Report on

4th Riparian Information-Sharing and Consultation Process on the Assessment Studies of a Proposed Rogun Hydropower Project

September 30 – November 4, 2013

Prepared by

Europe and Central Asia Region

World Bank

In partnership with the Independent Engineering and Dam Safety and Environment/Social Panels of Experts for the Rogun Assessment Studies

Contents

Representatives of Kazakhstan, Kyrgyz Republic, Tajikistan and Afghanistan participated in the sessions for riparian governments; Civil Society Organizations (CSOs) from Kazakhstan, Kyrgyz Republic, Tajikistan, Uzbekistan and Afghanistan participated in the session for civil society; written comments were received from

Responses were provide by the Consultants, the Engineering and Dam Safety Panel of Experts or the World Bank at the consultations sessions, and are included in a comprehensive matrix attached to this report.

Independent Engineering and Dam Safety Panel of Experts: During their presentations, the Panel of Experts endorsed the conclusions of the Consultants based on independent analyses and site visits. The Panel inspections emphasized the need to implement safety-

To encourage dialogue among riparians

To respond to the request of riparian governments with the support of international financial and donor communities

To ensure the highest quality of the Assessment Studies and a process that considers stakeholder concerns.

The consultation process provides information on key aspects of the Assessment Studies and enables

The information-sharing and consultation process followed the same structure as the three previous consultations. The Government of Tajikistan and the World Bank disclosed the reports in English and Russian on September 30, 2013. Comments were accepted until November 4, 2013, via email (rogunconsult@worldbank.org) and mail to the World Bank Country Offices in all riparian countries. Information-sharing and consultation meetings took place over three days as follows:

were made available on an as-needed basis. The Bank extends its appreciation to the Government of Tajikistan for welcoming participants. The agenda for all three sessions was similar. Findings were presented by the consultants followed by presentations by the independent Engineering and Dam Safety (EDS) PoE and then open questions and discussion with stakeholders. Comments from riparians were reviewed by the PoE and recommendations provided to the Government of Tajikistan for integration into the Phase 0 and Phase 1 reports. The documents as well as presentations are publicly available on the Bank's website at www.worldbank.org/eca/rogun.

This consultation report documents both the submitted comments and the information-sharing and consultation sessions. The report is structured as follows: Sections II and III focus on Phase 0 and Phase I, respectively, summarizing the findings, main issues discussed and questions raised by stakeholders; Section IV covers cross-cutting themes and issues raised by stakeholders that lie outside the specific scope of the two technical reports; Section V presents the PoEs' recommendations to the Government of Tajikistan related to the summary reports, integrating the opinions of, and discussions with, stakeholders. Section VI outlines next steps. Annex A provides the agenda of the meetings, and a more detailed matrix of questions and responses is provided in Annex B. This report is available on the Bank's website (www.worldbank.org/eca/rogun).

II. Phase 0: Geotechnical and Geological Investigation of the Salt Dome

In line with the agreed Terms of Reference (ToR) for the Techno-Economic Assessment Study (TEAS), the Consultant is required to undertake a risk assessment pertaining to the potential influence of the salt dome on dam safety. This section of the ToR, referred to as "Phase 0", covers the geotechnical and geological investigation of the salt dome or wedge in the dam foundation and reservoir. The Consultant presented both the assessment results and mitigation recommendations; specifically, potential salt dissolution scenarios, possible treatment options, residual risks during Rogun operation as well as how to mitigate these risks.

A body of salt referred to as the salt dome, is located within the 1 kilometer section of the Ionakhsh Fault,[3] increases in width by about 15 meters for every 100 meters in depth (hence a "wedge"). The unique geological feature has been extensively investigated and detailed information on its specific characteristics is available.

The salt wedge poses a potential issue with regard to dam safety, which is why the ToR for the Techno-Economic Assessment Study calls for a very thorough investigation. Under the effect of orogenic forces (i.e. the folding and faulting of the earth's crust), the wedge of salt is being extruded along the Ionakhsh Fault at an estimated rate of 2.5 cm per year. In the vicinity of the Vakhsh River, it is being dissolved at a similar rate, resulting in a state of equilibrium. The impoundment of the Rogun reservoir would result in the creation of a hydraulic gradient across the salt wedge and, if not mitigated, would result in accelerated dissolution of the salt wedge and potential formation of a cavity in the dam foundation over time.

Consultant findings

The Consultants conducted a review of previous assessments and available data on the salt wedge, including:

- Existing models and literature dating from the 1978 design;
- The original Hydro Project Institute (HPI) model on hydraulic conductivity; and
- An analysis of initially proposed mitigation measures that included a hydraulic curtain, a brine curtain and a grouting cap.

[3] The Ionakhsh Fault crosses the dam site, running from the north-east to south-west.

Existing documentation was augmented by visual surveys and additional site investigations. This analysis enabled the Consultant to identify the key parameters impacting the behavior of the salt wedge. In addition to the review of existing models, the Consultants developed new models to independently assess the results of the previous studies.[4] Mitigation measures proposed in previous studies to control the dissolution process were assessed and new mitigation measures were proposed by the Consultants utilizing up-to-date technologies. The efficiency of the recommended mitigation measures (to reduce dissolution) was assessed in sensitivity analyses. The estimated costs of the proposed mitigation measures were derived to be included in the overall estimated cost of a proposed project.

The Consultants concluded that measures are needed to manage the potential dam safety risks associated with the salt wedge in the long term. The data analysis and modeling results indicate that measures should include both: (i) grouting of the top of the salt wedge; and (ii) the establishment of a hydraulic barrier, complemented by adequate monitoring to detect any loss of efficiency and ensure

: Stakeholders asked about the extent of potential

the bearing capability of the supporting system complex, so that the tunnel structure would meet the required criteria of safety and serviceability.

Powerhouse and Transformer Hall Complex: Examination of the powerhouse and transformer hall complex revealed significant deformations (738 mm up to August 2012) in the powerhouse cavern walls. The observed strains and deformations do not meet required stability conditions for the cavern complex as a whole, and the Consultant concluded that additional reinforcement and stabilization measures are required before any further excavation in the powerhouse cavern can be undertaken safely. These measures could include rock anchors on both sidewalls. The analyses confirmed that, through the proposed set of stabilization measures, it is possible to improve the stability conditions in the caverns with the aim to achieve compliance with the required criteria of safety and serviceability. The proposed stabilization measures would need to be optimized by more detailed studies in any subsequent phase of the project. A suitable monitoring system to track performance of the remedial measures is a mandatory condition. Proposed remedial measures for all underground works would take a minimum of 18 months.

Panel of Experts

After extensive review and independent site inspections, the EmE(r)125(u)3(ld)]4(d)3(ed that)10(TBT1 0 0 1 481.66 650.7

studies. This document was disclosed and discussed during the 2nd Information Sharing Meetings in Almaty on November 6-7, 2012. The Design Criteria are a significant update from past standards and ensure that current international safety standards are applied. These design parameters consider population at risk as well as dam safety hazards, most importantly the design floods (PMF) and the design earthquakes (MCE)[6].

The establishment of such a new set of fundamental Design Criteria appropriately reflects the scale and risks associated with the Rogun site. The Design Criteria Document is applicable to all segments and components of a proposed project, including existing works. Existing works would need to be upgraded where they do not meet the Design Criteria.

Specific questions were raised with respect to the consideration of seismicity in the assessment of existing works. Using MCE as a Design Criteria, the seismic load methodology in the Phase I Report was developed using Eurocode recommendations. Eurocode recommendations cover important aspects of dam design such as the structural and geotechnical design of dams, including foundations, tunnels, slope stabilization, etc., in seismic regions.

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Fourth

Fourth

PoE Comments on Consultant studies

The PoE's direct comments on the studies follow.

A salt wedge exists under the upstream part of the dam axis along the creeping Ionakhsh fault which, if not addressed effectively to prevent dissolution by the potential hydraulic gradient, could impact the feasibility of the project.

Mitigation measures comprising an installation of a hydraulic barrier and grouting of the upper part of the salt wedge have been proposed by the TEAS Consultant.

The PoE commented that they endorsed the recommendations of the TEAS Consultant on the feasibility of the project vis-a-vis the extremely adverse condition imposed by the evaporitic intrusion at the dam foundation. This conclusions goes with the condition that a sophisticated monitoring system is installed, operating uninterruptedly, and new remedial work is to be ready to replace any failed works. The PoE also agrees that a 3rd level of protection, proposed by the original HPI design, comprising a brine curtain, should not be deployed due to a possible clogging of the injection holes and the enormous quantities of salt required.

As a conclusion, the PoE also pointed out that the dissolution of the salt in the dam foundation was a very slow process and that it would take a long time before significant impacts would begin to be felt. Therefore, implementation of remedial measures even after a few years would address the problem. Thus, this is not an issue with the same risk level as large earthquakes or extreme floods where adverse impacts can be immediate.

The disclosed report covers existing surface and underground works which comprise the following:

- Existing accommodation;
- Access roads;
- Borrow areas for the construction materials and their transportation to the construction site;
- Underground powerhouse and transformers hall cavern;
- Existing diversion tunnels DT1 and DT2;
- Other transportation tunnels;
- Early generation equipment.

The objective of this phase of work is to evaluate if the existing surface and underground structures are fit to use for river diversion, construction and operation of a potential dam.

The main focus of the PoE's presentation was on the powerhouse cavern, diversion tunnels DT1 & DT2, availability of the appropriate construction materials, and the status of the equipment for early generation, all of which could have a significant impact on the schedule and cost of the project.

The powerhouse cavern is approximately 21m wide, 69m high and 220m long. The cavern is located within sandstone and siltstone, the latter mainly occurring in the area of Units 5 and 6.

F70. In the 1990s, while the construction works were put on hold, both tunnels experienced partial collapse in the area where the alignments cross the fault F35.

The TEAS Consultant's findings of the Phase 1 work are as follows:

> DT1 & DT2 do not fulfill the technical requirements with respect to safety and serviceability required by the presently internationally recognized design criteria and standards.
> The tunnels need substantial remedial works (drain holes, additional concrete strengthening supported by additional rock dowels, stabilization of the tunnel invert in some sections, additional grouting in more permeable sections, and additional structural measures where the tunnels cross faults F35 and F70) before they can be used for river diversion.

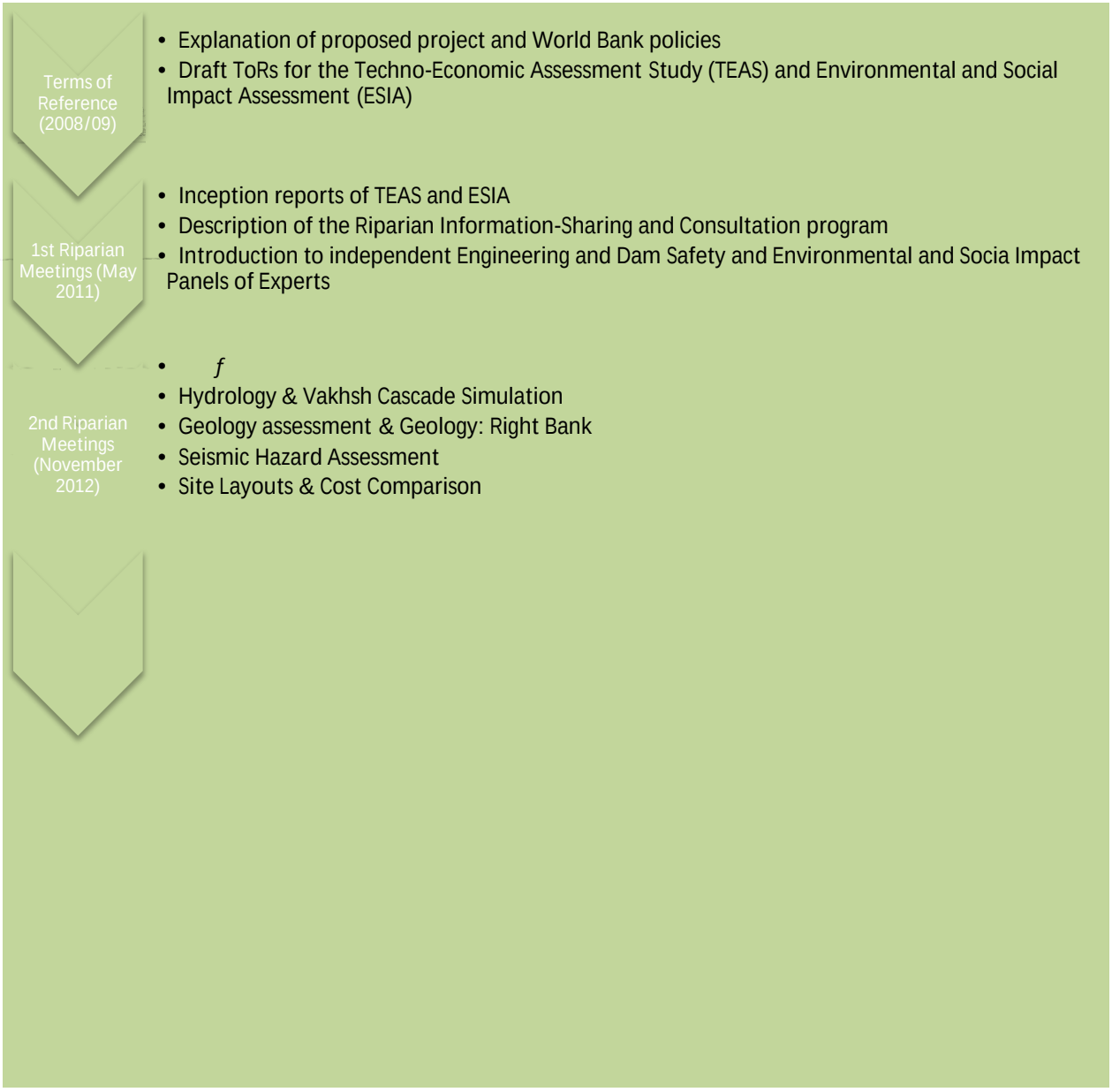
The PoE has done an independent inspection of the tunnels and review of appropriate documents. The PoE agrees with the assessments undertaken, methodology applied and the remedial works proposed, which have to be implemented before the tunnels could be used for river diversion.

f f f f It has been shown by the TEAS consultant that the volumes of material needed for dam construction are available in quarries / borrow areas and associated storages. However, some improvement in grading and moisture content of the core material from Borrow Area 17 will be necessary. Also, care would need to be given to timely extraction of the alluvium from Borrow Area 15as this borrow area will be flooded at the early stages of the construction.

f f The PoE agrees that the staged development as foreseen in the original scheme is both safe and expedient. The existing equipment for Units 5 & 6 does not require major

VI. Next Steps

Significant work


Terms of Reference (2008/09)
• Explanation of proposed project and World Bank policies
• Draft ToRs for the Techno-Economic Assessment Study (TEAS) and Environmental and Social Impact Assessment (ESIA)
1st Riparian Meetings (May 2011)
• Inception reports of TEAS and ESIA
• Description of the Riparian Information-Sharing and Consultation program
• Introduction to independent Engineering and Dam Safety and Environmental and Socia Impact Panels of Experts
2nd Riparian Meetings (November 2012)
• f
• Hydrology & Vakhsh Cascade Simulation
• Geology assessment & Geology: Right Bank
• Seismic Hazard Assessment
• Site Layouts & Cost Comparison

Annex A: Agenda of October 17 Meeting

ASSESSMENT STUDIES FOR PROPOSED ROGUN HYDROPOWER PROJECT

FOURTH RIPARIAN INFORMATION-SHARING AND CONSULTATION MEETING

MEETING OF RIPARIAN GOVERNMENTS

OCTOBER 17, 2013

Video and Audio Conference from Central Asia World Bank Country Offices
Chair: Dushanbe Country Office, Tajikistan Tel. (+992-48) 701 5810
48 Ayni Street, Business Center "Sozidanie", 3rd Floor

AGENDA

Purpose: To share new information from the assessment studies on a proposed Rogun Hydropower project

Chair: Marsha Olive, Country Manager, Tajikistan, World Bank
Co-Chair: Daryl Fields, Senior Water-Energy Specialist, Sustainable Development Network, Europe and Central Asia, World Bank

Time (Dushanbe)	Topic	Moderator/Speakers
13:30 – 14:00	Welcome Opening comments Welcome message from Tajikistan Comments from Heads of Delegations Update on Assessment SnBt SnBt SnBt SnBt SnBt	

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Annex B: Matrix of Comments Received and Responses

4th Information-Sharing and Consultation Meetings on the Assessment Studies of a proposed Rogun HPP
Comments received during comment period (September 30 - November 4, 2013) at rogunconsult@worldbank.org and information sharing sessions

The purpose of the *ı* *ƒ* (TEAS) and *ƒ* *ƒ* (ESIA)

Future Monitoring

Accurate monitoring of the salt formation has to begin immediately.

This is undoubtedly the most important recommendation of the Consultant. It is not subject to disputing

Technical efficiency and reliability of protection measures should be confirmed by facts.

I f f f f f f f f f f f HPP dam and of the measures on the salt and gypsum dissolution process has been taken into account.

Were the calculations and parameters used in the modelling certified appropriate? Is the data base adequate (sufficient and up to date)?

Expressed by stakeholders from Tajikistan and Kazakhstan.

The mathematical modelling is supported by a rich base of information, in part develop71 496.0aI(s)5(

Rock Characteristics

The reduced level of lithological conditions for the salt cap with respect to the bottom of the reservoir and thickness of rock materials are not presented.

Risk Assessment	Risk assessment and risk register missing. No risk assessment was performed (risks connected with simple dissolution of salt in combination with lixiviation of gypsum contained in other rocks surrounding the salt wedge, the risk of effect of the load of the dam and other facilities on easily soluble rocks). A risk assessment should be performed before and after mitigation measures. No risk register is prepared (probability, degree of risk, consequences). The measures recommended by the Consultant for prevention of dissolution of salt and consolidation of the rocks must minimize the risks to the level accepted internationally. The Report contains no data about it. Expressed by stakeholders from Tajikistan.	A Risk Assessment is being prepared as part of TEAS Phase II Summary Report. It will include, but is not limited to, residual risks and mitigation measures.
Cap Rock	Layer above salt cap not thick enough. According to Figure 4-1 Lithological conditions above the salt cap, the clay (formation) thickness is 3 m, what is less than 5 meters and cannot be considered as a reliable confining layer. The stated condition of the formation should be complemented with the following: the salt formation is in a stress state at depth. Expressed by stakeholders from Uzbekistan.	The long duration test evidenced that the cap aquifer behaves as a confined aquifer. The importance of the clay cover is crucial as it limits the leaching process. However its influence is related to the surface covering the wedge, not the thickness. To address potential uncertainty on the clay thickness, one scenario envisages that the clay cover is completely lost. The result of this modelling shows that one mitigation measure alone would not be enough to counter the dissolution effect and that in case of no clay cover, both grouting and hydraulic barrier have to be installed as recommended in the conclusions of the report.

First layer above salt wedge (breccia) is not impermeable as stated in the report.

In Figure 4-1, the first layer above the top of the salt wedge that consists of breccia, anhydrite and clay is specified as impermeable dense. Scientists from the Tajik Technical University (TTU) give a different definition:

"Over the top of the salt formation, there is a cavity formed as a result of salt lixiviation, was filled with breccia represented as a reddish-brown argillo-arenaceous dense gypsified mass with argillite fragments. 25-30 m above the salt cap breccia is loose and insufficiently consolidated; argillite is heavily loosened and adjacent to breccia were identified there. (Source: TTU bulletin No.3, 2008)."

In that case the filtration flow will move from the reservoir through decompressed oversalt cavity and unload to the downstream pond b

Was the potential increase in the solubility of rocks subjected to the effect of dam load taken into account during the modelling process?

The main purpose of point 5 «Mathematical modelling of the dissolution process» is to substantiate the measures (grouting, hydraulic barrier) aimed to prevent dissolution of salt and, consequently, to control suffosion. These measures are specifically aimed to reduce the loss of water from the reservoir, to reduce water pressure and to reduce the filtration flow rates. The measures recommended by the Consultant for mitigation of consequences of dissolution of salt and probably of gypsum, extend the route of water filtration, i.e., the length of the shortest path of percolation.

Were any studies undertaken of the influen

	Input data needs to be included in the final report for the mathematical model related to the identification of risks associated with excessive dissolution. A standard deviation of the mathematical model for identification of risks of excessive lixiviation of salt depends on the database components, therefore it is necessary to include data of design parameters included in the blocks of input data of sub-models into the final report. Expressed by stakeholders from Uzbekistan.	A sensitivity analysis on the input data was performed for the analysis underlying the Phase 0 summary report.

	What impact Ř2Ŝă úKŜ ăλűŜΩă ăŜλăYˆλŎλúě KI·ØŜ 2y˜Ŧ2ℕ úKŜ ăI·fű ØŜŘ∃ŜK aλ∃Kű Lű ŎℕŜI·űŜ ℕΛŦúă that increase the risks? Will impoundment increase the seismic risk? Expressed by stakeholders from Tajikistan and Afghanistan.	All of the seismic data collected in Tajikistan will be assessed and used in Phase II of the TEAS. The on-going geological assessment will further establish the status of the faults and risks. A risk assessment analysis to reflect such risks is currently being finalized. Preliminary results from the Deterministic Seismic Hazard Assessment presented at the 3rd Riparian information-sharing and consultation meetings in February 2013, indicated that the proposed project's design could appropriately account for the seismic conditions and potential challenges (including impoundment and reservoir triggered seismicity) and meet the design criteria of Maximum Credible Earthquake (MCE). The existing data is fully adequate to assess reservoir triggered seismicity given the availability of data collected from Nurek.

Salt Structure

The approximate total depth and potential volume of salt is not given in the report.

According to other source

Figures 1-1 and 4-1 are not translated into Russian.
The phrase kinematic porosity in point 7.2 of the Report (second line) is again translated as kinematic permeability (кинематическая проницаемость) instead of kinematic porosity (кинематическая пористость).

The Summary Report does not indicate if the works performed (e.g. tunnelling, installations) and constructed facilities deviate from the design data and/or technical requirements.

	power generation? Expressed by stakeholders from Uzbekistan.	beyond current design.
Hydrological Data	**The hydrological data is not sufficient.** The design of the surface and underground structures of the Rogun HPP is carried out in accordance with the scenarios of the previous project from the Soviet times and ignoring modern safety regulations. For substantiation of main parameters of the hydrosystems, data of hydrological observations for at least 3-4 years is required. Expressed by stakeholders from Uzbekistan.	International standards and an up-to-date database have been used to carry out the hydrological analysis. At the 2nd Riparian Information-sharing and Consultation Meetings in November 2012, interim findings on the Hydrology Report were discussed. These findings included the characteristics of the Vakhsh river basin, inflows at the site of the proposed project, floods and potential climate change impacts. It was determined that sufficient hydrological and seismic data exist with which to continue the studies at this stage. The dam has now been reassessed for the Maximum Probable Flood, in accordance with the current international standards for large dams. This point was reiterated at the 3rd Riparian Information-sharing and Consultation Meetings in February 2013.

		achieve, once the detailed intervention design will be completed, full compliance of the work with the required criteria of safety and serviceability. Proposed remedial measures for all underground works will take a minimum of 18 months.

Seismic Load

The seismic load methodology does not meet international standards.

I would like to point to Chapter 4. Technical Assessment Of Underground Structures, containing a methodology for assessment of seismic load as not acceptable. In fact, given the accidental nature of seismic loads depending on many factors including amplitudes, spectral

Translation

The following tables summarize the available amounts of material to be placed in the highest dam alternative. This sentence is translated as:

(in the Russian version the word ***alternative*** was excluded from the text for unknown reasons). Does it mean that the ***highest dam alternative*** means the dam height of 300 m (the design height is 335 m, alternative heights are 265 and 300 m).

In paragraph 3.1 **Present Status of the Underground Works,** it is stated: ***Extensive underground works have been performed at the Rogun project site during the period 1982-1990 with the total length of 27 km.*** The English version of the same paragraph **does not contain the phrase *with the total length of 27 km***. It states: ***Extensive underground works have been performed at the Rogun project site during the period 1982-1990.*** The total length about 27 km relates to 2012, and not to 1990 (see paragraph 2.1.2 of the Summary Report

	All Riparians, including Afghanistan, need to adhere to the Nukus Declaration and Protocol 566. Afghanistan begins gradually take an active part in the use of water resources in the Amu-Darya River basin. In this connection Afghanistan must sign the Nukus Declaration and Protocol 566, as a full-fledged member in using water resources of Amu-Darya river basin, before preparation and signing future agreements. Expressed by stakeholders from Uzbekistan.	
Alternatives	**What if the size of Dam is decreased instead of constructing a large dam?** Expressed by stakeholders from Afghanistan.	The TEAS Phase II study is comparing three dam heights and three generating capacities for each height as well as a no-Rogun option for a total of ten separate scenarios.
	Has the need or rationale for this dam been established taking into consideration economic and ecological considerations? Expressed by stakeholders from Afghanistan.	The ToR of the ongoing TEAS and ESIA Studies provides for consideration of economic and ecological factors.

Dam Safety	**What are the dam safety related measures in the event of dam failure?** As the planned reservoir is very big, and there are also problems at the foundation (Salt Zone), in case of dam failure what will be the effects on Tajikistan and neighbouring countries? Expressed by stakeholders from Afghanistan.	The design criteria for dam safety were revised for modern international standards. Dam safety (design) criteria were discussed at the 2nd Riparian Information-Sharing and Consultation Meetings in November 2012. The dam safety criteria is based on international guidelines including the ICOLD (International Commission on Large Dams), specifically that Probable Maximum Flood (PMF) be adopted in design structures for hydrological safety and that the Maximum Credible Earthquake (MCE) be taken into account for the seismic safety of the structural design of the dam and appurtenant works. Design criteria apply to all aspects of any proposed project, including existing and potential works. As a part of the international standards, every dam, especially a large one, will need to have the Operation Manual and Emergency preparedness Plan produced before the impoundment starts.
	The Rogun dam was designed 50 years ago based on Soviet technology. These standards are out of date and the experts responsible for this study need to approach the issue of dam safety with great responsibility. Expressed by stakeholders from Uzbekistan	The current feasibility assessment studies have reviewed all the design issues for the Rogun power project, including the critical aspects of dam safety, on the basis of design criteria that was developed in line with modern design practices. In addition, the work of the Consultants has been subjected to intense scrutiny by both the Panel of Experts and the World Bank and improvements in the proposed design have occurred as a result.

Annex C:

List of October 2013 Information Sharing and Consultation materials available on www.worldbank.org/eca/rogun

Meeting Agenda

List of Participants (for October 18, 2013)

Phase 0 -- Geological and Geotechnical Investigation of the Salt Wedge in the Dam Foundation and Reservoir: Summary

Phase I -- Assessment of Existing Rogun HPP Works: Summary

Presentations

- Key Issues of Participants (by World Bank)
- An Update on Studies (by World Bank)
- Geological and Geotechnical Investigation of the Salt Dome in the Dam Foundation and Reservoir (Summary) Phase 0 Report