

Monthly report

Railway Field Laboratory

October 2022

Client: Swiss confederation; Federal Offices for the Environment (FOEN) and Transport (FOT), CH-3003 Bern
The FOEN and the FOT are offices of the Federal Department of the Environment, Transport, Energy and Communications (DETEC).

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Remarks: This report was published on behalf the Swiss Federal Office for the Environment (FOEN) and Transport (FOT). The consultant is responsible for the content and all data displayed.

Version: V1

Date: 15.2.2023

1. Status railway field laboratory

Construction work on the tracks:

- none

Downtimes of the measurement systems:

- none

Downtimes of the sensors:

- MQ 1_2: v-mq12 (up to 19.10.)
- MQ 2_2: v-mq22 (up to 19.10.)

Maintenance and sensor exchange:

- MQ 1_2: v-mq12 (due to defect)
- MQ 2_2: v-mq22 (due to defect)

Modifications to the data, database, or analysis:

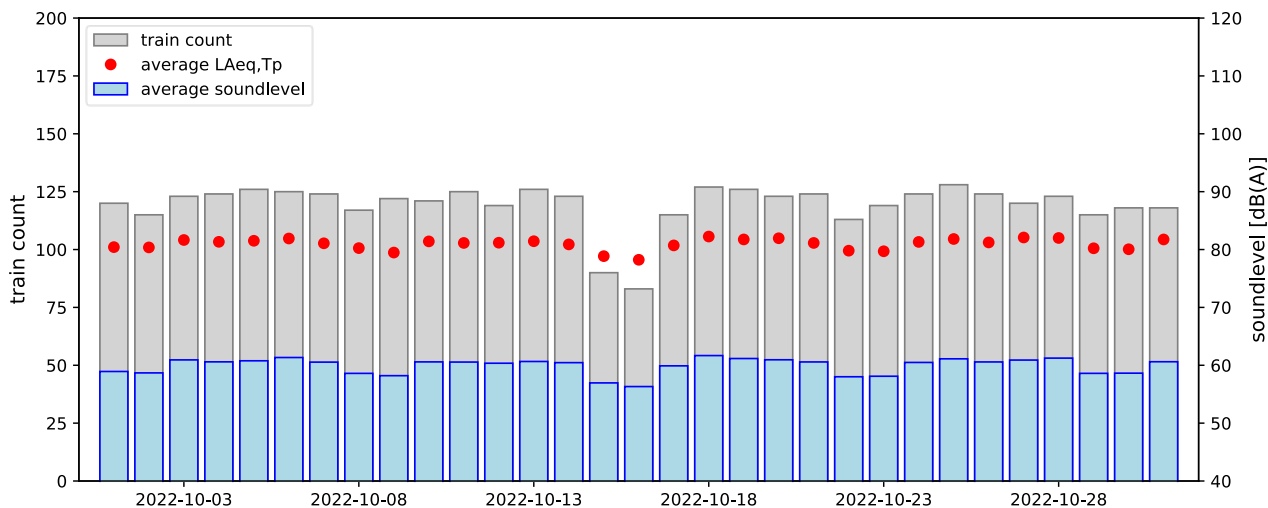
- none

Monthly data volume collected:

- 275 GB

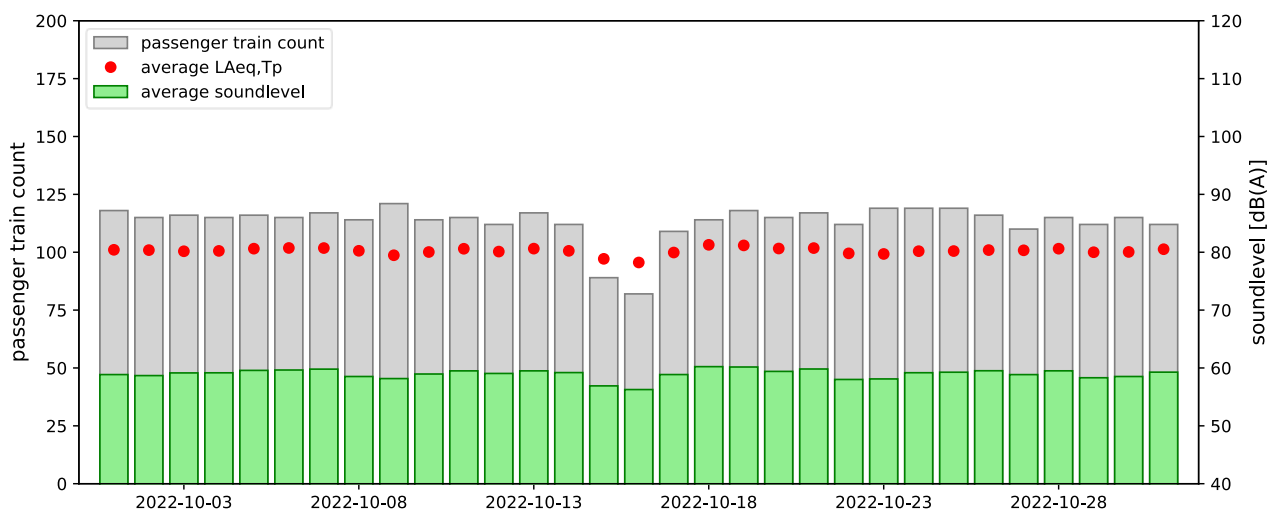
2. Measurement data

Daytime averages (24h) for all train passages at reference section (REF)



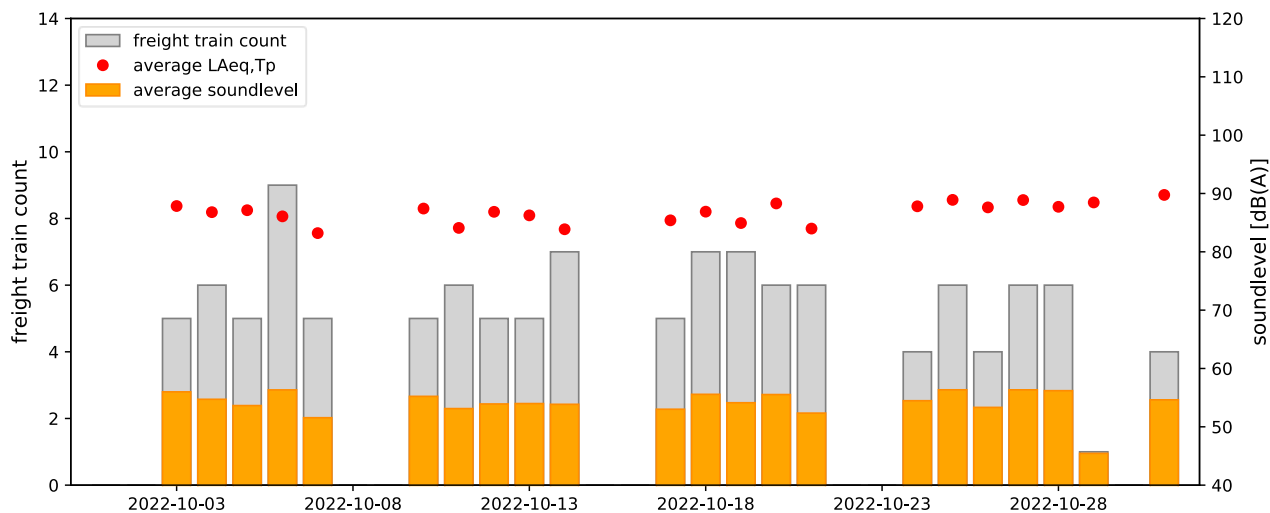
date	location	train count	passenger train count	freight train count	service train count	average LAeq,Tp	average soundlevel
01.10.2022	REF	120	118	0	0	80.4	58.9
02.10.2022	REF	115	115	0	0	80.4	58.7
03.10.2022	REF	123	117	5	0	81.6	60.9
04.10.2022	REF	124	115	7	1	81.3	60.6
05.10.2022	REF	126	116	5	2	81.5	60.8
06.10.2022	REF	125	115	9	0	81.9	61.3
07.10.2022	REF	124	117	5	1	81.1	60.5
08.10.2022	REF	117	114	0	1	80.2	58.6
09.10.2022	REF	122	121	0	0	79.5	58.2
10.10.2022	REF	121	114	5	1	81.4	60.6
11.10.2022	REF	125	116	6	1	81.1	60.6
12.10.2022	REF	119	112	5	2	81.2	60.4
13.10.2022	REF	126	117	5	2	81.4	60.7
14.10.2022	REF	123	112	7	1	80.9	60.5
15.10.2022	REF	90	89	0	0	78.9	57.0
16.10.2022	REF	83	83	0	0	78.2	56.3
17.10.2022	REF	115	109	5	0	80.7	59.9
18.10.2022	REF	127	114	8	2	82.2	61.7
19.10.2022	REF	126	118	7	0	81.7	61.2
20.10.2022	REF	123	116	6	1	81.9	60.9
21.10.2022	REF	124	117	6	1	81.1	60.6
22.10.2022	REF	113	112	0	1	79.8	58.0
23.10.2022	REF	119	119	0	0	79.7	58.1
24.10.2022	REF	124	119	4	1	81.3	60.5
25.10.2022	REF	128	119	6	2	81.8	61.1
26.10.2022	REF	124	116	5	2	81.2	60.6
27.10.2022	REF	120	110	7	1	82.1	60.9
28.10.2022	REF	123	115	6	0	82.0	61.2
29.10.2022	REF	115	112	1	0	80.2	58.6
30.10.2022	REF	118	115	0	0	80.0	58.6
31.10.2022	REF	118	112	4	1	81.7	60.6
month	REF	3700	3514	124	24	81.1	60.1

Daytime averages (24h) for all passenger train passages at reference section (REF)



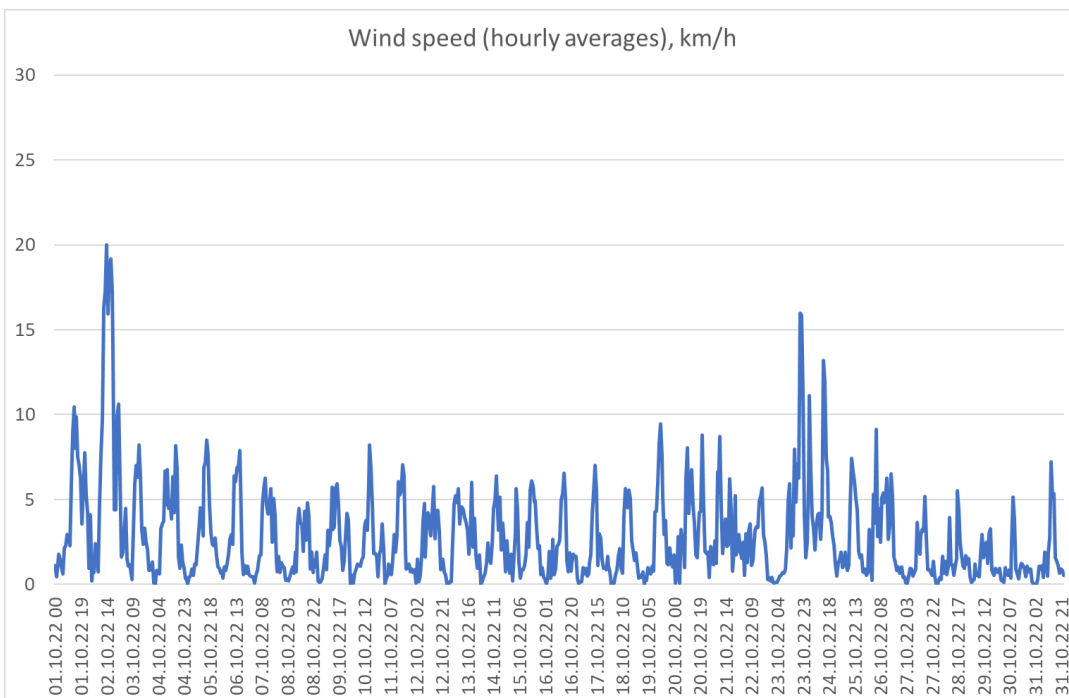
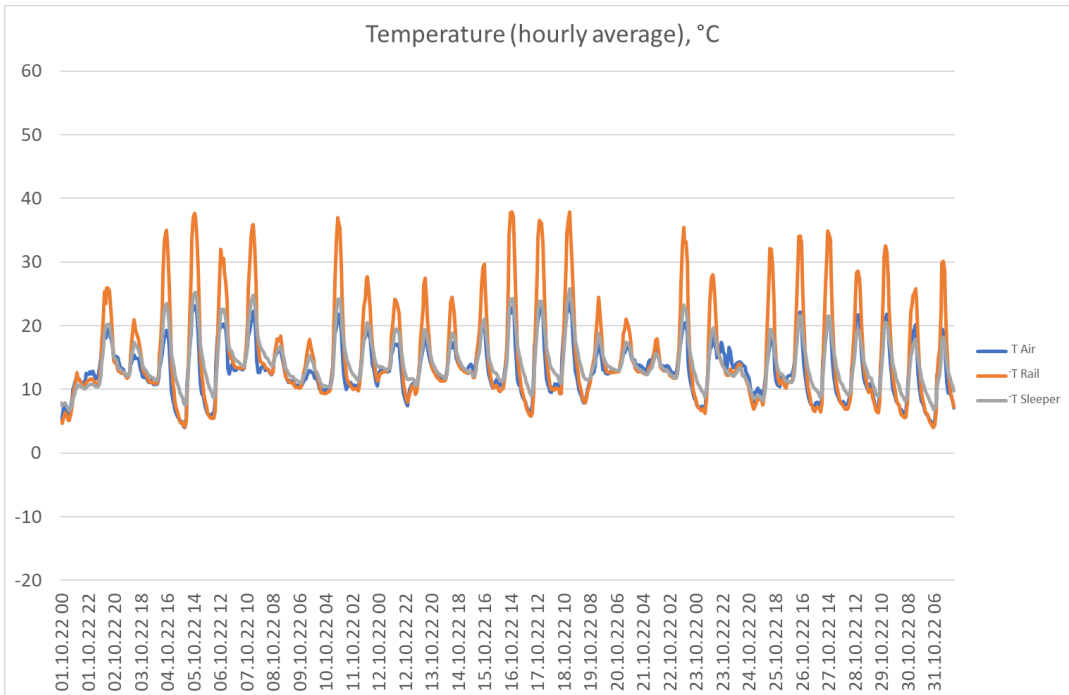
date	location	passenger train count	average speed	average length	average axlecount	average LAeqTp	average_soundlevel
01.10.2022	REF	118	113	140	21	80.4	58.9
02.10.2022	REF	115	112	140	21	80.4	58.7
03.10.2022	REF	117	111	161	24	80.2	59.1
04.10.2022	REF	115	112	162	24	80.2	59.2
05.10.2022	REF	116	113	163	24	80.6	59.6
06.10.2022	REF	115	113	164	24	80.7	59.6
07.10.2022	REF	117	112	169	25	80.7	59.8
08.10.2022	REF	114	113	140	21	80.2	58.5
09.10.2022	REF	121	111	140	21	79.5	58.2
10.10.2022	REF	114	112	161	24	80.0	59.0
11.10.2022	REF	116	112	161	24	80.6	59.5
12.10.2022	REF	112	111	165	24	80.1	59.1
13.10.2022	REF	117	112	161	24	80.6	59.5
14.10.2022	REF	112	111	169	25	80.2	59.2
15.10.2022	REF	89	101	143	21	78.9	56.9
16.10.2022	REF	83	97	144	21	78.2	56.3
17.10.2022	REF	109	111	165	24	79.9	58.9
18.10.2022	REF	114	110	160	23	81.3	60.2
19.10.2022	REF	118	112	161	24	81.2	60.2
20.10.2022	REF	116	112	158	23	80.6	59.4
21.10.2022	REF	117	113	166	24	80.7	59.8
22.10.2022	REF	112	113	140	20	79.8	58.0
23.10.2022	REF	119	111	137	20	79.7	58.1
24.10.2022	REF	119	110	158	23	80.2	59.2
25.10.2022	REF	119	111	160	23	80.2	59.3
26.10.2022	REF	116	109	164	24	80.4	59.5
27.10.2022	REF	110	113	155	23	80.3	58.9
28.10.2022	REF	115	112	165	24	80.6	59.5
29.10.2022	REF	112	112	139	20	80.0	58.3
30.10.2022	REF	115	109	138	20	80.0	58.5
31.10.2022	REF	112	112	159	23	80.5	59.3
month	REF	3514	111.0	155.2	22.8	80.3	59.0

Daytime averages (24h) for all freight train passages at reference section (REF)



date	location	freight train count	average speed	average length	average axle count	average LAeq,Tp	average soundlevel
01.10.2022	REF	0					
02.10.2022	REF	0					
03.10.2022	REF	5	79	242	50	87.8	56.0
04.10.2022	REF	7	87	210	47	86.8	54.7
05.10.2022	REF	5	90	184	35	87.1	53.6
06.10.2022	REF	9	85	225	51	86.1	56.3
07.10.2022	REF	5	68	226	49	83.2	51.6
08.10.2022	REF	0					
09.10.2022	REF	0					
10.10.2022	REF	5	84	223	48	87.4	55.2
11.10.2022	REF	6	80	234	53	84.1	53.1
12.10.2022	REF	5	97	219	44	86.9	53.9
13.10.2022	REF	5	89	247	56	86.2	54.0
14.10.2022	REF	7	78	212	48	83.9	53.9
15.10.2022	REF	0					
16.10.2022	REF	0					
17.10.2022	REF	5	78	212	41	85.4	53.0
18.10.2022	REF	8	95	221	50	86.9	55.6
19.10.2022	REF	7	80	216	49	84.9	54.1
20.10.2022	REF	6	92	193	38	88.3	55.5
21.10.2022	REF	6	76	195	44	84.0	52.3
22.10.2022	REF	0					
23.10.2022	REF	0					
24.10.2022	REF	4	90	232	52	87.8	54.5
25.10.2022	REF	6	92	193	43	88.9	56.3
26.10.2022	REF	5	92	195	37	87.6	53.3
27.10.2022	REF	7	94	197	44	88.9	56.3
28.10.2022	REF	6	89	223	48	87.7	56.2
29.10.2022	REF	1	81	96	21	88.5	45.4
30.10.2022	REF	0					
31.10.2022	REF	4	99	179	33	89.8	54.6
month	REF	124	86.1	212.8	45.9	86.7	53.0

3. Weather data



Appendix: measurement quantities

Transit Exposure Level *TEL*

A-weighted sound pressure level of a single train pass-by as energetic average over the entire exposure duration T and averaged over the pass-by duration T_p .

$$TEL = 10 \log \left(\frac{1}{T_p} \int_0^T \frac{p_A^2(t)}{p_0^2} dt \right) \quad (1)$$

Where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p_0 = 20 \mu Pa$ (reference pressure), [Pa]

$T_p = T_2 - T_1$ = pass-by duration of the train, time interval during which a train is within the measurement cross-section and which starts with the entry time T_1 into the measurement cross-section and ends with the exit time T_2 , [s]

T = time interval which starts when the smoothed sound pressure level (sound pressure level smoothed as a function of time with the frequency weighting A and a time weighting F („fast“) or averaging over a duration period of time, e.g. 100 ms) is for the last time 10 dB below that prevailing at the time of entering the measurement cross-section and which ends when the smoothed sound pressure level is for the first time 10 dB below the one at the time of leaving the measurement cross-section. [s]

A-weighted equivalent sound pressure level of the train pass-by $L_{Aeq,Tp}$

The A-weighted equivalent sound pressure level equals the (energetic) average of the sound pressure level over the train pass-by time T_p according to the following equation:

$$L_{Aeq,Tp} = 10 \log \left(\frac{1}{T_p} \int_{T_1}^{T_2} \frac{p_A^2(t)}{p_0^2} dt \right) \quad (2)$$

where

$p_A(t)$ = the A-weighted sound pressure, [Pa]

$p_0 = 20 \mu Pa$ (reference sound pressure), [Pa]

$T_p = T_2 - T_1$ = pass-by duration of the train, [s]

Sound Exposure Level *SEL*

The sound exposure level *SEL* references the acoustic energy of the entire pass-by event to one second. The SEL is used in calculating average sound level contributions from trains over longer periods of time (i.e. days/months/year). The SEL is related to the transit exposure level TEL through:

$$SEL = TEL - 10 \log (T_0 / T_p) \quad (3)$$

where

$T_0 = 1$ [s]

T_p = pass-by duration of the train, [s]

Average sound level (period)

Average (energetic) A-weighted sound pressure level measured over a given period of time.

For the average sound level contributions from train pass-byes this equals the sum (energetic) of all sound exposure levels during the period for a given measurement position:

$$\text{average soundlevel} = 10 \cdot \log_{10} \left(\sum 10^{\frac{SEL}{10}} \right) - A1 \quad (4)$$

where

$A1 = 10 \cdot \log_{10}(n \cdot 24 \cdot 3600)$ for a 24-hour period

SEL (see equation 3) taken from measurement data

n = number of days being averaged over

Average $L_{Aeq,Tp}$

Average (energetic) sound level of all the A-weighted sound pressure levels from the individual equivalent sound level of all train pass-byes in a given period of time (day/month/year).

Calculated per train category and per period day/night, month, year, etc. and per measurement location:

$$\text{average } L_{Aeq,Tp} = 10 \cdot \log_{10} \left(\sum T_p \cdot 10^{\frac{L_{Aeq,Tp}}{10}} \right) + 10 \cdot \log_{10} \left(\frac{1}{\sum T_p} \right) \quad (5)$$

where

T_p = pass-by duration of the train [s]

$L_{Aeq,Tp}$ (see equation 2) is calculated directly from the measurement data