COYNE ET BELLIER
Ingénieurs Conseils

ELECTROCONSULT

IPA
Energy + Water Economics

TECHNO-ECONOMIC ASSESSMENT STUDY
FOR ROGUN HYDROELECTRIC CONSTRUCTION PROJECT

OSHPC BARKI TOJIK

Phase II Report: Project Definition Options

Dam Safety

Part 2: Hydrology & Flood Control

Review of HPI's Design

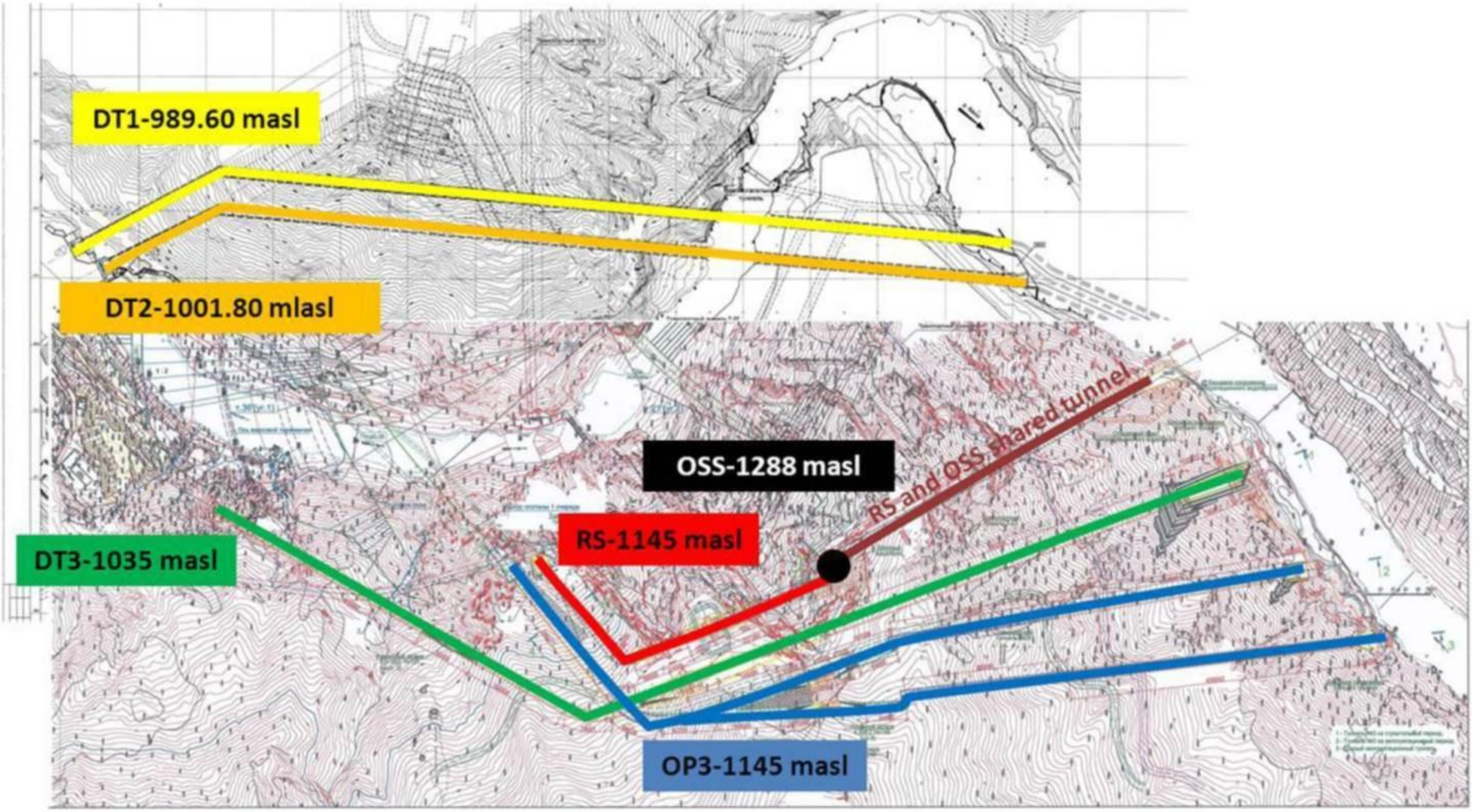
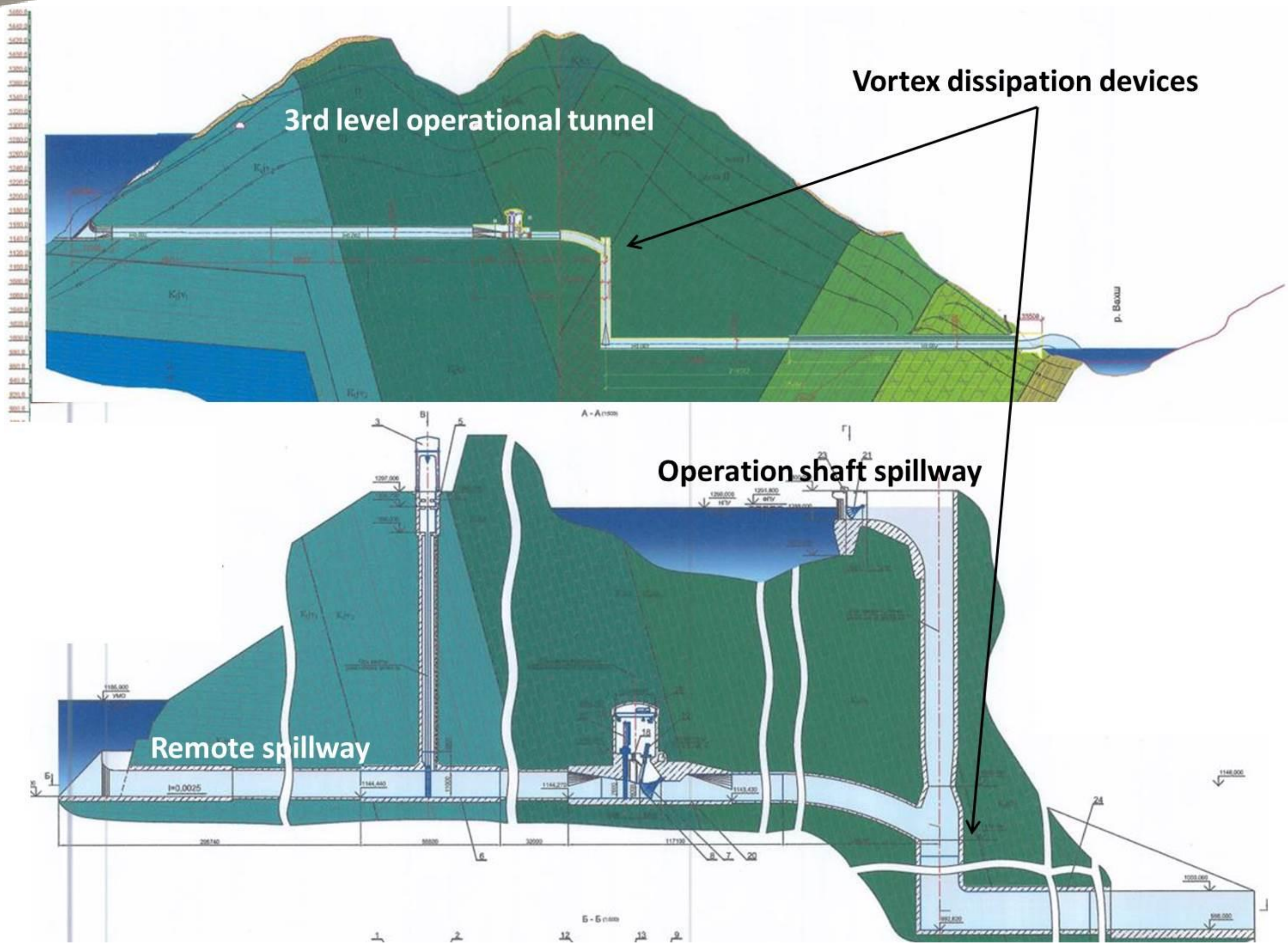
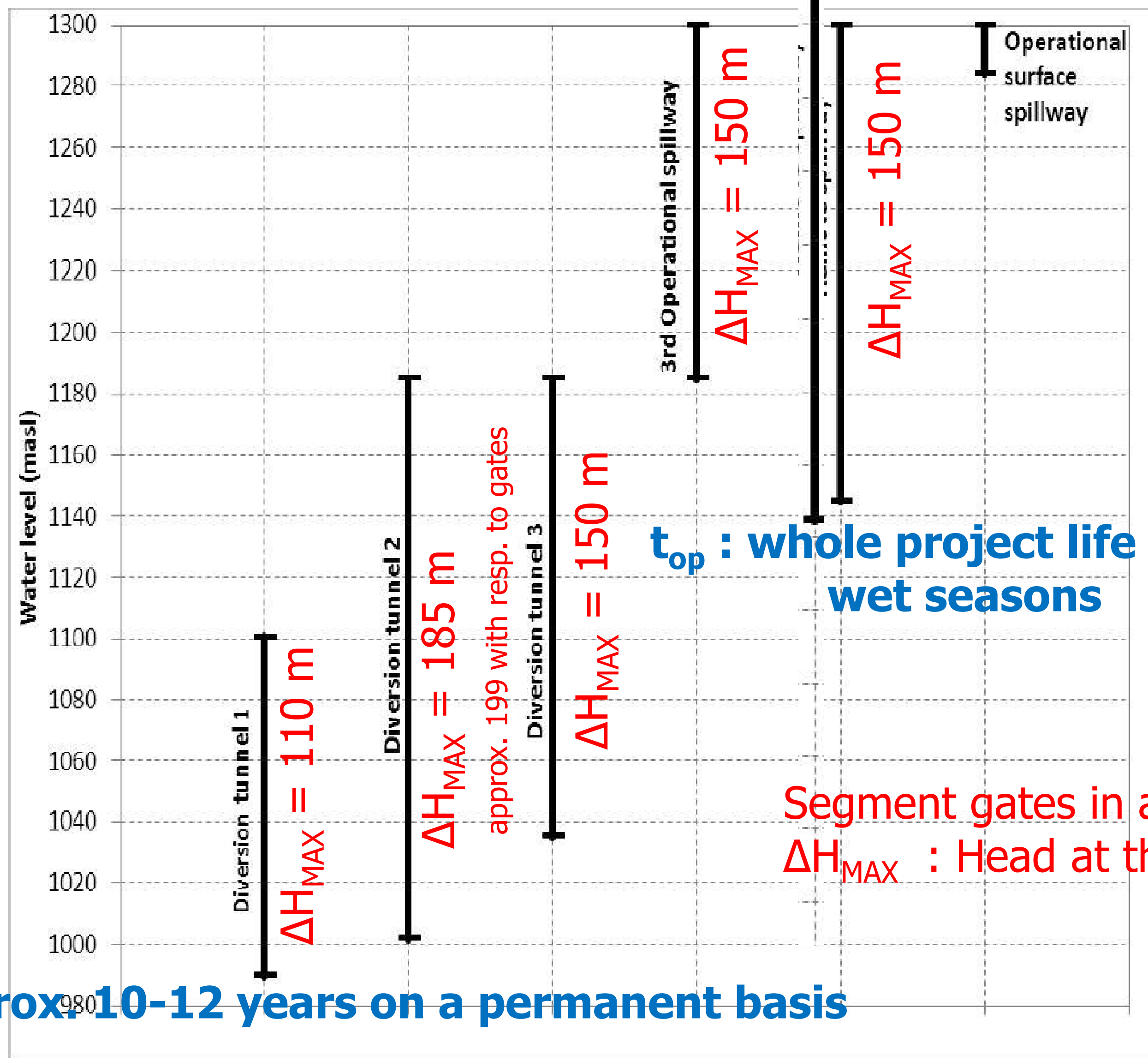


Figure 3.1 : Plan view - Diversion and spillway structures – HPI scheme



Vortex dissipation devices
3rd level operational tunnel
Operation shaft spillway
Remote spillway



t_{op} : whole project life only during wet seasons

Segment gates in all cases

ΔH_{MAX} : Head at the intake

t_{op} : approx. 10-12 years on a permanent basis

Figure 3.3 : Operation range of discharge tunnel - HPI

Conclusion:

According to the Consultant criteria, several items appear not to be fully safe:

- The level of protection of the cofferdam is not sufficient.
- The waterhead that all structures (temporary or final) have to support is too high.
- The Ionaksh fault is not mentioned and no remedial measures are proposed to cope with its displacements whereas there is a significant construction period of high dependence on DT3.
- Only two independent structures.
- Vortex dissipation devices have not been tested at this scale.
- There is no provision against GLOFs.
- Impact of sedimentation not taken into account.

Proposed TEAS Design

VAKHSH River at the ROGUN H.P.P.

Flood Probability

TMR	Peak Discharge (daily; m^3/s)		
(yr)	Lower*	**Calc.**	Upper*
2	2 200	**2 300**	2 300
5	2 600	**2 700**	2 800
10	2 900	**3 000**	3 100
20	3 100	**3 300**	3 400
50	3 400	**3 600**	3 800
100	3 700	**3 900**	4 100
200	3 900	**4 200**	4 400
500	4 200	**4 500**	4 800
1 000	4 500	**4 800**	5 100
2 000	4 700	**5 100**	5 400
5 000	5 000	**5 400**	5 800
10 000	5 300	**5 700**	6 100
PMF	6 100	7 000	**7 800**

** : Conf. Interval of 95% (99%)*

The probability of occurrence of a phenomenon with a mean period of return “TMR” within a certain period of time “TE” (time of exposure) can be evaluated with the formula:

$$P_{OCC} = (1 - (1 - \frac{1}{TMR})^{TE}$$

When TE << TMR the value of the probability of occurrence is close to the same ratio TE/TMR and is expressed as “one in N” or “one out of N cases”.

The design flood for each stage of the dam construction is selected on this basis:

1. an acceptable probability of occurrence is adopted,
2. period of exposure of each stage of construction is evaluated,
3. the resulting period of return of the flood is deduced,
4. the upper bound (97,5% confidence) of the peak discharge having that period of return is adopted,
5. evacuating facilities (tunnels, spillways, etc.) are checked or re-designed to provide the required level of safety.

Values of processes 1 through 4 are given in the next table.

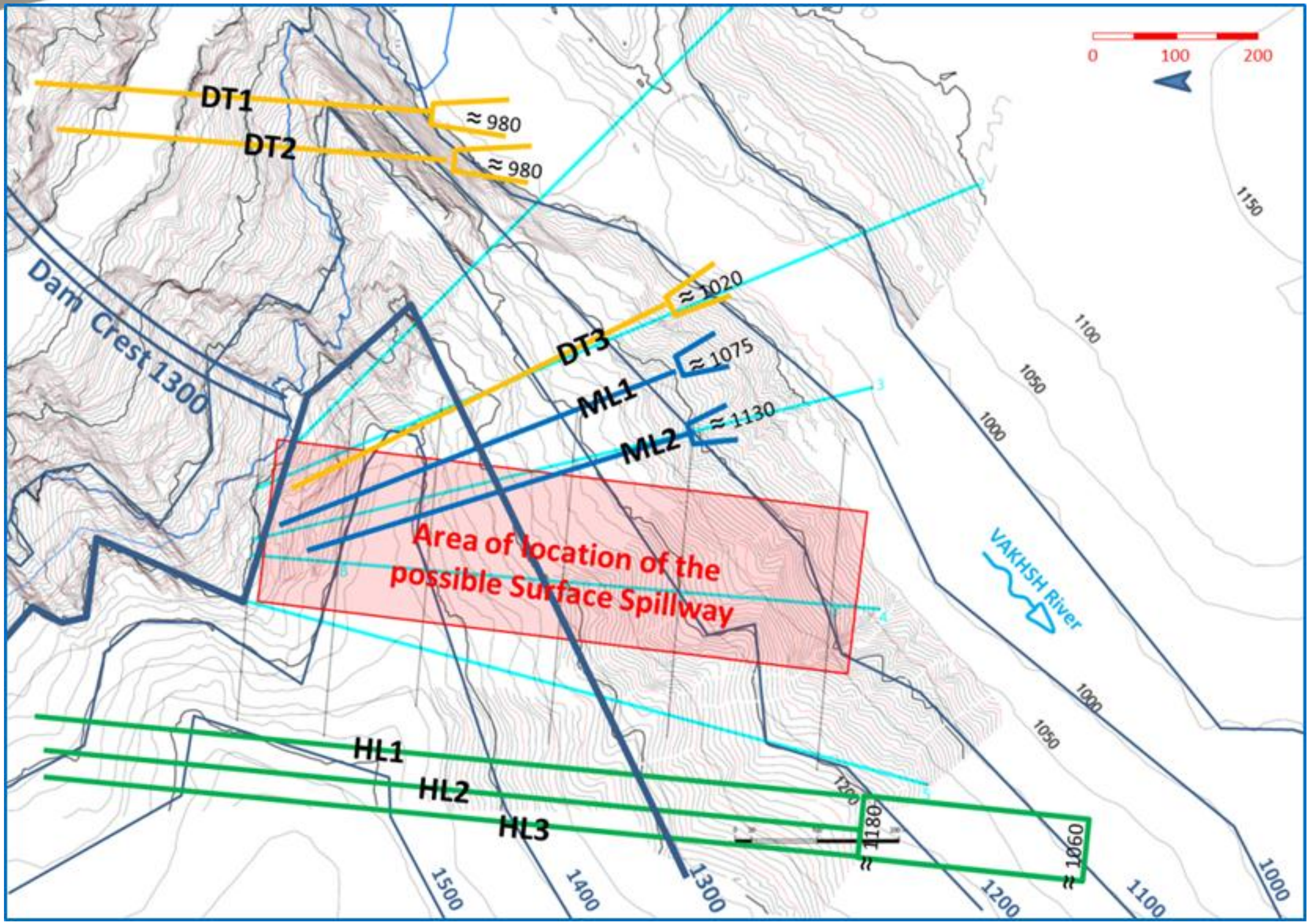
Design criteria:

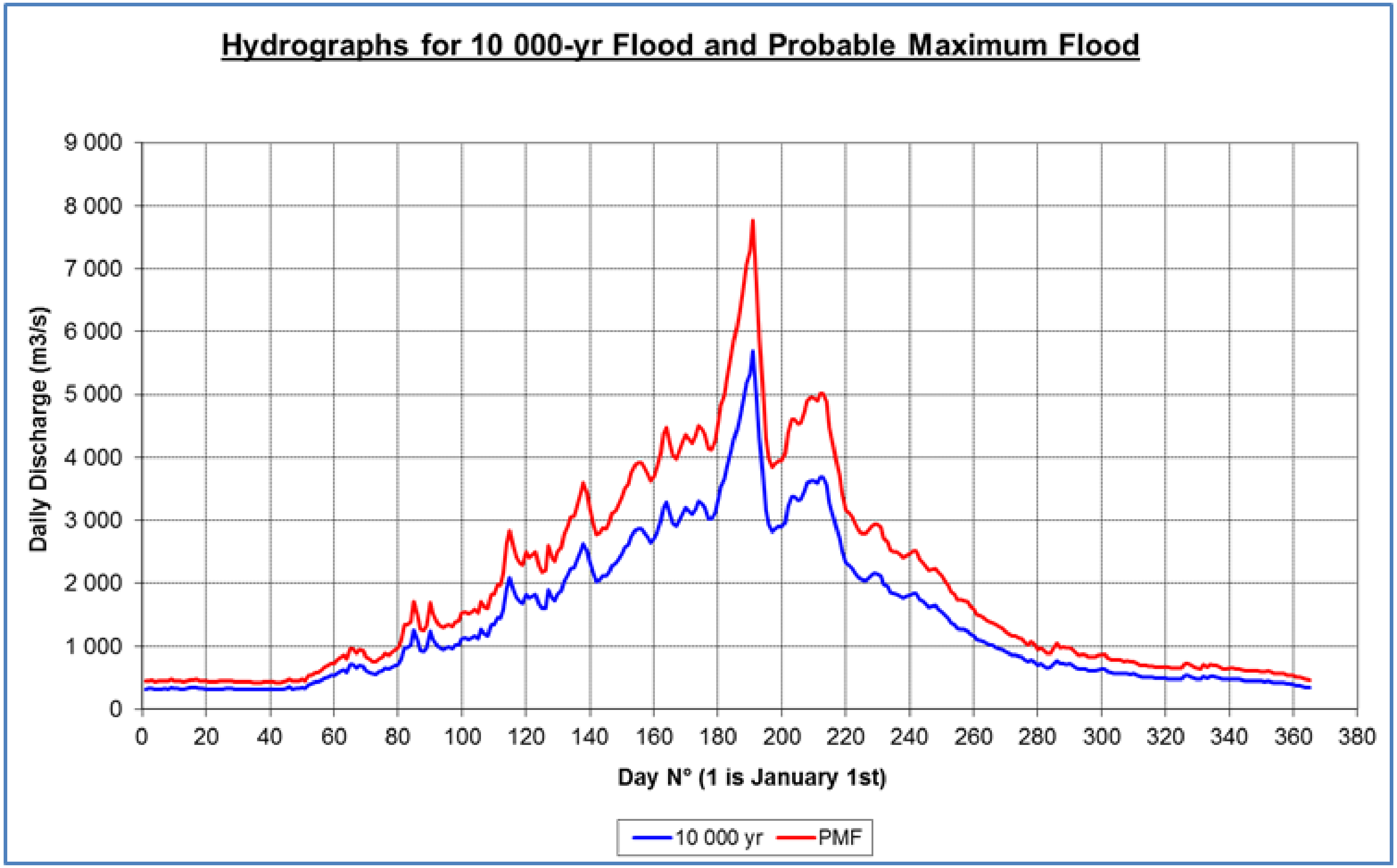
- Tunnels should not operate under heads higher than 120 m.
  This condition limits forces on gates and flow velocity to acceptable values. Exception is made for extraordinary (rare and short lasting) opportunities when heads up to 150 m are tolerated. Case of difficult operation during and after earthquakes, etc.

- For each construction stage at least two independent evacuating organs (i.e. tunnels) are required.

- For high reservoir levels flood routing effects (peak attenuation) are taken into account.

- No discharge through the turbines is taken into consideration during flood peaks.


DT1
DT2
≈ 980
≈ 980
Dam Crest 1300
≈ 1020
DT3
≈ 1075
ML1
≈ 1130
ML2
Area of location of the possible Surface Spillway
VAKHSH River
HL1
HL2
HL3
≈ 1180
≈ 1060
0
100
200
1500
1400
1300
1200
1100
1000
1050
1150



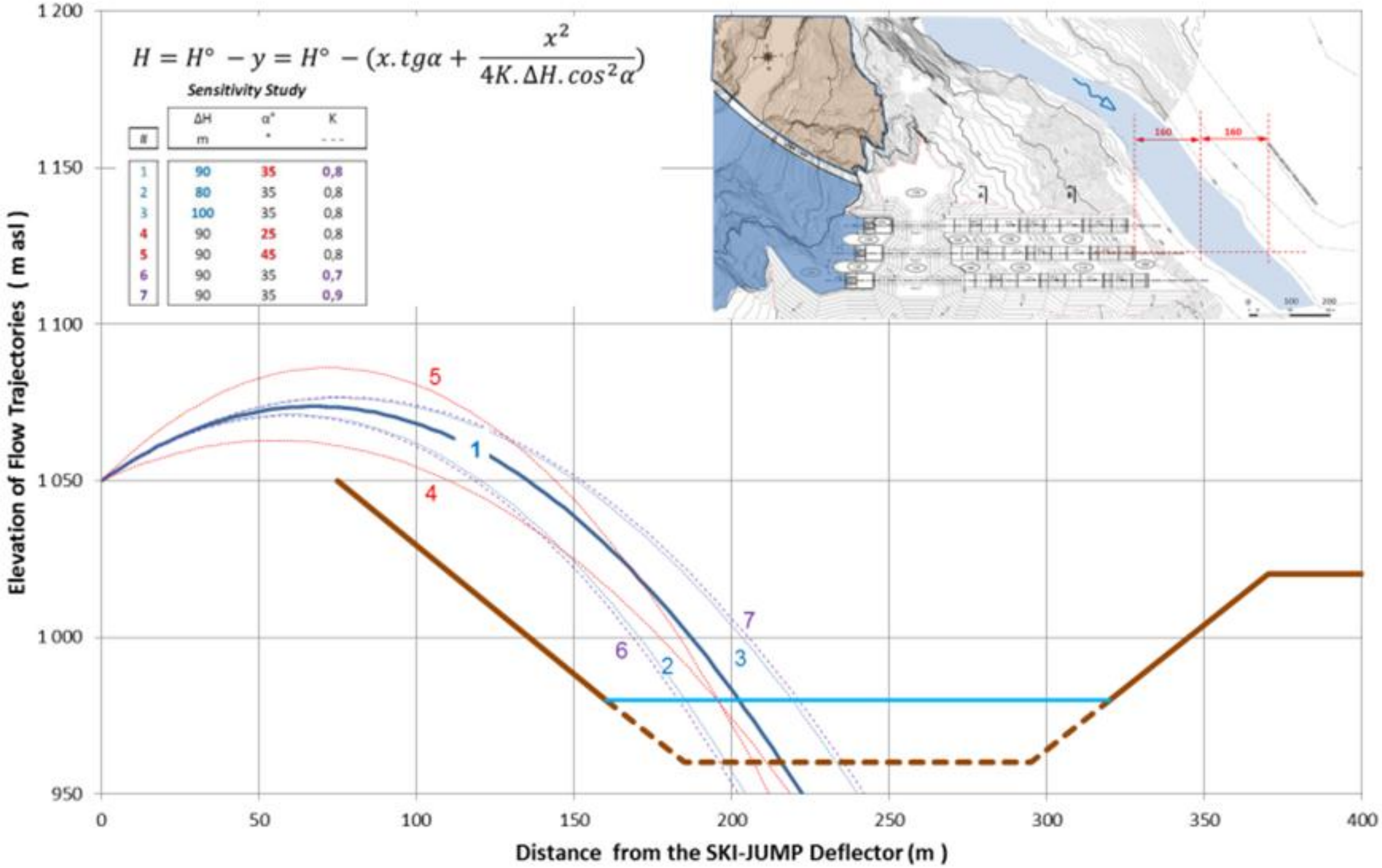
Hydrographs for 10 000-yr Flood and Probable Maximum Flood
9 000
8 000
7 000
6 000
5 000
4 000
3 000
2 000
1 000
0
Daily Discharge (m3/s)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
Day N° (1 is January 1st)
10 000 yr
PMF

Stepped Spillway - Ski Jump Trajectories

$$H = H° - y = H° - (x.tg\alpha + \frac{x^2}{4K.\Delta H.cos^2\alpha})$$

Sensitivity Study

#	ΔH m	α° °	K - - -
1	90	35	0,8
2	80	35	0,8
3	100	35	0,8
4	90	25	0,8
5	90	45	0,8
6	90	35	0,7
7	90	35	0,9



5. Conclusions and Recommendations

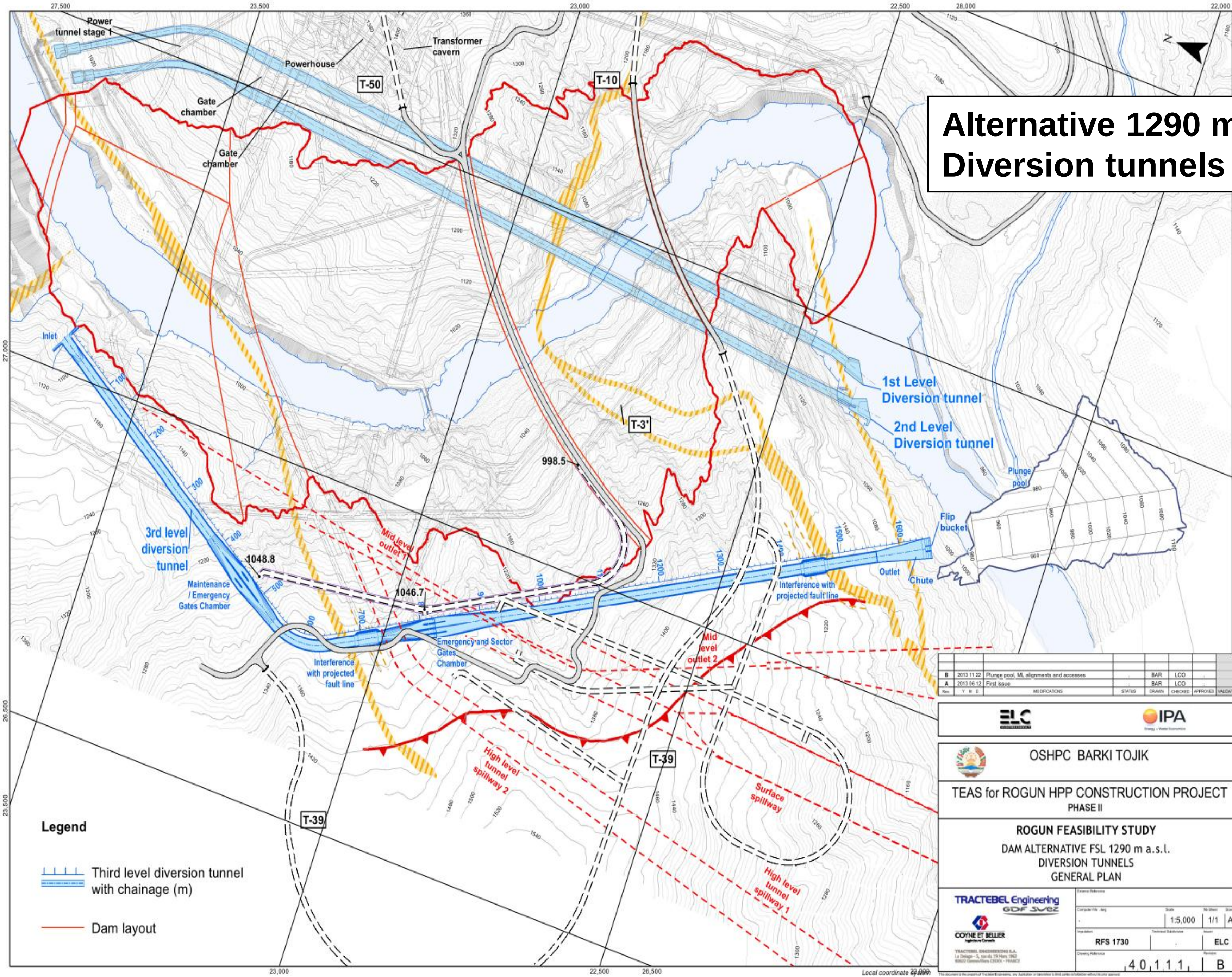
The feasibility of a surface spillway has been proven for each one of the three dam height alternatives, having a discharge capacity equal to the peak of the Probable Maximum Flood, to be implemented in the long term on the right bank of the reservoir, close to the dam.

This surface spillway is to replace the other flood evacuating organs once when the sediments in the reservoir make them useless or reduces their discharge capacities.

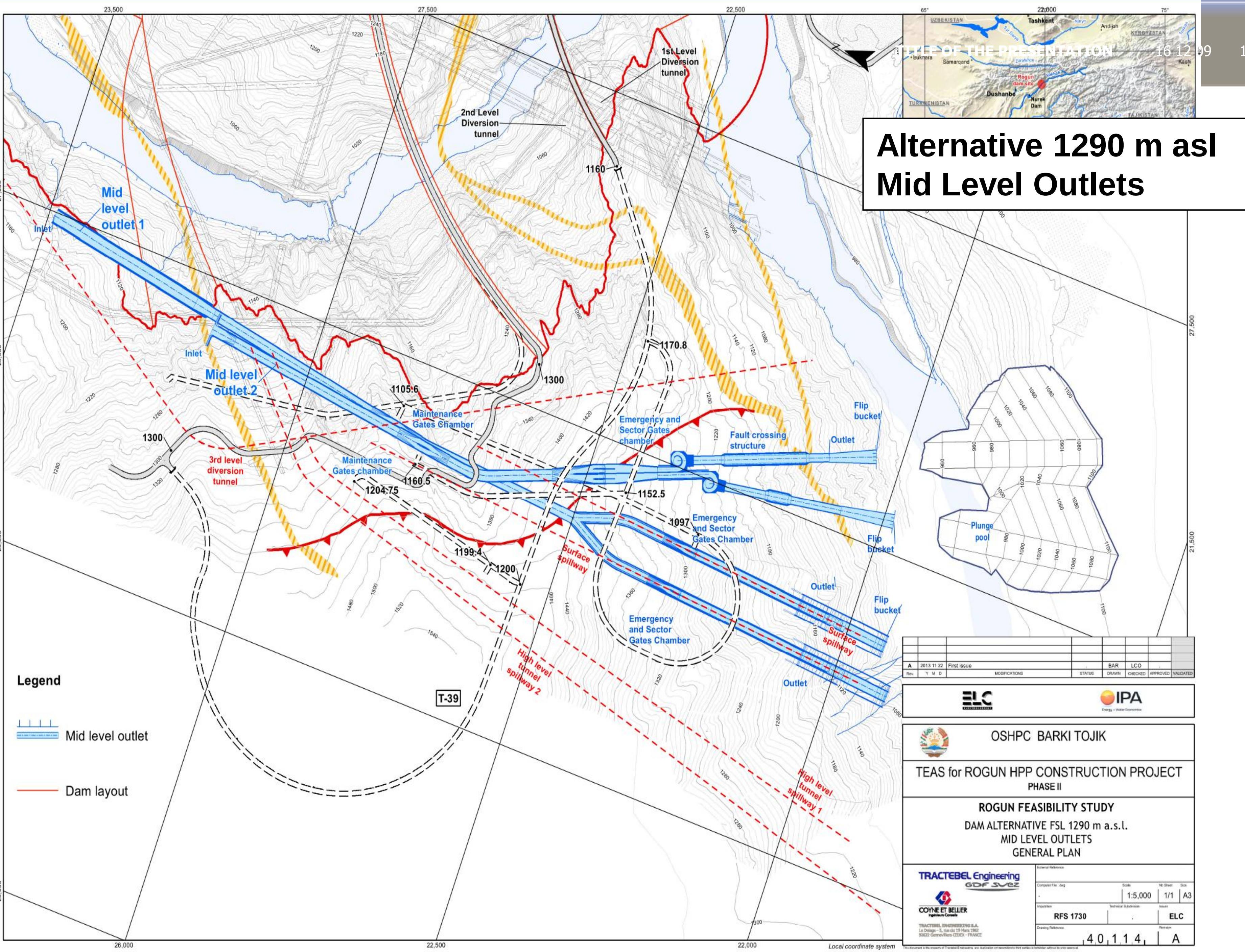
… main components are described ….

All these components have been designed and dimensioned on the basis of the state of the art and have been determined to be feasible. Model tests are recommended for design optimization.

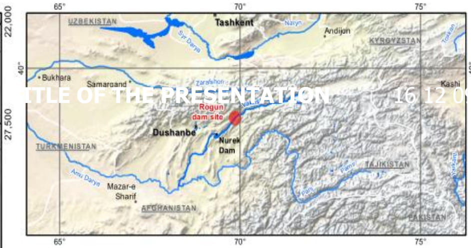
Alternative 1290 m asl Diversion tunnels

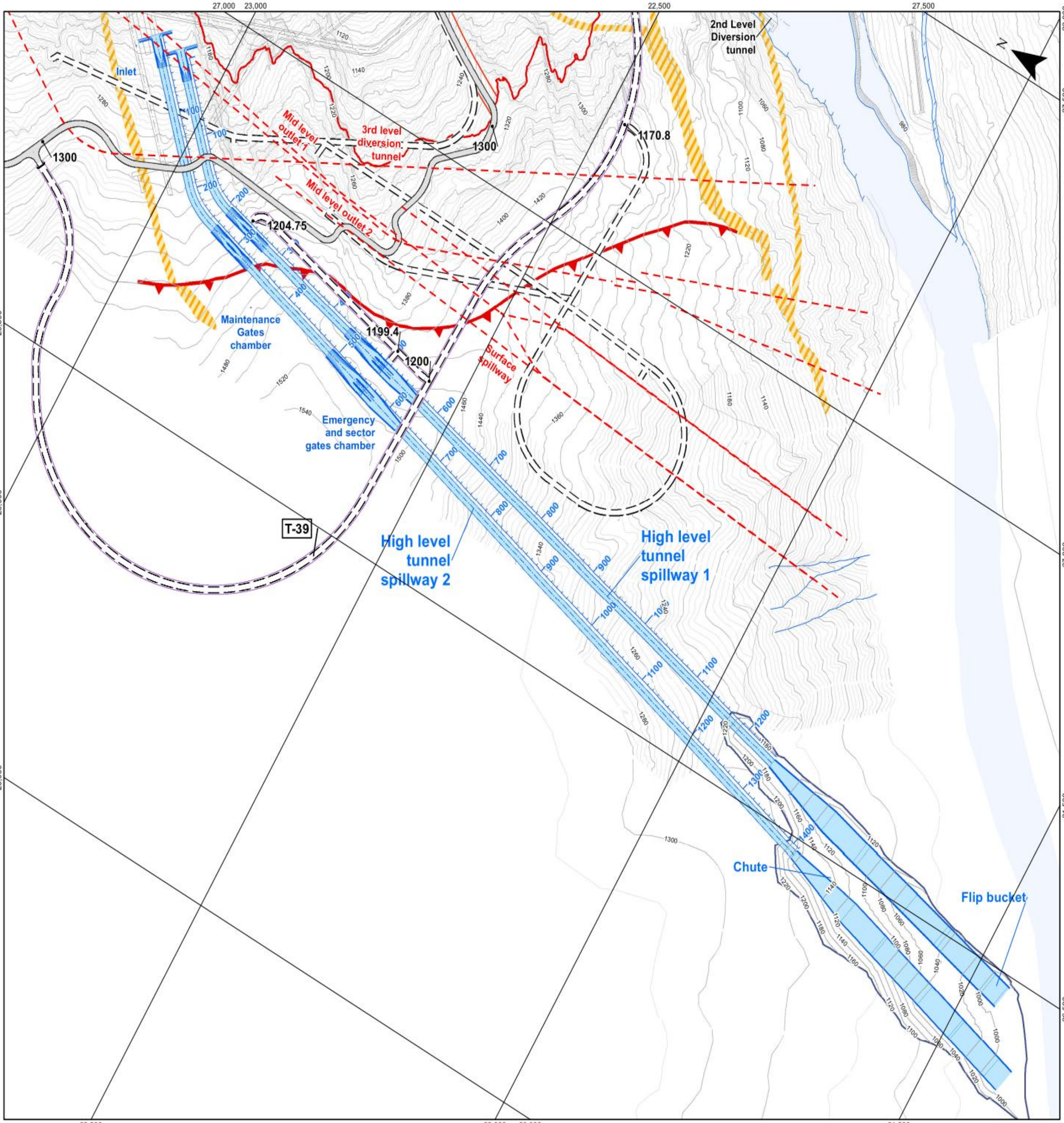


Alternative 1290 m asl Mid Level Outlets

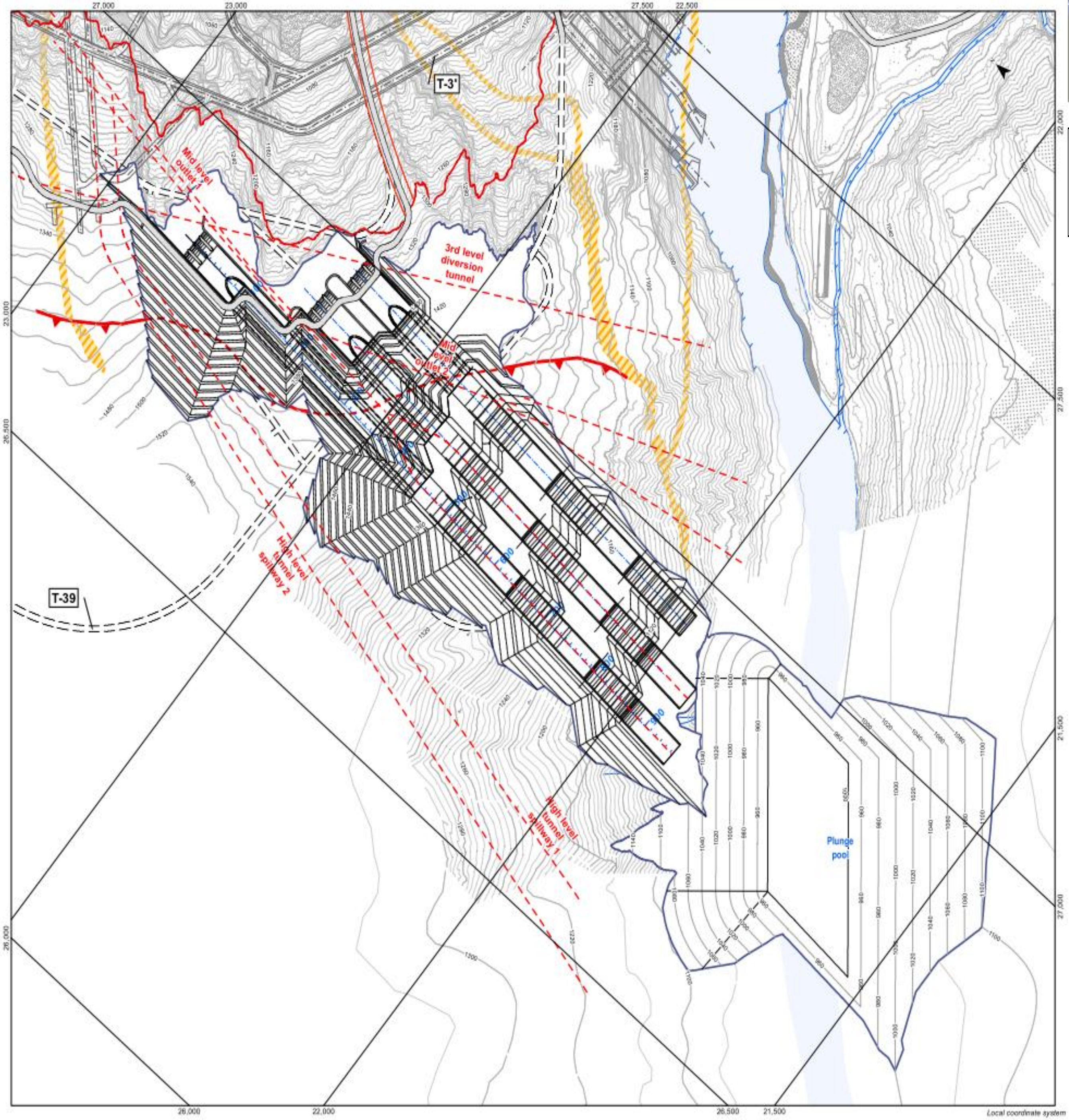


Alternative 1290 m asl High Level Tunnels





Alternative 1290 m asl Surface Spillway



Thank you !