1. Catchment characteristics and spatial monitoring design

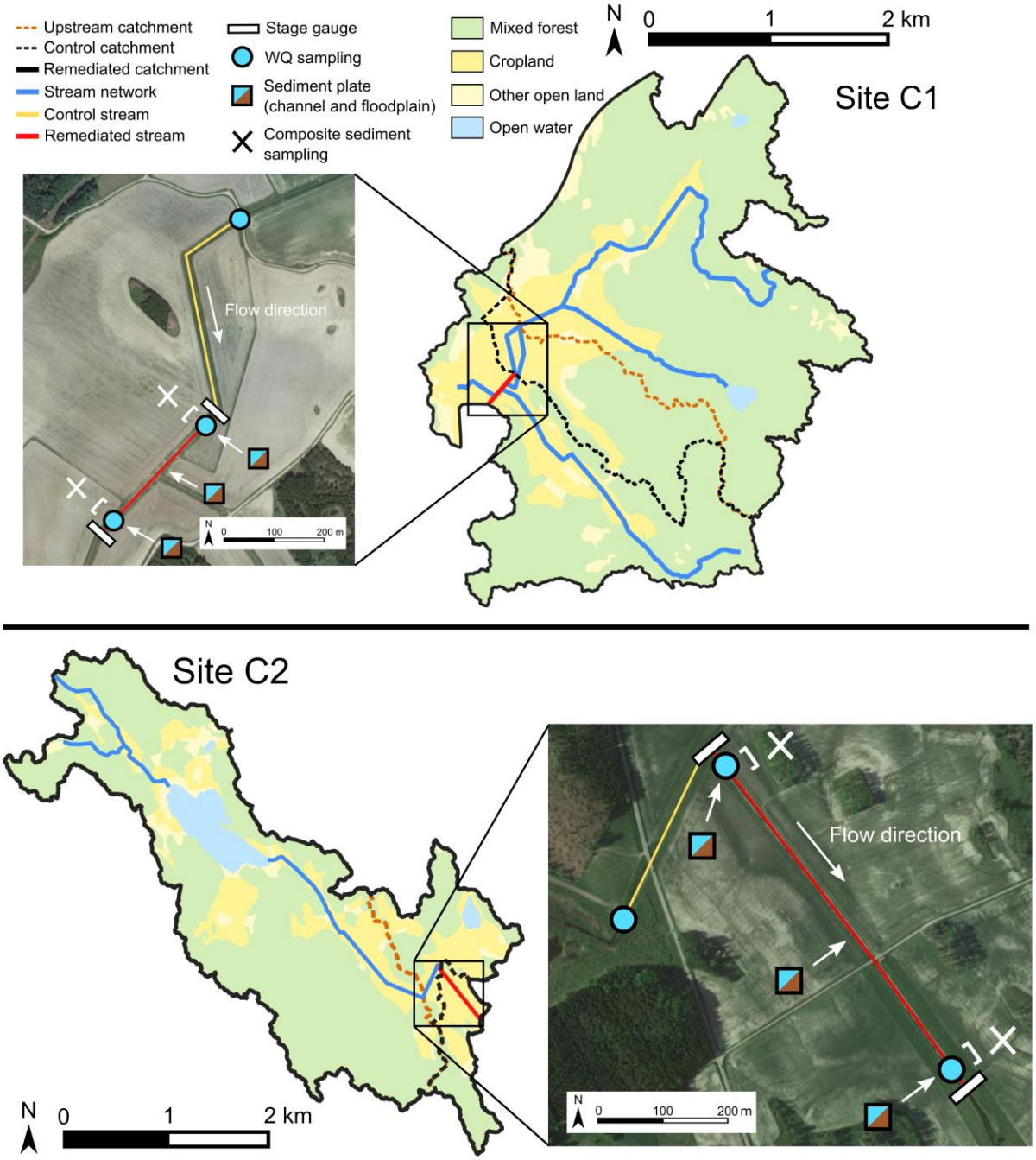


Fig. S1. Land use cover and catchment boundaries of remediated and control streams (C1 and C2). Location of stage gauges, water sampling, sediment plates and sediment sampling. Satellite images: Google, ©2023 Maxar Technologies. Land use maps: ©Lantmäteriet.

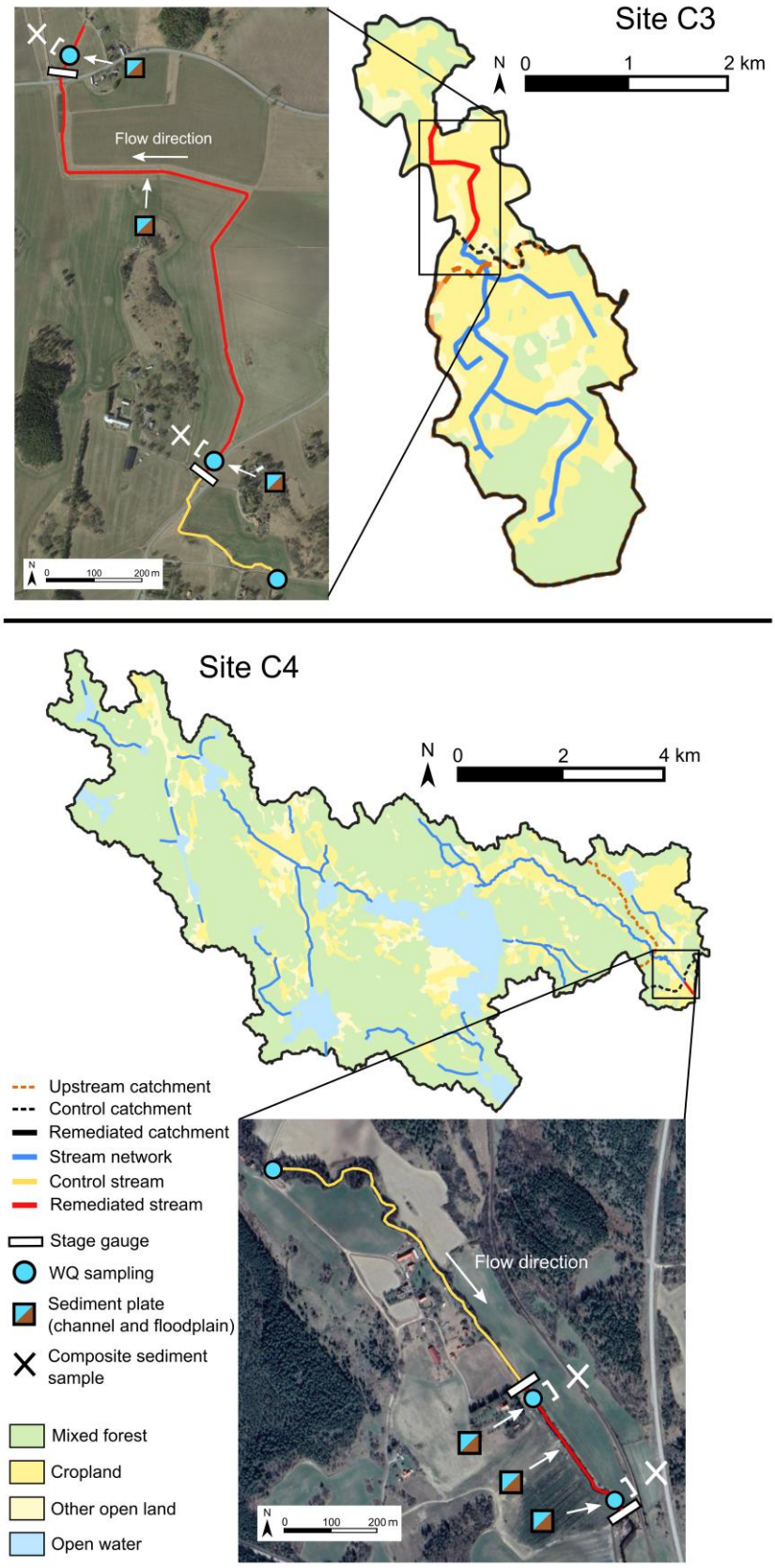


Fig. S2. Land use cover and catchment boundaries of remediated and control streams (C3 and C4). Location of stage gauges, water sampling, sediment plates and sediment sampling. Satellite images: Google, ©2023 Maxar Technologies, ©2023 CNES / Airbus. Land use maps: ©Lantmäteriet.

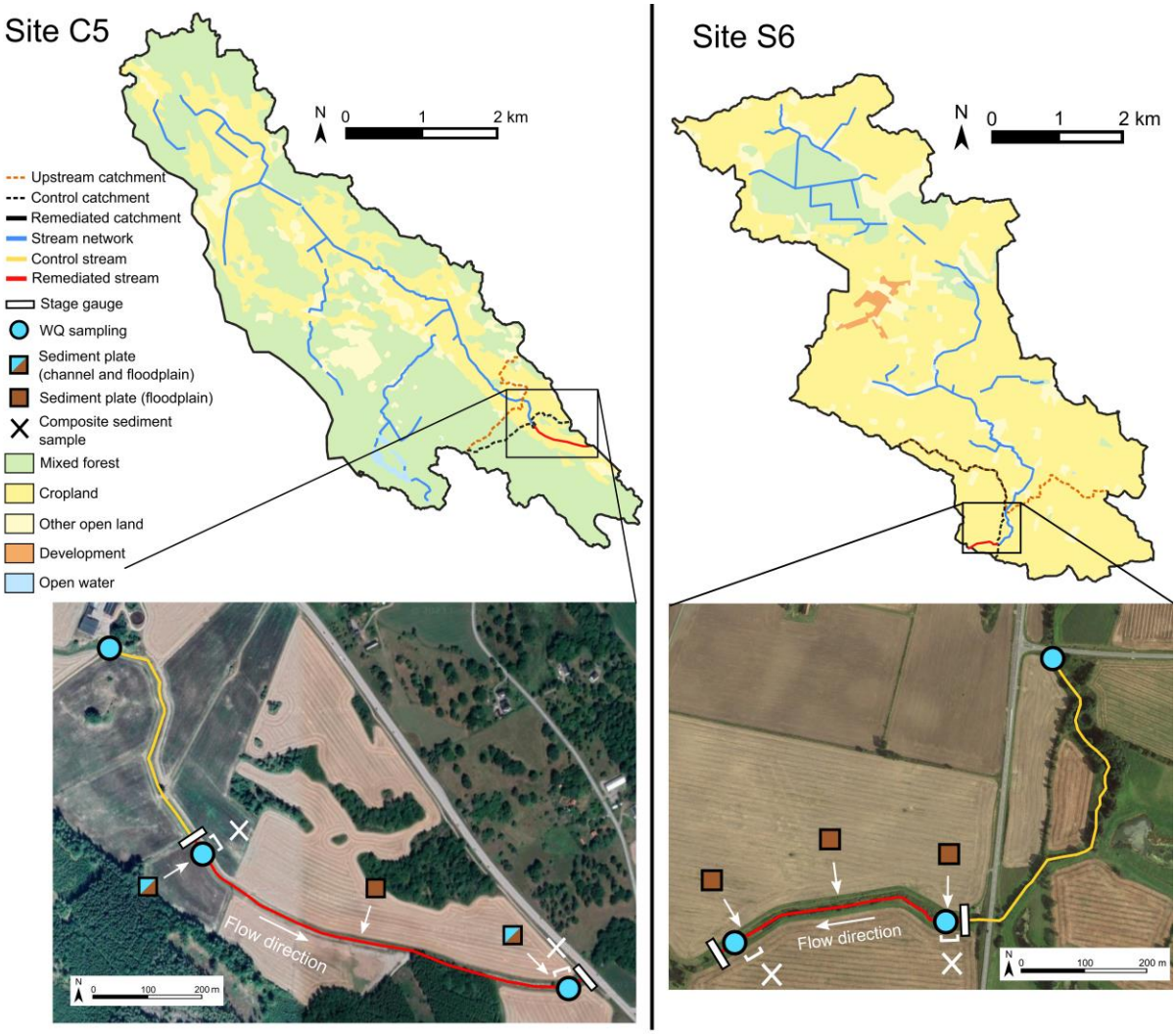


Fig. S3. Land use cover and catchment boundaries of remediated and control streams (C5 and S6). Location of stage gauges, water sampling, sediment plates and sediment sampling. Satellite images: Google, ©2023 CNES / Airbus. Land use maps: ©Lantmäteriet.

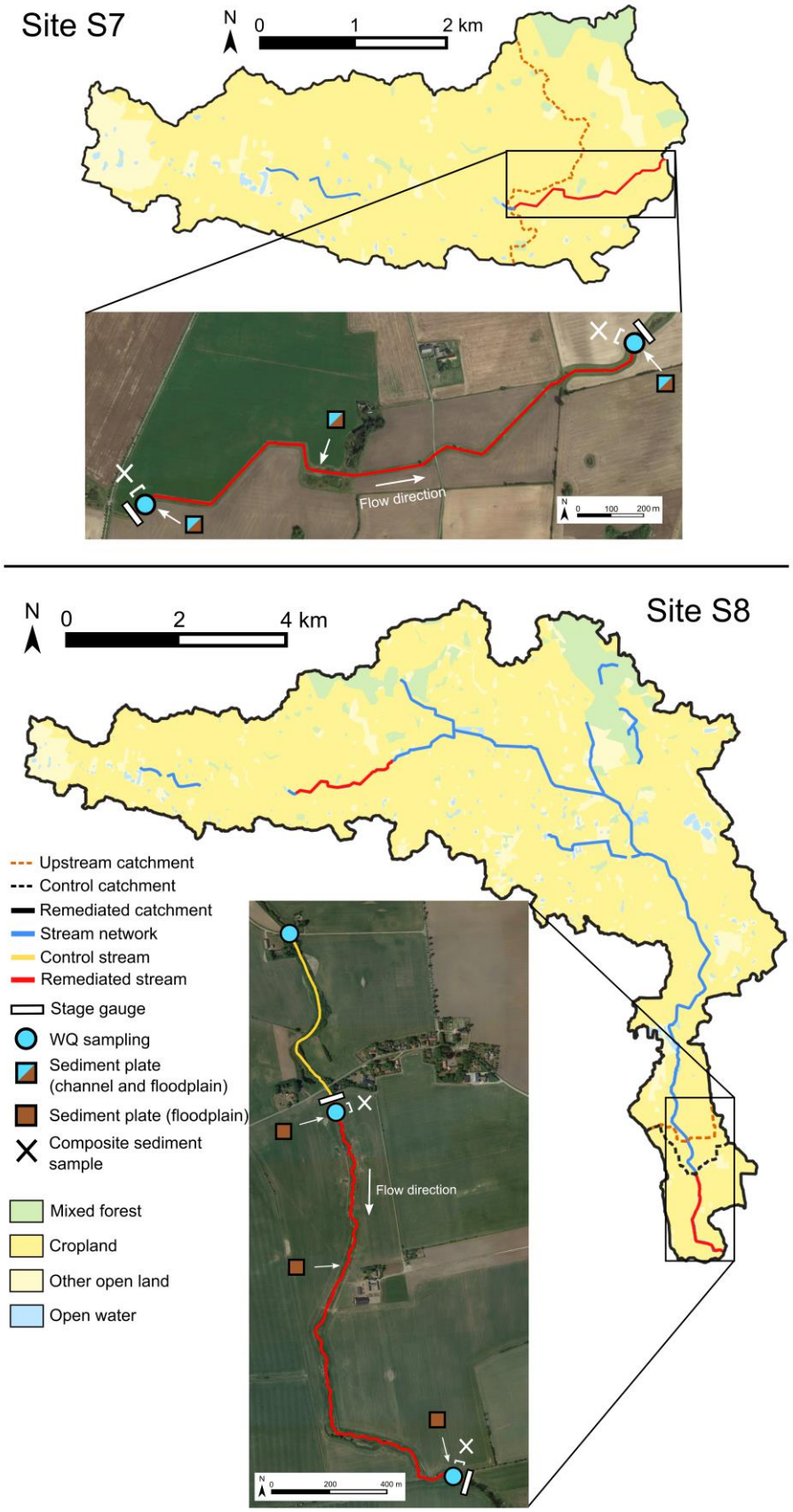


Fig. S4. Land use cover and catchment boundaries of remediated and control streams (S7 and S8). Location of stage gauges, water sampling, sediment plates and sediment sampling. Satellite images: Google, ©2023 Landsat / Copernicus. Land use maps: ©Lantmäteriet.

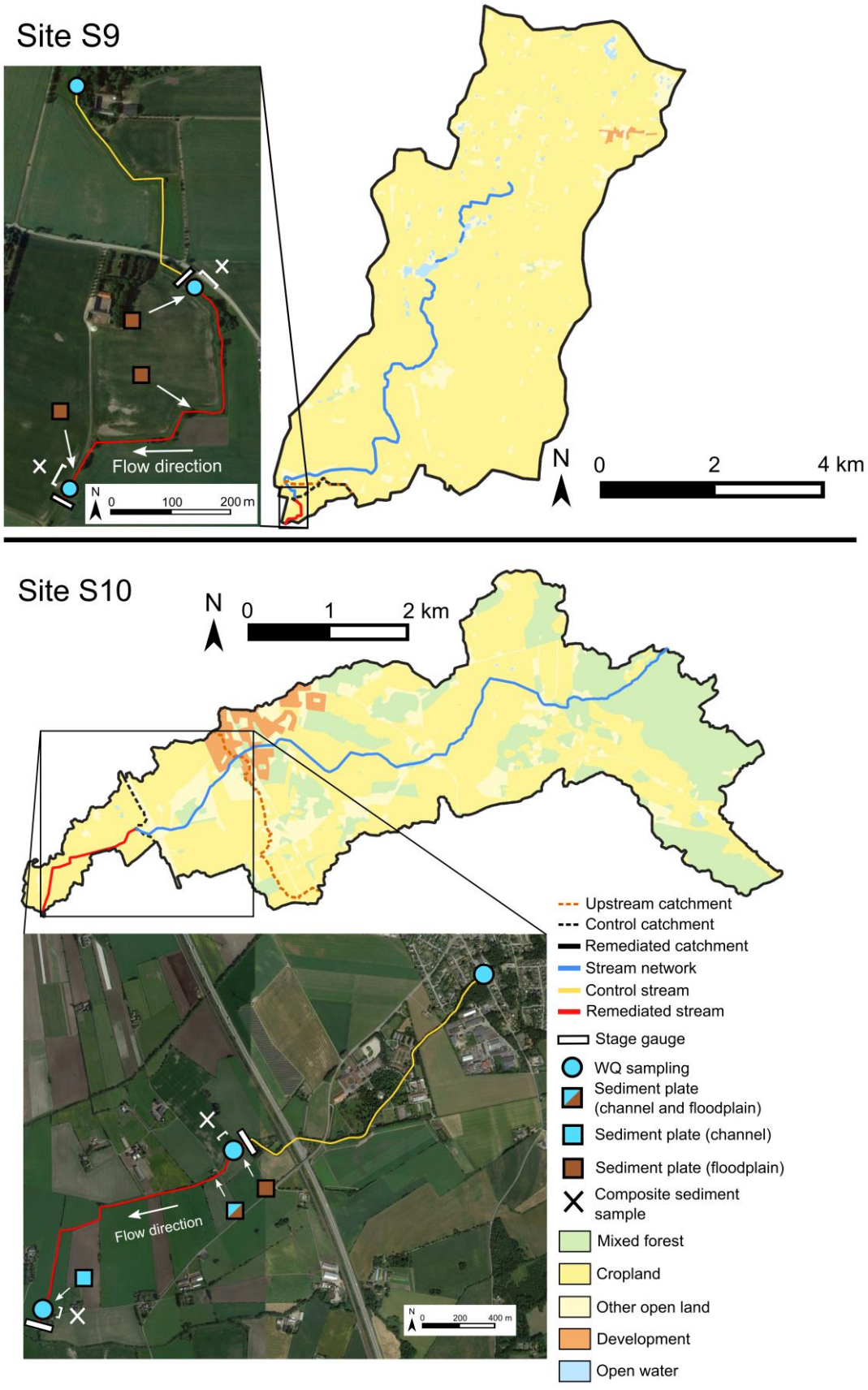


Fig. S5. Land use cover and catchment boundaries of remediated and control streams (S9 and S10). Location of stage gauges, water sampling, sediment plates and sediment sampling. Satellite images: Google, ©2023 Landsat / Copernicus. Land use maps: ©Lantmäteriet.

Table S1. Characteristics of sub-catchments draining control and remediated reaches (upstream catchment excluded) and channel geomorphology of control and remediated streams.

Site	Reach	Sub-catchment area (ha)	Agricultural land use (%)	Reach length (m)	Channel bed width (m)	Bank elevation (m)	Channel slope (-)
C1	Control	127	24	440	2.39	1.67	0.08
	Remediated	294	22	340	1.03	1.77	0.04
C2	Control	100	37	290	1.71	1.79	0.08
	Remediated	54	46	730	0.87	1.70	0.04
C3	Control	16	77	450	0.89	1.27	0.77
	Remediated	202	65	1500	1.01	2.24	0.30
C4	Control	326	35	900	-	-	0.37
	Remediated	46	46	320	2.63	1.41	0.10
C5	Control	52	60	450	1.57	2.32	0.37
	Remediated	184	14	780	1.08	1.79	0.14
S6	Control	236	84	620	1.74	1.70	0.71
	Remediated	102	92	400	0.95	1.62	0.17
S7	Remediated	298	82	1960	0.86	1.97	0.09
S8	Control	46	81	650	-	-	0.68
	Remediated	200	90	1770	1.30	1.33	0.47
S9	Control	13	93	450	-	-	0.25
	Remediated	42	90	630	1.22	1.37	0.44
S10	Control	234	61	1780	-	-	0.27
	Remediated	100	83	1760	6.00	2.17	0.09

2. Remediated and control stream profiles

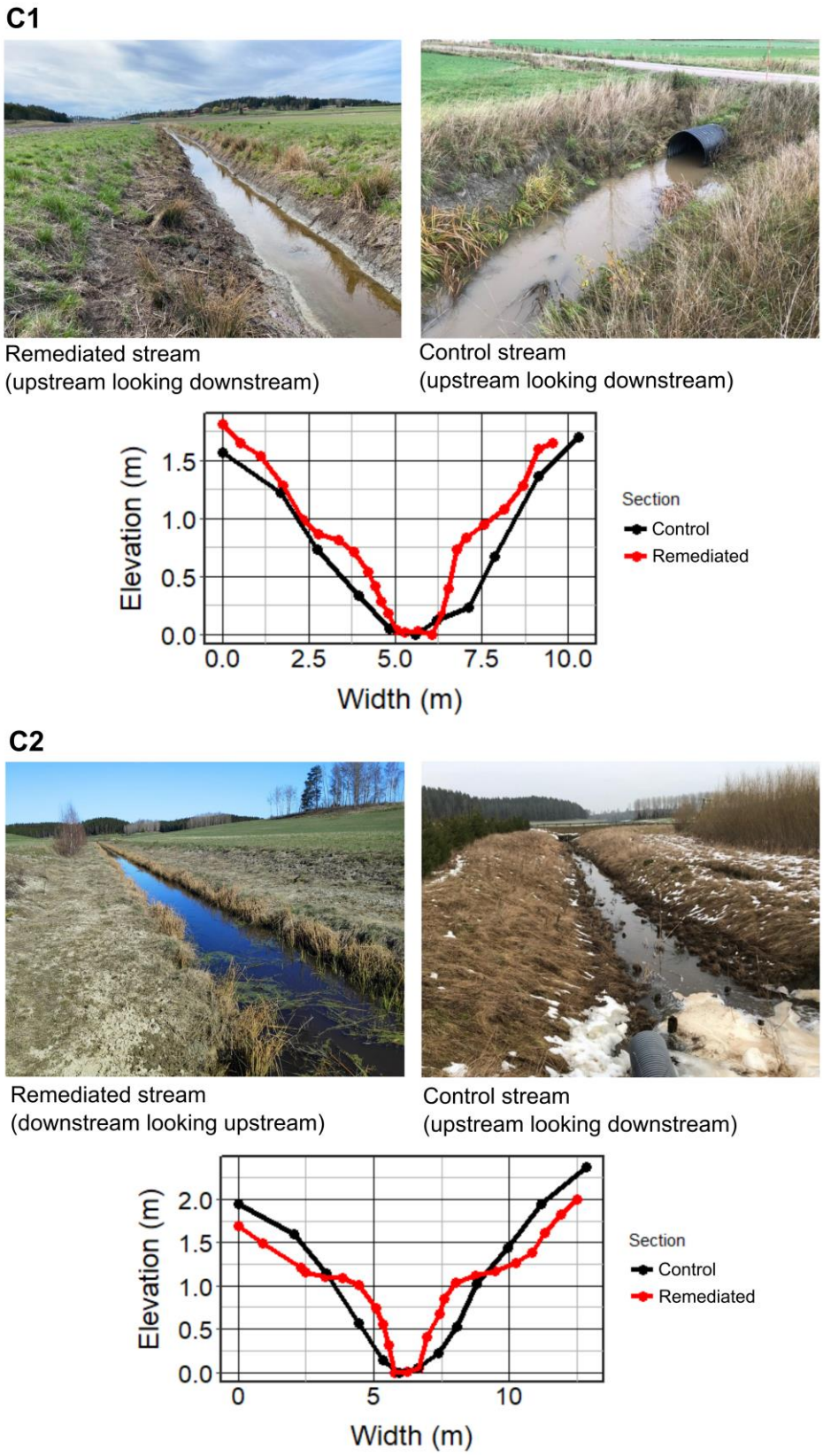


Fig. S6. Photographs and cross-section profiles of remediated and control streams at site C1 and C2.

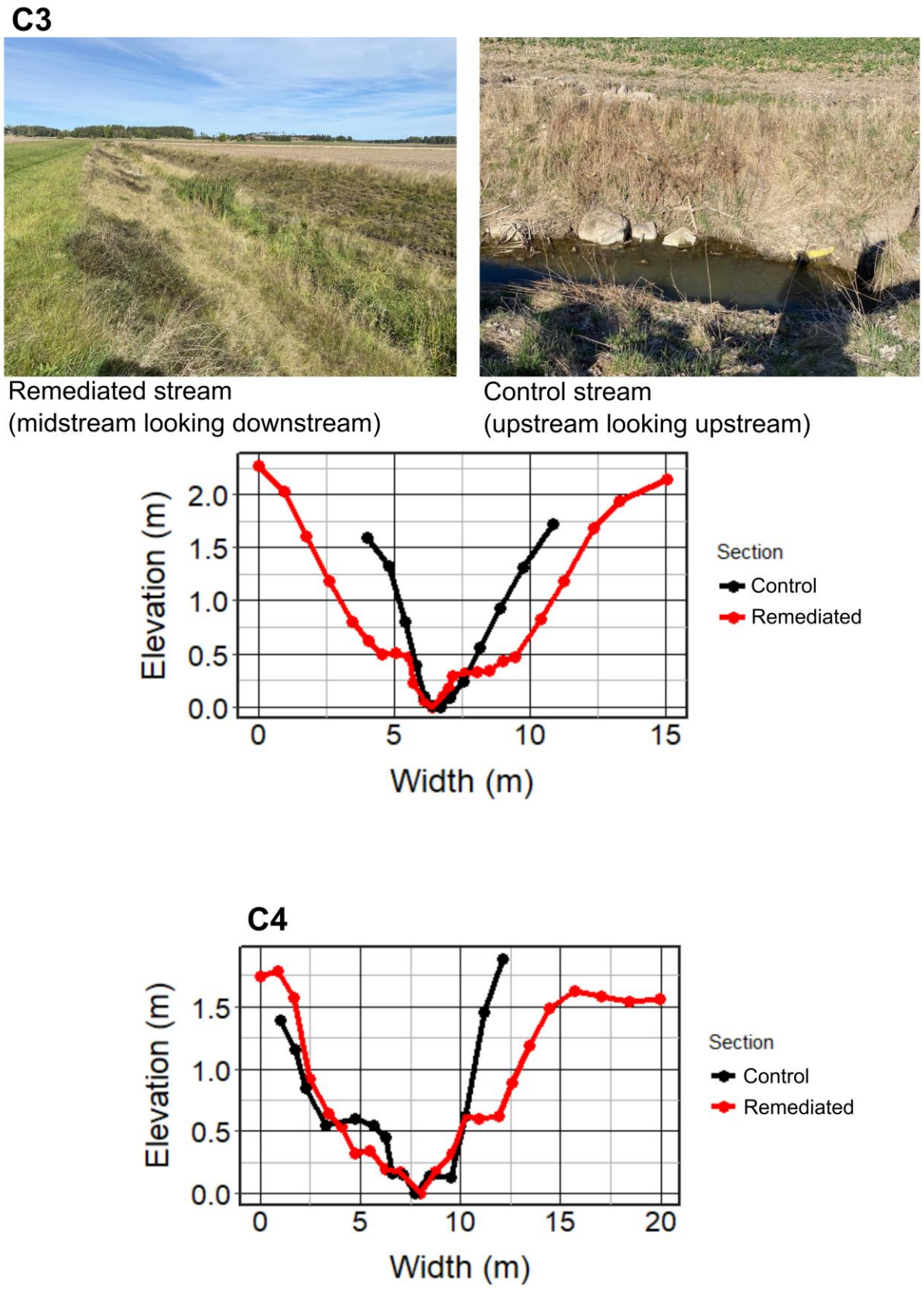
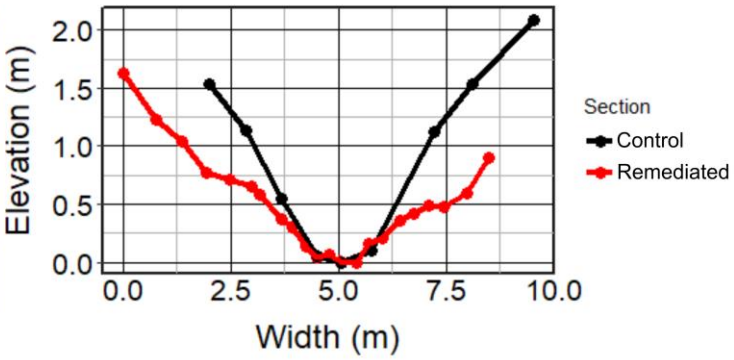


Fig. S7. Photographs (site C3) and cross-section profiles of remediated and control streams at site C3 and C4. No photographs taken of site C4 reaches.

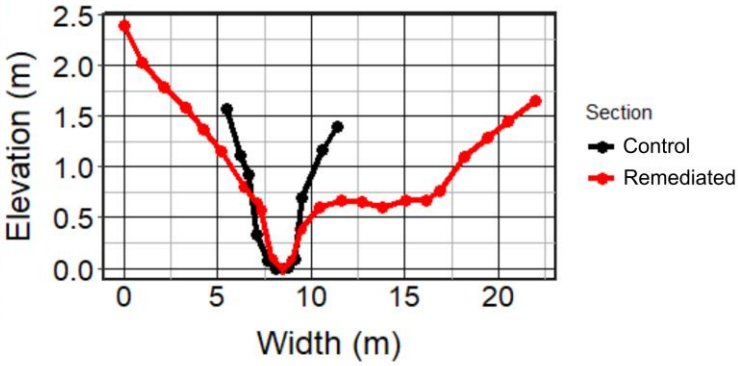
C5

Remediated stream
(upstream looking downstream)



S6

Remediated stream
(midstream looking upstream)



S7

Remediated stream
(upstream looking downstream)

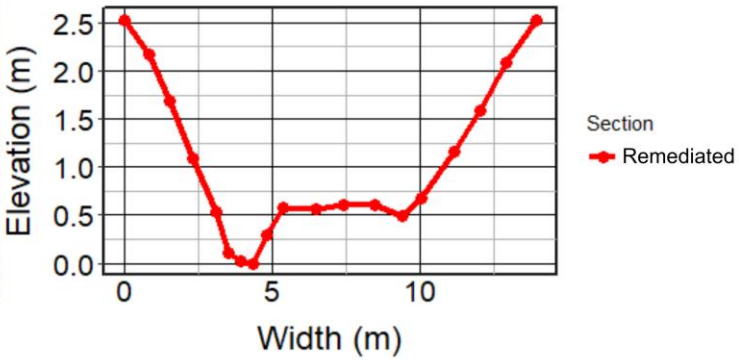
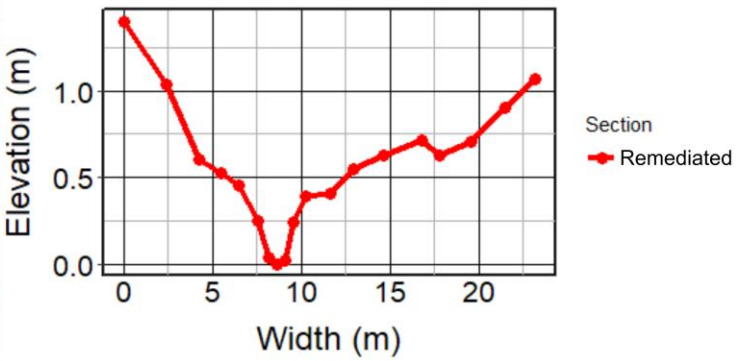


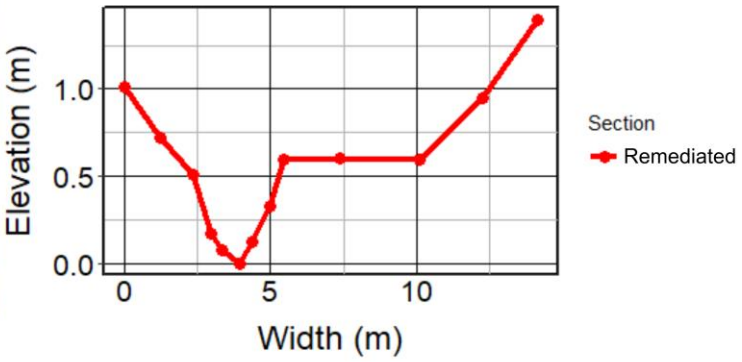
Fig. S8. Photographs and cross-section profiles of remediated and control streams at site C5, S6-7. No photographs taken of control streams (C5, S6) and no control stream exist for site S7.

S8



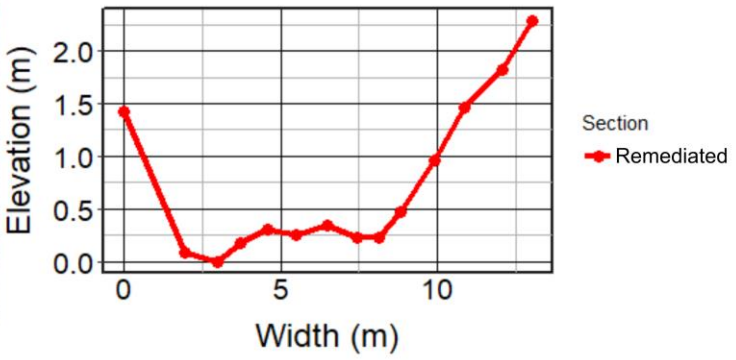
Remediated stream
(upstream looking downstream)

S9



Remediated stream
(midstream looking upstream)

S10



Remediated stream
(downstream looking upstream)

Fig. S9. Photographs and cross-section profiles of remediated streams at site S8-10. No photographs taken and no cross-section measured of control streams in site S8-10.

2. Sedimentation plates

Fig. S10. Photographs of sedimentation plates. Sedimentation plate deployed on floodplain surface (left). Sediment yield after retrieving sedimentation plate placed in channel, using a cylindrical frame to prevent sediment losses to water (right).

3. Validation of load estimation

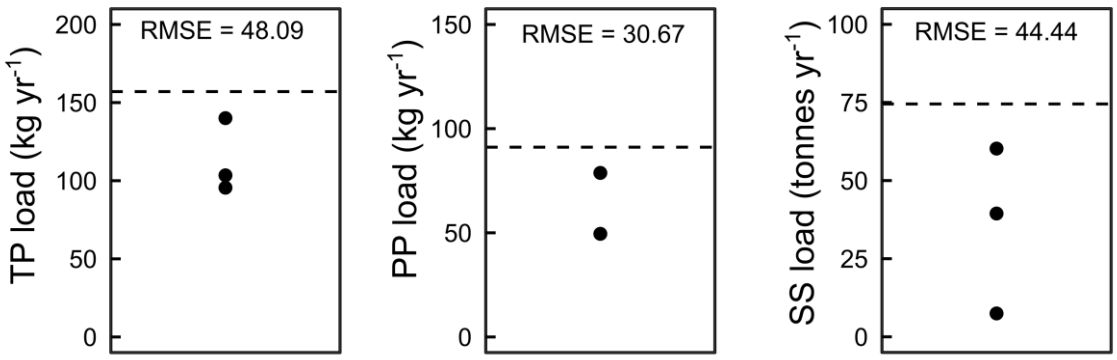


Fig. S11. Variation in calculated loads from a location 1 km downstream of site C3. Horizontal dashed lines denote accurate annual loads from fortnightly flow-proportional sampling during April 2020 to July 2022. Black circles denote annual loads calculated with flow-weighted mean concentration using water samples from two to three different days within each month over the study period. Root mean square error (RMSE) is a measure of bias and standard deviation between flow-weighted mean concentration and accurate loads.

4. Mean concentration and annual loads of P

Table S2. Mean concentrations ± one standard deviation and loads of total phosphorus (TP), particulate phosphorus (PP) and suspended sediments in control streams (TD), upstream remediated streams (US) and downstream remediated streams (DS). Samples were collected between April 2021 and June 2022. PP in site C3 was calculated as the difference of unfiltered TP and unfiltered reactive P. Longitudinal differences in water quality parameters were tested for each site with one-way ANOVA. Bold font denotes significant difference ($p < 0.05$) between locations.

		Total phosphorus		Particulate phosphorus		Suspended sediments	
Site	Location	Concentration ($\mu g\ L^{-1}$)	Load ($kg\ ha^{-1}\ yr^{-1}$)	Concentration ($\mu g\ L^{-1}$)	Load ($kg\ ha^{-1}\ yr^{-1}$)	Concentration ($mg\ L^{-1}$)	Load ($tonnes\ ha^{-1}\ yr^{-1}$)
C1	TD	98.86 ± 70.92		67.88 ± 59.07		21.60 ± 13.34	
	US	102.30 ± 53.65	0.47	72.18 ± 41.70	0.30	38.85 ± 42.77	0.11
	DS	112.27 ± 73.74	0.34	88.82 ± 66.11	0.23	54.89 ± 100.91	0.09
C2	TD	**339.50 ± 322.77**		**205.39 ± 253.12**		**57.32 ± 93.46**	
	US	**385.21 ± 216.26**	0.51	**293.34 ± 200.56**	0.36	**78.04 ± 83.77**	0.11
	DS	**206.24 ± 104.88**		**122.35 ± 61.95**		**24.87 ± 22.04**	
C3	TD	360.53 ± 346.56		170.51 ± 379.24		15.27 ± 14.18	
	US	240.82 ± 206.44	0.11	58.58 ± 103.47		14.13 ± 22.27	0.01
	DS	212.20 ± 155.07	0.17	63.74 ± 75.73		21.78 ± 32.34	0.01
C4	TD	**32.21 ± 13.55**		20.83 ± 12.04		8.69 ± 6.19	
	US	**47.44 ± 22.25**	0.07	31.80 ± 18.00	0.05	12.23 ± 6.98	0.02
	DS	**62.47 ± 54.62**	0.11	42.84 ± 46.27	0.07	11.19 ± 10.53	0.02
C5	TD	111.69 ± 51.08		**59.27 ± 28.91**		11.59 ± 5.97	
	US	131.90 ± 92.27	0.22	**84.06 ± 85.06**	0.11	30.22 ± 47.09	0.03
	DS	105.73 ± 50.86	0.23	**72.87 ± 51.16**	0.14	31.79 ± 34.28	0.05
S6	TD	88.19 ± 52.06		27.46 ± 10.31		20.17 ± 49.75	
	US	93.19 ± 55.09	0.54	26.79 ± 8.70	0.22	13.60 ± 24.33	0.08
	DS	104.48 ± 83.77	0.64	48.62 ± 64.62	0.35	40.10 ± 109.49	0.31
S7	TD	-		-		-	
	US	433.86 ± 774.73	1.10	309.48 ± 707.19	0.70	103.62 ± 209.82	0.31
	DS	474.22 ± 606.19	1.25	398.79 ± 589.92	0.94	54.40 ± 82.07	0.34
S8	TD	117.15 ± 59.18		59.80 ± 54.54		18.33 ± 35.60	
	US	145.67 ± 86.31	1.07	84.44 ± 78.59	0.73	24.50 ± 37.29	0.32
	DS	128.88 ± 51.59	0.63	61.84 ± 40.91	0.37	17.43 ± 19.32	0.14
S9	TD	149.62 ± 141.82		63.29 ± 98.83		10.94 ± 10.99	
	US	145.93 ± 111.35	0.26	60.35 ± 81.40	0.08	11.95 ± 14.36	0.02
	DS	143.55 ± 158.12	0.23	55.26 ± 58.55	0.09	9.91 ± 15.62	0.02
S10	TD	55.44 ± 48.29		38.19 ± 35.47		7.16 ± 8.86	
	US	54.00 ± 33.97	0.28	37.02 ± 27.41	0.20	9.08 ± 9.13	0.05
	DS	66.56 ± 48.56	0.35	45.28 ± 44.27	0.23	13.55 ± 28.34	0.05

5. Correlation between PP and SS concentrations

Table S3. Linear correlation between particulate phosphorus (PP) and suspended sediments (SS) stream water concentrations across control streams and remediated streams. Correlation assessed by coefficient of determination (R^2) and statistically significance of regression slope ($p < 0.05$). Samples were collected between April 2021 and June 2022. Correlation of site C3 was based on samples from upstream of control stream, being the only location with measured filtered and unfiltered TP for this site.

PP ~ SS correlation		
Site	R^2	P value
C1	0.46	< 0.01
C2	0.61	< 0.01
C3	0.51	< 0.01
C4	0.68	< 0.01
C5	0.59	< 0.01
S6	0.81	< 0.01
S7	0.65	< 0.01
S8	0.84	< 0.01
S9	0.23	< 0.01
S10	0.62	< 0.01

6. Changes in P concentrations across sediment P deposition rates

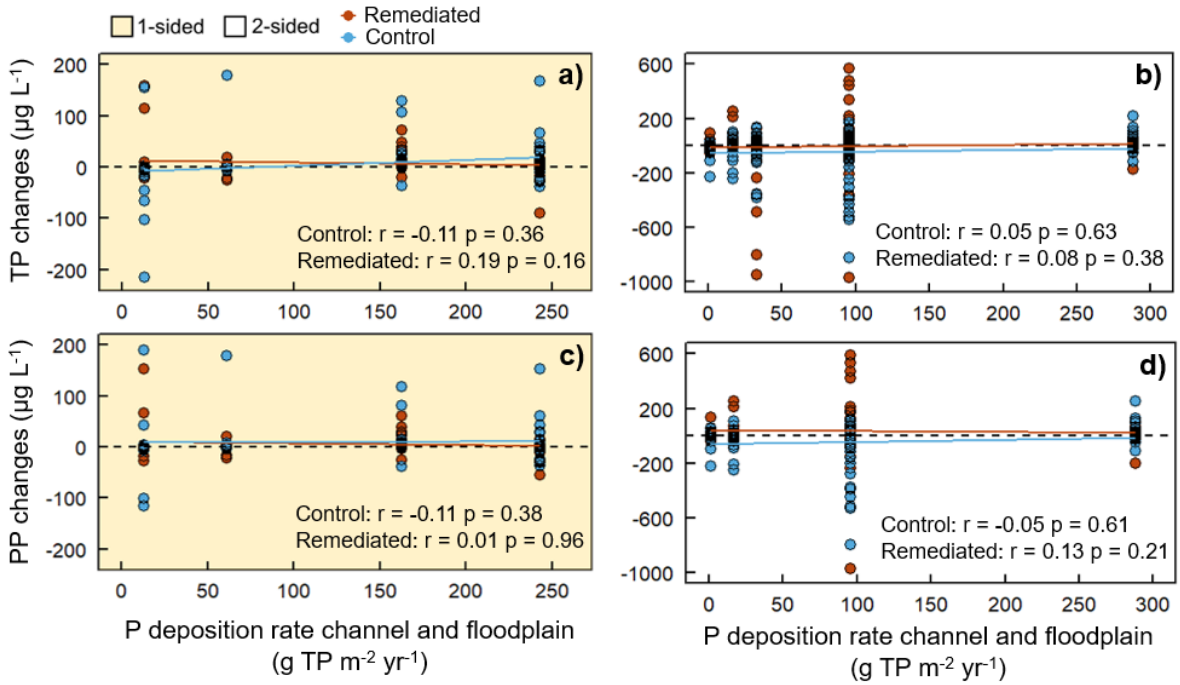


Fig. S12. Correlations between stream water P concentration changes along remediated and control streams and P deposition rates on channel beds and floodplains of remediated streams. Changes in TP concentrations along a) one-sided floodplains and b) two-sided floodplains and changes in PP concentrations along c) one-sided floodplains and d) two-sided floodplains. For sites without P deposition monitoring on channel beds (S6, S8–9), only floodplain deposition is shown. Site S7 was excluded due to no control stream. P-values of Pearson correlations are shown within each panels.

7. Catchment drivers for sediment P deposition

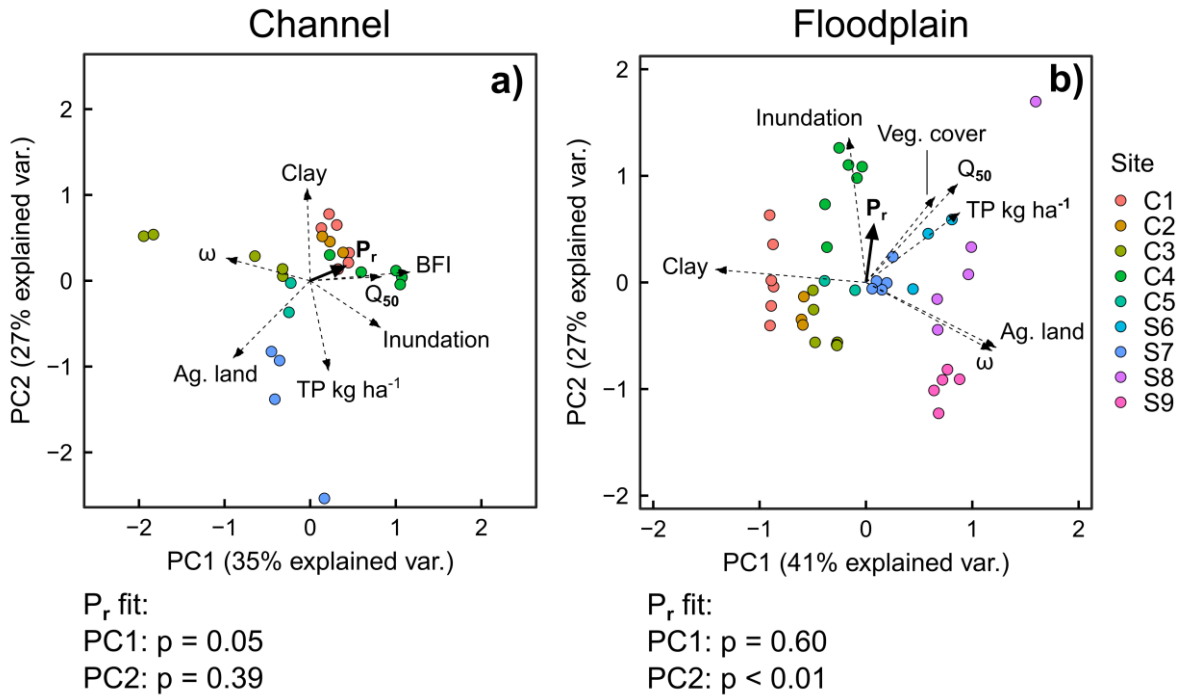


Fig. S13. Principal component analysis (PCA) of predictor variables (water chemistry, catchment and channel properties). Correlation with P deposition rates (P_r) on a) channel beds and b) floodplains. The influence of predictor variables on sample distributions are indicated by dashed vectors. The P_r was significantly correlated ($p < 0.05$) with the ordinations and is shown as blue vectors, with lengths proportional to the strength of the correlation. Circle color denote samples from 9 sites. Sample sites with missing variables were removed from the analyses and descriptor variables were standardized to equal standard deviations. ω = unit stream power, Q_{50} = median flow discharge, BFI = base flow index, SS load = 2.5 yr mean of suspended sediments loads (tonnes yr^{-1}).

8. Phosphorus fractions and content in composite sediments

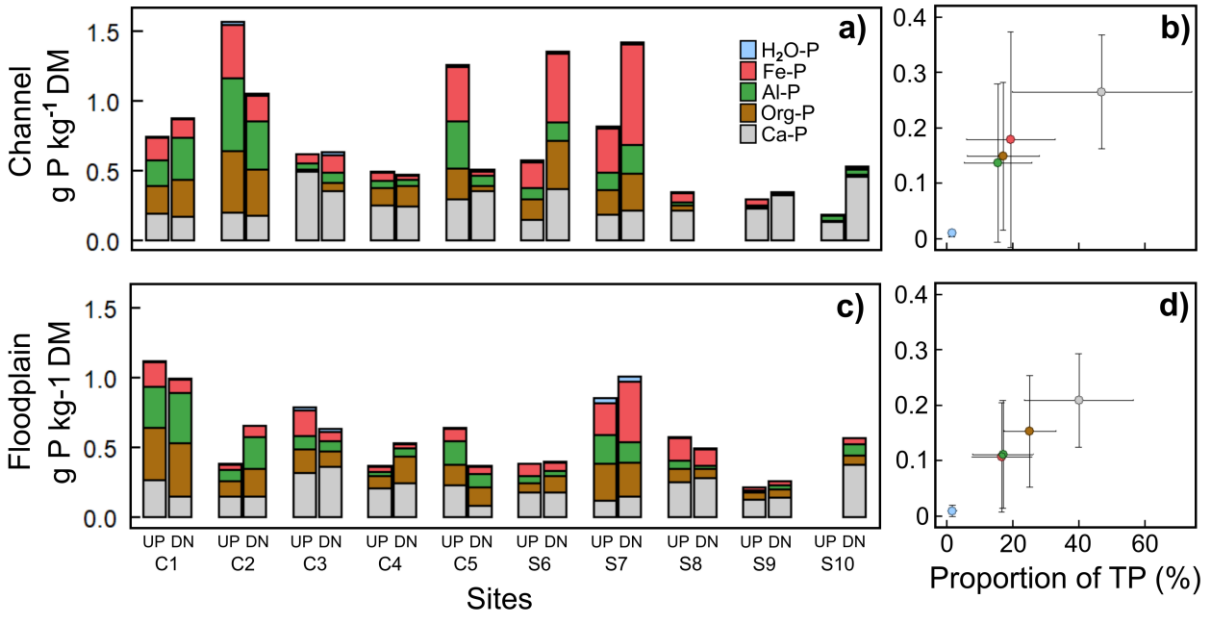


Fig. S14. Mass of P fractions in composite sediments in a) channel beds and c) floodplains of remediated streams across all studied sites. The relation between P fraction mass and proportions of total P in b) channel bed and d) floodplain sediments, with standard deviations shown as error bars. H_2O-P = water soluble P, Fe-P = P adsorbed to iron and manganese, Al-P = P adsorbed mainly to aluminum, Org-P = organic-bound P and Ca-P = calcium-bound P.