Water Resources Monitoring Program

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TABLE OF CONTENTS

1. Introduction

The proposed Water Resources Monitoring Program for the EKTU campus is designed to provide comprehensive monitoring and optimization of water use, ensure water quality, and enable rapid response to emergency situations. The program establishes objectives for sustainable water management, including reducing freshwater consumption, promoting water recirculation, and ensuring complete wastewater treatment. It also emphasizes engaging staff and students in fostering a culture of water conservation. The program is based on the Environmental Code of the Republic of Kazakhstan, which prohibits the discharge of untreated wastewater, as well as national sanitary standards for drinking water and domestic water supply. It also aligns with EKTU's internal policies, including the Sustainable Development Policy and the Water Resources Protection Policy. The program identifies key monitoring parameters (temperature, pH, oxidation-reduction potential (ORP), total suspended solids, dissolved oxygen, nutrients, heavy metals, microbiological indicators, etc.), explains their significance, and establishes threshold values. Proposed sampling locations include wastewater discharge points and monitoring sites in the adjacent water body.

2. Aims and objectives of the program

- • Optimize water consumption: Achieve further reductions in freshwater use (building upon the existing 51% reduction already accomplished through current initiatives) and establish annual KPIs for water consumption reduction.
- Protect water quality: Regularly monitor physicochemical, biological, and hydrological parameters to prevent pollution through the timely identification and elimination of contamination sources.
- Promote sustainable water use: Implement water reuse and treatment technologies, including closed-loop water recirculation systems and rainwater and wastewater harvesting systems.
- Ensure access to clean water: Provide all campus users – including staff, students, and visitors – with access to safe drinking water and adequate sanitation facilities.
- Engage the university community: Raise awareness and educate staff and students on responsible water use while encouraging participation in water conservation initiatives.

3. Regulatory and Legal Framework

- Environmental Code of the Republic of Kazakhstan (2021) establishes general requirements for the protection of water bodies, prohibits the discharge of untreated wastewater into surface waters, and requires laboratory monitoring when wastewater is discharged into soil. National sanitary regulations and hygienic standards also define maximum permissible concentrations (MPCs) for nitrates, microorganisms, heavy metals, and other contaminants in drinking and domestic water. Surface water quality is regulated by national standards, including GOST 17.1.3.07-82 “Rules for Water Quality Control in Water Bodies.”

- Water legislation: The Water Code of the Republic of Kazakhstan (including the latest amendments) regulates the use of both groundwater and surface water resources, including groundwater abstraction from wells and water consumption within established allocation limits.
- EKTU internal documents: EKTU's

Sustainable Development Policy promotes water reuse practices and ensures access to safe drinking water. Green Campus documentation outlines the university's ongoing environmental initiatives. Annual EKTU Green Campus Reports (2023 and 2024) provide information on monitoring activities and achieved results.

- International guidance: Where national regulations are unavailable or insufficient, the WHO Guidelines for Drinking-water Quality and the UNECE Water Convention may serve as reference documents.

4. Monitored Parameters (and Threshold Values)

- **Physicochemical:** temperature, pH (6.5-8.5), electrical conductivity, total suspended solids (TSS), total hardness; dissolved oxygen (not less than 6 mg/L); chemical indicators: nitrates (MPC ≈ 45 mg/L), nitrites, ammonium, chlorides, sulfates, phenols, petroleum hydrocarbons, biochemical oxygen demand (BOD_5); heavy metals (Pb, As, Hg, Cd) at concentrations recommended by the WHO or national standards; organic pollutants (surfactants, polycyclic aromatic hydrocarbons (PAHs), and pesticides, where applicable).
- **Biological:** total microbiological indicators (total coliforms and Escherichia coli (E. coli)) for drinking water (standard: 0 CFU/100 mL). For sanitary monitoring, hygienic biological indices (bioindicators) for assessing the ecological quality of rivers and other water bodies. For wastewater, analysis of pollutant concentrations in accordance with GOST “Drinking Water. Methods of Analysis.”
- **Hydrological:** groundwater well depth and yield; groundwater level; wastewater flow rate. Where a nearby water body is monitored, water flow velocity and water level should also be measured.
- **Quantitative:** total water consumption (based on water meter readings), stream discharge, and wastewater volume.

5. Sampling Locations

The following categories of sampling locations are proposed for identification and systematic monitoring:

№	Sampling Location	Description	Sampling Frequency	Sampling Depth/Method
1	Irtysh River	Behind the main building of D. Serikbayev EKTU	Seasonally	Shoreline sampling
2	Ulba River	Behind the main building of D. Serikbayev EKTU	Seasonally	Shoreline sampling
3	Wastewater Drainage	Discharge point of treated wastewater (“Prostor” septic treatment system)	Monthly (during operation)	Sampling from the inspection chamber / pipeline
4	Bukhtarma Reservoir (Monitoring Station)	Nearest surface water monitoring point (adapted from the Water Resources Center monitoring framework)	Quarterly (as part of the monitoring program)	Boat-based or shoreline sampling

Sampling Locations: Irtysh and Ulba Rivers

Although the Irtysh and Ulba rivers are located outside the university campus, D. Serikbayev East Kazakhstan Technical University voluntarily conducts regular water quality monitoring as part of its commitment to environmental stewardship. As a leading regional university, EKTU takes the initiative to support the sustainable management of local water resources, contribute scientific data for environmental protection, and promote environmental responsibility within the community.

Location of water wells and septic tanks

Parking plan with surface water treatment plants

6. Methods and Equipment

- **Field Methods:** Portable analyzers for pH, ORP, temperature, and electrical conductivity/salinity are used for rapid field measurements. Instruments for on-site determination of dissolved oxygen (DO) and turbidity, as well as hydrometric probes, are employed. Water samples are collected using glass or PET bottles for organic contaminants and calibrated sampling bottles for chemical analyses, with transportation in insulated ice containers. Groundwater samples are collected using a dedicated sampling pump at the static water level. Sediment samples are obtained using a sediment corer or sampling shovel.
- **Laboratory Methods:** Chemical and bacteriological analyses are performed in accordance with applicable GOST standards and methodological guidelines using spectrophotometry, titration, chromatography, atomic absorption spectroscopy (AAS), and other analytical techniques. Microbiological analyses include Petri dish culturing or membrane filtration methods for determining total coliforms and E. coli. Organoleptic characteristics (color and odor) are also

assessed. Where feasible, automated monitoring stations (e.g., continuous chlorine and pH analyzers) should be utilized.

- **Equipment:** A modern laboratory equipped with analytical reagents and calibration standards; portable multiparameter meters (pH/EC/DO); water level sensors; GPS devices for georeferencing sampling locations; flow measurement equipment (measuring tape, flow meters); and an integrated digital monitoring system, including smart water meters with telemetry.
- **Calibration and Validation:** All field instruments (e.g., pH electrodes and dissolved oxygen sensors) shall be calibrated regularly using certified buffer solutions before each field campaign. Laboratory analytical methods shall be validated using certified reference materials, duplicate analyses, blind samples, and standards with known concentrations. Calibration records, equipment maintenance logs, and quality certificates for analytical test systems shall be maintained.

7. Monitoring Schedule and Annual Work Plan

Monitoring activities shall be implemented according to the annual monitoring schedule:

- Spring (April-May): Post-flood assessment; preparation of equipment, instrument calibration, and personnel training. Water sampling after snowmelt and flooding events, including precipitation-related impacts and pH measurements.
- Summer (June-August): Monthly monitoring of drinking water quality from groundwater wells and treated water within the campus distribution system. Monthly recording of water consumption based on meter readings. Preparation of an interim monitoring report summarizing collected data.
- Autumn (September-October): Monitoring following heavy rainfall events (including runoff from parking areas) and quarterly assessment of chemical parameters, including BOD_5, N, and P.
- Winter (November-March): Inspection of water supply system insulation and leakage detection; annual testing for chemical contaminants in drinking water; preparation of the annual monitoring report.
- Monitoring Schedule: Monthly (or quarterly, where appropriate) field sampling campaigns shall be scheduled for all monitoring locations, with clearly assigned responsibilities. The schedule should be coordinated with the university academic calendar. The Program Coordinator and Field Engineer shall prepare and approve the monitoring schedule in consultation with the university administration.

8. Reporting Requirements and Stakeholders

- **Reporting Formats:** Monitoring results shall be presented in electronic spreadsheets accompanied by explanatory notes and graphical trend analyses. A comprehensive annual environmental monitoring report shall be prepared for the campus, including comparisons with regulatory standards and previous years' results. Where GIS data are available, pollution maps shall be included. The final report shall be issued in PDF format with an executive summary.
- **Stakeholders:** Internal stakeholders include the EKTU administration (Rector, Deans), the Environmental Department, the Trade Union, and student environmental organizations. External stakeholders include local sanitary-epidemiological authorities, water resource management agencies, relevant ministries (Environment and Education), and the general public. Monitoring results may be published on the university website or through a dedicated environmental dashboard. The EKTU Water Management Competence Center shall participate in data analysis and the development of technical recommendations.

9. Training and Communication Plan

- **Staff Training:** Annual training sessions shall be conducted for engineering personnel and laboratory staff on updated water sampling and analytical methodologies, operation of monitoring equipment, and database management systems. The academic course “Water Resources Monitoring” (Degree Programs 6B08601 and 7M07310) may partially support personnel training. Field personnel shall receive regular occupational safety and equipment operation briefings.
- **Student Engagement:** Organize lectures and seminars on water conservation, practical field exercises involving water sampling on campus, and

Response Plan for Exceedances and Emergency Situations

In the event that monitored parameters exceed established threshold values or an emergency occurs (e.g., leakage, sewer failure, or chemical spill), the following response procedure shall be implemented:

1. Immediate Verification: Collect additional samples immediately and conduct expedited laboratory analysis to confirm the exceedance.
2. Notification: Inform the Head of the Campus Environmental Department and the University Administration. Where public health may be at risk, notify the local sanitary-epidemiological authorities and the regional water utility.
3. Containment: If necessary, suspend water supply from the affected well or isolate the damaged section of the water distribution network. Arrange temporary alternative drinking water supplies (e.g., bottled water).
4. Corrective Actions: Identify and eliminate the source of contamination (e.g., filter replacement, repair of leaks or damaged infrastructure). In the event of environmental emergencies such as oil spills or wastewater releases, engage emergency response teams for containment and remediation.
5. Investigation and Corrective Measures: Conduct an internal investigation to identify the root cause of the incident, revise maintenance procedures and monitoring protocols where necessary, and document each incident together with measures implemented to prevent recurrence.

participation in environmental awareness events such as the “Environmental Hour.” Monitoring results should be published in the student newspaper and the university's official publication “For Knowledge!”

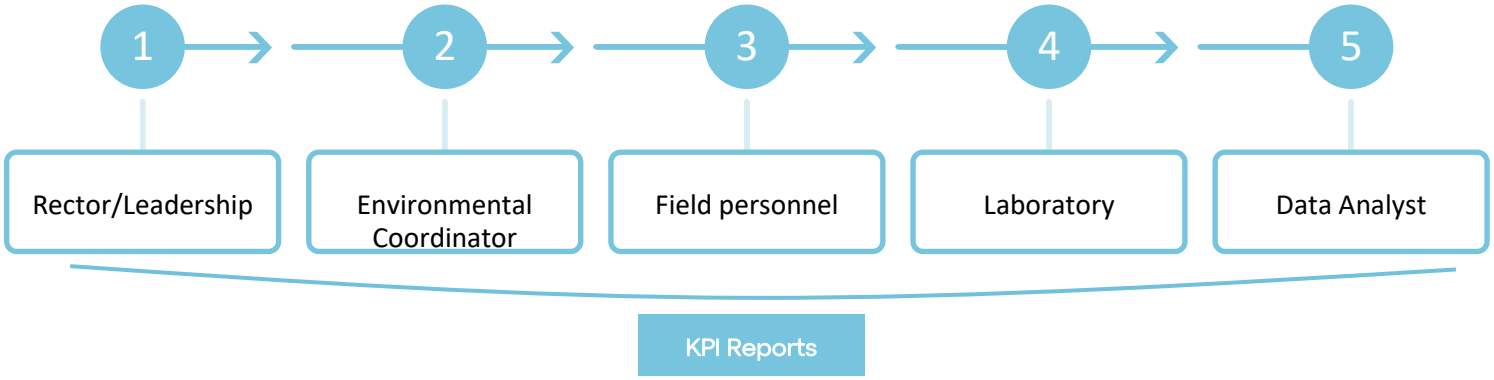
• **Communication:** Regular updates on campus water resource conditions shall be distributed via email and university notice boards. Collaboration with environmental clubs and academic departments should include organizing “Clean Water Days” and competitions for the best environmental project (building on existing initiatives such as the “Green Campus” campaign).

10. Digitalization and Data Visualization

• **Online Dashboard:** Develop a web-based platform (using GIS or BI technologies) featuring interactive sampling location maps and dynamic visualizations of key monitoring indicators, including temperature, water quality parameters, pH, and pollutant concentrations. Parameters such as water temperature and dissolved oxygen may be displayed in real time where continuous monitoring is available.

• **Automation:** Introduce automated monitoring stations equipped with telemetry, including water level sensors, flow meters, and automatic water samplers. The Smart Campus system may incorporate IoT technologies (e.g., GSM-enabled water meters) and integrate water monitoring data with campus energy management systems. This approach is consistent with EKTU's objective of strengthening electronic environmental monitoring through open data.

• **Visualization:** Develop water flow diagrams illustrating the campus water supply and wastewater circulation systems, together with flowcharts describing each stage of the monitoring process. The following Mermaid diagram presents the overall data flow and responsibilities within the proposed monitoring program.



This diagram illustrates the roles and responsibilities associated with sample collection, laboratory analysis, and decision-making. Thus, monitoring data flow from field measurements through laboratory analysis to reporting documents, involving all levels of responsibility throughout the process.

11. Performance Evaluation Criteria and KPIs

The effectiveness of the monitoring program shall be assessed using the following predefined KPIs:

- **Water Consumption Reduction**: Annual reduction in freshwater consumption per capita and across the campus (%), building upon the previously achieved 51% reduction.
- **Water Quality Compliance**: Percentage of water samples meeting all regulatory standards. Target: 100% of samples comply with MPCs and applicable sanitary standards.
- **Monitoring System Reliability**: Percentage of completed scheduled monitoring activities relative to the total planned measurements. Target: ≥95%.
- **Response Efficiency**: Time required to identify, verify, and contain an incident following the detection of a threshold exceedance. Target: no more than 24 hours.
- **Training Effectiveness**: Number of staff training sessions and training hours per employee per year, as well as the proportion of participating students.
- **Reporting Compliance**: Timely submission of quarterly and annual monitoring reports.
- **Public Transparency**: Publication of open-access monitoring data in accordance with the approved communication plan (at least once per year).

These KPIs will provide a quantitative basis for evaluating the effectiveness of the program (for example, improving EKTU's performance in SDG 6 sustainability rankings) and for making evidence-based adjustments to the monitoring program where necessary.

The report is based primarily on official sources, including EKTU's documentation ("Green Campus – Water" webpage, SDG 6 Policy, and Sustainable Development Policy), as well as the environmental legislation and sanitary regulations of the Republic of Kazakhstan (Environmental Code and national sanitary rules). These references provide the regulatory and institutional basis supporting the proposed monitoring program and its recommended implementation framework.