

Monthly report

Railway Field Laboratory

May 2023

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: V2
Data basis: Database V3

Date: 26.2.2024

1. Status railway field laboratory

Construction work on the tracks:

- none

Downtimes of the measurement systems:

- Stations have been out of operation due to track tamping from 24.3.2023 0:00 until 5.5.2023 24:00.

Downtimes of the sensors:

- REF: a-ref-1-s from 05.05. to 18.05.
- MQ1_3: a-mq13-2-rf from 05.05 to 18.05.

Maintenance and sensor exchange:

- Strain gauge sensor position on non-instrumented rail in measured track shifted by 60 cm for a larger distance and further redundancy in determining the train speed
- all sensors checked after re-installation
- sensor replacement:
 - a-ref-1-s am 18.05. (due to a defect)
 - a-mq13-2-rf am 18.05. (due to a defect)
 - a-mq22-2-rh am 5.5. (due to malfunctions)

Modifications to the data, database, or analysis:

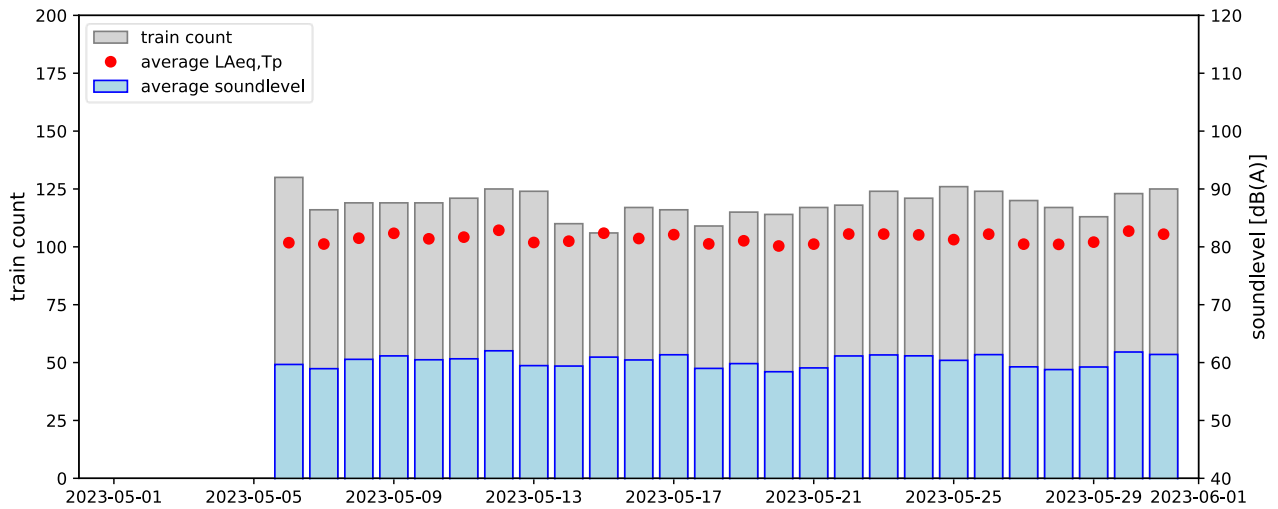
- Strain gauge digitisation (resolution) in h5 measurement files changed from 8bit to 16bit

Monthly data volume collected:

- 443 GB

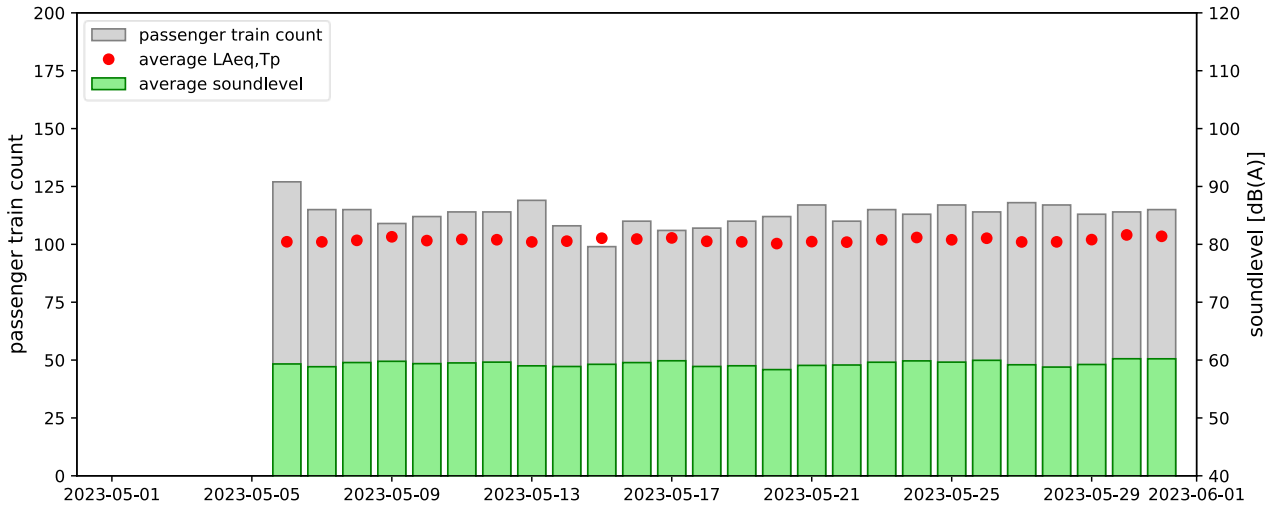
2. Measurement data

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



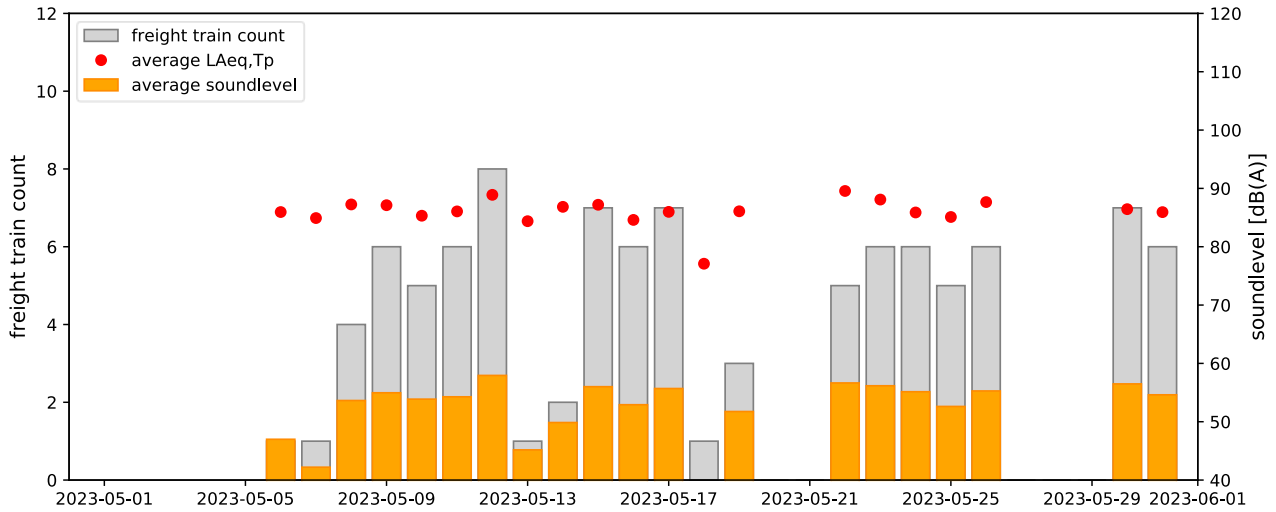
date	location	train count	passenger train count	freight train count	service train count	average LAeq,Tp	average soundlevel
01.05.2023	REF						
02.05.2023	REF						
03.05.2023	REF						
04.05.2023	REF						
05.05.2023	REF						
06.05.2023	REF	130	127	1	2	80,7	59,7
07.05.2023	REF	116	115	1	0	80,5	58,9
08.05.2023	REF	119	115	4	0	81,5	60,6
09.05.2023	REF	119	109	6	4	82,3	61,2
10.05.2023	REF	119	112	5	2	81,4	60,5
11.05.2023	REF	121	114	6	1	81,7	60,7
12.05.2023	REF	125	114	8	3	82,9	62
13.05.2023	REF	124	119	1	4	80,8	59,5
14.05.2023	REF	110	108	2	0	81	59,4
15.05.2023	REF	106	99	7	0	82,4	60,9
16.05.2023	REF	117	110	6	1	81,4	60,5
17.05.2023	REF	116	106	7	3	82,1	61,4
18.05.2023	REF	109	107	1	1	80,5	59
19.05.2023	REF	115	110	3	2	81	59,8
20.05.2023	REF	114	112	0	2	80,1	58,4
21.05.2023	REF	117	117	0	0	80,5	59,1
22.05.2023	REF	118	110	5	3	82,2	61,1
23.05.2023	REF	124	115	6	3	82,2	61,3
24.05.2023	REF	121	113	6	2	82,1	61,2
25.05.2023	REF	126	117	5	4	81,2	60,4
26.05.2023	REF	124	114	6	4	82,2	61,4
27.05.2023	REF	120	118	0	2	80,5	59,3
28.05.2023	REF	117	117	0	0	80,4	58,8
29.05.2023	REF	113	113	0	0	80,8	59,2
30.05.2023	REF	123	114	7	2	82,7	61,8
31.05.2023	REF	125	115	6	4	82,2	61,4
month	REF	3088	2940	99	49	81,6	60,4

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



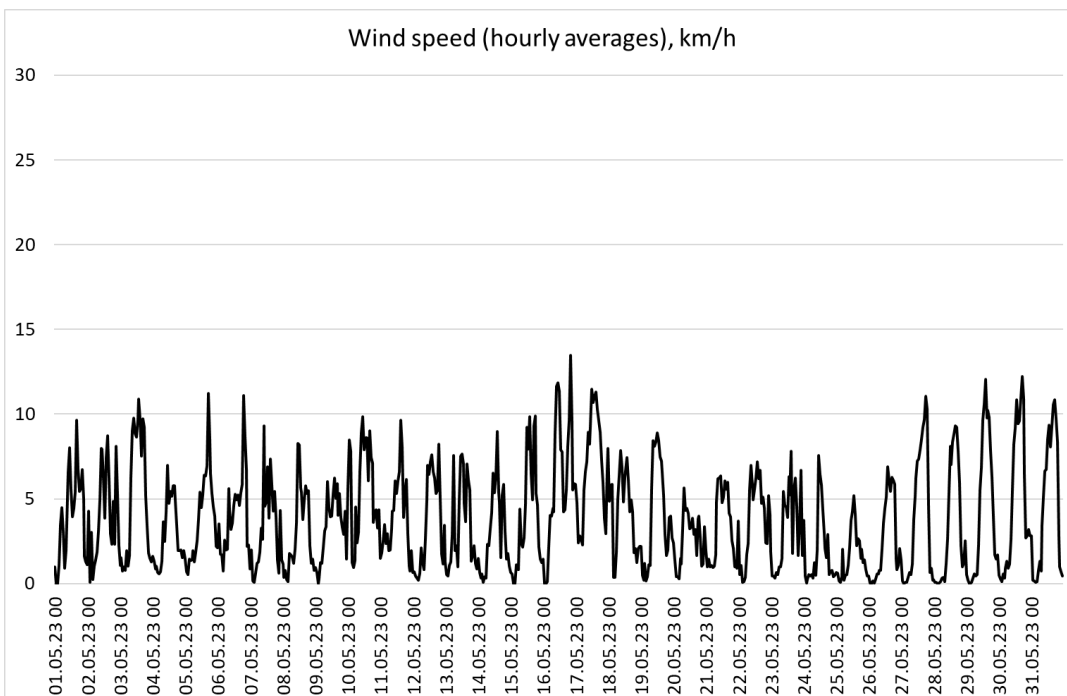
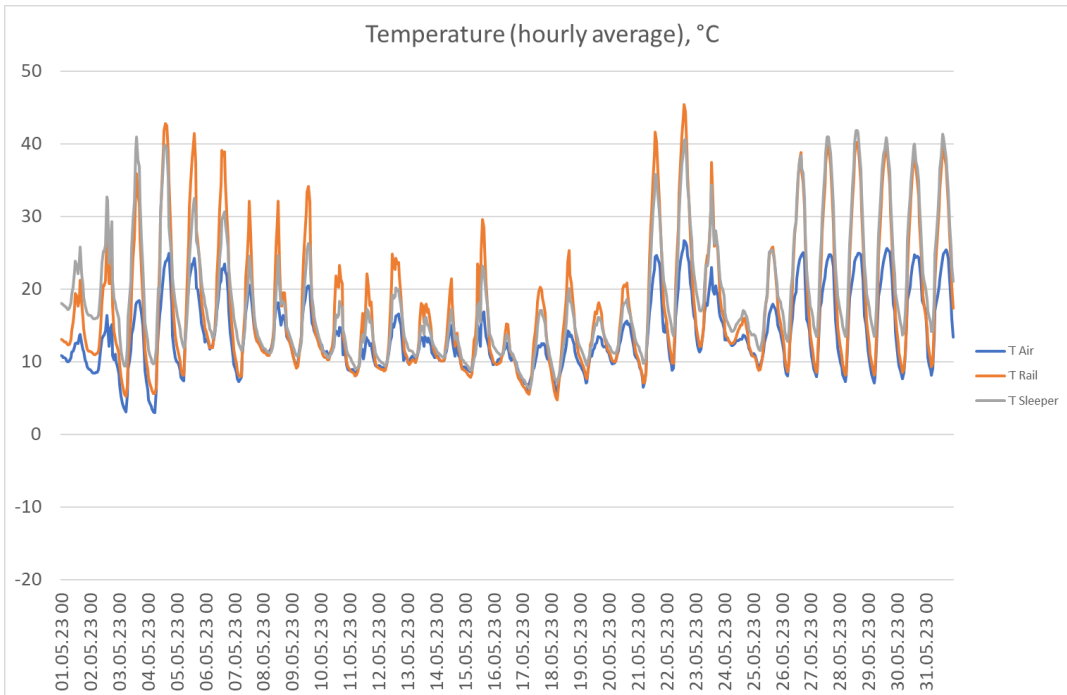
date	location	freight train count	average speed	average length	average axle count	average LAeqTp	average soundlevel
01.05.2023	REF						
02.05.2023	REF						
03.05.2023	REF						
04.05.2023	REF						
05.05.2023	REF						
06.05.2023	REF	127	108,2	137,5	19,9	80,4	59,3
07.05.2023	REF	115	110,9	144	21,1	80,4	58,9
08.05.2023	REF	115	111,7	163,2	23,6	80,7	59,6
09.05.2023	REF	109	113,3	161,2	23,5	81,3	59,8
10.05.2023	REF	112	111,5	160	23,2	80,6	59,4
11.05.2023	REF	114	112,4	156,6	22,8	80,8	59,5
12.05.2023	REF	114	112,2	165,1	24	80,8	59,6
13.05.2023	REF	119	111,8	146,5	21,3	80,4	59
14.05.2023	REF	108	112,3	151,2	21,9	80,6	58,9
15.05.2023	REF	99	113,9	166,1	24,2	81,1	59,3
16.05.2023	REF	110	113,8	164,7	24,1	80,9	59,6
17.05.2023	REF	106	112,4	175,8	25,8	81,1	59,9
18.05.2023	REF	107	112,1	153,3	22,5	80,5	58,9
19.05.2023	REF	110	111,4	158	22,9	80,4	59
20.05.2023	REF	112	113,6	144,8	21	80,1	58,4
21.05.2023	REF	117	113,3	151,3	22,1	80,5	59,1
22.05.2023	REF	110	113,8	165,1	24	80,4	59,1
23.05.2023	REF	115	112,2	162,5	23,7	80,8	59,6
24.05.2023	REF	113	113,5	162,3	23,6	81,2	59,9
25.05.2023	REF	117	111,9	159,1	23	80,8	59,6
26.05.2023	REF	114	113,1	168,8	24,6	81,1	60
27.05.2023	REF	118	112	152,4	22,2	80,4	59,2
28.05.2023	REF	117	112,1	140,5	20,4	80,4	58,8
29.05.2023	REF	113	111,2	145,6	21,4	80,8	59,2
30.05.2023	REF	114	113,5	158,6	23	81,6	60,2
31.05.2023	REF	115	112,1	163,2	23,8	81,4	60,2
month	REF	2940	112,3	156,6	22,8	80,8	59,4

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 LAeqTp	average soundlevel
01.05.2023	REF						
02.05.2023	REF						
03.05.2023	REF						
04.05.2023	REF						
05.05.2023	REF						
06.05.2023	REF	1	81,3	246,5	34	85,9	47
07.05.2023	REF	1	79,6	93	16	84,9	42,2
08.05.2023	REF	4	83,3	204,8	40	87,2	53,6
09.05.2023	REF	6	90	209,5	47,3	87,1	55
10.05.2023	REF	5	78,2	233,9	48,4	85,3	53,9
11.05.2023	REF	6	82,3	211	48,7	86,1	54,3
12.05.2023	REF	8	88,7	217,7	43,3	88,9	57,9
13.05.2023	REF	1	75,8	209,4	56	84,4	45,2
14.05.2023	REF	2	89,4	208,7	56	86,8	49,9
15.05.2023	REF	7	84,1	221,6	46,3	87,2	56
16.05.2023	REF	6	77,5	204,7	42,3	84,6	52,9
17.05.2023	REF	7	84,9	252	52,3	86	55,7
18.05.2023	REF	1	34,2	112,5	27	77,1	38,8
19.05.2023	REF	3	87,1	243,9	51,7	86,1	51,7
20.05.2023	REF	0					0
21.05.2023	REF	0					0
22.05.2023	REF	5	92,5	224	49,6	89,6	56,6
23.05.2023	REF	6	92,2	220	53,7	88,1	56,2
24.05.2023	REF	6	75,2	243,1	53,7	85,9	55,1
25.05.2023	REF	5	86	221,8	54	85,1	52,6
26.05.2023	REF	6	98,4	221,9	46,3	87,7	55,3
27.05.2023	REF	0					0
28.05.2023	REF	0					0
29.05.2023	REF	0					0
30.05.2023	REF	7	80,1	268,2	64,3	86,4	56,5
31.05.2023	REF	6	85,5	244,8	51	85,9	54,6
month	REF	99	84,7	225,2	49,1	86,8	53,2

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

$$T_0 = 1 \text{ [s]}$$

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:

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

where

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

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:

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

where

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

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