

Monthly report

Railway Field Laboratory

August 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 REF: a-ref-3-bl-u-x (until 12.8.)
- MQ 1_3: a-mq13-3-bl-l-z (until 12.8.)
- MQ 1_2: a-mq12-5-bl-l-z (until 12.8.)
- MQ 1_2: a-mq12-5-bl-u-y (until 12.8.)
- MQ 1_2: v-mq12
- MQ 2_2: v-mq22

Maintenance and sensor exchange (10.-12.8.):

- MQ REF: a-ref-3-bl-u (due to defect)
- MQ 1_3: a-mq13-3-bl-l (due to defect)
- MQ 1_2: a-mq12-5-bl-l (due to defect)
- MQ 1_2: a-mq12-5-bl-u (due to defect))
- MQ 1_2: a-mq12-4-rh (due to temporary disturbances)
- MQ 2_3: a-mq12-2-rh (due to temporary disturbances)
- MQ 2_3: a-mq12-4-rh (due to temporary disturbances)

Modifications to the data, database, or analysis:

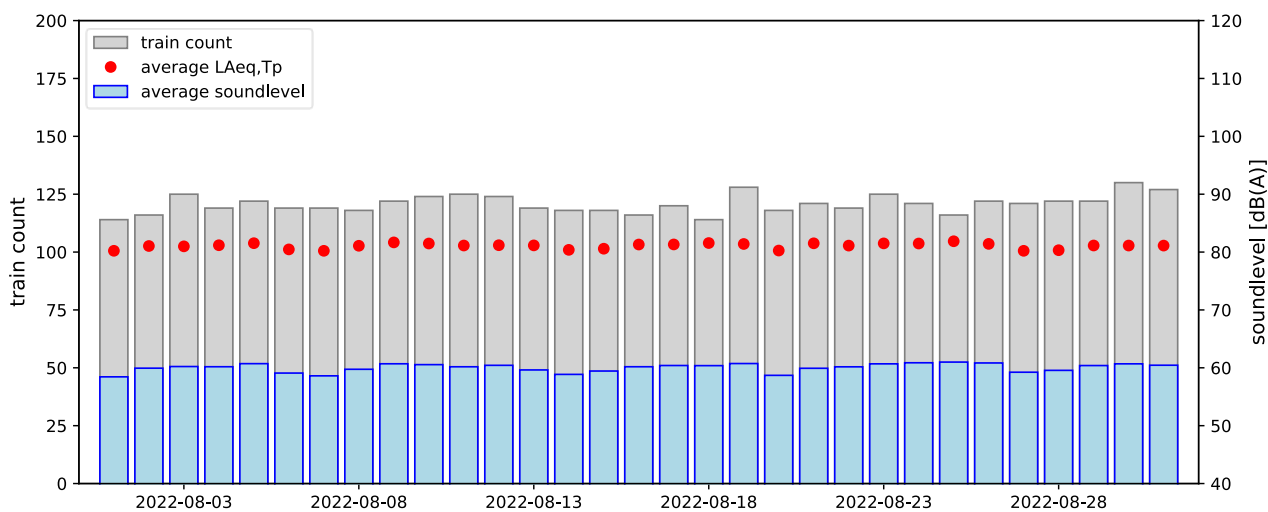
- Installation of an RFID reader and storage of the vehicle identifiers

Monthly data volume collected:

- 217 GB

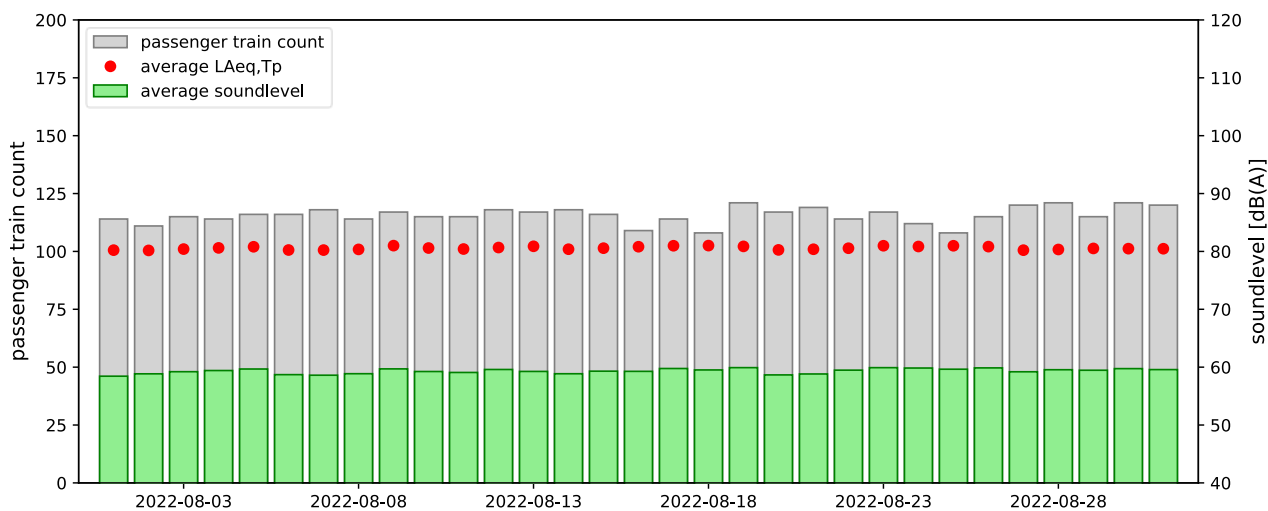
2. Measurement data

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



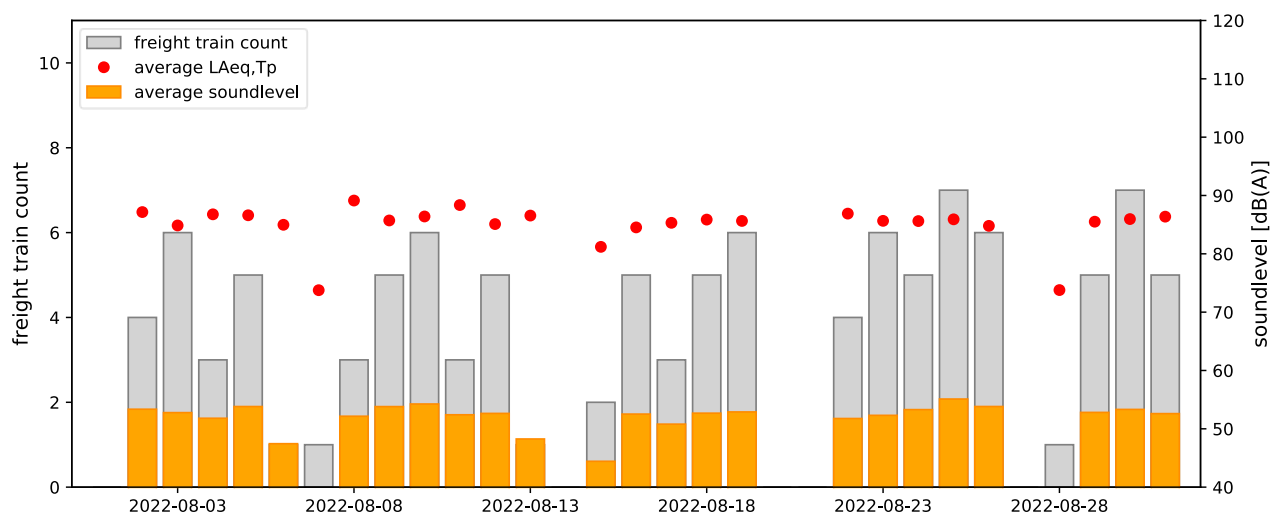
date	location	train count	passenger train count	freight train count	service train count	average LAeqTp	average soundlevel
01.08.2022	REF	114	114	0	0	80.2	58.4
02.08.2022	REF	116	111	4	1	81.0	59.9
03.08.2022	REF	125	115	6	1	81.0	60.2
04.08.2022	REF	119	114	3	1	81.2	60.2
05.08.2022	REF	122	116	5	0	81.5	60.7
06.08.2022	REF	119	117	1	0	80.5	59.1
07.08.2022	REF	119	118	1	0	80.2	58.6
08.08.2022	REF	118	114	3	0	81.1	59.7
09.08.2022	REF	122	117	5	0	81.7	60.7
10.08.2022	REF	124	115	6	1	81.5	60.5
11.08.2022	REF	125	115	3	0	81.1	60.2
12.08.2022	REF	124	118	5	0	81.2	60.4
13.08.2022	REF	119	117	1	0	81.2	59.6
14.08.2022	REF	118	118	0	0	80.4	58.9
15.08.2022	REF	118	116	2	0	80.6	59.4
16.08.2022	REF	116	109	5	0	81.3	60.2
17.08.2022	REF	120	115	3	0	81.3	60.4
18.08.2022	REF	114	108	5	0	81.6	60.4
19.08.2022	REF	128	121	6	0	81.4	60.7
20.08.2022	REF	118	117	0	0	80.3	58.7
21.08.2022	REF	121	119	0	0	81.5	59.9
22.08.2022	REF	119	114	4	1	81.1	60.2
23.08.2022	REF	125	117	7	1	81.5	60.7
24.08.2022	REF	121	112	5	1	81.5	60.9
25.08.2022	REF	116	108	7	0	81.9	61.0
26.08.2022	REF	122	115	6	1	81.4	60.8
27.08.2022	REF	121	120	0	0	80.2	59.2
28.08.2022	REF	122	121	1	0	80.3	59.6
29.08.2022	REF	122	115	5	0	81.1	60.4
30.08.2022	REF	130	121	7	1	81.1	60.7
31.08.2022	REF	127	120	5	1	81.1	60.4
month	REF	3744	3587	111	10	81.1	60.1

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



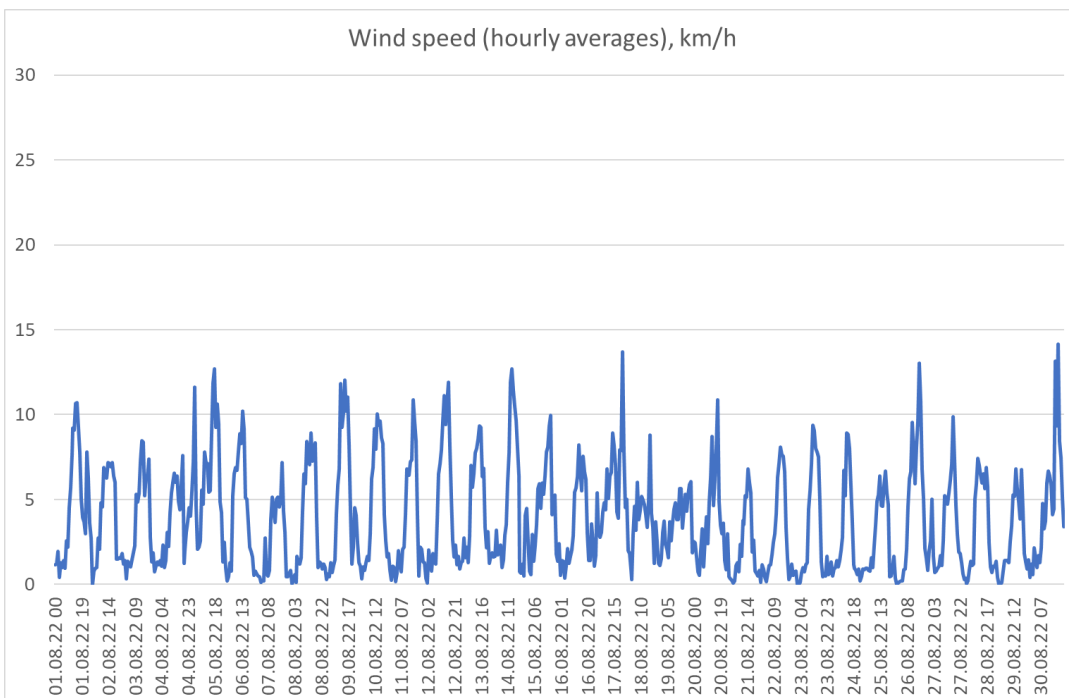
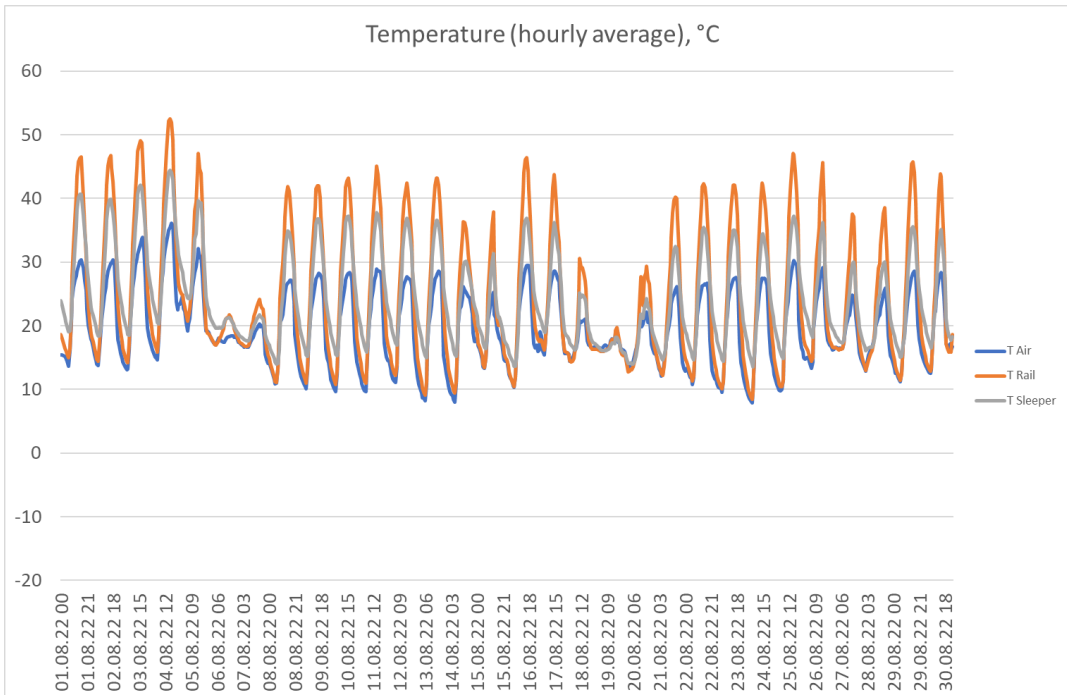
date	location	passenger train count	average speed	average length	average axlecount	average LAeqTp	average soundlevel
01.08.2022	REF	114	111	138	20	80.2	58.4
02.08.2022	REF	111	111	158	23	80.2	58.8
03.08.2022	REF	115	112	160	24	80.4	59.2
04.08.2022	REF	114	112	159	23	80.6	59.4
05.08.2022	REF	116	112	161	24	80.8	59.7
06.08.2022	REF	117	112	143	21	80.2	58.7
07.08.2022	REF	118	111	137	20	80.2	58.6
08.08.2022	REF	114	113	150	22	80.3	58.9
09.08.2022	REF	117	112	153	22	81.0	59.7
10.08.2022	REF	115	114	157	23	80.6	59.2
11.08.2022	REF	115	113	153	22	80.4	59.1
12.08.2022	REF	118	113	160	23	80.7	59.6
13.08.2022	REF	117	114	146	21	80.9	59.3
14.08.2022	REF	118	112	141	21	80.4	58.9
15.08.2022	REF	116	112	155	23	80.6	59.3
16.08.2022	REF	109	112	154	23	80.8	59.3
17.08.2022	REF	115	113	164	24	81.0	59.8
18.08.2022	REF	108	112	160	23	81.0	59.5
19.08.2022	REF	121	111	159	23	80.9	59.9
20.08.2022	REF	117	114	140	20	80.3	58.7
21.08.2022	REF	119	113	140	21	80.4	58.8
22.08.2022	REF	114	112	163	24	80.6	59.5
23.08.2022	REF	117	113	162	24	81.0	59.9
24.08.2022	REF	112	110	164	24	80.8	59.9
25.08.2022	REF	108	113	166	24	81.0	59.6
26.08.2022	REF	115	114	170	25	80.8	59.9
27.08.2022	REF	120	113	159	23	80.2	59.2
28.08.2022	REF	121	113	157	23	80.3	59.6
29.08.2022	REF	115	112	162	24	80.5	59.5
30.08.2022	REF	121	109	160	23	80.5	59.7
31.08.2022	REF	120	111	158	23	80.5	59.6
month	REF	3587	112.2	155.0	22.8	80.6	59.3

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
01.08.2022	REF	0					
02.08.2022	REF	4	90	194	38	87.2	53.4
03.08.2022	REF	6	86	187	41	84.9	52.8
04.08.2022	REF	3	97	231	45	86.8	51.8
05.08.2022	REF	5	96	216	48	86.6	53.8
06.08.2022	REF	1	95	365	88	85.0	47.4
07.08.2022	REF	1	79	52	8	73.8	28.3
08.08.2022	REF	3	105	153	22	89.1	52.2
09.08.2022	REF	5	85	215	48	85.7	53.8
10.08.2022	REF	6	95	209	42	86.4	54.3
11.08.2022	REF	3	92	165	25	88.4	52.4
12.08.2022	REF	5	86	203	46	85.1	52.6
13.08.2022	REF	1	100	352	84	86.6	48.3
14.08.2022	REF	0					
15.08.2022	REF	2	76	170	25	81.2	44.4
16.08.2022	REF	5	83	232	48	84.5	52.5
17.08.2022	REF	3	78	203	43	85.3	50.8
18.08.2022	REF	5	85	170	39	85.9	52.7
19.08.2022	REF	6	82	160	32	85.6	52.9
20.08.2022	REF	0					
21.08.2022	REF	0					
22.08.2022	REF	4	75	143	23	86.9	51.8
23.08.2022	REF	7	79	151	33	85.7	52.3
24.08.2022	REF	5	83	226	52	85.6	53.3
25.08.2022	REF	7	85	227	51	85.9	55.1
26.08.2022	REF	6	78	227	50	84.8	53.8
27.08.2022	REF	0					
28.08.2022	REF	1	80	52	8	73.8	28.4
29.08.2022	REF	5	82	213	42	85.5	52.8
30.08.2022	REF	7	94	162	32	86.0	53.3
31.08.2022	REF	5	91	174	30	86.4	52.6
month	REF	111	86.6	193.9	40.2	85.9	51.5

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

$T_0 = 1$ [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