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Austria

Technical Note

Project:	Future Circular Collider – Cost and Schedule Study	Date:	2 th May 2017
Subject:	Verification of Current Geological Information	Ref:	TN CERN FCC CSS 002
Author:	Werner Dallapiazza	Reviewer:	Leo Ariza

1 Introduction

This Technical Note (TN) has been prepared for the Future Circular Collider Cost and Schedule Study (CSS).

One of the key pieces of information used for the CSS is the depth of moraine deposits, which corresponds to the difference in elevation between the ground surface and the rockhead. ILF has reviewed this information and found that at some locations the level of molasses is higher than the ground surface level.

This TN presents the results of this review aiming at creating a discussion between the parties that have originated and subsequently managed this information.

Although It is currently perceived that **the above mentioned discrepancies do not have a major impact on the results presented for the CSS Phase 1 and 2 Reports, it is necessary to have coherent information that enables future project development.**

2 Information Used for the CSS

ILF has used the following information for the CSS.

2.1 Digital Terrain Model

ILF has used the Digital Elevation Model over Europe (EU-DEM) and the European Vertical Reference System EVRS2000.

2.2 Contours of the Top of the Molasse Rock

The contours of the top of the molasse were sent by CERN in the form of a GeoTIFF file. It has been assumed that the offset between EVRS2000 and LN02 is less than 1m and, therefore, not relevant for this project phase.

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2.3 Future Circular Collider Ring Alignments

ILF received two excel sheets with the coordinates of the FCC tunnel ring alignments which included information on the geological model. These files are Excel spreadsheets with coordinates for the proposed FCC ring alignments as follows:

- Baseline Design deep ring alignment: V4 P3 - 97.75km.xlsx
- Shallow Option ring alignment: V4 P2 - 97.75km_KoordShallowRing.xlsx

3 Detailed Description of the Discrepancies

The CSS included formulation of alternative inclined accesses that branch out from the ring alignments and are used to reduce construction programmes. The alignments for the inclined accesses were initially calculated by CERN using the model developed by ARUP. Upon receiving the first alignments, ILF carried out independent calculations using their own methods and found that both lengths and gradients did not coincide with the results provided by CERN.

From this review it is clear that some sections of the molasse layer exceeded the actual ground surface layer. ILF superimposed the digital ground surface contours and the digital molasse contours. The results shown in appendix A show that some areas of the molasse are effectively above the ground level (orange and red zones).

During a workshop between ILF and CERN on 24th April 2017, ILF were asked to provide longitudinal profiles of the FCC ring alignments (deep and shallow). As ILF only received the molasse GeoTIFF file, these profiles only show the surface elevation and the molasse level. Other geological layering referring to limestone and flysch interfaces are ignored.

ILF developed longitudinal profiles for the FCC ring alignments (see Appendix B). From these profiles it can be observed that where the molasse level reaches the ground surface, the GeoTIFF file was not interrupted as it extends above ground and continues to the next area where the molasses level hits the ground surface. The longitudinal profiles in Appendix B have been marked accordingly.

Although these discrepancies should not have a major effect on the current results for the CSS, it is clear that they do affect the creation of alignments for the inclined accesses.

4 Recommendations

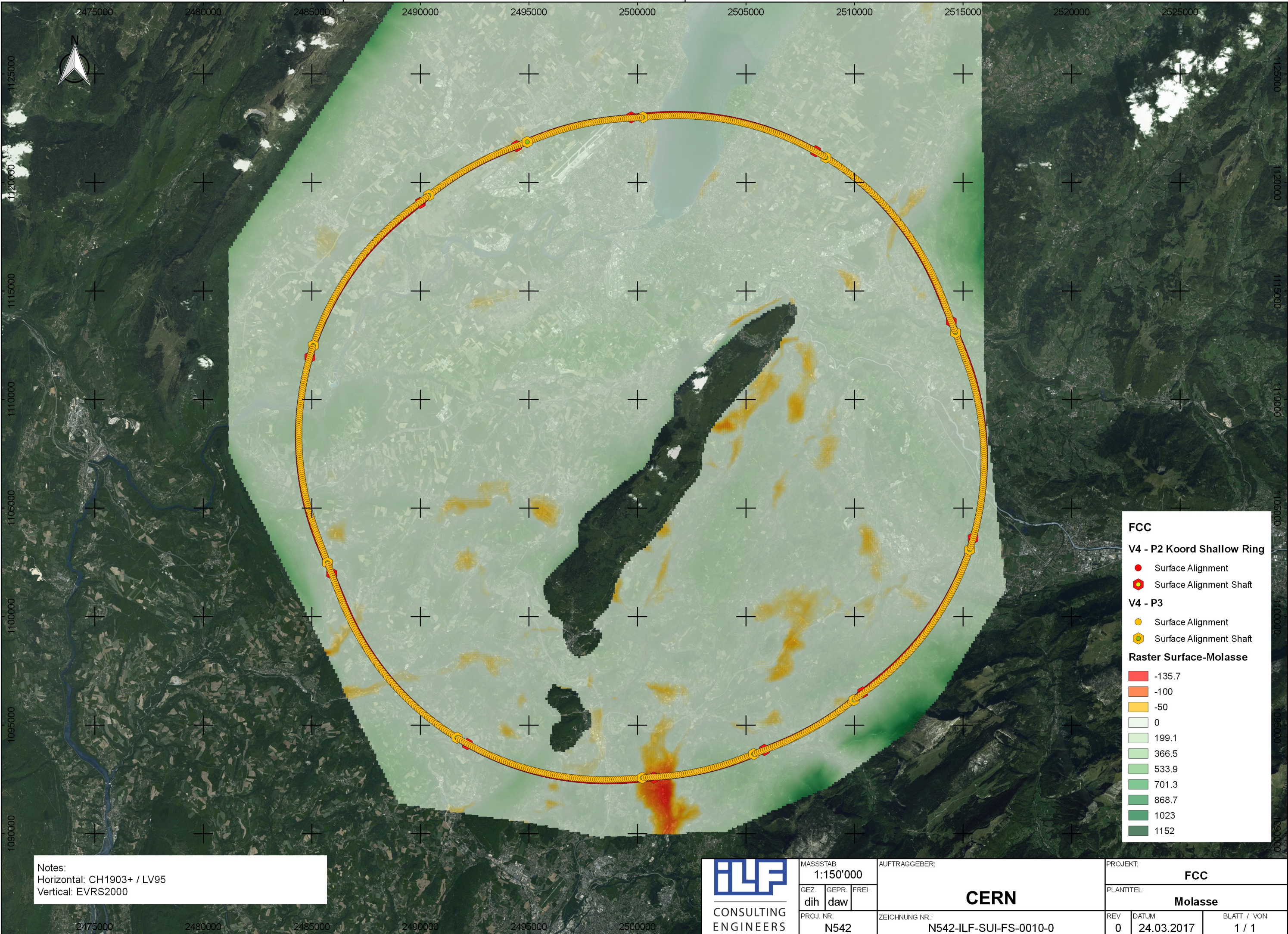
It is recommended to re-calibrate the model of the top of the molasse. A meeting is proposed with participation from CERN, ILF and the organisations that have created/ modified the current information in order to establish the corrections (if there are any).

If required, ILF is available to produce a complete 3D model for the ring alignments. ILF will also continue to develop construction schedules on the basis of their own model set up from CERN-data and will be available for any queries on the contents of this TN.

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APPENDIX A. Plot showing vertical level differences between ground surface and the top of the molasse

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 DEM: Produced using Copernicus data and information funded by the European Union - EU-DEM layers



Notes:
 Horizontal: CH1903+ / LV95
 Vertical: EVRS2000



MASSSTAB
1:150'000
 GEZ. GEPR. FREI.
 dih daw
 PROJ. NR.
N542

AUFTRAGGEBER:
CERN
 ZEICHNUNG NR.:
N542-ILF-SUI-FS-0010-0

PROJEKT: FCC		
PLANTITEL: Molasse		
REV 0	DATUM 24.03.2017	BLATT / VON 1 / 1

FCC

V4 - P2 Koord Shallow Ring

- Surface Alignment
- Surface Alignment Shaft

V4 - P3

- Surface Alignment
- Surface Alignment Shaft

Raster Surface-Molasse

- 135.7
- 100
- 50
- 0
- 199.1
- 366.5
- 533.9
- 701.3
- 868.7
- 1023
- 1152

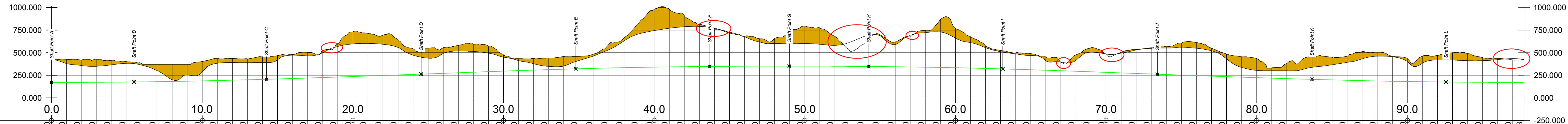
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APPENDIX B. Longitudinal profiles for the Baseline Design (deep alignment) and the Shallow Option with mark ups

Notes:

Horizontal: CH1903+ / LV95
 Level Terrain: EVRS2000
 Level Molasse: LN02 (?) - Offset between EVRS2000 and LN02 is irrelevant for this phase (< 1m)
 Elevation Values V4 - P2/P3 are taken from given Excel-Sheet

Alignment: V4-P3 (DEEP)
 Scale: 1:150000 / 1:25000

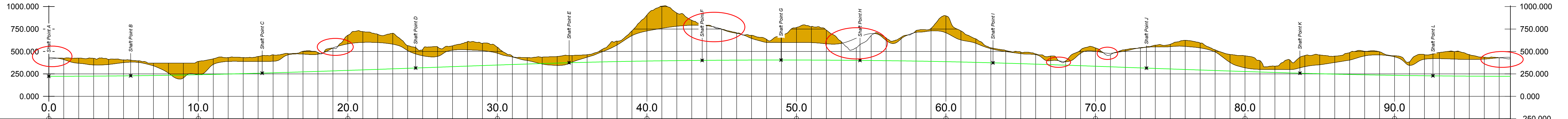


Tunnel Chainage [KM]	Level Terrain [m]	Level Molasse [m]	Level Machine Tunnel [m]
0.000	424.22	425.70	170.648
1.000	425.83	379.04	170.736
2.000	419.95	356.80	171.167
3.000	427.47	349.69	172.029
4.000	414.97	366.12	173.319
5.000	400.75	382.24	175.005
6.000	375.69	361.22	176.899
7.000	371.00	301.93	179.035
8.000	371.00	200.93	181.566
9.000	371.00	253.72	184.486
10.000	402.38	286.49	187.779
11.000	438.13	382.73	191.425
12.000	436.05	390.49	195.402
13.000	430.93	388.95	199.688
14.000	454.07	389.78	204.258
15.000	467.61	421.19	209.084
16.000	479.62	472.70	214.139
17.000	502.97	464.96	219.392
18.000	524.34	499.31	224.814
19.000	596.28	588.64	230.373
20.000	730.89	597.15	236.035
21.000	713.87	602.51	241.769
22.000	693.96	592.89	247.540
23.000	643.39	557.78	253.317
24.000	543.63	472.05	259.173
25.000	549.46	439.37	265.185
26.000	555.24	491.48	271.352
27.000	579.35	518.84	277.565
28.000	595.09	513.02	283.713
29.000	573.12	494.49	289.759
30.000	476.30	450.65	295.666
31.000	433.60	412.62	301.401
32.000	435.76	377.44	306.930
33.000	441.24	348.91	312.221
34.000	458.46	352.35	317.243
35.000	458.27	412.62	321.966
36.000	486.07	464.61	326.362
37.000	594.45	532.71	330.406
38.000	661.05	629.43	334.076
39.000	832.41	708.68	337.348
40.000	979.17	743.80	340.203
41.000	982.40	770.22	342.626
42.000	910.40	787.19	344.602
43.000	811.72	790.98	346.162
44.000	766.40	771.96	347.729
45.000	726.95	716.92	349.277
46.000	682.79	675.80	350.388
47.000	654.77	617.95	351.022
48.000	656.51	600.98	351.177
49.000	728.25	598.85	351.126
50.000	796.67	600.91	351.180
51.000	773.63	592.93	350.907
52.000	680.13	581.03	350.154
53.000	519.07	615.63	348.923
54.000	601.54	682.27	347.319
55.000	696.40	686.13	345.792
56.000	618.67	590.42	344.148
57.000	682.28	692.06	342.058
58.000	744.60	721.89	339.524
59.000	865.42	728.59	336.562
60.000	768.42	661.05	333.188
61.000	676.15	611.34	329.423
62.000	575.11	554.80	325.287
63.000	524.31	510.26	320.806
64.000	497.67	485.81	316.005
65.000	490.05	469.10	310.913
66.000	451.14	411.53	305.559
67.000	395.25	396.11	299.975
68.000	475.53	415.54	294.194
69.000	554.32	506.52	288.248
70.000	480.99	484.62	282.173
71.000	504.47	494.89	276.005
72.000	535.00	530.27	269.786
73.000	554.27	547.57	263.656
74.000	565.79	550.13	257.683
75.000	607.97	560.72	251.862
76.000	611.37	548.70	246.085
77.000	551.25	521.03	240.320
78.000	485.13	431.47	234.601
79.000	454.55	336.60	228.962
80.000	434.97	304.13	223.435
81.000	331.56	300.15	218.052
82.000	380.05	299.48	212.846
83.000	420.73	312.43	207.846
84.000	460.75	345.28	203.082
85.000	448.93	365.72	198.581
86.000	460.76	392.23	194.370
87.000	510.97	431.47	190.474
88.000	508.36	461.26	186.916
89.000	461.69	455.23	183.715
90.000	434.43	402.06	180.891
91.000	461.92	382.53	178.460
92.000	469.84	419.28	176.407
93.000	499.74	417.63	174.553
94.000	490.33	411.61	172.955
95.000	445.34	411.82	171.771
96.000	437.54	422.74	171.017
97.000	419.99	435.26	170.692
97.748	424.22	425.70	170.648

Notes:

Horizontal: CH1903+ / LV95
 Level Terrain: EVRS2000
 Level Molasse: LN02 (?) - Offset between EVRS2000 and LN02 is irrelevant for this phase (< 1m)
 Elevation Values V4 - P2/P3 are taken from given Excel-Sheet

Alignment: V4-P2 (SHALLOW)
 Scale: 1:150000 / 1:25000

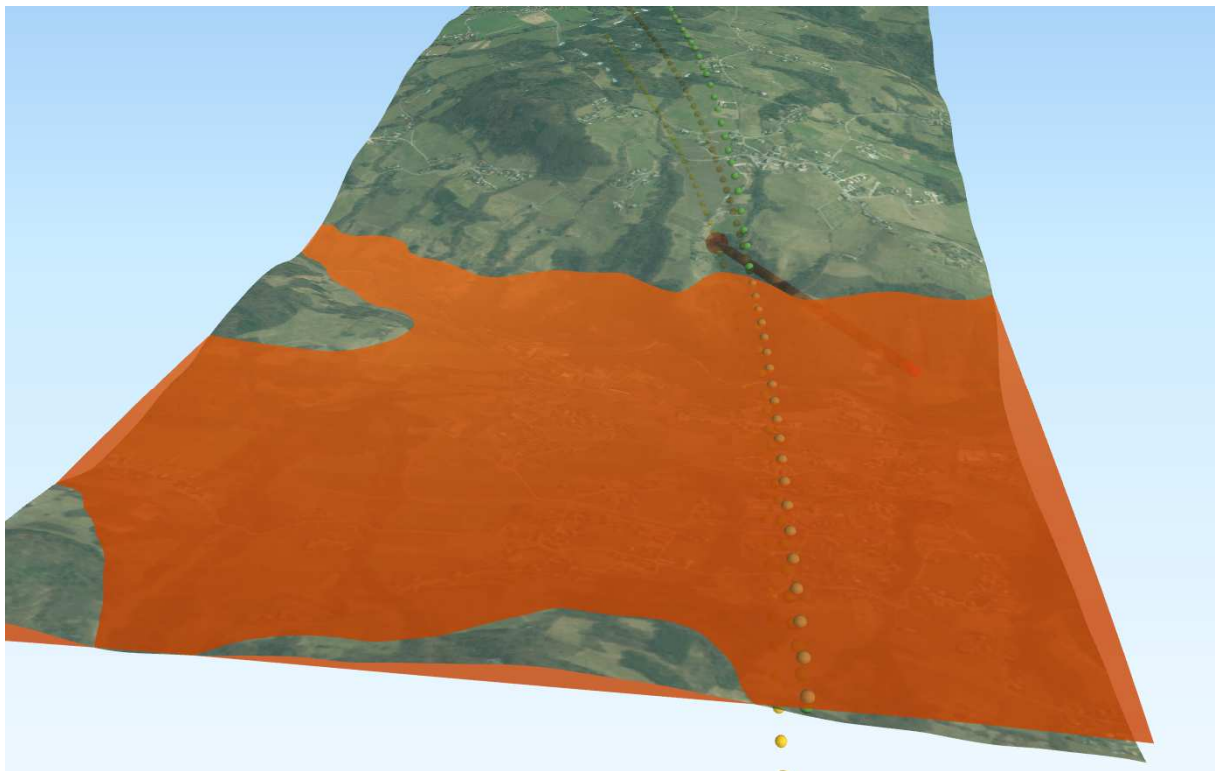
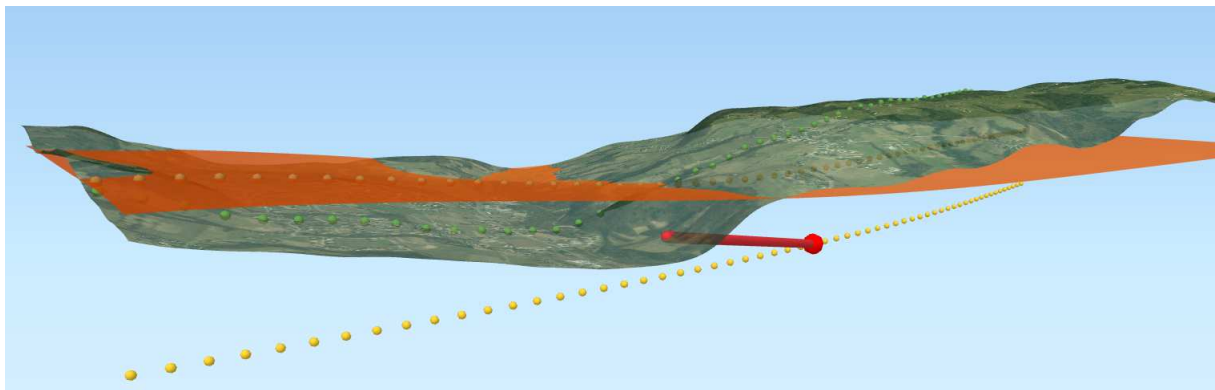


Tunnel Chainage [KM]	Level Terrain [m]	Level Molasse [m]	Level Machine Tunnel [m]
0.0	419.69	434.11	223.648
1.0	423.40	409.46	223.736
2.0	425.56	368.30	224.167
3.0	423.65	349.62	225.029
4.0	411.63	354.72	226.319
5.0	406.93	375.50	228.005
6.0	396.63	378.00	229.899
7.0	371.00	339.48	232.035
8.0	371.00	258.73	234.566
9.0	371.00	204.23	237.486
10.0	388.92	241.98	240.779
11.0	417.93	355.07	244.425
12.0	432.96	388.81	248.402
13.0	432.28	389.19	252.688
14.0	443.74	389.80	257.258
15.0	463.14	390.76	262.084
16.0	476.67	461.95	267.139
17.0	502.25	470.67	272.392
18.0	488.86	469.07	277.814
19.0	537.31	538.42	283.373
20.0	680.72	584.22	289.035
21.0	721.39	601.23	294.769
22.0	691.17	599.28	300.540
23.0	702.33	580.87	306.317
24.0	565.06	509.23	312.173
25.0	521.59	452.02	318.185
26.0	551.03	444.73	324.352
27.0	562.50	514.45	330.565
28.0	609.29	518.59	336.713
29.0	591.11	509.42	342.759
30.0	547.03	480.15	348.666
31.0	447.91	438.53	354.401
32.0	431.39	399.14	359.930
33.0	436.47	359.77	365.221
34.0	443.89	344.43	370.243
35.0	454.80	380.70	374.966
36.0	463.59	435.60	379.362
37.0	522.05	495.64	383.406
38.0	615.59	571.54	387.076
39.0	729.56	676.03	390.348
40.0	905.58	727.87	393.203
41.0	1004.34	757.79	395.626
42.0	928.77	780.65	397.602
43.0	847.37	792.73	399.162
44.0	791.53	786.85	400.729
45.0	749.11	747.41	402.277
46.0	707.72	701.96	403.388
47.0	679.69	644.89	404.022
48.0	635.22	600.49	404.177
49.0	672.41	599.99	404.126
50.0	766.64	599.67	404.180
51.0	777.06	598.88	403.907
52.0	737.99	585.24	403.154
53.0	609.33	589.75	401.923
54.0	541.61	647.94	400.319
55.0	677.95	699.32	398.792
56.0	650.54	622.70	397.148
57.0	656.91	640.43	395.058
58.0	732.13	713.00	392.524
59.0	755.86	728.69	389.562
60.0	896.49	707.17	386.188
61.0	729.50	627.63	382.423
62.0	640.72	590.59	378.287
63.0	540.94	531.01	373.806
64.0	510.23	498.59	369.005
65.0	493.95	475.73	363.913
66.0	472.95	464.25	358.559
67.0	448.90	398.02	352.975
68.0	394.49	385.94	347.194
69.0	515.53	478.05	341.248
70.0	539.31	501.54	335.173
71.0	463.77	479.24	329.005
72.0	520.68	505.07	322.786
73.0	542.21	537.91	316.656
74.0	569.39	550.83	310.683
75.0	579.73	553.11	304.862
76.0	624.11	556.48	299.085
77.0	593.83	539.18	293.320
78.0	518.69	494.48	287.601
79.0	466.28	377.33	281.962
80.0	451.20	317.52	276.435
81.0	397.54	300.51	271.052
82.0	336.77	300.26	265.846
83.0	405.11	299.23	260.846
84.0	454.51	330.55	256.082
85.0	460.96	351.71	251.581
86.0	447.86	377.01	247.370
87.0	487.24	403.42	243.474
88.0	502.62	450.03	239.916
89.0	496.90	461.03	236.715
90.0	452.88	440.21	233.891
91.0	384.43	345.07	231.460
92.0	464.21	412.96	229.407
93.0	487.95	420.09	227.553
94.0	498.88	414.89	225.955
95.0	464.28	410.48	224.771
96.0	435.91	414.86	224.017
97.0	429.24	430.34	223.692
97.748	419.69	434.11	223.648

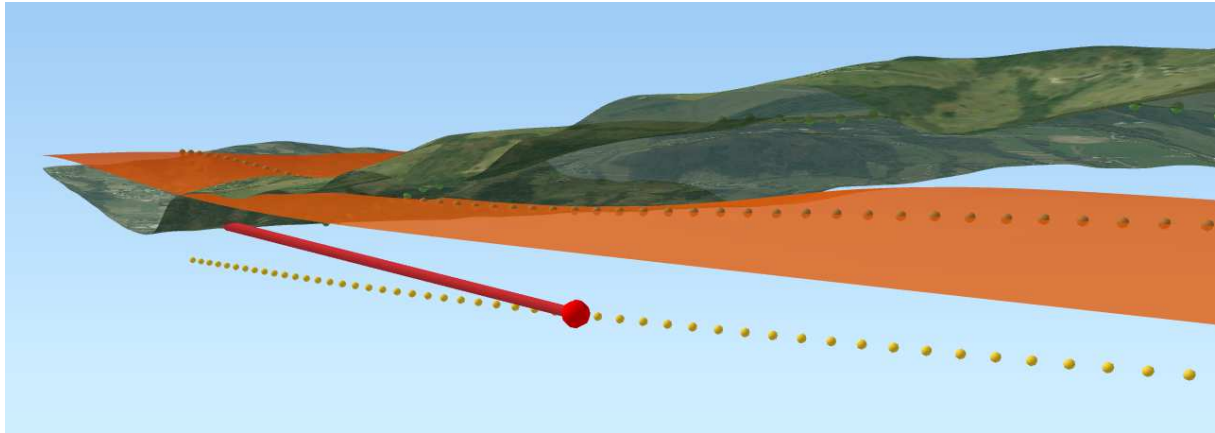
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APPENDIX C. 3D-Model area between shaft G and H, with possible inclined access and molasses contours exceeding surface contour

The following screenprints show different views of a valley between shafts G and H. Yellow dots are coordinates of the ring alignment for the Baseline Design (deep). Furthermore, the alignment at molasse and surfaces are shown dotted. The molasse rockhead is shown in orange and crops out of the surface within the valley. One possible inclined access is shown in the model.



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Following print shows possible portal locations for inclined accesses (from 10 to 15% slope, dark blue to white)

