APPROVED at the meeting of the
Academic Council of JSC
"Sh. Yesenov Caspian University
of Technology and Engineering".
Minutes No. 09 dated May 26, 2026.

Entrance exam program
for applicants for doctoral studies per group of educational programs
D087 – «Environmental protection technologies»

1. 1. General provisions.

1. The program is compiled in accordance with the Order of the Minister of Education and Science of the Republic of Kazakhstan dated October 31, 2018 No. 600 'On Approval of the Model Rules for Admission to Education in Educational Organizations Implementing Higher and Postgraduate Education Programs' (hereinafter referred to as the Standard Rules).

2. The entrance examination for doctoral studies consists of an interview with the applicant conducted by the Examination Committee of the higher education institution, writing an essay, and an examination in the speciality of the educational program group.

Block	Points
1. Interview with the applicant conducted by the admissions examination committee of the higher education institution	30
2. Essay	20
3 Exam in the specialty of the educational program group	50
Total	100

3. The duration of the entrance examination is 3 hours and 30 minutes, during which the applicant undergoes an interview, writes an essay, and responds to an electronic examination ticket. The interview is conducted at the higher education institution prior to the entrance examination.

2. Procedure for the entrance examination.

1. Applicants for doctoral studies in the group of educational programs D087 – «Environmental protection technologies» write a problematic / thematic essay. The volume of the essay is at least 250-300 words.

2. The electronic examination card consists of 3 questions.

Topics for exam preparation according to the profile of the group of the educational program.

Discipline "Industrial Ecology"

Topic 1. Pollution Sources and the Carbon Footprint of Industry

Subtopics: Modern Pollution Sources (including the Digital Economy and Energy). Greenhouse Gases and Carbon Footprint. ESG and Industrial Decarbonization

Pollution Spread Modeling. The Impact of Climate Change on Air Quality. Natural Sources of Air Pollution and Their Environmental Role. Physicochemical Properties of Pollutants (State of Aggregation, Dispersity, Density, Chemical Activity). Aerosols and Particulate Matter (Dust, Smoke, and Fog), Their Classification and Environmental Impact. Gaseous Pollutants (Sulfur, Nitrogen, and Carbon Oxides, Hydrocarbons, and Volatile Organic Compounds). Toxic Pollutants (Heavy Metals, Carcinogens, and Radioactive Substances). Formation and Spread of Pollutants in the Atmospheric Environment. Dispersion of Pollutants in the Atmospheric Air. The Impact of Meteorological Conditions on Pollution Spread (Wind, Temperature Inversion, Humidity, and Precipitation). Formation of ground-level pollutant concentrations. Standardization of pollutant emissions into the atmosphere. Maximum permissible emissions (MPE) and their environmental significance. The relationship between MPE and maximum permissible concentration (MPC). Temporarily agreed emissions (TAE). Methods for calculating pollutant emissions. Inventory of emission sources. Methods for monitoring and controlling pollutant emissions. Sanitary protection zones of industrial enterprises. Ecological and sanitary-hygienic consequences of air pollution. The impact of air pollution on human health and ecosystems. Modern problems of air pollution and ways to reduce them.

Topic 2. Innovative technologies for emission reduction

Subtopics. Best Available Techniques (BAT). Digital emission control systems (IoT, sensors). CO_2 capture and storage (CCS/CCUS). Next-generation filtration (nanofilters). Hydrogen energy as a method for reducing emissions. Sealing process equipment and preventing pollutant leaks. Optimization of fuel combustion modes and reduction of harmful substance formation. Use of alternative and environmentally friendly fuels. Organizational and technical measures to reduce emissions. Classification of gas emission purification methods. Mechanical methods of gas purification from solid particles. Gravity gas purification methods. Inertial gas purification methods. Centrifugal gas purification methods (cyclones, multi-cyclones). Filtration gas purification methods. Gas purification in fabric and bag filters. Gas purification in granular and porous filters. Wet gas purification methods. Gas purification in various types of scrubbers. Gas purification in Venturi apparatuses. Bubbling and foam gas purification devices. Electrostatic gas purification methods. Operating principle of electrostatic precipitators. Design and types of electrostatic precipitators. Collection of fine particles and aerosols. Collection of liquid aerosols and fogs. Physicochemical methods of gas purification. Absorption methods of gas purification. Adsorption methods of gas purification. Chemisorption methods of gas purification. Catalytic methods of gas purification. Thermal methods of gas purification. Biological methods of gas purification. Combined methods of gas emission purification. Promising directions for the development of gas emission purification technologies.

Topic 3. Water Resources and Water Recirculation Systems 4.0

Subtopics. Smart water systems (digital water consumption management). Next-generation closed-loop water circulation systems. Water stress and water shortages (global and regional). Wastewater treatment using membrane technologies. Caspian water challenges. The importance of water resources in industry and their role in technological processes. Main areas of water use in industrial enterprises. Classification of water supply systems for industrial enterprises. Direct-flow water supply systems and their characteristics. Recirculating water supply systems and their environmental significance. Closed-loop water supply systems and their application prospects. Combined water supply systems. Water supply sources for industrial enterprises (surface and groundwater). Water quality requirements for various industries. Water treatment for industrial needs. Methods of natural

water purification for industrial use. Rational use of water resources at enterprises. Water consumption and wastewater disposal at industrial enterprises. Water balance of an industrial enterprise. Main sources of wastewater generation. Classification of industrial wastewater. Industrial, domestic, and atmospheric wastewater. Characteristics of pollutants in wastewater. Physical, chemical, and biological quality indicators.

Topic 4. Waste Management and the Circular Economy

Subtopics: Circular Economy Concept. Zero Waste Strategy. Automated Waste Sorting (AI). Waste-to-Energy Technologies. Plastic and Microplastic Recycling. Environmental and Sanitary Issues Associated with Municipal Solid Waste. The Impact of Municipal Solid Waste on the Environment. The Impact of Waste on Air, Water Resources, and Soil. Municipal Solid Waste Management Systems. Municipal Solid Waste Collection. Temporary Waste Storage Methods. Municipal Solid Waste Transportation. Municipal Solid Waste Sorting. Manual and Mechanized Waste Sorting. Automated Waste Sorting Systems. Separate Waste Collection. Mechanical Recycling of Municipal Solid Waste. Waste Shredding and Equipment Used. Waste Separation (Magnetic, Air, Optical). Waste Granulation. Waste Briquetting. Composting of Organic Waste. Biotechnological Methods of Waste Recycling. Anaerobic Digestion of Waste. Biogas production from waste. Thermal waste processing methods. Waste incineration. Waste pyrolysis. Waste gasification. Plasma waste processing. Waste recycling for energy. Recovery of valuable components from waste. Waste recycling. Recycling of plastic, glass, metal, and paper. Modern solid waste recycling technologies. Environmental safety in waste recycling. Economic efficiency of waste recycling.
Solid waste landfills and their role in waste management. Current challenges in solid waste recycling. Promising waste recycling trends. Principles of sustainable waste management. Zero Waste concept. Environmental monitoring of waste recycling facilities.

Topic 5. Innovative technologies for industrial waste recycling

Subtopics. Integrated waste recycling technologies. Biotechnology in recycling
Plasma waste recycling. Sustainable waste management approaches. Digital waste accounting platforms. Key approaches to industrial waste recycling: neutralization, recycling, and reuse. Mechanical processing of industrial waste (crushing, sorting, separation). Thermal processing of waste (incineration, pyrolysis, gasification). Chemical processing and neutralization of waste. Biological processing of industrial waste (composting, anaerobic digestion, biotechnology). Energy utilization of waste (generation of heat and electricity). Recovery of valuable components from waste (metals, chemicals, building materials). Integrated waste disposal technologies (combination of mechanical, chemical, biological and thermal methods). Modern highly efficient waste disposal technologies. Industrial waste landfills: design, operation, sanitary and environmental requirements. Protection of soil, water and atmospheric air during waste placement and disposal. Control and monitoring of landfills and industrial facilities. Economic efficiency and profitability of disposal technologies. Problems of processing and disposal of industrial waste in Kazakhstan. Promising areas of development of industrial waste disposal technologies. Innovative technologies and automation of disposal processes. Principles of sustainable industrial waste management. Zero Waste for Industrial Production. Environmental Safety and Minimization of the Negative Impact of Industrial Waste on the Environment. International Experience and Best Practices for Industrial Waste Disposal.

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Discipline "Monitoring the state of the environment and methods of analysis"

Topic 1: Intelligent Environmental Monitoring Systems

Subtopics: Smart monitoring systems. IoT and sensor networks. Big Data and environmental analytics. Remote monitoring (satellites, drones). Digital environmental platforms. Physical, chemical, and biological indicators of environmental quality. Use of automated and remote monitoring systems. Application of geographic information systems (GIS) in environmental monitoring. Remote monitoring using satellite data. Laboratory methods for analyzing samples (soil, water, air). Instrumental methods for monitoring air pollution. Methods for monitoring the quality of surface and groundwater. Methods for monitoring the condition of soils and land resources. Biomonitoring and the use of indicator species to assess ecosystem health. Assessment of anthropogenic impact on the environment. Database creation and maintenance of environmental registers. Indicators and indices of the ecological state of a territory. Forecasting changes in the state of the environment. Ecological and economic aspects of monitoring. Monitoring compliance with environmental pollution standards. Early warning and emergency control systems. The role of monitoring in environmental management and environmental safety. State environmental monitoring programs. International standards and recommendations for environmental monitoring. Advanced technologies and innovative methods of environmental monitoring. Monitoring effectiveness and its integration into the sustainable development system.

Topic 2. Air Monitoring

Subtopics: Air quality monitoring. Air quality indices (AQI). Atmospheric pollution modeling. Impact of urbanization. Public health risks. Methods for measuring air pollutants. Instrumental monitoring methods: gas analyzers, dust meters, spectrometers, chromatographs. Laboratory methods for air sample analysis. Mobile and stationary observation posts. Automated air monitoring systems. Remote monitoring using satellites and unmanned aerial vehicles. Geographic information systems (GIS) and their use for air quality assessment. Calculation and monitoring of maximum permissible concentrations (MPCs) of pollutants. Methods for predicting pollutant dispersion.

Atmospheric conditions and their impact on pollutant concentrations (wind, temperature, humidity, precipitation). Classification of air pollution sources: point, linear, and area. Industrial, transport, and household sources of air pollution. Sanitary protection zones of industrial enterprises. Alert systems for exceeding pollutant concentrations. Assessing the risk to public health and ecosystems. National and international air quality monitoring. Maintaining an emission inventory and recording pollution sources. Using environmental indices and air quality indicators. Modern technologies and innovative methods for air monitoring. Forecasting and modeling atmospheric pollution. The role of air monitoring in environmental safety and nature management.

Topic 3. Monitoring of water bodies.

Subtopics. Digital water quality monitoring technologies. Satellite monitoring of water bodies. Oil pollution monitoring (relevant for the Caspian Sea). Water pollution modeling. Water security. Physicochemical water quality indicators: temperature, transparency, turbidity, color, odor, pH, dissolved oxygen content. Chemical indicators of water: concentration of organic and inorganic substances, heavy metals, nitrates, phosphates, petroleum products. Biological indicators: microorganisms, phytoplankton, zooplankton, bioindicators. Methods of collecting water samples for analysis. Laboratory methods of water quality control. Instrumental monitoring methods: sensors, automatic posts, remote systems. Automated systems for monitoring water bodies. Geographic information systems (GIS) for assessing the state of water resources. Remote monitoring of water bodies using satellite and unmanned systems. Monitoring the quality of wastewater and its impact on water bodies. Regulatory control of water quality and pollutant discharges. Calculation and control of maximum permissible discharges (MPD). The impact of anthropogenic sources of pollution on water bodies. Modeling the processes of pollution and self-purification of water bodies. Assessment of the ecological state of reservoirs and watercourses. Monitoring groundwater and aquifers. Methods for forecasting changes in the state of aquatic ecosystems. Maintaining a water resource cadastre and pollutant accounting. Environmental monitoring of water use at industrial and agricultural facilities. Forecasting and preventing negative impacts on water bodies. Modern technologies and innovations in water resource monitoring. The role of water body monitoring in ensuring sustainable

Topic 4. Soil Cover Monitoring.
Subtopics. Land Degradation and Desertification Monitoring. Satellite Data and GIS. Heavy Metal Pollution. Land Reclamation. Climate and Soils. Soil Biological Indicators: Microbiological Activity, Microbial Biomass, Bioindicators. Methods of Soil Sampling for Analysis. Laboratory Methods for Assessing Soil Quality and Pollution. Instrumental Methods for Soil Monitoring: Spectroscopy, Sensor Systems, Moisture and Temperature Sensors. Geographic Information Systems (GIS) for Soil Cover Mapping. Remote Monitoring of Soil Cover Using Satellite Data. Soil Degradation and Erosion Assessment. The Impact of Human Activity on Soil Conditions (Industry, Agriculture, Construction). Soil Pollution with Heavy Metals, Pesticides, and Organic Compounds. Methods for Reclamation and Restoration of Degraded Soils. Monitoring Agricultural and Forest Lands. Land Resource Inventory and Soil Cadastre Maintenance. Assessing the risk to ecosystems and human health from soil pollution. Impact of climate change on soil cover. Methods for predicting changes in soil conditions. Modern technologies and innovative methods for soil monitoring. The role of soil monitoring in environmental management and environmental safety. Linking soil monitoring with water, air, and vegetation monitoring. Ecological and economic aspects of soil resource conservation.

Topic 5. General approaches to regulating environmental quality by standardizing anthropogenic loads.

Subtopics. Risk-based approach. ESG reporting. Environmental standards (ISO 14001. Digital control of standards. Environmental risk assessment. Historical development of anthropogenic load regulation. Main approaches to regulation: maximum permissible emissions (MPE), maximum permissible concentrations (MPC), maximum permissible discharges (MPD). Methodology for establishing standards for atmospheric air. Methodology for establishing standards for water bodies.

Methodology for establishing standards for soils and land resources. Regulation of noise, vibration and radiation impact. Systems of environmental standards and criteria for environmental quality. Ecological and sanitary-hygienic significance of standards. Temporary and special standards for particularly hazardous substances. Calculation of maximum permissible emissions and discharges for enterprises. Methods of assessing environmental load and risk. Comprehensive assessment of the impact of industrial activity on ecosystems. Development of plans and programs to reduce anthropogenic load. Monitoring compliance with standards and control over pollution sources. Economic aspects of anthropogenic load regulation. International standards and agreements on pollution control (e.g., the Convention on Long-Range Transboundary Pollution). The role of public authorities in regulating environmental quality. Consideration of environmental standards in the design and modernization of industrial facilities. Modern approaches to reducing anthropogenic load and implementing environmentally friendly technologies. Application of the concept of "sustainable development" in regulating anthropogenic load. Promising directions for the development of the regulatory framework and environmental control systems.

Topic 6. Global Monitoring System.

Subtopics. Copernicus, NASA, GEO. Global climate monitoring. Greenhouse gases. International cooperation. Global environmental indicators. International environmental monitoring programs (e.g., GEMS/Water, GAW, GEO, Copernicus, Global Carbon Project). The role of the United Nations and international agencies in global environmental monitoring. Using satellite remote sensing systems for monitoring. Using unmanned aerial vehicles (UAVs) and ground-based sensor networks. Methods of collecting and processing data for global monitoring. Geographic information systems (GIS) and global change mapping. Monitoring atmospheric air quality at the global level. Monitoring water resources, oceans, and glaciers. Monitoring forest cover, biodiversity, and ecosystems. Monitoring climate change: greenhouse gases, temperature, precipitation, sea level. Assessing the anthropogenic load on global ecosystems. Integrating national and regional monitoring systems into a global network. Data exchange between countries and international organizations. Sustainable development indicators and global environmental indicators. Modeling global environmental processes. Forecasting environmental risks and natural disasters. Using global data for management decision-making and environmental policy. Modern technologies and innovations in global monitoring. The role of global monitoring in ensuring sustainable development and environmental protection. Challenges in standardizing and interoperable data at the global level. Promising areas for the development of global monitoring systems and international cooperation.

Topic 7. Monitoring and forecasting emergency situations.

Subtopics. AI-based emergency forecasting. Digital early warning systems. Environmental consequences of accidents. Monitoring man-made disasters. Integration with the sustainable development system. The main goals of emergency monitoring: prevention, damage minimization, and safety. Data sources for emergency monitoring: observations, sensors, satellites, meteorological stations. Emergency forecasting methods. Mathematical modeling and computer forecasting of emergency situations. Monitoring man-made hazards: accidents at industrial facilities, toxic emissions, explosions, fires. Monitoring natural hazards: floods, landslides, earthquakes, hurricanes, droughts. Monitoring radiation and chemical hazards. Early warning systems for emergencies. Forecasting the spread of pollutants during accidents. Geographic information systems (GIS) for analyzing and forecasting emergencies. Using satellite data and remote sensing to forecast emergencies. Assessing the risk of emergencies. Methods of quantitative and qualitative risk assessment. Developing emergency scenarios and possible consequences. Planning measures to prevent and eliminate emergencies. Organizing rapid response and emergency management systems. Coordinating the actions of government agencies, emergency services, and industrial enterprises. Monitoring and forecasting accidents at industrial facilities with hazardous substances. Forecasting the environmental consequences of emergencies. The role of international standards and agreements in monitoring and preventing emergencies. Using information and communication technologies to inform the public. Promising technologies and innovations in emergency monitoring and forecasting systems. Integrating emergency monitoring with environmental control and sustainable development system**s**

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Course: "Improving the Quality of Natural Waters"

Topic 1. Modern Water Quality Requirements

Subtopics: WHO standards. ESG and water resources. Water as a strategic resource. The impact of climate on water quality. Microbiological indicators. Radiological indicators. Key criteria for selecting a water treatment process. Water purpose: drinking, industrial, domestic. Source water type: surface, groundwater, desalinated. Contaminant composition and concentrations. Output water requirements. Economic and operational factors. Water treatment facilities: filters, settling tanks, reagents. Water quality classification according to standards (GOST, SanPiN, WHO). Maximum permissible concentrations of substances (MPC, MPE). Sanitary standards for drinking water. Regional requirements for industrial and domestic water.

Topic 2. Innovative Water Purification Methods

Subtopics: Membrane technologies. Nanotechnology. UV and ozonation. Water purification biotechnology. Desalinization (relevant for Aktau). Aluminum and iron salts, and other chemical coagulants. Polymer coagulants. The principle of action of coagulants on suspended particles. Flocculants and their application. Natural and synthetic flocculants. Mechanisms of floc formation

and sedimentation acceleration. Optimization of dosage and process conditions. Combining coagulation and flocculation. Monitoring coagulation efficiency. Determining residual turbidity. Studying floc size and strength. The influence of temperature, pH, and water hardness.

Topic 3. Sustainable water treatment systems

Subtopics: Smart water treatment. Energy-efficient technologies. Closed loops. Automation of treatment plants. Technological modeling of the sedimentation process. Fundamentals of sedimentation hydrodynamics. Calculating sedimentation time and settling velocity. Mathematical modeling and computer models. Types of settling tanks and their applications. Horizontal settling tanks: design, efficiency, and applications. Radial settling tanks: operating principle and advantages. Vertical settling tanks: features and applications. Shallow settling tanks: characteristics and limitations. The influence of physical and chemical factors on settling efficiency. Water temperature and viscosity. Concentration and nature of suspended solids. Application of coagulants and flocculants.

Topic 4. Innovative water disinfection methods.

Subtopics: UV-LED technologies and advanced oxidation processes (AOP). Ozonation with catalysts. Electrochemical disinfection methods. Next-generation nanomaterials and sorbents. Removal of microplastics and pharmaceutical contaminants. Online water quality monitoring (sensors, IoT). ESG requirements for drinking water quality. Chlorination and ozonation of water. Water disinfection with bactericidal rays. Electrodialysis units. Application of oxidizing agents and sorbents. Oxidation of organic micropollutants using chlorinating agents, potassium permanganate, and ozone.

Principles of chlorine disinfection. Dosing and control of residual chlorine. Advantages and limitations. Water ozonation. The mechanism of oxidation of organic and microbiological contaminants. Design features of ozonizers. Application in drinking and industrial water disinfection. Germicidal rays (ultraviolet). Principles of ultraviolet disinfection. Design solutions for UV units. Efficiency and limitations of the method. Electrodialysis units. Fundamentals of electrodialysis for water disinfection and softening. Application for the removal of heavy metal ions. Use of oxidizing agents and sorbents. Chlorinating agents, potassium permanganate, ozone. Removal of organic micropollutants. Monitoring disinfection efficiency.

Topic 5. Modern water treatment technologies

Subtopics: Oxidation-sorption method of water treatment. Membrane technologies (RO, NF, UF)

Smart water treatment systems. Biosorption and biofiltration. Heavy metal removal using nanotechnology. PFAS and organic micropollutant removal. Energy-efficient water treatment technologies. Water reuse. Oxidation and sorption of pollutants. Use of activated carbon and other sorbents. Water fluoridation and defluoridation technology. Fluoride content monitoring. Reagents and equipment used. Iron genesis in natural waters. Iron forms (Fe^{2+}, Fe^{3+}). Mechanisms of iron deposit formation. Iron removal from condensate, recycled water, and mine water. Chemical and biological removal methods. Sorption and filtration methods. Water demanganization. Manganese removal methods. Oxidation and filtration. Water degassing methods. Classification of methods: thermal, vacuum, and jet degassing. Theoretical Foundations of the Process

Topic 6. Theoretical Foundations of Water Softening and Classification of Methods.

Subtopics: Removal of Radionuclides and Toxic Elements. Mine and Oil-Containing Water Treatment. Digitalization of Water Treatment Processes. Water Security and Sustainable Management. Desalination and Desalination Methods and Their Classification. Desalination and Desalination by Distillation, Electrodialysis, and Extraction. Ion Exchange. Removal of Pesticides, Herbicides, and Ichthyocides from Water. Mine Water Treatment. Removal of Zinc, Copper, Arsenic, and Phenols from Water. Water Purification from Radioactive Substances. Distillation. Multi-Stage Distillation. Electrodialysis. Extraction and Membrane Technologies. Ion Exchange Methods. Operating Principle of Ion Exchange Resins. Water Softening and Removal of Specific Ions. Removal of Organic Contaminants. Pesticides, Herbicides, Ichthyocides, and Biocides. Sorption and chemical oxidation methods. Mine water treatment. Removal of zinc, copper, arsenic, and phenols. Physicochemical and membrane purification methods. Radionuclide removal. Sorption

and ion exchange methods. Monitoring residual radioactive contamination.

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Discipline **"Environment and biodiversity conservation"**

Topic 1: The Emergence of Planetary Systems

Subtopics: The Biosphere in a Changing Climate. Global Biogeochemical Cycles and Anthropogenic Impact. The Role of Microorganisms in Ecosystem Resilience. Ecosystem Services. Digital Ecosystem Modeling. Principles of Rational Use of Bioresources. The Origin of Life on Earth. Abiogenesis Hypotheses. The Main Stages of Biological Evolution. Early Life Forms and Microbiological Ecosystems. Levels of Organization of Living Matter. The Genetic Level, Populations, and Species. Communities and Ecosystems. The Biosphere as a Global Ecosystem. The Cycle of Substances in Nature. The Carbon, Nitrogen, Water, and Phosphorus Cycles. The Role of Microorganisms in Biogeochemical Processes. Human Impact on Natural Cycles

Topic 2: Anthropogenic Factors and Ecosystem Resilience
Subtopics: Urbanization and Industrialization. ESG and the Impact of Business on Nature. Biological Productivity in Climate Change. Environmental Risks and Their Assessment. Bioindicators and digital monitoring. Allogeneic (external) factors: industrial pollution, agriculture, transport. Autogenous (internal) factors: natural changes, adaptation processes. Impact on ecosystem productivity and species resilience. Species diversity and productivity. Genetic diversity and its importance. Indicator species of the environment. Methods for assessing ecosystem productivity. Environmental monitoring. Use of bioindicators. Methods for quantitative and qualitative analysis of ecosystems.

Topic 3: Modern approaches to biodiversity conservation
Subtopics: Nature-based solutions. Climate and biodiversity loss. Invasive species. Ecosystem restoration (restoration ecology). Genetic technologies (DNA monitoring). Diversity of communities and ecosystems. Key species and resources. Measuring biodiversity. Extinction rates. Human-induced species extinction. Extinction rates in water and on land. Habitat degradation and pollution. Pesticide pollution. Water pollution. Air pollution. Global climate change. Overexploitation of resources.

Topic 4: Biodiversity and Population Assessment Methods
Subtopics: GIS and satellite monitoring. Big Data in bioecology. Population modeling. Genetic diversity. Species repopulation and reintroduction. Effective population size. Environmental changes and disasters. Population monitoring. Formation of new plant populations. Ex situ conservation strategies. The problem of small populations, global warming, human activities, forest depletion, innovations in science and technology, species extinction, studying the causes of biodiversity threats. Species conservation through population conservation. Characteristics of small and vulnerable populations. Effective population size and loss of genetic diversity. Population monitoring and management. Methods of observing plant and animal populations. Formation of new populations and repopulation. Ex situ conservation strategies (zoos, botanical gardens, gene banks). Problems of small populations and global warming. The impact of human activity on population sizes. Species extinction, habitat loss. Innovations and technologies for biodiversity conservation.

Topic 5: Legal regulation and international standards
Subtopics: ESG standards. Convention on Biological Diversity (CBD). ITES. Green economy. Environmental policy of Kazakhstan. Terrestrial and aquatic ecosystems. Zoos, botanical gardens, nature reserves, wildlife sanctuaries, and national parks. Natural monuments. International biosphere reserves. Protected areas and their types. National parks, nature reserves, wildlife sanctuaries, and natural monuments. Biosphere reserves and international protected areas. Setting conservation priorities. Key species and threatened ecosystems. Selecting sites for biodiversity conservation. International agreements. Convention on Biological Diversity (CBD). CITES and other international regulations. Design of protected areas. Terrestrial and aquatic ecosystems. Methods for Protected Area Assessment and Planning

Topic 6: Protected Area Design
Subtopics: Landscape planning. Ecosystem approach. Climate-resilient protected areas. Ecological corridors. Digital biodiversity maps. Optimal protected area sizes. Factors influencing area size and location. Minimum area for population sustainability. Land allocation for nature reserves and sanctuaries. Land selection priorities. Methods for accounting for biodiversity and ecosystem services. Ecosystem conservation planning. An integrated approach to the conservation of terrestrial and aquatic ecosystems. Integrating protected areas into national and international conservation strategies.

Main:

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4. Протасова Н. А. Геохимия техногенных ландшафтов. Учебное пособие для вузов. 2009. -37 с.
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6. Экологическая геоморфология: новые направления: учеб. пособие / под ред. С.И. Болысова. М.: Географ. фак. МГУ, 2015. 220 с.