

Monthly report

Railway Field Laboratory

September 2024

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
Data basis: Database V3

Date: 17.12.2024

1. Status railway field laboratory

Construction work on the tracks:

- none

Downtimes of the measurement systems:

- Failure of a measurement card at measurement cross-section MQ 1_1 from 1.9. - 17.09. presumably due to lightning strike:
Affected sensors:
a-mq11-1-s,
a-mq11-2-rf, a-mq11-2-rh, a-mq11-2-rw
a-mq11-3-s,
a-mq11-3-ux, p-mq11-g1, p-mq11-g2
- Failure of two measuring cards at measuring cross-section MQ 1_2 from 1.9. - 17.09 presumably due to lightning strike:
Affected sensors:
a-mq12-1-s,
a-mq12-2-rf, a-mq12-2-rh, a-mq12-2-rw
a-mq12-3-lx, a-mq12-3-ly, a-mq12-3-lz,
a-mq12-3-s,
a-mq12-3-ux, a-mq12-3-uy, a-mq12-3-uz,
a-mq12-4-rf, a-mq12-4-rh, a-mq12-4-rw
p-mq12-g1, p-mq12-g2
- MQ 2_1: a-mq12-5-lx/y/z and a-mq12-5-ux/y/z (as of 11.9. cable probably cut during mowing work)

Downtimes of the sensors:

- - MQ 1_1: a-mq11-2-rw (1.9. - until 17.9.2024 presumably due to lightning strike)
- - MQ 1_2: a-mq12-2-rw (1.9. - until 17.9.2024 presumably due to lightning strike)
- - MQ 1_2: a-mq12-4-rf (1.9. - until 17.9.2024 presumably due to lightning strike)

Maintenance and sensor exchange:

- Replacement of the defective measuring card at measuring cross-section MQ 1_1 on 17.09.2024
- Replacement of the two defective measuring cards at measuring cross-section MQ 1_2 on 17.09.2024
- Replacement of the sensor on MQ 1_1: a-mq11-2-rw on 17.09.2024
- Replacement of the sensor on MQ 1_2: a-mq12-2-rw on 17.9.2024
- Replacement of the sensor on MQ 1_2: a-mq12-4-rf on 17.0.2024

Modifications to the data, database, or analysis:

- none

Monthly data volume collected:

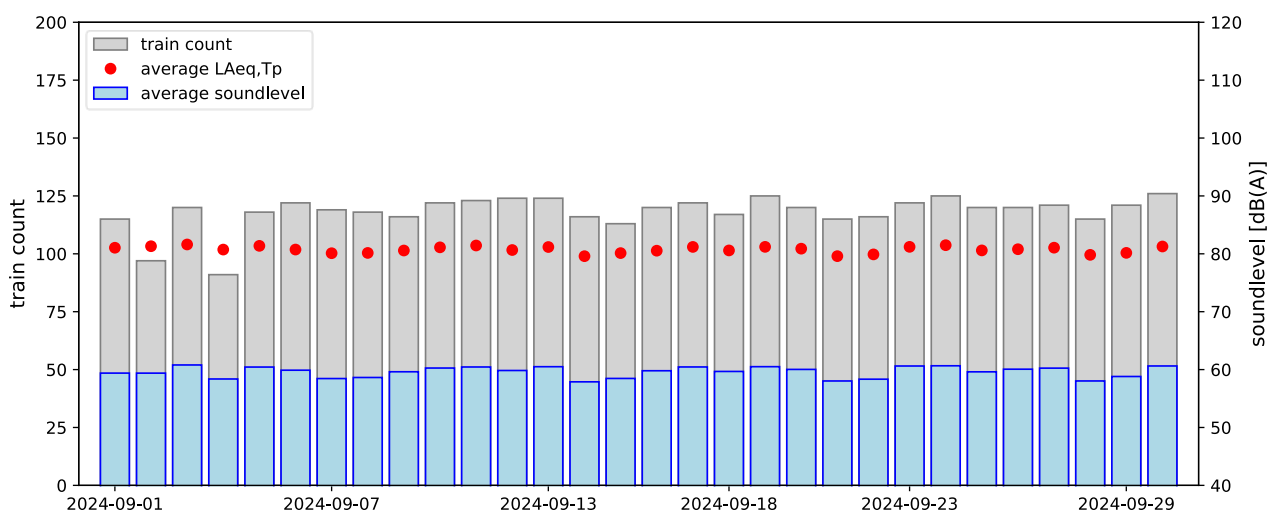
- 808 GB

Other

- MQ 1_2: v-mq12: Coordinate directions x and y swapped between 27. and 13.11.2024
- MQ 2_2: v-mq22: Coordinate directions x and y swapped between 6.12.2023 and 13.11.2024

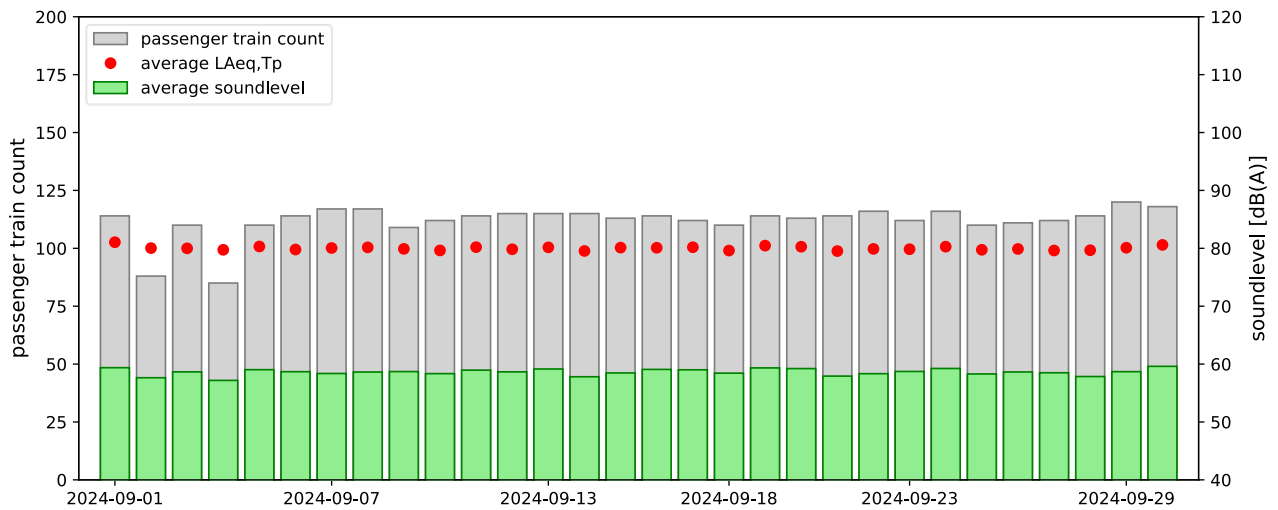
2. Measurement data

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



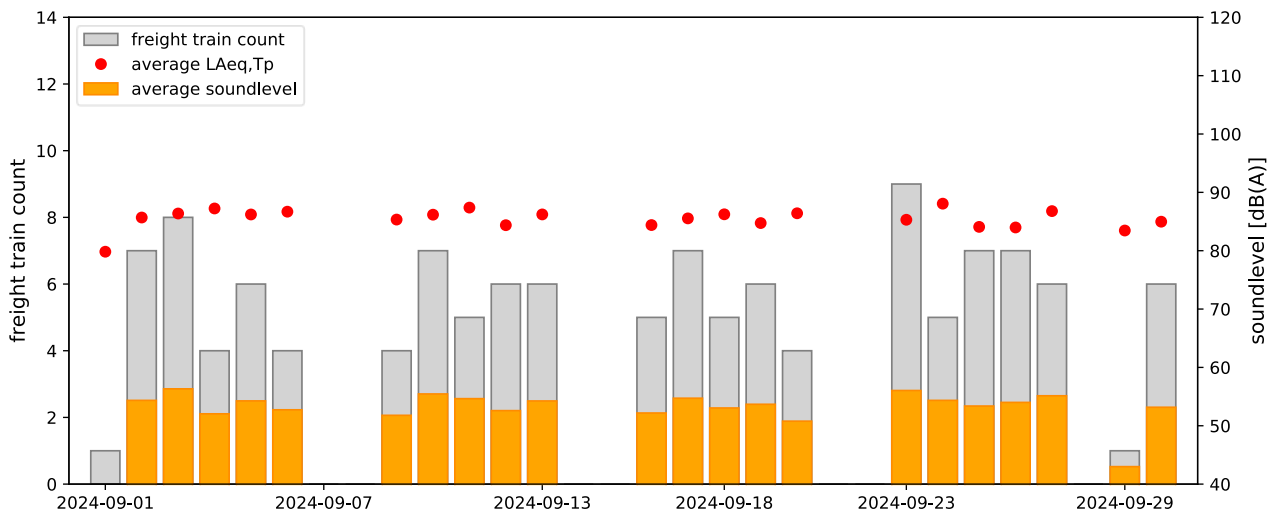
date	location	train count	passenger train count	freight train count	service train count	average LAeqTp	average soundlevel
01.09.2024	REF	115	114	1	0	81,0	59,4
02.09.2024	REF	97	88	7	2	81,3	59,4
03.09.2024	REF	120	110	8	2	81,6	60,8
04.09.2024	REF	91	85	4	2	80,7	58,4
05.09.2024	REF	118	110	6	2	81,4	60,4
06.09.2024	REF	122	114	4	4	80,7	59,9
07.09.2024	REF	119	117	0	2	80,1	58,5
08.09.2024	REF	118	117	0	1	80,2	58,6
09.09.2024	REF	116	109	4	3	80,6	59,6
10.09.2024	REF	122	112	7	3	81,1	60,3
11.09.2024	REF	123	114	5	4	81,4	60,4
12.09.2024	REF	124	115	6	3	80,7	59,8
13.09.2024	REF	124	115	6	3	81,2	60,5
14.09.2024	REF	116	115	0	1	79,6	57,9
15.09.2024	REF	113	113	0	0	80,1	58,5
16.09.2024	REF	120	114	5	1	80,5	59,8
17.09.2024	REF	122	112	7	3	81,2	60,5
18.09.2024	REF	117	110	5	2	80,6	59,7
19.09.2024	REF	125	114	6	5	81,2	60,5
20.09.2024	REF	120	113	4	3	80,9	60,0
21.09.2024	REF	115	114	0	1	79,6	58,0
22.09.2024	REF	116	116	0	0	79,9	58,3
23.09.2024	REF	122	112	9	1	81,2	60,6
24.09.2024	REF	125	116	5	4	81,5	60,7
25.09.2024	REF	120	110	7	3	80,6	59,6
26.09.2024	REF	120	111	7	2	80,8	60,1
27.09.2024	REF	121	112	6	3	81,1	60,3
28.09.2024	REF	115	114	0	1	79,8	58,0
29.09.2024	REF	121	120	1	0	80,2	58,8
30.09.2024	REF	126	118	6	2	81,3	60,6
month	REF	3543	3354	126	63	80,8	59,7

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



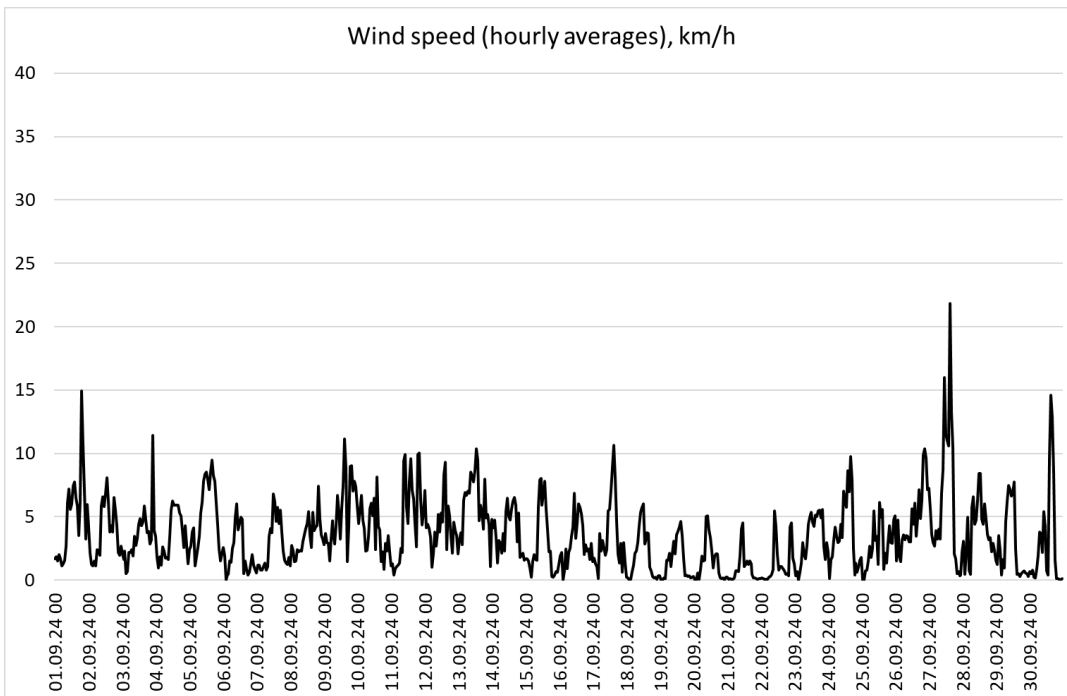
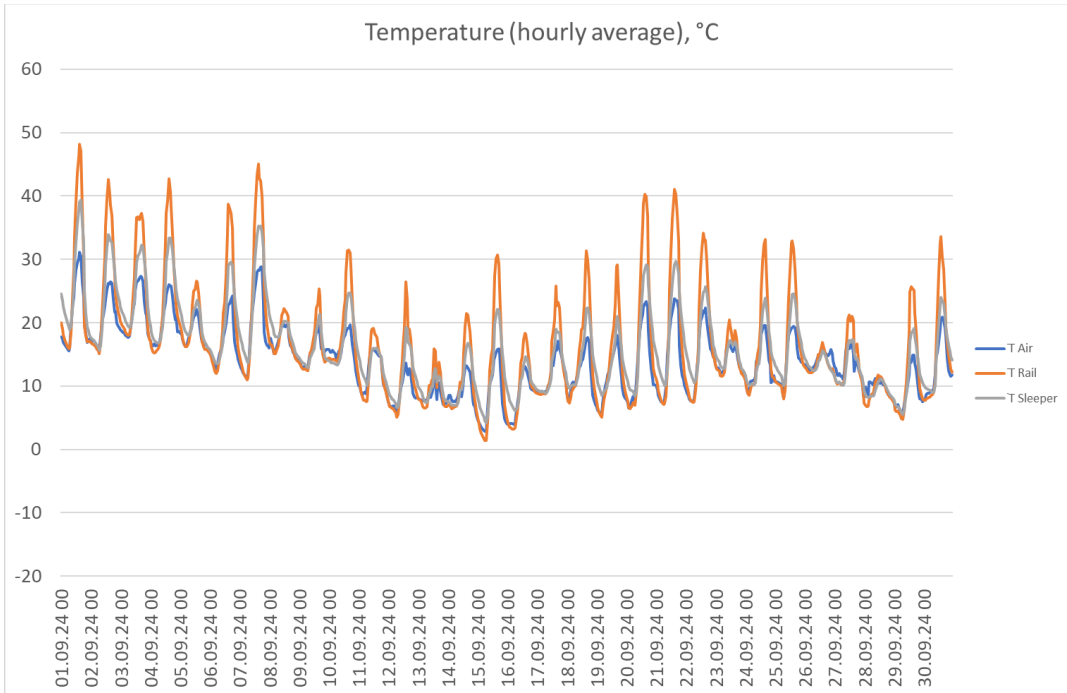
date	location	passenger train count	average speed	average length	average axlecount	average LAeqTp	average soundlevel
01.09.2024	REF	114	113,9	148,0	21,5	81,1	59,4
02.09.2024	REF	88	113,8	162,6	23,9	80,0	57,6
03.09.2024	REF	110	113,9	168,7	24,8	80,0	58,7
04.09.2024	REF	85	112,8	163,6	24,1	79,7	57,2
05.09.2024	REF	110	113,6	168,9	25,1	80,3	59,0
06.09.2024	REF	114	114,1	171,8	25,3	79,8	58,7
07.09.2024	REF	117	114,7	144,1	21,3	80,1	58,4
08.09.2024	REF	117	113,6	147,0	21,7	80,2	58,6
09.09.2024	REF	109	113,9	173,0	25,4	79,9	58,7
10.09.2024	REF	112	112,2	163,9	24,1	79,6	58,4
11.09.2024	REF	114	111,7	160,9	23,6	80,2	59,0
12.09.2024	REF	115	113,9	163,7	24,2	79,8	58,7
13.09.2024	REF	115	113,5	172,3	25,5	80,2	59,2
14.09.2024	REF	115	113,3	139,8	20,7	79,5	57,8
15.09.2024	REF	113	114,0	149,6	22,1	80,1	58,5
16.09.2024	REF	114	113,5	170,6	25,2	80,1	59,1
17.09.2024	REF	112	113,6	169,7	25,2	80,2	59,0
18.09.2024	REF	110	112,4	168,8	25,0	79,6	58,4
19.09.2024	REF	114	113,5	168,1	24,9	80,5	59,3
20.09.2024	REF	113	113,8	170,6	25,4	80,3	59,2
21.09.2024	REF	114	113,3	144,6	21,4	79,5	57,9
22.09.2024	REF	116	113,4	145,9	21,5	79,9	58,3
23.09.2024	REF	112	113,8	171,2	25,3	79,8	58,7
24.09.2024	REF	116	113,8	167,8	24,8	80,3	59,2
25.09.2024	REF	110	113,6	162,8	24,1	79,7	58,3
26.09.2024	REF	111	112,7	163,7	24,2	79,9	58,6
27.09.2024	REF	112	114,1	169,8	25,2	79,6	58,5
28.09.2024	REF	114	115,8	141,5	20,9	79,7	57,8
29.09.2024	REF	120	112,2	146,7	21,7	80,1	58,7
30.09.2024	REF	118	114,1	168,9	24,9	80,6	59,6
month	REF	3354	113,6	160,8	23,7	80,0	58,7

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
01.09.2024	REF	1	78,9	47,5	8,0	79,8	34,7
02.09.2024	REF	7	89,6	214,7	44,0	85,7	54,3
03.09.2024	REF	8	89,2	241,4	52,5	86,4	56,3
04.09.2024	REF	4	100,7	178,1	27,5	87,2	52,0
05.09.2024	REF	6	93,1	225,6	42,7	86,2	54,3
06.09.2024	REF	4	95,8	211,7	46,5	86,7	52,7
07.09.2024	REF						
08.09.2024	REF						
09.09.2024	REF	4	90,7	227,1	48,0	85,3	51,8
10.09.2024	REF	7	89,0	244,1	55,7	86,2	55,5
11.09.2024	REF	5	90,2	218,6	44,0	87,4	54,6
12.09.2024	REF	6	87,9	222,0	49,0	84,4	52,6
13.09.2024	REF	6	91,6	217,8	47,7	86,2	54,3
14.09.2024	REF						
15.09.2024	REF						
16.09.2024	REF	5	84,5	222,1	49,0	84,4	52,2
17.09.2024	REF	7	93,3	243,1	54,6	85,5	54,7
18.09.2024	REF	5	93,6	200,3	38,8	86,2	53,0
19.09.2024	REF	6	89,9	270,4	60,0	84,7	53,7
20.09.2024	REF	4	96,1	147,2	22,5	86,4	50,8
21.09.2024	REF						
22.09.2024	REF						
23.09.2024	REF	9	85,7	255,0	56,0	85,3	56,0
24.09.2024	REF	5	91,0	179,5	31,6	88,1	54,3
25.09.2024	REF	7	83,4	232,7	45,1	84,1	53,4
26.09.2024	REF	7	81,2	260,1	58,9	84,0	54,0
27.09.2024	REF	6	94,6	242,9	54,7	86,8	55,1
28.09.2024	REF						
29.09.2024	REF	1	34,3	71,2	19,0	83,5	43,0
30.09.2024	REF	6	78,1	204,8	43,0	85,0	53,2
month	REF	126	88,9	223,6	47,1	85,7	52,5

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