PCA Case No. 2023-01

IN THE MATTER OF AN ARBITRATION

-before-

THE COURT OF ARBITRATION CONSTITUTED IN ACCORDANCE WITH THE INDUS WATERS TREATY 1960

-between-

THE ISLAMIC REPUBLIC OF PAKISTAN

-and-

THE REPUBLIC OF INDIA

CERTIFIED TRANSCRIPT (SITE VISIT)

COURT OF ARBITRATION:

Professor Sean D. Murphy (Chairman)
Professor Wouter Buytaert
Mr. Jeffrey P. Minear
Judge Awn Shawkat Al-Khasawneh
Dr. Donald Blackmore

SECRETARIAT:

The Permanent Court of Arbitration

ON BEHALF OF THE COURT OF ARBITRATION:

CERTIFIED PURSUANT TO PARAGRAPH 19 OF ANNEXURE G

25 April 2024

Sean D. Murphy

Professor Sean D. Murphy
Chairman

Arbitration pursuant to Article IX and Annexure G
of the Indus Waters Treaty 1960

NJHEP Dam Site
Pakistan-administered
Kashmir and Jammu Region

Day 3 Thursday, 25th April 2024
Site Visit

Before:

PROFESSOR SEAN D MURPHY
PROFESSOR WOUTER BUYTAERT
MR JEFFREY P MINEAR
DR DON BLACKMORE
MR STEPHEN POMPER, NEUTRAL OBSERVER

BETWEEN:

THE ISLAMIC REPUBLIC OF PAKISTAN
-and-
THE REPUBLIC OF INDIA

Transcript produced by Anne-Marie Stallard, Lisa Gulland
and Trevor McGowan

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MR SYED MUHAMMAD MEHAR ALI SHAH, Commissioner for Indus Waters
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THE REPUBLIC OF INDIA WAS NOT REPRESENTED

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MR USMAN-E-GHANI, Additional Commissioner for Indus Waters
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MR MUHAMMAD AYUB MALIK, NJHPC
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MR DAAN NIEUWLAND, Videographer

Thursday, 25 April 2024
(10.09 am)
Bridge viewing
MR MIANA: Okay, gentlemen, Mr Chairman and the members of the court, again good morning to all of you.
From here we can see to the downstream side of the dam site. To the left we have the right bank, because the flow is in this direction. And to our right is our left bank. And this is the embankment dam to the left-hand side. At left is the crest opening of the two flap gates. Beside this we have the three radial gates which are visible in the black over there, and with them we have the undersluice over there, where the small water is coming out.
At the moment the total flow coming downstream is 250 plus or minus. So this varies about according to the inflows, as well as the level regulations.
There is also a natural stream coming from this upstream side, you can see in the downstream of this one. And beside this undersluice we have the desanders over there, and at the end of the desanders we have the collecting canal over there.
From there, collecting canal inside the mountain headrace internal starts. So this was just an overview of the dam from the downstream side so that you can

familiarise with these components.
The left side is the Panjal formation, and the right side is the Murree formation. So the more about the geology will be explained by the geologist, just to give you an idea about that one. So if you have any questions about this one, I'm ready to answer that.
MR MINEAR: Is this rockfill here?
MR MIANA: (Inaudible) this is the rockfill at left side, yes. And at right side is concrete dam.
THE CHAIRMAN: And the channel on the left, that's the channel you spoke of yesterday; is that correct?
MR MINEAR: The coffer.
THE CHAIRMAN: The coffer.
MR MIANA: No, no, these are the crest openings over there. We've got two flap gates.
THE CHAIRMAN: Okay.
MR MINEAR: Further to the left, what is --
THE CHAIRMAN: The opening?
MR MINEAR: There was a coffer dam that was mentioned yesterday, is that right?
MR MIANA: Rockfill dam, not coffer dam.
MR MINEAR: Okay. Thank you.
MR MIANA: At present 10-15 cumecs from undersluice, and the rest from the flap gates. So if the flow increases then we have the option for the radial gates 1, 2 and 3.

THE CHAIRMAN: And those are closed right now.
MR MIANA: Because the outflows are not too much to operate them, and the small opening of that gate is not recommended.
PROFESSOR BUYTAERT: What is the long-term average discharge of the Neelum?
MR MIANA: From flap gates it's 300 cumecs from each side.
PROFESSOR BUYTAERT: So a long-term average discharge of around 300?
MR MINEAR: Not now. At the moment it's 250.
PROFESSOR BUYTAERT: So now it's below the long-term average?
MR MIANA: It's below the long-term average from flap gates. Because the level is also 1,011.9 metres, something around this one. So that's the lower than maximum level of 1,015 metres. That's why we cannot operate, we will make some discharge from the flap gates.
PROFESSOR BUYTAERT: What season is at the highest flow?
MR MIANA: It's already setting in.
PROFESSOR BUYTAERT: Yes, okay.
MR MIANA: So we can expect that when it will rain in Kashmir upstream, obviously the flow is coming.
PROFESSOR BUYTAERT: Yes. Thank you.
THE CHAIRMAN: Very good.
MR MINEAR: Do you consider this a high sediment load at

this point, is this a high sediment load for you?
MR MIANA: We have to check the data. I'm not sure about that.
MR MINEAR: Okay, thank you.
(10.12 am)
(Pause)
(10.25 am)
Presentation 3: Dam and Reservoir General Site Orientation
MR MIANA: Thank you very much. My name is Muhammad Arfan, as you already know very well.
For presentation number 3, while we are here. From this place we have now the chance to see the dam physically from the upstream side, and the downstream side we have already seen from the bridge. And from here, we will be looking physically the various components of the dam, and same we'll also be presenting the presentation material very briefly.
With me, my co-presenter is Mr Alauddin. You already know him. He was the general manager at this project up until April 2019, and now he is working with us as an advisor to the company.
So let us start with this presentation. The sequence of the presentation will be that firstly I will briefly introduce the Neelum-Jhelum Hydropower Project and point out the various physical features so you have

some sense of layout about this one.
And second, Mr Nayyar Alauddin will then say a few brief words about the process of NJHEP design and the construction. And finally we will give you some briefing about the safety precautions while travelling around the dam.
(Slide 2) So this is NJHEP within Pakistan. So overall the Ministry of Water administers the water management within Pakistan, and under the Ministry of Water Resources we have the Water and Power Development Authority, which is commonly known as WAPDA. And under the WAPDA the Neelum-Jhelum company was formed, and this project had been constructed under the Neelum Jhelum Hydropower Company.
Basically, Neelum Jhelum Hydropower Company works with an independent board of directors. Among the -- the chairman of the board of directors is our chairman WAPDA, Lt Gen (Retd) Sajjad Ghani, and also one of the members of the board of directors with me, Mr Syed Mehar Ali Shah, is also a member of the board of directors. (Inaudible) some independent and some other officials. So Neelum-Jhelum power plant, which is 969 MW, is being operationalised under this scenario in Pakistan. Next, please.
(Slide 4) So this is a map. We have already seen

some similar map yesterday, but this will tell you more about the orientation, about the area, about this one. So this is the Neelum-Jhelum where we are standing over here, and from this we have the tunnelling system: the single tunnel, then the twin tunnel, and then we have the powerhouse in the Chattar Klass near Muzaffarabad. And then we have the tailrace tunnel that discharges the water in that River Jhelum again.
So we are taking the water from the Neelum, which is coming from the upstream side, the Indian side, and then we are diverting the same water to the River Jhelum. On the map, this is the upper limb of the River Jhelum, where we have the Uri 2 showing in this map, in the Indian side. And there we have the proposed Kohala Hydroelectric Power.
This red line is showing the line of control, and we can physically see that this mountain behind us is basically showing there is a control of line. So we are very much near to the line of control. And we can also see some prominent cities over there. Islamabad is over here, with this mountain here, city of Pakistan, and Muzaffarabad is over here, and this is the KP area of Pakistan.
Next slide, please (Slide 5). So about the NJHEP design feature, I would request Mr Nayyar to please come

and explain about these things.
MR ALAUDDIN: Mr Chairman and members of the court, as Mr Arfan has already introduced, my name is Nayyar Alauddin. I am working in this project since 2011 and I was also the director of this project. You will be seeing me a couple of times, a few times during the presentation and during the site visit.
(Slide 6) So, sir, this is the photograph of the headwork of Neelum-Jhelum Project. Starting from here, you see this is the Neelum River coming from the line of control. As you can see, right there is the Neelum River. Now, this becomes a point, because we have constructed the dam here. The length of our reservoir is about 4.5 kilometres. From here to here, the distance is approximately, or the length is about 250 metres.
So water from this reservoir comes to pass through this intakes gauge, and through this intakes gauge water goes into the desander structure and at the end of the desander structure there's a collecting canal. I shall show you from there. And then it goes into the headrace tunnel, and then goes up through the powerhouse through four number turbines, we generate 969 MW of electricity.
(Slide 7) some basic statistics of the project. Neelum-Jhelum has an installed capacity of 969 MW. Its

live storage is 3.8 million cubic metres, where it's dead storage is 6.2 million cubic metres. It has a catchment area of about 6,809 square kilometres. Its mean average flow is 283 cumecs.
In this river, the flow varies, the discharge varies. During the low flow -- during the winter season we get low flow, low discharge, and during the high flow season we get more water. But the mean average flow is 283 cumecs.
So this project has been designed for a 1,000-year flood for 7,600 cumecs, and probable maximum flood which can pass through this radial gates and the flap gates is 12,500 cubic metres.
Through these radial gates we can pass about -- through the spillway we can pass about 11,500 cumecs, and through our flap gates we can pass about 900 cumecs, so that's how. And as well as through the undersluice gate we can pass 166 cumecs of water. So that's how the probable maximum flow of 12,500 cumecs can easily pass through this structure without overtopping.
(Slide 8) Now I shall brief you about the history of the project and the different implementation stages of the project. This project was early conceived after 1980, when the government decided to construct the Neelum-Jhelum Hydroelectric Project. And based on that,

in 1984 and 1987, initial feasibility and design was prepared. But that design was for a smaller project of 550 MW. Its intake was here at Nausari, but the powerhouse was located at the upper limb of the Jhelum River. So it was then a little shorter project of 550 MW.

So after the feasibility and this completion of design, the government approved their project at a cost PKR 15 billion in 1998. But unfortunately the project could not be constructed because of several reasons. Subsequently, the government decided to have further exploration on that, and studies for enhancing its generation capacity, or studies for increasing its capacity, I mean from 550 to 969 MW, was planned, and for that purpose you see the revised feasibility study in 1996 and design completed in 1997 for a 969 MW project instead of a 550 MW project.

Design completed of 969 MW in 1997 and the detailed design completed in 1998. Based on that, in 2002 the government approved that project at a cost of 84 billion. You see, you are seeing this PC-1, what is this PC-1? This PC-1 is basically a pro forma and document on the basis of each committee approves any project in Pakistan. So PC-1 of the project was approved, at a cost of PKR 84 billion.

Unfortunately, even after the approval the work on the project could not be started due to several reasons. In 2005, we had a major earthquake in this area. There was a lot of destruction, about 76,000 people died due to that earthquake.

Our design of, you see design, the original design was based on the old seismic parameters. In 2005 the earthquake -- we recorded different seismic parameters compared with the original design. So it was thought to change the design based on the new seismic parameters.

So in 2005 and 2006, tenders were invited, and in 2007 contract was awarded to a consortium of two Chinese companies, Messrs China Gezhouba Group Company, and Messrs China Machinery Electric Corporation. China Gezhouba Group Company was contractor for the civil work, whereas China Machinery Electric Corporation was the contractor for the EMH work.

(Slide 9) Works on the project started in January 2008. But I told you that the design was changed. After the award of the contract, the process for changing the design was started. I shall give you a couple of examples during my presentation, in position number 5. Initially, simply briefly, I'll tell you, for example the dam was a concrete gravity dam. But later on it was changed to a hybrid structure. I mean

concrete gravity dam and rockfill dam.

The sequence of the different stages of the constructions are, in 2013 we completed the desander excavation work, which was a major task. In 2014, powerhouse excavation was completed, and in 2016 the diversion dam was completed.

In 2011, the river was diverted through a diversion tunnel of 500 kilometres, and after that you see work on the dam had already been started.

In 2017, we completed the excavation and lining of a 28-kilometre headrace tunnel, as well as 3.5-kilometre tailrace tunnel.

So as a result of all this completion of work we commissioned our first unit in 2018, in April 2018, the first unit was commissioned, and in December 2018, the fourth and last unit was commissioned. Since then, this project is generating power, which is going into the National Grid system.

(Slide 10) So these are some photographs of the civil works carried out. Because now the structure is ready and most of the components are submerged in water. So you can see, this is the desander structure. These are the inlet gates you can see, one, two, three, four, five, six. There are six inlet gates, and underneath there are sluicing gates.

Here you can see our spillways. This location is for the debris channel and the rockfill dam, which at that point of time were not ready.

(Slide 11) It's a very good view of our spillway. You see the sizes of the spillways is that its height is 15 metres, its width is 12 metres. So I've already mentioned that we can pass 12,500 cumecs of water through these spillways. You can see here, this is the inlet or diversion tunnel. The diversion was started here. This was the coffer dam construction, so that water may not go to the construction site.

(Slide 12) Now about the tunnelling. From this collecting canal, from the end point of the desander structure up to 0.8 kilometres, it is a single tunnel of about 10.5-metre internal diameter. After that it bifurcates into the twin tunnel, the twin tunnel of 19 kilometres. Then again it combines and becomes one channel, and then up to the powerhouse it is a single tunnel, and then water goes into the powerhouse.

The diameter of these twin tunnels -- finished diameter -- was about 8 metres.

(Slide 13) So I think you will know that in July 2022 a part of the -- a 50-metre part of the tailrace collapsed due to this generation from this project stopped. Immediately the remedial works on the tailrace started, day and night were carried out, and after 12 months -- I mean, in August 2023, the project was recommissioned and now, so far, it is satisfactorily functioning.

About the tailrace damages, there would be a separate briefing on that.

(Slide 15) So these are some of the brief history and implementations of the project, and now I would ask Mr Miana to say some advices on the safety of the project.

MR MIANA: So regarding the safety rules, usually we use the rubber soles, like hiking boots or tennis shoes. I think we all have the similar kind of that one. So perfect. And the visitor must wear hard hats, if you need for them, and go around further presentation number 7, and along with the safety vests, high-vis safety vests. We have already arranged for that one. We will also be following the safety section, written in a different location over there. And in case we have to go inside the water or inside the galleys downstairs, then we have to use the waterproof boots that are there. But at this moment we're not going there.

Please keep a safe distance from all handrails and guardrails. We will also have the cotton gloves, or the hand gloves over there, so that we can use that just to

avoid our hands from dirt. So these are small safety rules.

So if you have any questions we are available.

MR ALAUDDIN: Yes, if you have any questions.

Questions from THE COURT

THE CHAIRMAN: So one question I have is, has this dam ever been overtopped?

MR ALAUDDIN: No, it hasn't.

THE CHAIRMAN: And the diversion dam that you mentioned diverted the water on the far side of the river.

MR ALAUDDIN: Diversion tunnel, there are two things, diversion dam is the dam. Diversion tunnel is 500 metres, which starts just upstream of the existing structure, through which it is under the mountain and goes like this.

THE CHAIRMAN: The far side.

MR ALAUDDIN: On the far side, yes.

THE CHAIRMAN: And so the dam itself, the diversion dam itself would be somewhere up here before the tunnel.

MR ALAUDDIN: It's there.

THE CHAIRMAN: Right here?

MR ALAUDDIN: Yes.

THE CHAIRMAN: Ah, okay.

MR MIANA: There is a chance that we will go for the presentation no. 7 walkaround, we will see the outlet of

that diversion.

DR BLACKMORE: What's the maximum flow you've passed through the dam?

MR ALAUDDIN: It is about 2,100, or 2,200 or something.

DR BLACKMORE: Did you experience any issues?

MR ALAUDDIN: No, we didn't.

DR BLACKMORE: A lot of debris?

MR ALAUDDIN: Debris you see naturally comes, and we carried out the survey of the river from time to time to assess that.

DR BLACKMORE: Okay, thank you.

MR ALAUDDIN: Welcome.

PROFESSOR BUYTAERT: A couple of questions. I think slide 2 on the overall governance, who operates -- I think the next one. Yes, it doesn't really matter. The one with WAPDA. It was earlier. It doesn't really matter.

In Pakistan, who operates the power distribution network?

MR MIANA: (Inaudible: off microphone) The system is that the generation is separate. Transmission from the generation side is separate, and from the transmission to distribution is a separate network.

For the distribution we have the different companies, the different regional companies, so they are responsible for the distribution of the power to the

residents, commercial and industrial.

PROFESSOR BUYTAERT: A follow-up question. Does Pakistan have a power industry regulator which oversees the different companies that both provide and distribute the power?

MR MIANA: At the moment I do not have the idea and the information about that. I will get it and I will come back to you.

PROFESSOR BUYTAERT: That's fine.

Then a few questions about the hydrology. I don't know who is best placed. So I understand that the wet season is during summer. What is the month of the highest discharge, typically?

MR ALAUDDIN: It is July.

PROFESSOR BUYTAERT: Okay, yes.

MR ALAUDDIN: In July we get maximum discharge.

PROFESSOR BUYTAERT: And what is the reason for the highest discharge? Is it simply because it's the highest rainfall, or is there a contribution of glacier melt and potentially snowfall.

MR ALAUDDIN: It's ice melt basically.

PROFESSOR BUYTAERT: Sorry?

MR ALAUDDIN: Ice melt.

PROFESSOR BUYTAERT: Ice melt. Okay. Yes. Because my follow-up question was about the distribution between

direct run-off from rainfall, glacier and ice melt and snowmelt. What, roughly, do you have any idea of the relative contribution of those three?
MR ALAUDDIN: No, sorry. I don't have a precise idea on that.
PROFESSOR BUYTAERT: Yes. But there is substantial ice contribution?
MR ALAUDDIN: Yes, we will respond to it.
PROFESSOR BUYTAERT: What about snowmelt contribution, is that substantial?
MR ALAUDDIN: We think that is substantial, because of this the water comes --
PROFESSOR BUYTAERT: And I guess that probably comes earlier in the season when snow -- what is the peak of the snowmelt? Do you see any peak as a result of snowmelt when temperatures increase?
MR ALAUDDIN: It probably starts in April.
PROFESSOR BUYTAERT: April. So right now?
MR ALAUDDIN: Yes.
PROFESSOR BUYTAERT: Yes. Okay.
Do you see any impact of snowmelt on sediment loads, or icemelts? How does that vary throughout the year?
MR ALAUDDIN: We are monitoring and studying this because it is a complicated -- it's not -- it's complicated behaviour of these things, assessment and concluding

this takes time.
PROFESSOR BUYTAERT: Yes. Thank you.
MR ALAUDDIN: You are welcome.
MR MINEAR: Do you have gauges upstream in which you can monitor monthly mean discharges? Is that something that you monitor?
MR ALAUDDIN: Yes, there are gauges. There are three gauges at different intervals through which we collect data.
MR MINEAR: Thank you.
PROFESSOR BUYTAERT: Quickly, what type of gauge is that, do you happen to know?
MR ALAUDDIN: These are basically -- these are automatic gauges which provides data through the satellite to our control room.
PROFESSOR BUYTAERT: But are they water level gauges, combined with --
MR ALAUDDIN: Yes, level gauges.
PROFESSOR BUYTAERT: Do you know the rating?
MR ALAUDDIN: Discharge gauges.
PROFESSOR BUYTAERT: Okay, but what exactly do they measure? Because typically you have a water level gauge, which is then converted into discharge with a rating curve --
MR ALAUDDIN: Yes. The same thing, yes.
PROFESSOR BUYTAERT: Okay, thank you.
MR MINEAR: How far back do your records go with regard to

discharge?
MR ALAUDDIN: Sorry?
MR MINEAR: How far back do your records go with regard to historic discharge here?
MR ALAUDDIN: Sorry, I could not follow your question.
MR MINEAR: Do you have historic records of discharges?
MR ALAUDDIN: Yes, we have.
MR MINEAR: And how many years back do you go?
MR ALAUDDIN: You see our record starts many, many years back. But we have designed this project based on accurate data collected from 1992 and onwards five to six years.
MR MINEAR: Thank you.
THE CHAIRMAN: Well, you can see that your presentation provoked a number of questions from us. Thank you very much for the overview presentation. It's very helpful. And thank you for arranging for perfectly nice weather for this visit.
I think we don't have any further questions, so perhaps we'll move on to the next stage of the day. Although I think perhaps we'll try to do a single photograph of the court members with the dam in the background, if we can arrange that, either here or just down below, perhaps.
MR MIANA: Before going down can we explain a little bit

about the upstream side of the dam?
THE CHAIRMAN: Sure, absolutely.
MR ALAUDDIN: So if you please come here.
So you can see that this is the Neelum River coming from the line of control side. This is our reservoir. As I mentioned, this land is about 4.5 kilometres.
So on this side you have seen the same structure from the downstream side. Now we are the upstream side. You see just at the right you can see the rockfill dam. The significance, what is the significance of the rockfill dam? That will be explained in the coming presentation, as it has been said, for any effect of the fault line.
Now you see the two gates there. These are the flat gates. This is a debris channel. It has two functions. During the high flow season we pass the water, (indistinct) water, through these gates. Also the floating debris are also removed from it.
You see this red line, this we call log boom. The purpose of the log boom is that the debris should not go over the intake, on this part near the intake. So it keeps debris here. And you see when we -- with the passage of time, this debris flows towards the debris channel. Had it not been -- this red line not there, there would be a heap of debris in front of the intake

structure.

With this debris channel we have the undersluice -- sorry, the spillways, which are not visible.

Now, you can see from here, from this side, this is our desander structure. Under this you see the floating debris, and that trash cleaning machine is removing the debris also. So here we have six intake gates through which water goes into the desander structure. At the end of the desander structure, at the end you can see the structure for the collecting canal. From the collecting canal water goes into this head regulator. In the desander stretcher velocities slow down so that the sediment may settle at the bottom, and for that there is a sluicing arrangement.

So these are some of the salient features. If you have any questions, you are welcome.

Questions from THE COURT

DR BLACKMORE: You seem to have plenty of plastic.

MR ALAUDDIN: Yes.

PROFESSOR BUYTAERT: How often is the sediment removed from the desander? So how is it removed?

MR ALAUDDIN: Actually, these are removed, continuous monitoring of the sediment is carried out in the desander structures. But the maximum limit which we are now following is that when a layer of, say, 1 metre is

deposited, we carry out the sluicing of the sediments. But even then, from time to time, whenever we feel, we regularly take samples of the water and we see the behaviour of the sediment. It's not fixed that we wait for 1 metre. It can be whenever the operator realises that the sluicing is required, he carries it out.

You see, we also take samples from the collecting canal. That tells us the concentration of the sediments, which are passing from the desander structure going in there. If the construction becomes high, even then we carry out the sluicing of the desander structure.

PROFESSOR BUYTAERT: Okay. So you sluice it out when it accumulates too much. How often does it happen? Or is it highly variable?

MR ALAUDDIN: At the time I will tell you that in this desander structure, after three or four months, if you don't carry out the sluicing of the desander structure, after three months and a half months, or four months, a layer of 1 metre sediment is deposited, which is reflective that our design of the intake structure and the design of the desander is very effective.

PROFESSOR BUYTAERT: Do you ever empty them entirely and completely clean them out?

MR ALAUDDIN: This one?

PROFESSOR BUYTAERT: Yes.

MR ALAUDDIN: We time to time do that, yes. And there will be a separate briefing on the sediment trapping capacity.

PROFESSOR BUYTAERT: Okay.

MR ALAUDDIN: The garbage we have prepared for the desander structures.

DR BLACKMORE: Is the desander a critical -- many of these facilities don't have a desander, so would you say that's a critical part of your operation? If you had to pass that sediment at that level through the power station, what would be the outcome?

MR ALAUDDIN: Then simply we think that more sediment will go and will damage our runners, turbines.

DR BLACKMORE: We're yet to talk to how often you've got to maintain your runners, but I'm just wondering, with or without -- some of these facilities don't have desanders, so I'm just interested.

MR ALAUDDIN: So it is basically -- it is -- you see, it depends, there can be a number of options for it. There are projects without desanders like this.

DR BLACKMORE: Okay. So we'll call this one a Rolls Royce project with the sander.

Excellent, thank you.

(10.56 am)

(A short adjournment)

(11.33 am)

THE CHAIRMAN: Okay, I think we are ready to resume with presentation 4, whenever you are ready.

Presentation 4: Overview of Dam Site Physical Location and Elements

DR HAYAT: Mr Chairman, members of the Court of Arbitration, good morning. I am Dr Tahir Hayat and it's a pleasure to address you again. I am presenting with Mr Umar Farooq. Can you raise your hand, please? He is a senior engineer at National Engineering Services, Pakistan, NESPAK. And Mr Fiaz Hanif Sendhu, chief geologist/consultant of Tarbela 5th Extension Project.

Together we will address the geographic, topographic, hydrological and geological issues relevant to the Himalayan run-of-the-river design, construction and operation.

We will proceed in three parts.

First, I'll provide you with an overview of the physical and social geography and topography covering the Indus basin and the areas around the Neelum-Jhelum Hydroelectric Project.

In the second part, Mr Farooq will take you through the hydrology of the region, and point out some specific features relevant to Neelum-Jhelum Hydropower Project.

And thirdly, of course, Mr Sendhu will come in to address you on geology of the region, and particularly the Neelum Valley and the dam axis.

Again, please feel free to ask any questions at your convenience during or after the presentations.

Slide number 2, please. I'll start with the geography and topography of this region. As will be clear when I make my presentation, and the others also, the Indus basin is actually the lifeblood of Pakistan's water supply, and the only river basin of any consequence within our country.

Slide number 3, please. This slide shows a schematic representation of the principal rivers of Indus basin, and the catchment areas of the eastern and the western rivers. In the first place, please note the line of control. So this is the international boundary, and then this is the line of control.

The Indus River is 3,200 kilometres long, and its basin encompasses a total area of approximately 862,700 square kilometres. The Indus basin area in Pakistan is made up of the Indus River. So the Indus River, if I may point out here, this is the Indus River.

So the Indus River in Pakistan is made up of the Indus River and six major tributaries. The western rivers are the Indus, Chenab and Jhelum. I'll point

those out later, so Jhelum, Chenab, Indus. And the eastern rivers are Ravi, Sutlej and Beas. Sutlej, Beas, Ravi.

The Indus River originates in the Tibetan Highlands and then flows through Indian Administered Kashmir, enters Pakistan. This is Gilgit-Baltistan, near Gilgit.

By the way, this is where we are building the Daimer Basha Dam near the town of Chilas. There is Tarbela Dam, which is on Indus, flows through KPK, Punjab, down to Sindh, near Hyderabad. And then near Karachi it falls into the Arabian Sea. So this is the path it traverses.

The Chenab River, this one, originates in Himachal Pradesh state of India, and passes through the Indian Administered Kashmir before entering Pakistan in the Punjab province in Pakistan.

The third Western River is the Jhelum River. It originates in the Indian Administered Kashmir, and then it is joined by the Neelum River, which is not shown here, but in the next diagram I will show. We are actually somewhere here (indicates). So the Neelum River actually flows almost along the line of control, and joins the Jhelum River here, at Muzaffarabad. And then it flows down; this is Mangla dam. And of course all the rivers ultimately meet and they fall into Indus,

which then flows into the Arabian sea.

The only river coming from the other side is the Kabul River, which comes from Afghanistan, enters into Pakistan, and downstream of Tarbela it joins the Indus River.

So the green shading in this map shows the catchment area of the Western Rivers, all of this green area. And the somewhat yellow shading shows the catchment area of the Eastern Rivers.

Slide number 4, please. Next we see the same map, but this time showing the glaciers and snow cover, which is shown in this greyish colour in this area. The grey colouring shows the snow or ice cover. The major contributor of river flows is meltwater from snow and glaciers in the Karakoram and Himalayan mountain ranges. In fact, Indus is one of the most meltwater dependent river basins in the world.

So the combination of snow and glacial melt accounts for -- and that's your question maybe -- about 70-80% of the total flows in the basin rivers. The remaining flows are contributed by rainfall, mostly in the monsoon period, in the later part of summer: June, July, August.

DR BLACKMORE: Just a question then. So how far does the monsoon push in? Does the monsoon push right the way through into that upper area of the Indus?

DR HAYAT: Monsoon basically affects middle and southern parts of Pakistan.

DR BLACKMORE: Yes.

DR HAYAT: Mostly. But they do enter into the northern areas also. And as I said, previously they were supposed to be up to Dasu Project area, we were seeing signs of monsoon rain. But this, in the last one decade, we have seen that the monsoons or related rains have also crossed this previous sort of a boundary, and gone up to as high as about this area also. So this is almost all of Pakistan.

DR BLACKMORE: Sorry, but what's the elevation, when you've got the Indus coming around the top?

DR HAYAT: At Basha, the Indus elevation is about 950 metres above mean sea level, so it's not that high. But it rises very rapidly because we have, as you know, some of the highest mountain ranges in this area. So like K2 and Gasherbrum, Broad Peak, Nanga Parbat, to name some of the few.

So, yes. So at this point in time it's about at 950, at this place. That I know exactly, above mean sea level.

THE CHAIRMAN: And is the increased effects of the monsoon higher further north due at all to climate change conditions, or not?

DR HAYAT: We believe so. It's always -- you know, climate change is still -- I mean, you can -- even your app on there says it's so many percentage chance of rain, you know. It's a probability. So we can say that it's -- we are quite sure that it's part of the climate change that these things are happening.
THE CHAIRMAN: And that in turn affects the way that you operate the dam, in that if you've got greater hydro coming through, water coming through, you need to open your gates at certain times; is that correct?
DR HAYAT: Definitely, because the operation of the gates always depends on the amount of water that you're -- so you balance in terms of: you want to fill the reservoir because you need the water, so you ... and plus, if you know -- and because there are gauging stations all the way through. So you have -- and the dams are mostly, you know, in this reach down there.
So you have anywhere from 24 to 78 hours, or 72 hours of warning that a flood is coming. So the operator then has the option to know whether he has the capacity within the reservoir to fill that incoming flood; or if he thinks that he's short of that, then he'll open the spillway gates. And sometimes they do it before the storm arrives so that he can have more capacity to absorb whatever is the volume expected at

that point in time.
THE CHAIRMAN: Thank you.
DR BLACKMORE: Can I just ask one more question, sorry. I think these are important questions for us in terms of looking at the hydrology. So in the last decade, we've got more energy in the monsoons, pushing it further north. So that's likely to be a climate change response. Like, it could be in the balance of probabilities something else, but it's unlikely. So if that's occurring, we're going to see increases in the probable maximum floods along through this region.
The other issue for me is how many -- when you get to the top of the Indus, or along the -- when you start to go through the very high peaks, do you know what percentage of the glaciers are below 5,000 metres?
DR HAYAT: I don't have off top of my head.
DR BLACKMORE: Is it the vast majority of glaciers?
DR HAYAT: More than 18,000 glaciers, so I'll have to come back to you on that one, you know: how many are 5,000, 5,000-6,000, 7,000. I'll have to get back to you on that.
DR BLACKMORE: The reason for the question is that the science evidence is showing that glaciers below 5,000 metres are much more affected now by the climate change impact, and those above it are less affected. So

from a hydrology perspective, it's an important issue in terms of the reliability of flows and the timing of peaks, that's all.
DR HAYAT: I think in the next part of the presentation, Mr Farooq will be explaining the hydrology much more in detail. So he will be having more details on that, and I think he'll be answering many of your questions at that time.
MR MINEAR: Excuse me, this area here is outside the catchment here. Is that all low land? It surprises me that immediately adjacent to the Indus River you have an area that is not included in the --
DR HAYAT: This must be draining to the other side, sir, then. Not into the Indus. So this part would be draining to the Indus River, whereas this one will be sloped somewhere towards that side, so that it will be going to the other side, into the Arabian Sea.
THE CHAIRMAN: Okay. Dr Hayat, please proceed.
DR HAYAT: So Mr Farooq, as I said, will explain that heavy reliance on snow and glacial melt and flows in Indus are then definitely subject to seasonal variations: more in summers, less in winters.
So the climate patterns do not just vary according to season but across the length of the Indus basin. So this is coming to your question partly.

In the upper Indus basin, which is the areas of the Himalayas, Karakoram and Hindu-Kush ranges -- by the way, this is the place, near Gilgit, where all these three ranges meet: the Karakoram, the Himalayas and the Hindu-Kush -- most precipitation occurs in winter and spring, in terms of falling snow, especially in higher elevations.
The lower Indus Basin has subtropical and arid and semi-arid temperature, which is this area. And the precipitation is mostly from monsoons: rains from July to September.
The Indus Basin has an average annual precipitation, both rain and snow, ranging from 100-500 mm in the lower basin, to 2,000 mm and above in the Himalayan foothills and higher mountains.
So the Indus Basin has, as I said, about 18,495 [glaciers] -- somebody has counted, but I would say 18,500, let's say. And they span about 21,193 square kilometres. So it is one of the highest concentrations of glaciers in the world, I would say.
The climate change has caused warming and accelerated glacial melt, which is your observation, very correct. As you can imagine, the waters of the Indus Basin are therefore unusually exposed to the impacts of the increasing temperature and associated

change of climate.

Although there is considerable uncertainty -- as I said, you know there's probabilities, and this and that -- as to the exact consequence of this climate change, two patterns are predicted.

First, several studies predict that there will be a significant decrease in total water availability. One study predicts about 17% by the end of this century.

Secondly, increasing heat will put more demand for water for irrigation, because a lot of water will be getting evaporated, which is the principal water used in Pakistan, actually.

Slide number 5, please. Now I'll show you the map showing the population density in the Indus Basin. And if you look at the region, you know, it goes from -- basically, the population density is number of persons per square kilometre. So it goes from less than 20 to all the way to greater than 2,000.

Now, you can see the Indus Basin here, which I showed you before. And you can see that the significant part of population of Pakistan is water-dependent, and this is from Indus Basin, and that is where the population is centered. You see all this red area, which is centred around the Indus Basin and its tributaries, all of it. So this is why I say this

is the lifeline, and life and blood of Pakistan. So this contributes 95% of the total water sources of Pakistan, the Indus Basin.

So the Indus Basin is home to a population of 240 million people, out of which 78% live in Pakistan and 17% live in India. The remaining 5% live in Afghanistan and China. The population is increasing, and quite rapidly. It is predicted that the population within the Indus Basin will rise to 383 million by 2050. So from 240 [million], it will rise to 383 million by 2050.

Pakistan's population has increased by about 3% since 1961. So by 2050 it is predicted that we'll have about 400 million people. About 40% of our current population lives in urban areas. By 2050, this number would have jumped to 50%. So out of 400 million people, by 2050, 200 million will be living in urban areas.

So the density that you see here, and the growing size of Pakistan's population in the Indus Basin, has very important consequences for water management: (a), there will be higher demand, and that is food demand, because you have to feed 400 million people, so required increased agricultural output and irrigation, which requires water. And the increased urban population will also have water requirement for domestic use and

industrial use. So there is that increase that is compounded as the time goes by.

Slide number 6, please. So next I turn to the demand for power supplied by hydroelectic plants. I'll show you a series of slides that give you a snapshot of the area and local demand centres. In fact, the Neelum-Jhelum Hydropower Project, which by now I'm sure you -- we are sitting here right now, and this is the tunnel and this is the powerhouse area, and it crosses the Jhelum at this point in time.

So this actually supplies to a single grid in Pakistan. It has no specific demand centre: it actually goes into the bigger basket of power which is then distributed all over Pakistan.

So the green plants are the ones which are actually in operation, like the Neelum-Jhelum here, Patrind here. Those which are under construction: Kohala in red. And others which are under planning or designing in different colours, along different rivers here. This only shows up to Mangla Dam.

So what happens in a bigger basket that you have is that if one hydropower plant is deficient, that does not make it ineffective: then other plants kick in, and there is more flexibility if you have a lot of plants feeding into one grid system. You have more

flexibility.

Slide number 7, please.

PROFESSOR BUYTAERT: Sorry, can I ask a quick question on your previous slide?

DR HAYAT: Please.

PROFESSOR BUYTAERT: What is the difference between the red and the purple?

DR HAYAT: Okay. The purple triangles are the planned plants, and the red triangles are those which are under construction.

PROFESSOR BUYTAERT: Okay, because number 9 seems to be on top of the mountain, or perhaps that's on a tributary. Do you know why ...

DR HAYAT: Number 9 here?

PROFESSOR BUYTAERT: Yes.

DR HAYAT: Yes. So number 9 is under construction.

PROFESSOR BUYTAERT: Yes, but what type of plant is that? Because it seems to be off the main river, so I assume it's the tributary --

DR HAYAT: It's on one of the tributaries.

PROFESSOR BUYTAERT: Okay, yes, thank you.

THE CHAIRMAN:

DR HAYAT: But I can get you the number, and from that we can refer to it.

PROFESSOR BUYTAERT: Okay.

THE CHAIRMAN: Can I ask, doctor, of the ones that exist and the ones that are planned, roughly what's the percentage between the run-of-river dams and the storage dams?

DR HAYAT: Storage dams are few. Storage sites are few. So in terms of percentage, I don't have off my head. But, for example, if you look at the Indus cascade, we have Bunji, we have Basha, we have Dasu, Patan, Thakot. Out of these, only Basha is a storage dam.

Similarly, on the Indus we have -- only storage is -- the other one is Kalabagh, which is in cold storage right now. So that is the other.

So most of those plants are power plants, run-of-the-river, most of them. If you need an exact percentage --

THE CHAIRMAN: No, no, no, that's fine. I was just curious generally.

DR HAYAT: Generally.

THE CHAIRMAN: Yes.

DR HAYAT: Generally.

THE CHAIRMAN: Very good.

DR HAYAT: Yes, sir.

DR BLACKMORE: While we're talking hydropower, I just want to go on to pumped hydro, because you have a relatively small amount of storage-backed hydro, so you're on run-of-the-river. I'm just wondering whether there is

a role -- have you seen a role in Pakistan for pumped storage to meet peaking demands? Or is that somewhere in the future?

DR HAYAT: To the best of my knowledge, sir, no.

DR BLACKMORE: Okay.

THE CHAIRMAN: Okay, doctor, thank you.

DR HAYAT: Thank you, sir.

Can we move to slide number 7, please. So this is the area we look closer to the -- near the Neelum-Jhelum Project. This is the place where we are right now. And this is the line of control, as was pointed out to you. This is the tunnels passing. And this is the powerhouse location, you can see the load centres near it. So Islamabad is here. We have Abbottabad and other cities which are closer by.

But, as I said, this is not a specific plant that feeds only these load centres, but it -- in the next slides you will see it feeds into one big grid.

So actually, this Neelum-Jhelum, it operates in conjunction with two other plants, and one is this. We have Patrind somewhere around here, and of course Kohala is under construction. And Karot, which is down here somewhere, which is off the map somewhere here, near Mangla. So Patrind is 150 MW and Karot is 720 MW. And Mangla is of course 1,000 MW, and it's a storage dam.

All the others are run-of-the-river. Kohala is under construction.

DR BLACKMORE: Sorry, Mangla -- the release pattern for Mangla is around irrigation, not power. So is it primarily you're using the water -- while it's storage-backed hydro, the primary call is for irrigation, and power is a useful outcome?

DR HAYAT: Your observation is correct, sir.

DR BLACKMORE: Okay. I just wanted to make sure. Thanks.

DR HAYAT: Slide number 8, please. So here we are looking at the transmission lines. And as I said earlier, you know, this is the transmission line that is coming from Neelum-Jhelum, and it is feeding into a main grid. So most of -- the highest transmission line voltage that we have is 525/500 kV, which is shown in this magenta or red sort of colour. The greens ones are 220 kV.

Then of course this is the transmission voltage. As you go down, then you step down -- this is transmission voltage. They you step down from 525 to 220, from 220 to 110, 110 to 66, and all the way down till you go to the household or industries.

But this shows the main -- so it is one complete -- so the idea is to show that this is one complete grid from Karachi all the way to the north, in which all these plants feed in, and then it is distributed. So

whole of the Pakistan is connected to one single grid.

Slide number 9, please. Now, the principal immediate effect of any hydropower is caused by filling of the reservoir, and we inundate the area. And you saw the reservoir here also when you were on top of that building, which causes water level to rise. So the reservoir gives the run-of-the-river hydropower live storage, as I talked about yesterday, within that 24 or one-day cycle, so that you can have peak demand and all those things, and create generating head.

So the reservoir, normally in these run-of-the-river projects, it's in a narrow valley, which is constrained by its size. So therefore, as a consequence, the reservoir could be many kilometres long.

So the reservoir will be filled, actually, to the predefined level of an ungated spillway. If you have an ungated spillway, the maximum level that the reservoir will obtain will be that of the ungated spillway. And as the river rises above the ungated spillway, it will automatically spill over. And of course, if you have flood, there will be some flood surcharge over and above that.

If you have gates, then the maximum level of the reservoir is controlled by the top of the gates. So the top of the gates defines your reservoir level. And there, when there's more water, they are open to release excess water.

So in mountainous areas, you know, dam sites are quite narrow, which can pose quite a few challenges. Limited area, you have to put a lot, many things together. So the width of the valley and ability to pass the design flow through the spillway, how much space you need, if you have desanders, how you fit all these things together. And you have seen an example of how we have done it in Neelum-Jhelum, and we have done some excavation and things like that.

Now, I'll describe what happened to Neelum-Jhelum with that specific case when they filled the reservoir.

Next slide, please. So in slide number 10, you will see this is a Google image of the area before construction of the project. So this is the dam site. The dam total width is about 250 metres. That is after excavation and everything. And at full pondage level, which is 1,015 metres above sea level, you can see this is the contour which was predicted, that this would be the extent of the reservoir created. So you can see, compared to its maximum width of 250 metres, the width actually also decreases, and it is quite a rectilinear sort of feature that is created in a normal Himalayan run-of-the-river project.

Now I will go to slide number 11, please. And here you see satellite imagery after the dam was constructed. So this is the dam, and this is the -- you can see the reservoir, and this is about 4.5 kilometres from the dam. So this is the effect that a run-of-the-river in Himalayas, and the specific example of Neelum-Jhelum has.

So by constructing a 47-metre high dam, the reservoir extends about 4.5 kilometres either side. So the higher the dam, the longer the reservoir.

So that concludes my part of the presentation. Next will be hydrology, to be dealt with by Mr Umar Farooq. If at this point in time you have questions, please.

Questions from THE COURT

THE CHAIRMAN: Before we let you go, doctor, I do have a couple of questions.

So the reason why most of the dams in Pakistan are run-of-the-river dams is because it's not, in terms of the topography, possible to have a storage dam? Is that the main difference/reason?

DR HAYAT: You are quite right, sir, in that sense. Because for a storage dam, you require -- topography is one of the major features, as well as geology.

Most of Pakistan is actually quite flat. As you go down from Islamabad then up to Karachi, it is all flat

land, basically. So there's hardly -- because for dams, you need a space in which you can construct the dam and have it contained, sort of a reservoir. And normally you would look -- on a river when you're designing a dam, you look for a place where the river is narrow, i.e. there is a natural constriction of the river, but behind it you have an open valley, so that with each metre height of the dam you get more storage.

Like in this valley, this is okay for run-of-the-river. But if you have a very steep valley, you can hardly store any water in that. So you look for a valley which is -- at the dam site it will be narrow, so that you can save on the construction of the dam and it will be easier to build the dam. But behind the dam you have an open wide valley in which you can store water. So those storage dam sites, you know, they are a gift of nature in any country that you get those sites, and you try to maximise on those. And other than that, then you go for run-of-the-rivers.

THE CHAIRMAN: Is one way to think about the difference between a run-of-river dam and a storage dam that, for a run-of-river dam, you are able to have some amount of reservoir or pondage, but only enough to smooth out, on a daily basis, the peaks; whereas for a storage dam you are able to smooth out the entire year?

DR HAYAT: Very good, sir. I think you have hit the nail on the head.

THE CHAIRMAN: I get a degree, I think!

DR BLACKMORE: I've just got a couple of questions about the storage dams. So let's deal with Mangla for a moment, because it's downstream. And I'm not aware: does that have a reregulating pondage downstream of the dam? So you just release in peak, keep the flow downstream of the dam, even for what you need for irrigation, but enables you to use the power stations for peaking power? Tarbela does, but I'm not sure --

DR HAYAT: Tarbela has that reregulation going for Ghazi Barotha. And to the best of my knowledge -- but I'll refer that question to one of my colleagues sitting here -- to the best of my knowledge --

DR BLACKMORE: It doesn't.

DR HAYAT: -- Mangla does not have. Am I correct?

Mangla does not have one. (Pause)

THE CHAIRMAN: Just to remind everyone, we need to create a transcript of this, in part so our colleague, Judge Awn Al-Khasawneh can benefit from our conversation. So whenever anyone speaks, let's have a microphone in front of you.

That's not to cut anyone off: we want the information. It's just we want to capture it.

MR MINEAR: Two quick questions. First, were any villages inundated by the creation of this reservoir? Was anyone displaced as a result of this?
DR HAYAT: Few peoples displaced. There were few huts and all others in the reservoir. But it was a narrow area. So to give you the exact number, I will refer this to Mr Ayub Malik: I think he may have the answer of the exact number. But it was few.
Once the mic is with you, can you answer that question, please?
MR MALIK: There were some houses where we went on the top, where you saw that and where the desander is excavated. There was a few houses that have been relocated. And there was a girls' school there that WAPDA built on a replacement area. That school was built, and the people who were relocated from here were given compensation for that land.
So very few: I think it was hardly 100 people were relocated from this area.
MR MINEAR: If I could just go back to slide 5 for a second.
DR HAYAT: Please.
MR MINEAR: I was curious about this area south of the Indus. It does not receive any irrigation water from the Indus? Or does it get adequate water, or is it just not farmed in that area?

DR HAYAT: I think it's not farmed in that area. Part of it, if I'm correct -- if my high school lessons are correctly remembered -- quite of it is desert area.
MR MINEAR: Okay, thank you.
DR BLACKMORE: I'm going to come back to the question of sediment, because every time I look out at these mountains I worry about it, as you do.
So you've got run-of-the-river dams, and you've got sediment management to make sure that, in the end, the sediment goes downstream. Then at the end of this you've got Mangla. We won't deal with Tarbela, we'll stick with Mangla.
So is there an estimate of the lifetime of that dam? Because there's only a finite amount of time that you can put sediment into it before you start to impact its capacity. I'm just wondering whether there's -- and they're very difficult to flush. Like, this dam is very easy to flush. Mangla is, you know, almost impossible to flush. I'm just wondering whether there's some work being done that would give us an idea of the likely lifespan of Mangla.
DR HAYAT: You're aware, sir, there are several studies being done, have been done, both the two main reservoirs that we have, Mangla and Tarbela. And they have sediment coming in, as you know. The exact number and

the exact timeline on the life of the project and they keep on doing some exercises to maximise the life of these projects.
For example, at Mangla, they have done a lot of work in the catchment area by building small check dams, plantation, because that checks the amount of sediment. And it has had an effect, it has had a definite effect on the sediments that flows in, because of the type of the catchment that it has.
In terms of the exact number or time or the estimate -- it is always an estimate, it is never an exact number. So both for Mangla and Tarbela, there are studies with ballpark figures of how the sediment is moving, and how long it will take to move to a certain position.
If you want that information in detail, we'll provide you. I don't have it at my fingertips at this point in time.
DR BLACKMORE: I know a fair bit about Tarbela but I don't know anything about Mangla. So I just wanted to understand, because it's such a key piece of infrastructure for Pakistan, and if it has a life of 50 years you'd start to worry. If it has a life of 500 years you'd be less worried. So I just wanted to understand where you were on that journey.

DR HAYAT: As you know also, sir, we went for a heightening of Mangla Dam. So we have increased its capacity.
DR BLACKMORE: I've seen it. It's very nice.
THE CHAIRMAN: Very good. I think that's it for our questions. So, Dr Hayat, I guess it's Mr Farooq next.
(12.12 pm)
(Pause)
(12.15 pm)
THE CHAIRMAN: So, Mr Farooq, whenever you are ready.
MR FAROOQ: Mr Chairman and members of the Court of Arbitration, I am Muhammad Umar Farooq, working as senior engineer in the water and agricultural division of NESPAK. You will be hearing from me a couple of times during the course of these presentations. My focus for now is a short presentation on hydrology.
Slide number 13. This map shows the entire area of the Indus Basin, falling within the territories under the control of four states: in green, approximately 59% of the Indus Basin area is in Pakistan, which includes the area of Pakistan Administered Kashmir; approximately 21% of the Indus Basin area is in India, which includes the area of Indian Administered Kashmir, as you can see here in blue colour; the rest of the 20% area is almost equally divided between Afghanistan and China.
The hydrologists divide Pakistan's territory into

three hydrological units. By far the largest is the Indus Basin, which covers approximately 65% of Pakistan's territorial land. The two other basins include an endorheic basin in the Kharan Desert in western Balochistan, which has no outlet to the sea, it is here. And the other is Makran coastal basin, which directly drains into the sea here.

The Indus Basin is heavily influenced by winter precipitation in the high mountains in the form of snowfall, by summer monsoon rains, and by the upper atmospheric phenomenon. The extensive 2022 flooding, which displaced around 7.6 million population, was attributed to two atmospheric rivers that passed over southern Pakistan. These so-called atmospheric rivers are long narrow zones of wind that carry the water vapours out of the tropics. An average atmospheric river can carry roughly the amount equal to a month's flow of Mississippi River of the United States of America, and an exceptionally strong atmospheric river can transport water vapours about 15 times of that amount.

Slide number 14.

DR BLACKMORE: Sorry, can I ask a question?

Are these atmospheric rivers which we are seeing more and more -- I saw one in America recently, and

we've had one in Australia in the last six months -- are they becoming an increased phenomenon, or have they been around for -- is it being driven by climate change and increased energy, or has it been a part of the system for hundreds of years and we're just noticing them more --

MR FAROOQ: Sir, I see it as a part of the climate change phenomenon. For example, we have two severe floods in Pakistan in the last 13 years. One was in 2010, and the most recent flood was in 2022. So, yes, we can consider that these are due to the climate change. Climate change could be one of the phenomena that is driving these types of atmospheric rivers in such a severe condition.

Slide number 14. Now we have a closer look at the tributaries of the Indus Basin, or I would say Indus River. As Dr Hayat mentioned earlier, the Indus Basin is comprised of Indus River, and six of its major tributaries: River Jhelum, Chenab, Ravi, Sutlej and Beas join the Indus River at the left bank from the east side, and Kabul River joins the Indus River at the right bank from the west.

In the centre of the map, as shown in the orange triangle, it is the India's Kishenganga Hydroelectric Project, which is situated on the Kishenganga River near

the town of Gurez, about 12 kilometres upstream of the line of control.

To the centre left of the map, here is the Neelum-Jhelum Hydroelectric Project. Kishenganga River, as it passes through the line of control, its name changes to the Neelum River, and this Neelum-Jhelum Hydroelectric Project is situated on Neelum River here. It diverts the flows of the Neelum River through a tunnel and powerhouse and discharges into the Jhelum River here. The flows that are being diverted at Kishenganga Hydroelectric Project are not available for hydropower generation at Neelum-Jhelum Hydroelectric Project.

Slide number 15. Mr Chairman and members of the court, as you would have seen on the drive from the hotel to the dam site, Neelum River is flowing quite strongly, but not at its full level. You can still see some rocks visible in the water. At the moment, the river is flowing at a rate of about 250 cumecs but the flow will be around 1,200 cumecs or more in the month of July due to monsoon rains.

This graph shows the daily discharge in cubic metres per second for the years 1993 and 1994, showing a typical seasonal pattern of Himalayan rivers. The flow in Kishenganga on Neelum River is strongly

seasonal. The highest flow occurs from the month of May to the month of August, due to snowmelt in the upper catchment, and monsoon rainfalls in the lower catchment. Meltwater begins to start in spring, and monsoon rains typically occur from May to August and into September, and there is a long dry period from October to the end of March.

Slide number 16. This slide shows the daily sediment inflow in tonnes per day for the same period of 1993 and 1994. As you can see, it broadly tracks the flow of the Neelum River, as shown on the previous slide, and the importance of floods on the sediment transport is clear. Notice that the sediment transport drops to near zero in the dry season, despite continuing water flows, as you can see here.

During the winter, the dry season, the rivers run clear, but the dry season is also the only time of the year that sediment on the riverbed can be observed, because the bed is entirely submerged during the wet season.

Sediment flow rates are measured by sampling the sediment concentrations in the river during the wet season, and based on the observations and measurement of the size of the sediment on the riverbed during the dry season, the winters.

Different types of samplings during both wet and dry season is needed to better quantify the sediment transport. As we will come to discuss in the forthcoming presentation, the equilibrium between sediment inflow and outflow is important for maintaining the live storage. Several techniques can be used for this purpose.

Slide number 17. This slide summarises the inflow of sediment by month for multiple years of data. As was shown for the 1993 and 1994 data, almost all the sediment is delivered in the summer months, and virtually no sediment transport in the winter months or dry season.

Mr Chairman, this concludes my portion of this presentation on hydrology. I will now hand over to my colleague, Mr Sendhu, who will address you on geology, and before I do, if you have any questions, then I'm here to answer.

Questions from THE COURT

THE CHAIRMAN: Thank you, Mr Farooq. I think we do have at least one question.

DR BLACKMORE: So if we go back to slide 15, please, sir. So when we are going through the dry season -- this is just a typical one. So we're going through the dry season, the capacity of the power station and tunnels is

200 plus cubic metres a second.

MR FAROOQ: 280.

DR BLACKMORE: Yes. So we're way below that for five or six months of the year, or five months of the year, if I'm reading it correctly. So what is the decision on how much water you generate and how much you leave in the river? So what's your environmental flow or compensation flow strategy for this dam?

MR FAROOQ: For now, as the lowest recorded daily inflow at this dam site is about 20 cumecs, so the WAPDA is ensuring to release at least this amount downstream of the dam.

PROFESSOR BUYTAERT: A related question. So from when to when is the plant able to perform at maximum power production?

MR FAROOQ: So, sir, the design discharge of the intake is 280 cumecs, and from this graph I can show you that you can see from May to the month of August the plant will be generating its installed capacity, or will be operating at full capacity, and for the rest of the months it will not be.

PROFESSOR BUYTAERT: And so for the rest, is the environmental flow always 20, or does it depend on the inflow?

MR FAROOQ: I mean, it depends upon the inflow.

PROFESSOR BUYTAERT: Okay.

MR FAROOQ: The plant will not be operating for 24 hours of the day, but at least for part of the day, depending upon whatever we are getting flow at the dam site.

PROFESSOR BUYTAERT: Okay. And then I think the operation is determined both by the amount that appears in the river and I guess also the loads, the demand for electricity and the variation throughout the day; is that right?

MR FAROOQ: Partly. I mean, normally we have high demands in the evening and it is -- I mean, there are many factors, but one factor is that how the operator wants to run the plant. But as usually we have high demand in the evening, so most of the time we don't operate the run-of-river plant in the morning and collect the water in the operating pool and then release it in the evening when the demands are high.

PROFESSOR BUYTAERT: Okay. Thank you. Do you want to follow up on that?

Then I'll just ask my second question. So thank you for giving the overview of the hydrology of the entire country. For the Neelum basin in particular, would you know what the average precipitation is over the Neelum basin?

MR FAROOQ: I don't have the average value over the whole

Neelum catchment. But here where we are right now, in Muzaffarabad, the precipitation is of the order of 1,400 mm per year.

PROFESSOR BUYTAERT: Okay.

MR FAROOQ: But definitely as we go more in the north the precipitation reduces, and I don't have the exact figure for the whole catchment.

PROFESSOR BUYTAERT: Okay. And then perhaps asking again the question I asked earlier about the method for measuring streamflow. Would you happen to know what method was used here?

MR FAROOQ: Yes. So I can tell you, sir, that WAPDA has a dedicated department named Surface Water Hydrology Project, or SWHP. It has a monitoring network across all of the major rivers in Pakistan, and what they do is they install gauges -- they normally record manually -- they record manually at the gauges and they maintain a log for each site, and then they carry out the physical flow measurements at each site to develop a relationship between the gauge and the discharge.

PROFESSOR BUYTAERT: Mm-hm.

MR FAROOQ: Then the data is transported to their head office in Lahore where they apply some quality checks and water balance techniques to ensure the quality of the data. And after ensuring the quality of the data,

they translate the daily recorded gauges into the discharge series and then they publish it. And that is basically the data the designers rely for design of any hydropower project or development of water infrastructure.
PROFESSOR BUYTAERT: Yes. Would you happen to know the method that is used for the flow measurements?
MR FAROOQ: So basically surface water hydrology follows the guidelines as set forth by the USGS, and currently they are doing the physical flow measurements by current meter method.
PROFESSOR BUYTAERT: Okay, yes.
MR FAROOQ: And for all the measurements, whether they are flow measurements or sediment measurements, the standards to follow is the USGS.
PROFESSOR BUYTAERT: Yes. And the water level measurements that are done manually as well, do you know how often they are typically done? Is that daily, or perhaps hourly?
MR FAROOQ: Yes. At least that -- I can tell you in the high flow season or summers, at the key locations the gauge is recorded at one-hour interval, or you can say that there are 24 values in a day. And in winters they may be recording, say, four to six observations in a day, and depending upon whether it is a key location

or not.
PROFESSOR BUYTAERT: Okay. Thank you.
DR BLACKMORE: Just something I didn't understand. I don't understand a lot, but I didn't understand this, so we'll try and work through it a little bit.
So when you're releasing water through the power station and at some parts of the day you've switched off the power station, you're not generating, and other parts, for peak, you are, that tells me that you've got to have some operational pondage here.
MR FAROOQ: Yes.
DR BLACKMORE: I wasn't clear that there is an operational pondage. I thought it was a run-of-river facility. So what percentage of the dam capacity is in this operating range that you can use for meeting peak demands?
MR FAROOQ: Sir, the total capacity, or the gross capacity of the reservoir is around 10 million cubic -- 10 million cubic metres, and out of the 10 million cubic metres, 3.8 million cubic metres is the capacity of the operational pool.
DR BLACKMORE: And what's the operational range?
MR FAROOQ: The full pond level is at 1,015 metres above the mean sea level, and the minimum drawdown level is at 1,008 metres. So it creates an operational range of around 7 metres.

DR BLACKMORE: Okay. Thank you.
THE CHAIRMAN: Great. Thank you very much, Mr Farooq. Are you finished with your presentation? I think so.
MR FAROOQ: Yes, I am.
THE CHAIRMAN: Thank you very much. That's very helpful. And I think now we have Mr Sendhu.
(12.30 pm)
MR SENDHU: Mr Chairman and members of the Court of Arbitration, my name is Fiaz Hanif Sendhu. Presently I am working at Tarbela 5th Extension Hydropower Project as the chief geologist. Before that I have worked as the resident geologist at this Neelum-Jhelum Hydroelectric Project.
I have more than 35 years of experience. I have the honour to address you on the geology of the region and dam site. The geology of the region is very complex and challenging, due to pressing and folding of the strata and rocks in the region.
Slide number 19, please. This slide is showing the tectonic map of the region. Neelum-Jhelum Hydroelectric Project lies in these Himalayas, there is the dam site. The Himalayas are geologically young mountains, developed as a result of collision between several continental and microcontinental plate fragments. The northwestern part of the Himalayas is subdivided into

units: Sub Himalaya -- this is also called the foothills of the Himalayas; Lesser Himalayas; Kohistan sequence; and Higher Himalayas.
These units are separated by a series of parallel to sub-parallel thrust faults. This is the main boundary thrust, this is going like this, this is main central thrust, and this is main mantle thrust. These faults were developed due to collision between Eurasian plate and the Indian plate. Here is the Eurasian plate and here is the Indian plate along this MCT fault, Indian plate is subducting below the Eurasian plate. Due to Earth's subduction, stresses were developed towards the south side, and due to these compressions and stresses, these faults were generated. The MBT, main boundary thrust, passes below the dam foundation here.
Another important feature of this area is the Hazara-Kashmir syntaxial bend. All the lineaments and strata in this area have taken a bend of 160 degrees. Sediments deposited in this core of the bend with the passage of time were converted to sedimentary rocks, and in this other area, these are metamorphic rocks.
The region is tectonically active and geologically complex. This makes it challenging to build hydropower plants, but it can be done, as Neelum-Jhelum Hydroelectric Project shows.

Slide number 20, please. This slide shows the geology of the Kashmir region. All three types of rocks, sedimentary rocks, metamorphic rocks, and igneous rocks, are present in this region. Neelum-Jhelum Hydroelectric Project is located in the sedimentary rocks of this yellow, and here this is Neelum-Jhelum dam site and this is tunnel, it is mostly located into the sedimentary rocks. Only dam site, right abutment of the dam, is lying on the metamorphic rocks.

Next slide (21), please. These sedimentary rocks I'm talking about are unstable due to weak layering and tectonic deformations, because due to this bend these have become deformed and sheared. This slide is showing the geology of Neelum Valley. These are the sedimentary rocks. This yellow colour, this is the Murree formation, and the red and maroon are the Hazara formation and Tanol formation. These are metamorphic rocks. These names, Murree formation and Hazara and Tanol formation, these are stratigraphic names given by the Stratigraphic Committee of Pakistan, who differentiate the same type of rocks deposited in the same period. Also, there is metamorphic rock. This is Panjal formation. This is a group of metamorphic rocks.

Next slide, please, 22. This slide is a cross-section of the geology at the dam site. The

older rocks of metamorphic rocks have been thrusted up -- this is the fault line -- have been thrusted up and come into contact with the younger age rocks of the sedimentary rocks. They have moved from a horizontal to vertical position, because the position is horizontal, but due to thrusting they have been shifted to the vertical, to these deformations.

Mr Chairman and members, I have displayed some samples of the rocks just for your visual observation.

THE CHAIRMAN: Thank you.

MR SENDHU: This is sandstone. This is sedimentary rock. It forms when grains of the sand are cemented together over long periods of time. It is a hard rock, but due to stresses it has been deformed. In slide 27 we'll see how this hard rock has been deformed and folded.

DR BLACKMORE: Sorry, question: does this have a marine phase, or has it been freshwater?

MR SENDHU: Sorry.

DR BLACKMORE: Has it been laid down under the sea or laid down under freshwater, this rock, this sediment?

MR SENDHU: I'm sorry, I couldn't understand you. Sorry.

DR BLACKMORE: No, it's alright. I'm just wondering whether this was laid down as a sediment in a freshwater environment?

MR SENDHU: Yes, yes.

DR BLACKMORE: It's freshwater. Because I can't see anything else in it.

MR SENDHU: Because these sediments, all these sediments, as previously I have said, in the core these were sediments of previous already-existing rocks, they are sediments transported with the water, with the rain and with the gravity, and deposited, and then they were converted into the rocks.

DR BLACKMORE: How old? How old are the sedimentary rocks?

MR SENDHU: Yes?

DR BLACKMORE: How old? What age?

MR SENDHU: These sedimentary rocks are from 5.5 million to 23 million years before, Miocene age.

And second, this one is siltstone rock. It is a sedimentary rock that is composed mostly of silt. It is a type of mud rock with low clay content. So its maroon colour, reddish colour, is due to argillaceous material, due to clays.

And the third one is graphite schist. We don't have the sample of this rock -- this is metamorphic rock -- because a 7-8 metre bed was encountered during the excavation, and then it was buried under the dam structure. So at present we don't have its sample. It is medium to large-sized crystals. It is weak to moderately weak. It can easily split into thin flakes.

And the next here is greenstone rock. This is metamorphic rock, and it has been metamorphosed from the igneous rocks.

MR MINEAR: From igneous rocks?

MR SENDHU: Yes. In this area it is converted from basalt to greenstone.

THE CHAIRMAN: It does have a greenish look to it.

MR SENDHU: Yes, it is due to -- it's some mineral content epidote and chlorite. Those minerals have this greenish colour.

Slide 23, please. This is fault contact, MBT. Lower is sedimentary rocks. These are the siltstone, this is sandstone, and above are Panjal formation group of metamorphic rocks. This picture was taken about 1 kilometre downstream from the dam axis. This is at the right bank of the dam, and this fault slowly moves into the river, and at dam site it shifted below the dam foundation.

Then after 500 metres upstream from the dam, it shifted towards the left bank of the river. So in 1.5 kilometres, the fault shifted from the right bank to the left bank, passing below the dam foundation.

Next slide number 24, please. This slide shows the main boundary thrust at the Neelum-Jhelum Hydroelectric dam site. Here was a dam site, and this fault was

buried under the river alluvium at dam site, and these MDBH, these are the main dam boreholes. These three boreholes were drilled to determine the depth of the sound rock for placing the dam foundation and for locating the contact of the fault. These boreholes were drilled into the riverbed.
DR BLACKMORE: Sorry. So given that you've got a fault running up the river, basically, do we have any estimate of when it was last active? When the fault was last active, when it was moving?
MR SENDHU: It is not active. I am coming next to that.
DR BLACKMORE: Oh, okay. Sorry.
MR SENDHU: The right abutment of the rockfill dam is resting on the metamorphic rocks. So these are the Panjal formation metamorphic rocks, right abutment of the rockfill dam is lying on these rocks, and diversion tunnel also crosses through these metamorphic rocks. Upstream from this picture is the inlet, and this is the outlet of the diversion tunnel. At the time of this picture, the excavation was in progress from both ends of the diversion tunnel.
In 2005, an earthquake occurred in Muzaffarabad and adjoining areas. This earthquake was along the Muzaffarabad Fault. During construction in 2008, designers had to examine the main boundary thrust to

determine the impacts of the 2005 earthquake on the fault. A geological field survey found no signs of movement along the MBT. Surveys could not prove any rupture along the MBT fault at the dam site, but it cannot be ruled out that there could be a future movement on the main boundary thrust at the dam site during the lifetime of the project.
So keeping in view these risks of movement along this MBT fault during the lifetime of the project, the dam design was changed. Previously it was concrete gravity dam. Then it was redesigned as a composite dam. A rockfill dam with clay core covering the fault zone on the right side and the concrete dam with gated spillway and other structures on the left side.
Next, 25.
PROFESSOR BUYTAERT: Do you have an estimate of what is the potential direction of the movement here at this location? I know that on the continental scale it's a subduction, but is it also the same direction you expect here, or might there be lateral movements?
MR SENDHU: Actually the angle of the fault in the cross-section we are seeing, that is about 85 degrees. So it is expected to move along that plane.
PROFESSOR BUYTAERT: Okay, yes. Thank you.
MR SENDHU: Slide 25.

DR BLACKMORE: Just -- you may not be the right person to ask but I'm going to ask it anyway, put it on notice. So when you've put your flexible part of the dam in place, the rockfill dam, what was the impervious layer that you have used in that?
MR SENDHU: Clay core.
DR BLACKMORE: Is it clay core?
MR SENDHU: Clay core, yes.
DR BLACKMORE: Yes, okay. Thank you.
MR SENDHU: Slide [25], please.
This is during the excavation of the foundation. This is in the cross-section of this fault. This is the contact of the fault, the sharp contact. This is sedimentary rocks, these are siltstones, these are sandstones, and this is graphite schist.
Slide 26. These pictures show the impacts of MBT fault on the rocks. Deformation and open joins can be seen. These hard and brittle rocks have been broken and big cavities have developed. A lot of efforts had to be made to strengthen the foundation rocks. Tonnes of cement was injected to consolidate the dam foundation rocks. These rocks were encountered on the right bank below the rockfill dam foundation.
Next, please, [slide] 27. This is, finally, here are photos of the effect of compression on the

sedimentary rocks. In this area you can see this hammer is placed for the scale, to visualise the size of these micro folds. This is the same hammer I have placed here, just to understand (indicates).
Due to these folds, we have challenges with collapses, rockfalls, and landslides.
Next, [slide] 28.
So thank you, sirs, if you have any questions.

Questions from THE COURT

THE CHAIRMAN: Thank you, Mr Sendhu.
You just mentioned landslides. Have there been landslides up upstream or downstream from the dam since it was put into operation?
MR SENDHU: Landslides, the studies were carried out by NESPAK into the reservoir area, and they recommended some measures. But landslides, in the reservoir area, we have not found any landslide yet.
THE CHAIRMAN: Okay. Yes.
DR BLACKMORE: Sorry, I have two questions.
So where did you find the clay for the clay core? Where did the clay come from? In this valley or some other area?
MR SENDHU: Yes, this was away -- now I am not remembering the name, but this was the source from some other site.
DR BLACKMORE: Somewhere here?

MR SENDHU: Not somewhere here. At a distance.
DR BLACKMORE: Okay. Because I would have been mystified if you had been able to find it here.
So the second question is, when you're looking at that folded rock in the foundation -- and I think I asked the question yesterday but I'll ask it again. So when you were grouting and putting grout into this --
MR SENDHU: Yesterday, yes.
DR BLACKMORE: Yes, and it looks to me like it would take a very large amount of grout.
MR SENDHU: Yes.
DR BLACKMORE: But you only went 20 metres for 60-metre-high structures.
MR SENDHU: Yesterday you asked that question about the depths.
DR BLACKMORE: Yes.
MR SENDHU: And because this was 7 or 8 years before this work was carried out, so I told 24 metres.
DR BLACKMORE: 24.
MR SENDHU: No, but it was not, then suddenly after that I recalled that these are the depth of the drainage holes. The grouting depths for primary holes were 35 metres and secondary was 25 metres and tertiary was 15 metres. And these depths were variable. Along the slopes, these were 10 metres. And towards the left side

of the dam, there was alluvium, so a grouting tunnel was formed and 5 metres into the rock, that was grouted.
DR BLACKMORE: Thank you.
MR MINEAR: Since we have a geologist here, what is the composition of the sediment that flows into the reservoir here? What is the composition? Is it sandstone or schist, or ...
MR SENDHU: The composition of these rocks?
MR MINEAR: Of the sediment that flows down from upstream.
MR SENDHU: There are some samples that have been placed there of the sediments from the river. And our hydrologist, I think he will explain these samples that are lying there.
MR MINEAR: We'll get some later. Okay, thank you.
THE CHAIRMAN: Okay, I think we have no other questions for you, Mr Sendhu. Thank you very much for your presentation. It was very helpful.
So I think we've now finished this presentation.
MR MIANA: (Inaudible: off microphone). After the lunch we will go for presentation number 7, walk around the dam site.
THE CHAIRMAN: Okay. So for about 10 minutes we'll get ourselves organised and then we will have lunch.
MR MIANA: Yes, okay.
THE CHAIRMAN: Very good. Thank you so much.

MR FAROOQ: (Inaudible: off microphone) ... by Mr Buytaert when we were at the left bank, you asked, or maybe Mr Blackmore, what is the length of record available for a gauging station record.
So the maximum length of data that is available, it is at Muzaffarabad station, Neelum River at Muzaffarabad, and it starts from 1963, and to date the record is available. And the slide 14, I think, shows also the currently operational gauging locations on Neelum River.
PROFESSOR BUYTAERT: Those stations are upstream or downstream of the confluence?
MR FAROOQ: It is basically upstream of the confluence --
PROFESSOR BUYTAERT: Just to repeat my question: is the gauging station in Muzaffarabad upstream or downstream of the confluence?
MR FAROOQ: So it is upstream of the confluence and exactly on Neelum River.
PROFESSOR BUYTAERT: Yes, thank you.
MR FAROOQ: Thank you.
THE CHAIRMAN: Okay. So I think now we're finished. See you shortly at lunch.
(12.52 pm)
(A short adjournment)
(1.54 pm)

Presentation 7: Dam and Reservoir Inspection (I)
MR MIANA: Mr Chairman, members of the Court of Arbitration, now we'll start the presentation no. 7, which is a walkthrough of the dam area all together.
We will first go to the control room. We'll just have a look at the control room, what parameters we are getting inside the control room. Then we'll go up to the dam site and we'll have a look round up there. And then we'll go to the desander site and then finally collecting tunnel, and then we'll see the HRT, which we cannot see!
THE CHAIRMAN: Okay, very good.
MR MIANA: So let's start.
THE CHAIRMAN: Thank you.
MR MIANA: Thank you.
With me in this presentation, Mr Nayyar will also accompany me, he is my co-presenter, and also Mr Ayub Malik and Dr Tahir will assist me if there are some questions.
THE CHAIRMAN: Thank you.
MR MIANA: So let's start. (Pause)
So this is the control room for the operation and the regulation of the water from the dam site. We already explained about the available facility for the regulation of water through different sources, like the

radial gates, the flap gates, the undersluice and the two HRTs to the powerhouse.

So these are the level indicators over here, the three level indicators over here. At the moment we have 1,011.9, whereas the maximum level for the reservoir is 1,015. So almost 3 metres below that one, at the moment we are maintaining this level. The slight difference is due to the position of the sensor over there. There are two others located at the same level. Maybe it's some calibration issue.

On this side we get the information regarding every event that occurs, where we have the instrumentation and the control. So everything is recorded over here, with the date, month, hour, minute and even second. So that records. Some are in the white, which are just information; some are in the pink, which are also some warning. But when it is in the red, then it is news that we need some action to do that one.

This one is our CCTV. They are just having around all the facility, with CCTV cameras around there.

Behind these screens, on the main screen we have the discharge data that we just described over here. At the moment we have the full station over there. From there we can get -- this is the Taubat. It's just near to the line of control at 9 kilometres?

MR ALAUDDIN: 200 kilometres.
MR MIANA: No, no, 9 kilometres from the ... 9 kilometres from the (inaudible). And with this, the second is at Shadra?
CONTROL ROOM OPERATOR: Karimabad.
MR MIANA: This is Karimabad. The next one?
CONTROL ROOM OPERATOR: Shadra.
MR MIANA: Third one is Shadra. And the fourth one?
CONTROL ROOM OPERATOR: Islamapura.
MR MIANA: The Islamapura.
CONTROL ROOM OPERATOR: 15 kilometres from this.
MR MIANA: So this is the most nearest to this one.
So we get the information starting from the Kishenganga (indistinct) of the Neelum River, and we get through flow station [...] we are getting. And altogether with this, the route of the Neelum River, we get the data. And accordingly we manage during the flood season.
THE CHAIRMAN: I see.
MR MIANA: So this is the graph that we get from this one.
MR ALAUDDIN: So this graph is showing the discharges number on this Y-axis. It means that it's 2.5 cumecs, starting point. 2,500 cusecs (indistinct), water is coming. So that's why this is scale in cusecs --
MR MIANA: Cusecs, not the cumecs.

MR ALAUDDIN: -- not cumecs.
So this brown line is the Taubat discharge, one of the gauges there, and the other one is Shadra. The other two gauges so far, due to some issues, [are] not giving reading. Otherwise there are four gauges upstream of that dam site.
THE CHAIRMAN: Wouter, let's give you a microphone for you, sir. Thank you.
PROFESSOR BUYTAERT: Thank you.
What is the sudden surge between 12 and -- is it 24/25 April? That doesn't look like a very natural peak in the discharge. Is that --
MR MIANA: This one?
PROFESSOR BUYTAERT: Yes.
MR MIANA: That was when in the catchment area the flow was very high.
PROFESSOR BUYTAERT: Okay. So I would expect it to increase like that as a result. But why does it then suddenly decrease?
MR MIANA: That is the rain for two or three days.
PROFESSOR BUYTAERT: Okay. So really continuous rain, then it stopped?
MR MIANA: Yes.
PROFESSOR BUYTAERT: Okay. Thank you.
MR MIANA: So this is an overview of the control room.

THE CHAIRMAN: This is a very important room, I think.
MR MIANA: Yes.
THE CHAIRMAN: Very good. Thank you. (Pause)
MR MIANA: If you like, you can take a helmet. This is a hi-vis, you can also wear this one. (Pause)
This is the same building that we just came from here, the dining room and the conference room. And this is our emergency power supply in case of failure of the public network. So we have the two diesel generators over here, and we have the tank capacity of almost 12,000 litres for the generation. And with this capacity, we can generate further four days, continuous operation. Because this is in the far-flung area. So any kind of landslide in this may entrap the electricity for more time. So instead of one, we have put two diesel generators. These are some of the switch rooms over there for this one.
We have already seen in the morning, and from the top of that point. The desanders are on our left. And we're just heading towards the concrete (inaudible) dam that starts from here, and that is almost 160 metres?
MR ALAUDDIN: Yes.
MR MIANA: Plus the earthfill and rockfill dam is there.
MR ALAUDDIN: Total length from here to that end is 250 metres. The intake structure is 88 metres. Then

the composite dam is 160 metres.
MR MIANA: Okay. (Pause)
So we are on the top of the dam. Not so big, but still we're on top.
So we can see from here the upstream side and this one. So here we have the building, we were there in the morning. And prior to that, we were on the (indistinct) side, on the downstream side, and now we are at the dam site. So I am just going through the dam site, I will explain this one.
Here we can see there's a log boom over there, just to stop the floating debris over there. But the debris size is very small. We can take out the boulders but the small cannot be taken out, even with this grab. You can see they are taking out this one. Which is continuous also during the monsoon, and monsoon starting soon. So this debris is coming from the upstream side, even underwater it's coming, and it comes to the surface at this point.
THE CHAIRMAN: So you never get water coming --
MR MIANA: Never.
THE CHAIRMAN: -- never get water coming over on to the top?
MR MIANA: No, no.
MR ALAUDDIN: No, no.
THE CHAIRMAN: And that's because your freeboard is high

enough that it prevents --
MR MIANA: Yes. I think this level is 1,019?
MR ALAUDDIN: It is 1,019, yes.
MR MIANA: 1,019.
THE CHAIRMAN: Okay.
MR MIANA: And our maximum operating level is 1,015. So we have 4-metre freeboard over there.
MR MINEAR: What conditions -- when you have surplus storage, how high would the water come up here?
MR MIANA: We do not pass 1,015.
MR MINEAR: Okay.
THE CHAIRMAN: And can I ask: am I correct that this is earthen up here (indicating), and this is concrete down here, or ...?
MR ALAUDDIN: Yes, this is a roller-compacted concrete. The purpose is to stabilise the side slopes.
THE CHAIRMAN: Yes.
MR ALAUDDIN: This is the purpose of this.
THE CHAIRMAN: Yes, okay.
Please.
PROFESSOR BUYTAERT: So was this part excavated, or what's the reason that this slope is so unstable?
MR ALAUDDIN: Yes, this -- you see, if you can see the mountain, this was all mountain here. This has been excavated. It was, you can see, almost like this going

there. So major excavation work was involved for the desander structure.
DR BLACKMORE: Where did you put all the spoil? Where did you put all the spoil? Where did you put the rock?
MR ALAUDDIN: We had allocated lands for depositing the spoil material.
DR BLACKMORE: Okay.
MR ALAUDDIN: Some of the aggregates which were useful are also utilised again here.
DR BLACKMORE: Okay.
MR MIANA: So I think this was the part of that excavation?
MR ALAUDDIN: Yes.
MR MIANA: So you can see the extent how we have excavated from there. So this is the remaining of that one.
THE CHAIRMAN: Good.
MR MIANA: This is our intake gates for the desanders. We have two intake gates on either side, one is on this one and one is on that side, for the desander. And the control of that desander is there, if I can take you to it. (Pause)
So these are the control panels, electrical control panels for the hydraulic hoist, number 1 and then number 2, left and right. These are the motors. These are the hydraulic hoists used for that one. And these are the controlling valves for the flow water, either

forcing up or down.
THE CHAIRMAN: There's one intake or two intakes for each desander?
MR MIANA: Two.
THE CHAIRMAN: Two intakes for each desander.
MR MIANA: Two (Inaudible).
THE CHAIRMAN: Okay. So there's six total?
MR MIANA: Six total. And three undersluice.
THE CHAIRMAN: Three undersluice?
MR MIANA: That we saw in the morning: one was in operation. So these are this one, one that side and then this one.
We can go on that side. (Pause)
DR BLACKMORE: How long does the water take to pass through the desanding chamber?
THE CHAIRMAN: Say it again.
DR BLACKMORE: How long does the water take to pass through --
MR MIANA: Very minimum.
DR BLACKMORE: At the design flow, not a low flow?
MR ALAUDDIN: You see, we reduce the velocity to 0.2 metres per second. So it takes a lot of time to ...
DR BLACKMORE: Yes.
MR MIANA: And what is the length, this one?
MR ALAUDDIN: This length is 275 metres.
MR MIANA: So you can divide the depth and width, then you

get the second.
DR BLACKMORE: And depth?
MR ALAUDDIN: Depth ...
MR MIANA: 22 metres.
MR ALAUDDIN: Width is 25 metres, depth is 22 metres.
MR MIANA: 22 metres. Alright.
DR BLACKMORE: Okay. And what percentage of silt do you get out? From the input water, what percentage of the sand and silt do you get out?
MR ALAUDDIN: In terms of parts per million, when water goes to the desander and up to this, maximum is up to 30 ppm.
DR BLACKMORE: Right.
MR ALAUDDIN: 30 milligrams per litre.
DR BLACKMORE: Yes.
MR ALAUDDIN: So it means that the desanders' efficiency of trapping the sediment is quite good.
DR BLACKMORE: Okay.
MR ALAUDDIN: That 30 ppm is maximum. Most of the time, we found the concentration less than 30 in the collecting canal.
DR BLACKMORE: So what is the concentration coming in?
MR ALAUDDIN: For example, it's normally more than 100, normally more.
DR BLACKMORE: Okay. And when you take it out, you're going to sort of remove most of the large particles. So

you're going to have 30 ppm and it'll be relatively small?
MR ALAUDDIN: Yes. Actually the design has been made in such a way that particles more than 0.16 millimetres, greater than that, 0.15 or 0.16 millimetres, settle down at the bottom, and particles less than or lighter than that go through.
DR BLACKMORE: Go through.
MR MINEAR: They are suspended, mostly.
DR BLACKMORE: Okay.
MR MIANA: This is for the number 3.
We can go around to see the river from the top.
If you want, the Court can have the photo over here. This is a good photo here because behind is a good scenery for this one.
So here is the reservoir, smaller one, not the big one, and the river is coming from that side. And on your left we have the three radial gates, 1, 2 and 3; and to the end of that one, we have the two floodgates, the crest opening over there. And beside that, we have the upstream dam over there.
MR ALAUDDIN: Now you see the level, 1,015. That is the 1,015 maximum level of the reservoir, written there in red.
THE CHAIRMAN: Okay.

MR ALAUDDIN: Yes. So from here you can have an idea of the freeboard.
DR BLACKMORE: So how often do you have to repaint the gates, do you have to take them out and maintain them? I see you've got all the gear here, the cofferdams.
MR MIANA: Yes.
DR BLACKMORE: So do you take the gates out every one year, three years, five years, to maintain --
MR MIANA: You mean the radial gates?
DR BLACKMORE: Yes.
MR MIANA: Painting of the radial gates, if you want to paint on the upstream side, then you have to put these stoplogs over there.
DR BLACKMORE: Yes, yes. Cofferdams in, yes.
MR MIANA: Because these are normally painted with the epoxy paint, which is a good quality, so that takes a long time for the repainting.
DR BLACKMORE: Yes. Because there's a lot of erosive material going past it, even with epoxy paints.
MR MIANA: Yes, yes.
DR BLACKMORE: So is it five years, ten years?
MR MIANA: Actually just forecasting five years. So still we are in sixth year of operation.
DR BLACKMORE: Oh, you haven't started yet! Okay.
MR ALAUDDIN: Still, even after four/five years, the paint

is in very good condition.
DR BLACKMORE: Because I know on my dams, when I had to do the same thing, it was a massive task. My gates were 30 metres wide, so a different structure.
MR MIANA: It is a massive job, taking all the --
DR BLACKMORE: A big job.
MR MIANA: The big job, yes.
DR BLACKMORE: Big job.
PROFESSOR BUYTAERT: Another question about the gates. How often do you open them, or what's the ratio between them being open and closed?
MR MIANA: This one?
PROFESSOR BUYTAERT: Yes.
MR MIANA: Actually this depends upon the inflows.
PROFESSOR BUYTAERT: Yes.
MR MIANA: So when the inflows exceed the capacity of two flap gates, we have then the undersluice. Then there's no other chance just to operate this one.
PROFESSOR BUYTAERT: Okay. So they're mostly used to get the water out?
MR MIANA: Yes.
PROFESSOR BUYTAERT: Are they also used for the sediment control?
MR MIANA: Yes, for the flushing of the reservoir.
PROFESSOR BUYTAERT: Flushing. Okay, yes.

DR BLACKMORE: So do you use them to flush when the reservoir's got high flow or do you lower the reservoir to flush?
MR MIANA: The recommended is in the high flow, because in the high flow you can flush more effectively.
DR BLACKMORE: Yes, yes. So what do you do?
MR MIANA: In the high flow. We flushed last year in August.
DR BLACKMORE: Oh, okay, so in high flow.
MR MIANA: July. In July.
DR BLACKMORE: Okay. And how long do you have to take to flush? How many days?
MR MIANA: This takes a long time, because we have to control the level step by step.
DR BLACKMORE: Yes.
MR MIANA: Immediately, because these (indistinct) are discharged with this water. So we have to go very slowly just to get the water outside there.
(Videographer's note: due to loss of audio, part of the tour is missing from this section. The missing part was re-recorded the following day)
MR MIANA: For the sediment (indistinct), they use this crane, put that down, this one, take the sample over there, and they get analysis from the (inaudible).
MR ALAUDDIN: This is also used for checking the speed,

velocity, because it is a requirement. Suppose velocity is higher than 0.1 (indistinct), so sediments will not be settling and they will be going inside. So due to this, we check the velocity in the desander, as well as water samples also taken too.
THE CHAIRMAN: It looks like you could catch a whale with this!
MR ALAUDDIN: Yes! (Pause)
MR MIANA: With the difference of colours, we can recognise the brownish and the whitish: Murree formation, and the other is the Panjal formation.
THE CHAIRMAN: Yes, I can see that.
MR MIANA: I also like the green, that one.
THE CHAIRMAN: The greenstone, yes.
MR MIANA: The greenstone over there. Mr Fiaz was explaining about that one and showing some stone over there.
THE CHAIRMAN: Exactly. (Pause)
MR ALAUDDIN: So at the end we have sets of gates. We have four gates for the outlet gates, through which water goes into the collecting canal and then into the headrace tunnel. At the bottom there are four gates of 2.5-metre height and 4-metre width, at the bottom. So there are eight gates. The lower gates are for flushing the sediments, and the upper gates for supplying water

to the tunnel.
THE CHAIRMAN: I see. And those upper gates have a screen on them?
MR ALAUDDIN: No screen.
MR MIANA: Screen is in the underwater.
THE CHAIRMAN: By the time the water gets here, it's --
MR ALAUDDIN: It's already clean.
THE CHAIRMAN: Yes. (Pause)
MR MIANA: So first we'll look at that one, then we'll come back over here. (Pause)
So this is 75-metre-square area.
MR ALAUDDIN: Square metres, 75 square metres.
THE CHAIRMAN: Does that tunnel still ...
MR MIANA: Yes, it (inaudible) has been blocked.
THE CHAIRMAN: It's been blocked?
MR MIANA: [...] blocked from the upstream side.
MR MALIK: (Indistinct) gate on the upstream side, [...] and then the [...] floodgates in the middle.
THE CHAIRMAN: Okay.
MR MINEAR: May I ask: how many people work here? How many people work here at the dam site?
MR MIANA: At the maximum level, it was about 7,000.
MR MALIK: 2,000 people were working for the dam construction.
MR MINEAR: Okay. And how many does it take to operate it?

MR MALIK: How many work here at the dam site? 15 people? 20 people?
MR MIANA: No, no, no, it's more than 60 people. We have two different kinds of sections at dam site. The civil monitoring is different and the operation and maintenance section is different. So regulation is done by the operation and maintenance section, and the other formation is the dam monitoring. So they are all working together. So altogether, I think around -- over 65.
PROFESSOR BUYTAERT: The structure down here, is that to flush the desander?
MR MIANA: Yes.
PROFESSOR BUYTAERT: Okay.
MR MIANA: That's the outlet for the desander.
PROFESSOR BUYTAERT: That's what I thought. Thank you.
MR MIANA: Yes. (inaudible). Flushing out. (Pause)
Actually it's not like this, it is not reflecting. Basically it is like this. It's not like this. It's looking like (inaudible) but it's not like [...] high-velocity [...].
If you want to have the photo here, I think this is better.
THE CHAIRMAN: I don't know. I think maybe we've had enough photos? Yes, we're okay.

(Photo taken)
(Pause)
THE CHAIRMAN: The water that's coming out of the side ...
MR MIANA: The undersluice.
MR MINEAR: Earlier today we saw a sluice (indistinct), right?
MR MIANA: In the morning.
MR MINEAR: Yes.
MR MIANA: No, we are (indistinct) now. It depends upon the inflow. We are maintaining the level. So when the inflow reduces, we have to adjust the regulation.
THE CHAIRMAN: The inflow for the desander?
MR MIANA: No, no, no. The inflow coming to the dam site. So when we have to maintain the level, so we regulate the gates' pressure.
THE CHAIRMAN: Oh, we're not talking about those gates, we're asking about the water coming out of the ...
MR MIANA: I am also responding the same.
THE CHAIRMAN: Oh.
MR MIANA: So in the morning I (inaudible) 15 cumecs coming from that side, but at that time our inflows were higher. But now the inflows to the dam are lesser, so we are in charge of (inaudible).
MR MINEAR: That's a way to fine-tune the level?
MR MIANA: To fine-tune the level, yes. From this we cannot

fine-tune, but from that we can fine-tune.
PROFESSOR BUYTAERT: Where is the intake of that side gate?
MR MIANA: Intake?
PROFESSOR BUYTAERT: The little side gate, where does it come from?
MR MIANA: It comes from the intake. We have the three undersluices --
PROFESSOR BUYTAERT: Ah, okay.
MR MIANA: -- just under the intakes of the water.
PROFESSOR BUYTAERT: The sluice is underneath the water intake?
MR MIANA: They are underneath [...]
PROFESSOR BUYTAERT: Okay, yes.
MR ALAUDDIN: The setting is that there are six intake gates of size 4.5 by 4.56. So underneath each, for each gate, there is a single undersluice gate of size 1 metre high and 4.5 metres wide. So this is connected with the undersluice.
PROFESSOR BUYTAERT: Okay. So it's the outlet of those sluices.
MR ALAUDDIN: Yes. Below there is the invert of this.
MR MIANA: There are three intakes, but coming out is common.
PROFESSOR BUYTAERT: Thank you.
MR ALAUDDIN: You're welcome.

MR MIANA: Okay, let's move this way. (Pause)
So from here, we pass the collecting canal. This one. We can see the level as 11.6, like this one, 11.5 over here.
So it goes over there, in front of desanders. We'll just have a look around all this. (Pause)
Desander number 2.
MR ALAUDDIN: And these are the hydraulic hoists for four outlet gates.
MR MIANA: So from here, the tunnel HRT starts.
DR BLACKMORE: Okay.
MR MIANA: Not from here, just maybe -- how many metres from here? Maybe 100 metres, right?
MR ALAUDDIN: Yes, it is a transition phase, 100 metres, up to that point.
MR MIANA: Up to that point.
THE CHAIRMAN: So when the water is actually taken out of the desander, is that happening under this or is it over there? When you take the water to the tunnel --
MR ALAUDDIN: From here.
MR MIANA: From here?
THE CHAIRMAN: -- from down there.
MR ALAUDDIN: From here only, not from there.
MR MIANA: It is directly connected with the desanders. All three desanders are there, connected.

THE CHAIRMAN: Right.
MR MALIK: Water comes from the intake into the desanders. It drops the sand, the sediments there. And then the cleaner water from the higher elevation comes into the collecting canal and then it goes into that.
And it has got two purposes. One, you see the water is almost stationary there, when it's there, so it drops all the silt. And when it comes here, again there's no turbulence here. So you don't have air vortexes producing going into the tunnel.
THE CHAIRMAN: So when you close off, let's say, two of these, and only use one, that one is flowing into this area here --
MR MIANA: Yes.
THE CHAIRMAN: -- and then into the tunnel?
MR MIANA: Yes.
THE CHAIRMAN: Okay. (Pause)
MR MIANA: We will go around this one.
THE CHAIRMAN: So the tunnel is somewhere over there?
MR MIANA: Yes, it's one like this one. You can't touch!
THE CHAIRMAN: Too bad! Maybe if we dig down a little bit!
MR MINEAR: Can you remind me the diameter of the tunnel, how large?
MR MIANA: Is it 10.5 metres?
MR ALAUDDIN: 10.5 metres.

THE CHAIRMAN: Good. Questions, anyone?
PROFESSOR BUYTAERT: The tunnel has quite a low gradient, doesn't it? Would you know how much energy is lost by friction over the 35 kilometres?
MR MIANA: If we are operating at 969, the head loss is about 34 metres.
PROFESSOR BUYTAERT: Okay. Out of 400, wasn't it?
MR MIANA: Yes, 420 metres.
PROFESSOR BUYTAERT: So it's less than 10%.
MR MIANA: Yes, less than 10%.
PROFESSOR BUYTAERT: Okay.
MR ALAUDDIN: The original design was mostly shotcrete-lined, but later on, when we calculated the losses, the losses were very high. So it was decided that the drill and blast portion should be concrete-lined, to have a smooth surface and less friction.
So that is why -- there was a lot of improvement after the award of the contract. These were some of the design changes made later on.
MR MIANA: During the execution of the project.
MR ALAUDDIN: During the execution of the project, exactly.
MR MINEAR: When you switched to the two tunnels, did you lose more pressure as a result of that, through more friction because you were sending it through

two tunnels?
MR ALAUDDIN: Twin tunnels, sorry?
MR MINEAR: No, you have a -- this was a split in the two tunnels.
MR ALAUDDIN: Yes.
MR MINEAR: Does that result in greater friction and greater pressure loss?
MR ALAUDDIN: Not exactly. Not exactly, yes. Because, you see, it has been designed in such a way that those factors have been considered, division or bifurcation.
PROFESSOR BUYTAERT: Was the bifurcation part of the original design, or was that a solution?
MR ALAUDDIN: Not as -- there was some bifurcation, but not as we have now.
PROFESSOR BUYTAERT: Okay.
MR ALAUDDIN: We have 19 kilometres of twin tunnel. Actually this has been designed because when we go -- when we move along the tunnel, the overburden is also increasing. So due to the high overburden, it was realised that there was tremendous pressure. So by making twin tunnels, its cross-section is reduced, and it's found to be more stable under the high water pressure.
PROFESSOR BUYTAERT: Yes, with a negligible impact on the head loss, as I understand it.

MR ALAUDDIN: Yes.
PROFESSOR BUYTAERT: Yes.
DR BLACKMORE: How often do you inspect the tunnel?
MR ALAUDDIN: That's a very good question!
DR BLACKMORE: And my colleague here wants to volunteer!
MR ALAUDDIN: That's a very good question!
Actually so far, since 2018 till now, we haven't dewatered the tunnel. There are several reasons for it. You see, this pressure at the end is 420-metre, high pressure. So if we dewater, there is a concern that -- you see, the concrete lining, it's not impervious; this is pervious. So it's recharging the sandstone, the stones there. So the level in the surrounding model is saturated, but level of the water has risen. So if we dewater the tunnel, so you see there will be a lot of pressure on the concrete lining and it may damage.
So this is the reason that we haven't physically inspected. For physical inspection, dewatering is required, which we have so far not done.
DR BLACKMORE: Yes.
MR ALAUDDIN: But near future, we are planning to do that.
DR BLACKMORE: So what I used to do, when we had to dewater tunnels not as long as this, I'd find the youngest engineer in the team and send them down!
THE CHAIRMAN: Do you ever expect sediment in the tunnel to

increase at an important level, or are you confident over the life of the dam that the water is so clean there won't be any sediment build-up?
MR ALAUDDIN: In the tunnel, the velocity is, say, around 3 metres per second, or more than that. So under that velocity, we don't think that any sediment will settle.
THE CHAIRMAN: Good. Thank you.
MR ALAUDDIN: Thank you.

(The walkaround ended)

(2.29 pm)

(Pause)

(3.30 pm)

Closing remarks

THE CHAIRMAN: So, first of all, the court is very grateful for the presentations that we received today. They were extremely helpful, very informative, much appreciated. Arguably this day was the highlight of the visit in terms of seeing the dam and walking around it, and we really did appreciate the opportunity to do that.
We've thought about whether we had any particular questions for you right now and decided that we don't, knowing that tomorrow we'll be having fairly in-depth presentations.
At the same time, we do have an interest in sediment management issues and environmental management issues.

We're assuming that that's probably going to be covered tomorrow anyway, but we just thought we would pass to you our particular interest in that area.

So no particular questions for you for overnight, but we're certainly looking forward to hearing about it tomorrow.

SIR DANIEL BETHLEHEM: Thank you, Mr Chairman. And for the record, and relying on paragraph 3.4 of your site visit protocol, and the latitude given to lead counsel through the chairman just to raise an issue. It's simply to note that as the court was walking around on the site visit, many of the presenters to come -- and indeed those who had already presented but will still be in the room -- did not have the benefit of hearing the question and answer session, and it may very well be that there will be a number of questions that will be asked tomorrow which were, in fact, follow-on questions from questions that were asked today.

So in true parliamentary fashion, as I'm supposed to ask a question, my question is: could the members of the court, if they are asking questions to the presenters tomorrow that are follow-on questions, please just identify that they are follow-on questions and what the question was and what the answer is, so that the presenters tomorrow are not kind of stumbling into

something that has already been addressed which they haven't heard.

THE CHAIRMAN: So the idea is if a question tomorrow builds upon something that came out today in the course of the walkaround, it's helpful to recall what was asked and answered today as the foundation for that follow-on question?

SIR DANIEL BETHLEHEM: Yes, indeed. Also because the presenters tomorrow and the day after have very particular expertise, so they may be able to fill out issues that have already been addressed. But at the moment they don't know what has been addressed.

But, as I say, this is simply relying on paragraph 3.4 to identify an issue as a question.

THE CHAIRMAN: I don't see any difficulty in that. We will do our best to provide that foundation to you. So I don't see a difficulty.

But let me again reiterate how much I appreciate Dr Hayat, Mr Farooq, Mr Sendhu's presentation from this morning, Mr Miana, Mr Alauddin for the walkaround. It was really quite helpful to us. We're very grateful for all the efforts you're putting into this site visit and we're learning a lot, so it's very, very helpful. Thank you.

Given that, I think we're finished for today, and

tomorrow's schedule, I think the plan might be, at least for those of us in the court, leaving at 8.30 in the morning, just as we did today, coming back up to the dam site, having the two presentations with a lunch break in the middle that we can be a little more generous about, given that we have a little more flexibility in the schedule. So we look forward to that.

Very good. And we'll see you tomorrow. Excellent.

(3.34 pm)

(The day concluded)