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COLLIDER

UPDATE ON CIVIL ENGINEERING FOR THE FCC

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PROGRESS ON CIVIL ENGINEERING FOR THE FCC

Site and Civil Engineering Department (SCE) team directly supporting the FCC Project

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Acknowledging the contributions made by our external collaborators from Amberg, ILF, Quantum and University of Geneva
Special thanks to the Fermilab civil engineering team for their contributions throughout 2023

Contents

Tunnel Circumference: 90.7 km

Excavated vol: 6.2M m^3 (In the ground)

Access shafts: 12

Construction shafts: 1

Large experiment sites: 2

Small experiment sites: 2

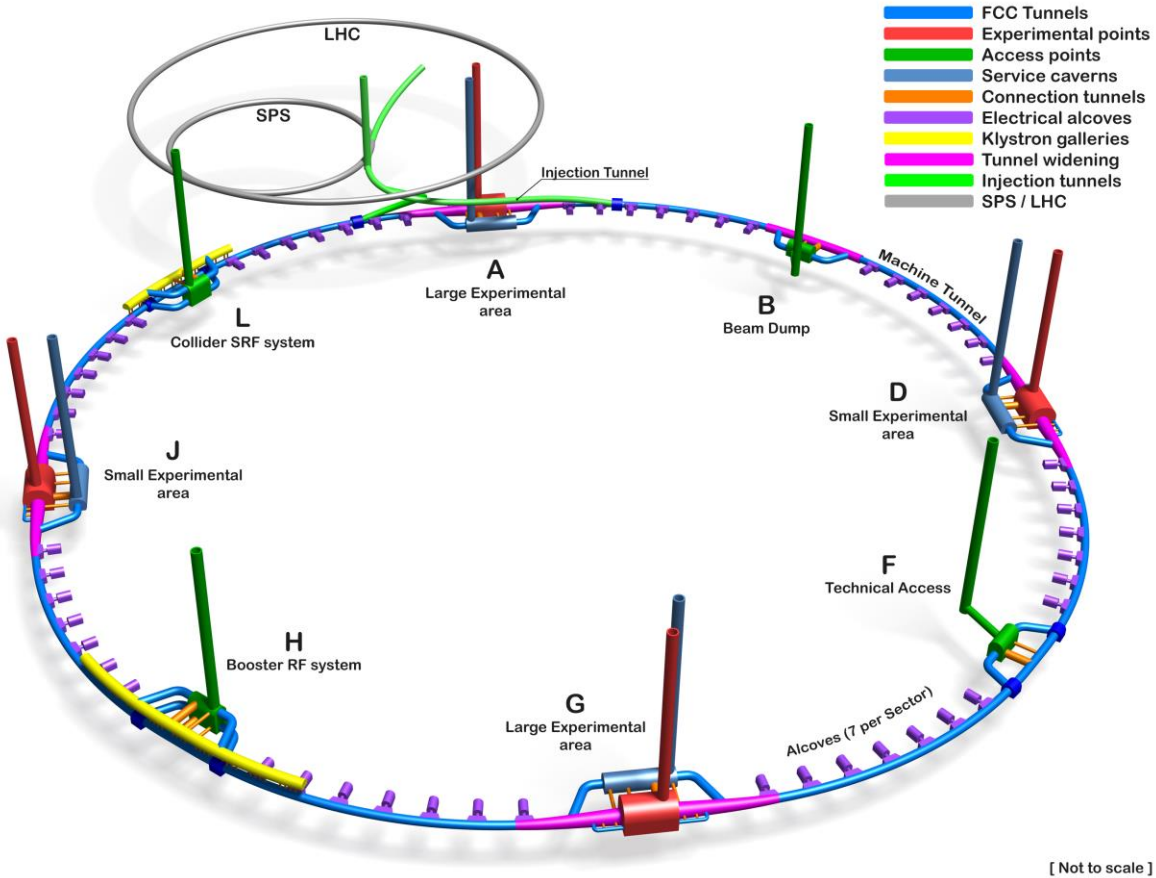
Technical sites: 4

Deepest shaft: 400m

Average shaft depth: 243m

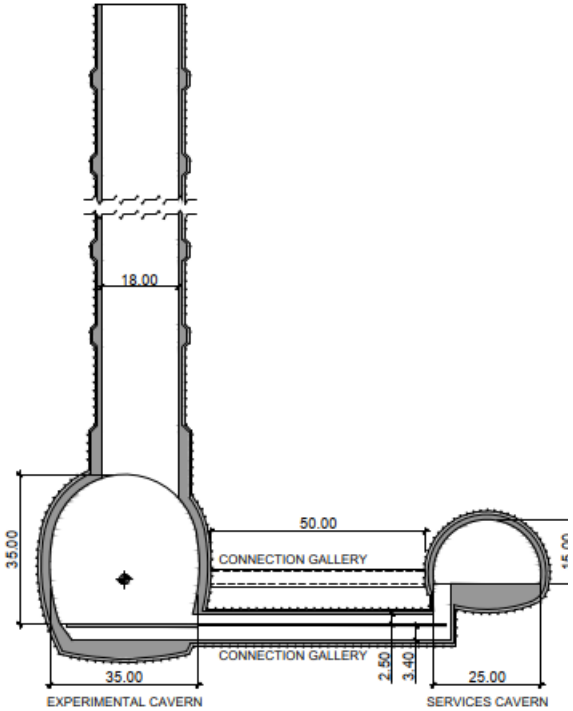
Total concrete volume: 1.9 M m^3

Steel weight: 130,000 metric tonnes



Schematic of the Underground Civil Engineering

Comparison FCC to ATLAS and CMS Cavern Complexes



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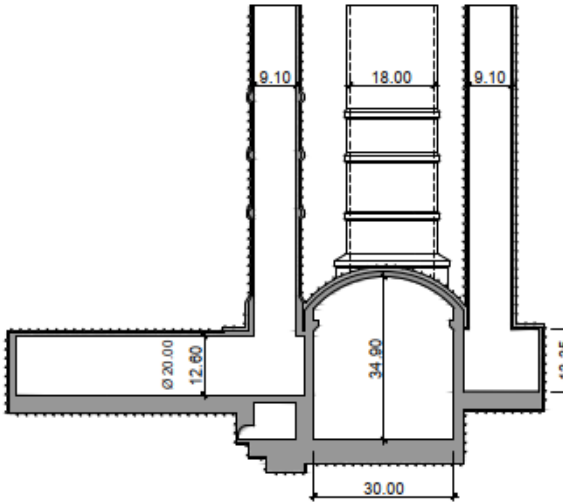
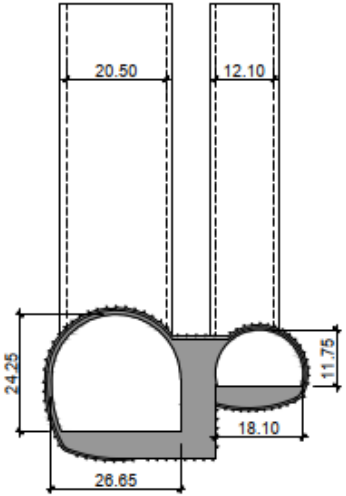


ATLAS



CMS

Key Civil Engineering Topics from the Mid-term Review

MTR was quite positive for the civil engineering. CE Team requested to investigate a number of topics and this work is ongoing.

1. Construction safety, ventilation and logistics aspects of an 11km single bore tunnel ✓
2. Further explore ground conditions, water table and potential for squeezing ground and mitigation measures – ✓
3. Engagement with industry on technical topics ✓
4. Engagement with industry on implementation strategies ✓

Construction Safety, Ventilation and Logistics

1. CERN commissioned specialist company Amberg to investigate this topic
2. Significant expertise in tunnel ventilation and long alpine tunnels
3. Various ventilation options evaluated
4. Logistics requirements for maximum TBM advance rate studied
5. Legislation and current practices for safety in long tunnels investigated

4.2.4. Conclusions

The average advance rate of 18 m/day can be reached by using a total of 4 MSV maximum, when the length of the excavated tunnel will exceed 7 km. 3 MSV are operating at the same time in the tunnel and a 4th one is required to mask the loading time at the shaft.

A maximum of 2 MSV will be at the same spot at the same time (crossing decks).

Person transport will be provided by smaller electric vehicles that will not impact MSV traffic.

Construction Safety, Ventilation and Logistics

1. 39 vehicle trips to TBM per day
2. 4 material transport vehicles required
3. At least 3 crossing bays required
4. Thermal engine vehicles currently only solution but OK for ventilation
5. Safety concept based around Refuge Stations located along the tunnel

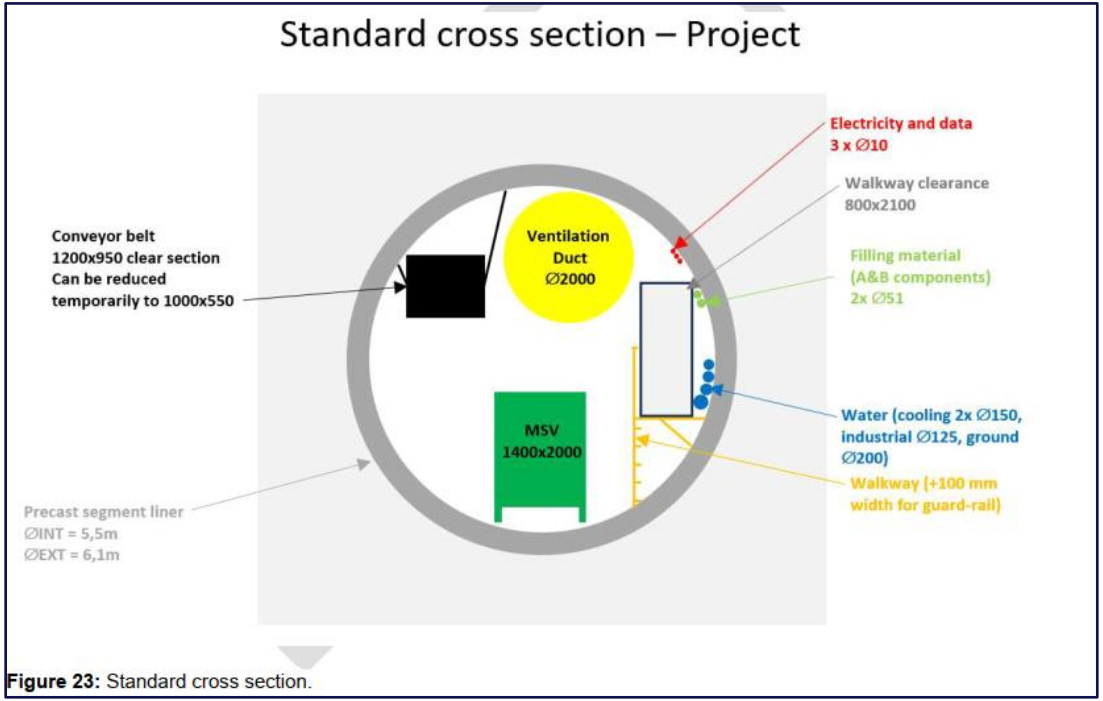
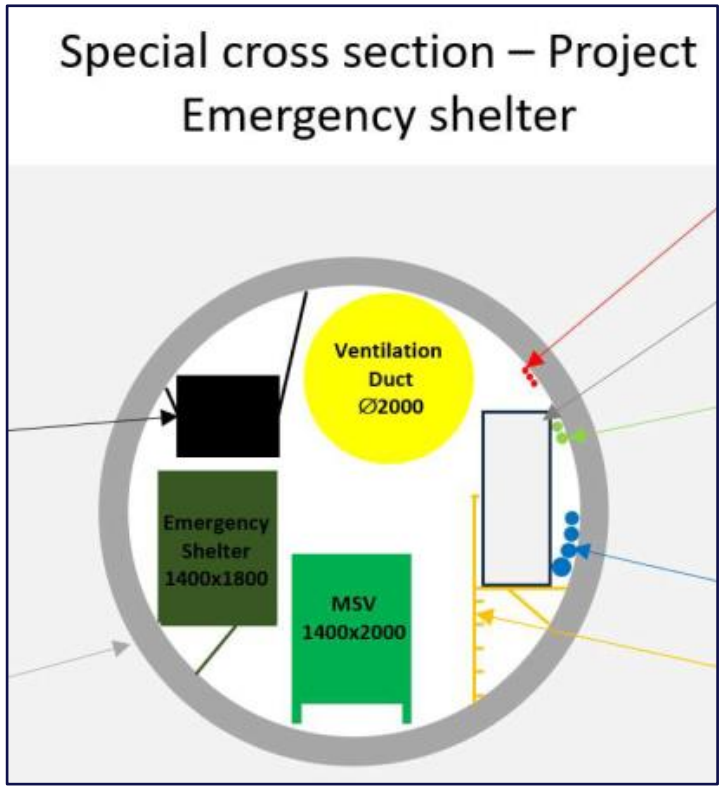
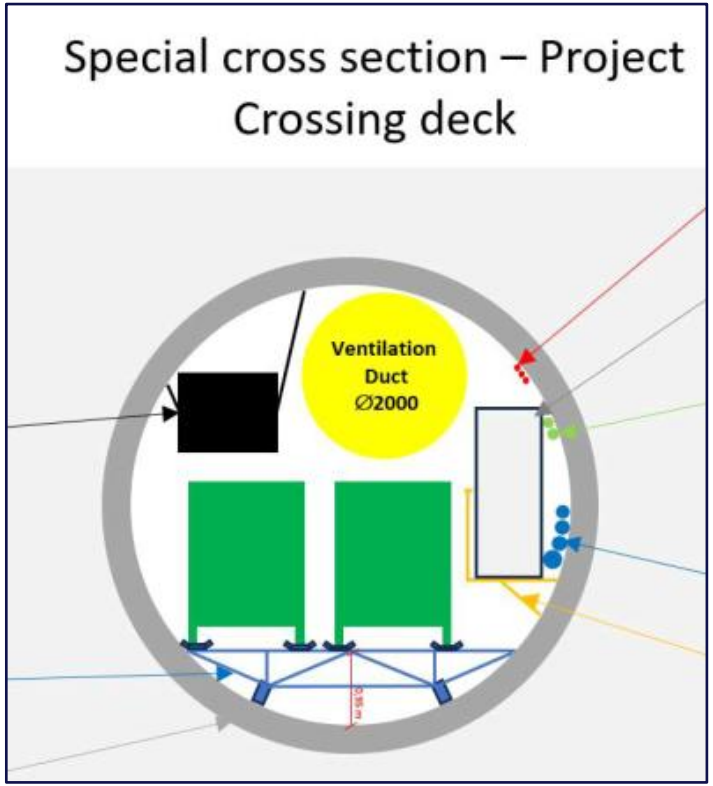


Figure 23: Standard cross section.

Construction Safety, Ventilation and Logistics





Construction Safety, Ventilation and Logistics

Figure 51: TBM refuge chambers [27].

Construction Safety, Ventilation and Logistics

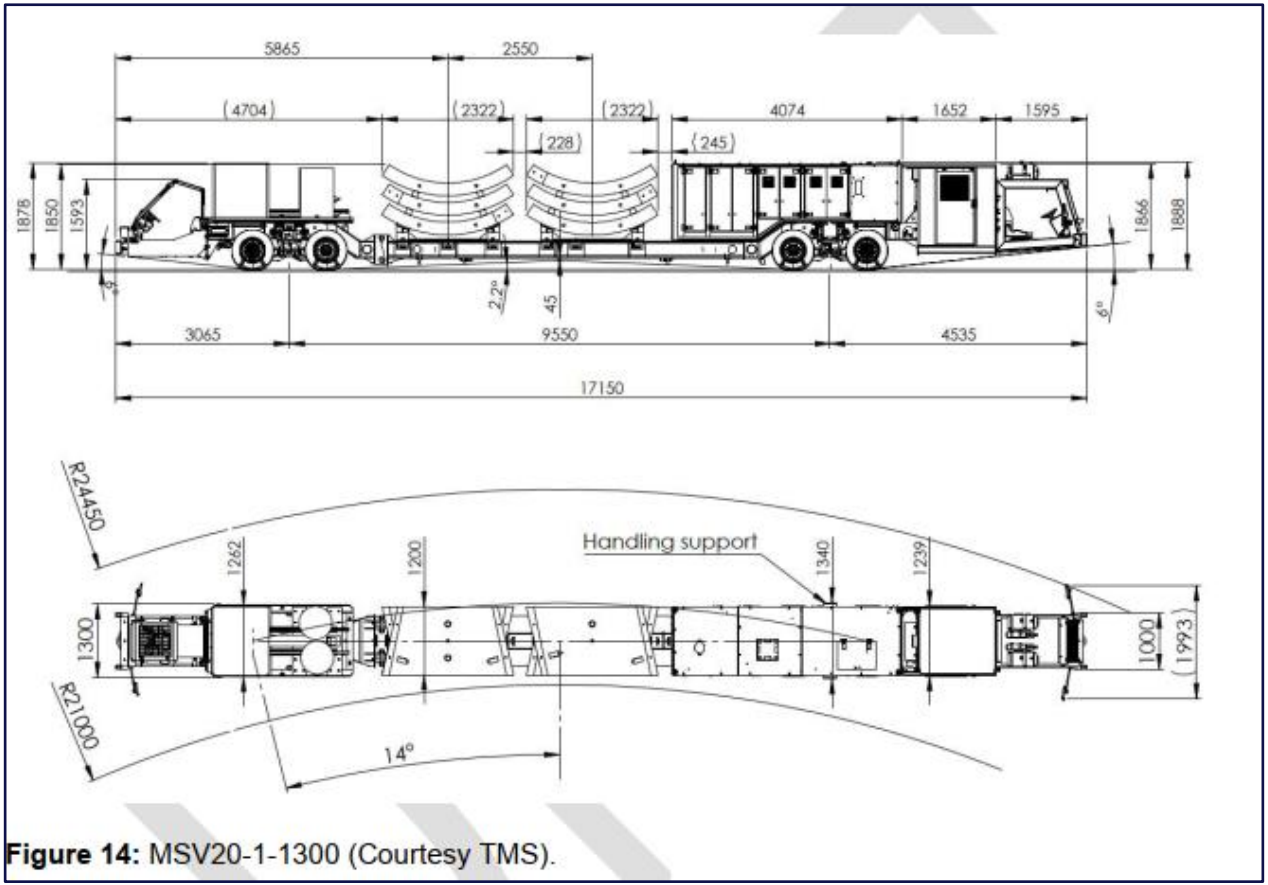


Figure 14: MSV20-1-1300 (Courtesy TMS).

Industry Feedback

1. CERN has met at least once with nine European companies each having extensive experience of underground civil engineering.
2. Four of the companies have been involved with underground works at CERN in the past (LHC or HL- LHC).
3. Technical aspects of the project were discussed as well as implementation strategies for the civil engineering works.
4. Follow up meetings are arranged with some of these companies as well as with additional companies scheduled for later in 2024.
5. Key technical and strategic points are as follows.

Technical Feedback

1. All of the companies considered that the underground works were feasible and well within the technological capabilities of the civil engineering industry today.
2. The long single access tunnel over 10 – 11 km was not considered to be an issue but may impact advance rates.
3. It was considered by some of the companies that CERNs underlying assumption of an average TBM advance rate of 18m/day was feasible but optimistic. CERN will review this in the light of new geological data and may reduce the rate in areas with complex conditions.
4. Having a single shaft to access the underground works was considered a potential bottleneck given that everything coming into and out of the underground would need to pass through this shaft. CERN is commissioning additional studies for the shafts.
5. All contractors admitted that dealing with excavated material was a major challenge and in their opinion, this was risk for the Client to manage in advance of the civil works. This is what CERN is doing.

Strategic Feedback

1. Most contractors considered that the complete civil engineering scope would be too great for one company to undertake alone.
2. Most contractors considered that contracting for two (of the eight or nine) construction packages would be sufficient to attract most capable European companies.
3. All contractors recognized the difficulty of working in France without a French partner. In this respect they all admitted they would probably prefer to come in Joint Ventures with one or two partners.
4. All contractors flagged the benefits of so called “ early contractor involvement” i.e., involving the works contractors during the design phase of the project.
5. None of the contractors foresaw a major issue in ordering 8 TBMs simultaneously but longer lead times should be expected.
6. All contractors recognized that there is only one European manufacturer of suitable TBMs and that Chinese manufacturers now held a very large part of the market.

Strategic Feedback

7. Some of the contractors considered that based on their recent experience (mainly on UK projects), a Target Cost type contract mechanism may present a good contract model.

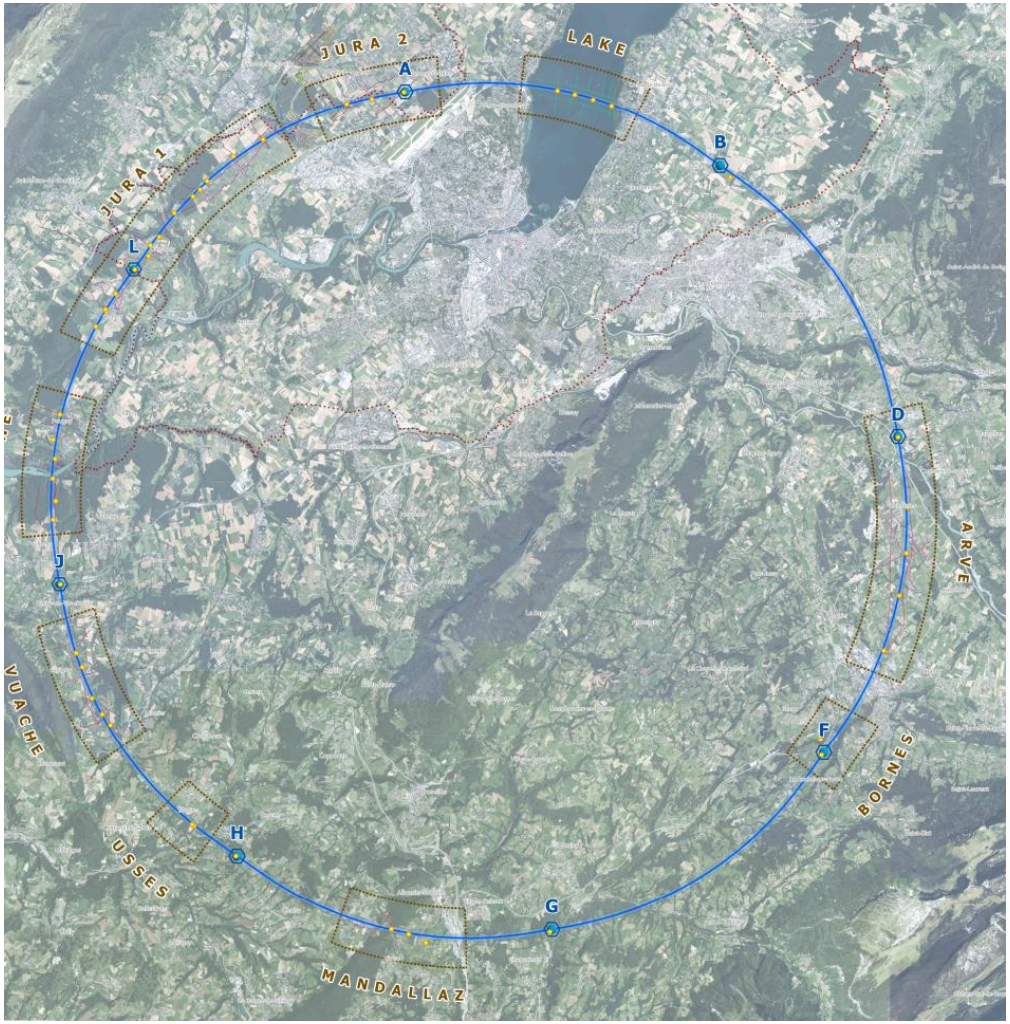
8. All contractors seemed willing to also adopt a traditional FIDIC type model with the associated risk share between contractors and client as long as the scope is well defined in particularly the geological conditions for the underground works.

Site Investigation

1. The contracts for site investigation have been delayed compared to the dates given at the last MTR.
2. This delay is partially due to the receipt of two similar offers leading CERN to adjudicate the works to both bidders.
3. CERN is now in the process of signing contracts with two bidders for the drilling and seismic site investigation works and preliminary preparation works have commenced under Letters of Intent.
4. Permitting for the works has proved challenging as all the proposed sites are outside current CERN property boundaries.
5. It is still expected to complete most if not all the works before March 2025, but some of the interpretative works may only be available after this date.
6. This work and the planned work in the post-feasibility phase of the project will be presented by Roddy Cunningham in the civil engineering session on Tuesday.

Site Investigation

- Two contractors
- Work split by country (FR and CH)
- Contractors working under Letters of Intent with Contractor Signature before end June
- On-Site seismic investigations should commence in August 2024
- Drilling works should start September 2024
- French geophysics permits are in-place
- Awaiting confirmation on French drilling permits.
- Swiss permitting ongoing.
- Preparing strategy for next phases of the investigations which need to target experiment sites.



Work Scope to Complete Feasibility Study

	2024						2025				
TASK	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	March	Apr	May
Seismic Investigations											
Drilling for Site Investigations											
Interpretation of Site Investigation data											
Complete Layouts for all Surface Works											
Place contract and execute costing of surface works											
Update PBS for Surface works											
Receive underground requirements from Integration Team											
Update all CE models and drawings											
Update PBS for underground works											
Update cost estimate and schedule (ILF)											
Complete dialogue with Industry											
Update Risk Register for civil engineering											
Update cost estimate and schedule											
Write Feasibility Study report											
Compile cost and schedule report											

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Thank you
for your attention.