

# Monthly report

## Railway Field Laboratory

January 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).

**Consultant:** Müller-BBM Rail Technologies GmbH  
Helmut-A.-Müller-Straße 1 - 5  
82152 Planegg  
[www.MuellerBBM-Rail.com](http://www.MuellerBBM-Rail.com)

**Author:** Natan Isert, Stefan Lutzenberger

**Supervision BAFU / BAV:** Franz Kuster, Fredy Fischer  
Robert Attinger, Christoph Dürig

**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:** V3  
Data basis: Database V3

**Date:** 26.2.2024

## 1. Status railway field laboratory

Construction work on the tracks:

- Track crossing on 30.01.2023 and 31.01.2023 between the sections MQ 2\_3 and the reference section resulting in track lowering. The measurement cross sections were not directly affected by this.

Downtimes of the measurement systems:

- Station MQ 1\_1 from 25.12.2022 to 17.1.2023
- Station MQ 1\_2 from 25.12.2022 to 17.1.2023
- Station MQ 1\_3 from 12.11.2022 to 17.1.2023
- Station MQ 2\_1 from 29.12.2022 to 17.1.2023
- Station MQ 2\_2 from 25.12.2022 to 17.1.2023
- Station MQ 2\_3 from 29.12.2022 to 17.1.2023

Downtimes of the sensors:

- downtimes of the weather data from 27.1.2023 to 17.2.2023

Maintenance and sensor exchange:

- none

Modifications to the data, database, or analysis:

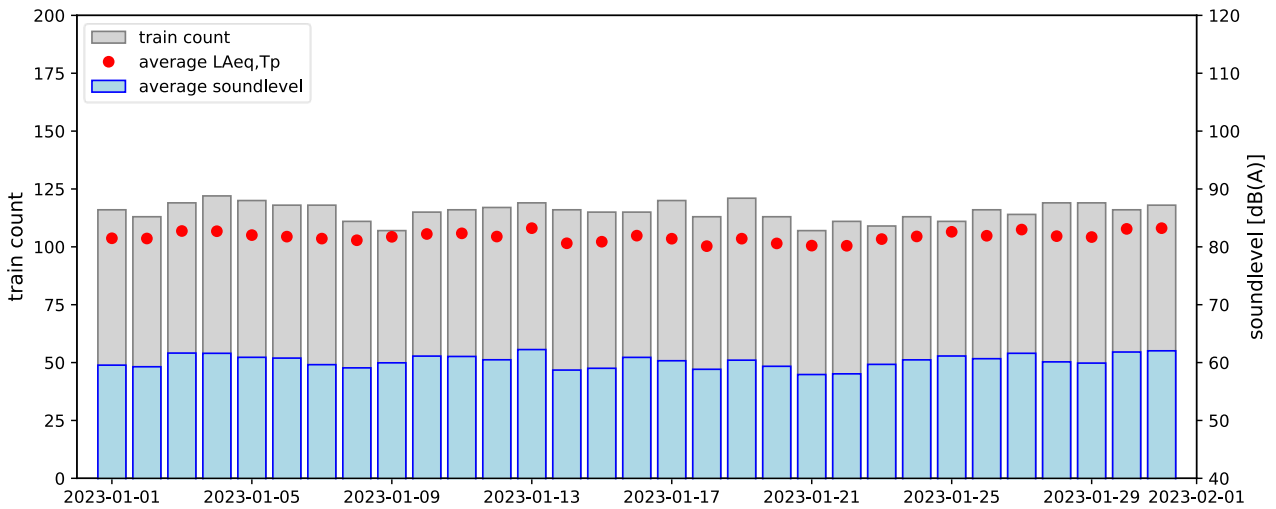
- Adjustment of the sample rate to  $f_s = 25$  kHz for all sensors from 20.1. 2023

Monthly data volume collected:

- 261 GB

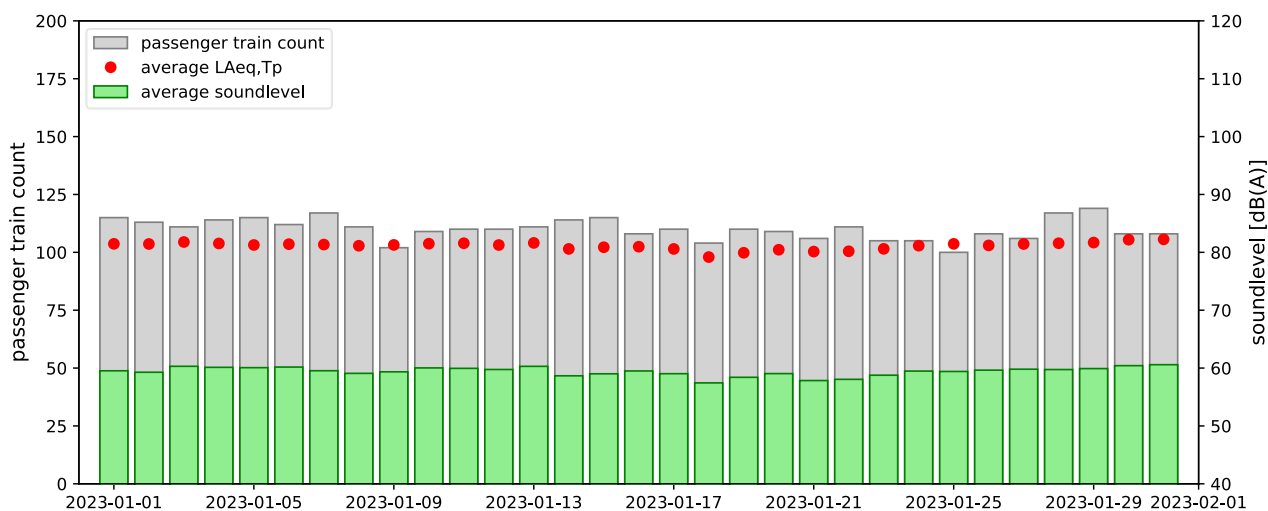
## 2. Measurement data

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



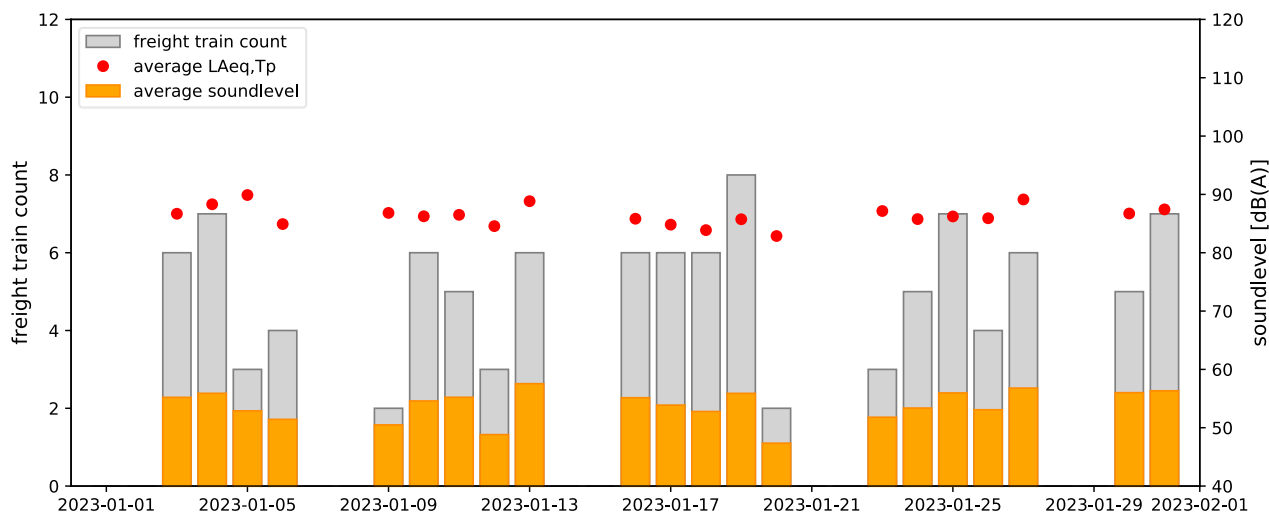
date	location	train count	passenger train count	freight train count	service train count	average LAeq,Tp	average soundlevel
01.01.2023	REF	116	115	0	1	81,5	59,6
02.01.2023	REF	113	113	0	0	81,4	59,3
03.01.2023	REF	119	111	6	2	82,7	61,6
04.01.2023	REF	122	114	7	1	82,7	61,6
05.01.2023	REF	120	115	3	2	82	60,9
06.01.2023	REF	118	112	4	2	81,8	60,8
07.01.2023	REF	118	117	0	1	81,4	59,6
08.01.2023	REF	111	111	0	0	81,1	59,1
09.01.2023	REF	107	102	2	3	81,7	60
10.01.2023	REF	115	109	6	0	82,2	61,1
11.01.2023	REF	116	110	5	1	82,3	61,1
12.01.2023	REF	117	110	3	4	81,8	60,5
13.01.2023	REF	119	111	6	2	83,2	62,2
14.01.2023	REF	116	114	0	2	80,6	58,7
15.01.2023	REF	115	115	0	0	80,9	59
16.01.2023	REF	115	108	6	1	81,9	60,9
17.01.2023	REF	120	110	6	4	81,4	60,3
18.01.2023	REF	113	104	6	3	80,1	58,8
19.01.2023	REF	121	110	8	3	81,4	60,4
20.01.2023	REF	113	109	2	2	80,6	59,4
21.01.2023	REF	107	106	0	1	80,2	57,9
22.01.2023	REF	111	111	0	0	80,2	58,1
23.01.2023	REF	109	105	3	1	81,3	59,7
24.01.2023	REF	113	105	5	3	81,8	60,5
25.01.2023	REF	111	100	7	4	82,6	61,1
26.01.2023	REF	116	108	4	4	81,9	60,7
27.01.2023	REF	114	106	6	2	83	61,6
28.01.2023	REF	119	117	0	2	81,8	60,1
29.01.2023	REF	119	119	0	0	81,7	59,9
30.01.2023	REF	116	108	5	3	83,1	61,8
31.01.2023	REF	118	108	7	3	83,2	62
<b>month</b>	<b>REF</b>	<b>3577</b>	<b>3413</b>	<b>107</b>	<b>57</b>	<b>81,9</b>	<b>60,4</b>

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



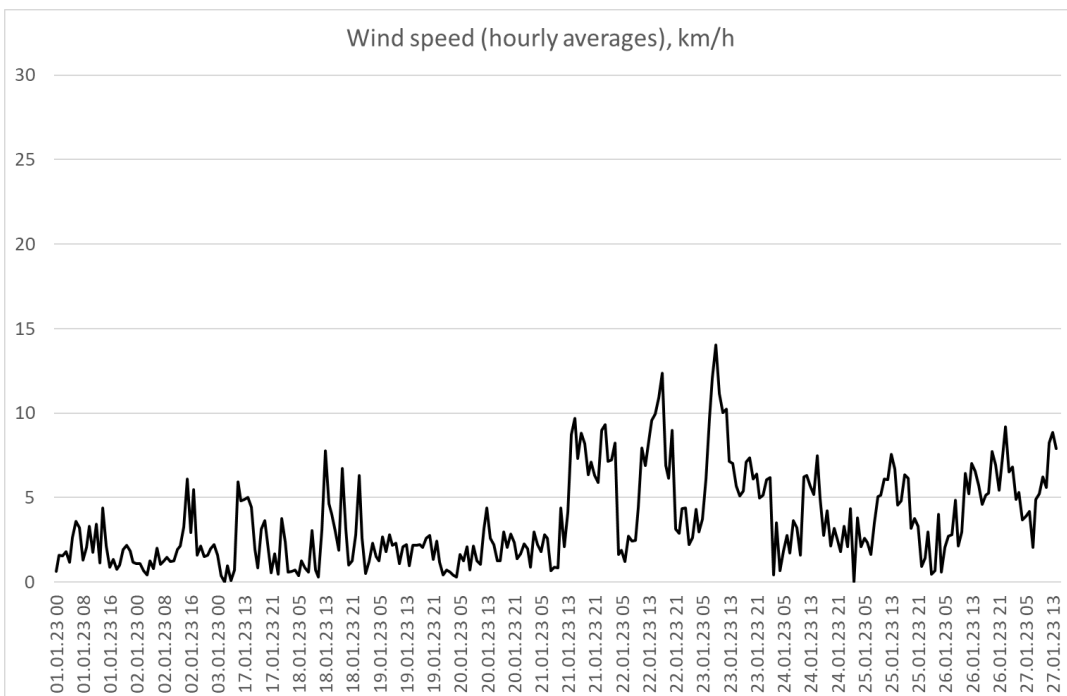
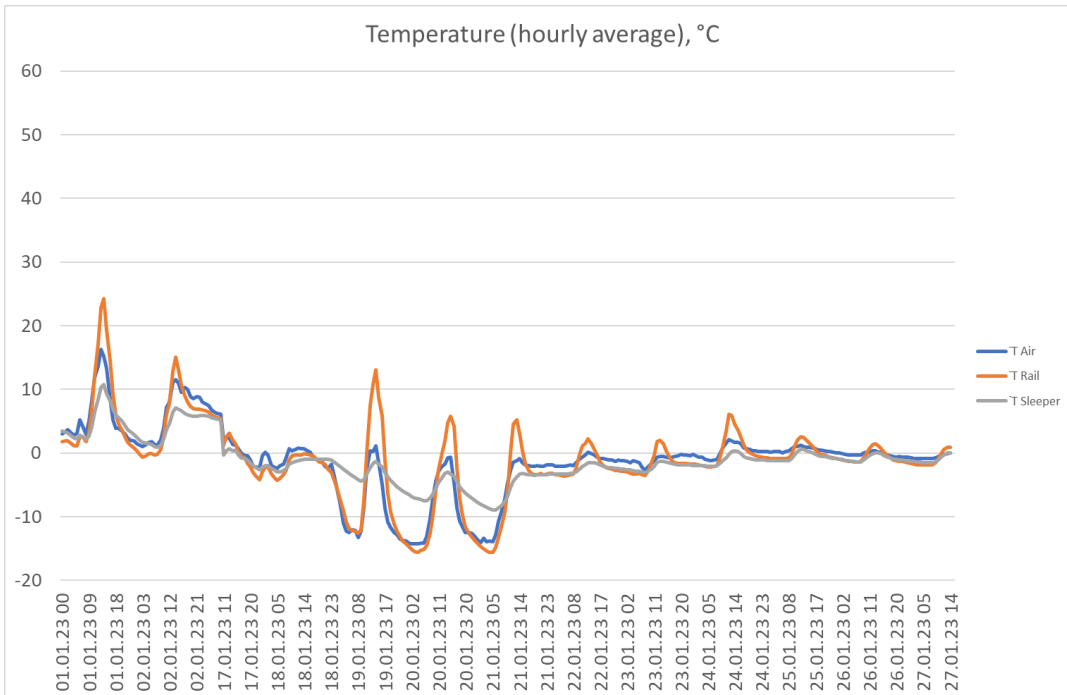
date	location	passenger train count	average speed	average length	average axlecount	average LAeqTp	average soundlevel
01.01.2023	REF	115	110,2	133,1	19,5	81,5	59,5
02.01.2023	REF	113	112,4	131,7	19,4	81,4	59,3
03.01.2023	REF	111	110,9	157,3	23,2	81,8	60,3
04.01.2023	REF	114	109,6	154,7	22,9	81,5	60,1
05.01.2023	REF	115	109,2	159,2	23,5	81,3	60,1
06.01.2023	REF	112	111	166,5	24,3	81,4	60,2
07.01.2023	REF	117	112,3	137,8	20,3	81,3	59,5
08.01.2023	REF	111	111	136	20,1	81,1	59,1
09.01.2023	REF	102	111,7	153,3	22,3	81,3	59,4
10.01.2023	REF	109	109,5	158,1	23,2	81,5	60
11.01.2023	REF	110	112,3	155,9	23	81,6	60
12.01.2023	REF	110	113	160,3	23,5	81,3	59,8
13.01.2023	REF	111	111,2	163,3	24	81,6	60,3
14.01.2023	REF	114	111,7	138,2	20,2	80,6	58,7
15.01.2023	REF	115	110,7	136,4	20	80,9	59
16.01.2023	REF	108	112,2	160,7	23,6	81	59,5
17.01.2023	REF	110	112,6	157,5	23,1	80,6	59
18.01.2023	REF	104	110,3	156,3	23	79,2	57,4
19.01.2023	REF	110	110	155,5	22,8	79,9	58,4
20.01.2023	REF	109	112,7	166,6	24,4	80,4	59
21.01.2023	REF	106	112,2	137	20	80,1	57,8
22.01.2023	REF	111	112,1	135,5	19,8	80,2	58,1
23.01.2023	REF	105	113,6	156,3	22,8	80,6	58,8
24.01.2023	REF	105	113,3	161,4	23,6	81,1	59,5
25.01.2023	REF	100	112,1	154,5	22,8	81,5	59,4
26.01.2023	REF	108	111,4	158,2	23,2	81,2	59,6
27.01.2023	REF	106	111,2	157,8	23,1	81,4	59,8
28.01.2023	REF	117	112,2	139,7	20,3	81,6	59,7
29.01.2023	REF	119	111,6	138,4	20,2	81,7	59,9
30.01.2023	REF	108	113,4	155	22,7	82,2	60,4
31.01.2023	REF	108	113,6	160,3	23,5	82,2	60,6
<b>month</b>	<b>REF</b>	<b>3413</b>	<b>111,6</b>	<b>151,2</b>	<b>22,2</b>	<b>81,2</b>	<b>59,5</b>

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
01.01.2023	REF	0					0
02.01.2023	REF	0					0
03.01.2023	REF	6	81,5	223,3	47,3	86,7	55,2
04.01.2023	REF	7	89,4	171,1	37,7	88,3	55,9
05.01.2023	REF	3	86,8	147,1	24,7	89,9	52,9
06.01.2023	REF	4	85,4	215,8	46	84,9	51,4
07.01.2023	REF	0					0
08.01.2023	REF	0					0
09.01.2023	REF	2	91,1	245,2	46	86,8	50,5
10.01.2023	REF	6	87,6	222,2	47,7	86,2	54,6
11.01.2023	REF	5	74,3	261,1	62	86,5	55,2
12.01.2023	REF	3	83,1	171,1	30	84,6	48,8
13.01.2023	REF	6	83,4	239,4	58,7	88,8	57,5
14.01.2023	REF	0					0
15.01.2023	REF	0					0
16.01.2023	REF	6	79	266,6	60,7	85,8	55,1
17.01.2023	REF	6	68,2	202,4	48,3	84,8	53,9
18.01.2023	REF	6	72,9	228,4	54,3	83,9	52,8
19.01.2023	REF	8	81,3	244	51,8	85,7	55,9
20.01.2023	REF	2	71,9	233,4	56	82,9	47,3
21.01.2023	REF	0					0
22.01.2023	REF	0					0
23.01.2023	REF	3	87,6	208,2	42	87,2	51,8
24.01.2023	REF	5	87,2	225,4	56,4	85,8	53,4
25.01.2023	REF	7	80,8	245,1	59,7	86,2	56
26.01.2023	REF	4	80,2	252,6	58,5	85,9	53,1
27.01.2023	REF	6	83	206,1	51,7	89,1	56,8
28.01.2023	REF	0					0
29.01.2023	REF	0					0
30.01.2023	REF	5	84,8	332,8	78,8	86,7	56
31.01.2023	REF	7	88,6	220,7	54	87,4	56,3
<b>month</b>	<b>REF</b>	<b>107</b>	<b>82,2</b>	<b>228,2</b>	<b>52,1</b>	<b>86,6</b>	<b>52,8</b>

### 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

$A1 = 10 \cdot \log_{10}(n \cdot 24 \cdot 3600)$  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