follows:

- division with regard to the cause of pollution (natural/biogenic or as a consequence of human activity/anthropogenic);
- division by origin of pollution (point source, concentrated, diffuse, non-point source);
- primary:
  - precipitation washes away nutrients, artificial and natural fertilisers and plant protection products from agricultural land,
  - slurry drains from unregulated manure storage or cesspools into the soil and on into surface water;
- secondary:
  - discharges of oils or fuel when washing or filling agricultural machinery,
  - washing vehicles used to transport fertilisers and plant protection products.

Systematic studies of soil pollution have been carried out in Slovenia from 1999 onwards. Scattered sampling has taken place across the entire territory of the Republic of Slovenia since 2004, along with priority sampling in the locations envisaged in the Resolution on the National Environmental Action Plan (ReNVPO). The annual sampling programme is also adapted to financial frameworks and current environmental problems. There are also some locations that were sampled before 1999 but correspond to criteria from the National Environmental Action Plan (NVPO) and the ReNVPO.

Studies of soil pollution in Slovenia have also been carried out in the immediate vicinity of the development under consideration (see the figure below). Sampling data for the most representative sampling location with regard to the development under consideration is provided below.

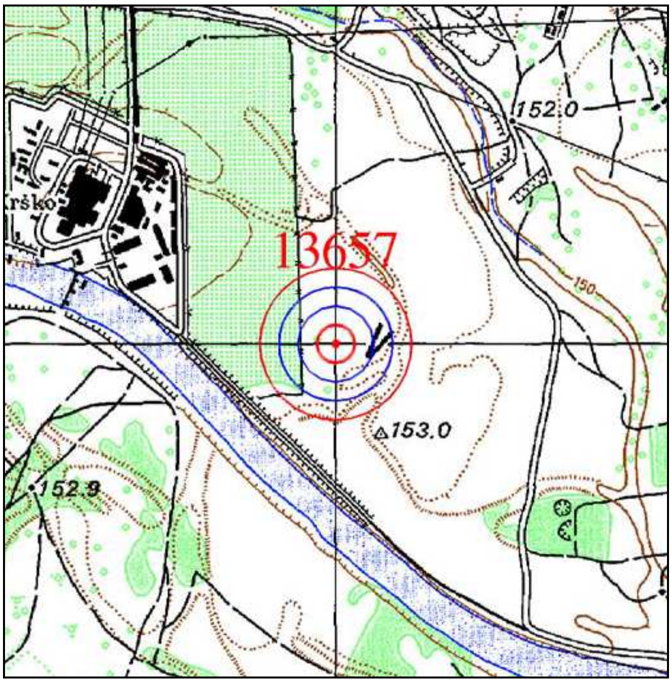


Figure 74: Soil sampling location (sampling point 13657)

Table 45: Results of analyses at the selected sampling location for studies of soil pollution in the vicinity of the development (Environment Atlas, ARSO, Ljubljana)

Sampling location	Description of sampling location	Comments on results of analyses
13657 Spodnji Stari Grad 153 m above sea level municipality of Krško sampling October 1991	The site is located on a plain, on a river terrace of the Sava. Field crop production predominates, with maize incorporated into the ground. The parent material consists of alluvial deposits of the Sava. The soil type is alluvial soils (eutric). The texture is silt-loam.	All inorganic hazardous substances were below the limit value or even below the limit of detection. Regarding organic hazardous substances, atrazine and simazine were above the limit value but still below the alert value. The values of desethyl-atrazine and alachlor were also elevated. The values of other organic hazardous substances were below the limit of detection (LOD).

According to the study "Examinations of soil to determine triazine pesticides, selected organochlorine pesticides and dichlobenil content" (Maribor Institute of Public Health, October 2003), pesticide formulations containing metolachlor and, in individual cases (two parcels), also terbuthylazine were the primarily used pesticides in the examined areas.

Soil pollution examinations and pedological studies were carried out in the area of the planned site of the Vrbina LILW repository in the municipality of Krško in 2006 as a basis for evaluation of the production potential of agricultural land, in accordance with Ministry of Agriculture, Forestry and Food (MKGP) guidelines, in the process of preparing a comprehensive environmental impact assessment.

The results of soil quality analysis from “Pedological analysis and soil pollution analysis in the potential location Vrbina” (Maribor Institute of Public health, Environmental Protection Institute, December 2006) are presented below.

The following Slovenian regulations were used to assess the results of the pedological analysis and levels of contaminants:

- Decree on the limit input concentration values of hazardous substances and fertilisers in soil (Official Gazette of the RS 84/2005);
- Decree on limit values, alert thresholds and critical levels of hazardous substances in soil (Official Gazette of the RS 68/1996 and 41/2004) This decree defines limit values, alert thresholds and critical levels.

For those parameters for which immission values are not defined by Slovenian regulations, the following sources were used:

- for organic halogenated compounds, selenium, thallium, vanadium and EOX,[111] a value of 1 mg/kg (up to 1996) or 0.3 mg/kg (from 2000 onwards) is used as the target value. For selenium, thallium and vanadium, target values, i.e. estimated values for the “unpolluted” state, and indicative values, estimated for “serious” pollution, are defined;
- for manganese, values for sedimentary carbonate geological substrates.[112]

The figure below shows the locations from which samples were taken for soil pollution analysis.

[111]Holland List, VROM, Circular on target values and intervention values for soil remediation, Netherlands Government Gazette, 24 February 2000, No. 39)
[112]Bowen, H.J.M., Trace elements in biochemistry, Academic Press, London (1966)

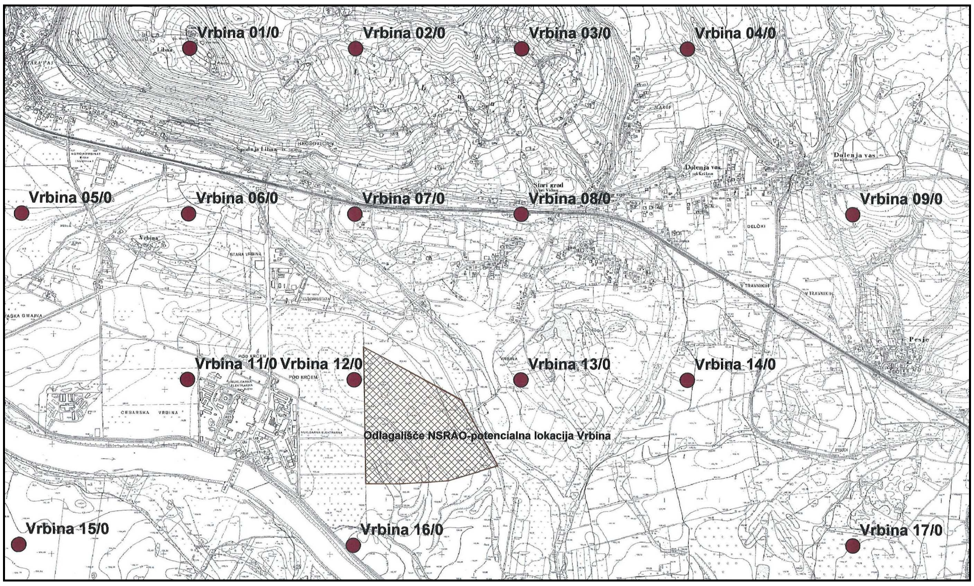


Figure 75: Overview of sampling locations for soil pollution examinations and the wider area

Odlagališče NSRAO – potencialna lokacija Vrbina	*LILW repository – Vrbina potential location*

The results of soil examinations for contaminants content were assessed:

- With respect to the limit values laid down by the Decree on limit values, alert thresholds and critical levels of hazardous substances in soil, and with regard to the reference values defined by the values from the corresponding expert sources;
- With regard to the geographical location of the sampling site.

Assessment with regard to limit or reference values

The results of the examinations in the table below show that immission limit values (mg/kg) for the chemical elements from the examinations programme are not exceeded. The only two exceptions are the measured lead and mercury content at the location Vrbina 16/06, Žadovinek area, but when measurement uncertainty is taken into account this exceedance is considered insignificant. Mercury content at the locations Vrbina 1/06, Vrbina 11/06 and Vrbina 12/06 is also assessed as “increased”, but the immission limit value is not exceeded. At the location Vrbina 16/06, Žadovinek area, the immission alert values (for lead and mercury) are not exceeded.

Measured values for manganese are within the framework of expected natural values for sedimentary carbonate geological substrates. The measured thallium and vanadium content does not exceed the target values defined by the Holland List. The exception is vanadium content in the locations Vrbina 2/06 and Vrbina 3/06, but taking measurement uncertainty into account the exceedance is considered insignificant. In this case, the indicative values are not exceeded.

The measured selenium content is in all cases below the lower limit of quantification for the testing method used, while the target value defined by the Holland List was not exceeded. The presence of organochlorine compounds from the DDT, “drins”, HCH and PCB group was not detected in the examined soils. The presence of other organochlorine compounds for which limit values are not defined by Slovenian regulations was not detected either. For all organochlorine compounds the measured content is at the limit of detection for the testing methods used.

Mineral oil content exceeding the immission limit value was not detected in the examined soils.

The measured phenolic substance content at the sampling sites Vrbina 3/06, Vrbina 6/06, Vrbina 7/06 and Vrbina 13/06 exceeds the immission limit value. Bearing in mind that phenolic substances at concentration levels around the limit of quantification of 0.1 mg/kg can also be of natural origin, and taking measurement uncertainty into account, the exceedance is considered insignificant. In all the cases mentioned, the immission alert value was not exceeded.

The measured total polycyclic aromatic hydrocarbons (PAH) content did not exceed the immission limit value.

Table 46: Chemical elements in soil – statistically processed results (concentrations of heavy metals and PAH are given in mg/kg)

Sample reference	Cadmium	Copper	Nickel	Lead	Zinc	Chromium	Mercury	Cobalt	Molybdenum	Arsenic	Manganese	Selenium	Thallium	Vanadium	PAO total
N	17	17	17	17	17	17	17	17	17	17	17	17	17	17	10
XMEAN	0.38	20	28	37	86	3D	0.22	9.6	0.71	9.1	626.5	<2	0.19	31	0.053
X90PERCENT	0.52	23	31	63	118	45	0.54	13.0	0.84	11.0	738		0.30	48	0.11
XMAX	0.53	48	34	95	160	49	0.95	17.0	1.20	12.0	1,100		0.32	51	0.34
XMIN	0.16	15	20	21	60	16	0.05	6.5	0.50	5.4	330		0.10	19	
SDEV	0.10	8	4	20	28	10	0.26	2.6	0.16	1.6	161.2		0.07	10	0.11
RSDEV	28	38	14	54	32	35	115	27	23	18	26		38	33	197
N>ILV	0	0	0	1	0	0	1	0	0	0					0

The table above shows statistically processed results for heavy metals and PAH. The following statistical parameters are used to process the data:

- **N:** number of data or results included in the calculations;
- **XMEAN:** mathematically calculated mean value of the results of N samples;
- **MAX:** highest measured value of the results of N samples;
- **MIN:** lowest measured value of the results of N samples;
- **SDEV:** standard deviation calculated for the results of N samples, used as a measure of the dispersion of results around the mean value;
- **RSDEV:** relative standard deviation calculated for the results of N samples, used as a measure of the dispersion of results around the mean value. For those parameters present in soil in a concentration range within a few % and at the mg/kg level, values around ± 25% are assessed as relatively even loading of the area under consideration, in other words without clearly marked spatial trends. For parameters such as mercury and PAH that appear in lower concentrations, higher RSDEV values are expected;
- **ILV:** immission limit value;
- **X90PERCENTILE:** a value shared by 90% of the examined samples, used as an additional criterion to assess the representativeness of XMEAN

Assessment with regard to the geographical location of the sampling site

It is logical to assess measured values of heavy metals and other contaminants from the point of view of the geographical location of the sampling site insofar as measurement uncertainty expressed by relative standard deviation exceeds ± 25 %. This is the estimated smallest measurement uncertainty as a consequence of the non-homogeneity of the investigated soils, if a suitable number of sub-samples and their distribution across the examined area is simultaneously guaranteed.[113]

Under this criterion it is necessary to highlight mercury. 90 percentile value, X90PERCENTILE=[Hg]90Percentile=0.54 mg/kg Hg more than double the mean value, XMEAN=[Hg]Mean=0.22 mg/kg Hg. Elevated values occur at the sampling sites Vrbina 1/06, Vrbina 11/06, Vrbina 12/06 and Vrbina 16/06. The last three locations are situated south and south-east of Krško NPP (where no causal link is demonstrated between the location of the sampling sites and Krško NPP).

Of the other examined parameters, it is also necessary to highlight total PAH at the location Vrbina 8/06 under this criterion. All compounds from the polycyclic aromatic hydrocarbons (PAH) group, with the exception of acenaphthene and naphthalene, are present at this sampling site. It is not possible to identify the reason for elevated PAH content on the basis of a field inspection and the results of soil examination for PAH content at this sampling site.

Silt properties

Soil samples taken from boreholes are silts, which, particularly in the upper part, transition into sandier or clayier variants. Carbonate materials (dolomite, calcite), quartz, feldspar and muscovite are most prevalent. There is little clay minerals (4–12 wt%). A little calcium montmorillonite was identified in all the samples. The content of major and trace (accessory) elements in the core of boreholes comply with the expectations in the area under consideration. The comparison of the average content of major elements in samples of borehole cores with the content in average shale and with the average values in Slovene and European grounds/soil have shown that the samples in question contain significantly (by several orders of magnitude) less sodium, potassium, and a little less aluminium, iron and manganese, while at the same time containing a lot more calcium and magnesium. This is the result of a primarily carbonate basin (catchment) of the Sava River, meaning that the described content was expected. A comparison of trace elements in core samples with the structure of average shale and with average values in Slovenian and European soils clearly shows that cadmium, copper, chromium and molybdenum content is lower or equal to the estimated average. Nickel and zinc content is higher than the average in European grounds. The level of arsenic is slightly higher than the average in Slovene and European grounds. In order to produce subsequent safety assessments we also determined essential parameters for soil samples that control certain processes for the migration of radionuclides through the geosphere: specific surface area of grains, the cation-exchange capacity, activity, organic matter content and the dissociation constant Kd.

[113]Decree on the designation of status of areas of aquifers and their drainage basins endangered by the use of plant protection products and on integrated rehabilitation measures (Official Gazette of the RS 97/2002)

The specific surface area of silt is small (mostly 15–35 m^2/g) and comparable with kaolinite or illite. The potential cation-exchange capacity of the examined samples is low and practically does not vary regardless of the borehole depth. This also apples to the effective cation-exchange capacity, which is higher than the potential capacity by a factor of 2, with slightly higher fluctuations in terms of depth. In terms of activity it could be categorised as kaolinite. Calcium, followed by magnesium, appears as a dominant exchange cation. The concentration of the exchangeable calcium is the highest in the upper layer, beginning to re-increase at a depth of 119 m, where the concentration of the exchangeable magnesium also increases.

The content of organic matter (substances) in samples was low.

The lowest activity (sorption) can be expected south of the repository site and the highest activity north of the site. For elements related to Pb (lead) we can adopt a value of 1800 L/kg, for elements related to Sb the Kd value of 45 L/kg, and For elements related to Zn a Kd estimate of 200 L/kg.

On the basis of the research conducted into leaching it was estimated that solubility at the site was low and that the pore water was in balance with the soil, and that the process of the dissolution of carbonate minerals is only taking place to a lower extent.

The results of radiological measurements of soil from varying depths show the expected radiological picture from the Krško-Brežice area. K-40 concentration increases with depth, with the highest value being at a depth on 100 m, (650 ± 60) Bq/kg. The concentration of radionuclides from the uranium (U-238) and thorium Th-232 (Ra-228) decay chains does not vary with depth, which confirms the general finding that natural radionuclides are evenly distributed in soil. Their concentrations do not differ from the concentrations measured at the surface in the Krško-Brežice area. The concentration of Cs-137 was below the quantification limit in all samples. The concentration of Sr-90/Sr-89 reduces with depth, the highest being at a depth of 0.1 m (2.6 ± 0.2 Bq/kg), which is comparable to the average specific activity of the radionuclide Sr-90/Sr-89 at a soil depth of up to 15 cm.

4.4.4.4 **Agricultural areas and pedological composition of soil**

The Krško–Brežice plain is characterised by intensive agricultural use – large areas of fields and extensive meadows. Following regulation in the early years of the last century, the flow of the Sava slowed and the land along the river was dried and converted into arable land. Intensive farming also heightens the loss of natural characteristics of an area and increases the proportion of regulated watercourses. Only areas with higher amounts of soil moisture are used less intensively.
Figures from the Ministry of Agriculture and the Environment (2014) show that there are 28,652.83 hectares of agricultural land in the municipality of Krško, of which forest predominates in terms of actual use (44.7%), followed by permanent meadows (22.8%), fields and gardens (14.5%), vineyards (2.9%), overgrown arable land (1.8%), extensive orchards (1.7%), intensive orchards (1.3%), trees and bushes (1.2%) and uncultivated arable land (0.8%).

Analysis of available graphical data (MKGP) has shown that alluvial soil systems are present in the impact area of permanent occupation of the repository site. One of the main ecological characteristics of the soils is that they represent a high-quality agricultural area in which categories of greater value for crop production appear. On the other hand, the pedosequence on gravel and sand represents an interesting and important construction area, since gravel and sand, as a raw materials resource, enable rapid construction.

Alluvial soils are generally highly fertile. They are typical of the middle and lower sections of watercourses. Finer particles predominate in alluvial deposits. Humus content is also present at depth. Gravel and sand deposits can appear in the lower part of a soil profile. If the lower part of a profile is of a heavier texture, slight signs of gleyification can be observed. Soils are usually fresh and well supplied with plant nutrients.

Agricultural areas along the lower Sava in the Krško and Brežice area extend most over the Krško Polje/Brežiško Polje area, which represents the most fertile soil for the production of all types of field crops, fruit and vegetables. Despite the fact that this area is a flood area of the lower Sava, the arable land is in the direct vicinity of the river channel.

The soil of the area in question is developed on a sand and gravel deposit of the river Sava. Although the surface of the area in question is relatively small, considerable diversity and alternation of soil types may be observed. In areas that have developed on river deposits, such a picture is usual. Depths of individual soil types are conditioned by the thickness of the sand deposit (sometimes slightly silty) on the gravel base. If this layer does not exceed 50 cm, the soil is classed as a shallow soil, a depth of between 50 and 70 cm defines a medium-deep depth, while a deposit thickness greater than 70 cm is characteristic of deep forms of alluvial brown soils (calcareous).

Among the regionally specific limiting factors for agriculture are the flood areas along the Sava with its tributaries (see the section on surface waters). At the same time it should be pointed out that natural conditions for agriculture in the area are good.

Soil pollution examinations and pedological studies were carried out in the area of the planned site of the Vrbina LILW repository in the municipality of Krško in 2006 as a basis for evaluation of the production potential of agricultural land, in accordance with Ministry of Agriculture, Forestry and Food (MKGP) guidelines, in the process of preparing a comprehensive environmental impact assessment.

Pedological analysis results from "Pedological analysis and soil pollution analysis in the potential location Vrbina" (Maribor Institute of Public health, Environmental Protection Institute, December 2006) are presented below.

Of all soil units, shallow soil is best represented at the superficial layer in the wider area under consideration. It is found to the greatest extent in the eastern part of the area and occupies approximately 44.4% of the total field complex. This unit is followed by medium-deep soil, which covers 32.7% of the area under consideration. Deep soil units (8.7%) and gleyic forms (1.4%) are scarcest.

Intermediate transitions between the three basic units have also been recorded, and 8.2% of the area in question consists of an intermediate stage between shallow and medium-deep units. Intermediate units between medium-deep and deep alluvial brown soils account for 4.5%.

Figure 76: Pedological map of the wider area

Pedološka karta širšega območja posega NSRAO	Pedological map of the wider area of the LILW construction
Obrečna rjava tla, karbonatna, plitva	Alluvial brown soil, carbonate, shallow
Obrečna rjava tla, karbonatna, plitva in srednje globoka	Alluvial brown soil, carbonate, shallow and medium deep
Obrečna rjava tla, karbonatna, srednje globoka	Alluvial brown soil, carbonate, medium deep
Obrečna rjava tla, karbonatna, srednje globoka do globoka	Alluvial brown soil, carbonate, medium deep to deep
Obrečna rjava tla, karbonatna, globoka	Alluvial brown soil, carbonate, deep
Obrečna rjava tla, karbonatna, oglejena	Alluvial brown soil, carbonate, gleyic
Meja posega	Activity (development) boundary
Merilo 1: 5000	Scale 1: 5,000

It is evident from analysis of the horizons of excavated profiles[114] (see figure below), that the calcium content of the soil is high, which is reflected in a high V value and in the measured soil reaction, which in all samples is basic and exceeds a pH value of 8. The results of the mechanical composition of the soil show that the silt content in the arable horizon is greater than in the lower-lying horizons (this applies to deep and medium-deep units – profiles 1 and 2), which are of a sandy texture. The texture of the horizons in profile 3 is silty throughout the profile, which confirms the assumption of a link between soil properties and past water flows.

[114]standard pedological analysis was carried out in the horizons of excavated profiles

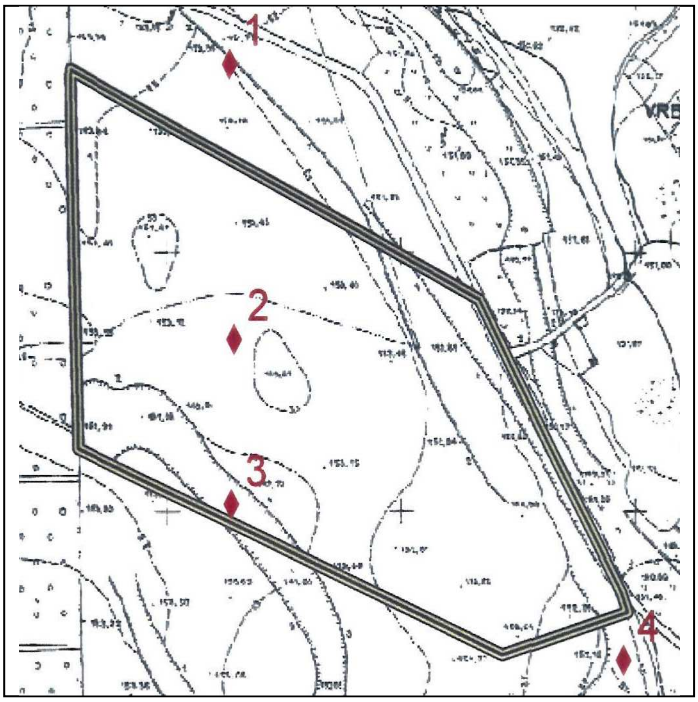


Figure 77: Locations of characteristic profiles

Results for plant-accessible nutrient content (phosphorus and potassium) point to unilateral and intensive fertilisation. There is an abundance of both nutrients in the soil, but potassium content predominates and is grossly disproportionate to phosphorus content.

4.4.4.5 Quality of agricultural land

The planned development involves the construction of a low- and intermediate-level radioactive waste repository on a site measuring just under 18 ha in the direct vicinity of Krško Nuclear Power Plant. The site encroaches on a large field complex measuring slightly over 53 ha.

From the point of view of the productive function of agricultural land, the best way to shed light on the area in question is via a spatial representation of agricultural land with regard to its production potential, i.e. the so-called detailed soil number. Agricultural land with poor production potential has a detailed soil number ranging from 0 to 39, areas with a detailed soil number ranging from 40 to 58 have medium-high production potential, and land with a detailed soil number ranging from 59 to 100 has a high or very high production potential.

The production potential of shallow soil is 49 agricultural land-rating points, rising to 60 points for medium-deep and 81 points for deep soil. Given the surface share of an individual unit, we can conclude that the average production potential of the area in question exceeds 55 agricultural land-rating points. The planned development therefore involves a relatively high-quality agricultural area.

The area in question falls into the area of prime agricultural land, defined as an agri-operations area – A3 (source: Municipal spatial planning information system; 2015). The entire area is given over to fields. In terms of the categorisation of agricultural land, the majority of the complex is classified in the first category of agricultural land, while only the most gravelly and shallow units of alluvial soil are classified in the second category of agricultural land.

4.4.5 *ECOSYSTEMS, FLORA AND FAUNA AND THEIR HABITATS (NATURE)*

In April, May and June 2006 the ecological engineering company Aquarius conducted field surveys of the areas in question and drew up inventories of species and habitat types. Habitat types were mapped on the ground and additional inventories made of plant and animal species. In the process of obtaining data on wild plant and animal species present in the area under consideration, the company also used publicly accessible data.

4.4.5.1 Habitat types

(Taken from the Environmental report for the low- and intermediate-level radioactive waste (LILW) repository).

Habitat types were mapped in a 500 m radius around the site proposed for the construction of the LILW repository. The wider area (a 1000 m radius around the site) was also surveyed. Mapping of habitat types took place in summer 2006. Designations of habitat types (HT) follow the Habitat Types of Slovenia (HTS) typology (ARSO, 2004). HT data were entered on the field maps and later added to 1:5,000-scale ortho-images of the terrain using ArcGis9 software (ESRI, USA).

The area proposed as the site for the LILW repository lies on the left bank of the river Sava and consists of a single habitat type – Field crops (82.11). It is an intensively cultivated maize field (in 2015 a grain field – barley) which is characterised by a small number of plant species (forced monoculture, plant protection products) and animal species (drastic changes to the microclimate, plant protection products).
Agricultural and cultural landscape predominates on the left bank of the Sava, where the proposed site is located. The largest part of the area consists of the habitat type Field crops (82.11). In places, particularly in the eastern part of the mapped area, Small woodlots (84.3), Hedgerows and small groups of trees or shrubs (84.2) and belts of Ruderal communities (87.2) are present between fields, or fields are left fallow (87.1). Shrub and low stem tree orchards (83.22) and Active industrial sites (86.3) occupy a considerable proportion of the mapped areas. The latter of these habitat types includes the area of Krško NPP to the west of the area in question and the Stari Grad landfill to the east. In terms of size of area, other notable habitat types are Villages, village peripheries and village features (86.2) and various sub-types of Middle European *Bromus erectus* dry and semidry grasslands (34.32). This is a priority habitat type, but in the greater part of the area under consideration it appears in a fairly species-poor form. In some parts of the mapped area, meadows (and also fields) are overgrowing with robinia (black locust), wild privet and blackthorn, while in other parts they are already overgrown and represent habitat types Locust tree populations and stands (83.324) or Medio-European and sub-Mediterranean rich-soil deciduous scrub (31.81). Along the river Sava (Rivers and streams – habitat type 24.1), the habitat types Tall-herb communities lining watercourses and tall-herb communities of other humid sites (37.715), where allochthonous species predominate, Poplar plantations (83.321) and Alluvial and very wet forests and brush (44). In Slovenia the maintenance of the last of these habitat types in a favourable state is a priority. Among the more important HTs in the mapped area of the Sava are Xero-mesophile medio-European lowland hay meadows on relatively dry soils and slopes dominated by tall

oatgrass (38.221), which in Slovenia is maintained in a favourable state as a priority. Even these habitats are rather depleted in terms of species in the area in question.

Table 47: Codes, designation and nature conservation evaluation of habitat types recorded in the site where construction of the repository is planned and in a 500 m belt around it.

Physis code, HTS (ARSO, 2004)	Habitat type	Value[1]
22.13	Eutrophic waters	3
24.1	Streams with more or less conserved natural banks	4
24.1	Regulated streams	3
24.1	River	4
31.81	Medio-European and sub-Mediterranean rich-soil deciduous scrub	3
31.8D	Shrubby deciduous forests and areas overgrowing with deciduous tree species	3
31.8D/44.92x87.2	Areas overgrowing with marsh and bog willow formations, in part with species of ruderal communities	4
31.8D/83.324	Areas overgrowing with black locust	2
31.8121	Medio-European thermophilous basiphilous thickets with wild privet and blackthorn	3
34.32* (*)	Medio-European *Bromus erectus* dry and semidry grasslands	4 or 5
34.322 (*)	Medio-European *Bromus erectus* moderately dry grasslands	4 or 5
37.7	Tall-herb communities lining watercourses and tall-herb communities of other humid sites (allochthonous species dominate)	3
37.72	Shady nitrophilous woodland edge fringes	4
38.13	Ruderalised abandoned grasslands	2
38.22	Medio-European mesotrophic to eutrophic lowland hay meadows	4
38.221	Xero-mesophile medio-European lowland hay meadows on relatively dry soils and slopes dominated by oatgrass	4
44	Grasslands and wetland forests	4
44.92	Marsh and bog willow formations	4
81	Intensively cultivated and additionally or completely sown meadows	2
82.11	Field crops	1
82.2	Fields with field margins and headlands	2
83.15	Orchards	2
83.22	Shrub and low stem tree orchards	2
83.321	Poplar plantations	2
84.2	Hedgerows and small groups of trees and shrubs	3
84.3	Small woodlots	3
85.3	Gardens	1
86	Built-up areas (towns, villages, industrial sites)	1
86.2	Villages, village peripheries and village features	0
86.3	Active industrial sites	0
86.42	Waste disposal sites	0
86.43	Railway embankments, stations, shunting yards and other open areas	0
87.1	Fallow fields and other previously cultivated areas	2
87.2	Ruderal communities	1

Physis code, HTS (ARSO, 2004)	Habitat type	Value[1]
89.22	Canals	3
65.82	Interstitial biocenoses with fresh soil water (phreatic biocenoses)	3
-	Asphalt roads	0
-	Cart tracks and macadam roads	1

Key:

[1] On the basis of mapping, individual habitats were evaluated on a 6-point value scale with scores ranging from 0 to 5, where the greater the number, the greater the nature conservation value. In this process, account was taken of the Decree on habitat types (Official Gazette of the RS 112/03), with particular attention paid to priority habitat types and those which, under the Decree, should be maintained in a favourable state as a priority. The values used in this study only apply to the area under consideration, where the baseline situation of the individual HT at the time of mapping is taken into account.

HT value scale:
0 – no value
1 – not important for nature
2 – low nature conservation value
3 – medium nature conservation value
4 – high nature conservation value
5 – high nature conservation value (priority HTs)

[2] In the field, we frequently encounter areas that are hard to define on the basis of vegetation and the typology of existing habitat types (HTS, ARSO, 2004). For such areas, we have used more general designations (Asphalt roads, Cart tracks and macadam roads) without classification in the system of habitat types;
* - priority habitat type
° - habitat type is maintained in favourable state as a priority.

There are no changes of code or habitat type in the light of amendments to the Decree (Decree on habitat types, Official Gazette of the RS 112/03, 36/09 and 33/13).

4.4.5.2 **Status of flora**
(Taken from the Environmental report for the low- and intermediate-level radioactive waste (LILW) repository).

The core site area is part of an intensively cultivated monoculture grain field. In such an environment, an extremely low diversity of flora is expected (fewer than 10 weed species per hectare), while the presence of endangered and protected plant species requiring protection with special conservation regimes is not expected. No floristically important areas are present within a 500 m radius of the site. Dry and semi-dry grasslands are present across smaller areas, although these only occur in floristically rich form on the right bank of the Sava. The wider surrounding area on Krško Polje (approximately 1,000 m from the site) is dominated by mixed oak-ash-elm forest, while the native hornbeam and oak community (*Querco-Carpinetum*) has to a large extent been cleared and today occupies less than 5% of the area of Krško Polje. Meadows occupy just under a fifth of the area, and fields almost three quarters. The part of Krško Polje below Krško NPP is periodically flooded and this area is typified by mesotrophic wet meadows in which marsh thistle (*Cirsium palustre*), cabbage thistle (*Cirsium oleraceum*), hoary willowherb (*Epilobium parviflorum*), water mint (*Mentha aquatica*) and wood club-rush (*Scirpus sylvaticus*) dominate.
The riverside belt along the Sava is covered with shrubs and trees, notably white willow (*Salix alba*), black poplar (*Populus nigra*), common ash (*Fraxinus excelsior*), common alder (*Alnus glutinosa*) and field maple (*Acer campestre*). For the most part they thrive singly and

represent an important element for the consolidation of riverbanks and habitat for invertebrates, birds and small mammals.

Table 48: Plant species catalogued and present in the wider project area

No.	Scientific name	Red List	Decree	Presence
1	*Achillea millefolium agg.*			+
2	*Agrostis stolonifera agg.*			+
3	*Ajuga reptans*			+
4	*Amaranthus retroflexus*			+
5	*Ambrosia artemisiifolia*			+
6	*Anagallis arvensis*			+
7	*Apera spica-venti*			+
8	*Aristolochia clematitis*			+
9	*Artemisia vulgaris agg.*			+
10	*Atriplex patula*			+
11	*Aavena fatua*			+
12	*Bidens tripartita*			+
13	*Calystegia sepium*			+
14	*Capsella bursa-pastoris*			+
15	*Chenopodium album agg.*			+
16	*Chenopodium polyspermum*			+
17	*Cirsium arvense*			+
18	*Convolvulus arvensis*			+
19	*Cynodon dactylon*			+
20	*Daucus carota*			+
21	*Digitaria sanguinalis*			+
22	*Echinochloa crus-galli*			+
23	*Equisetum arvense*			+
24	*Erigeron annuus*			+
25	*Erodium cicutarium agg.*			+
26	*Euphorbia cyparissias*			+
27	*Euphorbia helioscopia*			+
28	*Galeopsis tetrahit agg.*			+
29	*Galinsoga parviflora*			+
30	*Galium aparine agg.*			+
31	*Geranium dissectum*			+
32	*Knautia arvensis agg.*			+
33	*Lamium purpureum*			+
34	*Lathyrus aphaca*			+
35	*Lathyrus tuberosus*			+
36	*Matricaria chamomilla*			+
37	*Mentha arvensis*			+
38	*Papaver rhoeas*			+
39	*Plantago lanceolata*			+
40	*Plantago major*			+
41	*Poa annua agg.*			+
42	*Polygonum aviculare agg.*			+
43	*Polygonum lepathifolium agg.*			+
44	*Polygonum persicaria*			+
45	*Potentilla reptans*			+

No.	Scientific name	Red List	Decree	Presence
46	*Prunella vulgaris*			+
47	*Ranunculus arvensis*			+
48	*Ranunculus repens*			+
49	*Raphanus raphanistrum agg.*			+
50	*Rorippa sylvestris agg.*			+
51	*Rumex crispus*			+
52	*Rumex obtusifolius agg.*			+
53	*Senecio vulgaris*			+
54	*Setaria glauca*			+
55	*Sinapis arvensis*			+
56	*Solanum nigrum*			+
57	*Sonchus arvensis agg.*			+
58	*Sonchus oleraceus*			+
59	*Sorhum halepense*			+
60	*Stachys palustris*			+
61	*Stellaria media agg.*			+
62	*Symphytum officinale agg.*			+
63	*Taraxacum officinale agg.*			+
64	*Thlaspi arvense*			+
65	*Veronica agrestis*			+
66	*Veronica persica*			+
67	*Vicia cracca agg.*			+
68	*Viola arvensis*			+

Key:
Red List – species is listed in Annex 1 to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00); Ex?=presumed extinct, E=endangered, V=vulnerable, R=rare, O=out of danger (O1 – subcategory consisting of species protected by the Ordinance on the protection of rare or endangered plant species (Official Gazette of the SRS 15/76) which are no longer endangered but which could potentially become endangered again), K=data deficient.
Decree – species is mentioned in the Decree on protected wild plant species (Official Gazette of the RS 46/04, 110/04); Z-species is protected, H-measures for maintenance of a species' habitat at a favourable conservation status.
Presence – species is potentially present in the planned location of the repository.

Potentially present plant species in the area of the planned development do not belong in the Red List, and at the same time no potentially present species is mentioned in the Decree on protected wild plant species (Official Gazette of the RS 46/04, 110/04, 115/07, 36/09, 15/14).

Forests
Native vegetation in the Krško Polje/Brežiško Polje area consists of hornbeam forest with oak. The former hornbeam forests have been almost entirely cleared. Today forest covers less than 5% of the area of Krško Polje. Meadows account for just under a fifth of the area, while fields account for almost three quarters of the total area. The area around Brežice is planted with poplar plantations. The tree community along the river is made up of different species of willow. Alders and poplars also appear in the community.
Since forest does not appear in the area covered by the plan, impacts on forest were not addressed in the Comprehensive Environmental Impact Assessment or the Environmental Impact Report.

4.4.5.3 State of wild animal populations

(Taken from the Environmental report for the low- and intermediate-level radioactive waste (LILW) repository).

Fauna diversity is extremely low in the core area of the site, since the area consists of intensively cultivated monoculture fields separated from the surroundings by natural (Sava) and man-made barriers (road, railway line with embankments).

The wider area – the Krško Basin – represents a varied habitat for various animal communities and offers an important habitat to numerous wild species of vertebrates and invertebrates. The former include, in particular, numerous species of birds and amphibians, while many species of mammals and fish are also present. Of the invertebrates, most is known about the butterflies and beetles. The scarcity of data on other groups is the consequence of a lack of research and cannot be interpreted as a reflection of the actual situation.

The tables below list the vertebrate species known from the wider surrounding area of the site in the Krško Polje area (at a distance of up to approximately 1,000 m from the site). The data derive from literature (e.g. fish from the report "Ichthyological Study of the Sava from Vrhovo HPP to Krško NPP") or from the catalogues produced by the Flora and Fauna Mapping Centre (CKFF), or their presence was confirmed during the field survey by Aquarius. All species catalogued in UTM quadrant WL48, in which the potential site of the LILW repository is located, are also included. The tables show the potential presence of an individual species in the area of the development.

Owing to migration barriers, the species variety of large mammals in the area is likely to be quite limited. It is assumed that the southern white-breasted hedgehog (*Erinaceus concolor*), the European hare (*Lepus europaeus*) and martens are at least occasionally present in the area. Within the core area of the planned development, the presence of small populations of various species of mice, voles and moles (*Talpa europaea*) may be expected.

Table 49: Mammals (Mammalia) in the wider area under consideration

No.	Common name	Scientific name	Red List	Decree	Presence
1	striped field mouse	*Apodemus agrarius*			+
2	yellow-necked field mouse	*Apodemus flavicollis*			+
3	wood mouse	*Apodemus sylvaticus*			+
4	European water vole	*Arvicola terrestris*			+
5	lesser white-toothed shrew	*Crocidura suaveolens*	O1		+
6	white-breasted hedgehog	*Erinaceus concolor*	O1	E	+
7	European hare	*Lepus europaeus*			+
8	common vole	*Microtus arvalis*	O1	Z, H	+
9	weasel	*Mustela nivalis*			
10	Black rat	*Rattus rattus*			+
11	European mole	*Talpa europaea*	O1		+
12	fox	*Vulpes vulpes*			+

Key:
Red List – species is listed in Annex 3 to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00); Ex?=presumed extinct, E=endangered, V=vulnerable, R=rare, O=out of danger

(O1 – subcategory consisting of species protected by the Ordinance on the protection of rare or endangered plant species (Official Gazette of the SRS 15/76) which are no longer endangered but which could potentially become endangered again).
Decree – species is mentioned in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05); Z-protected species, H-species whose habitats are protected.
Presence – species is potentially present in the planned location of the repository.

In all likelihood there are no nesting birds, although some species appear there on a regular basis.
During the field survey several pheasants (*Phasianus colchicus*) were observed in the location, and the presence of quail (*Coturnix coturnix*), common wood pigeons (*Columba palumbus*), Eurasian collared doves (*Streptopelia decaocto*), crows and hooded crows (*Corvus corvus*, *C. corone cornix*), common ravens (*Corvus corax*), crested larks and Eurasian skylarks (*Galerida cristata*, *Alauda arvensis*), magpies (*Pica pica*) and common buzzards (*Buteo buteo*), and potentially also northern lapwings (*Vanellus vanellus*), is expected. Other bird species mentioned in the table below only appear exceptionally in the location in question, or merely overfly it.

Table 50: Birds (Aves) in the wider area under consideration

No.	Common name	Scientific name	Red List	Decree
1	marsh warbler	*Acrocephalus palustris*	O1	Z
2	long-tailed tit	*Aegithalos caudatus*	O1	Z
3	Eurasian skylark	*Alauda arvensis*	O1	Z, H
4	kingfisher	*Alcedo atthis*	E2	Z, H
5	mallard	*Anas platyrhynchos*		
6	tree pipit	*Anthus trivialis*	O1	Z
7	grey heron	*Ardea cinerea*		Z, H
8	common buzzard	*Buteo buteo*	O1	Z, H
9	European goldfinch	*Carduelis carduelis*	O1	Z
10	European greenfinch	*Carduelis chloris*	O1	Z
11	short-toed treecreeper	*Certhia brachydactyla*	O1	Z
12	little ringed plover	*Charadrius dubius*	V/E2	Z, H
13	white stork	*Ciconia ciconia*	V	Z, H
14	black stork	*Ciconia nigra*	V	Z, H
15	common wood pigeon	*Columba palumbus*	O1	Z
16	raven	*Corvus corax*	O1	Z
17	hooded crow	*Corvus corone cornix*		
18	rook	*Corvus frugilegus*	R	Z
19	quail	*Coturnix coturnix*	V	Z
20	common cuckoo	*Cuculus canorus*	O1	Z
21	great spotted woodpecker	*Dendrocopos major*	O1	Z
22	lesser spotted woodpecker	*Dendrocopos minor*	V	Z
23	yellowhammer	*Emberiza citrinella*	V	Z
24	European robin	*Erithacus rubecula*	O1	Z
25	collared flycatcher	*Ficedula albicollis*	V	Z, H
26	common chaffinch	*Fringilla coelebs*	O1	Z
27	crested lark	*Galerida cristata*	V	Z
28	Eurasian jay	*Garrulus glandarius*	O1	
29	barn swallow	*Hirundo rustica*	O1	Z
30	Eurasian wryneck	*Jynx torquilla*	V	Z, H

No.	Common name	Scientific name	Red List	Decree
31	red-backed shrike	*Lanius collurio*	V	Z, H
32	river warbler	*Locustella fluviatilis*	V	Z
33	common nightingale	*Luscinia megarhynchos*	V	Z
34	European bee-eater	*Merops apiaster*	E2	Z, H
35	white wagtail	*Motacilla alba*	O1	Z
36	grey wagtail	*Motacilla cinerea*	O1	Z
37	western yellow wagtail	*Motacilla flava*	V	Z
38	spotted flycatcher	*Muscicapa striata*	O1	Z
39	red-crested pochard	*Netta rufina*	K	Z
40	Eurasian golden oriole	*Oriolus oriolus*	O1	Z
41	Eurasian blue tit	*Parus caeruleus*	O1	Z
42	great tit	*Parus major*	O1	Z
43	marsh tit	*Parus palustris*	O1	Z
44	house sparrow	*Passer d. domesticus*	O1	Z
45	Eurasian tree sparrow	*Passer montanus*	O1	Z
46	common pheasant	*Phasianus colchicus*		
47	common chiffchaff	*Phylloscopus collybita*	O1	Z
48	common magpie	*Pica pica*		
49	great crested grebe	*Podiceps cristatus*	V	Z
50	sand martin	*Riparia riparia*	E2	Z, H
51	whinchat	*Saxicola rubetra*	O1	Z, H
52	Eurasian woodcock	*Scolopax rusticola*	E2	Z, H
53	European serin	*Serinus serinus*	O1	Z
54	Eurasian nuthatch	*Sitta europaea*	O1	Z
55	Eurasian collared dove	*Streptopelia decaocto*	O1	Z
56	European turtle dove	*Streptopelia turtur*	V	Z
57	common starling	*Sturnus vulgaris*	O1	Z
58	Eurasian blackcap	*Sylvia atricapilla*	O1	Z
59	common whitethroat	*Sylvia communis*	V	Z
60	Eurasian wren	*Troglodytes troglodytes*	O1	Z
61	common blackbird	*Turdus merula*	O1	Z
62	song thrush	*Turdus philomelos*	O1	Z
63	northern lapwing	*Vanellus vanellus*	V	Z, H

Key:
Red List – species is listed in Annex 4 to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00); Ex?=presumed extinct, E=endangered (E2 – subcategory consisting of species whose survival in Slovenia is unlikely if threat factors continue; species are critically endangered), V=vulnerable, R=rare, O=out of danger (O1 – subcategory consisting of species protected by the Ordinance on the protection of rare or endangered plant species (Official Gazette of the SRS 15/76) which are no longer endangered but which could potentially become endangered again), K=data deficient.
Decree – species is mentioned in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05); Z-protected species, H-species whose habitats are protected.

All fish species listed in the table below potentially appear in the river Sava, which is 450 m from the planned site of the repository at its closest point.

Table 51: Fish (Pisces) in the wider area under consideration

No.	Common name	Scientific name	Red List	Decree
1	Danube bream	*Abramis brama danubii*		
2	spirlin	*Alburnoides bipunctatus*	O1	
3	common bleak	*Alburnus alburnus*	O1	
4	asp	*Aspius aspius*	E	
5	common barbel	*Barbus barbus*	E	H
6	Romanian barbel	*Barbus meridionalis petenyi*	E	H
7	white bream	*Blicca bjoerkna*		
8	Prussian carp	*Carassius auratus gibelio*		
9	crucian carp	*Carassius carassius*		
10	common nase	*Chondrostoma nasus*	E	H
11	spined loach	*Cobitis taenia*	O1	Z, H
12	European bullhead	*Cottus gobio*	V	H
13	common carp	*Cyprinus c. carpio*	E	Z
14	northern pike	*Esox lucius*	V	H
15	Ukrainian brook lamprey	*Eudontomyzon mariae*	E	Z, H
16	gudgeon	*Gobio gobio*		
17	Danube gudgeon	*Gobio uranoscopus*	V	H
18	ruffe	*Gymnocephalus cernua*	O1	
19	Danube salmon	*Hucho hucho*	E	H
20	brown bullhead	*Ictalurus nebulosus*		
21	pumpkinseed	*Lepomis gibbosus*		
22	common chub	*Leuciscus cephalus*		
23	ide	*Leuciscus idus*	E	H
24	common dace	*Leuciscus leuciscus*	E	H
25	souffia	*Leuciscus souffia*	E	Z, H
26	burbot	*Lota lota*	E	
27	European weather loach	*Misgurnus fossilis*	E	
28	stone loach	*Noemachelius barbatulus*	O1	
29	common perch	*Perca fluviatilis*		
30	common minnow	*Phoxinus phoxinus*		
31	European bitterling	*Rhodeus seliceus amarus*	E	H
32	pigo	*Rutilus pigus virgo*	E	H
33	common roach	*Rutilus rutilus*		
34	rainbow trout	*Salmo gairdneri*		
35	river trout	*Salmo trutta* m. *fario*	E	
36	common rudd	*Scardinius erythrophthalmus*		
37	wels catfish	*Silurus glanus*	V	
38	zander	*Stizostedion lucioperca*	E	
39	grayling	*Thymallus thymallus*	V	
40	tench	*Tinca tinca*	E	
41	vimba bream	*Vimba vimba carinata*	E	
42	streber	*Zingel streber*	E	H

Key:
Red List – species is listed in Annex 7 to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00); Ex?=presumed extinct, E=endangered, V=vulnerable, R=rare, O=out of danger (O1 – subcategory consisting of species protected by the Ordinance on the protection of rare or endangered plant species (Official Gazette of the SRS 15/76) which are no longer endangered but which could potentially become endangered again).
Decree – species is mentioned in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05); Z-protected species, H-species whose habitats are protected.

The area covered by the LILW repository site does not represent a favourable living and feeding habitat for amphibians. It is assumed that individual specimens of relatively common species appear occasionally in the core area under consideration: the common toad (*Bufo bufo*) and the common frog (*Rana temporaria*).

Table 52: Amphibians (Amphibia) in the wider area under consideration

No.	Common name	Scientific name	Red List	Decree	Presence
1	common toad	*Bufo bufo*	V	Z, H	+
2	common frog	*Rana temporaria*	V	Z	+

Red List – species is listed in Annex 6 to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00); Ex?=presumed extinct, E=endangered, V=vulnerable, R=rare, O=out of danger.
Decree – species is mentioned in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05); Z-protected species, H-species whose habitats are protected.
Presence – species is potentially present in the planned location of the repository (plan area).

It is assumed that reptiles are relatively rare in the core area under consideration. It is likely that individual specimens of common species appear there occasionally – the slow-worm (*Anguis fragilis*) and the common wall lizard (*Podarcis muralis*).

Table 53: Reptiles (Reptilia) in the wider area under consideration

No.	Common name	Scientific name	Red List	Decree	Presence
1	slow-worm	*Anguis fragilis*	O1	Z	+
2	common wall lizard	*Podarcis muralis*	O1		+

Red List – species is listed in Annex 5 to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00); Ex?=presumed extinct, E=endangered, V=vulnerable, R=rare, O=out of danger (O1 – subcategory consisting of species protected by the Ordinance on the protection of rare or endangered plant species (Official Gazette of the SRS 15/76) which are no longer endangered but which could potentially become endangered again).
Decree – species is mentioned in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05); Z-protected species, H-species whose habitats are protected.
Presence – species is potentially present in the planned location of the repository (plan area).

The tables below list the species of known insects from the wider area under consideration. Owing to intensive farming methods using plant protection products, the presence of insect species in the core area of the planned location is expected to be limited to small populations of the more common species. The small size of the insect population is also the reason why there are few insectivorous vertebrate species in the area of the planned development.

Table 54: Butterflies (Lepidoptera) in the wider area under consideration

No.	Scientific name	Red List	Decree
1	*Anthocharis cardamines*		
2	*Agrotis segetum*		
3	*Allophyes oxyacanthae*		
4	*Amathes c-nigrum*		
5	*Ammoconia caecimacula*		
6	*Argynnis niobe*		
7	*Aricia agestis*		
8	*Artogeia napi*		
9	*Artogeia rapae*		
10	*Callophrys rubi*		
11	*Celastrina argiolus*		
12	*Chamaesphecia ampiformis*		
13	*Clossiana dia*		

No.	Scientific name	Red List	Decree
14	*Coenonympha glycerion*		
15	*Coenonympha pamphilus*		
16	*Colias alfacariensis*		
17	*Colias croceus*		
18	*Conistra vaccinii*		
19	*Cupido minimus*		
20	*Cyaniris semiargus*		
21	*Ematurga atomaria*		
22	*Erynnis tages*		
23	*Euclidia glyphica*		
24	*Eurodrias aurinia*		
25	*Everes argiades*		
26	*Glaucopsyche alexis*		
27	*Gonepteryx rhamni*		
28	*Hesperia comma*		
29	*Heteropterus morpheus*		
30	*Hypena rostralis*		
31	*Inachis io*		
32	*Iphiclides podalirius*		
33	*Lasiocampa quercus*		
34	*Lasiommata megera*		
35	*Leptidea sinapsis/reali*		
36	*Limenitis reducta*		
37	*Lithophane socia*		
38	*Lycaena dispar*	V	Z, H
39	*Licaena hippothoe*		
40	*Lycaena phlaeas*		
41	*Licaena tityrus*		
42	*Maniola jurtina*		
43	*Melanargia galathea*		
44	*Melitaea cinxia*		
45	*Melitaea phoebe*		
46	*Mellicta athalia*		
47	*Mellicta britomartis*	V	
48	*Minois dryas*		
49	*Mythimna albipuncta*		
50	*Mythimna vitellina*		
51	*Noctua janthe*		
52	*Noctua pronuba*		
53	*Ochlodes venata*		
54	*Opisthograptis luteolata*		
55	*Papilio machaon*		
56	*Pararge aegeria*		
57	*Phlogophora meticulosa*		
58	*Pieris brassicae*		
59	*Plebeius argus*	V	
60	*Plebeius argyrognomon*		
61	*Plbeius idas*		
62	*Polygonia c-album*		
63	*Polyommatus icarus*		

No.	Scientific name	Red List	Decree
64	*Pyrgus malvae*		
65	*Sayirium pruni*		
66	*Thymelicus sylvestris*		
67	*Vanessa atalanta*		
68	*Vanessa cardui*		
69	*Zygaena carniolica*		

Key:
Red List – species is listed in Annex 16 to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00); Ex?=presumed extinct, E=endangered, V=vulnerable, R=rare, O=out of danger.
Decree – species is mentioned in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05); Z-protected species, H-species whose habitats are protected.

Table 55: Beetles (Coleoptera) in the wider area under consideration*

No.	Scientific name
1	*Abax parallelus*
2	*Agonum lugens*
3	*Amara aenea*
4	*Amara similata*
5	*Badister dilatatus*
6	*Bembidion subcostatum javurkovae*
7	*Bembidion varium*
8	*Brachinus explodens*
9	*Callistus lunatus*
10	*Cylindera germanica*
11	*Drypta dentata*
12	*Dyschirius aeneus*
13	*Elaphropus quadrisignatus*
14	*Harpalus dimidiatus*
15	*Harpalus rubripes*
16	*Harpalus smaragdinus*
17	*Harpalus subcylindricus*
18	*Harpalus tenebrosus*
19	*Ophonus azureus*
20	*Ophonus diffinis*
21	*Ophonus stictus*
22	*Paratachys bistriatus*
23	*Poecilus lepidus*
24	*Pseudoophonus griseus*
25	*Pseudoophonus rufipes*
26	*Pterostichus melas*

* - None of the listed species is mentioned in the Annexes to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00) or in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05).

More than 20 species of dragonflies have been observed on Krško Polje, while a smaller number of species (7) have been recorded in the area of the Stari Grad gravel pit and could potentially appear periodically in the core area under consideration.

Table 56: Dragonflies and damselflies (Odonata) catalogued in the Stari Grad gravel pit*

No.	Common name	Scientific name
1	azure damselfly	*Coenagrion puella*
2	scarlet dragonfly	*Crocothemis erythraea*
3	common blue damselfly	*Enallagma cyathigerum*
4	blue-tailed damselfly	*Ischnura elegans*
5	broad-bodied chaser	*Libellula depressa*
6	white-tailed skimmer	*Orthetrum albistylum*
7	white-legged damselfly	*Platycnemis pennipes*

*- None of the listed species is mentioned in the Annexes to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00) or in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05).

Table 57: Other species of insects catalogued in the wider area under consideration*

No.	Category	Scientific name
1	dance flies	*Clinocera barbatula*
2		*Clinocera bipunctata*
3	ants	*Myrmica lobicornis*
4		*Myrmica rubra*
5		*Camptonosus ligniperdus*
6		*Lasius niger*
7		*Formica cunicularia*
8	true bugs	*Myrmus miriformis*
9		*Dryophilocoris flavoquadrimaculatus*
10		*Harpocera thoracica*
11		*Coreus marginatus*
12		*Conizus hyoscyami*
13		*Anthocoris nemoralis*

* - None of the listed species is mentioned in the Annexes to the Rules on the inclusion of endangered plant and animal species in the Red List (Official Gazette of the RS 56/99, 31/00) or in the Decree on protected wild animal species (Official Gazette of the RS 46/04, 109/04, 85/05).

Of the invertebrates, two species of earthworms (*Lumbricus terrestris*, *Octolasion tyrtaeum*) have been recorded in the wider area and are probably also present in the core area of the repository. The presence of two species of snails (*Pagodulina sparsa*, *Cochlodina commutata*) recorded in the wider area is not expected in the area of the planned development.

4.4.6 *NATURE PROTECTION AREAS*

The area of the development does not encroach on a Natura 2000 area, nor on any protected areas. The area under consideration contains no natural features or zones that are important to biodiversity. There is, however, a Natura 2000 area (SAC Vrbina) in the vicinity of the development site, an ecologically important area consisting of the Sava from Radeče to the national border (ID=63700) and, SE of the area, a valuable natural feature of local importance, namely Stari Grad–gravel pit (ID=7861).

The Special Area of Conservation designated SAC Vrbina (SI3000234) is approximately 950 metres from the area in which construction of the LILW repository is planned, at its closest point. It coincides or overlaps with the floristically richest part of the ecologically important area encompassing the Sava from Radeče to the national border.

4.4.6.1 Natura 2000 areas

The Special Area of Conservation designated SAC Vrbina is defined on the floodplain of the Sava between Krško and Brežice. Three smaller areas of calcareous dry grasslands with orchid sites are defined for it on the right bank, while on the left bank, in Vrbina, there are fragments of softwood floodplain forest connected to remains of poplar plantations and belts of riverbank vegetation along the Močnik and the Struga as a habitat of saproxylic beetles (*Cucujus cinnaberinus*, *Osmoderma eremita* and *Lucanus cervus*) and the narrow-mouthed whorl snail (*Vertigo angustior*).

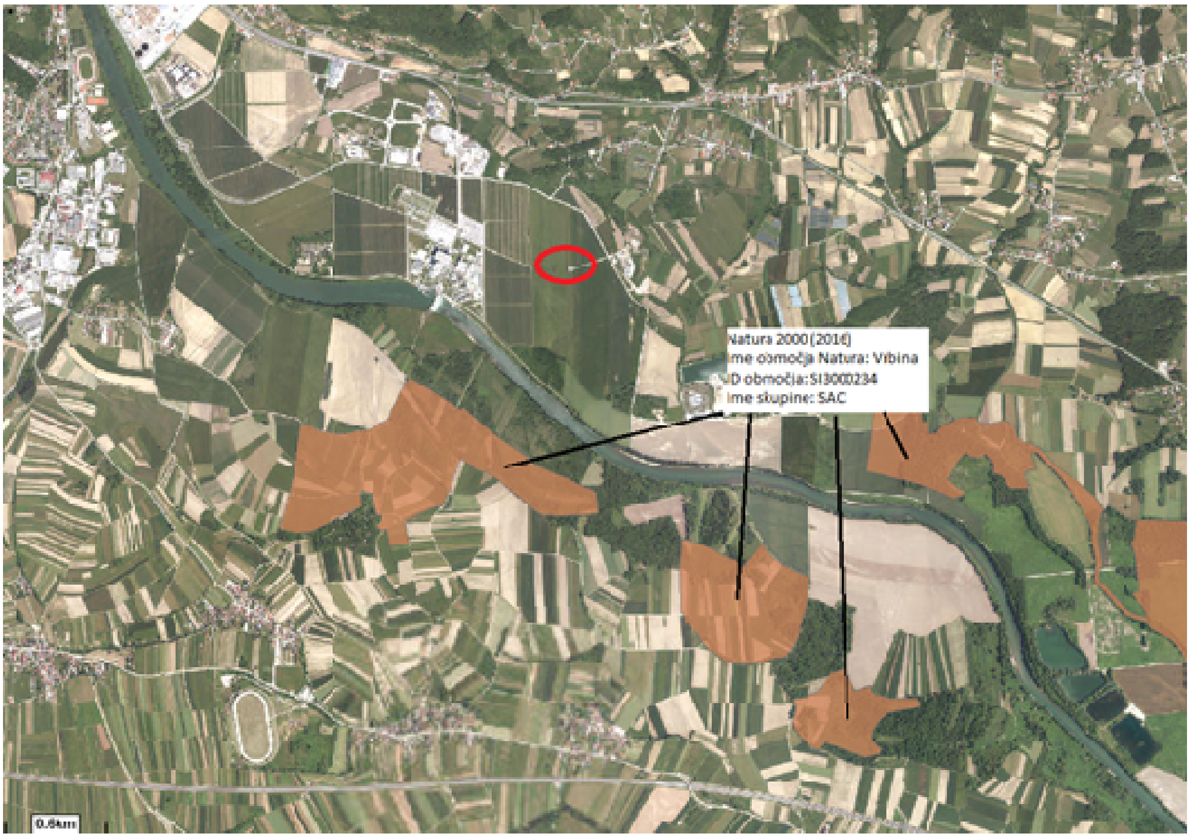


Figure 78: Natura 2000 area in the surroundings of the development (source: Environment Atlas, 2017)

Natura 2000 (2016)	Natura 2000 (2016)
Ime območja Natura: Vrbina	Name of Natura 2000 area: Vrbina
ID območja: SI3000234	ID of area: SI3000234
Ime skupine: SAC	Group name: SAC

Two grassland habitat types are qualifying types for the Natura 2000 area (SAC Vrbina):

- **(6210*) Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)**, which are priority habitat types.

This habitat type consists of meadows or pastures on limestone, dolomite or, more rarely, flysch, or on sand and old gravel beds. Growing sites are dry, light and warm. The substrate is neutral or slightly basic, with few nutrients. They do not tolerate fertilisation, except on very arid soil, where they also do well with moderate fertilisation. They grow on the slopes of hills (except north-facing slopes) where the soil is shallow and the ground is bare in places. They do not tolerate high levels of moisture or stagnation of water. They need extensive pasture or mowing 1–2 times a year, first after the majority of meadow plants have finished flowering, without fertilisation, with hay drying in the meadow, and are not damaged by pasture at the end of the season (August–October). In Slovenia, this habitat type appears in scattered form on suitable surfaces (unfertilised, particularly calcareous soils, sunny slopes). Threats include fertilisation of meadows, hay baling, conversion of meadows into fields, overgrowing with woody species and, in places, hill walking and infrastructure developments.

- **(6510) Lowland hay meadows (*Alopecurus pratensis, Sanguisorba officinalis*)**

Lowland hay meadows thrive on moderately fertilised, damp to moderately dry soils. They are mown 2–3 times a year. In the traditional cultural landscape, they usually appear as part of a mosaic that also includes dry and damp meadows. They are found across Slovenia but are rare in the Slovenian part of the Istrian peninsula and on the Karst plateau. They are not present in high mountain areas. Three forms of this habitat type are present in Slovenia: damp, dry and mesophilic. The last of these is, for the time being, least at risk, while dry grassland is most at risk from overgrowing, and damp grassland from drying out and intensification of meadows (conversion into fields, oversowing with grass mixtures, baling, overfertilisation, over-frequent mowing).

According to data from the SDF (Nature Conservation Atlas (NV Atlas)), the two habitat types each occupy 30% of the area of SAC Vrbina. Semi-natural dry grasslands and scrubland facies on calcareous substrates are in an excellent representative state, rich in species (including orchid species) and excellently maintained. Lowland hay meadows are in a good representative state and are well maintained.

4.4.6.2 **Ecologically important areas and valuable natural features**

Around 400 m from the development site is an ecologically important area consisting of the Sava from Radeče to the national border (Ev. No. 63700). This ecologically important area covers a total of 2850.9 ha and, downstream of Krško, with the exception of the channel of the Sava and its banks, includes large areas on the right bank of the Sava. Lowland hay meadows and semi-natural dry grasslands and scrubland facies on calcareous substrates, which represent potential important orchid sites, are located here. The ecologically important area also includes small areas on the left bank of the Sava. This is the part of the ecologically important area that is closest to the development site. The majority of this part of the ecologically important area is covered by fields, while grassland habitats are only conserved fragmentarily and are badly depleted in terms of species diversity. Also present on the left bank of the Sava, in addition to fields and meadows, is a narrow strip of riparian forest and riparian herbaceous cover, where alien species are prevalent, and a small plantation of poplars. In the area under consideration, the channel of the Sava is regulated and consolidated by stone retaining walls.

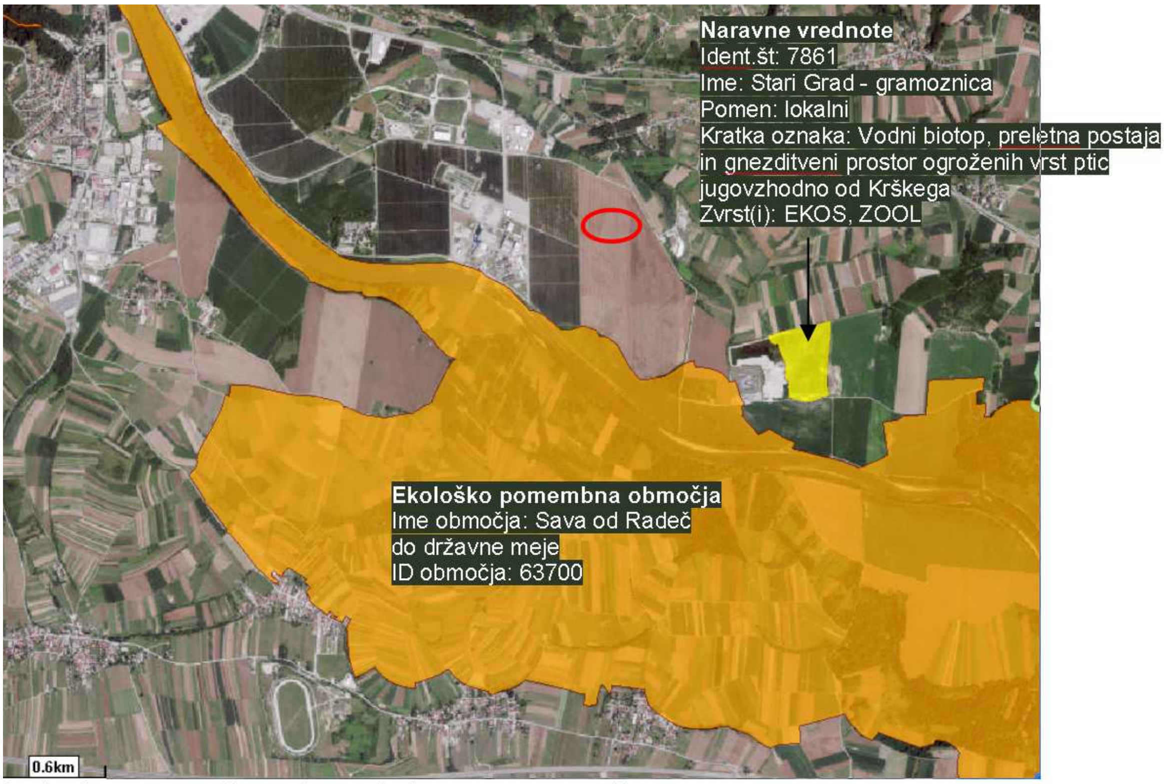


Figure 79: Ecologically important area and valuable natural feature in the vicinity of the development

Naravne vrednote	Area of natural value
Ident.št.: 7861	ID no.: 7861
Ime: Stari Grad – gramoznica	Name: Stari Grad - gravel pit
Pomen: lokalni	Importance: local
Kratka oznaka: Vodni biotop, preletna postaja in gnezditveni prostor ogroženih vrst ptic jugovzhodno od Krškega	Brief reference: Water biotope, overflight station and nesting area of endangered species of birds south-east of Krško
Zvrst(i): EKOS, ZOOL	Type(s): EKOS, ZOOL
Ekološko pomembna območja	Ecologically important area
Ime območja: Sava od Radeč do državne meje	Name of area: The Sava from Radeče to the national border
ID območja: 63700	ID of area: 63700

The proposed site also belongs to an area of exceptional bear presence (ID No. 4) and is relatively close to fringe bear habitat (approx. 5 km). Confirmation of bear presence on the repository site is not available. Owing to the limited accessibility of the site to large mammals (because of natural and artificial barriers), we assume that bears do not appear in the area in question.

Around 800 m to the south-east of the planned repository site, the Stari Grad gravel pit is located on the same (left) bank of the Sava. It is defined as an ecosystemic and zoological valuable natural feature of local importance, ID No. 7861. It represents an aquatic biotope, a stopping area for migrating birds and a nesting area for endangered bird species. The majority of bird species have been recorded in the gravel pit area. Data on sightings of 7 species of dragonflies and damselflies also come from there. Gravel extraction is still taking place in the immediate vicinity of the flooded gravel pit.

In the opinion of the Ljubljana regional unit of the Nature Conservation Institute of the Republic of Slovenia (ZRSVN) of 2 February 2006, it is established that for the Vrbina area, which is regulated by a national location plan, it is not necessary, under Article 97 of the Nature Conservation Act (Official Gazette of the RS 96/04–UPB2), to draw up nature conservation guidelines and issue a nature conservation opinion.
In the context of the environmental impact report, it was established that the plan does not have major significance with regard to environmental indicators for nature conservation areas:

- presence of valuable natural features and ecologically important areas,
- maintenance of biodiversity in the ecologically important area,
- presence of protected areas of nature, taking into account the importance and regime of these areas,
- importance of the plan/development for qualifying species and habitat types for Natura 2000 areas

4.4.7 *CHARACTER AND FEATURES OF THE LANDSCAPE*

The development site is located on Krško Polje, which is an extensive flat area on alluvial deposits, gravel, clay and loam of the lower courses of the rivers Krka and Sava. It is bounded to the north by the Krško Hills and to the south by the Gorjanci range and the hills of the Podgorje region. The area is typified by a very flat relief. Other features include the forest of Krakovski Gozd, which separates Šentjernejsko Polje in the east from the main part of the Krško Polje/Brežiško Polje area. The area's basic east–west orientation is determined by the course of the river Sava. Old roads mainly run below the foothills of the surrounding elevations, while the motorway runs across the basin. An ancient Roman road ran through the area in the direction of Sisak (Croatia) (Regional distribution of landscape types in Slovenia, Biotechnical Faculty, Ljubljana, 1998).

The development site is located in the Krško Polje/Brežiško Polje landscape unit (a sub-unit of the Posavje portion of the plain), which in turn is one of the landscapes of the southern sub-Pannonian region. The key characteristics of this landscape unit are:

- plain, flat forest areas, river Sava,
- open farmland, clustered settlements,
- little in the way of panoramic views, considerable openness of the plain with hills in the background,
- original forest, loss of natural characteristics,
- old towns, nuclear power plant, military airfield.

The area of the LILW repository is defined by flat relief on gravelly terrain at a height above sea level ranging from 150 to 155 m. To the north, the flat area continues towards Libna Hill (355 m a.s.l.). The channel of the river Sava is approximately 270 m from the southern edge of the site. Located in the immediate vicinity of the variants area are vestiges of the geomorphic action of the river Sava, which in the past flowed in a branched channel. Besides

meadows and riparian vegetation with individual trees, groups of trees and groups of shrubs, the wider area is also characterised by flatland forests.
Existing land use in the area of the LILW repository consists of intensive agriculture, with large field complexes. The land to the north, south and west of the variants area is also given over to intensive agricultural use. A large commercial orchard is located between Krško NPP and the variants area. Large connected areas with intensive (monoculture) agriculture create a large-scale landscape pattern. A landscape pattern of extensive agriculture appears at the transition into the hilly area. This pattern is characterised by alternating use of fields, meadows, small orchards and vineyards. The area of the LILW repository itself is uninhabited. Across the wider area, small clustered settlements dominate, while there is also a pattern of dispersed settlement outside settlement centres. The nearest settlements are Vrbina, Spodnja Libna and Stari Grad pri Vidmu.
The appearance of Krško Polje, or the area along the Sava between Krško and Brežice, underwent a major change with the regulation of the Sava more than 100 years ago. Regulation of the river significantly reduced landscape diversity, since numerous meanders and branches of the Sava were filled in, and the river was directed into a newly regulated channel. The biggest changes in the landscape picture in lowland areas have been caused by hydro-amelioration and regulation measures affecting all major watercourses and their tributaries. Scattered urbanisation is increasing in hill areas while in vineyard areas excessive construction of buildings (so-called vineyard cottages) is occurring and changing spatial structure relations in the area. The unit, in particular its lowland portion, is also under pressure from various infrastructure corridors. Krško NPP is very visible because of its size and position on the plain, and has brought with it the construction of high-voltage transmission lines. Other changes in the area have been caused by the new route of the Ljubljana–Obrežje motorway [6].

Among the numerous landscape patterns appearing in the wider area, the following are most typical of the area under consideration:

- Poplar plantations on the floodplain: this landscape pattern is present above all on the plains of former branches of the Sava at Brežice. It is characterised by a high degree of regulation and uniformity – trees planted in a grid pattern are of the same size and shape.
- Wet landscape along watercourses: a characteristic landscape pattern for the riparian floodplains of rivers (Sava, Krka) and streams (Močnik, Struga). As well as riparian vegetation, the pattern includes wet meadows with individual trees, groups of trees or groups of shrubs. Amelioration measures and poplar plantations have greatly reduced the size of this pattern.
- Unbroken agricultural landscape on the plain: large areas of continuous fields with monoculture agriculture create a large-scale landscape pattern without intermediate vegetation units.

The Posavje (Sava Valley) part of the Krško Polje/Brežiško Polje has a rating of 3–4 because of the relatively high degree of loss of natural characteristics and urbanisation (intensive agriculture, poplar plantations, gravel pits, nuclear power plant, transmission lines, roads).[115] The only areas of greater landscape diversity are in the vicinity of some oxbow lakes of the Sava. The area of the proposed site is not classified among outstanding landscapes or among

[115] Score on the landscape quality scale from 1 – maximum – to 4 – minimum (Regional distribution of landscape types in Slovenia, 1998)

distinctive landscapes of national importance. The symbolic value of its natural and cultural elements is of purely local importance. Krško NPP has become an important element of the identity of the area in people's minds (Cognitive Map of Slovenia, 2000, Regional distribution of landscape types in Slovenia, Landscapes of the sub-Pannonian region, 1998). The area of the LILW repository is visible from surrounding ridges, from the road and from settlements in the surrounding area.

Figure 80: Visibility of the planned repository site

Guidelines for the protection and regulation of the landscape of the Krško Polje/Brežiško Polje area include:

- conservation of riparian landscapes and wetlands
- conservation of lowland wet forests
- conservation of traditional settlement patterns and architecture
- sustainable management in flatland forests
- revitalisation of watercourses that have lost natural characteristics.

None of the above guidelines relates directly to landscape elements in the strict area of the proposed development. Neither does the development lie in the area of a nature park or other area with a special landscape protection regime.

4.4.8 *CULTURAL HERITAGE*

Since there are no recorded cultural heritage units and no protected archaeological sites in the area covered by the plan, impacts on cultural heritage were not addressed in the Comprehensive Environmental Impact Assessment or the Environmental Impact Report.

Guidelines No. 637/2004-MK of the Institute for the Protection of Cultural Heritage of Slovenia of 16 February 2006 set out general focuses for the protection of cultural heritage:

- Under the European Convention on the Protection of Archaeological Heritage (ratified in Slovenia in 1999 – Official Gazette of the RS 7/1999), the developer must ensure: **reserve protection** of archaeological heritage in both locations covered by the national location plan; **implementation of preliminary archaeological studies** (extensive, intensive, superficial and sub-superficial surveys, geophysical measurements and analysis of aerial images) in both locations of the national location plan, on the basis of which more precise conservation conditions will subsequently be defined and communicated; **implementation of protective excavations of potentially discovered archaeological sites**, including all post-excavation procedures; depending on the results of archaeological investigations, special technical solutions may also be required or, as necessary, major changes to spatial implantation plan; **permanent archaeological supervision** of all earthworks in the context of implementation of the location plan.

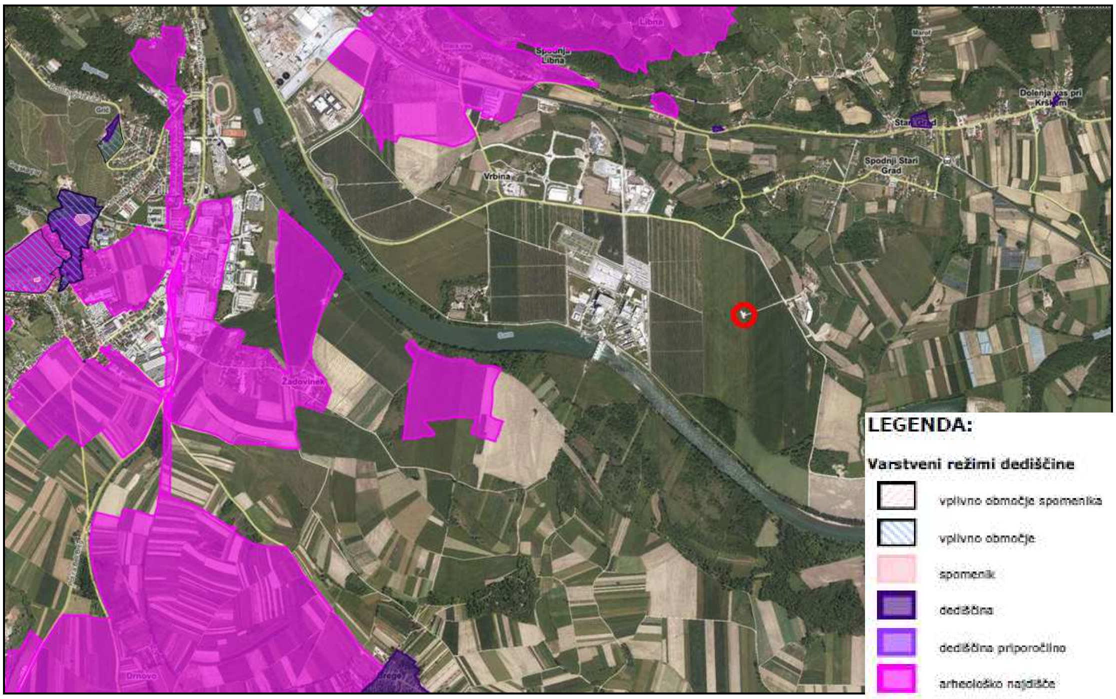


Figure 81: Wider existing situation

LEGENDA:	KEY:
Varstveni režimi dediščine	Cultural heritage protection regimes
vplivno območje spomenika	monument area of influence
vplivno območje	area of influence
spomenik	monument
dediščina	heritage
dediščina priporočilno	heritage recommended
arheološko najdišče	archaeological sites

In 2006 ARAO commissioned the background document "Archaeological evaluation report in the potential Vrbina location for the LILW repository, Institute for the Protection of Cultural Heritage – Novo Mesto regional unit, December 2006".

For the needs of the investigation, 108 test trenches measuring 120 x 120 cm were dug in the wider area of the proposed LILW repository construction site (see figure below). The evaluation used the SAAS methodology (Archaeology on the Motorways of Slovenia, Methods and Procedures, Ljubljana, April 1994).

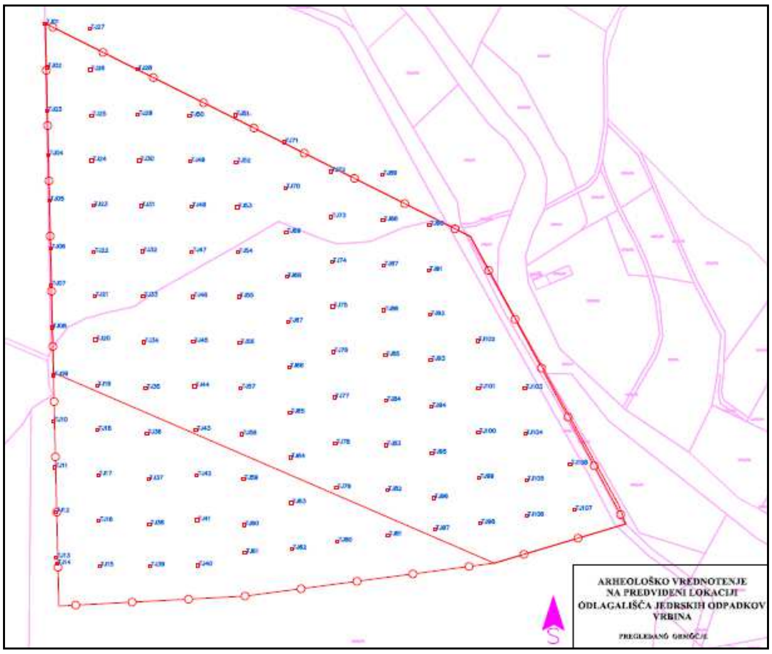


Figure 82: 108 test trenches for archaeological evaluation of the area of the planned LILW repository.

ARHEOLOŠKO VREDNOTENJE NA PREDVIDENI LOKACIJI ODLAGALIŠČA JEDRSKIH ODPADKOV VRBINA	ARHEOLOGICAL EVALUATION AT THE PLANNED SITE OF THE VRBINA KRŠKO LILW REPOSITORY
PREGLEDANO OBMOČJE	EXAMINED AREA

The results of archaeological investigations showed that the area was not settled in the past or that there are no visible signs of human presence in this area in the past.

4.4.9 *PRESSURES ON THE AREA CAUSED BY WASTE*

The area in which construction of the LILW repository is planned is undeveloped and given over to farmland. To the east, in the immediate vicinity of the LILW repository site, is the Spodnji Stari Grad Waste Management Centre, where the mechanical and biological treatment of waste takes place (D8, D9). Next to the Centre, to the north-east, is an urban waste landfill (Spodnji Stari Grad sanitary landfill), which ceased operating in 2007. The planned site of the development and the Waste Management Centre share a road connection.

Three fly ash landfills, which are found to the south or south-east of the LILW repository site, were also recorded within the scope of geosphere and hydrosphere research (figure below).

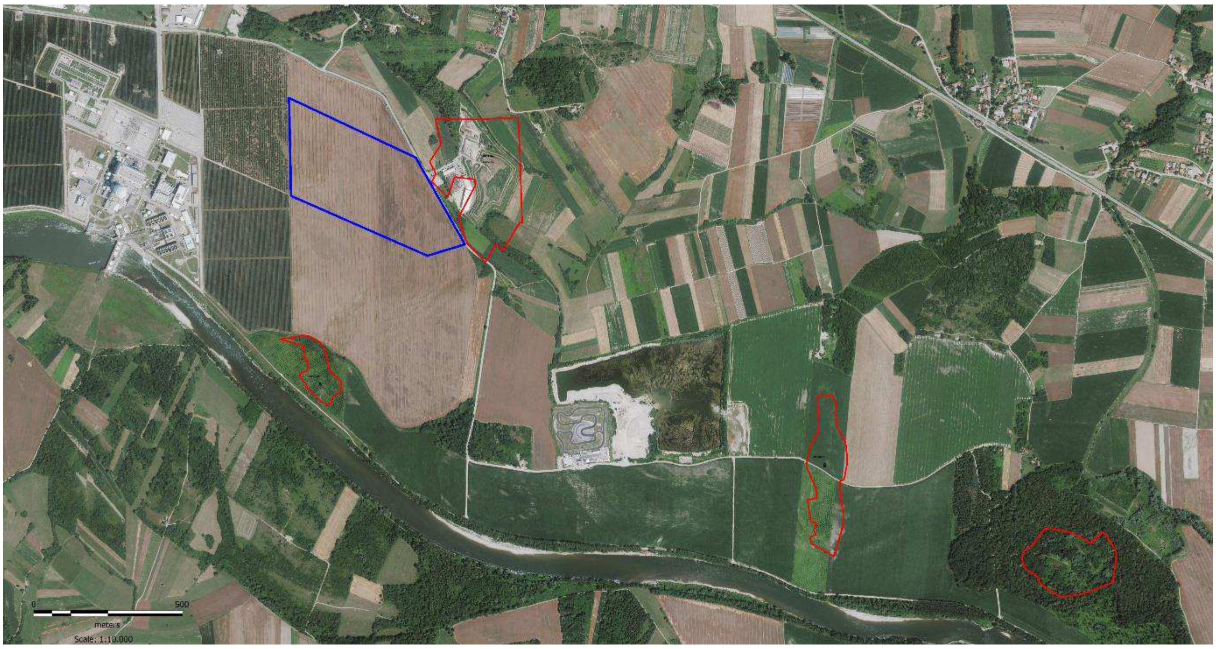


Figure 83: Fly ash landfill sites

Urban waste management in the municipality of Krško is regulated by the *Ordinance on urban waste management in the municipality of Krško (Official Gazette of the RS 33/07, 45/09, 47/10, 30/12, 11/15*. Kostak d.d. is the waste management provider (collection and treatment of specific types of urban waste) in the municipality of Krško. The mandatory municipal public utility service of disposing of residues from recovery and disposal of urban waste in the territory of the municipality of Krško is provided by the public enterprise CeROD (Center za ravnanje z odpadki, d.o.o.), at the CeROD regional waste management centre near Novo Mesto.

The Spodnji Stari Grad Waste Management Centre in the municipality of Krško, which is operated by Kostak d.d., has been operating in the area since 2004. Its facilities include a reception area with weighbridge, a roofed area for waste treatment, an area for the storage of separately collected waste fractions and a composting area. The Centre carries out mechanical and biological treatment of waste. Compost is used to remediate the closed municipal landfill. During the treatment process, biodegradable waste and other separate fractions such as paper, plastic, metals, packaging and combustibles are separated. Biological waste is treated in the composting plant. The majority of mixed urban waste is thus treated within the municipality of Krško, and only residual waste destined for permanent landfill is transported to the CeROD regional waste management centre at Leskovec near Novo Mesto.
Until 2007, urban waste and certain other types of waste (e.g. tree bark) were deposited in the municipal landfill, which is located next to the Spodnji Stari Grad Waste Management Centre. Disposal at the municipal landfill was then discontinued and it was remediated with fly ash. The majority of the urban waste landfill is planned to be remediated into agricultural land, while part of the area is destined for the Waste Management Centre. Remediation of the landfill and the immediate surrounding area will require large quantities of soil (around 30,000 m^3)

Figure 84: Spodnji Stari Grad Waste Management Centre (the orange arrow indicates the location of the closed urban waste landfill)

Figure 85: Planned location of the development (marked by an arrow) and, in the foreground, the Spodnji Stari Grad Waste Management Centre

Besides the Spodnji Stari Grad landfill, there are several small illegal waste dumps on the left and right banks of the Sava. These are shown in the figure below.

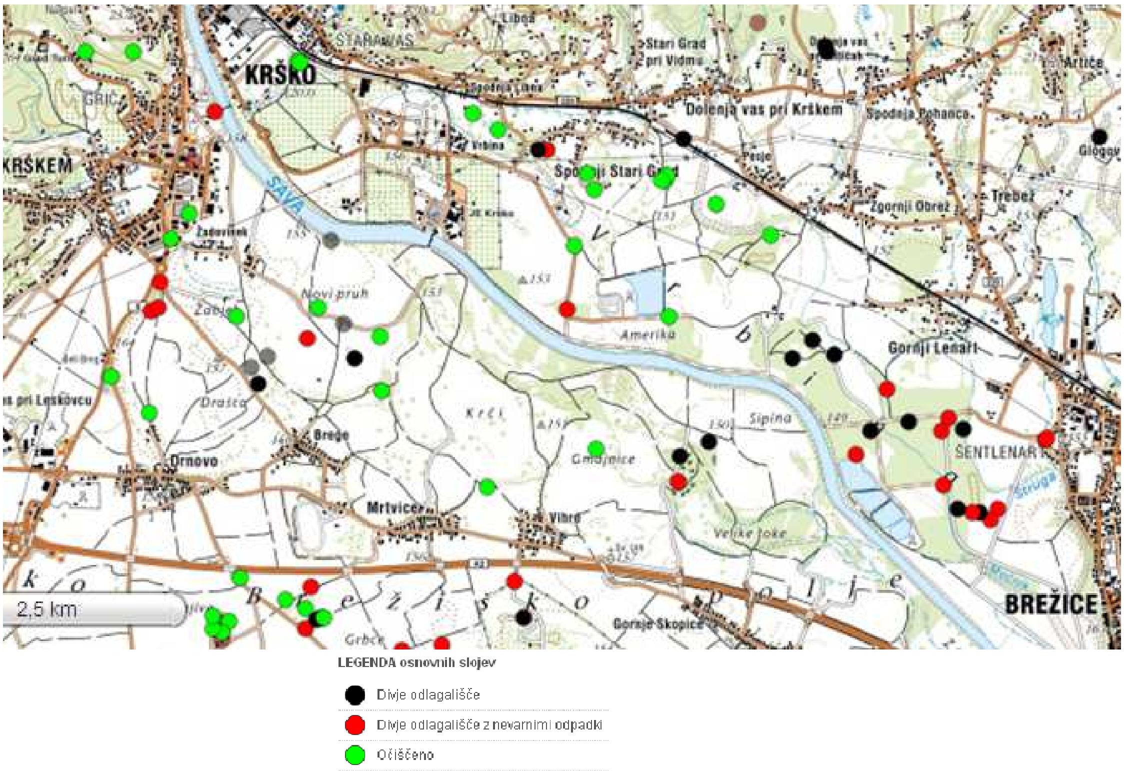


Figure 86: Register of illegal waste dumps (source: http://www.geopedia.si)

LEGENDA osnovnih slojev	KEY of basic layers
Divje odlagališče	Illegal waste dump
Divje odlagališče z nevarnimi odpadki	Illegal waste dump with hazardous waste
Očiščeno	Treated (cleaned)

4.4.10 *NOISE POLLUTION IN THE AREA*

4.4.10.1 **Data on noise pollution in the area**

Existing noise pollution at the site of the future Vrbina LILW repository has been determined on the basis of:

- Expert assessment of noise impacts on the environment – Emission of noise from the Spodnji Stari Grad Waste Management Centre, produced by the National Laboratory for Health, Environment and Food; Environment and Health Centre; Environment and Health Department Novo Mesto, report No. 44-4/14-11SKOK of 8 January 2014.
- Report on the state of ambient noise – Krško Nuclear Power Plant, produced by ZVD, report No. LFIZ-20100179-EB/P of 31 January 2011
- Report on ambient noise measurements – Krško Nuclear Power Plant, produced by ZVD, report No. LFIZ-20100179-EB/M of 31 January 2011
- model calculation (LimA Plus MS1 7812B) on the basis of calculation method NMPB-XPS 31-133 (external transport)

The greatest impact contributing to existing noise pollution at the site of the future Vrbina LILW repository comes from the Spodnji Stari Grad Waste Management Centre operated by Kostak d.d., while there is no impact from Krško NPP. The Waste Management Centre is 300 m from the planned LILW site.
The nearest residential buildings to the planned site of the LILW repository are less than 500 m away (more precisely, at a distance of around 400 m)

The main sources of noise in the area of the Spodnji Stari Grad Waste Management Centre are:

- existing waste sorting facility,
- new sorting facilities for mechanical processing of mixed urban waste,
- sorted waste compactor,
- construction waste processing plant,
- mobile plant,
- compost rotator,
- suction units from the composting plant,
- internal transport for moving containers using a lorry and self-loader,
- external movement of lorries (3/h lorries arriving at the landfill and 1/h departing the landfill).

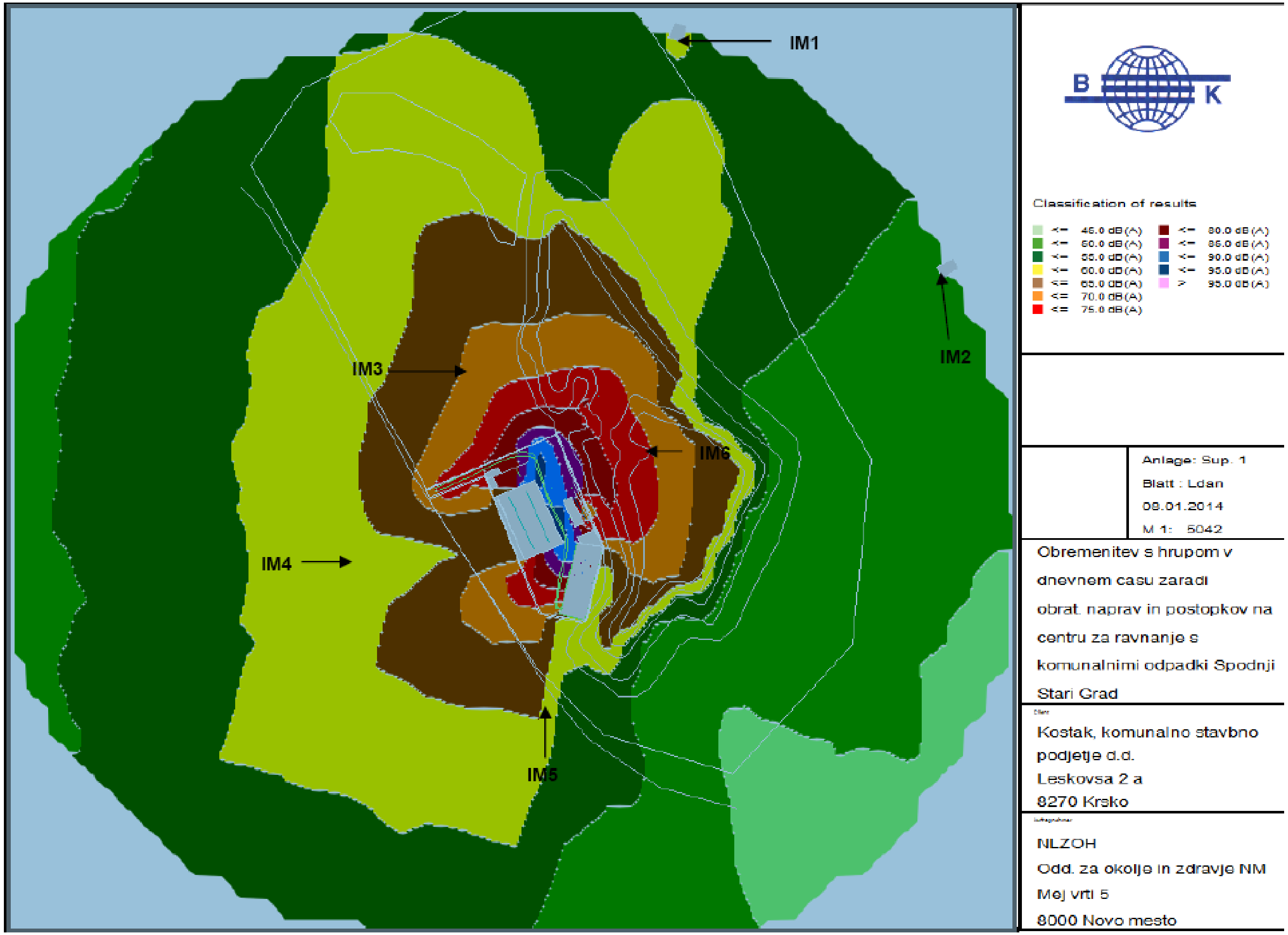


Figure 87: Noise model L_{day} – daytime operation of the Spodnji Stari Grad Waste Management Centre

Obremenitev s hrupom v dnevnem času zaradi obrat. naprav in postopkov na centru za ravnanje s komunalnimi odpadki Spodnji Stari Grad	Noise pollution during the day due to operation of devices and procedures at the Spodnji Stari Grad Waste Management Centre
Kostak, komunalno stavbno podjetje d.d. Leskovška 2 a 8270 Krško	Kostak, komunalno stavbno podjetje d.d. Leskovška 2a 8270 Krško
NLZOH Odd. za okolje in zdravje NM Mej vrti 5 8000 Novo mesto	National Health, Environment and Food Laboratory (NLZOH) Novo Mesto Environment and Health Department Mej vrti 5 8000 Novo Mesto

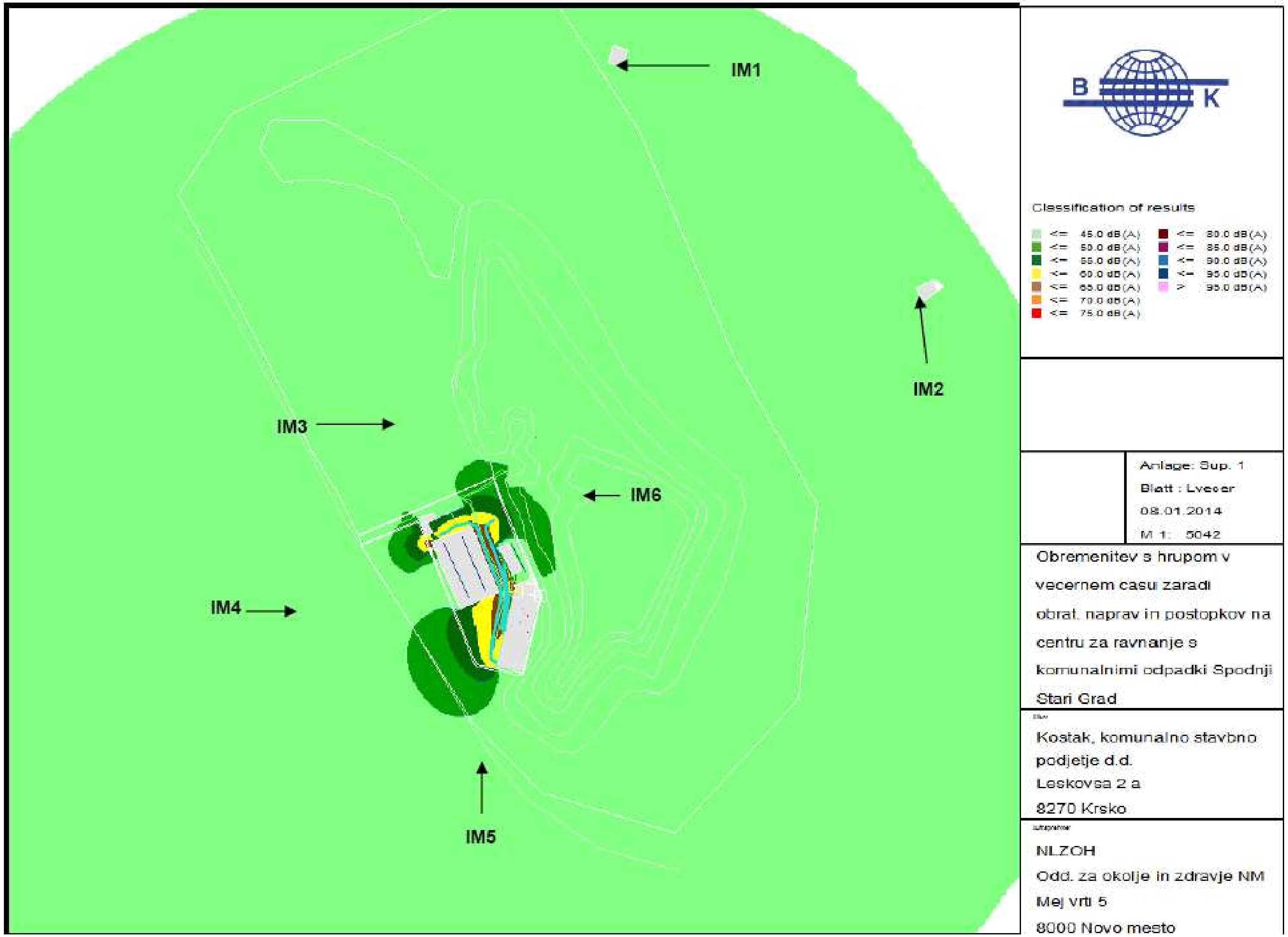


Figure 88: Noise model L_{eve} – evening operation of the Spodnji Stari Grad Waste Management Centre

Obremenitev s hrupom v večernem času zaradi obrat. naprav in postopkov na centru za ravnanje s komunalnimi odpadki Spodnji Stari Grad	*Noise pollution during the evening due to operation of devices and procedures at the Spodnji Stari Grad Waste Management Centre*
Kostak, komunalno stavbno podjetje d.d. Leskovška 2 a 8270 Krško	*Kostak, komunalno stavbno podjetje d.d. Leskovška 2a 8270 Krško*
NLZOH Odd. za okolje in zdravje NM Mej vrti 5 8000 Novo mesto	*National Health, Environment and Food Laboratory (NLZOH) Novo Mesto Environment and Health Department Mej vrti 5 8000 Novo Mesto*

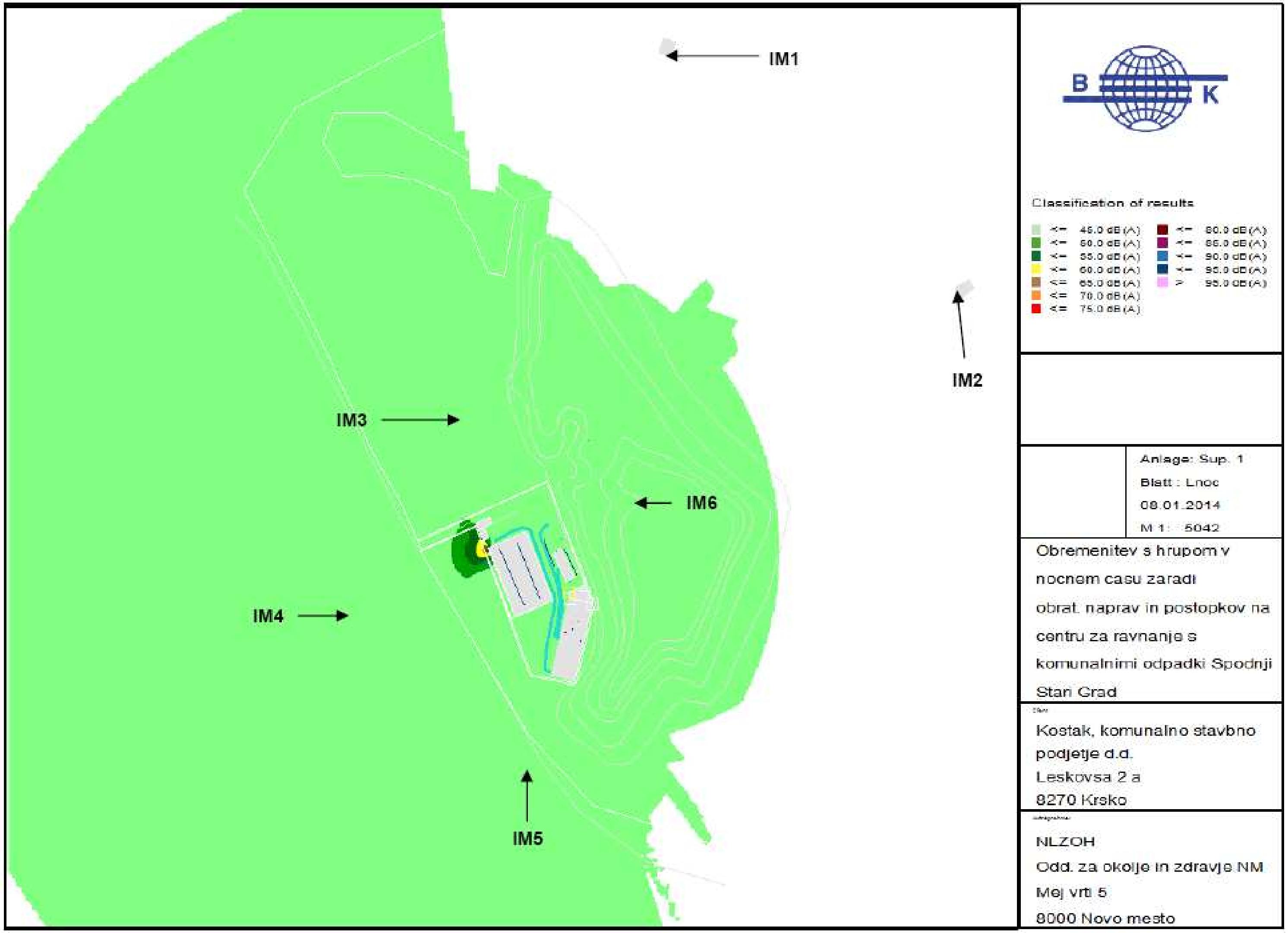


Figure 89: Noise model L_{night} – night operation of the Spodnji Stari Grad Waste Management Centre

Obremenitev s hrupom v nočnem času zaradi obrat. naprav in postopkov na centru za ravnanje s komunalnimi odpadki Spodnji Stari Grad	Noise pollution during night time due to operation of devices and procedures at the Spodnji Stari Grad Waste Management Centre
Kostak, komunalno stavbno podjetje d.d. Leskovška 2 a 8270 Krško	Kostak, komunalno stavbno podjetje d.d. Leskovška 2a 8270 Krško
NLZOH Odd. za okolje in zdravje NM Mej vrti 5 8000 Novo mesto	National Health, Environment and Food Laboratory (NLZOH) Novo Mesto Environment and Health Department Mej vrti 5 8000 Novo Mesto

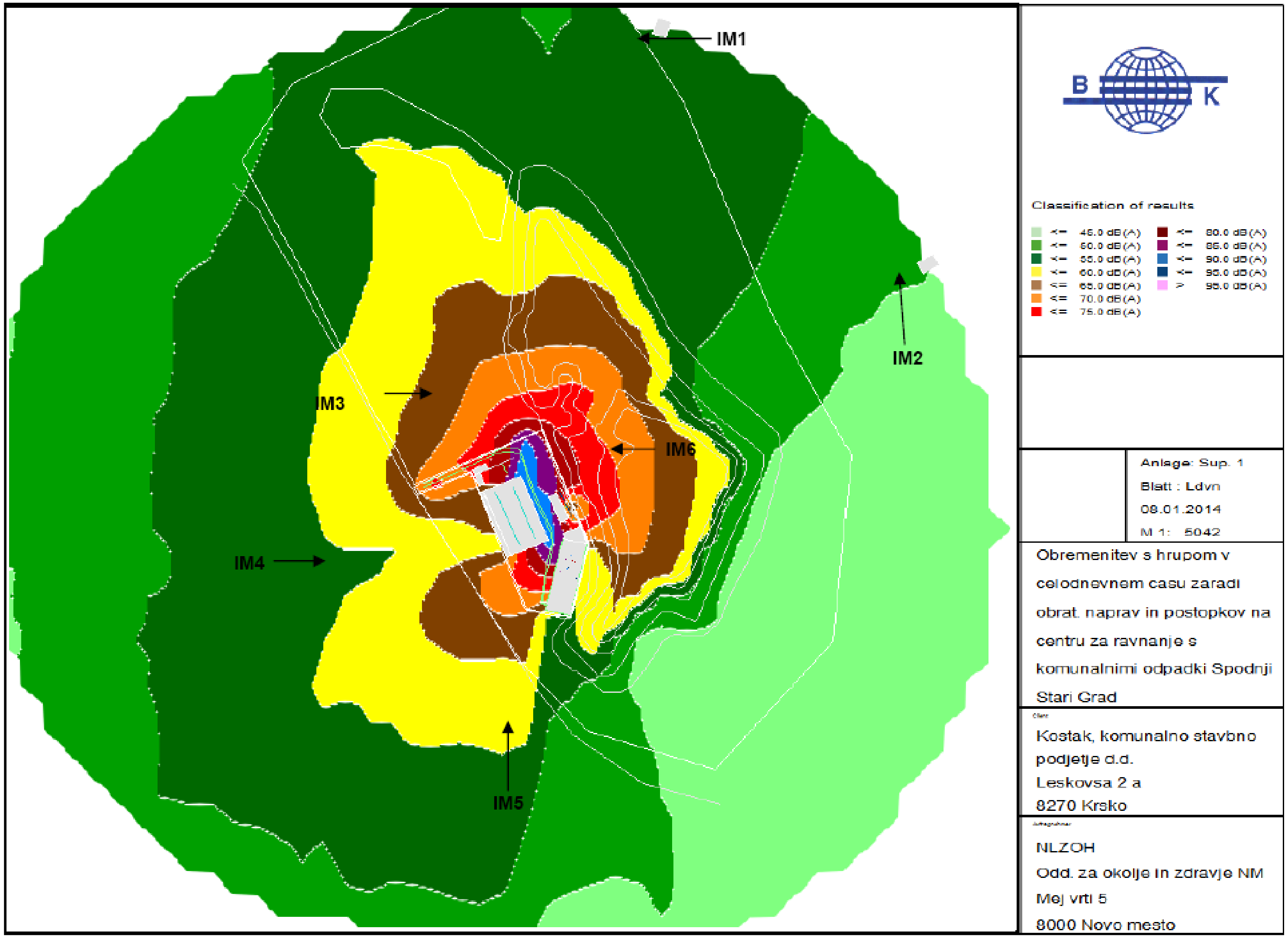


Figure 90: Noise model L_{den} – daily operation of the Spodnji Stari Grad Waste Management Centre

Obremenitev s hrupom v celodnevnem času zaradi obrat. naprav in postopkov na centru za ravnanje s komunalnimi odpadki Spodnji Stari Grad	Noise pollution during all-day operation and procedures at the Spodnji Stari Grad Waste Management Centre
Kostak, komunalno stavbno podjetje d.d. Leskovška 2 a 8270 Krško	Kostak, komunalno stavbno podjetje d.d. Leskovška 2a 8270 Krško
NLZOH Odd. za okolje in zdravje NM Mej vrti 5 8000 Novo mesto	National Health, Environment and Food Laboratory (NLZOH) Novo Mesto Environment and Health Department Mej vrti 5 8000 Novo Mesto

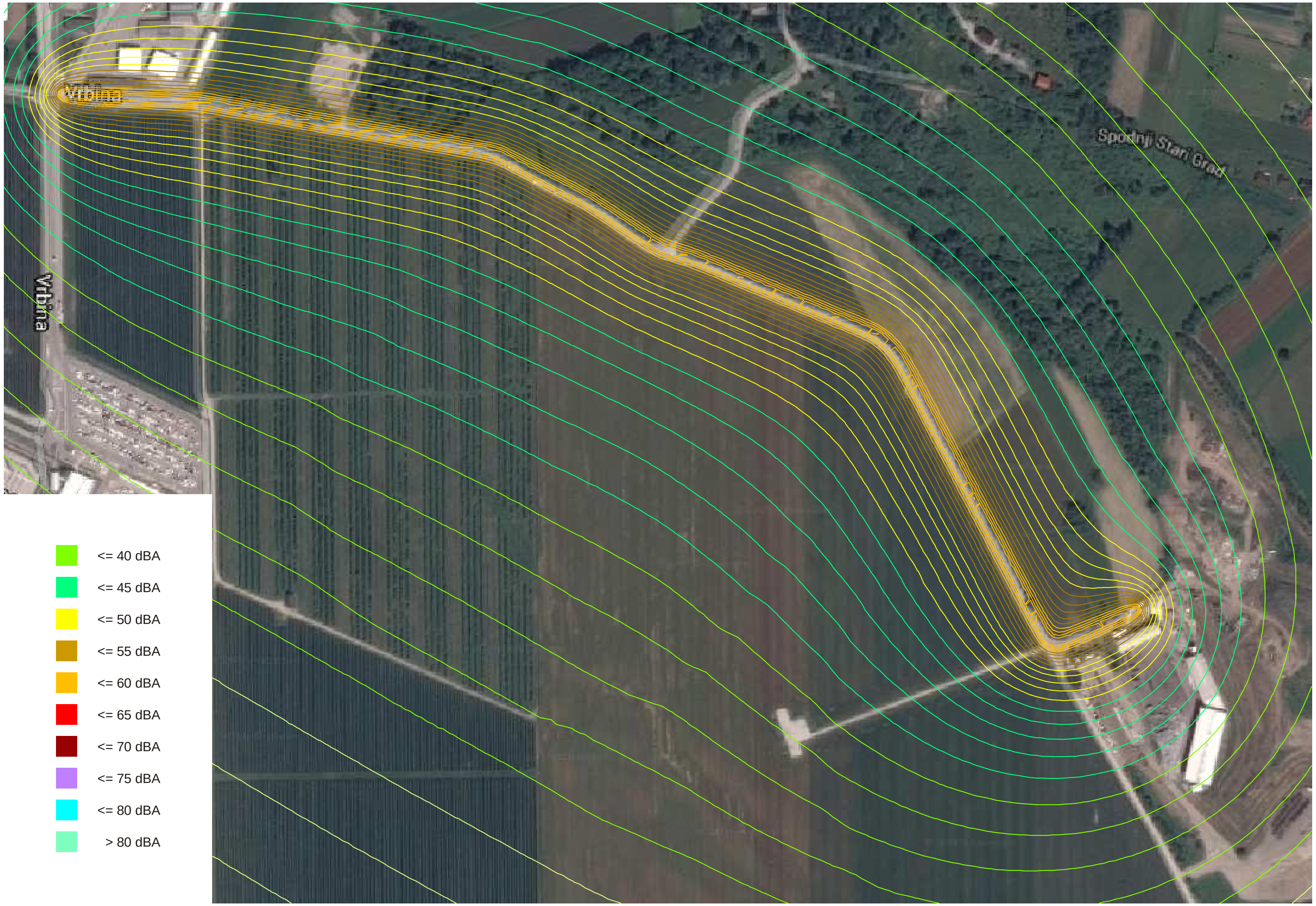


Figure 91: Noise model L_{day} – external transport to the Spodnji Stari Grad Waste Management Centre

All five figures above show model calculations for the operation of the Waste Management Centre. The noise model L_{day} shows the model calculation for the indicator of daytime noise, the noise model L_{eve} the indicator of evening noise, the noise model L_{night} the indicator of night noise and the noise model L_{den} the combined noise indicator. The model calculations derive from: Expert assessment of noise impacts on the environment – Emission of noise from the Spodnji Stari Grad Waste Management Centre, produced by the National Laboratory for Health, Environment and Food; Environment and Health Centre; Environment and Health Department Novo Mesto, report No. 44-4/14-11SKOK of 8 January 2014.

Noise model L_{day} – external transport shows the model calculation for transport into and out of the Spodnji Stari Grad Waste Management Centre. This calculation was made by Kova d.o.o.

The values of the daytime noise indicator for existing noise pollution were determined at the immission points shown in the table and figure below.

Table 58: Location of immission points – existing noise pollution

Immission point	Y	X
1	541542	88805
2	541339	88889
3	540998	89047
4	539924	89122
5	541429	88416

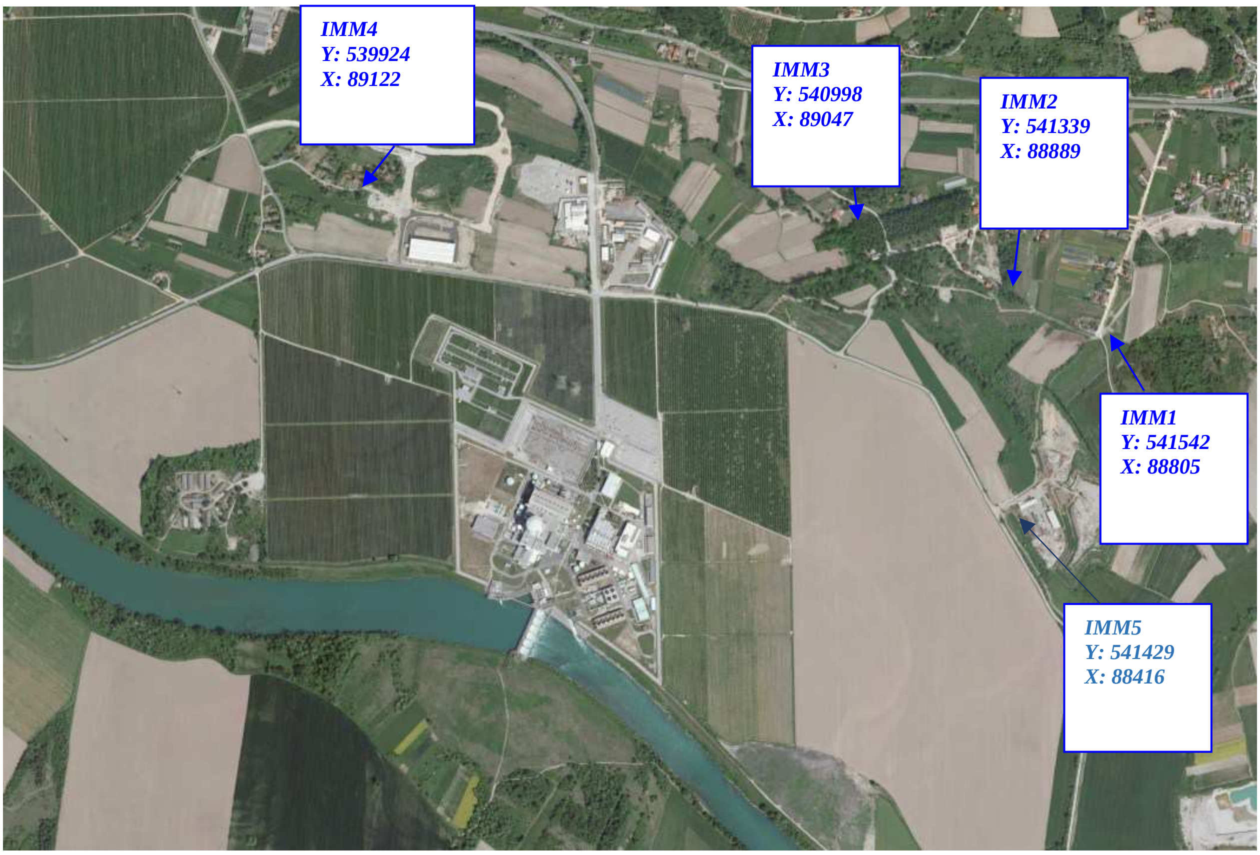


Figure 92: Location of immission points – existing noise pollution (Environment Atlas)

The table below states the calculated value of the daytime noise indicator for existing ambient noise pollution.

The results given in the table below were obtained on the basis of a model calculation in accordance with standard SIST ISO 9613-2 and NMPB-XPS 31-113. The model calculation also took into account transport to the gravel pit.

Table 59: Results of the calculation of the value of the daily noise indicator for existing environmental noise pollution.

	Value of the indicator of daytime noise (dBA)
	L_{day}
Immission point 1	56
Immission point 2	38
Immission point 3	39
Immission point 4	30
Immission point 5	65

The calculated values of noise indicators were assessed in accordance with the Decree on limit values for environmental noise indicators (Official Gazette of the RS, 43/18).

Immission points are classified in noise protection area III

Noise protection Zone III covers the following detailed land use areas:

- residential area: residential areas, special-purpose residential areas, rural settlement areas or holiday homes,
- central activities area: main central activities areas or other central activities areas,
- special area: sports centres or tourism areas,
- green area: areas for rest, recreation and sports, parks, allotments, other arranged green spaces or cemeteries
- areas of dispersed settlement and
- dispersed construction

Table 60: Noise indicator limit values L_{night} and L_{den}

Noise protection area	L_{night} dB(A)	L_{den} dB(A)
Area IV	65	75
Area III	**50**	**60**
Area II	45	55
Area I	40	50

Table 61: Critical values of noise indicators for permanent ambient noise pollution L_{night} and L_{den}

Noise protection area	L_{night} dB(A)	L_{den} dB(A)
Area IV	80	80
Area III	**59**	**69**
Area II	53	63
Area I	47	57

Table 62: Noise indicator limit values L_{day}, L_{night}, L_{eve} and L_{den} for noise caused by construction sites

Noise protection area	L_{day} dB(A)	L_{eve} dB(A)	L_{night} dB(A)	L_{den} dB(A)
Area IV	73	68	63	73
Area III	**58**	**53**	**48**	**58**
Area II	52	47	42	52
Area I	47	42	37	47

Table 63: noise indicator limit values Lday, Lnight, Leve and Lden for noise caused by construction sites

	L_{day} dB(A)	L_{eve} dB(A)	L_{night} dB(A)	L_{den} dB(A)
Source of noise	65	60	55	65

The results of the calculations of noise indicator values showed that the calculated values of noise indicators in the location of immission points correspond to the requirements of the *Decree on limit values for environmental noise indicators (Official Gazette of the RS, 43/18)* and that **the environment is not exposed to excessive noise pollution**.

4.4.11 *IONISING RADIATION LOAD IN THE AREA*

4.4.11.1 Existing sources and radiation loads

The site of the low- and medium-level radioactive waste repository in Vrbina is in the vicinity of Krško Nuclear Power Plant (Krško NPP). The latter has been operating since 1983 and its operation causes a radiological impact on the environment. This impact is regularly monitored by measurements of emissions and immissions. The results of measurements are used to estimate the dose received by an individual from a critical group of the population as a result of discharges from Krško NPP.
The programme for monitoring radioactivity in the area around Krško NPP complies with the Rules on monitoring radioactivity and the document Radioactive Effluent Technical Specification (RETS), Revision 6.

During operation, the nuclear power plant discharges small quantities of radioactive substances into the air and water. The impact of facilities that release radioactive substances into the environment is monitored in two ways. Emissions – i.e. radionuclide composition and released activity – are measured at the source of discharges, and then a model is used to estimate the dose load of the population in the area surrounding the facilities. The second method involves direct measurements that allow us to ascertain the immission of radioactive substances into the environment, which enables direct assessment of the exposure of the population. The latter measurements also enable an estimation of the exposure of the population to natural radiation and impacts from the wider environment, such as nuclear explosions and the Chernobyl disaster.

In order to encompass all impacts of radioactivity on the population, measurements in the surroundings of the power plant cover external radiation (radionuclide radiation in the air and from the soil, and direct radiation from the power plant) and concentrations of radioactive substances in the air, food and water, which cause internal radiation through intake into the body. To measure concentrations in air, food and water, samples are taken and analysed in laboratories outside the range of the radiation caused by the power plant.

External radiation is measured using electronic dose rate counters, which are used for the continuous monitoring of external radiation (MFM-203), and passive thermoluminescent dosimeters (TLD). Radioactivity in the air is determined from samples obtained by pumping air through aerosol filters and filters that retain iodine from the air, and from samples of rainwater and dry deposition.

Radioactivity in the river Sava, where liquid effluent is discharged, is determined from measurements of samples of water, sediments and fish, while the radioactivity of groundwater is determined from groundwater samples and water supply samples taken from reservoirs and pumping stations. Samples of food produced in the surroundings of the power plant and in which radionuclide content is measured are selected so as to enable an assessment of the total contribution of radioactivity in food to the dose. Radionuclide content in soil is also determined.

Impacts of Krško NPP

Monitoring of radiological conditions in the area around Krško NPP takes place by means of direct measurement of concentrations of radioactive substances in the environment, i.e. by monitoring the consequences of the immission of these substances into the environment. During operation of nuclear power plants, concentrations of emitted radionuclides in the environment are usually significantly below limits of detection. We therefore evaluate their impact on human beings and the environment indirectly from data on release into the atmosphere and liquid effluent. Public exposure is estimated using models that describe the spread of radionuclides via various pathways in the environment (Monitoring radioactivity in the area around Krško NPP, Report for 2014, Jožef Stefan Institute, Ljubljana, 2015).

Direct external radiation from facilities within the Krško NPP perimeter

The level of external radiation in the direct vicinity of some of the technological facilities within the Krško NPP perimeter is slightly increased. However, the impact of these facilities on exposure to radiation decreases rapidly with distance and is negligible at the Krško NPP perimeter and at greater distances.

Atmospheric discharges from Krško NPP

Radionuclides in atmospheric emissions differ significantly in terms of both emission properties and released activity. The most important groups of radionuclides in the case of Krško NPP, just as with other nuclear power plants, are the following:

- noble gases that are exclusively external emitters and significant with regard to external exposure during cloud passage;
- H-3 and C-14, which only emit beta particles and are biologically significant in the case of intake into the body; particularly as result of inhalation, and also via plant pathways in the case of the C-14 isotope;
- beta/gamma emitters in aerosols (isotopes of Co, Cs, Sr, etc.) via pathways: inhalation, external radiation from deposition, ingestion of radionuclides deposited on plants;
- isotopes of iodine in various physical and chemical forms, significant in the case of inhalation during cloud passage and as a result of intake into the body with milk.

The table below shows the evaluation of emissions by model calculations of dilution factors in the atmosphere for 2014 and for individual groups of radionuclides the most important pathways.

Table 64: Doses resulting from atmospheric emissions from Krško NPP for 2014 in the settlement of Spodnji Stari Grad

Type of exposure	Pathway	Most significant radionuclides	Annual dose (mSv)
external radiation from cloud	Immersion (cloud)	radioactive noble gases (Ar-41, isotopes of Xe)	3,1E-7
	Radiation from deposition	aerosols (I and Co isotopes, Cs-137, etc.)	6,4E-13
inhalation	cloud	H-3, C-14, I-131, I-133	3,2E-6
ingestion	Plant-based food	C-14	0

Table 65: Doses resulting from atmospheric emissions from Krško NPP for 2014 at the Krško NPP perimeter

Type of exposure	Pathway	Most significant radionuclides	Annual dose (mSv)
external radiation from cloud	Immersion (cloud)	radioactive noble gases (Ar-41, isotopes of Xe)	5E-7
	Radiation from deposition	aerosols (I and Co isotopes, Cs-137, etc.)	3,5E-12
inhalation	cloud	H-3, C-14, I-131, I-133	6,8E-6
ingestion	Plant-based food	C-14	4,0E-5

All methods of public exposure were negligible in comparison to natural radiation or dose limits. In terms of size, the ingestion dose as a result of C-14 intake from drinking milk in young children and eating cereals in other age groups is more significant. The indicated effective dose for C-14 is based on measured emissions from Krško NPP and on model estimates for similar nuclear facilities.

Discharges of liquid effluent

When a nuclear power plant is operating normally, environmental concentrations of activity of released radionuclides, with the exception of H-3, are significantly below limits of detection. We therefore evaluate their impact on human beings and the environment indirectly from data on release into the atmosphere and liquid effluent. Public exposure is assessed using models that describe the spread of radionuclides via various pathways in the environment.
As part of the environmental measurements programme, measurements were taken of the water of the Sava, sediments and aquatic biota (fish). Measurements were also taken of the Krško and Brežice water supply systems, pumping stations and groundwater.
A direct impact of Krško NPP is only measurable in an increased H-3 content in the river Sava at Brežice and Jesenice na Dolenjskem, downstream of Krško NPP, where H-3 content was increased in comparison to the reference location in Krško, upstream of Krško NPP. The measured average annual concentration of tritium in the Sava at Brežice in 2014 was 0.88 ± 0.04 kBq/m^3 and 0.63 ± 0.10 kBq/m^3 at the reference sampling point in Krško. Tritium concentrations in the river Sava in 2014 are low, which is the consequence of small quantities of liquid effluent discharged from Krško NPP. There was no outage at Krško NPP in 2014. In 2013, when there was an outage at Krško NPP, the calculated increase in tritium concentration at the site in Brežice in 2013 was 3.7 ± 3 kBq/m^3 and was similar to that in other years when there was an outage at Krško NPP (Monitoring radioactivity in the area around Krško NPP, Report for 2014, Jožef Stefan Institute, Ljubljana, 2015).

Concentrations of I-131 activity in the Sava fluctuate noticeably in unique samples and are also frequently below the limit of detection. More realistic estimates can only be based on unique samples of unfiltered water (quarterly sampling), not on composite samples collected over a period of one month or quarterly. The isotope I-131 is also detected in other rivers in Slovenia (Report on irradiation of the population in Slovenia in 2014, ZVD Zavod za varstvo pri delu d.o.o., March 2015), which is the consequence of the use of the isotope for medical purposes. Although I-131 was also detected in liquid effluent from Krško NPP, its activity concentration in the Sava, just as in other rivers, is attributed to its use in medical institutions. I-131 is very rarely observed in soil sediment, usually with a very low specific activity.

The presence of Cs-137 and Sr-90/Sr-89 in samples of Sava water and fish is attributed to Chernobyl contamination and nuclear test explosions. Average Cs-137 activity concentrations in other rivers throughout Slovenia are comparable to those measured in the Sava near Krško NPP (Report on irradiation of the population in Slovenia in 2014, ZVD Zavod za varstvo pri delu d.o.o., March 2015). A comparison of measurements taking into account measurement uncertainty shows that the impact of Krško NPP as a result of Cs-137 and Sr-90/Sr-89 in liquid effluent is non-quantifiable.

The highest measured concentrations of tritium in the water supply network and at pumping stations in 2014, as in the past, were at the Brege, Drnovo and Spodnji Stari Grad pumping stations. Authors have not established a direct connection between liquid effluent from Krško NPP and tritium concentration in the water supply network (Monitoring radioactivity in the area around Krško NPP, Report for 2014, Jožef Stefan Institute, Ljubljana, 2015).
A model calculation based on liquid effluent and data on the annual flow rate of the river Sava, and taking into account the characteristics of the reference group, showed that the highest annual effective dose resulting from effluent into the river Sava in a year for an adult in 2014 was 0.65 μSv at the reference location 350 m below the Krško NPP dam, where the majority of the dose is caused by C-14. The estimated dose is around 50% higher than in 2013, which is the consequence of taking into account C-14, which has a large bioaccumulation factor. At the location in Brežice, the estimated annual effective dose of an adult member of the population as a result of the discharge of effluent into the river Sava is 0.32 μSv.

Natural radiation

Measurements of external radiation in the surroundings of Krško NPP in 2014 confirmed findings from the past that it is a typical natural environment such as is also found elsewhere in Slovenia and around the world. The annual dose of gamma radiation and the ionising component of cosmic radiation in the surroundings of Krško NPP was on average 0.76 mSv per year outdoors, while the dose for indoor premises was estimated in 1998 as being 0.83 mSv per year. To this it is necessary to add the contribution of neutron cosmic radiation, which for the Krško NPP area is 0.1 mSv per year. Thus the **total effective dose of external radiation in 2014 in the surroundings of Krško NPP was 0.74 mSv per year**, which is comparable to the world average (0.87 mSv per year).

Measurements of natural radionuclide content in food shows values that are comparable with average values around the world. For the effective dose from ingestion, we can therefore recapitulate the conclusions from UNSCEAR 2000 (source: UNITED NATIONS, Sources and effects of Ionising Radiation, Report to the General Assembly with Scientific Annexes, United Nations Scientific Committee on the Effects of Atomic Radiation, (UNSCEAR), UN, New York, 2000).

Individual contributions to the natural radiation dose are shown in the table below. The total annual effective dose is estimated at 2.31 mSv, which is very close to the world average of 2.4 mSv per year (UNITED NATIONS, Sources and effects of Ionising Radiation, Report to the General Assembly with Scientific Annexes, United Nations Scientific Committee on the Effects of Atomic Radiation, (UNSCEAR), UN, New York, 2000).

Table 66: Contributions to the annual effective dose as a result of natural radiation in the surroundings of Krško NPP

Source	Annual effective dose (mSv)
Gamma radiation and directly ionising cosmic radiation cosmic neutrons	0.64 0.1
Ingestion (K, U, Th)*	0.27
Inhalation (short-lived daughters of Rn-222)	1.3
TOTAL	**2.31**

* Monitoring radioactivity in the area around Krško NPP, Report for 2014, Jožef Stefan Institute, Ljubljana, 2015

Chernobyl contamination and nuclear test explosions

Of all the isotopes deriving from the Chernobyl disaster and nuclear test explosions, only Cs-137 and Sr-90 are still measurable in the soil.

The contribution of Cs-137 to external radiation was estimated at less than 0.03 mSv per year, which is 3% of the average annual external dose from natural radiation in the surroundings of Krško NPP. The estimate is comparable to those in past years.

The predicted effective dose as a result of inhalation of radionuclides that are the consequence of general contamination is estimated at 0.6 nSv per year for an adult individual.

Traces of Cs-137 and Sr-90 from nuclear tests and the Chernobyl disaster were measured in individual types of food. The effective dose as a result of eating such food was for 2014 estimated to be (0.10 ± 0.01) μSv per year for Cs-137 and (0.80 ± 0.08) μSv per year for Sr-90, which is a total of around 1.5% of the annual effective dose from natural radionuclides (without K-40) in food. The estimated dose is comparable to those from previous years.

A summary of exposure of the public in the area around Krško NPP for 2014 is given in the table below, which shows the contributions of natural radiation, the impacts of Krško NPP and residual impacts of Chernobyl contamination and nuclear test explosions.

Table 67: Annual effective doses per capita from the area around Krško NPP

Source	Pathway	Annual effective dose (mSv)
Natural radiation	gamma radiation and ionising cosmic radiation cosmic neutrons	0.64 0.1
	ingestion (K, U, Th)	0.27
	inhalation (short-lived daughters of Rn-222)	1.30
	Total natural radiation	**2.31**
Krško NPP atmospheric discharges	direct radiation from Krško NPP facilities external radiation from cloud	undeterminable 5,4E-7

Source	Pathway	Annual effective dose (mSv)
	external radiation from deposition (isotopes of I, Co and Cs-137) inhalation from cloud (H-3, C-14) ingestion (C-14)	3,5E-12 6,8E-6 4,0E-5
Krško NPP discharges of liquid effluent (Sava)	reference group (350 m below Krško NPP dam) adult individual Brežice	6,5E-4 3,2E-4
Chernobyl contamination and nuclear tests	external radiation ingestion inhalation	< 0.03 8,6E-4 6E-7

*the total amount of Krško NPP contributions is not stated, since contributions are not additive in that they do not relate to the same groups of the population

Findings:

- In 2014 all radiation impacts of Krško NPP at the perimeter and 350 m downstream of the NPP dam on the surrounding population were estimated at less than 0.7 µSv per year.
- The estimated value is negligible in comparison to authorised limit doses for the population in the area around Krško NPP (50 µSv per year at a distance of 500 m and 200 µSv at the Krško NPP perimeter).
- The estimated value is negligible in comparison to the annual dose limit for the population, which is 1 mSv per year.
- The estimated value is lower than 0.03 % of the typical unavoidable natural background.
- Atmospheric and liquid effluent discharges from Krško NPP are comparable to those from similar nuclear power plants in Europe.

4.4.11.2 **Baseline measurements**

In 2006 and 2007 ARAO conducted a programme of baseline measurements of radiological status in the Vrbina location.

The purpose of the measurements was to obtain more data on the initial radiological status in the nearfield and farfield areas of the potential site and to supplement the data that are otherwise available from operational monitoring of Krško NPP. The results of the measurements will later be the basis for evaluation of the impact of operation of the radioactive waste repository on the environment and on humans.

Measurements of external radiation were carried out in the area of the repository, measurements of radioactivity of air, rainwater, groundwater and soil were carried out in the immediate surroundings (nearfield), and measurements of drinking water, food and the river Sava were carried out in the wider area (farfield).

Baseline radioactivity measurements showed that external radiation and contamination of the land in the area of the LILW repository site in Vrbina are typical for the standard natural environment. Contamination with Cs-137 and Sr-90 as a result of global contamination resulting from the Chernobyl disaster and bomb tests is within the framework of expected values for Slovenia.
Measurements of aerosol contamination showed that concentrations of radioactive isotopes at the Vrbina site correspond to the concentrations measured in the context of radiological monitoring of Krško NPP.
The results of radioactive isotope concentration measurements in groundwater samples from shallow boreholes are within the range of the values measured in the Krško water supply system and its pumping stations.

In addition to natural radioactivity and global contamination with Cs-137 and Sr-90, measurements carried out on samples from the river Sava covered I-131, which is used in diagnostics and therapy, and tritium. The increased tritium concentration behind the Krško NPP dam is the result of discharges of liquid effluent from Krško NPP.

Measurements of soil contamination showed the presence of natural radionuclides and global contamination. The soil is not contaminated with isotopes deriving from Krško NPP. Cs-137 and Sr-90 are no longer detected in strata deeper than 0.5 m. At greater depths, a dependence of concentrations of natural radionuclides on the geological composition of the strata is observable. In shallower strata, the distribution of natural radionuclides is uniform.

Measurements of radon concentration carried out at the repository site show that values are similar to those in the external environment elsewhere in Slovenia and are lower than 20 Bq/m^3.

Measurements of external radiation at the repository site were carried out using a grid with a resolution of 10 m. The average value of the absorbed dose in the air was 77 ± 5 nGy/h. The radiation field at the repository site is relatively homogeneous, without extreme values. The figure below shows the dose field at the site of the planned repository (Final report on the implementation of measurements under the programme of baseline measurements of radiological status at the potential Vrbina site, Jožef Stefan Institute, October 2007).

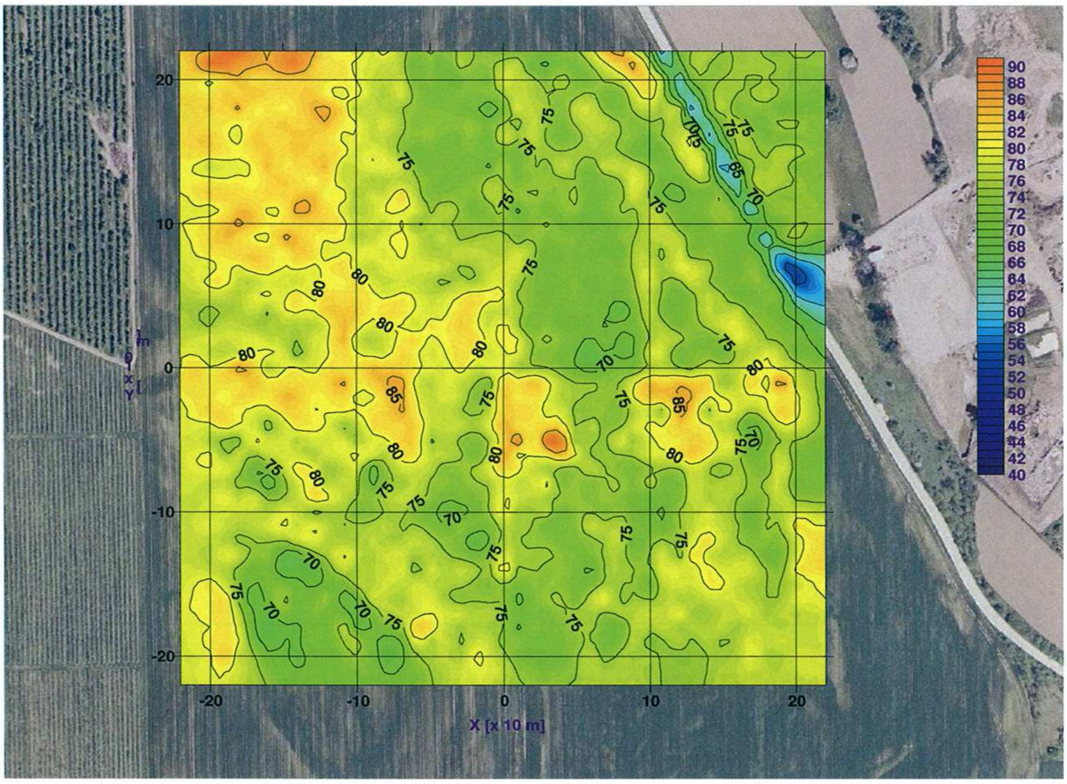


Figure 93: Dose field at the planned repository site

The figure comes from the reference Final report on the implementation of measurements under the programme of baseline measurements of radiological status at the potential Vrbina site, Jožef Stefan Institute, October 2007.

4.4.12 *ELECTROMAGNETIC RADIATION LOAD IN THE AREA*

Under the provisions of the Decree on electromagnetic radiation in the natural and living environment (Official Gazette of the RS 70/96, 41/04-ZVO-1), areas in the natural and living environment are categorised as Level I areas or Level II areas, depending on the sensitivity of the area in question to the effects of electromagnetic radiation.

- Level I protection from radiation applies to areas that require increased protection from radiation. Level I areas include hospitals, health spas, convalescent homes and tourist facilities designed for habitation and recreation, pure residential areas, areas containing educational facilities and basic healthcare services, sports fields and public parks, public green areas and recreation areas, commercial/business/residential areas that are simultaneously designed for habitation and small business or similar manufacturing activities, public centres where administrative, commercial, service or hospitality activities take place, and those parts of an area destined for agricultural activities that are simultaneously designed for habitation.

- Level II protection from radiation applies to areas where developments that are more intrusive because of radiation are permitted. Level II areas include above all areas without dwellings destined for industrial, light industrial or other similar manufacturing activities, transport, warehousing or service activities and all other areas not defined in the preceding paragraph as Level I areas. Level II protection from radiation also applies to areas in a Level I area that are destined for public road or rail transport.

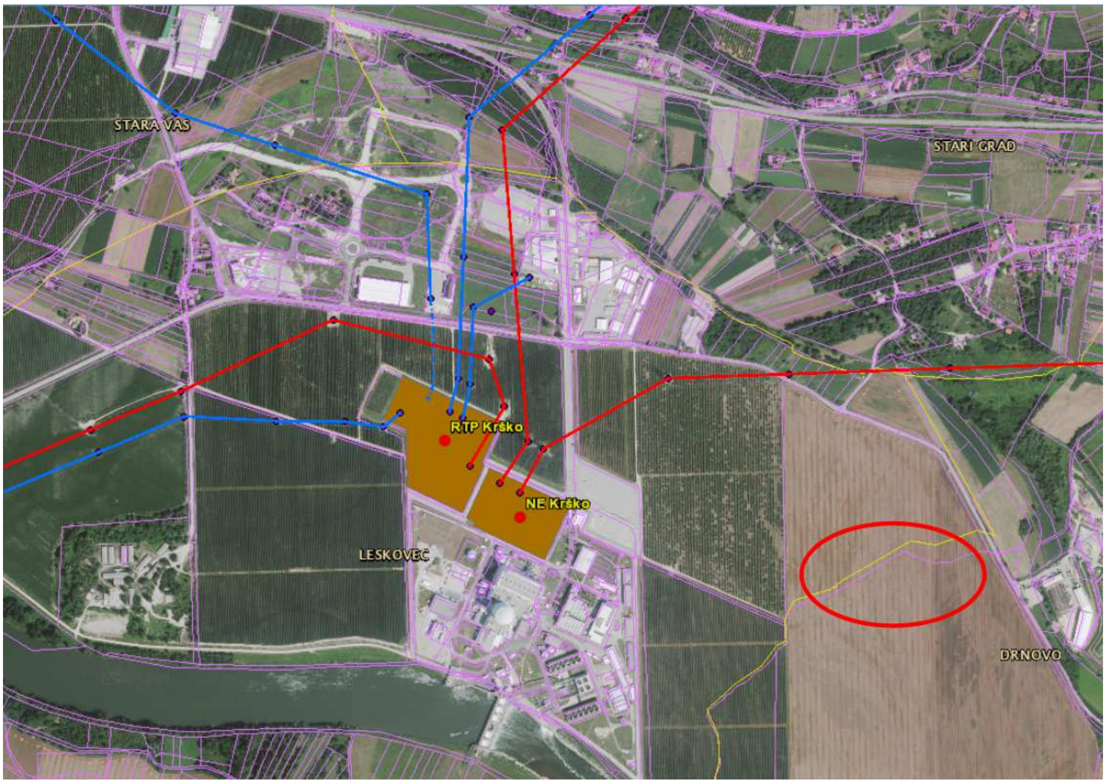


Figure 94: Sources of EMR in the surroundings of the planned development (the nearest being the 2x400 kV Zagreb–Krško transmission line).
Source: http://arcgis1.eles.si/ELES_GIS/

The development site is more than 40 m (approximately 100 m) away from the axis of the Zagreb–Krško transmission line at its closest point (see figure above).
Elements that belong in an area of increased protection from radiation are partially or fully located within a belt 40 m to the left and 40 m to the right of the transmission line axis. Since it is not possible to reduce the impacts of electromagnetic radiation in these elements, the developer must ensure a change to the purpose of use of the area that makes it possible to classify them as Level II areas in line with the provisions of Article 3 of the Decree. The frequency of the electromagnetic radiation which the transmission line, as a source of electromagnetic radiation, emits into the natural and living environment is 50 Hz and is therefore classified as a *low-frequency radiation source*.

4.4.12.1 *LIGHT POLLUTION IN THE AREA*

The development site is not illuminated.
Illumination is present from other sources in the surrounding area (Krško NPP, Spodnji Stari Grad Waste Management Centre).
Environmental light pollution is the emission of light from light sources that increases the natural illumination of the environment. Environmental light pollution causes illumination that is disturbing to human eyesight and causes a sensation of glare, is a risk to road safety because of dazzle, disturbs the life or migration of birds, bats, insects and other animals because of direct and indirect emission towards the sky, endangers the natural balance in protected areas, interferes with professional or amateur astronomical observation and, through emission towards the sky, consumes electricity unnecessarily.

The biggest contribution to light pollution is made by those light sources or lights that have a luminous flux oriented towards the sky. The proportion of a luminous flux that radiates upwards is the ratio between the luminous flux emitted in a direction above the horizontal and the total luminous flux emitted from bulbs or lamps within a light source. The entire luminous flux coming from a light body is taken into account, but not reflected light from the area around the lamp (e.g. from a supporting pole, from the ground and from other illuminated objects). Skywards emission of light is emission in a direction above the horizontal. Thus it is not only the strength of a light, but above all its the form that prevents light emission above the horizontal.

Illumination with environmentally friendly lights in accordance with the *Decree on limit values for environmental light pollution (Official Gazette of the RS 81/07, 109/07, 62/10, 46/13)* uses lights of which the proportion of luminous flux emitted upwards is equal to 0%.

Figures obtained from the municipality of Krško are given below. As can be seen from the table below, the target value (44.5 kWh/inhab.) set by Article 5 of the Decree on limit values for environmental light pollution is exceeded in the municipality. The limit value is exceeded in the municipality of Krško a little more than twice over (103.7 kWh/inhab.). The table indicates the envisaged consumption for the municipality of Krško, which is the calculated consumption that the municipality intends to achieve following renovation/repairs to public lighting throughout the municipality.

Table 68: Annual electricity consumption for public lighting in the municipality of Krško, showing planned repairs to public lighting (PL)

PL municipality of Krško			
	Current state	Planned	
power of all PL lights	614,338.00	260,970.00	W
electricity consumption for PL	2,675,906.00	1,143,048.60	kWh/year
population of the municipality of Krško	25,795	25,795	inhabitants
per capita consumption for PL	103.74	44.31	kWh/inhab.

4.4.13 *ODOUR POLLUTION IN THE AREA*

Unpleasant odour occurs when a person exposed to particular emissions perceives them as unwanted or a nuisance. A nuisance is not necessarily harmful to health, but it is disturbing on the basis of personal mental perception.
The main factors influencing the perception of unpleasant odours are:

- intensity,
- duration of exposure,
- frequency of occurrence of unpleasant odours,
- tolerance and expectations of the subject.

Foul smells are caused by substances with an intense odour such as mercaptans, ammoniac (NH3), hydrogen sulphide (H_2S), some ketones and substances that develop during anaerobic decomposition. In concentrations that are detectable by odour, they are not harmful to health but are a nuisance.

Evaluation and identification of unpleasant odours is not yet regulated by Slovenia legislation. Odour is measured in so-called odour units (OU). An odour concentration of 1 OU/m^3 means an odour at the limit of detection; 5 OU/m^3 is the limit of detection of an odour in an open environment where people are exposed to natural odours; 10–20 OU/m^3 is a concentration that already represents a nuisance if frequently achieved; 50 OU/m^3 is the limit of the area where a foul odour is already strongly perceived (prN 13725 standard). Regardless of the harmfulness to health, unpleasant odours at a concentration of above 1 OU/m^3 are regarded as odour pollution.

In nature dilutions takes place by mixing polluted air with clean air, so the pollution of air with unpleasant odours decreases rapidly as the distance from the source of emissions grows. The spread of unpleasant odours depends on meteorological factors (wind direction and speed, stability of the atmosphere, precipitation) and natural filters (forest). Odours spread furthest in the direction of the wind from the odour source. The condition for the spread of unpleasant odours over greater distances is a light wind (< 1 m/s) without turbulence (stable, non-turbulent atmosphere). In the case of stronger winds, a stronger mixing of air is present, and thus a dilution of substances that represent unpleasant odours.

Within the area of the planned development and its immediate surrounding area, odour measurements have not been carried out, according to the information available to us. The Republic of Slovenia does not have regulations governing the emission or immission of odours. In view of the fact that the greater part of the area under consideration is covered by agricultural land, we estimate that in spring and summer a source of odours is occasionally present in places as a result of agricultural activity (fertilisation with slurry). Another source of odours in the area of the planned site of the development may be represented by the closed urban waste landfill (landfill gas) and the Spodnji Stari Grad Waste Management Centre (composting).

5. IMPACTS OF THE DEVELOPMENT ON THE ENVIRONMENT AND HUMAN HEALTH

Assessment of the expected environmental impacts is carried out for the period of construction and operation of the planned activity, but also includes impacts during and after abandonment of the activity (LILW disposal). Cumulative impacts are also taken into account in the assessment.

Depending on the characteristics of the development, environmental impacts can arise during construction of the LILW repository, during operation and after the abandonment of the activity of LILW disposal (taking into account cumulative effects), namely: impacts on air, water, soil, nature, landscape, waste generation, noise emissions, electromagnetic radiation and light pollution.

Impacts during the construction of the LILW repository will be short-term, as will impacts in the first phase of abandonment of LILW disposal activities, since some small-scale demolition work will be carried out. Impacts during operation and after abandonment of the activity will be long-term. In addition, at the time of construction, operation and after the abandonment of the activity, we can talk about direct impacts of the activity on elements of the environment (water, air, soil, plant and animal species, the generation of noise and waste, etc.) and indirect impacts that may affect human health, plant and animal species, the landscape and nature conservation areas due to pollution of the environment with noise, waste and emissions. We can also talk about the long-distance impacts that the development might have on the wider environment.

5.1. STARTING POINTS AND METHODS FOR THE EVALUATION OF IMPACTS

In accordance with Article 9 of the *Decree on the content of the report on the impacts of a planned development affecting the environment and the method of drafting such a report*, it is necessary to describe and assess potential impacts during construction, use or operation, or for the duration of the activity concerned, as well as during and after abandonment of the activity. The table below shows the phases of the repository covered in the assessment of all envisaged possible impacts by phase, as defined by the Decree:

Phases of impact assessment under the Decree	Phases of the repository
Construction:	— Construction of the repository
Operation:	— Trial operation — Regular operation — Standby phase and preparation for renewed operation
Abandonment of the activity and later:	— Activities for closing the repository and its decommissioning — Active long-term control and monitoring phase — Phase of passive long-term surveillance — Establishing unrestricted use of the physical space

Environmental impacts due to construction and operation of the planned activity, taking into account impacts during the abandonment of the activity of LILW disposal, were evaluated by ranking them on a scale. This is limited on the one hand by the assessment of the actual state of an individual component of the environment, and on the other by the prescribed admissible load on the environment or the maximum permitted scope of changes as a result of the activity.

In the evaluation, the existing situation is taken as the starting point. For the evaluation of the impacts of the activity and acceptability of environmental loads and changes, a five-point scale is used, which assesses the load placed on the individual components of the environment and the acceptability of the expected changes; it is not, therefore, a direct conversion of quantified changes of environmental components into assessment scores, but an appropriate interpretation of the expected changes. For some components of the environment, standards and norms (limit values) are prescribed; for some there are data and baselines in foreign literature and regulations; for the remainder, the assessment of impact and acceptability is a matter of the expert judgement of the assessor.

Determination and evaluation of the environmental impact of an activity, in case of the activity in question, involves aspects such as:
- pollution of the environment,
- degradation of the environment,
- damage to the environment,
- risks and hazards for the environment,
- use and exploitation of natural resources.

The scale for evaluation of the impacts of operation also included cumulative effects that may occur in a particular component of the environment.

Table 69: Impact evaluation scale

no impact	**0**	change in the environmental component is non-existent or insignificant
NEGATIVE SCALE OF EVALUATION		
impact is ***insignificant***	**1**	insignificant or little relevant quantitative or qualitative change in the environmental component
impact is ***moderate***	**2**	quantitative and/or qualitative change in the environmental component is moderate
impact is ***strong***	**3**	quantitative and/or qualitative change in the environmental component is strong - at the permissible limit (reaches the maximum permissible concentration - MPC) but is still acceptable
impact is ***inadmissible***	**4**	quantitative and/or qualitative change in the environmental component exceeds legally prescribed limits - the impact on the environmental component excessive, therefore impermissible

5.2. CUMULATIVE IMPACTS

Cumulative environmental impacts may occur during construction, operation, and during and after the abandonment of the activity.

In the wider area of the LILW repository construction site, the following is also planned during the construction phase:
- the construction of a new route of the regional road from Krško to Brežice is the subject of a separate detailed plan of national importance, but the two spatial plans overlap in the area of the road connection to Krško NPP. The reconstructed local road from the area of the LILW repository will be connected to the planned new route via the southern arm of the Spodnji Stari Grad 1 roundabout.

The timetable for building the complete regional road from Krško to Brežice is not yet known (detailed plan of national importance is still in the process of being adopted). Despite this, Krško NPP, as the funder of construction of the repository, will begin building the above arm or section of regional road in order to ensure the safe and reliable transport of radioactive waste from Krško NPP to the final destination, i.e. the LILW repository. Construction is

therefore envisaged of two roundabouts – Krško NPP and Spodnji Stari Grad – and the section of road between them.
South of the planned site for construction of the LILW repository:

- Construction of the Brežice HPP reservoir was completed in 2017. Construction of the reservoir does not physically encroach upon the area of the detailed plan of national importance for the LILW repository. As a result of construction, however, certain changes have occurred which are already being taken into account as the existing situation.

Cumulative impacts during construction may occur due to existing illumination in the immediate area of the planned development and additional illumination due to construction works, should the works take place in the evening or at night; in other words there will be illumination for safety reasons both during construction and during operation.

There are also existing activities near the site (the nearest ones being Krško NPP with its access road and car park in the west and the closed municipal landfill with the Spodnji Stari Grad Waste Management Centre in the east). A few kilometres further to the south are the Kostak gravel pit and a Safe Driving Centre which, with their own emissions (emission of contaminants into the air and emission of noise from transport and operation), can place additional pressure on the environment during construction and operation. In the case of Krško NPP, the preparation of waste for disposal in the LILW repository and the transport of waste from Krško NPP to the LILW repository is taken into account as cumulative during operations.

During construction and operation and during and after abandonment of the activity, the environment may be burdened with more noise and a larger amount of generated waste as a result of cumulative impacts. There may also be greater environmental impacts on nature and the landscape and higher emissions into the air, into water, etc.

Cumulative impacts are considered in individual segments or elements of the environment during construction, operation and abandonment of the activity and thereafter. They are taken further into account in measures and are also considered during evaluation of the environmental impacts of the development and the acceptability of environmental loads and changes.

Emissions of contaminants into air, water and soil, noise emissions and waste generation of course have a significant direct or indirect impact on people and their health, **so one can also speak about potential environmental burdens and potential pressures on human health**.

5.3 IMPACTS OF THE DEVELOPMENT ON THE ENVIRONMENT AND HUMAN HEALTH

5.3.1 *IMPACTS ON AIR*

DURING CONSTRUCTION

All the works will be carried out in a compact area, so special transport routes on the construction site itself are not envisaged. All material is to be transported to the construction site by existing roads, along which the removal of excess material will also take place. Appropriate arrangements will be made on these roads.
The biggest sources of air pollution during construction will be represented by construction machinery (lorries, excavators, bulldozers, etc.). Construction work is expected to take place in daytime only, and will include earthmoving, construction of infrastructure, concreting, asphalting and finishing works. During construction of the underground concrete wall (diaphragm), it is planned that the site will also operate outside regular working hours (at night and on Saturdays, Sundays and holidays).

Impacts on air quality during construction will be noticeable above all because of increased emissions of dust particles from construction works, emissions from traffic as a result of operation of construction machinery and lorries delivering and removing material and transporting bulk construction materials.
The largest amount of dust emissions will be generated during construction of the embankment – during handling of earth materials and during the actual construction of facilities and external arrangements. Dust emissions will also be generated during the transport of earth and construction materials along unpaved roads within the construction site. Dust emissions will be greater on dry and windy days, when appropriate mitigating measures will need to be considered.
Exhaust gas emissions will also be generated on the construction site: carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO_X), etc., as a result of the use of various machinery (transport vehicles and construction machinery). We consider that emissions of exhaust gases into the air, taking into account the fact that all construction machinery and transport vehicles must be technically sound, will be insignificant.

Under the provisions of the Decree on the prevention and reduction of particle emissions from construction sites, a report on the prevention and reduction of particle emissions from construction sites must be drawn up and enclosed with the project implementation document for construction sites that meet at least one of the following conditions:

- construction works are carried out on the site for more than 12 months,
- the construction site is located in the territory of a settlement with town status or in a brownfield area and the surface area of the construction site exceeds 4,000 m^2 or its volume exceeds 20,000 m^3,
- the surface area of the construction site exceeds 10,000 m^2 or its volume exceeds 20,000 m^3.

The surface area of the construction site will be more than 10,000 m^2 and construction will last for more than 12 months. **For this reason a report on the prevention and reduction of**

particle emissions from construction sites must be drawn up during preparation of the project implementation document.

Impacts on air during construction will be time-limited – short-term.

Assessment of PM_{10} pollution of the environment

In order to estimate pollution of the development site with PM_{10} particulate matter, we carried out model calculations for a single construction lot, building the embankment, construction of facilities and silo 1 and construction of silo 2. The model calculations took into account the impact of transport and construction of infrastructure.
The model was created by Kova d.o.o. as part of background documentation for the EIA.[116]

An Austal View TG 6.0.0 Lagrangian particle tracer was used for the modelling. The source of meteorological data was the nearby Cerklje airfield. The model used an hourly frequency of calculated wind fields in the period 1 January 2014 to 1 January 2015. The dimension of the area of calculation of PM_{10} particles concentration was 2,000 x 1,400 m during construction of the embankment and 3,000 x 1,400 m during construction of facilities and silos 1 and 2. Ground roughness was set at 0.2 m in the calculations. Calculation of a three-dimensional wind and turbulence field was carried out on the basis of temporal wind data, data on topography and barriers.

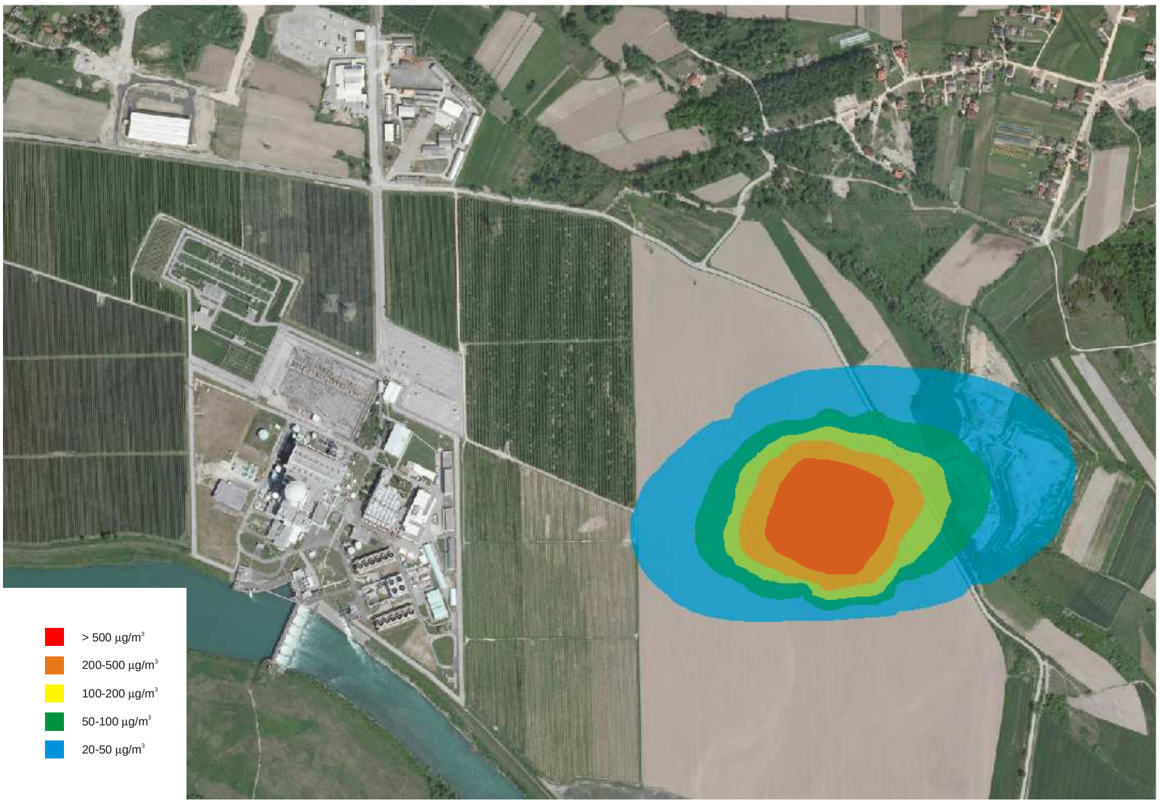


Figure 95: PM_{10} concentration in the area around the development site during construction of the embankment

[116] Background documentation for the EIA for the LILW repository, Air quality, ERICo d.o.o., DP 401/06/15, August 2015 – supplemented following review in November 2015.

During construction of the embankment, a localised increased concentration of PM_{10} particles can be observed, which falls steeply as the distance from the site increases to values that are lower than the daily limit value of 50 µg/m^3 for the protection of human health prescribed in the *Decree on ambient air quality (Official Gazette of the RS 09/11 and 8/15)*. The model calculation shows that the concentration is slightly increased in the direction towards the Spodnji Stari Grad Waste Management Centre. The calculations were made taking into account the highest possible particulate loading for the entire period of construction of the embankment.

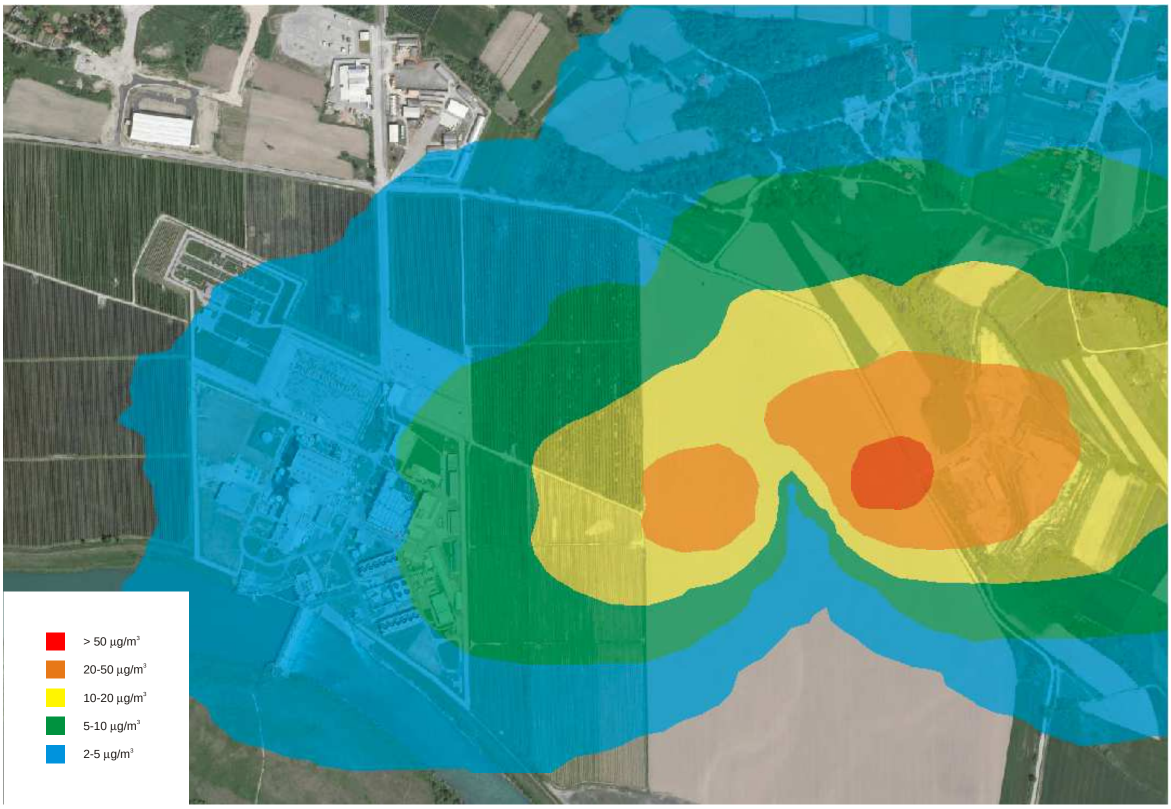


Figure 96: PM_{10} concentration in the area around the development site during construction of facilities and silo 1

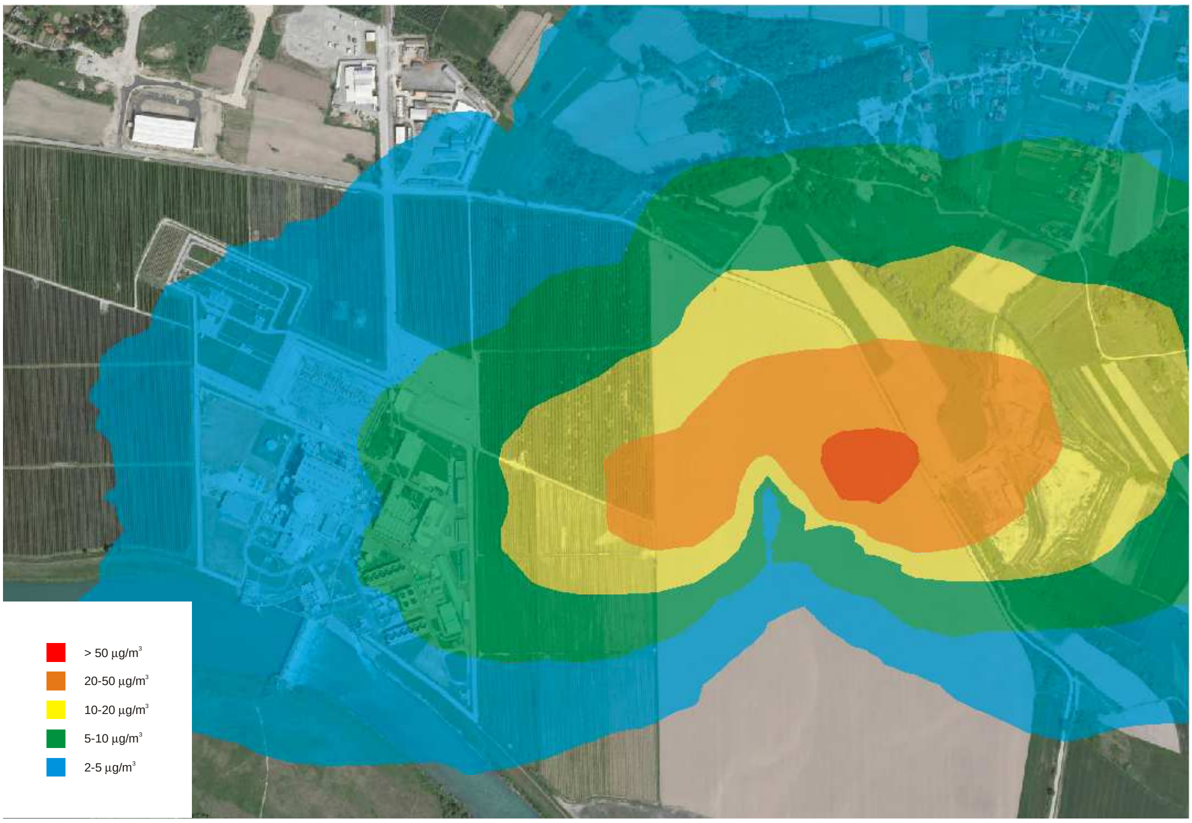


Figure 97: PM_{10} concentration in the area around the development site during construction of silo 2

During construction of facilities and silos 1 and 2, the concentrations calculated on the basis of model calculations are lower than the concentrations calculated during construction of the embankment. As with the model for construction of the embankment, the high PM_{10} concentration (50 µg/m^3) is limited to the immediate area of the development site.
We find on the basis of model calculations that PM_{10} concentrations at the nearest residential buildings will not be exceeded as a result of construction of the development in question.

The model calculations show that PM_{10} concentrations at the development site are low and will not excessively pollute the environment. Despite this, it is necessary to consider measures to reduce emissions during construction. These will need to be prescribed in detail in the report on the prevention and reduction of particle emissions from the construction site.

Cumulative impacts:

Cumulative impacts will be reflected as a result of construction of the road section in the north, which is part of the regional Krško–Brežice road, and construction of the Krško NPP roundabout – all to ensure safe and reliable transport of radioactive waste from Krško NPP to the final destination, i.e. the LILW repository. We must also take into account the existing state of the area with activities such as Krško NPP with its access road and car park and the Spodnji Stari Grad Waste Management Centre.

Pollution of the air with emissions of dust particles and exhaust gases from transport vehicles and site machinery during construction can be reduced through suitable planning of construction works and the use of technically sound vehicles and machinery. Weather conditions will also need to be taken into account.

Additional air pollution will occur during construction, but this impact will be short-term in nature. We consider that excessive air pollution resulting in a deterioration of air quality will not occur. We estimate impacts on air during construction, taken together with cumulative impacts, to be moderate (2).

Transboundary impacts

At the time of construction, there will be additional air pollution, but the pollution will be quite local, limited to the area of the construction site.
There will be no transboundary impacts during construction, since impacts are limited to the construction site itself (taking into account cumulative impacts).

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING OPERATION

Emission of pollutants into the environment during operation will occur:

- above all as a result of transport of LILW to the repository
- and filling voids in the silo with cement grout or concrete.

Installation of immovable sources of air pollution that would cause the emission of pollutants into the air is not planned at the LILW repository. Ventilation devices will be installed in the facility, but these will include a HEPA filter before release into the atmosphere. All discharges from ventilation will be radiologically controlled. Ventilation will be installed in the technological facility and disposal units (silo – access shaft).
Heating in the facility will be via a heat pump, which does not represent a source of air pollution.
Large quantities of gases are not expected to be generated in the silos during operation, mainly because there will be no free water present and waste will be in aerobic conditions. Nevertheless certain reactions could occur between individual materials, and could produce gases as a result. Possible reactions between individual materials include:

- corrosion of metallic materials (corrosion of aluminium – generates hydrogen),
- degradation of organic materials (degradation of cellulose – generates carbon dioxide),
- radiolysis (radiolysis of water – generates hydrogen).

In the context of safety analyses it was assumed that carbon dioxide generated by cellulose degradation would dissolve in water and participate in carbonation reactions in alkaline (cement) pore water. It is therefore envisaged that carbon dioxide will not be present in the mixture of gases generated in the silo during operation. It was also considered, in the context of safety analyses, that the quantity of gas generated by radiolysis of water is small, so this was not taken into account in the context of the repository's operational safety (Source: Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repository in Slovenia, Gas Generation Processes and Design Implications, ARAO, EISFI-TR-(11)-08 Vol. 4, Rev 1. NSRAO2-PCS-010-01-eng, 2012. *EISFI consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO).*

The quantity of gas generated during the operation of the repository was estimated in safety analyses on the basis of an estimate of gas generated by the corrosion of aluminium. The model takes into account uniform and linear corrosion and the surface area of deposited aluminium. The quantity of gas generated is estimated on the basis of the equation for the gas generation rate under standard conditions (m^3/year) in the corrosion of the surface of aluminium (the ends of individual pieces are not taken into account in the calculation).

We consider that the gases that will be generated in the silos are negligible and do not represent a source of pollution.

The only significant source of emissions of substances into the air are diffuse emissions resulting from the transport of waste (LILW) to the repository, lorries transporting filler material and the private cars of employees. Filling voids in the silo with cement grout or concrete will be carried out once a year, and the filling process will last approximately one month (an estimated total of 100 lorries to transport the grout or concrete). The transport of material will represent the only source of diffuse emissions, since the material for filling the voids in the silo will be delivered in a pre-prepared state.

Pollution of the environment with solid particles during operation of the LILW repository was estimated in the context of the preparation of background documentation for air.[117] Solid particle pollution during operation was estimated taking into account the expected activity of LILW transport and the dust load on paved surfaces using the methodology from EPA AP 42, Fifth Edition, Volume I, Chapter 13: Miscellaneous Sources.

The basic equation used to estimate diffuse dust emissions is:

$$E = A \times E_f \times (1 - \frac{E_r}{100}) \qquad \text{(equation 1)}$$

where:

E – emission,
A – level of activity (km driven),
E_f – emission factor (g/km driven),
E_r – reduction of emission as a result of measures, natural factors, etc.

Dust emissions from traffic are generated as a result of vehicles travelling on surfaces loaded with dust, tyre wear and combustion of fuel.

[117] Background documentation for the EIA for the LILW repository, Air quality, ERICo d.o.o., DP 401/06/15, August 2015 – supplemented following review in November 2015.

Dust emissions as a result of vehicles travelling on surfaces loaded with dust were estimated with the help of equation 2.

$$E_f = k(sL)^{0,91} \times (w)^{1,02} \times (1 - \frac{N}{4P}) \qquad \text{(equation 2)}$$

where:

E_f – emission factor (g/km driven),
k – factor for particle type (0.62 for PM_{10} particles and 3.23 for total dust),
sL – dust load of surface (g/m^2, 0.6 for roads),
w – average vehicle weight
N – number of wet days in the calculation period,
P – total number of days in the calculation period.

$$W = \frac{\sum_{i=1}^{n}(m_i \times s_i)}{s_{celotna}} \qquad \text{(equation 3)}$$

where:

W – average vehicle weight,
$_i$ – vehicle number,
m_i – mass of individual vehicle,
s_i – distance covered by individual vehicle,
$s_{celotna}$ – total distance covered by all vehicles.

Traffic emission factors for an individual load were calculated on the basis of input data on vehicle type. All transport takes place on hard surfaces – asphalt.

Transport of LILW to the repository is carried out by a vehicle with an estimated weight of 50 tonnes. The average distance covered by the vehicle in one year was estimated at 100 km. The vehicle completes 200 transports a year, at a rate of one transport per day.[118]
In addition to the transport of LILW, the filling of voids between containers will take place at the repository on an annual basis. This process will last one month. According to figures from the procurer, it is estimated that there will be 100 consignments of grout or concrete over the course of a month. The weight of an individual vehicle is estimated at 40 tonnes. The distance covered by the vehicles is estimated at 100 km.[119]
The estimate also took into account journeys by private cars. Given the planned number of parking spaces, it is assumed that 32 private cars with an estimated weight of 2 tonnes will travel to the site on a daily basis. The average distance covered by these private cars in one year is estimated at 800 km.

The estimated total PM_{10} particle load at the repository location is 18.8 g/day or 0.8 g/h. The estimate includes the transport of LILW (200 consignments per year), the filling of voids (200 consignments of material in one month per year) and personal transport by private car (32

[118] Design solutions for the LILW repository, IBE d.d., Ljubljana, IDZ, January 2016
[119] Disposal technology, NRVB 1T1010B, Design output, IBE, IDZ, January 2016

private cars). The estimate also took into account the fact that all journeys take place on a hard surface (concrete, asphalt) without mitigating measures (sweeping, washing the roadway).

According to the estimate, based on currently available data, air pollution as a result of solid particles during operation does not significantly impact air quality in the area of the LILW repository.

Cumulative impacts:
Cumulative impacts on the air will reflect the impact of local traffic along the Vrbina road, emissions from the closed urban waste landfill and the operation of the Spodnji Stari Grad Waste Management Centre in the immediate vicinity of the LILW repository. Not only that, but Krško NPP, with its access road and car park, is located to the west of the development site. During the period of operation of the LILW repository, the activity of Krško NPP includes the processing of LILW and its transport to the LILW repository.

Thus in addition to the LILW repository, there are other activities in the vicinity that pollute the air with PM_{10} particles.

- The Spodnji Stari Grad Waste Management Centre operates in the immediate vicinity, with 32 lorries and 30 private cars per day (source: email, 10 April 2015). The calculation assumes an estimated daily distance driven of 150 m and 300 operational days per year. The total PM_{10} load for the Spodnji Stari Grad Waste Management Centre is 79.0 g/day or 3.3 g/h. The estimate also took into account the fact that all journeys take place on a hard surface (concrete, asphalt) without mitigating measures (sweeping, washing the roadway).
- South-east of the site is the Stari Grad gravel pit, which operates for 260 days a year. It is estimated (by the manager of the Kostak gravel pit and quarry, via an email of 15 May 2015) that 30 lorry journeys to and from the site are made each day, for a total estimated annual distance of 780 km. The surface is paved with macadam, so a value of 70 g/m^2 (quarries and sand pits) was used for the dust load factor.[120] Total estimated PM_{10} air pollution is 2,677 g/day or 111.5 g/hour.

According to the estimate, based on currently available data, air pollution as a result of solid particles during operation has a minimal impact on air quality in the area of the LILW repository. Operation of the LILW repository contributes an insignificant part, taking into account cumulative pollution of the air with PM_{10} particles.

We consider that air quality in the area of the development will deteriorate slightly during operation, but that excessive pollution or a worsening of the level of pollution will not occur, since the direct and lasting impact on air pollution will be insignificant (1).

Transboundary impacts
There will be no transboundary impacts, as the planned activities do not provide for technological procedures or installation of facilities that would constitute an important source of emissions into the air – pollution is local in nature (only transport is significant).

[120] Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors, http://www.epa.gov/ttn/chief/ap42/index.html, August 2015.

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

During abandonment of the activity, i.e. during closure and decommissioning of the repository, environmental impacts will be similar to those during construction, but significantly smaller. Decommissioning will not in fact involve dismantling the silos, the sewage system or the Vrbina road. Air pollution will occur during decommissioning of the LILW repository as a result of emissions of dust particles and exhaust gases from transport vehicles and site machinery. Pollution can be reduced through suitable planning of construction works and the use of technically sound vehicles and machinery. Weather conditions will also need to be taken into account.

Following decommission, there will be no impact on air in the area of the development unless a new activity takes place on the site.

Cumulative impacts

We do not know what developments will be taking place in the vicinity of the LILW repository at the time that activity is abandoned (in 2061). We can, however, evaluate them as insignificant.

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Transboundary impacts

At the time of decommissioning, there will be additional air pollution, but the pollution will be quite local, limited to the area of the construction site. The planned LILW repository is about 13 km from the border with Croatia, which is significantly less than the distance from other neighbouring countries. There will be no transboundary impacts on Croatia during abandonment of the activity, since impacts are limited to the development site.

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

EVALUATION OF IMPACTS AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

Evaluation of the new development's impacts on the air takes as its starting point the existing situation, assessed on the basis of available data on air status in the area in question and its immediate surrounding area.
In our estimation, the impact of construction, operation and abandonment of the activity, together with cumulative impacts, will not cause increased environmental emissions – from the point of view of pollution, the impact will be moderate during construction (2) and insignificant during operation and during abandonment of the activity (1).

Table 70: Description and assessment of impacts of the development on air quality

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – AIR QUALITY	
Impact assessment	<u>During construction</u>: moderate impact (2) <u>During operation</u>: insignificant impact (1) <u>During decommissioning and abandonment:</u> impact during decommissioning is moderate (2); there is no impact after abandonment (0).
Impact characteristics and type	Impacts during construction, operation, and decommissioning will be direct and temporary (dust generation, exhaust gases). Cumulative effects are expected during construction and operation (construction of the Krško NPP and Spodnji Stari Grad roundabouts and the road between them, and operation of existing activities in the immediate vicinity of the LILW repository).
Likelihood of impact occurring and its consequences	The probability of air pollution occurring during construction and decommissioning is high, but of a local character. The LILW repository is not a source of unpleasant odours, so there is no likelihood that these will occur during operation.
Duration or frequency of impact and its consequences, and their reversibility	Air pollution as a result of dust generated during construction and decommissioning will last until the first heavy rainfall. Likewise pollution from exhaust gases will disperse within a few hours, given adequate ventilation.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	The impacts of the LILW repository on air quality during construction and decommissioning will not cause significant environmental changes. The degree of intensity of change in air quality will be moderate if appropriate measures are taken.
Scope of impact	The impact of dust generated during construction and decommissioning will be felt in the direct surroundings of the site. We find on the basis of model calculations that PM_{10} concentrations at the nearest residential buildings will not be exceeded as a result of construction of the development in question.
Interactions between individual impacts and their consequences	Dust generation can have minor impacts on agricultural production and natural growth, and thus an indirect impact on human health. This impact is reduced if appropriate measures are taken and disappears following the first more intense precipitation.

5.3.2 *IMPACTS ON GROUNDWATER*

This section covers evaluation of impacts on groundwater status on the basis of the criteria defined by the *Decree on groundwater status (Official Gazette of the RS 25/09, 68/12, 66/16).*

Radiological impacts of the LILW repository on groundwater are covered in the section "Environmental impacts from ionising radiation".

DURING CONSTRUCTION

The development in question will represent the greatest danger of groundwater pollution during the construction phase. Groundwater is most vulnerable in this phase because drainage is not yet regulated and site machinery is present on the construction site.

The construction of an anti-flood plateau or embankment is envisaged in the initial phase of construction. For the purposes of flood protection, it is planned that all facilities of the repository will be built on an anti-flood embankment, at a height which will be safe from the maximum expected floods. The finalisation of the platform up to the final elevation of 155.20 m above sea level will be carried out at the end of the construction of facilities, within the scope of external landscaping.

The current level of groundwater is at a depth of 4–5 m below the surface. With construction of the embankment, the distance above groundwater will increase to 7.5–8 m. The foundations of the above-ground parts of the repository will not reach down into the groundwater area. Only construction of the silo (underground construction) will encroach on the groundwater area.

Impact on groundwater quality

While construction works are being carried out, there is a possibility of groundwater pollution with motor oils and fuel from construction and transport machinery in the area of the construction site (indirect, remote impact), above all in the event of an accident involving construction machinery and transport vehicles. The most likely pollutant among fuels and lubricants is diesel fuel. Among lubricants, possible sources of pollution include machine oils, hydraulic oils, brake fluid, grease for bearings, for screw threads, etc. If machinery is adequately maintained and the construction site is suitably organised, the possibility of pollution is small.

A deterioration in the quality of groundwater could occur as a result of emissions into the soil and developments affecting the environment, such as:

- Pollution of soil through gas emissions, residues of fuel and lubricating oils, and other substances that form when means of transport and construction machinery are used. These substances can be detached from the soil by precipitation and washed into

groundwater. The pollution of groundwater with organic compounds from bituminous resins, motor fuels, lubricating oils and machine oils can be permanent;
- Pollution of groundwater with substances that are components of construction materials based on cement, lime and bitumen and other materials. Alkaline compounds can change the pH value of groundwater. This type of impact on groundwater is usually short-term and local in nature.

Pollution of groundwater with petroleum derivatives can occur above all in the following ways:
- Spillage of motor fuels when filling the tanks of site machinery and goods vehicles, which is a case of momentary pollution;
- Dripping from the engines of site machinery because of leaks, which is usually a case of quantitatively small, diffuse and slow pollution;
- Pollution of the environment with (special) waste as a result of disposal of cleaning cloths and other small waste in the area in which machinery is operated.

Impact during construction is assessed as moderate (2). The chemical status of the groundwater of the Krško Basin will not deteriorate as a result of construction of the LILW repository. We can estimate with great certainty that the chemical status will be good even during the construction phase.

Impact on groundwater quantity:

No perceptible changes in the groundwater regime (levels, movement of the surface, etc.) will occur during the construction phase. Given the size of the groundwater aquifer in the area in question, the silo represents an insignificant disturbance. The level of deterioration will be imperceptible; there will be a minor and local change to groundwater flows and levels next to the silo itself.

The excavation works as well as all other works for the silo will take place with the help of a heavy-duty tower crane, which will be set up directly by the silo (small arm) to provide the necessary carrying capacity. Excavations down to a depth of 13 m will take place in alluvial soil, then down to a final level of around 99 m above sea level in preconsolidated silt.

Given that these are soils (gravel, sandy silt), excavations can be carried out using standard mechanisation (excavators), where it will first be necessary to drain pore pressures in the Miocene silt (as a safety measure to prevent hydraulic shear). Excavations in the Miocene silt will follow the dynamics of pore pressure drainage. As can be seen from the results of the hydrogeological analysis, a minimum of 5 days would be needed for a layer 2 m thick.

So that excavations in the alluvial soil part of the aquifer can take place in dry conditions, preliminary pumping out of groundwater will be necessary.

In the area of the preconsolidated silt, particularly at greater depths, it will be necessary, in order to avoid the phenomenon of hydraulic shear, to ease pore pressure by installing pumping wells, as covered in the hydrogeological analysis.

Hydrogeological analysis of excavation of the construction pit – releasing groundwater pressure during construction is an integral part of the report Geostatic analysis of the substructure of the disposal silo (IRGO, November 2015), which is covered in plan 3/7 Strength of underground works. The findings of the hydrogeological analysis are given below.

In the area of the preconsolidated silt, especially at greater depths, in order to avoid the phenomenon of hydraulic shear it will be necessary to ease pore pressure by installing pumping wells.
The hydrological model envisages the implementation of seven wells: one in the middle of the silo and six around the perimeter at a distance of 2.5–3 m from the diaphragm wall. The wells will be built at least a further 20 m below the bottom of the lowest level of excavation. The calculation shows that at a constant rate of pumping of 0.66 l/s it will take 5–9 days to dry a 2 m thick layer of Miocene silt, which also means that it is necessary to anticipate pumping before the start of excavation works. The pumped clean groundwater will be drained outside the construction site onto the surrounding terrain, where it will then be able to return to the aquifer (as uncontaminated groundwater) or flow into the nearest drainage channel built for the requirements of Brežice HPP, where it will then return to the river Sava.

The wells will also be gradually shortened through progressive excavation. It is estimated that because of the low permeability of the silt ($k = 10^{-7}$ or 10^{-8} m/s), the quantities of seep water in the drainage system are extremely small.

Excavation of the diaphragm will progress in the presence of heavy bentonite slurry, which is intended to maintain the stability of the excavation. Given that the upper part of the wall will run through an alluvial section, partial losses of slurry are possible, but this is not expected in the lower part (more than -13 m deep), since it involves practically impermeable material ($k = 10^{-7}$, 10^{-8} m/s). The excavation material mixed with bentonite slurry will be pumped into the separator, where it will be separated from the bentonite. Further on in the cycle the bentonite is collected in a tank from which it is returned to the next excavation pit. This is a partly closed circular slurry system, where the quantity is supplemented as necessary from a special installation for preparing bentonite (in the event of losses during construction of the diaphragm).

Cumulative impacts

The closed Spodnji Stari Grad landfill (see the section on the baseline state) is already excessively polluting in its existing state. The consequence of any deterioration of groundwater quality during construction of the LILW repository will be insignificant if the remediation of the closed Spodnji Stari Grad landfill is taken into account.

In the area of the plan, the construction of a new route of the Krško–Brežice regional road is planned within the core area of the site under consideration. This is the subject of a separate detailed plan of national importance, but the two spatial plans overlap in the area of the road connection to Krško NPP. The reconstructed local road from the area of the LILW repository will be connected to the planned new route via the southern branch of the Spodnji Stari Grad roundabout.

The cumulative impact on groundwater of the implementation of other plans in combination with implementation of the LILW repository is high. The biggest impact comes from the construction of the Brežice HPP reservoir (increase in capacity), while remediation of the closed Spodnji Stari Grad landfill will result in a local improvement in groundwater quality.

Transboundary impacts:
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING OPERATION

Impact on the quantitative and qualitative status of groundwater

The repository is designed in such a way that radioactive waste is disposed of in disposal silos buried deep in the Miocene aquiclude. An appropriately high embankment is designed to ensure the flood safety of all the listed repository facilities during construction and operation and active monitoring following closure.

During operation/filling, the disposal silo is protected against the inflow of rainwater (roof above the silo) and the inflow of groundwater, where it is of key importance to prevent water inflow from reaching radioactive waste. The latter is achieved via the serial placement of radioactive waste in several hierarchical groups of containers (cask / packing cask / reinforced concrete container / fillers), which ensure the required waterproofing of the system as a whole.

No perceptible changes in the groundwater regime (levels, movement of the surface, etc.) will occur during the operation phase. Given the size of the groundwater aquifer in the area in question, the silo represents an insignificant disturbance. The level of deterioration will be imperceptible; there will be a minor and local change to groundwater flows and levels.

Operation of the LILW repository will not cause direct pollution of groundwater. Impact during operation is estimated as insignificant (1). The chemical status of groundwater of the Krško Basin will not deteriorate as a result of the operation of the repository. We can estimate with great certainty that the chemical status will be good even during the construction phase. It is likewise estimated that construction and operation of the repository will not have an impact on existing water resources used for water supply.

In this section we continue with a description of the generation and management of all wastewater that will be generated both in the radiologically controlled area of the repository and in the radiologically non-controlled area. It follows from the technical solutions that the application of all measures and design solutions means that the impact on groundwater is practically zero, as is the risk of contact between industrial wastewater and urban wastewater.

Radiologically non-controlled area

In the radiologically non-controlled part of the repository (which includes part of the technological facility of the non-controlled area, the administration and service facility, paved surfaces inside and outside the perimeter of the repository, the connecting road to the repository entrance and the Vrbina road), the following types of wastewater will be generated:

- rainwater run-off;
- urban wastewater.

Rainwater run-off will be generated as a result of stormwater flowing from the roofs of buildings and paved surfaces.
Urban wastewater will be generated through the use of washbasins, toilets and the kitchenette.

Radiologically controlled area

In the radiologically controlled part of the repository (which includes the area of the hall above the silo, the disposal silo, appurtenant paved surfaces, part of the controlled area of the technological facility), the following types of wastewater will be generated:[121]

- industrial wastewater;
- urban wastewater;
- rainwater run-off.

The management scheme – including types, maximum hourly quantities of outflows and methods of wastewater management for the entire area and repository systems – is shown for the radiologically controlled area and the radiologically non-controlled area in the figure below (source: NRVB---5T2020A).

[121] Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system, Official Gazette of the RS 64/12, 64/14, 98/15

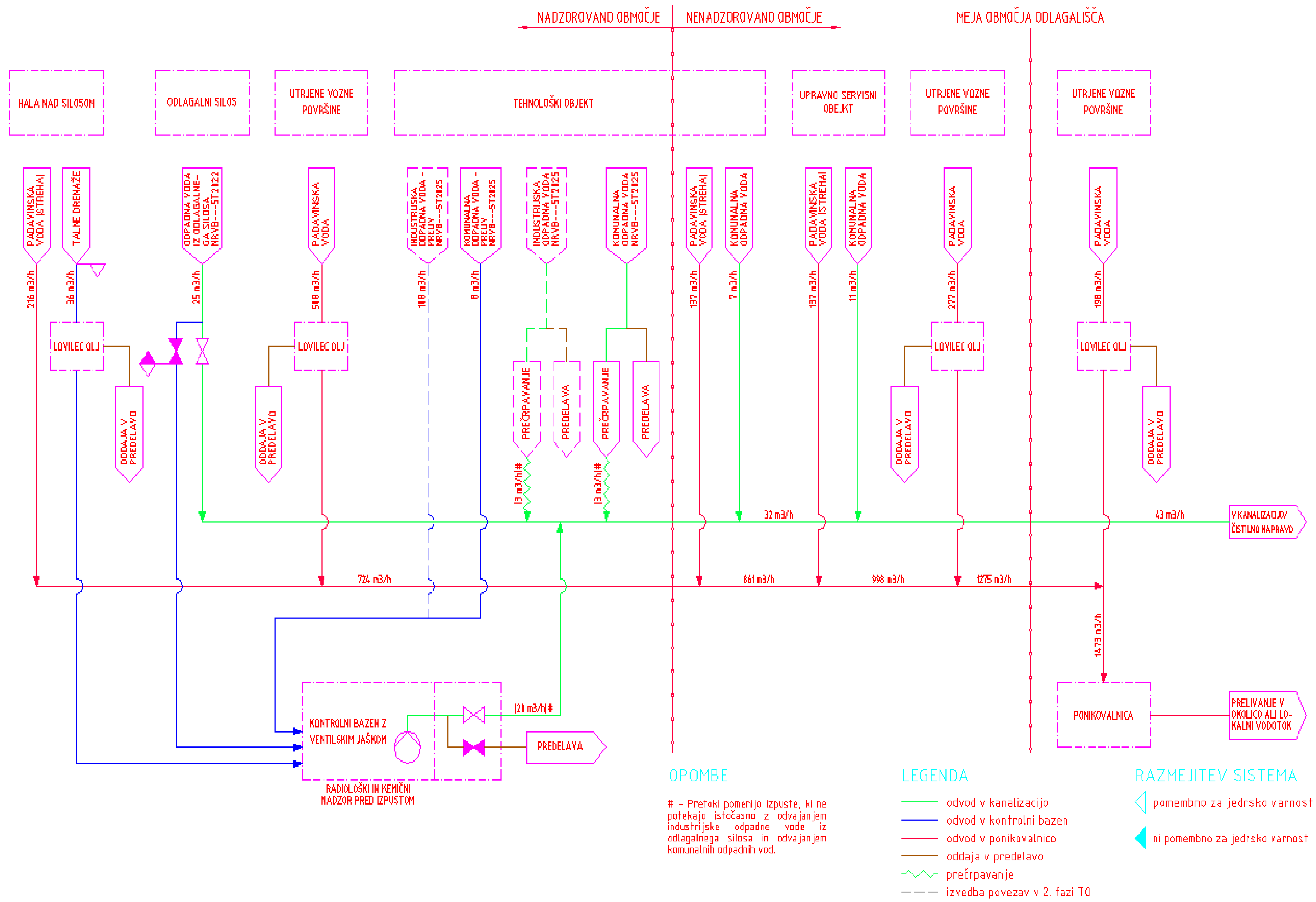

Figure 98: Management scheme for wastewater from the LILW repository

NADZOROVANO OBMOČJE	CONTROLLED AREA
NENADZOROVANO OBMOČJE	NON-CONTROLLED AREA
MEJA OBMOČJA ODLAGALIŠČA	BOUNDARY OF REPOSITORY SITE
HALA NAD SILOSOM	HALL ABOVE THE SILO
ODLAGALNI SILOS	DISPOSAL SILO
UTRJENE VOZNE POVRŠINE	SOLID DRIVING SURFACES
TEHNOLOŠKI OBJEKT	TECHNOLOGICAL FACILITY
UPRAVNO-SERVISNI OBJEKT	ADMINISTRATION AND SERVICE BUILDING
PADAVINSKA VODA (STREHA)	PRECIPITATION WATER (ROOF)
TALNE DRENAŽE	FLOOR DRAINAGE
ODPADNA VODA IZ ODLAGALNEGA SILOSA	WASTEWATER FROM THE DISPOSAL SILO
PADAVINSKA VODA	PRECIPITATION WATER
INDUSTRIJSKA ODPADNA VODA	INDUSTRIAL WASTEWATER
KOMUNALNA ODPADNA VODA	MUNICIPAL WASTEWATER
LOVILEC OLJ	OIL TRAP (SEPARATOR)
ODDAJA V PREDELAVO	SUBMISSION FOR PROCESSING
PREČRPAVANJE	RE-PUMPING
PREDELAVA	PROCESSING
V KANALIZACIJO/ČISTILNO NAPRAVO	INTO THE SEWERAGE SYSTEM/TREATMENT PLANT
KONTROLNI BAZEN Z VENTILSKIM JAŠKOM	CONTROL POOL WITH A VENTILATION SHAFT
RADIOLOŠKI IN KEMIČNI NADZOR PRED IZPUSTOM	RADIOLOGICAL AND CHEMICAL MONITORING BEFORE DISCHARGE
PONIKOVALNICA	SINK HOLE
PRELIVANJE V OKOLICO ALI LOKALNI VODOTOK	DISCHARGE INTO THE SURROUNDING AREA OR LOCAL WATERCOURSE
OPOMBE	NOTES
# - Pretoki pomenijo izpuste, ki ne potekajo istočasno z odvajanjem industrijske odpadne vode iz odlagalnega silosa in odvajanjem komunalnih odpadnih vod.	# - Flows mean discharges that do not take place simultaneously with the discharge of industrial wastewater from the disposal silo and the discharge of municipal wastewater.
LEGENDA	KEY
odvod v kanalizacijo	drainage into the sewerage system
odvod v kontrolni bazen	drainage into the control pool
odvod v ponikovalnico	drainage into the sink hole
oddaja v predelavo	submission for processing
prečrpavanje	re-pumping
izvedba povezav v 2. fazi TO	construction of links in Phase II of the TF
RAZMEJITEV SISTEMA	SYSTEM SEPARATION
pomembno za jedrsko varnost	related to nuclear safety
ni pomembno za jedrsko varnost	not related to nuclear safety

Below is a more detailed description of the management of wastewater from individual facilities.

MANAGEMENT OF INDUSTRIAL WASTEWATER

Management of industrial wastewater from the technological facility

The generation of industrial wastewater is not expected in Phase 1 of the Technological Facility (TF). In TF Phase 2 industrial wastewater may be generated periodically in the form of floor drainage when remediating the consequences of an emergency in the reserve storage facility. Activities in which contaminated wastewater can be generated chiefly include rinsing floors, decontamination of tools and equipment in the hot workshop, and decontamination of heavy vehicles in the reserve storage facility.

Another potential source of industrial wastewater is an emergency such as a fire in the part of the technological facility that will be built during TF Phase 2, for which the controlled collection of used firefighting water is planned (if fire-extinguishing takes place).

A drain is planned in the reserve storage facility of the technological facility for collecting floor drainage water. The floor drains with siphons that are installed in the measurement rooms and ventilation control room are intended primarily for controlled collection of used firefighting water. The capacity of the floor drainage system is planned for the drainage of firefighting water and amounts to 1.16 l/s. In order to prevent the discharge of firefighting water through the exits in the technological facility, each exit is fitted with a 2 cm sill.

Industrial wastewater from the floor drainage system is collected in a floor drain sump with a useable capacity of 2 m^3, which is located in the reserve storage facility in the technological facility. In the event of extinguishing a fire in the technological facility, the quantity of firefighting water used is much greater than the expected quantity of floor drainage, so the floor drain sump is connected via an overflow pipe to the control pool, which is located next to the hall above the silo. The walls and floor of the floor drainage sump are lined with a stainless steel liner, and the sump is covered with steel sheet-metal cover. The floor drainage sump is equipped with a level switch, which triggers an alarm in the control room when the tank is full, thus notifying the operators that the sump has to be emptied. On the plateau, the overflow pipe between the floor drainage sump and the control pool will be implemented as a pre-insulated pipe with leak detection.

Before emptying the sump, radiological and chemical monitoring of the collected wastewater (sampling) will be carried out. If the collected wastewater does not exceed the clearance criteria and if it meets the criteria for urban wastewater, it will (preferentially) be pumped into the sewer shaft using a portable submersible pump, and from there into the public sewage system or to the Vipap water treatment plant. Alternatively, the wastewater can be dispatched for treatment to the operator of the public utility service of removal and treatment of urban wastewater and rainwater run-off in the municipality of Krško. By agreement with the repository operator, the provider of the public service uses a suitably equipped heavy vehicle to empty the contents of the sump and transport it to the Vipap treatment plant.

If the collected wastewater exceeds the clearance criteria, it is treated as secondary radioactive waste and dispatched for treatment. The collected contaminated wastewater will be sent to Krško NPP, or suitable treatment capacities will be installed at the repository. During pumping of the contents of the tank, a temporary pumping station will be provided with adequate equipment to prevent contamination of the environment (tight joints on pipes, vacuum tank, catch basins, protective PE liners, etc.). The planned location for the temporary separator is at the reserve storage facility in the TF.

Radiological control of liquid effluent discharges

In the collection tank below the bottom of the disposal silo, a radiological monitor for monitoring the radioactivity of collected wastewater will be installed. Radiological monitoring will be carried out by taking a sample which will then be analysed using high-resolution gamma spectrometry. This monitor will take continuous measurements over regular time intervals. Such a monitoring method will allow it to be possible to ensure, on the basis of long-term monitoring of the radiological status and periodic sampling of wastewater, that the water will not exceed the limit values for release into the public sewage system. In such case, it will be possible to release the water into the public sewage system without prior sampling through the automatic activation of the pumps. Irrespective of the aforementioned possibility, the wastewater can be pumped from the collection tank into the control pool, where sampling can be carried out. This ensures that there is no flow of water into the control pool during the time from the taking of the sample to its release into the sewage system, and that the characteristics of the collected water are directly defined by sampling.
However, in cases when the radiological monitor detects increased radioactivity of water in the collection tank, the automatic activation of submersible pumps in the collection tank will be turned off and the alarm in the control room will be activated. In this case, the pumped water will be diverted to the control pool by changing the position of the valves.

Management of industrial wastewater in the hall above the silo

Industrial wastewater can only be generated in the hall above the silo in the event of extinguishing a fire on a cargo vehicle. For the purpose of collecting this wastewater, a drain is planned in the hall, from which the collected wastewater will pass through an oil trap before being discharged into the control pool. The capacity of the floor drainage system is planned for the removal of firefighting water in the event of fire extinguishing using external hydrants and amounts to 15 l/s.
At the platform, the connection pipe between the hall above the silo and the control pool will be designed as a pre-insulated pipe with leak detection.

Management of industrial wastewater in the disposal silo

Industrial wastewater accumulates in the silo as formation water that percolates through the silo wall. Collection and drainage of formation water is planned via segments of the wall drainage of the silo and segments of the wall drainage of shafts and stairs.

The purpose of collecting of water by segments is that in the event of the occurrence of radioactive contamination, it is possible to determine its source by sampling. Installation of the wall drainage system is described in the construction plan NRVB---5G/11A.

The collected wastewater from the wall drainage system will be routed via drainage pipes from each segment to the **collection tank**. The design of the drainage pipes is such that it allows performance of local sampling and monitoring of the inflow on a particular segment, as well as subsequent sealing of the pipe after completion of the discharge of wastewater.

The collection tank has a capacity of **20 m^3** and is located below the bottom of the disposal silo. The capacity of the tank is determined on the basis of the calculation of the inflow of formation water, which is given in the construction plan NRVB---5G/11A. The estimated inflow of formation water is approximately 1000 m^3/year or 2,7 m^3/day. Given the estimated inflow of formation water, the capacity of the collection tank is sufficient for an approximately 7-day quantity of formation water.

The collection tank will be equipped with level switches for switching on and off the pumps, a level meter for displaying the water level in the tank, and a radiological monitor for monitoring the radioactivity of collected wastewater.

Two submersible pumps are installed in the collection tank to pump collected wastewater. The activation and deactivation of the pumps is automatic via the level switches or can be performed manually locally. One of the pumps is operational and the other is a spare. Both pumps can also be switched on manually at the same time. The level meter also allows monitoring of the water level in the tank from the control room.

Each of the pumps has its own pressure pipeline. The pressure pipelines run from the pumping station along the installation shaft to the hall above the silo. Valves are located at the top of the installation shaft for leading the water into the sewage system or the control pool. The water outflow pipes then lead through the secondary liner above the diaphragm of the disposal silo and then underground along the hall above the silo to the overflow shaft or the control pool.

The overflow pipe between the installation shaft and the control pool will be implemented as a pre-insulated pipe with leak detection.

Pump details:

- number of pumps: 2, one on standby, one in reserve;
- flow rate: 18 m^3/h;
- delivery height: 55 m;
- pump type: submersible with automatic switch (auto-coupling);
- cooling method: pumped medium, flow sleeve;
- motor power: 20 kW;
- electrical supply: 3x400 V;
- regulation of motor rpm: frequency converter;
- flange dimensions: DN80;
- auto-coupling flange dimensions: DN100

Before emptying the tank, radiological and chemical monitoring (sampling) of the collected wastewater will be carried out. If the collected wastewater does not exceed the clearance criteria and if it meets the criteria for urban wastewater, it will be discharged via the overflow shaft by pumping into the public sewage system, and from there to the Vipap water treatment plant.

Therefore only water on which an analysis has been conducted (batch sampling) is pumped into the sewage system, or water for which it is possible to ensure through long-term monitoring of the radiological status and periodic sampling that the limit values are not exceeded. The latter pumping is carried out via automatic activation of the pumps.

However, in cases when the radiological monitor detects increased radioactivity of water in the collection tank, the automatic activation of submersible pumps in the collection tank will be turned off and the alarm in the control room will be activated. In this case, the pumped water will be diverted to the control pool by changing the position of the valves. In the event of automatic activation of the pumps, untested water will be discharged into the control pool.

It is envisaged that the system for draining wastewater from the disposal silo will operate until the disposal silo is sealed. After the decision to terminate the removal of water from the silo has been taken, the drainage pipes through which the water is removed shall be sealed.

The scheme of the system for draining wastewater from the disposal silo is shown in scheme NRVB---5T2022B.

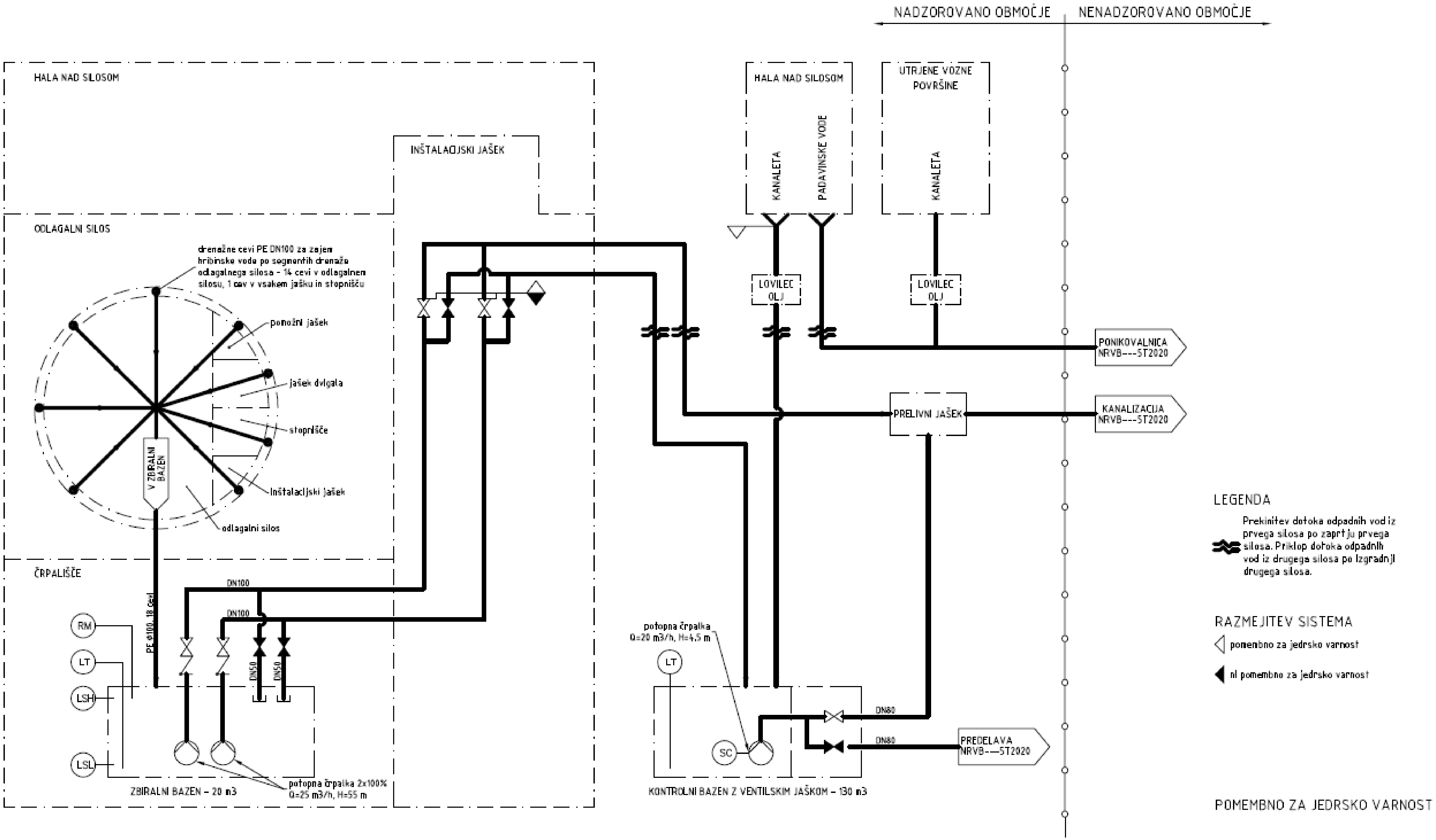

Figure 99: Scheme of the system for draining wastewater from the disposal silo (applies to both silos)

HALA NAD SILOSOM	HALL ABOVE THE SILO
INŠTALACIJSKI JAŠEK	INSTALLATION SHAFT
KANALETA	DRAIN
PADAVINSKE VODE	PRECIPITATION WATER
UTRJENE VOZNE POVRŠINE	SOLID DRIVING SURFACES
ODLAGALNI SILOS	DISPOSAL SILO
drenažne cevi PE DN100 za zajem hribinske vode po segmentih drenaže odlagalnega silosa – 14 cevi v odlagalnem silosu, 1 cev v vsakem jašku in stopnišču	drainage pipes PE DN100 for the collection of underground water by segment for disposal silo drainage – 14 pipes in the disposal silo, one pipe in each floor drain sump and staircase
pomožni jašek	auxiliary shaft
jašek dvigala	lift shaft
stopnišče	staircase
inštalacijski jašek	installation shaft
odlagalni silos	disposal silo
V ZBIRALNI BAZEN	INTO COLLECTION TANK
LOVILEC OLJ	OIL TRAP (SEPARATOR)
PONIKOVALNICA	SINK HOLE
PRELIVNI JAŠEK	OVERFLOW SHAFT
KANALIZACIJA	SEWERAGE SYSTEM
ČRPALIŠČE	PUMPING STATION
ZBIRALNI BAZEN – 20 m^3	COLLECTION TANK - 20 m^3
potopna črpalka 2x 100% Q= 25 m^3/h, H = 55 m	submersible pump 2 x 100% Q= 25 m^3/h, H = 55 m
potopna črpalka Q= 20 m^3/h, H = 4,5 m	submersible pump Q= 20 m^3/h, H = 4.5 m
PREDELAVA	PROCESSING
KONTROLNI BAZEN Z VENTILSKIM JAŠKOM – 130 m^3	CONTROL POOL WITH A VENTILATION SHAFT - 130 m^3
LEGENDA	KEY
Prekinitev dotoka odpadnih vod iz prvega silosa po zaprtju prvega silosa. Priklop dotoka odpadnih vod iz drugega silosa po izgradnji drugega silosa.	Disconnection of the inflow of wastewater from the first silo after the closure of the first silo. Connection of the inflow of wastewater from the second silo after the construction of the second silo.
RAZMEJITEV SISTEMA	SYSTEM SEPARATION
pomembno za jedrsko varnost	related to nuclear safety
ni pomembno za jedrsko varnost	not related to nuclear safety

Industrial wastewater in the control pool

Wastewater collected in the control pool cannot be immediately released to the public sewage system. As stated in the points above, the sources of inflow into the control pool may be as follows:

- contaminated wastewater from the collection shaft in the disposal silo;
- wastewater from floor drainage in the hall above the storage silo;
- wastewater flowing through the overflow pipe from the sanitary tank in the technological facility (TF, first phase); and
- wastewater flowing through the overflow pipe from the collection shaft in the technological facility (TF, second phase).

Net **volume of the control pool is 130 m^3**. The total capacity of the control pool is determined on the basis of the quantity of firefighting water needed for two hours of operation of external hydrants at 15 l/s, or a total of 108 m^3, and the volume of the collection tank below the bottom of the repository silo, which is 20 m^3.

The collection tank is equipped with a level meter for displaying the water level in the tank. The level meter allows monitoring of the water level in the tank from the control room.

A submersible pump is installed in the control pool to pump collected wastewater. The pump is manually activated. The pressurised pipe from the submersible pump runs through the ventilation shaft to the output shaft on the plateau.

Pump details:

- number of pumps: 1;
- flow rate: 18 m^3/h;
- delivery height: 10 m;
- pump type: submersible with automatic switch (auto-coupling);
- cooling method: pumped medium, flow sleeve;
- motor power: 1.1 kW;
- electrical supply: 3x400 V;
- regulation of motor rpm: frequency converter;
- flange dimensions: DN80;
- auto-coupling flange dimensions: DN80

Radiological and chemical monitoring of the collected wastewater will be carried out before the collection pool is emptied. If the collected wastewater does not exceed the clearance criteria and if it meets the criteria for urban wastewater, it will, when the tank is full, be discharged by pumping to the public sewage system, and from there to the Vipap water treatment plant.

If the collected wastewater exceeds the (non-radiological) criteria for discharge into the sewage system, it is dispatched to an authorised chemical waste processor for treatment.

If the collected wastewater exceeds the clearance criteria, it is treated as secondary radioactive waste, which will be processed at the repository or dispatched for treatment. During pumping of the contents of the control pool, a temporary pumping station will be provided with adequate equipment to prevent contamination of the environment (tight joints on pipes, vacuum tank, collecting containers, protective PE liners, etc.). The planned location of the temporary pumping station is on an asphalt surface, 5 m south-east from the control pool.

MANAGEMENT OF URBAN WASTEWATER

Urban wastewater in the technological facility in the radiologically controlled area

An area equipped with washbasins and a shower is planned within the control point in the technological facility for the decontamination of staff. Since there is therefore a risk of contamination, the urban wastewater from this area is not planned to be discharged directly into the public sewage system, but will be collected in a sanitary tank.

The sanitary tank is double-walled with leak detection and has a capacity of 12 m^3. The tank is located alongside the technological facility.

The collection tank is equipped with a level meter for displaying the water level in the tank. The level meter allows monitoring of the water level in the sump from the control room.

Another sanitary tank is planned for the controlled collection of used firefighting water for the part of the radiologically controlled area of the technological facility that will be built during TF Phase 1. To this end, all areas in the controlled radiation area of the technological facility that will be built during TF Phase 1 are equipped with floor drains with siphons, and the sanitary tank will have a built-in overflow pipe to the control pool. The capacity of the floor drains is planned for the removal of firefighting water in the event of fire extinguishing using internal hydrants and amounts to 1.16 l/s.

Radiological and chemical monitoring of the collected wastewater will be carried out before the tank is emptied. If the collected wastewater does not exceed the clearance criteria and if it meets the criteria for urban wastewater, it will be pumped into the sewer shaft using a portable submersible pump, and from there into the public sewage system or to the Vipap water treatment plant. Alternatively, the wastewater can be dispatched for treatment to the operator of the public utility service of removal and treatment of urban wastewater and rainwater run-off in the municipality of Krško. On agreement with the repository operator, the provider of the public service using a suitably equipped heavy vehicle empties the contents of the sump and transports it to the Vipap water treatment plant.

If the collected wastewater exceeds the clearance criteria, it is treated as secondary radioactive waste. The collected contaminated wastewater will be sent to Krško NPP, or suitable treatment capacities will be installed at the repository. During pumping of the contents of the sanitary tank, a temporary pumping station will be provided with adequate equipment to prevent contamination of the environment (tight joints on pipes, vacuum tank, catch basins, protective PE liners, etc.). The planned locations for the temporary separator are on the asphalt road towards the TF, 15 m south-east of the sanitary tank (TF Phase 1) or the asphalt driveway of the TF, 5m to the north-east of the sanitary tank (TF Phase 2).

PREDICTED QUANTITIES OF INDUSTRIAL AND URBAN WASTEWATER FROM THE RADIOLOGICALLY CONTROLLED AREA

All industrial and urban wastewater from the radiologically controlled area not exceeding the limit values will be discharged to the municipal sewage system in accordance with the Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewage system.

Radiological limit values for wastewater discharge are specified in the document Operating conditions and restrictions (reference documents for preparation of a safety report in accordance with the Ionising Radiation Protection and Nuclear Safety Act - ZVISJV).

The predicted quantities of wastewater and the method of discharge are shown in the table below.

Table 71: Wastewater discharge from RCA

Wastewater collection and sampling site	Quantity of wastewater during operation	Quantity of wastewater in case of emergency	Wastewater discharge method
1. Collection tank (20 m^3) at the bottom of the disposal silo	up to 1000 m^3/year; up to 2.7 m^3/day	up to 5000 m^3/year; up to 14 m^3/day; in case of exceeding the collection capacity, pumping into the control pool;	pumping into the sewage shaft on the platform;
2. Sanitary tank (12 m^3) in TF – first phase	up to 12 m^3/year; up to 0.5 m^3/day	up to 8 m^3 (fire); in case of exceeding the collection capacity, discharge into the control pool;	pumping into the sewage shaft on the platform or removal of the batch by vehicle;
3. Floor drain sump (2 m^3) at TF – second phase	0	up to 8 m^3 (fire); in case of exceeding the collection capacity, discharge into the control pool;	pumping into the sewage shaft on the platform or removal of the batch by vehicle;
4. Control pool (130 m^3) – on the plateau by the hall	0	up to 130 m^3 simultaneously	pumping into the sewage shaft on the platform;
TOTAL	**up to approx. 1000 m^3/year; up to 3 m^3/day**	**up to 5000 m^3/year; up to 14 m^3/day**	**to the public sewage system**

In accordance with the point 18 of Article 4 of the Decree on the emission of substances and heat when discharging wastewater into waters and public sewage system, urban wastewater also includes wastewater generated as industrial wastewater, if its average daily flow rate does not exceed 15 m^3/day, its annual quantity does not exceed 4,000 m^3 and in which the annual quantity of none of the pollutants exceeds the limit values of the annual quantities of pollutants.

As can be seen from the above table, the predicted quantity of industrial and potentially contaminated wastewater does not exceed 1000 m^3 per year or 3 m^3 per day and does not exceed the prescribed limits for pollutants. The resulting wastewater can therefore be considered as urban wastewater.

In the case of the occurrence of wastewater resulting from an emergency (e.g. fire, implementation of remedial measures after the fall of a container, accidental entry of water into the silo, etc.), the provisions of the Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewage system are not applied – as stipulated in Article 3 of the Decree. In this case, the discharge of wastewater into the public sewage system is carried out after prior sampling and harmonisation of requirements with the administrative authority competent for the field of radiation safety and with the operator of the sewage system and the treatment plant.

Urban wastewater in the technological facility in the radiologically non-controlled area and the administration and service facility

The route of the water supply network begins on the existing infrastructure water main on-site, which is fed from the municipal water main (on the Vrbina road) and runs to the water gauging shaft located within the area of the LILW repository.
Mains drinking water (hereinafter also sanitary water) will be used in:
The administration and service building:

- sanitary facilities, kitchenettes, washbasins, cloakrooms etc.;
- humidifier units for ventilation and air conditioning;
- filling the firefighting water tank via float valves (only first filling, topping up owing to evaporation and cleaning out the tank).

Technological facility:

- collection facilities, washbasins, cloakrooms, dressing rooms, decontamination;
- humidifier units for ventilation and air conditioning.

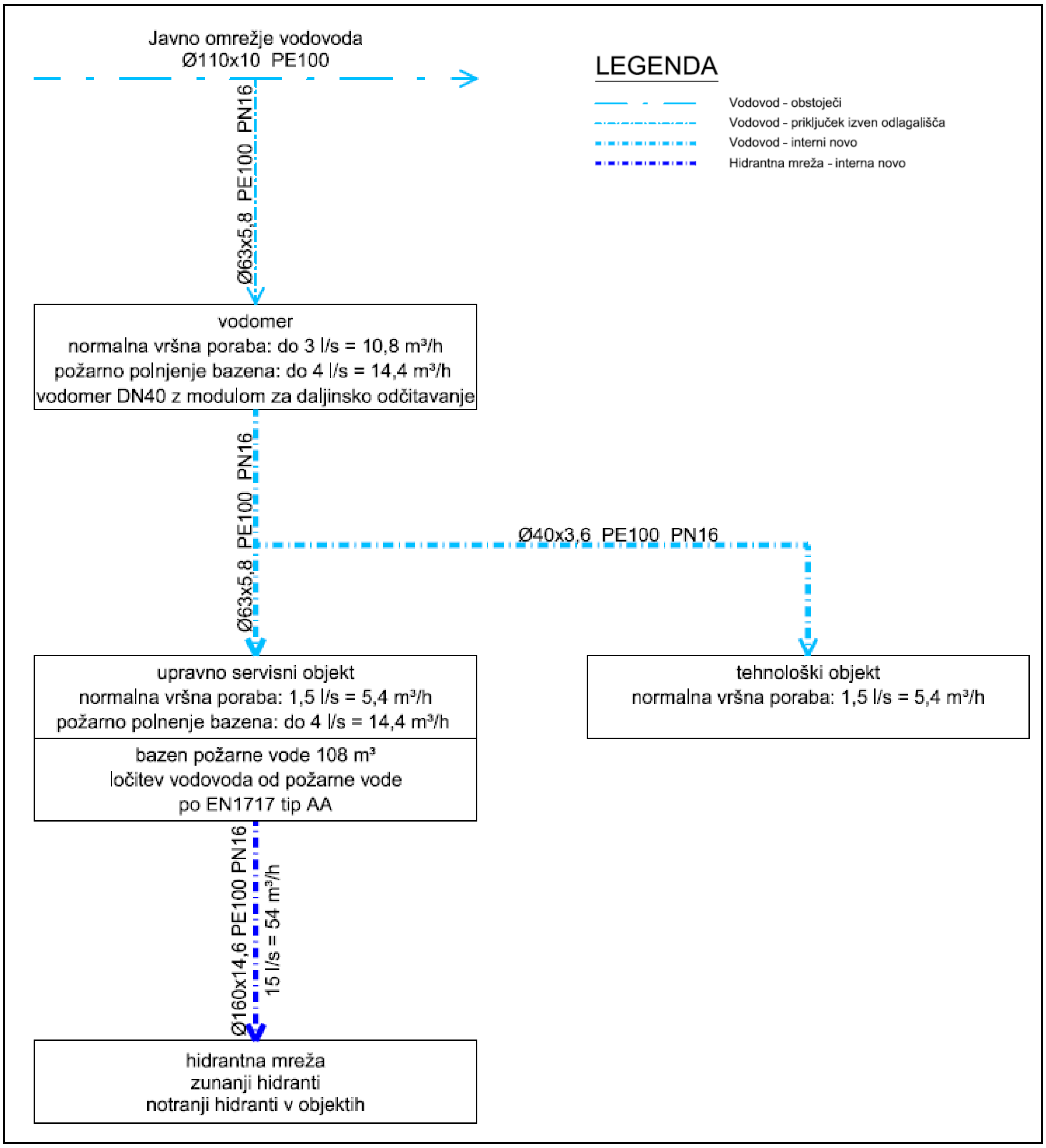

Figure 100: Schematic presentation of the water supply network

Javno omrežje vodovoda Ø110x10 PE100	Public water supply network Ø110x10 PE100
LEGENDA	KEY
Vodovod – obstoječi	Water supply network - existing
Vodovod – priključek izven odlagališča	Water supply network - connection outside the repository
Vodovod – interni novo	Water supply network - internal new
Hidrantna mreža – interna novo	Hydrant network - internal new
Ø63x5,8 PE100 PN16	Ø63x5,8 PE100 PN16
vodomer	water meter
normalna vršna poraba: do 3 l/s = 10,8m^3/h	normal peak consumption: up to 3 l/s = 10.8 m^3/h
požarno polnjenje bazena: do 4 l/s = 14,4m^3/h	filling of the fire water tank: up to 4 l/s = 14.4 m^3/h
vodomer DN40 z modulom za daljinsko odčitavanje	water meter DN40 with a module for remote reading
Ø40x3,6 PE100 PN16	Ø40x3,6 PE100 PN16
upravno servisni objekt	administrative and service building
normalna vršna poraba: 1,5 l/s = 5,4 m^3/h	normal peak consumption: 1.5 l/s = 5.4 m^3/h

požarno polnjenje bazena: do 4 l/s = 14,4 m^3/h	filling of the fire water tank: up to 4 l/s = 14.4 m^3/h
bazen požarne vode 108 m^3	fire water tank - 108 m^3
ločitev vodovoda od požarne vode	separation of the water supply system from the fire water
po EN1717 tip AA	under the EN1717 type AA
Ø160x14,6 PE100 PN16	Ø160x14,6 PE100 PN16
15 l/s = 54 m^3/h	15 l/s = 54 m^3/h
hidrantna mreža	hydrant network
zunanji hidranti	external hydrants
notranji hidranti v objektih	internal hydrants in the facilities
tehnološki objekt	technological facility
normalna vršna poraba: 1,5 l/s = 5,4 m^3/h	normal peak consumption: 1.5 l/s = 5.4 m^3/h

Outflows from sanitary facilities and elements will be routed into the vertical sewage system or urban wastewater collection system. Rates of flow for the urban wastewater collection system for the ASB and TF were set with regard to the number of sanitary elements (maximum flow rates):

- Administration and service building (ASB): up to 3.0 l/s (up to 11m^3/h)
- Technological facility (TF) – non-radiological part: up to 1.9 l/s (up to 7 m^3/h)

The annual quantity of urban wastewater from the non-radiological area is not defined in planning documents and is not necessary for the EIA. All collected urban wastewater will be discharged to the Vipap treatment plant.

MANAGEMENT OF RAINWATER RUN-OFF FROM RADIOLOGICALLY CONTROLLED AND RADIOLOGICALLY NON-CONTROLLED AREAS

Management of rainwater in the radiologically controlled part of the repository is part of the integrated system of rainwater drainage on the repository site. Drainage of rainwater run-off takes place indirectly through infiltration tunnels. The infiltration field is located in the entrance section of the repository.
Drainage of rainwater run-off from paved surfaces is via oil traps. Drainage of rainwater run-off from the roofs of buildings is via sand traps. In grassy areas rainwater run-off drains gravitationally into the ground.

Drainage for the car park is arranged so that water flows along the kerbs to the road drains and then through an oil trap to the infiltration tunnel.

Drainage of rainwater run-off within the core regulatory area of the LILW repository is divided into run-off from traffic areas, which must be treated in a coalescing oil separator before discharge, and roof run-off, which does not need to be treated in a coalescing oil separator. This reduces the amount of stormwater run-off that has to be treated prior to release.

Stormwater (treated) and roof run-off then flow into the common infiltration field that is planned in the SE part of the LILW repository site.

Estimated quantities of infiltration water (rainwater run-off from paved surfaces and roofs):

- from the plateau of the LILW repository 370 l/s (1332 m^3/h)
- from the external car park 55 l/s (198 m^3/h).

The expected quantity of stormwater is calculated using the following input parameters:

- duration of rainfall 10 minutes,
- return period 10 years

quantity for the location 315 l/s/ha.

Expected infiltration time is 10–15 minutes, which is expected to be achievable with the porosity of the filling of the modular elements in the infiltration field.

Water drainage from the Vrbina road carriageway will be diffuse via shoulders to lower lying terrain. With regard to the provisions of the Decree on the emission of substances in runoff from public roads and the nature protection conditions issued by the Ministry, it is not necessary to provide retention of precipitation runoff from the roadway for the section of national road that is being reconstructed (fewer than 12,000 cars per day). Drainage of the access road and pedestrian walkway will be provided through transverse drain channels and infiltration of water into the surrounding land.

Cumulative impacts

The closed Spodnji Stari Grad landfill (see the section on the baseline state) is already excessively polluting in its existing state but the contribution of any deterioration of

groundwater during repository operation is insignificant. After remediation of the closed Spodnji Stari Grad landfill is completed, excessive pollution is no longer to be expected.
The cumulative impact on groundwater of other plans in combination with the LILW repository **represents a major change from the point of view of the quantitative status of groundwater** (increase in the groundwater level because of Brežice HPP). The biggest impact therefore comes from the construction of the Brežice HPP reservoir (increase in capacity (+)), while remediation of the closed Spodnji Stari Grad landfill (as a measure carried out in the context of the construction of Brežice HPP) **will result in a local improvement in groundwater quality**. Here, too, we can talk about a positive impact (+).

Transboundary impacts:
All impacts during the construction phase are local and of a temporary nature, so there will be no transboundary impacts.

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

Impact on the quantitative and qualitative status of groundwater

Impact in the period after closure is estimated as insignificant (1).

Following the filling of the silo, the installation of an impermeable reinforced concrete cover and then a mineral cover up to the base of the surface Quaternary aquifer, and further filling up to the surface of the terrain or the top of the embankment, the **active monitoring period** will begin. After closing, the cover wall of the silo is thus located several meters below the bottom of the aquifer, while the space between the wall and the aquifer is sealed with impermeable mineral cover up to the top of the embankment (see Figure 9).

After closing the silo, the drainage system of the silo is put out of use. After discontinuation of pumping and after gradual deterioration of the watertightness of the concrete walls of the silo due to ageing, groundwater will begin to seep into the Miocene aquiclude silo, a process which may take from tens to hundreds of years, depending on the condition of the silo wall. Once the silo has filled with water and pressure and gradients have equalised with the surrounding aquiclude, groundwater flow through the silo will be established. The silo will represent a relative barrier to this flow, since its permeability is expected to be permanently lower than the permeability of the aquiclude. However, the flow of water through the silo does not mean its contact with radioactive waste. The durability of reinforced concrete containers can be hundreds of years, depending on the type of concrete used, and the same applies to stainless steel drums in a slightly alkaline geological environment (up to a thousand years). Here it should be emphasised that the planned concrete has extremely good chemical retention properties (sorption) for the individual radionuclides.

Long-term control and monitoring will continue for 300 years following closure of the repository (active long-term monitoring for 50 years and passive long-term monitoring for

250 years). Only after the disintegration of all the containers will the water reach radioactive waste. The filler materials contained in the containers will represent an additional barrier to the flow of water and, due to their chemical properties, will ensure the binding and retention of radionuclides and other substances. The flow of groundwater through them will therefore be even slower than flow through the silo, while the removal of material will be even slower than the flow of water.

With similar attention, the dispersal of radioactive and other substances from the repository is covered by the document "Draft safety analysis report for the LILW repository: Section 7 Safety analysis". A conservative approach was taken in the production of the safety analysis, the main purpose of which was to analyse the most adverse scenarios during operation and after closure of the LILW repository. The results thus obtained represent a sheath which shows the maximum possible impact of the repository on man and the environment.

In the context of safety analyses, the impact of toxic metals from the repository on a representative of the critical population group was also evaluated. The impact was compared to the drinking water standards of the Rules on drinking water. Toxic metals in waste are mainly found in waste containing stainless steel.

The approach taken to calculate the concentration of metals in groundwater included several conservative assumptions, such as: toxic metal releases due to corrosion come directly into the aquifer without taking into account dilution, dispersion, sorption or any other reaction. A so-called nominal scenario was used. The course of events in the nominal scenario is as follows: "*After the closure of the repository, the drainage system will also be closed and sealed. Since the silo lies in a saturated zone, the silo will become saturated, which will take some time. When drawing up safety analyses, it was conservatively assumed that upon closing the silo it is immediately saturated and that the potential transport of substances, whose main transport route is water, is immediately possible. For the nominal scenario, the simultaneous start of the decay of all engineering barriers was assumed. A well bored 100 m from the repository in the direction of contamination serves as a reference point for the collection of water samples for analysis.*"

The results of the calculations of concentrations of toxic metals expected from the repository are presented in the table below.

Table 72: Calculated concentrations of toxic metals from the repository and legal limits for drinking water

Toxic metal	Calculated concentrations [µg/l]	Legal limit [µg/l]
chromium	5.5	50
lead	0.0072	10
nickel	0.42	20
cadmium	0.00011	5
selenium	0.00066	10

It can be seen from the results and the limits in the above table that the expected, conservatively estimated releases of toxic metals from the repository are below the prescribed limits for drinking water and represent the maximum possible concentration that could occur. It is estimated, on the basis of the safety analysis, that in the period following abandonment of the activity there will be no impacts on the existing water resources used for water supply.

Decommissioning activities and the closed LILW repository will not cause direct pollution of groundwater during active and passive monitoring, in other words indirect pollution will be locally present on a negligible scale in the form of leachates that are characteristic of barriers made of cement binders (description below), but the degree of deterioration in the parameters[122] will not be detectable.

The chemical status of groundwater in the Krško Basin will not deteriorate as a result of the closed and remediated Spodnji Stari Grad landfill. We can estimate with great certainty that the closed landfill will not cause changes in the chemical status of groundwater in the area under consideration.

Decay of materials containing cement binder as a result of chemical or physical processes between the environment and the material – leaching processes

Materials containing a cement binder are subject to a process known as leaching, which essentially means the transporting of ions from the interior of the material through a system of pores into the surrounding area. During leaching, the solid components of cement paste first dissolve in water, which penetrates into the material (hydrolysis of hydration products), and are then transported from the material, either by diffusion because of differences in concentrations or by convection/advection as a result of flow/percolation of water through the material because of differences in pressures. Groundwater, lakes and rivers generally contain small quantities of chlorides, sulphates and bicarbonates of calcium and magnesium. These so-called hard waters do not as a rule attack cement hydration products. Pure water and soft water (rainwater, melted snow and ice) contain few or no calcium ions. When these waters come into contact with cement paste, they begin to dissolve calcium-containing hydration products until they reach chemical equilibrium. Further hydrolysis of hydration products is then halted.

In the case of percolation of water under pressure, the contact solution is constantly diluted, and in this way conditions are ensured for continuous hydrolysis of hydration products. Calcium hydroxide is one of the products of hydration that, because of its relatively high solubility in pure water (1230 mg/l) is most sensitive to hydrolysis. In theory, hydrolysis of cement paste continues until the majority of calcium hydroxide is leached from the cement paste; then the other components of the cement paste begin to break down (above all the C-S-H phases). In extreme cases, only silica gel and aluminium gel, which have an extremely low hardness, remain in the cement paste. Leaching increases the porosity of cement paste, and with that its permeability. At the same time it can also significantly reduce its compressive strength and elastic modulus.

FORMATION OF SOLUBLE CALCIUM SALTS

Solutions of ammonium chloride and ammonium sulphate present in agricultural land are capable of transforming cement hydration products into highly soluble products, for example:

$$2NH_4Cl + Ca(OH)_2 \rightarrow CaCl_2 + 2NH_4OH$$

[122] pH, redox potential, basic parameters, indicative parameters, metals, phenolic substances, and hydrocarbons.

Carbon dioxide can be present various forms: as free CO_2 in the air, bound in carbonates ($CaCO_3$), partially bound in hydrocarbonates ($Ca(HCO_3)_2$), in water as carbonic acid (H_2CO_3) or dissolved in water in gas form (free CO_2 in water). Only around 1% of CO_2 can react with water, resulting in the formation of carbonic acid, while the remainder is in gas form. Typical reactions that take place in cement paste between carbon dioxide or carbonic acid and calcium hydroxide are:

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

$$Ca(OH)_2 + H_2CO_3 \rightarrow CaCO_3 + 2H_2O$$

This process is known as carbonation. Carbonation causes the alkalinity of concrete to decrease.

After precipitation of calcium carbonate, which is insoluble, the reaction stops, unless there is free CO_2 in the water. If there is, calcium carbonate is transformed into a soluble bicarbonate:

$$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$$

Since the reaction is reversible, a certain quantity of free CO_2 (also known as equilibrium CO_2) is needed to maintain reaction equilibrium. However, any quantity of free CO_2 greater than equilibrium CO_2 acts aggressively on cement paste, which drives the reaction towards the right, which means an acceleration of the process of transformation of calcium hydroxide into soluble calcium carbonate, which can likewise be leached from the material as $Ca(OH)_2$. The equilibrium share of CO_2 depends on the hardness of the water.

It should be mentioned that the acidity of natural waters is, above all, the consequence of dissolved CO_2, which is found in significant concentrations in mineral waters, seawater and groundwater that is in contact with decomposing plants or animal remains. As a rule, if the pH of water is 8 or more, the concentration of free CO_2 is negligible, but if the pH is less than 7, harmful concentrations of free CO_2 can be present.

Data on the pH value of the soil in the area of the repository at the Vrbina location show that the pH ranges from 8 to 9.1 (see the section on groundwater – existing state). This means that at the Vrbina location we are below the limit of harmful concentrations of free CO_2.

CHEMICAL ATTACK WITH SOLUTIONS CONTAINING MAGNESIUM SALTS

Magnesium chloride, magnesium sulphate or magnesium bicarbonate are frequently found in groundwater, seawater and industrial wastewater. Magnesium solutions react with the calcium hydroxide in Portland cement paste and form soluble calcium salts. However, an attack of magnesium ions on cement paste is also characterised by the fact that the latter can also attack the C-S-H phase. In the case of long-lasting contact with a magnesium solution, the C-S-H phase gradually loses calcium ions, which are partly or entirely replaced by magnesium ions. The final product of the reaction can therefore be magnesium silicate hydrate, which causes a loss of binding properties.

Owing to the presence of magnesium in the soil at the repository site, whose magnesium content is above-average, we consider it logical to take into account the impact of solutions containing magnesium salts on the transformation of hydration products – calcium hydroxide and C-S-H gel – and the related decrease in alkalinity for the variants of LILW disposal in buried silos and underground tunnels in the further planning stage.

EXTERNAL SULPHATE ATTACK

This is the commonest type of sulphate attack, which typically occurs if waters containing dissolved sulphates penetrate into cement paste. The majority of soils contain sulphates in the form of gypsum $CaSO_4 \cdot 2H2O$ (typically 0.01–0.05% expressed as SO_4); this quantity is as a rule harmless to concrete. The solubility of gypsum in water at normal temperatures is limited (around 1400 mg/l SO_4). Higher concentrations of sulphates in groundwater are generally the consequence of the presence of magnesium, sodium and potassium sulphate. Ammonium sulphate is present in agricultural land and in water in the vicinity of agricultural land. Other sources of sulphates that cause sulphate attack are:

- seawater
- oxidation of sulphide minerals in clays in contact with cement paste – the result of the reaction is sulphuric acid that reacts with cement paste (this type of sulphate attack has also been traced in Slovenia, in the construction of tunnels in sivica clay and carbonic slate, which contain pyrite)
- the action of bacteria in the sewage system – anaerobic bacteria produce sulphur dioxide which dissolves in water and then oxidises into sulphuric acid.

The decay of cement paste as the result of reaction between products of cement hydration and sulphate ions from an external source can take two forms, which differ significantly from each other. Which of the two decay processes prevails in a given case depends on the concentration and origin of the sulphate ions and, of course, on the composition of the cement paste. Sulphate attack can manifest itself in expansion and the formation of cracks in cement paste. When cement paste cracks, its permeability increases and aggressive waters can enter its structure much more easily, which of course accelerates the decay of the cement paste. At the same time, sulphate attack manifests itself in a loss of hardness and a loss of mass, as a result of the loss of cohesion/bonds between hydration products.

In the case of an attack with sodium sulphate, the formation of sodium hydroxide ensures the continuous high alkalinity of the system, which is essential for the stability of the C-S-H phase. In the case of an attack with magnesium sulphate, the transformation of calcium hydroxide into gypsum is accompanied by the simultaneous formation of magnesium hydroxide, which is insoluble and reduces the alkalinity of the system. In the absence of hydroxyl ions in the solution, the C-S-H phase is no longer stable and can also enter a reaction with sulphate solutions. This means that magnesium sulphate is much more harmful for cement paste than sodium sulphate.

$Na_2SO_4 + Ca(OH)_2 + 2H_2O \rightarrow CaSO_4 \cdot 2H_2O +$

$2NaOH$ $MgSO_4 + Ca(OH)_2 + 2H_2O \rightarrow$

$CaSO_4 \cdot 2H_2O + Mg(OH)_2$

$3MgSO_4 + 3CaO \cdot 2SiO_2 \cdot 3H_2O + 8H_2O \rightarrow 3(CaSO_4 \cdot 2H_2O) + 3Mg(OH)_2 + 2SiO_2 \cdot H_2O$

Given the data on the concentrations and forms of compounds in the soil at the repository site, we can assume in this phase that the possibility of an external sulphate attack occurring is negligible.

ACID ATTACK

Acid attack can occur when concrete is exposed to groundwater or other sources of water with low pH. Acid leaches out soluble components in concrete ($Ca(OH)_2$), and the concrete then loses structural resilience and sees an increase in porosity. Field research shows that the pH of the groundwater in the vicinity of the repository is close to neutral, so degradation through acid attack is not to be expected.

CORROSION

Carbon steel

- When corrosion occurs to the reinforcement (carbon steel), the corrosion products have a greater volume than the corroded metal, which leads to swelling or cracking of the concrete. This also increases the permeability of the concrete.
- The corrosion rate depends mainly on the pH, and to a lesser extent on the chloride concentration. Because there will be a lot of concrete in the repository, the pH of the pore water will be relatively high, and only the hydration process described above will reduce it. Chloride concentration in the Miocene water around the repository is also low. The safety analysis assumes a corrosion rate of 10^{-7} m/year. Because corrosion causes swelling and thus damage to the concrete, it is assumed that the concrete degrades completely when the reinforcement is 25% to 50% corroded. This means that full degradation of the concrete owing to corrosion of the reinforcement (thickness 1 cm) will occur after 12,500 to 25,000 years.

Stainless steel

- Some of the waste disposed of at the repository will be made of stainless steel. This corrodes differently to carbon steel. The corrosion products do not occupy a greater volume than the base metal, and there is therefore no swelling or cracking of the concrete. In addition, the corrosion rate is much lower. This means that the corrosion of stainless steel is not a factor in the disintegration of the concrete, and leads more slowly to the elimination of activation products in waste made of stainless steel.

Cumulative impacts

We do not know what developments will be taking place in the vicinity of the LILW repository at the time that activity is abandoned (in 2061). We can, however, evaluate them as insignificant.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

EVALUATION OF IMPACTS AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

Criteria for evaluating changes in overall and total environmental loads derive from regulations that set environmental quality standards, alert and critical values, stages of impact

reduction and associated measures, sensitivity and vulnerability criteria and the related classification into classes or levels, and special legal regimes in the area under consideration.
The quantitative and chemical status of groundwater is determined on the basis of:

- Decree on groundwater status (Official Gazette of the RS 25/09, 68/12 and 66/16),
- Rules on groundwater monitoring (Official Gazette of the RS 31/09).

During the construction phase a potential impact on groundwater pollution exists as a result of the implementation of construction works, soil removal, pollution with petroleum derivatives and other pollutants from construction machinery and goods vehicles, accidents involving spillages of hazardous substances, etc. The biggest impact on groundwater will come from construction of the silo, while construction and operation of the other repository facilities, i.e. the technological facility and the administrative and service building, will have an insignificant impact on groundwater (1).

The total impact of the planned developments on groundwater during construction and/or operation is insignificant (1); emissions may cause a local and short-term deterioration of water quality, but the level of deterioration is imperceptible; there will be minor, local changes to groundwater flows and levels (during the construction phase), but the effect will fade with time.

There will be no change to the quantitative and chemical status of groundwater during construction, operation and abandonment of the activity. We continue to estimate with considerable certainty that the chemical and quantitative status in the area will be good, or in other words that the construction and operation of the repository will not cause changes to chemical and quantitative status.
No restrictions are specially prescribed regarding the water regime for groundwater within the area of influence of the development. Neither are there any water resources used for water supply, so no deterioration of drinking water in the area is to be expected either.

Table 73: Description and assessment of impacts of the development on groundwater quality

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – GROUNDWATER	
Impact assessment	During construction: moderate impact (2) from the point of view of groundwater quality. Additional pollution of groundwater may result in an exceeding of the lower limit of quantification for individual parameters; however, there will be no exceeding of the quality standards for individual parameters as defined by the *Decree on groundwater status (Official Gazette of the RS 25/09, 68/12, 66/16)*. There will be no significant changes in the quantitative and/or qualitative status of groundwater as a result of the development. From the point of view of the quantitative status of the aquifer, by taking into account cumulative impacts (Brežice HPP), we can talk about a quantitative increase of the aquifer. During operation: insignificant impact (1) from the point of view of groundwater quality. Additional pollution will not exceed the lower limit of quantification for individual parameters under the provisions of the Decree on groundwater status (Official Gazette of

	the RS 25/09, 68/12 and 66/16). There will be no changes in the quantitative and/or qualitative status of groundwater as a result of the development. From the point of view of the quantitative status of the aquifer, by taking into account cumulative impacts (Brežice HPP), we can talk about a positive impact. We can also talk about a positive impact from the point of view of the implemented remediation of the closed Spodnji Stari Grad landfill (as a measure at Brežice HPP). After abandonment of the activity: insignificant impact (1)
Impact characteristics and type	Impacts on groundwater will be direct (risk of pollution during construction and implementation of works, temporary change in the level of groundwater during the construction phase), indirect and remote during operation and after decommissioning (leaching (point-source) and migration of radionuclides (remote) from the area of the two silos), cumulative(in connection with other plans), and temporary.
Likelihood of impact and its consequences	The repository development will cause a temporary change in the local groundwater level during the process of relieving pore pressures during construction of the silos (diaphragm), but the effect will fade over time. The likelihood of groundwater pollution as result of on-site accidents, old contamination in the soil, the presence of site machinery and goods vehicles is insignificant. During operation and after abandonment of the activity, impacts are insignificant and below the limit of quantification.
Duration or frequency of impact and its consequences, and their reversibility	The impact of change to the water regime during operation will be insignificant. Any groundwater pollution during operation will be insignificant. In the event of a cessation of operation and decommissioning of the repository, the impact on groundwater will also cease. Any impacts will have disappeared after 300 years or will be below the limit of any quantification.
Type, degree or intensity of changes to the environment or part thereof that can be attributed to the impact	Impacts can be both on the groundwater regime and on groundwater quality. Changes in the environment will be temporarily present (temporary change in the level of local groundwater during construction) Impact on groundwater quality is insignificantly small.
Scope of impact	The scope of the impact is tied to the local area of the planned repository.
Interactions between individual impacts and their consequences	The impact on groundwater has an insignificant effect on interaction in connection with other impacts.

5.3.3 *IMPACTS ON SURFACE WATER QUALITY*

DURING CONSTRUCTION

Impacts that represent a potential negative impact on surface waters as a result of construction and after implementation of the development are evaluated. Impacts are evaluated on a five-point scale and also explained separately for the construction phase and the period after abandonment of the activity.

NW of the planned site (at a distance of more than 2 km) is the Potočnica stream, which because of its distance from the site cannot impact on conditions in the area of the development.

The only major watercourse in the immediate area of the development is the river Sava, which is 650 metres from the planned LILW repository site at its closest point.

ECOLOGICAL AND CHEMICAL STATUS OF THE RIVER SAVA (SI1VT913)

The planned development does not have an indirect or direct impact on the ecological and chemical status of the Sava during construction and operation because the impact area, both during construction and during operation of the repository, does not extend into the area of the watercourse. At its southernmost point, the development site is around 650 m from the river Sava (SI1VT913).

FLOOD SAFETY

For the needs of the repository, two key studies were carried out in the field of hydrology in 2015, on the basis of which the final heights of the repository platform and access roads were determined.

On the basis of the study "Hydraulic analysis of the influence area of the LILW repository Vrbina, Krško",[123] the flood safety of the repository area from the point of view of the flood waters of the river Sava has been recorded. The study is based on calculations carried out using a hydrodynamic numerical model that was previously calibrated, verified and audited as part of the project "Hybrid hydraulic modelling for the low water area of the Krško HPP, the area of the Brežice HPP and the area of the Mokrice HPP" (FGG, Hidroinštitut and IBE, 2011).[124] In the study "LILW Repository Vrbina, Krško / Elevation points and access roads'',[125] the potential impact of hinterland waters in the wider area of the repository site is also analysed.

The results show that the LILW repository and other facilities and arrangements in this area partially close existing routes for the run-off of surface water towards the Sava, thereby raising water levels by up to 3 cm. The rise in water levels is small, particularly taking into account the order of magnitude of the flow rate of the Sava in the scenario in question (11,130 m^3/s), although it should also be considered that these water levels remain considerably lower than at the present state (by up to around 80 cm). Since as well as taking the LILW repository into account the model also considered other developments and changes, it is impossible to determine the share of an individual cause (activity affecting the environment) in the resulting local rise in water levels. **Despite the rise in water levels in the core area of the LILW repository site, the results show that flood safety will improve relative to the current situation with the construction of all the planned facilities and arrangements in this area.**

[123] HYDRAULIC ANALYSIS OF THE INFLUENCE AREA OF THE LOW AND INTERMEDIATE LEVEL RADIOACTIVE WASTE REPOSITORY VRBINA, KRŠKO, July 2015. UL, FGG, Chair of Fluid Mechanics

[124] Hybrid hydraulic modelling for the low water area of the Krško HPP, the area of the Brežice HPP and the area of the Mokrice HPP, 2011. FGG, Hidroinštitut and IBE.

[125] LILW Repository Vrbina, Krško / Elevation points and access roads, August 2015. IBE d.d.

According to the calculations, the water from the Sava should only reach the LILW repository area at a flow rate of QPMF=7081 m^3/s (figure below). Taking into account the planned elevation of the embankment of the LILW repository at 155.20 m above sea level, it is possible to assert that the repository is also safe from extreme high water levels of the Sava. The results indicate that it would also be possible to ensure the flood safety of the LILW repository site when the water levels of the Sava are extremely high (PMF and Q = 11,130 m^3/s) with a lower embankment. Under future conditions, and taking into account all known existing and planned arrangements, at a flow rate of 11,130 m^3/s, excluding hinterland waters, the repository would already be safe at an elevation of 152.8 m above sea level.[122]
Based on the impact of high Sava flow rates, the maximum possible elevation in the area of the LILW site is defined as 152.73 m above sea level. Regarding the impact of extreme hinterland waters, additional analyses have shown that, under the conservative assumption of zero percolation, the height of hinterland waters in the vicinity of the repository cannot exceed 154.17 m above sea level. Due to greater uncertainty regarding a determination of the relevant height of hinterland waters, it has been proposed that the safety height should be 1 m instead of the 0.5 m proposed by ARSO for Q100. The uniform elevation of the LILW repository plateau is thus set at a height of 155.20 m above sea level.[122]
On the basis of the calculations of the relevant hinterland waters, it has been established that the elevation of the access road (152.20 m above sea level) is adequate on condition that the piping of the planned culvert between the Kostak landfill (Spodnji Stari Grad) and the LILW repository is at least Ø 1,000 mm.[124] On the basis of these calculations the investors observed the recommendations derived from this study and constructed the piping of the culvert in a dimension that was even larger than recommended with pipes of Ø 1200 mm (diameter).

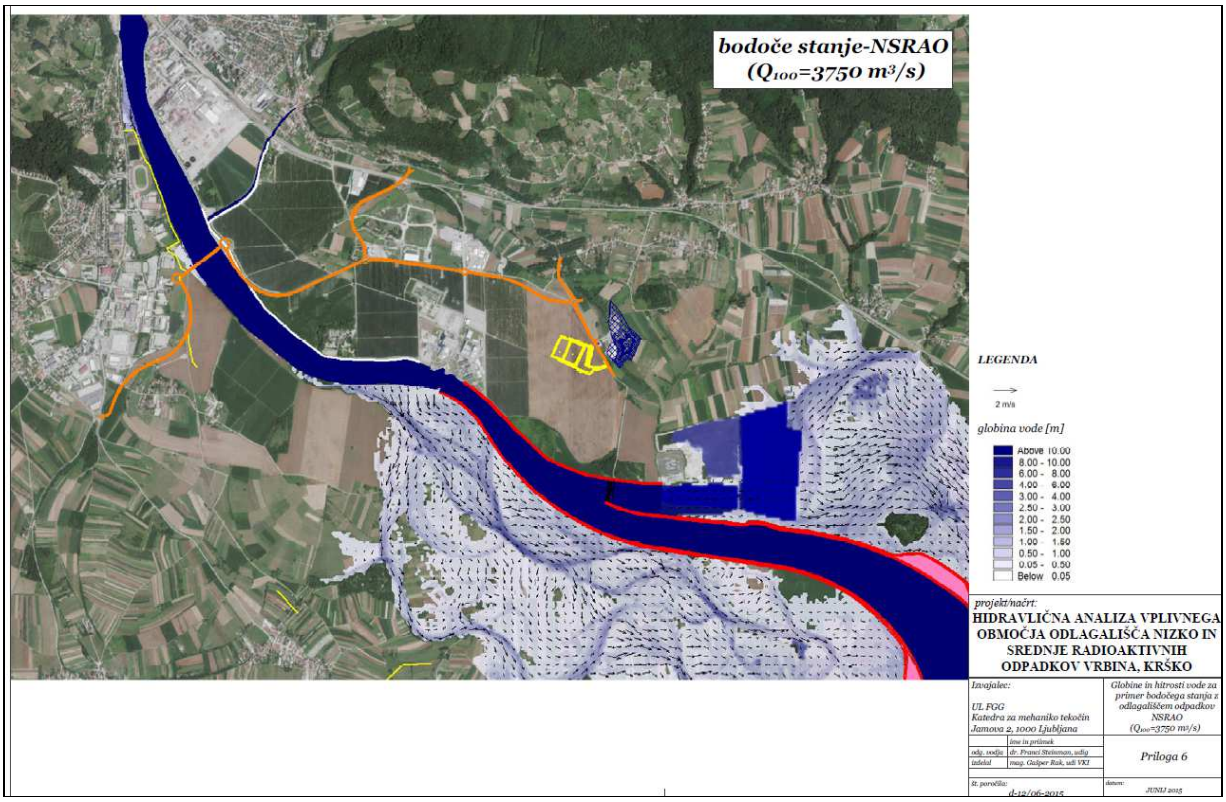

Figure 101: Water levels and speeds for the future situation with the LILW repository site at the flow rate of the Sava during 100-year floods.

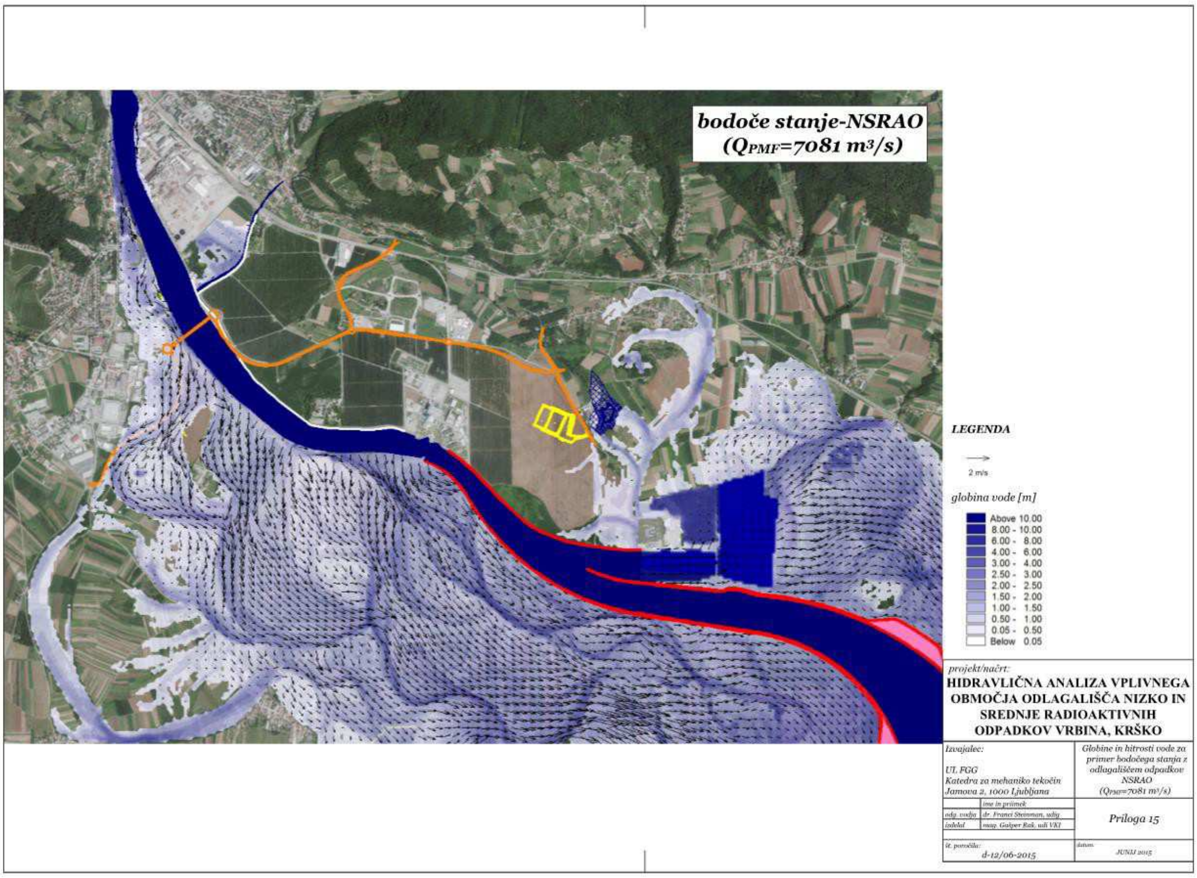

Figure 102: Water levels and speeds for the future situation with the LILW repository site at the maximum possible flow rate of the Sava (PMF).

bodoče stanje-NSRAO (Q_{PMF} = 7081 m^3/s)	Future state of LILW (Q_{PMF} = 7,081 m^3/s)
Legenda	KEY
globina vode [m]	water depth [m]
projekt/načrt: HIDRAVLIČNA ANALIZA VPLIVNEGA OBMOČJA ODLAGALIŠČA NIZKO IN SREDNJE RADIOAKTIVNIH ODPADKOV VRBINA, KRŠKO	Project/plan: "HYDRAULIC ANALYSIS OF THE IMPACT AREA OF VRBINA KRŠKO LOW- AND INTERMEDIATE LEVEL RADIOACTIVE WASTE REPOSITORY"
Izvajalec: UL FGG Katedra za mehaniko tekočin Jamova 2, 1000 Ljubljana	Contractor: UL FGG Department of Fluid Mechanics Jamova 2, 1000 Ljubljana
Globine in hitrosti vode za primer bodočega stanja z odlagališčem odpadkov NSRAO (Q_{PMF} = 7081 m^3/s)	Water depths and flow rates for the future state of the LILW repository (Q_{PMF} = 7,081 m^3/s)
ime in priimek	First name and surname
odg. vodja	Responsible head
dr. Franci Steinman, udig	Dr Franci Steinman, udig
izdelal	Drawn up by
mag. Gašper Rak, udi VKI	Gašper Rak, udi VKI
št. poročila: d-12/06-2015	Report no: d-12/06-2015

Priloga 15	Appendix 15
datum: JUNIJ 2015	Date: JUNE 2015

EROSION RISK

During implementation of the works described, the hydraulic conditions will be changed, but the flood risk of the facilities along the Sava and its tributaries will not be increased. In the event of high-water occurrences, the levels will be slightly increased in the area, but without increased erosion processes on the formed slopes of the LILW repository. Furthermore, erosion processes in the Sava River and its tributaries will not be increased due to the construction of the LILW repository.

IMPACT OF INDUSTRIAL WASTEWATER ON SURFACE WATERS

Industrial wastewater will be generated in the context of the radiologically controlled part of the technological facility, in the hall above the disposal silo and as formation water that percolates through the walls of the silo and collects in a 20 m^3 collection tank located below the bottom of the disposal silo. Industrial wastewater can only be generated in the hall above the disposal silo in the event of extinguishing a fire. For the purpose of collecting this wastewater, a conduit is planned in the hall, from which the collected wastewater will pass through an oil trap and will be discharged into the control pool mentioned earlier.

Before emptying the control pool, radiological and chemical monitoring of the collected wastewater will be carried out. If the collected wastewater does not exceed the clearance criteria and if it meets the criteria for urban wastewater, it will, when the tank is full, be pumped into the public sewage system, and from there to the nearby Vipap water treatment plant.

If the collected wastewater exceeds the clearance criteria, it is treated as secondary radioactive waste and dispatched to Krško NPP for preparation for disposal, or sent to an authorised chemical waste processor for treatment.

On the basis of the above description of the management of industrial wastewater, it can be stated that industrial wastewater will not have an impact on surface waters, since all the technical measures and the technical design of the LILW repository facilities prevent any contact with surface water (see also the section on groundwater).

IMPACTS DURING CONSTRUCTION

No impact on surface waters is expected during implementation of works. The development site is several hundred metres (around 650 m) from the river Sava. For this reason, it is not expected that implementation of the development could in anyway impact the quality of surface waters or cause pollution of water with motor oil or fuels from construction machinery.

There is a possibility that the development will have a minimal impact on the water regime, above all from the point of view of reducing overflow areas and altering the floodwater run-off regime. See the previous section (During construction – Flood safety).

Cumulative impacts:
The cumulative impact of implementation of other plans (construction of a section of road and the Krško NPP and Spodnji Stari Grad roundabouts) in combination with implementation of the LILW repository and the chemical and ecological status of the Sava is not relevant here, and flood safety and run-off conditions in the area under consideration are improved.
Construction of the Krško–Brežice bypass is coordinated with construction of Brežice HPP and the LILW repository. All facilities are installed in such a way as not to increase flood risk or worsen run-off conditions.

Transboundary impacts:
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

IMPACTS DURING OPERATION

Because of the distance of the development from the river Sava, no impacts on surface waters are expected during operation.

Minimal impacts on the water regime are possible, above all from the point of view of reducing overflow areas and altering the floodwater run-off regime. See the previous section (During construction – Flood safety).

Cumulative impacts
Construction of the Krško–Brežice bypass is coordinated with construction of Brežice HPP and the LILW repository. All facilities are installed in such a way as not to increase flood risk or worsen run-off conditions.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

IMPACTS DURING AND AFTER ABANDONMENT OF THE ACTIVITY

Reversibility of the development is possible and thus the recultivation of the area for agricultural use or other form of use, where no impacts on surface waters are predicted.

Cumulative impacts:
We do not know what developments will be taking place in the vicinity of the LILW repository at the time that activity is abandoned (in 2061). We can, however, evaluate them as insignificant.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

EVALUATION OF IMPACTS AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

There is no impact (0) or the impact is positive from the point of view of flood safety. The erosion risk of the wider area around the repository is not worsened by construction of Brežice HPP and the LILW repository.

Implementation of the arrangements in question will not lead to an exceeding of the limit values defined in the *Decree on groundwater status (Official Gazette of the RS 14/09, 98/10, 96/13, 24/16)* and the *Decree on the quality required of surface waters supporting freshwater fish life (Official Gazette of the RS 46/02 and 41/04-ZVO-1)*. There will be no changes in the hydrological and/or qualitative status of surface waters as a result of the development, nor a worsening of flood safety.

The retention area of Sava floodwaters will be reduced to a negligible extent and below the limit of quantification of model studies, while both developments (Brežice HPP and the LILW repository) actually improve run-off conditions in the event of high water levels.

Table 74: Description and assessment of possible impacts of the development on surface waters

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – SURFACE WATERS	
Impact assessment	0 – impact not present in any phase since no water body present in the surrounding area except the Sava, on which the LILW repository has no impact.
Impact characteristics and type	In terms of impact on surface waters, we do not expect any direct, indirect, remote, cumulative, synergetic, temporary or permanent impacts on the chemical and ecological status of the river Sava or other surface watercourses in the wider surrounding area.
Likelihood of impact and its consequences	Change to flow regime – does not impact on any watercourse. Expression of eutrophication – no impact. Changed ecological status of waters – no impact. Changed chemical status of waters – no impact. Improved/deteriorated flood safety – no impact.
Duration or frequency of impact and its consequences, and their reversibility	Construction, operation and decommissioning of the repository do not represent harmful impacts on conditions in surface watercourses in the surrounding area. Decommissioning of the repository is planned following abandonment of the activity. This will not impact on surface watercourses in the surrounding area.
Type, degree or intensity of changes to the environment or part thereof that can be attributed to the impact	The degree of changes to the environment (watercourse) is zero. No watercourses are present in the location, so no changes in surface waters are possible.
Scope of impact	There will be no impact on surface waters.
Interactions between individual impacts and their consequences	No additional interacting impacts are present, taking into account the construction of Brežice HPP (construction planned to take place before the start of construction of the LILW repository) Construction of Brežice HPP will also result in improved flood safety and run-off conditions in the area of the planned LILW repository.

5.3.4 *IMPACTS ON SOIL QUALITY*

Below we consider the assessment of the impacts and measures of the planned development with regard to soil quality.

DURING CONSTRUCTION

As a result of construction, there is a possibility of occasional and local soil pollution in the area of construction involving hazardous substances such as motor oils, cement and other substances hazardous to the environment, although such pollution will be below the limit values for individual pollutants and assessed locally in negligibly small areas (< 1 m^2).
Impacts on soil will occur across the entire planned construction site area during construction. These will include the removal of fertile topsoil, excavation, building of embankments and compacting soil, dust generation and potential pollution of soil and air.

All removed material will be used for recultivation and re-greening of the area after construction. In the event of improper storage of the humus layer overburden, there is a danger of erosion and the growth of alien invasive species, particularly ragweed.
Impact on the soil on the development site itself will be direct and permanent. The likelihood of erosion processes (landslides, subsidence) during construction is small because of the flat relief. Soil erosion is possible in the event of flooding.

Cumulative impacts
Construction of a new route of the regional Krško–Brežice road is planned within the core area of the location under consideration. This is the subject of a separate detailed plan of national importance, but the two plans overlap in the area of the road connection to Krško NPP. The reconstructed local road from the area of the LILW repository will be connected to the planned new route via the southern arm of the Spodnji Stari Grad roundabout.
The cumulative impact on soil pollution of the implementation of other plans in combination with implementation of the LILW repository is insignificant, since there is an already existing local road in the planned area of the new route of the regional road.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING OPERATION

No impacts on surface soil are expected during operation.

Cumulative impacts
The cumulative impact on soil pollution of the implementation of other developments (use of the regional Krško–Brežice road) in combination with implementation of the LILW repository is insignificant.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

A change of use of the land in the area of the development is possible after abandonment of the activity. Decommissioning could result in short-term pollution, although these impacts will be much smaller than during construction. The impacts of decommissioning (physical removal of the ASB and TF) may be considered insignificant.

Cumulative impacts
We do not know what developments will be taking place in the vicinity of the LILW repository at the time that activity is abandoned (in 2061). We can, however, evaluate them as insignificant.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

EVALUATION OF IMPACTS AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

Impact is insignificant (1) during construction, operation and decommissioning, while during and after abandonment of the activity there will be no impact (0).

As a result of construction, there is a possibility of occasional and local soil pollution in the area of construction involving hazardous substances such as motor oils, cement and other substances hazardous to the environment, although such pollution will be below the limit values for individual pollutants.

Erosion may occur in negligibly small areas (taking into account permanent occupation of the land) but will be limited to open areas within the building site. The structure of the soil may also change (compacting of soil, increase in the quantity of gravel and other components that reduce agricultural production). The impact is so small that self-remediation is possible. Alternatively, impacts can be reduced to a negligible level via a series of envisaged undemanding measures, both during construction and operation and after abandonment of the activity.

Table 75: Description and assessment of possible impacts of the development on soil quality

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – SOIL QUALITY	
Impact assessment	During construction: insignificant impact (1) During operation: no impact (0) During decommissioning and abandonment: the impact during decommissioning is insignificant (1), and there is no impact after abandonment (0)
Impact characteristics and type	Impacts on soil quality are both direct and indirect, remote (depositing of excavated soil in other areas) and temporary (area of temporary use because of the building site).
Likelihood of impact and its consequences	The likelihood of an impact on soil quality during construction depends on the condition of the machinery used. On the other hand, the likelihood of on-site accidents leading to soil pollution cannot be predicted. Action is necessary in the case of spills.
Duration or frequency of impact and its consequences, and their reversibility	The impact will be permanent in the permanently occupied area (level of the terrain raised). The duration of temporary occupation of the site (by the LILW repository) is around 300 years, after which recultivation or a partial return to the original state and land use is possible.
Type, degree or intensity of changes to the environment or part thereof that can be attributed to the impact	There will be a change both in relief and in the quality and composition of the soil. In global terms, the degree of environmental change (soil) will be small.
Scope of impact	The impact will extend within the area of the detailed plan of national importance and is only tied to the construction site itself (or to the locations of the individual facilities).
Interactions between individual impacts and their consequences	Polluted soil could result in local pollution of groundwater.

5.3.5 *IMPACTS ON AGRICULTURAL LAND*

DURING CONSTRUCTION

During construction of the LILW repository, around 16.5 ha of agricultural land will be permanently occupied (taking into account records of actual land use). The repository will have a negligible and short-term impact on neighbouring agricultural land as a result of increased dust generation caused by construction machinery and vehicles used to transport materials, but there will be no impact on agricultural production.
In the area of the planned development, there will be a change in actual land use during construction of the Vrbina LILW repository. Agricultural use is planned to be maintained in part of the area (the strips adjoining the forest on the northern and western sides, covering a total of around 3.4 hectares or possibly even more).
Pollution loads on crops in the immediate vicinity of the development site can be expected (in the absence of measures) in the form of increased deposits of mineral and organic soil components as a consequence of dust generation during earthmoving works and increased transport. Impacts on crops can be expected at the edges of neighbouring areas bordering on the LILW repository construction site and located next to the routes along which the necessary construction materials and bulk materials will be transported to the site, and also during delivery of all the necessary technical and mechanical equipment. The scope of the impact on crops will be temporary and dependent on the intensity of works during construction of the LILW repository. Dust generation can be successfully reduced by watering transport routes in dry periods and by adjusting speeds (reducing the speeds of goods vehicles).
Impacts on crops in the immediate surrounding area can occur during implementation of construction works. The size of the impact will depend above all on the period in which works take place. A possible additional negative impact is a change in the structure of agricultural land as a result of compaction of soil by site machinery and an increase in the gravel content of the fertile layer (the top 30 cm) if the backfilling of excavations is not carried out adequately.
The majority of transport routes will follow existing routes, or will be inside the area of permanent occupation. This will additionally prevent possible pollution and destruction of neighbouring agricultural land.

Cumulative impacts:
In the area of the plan, the construction of a new route of the Krško–Brežice regional road is planned within the core area of the site under consideration. This is the subject of a separate detailed plan of national importance, but the two spatial plans overlap in the area of the road connection to Krško NPP. The reconstructed local road from the area of the LILW repository will be connected to the planned new route via the southern arm of the Spodnji Stari Grad roundabout.
Construction of Brežice HPP, which has permanently occupied around 266 ha of agricultural land (including around 107 ha of fields), also has a noticeable cumulative impact on agricultural land in the wider area of the development.
The impact of the LILW repository on agricultural land, taking into account the cumulative impacts of the construction of Brežice HPP, is estimated as moderate.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING OPERATION

The adoption of the Decree on the detailed plan of national importance led to the purchase of the land mentioned above and, consequently, to a change in its designated use. In the area of the planned development, there will be a change in actual land use during construction of the Vrbina LILW repository (designated land use has already changed with adoption of the DPN). Crop production will no longer take place in the area of the planned development, but at the same time the LILW repository will not have an impact on neighbouring agricultural land.

The development as a whole affects one crop producer, who farms a total of 250.83 ha, of which 249.16 ha are fields and 1.67 ha are meadows. The planned construction will reduce this farmer's land by around 16.5 ha, or approximately 6.6%. Records show a total of 28,652.83 ha of agricultural land in the municipality of Krško (MKGP, 2014), which means that construction of the LILW repository represents a 0.005% loss of agricultural land at the municipal level. Adoption of the Decree on the DPN led to the purchase of the land in question and, consequently, to a change in the designated land use to building land (other infrastructure area T, E, O).
The impact of construction of the repository represents a reduction in total agricultural land in the municipality by 0.005%.

Cumulative impacts:
A noticeable cumulative impact on agricultural land in the wider area of the development comes from the constructed Brežice HPP, which has permanently occupied around 266 ha of agricultural land (including around 107 ha of fields).

The cumulative impact on agricultural land is noticeable, but the requirements of the competent ministry are taken into account in the Decrees on the adopted detailed plans of national importance for the LILW repository and Brežice HPP (as regards the safeguarding of agricultural land).

Agricultural use (permanent meadow or field) is planned to be maintained in part of the area (the strips adjoining the forest on the northern and western sides, covering a total of around 3.4 hectares or possibly even more), which reduces the cumulative impact on agricultural land.

The impact of the LILW repository on agricultural land, taking into account the cumulative impacts of the construction of Brežice HPP, is estimated as moderate.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

Following abandonment of the activity, the above-ground facilities of the repository will be removed or released for unrestricted use. A return to agricultural land would not be reasonable. Long-term control and monitoring will continue for 300 years following closure of the repository (active long-term monitoring for 50 years and passive long-term monitoring for 250 years).

Cumulative impacts

We do not know what developments will be taking place in the vicinity of the LILW repository at the time that activity is abandoned (in 2061). Brežice HPP will, however, still be present, so a large quantity of former agricultural land will still be permanently occupied.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

EVALUATION OF IMPACTS AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

The development as a whole affects one crop producer, who farms a total of 250.83 ha, of which 249.16 ha are fields and 1.67 ha are meadows. The planned construction will reduce this farmer's fields by around 16.5 ha, or approximately 6.6%. Records show a total of 28,652.83 ha of agricultural land in the municipality of Krško (MKGP, 2014), which means that construction of the LILW repository represents a 0.05% loss of agricultural land at the municipal level.

The impact of the LILW repository on agricultural land, taking into account the cumulative impacts of the construction and operation of Brežice HPP, is estimated as moderate. The planned maintenance of actual agricultural use (permanent meadow or field) in part of the area reduces the cumulative impact on agricultural land.

The adoption of the Decree on the detailed plan of national importance led to the purchase of the land and, consequently, to a change in its designated use.

Table 76: Description and assessment of possible impacts of the development on agricultural land

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – AGRICULTURAL LAND	
Impact assessment – as a whole	During construction: taking into account cumulative impacts, the impact is moderate (2). The development occupies land that is agricultural land in terms of actual land use but in terms of designated land use (as per Krško's Municipal Spatial Plan (OPN)) is classed as areas of environmental infrastructure (O) and other green areas (ZD). Pollution loads on crops in the immediate vicinity of the development site are to be expected (if mitigating measures are not implemented) in the form of increased deposits of mineral and organic soil components as a consequence of dust generation during earthmoving works and increased transport. During operation: taking into account cumulative impacts, the impact is moderate (2). The planned maintenance of (actual) agricultural use in part of the area reduces the cumulative impact on agricultural land. During decommissioning and abandonment: the impact, taking into account cumulative impacts, is insignificant (1), a return to agricultural land is not reasonable.
Impact characteristics and type	The planned development does not have an impact on neighbouring agricultural land.
Likelihood of impact and its consequences	The impact will be permanent in the permanently occupied area (level of the terrain raised); the area of agricultural land occupied during construction will be 16.5 ha, but this figure will be reduced during the operating phase as a result of a partial return to agricultural use (the strips by the forest on the northern and western sides). The duration of occupation of the site (by the LILW repository) is around 300 years, after which recultivation or a change to the area is possible.
Duration or frequency of impact and its consequences, and their reversibility	There will be a change in land use in a small area where the development is planned. The possibility of a return to agricultural use is not envisaged.
Type, degree or intensity of changes to the environment or part thereof that can be attributed to the impact	Taking into account mitigating measures, the planned development does not have an impact on the agricultural potential of neighbouring agricultural land.
Scope of impact	The planned construction will reduce the amount of agricultural land (in terms of actual use) by around 16.5 ha. In the context of the external arrangements of the LILW repository, it is planned to return part of the area to agricultural use, which represents a mitigating measure. Construction of Brežice HPP, which has permanently occupied around 266 ha of agricultural land (including around 107 ha of fields), also has a noticeable cumulative impact on agricultural land in the wider area of the development. The impact of the LILW repository on agricultural land, taking into account the cumulative impacts of the construction of Brežice

	HPP, is estimated as moderate.
Interactions between individual impacts and their consequences	The impact on land occupation will have no interaction with other impacts and their consequences.

5.3.6 *IMPACTS ON NATURE*

The area proposed as the site for the LILW repository lies on the left bank of the river Sava and consists of a single habitat type – Field crops (82.11). It is an intensively cultivated maize field which is characterised by a small number of plant species (forced monoculture, plant protection products) and animal species (drastic changes to the microclimate, plant protection products).

The core site area is part of an intensively cultivated monoculture grain field. In such an environment, an extremely low diversity of flora is expected (fewer than 10 weed species per hectare), while the presence of endangered and protected plant species requiring protection with special conservation regimes is not expected. No floristically important areas are present within a 500 m radius of the site. Dry and semi-dry grasslands are present across smaller areas, although these only occur in floristically rich form on the right bank of the Sava. Potentially present plant species in the area of the planned development do not belong in the Red List, and at the same time no potentially present species is mentioned in the Decree on protected wild plant species (Official Gazette of the RS 46/04, 110/04, 115/07, 36/09, 15/14.

Fauna diversity is extremely low in the core site area, since the area consists of intensively cultivated monoculture fields separated from the surroundings by natural (Sava) and man-made barriers (road, railway line with embankments). In all likelihood there are no nesting birds in the area of the planned development, although some species appear there on a regular basis. The area covered by the LILW repository site does not represent a favourable living and feeding habitat for amphibians. It is assumed that individual specimens of relatively common species appear occasionally in the core area under consideration: the common toad (*Bufo bufo*) and the common frog (*Rana temporaria*). Owing to intensive farming methods using plant protection products, the presence of insect species in the core area of the planned location is expected to be limited to small populations of the more common species. The small size of the insect population is also the reason why there are few insectivorous vertebrate species in the area of the planned development.

DURING CONSTRUCTION

Impacts on flora, fauna and habitat types

A permanent change of habitat type (HT) will occur during construction. In its existing state, the development site consists of an intensively cultivated maize field (HT 82.11 Field crops), which is of no special value from the point of view of flora, fauna and HTs. Additionally, plant species and less mobile animal species located in the direct area of the development will be destroyed. The impact will be direct and permanent. Owing to the nature of the development (construction of underground silos), the underground interstitial environment

(HT 65.82 Interstitial biocenoses with fresh soil water – phreatic biocenoses), which is inhabited by highly specialised interstitial fauna, will be affected.

Dust generation may occur during construction (remote impact), which may result in dust particles settling on the above-ground parts of plants in the direct area of the construction site (up to 15 m from the development boundary). This may reduce or halt the conductance of leaf stomata. We estimate that this impact will be short-term and that precipitation and wind will remove the dust particles from the plants, meaning that there will be no permanent negative consequences on vegetation.

A more important area from the point of view of nature conservation is represented by various grassland habitats. None of these are within the area of the development itself, but they do appear in small areas to the north, west and south-east of the development site. Those closest to the site are less than 100 m away, while species-rich grasslands are exclusively present on the right bank of the Sava (approximately 950 m from the development site) and are not reached by the impacts of the development, which is on the left bank of the Sava.

The possibility of a short-term impact on the environment (HT) as a result of the temporary depositing of material (humus, excavated earth) exists during construction. The use of heavy construction machinery during construction represents a potential risk of soil pollution with motor oil, fuels and lubricants. In the event of a spillage of these hazardous substances, the interstitial environment, which also represents a reservoir of soil water/groundwater, could be affected. In the event of a major accident, pollution could also spread to the river Sava and the area of the Stari Grad gravel pit. **However, we estimate that with suitable planning and implementation of the repository, and taking into account mitigating measures, a significant portion of the interstitial environment habitat type will not be destroyed**.
If the construction site is illuminated at night, this light will have a minor impact on insects, but endangered species in the wider area will not be significantly affected by the development because they are not present in the immediate surroundings.

Impacts on protected areas

The area of the development does not encroach on a Natura 2000 area, nor on any protected areas. The area under consideration contains no natural features or zones that are important to biodiversity. The nearest protected area to the site is a Natura 2000 area (SAC Vrbina), which is at a distance from the closest point of the site of less than 1,000 m and is separated by the stream of the River Sava. As part of the environmental report, an addendum for protected areas was not necessary. Two grassland habitat types are qualifying types for the Natura 2000 area SAC Vrbina (SI3000234):

- Lowland hay meadows (6510);
- Semi-natural dry grasslands and scrubland facies on calcareous substrates (6210 8*)

The LILW repository involves a very specific form of collection site for waste material, which given the classification of developments in the Rules on assessment of the acceptability of the impacts of the implementation of plans and developments affecting nature in protected areas, cannot be more precisely defined.

An amendment to the Rules on assessment of the acceptability of impacts of the implementation of plans and developments affecting nature in protected areas now provides that remote impact is determined in an area that is twice as large as the area of remote impact. In the case of the project in question, this remote impact is therefore 1,000 m. The table below shows that the remote impact is not defined for species that are typical of the Natura 2000 area in question, but exclusively for the brown bear, which according to known data for the project area is not present.

AREA OF ENVIRONMENTAL INFRASTRUCTURE

Development affecting nature	Direct impact	Area of direct impact (in m)	Remote impact	Area of remote impact (in m)
Arrangement of the collection site for waste material (refuse dumps, landfills and ecology islands) and waste disposal sites	ALL GROUPS	50	brown bear	500

Given the absence of brown bears in the area in question and the nature of the development (LILW repository), we may conclude with certainty that there will be no remote impact of the development in question on brown bears (since they are not present in the area). According to information from the LD Cerklje ob Krki hunting club, no brown bears have appeared in the Vrbina area (right bank of the River Sava) for the last 30 years (letter from the president of LD Cerklje ob Krki).

Impacts on ecologically important area and valuable natural feature

The planned development does not encroach on the ecologically important area encompassing the Sava from Radeče to the national border, since the latter area is around 400 m from the site. Not only that, but the parts of the area that are more important from the point of view of nature conservation are on the opposite bank of the Sava to the development site.
Similarly, the development does not encroach on the Stari Grad–gravel pit area, which has been designated a valuable natural feature. Although it lies on the same bank as the development site, this area is around 600–700 m away from the site.

We estimate that there will be no impacts on the ecologically important area or valuable natural feature during construction of the LILW repository.

Cumulative impacts
Cumulative impacts will not be present during construction.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING OPERATION

During operation, a new habitat with tall woody vegetation (trees) will be created in the predominantly intensive agricultural environment by means of new external planting:

The strip of forest vegetation that will frame the LILW repository on its northern and western sides will consist of a mixture of fast-growing and slower-growing tree species that are native to the surrounding area. The choice of a variety of native species facilitates better adaptation to the site and ensures a habitat for various animal and plant species in the area in question. A wide tree hedge consisting of a mixture of predominantly fast-growing tree species native to the area will be planted along the southern edge of the site. Tree planting is planned in the park area by the entrance section to the LILW repository and south of the access road.

For the forest strip, native tree species that make up forest communities in the Krško Polje/Brežiško Polje area have been selected:
hornbeam (*Carpinus betulus*) (20%), oak (*Quercus robur*) (20%), sessile oak (*Quercus petraea*) (20%), common alder (*Alnus glutinosa*) (10%), common ash (*Fraxinus excelsior*) (20%) and field maple (*Acer campestre*) (10%). The planted trees will be supplemented with seedlings of native species of trees, shrubs and herbaceous perennials in a process of natural succession.
For the area of park and trees on the meadow south of the access road, tree species native to the area have been chosen: hornbeam (*Carpinus betulus*), oak (*Quercus robur*) and sessile oak (*Quercus petraea*).
For the car park, a native tree species has been chosen: field maple (*Acer campestre*).
For the green areas by the administration and service building, two species have been chosen: field maple (*Acer campestre*) and Montpellier maple (*Acer monspessulanum*).

Predominantly native non-demanding flowering and structural perennials have been selected for planting in areas with perennials in the park area.

A mixture of grasses that grow well and are resistant to drier sites has been chosen for the lawn in green areas and on banks.
The use of grass and herbaceous species typical of lowland hay meadows mixed with species from semi-natural dry grasslands (*Festuco-Brometalia*) is planned for the meadow in the entrance section of the repository.

Impacts on flora, fauna and habitat types
During operation, a remote impact will be observable in the form of dust generation (particularly due to transport and traffic).
We estimate that these impacts will be insignificant (1).
From the point of view of nature and HTs, the external arrangements within the context of the development represent a mitigating measure that reduces negative impacts on nature, thanks to the formation of a forest area and the planting of trees on the meadow around the building areas of the LILW repository in an area that was formerly a monoculture field habitat.

Impacts on protected areas
There will be no impacts on protected areas during operation of the LILW repository.

Impacts on ecologically important area and valuable natural feature
There will be no impacts on the ecologically important area and valuable natural feature during operation of the LILW repository.

Cumulative impacts
Cumulative impacts will not be present during operation.

We estimate that additional air pollution and, indirectly, pollution of surrounding vegetation, will occur during operation, but that this impact will be short-term in nature. Impacts on fauna, flora and HTs during operation are estimated as insignificant (1). There will be no impacts on protected areas, ecologically important areas or valuable natural features (0).

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

After filling of the LILW repository and decommissioning of individual facilities, the area above the disposal areas will be covered, unpaved areas will be grassed over, and the entire area will be surrounded by a belt of trees. Over the years a diversity of animal and plant species and habitat types will be established in the area that will not be smaller than in the existing situation, and will even be better (in the existing situation the development site consists of an intensively cultivated maize field, which has no particular value from the point of view of flora, fauna and habitat types). There will also be a permanent change in the composition of communities and habitat types.
It will be necessary to plan the maintenance of the grassy area by mowing, or to leave the area to overgrow (shrubs → trees → forest).

With suitable planning, implementation and maintenance of the repository, and taking into account all mitigating measures, we do not expect pollution of the environment with radioactive isotopes.

Impacts on flora, fauna and habitat types
During decommissioning, a remote impact will be observable in the form of dust generation (above all as a result of demolition, transport and traffic) and slightly increased noise.
We estimate that these impacts will be insignificant (1) during decommissioning and that they will not be present (0) following abandonment of the activity.

Impacts on protected areas
There will be no impacts on protected areas during decommissioning and following abandonment of the LILW repository.
Impacts on ecologically important area and valuable natural feature
There will be no impacts on ecologically important areas or valuable natural features during decommissioning and following abandonment of the LILW repository.

Cumulative impacts
We do not know what developments will be taking place in the vicinity of the LILW repository at the time that activity is abandoned (in 2061). We can, however, evaluate them as insignificant.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

EVALUATION OF IMPACTS AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

We estimate that additional air pollution and, indirectly, pollution of surrounding vegetation, may occur during construction, but that this impact will be short-term in nature. Impacts on fauna, flora and HTs during construction are estimated as moderate (2), while there will be no impacts on protected areas, ecologically important areas or valuable natural features (0).
During operation, a remote impact will be observable in the form of dust generation (particularly due to transport and traffic). We estimate that these impacts will be insignificant (1). There will be no impacts on protected areas, ecologically important areas or valuable natural features during operation of the LILW repository.
During decommissioning, a remote impact will be observable in the form of dust generation (above all as a result of demolition, transport and traffic) and slightly increased noise. We estimate that these impacts will be insignificant (1) during decommissioning and that they will not be present (0) following abandonment of the activity.

Table 77: Description and assessment of possible impacts of the development on nature

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – NATURE	
Impact assessment – as a whole	During construction: The impact of the development during the construction phase does not reach protected areas (no direct impact and no remote impact) or ecologically important areas or valuable natural features – no impact (0). We estimate the impact on fauna, flora and HTs as moderate (2). During operation: The impact of the development during operation does not reach protected areas (no direct impact and no remote impact) or ecologically important areas or valuable natural features – no impact (0). We estimate the impact on fauna, flora and HTs as insignificant (1). There will be a permanent change in the composition of communities and habitat types during operation. During decommissioning and abandonment: The impact of the development during decommissioning and abandonment of the activity does not reach protected areas (no direct impact and no remote impact) or ecologically important areas or valuable natural features – no impact (0). We estimate the impact on fauna, flora and HTs during decommissioning as insignificant (1), while during abandonment of the activity there is no impact (0). Over the years, in fact, a diversity of animal and plant species and habitat types will be established in the area that will not be smaller than in the

	existing situation, and will even be greater thanks to an area of mature forest, co-formed by natural succession, and trees in the meadow.
Impact characteristics and type	Impacts will be direct (loss of habitat areas and habitat structures). During decommissioning, remote impact will be pronounced in terms of dust generation (particularly due to transport and traffic), increased noise and light pollution. In terms of duration, the effects during construction will be temporary, while during operation there will be a permanent change to the composition of communities and habitat types. The project itself, and the external works (planting of trees) is a mitigating measure that reduces the negative effects on nature.
Likelihood of impact and consequences	There is a certain likelihood of impact, as a permanent change to composition of communities and habitat types will be present.
Duration or frequency of impact and its consequences, and their reversibility	The impact duration during construction will be approximately 3 years, i.e. the duration of major construction works. When construction is concluded, the effect will be permanent and constant. After approximately 300 years re-cultivation by re-establishing the original habitat type (i.e. fields) is possible. However, this would require cutting down of a mature forest, which would have a major impact on existing plant life, animals, and HTs that developed during the operation of the project.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	There will be a permanent change to the composition of communities and habitat types. It should be noted, however, that from the point of view of nature the project itself, and the external works (planting of trees) is a mitigating measure that reduces the negative effects on nature.
Scope of impact	The impact affects a surface area of approximately 17.5 ha, of which 16.5 ha are former agricultural land (prior to entry into force of the Detailed plan of national importance for the LILW repository at Vrbina in the municipality of Krško).
Interactions between individual impacts and their consequences	Management of waste, wastewater, ground, and agricultural land directly impact the state of nature. In terms of indirect impacts, the factors include noise, light pollution, electromagnetic and ionizing radiation, and air pollution. The state of nature has an indirect impact on the quality of the human habitat, the appearance of the landscape, and agricultural activities.

5.3.7 *LANDSCAPE IMPACTS*

Listed below are the impacts that may negatively affect the landscape due to construction and after the conclusion of the project.

DURING CONSTRUCTION

Landscape impacts will be present during construction due to small-scale earthworks. Disturbances of the local landscape may appear due to access paths and the presence of the construction site, which can be regarded as a visual spatial disturbance. During construction the bare surfaces without vegetation cover in the construction area will be considered a disturbance. Relief impacts will appear due to the construction of the embankment, and the removal of vegetation and humus.

DURING OPERATION

The planned project will occupy a surface area of approximately 17.5 ha. Local relief changes are expected on this surface area due to the construction of the embankment. New construction engineering elements will be introduced into the landscape, such as the service building, the hall above the silo and the disposal silo itself. Since the embankment and the building are planned in the middle of a field with no tall vegetation, they will be visually exposed. The visual exposure will be mitigated with the newly designed landscaping, and planting of the banks and the immediate surroundings of the repository.

Landscaping takes into account the visual exposure of the location from Vrbinska road and from the vantage points (Libna) and the surrounding villages (Vrbina, Spodnji Stari Grad). The altitude of the terrain on-site varies from 151.50 m to 153.50 m above sea level (ASL). The average altitude of the embankment area is approximately 153 m ASL. According to the level of flood protection for the buildings, the buildings are set on the flood-protection embankment at an altitude of 155.20 m, at approximately the same altitude as the nearby orchard. The altitude is aligned with the embankments of the Brežice hydroelectric plant, which are approximately 600 m south of the LILW repository.
The altitude of the administrative and service building is approximately 5 m or 8 m above the altitude of the embankment. The technological facility is approximately 5 m (the lower part), and 9 m (the taller part) high, while the hall above the silo is 18 m high. The buildings together with the embankment are thus approximately 7 m, 11 m, and 20 m higher than the surrounding area. For comparison: the upper edge of the embankment of the nearby waste disposal site (CRO Spodnji Stari Grad) is approximately 14 m above the surrounding terrain.

The planting design as shown in the figure below takes into account the local vegetation patterns, such as the remainders of the forest between agricultural surfaces on the plains, and the pattern of the old, high-trunk orchards. The existing vegetation patterns on the plain between the River Sava and the regional road are generally regular as they follow the shape of the land plots, as is usual for cultivated landscape. Organic patterns only appear in Libna. The intensive orchards next to Krško NPP are also a highly pronounced pattern. The proposed vegetation within the LILW repository will increase biotic diversity (ecological aspect) and will break up the view from Vrbinska road to the administrative and service building.

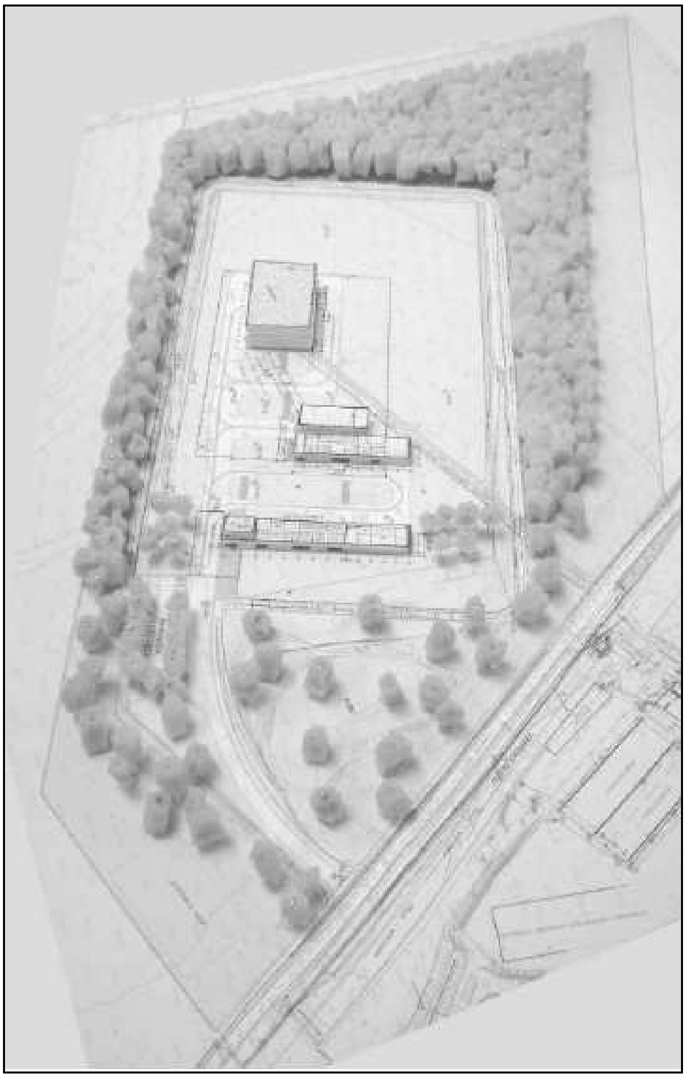

Figure 103: LILW Repository Vrbina – mock-up

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

DURING DECOMMISSIONING

No foreseen impacts, or (visual) impacts are mitigated after decommissioning.

DURING ABANDONMENT OF THE ACTIVITY

No foreseen impacts, or (visual) impacts are mitigated after decommissioning.

Remains of the repository

Following the conclusion of the active and passive long-term surveillance of the repository, the repository buildings are foreseen for decommissioning and removal, while the repository will be shut down. The area of the repository will be freed for non-restricted use.

The flood-protection plateau is forecast to be retained, while the hard surfaces will be removed, seeded with grass, and left to overgrow. In order to retain a historic memory of the radioactive waste repository, the repository location and the location of the silo are planned to be marked by the remnants.

The massive reinforced concrete walls on the eastern facade of the building, and perhaps the north-east reinforced concrete corner of the administrative service building could remain, marking the approximate width of the building.

At the location of the disposal silo, a permanent marker in the form of four massive upright reinforced concrete pillars, measuring 80 x 100 cm and 5 m high, is planned to remain, as well as the remainders of the portal of both doors for entry and exit of lorries into the hall above the silo in the southern and northern facade to mark the approximate silo location in the future forest.

The remains of the repository will thus consist of remains of the repository buildings, without requiring additional construction work or constructions. The location of the remains will not be turned into a park, and the surface areas will be left to be overgrown by the forest. The one exception is the potential remains of the administrative and service building, which would delimit the edge of the repository area, and which could be located on a mown pasture.

Figure 104: Schematic illustration of proposed remains

Cumulative impacts

We do not know which projects will be implemented near the LILW at the time of abandonment (in the year 2061). We can however evaluate them as insignificant.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

EVALUATION OF THE PROJECT IMPACT AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

The impact of the planned interventions in the landscape during construction and/or operation is small. While the landscape features and the general spatial relations will change to a certain degree, they are predominantly local in nature and do not lead to a significant deterioration of the landscape quality and its perception.

Table 78: Description and assessment of the possible impact of the project on the landscape

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – LANDSCAPE	
Impact assessment	During construction: moderate impact (2) During operation: insignificant impact (1) After decommissioning: insignificant impact (1)
Impact characteristics and type	The effect on landscape will be remote, both direct and indirect, both temporary and permanent, and cumulative.
Likelihood of impact and consequences	There is a possibility of impact, but with minimal consequences for the landscape.
Duration or frequency of impact and its consequences, and their reversibility	During construction, the impact will be due to the construction site. The access paths through individual built-up areas will not be active throughout the construction period (i.e. months), but only in individual construction phases, from a few days to a few weeks at a maximum. After the construction and the works are finished, the appearance of the landscape will improve gradually, especially by planting and establishing a natural succession. After the end of operation, and after the LILW is decommissioned, the impact will remain even with the appropriate measures (proposed landscaping). While the changes to the landscape will be noticeable, they will not necessarily be negative, as the breaking up of monoculture with the forest and the trees in the meadow will have a significant mitigating effect.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	The change to the landscape will be minor, and only visible from a few high vantage points due to flat landscape and forests.
Scope of impact	The impact is significant for the local repository area.
Interactions between individual impacts and their consequences	The landscape impact will have no significant interactions with other impacts.

5.3.8 *IMPACTS DUE TO WASTE GENERATION*

DURING CONSTRUCTION

During the project, the proposed construction works for the LILW repository will partially overlap, such as the construction of the embankment, the repository buildings and infrastructural buildings. No waste will be generated due to demolition works when constructing the first silo and the buildings, as the building site currently consists of agricultural land. The construction will therefore only produce significant amounts of excavation materials. These are proposed to be used to landscape the area around the LILW buildings, both for constructing the flood protection plateau, and for external landscaping of the LILW (i.e. green surfaces). The following construction waste types are anticipated: mixed construction waste (bentonite slurry), some waste concrete and bituminous mixtures. The waste concrete and bituminous mixtures will be collected separately and handed over to an authorised waste management company.

The construction of the second silo is anticipated in 2048 and 2049. The construction will predominantly produce a large amount of soil excavation, which will partially be used to landscape the LILW area, while the remainder will be disposed of at the permanent ash landfill (Kostak, 17,978 m^2, cadastral municipality 1316 Stara Vas), and on plot 2106/85, cadastral municipality Drnovo.

The second silo construction is envisaged to maximise re-use of the equipment and the construction elements resulting from demolition of the hall above the first silo. Part of the equipment, approximately 30%, from the first silo will be used to construct the second silo, and the majority – i.e. approximately 90% of the steel structure – of the first silo hall will be used on the second silo. Due to demolition works and construction, mixed construction waste and bituminous mixtures will be generated. The mixed construction waste from the construction of the first and second silos will likely be submitted to an authorized waste management or processing company.

The types and quantities of waste and their management is described in detail in Section 2.3.2 *WASTE TYPES AND QUANTITIES, AND WASTE MANAGEMENT*

See below for a short summary on quantities of excavated soil and its management:

- construction of embankment
- construction of repository facilities landscaping
- construction of infrastructure facilities
- construction of the second silo

<u>Construction of the embankment</u> requires fertile soil to be pushed to the edge of the construction site for re-use, excavation of the non-load-bearing sand-silt soil to a depth of about 1.5 m, and its incorporation into the non-load-bearing part of the embankment outside the area of the facility foundations.

All soil excavations (35,845 m^3) will be used on-site to construct the embankment. The fertile soil (14,189 m^3 of humus) will be used to apply humus and landscape the green areas around LILW facilities in the later stages of the project. An additional 75,806 m^3 of load-bearing material will have to be supplied for the construction of the embankment.

<u>Construction of repository buildings and landscaping</u>

The excavated material (43,734 m^3) produced during the silo construction will be transported and incorporated into the embankment within the construction site. All excavated soil will be used on the construction site. The load-bearing embankment material is anticipated to be transported from the nearest quarry (21,493 m^3). The fertile soil (8,132 m^3) will be used for the green areas and for landscaping (i.e. planting) around the LILW facilities.

<u>Infrastructure construction (transport infrastructure, infrastructure lines and connections)</u>

The excavated soil (for road landscaping and excavation of the municipal water ditch) in the total quantity of 8,710 m^3 will be built into the non-load-bearing part of the embankment plateau of the LILW repository. The average transportation distance is around 500 m. Load-bearing embankment material (total of 15,500 m^3) is anticipated to be transported from the nearest quarry. Fertile topsoil (1,100 m^3) will be used for the green areas and for landscaping (i.e. planting) along the road and around the LILW facilities. Surplus fertile topsoil (1,300 m^3)

will be used for arranging the area around the LILW facilities on the investor's land and will not be taken away from the construction site.

Construction will take place in an area with cultivated field and grassland surfaces. During the execution of works, a variety of construction waste will be generated (waste group 17 under the waste classification list in the Decree on Waste). In addition to construction waste, works will generate other waste that is not in the group with classification number 17, such as waste packaging for transportation of construction materials or construction products, waste that may be generated from transportation or the operation of machinery and devices at the construction site and urban waste generated from workers at the site.
With regard to the Plan of managing construction waste for the Conceptual Design phase (Study No. NRVB---1P/02B), mainly the following construction waste will be generated: waste concrete, mixed construction waste, bituminous mixtures and owing to earthworks, soil and rocks (see the table below).

Table 79: Type and quantity of construction waste that will be generated in construction of the embankment, the first silo and accompanying facilities and arrangements.

Waste classification number	**Name of waste**	**Anticipated quantity (t)**
17 01 01	Concrete	96.00
17 03 02	Bituminous mixtures other than those mentioned in 17 03 01	528.00
17 05 04	Earth and rocks other than those mentioned in 17 05 03	39,600.00 humus (24,721 m^3) 145,760.00 silt (80,980 m^3) 13,890.00 gravel (7,311 m^3)
17 09 04	Mixed construction waste and waste from dismantling of structures other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	840.00 bentonite slurry
TOTAL		**200,714.00**

* the table does not include the quantities of soil material delivered to the site, totalling 72,838 $m^{3.}$

Construction of the second silo
Forming the work plateau (diaphragm) of the second silo will require the removal of the top part of the embankment. The quantity in this section amounts to around 12,700 m^3. From this level down to the planned elevation, sand and silt will be removed from the vegetation-covered ground and replaced with high-quality materials from outside sources. The quantity of this part is estimated at around 11,500 m^3. This is a quantity based on the assumption that the thickness of the removed silt is 1.25 m. During the works, silt will be removed in its actual thickness, so the quantity may be greater or smaller than the assumption. The plateau formed in this way will serve as the basis for constructing the primary substructure (diaphragm) of the second silo. After the silo is completed, an embankment will be made of high-quality material, which will form the basis for the foundations of the hall above the silo. The quantity is estimated at around 9,800 m^3. It will be possible to incorporate around 2,700 m^3 of silt along the edge of the load-bearing part of the embankment in accordance with the profiles of the envisaged plateau at the LILW repository. In this case we envisage the removal to the external landfill of around 21,400 m^3, and later in the excavation for the silo around a further

43,800 m^3 giving a total of around 65,200 m^3. In the area of the repository it will be necessary prior to excavation of the silt embankment to remove around 2,400 m^3 of humus. Of this around 924 m^3 will be usable for later humus application. This will give a humus surplus of 1,476 m^3, which will be distributed as part of the landscaping on the investor's land. The surplus of excavated material in the construction of the second silo will be disposed of in the permanent ash dump (Kostak, 17,978 m^2, c.m. 1316 Stara Vas) and on parcel 2106/85, c.m. Drnovo.

During construction, waste associated with construction works, construction materials, equipment packaging and worker presence may be generated: excavated soil (classification no. 17 05 04), bituminous mixtures (17 03 02), waste concrete (17 01 01), mixed construction waste (17 09 04), waste packaging and equipment (15 01 ...). Waste oil from construction machinery is not anticipated, as the building contractor will perform construction machinery maintenance at service stations. According to the data from the Construction waste management plan, no hazardous construction waste will be generated during construction. Due to the construction and installation workers, urban waste will be generated (mixed urban waste, classification no. 20 03 01; paper and cardboard, 20 01 01; glass, 20 01 02; biodegradable waste, 20 01 08).

Negative impacts due to construction waste could occur predominantly due to inappropriate waste collection and separation, temporary storage, recording, transport, processing, or disposal. Inappropriate handling would predominantly affect the environmental burden from the waste, pollution and landscape appearance. Hazardous waste is not envisaged, except in exceptional circumstances, such as oil or fuel leaks. The Construction waste management plan has been compiled for waste resulting from construction of the first silo (IBE, 2015), as required by Article 5 of the Decree on the management of waste arising from construction work (Official Gazette of the RS, 34/08); Municipal waste management in the Municipality of Krško is regulated by the Ordinance on the management of municipal waste in the Municipality of Krško. Official Gazette of the RS, Nos 33/07, 45/09, 47/10, 30/12, 11/15. The company Kostak is contracted for waste management (collection and processing of certain types of urban waste) in the Municipality of Krško.

The project is designed to minimise waste quantities, and re-use is anticipated, in compliance with Article 9 of the Decree on Waste – Waste management hierarchy. Based on the knowledge of the project and the planned and additional proposed measures, we evaluate the negative impacts on the environment due to waste generation and management during construction works as moderate (2).

Cumulative impacts

No cumulative impacts of waste are expected.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

DURING OPERATION

The LILW repository is a nuclear facility at which all activities will be carried out that are directly linked to the disposal of radioactive waste. The effects of radioactive waste on the environment are further discussed in the Ionising Radiation section.
The subject of this part of the report is waste that does not generate ionising radiation. Waste will be generated in maintenance work, and owing to the presence of employees (12 jobs), urban waste will be generated. Waste will be generated during repairs, maintenance and cleaning. Personnel at the repository (maintenance operative) will only perform minor maintenance work. Major maintenance work will be performed by external specialised providers, either in the repository area or at the provider's location (e.g. vehicle servicing). In this way waste may be generated in the area of the repository and at the maintenance provider's location outside the repository in individual repair operations.

During operation, waste will be generated principally from minor maintenance work: electrical and electronic equipment waste (16 02 ..), waste batteries and accumulators (16 06 ..), content from devices for separating oil and water (13 05 ..), absorbents, filter materials, cleaning cloths and protective clothing (15 02 ..), urban waste from the maintenance of green areas: waste from gardens and parks (20 02 ..) and owing to the presence of workers separately collected fractions (except 15 01) of urban waste (20 01 ..). Minor quantities of hazardous waste may be generated. Hazardous waste management must ensure that there is no negative environmental impact (separate collection of waste in appropriately labelled vessels, interim storage and submission to authorized waste management contractors). Municipal waste management in the Municipality of Krško is regulated by the Ordinance on the management of municipal waste in the Municipality of Krško. Official Gazette of the RS, Nos 33/07, 45/09, 47/10, 30/12, 11/15. The company Kostak is contracted for waste management (collection and processing of certain types of urban waste) in the Municipality of Krško. The Waste Management Centre at Spodnji Stari Grad is very close, and will process the urban waste generated during LILW construction. Due to the closeness of the centre, the impacts due to urban waste will likely be reduced, as no extensive transport will be required, while processing of urban waste will also be provided. With proper handling, i.e. separate collection, interim storage and submission for disposal to authorized companies, the waste types listed above will not cause significant negative environmental impacts. The impacts are evaluated as insignificant (1).

The potential waste accumulated during operation and the envisaged estimated quantities per year are shown in *Table 16: Estimated waste quantities during repository operation* in Section 2.3.2 *Waste types and quantities generated, and waste management.*

Cumulative impacts

No cumulative impacts of waste are expected.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

After the end of repository operations, the above-ground facilities are scheduled for decommissioning, while underground facilities are scheduled for closure. During the decommissioning the control pool, an underground facility, will be checked for radiation and decontaminated if required. The facilities will remain on site or will be dismantled, as decided at the time.
The issues of decommissioning the repository will be detailed in the repository decommissioning plan, to be prepared by the repository operator after the decision is made to decommission the repository. Decommissioning of the repository is the procedure rendering the facility in the state of removal of its status as a nuclear facility. Decommissioning does not also signify necessarily disassembly and dismantling of nuclear facility structures. In the Vrbina LILW Repository project it is assumed that the disposal facilities (except for the LILW repository silo, which will be closed and covered from the top) and pertaining facilities (hall, platform) will be demolished and dismantled after closure of the disposal facilities, and non-disposal facilities will be decontaminated if required, then removed from the list of nuclear facilities and assigned to unlimited use.
Negative environmental impacts due to waste (non-radioactive waste only) could occur during demolition due to inappropriate waste collection and separation, temporary storage, handling monitoring, transport, processing and disposal. This could cause increased pollution and environmental burden. If the regulations are followed, and appropriate measures taken, the impacts will likely be moderate (2).

Cumulative impacts

We do not know which projects will be implemented near the LILW at the time of abandonment (in the year 2061). We can however evaluate them as insignificant.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

EVALUATION OF THE PROJECT IMPACT AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

The evaluation and acceptability of environmental burden due to waste is based on applicable standards and norms for waste management, on the envisaged types and quantities of waste scheduled for processing, and those generated by the activity itself. The evaluation presumes that all proposed and envisaged mitigation and remedial actions will be followed completely.
According to Article 10 of the Decree on Waste, waste must be managed in such a way that human health is not threatened, and that prevents negative environmental impacts, particularly:

- no risk to water, air, soil, plants and animals;
- no excessive noise or unpleasant odours;
- no harmful impacts on areas with specific regimes due to regulations on nature preservation or regulations on protection of sources of drinking water;

- no harmful impacts on the landscape or areas with specific regimes due to regulations on preservation of cultural heritage.

Taking into account all the envisaged measures, as well as those proposed in this report, the waste generated during construction and operation will not cause excessive pollution.

Table 80: Description and assessment of the possible impact of the project on waste

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – WASTE	
Impact assessment	During construction: Impact is moderate (2). During operation: insignificant impact (1) During decommissioning and abandonment: the impact during decommissioning is moderate (2), and there is no impact after abandonment (0).
Impact characteristics and type	The effects of the project during construction, operation and decommissioning will be indirect and temporary (generation of waste).
Likelihood of impact and consequences	No waste will be generated due to the demolition works when constructing the first silo, as the building site currently consists of agricultural land. Waste will be generated during construction, operation and abandonment (decommissioning). The project is designed to minimise waste quantities, and re-use is anticipated. Excavated soil will be used for embankments and landscaping. The remainder will be disposed of at authorised sites outside the construction site. Waste handling will be compliant with the legislation, and we thus expect no negative impacts due to waste.
Duration or frequency of impact and its consequences, and their reversibility	Waste will be generated during construction of the LILW repository. During repairs, maintenance and cleaning, waste will be generated: during trial operation and regular operation, during interruptions in operation, during activities to prepare the repository for the idling phase (closing of the first silo), and after 2049, as the repository is expected to restart operation in 2050 (second silo). Waste handling will be compliant with the legislation and the municipal regulations, and we thus expect no negative impacts.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	The impacts of the LILW repository due to waste generation during construction, decommissioning and operation will not cause significant environmental changes.
Scope of impact	Impacts due to waste generation during construction and decommissioning will be felt primarily in the direct vicinity. Excavated soil will be used in the direct vicinity (on-site and nearby). During operation only minor quantities of non-radioactive waste will be generated. Impacts due to waste transport will be minor. Handling such non-radioactive waste during construction and operation will be compliant with the waste management hierarchy as prescribed by law (prevention of waste generation, re-use, recycling and disposal). Negative impacts on built-up areas in terms of pollution or impact on landscape appearance are therefore not expected.
Interactions between individual impacts and their consequences	The excavated soil is proposed to be used to landscape the area around the LILW buildings, both for constructing the flood protection plateau, and for green areas of the LILW. Part of the equipment, approximately 30%, from the first silo will be used to

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – WASTE	
	construct the second silo, and the majority – i.e. approximately 90% of the steel structure – of the first silo hall will be used on the second silo. This handling will significantly decrease the impacts due to waste generation, and will at the same time use the waste in the direct vicinity of the project.

5.3.9 *ENVIRONMENTAL NOISE BURDEN IMPACTS*

DURING CONSTRUCTION

Embankment work

During the construction, the greatest source of noise will be construction machinery and the movement of lorries bringing in and removing building materials from the LILW repository construction site (source: Technical basis for the EIA for the LILW repository, Protection against noise, August 2015 – supplemented following review in November, December 2015, KOVA d.o.o., EK2015-1500501b, Assessment of environmental noise burden, LILW repository Vrbina, Krško, August 2018, KOVA d.o.o.).

At the construction site, machinery with the following sound powers will be used:

- Bulldozer L_W=106 dBA
- Roller L_W=104 dBA
- Excavator L_W=96 dBA
- Loader L_W=96 dBA
- Dumper L_W=106 dBA

The number of transports will be 30 per day.

The calculation was done according to SIST ISO 9613-2 and based on the calculation method NMBP-XPS 31-133, as required by the Decree on the limit values of noise indicators in the environment (Official Gazette of the RS, No. 43/18)

The values of the daytime noise indicator were determined at the immission points shown in the table and figure below.

Table 81: Location of immission points

Immission point	Y	X
1	541542	88805
2	541339	88889
3	540998	89047
4	539924	89122
5	541429	88416

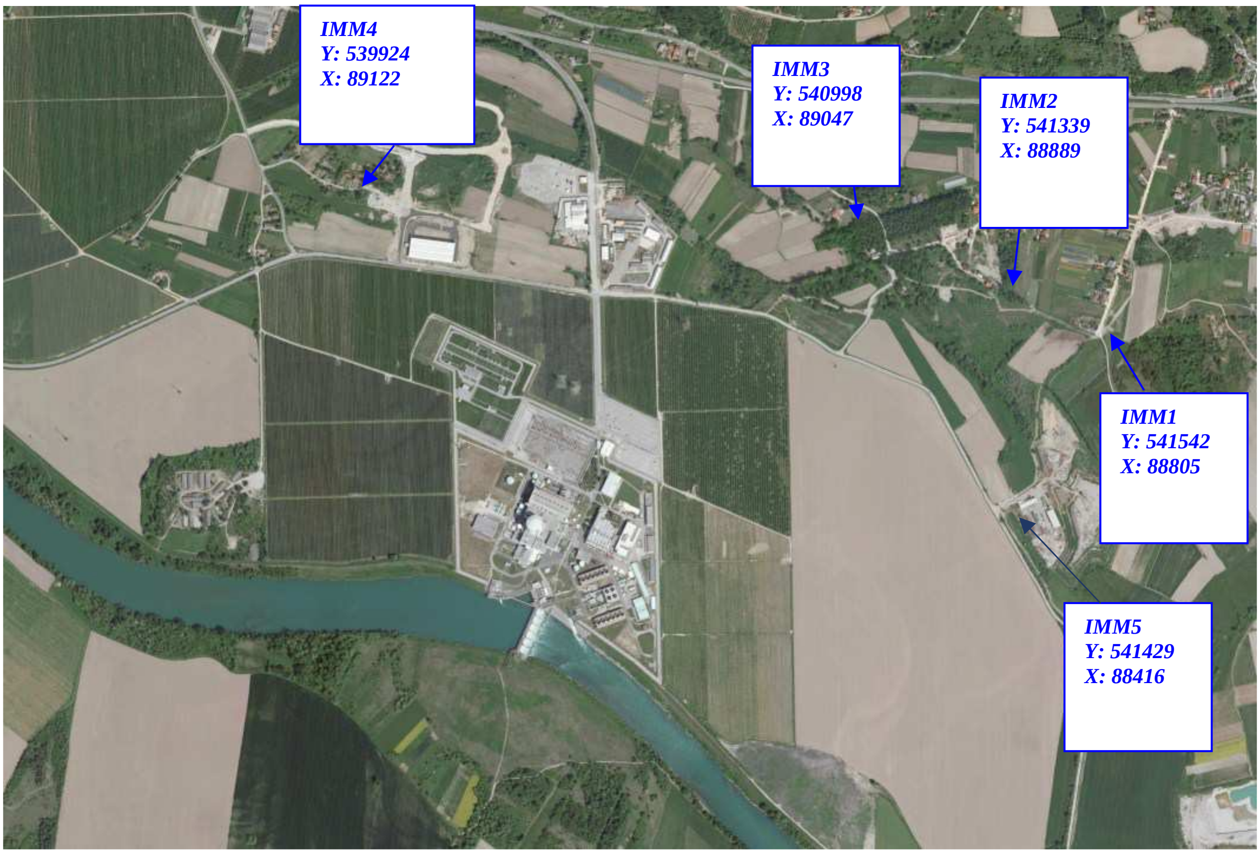

Figure 105: Location of immission points (Atlas of the Environment)

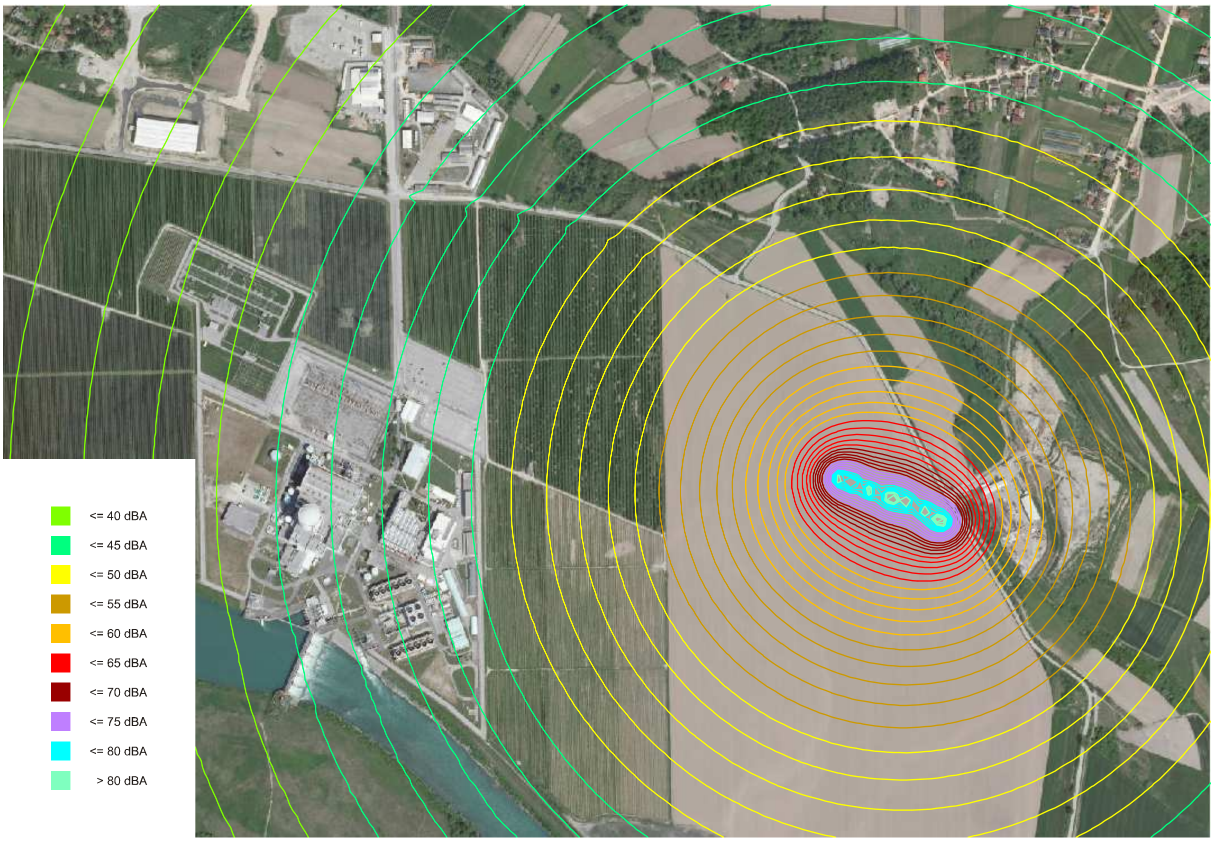

Figure 106: Noise model L_{dan} during daytime construction of the embankment

The table below states the calculated value of the daytime noise indicator.

Table 82: Results of calculation of the value of the indicators of daily noise during construction of the embankment

	Value of the indicator of daytime noise (dBA)
	L_{day}
Immission point 1	48
Immission point 2	48
Immission point 3	45
Immission point 4	35
Immission point 5	60

Repository structures including silo 1 and infrastructure facilities

During construction, the greatest source of noise will be construction machinery and the movement of lorries bringing in and removing building materials from the LILW repository construction site (source: Technical basis for the EIA for the LILW repository, Protection against noise, August 2015 – supplemented following review in November, December 2015, KOVA d.o.o., EK2015-1500501b, Assessment of environmental noise burden, LILW repository Vrbina, Krško, August 2018, KOVA d.o.o.).

At the construction site, machinery with the following sound powers will be used:

- Bulldozer L_W=106 dBA
- Roller L_W=104 dBA
- Excavator L_W=96 dBA
- Loader L_W=96 dBA
- Dumper L_W=106 dBA

The number of transports will be 20 per day for gravel and 5 per day for cement and reinforcement.

The calculation was done according to SIST ISO 9613-2 and based on the calculation method NMBP-XPS 31-133, as required by the Decree on the limit values of noise indicators in the environment (Official Gazette of the RS, No. 43/18)

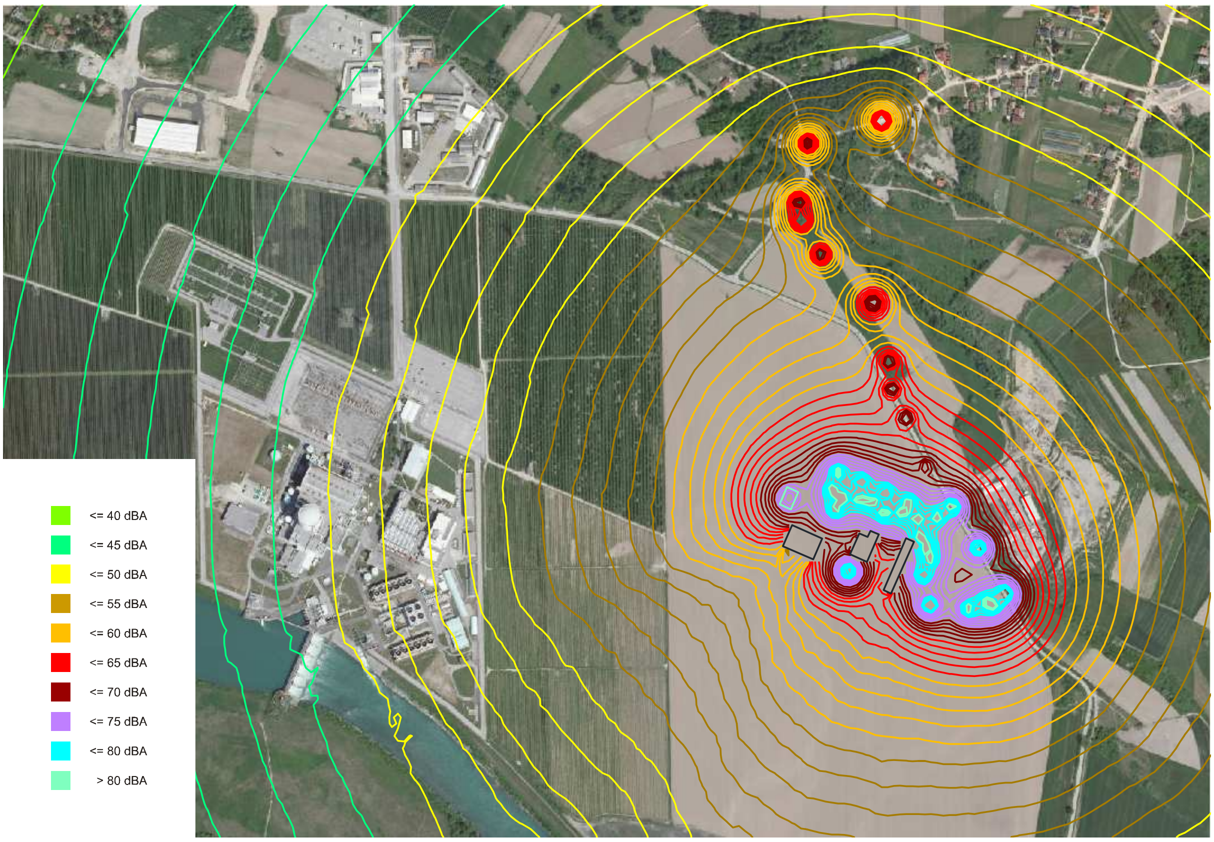

Figure 107: Noise model L_{dan} during daytime construction of repository and infrastructure facilities

The table below states the calculated value of the daytime noise indicator.

Table 83: Results of the calculated value of the daily noise indicators during construction of the repository structures and infrastructure facilities.

	Value of the indicator of daytime noise (dBA)
	L_{day}
Immission point 1	55
Immission point 2	57
Immission point 3	55
Immission point 4	42
Immission point 5	64

Silo 2

During construction, the greatest source of noise will be construction machinery and the movement of lorries bringing in and removing building materials from the LILW repository construction site (source: Technical basis for the EIA for the LILW repository, Protection against noise, August 2015 – supplemented following review in November, December 2015, KOVA d.o.o., EK2015-1500501b, Assessment of environmental noise burden, LILW repository Vrbina, Krško, August 2018, KOVA d.o.o.).

At the construction site, machinery with the following sound powers will be used:

- Bulldozer L_W=106 dBA
- Roller L_W=104 dBA
- Excavator L_W=96 dBA
- Loader L_W=96 dBA
- Dumper L_W=106 dBA

The number of transports will be 30 per day.

The calculation was done according to SIST ISO 9613-2 and based on the calculation method NMBP-XPS 31-133, as required by the Decree on the limit values of noise indicators in the environment (Official Gazette of the RS, No. 43/18)

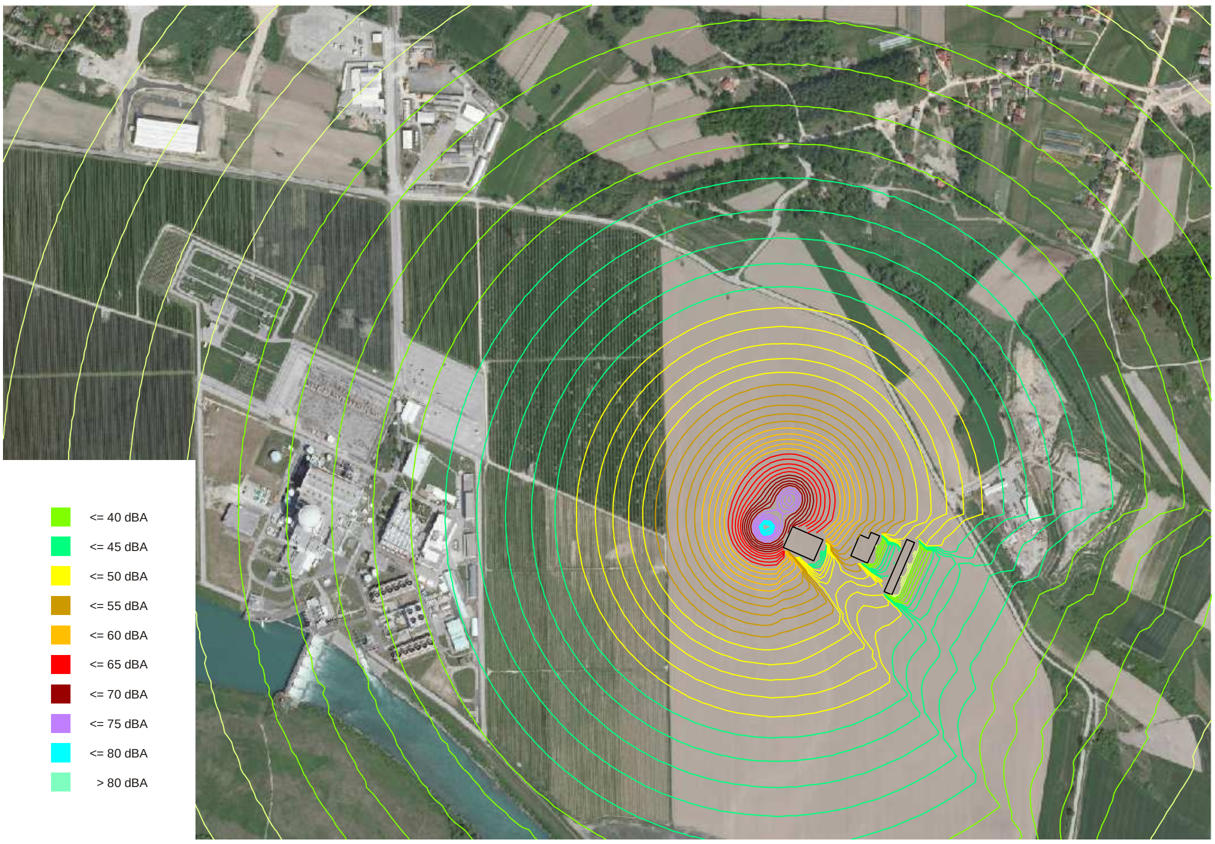

Figure 108: Noise model during construction of silo 2

The table below states the calculated value of the daytime noise indicator.

Table 84: Results of the value of the indicators of daily noise during construction of silo 2

	Value of the indicator of daytime noise (dBA)
	L_{day}
Immission point 1	39
Immission point 2	40
Immission point 3	39
Immission point 4	31
Immission point 5	45

During construction of the underground concrete wall (diaphragm), works are also planned to take place in the evening and night. The greatest source of noise will be water pumping, which according to the manufacturer's information will generate a sonic pressure of 80 dBA at 15 m.

The *Decree on the detailed plan of national importance for the low- and intermediate-level radioactive waste repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09)* states that noisy work can only be done between 7 am and 7 pm. See below for a model calculation for the values of indicators of daytime, evening and night-time noise, and the combined noise indicator.

The calculation was done according to SIST ISO 9613-2 and based on the calculation method NMBP-XPS 31-133, as required by the Decree on the limit values of noise indicators in the environment (Official Gazette of the RS, No. 43/18)

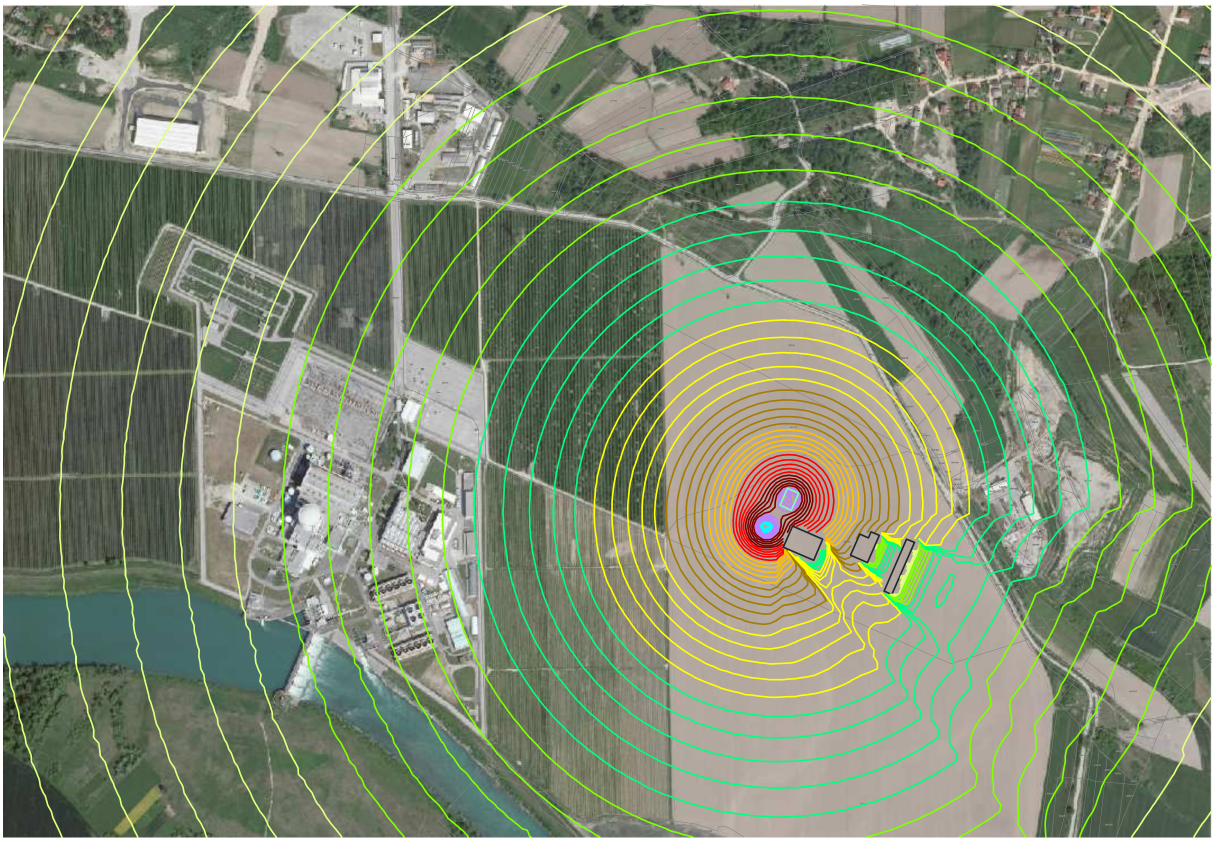

Figure 109: Noise model during construction of the diaphragm

The table below states the calculated value of the daytime, evening and night-time noise indicator, and the combined noise indicator.

Table 85: Results of the calculated value of the noise indicators during construction of the diaphragm

Immission point	Calculated value L_{day} (dBA)	Calculated value L_{eve} (dBA)	Calculated value L_{night} (dBA)	Calculated value L_{daily} (dBA)
Immission point 1	42	39	39	46
Immission point 2	43	40	40	47
Immission point 3	41	38	38	45
Immission point 4	33	30	30	37
Immission point 5	45	45	45	50

Cumulative impacts:

<u>Existing burden and embankment construction</u>

The table below shows the cumulative effect of embankment construction and the current environmental noise burden.

Table 86: Results of the calculation of the value of the daily noise indicator during embankment construction and of the existing environmental noise burden

	Value of the indicator of daytime noise (dBA)
	L_{day}
Immission point 1	57
Immission point 2	48
Immission point 3	46
Immission point 4	36
Immission point 5	66

Existing burden and construction of the repository facilities and infrastructure facilities

The table below shows the cumulative effect of construction of the repository facilities and infrastructure facilities, and the current environmental noise burden.

Table 87: Results of the calculated value of the daily noise indicators during construction of the repository structures and infrastructure facilities and the existing environmental noise burden

	Value of the indicator of daytime noise (dBA)
	L_{day}
Immission point 1	57
Immission point 2	57
Immission point 3	55
Immission point 4	42
Immission point 5	67

Existing burden and construction of silo 2

The table below shows the cumulative effect of construction of silo 2 and the current environmental noise burden.

Table 88: Results of the calculation of the value of the daily noise indicator during construction of silo 2 and of the existing environmental noise burden

	Value of the indicator of daytime noise (dBA)
	L_{day}
Immission point 1	41
Immission point 2	42
Immission point 3	42
Immission point 4	33
Immission point 5	65

Existing burden and diaphragm construction

The table below shows the cumulative effect of diaphragm construction and the current environmental noise burden.

Table 89: Results of the calculation of the value of the noise indicators during diaphragm construction and of the existing environmental noise burden

Immission point	Calculated value L_{day} (dBA)	Calculated value $L_{evening}$ (dBA)	Calculated value L_{night} (dBA)	Calculated value L_{daily} (dBA)
Immission point 1	56	39	39	54
Immission point 2	44	40	40	47
Immission point 3	43	38	38	45
Immission point 4	35	30	30	37
Immission point 5	65	48	48	63

DURING OPERATION

The greatest sources of noise during operation will be (source: Technical basis for the EIA for the LILW repository, Protection against noise, August 2015 – supplemented following review in November, December 2015, KOVA d.o.o., EK2015-1500501b, Assessment of environmental noise burden, LILW repository Vrbina, Krško, August 2018, KOVA d.o.o.):

- Two reversible heat pumps for the administrative and service building, on the roof of the building – L_W=80 dBA
- Two reversible heat pumps for the technological facility, on the roof of the building – L_W=80 dBA
- Air exhaust from ventilation of the radiologically monitored area phase 1
- Air exhaust from ventilation of the radiologically monitored area phase 2
- Air exhaust from ventilation of the radiologically monitored area – silo
- Transport – 1 lorry per day
- Filling in empty spaces in the silo with cement mortar or concrete 1 x annually for around 1 month, total estimate of 100 lorries for transport of concrete

The calculation was done according to SIST ISO 9613-2 and based on the calculation method NMBP-XPS 31-133, as required by the Decree on the limit values of noise indicators in the environment (Official Gazette of the RS, No. 43/18)

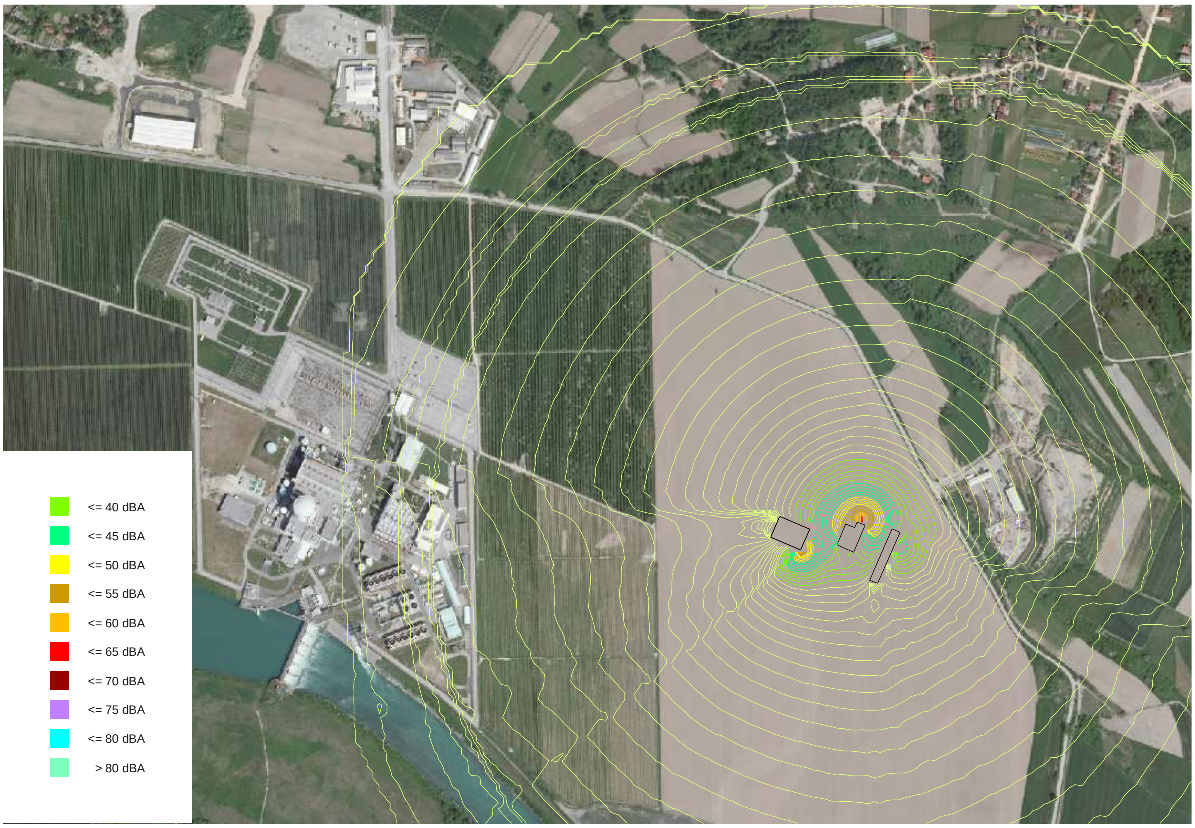

Figure 110: Noise model during operation

The table below states the calculated value of the daytime noise indicator.

Table 90: Results of the calculated value of the noise indicators during operation

Immission point	Calculated value L_{day} (dBA)	Threshold – L_{day} (dBA)	Calculated value $L_{evening}$ (dBA)	Threshold – $L_{evening}$ (dBA)	Calculated value L_{night} (dBA)	Threshold – L_{night} (dBA)	Calculated value L_{daily} (dBA)	Threshold – L_{daily} (dBA)
1	<35	58	<35	53	<35	48	<35	58
2	<35	58	<35	53	<35	48	<35	58
3	<35	58	<35	53	<35	48	<35	58
4	<35	58	<35	53	<35	48	<35	58
5	30	73	30	68	30	63	30	73

Cumulative impacts

Existing burden and operation

The table below shows the cumulative effect of operation and the current environmental noise burden.

Table 91: Results of the calculation of the value of the daily noise indicator during operation and of the existing environmental noise burden

Immission point	Calculated value L_{day} (dBA)	Threshold – L_{day} (dBA)	Calculated value $L_{evening}$ (dBA)	Threshold – $L_{evening}$ (dBA)	Calculated value L_{night} (dBA)	Threshold – L_{night} (dBA)	Calculated value L_{daily} (dBA)	Threshold – L_{daily} (dBA)
1	36	58	<35	53	<35	48	<35	58
2	38	58	<35	53	<35	48	<35	58
3	39	58	<35	53	<35	48	<35	58
4	<35	58	<35	53	<35	48	<35	58
5	65	73	45	68	45	63	62	73

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

During decommissioning, the impacts will be similar to those during construction. During abandonment, there will be no impacts of the project (0).

Cumulative impacts

We do not know which projects will be implemented near the LILW at the time of abandonment (in the year 2061). We can however evaluate them as insignificant.

Transboundary impacts

All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

EVALUATION OF THE PROJECT IMPACT AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

Under the provisions of the Decree on limit values for environmental noise indicators (Official Gazette of the RS, No. 43/18) the immission points 1, 2, 3, and 4 are classified as zone III noise protection, while the immission point 5 is classified as zone IV noise protection.

Zone III noise protection covers the following areas of detailed designated use of space:
- residential area: residential areas, special-purpose residential areas, rural settlement areas or holiday homes,
- central activities area: main central activities areas or other central activities areas,
- special area: sports centres or tourism areas,
- green area: areas for rest, recreation and sports, parks, allotments, other arranged green spaces or cemeteries
- areas of dispersed settlement and
- dispersed construction

Zone IV noise protection covers the following areas of detailed designated use of space:
- area of manufacturing activity: areas for industry, commercial zones or areas with industrial production facilities,
- transport infrastructure area,
- energy infrastructure area,
- communication infrastructure area,
- environmental infrastructure area,
- water infrastructure area,
- mineral raw material area: all areas,
- agricultural land area: all areas, except outdoor quiet area, and
- forest land area: all areas, except outdoor quiet area.

Table 92: Noise indicator limit values L_{night} and L_{daily}

Noise protection area	L_{night} dB(A)	L_{daily} dB(A)
Area IV	**65**	**75**
Area III	**50**	**60**
Area II	45	55
Area I	40	50

Table 93: **Critical values of noise indicators for permanent ambient noise pollution L_{night} and L_{daily}**

Noise protection area	L_{night} dB(A)	L_{daily} dB(A)
Area IV	**80**	**80**
Area III	**59**	**69**
Area II	53	63
Area I	47	57

Table 94: Noise indicator limit values L_{day}, L_{night}, L_{eve} and L_{daily} for noise caused by construction sites

Noise protection area	L_{day} dB(A)	L_{eve} dB(A)	L_{night} dB(A)	L_{daily} dB(A)
Area IV	**73**	**68**	**63**	**73**
Area III	**58**	**53**	**48**	**58**
Area II	52	47	42	52
Area I	47	42	37	47

Table 95: Threshold values for L_{day}, L_{night}, L_{eve} and L_{daily} for noise caused by construction sites

	L_{day} dB(A)	L_{eve} dB(A)	L_{night} dB(A)	L_{daily} dB(A)
Source of noise	65	60	55	65

Based on the predicted or estimated values and the calculation of noise level decrease with distance, we evaluate that noise immissions during construction will not exceed the threshold values as laid down by the Decree on the limit values of noise indicators in the environment (Official Gazette of the RS, No. 43/2018).
Furthermore, during operation, decommissioning and abandonment of the project, the noise immission at immission sites 1, 2, 3, and 4 (at the residential homes) will not exceed the noise thresholds for category III noise protection area. Immission site 5 (at the Spodnji Stari Grad Waste Management Centre) will not exceed the noise thresholds for a category IV noise protection area, as defined by the Decree on limit values for environmental noise indicators (Official Gazette of the RS, No. 43/2018).

Although the noise will not be excessive, during construction and operation of silo 2, the strip of forest that is expected to grow on the north and west edge of the LILW repository will further mitigate noise. The strip of forest is thus an important secondary measure that can mitigate the noise directed towards the built-up areas.

Table 96: Description and assessment of the possible impact of the project on noise

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – NOISE	
Impact assessment	During construction: moderate impact (2) During operation: insignificant impact (1) During decommissioning and abandonment: moderate impact (2)
Impact characteristics and type	The effects of the project during construction, operation and decommissioning will be indirect and temporary. Cumulative effects are expected during construction and operation (construction of the Krško NPP and Spodnji Stari Grad roundabouts, as well as the road between them, and operation of existing activities in the immediate vicinity of the LILW repository).
Likelihood of impact and consequences	The likelihood of impact is high during construction and decommissioning, and low during operation.

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – NOISE	
Duration or frequency of impact and its consequences, and their reversibility	The impacts will persist throughout construction works, but will not be equally frequent for all parts of the site. After the construction work is concluded, the impacts will disappear. They will reappear during operation, and will be frequent, but of low intensity.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	We expect the changes to the environment due to noise emissions during construction and decommissioning to be moderate, and insignificant during operation. We therefore evaluate them as acceptable for the environment.
Scope of impact	The scope of impact will be limited to the construction site, and later to the LILW repository. It will not exceed the permissible values at the nearest residential buildings.
Interactions between individual impacts and their consequences	While excessive noise affects quality of life, no excessive noise is anticipated.

5.3.10 *ENVIRONMENTAL IMPACTS FROM IONISING RADIATION*

In order to minimise the effect of the repository, operational limits and conditions (OLC) are prescribed (Operational limits and conditions, reference documentation for the Draft Safety Analysis Report, NSRAO2-POR-027-00 02-08-011-003. IBE, 2016)[126], as summarised by the Safety Analysis Report in the section Operational limits and conditions. The limits are as follows:

- The annual effective dose at the perimeter of the repository due to direct irradiation, liquid discharges and emissions into the air, and clearance of secondary radioactive waste substances may not exceed 200 µSv a year.
- The annual effective dose from liquid discharges at the repository perimeter may not exceed 5 µSv.
- The concentration of emitter activities in liquid discharges may not exceed the prescribed concentrations for clearance under the regulations (Decree on radiation activities, Official Gazette of the RS, No. 19/18).
- Measurement instruments and sampling points for the purpose of liquid discharge monitoring must be operable, by measurement points and sampling points, at least in the numbers listed in the Radioactivity monitoring program.
- The annual effective dose from discharges into the air at the repository perimeter may not exceed 5 µSv.
- Measurement instruments and sampling points for the purpose of monitoring of discharges into the air must be operable, by measurement points, at least in the numbers listed in the Radioactivity monitoring program.
- It is only permitted to dispose of LILW inserted into uniform disposal containers, which meet the WAC for disposal defined in the document RAW acceptance criteria for the LILW repository, ARAO NSRAO2-POR-014-00 02-08-011-003..

The upper thresholds can be treated as dose constraints and are much lower than the dose thresholds prescribed for the general population in the *Decree on dose limits, radioactive*

[126] Operational limits and conditions, reference document for Draft Safety Analysis Report, NSRAO2-POR-027-00 02-08-011-003. IBE, 2016

contamination and intervention levels (UV2, UL RS 18/18), i.e. 1 mSv per year. The 1 mSv annual effective dose is a dose that a member of the public receives from all facilities where sources of ionizing radiation are used, or where radiation practices are being performed. Since the operational limits for the repository are markedly lower, as stipulated in the previous paragraph, the total contribution to the dose received by the general public is small, and there is no concern that the effective dose of 1 mSv would be exceeded for the general public.

At the repository site, it is only permitted to accept, for the purpose of disposal, LILW disposal containers delivered in accordance with the LILW delivery programme and fulfilling conditions agreed in advance and verified at the time of takeover inspection.

SPECIAL REGIME AREAS

The site of the low- and medium-level radioactive waste repository (LILW) in Vrbina is in the vicinity of Krško Nuclear Power Plant (Krško NPP). Since this area already contains a nuclear facility (Krško NPP), and the LILW repository itself is a nuclear facility, the Decree as amended applies:

- Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS No. 36/04).
- Decree amending the Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS No. 103/06).
- Decree amending the Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS No. 92/14).

The *Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS, No. 36/04, 103/06 and 92/14)* stipulates the following:

- In the area of limited use of space no construction is permitted that would allow people to temporarily or permanently live here.
- In the exclusion zone and in the immediate restricted use area, all construction or activities are prohibited that would result in daily migrations exceeding 100 people in the exclusion zone or the immediate restricted use area that is within the spatial angle of 22.5 degrees from the centre of a nuclear facility. Workers entering the exclusion zone or the immediate restricted use area due to the requirements of the nuclear facility are not counted in the daily migration.
- The wider restricted use area must not exceed daily migrations of 8,000 people due to activities performed in this area. Workers entering the wider restricted use area due to the requirements of the nuclear facility are not counted in the daily migration.
- In the wider restricted use area, all construction or activities are prohibited that would result in daily migrations exceeding 1.000 people in the wider restricted use area that is within the spatial angle of 22.5 degrees from the centre of a nuclear facility. Workers entering the wider restricted use area due to the requirements of the nuclear facility, and people with permanent residence in the wider restricted use area are not counted in the daily migration.

- No construction of buildings prohibited by the Decree is permitted within the exclusion zone, the immediate restricted use area, and the wider restricted use area.
- Construction of buildings allowed by the Decree is permitted within the exclusion zone, the immediate restricted use area, and the wider restricted use area, if the Slovenian Nuclear Safety Administration consents to the solutions in the building permit project.
- Construction of buildings allowed by the Decree is permitted within the exclusion zone, the immediate restricted use area, and the wider restricted use area, if the Slovenian Nuclear Safety Administration consents to the solutions in the building permit project, and if the construction is intended for the requirements of the nuclear facility.
- If the construction complies with the national or municipal site plan which was adopted according to the spatial planning regulations, the impacts on radiation and nuclear safety of the construction are checked in the procedure of issuing an opinion on the site plan.
- In the case of construction of a simple building which can start without building permits according to the regulations on construction, the impacts on radiation and nuclear safety are checked in the procedure for issuing consent for the building, which is issued by the Slovenian Nuclear Safety Administration before the start of construction.
- In the case of construction of an undemanding building which requires a building permit according to the regulations on construction, the impacts on radiation and nuclear safety are checked in the procedure for issuing consent for the construction, which is issued by the Slovenian Nuclear Safety Administration and must be submitted by the investor with the application for building permit.

According to the *Decree amending the Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS No. 92/14)* the following areas apply to the Krško NPP:.

- the exclusion area is a circular area with the centre in the middle of the nuclear power plant reactor, with a 500 m radius;
- the immediate restricted use area is the area outside the exclusion area, and within the circular area with its centre in the middle of the nuclear power plant reactor, with a 650 m radius;
- the wider restricted use area is the area outside the immediate restricted use area, and within the circular area with its centre in the middle of the nuclear power plant reactor, with a 1500 m radius;

According to the *Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS No. 92/14),* the minimum size of the wider restricted use area is

- a circular area centred in the centre of the low- and intermediate-level radioactive waste repository, and with a 500 m radius.
- 50 m around the repository for a closed, near-surface repository of low- and intermediate level radioactive waste.
- Regardless of the minimum size of the wider restricted use area, the Slovenian Nuclear Safety Administration may, in a preliminary radiation and nuclear approval, also set a smaller area of restricted use in the conditions attached to the environmental consent if the environmental impact report indicates that radiation and nuclear safety

measures can be carried out unhindered in the immediate area of restricted use (Paragraph 8 of Article 3).

It follows from the Draft Safety Analysis Report (Chapter 7) that the doses received by persons present at the perimeter of the LILW repository would be considerably lower than set out in Article 3 of the Decree on areas of restricted use due to nuclear facilities and on the conditions of construction of facilities in these areas (UV3), i.e. considerably lower than 250 mSv or a thyroid dose of 3 Sv. The estimated doses at the repository fence during opreation is summarised in the subsections “DURING OPERATION” and “DURING AND AFTER ABANDONMENT”. During operation, the highest effective annual dose for a member of the general public at the repository fence is 11 µSv, 7.7 mSv for a repository worker under normal conditions, and a maximum of 17 mSv in exceptional conditions (airplane crash or fire). Since the estimated doses during the operation of the repository are significantly lower than the value in Article 3 of UV3, **we propose that for the duration of operation, the external fence of the LILW repository is the border of the limited use area.**

After the repository is closed, Decree UV3 sets the bottom limit for the wider limited use area as the area of the nuclear facility, increased by a 50 m wide strip around the silo. Section 15[127] in the safety report draft sets the limited use area according to the requirement in UV3. The area is shown in the figure below.

[127]Draft Safety Analysis Report for the Vrbina Krško LILW Repository, NSRAO2-POR-030, May 2017, Section 15, Environmental aspects

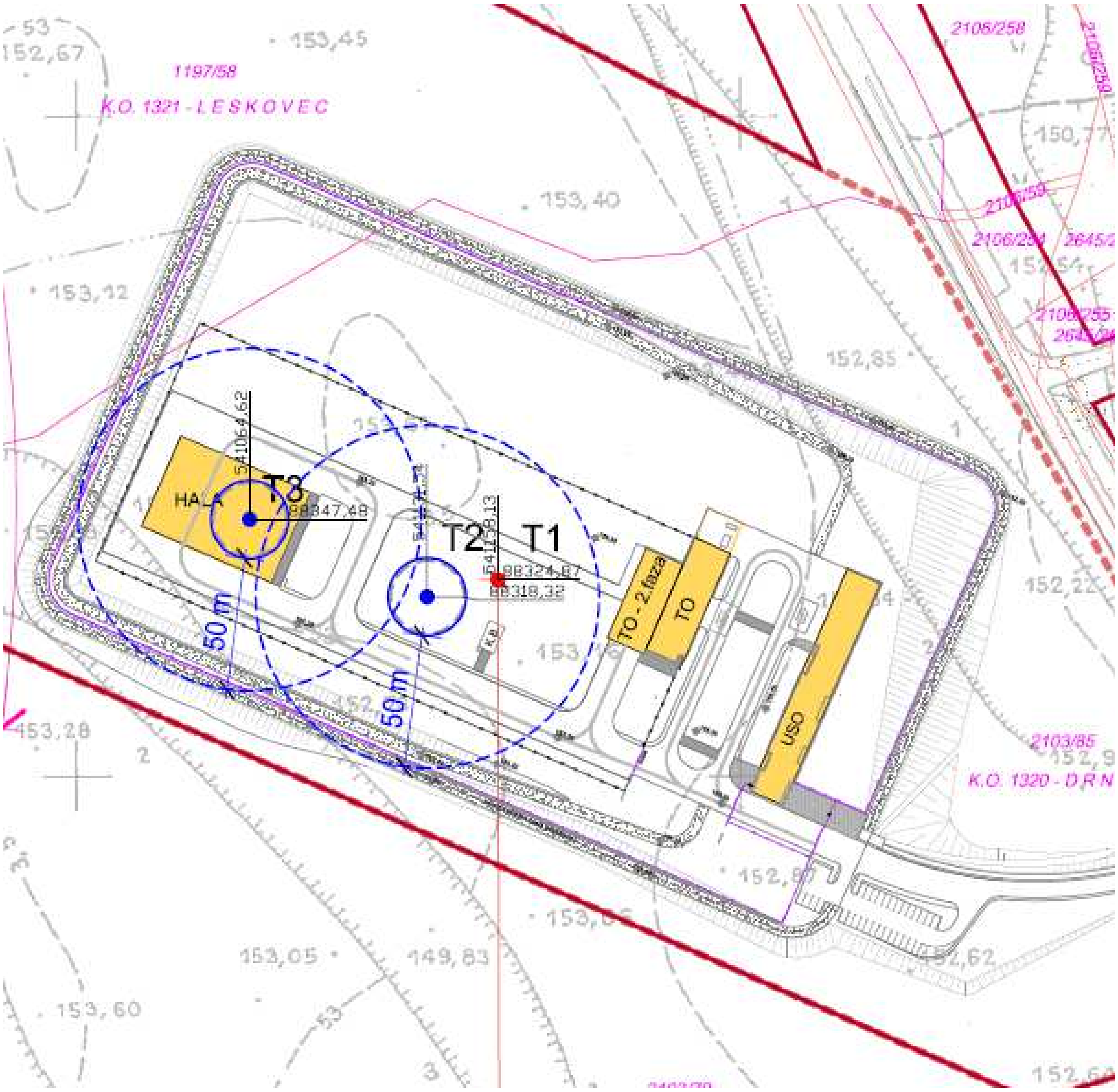

Figure 111: Restricted use area after decommissioning of the repository. Source: Draft Safety Analysis Report, Section 15, Environmental aspects, graphic attachment 15-5, IBE d.d., November 2016

The *Decree on areas of limited use of space due to a nuclear facility and the conditions of construction of works in these areas (Official Gazette of the RS, No. 36/04, 103/06 and 92/14)* further stipulates:

- If several nuclear facilities are in the same area, and the immediate restricted use areas of these facilities overlap, the most stringent regime used applies on the overlapping areas.
- In areas of restricted use due to underground LILW repositories, or underground repositories of spent nuclear fuel and highly radioactive waste, only those practices or activities that may, through deep interventions below the surface of the soil, compromise the protective functions of the geological layers surrounding the repository shall be prohibited.

- Regardless of the minimum size of the wider restricted use area, the Slovenian Nuclear Safety Administration may, in a preliminary radiation and nuclear approval, also set a smaller area of restricted use in the conditions attached to the environmental consent if the environmental impact report indicates that radiation and nuclear safety measures can be carried out unhindered in an immediate area of restricted use.

The construction of the repository itself must not compromise the safety of the nuclear facility. The repository consists of the repository part, the dug-in silo with the hall and the technological facility required for receiving, processing, and temporary storage of LILW, as well as the administrative and service building.
The technological facility is intended for temporary storage and the remediation of any damaged waste containers, measurements, technological process controls, and other required technological and service functions of the repository, as well as functions for ensuring nuclear and radiation safety. The technological facility is also the control point for entry to and exit from the radiologically controlled area. The technological facility will be constructed in two phases.
The administrative/service section of the core area of the repository contains an administrative/service building from which the repository will be operated and managed and associated administrative and service activities performed, along with activities to control access to and physically secure the repository, energy-related activities, fire water supply, the collection of municipal waste, the storage of spare parts and geological samples (core), and workshops.

According to the Ionising Radiation Protection and Nuclear Safety Act (Official Gazette RS, No. 102/04 – official consolidated text, 70/08 – ZVO-1B, 60/11 and 74/15), the employer must ensure that the areas are classified as **controlled and supervised areas.**

The project solutions permit the entire disposal area and the majority of the areas in the TF to be classified as controlled radiation areas (CRA) (Institute of Occupational Safety: Radiation safety study for the compiling of the design output for the LILW repository in Vrbina, No. LMSAR-48/2015-GO, rev. 5). The controlled area is restricted and secured with an inner fence or construction elements (in the TF). The external surfaces outside the fence (CRA) are not expected to be contaminated. The interior surfaces in the hall and in the TF will also not be contaminated. Only local and temporary contamination of surfaces can occur, and only in the event of exceptional design-basis events or in the event of conducting work with sources of radiation in the TF that will be installed in the TF in the second phase. Since the surfaces in the planned CRA will not be contaminated, and any contamination will be removed immediately, while at the same time the radiation load (dose rate) will be low in the majority of the CRA, during the period of operation of the repository the majority of the CRS will be able to be transformed into a radiologically monitored area (RMA). **Only the area of the silo and the hall will remain CRA.** Access to the CRAs in the hall and the silo will be provided via an auxiliary control point in the hall.

The boundaries of the controlled area are shown in the figure below. Since the controlled area is very large and also includes the parts that are only required to be in the supervised area, there is no supervised area as such. However, the classification into controlled and supervised area is not static and can change depending on the conditions. The classification of areas as controlled and supervised must be provided by the employer after consulting an authorised radiation protection expert, as required by the Ionising Radiation Protection and Nuclear Safety Act. It can therefore be expected that the boundaries of the controlled and the supervised areas will change. The controlled area can thus only include the hall above the silo, or even a narrow area within the hall above the silo, while the technological facility up to the exit point is the supervised area.

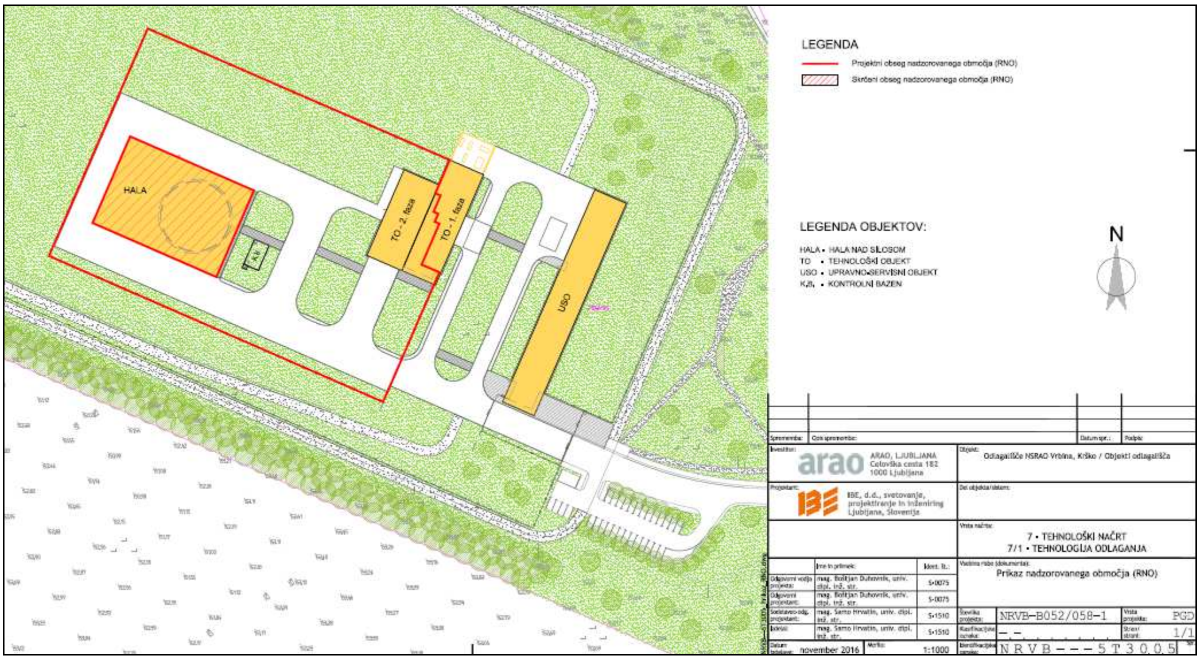

Figure 112: Boundaries of the controlled area at the repository during operation of one silo. The hall above the silo and part of the technological facility are classified as the controlled area. Source: IBE d.d., Engineering plan, Disposal engineering, Illustration of the controlled area, ID NRVB---5T3005.

LEGENDA	KEY
Projektni obseg nadzorovanega območja (RNO)	Project scope of the controlled radiation area (CRA)
Skrčeni obseg nadzorovanega območja (RNO)	Contracted scope of the controlled radiation area (CRA)
LEGENDA OBJEKTOV:	KEY FOR THE FACILITIES:
HALA – HALA NAD SILOSOM	HALA - HALL ABOVE THE SILO
TO – TEHNOLOŠKI OBJEKT	TO - TECHNOLOGICAL FACILITY
USO – UPRAVNO-SERVISNI OBJEKT	USO - ADMINISTRATION AND SERVICE BUILDING
K.B. – KONTROLNI BAZEN	K.B. - CONTROL POOL
Sprememba:	Amendment:
Opis spremembe:	Description of amendment:
Datum spr.:	Date made:
Podpis:	Signature:
Investitor: ARAO, LJUBLJANA Celovška cesta 182 1000 Ljubljana	Investor: ARAO, LJUBLJANA Celovška cesta 182 1000 Ljubljana
Objekt: Odlagališče NSRAO Vrbina, Krško / Objekti odlagališča	Facility: Vrbina, Krško LILW repository / Repository facilities
Projektant: IBE, d.d., svetovanje, projektiranje in inženiring Ljubljana, Slovenija	Designer: IBE, d.d., svetovanje, projektiranje in inženiring Ljubljana, Slovenia
Vrsta načrta: 7 – TEHNOLOŠKI NAČRT 7/1 – TEHNOLOGIJA ODLAGANJA	Design document type: 7 - TECHNOLOGICAL PLAN 7/1 – DISPOSAL TECHNOLOGY

Vsebina rabe (dokumenta): Prikaz nadzorovanega območja (RNO)	Content of use (document): Outline of the controlled radiation area (CRA)
Ime in priimek:	First name and surname:
Ident.št.:	ID no.:
Odgovorni vodja projekta:	Project manager:
Odgovorni projektant:	Responsible designer:
Sodelavec odg. projektant:	Associate responsible designer:
Izdelal:	Produced by:
Datum izdelave: november 2016	Date of production: November 2016
Merilo: 1:1000	Scale: 1:1,000
Številka projekta:	Project number:
Vrsta projekta:	Project document type:
Klasifikacijska oznaka:	Classification code:
Stran/strani:	Page/pages:
Identifikacijska oznaka:	Document ID:

When two silos will be present at the repository, the controlled area will be wider and will include both silos (figure below).

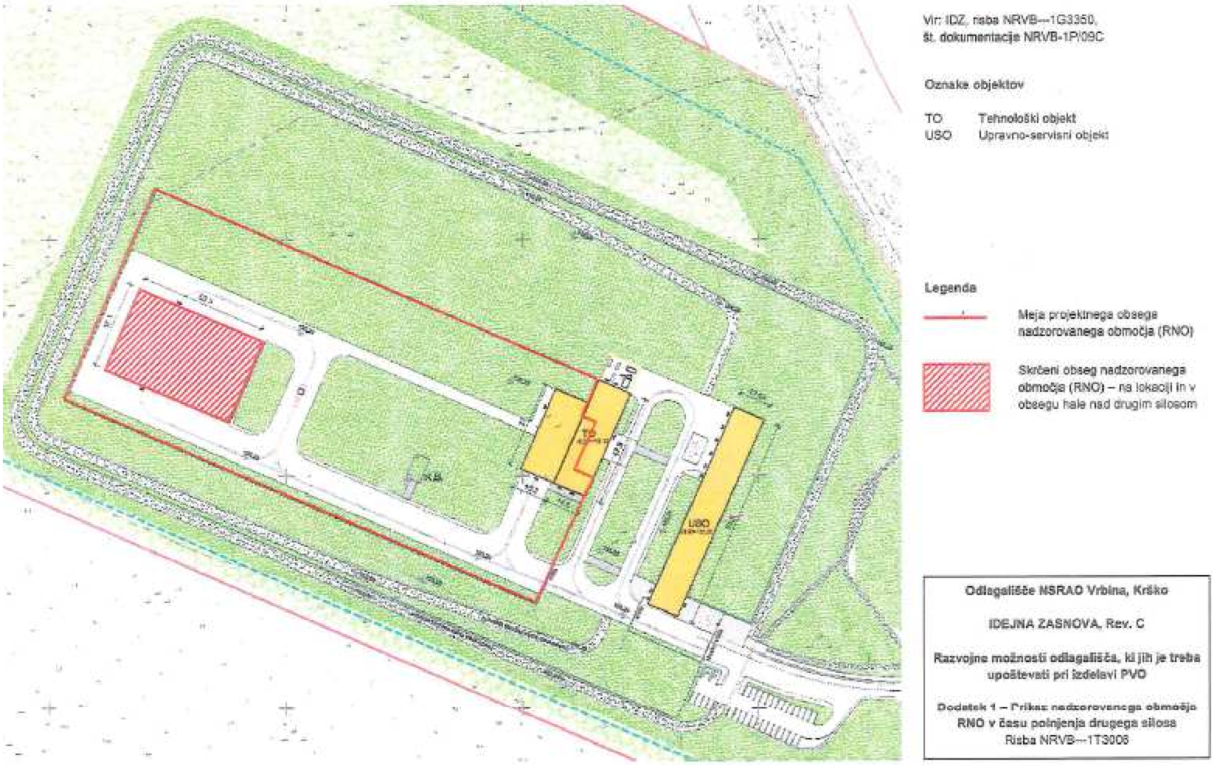

Figure 113: The boundaries of the controlled area at the repository with two silos present. Source: IBE d.d., Development potentials of the repository to be taken into account in elaboration of the EIA, Addendum 1 – Outline of the controlled area (CRA) during the filling of the second silo, Drawing NRVB---1T3006.

Vir: IDZ, risba NRVB---1G3350	Source: IDZ (conceptual design), drawing NRVB---1G3350
št. dokumentacije NRVB-1P/09C	document no. NRVB-1P/09C
Oznake objektov	Reference of facilities
TO Tehnološki objekt	TO - technological facility

USO Upravno-servisni objekt	USO - administration and service building
Legenda	Key
Meja projektnega obsega nadzorovanega območja (RNO)	Boundary of the project scope of the controlled radiation area (CRA)
Skrčeni obseg nadzorovanega območja (RNO) – na lokaciji in v obsegu hale nad drugim silosom	Contracted scope of the controlled radiation area (CRA) - on-site and in the scope of the hall above the second silo
Odlagališče NSRAO Vrbina, Krško	Vrbina Krško LILW repository
IDEJNA ZASNOVA, Rev. C	CONCEPTUAL DESIGN, Rev. C
Razvojne možnosti odlagališča, ki jih je treba upoštevati pri izdelavi PVO	Development potentials of the repository to be taken into account in elaboration of the EIA
Dodatek 1 – Prikaz nadzorovanega območja RNO v času polnjenja drugega silosa Risba NRVB---1T3006	Addendum 1 – Outline of the controlled radiation area (CRA) during the filling of the second silo NRVB drawing ---1T3006

Prior to disposal, all waste will be inserted into standard disposal containers. Inserting waste packages into disposal containers or preparation for disposal will be carried out entirely at Krško NPP. Supervision of the process of filling disposal containers and checking the compliance of filled containers with acceptance criteria for disposal will be carried out by ARAO at Krško NPP in accordance with the written procedures. Compliance with the requirements for transportation will be checked by Krško NPP or the transporter of containers from Krško NPP to the repository. This checking will also be carried out at Krško NPP. At the time of delivery of the shipment to the repository, verification of the compliance with transport requirements, including the control of radiation parameters, will also take place based on the Draft Safety Analysis Report for the LILW repository Vrbina, Krško, ARAO 02-08-011-004, revision 2 9-9/43, section 9.1.1.5. This verification will take place in particular in front of the controlled area entrance door for vehicles, in front of the third sliding door near the technological facility. The measurement of contamination and dose rate of the vehicle at the entrance will take 6 minutes. Upon completion of verification, the vehicle will continue its ride to the hall. Transport and acceptance of shipments or packages containing LILW that do not meet all the ADR requirements will take place in accordance with extraordinary agreements and special written procedures.

The capacity of the repository will be sufficient for the disposal of the LILW that will be generated during Krško NPP operation up to 2043 and the subsequent decommissioning of the plant, and for the disposal of LILW from other Slovenian producers (medicine, industry, research activities).

The relevant environmental impact report takes into account the impact of the repository during construction, operation, and abandonment, which includes decommissioning, as well as active and passive long-term monitoring after closing of the repository. The impacts were evaluated for a period of 10,000 years after decommissioning of the repository[128], but they were also calculated for later periods, up to 1,000,000 years after decommissioning. Needless to say, the results of these calculations should be taken as a qualitative evaluation and must be interpreted in the light of limitations that apply now.

[128] Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repositories in Slovenia, Post Closure Safety Assessment Synthesis Report Revision 1, PCSA Synthesis Report Rev.1, Technical Report ARAO, EISFI-TR-(11)-15 Vol.1, Rev.1, document designation NSARO2-PCS-001-01-eng, EISFI consortium, June 2012

DURING CONSTRUCTION

During the construction of facilities, there will be no takeover, processing or storage of radioactive waste in the repository. Therefore, there will be no radiological impact on the environment, workers or residents.

DURING OPERATION

Impacts during operation are temporary. The impacts are direct, with no cumulative effects on workers, while the effect of Krško NPP must also be considered for the general population. The estimated effective doses of the reference population group due to Krško range from a few tenths of µSv/year (0.18 µSv in 2015, for example) and are lower than the estimated annual effective doses of the reference population group due to repository operation under normal conditions.

See below for a summary of estimated worker or population dose during repository operation, both under normal conditions and in exceptional circumstances. Safety analyses that were used to provide data for the EIA calculate the distribution of radionuclides in the environment and the estimated doses for cases in which the entire waste activity is accommodated by one disposal silo rather than two, as proposed. This is an extremely conservative approach that overestimates the doses by a factor of about 2.

Normal operational conditions

Normal operational conditions assume that work is carried out as expected and no exceptional events or accidents occur. The dose estimates do not take into account the gas generated in the repository. The safety analyses[129] [130] deal with gas generation due to various processes: corrosion, radiolysis, organic material decomposition. These processes result in the isotopes H-3 and C-14. As is evident from Section 7.3.3.2.4., Table 7.21[131], the main waste streams containing H-3 and C-14 originate from the decommissioning of Krško NPP. The waste is expected to contain 1.23E+15 Bq of H-3 and 4.30E+13 Bq C-14. Not taking into account the half-life, it was estimated [132] that the total disposed inventory could emit 4.34E+09 Bq/year of C-14, which would be in the form of methane. The methane containing radioactive carbon (C-14) will be highly diluted with non-radioactive methane generated by the degradation of organic waste.

In the case of tritium, ignoring the half-life 2.0E+08 Bq/year of H-3 could be generated, although it will decay relatively quickly given the relatively short half-life (12 years).

[129] SAFETY ANALYSIS AND WASTE ACCEPTANCE CRITERIA PREPARATION FOR LOW AND INTERMEDIATE LEVEL WASTE REPOSITORY IN SLOVENIA, GAS GENERATION PROCESSES AND DESIGN IMPLICATIONS REVISION 1, Technical Report ARAO, EISFI-TR-(11)-08 Vol.4, Rev.1, EISFI consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO), 2012

[130] SAFETY ANALYSIS AND WASTE ACCEPTANCE CRITERIA PREPARATION FOR LOW AND INTERMEDIATE LEVEL WASTE REPOSITORY IN SLOVENIA, Phase II and III, Deliverable 2.7 Revised Operational Safety Assessment, ARAO, EISFI-TR-(15)-37 Vol. 1 Rev. 2, ARAO, EISFI-TR-(15)-37 Vol. 1, NSRAO2-PCS-019-01-eng. EISFI consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO), 2016, Section 4.1.

[131] Draft safety report for the LILW repository, rev. 2, Section 7 Safety analyses, April 2018.

[132] Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repository in Slovenia, Gas Generation Processes and Design Implications, ARAO, EISFI-TR-(11)-08 Vol.4, Rev 1. NSRAO2-PCS-010-01-eng, 2012. *EISFI consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO).*

The waste in the repository containing Ra-226 will generate Rn-222[130]. Radon has a relatively short half-life of 3.82 days. In the case of radon the half-life is a key factor, as the radon will decay before it reaches the surface.

The gases generated at the repository will migrate towards the surface in various ways,[133] i.e. in bubbles travelling with groundwater, while some gases will also dissolve in the water. Migration towards the surface will be prevented by engineered barriers and by natural barriers (concrete, silt, clay top, etc.). The gas (C-14 in particular) will then bind to the root systems of plants growing in the vicinity of the repository, and some will migrate into the air, where it will be further diluted.

In light of the above, and given that the complete inventory is taken into account in the radionuclide transfer models, the assessment is that the contribution to the total estimated effective dose by gases is negligible.

Exposure of repository workers

See the Draft Safety Analysis Report, Safety analyses section[134], for an estimate of effective doses received by workers handling radioactive waste. The conservatively estimated effective worker doses are:

- Security guard/receptionist: up to 2.7 mSv/year
- Radiation protection service employee: 3.3 mSv/year
- Operator: 7.7 mSv/year
- Logistician: 7.7 mSv/year
- External contractor for construction work (4 workers envisaged): 0.07 mSv/year

The dose is due to external radiation from radioactive waste containers.

Reference population group exposure

The reference population group is represented by a resident who can access areas near to the LILW repository fence. The member of the public will be exposed to radiation due to disposed of radioactive waste in the silo, the stored radioactive waste in the technological facility, and due to container transport in the LILW repository area. If a resident was near the LILW repository fence, they would receive an annual dose of 11 µSv for non-aged waste[135]. The dose is due to external radiation from the repository.

Extraordinary events

The SAFETY ANALYSIS AND WASTE ACCEPTANCE CRITERIA PREPARATION FOR LOW AND INTERMEDIATE LEVEL WASTE REPOSITORY IN SLOVENIA [135] document describes multiple scenarios of extraordinary events, and the estimated doses for the workers and the population. See below for dose estimates for each of these scenarios.

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[133] *A. J. Baker, D. A. Lever, J. H. Rees, M. C. Thorne, C. J. Tweed, and R. S. Wikramaratna,* Nirex 97: An Assessment of the Post-closure Performance of a Deep Waste Repository at Sellafield. Volume 4: The Gas Pathway, Nirex Science Report S/97/012, United Kingdom Nirex Ltd., Harwell, Oxfordshire. *1997.*

[134] Draft Safety Analysis Report, section Safety analyses, document designation: NSRAO2-POR-030 OsnVP_07:Varnostne analize.doc.

[135] SAFETY ANALYSIS AND WASTE ACCEPTANCE CRITERIA PREPARATION FOR LOW AND INTERMEDIATE LEVEL WASTE REPOSITORY IN SLOVENIA Phase II and III, Revised Operational Safety Assessment, ARAO, EISFI-TR-(15)-37 Vol. 1, NSRAO2-PCS-019-01-eng. EISFI consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO), 2016.

The dose estimates are given for adults. The document[136] also has a generic estimate of doses for children, and comparison to adult doses. This is then summarised in the Draft Safety Analysis Report, section 7. Safety analyses[137], subsection 7.2.4.5.. This study shows that taking into account the dose conversion factors and the intake paths, the adult doses are representative for all scenarios, and the children's doses are lower than the adult doses.

Estimate of dose from FP drop in technological facility

In terms of the impact on employees, two situations were addressed in the case of final packaging (FP) or a container being dropped in the technological facility:

- Exposure of employees immediately after the FP drop. The assumption was exposure for 10 minutes, during which time the employees withdraw from the technological facility.
- After a certain time, when the contamination has fully spread throughout the entire area where the drop occurred, employees enter the area to attend to urgent initial remediation of the event. In this case the exposure lasts 30 minutes.

It was assumed in the case of a drop that the FP disintegrates into three parts, and the direct exposure of employees was estimated on this basis at various distances from the FP (from 0.5 m to 2 m). The estimated doses for employees are presented below.

Table 97 : Estimate of dose for employees from FP drop in technological facility (source: Table B1.1.4.[129] The majority of the dose is received by the workers through inhalation. The inhalation dose and the external radiation dose are only listed for the average estimated dose. The ratio is similar in case of maximum dose. The submersion dose is one or two orders of magnitude less than the external radiation dose.

Brief description of situation during FP drop in technological facility	Average estimated dose for employee (for analysed situations at distance of 0.5 m to 2 m) [µSv per event]	Maximum estimated dose for employee (for analysed situations) [µSv per event]
10 min of exposure in immediate vicinity of disintegrated "average" FP, main contribution via inhalation	79.2, of which 65.1 due to inhalation and 14.1 from external radiation	94.4
10 min of exposure in immediate vicinity of disintegrated "hot" FP	979, of which 610 due to inhalation, and 369 µSv due to external radiation sources	1380
30 min of exposure, full spread of contamination, average FP	100, of which 56 due to inhalation and 42.4 due to external radiation	1650

[136] ARAO, Evaluation of DCFs for calculating effective doses that can be received by individuals in particular age groups for the LILW repository in the event of accidents 02-08-030 NSRAO2-OPS-006-00. 2018.
[137] Draft safety report for the LILW repository, rev. 2, Section 7 Safety analyses, April 2018.

Brief description of situation during FP drop in technological facility	Average estimated dose for employee (for analysed situations at distance of 0.5 m to 2 m) [µSv per event]	Maximum estimated dose for employee (for analysed situations) [µSv per event]
30 min of exposure, full spread of contamination, hot FP	146, of which 58 (57.6) due to inhalation and 88 due to external radiation	2840

The dose for a representative member of the public was also estimated as part of the FP drop scenario. For all cases it was assumed that the member of the public is exposed to a contamination plume for one day. The estimated doses for members of the public are presented below.

Table 98: Estimated dose for member of public from FP drop in technological facility. The dose is due to inhalation. Source: Table B1.2.1. Effective doses for members of the public at different distances and under different meteorological conditions due to a drop of an average container inside TF (3/3) [129]

Brief description of parameters assumed for FP drop in technological facility	Estimated dose for member of public [µSv per event] (exposure time: 1 day)	
Distance from technological facility [m]	100	1,000
Ventilation system works at 99.95% efficiency, average FP, worst weather conditions (wind 3 m/s, precipitation 10 mm/h)	0, 0036	0.0002
Ventilation system works at 99.95% efficiency, hot FP, worst weather conditions (wind 3 m/s, precipitation 10 mm/h)	0.032	0.0014
Ventilation system not working, entire contamination released, average FP, worst weather conditions (wind 3 m/s, precipitation 10 mm/h)	4.8	0.2

In the case of the estimated impact on a member of the public, the estimated doses are lower than the doses received from the natural environment for all situations assessed.

In the estimate of the dose for employees in the event of an FP drop in the technological facility, it can be seen that the doses depend primarily on the exposure time and distance from the radiation source. The estimated received doses have been estimated very conservatively, and could be reduced substantially, for example by using means of protection, appropriate procedures, etc.

Estimate of dose from FP drop in silo

The results of estimating the dose from an FP drop in the silo are presented below.

Table 99: Estimated dose for employee immediately after FP drop in silo. The main contribution to the dose is inhalation. Source: Section 6.2.1.2. and tables B.2.1 and B.2.2. [131]

Brief description of parameters assumed for FP drop in silo	Estimated dose for employee [µSv per drop]	
Drop height [m]	35	50
Employee remains at edge of silo for 10 min after drop, average FP	16.7	17.8
Employee remains at edge of silo for 10 min after drop, hot FP	161	169

The main contribution to the dose from an FP drop in the silo comes from inhalation, which is 100-fold greater than direct exposure to the damaged FP. The dose from waste already disposed of is even lower than that (3 orders of magnitude).

The estimated dose received by employees who remediate the situation after a certain time (when the contamination has fully mixed with the available air in the silo and in the hall above the silo) is presented below. It is assumed that the employee is in the position where remediation is carried out for 30 minutes.

Table 100: Estimate of dose for employee during remediation of FP drop in silo Source: Section 6.2.1.2. [131]

Brief description of parameters assumed for FP drop in silo	Estimated dose for employee [µSv per drop]	
Drop height [m]	35	50
After a certain time, employee remains 30 min at edge of layer of disposed waste, average FP	34.6	40.7
After a certain time, employee remains 30 min at top of layer of disposed waste, average FP	52.1	58.2
After a certain time, employee remains 30 min at edge of layer of disposed waste, hot FP	580	640
After a certain time, employee remains 30 min at edge of top of disposed waste, hot FP	1002	1007

In this case the key contributions to the dose for an employee come from direct exposure and inhalation.

Estimate of dose in fire scenario in technological facility

The results of estimating the dose from a fire in the technological facility in which an FP is involved are presented below.

Table 101 : Estimated dose for employee in fire scenario in technological facility

Brief description of parameters assumed for fire in technological facility	Estimated dose for employee [µSv per event]	
Distance from FP involved in fire [m]	0.5	2
Employee remains alongside fire for 10 min at defined distance from average FP	36.2	28
Employee remains alongside fire for 10 min at defined distance from hot FP	562	349
After fire (all contamination spreads throughout space), employee remains for 30 min at defined distance from average FP	58.7	34
After fire (all contamination spreads throughout space), employee remains for 30 min at defined distance from hot FP	1190	552

The estimated doses for members of the public are presented below.

Table 102: Estimate of dose for member of public in fire scenario in technological facility. Source: Section 6.2.2.1. [135]. The dose is due to inhalation, whereas the contribution due to submersion is negligible.

Brief description of parameters assumed for fire scenario in technological facility	Estimated dose for member of public [µSv per event] (exposure time: 1 day)	
Distance from technological facility [m]	100	1,000
Ventilation system works at 99.95% efficiency, average FP, worst weather conditions (wind 1 to 3 m/s, precipitation 10 mm/h)	0, 053	0.0023
Ventilation system works at 99.95% efficiency, hot FP, worst weather conditions (wind 1 to 3 m/s, precipitation 10 mm/h)	0.240	0.01
Ventilation system not working, entire contamination released, average FP, worst weather conditions (wind 3 m/s, precipitation 10 mm/h)	100	4.6

Estimate of dose in terrorist attack scenario

Only the main results are presented for the terrorist attack scenario. More on the scenarios and calculations is given in a separate report which is classified as CONFIDENTIAL.

Table 103 : Estimate of dose for member of public in terrorist attack scenario. Inhalation is the main source of the dose.

Brief description of parameters assumed for terrorist attack scenario	Estimated dose for member of public [µSv per event] (exposure time: 1 day)	
Distance from technological facility [m]	100	1,000
Average FP, worst weather conditions (wind 1 to 3 m/s, precipitation 10 mm/h)	64	3

Brief description of parameters assumed for terrorist attack scenario	Estimated dose for member of public [µSv per event] (exposure time: 1 day)	
Hot FP, worst weather conditions (wind 1 to 3 m/s, precipitation 10 mm/h)	570	27

Table 104 : Estimate of dose for employee in terrorist attack scenario

Brief description of parameters assumed for terrorist attack scenario	Estimated dose for employee (exposure time: 1 day) [µSv per event]
Distance from technological facility [m]	86
Average FP, worst weather conditions (no wind, precipitation 10 mm/h)	780

Estimate of dose in airplane crash scenario

The SAFETY ANALYSIS AND WASTE ACCEPTANCE CRITERIA PREPARATION FOR LOW AND INTERMEDIATE LEVEL WASTE REPOSITORY IN SLOVENIA [135] document estimates the doses for the population and employees in case of an airplane crash for various weather conditions and distance from the repository. Two impacts were assessed:

- the impact of an airplane crash caused by the collision of the airplane with the silo,
- the impact of an airplane crash caused by fire after the collision.

The estimated doses from an airplane crash into the silo and the resulting fire are presented in the table below. The assumptions were that an employee would be 30 m away from the silo, while the impact at other distances would apply to a representative member of the public. Inhalation of radioactive substances is the main source of the dose.

Table 105: Estimate of dose in airplane crash scenario including fire after impact

Brief description of parameters assumed for airplane crash scenario at silo	Estimated dose [mSv per event]		
Distance from silo [m]	30 (exposure: 8 hours)	100 (exposure: 1 day)	1,000 (exposure: 1 day)
Crash of airplane (30 tonnes), 99 average FPs, worst weather conditions	17	15	0.7
Fire after airplane crash (20 tonnes of fuel), 99 average FPs, duration of fire 1 hour, worst weather conditions	2.1	2.4	0.3

The total estimated dose in the airplane crash scenario (sum of crash and fire) is presented the table below:

Table 106 : Estimate of dose in airplane crash scenario (crash and fire combined). Inhalation of radioactive substances is the main source of the dose.

Brief description of parameters assumed for airplane crash scenario at silo	Estimated dose [mSv per event]		
Distance from silo [m]	30 (exposure: 8 hours)	100 (exposure: 1 day)	1,000 (exposure: 1 day)
Crash of airplane (30 tonnes), 99 average FPs, worst weather conditions	17	16	0.9

The calculated dose in the airplane crash scenario is the highest of all scenarios for extraordinary events.

RADIOACTIVE WASTE GENERATED DURING REPOSITORY OPERATION

Radioactive waste management is described in the document "Radioactive waste management programme", number NRVB---5X, October 2016, IBE d.d.
During normal operation, the repository will generate radioactive waste matter in solid, liquid, and gaseous form.

LIQUID EMISSIONS
Wastewater from the silo and the technological facility will be generated during normal operation, which is a potential liquid radioactive waste.
The silo water, collected in the collection tank below the silo, will have a radiation counter installed to monitor water contamination. The device will be linked to the control room.
The water from the technological facility (personnel decontamination room) will be collected in the sanitary tank in the first phase of building the technological facility, and in the collecting shaft in the second phase. Any water contamination in the tank will be analysed using high-resolution gamma spectrometry. If the water is not contaminated, it will be released into the sewer system. The release will only be made if the measured values are within authorised threshold values. If the thresholds are exceeded, the water will be pumped into the sanitary tank next to the technological facility, and released for further processing as contaminated water. The contaminated water can be used to produce filling grout, or it can be further processed on-site or at other locations with appropriate capabilities.

GASEOUS EMISSIONS
The likelihood of radioactive substances being contained in airborne discharges during operation is low and could only occur in the event of damage to the container and the radioactive waste management operations that would follow at the repository. Gaseous emissions form the silo will be monitored on the silo exhaust. The emissions will be monitored using a continuous aerosol sampler. The samples (i.e. filters) will be measured using gamma spectrometry.
Sampling of aerosols on the technological facility exhaust will be similar. During the first phase of operation, the exhaust from the decontamination room will be sampled. After the

second phase, when the additional storage rooms will be built in the technological facility, the air conditioning utility room exhaust will be monitored.
Since the waste contains Rn-226, Rn-222 concentration will be monitored in the silo and the vicinity. The ionising radiation monitoring programme is further defined in the Radiation protection evaluation. This will be performed later, in collaboration with an authorized radiation protection expert. The evaluation will define the alarm levels for individual measuring instruments at the LILW repository site.

Furthermore, gaseous emissions (e.g. of tritium, chlorine, iodine, radon etc.) are expected due to emissions from solid primary LILW. Although major emissions will not be generated, and the radiation limits at the repository fence will not exceed limits due to release into the air, as set in the Operating conditions and limitations (Draft Safety Analysis Report, Section 11), the presence of gaseous emissions will be subject to operational radioactivity monitoring.

It is estimated that during operation and decommissioning of the repository, approximately 10 m^3 of radioactive waste will be generated, i.e. two N2b containers.
The secondary LILW at the repository will be generated in the following cases ("Disposal technology", project number NRVB---B052/058-2, identification NRVB---1T1010B, October 2015, IBE d.d.):

- repairs of damaged disposal containers;
- operation of the radiological laboratory/measurement room (waste samples, waste equipment, waste sources etc.);
- part of the hot workshop (e.g. contaminated removed equipment, decontamination residues etc.);
- Ventilation (replaced HEPA filters), and
- when using personal protective equipment and ensuring personal hygiene in the radiological monitoring area (protective respirators, gloves, shoes, clothing, personnel decontamination residue etc.).

The secondary waste will be placed in drums at the location where it is generated, sorted by type. Storage, sorting, and measurements required for clearance of secondary LILW will be done in the storage room/measurement room (Measurement room 1) during the first phase of technological facility construction, as part of a checkpoint. In the second phase of the technological facility, this will also include the backup warehouse, where other LILW pretreatment procedures will be performed, and in the measurement room (Measurement room 2), which will be constructed alongside the backup warehouse capabilities.

Handling solid secondary radioactive waste will include the following:

- establishing their properties;
- sorting and separation;
- clearance;
- packaging;
- storage;
- labelling;
- moving, and
- submission to conditioning for disposal

The contaminated water that will be collected within the system of waste liquids and will exceed the limits for discharges into the municipal sewage system, will be processed at the repository site using rented technology (evaporation or ion exchange) or will be submitted for processing. The waste that will arise from processing will be returned to ARAO or will be handled by ARAO.

Part of the secondary waste will be generated during the repository closure procedure i.e. the decommissioning of the technological structures and components at the repository. This waste will be treated in part in the way described in general terms for primary waste, while part of this waste will have to be processed and conditioned for disposal outside Krško NPP and the TF (since these are planned to be already decommissioned at the time of processing). This last waste deriving from decommissioning will be conditioned in the hall above the disposal silo.

The basic packaging for secondary LILW is a 200 litre drum.

Transboundary impacts

Transboundary impacts can only arise in the period after the closure of the repository ("Evaluation of potential doses at Slovenia-Croatia Border", Technical Report ARAO, EISFI-TR-(15)-37 Vol.2, Rev. 1, October 2016). The estimated impacts are negligible to the extent that we can say that they are non-existent.

DURING CONSTRUCTION OF THE SECOND SILO

After it is filled with radioactive waste, the first silo will be covered with a 1 metre thick layer of concrete, and several metres of clay. This will completely block external radiation from the first silo, preventing exposure of the workers constructing the second silo.

Construction of the second silo will begin immediately after closure of the first one. No diffusion of radioactive substances in the environment will have happened at this point, and the workers will not be exposed to radioactive radiation from the ambient material and the groundwater.

In exceptional circumstances, the scenarios and the doses are the same as during operation.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

Abandonment of the activity and later includes:

- activities for closing the LILW repository and its decommissioning;
- Active long-term monitoring phase;
- passive long-term monitoring phase;
- establishing unrestricted use of the space.

After the repository is closed, various events can cause the radioactive substances to pass into the environment and affect the population.

The permissible impacts after closing the repository are listed in *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16).*

The Rules on radiation and nuclear safety factors list the following in Appendix 4: The Design Bases for the LILW/nuclear fuel repository list the dose limitations that the repository can cause after closure.

After closure, repositories may not impose a burden exceeding 0.3 mSv/year on a member of the public under the normal evolution scenario. In cases of alternative evolution scenarios for the repository, the following measurements should be taken into account for the implementation of measures to respond to the burden imposed on a member of the public:

- up to 10 mSv/year: no measures to optimise the repository required;
- above 10 mSv/year: measures required to minimise the likelihood of an alternative evolution scenario;
- above 100 mSv/year: measures required to minimise the consequences of the alternative evolution scenario.

The expert publication by the International Commission on Radiological Protection (ICRP): ICRP Publication 81 "Radiation Protection Recommendations as Applied to the Disposal of Long-Lived Solid Radioactive Waste" sets the dose constraint at 0.3 mSv during normal operation. This dose only applies to the effects of the repository, not to contributions from other sources of ionising radiation.
The impacts after the closure of the repository are permanent and can vary with time. The impacts after closure are direct, with no cumulative impacts.

The EISFI (ENCONET Consulting, Intera, Inc, Studsvik, Facilia AB, IRGO) consortium compiled analyses and studies which discuss the ionising radiation burden to the population and the environment after closure of the repository[138],[139].

Both documents discuss various scenarios after closure of the repository. They are listed below.

SCENARIOS

<u>Nominal scenario</u>
The nominal scenario is expected during the normal course of events, in which no unusual processes take place. Four sub-scenarios are further discussed:

- Nominal scenario, simultaneous onset of degradation of engineered barriers;
- Nominal scenario variant with alternative degradation of engineered barriers;
- Nominal scenario variant without well;
- Nominal scenario variant with conservative assumption of use of well for drawing water.

The nominal scenario is as follows: Upon closing, the silo with radioactive waste is completely soaked or impregnated with water. Barriers between the waste and the environment gradually degrade and radioactivity passes into the surrounding groundwater. It

[138] Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repositories in Slovenia, Post Closure Safety Assessment Synthesis Report Revision 1, PCSA Synthesis Report Rev.1, Technical Report ARAO, EISFI-TR-(11)-15 Vol.1, Rev.1, document designation NSARO2-PCS-001-01-eng, EISFI Consortium, June 2012

[139] Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repositories in Slovenia, Post Closure Safety Assessment Results, Revision 1, Technical Report ARAO, EISFI-TR-(11)-10, Rev.1, document designation NSARO2-PCS-017-01-eng, EISFI Consortium, June 2012

is assumed there are people living in a house 100 m from the repository and they are supplied with water from the well drilled at the site.

Radioactive substances pass into the aquifer and then into the River Sava. The well is located at the middle of the water stream that carries the material from the repository, at a distance of 100 m from the repository.

The population dose calculation uses the following exposure pathway:
All water ingested by the population is obtained from the well. All fish eaten is obtained from the River Sava. The land used to grow produce is irrigated by the River Sava. Livestock is fed water from the River Sava. People only eat local food and are permanently at the location, i.e. on irrigated soil.

Alternative repository evolution scenario
Alternate scenarios comprise undesired events or states following the closure of the repository, and caused by natural events or by human, animal or plant activity, that accelerate the long-term degradation of the repository and the migration of radioactive substances, and increase radiation (e.g. inadvertent human intrusion, water and mineral boreholes, the effects of greenhouse gases, the activation of fractures, global icing, failure of facility seals, migration that produces gases). The documents[129,130] discuss the following alternative evolution scenarios:
Scenario of early failure of engineered barriers (failure of all engineered barriers: waste packages, FPs, backfill, silo, clay top),

- Scenario of early failure of concrete barriers,
- Scenario of river meandering and surface erosion,
- Scenario of change to hydrological conditions
- Inadvertent human intrusion

Early failure of engineered barriers
The scenario assumes a complete, rapid failure of the engineered barriers that separate the waste from the environment after the end of institutional surveillance. The scenario includes a failure of the concrete barrier, and rapid corrosion and all other degradation processes. This can be seen as a worst-case scenario. This scenario does not reflect any known phenomena or processes and is included as a limit case. This scenario is equivalent to a scenario with no engineered barriers at all. The exposure pathway is the same as in the nominal scenario.

Early failure of concrete barriers
The scenario of the early failure of concrete barriers is complementary to the previous scenario, where in this case only the concrete barriers fail.

Changes in the course of the River Sava and surface erosion
The course of the River Sava may change due to natural processes or human activities. This would cause erosion to part of the aquifer, and changes to the course.
The exposure pathway is the same as in the nominal scenario, except that the water ingested is from the River Sava, not the well.

Inadvertent human intrusion

This event is very unlikely, considering the depth of the repository. Drilling into the body of the repository was used as a possible event.

Changes to hydrological conditions

Due to natural processes, climate change, dam constructions on the River Sava, or other actions, changes to the aquifer may occur. These factors affect the amount and direction of the water flow at the repository and in the aquifer.
The exposure pathway is the same as in the nominal scenario.

DOSE EVALUATION IN VARIOUS SCENARIOS

The document[140] calculates the population doses for the general population. Due to different half-lives of radionuclides, and their differing chemical and physical properties, various radionuclides passing from the repository to the environment cause different doses. The doses are time-dependent and calculated for each radionuclide. Furthermore, the maximum doses caused by all radionuclides after closing of the repository are summarised.

Nominal scenario

The maximum calculated dose per population member in the period of 10,000 years after closing the repository is 0.03 mSv annually, and is achieved approximately 1900 years after closing. Ca-41 and Ag-108m are the major contributors to this dose. The calculated dose is ten-fold lower than the limit of 0.3 mSv per year, as set in the *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16).*

The above document also deals with variants of the nominal scenario. If the barriers were to collapse inwards, the maximum calculated annual dose for general population is 0.014 mSv, 10,000 years after closure.

If well water was used for irrigation and livestock instead of water from the River Sava, the highest calculated annual dose is 0.62 mSv and appears approximately 3,000 years after closing the repository. The majority of this dose (0.61 mSv) is attributable to the isotope Ca-41. The probability of this scenario is extremely low and should not be used as a normal scenario, or for comparison with dose limits.

Alternative repository evolution scenario

Early failure of engineered barriers

The basic assumption of this scenario is the failure of all barriers 300 years after closure. This assumption is very conservative, almost extremely so. Such an event is possible under exceptional circumstances, e.g. an earthquake. The highest calculated annual dose per population member is 3.2 mSv in this case, approximately 800 years

[140] Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repositorys in Slovenia, Post Closure Safety Assessment Results, Revision 1, Technical Report ARAO, EISFI-TR-(11)-10, Rev.1, document designation NSARO2-PCS-017-01-eng, EISFI Consortium, June 2012

after the repository is closed. Ag-108m contributes the majority of this dose. The calculated dose is less than 10 mSv per year, and therefore measures to reduce the probability of such a scenario as per the *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16)* are not required.

Early failure of concrete barriers

In the scenario it is assumed that the concrete barriers fail very quickly, i.e. their properties evolve quickly from intact to disintegrated, which means they no longer constitute a hydrological barrier. It is highly unlikely that such an event would really occur in totality, for which reason this scenario needs to be understood as a marginal analysis of the faster failure of concrete barriers than that envisaged under the nominal scenario. The scenario is evaluated in the same way as the nominal scenario, except that it is envisaged that the concrete barriers are subject to rapid failure (a change in properties) after the end of institutional controls. It is assumed that an initial event could occur at a time between 300 and 10,000 years after the closure of the repository. Under the conservative approach, it is assumed in the evaluation of the scenario that there is an event immediately after the end of institutional controls, i.e. 300 years after the closure of the repository.

The highest calculated annual dose per resident is 0.23 mSv in this case, approximately 700 years after the repository is closed. Ag-108m contributes the majority of this dose (0.14 mSv). The calculated dose is less than 10 mSv per year, and therefore measures to reduce the probability of such a scenario as per the *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16)* are not required.

Changes in the course of the River Sava and surface erosion

In this scenario it is unlikely that changes to the course of the River Sava could cause erosion at the depth at which radioactive waste will be stored. The highest calculated annual dose per resident is 3 nSv, approximately 1,600 years after the repository is closed. The calculated dose is less than 10 mSv per year, and therefore measures to reduce the probability of such a scenario as per the *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16)* are not required.

Inadvertent human intrusion

The basic assumption of this scenario is forced entry 300 years after closure. The calculated dose for a person drilling into the repository is very low, as the exposure time is short, and very little material is excavated. The highest calculated dose for a person drilling is 50 µSv annually, 300 years after closing the repository, mostly due to Ag-108m and Nb-94. The calculated dose is less than 10 mSv per year, and therefore measures to reduce the probability of such a scenario as per the *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16)* are not required.

Changes to hydrological conditions

The calculations[141] assume that the rate of radioactive substances passing from the repository into the environment is increased by a factor of 4 compared to the nominal scenario. The highest estimated annual dose per resident is 0.08 mSv, approximately 1,400 years after the repository is closed. The calculated dose is less than 10 mSv per year, and therefore measures to reduce the probability of such a scenario as per the *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16)* are not required.

The table below summarises the calculated maximum annual doses per resident for various scenarios of repository development after closure.

Table 107: Calculated maximum annual doses for residents for various repository development scenarios.

Scenario	Maximum calculated annual dose per person	Years after closure where maximum dose is achieved
Nominal scenario	0.03 mSv	1900 years after closure
Alternative evolution scenarios		
Early failure of engineered barriers	3.2 mSv	800 years after closure
Early failure of concrete barriers	0.23	700 years after closure
Changes in the course of the river Sava and surface erosion	$3 \cdot 10^{-6}$ mSv	1600 years after closure
Inadvertent human intrusion	0.05 mSv	300 years after closure
Changes to hydrological conditions	0.08 mSv	1400 years after closure

The estimated dose of the population for the nominal scenario or for normal development of events is approximately 10-fold lower than the annual effective dose of 0.3 mSv, which is specified as a limitation by the *Rules on radiation and nuclear safety factors, JV5, Official Gazette of the RS, No. 74/16.*

The estimated doses for residents in the case of alternative evolution of the repository are less than 10 mSv per year, and therefore measures to reduce the probability of such a scenario as per the *Rules on radiation and nuclear safety factors (JV5, Official Gazette of the RS, No. 74/16)* are not required.

Cumulative impacts

The impacts after the closure of the repository are permanent and can vary with time. The impacts after closure are direct, with no cumulative impacts.

We do not know which projects will be implemented near the LILW at the time of abandonment (in the year 2061). They can be evaluated as insignificant.

[141] Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repositorys in Slovenia, Post Closure Safety Assessment Results, Revision 1, Technical Report ARAO, EISFI-TR-(11)-10, Rev.1, document designation NSARO2-PCS-017-01-eng, EISFI Consortium, June 2012

Transboundary impacts

In assessing transboundary impacts, the following assumptions are assumed in the document "Evaluation of potential doses at Slovenia-Croatia Border", Technical Report ARAO, EISFI-TR-(15)-37 Vol.2, Rev. 1, October 2016:

- radionuclides are released into the River Sava via the aquifer;
- a resident drinks water from the River Sava and all the fish he consumes is from the River Sava;
- fields are irrigated with water from the River Sava;
- the livestock only drink water from the River Sava;
- residents only consume food produced on fields that are irrigated with water from the River Sava;
- inhabitants spend 100% of the time on land that is irrigated with water from the River Sava;
- by default, the mixing of discharges with water in the River Sava is at the full extent;
- dilution of water in the River Sava due to the inflow of the River Krka is not taken into account;

In **estimating the dose** for the population, the study authors considered two examples. In the first, radionuclides are not disposed of in sediments; in the second it is assumed that radionuclides bind to sediments with moderate or fast absorption and do not reach the border between Slovenia and Croatia. Behaviour between the two examples can be realistically expected.

In the first case, the maximum dose received by the **resident is 0.1 µSv per year and occurs 50,500 years after the closure of the repository.** In the second case, the maximum dose is **0.001 µSv per year and occurs 40,349 years after the closure of the repository.**

Transboundary impacts can therefore only arise in the period after the closure of the repository ("Evaluation of potential doses at Slovenia-Croatia Border", Technical Report ARAO, EISFI-TR-(15)-37 Vol.2, Rev. 1, October 2016). The estimated impacts are negligible to the extent that we can say that they are non-existent. Estimated doses of the population are max 0.1 µSv per year and are hundreds of times smaller than the level of natural background.

EVALUATION OF THE PROJECT IMPACT AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

Table 108: Description and assessment of possible impacts of the development on IONISING RADIATION

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – IONISING RADIATION	
Impact assessment	During construction: no impact During operation: insignificant impact (1) During decommissioning and abandonment: insignificant impact (1)
Impact characteristics and type	The effects of the project during operation and decommissioning will be indirect and temporary. Cumulative effects are expected during operation (cumulative effects together with Krško NPP).
Likelihood of impact and consequences	The likelihood of impact is high during operation and decommissioning.

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – IONISING RADIATION	
Duration or frequency of impact and its consequences, and their reversibility	The impact will be present from the operation and decommissioning of the repository The impact will vary with time and depends on the events. The highest dose appears in early failure of engineered barriers, 800 years after closing the repository. For all other scenarios the calculated doses are two orders of magnitude lower.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	Changes to the environment due to radionuclide emissions or direct radiation will be minor, and we therefore evaluate the environmental burden as acceptable.
Scope of impact	The extent of the impact during operation and normal course of events will be limited to the repository area, up to a few metres from the repository fence due to the effects of external radiation, whereas radioactive emissions are not expected. After closure, the extent and presence of the environmental impact depends on the course of events. It may reach the state border with Croatia, but the impact at this range is negligible, at least four orders of magnitude less than the natural background.
Interactions between individual impacts and their consequences	Ionizing radiation affects people. The effects are deterministic and stochastic. Deterministic effects due to ionizing radiation from the repository will not appear. The probability of stochastic impacts is negligible. Population dose limits will not be exceeded due to the repository.

5.3.11 *ENVIRONMENTAL IMPACTS FROM ELECTROMAGNETIC RADIATION*

DURING CONSTRUCTION

As part of the construction of the repository, the following is planned:

- new transformer substation – TS, ARAO, 20/04 kV, 400 kVA.
- MV connection for the repository, and
- LV connection for the new sewage pumping plant

Both connections will be established from the existing transformer substation 20/04 kV, TS Kostak Landfill.
Supply of electrical power is envisaged from the existing transformer substations of 20/0.4 kV of the Kostak (T927) waste landfill site, operated by Elektro Celje. A MV cell (C03) is already envisaged at the transformer substation with equipment which through a 20 kV cable will supply the new ARAO transformer substation at the LILW repository.
The location of the free-standing transformer substation has been selected so as to suffice for the connection of loads in the **construction phase and as a final location for the needs of LILW repository operation.**

During construction, electromagnetic radiation impacts will appear due to the operation of the new ARAO transformer substation in the project area, as its connection and operation is

planned for the construction phase. During construction the transformer substation will already be built, and an operational regime will be in place.
Considering current measurements and experience in low-frequency EM radiation sources (source: EM radiation Forum project, May 2008), such as transformer substations (TS), the TS that convert 10 or 20 kV into 0.4 kV, with a nominal power between a few tens of kVA and a few MVA emit a relatively minor electrical field into the environment regardless of their placement, similar to that of power supply cables. When determining the area of impact of such a radiation source, the magnetic field, or rather the magnetic flux density, is important. The highest burdens caused by transformer substations, exceeding threshold values for radiation protection area II (100 µT), is limited to the area around the lines, the transformer and the electrical cabinets.

Public research and measurements in the vicinity of TS showed that the outside of the TS is subject to radiation with values below those required for non-ionising radiation protection level II (source: EMR influence area, Valič B., Gajšek P., Ljubljana, Forum EMS, 2008). The TS is more than 5 m away from the two permanent work stations in the technological facility. We estimate that the magnetic and electric field values during operation of the new TS and its infrastructure will be well below the permissible threshold values.

Cumulative impacts
Due to the distance of the new TS and its infrastructure no cumulative impacts from existing EMR sources are expected.

Transboundary impacts
There will be no transboundary impacts.

DURING OPERATION

During operation EMR impacts will appear due to the operation of the new transformer substation.
Considering current measurements and experience in low-frequency EM radiation sources (EMR influence area, Valič B., Gajšek P., Ljubljana, Forum EMS, 2008), such as transformer substations (TS), the TS that convert 10 or 20 kV into 0.4 kV, with a nominal power between a few tens of kVA and a few MVA emit a relatively minor electrical field into the environment regardless of their placement, similar to that of power supply cables. When determining the area of impact of such a radiation source, the magnetic field, or rather the magnetic flux density, is important.
The highest burdens caused by transformer substations, exceeding threshold values for radiation protection area II (100 µT), is limited to the area around the lines, the transformer and the electrical cabinets.
Public research and measurements in the vicinity of TS showed that the outside of the TS is subject to radiation with values below those required for non-ionising radiation protection level II (source: EMR influence area, Valič B., Gajšek P., Ljubljana, Forum EMS, 2008). The TS is more than 5 m away from the two permanent work stations in the technological facility. We estimate that the magnetic and electric field values during operation of the new TS and its infrastructure will be well below the permissible threshold values.

Cumulative impacts
Due to the distance of the new TS and its infrastructure no cumulative impacts from existing EMR sources are expected.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

During decommissioning the TS will continue operating, with EMR impacts present. After abandonment, no EMR impacts are expected as removing the ARAO TS will also remove the EMR source. In light of the above, after removing the new ARAO TS no further EMR impacts will be present in the area under discussion, while existing conditions in the wider area will remain.

Cumulative impacts
No cumulative EMR impacts.

Transboundary impacts
No transboundary EMR impacts.

EVALUATION OF THE PROJECT IMPACT AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

The effects of the new ARAO TS are estimated to be insignificant during construction and operation (1). During decommissioning, the effects will also be insignificant (1), as the TS will continue operation for decommissioning purposes, while there will be no EMR impacts on the environment (0) after abandonment.

Table 109: Description and assessment of possible impacts of the development on electromagnetic radiation

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – ELECTROMAGNETIC RADIATION	
Impact assessment	During construction: insignificant impact (1) During operation: insignificant impact (1) During decommissioning and abandonment: impact during decommissioning is insignificant (1); there is no impact after abandonment (0).
Impact characteristics and type	The effects of the new ARAO TS are estimated to be insignificant during construction and operation (1). Due to the distance of the new TS and its infrastructure no cumulative impacts from existing EMR sources are expected.
Likelihood of impact and	The likelihood of impact is low, and no consequences are expected.

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – ELECTROMAGNETIC RADIATION	
consequences	
Duration or frequency of impact and its consequences, and their reversibility	The EMR impact will be present throughout the construction and operation of the LILW repository. After abandonment, the impact disappears instantly and is reversible.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	No visible changes to the environment are expected.
Scope of impact	The extent of the impact will be local and limited to the TS area.
Interactions between individual impacts and their consequences	Interactions are not expected.

5.3.12 *LIGHT POLLUTION IMPACTS*

DURING CONSTRUCTION

During LILW repository construction, works will not continue into the evening, and the construction site will be lit for security only – minimal technical security. If the works continue at night (during diaphragm construction), floodlights will be installed on site in compliance with the regulations. General lighting of the construction site will be at least 50 lux according to the design team, and at least 150 lux at the site of excavation and cementing of the diaphragm. The lighting with capacities listed above will be provided by the building contractor.
During construction the light pollution will increase somewhat in the evenings, as according to the Decree on limit values due to light pollution of environment, uncovered outdoor construction sites can be lit with lamps that do not fulfil the requirements of Article 4 of this Decree.

The light pollution impacts will be short-term, during construction works. The effects are evaluated as insignificant (1).

Cumulative impacts
Cumulative impacts during construction will occur due to existing illumination in the immediate area of the intended activity and additional illumination due to construction works, should the works take place in the evening or at night, or there will be illumination for the purpose of security.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

DURING OPERATION

When planning exterior lighting, the requirements of the Decree on limit values due to light pollution of the environment were taken into account. Therefore, no negative impacts due to light pollution are expected.

For security purposes, the entire repository will be lit with lights mounted in fixtures at a height of approx. 7-9 m. This part of the repository lighting will be covered under physical security at the repository. The interior roads inside the fences will be lit with lights mounted in fixtures approximately 6-9 m high at the edges of the roads. All lamps must meet the requirements of the *Decree on limit values for light pollution of the environment (Official Gazette of the RS, No. 81/07, 109/07, 62/10 and 46/13).*
The area around the buildings will be lit by lamps installed on the building facade. Long-life, minimum power lamps were selected as per the *Decree on limit values for light pollution of the environment (Official Gazette of the RS, No. 81/07, 109/07, 62/10 and 46/13).*
In order to obtain a building permit, the requirements of Article 20 of the *Decree on limit values for light pollution of the environment (Official Gazette of the RS, No. 81/07, 109/07, 62/10 and 46/13),* must be met, whereby the electrical power of the lamps must not exceed thresholds defined for light sources by the Decree. Furthermore, all requirements of the Decree must be met during use and operation of these lamps.

Cumulative impacts
Cumulative impacts during repository operation will not occur due to existing Krško NPP lighting in the west, and the Spodnji Stari Grad Waste Management Centre to the east, and the traffic lighting of the complex.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

During decommissioning the lighting will be similar to that during construction, causing an insignificant impact (1). After abandonment, the area is not planned to be lit, so no impact (0) is expected after decommissioning.

Cumulative impacts
We do not know which projects will be implemented near the LILW at the time of abandonment (in the year 2061). We can however evaluate them as insignificant.

Transboundary impacts
All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there

will be no transboundary impacts of the LILW repository on the neighbouring country of Croatia.

EVALUATION OF THE PROJECT IMPACT AND ACCEPTABILITY OF ENVIRONMENTAL LOADS AND CHANGES

The impacts during construction due to minimal technical security and the possibility of construction in evening time, taking into account the Decree on limit values for light pollution of the environment, lighting of the construction site and existing activities near the construction site is evaluated as insignificant (1) and short-term.
When planning exterior lighting, the requirements of the Decree on limit values due to light pollution of environment were taken into account. Therefore, no excessive negative impacts due to light pollution are expected during operation, i.e. insignificant impact (1). On decommissioning, the impacts will be similar to those during construction – insignificant (1) and short-term. After abandonment, the area is not planned to be lit, so no impact (0) is expected.

Table 110: Description and assessment of possible impacts of the development on light pollution

DESCRIPTION AND ASSESSMENT OF POSSIBLE IMPACTS – LIGHT POLLUTION	
Impact assessment	During construction: insignificant impact (1) During operation: insignificant impact (1) During decommissioning and abandonment: impact during decommissioning is insignificant (1); there is no impact after abandonment (0).
Impact characteristics and type	Direct, temporary (during construction), permanent (during operation), and cumulative impacts are expected.
Likelihood of impact and consequences	The probability of insignificant impact is high.
Duration or frequency of impact and its consequences, and their reversibility	Minimum lighting is planned every day during operation (technical security) throughout the night. The burden is reversible.
The type, degree, and intensity of the changes to the environment or its parts that can be attributed to the impact	No visible changes to the environment are expected.
Scope of impact	If the lighting is inappropriate (above the horizontal line), the effects of diffuse lighting can be seen for kilometres. Otherwise, the impact of lighting will be zero about 150 m from the source.
Interactions between individual impacts and their consequences	Light pollution directly affects (disturbs) nocturnal animals. Most nocturnal insects are attracted by artificial light sources.

5.3.13 *IMPACTS ON HUMAN HEALTH*

The impacts on human health during construction, operation, and after abandonment of LILW activity could be present due to emissions into the environment, particularly emissions into the air and water, and by burdening the environment with noise and ionising radiation.

DURING CONSTRUCTION

Impacts on air will be time-limited – short-term. Furthermore, taking into account the mitigation measures presented in this report, there will be no excessive air pollution resulting in a deterioration of air quality. The effects on the air during construction are evaluated as moderate. Considering the model calculations for individual construction phases (embankment construction, facilities construction, and silos 1 and 2), the concentration of PM_{10} dust particles will not exceed the daily threshold value according to the *Decree on ambient air quality, Official Gazette of the RS, št. 09/11, 8/15.*

Emissions into the ground and groundwater during construction are only possible in exceptional circumstances, such as spills of oil or fuel from construction machinery and lorries. Even in this case, normal mitigation measures (i.e. removing contaminated soil) would reduce the impact significantly. The effects on water are classified as moderate. It should be noted that no drinking water sources are present in this area.

The model calculation results show that the construction site will not exceed the threshold values for noise protection area III at the nearest residential buildings, and noise protection area IV on-site.
No radioactive waste will be received or stored during construction, precluding radiological effects on the health of workers and residents around the proposed LILW repository.

The construction, taking into account both cumulative impacts and mitigation measures, will not affect human health **– no impact (0).**

DURING OPERATION

During operation the main sources of air pollutants will be transport of LILW waste, transport of lorries for the filling paste, filling of empty spaces in the silo, and employee transport with cars. The effects on air are classified ~~as~~ insignificant. According to the diffuse dust particle emission evaluation, no increased values in residential buildings are expected.

No release into the ground and the groundwater will occur during operation, taking into account the mitigating measures for protection of ground and groundwater. Industrial sewage (no radiological contamination) and municipal sewage will be collected by the public sewage system, concluding in the Kostak treatment plant. The excessive precipitation will be channelled to drains, while all external driving surfaces will be covered in tarmac, with normal drainage and oil traps.

The results of the model calculation for noise showed that noise immission at the applicable sites (nearest houses) will not exceed noise indicators for noise protection area III.

Population radiation dose limits will not be exceeded due to the repository, or will be far below the threshold.

The operation of the LILW repository, taking into account both cumulative impacts and mitigation measures, will not affect human health – **no impact (0).**

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

At the time of the abandonment of LILW disposal, which also includes demolition works, the impact is similar to that at the time of construction (only to a much smaller extent, as there will be no decommissioning of infrastructure facilities and the silo), and after abandonment, there will be no more sources of emissions into the air and water or noise burden.
Due to the nature of the activity – the LILW repository – the impact of ionising radiation on the environment will remain (possible mainly from the point of view of the impact via the waterway), but these impacts are insignificant, far below the limit values and will not affect human health.

During and after abandonment, taking into account both cumulative impacts and mitigation measures, there will be no impact on human health – **no impact (0).**

5.3.14 *EFFECTS ON REAL ESTATE*

5.3.14.1 VIBRATIONS

DURING CONSTRUCTION

During construction, vibrations at the construction site are expected due to construction machinery and transport, where the vibration intensity does not exceed the detection threshold (which is 0.6 mm/s) outside the proposed construction fence.
For lorries, the vibration is V_b= 0.2 mm/s at a distance of 10 m, and for compression (during embankment) the vibration level is V_b= 0,06 mm/s at a distance of 50 m. Damage to buildings occurs at a minimum vibration rate of V_b= 50 mm/s. Calculations from: John F. Wiss. 1981 Construction Vibrations: State-of-the-Art.

DURING OPERATION AND AFTER ABANDONMENT OF THE ACTIVITY

Vibrations will not be present during repository operation and after abandonment.

5.4 CHANGES TO THE OVERALL AND TOTAL ENVIRONMENTAL BURDEN

This section summarises all assessed or evaluated impacts of the activity, where all the influences that arise from the activity and its related activities are included; the effects of related activities – cumulative effects – are taken into account and mitigation measures are also included in the assessment.

Due to construction work, there will be slightly higher burdens of noise, waste, light and dust and the risk of contamination of groundwater and soil. As a result of construction work, there will be slightly increased traffic-related burdens: emissions of noise, exhaust gases, and dust particles.
During operation, impacts on agricultural areas are assessed as moderate; impacts on air, groundwater, nature from the point of view of impacts on vegetation, animals and habitat types, landscape, waste management, noise emissions, electromagnetic radiation, light pollution and ionising radiation are assessed as insignificant. Mitigation measures are included in the assessment. One of the important mitigation measures is the external arrangement of the LILW repository area, which will allow for one part of the area to remain in agricultural use. The design of the forest area and trees on the meadow (external arrangement of the LILW repository area) in the area of the former monoculture field habitat enables greater biodiversity and additionally, the landscape image of the LILW repository is improved due to planting.
Within the operation, the standby phase is included (especially the ionising radiation aspect).
At the time of the abandonment of the activity, which also includes demolition works, the impact is similar to that at the time of construction (only to a much smaller extent, as there will be no decommissioning of infrastructure facilities and silo), which was taken into account in the evaluation and listed as impact assessment given in the value scale provided below. At the end of decommissioning or demolition work, there will be no more sources of emission into the air, and there will be no noise pollution. Due to the nature of the activity – the LILW repository – the impact of ionising radiation on the environment will remain (possible mainly from the point of view of the impact via the waterway), but these impacts are insignificant, far below the limit values and will not affect human health.

During construction there will be no impacts of ionising radiation resulting from the activity; during operation, the radiation impacts are completely negligible, and only in the phase after the closure and degradation of engineered barriers can impacts occur, but according to safety analyses, we estimate that the impacts on people and the environment around the repository will be negligible.

All further burdens due to the project will be within the permitted values, or will be acceptable taking into account the mitigation measures.

Table 111: Value scale

SEGMENT/ FACTOR	Impacts during construction*	Impacts during operation*	Impacts during and after abandonment of the activity*
AIR	moderate (2)	insignificant (1)	moderate (2)
WATER - **Groundwater** - **surface water**	 moderate (1) no impact (0)	 insignificant (1) no impact (0)	 insignificant (1) no impact (0)
SOIL	insignificant (1)	no impact (0)	insignificant (1)
AGRICULTURAL LAND	moderate (2)	moderate (2)	insignificant (1)

SEGMENT/ FACTOR	Impacts during construction*	Impacts during operation*	Impacts during and after abandonment of the activity*
NATURE - **flora, fauna, and HT (habitat type)** - **protected areas** - **EIA and VNF (ecologically important area and valuable natural feature)**	moderate (2) no impact (0) no impact (0)	insignificant (1) no impact (0) no impact (0)	insignificant (1) no impact (0) no impact (0)
LANDSCAPE	moderate (2)	insignificant (1)	insignificant (1)
WASTE	moderate (2)	insignificant (1)	moderate (2)
NOISE	moderate (2)	insignificant (1)	moderate (2)
IONISING RADIATION	no impact (0)	insignificant (1)	insignificant (1)
ELECTROMAGNETIC RADIATION	insignificant (1)	insignificant (1)	insignificant (1)
LIGHT POLLUTION	insignificant (1)	insignificant (1)	insignificant (1)
HUMAN HEALTH	no impact (0)	no impact (0)	no impact (0)
VIBRATIONS	insignificant (1)	no impact (0)	no impact (0)

* taking into account mitigation measures and cumulative impacts

5.5 ENVIRONMENTAL IMPACTS IN NEIGHBOURING COUNTRIES – TRANSBOUNDARY IMPACTS

All potential and actual impacts of the LILW repository during operation and construction are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

In terms of ionizing radiation, it has been determined that after the abandonment of the project, i.e. after closing the repository, the following report was compiled as part of safety analyses and waste acceptance criteria: *Evaluation of Potential Doses at the Slovenia–Croatia Border, Technical Report, NSRAO2-PCS-018 (Safety analysis and waste acceptance criteria preparation for low and intermediate level waste repository in Slovenia), EISFI Consortium, October 2016.* The report addresses the spread of radionuclides through water (the likeliest pathway of spreading radionuclides into the environment), taking account of the surface waters (River Sava) under conditions of low sorption or the absence of sorption in the sediments. However, the estimated impacts are negligible to the extent that they can be considered non-existent. Estimated doses of the population are max 0.1 µSv per year and are hundreds of times smaller than the level of the natural background.

6 MEASURES TO PREVENT, REDUCE, OR REMOVE NEGATIVE IMPACTS

6.1 MEASURES DURING CONSTRUCTION

6.1.1 *AIR*

Measures from the environmental report*[142]*

- A non-binding proposal for implementation of an additional measure by constructing an internal road between Krško NPP and the LILW repository, as most waste will be transported from this location.
  Comment: No internal roads are planned due to changes in repository design and construction. One or two regional road sections will be constructed for safe and reliable transport of radioactive waste from Krško NPP to the final location. The construction of this section is not a subject of the EIA, except in cumulative form.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09)
- a summary of **Article 28 (air protection)**

1. In order to reduce negative impacts on the air, the regulations governing protection of air shall be observed.
2. Construction shall be organised and implemented in such a way as to prevent as much as possible additional air pollution, which is affected by the selection of working machinery, transport vehicles and the weather conditions during construction. The following shall be ensured:
   - moistening of materials, unprotected surfaces and transport routes in windy and dry weather;
   - the prevention of materials being dispersed from the construction site;
   - the cleaning of vehicles when leaving the construction site for public transport surfaces and
   - dust suppression protection of all construction site and public roads used for transportation.

Measures stemming from sectoral legislation:

The Decree on the prevention and reduction of particulate emission from construction sites (Official Gazette of the RS, No. 21/11) which stipulates the rules of conduct for construction works, the requirements for construction machinery and the organisational measures on construction sites with the aim of preventing and reducing particle emissions.
Considering the nature of the work, and the site characteristics, the following requirements and measures stemming from the Decree must be taken into account, especially:

[142] Environmental report in the preparation process of the DPN for LILW repository, November 2006, amended after revision in December 2006, amended after comments by the ministries, February 2007, amended after comments by the Ministry of Environment and Spatial Planning, March 2007, IMOS Geateh d.o.o.

- Article 4 (requirements for engines of construction machinery or other construction site devices)
- Article 5 (requirements for compression ignition engines)
- Article 6 (requirements for mechanical processing procedures at the construction site)
- Article 7 (requirements for construction machinery and other construction site devices)
- Article 8 (requirements for organisational measures on the construction site)
- According to Article 9 the contractor must compile a report on reducing and preventing particulate emissions from the construction site, and adhere to the measures in the Decree. The provisions of this decree apply to all projects lasting more than 12 months, projects in built-up areas with a city status, or projects in a degraded environment if the construction site surface area exceeds 4,000 m^2, or projects in other areas if the site exceeds 10,000 m^2.

Measures stemming from EIA

The monitoring of impacts during construction is primarily focused on ensuring control over measures to prevent the emission of substances (especially dust) into the air from the construction site and transport routes. Implementation of measures to reduce particulate emissions must be provided by the contractor with daily recording in the construction log, and the supervisor monitors compliance of the implementation of the measures with the study.

- reduce the amount of stored construction material and waste;
- the stored construction material must be covered, wetted, or protected against wind to reduce dust generation;
- provisions for washing the wheels and the undercarriage must be made on exits from construction roads and exits from the construction site to public roads;
- construction site roads that will be used for more than 12 months must be covered with a load-bearing tarmac surface, or continuously wetted with liquids that bind the dust to the road surface;
- construction site roads must be regularly cleaned using effective sweeping machines that do not cause dust generation, or by wet cleaning;
- as agreed with the road operator, immediate repairs of damage to public roads or cleaning must be implemented if the public roads are damaged or contaminated at the construction site exit;
- speed at the construction site must be limited to 40 kph unless the construction site roads are covered in tarmac and kept wet;
- The contractor must ensure that bulk construction materials, construction waste, and other construction material that generates dust is transported to and from the construction site covered or closed or in other manners that prevent dust generation.

6.1.2 *GROUNDWATERS*

Measures from the environmental report

- Activities affecting the ground should affect the smallest possible ground surfaces. Such measures should only be taken in areas defined before the start of work. Only materials that do not contain hazardous compounds (e.g. organic halogen compounds) can be used for construction or other work (e.g. water insulation).

- For temporary transportation and construction surfaces, the existing infrastructure and other handling surfaces must be used primarily. These areas must be defined/specified before start of work.
- The paved surfaces of the building construction site must have provisions for collecting and draining wastewater, if generated, using retention basins for precipitation, settling ponds and oil traps.
- In the area where excavated material will be temporarily disposed of and on the entire area of the route construction, transport paths and other handling surfaces, provision must be made for collecting and draining wastewater if generated. This is especially true for accidents where hazardous substances are spilled.
- The locations where excavated material will be temporarily disposed of must be known in advance. The material must be disposed of according to the Decree on management of waste arising from construction work, and the Decree on burdening of soil with waste spreading.
- The temporary landfills for the excavated materials must not be used to deposit other waste materials, including construction waste.
- The construction site area, transport routes and other handling surfaces used to transport removed and construction material can only be used by technically sound vehicles.
- If maintenance of lorries and other machines will be performed in the construction site area, transport routes and other handling surfaces, they must be paved.

Comment: All measures were taken into account when compiling the Conceptual Design, in January 2016.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09)
- a summary of **Article 27 (groundwater protection)**

- Performing safety analyses serving to check the possible impact of the repository on groundwater for all periods of the repository.

Measures stemming from sectoral legislation:

Decree on Waste (UL RS, No. 37/15, 69/15);

- If hazardous liquids are spilled, the contaminated material must be removed. The contaminated material (ground and other waste) is investigated according to the Decree in order to determine a proper disposal method.
- The construction site shall be provided with an appropriately equipped place for storing hazardous substances with a capture vessel of adequate volume, which in possible spillages, overflow or accident enables the capture of such substances and prevents direct entry into the groundwater. The storage room must be protected against atmospheric influence.
- Only original packaging must be used to store hazardous waste. The storage vessels must be closed and marked as hazardous. This measure was chosen to prevent groundwater contamination.

Decree on the emission of substances in the discharge of wastewater from petrol stations, facilities for the maintenance and repair of motor vehicles and car washes (Official Gazette of the RS 10/99, 40/04)

- The pumping platform for maintenance work must be covered in tarmac and separated using kerbs, enabling it to function as a containment vessel in case of a spill. The locations for construction machinery cleaning and maintenance must be oil-proof and provided with oil separators according to the requirements of the Decree.

Decree on the emission of substances and heat in the discharge of wastewater into waters and the public sewage system (Official Gazette of the RS No. 64/12, 64/14, 98/15).

- Drainage of precipitation from all external water-proof paved surfaces of the LILW repository, access roads to the repository, and the car park must be provided separately, using oil separators in the ditch for the drainage field, while precipitation from roofs can be drained directly into the drainage field, as per the Decree listed above.

Measures from the safety report

The final packaging unit (container), the silo, the control pool and the wastewater collection system must comply with the requirements listed in the Draft Safety Analysis Report, Section 6, Description of Systems and Compliance with the Project, which lists technical requirements, compliance requirements for regulations and standards, safety assessment, performing of safety functions and compliance with applicable criteria.

Measures stemming from EIA

Measures to ensure undisturbed (chemical) status of groundwater

- For temporary transportation and construction surfaces, the existing infrastructure and other handling surfaces must be used primarily. These areas must be defined/specified in the design output (organisation of the site). Activities affecting the ground should affect the smallest possible ground surfaces.
- In order to prevent possible spills of hazardous substances, the following measures should be taken throughout the construction period: only construction machinery in good working order may be used. All vehicles and machinery on the construction site must meet the conditions for sealing properties of machine assemblies and hydraulic connections so that there is no possibility of dripping of fuel and various other liquids into the ground. This is achieved by daily control of sealing properties (visual inspections) performed by the operator of an individual machine or vehicle and also by the direct manager of works at the construction site.
- Fuels and lubricants for the supply of machinery must be stored on a solid, limited and covered surface which can retain the total amount of stored substances without the possibility of inflow of rainwater and precipitation.
- The cleaning of machines and vehicles can only be carried out on a sealed surface.
- At the construction site, portable collecting containers and absorbent materials must be available for immediate action in case of leakage of fluids from the machinery;
- A plan of action in case of spillage must be drawn up. Action in the event of an accident depends on the extent of the pollution; however, every spill should be handled according to the measures listed below.
- Measures in case of a spill:
  - mark and secure the accident site;
  - if possible, remove all contaminated soil immediately;
  - cover the spill with absorbent material;
  - the amount of absorbent material must be such that it can neutralise the total amount of fuel contained in the machinery and vehicles on the site;

  - depending on the characteristics of the absorbent substance, remove the substance so as not to pollute the environment;
  - In the case of spillage of a larger amount of hazardous substance, disperse the absorbent material around the edge of the spillage to prevent the spread of the stain. Pump the contents or cover it with absorbent material.
  - Notify the emergency services, i.e. the fire brigade.
  - Inform the information centre about the accident; in the event of a spill, the construction supervision authority and the police must be informed.
- Outside of working hours, the construction machinery and lorries are to be left on suitable solid and impermeable surfaces with regulated drainage of rain water and with oil traps. In this way, direct discharges of pollutants into groundwater are avoided.

6.1.3 *SURFACE WATERS*

Measures from the environmental report

- Transport routes are only permitted in areas defined before start of work. Only materials that do not contain hazardous compounds (e.g. organic halogen compounds) can be used for construction or other work (e.g. water insulation).
- The construction site area, transport routes and other handling surfaces used to transport removed and construction material can only be used by technically sound vehicles.
- If maintenance of lorries and other machines will be performed in the construction site area, transport routes and other handling surfaces, they must be paved.

Comment: All measures were taken into account when compiling the Conceptual Design, in January 2016.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09)

- a summary of **Article 29 (water protection)**

- During construction, strict protection measures and monitoring shall be implemented, along with the organisation of the construction site such that it ensures the unimpeded flow of possible high water and prevents the pollution of water that might arise from transportation, storage and use of liquid fuels and other hazardous substances. All temporary storage areas and pumping stations for fuel, oil, lubricants and other hazardous substances shall be protected against the possibility of leakage into the soil and watercourses.
- During construction, construction vehicles and machinery in good working order shall be used, and appropriate disposal of construction waste and surplus materials shall be ensured.
- Possible contaminated precipitation wastewater from the waste disposal area and the area for the processing and conditioning of waste for disposal shall be radiologically checked and chemically analysed prior to discharge into the public sewer system.
- Prior to discharge into the public sewer system, industrial wastewater from an area in which there are no limits regarding protection against ionising radiation shall be chemically analysed. Such wastewater shall be handled in accordance with Article 10 of this Decree.

- All parking and transportation surfaces shall be reinforced and delimited with raised concrete kerbs so that precipitation wastewater drains from the reinforced surfaces in a controlled manner via oil traps.
- Hazardous substances shall be stored in separate premises in such a way as to be protected from atmospheric influences.
- In all spaces where there exists the possibility of the spillage of hazardous substances, appropriate sealing of the ground shall be ensured.
- In the event of a spillage of hazardous substances, immediate action shall be ensured by appropriately trained workers, and the location of the spill shall be immediately remediated.
- Regular cleaning and maintenance of the systems for removing and treating all wastewater shall be ensured.
- With regard to the protection of water, Article 27 of this Decree, which regulates the protection of soil and groundwater, shall apply mutatis mutandis.

Comment: All measures were taken into account when compiling the Conceptual Design, in January 2016.

- a summary of **Article 26 (protection against natural disasters)**

The third paragraph of Article 26 of the Decree on the DPN sets out an elevation of 157.50 m above sea level for the technological part of the repository, and the seventh paragraph sets out the requirement of the harmonisation of the plateau with the findings of the hydrological and hydraulic studies In accordance with the findings from the study of the Repository elevations and access roads; document no. NRVB---5G/03, IBE, August 2015, the elevation of the entire plateau is set at 155.20 m above sea level, which provides safety against flood waters from the River Sava. The measures planned on the basis of the DPN were thus taken into account in the design.

Measures from sectoral legislation and design output

Decree on Waste (UL RS, No. 37/15, 69/15)

- No materials containing harmful substances can be used on the site without oversight. Substances that are especially hazardous in terms of pollution include fuels, engine and lubrication oils, and bitumen-based insulation materials. Storage of hazardous substances (e.g. petroleum derivatives, oils etc.) must take place outside flood zones. This measure was taken to prevent release of harmful substances into the environment.

All connecting pipes for wastewater in the monitored area must be planned as pre-insulated pipes with leak detection.

Measures stemming from EIA

Measures to ensure appropriate hydrographic properties of surface waters and flood protection:

- In order to limit erosion, the exposed areas should be greened as soon as possible after completion of excavation work.
- Measures to ensure an acceptable chemical and ecological status of surface waters, combined with measures to protect groundwater – see measures to protect groundwater.

6.1.4 *SOIL*

Measures from the environmental report

- Economical use of soil in the area of the project must be ensured. All excess material from the fertile part of the soil in the project area must be used to re-cultivate agricultural land or establish new agricultural land.
- Construction machinery and transport vehicles must be in good working order and fuelled at other appropriate locations, not at the plan location. In case of spills from construction machinery, the location must be cleaned immediately. The construction site shall be provided with an appropriately equipped place for storing hazardous substances with a capture vessel of adequate volume. Hazardous waste must be submitted to an authorized hazardous waste collection organization. This must be recorded.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09)
a summary of Article 27 (water protection)

- In the project area soil shall be managed prudently, so as to ensure the least possible scope of its destruction and damage, the separate removal and depositing of fertile and infertile layers of soil and the use of fertile soil for recultivation and exterior arrangements.
- Only fertile soil obtained in the area of the project shall be used for recultivation. The use of soil from other construction sites shall be prohibited, in order to prevent the introduction of exotic invasive plant species in this area.
- Activities affecting the soil should affect the smallest possible ground surfaces. Those surfaces that will be uncovered during construction shall be recovered with grass or planted and protected from erosion. In the execution of works, appropriate protective measures shall be ensured to prevent harm to neighbouring land.
- The surplus ploughed layer of earth shall be allocated to improve lower quality agricultural land or to balance agricultural land in the Municipality of Krško, in accordance with the instructions of the authorized expert from the agriculture and forestry chamber. Topsoil shall be removed and disposed of in such a way as to preserve its fertility and quantity.
- The construction site shall be provided with an appropriately equipped place for storing hazardous substances with a capture vessel of adequate volume, which in possible spillages, overflow or accident enables the capture of such substances and prevents leaks into the ground and consequently into surface and groundwater.
- Working machinery and transport vehicles shall be supplied with fuel only in specified areas.
- If transport vehicles and other devices are fuelled in the area of the construction site, in transportation and other handling areas, they shall be reinforced, and on non-reinforced surfaces, mobile capture vessels shall be used.

a summary of Article 29 (water protection), already given in the surface water section

Measures stemming from EIA and expert basis[143]

Excavation work requires consistent handling of excavated material. Thus, the humus layer (soil up to 30 cm of depth) and the silty layer must be disposed of separately. The humus component is planned to be disposed of at the edge of the construction site. due to limitations on the compression of fertile soil, the humus piles must not exceed a height of 1.5 m, and no driving is permitted on the piles;

- due to the sufficient quantities of humus at the site, additional transport of soil from other construction sites is not permitted;
- washing of wheels of vehicles and working machinery upon entering the site, for the purpose of preventing the spread of the Japanese knotweed and other invasive plants;
- greening of humus piles with annual plants for green manure in case of a longer period of temporary deposit of humus material;
- sowing of grass on the slopes of the platform is carried out by hydroseeding in order to limit the erosion of the slopes to the minimum.

Measures on removal of fertile soil:

- Before removing the fertile part of the soil, driving with heavy machinery on the removal area must be avoided as much as possible; by doing so, the soil would be further compacted, and the structure of the soil would be destroyed.
- The fertile soil must be removed in dry weather, at least 24 hours must pass after the last heavy precipitation, which is determined by supervision during the construction period. This avoids further destruction of the soil structure and additional compaction of the soil. Its mass also decreases (gravity outflow of water).
- For longer-lasting disposal of larger quantities of fertile soil (more than a year), it is permissible to create taller piles (but no taller than 1.5 m) of any width and length.
- For the excavation material intended to be temporarily disposed of or stored at the repository, it must be ensured that it is not mixed with other wastes.

6.1.5 *AGRICULTURAL LAND*

Measures from the environmental report

- During works, all measures must be taken to prevent damage to adjacent land. Furthermore, free access must be ensured to all adjacent agricultural land.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09) a summary of Article 24 (protection of agricultural land)

- The investor must ensure the protection of agricultural land through appropriately organised construction and protection of land from pollution during construction of the repository.
- In the construction of the repository the movement of construction machinery in the area of the construction site must be limited, and existing roads are to be used for construction site transport. During construction, access to agricultural land must be maintained or ensured. No temporary structures or dumps may be placed on agricultural land, unless

[143] Background documentation for the EIA for the LILW repository, SOIL, August 2015 – supplemented following review in December 2015, ERICo d.o.o. Velenje, DP 171/08/15.

there are no other appropriate options. Cooperation is to be ensured with owners whose land is in temporary use.
- During construction, fertile land shall be treated appropriately so as to preserve its fertility and quantity and to make it usable for the recultivation of damaged land. The mixing of topsoil with inorganic substrate and fertile land must be prevented.
- On high-quality agricultural land, abandoned roads and land damaged by construction works and temporary use during construction shall be levelled to align with the surrounding terrain, humus added and it shall be arranged as arable land.
- The investor shall ensure the monitoring of measures implemented in relation to organisation of the construction site.

a summary of Article 36 (further obligations)
- Owing to the loss of the best agricultural land as a consequence of construction of the repository, by the time of obtaining a construction permit the methods shall be determined for compensating for lost agricultural land, specifically through cash compensation or substitute land for the owners of expropriated agricultural land, or through other appropriate measures.
  Comment: The land was purchased, and monetary compensation was awarded
- In order to compensate for agricultural land, priority shall be given to verifying three options for compensation stemming from the study Consequences of constructing the Vrbina LILW repository on the economic viability of agricultural production (produced by the Biotechnical Faculty, University of Ljubljana, task number 134/2009, November 2009).
  - The investor shall provide compensation for loss of earnings from agricultural land that is temporarily removed from agricultural use owing to construction of the repository. The payment is provided in order to acquire the right to build (temporary easement), before obtaining the building permit.

Measures from sectoral legislation

No measures envisaged.

Measures stemming from EIA

With the proper implementation of envisaged measures, no additional measures to protect agricultural land during construction are necessary.

6.1.6 *NATURE*

Measures from the environmental report
- Use of construction machinery and devices in good working order, appropriate disposal of construction waste and excess material during construction and possible expansion.
- Site lighting must be of a suitable type and appropriately directed.
- In case of spills from construction machinery, the location must be cleaned immediately. The construction site shall be provided with an appropriately equipped place for storing hazardous substances with a capture vessel of adequate volume. Hazardous waste must be submitted to an authorized hazardous waste collection organization. This must be recorded.

Measures stemming from EIA and expert basis

In case of occurrence of invasive species, they must be properly removed by mowing. The *Decree on measures to suppress harmful plants of genus* Ambrosia *(Uradni list, RS, št. 63/10)* must be applied.

http://www.mop.gov.si/si/delovna_podrocja/narava/invazivne_tujerodne_vrste_rastlin_in_zivali/vprasanja_in_odgovori/

One mowing is not sufficient. Ambrosia is an annual plant that germinates relatively late in the spring, and can only be recognised by the characteristic leaf shape in early summer. Ambrosia is thus removed in the summer and autumn. If the plants are mowed before flowering, i.e. before the inflorescence appears at the end of the shoots with male parts from which pollen is released, this prevents production of the pollen which is allergenic, and the maturation of female inflorescences, thus preventing seed formation.

Mowing must be repeated every few weeks, as soon as the mowed plants are observed to have recovered. If the mowing is repeated frequently enough during blooming season, no seeds will develop in that year. Unfortunately, in places where ambrosia has been present for several years, the soil contains many older seeds. These seeds survive the removal of the above-ground parts, and will germinate in the coming years.

In order to completely destroy ambrosia:

- mow at the start of summer,
- mow several times per year, several years in a row,

observe the mowed area for several years, and continue the process if required.

6.1.7 *LANDSCAPE*

Measures from the environmental report

- Formation of edges of the flood prevention plateau. The edges of the plateau must be formed in such a manner that the transition from the natural geomorphology is not too apparent. This will reduce the visual impact, and the contrast between the building and the landscape. The mitigation measure cannot prevent effects due to the changes in geomorphology, but it can make them more acceptable visually. The measure is appropriate in this sense. The measure is practicable. It must be included in the site plan and the project design output. Its execution must be monitored during earthworks. Experience shows that the probability of implementation is low unless monitored in all phases.
- Formation of repository facilities. Even though this is an industrial construction, high quality architecture and urban planning can help the facilities mesh with the landscape. The mitigation measure cannot prevent effects due to the installation of facilities with a pronounced industrial appearance, but it can make them more acceptable visually. The measure is appropriate in this sense. The mitigation measure is practicable. It must be included in the site plan and the project design output. The probability of implementation depends on the investor's enthusiasm and a certain degree of luck when choosing the building designers, as architectural competitions are not required for this type of facilities, and the investor cannot be required to do so.
- Planting. A well thought-out planting plan can mitigate the negative effects on visual appearance and help incorporate the facilities into the landscape. In open farmland, such as the Vrbina site, very dense planting is not recommended. The mitigation measure cannot prevent effects due to the changes in landscape, but it can make them more acceptable

visually. The measure is appropriate in this sense. The mitigation measure is practicable. It must be included in the site plan and the design output and its implementation monitored during repository construction and landscape remediation. Experience shows that the probability of implementation is low unless monitored in all phases.

Comment: The solutions have been approved by the expert committee and included in the Conceptual Design, in January 2016.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09):

a summary of Article 9 (landscape and other exterior arrangements for the repository)

- Landscape and other exterior arrangements must observe the landscape and visual characteristics of the physical environment.
- The entrance section of the repository will be arranged as a public area in accordance with modern principles of landscape design. Shading shall be provided for the parking area through the planting of suitable native tree species. Green areas and other open surfaces in the entrance section shall be arranged as a park area, enhancing the overall image of the entrance and other sections of the repository, with special emphasis on design of the information centre surroundings. The installation of municipal services equipment that matches the design of the structures shall be ensured.
- The planting of native trees shall be permitted in the administration and service section of the repository, taking account of the limitations owing to the need to ensure functionality of the repository and clear views on all transportation routes and handling areas.
- Native trees shall be planted in vacant areas of the repository. Planting must enable physical control and simple maintenance, it must ensure clearance and clear views along roads and paths as well as other built surfaces.
- The edges of flood control embankments shall be designed so as to observe the principles of landscape design.
- A service road shall be laid out on the external side of the fence along the core area of the repository, and shall connect to the repository access road.

Comment: All measures were taken into account when compiling the Conceptual Design, in January 2016.

Measures stemming from EIA

With the proper implementation of envisaged measures, no additional measures to protect the landscape during construction are necessary.

6.1.8 *WASTE*

Measures from the environmental report

- When moving soil, the humus layer must be removed carefully and disposed on-site separately from the other material, and used to cover the soil immediately after the end of construction.

- After the project is finished, all waste must be removed, and the terrain landscaped to match the overgrown terrain in the vicinity.
- The investor must provide temporary storage of waste at the construction site separated by type of construction waste from the waste classification list, and handed off to an authorized waste disposal company.
- All waste must be stored appropriately, preventing its spread: hazardous waste must be stored in impermeable and covered vessels protected against weather.
- The waste must not be disposed of in the natural environment.

Measures from sectoral legislation:

The Decree on the management of waste generated by construction work (Official Gazette of the RS, No 34/08).

This decree defines the obligation for handling waste generated during construction works. According to the Decree, the handling of construction waste on-site is the investor's responsibility. During construction, construction waste (excavated soil, mixed construction waste and bituminous mixtures), as well as other types of waste (waste packaging, municipal waste etc.) will be generated. According to Articles 4 and 8 of the Decree on management of waste generated by construction work, the investor **can use non-contaminated excavated soil at the same site or at another site where they appear in the role of an investor. The excavated soil is envisaged to be used to form the plateau at the excavation location, and the humus to be used for landscaping.**

The excavated soil is not polluted with hazardous substances such that it would have to be classified as hazardous construction waste under the regulation governing waste management, provided:

- it comes from an excavation whose volume is less than 30,000 m^3 and not contaminated with oils, bituminous mixtures or waste that is not of natural mineral material; or
- the data on composition of the excavated soil or the analysis of the excavated soil according to methods described in the regulation concerning waste management shows that the excavated material is not contaminated with hazardous substances to a degree that would require it to be classified as hazardous construction waste;
- the investor must ensure that documentation is produced with data on the volume of soil excavation generated during construction on site, including data on its composition or data on analyses of excavated soil using test methods prescribed by the regulations on waste management. The investor must use this documentation to produce a report on construction waste generated, and the handling of such waste, according to Article 9 of the Decree on waste, and keep it for at least three years after acquiring the operating permit according to the regulations on construction, and present this to the inspector defined in Article 15 of the Decree if requested.
- Construction waste must be stored temporarily at the construction site separately from individual types of waste from the waste classification list and separately from other waste so as to prevent environmental pollution; such waste must also be managed in a way that makes it possible to treat (Article 4 of the Decree).
- The investor may temporarily store construction waste on-site until the construction is completed, for no more than a year (Article 4 of the Decree).
- If a building permit is required by the regulations on construction to construct a new building, reconstruct a building, for a replacement building or removal of a building, the investor must submit a **Construction waste management plan** with the project

documentation for the building permit. (Article 5 of the Decree). Comment: The construction waste management plan has been produced.
- According to Article 6, the investor must ensure that construction waste is handed over to the construction waste handling company. The order for removal must be confirmed before the construction starts. Record sheets must be obtained on hand-off, and records kept, and waste evaluation must be produced for removal.
- The investor can authorise one of the contractors to hand over construction waste to the collecting or processing company for the entire site. They must fill out a record sheet for every delivery of construction waste, as prescribed by the regulations on waste management. For each shipment of waste, the source of the waste or the recipient authorised by the source of the waste must fill out the record sheet.
- The **report on construction waste generated and its handling** must be submitted by the investor to obtain an operating permit.
- The investor must submit to the Ministry a **report on construction waste generated and its handling** one time, at least 15 months after the end of construction, or at least 3 months after obtaining the operating permit, if the operating permit for building the structure was obtained before this deadline. (Article 10 of the Decree).

Decree on Waste (UL RS, No. 37/15, 69/15)

During construction, pollution of the soil or water and, consequently, the generation of hazardous waste, must be prevented; the contractor must have a prepared **plan for effective measures in case of spillage of pollutants (oil, fuel, etc.)** and handling hazardous waste if any is generated according to the Decree on Waste (contaminated soil must be removed and handed over to an authorized waste management company). Maintenance of vehicles, machines and devices is envisaged in service workshops outside the construction site. However, if works are performed on-site that could generate hazardous waste (e.g. waste oil, grease, solvents and their packaging, used protective equipment and its packaging, waste batteries, electrical and electronic equipment etc.), they must be handled with special care. Collection, storage and further handling must be carried out in such a way that it does not pollute the environment and pose risks to humans - it must be collected separately, in appropriate containers, stored separately for a temporary period, and handed over to authorised collectors of such waste. For all types of waste for which treatment is stipulated by special regulations, the contractor must comply with the provisions of these regulations regarding collection, temporary storage and transfer or disposal of such waste (Decree on waste oils, Decree on the management of packaging and packaging waste, Decree on management of batteries and accumulators and waste batteries and accumulators, Decree on waste electrical and electronic equipment management).

Measures stemming from EIA

- During construction, it is necessary to prevent pollution of the soil or water and, consequently, the generation of hazardous waste; the contractor must have a prepared plan for **effective measures in case of spillage of pollutants** (oil, fuel, etc.)
- In the construction of the second silo, a dismantling of the hall above the first silo will take place, whereby mixed construction waste generated in the demolition of the first silo is required to be processed in a manner to allow extraction of secondary raw materials from facade composite panels and roofing (steel sheet, mineral wool – 20 cm, waterproofing foil).

6.1.9 *NOISE*

Measures from the environmental report

- The need for mitigation measures does not stem from the assessment of impacts, but mainly from the valid legislation on noise, which identifies a new project as a new source of noise governed by the noise source indicator limit values, which will not be exceeded in the nearest residential buildings.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09) a summary of Article 30 (noise protection)

1. During construction, the legally defined noise levels may not be exceeded, and the following measures to protect against noise must be applied:
   - use of construction machinery equipped with certificates of sound power that may not exceed the legally prescribed values;
   - noisy work may be performed only between the hours of 7:00 and 19:00;
   - appropriate organisation of the construction site to be ensured (limitation of sonic signals, machine engines not to idle unnecessarily).
2. During operation, the same conditions as for the construction period shall apply to the performance of transportation.

Measures stemming from sectoral legislation:

Rules on noise emissions from machinery used in the open air (Official Gazette of the RS, No. 106/02, 50/05, 49/06 and 17/11)

- The sound power of construction machinery must meet the requirements of the Rules.

Measures stemming from EIA

In case of exceeding the noise indicators in the context of monitoring (according to the *Rules on initial assessment and operational monitoring for sources of noise and conditions for the implementation of monitoring (Official Gazette of the RS, No. 105/08)*), it should be taken into account that noisy works can only be performed between the hours of 6:00 and 18:00.

6.1.10 *IONISING RADIATION*

No environmental impacts due to ionising radiation will appear during construction, and no measures are required.

6.1.11 *ELECTROMAGNETIC RADIATION*

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09)
a summary of Article 17 (electrical power network)

- For the requirements of the repository, a new transformer station shall be constructed and connected, via a high-voltage (20 kV) cable, to the transformer station at the Kostak landfill (investor Elektro Celje).
- A low-voltage line supplying the pump shall be laid along the reconstructed Vrbinska road from the Kostak dump transformer station to the repository sewerage pump.
- A low-voltage cable connection shall be laid in the area of the repository. Low-voltage lines shall be placed outside the driving areas, or cable ducts installed with cable connections and shafts of the appropriate dimensions at locations where driving areas are planned.

a summary of Article 31 (electromagnetic radiation protection)

- The transformer station may not be sited in the immediate vicinity of areas in which people gather for longer periods of time.
- The regulations governing electromagnetic radiation in the natural and living environment shall be taken into account in relation to the installation of the transformer station and the laying of medium-voltage cables.

Comment: All measures were taken into account when compiling the Conceptual Design, in January 2016.

Measures stemming from EIA
With the proper implementation of envisaged measures, no additional measures to limit electromagnetic radiation during construction are necessary.

6.1.12 *LIGHT POLLUTION*

Measures from the environmental report
a summary of Article 9 (landscape and other exterior arrangements for the repository)

- Exterior lighting at the repository shall be provided with shaded lamps and directional lighting, or a means of lighting that generates the least possible light pollution, while also satisfying the requirement for ensuring the security of the repository.

Measures stemming from EIA
With the proper implementation of envisaged measures, no additional measures during construction are necessary.

6.2 MONITORING DURING CONSTRUCTION

6.2.1 *NON-RADIOLOGICAL MONITORING*

During construction, the pollution load of PM_{10} particulate matter must be monitored in the locations of the nearest residential houses. It is estimated that considering the nature of the activity, meteorological data and the distance of the activity from the nearest residential houses, monitoring is carried out during construction and at one location, by the nearest residential house (MM1).

It is proposed to be carried out as part of the regular annual operational monitoring of groundwater at the borehole VOP 3, which is carried out by the operator of the shut-down non-hazardous waste landfill at Spodnji Stari Grad. The borehole VOP 3 can be considered as the reference zero state of groundwater in the area of construction of the LILW repository and as a monitoring site during construction. If the measuring site is abandoned due to the reconstruction of Vrbinska road, a new borehole is to be drilled or a reference borehole from the period of investigative analyses of the geosphere sought, which will not be dismantled or affected at the time of construction. Precise monitoring (range and location) for monitoring the impacts during construction is formulated in the phase of the Design for Building Permit Acquisition documentation.

It is necessary to monitor the quality of the soil before and after the execution of the construction in connection with the organisation of the construction site, damage to the surrounding ground, pollution and the management of fertile soil.
Monitoring of status/impacts and the implementation of mitigation measures during construction must be aligned in terms of time and content with the construction works programme.
The following must be verified:
- earthworks and transports are implemented according to the site plan;
- the excavated layers of soils are properly disposed of (separate disposal of topsoil and the layer beneath, 1.5 m maximum pile height, no compression of infills);
- dust prevention measures (wetting of unpaved transport routes and construction surfaces with the top cover removed, temporary greening of disposed soil etc.);
- temporary waste repositories are protected against diffusion into the environment or leeching into the soil;
- the temporarily disposed layers of soil are unrolled in the correct order and thickness, taking into account natural sedimentation;
- after the construction is finished, the waste is completely removed from the former area of the construction site.

Implementation of soil monitoring:

- before start of earthworks (snapshot);
- during removal of soil and formation of temporary repositories for excavated soil;
- during unrolling of temporarily disposed soil after end of works;
- after end of works (overview of status after final arrangement as a basis for additional measures in case of non-compliance).

An agricultural expert must record the zero state and monitor the quality of the land before and after implementation of the measures. They should focus primarily on monitoring the implementation of proposed mitigation measures in connection with the organisation of the construction site, damage to the surrounding ground, pollution and the management of fertile soil.
By monitoring of the condition after construction, it is necessary to check whether the temporarily damaged land has been successfully recultivated.

In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during the most extensive construction works.
The first noise evaluation is implemented based on noise measurements according to SIST ISO 1996-2.
In the first noise evaluation, the liable person must ensure that the noise evaluation is implemented at the time when the source of noise is at maximum capacity. The noise caused by the source must be evaluated for every noise evaluation location as noise indicators L(day), L(night), L(evening), and L(daily). If the maximum operational capacity status cannot be ensured during the first evaluation, a rationale for not attaining maximum operational capacity must be provided, and the actual state of noise source loading at the time of evaluation described.
If the noise is evaluated based on noise measurements, the noise indicators L(AFeq), L(AF,01), L(AF,99), and L(background) must be evaluated, taking into account corrections due to pronounced pulses or pronounced frequency that occur at the noise evaluation site due to operation of the source of noise, unless described otherwise in the regulations that rule noise evaluations for each noise source.

Only low-frequency radiation sources (new TS) will be present. Since they are in area II of radiation protection, Article 17 of the Decree on electromagnetic radiation in the natural and living environment (Official Gazette of the RS, No 70/96, 41/04-ZVO-1) states that no operational monitoring is required.

Table 112: Monitoring programme during the construction of the low- and intermediate-level radioactive waste repository

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
AIR/CLIMATE				
Basic meteorological measurements.	Air temperature, relative humidity, quantity of precipitation, wind direction and speed.	Annual measurements can be taken from the Krško NPP weather station.	/	Continuously
During construction, the pollution load of PM_{10} particulate matter must be monitored in	Dust particles (PM_{10})	It is estimated that considering the nature of the activity, meteorological data		Continuously

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
the locations of the nearest residential houses.		and the distance of the activity from the nearest residential houses, monitoring is carried out during construction and at one location, by the nearest residential house (MM1).		
GROUNDWATERS				
Measurements of physical and chemical parameters, and groundwater table	Temperature, pH, colour, turbidity, electrical conductivity, oxygen, Cd, Pb, AOX, TOC, mineral oils, KPK, nitrite, nitrate, ammonia, Na, K, Ca, Mg, Fe, hydrogen carbonates, sulphides, sulphites, chloride, sulphate and phosphate. Water table measurements	1 sampling site at the deep borehole (VOP3) 1 water table measurement in one of the shallow boreholes in the immediate vicinity of the drainage field.	Only one monitoring site for groundwater quality is proposed: - once or twice during construction.	The frequency of measurements of each parameter will be defined by the hydrogeologist during preparation of the project documentation. Manual groundwater table monitoring is proposed at least weekly during construction.
SOIL				
The quality of the soil must be monitored before and after the execution of the construction in connection with the organisation of the construction site, the damage to the surrounding ground, pollution and the management of fertile soil.	/	/	/	/
AGRICULTURAL LAND				
An agricultural expert must record the zero state and monitor the quality of the land before and after implementation of the measures.	/	Monitoring should focus primarily on the implementation of proposed mitigation measures in connection with the organisation of the construction site,	/	/

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
		the damage to the surrounding ground, pollution and the management of fertile soil.		
NOISE				
In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during the most extensive construction works.	Monitoring during construction includes compliance verification of the used machinery and devices as required by the Rules on noise emissions from machinery used in the open air. Construction time limits are also monitored.	4 locations given in the Report (EIA).	During major construction work.	/

6.2.2 *RADIOLOGICAL MONITORING*

During the construction and before the operation of the repository, **pre-operational monitoring must be carried out in accordance with the Rules on the monitoring of radioactivity, Official Gazette of the RS, Nos 20/07, 97/09.** The purpose of pre-operational monitoring is to record the (radiological) state of the environment prior to the start of operation of the repository. It shall commence prior to the start of activities at the repository site and prior to the construction of the repository. The implementation of pre-operational radioactivity monitoring according to the *Rules on the monitoring of radioactivity, (Official Gazette of the RS, Nos 20/07, 97/09, Article 26)* is determined by the Slovenian Nuclear Safety Administration in the approval for the facility construction permit or the performance of construction or mining works, for which reason nuclear or radiation safety measures have to be carried out in order to establish the initial state of radioactivity. When the repository operator applies for the building permit, they will also have to submit a pre-operational monitoring programme.

6.3. MEASURES DURING OPERATION

6.3.1 *AIR*

<u>Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09)</u> a summary of Article 19 (heating)

- Facilities shall be heated with heating oil or natural gas, or through renewable sources.

Comment: Included in the Conceptual Design, January 2016 (heat pump envisaged).

Measures stemming from EIA
With the proper implementation of envisaged measures, no additional measures to protect the air quality during operation are necessary.

6.3.2 *GROUNDWATERS*

Measures from the environmental report
- Regular cleaning and maintenance of the sewage system and treatment plants is ensured.
- The results of environmental monitoring programmes for each environmental element are taken into account.

Comment: All measures were taken into account when compiling the Conceptual Design, in January 2016.

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09) a summary of Article 27 (groundwater protection)

1. Measures for protecting soil and groundwater shall comprise:
    - placing repository facilities in a geological area with low water permeability;
    - disposal of waste in impermeable repository structures, which shall be ensured through design solutions and the use of materials with the appropriate qualities;
    - equipping the silos for ensuring control of leakage through a drainage system, which will allow for the collection and treatment of any water that appears inside the facility, in accordance with Article 10 of this Decree;
    - disposal of waste in a form that retards the discharge of radionuclides into the ground and groundwater;
    - handling of wastewater in such a way as to prevent contamination of soil and groundwater;
    - the operation of disposal facilities that prevents radioactive substances entering the soil and groundwater;
    - ensuring of an adequate seal/cover between the silo and the aquifer after the disposal of the waste and the closure of the silo;
    - implementing operational monitoring and active long-term surveillance that includes monitoring groundwater.

Comment: All measures were taken into account when compiling the Conceptual Design, in January 2016.

Measures stemming from sectoral legislation:
Decree on the emission of substances and heat in the discharge of wastewater into waters and the public sewage system (Official Gazette of the RS No. 64/12, 64/14, 98/15).
- Drainage of precipitation from all external water-proof paved surfaces of the LILW repository, access roads to the repository, and the car park must be provided separately, using oil traps in the ditch for the drainage field, while precipitation from

roofs can be drained directly into the drainage field, as per the Decree. Comment: Included in the Conceptual Design, January 2016.

Measures stemming from EIA

Measures to ensure undisturbed (chemical) status of groundwater

- Urban (industrial) wastewater in the LILW repository area is pumped through the overflow shaft into the urban wastewater sewage system ending in the Vipap water treatment plant. The purpose of the measure is to prevent – by means of appropriate management of urban wastewater from the repository – any emissions into surface and ground water.
- In the event of increased radioactivity of the water from the silo in the collection tank detected through radiological monitoring, the pumping of water is redirected to a watertight control pool. In the control pool, contaminated water is retained until it is transported for processing.
- The collected contaminated wastewater will be sent to Krško NPP, or suitable treatment capacities will be installed at the repository. During pumping of the contents of the sanitary tank, a pumping station will be provided with adequate equipment to prevent contamination of the environment (tight joints on pipes, vacuum tank, catch basins, protective PE liners, etc.).
- Regular cleaning and maintenance of the sewage system is ensured.

6.3.3 *SURFACE WATERS*

Measures from the environmental report

- Regular cleaning and maintenance of the sewage system and treatment plants and maintenance of water monitoring in the control pool must be ensured.
  Comment: Included in the conceptual design, January 2016.

Measures stemming from EIA

With the proper implementation of envisaged measures, no additional measures to protect surface waters during operation are necessary.

6.3.4 *SOIL*

No measures are envisaged during operation.

6.3.5 *AGRICULTURAL LAND*

No measures are envisaged during operation.

6.3.6 *NATURE*

Measures stemming from EIA and expert basis

In the case of occurrence of invasive species, they must be properly removed by mowing (see additional measures during construction, Section 6.1.6 Nature).

6.3.7 *LANDSCAPE*

No measures are envisaged during operation.

6.3.8 *WASTE*

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09) a summary of Article 21 (municipal waste disposal)

- Urban waste shall be managed in accordance with the municipal regulations in the area of waste management.
- A space for the collection of urban waste shall be arranged in accordance with the regulations governing waste management, such that it meets the functional, aesthetic, hygienic, technical and fire-safety conditions and does not impede or endanger transport on public surfaces.
- The removal point for urban waste shall be spatially located and arranged in accordance with the conditions of the commercial public service provider in the Municipality of Krško.

Measures from sectoral legislation

The LILW repository is a nuclear facility at which all activities will be carried out that are directly linked to the disposal of such waste. The subject of this segment of the report is non-radioactive waste. Waste will be generated in maintenance work, and owing to the presence of 12 employees, urban waste will be generated. Major service works will be performed by external contractors. Environmental protective measures are envisaged in the LILW area.

Decree on Waste (UL RS, No. 37/15, 69/15)

- Article 27 of the Decree requires that every producer of waste that is a legal entity or sole trader and whose activity generates more than 150 tonnes of waste or more than 200 kg of hazardous waste in a given calendar year must have a waste management plan under which it carries out measures to prevent and minimise the generation of waste and manages that waste. The envisaged quantities of waste will not reach these levels.
- A producer of waste that is a legal entity or sole trader whose activity, in any given calendar year, generates more than 10 tonnes of waste or more than 5 kg of hazardous waste, must submit a report every year to the Ministry on the **waste generated and its management** for the previous calendar year by 31 March of the current year, as per Article 29 of the Decree.

- A producer of waste that is a legal entity or sole trader whose activity, in any given calendar year, generates more than 10 tonnes of waste or more than 5 kg of hazardous waste, keep **records on waste generation and its management**, as per Article 28 of the Decree.
- Waste must be packaged during temporary storage, collection, transport and storage in such a way as to not threaten the environment and human health. They must be labelled with waste designation and name.
- For each shipment of waste, the source of the waste must fill out the **record sheet**.

Measures stemming from EIA

- Mixing of different types of waste and the spillage of hazardous liquids or substances into the environment must be prevented. Instructions for action in cases of spillage of hazardous substances must be drawn up and employees must be trained for quick interventions.
- Should any decanting of fuel and oils into vehicles, machines and devices take place, it can only be carried out at adequately designed sites equipped with oil and fuel traps. Every spillage must be properly cleaned and the handling of hazardous waste resulting from the spillage must be arranged.
- Oil traps must be checked (maintained and emptied) regularly.
- Collection, storage and further handling of hazardous waste must be carried out in such a way that it does not pollute the environment and pose risks to humans – it must be collected separately, in appropriate and labelled containers, stored separately for a temporary period, and handed over to authorised collectors of such waste. For all types of waste for which treatment is stipulated by special regulations, the contractor must comply with the provisions of these regulations regarding collection, temporary storage and transfer or disposal of such waste (Decree on waste oils, Decree on the management of packaging and packaging waste, Decree on management of batteries and accumulators and waste batteries and accumulators, Decree on waste electrical and electronic equipment management). Management of these and other wastes must be regulated in a transparent and controlled manner.

6.3.9 *NOISE*

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09) a summary of Article 30 (noise protection)

- During operation, the same conditions as for the construction period shall apply to the performance of transportation.

Measures stemming from EIA

With the proper implementation of envisaged measures, no additional measures for noise protection during operation are necessary.

6.3.10 *IONISING RADIATION*

Measures under the Decree on the detailed plan of national importance for the LILW repository at Vrbina in the Municipality of Krško (Official Gazette of the RS, No. 114/09) a summary of Article 31 (protection against ionizing radiation)

- Detailed measures to protect exposed workers and reference population groups against ionising radiation shall be defined in the environmental impact report and safety analysis report, in accordance with the regulations governing ionising radiation protection, and incorporated into construction permit acquisition projects.

Measures stemming from sectoral legislation:

Ionising Radiation Protection and Nuclear Safety Act (Official Gazette of the RS, No. 102/04 – official consolidated text, 70/08 – ZVO-1B, 60/11 and 74/15)

- All works in repositories with radiation sources must take into account the principles of justification, optimisation and dose limits.

Decree on dose limits, radioactive contamination and intervention levels (Official Gazette of the RS, No. 18/18)

– Effective worker doses must not exceed 20 mSv annually, while the equivalent doses for individual organs or tissues may not exceed 500 mSv annually for hands, lower arms, feet, and ankles, 150 mSv annually for the eyeballs, and 500 mSV annually for skin.

Rules on the obligations applying to entities conducting radiation practices and holders of ionising radiation sources (Official Gazette of the RS, 3/17 and 8/17)

– The workers must use protective equipment, depending on the level of radiation and contamination. The equipment is defined by the radiation protection department.
– The workers must wear personal dosimeters during work.

Rules on the monitoring of radioactivity (Official Gazette of the RS, No. 20/07 and 97/09)

– Extraordinary radioactivity monitoring must be ensured in case of emergencies.

Measures from the safety report

In the area of the repository certain emergencies could arise. The repository operator must be ready to act upon such events, and must maintain a state of preparedness to respond to such events. The possibility of an accident or emergency occurring must be reduced to a minimum, but in the event of one occurring, the consequences must be mitigated and conditions ensured for re-establishing normal operation.

Prior to operation of the repository, instructions or a plan of actions in case of emergency must be formulated. The basic purpose of the instructions or plan will be to plan a response and measures necessary to manage emergencies at the repository, with the aim of preventing an escalation of the emergency into a radiological accident, to limit the risk and mitigate the consequences.

According to the operational conditions and limitations (Draft Safety Analysis Report, Section 11), the effective dose at the fence must not exceed 0.2 mSv annually. Radiological monitoring will be implemented to supervise this limitation (Section 6.4.2, Table). If the effective dose at the fence is likely to be exceeded, activities to reduce radiation burdens will be implemented, such as installation of additional shielding on the containers in the disposal silo.

The repository operator must implement all logical measures to prevent accidents.
The measures are as follows:

- For an effective response the repository operator will have a state of constant preparedness during and outside working hours.
- The repository operator will provide personal protective equipment and technical protective means including: full-face masks for respiratory protection, TK dosimeters, electronic dosimeters, respirators for respiratory protection, Tyvec protective overalls, shoe covers and latex gloves, dose rate counters, and contamination measuring devices.
- The repository operator will include a fiscal item in its work plan for emergency preparedness.
- The controlled radiation area will be physically secured during working hours (continuous presence of a security officer), and periodic patrols will be conducted by security officers outside of working hours. Technical security measures will be in place in the controlled radiation area 24 hours a day.
- The controlled radiation area will be physically secured during working hours (continuous presence of a security officer), and periodic patrols will be conducted by security officers outside of working hours. Technical security measures will be in place in the controlled radiation area 24 hours a day.
- Fires in the facility will be detected by the active fire protection system.
- Intrusions will be detected by the technical security system.
- The alarm will be connected to the reception desk and to the security provider's security control centre, and potentially also directly to the Police via the IP Infranet.
- In the transmission of information and spoken communication, all available telecommunication and IT infrastructure will be used.

Protective and mitigating measures in an emergency are measures to prevent environmental contamination and/or to reduce exposure of individuals to sources of radiation.

Measures stemming from EIA
With the proper implementation of envisaged measures, no additional measures for ionizing radiation protection during operation are necessary.

6.3.11 *ELECTROMAGNETIC RADIATION*

No measures are envisaged during operation, and no monitoring is required.

6.3.12 *LIGHT POLLUTION*

No measures are envisaged during operation, and no monitoring is required.

6.4. MONITORING DURING OPERATION

6.4.1 *NON-RADIOLOGICAL MONITORING*

Operational monitoring of wastewater
Wastewater generated during regular operation will not contain pollutants from Appendix 1 of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system (Article 5), while general, ecotoxicological and microbiological parameters will be compliant with the threshold values in Appendix 2 of the Decree.
The following parameters must be monitored:

- temperature (preliminary limit value 30 °C);
- pH-value (6.5–9);
- undissolved substances (80 mg/L); and
- total hydrocarbons (mineral oils) 5 mg/L.

Operational monitoring of wastewater must be carried out on a periodic basis, at the time of sampling for the needs of discharges to the sewage system in accordance with the requirements of the operator, i.e. Vipap water treatment facility. Periodic sampling, which applies to industrial wastewater and is conducted in accordance with Article 10 of the Rules on initial measurements and operational monitoring of wastewater, will not be carried out during regular operation due to the small quantity of industrial wastewater (total quantity will not exceed 4,000 m^3 and the wastewater can be considered to be urban wastewater).

In the case of the occurrence of wastewater resulting from an emergency (e.g. fire, implementation of remedial measures after the fall of the container, accidental entry of water into the silo, etc.), the provisions of the Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewage system are not applied – as stipulated in Article 3 of the Decree. In this case, the discharge of wastewater into the public sewage system is carried out after prior sampling and harmonisation of requirements with the administrative authority competent for the field of radiation safety and with the operator of the sewage system and the treatment plant.
In the case of the occurrence of wastewater resulting from an emergency (e.g. fire, implementation of remedial measures after the fall of the container, accidental entry of water into the silo, etc.), the provisions of the Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewage system are not applied – as stipulated in Article 3 of the Decree. In this case, the discharge of wastewater into the public sewage system is carried out after prior sampling and harmonisation of requirements with the administrative authority competent for the field of radiation safety and with the operator of the sewage system and the treatment plant.

By monitoring the condition after construction, it must be checked whether temporarily damaged soil and agricultural areas have been successfully recultivated.

In the case of occurrence of invasive species, they must be properly removed by mowing.

Two years after planting (within the scope of external landscaping), the condition of the plants is checked and any dead seedlings are replaced by plants of identical species and size.

In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during the most extensive burden.
The first noise evaluation is implemented based on noise measurements according to SIST ISO 1996-2.
In the first noise evaluation, the liable person must ensure that the noise evaluation is implemented at the time when the source of noise is at maximum capacity. The noise caused by the source must be evaluated for every noise evaluation location as noise indicators L(day), L(night), L(evening), and L(daily). If the maximum operational capacity status cannot be ensured during the first evaluation, a rationale for not attaining maximum operational capacity must be provided, and the actual state of noise source loading at the time of evaluation described.
If the noise is evaluated based on noise measurements, the noise indicators L(AFeq), L(AF,01), L(AF,99), and L(background) must be evaluated, taking into account corrections due to pronounced pulses or pronounced frequency that occur at the noise evaluation site due to operation of the source of noise, unless described otherwise in the regulations that rule noise evaluations for each noise source.

Table 113: Monitoring programme during the operation of the low- and intermediate-level radioactive waste repository

Type and description of measuring	**Sample type or measurement parameters**	**Sampling site**	**Sampling frequency**	**Measurement frequency**
WASTEWATER				
Operational monitoring of wastewater	Temperature, pH values, undissolved substances and total carbohydrates (mineral oils)	In the case of release into the sewage system (at a regulated site before discharge)	In the case of release into the sewage system	In the case of release into the sewage system
SOIL				
By monitoring of the condition after construction, it is necessary to check whether the temporarily damaged soil has been successfully recultivated.	/	/	/	/
AGRICULTURAL LAND				
By monitoring of the condition after construction, it is necessary to check whether the temporarily damaged land has been successfully recultivated.	/	/	/	/
LANDSCAPE				
After completion of the construction, the success of the planting	/	/	1st vegetation season after the construction	

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
is checked and, if necessary, lost vegetation is replanted. The compliance with the landscape plan is checked as well.				
NOISE				
In accordance with the Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during operation.		4 locations given in the Report.	/	/

6.4.2 *RADIOLOGICAL MONITORING*

Operational monitoring will be carried out during operation and the idle period of the repository, i.e. during the interruption in operation up to Krško NPP decommissioning. The measured values are compared with the values from pre-operational monitoring, which serves to assess the environmental impact of the facility and to calculate the doses for members of the public. By conducting operational monitoring, the operator of a nuclear facility is able to demonstrate that the radioactivity of discharges in normal operation and during the standby phase do not exceed the authorised limits and limit values laid down by regulations, and that the operation of facilities does not expose the population to radiation above the authorised limits and the other limits laid down by regulations, and other requirements of the competent administrative bodies concerning radiological impacts of the facilities on the population and the environment.
At the repository, the air at the exhausts from the ventilation of the silo staircase and TF will be continuously sampled and the obtained samples will be analysed on a monthly or quarterly basis. If an alarm value is detected, ventilation will be stopped and the exhaust will be isolated. The radioactivity in the collection tank below the silo will also be measured simultaneously. If it is detected that the reference values have been exceeded, an alarm will be set off and the automatic activation of pumps for pumping water to the surface will be disabled. Doses in the hall and in the spare warehouse of TF will also be measured simultaneously.

The document[144] provides for a programme for monitoring radioactivity as shown in the table below. The programme will allow regular monitoring of radioactive discharges and actions in case of increased values.

[144] Operational monitoring, Rev. 1, project number NRVB-B052/058-1, identification code NRVB---5X1031, IBE d.d., May 2016.

Table 114: Operational monitoring programme and monitoring during the standby phase of the LILW repository

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
EXTERNAL RADIATION				
Passive dosimeter	External radiation dose	Silo entrance 8 locations at the fence of the repository, each of the cardinal directions Reference location	Continuously	once per 3 months
In-situ measurements with the high-resolution gamma spectrometry method	Contamination of the area	Location at the repository	once per year	once per year
AIR (EMISSIONS)				
High resolution gamma spectrometry	Aerosol filter	Exhaust from the silo duct Exhaust from the AC machine room (TF, second phase) Reference location	Continuously	once per month
Strontium Sr-90, specific analysis (radiochemical isolation of Sr-90, detection with proportional counter)	Aerosol filter	Exhaust from the silo duct Reference location	Continuously	once per 3 months
C-14 Radiochemical isolation of carbon and detection of C-14 with liquid scintillation spectrometry	Aerosol filter	Exhaust from the silo Reference location	Continuously	once per 3 months
Total alpha/beta Liquid scintillation spectrometry for determining total activity of α and β emitters in water, or method with measurement on a proportional counter.	Aerosol filter	Exhaust from the silo duct Exhaust from TF (control point, first phase or AC machine room, second phase of TF) Reference location	Continuously	once per month
^{222}Rn	air - trace detector	Exhaust from the silo or location in the silo 8 locations around the silo	Continuously	once per month

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
		Reference location		
^{222}Rn	air - continuous measurements (measurements lasting for at least 1 week)	Location in the silo	Continuously	twice per year (winter, summer period)
GROUNDWATER				
High resolution gamma spectrometry	Liquid	Boreholes in the close vicinity of the repository, in the directions of water flows, 5 ~~6~~ deep, 5 shallow Reference location	once per 3 months	once per 3 months
Strontium Sr-90, specific analysis (radiochemical isolation of Sr-90, detection with proportional counter)	Liquid	Boreholes in the close vicinity of the repository, in the directions of water flows, 6 deep, 5 shallow Reference location	once per 3 months	once per 3 months
C-14	Liquid	Boreholes in the close vicinity of the repository, in the directions of water flows, 5 ~~6~~ deep, 5 shallow Reference location	once per year	once per year
Pu-239 Radiochemical separation of Pu and measurement with the alpha spectrometry method.	Liquid	Boreholes in the close vicinity of the repository, in the directions of water flows, 5 ~~6~~ deep, 5 shallow Reference location	once per year	once per year
H-3	Liquid	Boreholes in the close vicinity of the repository, in the directions of water flows, 5 ~~6~~ deep, 5 shallow Reference location	once per 3 months	once per 3 months

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
LIQUID RELEASES (EMISSIONS)				
High resolution gamma spectrometry	Liquid	Collection tank of the silo Sanitary tank tank (TF, 1st phase) Collection shaft (TF, 2nd phase) Control pool	Before every release	Simultaneous
1st Phase: Gross alpha/beta Liquid scintillation spectrometry for determining total activity of α and β emitters in water, or method with measurement on a proportional counter. 2nd phase: specific analysis of α and β emitters (potentially C-14, Sr-90, and H-3 in particular).	Liquid	Collection tank of the silo Sanitary tank (TF, 1st phase) Collection shaft (TF, 2nd phase) Control pool	Before every release	simultaneous
H-3	Liquid	Collecting basin of the silo Collecting tank (TF, 1st phase) Collecting shaft (TF, 2nd phase) Control pool	Before every release	simultaneous
SURFACE WATERS				
High resolution gamma spectrometry	Liquid	Entry of the channel into the gravel pit at Spodnji Stari Grad Reference location	Continuous sampling	once per 3 months
Gross alpha/beta Liquid scintillation spectrometry for determining total activity of α and β emitters in water, or method with measurement on a proportional counter.	Liquid	Entry of the channel into the gravel pit at Spodnji Stari Grad Reference location	Continuous sampling	once per 3 months

Type and description of measuring	**Sample type or measurement parameters**	**Sampling site**	**Sampling frequency**	**Measurement frequency**
Strontium Sr-90, specific analysis (radiochemical isolation of Sr-90, detection with proportional counter)	Liquid	Entry of the channel into the gravel pit at Spodnji Stari Grad Reference location	Continuous sampling	once per 3 months
H-3	liquid	Entry of the channel into the gravel pit at Spodnji Stari Grad Reference location	Continuous sampling	once per 3 months
SURFACE WATERS, SEDIMENT				
High resolution gamma spectrometry	Sediment	Entry of the channel into the gravel pit at Spodnji Stari Grad Reference location	Single sample	once per year
Strontium Sr-90, specific analysis (radiochemical isolation of Sr-90, detection with proportional counter)	Sediment	Entry of the channel into the gravel pit at Spodnji Stari Grad Reference location	Single sample	once per year
FOOD, GARDEN CROPS, FIELD CROPS				
High resolution gamma spectrometry	Garden and field crops (if not available, then grass/hay is sampled)	Location (field) in the vicinity of the repository, 2 samples Reference location	once per year, season sample	once per year
Strontium Sr-90, specific analysis (radiochemical isolation of Sr-90, detection with proportional counter)	Garden and field crops (if not available, then grass/hay is sampled)	Location (field) in the proximity of the repository, 2 samples Reference location	once per year, season sample	once per year
C-14 Radiochemical isolation of carbon and detection of C-14 with liquid scintillation spectrometry	Garden and field crops (if not available, then grass/hay is sampled)	Location (field) in the proximity of the repository, 1 sample Reference location	once per year, season sample	once per year
FOOD, FRUITS				
High resolution gamma spectrometry	Fruits	Location in the proximity of the repository, 2 samples Reference location	once per year, season sample	once per year
Strontium Sr-90, specific analysis (radiochemical isolation of Sr-90, detection with proportional counter)	Fruits	Location in the proximity of the repository, 2 samples Reference location	once per year, season sample	once per year

Type and description of measuring	Sample type or measurement parameters	Sampling site	Sampling frequency	Measurement frequency
C-14 Radiochemical isolation of carbon and detection of C-14 with liquid scintillation spectrometry	Fruits	Location in the proximity of the repository, 1 sample Reference location	once per year, season sample	once per year

6.5. MEASURES DURING AND AFTER ABANDONMENT OF THE ACTIVITY

6.5.1 *AIR*

The measures during decommissioning are similar to those during construction. After abandonment of the project, no measures or additional measures from the EIA are envisaged.

6.5.2 *GROUNDWATER*

After abandonment of the activity, no measures or additional measures from the EIA are envisaged.

6.5.3 *SURFACE WATERS*

After abandonment of the activity, no measures or additional measures from the EIA are envisaged.

6.5.4 *SOIL*

Measures stemming from EIA

- At the end of decommissioning, the soil at the sites of the removed facilities and construction site is to be rehabilitated and covered with grass.

6.5.5 *AGRICULTURAL LAND*

Measures stemming from EIA

- At the end of decommissioning and long-term surveillance, the surfaces of the plateau and its slopes are intended for a permanent meadow.

6.5.6 *NATURE*

Measures from the environmental report

- During closing down of the repository the mitigating measures are defined according to the intended use of the repository area and according to the decommissioning process of the technological facility.

Additional measures and nature protection monitoring are not required.

6.5.7 *LANDSCAPE*

Measures stemming from EIA

During the decommissioning of the repository, facilities are removed in a manner that takes into account the preservation of individual remains that will mark the former activity.

6.5.8 *WASTE*

The measures during decommissioning are similar to those during construction. After abandonment of the project, no measures or monitoring are envisaged.

6.5.9 *NOISE*

The measures during decommissioning are similar to those during construction. After abandonment of the project, no measures are envisaged.

6.5.10 *IONISING RADIATION*

After abandonment of the activity, institutional control and radioactivity monitoring will still have to be performed. No additional measures are envisaged.

6.5.11 *ELECTROMAGNETIC RADIATION*

After abandonment of the activity, no measures or monitoring are envisaged.

6.5.12 *LIGHT POLLUTION*

After abandonment of the activity, no measures or monitoring are envisaged.

6.6. MONITORING DURING AND AFTER ABANDONMENT OF THE ACTIVITY

6.6.1 *NON-RADIOLOGICAL MONITORING*

In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during the most extensive burden of decommissioning.
The first noise evaluation is implemented based on noise measurements according to SIST ISO 1996-2.
In the first noise evaluation, the liable person must ensure that the noise evaluation is implemented at the time when the source of noise is at maximum construction capacity. The noise caused by the source must be evaluated for every noise evaluation location as noise indicators L(day), L(night), L(evening), and L(daily). If the maximum operational capacity status cannot be ensured during the first evaluation, a rationale for not attaining maximum operational capacity must be provided, and the actual state of noise source loading at the time of evaluation described.
If the noise is evaluated based on noise measurements, the noise indicators L(AFeq), L(AF,01), L(AF,99), and L(background) must be evaluated, taking into account corrections due to pronounced pulses or pronounced frequency that occur at the noise evaluation site due to operation of the source of noise, unless described otherwise in the regulations governing noise evaluations for each noise source.

Table 115: Monitoring programme during and after abandonment of activity

Type and description of measuring	**Sample type or measurement parameters**	**Sampling site**	**Sampling frequency**	**Measurement frequency**
NOISE				
In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during decommissioning.		Monitoring will be adapted to the situation on-site and the applicable legislation.	/	/

6.6.2 *RADIOLOGICAL MONITORING*

The scope and duration of post-operational monitoring of radioactivity is determined in relation to the expected environmental impact in the vicinity of the closed radiation or nuclear facility.

Measurements or sampling are performed in the same places as operational monitoring, but less frequently. Furthermore, monitoring is not performed at all locations and for all types of samples or transmission paths as it is in operational monitoring. The scope of the programme is determined towards the end of the operation of the facility.

The estimated population doses after the closure of the repository under normal events are low, a maximum 30 µSv per year. Low doses are achieved by the use of engineered barriers, represented by: waste form, waste packaging into which waste is inserted at Krško NPP, concrete containers for the storage of waste, and the disposal silo itself. No special additional measures need to be implemented.

6.7. MEASURES TO PREVENT POTENTIAL TRANSBOUNDARY IMPACTS

All potential and actual impacts of the LILW repository are – taking into account the mitigation measures – assessed as insignificant. As this is a local impact, we find that there will be no transboundary impacts of the LILW repository on the nearest neighbouring country, Croatia.

Transboundary impacts, in terms of ionizing radiation, can therefore only arise in the period after the closure of the repository ("Evaluation of potential doses at Slovenia-Croatia Border", Technical Report ARAO, EISFI-TR-(15)-37 Vol.2, Rev. 1, October 2016). The estimated impacts are negligible to the extent that we can say that they are non-existent. Estimated doses of the population are max 0.1 µSv per year and are hundreds of times smaller than the level of natural background. No special measures need to be taken to reduce transboundary impacts in the period after closing of the repository.

No special measures need to be taken to reduce transboundary impacts during construction, operation, and after abandonment of activity, as the impacts are negligible or non-existent.

6.8. ADDITIONAL MEASURES ACCORDING TO THE EXPECTED TOTAL OR COMMON ENVIRONMENTAL BURDEN

The consequence of the intended project, i.e. construction of the LILW repository and the associated activities, will be a somewhat increased environmental burden. The evaluation of expected impacts in various project phases (construction, operation and abandonment of activity) shows that all additional environmental burdens are within the prescribed values, and will be acceptable taking into account the envisaged and additional mitigating measures.
Considering the evaluation of expected impacts, no additional burden on the environment that would exceed permissible values is expected. Taking into account the expected total or common environmental burden, special additional measures are not envisaged or required.

Facilities that affect the environmental burden already exist in the vicinity of the project (Krško NPP and the Waste Management Centre at Spodnji Stari Grad). The LILW repository project itself will not cause major impacts on the environmental burden.

6.9. PRINCIPAL ALTERNATIVES TO OTHER POSSIBLE MEASURES

The mitigating measures chosen take into account the specifics of the construction, best practices to mitigate negative environmental impacts, the specifics of the location and the vulnerability of the environment in which it will be placed, while at the same time ensuring the project has no excessive impacts. Therefore, alternative measures have not been investigated.

When planning the project, the best solutions with minimal impact on the environment were considered for the placement in the physical environment; solutions were selected that require the minimum amount of construction works, and the best disposal option was selected as part of the Variant Study.
In this way, with prior planning, the greatest protection of the environment is guaranteed with the lowest environmental impacts that can be achieved in this project, taking into account the envisaged mitigation measures. In addition to this, however, some additional measures are proposed in this report, for which we assessed that it was reasonable to propose them in view of the environment in which the activity is being placed.

We estimate that the envisaged and additional measures to prevent, reduce, or remove negative impacts listed in this Report (EIA) are appropriate and ensure that the project is environmentally sound if implemented consistently.

There are certain alternatives that are not feasible in this case:

- Construction works could be conducted using machinery that does not use hazardous chemicals (e.g. using electric machinery) to prevent spilling of hazardous substances into the environment. As the current state of the art does not permit commercial use of such technology, this option was not considered. The measures chosen are optimised for lowest possible pollution.
- Possible alternative measures for arranging the fertile soil landfills are technical in nature, e.g. covering the piles with geotextile to prevent erosion and overgrowth of trees and other undesirable invasive plants. This measure was not chosen due to the use of natural resources (re-use of fertile soil in the construction area), and because the construction period is relatively short.

7. DEFINITION OF THE AREA IN WHICH THE PROJECT WILL CAUSE AN ENVIRONMENTAL BURDEN THAT COULD AFFECT HUMAN HEALTH OR PROPERTY

7.1. Starting points and methods for the definition of the area in which the project will cause an environmental burden that could affect human health or property

Pursuant to the ZVO and Article 15 of the Decree on the content of the report on the effects of intended activity on the environment and its method of drawing up (Official Gazette of the RS, No 36/09), the report must define the area in which the intended development will cause an environmental burden which might affect human health or property. The area must be defined in such a way as to take into account expected environmental burdens in consequence of the impacts of the environmental encroachment, especially from:

- emission of substances into the atmosphere,
- emission of substances into water,
- waste generation and waste management,
- the use of hazardous substances and associated risks,
- environmental burden from ionising radiation,

- burdening the environment with noise or vibrations,
- environmental burden from electromagnetic radiation
- light pollution.

Table 116: Overview of impacts on human health and property

Type of impact	Impacts during construction and abandonment of activity	Impacts during operation
emission of substances into the atmosphere	+	+
emission of unpleasant odours	-	-
emission of substances into water	+	+
waste generation and waste management	+	+
the use of hazardous substances and associated risks	+	+
environmental burden from ionising radiation	- (+)	+
environmental burden from noise	+	+
environmental burden from vibrations	+	-
environmental burden from electromagnetic radiation	+	+
light pollution	+	+

Key: + indicates that an impact is present and dealt with
- indicates that an impact is not present and was not dealt with

7.2. **Description and illustration of the area in which the project will cause an environmental burden that could affect human health or property**

The area in which the impact causes environmental burdens that can affect human health and property (hereinafter impact area) is defined within the framework of the rules of the profession concerned with environmental impact assessments.

Since there are no detailed rules on defining the area, the Report takes into account all provisions in Article 15 of the Decree on the content of the report on the effects of intended activity on the environment and its method of drawing up (Official Gazette of the RS, No 36/09). We also took into account the fact that if the measures prescribed in the report are taken in all phases (construction, operation and abandonment), no unauthorised pollution will take place, as the emissions will be below the permissible levels and the waste will be handled as required by the regulations. The reference immission points will not exceed threshold values for daytime noise indicators for noise protection area III.

Impacts taken into account to determine the impact area:

- Based on model calculations we find that PM_{10} concentrations at the nearest residential buildings will not be exceeded as a result of construction of the development in question, causing no effect on human health. The impact area due to emissions during construction is listed below (Figures 115 and 117). During operation, the project will not cause significant impacts on emissions into the air, and the impact area is confined to the project area.
- The project will cause no unpleasant odours.
- Emissions of pollutants during construction, operation and decommissioning (as part of abandonment of the activity) in the project area will be below limit values. Therefore, pollutant emissions into waters are limited to the project area in terms of impact on human health.

- During construction, operation and abandonment waste will be handled as required by the legislation, and no impact on human health will be present. The impact area is limited to the project area.
- During construction and decommissioning, handling of hazardous substances (fuel and lubricants) in transport and construction machinery will take place. The construction and transport machinery will be properly serviced and maintained. In case of a spill, the contaminated soil will be removed immediately and handed over to an authorized organisation, precluding impacts on human health and property. The impact of hazardous substances during construction will be limited to the project area. In case of a spill, the contaminated soil will be removed immediately and handed over to an authorized organisation, precluding impacts on human health and property during operation. The impact of hazardous substances during operation will be limited to the project area.
- The project will be a source of noise, primarily during construction and decommissioning (as part of the abandonment), and during operation. However, the noise can only affect human health in areas with existing buildings with protected spaces (residential buildings, schools, kindergartens, hospitals etc.) and in areas where construction of residential buildings or other buildings with protected spaces is possible. The project area is not inhabited. The closest house is approximately 400 metres from the project, and the immission values of noise indicators were below limit values. Since the project area is on farmland, i.e. on a non-inhabited area, no impact area for human health and property was defined. Noise emissions will not affect human health and property, as there are no people living here, and the area has no buildings with protected spaces. See below for impact areas due to noise burden during construction (Figures 114 and 116), and during operation (Figure 118).
- The project is not a significant source of vibration.
- The project will be a source of electromagnetic radiation (EMR) during construction, operation and decommissioning due to the construction of a new TS. However, substations emit so little EMR that even the exterior of the facility itself has lower values than prescribed for level I and also level II EMR protection. Therefore, there will be no impact on human health due to EMR emissions. The impact of EMR emissions is non-substantial and is limited to the project area.
- The project is a source of ionizing radiation. During operation the radiation impacts are completely negligible, and only in the phase after the closure and degradation of engineered barriers can impacts occur. The document “Evaluation of potential doses at Slovenia-Croatia Border”, Technical Report ARAO, EISFI-TR-(15)-37 Vol.2, Rev. 1, October 2016, estimates the doses for residents at the Slovenia-Croatia border. The highest estimated doses are low, of an order of 0.1 µSv, and appear 10,000 years and more after the repository is closed.
- The project will be a new source of light pollution during construction, and especially during operation (continuous source). However, the lighting is compliant with the legislation, precluding effects on human health and property.
- The development as a whole affects one crop producer, who farms a total of 250.83 ha, of which 249.16 ha are fields and 1.67 ha are meadows. The planned construction will reduce this farmer’s fields by around 16.5 ha, or approximately 6.6%. Part of the area (the strips adjoining the forest on the northern and western sides) is envisaged to maintain agricultural use. Records show a total of 28,652.83 ha of agricultural land in the municipality of Krško (MKGP, 2014), which means that construction of the LILW repository represents a 0.05% loss of agricultural land at the municipal level. The

adoption of the Decree on the detailed plan of national importance led to the purchase of the land and, consequently, to a change in its designated use.

Impact area during construction of Silo 1 and the repository facilities with infrastructure

We set as the limit of the impact area the limit value of the indicator of daily noise generated by the construction site, which is 65 dBA, and the limit of the impact area for air (PM_{10}) at a concentration of 50 μg/m^3.

Figure 114: Impact area due to noise burden during construction

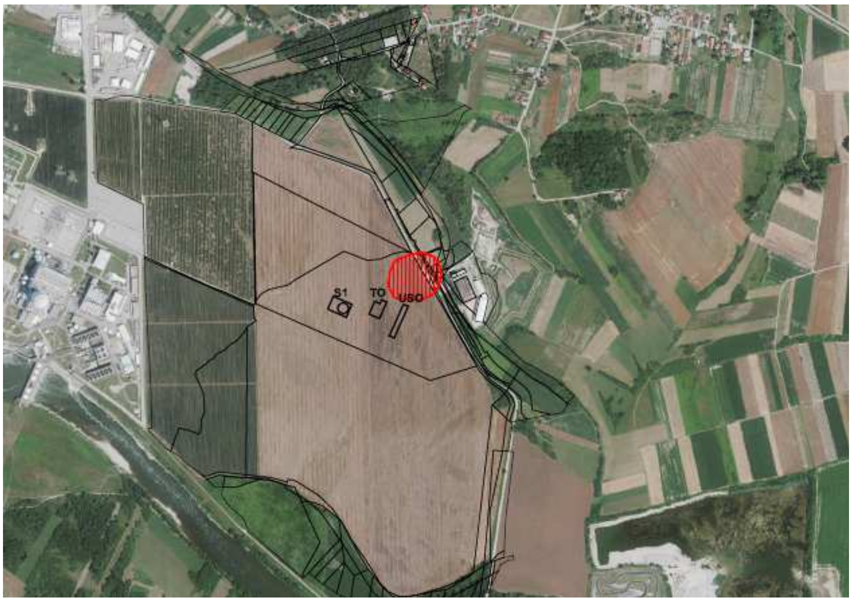

Figure 115: Impact area during construction due to air emissions (PM_{10})

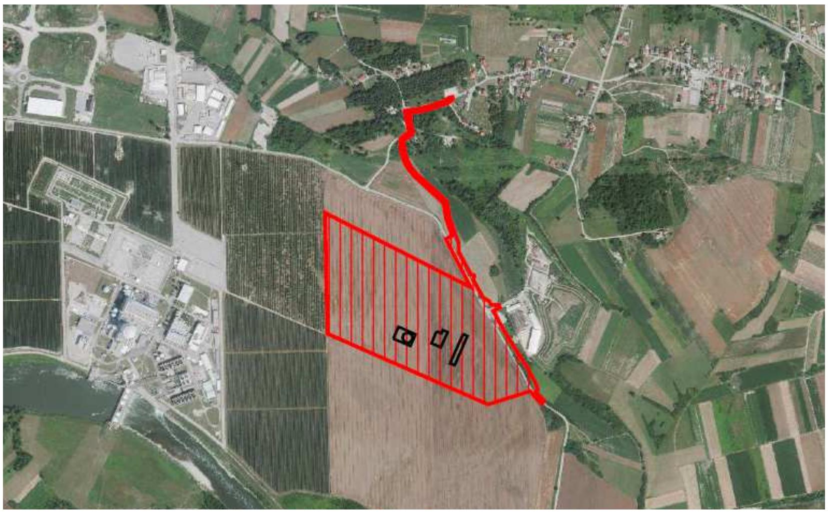

Figure 116: Impact area during construction for other segments of the environment

A graphical representation of the common impact area during construction of Silo 1 and the repository facilities with infrastructure including all segments is listed in Appendix 2 and includes the following plot numbers:

Stari Grad c.m.: 1179/64, 1179/68, 1179/70, 1179/71, 1179/75

Drnovo c.m.: 2103/85, 2103/88, 2103/89, 2103/90, 2103/91, 2103/92, 2103/93, 2103/94, 2106/2, 2106/59, 2106/88, 2106/89, 2106/95, 2106/96, 2106/97, 2106/98, 2106/99, 2106/100, 2106/102, 2106/103, 2106/104, 2106/105, 2106/106, 2106/107, 2106/108, 2106/109, 2106/110, 2106/112, 2106/254, 2106/257, 2106/262, 2106/277, 2645/15, 2645/17, 2645/18, 2645/19, 2645/20, 2645/21, 2645/24, 2645/26, 2645/29, 2645/31

Leskovec c.m.: 1197/57, 1197/58, 1197/401, 1197/437, 1197/438, 1197/439, 1206/5, 2618/1, 2618/2

Impact area during construction of Silo 2

We set as the limit of the impact area the limit value of the indicator of daily noise generated by the construction site, which is 65 dBA, and the limit of the impact area for air (PM_{10}) at a concentration of 50 µg/m^3.

Figure 117: Impact area due to noise burden during construction of Silo 2

Figure 118: Impact area during construction of Silo 2 due to air emissions (PM_{10})

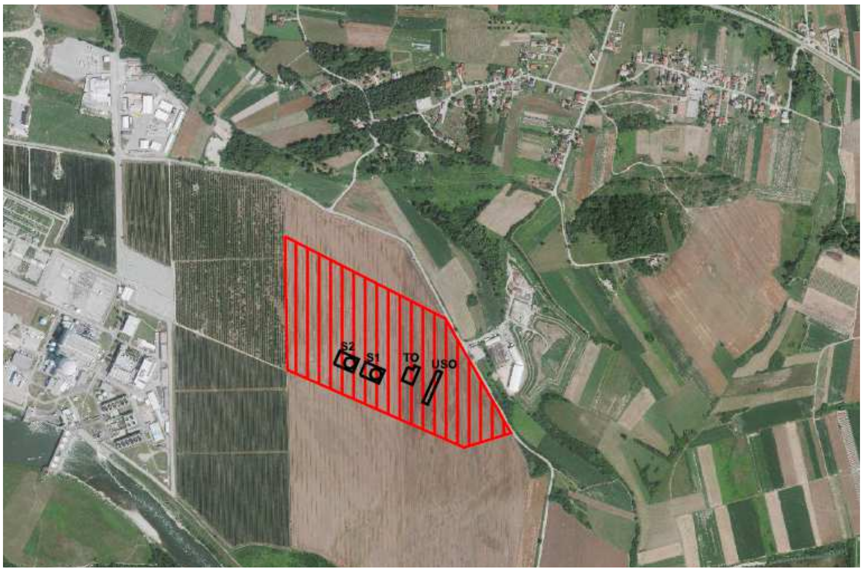

Figure 119: Impact area during construction of Silo 2 for other segments of the environment

A graphical representation of the common impact area during construction of Silo 2 including all segments is listed in Appendix 3 and includes the following plot numbers:
Drnovo c.m.: 2103/79, 2103/85, 2103/88, 2103/89
Leskovec c.m.: 1197/57, 1197/58, 1197/438, 1197/439

Impact area during operation

We set as the limit of the impact area for noise the limit value of the indicator of night-time noise, which is 48 dBA.

Figure 120: Impact area due to noise burden during operation.

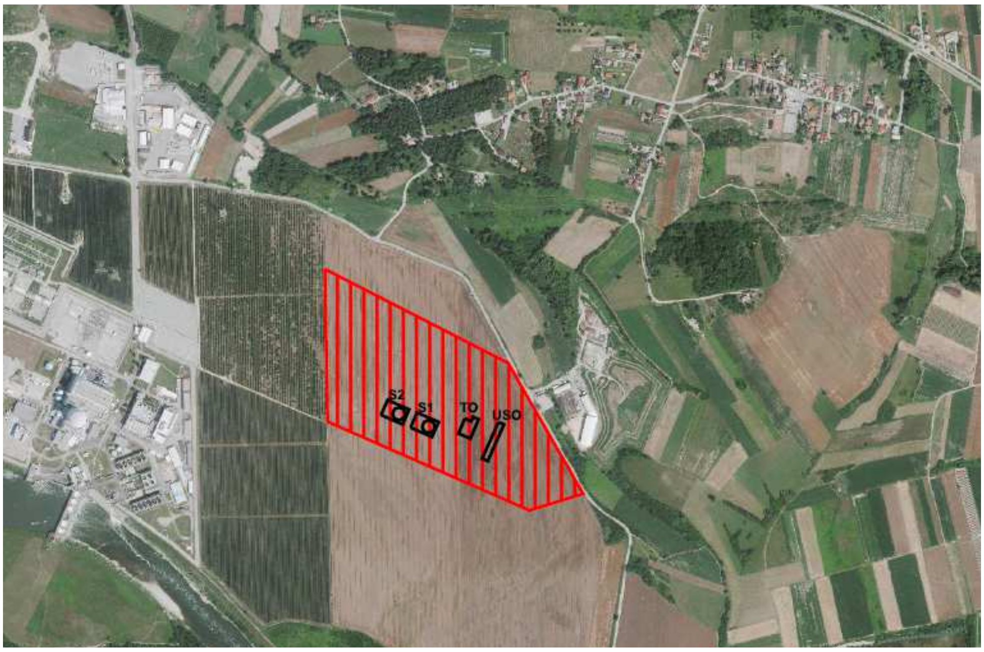

Figure 121: Impact area during operation for other segments of the environment

A graphical representation of the common impact area during operation including all segments is listed in Appendix 4 and includes the following plot numbers:
Drnovo c.m. (1320): 2103/85;

Leskovec c.m. (1321): 1197/58.

Impact area during and after abandonment of the activity

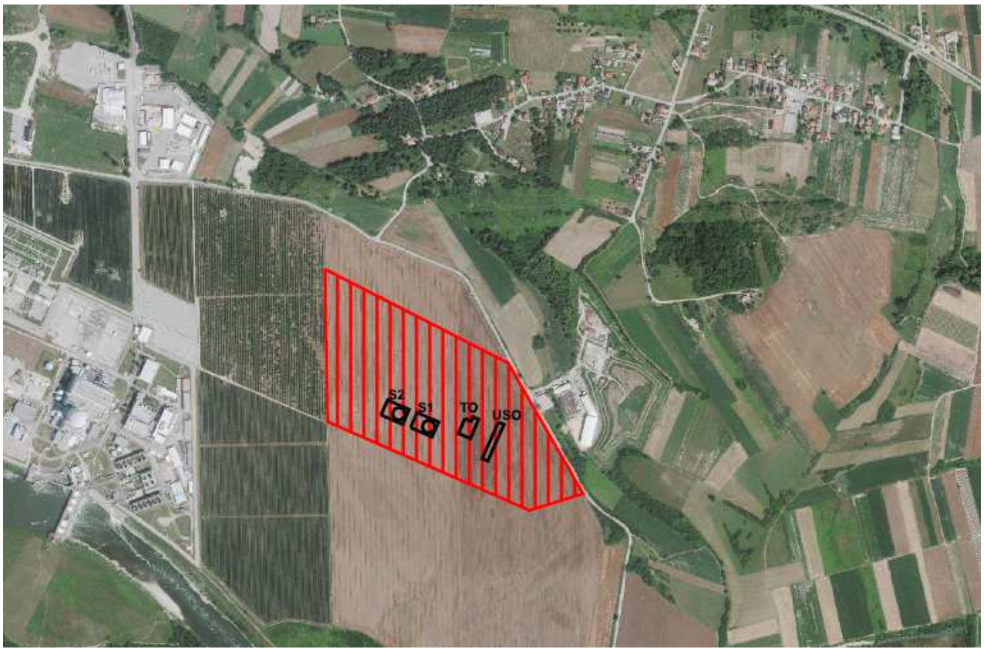

Figure 122: Impact area for all environmental segments during and after abandonment of the activity

A graphical representation of the common impact area during and after abandonment of activity including all segments is listed in Appendix 5 and includes the following plot numbers:
Drnovo c.m. (1320): 2103/85;
Leskovec c.m. (1321): 1197/58.

8.LAY REPORT SUMMARY

Responsible body: Republic of Slovenia
Gregorčičeva 20-25
1000 Ljubljana

by authorisation of

ARAO, Ljubljana
Celovška cesta 182
1000 Ljubljana

Project name: LILW Repository Vrbina, Krško

Types and main characteristics of the project:

The project "LILW repository Vrbina" falls under the *Decree on categories of projects for which an environmental impact assessment is mandatory (Official Gazette of the RS, No. 51/14, 57/15)* ~~in the following point~~, in accordance with Annex I Types of environmental encroachment for the following type of project: D.II Nuclear energy, D.II./ A permanent repository of spent nuclear fuel or exclusively radioactive waste.

In Slovenia, which is among the countries with a nuclear programme, final disposal of low and intermediate level radioactive waste (hereinafter LILW) has not yet been regulated; therefore, a permanent radioactive waste repository needs to be arranged. With the construction of the repository, a long-term solution of the problem of LILW management of LILW will thus be established in a country where LILW is generated. For an effective, permanent and environmentally ethically responsible solution to the issue of LILW, Slovenia must therefore ensure its safe and final disposal at an appropriate facility while taking into account international standards and achieving social and environmental acceptability.

The essential feature of the LILW repository is that, together with the natural environment in which it is located, it provides long-term prevention against discharges of radioactive isotopes from the repository into the environment. The integrity of the repository is ensured for the period of time that the waste is radioactive or until its activity approaches the activity of the natural environment.

The Vrbina repository in the municipality of Krško is a nuclear facility designed for permanent disposal of low- and intermediate level radioactive waste generated in the Republic of Slovenia. When ensuring the disposal of LILW, we will take into account the generally accepted principles that radioactive waste should be managed in a way that ensures the protection of human health and the environment, does not burden future generations in any way, and where control of the safety of facilities and activities related to radioactive waste is ensured by the proper inclusion of independent administrative authorities.

The surface area of the detailed plan of national importance amounts to: 26.3 ha
The surface area of the envisaged project zone as discussed in the EIA is smaller, amounting to: 17.5 ha
Construction will take around 3 years (not counting the creation of the embankment plateau). Construction of the silo will take the longest time.
Construction will progress in stages that may also overlap:

- embankment work,
- repository facilities and
- infrastructure facilities

The project includes the construction of a LILW repository, comprising:

Repository facilities (including exterior and landscaping arrangements):

- Administrative and service building,
- Technological facility (TF), phases 1 and 2,
- Disposal facility - silo with the associated hall above it;
  - 1st silo (construction envisaged by 2020),
  - 2nd silo (construction envisaged 2048-2049),
- Control pool and other smaller facilities.

Exterior and landscaping arrangements cover:

- the plateau (including load-bearing embankment),
- municipal service, energy and telecommunications lines and facilities,
- transport areas,
- green areas and landscape arrangements,
- fences and other exterior arrangement facilities.

Infrastructure facilities:

- Transport infrastructure;
  - reconstruction of section of local road with path for pedestrians and cyclists;
  - arrangement of access road from the LILW repository to the connection with the public road and parking area for the needs of the LILW repository (including load-bearing embankment);
- infrastructure lines;
  - connection to water supply network;
  - connection of new pumping station for the municipal sewers to the power supply network from the Kostak landfill substation;
  - connection of new substation at the LILW repository (20 kV transmission line) running from the Kostak landfill substation;
  - drainage system for precipitation water runoff with infiltration field;
  - drainage system for urban wastewater with new pumping station and flow to the Libna pumping station;
  - connection to the telecommunication network.

The repository comprises spatially:
- an entrance section with vacant exterior surfaces (outside the fence of the core area),
- the core area of the repository.

In the entrance section of the repository, there is an access driveway from Vrbinska road arranged outside the fence of the core area (connecting road). In the entrance section, parking areas for employees and visitors (a parking area with 32 spaces for cars) as well as green surfaces and other open surfaces are to be arranged. The vacant exterior surfaces of the repository are planted with trees to represent a green barrier between the repository and its surroundings.

The core area of the repository is intended for administration and service activities, waste takeover and disposal, and for provision of physical security of the repository. This area includes:
- Administration and service building (ASB),
- Technological facility (TF),
- Disposal silo with a hall above the silo (Hall),
- Control pool.

The core area of the repository is fenced in and comprises a flood-protection embankment and a surface at the elevation of the natural terrain, and is divided into:

c) **a fenced controlled area**, at the elevation of 155.20 m, with the administration and service building. Access to the area is possible through the main (and only) entrance to the repository and after prior checking at the administration and service building located by the entrance in the controlled area of the repository, with a fence and physical security. The area also includes an inner peripheral service road and the area with control wells at the elevation of 153.60 m;

d) **controlled area** (from the point of view of radiation protection), also on a flood-protection embankment with an elevation of 155.20 m, which protects the area from the probable maximum flood (PMF). The area represents the core of the controlled area. The project solutions enable the controlled area to cover the entire area of the technological section of the technological facility (TF) and the hall with the disposal silo, which is enclosed with an additional, inner protective fence. This is connected to the technological facility at both ends.

Both areas are mutually connected by the main communication that runs through the entire complex of the repository, from Vrbina road to the disposal facility.

The entrance section of the core area of the repository contains an administrative and service building from which the repository will be operated and managed and associated administrative and service activities performed, along with activities to control access to and physically secure the repository, energy-related activities, fire water supply, the collection of urban waste, the storage of equipment and geological samples (cores), and a workshop.

The core of the central, controlled area of the repository is made up of the technological facility (TF) and a disposal silo with a hall (first the construction of the first silo, construction of the second silo in 2048-2049). The TF is intended for the temporary storage and repair of any damaged waste containers, basic laboratory research, control of technological processes, and the remaining necessary technological and service functions of the repository as well as functions for the provision of nuclear and radiation safety. The TF also contains the radiological entry / exit checkpoint for the controlled area.

In accordance with the level of protection of facilities against floods, the facilities are built on a platform with an elevation height of 155.20 m. The dimensions and shape of the platform are conditioned by technological requirements, the need for disposal of material on-site and relief features that influence the flow of high (rear) waters. The repository is surrounded by an outer service road at an elevation of 153.60 m.
Construction of the repository is envisaged to take 3 years (not including the creation of the embankment plateau). A single disposal silo, all technological and other facilities and associated infrastructure will be built. The other silo will be built in 2048-49.
A two-year trial operation period will start at the end of construction. The purpose of the trial operation is to carry out tests of the operation of the constructed repository in order to verify and define the conformity of constructed facilities with approved design solutions and the required design conditions, and at the same time the relevance of design solutions and operating procedures which address the use of these solutions, depending on the desired functions of structures, systems and components.
After two years of trial operation, the repository is expected to start regular operation.
Idle phase is the operational condition of the repository which corresponds to a longer interruption of operation and during which no disposal or other more extensive work is carried out at the repository. Preparation of the repository for the standby phase will take one year. After finishing the activities to prepare the repository for the standby phase, the repository will enter the standby phase.
In the event of a decision on the final closure of the repository after the decommissioning of Krško NPP, the closing of the repository will be initiated when the decommissioning of Krško NPP is completed. The activities for decommissioning of the technological facilities (first step) and the closure of the repository (second step) will be implemented on the basis of the authorisation of the competent authority and will be carried out in accordance with the Programme of Decommissioning and the Programme of Closure. The decommissioning will be carried out only for technological facilities and/or for facilities in the controlled area. Technical procedures that are an integral part of the decommissioning (decontamination, dismantling, disassembly, etc.) will also be carried out (in accordance with the closure programme) in the area of the disposal unit (silo).
After closing the repository, it will enter the period of post-closure monitoring and maintenance. During this period, the operator identifies and monitors the effectiveness of the performed activities for closure and carries out the necessary maintenance and corrective measures that bring the repository to a state appropriate for the repository to be submitted for post-closure monitoring and maintenance. The active long-term monitoring begins when all preparatory activities are performed for submission to monitoring and when the competent authority or the monitoring provider takes over the repository for long-term monitoring. After the end of active long-term monitoring, the repository will pass into the phase of passive long-term monitoring. The above-ground facilities of the repository will be removed or assigned to unlimited use. It is assumed that the earth-filled plateau of the repository will continue to remain at the site in the phase of passive long-term monitoring. The plateau can also be removed.
At the end of the passive monitoring period, the repository site will transition into unrestricted use.

Alternative solutions and rationale for the submitted solution:

Alternative solutions for construction

Activities in the area of the design concept of the repository began to be intensively implemented in May 2006 with the elaboration of the Design Bases as one of the basic starting points for design.

The selection of technically appropriate options was carried out in a professional assessment procedure. The following variants were assessed as technically appropriate:

- Variant – disposal in buried silos;
- Variant – disposal in shafts;
- Variant – surface disposal.

In December 2006, expert groundwork was carried out for the selected variants with a view to the Variant Study, and in 2007 for concept designs.
The option which proved to be the most appropriate in the evaluation process and mutual comparison in the Variant Study was the use of buried silos. In the procedure for selecting the location and type of repository, the amended draft of the Detailed plan of national importance for the LILW repository was unveiled in February 2008, including a summary for the public, environmental report, solution variants for spatial planning with a rational for the proposal of solution, and expert basis for amendments to the Plan. With the adoption of the Decree on the National Spatial Plan for the LILW repository at the Vrbina site in the municipality of Krško in December 2009, the location was confirmed and the type of repository was selected.

Later the optimisation of the project solutions was performed, with the aim principally of reducing the costs of construction and operation of the repository and, at the same time, increasing the technical feasibility. A significant optimisation step was made in 2010, whereby the **conditioning of LILW for disposal would not be performed at the repository, but at Krško NPP and only disposal would take place at the repository.**

At the same time, with further optimisation of technological procedures for conditioning for disposal, **optimisation of the plans for disposal silos** was carried out in 2011, taking into account the recommendations of the IAEA experts. These were mainly aimed at **providing robust and conservatively safe construction solutions and at effective groundwater management during construction**. In 2014, the optimisation of the non-disposal part of the repository was carried out.

In the Conceptual Design (IDZ), January 2016, the facilities are designed to meet the technological conditions and requirements with their dimensions, capacities and selection of final machining. At the same time, special attention was devoted in the spatial arrangement of the structures and in their architectural design to their appropriate harmonisation and adaptation to the surrounding environment.

It is anticipated that the facilities will provide appropriate conditions for the healthy, safe and comfortable use, presence and work of all users of the facilities and other persons, while fulfilling all the essential requirements for buildings (mechanical resistance and stability, fire safety, hygienic and health protection and environmental protection, safety in use, noise protection, energy saving and heat preservation).

In general, due to their relatively large size and distance from publicly accessible vantage points, the structures are designed large-scale, with clearly articulated facade surfaces.

Alternative options for technical and engineering solutions

The solutions of the disposal technology for the LILW repository at the Vrbina, Krško site are based on established solutions around the world, on previous domestic solutions and experiences and on solutions that have been defined in the process of spatial placement of the repository in accordance with the *Programme for the drawing up of a detailed plan of national importance for the LILW repository*, and are elaborated in detail in the design output. In the elaboration of optimized solutions, the findings of the review procedures and the recommendations from domestic and foreign experts were also taken into account.

Before finalisation (Conceptual Design, January 2016), the project for the repository was subject to assessment by the IAEA expert mission, and relevant opinions on the method of LILW disposal were obtained from the IAEA in the process of preparing the review of the plan for the decommissioning of Krško NPP. Moreover in 2010, ARAO carried out an external review of the project. One of the important common points of all reviewers was the finding that the conditioning and actual disposal of radioactive waste is complex and that technological procedures for disposal need to be optimised in the further stages of the project.

With the aim of verifying the possibilities for optimising the operation of the repository, the project team for formulating the decommissioning programme for Krško NPP (Programme of NPP Krško Decommissioning and SF & LILW Disposal, revision 2, ARAO/APO) launched an initiative at the end of 2009 to verify the costs of operating the repository in the event of cessation of operation and idling of the repository. The issue was addressed in the study Cessation of operation of the LILW repository and impacts on the cost estimate, IBE, Proj. No. NRVB-052/068, Ljubljana, 2010. At the same time, the start of the procedure for extending the operating life of Krško NPP in 2009 signalled some new circumstances that redefined the marginal conditions for implementing technological procedures and at the same time the demands to optimise these procedures. The optimisation was supposedly aimed principally at reducing the costs of construction and operation of the repository and, at the same time, increasing the technical feasibility. The optimisation was addressed in the study Technology Development for Disposal Plans, Rev. A, IBE, Project Number NRVB-B052/069-1, Ljubljana, 2010 **The study made a significant optimisation step whereby the conditioning of LILW for disposal would not be performed at the repository, but at Krško NPP and only disposal would take place at the repository.** At the same time it was determined that such optimisation would enable the transition to using smaller disposal containers. The management board of Krško NPP notified ARAO of preliminary formal agreement regarding implementation of the conditioning for disposal at Krško NPP. As part of the procedure of preparing for implementation of the project under discussion, in 2011 Krško NPP produced and in September 2012 supplemented a preliminary design for performing conditioning for disposal at Krško NPP (CDP). The project was also listed in the Krško NPP Business Plan for 2012, and in 2014 Krško NPP obtained a construction permit for the facility in which conditioning of waste for disposal would be performed. Continuation of the procedure for investment towards optimising the variants was also approved by the Management Board of ARAO (9th regular meeting, 16 September and 6 October 2011, decision 48).

At the same time, with further optimisation of technological procedures for conditioning for disposal, optimisation of the plans for disposal silos was carried out in 2011, taking into account the recommendations of the IAEA experts. These were mainly aimed at providing robust and conservatively safe construction solutions and at effective groundwater management during construction. In 2014, the optimisation of the non-disposal part of the repository was carried out.
Taking into account the reduced scope of investment owing to the conditioning for disposal being performed at Krško NPP, a feasibility study was produced at the end of 2013, and was confirmed by the ministry competent for infrastructure on 8 July 2014. The confirmed feasibility study envisaged construction of the repository for half the LILW that would be generated at Krško NPP up until the end of the extended operating period in 2043, and in decommissioning after the end of operation, and also for the disposal of all Slovenian institutional waste.

Main reasons for selecting the existing solution

The subject of the Variant Study under the national site plan has been the variants of arranging a LILW repository at the Vrbina site in the Municipality of Krško.

All the variants for the LILW repository at Vrbina have envisaged the arrangement of disposal and non-disposal facilities and all the necessary arrangements at the same site, while the differences in the variants have centred on the type of repository (surface, underground) and the construction technology. The evaluation of variants performed as part of the Variant Study was adapted to these particularities. Thus certain aspects in the study were addressed, although there are no differences between the variants (for instance regional development impacts, part of the content relating to impacts on urban development), since it was assessed that such treatment was necessary since it could contribute to justifying the acceptability and towards seeking the best possible solution on the ground.

In the Variant Study made in December 2006, three variants were addressed at the Vrbina site as being technically appropriate and feasible solutions:

- Variant B – Disposal in buried silos;
- Variant D – Disposal in tunnels; and
- Variant E – Surface disposal.

Based on the evaluation and the review of advantages and weaknesses of Variants B, D and E, the study found that the most appropriate variant is B – disposal in buried silos.

Existing state in which the project and its parts will be placed

The Vrbina site lies within the Municipality of Krško, in the gravel plain area, with individual depressions formed by the former course of the Sava. The nearest towns of Krško and Brežice are located 2.5 and 5 km from the site respectively. The site is located approximately 13 km from the border with neighbouring Croatia. Krško NPP is situated approximately 300 m from the western edge of the site. Approximately 400 m north-east of the site is the settlement of Spodnji Stari Grad. The plain on the southern side of the site is bounded by the Sava riverbed, which is approx. 650 m from the repository site at its nearest point. To the north, the plain extends towards Libna Hill. The site is bounded to the east by a local road running SE from the settlement of Vrbina, towards the bank of the Sava. The wider area of the site is used for agriculture and is officially designated prime agricultural land. There are fields within the site itself and a commercial orchard at the site's far western edge.

The native vegetation of the Krško Polje/Brežiško Polje area consisted of hornbeam forest with oak. The former hornbeam forests have been almost entirely cleared. Today forest covers less than 5% of the area of Krško Polje. Meadows account for just under a fifth of the area, while fields account for almost three quarters of the total area. The area around Brežice is planted with poplar plantations. The tree community along the river is made up of different species of willow. Alders and poplars also appear in the community.

Relatively hot summers and relatively mild winters are characteristic of the wider Krško area. Average January temperatures are below zero and average July temperatures are almost 20°C. Frequent temperature inversions are typical of the plain; these have a significant effect on the dispersion of particles in the air. They occur mainly at night and in the morning, and usually break down before noon. Inversions are stronger in the winter months. The average height of an inversion is approx. 90 to 110 m.
The winter half of the year is the most humid, although the summer months are, on average, not very dry (average above 75% with low standard deviations). The standard deviations in daily humidity are considerably greater. This means that the air is fairly humid only rarely through the whole month; differences arise between periods which in the monthly averages balance out the conditions between "dry" and more "humid" days (which frequently produce rain).
Krško Polje is part of the basin of the river Sava, which at Krško leaves the valley along which it has made its way through the Prealpine hills and continues its way over the flat Krško Polje towards the Pannonian plains. The flat plain of Krško Polje, which descends in a series of terraces towards the rivers Sava and Krka, was created by the Sava and its tributaries with their Pleistocene and younger deposits. High water levels in the Sava cause the river to overflow on Krško Polje onto the lowest (Holocene) terrace and on the left bank to flood large areas of the Brežice part of Vrbina and, secondarily, the Krško part of Vrbina. In geological terms, the location is part of the Krško depression of the Alpine geosyncline. The permeable bedrock of the Krško Polje/Brežiško Polje area means that precipitation drains into groundwater.

The area in question of the project contains no particular natural features, protected areas or areas important to biodiversity. Close to the Vrbina site is an ecologically important area of the River Sava (the Sava from Radeče to the national border, EPO 63700).

There are no cultural heritage units or protected archaeological sites listed in the area. The site of the planned development does not lie within a protected landscape/nature park or other area with a special landscape protection regime.

No restrictions are specially prescribed regarding the water regime for groundwater within the project location, nor are there any water resources used for water supply, so no deterioration of drinking water in the area is to be expected either.

Furthermore, there are no protection forests or forest reserves defined by the *Decree on protection forests and special purpose forests (Official Gazette of the RS, Nos 88/05, 56/07, 29/09, 91/10, 1/13, 39/15)* in the area of the development.

The wider area is used for agriculture and is officially designated as prime agricultural land. There are fields within the envisaged site and a commercial orchard in the site's direct vicinity. The site of construction of the LILW repository does not encroach on any water protection area. The hydrogeological structure of this site is assessed as being less challenging.

In the core area of the plan the following spatial use zones are in effect:

– Prime agricultural land
  The programme of conditioning agricultural land permits lowland melioration – An3, Stari Grad and commassation K11 and irrigation N1, Stara vas;
– Energy infrastructure zones
  NPP – Krško nuclear power plant with protective buffer zone (500, 650 and 1500 m), transmission line – 20 kV with corridor
  – 110 kV above-ground transmission line
  – 2x400 kV above-ground transmission line, Zagreb - Krško;
– Municipal services with infrastructure
– The closed urban waste landfill and Spodnji Stari Grad Waste Management Centre.
– The area of Cerklje airfield
  Restricted use of space.

Types of activity in the core area:

– farming;
– energy activity in the area of the nuclear power plant;
– municipal services work within the closed urban waste landfill and Spodnji Stari Grad Waste Management Centre.

Significant potential sources of air pollution in the direct vicinity of the development site are:

- Krško NPP
- the closed municipal waste landfill and the Spodnji Stari Grad Waste Management Centre,
- local traffic along the Vrbina road,
- individual furnaces during the winter in surrounding settlements,
- Raceland safe driving & sport driving centre – SE of Krško NPP (more than 1.5 km from the development site).

The construction site for the LILW repository lies within the Krško Basin groundwater body (VTPodV_Krška kotlina). The chemical status of the underground water body in the Krško basin has been good in the past few years, with a statistically significant trend of a lowering of the groundwater level, which may presumably be linked to erosion and sedimentation processes in the channel of the river Sava. It is anticipated that constructing the Brežice hydroelectric plant will halt the decreasing trend, and improve the quantities of water.

The chemical status of the River Sava in the section between VT Sava Krško and Vrbina for the period 2009–2013 is good. The overall evaluation of the ecological status of the section between VT Sava Krško and Vrbina for the period 2009-2015 is good.

The soil in the wider area is burdened by agriculture, industrial and production resources, and urban and traffic resources. Both indirect and direct sources of pollution are present, as are diffuse, point and line sources of pollution. The results of the investigations show that immission limit values for individual chemical elements are not exceeded. All inorganic hazardous substances were below the limit value or even below the limit of detection. Regarding organic hazardous substances, atrazine and simazine were above the limit value but still below the alert value. The values of desethyl-atrazine and alachlor were also elevated. The values of other organic hazardous substances were below the limit of detection.

The greatest impact contributing to the existing burden of noise at the site of the future LILW repository Vrbina comes from the Spodnji Stari Grad Waste Management Centre operated by the company Kostak, while there is no noise contribution from the Krško nuclear power plant. The planned site of the development and the Waste Management Centre share a road connection.

The main sources of noise in the area of the Spodnji Stari Grad waste management centre are:

- existing waste sorting facility,
- new sorting facilities for mechanical processing of mixed urban waste,
- sorted waste compactor,
- construction waste processing plant,
- mobile plant,
- compost rotator,
- suction units from the composting plant,
- internal transport for moving containers using a lorry and self-loader,
- external movement of lorries (3/h lorries arriving at the landfill and 1/h departing the landfill).

Measurements of external ionising radiation in the surroundings of Krško NPP in 2014 confirmed findings from the past that it is a typical natural environment such as is also found elsewhere in Slovenia and around the world. The annual dose of gamma radiation and the ionising component of cosmic radiation in the surroundings of Krško NPP was on average 0.76 mSv per year outdoors, while the dose for indoor premises was estimated in 1998 as being 0.83 mSv per year. To this it is necessary to add the contribution of neutron cosmic radiation, which for the Krško NPP area is 0.1 mSv per year. Thus the **total effective dose of external radiation in 2014 in the surroundings of Krško NPP was 0.74 mSv per year**, which is comparable to the world average (0.87 mSv per year). Measurements of natural radionuclide content in food shows values that are comparable with average values around the world.

There are no sources of electromagnetic radiation in the immediate project area, however, Krško NPP and its transmission lines are in the immediate vicinity. The area is under level II EMR protection.

The development site is not illuminated. Illumination is present from other sources in the surrounding area (Krško NPP, Spodnji Stari Grad Waste Management Centre).

Within the area of the planned development and its narrower surrounding area, odour measurements have not been carried out, according to the information available to us. The Republic of Slovenia does not have regulations governing the emission or immission of odours. In view of the fact that the greater part of the area under consideration is covered by agricultural land, we estimate that in spring and summer a source of odours is occasionally present in places as a result of agricultural activity (fertilisation with slurry). Another source of odours in the area of the planned site of the development may be represented by the closed urban waste landfill (landfill gas) and the Spodnji Stari Grad Waste Management Centre (composting).

Project impacts on the environment and its parts, and possible environmental burden impacts

Depending on the characteristics of the development, environmental impacts can arise during construction of the LILW repository, during operation and after the abandonment of the activity of LILW disposal (taking into account cumulative effects), namely: impacts on air, water, soil, nature, landscape, waste generation, noise emissions, electromagnetic radiation and light pollution.

Impacts during the construction of the LILW repository will be short-term, as will impacts in the first phase of abandonment of LILW disposal activities, since some small-scale demolition work will be carried out. Impacts after abandonment of the activity will be long-term. In addition, at the time of construction, operation and after the abandonment of the activity, we can talk about direct impacts of the activity on elements of the environment (water, air, soil, plant and animal species, the generation of noise and waste, etc.) and indirect impacts that may affect human health, plant and animal species, the landscape and nature conservation areas due to pollution of the environment with noise, waste and emissions. Long-distance impacts that the development has on the wider environment are also possible.

The table below shows a summary of all assessed or evaluated impacts of the activity, where all the influences that arise from the activity and its related activities are included; the effects of related activities – cumulative effects – are taken into account and mitigation measures are also included in the assessment.
Due to construction work, there will be slightly higher burdens of noise, waste, light and dust and the risk of contamination of groundwater and soil. As a result of construction work, there will be slightly increased traffic-related burdens: emissions of noise, exhaust gases, and dust particles.
During operation, impacts on agricultural areas are assessed as moderate; impacts on air, groundwater, nature from the point of view of impacts on vegetation, animals and habitat types, landscape, waste management, noise emissions, electromagnetic radiation, light pollution and ionising radiation are assessed as insignificant. Mitigation measures are included in the assessment. One of the important mitigation measures is the external arrangement of the LILW repository area, which will allow for one part of the area to remain in agricultural use. The design of the forest area and trees on the meadow (external

arrangement of the LILW repository area) in the area of the former monoculture field habitat enables greater biodiversity and additionally, the landscape image of the LILW repository is improved due to planting.

Within the operation, the standby phase is included (especially the ionising radiation aspect).

At the time of the abandonment of the activity, which also includes demolition works, the impact is similar to that at the time of construction (only to a much smaller extent, as there will be no decommissioning of infrastructure facilities and silo), which was taken into account in the evaluation and listed as impact assessment given in the value scale provided below. At the end of decommissioning or demolition work, there will be no more sources of emission into the air, and there will be no noise pollution. Due to the nature of the activity – the LILW repository – the impact of ionising radiation on the environment will remain (possible mainly from the point of view of the impact via the waterway), but these impacts are insignificant, far below the limit values and will not affect human health.

During construction there will be no impacts of ionising radiation resulting from the activity; during operation, the radiation impacts are completely negligible, and only in the phase after the closure and degradation of engineered barriers can impacts occur, but according to safety analyses, we estimate that the impacts on people and the environment around the repository will be negligible.

Table 117: **Value scale**

SEGMENT/ FACTOR	Impacts during construction*	Impacts during operation*	Impacts during and after abandonment of the activity*
AIR	moderate (2)	insignificant (1)	moderate (2)
WATER - **Groundwater** - **surface water**	moderate (1) no impact (0)	insignificant (1) no impact (0)	insignificant (1) no impact (0)
SOIL	insignificant (1)	no impact (0)	insignificant (1)
AGRICULTURAL LAND	moderate (2)	moderate (2)	insignificant (1)
NATURE - **flora, fauna, and HT (habitat type)** - **protected areas** - **EIA and VNF (ecologically important area and valuable natural feature)**	moderate (2) no impact (0) no impact (0)	insignificant (1) no impact (0) no impact (0)	insignificant (1) no impact (0) no impact (0)
LANDSCAPE	moderate (2)	insignificant (1)	insignificant (1)
WASTE	moderate (2)	insignificant (1)	moderate (2)
NOISE	moderate (2)	insignificant (1)	moderate (2)
IONISING RADIATION	no impact (0)	insignificant (1)	insignificant (1)

SEGMENT/ FACTOR	Impacts during construction*	Impacts during operation*	Impacts during and after abandonment of the activity*
ELECTROMAGNETIC RADIATION	insignificant (1)	insignificant (1)	insignificant (1)
LIGHT POLLUTION	insignificant (1)	insignificant (1)	insignificant (1)
HUMAN HEALTH	no impact (0)	no impact (0)	no impact (0)
VIBRATIONS	insignificant (1)	no impact (0)	no impact (0)

* taking into account mitigation measures and cumulative impacts

Measures to prevent, reduce or remove negative impacts of the project on the environment and human health, and main alternatives studied in terms of measures.

When planning the activity, the best solutions for placing the project in the physical environment with minimal impact on the environment were considered; the solutions were selected that require the minimum amount of construction works, and the use of state-of-the-art technology is envisaged in the execution of works. In this way, with prior planning, the greatest possible protection of the environment is guaranteed – or the lowest environmental impacts that can be achieved in this operation – of course, taking into account the envisaged mitigation measures. In addition to this, however, some additional measures are proposed in this report, for which we assessed that it was reasonable to propose them in view of the environment in which the activity is being placed.

In order for the intended activity to minimise its environmental burden and/or impact, it is necessary to take into account the envisaged measures that are legally prescribed for the individual segments of the environment which will be affected by the activity, or the measures that are taken from the environmental report, the Decree on the detailed plan of national importance, design output, expert background documents and design conditions. In addition to the measures envisaged, however, some additional measures are proposed in this report, for which we assessed that it was reasonable to propose them in view of the environment in which the activity is being placed.

The additional measures are foreseen for the time of construction and operation, while during abandonment of activity and afterwards no additional measures are envisaged.
See below for additional measures and monitoring in individual phases.

DURING CONSTRUCTION

- The monitoring of impacts during construction is primarily focused on ensuring control over measures to prevent the emission of substances (especially dust) into the air from the construction site and transport routes. Implementation of measures to reduce particulate emissions must be provided by the contractor with daily recording in the construction log, and the supervisor monitors compliance of the implementation of the measures with the study.
- For temporary transportation and construction surfaces, the existing infrastructure and other handling surfaces must be used primarily. These areas must be defined/specified in the design output (organisation of the site). Activities affecting the ground should affect the smallest possible ground surfaces.
- In order to prevent possible spills of hazardous substances, the following measures should be taken throughout the construction: only technically flawless construction machinery may be used, all vehicles and machinery on the construction site must meet the conditions for sealing properties of machine assemblies and hydraulic connections so that there is no possibility of dripping of fuel and various other liquids into the ground. This is achieved by daily control of sealing properties (visual inspections) performed by the operator of an individual machine or vehicle and also by the direct manager of works at the construction site.
- Fuels and lubricants for the supply of machinery must be stored on a solid, limited and covered surface which can retain the total amount of stored substances without the possibility of inflow of rainwater and precipitation.
- The cleaning of machines and vehicles can only be carried out on a sealed surface.
- At the construction site, portable collecting containers and absorbent materials must be available for immediate action in case of potential leakage of fluids from the machinery;
- A plan of action in case of spillage must be drawn up. Action in the event of an accident depends on the extent of the pollution; however, every spill should be handled according to the measures listed below.
- Measures in case of a spill:
    - mark and secure the accident site;
    - if possible, remove all contaminated soil immediately;
    - cover the spill with absorbent material;
    - the amount of absorbent material must be such that it can neutralise the total amount of fuel contained in the machinery and vehicles on the site;
    - depending on the characteristics of the absorbent substance, remove the substance so as not to pollute the environment;
    - In the case of spillage of a larger amount of hazardous substance, disperse the absorbent material around the edge of the spillage to prevent the spread of the stain. Pump the contents or cover it with absorbent material.
    - Notify the emergency services, i.e. the fire brigade.
    - Inform the information centre about the accident; in the event of a spill, the construction supervision authority and the police must be informed.

- Outside of working hours, the construction machinery and lorries are to be left on suitable solid and impermeable surfaces with regulated drainage of rain water and with oil traps. In this way, direct discharges of pollutants into groundwater are avoided.
- In order to limit erosion, the exposed areas should be greened as soon as possible after completion of excavation work.
- Excavation work requires consistent handling of excavated material. Thus, the humus layer (soil up to 30 cm of depth) and the silty layer must be disposed of separately. The humus component is planned to be disposed of at the edge of the construction site. due to limitations on the compression of fertile soil, the humus piles must not exceed a height of 1.5 m, and no driving is permitted on the piles;
- due to the sufficient quantities of humus at the site, additional transport of soil from other construction sites is not permitted;
- washing of wheels of vehicles and working machinery upon entering the site, for the purpose of preventing the spread of the Japanese knotweed and other invasive plants;
- greening of humus piles with annual plants for green manure in case of a longer period of temporary deposit of humus material;
- in the case of occurrence of invasive species at the construction site they must be removed by mowing;
- sowing of grass on the slopes of the platform is carried out by hydroseeding in order to limit the erosion of the slopes to the minimum.
- Before removing the fertile part of the soil, driving with heavy machinery on the removal area must be avoided as much as possible; by doing so, the soil would be further compacted, and the structure of the soil would be destroyed.
- The fertile soil must be removed in dry weather, at least 24 hours must pass after the last heavy precipitation, which is determined by supervision during the construction period. This avoids further destruction of the soil structure and additional compaction of the soil. Its mass also decreases (gravity outflow of water).
- For longer-lasting disposal of larger quantities of fertile soil (more than a year), it is permissible to create taller piles (but no taller than 1.5 m) of any width and length.
- For the excavation material intended to be temporarily disposed of or stored at the repository, it must be ensured that it is not mixed with other wastes.
- During construction, it is necessary to prevent pollution of the soil or water and, consequently, the generation of hazardous waste; the contractor must have a prepared plan for **effective measures in case of spillage of pollutants** (oil, fuel, etc.)
- In the construction of the second silo, a dismantling of the hall above the first silo will take place, whereby mixed construction waste generated in the demolition of the first silo is required to be processed in a manner to allow extraction of secondary raw materials from facade composite panels and roofing (steel sheet, mineral wool – 20 cm, waterproofing foil).
- In the event of exceeding the noise indicators in the context of monitoring, it should be taken into account that noisy works can only be performed between the hours of 6:00 and 18:00.

NON-RADIOLOGICAL MONITORING

During construction, the pollution load of PM_{10} particulate matter must be monitored in the locations of the nearest residential houses. It is assessed that considering the nature of the activity, meteorological data and the distance of the activity from the nearest residential houses, monitoring should be carried out during construction and at one location, by the nearest residential house (MM1).

It is proposed to be carried out as part of the regular annual operational monitoring of groundwater at the borehole VOP 3, which is carried out by the operator of the shut-down non-hazardous waste landfill at Spodnji Stari Grad. The borehole VOP 3 can be considered as the reference zero state of groundwater in the area of construction of the LILW repository and as a monitoring site during construction. If the measuring site is abandoned due to the reconstruction of the Vrbinska road, a new borehole is to be drilled or a reference borehole from the period of investigative analyses of the geosphere is sought, which will not be dismantled or affected at the time of construction. Precise monitoring (range and location) for monitoring the impacts during construction is formulated in the phase of the Design for Building Permit Acquisition documentation.

It is necessary to monitor the quality of the soil before and after the execution of the construction in connection with the organisation of the construction site, damage to the surrounding ground, pollution and the management of fertile soil.

An agricultural expert must record the zero state and monitor the quality of the land before and after implementation of the measures. They should focus primarily on monitoring the implementation of proposed mitigation measures in connection with the organisation of the construction site, damage to the surrounding ground, pollution and the management of fertile soil.
By monitoring of the condition after construction, it is necessary to check whether the temporarily damaged land has been successfully recultivated.

In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during the most extensive construction works.
The first noise evaluation is implemented based on noise measurements according to SIST ISO 1996-2.
In the first noise evaluation, the liable person must ensure that the noise evaluation is implemented at the time when the source of noise is at maximum capacity. The noise caused by the source must be evaluated for every noise evaluation location as noise indicators L(day), L(night), L(evening), and L(daily). If the maximum operational capacity status cannot be ensured during the first evaluation, a rationale for not attaining maximum operational capacity must be provided, and the actual state of noise source loading at the time of evaluation described.
If the noise is evaluated based on noise measurements, the noise indicators L(AFeq), L(AF,01), L(AF,99) and L(background) must be evaluated, taking into account corrections due to pronounced pulses or pronounced frequency that occur at the noise evaluation site due

to operation of the source of noise, unless described otherwise in the regulations governing noise evaluations for each noise source.

RADIOLOGICAL MONITORING

During the construction and before the operation of the repository, pre-operational monitoring must be carried out in accordance with the *Rules on the monitoring of radioactivity, Official Gazette of the RS, Nos 20/07, 97/09.* The purpose of pre-operational monitoring is to record the (radiological) state of the environment prior to the start of operation of the repository. It shall commence prior to the start of activities at the repository site and prior to the construction of the repository.

DURING OPERATION

- Urban (industrial) wastewater in the LILW repository area is pumped through the overflow shaft into the urban wastewater sewage system ending in the Vipap water treatment plant. The purpose of the measure is to prevent – by means of appropriate management of urban wastewater from the repository – any emissions into surface and ground water.
- In the event of increased radioactivity of the water in the collection tank detected through radiological monitoring, the pumping of water is redirected to a watertight control pool. In the control pool, contaminated water is retained until it is transported for processing.
- Potential contaminated water is processed as a priority at the repository site with the involvement of external contractors (as a priority) or is submitted for processing and conditioning to Krško NPP.
- Regular cleaning and maintenance of the sewage system is ensured.
- Mixing of different types of waste and the spillage of hazardous liquids or substances into the environment must be prevented. Instructions for action in cases of spillage of hazardous substances must be drawn up and employees must be trained for quick interventions.
- Should any decanting of fuel and oils into vehicles, machines and devices take place, it can only be carried out at adequately designed sites equipped with oil and fuel traps. Every spillage must be properly cleaned and the handling of hazardous waste resulting from the spillage must be arranged.
- Oil traps must be checked (maintained and emptied) regularly.
- Collection, storage and further handling of hazardous waste must be carried out in such a way that it does not pollute the environment and pose risks to humans – it must be collected separately, in appropriate and labelled containers, stored separately for a temporary period, and handed over to authorised collectors of such waste. For all types of waste for which treatment is stipulated by special regulations, the contractor must comply with the provisions of these regulations regarding collection, temporary storage and transfer or disposal of such waste (Decree on waste oils, Decree on the management of packaging and packaging waste, Decree on management of batteries and accumulators and waste batteries and accumulators, Decree on waste electrical and electronic equipment management). Management of these and other wastes must be regulated in a transparent and controlled manner.

- In the case of occurrence of invasive species, they must be properly removed by mowing.

NON-RADIOLOGICAL MONITORING

Operational monitoring of wastewater
Wastewater generated during regular operation will not contain pollutants from Appendix 1 of the Decree on the emission of substances and heat in the discharge of wastewater into waters and the public collection system (Article 5), while general, ecotoxicological, and microbiological parameters will be compliant with threshold values from Appendix 2 of the Decree.
The following parameters must be monitored:

- temperature (preliminary limit value 30 °C);
- pH-value (6.5–9);
- undissolved substances (80 mg/L); and
- total hydrocarbons (mineral oils) 5 mg/L.

Operational monitoring of wastewater must be carried out on a periodic basis, at the time of sampling for the needs of discharges to the sewage system in accordance with the requirements of the operator, i.e. Vipap water treatment facility. Periodic sampling, which applies to industrial wastewater and is conducted in accordance with Article 10 of the Rules on initial measurements and operational monitoring of wastewater, will not be carried out during regular operation due to the small quantity of industrial wastewater (total quantity will not exceed 4,000 m^3 and the wastewater can be considered to be urban wastewater).

In the case of the occurrence of wastewater resulting from an emergency (e.g. fire, implementation of remedial measures after the fall of the container, accidental entry of water into the silo, etc.), the provisions of the Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewage system are not applied – as stipulated in Article 3 of the Decree. In this case, the discharge of wastewater into the public sewage system is carried out after prior sampling and harmonisation of requirements with the administrative authority competent for the field of radiation safety and with the operator of the sewage system and the treatment plant.

By monitoring the condition after construction, it must be checked whether temporarily damaged soil and agricultural areas have been successfully recultivated.

In the case of occurrence of invasive species, they must be properly removed by mowing.

Two years after planting (within the scope of external landscaping), the condition of the plants is checked and any dead seedlings are replaced by plants of identical species and size.

In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during the most extensive burden.
The first noise evaluation is implemented based on noise measurements according to SIST ISO 1996-2.

In the first noise evaluation, the liable person must ensure that the noise evaluation is implemented at the time when the source of noise is at maximum capacity. The noise caused by the source must be evaluated for every noise evaluation location as noise indicators L(day), L(night), L(evening), and L(daily). If the maximum operational capacity status cannot be ensured during the first evaluation, a rationale for not attaining maximum operational capacity must be provided, and the actual state of noise source loading at the time of evaluation described.
If the noise is evaluated based on noise measurements, the noise indicators L(AFeq), L(AF,01), L(AF,99), and L(background) must be evaluated, taking into account corrections due to pronounced pulses or pronounced frequency that occur at the noise evaluation site due to operation of the source of noise, unless described otherwise in the regulations governing noise evaluations for each noise source.

RADIOLOGICAL MONITORING

Operational radioactivity monitoring will be carried out during operation and the idle period of the repository, i.e. during the interruption in operation up to Krško NPP decommissioning. The measured values are compared with the values from pre-operational monitoring, which serves to assess the environmental impact of the facility and to calculate the doses for members of the public. By conducting operational monitoring, the operator of a nuclear facility is able to monitor the status and ensure that the radioactivity of discharges in normal operation and during the standby phase do not exceed the authorised limits and limit values laid down by regulations, and that the operation of facilities does not expose the population to radiation above the authorised limits and the other limits laid down by regulations, and other requirements of the competent administrative bodies concerning radiological impacts of the facilities on the population and the environment.

DURING AND AFTER ABANDONMENT OF THE ACTIVITY

- At the end of decommissioning, the soil at the sites of the removed facilities and construction site is rehabilitated and covered with grass, and the surfaces of the platform and its slopes are intended for a permanent meadow.
- During the decommissioning of the repository, facilities are removed in a manner that takes into account the preservation of individual remains that will mark the former activity.

NON-RADIOLOGICAL MONITORING

In accordance with Articles 4 and 9 of the Rules on initial measurements and operational monitoring of noise sources and on conditions for their implementation (Official Gazette of the RS, No 105/2008), initial assessment of noise must be carried out during the most extensive burden of decommissioning.
The first noise evaluation is implemented based on noise measurements according to SIST ISO 1996-2.
In the first noise evaluation, the liable person must ensure that the noise evaluation is implemented at the time when the source of noise is at maximum construction capacity. The noise caused by the source must be evaluated for every noise evaluation location as noise

indicators L(day), L(night), L(evening), and L(daily). If the maximum operational capacity status cannot be ensured during the first evaluation, a rationale for not attaining maximum operational capacity must be provided, and the actual state of noise source loading at the time of evaluation described.

If the noise is evaluated based on noise measurements, the noise indicators L(AFeq), L(AF,01), L(AF,99) and L(background) must be evaluated, taking into account corrections due to pronounced pulses or pronounced frequency that occur at the noise evaluation site due to operation of the source of noise, unless described otherwise in the regulations governing noise evaluations for each noise source.

RADIOLOGICAL MONITORING

The scope and duration of post-operational monitoring of radioactivity is determined in relation to the expected environmental impact in the vicinity of the closed radiation or nuclear facility.

Measurements or sampling are performed in the same places as operational monitoring, but less frequently. Furthermore, monitoring is not performed at all locations and for all types of samples or transmission paths as it is in operational monitoring. The scope of the programme is determined towards the end of the operation of the facility.

Estimated population doses after the closure of the repository under normal events are low, at a maximum 30 µSv (0.030 mSv) per year. Low doses are achieved by the use of engineered barriers, represented by: waste form, waste packaging into which waste is inserted at Krško NPP, concrete containers for the storage of waste, and the disposal silo itself. No special additional measures need to be implemented.

Figure 123: Placement of LILW repository in the existing space

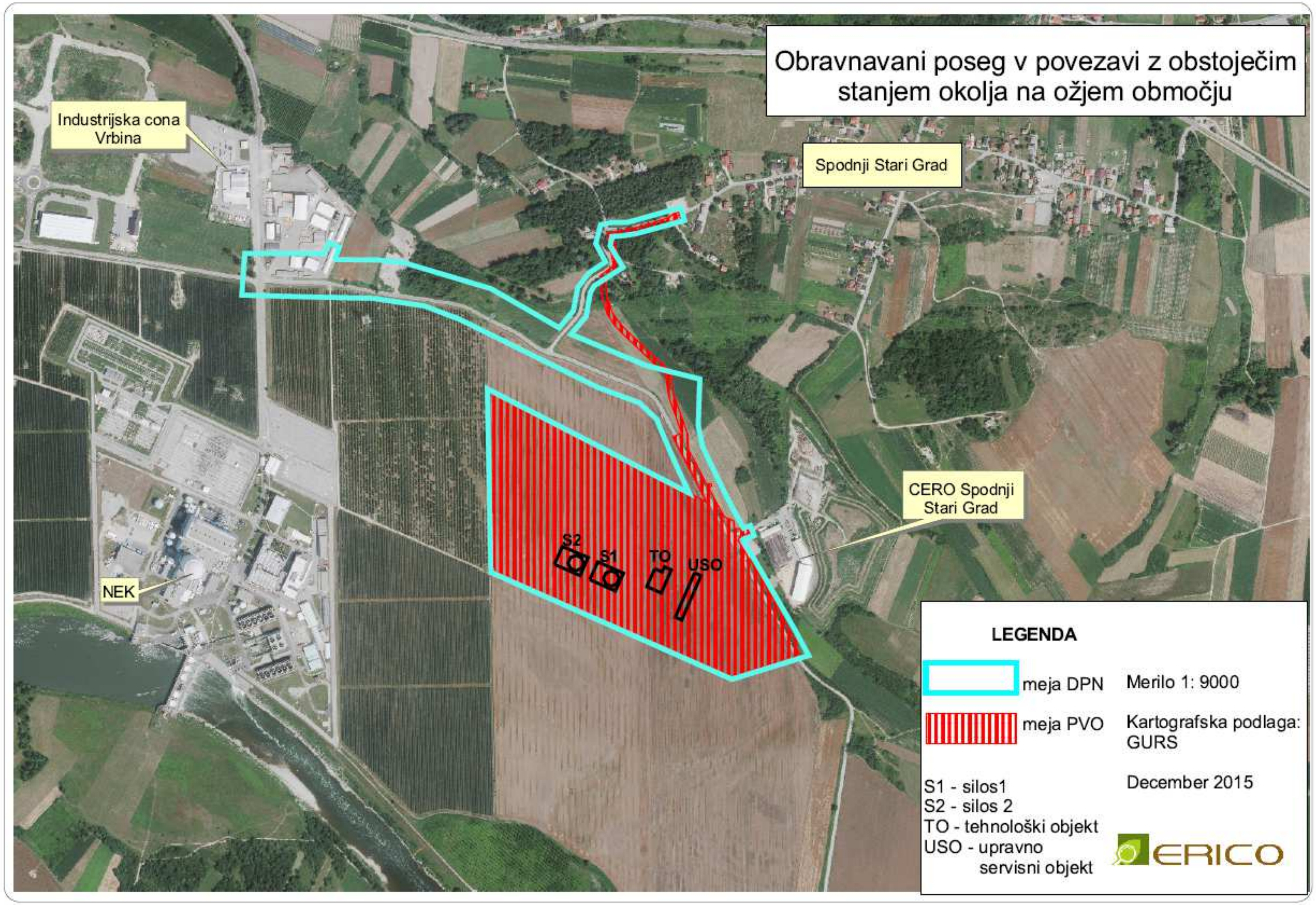

Figure 124: Development under consideration in connection with the current situation of the environment in the core area

Obravnavani poseg v povezavi z obstoječim stanjem okolja na ožjem območju	Development under consideration in connection with the current situation of the environment in the core area
Industrijska cona Vrbina	Vrbina Industrial Zone
CERO Spodnji Stari Grad	CERO Spodnji Stari Grad
NEK	Krško NPP
LEGENDA	KEY
meja DPN	boundary of the DPN area
Merilo 1 : 9000	Scale 1: 9,000
meja PVO	boundary of the EIA
Kartografska podlaga: GURS	Cartographic basis: GURS (Surveying and Mapping Authority of the Republic of Slovenia)
December 2015	December 2015
S1 – silos 1	S1 - silo 1
S2 – silos 2	S2 - silo 2
TO – tehnološki objekt	TO - technological facility
USO – upravno-servisni objekt	USO - administration and service building

9. CONCLUSION OF THE REPORT

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- Proposed construction site organisation for EIA needs. Vrbina Krško LILW repository. New construction. Project no: NRVB-B052/058-1. Folder No: NRVB---1P/M05B. IBE, Ljubljana October 2015. Study No: NRVB---1P/05B.
- Hydraulic analysis of the impact area of the Vrbina, Krško low- and intermediate level radioactive waste repository, FGG, June 2015.
- Ferdinand Deželak, article in progress, 9 June 2016: Straight barriers as the worst noise prevention measure: http://www.delo.si/znanje/znanost/najslabsi-protihrupni-ukrep-so-ravne-pregrade.html

- EMR influence area, Valič B., Gajšek P., Ljubljana, Forum EMS, 2008.
- John F. Wiss. 1981 Construction Vibrations: State-of-the-Art.
- Study No. E 1193/14-420-2 on the requirements for materials for RC containers at the Vrbina LILW repository (ZAG Ljubljana, May 2015).
- Safety Analysis and Waste Acceptance Criteria Preparation for Low and Intermediate Level Waste Repository in Slovenia, Gas Generation Processes and Design Implications, ARAO, EISFI-TR-(11)-08 Vol. 4, Rev. 1. NSRAO2-PCS-010-01-eng, 2012. *EISFI Consortium (ENCO, INTERA, STUDSVIK, FACILIA, IRGO).*
- *A. J. Baker, D. A. Lever, J. H. Rees, M. C. Thorne, C. J. Tweed, and R. S. Wikramaratna,* Nirex 97: An Assessment of the Post-closure Performance of a Deep Waste Repository at Sellafield. Volume 4: The Gas Pathway, Nirex Science Report S/97/012, United Kingdom Nirex Ltd., Harwell, Oxfordshire. 1997.
- ARAO, Evaluation of DCFs for calculating effective doses that can be received by individuals in particular age groups for the LILW repository in the event of accidents 02-08-030 NSRAO2-OPS-006-00. 2018.

9.2. WARNINGS

The sources used to produce the Environmental Impact Assessment report for the LILW repository, Krško were available, of high quality, and up to date due to the number of professional bases produced. Further information and explanations required to produce the EIA were acquired from the designer, IBE d.d., and the project owner (ARAO).

No special warnings

9.3.GRAPHIC ILLUSTRATIONS

Graphic illustrations required by Article 19 of the Decree on the method of drafting and on the content of the report on the effects of planned activities affecting the environment (Official Gazette of the RS, No. 36/09) have been included in the existing EIA, as follows:

- graphical illustrations of the existing environmental state in the immediate project area and project spatial characteristics are available in sections: *2. Type and characteristics of project* (subsection 2.1), 4. *Description of the existing state of the environment* (subsections 4.1.7, 4.2.2, 4.3, 4.4.3, 4.4.6, 4.4.8, 4.4.9)
- Illustration of the area in which the project will cause an environmental burden that could affect human health or property is shown in Section *10. Appendix* (Appendices 2, 3, 4, 5, and 6)

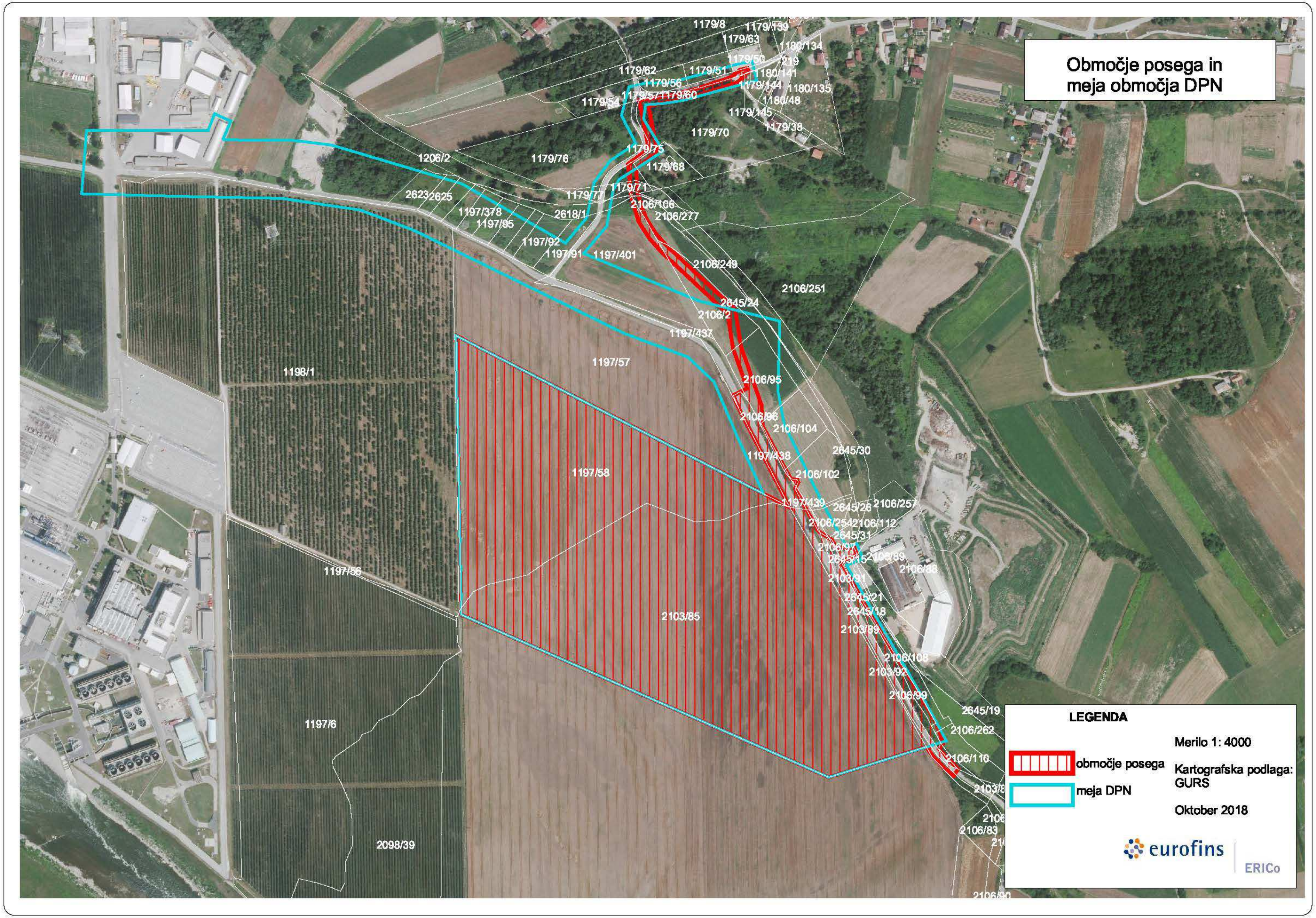
9.4. FINAL EVALUATION AND PROJECT ACCEPTABILITY EVALUATION

We assess that taking into account the cumulative impact, all envisaged measures and additional mitigation measures proposed in the report, the construction, operation and future abandonment of the activity of low and medium-level radioactive waste (LILW) disposal will not cause an excessive environmental burden in the Republic of Slovenia and is acceptable from an environmental aspect.

10. ANNEXES

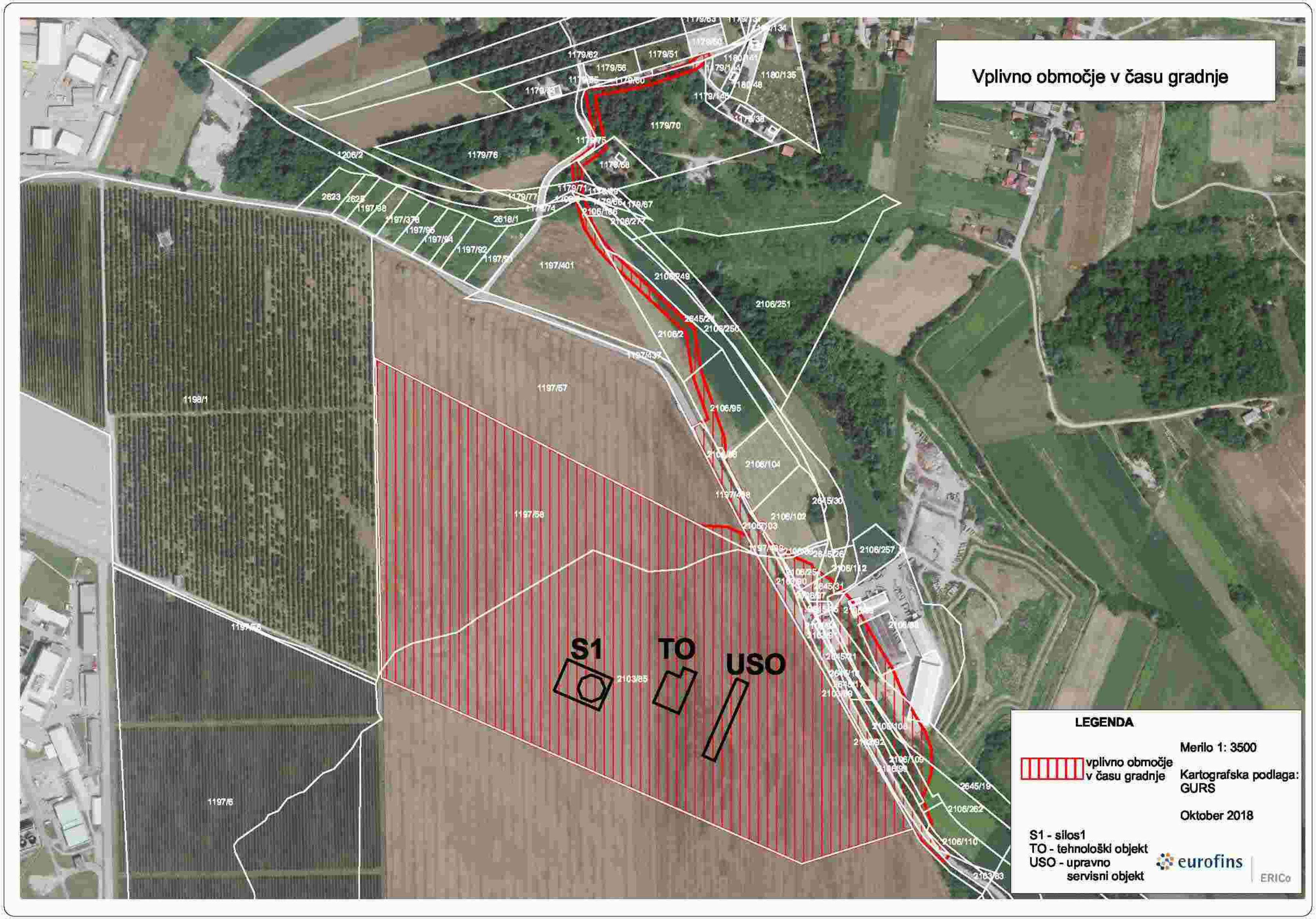
- **Annex 1:** Area of development (activity) and boundary of the DPN area
- **Annex 2**: Impact area during construction of Silo 1 and the repository facilities with infrastructure
- **Annex 3**: Impact area during construction of Silo 2
- **Annex 4**: Impact area during operation
- **Annex 5**: Impact area during and after abandonment of the activity

Annex 1: Area of development (activity) and boundary of the DPN area


Območje posega in
meja območja DPN
LEGENDA
območje posega
meja DPN
Merilo 1: 4000
Kartografska podlaga:
GURS
Oktober 2018
eurofins
ERICo

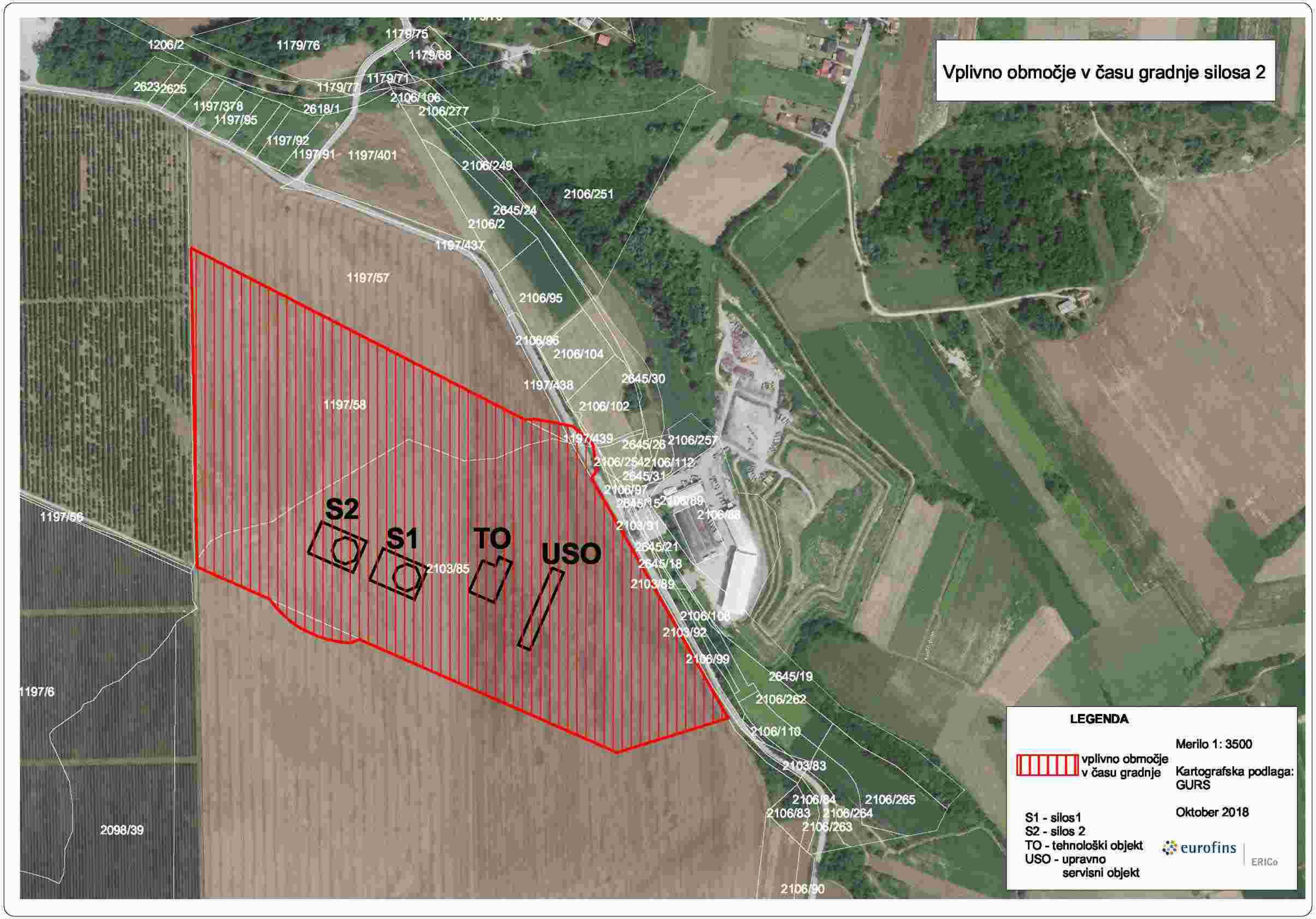
Območje posega in meja območja DPN	Area of development (activity) and boundary of the DPN area
LEGENDA	KEY
Merilo 1:4000	Scale 1:4,000
območje posega	area of development (activity)
Kartografska podlaga: GURS	Cartographic basis: GURS (Surveying and Mapping Authority of the Republic of Slovenia)
meja DPN	boundary of the DPN area
Oktober 2018	October 2018

Annex 2: Impact area during construction of Silo 1 and the repository facilities with infrastructure


Vplivno območje v času gradnje
S1
TO
USO
LEGENDA
vplivno območje v času gradnje
Merilo 1: 3500
Kartografska podlaga: GURS
Oktober 2018
S1 - silos1
TO - tehnološki objekt
USO - upravno servisni objekt
eurofins
ERICo

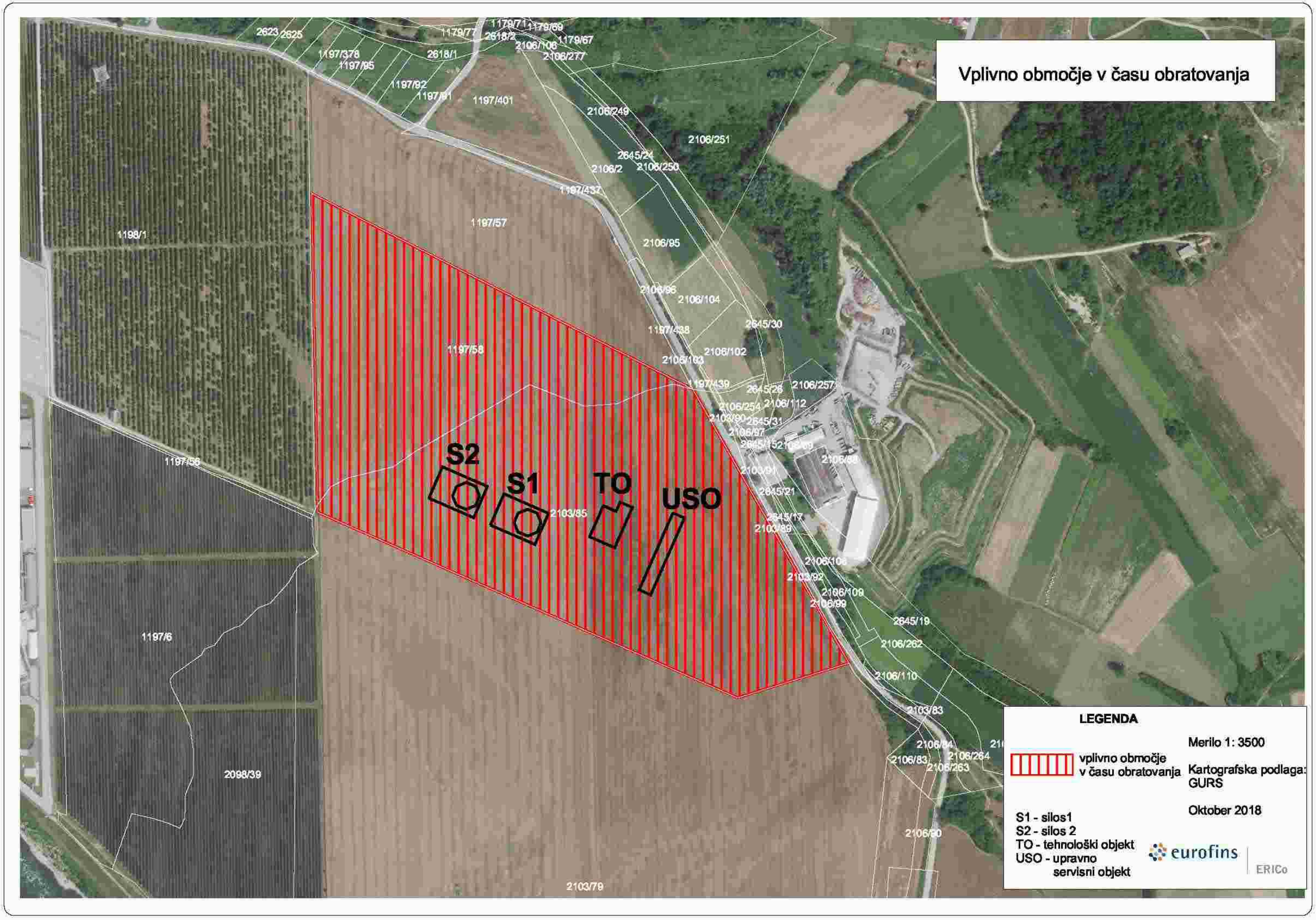
Vplivno območje v času gradnje	Impact area during construction
LEGENDA	KEY
Merilo 1:3500	Scale 1:3,500
območje posega	area of development (activity)
Kartografska podlaga: GURS	Cartographic basis: GURS (Surveying and Mapping Authority of the Republic of Slovenia)
Oktober 2018	October 2018
S1 – silos	S1 – Silo
TO – tehnološki objekt	TO - technological facility
USO – upravno servisni objekt	USO - administration and service building

Annex 3: Impact area during construction of Silo 2


Vplivno območje v času gradnje silosa 2
S2
S1
TO
USO
LEGENDA
vplivno območje v času gradnje
Merilo 1: 3500
Kartografska podlaga: GURS
Oktober 2018
S1 - silos1
S2 - silos 2
TO - tehnološki objekt
USO - upravno servisni objekt
eurofins
ERICo

Vplivno območje v času gradnje silosa 2	Impact area during construction of silo 2
LEGENDA	KEY
Vplivno območje v času gradnje	Impact area during construction
Merilo 1:3500	Scale 1:3,500
območje posega	area of development (activity)
Kartografska podlaga: GURS	Cartographic basis: GURS (Surveying and Mapping Authority of the Republic of Slovenia)
Oktober 2018	October 2018
S1 – silos 1	S1 - silo 1
S2 – silos 2	S2 - silo 2
TO – tehnološki objekt	TO - technological facility
USO – upravno servisni objekt	USO - administration and service building

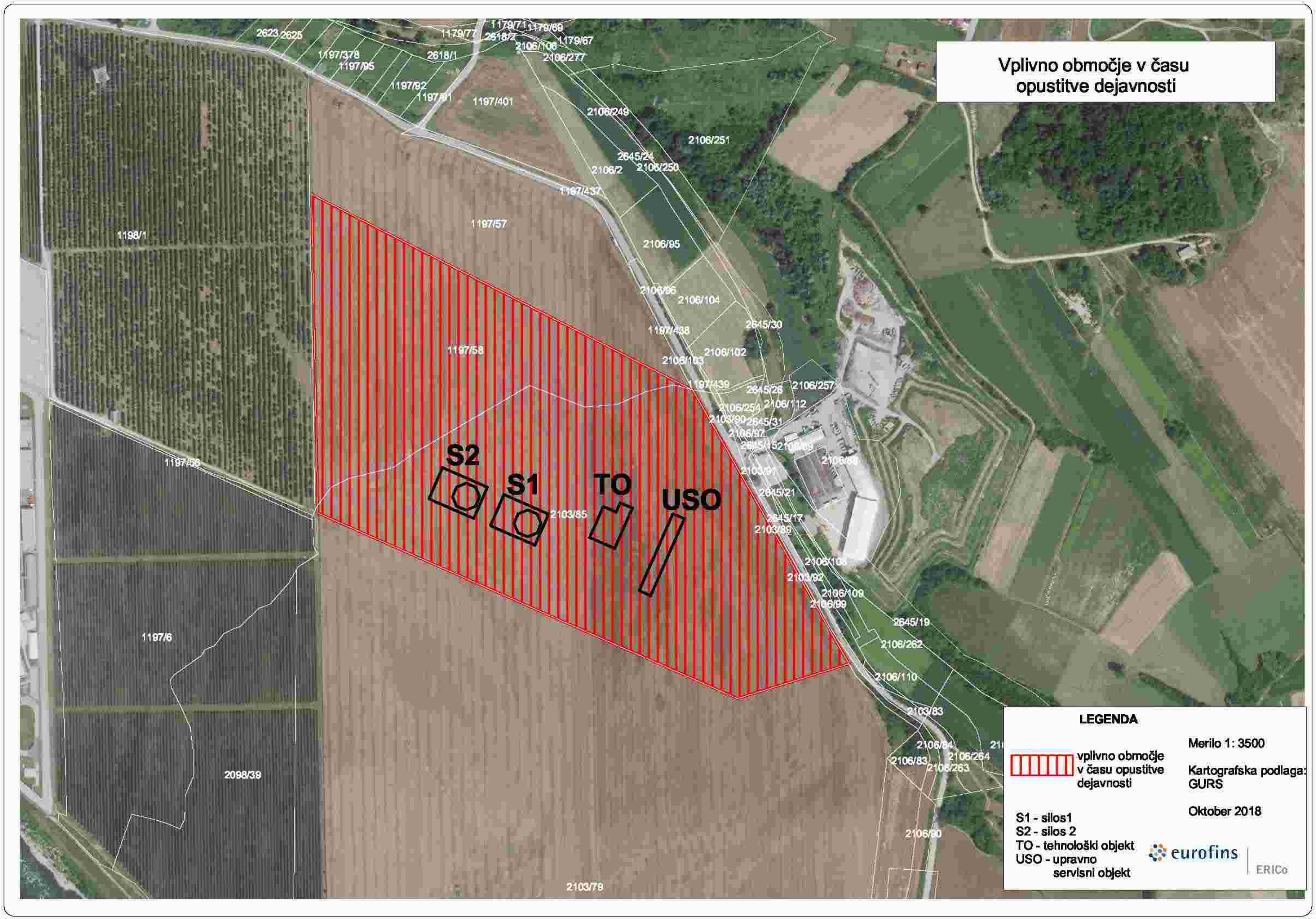
Annex 4: Impact area during operation



Vplivno območje v času obratovanja
S2
S1
TO
USO
LEGENDA
vplivno območje v času obratovanja
Merilo 1: 3500
Kartografska podlaga: GURS
Oktober 2018
S1 - silos1
S2 - silos 2
TO - tehnološki objekt
USO - upravno servisni objekt
eurofins
ERICo

Vplivno območje v času obratovanja	Impact area during operation
LEGENDA	KEY
Merilo 1:3500	Scale 1:3,500
območje posega	area of development (activity)
Kartografska podlaga: GURS	Cartographic basis: GURS (Surveying and Mapping Authority of the Republic of Slovenia)
Oktober 2018	October 2018
S1 – silos 1	S1 - silo 1
S2 – silos 2	S2 - silo 2
TO – tehnološki objekt	TO - technological facility
USO – upravno servisni objekt	USO - administration and service building

Annex 5: Impact area during and after abandonment of the activity


Vplivno območje v času opustitve dejavnosti
S2
S1
TO
USO
1198/1
1197/57
1197/58
1197/56
1197/6
2098/39
2103/85
2103/79
1197/401
2106/249
2106/251
2106/95
2106/104
2645/30
2106/102
2106/257
2645/19
2106/262
2106/110
2103/83
2106/90
LEGENDA
vplivno območje v času opustitve dejavnosti
Merilo 1: 3500
Kartografska podlaga: GURS
Oktober 2018
S1 - silos1
S2 - silos 2
TO - tehnološki objekt
USO - upravno servisni objekt
eurofins
ERICo

Vplivno območje v času opustitve dejavnosti	Impact area during the abandonment of activity
LEGENDA	KEY
Merilo 1:3500	Scale 1:3,500
območje posega	area of development (activity)
Kartografska podlaga: GURS	Cartographic basis: GURS (Surveying and Mapping Authority of the Republic of Slovenia)
Oktober 2018	October 2018
S1 – silos 1	S1 - silo 1
S2 – silos 2	S2 - silo 2
TO – tehnološki objekt	TO - technological facility
USO – upravno servisni objekt	USO - administration and service building