REPORT

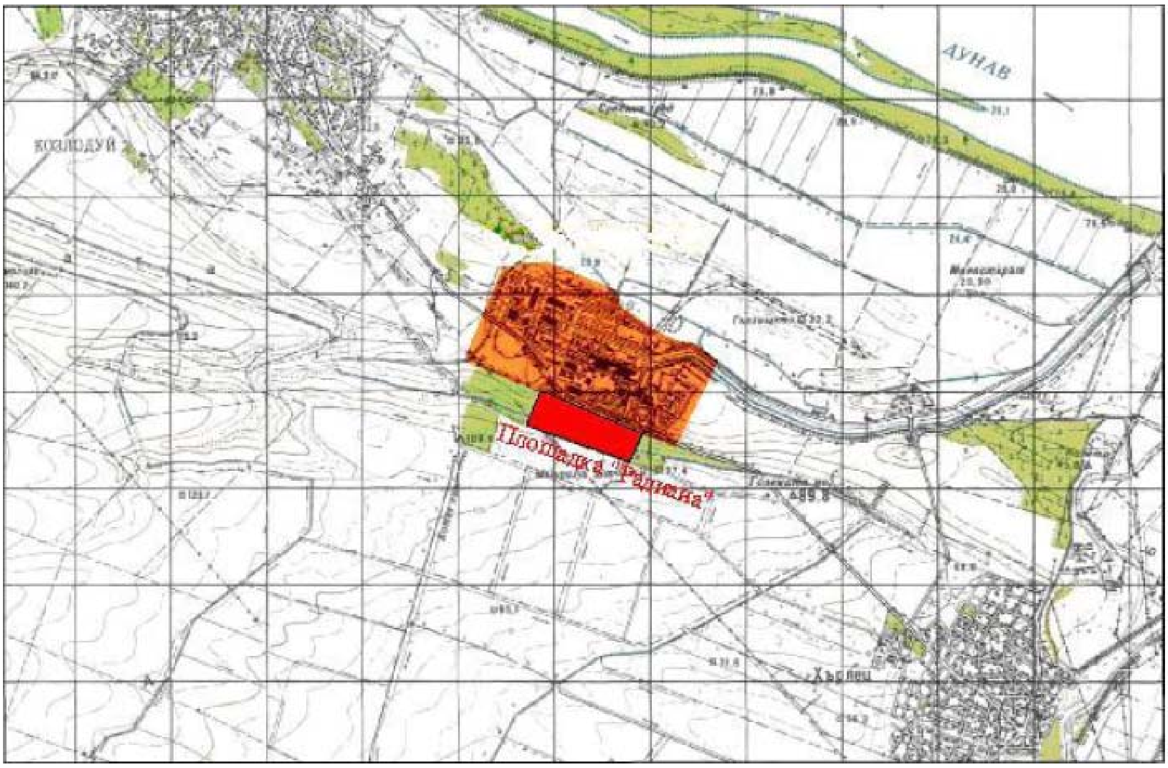
ON ENVIRONMENTAL IMPACT ASSESSMENT /EIAR/

on investment proposal

for

Construction of National Repository for Low and Intermediate Level Radioactive Waste Disposal – NRRAW

CONTRACTING AUTHORITY – SE RAW



Sofia January 2011.

INFORMATION ABOUT THE CONTRACTING AUTHORITY

Contracting authority data. Contact persons.

Legal entity: State enterprise "Radioactive Waste"

Represented by: Eng. Dilyan Petrov, Executive Director

Identification №: 131 218 471

Headquarters and company address: Sofia 1407, 51 James Bourchier Blvd., Fl.18

Tel.: 962 49 48; Fax**:** 962 50 78

Contact person : Ira Stefanova

Tel.: 962 49 48 Fax**:** 962 50 78

e-mail: ira.stefanova@dprao.bg

EIAR Authors

Eng. Krassimira Kroumova – Manager of „Eco Energoproekt" LTD

tel./fax: 862 93 21; GSM 0898 53 06 11; **e_mail**: krumova@ecoep.com

Sofia   Sofia 1407, 51 James Bourchier Blvd., Fl.18

Eng. Stela Ivanova – Head of Team – GSM – 0887 57 25 81;

e_mail: ivanova_stela@yahoo.com

INTRODUCTION

Title of the investment project. Purpose.

Subject of the environmental impact assessment report is the Implementation of near surface National repository for low and intermediate level radioactive waste /NRRAW/ in the "Radiana" locality in the land of the village of Hurlets, municipality of Kozloduy, District of Vratsa, UCATTU 775548.

The EIAR is in compliance with the requirements of the Assignment to determine the scope of the EIA, corrected after consultations with the competent authority for decision making MEW, RIEW Vratsa and other departments and institutions /for reference – art.8 of the present EIAR/.

Purpose and subject of the investment proposal

The Republic of Bulgaria commissioned the first power unit of Kozloduy NPP in October 1974, and by August 1991 consistently put into operation additional 5 power reactors. Pursuant to the memorandum between the Bulgarian government and the European commission of November 1999, units 1 and 2 were excluded from the power system on 31.12.2002, and units 3 and 4 on 31.12.2006 and are subject to decommissioning in accordance with the Updated decommissioning strategy of units 1-4 of Kozloduy NPP [109]. At the same time, the Belene project, which is consistent with the Energy Strategy of R Bulgaria, adopted with CoM Decision №279/11.05.2002 and approved by the National Assembly on 17.07.2002 (SG, issue 71/23.07.2002) and CoMD №260/08.04.2005 for the construction of nuclear plant at Belene site to be constructed at "Belene" NPP, envisages the construction of two BBEP(VVER)-1000 power units.

The radioactive waste generated as a result of the operation of Kozloduy NPP, as well as the waste that is to be received as a result of the decommissioning and the operation of the nuclear reactors, must be safely and permanently isolated from the environment by burying it in a repository for low and intermediate level radioactive waste in compliance with Bulgarian legislation and the safety standards of the International Atomic Energy Agency.

The construction of National repository for the disposal of low and intermediate level short-lived radioactive waste (NRRAW) shall be carried out in accordance with the *Strategy on Spent Fuel and Radioactive Waste Management* [127], approved by the Bulgarian government on 23.12.2004, which describes the strategic targets for making decision on the long-term safe management of spent fuel and radioactive waste, in accordance with the requirements for human health protection, environmental protection and non-encumbering of future generations. NRRAW must be built by 2015 and meet all current national and international requirements for safety, security, human protection and environment.

The construction of the National Repository for low and intermediate level short-lived radioactive waste (NRRAW) shall complete the management of radioactive waste cycle. The obligations of the Republic of Bulgaria under the *Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management*, ratified by law, SG issue 42/23.05.2000 [126], are being fulfilled.

On 25.07.2005 the Ministerial Council adopted a separate decision for the construction of the NRRAW by 2015 - Decision № 683/25.07.2005 and assigned the activity to "Radioactive Waste", whose activities in accordance with the *Safe Use of Nuclear Energy Act* [128] include the disposal of radioactive waste, such as those of theNRRAW. CoMD № 683/25.07.2005 expresses the government's responsibility and the political will to build the NRRAW. The decision was also adopted in compliance with the requirements of SUNEA, according to which "the Ministerial Council shall adopt the decision for the construction of a national repository for radioactive waste disposal".

Currently, global practice is governed by internationally accepted safety standards of the International Atomic Energy Agency (IAEA) and the recommendations of the International Commission on Radiological Protection (ICRP).

In accordance with internationally accepted standards and best practices in the EU the NRRAW is a **near surface multi-barrier modular engineering facility**. It is intended for disposal of conditioned and packed in reinforced concrete low and intermediate level short-lived radioactive waste, category 2a, according to the Bulgarian legislation [93].

The investment proposal of SE RAW for the construction of the NRRAW at the Radiana site, in the land of the village of Hurlets, municipality of Kozloduy, District of Vratsa, EKATTE 775548 includes:

- Construction of a system of modules designed for RAW disposal;
- Inspection and monitoring;
- Building of small land service buildings.

LIST OF PARTS OF THE REPORT

СЪКРАЩЕНИЯ И ТЕРМИНИ

Part "Introduction"

This investment proposal is the subject of the Report on the Environmental Impact Assessment.

A facility for processing and storing of RAW, generated by the plant, is in regular operation at the site of Kozloduy NPP since 2004, operated by ""RAW" SE. It includes a unit for radioactive waste processing and a line for liquid RAW processing, a warehouse for storing conditioned radioactive waste, and a site for storing non-processed and processed RAW. These activities are in the scope of the present EIAR. The unit for radioactive waste processing and the warehouse for the storing of conditioned radioactive waste are constructed according to the decisions based on the EIAR, issued by the competent authority MEW. It is envisaged that conditioned RAW stored on this site will be moved to the NRRAW after conclusion of its construction.

The construction of the NRRAW aims at safe burial of low and intermediate level short-lived radioactive waste and its permanent and final isolation from the environment and human beings. The fundamental principles of RAW management are being observed, as defined by IAEA in [321]:

Principle 1 Human health protection

Principle 2 Environmental protection

Principle 3 Protection beyond national border

Principle 4 Protection of future generations

Principle 5 Non-encumbrance of future generations

Principle 6 National legal basis

Principle 7 Control over the generation of RAW

Principle 8 Relationship between the waste generation and its management

Principle 9 Safety of equipment

The radioactive waste is an immutable by-product of the electricity production in nuclear reactors. Art. 3 of the *Act for Safe Use of Nuclear Power* [128] states "nuclear energy and ionizing radiation are used in accordance with the requirements and principles for nuclear safety and radiation protection to ensure the **protection of human life, health and living conditions of the present and future generations, environment** and property from the harmful effects of the ionizing radiation". This is achieved through safe disposal of radioactive waste in the NRRAW. In accordance with the requirements of the law [128] during the construction, operation and closure of the NRRAW "the nuclear safety and the radiation protection have priority over all other aspects of this activity" and "the exposure of the personnel and the population is maintained as low as reasonably achievable level." (ALARA principle).

The construction of the NRRAW is subject to the licensing regime in compliance with the nuclear legislation [128]. The EIAR procedure is an important part of the licensing regime.. Under the provisions of the Ordinance on *procedures for issuing licenses and permits for the safe use of nuclear energy* [130], in order to issue an order approving the selected site and authorizing the design of the NRRAW by the Nuclear Regulatory Agency, a decision on the EIA is required.

Purpose of EIAR

The EIA procedure is regulated by the *Environmental Protection Act* [1] and the *Ordinance on procedure for assessing the environmental impact* [2]. The provisions of Bulgarian legislation are harmonized with those of the EU law - EU Directive 85/337/EEC on the assessment of environmental impact, as amended by Directive 97/11/EC, as amended by Directive 2003/35/EC on the participation of the public in drawing up certain plans and programmes relating to the environment [115]. The national legislation [1,2] also regulates the EIA procedure in the transboundary context in accordance with the *Convention on EIA in Transboundary Context*, ratified by Bulgaria in 1995 [73]. The EIA procedure of the NRRAW also complies to the requirements of the EBRD on the environment [96-97].

Statutory regulations allow the public to express its opinion on the results of the EIA (and indirectly on the plan itself, the project or the facility in operation). Thus, the adoption of one decision or another can actually be influenced – in view of existing alternatives, the proposal of new alternatives or, in some cases, even the failure to authorize the implementation of the project or partial suspension of currently operating sites.

In accordance with the requirements of the EPA [1], the investment proposal of SE RAW for the construction of the NRRAW is subject to mandatory EIA as it falls within sect. 3 of Appendix № 1 to art. 92. In compliance with the requirements of the *Convention on EIA in Transboundary Context* [73]. The competent authority MEW has notified officially the Romanian side by sending Notification under art. 3 of the Convention [402]. In an official response the Romanian side declared its willingness to take part in the EIA procedure of NRRAW.

In accordance with the requirements of the *Ordinance on the conditions and procedures for conducting environmental impact assessment* [2] in 2006 SE RAW sent written notification about its investment proposal to the mayors of the municipalities on whose territories the potential sites are situated, and the affected population was notified by notices published in the "Novinar" national daily newspaper and in the local "Kozloduy dnes" newspaper.

Consultations on the structure and the content of the EIAR began in 2009 with the presentation of the Assignment to determine the scope and the content of the EIAR to MEW and the affected parties. The assignment was corrected on the basis of the consultations with the competent authority for decision making MEW, RIEW Vratsa and other departments, institutions and interested parties and public organizations. The assignment was sent to the Romanian side by the competent authority on EIA – MEW.

The present EIAR is in compliance with the requirements of the corrected Assignment for defining the scope and the content of the EIA.

The main targets of the present environmental impact assessment of the Investment Proposal /IP/ of the State Enterprise "Radioactive Waste" for the implementation of a "National repository for low and intermediate level radioactive waste disposal" are as follows:

- To assess at the earliest stage the impact on all environmental components and the factors that affect it the most, especially on the health of people in the region and the staff during the construction, operation and closure of the repository.
- To introduce measures to minimize the negative impacts on environment of IP.

Since the NRRAW must be constructed, operated and closed in a way that ensures the long term isolation of the radioactive waste from humans and the environment, its closure and potential impact in the post-operational period was assessed in the present EIAR. According to the Bulgarian legislation in the nuclear field [128], closure is also subject to licensing and a separate EIA procedure must be carried out before closing the facility [130].

Methodology

The report on the environmental impact assessment of the Investment Proposal /IP/ of the State Enterprise "Radioactive Waste" for the implementation of the "National Repository for Low and Intermediate Level Radioactive Waste Disposal" shall be elaborated by observing:

Requirements of the Bulgarian legislation:

- Environmental Protection Act;
- Ordinance on Environmental Impact Assessment Procedures.

Guidelines of MEW:

Guidelines for the elaboration of EIA of investment proposals, MEW, 2002 (harmonized with the EU guidelines for EIA – Guide to EIA, 2001.

EU Directives:

- EU Directive 85/337/EEC, amended and supplemented by 97/11/EC, "EU Directive on EIA"
- EU Directive 2001/42/EC, "Directive on assessment of the impact on certain plans and programmes on the environment"
- Convention on EIA in Transboundary Context
- Assessment methods, used by individual team experts, who prepared the EIAR, as given in sect. 6 of EIAR.

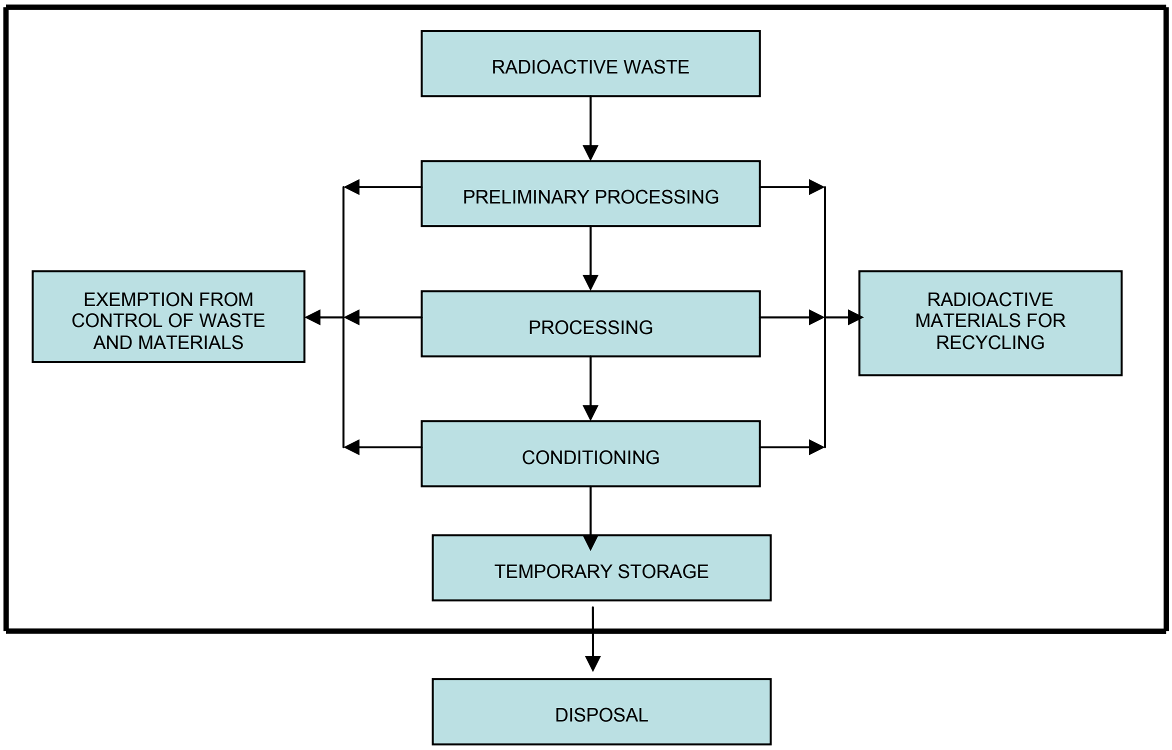


Figure 0-1 Radioactive waste management cycle

Part I

CONTENT

Part I

1. ANOTATION OF INVESTMENT PROPOSAL FOR NRRAW CONSTRUCTION, ACTIVITIES AND TECHNOLOGIES

NRRAW need and justification for its construction

The Republic of Bulgaria commissioned the first power unit of Kozloduy NPP in 1974, and by August 1991 consistently put into operation 5 more reactors. Purusant to the memorandum between the Bulgarian Government and the European Commission of November 1999, Units 1 and 2 were excluded from the energy system on 31.12.2002, and Units 3 and 4 on 31.12.2006. All four units are subject to decommissioning in accordance with the updated strategy for the decommissioning of units 1-4 of Kozloduy NPP [109]. Meanwhile, the Belene project, which is consistent with the Energy strategy of Republic of Bulgaria, adopted by Decision of MC No.279/11.05.2002 and approved by the National Assembly on 17.07.2002 (SG, issue 71/23.07.2002) and DMC No.260/08.04.2005 for the building of a nuclear plant on Belene site to be built at Belene NPP, envisaged the construction of two VVER-1000 power units.

The radioactive waste generated as a result of the operation of Kozloduy NPP, as well as the waste to be received as a result of the decommissioning activities and the operation of the nuclear reactors must be safely and permanently isolated from the environment by burying it in a repository for low and intermediate level radioactive waste in compliance with the Bulgarian legislation and the safety standards of the International Atomic Energy Agency. The analysis of world experience [203] shows that most advanced countries with developed nuclear power have provided for the disposal of its low and intermediate level radioactive waste in repositories specially built for this purpose. A special clause in the *Ordinance on the Safety of Radioactive Waste Management* [93] requires the RAW generators to bring it to the State enterprise "Radioactive waste" for disposal in "the shortest possible time after its generation", but for such purpose a repository must be built and put into operation. The existence of a National Repository in 2015 is crucial for the successful implementation of the commitments made by the Republic of Bulgaria for decommissioning of Units 1- 4 of Kozloduy NPP [109].

The NRRAW is intended for disposal of conditioned and packed low and intermediate level radioactive waste, received from the operation of "Kozloduy" NPP, the decommissioning of "Kozloduy" nuclear power plant, the future operation of "Belene" NPP and from conventional sources – medicine, scientific researches, technical applications and etc.

The construction of NRRAW shall close the cycle of low and intermediate level radioactive waste management in accordance with the requirements of the national legislation, the *Joint Convention on the safety of spent fuel management and on the safety of radioactive waste management* [126] (ratified by Law, adopted by 38th National Assembly on 10.05.2000, SG issue 42/23.05.2000), the safety standards of the International Atomic Energy Agency (IAEA), as well as the best practices for radioactive waste management in the EU.

The construction of NRRAW shall be carried out in accordance with the *Strategy for spent fuel and radioactive waste management [127]*, approved by the Bulgarian government on 23.12.2004, according to which the NRRAW must be constructed by 2015. By the end of 2010 the Ministerial council shall adopt the updated *Strategy for spent fuel and radioactive waste management by 2030,* which also defines the construction of the NRRAW as a national priority and confirms the 2015 planned deadline.

The NRRAW is a site of national importance under the Spatial Development Act [128]**.**

In accordance with the requirements of the *Safe Use of Nuclear Energy Act* [128], the Ministerial Council adopted a separate decision – *Decision No.683/25.07.2005* for the construction of the NRRAW by 2015 and assigned the activity to SE RAW (Appendix No.1).

The construction of the NRRAW aims safely dispose of low and intermediate level radioactive waste and isolate it definitively and permanently from the environment and human beings.

The NRRAW is a near surface multi-barrier modular engineering facility intended for the disposal of low and intermediate short-lived radioactive waste conditioned and packaged in reinforced steel containers. The decision to construct a near surface type of repository was taken at the strategic level along with the *Strategy for spent fuel and radioactive waste management* [127].

The investment proposal of SE RAW for construction of the NRRAW on the "Radiana" site in the land of the village of Hurlets, Municipality of Kozloduy, District of Vratsa, EKATTE 775548 includes:

- Development of a system of modules intended for RAW disposal;
- Inspection and monitoring;

- Building of small land service buildings.

This investment proposal is subject to the Assessment Report on Environmental Impact.

Licensing process and responsibilities of the various institutions during construction of the NRRAW

The description of the licensing process, including the responsibilities of various institutions to ensure NRRAW safety, physical security and funding was adduced in response to the recommendations of the Romanian side [400].

In accordance with the requirements of the *Safe Use of Nuclear Energy Act* [128] SE RAW is responsible for the management of the RAW outside the premises in which they are generated. The subject of the activity of the enterprise is:

(1) radioactive waste management, which includes all activities related to the manipulation, preliminary processing, processing, and conditioning of radioactive waste, and its storage, including the decommissioning of a facility for radioactive waste management;

(2) construction, operation, rehabilitation and reconstruction of radioactive waste management facilities;

(3) radioactive waste transportation outside the site of the corresponding nuclear facility, if it has received a permit or license for transportation under this law.

SE RAW implements these activities in compliance with the requirements for nuclear safety and radioactive protection on the grounds of the permits for site selection, design, construction and commissioning issued by the NRA Chairman and the operating license of the radioactive waste management facility.

RAW management activities are financed by the "Radioactive Waste" fund, and the activities related to the decommissioning of nuclear facilities, by the "Decommissioning" fund. Both funds are established pursuant to the *Safe Use of Nuclear Energy Act*.

The activities for the construction of the NRRAW are subject to licensing in accordance with the *Ordinance on procedures for issuing of licenses and permits for the safe use of nuclear power* [130], which includes:

⇒ permit for site selection (localization);

⇒ design permit;

⇒ building permit;

⇒ commissioning permit;

⇒ operating license;

⇒ closure permit

The selection of the site and the design stages shall be completed upon the issuance of the Order for approval of the site and the Order for the approval of the technical project, issued by the Chairman of the NRA on the basis of the technical and organization documents and safety assessment statements.

The Order for the approval of the site shall be issued after implementation of the EIA procedure and positive decision on the EIA. The Closure permit of the NRRAW shall be issued after the implementation of a separate procedure under the EIA and positive decision under EIA.

Permission for the selection of the NRRAW site may be issued only if the Ministerial Council has adopted a decision to build the NRRAW.

The decision of the Ministerial Council to build the NRRAW No.683 was adopted on 25.07.2005. By the same decision the Council of Ministers explicitly assigned the responsibility for the construction of the NRRAW to SE RAW and set 2015 as the deadline.

SE RAW began the activities for the selection of the NRRAW site in May 2006 when the Chairman of the Nuclear Regulatory Agency issued permission for the implementation of the activity – Permit No.NR3211/05.05.2006. The implementation of the activities related to the selection of the site in accordance with the terms of the permit is mandatory under the provisions of the *Safe Use of Nuclear Power Act* [128].

The process related to the selection of the site takes place in four stages, illustrated in **Figure 1.0-1**.

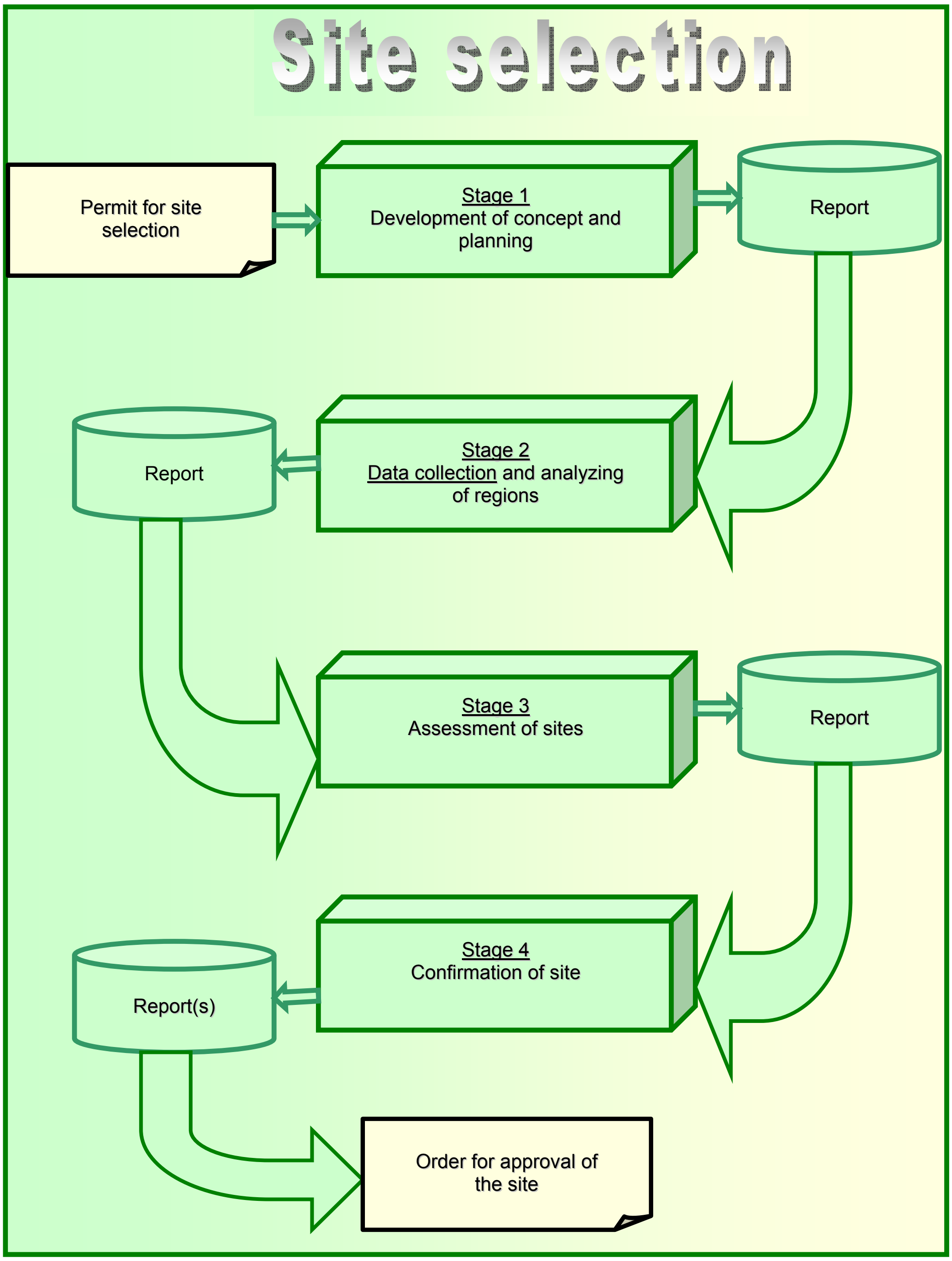


Figure 1.0-1 Stages of the selection of a site for the NRRAW

The stages are in compliance with the requirements of the *Ordinance on the safety of radioactive waste management* [93], the recommendations of the International Atomic Energy Agency [324, 329, 330] and the best practices for RAW management in developed European countries and include:

⇒ Elaboration of a concept for the disposal and planning of the selection of a site;

⇒ Data collection and analyzing of areas – defined as potential regions and sites, which are subject to detailed field and laboratory research;

⇒ Assessment of sites – conducting detailed field and laboratory research of the potential sites: Marichin valog, Brestova padina, Radiana and Vurbitsa. The stage shall be concluded with the determining of Radiana site as the preferred site.

⇒ Confirmation of site – execution of additional, thorough field and laboratory tests of the site of Radiana

All activities related to the selection of the site are carried out in accordance with the regulatory requirements, the recommendations of the IAEA, the best EU practices and the terms for the selection of site permit, issued by the NRA.

All activities are subject to control on behalf of the NRA, which shall approve the plans and the results for implementation of each stage and the regular (6-month) reports on the implementation of the activity. The selection of the site shall conclude with an administrative order for the approval of the site issued by the NRA Chairman. Significant requirements for the issuance of such order is the positive decision under EIA and the determination on the safety of the system by a preliminary evaluation report on safety [130].

The activities related to the construction of the NRRAW are subject to authorization from the Ministry of Regional Development and Public Works in accordance with the requirements of the *Spatial Development Act* [79]. Permits are issued for the design and construction. The investment proposals are also to be approved in compliance with the regulations of the *Spatial Development Act* [79].

In accordance with the *Safe Use of Nuclear Energy Act* [128] the state policy on waste management is conducted by the Ministry of Economy, Energy and Tourism. The control of nuclear and radiation safety is carried out by the Nuclear Regulatory Agency. The physical protection of facilities for RAW management is carried out in accordance with the *Ordinance on ensuring the physical security of nuclear facilities, nuclear material and radioactive substances* [107] and is controlled both by the Nuclear Regulatory Agency and the specialized bodies of the Ministry of the Interior.

1.1. General information about the NRRAW and area available

1.1.1 Location of NRRAW site. Physical characteristics

During the past years 78 potential sites for the building of NRRAW have been studied. After analyzing the characteristics of these sites, 12 were identified as most suitable for the locating a RAW repository and were pre-selected. It was followed by characterization of the sites, as a result of which four were preferred, namely: "Marichin valog" "Brestova padina", "Vurbitsa" and "Radiana". Within the framework of a project, funded under the EU PHARE programme, the characteristics of these four sites were analyzed and the "Radiana" site was defined as the priority one. Within the framework of the same project a conceptual project and preliminary report on the NRRAW safety analysis were elaborated [190].

After a precise analysis and expert assessment under certain criteria, the "Radiana" site was defined as the priority one. It is situated on land of the village of Hurlets, Municipality of Kozloduy, District of Vratsa EKATTE 775548 /according Protocol No.2/16.08.2010 of EFT to MEET /(**Figure 1.1-1**).

The site of the national repository and its facilities shall occupy approximately 36 hectares and its capacity will be 138200 m^3 LIRAW, including the packaging. Environmentally friendly technologies and materials will be used during the building and operation of the NRRAW and no protected areas are going to be affected.

The site is located between two roads, one on the north controlled by Kozloduy NPP and considered as an interplant road and which connects the town of Kozloduy with Kozloduy NPP, and one on the south, a secondary road (road No.11) from the village of Hurlets to the town of Kozloduy. (**Figure 1.1-2**).

The site falls within the boundaries of the 3-km radiation protection area of Kozloduy NPP (**Figure 1.1-3**). It is situated 3.2 km southeast of the regulation line of the town of Kozloduy, 6.6 km southwest of the construction limits of the village of Hurlets and about 4.0 km southwest of the right bank of Danube river.

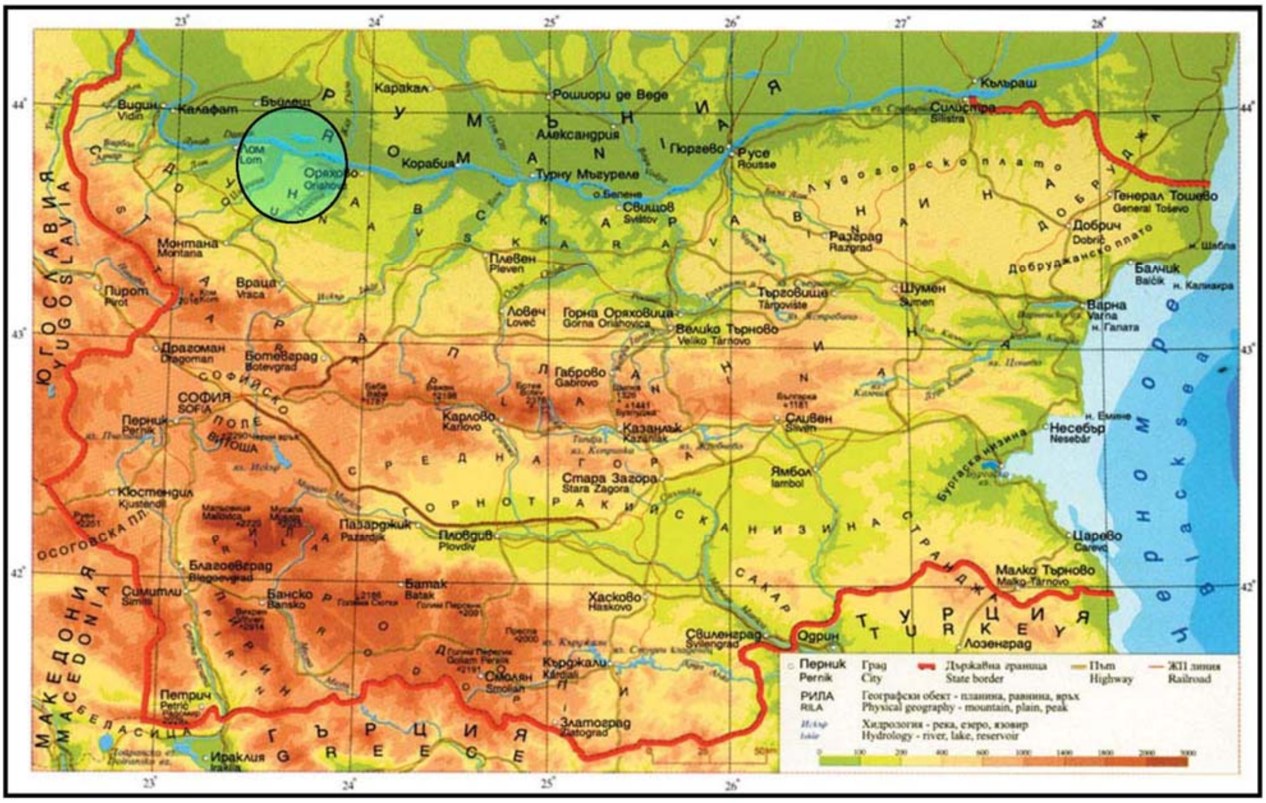


Figure 1.1-1 Physical-geographical map of Bulgaria with marked location of the NRRAW site

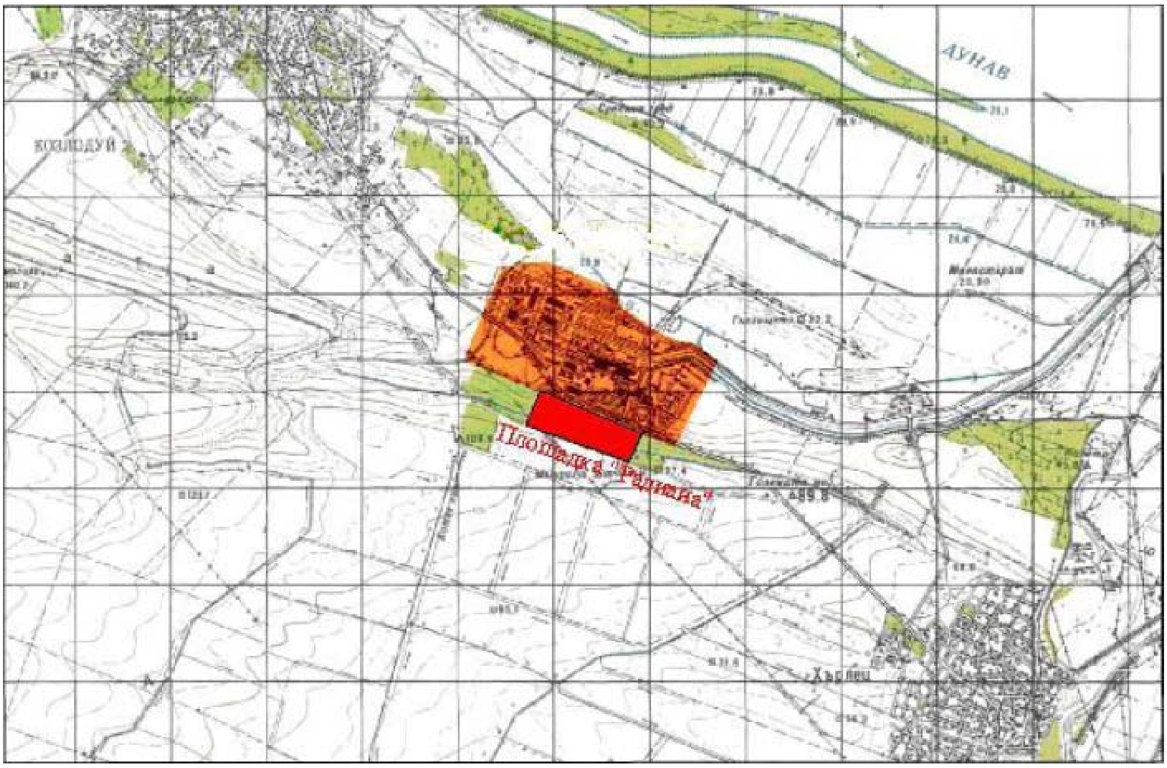


Figure 1.1-2 Location of "Radiana" site

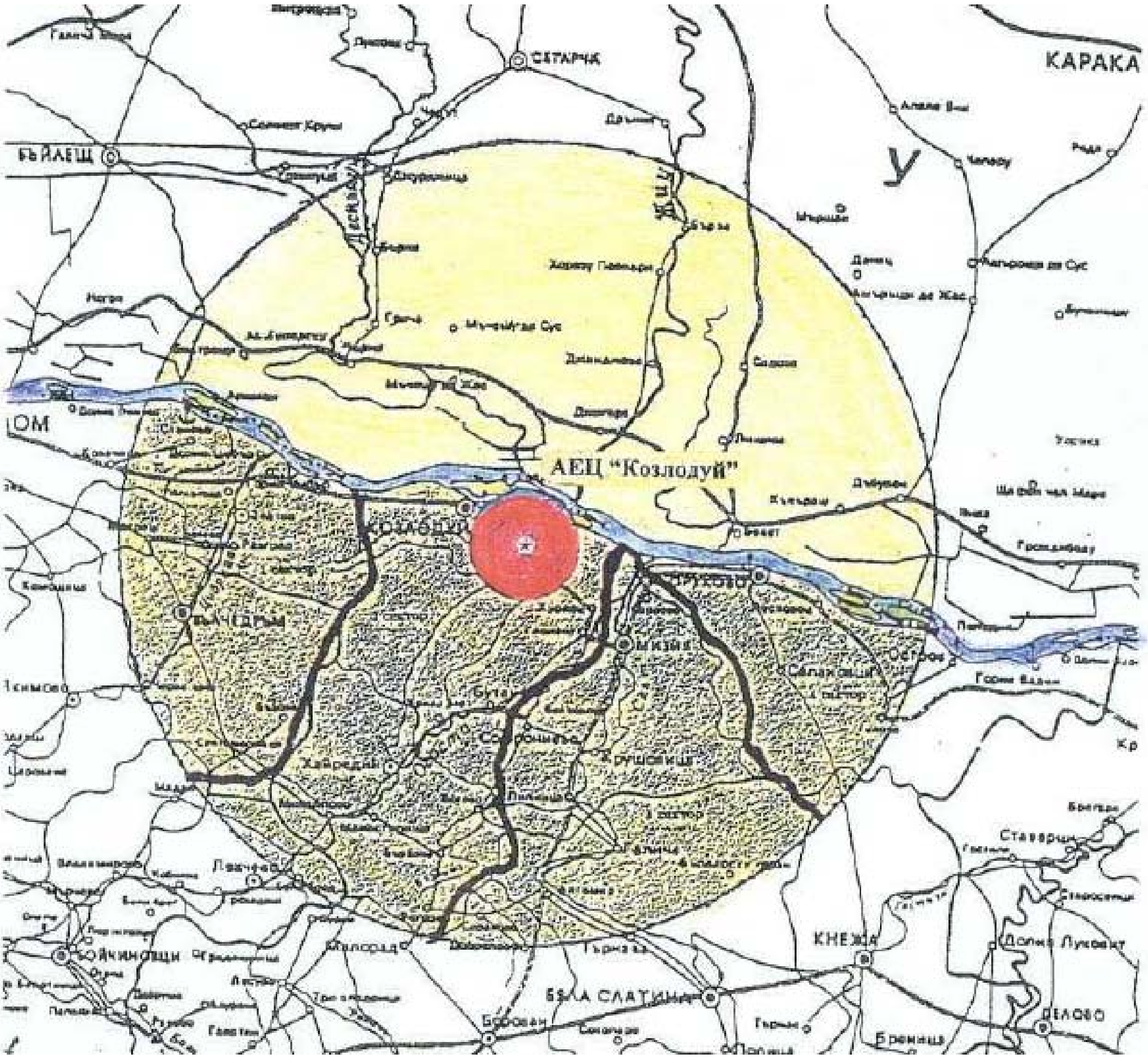


Figure 1.1-3 Map of the three-kilometer radiation protection area and the thirty-kilometer monitored zone of “Kozloduy” NPP

The boundaries of the site are shown in **Figure 1.1-4** on a detailed geodetic map of the area of the site on a scale of 1:1000. The coordinates are marked on the map. The detailed geodetic map is enclosed in Appendices No.5,6.

The site is located on the slope between the first and the sixth loess terraces with displacement between them of about 60 m (from elevation +35 m to elevation +94 m). The average slope of the site is 8º30’. The “Radiana” site falls within the northern periphery of the Moesian region. The slope outlines on the south the Danubian plain of Kozloduy.

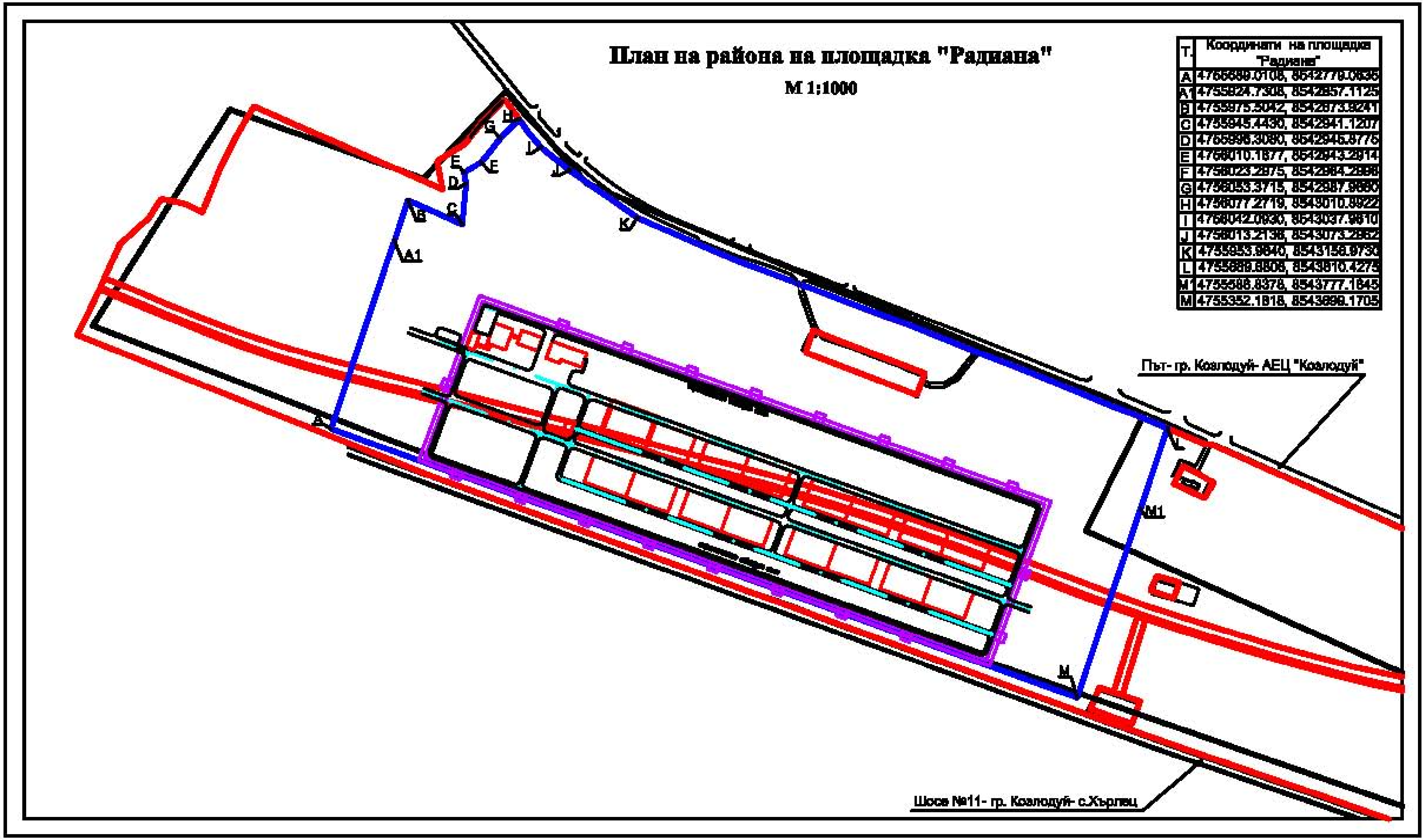


Figure 1.1-4 Plan area of the Radiana site, site boundaries (marked in blue) and coordinates

The status of the land within the site and in its area, according to data of the detailed geodetic map [409] and according to current information of the "Agriculture and Forests" municipal service and the Cadastre, Geodesy and Cartography Agency is given in **Table 1.1.1**. The schemes by type of property ownership and type of permanent usage are provided as appendices.

Table 1.1.1 Type of property at the Radiana site and its region

No. of property	Owner	Type of permanent usage	Type of property	Area, dka	Area required according to Detail Site Development Plan
000238	SLF	Forests in agriculture lands	State private	409,848	309 633
000232	Municipality of Kozloduy	Water management facility	Municipal private	1,569	
000231	SLF	Forests in agriculture lands	State private	209,099	129 871
000229	MAF-HMS	Irrigation canal	State private	32,904	15 606
000228	Municipality of Kozloduy	Water management facility	Municipal private	0,603	
000227	Municipality of Kozloduy	Water management facility	Municipal private	1,017	
000225	Municipality of Kozloduy	Disputed territory	Municipal private	4,26	4 260
000038	Municipality of Kozloduy	Field road	Municipal public	1,091	
000005	Municipality of Kozloduy	Field road	Municipal public	10,532	4656
					464 026

It is evident from the Table that the land is mainly state private property, owned by the "State Land Fund" (61.9 hectares). There are also small land plots which are municipal private property (0.74 hectares), as well as municipal public property (1.16 hectares).

The Investment Proposal affects:

- part of property No. 000238, owned by "State Land Fund" part of property ""Forests in agriculture land" – type of property - State private - area F= 409,848 dka in the "Starite lozya" locality
- part of property No. 000231, owned by "State Land Fund" with TPU "Forests in agriculture land" – type of property - State private - area F= 209,099 dka in the "Starite lozya" locality".
- part of properties, state private property, owned by "State Land Fund" with TPU "Forests in agriculture land" ;
- part of property No. 000005 part of property – "field road";
- part of property No. 000229 part of property – irrigation canal;
- property No. 000225 part of property "disputed territory".

According to the statements of the Regional Forest Directorate, town of Berkovitsa, ref. No. 13g/19/01.06.2009 and the "Agriculture" Regional Directorate with ref. No. 747/26.05.2009, town of Vratsa by type of territory the land plots No. 000231, 000238 are "for agriculture needs". These land plots are offered to be included in the state forest fund.

By letter ref. No. 70-275301.10.2010 to the Minister of Agriculture and Forests, SE RAW deposited a demand for the termination of the procedure for the inclusion of land plots No. 000231, 000238 in the state forest fund on the grounds of DMC No.683/25.07.2005 and the amendment to the Safe Use of Nuclear Energy Act, according to which NRRAW is a national site in the meaning of the Spatial Development Act.

The investment proposal does not affect private land plots and has no boundaries with private lands. The nearest private lands are situated at a distance of 30 m.

The land is not used for agriculture purposes. The area is overgrown with low standard forest, mainly acacia and shrubs.

The total area of land to be used for the needs of the NRRAW is about 36 Ha. During the construction additional land shall not be necessary, as it has been envisaged that the provisional activities will be carried out within the boundaries of the "Radiana" site.

According to preliminary data of the territory there are no any separate plots (regulated and not regulated, and those involved in the plot plan for any construction activity). The territory has no any general development plan. Currently, detailed site development plan is in the process of development, coordination and adoption. Conceptual (preliminary) project for detailed development plan - a plan for construction is made according to given function - a flow diagram and covers territory deemed sufficient for the intended capacity of future repository.

The final site development plan for the territory will be established as land plot, which will be regulated by Regulation Plan (RP) and will be done to prejudice the allocation of its functional purpose. (The area proceed Detailed Site Development Olan is increased by about 20% and is proposed to be maintained as green area

1.1.2 Relation to other existing and approved for development or by other plan sites and activities

The Investment proposal site relates to:

⇒ ***The activity of a Unit for processing of RAW (UPRAW) and a Warehouse for Storing RAW (WSRAW) of UP "RAW – Kozloduy" of SE RAW, situated at the site of Kozloduy NPP.***

The radioactive waste generated during the operation of Kozloduy NPP is processed and conditioned in UPRAW. The currently generated waste from the operation of Units 5 and 6 of Kozloduy NPP will also be processed in the same unit. The low and intermediate level radioactive short-lived waste which is to be generated during the decommissioning of Units 1-4 of Kozloduy NPP shall also be conditioned in the UPRAW. After its temporary storage in the WSRAW, the radioactive waste will be presented for disposal in the NRRAW. It is the main source of RAW to be disposed of in the NRRAW.

⇒ ***RAW management in Kozloduy NPP***

There is no direct relation with the RAW management in Kozloduy NPP, as all RAW generated in the plant is processed in the UP RAW-Kozloduy. As has been mentioned hereinbefore, this includes the future waste generated from the operation and the decommissioning of the Units of Kozloduy NPP.

⇒ ***Environmental monitoring, conducted by Kozloduy NPP***

The NRRAW is to be positioned in the radiation protection area of Kozloduy NPP. The site is within the scope of activity of the Programme for environmental monitoring of the Unit for Radiation monitoring of Kozloduy NPP, and therefore it has a significant volume of data related to radiological environmental monitoring. However, in accordance with the recommendations of IAEA [325, 345, 410] until the time the NRRAW is put into operation, thorough pre-operational monitoring shall be implemented which will become a routine activity during the launching of the NRRAW.

⇒ ***System for physical security of Kozloduy NPP;***

Kozloduy NPP as a nuclear facility is subject of physical security in accordance with the *Ordinance on ensuring the physical security of nuclear facilities, nuclear material and radioactive substances* [107] and the special provisions of the Ministry of the Interior. Since the NRRAW borders Kozloduy NPP, it is envisaged that the system for physical security of Kozloduy NPP will also cover the NRRAW.

⇒ ***System for radiation protection of Kozloduy NPP;***

At the moment units responsible for the radiation protection and the dosimetric control are established within the organizational structure of all special units of SE RAW. The special units are facilities with technical means for radiation protection, fixed and portable devices for radiation and dosimetric control and personal dosimeters. The radiation protection and the dosimetric control are controlled by the General Department of SE RAW (safety control and analysis) and by the regulatory bodies – NRA and the Ministry of Health through the National Radiobiology and Radiation Protection Centre. This practice shall be continued in the NRRAW.

⇒ ***System for fire protection in Kozloduy NPP;***

NRRAW will be secured with its own fire protection system and fire safety.

⇒ ***Management of non-radioactive waste in Kozloduy NPP;***

Since the site of Kozloduy NPP has a functioning special unit of SE RAW – SU RAW-Kozloduy, the structuring of another special unit is under way which shall be responsible for the decommissioning of Units 1 and 2 of Kozloduy NPP. Contractual relationships are also being established between SE RAW and Kozloduy NPP, by the virtue of which SE RAW will submit to Kozloduy NPP the non-radioactive waste. This practice is envisaged to continue during the operation of NRRAW, unless the economic relations provide a more viable option for the submission of the waste to specialized organizations/companies.

⇒ ***Supply with fuel, heavy oil and oils;***

The supply of fuel, heavy oil and oils for the entire enterprise shall be carried out on commercial basis through their purchasing from specialized companies after implementing procedures under the Public Procurement Act.

⇒ ***Infrastructure – roads, power supply, water***

The area around the site has a developed infrastructure.

The site is accessible from the south by road No.11 from the village of Hurlets – town of Kozloduy and from the north by the inter-plant road of Kozloduy NPP. In other words, it is not necessary to build new roads to the site. Internal roads will be built within the boundaries of the site.

The electricity supply will be taken from the power grid of the CEZ electricity distribution company or from the site of Kozloduy NPP where specialized units of SE RAW are situated.

The supply of drinking water will be carried out via a deviation of the drinking water pipeline, supplying Kozloduy NPP.

Domestic-fecal sewage will be discharged in the domestic-fecal sewage system of Kozloduy NPP.

⇒ ***Auxiliary sites and activities.***

The operation of the NRRAW does not depend on auxiliary sites and activities.

1.1.3 Natural and legal persons who may be affected by the implementation of the investment project

The implementation of the investment proposal shall affect the following:

⇒ Kozloduy NPP shall submit low and intermediate level radioactive waste of SU RAW-Kozloduy to SE RAW which, after processing, conditioning and packaging, shall be disposed of in the NRRAW.

⇒ The population of the towns and villages located near to the village of Hurlets in the municipality of Kozloduy, respectively the town of Kozloduy, who are expected to be directly or indirectly affected by the implementation of the investment proposal.

⇒ The village of Hurlets, municipality of Kozloduy, where the site is located and neighbouring lands and other affected organizations, institutions, which are listed in section 8.

⇒ Construction companies and organizations that might eventually take part in the building works.

1.2. NRRAW Characteristics

1.2.1 Major safety principles, requirements and criteria

The NRRAW is intended for the disposal of low and intermediate level short-lived radioactive waste. The main purpose of NRRAW is to secure the safe isolation of the disposed radioactive waste for the entire period during which the RAW shall be potentially a danger to people and the environment.

In this sense, the **main objective** of the construction, operation, closure and post-operational period is **to ensure the safety and effective protection of the operating staff, the population and the environment from the potential impact of the disposed waste during the operation and post-operation period**.

Measures to ensure safety are taken throughout the entire life cycle of the NRRAW – during the stages of site selection, design, construction, operation, closure and the period of institutional control.

In compliance with the *Joint Convention on Safety of Spent Fuel Management and on Safety of Radioactive Waste Management* [126], the requirements of the Bulgarian legislation, the IAEA safety standards [321-323, 329, 330], and the recommendations of the International Commission on Radiological Protection (ICRP) [331, 332], during the construction, operation and closure of the NRRAW the following **main safety principles and requirements** must be observed:

1. The NRRAW must be situated, designed, built, operated and closed down in a way that the exposure to radiation of the staff and the population does not exceed the limits specified in the *Ordinance on Basic Standards for Radiation Protection and in the Ordinance on the Safety of Radioactive Waste Management* [93];

2. The exposure of the staff and the population must be maintained at the as low as reasonably achievable level, taking into account the economic and social factors (ALARA principle);

3. The level of protection of the population outside the national borders must not be lower than the level of protection of the population inside the country;

4. The level of protection of future generations must not be lower that the level of protection of the present generations;

5. Future generations should not be burdened with the existence of an NRRAW endeavoring to restore or maintain the safety level of the facility;

6. The NRRAW must be situated, designed, built, operated and closed down so as to ensure the protection of environment in accordance with the *Environmental Protection Act* [1] and the international requirements related to the environmental protection [73, 77, 115-118];

7. In ensuring the safety of NRRAW, the principle of restraint and seclusion shall be applied;

8. The construction of NRRAW must correspond to the latest scientific and technical achievements and the globally recognized operational experience;

9. The safety of NRRAW shall be provided through passive means;

10. The safety of NRRAW shall be based on the application of defense in depth protection which is based on simultaneous application of the physical barriers and administrative measures, ensuring the following levels of protection:

⇒ System for continuous physical barriers along the way of distribution of the radioactive substances in the environment;

⇒ System of technical and organizational measures for the protection of the barriers and preservation of their efficiency;

⇒ System of technical and organizational measures for protection of the operating staff;

⇒ System of technical and organizational measures for population and environmental protection

11. The system of physical barriers is based on the multi-barrier concept, where each barrier helps to ensure safety through its safety functions. NRRAW safety cannot be based on a single barrier. If a certain barrier cannot fulfill its safety functions, then the system as a whole must ensure the isolation of RAW in accordance with the safety criteria.

12. The construction of disposal facilities should be able to provide the implementation of corrective measures, including changes in the system of protective barriers and/or partial or complete removal of the radioactive waste stored in the repository.

13. The construction of disposal facilities should provide easy and efficient operation, maintenance, control and monitoring;

14. The entire construction process of NRRAW must be transparent and an open dialogue with the population must be established. The requirements of the public must be considered in the process of site selection and be included in the facility design to the extent that is technically possible and economically efficient;

The main safety criteria are the **radiological criteria,** established in the *Ordinance on basic standards for radiation protection [90] and in the Ordinance on safety in radioactive waste management* [93]:

1. The annual individual effective dose for the corresponding critical group of members of the public during normal operation of NRRAW must not exceed 0.3 mSv;
2. The annual individual effective dose for the corresponding critical group of members of the public in case of design-based accidents in the repository must not exceed 5 mSv v;
3. The annual individual effective dose for the corresponding critical group of members of the public after the closure of the NRRAW must not exceed 0.3 mSv;
4. The limit of the effective dose for the personnel, operating the NRRAW, is 100 mSv for the period of 5 consecutive years, and the maximum effective dose for each year cannot exceed 50 mSv;
5. The limits for the annual equivalent doses for the staff, operating the NRRAW, are 150 mSv for eye lens, 500 mSv for skin and 500 mSv for hands, palms, arms, feet and ankles.

The dose limits for the population during the operation of the NRRAW and after its closure (post-closure period) are lower from the limit for the annual effective dose for each member of the population by 1 mSv/a, set by the *Ordinance on basic radiation protection standards [90]*. The safety criteria correspond to the safety standards of IAEA, the *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* [323] and the recommendations of International Commission on Radiological Protection [331, 332].

Based on current international law, domestic and foreign regulations and recommended documents is selected disposal of low and intermediate level radioactive waste in the **engineering near surface facility of modular type** [93, 330]. The decision for near surface type of repository is supported at political level with the *Strategy for Spent Nuclear fuel and Radioactive Waste Management* [127], which was approved by the Council of Ministers of Republic of Bulgaria.

In line with current tendencies in the management of radioactive waste, SE RAW has carried out preliminary (feasibility) studies. Within these studies, in accordance with the detailed study of site conditions at Radiana site, have been developed preliminary draft projects for trench, tunnel and shaft types of NRRAW [200, 359, 360]. On the basis of a thorough analysis of the preliminary design materials and the recommendations of the Project Consultant on the NRRAW [412], a **trench type engineering multi-barrier modular repository** was determined. The construction of this repository is generally similar to the construction of realized in Centre d'Obe - France and El Cabril - Spain [156], taking into account the characteristics of the Radiana site.

The NRRAW will store conditionedlow and intermediate level short-lived radioactive waste (included in cement matrix) and low and intermediate level short-lived radioactive waste packed in reinforced concrete containers (RCC) with outer dimensions of 1. 95 x 1.95 x 1.95 m. Disposal of large RAW and/or free bulk materials is not envisaged. More information about the packaging characteristics (reinforced concrete containers) and the shape of the waste is provided in sect.1.2.9 Characteristics of RAW subject to disposal in NRRAW.

1.2.2 Description of the NRRAW

The preliminary NRRAW project was elaborated on the basis of the concept for a multi-barrier engineering modular trench repository developed by the Bulgarian Academy of Science [358]. The preliminary project is the feasibility study under *Ordinance 4 for the scope and content of the investment projects*. It was developed as a project under PHARE programme [200].

The NRRAW consists of facilities for disposal and service buildings and facilities, whose locations are shown in **Figure 1.2-1**. The details (1:2500 scale) are shown in **Figure 1.2-10** in section 1.2.3 General plan and in Appendix No. 9. The facilities for disposal and the service buildings and facilities are described below. **Processing and/or conditioning of radioactive waste shall not be carried out at the site of the NRRAW.**

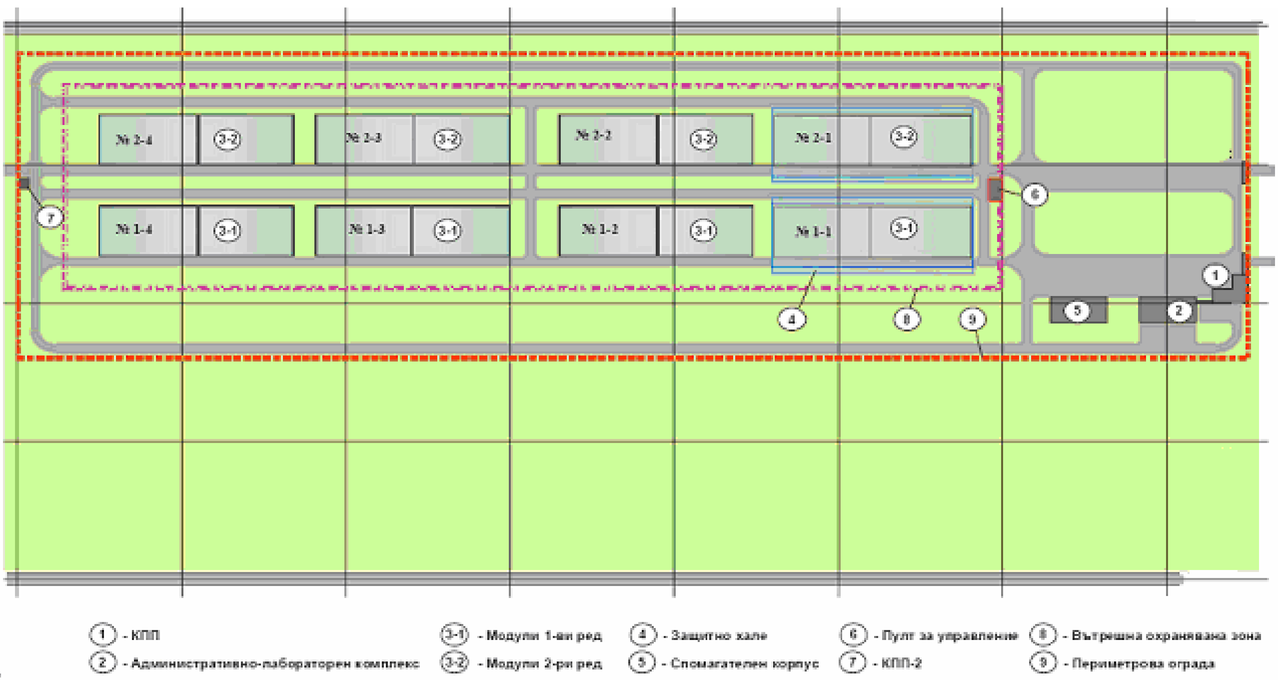


Figure 1.2-1 Positioning of equipment on the general plan of the NRRAW

The preliminary project considers construction of modular type of disposal facility for low and intermediate level short-lived radioactive waste placed in reinforces concrete containers. It is considered to have site for working area, area for relevant supporting communication, as well as for maintenance of facilities and buildings. It is indicated a balance of the necessary areas according to their functional purpose, such as for example for buildings and structures. In the next phase of design (Final project – Detail Site Development Plan and other designs) siting of the facilities can be refined to optimize their functional purpose. Transport - communication project will be developed to refine the traffic flows and linkages with the existing road infrastructure and specialist schemes for the organization of movement, access control, engineering - technical infrastructure, etc. In terms of construction (Construction Plan) to the next stage of design will determine the parameters of the development (density, intensity ratio, landscaped area, maximum height of buildings and other development indicators.)

1.2.2.1 DISPOSAL FACILITIES

The investment proposal envisages the construction of 8 uniform reinforced concrete modules, arranged in two parallel rows, as shown in **Figure 1.2-1 and Figure 1.2-10**. Step placement is selected for the positioning of the two rows of modules, which compared to positioning them on a single level leads to a smaller volume of excavation works and, as a result, a lower amount of excess soil. The details of the two positioning options are provided in Appendix No. 10.

The predetermined size of each module is 117 m in length, 35.5 m in width and 10 m in height. The modules are separated by longitudinal and transverse walls forming a sealed chamber. Each module consists of 16 identical chambers, also located in two parallel rows of 8 chambers in a row. (**Figure 1.2-2**).

Figure 1.2-2 Positioning of chambers in the disposal modules

Because of design considerations, an expansion joint is envisaged in the middle of each module between every 4 pairs of chambers (**Figure 1.2-1**).

The size and number of chambers in a module is determined by technological and design considerations and by the realities of the chosen site. The chambers are rectangular, 17 m long x 14 m wide.

The reinforced concrete containers (RCC) are positioned in 4 rows in the disposal chamber. They are grouped into 4 groups in each chamber. The groups which consist of 4x3x4 RCC are to be positioned in the four corners of the chamber, as it shown in **Figure 1.2-3**. An empty space of approximately 90 cm separates each group from the other and allows inspections of the state of RCCs to be carried out during the operation period. 192 RCCs can be positioned in each chamber.

When closing the module, the empty space between the containers will be filled with loess grout containing an appropriate absorption material (zeolite).

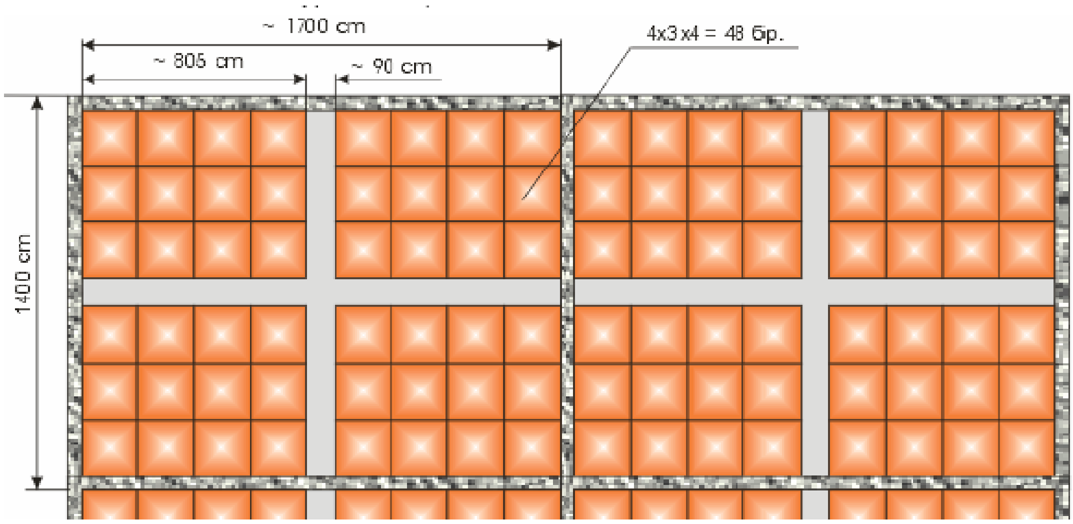


Figure 1.2-3 Overhead view of chamber for RCC disposal

The chambers are built of reinforced concrete with a wall thickness of 500 mm and bottom plate thickness of 1000 mm. The walls and the bottom of each chamber are covered with waterproof material.

The bottom of each chamber is inclined towards the centre, through which passes a drainage pipe for leading out any possible water. The bottom is covered with a layer of compacted gravel and gravel, leveling strictly horizontally.

Under the bottoms of the chambers are constructed reinforced concrete inspection (drainage) galleries (two pieces in a gallery for each line of parallel chambers in a module). These passunder the modules and form a system of inspection galleries under the repository (**Figure 1.2-4**). The drainage pipes from the chambers discharge into these galleries. They are used to inspect the bottom of the disposal chambers and are part of the leakage control system. Their preliminary defined dimensions (2.00 x 2.20 m) allow the staff to carry out inspections.

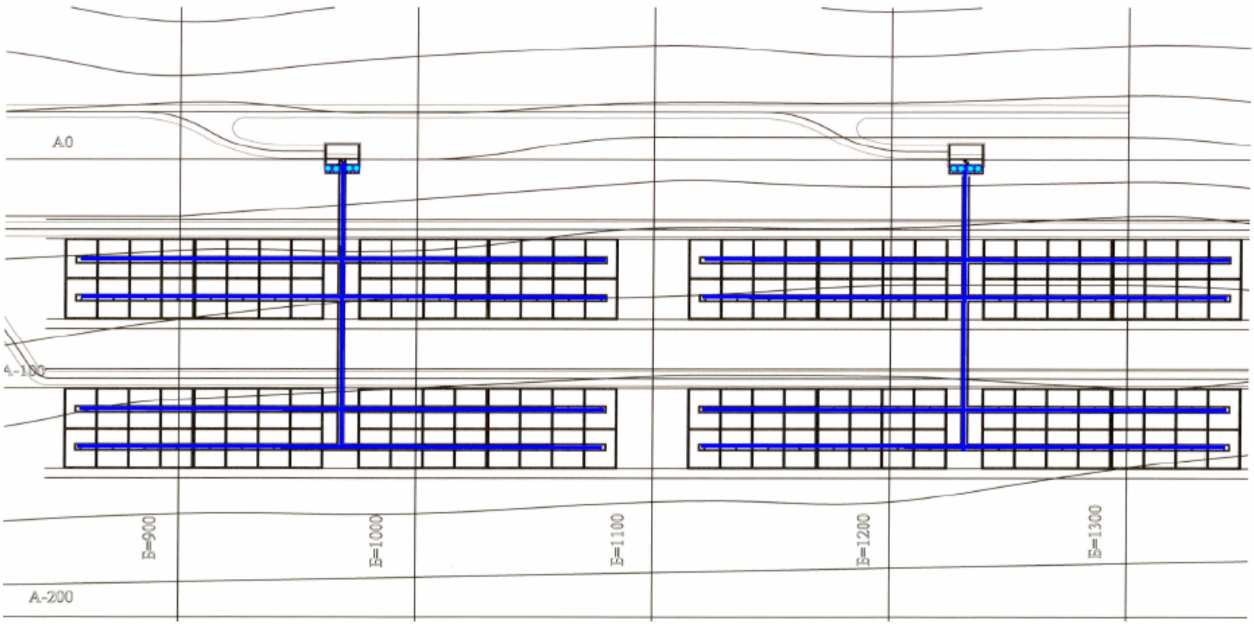
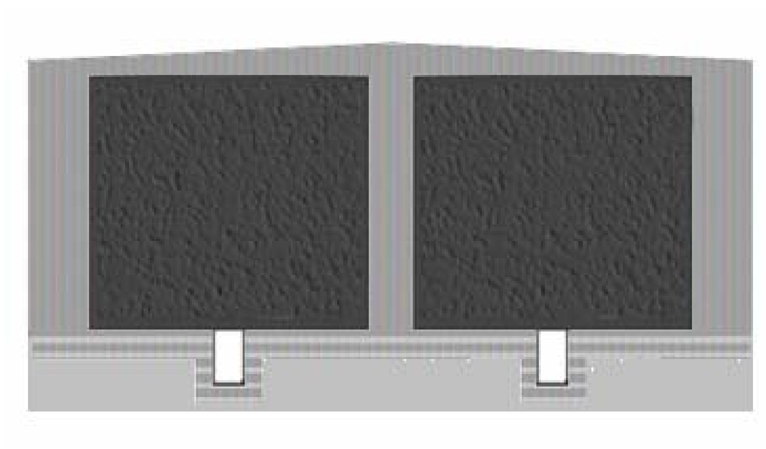


Figure 1.2-4 Scheme of inspection (drainage) galleries



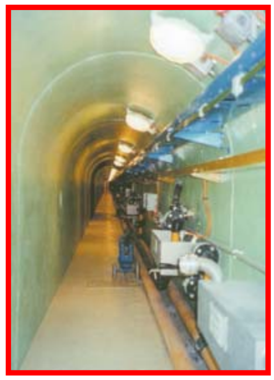


Figure 1.2-5 Illustration of inspection (drainage) galleries: (a) situation; (b) type of galleries following the example of the repository in Mochovce, Slovakia

This approach is in line with the good modern practice. The inspection (drainage) galleries are illustrated in **Figure 1.2-5a.** To the right of this figure,Figure 1.2-5b shows the location of the drainage pipes per the example of the repository for low and intermediate level radioactive waste in Mochovce, Slovakia [213]. Tunnel ventilation is achieved by natural aeration through a system of shafts and vents.

The foundation of the modules is a loess-cement cushion with an approximate thickness of 4000 mm, which provides a gradual transition between the ground and the disposal modules, enables increasing the admissible soil loading in the foundation zone and creates an additional filtration screen against the movement of the groundwater from and to the repository. The inspection (drainage) galleries are incorporated in the loess-cement cushion. It is sealed by a 100 mm concrete pad. An additional loess-cement screen (walls) with a thickness of approximately 1 m is constructed around the outside of the modules, and the free space is filled with compacted loess. Details of the construction are given in Appendices Nos. No.11 and 12.

Closing the modules is carried out by filling the free space between the containers with loess-cement, which includes absorption material (e.g. zeolite), the construction of a reinforced concrete roof plate-cover; which is covered with suitable waterproof material, the construction of an additional layer of loess-cement of up to 1 m thick, similar to layer around the module's walls and the construction of a **multi-barrier protective cover**.

The multi-barrier protective cover serves several purposes: to isolate the waste in the modules from rain water; to prevent access of plant and animal organisms to the disposed waste (small animals like rodents and etc., roots of trees, shrubs and etc.); to protect the storage chambers from surface erosion and sudden temperature changes, to prevent or minimize inadvertent human intervention. It must preserve impermeability for the entire institutional period (300 years). The main characteristics of the multi-barrier protective cover are:

⇒ impermeability – the amount of infiltrated water must be very small, in order to prevent the extraction of radionuclides from waste and their migration in the biosphere;

⇒ stability – it must preserve its integrity and impermeability for the entire period of institutional control;

⇒ elasticity – preservation of the impermeability in case of changes in the terrain due to subsidence of the modules and of the radioactive waste containers;

⇒ thickness – the protective cover must be thick enough and stable enough to protect the modules from external factors – erosion, repeated cycles of freeze-thaw and biological effects;

⇒ to allow some, albeit minimized repair and maintenance activities, as its protective function cannot be guaranteed for a period of 300 years without adequate repair and maintenance, even if the materials used are characterized by exceptional durability.

The multi-barrier protective cover (**Figure 1.2-6**) consists of a sand layer with drainage function, a layer of compacted clay with insulating function (prevents the ingress of rainwater in depth),a sand and gravel layer with drainage function. It is topped with a soil layer, which is stabilized by planting appropriate vegetation and protects the facilities from erosion.

The rainwater is discharged into the platform-type drainage system, built around each module.

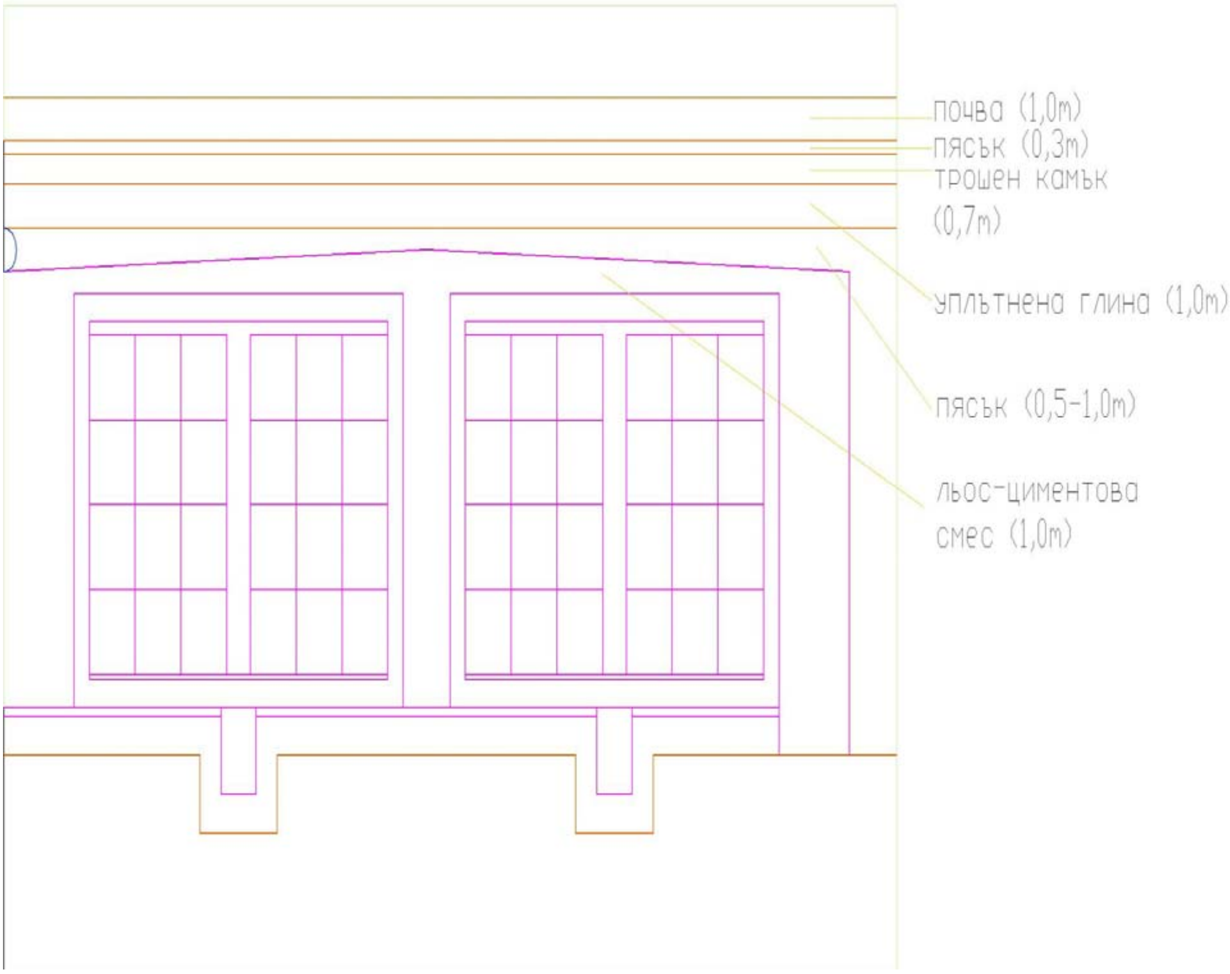


Figure 1.2-6 Scheme of sealed module with multi-barrier protective cover

Figure 1.2-7 shows the exterior of a repository with a built multi-barrier protective cover. This cover is exemplified by details of the protective cover of the planned Belgian repository, provided in **Figure 1.2-7b** as exemplified by the sealed repository for low and intermediate level active waste La Manche, France [213]

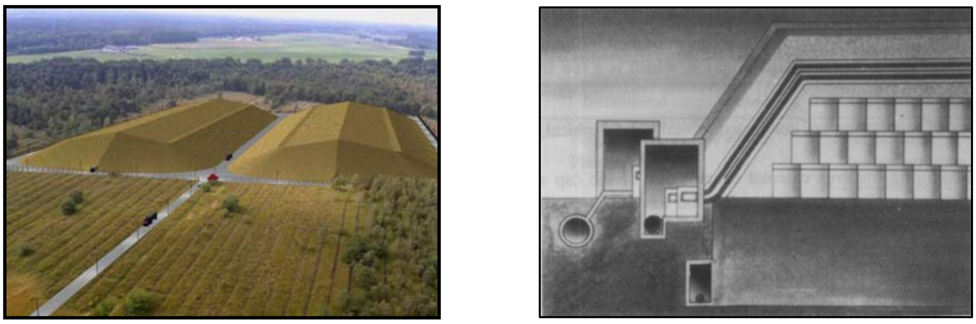


Figure 1.2-7 Sealed modular trench repository with built multi-barrier protective cover; (a) exterior; (b) protective cover details

The investment proposal of SE RAW envisages the construction of a test area at the site of the NRRAW for testing the multi-barrier cover and defining the thickness of the protective layers.

With this proposed structure the safety of the disposal facilities is ensured by multi-barrier approach by providing deep echelon protection:

⇒ **First engineering barrier**: cemented matrix in which the radioactive waste is conditioned;

⇒ **Second engineering barrier:** the walls of the reinforced concrete container, covered with waterproof material

⇒ **Third engineering barrier:** the reinforced concrete walls of the chamber, covered with waterproof material and loess-cement filling material containing natural, inorganic sorption materials (zeolite)

⇒ **Fourth engineering barrier:** the strong loess-cement layer around the chambers

⇒ **Fifth engineering barrier:** compacted loess

⇒ **Sixth natural barrier:** the loess complex in which the modules are constructed and sealed – as previous studies have shown this complex is practically completely dry, and it has very good absorption qualities, preventing the migration of radionuclides;

⇒ **Seventh engineering barrier:** the protective multi-barrier engineering cover.

The adopted decision provides an opportunity to conduct inspection and control of the status of the packages and the facility throughout the operational period – before and after the closure of the modules.

The Ordinance on the Safety of the Radioactive Waste Management [93] requires the construction of the disposal facilities to enable the application of corrective measures, includinguding changes in the protective barriers system and/or partial or complete removal of the radioactive waste disposed in the repository. The adopted decision provides for the relatively easy implementation of measures towards rehabilitation of the construction and/or the removal of the packed RAW.

During the operational period of the disposal facilities the modules are protected with a protective hall **(Figure 1.2-8)** equipped with gantry crane.

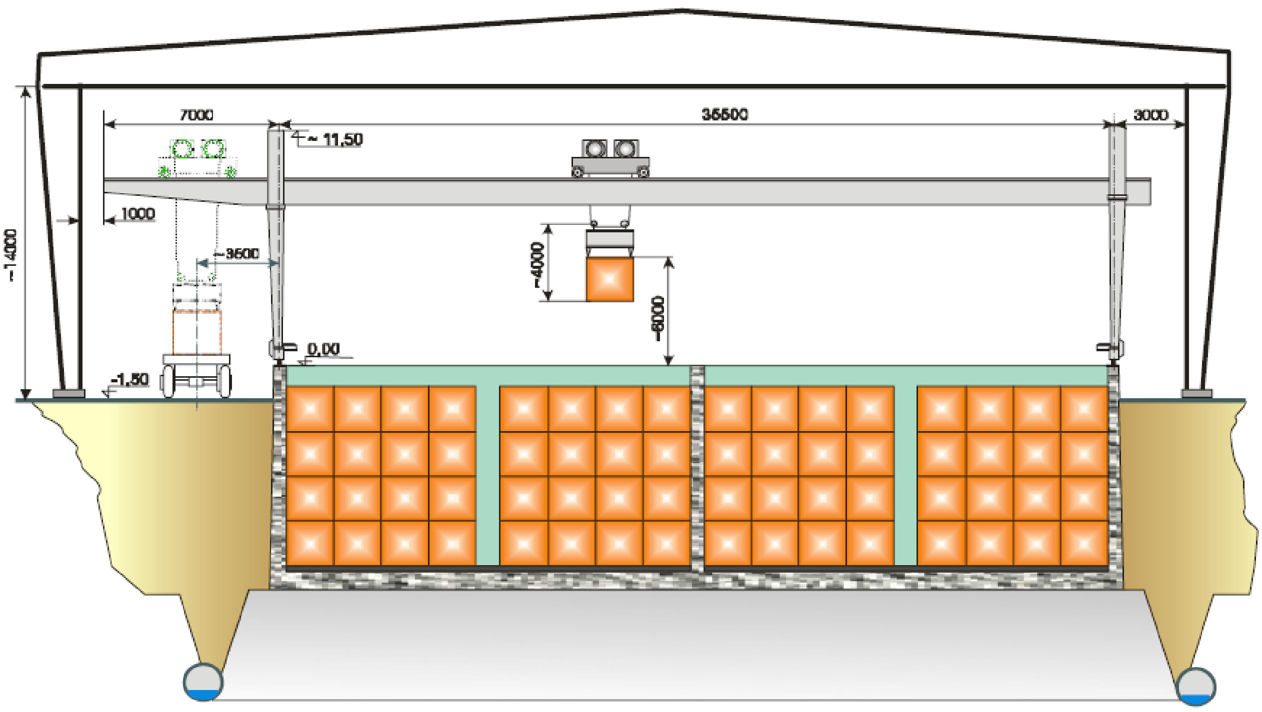


Figure 1.2-8 Cross section of a disposal module with a gantry crane and a protective hall

The purpose of the protective hall is to ensure protection from weathering of the work area when conducting transport technological activities; of the personnel when conducting inspections, and of the opened chambers. The overall dimensions are approximately 51 x 60 x 20 m (width/length/height). The protective hall is mobile. It covers half of the module. After the filling of the chambers in the first half of the module, the protective hall is moved over its second half. After completing the work on the first module, the hall is dismantled and repositioned over the second module. The positioning of the reinforced concrete containers (RCC) in the chambers shall be carried out remotely by gantry crane with a trolley with remote control, which after completion of the work on the first module shall be dismantled and mounted over the second module.

The proposed approach is in line with the best EU practices. To illustrate this, **Figure 1.2-9** shows examples from the repositories at L'Aube in France, El Cabril in Spain, and Mochovce in Slovakia [213].

Figure 1.2-9 Modern repositories for low and intermediate level RAW with protective constructions during the operational period: (в) Mochovce, Slovakia

1.2.2.2 AUXILIARY BUILDINGS

1. Checkpoint

The building is designed to provide controlled access conditions for personnel and transport vehicles to/from the NRRAW territory, as well as comfortable working and recreation conditions for the staff that provides physical security on the territory of the site. It is divided into two functional areas: a flow zone where the personnel on duty are situated and in which are mounted the technical means providing the control over the passage of people and transport vehicles, and a administrative-residential part which contains offices, recreation rooms for the staff and where auxiliary technical means are fitted.

2. Administrative building

The building is designed to provide suitable working conditions for the personnel of the NRRAW. There are offices, a conference room, facilities for archives and auxiliary technical means.

3. Laboratory building

The main purpose of the building is to provide conditions for carrying out laboratory analysis of various potential or real radioactive samples. Considering the possible radioactive contamination, the building is separated from the administrative one, and the entrance/exit is controlled by devices for detecting external contamination of clothing and body. Emergency showers for decontamination are envisaged.

4. Auxiliary building

This building combines two functionally independent parts: the garage and mechanical workshops with different purposes and a technology section which contains facilities for power equipment and other auxiliary systems. There are also relevant offices and residential premises.

5. Information centre

At this stage of the investment proposal the information centre is envisaged to be placed in the administrative building. This approach shall be reconsidered during the design process on the basis of public opinion survey. Public awareness, an open dialogue and the opportunity for the people to be informed about the activity of radioactive waste management in the NRRAW is very important to SE RAW. It might be more rational to build a separate information centre with an exhibition and conference hall, and even to provide the possibility for visitors to monitor online the monitoring and control system indicators.

It is envisaged that all buildings shall be of light design type. The foundations will be made on strip footing. The main structure of the buildings is a skeletal-beam system with structural elements of steel and reinforced concrete. The façade walls will be constructed with aerated concrete blocks and internal partitions of gypsum boards. The internal coatings and finishes shall be latex paint, faience and terracotta tiles and granite. Larger scale plans of the buildings and their location are provided in Appendices No.13-18.

The need for more auxiliary buildings (if necessary), enabling implementation of activities directly related to the operation of the NRRAW (e.g. garages, warehouses and etc.), shall be specified during the design stage.

1.2.2.3 AUXILIARY FACILITIES AND SYSTEMS

1. Protective hall

It is a light metal construction, covering an area over and around half a module with an approximate size of 51 x 60 x 20 m (width/length/height). The construction shall be completed by columns and trusses of cold bent steel profiles. The construction is shown in Appendix No.19**.** The siding will be of sheet iron with corrosion-resistant coating and insulation. The venting of the hall shall be through natural aeration. The structure shall be mounted on a rail, which can be moved using a separately installed propulsion system. As stated above, the protective hall is mobile, removable and shall be used consecutively as the modules are filled.

2. Gantry crane

As stated above, the transport-related technology operations shall be carried out with a crane. The crane is gantry, dual-beam, with a trolley and remote control, micro-gears and electric propulsion. Its main characteristics are: load capacity - 25 t; lifting height - 6 m; drop depth - 9 m. It is managed remotely from a fixed position. It is mounted on rails on the longitudinal walls of the module.

3. Leakage control system

The purpose of the system is to control the possible presence of water in the RAW chambers and allow inspection of the activity of flowing water in order to exert indirect control over the integrity of RCC both during the operation period of the NRRAW and after its closure.

The system is structured in modules and in accordance with the internationally adopted requirements in the area of radioactive waste management, based on the idea of maximum simplicity.

As it is described above, the bottom plate of each chamber is slightly inclined towards the centre part, through which passes a drainage pipe for the removal of any possible water. The bottom is covered with drainage layer of compacted gravel and gravel facilitating the runoff. The drainage pipes from each chamber discharge into the inspection (drainage) gallery. There is one collector in each gallery. The runoff from the drainage pipe is through funnels incised in the collector. At the exit points of the galleries the two collectors of each module merge in a single one which is routed into another perpendicular drainage gallery, connecting a group of four modules with control reservoirs – one for each module.

The reservoirs are placed in an underground premises in such a way as to ensure gravity runoff of possible leakage into them. In the case of leakage of radioactive contaminated water, the water collected in the tanks shall be pumped into a tanker truck and transported to the Special department of SE RAW at SD RAW-Kozloduyfor processing.

Over the underground chamber is situated a light building, connected to it via a shaft and staircase. In this building shall be placed a tank for removing, when necessary, the contaminated water. The building shall also provide access to the drainage gallery and the tunnels under the chambers.

The inspection (drainage) gallery with drainage pipes is displayed at **Figure 1.2-5** following the example of the low and intermediate level active waste repository in Mochovce, Slovakia.

The construction of the leakage control system is displayed in Appendices Nos.20, 21, and the scheme of the drainage galleries at **Figure 1.2-4.** Austenitic grade stainless steel shall be used. Much research indicates that it has high resistance – the rate of the general corrosion in water is about 0.05 μm/a – and it belongs to the group of completely resistant steel types as per BSS 7960-70. The system is designed so as to enable control and sampling of each radioactive waste disposal chamber; as well as for automatic alarming.

4. Site rainwater sewer

There is a powerful drainage system for removal of rainwater and melting snow water In the area of each module. The water is discharged into a water collection facility and controlled. The rainwater is expected to be conditionally clean and to be included in the general flow of surface water discharged into a main Brisha drainage canal or to be used in dry weather for washing alleys and the irrigation of sites and green areas. In the case of contamination the water shall be transported to special treatment facilities in the SE RAW on the site of Kozloduy NPP.

After the closing of the modules, the drainage system of the protective multi-barrier cover shall be connected to the drainage system around the modules.

5. Physical security system

In addition to the 24-hour armed guard of the NRRAW, the physical security system shall include, as a minimum, fencing formed by wired fences fixed to concrete poles and technical means, including a system for control and access registry, perimeter alarm system, perimeter video monitoring system, system equipped for monitoring of the radioactive waste modules and alarm system, as well as emergency lighting.

The physical security system shall be established in compliance with the provisions of the *Ordinance on ensuring the physical security of nuclear facilities, nuclear material and radioactive substances* [107] and the special requirements of the Ministry of the Interior. The project shall be approved by the services of the Ministry of the Interior. The system is designed to minimize unauthorized access to the NRRAW by considering possible terrorist threat.

6. Fire protection system

The site is designed in accordance with the requirements of the new *Ordinance No. Iз-1971 on fire-safety construction and technical rules and standards*, which came into effect on 15.06.2010. The site is built with materials that minimize the risk of fire, and a fire-fighting water supply as well as fire perimeter bands shall be provided. The volume of fire-fighting water supplied shall be 8.3 l/sec. The need for a fire-fighting pool shall be considered at a later design stage.

7. Experimental facility and test sector

The experimental facility is designed to test foundation solutions, the stability of the loess-cement cushion and the bottom slab, the stability of the trench construction, the stability of the slopes. The facility shall be constructed before building the NRRAW within the framework of the programmes for pre-operational monitoring so that the results can be used during the design and construction of the NRRAW. The test sector, designed for research intothe multi-barrier protective cover shall be constructed in parallel with the building of the NRRAW. The research shall be carried out during the period of operation of the NRRAW.

1.2.2.4 INFRASTRUCTURE

The infrastructure systems include internal roads, power supply, water and sewage installations and communications.

As was mentioned above, the site is accessible from the south by road No.11 and from the north by the road controlled by Kozloduy NPP. The route to be used for the transportation of RAW is described in section 1.2.3 NRRAW Site Plan. Interior roads shall be built on the site with dimensions defined by the process technology and by FCTS. The scheme of interior roadd is shown in **Figure 1.2-10 and Figure 1.2-11**.

The roads around the modules shall be 7 m wide and paved in a heavy type of pavement. They will be built in accordance with Appendix No.10 detail for type "A" pavement. All other roads shall be built in accordance with the enclosed detail for type "B" pavement in Appendix No.23.

Water for drinking and fire protection needs shall be provided from the existing water-conduit for drinking water of Water Supply and Sewerage – Vratsa, Kozloduy branch, supplying Kozloduy NPP, which has the necessary additional capacity. Water for drinking shall be supplied in the following buildings: checkpoint, administrative sector, laboratory unit and auxiliary facility. For external fire-fighting needs an FH 70/80 fire hydrant is envisaged, providing a flow of 8.3 l/s. The internal plumbing shall be done with PN16polypropylene pipes for cold water and PN20 pipes for hot water. The external water pipeline shall consist high-density polyethylene pipes - HDPE PN10 Ø90, in reinforced concrete housing for laying pipes in loess soils.

There is no operating domestic sewage system at the site. The sewage system shall be built and will discharge in the WS network of Kozloduy NPP. The internal sewage installations shall be made with PVC pipes Ø50 and Ø110, and the sector under elevation ±0.00 of the buildings - with PVC thick-walled pipes Ø160, in reinforced concrete housing for laying pipes in loess soils. The external domestic sewage shall be constructed with PVC thick-walled pipes Ø160 also laid in reinforced concrete housing.

Rainwater sewers shall be built. During the first stage, the rainwater from the four RAW storage modules shall be discharged into drainage ditches, which are to be built on both sides of the modules. These ditches shall also collect, through street runoffs, the rainwater from the roads. the rainwater shall be discharged by inspection shafts and sewers from PVC pipes Ø300 and Ø400 into three reinforced concrete rainwater tanks. Each tank has volume of 105 m^3 and dimensions 9.0/15.0/3.0 m = H. After dosimetric control, if not contaminated, the rainwater is included in the surface flow, used for irrigation and washing of alleys or discharged in the main Berisha drain of the Kozloduy NPP.

The power supply shall be provided from the power grid of CEZ or from the site of Kozloduy NPP where SE RAW has a division.

1.2.2.5 PERSONNEL

The NRRAW shall be an independent structure unit within SE RAW – Special unit SU NRRAW. The total number of employees shall be 64 people. The NRRAW personnel shall work in single-shift regime.

The proposal is in compliance with the stringent requirements in the area of nuclear safety and economic efficiency in the management of RAW. It is based on the requirements for the possible maximum protection of personnel, population and environment during the operation of the NRRAW in normal operation and any emergency conditions and the minimization of the investment and operational costs.

The safety of the disposal facility is ensured through passive means and the application of the principle for deep trench protection and the multi-barrier engineering system. In compliance with the modern tendencies and the good practices of the developed European countries [213] many barriers are provided to prevent the transition of radionuclides into the environment. Means for control, monitoring and inspection are envisaged. In accordance with the requirements of the legislative basis in case of possible radioactive contamination in the internal drainage system, the disposal technology envisages the technical possibility of applying corrective measures-changes in the engineering barriers and even the removal of defective containers, all which redounds in better public acceptance.

1.2.3 NRRAW site plan

The NRRAW comprises the above mentioned disposal facilities (modules) and small auxiliary buildings, shown to scale 1:2500 in **Figure 1.2-10** and in Appendix No.9.

The site is divided into a "Restricted area" and an "Administrative area". These areas correspond to:

⇒ Controlled area and supervised area as per art. 20, para 1 of the *Ordinance on basic standards radiation protection*, and to

⇒ Protected area and controlled access area as per art. 9, para 1 of the *Ordinance on ensuring the physical security of nuclear facilities, nuclear material and radioactive substances*.

In the Administrative Area are situated: the checkpoint, the administrative building, the laboratory building, the auxiliary building, the information centre, and other auxiliary buildings and facilities (if necessary) ensuring the implementation of the activities directly related to the operation of the NRRAW (for example: garages, warehouses and etc.).

Within the Restricted Area shall be situated the modules, the protective hall and panel/building for control and management of systems and equipment. A sanitary checkpoint shall be set up at the border between the two areas .

In compliance with the requirements of the *Ordinance on Terms and procedures for identification of special status areas near nuclear facilities and sites with sources of ionizing radiation* [108], a radiation protected area and monitored area shall be established. The preliminary research shows that the requirements for the external boundary of the radioactive protected area can be reached within 6 meters distance from the disposal modules [201], which means that the radiation protected area shall be within the fenced area of the NRRAW. This is also a requirement of SERAW set for the future project activities, recorded in the design terms of reference. The monitored area shall be defined at a later design stage. It shall include the nearby populated places and shall maintain confidence among the population about the absence of effects on humans and environment from the NRRAW by ongoing radioecology monitoring.

The radioactive waste shall be transported from the site of Kozloduy NPP on the service road, controlled by Kozloduy NPP. The transport scheme is shown at **Figure 1.2-11** and it is provided in Appendix No.22.

Necessary areas for the implementation of the investment proposal.

The necessary areas for the implementation of the investment proposal amount to approximately 36 ha. A substantial part of it, practically 50%, will remain undisturbed terrain or terrain which shall be cultivated in order to create an aesthetic environment. The maximum area of the terrain which shall be occupied by the disposal facilities, the service buildings and equipment, amounting to 17 ha, (including the area for Stage I and Stage II of the facility and supporting buildings amount of 3,2 ha). Parking, communication roads and other facilities covering 3.5 ha. As stated above, the site shall be fenced and secured in accordance with the requirements of the NRA for physical security of the radioactive waste management facilities.

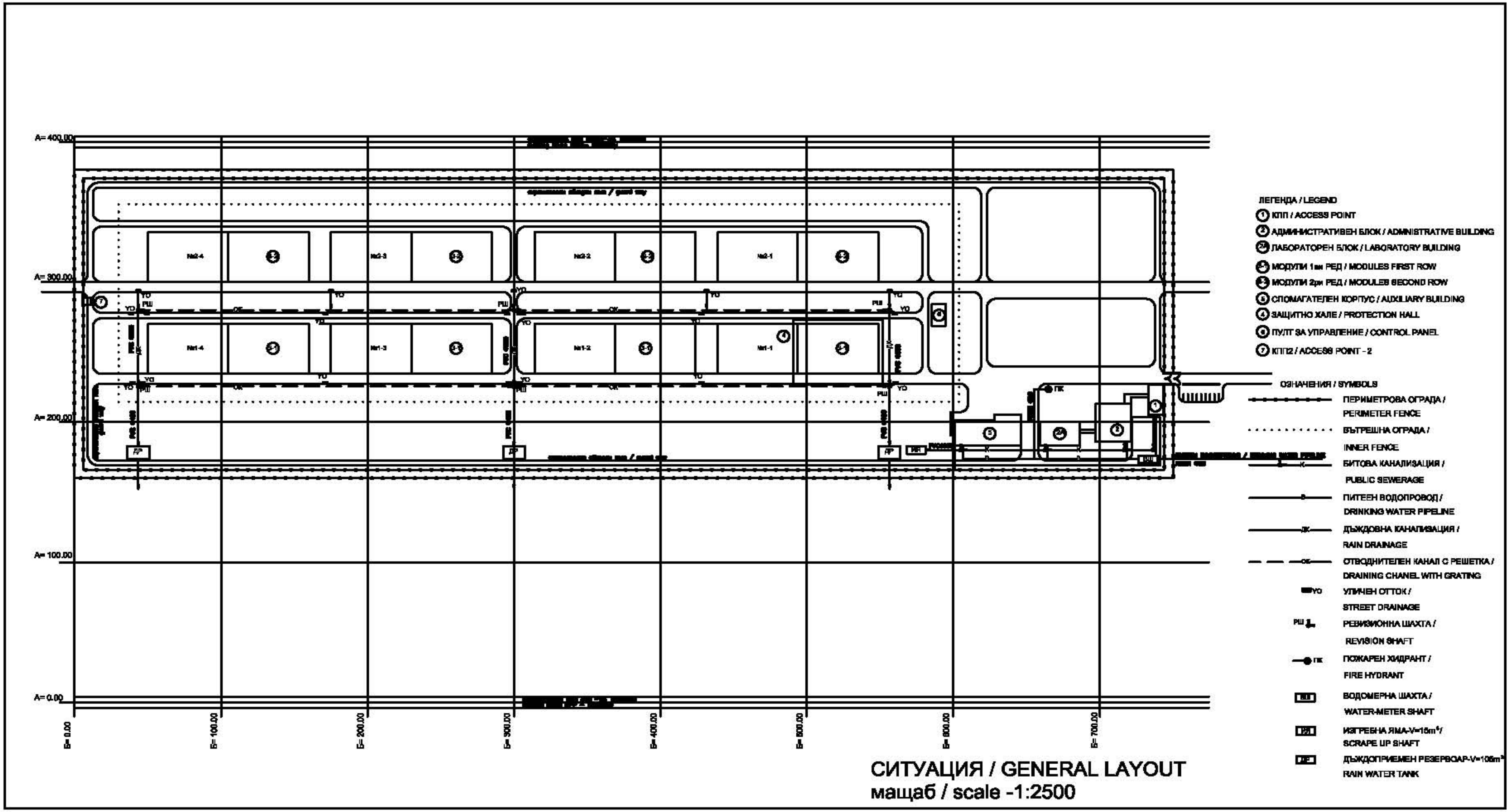
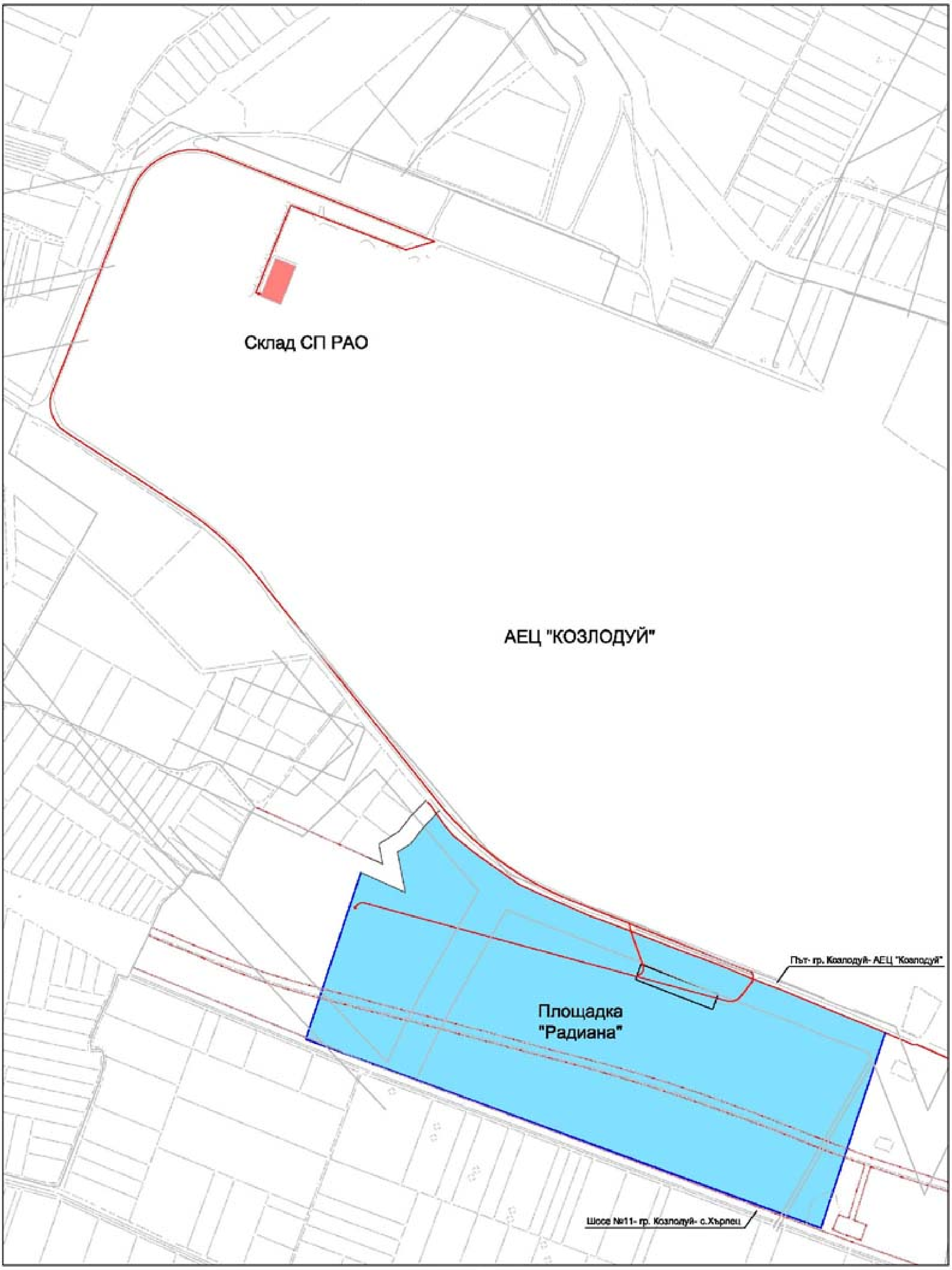


Figure 1.2-10 NRRAW general layout

ТРАНСПОРТНА СХЕМА
от Склад на СП РАО до площадка "Радиана"



М 1:6000

Figure 1.2-11 Transport scheme of the Warehouse for conditioned RAW storage near Radiana site

1.2.4 NRRAW capacity

The national repository for low and intermediate level radioactive waste must provide:

⇒ Capacity for the disposal of stored radioactive waste, generated in the country and stored at places of their generation and in the facilities for radioactive waste management of SE RAW;

⇒ Capacity for disposal of waste to be generated by 2075.

The preliminary assessment of the quantity of radioactive waste which is to be disposed of and stored in the NRRAW amounts to 138 200[(1)] m^3 (345 500t), which also defines the maximum capacity of the facility. The assessment of the total value of radioactive waste, subject to disposal in the NRRAW, was carried out within the framework of Task 3 *"Update of the radionuclide inventory of NRRAW*" of the agreement under PHARE [198]. The assessment is conservative and does not take into consideration programmes for minimizing the generation of radioactive waste or the future implementation of new technologies leading to minimization of the volume of radioactive waste.

Table 1.2.1 Volume of RAW subject to disposal in NRRAW

Conditioned RAW stream	Quantity of packaged conditioned RAW	Volume, m^3
RAW from the entire operational period of Kozloduy NPP	**11 756**	**87 169**
Conditioned solid RAW, DE1	2 298	17 039
Conditioned liquid RAW:	8 714	64 613
Conditioned liquid RAW – decantat from CPU, DE21	2 070	15 349
Conditioned liquid RAW – "solid stage" from CPU, DE22	6 644	49 264
Conditioned sorbents and slurry DE3	744	5 517
RAW from the decommissioning of Kozloduy NPP	**5 690**	**42 191**
Conditioned RAW in the preparation stage for safe storage and safe keeping DD1	187	1 387
Conditioned RAW from dismantling of equipment DD2	5 503	40 804
TOTAL for RAW from Kozloduy NPP	**17 446**	**129 360**
RAW from research reactor RR-2000 DD	**54**	**400**
RAW from operation of Belene NPP , DE	**810**	**6 000**
RAW from nuclear applications, DA	**305**	**2 440**
TOTAL	**18 615**	**138200**

The radionuclide composition is the most important characteristic defining the main properties of the radioactive waste. The radionuclide inventory of the NRRAW is also defined within the framework of the above mentioned project [198]. It is presented in the table below together with the properties of the radionuclides.

Table 1.2.2 Radionuclide inventory of RAW

Radionuclide	Stream / radionuclide composition, Bq						Total for radionuclide, Bq
	DE1	DE21	DE22	DE3	DD1	DD2	
^{54}Mn	2,1E+11	7,9E+10	N.A	2,9E+11	1,7E+10	5,0E+11	1,1E+12
^{59}Fe	2,0E+11	7,5E+10	N.A	N.A	1,7E+10	4,9E+11	7,9E+11
^{58}Co	2,0E+11	5,6E+10	N.A	N.A	1,7E+10	4,9E+11	7,7E+11
^{60}Co	1,4E+12	1,5E+12	7,0E+12	1,9E+12	1,1E+11	3,4E+12	1,5E+13
^{110m}Ag	4,8E+11	1,6E+10	N.A	N.A	3,9E+10	1,2E+12	1,7E+12
^{134}Cs	3,7E+11	9,1E+12	N.A	9,7E+12	3,0E+10	8,8E+11	2,0E+13
^{137}Cs	6,0E+11	4,6E+13	6,0E+13	3,2E+13	4,9E+10	1,4E+12	1,4E+14
^{95}Nb	1,0E+11	N.A	N.A	N.A	8,2E+09	2,4E+11	3,5E+11
^{233}U	N.A	1,1E+07	7,7E+06	N.A	N.A	N.A	1,8E+07
^{234}U	N.A	2,0E+07	8,5E+07	N.A	N.A	N.A	1,0E+08

[(1)] The volume includes both the radionuclide waste and the volume of the reinforced concrete containers in which it is packed.

Radionuclide	Stream / radionuclide composition, Bq						Total for radionuclide, Bq
	DE1	DE21	DE22	DE3	DD1	DD2	
^{235}U	N.A	1,1E+07	7,9E+06	N.A	N.A	N.A	1,8E+07
^{238}U	N.A	1,4E+07	3,9E+07	N.A	N.A	N.A	5,3E+07
^{238}Pu	N.A	1,7E+07	5,2E+09	N.A	N.A	N.A	5,2E+09
$^{239/240}Pu$	N.A	1,5E+07	8,7E+09	N.A	N.A	N.A	8,7E+09
^{242}Pu	N.A	1,1E+07	2,6E+07	N.A	N.A	N.A	3,7E+07
^{242}Cm	N.A	1,1E+07	8,6E+07	N.A	N.A	N.A	9,8E+07
^{244}Cm	N.A	1,2E+07	3,0E+09	N.A	N.A	N.A	3,0E+09
^{241}Am	N.A	1,6E+07	1,3E+10	N.A	N.A	N.A	1,3E+10
^{129}I	N.A	2,4E+07	6,1E+07	N.A	N.A	N.A	8,6E+07
^{14}C	N.A	6,4E+10	2,6E+12	N.A	N.A	N.A	2,7E+12
^{90}Sr	N.A	2,7E+10	3,1E+11	N.A	N.A	N.A	3,4E+11
^{63}Ni	N.A	9,8E+11	3,4E+12	N.A	N.A	N.A	4,4E+12
^{55}Fe	N.A	1,4E+10	1,4E+13	N.A	N.A	N.A	1,4E+13
^{99}Tc	N.A	2,1E+08	1,6E+09	N.A	N.A	N.A	1,8E+09
^{94}Nb	N.A	1,1E+08	3,2E+09	N.A	N.A	N.A	3,3E+09
$\sum\alpha$	3,9E+08	N.A	N.A	3,9E+13	3,2E+07	9,4E+08	3,9E+13
∑ for the stream	**3,6E+12**	**5,7E+13**	**8,7E+13**	**8,2E+13**	**2,9E+11**	**8,5E+12**	**2,4E+14**

In accordance with the recommendations of the IAEA and the good practices in the area of the radioactive waste management, the radionuclide inventory is subject to further specification and update by defining the different waste streams and the implementation of analysis methods. It is a mandatory condition throughout the lifetime of NRRAW to maintain records and store information about the properties of the disposed radioactive waste.

The output of the NRRAW is from 3 to 4 RCC/day. This is defined with reference to the positioning within two years of existing RCC, which are currently stored in the Warehouse for conditioned RAW at the site of SU RAW-Kozloduy. The output also takes into account the planned increase of RAW processing output on the territory of Kozloduy NPP due to the activities related to the decommissioning of Units 1 to 4 of Kozloduy NPP. .

The maximum annual output is 800 RCC, defined on the basis of receipt of RAW **200 days annually**, taking into consideration the fact that the transport of RAW is performed only on working days and that the transport shall not be performed in poor meteorological conditions.

1.2.5. Stages of the investment proposal

The main stages of the investment proposal are as follows:

1. Selection of site 2006 -2011.;
2. Design 2010 – 2012.;
3. Construction 2012 - 2014;
4. Operation 2015 – 2075.;
5. Closure 2075 – 2090.,
6. Institutional control 2090 – 2390.

Table 1.2.3 Schedule of activities during the investment proposal stages

Stages	Activities
Preparatory stage	Defining of RAW management strategy

Stages	Activities
	Adoption of governmental decision on the construction of the NRRAW – DMC No.683/25.07.2005. Analysis, elaboration of documentation and submission of application to the NRA for the selection of site permit
Selection of site:	*Beginning of stage:* *Issuance of permit by the NRA for the selection of site*
(1) Development of disposal and concept and planning	Elaboration of disposal concept; definition of safety requirements; definition of criteria for selection of suitable site; elaboration of detailed schedule
(2) Data collection and analysis of areas	Execution of thorough analysis of existing information about the territory of the country, about the typical features of the environment; consideration of social and economic aspects; definition of potential areas and sites, subject to thorough field and laboratory research. Exclusion of areas unsuitable for construction of the repository by the method of exclusion. of . Definition of potential areas where sites are identified. Thus, initially on the basis of analysis, 78 potential sites were selected for the construction of NRRAW. After a thorough analysis they were limited to 12; out of which the 4 most suitable sites were defined: Marichin valog, Brestova padina, Vurbitsa and Radiana.
(3) Assessment of sites	Conducting thorough field and laboratory studies on the potential sites of Marichin valog, Brestova padina, Radiana and Vurbitsa; Comparing their characteristics. On the basis of multi-criteria, the Radiana site was defined as the most suitable site
(4) Confirmation of site	Further more detailed field and laboratory studies are conducted at the designated site; Preliminary projects on the NRRAW are elaborated according to the characteristics of the site – for Radiana site preliminary projects are elaborated for a repository of trench, shaft and tunnel type. The preferred construction of the repository is defined. The most suitable construction for Radiana site is determined to be a trench type multi-barrier engineering repository. The EIA is executed. Application is submitted to the Chairman of NRA for obtaining of order approving the selected site and for design permit. The preliminary safety assessment is the basic document. Programmes are elaborated on pre-operational monitoring conducted before the repository is put into operation.
	End of stage: *Order of the NRA Chairman for approval of the selected site*
Design	
(1) Elaboration of DDP	*Beginning: Order of the Minister of Regional Development and Public Works on DDP* The elaboration of detailed development plan – the regulation and construction plan at Radiana site is aimed at optimal volume and planning decision for the NRRAW site, organization and management of NRRAW designed for engineering and technical purposes. On the basis of approved DDP, the land status is changed. It serves for obtaining full planning permission from MRDPW. An application for full planning permission is submitted to MRDPW. *End: Order of the Minister of Regional Development and Public Works*
(2) Elaboration of conceptual design	*Beginning: Full planning permission from NRA and MRDPW.* The conceptual design shall follow the provisions of the detailed development plan. Two versions are envisaged, both of which shall meet the requirements of Ordinance 4 on the scope and content of the investment projects and of the requirements of the nuclear legislation. The best option shall be selected based on feasibility study.
(3) Elaboration of technical project	The Technical project shall be elaborated on the basis of the selected conceptual design. An Interim safety assessment, the main document for the approval of the technical project, shall be elaborated. Application shall be submitted to the NRA for the approval of the technical project and for the obtaining of building permit. Preliminary contracts shall be concluded with operational entities (electric power distribution, water and sewage). Application for approval of the technical project and for obtaining of building permit shall be submitted to MRDPW. *End: Approval of the technical project by MRDPW; Order of the NRA Chairman on the technical project*
Construction	*Beginning: Building permit issued by MRDPW and NRA* Building of disposal facilities, auxiliary buildings, connecting infrastructure systems to the points of connection, supply and installation of equipment . The building shall be implemented in two stages. Four modules shall be constructed during the first stage. Activities related to the construction of NRRAW are described in detail in sect.1.2.6. At the present stage of the investment proposal it is accepted as optimal that the first two modules be put into operation

Stages	Activities
	upon their completion, and that the construction of the other two modules to be carried out in parallel with the exploitation of the first two. At the present stage of the investment proposal it is accepted that the optimal term for the initiation of the 2nd stage of construction is to begin after the decommissioning of the Units 1-4 of Kozloduy NPP. *End: obtaining a permitn from the State Acceptance commission for the use of the facility*
Operation	*Beginning: receiving permission from NRA for commissioning.* The commissioning shall be carried out in accordance to a detailed schedule. The commissioning results shall be included in the updated safety assessment which is the basis for the obtaining of NRA license for the operation of NRRAW. Receiving a license for operation with a maximum term of 10 years. The license shall be renewed on the grounds of documents proving the observation of safety requirements, basic document – updated safety assessment. Placement of RAW in the disposal facilities; control of the status of the facilities and the disposed waste; radiation control and monitoring of the site; radiation protection and monitored areas, described in detail in sect.1.2.8. The filled modules are controlled and monitored for a period of time which will be determined during the following design stages. During the operation, on the basis of operational experience, this period shall be further refined. At the present stage of the investment proposal at least 10-year term of monitoring and control is considered. *End: filling of the disposal modules and expiry of the period of their monitoring and control, set in the technical project and revised on the grounds of operational experience.*
Closure of NRRAW	*Beginning: permission/license for the closure issued by NRA Chairman* The closure project shall be elaborated on the basis of the Part "Closure" of the technical project of the NRRAW, updated with the results from the site monitoring and control during the entire operational period of NRRAW, new knowledge, technologies and materials, developed during the operation of NRRAW, and long-term studies conducted on protective multi-barrier covers. The EIA on closure and updated safety assessment are the basic documents for applying for and receiving the closure permission/license. The closure consists of decommissioning and dismantling or sealing of all building constructions, systems and equipment, used for the acceptance and deployment of RAW; disposal of RAW generated as a result of such activities; conditioning of the facility in status ensuring its long-term safety; establishing systems for monitoring and surveillance of the facility, the site, radiation protected and monitored area; updating and archiving the information regarding the facility. The nuclear legislation allows phased closure of the filled modules, combined with the operation of the empty modules. *End: approval of the closure activity granted by NRA.*
Post-operational period	*Beginning: permission/license for entering into post-operation period* Includes a period of institutional control with total duration of 300 years. Active institutional control within the period of the first 100 years, during which monitoring, access control, minimal technical maintenance of facility and related systems and infrastructure shall be conducted and, in case of proven need and efficiency, any reconstruction and corrective measures. Passive institutional control used to implement administrative control measures regarding the use of the land. *End: release of the site for unrestricted use.*

1.2.6 Description of the main processes during the construction stage of NRRAW and used resources

Description of the main processes during the construction

The construction of NRRAW shall be carried out in stages. Four modules shall be built during the first stage. Initially the first two modules shall be built and the construction of the second two modules shall be combined with the operation of the NRRAW (beginning of the first module loading).

This schedule is determined by the requirement that the NRRAW be put into operation in 2015, as is stated in the *Strategy for spent fuel and radioactive waste management* [127] and in compliance with DMC No.683/25.07.2005 for the construction of the NRRAW. This strategy accounts for the possibility of amendments in the project on the basis of the operation of the first two modules in accordance with the requirements of the nuclear legislation. Besides, the approach is far more efficient as it does not require long-term maintenance of the facilities before their loading with radioactive waste. The excavation works shall be relatively limited in volume and can be accomplished within a single spring-summer season (approximately six months). The distancing of the building works at a distance of approximately 150 m provides conditions for safe operation and steady execution of the building activities on the latter two modules.

The building works of the above stated approach shall be organized as follows:

1. Excavation for the first two modules, compactiing of the earthen structure.

2. Beginning of the execution of the loess-cement cushion together with the excavation works for the second two modules. Besides, the excavated upper layer loess can be added directly in the loess-cement cushion instead of being transported for disposal.

3. The completion of the loess-cement cushion coincides with the completion of the excavation works and the compacting of the ground under the latter two modules begins. Pending the completion of this process, the preparation of the commencement of the concrete works is carried out.

4. After completion of the compacting, the simultaneous construction of the first two modules and the execution of the loess-cement cushion under the second pair of modules begin.

The implementation of the first stage of the NRRAW (construction of four modules) is as follows:

1. Clearing of the building site: removal of vegetation, displacement of existing communications; fencing the building site with temporary fence; temporary roads and drainage ditches; geodetic network and benchmarking of the main items;

2. Removal of surface humus layer, deposition for safe-keeping at the site, as it shall be used for the for cultivation of the aesthetic environment of the site and during the construction of the protective multi-barrier cover, preparation for the excavation works – building of drainage ditches along the periphery of the future excavation.

3. Digging for loess for the loess-cement cushion and back filling. Excavation works for the removal of collapsible loess. It shall be used for the execution of the loess-cement cushion and the back filling. According to the geological report [173] and on the basis of the experience in the building loess-cement cushion during the construction of Kozloduy NPP, the content of the loess in the surface layers is more suitable for the loess-cement and the specially treated back filling. It is stored in a depot built at the Radiana site;

4. Digging of loess representing surplus spoils. The loess from the lower layer of excavation (the last 6 m) is more clay bearing and inappropriate for backfilling; it is removed from the site for purposes described in sect.1.2.12;

5. Stabilization of the soil structure by piling short pyramidal piles with a section of the basis 0,45 x 0,45 m and length 6 m;

6. Execution of the loess-cement cushion with a thickness of about 4000 mm, which functions in the repository construction are described above. Execution of layers from 100 to 150 mm with varying cement content from 2 to 8 %. Placing of drainage pipes and organizing the drainage system for the collection of slope and surface water during the construction works;

7. Execution of the inspection (drainage) galleries under each row of chambers in the modules and placement of the collectors with fixed penetrations in their roof slabs;

8. Execution of the reinforced concrete construction of the modules, includinguding the bottom slab and the chamber walls. Strict observation of the continuity of the process of concreting and implementation of strict quality control of materials;

9. Execution of the drainage galleries and facilities – includes the further construction of the above stated in sect.7 inspection (drainage) galleries and their equipping with equipment for sampling of each chamber, construction of perpendicular drainage galleries (**Figure 1.2-4**) of the drainages outside the sites;

10. Execution of the back filling using standard technologies with compacted loess;

11. Formation of roads, technologic sites and equipment

12. Execution and assembling of additional facilities: crane way, crane, stripe base of the steel protective hall and the hall. The hall is mounted over 1/3 of the module, but the stripe base shall run along the whole length of the module;

13. The execution of the auxiliary buildings shall be carried out in parallel with the construction of the disposal facilities in the following order: at the end of the stage of the excavation works, the site shall be prepared, and building shall begin before the end of the back filling stage and the underground communications around them shall be front-running. The auxiliary buildings must be completed before

beginning the activities related to the formation of the roads and the sites and the installation of the facilities around the modules.

The construction period of the 2 modules of the NRRAW together with the ancillary buildings and facilities shall be approximately 24 months. The construction of the second two modules of the first stage shall be carried out parallel with the operation of the first two modules.

The modules which are situated in the lower and flatter part of the Radiana site shall be built during the first stage.

The execution of the activities associated with the construction of the second 4 modules shall be similar to the first stage activities with the only difference that the auxiliary buildings and facilities are constructed during the first stage. At this stage of the investment proposal it is accepted that the second stage of the construction of the NRRAW shall be completed after the decommissioning of Units 1-4 of Kozloduy NPP is finalized.

Proposed building methods

As is evident from the above detailed description of the activities for the construction of the NRRAW, all activities, including excavation works, building works for the construction of the modules, activities for the construction of the ancillary buildings and facilities that are standard and typical for this type of sites. The execution of the loess-cement cushion has been tested and proven during the building of Kozloduy NPP and the building works completed to date at Belene NPP.

The concrete shall be delivered from the nearest concrete plant.

The reinforcement shall be prepared and delivered finished at the site. The building works shall be carried out by using advanced level building machinery.

All building activities shall be carried out under strict quality control of supplied materials and of the building process – quality certificates and additional testing. The control shall be implemented not only by specialized companies licensed to exert control over the quality of the building activities, but also by the personnel of SE RAW. SE RAW is also planning to exert control over the quality of the building works with the help of non-destructive methods.

The location of the depots for hummus, spoils and construction waste are given in **Figure 1.2-12.**

Personnel necessary for the construction of the NRRAW

The average number of employees of the building works Contractor will be an average of 55 people. In addition, an average of 7 people shall be present at the site, who will be representatives of the Investor and the Construction supervision. The maximum number of workers and personnel on site shall not exceed 75 people.

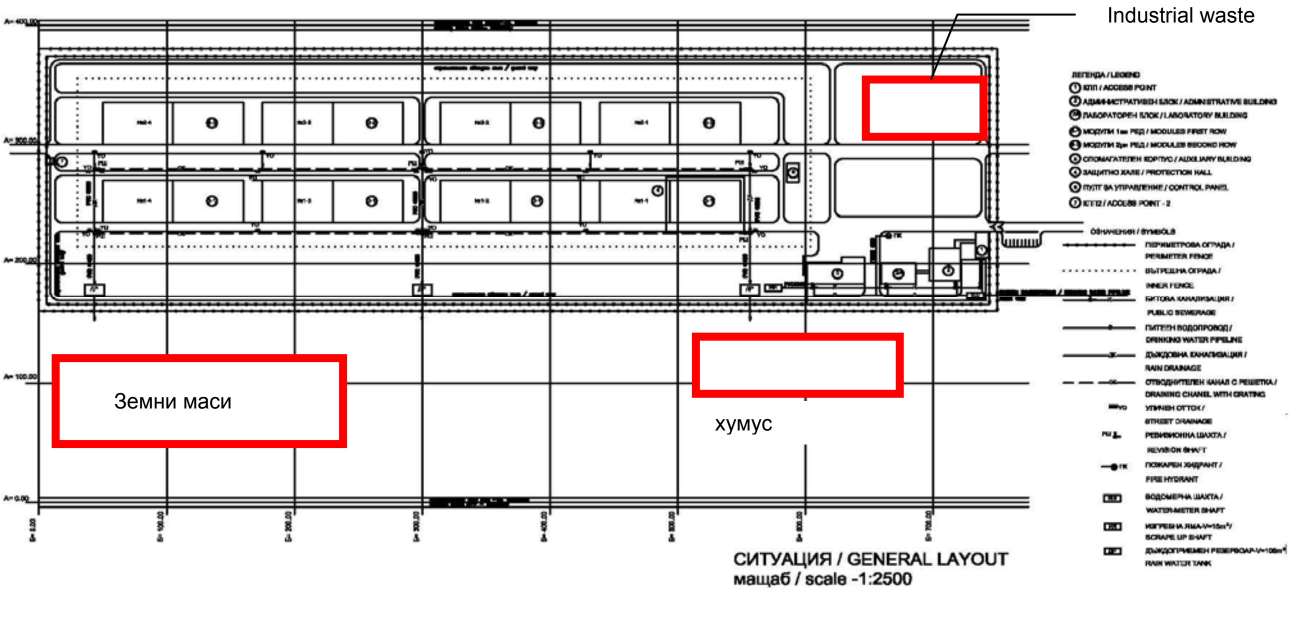


Figure 1.2-12 Location of temporary depots for spoils, hummus and construction waste at the Radiana site

Temporary storage of soil mass and humus will be on a special location outside of the site defined for facility. This location will be defined later at the following stage of project design.

1.2.7 Description of the main activities during the operational stage of the NRRAW

The main activities of the radioactive waste disposal in disposal facilities are simple technological operations relating to deployment in disposal chambers and strengthened control over the radioactive waste status, the facilities, the radioactive protected and monitored areas. **Activities related to the processing and conditioning of radioactive waste at the NRRAW site are not envisaged.** The radioactive waste transported to the NRRAW site is processed, conditioned and packed in reinforced concrete containers (RCC) with dimensions of 1.95 x 1.95 x 1.95 m, described in detail in sect.1.2.11. Solid waste or bulk materials are not envisaged for deployment and disposal in the disposal facilities.

Low and intermediate level radioactive short-lived waste (category 2a according to the categorization in the Ordinance on safe radioactive waste management [93]) generated on the territory of Republic of Bulgaria shall be disposed of in the NRRAW. ,

The NRRAW personnel of 64 people shall be working in one-shift working mode, with the exception of the police security.

In accordance with the requirements of the Bulgarian nuclear legislation for the operation of radioactive waste management facilities and the IAEA standards on safety and good practices, the operational process in NRRAW shall have two aspects:

⇒ Execution of technological activities related to the deployment of RCC in the disposal facilities;

⇒ Inspection and monitoring, control over the status of: stored RCC, disposal facilities, the site, the radiation protected area and the monitored area.

Technological activities related to the deployment of RCC in the disposal facilities

(1) Transportation of reinforced concrete containers

The transportation of RCC to the NRRAW shall be carried out by a specialized transport unit (STU) with 20 t load capacity following a strict itinerary as shown in **Figure 1.2-11.**

The itinerary includes: Warehouse for storage of conditioned radioactive waste (WSCRAW) of SE RAW (SU RAW-Kozloduy), situated at the site of Kozloduy → gates of SE RAW-Kozloduy → Dose control gateway of Kozloduy NPP → Checkpoint of Kozloduy NPP → road controlled by physical security of Kozloduy NPP → Checkpoint of the NRRAW. The transportation is carried out over internal roads within the site of Kozloduy NPP, the road controlled by Kozloduy NPP, and the internal roads of NRRAW.

The transportation shall be carried out in accordance with the specially developed instructions and procedures, at below a maximum speed of 20 km/h. It is carried out by special transport vehicles of SE RAW, which holds a license to transport radioactive substances. The specialized transport vehicle (STV) is accompanied by a car with accompanying persons, in accordance with the established practice at SE RAW. The RCC transport activities shall be carried out in accordance with the requirements of the *Ordinance on basic standards and procedures for transportation of radioactive substances* [110], the provisions of the *European agreement concerning the International Carriage of Dangerous Goods by Road (ADR)* [111] and the terms of the license issued by the NRA.

At the present stage of the investment proposal it is accepted that the radioactive waste from Belene NPP shall be transported by the personnel of Belene NPP to the WSCRAW of SE RAW for control and monitoring for a certain term before transporting it to the NRRAW for disposal. This approach shall be developed in more detail during the stage of elaboration of the technical project of the NRRAW and even further developed at a later stage during the operation of Belene NPP on the basis of the control exerted by the experts of the NRRAW on the programmes and technologies of Belene NPP for radioactive waste management.

(2) Acceptance and entry control of RAW packages

The acceptance begins with control of the packages prepared for transportation at the place of their temporary storage – WSCRAW. Their acceptance on the territory of the NRRAW shall be carried out under a specified regulation by the person in charge of the acceptance and in the presence of the radiation control officer on duty. The police security guards shall check the RCC. The personnel of NRRAW shall verify the completeness of the accompanying documentation and carry out the initial radiation control of the package. The transport vehicle shall move to the intended area before the laboratory unit. Thorough entry control shall be carried out, followed by the elaboration of the relevant record. The entry control shall be carried out to guarantee that the RCCs and their contents correspond to their acceptance criteria for radioactive waste to be disposed of in the NRRAW. In general the preliminary criteria which correspond to the current stage of the investment proposal are given in the table below. They have been developed in accordance with the recommendations of the IAEA and the requirements of the Ordinance on safe management of radioactive waste [93]. At subsequent design stages the criteria shall be specified in accordance with the results of the safety assessment.

Table 1.2.4 Criteria for acceptance of RAW and its control

Criteria	Verification of compliance
Waste type	
1) Conditioned, low and intermediate level short-lived RAW category 2a are accepted for disposal 2) RAW containing only natural radioactive substances, including technologically changed concentration of radionuclides, with the exception of disused Spent Radioactive Sources shall not be accepted for disposal . 3) RAW which may be exempted from subsequent regulatory control shall not be accepted.	Entry control – as per documents
Waste form requirements	
4) RAW, conditioned by cement technology, approved by the repository operator shall be accepted for disposal in the NRRAW	Entry control
5) Chemical and physical compatibility between the waste, the matrix and the container.	Verification of documents and analysis
6) Not less than the statutory rate of the washing away of key radionuclides from the matrix (provided in sect.12.12)	Analysis of samples from the matrix
7) The mechanical properties of the matrix shall not be lower than the statutory requirements (provided in sect.12.12)	Analysis of samples
8) Materials in RAW or the matrix which may cause matrix degradation or dangerous reactions and physical phenomena are not allowed	Analysis of samples
9) Chemically dangerous substances, except the protections of the processed sources conditioned in the package, shall not be allowed in the content.	Analysis of samples
10) The content of free liquid (aqueous solution) shall be limited to the extent practically possible, not higher than 1 vol.%. The content of organic solvents, oils and greases shall be limited to the extent practically possible.	Analysis of samples
Package requirements	
11) The suggested use of uniform package for RAW disposal on the basis of: Waterproofing ferroconcrete container with dimensions 1950 x 1950 x 1950 mm, mass of filled container ≤ 20 t.	Verification of documents. Entry control of the marking, weight, surface condition, dimensions
12) MED gamma radiation must be ≤o т 2 mSv/h at any surface point, and at a distance of 1 m from the surface ≤ 0.1 mSv/h.	Verification of documents Entry control – checking for MED
13) Non-fixed contamination on accessible surface averaged over 300 cm^2, Up to 4 Bq/cm^2 for β-, γ-emitters and low-toxic α-emitters and Up to 0.4 Bq/cm^2 for other α-emitters.	Entry control
14) The container must preserve its mechanical integrity and provide for the full retention of the radioactive substances over a period of not less than 50 years. For this purpose, the following requirements are defined for the concrete of the container: Strength index not lower than 25 MPa, Watertightness not lower than 0.8 and Frost resistance F 100.	Review of the system ensuring the quality of the manufacturer of containers Tests of container Certificates Monitoring
Requirements for the activity and the radionuclide inventory of the package	
15) Maximum activity in one package ≤ $8,3.10^{10}$ Bq,	Verification of documentation

Criteria	Verification of compliance
16) The specific activity of long-lived radionuclides in one package is limited to 4.10^5 Bq/kg.	Entry control
Requirements for marking and identification	
17) Each package must be marked with identification marks, to enable its identification and removal at any time during the lifetime of the repository.	Entry checking, verification of compliance with the marking procedure
18) Each package must be accompanied by the corresponding documentation, enabling the identification of the package and containing as a minimum the origin, time, place and method of conditioning, activity and radionuclide inventory, properties of RAW and matrix, strength of dose and radioactive contamination of the container surface, mass.	Review of documentation verifying the completeness and proper filling.

The implementation of control is the responsibility not only of the NRRAW Operator but also of the RAW Producer. The responsibility of the RAW producers, in this case SE RAW-Kozloduy and the future Belene NPP, is to implement the technological activities related to processing, conditioning and packaging in RCCs in accordance with the technological regulations, subject to approval by the NRRAW Operator. The NRRAW personnel shall inspect the places for processing, conditioning and packaging. At the NRRAW site the personnel shall thoroughly review the documentation, check the marking, carry out visual control on RCCs (package integrity, lack of violations); perform radioactive and dose control (verification of the rate of gamma radiation dose, the surface contamination, the gamma spectrometric analysis), and control the status of conditioned waste and the reinforced concrete container by non-destructive methods. It is not envisaged to use destructive methods of analysis which could cause the generation of secondary radioactive waste.

(3) Transfer of packages from the transport vehicle into the disposal chambers

If entry control is satisfactory, the transport vehicle with the package is moved to the loading module and is positioned next to the chamber where the packed RAW shall be deployed. The driver of the STU and the rest of the personnel then leave the area and further operations are carried out remotely using a video camera monitoring system. The management is performed from a Control panel (CP), situated in the building next to the modules, by the NRRAW operators. Relevant records are kept during the transfer of the package. The driver of STU, accompanied by the Radiation control officer, leads the STU out of the module area (protective hall) and of the controlled area. The loading of RCC in the modules is carried out under a schedule ensuring the dose load (self-shielding of the packages, using each one as biological shield) and even loading of the bottom slab of the modules.

(4) Recording

All operations are recorded. One of the prime tasks of the NRRAW is to maintain a database of the accepted and stored packages and information about the specific properties of the facility as a whole. An archive is set up and maintained in electronic form and in hard copies of records/documents which must be stored throughout the entire operational period of the NRRAW.

Inspection and monitoring, control over the state of: disposed RCCs, condition of the disposal facilities, the site, the radioactive protected area and the monitored area

During the entire operation period before the decommissioning of a module, the state of the construction of the module and the packages (RCCs) disposed in it shall be checked. The control over the packaging is visual by a special manipulator, equipped with TV cameras, which moves easily along a movable structure over the controlled chamber, and by TV cameras, attached to a specially designed bar, suspended to the crane trolley. The outside condition is checked in order to identify the potential problems such as dents, holes, cracks, bulging, loss of integrity of the coating, corrosion of metal parts, signs of leakage (changed colour, stripes), and damaged elements of the packaging. The early detection of potential problems enables rehabilitation actions aimed at preventing further degradation of the barrier from and release of radioactivity. Automatic measurement is carried out of the equivalent dose gamma radiation in the disposal modules and aerosol activity is detected. The drainage system of the disposal modules is monitored for possible presence of infiltrated water. In case of detected infiltrated water, its volume and total beta activity must be determined. When radiation values distinguishable from the background ones are recorded, spectrometric analysis must be carried out along with radiochemical determination of the difficult-to-detect radionuclides. If there is no radionuclide contamination, the water is considered as waste drainage water and is treated as described in sect.1.2.12. If radionuclides are detected in the drainage water, it must be treated as a secondary liquid radiation waste and must be processed in the installation of SE RAW-Kozloduy at the Kozloduy NPP site.

Continuous radiation and dosimetric control is carried out on the territory of NRRAW by using stationary and portable systems and equipment. The personnel situated within the controlled area or that carry out any activity related to exposure risk shall be equipped with individual dosimetric equipment. In accordance with the established practice in SE RAW, the maximum levels for personnel shall be stated, and these shall be significantly lower than the ones provided in the *Ordinance on basic standards of radiation protection*. The surface contamination of all people and transport vehicles leaving the controlled area and the NRRAW territory shall be controlled. The radiation field around any delivered packaging with RAW shall be measured. Periodic measuring of the radiation field is carried out in the controlled area.

The disposal modules and the site are controlled and measured by geodetic monitoring, geotechnical and geodynamic monitoring, control on the seismic behaviors of the site and the construction materials and structures, and by meteorological monitoring. Particular attention is paid to the hydrogeological monitoring which controls the movement of underground water from the NRRAW site.

The radiation monitoring of the site, the radiation protected area and the monitored area includes: detection of the gamma radiation background and control of possible radionuclides from the inventory of the NRRAW in the ground, air, precipitation, surface and underground water, water supplies, soils, vegetation and agricultural products.

All activities and results shall be recorded. The information is stored in the database in printed and electronic form.

Personnel Required for Operation of the NRRAW

The NRAAW shall be an independent structure unit within the framework of SE RAW – Specialized unit SW NRRAW. The total number of personnel comes to 64 persons, distributed as follows: 24 administration staff, 26 operational staff and 14 maintenance staff.

1.2.8 Description of the major activities during the stage of NRRAW closure

The closure of the NRRAW shall be carried out under a specifically developed technical project upon the completion of the environmental impact assessment and upon obtaining a permit/license from the NRA.

The objective of the closure is to safely isolate the radioactive waste from the environment and people by filling the empty space between RAW packages and establishing protection shields along the water flow around the modules. It shall be accompanied by assessment of NRRAW safety during the institutional control period and the performance of post-operation monitoring.

The filling of the space between the modules shall be carried out with suitable loess-cement substances, containing natural non-organic absorbents. The mechanic stability of the construction and the waterproofing of the RAW containers must be ensured, as well as the maximum retention of the radionuclides in them. The modules shall be shielded by protective shields preventing water flow, gas transition, penetration of underground animals and plant roots. The shields shall be constructed of natural materials.

At the present stage of the investment proposal the activities related to the closure of the modules are as follows:

(1) Analysis of the operational documentation, includinguding the results from the packaging condition control and the construction elements of the module;

(2) The gaps in the inner space of each chamber shall be filled with loess-cement substance, which includes a suitable filler – for example zeolite. The substance shall be poured up to the level of the upper edge of the module;

(3) Over the so-formed loess-cement matrix a reinforced concrete slab-cover of the module is cast and it is covered with suitable waterproof material;

(4) Backfilling up to the edge of the cover is executed as described above.

(5) A loess-cement of up to 1 m thickness layer is formed above the cover and in the space around it.

(6) A layer of waterproof clay can be poured above it and then covered with geotextile. Next, a layer of sand, a layer of gravel and again a layer of sand shall be poured, in that order, and then topped with a soil humus layer on which suitable vegetation shall be planted, i.e. a multi-barrier protective cover shall be executed, as described in sect. 1.2.2. The forms of the relief shall be restored during the building of multi-barrier protective cover, if necessary geotechnical treatment of the massif has to be executed to ensure its long-term stability. The humus deposited on the site shall be used for the restoration of the soil layerm. The rainwater drainage, constructed on both sides of the modules, shall be used for the discharge the rainfall water from the multi-barrier cover. The drainage water must be collected in reservoirs for radiation

monitoring. If there is no radionuclide contamination of the water, it shall be treated as described in sect.1.2.12. If radionuclides are detected in the drainage water, it should be treated as liquid radioactive waste and processed in the installation of SURAW – Kozloduy. The drainage water from the inspection galleries shall be controlled the same way.

(7) Programmes for post-operational monitoring shall be developed. They shall meet the requirements of the nuclear legislation, defined in the *Ordinance on safe management of the radioactive waste* [93] and the *Ordinance on Terms and procedures for identification of special status areas near nuclear facilities and sites with sources of ionizing radiation* [108], the recommendations of EIAR and the good practices, defined in the IAEA recommendations [352].

At the present stage of the investment proposal it is accepted that the closure activities shall be carried out within 15 years. This period shall be followed by 100 years of active institutional control and 200 years of passive institutional control.

The period of institutional control shall begin upon the receipt of permit/license issued by the NRA. At the present stage of the investment proposal it is accepted that the buildings and the ground facilities shall be used during the period of active institutional control. They shall be disassembled at the end of the active institutional control period.

A programme for radiation monitoring and programme for environmental monitoring shall be implemented during the period of institutional control. The monitored parameters shall be carefully selected, so as to ensure efficient monitoring without burdening future generations.

The aim of the monitoring is to ensure early detection of system failure, which could lead to unacceptable impact on people and environment. Besides, it shall serve to confirm the envisaged behaviors of the disposal system. Finally, it shall also create confidence among the public that the system is operating as planned.

The monitoring in the active institutional control period includes:

(1) Monitoring and control of the facility – state of the multi-barrier cover, drainage system, movement of modules, etc. Geodynamic monitoring in full volume as per the requirements of the facility's design.

(2) Environmental monitoring aimed at detecting all unexpected changes in the environment (meteorological conditions, hydrology and hydrogeology, geochemistry of water, stability of earth layers, erosion, fast and slow movements, i.e. earthquakes, vibrations if necessary);

(3) Radiation monitoring for potential release of radionuclides into the environment

(4) Control of potential releases in the immediate vicinity of the facility – measuring the gamma-dose, control of water with a stress on the potential paths of distribution (infiltration, surface and underground water). The control includes not only the radiological properties, but also toxic substances, if present, and other parameters important for the repository like the volume of infiltrated water, the groundwater gradient and the drainage direction. If other paths of distribution are identified, they shall be also included, for example gases and aerosols in case of breach of integrity of surface layer, if the potential release could lead to contamination of soil and vegetation);

(5) If necessary, radiation monitoring shall be performed at the end points – springs, rivers, soils and vegetation, toxic substances

(6) Strength of the gamma-dose

(7) Migration of the radionuclides through underground water – for the radionuclides with the highest mobility of the inventory of the repository;

(8) Monitoring and control on agriculture production – upon the request of the local authorities

For the period of passive institutional control it is envisaged that the radionuclides have disintegrated to an extent that the normal and changed evolution of the system shall not lead to the release of radionuclides into the environment. The potential releases relate to human intrusion, which is prevented through restrictions in the land use. Monitoring is not envisaged. Passive control is limited to observations ensuring restrictions on land use.

It is possible to modify the monitoring schedule in case of unexpected observations or changes in the regulatory requirements. The final monitoring programme shall be elaborated at the closure stage of the facility along with the final report on its safety analysis.

Stable acceptable monitoring results over a long period fo time may serve as a criteria for pre-term termination of active control. This notwithstanding, the monitoring programme shall be elaborated for the envisaged term of this control. The final decision regarding the termination of the control shall be adopted by future generations, taking into account the scientific and social factors of the time.

The responsibilities of the operator shall include the provision of mechanisms for making such a decision, and in particular, for preservation of information regarding the results of the monitoring throughout the entire lifetime of the repository, including the period after the closure of the facility.

Personnel necessary for the closure of the NRRAW and the period of institutional control

The number of personnel necessary for the closure of the NRRAW is estimated at approximately 40. During the period of institutional control, similarly to existing repositories that have entered into such a period, the number of personnel requiredis estimated at 15.

1.2.9 Used resources. Raw materials and materials used.

During the construction the following raw materials and materials shall be necessary:

Water supply – *Water for drinking and technical needs*

Water for drinking: about 8 m^3/d, determined on the basis of simultaneous presence at the site of 75 people: around 2000 m^3/year (250 working days per year). Bottled water shall be used for drinking.

Water for technological needs, including irrigation in dry weather; washing of transport vehicles; technological washing of poured concrete: ≤1500 $м^3$/year

The water for drinking needs shall be supplied from the drinking water supply pipeline of Vratsa, Kozloduy branch, which supplies Kozloduy NPP and has the additional capacity. Bottled mineral water for drinking needs will be delivered for the builders at the site.

Technical water shall be supplied for technical needs from Kozloduy NPP. This shall be also used for fire-protection purposes during the construction period. At the discretion of the operation of the building works, a buffer/emergency volume of water (cistern) can be delivered at the site.

Until the incorporation of the site to the water supply pipeline system of Kozloduy NPP, river water shall be used, after being filtered with suitable filters. The possibility of using technical water if necessary in dry weather (river water in cistern) shall be considered.

During the construction of the NRRAW ***standard building materials*** (concrete, reinforcement, bricks, paint, etc.) shall be used, which shall be submitted to strict control of quality certificates and additional testing, both by the construction supervision and by SE RAW. In addition, SE RAW is planning to implement quality control of building activities by non-destructive methods. The basic materials are listed below.

Table 1.2.5 ***Aggregates***

Type of material	Stage of construction of NRRAW		
	Stage one	Stage two	Total for the entire period of construction
Aggregates for drainage (felt)	3 500 m^3	2 000 m^3	5 500 m^3
Spoils (loess) for loess-cement and back filling	300 000 m^3	300 000 m^3	600 000 m^3
Gravel for roads base, parking lots and etc.	7 500 m^3	2 000 m^3	9 500 m^3
Humus	14 000 m^3	12 500 m^3	26 500 m^3

The delivery of gravel and aggregates for the drainage works (felt) to the site shall be carried out via temporary roads to be constructed for the purpose of the construction. These materials can be transported to the temporary roads both by road 11 and the road to Kozloduy NPP.

The spoils for back filling and loess-cement and the humus shall not be transported from the site. Depots for the humus and the spoils and the loess-cement shall be established at the site, as shown at **Figure 1.2-12.**

Table 1.2.6 *Concrete mixes and metal constructions*

Type of material	Stage of construction of NRRAW		
	Stage one	Stage two	Total for the entire period of construction
Concrete mixes	50 000 m^3	48 000 m^3	98 000 m^3
Metal constructions	60 t	40 t	100 t

The concrete mixes shall be delivered by ready-mix trucks from the nearest concrete plants.

The transportation shall be carried via internal roads, without entering residential areas.

Table 1.2.7 *Fuel for construction machines* (excavator, dumper, concrete pump car)

Type of material	**Stage of construction of NRRAW**		
	Stage one	**Stage two**	**Total for the entire period of construction**
Fuel (diesel)	120 t	90 t	210 t

Electrical energy

The electrical energy supply for lighting and heating of temporary buildings can be taken from the existing power grid at the Radiana site (20 kV) or from the Kozloduy NPP site where SE RAW has a unit. The necessary maximum power shall be up to 250kW.

During the operation

Drinking water – Bottled water shall be supplied for the staff at the site.

Water supply – The water consumption for domestic and industrial needs of the NRRAW is determined to Q av.day.= 8-12 m^3/day.

Drinking water for the staff. Bottled water shall be used.

The total number of personnel is 64 people including:

- 24 people administration staff
- 26 people operational staff
- 14 people maintenance staff

Water for drinking and domestic needs: total Q av.day. = 5.28 m^3/d.- 1400 $м^3$/year.(250 working days per year).

For domestic needs of the personnel (toilets, washing) approximately 1400 m^3 per year shall be needed. This is determined on the basis of standard rates if daily washing is mandatory only for the operational staff and the staff maintaining the facilities, but not for the administration. The minimum water quantities (100-200 m^3) are necessary for washing the working surfaces, laboratory equipment, disinfection of working surfaces and security systems and equipment. The standard washing of the car park shall be carried out outside the site at car washes. The water quantity necessary for firefighting needs is 8.3 L/sec.

The total necessary water quantity is 3000 m^3 per year, half of which is for irrigation of green areas, washing of alleys, platforms, etc.

The water shall be supplied by a link with the water pipeline of Kozloduy NPP. The optimization of the water supply system, to be carried out during the next design stages can include:

⇒ Buffer water reservoir for firefighting needs;

⇒ Usage of technical water from Kozloduy NPP for industrial needs, mainly irrigation of green areas, washing of alleys, platforms;

⇒ Realization of purifying module for self-purification of domestic waste water from the site (II alternative for domestic waste water treatment), the water purified and passed through filter and UV desinfection system can be used for industrial needs (fire fighting, washing of alleys, irrigation of green areas);

⇒ Usage of waters collected from the drainage systems for industrial needs;

⇒ The possibility for water supply from own water supply shall be considered.

Fuels for machines and equipments – total of 5 m^3/year. This quantity includes daily use for the transportation of the staff to work at the average distance of 10 km during the entire year, transportation of RCC from WSCRAW to NRRAW (4 runs per day, 200 days per year), internal transport technological equipment.

Electrical energy – during the period of operation, needed mainly for lighting and operating of certain equipment. Under the project, the power is 416 KW. The expected consumption shall be approximately 426 MW/h per year in case of 50% utilization of installed power.

During the closure of NRRAW

Water for drinking and domestic and industrial needs – approximately 4.2 m^3/d, determined on the basis of the simultaneous presence of 40 people at the site; 1050 m^3/year. Water for industrial needs in dry weather; washing of transport vehicles; technological washing of poured concrete: ≤1500 m^3/year.

Aggregates and concrete for the closure of modules: 44 800 $м^3$ of concrete; 33 228 $м^3$ of sand; 33228 $м^3$ loess-cement mixture; 33228 $м^3$ of compacted clay; 23260 $м^3$ of rubble; 33 228 m^3 of soil. The quantities are approximate and shall be further determined during the next project stages. The technical project for the closure is developed on the basis of the section Closure of the technical project of NRRAW and on the basis of the operational experience, taking into account the new methods, technologies and materials which shall be developed. The closure is the subject of a separate EIA.

During the period of active institutional control

Water for drinking and domestic needs 1.65 m^3/day, 420 m^3/year determined on the basis of the simultaneous presence of 15 employees. For *technological* needs – for laboratory analysis – approximately 5 m^3; for technological needs, irrigation of green areas, washing of alleys, platforms – approximately 1500 m^3/year.

1.2.10 Other activities related to the investment proposal

Additional processing and/or conditioning of delivered radioactive waste containers is not envisaged to be carried out at the site of NRRAW.

1.2.11 Characterization of RAW subject to disposal in NRRAW

Only low and intermediate level radioactive waste, as per the classification scheme of IAEA [419], shall be disposed in NRRAW. This corresponds to low and intermediate level radioactive waste category 2a, which are defined by the *Ordinance on safety of radioactive management* [93] as follows:

"short-lived low and intermediate level radioactive waste with mainly short-lived radionuclides (with half-lives shorter than or equal to the half-life of Cs-137), and long-lived alpha-active radionuclides with specific activity, less than or equal to 4.10^6 Bq/kg for one package and less than or equal to 4.10^5 Bq/kg in the total volume of RAW"

The disposal of long-lived low and intermediate level radioactive waste, which contain by definition long-lived radionuclides (with half-lives longer than the half-lives of Cs-137) with specific activity exceeding the limits for category 2a, shall not be allowed in NRRAW.

Only radioactive waste generated on the territory of the country shall be stored.

Only radioactive waste conditioned and packed in reinforced concrete containers (RCC) shall be disposed of in the NRRAW. The disposal of solid radioactive waste or free bulk materials is not envisaged.

The conditioning and temporary storage of radioactive waste subject to disposal in the NRRAW shall be executed outside the NRRAW site.

Characteristics of the RAW package

The reinforced concrete containers are displayed in

Figure 1.2-13. They are reinforced concrete containers with a cubic shape and cover with a mounted device for handling by gantry crane. Their wall thickness is not less than 10 cm; bottom thickness – 14 cm; an cover thickness – not less than 8 cm.

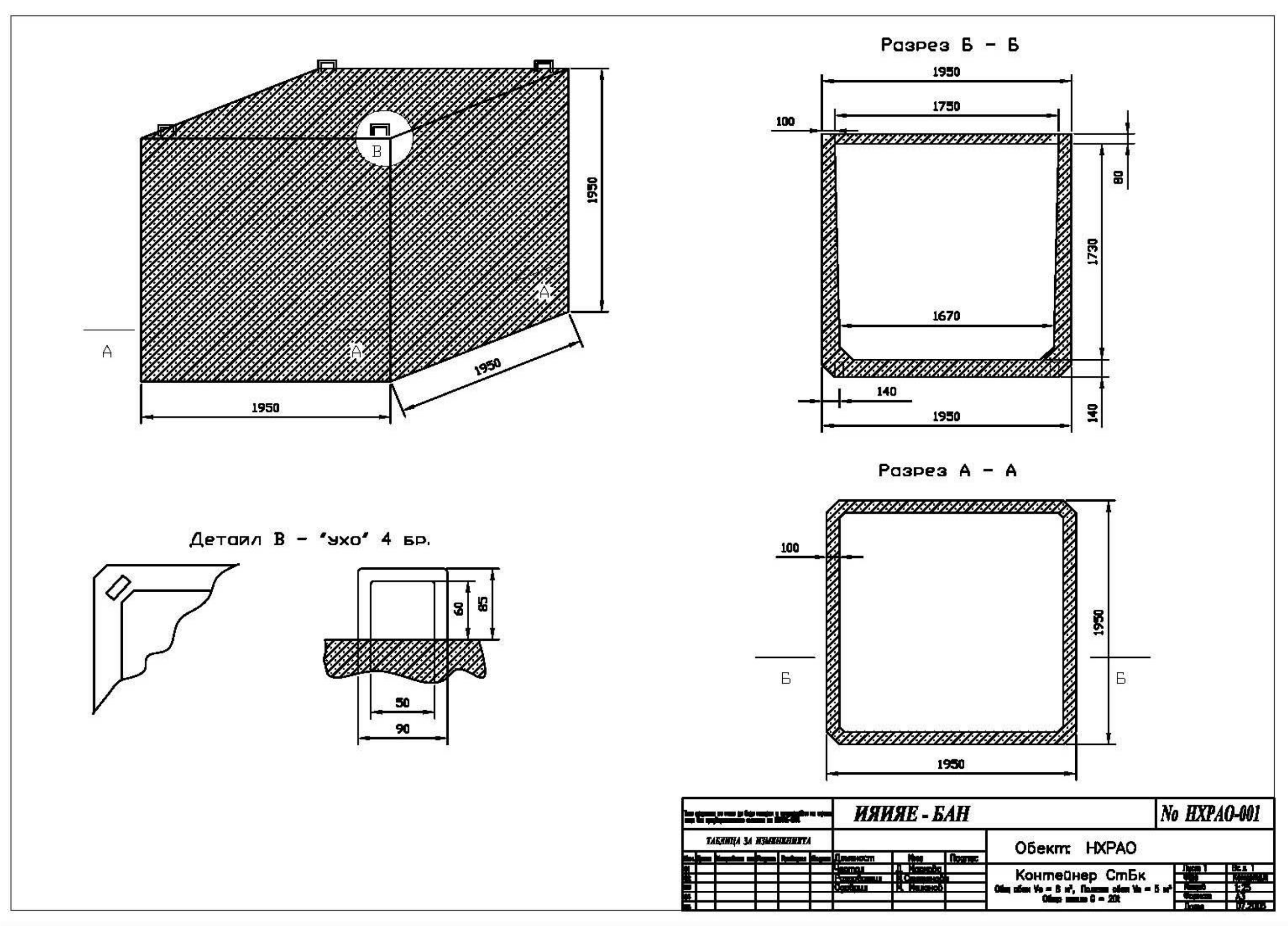


Figure 1.2-13 Reinforced concrete containers for low and intermediate level RAW

The RCCs are designed as containers for the storage and transportation of radioactive waste [413]. In compliance with the technical project [413] and the specification of the packages [414] they ensure the full retention of the radioactive material for not less than 50 years.

Their main characteristics are as follows:

⇒ Overall dimensions 1950 x 1950 x 1950 mm; dead load – 6 tons; mass of filled container not more than 20 tons; total volume 7.41 m^3; useful volume 5 m^3.

⇒ Characteristics of the concrete of the container: compressive strength not less than 25 MPa; watertightness not less than 0.8; frost-resistance class F 100.

⇒ The inner walls of the containers are covered with waterproof coating

The RCCs are designed and made in such a way that they to be moved by a crane and grouped in 4 rows. **Figure 1.2-14** shows the handling operations of the RCCs and their storage in the Warehouse for storage of conditioned radioactive waste (WSCRAW) and operations with a gantry crane in the contemporary repository in Machovce, Slovakia. The WSCRAW is situated on the territory of Kozloduy NPP and is part of the facilities related to the radioactive waste management of the specialized unit of SE RAW – SU RAW-Kozloduy.

Figure 1.2-14 Reinforced concrete containers for low and intermediate level RAW

(1) temporary storage in WSCRAW at the site of Kozloduy NPP
(2) grouping of RCC at 3rd row
(3) similar operation performed with gantry crane in the Mochovce repository, Slovakia

The radiation characteristics of the package subject to disposal in the NRRAW, RCCs with conditioned RAW, are as follows:

⇒ equivalent dose gamma radiation on the surface ≤ 2 mSv/h at any point on the external surface,

⇒ equivalent dose gamma radiation at a distance of 1 m ≤ 0.1 mSv/h.

The RCCs meet the requirements of the *Ordinance on procedures for transportation of radioactive substances* [110]. According to the Ordinance, the non-fixed contamination of the external surfaces of an RCC must not exceed the following levels of activity, valid for the average area of 300 cm^2 of each surface part: 4 Bq/cm^2 for beta/gamma radionuclides and alpha radionuclides with low toxicity; 0.4 Bq/cm^2 for all other alpha radionuclides.

Each package is identified with a unique code. The database contains complete information about the characteristics of the container and the characteristics of the conditioned radioactive waste, including the radionuclide inventory of the package, the origin and composition of the waste, and a description of the technological operation related to its processing and conditioning.

Characteristics of the waste shape

The liquid and solid waste is immobilized by cementing. The characteristics of the cement matrix are as follows [415]:

⇒ Washing out less than 3.10^{-3} $g/cm^2.d$ for ^{137}Cs, less than 3.10^{5} $g/cm^2.d$ for ^{60}Co and under 10^{-7} $g/cm^2.d$ for long-lived radionuclides

⇒ Mechanical features: compressive strength on 28th day – more than 3.5 MPa; water resistance – must not reduce by more than 10% the compressive strength after 90-day period under water; resistance to thermal cycles – compressive strength of end product more than 0.35 MPa after 30 cycles from minus 15°C to plus 60°C;

The RAW shall be processed outside the NRRAW site in a Unit for radioactive waste processing of the Specialized unit of SE RAW (SU RAW-Kozloduy), situated on the site of Kozloduy NPP.

The processing of liquid RAW is an additional concentration through evaporation, conditioning through cementing and packaging in reinforced concrete containers (RCCs).

The processing of solid RAW is a reduction of the solid RAW volume by: shredding, loading in 200 l barrels, pre-extrusion in the 200 l barrels and extra-extrusion of the barrels, assembling and packaging in the RCC. The empty space in the RCC is filled with liquid cemented RAW or pure concrete solution.

The radioactive waste from the Belene NPP is envisaged to be conditioned by cementing and packaging in RCC in the future plant.

The maximum activity of any one package is not more than $8.14.10^{10}$ Bq.

Sources of RAW subject to disposal in the NRRAW

Sources of RAW subject to disposal in the NRRAW are as follow:

⇒ The accumulated to date low and intermediate level short-lived radioactive waste from the operation of Units 1-4 of Kozloduy NPP (BBEP-440); accumulated and future waste from the operation of Units 5 and 6 of Kozloduy NPP (BBEP-1000)

⇒ Low and intermediate level short-lived radioactive waste to be generated during the decommissioning of the discontinued Units 1-4 of Kozloduy NPP and the waste to be generated during the decommissioning of operating Units 5 and 6 of Kozloduy NPP, whose design lives are 2017 and 2021, respectively;

⇒ Low and intermediate level short-lived radioactive waste to be generated during the operation of the two nuclear energy units BBEP-1000 of Belene NPP

⇒ Low and intermediate level short-lived radioactive waste from nuclear application;

⇒ Low and intermediate level short-lived radioactive waste from the ИРТ-2000 research reactor at the Institute on nuclear research and nuclear energy of the Bulgarian Academy of Science. The research reactor was decommissioned in 1998 in compliance with governmental decisions and it will be reconstructed as a reactor of low power for medical staff training and for medical purposes. According to the reconstruction plans, it shall be in operation for 40-50 years [418].

The evaluation of the waste quantities from different sources is provided in sect. 1.2.2 NRRAW Capacity.

The solid radioactive waste generated during the operation of NPPs are contaminated with technogenic radionuclides. Sites, environment, materials and supplies which are used and/or used to be used in the technological process of producing electricity. They are divided into:

⇒ Compressible RAW: textile (special clothing used in the controlled area, towels, cheesecloth used for cleaning and sanitation), polymers (polyethylene used as cover material and for protection of surfaces from contamination, latex gloves, materials based on polyvinyl chloride, etc.), wool (insulation of pipes and drums of I-circuit), rubber (rubber contaminated seals, rubber gloves, etc.); wood (contaminated planks used for scaffolding in building works, wooden packaging of equipment and tools), paper (cardboard boxes, wrapping paper, etc.); exhaust aerosol filters;

⇒ Non-compressible RAW: metals (elements of technological equipment, decommissioned or replaced during repair works, replacement of insulation sheets, chips which are waste material from the treatment of radioactive contaminated materials in mechanical workshops); construction waste (concrete, bricks, plaster, flooring and etc. separated during building works); surface contaminated cables;

Average radionuclide composition of non-processed solid waste from the operation of Kozloduy NPP, determined on the basis of regular measuring of 200-litre barrels, before the extra-pressing is as follows:

Table 1.2.8 Average radionuclide composition of non-processed solid RAW

Radionuclide	Specific activity, Bq/kg	Radionuclide	Specific activity, Bq/kg
^{54}Mn	2,54E+04	^{110m}Ag	2,18E+04
^{55}Fe	7,20E+03	^{134}Cs	2,94E+04
^{58}Co	1,46E+04	^{137}Cs	7,31E+04
^{60}Co	2,12E+05	^{95}Nb	4,41E+03

The liquid radioactive waste from the operation of Kozloduy NPP is the radioactive concentrate (prefactionator bottom residue) resulting from the concentration by evaporation of radioactively contaminated water and stored in stainless steel tanks. Its characteristics are as follows: total salt-content of the liquid phase 32 w.%; PH 8.5; concentration of boric acid 7-10%, presence of solid (crystallized) mass. Average radionuclide composition of liquid and solid phase under the data from [416] is as follows:

Table 1.2.9 Average radionuclide composition of unprocessed radioactive concentrate

Radionuclide	Specific activity, Bq/kg		Radionuclide	Specific activity, Bq/kg	
	Liquid stage	Solid stage		Liquid stage	Solid stage
^{137}Cs	3,71E+07	5,45E+06	^{60}Co	9,41E+05	915
^{241}Am	2.7	2140	^{238}U	4,6	6,4
^{239}Pu/^{240}Pu	1,3	1498	^{235}U	<1E+0	1,21
^{90}Sr	1840	4,51E+04	^{242}Cm	<1E+0	8,1
^{55}Fe	1970	2,13E+06	^{129}I	9,3	16
^{63}Ni	8,3E+05	3,51E+05	^{99}Tc	195	150

The radioactive wastes from decommissioning which are subject to disposal in the NRRAW are 8-9 % of the total volume of waste to be generated during the decommissioning of Kozloduy NPP [417]. They are contaminated construction equipment, installations and systems, as well as accompanying compressible radioactive waste. The evaluation is made on the basis of analyzed experience from the decommissioning of the Greifswald NPP, Germany. The radioactive chemical characteristics of this RAW are similar to the ones generated during the operation of Kozloduy NPP. The physical, physical-chemical and chemical properties are also identical to the RAW from the operation of Kozloduy NPP.

By type, origin and characteristics the low and intermediate level short-lived radioactive waste from Belene NPP is similar to those from Kozloduy NPP. It must be stressed that the construction of a modern plant, equipped with new modern installations for processing and conditioning of radioactive waste, as well as the application of programmes for minimizing the RAW generation, leads to significantly reduced quantities of RAW, category 2a, which shall be disposed of in the NRRAW. This is in line with modern trends in this field.

The radioactive waste from the ИРТ-2000 research reactor is a small part of the total volume of waste, subject to disposal in the NRRAW – less then 0.2%. It is typical solid waste including building waste to be generated during the conversion of the research reactor into a reactor of low power [418].

The radioactive waste from nuclear application is also a small part of the waste subject to disposal in the NRRAW – approximately 1.8%. Currently it is stored in facilities for radioactive waste management in the specialized unit of SE RAW – SU RURAW-Novi Han. It also includes the radioactive waste generated during the operation of the above cited research reactor before its decommissioning in 1998, as RURAW-Novi Han was built for storage of RAW from nuclear applications and from the research reactor. The NRRAW shall receive part of the RAW currently stored in SU RURAW-Novi Han – mainly solid RAW and small part of the closed radioactive sources, which are category IV and V according to [420]. Radioactive sources containing long-lived radionuclides shall not be disposed of in the HRRAW.

1.2.12 Characteristics of expected emissions and waste

Waste and emissions during construction of the NRRAW

It is expected that during the construction of the NRRAW, avolume of 1000 m^3 of construction waste shall be generated during the first stage of the construction of the 4 modules, including 100 kg of waste materials from paints and varnish; about 750 m^3 building waste from the removal of existing facilities at the site (demolished concrete pavement of sport playground, relocation of the irrigation channel M1) and from defective, non-accepted building works; and about 200 m^3 of standard waste from the concrete pump. Workers shall use chemical toilets, so generation of faecal water is not expected.

The quantity of construction waste during the second stage of construction is assessed at the rate of about 300 m^3, including about 100 kg of waste materials from paints and varnishes.

Considering the selected technology of stepwise deployment of the radioactive waste disposal modules, the spoils shall be approximately 1200000 m^3 and about 60000 m^3 of humus. The quantities are equally divided in the two stages. During the first stage 600000 m^3 spoils shall be generated. Half of it (300000 m^3) shall be used for the preparing of loess-cement and for the back filling. The rest of the amount shall be used by Kozloduy NPP for technological strengthening of the hot channel 2 (90000 m^3) and deployment in a depot next to the hot channel (40000 m^3), provided for in Appendix No.25. The municipality of Kozloduy has provided for the deposit of earth with the size of 170000 m^3, according to letter ref. No. 53-00-63/1/14.10.2009. During the second stage of the construction 600000 m^3 spoils shall be generated. Half of it (300000 m^3) shall be used for preparing of loess-cement and for back filling. At this stage of the investment proposal it is believed that the rest of it, around 300000 m^3, can be deposited in the above mentioned depot. As the second stage of the construction of NRRAW shall begin after the decommissioning of Units 1-4 of Kozloduy NPP, by then other ways to use the excess earth shall probably have been determined The humus and the earth which shall be used for the back filling shall be stored at the site, as stated in sect.1.2.6. At this stage of the investment proposal it is accepted that a temporary depot will be set up for the building waste at the site until its removal to the depot for building waste of the municipality of Kozloduy.

Waste and emissions during operation of the NRRAW

Minimum volumes of secondary RAW are expected to be generated, including contaminated working clothing and personal safety equipmentб potentially contaminated water from showersб contaminated water from the radioactive chemical laboratory, liquids and detergents from contaminated building resources and working surfaces, and operational equipment. According to their level of beta contamination, working clothes, underwear and other personal protective equipment is divided into three groups: group I, up to 200 βpart/cm^2.min; group II, up to 1000 βpart/cm^2.min; group III, over 1000 βpart /cm2.min. Contaminated special clothing from groups I and II is deactivated by chemical reagents and that from group III is treated as secondary waste, i.e. it is not subject to desactivation.

It is Decontamination facilities for packaging waste and equipment, and contaminated clothing and shoes are not envisaged in the repository. The organization of the acceptance of containers with radioactive waste and the subsequent operation practically excludes the generation of contaminants from the second and third group and the possibility of such being generated from the first group is only theoretical.

Nevertheless, it is envisaged that during operation of the repository, the secondary RAW shall be collected, packaged and transported to Kozloduy NPP for processing. Waste, generated during emergency situations shall be treated the same way – in accordance with the emergency plans of the repository.

Contaminated water from the operation of NRRAW, if such is generated, shall be collected in special tanks and submitted for processing in SU RAW-Kozloduy.

Gaseous emissions from construction, operation and closure of the facility are not expected, due to the negligible quantities of radionuclides in the gas-generated inventory of the repository.

Minimal quantities of construction waste shall be generated during repair and maintenance activities. .

Waste and emissions during closure of the NRRAW

According to preliminary evaluation, building waste to the amount of 150 m^3 shall be generated during the closure.

Waste and emissions during the institutional control period

Based on the example of the decommissioned La Manche repository in France, generation of radioactive waste is not expected during the institutional control period, apart from small volumes of laboratory waste. At the end of the active institutional control, the buildings will be dismantled and thus become building waste.

1.2.13 Social significance

This assessment of the social significance of the site has been prepared on the basis of expert reports, the NSI data and information provided by MBMD on conducted research and analysis of public opinion (cited in the *Assignment on the scope and content of the EIA of the investment proposal for construction of NRRAW)*, data from the Special Eurobarometer No. 297 "Attitudes towards radioactive waste" (EC, Special Eurobarometer, Attitudes towards radioactive waste) 2008. To determine the social importance of the facility, it is necessary to indicate the main groups affected and the corresponding effects, the objectives of the project, justification of its need and its compliance with relevant regulations. These points are partially developed in this part of the text, where necessary, and analyzed in detail in 3.11 *Demographic, social and socio-economic conditions*.

Radioactive waste as a source of ionizing radiation is potentially hazardous to human health and should therefore be safely managed. The method chosen- burial in a surface multi-barrier engineering modular trench type repository - has been tested in the developed European countries and is recognized by the International Atomic Energy Agency along with with UNESCO as a method that is safe for humans and the environment.

Experience shows that broad public support is crucial to increasing the chances for project approval. Therefore, trust in the project managing agency plays a significant role, ensuring the participation at each stage of the parties concerned, providing publicity and sharing of statements, and access to information on how public comments are considered and addressed. Experience shows that confidence is gained primarily through the provision of clear and understandable information:

(http://www-pub.iaea.org/MTCD/publications/PDF/te_1553_web.pdf)

The construction of the National repository for short-lived low and intermediate level radioactive waste disposal produces effects on several levels, namely:

- Environment
- Built environment/infrastructure (for example the transport network)
- Social condition (mostly ensuing from community interactions)
- Economic conditions (for example the related to the labour market);
- Land use

The storage of low and intermediate level radioactive waste is matter of prime significance, because on one hand it is related to environmental protection and ensuring a quality standard of living for future generations, and on the other, it relates to increasing confidence in the nuclear energy as a whole, by ensuring the safe storage of this waste. When these conditions are met, attitudes change. All of this allows us to state that construction of NRRAW is of great social significance.

The social importance of the site refers mostly to the selected alternative for the disposal of low and intermediate level short-lived radioactive waste: a **surface multi-barrier trench type facility**, described above in the characterization of the investment proposal. For this purpose, several sites were considered, and the selection was made according to specific criteria which are detailed in the documents. The choice is legally regulated in the Ordinance on the Safety of Radioactive Waste Management and it is considered in the *Report on Implementation of Phase 3 Characterization of sites for the NRRAW,* Sofia 2010. The main criterion for the selection of the site is the radiological criterion (op.cit), limiting the effective dose received by critical population group after the closure of the repository. Of paramount importance in the selection of the site is the observation of a few basic criteria, some of which result from different stages of public discussions and opinion poll surveys. The selection is made from among four potential sites. Socio-economic acceptability belongs to group D of signs, classified in the system used for analysis (p. 138, op.cit.). The following features are classified in this category :

- Nuclear experience of the population near the NPP
- Infrastructure
- Adverse effect on businesses
- Proximity to state border
- Public acceptance
- Relatively low construction expenses.

The Radiana site is within limits of the protected area of the existing Kozloduy NPP. According to the above-mentioned report, the Radiana site falls within the agriculturally underdeveloped region, while the level of acceptance of the other sites in this regard is lower. It is noteworthy that the population near Marichin Valog and Brestova Padina categorically reject the building a repository at those sites.

The location of Radiana site defines the international character of the interested parties, as Romanian residential areas are in the vicinity of the site. The alternative technical decisions and the selection of the present Radiana site are envisaged in a way to guarantee the lack of risk for human health of the construction workers, the population in the region and, indirectly, of the other affected groups.

There is no contribution of additional radioactive contamination from the site, but there is significant safety related to the control and management of the low and intermediate level short-lived RAW.

The choice of storage technology is based on the evaluated relationship between price and risk, and on international experience with similar technologies so as to ensure safety, or rather, a lack of increased risk, as experience shows that there is no health risk.

It is important to emphasize that due to the very nature of the project and its scope, the social impact of it spans beyond the national territory, and the effect is not limited to the specific location and time, but concerns largely future generations, because they are among the potential affectees. In essence, the project deals with storing low and intermediate level radioactive waste in a manner that ensures the safety not only of the current but also of the future generations. For its part, the construction of this facility is part of the international agreements of the parties [126] using nuclear energy for peaceful purposes: a commitment by each country to preserve the planet. Therefore it is expected to have a **long-term effect.** To understand the social impacts of the project, it must be noted that the different stages (*construction, operation and closure)* have an impact on job creation, although due to the scale, this aspect is less significant than others.

The potential positive impact is associated with increased economic activity in the region, as construction of the repository would lead to increased demand for various services. In the case of building the NRRAW, it will lead to the creation/retention of jobs. A possible positive knock-on effect of the creation of new jobs would be the need to build new housing, educational and related infrastructure.

In the future it is planned to relocate to the NRRAW the low and medium radioactive medical and other waste stored at this stage in the Novi Han RAW.. The **potential impact** of the repository building relateds to this activity, because without this facility the continuation of these medical procedures cannot be ensured. The strategic decision to construct the NRRAW is predetermined by the requirements for the presence of such facility on territory of each country producing nuclear energy.

Definition of affected groups

According to the Bulgarian legislation, the ***people directly affected*** by the investment proposal are mainly the **residents of the nearby villages**, including the workers of adjacent agricultural land, as a whole, or partially, the inhabitants of the settlements of eight municipalities, namely Kozloduy, Vulchedrum, Hayredin, Mizia, Lom, Byala Slatina and Oryahovo, and the residents of 23 residential places in the Romanian region of Dolj, among which are the town of Dăbuleni (13526 residents), the town Bechet (3963 residents) and other smaller villages[1] situated within the 30-km monitored area (fig. 4-2). The group of persons directly affected must include the **future personnel of NRRAW** and those of the **nearby sites** and, for some time, the **staffs of companies and organizations** which will take part in the construction and the closure of the site. We should not exclude from the group of those affected the **members of their families**. The formation of the latter group derives from the fact that the building of the NRRAW is essentially an economic activity associated with the creation of new jobs with different specializations (essentially new professional qualifications).

Indirectly affected is the entire **population** of the Republic of Bulgaria, as the project provides effective control and management of RAW on the territory of the country – from the activity of Kozloduy NPP and the future activity from Belene NPP. In the future ,it is envisaged to move the low and medium active waste from medical procedures stored in the PRRAW Novi Han to the new repository. The definition of this group stems from the activity of Kozloduy NPP and Belene NPP (electricity production), which refers to the population as a whole and, in this sense, the waste generated is a direct effect in and of itself and therefore, its treatment necessitates such a definition of the group. The same applies to the storage of medical waste.

Due to commitments and obligations and the nature of the site and its use, it can be assumed that the persons indirectly affected by the project extend the territory **outside the scope of national as well as in the timetable**. This extension of the group indirectly affected by the project stems from the fact that its construction is part of international agreements that aim to ensure sustainable development with a thought for future generations, which determines its reach in time and space. The location of the Radiana site defines the international character of the interested groups, as cities of the Republic of Romania fall in its vicinity.

Social impact and project significance

The main social impact associated with the construction and operation of the NRRAW is directly related to **its construction**. As a result, on the national level a repository meeting all regulatory requirements (national and international), which has never existed on the territory on the country, shall be achieved. Thus, **compliance with the commitments made** by Bulgaria to the EU shall also be achieved, a fact that underscores the political dimension of the project.

During the construction works, construction companies will be contracted that have the necessary qualifications – up to 55 - 75 people, depending on the work performed, for work which is not on a large scale and is limited. This shall lead to the **opening of temporary jobs**.

Construction and operation of NRRAW will **create approximately 75 temporary jobs during the construction works and 65 jobs during facility operation**. As a result, a positive social impact is expected. The number of jobs, however, will not be large, which means that the positive effect on employment levels would be relatively small, as is specified in the above cited assignment document. However, we must take into consideration the fact that the creating[2] of these jobs within the municipality is important for **overcoming of the lack of attractiveness of the location**. During operation, there will be professionally trained staff, almost entirely composed of specialists currently working in the nuclear plant, but due to the specifics of the work, all of them will be reclassified. This in itself also represents a significant

[1] Romanian Statistical Yearbook. 2 Population 2007.pp:70

[2]We prefer the term "creating", as it refers for a different professional qualification.

social impact of the project, as it is connected to the idea of **lifelong learning**[3]. Courses could be offered for young replacement staff, training of physicians and other specific activities related to the management of radioactive waste.

Another longer-term social effect of the project relates to the **planned transfer of the storage of radioactive medical waste from PRRAW Novi Han to the NRRAW**. The safe storage of this waste **shall ensure the continuation of the medical activities and procedures associated with it**, which definitely can be classified as a **positive, long-term socially significant effect**.

Given the nature of the property ownership[4], described in the above cited document, no involuntary resettlement of people is expected, as the land appropriate for the implementation of the investment plan area (approximately 36 hectares) is situated within the limits of the state/municipal property. This aspect, although it may seem irrelevant to the project due to the corresponding legal framework, is important and is one of the criteria considered in the elaboration of the social impact assessment.

The economic effects are usually associated with reporting the impact on factors such as unemployment, taxes, changes in property prices (it is possible to influence land prices due to the proximity of the repository). The effect on employment levels is relative and in quantitative terms is negligible, but the social effects of job creation and the retraining of some staff should not be underestimated. This social effect could be sought in the direction that the building of NRRAW would be regarded as an extension of existing nuclear power plant and therefore as bound to a major sector of the local economy. Thus, the retention of employment for some workers means they can maintain their expectations for the development of the city.

According to the Municipal Programme for development of tourism for the period 2008-2011, the main development strategies in the sector of tourism relate to the historic complex "Botev's route", the National walking tour "In the footsteps of Botev Kozloduy-Okolchitsa", some other cultural sites as the St. Trinity Church in the town of Kozloduy, the church Sv.Voznesenie in the village of Butan and the "National Cultural Memorial Centre "Hristo Botev – 1879" in the town of Kozloduy, as well as the Roman excavations "Augusta" and the possibility for the development of water tourism associated with the Danube River, equestrian competitions and horse riding at the riding centre in the village of Butan, and ecotourism, for example, associated with the wetlands along the Danube. The scope of this tourism would probably be local, i.e. related mainly to the recreation activities of the residents of the region, and thus less probable to contribute to regional development. This aspect, however, must not be underestimated, because it relates to creating good quality living conditions, However, it should be noted that the presence of the nuclear plant and the building of tge NRRAW could have a negative impact on these programmes, because of the generalized fear people have of nuclear energy and the radiation associated with it, as well as the already stated shape of waste, so it is possible that the poject might have a **negative effect** on this economic sector. Thus, more attention must be paid to awareness campaigns clarifying the safety of the implementation of NRRAW and the nearly zero environmental impact and lack of health risk for the population in the region. On the other hand, we should mention another possibility for the development of the tourist strategy in the region, which might have a larger scope, namely, the development of so-called industrial tourism.

Another possible effect, or rather "use", is the proposal related to the development of a new type of educational tourist destination originating from the nature of the site. These would be study trips for educational purposes: developing the visualization of the existing repository. Thus, students could see how the facility is built and operates. However, we must stress that this possibility could exist independently from the particular chosen solution and it is a different possibility for the socialization of the site and its use for purposes rather than its narrow special purpose.

Other elements of social significance

Providing a healthy living environment and healthy working conditions. The health risk of the construction of NRRAW is reviewed in p.3.11. However, official statistics show that the level of cancer in the area is lower than the average for the country. In order to avoid increasing of mortality, it is important to observe the best international and European practices in this area.

The physical environment of the repository and the importance of the territory

The fact that the repository is part of the arable soils is a fundamental precondition for the choice of location. On September 26, 2007, at the initiative of municipal leadership, a meeting was held between the

[3] "Lifelong learning", is often referred to with the abbreviation LLL. It is one of the main priorities of the Program for development of human resources in the EU(http://llp.hrdc.bg/). The main positive aspects of this phenomena can be sought in the social integration, civil participation and personal growth. Having in mind that in this case, it is a matter of a specific economical sector, in which finding a job is extremely difficult in Bulgaria, the possibilities for mobility and migration of workers, the possibility for requalification is extremely important.

[4] NRRAW is part of the radiation protection zone around NPP Kozloduy, so there are no people living on its territory, while the land is state property.

management of SE RAW and the chairpersons of standing committees to the City Council of the town of Kozloduy. The meeting aimed to improve the communication and to restore the dialogue on the NRRAW between the local administration and the SE RAW, where representatives of the City Council expressed an the understanding of the local population regarding the need to build a NRRAW, suggesting that most likely selected site would be on the territory of the municipality of Kozloduy. Opinion was also expressed that the local people believe the building of NRRAW would be acceptable, if the site is not located on agricultural land (in the Zlatiyata area, where Marichin valog site is located) with rich soil used for the cultivation of cereals. The soils around the site of the national repository for disposal of low and medium active radioactive waste - the subject of the investment proposal of SE "RAW" (Radiana) - are typical for the region - carbonate, typical and meadow and alluvial humus - (deluvial-) meadow soils. Overall, they are heavily influenced by industrial activity. The soil at the Radiana site is not noticeably affected by radioactive contamination due to the activity of the Kozloduy NPP. The lands at the Radiana site to be used in connection with the construction of a national repository for disposal of low and medium active radioactive wastes is not agricultural, in the specific context of this term, used for agriculture purposes. They consist mostly of forested lands or self-forested, a sports facility, a field road and an irrigation facility. Only those lands with tree and shrub vegetation planted on them have any ecological significance.

The social significance of the site concerns the already selected alternative for disposal of low and medium short-lived radioactive waste: **near surface multi-barrier engineering facility**, described above in the characterization of the investment proposal. For this purpose, several sites were considered. The choice was made following the specific criteria which are detailed in the documentation. The selection is legally regulated in the Ordinance on the Safety of Radioactive Waste Management and is discussed in the *Report on Implementation of Phase 3 Characterization of sites for NRRAW*, Sofia 2010. The main criterion for the selection of the site is the radiological criterion (op.cit), limiting the effective dose received by the critical population group after the closure of the repository. Of paramount importance for the selection is the observation of a few basic criteria, some of which are a result of different stages of public debates and opinion polls, and the selection was made from among 4 potential sites. Socio-economic acceptability belongs to group D of the attributes, classified in the system used for analysis (p. 138, op.cit.).

The following features are classified in this category: :

- Nuclear experience of the population near the NPP
- Infrastructure
- Adverse effect on businesses
- Proximity to state border
- Public acceptance
- Relatively low construction expenses
- Public acceptance
- Relatively low construction expenses
- Radiana site is located within the scope of the protected area of the existing NPP

According to the cited report, the Radiana site falls within the agriculturally underdeveloped region, while the level of acceptance of the other sites in this regard is lower. It is noteworthy that the population near Marichin Valog and Brestova padina categorically rejects the possibility of building a repository there.

The location of Radiana site defines the international character of the interested parties, as Romanian residential areas are in the vicinity of the site. The alternative technical decisions and the adoption of the present decision are envisaged in a way to guarantee the lack of risk for human health of the construction workers, the population in the region and, indirectly, that of the other affected groups. There is no contribution of additional radioactive contamination from the site, but there is significant safety of the control and management of the low and intermediate level short-lived RAW. The choice of storage technology is grounded in the evaluated relationship between price and risk, and is based on international experience with similar technologies to ensure safety, or rather, a lack of increased risk, as experience shows that there is no health risk.

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

Part I

1. 1. ANNOTATION OF INVESTMENT PROPOSAL FOR NRRAW CONSTRUCTION, ACTIVITIES AND TECHNOLOGIES

1. Decision of MC No.683/25.07.2005 for the construction of NRRAW
2. Decision No.HX3211/05.05.2006 for defining the location (selection of site) of the facility for radioactive waste management – National repository for radioactive waste disposal (NRRAW)
3. Decision No. HX3489/03.05.2010 for defining the location (selection of site) of the facility for radioactive waste management – National repository for radioactive waste disposal (NRRAW)
4. Topographic map with marked location of the Radiana site to Kozloduy NPP
5. Detailed geodetic map of Radiana site – site plan in M 1:1000
6. Detailed geodetic map of Radiana site – agriculture lands plan in the area of the site in M 1:1000
7. Scheme of the agriculture lands in the area of Radiana site as per their property type
8. Scheme of the agriculture lands in the area of Radiana site as per their permanent usage type
9. Master plan of engineering multi-barrier near surface trench type repository at Radiana site
10. Options for the deployment of the modules on the slope
11. Scheme stage 1
12. Scheme stage 2
13. Plan and each checkpoint location, administrative block,
14. Plan of the auxiliary unit
15. Detailed checkpoint plan
16. Detailed administrative unit plan
17. Detailed laboratory unit plan
18. Detailed ancillary unit plan
19. Construction of protective hall
20. Scheme of leakage control system of NRRAW
21. Scheme of leakage control drainage galleries
22. Transport scheme of Warehouse of SE RAW to Radiana site
23. Detail of asphalt "B" type pavement
24. Detail of asphalt "A" type pavement
25. Scheme of location of spoils depot

Part II

CONTENT

Part II

2. ALTERNATIVES FOR LOCATION AND/OR ALTERNATIVES TO THE PROPOSED TECHNOLOGY AND THE REASONS FOR THE SELECTION

The investment proposal for the construction of a National Repository for low and intermediate level short-lived radioactive waste (NRRAW) envisages the construction of a **multi-barrier engineering modular near-surface trench-type repository at Radiana site**, situated close to Kozloduy NPP in the land of the village of Hurlets, municipality of Kozloduy, District of Vratsa. This is ”Alternative 1”.

Furthermore, “Zero Alternative” was considered, which means not to construct an NRRAW.

Other alternatives were also considered:

(1) Alternatives by location: alternative sites are Marichin valog, Brestova padina and Vurbitsa

(2) Alternatives by method of long-term management of RAW: long-term storage in warehouses for storage and disposal in a geological repository

(3) Alternatives by technological decisions for disposal: disposal in a shaft-type repository and disposal in a tunnel type repository

2.1 Alternative “0” - “Zero” alternative

The zero alternative means not to implement the investment proposal. It is directly rejected because:

- It does not correspond to the nuclear legislation, according to which the **radioactive waste must be disposed of in the shortest possible time after their generation**;

- It does not meet the requirements of the *Joint Convention on the Safety of spent fuel management and safety management of RAW* [126], the *Law on Safe Use of Nuclear Energy (ASUNE*) [128] and the *National strategy for management of spent nuclear fuel and radioactive waste*, adopted by the Ministerial Council on 23.12.2004 [127];

- It results in suspension of the process of conditioning of RAW from the operation of Kozloduy NPP, which is carried out in SE “RAW – Kozloduy”, due to exhaustion of the capacity of the warehouses to store the conditioned RAW;

- It prevents the decommissioning of the shut-down blocks of Kozloduy NPP, for which Bulgaria has committed to the EU;

- It prevents the production of electricity in the operating units 5 and 6 of Kozloduy NPP due to exhaustion of the capacity of the warehouses to store the conditioned radioactive waste and of the temporary repositories of the units to store the non-processed radioactive waste.

- By decision of the Council of Ministers No. 683 of July 25, 2005 of the State Enterprise "Radioactive Waste" was commissioned the building in 2015 of a national repository for disposal of RAW (NRRAW) with funds from the “Radioactive Waste " Fund”.

The non-implementation of the investment proposal entails risks for:

- Health of the staff of Kozloduy NPP and the inhabitants of neighboring villages - Kozloduy, Mizia City, and the villages of Harlets, Glozhene, Butan, Kriva Bara, etc.;

- The state of the environment, which can lead to contamination with radionuclides in the soil layer and the near the surface area and the groundwater, mainly underground water body "Ferrets water in Quaternary - Kozloduy Valley” with code *BG1G0000Qal005*, by which is accomplished the water supply by built water intake facilities and it is a protected area for drinking water supply.

2.2 Alternative ”1” – Selected alternative

Alternative ”1” is in compliance with the *National strategy for management of spent nuclear fuel and RAW*, adopted by the Ministerial Council on 23.12.2004 [127]

2.2.1 Selected alternative by location

The selection of a site for an NRRAW was made in compliance with the requirements of the national legislation and of the IAEA documents, on the basis of the research conducted by the Geology and Geophysical Institute of the Bulgarian Academy of Science and the University of Mining and Geology "St. Ivan Rilski" [164-177, 19-180, 182, 183, 224].

The selection of the site is defined under the following priorities:

⇒ Ensuring the safety of the population and environment during the entire lifetime of the NRRAW during its operation, closure and period of active and passive institutional control

⇒ Timely provision of the necessary capacity, taking into account the economic and social aspects of the activity

On the basis of the research and analysis carried out, the Radiana site was determined as the most suitable site for the construction of the NRRAW.

The Radiana site offers the most favourable conditions for construction and operation, ensuring the preservation of the environment and human health protection and avoidance of undue burdens of future generations.

The location of the Radiana site was determined in compliance with "Permission № HX-3211/05.05.2006 for the selection of site for NRRAW", issued by NRA and which includes four stages, each of them being subject to authorization and control from NRA: "Development of a concept for disposal and selection of site planning", "Data collection and analyzing of the regions", "Characterization of the sites" and "Confirmation of the site" and after considering the specific purposes of all interested parties (NRA, local administration, critical population group and SE RAW), as well as the health, ecological, technological and demographic requirements for the construction of the short-lived low and intermediate level RAW disposal facility.

The thorough study of the four sites: "Radiana" , "Marichin valog", "Brestova padina" and "Vurbitsa" and their benchmarking was carried out during the "Characterization of the sites" stage. The results for each site were systemized and analyzed in a uniform way in the report for the implementation of the stage. The description includes: location, lithostratigraphical construction, tectonic and neotectonic conditions, geomorphologic conditions, geotechnical conditions, hydrogeological conditions, migration of radionuclides, seismicity, ekzogeodynamic processes, impacts of floods, meteorological processes and phenomena, technogenic hazards, water and mineral resources, land use and land ownership, transportation of radioactive waste, population and urban network, plant and animal species, national cultural and historical values, nuclear experience of the population and proximity to nuclear power plant, infrastructure, proximity to state border, public acceptability.

In compliance with the requirements of the *Ordinance on radioactive waste safety management,* the *Ordinance on nuclear power plants safety* and the recommendations of NRA, the criteria for acceptability assessment of the site were defined. The criteria included: safety determined by the geological conditions, safety determined by the hydro-geological conditions, migration of radionuclides, safety determined by geo-chemical characteristics (geo-chemistry of underwater and sorbate minerals in geological environment), safety defined by tectonic and seismic conditions, environmental and population impact (presence of water and mineral resources in the area of influence of the NRRAW, land use, existing ecological and culture protected areas within the area of the NRRAW), RAW transportation (the distance to the NRRAW, established road network, number of residential locations along the route), social and economic acceptability (public acceptability, blocking of productive land, new infrastructure, unfavorable effect on business activities).

On the grounds of this multi-criteria analysis, the Radiana site was determined as the site offering the most favourable conditions for the construction of the NRRAW. During the "Confirmation of the site" stage, additional thorough studies of the site were conducted, confirming the correctness of the choice.

Additional information is provided in Appendixes Nos. 1, 2, 17, 18.

2.2.2 Selected alternative under the RAW long-term management method

In compliance with the recommendations of NRA and the requirements of the nuclear legislation, the method selected for the long-term management of low and intermediate level radioactive waste is **disposal in a near-surface repository.** This method was determined by a strategy on spent nuclear fuel and radioactive waste management, adopted by the Ministerial Council on 23.12.2004, according to which the NRRAW is a near-surface repository. The rejected alternatives are described in Section 2.3.1.

2.2.3 Selected alternative under technology for disposal of RAW

The alternative selected for disposal of low and intermediate short-lived radioactive waste was **modular near-surface multi-barrier engineering trench-type facility**. It enables the step-by-step construction of the separate elements of the facility and the its gradual increase in capacity.

The scheduled volume of spent short-lived low and intermediate radioactive waste is approximately 138 200 m^3 including the packaging.

This alternative was selected on the basis of evaluation and analysis of alternative methods (long-term storage, geological disposal, etc.) and of alternative technologies (shaft repository, tunnel repository), which were rejected due to the reasons listed in Section 2.3, as well as based on other European countries' experience with constructed near-surface repositories in their territories – in Centre d'Obe, France, El Cabril, Spain, Mochovce in Slovakia, Dukovany in Czech Republic, Japan, USA and others [213].

This technology corresponds to good practices in the EU and in other countries with developed nuclear energy. The technology for disposal of low and intermediate level radioactive waste in the selected type of repository is a tested technology, proven in the management of radioactive waste.

It includes numerous barriers along the way of distribution of the radionuclides in the environment, serving as a deep separation protection.

Strict control and monitoring of the facilities is implemented. The technical implementation of control and monitoring measures is simple and efficient, which is one of the main requirements in the area of radioactive waste management.

The construction of the disposal facility is simple and safe. Application of complicated maintenance and repair activities are not necessary.

The disposal facilities are compact, utilizing the maximum area.

The requirements of the Bulgarian nuclear legislation are being implemented in the facility draft project in order to enable measures for the reconstruction of the engineering barriers in case of any disturbances and/or removal of radioactive waste container(s).

The purposes of the project are being implemented for the radioactive waste to be safely isolated from the environment and from people for the entire life cycle of the disposal facilities.

The selected technology is efficient with regard to the construction, maintenance and repair expenses, as well as expenses related to the closure of the facility.

2.3 Alternative ”2” - Other alternatives

2.3.1 Alternatives under the methods for long-term management of RAW

Two alternative methods for long-term RAW management were analyzed:

Long-term storage in a warehouse

Currently the conditioned low and intermediate level RAW is stored in the *Warehouse for Storage* of *Conditioned RAW (WSCRAW) in SU ”RAW - Kozloduy”.* The warehouse has a capacity of 1920 pieces of RCC and was designed for temporary storage of conditioned radioactive waste for a period of 50 years. The warehouse cannot be used for long-term storage of RAW due to:

(1) exhaustion of its capacity;

(2) not being designed for long-term storage

There is a theoretical possibility for long-term storage of conditioned RAW in a specially constructed warehouse. The radioactive waste must be stored in such a warehouse for a period which ensures its safe disposal for 300 years. This method was rejected. The experience of our country and of the leading world states in RAW management rejects this alternative which is stated in the documents of the International Atomic Energy Agency in Vienna, due to the following reasons:

(1) inability to ensure the long-term safety of the facilities;

(2) encumbering future generations with the RAW maintenance;

(3) much higher price for the storage of RAW until the time when it can be released from institutional control, i.e. when the activity of the radionuclides fall below levels which are dangerous to humans and the environment;

RAW disposal in a deep geological repository.

This alternative is regulated in the *Ordinance on safe RAW management* for disposal of low and intermediate level long-lived and high-activity RAW. It was rejected in reference to low and intermediate level short-lived RAW due to the disproportionately high cost for disposal of unit volume of conditioned radioactive waste and the fact that international experience shows that the near surface repositories are reliable enough to bury this type of waste.

Besides, this alternative contradicts the *Strategy for spent fuel and radioactive waste management,* adopted by the Ministerial Council on 23.12.20004 [127], according to which NRRAW is a near surface repository.

2.3.2 Alternative under RAW disposal technologies

The feasibility studies carried out included the development of preliminary projects on a shaft-type repository [214, 360] and on a tunnel-type repository [186] specific for the conditions at Radiana. Both facilities are multi-barrier engineering near-surface modular-type repositories and are an alternative to the selected multi-barrier, engineering modular trench-type facility, thoroughly described in Part 1. The near-surface facilities as a construction volume, facility types and activities are identical to the ones described in Part 1.

Alternative under technology 1 – construction of a shaft type repository [360]

A concept developed in Belgium was used as a prototype for the feasibility draft on a shaft-type repository [214] (Appendix No. 3), which was later abandonned and replaced by a trench-type repository, as well as the concept on RAW disposal, developed in Slovenia.

The repository consists of two shaft modules with large diameter, with a distance between them of approximately 300 m. Details regarding the location and the construction are provided in Appendices Nos. 4-8.

Each shaft module is a two-wall facility with double walls and double bottom. It is built from an outer shaft with a diameter of 62 m and height of 46,6 m, where the inner shaft for the disposal of the RAW is placed with a diameter of 52 m and working height of disposed radioactive waste of 5..1 m. The two bodies of the shaft module – outer and inner shafts for disposal of radioactive waste (inner shaft) are built of high-strength reinforced concrete with a wall thickness of 1,5 m. The outer and inner shafts are connected by reinforcing elements placed at 3.5 m from the bottom of the outer shaft, radially positioned. Clear distance of 2 m between walls and 2.5 m between the bottoms of the outer and inner shafts is formed. Thu, the so-called hydraulic cell, preventing access of groundwater to the radioactive waste containers, is formed. In addition, the outer surface of the outer shaft is covered with a waterproof coating. The bottom of the inner shaft is a reinforced concrete slab with a diameter of 59 m and thickness of 2 m. The bottom of the inner shaft is built upon 105 pieces of cylindrical supporting columns with diameter of 2 m and 2.5 m in height.

The upper part of the shaft module is located in a loess stratum, and the lower part in pliocenic clays. It is necessary to strengthen the stratum due to significant size of the of equipment and the emerging normal stress in the ground by the weight of containers with radioactive waste. It is envisaged that combined strengthening of the loess stratum with inclined micropiles with length of 10 m and hardening by injection of silicate solution (silicification). Pliocene clays shall be strengthened through inclined micropiles with length of 10 m and bottom vertical piles to a depth 15 m, forming a skeleton cross into the shaft.

Cross tunnel passages to the double bottom of each shaft module under 5% slope with length 280 m, designed to capture any infiltrations and contaminated water collected at the exit of the galleries in tanks. Free space is used for control and inspection of the walls and bottom of the shaft unit and the drainage system. Access is through lifting equipment (elevator room).

Each shaft module is equipped with its own independent ventilation. Ventilation systems are represented by standard mine ventilation fume type. Clean air comes from the drainage cross tunnel at the base of the module, passes through the space between the double bottom and radial clear space between the support wall and the inner shaft and through the vent is drawn from the main fan shaft

The containers (RCC) are buried in the inner shaft which is divided into 4 sectors with internal walls. The capacity of each module is 8424 pcs. Deployment of RCC in the shafts is carried out with 2 overhead (gantry) cranes. The cranes are remotely controlled with CCTV system and process control. During the operation the module is coated with a protective hall (detachable metal design) 14 m of height, width of 70 m and length 76 m, analogical to the trench-type repository described in Part 1.

Each of the modules fits 18 rows of RCC. Since the mechanical strength of RCC is such that they can be set in 4 horizontal rows, after the positioning of every fourth row, the RCC system is filled with high-cement-sand hydro-mixture containing 45-50% cement. A form-molded concrete layer, which includes 4-rows of containers, forms the basis for the next 4 rows of containers.

After the deployment of the last row of containers and filling of the space with the above described cement mixture, a roof slab is constructed, waterproof coating and multi-barrier protective cover are applied similar to that of trench-type repository.

The following elements are considered by the authors of this report as elements of the multi-barrier system:

⇒ **First engineering barrier:** cement matrix;

⇒ **Second engineering barrier:** container walls covered with waterproofing material;

⇒ **Third engineering barrier:** shaft module walls covered with waterproofing material;

⇒ **Fourth engineering barrier:** cementing area or silicatization around the module**;**

⇒ **Fifth engineering barrier:** the empty space between the double walls and the bottom of the shaft module;

⇒ **Sixth engineering barrier:** protective multi-barrier cover**.**

⇒ **Seventh natural barrier:** loess complex and pliocenic clay.

This technological solution for deployment of radioactive waste is rejected at an early stage of the development due to the following reasons:

(1) the solution does not provide opportunity for inspection and control of the adjacent containers during the filling of the module; only RCC can be controlled, which are available in the last 4 rows before applying the filling layer of high-strength cement;

(2) the solution does not provide an opportunity for undertaking measures towards restoring the engineering barriers in case of possible violations. It does not provide an opportunity to remove defective containers;

a. The fourth engineering barrier (cementing or localization around the module) is rather a method for compensation of violations in the immediate vicinity of the shafts which have occurred during their passage, and not an additional engineering barrier. The cementing/silicatization, according to the development, is limited to approximately 50 cm;

(3) It is a new technological solution which has not been tested in the radioactive waste disposal practice. The Belgian concept which serves as a basis of this technological solution has been replaced with deployment of radioactive waste in trench-type repository, similar to the one described in Part 1;

(4) The proposed technology for strengthening does not guarantee the long-term stability of the system. The high specific loading is a precondition for violation of the geological structures and occurrence of unacceptable displacements and deformations of the structure in the long term;

(5) Complicated and risky organization of loading the module with containers; it does not fulfill the limiting requirements for lifting of RCC at maximum height of 9 m, for which the containers have been designed;

(6) The construction of the modules is associated with many technical difficulties;

(7) The construction period is approximately 10 years which is unacceptable in view of the term of commissioning of the NRRAW – 2015, enacted by the Strategy for spent nuclear fuel and radioactive waste management, adopted by the Ministerial Council on 23.12.2004, contradicts the DoMC 683/25.07.2005.

(8) Disproportionately high cost of shaft type repository

Alternative under technology 2 – construction of tunnel-type NRRAW [186]

The repository consists of several underground parallel tunnels with a large cross-section (6.5 m) and a length of 1130 m, the access to which is carried out through horizontal drift-in tunnels with a small diameter (3.7 m).

The auxiliary buildings and facilities shall be constructed on the surface. They shall be situated on two sites with different purposes. The overall plan and detailed schemes of deployment of facilities are provided in Appendices Nos. 9 and 10.

According to the authors of the development, the total area which has to be fenced for the needs of a tunnel-type repository is approximately 35 ha. Considering the common approach that the roads used for the transportation of the radioactive waste, controlled by Kozloduy NPP to the disposal facilities must be within the framework of the NRRAW site, the necessary area is approximately 50 ha.

The repository consists of 8 parallel tunnels for the deployment of radioactive waste containers (RCC), each one 1130 m long and with diameter 6.5 m and 4 servicing galleries (transport tunnel, service gallery, ventilation tunnel and experimental tunnel) with diameter 3.7 m and total length about 730 m. The distance between two galleries for radioactive waste deployment (axis to axis) is 20 m, and the size of the arch is 12.6 m. The underground passages are situated on one level at a depth of 25–30 m under the surface of the terrain. The access is through a horizontal transport tunnel from elevation 59. The details of the construction are provided in Appendices Nos. 11 and 12.

Each one of the galleries is considered as a separate module of the repository, and the capacity of one module is 2150 RCC. Two radioactive waste sectors are formed in each module, each one with a capacity of 1075 RCC. The containers are placed lengthwise in the galleries to accommodate two rows, two in height - in cross-sectional four containers can be placed.

The tunnels for disposal of radioactive waste are equipped with a multi-layer, moisture-proof, reinforced concrete lining with total thickness of 0.45 m,. The lining of the service underground passages (transport and ventilation tunnels and service gallery) is 0.33 m thick. The body is strengthened with micro-piles and injection silicatization. The depth of the silicatization, according to the authors is 40 cm.

The bottom part of the passage shall be a 40 cm concrete slab with drainage ditches, which are part of the system for mine water collection. Pipes shall pass under the concrete slab for the outlet of possibly contaminated water. The water shall be managed separately and shall be discharged into separate collectors located on the Iztok site, which are equipped with testing equipment. In order to facilitate the water flow-off, the galleries have a slight slope of 5%.

The system is equipped with U-shaped (reverse flow) mine ventilation. The clean ventilation stream enters through the transport tunnel, passes through the galleries for deployment, and is sucked up to the ventilation tunnel by the main ventilation fan, which is working in suction mode.

The deployment of the radioactive waste in the modules for disposal is carried out through the transport tunnel with heavy electric vehicle (battery-type) with overhead capture of RCC, which run on rails, dug into the concrete foundation of the transport tunnel and of the galleries for deployment of radioactive waste. This electric vehicle is managed remotely from a control panel, located on the surface using a surveillance system of video cameras. Unloading and placement of RCC in disposal location shall also be carried out remotely.

After filling the galleries with radioactive waste, the free space is filled with inert material preventing distribution of radionuclides.

The following elements are considered by the authors of this report as elements of the multi-barrier system:

⇒ **First engineering barrier:** cement matrix;

⇒ **Second engineering barrier:** container walls covered with waterproofing material;

⇒ **Third engineering barrier:** walls of shaft module covered with waterproofing material;

⇒ **Fourth engineering barrier:** cementing area or silicatization around the tunnel passages**;**

⇒ **Fifth engineering barrier:** the empty space between the double walls and the bottom of the shaft module;

⇒ **Sixth engineering barrier:** protective multi-barrier cover**.**

⇒ **Seventh natural barrier:** loess complex and pliocenic clay.

The auxiliary buildings and facilities shall be situated on the surface of the two sites – Zapad and Iztok. The technological facilities for radioactive waste management shall be positioned at the Zapad site, and the mining complex and mining ventilation installation shall be built on the Iztok site. Thus, the diversification of the activities is completed. The Zapad site is technological, connected with the activities related to the management of radioactive waste and their deployment in the tunnel installations, while the Iztok site is used for underground buildings and for the ventilation system.

Part of the auxiliary buildings are very similar to the buildings considered in Part 1 – checkpoint and administrative and laboratory complex. It is envisaged that the acceptance of the radioactive waste will be carried out in a close type hall place. In addition, a diagnostics and RCC repair point is envisaged. Small machines for treatment of secondary radioactive waste are proposed (100 t press and cementing of liquid RAW in 200 l barrels) with the express stipulation that due to the minimum quantity of secondary radioactive waste, they can be sent to SU RAW-Kozloduy for processing. A gantry crane is envisaged with load weight 25 t for handling RCC in the acceptance complex and loading of the battery-type electric vehicle. Battery charging station for the electric vehicle is envisaged.

Anticipatory construction of the experimental tunnel is envisaged in view of the in situ research of the relation of the underground installation – fitting body, to determine the tensions to occur in the body and to test the different methods for tunnel passing and their strengthening. During the operation of the repository in the experimental tunnel tests shall be executed related to the establishing of optimal filling mixture, which shall be used for filling the empty space between the walls of the module and RCC when closing the facility.

The construction shall be carried out by standard mining methods with machines, shown in Appendix No. 13. The excavated land shall be evacuated in small carts (2.8 m^3), driven by battery-type mining locomotives to the Iztok building site by rail, serving the purposes of construction and later dismantled. At the start of the mine building, the ventilation shall be carried out through mine ventilator fans for local airing, situated on the surface at appropriate (and regulated by normative documents) places close to the mouth of the access passage. After the construction of the transport passage, the ventilation passage and the pile foundation of the tunnel passage most remote from the mouth, the mine ventilation is put into service. The construction of the tunnel for the disposal of radioactive waste is a double-stage process, which includes: the construction of the so-called pile foundation with a small diameter (4.00 m); installation of temporary lining; 4-6 months waiting for the stress to balance; widening up to the final diameter (7,40 m) and construction of final multi-layer lining. The essential point is that because of the requirements for the underground works concrete, it is not transported to the site by ready-mix truck, but it is prepared on the surface under the given technology.

The main activities during the operation of the repository are similar to those discussed in Part 1, taking into consideration the specifics of the work in underground mine.

The closure of the repository is carried out by consistent filling of the modules with buffer material (loess-cement-concrete mixture) and sealing of the entries as early as at the operational stage, by using standard pneumatic and hydraulic handling equipment. Before the filling, the entries of galleries are sealed with a clay “cap” and concrete walls. The facilities in the ventilation and the transport passages are dismantled. The passages are filled with aggregate. The passage mouths up to the level of the first module for deployment are filled with clay material and separation walls are constructed in them. The water, that has eventually emerged in the repository or generated as a result of dehydration of the filling material and the packages, shall be discharged into the front of the ventilation gallery, to the equipped concrete reservoir with enough capacity filled with sorbate material.

Out of all the above described activities, the most important one is the filling of the empty space between the walls of the module and the radionuclide waste. It must be filled in a way ensuring a lack of empty space which in time might be filled with water penetrating through the walls. After the loading of the tunnel construction with radioactive waste, many geotechnical measurements must be carried out in order to prove that equilibrium is achieved in the system enclosed massif – tunnel loaded with RCC. Then, the empty space shall be filled. Loess-cement with zeolites, sand-loess mixture and other natural substances can be used as filling materials. The specific filling materials shall be tested in the experimental passage during the operation of the repository. The filling shall be implemented in two stages. Initially the entire space is filled with aggregates. After a certain period necessary for the development of the processes of self-sealing, the rest of the empty space is filled. At this stage of IP the loess-cement is considered as filling material, which is fed under pressure through the pipeline with an inside diameter of ф 150 mm and length of approximately 1500 m. The filling technology is tested for standard mine constructions but has not been applied for tunnels with great length (1130 m) with radioactive waste.

The construction of clay caps at the end meters to mouth of the entry passages of standard mine technology. The clay caps are a 30 m construction, limited on both site of the reinforced concrete walls with thickness 35 cm, inside of which at every 10 m are built 2 such reinforced concrete separation walls with thickness 35 cm. The space between the separation walls shall be filled with clayey pulp by compression pump “until repulsion”. The last reinforced concrete separation wall is at the entry of the passage.

The term and the type of activity during the institutional control are similar to the trench-type repository. The specificity here is that the underground facility must be controlled, which leads to certain difficulties in the implementation of the control methods, the modern technologies and technical means, which shall be developed until the closure of the facilities, and safe monitoring and control system must be established.

The proposed technological solution is a new technology which has not been yet implemented for radioactive waste disposal. Tunnel-type repositories for the disposal of low and intermediate level radioactive waste were constructed and operated in the developed European countries with developed nuclear energy, but these repositories were built in solid rock and at a significantly greater depth. The technical solution is for the construction of a shallow repository, approximately 34 m under the surface, in a loess massif, whose characteristics significantly differ from those of solid rock (granite, basalt, gneiss). The expenses for the construction and operation of an underground type repository are higher than of a trench-type repository. An additional argument is that the tunnel repository depends mainly on instrumental means for monitoring and control, and the possibility for the application of compensating activities, related to the measures for reconstruction of engineering barriers in case of violations and/or removal of defective containers is difficult to achieve.

2.3.3 Other alternatives by location

Alternative locations for the NRRAW are the sites at Marichin valog, in the land of the town of Kozloduy, municipality of Kozloduy; Brestova padina, in the land of the village of Butan, municipality of Kozloduy; and Vurbitsa, municipality of Vratsa.

Alternative by location, “Marichin valog” site

The site is located about 2.5 km west-northwest of Kozloduy NPP. It is situated at elevation 90-100 m on a very gentle slope of a small valley without a constant near surface water flow. The slope was formed in the sediments of the Brusarska Formation, whose upper surface is diluted up to elevation 87-85 m and it has a slope to east-northeast. The displacement of the site to the erosion basis is under 30 m, the slope angle is between 5^0 and 10^0. Changes cannot be expected in the natural conditions of drainage of surface water for the time of existence of the repository. The coordinates of the site are as follows:

N	E		N		E
1 43º44'00,38"	23º43'23,93"	43 44 00.38	43.733439 23	43 23.93	23.723314
2 43º44'25,66"	23º43'57,95"	43 44 25.66	43.740461 23	43 57.95	23.732764
3 43º44'21,12"	23º44'06,18"	43 44 21.12	43.739200 23	44 06.18	23.735050
4 43º43'55,99"	23º43'31,87"	43 43 55.99	43.732219 23	43 31.87	23.725519

The ground at the site consists of sediments of two complexes: quaternary and pliocenic. The quaternary sediments of the site contain two layers: layer 1 - loess and loess clays with a thickness between 5 and 14 m and a layer of gravel with two clay-sand cores with a thickness of 0,5 – 2,0 m. The pliocenic deposits are divided into four layers (Fig. 4.) – clay, sandy to dust, yellow-rusty (layer 3) with a thickness of 16.5 to 18,0 m; grained sand (layer 4) - present in the sections below form of thin lenses and layers failed module in layer 3; grained sand to clayey aquifer (layer 5) - is widely developed in the layer 3 and a thickness of between 1.5 and 3.0 m; clay yellow-rusty to gray, dense, with marl like structure (layer 6) - the thickness is about 60 m, serves as the local water-stops.

In the hydrogeological section of the site are the following: unsaturated (aeration) zone, aquifer and water stops. Under the zone of aeration, in the fine sand, at an elevation of about 64-65 m, the low-powered site is formed (1.5 – 2.0 m) and less-abundant aquifer which recharge areas and drainage and hydrodynamic parameters are well clarified (Fig. 5) - pressure gradient varies from 0.01 to 0.004 (just below the site is 0,007), the conductivity of the layers is about 2,0 m^2/d, and the coefficient of filtration ~ 1,1 m/d. The general direction of groundwater flow is from southwest to northeast. Its drainage is in the lower part of the tributary valley, at a distance of about 300-350 m from the northeast end of the site.

A layer of solid, practically non -permeable clays of Brusarski Formation with a thickness of about 60 m, serves as a local water-stop. Heavy-water aquifer in the sands of Archarskata Formation is about 100 m from the surface. Water conductivity reaches 100-150 m^2/d. The natural resources of the aquifer are estimated at 1 m^3/s. The flow of underground water is from south-southeast of the north-northwest. Engineering and geological profiles and a piezo-metric map are given in Appendix No. 16 and more detailed information in Appendix No. 18.

The two most important soil types, which act as a geological barrier against the spread of radionuclides at Marichin Valog site are gravel with a sandy-clay core and dust to sandy clay, layer 2 and layer 3 (Fig. 4) respectively. The mineral content in both soil types of clay is above 70%. The main clay minerals are from the smectite group (35%). The clays from Brusarska Formation have an ion exchange capacity of 22 meq/100 g, which determines a very good attenuation of these sediments in terms of distribution of radionuclides.

The Marichin valog site is located in the "Zlatiyata" location, one of the most fertile parts of the Danubian plain and falls under the Natura 2000 protected area in BG0002009 "Zlatiyata" for the conservation of wild birds, declared by Order № RD-548/05.09.2008 of the Minister of Environment and Water (SG issue 83/23.09.2008). The population of the municipality of Kozloduy is against the construction of a repository on the arable lands. The site is parceled and belongs to different private owners.

Alternative by location, Brestova Padina site

Brestova padina site is located in the location of the same name, 12 km southwest of Kozloduy NPP, 6,0 km northwest of the village of Kriva Bara, 7.5 km northwest of the village of Butan. Its elevation is 100-120 m. It is located on a wedge dividing plateau (slope 2-3^0), between two valleys. The surrounding terrain, in which is inscribed the hollow plane, is inclined from west to east with an average gradient slope of about 5-6^0. Changes in the natural conditions of the drainage of surface water for the life cycle of the repository are not anticipated. Coordinates of the "Brestova Padina" site:

N	E		N		E
1 43º40'33,37"	23º38'11,68"	43 40 33.37	43.675936	2338 11.68	23.636578
2 43º40'22,33"	23º38'51,36"	43 40 22.33	43.672869	2338 51.36	23.647600
3 43º40'14,02"	23º38'46,83"	43 40 14.02	43.670561	23 38 46.82	23.646339
4 43º40'25,28"	23º38'07,28"	43 40 25.28	43.673689	23 38 07.28	23.635356

The ground at the site consists of sediments of two complexes - quaternary and pliocenic. Quaternary sediments at the site include three layers: a typical loess dust (layer 1^a), loess clays (layer 1^b) and delluvial clayey loess (layer 1^c).

In the area of the site the pliocenic complex begins from a depth of 15 m (elevation about 97 m) and includes: reddish-deluvial proluvial clay (layer 2) - thickness 1.5 – 2.0 m); yellow-rusty powder sandy clay (layer 3) - with a thickness of about 20-21 m; grained sand (layer 4) - horizontal lenses and layers in layer 3, thickness about 5 – 5.5 m; grey-blue clay dust (layer 5) - under elevation +74 m, serves as the local water-stop. Layer 3, layer 4 and layer 5 refer to Brusarska Formation, as layer 3 and layer 4 are within the upper flat (oxidized) part of the formation, and layer 5 - unchanged in the lower part, formed in reduction environment.

In the hydrogeological section of the site there is an unsaturated (aeration) zone, an aquifer and a water-stop. During the construction of a half-dug trench-type repository at elevation about 100-101 m (Fig. 6.) underneath there will be a relatively thin unsaturated zone with a thickness of ~7 m, made up of loess and delluvial clay and of about 1 m pliocenic clays.

Under the aeration zone in the pliocenic clay-sandy sediments (layer 3 and layer 4) there is a low-abundant aquifer, which recharges areas and drainage and hydrodynamic parameters are well understood - pressure gradient is 0.012, the conductivity of the layers is about 10 0 m^2/d, and the coefficient of filtration 0,8÷0,9 m/d.

Within the site , the local aquifer is fed by the loess plateau from the west and drains about 600 m in an east-southeasterly direction into the site, in the area where the two valleys come together. A thick gray-blue clay layer 5 forms a local water-stop in hydrogeological terms. The aquifers in the sands of the Archarskata Formation is located about 40 m from the bottom of the potential repository. Its thickness is 60-80 m. It is fed by atmospheric precipitation from the areas to the south and south-east. Water conductivity is 100-150 m^2/d. The flow of underground water is from south-southeast to the north-west towards the Danube river, where it is in hydraulic connection with the water from the lowest river terrace. The engineering and geological profile and piezo-metric map are given in Appendix No. 16 and more detailed information in Appendix No. 18.

The most important soil types, which act as a geological barrier against the spread of radionuclides at the "Brestova Padina" site are loess clay (layer 1b) and dust to sandy clay (layer 3). In the pliocenic dust-sandy clay the content of clayey minerals is high - nearly 80%. The main clay minerals are from the smectite group (42%). Ion exchange capacity is high - over 24 meq/100 g, which implies a very good attenuation of powder-sandy clay layer 3, with regard to the distribution of radionuclide.

The site falls within the eastern end of Zlatiyata, the granary of West Bulgaria. The 5-km zone is dominated by carbonate humus. The conditions for the crop are very good. In the 10-km zone, the farmland is over 85%.

The site falls within the protected zone BG0002009 "Zlatiyata" for conservation of wild birds, declared by Order No. RD-548/05.09.2008 of the Minister of Environment and Water (SG issue 83/23.09.2008).

The population of the municipality of Kozloduy is against the construction of a repository on the arable lands. The site is parceled and belongs to different private owners.

Alternative by location, "Vurbitsa" site

The site is located about 3 km southeast of the village of Vurbitsa, municipality of Vratsa, and 27 km from the town of Vratsa and 52 km south of Kozloduy NPP. It is situated on a plateau at 310-335 m and it is inclined 3-4^0 to the north-northeast, on left bank of the tributary valley which leads to the Skut river. The coordinates of Vurbitsa site are as follows:

	N	E		N		E
1	43º16'35,58"	23º51'45,17"	43 16 35.58	43.276550	23 51 45.17	23.862547
2	43º16'17,40"	23º52'34,02"	43 16 17.40	43.271500	23 52 34.02	23.876117
3	43º16'07,16"	23º52'27,97"	43 16 07.16	43.268656	23 52 27.97	23.874436
4	43º16'23,62"	23º51'41,42"	43 16 23.62	43.273228	23 51 41.42	23.861506

The site is on pliocenic erosion surface-type states, which cuts the marl of Sumerskata Formation. The terrain of the site is a pliocenic peneplain, surrounded by valleys. Only the south side of the site does border with a valley but gradually turns into a slope. This way the site is well drained on the north to the tributary valley. The displacement of the site to the erosion basis of the depression is less than 30 m, the slope is inclined below 10^0. Changes in the natural conditions of the drainage of surface water is not anticipated for the lifetime of the repository.

The ground of the "Vurbitsa" site to a depth of about 50 m consists of three engineering geological layers (Fig. 8): Deluvial-proluvial quaternary clay and gravel (layer 1) - their thickness varies from 4-5 m in the NE area site to 11.0-11.5 m in SW area of the site; subdued marl (layer 2) - thickness of layers varies from 4.5 to 10 m; non-subdued marl of lower cretaceous age (layer 3) - refers to semi-rock engineering types, according to data from surveys for oil and gas; thickness of the marl in the area of the site is over 1000 m.

The engineering construction of the "Vurbitsa" site and the engineering mechanical parameters of the variations of the earth, where eventually the repository might be constructed, are favorable. No special activities to prepare the ground are necessary. The engineering and geological profile is given in Appendix No. 16 and more detailed information in Appendix No. 18.

The area of the "Vurbitsa" site is in the pre-Balkan part of the Moesian deep artesian basin. During drilling surveys for oil and gas, some very deep water-bearing complexes were found - Triassic aquifer complex, Upper Jurassic-Lower Cretaceous aquifer and Aptian aquifer. These hydrogeological complexes did not and could not have a role in the safety assessment of the possible near surface repository for radioactive waste.

In practice, within the area of the site there are no permanent water-bearing bodies that have direct influence on the operation of the repository. Only at the bottom more gravelly layer 1 there is a form of temporary waterlogged areas, which drain infiltrated rainwater. Provided that the repository's foundations are at an elevation of approximately 304 m (Fig. 8), it will fall within the subdued and/or the fresh Lower Cretaceous Aptian Mert of the Shumerska Formation. The latter serve as regional water-stop slab. These are very dense low-permeable rocks with a porosity of <0,30. The results of the experimental field-filtration tests showed that the rate of filtration of the marl ranges $1.10^{-4} \div 1.10^{-5}$ m/d. Perhaps in depth, as shown by some data, the Lower Cretaceous marls become even more impenetrable. At a significant depth of 1000-1100 m below Shumerskite marls in the karst limestone is located in the Lower Cretaceous aquifer, which virtually has no effect on the discussed task.

The two most important soil types, which act as a geological barrier against the spread of radionuclides at the "Vurbitsa" site are subdued (layer 2) and fresh marl (layer 3). The content of clay minerals in them is 63-65%. The clay minerals from the smectite group are 23-26%. The geochemical aspect, the marly varieties from the "Vurbitsa" site are defined as calcareous dusty clay. They are characterized by a lower sorption capacity (about 4-6 meq/100 g) of Pliocene and Quaternary clays of the sites of "Marichin valog", "Radiana" and "Brestova padina" and generally by a bit lower partition coefficients in respect of the radionuclides.

The shortest road from Kozloduy NPP to the site is 90 km - 68 km by secondary road No. 4 from Kozloduy to Vratsa and 22 km by third class road No. 1306 that needs repair. Transportation via this road will pass through 14 villages. The population has no nuclear culture and experience. The region is underdeveloped, there is no infrastructure close to the site. The land at the site is privately owned and used for agricultural purposes. The site is outside the scope of protected areas under "Natura 2000".

LIST OF APPENDIXES

Part II

2. ALTERNATIVES FOR THE LOCATION AND/OR ALTERNATIVES TO THE PROPOSED TECHNOLOGIES AND THE REASONS FOR THE SELECTION

1. Zoning of the territory of the country and separation of the most acceptable site
2. Multi-factor system analysis for comparing the potential sites
3. Concept for shaft type repository disposal, Belgium
4. Conceptual scheme of NRRAW – shaft type plan
5. Conceptual scheme of NRRAW - shaft type plan – upright projection
6. Master plan of shaft type repository
7. Conceptual construction of NRRAW – shaft type
8. Conceptual scheme of NRRAW – tunnel type plan
9. Conceptual scheme of NRRAW – tunnel type plan
10. Tunnel repository plan at "Zapad" and ""East" sites
11. Tunnel repository: Generalized scheme of the underground tunnel type repository and Cross profile of the gallery for deployment of RCC
12. Tunnel type repository: Location of the transport passage to the RAW tunnels in geological column; Cross section with distances between the tunnels for RAW disposal; Transportation of RCC by transport-loading machine (battery-type electrical car) and positioning of RCC in the deployment gallery
13. Tunnel type repository: basic machinery for construction
14. Tunnel type repository: barring
15. Tunnel type repository Tunnel type repository before the deployment of the first RAW container; Tunnel type repository during the operation and construction
16. Maps of alternative locations
17. Short description of "Radiana" site, elaborated similar to the description of the sites of Brestova padina, Vurbitsa and Marichin valog
18. Generalized characteristic of the potential sites from [156],SERAW, 2010

Part III

CONTENT

Part III

3 DESCRIPTION AND ANALYSIS OF THE COMPONENTS AND FACTORS OF THE ENVIRONMENT, AS WELL AS THEIR INTERACTION

The Radiana site is located next to Kozloduy NPP, in its radiation protected zone, in the land of the village of Hurlets, municipality of Kozloduy. It is 3.5 km southeast of the town of Kozloduy and about 4.0 km from Danube river.

Due to Radiana’s specific location, Kozloduy NPP will be reviewed as the main industrial site in the area during the description and analysis of the environmental components and factors.

3.1. Ambient air

3.1.1 Climate and weather conditions

The reviewed area is located in the western part of two climatic zones according to Bulgaria’s climatic zoning – north and middle region of the Danube hilly plain of the moderate continental climate subarea. The nature of the topography and the proximity to Danube river, which is considered as a major aeration channel, are essential to the local climate. It results in substantial non-homogeniety for certain meteorological elements, such as minimum temperatures and ground wind, which are highly sensitive to the shape and location of the site.

The meteorological data used for the evaluation came from the records of Kozloduy NPP’s automated system for weather monitoring (SWM), which includes three automated meteorological stations class III, located in the lower part close to Danube river north of EP-1 and EP-2 (altitude 33 m), on a plateau, south of EP-1 and EP-2 (altitude 85 m), and in Hurlets – southeast of the NPP, in the hilly part at the mouth of Skut river (altitude 80 m).

Up to 1997 the climatic characteristic of the region was based on a dataset on the basis of statistics from the regular weather observation station at Kozloduy, carried out in the period 1970-1982 and from Lom station. Independent meteorological data was used after 1997, obtained from three automated measuring stations (SWM), which is a precondition for objective evaluation, reporting the local micro-meteorological features in the region of Kozloduy [162], [207], [221]

Air temperature

The average air temperature in the research area is in the range from 11.5º C to 12º C, decreasing with increasing altitude. The annual course of monthly maximum temperatures are observed in July (from 23ºC to 24ºC) and the minimum in January (from 0ºC to -0.5º C). The average temperature in winter is around 0.9º C and in summer from 21ºC to 22º C. The autumn is warmer than the spring, with the difference increasing with increasing altitude.

The lowest average monthly temperature at Lom observation station was registered in 1940 (10.017ºC) and the highest in 1994 (13.25ºC). See Fig. 3.1-1. The average monthly temperature is 11.5º C – the middle thick green line in the figure.

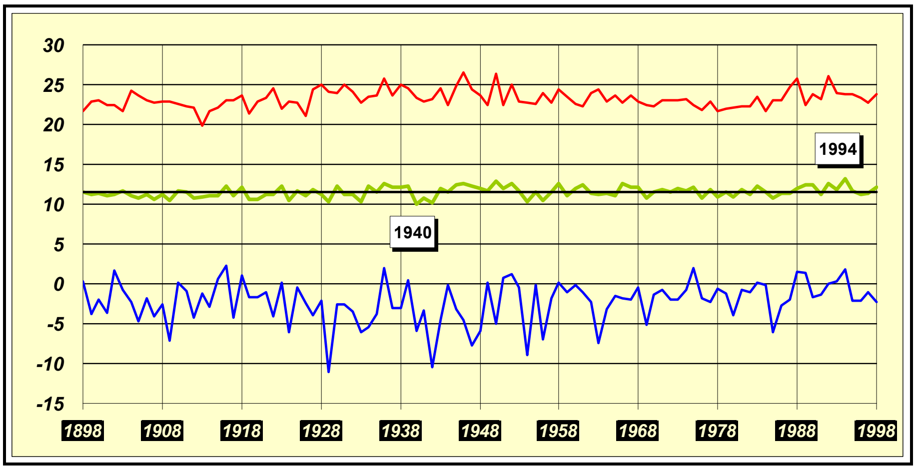


Figure 3.1-1 Average monthly maximum, minimum and average monthly temperature at Lom station for 100 years

Fig. 3.1.2 shows the annual course of the absolute maximum (41.9ºC in July), the absolute minimum (-17.2ºC in December) and monthly temperature for the period 1998-2004, obtained by the three automated measuring stations (SWM) of the ARC-VRK system. The annual average monthly temperature for the period is 12ºC. Monthly data with an amplitude of about 26°C.

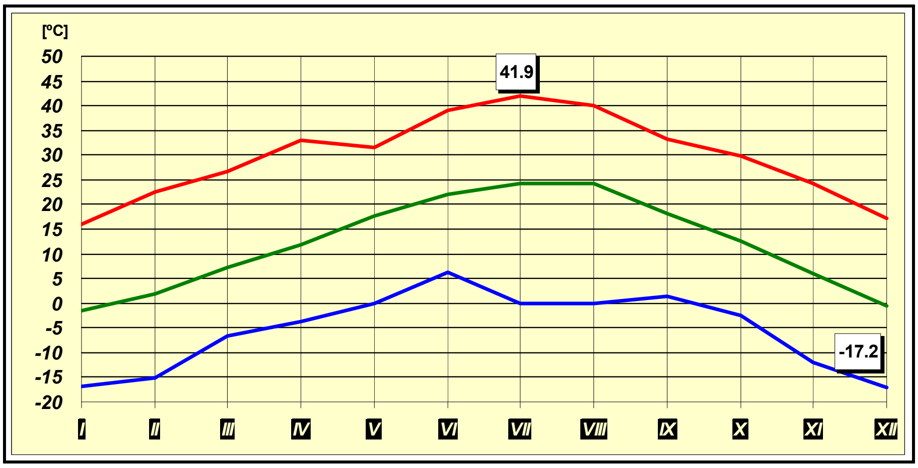


Figure 3.1-2 Absolute maximum and minimum and average monthly temperature for the period 1998-2004

The figure shows that higher absolute maximum temperatures were observed in April than in May, and in July and August lower absolute minimum temperatures were observed than in June or September. So during that period the spring and autumn were warmer.

Specific humidity and rainfall

The minimum specific humidity is in August and July (68.5% and 67.1%). Average monthly air temperatures during these months are close to the maximum and the expressed drought is better developed, which prevents the enrichment of air with moisture. Furthermore, in August the rate of entry of fresh and moist Atlantic air is relatively small, which is due to the influence of the Danube river.

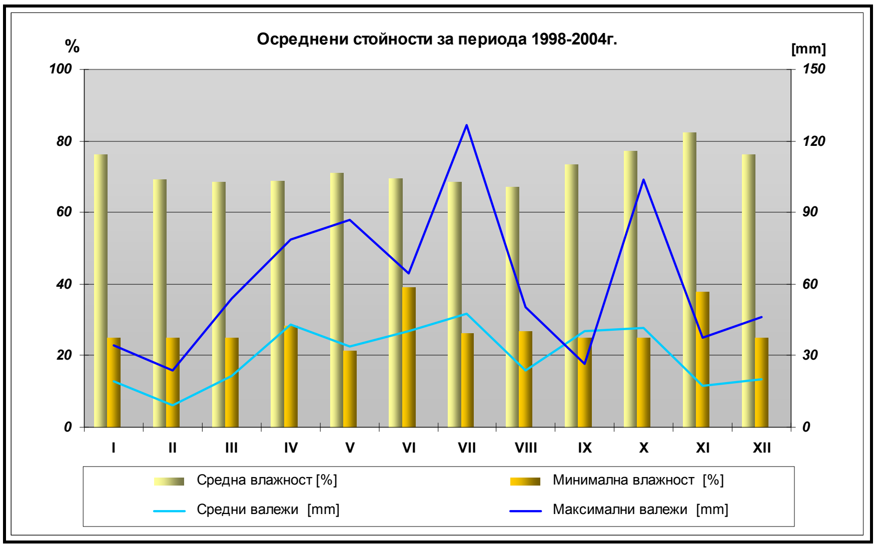


Figure 3.1-3 Average and maximum values of rainfall and relative humidity for the period 1998-2004

The maximum of the monthly maximum and average amounts of rainfall is in July, with a secondary peak in autumn (October) and spring (April, May). The minimum is in February. The secondary minimum is the maximum rainfall in September, while the average is in November.

Figure 3.1-4 shows the distribution of the total quantity of rainfall by sectors for the period 1998 to 2004, using the so-called "rose of precipitation". The largest amounts of rainfall were recorded in the west wind (15.47%) where the share in June (red rectangle) is the highest (7.47%). Largest precipitation is followed by west-northwest (10.34%) with the largest share of rainfall in July (1.64%) and December (1.24%). The third largest amount of rainfall is from west-southwest (9.93%), with the greatest share of rainfall in July (1.93%), September (1.82%) and October (1.6%). The biggest rainfall is in April (1.82%) from the north-east.

The least precipitation is during purely north (2.79%) and south-southeast winds (3.12%).

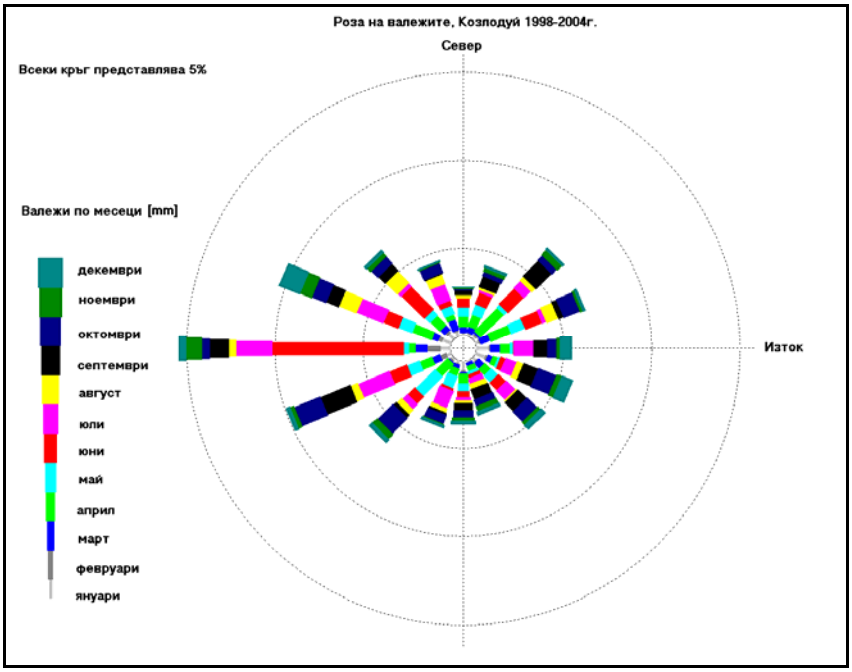


Figure 3.1-4 Rose of precipitation for the period 1998-2004

Figure 3.1-5 and **Figure 3.1-6** display the absolute maximum values, the average and summary amounts of rainfall by months and times of day.

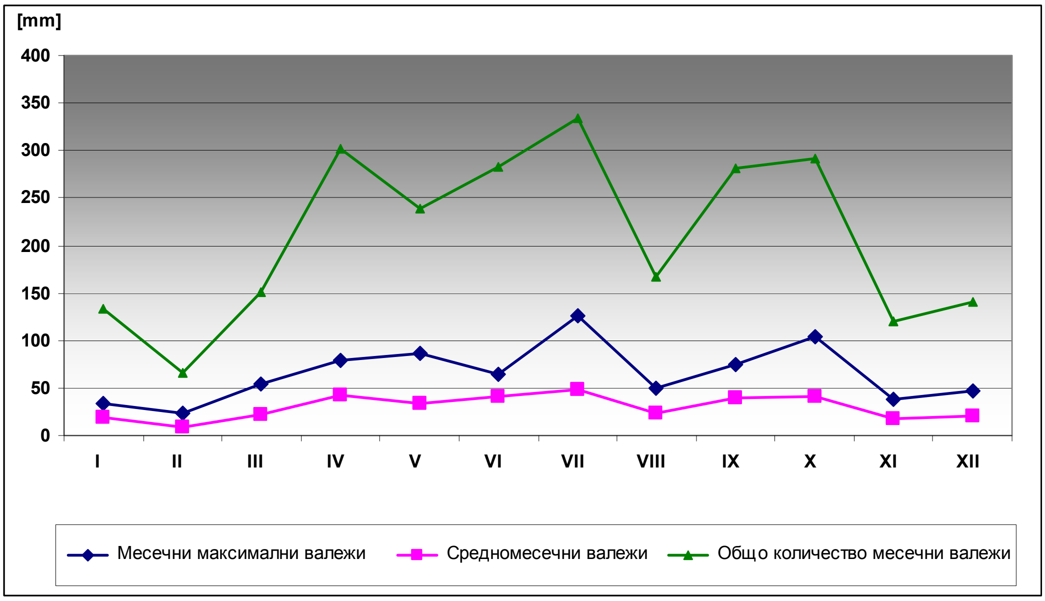


Figure 3.1-5 Maximum summary amounts of rainfall per month, average summary amounts per month and total amounts of rainfall for the period 1998-2004

The maximum monthly rainfall is in July and the minimum (among these maximums) is in January (the blue line). The average monthly rainfall is also in July, whereas the lowest amount is in February – the green line.

The maximum hourly amounts, as well as the total amounts of rainfall are at 2pm, while the average hourly rainfall is at about 7-8pm.

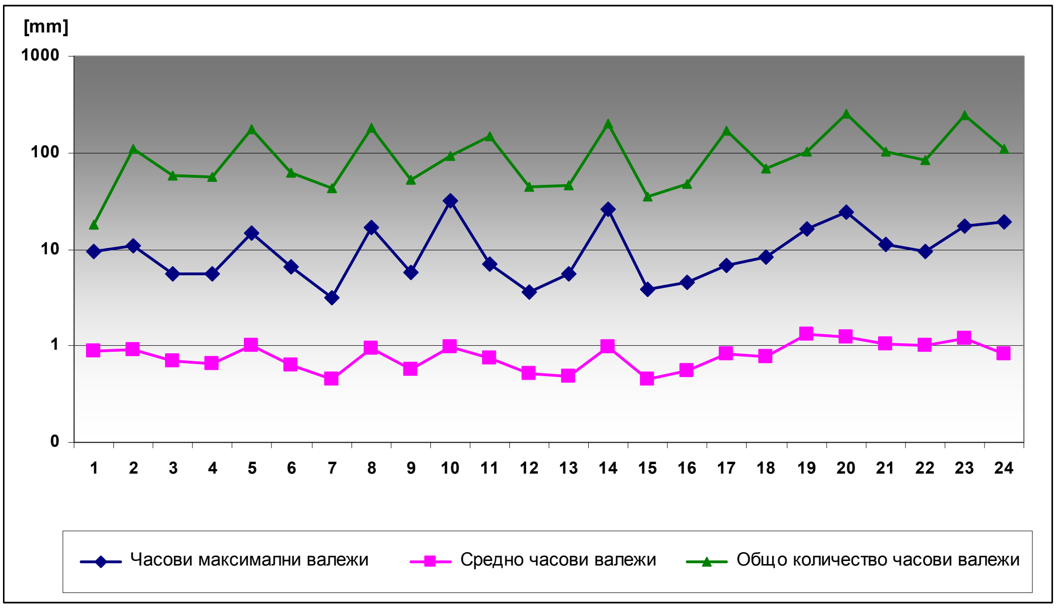


Figure 3.1-6 Absolute maximum, average hourly values and summary hourly amounts of rainfall for the period 1998-2004

The analysis of this data suggests that most rain falls at 8 am, 2 pm and 8 pm. The least rain is observed at 1 am and 5 am. As to the combination of wind-hour, the largest amounts of rainfall correspond to the combination west-southwest wind and 8 pm.

Figure 3.1-6 shows the distribution of the summary amount of rainfall according to sectors for 2001-2008. The greatest amounts are registered at west-southwest, west and west-northwest winds. The total amount for these three patterns is 33.47%. The least amount of rainfall is during purely north and south winds.

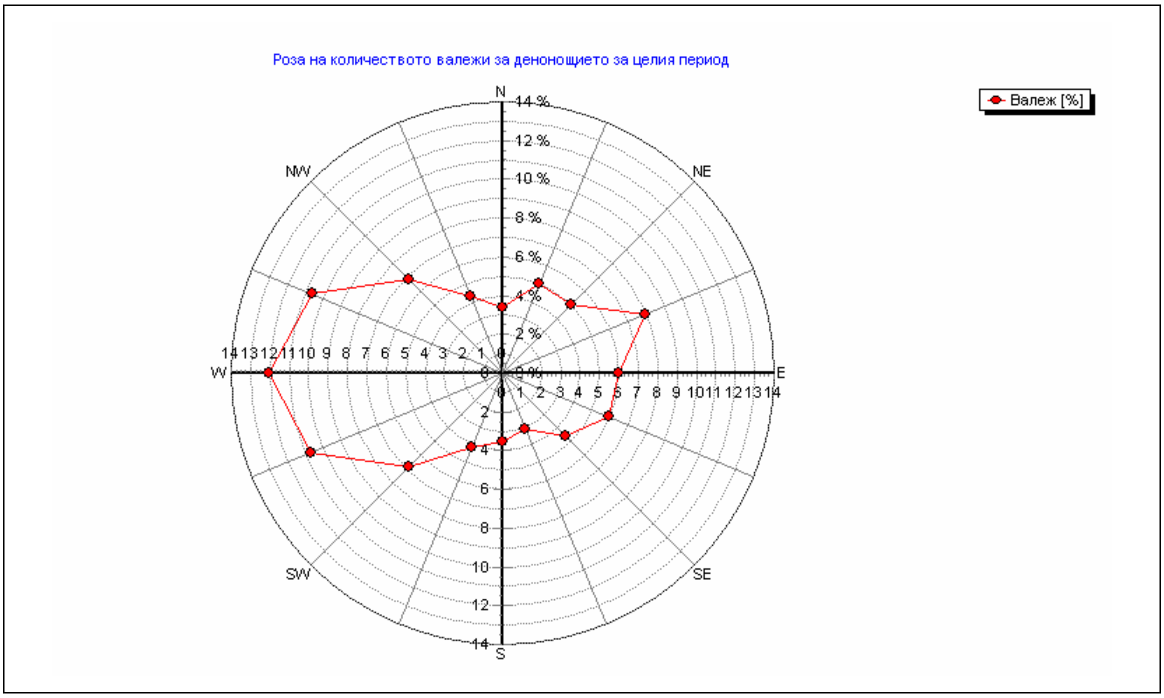


Figure 3.1-7 Total precipitations by sectors, 2001-2008

Wind

The dynamics of air flow in the surface layer is characterized by the wind rose – the speed and wind direction is measured at 16 rhumbs: the wind in a location is a meteorological element, which depends strongly on local conditions and particularly on forms of topography. A hilly topography leads to redistribution and deformation of the airflows, which results in changes of wind speed and directions. A region such as the reviewed one is influenced by the proximity of the large basin formed by the Danube river (aeration channel).

Figure 3.1-8 andFigure 3.1-9 show the integrated wind roses for the periods 1998-2004 and 2001-2008, respectively. In the middle of each rose is recorded the "quiet" time rate – when the speed of the wind is less than 1 m/s.

During the first period, a strong eastern component is observed, whereas a strong western component is present during the second. The cause of this is subject to a different study, which is not related to this EIA.

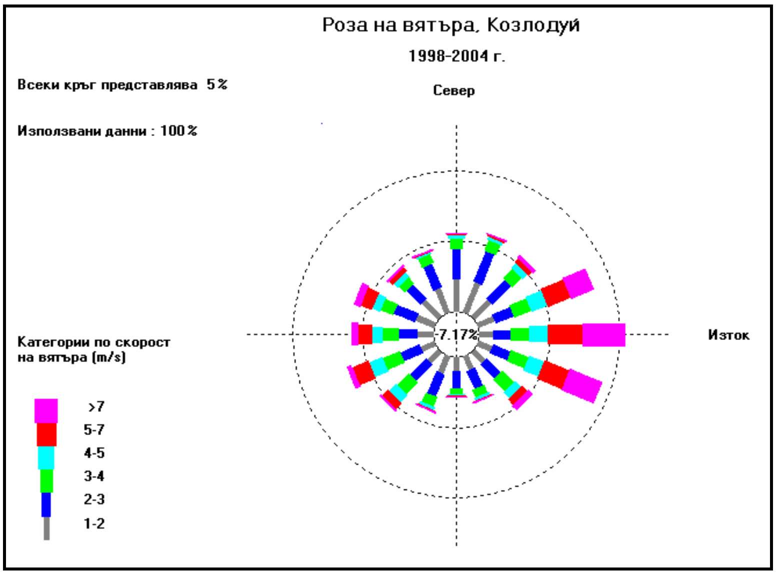


Figure 3.1-8 Wind rose Kozloduy, 1998 – 2004

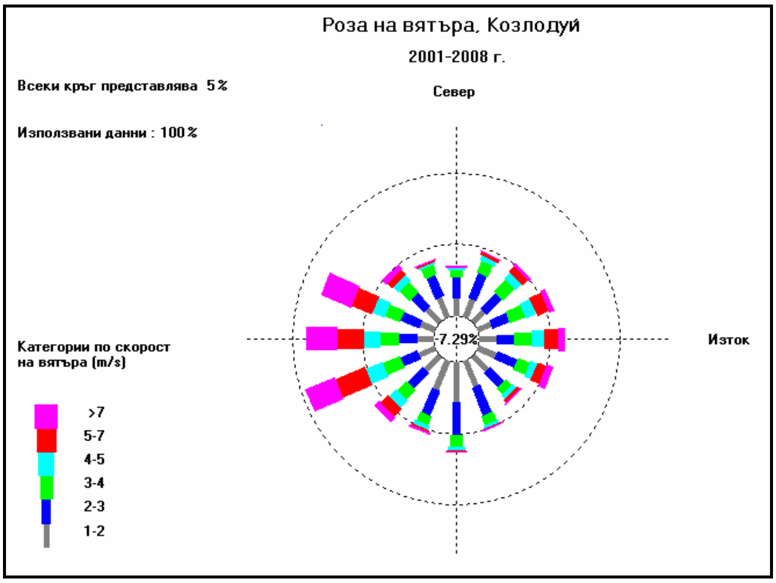


Figure 3.1-9 Wind rose Kozloduy, 2001–2008

Figure 3.1-10: the gradation in wind speed for the period 1998-2004 according to the 16 wind directions, without the quiet time – the speed below 1 m/s.

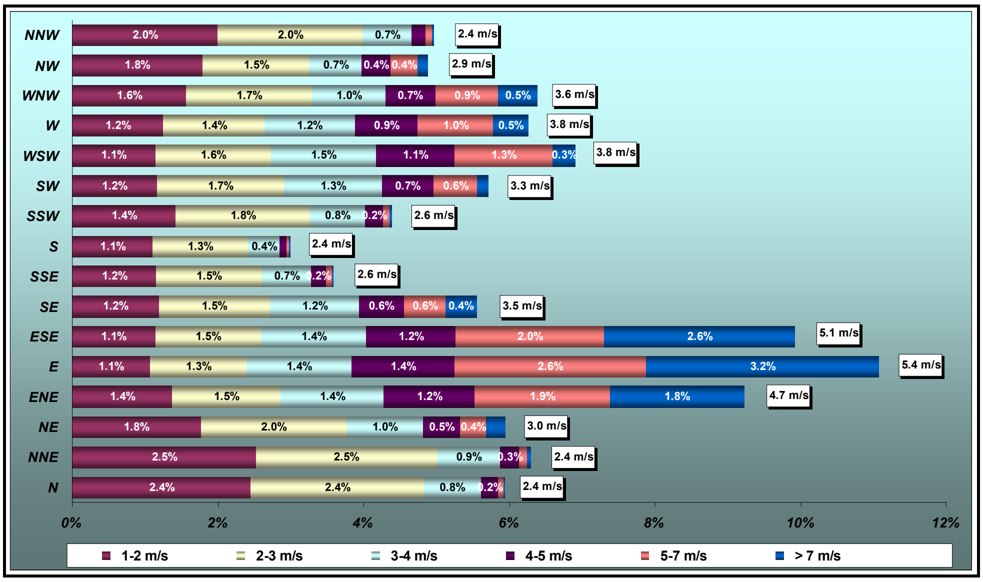


Figure 3.1-10 Gradation in wind speed for the period 1998-2004 according to the 16 wind directions

Overall, the annual prevailing winds are in the range 1-2 m/s and 2-3 m/s, where the strongest are from the east (5.4 m/s).

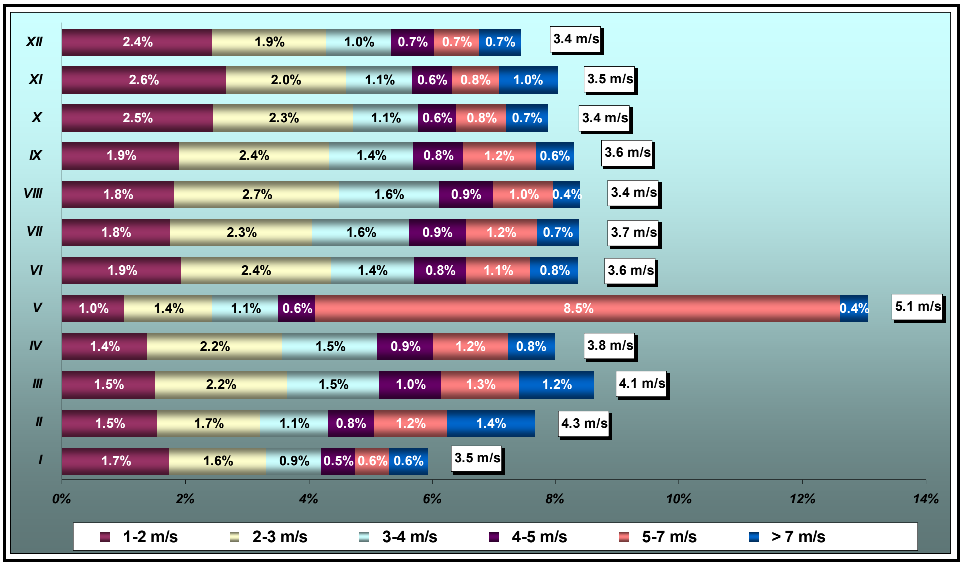


Figure 3.1-11 Gradation in wind speed for the period 2001-2008 according to the 16 wind directions

Strong winds are observed in February and March (4.3 m/s and 4.1 m/s), and the strongest are in May - 5.1 m/s .

Grades of atmospheric stability

The atmospheric stability (or resistance) has six grades: A - strong instability, B - moderate instability, C - low instability, D - neutral stratification, E - weak stability and F - moderate resistance, and are an important feature for the diffusion properties of the atmosphere.

Figure 3.1-12 andFigure 3.1-13 show the integrated roses of resistance grades for the period 1998-2004 and 2001-2008, respectively:

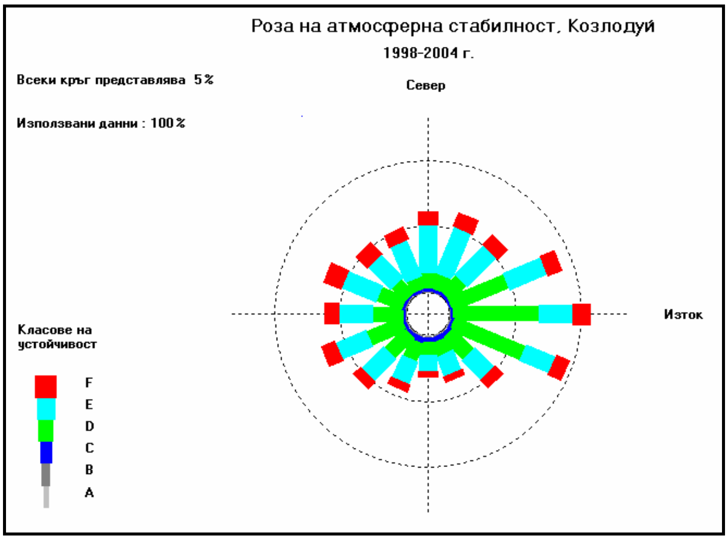


Figure 3.1-12 Integrated roses of resistance grades for the period 1998-2004

In unstable conditions (classes A, B or C), diffusion of pollutants takes place very quickly, due to strong turbulence in a vertical direction, leading to rapid vertical mixing of contaminants with the surrounding air quantities. Large ground concentrations can be observed very near the source in case of low wind speeds in daylight hours in sunny weather.

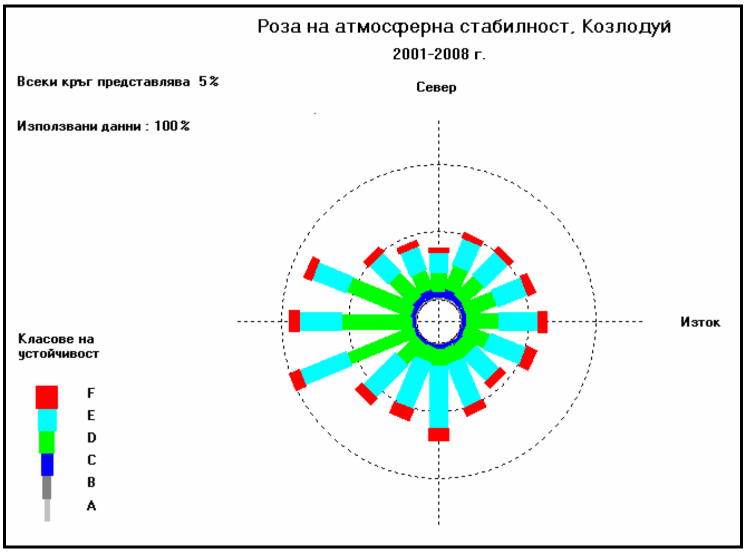


Figure 3.1-13 Integrated roses of resistance grades for the period 2001-2008

In stable atmospheric conditions (classes E and F) the very poor turbulence or its lack prevents the spreading of contamination in a vertical direction and spreads them in a horizontal direction. Such conditions are realized in the presence of inversions in the late evening and night hours **- Fig.3.1-14**.

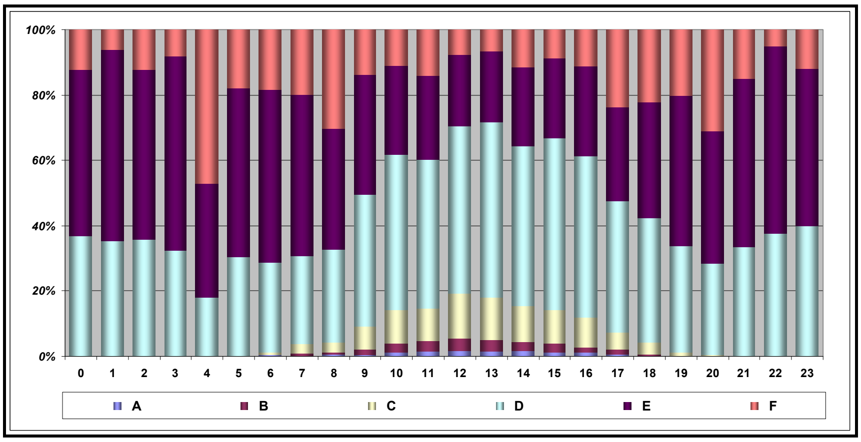


Figure 3.1-14 24-hour movement of the resistance grades for the period 1998-2004

An interesting microclimatic link, showing the possible wind with a determined speed within a specific resistance class, is shown in **Figure 3.1-15** for the period 1998-2004 and in **Figure 3.1-16** for the period 2001-2008.

Low wind speeds dominate during both periods for classes A and B, while within class C the winds also range between 3-4 m/s. Within the neutral class D, wind speeds vary throughout the whole range, however, the strongest winds are here – over 7m/s. In class E we can see speeds between 2-4 m/s and in class F – between 1-3 m/s.

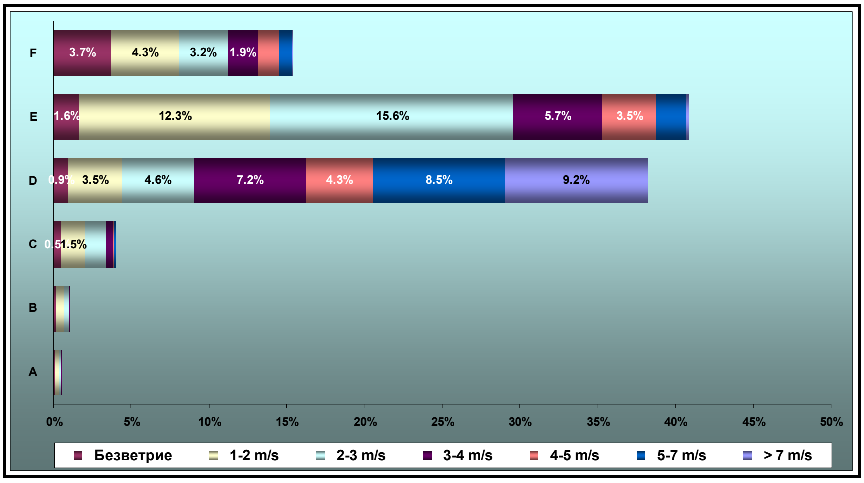


Figure 3.1-15 Distribution of the wind by grades of atmospheric stability in percentage for the period 1998–2004

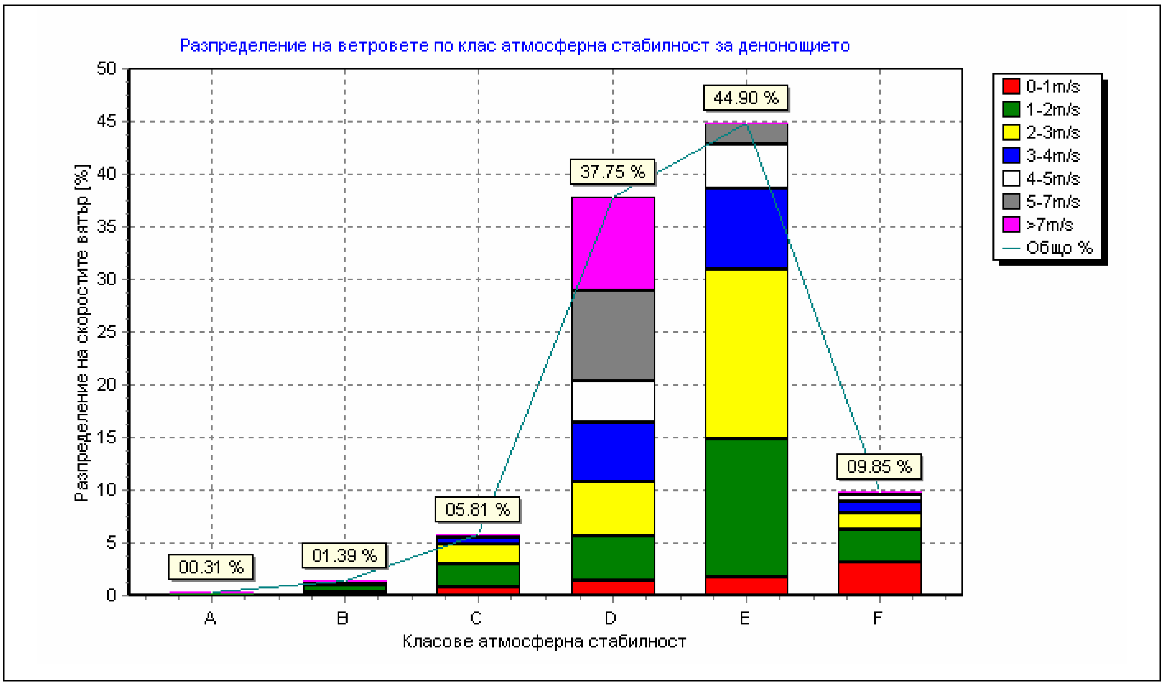


Figure 3.1-16 Distribution of the wind by grades of atmospheric stability in percentage for the period 2001–2008

The wind roses, the resistance grades and rainfall allow for a 4-component distribution by "direction, speed of wind, grades of resistance, and rainfall" to be determined, which is a meteorological pre-processing unique for this region, quite necessary for the solution of a wide number of tasks, concerning the ecological status of the plant, in this case – the evaluation of the individual doses of aerosol-gas emissions.

Conclusion

Based on the provided data and evaluations, the following conclusions can be drawn about the processes and occurrences, which are of interest to the site of the investment proposal in connection with the site's specifications.

- Potential air pollution in the region is very low – a little under 7% in quiet time for both reviewed periods – 1998-2004 and 2001-2008;
- The strongest winds can be observed during neutral atmospheric conditions – over 7 m/s.

- The months with the most rainfall are April and July, the ones with the least – February and November.
- Hourly maximum amounts and total amounts of rainfall occur at 2pm, whereas the minimum of the average hourly rainfall is at 7-8pm.
- No sand-sprouts have been registered in the area up to now. Research shows a scarce possibility of one (10-6 cases a year)

1. **It is to be concluded that the climate and meteorological characteristics of the region are favorable for the dispersion of harmful emissions discharged into the atmosphere, as well as for the reducing of local impact on environment components. Therefore, specific measures for preventing dust pollution do not need to be envisaged during designing.**

The climate change is a process of the increasing greenhouse effect in the earth's atmosphere due to large emissions of CO_2, CH_4, N_2O and fluorides as a result of anthropogenic activities such as the combustion of fossil fuels and changes in the means of land use over the years. It is known that significant climate changes cannot occur over short periods of time and that they are the result of continuous processes, which are distanced in time and space.

2. **Therefore, just as the scale of this project, the technology for the construction of NRRAW, will not cause climate changes in the region. In order for such changes to happen, a site of great size would be necessary, which would change the global circulation first and then it will influence the local one.**

3.1.2 Quality of ambient air (AIQ)

In a non-radiation aspect - [206]

3.1.2.1. Measured concentrations

Two measurements of air quality have been performed by AMS by regional laboratory in Pleven, in compliance with the implementation of the schedule of the automatic mobile stations (AMS) for controlling air quality established by the MEW to make additional measurements in areas with no or limited number of fixed points in 2008, on the site of RSPAB, Kozloduy.

In order to evaluate the air quality in the region, the following data has been analyzed: protocol No. 243/28.03.2008 for the period from 24.03.2008 to 28.03.2008 and Protocol No. 787/30.09.2008 for the period from 26.09.2008 to 30.09.2008 of the concentrations in the atmospheric ground layer of sulfur and nitrogen oxides (nitrogen dioxide and nitrous oxide), ozone, hydrogen sulfide, benzene, methane, ammonia, non-methane hydrocarbons and carbon monoxide

Figure 3.1-17 and**Figure 3.1-18** show the weather conditions for the measurement periods, respectively in spring – in March and in autumn - in September. Depending on the solar radiation, wind speed and time of day are defined the resistance grades under Pasquill - A = 1, B = 2, C = 3, D = 4, E = F = 5 and 6. It is evident that the persistent state of the atmosphere is in the evening and at night hours - between 19:00 and 08:00. Wind roses for the periods in March and September are shown in **Figure 3.1-19** and**Figure 3.1-20**. During both periods the southern winds prevail..

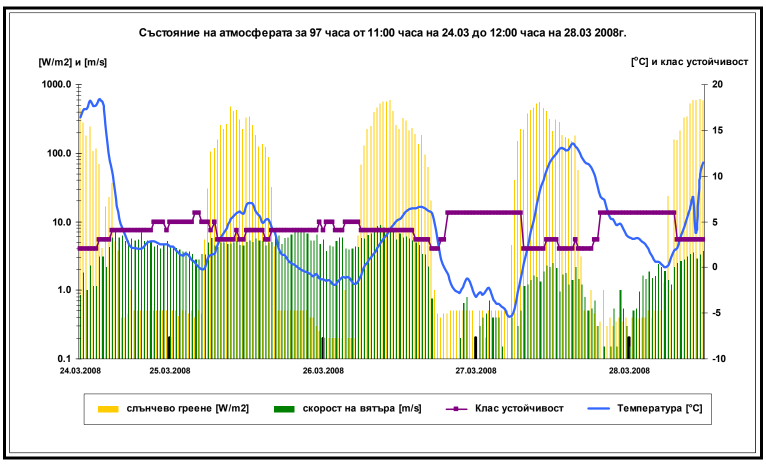


Figure 3.1-17 Atmospheric conditions in the March measurement period

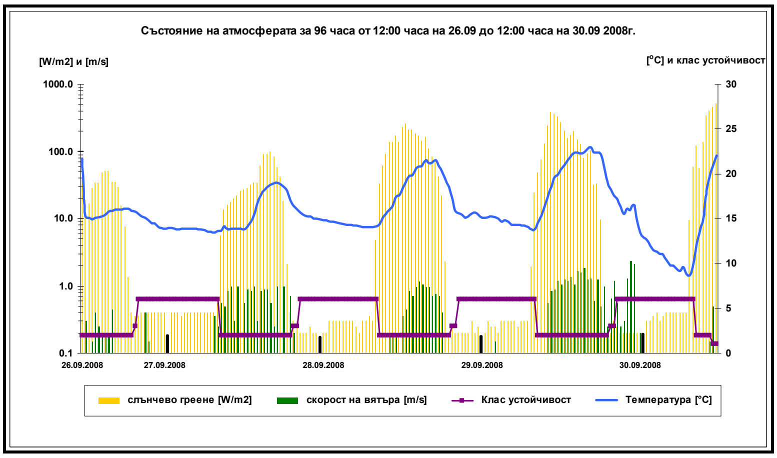


Figure 3.1-18 Atmospheric conditions in the September measurement period

Table 3.1.1 Average, maximum and minimum values of the measured meteorological elements and relevant concentration of pollutants

Values	Temp	Atm. pressure	Wind direction	Wind speed	Humidity	Sun radiation	SO_2	NO_2	NO	O_3	H_2S	CH_4	NMHC	NH_3	CO
	[°C]	[hPa]	[°]	m/s	[%]	[W/m2]	[μg/m3]				[mg/m3]				
MARCH - Protocol № 243/28.03.2008г. for the period 24.03.2008г. to 28.03.2008г.															
Maximum	18.5	994.7	356.5	8.8	94.95	610.05	10.0	16.0	33.0	39.5	0.002	1.6	1.7	0.008	3.5
Minimum	-5.4	966.4	0.5	0.1	16.6	0.2	0.8	3.8	2.0	7.0	0.001	1.1	0.1	0.003	0.3
Average	3.8	982.8	179.0	3.5	53.0	119.2	7.5	11.2	10.1	25.8	0.002	1.4	0.1	0.008	0.7
SEPTEMBER - Protocol № 787/30.09.2008г. for the period from 26.09.2008г. to 30.09.2008г.															
Maximum	23.0	1905.3	358.5	2.4	100.0	521.05	18.5	24.0	20.3	57.5	0.002	1.4	2.4	0.009	3.2
Minimum	8.8	500.9	2.5	0.0	45.6	0.2	7.5	1.3	2.5	1.8	0.001	0.4	0.1	0.004	0.6
Average	15.9	1005.1	168.5	0.5	85.6	48.5	14.0	9.1	5.3	15.7	0.001	1.2	0.1	0.008	2.0

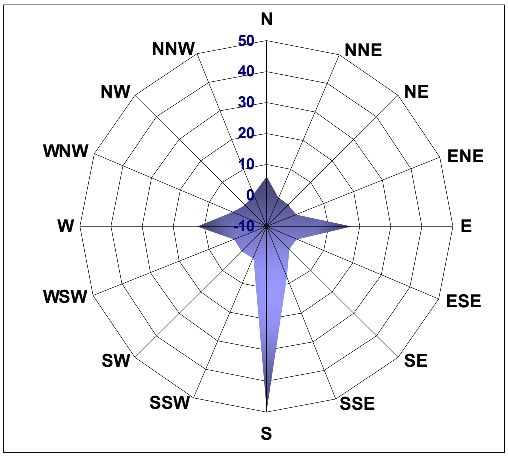


Figure 3.1-19 Rose for the days in March

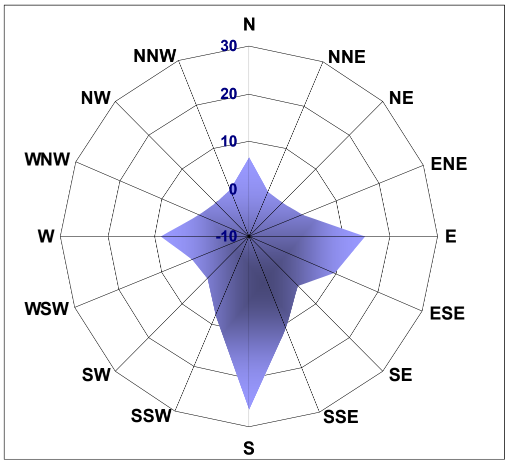


Figure 3.1-20 Rose for the days in September

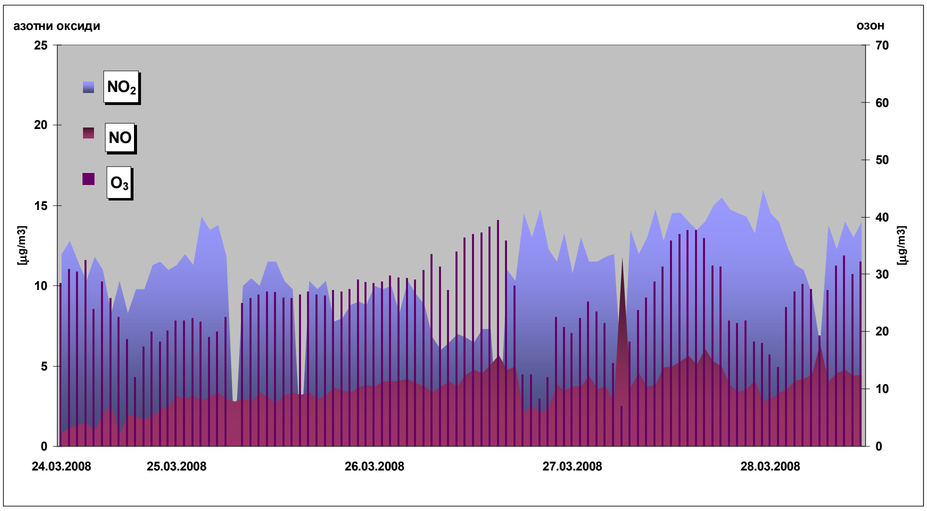


Figure 3.1-21 Concentration of ozone and its precursors – nitrogen oxides in March.

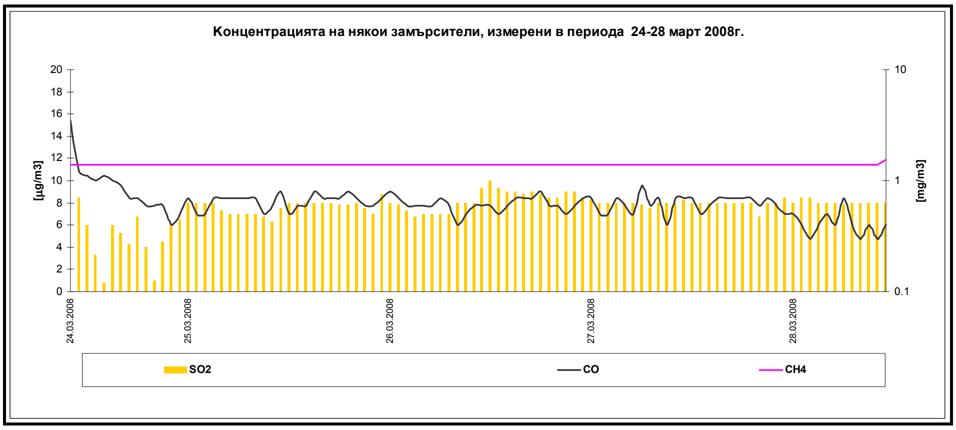


Figure 3.1-22 Concentration of sulfur oxides, carbon monoxide and methane in March.

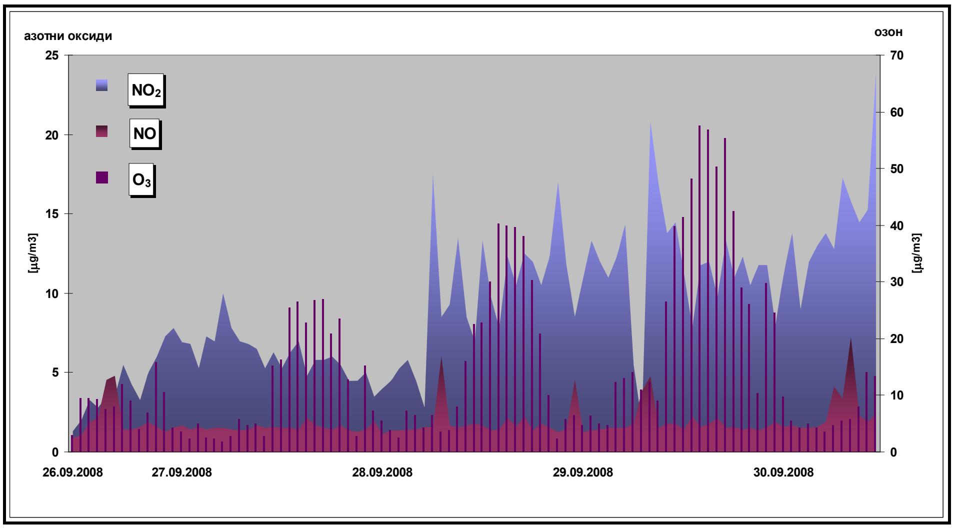


Figure 3.1-23 **Concentration of ozone and its precursors – nitrogen oxides in September.**

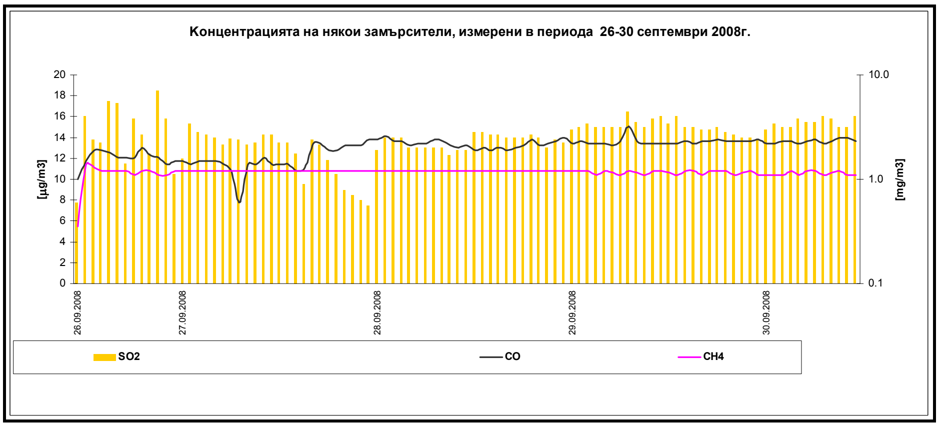


Figure 3.1-24 **Concentrations of sulfur oxides, carbon monoxide and methane in September**

Table 3.1.1 displays the average, maximum and minimum measured values of meteorological elements and the concentrations of pollutants for two months.

Conclusion

During midday hours the weather conditions are unsustainable - grades B=2 and C=3 and in the remaining daily hours - with low stability (grade C=3) or neutral (D=4). The difference in the average temperature for 96 hours between March and September is 12.1° C. Sunshine was greater in March than in September, which may be due to more clouds in autumn (this parameter is not recorded) or more precipitation, as indicates the higher humidity measured in September. The higher speeds are during the spring (maximum 8.8 m/s), while the days in September were very windless, which results in the emergence of stable conditions of the atmosphere at night - grade F=6.

These weather conditions also determine the difference in concentrations of some key pollutants:

Sulphur dioxide - in March, the levels of SO_2 in ambient air were lower than in September. March is a month when burning fossil fuels were used for heating, but the less stable conditions of the atmosphere have been rapidly mixing its concentration with the ambient air, which decreased its content in the surface layer. In September the stable atmospheric conditions preserve for longer its concentrations in this layer.

Ozone and its precursors - nitrogen oxides - in March the levels of these pollutants are lower than September, in clearly expressed stable conditons of the atmosphere. It is interesting to follow the ongoing monitoring of daily concentrations of ozone and its precursors - nitrogen oxides on 29 and 30 September. Under the influence of sunshine and as a result of photochemical reactions, the morning peak of NO and NO_2 determine the soil of the early afternoon maximum of ozone, which is a typical daily course in fine weather;

The remaining pollutants showed similar levels of ambient concentrations. The measured concentrations of any pollutant do not exceed the corresponding average hourly rate (CAHR), or the maximum single MAC.

Therefore, the air quality in the area of the site is good.

***3.1.2.2. Determining air quality and areas of traffic pollution on the Hurlets- Kozloduy road -* [208], [221]**

According to European norms and the relevant Bulgarian legislation, the methodology to be used to determine the dispersion of harmful emissions from vehicles and their concentration in the near surface atmospheric layer - software product **TRAFFIC ORACLE** (Order № RD 994/04.08.2003 of MEW). The programmeme consists of two main modules - ***EMISSIONS*** and ***DIFFUSION.***

The ***EMISSIONS*** module calculates the emission of certain pollutants in the exhaust gases from internal combustion engines of motor vehicles (MV). It is assumed that emissions from vehicles when they are moved on highways and complex street network, could be approximated as continuously operating linear or area sources.

Vehicle categories for which emissions are calculated are defined by the **SNAP** nomenclature (Selected Nomenclature for Sources of Air Pollution) of the EMEP/CORINAIR.

Emissions from motor vehicles are calculated by two methods - simple and detailed.

The assessment of emissions from vehicles on the Hurlets-Kozloduy road is based on data from a census of vehicles, corresponding to the long-term prognosis for the development of traffic, carried out by the Central Laboratory for Roads and Bridges (**Table 3.1.2**) where the traffic volume for 2015 is viewed, which is more foreseeable in its future period for the operation of the facility.

Estimates of concentrations in the surface layer of the atmosphere are calculated by the ***DIFFUSION*** module. It gives statistics or typical estimates of the levels of contamination by certain pollutants.

As annual climate roses are used, the contours of expected concentrations are compared to annual rates.

Table 3.1.2 MV traffic on the road Hurlets-Kozloduy

Year	Number of the census office	Road Number	Location of census section (km)	Beginning of census sector (from km}	End of census sector (to km)	Motor vehicles	Buses	Light trucks	Medium trucks	Heavy trucks	Trucks with trailer	Total trucks	Total motor vehicles
2005	496	11	94 484	83.899	97.838	3504	168	343	103	68	49	563	4235
2010	496	11	94.484	83.899	97.838	4030	176	360	108	71	51	590	4796
2015	**496**	**11**	**94 484**	**83.899**	**97.838**	**4634**	**189**	**387**	**116**	**76**	**55**	**634**	**5457**
2020	496	11	94.484	83.899	97.838	5445	203	416	125	82	59	682	6330

Year	Number of the census office	Road Number	Location of census section (km)	Beginning of census sector (from km}	End of census sector (to km)	Motor vehicles	Buses	Light trucks	Medium trucks	Heavy trucks	Trucks with trailer	Total trucks	Total motor vehicles
2025	496	11	94.484	83.899	97.838	6398	223	458	138	90	65	751	7372

Table 3.1.3 shows the estimated annual maximum concentrations of pollutants for which the Bulgarian legislation has average annual rates (AAR), the annual limit values (ALV) and the annual lower assessment threshold (ALAT).

Table 3.1.3 Annual concentrations of individual pollutants

Pollutant	NOx	C_6H_6	Cd	Pb	FDP_{10}
AAR /ALV [mg/m^3]	**0.04****	**0.005** ***	**0.000005** **	**0.0005** **	**0.04***
ALAT [mg/m^3]	**0.026****	**0.002** ***	**0.000002** **	**0.00025** **	**0.02***
Maximum annual concentration [mg/m^3]	0.0003728	0.0000038471	0.0000000008	0.0000001637	0.0000140

* **Regulation № 12/2010**. – Norms for concentration of sulfur dioxide, nitrogen dioxide, particulate matter, lead, benzene, carbon monoxide and ozone in ambient air.17]

** **Regulation № 11/2007** – Norms for for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons in ambient air .[18]

In accordance with **Regulation № 12/2010 г**.[17]:

- average annual rate (AAR) for nitrogen oxides (NOx) is 0.04mg/m^3. Average lower assessment threshold (LT) to protect human health is 65% or 0.026 mg/m^3 Maximum Permissible Concentration (MPC)
- AAR for particulate matter (PM10) is 0.04mg/m^3. Average lower assessment threshold (LT) to protect human health is 0.02mg/m^3.
- AAR for lead (Pb) is 0.0005mg/m^3. Average lower assessment threshold (LT) to protect human health is 0.00025 mg/m^3;
- AAR for cadmium (**Cd**) is 0.000005mg/m^3;

AAR for benzen (**C_6H_6**) is 0.005mg/m^3. Average lower assessment threshold (LT) to protect human health ise 0.002 mg/m^3

As seen from the table, not even one pollutant exceeds the relevant standard.

Figure 3.1-25 shows the annual scope of pollution from nitrogen oxides just in order to complete the study.

The depicted areas have concentrations of 0.0001mg/m³, 0.0002mg/m³ and 0.0003 mg/m³. The maximum received concentration of 0.000373 mg/m³ (over 100 times smaller than the AAR, which is 0.04 mg/m³) is marked by a black cross.

Figure 3.1-25 Average annual pollution with nitrogen oxides (NO_X) from the traffic on the road Hurlets-Kozloduy.

The iso-line is drawn in the green contour, which shows that the southeastern part of the site of Kozloduy NPP has permanent annual concentrations of nitrogen oxides from 0.00001 mg/m³, due to its proximity to the road Hurlets-Kozloduy.

In the section of the road, which passes near NRRAW, at a distance of 1, 5, 10 and 50 m along 3 000m of the road are positioned receptor (96 points), which monitor the concentration of pollutants.

Analysis of ambient air quality shows that the environment around the building is INTACT.

In the aspect of radiation

Radiation, atmospheric radioactivity [148], [162], [163], [367]

For the Republic of Bulgaria, the strength of the natural gamma radiation background is in the range of 0.06 to 0.60 μSv/h. It has been measured continuously since mid 1980s.

The natural gamma background consists of two components – aerospace radiation and terrestrial (earth) radiation.

The aerospace component for a given location is determined solely by its high elevation and latitude, while the earth component is determined by the contents of natural radionuclides in the geological environment and varies widely.

The contribution of radon to the terrestrial component is significant. The level of escalation of radon, which is a heavy inert gas, is influenced significantly by changes in weather conditions, which reflects the value of the gamma background.

Large differences in the level of background gamma radiation are found in different populated regions of the earth.

The National Automated System for Continuous Monitoring of Gamma background in Bulgaria was put into operation in 1997. It has a hierarchical structure and is controlled by computer. It consists of a central monitoring station, 9 regional stations, 26 local stations, one mobile station, a crisis center and emergency station.

The Central Station carries out the duties of the general administration, management, coordination and supervision of work of local and mobile stations and visualization of information under normal conditions. These activities are carried out by the crisis center in emergencies.

The elaboration, maintenance, operation and development of the automated system is legally regulated.

Some of the key stations of the system are shown in **Figure 3.1-26**

Figure 3.1-26 Scheme of the location of monitoring stations of the National Radiation Monitoring System

Data on the natural gamma background of soils and neogene rocks and the specific activity of natural radionuclides during the time before the construction of Kozloduy NPP are contained in the pre-operational measurements of the National Centre of Radiobiology and Radiation Protection (NCRRP) in 1972-1974, and in the so far unpublished data on geological and geophysical reports former SE Rare metals.

The region of Kozloduy NPP is characterized by relatively low background activity, i.e. contents of uranium, thorium and their radioactive products of degradation are below average. This was due to the predominant origin of sedimentogenic geological formations, which lie on the plant site.

There are no recorded high levels of gamma radiation in rocks from geological excavations in the Lom depression in about a hundred exploratory drillings for uranium at a depth of up to 250 m. Radioactive anomalies by gamma radiation with higher intensity are only found in 3 boreholes.

There are two specified areas for the monitoring and evaluation of the radioactive influence of anNPP on the environment: a 3 km area and a monitoring area – a 30km radius around Kozloduy NPP. There is a total of 36 control points where sampling for laboratory tests is done for the detecting technogenic radionuclides in the main components of the environment – air, water, soil, vegetation. Particular attention is given to drinking water and water of the Danube river. In a 3-km zone is carried out continuous automated monitoring of the dose and content of I-131 in near surface air layer through 10 monitoring stations AISVRK "Bertolt. The system consists also of 3 automated weather stations and 5 water stations for monitoring the activity of unbalance and waste water.

The National Automated System for Continuous Monitoring of Gamma background and Automated Information System for External Radiation Monitoring of the Kozloduy nuclear power plant is in accordance with the decision of the NRA. As a result, at 26 monitoring points in the national automated system, 8 more control stations are included within the 2 km zone around the site of the Kozloduy NPP. At the site there are two base stations (BS). This is a Joint Information System for Radiation Monitoring, which allows the NRA and the competent government authorities to obtain real-time data about the state of the radiation background at the site of Kozloduy NPP.

Table 3.1.4 Automated control of radiation gamma background in a 3 km zone, 2008 г., μSv/h

Radiation gamma background in 2008, average values, μSv/h							
KC-1	KC-2	KC-3	KC-4	KC-5	KC-6	KC-7	KC-8
0.123	0.126	0.132	0.129	0.127	0.131	0.133	0.128

In addition to the continuous measurements, the radiation background is monitored through periodic measurements with a portable radiometer apparatus type SRS-68-01 AD2/ADT and a set of thermoluminescent dosimeters type of $CaSO_4$: Dy, placed at fixed locations along the fence on the site.

The results obtained from these observations are shown in **Figure 3.1-27**. They show that the power of the equivalent dose of gamma radiation varies within the natural radiation background.

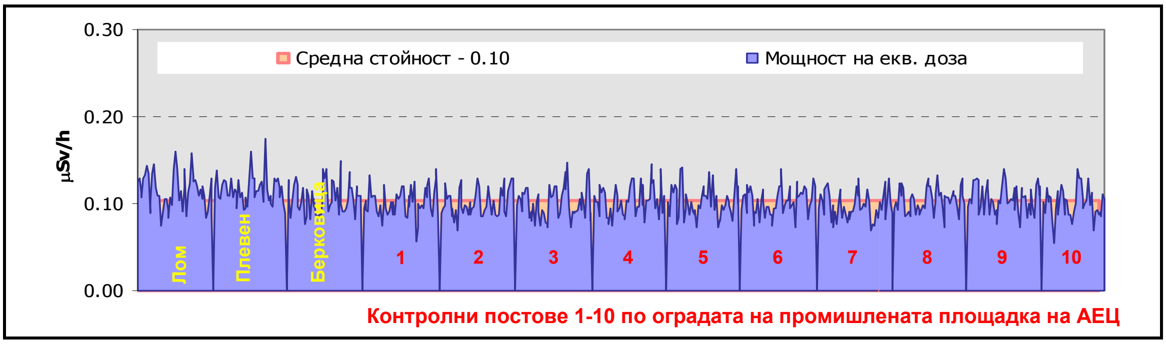


Figure 3.1-27 Power of the equvalent doze (μSv/h) of gamma radiation in residential locations in H3 and the fence of Kozloduy NPP, 1996–2008

Data from the systems of MEW regarding the radiological monitoring, the measurements of the Department of Radiation control of the environment is systemized and analyzed in the EIA of Kozloduy NPP in 1999 in order to evaluate the background gamma and atmospheric radiation. Accordingly, emphasis is placed on the site characteristics of Kozloduy NPP and in the area of plant, in the radiation protected zone and the nearest towns - Kozloduy and the village of Hurlets. We also have analysis of available data on Area for emergency protective measures (30-km) and part of the Area of long-term protection measures (in particular the region of Vratza).

Control of radiation gamma background in the country and particularly in the areas of emergency planning of Kozloduy NPP is also carried out by the State Agency for Civil Protection through fixed stations, five of which are within the 30-km zone of the plant. Periodic inspection and NIMH with BAS is also carried in Oryahovo and Vratsa.

Data on ambient air quality in the aspect of radiation must be from the specific region, close to the Radiana site; such are the findings from the Radioecological monitoring laboratory of Kozloduy NPP, as well as the intentional studies from the Radiana site, which can be found attached.

The summary of the data from long-term observations of the radiation background in the region of Kozloduy NPP shows that:

Throughout the entire period of operation of Kozloduy NPP, the radiation gamma background in the radiation protected area and the areas of emergency planning is stable with relatively small deviations from the accident at Chernobyl NPP to other areas in the country and no exceedence of the typical background values for different regions. Average rates in the pre-operational period (until 1974) and afer that are close and comparable. Since 1995, with the increasing of the accuracy of the measurement lower average rates have been established, with smaller variations of the power of equivalent dose;

In the area of Kozloduy NPP, in the 30-km zone protected area, as well as in the observed cities within 100 km from the plant, the radiation gamma background is lower than in other areas in the country (Sofia, Sofia, Plovdiv) where the averages of the dose is about 0.16 μSv/h, and maximum values reached in some years 0.20 μSv/h;

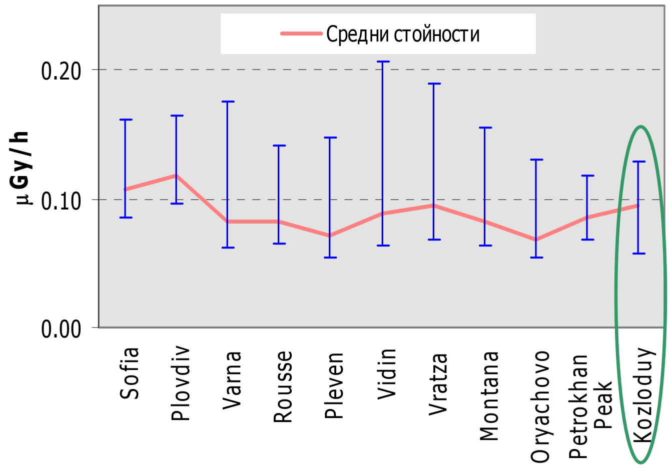
The radiation background at the monitoring station of the Romanian authorities nearest to Kozloduy NPP, varies around 0.1 μSv/h.

In general, the power of the dose due to gamma background in the various points of measurement has small fluctuations due to seasonal changes, mostly related to atmospheric precipitation. In none of the station points are statistical differences in the values of the dose of radiation gamma background measured before and after launching the plant in operation.

Comparison with data from the United national system of radiation monitoring of gamma-background /UNSRM/ with the Ministry of Environment and Water /MEW/ is displayed in **Table 3.1.5**. The results are for the larger cities of the country [163].

Table 3.1.5 Radiation gamma-background in larger cities of the country, 2008/ENSRM-MEW/, μGy/h

Populated area	Gamma-background, μGy/h
Sofia	0,086 – 0,161 avg. 0,107
Plovdiv	0,096 – 0.164 avg. 0,118
Varna	0,062 – 0,176 avg. 0,083
Ruse	0,065 – 0,141 avg. 0,083
Pleven	0,054 – 0,148 avg. 0,072
Vidin	0,064 – 0,207 avg. 0,089
Vratsa	0,069 – 0,189 avg. 0,095
Montana	0,063 – 0,156 avg. 0,082
Oryahovo	0,054 – 0,130 avg. 0,068
Petrohan Peak	0,068 – 0,118 avg. 0,086



Atmospheric radioactivity

The radioactivity in ambient air is observed by defining the natural and technogenic radionuclides in aerosols in ambient air and in samples of atmospheric deposition, established with gamma-spectrometric analysis of periodic samples from the air. Such studies are carried out weekly by sampling on filters by the department of Radiation econlogical monitoring of the NPP Unit at 11 control points in the 100-km zone around the NPP. The content of technogenic Cs-137 in aerosols is close to the background values and is in the range of 1-2 μ Bq/m³. These values are typical for the near surface air in this geographical region and the global radioactive pollution. The total beta activity of long-life radionuclides is within their natural limits, with an average of 0.47 mBq/m³. The results for the total beta activity of atmospheric deposition at the 36 control points in the monitored zone around the Kozloduy NPP ranges from 0.025 - 3.0 Bq/(m³. d) with an annual value of about 0.45 Bq / (m³. D).

The data is stable for the period of 10 years, expressing a slight seasonal dependence with higher values during the months with heavy precipitation evident from

Figure 3.1-28.

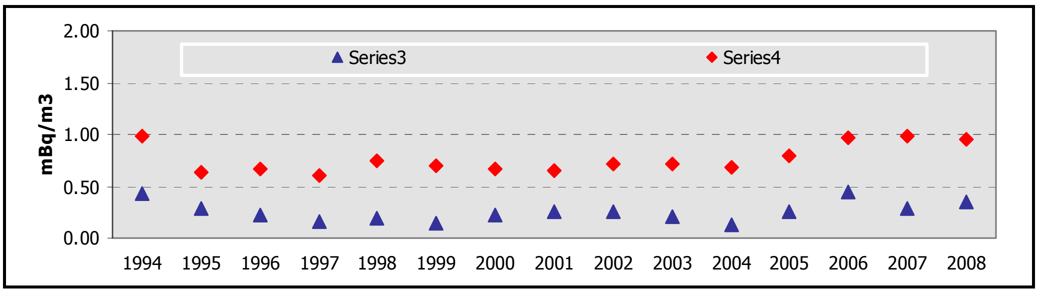


Figure 3.1-28 Average values of long-life summirized beta activity (mBq/m^3) in aerosols from the 100 km monitored area of Kozloduy NPP, 1994-2008

The atmospheric radioactivity and radiation background in the region have been systematically measured by different organizations, even before the construction of the NPP.

Given the analysis of all indicators of the radiation condition of the ambient air, it can be summarized that the current operation of Kozloduy NPP has not changed the radiation gamma background nor the atmospheric radioactivity as long-term characteristics.

Data on radioactive discharges into the atmosphere from the ventilation pipes of Kozloduy NPP for the past eight years is given in **Table 3.1.7** Aerosol-gas emissions, 2001-2008. Taking into consideration the decommissioned Units I to IV and the fact that the operational blocks are a source of emissions of RNG and Iodine-131, Kozloduy NPP has taken a more conservative approach compared to the administrative limits of the annual discharges. The limits are defined so that they do not reach or exceed the control level for individual effective dose per capita - 50 μ Sv/a. [367]

Table 3.1.6 Administrative annual limits of discharges from Kozloduy NPP

Emission components	**NPP - total**
RNG,TBq	5600
^{131}I,GBq	65
LLA,GBq	50
^{3}H,TBq	250
^{14}C,GBq	38000

The released in 2008 gas-aerosol emissions (see Table 3-1-2-5) are well under the conservatively specified limits (Table 3.1.2.2.5.), respectively: RNG - 0.01%, LLA - 0.04% and Iodine- 131-0002%. The results for the last five years are presented graphically in **Figure 3.1-29**.

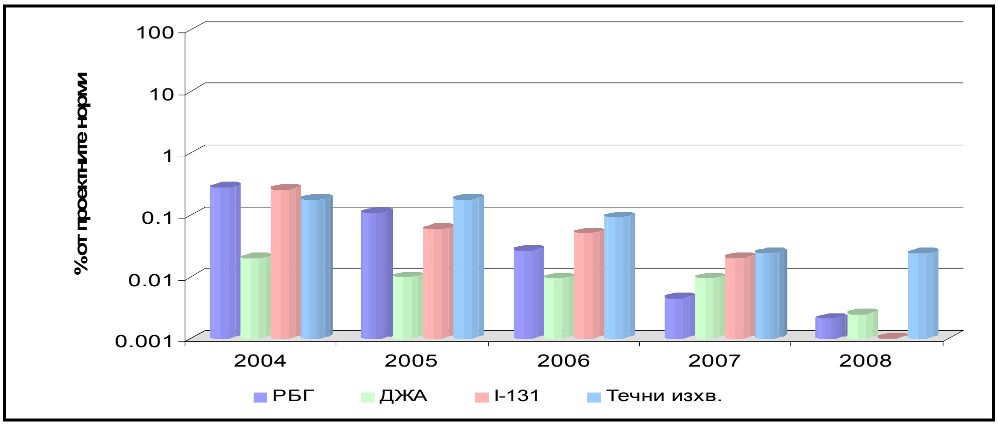


Figure 3.1-29 Total activity of gas-aerosols (RNG, LLA, Iodine-131) and liquid discharges in % from admissible annual values for the site, 2004 - 2008.

Table 3.1.7 Gas-aerosol discharges, 2001-2008.

Gas-aerosol discharges	2001	2002	2003	2004	2005	2006	2007	**2008**
Radioactive noble gases (RNG), TBq	293.8	267.1	253.4	71.5	27.8	6.83	1.15	**0.55**
Radioactive aerosols (LLA), GBq	1.54	1.67	1.30	0.10	0.074	0.069	0.070	**0.019**
Iodine-131 (^{131}I), GBq	3.84	2.94	2.58	1.31	0.32	0.26	0.10	**0.0011**

Throughout the period of operation of all blocks of Kozloduy NPP, the emissions of radioactive noble gases and long-lived aerosols (LLA) do not exceed 2% of limit range.

SUMMARY [367]:

- **Radioactive clarity of the atmospheric air in the area of Radiana site has not been affected by the operation of the Kozloduy NPP.**
- **The levels of the measured values are of a background characteristic, typical for this geographical region.**
- **Technogenic activity is about 10^6 times under the limit [112]**

3.2. Underground. Geological environment, minerals and seismic activity

■ **Lithostratigraphy**

The Radiana site is located in the Lom depression in the western Moesian platform.

The Lom depression is formed by quaternaric formations and neogenic sediments, padded by mesozoic and paleogenic sediments revealed by deep structural drills.

The Mesozoic is represented by the Triassic, Jurassic and Cretaceous as follows:

- *Triassic* – unites the Petrohan group (Red sandy fellowship /1T_1/ and aleurolites and sandstone of the Aleksandrovska formation /aT_1^{sp}/), Iskar carbonate group (Doyrenska formation /doT_1^{sp}/, Mitrovska formation $/T_2^1 - T_3^k/$, Rusinovdelska formation $/rdT_3^k/$ and Preslavska formation $/prT_3^k/$ with Pisarevski member) and Moeasian group, comprising sandstones, shales, limestone and dolomites of the Kozloduy formation $/kzT_3^{k-r}/$;

- *Jurassic* – unites three lithostratigraphical units: Yavoretska $/jJ_2^c - J_3^o/$ and Ginska $/gJ_3^{o-k}/$ formation, built of limestone and the Pleven formation $/plJ_2^c - J_3^t/$, including limestone, dolomite limestone and dolomite;

- *Upper Jurassic-Lower Cretaceous* – covers the Glozhene formation $/glJ_3^t - K_1^{bs}/$ (afinite limestone) and Kaspichan formation $/kJ_3^t -_1^h/$ (limestone, dolomite limestone and dolomites);

- *Lower Cretaceous* – covers the Salashka formation $/sK_1^{ls-b}/$ (limestone and marl), Hairedin formation $/hK_1^{b-ap}/$ (shales and marl) and Trambesh formation $/tK_1^{ap-al}/$ (marls, alevrolits and clay limestone);

- *Upper Cretaceous* – includes the Sandanov formation $/sK_2^{cm-t}/$ (marls and clay limestone), Belo bardo formation $/bbK_2^{cn-st}/$ (marls and aleuite limestone), Knezha formations $/knK_2^{cp}/$ (marls and clay limestone), Mezdra formations $/mzK_2^{cp-m}/$ (sandstone and clay limestone) and Kailuk formations $/kK_2^m/$ (limestone and organo-gene limestone).

The Paleocene covers three fellowships: limestone $/2Pg_1/$, *marl-limestone* $/3Pg_2^{1-2}/$ and clay-marl $/4Pg_2^3/$.

The Neocene includes Delejnska, Krivodolska, Smirnenska, Archarska and Brusarska formations.

The Delejnska formation (dlN_1^b) is represented by livid clay, thin-film, limestone, silstone. Among them are found single layers of clay limestone and sandstone silstone. In the middle part of the cut across the Lom depression developed and white pack of light yellow gypsum and less layers of anhydrite. The total thickness of Deleynska formation is usually 200 to 440 m.

The Krivdol formation (krN_1^s) COMPRISES gray and livid, laminated, calcareous clays and aleurite and limestone clay. These include frequent layers of dense clay marl and dark gray limestone. The thickness of the Krivodolska formation in the region of Kozloduy is 120 ÷ 140 m.

The Smirnenska formation (smN_1^{m-p}) *consists of mainly grey and grey-greenish, light* limestone and particulate clay, clay with layers of limestone, marl and sandstone at the bottom of the cut to a thickness of 5 ÷ 10 m. The thickness of the site is 200-250 m.

The Archar formation (arN_1^p) is made up of ferruginous or yellowish to greenish, to retail oligomictic grain sands, often with hair lamination. In the bottom layers the sands are dark gray, slightly calcareous, thin-film gels. Its lower boundary with the Smyrna formation is normal. It is covered by the Brusarskata formation with normal limit or quaternary sediments by surface blurs. The thickness of the formation in the region of Kozloduy is 40 ÷ 50 m.

The Brusarska formation (brN_2) is represented by gray-greenish and mottled sandy clays and aleurite layers of coarse-grained sands or yellow-gray lenses of lignite at the bottom. The thickness of the site is 50 ÷ 60 m.

The Quaternary is represented by pleutocenic alluvial-pro-alluvial, Eolithic and Holocene alluvial formations.

The Alluvial and pro-alluvial formations /a-prQ$_{eop}$/ are of gravel and coarse-grained sands. They are disclosed in the strip on the surface of the right slope of the valley of the rivers Danube and Tsibritsa.

The Eolithic-alluvial formations $/e-aQ_p^1/$ of red-brown sandy clays occur at the base of the loess complex.

The Eolithic formations $/eQ_p^{2-3}/$ are referred to the loess complex. They are represented by dust loess and loess-type of dust-sandy clay, consisting of buried soils of humus type. Occur on the surface and on the right slope of the river Danube.

The Alluvial formations of the floodplain and the river Danube in the Kozloduy valley (aQ$_h$) are multi-grain sand with gravel fillers, which are over asandy clay layer. The periphery of the valley is formed by a sandy clay loop with pre-deposited loess.

The Alluvial formations of the first and second above-floodplain terraces (aQp^3) are represented by sand with different gravel case fillers under a deposit of loess clay. They are disclosed in the southern periphery of Kozloduy Valley.

The immediate location of the Radiana site to the geological environment and the terrain around it comprises modern soil cover and Quaternary formations, which occur in the Neogene sediments.

The Quaternary includes:

- Dust and loess loess-type clay with buried soils with variable thickness of 6,5 to 43,4 m

- Sandy gravel and sandy-clay with thickness from 1.6 to 7.0 m.

The *Neocene sediments* belong to the lithostratigraphical Brusarska formation, built of clay, sandy clay, sand and clayey multi-grain sands. The thickness is 24 m in the northern part of the site to about 50 m high in the south. Neocene sediments of the jacket are found at depths of 16.20 ÷ 18.50 m (elevation 23.5 ÷ 24.8) in the lower north to 42.8 ÷ 48.6 m (elevation 50.9 ÷ 52.6) southern site (UMG "Engineering" Ltd., 2008).

■Tectonics

Fault structures of sub-equatorial and diagonal (northwest-southeast, lower south-north) direction are established in the Moesian platform, set by lineament in late primary and early Triassic. The western part of the Moesian platform is characterized by low seismic activity and seismic dynamics.

In the Meso-alpine superstructure Triassic, lower-middle Jurassic, upper Jurassic-Upper Cretaceous, Paleogene, Miocene and Pliocene, structural floors are distinguished.

In the Triassic structural floor, block and fault structures are formed. Plikative structures in the area are buried Kozloduy elevation (Kozloduy, Gornognoynishko, Bhutanese, etc.). Epirogenic elevation in terms of stretching tensions have led to breaking and block structure of the region. The largest blocks are Kozloduy, Gornognoyneshkiya, Glozhen, Oryahovo, Hayredin and Butan. In seismic and drilling data are marked multiple abruptions and interruptions. Most prominent is the Hayredin fault in direction 125^0. Along the rivers of Ogosta and Tsibritsa is the Ogosten and Kotlansko-Krivodol fault. They are marked in the lower-mid-jurasic structural plan.

In the next younger structure levels of the pliocenic, have not been found elements of old faults and the formation of independent applicative structures.

In the local area around the Radiana site, in an area with a radius of up to and more than 5.0 km, tectonic conditions for the construction of NRRAW are favorable since neogenic sediments and Quaternary formations lie almost horizontally and lack of surface signs of tectonic disturbances.

■ **Geomorphological conditions**

In morphological terms, the Radiana site falls on the slope along the Danubian Kozloduy valley with an altitude range of 35÷94 m. The slope of the ground to the north-northeast with an average gradient 7÷80, fitting the range from $3÷4^0$ to $10÷12^0$. The are two terraces on the slope of loess accumulation – the terraces T_2 and T_6.

The width of T_6 terrace is about 300 m and the absolute elevations of the plinth is 50÷53 m. Above the plinth there is alluvial gravel with sandy clay-fillers and reddish sandy clay, often with pieces of gravel with a thickness of 2 to 6 m. Alluvial is covered by loess complex with thickness in the highest part of the slope of 36÷40 m, and of 8.0 m in the lower part.

T_2 terrace covers the lower part of the slope with elevations 40÷45 m. The plinth is incised in its early roman clays and sands of absolute elevation about 23÷25 m. The alleviate is presented at the base by gravel with thickness of 0.50 m and dust and oily clay with thickness from 1.8 to 5.0 m. The alluvial is topped by two particular dusty loess horizons, separated by a buried soil.

The natural conditions of the drainage of the surface water will be almost completely recovered after the closure of the repository.

■ **Engineering-geological conditions**

Conducted on the basis of engineering geological and hydrogeological studies and research [173], it has been established that the subsurface zone of the future construction at the site of Radiana is composed of two complexes: Neogene and Quaternary (Brusarska formation), in which several engineering and geological variations are differentiated and classified.

The quaternary complex includes soil with thickness of 0.5÷2.1 m and loess sediments, including loess dust with yellowish color (layer 1^a), loess-type soils and buried clays (layer 1^b), sandy clay (layer 2^a) and gravel sandy clay (layer 2^b).

The Brusarska formation in the Neocene complex includes dust powder sandy clay, grey-brownish to grey-greenish, with rusty spots (layer 3) and sand beige multi-grain clayish sand of grey-greenish colour (layer 4). At depths below 94 m only one borehole is reached, and beige to grey-greenish clay sand (layer 5), which marks the upper of Archarska Formation (upper pont) in the Neogene, which has no reference to the foundations of the NRRAW facilities due to the significant depth of occurrence (**Figure 3.2-1**).

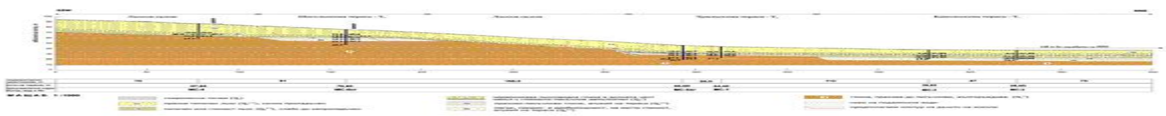


Figure 3.2-1 Engineering-geological profile of Radiana site

The average values of the basic physical and mechanical parameters as a results of laboratory tests and the permissible loading of ground, specified in regulations for the design of the foundation plate are shown in **Table 3.2.1**:

Table 3.2.1 Average values of basic physical and mechanical parameters and permissible ground

№	Indexes	Dimension	Lithological variations						
			Layer 1a	Layer 1b	Layer 2a	Layer 2b	Layer 3	Layer 4	Layer 5
1	2	3	4	5	6	7	8	9	10
1	Volume weight, γ	kN/m^3	16,0	17,6	20,3	20,9	20,3	20,2	-
2	Water content, w	%	10,0	13,9	15,8	13,1	19,4	16,5	16,4
3	Pores coefficient, e	-	0,91	0,79	0,57	0,49	0,60	0,54	-
4	Consistency index, Ic	-	2,31	1,34	1,01	1,51	0,97	0,73	-
5	Water-saturation level, Sr	-	0,33	0,51	0,76	0,72	0,87	0,82	+
6	Angle of internal friction, φ	degree	20,5	20,1	21,2	21,1	22,0	29,0	-
7	Cohesion, C	кPa	18,0	25,1	33,2	33,3	116,4	63,7	-
8	Compression module, M	MPa	3,6÷82,1	2,9÷29,7	6,8÷22,0	8,7÷13,2	9,1	7,5	
9	Macro-pore volume, nmp300	%	0,4÷15,1	0÷2,7	-		-	-	-
10	Initial load of frustration, P	MPa	13÷40	93÷230	-	-	-	-	-
11	Calculation load, R0	MPa	0,17	0,19	0,30	0,35	0,27	0,27	-

■ **Geochemical characteristics**

Five main lithological types are distinguished in Radiana's environment, which serve as a geological barrier against the dispersion of radionuclides; Layer 1 - loess, layer 2 – loess-type clay, layer 3 - sandy clay and loamy sand, layer 4 - sand and gravel with sandy-clay filler, layer 5 - neogenic dust clay with sand layers.

The main geochemical parameters of these layers are presented in **Table 3.2.2**.

Table 3.2.2 Main geochemical parameters

№	Geochemical index		Dimension	Lithological variations				
				Loess	Loess-type clay	Sandy clay	Sandy gravel with sandy clay filler	Particulate clay with sand layers
1	2		3	4	5	6	7	8
1	Content of sand fraction		Content of sand fraction	6,9	14,5	10,1	9,0	42,1
2	Mineral content of clay fraction	Mineral content of clay fraction	%	58	56	81	75	81
			%	36	33	42	41	25
3	Ion-exchange capacity		Ion-exchange capacity	5,55	13,03	14,50	9,26	16,39
4	Specific surface of the fractions with sizes below 1 mm		Specific surface of the fractions with sizes below 1 mm	10	17	20	15	20

4	Organic carbon content		Organic carbon content	0,13	0,13	0,095	0,063	0,102
5	Carbonate content ($CaCO_3$)		Carbonate content ($CaCO_3$)	34,4	28,5	10,5	6,6	3,3
6	pH of water extract		pH of water extract	9,0	9,0	8,5	8,5	8,5
7	Content of soluble components	Content of soluble components	m/dm^3	15,8	8,1	14,0	7,6	10,1
			m/dm^3	0,05	0,04	0,05	0,07	0,12
			m/dm^3	6,0	9,6	-	1,2	-

Based on the results of the direct and indirect definitions in **Table 3.2.3,** the distribution coefficient Kd is a set of eight radionuclides for the soil types at the site of Radiana, covering the entire range of information contained in RRAW pollutants [421].

Table 3.2.3 Average values of the distribution coefficient K_d as to the main radionuclides - 137Cs, 90Sr, 63Ni, 241Am, 129I, 14C, 94Nb и 239Pu

Radionuclide	Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	Layer 6	Layer 7
	Sandy-loess	Buried soil and loess-type clay	Sandy clay with gravel	Gravel clay with sandy-clay filler	Gravel with sand filler	Particulate clay with sandy-clay layers	Fine sand
	m^3/kg	m^3/kg	m^3/kg	m^3/kg	m^3/kg	m^3/kg	m^3/kg
^{137}Cs	0.20	0.25	0.23	0.14	-	0.40	0.10
^{90}Sr	0.07	0.12	0.14	0.075	-	0.20	0.04
^{63}Ni	0.30	0.65	0.65	0.40	-	0.65	0.30
^{241}Am	10.00	20.00	20.00	20.00	-	30.0	8.00
^{129}I	0.001	0.002	0.002	0.001	0.001	0.003	0.001
^{14}C	0.0035	0.0035	0.0035	0.001	0.001	0.005	0.001
^{94}Nb	0.16	0.55	0.55	0.16	-	0.55	0.16
^{239}Pu	0.11	0.21	0.16	0.15	-	0.56	0.10

■ Underground minerals

In the subsurface at the site of "Radiana" and its surroundings, the stocks of minerals have not been studied and confirmed. According to a letter of the Subsoil and Mineral Resources Directorate in MEW Ref.No.ZNPB-2358/20.10.2010, the latter “is not included in the mineral resources which are not in record of the National balance of reserves and resources of the mineral resources fund, or of valid permissions for search and/or study of mineral resources”. In a wider region, the lithological geological structure determines the presence in the area concerned only non-metallic minerals, namely:

- Fossil fuels - oil and gas, lignite;
- Building materials - limestone, gypsum, sand, gravel, loess.

Oil and gas are found in secondary and upper Triassic sediments at depths over 3500 m and have great potential. To the Triassic system is tied gas field near the village of Bhutan.

Lignite at Kozloduy in the lower point of the Brusarska formation in Neogene at a depth of 70 ÷ 110 m. The thickness of the coal seams together with the host clays does not exceed 3.0 m. Their stocks have not been studied. Significant reserves of lignite have been studied in Tsibritsa west of the river, where the Lom coal basin is situated.

Gypsum can be an industrial interest only in the region of the town of Oryahovo, limestone - near the town of Moesia.

Loess is used for making bricks. Near Kozloduy and Moesia there are small quarries for local needs.

Sand and gravel are mainly terraces of the Danube, Ogosta, Skat and Tsibritsa. They are produced mainly on the Danube.

■ **Physical-geological processes and occurrences**

Among the physical and geological processes and phenomena, more significant development within the region have erosive-accumulating and gravitational phenomena and processes and the failure of eolic entities.

Accumulating-erosive processes are determined by the hydrological factors of surface water and the results of their impact on the landscape.

The most important products of these processes are the formed asymmetric valleys with steep right banks and left slanting slope with clearly expressed terraces of rivers Tsibritsa, Ogosta and Danube in Kozloduy valley.

Gravitational processes and phenomena (mainly landslides) are typical for the steep right slopes of Danube, Tsibritsa, and others. They are developed in quaternaric loess formations and their occurrence in the clayey-sandy sediments of the Neogene in Brusarska formation, containing weak layers clays in the core, on which a slipping surface is usually formed.

Collapses are the ability of eolithic loess formations in the tense situation, arising from external loads and/or by their own weight, further slump (collapse) when wet. This property characterizes them as special (structurally unstable) soils. The most significant is the failure of loess in the loess (layer 1a) and loess-type (layer 1b) formations in the zone of aeration above the groundwater. Below the water level, where the loess clays are water-rich, collapse is virtually absent.

In the scope of the Radiana site and the immediate terrain around it, there are no developed adverse physical and geological processes and phenomena of a gravitational nature, but it is necessary to conform the design decisions regadring the NRRAW project with the stability of slopes in their natural state during the construction and after the loading of the repository with storage modules. With regard thereof:

- In order to assess the stability of the slope in its natural state with a programme "SLOPE W" of the Canadian company "GEOSLOPE" Ltd. multi-variety stabilizing forecasts under a combination of basic loads and loads of special combination (with respect to seismic effects with different intensities (VII ÷ IX degree). Received the following rates of resistance K_{res} [173]:
- for particular combination of loads - Kres = 2,41;
- for particular combination of loads (VII degree) - K_{res} = 1,86;
- for particular combination of loads (VIII degree) - K_{res} = 1,66;
- for particular combination of loads (IX degree) - K_{res} = 1,32.
- analogical multi-variety stabilizing forecasts are implemented in step selected four lines available in the module repository mainly a combination of loads and loads of special combination (with respect to seismic effects with an intensity of VII grade (K_c = 0,10). The following stability coefficients are received K_{res}:
- for general combination of loads - K_{res} = 3.42;
- for particular combination of loads - K_{res} = 3.22.

The location of the most dangerous slippery surfaces is illustrated on **Figure 3.2-2** and**Figure 3.2-3**.

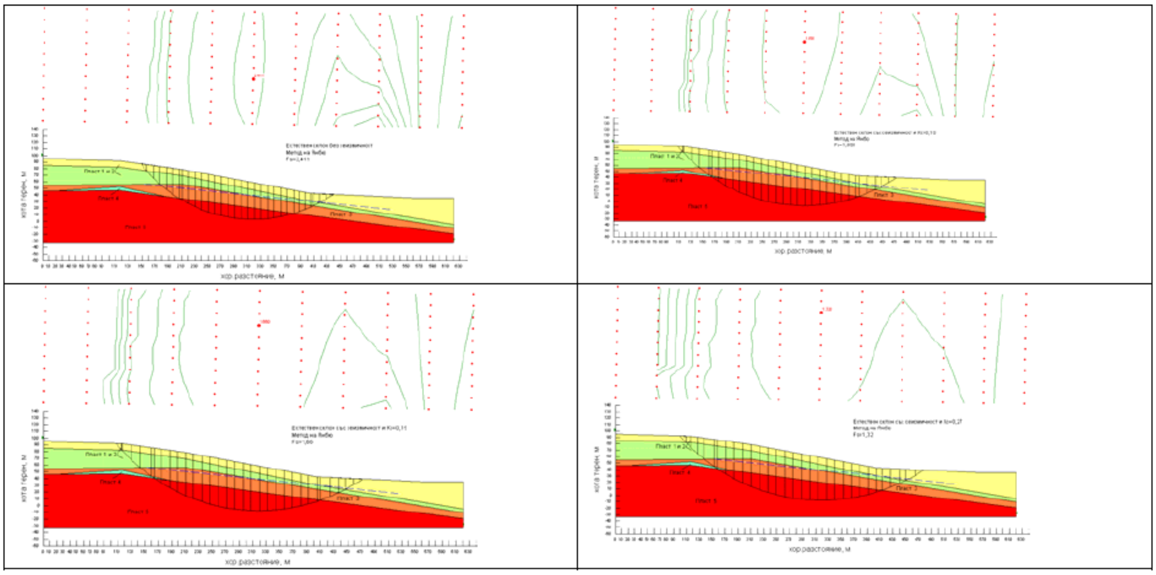


Figure 3.2-2 Calculation profile for the stability forecast of the natural slope on the main combination and on particular combination of pressure (by taking into account the seismic impact with various intensity (VII÷IX degree)

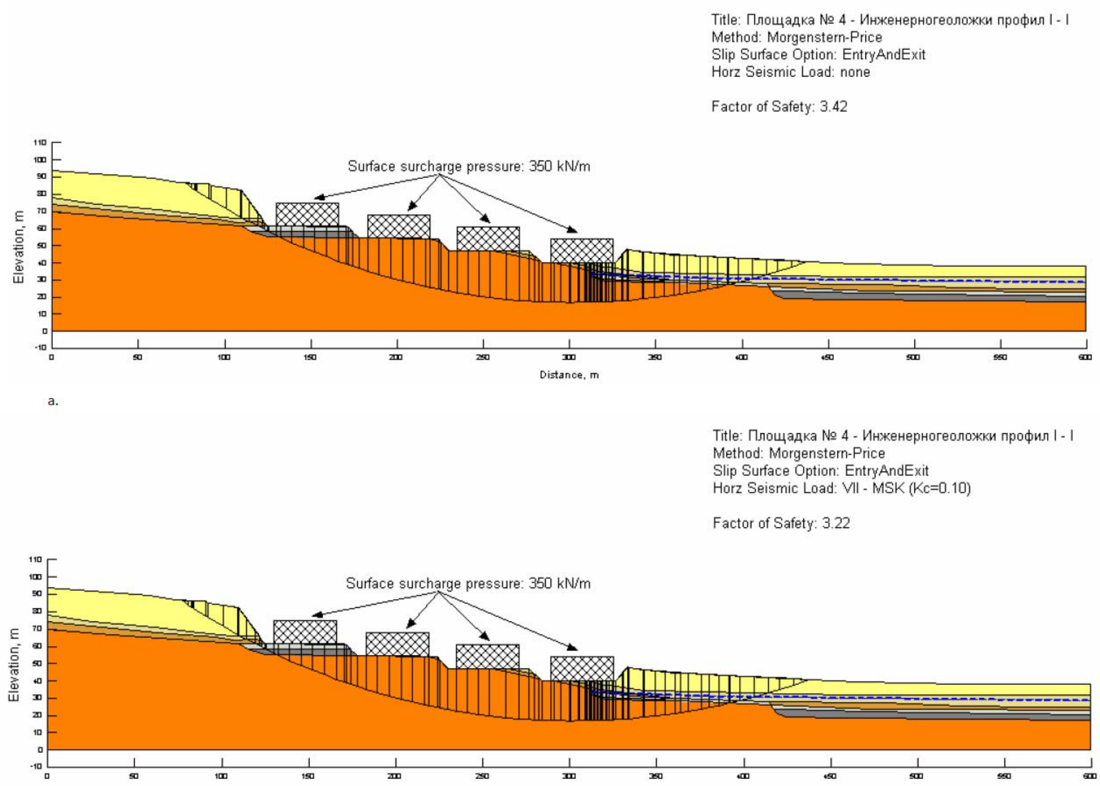


Figure 3.2-3 Calculation profile of the forecast of stability of natural slope under additional pressure from repository modules R_0 = 0,35 MPa for the main combination and for the particular combination of pressure (by taking into account the seismic impact with intensity of VII degree)

The results obtained from stabilizing projections indicates that the slope of the Radiana site, where the construction of NRRAW is planned, is characterized by resistance ratios greater than the minimum values of art. 73, paragraph 2 of the "Standards for the design of flat foundation" Cousteau> 1,3 - mainly for a combination of loads and Cousteau> 1.10 - for a particular combination of loads (considering seismic effects), both naturally occurring and after loading it with the repository modules.

Seismic activity

The seismicity of the region was investigated by the Geophysical Institute of Sciences in 1990. The parameters examined for this purpose of 3195 earthquakes are unified and standardized by estimates of intensity under the MSHK scale and the magnitude values are rated on the MLH scale.

Earthquakes in a 150 km area around the Radian" site are generated in the crust at a depth of 50 km. The maximum density of the hypo-centers of earthquakes occurred in the deep layer between 5 and 25 km. Strong intermediate-focus earthquakes, with prominent Macro seismic effects over long distances is generated at depths of 90 to 230 km in the Vrancea seismic zone – intermediate-focus which is at a distance of over 240 km.

The Radiana site is located within the stable part of the Moesian platform, which determines the low level of seismic activity at the subregional level. The maximum expected earthquake in the subregion is to Mmax = 5.0.

The main sources of seismic risk are the seismic zones outside the region. The most important of these is the area of Vrancha in neighboring Romania, which has generated events with magnitude M> 7. Local outbreaks have been recorded - earthquakes with M <4, which fall into the category of background seismicity. According to maps of earthquakes for periods of 1000 and 10,000 years, the area may be subjected to seismic effects from VII degree MSHK-64 scale on which the buildings and facilities are secured by the seismic coefficient CC = 0.10 (Decree № 2/23.07.2007 for designing buildings and structures in seismic areas).

Estimates of maximum acceleration with an annual probability of exceeding 10^{-4} are significantly smaller than the value (0.4g) in favour of rejecting the site, according to the Bulgarian standards. By conservative estimates can be regarded 85% of the values for maximum acceleration, maximum speed and even-resulting response specters.

3.3. Surface water and groundwater. Hydrology and Hydrogeology

3.3.1 Ground waters

■ **Hydrogeological conditions**

Investment proposal "Establishment of a national repository for disposal of low and intermediate level radioactive waste (NDF)" Radiana site, village Harlets, Kozloduy municipality, falls on the ground water bodies and areas for protection drinking water of groundwater bodies:

Body of groundwater in the Quaternary browsed waters - Kozloduy Valley, has the following characteristics: BGIGOOOOQAL005 code and area of 39,336 km2. . Collector aquifer is characterized by typical two-layers construction: a substrate composed of gravel and sand with different grain sizes and thickness of 2 ÷ 3 10 ÷ 12 m, average about 5 ÷ 6 m, and secondary - from sandy and clay powder with an average thickness of 6 ÷ 7 m. For substrate serve sandy clays and sands of Brusarski Formation in the Neogene. Filtration characteristics of the groundwater body consists of conductivity 150 ÷ 2160 m^2/d, an average 480 m^2/d and average coefficient of filtration gravel - 89 m/d, for different grain size Sands - 10 m/d, for fine-grained sands – 3,0 m/d, particulate clays - 0,01 m/d. Gravitational water conductivity of upper sandy-clay layer is between 0,03 and 0,06. Recharge of the aquifer is from infiltration of rainfall, the Danube River at high water standing in the upper flooding terrace and deep layers of sand in the substrate. Its drainage is through runoff into drainage canals and the river Danube at low water standing as well as water intake structures (pipe and shaft wells). The water level is established in the upper sandy clay layer at a depth of 0,5 ÷ 4,0 m. The direction of groundwater flow is north-northeast over the Danube with a hydraulic gradient 0,005 ÷ 0,006. Chemical status of groundwater body is assessed as good condition and the quantity is evaluated in bad. Specific environmental objective of groundwater body BG1G0000QAL005 code is "Save the good condition of water body". The body is an area for protecting drinking water from groundwater bodies falling BG1DGW0000QAL005. Used water quantities from the area of public drinking water supply are 8 632.459 m^3/day. State of the area to protect drinking water from groundwater bodies is bad.

Body of groundwater in the Quaternary browsed water - between the rivers Iskar and Lom, has the following characteristics: BG 1G0000QPL023 code and area 2887,916 km2. Specialized is the basis of eolichnite entities array between rivers Lom-Tsibritsa, Tsibritsa-Augusta Augusta-and Iskar. It consists of unconfined groundwater flow direction of which is determined by the river-tavine network. Static level of groundwater are found in loess eolichni formations at various depths. In central and southern parts of the site water level is relatively deep (typically in the range 35 ÷ 50 m below ground) and is located in the sediments of Brusarski Formation. North to NPP water level gradually becomes more shallow. Holds up to a depth of 11.0 to 18,2 m altitude 29,1 ÷ 30,5 m and in the saturation part includes deep levels of complex loess (loess clays) and underlying sediments beneath them. Recharge of ground water body is precipitation in the zone of aeration, reaching a depth of up to 15 ÷ 30 m below NDF and about 35 ÷ 50 m below the terrain surface and groundwater in Brusarski collapsed zone, and drainage is performed by descendants springs a rate of 0,5 to 5,0 l / s, which give rise to almost all valleys in the plateau "Zlatiata", as well as water intake structures - mostly shaft wells to meet the population needs. Filtration flow of underground water body BG1G0000Qrl023 is directed to the north and northeast to the first non-flooding terrace of the Danube, which is formed in the body of groundwater code BG1G0000Qal005, which is in hydraulic connection. Filtration properties are characterized by the filtration coefficient determined by field experiments, filtration and laboratory tests as follows: the sands and gravels with sandy clay core of the order of 1,5 ÷ 5,5 m / d, while the powder-sand loess 0,5 ÷ 1,0 m / d [173]. Chemical and quantitative status of groundwater body are rated in good condition. Specific environmental objective of groundwater body BG1G0000QPL023 code is "Save the good condition of the water body". The body is a zone to protect drinking water from groundwater bodies falling BG1DGW000OQPL023. Used water quantities from the area of public drinking water is 4975 , 836m3/day. The condition of the area to protect drinking water from groundwater bodies is good;

Body of groundwater browsed water Neogene - Lom-Pleven depression, has the following characteristics: BG IGOO0OON2O34 code and area 3066,0497 km2. It consists of two layers - top and bottom.

The top layer is essentially a layered complex with unconfined aquifer and head character, formed in Brusarski Formation by dak-Roman age, built of sand layers, layers and lenses in the midst "sivozelenikavi" sandy clays and lignite at the base of the cut, which are widely diffuse Development within Lom coal basin. Dak-Romance aquifer is described in the literature. Feeding him is carried out by infiltration of precipitation and surface water and drainage is in-river ravine network, gravel-sand formations of Kozloduy Valley (ground water body BG1G0000Qal005) and / or water intake structures.
Groundwater flow is directed from south-southeast to north-northwest with an average gradient within the site "Radiana" around 0,002 that to the North increase to 0.05 and is almost completely drained in the first non-flooded terrace. The average thickness of the ground water body is 70 m, but reaches about 100 m. Filtration properties are characterized by the average rate of filtration 2,0 m / d and conductivity of 140 m2 / d (BDDR, 2007), characterizing it as a medium saturated. In chemical composition the waters are hydro-calcium magnesium with mineralization up to 500 ÷ 600 mg / l, total hardeness is 1, 8 ÷ 2,4 mgΣqv / l and increased content of ammonia, due to cuts in coal and coal clays. Characterized by the values of the total beta activity, total alpha activity of natural uranium content and specific activity of test radionuclides listed in Table 3.3.1

Таблица 3.3.1 Total and specific activities of investigated radionuclides

№	Наименование на показателя	units	Results of investigations			MC on ОНРЗ-2004 и Reg. № 9/2001
			Sample B 533 of MC 1	Sample B 534 of MC 9	Sample B 535 of MC 10	
1	2	3	4	5	6	7
1	Ka-40	Bq/l	0,30±0,02	0,33±0,02	0,39±0,02	9,2
2	Mg-54	Bq/l	< 0,05	< 0,05	< 0,05	120
3	Kd-109	Bq/l	< 0,05	< 0,05	< 0,05	40
4	Cs-137	Bq/l	< 0,05	< 0,05	< 0,05	11
5	La-140	Bq/l	< 0,05	< 0,05	< 0,05	30
6	Bi-214	Bq/l	0,305±0,027	0,335±0,029	0,301±0,027	520
7	Sn-214	Bq/l	0,292±0,024	0,322±0,027	0,277±0,025	380
8	Ra-226	Bq/l	0,055±0,008	0,060±0,009	0,051±0,079	0,1
9	Th-232	Bq/l	0,042±0,006	0,042±0,006	0,040±0,006	0,6
10	U-238	Bq/l	0,102±0,009	0,118±0,010	0,090±0,009	2,3
11	U-235	Bq/l	< 0,005	< 0,005	< 0,005	2,2
12	Nat. U	mg/l	0,0566±0,006	0,020±0,01	0,080±0,00004	0,06
13	Total β-activity	mg/l	0,102±0,009	0,114±0,011	0,061±0,007	2,0
14	Total α- activity	mg/l	0,066±0,004	0,061±0,004	0,041±0,003	-

These test results are less than the maximum values of specific activity of radionuclides in the Regulations on basic standards for radiation protection and the requirements of Regulation № 9/16.03.2001 water quality for drinking purposes.

The lower layer, known in the literature as Gornopontski aquifer is composed of small to medium, grains and in places with low power big-grain sands clay layers. It has a regional distribution in Lom depression, on Bulgarian territory and the territory of Romania. The jacket is a depth of 50 ÷ 60 m below NHRAO. Recharge of the aquifer is performed by infiltration of precipitation, irrigation water from rivers and Lom Nechinska bar Tsibritsa and others. In the periphery of the depression, where sand and gravel are revealed on the surface in the form of strip width of 1 ÷ 10 km. In this vast area aflyorimental and river terraces formed common unconfined aquifer. North to the Danube, it sinks into dak-Roman sediment and acquires a pressure character. Between the villages Archar, Dobri dol and merge west and between Kozloduy and the village of East Harlets Gornopontskiya aquifer crosses the Danube in the alluvial formations Archar-Orsoyskata and Kozloduy Valley. In these strips aquifer draining into the Danube made directly through the hydraulic connection with groundwater body BG1G0000Qal003 the west and the underground water body BG1G0000Qal005 east underground stream is a general direction north-northeast with an average hydraulic gradient of about 0.0018. Filtration properties are expressed in the filtration coefficient of 8 ÷ 38 m/d, conductivity from 150 to more than 3000 m^2/d. Mean values - the coefficient of filtration 25 m/d and the conductivity of 2500 m^2/d Gornopontskiya aquifer characterized as very vodoobilen. In relation to hydrochemical groundwater is hydro-sodium-calcium, calcium hydro-hydro-sodium and magnesium, sodium, with mineralization 400 ÷ 730 mg/l, total hardness from 6,0 to 8,8 mgΣqv/l and neutral active reaction (pH = 6,9 ÷ 7,5). Chemical status of groundwater body is bad. indicator of nitrate tolerance as a result of diffuse sources of pollution. Quantitative status of water body is assessed in good condition. Specific environmental objective of groundwater body BG1GO00OON2034 code is "Achieving good status of groundwater" The body is an area to protect drinking water from groundwater bodies falling BGIDGW00000N2034. Used water flows from the area of public drinking water is 7 250.181 m3/den. The condition of the area to protect drinking water from groundwater bodies is good.

- For zones to protect drinking water is a specific environmental goal: "Reduce the need of water treatment prior to their use and ensuring the project in the amount of water intake facilities by 2015.

■ Natural resources and exploitation of groundwater. Intake facilities. Sanitary protected areas.

Summarized data on the regional, natural, attracted and operational resources of the described underground water bodies for abstraction and permitted free amounts are reflected in **Table. 3.3.2:**

Table 3.3.2 Summary of the data on the regional natural, attracted and operational resources of the mentioned water bodies

Code of UWB	Total area of UWB Km^2	Regional resources l/s			Total output l/s	
		Natural	Attracted	Operational	Permitted annual output	Free quantities
2		3		4	8	9
BG1G00000N2034	3065	1730	-	1640	96	424
BG1G00000Qal023	56	2310	-	1160	0	580
BG1G00000Qal005	39	160	2000	2130	491	174
BG1G0000Qal015	250	625	500	875	107	331

The groundwater resources of those water bodies are in the municipality of Kozloduy, where the site of Radiana is situated, are a source for drinking water, industrial water, irrigation water and water for other needs. For this purpose, many intake facilities are built.

In letter No. APIA 176/05.2009 of the Danube Region Basin Directorate - Pleven provides information about the issued permits for abstraction of water from water sources for drinking in the municipality of Kozloduy and their debits, which are summarized in the following **Table 3.3.3.** together with the approximate distances to the site of Radiana. Moreover, given the coordinates of zone III of the sanitary protectied zones of SK-Raney 1, 2 an 3 PS Kriva bara - TC 6 and TC 6-1. The establishment of sanitary protected zones is pending as per Ordinance No. 3/16.10.2000 [47] to the Water Act and other intake facilities, stated in the table.

In the scope of the Radiana site and the surrounding area, there are no studies and validated resources of mineral waters.

Table 3.3.3 Information on permits issued for abstraction of water from water sources for drinking in the municipality of Kozloduy

№	Water-taking facility	Projected debit l/s	Approximate distance from Radiana site to water-taking facilities, km	Water source (Groundwater body)
1	2	4	5	
1	SK 1, 2 and 3	111,30	9,3÷10,5 (≈ 8,5 to CO3)	*BG1G0000Qal005*
2	„Mizia I" – 6 – Blatoto	12,00	4,3	
3	„Hurlets I" – 1 и 2	2,74	1,5÷2,0	
5	„Hurlets II" –1, 2 и 3		4,0÷4,5	*BG1G0000Qal015*
6	"Poleto dvor" № 6 и 7		5,0÷5,3	
7	"Third well-old" - Butan		8,7	
8	„Butan" II - 1 и 2	18,30	Water-taking facilities are not mentioned in the table	
9	„Kriva bara" – TK 6 and TK 6-1	4,28	13,0	
10	"Grudov well." № 1 и 2-Sofronievo	-	10,5÷11,0	
11	„Butan" I – TK 16	1,80	10,9	*BG1G00000N2034*

The location of the water intake facilities and of the established sanitary protected zones are illustrated on the attached scheme (**fig. 3.3-1**). It could be concluded that Radiana site is outside the boundaries of zone III of the established sanitary protected zones.

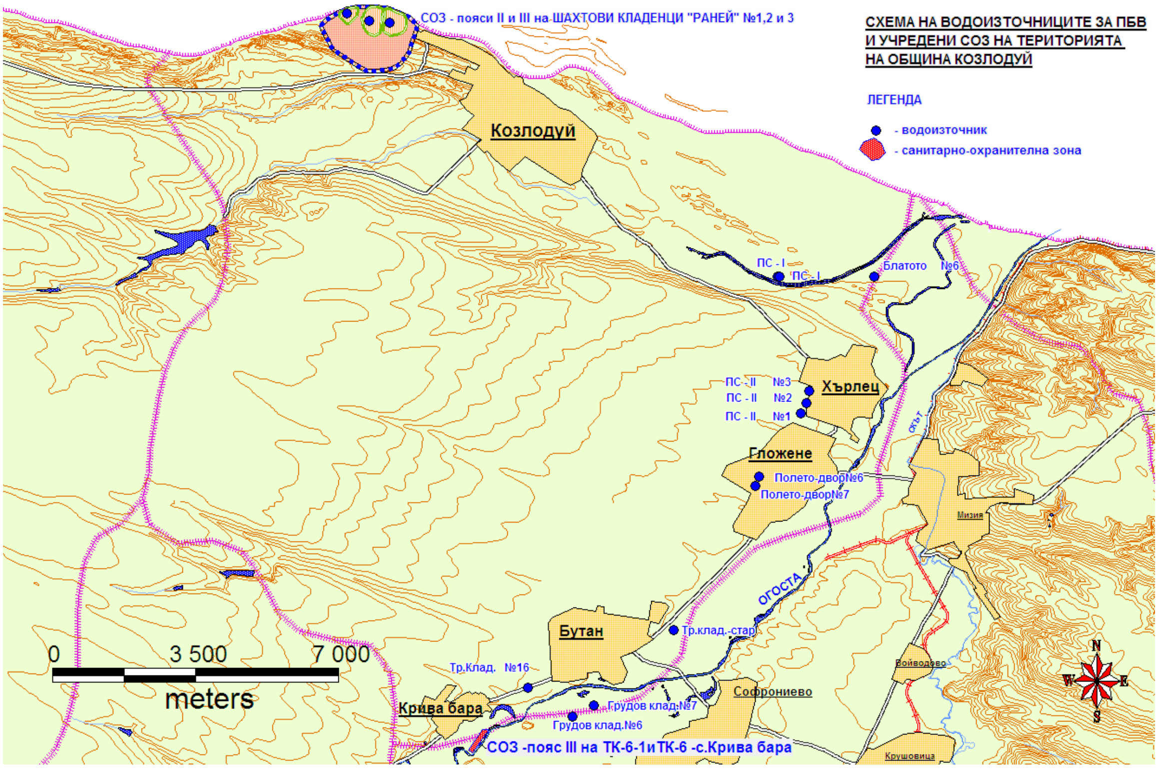


Fig.3.3-1. Scheme of the water-intake facilities for drinking and public needs water supply and of the established sanitary protected zones on the territory of the municipality of Kozloduy

Continuous studies of drinking water conducted by the Kozloduy NPP under the programme for environmental monitoring shows that the values for total beta activity were significantly lower than the maximum limits as required by *Regulation No 9/16.03.2001 quality water for drinking purposes* [33], and the content of radionuclides ^{90}Sr and ^{137}Cs was below the standards in the Regulations on basic standards for radiation protection. In 2008 these figures were: total beta activity 0.019 ÷ 0.13 Bq/l, ^{137}Cs - below minimum detectable, 90Sr in the range <0.7÷1.6 mBq/l.

Groundwater is part of the programme for radioecological monitoring by project drilling at the site of the Kozloduy NPP [367]. Groundwaters are generally higher in salt content than surface waters, and respectively have higher natural radioactivity. The water in 2 wells, at least once in 2008, had a total beta activity in the range 0.75÷1.5 Bq/l, while in 3 other wells, at least once during the year, had a total beta activity greater than 1.5 Bq/l .

Samples were taken from 115 wells out of 115 wells in the programme for testing the radioactivity of groundwater on the industrial site of the Kozloduy NPP in 2008. 29 of them are within the EP-1 territory, 30 within the EP-2 territory, 26 are in the area of CPRAW and the RAW warehouse, 25 in the regions of HOG, RRAW, the lime production site and the site for temporary solid waste open storage and 5 more on the spoils depot. In August 2004 sampling and analysis started on 3 newly drilled benchmark wells located at the entrance and exit of the aquifer near the industrial site.

Water samples from the drilling wells are analyzed four times a year for total beta activity and the levels of tritium.

Figure3.3-2 and **Figure 3.3-3** show the results for the radioactivity of groundwater in areas of processing, conditioning and storage of radioactive waste at the site of the Kozloduy NPP and RRAW in 2008. For each group of wells the results for total beta activity and tritium content have been presented.

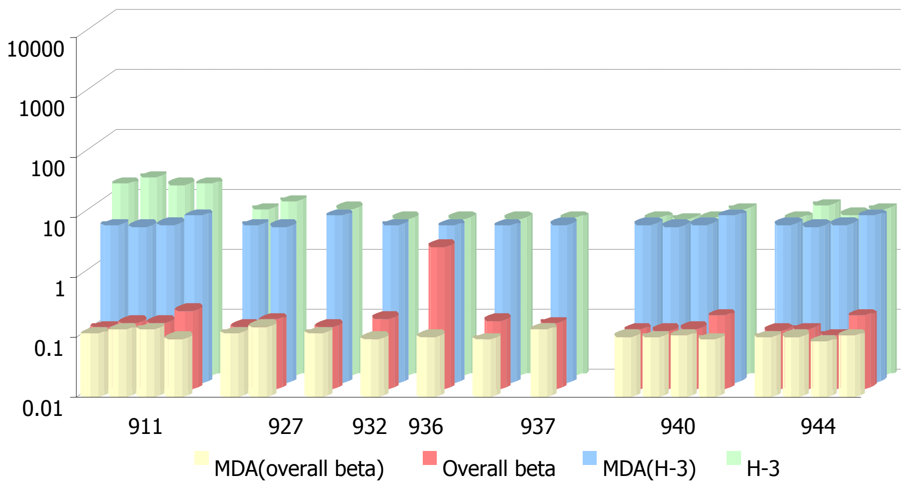


Figure 3.3-1 Content of tritium and total beta activity (Bq / l) in water from RRAW wells of Kozloduy NPP, 2008

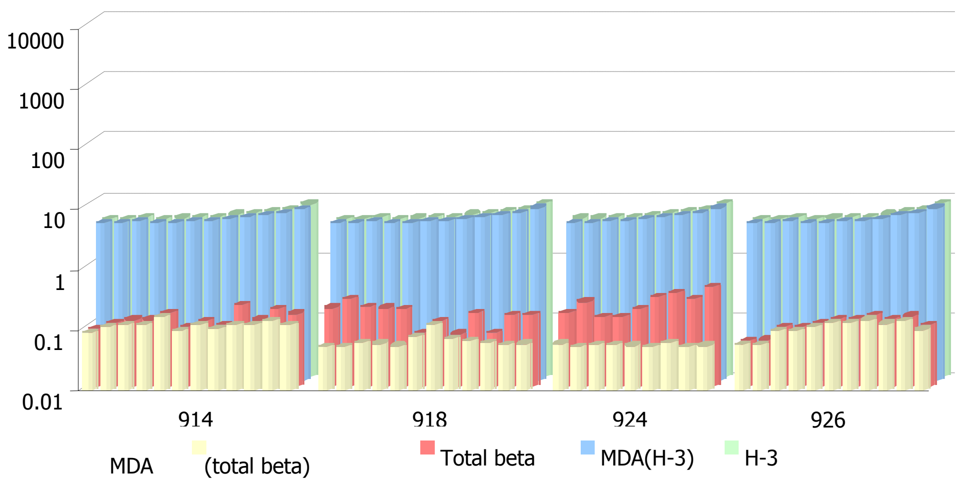


Figure 3.3-2 Content of tritium and total beta activity (Bq/l) in water from wells at the site for temporary storage of solid waste at Kozloduy NPP, 2008

Radioactivity in the remaining drills conducted at the site and benchmark drillings is very low (around MDA), indicating that there was no impact of the work of the NPP on the aquifer in the area.

CONCLUSION: The impact on groundwater is only local in certain parts of the site. The results of the radioecological monitoring of Kozloduy NPP in 2008 [367] are similar to those from previous years.

3.3.2 Surface waters

Investment proposal "Establishment of a national repository for disposal of low and intermediate level radioactive waste (NHRAO), " at "Radiana" site, territory v. Harlets, Kozloduy community falls within the following surface water body:

Surface water body, well-modified Category river, named Danube, has the following characteristics:

- Name: River RWB0I; code: BG1DU000R001; length: 650,650 km;
- Geographical description: The Danube from the border at village of Novo till the border at village Silistra.
- Ecological status of water body is moderately, components: biotic index - not available; physical chemistry - moderate, moderate-specific substances.
- Chemical state is bad (as assessed by strength of priority substances under Directive 2008 / 105/ES, Appendix 1).

Environmental objective for surface water body code BG1DUOOORO0I is "Preventing the deterioration of the ecological potential and achieve good to 2021. Prevent deterioration of the chemical state and achieve good to 2027.

According RBMP, Danube basin management is an area of 47,235 km, or 42.5 percent of the territory of Bulgaria. The area of individual basins is as follows:

River	**Total river area, km^2**
Erma	436,350
Nishava	700,960
West of Ogosta	3910,578
Ogosta	4282,290
Iskar	8633,654
Vit	3227,565
Osam	2838.009
Jatra	7861.909
Rusenski Lom	2985,355
Donau Dobrujanski rivers	8140,571
Donau	4217,437
Together	**47234,678**

On the territory of the Radiana site there are no rivers. The nearest rivers are Danube, Ogosta and Skut.

The natural topographical conditions and the remoteness of these rivers preclude that they will have any impact on the condition of the site of the investment proposal.

The IP site borders the site of Kozloduy NPP, which is located on the right terrace of the Danube river. The drainage systems in the region are sized for removal of surface water from intense rain of varying duration and security of high rainfall 0.01% (once every 10,000 years).

The available water resources in the municipality of Kozloduy NPP are formed by the Danube River and the lower current of the rivers Ogosta and Skut. The water plains and streams compose an area of 17,188 ha. The artificial basins in the municipality of Kozloduy are the Asparuhov Val dam and Butan dam with a total area of 4,025 ha.

Figure 3.3-3 Map of Danube river

The Danube is the second largest river in Europe. It rises in the Schwartzwald mountains and with its length (2,859 km) it is the second longest river in Europe (after the Volga). The average river flow before the delta is 6500 m³/sec.

The Danube River passes through 10 countries: Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Bulgaria, Romania, Moldova and Ukraine. Its basin occupies a total of 817,000 sq. km. In its merge into the Black Sea it divides into three branches - Kiliysk, Sulinsk and Georgievsk. The northernmost branch - Kiliysk serves as a border between Romania and Ukraine. The middle branch - Sulinsk is the deepest and most water abundant.

It is included in the most endangered world rivers list, prepared for the World Water Day in 2007.

In the southeast of Europe around the Black Sea, i.e. at the lower stream along the Danube, the countries of Bulgaria and Romania are situated and their common border is 631.3 km long, of which 420 km is midstream in the River Danube. Both countries bear the intense pollution of the Danube waters coming from the upper parts.

The major tributaries of the Danube in Bulgaria are the rivers Lom, Ogosta, Tsibritsa, Iskar, Vit, Osam, Yantra, Ruse Lom (the nearest to Radiana site is Ogosta river). The Danube hydrographic region has an area of F=49,630 km^2 or 42.3% of the territory of Bulgaria. (Closest to the site is Ogosta river)

Major tributaries and their water-intake area.

Ogosta – water-intake area F=3154km2

Iskar - water-intake area F=8646km2

Vit - water-intake area F=3225km2

Osam - water-intake area F=2824km2

Yantra - water-intake area F=7869km2

Ruse Lom - water-intake area F=2974km2

The Bulgarian Danube bank has a length of 471.45 km (from river Timok to the border at Silistra). In many places the coast is narrow and descends steeply to the river. In some places it is up to several kilometers wide and encloses relatively large lowlands, which are periodically flooded. For the prevention of flooding by the high waters of the Danube earth dams were built.

Under forest-plant zoning the coast and islands of the Danube fall under the Moesian forest-plant area. It has a moderate climate.

About the Danube's vertical zoning, the Danube lands are in the lower plain and hilly belt, and in particular in its under belt of floodplains and riparian forests. By nature these areas are floodplain terraces, alluvial lowlands and islands of the Danube and its tributaries. The groundwater level, and duration of flooding by river water are also important for their forest-plant conditions other than the structure and nutrient content.

The river passes through a region with a large number of settlements / population over 80 mln. people/ and is a natural habitat for many endangered species of plants and animals..

It is necessary to exert strict control and effective management in order to prevent and quickly remove the accidental release into the air and water of harmful substances which are above determined requirements under existing environmental legislation in the country, harmonized with the EU as to prevent health risk to the population.

Studies on the flow of the Danube are held on the main hydrometric stations in the area in Oryahovo - ^{km}678 and Jiu River ^{km}693 on the basis of 57 annual series (1940-1996). They are based on official information from the directories of the Danube Commission, hydrological Danube guide, UPPD - Ruse Energoproekt and NIMH - Sofia. (EIA NPP Kozloduy, 1999).

The hodograph of the average and maximum and minimum annual water levels is given in **fig.3.3-5,** which shows that in the distribution of annual runoff of the river, there have been two continuous sequences of 12 years each with a low-flow (1942-54 and 1981-93) and a long high-flow period of 26 years (1955-80). Since 1994, river flow tends to increase.

The statistical parameters of the monthly series and annual runoff are given in **fig.3.3.4**. The table shows that the variance of the Danube flow is greatest during the months of low flow (August to January). The most resistant period of the river flow is during the high flow (February-July). The average monthly percentage of participation in the formation of the Danube flow is presented in **table. 3.3.5**. It shows that the lowest flow of the river is in October and the highest - in April.

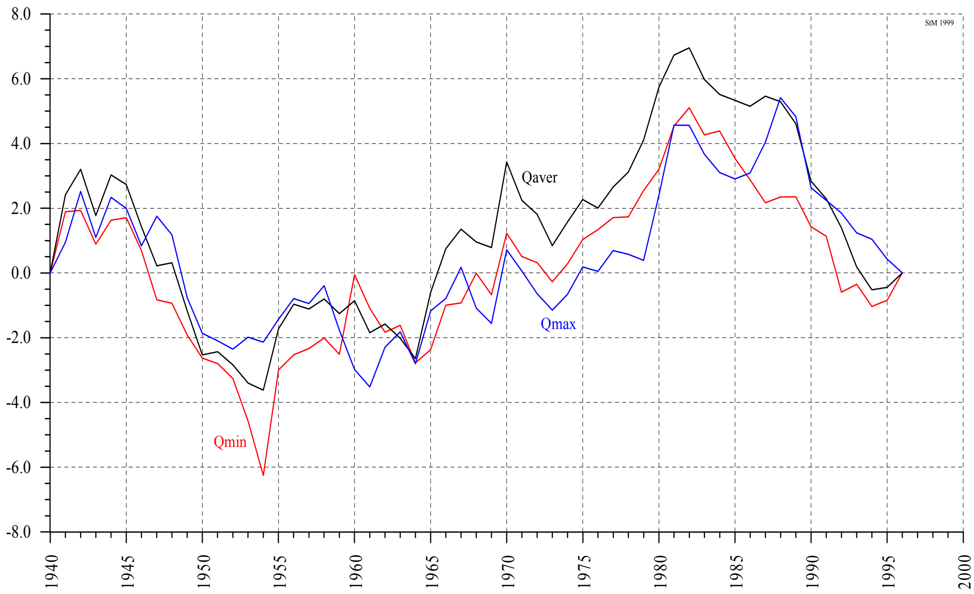


Table 3.3-4 Sequences of low and water-abundant years of the Danube flow

Q max – for maximum water quantities;

Q aver – for average annual water quantities;

Q min – for annual minimum water quantities

Table 3.3.4 Statistical characteristics by months

Characteristic	1	2	3	4	5	6	7	8	9	10	11	12	Per year
Qav m^3/s	5217	5673	6851	8202	7776	6883	5792	4588	3958	3837	4532	5337	5719
Std m^3/s	1686	1630	1924	2136	2039	1878	1693	1459	1216	1254	1702	1780	978
Cv	323	287	281	260	262	273	292	318	307	327	376	334	171
Cs	314	470	438	097	625	857	1.073	508	688	581	1.160	525	608

Table 3.3.5 Inner annual distribution of the flow for an average fictitious year in the period 1941 – 1996.

Characteristic	1	2	3	4	5	6	7	8	9	10	11	12	Per year
P % monthly	7.60	8.26	9.98	11.95	11.33	10.03	8.44	6.68	5.77	5.59	6.60	7.77	100

The annual flow of the river in the considered section of $^{km}678$ near Oryahovo to $^{km}693$ at r. Jiu is given in **Table 3.3.6**.

Table 3.3.6 Annual flow of the Danube in the region from $^{km}693$ to $^{km}678$

P	%	10	25	50	75	90	95	98	99
Q	m^3/s	7033	6300	5585	5000	4578	4363	4155	4035
W	$m^3.10^9$	221.8	198.7	176.1	157.7	144.4	137.6	131.0	127.2

The theoretical curve of collateral for the annual runoff of the Danube is presented in **Figure 3.3-5**. It optimally approximates the function of "Piersen-III".

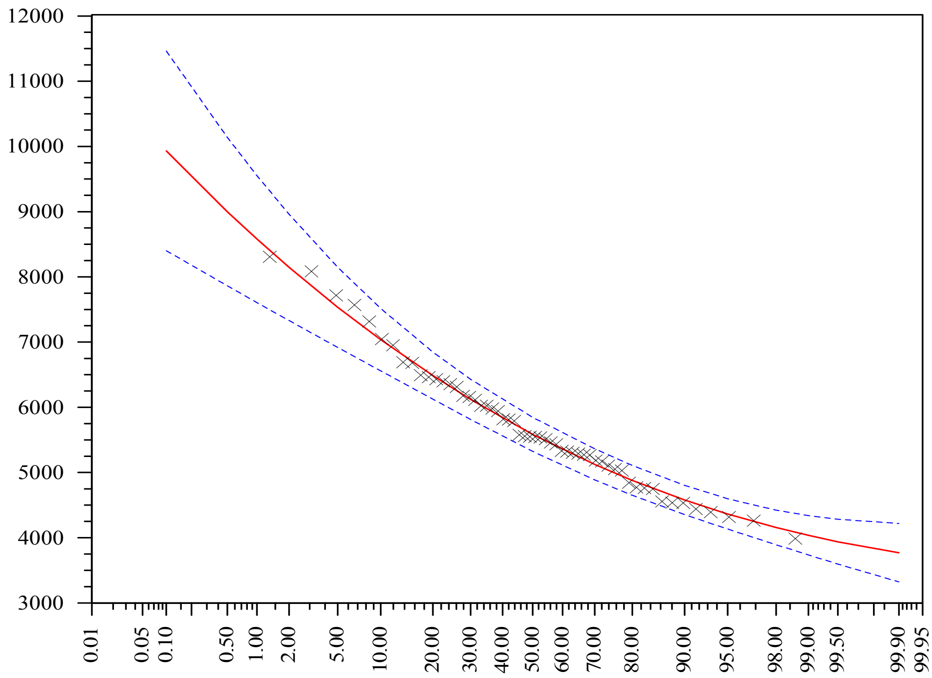


Figure 3.3-5 The theoretical curve of collateral for the annual flow of the Danube

The minimum flow in the Danube area of Oryahovo has been studied in several aspects:

- monthly minimum water quantities (the viability of each of them is usually 24 hours) with 95% certainty. The results of the calculations are summarized in **Table 3.3.7**.
- Monthly water levels with 95% certainty (their durability is equal to the number of days in the month), given in

- **Table 3.3.8**.

Table 3.3.7 Monthly minimum water levels, with 95 percent certainty

month	01	02	03	04	05	06	07	08	09	10	11	12	Annual. min
Q, m^3/s	1810	2450	3270	3950	3935	3375	2720	2070	1944	1852	1928	1980	1659

Table 3.3.8 Monthly water levels, with 95% certainty

month	01	02	03	04	05	06	07	08	09	10	11	12	Ann.
Q m^3/s	2660	3007	4248	4840	4760	3875	3545	2430	2343	2156	2456	2730	4364

The maximum flow of the Danube in the region of Kozloduy NPP is determined on the basis of the conducted regime surveys on water levels as follows:

- ^{km}678 - Oryahovo (Russe);
- ^{km}687.50 – Coastal pumping station (Kozloduy NPP);
- ^{km}704 – Water-reporting station Kozloduy (by 1969).

The specific significances of the achieved results for the maximum water quantities are entered in **Table 3.3.9**.

Table 3.3.9 Maximum water quantities of specific significances of the section of the river Danube from ^{km}678 (Oryahovo) to ^{km}689.3 (river Jiu)

Security in %	Period 1941-1996		Period 1840-1996		Model for period 1840-1990	
-	Qp	$Qp_{95\%}$	Qp	$Qp_{95\%}$	Qp	$Qp_{95\%}$
0.01	18758	21680	18093	20190	21206	21299
0.1	17045	19484	16325	18106	18647	18722
1.0	15193	16717	14453	16370	15942	15998
10.0	12875	13637	12280	13860	12936	12971

It can be concluded that for later use by all test curves of security the curve of security for Oryahovo is recommended, calculated under Pierson - 3 output distribution 57 year line –.**Figure 3.3-6**.

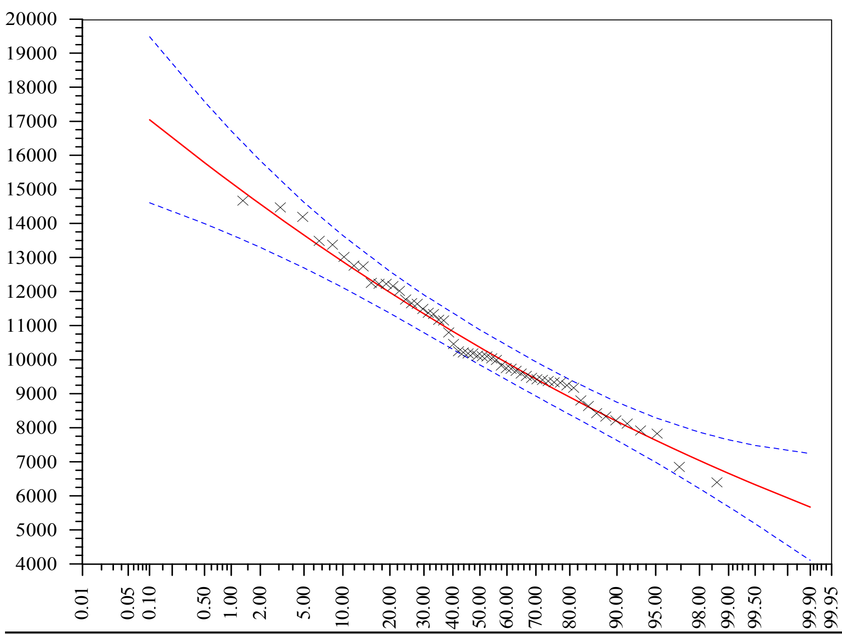


Figure 3.3-6 Curves of security of maximum annual water quantities – river Danube at ^{km}687.3

By the security curve of annual maximum water standings, the water levels are defined in Oryahovo and the possible flooding at the site. It is recommended to use the results of the model for the maximum flow during the period 1840-1990 for the the assessment on the protection of Kozloduy NPP from floods.

Due to the significant deformation of the riverbed due to general processes of erosion of the riverbed, and the intensifying of the work of "Iron Gates" 1 and 2 extending into Oryahovo it is impossible to directly use the data from the measured water levels at high waters (1970). Therefore the water standings are adjusted to today's permeability of the riverbed. It can be concluded that the key curve in the aspect of high waters (probably after 1990) is reduced by about 35-38 cm in comparison to 1970.

In the section from ^{km}704 to ^{km}678 are discharged the rivers Jiul (left bank at ^{km}693) and Ogosta and Skut - right bank at ^{km}684. The average multi-year water discharge of perennial tributaries does not exceed 3% of the average multi-year runoff of the Danube in this area. This value is less than the error, which measured water levels for Danube. Therefore, for the purpose of engineering research, it can be assessed as insignificant.

Given the above results, it can be determined that the activity of Kozloduy NPP at full power (3,760 MW and 180 m^3/s), which is very unlikely, even in very low flow years (99% certainty) the water use of the headquarters at the Danube is very small - only 4.5% of the river flow. Irretrievable loss of water at Kozloduy NPP is estimated at 0.00092% of the flow of the Danube and 0.044% of all water used by the plant. It can therefore be concluded that Kozloduy NPP does not affect the flow of the Danube.

To assess the state of water resources from surface waters in the region and other rivers, a hydrometric data backbone network is used. These belong to the Danube river basin management area. The river network in question consists of 16 hydrometric stations (IDS), 4 of which are Ogosta River and 12 of its tributaries. For the respective points, parameters of the flow were calculated giving a quantitative assessment of available water resources in rivers and their tributaries.

The other nearby rivers are: Lom, Tsibritsa, Ogosta, Skut (in order of incorporation into the Danube) which originate from the main ridge of Stara Planina, except Tsibritsa and Skomlya river which spring from the foothills of Stara Planina. The total area of the basins is 6,305 km^2.

The *Lom River* originates in the eastern slopes of the mountains in the border mountains in the region of the village of Gorni Lom. It is formed by many gullies, and the start of the sources are taken as the river Byrza under the Midzhur peak. These little rivers have a mountainous character, steep slopes of the riverbed and a high flow velocity. Characteristic for the river in its lower course is the increase of its water obtained from higher levels of the Danube.

Tsibritsa river originates in hills above the village of Smolyanovtsi, and the village of Vinishte from the bases of the Tserov and Costin peaks. Many small tributaries form two main rivers, which after merging at Dolno Tserovene run under the name of Tsibritsa river from Dolno Tserovene to its mouth in the Danube at Dolni Tsibar. The Tsibritsa river has a very small slope and runs through cultivated areas. It is therefore has multiple curves. The banks are low and in the case of heavy rains overflowing waters cause floods. In view of this the lower reaches were corrected.

Ogosta River. The start of Ogosta is Chiprovska river which springs under the Vrazha glava peak (935 m) on the border with Yugoslavia. The beginning of Chiprovsa River is a typical mountain gully with a steep slope average of 160 $^0/_{00}$. After the city of Montana the valley becomes wider. The afforestation almost disappears. The riverbed is covered with large and fine gravel.

Skut River originates in the foothill upland in the region of the villages of Upper Peshtene, Tishevitsa, Zakonitsa and others. The height of these uplands is 500-600 m, their northern slopes are woodless the and small rivers have a torrential character. All these rivers meet just over Golyamo Peshtene under the name Skut.

The rivers in question are mainly afforested by low forests and little beeches. The afforestation in percentage is about 25% of the entire area. Beech forests spread as a continuous belt high on the crest of the Western Balkans, as most are spread along the Ogosta. The smallest afforestation is along the river Skut. This weal afforestation of the valley is due to the low altitude of its springs.

Table 3.3.10 Orohydrographic characteristics of the rivers

River name	length	area	slope	Density of the river network	Afforestation
	km	km^2	‰	km/km^2	%
Lom	93	1140	18.3	0.7	35
Tsibritsa	88	934	7.3	0.3	
Ogosta	144	3157	11.4	0.73	37
Skut	134	1074	2.8	0.27	6

The average Ogosta river flow according to the data from hydrological stations is 23.554 m^3/s (742.8*$10^6 m^3$) at the town of Mizia. The fluctuations in the period (1961-2000) were in the range of 10.166-37.951 m^3/s at the post. The deviation of the average is 8.084 m^3/s for the same post, the coefficient of variation (Cv) is 0.343, and the asymmetry coefficient (Cs), respectively 0.091.

The drainage module which gives an idea of the intensity of runoff-generation is 7.540$l/s/km^2$ at the mouth of Ogosta River. Most modules which have a higher drainage have Balkan mountain tributaries, which have the highest average altitude of the basins, such as the river Desna bara at the village of Barziya with an altitude of 1100 meters has 28,966 $l/s/km^2$, and the mouth of river Skut at an average altitude of 200 m has an average drainage unit of only 1.620 $l/s/km^2$.

Average annual water quantities and components, and other standard statistical parameters (σ. *Cv* and *Cs*) for the main hydrometric stations network located closest to the site of the IP are given in **table 3.3.11**.

The total annual flow is 1 014.36.$10^6 m^3$. Larger rivers are Lom 202.106m^3 and Ogosta with an annual flow of 750.106m^3.

The minimum annual runoff value of the river Ogosta is 10.273 m^3/s at the mouth. In relation to the average annual units $\overline{Q}$, i.e. $k_{\min} = \frac{\overline{Q}_{\min}}{\overline{Q}}$ it almost does not change and moves within 0.430-0.470. For tributaries the range of spatial changes is between 0.282 for river Skut near the village of Mizia and up to 0.510 for the river Dalgodelska Ogosta near the village of Govezhda (**Table 3.3.11**)

The minimum monthly average flow appears as a rule during the summer-autumn low water, which for most of the rivers is in August. For some of the rivers in the area concerned, the minimum monthly average flow is in September. It has a very wide range: from 0 for less regulated small natural river flows as the river Skut near Nivyanin and others up to 10,273 for the river of Ogosta at its mouth (**table 3.3.11**).

The relative expressions of the minimum monthly average flow in comparison to the average annual ($k_{\min} = \frac{\overline{Q}_{\min}}{\overline{Q}}$ monthly) reaches the highest value for 0.096 for the river of Ogosta at its top flow. This proves that the highest share of underground recharge during low water is in that part of Ogosta .

Table 3.3.11 Average multi-year water levels and flow modules for the relevant points in the hydrometric network

River, point	Area (A)	Annual values					
		$\overline{Q}_{1961-98}$	$\overline{M} = \frac{\overline{Q}}{A}$	$\overline{Q}_{\min}^{anuual}$	$\overline{Q}_{\max}^{annual}$	**Cv**	**Cs**
	km^2	m^3/s	$l/s/km^2$	m^3/s	m^3/s		
River Ogosta at Mizia	3112.0	23.554	7.569	10.166	37.951	0.343	0.091

River, point	Area (A)	Annual values					
		$\overline{Q}_{1961-98}$	$\overline{M} = \frac{\overline{Q}}{A}$	$\overline{Q}_{\min}^{anuual}$	$\overline{Q}_{\max}^{annual}$	Cv	Cs
	km^2	m^3 / s	$l / s / km^2$	m^3 / s	m^3 / s		
River Ogosta at the mouth	3157.0	23.803	7.540	10.273	38.351	0.343	0.091
River Skut at Mizia	1035.0	1.677	1.620	0.530	3.790	0.457	0.598
River Lom at the mouth	1140.0	6.414	5.626	2.119	11.054	0.361	-.033
River Tsibritsa at the mouth	934.0	1.969	2.108	0.857	3.489	0.338	0.591

The internal annual distribution of runoff is determined by the seasonal changes in runoff-forming factors specific to the climatic region in which the catchment area falls under with its typical rain or unstable and short-term snow cover during winter, for low areas, and the retaining of a relatively stable snow cover in winter in the mountainous parts of the pool, massive rains in spring and prone to drought periods with little rainfall in summer and autumn and high temperatures throughout the region.

In the valley of the River Ogosta, River Lom and River Tsibritsa freshet occurs during April-May, when spring rains overlap with mass snow melting of the retained snow in the high parts of the basin which lasts until mid-March. For the River Skut this period is in May-June. Freshet is terminated in June and in July comes the summer low water.

The most intense mountain freshet of the Ogosta River mountain tributaries reaches 23.6% in May, and the most intense drought is observed in almost every river in August, fluctuating in the range of 2.3% - 5%.

Silt levels in the rivers Lom and Tsibritsa have low values for all periods. Accordingly, the values of the average modules are also the same.

The maximum module of the river Lom reaches up to 502 t/ap.km^2, and that of the river Tsibritsa reaches 151 t/ap.km^2, which is an index for insufficient erosion protection from erosion occurring in wet years. Maximum values of MR for the river Skut have very low levels, which can be explained by the plain nature of the catchment and the high degree of land in use for agricultural purposes.

In the annual course of silt levels is clearly highlighted a continuous downward trend since 1982, and after 1988 the floating sediment runoff is practically terminated because of the deepening drought in the region. This result is confirmed by the cumulative curves of sediment quantity.

In the catchment of the three rivers there are no large industrial polluters to be sources of alluvial materials of industrial origin.

Through the site designed for the building of NRRAW, the main irrigation canal M-1 which under *the Water Act* is a water site. Data from Irrigation Systems Ltd., a subsidiary of Vratsa and Danube Basin Directorate with headquarters in Pleven, MEW, branch Vratsa, channel M-1 is part of the irrigation system Asparuhov val and is meant to supply the area under it with water for the irrigation of other technical crops. Currently, the vast majority of facilities are morally and physically obsolete and for its efficient use rehabilitation is needed which requires significant financial resources, which is not financly justified.

Irrigation system Asparuhov val is built for the irrigation of 59,160 ha of agricultural land, including suitable for irrigation 29,723 ha (According to the census of irrigated areas by December 1999) to this moment irrigated areas have been considerably reduced (<15% of the project).

The Danube river is a major water source, where through "Asparuhov val" the water is meant to be accumulated in the dam “”Asparuhov Val” with a volume of about 7 million m³ water through motorway channels M-1 and M-2 it will be delivered by the irrigation system. The technical parameters of the main units along the water allocation are as follows:

- FPS /Floating pump station/ “Asparuhov val” - Put into operation in 1991, Qbuilt.= 3600 l/sec; Built power-3200 kw and power supply power tube at 110 kw.
- Through the penstock with L=450m and D=1300mm the water comes into channel M-O. The same is put into operation in 1964 and is located on the territory of Kozloduy city. Built with trapezoidal cross sections, the concrete lining and a length amounting to 3163 m, Qmax = 3.6 m^3/sec;
- Channel M-0 leads the water to FPS"Asparuhov val" -2, which is located on the highway channel M-1 and by channel M-4 the dam “Asparuhov val” is filled up.
- Dam “Asparuhov val” is put into operation in 1969 and is located in the town of Kozloduy and the village of Zlatiya. The wall is a land-mass H = 22.3 m, Lk = 580 m and flooded area F = 1250 ha; cWoб=16072 and Wп=1110. In this stage it is with a limited impoundment regime because of landslides in the wall. Through a steel mesh intake tower and a main drain Cd = 950 mm, water is distributed in motorway channels M-1 and M-2 as follows:
- Channel M-1 was put into operation in 1964. It provides irrigation water to fields of the lands of Kozloduy, Hurlets, Glozhene and Butan. The channel length is 30,239 meters and irrigation plains built underneath it are 30 898 ha and 11928 ha. The main ways of irrigation are gravitational irrigation and sprinkler irrigation with mobile techniques. The main crops irrigated in this region are tobacco and maize. Its technical parameters are: Qmax = 3.6 m3, trapezoidal cross sections and concrete lining.
- According to Irrigation Systems, Ltd., the Vratsa branch needs to have annual repairs and have constant monitoring of the presence of possible landslides due to the easy collapse of the loess terrain on which it is situated, which makes use of the irrigation system difficult.
- The route of the canal passes over Kozloduy NPP and in this part has a water intake facility, which is meant to provide an emergency water supply to the plant. According to Kozloduy NPP at this moment the channel is ruled out as an emergency water source for the plant and is not used according to its original purpose.
- Pumping station Asparuhov val-2 was put into operation in 1965 and serves to lift water from M-1 to M-2 channel with Qз = 3520 l/sec and Wз = 2010 Kw. The water is submitted through the 2 penstocks /steel with L=38 m and D=1200 mm;

Channel M-2 was put into operation in 1964 and serves to supply water to 28,266 ha of agricultural land including suitable for irrigation under 17,797 ha, according to Balance of irrigated plots as of 1999. In recent years, this channel is not in full operation due to landslides in Kozloduy, Hurlets, Glozhene, Butan, Kriva bara and Q = 3.4 m^3/s and considerable funds are needed for its rehabilitation. (The profile of the channel is trapezoidal and lined with concrete as the collapsed part is restored with concrete pipes).

The opinion of Irrigation Systems, Ltd., a subsidiary of Vratsa, is that channel M-1 of irrigation system Asparuhov val (“Shishmanov val”) is used annually for irrigation of various technical crops (mainly maize and tobacco) and annually funds are invested into the maintenance of various areas of it in normal function.

At this stage SE”RAW” is coordinating with Irrigation Systems Ltd - Vratza Branch the activities, ensuring opportunities for irrigation of agricultural land previously irrigated after realignment of channel M-1 of the existing irrigation system. As a result, near the site of "Radiana" there will not be a section of the irrigation ditch running through the site

The IP site borders the site of Kozloduy NPP, which is located on the right terrace of the Danube. The natural topography and remoteness of the mentioned rivers preclude them from having any impact on the conditions at the site of the investment proposal. The IP cannot have a direct impact on these open streams.

Site of the IP can not be submerged in a flood, as it is situated at an elevation considerably higher than the maximum lift level even higher at 1000 annual wave. Furthermore, dams are built, sized for running in 1000 annual wave along the Danube with the necessary statutory reserve.

Due to the nature of the site (located on a slope with an average slope angle of about 8 º 30 ') surface water drains in a northerly direction to Kozloduy NPP, in the area of which the drainage systems are constructed in size so that they will be suitable for the removal of surface water from intense rainfalls of varying lengths and security precipitation height 0.01% (once every 10 000 years).

In the realization of the investment proposal significant negative impacts on surface waters are not expected.

A potential source of contamination of the main water basin in the region of the Danube, is Kozloduy NPP, which uses the river as a source of industrial water and deposits its wastewaters into it.

The connection with the Danube is built through channels in which water is monitored for radioactive and conventional pollution.

Quality of surface waters

The assessment of the status of surface waters is also related primarily to the main body of the Danube River - a source of industrial water for the plant and a receiver of its waste water.

A detailed description was made of the radioactive and non-radioactive pollution of the Danube River near the plant. This report updates previous assessments made.

Radiational condition

A radiological monitoring of the radiological indicators in the region was carried out by the Executive Environment Agency (EEA) and Kozloduy NPP. The monitoring system for Kozloduy NPP is integrated into the EEA. The two institutions carry out joint periodic measurements and data exchange. [162], [163], [364], [365], [366]

Monitoring carried out by EEA for the period 2004 - 2008.

The radiological monitoring of rivers, lakes and dams in the country is carried out through a network of stations and is in control of the parameters under Decree No. 7/08.08.86 on Indicators and Standards for Determining the Quality of Running Surface Water - common beta-activity (750 mBq/l), total uranium content (0.6 mg/l), content of radium-226 (150 mBq/l).

The region of Kozloduy NPP is characterized by relatively low background activity, i.e. the contents of uranium, thorium and their radioactive products of break-down are below the average for the country. This is due to the predominant origin of sediment-like geological formations, on which this area is located

Before the construction and commissioning of Kozloduy NPP, the environmental radioactivity in the area was studied, which serves as a reference base for the impact of all nuclear installations operated so far.

The summarized data from the monthly monitoring of the EEA with MEW in the last five years (2004 - 2008) on total beta activity in the waters of the Danube river and the non-balanced waters of Kozloduy NPP are listed below:

The weekly radiological control of waste waters from the plant includes the following posts:

- Danube river at Kozloduy – port;
- Non-balanced waters, unit 5-6– clean zone;
- Non-balanced waters, unit 1-4;
- Drainage channel (DC);
- Leading channel;
- New channel "Valyata;
- Old channel "Valyata";
- Danube river at the town of Oryahovo – port.

The determined total beta activity of the waste waters during the last five years varies in the range of 0.04 Bq/l to 0.8 Bq/l.

The potential impact of objects with sources of ionizing radiation is estimated by comparing radiation parameters of objects from the environment to those of the pre-operational period.

Table 3.3.12 Radioactivity of objects from the environment of the Kozloduy NPP in the pre-operation period 1972-1974

Object	Content of:		
	Cesium-137	Strontium-90	Total beta-activity
Soils, Bq/kg	7.6 ± 0.6	5.0 ± 0.4	703 ± 30
Waters (excl. river Danube), mBq/l	10.0 ± 6.0	7.0 ± 6.0	420 ± 170
Bottom sediments (excl. river Danube), Bq/kg	5.6 ± 0.4	5.4 ± 0.2	778 ± 52
Waters from the Danube river, mBq/l	4.0 ± 1.2	12.0 ± 2.0	248 ± 70
Bottom sediments from the Danube river, Bq/kg	3.6 ± 1.4	2.6 ± 0.6	889 ± 74
Grass, Bq/kg	2.1 ± 0.1	4.4 ± 0.3	963 ± 259
Wheat, Bq/kg	0.25 ± 0.02	0.15 ± 0.01	85 ± 4
Cow milk, mBq/l	133 ± 11	111 ± 15	-
Cow meat, Bq/kg	0.296 ± 0.026	0.092 ± 0.011	67 ± 3.7
Bones, Bq/kg	< 0.1	10.0 ± 1.6	170 ± 18.5
Fish – meat, Bq/kg	4.44 ± 1.70	0.37 ± 0.09	82 ± 3
Fish - bones, Bq/kg	0.37 ± 0.12	1.48 ± 0.20	140 ± 20
Ambient sediments, Bq/m2.a	12.0 ± 3.0	11.0 ± 4.1	-

The average concentrations of uranium in the waters of the Danube River are within (2.0 ± 0.2) × 10-6 g/dm3 (25 mBq/dm3). Given the significantly lower solubility of the compounds of thorium, river waters are characterized by much lower concentrations which in the waters of the Danube do not exceed 0.1 mBq/dm3. Among the break-down products of uranium most significant to the Danube is the presence of radium (226Ra) -2.7 ± 0.9h10-13 g/dm3 (9.7 ± 3.4 mBq/dm3).

In 2008, from the Department of Radio-ecological Monitoring of Kozloduy NPP 41 samples have been taken and a total of 134 analyses has been conducted - 38 gamma spectrometric, 41 radiometric for the general beta activity, 41 liquid scintillation for tritium and 14 with radiochemical isolation of strontium. The summarized results of the monitoring of the natural waters in 2008 are presented in **Table 3.3.13**

.

Table 3.3.13 Summarized data of the natural waters monitoring, 2008

NATURAL WATERS	Weekly samples of the Danube river Annual samples from Ogosta river, Tsibritsa river, Kozloduy dam Taken : 41 samples with conducted 134 analyses /38 gamma-spectrometric, 41 radiometric on the total beta activity and 14 with radio-chemistry on Strontium, 41 liquid-scintillation of Tritium / RESULTS In normal limits typical for natural waters Total beta activity < 0.027 ÷ 0.13 Bq/l, av. annual – 0.054 Bq/l Activity of 90Sr – < 0.8 ÷ 8.4 mBq/l, av. annual – 2.5 mBq/l Activity of 3H - < 2.5 ÷ 23.1 Bq/l Activity of 137Cs - 0.6 ÷< 1.4 mBq/l
SUMMARY: The results are comparable with those from previous years. Impact of the NPP is not reported on the aquatic ecosystem in the region.	

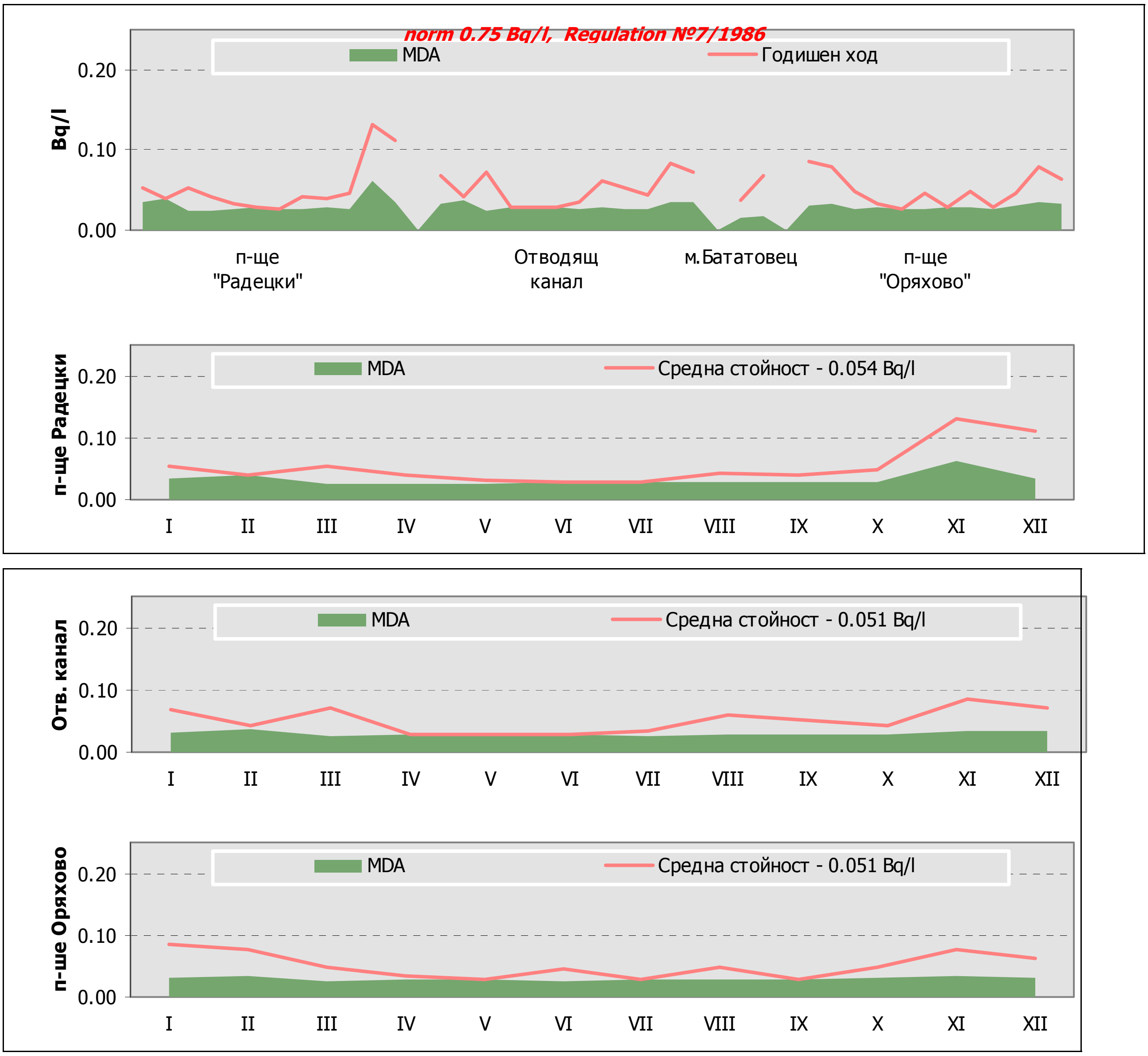


Figure 3.3-7 Total beta activity (Bq/l) of Danube waters, 2008

The total beta activity, measured in the open water reservoirs is normal: from <0.027 to 0.13 Bq/l, which is only 17% of the normal (0.75 Bq/l under Regulation № 7/1986) [27]. For the waters of the Danube river, the maximum measured value is 0.13 Bq/l. For the water draining channel of the NPP, the results are within the limits <0.028 ÷ 0.084 Bq/l. As shown in **Figure 3.3.-9** and **Figure 3.3-10**, the comparability of the results at various points along the stream (before and after the NPP) proves the lack of impact from the release of unbalanced waters in regard to the total activity.

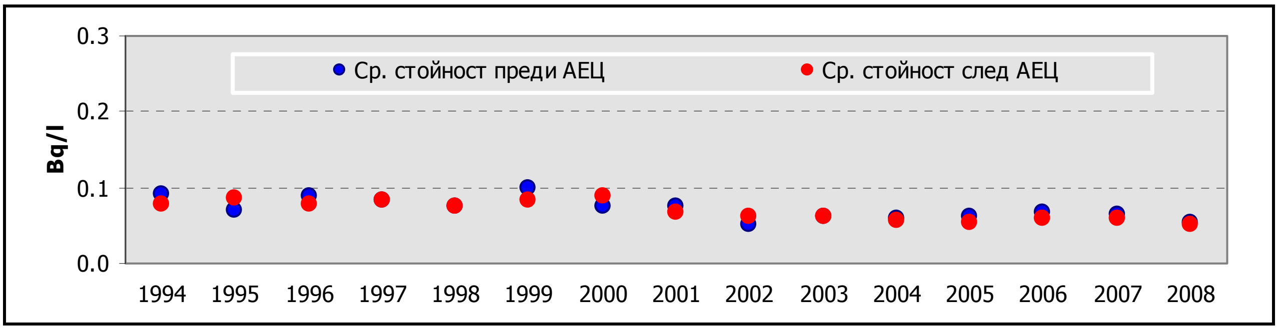


Figure 3.3-8 Summarized results for the total beta activity (Bq/l) of the waters of the Danube river, 1994 – 2008.

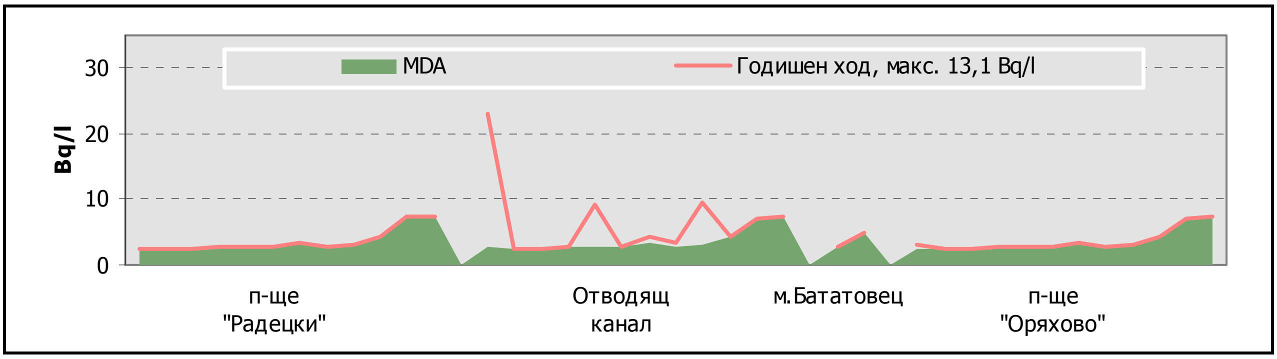


Figure 3.3-9 Tritium activity (Bq/l) in the waters of the Danube river, 2008

Figure 3.3-10 shows that in 2008 tritium activity was recorded only occasionally in the waters of the NPP drainage channel - up to 23.1 Bq/l. In the other control posts tritium over MDA, to 7.4 Bq/l, was not measured. The measured activity of tritium in the waters of the drainage channel of the NPP reflects the minimum impact of the plant with the discharge of unbalanced water into the channel. Even compared to the rate of tritium in drinking water (100 Bq/l, Ordinance No. 9/2001) [33], the results for the draining channel are very low (only 23%). There is a comparison of the summarized data from the long-term studies of tritium in the Danube River - after the NPP, as shown in **Fig. 3.3-11**.

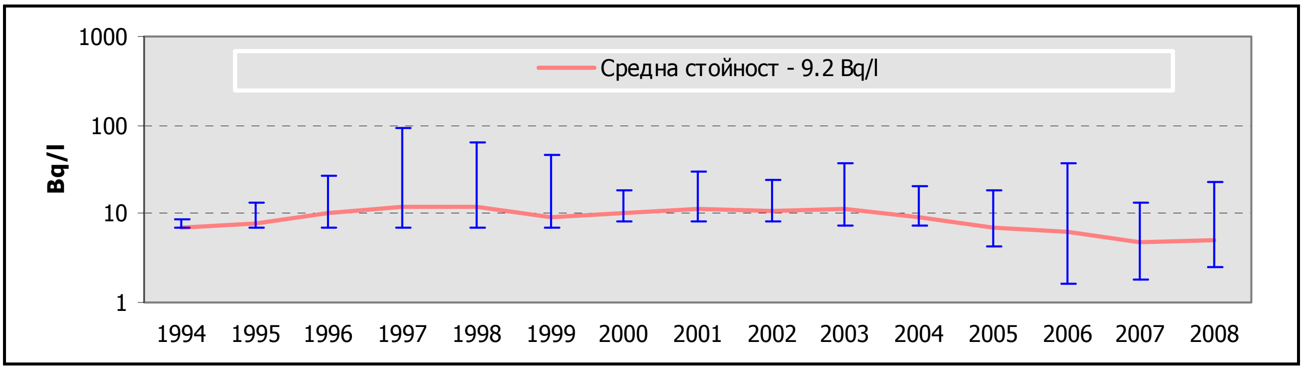


Figure 3.3-11. The summarized data for Tritium (Bq/l) in the waters of the Danube river after Kozloduy NPP, 1994–2008.

The radioactivity of the water from the inland rivers Ogosta, Tsibritsa and Kozloduy dam, is within the typical values for natural waters. The total beta activity is between 0.065 - 0.097 Bq/l, but the content of tritium is under MDA (<2.9÷<5.1 Bq/l).

Radiological monitoring in the areas around the Kozloduy NPP, 1999-2008.

For the localization of radiation effects during the operation of a nuclear power plant there are three areas: radiation protected - 3 km, controlled zone - 12 km, and monitored zone - 100 km radius around the nuclear power plant.

Periodical monitoring is executed on the radioactivity in the air, atmospheric depositions, soil, vegetation and radiation gamma background. Beyond those points, samples of water, milk, meat, fish and other products are analyzed. Particular attention is paid to the investigation of the Danube river, where there are several sampling posts, as well as investigation of drinking water. Annually about 2,300 samples are analyzed, using standard methods.

Continuous automated monitoring is carried out of the dose and content of I-131 in the near surface air by 10 monitoring stations in the 3-km zone for preventive protection measures (PPM) around the plant. In addition, this system operates continuously together with three automated weather stations, as well as 5 water stations to control the activity of unbalanced and waste waters.

There are 36 monitoring posts established in the 30km zone around Kozloduy NPP, which carry out measurements and sampling for laboratory analysis of the contents of natural and anthropogenic radionuclides.

The total beta activity measured in the open water reservoirs in the region is within the range of 0.026 to 0.44 Bq/l, which is 60% below the norm (0.75 Bq/l). For the waters of the Danube river, the maximum measured value is 0.44 Bq/l. The content of tritium is 10 Bq/l. Relatively higher values were measured in the draining channel of the plant. The maximum value of 46 Bq/l is far below the norm for drinking water which is 100 Bq/l.

The analyzed samples of drinking water in the region around Kozloduy NPP show that the total beta-activity varies in the range of 0.034 to 0.69 Bq/l. The content of tritium is in the range of the minimum detectable activity of 6.9 to 13.6 Bq/l. The values are much lower than the admissible levels for drinking water - 2 Bq/l total beta activity and 100 Bq/l for tritium.

Conclusions on water quality in the aspect of radiation

The analysis of the results by total beta-activity for the period January 1999-2008, compared to those of previous years and the analysis performed up and down along the river near the plant, show no trends of radioactive contamination on the river and on the open water bodies in the surveillance zone around the Kozloduy NPP.

Non-radiation state

Monitoring of non-radiation conditions is carried out by the EEA and the Kozloduy NPP, similar to that of the radiological conditions.

Non-radiation conditions under the monitoring of EEA

Under the River Basin Management Plan - RBMP for the Danube region, the Danube in the Bulgarian section is typified as a large sandy river water body code BG1DU000R001.

In MPWB, the Danube in its hydromorphological characteristics is categorized as a heavily modified water body due to the extraction of gravel, corrections and river shipping.

For the control of the water quality of the River Danube in the common Bulgarian-Romanian EEA area is carried out a monitoring for the entire Danube basin from 76 posts. In the international monitoring network 11 points are included, 5 of which on the Danube and the rest – on the tributaries. The examined data on the Danube River are for 10 posts - Novo Selo, Vidin, Lom, Oryahovo, Baikal, Nikopol, Svishtov, before Russe, after Ruse, and Silistra, shown in **Figure 3.3.-12.** The controlled indicators are dissolved oxygen (dissolved O_2), BOD_5, permanganate oxidation (oxidized Mn), ammonium nitrogen (NH_4-N) nitrate nitrogen (NO_3 – N), phosphate (PO_4). The period from January 2002 to June 2004 is examined.

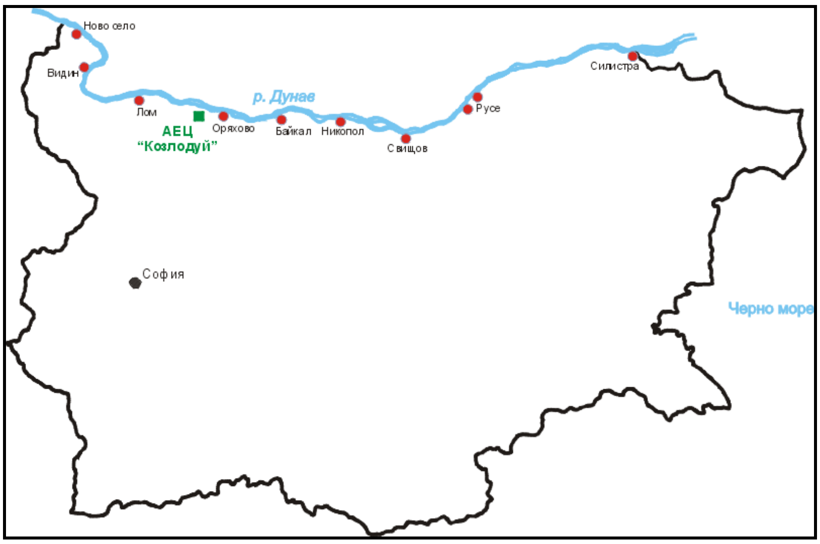


Figure 3.3-10 Map of the points along Danube river

Table 3.3.14 Average annual concentrations

Index	2002	2003	2004
Dissolved oxygen	7 – 17	4.5 – 14.5	5 – 10
BOD_5	1 – 4	1 – 4	2 – 4
Pergamanganate oxidation	2 – 5	2 – 6.5	2 – 8
NH_4 – N	0.01 – 0.1	0.02 – 0.15	0.01 – 0.3
NO_3 – N	0.8 – 3	0.2 – 6	1 – 2
PO_4	0.01 – 0.8	0.01 – 1	0.01 – 0.50

In the next period until 2009 the measurement indexes are in the same order, and the values of the studied indicators are much lower than the limit indicators.
Concentration limits for various categories of water bodies are as follows:

Table 3.3.15 Limit values of concentration for different categories of water bodies

Index (mg/l)	First category	Second category	Third category
Dissolved oxygen (O2)	6	4	2
BOD_5	5	15	25
Pergamanganate oxidation	10	30	40
NH_4 – N	0.1	2	5
NO_3 – N	5	10	20
PO_4	0.2	1	2

The change of water quality in the Danube river is characterized by a weak variation of the measured parameters. The concentration of BOD_5, Mn and nitrate nitrogen under Regulation No. 7/86 [27] on Meeting the Quality of Category I. The dissolved oxygen, ammonium nitrogen (<2 mg / l) and phosphate (<1 mg / l) vary between I and II category. All indicators presented meet the standards for category I and II.

The control of the non-radiation condition around the site of the Kozloduy NPP (from the side of the NPP) is minimal and mainly relates to the HFS of the Kozloduy NPP. In line with the NPP programmes, monitoring of the surface water and wastewater from the HFS is carried out.

In the waters of the Danube, priority substances have not been established - heavy metals and organic pollutants under Directive 2008/105 of the ESS.

The available information on physico-chemical elements for quality became a reason for the ecological status of the Danube to be defined as "moderate."

Based on the above mentioned facts it can be concluded that the characteristics of the surface waters of the Danube in the region of the Kozloduy NPP are determined by the following more important factors: the intensity of the river flow and its seasonal and multiannual sustainability, habitual, industrial and agricultural sources of pollution in the watersheds of the region, correction of the rivers flowing into the Danube River, construction of protective dykes and dams and gravel mining as factors for the hydromorphological condition of the rivers. The emission status of the Danube is dependent on the effective control and management of all countries through the territories of which it passes, and the prevention of risk of accidental pollution mainly in emergency situations from pollutants.

3.4. Lands and soils

The Radiana site is situated in the vicinity of Kozloduy NPP between two roads – a service road, connecting Kozloduy and Kozloduy NPP to the north and second class road No.11 Hurlets – Kozloduy to the south.

Under the Land Commission within the Municipality of Kozloduy, the Rdiana site is in the land of the village of Hurlets UCATTU 77548, municipality of Kozloduy, District of Vratsa. The site is within the 3km radiation protected zone. It stands 3.2 km to the southeast of the regulatory line of Kozloduy, 6.6 km to the southwest of the construction borders of Hurlets and 4.0 km south of the Danube river.

In accordance with the statements of the Regional Forest Directorate, Berkovitsa, ref.No. 13/19/01.06.2009 and the Regional Agriculture Directorate, Vratsa, by type of property the lands under No. 000231, No.000238 are designated „for agricultural purposes". These properties are offered to be included in the state forest fund.

The Radiana site, in accordance with the Land Commission of the Kozloduy municipality, falls under the land properties of Hurlets with UCATTU 77548, municipality of Kozloduy, within the 3 km radiation protected zone of NPP Kozloduy and stands 3.2 km to the southeast from the Kozloduy regulatory line.

The status of the land within the site and its area, according to data from the Detailed geodesic map [409] and information from the municipal office of "Agriculture and Forests" and the Cadastre, Geodesy and Cartography Agency is given in **Table 3.4.1.** The schemes of the properties by type and type of use are given as appendixes.

Table 3.4.1 Status of the properties of the Radiana site and its area

№ of property	Owner	Purpose of use	Type of property	Area, da
000238	SLF	Wood in agriculture lands	Private state property	409,848
000232	Kozloduy municipality	water facilities	Private Municipal property	1,569
000231	SLF	Wood in agriculture lands	Private State property	209,099
000229	MAF-HMS	Irrigation channel	Private State property	32,904
000228	Kozloduy municipality	water facilities	Private Municipal property	0,603
000227	Kozloduy municipality	water facilities	Private Municipal property	1,017
000225	Kozloduy municipality	disputed territory	Municipal property	4,26
000038	Kozloduy municipality	field road	Municipal public property	1,091
000005	Kozloduy municipality	field road	Municipal public property	10,532

The land is predominantly private state land with "State land fund" as owner (61.9 ha). There are also small lots, which are private municipal property (0.74 ha), as well as Municipal public property (1.16 ha).

The investment proposal affects parts of these properties:

- part of property No. 000238 – Private state property, owner – State land fund with purpose of use F= 409,848 da in the «Starite lozya» area

- part of property No. 000231 – – state property, owner – State land fund with purpose of use F= - 209,099 da in the « Starite lozya » area

- part of property No. 000005 with purpose of use – „field road";

part of property No. 000229 with purpose of use – irrigation channel;

- property No. 000225 with purpose of use „sports territory".

In accordance with the statements of the Regional Forest Directorate, Berkovitsa, ref.No. 13/19/01.06.2009 and the Reginal "Agriculture" Directorate, Vratsa, state properties No. 000231, No.000238 are designated "for agricultural purposes". These properties are offered to be included in the state forest fund.

With letter ref. No. 70-275301.10.2010 to the Minister of Agriculture and Forests, SE RAW has deposited a request for the termination of the procedure for the inclusion of properties No. 000231, 000238 in the state forest fund under Council of Ministers Decision No. 683/25.07.2005 and the amendments to the Safe Use of Nuclear Energy Act, according to which NRRAW is a national site under the law for territorial development.

The following facilities are situated on the property:

Power line of 220 kV Buildings and facilities cannot be built and tall vegetation cannot be planted at a distance of 25 meters on both sides to the end conductors or 30 m from the axis of the power line. Long-term plantations must be conserved and operated in accordance with Art.18 of the Ownerhsip and Use of Agericulture Land Act until the end of their useful life.

Characteristics of the condition of soils

The site of the national repository for disposal of low and intermediate level radioactive waste - the subject of an investment proposal from SE "RAW" - Sofia, is available on an area of 36 ha adjacent to the southern boundary of the site of Kozloduy NPP in the land of Hurlets village, municipality of Kozloduy. The distance from the regulation of the village located southeast of it is about 6.6 km, while that of the Danube river – is 4 km. [154, 184-186, 192].

The territory of the selected Radian site is located in the 3-kilometer protected zone that relates to the soil-geographic area of the Danube sub-zone of black soils - Middle Danube province and Danube plains and hilly pre-Balkan sub-zone – Middle Danube plains and hilly pre-Balkan province.

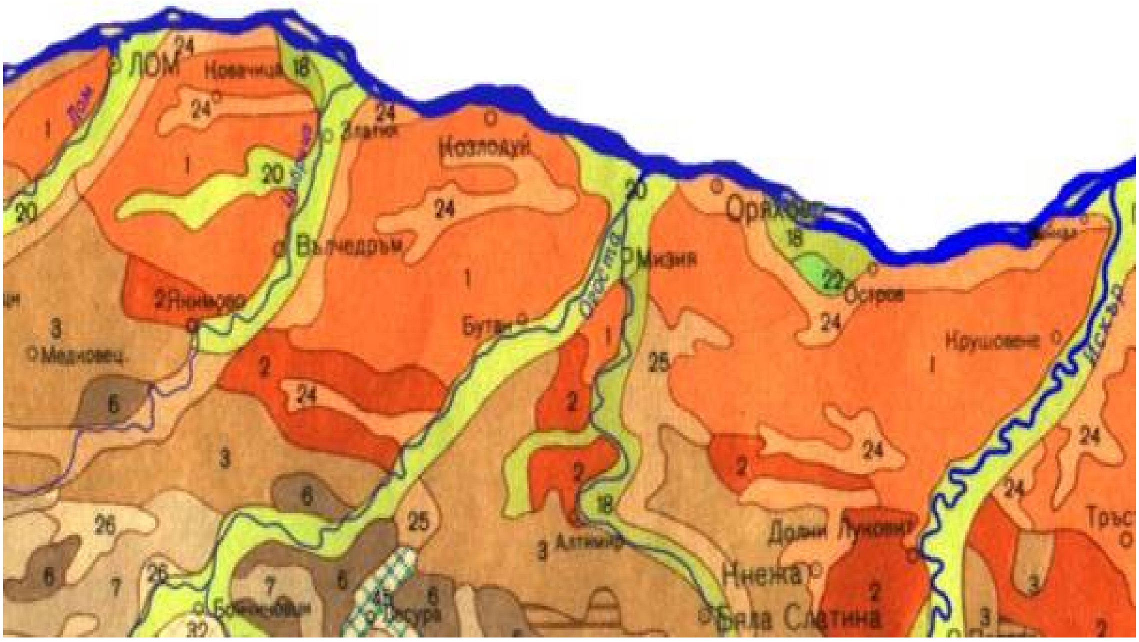
Soils of the project site are within the agri-environmental region of the black soils. The main soil types are carbonate, typical and meadow and alluvial-black soil (deluvial) meadow soils. In relation to the mechanical composition and density black soil are characterized as sandy-clay slightly to severe sand-clay texture with a factor of 2 to 1.3. Alluvial soils are sandy and sandy clay depending on the nature of the sediment material.

As to the rating grouping of soils, they are in the first (land rating grade 80 and over) and second rating group (good land rating 60-80 grade).

In climatic terms, the area falls within the moderate continental climate of the European sub-continental climate characterized by cold winters and hot summers - with absolute maximum temperature of 43.50 C, absolute minimum -35.50 C and 60-70 days per year with temperatures lower than 0^0C, over 30% higher summer rainfall than winter, stable and greater thickness of snow cover, frequent and strong winds.

The main soil formation rocks on which are located mainly sandy clay and sandy clay soils are carbonate materials, conglomerates and sandstones, in lowering and the river terraces - alluvial and deluvial sediments. Vegetation cover is represented mainly by coppice forests of rare hornbeam, flowering ash, oak, acacia, sometimes mixed with conifer crops. From the bushes most commonly hawthorn, raspberry, sloe, thorn, briar, blackberry, etc.

These are the main soil formation factors contributed to the formation of the region’s identified genetic soil types: carbonate black soil - in a wide strip around the Danube, typical black soil - south of carbonate close to the average currents and Ogosta, leached black soil - in higher parts of the territory south of the carbonate and typical, gray forest (usually above 500-800 m) alluvial (deluvial)-meadow soils - Tsibritsa around rivers, and Ogosta and their tributaries and a small part of the eastern part of the ground grassland-marsh. Diversity in gray forest soils as a result of the influence of bedrock and the elementary soil processes is complemented by various degrees of erosion and soil mechanical composition differences [312 – 316].



15 km

Legend:

1 – Carbonate black soil	20 – Alluvial and meadow alluvial
2 – Typical black soil	22 – Pastures and swamps
3 – Leached black soil	24 – Eroded carbonates and typical black soil
6 – Dark gray forest	25 – Eroded used black soil
7 – Gray forest	26 – Eroded gray forest
18 – Meadow black soil	32 – Gray forest

Figure 3.4-1 Typical soils for the area of the Radiana site (Soil resources Agency (http://www.soils-bg.org/soilmap/bul_soils/att/SMUTMBG_2793.html)

Carbonate black soils are distributed in the form of a strip along the Danube. They contain carbonates from 50 cm near the surface of the soil profile and it can be described as Ak-ASA-Bcc. Total power of humus-accumulative horizon between 40 and 80 cm, but the power of the entire account reaches 80-150 cm. They are formed on the basis of loess. Throughout the soil profile were observed loose and active biological activity - roots moves of insects and other miner. The mechanical composition is slightly sandy-clay. Within the boundaries of the soil profile, the mechanical composition is almost homogeneous. The primary minerals are represented mainly by quartz, feldspars and micas. In the Ilov fraction it is kaolinite and montmorillonite. The chemical composition is characterized by free earth carbonates throughout the profile. In the upper horizons, the carbonates are slightly increased in depth. In the loess soil formation decrease. Humus content in arable soils is between 2.5% to 4.5%; in fallow land and common stocks it is high - 80 to 100 t/ha. Abundance of humus nitrogen is high. The nitrogen content in the fallow land is 3-5 t / ha, but its loss forms are few. The content of phosphorus is also high, but less absorbable form. The content of total potassium is also high - 1.5 to 2.5%, but these soils are characterized by favorable potassium regime. Trace elements in these soils are usually in significant quantities, but due to higher amounts of carbonates in their loss forms are few. [233, 234, 311].

Carbonate black soils have good general physical properties and structure, they have little plasticity and can be treated well. The water regime of these soils is not very good, due to persistent droughts in summer and significant unproductive evaporation of moisture.

In terms of productivity of these soils, it could be noted that they possess favorable qualities that emerge in relatively good fertility. It can be enhanced by applying complex melioration events - mineral and organo-mineral fertilization, irrigation, appropriate speed and proper management in terms of the used crops.

With respect to their resistance to pollution, they fall into high-end because of the high amount of carbonates and the relatively high amount of humus. [236].

Typical black soils are relatively less in the area located south of the carbonate black soils and due to the hilly topography and because some of them are eroding. Therefore, the power of the humus horizon and the soil profile are quite different - respectively 50-60 cm and 90-110 cm in non-eroding and slightly eroding and therefore 10-20 cm and 20-50 cm on average and highly eroding. The transition between horizons is gradual. Carbonates is set at 40-50 cm depth, but eroding the surface.

As per mechanical structure, the first ones are moderate - sandy clay in the presence of physical clay (particles smaller than 0,01 mm) between 35 and 55%, the second - light and medium sand - clay 25 - 45% clay.

Preservation with humus, total nitrogen and total phosphorus is low, and average and better potassium. Soil reaction is neutral and alkaline.

Leached black soils are formed mainly on loess, and clayish loess and loess-type sandy clay. Unlike the previous types, they are better designed and have a more powerful and humic horizon soil profile. Their power is respectively 50 and 90 to 80 to 150 cm. Carbonates and other easy-soluble salts are washed at a depth of 80-120 cm – i.e. at the bottom of the transitional horizon. The soil profile is sealed and the transition between horizons is clear.

The total amount of salts (dry residue) is normal - 0.06 to 0.10 percent.

With regards to the sustainability of these soils to chemical pollution because of its neutral to slightly alkaline reaction, they could be attributed to the second and third grade.[233, 234, 236, 311].

Alluvial and alluvial-meadow soils are located in the floodplain and terraces of upper bay of the rivers of Danube, Tsibritsa, Ogosta, Skut, flowing into it and their tributaries. They are formed on the alluvial sediments under the influence of meadow vegetation and groundwater near in winter-spring period. They have loose and well aerated humus horizon and profile in varying degrees humusiran (average 1-3%), whose power is usually between 10 and 40 cm. There are layers of debris underneath, some of which are influenced by soil-formating process, but subsequently flooded and buried. The mechanical composition is extremely diverse, but mostly sandy and clayey-sandy. Soil reaction in almost all cases is neutral to slightly alkaline.

Alluvial (-deluvial)-meadow soils in the region have a powerful medium humus horizon (30-40 cm) and, except for those around the Danube, not a very deep soil profile (up to about 60-70 cm). They are loose, almost structureless or styled with a low and unhealthy trohovidno-grain structure in the surface horizon. In-depth follow non-carbonate or carbonate sand, gravel and sandy clay.

The mechanical structure is lighter - usually clay-sandy, with a physical clay in mild humus horizon from 11.4 to 19.0%.

They are humus poor soils and low stocks, total nitrogen. Values were below 1% and below 0.100%. Soil reaction surface horizon is neutral - pH (N2O) and pH 6.90 (KCl) 5.95. In coming down the soil horizons and layers reaction is slightly alkaline.

With regard to the sustainability of these soils to chemical pollution because of its neutral to slightly alkaline reaction, they could be attributed to the third grade.

Meadow-marsh soils located near the site described, hydro-formed soils are formed under the influence of process and meadow with high groundwater. Typically, water is at a depth of 50-100 cm, but depending on the humidity of the year, it could be deeper or higher. Their carbonates are most frequently from the surface and in depth they are increased. The mechanical composition is heavy and their profile observed gleevi spots. In virgin soil humus content is above 5%, and arable - about 3-4%. The total content of essential nutrients is high. Soil reaction is neutral to slightly alkaline. Sorption capacity of these soils is high and saturation of their bases - is also high. Physico-mechanical properties of the soil is good, but their filter capacity is weak. These soils are naturally set in the "swamp" as the main drainage channel and channel assembly help maintain marching and contamination.

Due to the alkaline reaction of soils and their heavy mechanical composition they may be referred to the third grade of resistance to chemical pollution.

The natural resources (topography, soils and climate) predetermine a typical agricultural area characterized primarily by high performance grain (grain-grain bread and fodder crops), which occupies 40% of arable land. Crops are predominantly wheat, barley and maize. Significant proportion have some industrial crops - 20% of arable land is cultivated sunflower. Vegetables and perennial crops is primarily in private farms. Annually on tobacco-producing area of 3000 ha. Livestock in the municipality is low. The municipality operates Pig in 1000. pigs, which is owned by the Kozloduy NPP. [233, 234, 316].

The total area of agricultural land in the municipality of Kozloduy is now 284833,26 dka. (Including 240248,89 dka - cultivated and uncultivated 44584,37 dka-and uncategorized). The major part of agricultural land in the municipality of the fourth category - 64%, and from third to fifth category including - 79.63%.

The main part of the radiation protection zone of the plant covers agricultural land from the adjacent area. North of the NPP are land area of the "Swamp" in the floodplain terrace of the river, some of which after the construction of drainage network is not marching and are usable. To the east the lands are in the first non-floodplain terrace of the river and higher terraces. Right next to the fence of Kozloduy NPP is business yard of former state farms, which are used by construction companies and warehouse. In the south within the radiation protection zone falls a greenbelt area of coastal and land on loess plateau - the subject of investment proposal and the west is agricultural land except linear projects, communications, heating, etc.. This area includes small areas of residential areas in the eastern town of Kozloduy.

The NRRAW site (In accordance with the statements of the Regional forest directorate, Berkovitsa, ref. № 13г/19/01.06.2009. and letter ref. № 747/26.05.2009 of the Area "Agriculture" Directorate, Vratsa) affects the following properties:

- part of state properties № 000231, №000238 designated „for agricultural purposes", owner SLF.
- part of property № 000005 with purpose of use – „field road";
- part of property № 000229 with purpose of use – irrigation channel;
- property № 000225 with purpose of use „disputed territory".

Radiation protection zones of the site fall into the protective zones of Kozloduy NPP. For those, subject to the site of agricultural lands, a procedure must be held to change their intended purpose under the Act to protect farmland and the Regulations for its implementation. According to the plan of State Forest Fund – Oryahovo from 2006, the proposed site, part of property № 231 includes subdivision of division № 18 of the fund. Part of property № 238 also includes subdivision from div. 18 with tree species older than 15 years. In September 2008 for the real estate № 000231, 000238 a procedure was initiated by SFF - Oryahovo (Letter № 617/06.07.2009 г.)for their inclusion into the forested or self-forested land under the Forestry Act. [192]. In September 2010, the executive director of SE RAW eng. D. Petrov writes a letter to the minister of agriculture and foods with a request not to change their status, so that the procedures of the changing of status if these properties aren't complicated, as in fact they are wood terrains.

Figure 3.4-2 Part of the properties with NTP„Forests in agriculture lands"

Table 3.4.2 shows data for the characteristics of the vegetation on the territory of the Radiana site. From the plan of SFF – Oryahovo it is clear that the lands are carbonate black soil, deep, fresh, rich to average rich, dense, clay, without rock content on the loess. Only one soil in property 238 is of a subdivision 18-ц, where there is a 30 year old plantation of small-leaved lime mixed with mountain ash, maple, birch and maple. The plantation is with a plain relief, 100 m above sea ground, with north exposition. The habitat is categorized as M-I-2, E2 (12) in a plain-hilly sub-belt. The age of the plantations is between 5 and 15 years than those in the table.

Table 3.4.2 Characteristics for the use of lands on the Radiana site

№	Div/Subdivision	Area, ha	Incline,	Species composition	Rating
1	18-и 1	5,1	6°	Acacia	3
2	18-з 1	2,7	9°	Acacia and ash (40 y)	2
3	18-ж 1	1,9	5°	Acacia and ash	3
4	18-о 1	1,0	8°	Acacia, oak, lime and elm	2
5	18-д 1	2,4	8°	Acacia	2
6	18-г 1	0,6	8°	Rowan	2
7	18-п 1	0,9	7°	Acacia	2
8	18-к 1	1,6	5°	Acacia, gledicia	3
9	18-9	0,3	6°	Golin	2
10	18-х	2,8	12°	Summer oak	1
11	18-ц	3,4	2°	Small leaved lime, 30 y	2
12	18-ч	13,1	9°	Acacia, gledicia	2
13	18-ш	2,7	3°	Small leaved lime, 30 y	2
14	18-ю	5,5	9°	Acacia	2

Degraded land and soils and such with known degree of degrading

The Radiana site, envisaged for the building of a national repository for disposal of low and intermediate level radioactive waste (NRRAW) is located adjacent to the southern boundary of Kozloduy NPP and occupies mainly forested and self-forested land, an abandoned concreted basketball court, a field road and an irrigation facility. At the same time, the requirement to develop the EIA report incorporates the presumption of risk of degradation of land and adjacent soils, it is therefore necessary to characterize the current state of soil and take into account the presence of such soils in adjacent lands.

- Eroded soils

In relation to erosion, the land and soils of the protected zone and 30-km zone around Kozloduy NPP within the non-eroded groups, slightly eroded and eroded soil on average. Due to the openness of the terrain and typical northeastern and north winds in the area soils, mainly agricultural land used for annual crops are undergoing deflation mainly in winter, when no plant cover. But these are the soil of agricultural land outside the site. Water erosion is important for them during the spring and autumn when more intense rainfall falls. Common in some parts of the region are hailstorms. On the woodland on the site of "Radiana" these processes have no significant impact. If the tree covers on the bushes most of the site after construction of the facility is restored, erosion will not have any negative impact on both the site and its adjacent lands.

- Oxygenated, dampened and swampy soils

In the area of the alleged impact of the site of "Radiana", there are no oxygenated soils, because the genetic soil types are naturally alkaline, slightly alkaline or neutral reaction.

Dampening or swampy processes are not observed, either. On them there is no noticeably pre-compaction, leading to deterioration of the density and their filtration qualities. The exception is the area "Blatoto", where pre-damping and swampy processes are observed as well as soils contaminated with debris, but it is too remote from the site. Swamping here is caused by natural processes of influence of the Danube and its tributaries as the site is located in the lowest part of the Kozloduy plane built by loess sediments and loess-type and filled with carbonate sediments deluvial from neighboring lands and river slopes. With regard to the swamping, the soil fertility is low. North, south, southwest and southeast of the "Blatoto" area are situated chernozem carbonates, medium powerful, with significantly better water-physical characteristics and higher fertility. [185, 186, 190].

Contaminated lands and soils [162], [163], [364], [365], [366]

Lands in the 3 km zone of Kozloduy NPP, including the site "Radiana", is envisaged for the building of a national repository for disposal of low and intermediate level radioactive waste (NRRAW). They may be contaminated by radioactive elements, heavy metals, petroleum products, pesticides, concentration of large quantities of organic waste on small areas, mineral fertilizers and others.

A summary of the survey data in connection with the preparation of EIA report of Kozloduy NPP in 1999 and data from other administrative and scientific institutions shows the following:

- Contaminated lands and radioactive elements

The radioactivity of the soils in the area of NPP Kozloduy has been subject to detailed and systematic monitoring by the plant since 1974. The interest in the radiation status of the soils is that they are an ecological seal of time and give valuable information for the history and origin of the radioactive contamination.

In a 100 km radius of the monitored zone, soil sampling takes place for analyzing more than 36 control posts. The soil sampling is done in the vicinity of the control posts, preferably from non arable terrains.

A main object of interest is the content of long-living Technogenic radionuclides with strong radiation toxicity, typical for BBEP reactors – ^{137}Cs, ^{134}Cs, ^{90}Sr and others. The results are verified annually with research from parallel programmes of the MEW and NCRRP (MH).

The minimal detectable activity /MDA/ for ^{137}Cs, which can be defined during the used methods and the conditions for measurement vary in the range $0.36 \div 0.69$ Bq/kg a.d.w. The value of MDA when defining the content of ^{90}Sr is 0.25 Bq/kg a.d.w. on average.

In the EIA report of Kozloduy NPP in 1999 are summarized data from various studies on soil samples performed before 1989 and after that period, but the authors have done their own research and as samples were analyzed in three laboratories. Because the country has no standardized methods for the establishment of radioactive contamination in soils, results are somewhat different. However, these results allow conclusions to be drawn to give an idea of the state of the radioactive background of the soil near a nuclear power plant within 30 km zone around it. The data from the research during the years of construction of the plant 1974 – 2008 show negligible change in the radiation background in the 100 km radiation protection zone.:

– In three of those surveyed in NIPA soil samples taken near the SPA of Kozloduy NPP marked detectable Co-60 levels. Average levels of Cs-137 in the samples examined was 31 ± 18 Vq / kg (60%), the result testifies to the absence of additional deposition of radionuclide studies, as a result of the operation of the Kozloduy nuclear power plant or transboundary.

– It is established that the old pollution in the area of the drainage channel north of the plant, is due to the discharge of wastewater from nuclear containing radionuclides to the BPC in 1994.

– The results of laboratory gamma-spectrometric analysis of samples of earth and bottom sediment from drainage ditches at the bottom of the dry channel at a distance of 100 tons of south end of the reclaimed area and its channel since reclaimed area show very high levels of Cs-137 - Vq 15563/kg (sample 2) and 9954 Vq/kg (sample 1) and significant levels of Co-60. The presence of other anthropogenic radionuclides Cs-134 and Am-241 have been permanently increased to averages. The specific activity of natural radionuclides U-238, Ra-226 Th-232, K-40 and Pb-210 is a low background value, characteristic of soils in this region. The presence of high activity of technogenic radionuclides in bottom sediments may lead to contamination of soil in any dispersal and atomization of excavated bottom sediments. Likelihood of such a project after the performances for the treatment of contaminated earth and reclamation conducted in 1999 was minimal, but exists in relation to any other untreated some small quantities of earth around the canals. With reclamation provided by shrubs or other suitable plant species with shallow root system is strengthened and protected from wind erosion soil layer affixed buried contaminated with radionuclides spoils.

– Data from EIA (2000) showed minor changes in the radioactivity of soils in the area. Some modifications were found in bottom sediments from drainage channels and the bottom of the dry channel. In recent years, no new contamination occurred as a result of emergency or uncontrolled releases of materials containing technogenic radionuclides over the rules. It is necessary to fully implement measures to decontamination, reclamation and control of all land (earth) around the sites of old contamination.

– Additional data presented for the period 1999 - 2003 by Directorate Safety and Quality - Management of Safety, Division Radioecological Monitoring - RM Unit Directorate B and C in a 100 km zone of Kozloduy NPP

– **Table 3.4.3** shows that results are commensurate with the recorded data from previous years, but tend to decrease technogenic activity in the samples examined in the region of Kozloduy. The department of "Radioecological Monitoring" at Kozloduy NPP believes that the overall activity of technogenic radio-cesium and strontium is due to cross contamination due to "Chernobyl" accident and nuclear testing in the 50 years of 20 century [148, 159, 161-163, 190].

Table 3.4.3 Summarized results of the measurements of the radioactivity of the soil samples in the 100 km zone of Kozloduy NPP,1999 – 2003

year	Measurement results								
	Radiometry						γ-spectrometry ^{137}Cs		
	total β-radioactivity			^{90}Sr					
	min	max	avg	min	max	avg	min	max	avg
1999	-	-	-	0.51	5.81	2.00	1.74	48.42	25.49
2000	-	-	-	0.25	3.49	1.30	2.99	75.21	25.14
2001	-	-	-	1.10	4.10	2.23	2.28	82.36	23.77
2002	-	-	-	0.33	1.86	1.28	<0.42	58.30	19.71
2003	-	-	-	1.48	5.39	2.41	2.37	54.24	19.89

The calculated results refer to soils:

Sr-90 Posts №: 28,29,30 and radiuses - I, II, III, IV and V

γ-spectrometry of posts № 1,2,4 and 5 to 30

Data was obtained from the processing of samples from three separate areas of monitoring the environment within a radius of 100 km around the plant where there are 36 control points established. For the analysis of samples were used standardized and validated in our and foreign practice methods such as gamma spectrometry, low-background radiometry of common beta activity and radiochemical isolated radio-strontium and more. The results of factory monitoring radiation annually verified by concurrent radio-ecological research programmes and MEW NCRRP (MH).

The results of the total beta activity of atmospheric deposition in the 36 control points in areas around nuclear observations vary in the range 0,025 - 4,3 Bq/(m2.d) at an average annual rate 0,48 Bq/(m2.d) and did not differ from those of previous years. These data do not differ notably from the average insurance, which means that air radioactive background of the soil is not raised.

The measured activity of Cs-137 in soils from 36 control posts in the range of 1.7 to 82 Bq/kg dry soil. Some samples were measured minimum activities of other anthropogenic radionuclides - Cs-134 Co-60, Sr-90 - 1 boundaries in 1÷6 Bq/kg. The results are comparable with data recorded from previous years, but tend to decrease technogenic activity in the samples examined in the vicinity of NPP.

The summarized data from the soil monitoring from later research are shown in **Table 3.4.4**. They show that:

- ➢ The results are comparable as a whole, to those from previous years.
- ➢ The technogenic activity is due to a transboundary transmission (Chernobyl) as well as from nuclear weapons testing.
- ➢ No influence on the soils in the area has been registered as a result from the NPP's activity.

Table 3.4.4 Summarized data from the soil monitoring, 2008

<u>Soils</u>	✓ Sampling from 36 control posts in 100 km radius ✓ Taken : **72 samples** with **86 analyzes** */72 gamma – spectrometry and 14 radio-chemical with Sr isolation/* **RESULTS** ✓ Activity of ^{137}Cs in the range of 1.53 ÷ 48.5 Bq/kg a.d.w. ✓ Activity of ^{90}Sr in the range of 0.37 ÷ 3.51 Bq/kg a.d.w.

The data from the self-monitoring of the NPP for the activity of ^{137}Cs are atmospheric residues **(Bq/m^2*d)** from the control posts from the site and the 100 km radiation protection zone for 2008 are presented graphically in **Figure 3.4-3**.

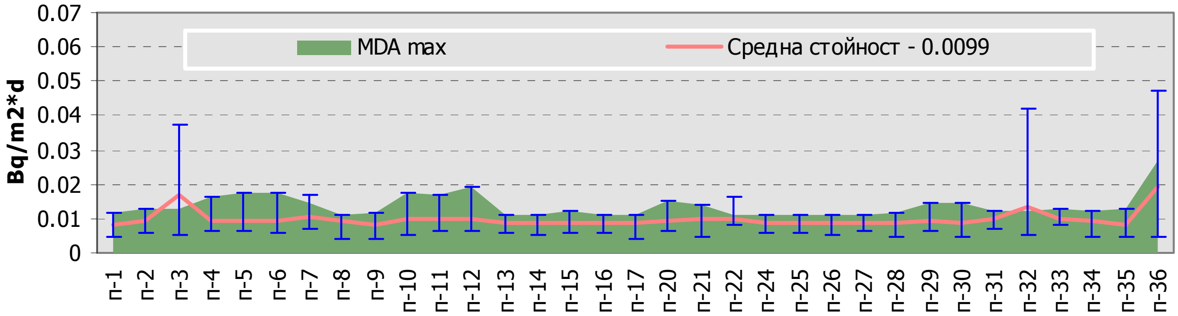


Figure 3.4-3 Activity of ^{137}Cs atmospherioc residues (Bq/m^2*d) from the control posts from the site and the 100 km radiation protection zone, 2008

The maximum value of the measured activity of ^{137}Cs is 0.047 Bq/(m^2.d) in post-36 during October 2008. In the same sample, the isotope maximum has been measured ^{134}Cs: 0.020 Bq/(m^2.d). Despite the relatively small levels of activity, the ratios of the isotopes of radiocesium ^{134}Cs/^{137}Cs in this and other samples from post-36, shows a recent contamination source from Kozloduy NPP. Similar values of ^{137}Cs have been measured in post-3 and 32 (up to 0.037, 0.042 Bq/(m^2.d) respectively). The above background activity of ^{60}Co: 0.015 Bq/(m^2.d) has been measured In post-3, in august 2008. Technogenic radionuclides in the atmospheric residues from the mentioned posts have been registered before. In past years, the maximum concentration of ^{137}Cs from post-32 have been measured in April 1994 г. – 2.88 Bq/(m^2.d) and march 2000 – 2.07 Bq/(m^2.d). A possible reason is a wind transition of contaminated with radionuclide particles earth masses and dust, which fell into the sampling device.

In the rest of the posts on the site and the 100 km protective zone, no technogenic radionuclides have been detected.

Figure 3.4-4 shows the average values from the long-term research of the content of ^{90}Sr and ^{137}Cs in soils in the area of Kozloduy NPP.

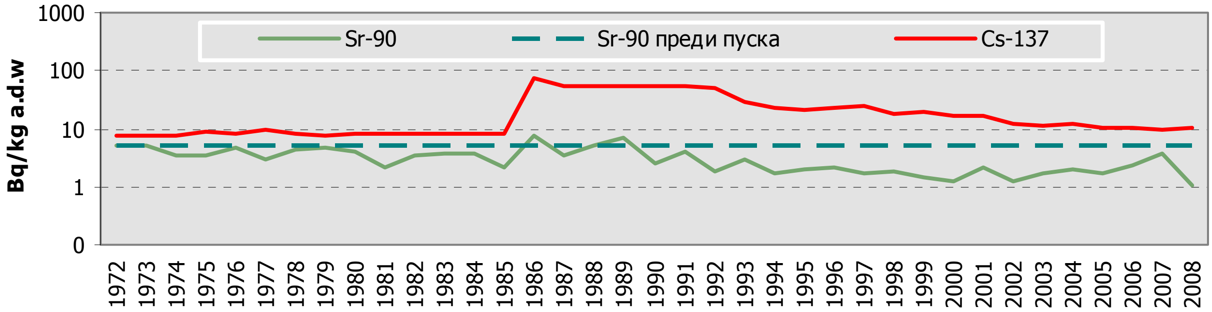


Figure 3.4-4 Radioactivity of soils (Bq/kg a.d.w) in the 3km radiation protected zone around Kozloduy NPP, 1974 – 2008.

From this data, the following conclusion can be made:

The above background technogenic radioactivity has been measured only in post-3, 32 and 36 of the NPP site. As a whole, the radioactivity of the atmospheric residues in a 100 km radius is in the normal range and hasn't been influenced by the exploitation of NPP Kozloduy.

There is no registered distortion or change of land categories, depending on the radioactive contamination, and no damage to the soil or change in soil fertility observed by self-monitoring of plant and control by state authorities area around Kozloduy. The fact that soil and air are not affected by radioactive contamination from the plant, the survey data and food derived from the region also indicates the absence of influence of the Kozloduy nuclear power plant on them.

The comparing of data for 1974-2008, with those from previous years and received before the commissioning of the plant, shows the absence of adverse trends in the radiation environment and the ecological status of soils in the 100 km zone around the Kozloduy NPP, resulting from the operation of plant. [148, 159, 161-163, 190, data from the monitoring of NPP].

- Lands contaminated by heavy metals

Samples analyzed in relation to the development of "Ecological model of the Municipality of Kozloduy" show a relatively good picture of the state of pollution in the municipality by different industrial activities, including Kozloduy NPP. As sources of pollution are marked, apart from the nuclear power plant, the concrete plant, a construction company, asphalt and ceramic factory, gas field and industrial company in the city of Mizia, which because of the windy characteristic are directly influencing the relevant territory. The EIA report indicates that the area investigated in connection with the NPP is contaminated as follows:

– There is increased air pollution with dust around some enterprises;

– There are lead-contaminated soils around the the villages of Glozhene, Hurlets, Butan (farmyard and gas field) within the town of Kozloduy, along Ogosta River and the southern boundary of the Municipality of Kozloduy;

– There are high excessive amounts of lead, copper and zinc in the soil near MTF-Glozhene due to the motor vehicles - tractors, trucks and agricultural equipment. The case is isolated and atypical (unrepresentative) for the region;

– The content of manganese in soil samples tested in the limit of clark concentration of 850 mg/kg, 4 times as deviations above the background content near Glozhene and Sofronievo, from along the Ogosta river and garage of Kozloduy NPP.

The recorded amounts of certain heavy metals such as copper, lead and etc. are not associated with the activity of the Kozloduy NPP. Recorded higher levels of copper in some agricultural areas of Vratsa region most likely related to the use of copper-content preparations for spraying vineyards and other crops (of 31 agricultural array plantations established in 23 higher concentrations of copper and zinc).

The data in **Table 3.4.5** show the specific contamination with heavy metals in the region of Kozloduy NPP, analyzed in EIAR. [159, 160].

Table 3.4.5 Content of heavy metals and metalloids in soil samples (mg/kg) in 30-km zone of Kozloduy NPP

Sample №	pH	Cu		Pb		Zn		Ni		Hg		As		Cd		Cr		Mn	Co	Fe	B
		result	TLV	result	TLV	result	TLV	result	TLV	result	TLV	result	TLV	result	TLV	result	TLV	result	result	result	result
1	6.9	28.950	<260	20.408	<80	60513	<340	27.765	70	-	-	-		residue	3.0	-	-	320.123	7.831	745.610	-
2"	7.2	21.244	<270	18.070	<80	32.695	<360	28.814	70	-	-	-	-	residue	-3.0	-	-	293.270	6.837	760.402	-
4*	7.0	18.929	<260	23.481	<80	44.566	<340	32Л07	70	-	-	-	-	residue	3.0	-	-	298.304	7.188	751.390	-
5*	7.0	20.747	<260	21.850	<80	37.080	<340	26.927	70	0.232	1	8.6	29-55	residue	3.0	-	-	278.317	7.504	689.503	-
6	7.0	17.705	<260	18.548	<80	30.773	<340	24.871	70	-	-	5.98	25	residue	3.0	23.3	200	265.366	6.323	660.990	36.7
7-	7.0	18.031	<260	21.930	<80	41.910	<340	26.072	70	-	-	-	-	residue	3.0	-	-	280.458	7.066	1561.89	35.6
8	7.0	18.689	<260	20.678	<80	32.607	<340	25.052	70	-	-	0.2	25	residue	3.0	-	-	259.066	7.158	624.304	-
9	6.8	35.413	<260	47.217	<80	57.515	<340	26.874	70	-	-	-	-	residue	3.0	-	-	322.986	8.037	787.121	39.5
10	7.3	20.583	<270	19.142	<8()	36.226	<360	31.286	70	0.412	1	10.3	25	residue	3.0	-	-	279.722	8.645	645.892	-
11	7.5	22.533	<270	21.347	<80	39.611	<360	30.123	70	-	-	-	-	residue	3.0	34.0	200	312.381	8.776	744.307	52.0
12	7.3	17.735	<270	32.711	<80	53.992	<360	23.252	70	-	-	-	-	0.197	3.0	-	-	262.868	5.518	609.285	-
13	7.0	22.001	<260	22.719	<80	38.741	<340	28.219	70	-	-	-	-	residue	3.0	-	-	306.103	8.370	749.474	-
H	7.0	16.858	<260	21.639	<80	36.987	<340	22.142	70	-	-	-	-	residue	3.0	-	-	256.894	5.787	772.192	-
15	8.0	17.200	<280	10.500	<80	43.700	360	21.000	70	1.350	1	4.4	25	.0.440	3.0	23.6	200	335.000	2.800	-	37.1
14'	-	--	-	-	-	-	-	-	-	1.040	1	-	-	-	-	-	-	-	-	-	-
15'	-	-	-	-	-	-	-	-	-	0.810	1	-	-	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-	-	0.602	1	-	-	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-	-	<0.050	1	-	-	-	-	-	•	-	-	-	-

Note: Samples with an asterisk (*) – Nos.: 2, 4, 5 and 7 fall within the NPP site and are regarded as representative of non-agricultural land, i.e. as land with old pollution from industrial enterprises (by the standards of "Dutch List").

- Petroleum contaminated land

Data from the research team, which examined the soils in the region of Kozloduy NPP in relation to the EIAR, indicate that pollution with oil products does not differ from what is seen in one way or another about any industrial enterprise at any industrial facility which is controlled by self-monitoring system and by the state control authorities.

The authors of the EIA report on the Kozloduy NPP in 2000 have studied the salt content in soils. The chemical analysis found that their conductivity is not more than 4.0 mS/cm, indicating that the soil is within the zero class as per saltiness (0 to 4 dS/m). In general, soil contamination with petroleum products in the region of the Kozloduy nuclear power plant is minimal and does not differ from that of any industrial facility, which is controlled by self-monitoring system and by state control authorities. [148, 152].

Conclusions:

The soils around the site of the national repository for disposal of low and intermediate level radioactive waste - the subject of an investment proposal from SE "RAW" (Radiana) are typical for the region - carbonate, typical and meadow and alluvial-black soil (deluvial-) meadow soils. Overall, they are heavily influenced by industrial activity;

The soils at the site of Radiana are not noticeably affected by radioactive contamination due to the activity of the Kozloduy NPP.

The land at the site of Radiana which is to be disturbed in connection with the construction of the national repository for disposal of low and intermediate level radioactive waste is agricultural in the context of such used in agriculture. The land is mostly forested land or self-forested, sports facilities, field road and irrigation facility. Of ecological value are only those with tree and shrub vegetation on them.

3.5. Biodiversity. Delicate territories.

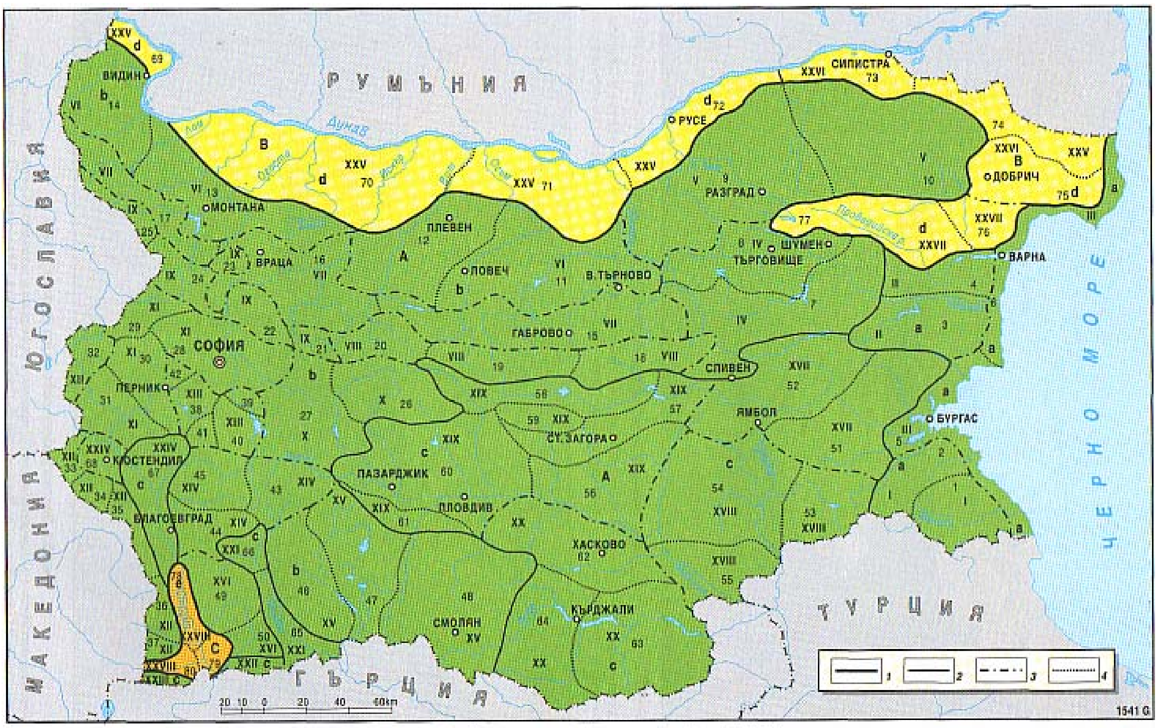
As a technology, the process of storing RAW in NRRAW does not involve a risk of gas leak in the atmosphere or the water, both in normal and emergency situations.

3.5.1. Vegetation

By the geo-botanical area division, Geography of Bulgaria, 2002 [274], NRRAW „Radiana" is near the river Danube, the north boundary of the Republic of Bulgaria, ***The Euro-Asiatic steppe and Euro-Asiatic forest steppe areas, (fig. 3.5-1, B) the Downstream Danube province (fig. 3.5.1, d), The Near Danube area (fig. 3.5-1, XXV):***

- Zlatiyski area (fig. 3.5-1 XXV-70), which takes up the land westwards from Lom to the downstream of the river Vit. In the past, the woods were formed of Quercus virgilliana and Q. pubescens – today there are:

- Remains of woods with mainly Fraxinus ornus, more rarely Q. cerris and Q. pubescens;
- In places there are artificially planted acacia - Robinia pseudoacacia;
- The steppe types are most common - Camphorosma monspeliaca, Potentilla pirotensis, Chamaecytisus danubialis;



Геоботаническо райониране (по Бондев, 1997).
1 – области (A, B, C); 2 – провинции (a, b, c, d, e); 3 – окръзи (I-XXVIII); 4 – райони (1-80).

Fig.3.5-1 Geobotanical area division in Bulgaria

The vegetation in the different parts of the "Radiana" - tunnel type NRRAW site, consists of different plants with various area dominance, depending on the specific environmental and climatical conditions as follow:

- **In wet terrains near the river Danube the water plants are widely populated:**

Ranunculaceae family: Ranunculus aqualilis, Ranunculus penicillatus, Ranunculus trichophyllus;

Polygonaceae family: Persicaria amphibia;

Haloragaceae family: Myriophyllum spicatum, Myriophyllum verticillatum,

Apiaceae family: Oenanthe aquatica;

Callitrichaceae family: Callitriche cophocarpa, Callitriche platycarpa;

Butomaceae family: Butomus umbellatus;

Alismataceae family: Alisma plantago-aquatica; Alisma lanceolatum, Alisma gramineum, Sagittaria sagittifolia;

Juncaginaceae family: Triglochin palustris;

Potamogetonaceae family: Potamogeton crispus, Potamogeton natans;

Zannichelliaceae family: Zannichellia palustris;

Najadaceae family: Najas minor;

Iridaceae family: Iris pseudacorus;

Cyperaceae family: Bolboschoenus maritimus; Eleocharis palustris; Schoenoplectus tabememontanii;

Poaceae family: Phragmites australis;

Lemnaceae family: Lemna minor, Lemna minor, Lemna trisulc;

Sparganiaceae family: Sparganium erectum;

Typhaceae family: Typha angustifolia, Typha latifolia.

- **In the antropogenically busy parts of the terrain (urbanized area and other parts in the industrial zone of NPP "Kozloduy" the following ruder plants are widely populated:**

Equisetaceae family: Equisetum arvense;

Ranunculaceae family: Ranunculus repens;

Papaveraceae family: Chelidonium majus ;

Portulacaceae family: Portulaca oleracea;

Caryophyllaceae family: Arenaria serpyllifolia, Silene alba , Stellaria media;

Chenopodiaceae family: Atriplex patula, Atriplex nitens , Chenopodium bonus-henricus, Persicaria lapathifolia , Polygonum aviculare, Rumex obtusifolius, Rumex acetosella ;

Clusiaceae family: Hypericum perforatum ;

Brassicaceae family: Capsella bursa-pastoris, Cardaria draba, Lepidium ruderale , Lepidium campestre, Sinapis arvensis, Sisymbrium altissimum , Sisymbrium officinale

Malvaceae family: Malva neglecta, Malva sylvestris ;

Urticaceae family: Urtica dioica;

Euphorbiaceae family: Euphorbia cyparissias;.

Rosaceae family: Potentilla reptans;

Onargaceae family: Oenothera biennis ;

Fabaceae family: Medicago lupulina, Vicia hirsuta ;

Geraniaceae family: Geranium molle ;

Apiaceae family: Daucus carota, Chaerophyllum temulentum , Chaerophyllum bulbosum , Pastinaca sativa;

Dipsacaceae family: Dipsacus fullonum ;

Solanaceae family: Hyoscyamus niger, Datura stramonium, Solanum dulcamara, Solanum nigrum;

Convolvulaceae family: Convolvulus arvensis;

Boraginaceae family: Anchusa officinalis, Cynoglossum officinale , Echium vulgare;

Scrophulariaceae family: Linaria vulgaris;

Globulariaceae family: Veronica persica;

Plantaginaceae family: Plantago major ;

Asteraceae family: Arctium minus, Arctium lappa, ArteMizia absinthium , ArteMizia annua , Carduus nutans , Cirsium arvense, Lactuca serriola , Lapsana communis, Senecio vulgaris, Tanacetum vulgare, Tussilago farfara Tragopogon pratensis Xanthium strumarium , Cichorium inthybus;

Cyperaceae family: Carex hirta;

Poaceae family: Agrostis canina , Bromus tectorum, Bromus sterillis, Hordeum murinum, Poa amnua, Taraxacum officinale, Xeranthemum annuum

- **In the steep forestry area of the site, there is a wide population of the following forest plants:**

Aspleniaceae family: Phyllitis scolopendrium;

Dennstaedtiaceae family: Pteridium aquilinum;

Athyriaceae family: Athyrium filix-femina;

Aspidiaceae family: Dryopteris carthusiana, Dryopteris filix-mas;

Aristolochiaceae family: Aconitum lycoctonum; Actaea spicala, Anemone nemorosa

Сем Ranunculaceae family: Clematis vitalba, Hepatica nobilis;

Hypecoaceae family: Corydalis bulbosa;

Caryophyllaceae family: Stellaria holostea;

Fagaceae family: Quercus cerris, Quercus robur;

Сем.Betulaceae family: Carpinus betulus;

Pyrolaceae family: Orthilia secunda;

Primulaceae family: Cyclamen hederifolium;

Violaceae family: Viola hirta, Viola reichenbachiana, Viola odorata;

Salicaceae family: Populus tremula, Salix caprea, Salix cinerea;

Brassicaceae family: Lunaria rediviva;

Cannabaceae family: Humulus lupulus;

Euphorbiaceae family: Mercurialis perennis;

Rosaceae family: Agrimonia eupatoria, Amelanchier ovalis, Cotoneaster integerrimus, Crataegus monogina, Fragaria vesca, Geum urbanum, Rubus idaeus, Rosa gallica, Rosa canina, Rubus caesius, Sorbus aucuparia;

Onagraceae family: Epilobium angustifolium;

Fabaceae family: Lathyrus sylvestris;

Aceraceae family: Acer platanoides, Acer campestre;

Oxalidaceae family: Oxalis acetosella;

Celastraceae family: Euonymus europaea;

Geraniaceae family: Geranium sanguineum, Geranium robertianum;

Balsaminaceae family: Impatiens noli-tangere;

Cornaceae family: Cornus sanguinea;

Apiaceae family: Sanicula europaea, Lonicera xylosteum;

Caprifoliaceae family: Sambucus nigra, Vibumum lantana;

Rubiaceae family: Galium odoratum;

Oleaceae family: Fraxinus excelsior, Ligustrum vulgare;

Boraginaceae family: Myosotis sylvatica; Pulmonaria officinalis;

Scrophulariaceae family: Melampyrum sylvaticum, Scrophularia nodosa;

Verbenaceae family: Glechoma hederacea, Lamium maculatum, Teucrium scordium;

Asteraceae family: Solidago virga-aurea;

Liliaceae family: Lilium martagon;

Convallariaceae family: Polygonatum odoratum;

Trilliaceae family: Paris quadrifolia, Orchis mascula;

Juncaceae family: Luzula sylvatica;

Cyperaceae family: Scirpus sylvaticus;

Poaceae family: Poa nemoralis, Melica uniflora;

Araceae family: Arum maculatum;

- ***The part proposed from property № 231 of the tunnel type NRRAW site, under the Forestry planning project of SFA "Oriahovo" (state forestry agency), 2006, includes under section 18 the following tree vegetation:***

  Subsection „и 1", 5,1 ha , 11 year old acacia;

  Subsection „з 1", 2,7 ha , 11 year old acacia and 40 years old ash;

  Subsection „ж 1", 1,9 ha , 10 year old acacia;

  Subsection „е 1", 1,0 ha , 15 year old oak, 6 year old acacia;

  Subsection „д 1", 2,4 ha , acacia and 13 year old;

  Subsection „г 1", 0,6 ha , 13 year old sophora;

  Subsection „в 1", 0,9 ha , 5 year old acacia and gleditsia;

  Subsection „9", 0,3 ha , goline;

  Subsection „к 1", 5,1 ha , 6 year old acacia;

- ***The part proposed from property № 238 of the tunnel type NRRAW site, under the Forestry planning project of SFA "Oriahovo" (state forestry agency), 2006, includes under section 18 the following tree vegetation:***

  Subsection „х", 15 year old oak;

  Subsection „ц", 30 year old tilia, ash, acer, birch, maple;

  Subsection „ч", 5 year old acacia;

  Subsection „ш", 30 year old tilia, ash, acer, walnut, acacia;

  Subsection „ю", 7 year old acacia;

  Through the two properties pass 3,6 ha of electrical power transmission;

In September 2008 a procedure for ingress into a forestry fund of afforested or self-afforested land has been conducted for lands No. 00231 and No. 000238 by the SFA – Oriahovo in compliance with the Forestry act. A procedure (taxation characterization and change of purpose) is to be conducted in the next stage under the Forestry act and its Rules of application [192]

On the territory of the investment proposal no protected species were found by the Red book or the environmental protection law. The negative effects over the vegetation, inflicted by the NRRAW will be insignificant, or caused by emergency situations.

According to the annual report on radiation monitoring of the environment around Kozloduy Npp in 2008 [367], the vegetation (grass) has been studied four times each year at the stations at Kozloduy, Hurletz and Oriahovo (gama-spectrometry and ^{90}Sr) two times each year on the NPP site (gama-spectrometry) and at stations at Lom, Pleven and Berkovitza (gama-spectrometry, ^{90}Sr once a year).

18 samples, colected form a 100 kilometer observation area were analyzed in 2008. 30 analyses were performed altogether – 18 gama-spectrometrical and 12 radiochemical isolations of strontium. Figure 3.5-2 shows the results for ^{90}Sr activity in the vegetation 100 kilometers around during 2008.

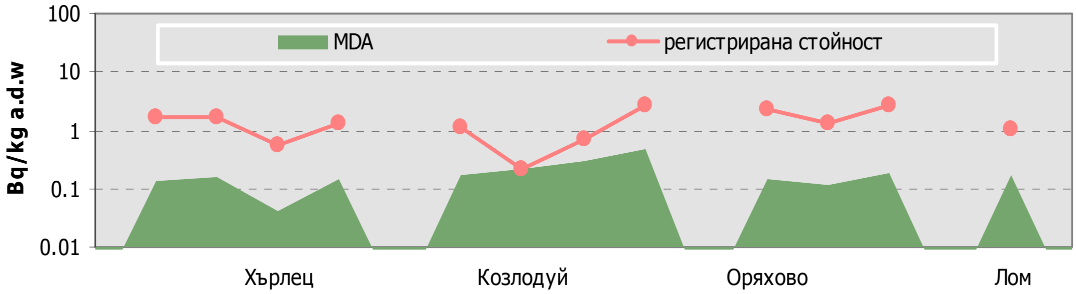


Figure 3.5-2 Activity of ^{90}Sr (Bq/kg a.d.w.) in the vegetation 100 kilometers around NPP "Kozloduy" 2008

Results for the ^{90}Sr content in the vegetation in 2008 are within the limits of <0.22 ÷ 2.78 Bq/kg a.d.w, the average amount is 1.45 Bq/kg a.d.w. Results are comparable with those of previous years. The maximum amount was recorded at site 27 (Oriahovo). The observed differences are caused by the different types of vegetation over the years and the different season. For example, during long dry periods it is impossible to gather samples from fresh grass, and because of that samples are usually taken from dry vegetation (stems) that contain more cellulose.

Long-term studies of ^{90}Sr in the vegetation 100 kilometers around are 4.4 ÷ 0.3 Bq/kg a.d.w.shown in Figure 3.5.-3. Before the start of operation of Kozloduy NPP the average activity levels were.

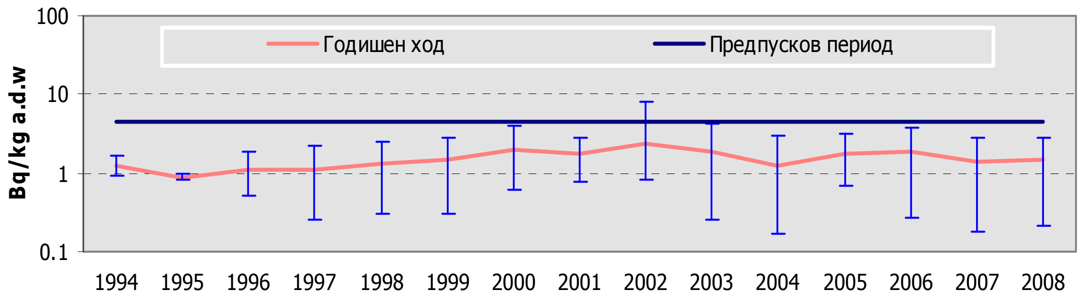


Figure 3.5-3 Activity of ^{90}Sr (Bq/kg a.d.w.) in the vegetation 100 kilometers around Kozloduy NPP 1994-2008

The activity of ^{137}Cs in the vegetation in 2008 is within the <0.74 ÷ 4.48 Bq/kg a.d.w limits. The maximum amount was recorded at site 13. All the samples, including those gathered from the industrial site have shown results for ^{54}Mn, ^{60}Co and ^{134}Cs lower form their respective maximum allowances.

The radionuclide pollution of the vegetation in the area was caused by the Chernobyl accident, according to the environmental protection programme of Kozloduy municipality for the 2004-2010 period. The values, defined by the frames of the radiation ecological monitoring programme of Kozloduy NPP for 2008 for vegetation samples in the area, mainly grass, are as follow: <0.74÷4.48 Bq/kg a.d.w за ^{137}Cs and <0.22÷2.78 Bq/kg a.d.w за ^{90}Sr. They correspond to the results of previous years (1994-2007.).

The agricultural production in the area around the Radiana site is represented by common grain-forage crops – barley, wheat, corn, sunflower. The results from radio-ecological monitoring, carried out by Kozloduy NPP show normal radionuclide values in agricultural produce from the areas closest to the plant (3 km away). The radionuclide values for 2008 compared to those of previous years are as follow: for ^{137}Cs from <0,20 to <3,25 Bq/kg a.d.w, за ^{90}Sr <0,043÷1,7 Bq/kg a.d.w, and the total beta activity is caused almost entirely by the natural ^{40}K.

CONCLUSION:

Radioactivity in the samples studied is within the admissible limits for these plant species. No impact on vegetation from the NPP has been observed.

No significant effects on the vegetation, including agricultural produce, are expected in case of the realization of the investment proposal, since NRRAW will be planned and built in accordance with the safety requirements, stated in the IANE norm and recommendations base, and by applying the principle for in-depth protection and building the NRRAW as a multibarrier engineering facility, preventing the radionuclide pollution of the environment, as well as exploitation of the facility, in accordance with the principles and rules for safe management of radioactive waste sites. In the text below, the expected effects on the flora during the period of building, exploitation and decommissioning of NRRAW will be analyzed and evaluated..

Given the above circumstances, there is no reason to state, that because of the operation and re-cultivation of the facility, biodiversity in that part of the country will suffer irreparable damage; that will not lead to distortion of existing habitats and to the extinction of rare or endangered species.

The analysis and expected impact of the construction, operation and closure of NRRAW on the flora can be found in Part 4.3 of this EIAR,

3.5.2. Animal wildlife

Under the zoo-geographical area division, the IP falls under the Eurosiberian subarea, (Georgiev, 979, 1982) Danube region (A.L.). The Danube region consists of the Danube plains, the Ludogorie and parts of the Dobrudzha highland (excluding the seaside) [290].

The chosen site stands about 6,000m north-westward of the building borders of the village of Hurlets and about 3,200m southeastward of the regulatory line of the town of Kozloduy, as well as 4,000m south of the river Danube. From the north, the lot is restricted by the controlled territory of Kozloduy NPP. The slope of the terrain is from 7^0 to 15^0. The altitude of the site of the IP is between 35 and 105 meters.

The landscape in the region of the site, selected among the alternatives, is flat, but it is also placated in certain parts, for instance the dry river bed, where, in the southern slope, the repository for short-lifespan low-and intermediary level RAW will be constructed.

The main part of Kozloduy NPP takes up mainly agro-landscape and partly field and forest landscapes, the latter taking up most of the site, selected for the construction of the repository for short-lifespan low-and intermediary level radioactive waste. According to the forest and plants area division, the territory of the site is part of the downer Plain hill and hill-mountain zone of oak woods (0-900m. elevation) and more specifically in the Plain-hill oak woods subzone (0-600 m. elevation). In the area of the site, the tree vegetation is various in it species structure.

The main element, comprising the environment of the selected site is forest type (tree and bush species) vegetation, with predominant presence of shrubs in certain parts; specific here is that the vegetation has been artificially planted, including the introduction of foreign tree species such as Chinese rain tree(*Koelreuteria paniculata* Laxm.), American ash tree (*Fraxinus americana* L.), gleditschia (*Gleditschia triacanthos* L.), ailant (*Ailanthus glandulosa* Desf.), white mulberry (*Morus alba* L.), walnut, (*Juglans regia*), apricot, (*Armeniaca vulgaris* Lam.) as tree species and Japanese nail (*Lonicera Maackii* Maxim.) and amorpha (*Amorpha fruticosa* L.) as shrub species. Except for the above-mentioned foreign species, the following species of artificially planted or self-planted trees and shrubs can be found on the site: field elm (*Ulmus campestris* L.), mahaleb, (*Padus mahaleb* Borkh.), giancanna, (*Prunus cerasifera* Ehrh.), acacia *(Robinia pseudoacacia), a*cer *(Acer campestre), a*sh *(Fraxinus excelsior)*, summer oak *(Quercus robur)* as tree species, and briar (*Rosa canina* L.), hawthorn *(Crataegus monogyna Jacq)*, blackthorn (*Prunus spinosa* L.), ligustrum (*Ligustrum vulgare* L.), dogwood (*Cornus sanguinea* L.), blackberry *Rubus fragariiflorus* L.), clematis (*Clematis vitalba* L.), spindle tree (*Euonimus europaea* L.) as shrub species and red nightshade (*Solanum dulcamara* L.) as subshrub species. A cemented water channel (duplicate watering channel for the power plant form “Shishmanov val” dam) and a dirt road cross the afforested territory.

The fauna, including the vertebrates and invertebrates in the area, is complemented by species, typical for the lower (plain) parts of the country, including the Danube Plain. In the zoogeographical aspect, the fauna is from a pale arctic type and more specifically from species with habitats in the southern parts of the European subcontinent, ie Mediterranean species. Considering the above, most fauna species in the region are with eurosiberian and european elements. The other species are predominately of holearctic and palearctic population. A typical example are spiders, among which there are almost no Mediterranean types. On the other hand, the continental climate causes a wider variety of species like amphibians, while reptiles are fewer. There are almost no endemites from the above ground fauna, while from the underground fauna, there are 2 Balkan and 4 Bulgarian endemites. Mediterranean birds here have the least representation in comparison to the other zoogeographical areas, as the species with a northern type of population are 4 times more numerous than the species from southern type.

The characteristics of the territory for the future NRRAW site as a habitat defines the specifics of its wildlife – species with mainly forest habitats on one side and species with open, grass agrolandscapes, which can be encountered in the territory mainly because of its biocorridor functions, due to the agricultural lands nearby.

After inspections and searches made on the site, no conservationally relevant or protected invertebrates, amphibians, reptiles or mammals were registered on the territory of the NRRAW site. In accordance with the available data on the conservation importance of the local biodiversity, the following has been established:

Invertebrates

The first research on the Bulgarian invertebrates was carried out in 1800 by foreign and Bulgarian scientists. In spite of that, the exact number of invertebrates on the territory of the republic of Bulgaria is still not known. In this aspect there are still species that are not well studied, or even studied at all. Weevils in Bulgaria are represented by more than 1000 species, and they are just one of many families from the twenty orders of insects. Insects, respectively is just one of the dozens of invertebrates in the country. Below are summarized some basic data for the better studied taxons on the territory of the country.

Taxons Protozoa, Nematoda, Oligocheta, Mollusca, Crustacea, Arachnida, Myriapoda.

Insects aside, as they have been reviewed on their own below, the best studied groups of invertebrates in Bulgaria are as follow:

- Subkingdom Protozoa with 1 800 known species from 7 types;
- Class Nematoda (Type nematodes) with 517 known species;
- Class Oligochaeta (Type Anneida) with 54 known species;
- Type Mollusca (Мекотели) with 432 known species;
- Class Crustacea (Type Arthropod) with 93 known species;
- Class Arachnida (Type Arthropod) with 1 266 known species;
- Class Myriapoda (Type Arthropod) with 215 known species;

The total number of established known species from the upper taxons is estimated at around 4377. From them, the rare, endemic and relict types are studied best.

Rare species. The number of rare species in these groups is estimated at around 991, or 22,6 % of all species. The territories, where the rare species are most populated are: the Black Sea coast (222), Vitosha mountain (182), Western Rhodopes (93), the Struma river valley (87) and Strandzha mountatin (86). As can be seen, the Radiana site for the IP is located a significant distance from all of these territories and has one of the best possible positions in accordance to them as a whole.

Endemic species Endemic species, in Bulgaria are estimated at around 387 of all established species and subspecies of the abovementioned groups of invertebrates, or 8,8% of the total number of species. The regions with the highest populations of endemic species (Bulgarian/ Balkan) are: Western Rhodopes (82/20), Western Stara Planina (49/16), Pirin (57/14), Central Stara Planina (49/16) and Rila (42/10). The NRRAW site Radiana again is a significant distance away from the areas with highest endemic rates..

Class Insecta.

Class Insceta is the richest of the wildlife, as it includes more species than all other classes together.

The available data shows that around 37 % of the insect fauna in Bulgaria is complemented by the orders: Odonata (dragonflies), Ephemeroptera (mayflies), Plecoptera (stoneflies), Homoptera), Heteroptera (true bugs) и Coleoptera (sheathwings). Their families and species are one of the most widely populated in the modern-day fauna, because of which they are reviewed separately. In this case, the percentage of rare species is greatest in Plecoptera (29%) and Odonata (26,6%). The percentage of endemic species is greatest in Plecoptera (25%) and Ephemeroptera (11,8%). Heteroptera has respectively the biggest percentage of relict species - (7,2%). Most areas with some of the most valuable orders of these communities are concentrated in the high mountains, on the Black Sea coast and the southwestern part of Bulgaria (the southern part of the river Struma).The areas with most representative species of biodiversity from the different orders are also concentrated in the mountains, especially in Rila, Pirin, Vitosha and the Western Rhodopes. Most of the mentioned groups are ones of the best studied in Bulgaria. Table 3.5.1 shows general data on the total number of the species, , as well as the number of rare, endemic and relict species.

Table 3.5.1. General number of insect classes in Bulgaria. Rare, endemic and relict species.

Order	**Estimated number in Bulgaria**					Extent of study in Bulgaria (%)
	Families (number)	Species				
		Total	**Endemites**	**Relicts**	**Rare**	
Odonata	10	64	-	1	17	85%

Ephemeroptera	15	102	12	-	19	73%
Plecoptera	7	96	24	-	28	85%
Homoptera	14	500	13	10	49	62%
Heteroptera	39	1020	31	73	92	96%
Coleoptera	79	5370	393	24	560	67%
Total	*164*	*7152*	*473*	*108*	*765*	

Rare species. The total number of rare species from the orders above is at least 765 (or 10.7% of the established species). On the territory of the the country, the regions with the biggest number of rare species is in the southern part of the Struma river valley – south from Simitly near the border with Greece (111) and on the southern coast of the Black Sea near cape Emine (108), in a lesser degree in Strandzha (25) and in Central and Eastern Stara Planina (24). It is interesting to note that a relatively small amount of rare species are populated in the higher mountains like Slavyanka (9), Rila (10), Belasitsa (9), in Western Stara Planina (6) and Pirin (5).

Endemic species The total number of endemic species and subspecies from all 6 above mentioned orders is 473 (6.6% of all species). The areas with highest number of endemic species are: Rila (117), Western Rhodopes (107), Pirin (103) and Central Stara planina (102). A large number of endemic species are also found in the southern part of the river Struma (95)m Western Stara Planina (83), Vitosha (83) and the southern Black sea coast (67). In a lesser degree endemic species can be found in Strandzha (43), on the northern coast of the Black sea (31), Slavyanka mountatin (25) and Belasitsa (16).

Relict species. The total number of relicts (without endemites) from the reviewed orders of Class Insekta so far is 108 (or 1.5% of all species). Here one has to have in mind, that there are no such species found from the orders Ephemeroptera and Plecoptera, and for Odonata only one has been found (in Strandzha). The areas with the highest number of relict species are: Vitosha (66), Rila (62), Pirin (42) and Western Rhodopes (34). In a smaller degree, they can be found in other regions of our country: Central Stara Planina (18), Western Stara planina (14), Slavyanka (6), Belasitsa (4) and in the southern part of the Struma river valley (3), in Strandzha (1).

As it can be seen, in the Danube Plain and more specifically – its western part, in which the NRRAW site is planned to be placed, 6 orders mentioned above are not listed in the regions, populated with rare, endemic or relict species. The table below shows a general review of the population of the rare and endemic species (Bulgarian/Balkan) on Bulgarian territory . Table 3.5.32 shows the common distribution of the rare and endemic species (Balkan/Bulgarian) on Bulgarian territory .

Table 3.5.2 Distribution of are and endemic species (Balkan/Bulgarian) of certain orders from Insects class on the territory of the contry.

Areas of population Odonata, Ephemeroptera, Plecoptera, Homoptera, Heteroptera, Coleoptera	**Endemic species**			**Rare species**
	Bulgarian	Balkan	All	
Southern part of the river Struma valley	54	41	95	111
Southern Black sea coast	36	31	67	108
Western Rhodopes	66	41	107	58
Vitosha	42	39	81	56
Rila	64	53	117	10
Central Stara planina	62	40	102	24
Pirin	56	47	103	5
Western Stara planina	54	29	83	6
Northern Black sea coast	18	13	31	47
Eastern Stara planina	29	17	46	24

Strandzha	29	14	43	25
Eastern Rhodopes	16	24	40	14
Slavyanka	11	14	25	11
Belasitsa	6	10	16	9
Sredna Gora	12	7	19	4
Osogovo	3	8	11	3
Plana	3	2	5	7
Lyulin	3	5	8	3
Sakar	5	6	11	-
Golo Bardo	2	5	7	3
Lozen planina	1	2	3	3
Ograzhden	2	1	3	3
Malashevska planina	1	1	2	2
Ruy	1	2	3	1
Verila	-	-	-	1
Vlahina planina	-	-	-	1
Total number of all 6 orders	307	166	473	765

In this case, the site provided for NRRAW for Kozloduy NPP is far enough from all the areas, meantioned above.

Regarding the rest of Class Insecta, 54 % (about 10 300 species) from the entomofauna of Bulgaria is composed by species from the following orders: Blattodea (Cockroaches), Mantodea (Mantises), Isoptera (Termite), Orthoptera (Crickets), Dermaptera (Earwigs), Embioptera (Embiids), Megaloptera (Largewings), Raphidioptera (Snakeflies), Neuroptera (Lacewings), Mecoptera (scorpion flies), Hymenoptera (Membranewings), Trichoptera (Caddisflies), Lepidoptera (butterflies) и Diptera (Twowinged). From them, the most numerous are the Hymenoptera (4000), Lepidoptera (2860) and Diptera (2800). The rare (793), endemic (271) и relict species (42) represent 10,7 % from the species of the 14 orders mentioned above. The biggest percentage of rare species is in Neuroptera (27,4%) and Trichoptera (18,0 %). Most of them can be found in the Kresna ravine, in the Sandansi – Petrich region (20,3%) and on the northern Black sea coast (14,4%). The percentage of endemites is highest in Orthoptera (28,0%) and lowest in Diptera (1,0%). Endemites are mostly populated in Pirin (21,8%) and Rila (20,7%), in the area Sandanski – Petrich and the Kresna ravine, the Black sea coast, the higher parts of the mountains Pirin, Rila, Western Rhodopes and Vitosha, as well as the middle stream of the river Struma. The richest territories on species are the middle stream of the river Struma, the northern Black sea coast and Pirin. Despite the fact that there has been made a considerable amount of regional research, almost all species are concentrated in the southern part of Bulgaria, while in the northern parts and the Danube Plain, most of the existing research is nor complete or is old. Table **3.5.33** below shows data for the established biodiversity, the estimated number of rare, endemic and relict species from the orders mentioned above, and Table **3.5.34** shows the information for the number and distribution of the established rare, endemic and relict species (according to the available data) on the the Danube Plain.

Table 3.5.3. Data for the established biodiversity, the estimated number of rare, endemic and relict species from certain orders from the Insects class in Bulgaria

Order	Estimated number of species on the territory of Bulgaria				Extent of study in Bulgaria (%)
	Total	Endemites	Relicts	Rare	
Blattodea	15	1	0	2	75.0

Mantodea	4	0	0	1	80.0
Isoptera	2	0	0	1	100.0
Orthoptera	207	58	3	29	82.8
Dermpatera	7	0	0	3	46.6
Embioptera	1	0	0	1	50.0
Megaloptera	3	0	0	1	75.0
Raphidioptera	14	2	0	3	82.3
Neuroptera	113	1	1	31	94.2
Mecoptera	7	0	0	2	70.0
Hymenoptera	4,000	45	0	317	33.3
Trichoptera	250	33	1	47	96.1
Lepidoptera	2,860	103	37	136	68.1
Diptera	2,800	28	0	218	28.0
Total	10,283	271	42	793	38.2

Table 3.5.4. Data for the number and distribution of the established rare, endemic and relict species from them on the territory of the Danube Plain.

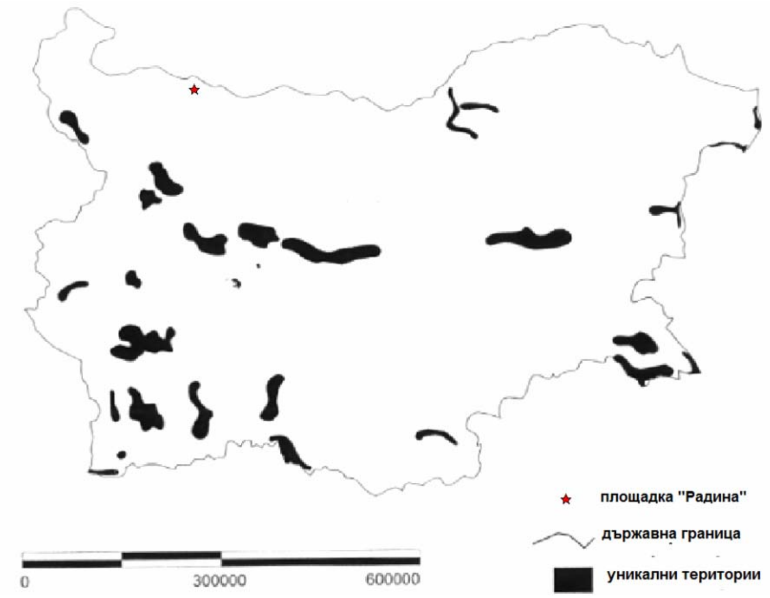
Areas of distribution in the Danube Plain	Total	Endemites	Rare	Relicts
		Number of species		
Danube Plain		1	-	-
Western part	10	3	7	-
Central part	6	3	3	-
Eastern part	12	4	8	-

As can be seen, an insignificant number of the established endemic (271) and rare (793) species from the 14 orders of insects analyzed are located in the western part of the Danube Plain, where the Kozloduy NPP is located and the future NRRAW site will also be located. No relict species are known in that area. The others are registered in Stara planina, the mountains and some valleys of the transitional mountain-hollow zone (including the Kraishte area, Konya area, Strandzha and others), the mountains and the river valleys of the Rilo-Rhodope massive, the Black Sea coast, as well as the Prebalkan. Upper in the text are noted the territories with the biggest variety of rare, endemic and relict species.

It is necessary to point out, that as a country, Bulgaria has a varied landscape, different atmospheric influences and that it is located between two continents and two totally different zoogeographical subareas (the eurosiberian and the mediterrenean) and has one of the richest and most extraordinary insect faunas.The topography, climate and paleogeographical development of the area during the Tertiary and Quaternary periods were the main factors in the creation and maintenance of many unique ecosystems and cosocieties. Overall, the most significant groups of invertebrate fauna in Bulgaria are common in forested areas, mountains and alpine ecosystems in karst areas and cave habitats, coastal habitats (beaches, sand dunes, lakes and swamps) also gorges and river valley habitats. Alpine peat bogs, glacial lakes, mountain streams, caves and coastal wetlands are the most important for the existence of many other groups. In practice, the IP site and adjacent areas and can be considered habitat with these characteristics, while being far enough away from them.

Figure 3.5.-4 shows a map of the most unique and significant territories, regarding the invertebrate population in the country.

Map 3.5-4 Territory of important invertebrate habitats in Bulgaria.



Source: *Biodiversity Support Programme, c/o World Wildlife Fund*

The target invertebrate species, which are subject to conservation in this part of the Danube plain, where the NRRAW site is planned to be built, are similar to those described in the nearest protected areas in the Habitats Directive of the environmental network Natura 2000. These are a total of 5 types: one type of Class mussels, one of snails and three of insects. After the field inspections, such species were not identified. These species are listed in Table 3.5.2.5, after which is presented data on their conservation status, their ecology and probability of occurrence near the NRRAW site.

Table 3.5.5. Target invertebrate species, subject of conservation in the range of the investment proposal

Species	**LBD** (App.2,3)	**Berne convention**	**Dir. 92/43 EEC**	**IUCN Red List (2008)**
Pearl oyster (*Unio crassus*)	App. 2, 3	-	+	+ (PE)
Stag beetle (*Lucanus cervus)*	App. 2, 3	+	+	-
Morimus funereus	App. 2	-	+	+ (V)
Rosalia alpina	App. 2, 3	+	+	+ (V)
Theodoxus transversalis	App. 2, 3	-	+	- (IS)
+ Included - Not included	PE ("potentially endagered" species) V ("vulnerable" species) IS ("insufficiently studied")			

Pearl oyster (<u>*Unio crassus*</u>). The species inhabits sandy-mud bottoms of many of our rivers and their tributaries. The nearest river, where it can be found, is the Danube, which is about 4 km south of the location of the intended site.

Stag beetle **(**Lucanus cervus**).** The species is associated with old oak trees. The female of the species lays eggs in their old stumps. The larvae feed on the rotting wood. In the area of the site there are no oak trees, and the species has not been encountered in the inspections.

Long-Horned Beetle(*Morimus funereus)* – Associated mainly with beech forests. The larvae develop in dead beech wood trees. In the area of study no such habitats and species were encountered and are unlikely to be encountered in the future.

Alpine Rosalia (*Rosalia alpine)* – lives in predominantly in older oak forests with altitude 500 - 1000 m. The larvae are exclusively linked to those forests, so the type is not present in the researched area of the site.

The last three species are typical forest dwellers, whose development depends crucially on deciduous wood. Protecting their habitat is mainly related to the conservation of old trees and fallen dead wood, which is their basic propagating substrate. The relevant territory has some of the conditions conducive to the development of the species, but they are not fully sufficient for their permanent inclusion.

Theodoxus transversalis Small freshwater snail common in the waters of the Danube.

Vertebrates

Class Pisces.

The nearest biotopes of this group of vertebrates are in the Danube River (4 km) and accordingly, the servicing channels of NPP, Kozloduy (just over 1 km).

Overall, the Bulgarian section of Danube River and its tributaries constitute one ichthyological complex, in which a total of 77 species and subspecies of fish can be found. Twenty of them are found only in the Danube and have not been encountered in its tributaries (Hucho hucho, Alosa caspia nordmani, some of the sturgeon fish, etc.). Conversely, ten cold-loving species (mostly species of the orders Salmo, Cobitis, Cottus, etc.) inhabit only the upper parts of the middle streams of tributaries. Thus, in the Bulgarian part of the Danube a total of 65 species of fish can be found. The best represented families are- Cyprinidae, Percidae, Cobitidae and Gobiidae. The Danube basin with its Bulgarian sector is an important typeforming center. Here can be found endemic species like the Bulgarian loach, Gymnocephalus schraetzer (Bryde redfish), G. baloni, Hucho hucho (Danube trout), Barbus barbus (barbel Danube), Vimba vimba , Aspro streber and others.

Species such as bream (Abramis brama), bleak (Alburnus alburnus), White barbel (Barbus barbus), Normal gudgeon (Gobio gobio), chub (Leuciscus cephalus), River perch (Perca fluviatilis), pike (Esox lucius), Lynn (Tinca tinca), golden carp (Carassius carassius), White tolostolob (Hypophthalmichthys molitrix), Common loach (Cobitis taenia), Nase (Chondrostoma nasus), Sand goby (Neogobius fluviatilis), Morunash (Vimba vimba), Little Flat goby (Neogobius gymnotrachelus), Strong (Neogobius melanostomnus), Babushka (Rutilus rutilus), also - rarely Belitsa (Blica bjoercna), Mazdruga (Leuciscus idus), shad (Alosa pontica pontica), Russian sturgeon (Acipenser gueldenstaedtii) and others have a good distribution in this stretch of the Danube and the bottom of its tributaries (near the town of Kozloduy).

Conservationally significant fish species in this region of the Danube and its tributaries (around Kozloduy) (Table 3.5.36) coincide with the species covered in the protected areas nearby. Namely:

Table 3.5.6 Conservationally significant fish species in Danube river and the region of the investment proposal

Species	**LBD** (App.2,3)	**Berne convention**	**Dir. 92/43 EEC**	**IUCN Red List (2008)**
Zingel streber	App. 2	+	+	+ (WA)
Alosa immaculata	App. 2	+	+	+ (V)
Aspius aspius	App. 2	+	+	+ (WA)
Barbus meridionalis	App. 2	+	+	+ (PE)
Cobitis elongata	App. 2	+	+	+ (WA)
Cobitis taenia)	App. 2	+	+	+ (WA)
Eudontomyzon mariae	App. 2	+	+	+ (WA)

Gobio albipinnatus	App. 2	+	+	+ (WA)
Gymnocephalus baloni	App. 2,3	+	+	+ (WA)
Gymnocephalus schraetzer	App. 2	+	+	+ (WA)
Pelecus cultratus	App. 2	+	+	+ (WA)
Misgurnus fossilis	App. 2	+	+	+ (WA)
Rhodeus sericeus amarus	App. 2	+	+	+ (WA)
Sabanejewia aurata balcanica	App. 2	+	+	+ (WA)
Zingel zingel	App. 2	+	+	+ (WA)
+ Included - Not included	PE ("potentially endangered " species) V ("vulnerable" species) WA ("weakly effected" species)			

In the immediate vicinity of the NRRAW site, there are no bodies of water, in which the above mentioned species can be found. The closest such objects are the servicing channels of Kozloduy NPP, which are little more than 1 km from the Radiana site

Classes Amphibia and Reptilia

Due to its geographical position and its varied topography, Bulgaria has one of the richest herpetofauna in Europe. So far, over 52 species of amphibians and reptiles have been identified, of which two types of snakes (Vipera aspis and Vipera ursinii) are considered missing since they have not been detected in the last 60 years, and two species of marine turtles are occasional visitors to the Black Sea coast (respectively. 48 species). The majority of Bulgarian herpetofauna (31 species) is protected from extinction by a special order from MEW No 729/1986 and the Red Book of Bulgaria, in which 14 species (Beshkov, 1985) are included.

Bulgarian amphibian and reptile fauna can be divided into 3 groups according to their zoogeographic distribution: 1. the northern European species, which are widespread in the mountains, most especially in coniferous zone 2. Middle and southern European species distributed in Bulgaria, the Danube plain included - in the case of the region of the NRRAW site, this group is typical. 3. Mediterranean and Middle Eastern species, which enter only in the warm and low-lying parts of South Bulgaria; Overall, the most important ecosystems and habitats of unique importance for amphibians and reptiles in the country are located, where the Mediterranean climatic influence is greatest - in the valley of the river Struma, the Maritza River Valley, the Eastern Rhodopes, as well as the southern Black Sea coast (south of Bourgas), territories, significantly away from Kozloduy NPP and the Radiana site. After inspections, carried out on the area of the future site, in the passed accessible locations, passed no amphibian or reptilian presence was registered. A characteristic of the herpetofauna in this part of the Danube plain can be found below, including the conservation status of individual species and the likelihood to be encountered at the site, depending on the typical ecology.

- Amphibia

Populated in all water bodies in the region are the Marsh Frog (*Rana ridibunda*) and the Green Frog (*Rana esculenta*). In the standard forms of the nearest protected areas (PA "River Ogosta", PA "Tsibar, etc.) under the Habitats Directive are described a total of 9 species of amphibians, 5 of which are Classified as significant and 4 as target species (conservationally significant species, subject to conservation in the region Dir. 92/43/EEC, Table 3.5.37), as follows:

Table 3.5.7 Conservationally important amphibia species in water bodies in the region of the investment proposal

Species	**LBD** (App.2,3)	**Berne convention**	**Dir. 92/43 EEC**	**IUCN Red List (2008)**
Target species				
Bombina bombina	App. 2,3	+ (II)	+	+ (WA)
Bombina variegata	App. 2,3	+ (II)	+	+ (WA)
Triturus karelinii	App. 2,3	+ (II)	+	+ (WA)
Triturus dobrogicus	App. 2,3	+ (II)	+	+ (PE)
Significant species				

Rana dalmatina	-	+ (II)	+ (IV)	+ (WA)
Pelobates fuscus	App. 3	+ (II)	+ (IV)	+ (WA)
Pelobates syriacus	App. 3	+ (II)	+ (IV)	+ (WA)
Bufo viridis	App. 3	+ (II)	+ (IV)	+ (WA)
Hyla arborea	App. 3	+ (II)	+ (IV)	+ (WA)
+ Included PE ("Potentionally endangered" species) - Not included WA ("weakly affected" species)				

After the inspections carried out in the area of the Radiana site, in the accessible areas, there was no registered amphibian presence. The respective species can be found in biotopes, typical for them, as below is analyzed the probability of that happening in the site, or in its vicinity.

- ✓ Target amphibian species.

Bombina bombina. This frog lives mainly in puddles, ditches and ponds, but can be found in larger ponds covered with vegetation. Bombina bombina is very closely tied to water, because of which it cannot be found on the investment site or in its immediate vicinity. Their closest habitation is near the mouth of the river Danube in Lom.

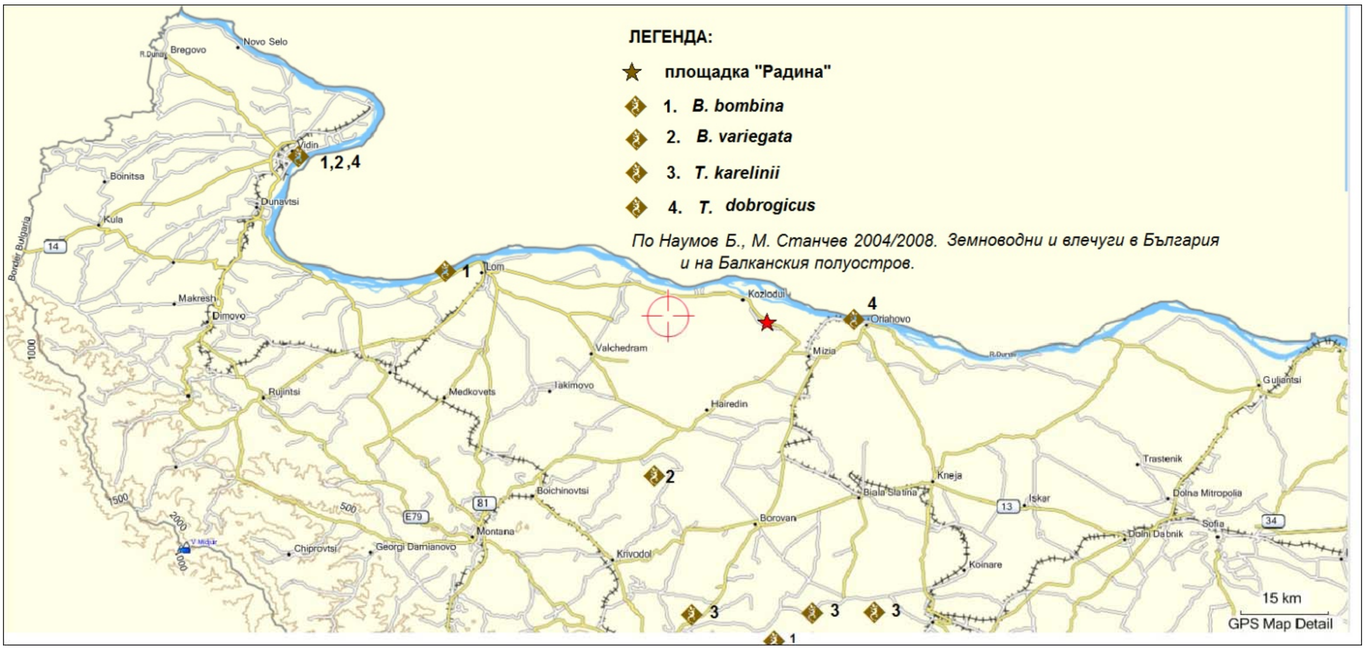
Bombina variegata**.** Bombina variegata was not located on the territory of the site. It is spread throughout the country. Lives both in the plains and the mountains, on an altitude up to 1900 m. It very rarely deviates from the water - no more than 0.5 to 0.6 (max. 1.0) m and therefore cannot be found on the investment site, or its immediate vicinity. Its nearest known habitat is in the middle reaches of Ogosta. Most of its habitats are concentrated in the south of the country.

Triturus karelini. Can be found in swamps, lakes and slow flowing rivers, which it leaves periodically during summer. It spends the winter on land, near the vicinity of water ecosystems. It cannot be found on the investment site, or its immediate vicinity.

Triturus dobrogicus. Can be found in the Danube Delta and along its lower reaches, on the territory of Bulgaria and Romania. It is widespread in the wetlands in the mouths of tributaries of the Danube and river islands. Accordingly, it cannot be found on the investment site, or in its vicinity. Its nearest massive population is near Oryahovo and the mouth of Ogosta river.

Habitats of the above species are related to ponds. On the territory of the investment proposal and its immediately vicinity such ponds do not exist, therefore the conditions are not appropriate for these species. Figure 3.5-5 indicates their nearest known localities

Figure 3.5-5. Map of the closes to the IP habitats of target amphibian species



As it can be seen, the nearest habitat is that of *Triturus dobrogicus,* which is about 13 km away.

✓ Significant amphibious species:

Agile frog (*Rana dalmatina*) prefers moist areas such as riparian meadows, deciduous forests and swamps. The area of the investment proposal creates some favorable conditions for housing of this type, but it lacks the wet areas - most of the time of the year it is dry. No sightings of the species have been made, nor have any data, indicating its presence been found from direct or other sources.

Common spadefoot (*Pelobates fuscus*) and European spadefoot (*Pelobates syriacus*) mainly inhabit areas with steppe vegetation and loose soil (loess, alluvial deposits, sand, etc.), including arable land, and therefore not registered in the territory. Likely to be found in the neighboring agricultural land south and west of the site.

European green toad (*Bufo viridis)* is quite a drought resistant species, so it can be found even in areas without nearby ponds. Typical for the plain steppe areas. Well adapted to intensively cultivated land, like the one near the proposed site across the road Hurlets - Kozloduy. The species is more numerous in rural backyards, rather than outside the settlements. In Bulgaria the green toad is found throughout the country to an altitude of 1200 m. The species has not been encountered during the search of the site, but it is likely to appear in the future.

Tree frog (*Hila arbore*) prefers wet places - mixed deciduous forests, mountain meadows, urban parks, most often near stagnant ponds, which are not present near the site. In Bulgaria, it can be found throughout the country to an altitude of 1300 m. The area of the site provides partly appropriate conditions, but the species has not been observed or heard.

✓ Other amphibian species.

The Marsh frog (*Rana ridibunda*) and the edible frog (*Rana esculenta* , as it was mentioned above, are ubiquitously populated in all water basins in the area, as well as on their coasts, but there are no such places in the vicinity of the site.

✓ Reptiles (Reptilia).

In the standard forms of the closest protected areas (PA "Ogosta river", PA "Tsibar" and others) under the habitats directive are described a total of 11 reptilian species, 8 from which are classified as significant and 3 as target (conservationally significant species, subject to protection in the area under Dir. 92/43/EEC, Table 3.5.38), as follows:

Table 3.5.8 Conservationally important reptile species subject to Application 2,3 of LBD in the closest to the IP protected zones

Species	**LBD** (App.2,3)	**Berne convention**	**Dir. 92/43 EEC**	**IUCN Red List (2008)**
Target species				
European pond turtle (*Emys orbicularis*)	App. 2,3	+ (II)	+	+ (PE)
Hermann's tortoise (*Testudo hermanni*)	App. 2,3	+ (II)	+	+ (PE)
Rat snake (*Elaphe quatuorlineata*)	App. 2,3	+ (II)	+	+ (PE)
Significant species				
Caspian whip snake (*Coluber caspius*)	App. 3	+ (II)	+ (IV)	+ (WA)
Aesculapian Snake (*Elaphe longissima*)	App. 3	+ (II)	+ (IV)	+ (WA)
Horned viper (*Vipera ammodytes*)	App. 3	+ (II)	+ (IV)	+ (WA)
Dice snake (*Natrix tessellata*)	App. 3	+ (II)	+ (IV)	-
Crimean lizard (*Podarcis taurica*)	App. 3	+ (II)	+ (IV)	+ (WA)
Common wall lizard (*Podarcis muralis*)	App. 3	+ (II)	+ (IV)	+ (WA)
Green lizard (*Lacerta viridis*)	App. 3	+ (II)	+ (IV)	+ (WA)
Juniper skink (*Ablepharus kitaibelii*)	App. 3	+ (II)	+ (IV)	+ (WA)
+ Included PE ("Potentionally endagered species") - Not included WA ("weakly affected" species)				

During the inspection carried out of the NRRAW site in the accessible locations passed, the presence of reptiles was not registered. The species inhabit habitats with different environmental conditions. The table below shows the probability of the species appearing on the site or near to it.

✓ Target reptilian species.

European pond turtle (*Emys orbicularis*). Can be various slow flowing waters or wetlands, some of which may dry up completely during the summer. Typical examples are drainage ditches, fishponds, marshes, ponds, rivers and small streams, brackish waters of estuaries, coastal water areas. Characteristic for the habitats is the presence of abundant aquatic vegetation. Such habitats at the site of the investment proposal are not present, so this species cannot be registered here. The closest suitable habitats are the channels servicing the NPP, which lie just over 1 km away.

Hermann's tortoise (*Testudo hermann*). No registered presence. The Hermann's tortoise prefers thin forests (low tree and shrub vegetation), unlike the Greek turtle (testudo graeca), which is typical for grass landscapes. The terrain, subject to assessment is rather shady and dank, which suggests that it is not a permanent habitat for this species. The species is most likely to be encountered particularly during biocorridor functions in search for a winter den. The species is weakly affected by displacement or anxiety. Most adults are conservative in terms of their individual territories, but there are established cases of individuals performing long-distance migrations. The area of the investment proposal is not a suitable habitat for the species because there is a combination of dense trees and arable agricultural land in the vicinity.

Rat snake (*Elaphe quatuorlineata*). Prefers dry, rocky terrain with well-developed micro landscape, covered with thin forests and scrub. Its conservationally significant habitats in the country are concentrated in southwestern Bulgaria in the valley of the river Struma and the Kresna Gorge, to the north. During the made inspections, the species wasn't found and there is a very low probability that it will appear in the territory or in its vicinity, because of its zoogeographic distribution in the country (the southern part of the Struma river valley.

Figure 3.5-6 shows the closest known mass location of the target reptilian species, which can be found in this part of the country. (*Emys orbicularis* and *Testudo hermanni*).

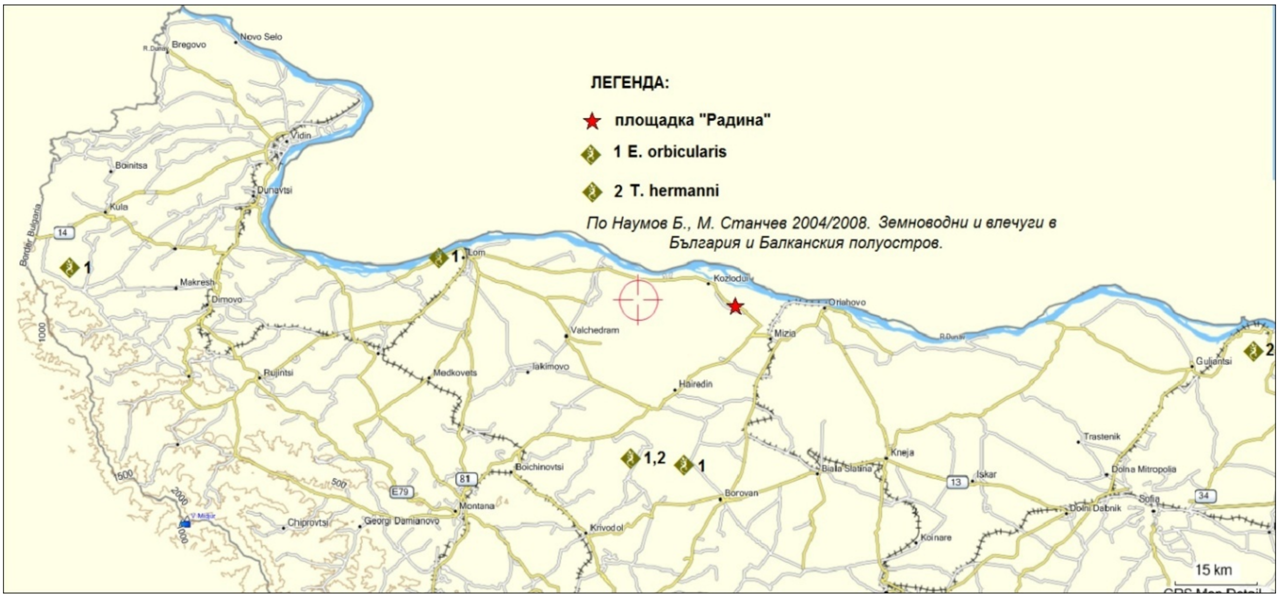


Figure 3.5.6 Mass locations of target reptilian species, closest to the IP

The closest location is over 30 km away southward from the IP site.

✓ Significant reptilian species:

Caspian whip snake (*Coluber caspius*). Inhabits rocky and high grass areas, because of which it cannot be found on the site of the IP, as there are no suitable biotopes for that. There is a high probability that it can be found in the neighboring arable lands across the Hurlets-Kozloduy road.

Aesculapius Snake (*Elaphe longissima*) is populated throughout the country at an altitude as high as 1600m. It is less populated in the plain areas with intense agriculture. The aesculapian snake prefers old deciduous and mixed forests. No presence has been accounted, but the territory has the appropriate conditions. Because of that there is a probability that the species could be found there in the future.

Horned viper (*Vipera ammodytes*) can be found throughout the country up to an altitude of 1450 m. The exceptions are some high fields in the western part of the country, although it can be found in the neighboring mountain slopes. Prefers open, rocky, sunny spots, overgrown with high grass vegetation, ferns, bushes and usually with enough holes for underground shelters. The territory of the IP is not a suitable habitat for this species, which is why it is unlikely to be encountered (including the cultivated areas nearby).

Dice snake (*Natrix tessellata*) – species, attached to the water. Rarely deviates more than 20 m from it, feeds primarily with fish, this is why it cannot be found in the IP site or in the nearby areas.

Crimean lizard (*Podarcis taurica*) prefers dry sunny grassy areas with rare shrubs or trees. Therefore, it has not been encountered during the inspections, nor any data from other sources has been received about its presence in the area of the IP. It is unlikely to be found in the vicinity because of the nature of arable land in the vicinity.

Common wall lizard (*Podarcis muralis*) can be found throughout the country up to an altitude 1400 meters. Lives only in rocky terrain, including manmade, as railway and road embankments, retaining walls, and others. Does not occupy the territory of the IP itself, but can be found on or adjacent to the site of Kozloduy NPP and in some - distant buildings.

Green lizard (*Lacerta viridis*) is widespread throughout the country up to an altitude of 1200 meters and prefers dry sunny areas - meadows and rocky terrain, sometimes overgrown with bushes or rare woods. Does not dwell within the investment proposal, but is certainly present in some of the - neglected (uncultivated) adjacent areas, that are not occupied by dense trees.

Juniper skink (*Ablepharus kitaibelii*) is populated in separate places in most parts of the country at an altitude to 1100 m. Prefers dry, sunny, grass and stones more open spaces with bushes or trees, characteristics that the IP does not provide, since the trees on its territory are quite danker.

✓ Other reptilian species:

Blind worm (*Anguis fragilis*). This type of legless lizard inhabits shady, moist places, overgrown with high vegetation, or trees and bushes. Hiding under rocks, stumps, rodent holes, leaves, etc.. It is typical for the whole country up to 1900 m. The site of the IP is appropriate for this kind and it is likely to be encountered. It is included in App. 3 of LBD but does not fall into any of the Berne Convention applications, Dir. 92/43 EPS does not appear in the Red List of endangered species of IUCN.

Class Mammals (Mammalia).

On the territory of the country are reported 23 kinds of large mammals (Macrommamalia), one of which is considered extinct, 42 species of small mammals (Micromammalia), of which 28 species are found within the Danubian plain and 33 species of bats (Chiroptera), by the bat diversity is highest in the zone between 100 and 400 meters, they live in relatively small places between 17 and 20 species (on the altitude of the Radiana site, the range is 50 to 90 m) and at least 10 species are 'forest bats "- species closely related to the forest as a place for living and dining (all bat species are strictly protected by the domestic and international law).

In the area of the NRRAW site ("Radiana") in the standard forms of the nearest protected areas under the Habitats Directive are described a total of 10 kinds of mammals, 7 of which are Classified as significant and 3 as target species (conservationally significant species subject to protection in the area under Dir. 92/43/EEC, Table3.5.9), as follows

Table 3.5.9. Conservationally important mammal species subject to Application 2,3 of LBD in the closest to the IP protected zones

Species	LBD (App.2,3)	Berne Convention	Dir. 92/43 EEC	IUCN Red List (2008)
Target species				

Otter (*Lutra lutra*)	App. 2,3	+ (II)	+	+ (PE)
Romanian hamster (*Mesocricetus newtoni*)	App. 2,3	+ (II)	+	+ (PE)
European ground squirrel (*Spermophilus citellus*)	App. 2	+ (II)	+	+ (V)
Significant species				
Wild cat (*Felis silvestris*).	App. 3	+ (II)	+ (IV)	+ (WA)
Lesser White-toothed Shrew (*Crocidura suaveolens*)	-	+ (II)	-	+ (WA)
Bicoloured Shrew (*Crocidura leucodon*)	-	-	-	+ (WA)
European hamster (*Cricetus cricetus*)	App. 3	+ (II)	+ (IV)	+ (WA)
Lesser Mole Rat (*Nannospalax leucodon*)	-	-	-	-
Mediterranean Shrew (*Neomys anomalus*)	-	-	-	+ (WA)
Steppe polecat(*Mustela eversmannii*)	App.2,3	+ (II)	+ (II, IV)	+ (WA)
Weasel (*Mustela nivalis*)	App. 3	+ (III)	-	+ (WA)
East European hedgehog (*Erinaceus concolor*)	App. 3	-	-	+ (WA)
+ Included - Not included	PE ("potentionally endangered " species) V ("vulnerable" species) WA ("weakly effected" species)			

During the initial inspections of the NRRAW site, in the accessible locations, the presence of the above species of mammals or traces of such were not registered. Below is analyzed the probability of the appearance of any of the species on the territory of the site or its vicinity in the future, based on their natural habitat.

- ✓ Target mammals.

Otter (*Lutra lutra*). Typical species for the fish-rich mountain streams, as two thirds of its natural habitats are concentrated below 1000 m above sea level. It goes ashore at night, looking for sleeping or hatching birds. Otters live near rivers with wooded banks, where they make their entrances. In Bulgaria, it can be found almost anywhere across the country, with the exception of Dobrudja and much of the Ludogorie. There is also evidence that South Bulgaria has one of the highest population densities of this species for the territory of the whole country. No sightings have been made on the territory of the IP site and its surroundings and there isn't likely to be any.

Romanian hamster. (*Miniopterus schreibersi*). The species is rare, most often occupying the uncultivated grassland, celery, corn fields with crops, alfalfa and others, like the ones on the other side of the Hurlets - Kozloduy road, and east from the Kozloduy NPP site. However, it doesn't occupy the NRRAW site or its supporting infrastructure on the surface. In Bulgaria it can be found mainly in Dobrudzha, the middle and eastern part of the Danube Plain, to the west of the river Ogosta from which the IP stands about 5-6 km to the west. The negative factors acting on the population of the Romanian hamster are mostly the chemicization and mechanization of agriculture and its natural enemies - predatory birds and mammals, mostly fox, as the latter most likely hunts in the area of the site.

European ground squirrel (*Spermophilus citellus*). The nearest populations of this type are the adjancent non-urbanized territories Oryahovo (Peshev, 1977, 1987, Markov, 1957; Tsonev, R., 2005; Paspalev, D., C. Peshev, 1957), which are located about 13 km east of the IP and the village of Zlatiya (1996 survey), located 20 km west of the site. The species inhabits open uncultivated areas covered with low grass vegetation (meadows, pastures, dry steppes, the edge of cultivated fields, along roads, etc.). Its main food is grass and seeds. The European ground squirrel uses holes in the ground for shelter which it digs itself. There he spends the night hiding from predators, raises its young and goes to sleep in winter. There are several types of holes: temporary, permanent and holes for hibernation. Given the above characteristics of the species, the latter is not found around the site or its surroundings, since the site’s surface is covered by dense trees, and in its vicinity are almost entirely arable lands.

- ✓ Significant mammals.

Wild cat (*Felis silvestris*). Overall, the territory of the IP offers adequate shelters for this species, but it is very unlikely to be encountered because of the anthropogenic character of the surrounding areas - roads, NPP site and farmland.

The lesser white-toothed shrew (*Crocidura suaveolens*) *and* the bicoloured shrew (*Crocidura leucodon*) relate to the eurotropian species, and are populated throughout the country, more often in the plains, and prefer open areas with grass and bush vegetation, which are not present on the territory of the IP. More rarely they can be found in woody areas.

European hamster (*Cricetus cricetus*) is more widely populated in Dobrudzha and some of the territories near the Danube in the north of Bulgaria (Gen. Toshevo and the transect between Balchik – Kaliakra and Durankulak). Similar to the Romanian hamster, it dwells mainly in celery fields of cereal crops, alfalfa and others, like the ones on the other side of the Hurlets - Kozloduy NPP road, and east from the Kozloduy NPP site. However, it does not occupy the NRRAW site or its supporting infrastructure on the surface.

Lesser Mole Rat (*Nannospalax leucodon*) can be found mainly in cultivated land and gardens, like the ones that can be found nearby the site territory, but not on it.

Mediterranean Shrew (*Neomys anomalus*) has not been registered on the IP site or in its vicinity, since there are no suitable habitats – it prefers forests with flowing water basins.

Steppe polecat(*Mustela eversmannii*). It is a rare species and few in number on the territory of the country, which cannot be found on the territory of the IP and its vicinity. It mainly populates open grass terrains, the so called “steppe areas”. It is populated in such areas mainly in Dobrudzha, the Ludogorie and westwards to the village of Chomakovtsi near Cherven Bryag. The loss of habitats and poaching are the main reasons for the polecat to be an extremely rare species in Bulgaria.

Weasel (*Mustela nivalis*) inhabits low-mountain forest and areas, adjacent to settlements, which is reason to believe that it is very likely that the species can be found on the territory of the site, even though no sightings were registered during the inspections.

Eastern European hedgehog (*Erinaceus concolor*) there is a slight probability that the species can be encountered on the site, mostly when it searches for places to spend the winter in, or in search of food.

- ✓ Other mammal species

The territory and its vicinity have adequate conditions for shelter and habitation of the hare (*Lepus capensis*), fox (*Vulpes vulpes*), jackal (*Canis Aureus*) marten (*Martes foina*) – also in populated places, black foumart (*Mustela putorius) – also in populated places,* common squirrel (Sciurus vulgari), common mole (*Talpa europaea*), domestic mouse (*Mus domesticus*), forest mouse (*Apodemus sylvaticus*), wild hog (*Sus scrofa*) – in the autumn and winter seasons, common roe (*Capreolus capreolus*) - in the autumn and winter seasons. In the closest cultivated areas can also be found the common vole (*Microtus arvali*), field mouse (*Apodemus agrarius*) and others, as well as homeless pets dogs (*Canis fammiliaris*), cats (*Felis domestica)* etc.

Regarding the bat fauna, on the territory there are no adequate shelters for resting and reproduction for them. Most trees are relatively young and middle-aged, and no holes, hollows or dents were found on them or anything similar in which the forest bat (at least 10 species) prefers resting, wintering or raising offspring . The investment proposal site provides mainly conditions for hunt and food for some of these species and maybe shelter in some of the abandoned or rarely used buildings in the adjacent territories of the region (including the NPP site). Species are not specified, because there is not enough relevant data about them in the region of the investment proposal, moreover, the territory of the investment proposal, as it was mentioned above, is not a reproductive habitat for bats.

Class Birds (Aves). State of birds

The Fauna, including the **vertebrates** (type **Chordata,** subtype **Vertebrata**), which is the best studied type of fauna, and whose conservation status is best regulated in our country, in this area is from species, typical for the lower parts of the country, including the Danube Plain. In a zoogeographical aspect, the fauna is from species, typical for the Palearctic area and particularly of species, typical for the temperate latitudes. In the area can be found also some species with typically south located habitats on the territory of the European subcontinent ranges, i.e. with ranges in or in the Mediterranean subregion of the Palearctic, called Mediterranean, which by definition of these species, is not entirely correct because ranges of them are located predominantly in other zoogeographical regions and subregions.

Of the vertebrates in the area in which the object falls into, the most numerous are the birds (Aves). The character of the area of the IP defines the habitat characteristics of its animal world - from species, typical of forests to such, typical of open areas and shrub habitats.

In the area of the site - the site's own territory (in the wooded, rising to the south land mass) plus its adjacent territories – as typical and characteristic for Birds (vertebrates) the following species can be pointed out: (List 1)

List 1.

Birds (Aves)

1. White Stork (Ciconia ciconia L.)) - breeds in localities
2. Common Buzzard (Buteo buteo (L.))
3. North buzzard (Buteo lagopus (Pontoppidan)) - in the autumn-winter period
4. Big Hawk (Accipiter gentilis (L.)) - flying individuals
5. Little Sparrowhawk (Accipiter nisus (L.)) - flying individuals
6. Marsh harrier (Circus aeruginosus (L.)) - in the autumn-winter period
7. Corn Harrier (Circus pygargus (L.)) - in the autumn-winter period
8. Hen harrier (Circus cyaneus (L.)) - in the autumn-winter period
9. Hobby (Falco subbuteo L.) - flying individuals
10. Merlin (Falco columbarius L.) - in the autumn-winter period
11. Chernoshipa kestrel (Falco tinnunculus L.)
12. Woodcock (Scolopax rusticola (L.)) - in the autumn-winter period
13. Partridge (Perdix perdix (L.)) - in open areas around the site
14. Quail (Coturnix coturnix (L.)) - in open areas around the site
15. Hunting pheasant (Phasianus colchicus L. ssp.)
16. Semi-wild pigeon (Columba livia (Gmelin) f. domestica) - in the population. places
17. Wood pigeon (Columba palumbus L.)
18. Dove (Streptopelia turtur (L.))
19. Gugutka (Streptopelia decaocto (Friv.)) - in the population. places
20. Common Cuckoo (Cuculus canorus L.)
21. Shore Forest Owl (Asio otus (L.))
22. Swamp Owl (Asio flammeus (Pontoppidan)) - in the autumn-winter period

23. Normal owl (Athene noctua (Scopoli)) - in the population. places
24. Swift (Apus apus (L.))
25. Alpine Swift (Apus melba (L.))
26. Bee-eater (Merops apiaster L.) - during the seasonal migrations
27. Green woodpecker (Picus viridis L.)
28. Great Spotted Woodpecker (Dendrocopos major (L.)) - in the autumn-winter period
29. Syrian Woodpecker (Dendrocopos syriacus (Ehr.)) - mainly in urban areas
30. Lesser Spotted Woodpecker (Dendrocopos minor (L.))
31. Skylark (Alauda arvensis L.)
32. Crested Lark (Galerida cristata (L.)) - near and in the population. places
33. Barn Swallow (Hirundo rustica L.)
34. House Martin (Delichon urbica (L.))
35. Tree Pipit (Anthus trivialis (L.)) - during the seasonal migrations
36. Water (mountain) Pipit (Anthus spinoletta (L.)) - in the autumn-winter period
37. White Wagtail (Motacilla alba L.) - incl. and population. places
38. Black-headed Wagtail (Motacilla flava feldeggi Michaheles)
39. Whinchat (Saxicola rubetra (L.)) - during the seasonal migration
40. Chernogusho Stonechat (Saxicola torquata (L.))
41. Nightingale (Luscinia megarhynchos CL Brehm) - incl. in the population. places
42. Robin (Erithacus rubecula (L.))
43. Kos (black Thrush) (Turdus merula L.)
44. Missel (Turdus viscivorus L.)
45. Mavis (Turdus philomelos C. L. Brehm)
46. Fieldfare (Turdus pilaris L.) - in the autumn-winter period
47. Redwing (Turdus iliacus L.) - in the autumn-winter period
48. Garden Warbler (Hipolais icterina ((Vieillot)) - during the seasonal migrations
49. Black-headed Warbler (Sylvia atricapilla (L.))
50. Obiknoveno belogusho Warbler (Sylvia communis Latham)
51. Few belogusho Warbler (Sylvia curruca (L.))
52. Spruce singer (Phylloscopus collybita (Vieillot))
53. Forest (beech) singer (Phylloscopus sibilatrux (Bechstein)) - during the seasonal migrations

54. Willow warbler (Phylloscopus trochilus (L.)) - during the seasonal migrations
55. Marsh Tit (Parus palustris L.) - in the autumn-winter period
56. Black (Pine) Tit (Parus ater L.) - in the autumn-winter period
57. Blue Tit (Parus caeruleus L.)
58. Great Tit (Parus major L.)
59. Long-Tit (Aegithalus caudatus (L.))
60. Nuthatch (Sitta europaea L.) - in the forests around the site
61. Spotted Flycatcher (Muscicapa striata (Pallas)) - during the seasonal migrations
62. Collared Flycatcher (Ficedula albicollis Temminck)
    - Ssp. Collared Flycatcher (Ficedula albicollis albicollis Temminck) - during the seasonal migrations
    - Ssp. Semi-collared flycatcher Ficedula albicollis semitorquata (Homeyer)) - during the seasonal migrations
63. Zhalobna flycatcher (Ficedula hypoleuca (Pallas)) - during the seasonal migrations
64. Wren (Troglodytes troglodytes (L.)) - in the autumn-winter period
65. Grey Shrike (Lanius excubitor L.) - in the autumn-winter period
66. Redbacked Shrike (Lanius collurio L.)
67. Raven-marshar (Corvus corax L.)
68. Hoodie (Corvus corone cornix L.)
69. Bean crow (Corvus frugilegus L.) - numerous in the autumn-winter period
70. Daw (crow) (Corvus monedula L.) - in the population. places
71. Magpie (Pica pica (L.)) - incl. in the population. places
72. Jay (Garrulus glandarius (L.))
73. Oriole (Oriolus oriolus (L.))
74. Starling (Sturnus vulgaris L.) - incl. in the population. places
75. Home sparrow (Passer domesticus (L.)) - in the population. places
76. Field sparrow (Passer montanus (L.)) - in the population. places
77. Periwinkle (Carduelis chloris (L.)) - incl. in the population. places
78. Goldfinch (Goldfinch) (Carduelis carduelis (L.)) - incl. in the population. places
79. Elshova Siskin (Carduelis spinus (L.)) - in the autumn - winter period
80. Linnet (Acanthis cannabina (L.))
81. Chaffinch (Fringilla coelebs L.)
82. Mountain Finch (Fringilla montifringilla L.) - in the autumn-winter period

83. Authority (serin) (Serinus serinus (L.)) - in the autumn-h period imniya - rare
84. Bullfinch (Pyrrhula pyrrhula (L.)) - in the autumn - winter - incl. in the population. places
85. Grosbeak (Coccothraustes coccothraustes (L.))
86. Gray (Field) Bunting (Emberiza calandra L.) - in open areas
87. Yellowhammer (Emberiza citrinella L.) - in the autumn - winter period
88. Black-headed Bunting (Emberiza melanocephala Scopoli)

As it can be seen from List 1, there are 88 types of birds. For a territory of such size (the site and its surrounding territories) this is a significant number of species.

The species, given in List 1 however, are not to be considered the full (final, the possible maximum) species composition of the birds in the area, as especially during seasonal and other migrations here can be registered significantly more species. For example – in this part of the country one can also encounter the following species: birds - black stork (C*iconia nigra* (L.)), Lesser Kestrel (*Falco naumanni Fleiche*r), hunting pheasant (*Phasianus colchicu*s L. *ssp*.), Roller (*Coracias garrulus* L.) - during seasonal migrations, Tawny Pipit (*Anthus campestris* (L.)), Garden Warbler (*Sylvia borin* (Boddaert)), Shrike (*Lanius minor* Gmelin), pastor (*Sturnus roseus* (L.)) - very rare, Spanish Sparrow (*Passer hispaniolenssis* (Temminck)), etc.;

The most numerous birds are the southern nightingale, oriole and chaffinch, and in the arable agro landscapes – the skylark. In urban areas, most numerous are the domestic sparrow, urban swallow, after them - the rural swallow, semi-wild dove, turtle, starling, the great tit, goldfinch and others. Furthermore, in various parts of the region during different seasons and periods (mainly during the autumn-winter) a large number of species concentrate and feed (mostly in open areas) like the goldfinch, periwinkle, siskin, linnet, chaffinch, mountain finch, bunting, common starling, propagation crow, jackdaw, and others.

As indicated above, the species composition in Schedule 1 is for the region, where the site will be located - the site's own territory (in the wooded, rising to the south land mass) plus its adjacent areas. From this very large territory, the area of the IP covers a very small proportion, respectively percentage, and it is mainly a wooded area. In this case relevant are the species that are most closely related to the site – the ones who use it for breeding grounds (nesting in this case - marked with "P") and those for whom the territory is an important food base (List 1a)

List 1a.

Birds (Aves)

1. Common Buzzard (Buteo buteo (L.))
2. Blackthorn kestrel (Falco tinnunculus L.)
3. Woodcock (Scolopax rusticola (L.)) - in the autumn-winter period
4. Partridge (Perdix perdix (L.)) - in open areas around the site
5. Quail (Coturnix coturnix (L.)) - in open areas around the site
6. Wood pigeon (Columba palumbus L.)
7. Dove (Streptopelia turtur (L.)) - P
8. Common Cuckoo (Cuculus canorus L.) - P
9. Field Lark (Alauda arvensis L.) - in open areas around the site
10. Black-headed Wagtail (Motacilla flava feldeggi Michaheles)
11. Nightingale (Luscinia megarhynchos CL Brehm) - P
12. Kos (black Thrush) (Turdus merula L.) - P
13. Mavis (Turdus philomelos CLBrehm) - P
14. Black-headed Warbler (Sylvia atricapilla (L.)) - P
15. Common whitenecked Warbler (Sylvia communis Latham) - P
16. Redbacked Shrike (Lanius collurio L.) - P

17. Hoodie (Corvus corone cornix L.)
18. Jay (Garrulus glandarius (L.)) - P
19. Oriole (Oriolus oriolus (L.)) - P
20. Periwinkle (Carduelis chloris (L.)) - incl. in the population. Places - P
21. Goldfinch (Goldfinch) (Carduelis carduelis (L.)) - incl. in the population. Places - P
22. Chaffinch (Fringilla coelebs L.) - P
23. Gray (Field) Bunting (Emberiza calandra L.) - in open areas
24. Black-headed Bunting (Emberiza melanocephala Scopoli)

As it can be seen from List 1a, there are significantly less species (almost 3 times)– 24, from which a total of 19 can be listed as nesting, but not every year.

The species from List 1, falling under **Appendix No 2** of the **Law on biodiviersity (LBD)** (SG, n. 77, Section II – Protected areas, art. 6, p. 4 (2) и (3)) – the appendix of animal and plant species, endangered from extinctio, the protection of which is of high priority, are given in **List 2**:

List 2.

1. White Stork (Ciconia ciconia L.)) - breeds in localities

2. Marsh harrier (Circus aeruginosus (L.)) - in the autumn - winter period

3. Corn harrier (Circus pygargus (L.)) - in the autumn - winter period

4. Hen harrier (Circus cyaneus (L.)) - during the autumn-winter period

5. Merlin (Falco columbarius L.) - only in the autumn - winter period

6. Swamp Owl (Asio flammeus (Pontoppidan)) - in the autumn - winter period

7. Bee-eater (Merops apiaster L.) - during the seasonal migrations

8. Syrian Woodpecker (Dendrocopos syriacus (Ehr.)) - mainly in urban areas

9. Collared Flycatcher (Ficedula albicollis Temminck)

- Ssp. Collared Flycatcher (Ficedula albicollis albicollis Temminck) - during the seasonal migrations

- Ssp. Semi-collared flycatcher (Ficedula albicollis semitorquata (Homeyer)) - during the seasonal migrations

10. Pied flycatcher (Ficedula hypoleuca (Pallas)) - during the seasonal migrations

11. Redbacked Shrike (Lanius collurio L.)

As can be seen from List 2, there are listed 11 species from appendix 2 of LBD. This is not a particularly large, but it is a significant number of species, whose protection is of high priority.

The white stork in the area, as well as in other parts of the country nests exclusively in urban areas and other antropogenized (built up) territories. Because of this, the area of the site is not a nesting space for the species, and because of its woody characteristics, and is not a feeding ground for the species either.

From the 4 birds of prey (Falconiformes) (numbers 2-5 in the list), in the area have been seen only species that are circling or flying by. The territory of the IP isn't suitable for nesting for the three types of harriers, which build their nests on the ground, only in open areas (the cane and pasture harriers nest and live in wetlands, including pond areas). In this part of the country only the Western Marsh Harrier has been registered to be nesting. The merlin can be seen in the country and the region only during the autumn-winter period (wintering individuals), and the same goes for the only kind of bird of prey (Strigiformes) – the swamp owl. All 4 types hunt in open areas, so that the area of the IP is not a habitat or feeding ground for them. Individuals of these 4 types could use tree and shrub vegetation of the woodland for resting or for spending the night, but vegetation of this type is of sufficient quantity in the area of the site, so the IP's implementation will not compromise the need for rest and accommodation of individuals of these species in the area.

The common bee-eater – flying and hunting individuals - in the area of the IP has been registered both during the breeding season and during seasonal migrations (including larger or smaller flocks. The territory of the facility lacks the adequate type of nesting sites (steep banks in which couples dig their nesting shelters). The species is of the group, hunting in or from the air - in particular the subgroup of hunting in the air, as the individuals do not hunt close to crops, the implementation of the IP will not effect in any direct way the feeding and nesting of this species. Individuals of this type could use tree and shrub vegetation in the wooded area for resting or to spend the night during seasonal migrations, but the vegetation of this type is in sufficient quantity in the area of the site.

Both the two types of **collared and the pied flycatche**r are registered on the area of the site only during seasonal migrations – while feeding or resting on the area's tree vegetation. The realization of the IP, because of its small size, will take away an insignificant part (as size and percentage) from the feeding grounds in this area of the Kozloduy valley.

From the remaining 2 species, the **syrian woodpecker** is registered in the area, including as nesting, mainly near settlements. In the forested areas, including the IP's site, during the nesting season, the species has not been registered, but this is possible to happen during the post-nesting season (while searching for food). It is also the most-numerous woodpecker species in both urban areas and the lower parts of the country (around 900-1000 m), as only in wooded areas with higher density levels, significant canopy and older plantation, can be outnumbered by the great spotted woodpecker. The realization of the IP, because of its small area size, will take away an insignificant part (as size and percentage) of the feeding grounds in this part of the valley.

The last species – **the redbacked shrike** - inhabits and nests in low tree and shrub vegetation in open areas or sills and thinner forest stretches, including in urban areas, including in Sofia, Plovdiv, Stara Zagora, Nova Zagora, Burgas, Varna, Vidin, Shumen, Silistra, Pernik Sandanski and other cities, but also in villages and in various other built-up areas (yards of industrial plants, warehouses etc.), including their insides. This species is numerous throughout the country, and can be encountered from sea level up to very high altitudes - during the breeding season it has been registered on altitudes over 1600 m or even close to 1800 m (egg peak Mursalitsa " and its neighboring peak to the east, in the Western Rhodopes – 1791.6 m respectively and 1795.2 m - on 22.06.2006 on), and in the end and after the breeding season - and over 2000 m in sub-alpine parts of the mountains Rila and Pirin. Individuals of the species, including their nests were recorded in low tree or shrub vegetation in peripheral areas (sills) of the forested areas (the latter is possible in tree-thinned areas inside, which are present only in the peripherals of the IP area - the dirt road and the big cement channel). The area of IP due to its small size compared to that of the region, in which it falls, will only marginally affect the food grounds and even less the breeding grounds of the species in the area. Besides, my personal opinion is that the place of the last two species is not Appendix 2 of the LBD, which should be only for rare and endangered the country species, as the LBD itself is a document and in particular a Law on biodiversity, but on the territory of our country, and not the entire European subcontinent. If mining activities affected a nest habitat of a nesting couple in the corresponding period (during the year) it will not be a problem for the species to nest in an adjacent place or on a lesser or greater distance from the surface of the object, since suitable habitats are present and sufficient in the area and its vicinity.

From the species above, in the area of the wooded territory, in which the IP falls into, only the rednecked shrike has been spotted during the nesting season. Individuals of the syrian woodpecker can also be encountered in their search for food, but mainly in the autumn-winter period. Only during seasonal migrations (mainly in spring), the two types of collared and the pied flycatcher have been spotted. From the other species, separate individuals could to use the area for resting and spending the night (and most probably have done so, maybe excluding the white stork).

The utilization of the territory to build the NRRAW site, the permanent human presence during its operation, the fence around the NRRAW site, will exclude the possibility for permanent habitats of animal species with the exception of some small mammals and reptiles.

Data on the radiation status of fauna in the region

The livestock production in the area has been studied for presence of radioactive pollutants in the range of the programme of Kozloduy NPP for radio-ecological monitoring of the environment:

- analyzed milk samples from three farms in the region - the town of Kozloduy, Hurlets village and town of Mizia.
- fish (carp, carp, barbel, pike) caught once a month in the cold channel of Danube river (before the NPP) and in the confluence of the hot channel (after the NPP) - more then 2 kilograms each

The results for 2008 [367] show that the main potential contaminant - the plant, had no impact on the radiation purity of milk. The results are for total beta activity, ^{137}Cs and ^{90}Sr are commensurable with the results of the plant's pre-release period. Average total beta activity in 2008 is 37,9 Bq / L, which is below the average 44,0 Bq / L for the period 1972-1974. before placing the plant in service and is comparable with the results for the period 1998 to 2007. For 2008 the content of the technogenic ^{137}Cs was within the maximum detectable range <0,076÷<0,092 Bq/L, and for ^{90}Sr in the range of <7,1÷24 mBq/L with an average value of 12 mBq / L, comparable with the results of recent years. For comparison the activity of ^{90}Sr activity in the cow's milk in the same region after the Chernobyl disaster reaches 450 mBq / L, then gradually declined to 35 mBq / L in 1991.

The results are similar for the presence of radioactive contaminants in fish from the Danube river. The values 0,15÷0,72 Bq/kg f.w for ^{137}Cs и 0,41÷1,13 Bq/kg f.w are ^{90}Sr for 2008 are commensurable with the results of the previous years (1994-2007) and do not show any effect on the ichtiofauna in the basin of the Danube river.

The data given above is in accordance with the report on the results from the radioecological monitroing of Kozloduy NPP.

After the realization of the IP, no significant impacts are expected on the wildlife, including agricultural production, since the NRRAW will be designed and constructed in accordance with the requirements for safety, set out in the regulations and recommendations of the IAEA, the applying of the principle of in depth protection and the building of the NRRAW as a multibarrier engineering structure to impede the spread of radionuclides into the environment, as well as operating the facility in accordance with the principles and rules for safe management of facilities for radioactive waste management. In the EIA report, the impact on fauna is analyzed and evaluated during the period of construction, exploitation and decommission of the NRRAW.

3.5.3.Natural sites. Protected Areas

The investment proposal for a tunnel type NRRAW in biogeographic regionalization, Georgi Georgiev, 2004, is located in territory of the North region, Danube subregion (V.2 - Fig.3.5-7), which covers the territory next to the Danube River with the Prebalkan and the Ludogorie as a south border and Dobrudja – as an eastern border..

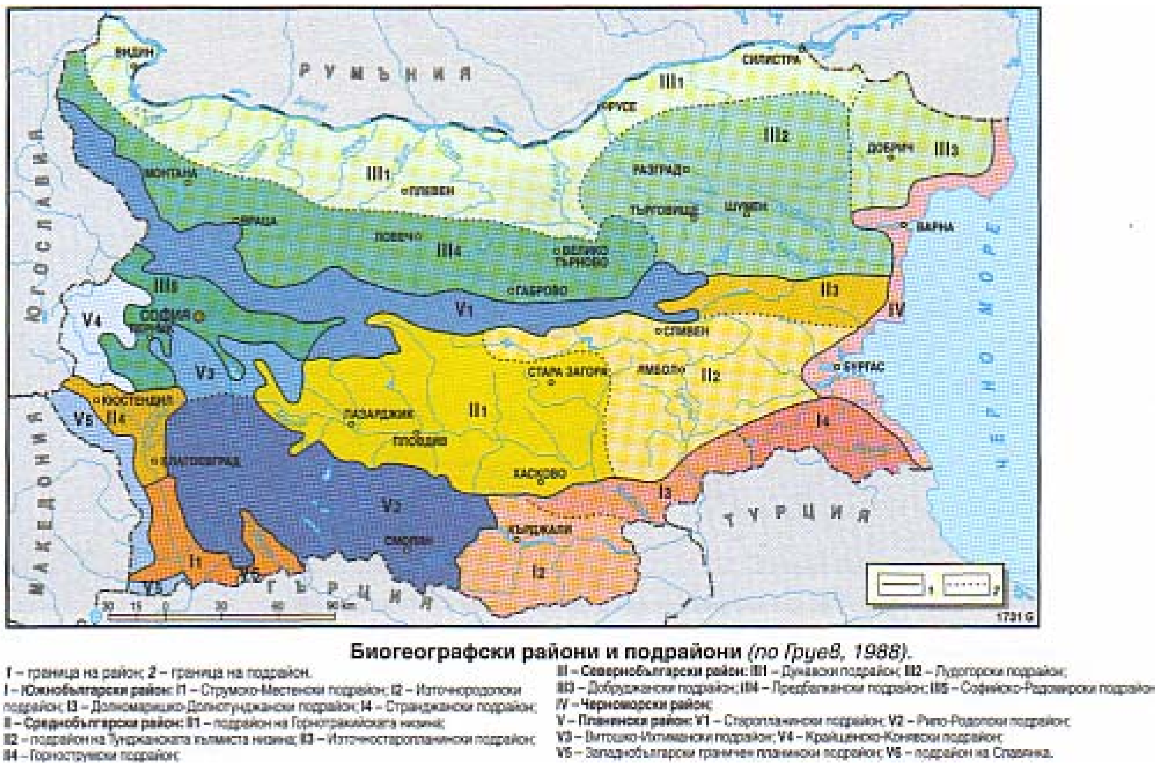


Fig.3.5-7 Biogeographic regionalization

The two-kilometer strip around the Danube river covers protected areas like:

- Reserves (2) with a total area of 55,4 ha. ;
- Maintained reserves (3) with a total area of 1 311 5 519 ha.;
- Landmarks (2) of the total area of 3, 0 ha.;

- Protected areas (20) covering 8069, 6986 ha;
- Park (1) with a total area of 762, 2 ha.

Under the programme for environmental protection of Kozloduy Municipality for the period 2004 2010 [], on the territory of Kozloduy Municipality there are no natural monuments and physical-geographical formations with a conservation value of national or protected areas.

Protected natural object is the deposit of Badurche (yellow water lily), located in dike No. 2, which has appeared in the last 7-8 years due to the created microclimatic conditions.

As unique in the municipality can be considered specimens of old oak trees, over 100 years, but only one tree was declared venerable according to the RIEW Vratsa environmental report for 2008. The oldest tree, Damforov durmast, aged 680 years, is off about 24 km southeast, between the villages and Galiche and Altimir, in the area Gorne Livade In the Lazarovtsi area, in the village of Sofronievo, there are four oak trees, aged from 170 to 300 years. These trees are preserved and develop normally.

The historical place of "Botev Park", with an area of 16.3 hectares was proposed for a protected area, but it was not accepted. The area Kozloduy, with an area of 10.0 hectares was declared a protected area (before it was a historical area). Subjects of protection of the protected area Kozloduy is the maintenance of the landscape in accordance with the "Ostrovsky marsh and the swamp of Orsoya (outside the Municipality of Kozloduy, a distance of 28 km east of the Radiana site) were declared protected areas for plant species. The Ibish Reserve, covers the homonymous island, where nesting colonies of rare water birds are located; it stands at a distance of 24 km west of the site outside the municipality of Kozloduy.

According to data of the *Regional Directorate of Agriculture - Vratsa* [393]in the range of 30 km zone around the site Radiana falls the protected areas "Kochumina", "Gola bara" and "Kalugerski grad - Topolite" in the village Selanovtsi, Oryahovo Municipality as well as "Koritata" and "Daneva mogila"in the village Sofronievo, Mizia municipality, Vratsa region.

Sensitive areas within the municipality are the so called "Wetlands". The nearest "wetlands" around the lake "Shishmanov val", the islands and the Danube, are all located a distance of 5-10 km from the Radiana site. There grows hydrocharition vegetation like cane, purple loosestrife, cattail, katushka, willow herb and some rare species. The plants are also a transitional bases for spring and autumn migrations of many rare species of birds. Sensitive areas are all water bodies in the Danube catchment, according to data from the Danube Basin Directorate, with center Pleven.

Given the above mentioned distance from the Radiana site, after the implementation of the IP are not expected any significant impacts on the protected areas. Below will be analyzed and evaluated the expected effects of the NRRAW on biodiversity of protected areas and the natural environment surrounding them.

Table.3.5.10 Protected territories on the two-kilometer stripe of the Danube river, Kozloduy

Code of PT №	**Name of PT**	**Announcement goal**	**Announcement date**	**Area, ha**	**Settlement**
1.	Maintained reserve (MR) „Ibisha"	Typical Danube island communities, floodplain forests and swamps inhabited by protected species of plants and animals	15.10.1999 г. RD-394	34,3	Dolni Tsibar
2.	PT „Kozloduy"	Historical place – landscape protection	26.05.2003 г. SG 60/ 2003 г.	10,0	Kozloduy
3.	PT „Kochumna"	Water lily deposit	26.05.2003 RD 642, SG60/ 2003	2,5	Selanovtsi
4.	PT „Gola bara"	Water lily deposit	26.05.2003 RD 643, SG60/ 2003	2,0	Selanovtsi
5.	PT „Kalugerski grad"	Staritotes aloides deposit	26.05.2003 RD 644, SG60/ 2003	0,2	Selanovtsi

It is necessary that the typical biodiversity of the object is restored after the new changes so that the terrain is easily integrated with its surrounding environment.

The local and controlled range of the NRRAW (tunnel type) has an insignificant territory effect. The protected territories and zones are protected by the surrounding hills and gorges, as well as by the process of deep storage and burial. The presented information so far proves that the effect that the IP will have on the environment will be insignificant, mainly in events of an emergency breakdown.

3.5.4. Protected zones under NATURA 2000

The two-kilometer striper near the Danube covers protected areas, and namely under:

· Directive 92/43/EEC (for the Habitats, 33 ed.) Total area of 16 660, 7710 ha. ;

· Directive 79/409/EEC (the Birds, 1 ed.), A total area of 448,2 ha.

The representative data for protected (and close to the NRRAW site) zones are shown in table 3.5.11, and the position of the IP "Radiana site" – on fig 3.5-8

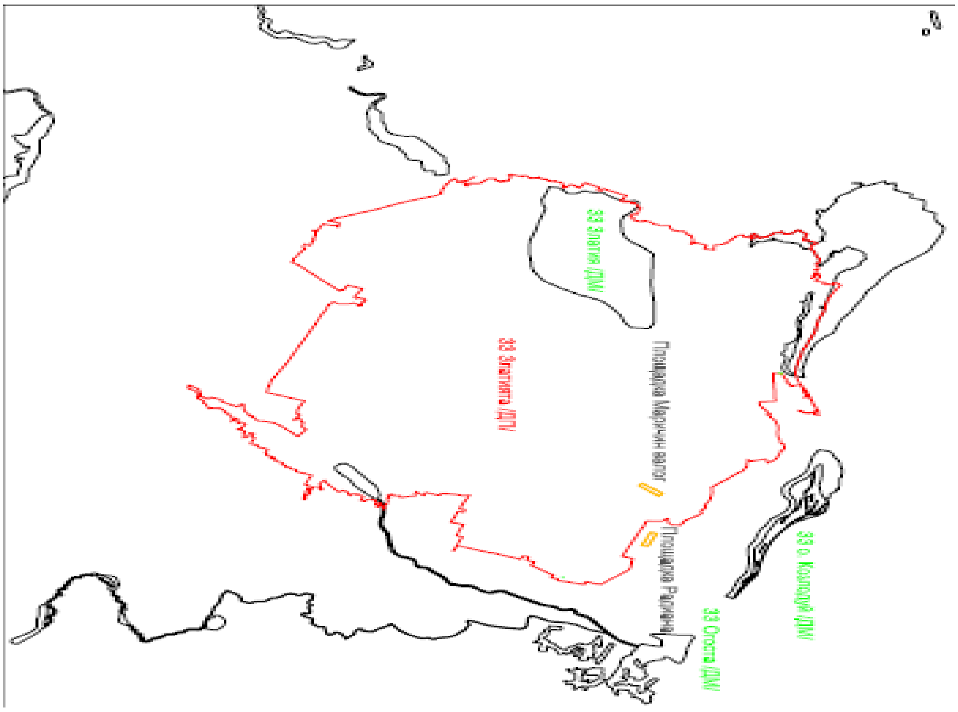


Fig. 3.5.-8. Situation of the IP „Radiana site" in accordance to its surrounding protected zones under the European ecological network NATURA 2000

The protected territories under Natura 2000 on the territory of Kozloduy Municipality, are "Zlatiyata" (code BG0000336) [297] under Directive 79/409/EEC on the Birds [118], and under the 92/43/EEC Habitats Directive on protected areas are the "Kozloduy loess wall"(code BG0000527),[295] "Kozloduy Islands" (code BG0000533), "Ogosta River"(code BG0000614) [298] and "Tsibar" (code BG0000199) [299]. For the nearest protected area – "Zlatiyata" (2-3 km distance from the ground radio) DP RAO has sent a notification to MEW under the *Ordinance for assessing the compatibility of plans, programmes, projects and investment proposals with the object and purposes of conservation of protected areas*[3].

The presented data is for the protected areas nearby, but outside the Kozloduy NRRAW site, are as follows:

Table.3.5.11 Protected territories on the two-kilometer stripe of the Danube river, Kozloduy

№.	**Code and name of the territory:**	**Announced under Directive**	**From date**	**Area, ha.**
1.	**BG0000199 „Tsibar"**	92/43/EEC (on habitats)	**11/2 006**	**2 968,43**

Еко Енергопроект ООД

2.	**BG0000527 „Kozloduy"**	92/43/EEC (on habitats)	**11/2 006**	**125,3778**
3.	**BG0002009 „Zlatiyata"**	PT under the Directive on birds, which covers PT under the Directive on habitats	**02/2 008**	**43 494,44**
4.	**BG0000336 „Zlatiya"**	PT under the Directive on habitats, which covers the PT under the Directive on birds	**02/2 008**	**3.194,78**

The closest protected territories under Directive 92/43/EEC (On habitats) on the territory of the republic of Bulgaria are as follows:

1. Protected territory ",Kozloduy Islands" with code BG 0000533, situated 4 km to the north of the IP site (Radiana).

Subject to conservation area the following types of habitats: 3130 Oligotrophic to mesotrophic standing waters with vegetation of Littorelletea uniflorae and / or Isoeto-Nanojuncetea; 3270 Rivers with muddy banks and Chenopodion rubri Bidention ; 91 EC * Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Pandion, Alnion incanae, Salicion albae); 91 F0 Riparian mixed forests of Quercus robur, Ulmus laevis and Fraxinus excelsior or Fraxinus angustifolia along the great rivers (Ulmenion minoris). According to the Natura 2000 standard form existing activities outside the area which have negative impacts on it are: "Artificial forestation," "Forestry felling, 'Erosion" and "Invasion of a species". The properties concerned by the Radiana site, are from the State Land Fund with UCP - Forests in the land fund for the needs of agriculture. In this case, the realization of the NRRAW will remove some of the trees on the site (almost entirely in the modular version. The removal of this vegetation, especially in the tunnel type repository cannot cause really significant negative impacts on the area itself, due to its remoteness and the presence of strong fragmentation between the site and the area - roads, located close arable land, urban environment (Kozloduy), the Danube itself and others. Even more, some of the trees on the site may be referred to as invasive species (sofora and aylantus).

2. Protected territory ",Ogosta River" with code BG 0000614, situated 6 km to the east of the IP – the Radiana site.

Subject to preservation in the zone are the following types of habitats under Appendix I of Directive 92/43/EEC: 3150 Natural eutrophic lakes with vegetation types or Magnopotamion Hydrocharition; 3260 flat or mountainous rivers with vegetation Ranunculion fluitantis and Callitricho-Batrachion; 3270 Rivers with muddy banks with Chenopodion rubri and Bidention pp; 6250 * Pannonian loess steppe grasslands; 91 EC * Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Pandion, Alnion incanae, Salicion albae); 91 ZO Moesian silver lime woods. According to the Natura 2000 standard form existing activities outside the area which have negative impacts on it are: "Mining of sand and gravel", "Management of water fields, 'Use of Pesticides," fertilizer " and "Grazing " . The nature of the IP does not imply the implementation of any of these activities.

3. Protected territory "Kozloduy" with code BG 0000527, situated 12km to the north-west from the Radiana site (the IP).

Subject to conservation in the territory are the following types of habitats under Appendix I of Directive 92/43/EEC: 6250 * Pannonian loess steppe grasslands. According to the Natura 2000 standard form existing activities outside the area which have negative impacts on it are: "cultivation" and "General forest management. The nature of the IP does not imply the implementation of any of these activities, and besides, the IP site is on a significant distance from the protected territory, and its space is almost entirely occupied by arable lands.

4. Protected territory "Zlatiya" with code BG 0000336, situated 14 km to the west of the IP site (Radiana).

Subject to conservation in the territory are the following types of habitats under Appendix I of Directive 92/43/EEC: 6250 * Pannonian loess steppe grasslands. According to the Natura 2000 standard form existing activities outside the area which have negative impacts on it are: "cultivation" and "General forest management. The nature of the IP does not imply the implementation of any of these activities, and besides, the IP site is on a significant distance from the protected territory, and its space is almost entirely occupied by arable lands, including the dam "Shishmanov val".

5. Protected territory "Tsibar" with code BG 0000199, situated 20 km to the north-west from the IP site (Radiana).

Subject to conservation in the territory are the following types of habitats under Appendix I of Directive 92/43/EEC: 1530 * Pannonic salt steppes and salt marshes; 2340 * Pannonian inland dunes; 3130 Oligotrophic to mesotrophic standing waters with vegetation of Littorelletea uniflorae and / or Isoeto-Nanojuncetea; 3150 Natural eutrophic lakes with vegetation of the Magnopotamion type or Hydrocharition type; 3270 Rivers with muddy banks with Chenopodion rubri and Bidention pp; 6250 * Pannonian loess steppe grasslands; 91 EC * Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Pandion, Alnion incanae, Salicion albae). According to the Natura 2000 standard form existing activities outside the area which have negative impacts on it are: "cultivation", "General management of forests and urban areas, areas inhabited by humans. does not imply the implementation of any of these activities near the zone, considering its considerable distance from the site.

3.6. Landscape

Short descriptions of the main features of the structure and functioning of the landscapes in the region in question

The landscape is considered as natural-territorial and geographical complex with a specific structure and appearance, human environment and natural genetic fund, resources, social environment.

According to the taxonomic system of regional units in landscape regionalization of the country (P. Petrov, Geography of Bulgaria in 1997) the site falls within the Severobalgarska zonal area of the Danube Plain, the North Dunavskoravninna subarea; Zlatiyski area.

According to the classification system of landscapes in Bulgaria, it falls under the planar landscapes class; Type - landscapes of the temperate steppe, meadow-steppe and forest-steppe plains; Subtype - landscapes of humus-steppe plains; Group - Landscapes of humus-steppe plains of loess rocks with high agricultural utilization; Group - Landscapes of humus-steppe plains on carbonate rocks with moderate agricultural utilization.

Each landscape area differs from the adjacent areas by its local variance of the rock substrate mezorelief, horizontal and vertical landscape structure. In the lowland areas, landscape areas are determined mainly by combinations of groups of landscapes; in the mountains - the present range of altitude landscape zonality. From a geoecological perspective, it is necessary to take into account the anthropogenic factor. Anthropogenic activities cause changes in microclimate and local climate.

The degree of the landscape's resistance to external influences is determined by the most sustainable natural geocomponents – the morpholitogeneous foundation. According to it are defined the landscape classes.

The rock base is considered the most stable and slowly changing. For the most dynamic and rapidly changing components are considered the biogeneous ones. In this sense, the biocenoses have a very important role in the morphological differentiation of landscapes. In each phase they are accompanied by a unique microclimate and determine the formation of the microlandscapes.

Weakly affected by the antropogenous activity in Bulgaria are only the medium and high mountain landscapes.

Most strongly affected by man natural geocomponents are the soils and waters

In the lower mountain landscapes, the initial oak forests were destroyed long ago, naturally replaced by lowstem hornbeam or oak shrubs or artificially planed with Austrian pine.

As a result of the agricultural utilization of the land resources, the natural vegetation has been destroyed. The geochemical balance of the soils has also been changed, which leads to landscape changes as well.

The industrial utilization of the territory of the country has lead to a significant pollution in parts as well as serious degradation of the landscapes. The pollution is especially strong at the bottoms of the inner mountain valleys.

The current condition of separate components of the landscape are analyzed in separate poinst of the Report. Following is an analysis of the aesthetic side of the landscape.

The EIA report analyzes alternatives for the placement of the site, as well as alternatives for the proposed technologies and motives of the current choice.

For alternatives of the RAW burial technology, a preproject (preinvestment) research has been carrie dout for the burial of low and intermediate short-lived radio-active waste in a repository, close to the surface, trench or tunnel type. The generally accepted principles on RAW management define the need for their collection, processing, packaging and storage in a manner that ensures environmental protection and human health, so that they will not be a burden for future generations. In this regard, several alternative are reviewed and evaluated.

5 sites were proposed for the placement of the site: „Marichin Valog", „Brestova padina", „Varbitsa", „Radiana" Kozloduy. Additional research was carried out on the proposed sites so that the most suitable for NRRAW construction could be chosen.

After a precise analysis of certain criteria, the site in the area of Hurlets, Kozloduy Municipality, Vratsa region was chosen. The Radiana site is located close to Kozloduy NPP. From the north it is restricted by a road, controlled by the Kozloduy NPP, and from the south – the municipal Hurlets – Kozloduy road. It stands 3.2 km to the southeast from the regulation line of Kozloduy, 6.6 km to the southwest of the construction boundaries of Hurlets and about 4.0 km southwest of the right bank of the river Danube.

The status of the land intended for the NRRAW construction and the terrain around it is a public private property, with the State Land Fund as an owner (61.9 ha) and small privately owned municipal land (0.74 hectares) and municipal public property (0.11 hectares). In September 2008 a procedure for ingress into a forestry fund of afforested or self-afforested land has been conducted for lands No. 00231 and No. 000238 by the SFA – Oriahovo in compliance with the Forestry Act. A procedure (taxation characterization and change of purpose) is to be conducted in the next stage under the Forestry Act and its Rules of application [192]

The terrain is mainly forested with acacia vegetation and lowstem vegetation.

The site of the national repository and its facilities take up an area of 36 ha, and its capacity will be 138 200 m^3.

The lands and soils in the area of the NRRAW site – subject to the IP from SE RAW (Radiana) as a whole are not seriously affected by industrial activity. The soils of the Radiana site are not notably affected by a radio-active contamination, caused by the operation of Kozloduy NPP.

The site, provided for the construction of the NRRAW consists of mainly forested and self-forested land, a dirt road and an irrigation facility.

Sanitary protection zone of the site fall under the three-kilometer protection zone of Kozloduy NPP.

With the construction of Kozloduy NPP, the local landscape had been changed from aquatic (the river Danube), agricultural and foresty landscape to anthropogenic – (result of human activity, which changes to a different degree some of the natural components.

At the moment, the local landscape of the region is industrial, on the boundary with agricultural and foresty landscape. With this change, the main landscape type (according to the landscape classification system) has been conserved.

Falling under the anthropogenic landscape are most of the modern landscapes, but they are also an important part of the activities for rational usage of natural resources and the environmental protection.

Depending on the predominant feature of the territories of the landscapes, they can be differentiated into certain groups - metropolitan (urban), agriculture (agricultural), water and nearwater, roadsides, industrial, etc. Similar classifications reflect the impact of man-made objects, structures, territorial complexes and linear structures on the appearance of the landscape, the specific changes that occur in natural environmental components and their ecological unity.

Functional problems are connected mainly with the degree of suitability of the landscape to accommodate the various human activities within the functional structure of the territory and the compatibility of the main function with the attendants ones.

As natural resources are limited and human activities – multiple and various, it is necessary that the approach, when planning the issues of the territory, is multi-functional, so that a reasonable compromise can be found between the needs of society and the capacity of the landscape. The proper solution of the functional structure reduces the risk of complex environmental, economic and aesthetic problems.

For the protection of the landscape in Bulgaria, apart from the Bulgarian legislation, the European Landscape Convention [120] also plays an important role - ratified on 13.10.2004 / SG issue 94/October 22nd 2004 / in force for the Republic of Bulgaria since March 1st 2005

The Convention is based on the idea that there is a single landscape, each component of which is important for someone and that both the cultural and natural aspects are relevant to the character and explains its present condition. The main objective of the Convention on the landscape is to preserve Europe's cultural and natural heritage that defines the appearance of pan-European landscape. To achieve this objective, the Convention brings together the efforts of contracting parties and organizes an effective cooperation for their implementation at European level, while supporting them to develop a policy for the protection, management and planning of European landscapes at a national and local level. Another objective of the Convention is to demonstrate that natural and cultural components of the landscape can be protected and enhanced and without them being declared as monuments.

The two main aspects of the convention are:

- accepting the value of all landscape components and their role in providing the quality of human life and their originality.

- the active role of society when accepting and evaluating the landscape.

Different systems of influence are grouped into zones. Part of the territory bordering with the international zone is defined as a zone of influence, having a direct contact with the specific treatment area

- d*irect zone of influence* - comprises an area with a radius of 3 km (Sanitary-protection zone of Kozloduy, in coordination with the Ministry of Health, from 3000 m is observed).

- i*ndirect zone of influence* - comprises an area with a radius of 30 km

The total area of the municipality of Kozloduy, in which is the Kozloduy NPP is 284,874 ha. The population in the 30-km surveillance zone around the NPP 31.12.2002 according to data from the National Statistics Institute (NSI) is 66,993 people. In this area are carried out sample analysis of the air, soil, vegetation, waters of the Danube river and potable water. The dynamic readings show no risk of adverse effects, associated with excessive levels of contaminants.

The extended influence zone is the whole territory, bordering with the given zone.

Status and potential of the natural landscape and environment conditions are a factor for the development of elements of industrial infrastructure.

Each landscape has its own aesthetic capacity determined by its external structure and ecological capacity, determined by its internal structure. Aesthetic capacity is determined by the limit in which are maintained both the visual aesthetic unity and harmony of the landscape. Environmental capacity is determined by the self-preservation mechanisms of the landscape, providing for the maintenance of existing ecological balance.

3.7. Waste

On the territory of the Radiana site there is no accumulated waste from past activities.

3.8. Hazardous substances.

On the territory of the Radiana site, there is no presence of permanent or temporary storage of substances, classified as "hazardous" (oil containers, petrol products, etc, pesticides or any other plant protection products.

3.9. Risk energy sources

3.9.1. Non-radiation factors

Thermal influence of NPP “”Kozloduy” on the environment

One of the non-radiation factors is the heat production, which is typical for a nuclear power plant, but its effect on the IP site is not significant.

The site will have buildings and installations, and each of them can be a source of influence on the environment, but only locally and insignificantly so.

The proposed NRRAW will not release cooling water and therefore will not have a thermal effect on the Danube.

Electromagnetic fields

Electromagnetic radiation at different wavelengths is another non-traditional factor for an environmental impact. The parameters of the EMF with ELF do not exceed the permitted standard norms. The requirements for sanitary - protective zones around the substations and high voltage power lines are also met. On the sites with registered deviations, as a rule, people cannot live very long. The effects of these harmful physical factors on humans and the environment from the chosen NRRAW construction site are negligible.

Noise and vibrations. Characteristics of the host environment (current condition)

Noise is a constantly active harmful physical factor. There are no noise sources in the area of the future NRRAW site that can generate noise, above the typical noise levels of the NPP itself.

The site, provided for the building of the NRRAW is located to the Kozloduy NPP site in the Radiana area. Currently, there are no sources of noise there. Noise sources in the area are transport vehicles, using the the II-11 road, the road leading to the Kozloduy NPP main entrance and the nuclear production site of the plant.

The noise characteristic of the traffic flow on the II—11 road (equivalent noise level Leq, dBA), based on the data on its traffic load for 2010, provided by REA is 69.6 dBA per 7.5 m. from the axis of the traffic with a maximum speed of 80 km/h. According to data from the EIA report for Kozloduy NPP from 1999, the noise levels on the periphery of the site are considerably lower than the normative level of 70 dBA. The town of Kozloduy stands about 3 km away from the NPP site and its activity is not a source of noise on its territory.

Overall, the increased level of backgrounds noise, typical for the plant does not effect the residential areas of the town of Kozloduy.

3.9.2. Radiation emissions

[148], [152], [162]

The NRRAW site is located within the three-kilometer zone around Kozloduy NPP. It is a well-known fact, that, to assess the impact of Kozloduy NPP on the environment and the population, 3 zones of control with different radii are formed around the plant: radiation protection zone – RPZ /3 kilometers/, controlled zone – CZ /12 kilometers/ and observed zone – OZ /up to 100 kilometers/. Laboratory and automated control of the environmental elements is performed. A total of 36 control stations for the land ecosystem and 7 stations for the water ecosystem are established in the observed zone, that gather samples for laboratory analyses and measurements of the activity of the technogenic radionuclides in the samples. The air, soil, vegetation, waters, and bottom sediments, are analyzed, and the gamma-radiation background is measured. Almost all posts are located within the 12-kilometer controlled zone; outside this zone are the three benchmark stations in Lom, Pleven and Berkovitsa.

Radiation emissions are currently formed by gaseous emissions from the ventilation units of Kozloduy NPP and the special casings, located at the industrial site. It is proved by the reports of the RM[367, 375, 376,377, 378] department that such radiation emissions do not alter the radiation background during normal operation. In Section.3.1.2 of the present report there is data on the radiation rays.

The packages and containers for the transport of RAW are licensed and protect from the radiation of alpha-emitters, as well as beta and gamma emitters up to the allowed control dose.

In addition to the radio-ecological monitoring in the 100-kilometer observation zone around the NPP, radiological measurements are performed on the work site. The gamma-radiation background, the subterranean waters, the air, the atmosphere depositions, the vegetation and the soil are controlled. The charge of the equivalent dosage of the gamma-radiation is measured by 10 thermo luminescent dosimeters

/TLD/ on the fence of the NPP, 20 TLD around the facilities of SD RAW-Kozloduy and 10 on the fence of RSNF.

The lack of impact outside the fence of the protected zone from the radiation rays resulting from the operation of the reactors of Kozloduy NPP is proven in the reports of RM department and MEW

The gamma-radiation background has common values for the region of 0.07 – 0.14 μSv/h, which is within the range of the natural radiation background. [367]

3.10. Historical and cultural heritage

In connection with the preparation of a report on the evaluating of environmental impact of the future construction of a national repository for disposal of low and medium radioactive waste and according to the "Terms of Reference for the evaluation of environmental impact", the Regional History Museum of Vratsa informed that in the area is registered a Thracian mound necropolis. According to Art. 161 (1) of the Law on Cultural Heritage, SG 19/March 19th 2009, it is necessary that preliminary archaeological studies (Field walks) be carried out to determine whether the excavation work will affect or distort the non-movable cultural valuables.

In the 3-km radiation protection zone around the NPP, where respectively facility will be located, there are no any shrines, buildings of architectural value or places of cultural significance.

After site visits and conducted field patrols around the perimeter to build a national repository for disposal of low and medium kratkozhiveeshti radioactive waste in the "Mounds", located on the territory of the Municipality of Kozloduy it was defined that one of four existing falls within burial mounds arranged equidistant from one another in a series of east-west direction. Periphery of the mound is cut from two sides and it can be seen partially destroyed profiles. For purposes of this EIA it was commissioned to undertake archaeological research - geodesic and geometric by the team of specialists from the Laboratory of Experimental arheometriya and archeology at New Bulgarian University.

Subject of the research are 5 (6) mounds, situated to the south and east of Kozloduy NPP, from both sides of the Hurlets – Kozloduy road. They are basically situated on one axis with a deviation of 10^{o} southwards. The maximum distance between the mounds, furthest to the east and west in the complex is 11 500 m.

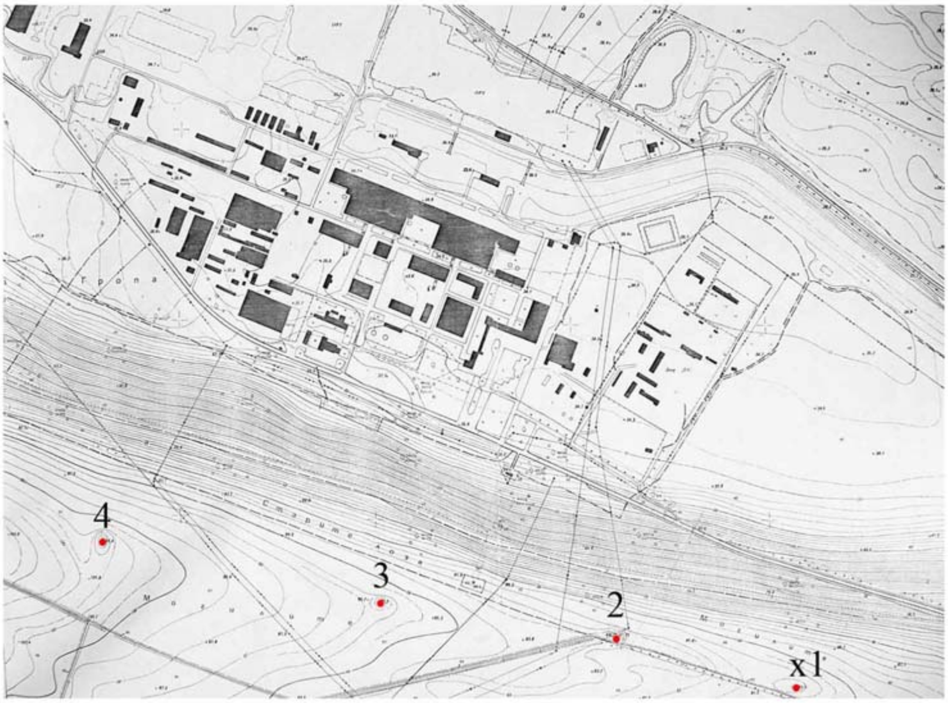


Fig. 3.10-1 Topographic map 1:5000 (1985)

The mounds, established through local and satellite image analysis, are numbered accordingly 1, 2, 3 and 4 (from east to west) and mounds A and B, also from east to west. The whole area, where mounds 2, 3 and 4 are placed is called "Mogilite". In the report, the mounds are characterized with their coordinates, size and archaeological characteristics; this has been done for the western group (2 – 4), but not for the mounds of the eastern group as they have not been studied yet, because of the strictly guarded terrain in the close vicinity to the Kozloduy NPP entrance.

- ***Mound №2*** (Maguraluy Sherbanoy) has a base size of about 45-40 m, and preserved height in the concrete benchmark - 5.10 m. The mound was a subject of numerous anthropogenic interventions and completely lost its original appearance - its southern periphery has been destroyed during the construction of road No. 11 between Hurlets and Kozloduy; the western periphery has also been destroyed by unknown reasons. In the northern part of the mound there is quite a large pit, and on its highest point (in the south) there is a concrete post. Archeological studies have been made on the mound through the preparation of profiles, during which archeological findings were discovered - pieces of pottery. Since mound No.2 is under a high-voltage transmission line, that affects the geomagnetic field, no geomagnetic research has been made.

Mound №3

- *Mound №3* is the smallest of all studied mounds. It has a base size of 50-50m, and preserved height of 1.5 m. It has been strongly affected by agricultural land cultivation and as a result of systematic plowing, the mound's peak is very rounded, and its periphery too rolling. After the geomagnetic studies of the mound and the analysis of the anomalies found, the presence of a rectangular structure was established, orientated north to south or of a big funeral pyre. There are also indications of the presence of iron objects (weapons, horse ammunition elements) and small fireplaces, indicating the rituals associated with the stages of accumulation of the mound.

Mound №4

- *Mound №4* (Maguraluy Krastoy) has a base size of 60-70m, and preserved height of 4.5 m. Despite the large displacement of the center of the mound, it has also been subjected to cultivation by agricultural machines and the most heavily affected part is the southern periphery of the mound. The results of geomagnetic survey indicate the presence of a large funeral pyre in the center of the mound.

The described sites are characterized in detail and indicated on the maps of the appendix of the report, made by the experts from the laboratory on archeometrics and experimental archeology at the New Bulgarian University.

Table 3.10.1 Distance between the mounds

Mound No	Metres	Deviation
4-3	725	98,3º
4-2	1335	100º

4-1	2750	100,5°

During the inspection, there were no other non-movable objects, part of the historical or cultural heritage in the perimeter for the construction of the National repository

3.11. Demographic, social and socio-economic conditions. Health and hygiene aspects of the environment

Description of demographic, social and socio-economic conditions (eg employment) in the region of the investment proposal.

Demographic conditions

The National Repository for Radioactive Waste will be built in northwestern Bulgaria, on the land of the town of Kozloduy. The selected site - “Radiana” is situated to the south of Kozloduy NPP, near the village of Hurlets, Kozloduy Municipality, 6.6 km away. It stands 3.5 km to the southeast of the town of Kozloduy, next to the southern border of the Kozloduy NPP site and about 4.0 km southwest of the right bank of the Danube. The site has an area of 36 ha. The “Radiana: site is situated within the three-kilometer radiation protection zone around Kozloduy NPP.

The data on the location of the site shows that there are no sites in close proximity to a specific sanitary protection status. No recreational areas, hospitals, sanatoriums, schools, protected areas, sanitary protection zones around water supplies and facilities for potable water are situated in the region. The “Radiana”site is situated in the 3 km radiation protective zone of Kozloduy NPP. It is not used for agricultural purposes. There are no built gas or oil lines. The airspace above the site is not crossed by corridors of civil airlines.

Around the Kozloduy NPP a 30 kilometer controlled zone is maintained, in which measures for radiation monitoring and emergency planning are taken.

The Demographic characteristics of the area is provided for by data from the NSI. Up to 31.12.2009, the population of the Vratsa and Montana regions, falling partially or entirely under the monitored 100 km is 352 728 people with an average density of 63.2 people/km^2. If the conservative population on the Romanian side of the Danube is also taken into account, the density becomes under 59.6 people/km^2.

Most of the population live in the town of Vratsa (57.6%), as this aspect is lower than the data from the other parts of the country (an average of 71.4% town population). The sex correlation is close to the average for the country – 1067 women for 1000 men. In Vratsa it is 1064. Age dependency ratio is higher than the average for the country (45.1%), and 49.9% respectively for Vratsa.

Natural growth is negative (Table 3.11.43) as it is for the whole country, but with expressed less favorable trends 3.5 ‰ Total for the country, - 9.4 ‰ for the Vratsa region and, mainly at the expense of the low natural growth in the villages.

This tendency is expected to increase in the following two years, not only as a demographic, but as a socio-economic process.

Table. 3.11.1 Natural growth dynamics on a base of 1 000 people of the population

Natural growth dynamics on a base of 1 000 people of the population									
		2004			2006			2009	
	Natural growth (‰)			Natural growth (‰)			Natural growth (‰)		
	Total	Towns	Villages	Total	Towns	Villages	Total	Towns	Villages

Total for the country	**-5,2**	**-2,6**	**-11,1**	**-5,1**	**-2,1**	**-12,4**	**-3,5**	**-0,7**	**-10,8**
Vratsa	-10,0	-3,5	-18,5	-10,3	-3,8	-18,9	-9,4	-2,6	-18,6

Because of that, the prognosis for the population for the next 30 years is with expressed negative tendencies. According to data from the NSI, the prognosed quantities of the population are with respectively 45797 and 38427 lower in comparison to 2010 (Table. 3.11.44)

Table. 3.11.2 Population prognosis in the Vratsa region

Population prognosis					
	Years				
	2010	2015	2020	2025	2030
Vratsa	193658	180801	169091	158225	147861

The 30-km observation zone around Kozloduy NPP includes, fully or partially, settlements of eight municipalities: Kozloduy, Valchedrum, Hajredin, Mizia, Lom, Byala Slatina and Oryahovo (Table 3.11.45) and about 23 settlements from the Romanian region Dolj, among which are Dăbuleni (13526 inhabitants), Bechet (3963 inhabitants) and 21 other smaller villages[1].

The analysis of the demographic situation in the region shows a steady tendency for decrease of the population – the total population in 2002 was 66,993 people, in 2004 - 63,800 in 2006 - 61,755 in 2009 - 57,750 people.

As in the country average, the population in the municipalities shows a visible aging trend. The number of people below working age is significantly lower than the number of people over working age. In the Hajredin and Valchedrum municipalities the number of people under and over working age is almost equal.

Table. 3.11.3 Population up to 31.12.2009 in municipalities, falling under the 30 km surveillance zone, by sex and residence (number)

Population up to 31.12.2009 in municipalities, falling under the 30 km surveillance zone, by sex and residence (number)									
Municipalities in the 30-km surveillance zone	**Total**			**In the towns**			**In the villages**		
	total	**men**	**women**	**total**	**men**	**Women**	**total**	**men**	**women**
Kozloduy	22 269	10 925	11 344	13 934	6 914	7 020	8 335	4 011	4 324
Mizia	7 466	3 603	3 863	3 354	1 614	1 740	4 112	1 989	2 123
Oryahovo	12 314	5 922	6 392	5 400	2 568	2 832	6 914	3 354	3 560
Byala Slatina	27 104	13 157	13 947	12 433	5 930	6 503	14 671	7 227	7 444
Hajredin	5 303	2 554	2 749	-	-	-	5 303	2 554	2 74
Valchedrum	10 398	4 967	5 431	3 817	1 813	2 004	6 581	3 154	3 427
Lom	30 198	14 407	15 791	24 300	11 610	12 690	5 898	2 797	3 101

This phenomenon is both due to the decrease in the natural growth, which is up to two-three times lower from the average in the country in the monitored areas and municipalities, an also due to the increase of the average age and population migration.(Table.3.11.46.).

Table. 3.11.4 Natality, mortality and natural growth up to 31.12.2009 г in the municipalities in the 30-km surveillance zone

Natality, mortality and natural growth up to 31.12.2009 г in the municipalities in the 30-km surveillance zone

[1] Romanian Statistical Yearbook. 2 Population 2007.pp:70

Municipalities in the 30-km surveillance zone	Liveborn (number)			Dead (number)			Natural growth (number)		
	total	boys	girls	total	men	women	total	men	women
Total for the country	**80956**	**41312**	**39644**	**108068**	**56849**	**51219**	**-27112**	**-15537**	**-11575**
Kozloduy	222	101	121	337	168	169	-115	-67	-48
Mizia	53	23	30	171	85	86	-118	-62	-56
Oryahovo	87	43	44	301	160	141	-214	-117	-97
Byala Slatina	292	139	153	534	259	275	-242	-120	-122
Hajredin	38	22	16	170	92	78	-132	-70	-62
Valchedrum	101	45	56	279	140	139	-178	-95	-83
Lom	251	118	133	562	274	288	-311	-156	-155

The gender analysis of the population shows a slightly larger portion of women, about 0.8%-1.4% above the average. Gender differences within the working population have the following characteristics: the number of boys and girls below working age is almost equal. The share of men in working age is bigger than the share of women, but that difference is of no statistical importance. The share of men above working age is much smaller then the share of women. This is due to the higher mortality of men in comparison to women above 60-years of age. The main reason for that mortality are cardiovascular diseases. From a socio-economic point of view, that demographic age and gender distribution has very unfavorable characteristics.

The "Radiana" site is in the municipality with administrative center of the Kozloduy municipality. It includes 5 settlements – Kozloduy, Hurlets, Glozhene, Butan and Kriva Bara. The population density in the municipality for 2004 is 87,4 people/km^2. It is comparable to the country average, but it is higher then the average for Vratsa District, where Kozloduy municipality is located. A large part of the population of Kozloduy is still connected socially and economically to the NPP. The demographic profile of Kozloduy municipality is highly influenced by the specifications of the municipal center, Kozloduy city. The existing large industrial facilities and mostly Kozloduy NPP form two distinct types of migration: natural migration from the villages to Kozloduy city and migration of construction workers and specialists from the entire country because of the construction and operation of Kozloduy NPP. Regardless, the total population of the municipality is decreasing, respectively 25115 in 2002, 24779 in 2004 and 23 126 in 2009. These negative trend follows the general negative trend of population decrease in the country.

Table 3.11.5 Population of Kozloduy municipality by July 21st 2009

Location	Total	Male	Female
Kozloduy	14 566	7 198	7 368
Hurlets	2 181	1 077	1 104
Glozhene	2 909	1 432	1 477
Butan	3 022	1 437	1 585
Kriva Bara	448	213	235

More than half of the Kozloduy population live in the town (13043), with an insignificant dominance of women (7109 women for 7004 men). The Kozloduy Municpality is one of the two municipalities in the Vratsa region with a predominant town population.

The population dynamics is related to its age structure (Table 3.11.48). From the total number of inhabitants on the territory of the municipality, 64% of all the inhabitants are of a working age. Under working age (0-17 year olds) are 19% and people above the working age (60 years for women; 63 for men) – 17% of the inhabitants.

Table 3.11.6 Age structure of the population of Kozloduy municipality

Age	Number

From 0 to 7 years old	448
From 7 to 13 years old	1 813
From 14 to 17 years old	1 187
Female From 18 to 59 years old	6 986
Male From 18 to 62 years old	7 580
Female above 60 years old	2 610
Male above 63 years old	1 502

The ratio of the population above and under working age in Kozloduy municipality is comparatively more favorable. Children under working age are 336 more than adults over 60-65 years old. The share of working age individuals is bigger. This is explained with the work opportunities, provided by Kozloduy NPP.

Demographic development in the municipality of Kozloduy is both specific and typical for such settlements with large industrial facilities built nearby. The specific factors, defining the specifics of the population are the migration of the population (normal for rural areas) to the cities, and to Kozloduy in particular.

As a whole, the population of Kozloduy municipality decreases every year (for instance, in comparison with 2002). This is a clear indicator of a bad demographic situation. Particularly expressed is the decrease of population in the group under working age (898 children less then 2002 and 585 children less then 2004. This tendency can affect the labor market, expressing in a lack of workforce in the next two years. This can partially be attributed to the negative trend of the natural growth of the population.

In a trans-border context it must be remarked, that in the five-kilometer sanitary-protective zone around the IP there is no Romanian population. As mentioned above, the potentially affected Romanian population lives in 23 settlements in the Doji region, among which are Dăbuleni (13526 inhabitants) and Bechet (3963 inhabitants) and 21 more small villages. They are all situated in the 30-kilometer observed zone. Since the Romanian site has not submitted any information on the demographic characteristics, social and socio-economic conditions, as well as on the health status of the potentially affected by the IP Romanian population, assessment of some of those indices is made based on data from the Romanian statistical yearbook for 2007 (Romanian Statistical Yearbook. 2 Population 2007.pp:70), but it only contains data on the Doji region as a solid administrative unit.

Doji is the biggest district in Macroregion 4, part Southwestern Oltenia, its area a total of 7414 km^2. The district has 7 cities (3 district centers), 104 municipalities and 378 villages. The population of the district is 712178 (345993 male and 366194 female), with average population density of 96.1%/ km^2 .

The cities are inhabited, as follows: Craiova **–** 299429 inhabitants (major city); Băileşti **–** 19992 inhabitants (major city);; Calafat **–** 18258 inhabitants (major city); **Bechet – 3963** inhabitants; **Dăbuleni - 13256** inhabitants; Filiaşi – 18944 inhabitants and Segarcea – 8266 inhabitants.

More than half of the population in the Doji district is urban (53.7%), with a slight predominance of the female population (345993 male and 366194 female)

68.56% of the entire population are of working age. Under working age (between 0 and 19 years old) are 14.47%, and above working age (over 65 years old) are 17% of the population. This age specifics explains the negative natural growth, strongly emphasized in the rural population.

While the natural migration of population to cities (for the country as a whole and especially for the Doji district) shows a balance of natality and mortality, in the villages natural growth is significantly lower (-4.0‰ for the country as a whole). In the Doji municipality, because of the aggregation of elderly people and the bad socio-economic conditions, the low birth rate and a significantly higher mortality rate the natural growth rate I very low: -0.4‰. Table 3.11.49

Table 3.11.7 Demographic indicators for the natural growth rate of the population in Doji district, Romania in 2007

	Liveborn (‰)	Died (‰)	Natrual growth (‰)
Country average	10.0 ‰	11.7 ‰	-1.7‰
Dolj average	8.9 ‰	13.7 ‰	-4.8 ‰
Country average - cities	9.8‰	9.7‰	0.1‰
Dolj - cities	9.4‰	9.4‰	0
Country average - villages	10.2‰	14.2‰	-4.0‰
Dolj – villages	8.2‰	18.6‰	-10.4‰

In conclusion we must state, that the demographic characteristics of the region show significant negative trends for the rural areas, such as the one that is situated within the 30-kilometer observation zone around the investment proposal.

Social conditions

The construction of the power plant ("Kozloduy – I", "Kozloduy – II" and "Kozloduy – III") and the closure of energy capacities played a significant role in the development of the municipality and for the demographic and social changes that took place in it.

During the construction of the power plant, the labor market in Kozloduy municipality was characterized by relatively steady employment. The unemployment coefficient in Kozloduy municipality reached 16% in 2002. It is lower than the country average (17.7%) and in the Vratsa district (24%). During that period the municipality also had a positive population growth because of the migration of specialists and construction workers from the rest of the country for the purposes of construction and operation of the NPP . The reason for that were the opportunities for professional realization, related to the operation and maintenance of the NPP.

At the end of 2002 Blocks 1 and 2 were closed, and at the end of 2006 Blocks 3 and 4 of Kozloduy NPP were closed. After their closure, new economic conditions completely changed the socio-demographic characteristics of the municipality, which, together with negative natural growth significantly decreased the population growth – from positive in 2002 to -69 people in 2003 and -118 in 2009.

As for the entire country, the period between 2000-2008 showed a steady positive trend in the decrease of unemployment, registered in the labor offices in Kozloduy municipality. In 2008, the unemployment level of Kozloduy municipality, regardless of its drop in absolute value (here we must take into consideration the considerable migration of work force from the municipality), is higher than the country average, 5.0% and 7% Respectively. For that reason, the Programme for management of social consequences of the closing of Blocks 1-4 of the NPP was developed. Its aims are to reduce the negative consequences of that process to 2018, optimizing human resources during the process of decommissioning and vocational retraining of the NPP employees.

During the studied years, the Municipalities had a well-developed network of nurseries, elementary and basic schools. The municipal education and nursery institutions consist of:

– 8 nursery institutions (3 DN and 5 PN) holding 716 children in pre-school age and 88 nursery groups, and 1 Integrated child's complex

– 6 schools, that are in the following education degrees: 1 elementary school (Kozloduy), 3 basic schools (Butan, Glozhene and Hurletz), 2 middle general education schools (Kozloduy), 2 vocational middle schools (Kozloduy, Butan) For the 2009/2010 school year they held a total of 2834 students, distributed in 129 classes. It is notable that the demographic trend showed a steady decrease of 269 children enrolled in the school system between 2007/2088 school year and 2009/2010 school year (which confirms again the negative trends in the demographic characteristics in the municipality.

There is one hospital with 80 beds, one occupational medicine service for Kozloduy NPP , one dental clinic and dental offices in the villages, four health services and 11 GP's (8 in Kozloduy and three, respectively in Hurlets, Glozhene and Butan) and 9 pharmacies on the territory of the municipality.

There are eight social services institutions (retirement homes, day care for children and adults with mental disabilities, social services offices, clubs for disabled people, public canteens and other) in the Vratsa district, with a joint capacity of 2100 places.

The town of Kozloduy has a sports center, an indoor and outdoor swimming pool, gym and sauna,and tennis courts. In all the villages there are stadiums, the population in 2009 according to the NSI.

Socio-economic conditions

According to the data of the National Statistical Institute of the Republic of Bulgaria, Kozloduy municipality is located in the Danube plains and occupies and area of about 285 km$^{2.}$ Its landscape is primarily plain, about 25 meters above sea level. The territory of the municipality is part of the so-called Zlatiyata area. In the recent past, the occupation of the population of the Kozloduy municipality was almost exclusively in the agricultural sphere. Even now, the main part of the municipality Kozloduy (80% or 238 190 ha) is occupied by agricultural land. Much lower - the proportion of forest and other areas at the end of 2008 data for agricultural land per capita of 9,873 acres. The largest share in agriculture is grain production. 4 agricultural cooperatives grow mainly wheat, barley, maize (40% of agricultural lands) and some industrial crops - sunflower, rapeseed and sugar beet and others (20% of agricultural lands). Private farms grow grapes, potatoes and vegetables. Livestock breeding in the municipality is low and is concentrated in the hands of private breeders. Leading livestock breeding industries are cattle, sheep, goat and poultry.

Currently the city is the center of the nuclear energy sector in the country and its economy is strongly altered by the presence of Kozloduy NPP. On the territory of the municipality also function firms, a large part of which specialize in performing construction and repair activities. These firms are situated around Kozloduy NPP and work primarily for it, but also on the territory of North-western Bulgaria.

There are also firms that specialize in processing, conservation and trade with fruit and vegetables, as well as a lot of small and medium sized family businesses. The required sanitary zones of some of them are small and overlap with the Kozloduy NPP sanitary zones. The latter do not cause a significant influence on the environmental components in the region.

The main part of the employees in the non-financial sector of the municipality of Kozloduy work in energy and construction. At the end of 2008 employees in the nonfinancial sector of the municipality were 9930 (83.93 percent of the number of economically active people) and have decreased in number, in comparison with 2000 when their number was 10173 (91.77% percent of the number of economically active people)

As a whole, the economy of the Kozloduy municipality is highly dependent on the NPP. At the moment, only reactors 5 and 6 are in operation, which, regardless of the relative decrease in the number of unemployed, registered in the labor offices (unemployment in the region is higher then the country average), based on the data for decrease in employment and a significant negative growth of the population, we can assume that there is a increase of hidden unemployment, especially among the low-education level unemployed individuals. On the other hand, articulator is not of big significance for the municipal economy and it cannot offer employment for those people in case they lose their current occupation.

In conclusion we must emphasize that the socio-economic conditions are currently in a process of deterioration because of the closure of the NPP" units and the steady trend in deserting agricultural lands in the new economic environment.

Health condition

Data on the natural movement of the population in Kozloduy municipality according to NSI is presented in Table 3.11.50 In comparison with the data for the country for the same period, mortality in Kozloduy municipality is about 2 points higher then the country average (14.7 ‰), while the natality is lower than the country average (10.2 ‰). Child mortality (mortality of children between 0 and 12 months of age) is almost equal to the country average (9.7‰). The natural growth rate of the population in Kozloduy municipality is negative – 7.3‰, while the average natural growth in the Republic of Bulgaria in 2008 is 5.7‰

The relatively worse indicators of the natural movement of the population in Kozloduy municipality in comparison with the country averages can be attributed to the worsening socio-economic condition of the population, its aging, decreased employment, decreasing opportunities for finding a suitable occupation for people in working age and their unhealthy lifestyle.

Table 3.11.8 Demographic indicators for the movement of the population in the Kozloduy, 2008

	Liveborn	Child mortality	Mortality
Country average	**10,2 ‰**	**9,7 ‰**	**14,7 ‰**
Kozloduy	9.5 ‰	9.2 ‰	16,8 ‰

Mortality is an integrated indicator, that gives indirect data on the morbidity of the population. The proportions of the number of deceased per 100 000 inhabitants for 2008, is presented in Table 3.11.51. The main groups of illnesses are presented by the ICD – X revision, which are connected to the possible adverse influences on the environmental factors and the way of living of the population of the Vratsa region in comparison to that of the whole country.

Table. 3.11.9 Deaths by causes during 2008, by sex (on a base of 100 000 inhabitants)

Deaths by causes during 2008, by sex (on a base of 100 000 inhabitants)					
Causes of death, ICD - X revision, "European shortlist" [1]	**Bulgaria**			**Vratsa**	
	Total	**men**	**women**	**men**	**women**
Class II Neoplasms (C00-D48)	238,5	288,0	191,9	274,4	156,5
Malignant Neoplasms (C00-C97)	236,3	285,3	190,4	272,3	156,5
Class III Diseases of the blood forming organs and certain disorders involving the immune mechanism (D50-D89)	1,8	1,5	2,0	-	2,0
Class IV Endocrine diseases, disorders of nutrition and metabolism (E00-E90)	28,6	26,1	30,9	19,5	17,4
Class IX Diseases of the circulatory system (I00-I99)	937,8	949,7	926,6	1289,9	1250,9
Class X Respiratory diseases (J00-J99)	58,6	73,2	44,9	112,6	86,0
Class XI Diseases of the digestive system (K00-K93)	46,7	66,4	28,2	44,0	24,1
Class XIII Diseases of the musculoskeletal system and connective tissue (M00-M99)	0,7	0,6	0,8	2,0	-
Class XVII Congenital anomalies (developmental defects), deformations and chromosomal aberrations (Q00-Q99)	2,7	2,8	2,7	1,0	3,9
Transport accidents (V01-V99)	14,3	23,1	6,1	31,7	6,8
Intentional self-harm (X60-X84)	12,3	18,8	6,2	22,5	4,8

The standardized mortality data by causes does not differ significantly from both the national average and those in other areas, despite the fact that men and women in Vratsa district have higher mortalities due to cardiovascular and respiratory diseases. The data shows that the main factor for the diseases, that cause the mortality of the population is their lifestyle – unhealthy food, overweight, damaging habits (alcohol drinking, smoking). The double mortality rate due to transport accidents and self-harm is also significant.

Mortality data for the group of diseases, most often connected to radiation effects (malignant neoplasms, diseases of blood and blood forming organs , endocrine diseases, congenital anomalies) are below the national average.

The data on cancer prevalence for Bulgaria for 2004, published in 2007 in the National Cancer register show that:

- Total population - 214,522 people including 104,930 men and 109,592 women. Diseased from cancer were 0.238% to 0,247% men and 0,223% women. These diseases are with higher rates in Burgas, Sofia, Varna and others, as the average for the country oncological diseases are 0.442% for men and 0.378% for women. Consequently, the occurrence of such type of diseases is lower than the national average - 0,442% for men and 0,378% for women.

- In the region of Vratsa, oncological diseases have been established in 0,247% of men and 0,223% of women.

- The malignant neoplasms show higher rates in Burgas, Sofia, Varna, etc. Consequently, the rates of these type of diseases is lower than the average for the country and other regions of the country.

As a whole, this gives us reason to believe that the exploitation of the Kozloduy NPP does not have a negative effect on the health of the local population.

Based on the above data we can conclude that the health status of the population in the area of the investment proposal does not differ from the country average. Its demographic characteristics, morbidity and mortality do not differ from the country averages. No changes can be established that can be attributed to the specific impact on the environment. We can assume that the operation of Kozloduy NPP has no negative effect on the health of the population in the region.

In the Romanian part of the 30-kilometer observed zone the indicators of natural movement of the population are worse then the country averages, because of the predominant rural population (Table 3.11.52)

Table 3.11.10 Demographic indicators for the movement of the population in the Doji district, 2007

	Liveborn	Children mortality	Mortality
Country average	**10.0 ‰**	**12.0 ‰**	**11,7 ‰**
Doji district	8.9 ‰	11.3 ‰	13.7 ‰

Life expectancy in the district is lower then the country average, while the population with shortest lifespan are men and women from the rural areas, respectively 68.1 years and 75.27 years.

Table 3.11.11 Demographic indicators on the population in the Doji district in 2007 (years)

	TOTAL	Men	Women
Country average	**72.61**	**69.7**	**76.13**
Doji district	72.18	68.81	76.69

Mortality reasons in 2007 do not show any significant difference from those on a global scale. Most common causes of death are blood circulation diseases (6703 total, among which 5180 cardiovascular and 2815 cerebrovascular)

Second are the neoplasms – 1370 deaths. Third and four places are occupied by respiratory diseases (522 deaths) and diseases of the digestive system (438 deaths), as well as traumas, poison and other external causes – 381 deaths.

In most of the cases, where the cause of death is an infectious disease (87 deaths total) it is tuberculosis (55 deaths), followed by kidney disease (68 deaths), endocrine disorders (58 deaths), diseases of the nervous system (38 deaths), congenital malformations leading to death – 19.

The significant negative trends in the health and demographic characteristics in the Doji district (part of which crosses the 30-kilometer observation zone around the IP) are mainly caused by the lower natality rate, the high mortality rate, especially in the rural areas, which leads to aging of the population, combined with the worsening of the socio-economic status during the crisis.

In conclusion, we must emphasize that, given the above demographic and socio-economic trends, the investment proposal has a significant health and social importance; on one hand in achieving effective RAW control and management, and in creating new occupation opportunities on the other hand.

No changes in the health, demographic and social indicators on Romanian territory are expected.

Consideration on the affected population

A description of the affected population is provided in Section 1.2.11

Fear of the unknown is always present when there is a big industrial project at hand, especially when a nuclear plant is concerned. This fear is usually bred by known risks, in particular case the fear of nuclear pollution. This is usually described as a NIMBY acceptance (Not In My Back Yard); in other words, the population's attitude is generally positive, but as long as the facilities in question are situated far enough from them. According to the *Assignment for range and content of EIA of investment proposal for construction of NRRAW* this is the main obstacle to the realization of the project, because even the given social acceptance and the commonly-known need for its construction, it is required to be built far from populated places. Cooperation with the local authorities is of vital importance for overcoming this fear, but this cooperation is as vital on national level, because the observations usually show that this is one of the main reasons for rejecting such projects (Barrow, 2000; Klessig and Strite, 1980).

We must emphasize, however, that the specifics of the area, that is the proposed site for NRRAW, namely the fact that for thirty years now there has been a working NPP, which generates most of the employment in the area. This fact has been taken into consideration in the selection of site between the four alternative proposals: the existence of a facility increases the social acceptance. However, we must not underestimate the fact, that NRRAW is a different facility, as the initial research and the media material show – it bears negative connotations because of *Assignment for range and content of EIA of investment proposal for construction of NRRAW* the fact that it is associated with a landfill, where nuclear waste is dumped on the ground (*Assignment for range and content of EIA of investment proposal for construction of NRRAW*) or with a "radioactive waste graveyard", as it is referred to by the media. These negative connotations are related to its purpose, waste storage; in a cultural context, waste is associated with something dirty and unclean, which leads to the desire to drive it as far away from the settlements as possible. As recent specific Eurobarometer research shows, however, waste treatment questions is a very important topic regarding the inversion of the social attitude.

The Eurobarometer that took place in 2008 regarding attitudes to radioactive waste management showed several important trends in public opinion on nuclear energy, storage of radio-active waste, the links between the two, and the dynamics of the opinions. As a whole, the citizens of the countries with operating reactors look more positively on this type of energy than others. In the group of those that usually stand against nuclear energy, those who are willing to change their opinion if a permanent solution to the radioactive waste problem is found are mainly young people and people of high education level. Those above 40 years of age and those, who studied to the age of 15 are the most unlikely to change their opinion;

in other words, they are those that keep their negative opinion on nuclear energy regardless of the possible solutions of the problem. According to the data analysis, in Bulgaria, more then one quarter of the population state that they do not believe that there is a permanent and secure solution altogether. (Eurobarometer, op. Cit.)

The data from the Eurobarometer show that the secure and permanent solution of the radioactive waste problem is the key to opinions related the nuclear energy as a whole; guaranteeing a secure and long-lasting technology can lead to a change in the negative opinions.

Because of that, public opinion feelers and a referendum have been called. Public attitude towards the project at the beginning of its implementation is extremely negative; at a referendum, that comprised 27%[2] of the population, 95% reject the project. Research, performed by MBMD in November 2006 at a regional and national level, is quoted in the Assignment that shows, that the Bulgarian population is poorly informed about the problems of radioactive waste.

Two main points are emphasized:

1. *"no difference is made between the three types of radioactive waste – low, intermediary and high-level radioactive waste. For that reason the respondents consider all types of radioactive waste very dangerous."*

2. *"it is not clear what exactly a RAW repository is, according to the statements of the respondents it is a landfill, where radioactive waste is dumped on the ground"*

One of the main fears can be explained by the "fear of the unknown"; storage of radioactive waste, is a completely new activity; moreover, it is an activity loaded with negative connotations; as well as the above mentioned acceptance, as long as the activity takes place away from the populated place, also called "not in my back yard" (NIMBY). This attitude is the reasoning behind the decision not to build the NRRAW in Marichin Valog, so that the IP can respond to the requirement of the publicity to build the repository on a territory that does not belong to the "Zlatiyata". In March 2008 SE RAW launched a communication programme for Kozloduy municipality by opening an information center in Kozloduy. The communication programme aims in public trust in the safety of the NRRAW project and public acceptance of the need for the construction of the NRRAW as a natural ending to the cycle of nuclear fuel. Aiming to improve the level of information about the activities of SE RAW and the radioactive management of the local publicity, in 2008 SE RAW started an educational initiative in seven schools in Kozloduy municipality, teaching the specifics of radioactive waste and its safe storage. The initiative includes teacher workshops in physics and chemistry and teaching the middle-school students the basics in radiation, radioactive waste and the activities in SE RAW.

Aiming these efforts at young people and children is important. The most probable reason for that is that thus it is expected to bring some influence on their parent's opinion, because that target group is the most easily accessible (because of the active national educational network), and the acquaintance with the problem is integrated within the education process, in an environment well-known to the parents, that they usually associate with learning new things. Cooperation with the mayors of the affected places is also underway. In November 2008 mayors of settlements and municipal councilors from Kozloduy municipality visited the radioactive waste repository El Cabril, Spain, the visitors information center and the Fuente Ovejuna municipality, where the basis of the cooperation between the two municipalities were set.

Research, performed by MBMD[3] show the difficulty in determining the difference between the types of radioactive waste (low, intermediary and high level of activity), which are considered the same, as the

[2] A local referendum is considered invalid if it does not comprise at least half those who have the right to vote in the municipality, in compliance with Article 34 Paragraph2 from the Referendums Act (Decree №671/March 9yh 2007 of the Municipal council of Kozloduy municipality, based on Decree №09/February 17th 2007 of the District electoral committee). The Referendum has not been repeated.

[3] *"no difference is made between the three types of radioactive waste – low, intermediary and high-level radioactive waste. For that reason the respondents consider all types of radioactive waste very dangerous." Quoted in: : Assignment for range and content of EIA of investment proposal for construction of NRRAW, page. 100*

main reason for the negative attitude of the entire Bulgarian population. The solution is increasing the level of information, which complies with the main course of action when projects of high social importance are concerned.

The public campaigns that took place that also included representatives of the local authorities in the affected places have the anticipated effect on the public opinion. At the current stage it is important to emphasize, that the importance of acquainting the population with the goal of the project is predominantly associated with their right of information and public contribution in making decisions more then with changing their opinions. This is important, because otherwise the aim of theses actions can be replaced by advertising actions.

Vulnerable groups

The definition of vulnerable groups differs in different countries, as well as in different institutions, but usually the determining of these groups is done based on several characteristics. According to the definition of the EBRD, vulnerable, or "risk" groups usually include people that, because of their gender, ethnicity, age, physical or mental disadvantages, will be more economically or socially disadvantaged by the negative effects of the project, population movement for instance. Vulnerable groups also include people, who live under the poverty line, elderly people, households, whose paterfamilias is a women or a child, ethnic minorities and those, who rely of natural resources[4].

Because of the location of the NRRAW on a non-populated terrain, no specific direct effect on the vulnerable groups is expected. Such effects may occur in cases, where they are part of the affected by the project.

However, usually infrastructure projects that are expected to have extremely positive effect by creating new work opportunities and conditions for development of small businesses that are also involved in supporting services, not only in the direct construction and maintenance activities, are of great significance. This project is expected to have an impact on ethnic and gender relationships, thus indirectly affecting certain vulnerable groups. According to the prognosis, this effect is expected to continue after the end of the project, when it will rely on established new practices and new services, related to the support of the facility constructed.

The main problems that can be related to the vulnerable groups of the population derive from their disadvantaged status. The project, however, is not going to produce a necessity to relocate parts of the population, so this very common risk can be ruled out. Due to the nature of the investment and the importance of local support and collaboration, the most significant risk seems to be access to information and contribution to taking decisions for all the groups of the population in the directly affected area problem. The assurance that these groups will not be kept less well informed about the development of the project and about the functioning and operation of the NRRAW than the rest of the population is very important, because certain parts of them (mentally disadvantaged people, children outside of the education system or lonely elderly people without access to means of communication, for instance) can have troubled access to that information, that the other members of the community have. Because of that, it may be required to take additional measures to inform them, in an accessible language, if need be. As we mentioned already, the main communication strategies are aimed at young people and children, which is why even single-parent households, whose children are part of the public education system, are not likely to stay uninformed.

There are eight social services institutions (retirement homes, day care for children and adults with mental disabilities, social services offices, clubs for disabled people, public canteens and other) in the Vratsa district, with joint capacity of 2100 places. Allowing access to information to these people is very important, but because of their enrollment in specific institutions reaching them will be fairly easy.

[4] *Environment and Social Policy,* EBRD, May 2008, http://www.ebrd.com/downloads/about/sustainability/2008policy.pdf (last visited july 2010)

Ethnic roma, who are usually qualified as the most disadvantaged vulnerable group because of their socio-economical status[5], can suffer from the same lack of information like the rest, which is why it is important for measures to be taken for their information.

5 The EBRD strategy for Bulgaria shows a trend towards improving of their status, yet the document emphasizes on their low social status: http://www.ebrd.org/downloads/country/strategy/bulgaria.pdf, last visited july2010

1. LIST OF FIGURES

2. LIST OF TABLES

3. DESCRIPTION OF APPENDIXES

Part III

DESCRIPTION AND ANALYSIS OF THE COMPONENTS AND FACTORS OF THE ENVIRONMENT AND THEIR INTERACTION

1. Field-situational plan with location of geological surveying
2. Geological map of the NRRAW site (by Filippov and others. 1989, 1989, 1993, 1995 with amendments)
3. Geomorphologic map of the Radiana site
4. Isopahitic map of the neogene sediments
5. Structural map on top of the upper pont (Archarska Formation)
6. Structural card upper medium triass (Babinska Formation)
7. Structural card upper Upper Cretaceous
8. Photos of samples of ground Radiana
9. Basic structure of infiltrometric drilling and testing scheme for testing with constant head
10. Prepared for launching tube and infiltrometrichnata Basic structure infiltrometrichen drilling in a falling head test
11. Photographs: testing the pouring of constant head (CCHP apparatus); experimental pouring with falling head;
12. Photos: Apparatus for determining the coefficient of filtration in the laboratory-A filtration cartridge
13. Tabular material: radiological indicators of water from the first aquifer, specific activity of natural radionuclides in water from the first aquifer, specific activity of natural radionuclides in soil types from the site
14. Ion-exchange capacity (CEC) of the studied soils (fraction <1 mm)
15. Dosimetric map of the "Radiana" site
16. Placement of "Radiana" site in respect to the nearest protected areas Natura 2000
17. Natura 2000, BG0000336 "gold" (last update 200802), maps
18. Natura 2000, BG0002009 "gold" (last update 200802), maps
19. Natura 2000, BG0000614 "River AUGUSTA (last update 200802), maps
20. Natura 2000, BG0000527 "Kozloduy" (last update 200802), maps
21. Natura 2000, BG0000533 "Islands Kozloduy (last update 200802), maps
22. Natura 2000, BG0000199 "Tsibar (last update 200802), maps
23. Map of the protected area ROSCI0045 Coridorul Jiului, Romania
24. Map of the protected area ROSRA0023 Confluenta Jiu - Dunare, Romania
25. STAGE 2 Archaeological research, Hill 2, forming the profile and detection of ceramic handle – photos
26. Outline of the sources for PBV and Sanitary Protection Belt established in the municipality of Kozloduy
27. Taxonomy characterization of DL "Oryahovo
28. Regional situation of the NS “Asparuhov val "

Part IV

TABLE OF CONTENTS

Part IV

4. DESCRIPTION, ANALYSIS AND ASSESSMENT OF THE POTENTIAL IMPACTS ON HUMANS AND THE ENVIRONMENT AS A RESULT OF THE IMPLEMENTATION OF THE NRRAW.

The EIAR report includes an analysis and an evaluation of potential impacts anticipated from the construction, operation and closure of the NRRAW on personnel, the environment and the factors that affect it, as well as the likely nature and scope of these impacts. An analysis and evaluation of the safety measures provided to prevent risk to the population and workers in the area of the site [190] are also included.

The possibility of a potential impact is analysed and evaluated in a transboundary context in relation with the location of the selected site of the NRRAW near the border with the Republic of Romania and the manifested willingness of this country to participate in the EIAR procedure.

4.1. Use of natural resources. Use of raw materials and fuels

The "Radiana" site is selected for the construction of the NRRAW in the zone near the 3 - kilometer PZ of the Kozloduy NPP. Digging, backfilling, transport and works will be carried out at the site during the time of construction.

The natural resources which will be used during the construction include water, inert materials, construction materials, fixtures and more. Fuel and electricity, as well as auxiliary materials in service - water, fuel, electricity and other auxiliary materials shall also be used. During the decommissioning stage, natural materials will be used – loess concrete, bentonite clay and a mixture of bentonite and inert material (sand) – mostly, and they will fill the spaces between the separate RCC during closure of NRRAW.

The Kozloduy NPP has a developed infrastructure, good and safe power supply, fire protection, and provides drinking water supply, sewage, drainage and flood prevention in natural disasters, and it has asphalt and concrete internal roads. The plant has toilets and bathrooms, a canteen for warm food and fast food venues. There is a healthcare center on the site of the NPP- Occupational medicine and the ability to provide skilled medical care. This provides an opportunity for normal living and safe work for the staff who will be occupied with the construction of the NRRAW.

Number of workers and employees in the process of construction, operation and closure.

Number of workers and employees in the process of construction

The average number of workers and employees of the SMR Contractor will be 55 people, and an additional average of 7 people will attend, including representatives of the Principal Designer and Construction Supervision, resulting in an average of 75 people.

Number of workers and employees during operation.

NRRAW will be an independent structural unit within the SE RAW - Specialized unit SU "RAW". The staff of NRRAW is intended to be of approximately 64 people, working one shift, except for the police security force. The staff includes 24 people in administration, 26 operating personnel and a maintenance staff of 14 people).

Number of workers and employees in the process of closure

The personnel necessary for the closure of the NRRAW is expected to be around 40 people. The staff is estimated at 15 people in the period of institutional control by comparison with existing repositories intervened in this period.

Number of employees in the process of active institutional control, by analogy with existing repositories, intervened in this period, is estimated at 15 people.

Besides the permanent staff in the different periods of implementation of the NRRAW, specialists with specific qualifications to perform specific activities related to construction, operation and closure of the repository will be used periodically.

Water, raw materials, fuels, electricity consumption.

During the construction of the NRRAW

The construction will include the following:

- Digging and construction of concrete foundations
- Construction of NRRAW.
- Facilities for the physical protection of the NRRAW
- Suitable infrastructure

The construction will require the following materials: concrete, sand, gravel, cement, lime, reinforcement and other construction materials - bricks and roofing materials of constructions, formwork for concrete structures, pipes, valves, wiring, etc. The materials needed during construction will include: electricity, water, fuel etc. The construction of the NRRAW will include delivery of materials to the site.

In IP the quantities of water, electricity and raw materials necessary will be tentative, given the early stage of design. More accurate quantities will be fixed in the next phases of design, but they are expected to be of the same order .

According to the expert evaluation during the construction of the NRRAW, no significant impacts of non-radiation aspects are expected on the tangible assets - consumption of fuels and raw materials.

The materials used in the construction will be in accordance with the Ordinance on the essential requirements and conformity assessment of construction products. Individual (non-series) construction products and equipment will have a certain performance and will meet the specific investment project for construction.

During the construction of NRRAW, the impact on tangible assets - consumption of fuels and materials will be negative, direct, without secondary and cumulative effects, temporary, short-term and irreversible and will cover the limits of the allocated NRRAW site, the site of the Kozloduy NPP and the 3 km radiation protection zone of the Kozloduy NPP.

Quantities of used water during the construction period

During the construction period, water with drinking quality will be used in the NRRAW for the domestic needs of workers and service personnel.

Qav.= 8 m^3/d 2000 m^3/y.

Bottled drinking water will be delivered to the site until the construction of a water supply line from Kozloduy NPP.

The water for domestic use will be delivered in NRRAW by a branch from the main water supply for drinking water, powering SR-3 of the Kozloduy NPP, from the shaft in the repair shop for trailers. The total length of the branch, made with PE pipes with a diameter of 25 mm is approximately 150 m and will feed the toilets and showers in the parlor. Drinking water is not needed for the storage hall. The total drinking water needed for the NRRAW is estimated at 0.6 l/s, based on the method for calculating the specific flow of sanitary fixtures and the simultaneous operation of multiple fixtures.

Water for fire repellent needs will be provided by the Kozloduy NPP. The new approach to the region and the degree of protection by the fire brigade, are consistent with the requirements.

In IP, portable foam fire extinguishers will be applied - for the area around the truck, room service and other facilities.

The possibility of building a buffer water tank for fire protection that requires 8 l/s will be refined.

Water for technological needs: for watering concrete, washing vehicles, spraying (if necessary in dry weather, etc) of alleys and green areas.

Qav. year.= 1500 m^3/y (water for the cleaning of the transport vehicles, maximum Q = 1m^3/d max. Q= 60 m^3/ y . The possibility of using waste water after local treatment in a mud/oil stopper and filter will be refined).

- *Inert materials used for the purposes of construction at the site of the NRRAW are:*

- Felt for the drainage - 3500 m^3 for stage I + 2000 m^3 for stage II = Total for the two stages: 5500 m^3 for the whole construction period
- Spoils for loess cement and backfilling: 300000 m^3 for the two stages – Total of 600 000 m^3 for the whole construction period.
- Gravel for the roads, parking lots, etc: 7500 m^3 for stage I + 2000 m^3 for stage II = Total for the two stages of 9500 m^3 for the whole construction period.
- Humus – 14 000 m^3 for stage I + 12500 m^3 for stage II = Total for the two stages of 26500 m^3 for the whole construction period.

Supply of the gravel and felt to the site will be done along temporary roads that will be built for the construction of NRRAW. These materials can be transported along the ring road and along the road to the Kozloduy NPP to the temporary roads.

The spoils for backfill and loess cement and humus will not be removed from the site, but instead will be separated in repositories for humus and spoil for backfill and loess cement.

Concrete solutions

Necessary amount of concrete solutions - 50000 m^3 for stage I + 48000 m^3 for the II stage = Total for the two stages of 98000 m^3 for the whole construction period.

- <u>*Metal constructions*</u> – 100 t for the whole construction period
- <u>*Fuels –*</u> *diesel for excavators, dumpers, auto concrete pump* **–** total for the two stages: 210 m^3 of diesel for the two stages i.e. for the whole construction period incl. 60% for stage I + 40 % for stage II
- <u>*Electrical Energy*</u> - Power supply can be made from the existing distribution network or from the site of the Kozloduy NPP, on which SE RAW has a division. A power to the pumping station of 20 kV is projected to come from the existing network.

  The required maximum power will be up to 250 kW.

During the operation of the NRRAW

- *Quantities of used water during the operation of the NRRAW.*

Drinking water will be used in the NRRAW for domestic needs of workers and service personnel during operation (64 people, including 24 people in administration, 26 people employed in the operation, and 14 people employed in support).

Water for domestic needs for a total of 64 people (during 250 work days).

Q = 64x 45 l/d/ 1000 = 2.88 m^3/d Q= 720 m^3/y

Only the operation and support workers will use the shower (during 250 work days)

Q = 40x 60 l/d/ 1000 = 2.40 m^3/d Q= 600 m^3/y

Total consumption of drinking water Qav = 2.88+2,40 = 5.28 m^3/d Q= 1320 m^3/y

(The possibility of using bottled water provided by the Principal for drinking purposes will be refined).

Water for technological needs:

- Water for the external washing of the STVs (specialised transport vehicles). The possibility of using circulating water after local treatment in a mud/oil catcher and filter will be refined. Q = 2 STV x 300 l/washing x 52 weeks =31,2 m^3/y
- Water with reagents for decontamination of work surfaces, STVs, washing of laboratory equipment, etc: maximum Q = 5 m^3/y

Total water consumption once the project is in operation is expected to be:

Q = 1320 + 31.2 + 5 = 1356.2 m^3/y around 1400 m^3/y

Water for firefighting needs 8.3 l/s (a buffer reservoir will be built).

Total amount of technological water is estimated as up to 1500 m^3/y

- *Inert materials, concrete, paint and varnish in minimum quantities will be used for the maintenance and repair of the facility.*
- *Fuels during the operation period of the IP*

Total of 5m^3/y including for personnel transport over a distance of 10 km.– 2l/day x360= 720 l.

For transport of RCC - 4 trips / day - 10l/day x 200= 2000 l.

For internal transport of technology equipment - 5 l / day x 360= 1800 l.

- ***El. Energy –*** Power supply can be sent from the existing distribution network or from the site of the Kozloduy NPP, where SE RAW has projected a 416 kW unit. The estimated consumption will be about 426 MW/h per year at 50% installed capacity and over an 8 h working day, 250 days a year.
- With an alternative solution for treatment of the site wastewater in a local treatment plant with a maximum capacity of 30 eq. residents, the dual power supply needs to be sent from two independent sources (diesel aggregate will be used in one)

During the closure of the NRRAW

- *Quantities of used water for the closure of the NRRAW.*

Water will be used for the domestic needs of the workers and support personnel during the closure of the NRRAW.

Water for domestic needs for a total of 40 people (during 250 working days)

Q = 40x 110 l/d/ 1000 = 4,4 m^3/d Q= 1100 m^3/y

(The possibility of using bottled water provided by the Principal for drinking purposes will be defined).

Water for technological needs :

- Water for external washing of STVs (specialised transport vehicles). The possibility of using circulating water after local treatment in mud/oil catcher and filter will be defined. Q = 1500 m^3/y

8.3 l/s of water are needed for firefighting (a buffer reservoir will be built)

- **Inert materials and concrete –** the following materials will be needed for the filling of the NRRAW with inert materials for the purpose of decommissioning:
  - 44800 m^3 – concrete
  - 33228 m^3 – sand
  - 33228 m^3 – loess cement mixture
  - 33228 m^3 – compacted clay
  - 23260 m^3 – compacted clay
  - 33228 m^3 – soil

During closure

Recultivation of the damaged land will be carried out during closure.

Period of institutional control after the closure of the NRRAW

- *Quantities of used water during the period of institutional control after the closure of NRRAW*

Water will be used for the domestic needs of 15 workers and support personnel during this 250-day period.

Q = 15 x 110 l/d/ 1000 = 1.65 m^3/d Q= 420 m^3/y

(The possibility of using bottled water provided by the Principal for drinking purposes will be defined).

- *Water for technological needs:* maximum Q = 5 m^3/y

Water for firefighting needs: 6 l/s. (a buffer reservoir will be built)

Recultivation of the damaged land will be carried out during closure.

4.2 Emission of pollutants during construction, normal operation and during emergency situations, and waste generation (considered for the various components and environmental factors)

4.2.1. Generation of solid waste (radioactive and non-radioactive)

- **Defining the type and quantities of the generated waste and their treatment, including industrial waste**

The activities and obligations of non-radioactive waste management are regulated by the Law on Waste Management (LWM) [4] and by the RAW - with the Regulation on the Safety of Radioactive Waste Management [93].

A programme for waste management will be prepared.

The non-radioactive waste of the NRRAW should be included in the accounting books, according to Art. 25 paragraph 1 of the law on waste management [4]. Moreover, under Art. Art. 7paragraph 1 of the LWM people are required to apply for permission to build. Art.144, paragraph 1 of the Spatial law also presentsinformation on the quantity and type of industrial and hazardous wastes which will be generated after the implementation of the investment project. In accordance with the requirements of Regulation no. 3 for the classification of waste (Art.7) [5], after the NRRAW is put in operation it is necessary to complete worksheets for the classification of waste produced.

✓ ***Generated waste during construction***

Non-radioactive waste

The following non-radioactive domestic, construction, non-hazardous industrial waste is expected to be generated during construction:

Domestic waste – code 20 03 01 (mixed domestic waste) by the workers, with a total amount of 0.5 m^3 per worker per year or a total of 37.5 m^3 will be generated. It will be collected in temporary containers in some places on the site, sprinkled with lime or chlorinated lime and disposed of in the landfill for hazardous domestic and industrial waste of the town.

Construction waste - code 17 01 07 (mixed concrete, bricks, roof tiles, tiles, faience and pottery) will be disposed of in the DNO in a cell for construction waste or in a place established by the municipality of Kozloduy.

Stage I of construction – 1000 m^3 incl.

The amounts include:

- Removal of the channel if necessary: 1 m^3 x 700 m = 700m^3
- Removal of existing structures – 50 m^3
- Waste from the concrete pump: 1 concrete pump gives around 0.5 m^3/d

0.5 m^3/d x 120 days/year x 4 years (4 years construction for 4 modules) = 240 m^3

Stage II of construction - 300 m^3, incl.

Total of the generated waste for the two stages is 1300 m^3

Extra spills - code 17 05 06 (dredging spoils). Total amount of spills according to the spills balance is 1200000 m^3

Incl. stage I 600000 m^3 and stage II 600000 m^3

Soil around the site will be disrupted during the construction. It is projected that the humus layer will be dredged during the digging and stored in a soil depot for future remediation of the site. Part of the soil below the humus layer will also be dredged and poured over the geological layer that will be sealed over the repository.

Soil material will not be used during the operation except for the recultivation of areas damaged during construction and grassing of areas.

Recultivation of damaged areas will be carried out during closure.

A preliminary balance of the land masses has been made:

For stage I:

- 300000 m^3 for loess cement and backfiling
- 170000 m^3 accepted by the municipality
- 90000 m^3 for technological strengthening of warm channel 2 (TK-2) of the Kozloduy NPP
- 40000 m^3 for the placement of a depot near TK-2

For the stage II:

- 300000 m^3 for loess cement and backfilling
- 300000 m^3 for the placement of a depot near TK-2 (the area which can be used for the depot is around 100000 m^2) or other technological needs

One part will be used for landscaping and the excess will be deposited on the designated site or can be used for roofing layers of non-radioactive landfill for municipal and industrial waste on roads, filling the damaged sites and others. No excess pollution is not expected, because of the place where it is generated.

Industrial non-hazardous waste

- Paper and cardboard packages - code 15 01 01 - around 2 m^3 for the whole construction period, temporarily gathered in a container at an on-site location and delivered to the licensed company for recycling after signing a contract.

- Plastic packages code 15 01 02 - around 2 m^3 for the whole construction period, temporarily gathered in a container at an on-site location and delivered to the licensed company for recycling after signing a contract.

- Mixed packages 15 01 06 - for materials and equipment that are expected to occupy about 5.0 m^3, which will be deposited in the landfill for non-hazardous domestic and industrial waste.

Hazardous waste

- Used oils, code 13 02 05 (non-chlorinated engine, lubricating oils and mineral-based gear) from the construction mechanisation machinery with an expected volume of 100 l, which will be provided to external licensed companies for recycling.

- Blown mercury and fluorescent lamps - code 20.01.21 (fluorescent tubes and other waste containing mercury) - about 5 pieces for the whole construction period. Temporarily stored in specially-designed containers. Their treatment is carried out under the legal requirements for the marketing of fluorescent lamps containing mercury, and treatment and transportation of discarded fluorescent and other lamps containing mercury [11]. They will be forwarded to a licensed disposal company under the Regulation on the marketing of electrical and electronic equipment and treatment and transportation of waste electrical and electronic equipment (Official Gazette. issue 36 of 2 May 2006.) [11].

- Packages containing waste from hazardous materials or contaminated with hazardous materials with code 15 01 10* packages of paint and varnishes - of 0.1 m^3 for each stage- and a total of 0.2 m^3 for the whole construction period.

<u>* Radioactive waste</u> *- no radioactive waste is expected to be generated during construction.*

✓ ***Generated waste during operation***

Domestic, construction, manufacturing and comparative minimum quantities of hazardous and radioactive waste are expected to be generated during operation.

Non-radioactive waste

Domestic waste - code 20 03 01 (mixed waste) from the builders. An amount of about 0.5 m3 per worker per year or approximately 32 m^3 will be temporarily collected in containers in some places on the site, sprinkled with lime or lime and chlorine and disposed of in a landfill for hazardous domestic and industrial waste of the settlement.

Construction waste - code 17 01 07 (mixed concrete, bricks, roof tiles, tiles, faience and pottery) – incidental in repair during the operation, with an expected amount of about 0.1 m^3 per year. It will be disposed of at DNO in a cell for construction waste or in a place specified by the municipality of Kozloduy.

Industrial non-hazardous waste - packages, code 15 01 01 (paper and cardboard packages) and 15 01 02 (plastic packages) will be provided to a licensed company for recycling.

- 15 01 06 (mixed packages) - from materials and equipment. An expected amount of about 0.05 m^3 will be deposited in the landfill for non-radioactive domestic and non-hazardous industrial waste.

Hazardous waste - Blown mercury and fluorescent lamps - code 20.01.21 (fluorescent tubes and other waste containing mercury) - about 5 pieces for the whole construction period. Temporarily stored in specially-designed containers. Their treatment is carried out under the legal requirements for the marketing of fluorescent lamps containing mercury, and treatment and transportation of discarded fluorescent and other lamps containing mercury [11]. They will be forwarded to a licensed disposal company under the Regulation on the marketing of electrical and electronic equipment and treatment and transportation of waste electrical and electronic equipment (Official Gazette. issue 36 of 2 May 2006.) [11].

Radioactive waste

In general, radioactive waste is expected to be generated during operation, but in very small quantities.

Small quantities of radioactive waste are expected to be generated during operation. They shall be determined by dosimetric control.

There shall be relatively few personnel protective equipment items such as protective clothing, shoes or gloves (not more than 40 sets per year, or around 0.05 m^3/year maximum). They will be handled by existing facilities in the SU RAW: equipment for the processing of solid waste.

Minimum quantities of hard waste - cotton, filter paper, gloves, contaminated clothing (40 people) and personnel protective equipment, laboratory samples, glassware, tools

During closure

Waste is expected to be generated during closure:

Non-radioactive waste - mostly construction waste and a limited amount of non-hazardous domestic and industrial waste.

The buildings will be used after closure for the needs of institutional control. Known quantities of construction waste will occur in the final sealing of the modules and will make the system capable of institutional control. The amount of waste projected for this phase is estimated at about 150 m^3.

Radioactive waste – it is not expected to be generated, but certain types of waste will be tested and then classified and treated.

The amounts of waste cannot be established for certain at this stage, but their treatment will be determined with a specific program.

– For construction waste - after checking the radioactivity and verifying that the waste is not contaminated - disposal of non-radioactive landfill for municipal and industrial waste and construction waste on site.

– Radioactive waste is not expected

- **Description of the methods for collection, storing, handling, transportation and final disposal of solid waste** [139]

Non radioactive waste- Containers for waste collection from the NRRAW and the machinery driving them will be selected on the basis of the present experience, for the sake of convenience during collection, transport and pouring. The transport and waste treatment needs to be carried out in accordance with the legislative requirements for treatment and transportation of industrial and hazardous waste [7].

The final disposal of domestic and industrial waste is carried out on the plant's own landfill.

The landfill for municipal and industrial non-radioactive waste is located 3.7 km south of the Danube against 693 km of the Bay Terrace, a protective dike with an average crown elevation of 28 m. The nearest towns are Kozloduy (3.75 km to the northwest), the village of Hurlets (3.7 km to the southwest) and Glozhene village (4.75 km to the southwest), i.e. the sanitary requirement –of a 1000 m security zone to the nearest populated place, as per Ordinance 7 of IB for sanitary protection zones, is met. The landfill covers an area of 11385 m^2, and is built on land expropriated for the NPP.

To the east the landfill is bordered by water channels for plant maintenance, to the west with electrical high voltage lines and to the south are the lime farm, the repository for RAW and the 110 kV open distribution system. The sanitary - protective zone requirements Ordinance 7 of IB for sanitary protection zones are met in the listed sites.

The landfill was designed in 1996 and received a positive review by the EIAR report. In 1999 the project was revised in accordance with decree no. 13/06.11.1998 on conditions and requirements for construction and operation of landfills, replaced by decree no. 8/24.08.2004 [22], which is harmonised with EU legislation in this area. Since the entry into operation in December 2001 and the waste management process optimisation in April 2002, all waste was generated within the protected zone of the Kozloduy NPP according to the law on radiation protection during activities with sources of ionizing radiation. [90]

The collection, storage, transportation and treatment of all waste resulting from construction, operation and decommissioning of the NRRAW will be conducted in accordance with the regulations.

Hazardous waste:

The blown mercury and fluorescent lamps can be collected in specially-designed containers for temporary storage (to be treated in accordance with Ordinance requirements for marketing and other fluorescent lamps containing mercury, and treatment and transportation of discarded fluorescent lamps and other elements containing mercury [11].

Waste oils from machinery shall be collected in construction drums –of erection companies, and then delivered to external companies for recycling.

Radioactive waste: PPE (protective clothing, shoes, gloves, work clothes) will be deactivated in special washing machines if pollution exceeds the level permitted in BTRS-2004. If contamination is persistent, which is unlikely, these PPEs will be treated as radioactive waste. RAW are collected in plastic bags and transported on a particular route in freight containers, accompanied by vehicles with equipment for radiation monitoring, personnel protective equipment, decontamination and fire fighting equipment and other necessary emergency items. There are specific instructions for every RAW activity, and compliance with them is essential for radiation safety and personnel protection.

During closure

Generation of construction and radioactive waste is expected. It will be treated as follows:

Construction waste - after a radioactivity check and verifying that is not contaminated - shall be transported with vehicles for their disposal on the landfill. Non-radioactive, domestic and industrial non-hazardous waste shall be kept in a cell for construction waste or at a site specified by the municipality for construction waste, as their use is possible.

Radioactive waste shall be treated and, if necessary, transported in SU RAW according to established practice.

During accidents

Potential accidents include interruption / failure of the process / facilities, traffic accidents, spills, fires and explosions and natural disasters such as earthquakes or floods. As a result of each of these accidents it is possible to obtain non-radioactive and radioactive waste. The exact types and quantities of waste are not known at present. The appropriate regulators and indicators for monitoring and tracking trends in the safety culture of staff are introduced and constantly updated in the Kozloduy NPP. Attention is paid to errors in operation and repair of equipment, compliance with instructions and technical regulations, requirements for protecting the environment, fire protection, restricted access emergency safety zones (restricted area) and others, i.e. to take all measures to prevent accidents.

The following need to be developed and continuously updated:

- Program for waste management of the NRRAW, agreed with the waste management programme of the Kozloduy NPP and the competent authority.
- NRRAW emergency plan agreed with the emergency plan for the Kozloduy NPP and the competent authority [133], [193].

4.2.2. Generation of liquid waste - radioactive and non-radioactive

During construction

Non-radioactive waste

During construction domestic wastewater is formed by an average of 75 people. Chemical toilets or a pit scrape may be used during construction, before the water sewers of the Kozloduy NPP are installed.

Formed pollutant load:

Qav.day	-	7.0 m^3/d ;
BOD_5	-	1.5 kg/d;
COD	-	3.0 kg/d ;
Solid substances/SS	-	1.8 kg/d ;
Nitrogen total/Nt	-	0.28 kg/d ;
Phosphorus total/Pt– 0.04kg/d	-	0.05 kg/d ;

During the construction of the NRRAW before the construction of the sewer system, chemical toilets or a pit scrape will be used by workers.

In establishing the conditions for the washing of vehicles, the possibility of the implementation of their washing facility, equipped with mud-oil trap and filter will be clarified. Waste water after filtration can be used freely because it will form periodically and in minimum quantities- Qav.< 1 m^3. content of petroleum products < 10 mg/dm^3

Liquid radioactive waste

No liquid radioactive waste will be generated during the construction.

Discharge of waste from the site to water bodies is not expected during the construction and no authorisation is required to discharge. The amount of domestic waste water is <10m^3 / d and form a pollutant load BOD5 <30 Eq.

During operation

Liquid non-radioactive waste

Domestic contaminated (non radioactive) waste water from 64 support personnel (production staff and administration) during operation.

The pollutant load during operation is generated by 64 people (22 equivalent inhabitants):

Qav.day - 6-7 m^3/d ;

BOD_5 - 1.3 kg/d;

COD - 2.6 kg/d ;

Solid substances /SS - 1.5 kg/d ;

Nitrogen total/Nt - 0.25 kg/d ;

Phosphorus total/Pt– 0.04kg/d - 0.04 kg/d ;

In establishing the conditions for the washing of vehicles, the possibility of the implementation of their washing facility equipped with mud-oil trap and filter will be clarified. Waste water after filtration can be used freely because it will form periodically and in minimum quantities - Qav.< 1 m^3, content of petroleum products < 10 mg/dm^3.

Rain water from the surface of the site is not contaminated and some of it will be poured freely into the ground or be discharged into the Brisha drain channel, for which there is a permission letter.

Liquid radioactive waste

Liquid waste is not expected during the normal operation of the NRRAW. The working clothes will be washed / deactivated in special washing machines, available in the SU RAW if pollution exceeds the level permitted in RBNRP-2004. If the contamination is persistent, which is unlikely, these PPE will be treated as radioactive waste. The RAW is collected in plastic bags and transported on a particular route in freight containers on the vehicle, accompanied by vehicles with equipment for radiation monitoring, personnel protective equipment, decontamination and fire extinguishing and other means necessary for action in emergencies. For each activity, the RAW includes instructions, compliance with which is essential for radiation safety and protection of personnel.

Liquid waste is not expected during the normal operation of the NRRAW. If water pollution is found due to emergency or other reason, it will be collected in special containers (from 2 to 10 m^3), measured and transmitted to the processing systems for special water purification of the Kozloduy NPP. These systems represent the evaporator designed to purify radioactive contaminated water before being discharged into the Danube river .This process is regulated and executed by special permission of the NRA.

20 x 52 weeks = 1040l/year = 1.4 m^3/year i.e. maximum 1.5-2 m^3/year

Minimum quantities of liquid waste from laboratories:

10l x 52weeks = 520l/year = 0.52 m^3/year i.e. maximum 1 m^3/year

Regular quantities of potentially contaminated water from the drainage of the trenches are not normally expected. There will be a reservoir to collect them. Dealing with these waters is clear - collection, control and then drainage or export for processing outside the NRRAW. The maximum quantity of such water is less than the volume of the tank.

A small fraction of rain drainage water for which a potential risk of contamination can be expected is collected in tanks and then, after an inspection, is sent to the SU RAW for deactivation or to demonstrate that it complies with legal requirements and can be used for washing vehicles, paths and others.

If contamination of waste water is detected due to emergency or other cause, it is collected, measured and transmitted to the processing systems for a special water scrubbing in the SU RAW in Kozloduy. These systems represent the evaporator, designed to purify radioactive contaminated water before it is released in the Danube river. This process is regulated and executed with the special permission of the NRA.

During the closure of the NRRAW

Liquid non-radioactive waste

Only domestic waste water from 40 workers with the following contaminated load will be generated during the closure of the NRRAW.

The pollutant load during operation is formed by 40 people (15 equivalent inhabitants) ;

Qav.day - 4,0 m^3/d ;

BOD_5 - 0.8 kg/d;

COD - 1.6 kg/d ;

Solid substances /SS - 1.0 kg/d ;

Nitrogen total/Nt - 0.,15 kg/d ;

Phosphorus total/Pt– 0.03 kg/d ;

In establishing the conditions for the washing of vehicles, the possibility of the implementation of their washing facility, equipped with mud-oil trap and filter will be clarified. Waste water after filtration can be used freely because it will form periodically and in minimum quantities - Qav.< 1 m^3; content of petroleum products < 10 mg/dm^3

Rainwater from the surface of the site is not contaminated and some of it will be poured freely into the ground or be discharged into the Brisha drain channel, for which there is a permission letter.

During the institutional control period of the closed NRRAW

Only domestic waste water from 15 workers will be generated.

The pollutant load during this period 15 workers (5 equivalent inhabitants) ;

Qav.day - 1,5 m^3/d ;

BOD_5 - 0.3 kg/d;

COD - 0.6 kg/d ;

Solid substances /SS - 0,4 kg/d ;

Nitrogen total/Nt - 0.,06 kg/d ;

Phosphorus total/Pt– 0.014 kg/d ;

Дъждовните повърхностни води от площадката не са замърсени и част от тях ще се изливат свободно по терена или ще се заустват в главен отводнителен канал Бриша, за което има съгласувателно писмо.

Liquid radioactive waste

No liquid radioactive waste is expected to be generated during the closure of the NRRAW.

However, the drainage water, which is a potential risk associated with drainage storage tanks, can be monitored and then used for washing or sent for disposal purposes.

4.2.3 Generation of waste gases – radioactive and non-radioactive

Non-radioactive waste gases

Generation of dust and gaseous emissions into the atmosphere

The NRRAW will be located on the "Radiana" site, located in the immediate vicinity of the Kozloduy NPP (areas in orange / ▬ /) and fall within the 3-kilometer radiation protection zone of the Kozloduy NPP- the area enclosed in red / ▬ /, in the town of Kozloduy, 3.5km south of it – **Figure 0-1**.

Figure 0-1 Location of NRRAW

The figure also shows roads with a length of over 2250m (marked in blue / ▬ /) for the removal of earth from the NRRAW site to a temporary dump with an area of 102843m^2 - the area in light blue / ▬ /, located north of the Kozloduy NPP.

Gas emissions ***- [218], - [219]***

In both types of NRRAW structure, the area on which the construction earth-digging work will be carried out will be a main source of dust and, to a lesser degree, of emissions from exhaust gases of internal combustion engines (ICE) of the technique used - carbon and nitrogen oxides, a highly volatile organic compounds, soot (PM10) and negligible amounts of cadmium and persistent organic pollutants.

Table 4.2.1 Envisaged technique during construction and digging work

Required Equipment	ICE Power [HP]	Working time [h]	Quantity
Bulldozer- type 1	108	7	1
Bulldozer- type 2	200	7	1
Excavator- type 1	75	7	1
Excavator- type 2	50	7	1

Their emissions are defined by the EMEP/EEA CORINAIR methodology, SNAP code 0808 - [218], and for carbon dioxide – by IPCC (NFR 1A5b iii)- [219]

For one seven-hour shift, the exhaust gases from the ICE are shown in **Error! Reference source not found..**

Table 4.2.2 Emissions from equipment for one working day

Emissions[kg] / Equipment	Greenhouse gases			Basic and specific pollutants					
	CO_2	**CH_4**	**N_2O**	**NO_x**	**SO_X**	**CO**	**NMVOC**	**FDP_{10}**	**NH_3**
Construction equipment	1883.85	0.113	0.791	8.24	0.059	11.30	1.3	0.74	0.005

The amounts of emissions from above are released directly into the air from the exhausts of the ICE equipment

Dust emissions [220]

The source of dust emissions in both types of NRRAW construction (shaft and trench type) is the dump, as well as the pits themselves in the trench type.

The quantities of earth-digging masses are identical (600000 m^3 for stage I), so the area of the dump and the digging for a trench will have dust emissions from the handling of powdered bulk materials, etc, bulldozing and from wind erosion.

The inventarisation of the total suspended dust (TSD), fine dust particles to 10 and 2.5 microns (FDP10 and FDP2.5) was made for the various activities on emission factors for dust sources discovered by the U.S. Environmental Agency (EPA) AP-42 [218], from the annual balance of earth material stored on the dump –**Table 4.2..**

Table 4.2.3 Emissions from the processing of earth mass

Bulldozing			Bulk Processing materials		
Dust	FDP_{10}	$FDP_{2.5}$	Dust	FDP_{10}	$FDP_{2.5}$
42.3	20.4	6.3	3.9	1.89	0.57

The quantity of dust emissions from the trench itself is negligible

The intensity of the dust separation depends largely on weather conditions during the construction activities, the season in which the work will be carried out, climatic and meteorological factors (wind, humidity, temperature, atmospheric stability), characteristics of the earth particles and many other conditions.

To minimise the influence of this factor, water trucks should be used for irrigation of the workstations.

Transport activity- **[218] , [219]**

During the construction works, 150,000 m3 of dredging spoils are exported per year. Their export from the site is developed with heavy duty trucks with load capacity up to 15 m^3 to the dump north of the NPP over a transport distance of 2250m.

Emissions **(Table 4.2.4. Emissions from transport activity**

) from the transport activity (25 courses a day, 7 hours each) are evaluated as per EMEP/EEA CORINAIR, SNAP code 0808 - [218]. Carbon dioxide emissions are evaluated as per IPCC (NFR 1A5b iii) - [219].

Table 4.2.4. Emissions from transport activity

Emissions [kg] / Equipment	Greenhouse gases			Basic and specific pollutants					
	CO_2	CH_4	N_2O	NO_x	SO_X	CO	NMVOC	FDP_{10}	NH_3
Transportation equipment	173.85	0.0105	0.05	0.75	0.0055	1.05	0.1	0.065	0.0004

The quantities of emissions from above are released directly into the air from the exhausts of the equipment with an internal combustion engine.

*A significant reduction of harmful emissions can be expected if construction machinery which meets the requirements of code no. 10/2004 (SG no. 28 of 06.04.2004g.) * harmonized with Directive 2002/88/EC supplementing Directive 97/68 - measures to reduce gaseous and particulate pollutants from internal combustion engines installed on non-road and construction machinery, are used during the construction.*

During operation

Exhaust emission from the equipment with internal combustion engines will be present during the operation (ICE) – (**Table 4.2.5.**)

List of special transportation vehicles (STV), which have diesel engines and one excavator

Table 4.2.5. Envisaged equipment during operation

Required Equipment	Power of the ICE [HP]	Working time [h]	Quantity
Specialized transportation vehicles (STV)	105	3÷6	2
Excavator	50	7	1

Their emissions are defined by EMEP/EEA CORINAIR methodology, SNAP code 0808, andby IPCC (NFR 1A5b iii) for carbon dioxide [219].

Table 4.2.6. Emissions from the equipment during operation

Emissions[kg] / Equipment	Greenhouse gases			Basic and specific pollutants					
	CO_2	CH_4	N_2O	NO_x	SO_X	CO	NMVOC	FDP_{10}	NH_3
Required Equipment	1333.07	0.080	0.561	5.74	0.042	8.02	0.9	0.51	0.003

The quantities of emissions from above are released directly into the air from the exhausts of the equipment with internal combustion engine.

Emissions (**Table 4.2.7**) from the transport activity of the concrete trucks (10 courses a day from 7 hours) are evaluated by EMEP/CORINAIR, SNAP code 0808 - [218], and for carbon dioxide – by IPCC (NFR 1A5b iii)- [219].

Table 4.2.7. Emissions from transport activity

Emissions [kg] / Equipment	Greenhouse gases			Basic and specific pollutants					
	CO_2	CH_4	N_2O	NO_x	SO_X	CO	NMVOC	FDP_{10}	NH_3
Concrete trucks	77.3	0.005	0.0	0.3	0.002	0.5	0.0	0.03	0.0002

- **Description of the types and quantities of emissions of waste gases resulting from the investment proposal**

The assessment of emissions from non-road heavy construction machinery can be done by the EMEP / CORINAIR Atmospheric Emission Inventory Guidebook, Third Edition, B810 (Other mobile sources and machinery), 2003.

The emissions and concentrations in the exhaust gases discharged into the air for 1 hour operation on 1 excavator with a capacity of 250 kW, a truck for transportation of sand, stones, etc. with an output of 300 kW and a crane with a capacity of 150 kW are given in **Table 4.2.8**

Table 4.2.8 Estimated hourly emissions from the machines

	Emissions [kg]						
	NOx	N_2O	CH_4	CO	NMVOC	PM	NH_3
Excavator (250 kW)	3.60	0.09	0.01	0.75	0.33	0.28	0.0005
Truck (300 kW)	4.32	0.11	0.02	0.90	0.39	0.33	0.0006
Crane (150 kW)	2.16	0.05	0.01	0.43	0.19	0.16	0.0003

- **Description of the composition and toxicity of air emissions**

Regarding the NRRAW, the gas discharges are described in Part 3 are not expected to change after the commissioning of the NRRAW.

- **Description of methods for collection, treatment and release of these emissions in the air**

The serviced areas will have a system of forced ventilation. There is no system for purification of air spaces with natural ventilation.

During closure

Gas emissions

During the closure of the repository after 2075, the following are consistently performed: supply of machinery and equipment for filling the space in the chambers with lyoso-concrete solution, casting of rainforthed concrete roof slab, building of multibarrier protective cover consisting of alternating layers of clay, geotextile, sand, gravel and ending with a layer on which suitable vegetation planted, dismantling and demolition of buildings and facilities at both sites (clean and controlled) on the surface and finally the reclamation of land on both sites.

The area on which these works will be performed, will be mainly a source of dust and, to a lesser degree, of exhaust gas emissions from internal combustion engines (ICE). The equipment used are the same as during construction.

Dust emissions

There will be dust emissions at the site from bulk handling of powdered and other materials, bulldozing and others.

The inventarisation of the total suspended dust (TSD), fine dust particles between 10 and 2.5 microns (FDP_{10} and $FDP_{2.5}$) where made for the various activities on emission factors for dust sources discovered by the U.S. Environmental Agency (EPA) AP-42 [220], from the annual balance of earth material stored in the dump. –**Table 4.2.9.**

Table 4.2.9 Emissions from the processing of earth

Bullldozing			Bulk processing materials		
Dust	FDP_{10}	$FDP_{2.5}$	Dust	FDP_{10}	$FDP_{2.5}$
28.5	13.9	4.2	1.05	0.51	0.16

To minimise the influence of this factor, water trucks should be used for irrigation of the workstations.

Transport activity

Emissions (**Table 4.2.10**) from transport activity (20 courses a day for 7 hours) are evaluated by the EMEP/EEA CORINAIR, SNAP code 0808 - [218], wherease for carbon dioxide they are evaluated by the IPCC (NFR 1A5b iii) - [219].

Table 4.2.10 Emissions from transport activities

Emissions [kg] / Equipment	Greenhouse gases			Basic and specific pollutants					
	CO_2	CH_4	N_2O	NO_x	SO_X	CO	NMVOC	PM_{10}	NH_3
Transportation equipment	139.1	0.008	0.1	0.6	0.004	0.8	0.1	0.05	0.0003

The above quantities of emissions are released directly into the air from the tailpipes of ICE machinery.

Radioactive waste gases

As a technology, the process of conservation of RAW in the NRRAW is not associated with any likelihood of gas emissions into the air, both during normal operation and in emergencies.

As analysed in the preliminary report of safety, the radionuclides, which are in gaseous form or are included in gaseous molecules, such as ^{3}H, ^{14}C, ^{222}Rn, ^{85}Kr and ^{129}I, may leak from the near field to the atmosphere mainly by diffusion and convection. The gaseous product transfer processes are reported in the MB of the reference system.

Radionuclides ^{14}C, ^{129}I and ^{222} Rn, are present in the inventory of the NRRAW [198] as a subsidiary product of the radioactive decay. Unfortunately, at this stage an analysis has not been conducted to identify the chemical form and quantity of ^{14}C and ^{129}I in the waste, so the leakage of those in gas form cannot be evaluated.

As seen from the material, the concentration of ^{222}Rn, 500 years after closure of the repository will be 2.15E-04 Bq/kg which is equal to 5.30E+04 Bq of total activity of ^{222}Rn for the entire repository. The maximum activity of ^{222}Rn is evaluated as 5.30E+07 Bq and will generate around 2.0E+06 years after the closure of the repository.

4.2.4 Harmful non-radioactive physical emissions

- **Harmful non-radioactive physical emissions**

Noise sources envisaged in the investment proposal

Implementation of the investment proposal (IP) for the construction of the NRRAW is associated with three periods of noise emissions: construction, operation and closure.

During construction

The construction - mounting technique used for the various types of activities provided for the construction of the main objects (technological) and ancillary sites (checkpoints, administrative and laboratory block, auxiliary units 1 and 2, the pumping station, working hall, construction ventilation system, compressor room, kiosk, etc.) will be a source of noise in the environment. There are plans to build technological routes. The noise levels from the main machines used are: excavator - 80 ÷ 91 dBA, bulldozer - 97 ÷ 105 dBA, crane - 92 ÷ 98 dBA, concrete mixers and trucks - 80 ÷ 92 dBA, fadrome - 80 ÷ 95 dBA.

The investment proposal considers two options for a repository - trench and tunnel type.

In the trench type, the main machine for digging a trench is an excavator with a noise level as mentioned above. It is a source of environmental noise at work in the early stages of construction on the facility surface until a depth of about 2/2.5 m. With the increasing depth of the trench, it will not be a source of noise to the environment due to the strong shielding effect of the slopes. The noise will be a factor of the working environment. The noise level is reduced with the use of modern machinery.

The sources of noise during ground construction work will be focused on the construction site with the exception of freight transport for transportation of mining rock to the dump and to supply the necessary materials and technological elements. The equivalent noise level at the site near the operating equipment can reach 90 dBA at certain times.

The excavated earth will be transported by truck to the site within the NPP (according to data from the information of the contracting authority).

It is envisaged that the transport of earth will be done with auto dumpers, with 25 trips a day to a distance of about 3 km. The equivalent noise level of this transport is about 60 dBA. This transport does not pass through populated areas. At this stage there is no information on the number of freight trips for the transportation of construction waste and delivery of the necessary materials and elements of the facilities.

The construction servicing transport will travel by road in the area and can change its acoustic performance by about 1 dBA over a period of intense construction-mounting activity.

During operation

During the operation of the repository, the environment noise sources will be facilities serving drive activities, verification of compliance and storage of fuel (especially for wheeled vehicle travel (STV), trucks, concrete) that generate 85 dBA of noise. Noise sources will include all the auxiliary equipment and systems providing normal operation of the repository (ventilation systems, diesel aggregate, compressor, crane, mechanical works, etc) with different levels of noise ranging from 85 dBA to 105 dBA.

The facilities are located in buildings with solid concrete structures. Exterior barrier walls are made of aerated concrete blocks with an insulation index of no lower than 45 dB.

The working hall over the shaft for waste conservation is designed with a metal hanging construction and surrounding sandwich panel walls with an insulation index of around 25 dB.

The expected noise level, received from the premises of the construction in the surrounding area of the site, is up to 60 dBA.

The transport servicing the operation of the NRRAW (STV, trucks, concrete mixers) will be run at low speed on technological roads at the NPP path.

During the closure of the repository

Noise sources are the machinery and equipment for various activities related to the closure of the repository (the filling of all the underground structures with lyoso-concrete mixture, construction clay stoppers and multi-barier cover, dismantling and demolition of buildings and structures on the surface of the sites, including site recultivation).

The main machines and equipment are: filling complex, excavators, bulldozers, concrete mixers, trucks with noise levels within the 80/105 dBA range. The number of trips that the hopper trucks will do is small - 10 per day and they will not be a significant noise-creating factor on the repository site.

The equivalent noise level can reach 90 dBA on the repository site, around the operating equipment.

Vibrations generated during the construction are related to the specific activities and are limited to the area of the construction site.

Heat, lighting and EMF - During the construction of the NRRAW the use of machinery and equipment as essential sources of lighting, heating and EM-fields is not projected. Since such equipment will be used by the future builder in some specific construction activities, it should be installed in accordance with the instructions for equipment operation.

During normal operation

Heat – The NRRAW is not a heat source.

Light and EML- According to the project, the lighting projected is in accordance with German standard DIN 5035. The use other background sources of illumination and/or generators of abnormal EML is not envisaged. Equipment such as measuring devices, monitors, etc, a potential source of EML, comply with technical standards. There will be no impact of EML.

- **Harmful radioactive emissions**

Harmful radioactive emissions from the NRRAW to the nearest populated area, the town of Kozloduy, are not expected [190].

4.3 Analysis of the expected impacts and their range

4.3.1 Potential impacts during the construction of the NRRAW

The impact of the NRRAW on the population and environment can be divided into impacts during construction, operation and during decommissioning, as the expected impact is seen in the radioactive and non-radioactive aspect.

No impact of radiation factors associated with the investment proposal during construction are expected because of the absence of radioactive sources in this phase. The only way for radioactive sources to be used during this period is in the control of metal in welds of structures by radio-defectoscopy. In such a case the rules and prescribed regulations for work must be strictly adhered to.

4.3.1.1 Potential impacts during the construction of the NRRAW on the NRRAW site staff and the Kozloduy NPP site staff (impacts of radioactive and non-radioactive factors)

The total area of land is about 36 ha. Additional space will be needed during construction for temporary activities within the Radiana site itself.

Construction of separate underground modules is projected on the Radiana site, representing the reinforced concrete structure, located at / below the surface [200].

The construction of auxiliary constructions and facilities, a checkpoint, a device for monitoring incoming RAW packed in concrete containers (control of the documentation and measurements), an administrative and laboratory complex and an auxiliary building (warehouse, garage, workshop), crane way for gantry crane handling of the packed and conditioned RAW is envisaged.

Construction of a new transport link from the north road, controlled by the Kozloduy NPP, is projected. This road will be used to transport radioactive waste.

Non-radioactive aspect

Construction will include the following activities: land digging and bulk works, material procurement to the site and construction of concrete foundations, construction of the NRRAW, construction of auxiliary constructions and facilities for the physical protection of the NRRAW, construction of adequate infrastructure.

Activities related to truck and heavy construction work machinery traffic, the use of large quantities of construction materials leads to the generation of additional noise and vibrations, air pollution with harmful and irritating gases, common soil, construction dust and particulate with a particle size of between 2.5 μm and 10 μm. The construction site could be contaminated with spent lubricating oils used for heavy machinery, fuel and construction material containing anti-corrosive, waterproofing, electrical insulation materials, adhesives, organic solvents and waste polymers.

The construction will require the following materials: concrete, sand, gravel, cement, lime, reinforcement and other construction materials - bricks and roofing materials for constructions, formwork for concrete structures, pipes, valves, wiring, etc. The materials needed during construction will include electricity, water, etc.

The main risk factors for workers during the construction of the NRRAW associated with hazardous substances are summarized in Table 4.3.1, others adverse health effects associated with physical work environment factors, physiological load and accidents during the construction activities in the construction of the facility are summarized in Table 4.3.2.

Table 4.3.1 Hazardous substances, chemicals and materials with adverse health effects during construction activities in the construction of the NRRAW (according to safety datasheets)

Chemical preparation CAS no.	Sign of danger	Adverse health effects	Risk exposure

Chemical preparation CAS no.	Sign of danger	Adverse health effects	Risk exposure
Carbon monoxide 630-08-0	F+ Highly flammable, T toxic	Highly flammable, toxic by inhalation - causes hypoxia and hypoxemia. Produces carboxyhemoglobin. Damages the nervous, cardiovascular system, blood formation, Toxic for reproduction.	Emissions from gas exhausts
Carbon dioxide 24-38-9		Asphyxant - displaces oxygen in the air. Damages the nervous system.	Emissions from gas exhausts
Nitrogen oxides 10102-44-0	T+ Toxic Xn Hazardous	Toxic, causing vesicle lipid peroxidation. In high concentrations it leads to lung edema, alveolitis. It irritates the respiratory tract, eyes and skin, causes chronic bronchitis and frequent bronchopneumonias	Emissions from gas exhausts
Sulphur dioxide 7446-09-5	T Toxic, C Corrosive	Toxic by inhalation - damages the respiratory and nervous system and the heart. In high concentrations itleads to chemical burns. Irritating to the respiratory system, eyes and skin. It has a strong, unpleasant smell. Hazardous for the environment.	Emissions from gas exhausts
Diesel fuel 8006-61-9	Xn Hazardous N Hazardous for the environment	Harmful. Danger of cumulative effects. Allergen. Damages the nervous system, skin, blood formation, liver, kidneys. Mutagen. Hazardous for the environment.	Chronic effects of non-compliance with the requirements for safety at the workplace.
Cement	Xi Irritant Allergen	Irritant to skin, eyes and respiratory system. Allergen. Contains pollutants (Cr-VI, Cd, Co, Ni). Supervised by Decree no. 156 / 2004, hexavalent chromium content of 0.0002%. Inflammatory and allergic skin lesions and mucous membranes.	Chronic effects of non-compliance with the requirements for safety at the workplace.
Asphalt 84989-11-7	T Toxic	Chronic impairment of blood formation, respiratory system, liver and skin, endocrine glands and immune defense. It is classified as a human carcinogen category 2, and photo allergen.	Chronic effects of non-compliance with the requirements for safety at the workplace.
Polyurethane and epoxy surface coatings and adhesives	Xi Irritant Allergens	Causes acute and chronic diseases due to allergic reactions or irritation of the respiratory system (asthma) and skin	Use without prior information on labels and instructions for use
Soil dust from construction materials FDP2.5, FDP5, FDP10		Causes chronic inflammation of the upper respiratory tract, chronic bronchitis, eye irritation, worsening the state of the cardiovascular system	Digging works Traffic of trucks, the work of heavy construction machinery, the use of large quantities of construction materials

* - Law on protection from harmful effects of chemicals, preparations and products, Law amending the Law on Protection from harmful effects of chemicals, preparations and products Decree no. 316 of the code on the manner and procedures for classification and labeling existing and new chemical substances, preparations and products and Decree no. 174 on amendment of Decree no. 316 [54].

** - Decree no. 156 amending the code on hazardous substances, preparations and products subject to prohibition or restrictions on trade and use adopted by Decree no. 130

Adverse effects associated with hazardous chemical substances from construction machinery and commercial vehicles can be controlled by using diesel fuel meeting the requirements of Regulation no. 17 on the levels of lead in fuel, sulphur and other environmentally harmful substances.

Other adverse effects associated with construction activities in the construction of the NRRAW that are likely to occur are classified in **Table 4.3.2**

Table 4.3.2 Adverse health effects associated with physical work environment factors, physiological load and accidents during the construction activities in the construction of the NRRAW

Harmful factors	Adverse health effects	Risk exposure
Physical factors in the working environment		
* Noise and vibration from construction machinery, lorries, construction activities	Hearing damage at high frequencies, neurosis, neurasthenia, high blood pressure, disturbed metabolism and immune	Truck traffic, the work of heavy construction machinery, the use of large quantities of construction materials, working with older, unsupported machines, bad routes, unsafe cubicles without earplugs
Microclimate outside the comfort zone **	Outdoor use. Chilling, freezing or overheating. Damage to the cardiovascular and musculoskeletal systems, infectious diseases	Lack of rest areas. Inappropriate clothing, gloves and shoes
Physiological and ergonomics factors in the working environment		
Weight lifting	Damage to joints, bones, heart problems	Failure to comply with the requirements of Regulation no. 16/1999 ***
Physical strain and fatigue	Damage to joints, bones, neurological and cardiovascular problems	Failure to comply with the requirements of Regulation no. 15/1999 ****
Psycho-sensory load	Neurosis, neurasthenia, heart problems, stress	
Forced working posture	Damage to joints, bones	Specific activities during construction
Emergency breakdowns and accidents		
Accidents Injuries	Falling into the pits, high-piles, injuries from heavy machinery and equipment	Specific activities during construction
Fires and explosions	Burns, trauma, suffocation. Shocks.	Lack of electric protection Poor storage of petroleum products and fuels
Traffic accidents	Trauma, burns, impairment of petroleum fuels with disposal aggregates	Transporting large quantities of construction materials

* BDS 14478-82 Noise level limits for working places. General requirements for conducting the measurements.

** BDS 14776-87 Production microclimate

*** Regulation no. 15 on the terms and requirements for development and implementation of physiological systems of work and rest during work

**** Regulation no. 16 on physiological norms and rules for the manual handling of loads

Radiation impacts

Because of the absence of radioactive sources, radiological impacts during the construction of the facility are not expected. The only way for radioactive sources to be used during this period is in the control of welds in metal structures by radio-defectoscopy. In such a case, rules for work and regulation prescriptions must be strictly adhered to.

Characterisation of the exposure: During project implementation, construction workers will be subject to a wide range of harmful non-radioactive health effects. The terms of these effects are not unique and are the same for each of them, they depend on the particular profession, job assignment and length of employment. Therefore, the exposure should not be evaluated for the duration of the shift, but at the time of each production task. Thus, the effects can be defined as direct, short-term, temporary and localised within the construction site of the investment proposal.

Estimate of the possibilities of combined, complex, cumulative and remote impacts on the established risk factors.

- ‘Combined’ is the impact of the gaseous pollutants with a local irritant and particulate aerosols with organic solvents and hydrocarbons.
- The predominantly local irritative impact of gases is combined with that of dust aerosols and the cooling microclimate (when working in the cold and transitory period of the year), of the noise and vibrationand of bituminous materials with UV radiation.
- Substances with high oncogenic probability have remote impacts. - 3.4 benzipyren. The bitumen released during isolation works has a lower oncogenic probability.

Conclusion:

The probable non-radioactive impacts during the construction of the NRRAW will have a limited scope only within the main construction site.

They will primarily affect the construction workers. The adverse impacts will be immediate and temporary reversible. Secondary and cumulative impacts are not expected. The health risk is acceptable and controllable.

An increased health risk to the residents of the nearby settlements and the staff of the neighboring sites of the Kozloduy NPP is not expected .

There will be no radiation impact.

Transboundary impacts are not expected, both in radiation and in non-radiation terms.

4.3.1.2 Potential impacts on the air and atmosphere

Determining the scope of impact (the areas of pollution) of the air

The main pollutants in the ground atmospheric layer are dust emissions from the bulk handling of powdered materials, bulldozing recultivation and emissions from internal combustion engines of the construction equipment and freight transport used for land masses to the dump and the supply of concrete. Contamination areas will be determined by mathematical modelling of the spread of pollutants from both types of sources (areal and linear).

The estimated annual average concentrations of ambient air pollution concentrations and the maximum single concentrations, i.e. the maximum potential contamination which can be obtained from on-site sources, defined as the maximum amount of pollution and the weather conditions under which it occurs, are determined.

Annual concentrations

Area sources

A version of the software product "DIFFUSION" is used to determine scattering of pollutant sources from areas in which the percentage is also recorded of "quiet time" during the annual rose wind consideration.

The total dust emissions have a local impact on air. They are carried over small distances from the source, because they are cold (with the ambient air temperature), have a great gravity deposition velocity and a low release height. The emissions of fine dust particles (FDP10) has been investigated to characterize the impact of dust emissions from the activity of the accumulation of 600,000 m3 of spoils for stage I in the dump on the air quality around the site and the nearby populated areas. The pollutant does not travel long distances during the spread of the dust particles.

According Ordinance no. 12/2010 [17] the average rate (SGN) for FDP_{10} is 0.04mg/m^3. The average lower assessment limit (LAT) for the protection of the human health is 0.02mg/m^3 (the contour in pink / ▬ /). The road to the dump is outlined in blue / ▬ /, and the dump Is shown in light blue / ▬ /).

Figure 4.3-1 Average annual contamination with FDP_{10} for the construction stage

The red contour in the figure / ▬ / shows the 3-kilometer radiation protection zone of the Kozloduy NPP. The maximum concentration obtained of 0.0133mg/m^3 is very near the dump. Measures should be taken to provide personel protective equipment.

With the tunnel type, the particle impact from the Radiana site itself is minimal, since the large-scale construction is indoors (tunnel), so the particulate emissions are very limited in space - at the entrance of the tunnel.

Sufficient moisture in the work areas during the dry summer and autumn months should be maintained to lower the risk of dust impacts by almost 80% on both sites.

Linear sources

Path to a dump.

The estimated evaluations of pollution from the ICE on the road in the surface layer of the atmosphere are calculated using the TRAFFIC ORACLE mathematical model.

The pollution is modeled for 25 courses of shift and emissions from transport activity. The maximum values of annual concentrations obtained from linear sources are summarized in **Table 4.3.3**

Table 0.1 Annual concentrations of linear sources

Maximum annual concentrations						
NO_X	SO_2	CO	FDP_{10}	C_6H_6	CO_2	
0.04**	0.05 (1)	none **	0.04**	0.005**	none	SGN [mg/m^3]
0.026**	0.008*	none **	0.02*	0.002**	none	LAT av.y [mg/m^3]
Cmax[mg/m^3]						
0.0000513	0.0000004	0.00007	0.000004	0.0000002	0.01215	

(1) Recommended standard by the World Health Organization

** Ordinance no. 12/2010 - Norms for sulfur dioxide, nitrogen dioxide, ozone, particulate matter, lead, bensen, carbon oxides in ambient air. [17].

- Average annual rate (AAR) for nitrogen oxides (NO_x) is 0.04mg/m^3, which comes into effect from 2010. Average lower assessment limit (LAT) to protect the human health is 65% of MAC or 0.026 mg/m^3, and LAT for ecosystems – 0.0195 mg/m^3;
- AAR for sulfur oxides (SO_x) none. (There is a recommended standard by the World Health Organization (WHO) of 0.05mg/m^3). The average annual LAT for ecosystems is 0.008mg/m^3;
- AAR for FDP_{10} is 0.02mg/m^3, which comes into effect from 2010. The average lower assessment limit (LAT) to protect the human health is 0.01 mg/m^3.
- AAR for benzene (C_6H_6) is 0.005mg/m^3, which comes into effect from 2010. The average lower assessment limit (LAT) to protect the human health is 40% of MAC or 0.002 mg/m^3;
- AAR for carbon monoxide (CO) none.

As shown in Table 4.3.1.3 there is no exceedence of the standards for any pollutant.

Figure 4.3 2 completes the study with the average annual pollution with nitrogen oxides (NOX) from the traffic on the road (outlined in blue / ▬ /) to the dump in yellow / ▬ /). Plot contours are well below the AAR of NO_X of 0.04 mg/m^3. The maximum concentration is with a value of 0.000051mg/m^3

Figure 4.3-2 Average annual nitrogen oxides (NO_X) pollution from the traffic on the road to the dump (NO_X)

Consequently, the following impacts are not expected in the long tern (annually) during construction:

- **Fine dust particles from the source areas or with very low level of impact.**
- **Truck traffic from NRRAW to the dump.**

Maximum single concentrations

An important feature is the maximum possible contamination, which can be obtained from on-set sources, defined as the maximum amount of pollution and also the weather conditions under which it occurs. This is the only feature of pollution, which can be obtained if all other weather data for the region are missing. In the range of variation of meteorological parameters - wind speed for each of the 8 standard directions and stability class (A - a strong instability, B - moderate instability, C - low volatility, D - neutral stratification, E - weak sustainability and F - moderate resistance) the field of pollution is obtained to determine its maximum value during the relevant meteorological parameters and wind direction.

Surface sources

The most adverse weather conditions are the north wind with speeds of 2.5 m/s and stability class E. In these conditions, due to weak turbulence in the vertical direction, a large gravitational deposition velocity (0.05 m/s) and low-level emission, the diffusion of pollutants is not transmitted out of the source.

Since Regulation no. 12/2010 [17] has no average hour rate for fine dust particles, the maximum single total dust pollution has been estimated. Its concentrations are established by Decree 14/1997, namely the average hourly limit concentration (TLC_{ahc}) of 0.5 mg/m^3. The resulting maximum modeled concentration is 0.165 mg/m^3, which is below $TLC_{ahc.}$

Linear sources

The most adverse weather conditions are the southeast wind with a speed of 2.5 m/s and stability class E. In these conditions, due to the low turbulence and vertical diffusion, the pollutants are exported away from the source, but because the sources here are cold and low, the distance is not far from the road.

Such conditions occur after sunset. The data for maximum concentrations for various contaminants are summarized in **Table 4.3.4.**

Table 4.3.4. Maximum single concentrations of linear sources with northeast wind

<table>
<tr><td colspan="6">Maximum concentrations</td><td rowspan="6">speed **2.5** m/s
direction **0°**
resistance class **E**
AHR [mg/m^3]
LAT [mg/m^3]</td></tr>
<tr><td>**NO_X**</td><td>**SO_2**</td><td>**CO**</td><td>**Dust**</td><td>**C_6H_6**</td><td>**NH_3**</td></tr>
<tr><td>0.2*</td><td>0.35*</td><td>10**</td><td>0.5***</td><td>*none* **</td><td>0.25***</td></tr>
<tr><td>*0.1**</td><td>*0.05**</td><td>*5***</td><td>*none****</td><td>*none* **</td><td>*none* ***</td></tr>
<tr><td colspan="6">Cmax[mg/m^3]</td></tr>
<tr><td>0.014166</td><td>0.000105</td><td>0.020237</td><td>0.001214</td><td>0.000061</td><td>0.000008</td></tr>
</table>

* Regulation no. 12/2010 Standards for sulfur dioxide, nitrogen dioxide, fine dust particles benzene, carbon monoxide and lead in ambient air. [17]

** . Ordinance no. 14/1997 Emission Limits on harmful substances in ambient air in the populated areas [16].

According to Decree no. 12/2010:

- The average annual rate (AHR) for nitrogen oxides (NO_x) is 0.2mg/m^3, which comes in effect from 2010. The average hourly lower assessment limit (LAT) for the protection of the human health is 0.1 mg/m^3;
- AHR for sulfur oxides (SO_x) is 0.35mg/m^3, and the average hourly lower assessment limit (LAT) for the protection of the human health is 0.05 mg/m^3;

- AHR for benzene (C_6H_6) none;
- Dayly norm (average 24 hour rate) for carbon monoxide (CO) is 10mg/m^3, and the AHR (averaged for 8 hours) for lower assessment limit is 5mg/m^3.

According to Decree no. 14/1997:

- The maximum single limit concentration (TLC_{ahc}) for total dust is 0.5 mg/m^3.
- The maximum single limit concentration (TLC_{ahc}) for ammonia (NH_3) is 0.25 mg/m^3.

As the table shows, none of the pollutants exceed the standards.

Therefore, the facility is not expected to affect air quality around the plant in terms of the considered pollutants in the short term during construction.

4.3.1.3 Potential impacts on surface water including the Danube river

The potential impacts on surface water during the construction of the NRRAW can be summarized as follows:

The construction of the NRRAW will require water for the drinking needs of the builders (deliver botled drinking water), domestic and other work done on site (concrete, wet processes, etc.). This means that there will be some increase in water consumption. Quantities will be limited and will not constitute a substantial violation of the water use in the NPP. The scope of this impact will be temporary (construction period) and limited within the NRRAW site. Regardless of the insignificance of the impact, it will be negative and direct. There will be no secondary or cumulative impacts. It will be temporary (for the construction period) and short term.

During the construction of the NRRAW, limited amounts of wastewater will also be generated. The ability to place chemical toilets or excavated pits will be refined. Wastewater will not pose any problem for the NPP sewer or treatment facilities of the NPP. The impact will be temporary and short-term during the construction period and periodic during operation. Waste water generated during the construction and operation of the NRRAW will not violate water quality in the surrounding waters.

In the radiation aspect, no impact is expected on surface water due to the absence of radioactive sources during construction.

4.3.1.4 On ground water

Regarding the non-radioactive aspect during construction:

- An impact on the quantitative status of underground water body "pore waters in the Quaternary - Kozloduy Valley code BG1G00000Qal005" is expected, following a further abstraction for drinking and construction needs of the NRRAW through the existing intake systems and facilities outside the site of the investment proposal. This impact will be direct, short-term and reversible, with a limited territorial range and low range in the creation zone of influence around the water intake facilities. It is considered negligible because abstraction is implemented as required by the Water Act and its regulations on the basis of relevant permits for abstraction;

- An impact on the chemical state of the upper layer of underground water body BG1G00000N2034 (Dak-Roman aquifer) is not expected, as the potentially infiltrating small amounts of polluted water generated in the process of short-term construction activity in the performance of digging, embankments, and concrete sealing work in the construction of the mine workings, cleaning the site of construction and transport equipment, etc., will be held in the relatively powerful and with low filtering-property aeration zone, without reaching the groundwater below. This impact will be negative, direct, temporary, short-term and reversible, with a limited territorial range and low level in the range of the site of the investment proposal. It is considered negligible;

- No impact is expected on groundwater bodies near the "Radiana" site and on the existing intake facilities, which are not supposed to meet the drinking needs of the NRRAW.

As regards radiation, no impact is expected on groundwater due to the absence of radioactive sources during construction.

4.3.1.5 On the subsurface and the mineral diversity

As regards the non-radioactive aspect the impact during construction will be from the:

- Mechanical distortion of the earth in preparation for construction of the construction site and the phased construction of the NRRAW. This will inevitably have a direct, permanent and irreversible impact, with a range within the territory of the site, possibly part of the land around it (temporary roads depot for excess spoils, etc.). Depending on the type of repository, the impact is expected to be of a high level of distortion of the earth in the trench-type repository, with low level in the tunnel (gallery)-type repository and with medium level in the shaft-type repository;

- Potential infiltration into the subsurface layer of the earth with small amounts of polluted water generated in the construction process.

No impact on the mineral diversity is expected since mineral resources of economic significance are absent from the scope of the "Radiana" site. The need for the inert construction materials will be provided outside of the investment proposal area and loess and clay materials from the diggings at the site of the investment proposal will be used for the construction of the envisaged insulation screens and subsequent infilling of the repository modules.

As regards radiation, no impact is expected on the earth due to the absence of radioactive sources during construction.

4.3.1.6 On the soil

During the construction of the NRRAW, the impact on the soil will be actually from: earth-digging activities, transport - import and export of construction materials, removal of excess earth and ground transportation to the site for their conservation or use; pressure from construction activity on an area of around 40 dka and minor change of the land use on the NPP own site. Hummus will be disposed of within the borders of the property, according to the regulations and 100% of it will be used. The resulting digging spoils will be used to correct the damaged sites or will be used for recultivation. The land in the neighboring properties will not be directly affected during construction. NO adverse impact is expected on adjacent lands indirectly through dust gas emissions, but measures are proposed to bring them to a minimum by complying with certain conditions (in order to maintain the construction and transport equipment, irrigation of the site in dry weather, etc). Lands that could be considered permanently destroyed are only those situated on the site, that have built facilities, constructions, roads, paths and others.

The impact on soil will be negative, direct, temporary, long-term and irreversible:

Way of impact - direct. The indirect impact can be in the 3-km zone, where the unnecessary dredging spoils during construction will be moved.

Degree of impact: strong and irreversible (unless it is considered temporary because of the recultivation of land)

Duration of impact: temporary, but will irrevocably change the soil profile and use of land above the repository itself, but with limited scope within the site NHRAO;

Frequency of impact: during construction

Cumulative impacts: none are expected

Transboundary impacts: none are expected

Reversibility of effects: to some extent reversible after the technical and biological recultivation. There is an opportunity to build a plant belt and landscape with vegetation. A change of the status of the land on the site is necessary. For the construction of new infrastructure, land and soils from the land fund will be violated. [162, 163, 310, 317, 318, 370].

As regards radiation, no *impact on soil is expected due to lack of radioactive sources during construction.*

4.3.1.7 Expected impacts on biodiversity

On the vegetation

The IP is related to the construction assembly activities affecting land and existing vegetation on the site. In the construction items on the developed work schedule, the vegetation will gradually be completely eradicated. With the change of land use, the appearance of the land changes as well.

As regards the non radioactive aspect:

Way of impact - direct. The indirect impact can be in the 3-km zone, where the unnecessary dredging spoils during construction will be moved.

Degree of impact: strong and irreversible (unless it is considered temporary because of the recultivation of land)

Duration of impact: temporary, but will irrevocably change the soil profile and use of land above the repository itself, but with limited scope within the site of the NRRAW;

Frequency of impact: during construction

Cumulative impacts: none are expected

Transboundary impacts: none are expected

Reversibility of effects: to some extent reversible after the technical and biological recultivation. There is an opportunity to build a plant belt and landscape forming with vegetation. A change of the status of the land on the site is necessary. Land and soils from the land fund will be violated [162, 163, 310, 317, 318, 370] for the construction of new infrastructure. It will be reversible to some extent, after the technical and biological recultivation. There is an opportunity to build a plant belt and landscape design with plants.

As regards radiation, no *impact on soil is expected due to lack of radioactive sources during construction.*

Protected plant species were identified or described in RB applications of EPL within the territory of the IP. Therefore, given the small area affected in the region, the negative impacts on vegetation in the construction of the NRRAW will be negligible.

Expected impacts on the fauna

In non-radiation aspect:

Overall, no significant negative impacts on the fauna (invertebrates, fish, amphibians and reptiles, mammals and other birds) in this part of the Danube Valley can be expected to lead to significant and irreversible loss of biodiversity, including. cumulative impacts during the construction of any one of the options of facilities for radioactive waste. No group habitats of rare and endangered species of wildlife were recorded during inspection or in literature data in the estimated overall site (36 ha) and in its vicinity. The territory itself is located in a somewhat isolated but also fragmented area that is surrounded by significant anthropogenic affected areas - south of second-class road village Hurlets - Kozloduy and beyond arable land, north path access to the Kozloduy NPP and the NPP site itself, arable land to the west and east. All this greatly impedes the free and undisturbed access to this stretch of some ground moving species, particularly those that are characterized by a higher limit of the anxiety factors.

During construction, the options viewed for technical solutions are mainly the expected mortality of individuals of invertebrate fauna (invertebrates), which occurs in the affected outdoor areas, mainly soil and terrestrial invertebrates, but that inevitably accompanies all types of construction and other activities (especially agriculture) in rural territories. In terms of the invertebrate fauna, the characteristics established in the descriptive part show that IP is at a significant enough distance from all regions with a widespread population and variety of rare and endemic invertebrate species in Bulgaria. This part of the Danube plane has one of the smallest and most negligible country-wide number of endemic and rare species, while no relics are registered. Five target invertebrate species of conservation importance are listed and described, and they are the subject of protection applications Dir.92/43 EEC, LBD and others. They are distributed in aquatic ecosystems or mainly in beech and ancient oak forests, which are non-existent in the IP region. In such case, mainly widespread species with multiple populations will be affected, as mortality of the invertebrate fauna should be considered rather due to the aspect of loss of food base for other vertebrate taxons, but it will be imperceptible, negligible for the region and somewhat reversible. It should also be considered that the negative effects on invertebrates will be on a much lower level during the construction of the tunnel-type facility than other variant solutions as the main construction activities will initially focus on such a depth (25-35 m) in which invertebrate fauna is absent, given that such soil is concentrated only in the soil curtain. In practice, in the tunnel-type structure, negative impacts will be mainly found in the construction of the incoming and supporting infrastructure on the surface, resulting in shorter travel deviations from the main internal transport route to the site of the NPP and two external servicing sites on a total area of approximately 32 acres.

For the trench type repository the construction will focus on the surface and is associated with the formation of open ditches for the modules (total 8 pcs in two stages of construction), during which a much wider area will be cleared and penetrated in depth (about 60 acres for the facilities, service constructions, communications and others, which may be reduced to 40 acres in case of two stage construction)..

In terms of vertebrate fauna, no impact on the representatives of Class Pisces will occur during the construction of all the variant solutions, as the area of the site lacks any living conditions for them: the nearest water sites are about 4 km away (Danube river) and slightly more than 1 km away (the service channels of the Kozloduy NPP).

Although attendance is not registered, there is a possibility that amphibians and reptiles can be partially affected, but in a weak and admissible level. The only populations in this part of the country are representatives of the green toad (Bufo viridis), slow-worm (Anguis fragilis), Aesculapian Snake (Elaphe longissima) and some lizards, for which the site provides favorable conditions for housing and shelter to some extent. If present in the future this is expressed as a risk of mortality of single individuals (including their offspring) from being run over by heavy vehicles in transport activities as in the work of construction equipment for clearing and processing of the necessary land from the envisaged site. It is essential to note that this risk when selecting a tunnel-type repository option will be much lower than with another option, for reasons already discussed and with the invertebrate fauna (the difference in the affected areas on the surface in different versions). In all cases, it generally will not significantly affect the density of the populations of those species, as the latter, although included in Annex 3 of the LBD, are common in these and other habitats throughout the country and are found in sufficient quantity and are able to support the population structures and functions. The first two species are not endangered nationally and globally and do not fall into the ‘rare’ category in the Red List of Threatened Species of the IUCN: the first is included as slightly affected (incl. Aesculapian Snake) and the slow-worm is not at all included. The green toad is characterized by its synanthropic adaptability, i.e very common in urban areas where it often falls prey to other animals there. The slow-worm is widespread throughout the country in various areas - mainly in non-xerophytic forest massifs and open areas among them. The aesculapian snake, although listed as an endangered species in the Red Book of Bulgaria, except mostly in moist deciduous and mixed forests in their vicinity, does not avoid human settlements, such as entering and often can be found in vineyards, orchards and vegetable gardens and in the courtyards of the houses, where it often falls victim to the farmers. That is exactly why this has to do with one of the greatest threats to the populations of this species. Overall, the risk of mortality of aesculapian snake (Elaphe longissima) individuals at the site of the NRRAW is low, especially if you take certain precautions, mostly associated with the training of work personnel, will be reduced to an even lesser degree. Given that, in this case the tunnel-type repository is best, and also regarding the other two species. No significant impacts are expected on the other described species of amphibians and reptiles during construction. There are no known deposits of targeted and relevant taxons near the IP.

Regarding the mammal fauna, no significant direct negative impacts of construction activities associated with the mortality of individuals and others are expected. The main effects will be mostly related to the expulsion of existing terrestrial mammals from the territory of the surface construction sites during their clearing from the trees and the preparation for construction. Moreover, regardless of the chosen type of the repository, it is not expected to affect the populations of the typical described target species of the region and an object of protection in the nearest protected zones and their respective fields. The area does not offer appropriate conditions and the presence of such species is not registered. Although they were not observed, the only significant land species that could be affected are the weasel (Mustela nivalis) and the white-chested Hedgehog (Erinaceus concolor). Both types are often found near cities, and although they are included in Appendix 3 of the LBD as not threatened nationally and globally, they are not in the "rare" category, and in the red list of threatened species of IUCN they are listed in the "slightly affected" Category. Even if removed from the territory of the IP, this will not affect significantly the structure of their populations, as there are suitable habitats nearby where they can be accommodated. (The surface irreversibly affect is much smaller at the tunnel type facility compare to trench type facility). With regard to the bat fauna, as mentioned in the narrative, there are no adequate shelters for resting and reproduction of forest bats (at 10) on the territory. In practice, the site of the IP provides mainly the working conditions for hunting and feeding some of them, as a result of the clearing and the work on site of many individuals of those species most likely will begin to visit other hunting areas, especially in the implementation of the trench type repository. There are suitable sites around the servicing external channels of the Kozloduy NPP, near the Danube River and many others, so their numbers in the region as a result of the construction of the NRRAW are not expected to undergo substantial changes. Upon the implementation of the tunnel type depot, such bat species will probably continue to hunt in its over-ground perimeter in numbers approaching pre-construction. Most of the other types of mammals listed are hunting species, and all are widely spread throughout the country and there cannot be any serious consequences upon them from their expulsion.

As regards the species of birds listed in appendix 2 of the LBD (List 2 in the narrative), as noted in the area of forested territory, which includes the IP, only a red-backed shrike was registered during the nesting period. It is likely that individuals of the Syrian woodpecker can be found in search of food, but mainly during the autumn-winter period. The Red-backed shrike is very common in Bulgaria, and it can be found from the sea level to very high altitudes. The area of the IP, due to its small size compared to that of the region, among which it falls will affect very small proportion of food and even less of the breeding base of the red-backed shrike in the area. Only during periods of seasonal migrations, longer during the spring, individuals of the collared flycatcher (both subspecies) and the pied flycatcher are registered. From the other species, separate individuals would use the trees in the wooded area for landing during rests and overnight stays (and most likely have done, perhaps with the exception of the white stork).

Based on the above, it can be concluded that during the construction of the investment proposal, no significant damage will be caused to the fauna in this region of the country, as the outer sites of the investment intention are on a limited area and there is no serious risk of the destruction of rare and endangered species. In practice, the number of faunistic complexes in the area will remain slightly amended, or unamended.

Impacts on the fauna due to the construction of the investment proposal will be with the following parameters:

Territorial range: on a local level, confined within the range of the "Radiana" site - for the trench type of the facility the area within the boundaries of the modules of the facility, utility buildings and facilities, parking space, outside transport links, paths for pedestrian movement and others (fenced area is about 17 ha, of which 50% will be green areas). Construction modules stepvise (in two stages) will significantly reduce the negative impacts. It is envisaged exavated soil will be disposed at existing disturbed area within the NPP, therefore its impacts on the fauna are not expected.

Way of impact - directly in terms of less mobile invertebrates within the site. Directly and particularly in relation to less-mobile invertebrates within the construction polygons and single individuals of amphibians and reptiles from the vertebrates fauna if they are present, secondary during the displacement of the mammal fauna and indirectly on some taxa distributed in the immediately adjacent areas.

Degree of impact: from negligible (tunnel type) to low (trench type), no effect on the number of faunistic complexes in the area and without any significant fragmentation of habitats, as they exist at the moment.

Duration of impact: temporary, permanent medium to long-term impact during construction;

Frequency of impact: lower in the tunnel type, mostly during the stage of forming the outer grounds and bringing infrastructure and in higher trench type due to above-ground construction of disposal facilities (modules).

Cumulative impacts: the emergence of such with similar investment intent and construction activities in the area are not expected

Transboundary impacts: none are expected in both types

Reversibility of the impact: to a less reversible degree with the trench type and largely reversible with the tunnel type after closure and liquidation of surface serving sites

In radiation aspect

No any impacts are expected on the fauna in the area during construction as regards radiation, as the facility or the module selected as relevant type in the stage of construction will not be in operation as intended. It should be noted that with the trench type, there would be a phaseability in the construction to some degree, which will coincide with the operation, i.e. some modules will already be operating, while others are to be built.

On the protected territories and zones - There cannot be any direct or indirect significant (dust etc.) negative impacts during construction on the nearby protected areas and habitats subject to protection in them, mainly because of the adequate site distance from all such territories, and the proposed sites for dredging spoils and others. As regards the cultivated agricultural areas which occupy spaces between the place of the IP, they are likely to have a much more tangible negative effect

4.3.1.8 On the landscape

The various components of the landscape are discussed in separate sections.

The specific requirements during the forming of the land are determined by the functional use of the territory. The most aggressive anthropogenic disturbances are negatively affecting the manifestation of favorable environmental and aesthetic impact on the local landscape.

Soil and water pollution are not registered In recent years in the area of the municipality air. Existing pollutants and their evaluation are provided in the individual points in the report components.

The impact of the implementation of the investment intention on the landscape can be divided into two phases: during construction and during operation.

There will be a definite impact on the landscape during the construction phase. During the construction works, the landscape will be amended. The changes are related to disturbances on the surface soil layer of the earth, vegetation and visibility, from the use of machinery and equipment (noise, emissions), and certain quantities of cluster masses excavated soil and construction materials. During this time, there will be a relatively short and weather-dependent impact.

The seizure, preservation and recovery of humus from areas affected by construction will be conducted in the established order.

In the implementation of the project, the landscape will be amended visually, but the basic type of landscape will not change.

The visual connection between the territory is characterized by the specificity of the local landscape (industrial landscape) - its distinction with a dominant Kozloduy NPP. The visual frames of the NRRAW will be defined mainly by road and communication links in different directions and different views from neighboring areas. The elements that affect the aesthetic and vision are related to the construction process and cannot be clarified in the feasibility studies. The problem concerns a specific video aesthetic and psychological assessment of the object, which in turn has a particular dynamic, depending on the landscape shaping of the terrain in the region. They depend on future investment intentions in the region.

The visual impact can cause a negative feeling for a too strong human intervention in the region. All this depends on the landscape shaping with vegetation. In an appropriate shaping with vegetation, the site may picturesquely incorporate itself in the surrounding landscape.

Territorial range: limited on a small area mainly in the reach of the terrain. Envisaged dredging spoils will be disposed of within the set limits of the terrain.

Type of impact – direct

Degree of impact: negligible to low, and relative to the aesthetics of the environment. The terrain falls into the industrial local landscape type.

Duration of impact: only a temporary impact during construction (7 years);

Frequency of impact: during construction

Cumulative impacts: none are expected.

Transboundary impacts: none are expected.

Reversibility of the impact: to some extent reversible after the construction phase. Possibility of construction of a vegetation zone and landscape shaping with vegetation.

4.3.1.9 Impact of construction, non-hazardous and hazardous waste associated with construction activities

Possible impacts during the construction of the NRRAW from deposition of waste associated with construction activities are as follows:

Potential impacts associated with the generation of the following waste are expected during the construction of the NRRAW: excessive spoils, waste from construction, construction materials, packaging of construction materials and equipment, construction waste and waste oils from the machinery from the construction mechanization.

The expected range of impact during the construction of the received waste described above is within the NRRAW site, since the waste will be formed there, as well as in the 3-km zone around the NPP, in relation to waste treatment. The impact is negative, because they pollute the ground; they act directly on the NRRAW site and indirectly to the 3-km zone. In carrying out the measures and strict control, the negative impacts will be minimized. Secondary or cumulative effects are not expected. As regards frequency, it is expected to be temporary, as regards duration is it expected to be short (during construction) and as regards reversibility it is expected to be irreversible in the 3-km zone and reversible in the NRRAW site.

Prediction and assessment of these impacts: only non-radioactive waste will be formed during construction, which will be treated in accordance with the established practice of the NPP. They will not remain on site and will be collected and removed immediately after their formation, outside for their subsequent treatment, i.e. their impact on the site is limited and it will cease upon completion of construction.

4.3.1.10 Impact from noise, vibration and other non-radioactive factors

<u>During construction</u>

Sources of environmental noise will be various construction machines for the various types of activities envisaged for the construction of objects (excavator, bulldozer, bulldozers, crane, concrete laying machinery, trucks, etc). The sources of noise during ground construction will focus on the construction site with the exception of freight transport for transportation of mining rock to the dump and to supply the necessary materials and technological elements. At certain times the equivalent noise level can reach 90 dBA near the operating equipment on the site. In both variants of the repository, the envisaged modern mining equipment for underground construction will not be a source of environment noise.

The impact of noise emissions on the environment during the execution of the construction works is inevitable, negative, temporary (only during the day time) and it covers the territory of the construction site and parts of the land surrounding it. The land around the site is not subject to requirements regarding noise regime, but the construction activity will temporarily change the currently existing background noise. No impact is expected on the settlements in the area because of their great distance from the site of the future project.

Noise impact during the construction works has emerged as a significant factor mainly in the working environment (service personnel). Personnel protective equipment should be provided for the workforce.

During the construction of the NRRAW, the servicing freight transport will increase the level of noise emitted by traffic flows on roads in the area. The expected noise characteristics of traffic flow on the main road II-11 for 2015 is 70 dBA (7.5 m away from the axis of motion). The expected increase for road II-11 is about 1 dBA cumulative effect).

Table 4.3.5 Noise impact at the time of the construction of the NRRAW

Way of impact	Direct, negative
Territorial range	localized (mainly on the construction site)
Frequency of impact	temporary, periodically (day only)
Degree of impact	average for the work site and compatible to its surrounding environment
Cumulative impact	expected regarding the construction-servicing transport
Transboundary impact	Not expected

4.3.1.11 Impact on cultural heritage

According to the statement in the expert conclusion from the laboratory of archeometry and experimental archeology at the New Bulgarian University, the group of mounds in the region of Kozloduy NPP may be considered an archaeological complex with regional significance. Research shows that the mounds of the western group are highly threatened by destruction as a result of construction (Mound no. 2) and intensive agriculture (nos. 3 and 4). The data from the geomagnetic measurement contains sufficient indications of archaeological structures, partially affected by agricultural machinery, and therefore require urgent study with the methods of archeology. To prevent the negative impact of future construction works on archaeological finds under research at the moment, the actions envisaged in Cultural Heritage Act Art.161, par.1, must be taken, namely to complete the archeological surveys made at that time before the implementation of investment plans and the start of construction works.

It is necessary to comply with the order specified in the law by Art.92, 93, 94 for the transmission of cultural values found in RHM, Vratsa for their identification, conservation, restoration and exhibition. Construction activities can start after the above actions CHA [147] have been taken.

One should not exclude the possibility that in the course of the construction works, unregistered archaeological findings objects or parts of them may appear, so it is necessary to comply with Art.161, para 2 of CHA [147] namely, a surveillance by archaeologists is to be conducted in the process of construction activities. In these cases the detection of archaeological sites, Art.148 and Art.160 CHA [147], as the activity is stopped immediately and action is taken according to Art.72 and Art.73 as the mayor and the head of the Regional Inspectorate for Protection of Cultural Heritage are notified about the location of the cultural value. It is necessary to comply with Art.147 para.5, item 2 and carry out rescue archaeological fieldwork.

In compliance with the measures as provided in the Cultural Heritage Act, described above all negative impacts on both the existing registered and unregistered heritage sites will be prevented.

4.3.1.12 From the possible radiation impacts associated with the construction of the NRRAW

There will be no impact from radiation factors during the construction of the proposed IP, due to lack of radioactive sources at the site in this phase. The only way for radioactive sources to be used is during this period, if the performance of non-destructive control during welding of construction with radio-defectoscopy is projected. In this case the rules and regulations must be strictly adhered to.

4.3.2 Potential impact during operation and closure of the NRRAW

4.3.2.1 On site staff of the NRRAW and on-site staff of the Kozloduy NPP (impacts of radiation and non radiation factors), during the normal operation and closure of the NRRAW (data on the possible exposure)

The period of operation of the NRRAW is envisaged for 2015 - 2075. Waste that is processed and packed in TSPRAO will be buried in it. Recycling is limited to the cementing of cubes residue (liquid RAW), extrusion of solid waste, packaging of cement mixture and solid waste in RCC. The final product from the processing of liquid and solid RAW are conditioned RAW, packed in concrete containers eligible for long-term safe storage.

In accordance with the requirements of the Bulgarian nuclear legislation regarding operation of facilities for the management of radioactive waste and the IAEA standards for safety and best practices in the manufacturing process the NRRAW has two aspects:

- Performing technological operations for the disposal of RCC
- Monitoring the status of: processed and disposed RCC, the state of disposal facilities, site, radiation protection and surveillance zones.

64 service personnel people will work at the NRRAW site during the operation period.

<u>In non-radioactive aspect</u>

During operation

The main risk factors in non-radioactive aspect for the working staff during operation of theNRRAW are the hazardous substances in the working environment, adverse physical working environment factors, psycho-physiological load of the personnel directly employed with the specific activities in the NRRAW and control to prevent emergency breakdowns and work accidents (Table 4.3.6).

Table 4.3.6 Hazardous substances and mixtures with adverse health effects, during the construction and operation of NRRAW.

Chemical preparation CAS no.	Sign of danger	Adverse health effects	Risk exposure
Ozone 10028-15-6	Xn Harmful	Disturbed vision, neurasthenia, eye irritation and respiratory tract, headache, cough, shortness of breath, chronic bronchitis, cardiovascular disorders	Welding in confined spaces without ventilation
Ferric iron oxide dust and vapor	Xi Irritants/Stimuli	respiratory and eye irritation, cough, shortness of breath and sometimes fever	Welding in confined spaces without ventilation
Hydrogen cyanide, cyanide 74-90-8	T toxic	Headache, fatigue, dizziness, cardiovascular disorders, anemia, endocrine and immune disorders	Welding in confined spaces without ventilation
Helium		Inert gas that can cause suffocation due to lack of oxygen in the air	Leaking in the air at the workplace
Carbon monoxide 630-08-0	F^+ Highly flammable, T Toxic	Highly flammable, toxic by inhalation, causes hypoxia and hypoxemia. Produces carboxyhemoglobin. Damages the nervous, cardiovascular system, blood formation. Toxic to reproduction	There is a risk of anemia, headache, and fatigue from gas exhausts.
Carbon dioxide 24-38-9		Asphyxiant - displaces oxygen in the air. Damages the nervous system.	Exhaust emissions can cause headache.
Nitrogen oxides 10102-44-0	T^+ Toxic Xn Harmful	Toxic- causing damage vesicle lipid peroxidation. In high concentrations lead to edema of the lung, alveolitis. Irritate the respiratory tract, eyes and skin, chronic bronchitis, frequent bronchopneumonia.	Exhaust emissions can cause chronic bronchitis, bronchopneumonia
Lubricants, Diesel fuel 8006-61-9	Xn Harmful N Hazardous for the environment	Danger of cumulative effects. Allergens. Damage to the nervous system, skin, blood formation, liver, kidneys. Mutagens.	Chronic effects of non-compliance with the requirements for safe work

Other possible harmful effects on personnel involved in the operation of the NRRAW are presented in **Table 4.3.7.**

Table 4.3.7 Adverse health effects associated with physical factors of the working environment, physiological load and accidents during the operation of the NRRAW.

Harmful factors	Adverse health effects	Risk exposure
Physical factors in the working environment		
Microclimate outside the comfort zone: High temperatures	High temperatures in activities which involve welding. It can cause damage to the cardiovascular system	Gaps in temperature control in the workplace
Lighting*	Risk of accidents in the insufficient and inadequate lighting in the working areas	Failure to comply with the requirements for lighting **
Gas pressure	Risk of accidents, trauma and injuries (air or helium under pressure)	Failure to comply with safety requirements
Non-ionizing radiation during welding in NRRAW	Eye damage. Early development of cataract.	Inadequate personnel protective equipment for the eyes
Physiological and ergonomics factors of the working environment		
Weightlifting (covers of the cartridges, heavy equipment)	Damage to joints, bones, cardiovascular problems	Failure to comply with the requirements of Ordinance no.16/1999.
Physical fatigue and strain - large amounts of the packing kits	Damage to joints, bones, neurological and cardiovascular problems	Failure to comply with the requirements of Ordinance № 15/1999
Psycho-sensory load	Stress and fatigue, neurasthenia, cardiovascular problems	
Forced labor posture	During welding in the NRRAW, venting, drying. Damage to joints and bones.	Specific activities
Emergency breakdowns and work accidents		
Working accidents	Falling from high and open places	Specific activities
Traumas	Injuries when working with machinery and equipment.	Specific activities
Containers falling	Traumas	Specific activities
Accidents during transportations	Trauma, burns, damage caused by fuel and filling of inert materials	Transporting large quantities of construction materials

* BDS 1786-84 Lighting. Natural and artificial

** Ordinance for the lighting of constructions no. 0-49 [119]

Non-radioactive impact during the operation of the NRRAW on the health of NRRAW personnel engaged in the activity is negative, direct, combined and cumulative. It is risk-related from the impact of adverse physical, chemical, psycho-sensory, physiological and ergonomic factors in the workplace, emergency breakdowns and potential accidents.

During closure

Operation of the NRRAW is projected until 2075 The closure of the facility (according to IP [192]) will be carried out after 2075 with a subsequent monitoring period of 300 years, with maximum safety of the activities and personnel based on appropriate measures for the actual condition of the NRRAW and scientific developments in this area, particularly investment proposals.

The non-radioactive impact in the decommissioning of the NRRAW on the health of its personnel and the personnel of Kozloduy NPP is expected to be the same as during the time of its construction.

In radiation aspect

During operation

Harmful effects of ionizing radiation on humans are expressed in the emergence of two types of effects - deterministic and stochastic (probabilistic). The former are directly related to the radiation dose received. They are limit effects, i.e. for them to occur it is necessary to obtain a dose. The limit dose is different for different effects, from small borders depending on individual exposure sensitivity. They are due to the death of a number of cells from an organ or tissue, leading to the breach of their functions. The severity of injury increases with the dose. These effects are somatic, primarily affecting the body's cells and are expressed only in the irradiated individual. Depending on the exposure sensitivity of the organ, the dose received and especially from its power, they can be early (from minutes, days and weeks after exposure) or late (years after exposure).

The stochastic effects occur later. Depending on the type of the cells affected they are somatic, appearance of cancer in exposed persons or genetic disabilities in the offspring.

Ionizing radiation as a damaging factor in the working environment has certain characteristics that are intrinsic only to it. The biological action of ionizing radiation is associated to the probability of occurrence of adverse health effects directly on the exposed individual but also on its offspring. An important characteristic of the effects of ionizing radiation is the impossibility of their establishment in the work environment directly from the individual, due to the absence of sensory organs for them. Additionally, the effect of ionizing radiation is cumulative and the nature of lesions on the body is irreversible. These features of the function of ionizing radiation on the body define terms "radiation hazard" and "injury". They underlie the principles of radiation protection, which is essential to achieve a reasonable level of radiation risk (a level of less than 10^{-4} per year is considered). Professions at risk of such order are related to the hazardous occupations category, according to the World Health Organization. To keep the radiation risk at an acceptable level it is necessary to have strict normalization of the radiation factor of the working environment by setting limits on the doses and introducing mandatory measures to protect the individual. This is achieved by regulating the issue of legislative documents and by providing an appropriate labor organization.

Under EU Directive 89/391/ES, improving working conditions is important to prevent accidents and professional diseases. Thus achieved, both for the general improvement of health and to reduce costs on the national, sectoral and company level.

The assessment of the workplace has a wider scope and is directed mainly towards improving the situation in the workplace. All aspects of work such as physical and chemical environmental factors, ergonomics, safety, mental stress and work organization are discussed.

The types of activities performed in an environment of ionizing radiation should be valued under the regulations on integrated assessment of working conditions in accordance with items listed in Section IX "Ionizing Radiation" of the Ordinance. The compensations received, resulting in additional cost, additional paid home leave, protective foods, clothing, etc., should comply with other legislation dealing with these issues.

The limits of human radiation exposure in Bulgaria are regulated by Ordinance on basic standards for radiation protection (OHP3-2004) [112]. Additional guidelines and limits for radiation protection measures, in addition to OHP3-2004, are given in the Ordinance on radiation protection, in activities with sources of ionization exposure [90].

Both regulations specify the requirements for radiation protection and measures that should be taken into account when carrying out activities using nuclear energy and sources and sources of ionizing radiation within the requirements of the safe use of nuclear energy law [128]. In addition, ONRZ also controls the radioactive exposure of the population by natural sources of radiation.

In accordance with this document, the following limits are defined for the workers in the future NRRAW (category A personnel). For a period of 5 consecutive years, the effective dose limit for personnel is 100 mSv, as the maximum effective dose for each separate year must not exceed 50 mSv.

The annual equivalent dose limits for staff are:

- 150 mSv for the eyes;
- 500 mSv for the skin (This limit applies to the average doses of an area of 1 cm^2, regardless of the area of irradiated surface);
- 500 mSv for hands and arms, feet and ankles.

In addition to the limits of the radiation, defined by this Ordinance, there is a fundamental requirement in world practice to ensure that all radiation exposures are justified and will be kept at ALARA levels, below the dose limits specified in the Ordinance, taking into account the social and economic conditions.

In accordance with the Ordinance on basic standards for radiation protection (OHP3-2004) and implementation of the ALARA principle, it is advisable to set lower limits for occupational exposure of the staff. If the estimated annual dose of radiation to any person of the population of the RAW managing facility is less than 0.01 mSv, it is presumed that the best available means of waste management and the requirement art.8, paragraph 2 of the Ordinance on the Safety of Radioactive Waste Management [93] in terms of population have been used.

The waiting time for each person during the transport operations, loading, deactivation, welding, inspection, removal and storage should be calculated and shown to be real for the performance of each task without undue change of staff during the process, i.e. not more than 10 (ten) people should be included in all of these operations.

The investment proposal of the NRRAW guarantees that radiation exposure of the workers is consistent with the ALARA principle and is constrained by the limits laid down in OHP3-2004. It is believed that the experience gained with due process of the procedures of the Kozloduy NPP will be applied during normal and emergency actions and conditions and will minimize the radiation exposure in the future.

All requirements from the regulations for radiation protection of personnel, the population and nuclear safety described in this section of EIAR Legislation will be met, as well as those that will be established as a condition in the license for the operation of the NRRAW. The expected real dose effects will be many times below the limits, due to the specifics of the activity.

In accordance with the investment proposal, radiation protection of the personnel working in the construction of the NRRAW will be provided by:

- Appropriate shielding (protection), to avoid exceeding the limits for exposure;
- Continuous radiation monitoring with alarm devices;
- Minimizing the time for work, repair and maintenance in radioactive environments;
- Zoning of the premises of the NRRAW;
- Controlled access to the premises of the controlled zone (CZ) of the NRRAW;
- Dosimetric personnel control;
- When assessing the risk of the performed activity and the need of its use, personal protective equipment is administered;

Depending on the phase of operation, shielding is ensured by the very matrix in which they have PAO in reinforced concrete containers, their walls, the walls of the constructions, and the depth of disposal with an inert material. Last but not least is the effect of self–shielding for the placement of the containers.

In accordance with the current legislation, the following limit exposure levels are set as the main criteria for a loading dose, produced by the new facility in normal operation [343]:

- Exposition dose on the surface of the containers – max 2 mSv/h;
- Exposition dose at a distance of 1 m from the containers – max 0.1 mSv/h;
- Maximum equivalent doses in the storage space of the containers with RAW in the NRRAW (in the protected zone):
- For the serviced premises - 5 μSv/h
- For the half serviced premises - 10 μSv/h

According to [90] the following dose limits are defined for Kozloduy NPP.

- Maximum equivalent dose in the supervised area of the NPP - 1 μSv/h;
- Maximum dose equivalent outside the supervised area of the NPP - 0.025 μSv/h above the radiation background

The same limits will be defined for the observation zone of the repository.

Radiation exposure of the different staff groups is as follows:

- In normal technological regime, the duty dozimetrist in the admissions office, located at a distance of 0.5 meters from the package is exposed to radiation effects for a duration of 1 hour daily, 200 times annual, or 200 hours.
- The analyst, who takes samples for surface contamination is at a distance of 0.3 meters, 4 times a month, for 10 minutes, or 8 hours a year.
- Operators conducting radiometric and geo-monitoring control :2 hours by 12 times, by a distance of 4 meters from the protected package-24 hours per year;
- Emergency team- 2 people for 2 hours, on a distance of 2 meters from the package, 4 hours a year;

All other dosimetric and radiometric measurements in a controlled and observed zone are negligible due to the background values of the objects.

During the operational phase, in view of the project and supraprojectory events, accidents and breakdowns, personnel receives significantly less than the eligible doses - around 0.2 % from the maximum eligible 20 mSv.

Solid waste - Personnel protective equipment (PPE) worn by the workers would need to be treated as solid radioactive waste, which cannot be deactivated. It is believed that the amount of PPE that should be treated as solid radioactive waste can be brought to a minimum if some of it, such as working clothes, shoes and hats, is washed and reused. During ordinary maintenance and repairs during the operation of the NRRAW, forming of solid radioactive waste is not expected. The amount of PPE to be treated is not specified but is expected to be extremely small (more like zero, if the recommendation made in this EIAR is met) compared with operation of the waste generated in NPP and SDRW.

When subjected to more conservative criteria for surface contamination of external surface containers, floors and walls (in one of the recommendations of this EIAR) it is almost possible to not generate this type of RAW at all.

Data on potential loading doses during the performance of repair activities in the NRRAW are not given.

Under Bulgarian legislation, appointments of staff in operation of the NRRAW are carried out under the Labor Code. An obligatory element before the acceptance of work is the preventive examination by a team of specialists, and its conclusion is signed by a qualified specialist in internal medicine. Each year the Office of Occupational Medicine carries out targeted preventive examinations and an analysis of the health status of workers.

Regular medical examinations of the workers in the CRRAW seek regular evaluation of their health. As already pointed out, constant individual dosimetric control is performed for all employees of the NRRAW.

Regular and specialized medical examinations studies are carried out to assess the overall health state of the workers. This state depends both on the genetic nature of the person and the many factors of the professional and consumer environment, including factors such as contact with toxic substances, noise, vibration, bad habits (smoking, alcoholism) and others. The radiation factor is only one of them.

The immunological studies are especially important, since early diagnosis of disorders of the immune system and their potential removal could prevent the development of many diseases. Furthermore, some authors believe that changes in the immune system may occur when receiving lower radiation doses. Individual sensitivity is more pronounced in violation of immune status. When working in NRRAW such abnormalities that could be associated with action of radiation or other toxic factor are absent. The parameters that were studied are cellular and humoral immunity.

To identify a possibly greater likelihood of occurrence of stochastic effects in comparison with their frequency in the overall Bulgarian population, a number of indicators reflecting the state of the genome of the exposure-sensitive cells in the body (peripheral blood lymphocytes) should be tested in workers. Indicators are cytogenetic micronucleuses and chromosomal aberrations in lymphocytes and molecular biochemistry. It should be noted that changes in these indicators do not imply the occurrence of stochastic effects, but only give a signal that they could occur with a greater probability than in those not involved professionally with the above-mentioned factors. When positive, modern science provides appropriate prophylaxis.

The radiation risk to staff of the NRRAW with a good work organization, applying the principles of radiation protection can be determined by the extent of hazardous occupations, according to the classification of the World Health Organization.

The analysis of the given data indicated that during normal operation of the NRRAW when subject to regulatory requirements and approved programs for radiation protection, effects on the personnel performing activities on service containers/packages of RAW were found to be within the limits of the project requirements given in the investment proposal.

No impact is expected on the radiological aspect of the operation of the NRRAW personnel at the site of Kozloduy NPP and the Radiana site.

In decommissioning

Decommissioning will be conducted in strict compliance with the Ordinance approved by the NRA for the decommissioning of nuclear facilities [140], plans and programs for decommissioning.

As stated in the technical proposal [192], all visible surfaces will be measured and sampled to determine whether pollution is present (roof panels, walls, ceilings, floors, roads, reinforced surfaces, surfaces of equipment, etc). Representative samples will be taken from hidden or covered materials (insulation, surface coating under, bricks, floors, pipes and cables in the channels, etc). Various methods will be applied for buried installations to check the measurements for radioactivity leaks in the area in view of conventional digging and dismantling or their removal. The sampling of groundwater and soils at different levels will probably be taken with a robot, lowered in the sewage to prove the presence or absence of impact on the zone.

During decommissioning, the effects of radiation exposure on the staff are expected to be within the legal requirements valid at the time of decommissioning. As of today, this radiation exposure is far below the specified limits in practice. The approved plans for the decommissioning of the nuclear facility will be in accordance with the safety requirements.

No impact is expected on the radiological aspect of the operation of the NRRAW on the personnel at the Kozloduy NPP and the site of "Radiana".

4.3.2.2 On the population during normal operation and decommissioning (in the social and health aspect)

In the non radioactive aspect

During operation

European health indicators for the assessment of environmental effects on humans are air quality, noise levels, habitat, including at home, traffic-related accidents, quality of domestic drinking water, accidents with chemicals and radiation. **Based on the collected information on the current state of the Kozloduy NPP and the non-radioactive risks associated with the investment proposal it can be assumed that the operation of the NRRAW for 50 years will not have a negative impact on the population in the 100 km zone around the plant.**

No significant social impacts are expected.

During closure

No radioactive impact is expected on the population outside the NPP site during the decommissioning of the NRRAW, as there will be no digging of aggregates and there will be no activities related to trafficking if trucks remain outside the 3-km zone. The negative impact associated with the operation of heavy construction machinery and the transport of large quantities of construction waste will be spread only to the limit of the 3-km zone around the Kozloduy NPP where the waste is land filled.

The closure of the NRRAW is not expected to have a negative impact on the population of the nearest residential area (town of Kozloduy) and the village of Harletz and the population in the 30-kilometer zone around the plant.

In the radiation aspect

During operation

The main function of the systems and facilities of the NRRAW is the isolation and safe storage of RAW for the entire project period. The measure of potential radiation impact on the population is the individual dose per person from the risk (critical) group.

The exposure limits for the population under BRPS-2004 are as follows:

Annual effective dose of 1 mSv. An exposure above the limit may be permitted in special circumstances and provided that the average effective dose for 5 consecutive years does not exceed 1 mSv.

The boundaries of the annual equivalent doses, under the effective dose limits referred to in paragraphs 1 and 2 are as follows:

- 15 mSv for eye lenses;
- 50 mSv for the skin (this limit applies to the average doses received from and area of 1 cm^2, regardless of the area of irradiated surface).

The Ordinance on safety during the operation of RAW sets an even lower annual individual effective dose for the critical group of the population during normal operation of the NRRAW from 0.3 mSv per calendar year.

The potential effects of ionizing radiation on the population located in the vicinity of the Kozloduy NPP are assessed and discussed in the following case.

A well-known methodology in the world is used for quantification of these impacts based on the recommendations of the US EPA (Agency for Environmental Protection of the U.S). The methodology includes four steps:

1. Hazard identification
2. Evaluation of dose-response relationship
3. Exposure assessment
4. Risk characterization

Hazard identification

RAW packages will be stored in sealed containers located in tunnels which prevent releases into the environment and provide adequate protection from gamma/beta radiation and naturally eliminates entirely the presence of alpha radiation outside the packaging.

The impacts caused by the discharge of gaseous, particulate, liquid and solid waste in load activities and activities carried out in the NRRAW are considered virtually absent.

Therefore, external exposure from RAW packages during transportation to the NRRAW and potential external influences during their storage in the NRRAW requiring any repairs may be considered as the only factor bearing a health hazard.

In terms of health impacts, the concerned case is of long-term (even lifelong) exposure to very low radiation doses that are virtually impossible to measure. Radiation exposure of the population is within the projected levels under normal operation, and therefore it is much lower than the levels where the occurrence of deterministic effects can be expected.

A dose-response evaluation

During exposure to ionizing radiation, the health risk assessment is based on the understanding of the relationship between the dose and the effect. The effective dose is the measure of this effect. According to modern understanding, the impact of the radiation exposure has a probabilistic (stochastic) effect. This means that with the increase of the dose, the likelihood of a stochastic effect i.e. occurrence of cancer, is also increased, but not the importance of the consequences. This effect is presented with a number of cases among the population with respect to total population (e.g. number of cases per million).

The international Commission on Radiological Protection (ICPR) presented a linear borderless model for the effects of ionizing radiation in 1991, and after its publication it was approved by the model of other institutions (WHO, IAEA). This concept stems from the idea that a radiation dose (even minimal) has a carcinogenic effect and that the ratio of the dose and number of cases is (in the range of low doses) linear. For now, all the regulations, risk coefficients and limits are based on this model. The most recent recommendations of ICRP in 2007 retained the basic dose limits and the linear borderless model.

The main problem with limit values is the social acceptance of the risk. The international sources offer 1 case per 1,000,000 inhabitants per year (10^{-6}) as the limit of acceptability. This is the theoretical value and from a practical point of view it is a negligible value. For example, in Europe every fourth or fifth person dies of cancer. Despite this strict criterion 10^{-6} is used further in the analysis

The ICRP recommended a nominal rate risk, satisfying the probability of death from all cancers, caused by radiation exposure of the population P=0.05, i.e. if 100 people are irradiated with 1.5 Sv they would have developed a deadly cancer. It should be noted that the dose of 1 Sv is a value of great magnitude, which is very hard to reach, even one-third for the entire professional life of a high risk worker in a nuclear installation.

The second possible effect of ionizing radiation is the impact on the genetic material and hence on children. These effects occur at very high doses and in the case of the NRRAW are completely excluded.

Exposure assessment

One of the important criteria for acceptance of reinforced concrete storage containers in the NRRAW is the power of the equivalent dose of gamma radiation at a certain distance. The restriction on this parameter on the surface for each such container is 2mSv/h. The actual maximum power of the equivalent dose on record in annual reports of SPRAW-Kozloduy is less than 1mSv/h. It is obvious that under the law, weakening the power of the gamma dose equivalent to the square of the distance, that the calculated equivalent dose to the nearest residential area, i.e. the town of Kozloduy, which is around 3500 m, is practically zero. And every estimate for any given period will give zero values. Consequently, the exposure within a human life is zero.

Risk characterization

Under the dose-response relationship according to ICRP (1 Sv => P=0.05, i.e. 1 μSv => P=$5x10^{-8}$) it can be calculated that the risk to an individual in the town of Kozloduy during his/her lifetime is

≈ 0 μSv x $5x10^{-8}$ μSv^{-1} = 0

i.e. the estimated risk is virtually zero and naturally far below the natural criterion of international acceptance (10^{-6}). The estimate made by this method is only to illustrate the approach of the risk assessment for the population.

The results from the monitoring of the environment in which the population lives close to PRRAW-Novi Han villages (the villages of Novi Han, Krushovitsa and Gabra) can be used as an example. These results show that with the nearly 45-year period of operation of the repository, the values of the main environmental parameters are included in the normal radiological status of the country. During the measurements of the Executive Environment Agency, MEW, Civil Defense and other agencies, these values do not exceeded 0.2 μSv. (from 0.11 to 0.19 μSv). The natural radiation background in the region of NPRAW is within normal values, typical of places with a presence of magmatic rocks, such as Lozen mountain. The radiological environmental risk to the population from nearby cities is much lower than the one determined by the accepted limit for annual effective dose for each member of the public - 1 μSv / a. The latter is estimated at 6.0.10-5/a-1 for carcinogenic effects and genetic effects 1.3.10-5/a-1 for a total 7.3.10-5/a-1 considered acceptable. The actual radiation risk to the population is closer to that which results from the annual effective dose of 0.1 μSv / a, which accordingly is 7.3.10-6/a-1 and is largely considered to be negligible.

CONCLUSION

Therefore, the expected radiation load will not exceed the natural background of about 0.1 μSv/h, the health risk during the normal operation of the NRRAW on the population from the nearest residential area (the town of Kozloduy) and the village of Hurlets is negligible. No impact is expected on the population in the 30-kilometer zone around the Kozloduy NPP.

The closure of the NRRAW is not expected to have a negative impact on the population of the nearest residential area (the town of Kozloduy and the village of Hurlets) and on the population in the 30-kilometer zone around the Kozloduy NPP.

In the social aspect

The main social value resulting from the construction and operation of the NRRAW is linked directly to its construction. As a result, a national repository, meeting all regulations (national and international) will be built - one that has not existed so far on the territory of the country. This way, compliance with the commitments made by Bulgaria to the EU will be achieved. This in itself is a political dimension of the project.

During the construction work, construction firms with the necessary qualification will use up to 75 people, depending on the task, which is not on a large scale and is limited. This will lead to the creation of temporary jobs.

The average number of the workers and employees of the CMP Contractor will be on average 55 people. Additionally, present on the site will be an average of 7 representatives of the investor, designer and the construction supervision. The maximum number of workers and employees at the site will not exceed 75 people.

The construction and subsequent operation of the NRRAW will create 64 jobs, with an expected positive social impact. The number of jobs, however, will not be large, which means that the positive effect on levels of unemployment will be relatively small in quantity as specified and in the already cited reference. However, the fact that the creation of these jobs within the municipality is important for preventing the loss of the attractiveness of the residence should be considered. There will be a professionally trained staff during operation, almost entirely composed of the specialists working in the NPP in the moment, but due to the specific nature of the work, they will all have to be reclassified. This is also a socially significant effect of the project in itself, because it is connected with the idea of lifelong learning. Courses can be offered for young replacement staff, training of physicists and others for this specific activity - the management of radioactive waste.

Another distant future event of the social impact of the project (effect) may be sought within the envisaged relocation of the storage of medical radioactive waste from the PRRAW of Novi Khan to the NRRAW. The safe storage of this waste will ensure the continued performance of related activities and medical procedures that can safely be categorized as having a positive and lasting impact of social importance.

The nature of the ownership[1] described in the above-mentioned document means that involuntary displacement of people is not possible, as the necessary area for the implementation of the investment plan (around 36 ha) is within the state/municipal property. This aspect, although it may seem irrelevant to the project because of the relevant legal framework, is really important, and is one of the criteria for the preparation of the assessment of social impact.

The economic impacts are usually associated with reporting the impact on factors such as unemployment, taxes, changes in property prices, and they may influence land prices due to the proximity of the repository. The effect on employment levels is relative and in quantitative terms is negligible. But the social effects of job creation and retraining (where and if necessary) part of the staff should not be underestimated. The construction of NRRAW will be thought of as a continuation of the existing NPP and therefore bound by the main branch of the local economy. Thus, maintenance of employment for some portion of workers would maintain their expectations for the development of the city.

According to the Municipal Development Program for tourism for the period 2008-2011, the main development strategies in the tourism sector are related to the "Botev put" historic complex, the National "In the Footsteps of Botev's party Kozloduy-Okolchitsa" tourism hike, some other cultural sites as the St. Trinity Church in Kozloduy, the church St.Voznesenie in the village of Butan, "National center memorial Hristo Botev - 1879" in Kozloduy, "Augusta" Roman excavations or the possibility of the development of water tourism associated with the Danube river, sporting events and riding related to the horse race in the village of Butan, such as ecotourism associated with the wetlands along the Danube. The scope of this tourism probably would be local, i.e. mainly as recreational activities of the inhabitants of the region and it is less likely to be an engine for development. This aspect, of course, is not negligible, because it is related to creating good quality of life conditions. However, it should be noted that the presence of the NPP and the construction of the NRRAW could have a negative impact on these programs because of the general fear of nuclear energy and related radiation, as well as the already cited image of the waste, so it is possible that the project could have a negative impact on this economic sector. On the other hand, we should mention an opportunity for the development of the region's tourism strategy that is likely to have a wider scope, namely thinking towards the development of a so-called industrial tourism.

Measures:

- Activities that raise awareness of citizens in order to strengthen their participation in the decision-making process and their expertise on issues of sustainable development and environmental protection and security for future generations
- Courses for retraining: specific activity - radioactive waste management

4.3.2.3 On the air and the atmosphere during operation and closure

In non-radiation aspect [221]

During operation

During operation there will be emissions from the ICE of the concrete trucks, but since their route, size and range have not been given in the project, their effect on the environment cannot be assessed.

During decommission

Annual concentrations

Area sources

Emissions of fine particulates (FDP_{10}) have been studied on the air quality around the site and populated areas for the characterization of the impact of the particulate emissions from the activity of recultivation of the dump area of 102 843m^2.

According to Ordinance no. 12/2010 [17], the average annual rate (AYR) for FDP_{10} is 0.04mg/m^3,. The annual average limit limit values (TLV) for protection of the human health is 0.02mg/m^3. Contour in red / ▬ /) shows concentration of 0.02mg/m^3 , contour in pink / ▬ / _0.01 mg/m^3.

[1] The NRRAW falls within the radiation protection zone of the Kozloduy NPP and therefore nobody lives on its territory, and the ownership of the land belongs to the state.

Figure 4.3-3 Annual average contamination with FDP_{10} for the closure stage

The pink contour on the figure / ▬ / shows a concentration above the TLV. The maximum concentration obtained was 0.0255mg/m^3 and it was found in the area of the dump itself (/ ▬ /). However, personal protective equipment should be required for the workers.

The impact of the dust emissions from operations in the recultivation of the repository area is negligible.

Maintaining sufficient moisture in the work areas should be recommended during the dry summer and autumn months, which lower the risk of dust impacts by almost 80% on both sites (the dump and the repository itself).

Linear sources

Path to the dump

Estimates of pollution from ICE from the traffic on the road in the surface layer of the atmosphere are calculated using a mathematical model called TRAFFIC ORACLE

The pollution is modeled at 20 courses during change and emissions. The obtained maximum values of annual concentrations of linear sources are summarized in **Table 4.3.8**

Table 4.3.8. Annual concentrations of linear sources

Maximum annual concentrations						
NO_X	SO_2	CO	FDP_{10}	C_6H_6	CO_2	
0.04*	0.05 (1)	none*	0.02*	0.005*	*none*	AAR [mg/m^3]
*0.026**	*0.008**	none**	*0.01**	*0.002**	*none*	*TLV* av.year. [mg/m^3]
Cmax[mg/m^3]						
0.00002053	0.00000015	0.00002932	0.00000176	0.00000009	0.0049	

(1) Recommended standard by the World Health Organization

* Ordinance no.12/2010. – Standards for dioxide, nitrogen dioxide, fine dust particles and lead in ambient air.[17]

In accordance with ordinance no. 9/1999 [17]

- Average annual rate (AAR) for nitrogen oxides (NO_x) is 0.04mg/m^3, which comes into effect in 2010. The annual average limit limit value (TLV) for protection of the human health is 65% of MAC or 0.026 mg/m^3, and TLV for ecosystems (0.0195 mg/m^3)
- AAR for sulfur oxides (SO_x) is zero. (There is a recommended standard by the World Health Organization (WHO) of 0.05mg/m^3). The average annual TLV for ecosystems is 0.008mg/m^3;
- AAR for FDP_{10} is 0.04mg/m^3,. The average annual limit limit values (TLV) for protection of the human health is 0.02 mg/m^3.
- AAR for benzene (C_6H_6) is 0.005mg/m^3,. The average annual limit limit values (TLV) for protection of human health is 40% of MAC or 0.002 mg/m^3;
- AAR for carbon monoxide (CO) is zero.

As seen in *Table 5.2.1.3-1* there is no exceedence of the annual standards for any pollutant.

Consequently, in the annual (long-term) aspect during the closure, no impact is expected from:

- Fine dust particles from the source areas or with very low level of impact.
- From the traffic of cargo trucks from the NRRAW to the dump

Maximum single concentrations

An important characteristic is the maximum possible contamination, which can be obtained from on-site sources, as the maximum amount of pollution and the weather conditions under which they occur are defined. This is the only characteristic of the pollution which can be obtained in case that there are no meteorological data for a certain region. Altering a range of meteorological parameters-wind speed for each of the 8 standard directions and class resistance (A - strong instability, B - moderate instability, C - low volatility, D - neutral stratification, E - weak sustainability and F - moderate resistance) the field of pollution is obtained to determine its maximum value at the relevant meteorological parameters and wind direction.

Surface sources

Most adverse weather conditions are north wind speeds of 2.5 m/s and stability class F. Under these conditions, due to weak turbulence in the vertical direction, a large gravitational deposition velocity (0.05 m/s) and low-level emissions, the diffusion of pollutants is not exported out of the source. The resulting maximum concentration from the model is 0.318 mg/m^3, which is below the MAC of 0.5 mg/m^3.

Linear sources

The most adverse weather conditions are a south wind with a speed of 2.5 m/s and resistance class F. Under these conditions, due to the low turbulence in vertical direction, the diffusion of pollutants is exported away from the source, but because the sources are cold and low, this distance is not far from the road.

These conditions occur in the late daylight hours after sunset. The data for maximum concentrations for various pollutants are summarized in Table 4.3.9.

Table 4.3.9. Maximum-single concentrations of linear sources in north east wind.

Maximum concentrations						speed 2.5 m/s;
NO_X	SO_2	CO	Dust	C_6H_6	NH_3	direction 0°; Resistance class E
0.2*	0.35*	10**	0.5***	*none* **	0.25***	AAR [mg/m^3]
*0.1**	*0.05**	*5***	*none* ***	*none* **	*none* ***	*TLV* [mg/m^3]
Cmax[mg/m^3]						
0.005666	0.000042	0.008095	0.000486	0.000024	0.000003	

* Ordinance no.12/2010 Standards for sulfur dioxide, nitrogen dioxide, fine dust particles and lead in ambient air.[17]

** Ordinance no. 14/1997 Standards for hazsrdous substances in ambient air for populated areas.[16]

According to Ordinance no. 9/1999[17]:

- Average annual rate (AHR) for nitrogen oxides (NO_x) is 0.2mg/m^3, which comes into effect from 2010. The average hourly lower assessment limit (LAT) to protect the human health is 0.1 mg/m^3;
- AHR for sulfur oxides (SO_x) is 0.35mg/m^3, and the average hourly lower assessment limit (LAT) to protect the human health is 0.05 mg/m^3;
- According to Ordinance no. 1/2004[19]:
- AHR for benzene (C_6H_6) none;
- A24R (average 24hour rate) for carbon monoxide (CO) is 10mg/m^3, and the AHR (averaged for eight hours) for lower assessment limit is 5 mg/m^3.

According to Ordinance no. 14/1997[19]:

- The maximum single concentration for the limit limit value (TLV) for common dust is 0.5 mg/m^3.
- The maximum single concentration for the limit limit value (TLV)) for ammonia (NH_3) is 0.25 mg/m^3.

As the table shows there is no exceedence of the standards for any pollutant.

Therefore, during the closure in short term the facility is not expected to have an impact on the quality of the air in the area around the plant in terms of the considered pollutants on both sites (dump and repository)

4.3.2.4 On the water during normal operation as in closure

■ On surface water

In non-radiation aspect

During operation, decommissioning and institutional control

Given the low consumption of drinking water (0.6 l/s), it can be concluded that the impact on the total water consumption of Kozloduy NPP and the water sources of the NPP will be negligible. (Work is done with 0.6 l/s of water, because it is the most negative value and it corresponds to the maximum capacity for water consumption of the system and not the actual consumption). Drinking water in NHRAO operations will be delivered in bottles, therefore will have no additional impact on water use of NHRAO.

Fecal domestic waste water from toilets and bathrooms used by the staff have no impact on the aspect of radiation. Regarding the non-radioactive aspect, it must be mentioned that the flow of wastewater will not pose any problem for the site sewage system of the Kozloduy NPP, nor to the treatment facilities of the plant, when they are working well. The generated wastewater will not affect the quality of the water in the surrounding water basins.

Rainwater only has a non-radiation-related impact. It will be assessed as negligible. There will not be secondary or cumulative effects. It will be temporary (only when it rains) and long term. The results will be reversible, since the water will be discharged into the water receiver at a later stage with the rest of the purified wastewater. Rainwater has a negligible impact on both the quality of the water and the surrounding water basins, as well as on the restoration of the water resources.

Contaminated wastewater drainage can form periodically in minimum quantities. It will reach a certain volume, meeting all regulatory requirements and be subjected to control of the specific pollutants to be transported, also according to the regulatory requirements of Kozloduy NPP for disposal.

No thermal impact is expected on the Danube River.

During closure

No impact on surface water is expected during closure.

In radiation aspect [190]

The wastewater generated by the showers and wash basins may have an impact on the environment if the water is contaminated. Therefore this stream must be kept in tanks and only after appropriate controls can it be discharged in the sewers of the Kozloduy NPP or collected in tanks for a specific contamination and sent for treatment in the specialized contaminated waste water treatment facilities of the Kozloduy NPP (evaporative systems and others). These facilities are an element of the management of RAW and clean all of the radioactively contaminated waters, before being released into the Danube river. This process is regulated by the NRA.

Prediction of the migration of radio nuclides in the subsurface [421]

According to international practice, the preliminary safety assessment is based on the normal evolutionary scenario. The most likely paths for potentially radioactive impact on the biosphere are considered in such scenarios. In the most general case of the near surface repository, these roads are linked to the migration of radio nuclides through engineered barriers and thus in the underground area of the geosphere.

For a period of time (usually time for institutional controls), these barriers retain their full integrity and design parameters, the migration of radio nuclides in them is based solely on molecular diffusion, which by nature is a very slow process. Slow diffusion and the high absorption properties of the engineered barriers constructed mainly of cement-based materials (concrete, etc.) ensure the long-term limitation of the radionuclide migration from the repository system. However, the gradual destruction of these barriers, including physical degradation of concrete in the repository containers will allow moisture transfer through the waste and the faster extraction and leaching of radio nuclides in the neighbouring underground space. After crossing the main geological barrier (the aeration zone), radio nuclides may enter the groundwater, where their movements can be significantly accelerated as a result of hydrodynamic flow.

Migration of chemical elements and substances in the Earth's environment is complex and a multifactor process. It is usually done by several hydrodynamic and physiochemical processes in co-operation. The process is more complicated, since migration is accompanied by the radioactive decay of radionuclides.

Forecast analyses were performed with the eight following radionuclides: **^{137}Cs, ^{90}Sr, ^{63}Ni, ^{241}Am, ^{94}Nb, ^{239}Pu, ^{14}C and ^{129}I.**

These radio nuclides provide an overview of the possible spread of buried RRAW in radionuclides into the subsoil and groundwater. The reasons for this choice are:

- Cesium-137 and Strontium-90 are among the major components of the waste that traditionally "necessarily" are present in the forecasts for the possible spread of radio nuclides from the NPP and NRRAW.
- Iodine-129 and Carbon-14 are among the most distributable (mobile) radionuclides due to their long life (especially iodine) and their very weak adsorbency (low retention) in natural rocks and soils. With them the most significant distribution should be expected in the subsoil.
- Americium-241, Niobium-94 and Plutonium-239 are also long-lived, but are characterized by strong adsorbency in the soils (especially americium), so they suggest continuous but very slow distribution layers (unlike iodine and carbon).
- Nickel-63 occupies an intermediate position in terms of longevity and adsorbency in natural materials. He (along with cesium and strontium) presents a somewhat "average behavior" of the isotopes in the repository.

All estimates fall within the recommended items list of the IAEA for illustrative radionuclides in the safety assessment of near surface repositories. **Table 4.3.10** shows the basic parameters in the case of seven important radionuclides included in the forecast calculations.

Period ranges from 30,000 to 100,000 years were used for the different optional calculation models (forecasts). The optimal duration is determined by the mobility of the radionuclide in question, respectively its ability to adsorbs (holds) from the middle and by its half-life period. Therefore, the forecast period for ^{137}Cs, ^{90}Sr and ^{63}Ni is 30000 years ^{241}Am is 33,000 years for ^{129}I is 45,000 years for ^{14}C is 50,000 years and ^{94}Nb and ^{239}Pu is 100,000 years.

Table 4.3.10 Basic parameters of the eight major radionuclides that underpin the forecast estimates of migration in the ground during operation

Radionuclide	Period of half-life $T_{1/2}$	Decay factor γ	Activity in 1 RCC	Estimated total activity in the repository	Coefficient of distribution, K_d (for the concrete)	Delay factor R	Activity in the source
	a	d^{-1}	*Bq*	*Bq*	m^3/kg	-	Bq/m^3
1	2	3	4	5	6	7	8
^{137}Cs	3.01E+01	6.29E-05	8.12E+09	1.40E+14	3.00E-03	42.25	1.50E+08
^{90}Sr	2.90E+01	6.64E-05	1.97E+07	3.40E+11	1.80E-03	25.75	5.97E+05
^{63}Ni	1.00E+02	1.90E-05	2.55E+08	4.40E+12	1.23E-01	1692.25	1.18E+05
^{241}Am	4.32E+02	4.39E-06	7.54E+05	1.30E+10	6.4E00	88001.00	6.68E+00
^{94}Nb	2.00E+04	9.49E-08	1.91E+05	3.30E+09	3.5E-02	482.25	3.09E+02
^{239}Pu	2.41E+04	7.87E-08	5.04E+05	8.70E+09	4.3E-00	59126.00	6.65E+00
^{129}I	1.57E+07	1.22E-10	4.99E+03	8.60E+07	6.4E-02	881.00	4.41E+00
^{14}C	5.73E+03	3.31E-07	1.57E+08	2.70E+12	10.00E00	137501.00	8.88E+02

The results show that:

- A big part of the "key" radionuclides (^{137}Cs, ^{90}Sr, ^{63}Ni and ^{241}Am) are a result of the ongoing processes of natural decay and absorption decrease their activity to practically null values in the subsoil. In practice the more intensively contaminated zone is limited to a depth of 3-4 m beneath the storage modules, i.e. degraded within the barriers. The maximum activity at a depth of 21 m below the repository, i.e. slightly above the level of groundwater, for ^{137}Cs, ^{90}Sr and ^{63}Ni is between 10^{-41} and 10^{-49} Bq/m^3, and for ^{241}Am it is 10^{-69} Bq/m^3 (see table. 3.4). This means that these isotopes practically retain and degrade completely in the unsaturated zone, i.e. spreading further is of no interest, much less any kind of danger.
- The behavior of very slowly decaying isotopes ^{94}Nb and ^{239}Pu is slightly different. The contaminated area, albeit after a very long period, covers the area to a depth of 5-6 m beneath the repository. The maximum activity in this area is reached after tens of thousands of years. Activity remains low without reaching its peak at a greater depth and away from the repository throughout the forecast period (100000 years). At the end of the forecast period, activities will be extremely low (between 10^{-9} and 10^{-12} Bq/m^3), making calculations for the estimated distribution of ^{94}Nb and ^{239}Pu in the saturation zone completely pointless.
- Isotopes ^{129}I and ^{14}C are more special cases. The first of them is extremely stable (half-life 15.7 million years) but at the same time hardly retained by the filtering environment. The other, regardless of its lower half-life is also practically non-adsorbent The time for passage of the first "portions" of the two isotopes in the zone of aeration is about 1900-2000 years when the activity of ^{129}I and ^{14}C in groundwater levels reaches detectable levels, but it has a very low value of 0.01 and 1.0 Bq/m^3 respectively. Their maximum activities at the border between the saturated and unsaturated zone, which is expected to occur after 5810 years for ^{129}I and after 6010 years for ^{14}C, are almost the same as in the repository. Therefore, a forecast for their spreading into the groundwater is made only for these two isotopes .

The forecast for a possible migration of radionuclides in the groundwater near the "Radiana" site with the trench type RRAW was made by three-dimensional (3D) mathematical simulation of the conditions for substance transmission. For this purpose, two basic 3D models have been developed: a filtration and a migration model.

Only the distribution of isotopes ^{129}I and ^{14}C is projected in groundwater because they have longer half-lives, while they are conservatively admitted to be practically non-adsorbent. No evaluations for the migration of other radionuclides in the saturation environment have been done in the cited study because estimates made for the migration in the engineered barriers and subsoil show that most of them are held entirely in this area, and ^{94}Nb and ^{239}Pu reach the groundwater, but after an extremely long period (more than 100,000 years!) with very low activity.

The results of the migration model, which is a forecast of the migration of ^{129}I and ^{14}C in groundwater were calculated in three moments - 100, 250 and 500 years after their entry into the aquifer. Indeed, these moments are preceded by a long period of several thousand years during which ^{129}I and ^{14}C pass through the zone of aeration (plus the adopted initial 300 years of institutional control). Therefore, the results correspond to the situation around 6000-7000 years after the construction of the repository.

For that forecast period, in-depth migration is confined within the Brusarski Formation. Further north, the two isotopes are distributed in the non-flooding terrace of the Danube. At the end of the forecast simulation their activity in the first receiver (drainage channel) reaches noticeable values: the expected activity of ^{129}I is 0.00001 Bq/l, and that of ^{14}C - 0.001 Bq/l. These values are repeated (two to three or more ranges) lower than the levels for drinking water.

When it comes to the possible distribution of isotopes such as iodine-129 in groundwater, it should be taken into account that the legally allowable concentration for it in drinking water is 0.96 Bq / l. This makes the forecasting of the distribution in groundwater practically unnecessary to some extent, because its concentration poses no real danger of radioactive contamination of the water.

The same can be said for the nuclide of ^{84}Nb and ^{239}Pu. They reach the groundwater after an extremely long period of more than 80,000 years and have activities below the limit, as the area of distribution will also be much more limited than that of Iodine-129.

In short, it could be argued that the groundwater in the area of the NRRAW is not threatened by radioactive contamination.

During closure

If unacceptable pollution is found in the sewage system of the showers or the construction it will also be removed by standard procedures, e.g. extraction, wiping, wet wiping, removal with surface disintegration. When measurements show that no contamination remains, the equipment and the construction will be taken by the radiation control and may be destroyed or subjected to a conventional method of recycling.

It is known that after the cessation of operation of repositories for low and medium radioactive waste and remediation, the main danger for the spread of radio nuclides into the environment is the water route of migration.

As a result of the evaluations of the expected radiation doses to the population, it can be stated with a high level of certainty that the operation of the NRRAW on the selected site will not create a risk that induces adverse effects on the health of the population and risks to future generations from more than background radiation in the effective migration of radio nuclides in the environment-plants-animals-man chain.

■ **On groundwater**

In non-radioactive aspect during the normal operation of the NRRAW:

- Impact on the quantitative status of the groundwater body is expected on the water body, "Pore water at Quaternery - Kozloduy Valley with code BG1G00000Qal005 " following additional intake for drinking and construction needs of the NRRAW from existing water intake systems and facilities outside the site of the investment proposal. This impact will be direct, permanent and reversible, with a limited territorial range and low range in the creation zone of influence around the water intake facilities. It is considered negligible, since the abstraction is implemented as required by the Water Act and its regulations on the basis of relevant permits for abstraction;

- Impact on the chemical state of the upper body of underground water is not expected BG1G00000N2034 (Dak - Roman aquifer) as it does not provide direct and / or indirect discharge in groundwater, of waste generated by the NRRAW, domestic sewage and occasionally entering runoff of rain water. Their removal will be done through the established system of drainage and infiltrate collection and treatment for local and preserving potentially contaminated water;

- Impact on the quantitative and qualitative status of the other ground water bodies near the "Radiana" site, is not expected, and no extraction of waters to meet the needs of the NRRAW will take place;

- No impact on the chemical state of abstracted water abstraction facilities is expected .

In the aspect of radiation during normal operation, no impact on groundwater is expected, as the period of institutional control (300 years duration, which is much larger than the period of operation of the NRRAW) the engineered barriers retain their integrity and design characteristics. The slow rate of diffusion processes and high adsorption characteristics of the engineered barriers, which are mainly of cement based materials, provide long-term restriction of migration of radionuclides from the repository.

During the closure of NRRAW

■ **On groundwater**

In the non-radioactive aspect, no impact on groundwater from the closure of the NRRAW is expected, as occasionally the infiltrating storm water will be discharged through the established system of drainage, drainage and infiltrate collection and local treatment and preservation of potentially-contaminated water.

In the aspect of radiation after the institutional control phase (lasting 300 years), the protective coating is destroyed and a relevant percentage of average annual precipitation freely infiltrates the conditioned waste. The results from the analysis of migration of key radionuclides is given above.

The main conclusion from the mathematical modeling of migration is that all the radionuclides studied (except ^{129}I and ^{14}C) are retained and fall apart before the water saturated zone (aeration zone) below the repository and do not reach the groundwater. The activity of radionuclides ^{129}I and ^{14}C is low, which makes them practically safe in the groundwater. This finding suggests the absence of radiation effects on groundwater. Therefore, preconditions are absent for reconciling burdens with weights in the Water Act established and upcoming establishing sanitary protection zones around the existing "Radiana" site (which will inevitably be limited to the boundaries of the terrace Ogosta where they are located), intake facilities in the territory of the investment proposal. The construction of the NRRAW is thus not contrary to the prohibition on "Processing and storage of radioactive substances and waste" in Annex no. 2 of art.10, para. 1 of Decree no. 3/16.10.2000 on terms and conditions for research, design, approval and operation of sanitary protection zones around water sources and facilities for drinking water and some mineral water sources used for therapeutic, prophylactic, drinking and sanitation needs.

4.3.2.5 On the subsurface and the mineral diversity

In the *non-radioactive aspect*, no impact on the earth during normal operation is expected because the occasionally self-infiltrating runoff rainwater and generated domestic sewage will be discharged through the established system of drainage, drainage and infiltrate collection and treatment and local preservation of potentially contaminated water.

In the *aspect of radiation*, no impact on the Earth is expected, due to the fact that during the period of institutional control (taken with 300 years duration, which is much larger than the period of operation of the NRRAW) engineered barriers retain their integrity and design features. The slow rate of diffusion processes and high adsorption characteristics of the engineered barriers, which are mainly of cement-based materials provide long-term restriction of migration of radionuclides from the repository.

4.3.2.6 On the soil during normal operation and closure

In the non-radioactive aspect

During operation

The impact of non-radioactive factors is expressed in the contamination of adjacent areas with non-hazardous waste, domestic, oil and industrial pollution from oil spills, from repairs to adjacent structures or to the the NRRAW construction itself. This contamination is traditional for each industrial facility and extends to the site of the IP.

No impact is expected from non-radioactive factors on the soil and underground during normal operation.

During decommissioning

No negative impact is expected from non-radioactive factors on the soil and underground during decommissioning.

In radiation aspect

During operation

During normal operation of the NRRAW, no contamination of soil and land of the site and of adjacent sites is expected due to the storage of RAW in containers / packages with the necessary isolation. The production of small quantities of solid radioactive waste (clothes, shoes) is expected and they will be collected and treated in an appropriate manner and will not pollute the land and soil.

No radioactive impact on land and soil is expected during normal operation of the NRRAW.

The final sealing of the storage facilities, technical liquidation and biological recultivation of land will be done during the closure of the repository. These activities include transportation of spoils from the sole to the repository, filling of the damaged areas, rehabilitating relief forms, the dismantling of constructions and facilities, as well as cultivation of land by planting suitable tree species. These activities are not expected to have a negative impact on neighboring agricultural lands and existing users.

No impact is expected on land or soil during the decommissioning of the site.

4.3.2.7 Biodiversity. Protected areas and zones. Potential impacts during normal operation and closure

Expected effects on the flora. D*uring operation*

In a non-radiation aspect:

No significant impacts on plant species and their communities are not expected, including agricultural production during the implementation of the investment intention (including operation and closure).

The impact on the flora resulting from the operation of the investment proposal will be with the following parameters;

- Territorial scope: local within the borders of the external sites and bridging roads.
- Degree of impact: from negligible to minor;
- Duration of impact: during the operation (about 25 years);
- Impact Frequency: periodically in both variants, mostly - in the outer part of daily transport in the day.
- Cumulative impacts: not expected to occur as a result of such joint operations with the NPP.
- Transboundary impacts: these are not expected.

In radiation aspect:

Negative impacts on plant life for reasons arising from the NRRAW are insignificant or caused by emergency situations. The NRRAW will be designed and constructed in accordance with the requirements of safety set out in legislation and based on IAEA recommendations, implementing the principle of protection in depth and construction of the NRRAW as a multi-barrier engineering facility, preventing the spread of radionuclides to the environment, and operation of the facility in accordance with the principles and rules for safe management of facilities for radioactive waste management.

Impacts on the flora resulting from the operation of the investment proposal will be with the following parameters;

- Territorial scope: local within the borders of the external sites and bringing roads.
- Degree of impact: from negligible to minor;
- Duration of impact: during operation (about 25 years);
- Impact Frequency: periodically in both variants, mostly - in the outer part of daily transport in the day.
- Cumulative impacts: not expected to occur as a result of such joint operations with the NPP.
- Transboundary impacts: these are not expected.

Expected impacts on the fauna.

During operation

In non-radiation aspect:

Significant direct, secondary and indirect negative impacts on the fauna in the region cannot be expected during operation since the main ones will occur during the construction period. In this case, it is likely that some representatives of the vertebrates that have been displaced from the site due to construction activities can return near the affected areas. For this purpose it is necessary to design and install a suitable fence, with which the "Radiana" site is generally expected to be differentiated. There is only a low risk of mortality for some small and less mobile vertebrates (amphibians and reptiles) in the transport of STB containers including waste from specialized vehicles (STV) by way of departure, at the Kozloduy NPP to the site host (or the module) of the repository. In practice, this risk is insignificant against the total of the existing transport traffic in the area of the NPP, also considering the shortest route (from 2.7 to 2.8 km) and that the STV will run at low speed (10 to 20 km /h). The utilization of the territory for the construction of the NRRAW, the constant human presence in its operation, the fence around the NRRAW would exclude the possibility of permanent habitats of animal species with the exception of some small mammals and reptiles.

In radiation aspect:

During the operation of any one version of the selected storage facilities for preparation and packaging low- and intermediate-level waste, no radiation effects in the LV dimension on the fauna in the region are expected since there is a number of stopping barriers which will impede the penetration of radioactive isotopes and radiation in the environment. Such impacts will be confined around the values characteristic of the natural radioactive background in the area, i.e. within normal limits.

In this case it is necessary to emphasize that it is for storing conditioned short-lived low and medium radioactive wastes such as contaminated clothing and personal protective equipment, contaminated equipment and tools, construction waste, laboratory waste, cubes residue resulting from the purification and concentration of different types of radioactively contaminated water created during the plant's operation, spent ion exchange resins and sorbents. Highly radioactive waste resulting from the work of the reactors of the NPP (spent nuclear fuel and its derivative mixtures) will not be disposed of in the facilities. Geological repositories are commonly used for the storage and disposal of such wastes (at depths greater than 200 m), whereas in the case concerned the trenches and tunnel-type storage facilities for RAW generally fall into the type of surface storage. In both cases it comes to multi-barrier engineering facilities whose safety is ensured by passive means. Safety is based on the application of deep-echelon defense, which is achieved by the simultaneous application of a system of physical barriers, technical and organizational measures. In most cases there are prominently selected physical barriers, namely:

1. The first engineering barrier is the cement matrix, in which RAW is included, and a reinforced concrete container covered with insulation, which incorporates a matrix. Reinforced containers are licensed for the carriage of radioactive substances and to protect against radiation. In any case the overload of containers from STV (a gantry crane or transport dumping machine) will be done in closed constructions and halls, insulating the containers from the external environment;

2 The second (intermediate) engineering barrier constitutes an element of the watertight structure of the respective type of repository and includes:

- With the trench type the concrete walls of the repository cameras are covered with insulation and filling material around the containers;
- With the tunnel type there are the reinforced concrete roof supports (0.45 m) of the repository galleries for deployment, covered with a waterproof screen, on which a concrete layer and filling material around the container also has a bearing .

3. The third (outer) engineering barrier is also an element of the structure of the repository and includes:

- With the trench type there are the external casing and the ground cement multilayer (multi barrier) protective cover (or protective embankment). Additional disposal facilities shall be protected from surface water (precipitation, surface runoff due to rainfall and melting snow) through a system of drainage of surface water.
- With the tunnel type the third (outer) barrier is a reinforced zone of cementing (silicification) around the gallery (tunnel), whose thickness is 40 cm

4. The fourth barrier is a natural barrier and represents the geological environment of the "Radiana" site, in which the selected type of repository will be located at, consisting of loess type clays and loess at the surface. It shall be completely dry and have very good adsorption properties, preventing the migration of radionuclides.

- With the trench type individual facilities (modules) in practice will be foundation in the loess complex, they will not be fully embedded in it, i.e., after their filling with containers they will have to be closed on the surface with a concrete slab covered with insulation and covered in a multi barrier blanket, loess cement layer, a layer of waterproof clay, a geotextile layer, a sand layer, a layer of gravel, sand, soil and a humus layer.
- With the tunnel type, which will be dug in the loess underground complex, as a substantial and significant natural barrier can be considered undisturbed by the works, and it has high waterproof properties and extremely low sensitivity of structures to seismic and anthropogenic impacts. Also of importance is the depth from the surface of storage of containers, which is between 25 m and approximately 35 meters and virtually completely prevents the migration of radioactive isotopes in the ground and the penetrating ability of radiation from damaging them.

The envisaged drainage systems for removal of suspected infiltrators and further polluted water from the interior of the type of facility can be considered a single barrier. It should be noted that given their waterproof exterior walls, the additional hydro and such costly engineering solutions, a break in ground water and flooding of the selected type of repository is not expected during the period of operation. However, in any case, water conditioned containers of radioactive waste that allow capture and potentially penetrated (infiltration) are provided for both options an internal drainage system. With that potentially "contaminated" water is discharged to the tanks for contaminated water, where after pre pumping it is be transported for further treatment. With both possible types of repositories the contaminated water storage will be completely shielded from the environmental components in the galleries, works and tunnels in which radioactive contamination of groundwater and secondary negative effects on flora and fauna of the area are not expected.

Along with the described physical barriers, a number of events of technical and organizational nature are provided (incl. detailed dosimetric and radiometric monitoring of STV and RCC, security, monitoring, and many others). They are examined in detail in the analytical part of this EIAR, which will help to eliminate any risks associated with substantial alteration of the natural background radiation in the area of the site and the Kozloduy NPP in transportation, overloading and installation of containers with RAW in the selected type of repository during its operation.

In conclusion, during normal operation of any of the selected types of equipment, no significant negative impacts are expected on the fauna in the non-radiation and radiation aspects because the expected technologies for storing RAW are reliable and prevent any contamination from radioactive nature in the area. There is only a slight risk of isolated cases of mortality in some slow-moving species as a result of being accidentally run over during operation at the sites, but it is practically negligible and fits into the overall risk, which anyway exists in this area of the whole NPP site and the nearby national road network.

Impacts on the fauna resulting from the operation of the investment proposal will be with the following parameters:

- Territorial scope: local within the borders of the external sites and bringing roads.
- Degree of impact: from negligible to minor;

- Duration of impact: during operation (about 25 years);
- Impact Frequency: periodically in both variants, mostly in the outer part of daily transport in the day.
- Cumulative impacts: not expected to occur as a result of such joint operations with the NPP.
- Transboundary impacts: these are not expected.

During closure

In non radioactive aspect:

In the non-radioactive aspect, positive, rather than negative, impacts on the local fauna may be expected with the closure of any of the two selected versions of repositories. During the period of closure, constructions will be practically deactivated and dismantled (mostly light-type structures). The facilities and the equipment servicing the external sites and then the release sites will likely undergo further recultivation. This recultivation is certainly intended to be implemented on the packed facilities in the trench type repository, and after the sealing of the modules they will be covered with a humus layer on which suitable vegetation will be planted. Recultivation will be carried out after the closure. Thus, after these events, on the freed and reclaimed areas with proper conditions for the accommodation of the representatives of some species, this trend will increase even more after the dismantling and removal of constructions and other facilities, including the system for physical protection and the protection fence in the transition from active to passive institutional controls.

In radiation aspect:

Before closure, regardless of the type of NRRAW, the free spaces between the separate RCC will be filled with natural materials – loess cement, bentonite clay and a mixture of bentonite and inert material (sand) or keramzite. Landfills will then be reliably sealed, the trench type by RC modular plates covered with insulation, etc., and the tunnel type with clay plugs RC and thick walls. These stopping barriers and other physical barriers are fully adequate to prevent the penetration of radioactive isotopes and radiation in the environment and local flora in some of the RCC failures during the remaining period of activity of short-lived low - and medium period RAW with a half-life of less than or equal to 30 years.

Overall, the final decommissioning will continue for at least 15 years depending on the scenario and in accordance with the requirements of nuclear law, subject to authorization by the NRA and a new assessment of the impact on the environment, in which case potential impacts on fauna should be viewed in detail.

Risk of emergency in terms of the flora and fauna (floods, earthquakes, torrential rains and terrorist attacks) and accidents during transport.

There may be impacts on the flora and fauna during emergency situations, mostly by external sources with outer character (incidents during transport (TI), floods, torrential rains, strong earthquakes, terrorist attacks and certain others).

In the event of a TI with an STV during transport, taking into account that the speeds of movement of the vehicle are minimal (10 to max. 20 km / h), the intensity and the impact will not be high, i.e. no deformation of the container with RAW is expected. Even if present, the container will be immediately shipped with another STV to a facility for faulty packaging or to SU RAW Kozloduy for extra wrapping and repackaging. During this time, given the nature of RAW, there is little risk of obtaining short-term and low level exposure of the available flora and fauna (mainly insects) in the immediate vicinity of the incident, which in practice would be irrelevant to the flora and fauna in the area.

Impact of floods on natural or anthropogenic causes is excluded due to the climatic and hydrological characteristics of the site, its remoteness and altitude relative to the Danube, and the tilt and displacement. The probability of emergence of a tornado is negligible.

Casualties in earthquakes are possible in very strong ones (VII degree scale MSHK-64), during which there is a possibility of the demolition of repository structures and strong deformation of the containers with radioactive waste from the pressures of the geological environment itself. There is a risk of release and migration of short-lived low and medium radioactive isotopes into the environment, but it is negligible against the risk of damage that could be caused by the adjacent Kozloduy NPP for obvious reasons. It should be noted that the main sources of seismic risk are seismic zones that are off-site. According to earthquake maps for periods of 1000 and 10,000 years, the "Radiana" site can be subjected to seismic effects of level VII scale MSHK-64 caused by events in the Vrancea seismic zone in Romania (a distance of over 240 km). The structures of both types of facilities will be secured against earthquakes of such a degree through various technological solutions, which will include precise calculations and ratings in that part of the technical design documentation

With regard to possible terrorist attacks, there is a ban on overflying aircraft over the area, and access to the perimeter of the "Radiana" site will be monitored by police guards. It was found that the only significant event with technogenic origin, which can happen in the region is an explosion of a vehicle crossing road 11 or road 23. There will be no any processes of mass energy transfer, pressure vessels, warehouses for hazardous materials as explosions etc.

The NRRAW is classified as a nuclear facility, according to Bulgarian legislation (to distinguish from a nuclear plant). Bulgarian laws and regulations describe the safety measures for such facilities. These regulations are consistent with IAEA recommendations. The facility is designed to store only short-lived NSRAO conditioned and immobilized in RCC (conditioning and immobilization is outside the repository). The content of RAW, the form of the waste and the weight of the containers (tens of tons) do not provide opportunities for spreading or theft. Immobilized short-lived NSRAO are of no interest to terrorist attacks because there is no possibility of causing negative environmental impacts and large lesions, but this does not exclude taking into consideration the above safety measures.

Expected impacts on the nearest protected areas.

During operation, no impacts are expected on the most protected areas of European ecological network Natura 2000 (in radiation, and non-radiation aspect), as the envisaged multi-barrier engineering facilities for the storage and conservation of RAW are reliable and prevent possible contamination of radioactive nature in the area. Safety is ensured through the implementation of quick-echelon defense, which is realized through the simultaneous implementation of a number of physical barriers, such technical measures and organizational in nature. All of them are discussed in detail in the characteristics of the IP in the current EIAR.

During closure, in case of malfunction of some RCC during the remaining period of activity of the short-lived low- and intermediate-level RAW with a half-life of less than or equal to 30 years, all provided stopping physical barriers are adequate to impede the penetration of radioactive isotopes and radiation in the environment and therefore such migration to the nearest protected areas.

With regard to the possible impacts on the flora and fauna during emergency situations, they are mostly from external sources with outer character (incidents during transport (TI), floods, torrential rains, strong earthquakes, terrorist attacks and others). In the event of TI with STV during transport, deformation of a container with RAW is not expected. Even in such cases, it is assumed that the site of the accident would be "decontaminated" and cleared quickly enough, reliably and efficiently, so that will not generate any significant radiation effect on nearby protected areas. Direct risk from flooding, hurricanes and storms to the zones currently exists and, such phenomena cannot occur in respect of the relevant stored RAW repository (this is especially true for the tunnel option). The selected type of facility will be designed and constructed in accordance with the seismic degree of the region (VII degree of the MSHK-64 scale). The nearest protected areas in Dir.92/43 for the habitats that are at a distance between 4 and 20 km away from the NRRAW and will not be affected.

The NRRAW is classified as a nuclear facility, according to Bulgarian legislation (to distinguish it from a nuclear plant). Bulgarian laws and regulations describe the safety measures for such facilities. These regulations are consistent with IAEA recommendations. The facility is designed to store only short-lived NSRAO conditioned and immobilized in RCC (conditioning and immobilization is outside the repository). The content of RAW, the form of the waste and the weight of the containers (tens of tons) do not provide opportunities for spreading or theft. Immobilized short-lived NSRAO are of no interest to terrorist attacks because there is no possibility of causing negative environmental impacts and large lesions, but this does not exclude taking into consideration the above safety measures.

Possible direct and indirect impacts on the targeted species in the areas during different periods are discussed in detail in the EIAR at the point concerning biodiversity.

The local and controlled range of the NRRAW (tunnel type) only has a minor territorial impact. The protected areas will be protected against the negative effects of radioactive waste in deep

storage and disposal, and additionally from the ridges and gullies surrounding the investment proposal.The foregoing demonstrates the impact of the investment proposal on the

Possible cumulative effect of operating the facility on biodiversity and the closest protected areas.

In this case the emergence of such radiation risk in radioactive aspect is of great interest. It should be emphasized that the results of the radiation monitoring for the past three years in the region, for the needs of the NPP shows that the radiation purity of air, soil, water, vegetation and animal species and their products meet regulatory requirements, as the measured values are in the natural boundaries for the region and below the values that are practically unaffected by the work in the Kozloduy NPP. Accordingly, the cumulative effect from the operation of NRRAW in the region cannot be expected.

4.3.2.8 On the land shaft

In the non-radiation aspect

No negative effects on components subject to conservation are expected during operation of the site.

Compliance with sanitary and hygienic requirements for sites of this type is necessary.

Landscapes are dynamic entities. Each landscape has its genesis, dynamics and development, often caused by the interference of external factors. Landscapes may often develop following their own internal reasons, which means self-development.

The development of landscapes is cyclical in nature, i.e. it has the ability to self-regenerate and develop forward and not repeat its previous state. Simple conversion of a landscape to another takes place when its more stable components and elements are significantly altered. When the slow quantitative accumulation results in a new negative quality, further self-development and self-restoration of the landscape is impossible.

Two types of changes are inherent for landscapes: reversible and irreversible. Significant negative change can lead to complete degradation of landscapes i.e. to their permanent change. Many of the irreversible changes are caused by excessive human intervention in the structure of landscapes.

Each landscape has its own aesthetic capacity determined by its external structure and ecological capacity, determined by its internal structure. Aesthetic capacity is determined by the boundary at which preserves the visual aesthetic unity and harmony in the landscape. Environmental capacity is determined by mechanisms of self-preservation of the landscape, providing for the maintenance of existing ecological balance. Potential to restore landscapes to mechanical distortion of the soil practically does not exist.

After the construction phase, it is necessary to take measures to restore the damaged adjacent land (if any), respecting all the technological requirements for the operation of the facility of this type, and shaping them with appropriate vegetation, possibly establishing a vegetation ring around the site. Taking appropriate measures to counter erosion events, refurbishment of the upper layer and the maximum retention of existing vegetation in adjacent plots in their natural state will mitigate the changing landscape and the artificial introduction of such a landscape as a dominant NRRAW.

It is not possible to provide a definitive assessment of the nature of the visual effects of the construction of such objects.

The construction of the NRRAW will lead to the creation of a new type of landscape while maintaining the local landscape features, which will change the appearance of the area. This leads to high costs of changing the landscape and the natural framework which can be assessed from an economic and landscape-aesthetic point of view.

Problems arising from the interaction between the technical infrastructure as a functional system and landscape as well as a territorial system depending on their origin and character, may be the following:

- Economic - as a result of the interaction of the technical infrastructure and economic development, the need for maximum protection of natural resources and minimal use of funds for repayment of violations;
- Technical - construction of the site in accordance with the basic natural components from which the reliable and simplified construction, impeccable operation and easy maintenance depends. The nature of the intention requires compliance with all hygiene and sanitary requirements;
- Aesthetic - they require an established system and its components to be bound by this landscape for maximum retention of its nature and structure
- Scale and aesthetic harmony - the visual impact of changing the type of terrain can be somewhat mitigated in the implementation of appropriate shape with the typical vegetation of the area.
- Implementation of the project will not cause an increase in the existing background pollution, water and soil pollution, and physiological change in the development of the flora and fauna in the area subject to hygiene requirements adopted for the construction of the NRRAW.
- The main negative impact is changing the apparent aesthetic environment;
- In implementing the envisaged investment intention in the project, the local landscape will be amended, but it will not change the basic type of landscape.

The expected impact on the landscape from the viewpoint of visibility is as follows:

- Area of influence: local and wide visual
- Degree of impact: relative
- Duration of effects: while the operation continues.
- Cumulative effect: not expected.
- Transboundary effects: not expected
- During closure

No radioactive impact of factors are expected on the landscape during the closure of the NRRAW.

Operation of the NRRAW will continue in the period 2015 – 2075.

The partial closure of the RCC packed modules is projected. The final closure will continue for at least 15 years in accordance with the requirements of nuclear law, and it shall be subject to authorization by the NRA and a new evaluation of environmental impact.

The original landscape of the site will be restored during closure. 100 years of active institutional controls will be set in place after the closure of NRRAW during which programs for control of the state of facilities and radiation monitoring of the site, radiation protected zone and a surveillance zone, security and access control shall be implemented.

Then 200 years of passive institutional control will be set in which administrative measures to control land use on the site are applied. After this period (300 years), the site is released for unrestricted use.

4.3.2.9 Impact on the generation of waste associated with the stages of normal operation and decommissioning of the NRRAW

The received waste, associated with the stages of normal operation and decommissioning will collect, classify, process, store and dispose of, according to existing legislation and established good practice in the establishment of IP.

The possible impacts during operation and decommissioning of the NRRAW from the formation and deployment of different types of waste are listed below:

In non-radioactive aspect

During operation

Possible impacts in terms of the non-radioactive aspect during operation are related to the generation of the following non-radioactive waste: domestic waste, construction waste generated from the repair during the operation, industrial waste - packaging and hazardous waste - Burned out fluorescent (mercury) lamps.

The expected range of non-radioactive waste impact is within the NRRAW site, since the waste will be formed there, and 3-km zone around the NPP - in relation to waste treatment. The impact is negative, because they pollute the ground; they act directly on the site of the NRRAW and indirectly to the 3-km zone. No secondary or cumulative impact is expected. Frequency is expected to be permanent, duration to be long (because the operation is for a long period - at least 50 years) and reversibility shall be reversible at the site of the NRRAW and irreversible in the 3-km zone around the NPP, since they will be treated in this region.

During closure

The possible effects in non-radioactive aspect during the decommissioning are associated with the generation of construction waste generated from the demolition of constructions and facilities. After checking for radioactivity and proving that they are not contaminated they will be transported by truck for disposal on the construction waste site. Their impact will be the same and the resulting debris during construction or repair during the operation.

In radioactive aspect

During operation

The possible radiation effects in terms associated with the following minimum generation of the following radioactive waste - protective clothing, shoes and gloves for the staff. The special working clothing is treated as RAW, if after the applied deactivation in the special washing machines, the pollution exceeds the permitted in BRPS-2004.

The expected range of impact of such waste is within the limits of the site of the NRRAW. The impact is negative; they operate directly on the site of the NRRAW. Secondary or cumulative effects are not expected. Frequency is expected to be constant, while operating as they will constantly form, as regards duration it will be long term (because the operation was for a long period - 50 years) and as regards reversibility it will be reversible

Prediction and assessment of these impacts - radioactive waste will potentially form throughout the operation, but their quantities will be minimal and will relate to the protection of staff (personnel protective equipment). These wastes will remain on site and immediately after their formation will be collected and removed outside for their subsequent treatment, according to the established practice of SE RAW, so their impact on site is limited.

During closure

Radioactive waste is not expected to be generated during closure. They will be checked, collected and removed from the NRRAW to "SE RAW for further treatment, according to the established practice of the NPP / SE RAW. The expected RAW will have very low radioactivity. They are not expected to have a negative impact, when complied with the plans for decommissioning of the nuclear facility and all Bulgarian and international legal working requirements and practices.

4.3.2.10 Effects of noise factor

<u>During operation</u>

During the operation of the repository, sources of noise in the environment will be the facilities, providing the general specific activity of the repository, as well as all support facilities and systems (diesel aggregate, compressor, valve, ventilation, etc.) with the emitted noise levels of 85 dBA to 105 dBA.

The use of modern machinery and equipment including good technical and acoustic performance is envisaged. There are also appropriate measures for noise protection.

The envisaged support facilities are located in constructions which outer surrounding structures have and index of soundproofing of 25 dB to 45 dB (depending on the type of wall). The expected level of noise passed by the premises of constructions in the environment is up to 60 dBA, which exceeds the limit values of noise production and storage areas.

The operation activities are not a source of noise disturbance to the settlements in the area, owing to their great distance from it.

The impact of the noise radiated in the environment during the operation of the repository is constant, covers the area of its site, without exceeding the statutory hygiene standards in our country.

Table 4.3.11 Noise impact during the operation of the NRRAW

Way of impact	Direct, negative
Territorial scope	Localized (on the site of the facility)
Frequency of impact	Constant (during the operation of the repository)
Degree of impact	Compatible (the effect is within the statutory norms)
Cumulative impact	Not expected
Transboundary impact	Not expected

<u>During closure</u>

Constructions and facilities on the surface sites will be practically dismantled and destroyed during closure and then the land will be reclaimed. Noise sources are the same as during the construction of the repository with noise levels of 80 dBA to 105 dBA.

The impact of this activity is the same as during the construction period.

Table 4.3.12 Noise impact during the closure of NRRAW

Way of impact	Direct, negative
Territorial scope	Localized (on the site of the facility)
Frequency of impact	Temporarily, periodically (Only during day time)
Degree of impact	average for the site and compatible to its surrounding environment
Cumulative impact	expected in terms of freight transport
Transboundary impact	Not expected

<u>During emergencies</u>

Temporary increase in noise level can be expected in emergency situations, at the site of the repository and the roads leading to it, associated with the accumulation of specialized vehicles, people, etc. The impact will be:

Table 4.3.13 Noise impact during emergencies

Way of impact	Direct, negative
Territorial scope	Localized (near the site of the repository)

Frequency of impact	incidentally, temporary
Degree of impact	From middle to heavy on separate occasions
Cumulative impact	Expected in terms of transport vehicles
Transboundary impact	Not expected

4.3.2.11 *Analysis and evaluation of the alleged effects on cultural – historical, architectural and archaeological heritage, as a result of implementation of the investment intention*

During the operation of the NRRAW and its decommissioning, impacts in non-radioactive and radioactive aspect of the material valuables and the reducing of non-renewable resources are not expected, as their use is not envisaged.

Impact of potential radiological impacts associated with the operation and decommissioning of NRRAW [190]

During the operation, programs are run for dosimetric monitoring and control, to demonstrate compliance with the limits set out in the Regulations.

An assessment of the radiological consequences of the transport and subsequent storage of RAW in the NRRAW is made.

By an estimated evaluation during the regular operation of the NRRAW there is no possibility of excessive radiation effects as a prerequisite for this are the technical solutions chosen, the provided tight control and minimum dependence on human intervention during the operation of the facilities.

According to the Ordinance on Safety during the closure of nuclear facilities[140], art. 6 and technical specifications of the permit holder of the site, design construction and commissioning should develop preliminary and intermediate concepts and plans for the decommissioning of the nuclear facility under the previously adopted strategy for decommissioning when it complies with all Bulgarian and international legal requirements at the time of decommissioning.

The ultimate goal of the decommissioning of the NRRAW is the full and final release of the site from sources of ionizing radiation capable of subsequent use for farming or other purposes (Article 4 (2) of the Ordinance on the Safety of decommissioning of nuclear facilities.

Since the National Strategy for safe handling of RAW (Decision no. 693/1999, the Council of Ministers) has no indication that it intends to use the NRRAW site at this stage can be assumed that the NRRAW site will be released in full. Therefore, the concept of the project must include measures to complete the removal of the entire plant and the adjoining site.

Cumulative environmental impact on the environment from the work of Kozloduy NPP and the NRRAW

In non-radioactive aspect

During the normal operation of the NRRAW, no cumulative effect from non-radioactive factors is expected. The gas emissions from internal combustion engines of the special machines are so negligible that neither will be carried over long distances, nor prevent the ability of the atmosphere for self cleaning. The same applies for waste water and waste, from which cumulative effects are also not expected.

In radioactive aspect

The estimated dose at 3.5 km (the distance to the nearest populated area) from the NRRAW in result of its operation is approximately 1 x 10^{-20} μSv / h. This means that the individual effective dose for the population is 1 x 10^{-15} μSv / year, thus practically zero and immeasurable. Radiation effects are several orders of magnitude lower than the radiative effects of the operation of NPP units 5 and 6, and several orders of magnitude lower than at the time when the plant was operating at full capacity of all units 1 to 6 . The conclusion is that the operation of NHRAO will not contribute to an increase in aggregate radiation impact (cumulative). Evidence of the values are provided below.

The maximum individual effective dose resulting from the release of emissions from the NPP is estimated to be in the range of 2.68-3.76 x 10^{-7} Sv/year, and that as a result of emissions of fluids is up to 1.66 x 10^{-11} Sv/year.

This means, that **the contribution of the NRRAW to the radiation background in the vicinity of the town of Kozloduy from external radiation is negligible and is at least four orders of magnitude smaller than the contribution of all blocks in the NPP.**

There will be no releases of radioactive gas from the NRRAW and no liquid radioactive discharges are expected. However, as described above, containers-packages for RAW are sealed by welding, cleaned and deactivated before moving and transported in the NRRAW. So the impact on these roads is expected to be missing in normal operation.

The conclusion is that, **the cumulative environmental impact is negligible.**

4.3.3 Potential impacts resulting from accidents [190]

Potential risks of accidents during the construction, operation and closure of the NRRAW associated with any potential:

- Damage to containers and / or facilities;

- TI accidents;

- Spills, fires and explosions;

- Natural disasters (as earthquakes, floods).

The construction of the containers with spent nuclear fuel is based on the concept of "zero leakage", which implies the absence of effects on groundwater and subsurface soil for recruitment and decommissioning of the repository, since their integrity is not compromised during handling (dropping, hits, etc.) or as a result of external events (explosions, fires, traffic accidents and earthquakes). Moreover the leveled relief and position of the site exclude the danger of flooding.

Expanding the impact on the Earth in the construction process is possible only in non-radioactive aspect when design solutions not conforming with the conditions for sustainability of the ground array, following the occurrence of landslide and other distortions in both primary and special conditions when putting load on the earth base (from seismic effects and / or vibration of sealing machines and equipment, accompaniment of any damage to constructions and facilities built.

– Interruption or damage to equipment or process;

Air: as a technology, the process of storing in the NRRAW is associated with a low probability of a failure of equipment occurring, but even then it is a source of bursts of non-radioactive pollutants with consequent adverse effects on the ambient air.

– TI accidents;

Air: there are no conventional motor vehicles on the site of the NRRAW that can have an accident.

In the region of Kozloduy NPP the traffic of specialized transportations vehicles is made in strict timetables and routes with low speeds where there is zero likelihood of accidents between them.

– Spills, fire and explosions;

Air: spills are not expected. No fire or explosive materials, which can be combustible non-radioactive sources of pollutants with consequent adverse effects on ambient air.

– Natural disasters (e.g. earthquakes, floods).

Air: Tornado and hail are considered hazardous weather phenomena to the region of Kozloduy NPP. The probability of a tornado crossing over Kozloduy NPP in the duration of one year is estimated at 10^{-6}. From a statistical perspective, hailstorms are accidental phenomena, due to its large spatial and temporal variations. During the period from May 5 to July 31, in the region of the Kozloduy NPP.

The following extraordinary events, divided into three categories are taken into account when designing the containers:

– Incidents - these are situations that, for security reasons are expected to occur one or more times during the lifetime of the facility. The design is capable of withstanding these incidents in a way that avoids additional environmental impacts that are above the extremely low levels associated with periods of normal operation.

– Alleged incidents - these are situations that, for security reasons are not expected to occur during the lifetime of the facility and the construction are capable of withstanding.

– Unlikely accidents - these are very rare events, usually due to unexpected circumstances or external factors. The structure is able to withstand such events

Preliminary safety analysis showed that even in an emergency radiological consequences are significantly lower than the legal limits to protect the population, and established safety standards of the IAEA.

Pursuant to the requirements of the nuclear legislation around nuclear facilities and sites with sources of ionizing radiation areas with special status are established. The preliminary safety analysis showed that the criteria for individual annual effective dose for the population, corresponding to the outer limit of areas with special status / RZZ zone and preventive safety measures / reached a distance of about 6 meters from the modules for disposal. Beyond this limit, as shown above, radiation exposure for the population is negligible and practically equal to zero. This means that construction of NHRAO near the NPP will not lead to a change in the dimensions of existing areas with special status of Kozloduy NPP.

Development of the Emergency Action Plan for the NRRAW should be coordinated with the Emergency Action Plan for the Kozloduy NPP, and both developed in accordance with the ALARA principle, provides for organizing all activities for the prevention of emergency and other situations that make the facility safe. The Kozloduy NPP has an Emergency Action Plan, which is in accordance with harmonized regulations and all necessary safety requirements in case of natural disasters i.e. floods, frosts, snow, earthquakes, storms and winds are taken into account.

Soils

Impacts of the NRRAW subject to the investment proposal during emergency situations are the most hazardous of all possible negative impacts on land and soil, and for the surrounding ecosystem. These effects can be seen in several aspects - surface and groundwater, i.e. in the repository itself and radioactive and non radioactive. Although these effects are negligible unlikely, we can point out some of them, which can spread to adjacent areas. These effects may be caused by:

➢ Fires caused by negligence or ill-intentioned people on the surface of the repository. Such fires are suppressed fast, but they accumulate a lot of hard work and money. They can affect adjacent land or plant and animal habitats. Therefore very strict control is required not only of workers from the landfill, but also control of the checkpoint to prevent outsiders on the site. The developing of a contingency plan with rigorous estimates for all events in extinguishing fires which might arise is necessary. These fires can be seen as similar to those in all other industrial sites.

➢ Intense rainfall causing flooding and overflow of water from higher parts of the terrain to the lower parts. These waters are erosion waters, which will carry mud and organic material to the sewer. They will not only contaminate the soil around the site, but also lands down to the watershed. That is why the more favorable outcome is, after the bulk digging works during construction, each defined surface without earmarking to be landscaped to prevent any erosion of the ground.

➢ Possible earthquakes may also cause some damage on the surface of the repository. They can be expressed in the development of landslide processes, separation of parts of unhealed surfaces after construction and their distribution on the adjacent lands.

- Such drastic effects of an emergency situation on the NRRAW cells could not be expected, since they are both protected from any leakage of radiation and the effects of tectonic movements. Therefore we do not consider the impact of radiation on the soil due to an emergency of this kind.

- Negative impacts on the soil from the leakage of radiation is not likely, in other emergency situations, possibly from the still unburied waste during their transportation to the NRRAW. The characteristics of less likely effects on soils in these situations, are input in the matrix.

To reduce the effects of any emergency it is necessary to develop a contingency plan with rigorous calculations of all measures to prevent any possible emergency situations in an investment proposal site. This plan must be coordinated with the relevant authorities responsible for preventing or reducing the consequences of emergencies. After its adoption, it must be observed that the work of the NRRAW is subject of the investment proposal, to be controlled from the control bodies of the NPP and those responsible for actions during emergency situations.

Conclusion:

The preliminary safety analysis performed herein showed that the integrity of the container will be maintained under all foreseeable accidents and incidents such as leakage of the container due to errors in handling. Adverse environmental impacts will be prevented even under extreme conditions laid down in the project, e.g. external events such as fire or earthquake.

The emergency cases (and the subsequent effects on the human health and the environment) which will be subject to a detailed quantitative assessment in OAB will confirm the concept of "zero leak" and will prove that more than described in this EIAR implications on the environment or population will not appear .

As part of the licensing process in respect to safety, it is necessary to obtain approval from the interim OAB NRA **before** the start of construction of the NRRAW. Final approval of the NRA OAB must be obtained **before** the NRRAW goes into operation.

4.3.4 Transboundary impact

- **Bulgaria has notified Romania, according to the Ordinance on procedures for the conducting of EIAR (Ch. 8)** and the Convention for assessment of environmental impact assessment in a transboundary context (Official Gazette. 86 of 1 October 1999., Corr. Double.No. 89 of October 12, 1999. The notification to Romania is formal, through the provision of project information in the form according to Art. 3 of that Convention (ESDP).
- The IP falls in Appendix 1 Item 3 of the Convention and the Ordinance (projects for which the conduct of an EIAR is mandatory and should take into account transboundary impacts). Bulgaria is a country of origin for this project. In preparing the EIAR report on transboundary effects following the procedure described in Art.25 of Chapter 8 of the Ordinance for EIAR. The competent body is MEW.
- In connection with the implementation of Article 25, paragraph 2, the Minister of MEW informed the Romanian authorities for the project through the document Notification about the investment proposal for the implementation of a national disposal facility for low and intermediate radioactive waste.
- Romanian authorities have decided to participate in the EIAR procedure for the project and informed the Bulgarian authorities
- **The resulting recommendations to the scope and content of the EIAR report on the Romanian side were taken into account in finalizing terms of reference based on which this EIAR has been prepared.**
- EIAR follows the content of the documentation on EIA, as required in Annex 2 of the Convention on ESDP taking into account all requirements in accordance with Art.4.
- The object is depending mostly on the arguments in the Report on safety, the preliminary estimation for the safety and the management measures taken, are expected to ensure quality in all aspects of security.

- *In addition, as required by the Romanian side and art.6.3. of the Habitats Directive a map is applied,* showing the position of the object in relation to the zones under Natura 2000. In the EIAR report, a detailed analysis and impact assessment of the NRRAW is made in the different periods of construction, operation and closure on all components of the environment and consequently on the proximity of protected areas in Bulgaria. The impact is minor and it could be argued that there is no negative impact on the protected zones located in Romania.
- *According to the recommendation of the Romanian side, the following issues in the EIAR are discussed in detail:*

  a/ In assessing the component water issues related to the generation of waste water during the operation of the facilities, quantities, loading and storage methods and their treatment, are discussed in detail according to all regulatory requirements (detailed description in p.4.2 of the EIAR). Quantities of domestic water are minimal, generated from 64 employees and production polluted waters are not expected to be discharged into water bodies. The environmental impact is negligible and cannot have any transboundary impact.

  b/ The requirement to prepare plans for prevention and intervention in case of unexpected pollution due to hazardous hydro meteorological phenomena or damage to facilities is conducted, as a detailed emergency plan that will ensure non-risk area of the site is to be developed with the Project, and it will respectively ensure and prevent risk for the Romanian side.

  c/ The recommendation in the EIAR report to track the characteristics of the "Radiana" site in terms of flooding, seismic activity and geotectonics with respect that extreme floods of the Danube River or its tributaries or intense rainfall, as well as earthquakes and landslides can cause accidental pollution is executed. The proposed solutions are consistent with the risk arising from the location where the above phenomena are described in detail by various experts in EIAR p.5.5. There are measures to prevent risk of pollution in the area and consequently the emergence of a situation of risk of transboundary contamination it is not possible.

  d/ No migration of contaminants to the Romanian territory by groundwater is expected. The explanation is explicitly described in the EIAR p.4.3. The text has a figure showing the migration of isotopes in groundwater in the zone of aeration and they cannot fall into the Danube, and also in groundwater bodies that pass under the river and from there reach the Romanian territory.
- *Data for additional doses, effects on population, resulting from the normal operation of all sites / NRRAW Kozloduy and the associated facilities / specific to the different scenarios of operation / quantity of transport machines, fuel type, etc. /*

  Transboundary impact regarding the air is not expected

An estimate has been made in the EIAR for the radioactive impact on the population in the area and in case of accidents, following the subsequent circumstances during transport, floods, earthquakes, torrential rains and terrorist attacks, from the expert impact evaluation of IP on the separate components of the environment.

In the safety analysis of the repository for disposal of RAW it is important to assess the behavior of the system for disposal and under current and future conditions, including expected and unlikely events, taking into account many different factors (e.g. uncertainty of conceptual models and parameters extended periods of time, human behavior and climate change). This is most commonly achieved through the formulation and analysis of a set of scenarios.

For the purposes of this methodology the following definition is adopted: "The scenario is a hypothetical sequence of processes and events, and is one of many designed to illustrate the range of future behaviors and states of the system of the repository, for the purposes of the safety assessment".

Features, processes and phenomena (FPP)-

The results from the transport of the radionuclides in the unsaturated zone are presented in Table 3 ([24] of the lit. reference of PAD). From these results it can be concluded that none of the studied radionuclides can reach the aquifer for a period of 300 years after the closure of the repository. ***The period after which radionuclides reach the aquifer is sufficiently long compared with the half-life of these nuclides, i.e. they will have decayed completely. Exceptions are only*** **^{129}I and ^{129}C*, but their concentrations throughout the repository are well below the norm for drinking water and doses higher than 0.1 mSv / a are not expected to be received.***

It is assumed that the complete degradation of the engineered barriers will occur at the end of the period of institutional control, i.e. 300 years after closure.

In assessing the proposed location is reported that impact is not expected, potential impact in the context of current changes and characteristics of the currents of the Danube as a result of climate change because of the remoteness of the site (p.4.2.of EIAR)

The process is convergent: it cannot prove an unambiguous correlation between climate change and ongoing changes and characteristics of the currents of the Danube river.

Changes and the characteristics of the currents of the Danube depend both on the synoptic factors (or the genesis of a cyclone or anticyclone), far away from the area of the investment proposal and from technical facilities on the river itself and they are not a purpose of study in the EIAR.

Information for the declaration of the investment under Article 37 of the Contract EURATOM - (Article 37-Each member state must provide the Commission with general information about each plan to store radioactive waste in whatever form to make it possible to determine whether the implementation of this plan may result in the radioactive contamination of water, soil or air of another member state. The Commission will provide its opinion within six months after consulting a panel of experts, as provided for in Article 31 / under this Article the procedure is underway).

The site is consistent with international best practices and for the post-operational and closure periods, not only for the phases of construction and operation, as reported in the notification

The necessary measures have been taken described in p.7. of EIAR against possible terrorist attacks, taking into account the estimated size of the repository of 36 ha and ensuring the safety of the area and the site.

The safety report also examines such a scenario - frequency and result of the event (which can actually be seen as a failure), i.e. this is an emergency with a different cause. The assessment of such effects is complex and the impact on all factors and environmental components must be considered, so appropriate measures are proposed to mitigate the impacts. In the EIAR the evaluation for accidents is made separately for each component.

- Connection between the aquifer and the Danube river and Impact Assessment on the Danube river during all phases of the repository.

The construction of the NRRAW is envisaged on the "Radiana" site at an altitude above 50 ÷ 55 m, while the terrain along the Danube is at an altitude of 25 ÷ 30 m. Groundwater body BG1G0000Qal005 "browsed water in the Quaternary - Kozloduy Valley and the estuary stretch of ground water body BG1G0000Qal015" browsed waters in the Quaternary - Ogosta river " have a hydraulic connection with the river. This area is beyond the borders of the "Radiana" site, where the construction of the NRRAW is projected. According to the results from the modeling of the migration processes, the radionuclides ^{137}Cs, ^{90}Sr, ^{63}Ni, ^{241}Am and ^{239}Pu and ^{94}Nb persist in the repository itself or in the subsoil. To the local aquifer under the NRRAW (groundwater body BG1G00000N2034 "browsed water in the Neogena - Lom - Pleven depression") after about 3500 years from the closure of the repository, only radionuclides ^{129}I and ^{129}C reach, which have low activity, which makes them safe in the groundwater.

Therefore, there are no preconditions for impact of the Danube on the NRRAW during all its phases and a very long period after its closure;

The requirements of the Romanian side for the implementation of environmental impact assessments of radioactive environmental factors in the pre-operational stage on the border objects with Kozloduy NPP on the Romanian territory, geological formations in Romania in the border areas by taking drilling samples for this purpose, a hydro geological study using traces of Rhodamine B by sulfuric dichromate and for the determination of the circulation of groundwater on the Romanian-Bulgarian border is not justified. In our view further studies are unnecessary because they are not subject to EIAR.

The requirement for the implementation of local meteorological study of the repository, including the border area of Romania is not necessary.

The automatic weather stations around the Kozloduy NPP are representative of the meteorological description of the area of the repository, including the border water area with Romania. However, the Danube as a major channel of water redistributes the meteorological parameters on the land territory of Romania. For this area the meteorology is described from observations made by the Romanian weather stations.

– *Requirements of the Romanian side for:*

a/ Determination of distribution coefficients for the main radionuclides from RAW, which are to be stored in clay and providing samples of the actual drilling repository

b/ Establishment from the Bulgarian side of the content of the long-living radionuclides from the wastes for storage / C-14, Cl-36, Nb-94, Ni-59 and separate uranium and trans uranium /

Since the rate of leakage of gases to the atmosphere is determined by the thickness of the layer, which takes place in the end (in this case it is assumed that due to the depth of placement of the trenches, building a solid reinforced concrete block then fill the disposal chambers with lyoso-concrete mixture andprovision of powerful multi-barier protective cover), then with greater confidence can be confirmed that leakage of gaseous radionuclides from the NHRAO would be negligible

This is confirmed by the results from the conducted within the [25] analysis of the dose exposure from internal exposure during inhalation of ^{3}H, ^{14}C and ^{222}Rn, leaking in gaseous form, showing that the radiological criteria are not exceeded.

The following milestones will be achieved during the design phase:

- Agreement with the Romanian side for some common actions on the prevention of incidents
- Agreement with the Romanian side for some common actions on reducing or preventing incidents resulting from the repository (the principle of "recoverable waste" to be taken into account)

The characteristic of the "Radiana" site includes detailed information on geology, hydrology, hydrogeology, geochemistry, tectonic and seismic processes, surface processes, water and climate, anthropogenic impact on the site in EIAR and a description of the environmental situation in the region of the site.

The form and content of the waste, including radionuclides, are detailed in EIAR.

A monitoring program in the period of operation, solutions for closure and institutional control is proposed.

The monitoring program covers all life stages of the repository (design and construction, operation, active institutional control) and all types of monitoring (radiation, geo dynamic, weather), and monitoring all areas (facilities, site, radiation-protection zone, surveillance zone).

The radiation monitoring program will meet the requirements of the Ordinance on radiation protection during activities with sources of ionizing radiation, Chapter 8 and the requirements of the Ordinance on procedures to identify areas with special status around nuclear facilities and sites with sources of ionizing radiation.

The overall objective of the monitoring program is to provide direct evidence of measured presence or non-detection of radionuclides and radiation in the environment that may be related to the disposal facility. Programming is closely related to the evaluation of safety so that monitoring results can be applied to confirm the assumptions in the safety assessment.

The safety assessment for near surface disposal facilities is a procedure to assess the behavior of a disposal facility and, in particular, its potential radiological impact on human health and the environment. The ways of distribution of the radionuclides in the environment are defined during the assessment of the safety and the potential health effects.

The monitoring before the beginning of the operation provides basic levels to identify any additional environmental changes that may be associated with discharges from the disposal facility.

The monitoring during operation and after closure of a disposal facility is intended to show that the actual measurements in the environment do not nullify the assumptions and estimates of the safety assessment.

For near surface disposal facilities, the acceptability for the regulator of the design for the facility and the demonstration of compliance after the start of the operation are based on a comparison of results from the safety assessment and its norms and standards applicable to the facility. The monitoring data provides support to the assumptions of the evaluation and its results.

It is expected that there will be no significant migration of radioactive substances from the disposal facility, at least during the operation and after its closure during the control period. The maintenance of the monitoring will be the non-detection of specific radionuclides and the absence of statistically significant changes in the levels of other pollutants. The monitoring is designed so that the result "less than a current activity or concentration" is sufficient to support the safety assessment. Similarly, the surveillance program of the facilities is being developed in such a way that the degradation of structures and systems of the disposal facility to an extent that compromises the validity of the safety assessment, so that it cannot occur without being detected.

Conclusion:

No negative transboundary impact on separate components of the environment and the factors that influence it in the non-radiation and radiation aspects are expected.

During the conducted analysis of the impact, it can be argued that the emergence of a risk in radiation aspect is not expected in the area of the site and it precludes any in transboundary aspect.

The results from the radiation monitoring for the past three years in the region for the needs of the Kozloduy NPP show that the radiation purity of air, soil, water, vegetation and animal species and their products meet the legal requirements, such that measured values are in the natural boundaries for the region and in the permissible values, which practically are not affected by the operation of the Kozloduy NPP.

The impact during the periods of construction, operation and closure of the facility is definitely proven. No cumulative impact is expected in the region and therefore it cannot be expected in the transboundary aspect.

4.4. Matrixes for assessing the potential impacts on people and the environment

The probability of occurrence or not of the potential radioactive and non radioactive impacts on human and environmental factors, resulting from completion of the construction, operation, closure of the NRRAW and emergency situations is identified and assessed in "Matrixes for assessing potential radioactive and non-radioactive impacts on humans and the environment".

The matrix for assessing potential non-radioactive impacts on humans and the environment during the implementation of the NRRAW is presented in Table 4.4.1.1 for the Radiana site;

Due to a number of complex environmental indicators, the negative effects of the trench type facility construction on the Radiana site are economically justified and optimized with the most favorable location. For the environment, the most effective technology is the one in which the disposal is in a repository tunnel (during construction, operation, and closure in the period of institutional control) [186].

In the underground working of a tunnel-type NRRAW, spoils will be recalled, transported, disposed of and planned (in the construction phase, the construction spot around the entrance part of the existing habitat will be liquidated).The construction is related to partial changes in the typical landscape of a limited part of the territory. Expectations are focused on reversible negative impact after appropriate recultivation activities and preferred stock of available flora and fauna.

The matrix for assessing potential radioactive impacts on humans and the environment during the implementation of NRRAW is presented in Table 4.4.2.1 for the Radiana site.

As a technology, the process of conservation of RAW in the NRRAW is not associated with a probability of a release of gas emissions into the air or on waterways such as during normal operation and in emergencies.

4.5. Analysis and evaluation of potential impacts

In non-radioactive aspect

Upon the population – There is no likelihood of a negative impact occurring upon the population in the area during the time of construction, operation and decommission of the NRRAW site. If all instructions are complied with, there is no probability of a health risk occurring for the workers on the site.

In emergency situations it is possible that an indirect, negative, short time, temporary and reversible impact in range of the borders of the NRRAW site can occur, but there are no health risks to the population in the area or any cross boundary effect.

On the air

Impact on the ambient air is evaluated as:

During the time of construction of the NRRAW the impact of the emissions of internal combustion engine exhaust of the construction machinery and dust in land-and bulk digging will be negative, direct, without secondary and cumulative effects, temporary, short time and reversible and will cover the range allocated to the NRRAW site, the Kozloduy NPP site, a 3km and 30 km zone, from where the materials are expected to be brought.

During the operation of the NRRAW no impact of the emissions of internal combustion engine gases of the special transportation machinery and the site of the Kozloduy NPP is expected.

During the closure of the NRRAW the impact is expected to be the same as the one during the construction: exhaust from internal combustion engines of the construction machinery and dust during the demolition of the separate elements of the construction and the reinforced foundations and protective barrier or digging of the surface of the road will cause negative, direct, without secondary and cumulative impact, temporary, short time and reversible impact and will cover the range of the Kozloduy NPP site and a 3km zone, to where the construction waste will be transported.

During potential accidents: emissions of harmful substances, both during construction and during operation are from fire (intentional or unintentional). The amount of emission depends on the size of the accident, i.e. by its duration and quantity of the substance involved in the accident, such risk is subject only to personnel directly involved in the current operation. The impact will be direct, negative, short-term and reversible.

On surface water: There is no likelihood of a negative impact occurring upon the population in the area during the time of construction, operation and decommission of the site of the NRRAW. No health risk is expected if all instructions are complied with.

During emergency situations there is a possibility of indirect, negative, temporary, short time and reversible effect in range of the NRRAW site, but there isn't any health risk to the population in the area or any cross boundary effect.

On ground water

There is no likelihood of impact occurring on ground water during construction, operation and decommission of the NRRAW.

During emergency situations there is a possibility of indirect, negative, temporary, short time and reversible effect in range of the NRRAW site, but there are no health risks to the population in the area or any cross boundary effect.

On the Earth

During the construction of the NRRAW, a directly adverse, but objectively inevitable, permanent, permanent and irreversible impact will be implemented of a range within the borders of the NRRAW site and the immediate terrain around it, where the disposal of surplus spoils is expected.

During the operation and closure of the NRRAW impact on the earth is not expected.

In emergency situations an indirect negative short-term, temporary and reversible impact is possible in a range within the borders of the NRRAW site.

On the soils, the biodiversity and the landscape. During the construction of the NRRAW, direct, adverse, but objectively inevitable, long term, permanent and irreversible impact will be implemented with a range within the borders of the NRRAW site and the immediate terrain around it, where the disposal of surplus spoils is expected.

During operation and closure of NRRAW a positive impact on rehabilitation of certain sections is expected.

No cross boundary impact is expected.

Non radioactive harmful physical factors - Closest to the site areas with noise normalization procedure are the town of Kozloduy (3,2 km.), the village of Hurlets (6.6 km.) and the industrial site of the Kozloduy NPP.

Limits on noise levels for different areas and construction areas are regulated by Regulation no. 6 on the indicators of environmental noise (MH, MEW, 2006.) and are as follows for:

- Residential areas: day - 55 dBA, evening - 50 dBA, night - 45 dBA;
- Industrial areas: 70 dBA for day, evening and night.

Therefore the proper distance of the repository site from sites with statutory requirements for noise, the activities of its construction, operation and closure will not be a source of noise to them.

The service transport during the construction of the repository, depending on the route of travel by road in the area will deteriorate the acoustic environment of the land around it, passing through towns. The impact is just during the day.

The service transport in operation and closure of the NRRAW will not pass through the territories of the nearby settlements.

There will be no excessive noise levels within the repository site for RAW

In radiation aspect

On ground water

The impact on groundwater during construction, operation and closure of the NRRAW is not likely to occur.

Based on the mathematical modeling of the migration after the institutional control phase (lasting 300 years), it was found that all investigated radionuclides (except ^{129}I and ^{14}C) retain and degrade even in a water inconsistent zone (zone of aeration) underneath the repository and do not reach groundwater in general. Radionuclides ^{129}I and ^{14}C, after a long period of about 6000 years during which they pass through the zone of aeration, first penetrate the no flooding terrace, on which the Kozloduy NPP was built Theoretically the penetrated quantity is characterized by very low activity (practically negligible), which makes them safe in the groundwater, which is why they are not threatened by radioactive contamination. In view of this fact and absent preconditions for reconciling burdened with the burden of the Water Act established and upcoming establishing sanitary protection zones around the existing 'Radiana site, intake facilities in the territory of the investment proposal, which is why the construction of the NRRAW does not contradict the ban on "Processing and storage of radioactive substances and waste in Annex no. 2 of art. 10, Par. 1 of Decree no. 3/16.10.2000

In emergency situations an indirect negative short-term, temporary and reversible impact with a range within the NRRAW site is possible.

On the Earth

No impact is expected on the Earth during the construction, operation and closure of the NRRAW.

After the institutional control phase (lasting 300 years) there seems to be an indirect, permanent and reversible, low impact and local territorial scope within the site of the NRRAW. It will mean the arrest and the dissolution of radionuclides in the water inconsistent zone (zone of aeration) in the repository.

In emergency situations an indirect negative short-term, temporary and reversible effect of a range within the NRRAW site is possible.

Analysis and assessment of anticipated potential impacts (and Transboundary aspects).

Mildly expected pronounced negative potential impacts on the environment are expected during all stages (in construction, in operation, and closure and in the period of institutional control). The more complex environmental indicators (biodiversity, protected areas and protected zones) and the negative effects are most favorable and most effective IP is for the Radiana site.

The construction is related to partial changes in the typical landscape of a limited part of the territory, but reversible.

The location on the proposed IP NRRAW tunnel type is consistent with the requirement of meeting specific needs, but only for our country and not for those of other countries (issues related to safe operation of the NRRAW). In this case:

- Type of impact-direct, long-term, negative, but local in nature and reversible upon successful recultivation of damaged parts.
- Scope of impact, Local, within IP.
- Probability of occurrence of impact-in the construction and operational phase during radioactive waste disposal and particularly in emergency situations, to progressive depletion of the project stock volumes and appropriately implemented phased recultivation.
- Duration, frequency and reversibility of the impact. To the phased depletion of the project stocks and appropriate disposal implemented phased recultivation, i.e. within five years after the successful grassing / forestation.

No transboundary transport of hazardous substances, by water and air are expected.

The largest interest is in the occurrence of a risk in the aspect of radiation.

It should be emphasized that the results of the radiation monitoring for the past three years in the region for the NPP site show that the radiation purity of air, soil, water, vegetation and animal species and their products meet regulatory requirements, measured values are in the natural boundaries for the region and the values in practice are unaffected by the work of the Kozloduy NPP. Accordingly, no cumulative effect of the operation of the NRRAW in the region can be expected.

No negative transboundary impact is not expected during the period of construction, operation and closure of the NRRAW on air, soil, water, vegetation and animal species and products in both the non-radiation and radiation aspect.

LIST OF FIGURES

LIST OF TABLES

DESCRIPTION OF APPENDICES

Part IV

4. DESCRIPTION, ANALYSIS AND ASSESSMENT OF POTENTIAL IMPACTS ON HUMANS AND THE ENVIRONMENT AS A RESULT OF THE IMPLEMENTATION OF NRRAW

1. Results from mathematical model researches for the evaluation of the migration of radionuclides through the engineered barriers and subsoil in the area of the "Radiana" site in the trench type NRRAW [421]
2. Results from mathematical model researches for the evaluation of the migration of radionuclides in the subsoil in the area of the "Radiana" site in the trench type NRRAW [421]
3. General results from the safety evaluation [201]
4. Matrices for the evaluation of the potential impacts on humans and the environment
5. Transboundary impact procedure

Part V

TABLE OF CONTENTS

PART V

5. JUSTIFICATION OF THE CHOSEN ALTERNATIVE

5.1 JUSTIFICATION OF THE CHOSEN ALTERNATIVE BY LOCATION

The **proposed sites are "Radiana", "Marichin valog", Brestova padina" and "Vurbica".**

According to a series of complex environmental factors (biodiversity, PZ and PT), the best and most economically suited is the "Radiana" site.

The most effective environmental control technology with the least potential negative consequences is that of of burying the wastes in a trench type repository (during construction, operation and post-operation institutional control).

During the digging of a trench type NRRAW, land masses will be dug up, transported and disposed of. The construction will cause partial changes to the landscape in a small part of the area. It is expected that these consequences could be reversed after proper recultivation actions are taken.

The proposed location of the Investment Proposal for the NRRAW is in accordance with the specific needs of our country, but not those of other countries (there could be potential problems with transportation and proper operation of the NRRAW).

In the preliminary safety analysis of the NRRAW we have justified the choice of the "Radiana" site.

The general requirements regarding the choice of a proper site for a radioactive waste repository are specified in the Ordinance for safety procedures when operating RAW, the Laws for safe management of atomic energy, and many other MAAE documents.

According to the requirements, the site of the facility for near surface type disposal of RAW must meet the following criteria:

- The geological structure of the site must contribute to the isolation of the wastes and it must help prevent the emission of radionuclides towards the biosphere. It must also provide stability in the disposal system as well as the necessary geotechnical properties needed for burying the expected quantities of RAW in accordance with the chosen method;
- The hydrological properties of the site must include low speeds and long routes of the underground waters to help contain the emission of radionuclides;
- The geochemistry of the underground waters and the geological environment must contribute to limiting the emission of radionuclides from the disposal facility while at the same time they should not reduce the period of functionality of the protective barriers;
- The site must be located at a region with minimal tectonic and seismic activity, so as to insure the isolation properties of the system stay intact;
- The processes taking place on the surface of the device, such as erosion, landslides and floods must not interfere with the system's capability to act within the safety limits;
- The meteorological properties of the region where the site is located must be well known so that any meteorological extremeties are properly described in the project plan;
- The site must be located at a place where the functions of current and future generations, on it or near it, will have little to no effect on the isolating functions of the device;
- The placement of the site must ensure an easy transportation method of RAW to the device with minimal risk to the surrounding population.

For selecting the proper site, the advantage goes to these sites which require the least amount of geological and hydrological studies and are subject to simple and truthful mathematical analysis, while providing the greatest degree of security for the staff, the population in the vicinity and the environment.

The factors for acceptability of the site are divided into three categories: Favorable, Acceptable and Unacceptable, in accordance with the safety regulation criteria.

Favorable sites for NRRAW placement are those whose characteristics along with the full construction of the facility (barriers, volume, consistency, shape and method of sealing of the radioactive wastes) allow for the radiation, to which staff and population will be exposed, to be kept at the lowest possible level. By regulation, annual individual evaluations of any given person who has operated the NRRAW must not exceed the standard safety limit of 0.01 mSv. This criterion should be easily met given that the site in question has the following favorable characteristics and properties:

- Regulation standards for radiation protection, fire safety and physical protection, as specified by law are all met;
- The site is located within a tectonic block which has not been compromised by geodynamic activity or other landscape inconsistencies;
- The maximum earth velocity of free surface layers during earthquakes, based on an annual possibility of 10^{-4}, must not exceed $1 m/s^2$;
- Flooding of the site must be impossible.

Unfavorable, but acceptable sites for NRRAW placement are those whose characteristics along with those of the facility as a whole allow for the radiation levels to which the staff and population are exposed to not exceed the safety limits as specified in the Ordinance safety regulations for operating RAW and RBNRP - 2004. The safety evaluation of the vault system must show the following:

- An annual individual effective dose for the specified group of the population, resulting from operation of the NRRAW ,during and after its sealing, not exceeding 0.3 mSv;
- An annual individual effective dose for the specified group of the population, resulting in an incident during the project in NRRAW not exceeding 5 mSv.

In carrying out the technical and organizational measures that ensure the implementation of these safety criteria, the deployment of an NRRAW is allowed at a site possessing the following acceptable characteristics and properties:

- Regions in which have artesian basins and extensive exchange of subterranean and surface waters;
- Regions endangered by high velocity winds;
- Regions in which high velocity winds, with average speeds exceeding 12m/s are present;
- Regions endangered by tsunami, high water risings and extreme floods;
- Regions which can be flooded by high tides in the event of a water dam wall breach;
- Regions where an NP would be placed in such a way that the dominant winds could flow from it towards existing populated places;
- Regions where the maximum velocity of freed earth layers during an earthquake with an acceptable annual probability of 10^{-4} exceeds $1 m/s^2$;
- Regions which have current differential movements of the earth core (vertical with speeds higher than 10mm per year, and horizontal movements higher than 50mm per year);
- In linear geodynamic zones with existing differential tectonic movements over the past million years with a gradient of the quaternary movements of 10^{-9} per year and higher (without having any active troughs on the surface);
- In regions that have tectonic inconsistencies (such as cracks in the earth's surface);
- In regions of developing karst (thermokarst);
- Regions with abandoned mines or other digging activities except those which could be favorable for the placement of underground NP;
- In regions of potentially active or recent landslides and other hazardous processes;
- In regions which have been established to be focal points for thunderstorms – in which the chances of an intense thunderstorm activity is significantly higher than in the surrounding areas;
- At locations of overflowing riverbeds and the shores of bodies of water with a moving shoreline with speeds of over 1m per year;
- On sloped landscapes exceeding 15 degrees;
- Sites with underground waters at a depth less than 3m beneath the lowest point in layers with thickness over 10m and having a filtration coefficient 10m or higher per day;

- In areas with widespread structural and dynamically unstable earth layers as well as terrestrial strata deformation modulus of 20 MPa under;
- In areas with possible fires due to external reasons hazardous for NP;
- Territories, within which are located sites, including military, which have possible discharge of flammable, toxic and corrosive substances and other impacts, including shock wave and airborne objects in the event of fires and explosions;
- Areas of medium population density in the zone in question exceeding 100 people per km2, calculated for the entire lifespan of the NPP.

Unacceptable conditions:

- Territories on which the deployment is prohibited by a legislative act, or on sites that do not comply with the law on environmental protection, the requirements for radiation protection, fire safety and physical protection, or other requirements laid down by legislative act;
- Sites located directly on the active landscape faults;
- Sites with a maximum acceleration of free surface layers in an earthquake with a certain annual probability of 10-4 is 4 m/s2 and higher;
- In the area on karst (thermokarst), suffosion and karst-suffosion processes;
- At sites in regions of transition of snow avalanches or mud flows;
- Sites subjected to the effects of tsunami;
- In mining sites, the durability of which cannot be ensured for the entire lifespan of the NPP.

Furthermore, the requirements for choosing a site for deployment of an NRRAW are established in documents MAAE 111-G-3.1 *Siting of Near Surface Disposal Facilities*[329] and WS-R-1 *Near Surface Disposal of Radioactive Waste* [330]. The characteristics of the site and basic safety principles are enshrined in MAAE 111-F *The Principles of Radioactive Waste Management* [321].

The site is considered acceptable for construction of an NRRAW if it provides objective opportunities for safe operation of nuclear facilities with regard to natural phenomena, processes and external events, and also ensures the safety of the population and protection the environment from radiation effects after its closure.

Determining a suitable site for a surface repository includes consideration of geological, environmental, technical, social and infrastructure factors. Determining a suitable site means finding a physically and chemically stable geological environment that provides the required level of retention of waste for a period of not less than 300 years. The most important features of the natural barriers are to limit exposure to water of the waste and the delay, dissolution and dilution of the radionuclides that may have leaked from storage.

In accordance with the Ordinance on the Safety Management of Radioactive Waste, the "Analysis of the conditions for near surface disposal of RAW" includes the assessment of four potential sites for deployment of an NRRAW.

In assessing the acceptability of the site, the following aspects are analyzed:

- influence of natural phenomena, processes and external events that take place around the site on the RAW;
- characteristics of the area of deployment and the environment that may affect the transport and accumulation of radioactive products;
- Medical-demographic indicators and characteristics of the area of NRRAW deployment important for ensuring the measures to protect population.

The following groups are considered determinants of site selection, vault construction, operation, closure, and then its operational period: geological, hydro-meteorological, technological, social, political, socioeconomic, environmental health care.

Within the conceptual design of the proposed NRRAW project, safety criteria based on Bulgarian legislation and the reporting requirements of the MAAE assessment identified in preliminary studies of potential sites, and measurable attributes are used to assess the performance of safety criteria.

Safety criteria and measurable attributes are presented in Table 5.1.1.

[190]

Table Error! No text of specified style in document.**.1** **Safety Criteria**

№	Criterion	Measurable attributes of conformity assessment
1	**Geology**	
1.1	Geological formations must include sufficiently thick layers containing clay minerals. (Criterion of highest priority)	The thickness of the layers with predominantly clay minerals (preferably smectite) to the nearest level of groundwater
1.2	Quality of engineering geological formations must permit construction of a disposal facility using normal construction methods.	Project (legal) burden on the foundation ground > 0.3 MPa (Bulgarian АЕЦ requirement) The slope of the hill
2	**Hydrology**	
2.1	The level of underground water must be below the repository in which it is not likely to reach this level of storage in any conditions for the entire duration of the repository.	Distance between the highest annual rate of groundwater level and natural ground
2.2	Capacity of aqua layers, ambient in the disposal facility must be low enough to restrict the movement of groundwater from the facility to the biosphere. (Criterion of the highest priority)	The flowthrough capacity of the layers under and around the facility for disposal
2.3	Flow path of groundwater must be long enough.	The distance to the nearest underground springs or other waters which can be reached by the flow from the site's waters
3	**Geochemistry**	
3.1	At this stage, no criterion will be defined due to the fact that the design of the system of artificial barriers is not final and geochemical properties can also be further explored at the stage of consolidation of the site (according to MAAE)	At this stage we do not take into account any characteristic parameters of the site
4	**Tectonics and seismicity**	
4.1	Insulating ability of the disposal facility must not be endangered by earthquakes and associated ground deformations. (Criterion of the highest priority)	Need to take construction measures to prevent deformations of the earth when earthquakes occur
5	**Surface processes**	
5.1	The risk of occurrence of landslides and other types of erosion or liquification of the ground should be low.	Likelihood of significant landslides, liquification or erosion of land
5.2	Likelihood of flooding at the site must be very low. (Criterion of the highest priority)	Possibility of flood
6	**Meteorology**	
6.1	Meteorology of the area of the site (precipitation, wind) should be adequately reflected in the design of the facility (regardless of the site characteristics).	There are no parameters on the characteristics of a site which could be critical

Under Task 2 of the conceptual design of the NRRAW[196, 197], sites are evaluated on performance as defined in Task 1, the safety criteria; in addition, developed criteria for acceptability and public acceptance are presented in Table 5.1.2.

Table Error! No text of specified style in document.**.2** Eligibility criteria for public acceptance and cost

№	Criteria for assessment of public acceptability and cost
1	**Transportation**
1.1	Transport should be possible without passing through the cities and towns.
1.2	The cost of transport (including all necessary construction or reconstruction of roads) must not be unreasonably high.
2	**Land ownership**
2.1	Land must be owned by the state, municipally or by an enterprise (organization) to avoid the purchase of land by private individuals.
2.2	Cost of land purchase must not be unreasonably high.
3	**Usage of the land**
3.1	Regional planning and development of the area should be extended to the year 2050 and beyond.
3.2	The area reserved for the site must be suitably sized so that it can accommodate the facility and its possible future extensions and the necessary geological barriers.
3.3	There should be no valuable mineral resources near the site.
3.4	Proximity to agricultural fields should not cause major difficulties for a disposal site.
3.5	There should be a protected area with a radius of 5 km around the site, where restrictions are imposed on the risky industrial facilities, water supply, air navigation corridors, deep excavation and diggings and where permanent settlements should be as few as possible.
3.6	Persistent breaches of public water systems should not be caused
4	**Environment**
4.1	Impact on endangered species should be avoided.
4.2	Any archaeological finds must be taken into account.
5	**Infrastructure**
5.1	The site must be near Kozloduy NPP to facilitate the hiring of workers and take advantage of the opportunity to familiarize the public with nuclear energy.
5.2	The site must be near Kozloduy NPP in order to minimize the costs of transport investment and to utilize existing facilities.
5.3	The cost of site preparation and construction of the necessary barriers (including drainage systems, changes in topography and elevation of ground or other measures to protect the water) must be reasonable.
5.3	**Transportation**

Comparative analysis of surveys for NRRAW construction sites

The "Analysis of the conditions for near surface disposal of RAW" resulted in the following candidate sites for deployment of an NRRAW which conform to the instructions and recommendations of the IAEA:

- "Radiana" site, which is located on the slope south of Kozloduy;
- "Marichini valog" site, located in the eponymous patriot valley in the territory of the municipality of Kozloduy, a 2.5 km southwest of Kozloduy NPP;
- "Varbitsa" site, which is situated about 1.5 km from the eastern edge of the village Varbitsa, 20 km from Vratsa and 52 km south of Kozloduy NPP;
- "Brestova Padina" site, located in the region of "Brestova padina", 12 km southwest of Kozloduy NPP, 6 km northwest of the village of Kriva Bara and 7.5 km west-northwest of the village of Butan.

Table 5.1.3. presents the results of the comparative analysis of the main characteristics of the sites surveyed.

Table Error! No text of specified style in document.**.3** Comparison of main factors of the studied sites **[190]**

Element	Index	Characteristics of index			
		Radiana	**Marichini valog**	**Brestova Padina**	**Varbitsa**
Landscape	Type	Slope	Inlet Valley	Wedge watershed even grounds	Pliocene plateau
	Sloped	7-8^0	5-10^0	2-3^0	3-4^0
	Slope direction	North	East-northeast	East	North-northeast
Soils	Type	Leoss and leoss clay (layer 1) Gravel sand clay and gravel with clay-sand core (layer 2) Clay powder (layer 3) Lenses of fine sand to clay sand (layer 4)	Leoss and leoss clay (layer 1) Gravel with clay-sand core (layer 2) Powder sand clay (layer 3) Lenses of fine sand (layer 4)	Leoss and leoss clay (layer 1) Deluvial-proluvial clay (layer 2) Powder sand clay (layer 3) Lenses of small-grained sand (layer 4)	Deluvial-proluvial clay (layer) Dark gray marl (layer 2) Fresh marl (layer 3)
	Thickness of the layer	6-42 m (layer 1) 1.5-7 m (layer 2) 50-55 m (layer 3)	5-14 m (layer 1) 0.5-2 m (layer 2) 16.5-18 m (layer 3)	13-15 m (layer 1) 1.5-2 m (layer 2) 20-21 m (layer 3)	4-11.5 m (layer 1) 4.5-10 m (layer 2) > 1000 m (layer 3)
Growth	Type	Grassy, Bushes	The site is located on agricultural land occupied by crops and vinyards.	The site is located on agricultural land occupied by crops and vinyards.	Grassy, bushes
Hydrology and hydrogeology	Average precipitation	518-558 mm	550 mm	590 mm	680 mm
	Surface waters	In an area of 4 km to the Danube river. R. Cibrica and Ogosta as well as Shishman val mineral spring are more than 10 km away from the site.	In close proximity to the Danube and Ogosta rivers, passing the 10 km zone. No mineral springs in the vicinity.	Ogosta river passes 6km southeast of the site, and 9.5 km to the northwest is the "Shishmanov val" dam	Only two small rivers with unstable flow pass through the 5-km zone
	Floods	Impossible			
Meteorology	Climate	Temperate continental climate			
	Average annual temperature	12-13^{0}C	No Data	No Data	No Data
	Average maximum temperature	36^{0}C	No Data	No Data	No Data

Element	Index	Characteristics of index			
		Radiana	Marichini valog	Brestova Padina	Varbitsa
	Average minimum temperature	20-25^{0}C	No Data	No Data	No Data
	Average wind speed	1,6 m/s	3 m/s	1,6-2 m/s	1,8 m/s
	Maximum wind speed	No Data Prevailing weak to moderate winds (up to 15 m/s)	No Data Weak to moderate prevailing winds (up to 15 m/s)	No Data Weak to moderate prevailing winds (up to 15 m/s)	No Data Weak to moderate prevailing winds (up to 15 m/s)
	Prevailing wind direction	West, northwest	West, northwest	West, northwest	West, northwest, southwest
	Lightning activity	High (for the whole territory of Bulgaria)			
Geology	Geomorphology and litostratigraphy	The studied terrain is composed of Quaternary sediments are Neogene, in five distinct layers - layer, loess, clay loess, alluvial sands, clays Pliocene. Geological hazardous processes did not occur in the the site studied, except for the collapse of loess.	Geological structure shows a thin cover of Quaternary sediments (soil, loess, loess clay), followed by a layer of Pliocene clay sediments (clay to sandy failure, close-grained sand). Lithostratigraphical construction is well defined and the upper part (Quaternary Complex and Brusarski Formation) is relatively inhomogeneous. There were no contraindications to the geomorphological character.	Geological structure shows a thin cover of Quaternary sediments (soil, loess, loess clay and loess), followed by a layer of Pliocene sediments (deluvial proluvial-clay-sandy clay pahovo, grained sand and clay powder). Lithostratigraphical construction is well defined. Layers in the geological profile are in a nearly horizontal position, as in the upper part is dominated by clay sediments and the bottom is relatively dispersed. In that site there are no monitored hazardous geological processes except possibility of landslide of the loess.	Ground at the site was built by deluvial-poluvialna clay marl flat and gray Lower Cretaceous clay marl. The site is the most homogeneous Lithostratigraphy construction. There are no hazardous geological processes on the site.
	Geotectonics	There are no landscape forming faults within an area with a radius of 10 km.	There is no evidence of active faults after neogene age within a 5 km zone around the site.	There is no evidence of active faults after neogene age within a 10 km zone around the site.	There is no evidence of active faults near the site.

Element	Index	Characteristics of index			
		Radiana	Marichini valog	Brestova Padina	Varbitsa
	Geotechnical conditions	The incision on all accounts is very stable in regards to the electrical resistance in depth which indicates homogenity of the Igeological structure of the site's soil. In the case of a half-dug trench type repository with foundations over the leoss and leoss clay (layer 1) there will be a need for anti-collapsing preparation of the soil as well as strenghtening of the walls. According to the stability analysis conducted, coefficients of resistance are as follows: natural slope without earthquake - Fs = 2.411; earthquake with a natural slope degree VII - Fs = 1.858; earthquake with a natural slope degree VIII - Fs = 1.,660; natural slope of IX degree earthquake - Fs = 1.320.	The incision on all accounts is very stable in regards to the electrical resistance in depth which indicates homogenity of the Igeological structure of the site's soil. The calculated ground pressure if the foundations are laid on layer 2 or layer 3 will be Ro=0.325 MPa, which would ensure the strength necessary to forego additional strenghtening procedures.	The incision on all accounts is very stable in regards to the electrical resistance in depth which indicates homogenity of the Igeological structure of the site's soil. Geotechnical conditions are favorable, provided the foundation is on loess clay (layer 1b) at about elevation +100 m, to avoid subsidence and highly slegvaema part of the loess complex (layer 1a). In this way you will not have a need for prior anti-collapse preparation of the ground.	The incision on all accounts is very stable in regards to the electrical resistance in depth which indicates homogenity of the Igeological structure of the site's soil. Geotechnical conditions are favorable and do no special ground preparation is required.

Element	Index	Characteristics of index			
		Radiana	Marichini valog	Brestova Padina	Varbitsa
	Seismic Activity	The site is in the area of the very stable portion of the Mizian plateau in a region with very low seismic activity - VII degree on the MSK-64, with a maximum expected seismic activity of Mmax=5.0. In the current engineering, hydro geological and geomorphologic conditions, the slope is in a stable condition.	The site is in the area of the very stable portion of the Mizian plateau in a region with very low seismic activity - VII degree on the MSK-64, with a maximum expected seismic activity of Mmax=5.0. The analysis shows that there is potential for liquification of layer 5 with total deformation of around 2cm at maximum speeds.	The site is in the area of the very stable portion of the Mizian plateau in a region with very low seismic activity - VII degree on the MSK-64, with a maximum expected seismic activity of Mmax=5.0.	The site is located in an area with low seismic activity of grade VII on the MSK-64, scale with a maximum expected seismic activity of Mmax=5.5. The subregion in a 50km radius around the Vurbica site is located in the southern part of the Mizian plateau(a stable region) and encompases the northernmost parts of the Sofia seismic areas.
	Geological and geochemical characteristics	The zone of aeration above the vault has good insulating properties, and host environment in the facility has good sorption properties on the main radionuclides.	Soil types, which act as a geological barrier against the spread of radionuclides gravel with sandy-clay core (layer 2) and prohovo-sandy clays (layer 3), a predominant smektitov composition and high sorption coefficient, which is a prerequisite for high attenuation.	Soil types, which act as a geological barrier against the spread of radionuclides loess clay (layer 1b) and prohovo-sandy clay (layer 2), a predominant smekt composition and high sorption coefficient, which is a prerequisite for high attenuation.	Soil types, which act as a geological barrier against the spread of radionuclides weathered marl (layer 2) and fresh marl (layer 3) are characterized by lower sorption capacity of the Pliocene and Quaternary clays of the other sites and generally with little lower partition coefficients.
Radiation conditions	Radiation background	0.12 до 0,16 µSv/h	No data	No data	No data
Anthropogenic factors	Trails of oil lines and gas lines	No data			
	Airline corridors	No data			

Element	Index	Characteristics of index			
		Radiana	Marichini valog	Brestova Padina	Varbitsa
	Heavy traffic roads	The area of the site is located between a secondary road and road № 11, serving Kozloduy NPP - road № 23	№ 15 secondary road from Vratsa and NPP for Mizia and secondary road Vidin № 11 of Nikopol, third class road to Montana.	In the vicinity there are third-class and second class roads to Montana and Vratsa	A third class road passes through the 5 km area which connects v. Vurbica with the other villages in the vicinity. From the south side of the village there is a dirt road connecting it to the site (~2-2.5km), which, is unpassable during bad weather conditions.
	Industry	Directly next to the site at Kozloduy NPP. Close to KTSH - Mizia and gas basin at Butan.	Highway near Kozloduy NPP, PPP - Mizia, gas basin at Butan	Near the gas basin in the village of Butan.	No such data for the vicinity
	Agriculture and Livestock	The land is not used for agricultural purposes.	Use of land for growing crops.	Use of land for growing grain. The area falls in the eastern end of Zlatiyata - granary in northwestern Bulgaria.	The site is on pastures and meadows with livestock farming.
Demography	Residential areas	The nearest settlements are the town of Kozloduy at 2.6 km southwest of the village Hurlets and 3.5 km southeast of the site	The city of Kozloduy is in a 5-kilometer area, and the 10-kilometer area includes the villages Hurlets, Glozhene and Butan.	The 10-kilometer area includes the villages of Butan, Kriva bara, Sofronievo, Hajredin and Buzovets.	The 5-kilometer area - the village of Varbitsa and the village of Drashan. The 10-kilometer area includes 12 small villages. Most cities are located near Byala Slatina (23 km) north, Cherven Bryag (16 km) east, Roman (15 km) southeast and Mezdra (18 km) southwest
	Land usage	The area of the site falls within the controlled area of the Kozloduy NPP.	Agricultural arable.	Arable farming	The site is located on non-agricultural land.
	Land ownership	State land managed by Forestry Oryahovo, but it is not in a forests foundation	The lands are private property.	The lands are private property.	The lands are private property.
Social-economic factors	Public acceptance	The sites are located near Kozloduy NPP. Much of the population has nuclear experience and is well informed about the risks of the operation of nuclear facilities and storage of RAW.			Population has no nuclear experience.

In considering the criteria relating to public acceptance and expenditure of the "Radiana" site, it is undoubtedly a priority because of its proximity to the site of Kozloduy NPP and the minimum impact on environment and population. The site "Marichini valog", which is ranked second, is located amidst agricultural arable lands that are privately owned - a fact of concern to the local population.

According to safety criteria the most appropriate site is determined to be "Marichini valog" followed by site "Varbitsa". Sites "Brestova Padina" and "Radiana "are equally appropriate with respect to safety criteria[190].

In considering the criteria relating to environmental protection in various components and factors that influence it, including Biodiversity Conservation, the priority choice for construction of an NRRAW is the site "Radiana"

Selecting a construction site for an NRRAW for LILRAW is made as a decision formulated by the following list of basic attributes and measurable indicators on the basis of which (after consultation and approval by all stakeholders), the classification procedure[190] is implemented:

- **Safety ensured by:**

- *Factors ensuring sustainability of long-term storage and preservation of waterproofing properties*:
- *Geological factors, insulating air, surface and groundwater and limiting their impact on store:*
  - Water collecting capacity of the site;
  - Depth of penetration of rain and melting water in the array;
  - Presence of water-rich layers and lenses within the zone of influence of storage facility;
  - Relationship between water content in the local aquifer and the seasonal;
  - Weather (Does flow increase in aquifers with rainfall and by how much, in terms of minimum / average quantity);
  - Maximum water content in ground above the foundation of the repository facility.
- *Geological factors limiting the spread of radionuclides from the repository into the environment.*
- *Factors minimizing the extent of the impact of radionuclides discharged on the biosphere and human health*:
- *Factors minimizing anthropogenic impact on the dielectric properties of the barriers after closure of the store.*
  - Possible development of irrigation agriculture, irrigation and reclamation of land near the repository;
  - Possible development of production and transport corridors generating;
  - High frequency periodic impacts (industrial explosions, vibration machines, heavy transport and other);
  - Chance of drilling with the purpose of a local water supply, archeology, exploration for oil and gas;
  - Chance of falling of heavy aircraft or meteorite.
- *Technical factors and design decisions:*
  - Total water capacity area of the modules for storing RAW;
  - Relationship between the area of the repository and the area of population with a strict regime;
  - Total area of damaged insulation properties of the earth-digging.

- Public acceptance of the municipal administration level / municipality: Formulating public acceptability, ownership of land, the need for expropriation of land use on republican roads network for transporting RAW.

- Public acceptance of the critical level of population: Employment of the population in areas potentially threatened by the existence of NRRAW (agriculture, tourism); Employment of the population in developing regions of the existence of NRRAW (maintenance, supply, health, education, catering); Transportation of Radioactive Waste in settlements or agricultural land; Location of NRRAW site in terms of arable land and pastures determining their potential contamination.

- Technoeconomic factors: Distance from the generator of RAW; Value of construction of store, volume of digging; volume by using additional areas for leveling of earth masses; Availability of infrastructure at the site; Availability of skilled labor; Opportunities for electricity, heating, water supply.*The migration of radionuclides [421] showed very low levels of migrated nuclides with concentrations having a very large stock to legally allowable concentrations for drinking water. There are inherently small nuclide contents in NRRAW and calculations show virtually null values of migrants, with similar values for different sites. According to these figures, the results are of rather theoretical and evidentiary value and not a practical criterion for site selection. Therefore, when choosing one of four sites tested, the criterion "migration of radionuclides from RRAW" has little (virtually negligible) importance, since all sites are perfectly suitable and safe from that standpoint. Therefore, the choice of site (between the four studied) must be determined on other natural, technical and economic conditions and criteria.*

Justification for the selected site in terms of distribution of radionuclides[180, 190]

Besides the above, the "Radiana "site is appropriate in terms of the possible spread of radionuclides migration in groundwater and groundwater area. All studied radionuclides (including 129I) are retained and degrade even in the area of aeration and are warehoused upon reaching groundwater. 129I activity makes it safe in the groundwater and there is no real risk of radioactive contamination of the region through these waters. In their absence excluding factors and its characteristics meet the requirements of the regulations and safety criteria. Table 5.1.4.gives the main features of the site and the corresponding estimates[190] under the Regulations to ensure the safety of nuclear plants.

Table 5.1.4.gives the main features of the site and the corresponding estimates[190] under the Regulations to ensure the safety of nuclear plants.

Table 5.1.4. Characteristics of the "Radiana" site [190]

Element	Characteristics	Evaluation
Landscape	The site is located on the northern slope with a gradient of 7-8^0.	Favorable
Hydrology and hydrogeology	The annual rainfall is about 518-558 mm and is one of the lowest in the country. Normative value of pressure from the weight of snow on a flat surface 1m2 e St = 0.7 kN/m2. Aquifer in Archarskata Formation, about 100 meters below ground or about 40 m beneath the future site. Location of the site prevents flooding.	Favorable
Meteorology	The area falls within the moderate continental climate with an average annual temperature of 9-10C.The average maximum temperature is 36C, and the absolute maximum in August is 39.80C. The minimum temperature reached minus 20-25C, absolute minimum temperatures in some cases may fall to around 30C below freezing. The prevailing wind direction is from west, northwest. The average wind speed is 1.6 m / s, the maximum – 2.2 m / s. Once in 10 years is likely to appear wind speed 27 m / s, once every 100 years - a rate of 37 m / s, and once in 10,000 years with a speed of 45 m / s and more. Thunder activity is high, but this is typical of the whole territory of Bulgaria.	Favorable

Element	Characteristics	Evaluation
Geology	The studied geological terrain is composed of Quaternary Neocene sediments, which are divided into five engineering types - layer, loess, clay, alluvial sands, clays Pliocene. On the territory of the studied site there is no record on any disadvantages or geological hazardous processes Tectonic conditions of the sites are well researched and are conducive to construction a repository for HCRAW, there are no faults in relief forming zone with a radius of 10 km. Stability analyses were conducted for the following options: slope stability in the natural state for basic combination of loads and earthquake of VII, VIII and IX degree. Coefficients of resistance are as follows: - Natural slope without earthquake - Fs = 2,411; - Natural slope degree of earthquake VII - Fs = 1,858; - Natural slope degree of earthquake VIII - Fs = 1,660; - Natural slope of IX degree earthquake - Fs = 1,320. Stability analysis shows under current slope engineering, hydro geological and geomorphologic conditions in steady state, both in basic combination of loads and in earthquake. Resistance coefficients satisfy the requirements of Regulation № 12. Seismic activity of the site is VII degree in MSK-64 and seismic coefficient CC = 0.15 should be used in the design of the structure. The zone of aeration above the store has good insulating properties, and host environment has good sorption properties on the main radionuclides.	Favorable. The movement of the Loess is the only exception, which is unfavorable for construction characteristics.
Technogeneous factors	No established trails of oil and gas pipelines. The civil aviation corridors do not pass through the airspace above the site.. The area of the site is located between highway 11 and highway № 23, near Kozloduy NPP. The area of the site falls within the controlled area of the Kozloduy nuclear power plant and is not used for agricultural purposes. Managed by Forestry Oryahovo, but not a forests foundation.	Favorable in the aspect of RAW transportation
Demographics	The nearest settlements are Kozloduy 2.6 km to the southwest and Hurlets 3.5 km to the southeast	Favorable

Selection and assessment of the site "Radiana" was made based on multi-year research and the preliminary assessment of safety. Analysis and assessments were made by judging the possible impacts on various environmental components and factors that may have an effect on it.

- Geographic, topographic and demographic conditions of the site location, use of natural resources, land use and water resources

- Technogenic factors specific to the site – In the 30 km zone around the site the only major industrial facility is Kozloduy NPP. On its territory there are six energy units, four BBEP-440 and two BBEP-1000. Only blocks 5 and 6 and currently operating with reactors BBEP-1000 and the other four energy units are not in in operation. Furthermore, built on the site of Kozloduy NPP are: a repository for spent nuclear fuel (wet SNFR), plant for processing RAW (a subsidiary of SE "RAW") and a warehouse for temporary storage of RAW. In the process of construction is a repository for spent fuel dry storage.

- Industry: The 12-km zone of Kozloduy NPP includes the following businesses in towns Mizia And Kozloduy: PPP Mizia (discontinued operation); gas field near the village of Butan; Two petrol stations in the city of Kozloduy - the possible effects of blasting on one of the stations are negligible with regard to causing an emergency initiating event at the "Radiana" site.

- Agriculture and forestry industry - The region has no forest industry. No large forest. Agriculture is well supported, mainly crop. Livestock production is small scale, mainly to meet only the needs of the population.

- Transport infrastructure - roads, transportation

- Hydraulic Structures - Radiana site is located between first and second terraces above Kozloduy, which is why it is considered that failures of hydraulic structures along the Danube do not affect the safety of the site. Located near the site of Radiana (at about 12 km) is the dam "Shishmanov val", which was built as a backup reservoir for Units 1 and 2 of Kozloduy NPP. There is a channel through the dam site, but there is provision for its removal (infilling) due to the decommissioning of the 1-4 block. The dam itself is removed in the southwest and transfusion is possible to flood the site from it. Water near the site is not used for water supply because of the large depth of aquifer.

- Quarries and landslides - digging industry is represented by the quarry "Valyata", located east of the site of the River Danube. Extraction aggregates from the river bed. Explosives are not used. In the area of the site no landslides are observed nor any other processes of local nature. The Quarry is distant from the "Radiana" site and does not affect safety.

- Geological and hydrological features of the site
- Hydrogeological characteristics
- Seismo-tectonic and geological engineering conditions
- Seismo-tectonic conditions
- Hydro-meteorological conditions
- Hydrological conditions in the area of the site
- Weather conditions

- Geochemical characteristics of underground water and the geological environment
- Geochemical characteristics of the geological environment including Geochemical parameters of soil types and distribution coefficient (Kd) of soil types
- Geochemical characteristics of underground waters
- Processes of geological and climatic hazards

Table Error! No text of specified style in document.. 5 Hazardous climate and geological processes applicable for the region of the NRRAW site

№	Processes, phenomena and factors	Applicability of the processes, phenomena and factors to the area in which the NRRAW site is located
1.	**Meteorology and climatology of the site and region (extreme weather conditions)**	
1.1	Rainfall (average and extremes, including frequency, duration and intensity)	
1.1.1	Rain, hail, snow and ice	The most abundant daily rainfall is observed in summer. Sometimes torrential rains are accompanied by hail, violent winds, and floods. During the months from May to July the frequency of thunderstorms and hail increases. The annual rainfall is about 518 - 595 mm. In winter precipitation is about 110 - 120 mm, in the spring, it is 135 -150 mm (27 - 28%) and during the summer 145 - 150 mm (28 - 30%). The maximum intensity of the intensive rainfall is 3 to 4 times greater than average with a duration of rainfall of up to 30 minutes. This excess is not significant for rainfall with a longer duration. Heavy precipitation, snow or hail can be a cause of outages and the occurrence of accidents on the roads which could prevent transportation of the container to store RAW. In the period after closure, the effects of heavy rainfall are reflected in increased water infiltration into soil and water erosion of topsoil.
1.1.2	Snow and ice cover (including the potential of blocking the entrances and exits)	The maximum observed depth of the snow cover in the region (the maximum possible) is 111 cm. The area of the NRRAW site falls in this part of the country where the average amount of pressure from the weight of snow on a horizontal surface is 1 m2 st = 1.2 kN/m2, which is taken into account when designing constructions and surface facilities. The most likely combination temperature, wind, humidity on the occurrence of icing in a relatively narrow likelyhood range for virtually all non-mountain regions of the country, namely: a temperature between 0ºC and minus 2ºC to minus 4ºC, with wind speeds between 0 and 3 to 5 m/s and relative humidity along the Danube between 95 and 100%. The formation of snow or ice cover can be a cause of outages and of accidents when conducting container transport activities to store RAW. In the period after closure, the phenomenon is not relevant to the storage of containers in RAW entrance tunnels.

№	Processes, phenomena and factors	Applicability of the processes, phenomena and factors to the area in which the NRRAW site is located
1.1.3	Drought	The maximum duration of drought periods vary in different months. The average is 7-8 days during the months with maximum rainfall and around 9-10 days during the rest of the months. In some years the drought period can last 20-25 days or even more. In the period after closure, the effects of prolonged drought in the region may lead to the emergence of so-called resuspension; a phenomenon that is not expected to affect the safety of stored RAW containers, because most of the stationing is of deep mining.
1.2	Wind (average and extreme winds, including frequency, duration and intensity) · Tornado · Hurricanes · Cyclones	Catastrophic hurricanes in the region are not registered. Maximum winds recorded in the area of the site do not exceed 30 m/s. Wind load on the region of the city of Kozloduy with security of 2% (once every 50 years) is equal to 0.48 kN/m2, corresponding approximately to a wind speed of 28 m/s, which is taken into account when designing constructions and surface facilities. In the period after closure, the effects of strong winds are expressed in wind erosion of topsoil. The phenomenon is not relevant to the storage of containers in RAW entrance tunnels. Due to the geographical location of the NRRAW site, phenomena such as tornadoes and cyclones (tropical) in the region are impossible.
1.3	Power and duration of direct solar radiation (insulation, medium and extreme values)	The climate in the region is moderate continental and this factor is taken into account when designing constructions and surface facilities. In the period after closure, the consequences of global warming to tropical climate which will increase power and duration of solar radiation should be considered in the analysis of alternative evolutionary scenarios.
1.4	Temperatures (average and extremes, including frequency and duration)	Minimum air temperatures reach minus 20 - 25ºC and absolute minimum temperatures in some cases may fall to around 30ºC below zero. Average temperatures in July are about 23.4 - 24.3ºC, average maximum temperature is 36ºC, but the absolute maximum in August is 39.8ºC. These conditions are taken into account when designing constructions and NRRAW surface facilities. In the period after closure, the consequences of global warming to tropical climate must be considered in the analysis of alternative evolutionary scenarios.
1.4.1	Permafrost and cyclic freezing and thawing of soil	Due to the geographical location of the NRRAW site, the permafrost phenomena in the region is impossible. In the period after closure, implications of global climate cooling must be taken into account in the analysis of alternative evolutionary scenarios.

№	Processes, phenomena and factors	Applicability of the processes, phenomena and factors to the area in which the NRRAW site is located
1.5	Barometric pressure (mean and extremes, including frequency and duration)	Barometric pressure does not affect the protective barriers in the entrance tunnels, which are stored in the RAW containers, since they are located 20 m to 30 m below ground level. In the period after closure, the change in barometric pressure is relevant to the transport of radionuclides in gaseous form.
1.6	Humidity (average and extremes, including frequency and duration)	The average minimum relative humidity coincides with the peak average temperature, which is clearly noticable in July and August. The relative humidity near the NRRAW site ranges from 62 to 86 percent monthly and an annual average of 73 to 78%. Due to the accepted concept of NRRAW construction, humidity does not affect the protective barriers of the facility.
1.6.1	Fog and frost	In the area of the site there are no observations of the system of mists and therefore no data on the frequency and duration of days with fog and frost is available. The formation of dense fog or frost may cause an accident when conducting container transport activities to store RAW In the period after closure, the phenomenon is of no consequence to the RAW storage containers.
1.7	Lightning (frequency and intensity)	The area of the NRRAW site falls in this part of the country where the intensity of lightning is between 50 and 60 hours, with average number of lightning a 6 on km^2. The NRRAW project provides for surface lightning protection for constructions and facilities. The phenomenon is not relevant to the storage of containers in RAW entrance tunnels.
2.	**Hydrology and hydrogeology of the site and region**	
2.1	Surface runoff (average and extremes, including frequency, duration and intensity) · Flooding (frequency, duration, intensity) (external flooding) · Erosion (Grade)	The NRRAW site is located on the slope between the first and second Danube terraces and is sufficiently distant from the banks of the Danube and its tributaries Ogosta, Tsibritsa and Skat. Near the site there is no water used for drinking water supply. The nearest reservoir is the "Shishmanov val" dam (at a distance about 12 km west), which is powered by Danube waters. The distance to the hot and cold duct of NPP is about 1 km to the north. Flooding of the site is impossible because of the remoteness and surface water streams and reservoirs.

№	Processes, phenomena and factors	Applicability of the processes, phenomena and factors to the area in which the NRRAW site is located
2.2	Characteristics of underground waters (average and extremes, including frequency and duration)	Within the boundaries of the NRRAW site an underground filtration flow is formed, whose general direction is north and northeast to the first terrace of the Danube. In the central and southern parts of the site the water level is relatively deep (typically in the range 35-50 m below ground) and is located in the pliocene sediments of "Brusarskata svita", ie the loess complex and subloess pleistocene materials are drained and form the so-called zone of aeration. To the north, the water level gradually becomes more near surface type (to about 10-15 m below ground) and in the saturation part there are already deep levels of loess complex (loess clays) and underlying sediments beneath them. These characteristics are recorded in the repository project, which considers facility construction only in central and southern parts of the site above the groundwater. The presence of karst groundwater and dilution processes are not typical for the area at the NRRAW site.
2.3	Wave influence (average and extremes, including frequency, duration and intensity): · High tides, high waves and tsunamis · Flooding (frequency, intensity and continued) · Coastal erosion (grade)	Not relevant to the NRRAW site, because it is distant from the seas and oceans.
3.	**Geology of the site and region**	
3.1	Lithology and stratigraphy (geotechnical properties of materials at the site)	The area in which the NRRAW site is located consists of: · Modern soil layer with a thickness of 0.5 m to 2.1 m; · Powder typical loess (highly collapsible) with a thickness of 7 m to 18 m - layer "1a"; · Typical clay or poorly unfallable loess (layer "1b"), loess clay (layer "1c), alluvial sandy clay powder (layer '2 ') aluvialen sand, medium to fine-grained (a layer of" 2b ") with a total thickness which ranges from 5-6 m to about 15-16 m; · Clay to sandy dust rust-colored yellow (layer 3 "), which serves as the bedrock. When designing, ground constructions and underground workings and the geotechnical characteristics of the site are taken into account. Tunnel workings within layer 3 ". Characteristics of the receiving environment relevant to the migration of radionuclides, for which reason they are reported in the trials for post-operational period.
3.2	Seismic activity	
3.2.1	Landscape faults and zones of other violations	The NRRAW site is located in relatively the most stable part of Moesian platform, which has no detected presence of seismotectonic displacements, seismodislocations or any other kinds of movements and surface breaks which would have adverse consequences for NRRAW facilities.

№	Processes, phenomena and factors	Applicability of the processes, phenomena and factors to the area in which the NRRAW site is located
3.2.2	Earthquakes (frequency and intensity)	In the local area there are no documented historical seismic events above 4.0. The NRRAW site falls within the seismic zone of grade VII on the MSK-64 scale, which is reported in the project draft for the surface and underground storage facilities. These characteristics determine the need for analysis of the potential for the occurrence of an earthquake of a magnitude above grade VII on the MSK-64 scale.
3.3	Volcanism (volcanic fragments and ash)	On the territory of Bulgaria there are no volcanoes, and no geological structures suggesting potential volcanism. This natural hazard does not exist for the NRRAW site. In Bulgaria there are mud volcanoes, which fall within the territory of Central South Bulgaria and do not represent a danger to the NRRAW facility because of their remoteness - 200 km.
3.4	Historic mining and prospecting activities, leading to subsidence of ground	The region has not had any mining and exploration activities that could lead to subsidence of the ground.
4.	**Geomorphology and topography of the site:**	
4.1	Stability of natural material	
4.1.1	Breach of the slopes, landslides and subsidence	There are no conditions for the development of landslides near the NRRAW. Subsidence of the ground there is possible and is related to the presence of thick, greatly neglected loess deposits whose microporous structure is destroyed by the action of them falling into water and the existing actual load. In natural conditions this process proceeds slowly. Consequences in the event of a collapse of the site will affect only surface constructions and structures
4.1.2	Avalanche	There are no conditions for development of snow-stone and stone-block avalanches in this part of the Moesian platform where the NRRAW site is located.
4.2	Surface erosion	The NRRAW project draft provides for the protection of the site from erosion by recultivation of damaged regions that have been marked for construction of surface constructions and facilities.
4.3	Effects on the terrain (topography) of climatic conditions or the effects of extreme weather conditions	Examples of such effects are the formation of mud flows as a result of intense rainfall. In the area of the NRRAW site there are no conditions for the formation of mud flows.

Radiological conditions at the site [148], [162]

On the territory of Kozloduy NPP laboratory an automated control of the environmental components is carried out. Air, soil, vegetation, water and bottom sediments are all analyzed. Also gamma background radiation is measured.

Radiation monitoring of the environment is carried out by an automated information system for external radiation monitoring AISERM [1]"Berthold" with 10 measuring stations. This system controls the dose of gamma radiation and ground concentration of ^{131}I. As part of AISERM meteorological observations are made by three automatic weather stations (AWS) located at sites representative of the terrain. Measurements of the system of meteorological monitoring (SMM).

Automatic system for aerological probing (ASAP) builds and develops the capabilities of the existing SMM of the Kozloduy NPP. With this system, meteorological characteristics of the atmosphere are being measured up to a height of 25 m.

The results of radiation monitoring of the environment within a 30 km zone of NPP are reported to the NRA and published annually in the Annual Report of the NRA. According to the NRA's Annual Report for 2008, a comparison of data for 2008 with those from previous years and those before NPP operation shows no adverse trends in radio-ecological situation due to the work of the Kozloduy NPP. Radiological parameters were within normal limits with typical background values for the region.

The specific objectives of the program for pre-operational monitoring are:

- To provide input data required for safety assessment;
- To help characterize the pathways of radionuclides;
- To define the parameters of the existing environment (Geosphere, atmosphere and biosphere) for further evaluation of the amendments thereto;
- To define basic radiological conditions for comparison with subsequent monitoring results;
- To take samples of environmental media for the archive;
- To design a monitoring program during the operation.

The program determines the observed parameters (radiological and nonradiological), control methods and responsibilities of the operators, controller and other organizations. Period for the program implementation includes the design and construction of the facility prior to being placed in service.

Since the "Radiana" site falls within the surveillance zone of Kozloduy NPP, many of the environmental components can be obtained from current and historical data from the Environmental Monitoring of NPP.

In accordance with RBNRP - 2004 for radiation control, certain limits are introduced based on the average volumetric activity of a radionuclide in air, drinking water etc.

Background radiation within the site

The observed results show that the operation of the Kozloduy nuclear power plant did not influence the radiation frequency of the air. The measured values are at minimal levels typical for this geographical area. Radiation clarity of the air fully meets the statutory requirements set out in RBNRP - 2004.

From the given analysis it can be concluded that the total beta activity is characteristic of natural area values. No technogenic activity is registered.

Drinking water

The acceptable values for drinking water are regulated by Regulation № 9/16.03.2001g for the quality of water intended for drinking purposes - 2 Bq / l. Particular attention is given to drinking water for the town of Kozloduy, village of Hurlets, Kozloduy NPP and the city of Oryahovo. Drinkable water is examined

[1] Automated Information System for External Radiation Monitoring

monthly for total beta activity and tritium. Measurements are taken twice a year from the Kozloduy NPP and Hurlets catchment wells and four times a years from the Oryahovo water network to determine ^{90}Sr and ^{137}Cs. From the results of the measurements it can be concluded that the radiation status of drinking water sources in the region fully meets the health standards.

Soil

Radioactivity of the soil in the region of Kozloduy NPP is the subject of detailed and systematic research. Radiation status of the soil is of great importance, because the soil provides valuable information about the history and origin of radioactive contamination. Soil is controlled twice a year in all 36 control posts in the 100-kilometer surveillance zone. Measured over the years in radiocesium activity (134Cs 137Cs) their ratios prove their transboundary origin in the soil of the 100 km surveillance zone - mainly from nuclear testing in the 50s and the nuclear accident at Chernobyl NPP in 1986.

Cross technogenic activity of global fallout is relatively low compared to other regions of the country.

Radio ecological status of the soils in the region is not influenced by the Kozloduy NPP.

5.1 Justification of the chosen alternative with regard to the technical decisions

There have been 3 alternatives proposed as a technical solution to constructing the NRRAW

- Trench type depository
- Tunnel type depository
- And a shaft type depository, which is rejected in the initial phases of design

After a precise project analysis with technoeconomical justification by the Assignor, a trench type depository is selected for the next phases of development.

For the purposes of REIA, an appendix has been formulated with a comparative analysis of the selected technology for construction of an NRRAW that is in accordance with the Safety Regulation for handling radioactive wastes with the recommendations of the International Atomic Energy Agency.

The disposal of radioactives wastes (through disposal) is not subject to the Reference document on Best Available Techniques. Due to this fact, it can be considered that the applicable rules are those for safe usage of atomic energy and the regulations for safe operation of RAW, Safety Convention for Fuel and Safety in Handling Radioactive Wastes ratified with the bill brought before the 38th National Assembly on the 10.05.2000 SG, No. 42 from 23.05.2000.

The regulations for handling RAW define the standards, the requirements and the rules for selecting the site, design, construction, operation and post operation actions of the facility.

Due to the lack of a comparative document for the best techniques for construction of a depository with low and moderately radioactive wastes and a similar number of points gained by all 3 alternatives, the guidelines for making a choice must be based on their constructionally-technological aspects, applicability in the specific geological conditions, economical specifics, investment offers etc.

COMPARISON OF THE SELECTED ALTERNATIVE WITH THE CONCLUSIONS FROM THE BEST POSSIBLE AVAILABLE TECHNIQUES IN BREF DOCUMENTS REGARDING THE SPECIFIED ACTIVITY

Based on the best available technological decisions, implementation of the Strategy for management of spent fuels and radioactive wastes, quality of reliable monitoring to ensure correct operation of the facility of the Investment Proposal, the best technique for disposing of low and medium radioactive wastes, and at the same time protecting the environment and the health of the population, is the TTR (trench type repository).

During the comparative analysis of the TTD and the tunnel type depository, the following drawbacks of the tunnel type depository have been registered:

(1) The tunnel type depository presumes control of an underground facility, which could lead to some substantial difficulties in controlling the facility

(2) Taking into consideration the requirements for the concrete necessary to build the underground structures, it will not be shipped in by trucks, but rather mixed on the surface by using specific technology

(3) In the more advanced European countries, depositories of the tunnel type have been constructed but only in hard rock and at a considerably greater depth. IT is a technical solution for creating a depository at a more near surface depth around 34m below the surface in a leoss layer whose characteristics greatly deviate from those of hard rock (granite, basalt)

(4) The expenses incurred in constructing and operating a depository of the underground type compared to those necessary for a trench type are considerably greater

(5) The tunnel type facility relies on using tools for observation and control, and any activity concerning repairs or other maintenance is very hard to accomplish

(6) The total area that needs to be set aside for a tunnel type facility is 35 hectars.Taking the established rule that the roads servicing the Kozlodui site must be within the boundaries of the site itself, the area grows to 50 hectars, while in comparison the trench type would require only 36 hectars

(7) The electric energy needed to run a tunnel type facility is twice as much as that needed for the trench type facility. The material needed to seal off the depository is 4 times as much as that needed to seal a trench type depository

(8) The estimated necessary staff during construction is 105 people. Additionally there will be 7 more people present (representatives of the investors, the designer or the construction management). The maximum number of staff on site will not exceed 112 people (while the number for the trench type facility is 75)

(9) Total build up area – 57 000 m^2 for the tunnels, 33 228 m^2 for the trench

The shaft type is rejected in the very first stages of design due to the following reasons:

(1) The shaft type facility does not allow for inspections and containment control of the packages stored. They can be controlled only by RCC placed in the last 4 rows before being sealed in by the high strength concrete;

(2) It does not allow for maintenance and repair measures in the event of an accident. Defective containers can not be extracted;

(3) The fourth barrier zone around the module is actually a method of compensating any flaws in close proximity to the shafts created during their construction, rather than an actual barrier. The cementing zone is limited to around 50 cm;

(4) The shaft type is a new technological solution which has not been tested in practice for disposal of radioactive wastes. The Belgium concept, on which it is based, is later abandoned and amended to a depository of the trench type, close to that of the investment offer;

(5) The support technology cannot guarantee long-term stability of the system. The high amount of specific pressure is a foundation for creating flaws in the geological structures and the provoking of unacceptable changes and deformities in the structure in the future;

(6) The method of loading the module with the containers is complex and risky. The regulation prohibiting the lifting of RCC at a maximum height of 9 m (for which they are designed) is exceeded;

(7) The construction time is approximately 10 years, which is unacceptable with regards to the deadline for putting the NRRAW into production – 2015 in accordance with the Strategy for handling fuel and radioactive wastes as passed by the Council of Ministers on the 23.12.2004, violates DCM 683/25.07.2005;

(8) The construction of the modules poses many technical difficulties.

TABLE SUMMARY

APPENDIX SUMMARY

PART V

5. JUSTIFICATION OF THE CHOSEN ALTERNATIVE

1. Appendix to the REIA of NRRAW – Comparison of the proposed technology with НДНТ for construction of the НХРАО regarding the safety regulations during handling of radioactive wastes, the recommendations of the International Atomic Energy Agency in accordance with article 99 from EPL (SG, No 61/2010)

Part VI

TABLE OF CONTENTS

Part VI

6. INFORMATION ON THE METHODS OF PROGNOSIS AND ENVIRONMENTAL ASSESSMENT USED. SOURCES OF INFORMATION

1. Experimental and methodical research, verifying the methods and methodologies used to conduct the research and ascertaining the admissibility of sites for construction of the NRRAW, GI-BAS 2007 Research is conducted during the “Characterization of sites” phase
2. Methodology for determining the dispersion of hazardous substance emissions from vehicles and their concentrations in the nearest to the ground atmospheric layer - – software **TRAFFIC ORACLE**
3. Field research assessing species diversity, rare and endangered taxons and habitats, in the assessment of the project's effect on the fauna. Individual field observations:
   - ground;
   - route;
   - static;
4. Field and route studies of affected grounds
5. Guide for Assessment of plans and projects significantly affecting NATURA 2000 sites, (Assessment of plans and projects significantly affecting NATURA 2000 sites, Methodological guidance on the provisions of Article 6(3) and (4) of the Habitats Directive 92/43/EEC, EC, November 2000).
6. Method for sanitary investigation – Assessments, conclusions, suggested measures and recommendations are based on field studies and observation of the specifications of the activities conducted, the reasons and sources of professional injuries, the state of sanitary technical equipment (Hygiene and professional diseases guide, edited by D. Tsvetanov, Sofia, Medicina I Fizkultura, 1994).
7. Method of indirect exposure – prognosis of harmful health effects related to nature, intensity and exposure of the hazards of the environment (Hygiene and professional diseases guide, edited by D. Tsvetanov, Sofia, Medicina I Fizkultura, 1994).
8. Methods of epidemiological studies of the impact of the environmental factors on human health (Hygiene and professional diseases guide, edited by D. Tsvetanov, Sofia, Medicina I Fizkultura, 1994).
9. Methodology and interpretation for conducting monitoring of subterranean waters in Bulgaria. M. Gulabov and colleagues.
10. Method for sanitary investigation Hygiene and professional diseases guide, edited by D. Tsvetanov, Sofia, Medicina I Fizkultura, 1994
11. Biotype index (BU) for assessment of quality of surface waters with five-degree scaling system (approved by MEW monitoring method since 1998)
12. Braun Blanke, Method for contemporary floristic, fitocenologic and geo-botanical studies
13. Methods for assessment of the state of biocenosis, regarding the boicenotical activity of the area.
14. Assessment of the plant and animal populations
15. Methodology for balance calculations of the polluting emissions in the atmosphere , MEW, 2000, Sofia
16. Method for assessment of biological sufficiency of river ecosystems (senior fellow II degree engineering PhD. K.Zarbowa, “Water Works” 1/91
17. Method for landscape assessment. Analysis of the state of the landscape. Analysis and assessment of polluters. Specifications of the different aspects of the landscape in the process of their recreation. Changes in the functional, spatial, socio-economical and aesthetic characteristics of the landscape due to the construction and operation of the facility.
18. Research, scientific works, studies, etc. related to the assessments of the specialist, literature overview.

19. Assessments of the authors of REIA for the impact of NRRAW on the separate components of the environment and the factors that influence it in the periods of construction, use and closure

20. Calculation methods: Transect method and test platform method are used in studying the flora. The determination of species is based on the "Flora of the People's Republic of Bulgaria", vol. 1-10, and "Determining the high plants in Bulgaria, 1992". Determination of habitats is based on "Guide to determining habitats in Bulgaria of importance for All Europe (V. Kavrukova, D. Dimova, M. Dimitrov, R. Tsonev and T. Belev, 2005) Vegetation of the meadows and pastures in Bulgaria (I. Ganchev, I. Bondev and S. Ganchev, 1964)

21. Gromkova, N. - Pre-processed Hourly Data Set - The Meteorological Input of Applied Diffusion Models, 1998, *Bulg. Geoph. J.*, v. XXIV, No 3-4.

22. Joint EMEP/EEA CORINAIR 2009 methodology, june 2009,

23. Methodology for determining the dispersion of hazardous substances emissions from vehicles and their concentrations in the nearest to the ground atmospheric layer - – software **TRAFFIC ORACLE** (Ordnance № RD 994/August 4th 2003, MEW).

24. Engineering methods for safety assessment of installations.

25. Survey data from local foresters and hunters, local hunters and naturalists.

26. Data taken from literary sources, specialists in the field of fauna.

27. Regulation No. 6 dated June 26th 2006 on the indices of environmental noise, indicating the degree of discomfort at different times of the day, limit amounts of the indices of environmental noise, assessment methods of the values of the indices. (MA, MEW), given in Appendix 1, Appendix (pp.1 and 4)

28. Ordinance on procedures for evaluating environmental impact (Official State Gazette. 25/18.03.2003, the last amend. and supplemented. gazette. br.3/11.01.2011g.

29. Ordinance on procedures for assessing the compatibility of plans, programs, projects and investment proposals with the object and purpose of conservation of protected areas (Official Gazette. br.73 of September 11, 2007, Amb. am. SG 0.3 of 11 January, 2011)

Part VII

TABLE OF CONTENTS

Part VII

7. DESCRIPTION OF THE MEASURES MEANT TO PREVENT, DECREASE OR WHERE POSSIBLE TO STOP CONSIDERABLE NEGATIVE INFLUENCES ON THE ENVIRONMENT AND PLAN FOR THEIR EXECUTION

All requirements of the "Waste management law" have been accounted for in the investment proposal. The concept of compartmentalized protection is applied, based on the simultaneous application of an engineering multibarrier system and administrative precautions.

The multibarrier system includes:

⇒ **The First engineering barrier** – a cement matrix where the radioactive waste is conditioned

⇒ **The Second engineering barrier** are the walls of the reinforced concrete container, covered in hydroisolation material

⇒ **The Third engineering barrier** are the reinforced concrete walls of the repository cell, covered in hydroisolation material and the loess-cement filling material containing natural unorganic sorbing materials (zeolite)

⇒ **The Forth engineering barrier** is the strong loess–cement layer around the cells

⇒ **The Fifth engineering barrier** is the compact loess

⇒ **The Sixth (natural) barrier** is the loess complex where the modules are engineered and closed – according to former studies, this complex is practically completely dry and has good sorbing qualities, which prevent the migration of radionuclides

⇒ **The Seventh engineering barrier** is the protective multibarrier engineering cover.

There is another barrier, which is the system for collecting atmospheric waters and drainage around each repository cell.

The multibarrier system is applied during the construction and sealing of the repository.

The administrative measures taken during the operation and after sealing the repository are a system of technical and organizational measures for the protection of the barriers and maintaining their efficiency, as well as for the protection of the population and the environment. In general they include:

- during the operation period – control over the documentation of the assumed conditioned nuclear waste, inspection measurement for determining package weight, power dose, general and specific activity of radionuclides, testing for surface radioactive contamination, etc., radioactive monitoring and geomonitoring in the specified protective and observational areas;
- during the stage of closure and sealing the repository – decontamination and dismantling or sealing all constructions, systems and equipment used, location of radioactive waste, active departmental control on the execution of monitoring programs for site and equipment condition and for radiation monitoring as well as passive control through administrative precautions for land use.

Recommendations:

- Project decisions for the establishment of an NRRAW (National Repository for Radioactive Waste) are to be substantiated with calculations for bearing strength and stability of the ground along with a reading of the present collapsible soils /loess/ in it
- The final Detail Site Development Plan - DSDP, which is now in the process of preparation and coordinating the positioning of individual facilities can be tailored to optimize the operation of the site. It will define the parameters of the development: density, intensity ratio, landscaped area, height of buildings and others. development indicators.
- The final DSDP and the next phases of design will specify transport - communication project to refine the traffic flows and linkages with the existing road infrastructure and special schemes for organization of traffic control.
- In the preliminary conceptual design of NHRAO the border of radiation protection zone is defined as 6 m from the walls of disposal faciliy. In the next phases of design, as approved by the NRA methodology the areas of special status will be determined. When determiningn this it is necessary to comsider the dimensions of areas of special status for NPP, which at the time of preparation of the EIA is updating.
- In the next phases of project development and implementation the requirement must be considered to minimize the radiation impact and avoid increasing the size of areas of special

status of NPP due to the presence of NHRAO (at preliminary estimate it is not expected cumulative effect of activity as in normal operation and in case of emergency situations at NHRAO).

- In the implementation and operation of the investment proposal it must comply with the conservation of water bodies, set in the requirements of RBMP to achieve the goal of RBMP - achieving, maintaining and improving the conditions and management of water in the Danube basin by 2015 (Section 7 of RBMP underlie programs for the prevention and reduction of anthropogenic pressures and impacts on water resources that are taken into account and IP and will be realized in subsequent phases of design, construction, operation and closure of the site):

- Program 7.1.3. (Section 7 of RBMP). Measures to protect water for drinking water, including measures to protect their quality in order to reduce the level of treatment to obtain drinking water quality.

BG1MB011 Prohibition of direct discharge of water containing hazardous and noxious substances in the zones to protect groundwater.

The IP does not provide direct water discharges in areas of groundwater protection.

BG1MB018 Compliance with regulations for the assessment of environmental impact assessment (EIA). According to EPA, the investment proposals for mining, underground construction and other activities and technologies that are likely to affect the quantity and / or quality of drinking water.

In the IP and EIA measures are considered for the next phases of design to meet all the requirements of current legislation to prevent creation of conditions for deterioration amount and / or quality of drinking water

BG1MB022 Control over the conditions of EIA decisions, permits in WA and EPA orders, Sanitary Protection and others regulations.

• Program 7.1.5.1. (Section 7 of RBMP). Measures to regulate emissions to the Groundwater by setting prohibit for introduction of pollutants from point sources of pollution or requirements for issuing permits and their periodic review and update.

BG1MB040 Prohibition on issuing permits for direct discharge of pollutants into groundwater,

The IP does not permit direct water discharges

BG1MS015 Regulation on permits for abtake of groundwater for internal monitoring of groundwater and requirements for the monitoring program.
This measure is necessary to provide the next phase of design.

BG1MS016 Prohibition on disposal of priority substances and other activities on the surface and underground water, which may lead to indirect discharge of priority substances in groundwater.
E need to keep in mind the next phase of design

BG1MS0I7 Prohibition on use of materials containing priority substances in the building of structures, buildings, facilities, etc., which is has possible contact with groundwater and that may be contaminated groundwater.

• Program 7.1.6. (Section 7 of RBMP). Measures to determine prohibit the introduction of pollutants from diffuse sources of pollution and measures to prevent or control pollution

BG1MB098 Prohibitions abandonment, unauthorized dumping and incineration or other forms of uncontrolled waste disposal

There is a need to keep in mind the next phase of design and development of company programs for waste management.

BG1MB082 Control enforcement of conditions and decisions of EIA

BG1MB108 Control of industrial areas for industrial and hazardous waste

BG1MB109 Control the impact of air pollution on water status

BG1MB110 Periodic monitoring of soil indicators under the monitoring plan (Act 29 of soil) during the operation of landfills, quarries and raw materials, removal of inert materials from rivers and reservoirs for soil protection from pollution, including Applications 1 and 2 of the EPA

BG1MB085 Monitoring of surface and groundwater to assess the condition of water bodies

Measures should be considered in subsequent phases of design and operation of NHRAO for:

- Prepare and periodically update the program for management of environment.
- Prepare and periodically update the instructions for the individual process units and instructions BHTPB.
- Prepare and periodically update the plan for monitoring, Action Plan for Emergency Respond Program for waste management and others.

• Program 7.1.7. (Section 7 of RBMP). Measures to prevent water pollution by priority substances.

The preliminary technical solutions for realization of NHRAO in IP and preliminary safety assessment does not provide for activities related to direct discharges of polluted wastewater generated by the priority substances in water bodies, however, in subsequent phases of design it is necessary to consider those measures.

BG1MB055 Monitoring of waste water containing harmful and dangerous substances through the introduction of control of certain indicators judged necessary in the next phases of design.

BG1MB056 Water monitoring and water bodies that are influenced by discharges of waste water containing harmful and dangerous substances.

The measure will be considered in subsequent phases of design, judged necessary and coordination of project development with the competent authority.

Necessary measures should be considered in subsequent phases of design and operation of NHRAO:

- Prepare and periodically update the plan for its monitoring, Action Plan and Emergency Program for Waste Management Program for Environmental Management and others.

BG1MB083 Prohibition of commissioning of facilities and implementation of activities without being approved by the row treatment facilities except where they are needed.

The measure will be considered in subsequent phases of design, judged necessary and coordination of project development with the competent authority

BG1MB084 Persons of the business generated waste water are required to construct the necessary treatment facilities in accordance with the requirements for discharge into water body when the territory has no sewerage system.

The measure will be considered in subsequent phases of design, judged necessary and coordination of project development with the competent authority

• Program 7.1.8. (Section 7 of RBMP). Measures to prevent or reduce the impact of accidental pollution

BG1MB113 Operator of an installation with an integrated permit shall notify the competent authority of any incident or accident significantly affecting the environment

BG1MB114 In emergency cases, creating preconditions for contamination of the water body, the holder of the permit must take appropriate measures to limit and / or elliminate the effects of pollution and shall immediately notify the appropriate authorities

BG1MB117 Operators of plant and / or equipment with high risk potential should prepare a safety report and emergency plan for the plant and / or facility

BG1MB118 Regulation for actions of business operators and / or equipment in case of major accident

BG1MB120 Prevention activities to prevent and reducing the harmful consequences in the event of accidents

Although the evaluations and conclusions made regarding the safety of the site, subject of IP is necessary these measures should be considered in subsequent phases of design and operation of NHRAO in the Action Plan for emergencies:

- Prepare and periodically update the Action Plan for emergencies

- Prepare and periodically update the instructions for the individual process units and instructions BHTPB, its monitoring plan, Waste Management Program for Environmental Management. etc.

- Opportunity for removal of the irrigation channal located on-site NHRAO should be determined by the Ministry of Agriculture and Food.

- A main measure in relation with the flora and fauna is the regular and frequent, particularly at the beginning of the operation, monitoring of the radiation status of the fauna on site, monitoring of the animal products from populated areas and the Donau river. If radiation levels exceed background levels for the region and TLV, it is necessary to find the cause immediately by comparing monitoring research done for the purposes of the power plant. Should it be determined that the cause is the activity of the low RAW repository, steps for decontamination of the affected area as far as possible must be taken immediately and repository activity is to be terminated until the deactivation of the source.
- Positioning the equipment on the platform should be with regard to the decrease in the volume of dredge spoils, minimizing additional technical action to ensure the geotechnical stability of the system.
- Transportation and storage containers for RAW must be constructed and tested, based on reliable technology.
- Before starting construction on the site the construction grounds should be visited by a zoologist and if any slow moving species of conservation importance are found (possibly amphibians or reptiles), the latter should be removed from the area and let free in suitable areas or habitats in the region.
- Seismic behavior on the platform should also be monitored with the appropriate equipment.
- The suggested positioning of IP NRRAW takes into consideration meeting the needs of our country, but not those of other contries (the problems are connected with transportation and the safe operation of NRRAW).
- Developing an occupation safety plan is absolutely obligatory, as well as instructing the employees with regard to it.
- Places for recultivational activities are to be restricted until the habitat has become consolidated (5 years minimum).
- The specific biodiversity on site must be restored along with changes for the smooth incorporation of the damaged ground to the surrounding environment.

7.1. Execution Plan

Table 7.1.1 Execution plan for the measures and for the decrease of negative influences on the environment

№	Measures	Period (phase) of execution	Result
1.	Atmospheric air		
1.1	Construction equipment. Maintenance of construction and transportation machines. Internal combustion engines and freight vehicles must be kept in good condition so as not to let gas emissions increase.	*CIW, E, C*	Keeping air clean and protecting the health of the employees and the population in the area. Decreasing harmful gases in the atmosphere and bringing the negative influence on the atmospheric air in the region to a minimum.

№	Measures	Period (phase) of execution	Result
1.2	Oversize loading of earth and rubble on freight vehicles is not to be allowed. After crushing, these materials become sources of uncontrolled dust emissions.	CIW,C During loading	Keeping the air and soil clean and protecting the health of the employees and the population in the area.
1.3	"Compaction" of the work mode of construction and transportation machines to disallowing engine work outside of work schedule.	CIW, C	Decrease in harmful gas emissions to the atmosphere. Protecting the air and the health of employees and population in the region.
1.4	Using a mobile spraying system during construction to suppress dust emission during certain operations / loading – unloading, drawn, mound, etc./	CIW, C	Decreasing dust emissions to the atmospheric air; Preventing waste dispersion.
1.5	Using low sulphurous diesel.	CIW, C	Decreasing harmful gas emissions to the atmosphere.
1.6	Storage areas for bulk construction materials (mainly sand) and construction waste in dry and windy weather are to be wetted to decrease dust emissions.	CIW, C - In appropriate weather conditions	Protecting the air and the health of employees and the population in the region. Decreasing dust emissions to the atmospheric air.
1.7	Dump trucks are to be equipped with tarpaulins during transportation of excavated earth, construction materials, construction waste, etc.	CIW, C	Preventing dispersion of materials and waste.
1.8	Storage areas for bulk construction materials are to be carefully cleaned immediately after the end of construction work.	Immediately after finishing CIW, C	Keeping air clean. Waste management.
1.9	Radioactive monitoring should include regular measuring of the fallout and aerosol activity.	P, CIW, E	Keeping air clean.
2.	Surface water and ground water		
2.1	Municipal wastewaters are to be discharged into a chemical toilet or into an excavated pit during construction before connection wastewater sewers on the site of the NNRAW with the sewers of the SD RAW of Kozloduy NPP To contract with an operator of urban wastewater treatment plant for download, transport and treatment of local wastewater from the excavation pit or chemical toilet	CIW	Preventing water and soil pollution.
2.2	Electric and mechanical equipment is to be kept in good condition.	E	Optimal management of work on the site.
2.3	To prevent pollution of surface and groundwater in the area of IP. To provide for strict monitoring of radiation and non-radiation status of surface and groundwater in the area surrounding the site of IP and groundwater, rainwater and wastewater at the site of IP. .	CIW, E	Bringing the impact of the site on waters and biodiversity in the region to a minimum.
2.4	Concrete structures are to be designed and implemented with watertight concrete.	P, CIW	Preventing leakage and water and soil pollution.
2.5	Provide special platform for construction equipment used to secured against pollution of surface and groundwater with petroleum products	P, CIW, C	Preventing oil contamination of soil and waters.
2.6	Operation instructions for the equipment are to be developed and their application for the protection of environmental components is to be controlled.	P, CIW, E, C	Limitation of human health hazards and environmental component endangerment.
2.7	Avoid contamination of receiving waters formed by the activity on the site of rainwater, drainage and wastewater.	CIW, E, C	Bringing the site impact on waters and biodiversity in the region to a minimum. Preventing health hazards for the population in the region.
2.8	Strict control and management of the technological processes in NRRAW is to be conducted. Equipment is to be maintained in good condition.	E	Ensuring efficiency of work and meeting all requirements of the current legislation

№	Measures	Period (phase) of execution	Result
2.9	A Plan for individual monitoring is to be prepared and updated periodically. Parts of the plan related to self-monitoring component of the water to provide for coordination Basin Directorate for Water Management in the Danube region with center Pleven (BDUVDR).	P, CIW, E, C	Ensuring efficiency of NRRAW work.
2.10	An Emergency plan is to be prepared and updated periodically. Parts of the plan related to planned actions in emergencies impacting the surface, groundwater, stormwater, drainage and wastewater should be submitted for consultation in the Basin Directorate for Water Management in the Danube region with center uin Pleven (BDUVDR).	P, CIW, E, C	Ensuring efficiency of NRRAW work.
2.11	Designing NRRAW and the multibarrier system for human and environment protection in accordance with our legislature and EU directives and practices.	Design	Creating prerequisites for establishing the NRRAW.
2.12	Drafting the project for relocation of the Main irrigational canal № 1 so that there will be zero risk for NRRAW.	Design	Preventing risk and safe work of NRRAW. Creating prerequisites for irrigation of agricultural areas in the area of the “Kozloduy” municipality.
2.13	Establishing the NRRAW and the population and environment protection system.	Construction	Ensuring conditions for LILRW storage.
2.14	Establishing a NRRAW monitoring system as part of the SD RAW and NPP“Kozloduy” monitoring.	Construction	Bringing the impact on the environment and on waters to a minimum.
2.15	Storage of LILRW	Operation	Safe storage and bringing the impact on the environment and waters to a minimum.
2.16	Closure of NRRAW	Post-operation period	Bringing the impact on the environment and on waters to a minimum.
2.17	Quality of construction work and recovery of the land around the new constructions and facilities.	CIW	Preventing groundwater pollution.
2.18	For temporary storage of waste a special site is arranged equip and secured against pollution of surface and groundwater .	CIW	Preventing groundwater pollution.
2.19	Keeping in good condition the buildings and facilities; water supply, sewerage and drainage systems and facilities associated with their operation. .	E	Preventing groundwater pollution.
2.20	Strict control and efficient management of the waters at NRRAW, so as to bring the ecological risk for waters and soils in the region to a minimum, which is achieved through the foreseen protective barriers and technological solutions in the IP.	CIW, E, C	Preventing groundwater and soil pollution.
2.21	Proposed Detail Site Development Plan (DSDP) [n part of water supply and sewerage schemes should be aproved by Pleven BDUVDR .	P	Protecting soil and water pollution
2.22	The conceptual design for the site be presented to BDUVDR for an opinion on compliance with the requirements of the Water Act and RBMP.	P	Protecting soil and water pollution
2.23	The working draft of the object be presented to BDUVDR for advice on the implementation of observations and recommendations given in the opinion of the Directorate for conceptual design.	P	Protecting soil and water pollution

№	Measures	Period (phase) of execution	Result
2.24	In the implementation and operation of the investment proposal it must comply with the conservation of water bodies, set in RBMP to achieve the goal of RBMP - maintaining and improving the quality of water in the Danube basin by 2015 (Section 7 of RBMP underlie programs for the prevention and reduction of anthropogenic pressures and impacts on water resources that are taken into account and IP will be realized in subsequent phases of design, construction, operation and closure of the site).:	P, CIW, E, 3	Ensure the preservation of water bodies from pollution
2.25	In the next phases of design to take into account the legal requirements associated with the passing water for NPP. and reporting requirements of all MH-related non-health risk	P, CIW, E, 3	Guarantee the health of workers in the water bodies
2.26	Available in the vicinity unused pressure reservoirs for drinking water need to be decommissioned and scrapped in order specified by the MERB		Environmental protection in the region
2.27	To clarify the possibility of utilising of collected surface clean rainwater and use it for technical needs of the site (washing of paved paths, irrigation of green areas, etc.)..	P	Reduce water consumption and reduce to a rational minimum impact on the "water' component
3.	Bowels of the earth		
3.1	Conducting Geological engineering and hydro geological research.	P	Obtaining data on well-founded project solutions for the preservation of groundwater and earth bowels.
3.2	The requirements for the seismic level of the region are to be met.	P, CIW	Preventing health hazards.
4.	Earth and soil		
4.1	Bringing temporary and permanent expropriation from the land and forest fund to a minimum.	P	Preservation of the land and forest fund
4.2	The humus is stored and returned to be recultivated after the end of construction work. The humus is to be stored separately from other substances.	P, CIW	Soil preservation.
4.3	Usage of part of the dredging spoils for counter embankment and clearance of construction disorders, as well as recultivating the site.	P, CIW	Staged reclamation of damaged terrains
4.4	Reclamation of land damaged by construction, removal of temporary sites and spoils depots, and recovery of damaged soil and vegetation cover.	P, CIW	Restoration of disturbed soil cover and landscape in the region
4.5	Fortification of the damaged land with regional vegetation	P, CIW	Preservation of regional vegetation.
4.6	Changing the purpose of the land damaged by the site and landscaping of the vacant spaces.	P, CIW	Compliance with the regulatory requirements.
4.7	Positioning the appliances on the platform is to be with regard to the decrease in the the volume of dredge spoils, bringing additional technical activitiy for ensuring the geotechnical stability of the system to a minimum.	P, CIW	Bringing impact on the environment to a minimum and protection of the soil.
5.	Biodiversity. Protected territories.		
5,1	Ensuring good maintenance of lawns – herbaceous and woody shrub groups and arrays.	CIW, E, C	Preservation of land, soils and genuine landscapes.
5.2	The reclamation of damaged land by unnecessary deposited spoils is to be carried out according to a project by a landscape architect	CIW, C	Preservation and inclusion after recovery of the site to the surrounding area.
5.3	Target preservation of existing trees.	CIW, C	Preservation of forest plantation as well as other woody shrub species.

№	Measures	Period (phase) of execution	Result
5.4	Plantation is to be done favoring typical vegetation for the region.	CIW, E, C	Avoiding unwanted erosions as well as post-planting problems.
5.5	Initial vegetation care is to be provided during the strengthening and adjusting to vegetation conditions.	E, C	Preserving biodiversity in the region.
5.6	Construction work is not to be done during the period of fauna propagation (spring and the first half of summer).	CIW, C	Bringing the impact of the site on the animal world in the region to a minimum
5.7	Recovery of the distinctive biodiversity of the site along with new changes is necessary for the smooth incorporation of the damaged land to the surrounding environment.		Preserving the biodiversity of the region
5.8	Before construction of the outer platforms begins, construction polygons should be examined thoroughly by an expert zoologist and if any slow-moving species of conservation importance are found (possibly amphibians or reptiles), they are to be removed and released in a proper habitat in the region.	CIW, E	Preserving species of conservation importance from extinction.
5.9	Regular and frequent, particularly at the beginning of the operation, monitoring of the radiation status of the fauna in the region and of the animal products from populated areas and the Donau river. If radiation levels are determined to exceed the background levels for the region and TLV, it is necessary to find the cause immediately by comparing monitoring research done for the purposes of the power plant. Should it be determined that the cause is the activity of the low RAW repository, steps for decontamination of the affected area as far as possible must be taken immediately and repository activity is to be terminated until the deactivation of the source.	E	Preventing radioactive influences on the fauna in the region during operation.
5.10	To draft a project on landscape restoration by aligning with professionals and ornithologists, biologists, forest engineers, etc. To make recommendations for sustainable development of the ecosystem and biodiversity respectively in the area, compliance with all legislative requirements relating to fire safety and others. in building finish and operation of similar facilities. Vegetation to be maintained in good conditions.	DSDP, P, E, C	Preservation of biodiversity in the region
6.	Landscape		
6.1.	The work schedule is to be strictly observed, as are the sanitary and hygienic requirements for such sites.	P, CIW, E, C	Integration into the surrounding landscape.
6.2.	Taking steps for the recovery of the damaged land and planting the appropriate vegetation is necessary during and after the construction period. Taking proper precautions against erosion, recultivating the upper layer, maximum preservation of the surrounding areas, and the appropriate usage of vegetation will soften the change in the landscape and the introduction of a dominant structure (NRRAW) into the local industrial landscape.	P, CIW, E, C	Integration into the surrounding landscape.
6.3	Appropriate architectural layout of the visible part of the facilities.	P, CIW, E, C	Integration into the surrounding landscape.
6.4	A landscape project is to be developed on the premises.	P, CIW, E, C	Integration into the surrounding landscape.
6.5	Measures are to be taken after construction is done to soften the impact – recovering damaged land and planting vegetation where necessary – on the free space around the facilities with the purpose of integrating the site into the environment.	P, CIW, C	Integration into the surrounding landscape.

№	Measures	Period (phase) of execution	Result
7.	Waste		
7.1	A Waste management program is to be prepared and updated periodically. The walls of the packages must be carefully observed in case of any surface radioactive contamination and packages should be within release control limits.	P, CIW, E	Compliance with the regulatory requirements. Decrease or elimination of secondary RAW generated by the operation of NRRAW.
7.2.	Reaching a decision on waste activity according to Art. 12, paragraph 1, p.1 of the WML.	P, CIW, E	Compliance with the regulatory requirements.
7.3	Timely removal of the generated waste.	E	Preventing soil and water pollution.
7.4	Temporary disposal sites are to be provided for waste storage until it is transported by a specialized company.	P, CIW, E	Preventing pollution in the region and nearby areas.
7.5	Construction waste is to be transported to a construction waste depot after work is finished.	After CIW	Preservation of soils. Waste management.
7.6	Temporary disposal sites are to be provided for municipal wastes until they are transported by a specialized company.	P, CIW, E	Preventing pollution in the region and nearby areas. Waste management.
8	Harmful physical factors – noise, vibration and others		
8.1	Modern short-term construction technologies are to be used, but not during the nesting period of the birds.	CIW	Preservation of the birds in the region.
8.2	During construction, protection from noise should be provided for the personal safety of employees.	CIW, E	Preventing health risks to employees and the population of the region.
8.3	The machinery used has to be in working order and has to meet all current technical requirements, specifications and regulations in the EU.	CIW, E	Preventing health risks to employees and the population of the region.
8.4	For the protection of the birds from noise disturbances we recommend that noise generating machines be used only during daylight hours, until 5pm.	CIW, E	Preventing health risks to employees and the population of the region. Protecting birds in the region from noise disturbances.
8.5	The IP plans on using modern technology and construction equipment and operation of the repository by good technical means. Appropriate silencers will be provided for the ventilation systems, which need to be kept in good working condition.		Preventing health risks to employees and the population of the region. Protecting birds in the region from noise disturbances.
8.6	The machinery and equipment being operated outdoors must meet the requirements of the Ordinance on the essential requirements and conformity assessment for machinery and equipment being operated outdoors in relation with their emitted noise. The Ordinance is synchronous with Directive 2002/88/EU.		Preventing health risks to employees and the population of the region.
8.7	The transport service route is to be agreed on by the Kozloduy municipality and the respective city halls during the establishment of the NRRAW.		Preventing health risks to employees and the population of the region.
9.	Hazardous substances		
9.1	Preparation of instructions for safety at work and use of personal protection equipment.	CIW, E	Preventing health risks to the workers on site.
9.2	All instructions for safe handling of hazardous substances must be strictly followed. During construction on site, and mostly during the laying of asphalt pavement, all requirements must be strictly complied with.	CIW, E	Preventing health risks to the workers on site.
9.3	Guarantee of the requirements for reagent warehouses. The requirements for the loading-unloading of powder materials must be met in order to reduce the possibility of negative effects –delivery in paper or polymeric bags, proper storage of hazardous substances.	P, CIW, E, C	Preventing air pollution in the working environment. Protecting the health of the employees.

№	Measures	Period (phase) of execution	Result
9.4	The delivered materials for the site activity must include Analysis Certificates, Safety Data Sheets, and Instructions for safe use, including measures in the case of spills, sputtering and health impairment of the staff. Each original packaging must have a label stating the health and ecological hazards and safety measures. Hazardous substances and products are to be controlled by HM.	CIW, E, C	Preventing health hazards for the workers on site. Protecting the health of the employees.
10.	Material and cultural heritage		
10.1	The requirements of art.83 paragraph 1 and 2; art. 93, paragraph 1; art. 94, art. 97 of the Cultural Heritage Law for preservation and identification of cultural values, as well as art. 15 paragraph 1 for the transfer of movable archeological values to the Regional History Museum in Vratsa.	P, CIW	Preservation of cultural monuments.
10.2	Archeological research of the endangered mounds and findings must be done – movable cultural valuables must be transported to RHM in Vratsa according to art. 161 paragraph 1 of the CHL.	P, CIW	Preservation of cultural monuments.
10.3	According to art. 160 paragraphs 1 and 2 of CHL, if any findings which exhibit signs of cultural value are made during construction and urbanization work, work will cease immediately and art. 72 and 73 will be applied.	P, CIW	Preservation of cultural monuments.
10.4	If any findings which resemble cultural monuments are made during construction, according to art. 18 of the Law on Monuments and Museums, work will temporarily cease and the respective municipality will be informed.	P, CIW	Preservation of cultural monuments.
11	Health protection and risk management.		
11.1	All instructions regarding hygiene and fire safety at work must be followed.	P, CIW, E	Preventing risks.
11.2	All construction and renovation activities must be consistent with REGULATION № 2 dated 22.03.2004 for the minimal requirements of health and safety conditions at work during construction and installation works – Annex № 1-5 to art. 2, paragraph. 2. and REGULATION № 4 dated 27.12.2006 for the limitation of harmful noise through noise isolation during construction works and for the rules and regulations during construction in reference to the noise emitted.	P, CIW, E	Preventing risks.
11.3	All requirements for safe working conditions established in the projects according to the Law for Healthy and Safe Labor Conditions/1997/ must be met	CIW, E	Decreasing health risks to workers on site during construction and operation.
11.4	Compliance with all the preventative health requirements in regard to the physiological work norm and the norms for manual handling of loads referred to in the Regulations of the HM.	CIW, E	Decreasing health risks to workers on site during construction and operation.
11.5	Strict use of the personal and collective protection equipment provided.	CIW, E	Preventing risks
11.6	Mandatory briefing of the workers by qualified specialists.	CIW, E	Preventing risks
11.7	Decreasing dust emissions by spraying water in places where dust is raised (in dry and windy weather). Use centralized prepared in ready-mix concrete and mortars and their application mashineri.	CIW, E	Preventing risks

№	Measures	Period (phase) of execution	Result
11.8	Oil spills are not to be allowed. In the case of a spill, immediate measures are to be taken for its location, elimination and transport to the appropriate depots.	CIW, E	Preventing risks
11.9	After finishing construction and installation work, places where construction materials have been temporarily stored outdoors are to be thoroughly cleaned. This will stop the emission of dust in dry and windy weather.	CIW, E	Preventing risks
11.10	Maintaining working order. Optimal load of construction machines, so as to decrease the quantity of exhaust gases along with noise and vibrations.	CIW, E	Preventing risks
11.11	The work and rest regime under vibration influence is to be established so that total exposure per shift (contact with vibrations) does not exceed 90-120 min.	CIW, E	Preventing risks
11.12	Appropriate uniforms according to the season and safety equipment in the case of harmful factors in the working environment (anti dust masks, noise silencers, anti vibration gloves) must be used throughout all professional activities, as well as a rational regime of work and rest.	CIW, E	Preventing risks
11.13	A first-aid kit in good condition must be kept at all times on site.	CIW, E	Providing timely first-aid to the injured.
11.14	As ^{14}C has the greatest contribution to the individual equivalent dose, it is recommended that thorough studies are carried out in order for the quantity of the substance to be determined in the waste, which would allow for exact migration analysis.	E	
12	Socio-economic aspects		
12.1	Activities on raising public awareness with the purpose of enhancing participation in making decisions and competence on sustainable development and preservation of the environment and the safety of future generations.	P, CIW, E, C	
12.2	Prequalification courses: specific activity – RAW management.	P, CIW, E, C	
13	Other recommendations		
13.1	In the next stages of design, all recommendations and measures suggested by the experts from EIA should be taken into consideration with strict control and management for their execution during operation by the NRRAWB.	P, CIW, E, C	Preventing risks to the working and natural environment.
13.2	In the next stages of design, the following should be prepared and - in the case of operation and closure – updated periodically: - Environment management program - Monitoring plan - Waste management program - Emergency situation plan	P, CIW, E, C	Preventing risks to the working and natural environment.
13.3	At the next phases of design it is necessary to calculate areas with special status in NHRAO approved methodology by the NRA and to specify the exact boundaries of the site and supervised area on the map.	P	Prevention of risks to environment and working environment. Demonstration of a lack of cumulative effect

№	Measures	Period (phase) of execution	Result
13.4	In the next phases of design to observe the requirement of the external border of the site be within the fence of NHRAO.	P	Prevention of risks to environment and working environment. Demonstration of a lack of cumulative effect
13.5	Safety assessment be updated periodically during the next phases of design, operation and closure	P, E, C	Environmental and human health risk prevention

P – planning; C,IW – construction and installation works; E – operation; C – closure

7.2. Recommendations for environment quality management

The **Operator's system for environment quality management** is applied.

Environment policies of the company

Protecting the environment by decreasing harmful emissions from the NRRAW activity is a priority for the SE "RAW" Operator in all aspects connected with his work.

A number of studies, designs, plan and program developments for implementation have been carried out in compliance with the regulatory requirements.

A clear environment and human protection policy is applied in this regard, which includes:

- Measures for the constant decrease of the impact on the environment through long- and short-term modernization.
- Bringing influences of harmful emissions from NRRAW activity during the different stages of construction, operation, closure of NRRAW and the occurance of potential emergencies to a minimum.
- A choice of equipment and technology in accordance with European standards, which ensure complete protection from long- and short-term radioactive influences.
- Personal monitoring of wastewaters, gases, waste and the quality of the work environment within the regulatory requirements.
- Reducing the quantity of natural resources being used.
- The most rational usage of available raw resources in the region, connected with NRRAW (using excess spoils, construction materials, etc.)
- Preventing and bringing the possibility of emergencies to a minimum, according to the Action plan for disasters, emergencies and accidents, which is updated periodically.
- Achieving European standards for the management of environment components.
- Evaluation and management of environment risks and health preservation. Compliance with all regulatory requirements for protection of the environment and bringing health hazards to a minimum. Strict following of instructions for operation and during work on site in the stages of construction, operation and closure of NRRAW.
- Management of environment protection activities. Control and management of the essential ecological aspects: emissions to the atmosphere, wastewaters, waste management, soil pollution, maximum conservation of raw materials and natural resources
- Limiting the negative influence on the environment and improving the ecological balance in the area.
- Meeting the permit requirements (for waste disposal and collection, transportation, temporary storage, etc.)
- Obligatory record-keeping.
- Keeping information about buried RAW throughout NRRAW's entire lifespan.
- Creating a database for future solutions for providing a quality working environment.

Environment management system

The Operator is to incorporate an environment management system (ISO 14001 or EMAS).

Environment management is directly connected with NRRAW and its target is maintaining equipment in excellent working order at optimum energy and technological capacity. This ensures metrical and qualified operation in accordance with environment regulations, establishment and constant improvement of the monitoring systems, as well as control over the influence on the environment. The environment management system includes control and management personnel who will be responsible for reporting and record-keeping in connection with monitoring, waste, etc.

Reports on environment management will be done according to the respective regulations.

Good management practices.

Control of the technological activities, ensuring the health and safety of the wokers on site and the population in the region during the design, implementation, operation and closure of NRRAW;

- Monitoring of the emissions into the environment – radioactive or otherwise. Monitoring is part of the management process of RAW. A source element of this process are the parameters of the environment, which are measured, controlled and documented according to the requirements of the Appliance monitoring programme. Documented instructions will be made within this programme, where the control variables, the methods and their periodicality will be described. An important element is the metrological provision of the monitoring equipment, which is the subject of a specific instruction. The monitoring results are quality records. (eg. Work with powder materials is to be ceased in unsuitable weather conditions, such as strong wind. A spraying system for maintaining sufficient moisture in the work areas is to be provided if construction and closure are carried out in the dry summer and autumn months
- Creating a system for Quality environment control management is necessary, as the obtained data from site control and management is analyzed and evaluated. A complex evaluation of the current situation is done periodically and the Plan for necessary measures is updated, so as to bring the impact of the site on the environment to the rational minimum and to guarantee the absence of health hazards for the workers on site and the local population.
- Keeping a current and appropriately documented database on the influence of the individual components on the environment;
- Reporting monitoring results to the respective authority in accordance with the requirements of the legislation;
- Waste management. An updated Waste management programme has been made.
- The personnel is to be instructed and trained periodically
- An organization scheme of project improvements – which will be updated throughout operation - is to be created for compliance of the NRRAW with the regulatory requirements, which includes:
    - Control and management of NRRAW;
    - Equipment maintenance;
    - Staff training;
    - Emission control and management;

7.3. Recommendations for the Individual monitoring plan

The monitoring program is an essential element for ensuring that the RAW surface repository provides the necessary level of retention, isolation and protection during the pre-operation and operation periods and after its closure. The development of the program is in accordance with the requirements of the Terms of Reference and the Ordinance concerning the procedure for issuing licenses and permissions for the safe use of nuclear power of NRA.

NRRAW will be exploited and managed by SE "RAW". The site "Radiana" for stationing NRRAW lies very near NPP "Kozloduy".

At the “Site confirmation” stage, a preliminary program for the monitoring of NRRAW was developed by Worley Parsons. It entails all the stages of the repository life (design and construction, operation, active institutional control) and the types of monitoring (radiation, geodynamic, meteorological) as well as all the observation areas (facilities, site, radiation protection area, observation area).

Monitoring before the beginning of operation ensures basic levels for determining all additional alterations in the environment which could be linked with the discharges from the disposal facility.

Monitoring during operation and after closure of the disposal facility is meant to prove that actual measurements in the environment do not exceed the assumptions and forecasts of the safety evaluation.

The monitoring does not consider control of individual staff load, which is strictly regulated by a separate Regulation, [142].

Monitoring of the NRRAW site

The purpose of the monitoring is to comprehend the unfavorable processes which will appear after the establishment of NRRAW, as well as the geo-ecological risks which will be generated in the region. Like other facilities with a long operation period connected with the condition of the surrounding environment, the observation and control system has to be constructed along with their operation. After their capacity has been exhausted and they have been closed, certain measurements continue. This is how reliable operation is conducted and more information about the processes in the soil and the geological environment is obtained.

The type of equipment and control systems are consistent with:

- the typical characteristics of the site
- the climate indications in the region
- the type of repository and the potential risk of contamination of soil and the geological environment
- the requirements for the type of alarm and safety in the event of environmental danger;

In order for a monitoring project to be designed, the minimum requirement is to obtain the necessary information on the specific conditions of the site and the natural parameters of the environment.

The monitoring system project in this particular case is preceded by certain activities in the following areas:

- generalization of information on the natural soils on the site;
- assessment of the natural characteristics of the site in consistence with the weather conditions in the region
- geological engineering, hydro geological and geotechnical assessment of the site
- bio-ecological characteristics of the site, specification of the methodology and technology connected to the installation of particular appliances and observation equipment
- repository work technology
- technology and landscape structure of the site after finishing repository activities – reclamation.

The characteristics of these activities have been described in the different sections of the REIA.

Control areas and types of measuring

The areas subject to soil control can be two:

- **I^{-st} area** - the external environment around the repository;
- **II^{-nd} area** – the area around the site;

Subject to control measurements in the first area are: rain and temperature (maximum and minimum); wind strength and direction, surface waters and radioactive emissions.

The control measurements of the second area are: soil subsidence and stability after construction and radioactive emissions.

Volume and frequency of the measurements

The described observations and measurements are consistent with REGULATION № 1 dated 15.11.1999 for radiation protection purposes and safe elimination of the uranium industry in Bulgaria

Measurements in area I

They serve to establish the water balance of the repository terrain and to determine possible precautions to avoid erosion. Measuring the temperature, and the direction and speed of the wind and fumes completes the weather data set. The water balance and other weather characteristics – data on the air temperature, humidity, rain, atmospheric pressure and wind - can be rendered at the hydro meteorological station closest to the repository.

Table 7.3.1 NRRAW monitoring in area I

№	Indication during operation	After closure of the repository
1	Amount of rain	Daily, added to monthly
2	Temperature (minimum, maximum and at 2pm)	Monthly average Absolute minimum Absolute maximum
3	Wind direction and speed	Not required
4.	Radiation condition. Once a month, in the same interlock as an NPP	In the same interlock as an NPP

Measurements in the second area

Soil monitoring over NRRAW, during operation as well as after closure, controls two groups of parameters which usually interact and have a direct influence on the environment.

The first group includes parameters influenced by physico-chemical processes happening in the geological environment and in the soils for a long period of time. Control is achieved through radiation control, which is uninterrupted during operation, and periodic measurements on the terrain after construction work and reclamation after finishing the repository operation.

Table 7.3.2 NRRAW monitoring in area II

№	Indication during operation	After closure of the repository
1.	Volume and composition of the surface waters	Once every six months
2.	Monthly radiation control	Radiation control once every six months
3.	Geotechnical parameters connected with repository stability	Once every two years

The second group includes geotechnical parameters connected with the stability of the repository. Parameters such as compaction and movement of slopes are essential for the general safety and the existence of the recultivated terrain.

Based on a geodetic network made before the recultivation project, the compaction of the repository terrain is to be observed. Unless there are extraordinary phenomena (great floods, earthquakes), such measurements are only carried out once every two years.

Compaction in different points in the soil over the repository is determined through leveling an observed leveling benchmark in opposition to a fixed leveling benchmark. The radiation condition is tracked via monthly soil control – a probe 0 – 5 cm surface soil layer for determining the specific activity of gamma-emitting natural and technogenic radionuclides and specific activity 226Ra. The norm for grassing and recultivating rock dumps and forests is 1000Bq/kg in the soil.

It is recommended that the "NRRAW individual monitoring plan" include, along with the intended activities in the preliminary monitoring program, monitoring of groundwater which would require:

- design and construction of at least three piezometers (above, in and under the repository), equipped for the observation of groundwater levels and collecting water samples;
- constant and periodic measuring of the chemical, radiological and microbiological indications of the samples;
- periodic measurement of the radiological substances in the water from the nearest source to the NRRAW - / well / canal water facilities "SW-Ranei 1, 2 and 3", PS "Hurlets I – SW 1 and 2" and PS "Hurlets II – SW 1, 2, and 3"

- concentration of sulfur and nitrogen oxides in the ground atmospheric layer should be measured once every two years

These recommendations should be regarded as essential parts of the "Individual monitoring plan" for Kozloduy NPP.

7.4. Recommendations for the Emergency situation plan

The next stage is to design a current NRRAW emergency situation plan, creating consistency with Kozloduy NPP.

The agreement of all instances is necessary.

The Plan needs to be updated periodically. Concentration of sulfur and nitrogen oxides, ozone, sulfide, benzene, methane, ammonia, non-methane hydrocarbons and carbon dioxide in the ground atmospheric layer should be measured once every two years.

Recommendations for the Emergency plan

With the inclusion of NHRAO Contingency Plan in the Kozloduy [193], provides the organization needed to regulate the procedure for action in an emergency or other events that may effect safety and security of the facility as non-radiation environmental effects.

NRRAW's Plan is connected to the Emergency plans of other nuclear facilities ("RAW-Kozloduy", Kozloduy NPP). Recommendations for the next stage are necessary in order to prevent incidents and unforeseen events (preventive measures, training, contingency plans).

TABLE LIST

DESCRIPTION OF THE APPLICATIONS

Part VII

7. DESCRIPTION OF THE MEASURES MEANT TO PREVENT, DECREASE, OR WHERE POSSIBLE TO STOP CONSIDERABLE NEGATIVE INFLUENCES ON THE ENVIRONMENT AND PLAN FOR THEIR EXECUTION

1. Monitoring programme for the platform vol. IV, Conceptual design for NRRAW; Task 4 – Confirmation of the platform; Part 4.4 Monitoring programme for the platform; BG 2004/016-815.01.05, July 2008-October 2008; Worley Parsons; TVO Nuclear services; TVO Risk Engineering
2. Emergency plan
3. Sample construction of a monitoring well from the system for local monitoring of groundwaters in the region of NRRAW «Radiana»

Part VIII

TABLE OF CONTENTS

PART VIII

8. STATEMENTS AND OPINIONS OF THE AFFECTED COMMUNITY AND THE COMPETENT AUTHORITIES REGARDING THE DECISION ON THE EIA AND OTHER SPECIALIZED INSTITUTIONS, RESULTS FROM THE CONSULTATIONS HELD

Table 8.1 Statements from the competent authorities and other specialized departments taking decisions on REIA

№	*Specialized institution/ representatives of the affected community*	*Submitter on date/ Ref. number*	*Statements/ recommendations on the EIA Report*	*Activities*
1.	European Bank for Reconstruction and Development	Incoming PMG №:NDF-PMU-CO-ALL-0046/July 14th 2009	The maximum range and area of the entire project must be expressed plainly. Community consulting plan must be made. The best technologies and practices must be given. The alternative variants must be discussed. Socio-economical, work conditions impact, and public impact must be included as base data. A sociologist, hydro-geologist and a PR expert must be enlisted in the EIA team.	Taken into consideration. Recommendation is fulfilled on p.1, p.2, p.3, p.4. p.5, p.7, p.8 of the EIA report.
2.	NRA	Ref. №71-00-34/May 28th 2009	NRA is not a competent authority on the matter of discussion.	Taken into consideration.
3.	Embassy of Republic of Bulgaria to MEW, Bulgaria	Ref. №782/September 23rd 2009	Enclosed: Letter № 7439/NN/September 15th 2009 Letter № 7439/EGU/November 16th 2009 Letter № H2/3970	Taken into consideration.
4.	MEW	Ref. №26-00-1223/June 23d 2009	The assignment's structure does not correspond to the requirements. Information on IP is missing. Proof of notifying the affected municipalities, councils and communities is missing Information on the planned consultations on the assignment is also missing. Procedure based on Art. 31 of the Bio diversity act must be started. A trans-boundary EIA procedure must be started	Taken into consideration. Recommendation is fulfilled on p.12, p. 4.3.4, 3.5 and p.8 in the EIA report. Correspondence with Republic of Romania has been conducted, and it is included in the EIA procedure
5.	EEA	Ref. №53-00-2840/May 29th 2009	RAW data must be filled in; Alternative sites and best technology Information on the components of the CA must complemented. Prevention measures must be recommended... as well as RZZ and NZ, inclusion in the national monitoring network.	Taken into consideration. Recommendation is fulfilled on p. 1.2.9, p.2, p.3 and, p.7, of the EIA report.
6.	RIEW Vratsa	Ref..№B-890/May 21st 2009	Recommendation on REIA. Alternative sites must be reviewed and the choice of site must be given proper reasoning. Consultations with the affected community and the HM authorities must be included. Protected zones nearby must be taken into consideration. Prevention measures must be formulated. Contemporary data and assessment methods must be used.	Taken into consideration. Recommendation is fulfilled on p.2, p.3.5.3, p.3.5.4, p.4. p.5, p.7, p.8 of the EIA report.

№	*Specialized institution/ representatives of the affected community*	*Submitter on date/ Ref. number*	*Statements/ recommendations on the EIA Report*	*Activities*
7.	Danube region based in Pleven, basin Directorate	Ref.№2455/June 2nd 2009	The subterranean water basin near the site must be considered. The prohibitions stated in the Protection of Subterranean Waters Act must be considered. The water sources, installments and water protection events in the region of IP impact must be taken into consideration in REIA.	Taken into consideration. Recommendation is fulfilled on p.3.3.1, p.3.3.2 of the EIA report.
8.	Ministry of Healthcare	Ref. №26-00-252/June 30th 2009	Assignment is concerted.	Taken into consideration.
9.	RIPCPH – Vratsa		No response	
10.	Regional roads administration – NARI		No response	
11.	NCRRP, MH	Ref. №RD-02-10-40/June 18th 2009	No requirements or recommendations	Taken into consideration.
12.	National institute for protection of cultural heritage, Ministry of culture	Ref. №1316/June 9th .2009	No objection on the range and content of REIA	Taken into consideration.
13.	Regional museum of history – Vratsa	Ref .№27/June 3d 2009 Ref. №33/July 2nd 2009	There are immovable cultural values in the region of IP. Cooperation offer, future archaeological excavations and popularization of the Thracian mound	Taken into consideration. Recommendation is fulfilled on p.3.10 of the EIA report. Thorough archaeological study has been conducted by the Regional museum of History, Vratsa
14.	Municipal office “Agriculture” - Kozloduy		SE RAW has been given information about the number, property NTP and size of the properties. REIA must comply with the updated map of the returned land around Hurlets village and actions must be taken to change the status of the lands f the site.	Taken into consideration. Recommendation is fulfilled on p.3.4, of the EIA report.
15.	Regional Directorate “Agriculture” - Vratsa under Ministry of agriculture and foods	Ref.№747/May26th .2009	REIA must comply with the updated map of the returned land around Hurlets village. A procedure for changing the purpose of agricultural lands must be conducted in compliance with the Agricultural Lands Protection Act. This procedure has been conducted for properties №000231 an №000238 by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry act. The relevant procedure can be conducted, in compliance with the Forestry Act and its Rules of Implementation	Taken into consideration. Recommendation is fulfilled on p.3.4, and p. 3.5.1. of the EIA report.
16.	National forestry executive agency	Ref. 92-215/July 17th 2009	REIA must comply with the updated map of the returned land around Hurlets village. A procedure for changing the purpose of agricultural lands must be conducted in compliance with the Agricultural Lands Protection Act. This procedure has been conducted for properties №000231 an №000238 by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry Act. The relevant procedure can be conducted, in compliance with	Taken into consideration. Recommendation is fulfilled on p.3.4 p.3.5.1., of the EIA report.

№	*Specialized institution/ representatives of the affected community*	*Submitter on date/ Ref. number*	*Statements/ recommendations on the EIA Report*	*Activities*
			the Forestry Act and its Rules of Implementation	
17.	National forestry agency. Regional forestry directorate – Berkovitsa.	Ref. №13г-19/June 01st 2009	Tax data are given. The report must comply with the updated map of the returned land around and the taxation data on the plantations. A procedure was conducted in September 2008 for properties №000231 and №000238 by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry Act. The relevant procedure can be conducted, in compliance with the Forestry Act and its Rules of Implementation	Taken into consideration. Recommendation is fulfilled on p.3.4 p.3.5.1.,
18	National forestry Oryahovo	Ref. № 617/06.07.09	Tax data are given. The report must comply with the updated map of the returned land around and the taxation data on the plantations. A procedure was conducted in September 2008 for properties №000231 and №000238 by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry act. The relevant procedure can be conducted, in compliance with the Forestry act and its Rules of implementation	Taken into consideration. Recommendation is fulfilled on p.3.5.1.,
19.	„Irrigation systems" Inc – Vratsa	Ref. № 410/May 20th 2009	Irrigation channel in the region of the site that is supposed to be operational in the future.	Taken into consideration. Recommendation is fulfilled on p.3.3.1
20	Ecological association "Za zemiata"		No response	
21.	Notification of SE "RAW" in nw. "Novinar"'	December 27th 2006		
22.	Mayor of Hurlets municipality	Ref..№ 338/June 24th 2009	No requirements or recommendations	Taken into consideration.
23.	Mayor of Kozloduy municipality		No response	
24.	Mayor of Vratsa municipality	Ref.№ 9100-12445/04.09.09	The letter has been put on the information board of Vratsa municipality and is published on the municipality's Internet site No complaints or objections have been received by Vratsa municipality yet.	Taken into consideration.
25.	Mayor of Vurbitsa village		No response	
26.	Vratsa municipality	Ref. №9100-1244511/September 4th 2009	The letter has been put on the information board of Vratsa municipality and is published on the municipality's Internet site No complaints or objections have been received by Vratsa municipality yet.	Taken into consideration.
27.	WSS – Kozloduy region	Ref. № 90/June 30th 2009	On the site south of the NPP there is plumbing, supplying drinking water for	Taken into consideration. Recommendation is

№	*Specialized institution/ representatives of the affected community*	*Submitter on date/ Ref. number*	*Statements/ recommendations on the EIA Report*	*Activities*
			the plant, the pump house Kozloduy NPP reservoir 3000m3 and two reservoirs 750 m3. In the current stage the reservoirs are not in use and there are no plans for their future use. SOZ around the reservoir are not planned SOZ around the NPP pump house are marked with the existing external fences.	fulfilled on p.3.3.2.
28.	BBPA		No response	
29.	NPA “Green Balkans”		No response	
30.	Nature protection association		No response	
31.	NA “Ecoglasnost” – Sofia		No response	
32.	NA “Ecoglasnost” – Montana branch		No response	
33.	Wild nature association “Balkans”		No response	
34.	National radiobiology and radiation protection center	Ref. № РД-02-10-40/ June 6th 2009	No requirements or recommendations	Taken into consideration.
35.	Ministry of forestry and environment, Bucharest, Romania to MEW-Bulgaria	Ref. №7439/January 22nd 2010	The Romanian publicity and NGO's have shown interest in the development of the IP and REIA. A public debate is to take place on Romanian ground.	Taken into consideration.
36.	Bulgarian nuclear association	Ref. № 1 / February 15th 2010	No requirements or recommendations	Taken into consideration.
37.	MEW	Ref. № REIA – 493/ March 22nd 2010	The assignment is accepted, but there is the following objection to point 4.4: In the last paragraph on page 57 the text must be corrected, because Romania has already expressed its willingness to participate in the EIA procedure and their comments and recommendations are given on p. 8.3. of the assignment.	Taken into consideration; the text of the assigned has been rectified.
38.	“Irrigation systems” Inc. - Vratsa	Ref.№ 1014/ September 27th 2010	The irrigation channel in the area of the site is supposed to be operational in the future. It is possible the channel’s path will be relocated, so that it will avoid the site of the repository. A common obligations contract is to be singed for a project for the relocation of this channel.	Taken into consideration. Recommendation is fulfilled on p.3.3.1.
39.	MEW “Earth crust and subterranean resources” directorate	Ref. №ZNPB-2358/October 20th 2010	The Radiana site does not cross the borders of any fields that fall under the National Balance of Resources and Reserves (Н63Р) of fields of subterranean resources, nor does it cross the fields of active allowances for searching and/or studying of subterranean resources.	Taken into consideration. Recommendation is fulfilled on p.3.4.

Letter with Ref. GUP № NDF-PMU-CO-ALL-0046/July 14th 2009 from the European Bank for reconstruction and development.

Response: The maximum range and space of the entire project is to be shown clearly. A plan for consulting the publicity is to be developed. The best practices and technologies are to be adopted. The alternative variants are to be taken into consideration. Base data, socio-economical, labor, public health and safety effects are to be included. A sociologist, a hydrologist and a PR-expert must be enrolled into the EIA team.

In preparing the EIA and EOC the recommendations made are taken into account.

Letter with Ref. № 71-00-34/ May 28th 2009 from the Nuclear regulatory agency

Response: NRA is not a competent authority on the matter.

Letter with Ref. № 782/September 25th 2009 form the Bulgarian Embassy, Bucharest to MEW, Bulgaria

Response: Applications:

- Letter № 7439/NN/September 15th 2009.06.18,
- Letter № 7439/EGU/November 16th 2009,
- Letter № H2/3970

Letter with Ref. № 26-00-1223/June 23 2009 from MEW

Response:

- The assignment's structure does not match the requirements. IP information is missing. Proof about the notification of the municipalities and publicity and population in question is also missing. Information on the planned consultations on the assignment is missing.
- A procedure under Article 31 of the Biological diversity act must be started.
- A trans-border REIA procedure must be started.

All recommendations were implemented. Revised Terms of Reference was agreed by the competent authority MEW

Letter with Ref. № 53-00 №2840/May 29th .2009 from the Environment executive agency. We recommend development of monitoring on subterranean waters, inducing, basins, used for domestic and water supply.

Response: During the “Approval of site” phase Worley Parsons has developed a program for preliminary monitoring of NRRAW. The program includes all stages of the repository's lifespan (planning, construction, active institutional control) and types of monitoring (radiological, geo-dynamical, meteorological) and all zones of monitoring (installments, site, radiological protection zone, zone under surveillance)

In chapter 7.3 of EIA the “Plan for separate monitoring of NRRAW” is recommended to “include a monitoring on the subterranean waters, where such is needed ”:

- planning and construction a minimum of three piesometers (above, in and under the repository), equipped for monitoring of the levels of subterranean waters under the repository and obtaining water samples from the waters;

- constant and periodic examination of the chemical, radiological and microbiological indicators of the water samples obtained;

- periodic examination of the radiological indicators of the water, obtained from the closest to NRRAW water supply installments “SW-Ranei 1, 2 and 2”, PS “Hurlets I – SW 1 and 2” and PS “Hurlets II – SW 1, 2 and 3”

Letter with Ref. № B-890/May 21st 2009 from REWI – Vratsa

Response: In REIA

- The alternative options must be reviewed and the basis for the selection of site must be given
- Consultations with the affected publicity and the authorities of MH must be included
- The protected areas located nearby must be taken into consideration.

– Prevention measures must be specified. Current data and contemporary methods of assessment must be used

Letter with Ref. № 2455/June 2nd .2009 from the Danube region basin directorate, based in Pleven. The following opinion was expressed: *„The fact, that the Radiana site in the vicinity of Hurlets village, Kozloduy municipality, is in very close proximity to and partially overlaps subterranean water basin BG1G0000Qal005 – Pore waters in the Quaternary – Kozloduy lowland, the subterranean flow oriented to Danube river and parallel to it, must be taken into consideration. . The subterranean water basin is used by the population for drinking and domestic purposes, in compliance with Art. 119a of the Waters act."*

It is possible after the planning of WHO of the closest water sources the outcome to be the overlapping of certain aggravated by the Water terrains act territories with the territory of the investment proposal. This is not admissible, due to the current enactments regarding waters.

On the other hand – ordinance № RD-970/September 28th 2003 of the Ministry of environment and waters, all waters in the Danube basin are included in the sensitive zones of surface waters of the Republic of Bulgaria list, which are subject to advanced protection from biogenic elements pollution - Art. 119a of the Waters act"

Response: The "Radiana" site truly is in very close proximity but it does not overlap subterranean water basin BG1G0000Qal005 - Pore waters in the Quaternary – Kozloduy lowland, because it is outside of its boundaries and those of the subterranean water basin BG1G0000Qal015 – Pore waters in the Quaternary – Ogosta river. The hydro-geological section under NRRAW includes an aerated zone 15÷30 m thick and the upper part of the upper layer of subterranean water basin BG1G00000N2034 „Pore waters in the Neogene – Lom-Pleven depression, (Dak-Roman aquifers horizon).

The results of the modeling of the migration processes, based on the examination of the geo-chemical, filtration and migration characteristics of the geological environment of the "Radiana" site, conducted by "Aqua Systems Modeling Group" Ltd are described in chapter 4.3.3 of the EIA The major outcome of the mathematical modeling of the migration is that all radio nucleons studied (excluding ^{129}I) are held and deteriorate in the non-aquifers zone (the aeration zone) under the repository and do not reach the subterranean waters. The radio nucleon ^{129}I, which has a lower radioactivity that makes it safe in subterranean waters, penetrates the first non-inlet terrace of the Kozloduy lowland (subterranean water basin BG1G0000Qal005), on which the NPP "Kozloduy is built, to a 150÷600 m for about 50-100 years, after a long period of 3300 years, that will be needed for the ^{129}I to cross the aeration zone. Moreover, the initial radioactivity of this isotope In the repository (data taken from the Geological institute of BAS) amounts to 0.,0213 Bq/l, while the admissible volume radioactivity of that isotope in drinking water is higher – 0.96 Bq/l (according to the Decree on the basic norms of radioactivity protection, promulgated State Gazette issue 73/August 20th 2004).

Eventual boundaries of zone III of sanitary protection zones of the supply installations ,closest to the "Radiana" site water PS Hurlets I – SW 1 and 2" and PS "Hurlets II – SW 1, 2 and 3", are supposed to be about 1500÷3000 m to the east-southeast, the boundaries of WHO zone III of water supply instalations "SW-Ranei 1, 2 and 2" are supposed to be about 8500 m northwest of NRRAW. Therefore, the construction of NRRAW will not result in "overlapping of aggravated by the Water terrains act and the territory of the investment proposal and does not contradict the interdiction of "Processing and preservation of radioactive substances and waste", derived from Addendum № 2 to Art 10, Para. 1 of the "Regulation " № 3/October 16th 2000 on the conditions and order for study, design, approval and operation of the sanitary protection zones around the water sources and the installations for drinking and domestic water supply and around the sources of mineral water, used for medical, prophylactic, drinking and hygiene purposes.

Letter with Ref. № 26-00-252/ June 30th 2009 from the Ministry of Healthcare

Response: The assignment has been concerted.

Letter with Ref. № 1316/ June 9th 2009 from the National protection of cultural heritage institute, Ministry of culture

Response: No objections on the range and contents of REIA.

Letter with Ref. № 27/ June 3d 2009 and Letter with Ref. № 33/July 2nd from the Regional museum of history – Vratsa

Response: There are immovable historical heritage objects in the range of the IP. Assistance proposal, future archaeological diggings and promotion of the Thracian mound.

Letter from Municipal office "Agriculture" - Kozloduy

Response: REIA must comply with the updated map of the returned land around the Hurlets village. Measures for changing the status of the lands in the site must be taken.

Letter with Ref № 747/May 26th 2009 from Municipal office "Agriculture" - Vratsa, Ministry of agriculture and foods

Response: REIA must comply with the updated map of the returned land around the Hurlets village. A procedure for changing the purpose of agricultural lands must be conducted in compliance with the Agricultural lands protection act.

This procedure has been conducted for properties № 000231 and № 000238 by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry act. The relevant procedure can be conducted, in compliance with the Forestry act and its Rules of implementation

Letter with Ref. № 92-215/ July 17th 2009 from the Forestry executive agency

Response: REIA must comply with the updated map of the returned land around Hurlets village, Kozloduy municipality. A procedure for changing the purpose of agricultural lands in compliance with the Agricultural lands protection act must be conducted; for properties № 000231 and № 000238 a procedure has been conducted by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry act. The relevant procedure can be conducted, in compliance with the Forestry act and its Rules of implementation

Letter with Ref. №13g-19/June 1st 2009 from the Forestry executive agency, Regional forestry directorate – Berkovitsa

Response: Tax data is given. The report must comply with the updated map of the returned land around and the taxation data on the plantations . A procedure has been conducted in September 2008 for properties № 000231 and № 000238 by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry act. The relevant procedure can be conducted, in compliance with the Forestry act and its Rules of implementation

Letter with Ref. № 617/July 6th 2009 from State forestry – Oryahovo

Response: Tax data is given. The report must comply with the updated map of the returned land around and the taxation data on the plantations. A procedure has been conducted in September 2008 for properties № 000231 and № 000238 by SF – Oryahovo, and they have been introduced to a forestry of afforested or self-afforested lands, in compliance with the Forestry act. The relevant procedure can be conducted, in compliance with the Forestry act and its Rules of implementation

Letter № 410/May 20th 2009 „Irrigation systems" Inc. Vratsa branch

The following opinion was expressed: *„The main irrigation channel № 1 is used annually for watering of different industrial crops (mainly tobacco and corn). Due to the technical characteristics of the loess that it is constructed upon in the different parts, funds are annually invested in support of its normal operational state. The channel is expected to continue its constant operation in the future. At the current stage, it is impossible to change its route due to the fact that this channel and the "Asparuhov most" dam are one of the methods of water supply of the NPP in case of emergency.*

Response: In. Section 7 of the EIA it is recommended to provide a new route for the possible operation of the irrigation canal № 1 off-site the designated for construction of NHRAO, which is agreed with the Irrigation Systems PLC.

Letter with Ref. № 338/ June 24th 2009 from the Mayor of Hurlets Village

Response: No objections and recommendations.

Letter with Ref. № 9100-12445/ September 4th 2009 from the Mayor of Vratsa Municipality

Response: The letter has been put on the information board of Vratsa municipality and is published on the municipality's Internet site. No complaints or objections have been received by Vratsa municipality yet.

Letter with Ref. № 90/June 30th 2009 from WSS – Kozloduy region

Response: On the site south of the NPP there is plumbing, supplying drinking water for the plant, the pump house, NPP reservoir 3000m3 and two reservoirs 750 m3. At present the reservoirs are not in use and there are no plans regarding their future use. SOZ around the reservoir are not planned. SOZ around the NPP pump house are marked with the existing external fences.

Letter with Ref. № REIA-493/ March 22nd 2010 from MEW

Response: The assignment is accepted, but there is the following objection to point 4.4:
In the last paragraph on page 57 the text must be corrected, because Romania has already expressed its willingness to participate in the EIA procedure and their comments and recommendations are given in p. 8.3. of the assignment.

Letter № 1014/September 27th 2010 "Irrigation systems" Inc. Vratsa Branch

Response: The irrigation channel in the area around the site is supposed to be operational in the future. It is possible to relocate the channel's path, so that it will not cross the site of the repository. A common obligations contract is to be signed and a project for the relocation of the channel must be presented.

Letter with Ref. №ZNPB-2358/October 10th 2010 from MEW, Earth crust and subterranean resources" directorate

Response: The Radiana site does not cross the borders of any fields that fall under the National balance of resources and reserves (H63P) of fields of subterranean resources, nor does it cross the fields of active allowances for searching and/or studying of subterranean resources.

Romanian proposals:

- *The relation between the aquifers horizon of Danube river and the assessment of the impact on Danube river during of phases of the National repository.*

Response: Construction of NNRAW is envisaged on site "Radiana" above 50÷55 m above the sea level, whilst the terrain around Danube river is 25÷30 m above the sea level. Subterranean water basin "BG1G0000Qal005 - Pore waters in the Quaternary" and the near-orifice part of subterranean water basin "BG1G0000Qal015 – Pore waters in the Quaternary – Ogosta river", the area of which is outside of the boundaries of the "Radiana" site, where the NRRAW is to be constructed, are hydraulically connected to the river. According to the results from the modeling of the migration processes of radio nucleons ^{137}Cs, ^{90}Sr, ^{63}Ni, ^{241}Am, ^{239}Pu and ^{94}Nb, they are held only in the repository itself or in the aeration zone. Only the radio nucleon ^{129}I reaches the local aquifers horizon under NRRAW (BG1G00000N2034 „Pore waters in the Neogene – Lom-Pleven depression,"), and this about 3500 years after the closure of the repository. It is of low radioactivity, however, which means it is not hazardous for the subterranean waters. Therefore there is no possibility that there could be any impact on the Danube river during any phase of the NRRAW and for many centuries after its closure.

- **Characterization of the Radiana site, including the minimum information on the following subjects:** *geology, hydrology, hydro-geology, geochemistry, tectonics and seismic activity, meteorology and climate, human action impact on the repository.*

Response: In section 3 of EIA the geological structure, tectonics, meteorology and climate, hydrology, hydrogeology, geo-engineering conditions, geochemistry, seismics and physical geology processes and phenomena are described in detail. The impact of the NRRAW on human beings and the environment is analyzed in section 4.

– *Romanian publicity and NGO's have taken interest in the development of the IP and REIA. A public debate must take place on Romanian ground.*

Response: Taken into Consideration.

LIST OF TABLES

Part IX

TABLE OF CONTENTS

Part IX

9. EXPERTS CONCLUSION

The current EIAR of the investment proposal of SE ''RAW'' for the implementation of the NRRAW on the lands of Harlets, Kozloduy Municipality, Vratsa region was prepared by a group of licensed experts in the fields of EIA and EA.

The consultations, opinions and advices from the meetings with the affected public, the competent authorities, departments and institutions, concerning the preparation of the ToR, the structure and the content of the EIAR are taken into account in the analysis and assessments on the level of impact of the object on the respective components of the environment, and the factors that affect them, as well as the suggestions of measures which would reduce the negative impact from the site on the environment to the minimum possible,.

The EIAR was prepared on the basis of:

- A plan for the scope and contents of EIAR;
- Visual inspections and field observations of the NRRAW site;
- Research, designs and other documents;
- Inventory, analysis and assessment of the existing information for the preparation of the report (actual observation and measurements, scientific research, publications, reports and others);
- Consultations with specialists;
- Statements of the environmental protection agencies, the opinions and advice of authorities and institutions affected by the implementation of the investment proposal, the local population and authorities, non-governmental ecological organizations and others;
- Methods for the assessment and prognosis of the impact of the object used by the experts on the respective components of the environment and the factors that impact it;
- Regulatory documents

Prognoses and assessments have been made for the potential impact of the NRRAW during its periods of construction, operation and decommissioning on the components of the environment, the personnel, and the population of the region. Measures have also been proposed to minimize these impacts, in accordance with all requirements of the European legislation.

An ecological analysis of the alternative solutions has been performed in the EIAR, and a number of measures and recommendations the negative impact on the environment and the factors that impact it as much as possible have been put forward, in order to guarantee the full safety of the occupational personnel and the population of the region during the periods of construction, operation and closure of the NRRAW, with regard to both radiation and non-radiation aspects.

Provided the management of the NRRAW is effective, no significant negative impacts on the environment are expected. The implementation of the predicted safety measures guarantees that there will be no health hazards for the personnel and local population.

The territorial span of the impact is within the boundaries of the field of the investment proposal and the immediate perimeter;

- There is no planned construction of new water ways for the supply of the NRRAW;
- The underground waters as well as the existing ground water installation on the perimeter around the investment proposal are in no danger of contamination with wastewaters or radionuclides from the NRRAW.

The impact on the underground substrata is expected to be considerable in non radiation aspect, but practically unavoidable. It will stem mainly in earthwork assoicated with the construction of the NRRAW and the concomitant buildings and installations. Its territorial coverage is within the boundaries of the field of the investment proposal.

The investment proposal has pointed out advisable measures for the protection of the underground substrata and the underground waters from the penetration of pollution and radionuclides after the closure of the NRRAW.

The long-term examinations of the drinking water conducted by NPP Kozloduy under the environmental monitoring program show that the values for the total beta activity are considerably below the maximum permissible values according to the requirements of Regulation no. 9/16.03.2001 on the quality of the drinking water. The amounts of radionuclides 90Sr and 137Cs are by orders below the limits according to the Regulation of Basic Norms of Radiation Protection .For the year 2008 these values are: total beta activity 0.019÷0.13 Bq/l, 137Cs – below the detection limit, 90Sr in the range < 0.7÷1.6 mBq/l.

The long-term examinations and the environmental monitoring to date give the results of the examined parameters that characterize the quality of the individual parameters of the environment as below the norm according to the Basic Norms of Radiation Protection. The implementation and operation of the NRRAW are not expected to cause additional impacts on the individual components of the environment or on the factors have an impact on it and, thus, there are no expected health hazards for the population in the region.

The results from the evaluation of the doses in the period after the closure of the repository in the Preliminary Safety Analysis show that because it evolves normally, the individual effective dose for members of the public will not exceed the 0.01 mSv/a limit. In accordance with Article 10 from the Regulation for safe management of radioactive waste, this means that the best possible means for RAW management have been used and the exposure of the personnel and population is kept to the lowest reasonably achievable level.

On these grounds it can be stated that the site is suitable for the construction of a near surface disposal facility for low and intermediate level short-lived radioactive waste.

Radioactive aspects

In the development of the concept for the construction of the NRRAW it has been found that a surface, multi-barrier repository of the trench type, composed of individual modules for the arrangement of the reinforced concrete containers, is most suitable.

The nine fundamental principles of RAW management formulated by the IAEA will be applied in the construction of the NRRAW:

- 1st principle: Human health protection
- 2nd principle: Environmental protection
- 3rd principle: Protection beyond the nation's borders
- 4th principle: Protection of the future generations
- 5th principle: No burden on future generations
- 6th principle: National legislation
- 7th principle: Control over the generation of RAW
- 8th principle: Dependencies between the generation of RAW and its management
- 9th principle: Safety of the facility

According to the Act on the Safe Use of Nuclear Energy (1):

- *Article 3 (1) Nuclear energy and ionizing radiation shall be used in compliance with nuclear safety and radiation protection requirements and principles. With the aim of ensuring the protection of human life, health and living conditions of both present and succeeding generations, the environment and property against harmful impact of ionizing radiation.*
- *(2) In the uses of nuclear energy or ionizing radiation, and in the radioactive waste management and spent fuel management:*
- *1. Nuclear safety and radiation protection shall have priority over all other aspects of the activity;*

- *2. Occupational and public exposure to ionizing radiation shall always be kept as low as reasonably achievable*

All these principles were taken into account during the preparation of the Conceptual Design and are rated in the Preliminary Safety Analysis (PSA).

The dose burden of the personnel during the operation will not exceed the limits under BNRP 2004 and will practically be considerably lower, as are the requirements of ALARA principle.

The NRRAW must provide effective protection of the health of the population and the environment against the potential impact of the radioactive waste stored in it after its closure by avoiding the uncontrolled spread of radioactive substances into the biosphere with the aid of the multi-barrier protection of the biosphere and a number of technological and administrative measures.

The basic criteria proving that the goal has been reached are the radiological criteria established in the Regulation on Basic Norms for Radiation Protection and the Regulation for Safe Management of Radioactive Waste.

In this line of thought the last point of the analysis of EIAR is the **limit of the annual individual effective dose of a critical group of the population.** The conclusions are based on the presented Conceptual Design and the PSA.

The National Disposal Facility for short-lived low and intermediate radioactive waste will be operated and managed by SE"RAW". The "Radiana" site for the NRRAW location is in the immediate vicinity of Kozloduy NPP

According to the chosen Conceptual Design the repository is of the trench type. The monitoring program will fulfill its functional goals in the support of the Environmental Impact Assessment Report

A safety assessment of near surface disposal facilities has been made. This is a procedure for the assessment of the behavior of the disposal facilities and specifically, of their potential radiological impact on human health and the environment. The safety assessment defines the dissemination paths of radionuclides in the environment and assesses the potential health hazards..

Pre-operational monitoring provides the basic levels for the assessment of all the surplus changes in the environment which could be linked to the discharges from the disposal facilities.

Monitoring during operation and after closure of the disposal facility is intended to show that the actual measurements in the environment do not invalidate the assumptions and estimates of the safety assessment.

For near-surface disposal facilities, the approval by the regulator of the project of the facility and demonstration of compliance after the beginning of the operation are based on a comparison of results of safety assessments of the facility and the applicable norms and standards. The monitoring data provides support for the assumptions of the assessment and its results. The monitoring shall be designed so that the result "less of an activity or concentration" is sufficient to support the safety assessment. Similarly, the surveillance program of the facilities is being developed in such a way that the degradation of structures and systems of the disposal facility to the extent that compromise the validity of the safety assessment cannot occur without being detected.

It is expected that there will be no significant migration of radioactive substances from the disposal facility, at least during the operation and after its closure during the control period. Maintenance of monitoring will be the absence of detected specific radionuclides and the absence of statistically significant changes in the levels of other pollutants.

During operation are not expected environmental radiation impacts beyond regulatory limits.

The Radiana site is appropriate in terms of the possible spread of radionuclides in groundwater and groundwater space. All investigated radionuclides (including 129I) are retained and decayed in the aeration area under the storage facility and they do not reach groundwater. The activity of 129I makes it safe to groundwater and there is no real risk of radioactive contamination of the region through these waters. There are no excluding factors in it and its characteristics meet the requirements of the regulations and safety criteria.

Despite the excessive conservatism, the results of the assessment of the doses in the period after closure of the repository shows that with normal evolution, the individual effective dose for members of the public does not exceed the legal limit of 0.01 mSv / a.

Given the available radiation characteristics of packages of radioactive waste to be buried in NHRAO and presented estimates of the impact of NPP on the environment, according experts estimation it is not expected cumulative effect in the radiation zones of these two objects. This conclusion follows as naturally fact that there will be no direct gaseous and liquid discharges during the lifetime of NHRAO and in the period following the closure.

Based on the expert assessments carried out, it can be stated that the implementation of the NRRAW during the periods of construction, operation and closure will not have any transnational impacts.

The team of independent experts that has prepared the report on the EIA, in light of the studies and analyses performed; the conclusions reached; the estimates developed; and the implementation of the measures proposed, recommends to the competent authority **MEW** that it allow the implementation of the investment proposal of the Employer - **SE "RAW"** for the construction of the NRRAW at the "Radiana" site on the lands the village of Harlets, Kozloduy Municipality.

Part X

TABLE OF CONTENTS

Part X

10. LIST OF APPLICATIONS REQUIRED

10.1 Graphic applications

10.2 Tables

10.3 Figures

10.4 Applications

10.5 Declarations of independence, Certificates of registration of the experts involved in the developing of the EIA;
10.6. Protocols / Meeting protocols / meetings with the affected people, comments and responses to remarks.

All graphics and other applications are given as a list in each chapter. Tables and figures are shown in a separate list from the EIA. They are also given as lists in each chapter.

Part XI

TABLE OF CONTENTS

Part XI

11. SOURCES OF INFORMATION. LIST OF BASE DATA.

11.1 Enactments used

1. Environment protection act (State Gazette, issue 91, September 25th 2002, amended and complemented State Gazette, issue 46, June 18th 2010)
2. Provisions and order for conduction of environmental assessment (promulgated State Gazette, issue 25, March 18th 2003, amended and complemented State Gazette, issue 3/11.01.2011г
3. Provisions and order for conduction of compatibility assessment of plans, programs, projects and investment proposals with the matter and aims of protection of protected zones regulation (promulgated State Gazette, issue 73, September 11th 2007, amendment 3 of 11 January 2011)
4. Waste management act (State Gazette, issue 86 September 9th 2003, last amended and complemented State Gazette, issue 41, June 1st 2010)
5. Regulation № 3/01.04.2004 on waste classification (State Gazette, issue 44/2004)
6. Regulation № 9/21.10.2004 on order and forms, used for submission of information on the activities regarding the waste, also on the order of keeping the public register of permits issued, registration documents and closed projects and activities (promulgated State Gazette, issue 95 October 26th 2004, amended State Gazette, issue 113, December 28th 2004)
7. Requirements for the treatment and transportation of construction and hazardous waste regulation, adopted with CMD № 53, dated March 19th 1999, State Gazette, issue 29/ March 30th 1999
8. Requirements for the treatment and transportation of worked off oil and waste oil products regulation, adopted with CMD № 230, dated November 1st 2005, promulgated State Gazette, issue 90/ November 1th 2005, State Gazette issue 53/2008
9. Regulation № 6 dated July 28th 2004 on requirements for construction and operation of incineration installations and joint incineration of waste (State Gazette issue 78/2004, amended State Gazette issue 78/November 11th 2004)
10. Requirements for market admission of batteries and accumulators and for treatment and transportation of battery and accumulator waste regulation, adopted with CMD № 144, dated July 5th 2005, State Gazette, issue 58/ July 15th 2005
11. Regulation on the marketing of electrical and electronic equipment and treatment and transportation of waste from electrical and electronic equipment (Official Gazette. issue 36 of 2 May 2006.).
12. Requirements for market admission of electric and electronic equipment and for treatment and transportation of electric and electronic equipment waste regulation,(promulgated State Gazette, issue 36/ May 2nd 2006, amended and complemented State Gazette, issue 53/2008);
13. Packing and packing waste regulation, adopted with CMD № 41/2005,(State Gazette, issue 23/March 23d 2004, amended and complemented State Gazette, issue 58/August 15th 2005, amended and complemented State Gazette, issue 53/2008).
14. National program for management of activities, regarding waste 2003 Environment protection act (State Gazette, issue 91, September 25th 2002, amended and complemented State Gazette, issue 46, June 18th 2010)-2007
15. Purity of atmospheric air act (promulgated State Gazette, issue 45 May 18th 1996);

16. Regulation № 14/September 23d 1997 on ultimate admissible concentration of noxious substances in atmospheric air over populated areas (promulgated State Gazette, issue 88 March 10th 1997);
17. Ordinance № 12/2010 on - standards for sulfur dioxide, nitrogen dioxide, particulate matter, lead, benzene and carbon monoxide in ambient air. (promulgated, SG. 58 of 07.30.2010)
18. Ordinance № 11/2007 on limits for arsenic, cadmium, nickel and polycyclic aromatic hydrocarbons in ambient air (promulgated, SG. 42 on 5/29/2007)
19. Regulation № 7 of 3.05.1999 on the evaluation and management of air quality (promulgated, SG. 45 of 14.05.1999, in force 1.01.2000)
20. DIRECTIVE 2003/17/EC complementing DIRECTIVE 98/70 – *regarding the quality of gasoline and diesel fuels*
21. DIRECTIVE 2002/88/EC complementing DIRECTIVE 98/70 – *measures for decreasing the amounts of gaseous and dust polluters from the engines of internal combustion engines, installed in off-road and construction machinery*
22. Regulation № 8/August 24th 2004 on the conditions and requirements for construction and use of repositories and other installments for utilization and disposal of waste (promulgated State Gazette issue 83 date September 24th 2004);
23. Regulation on control and management of substances that damage the ozone layer, adopted by decree № 254 of the Council of Ministers, 1999г (promulgated State Gazette issue 3 dated January 11th 2000);
24. Framework Directive 2000/60/EC on water.
25. Waters act (promulgated State Gazette, issue 67 dated July 27th 1999 amended and complemented State Gazette, issue 103 December 29th 2009);
26. Directive 76/160/EEC regarding the quality of bathing waters: 31976L0160
27. Regulation № 7/August 8th 2004 on indices and norms for determining quality of surface flowing waters (State Gazette, issue 96/86)
28. Regulation № 11/February 25th 2002 on the characteristics of bathing waters (State Gazette, issue 25/March 3d 2002)
29. Regulation № 4/October 20th 2000 on the quality of fish breeding and valve organism breeding waters(State Gazette, issue 88/October 10th 2000)
30. Ordinance №RD – 272/May 3d 2001 for categorization of surface waters in water areas or parts of them;
31. Ordinance №RD – 970/July 28th 2003 for determining the sensitive areas in water basins.
32. Directive 98/33/EC regarding quality of water, fit for human consumption
33. Regulation № 9 dated March 16th 2001 on the quality of water, used for consumption and domestic purposes. (State Gazette, issue 30/2001)
34. Directive 75/440/EEC regarding the requirements on quality of surface waters, used for consumption and domestic purposes, amended by Directives 79/869/EEC and 91/692/EEC
35. Regulation № 12/June 2002 on the requirements on quality of surface waters, used for consumption and domestic purposes, (State Gazette, issue 63/June 28th 2001) corresponding to Directives 79/869/EEC and 91/692/EEC.
36. Regulation № 6 September 9th 2000 on emission norms on admissible amounts of noxious substances in waste waters, winding into water basins (State Gazette, issue 97/2000) - Directives 79/464/EEC regarding noxious substances and it's five subordinate directives, 91/271/EEC);
37. Regulation № 5 on the order and methods of creating the networks and the activities of the national monitoring system (2007)
38. Regulation № 2/July 23.2007 on design of constructions and installations in seismic areas.
39. BAS, 1987: Norms for design of constructions and installations in seismic areas. - 2007

40. Regulation № 1/September 1st 1996 on design on flat founding (promulgated State Gazette, issue 85/96)
41. Rules on accepting land works and land installations (State Gazette, issue 48/1988, updated issue 7/1988, BAO, issue 6/1988)
42. Regulation on the requirements for protection of soils upon use of IEEC form purification of waste waters for the necessities of agriculture (adopted with CMD № 262, 200, State Gazette issue 101/2000)\
43. Directive 91/676/EEC regarding protection of waters from nitrate pollution caused by agricultural sources.
44. Regulation № 2/October 16th .2000г on the protection of waters from nitrates pollution from agricultural sources (State Gazette,issue. 87/2000).
45. Directive 80/68/EEC regarding protection of subterranean waters from noxious substances pollution, amended by Directive 91/692/EEC
46. Regulation № 1 dated July 7th 2000 on researching, use and protection of subterranean waters (State Gazette, issue 57/2000), corresponding to Directives 80/68/EEC and 91/692/EEC .
47. Regulation № 3 dated October 16th 2000 on the conditions and order of exploration, design, recognition and operation of sanitary-protection zones surrounding water basins , installations for consumer and domestic purposes water, and sources of mineral water, used for medical, prophylactic, consumption or hygiene purposes. (State Gazette, issue 88/2000) , corresponding to 98/83/EC, 91/676/EEC and 79/869/EEC
48. Regulation № 10 dated July 3d 2001 on issuing of licenses for winding of waste waters into water basins and determining of individual emission restrictions of point sources of pollution, issued by the minister of environment and waters (promulgated State Gazette, issue 66 dated July 27th 2001, in force since July 27th 2001) 91/271/EEC and 80/68/EEC 1
49. Directive 76/464/EEC regarding pollution of waters with noxious substances and 7 subordinate, all amended by Directive 91/692/EEC
50. Resolution 77/795/EEC regarding transfer of information on the quality of surface fresh waters in the EC.
51. Protection from the harmful effects of chemical substances, detergents and products act, State Gazette, issue 10 dated in force since February 4th 2000,
52. Regulation regarding hazardous chemical substances, detergents and products, forbidden or restricted for trade and use. Decree of CM № 130/July 1st 2002, State Gazette issue 69/ July 17th 2002
53. Regulation № 2 dated September 12th 1990 regarding protection from accidents during activities involving hazardous chemical substances (State Gazette, issue 100/1990)
54. Regulation regarding order and classification methods, packing, labeling, of existing and new chemical substances, detergents and products CMD 316/December 20th 2002, State Gazette issue 5/January 17th 2003, title amended State Gazette issue 66/2004
55. Regulation regarding hazardous chemical detergents and products, forbidden or restricted for trade and use. (State Gazette issue 69/ July 17th 2002)
56. Decree of CM № 12/ January 27th 1999 regarding regime of introduction of hazardous substances (Appendix 2, Art.3); a list of chemical substances, controlled by MEW, according to the UN classification is enclosed.
57. Directive 67/548/EEC regarding classification, packing and labeling of hazardous substances (The Seventh Directive 92/32/EEC, which complements it);
58. Directive 93/67/EEC regarding the principles of assessment of risks for humans and the environment, posed by hazardous chemical substances.
59. Regulation on the order and method of importation and exportation of hazardous chemical substances on the territory of Republic of Bulgaria (CMD № 161/July 12th 2004, State Gazette, issue 66/2002),
60. Regulation on the order and method of notifying of new chemical substances. Decree of CM № 137 dated July 3.. 2002, State Gazette issue 67 /July 2nd 2002 ins force since January 1st 2004

61. Regulation of final assessment of risks for humans and the environment, posed by hazardous chemical substances. Decree of CM № 13 dated July 1st. 2002 г., State Gazette issue 67 /July 2nd 2002 in force since January 1st 2004
62. Regulation № 3 norms, regarding the admissible concentration of noxious substances in the soil. State Gazette issue 36 / May 8th 1979, last amended and complemented State Gazette, issue 71/2008.
63. Regulation № 32, dated July 9th 2001 on control over plants and plant products, fertilizers and testing sites, registration and control of phitopharmaceutical medicine.
64. Regulation № 6 dated June 26th 2006 on the indices of environmental noise, indicating the degree of discomfort by different times of the day, limit amounts of the indices of environmental noise, assessment methods of the values of the indices.
65. Rules for organization and activities, preventing and clearing the effects of natural disasters, accidents and catastrophes(promulgated State Gazette, issue 13 dated February 2nd 1998)
66. Regulation № 7 regarding hygiene requirements for heath protection in populated places (promulgated State Gazette, issue 46/1996, last amended and complemented State Gazette issue 40/2008)
67. Biological diversity act (promulgated State Gazette, issue 77/August 9th 2002, amended State Gazette, issue 103/December 29th 2009)
68. Protected territories act (State Gazette, issue 133/November 1th 1998, last amended and complemented State Gazette, issue 29 dated December 29th 2009)
69. Medical plants act (State Gazette, issue 29/April 7th 2000, last amended State Gazette, issue 29 dated December 29th 2009)
70. Hunting and game protection act (State Gazette, issue 78/2000, last amended and complemented State Gazette, issue 92 dated November 20th 2009).
71. Fishing and aquacultures act (State Gazette, issue 41/2001, last amended and complemented State Gazette, issue 82 dated October 16th 2009).
72. Regulation regarding the conditions and order of methods for conduction of ecological assessment of plans and programs, (promulgated State Gazette, issue 57/July 2nd 2004, amendment 3 on 11 January 2011)
73. Assessment of trans-border environmental impact convention (ratified through Act, adopted by the 37th National Assembly, March 16th 1995) State Gazette issue 28/1995 in force since September 10th 1997 (promulgated State Gazette issue 86/November 1st 1995)
74. Regulation on determining and imposing sanctions for causing damage or polluting the environment beyond admissible norms promulgated State Gazette, issue 865/March 18th 2003)
75. Regulation №3/May 15th 2003 on the national ecological marking scheme (promulgated State Gazette, issue 49 dated May 29th 2003)
76. Regulation on national environment management and auditing scheme, (promulgated State Gazette, issue 26/March 21st 2003)
77. Information access, community participation in taking decisions and access to justice in matters, regarding the environment convention (ratified through Act, adopted by the 39th National Assembly, November 2nd 2003, State Gazette, issue 91/2003,in force since March 16th 2003, promulgated State gazette issue 33/April 4th 2004).
78. Access to public information act, (promulgated State Gazette issue 55/July 7th 2002 last amended State gazette issue 104 dated December 5th 2008)
79. Territory planning act, in force since March 31st 2001 (promulgated State Gazette issue 1 dated January 2nd 2001, last amended and complemented issue 41 dated June 1st 2010)
80. Soil protection act (promulgated State Gazette issue 89 dated November 6th 2007)
81. Natural disasters protection act, promulgated State Gazette issue 102 dated December 19th 2006, last amended and complemented State gazette issue 93 dated November 24th 2009.
82. Forestry act, covered denomination from July 5th 1999 (promulgated State Gazette issue 125 dated December 29th 1997, last amended and complemented State Gazette issue 32 dated April 28th 2009)

83. Regulation № 4/2001 regarding the range and content of investment projects. State Gazette 51/2001/.

84. Regulation regarding the order of determining and imposing sanctions for causing damage and polluting environment beyond admissible norms /State Gazette 15/1993, 107/2000/

85. CMD № 18/January 23^{d} 1998 and Rules for organization and activities, preventing and clearing the effects of natural disasters, accidents and catastrophes(State Gazette,13/1998)

86. Regulation on the conditions and order for issuing licenses for construction and operation of new and operation of operative establishments and installments, which employ systems for prevention of major accidents, involving hazardous substances and limitation of their effects, including 11 Appendices /State Gazette,38/2003./.

87. Regulation № 26 /October 2nd 1996 on re-cultivation of damaged terrain, improvement of low productivity lands, divestation and utilization of the humus layer (promulgated State Gazette issue 89 dated October 22nd 1996 item 9, line 6 № 889, amended and complemented State Gazette issue 30/2002)

88. Regulation on inventory and examination of polluted soil lands, required recreation measures and sustaining the conducted recreational actions, in force since August 17th 2007 (promulgated State Gazette issue 15 dated February 16th 2007)

89. Regulation № 1 dated November 15th 1999 on the norms and aims of protection from radioactivity, and safety in cleaning the after-effects of the uranium industry in Republic of Bulgaria, issued by the chairman of the Peaceful use of nuclear energy committee, the minister of environment and waters and the minister of healthcare (promulgated State Gazette issue 101 dated November 11th 1999)

90. Regulation on protection from radioactivity during activities, involving emitters of ionized rays (promulgated State Gazette issue 74 dated August 24th 2004, amended State Gazette issue 74 dated September 8th 2006 – also in subterranean waters)

91. Regulation № 4 dated January 12th 200 on soil monitoring, promulgated State Gazette issue 19 dated March 13th 2009

92. Healthcare act (promulgated State Gazette issue 70 dated August 10th 2004, last amended and complemented issue 50 dated July 2nd 2010).

93. Regulation on radioactive waste management safety, promulgated State Gazette issue 72 dated August 17th 2004

94. Regulation on providing security for nuclear power plants, promulgated State Gazette issue 66/July 7th 2004, amended issue 46/June 12th 2007

95. Environmental and social policies of EBRD, adopted May 12th 2008

96. Public information policy of EBRD, adopted May 12th 2008

97. Environmental procedures of EBRD, adopted July 28th 2003

98. Directive 1999/31/EC (complemented by 2003/33/EC) on nuclear waste repositories 91/689/EEC (complemented by 94/31/EEC) controlled management of hazardous waste

99. ILO Labour conventions

100. Convention on biological diversity 1993

101. Convention on the Physical Protection of Nuclear Material (ratified April 1984 – amendment ratified March 2006).

102. Convention on Early Notification of a Nuclear Accident (ratified February 1988).

103. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (ratified February 1988)

104. Convention on Nuclear Safety (ratified November 1995).

105. Joint Convention on the Safety of Spent Fuel Management and on the Safety of

106. Radioactive Waste Management (ratified June 2000)

107. Regulation on providing physical protection of nuclear installments, nuclear fuel and radioactive substances promulgated State Gazette, issue 77/September 3^{d} 2004 .

108. Regulation on the condition and order of defining special status zones surrounding nuclear installments and emitters of ionized rays, promulgated State Gazette issue 69/August 6th 2004.
109. Updated strategy for decommissioning of blocks 1-4 of Kozloduy NPP KPMU/DCS/001 – Draft. 0, 2006
110. Regulation on the conditions and order of transportation of radioactive substances, promulgated State Gazette, issue 60 dated July 22nd 2005
111. European agreement on international land transportation of hazardous cargo(ADR), State Gazette, issue 28/March 28th 1995, last amended State Gazette, issue 63/August 2nd 2005
112. Regulation on the basic norms of radioactive protection, promulgated State Gazette, issue 73/August 20th 2004
113. Directive 85/337/EEC, EU Directive on environmental assessment of certain public and private projects, dated June 27th 1985 (amended by EC Directive 97/11/EC dated March 3d 1997)
114. EC Directive 2001/42/EC, Directive on assessment of environmental impact of certain plans and programs, dated June 2001
115. EC Directive 85/337/EEC on environmental impact assessment, amended Directive 97/11/EC, amended and complemented by Directive 2003/35/EC regarding the participation of publicity in the preparation of certain plans and programs concerning the environment.
116. EC Directive 92/43/EEC (1992) on the Convention of natural habitats and wild flora and fauna (Natura 2000) – Habitats directive
117. EC Directive 78/659/EEC dated July 18th on the quality of fresh waters needing protection or improvement in order to support fish life.
118. EC Directive 79/409/EEC dated April 2nd 1979 on the convention regarding wild birds.
119. Regulation on artificial lighting of constructions № 0-49
120. European landscape convention
121. National plan for environmental action – health, Council of Ministers, updated, Sofia, 2003
122. Strategy for environmental protection with activities plan 2001-2006, Council of Ministers, Sofia 2001
123. National strategy for protection of biological diversity
124. International conventions on protection of biological diversity
125. National biomonitoring program Bulgaria
126. Common convention on management of spent fuel safety and management of radioactive waste safety. Ratified through Act, adopted by the 38th National Assembly on May 10th 2000, State Gazette issue 42/May 23d 2000
127. Strategy for management of spent nuclear fuel and radioactive waste, adopted by CM on December 23d 2004
128. Safe use of nuclear energy act, promulgated State Gazette issue 63/June 28th 2002, last amended issue 36/April 4th 2008
129. CMD № 683/July 25th .2005 on the construction of National repository for the disposal of radioactive waste
130. Regulation on the order of issuing licenses and allowances for safe use of nuclear energy, promulgated State Gazette issue 41/May 18th 2004, last amended State Gazette issue 73/September 30th 2005
131. Clearance № НХ3211/May 5th 2006 on determining the location (choosing of site) of the radioactive waste management site - National repository for the disposal of radioactive waste (NRRAW).

132. Measurements act, Promulgated State Gazette issue 46 dated May 7th 2002, in force for six months after May 7th 2002, except § 4 – in force since May 7th 2002; National Assembly Decree NQ 141 2002

133. Regulation on accident planning and accident readiness in case of nuclear and radiation accident dated August 13th 2004

134. Regulation on the conditions and order of informing the Nuclear regulatory agency about events in nuclear installments and sites with emitters of ionized rays dated August 13th 2004, amended issue 46 dated June 12th 2007

135. Regulation on the order of obtaining professional qualification and on the order of issuing of licenses for special training and certificates for nuclear energy use capacity dated August 24th 2004 amended issue 46 dated June 12th 2007

136. VIENNA CONVENTION on civil liability for nuclear damage (ratified by the National Assembly by Act, adopted on July 27th 1994 – State Gazette issue 64/August 9th 1994, in force for Republic of Bulgaria since the day of ratification, amended State Gazette isuue76/September 20th 1994)

137. CONVENTION on the physical protection of nuclear material (ratified by State Council Decree № 341 dated February 3d 1984 – State Gazette issue 12 February 10th 1984, promulgated State Gazette issue 44/June 9th 1987, in force since February 8th 1987) CONVENTION on assistance in case of nuclear accident or radiological emergency (ratified by State Council Decree № 3514 dated December 30th 1987 – issue 2 January 1st 1988 .), promulgated State Gazette issue 13/February 16th 1988m, in force since February 26th 1987)

138. CONVENTION on operative informing in case of nuclear accident (ratified by State Council Decree № 3514 dated December 30th 1987 – issue 2 January 1st 1988, promulgated State Gazette issue 12/February 12th 1988, in force since October 22nd 1986

139. REGULATION on the conditions and order of delivering of the radioactive waste of Government company “Radioactive waste”, State Gazette issue 64/July 23d 2004

140. REGULATION on safety during the decommissioning of nuclear installations, State Gazette issue 73/August 20th 2004

141. Healthy and safe work conditions act

142. Regulation № 32 dated November 7th 2005 on the conditions and order of conducting individual dosimetric control of persons, working with emitters of ionized rays. Issued by the minister of healthcare, promulgated State Gazette issue 91, dated November 15th 2005

143. Regulation on radioactivity protection in work with sources of ionized rays_dated August 24th 2004 amended and complemented issue 74 dated August 8th 2006, amended issue 46 dated June 12th 2007.

144. Regulation №2 on the minimum requirements for healthy and safe working conditions for conducting construction and montage works, State Gazette issue 37/2004

145. Regulation on the existing requirements for assessment of correspondence of construction materials State Gazette issue 106 December 12th 2006

146. Regulation on the existing requirements for assessment of correspondence of machinery and installments, working open air, regarding the noise they emit in the air, State Gazette issue 11/February 10th 2004

147. Order №RD-548/September 5th.2008 of the minister of the environment and waters (State Gazette issue 83/September 23d 2008)

11.2 Base Data

148. Report on the environmental assessment of NPP “Kozloduy” (NPP REIA), 1999
149. Report on the development of concept for RAW disposal, Summary report: Development of concept for disposal of RAW and review and selection of potential NRRAW sites , 2004 INRNP - BAS
150. Report on review and selection of potential NRRAW sites; Annex to the Summary report; Development of concept for disposal of RAW and review and selection of potential NRRAW sites ; 2004; GI, GPI - BAS
151. Protocols of analyses, photos, INRNP reports on contract – CD; Transfer protocol; Characterization of the fluid RAW in regard of radionuclides, relevant to the long-term safety of their disposal; 2005; INRNP - BAS
152. REIA on repository for dry storage of spent nuclear fuel in NPP “Kozloduy”, September 2005
153. Reports on pre-project research on NRRAW sites, reports to NRA
154. Report on implementation of “Development of concept and planning of selection of site” phase, report to NRA, 2000
155. Report on implementation of “Gathering of data and region analysis” phase, report to NRA, 2007
156. Report on implementation of “Characterization of NRRAW sites” phase, SERAW, 2010
157. Report on review and selection of potential NRRAW sites; Research conducted under the “”Gathering of data and region analysis ”; 2006; GI-BAS
158. REIA; SD “D - Kozloduy”
159. Environmental protection program of the Kozloduy municipality for the 2004-2010 period .
160. Marketing profile of Kozloduy municipality.
161. Tourism development program of the Kozloduy municipality for the 2008-2011 period..
162. Annual reports on the results of the radioecological monitoring of NNP “Kozloduy” 2004-2009
163. Annual reports on the state of the environment 2006 -2008; REWI-Vratsa , MEW
164. GFI Report 07-01; Complex analysis of regional geophysical fields and assessment of seismic risk (Introduction) Research conducted under the “Characterization of sites” phase; July 2007; GFI- BAS, MGU
165. Analysis of the distribution and relations between regional geophysical fields; Complex analysis of regional geophysical fields and assessment of seismic risk Research conducted under the “Characterization of sites” phase; July 2007; GFI- BAS, MGU
166. Part two - Complex analysis of regional geophysical fields and assessment of seismic risk Research conducted under the “Characterization of sites” phase; July 2007; GFI- BAS, MGU
167. Part three - Complex analysis of regional geophysical fields and assessment of seismic risk Research conducted under the “Characterization of sites” phase; July 2007; GFI- BAS, MGU
168. “Joint analyses of the results on highly-accurate geodesic measurements, geo-morphological and geo-tectonic observations” report; Research conducted under the “Characterization of sites” phase; July 2007 GI - BAS
169. Tome 2: graphics - “Joint analyses of the results on highly-accurate geodesic measurements, geo-morphological and geo-tectonic observations”; Research conducted under the “Characterization of sites” phase; June 2007; GI – BAS; GI – BAS; MGU
170. Summary report “Conducting of engineering-geological, hydrogeological and geophysical researches”, Research conducted under the “Characterization of sites” phase; July 2007; GI – BAS; MGU
171. Appendices to Summary report “Conducting of engineering-geological, hydrogeological and geophysical researches”, Research conducted under the “Characterization of sites” phase; July 2007

172. Report “Preliminary prognosis of the geomechanical processes of the inserted massive and its impact on the supporting constructions of a tunnel type (mining works network) subterranean installment 50 meters deep below the site, selected for deployment and disposal of low and intermediate level radioactive waste (RAW) in compliance with the construction concept and the measures of the installment; November 2008, MGU П

173. Report on the geological, geophysical, engineering-geological, hydrogeological and laboratory researches. Research conducted under the “Characterization of sites” phase; 2009; MGU-Engineering

174. Summary report: “Conducting of experimental and methodological research aiming to verify the methods and methodologies for research and approval of sites for construction of NRRAW. Research conducted under the “Characterization of sites” phase; 2009”; July 2007; GI - BAS

175. Report – Geophysical research of the “Skata” site; 2007; MGU

176. Report – Characterization of site № 4; Research conducted under the “Characterization of sites” phase; October 2007; GI BAS

177. Report “Analysis of the conditions for surface disposal of RAW Research conducted under the “Characterization of sites” phase 2007; MGU

178. Report: “Technical solution for construction a shaft LILRW repository on the “Skata” site, south of NNP “Kozloduy” 2007

179. Approval of site for NRRAW construction, September 20088; GI BAS

180. Report “Prognosis on the probable spread of radionuclides from NRRAW into the sub-soil area and the subterranean waters of the Radiana site”, April 2008, Aqua systems modeling group Ltd.

181. Report – Geodesical and geo-magnetic research of mounds arounf NPP-Kozloduy; 2009, NBU, Arceometry and experimental archeology laboratory;

182. Report “Conducting of additional drilling and geophysical works on the Radiana Site ; 2008, MGU-Engineering Ltd.

183. Status report – Conducting of geological-geophysical, hydrogeological and geochemical research on the site; 2008 MGU-Engineering Ltd.

184. Status report “Pre-project research for construction of NRRAW” Tunnel repository planning; Shaft/silo repository planning, November 2008, Minproect Inc.

185. Pre-project research for construction of NRRAW, shaft type repository; May 2009, Minproect Inc.

186. Pre-project research for construction of NRRAW, tunnel type repository; May 2009, Minproect Inc.

187. Report: “Selection of appropriate contemporary software and calculation models for prognosis of geomechanical processes and of the behavior of the “soil massive-engineering construction” system given conditions of static and seismic pressure on a loess and Pliocene clay massive, that is planned to hold the shaft repositories for deployment and disposal of low and intermediate-level radioactive waste (RAW) in compliance with the approved concept and parameters of the installment offer”, Minproect Inc.

188. Research and analyses of the world experience in planning and construction of LILRW repositories; September 2008

189. EPRS-08-2B Report, Task 3 – Development of procedures for optimization and update of a centralized system for accident planning of effective coordination within SERAW and with competent authorities.

190. Technical and economical basis, updated TOB and documentation in compliance with the requirements of NRA for approval of site: “Updated preliminary analyses of the safety of the repository” BG 2004/016-815.01.05, RI/DI–701, “RiskEngineering” Inc., March 2010

191. “Selection of site for national repository for disposal of radioactive waste (NRRAW)” Implementation plan for “Characterization of NRRAW sites” phase, February 2nd 2009, SERAW

192. Technical assignment for EIA of IP for construction of NR for disposal of low and intermediate-level RAW, April 28th, 2009, SERAW

193. Emergency plan of NPP "Kozloduy"

194. Concept project for NRRAW; Task1 – Defining of project basis of the installment, safety criteria for selection of barriers and methodology for selection of site – Final report; BG 2004/016-815.01.05, August 2008; WorleyParsons; TVO Nuclear services; TVO; Risk Engineering Ltd.

195. Technical assistance from SERAW for creating emergency system for radiological accident, Task 1 – assessment of the current state EuropeAid/1245000/D/SER/BG, TVO Nuclear services; Risk Engineering LTD, Eco Energy Ltd, Aegis Ltd

196. Concept project for NRRAW; Task2 – Engineering assessment of the five sites selected and confirmation of their strengths and weaknesses – Final report; BG 2004/016-815.01.05, August 2008; WorleyParsons; TVO Nuclear services; TVO; Risk Engineering Ltd.

197. Technical assistance from State Estate "Radioactive Waste" for creating emergency system for radiological accident, Task 2 – review of the organization and emergency planning system of SERAW EuropeAid/1245000/D/SER/BG, TVO Nuclear services; Risk Engineering LTD, Eco Energy Ltd, Aegis Ltd

198. Concept project for NRRAW; Task3 – Update of the radionuclide equipment for NRRAW – Final report; BG 2004/016-815.01.05, December 2007 – July 2008; WorleyParsons; TVO Nuclear services; TVO; Risk Engineering Ltd.

199. Technical assistance from State Estate "Radioactive Waste" for creating emergency system for radiological accident, Task 3 – Development of procedures for optimization and update of a centralized system for accident planning of effective coordination within SERAW and with competent authorities. EuropeAid/1245000/D/SER/BG, November 2008,TVO Nuclear services; Risk Engineering LTD, Eco Energy Ltd, Aegis Ltd

200. Concept project for NRRAW; Task4 – Confirmation of site; Part 4.1:Concept Project – Final report; BG 2004/016-815.01.05, July 2008 – October 2008; WorleyParsons; TVO Nuclear services; TVO; Risk Engineering Ltd.

201. Concept project for NRRAW; Task4 – Confirmation of site; Part 4.2. Preliminary safety analysis report; part 4.3 Criteria for disposal of waste in NRRAW; 4.4. Site monitoring program; 4.5 Review of the range, form and contents of REIA – Final report; BG 2004/016-815.01.05, July 2008 – October 2008; WorleyParsons; TVO Nuclear services; TVO; Risk Engineering Ltd.

202. Technical assistance from State Estate "Radioactive Waste" for creating emergency system for radiological accident, Task 4 – Determining of the equipment required for developing an updated system for emergency readiness. EuropeAid/1245000/D/SER/BG, November 2008,TVO Nuclear services; Risk Engineering LTD, Eco Energy Ltd, Aegis Ltd

203. Concept project for NRRAW; Task5 – TZ for development of technical project for NRRAW in Bulgaria – Final Report; BG 2004/016-815.01.05, WorleyParsons; TVO Nuclear services; TVO; Risk Engineering Ltd.

204. Technical assistance from State Estate "Radioactive Waste" for creating emergency system for radiological accident, Task 5 – Development of methodology for determining the size of special status zones of the Novi Han specialized division of PHRAW in a state of emergency EuropeAid/1245000/D/SER/BG, November 2008,TVO Nuclear services; Risk Engineering LTD, Eco Energy Ltd, Aegis Ltd

205. Technical assistance from State Estate "Radioactive Waste" for creating emergency system for radiological accident, Task 6 – Training and experience exchange EuropeAid/1245000/D/SER/BG, November 2008,TVO Nuclear services; Risk Engineering LTD, Eco Energy Ltd, Aegis Ltd

206. Protocols № 243/March 28th 2008 for the period between March 24th 2008 and March 28th 2008 and № 787/September 30th 2008. for the period between September 26th 2008 and September 30th 2008 on the concentration of sulfur and nitrogen oxides (nitrogen dioxide and nitrous oxide), ozone, hydrogen sulfide, benzene, methane, ammonia, non-methane hydrocarbons and carbon monoxide in the surface atmosphere layer over the ROFES site, Kozloduy, MAS of the regional laboratory – Pleven.

11.3 Bibliography

207. EPRS-08-2B Report, Task 3 – Development of procedures for optimization and update of a centralized system for accident planning of effective coordination within SERAW and with competent authorities.

208. Letter CL-1057/0962 dated August 18th 2009 – CENTRAL ROADS AND BRIDGES LABORATORY – Data on average diurnal annual intensity of motor traffic by the existing counting points (primary and secondary) in the sections Borovan-Oryahovo (from 31.323 kilometer to 77.023 kilometer) of road 11-15 and Hurletz - Kozloduy (from 83.899 kilometer to 97.838 kilometer) of road 11-11 for 2005 and prognosis for 2010, 2015, 2020 and 2025.

209. Yankov, "Species diversity of woodpeckers living in populated areas of Bulgaria" "Priroda" (People's Republic of Bulgaria), 1986, 35, № 5, 65 – 67.

210. Archaeological research of Mound 2 and the necropolis, located south of Kozloduy NPP, regional museum, Varna

211. Labor safety bulletin MLSP, Sofia, 1995

212. Pre-project researches, "RiskEngineering" AD,

213. Stefanova, I. "Disposal of low- and intermediate level active waste", library "Radioactive waste and radio-ecology", Sofia, 2003"

214. Bonchev, N "Technical solution of construction of LILRW shaft repository on "Skata" ground, south of Kozloduy NPP, Sofia, 2007

215. Bonchev, N., "Survey and analysis of worldly experience in methods and technologies for disposal of low- and intermediate level radioactive waste (LILRW)", Sofia, 2008"

216. "Development of concept project for national repository for low and intermediate-level radioactive waste with short lifespan", (trench NRRAW). 2008

217. Concept project of National repository for disposal of low- and intermediate level RAW, report on task 4.1. of PHARE project №ECROPEAID/122568/D/SV/BG, 2008

218. EMEP/EEA CORINAIR'2009 (SNAP code **0808**) – emissions of exhaust gases form internal combustion engines (ICE)

219. IPCC (NFR code 1.A.5.b.iii) – carbon dioxide emissions in exhaust gases from ICE

220. American environment agency – emission factors based on method EPA AP-42 for open dust sources sections 11 and 13,

221. Method for determining the spread of hazardous substances emissions of vehicles and their concentration in the lowest layer of the atmosphere – software TRAFFIC ORACLE. (Ordnance № RD 994/ August 4th 2003 MEW)

222. Climate manual of the People's republic of Bulgaria, Publishing House "Nauka I izkustvo", Sofia, 1982

223. Gromkova, N. 1998, Pre-processed Hourly Data Set - The Meteorological Input of Applied Diffusion Models, *Bulg. Geoph. J.*, v. XXIV, No 3-4

224. Evstatiev, D and colleagues "Geological conditions assessment for long-term keeping of conditioned RAW on and around the ground Kozloduy NPP - Stage 1 "Examination of the region and of the "Marichin Valog" area and localization of the future ground"" and Stage 2: "Examination of the localized future ground in the "Marichin Valog" area", Archive of the Geological institute of BAS, Sofia, 2002

225. Evstatiev, D "Development of preliminary concept of injection fortification of construction soil, forming the loess massive and Paleocene clay, that for the construction basis of shaft and tunnel repositories for deployment and disposal of low- and intermediate level radioactive waste" Geological institute of BAS, Sofia, 2008

226. Цытович, Н. 1973 Механика грунтов, Москва, "Высшая школа".

227. Ржевский, В., Г. Новик 1973. Основы физики горных пород, Москва, "Недра",

228. Parashkevov, R “Rock Mechanics”, Sofia, “Technika”, 1969

229. Гелескул, М.Н., В.Н. Хорин и др. 1976. Справочник по креплению горных выработок", Москва, "Недра",

230. Vasilev, V “Proposal for selection of appropriate software products and calculation models for prognosis on geo-mechanical processes and the “soil massive-engineering construction” system in the construction of shaft repositories for radioactive waste”, BAS, 2008

231. Milchev, M, Mihailov, B, Grigorov, D and others, “Model for digital processing of data, regarding the pressure on the supporting and measurement of the appropriate supporting of the main and preparation works in subterranean mining facilities, ” Archive of “Minproect” Inc., 2004

232. Kolev, K “Preliminary prognostic assessment of geo-mechanical processes of inserted massive and effect on supporting structures of a subterranean tunnel installment (mining installments network) in depth up to 50 meters down from the zone of the ground chosen for deployment and disposal of low- and intermediate level radioactive waste (RAW), in compliance with the construction concept and the measurements of the installment 2008

233. Soil science – professor PhD Marin Penkov, Zemizdat 1988

234. Valuation of the farm lands in Bulgaria - professor PhD Marin Penkov, Zemizdat 1988, SIAC, 1995

235. Soil erosion and methods of its countering, professor engineering Ivan S. Stanev, 1

236. Soil pollution and its effect on ecosystems, M. Broshtilova, 2001(TEMPUS JET)

237. Landscape planning – architect V. Troeva, engineer G. Tsolova, ASGU 1997

238. Bulgarian Biogeography – Asen Asenov, 2006

239. Antonov Hr. and others: 1962, Works on Bulgarian geology. Geology and hydrology series, book 1

240. Filipov, L and others, 1992, Explanatory addendum to a geological map of Bulgaria, Scale 1:100,000, map list White

241. DRBD, 2007 Register of operational resources of subterranean waters February 2007

242. MEW, DRBD 2007 – List of subterranean waters in Republic of Bulgaria

243. MEW, DRBD 2007 Characterization of subterranean waters in Republic of Bulgaria.

244. Risk Assessment - InternaInstitute

245. Climate manual of the People's republic of Bulgaria , tome 4, Publishing House “Nauka I izkustvo”, Sofia, 1983

246. Climate manual – Rains in Bulgaria, Publishing House, BAS, Sofia 1990 г.

247. Petrov, P.G. And others – protection of subterranean waters from pollution and draining, Tehnika, Sofia 1976 (Methodological principles for assessment of subterranean waters pollution)

248. Antonov, Hr, Danchev, D., 1980 Subterranean waters in the People's republic of Bulgaria Sofia, Publishing House “Tehnika ”

249. Gulabov, M 1980 Dynamics of subterranean waters, Sofia, “Tehnika”

250. Norms for designing of plumbing and sewerage installments in constructions, 2001, MRDPW

251. Fire-precaution and construction technology norms. Fire-precaution water supply 2995 г., MIA and MRDPW

252. Ecological assessment and protection of water flaws from pollution – Dyadovsky and colleagues.

253. MEW – Environmental status bulletin.

254. Healthcare, 2003 National statistical institute and National healthcare information center, Sofia 2003, 1-162

255. Georgiev, M Physical geography of Bulgaria, DI “Nauka i izkustvo”, Sofia, 1980

256. Zoological analysis based on literature data.

257. Programs for determining changes in biological diversity monitoring and monitoring of BWA. Terrain researches include main description and typification of certain habitats in the zones with environmental changes.

258. Brief diagnostic and criteria on the basic taxonomic subdivisions of soils in the People's Republic of Bulgaria. Improved classification scheme, Sofia, 1983

259. Red Book of the People's Republic of Bulgaria, tome 1 and 2, BAS, Sofia, 1984.

260. Geography of Bulgaria, FORKOM, Sofia, 2002

261. Georgiev, G.,2004 National and nature parks and reservations in Bulgaria, Geya, Sofia.

262. Mihaylov, Hr, Stoyanov, St. 2001 Game birds and mammals in Bulgaria, PENSOFT, Sofia-Moscow

263. Nankinov, D. 2000 Endangered species in Bulgaria, academic publishing house “Professor Marin Drinov”, Sofia

264. Manual for determining of habitats of European importance in Bulgaria, 2005.Global wild nature fund, Danube-Carpathian program and “Green Balkans” federation, Sofia

265. Hydrological manual of rivers in the People's Republic of Bulgaria,, Sofia, 1980

266. Rules for accepting ground works and ground installations (State Gazette issue 45/1988 complemented State Gazette issue 7/1993)

267. Zarbova, K – Preservation of biological stability of river ecosystems (Water works 1/91)

268. Beshkov, Vl, Nanev, Kr 2002 Amphibians and reptiles in Bulgaria, Pensoff, Sofia.

269. BSS 1786-84 Light. Natural and artificial.

270. Georgiev, G.,2004 National and nature parks and reservations in Bulgaria, Geya, Sofia

271. Karapetkova, M, Zhivkov, M 2000. Fish in Bulgaria, Geyalibris, Sofia

272. Poryazov, Ya, Tonchev, G, Dobrichov, I 2004 Taxator's manual, Bulvark

273. Biserkov, V (editor) 2007 Guide to amphibians and reptiles in Bulgaria, Sofia, Green Balkans, page 196

274. Bondev, 1997 Geo-botanical zoning, found in “Geography of Bulgaria”, “M. Drinov” Publishing House

275. Infrasound, ultrasound, noise and vibration, edited by D. Tsvetkov and M. Anglelov, “Medicina I Fizika”, 1995

276. Pavlov, 1998. Fitocenical basis of forest typology in Bulgaria, PhD dissertation, . FTU.

277. Новак С. М., А. С. Логвинец. Защита от вибрации шума в строительстве. Справочник, Киев, Будивельнык, 1990.

278. Dakova S., Uzunov Y, Mandadjiev D., 2000 – Low flow - the River’s Ecosystem Limining Factor.Egol. Engineering,

279. Hygiene and professional diseases guide, edited by D. Tsvetanov, Sofia, Medicina I Fizkultura, 1994.

280. Popov, V, Sedefchev, A 2003, Mammals in Bulgaria, Geosoft Inc, Sofia, page 290 .

281. Vegetation in Bulgaria. Vegetation map, scale 1:600,000 with explanatory text. University publishing house “St. Clement Ochridski”, 1991

282. Yankov, “Species diversity of woodpeckers living in populated areas of Bulgaria” “Priroda” (People's Republic of Bulgaria), 1986, 35, № 5, 65 – 67.

283. Guide on assessment of protected zones, based on Art.7 Para. 3 and 4 of the Biological diversity act, including habitats of bird species, Kostadinova, I, Dereliev, S, 2001

284. Information from bibliographical sources, form fauna specialists.

285. Vasilev, M, Stanchev, R, Stoyanov, G, Zoology Institute, bul. “Tsar Osvoboditel” №1, Sofia; Anglov, M, “Green Balkans federation”, bul. “September 6th” №160, Plovdiv

286. Synopsis on plant cohabitates in Bulgaria, Apostolova, I, Slavova, L, Sofia 1997

287. Phitoecology, Liubenova, M 2004, Academic publishing house “Marin Drinov”, Sofia, page 574

288. Guide to plants in Bulgaria (Delipavlov, 1992)

289. Field guide, macrophytes (high water vegetation), EEA, MEW

290. Geography of Bulgaria, 2002, Geography institute, BAS

291. Manual for determining habitats of European significance in Bulgaria,2005, WWF – world wilderness fund edition, Green Balkans – Environmentalist associations federation, MEW, 128 ,

292. Atlas of endemic plants in Bulgaria, BAS, Sofiam Velchev Vl, Kozhuharov, St, Anchev, M (editor), 1992

293. Naumov, B, Stanchev, M 2004/2007 Amphibians and reptiles in Bulgaria and the Balkan peninsula, Digital edition of the Bulgarian Herpetologist association, web address: www.herpetology.hit.bg.;

294. Bats. Method of preparation of EIA and E (Manual for contractors and expert in the environmental field – National nature science musECm, BAS, Sofia, 2008)

295. NATURA 2000, Standard Form, BG 0000527 ,,Kozloduji loess wall” (last update 200802), including maps

296. NATURA 2000, Standard Form BG0000336 ”Zlatiya” (last update 200802), including maps

297. NATURA 2000, Standard Form BG0002009 ”Zlatiyata” (last update 200802), including maps

298. NATURA 2000, Standard Form BG0000614 ,,Ogosta River” (last update 200802), including maps

299. NATURA 2000, Standard Form, BG0000199 ”Tsibur” ((last update 200802), including maps

300. Red Book of Bulgaria, AS, Sofia, 1984.

301. Publications from Bulgaria's Biological Diversity: Biodiversity Support Program, c/o World Wildlife Fund:

302. Invertebrates (Non-Insecta) in Bulgaria. Christo Deltshev, Stoice Andreev, Gergin Blagoev, Vasil Golemansky, Gabriela Milojkova, Vlada Peneva, Dobrin Dobrev, Milcho Todorov, and Zdravko Hubenov;

303. Insects of Bulgaria, Part 1: Odonata, Ephemeroptera, Plecoptera, Homoptera (Auchenorrhyncha), Heteroptera, Coleoptera. Vasil Gueorguiev, Venelin L. Beshovski, Boris K. Russev, Krasimir P. Kumanski, Michail V. Josifov, and Vladimir P. Sakalian;

304. Insects of Bulgaria, Part 2: Blattodea, Mantodea, Isoptera, Orthoptera, Dermaptera, Embioptera, Megaloptera, Raphidioptera, NECroptera, Mecoptera, Hymenoptera, Trichoptera, Lepidoptera, and Diptera. Zdravko Hubenov, Venelin Beschovski, Stoyan Beshkow, Janko Kolarov, Krasimir Kumanski, Alexi Popov, and Emiliya Vassileva

305. Freshwater Fish of Bulgaria. Maria Karapetkova, Mladen Ґivkov, and Koyka Alexandrova-Kelomanov;

306. Beshkov V., Bulgaria's Amphibians and Reptiles.

307. Spiridonov, G.and N. Spassov, Large Mammals (Macromammalia) of Bulgaria.;

308. Popov, V., The Small Mammals (Insectivora, Lagomorpha, Rodentia) of Bulgaria.;

309. Beshkov, V., The Bats of Bulgaria.

310. Василенко, И.Я., О. И. Василенко. 2002. Радиация и человек. Проблемы глобальной безопасности. N 6, С. 13–16

311. Donov, V, 1993. Forest soils science, “Martilen” publishing house page. 222

312. Yolevsky, M, Hadzhiyanakiev, A, Kabakchiev, Iv (1982): Agricultural production grouping of soils, In: Geography of Bulgaria, BAS publishing house

313. Yolevsky, M, Hadzhiyanakiev, A, Georgieva, Ya, Kabakchiev, Iv (1980): Map of agrarian ecological zones in Bulgaria

314. Kabakchiev, Iv (1982): Azonal soils In: Geography of Bulgaria, BAS publishing house

315. Kabakchiev, Iv (1982): Quality of agricultural soils based on agricultural production groups In: Geography of Bulgaria, BAS publishing house

316. Ninov, N (1982): Soil geographic regions, page 399-400 In: Geography of Bulgaria, BAS publishing house

317. Raykov, L 1978. Radioactive elements in the soil and their assimilation by plants, Zemizdat, Sofia, page 150

318. Tabakov, B 2006 Degradation of land caused by industry, mining, urbanization and other areas excluding agriculture and forestry. Discussion report, project .No 00043507: Construction of Sustainable Land Management Capacity in Bulgaria.

319. State of the environment and natural resources – natural and technological radioactivity. Annual report on the state of the environment in Bulgaria. 1999

320. Report on the results of the conducted geological, geophysical, ego-engineering, hydro-geological and laboratory researches. MGU “Engineering” Inc. Sofia 2009.

321. IAEA, The principles of radioactive waste management, Safety Fundamentals, Safety Series No.111-F, Vienna, 1995.

322. IAEA, International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources. Safety Series No. 115, Vienna 1996.

323. IAEA, Fundamental safety principles, Safety Standards, No.SF-1, Vienna, 2006.

324. IAEA, 1999, Safety Assessment for Near Surface Disposal of Radioactive Waste. Safety Guide. Safety Standards Series No. WS-G-1.1 , IAEA, Vienna

325. IAEA, Environmental and Source Monitoring for Purposes of Radiatioп Protectioп, Safety Guide RS-G-1.8;

326. IAEA, Moпitoriпg aпd Surveillaпce of Residues from the Miпiпg aпd Milliпg of Uranium and Thorium, Safety Reports Series No. 27, IAEA, Vienna (2002);

327. IAEA, 2002, Prepareness and response for nuclear or radiological emergency, Safety Requirements, Safety Standards Series No. GS-R-2, IAEA, Vienna

328. IAEA, 2000, Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety, Safety Requirements No. GS-R-1, IAEA, Vienna

329. IAEA, Siting of Near Surface Disposal Facilities, Safety Series No.111-G-3.1, Vienna, 1994.

330. IAEA, Near surface disposal of radioactive waste, Safety Requirements No. WS-R-1, Vienna, 1999.

331. ICRP, Radiological Protection Policy for the Disposal of Radioactive Waste, Publication No. 77, Elsevier, Oxford, 1997.

332. ICRP, Radiation Protection Recommendations as Applied to the Disposal of Long-Lived Solid Radioactive Waste, Publication No. 81, Elsevier, Oxford, 1999.

333. ICRP, Priпciples of Moпitoriпg for the Radiatioп Protectioп of the Populatioп, Puьlicatioп43, Pergamoп Press, Oxford aпd New York (1984);.

334. IAEA, Radioactive waste management glossary, 2003 Edition, Vienna, 2003.

335. Considerations in the development of near surface repositories for radioactive waste, Technical reports series No.417, 2003

336. Disposal options for disused radioactive sources, Technical reports series No.436, 2005

337. Technical Report, Task 2 Development of Regulatory Guides on Applying Decommissioning Regulations, Sub-Task 2.4 Format and Content of Safety Analysis Report for Near Surface Radioactive Waste Disposal Facility, Final Revision, July 2007

338. Scientific and technical basis for the near surface disposal of low and intermediate level waste, Technical reports series No.412, 2002

339. Disposal Aspects of low and intermediate level decommissioning waste, IAEA-TECDOC-1572, 2007

340. Safety considerations in the disposal of disused sealed sources in borehole facilities, IAEA-TECDOC-1368, 2003

341. IAEA - Tecdoc-1372, Safety iпdicators for the safety assessmeпt of radioactive waste disposal, IAEA, Vienna (2005)

342. IAEA-TECDOC-1380, Derivation of Activity Limits for Disposal of Radioactive Waste to Near Surface Facilities, Vienna, 2003

343. Technical considerations in the design of surface disposal facilities for radioactive waste, IAEA-TECDOC-1256, 2001

344. Performance of engineered barrier materials in near surface disposal facilities for radioactive waste, IAEA-TECDOC-1255, 2001

345. Procedures and techniques for closure of near surface disposal facilities for radioactive waste, IAEA-TECDOC-1260, 2001

346. IAEA, Low and intermediate level waste repositories: socioeconomic aspects and public involvement, IAEA-TECDOC-1553, Vienna, 2007.

347. IAEA, Surveillance and monitoring of near surface disposal facilities for radioactive waste, Safety Reports Series No.35, Vienna, 2004.

348. IAEA, Regulations for the Safe Transport of Radioactive Material, 2005 Edition, Safety Requirements No. TS-R-1, Vienna, 2005.

349. IAEA, 1996, Quality Assurance for Safety in Nuclear power plants and Other Nuclear Installations: Code and Safety Guides Q1-Q9, Safety Series No 50-C/SG-Q, IAEA, Vienna

350. IAEA-TECDOC-846, Safety Assessment of Near Surface Radioactive Waste Disposal Facilities: Model Intercomparison Using Simple Hypothetical Data (Test Case 1), Vienna, 1995

351. IAEA, ISAM report, Safety Assessment Methodologies for Near Surface Disposal Facilities, Results of a co-ordinated research project, Volume 1: Review and enhancement of safety assessment approaches and tools, Volume 2: Test cases, Vienna, 2004

352. IAEA, Draft Safety Guide DS284, Safety Standards Series, Safety Assessment for Nuclear and Radiation Facilities Other than Reactors and Waste, Vienna

353. IAEA, Draft Safety Guide DS292, Storage of Radioactive Wastes, Vienna

354. Stefanova, I, Disposal of high level radioactive waste, Sofia, publishing house Termit, 97 Lld., 2004 .

355. Barrow, C. J. 2000. Social Impact Assessment: an Introduction. London: Arnold.

356. Becker, H. A., 1997. Social impact assessment : method and experience in ECrope, North America and the developing world London : UCL Press

357. Klessig, Lowell L., and Victor L. Strite. 1980. The ELF Odyssey: National Security Versus Environmental Protection. Boulder, CO: Westview Press

358. NENEI, BAS, Report on the development of the concept of disposal of radioactive waste, attached to agreement № 204001/09.12.2004 “Developing a concept for disposal of REW, survey and choice of potential sites for NRRAW”

359. Pre-project (pre-investment) research on construction of tunnel NRRAW, Minproekt Inc, 2009

360. Pre-project research on construction of shaft NRRAW, Minproekt Inc,, 2009

361. Assessment of quality of surface and subterranean waters due to nitrate pollution, caused by agricultural sources. DRBD, 2007

362. Regional development strategy, Vratsa district, 2005-2015, adopted by the assembly on November 11th 2005, during the Regional development council of Vratsa district.

363. Environmental protection program of the Kozloduy municipality for the 2004-2010 period .

364. Report of REWI-Vratsa, MEW on the state of the environment in 2008

365. Report of REWI-Vratsa, MEW on the state of the environment in 2007

366. Report of REWI-Vratsa, MEW on the state of the environment in 2006

367. Annual Radio-ecological monitoring research results for Kozloduy NPP -2008

368. Report of Kozloduy NPP Inc,, dated March 2009

369. Report on the assessment of the environmental impact of Kozloduy NPP (REIA of NPP), Sofia, 1999

370. Report on the assessment of the environmental impact of Kozloduy NPP, Sofia, March 10th 2001

371. Report on the assessment of the environmental impact of the repository for dry conservation of spent nuclear fuel located in Kozloduy NPP, 2005

372. Letter from Watering systems LLC, Vratsa branch, № 410/May 20th 2009

373. Letter from Danube region basin directorate, based in Pleven, MEW, reference № 2455/June 2nd 2009

374. Letter from Kozloduy NPP NPP reference № 3401-E/September 15th 2009

375. Results from the radio-ecological monitoring of Kozloduy NPP - 2007, Annual report of Kozloduy NPP Inc., March 2008

376. Results from the radio-ecological monitoring of Kozloduy NPP - 2006, Annual report of Kozloduy NPP Inc., March 2007

377. Results from the radio-ecological monitoring of Kozloduy NPP - 2005, Annual report of Kozloduy NPP Inc., March 2006

378. Results from the radio-ecological monitoring of Kozloduy NPP - 200, Annual report of Kozloduy NPP Inc., March 2005

379. Letter from Danube region basin directorate, based in Pleven, MEW, reference№ APIL 176/May 26th 2009

380. BSS 1786-84 Lighting. Natural and artificial.

381. U.S.EPA. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". OSWER Directive 9285.6-03, Office of Emergency and Remedial Response, March 25, 1991.

382. U.S. EPA. Guidelines for Carcinogen Risk Assessment. EPA/630/P-03/001F. 2005. Washington, DC: Risk Assessment Forum, U.S. Environmental Protection Agency. Available: http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=439797/

383. WHO Assessing human health risks of chemicals: derivation of guidance values for health-based exposure limits. Environmental Health Criteria) 170, World Health organization/ International Chemical Safety Program, 1994, Geneva

384. WHO/UNEP/ILO Approaches to integrated risk assessment Document, World Health organization/ United Nations Environmental Program/ International Labor Office/01/12, December 2001, Geneva

385. Air quality guidelines for Europe. 2nd Edition, 2000. WHO Regional Publications, European Series, No. 91, pp. 286

386. Marketing profile of Kozloduy municipality.

387. Tourism development program of the Kozloduy municipality for the 2008-2011 period.

388. Letter from Regional Directorate "Agriculture" - Vratsa, Ministry of agriculture and food № 747/May 26th 2009

389. Letter from Regional Directorate for forestry, National forestry agency, Council of ministers reference № Br-19/June 1st 2009

390. Letter from National forestry agency– Oryahovo, reference. № 617/July 6th .2009.

391. Letter from Municipal agricultural office, Kozloduy, Regional directorate

392. "Agriculture" - Vratsa, Ministry of agriculture and food, reference №284/July 6th 2009

393. Letter from Regional Directorate for forestry – Berkovitsa National forestry agency, Council of ministers, reference № NGD-08/July 17th 2009

394. Letter from National forestry agency, Council of ministers reference № 92-215/July 17th 2009

395. Letter from the Regional history museum, Vratsa reference . №27/June 17d 2009

396. Letter from MEW reference № 48-00-566/July 13th 2009

397. Letter from national protection of immovable cultural values institute.

398. Ministry of culture, reference № 1316/June 9th 2009

399. Letter from EEA, MEW reference № 53-00-2840/May 29th 2009

400. Letter from the Ministry of Environment of Romania, reference№ 7439/EGU/November 16th 2009

401. Letter from MEW reference. №26-00-1223/20.11.2009 г.

402. Notification to an affected party of a proposed activity under article 3 of the Convention on Environmental Impact Assessment in trans-boundary context about Investment Proposal for Implementation of National Disposal Facility for Low and Intermediate Level Radioactive Waste, SERAW, 2009; sent in MEW via letter of GC RAW reference № GU-OK-269/July 24th .2009

403. ISO 14001:2004 "Environmental management systems. Requirements and guidelines. "

404. Characteristics of subterranean water basins DRBD, 2007

405. BSS EN ISO 9001:2000 Quality management systems. Requirements.

406. BSS 14478-82 Noise. Admissible levels in work places. Common requirements for conducting measurements.

407. BSS 14776-87 Production microclimate.

408. BSS 1786-84 Light. Natural and artificial.

409. ICRP, Publication 103, 2007

410. Geokadmin, Detailed geodesic map of the Radiana site, 2009

411. Site monitoring program, tome IV, Task 4 "Approval of site", Parsons, July 2008

412. Protocol № 2 from Technical expert council assigned to the Minister of economy, energy and tourism, conducted on August 16th 2010, approved by the Minister of economy, energy and tourism,

413. Consortium EAVTEN (Empresarios Agrupados, VT Group, Enpro Consult), Bulgarian National disposal facility assessment of conceptual design applicability, report P0061-10071-002, 2009

414. SERAW 2006, Implementation of technical solution №RAW.TR-088/June 2nd 2006 for changing the build of StBK transportation and reposition of RAW from NPP “Kozloduy” container.

415. SD “RAW-Kozloduy” 2006, Technical specifications of the containers of conditioned RAW ID №RK.RAW.ED.TSP.001

416. SERAW, 2007, Updated safety analysis for SD “RAW-Kozloduy

417. Decommission plan for blocks 1 and 2 of NPP “Kozloduy”, Kozludui, GUP 2007

418. REIA on the decommission of blocks 1-4 of NPP “Kozloduy”, edition 1, 2010 EWN, Energy Institute

419. Report on the safety analysis for the reconstruction of the NPNRI - BAS's scientific reactor IRT into a low-power reactor

420. IAEA, Classification of radioactive waste, General Safety Guide No.GSG-1, 2009

421. IAEA, Categorization of radioactive sources, RS-G-1.9, 2005

422. Modeling of the migration of key radionuclides from applicable types of NRRAW for the characterized sites. Geotehnika ABS 2010

Part XII

TABLE OF CONTENTS

Part XII

12. DESCRIPTION OF THE CAUSES OF THE DIFFICULTIES ENCOUNTERED IN THE PREPARATION OF THE EIA

The difficulties encountered in preparing the EIA report are mainly due to:

- ✓ A deficit of information for some components of the environment;
- ✓ The need to ensure that the information downloaded from the Internet, although insufficient in volume, was used in accordance with the objective of this evaluation
- ✓ Unlawful and excessive requests for information and assessments, which significantly exceeded the requirements for an investment stage proposal on which an EIA is carried out;
- ✓ Presentation of large amounts of information by the Customer in connection with an inquiry into a long period of time
- ✓ The early design stage of the investment proposal;
- ✓ Various sites prior to the siting "Radiana” site
- ✓ Different technical solutions for NHRAO
- ✓ Specificity of action and responsibility for the decision of the Customer for priority selection of the proposed alternatives and consequently assess the environmental impact by individual experts of the team prepared the EIA report.

Part "Abbreviations and terminology"

CONTENTS

ABBREVIATIONS

AAQ	Ambient air quality
AMS	Automatic meteorological stations
BRPS	Basic radiation protection standards
CA	Compatibility assessment
DFS	Domestic-fecal sewage
DRBD	Danube Region Basin Directorate
EA	Ecological assessment
EEA	Environmental Executive Agency
EIA	Environmental impact assessment
EMF	Electromagnetic fields
EPL	Environmental Protection Law
EU	European Union
FDP	Fine dust particles
HFS	Host faecal sewage
HM	Healthcare Ministry
IAEA	International Atomic Energy Agency
IHO	International healthcare organization
INDA	International Nuclear Defense Agency
IP	Investment proposal
LILRAW	Low and intermediate level radioactive waste
LNHW	Landfill for non-hazardous waste
LSUNE	Law for the safe use of nuclear energy
LB	Law on biodiversity
MEW	Ministry of Environment and Waters
MLF	Medium and low frequency
MMS	Meteorological monitoring system
MRD	Ministry of Regional Development
MPP	Means for personal protection
NEN	National Ecological Network
NPP	Nuclear power plant
NRA	Nuclear Regulatory Agency
NRRAW	National repository for the burial of low and intermediate level radioactive waste
PA	Protected areas
PMG	Project management group
PSA	Preliminary safety assessment
PT	Protected territories
RAW	Radioactive waste
RB	The Red Book
RBNRP	Regulation for basic norms of radiation protection
RCC	Reinforced concrete container
REIA	Report on environmental impact assessment
REM	Radio ecological monitoring
REWI	Regional Environmental and Waters Inspectorate
RISS	Research Institute of Soil Science

SD	Special division
SE"RAW"	State Estate "Radioactive Waste"
SU RAW	Specialized Unit "Radioactive waste"
SCRAW	Storage for conditioned radioactive waste
SNF	Spent nuclear fuel
SV	Specialized vehicles
TA	Traffic accident
TLV	Threshold limit values
UBRD	European Bank for Reconstruction and Development
WML	Waste Management Law
WSHFS	Work safety and hygiene and fire safety

LIST OF TERMS

"Emergency readiness" is the ability to take immediate actions to effectively minimize the impact of any possible accident on human health, the environment and material valuables.

"Emergency exposure" is the irradiation of individuals during an emergency. (This does not include radiation exposure in the prevention and management of emergencies.)

"Emergency" is an extreme event which results or may result in exceeding the limits or breaching the terms of radiological impact on humans and the environment, specified in the rules and regulations on nuclear safety and radiation protection.

"Activation" is the process of producing radionuclides by irradiation (induction of radioactivity in living and nonliving matter).

"Activity" of a radioactive source is the average number of spontaneous nuclear transformations (crumbling) (dN) in it for a small interval of time (dt) and the duration of this interval:
A = dN / dt
Unit: Becquerel [Bq]
1 Bq = 1 s-1

"Nuclear power plant" is a power plant, in which energy is generated by one or more nuclear reactors and which may include the associated facilities for the management of radioactive waste and spent nuclear fuel located on site, for which general physical security and emergency planning are provided .

"A Barrier" is any physical (engineered or natural) barrier that prevents the spread of radioactive waste and protects RAW from internal and external negative effects.

"Vienna Convention" is the Vienna Convention on Civil Liability for Nuclear Damage.

"Commissioning" is the process during which systems and components of the nuclear facility or other sources of ionizing radiation may be put into a serviceable condition and be evaluated for compliance with the project requirements and criteria for performance.

"Radiation generator" is a device capable of generating ionizing radiation if supplied with energy from an external energy source.

"Geological burial (of RAW)" is the deployment of radioactive waste in a stable geological formation at a depth of 100 meters through the use of engineered and natural barriers.

"Closed source" is a source of ionizing radiation which is used without compromising its integrity, and the structure of which is such that under normal operating conditions excludes the distribution of the contained therein radioactive substances into the environment. Spent nuclear fuel is not a closed source.

"Closure" is the finalization of all operations at a certain moment of time after the deployment of radioactive waste in a disposal facility. This includes the final engineering or other works required to bring the facility into a safe state in the long term.

"Protected area" is an area designated for the purpose of physical protection and located within the site of a nuclear facility or another site which uses or stores nuclear materials or radioactive substances, which is under constant surveillance by guards or electronic devices, is surrounded by a physical barrier with a limited number of entry points, and to which access is possible only for people with special passes.

"Controlled access area" is an area designated for the purpose of physical protection, covering the area around the protected zone of a nuclear facility or another site which uses or stores nuclear materials or radioactive substances, to which access is controlled.

"Siting" is the process of selecting a suitable site for the construction of a nuclear facility or a facility with sources of ionizing radiation, including appropriate assessment and determination of design basis.

"Decommissioning" includes all the administrative and technical actions undertaken to release the nuclear facility from regulation under this Act, including closure of a disposal facility for radioactive waste or spent nuclear fuel. These measures include the processes of deactivation and dismantling.

"Source of radiation" or "source" is a device, a radioactive substance, system, plant or equipment that has the ability to emit ionizing radiation or releases radioactive substances (except for nuclear facilities).

"Discards" are planned and controlled releases of liquid or gaseous radioactive materials into the environment generated during the normal operation of a nuclear installation, nuclear facility or another facility with sources of ionizing radiation, as a legitimate practice, within the limits authorized by the competent authorities.

" Nuclear source material" means: uranium containing the mixture of isotopes occurring in nature; depleted uranium; each of these substances in the form of metal, alloy, a chemical compound or concentrate; a material which contains one or more of these substances with a concentration and amounts exceeding the values established in the normative act.

"Incident" is a technical event or deviation which, although not directly or immediately influencing nuclear safety and / or radiation protection, is capable of causing a subsequent revaluation of nuclear safety and / or radiation protection.

"Ionizing radiation" is the transfer of energy in the form of particles or electromagnetic waves with a wavelength of 100 nanometers or a frequency of over 3 x 10 (15) Hz including, capable of producing ions directly or indirectly.

"Conditioning (RAW)" is bringing the waste into a form suitable for its subsequent transport, storage and / or disposal.

"Container" is a volume which facilitates radioactive waste for safe handling, transportation, storage and / or disposal.

"Controlled area" means any area which requires measures for radiation protection of the staff, monitoring of occupational exposure and radioactive contamination under normal operating conditions, as well as measures to prevent and limit potential exposure.

"Critical group" is a group of the population, which is sufficiently homogeneous in terms of irradiation received by a certain source and way of exposure, and is representative of the people who receive or will receive the highest effective dose or equivalent doses (according to the case) of the designated source and way of exposure.

"Monitoring" is the measuring of radiation or other parameters for the purpose of assessment or control of exposure to radiation, and interpretation of results.

"Supervised area" is any area outside the borders of the controlled area where there is radiation control of the working environment, but which does not require taking measures for the radiation protection of the staff.

"Beyond project accident" is an accident for which no technical means within the project have been provided.

"Irradiation" is the process of impact of ionizing radiation on humans.

"Irradiation of the population" is the irradiation received by the population due to authorized or unauthorized activities with sources of ionizing radiation, with the exception of occupational irradiation, medical irradiation and the normal natural background radiation typical for the particular place of work or life.

"Processing (RAW)" are activities that lead to a change in the characteristics and composition of RAW. These activities include pre-processing, processing and conditioning of RAW.

"Package" is a set of components necessary for the full retention of radioactive substances, including the radioactive waste itself.

"Spent nuclear fuel" or **"spent fuel"** is nuclear fuel that has been irradiated in the core of a nuclear reactor and is permanently removed from it.

"Safety assessment" is the examination of all aspects of the project and operation of the nuclear facilities or other sources of ionizing radiation associated with its safety and the protection of people, including the analysis of the measures of nuclear safety and radiation protection, and risk under normal conditions and in case of emergencies.

"Shallow burial (of RAW)" is the deployment of RAW on and below ground surface at a depth of 100m using natural or engineered barriers.

"Burial" is the emplacement of spent fuel or radioactive waste in an appropriate facility or location with no intention of retrieving it again.

"Potential irradiation (possible irradiation)" is irradiation the occurrence of which is not certain but is possible.

"Pre-processing (RAW)" are activities related to collection, sorting, chemical and mechanical treatment of waste prior to processing.

"Processing (RAW)" are activities that change its characteristics, such as: pressing, burning, crushing, melting, and deactivation of RAW resulting in a change of its characteristics.

"Radiation monitoring" is obtaining evaluations and information on the radiation situation at sites with sources of ionizing radiation, in the environment, and the exposure of people (including radiometric and dosimetric control).

“Radiation risk” is the probability of adverse health effects in humans or in their offspring as a result of exposure to ionizing radiation.

"Radiation protection” is a complex of organizational and technical measures designed to protect people from exposure to ionizing radiation, including ensuring the safety of sources of ionizing radiation and work with them, i.e. providing minimal risk of undue irradiation, a minimum number of irradiated workers, a minimal amount of irradiation of people without exceeding the prescribed limits of the doses of irradiation, the prevention of accidents and limiting their consequences.

"Radioactive source" is a source whose properties to emit ionizing radiation are solely due to the contained therein radionuclides.

"Radioactive waste" is a radioactive material in gaseous, liquid or solid form, the use of which is no longer foreseen by the licensee holder or permit holder and which is controlled by the agency as radioactive waste under this Act, including a radioactive source the safe use of which has expired under the design documentation.

"Safety Systems" are systems intended for the prevention of accidents, including fires, and limiting their consequences.

“Safety crucial systems "are safety systems and systems for normal exploitation, the failures or break-downs of which are the starting points of accidents.

"Specific activity (mass activity)” is the activity of the radioactive source divided by its mass. Unit: Bq / kg ($Bq.kg^{-1}$).

"Scenario" is a set of conditions or events used in the planning, design and safety assessment of a facility for the management of RAW.

"An event" is any deviation from the set mode of operation, including one or more equipment failures, errors or mistakes of staff and / or faults in instructions and procedures that led or could lead to the release of radioactive substances in the work surroundings or the environment, or to the undue irradiation of the population or staff, or to a breach of the requirements, rules and standards of nuclear safety and radiation protection.

"A facility for spent fuel management" is any facility the primary purpose of which is the management of spent fuel.

"A facility for radioactive waste management" is any facility, the primary objective of which is radioactive waste management, which includes a nuclear facility in the process of being decommissioned only if it is designated as a facility for radioactive waste management under this law.

"Storage” is the depositing of nuclear material or radioactive substances, including spent fuel or radioactive waste, in a facility that provides the restriction of their impact with the intention of their retrieval.

"Severe natural disaster of exceptional nature” is a catastrophic, unforeseeable and unavoidable natural disaster.

"Technogenic radionuclides" are radionuclides the presence of which or concentration in the radioactive substance of which is attributable to human activity.

“Spent fuel management "means all activities related to the handling or storage of spent fuel, excluding off-site transport. It may also involve discharges.

"Radioactive waste management" means all activities that relate to the handling, pre-treatment, processing, conditioning, storage, and disposal of radioactive waste.

"Physical Protection" is a combination of technical and organizational requirements, measures, means and methods designed to effectively prevent illegal influences and violations of nuclear material, nuclear facilities and radioactive substances (theft, illegal intrusion on the territory of a nuclear facility, unauthorized access to areas of particular importance for the safety of the nuclear installations, sabotage, terrorist acts), the timely detection, termination and return of illegally acquired nuclear material.

"State of the radioactive waste" is the physical and chemical state of radioactive waste after processing which has led to the obtaining of a product suitable for packaging.

"Safety function” is a physical or chemical process, or property with a contribution to safety.

"**Characterization of radioactive waste"** is the definition of physical, chemical and radiological properties of waste to determine the need for processing, storage and / or burial.

"Nuclear material" is a source material, special nuclear material and other materials specified by the Council of Ministers.

"Nuclear Reactor" means any nuclear installation containing nuclear fuel positioned in such a way that inside of it a self-sustaining nuclear fission chain reaction can occur without an additional source of neutrons.

"Nuclear incident" is an incident involving the release of radioactive substances into the environment or potentially dangerous exposure of personnel or the population caused by the breach of control and management of the fission chain reaction, formation of critical mass, disrupting of the leading away of heat from the irradiated nuclear material, or damage to nuclear material including nuclear fuel.

"Nuclear safety" is the state and the ability of a nuclear facility and its systems and personnel to prevent an uncontrolled fission chain reaction or unacceptable release of radioactive substances or ionizing radiation in the work surroundings or the environment, prevention of incidents and accidents and limiting their consequences.

"Nuclear installation" in accordance to the Vienna Convention is a nuclear reactor (including critical and below critical stand); a research reactor; a nuclear power plant; a facility for spent fuel management; a facility for conversion or enrichment of nuclear material and equipment for the manufacture or reprocessing of nuclear fuel.

"Nuclear plant” is a nuclear facility used to generate electricity and / or thermal energy.

"Nuclear fuel" means any special nuclear material that is capable of producing energy by a self-sustained nuclear fission chain reaction.

"Nuclear facility" is a facility, including the associated land, buildings and equipment, which extracts, produces, processes, uses, handles, stores or disposes of nuclear materials in a scale that requires the reporting of nuclear safety and radiation protection. "Nuclear facility" also means any facility for radioactive waste management.

DOSIMETRY

Dimension	Definition	Units	Formula
Dose (D)	the ratio of average transmitted energy in the volume of the exposed substance to the mass of the substance in this volume	Gray [Gy]	$D = d\overline{E} / dm$, where: $d\overline{E}$ is the average energy transmitted by the ionizing radiation in the elementary volume of substance exposed; dm - the mass of substance in this volume
Equivalent dose (EqD).	the absorbed dose averaged over an organ or tissue multiplied by the appropriate radiation weight coefficient	Sievert [Sv], $1Sv = 1\ J.кg^{-1}$	$H_{T,R} = w_R . \overline{D}_{T,R}$, where: $\overline{D}_{T,R}$ is the average absorbed dose in a given organ or tissue T, due to the radiation R; w_R - radiation weight coefficient for the radiation R If the radiation field is composed of several rays with different values WR, the equivalent dose is defined according to the formula: $H_T = \sum w_R . \overline{D}_{T,R}$
Effective dose (EfD)	the amount of the works of the equivalent doses in the organs and / or tissues with the appropriate tissue weight coefficient	Sievert [Sv], $1Sv = 1\ J.кg^{-1}$	$E_T = \sum w_R . \overline{H}_T$, where: $\overline{H}_T$ is the value of the equivalent dose in the tissue or organ T; WT - tissue weight coefficient for the tissue or the organ T.
Capacity of the dose	the relation of the increase of the dose of dD for an interval of time dt to this interval	the units for the corresponding dose divided by the unit of time	$D = dD / dt$
Extensive radiation	the activity of a radioactive source, divided by the volume of the substance which contains this activity	Becquerel per cubic meter $[Bq.m^{-1}]$, Becquerel per liter $[Bq.l^{-1}]$	
Density of the flow of beta particles (DF)	ratio of the number of the dN particles passing for time dt through the central sectional area of the elementary sphere dS	[number of particles per $m^2.s$]	□ = dN / dS.dt