Wash-off and sediment transport tests description

1. Experimental procedure

The experiments consist of measuring total suspended solids (TSS) and particle size distribution (PSD) at the pipe system outlet and at the entrance of both gully pots given an accurately known initial load of sediment over the model surface. The data regarding wash-off and sediment transport tests is included in the zip file '7_*Wash-off_tests.zip*'. The initial load of sediment is 20 g per meter of curb and it was distributed realistically over the roadway. The initial distribution of sediment for all the experiments is showed in Figure 1. Five sediment classes (Figure 2) have been used to study the effect of sediment characteristics in the wash-off and sediment transport processes. In '*SedimentsClasses_granulometries.csv*', the detailed granulometries of the different sediment classes measured by a coulter can be consulted. The density, measured by pycnometer for all the granulometries, is 2557±16 kg/m^3.

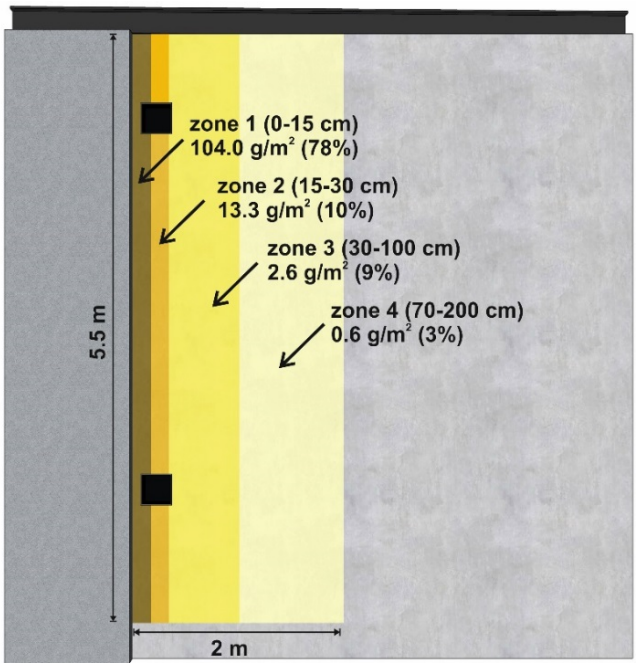

Figure 1. Distribution of sediment over the model surface

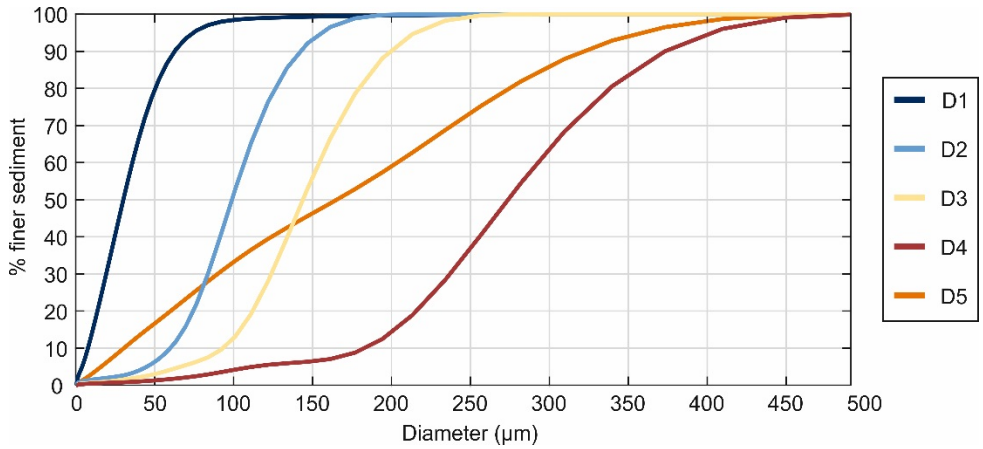

Figure 2. Sediment classes granulometries

Each test configuration combine a sediment class (D1-D5 in Figure 2) and a homogeneous and steady rainfall of 30, 50 or 80 mm/h of intensity with a duration of 5 minutes. In Figure 3, the location and the ID of the different measuring points are presented. During the simulated event, TSS and PSD punctual measurements are obtained respectively by manual grab samples at the gully pots and, together with online turbidity records, at the pipe system outlet (Figure 4). In addition, pipes depths and pipe system outlet discharge is measured using the same methodology than in the hydraulic experiments (see *'4_Hydraulic_tests_description.pdf'*). Further details of location, sensors used, acquisition time and units for each result are also presented in *'Measuring_points.csv'*.

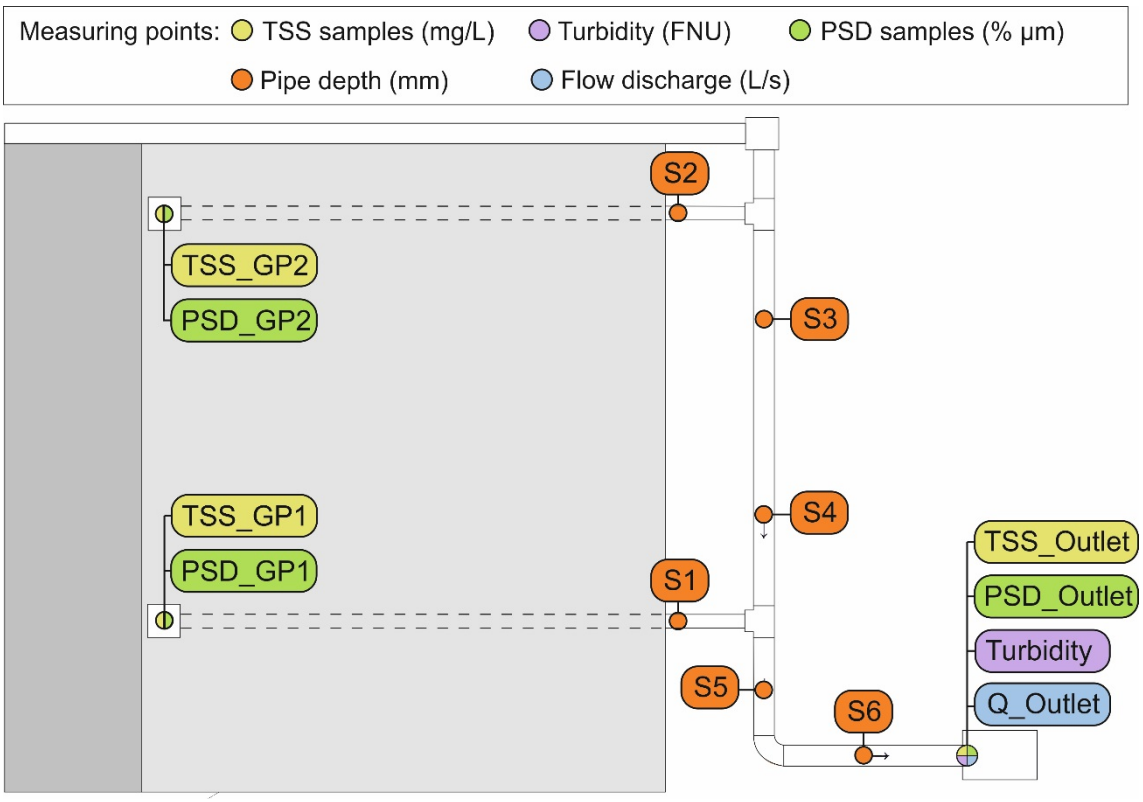

Figure 2. Street section physical model scheme

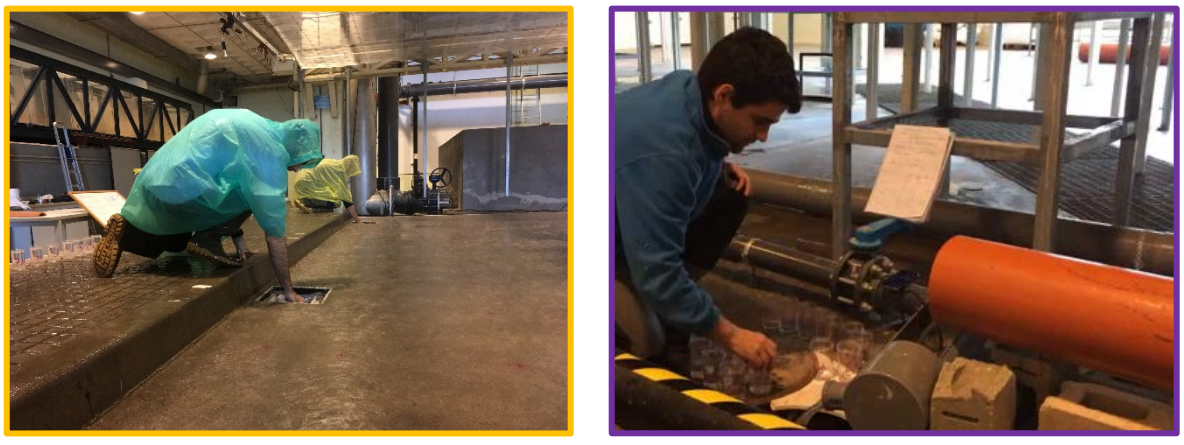

Figure 3. TSS samples in gully pots (left) and turbidity measuring point and samples in pipe system outlet (right).

The solids that remained in the physical model at the end of the experiment were collected to perform a sediment mass balance and verify the correct operation of the experiments. Firstly, sediment remained over the surface and inside gully pots was collected with an industrial vacuum. Surface was divided in 7 areas to analyse the final distribution of sediment over the street surface as it can be seen in Figure 4. Finally, pipes are cleaned using a pressure washer, and sediment deposited in pipes is collected with a 10 µm sieve at the pipe system outlet. During the vacuuming, a small portion of concrete particles was eroded from the roadway surface. Therefore, eight blank tests have been performed to obtain a mean concrete mass to substract from the total masses collected in order to close adequately the sediment mass balances. In addition, a laser coulter particle size analyser (Beckam-Coulter LS I3 320) was also used to obtain PSD of each mass collected

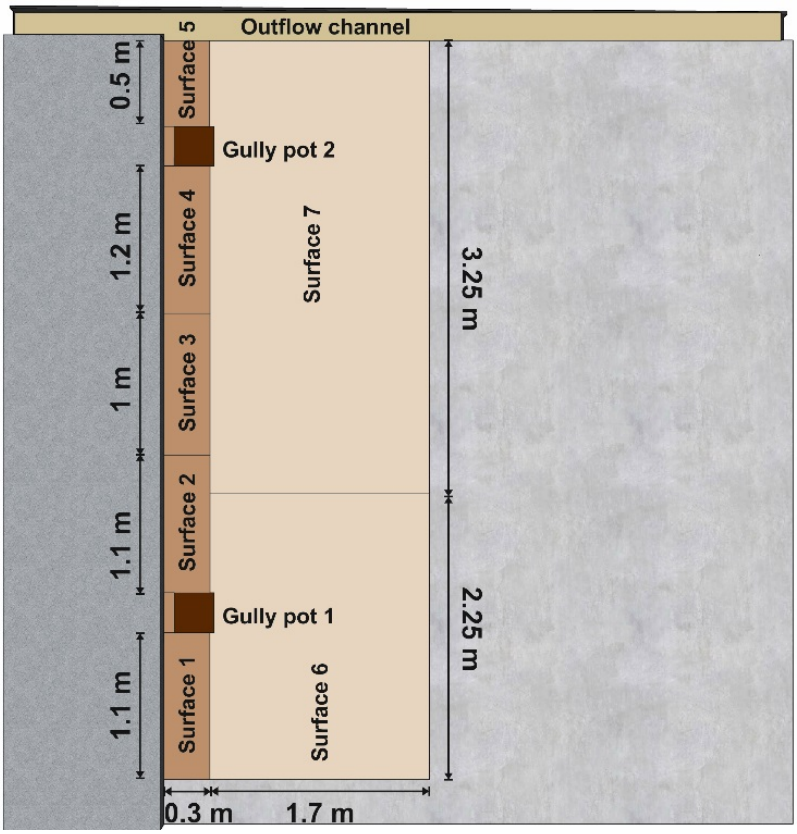

Figure 4. Areas from where remained sediment is vacuumed at the end of the experiment to perform a mass balance.

Manual TSS and PSD samples at the entrance of the gully pots can interfere in the mass balance and the results at the pipe system outlet. Each experiment, configured as a combination of a rain intensity (30, 50 or 80 mm/h) and a sediment class (D1-D5), is therefore repeated without collecting samples at the gully pots to ensure reliability in pipe system outlet samples and final mass balances. However, some experiments with low rain intensity and larger sediment grain sizes presented negligible TSS concentrations at the pipe system outlet since most part of the

sediment is remained in surface or deposited in gully pots. In these cases, experiments are performed only once measuring TSS and PSD at the gully pots. Table 1 shows all the tests and their configuration.

Table 1. Wash-off and sediment transport tests ID and configurations

Test ID	Rain intensity (mm/h)	Sediment class	Gully pot samples	Test ID	Rain intensity (mm/h)	Sediment class	Gully pot samples
ST01_30_D1_GP	30	D1	Yes	ST16_50_D3_O*	50	D3	No
ST02_30_D1_O	30	D1	No	ST17_50_D4_GP	50	D4	Yes
ST03_30_D2_GP	30	D2	Yes	ST18_50_D4_O*	50	D4	No
ST04_30_D2_O*	30	D2	No	ST19_50_D5_GP	50	D5	Yes
ST05_30_D3_GP	30	D3	Yes	ST20_50_D5_O	50	D5	No
ST06_30_D3_O*	30	D3	No	ST21_80_D1_GP	80	D1	Yes
ST07_30_D4_GP	30	D4	Yes	ST22_80_D1_O	80	D1	No
ST08_30_D4_O*	30	D4	No	ST23_80_D2_GP	80	D2	Yes
ST09_30_D5_GP	30	D5	Yes	ST24_80_D2_O	80	D2	No
ST10_30_D5_O	30	D5	No	ST25_80_D3_GP	80	D3	Yes
ST11_50_D1_GP	50	D1	Yes	ST26_80_D3_O	80	D3	No
ST12_50_D1_O	50	D1	No	ST27_80_D4_GP	80	D4	Yes
ST13_50_D2_GP	50	D2	Yes	ST28_80_D4_O*	80	D4	No
ST14_50_D2_O*	50	D2	No	ST29_80_D5_GP	80	D5	Yes
ST15_50_D3_GP	50	D3	Yes	ST30_80_D5_O	80	D5	No

*experiment not performed

2. Data postprocessing

TSS values were obtained filtering samples following the APHA method. The TSS samples at the pipe system outlet were used in each experiment to convert online turbidity records to TSS data performing a linear regression. PSD data was obtained from manual samples by a laser coulter particle size analyser (Beckam-Coulter LS I3 320).

3. Result files

Sediment masses collected after the experiments from the different vacuuming areas in the surface, gully pots, pipes and outflow channel are provided for all the tests in a single file ('*MassBalance.csv*'). The mean of the concrete masses collected in the blank tests, which are also included in this file, have already subtracted. Then, each experiment considered in Table 1 include the following files, referring the time in all cases to the beginning of the rainfall:

'*TSSsamples.csv*': Collection time and TSS concentration value for gully pots (TSS GP1 and TSS GP2) and outlet (TSS Outlet) manual samples.

'*Turbidity.csv*': Raw time series registered by the turbidity probe installed in pipe system outlet deposit. In addition, TSS values resulted using the correlation turbidity-TSS samples is included.

'*PSDSamples (folder)*': granulometries of PSD samples in gully pots and at the pipe system outlet named as '*PSDSample*_(measuring point)_(sample time)*s.csv*'

'*PSDMassB (folder)*': PSD of the different masses collected for the final mass balance named as '*PSDMassB*_(measuring point)*s.csv*'

'*Flow_RawSignal(V).csv*': Raw time series registered by the sensor installed in pipe system outlet deposit to measure flow.

'*Flow_Processed(Ls).csv*': Processed flow discharge result at the pipe system outlet.

'*Depths_RawSignal(V).csv*': Raw time series registered by the turbidity probe 6 distance sensor installed in the pipes (S1-S6). 60 seconds before rain data was additionally included to ensure correct measurement of the distance to dry surface or pipe.

'*Depth_Processed(mm).csv*': Processed pipe depths results for sensors S1-S6.

The plots in Figure 5 show the TSS results for rain intensities of 80, 50 and 30 mm/h and the different grain sizes. Figure 6 shows balance masses for each combination of rain intensity and sediment classes.

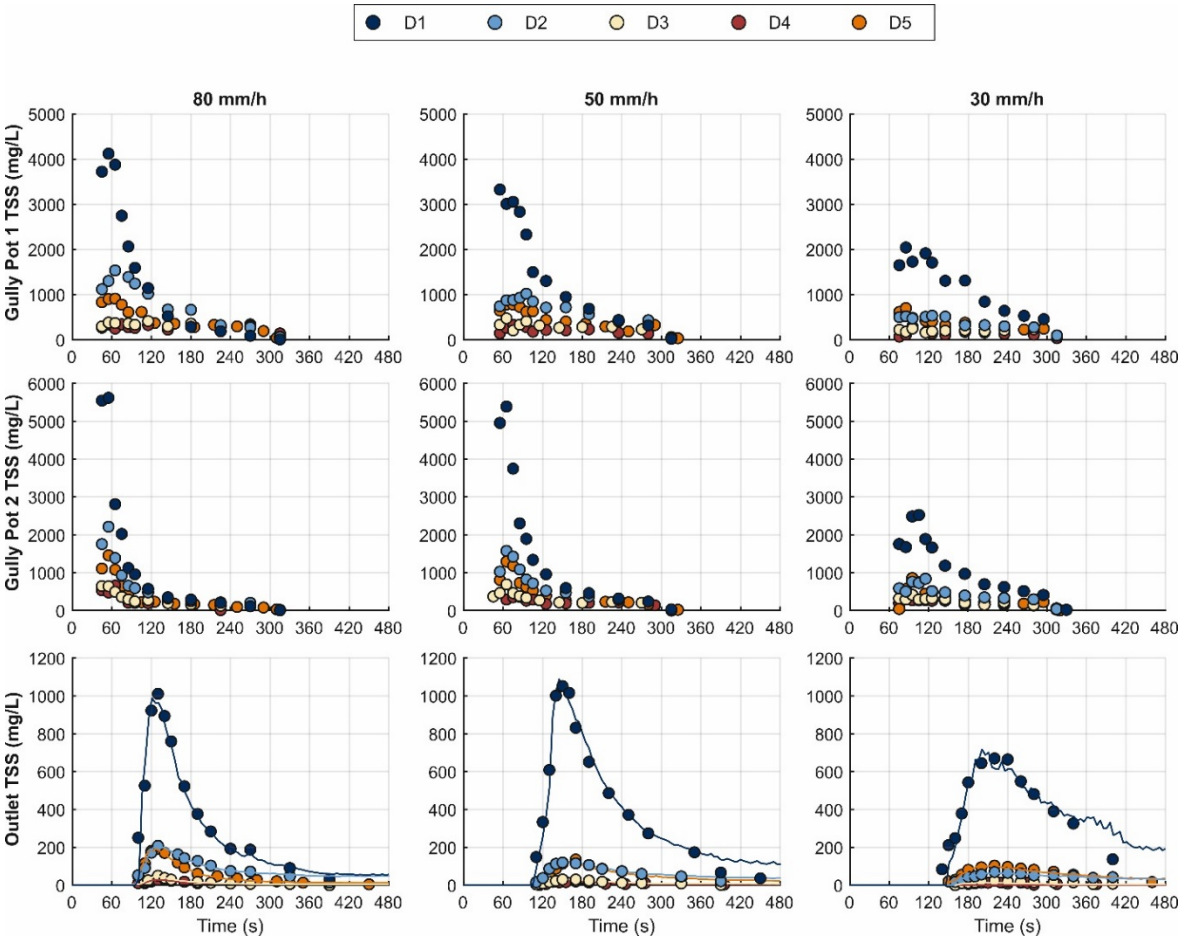

Figure 5. Total suspended solids (TSS) results in both gully pots and in the pipe system outlet for the five different grain sizes (D1-D5) and rain intensities of 80, 50 and 30 mm/h.

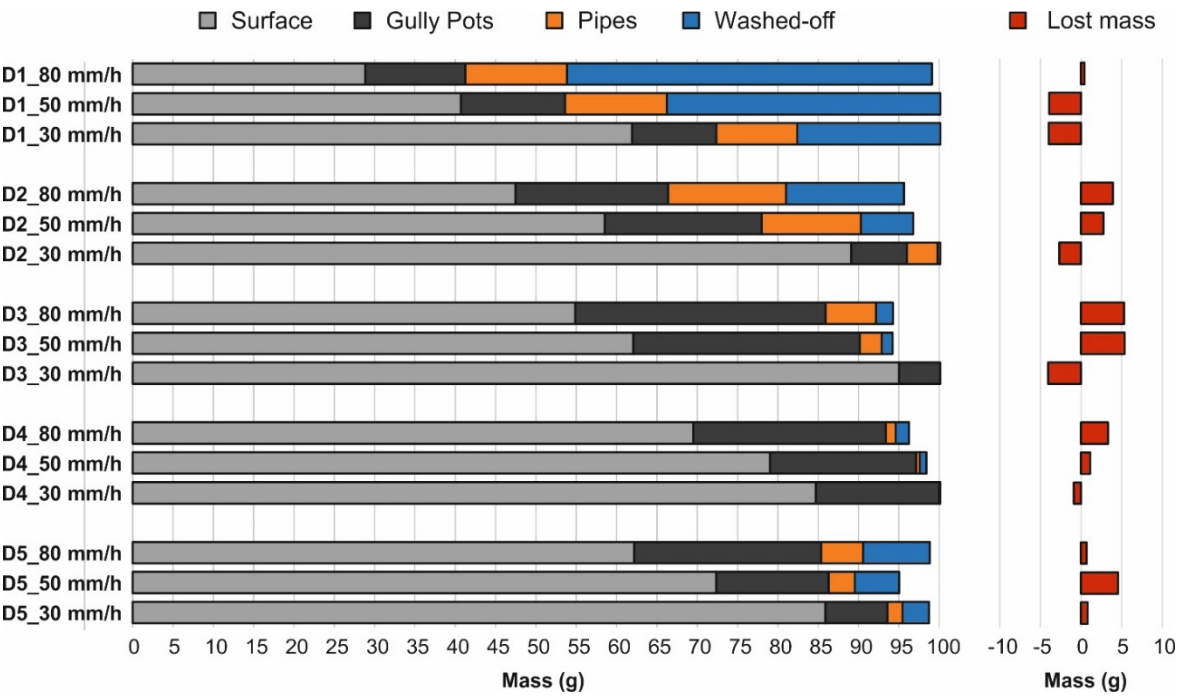

Figure 6. Mass balances results for the five different grain sizes (D1-D5) and rain intensities of 80, 50 and 30 mm/h.