



20 1. *“This is a well-written manuscript presenting a pilot experiment in a new and promising*  
21 *outdoor facility. However, there are two major issues and one minor issue with the manuscript*  
22 *related to the design for meandering and the underlying assumptions on the meandering*  
23 *process and related to the interaction between sediment sorting and morphological response.*  
24 *The less major issue is a poor development of reasons to do this kind of experiment, which is*  
25 *biased towards the outdated dogmas of engineering scale models. As such, the necessary*  
26 *recommendation is reject. I strongly suggest the authors to reconstruct a paper with much less*  
27 *focus on the meandering and much more focus on the armouring processes.”*

28 We are grateful for these constructive comments, and for the many helpful suggestions  
29 regarding the manuscript. Based on this, we substantially reconstructed the narrative so  
30 that the paper more clearly communicates its primary message which is that the OERF is  
31 built, operational, and the pilot campaign taught us what enables and what limits mobility  
32 at prototype scale under sediment-limited conditions.

33 We agree that the motivation should reflect the modern philosophy of experimental  
34 geomorphology (process similarity / relaxed scaling), rather than sounding “engineering  
35 scale-model dogma” which is infeasible in most studies. We therefore revised thoroughly  
36 the Introduction, removing the following text:

- 37 • “Field monitoring, physical modeling, and numerical simulation are all  
38 essential... Physical models enable control of key variables, but cannot reproduce  
39 the full complexity... Numerical models... rely on mathematical approximations  
40 and empirical relations... Thus, comprehensive experimentation in diverse  
41 natural settings is needed to address these limitations, capturing the full spectrum  
42 of morphodynamic processes, including the transient and non-equilibrium  
43 behaviors (Church and Ferguson, 2015).” (original manuscript, line 22 to 36).
- 44 • “Due to these small scales, maintaining dynamic similarity requires the relaxation  
45 of the Reynolds number, which in turn alters the fluid dynamics and can lead to  
46 hydraulic dynamics not representative of field conditions (Ashworth et al., 1996;  
47 Felder and Chanson, 2009). Additionally, excessive downscaling of sediments,  
48 especially fine particles like clay or silt, can results in unnatural patterns of  
49 sediment transport and deposition (Peakall et al., 2007a). As a result, when results  
50 from small-scale flumes are up-scaled — by scale factors of 30 or more — these

51 distortions can lead to inaccurate predictions for real-world applications (Wei and  
52 Li, 2004).” (original manuscript, line 39 to 45).

- 53 • “Given these limitations, large-scale experimental facilities offer the opportunity  
54 to better approximate the complexity and scale of natural river systems. By  
55 creating flow conditions at scales similar to field prototypes, large facilities can  
56 create realistic Reynolds numbers and turbulent structures, expand the range of  
57 experimental variables, and provide more accurate representations of natural  
58 conditions. However, working at larger scales still requires a balance between  
59 realism and control (Kakinuma and Shimizu, 2014)” (original manuscript, line  
60 46 to 50)

61 We replaced this with a tighter introduction explicitly grounded in relaxed scaling  
62 and regime/process similarity, and we clarified which mechanisms are most scale-  
63 sensitive (sorting/armouring, cohesion/biota, turbulence structure, bank–floodplain  
64 exchange). In the revised manuscript, we added:

- 65 • “Existing models cannot capture all these relevant processes ..... This persistent  
66 challenge has motivated a research philosophy of process-based investigation that  
67 spans diverse approaches ..... and at scales that range from small laboratory water  
68 tables to field-scale experiments (Paola et al., 2009). Some of these processes,  
69 such as sediment sorting and cohesive effects are scale-dependent, and are  
70 inherently difficult to study at planform scale with existing facilities (Kleinhans  
71 et al., 2014, 2024).” (revised ms, line 23 to 36)
- 72 • “In order to preserve the similarity of the processes affecting planform evolution,  
73 researchers have moved from conventional engineering scaling, which is  
74 unfeasible, to more effective relaxed scaling requirements (Paola et al., 2009;  
75 Kleinhans et al., 2014, 2024). These experiments typically aim to: (1) maintain  
76 the relevant flow regime (typically subcritical flow, appropriate for investigations  
77 of morphological features such as alternate bars); (2) ensure sediment is mobile  
78 at the intended transport stage and mode (e.g., bedload vs suspension, partial vs  
79 full mobility); and (3) achieve the right hydraulic resistance regime at the  
80 boundaries (e.g., hydraulically rough bed vs viscosity-dominated). To

81 simultaneously satisfy these requirements at reduced scales, researchers often  
82 force deliberate distortions, such as vertical exaggeration, steepened channel  
83 slope, or the use of lightweight sediment (Gorrick and Rodríguez, 2014), each of  
84 which can alter flow dynamics or sediment transport (e.g., Ashworth et al., 1996;  
85 Lu et al., 2013; Kleinhans et al., 2015).” (revised ms, line 37 to 50).

- 86 • “Studying planform evolution processes at reduced scale commonly challenges  
87 simultaneous satisfaction of these scaling rules, especially with evolving bed and  
88 banks..... In such setups, a hydraulically rough bed can conflict with the need for  
89 sufficient sediment mobility (Kleinhans et al., 2014). Many experiments therefore  
90 end up bedload-dominated and thus behave morphodynamically more like  
91 gravel-bed rivers (e.g., Van Dijk et al., 2012), while scarcely representing  
92 suspension-dominated sand-bed rivers. This limitation is more evident for  
93 floodplain flow when flow depth is shallower than 1 cm (e.g., Braudrick et al.,  
94 2009) which is likely laminar. Accordingly, floodplain construction and bank  
95 strength that strongly depend on fine-sediment exchange and overbank deposition  
96 tend to be under-represented in small-scale experimentation (Lajeunesse et al.,  
97 2010).” (revised ms, line 51 to 64).

- 98 • “Investigating scale-dependent processes requires larger-scale research, which is  
99 challenging. Bank erosion is governed by near-bank stresses and turbulence  
100 structure that contribute to sequences of toe scour, undercutting, and mass failure  
101 (Simon et al., 2000; Engel and Rhoads, 2017; Das et al., 2019). For example, Roy  
102 et al. (2020) observed in controlled undercut experiments that near-bank  
103 turbulence intensities peak within the most eroded zone, highlighting how  
104 turbulence strength (i.e., at sufficiently high Reynolds number) can govern bank  
105 erosion rates. In gravel-bed rivers, for example, the near-boundary entrainment is  
106 dominated by turbulent stresses, and the forcing experienced by banks and bed  
107 grains is mediated by large, energetic flow structures rather than by mean flow  
108 alone (Roy et al., 2004; Nikora, 2007). Biota (e.g., vegetation and microbial  
109 effects) and cohesion play a vital role in controlling bank erosion (van Dijk et al.,  
110 2013; Vignaga et al., 2013). These effects are scale-dependent and difficult to  
111 represent at small scales. As stated by Kleinhans et al. (2014) (p.44), "no

112 convenient theory is available to scale bank erosion rate and floodplain  
113 sedimentation". These challenges make meandering experiments typically more  
114 demanding to sustain than braided patterns (e.g, Peakall et al., 2007; Braudrick  
115 et al., 2009). Furthermore, sediment sorting can be scale-dependent. Not only  
116 does scaling down a gravel-sand mixture often force the finer fraction into the  
117 silt-clay range, but viscous effects can then dominate the transport, inhibiting the  
118 non-cohesive sorting and armouring processes that are naturally dominant at the  
119 prototype scale (Hassan et al., 2024). These dependencies do not imply that low  
120 Reynolds number experiments are unrepresentative in general (Paola et al.,  
121 2009), rather, they identify specific mechanisms (particularly those tied to flow  
122 anisotropy, intermittency, turbulence structure, secondary circulation, bank  
123 material strength, and bank–floodplain exchange) for which regime fidelity  
124 becomes more essential.” (revised ms, line 68 to 86).

125 We clarified the intentions of the pilot experiment. We agree that meandering nor a lack  
126 of meandering should be positioned as the central outcome. We now state that this  
127 manuscript is the first of three planned experimental campaigns and is intended to guide  
128 subsequent sinuous/vegetated experiments with sediment recirculation:

- 129 • “This paper reports the first of three planned experimental campaigns at the  
130 OERF, which together strive to isolate key controls on bank erosion and planform  
131 adjustment: (study 1) a straight channel with no sediment supply (this study);  
132 (study 2) a sinuous channel with sediment recirculation; and (study 3) a vegetated  
133 sinuous channel with sediment recirculation. We view this paper as a foundational  
134 exploration of the facility’s capabilities and operational challenge, providing  
135 essential lessons for designing subsequent experiments, and sharing these  
136 capabilities to the broader research community. It is hoped that publicizing the  
137 OERF’s capabilities will foster research partnerships to design and conduct future  
138 experimental campaigns.” (revised ms, line 105 to 111)

139 We removed wording that made the pilot run read like it primarily “failed to meander,”  
140 e.g.:

- 141 • “...but did not initiate meandering.” (original ms line 9)

- 142                   • “We focused in particular on whether a straight channel would develop incipient  
143                   meandering in response to a perturbation in the bed topography” (original ms line  
144                   136 to 137)

145                   In the Design of initial experiments subsection, we explicitly de-emphasized incipient  
146                   meandering as a target outcome:

- 147                   • “Rather than targeting sustained free alternate bars or reach-scale incipient  
148                   meandering, we tested whether a controlled, localized bed topography  
149                   perturbation could generate forced bar-like responses with associated near-bank  
150                   forcing and sediment sorting (armouring) under sediment-limited conditions.”  
151                   (revised ms, line 209 to 212)

152                   2. *“I congratulate the authors on obtaining a great experimental facility. In my opinion these  
153                   experiments remain necessary complements to numerical modelling especially for the channel-  
154                   bank interactions and for sediment sorting dynamics that are the focus of this paper.”*

155                   We appreciate this encouraging statement. We agree that large-scale physical experiments  
156                   remain an essential complement to numerical modelling, particularly for scale-dependent  
157                   processes such as sediment sorting/armouring dynamics.

158                   As discussed in our reply to Comment 1, we reconstructed and narrowed the Introduction  
159                   to avoid a generic numerical vs physical debate, while still making the complementarity  
160                   explicit and directly tied to the specific process gaps relevant to this study. In the revised  
161                   manuscript, we now state:

- 162                   • “Existing models cannot capture all these relevant processes... This persistent  
163                   challenge has motivated a research philosophy of process-based investigation that  
164                   spans diverse approaches (e.g., field monitoring, physical modelling, and  
165                   numerical simulation)...” (revised ms, line 23 to 29)

166                   3. *“The arguments for doing physical modelling are poorly developed and need nuance.”*

167                   We agree that the arguments for doing physical modelling were not well presented. We  
168                   have expanded the motivation for physical experiments with clearer framing [models as  
169                   representations / effective similarity], and a more detailed discussion of what physical  
170                   experiments can and cannot do, citing modern scaling philosophies (e.g., Paola et al.,  
171                   2009; Kleinhans et al., 2014).

172 We removed the generic paragraphing and replaced it with a tighter, process-based  
173 discussion: (revised ms, line 37 to 86) listed above in the response of comment 1. For  
174 example:

- 175 • “...sediment sorting and cohesive effects are scale-dependent...” (line 35)
- 176 • “...researchers have moved from conventional engineering scaling, which is  
177 unfeasible, to more effective relaxed scaling requirements...” (line 37)
- 178 • “...researchers often force deliberate distortions... each of which can alter flow  
179 dynamics or sediment transport...” (line 48)
- 180 • “Many experiments therefore end up bedload-dominated... while scarcely  
181 representing suspension-dominated sand-bed rivers... floodplain construction and  
182 bank strength... depend on fine-sediment exchange and overbank deposition...”  
183 (line 59)
- 184 • “These dependencies do not imply that low Reynolds number experiments are  
185 unrepresentative in general (Paola et al., 2009), rather, they identify specific  
186 mechanisms... for which regime fidelity becomes more restrictive.” (line 83)

187 4. *“The experimental conditions conducive to meandering, which is apparently the purpose of*  
188 *the experiment, are not met. Literature suggestions are given.”*

189 The focus of the experiments was not to investigate the initiation of meandering. To  
190 remove ambiguity about purpose, we explicitly framed the paper as the first of three  
191 planned campaigns, where the meandering experiments are part of later studies:

- 192 • “This paper reports the first of three planned experimental campaigns at the  
193 OERF, which together strive to isolate key controls on bank erosion and planform  
194 adjustment: (study 1) a straight channel with no sediment supply (this study);  
195 (study 2) a sinuous channel with sediment recirculation; and (study 3) a vegetated  
196 sinuous channel with sediment recirculation. We view this paper as a foundational  
197 exploration of the facility’s capabilities and operational challenge, providing  
198 essential lessons for designing subsequent experiments, and sharing these  
199 capabilities to the broader research community. It is hoped that publicizing the  
200 OERF’s capabilities will foster research partnerships to design and conduct future  
201 experimental campaigns.” (revised ms, line 105 to 111)

202 Further to this, we have clarified the text that conditions for self-sustained meandering  
203 (specifically width-to-depth ratio and bank strength) were not met. We also clarified that  
204 the initial experiment was not designed to meet the specific conditions for incipient  
205 meandering but rather to test a forced perturbation under sediment-limited conditions for  
206 the foundational exploration of the new facility.

- 207 • “Although bar theory suggests that free, migrating alternate bars typically require  
208  $W/D \gtrsim 20\text{--}25$  (Kleinhans and van den Berg, 2011; Kleinhans et al., 2024) and are  
209 rarely observed when  $W/D < 10$  (Crosato and Mosselman, 2020), we selected a  
210 moderate  $W/D$  ratio to balance sediment mobility with experimental control. This  
211 design choice was based on the assumption that topographic perturbations can  
212 force bars to develop in channels with  $W/D$  ratios below the free-bar threshold  
213 (Redolfi et al., 2021). Furthermore, scaling analyses indicate that small-scale  
214 laboratory channels require  $W/D$  ratios approximately 1.5 times larger than their  
215 natural counterparts to reproduce equivalent bar patterns (Kleinhans et al., 2014).  
216 In these initial exploratory runs, we therefore aimed to probe the thresholds for  
217 morphodynamic adjustment by implementing a controlled, incrementally  
218 increased perturbation, while operating within a conservative mobility regime to  
219 avoid a rapid transition to multi-thread behavior.” (revised ms, line 218 to 227)
- 220 • “... vegetation and cohesive sediments are key mechanisms for meandering (Van  
221 Dijk et al., 2012; Kleinhans et al., 2024), future experiments should also integrate  
222 these factors.” (revised ms, line 392 to 394)

223 We added the following literature references (Kleinhans and van den Berg, 2011; Dijk et  
224 al., 2012; Kleinhans et al., 2024).

225 5. *“The interesting interaction between sediment sorting and morphological development is in*  
226 *part presented, but the essential point (the different timescales for armouring and for*  
227 *morphological response) is underdeveloped. Literature suggestions are given.”*

228 We agree, and we addressed this directly by expanding the Results in both Sections 4.1  
229 and 4.2, consistent with the objectives of this pilot study as a foundational exploration of  
230 the facility:

- 231           • “Together, these observations highlight the mixed-sediment tendency for a rapid  
232 sedimentological adjustment (selective transport and surface coarsening), which  
233 outpaces longer-timescale morphological adjustment associated with alternate-bar  
234 growth and planform change, particularly apparent when mobility is limited and  
235 upstream sediment supply is absent (Lanzoni, 2000; Kleinhans et al., 2013).”  
236 (revised ms, line 338 to 341)
- 237           • “...they emphasize the need to tune sediment mobility and sediment boundary  
238 conditions to allow morphological responses to develop on comparable timescales  
239 to sorting processes.” (revised ms, line 359 to 361)
- 240           • “As part of the facility characterization, we used ADV measurements to test the  
241 applicability of intrusive, point-based velocity profiling in a large channel with  
242 evolving bed and bank boundaries, with particular attention to near-bank flow  
243 where instrument placement and flow disturbance can be most limiting.” (revised  
244 ms, line 362 to 365)
- 245           • “Although this dataset does not aim to resolve the full turbulence structure, it  
246 provides an indicator of how the imposed topography redistributed high-velocity  
247 flow and near-bed forcing locally.” (revised ms, line 367 to 369)

248           To support this interpretation we incorporated the literature suggestions: (Lanzoni, 2000;  
249 Kleinhans et al., 2013).

250 6. *“Ln:8 the abstract would be more readable in words and without unexplained symbols”*

251           We have revised the abstract to improve readability and remove undefined symbols.

252 7. *“Lns:18-19 a recent review is found in my paper Kleinhans et al. 2024”*

253           We have added the Kleinhans et al. (2024) reference at [the revised ms line 23](#) and the  
254 following lines to the manuscript: [line 243](#) and [line 393](#)

255 8. *Ln:24 a more appropriate reference is Schumm's ten ways to be wrong”*

256           This paragraph was removed to narrow the focus of the introduction as detailed in the  
257 response of comment 1.

258 9. *“Ln:26 this is far too simplistic and needs more nuance. Of course no physical model can ever  
259 produce the full complexity of natural river systems, because all models are simplified, namely  
260 on the controlled initial and boundary conditions, in the processes and mechanisms that are  
261 allowed by the operators, and possibly in certain scale effects (also see my 2024 paper for*

262 *development of a complex systems view). Physical and numerical models are representations*  
263 *of a target system, in which the aim is to include relevant respects and to obtain a sufficient*  
264 *degree of similarity. The whole point of these models is to simplify otherwise science would be*  
265 *impossible for humans.”*

266 We have revised the text to nuance the discussion on physical models, clarifying that they  
267 are deliberately constrained to achieve similarity for specific questions rather than  
268 reproducing full complexity. The response is detailed in our response to comment 1. For  
269 example, the following text has been added:

- 270 • “Existing models cannot capture all these relevant processes ..... This persistent  
271 challenge has motivated a research philosophy of process-based investigation that  
272 spans diverse approaches ..... and at scales that range from small laboratory water  
273 tables to field-scale experiments (Paola et al., 2009). Some of these processes,  
274 such as sediment sorting and cohesive effects are scale-dependent, and are  
275 inherently difficult to study at planform scale with existing facilities (Kleinhans  
276 et al., 2014, 2024).” (revised ms, line 23 to 36)
- 277 • “.... These dependencies do not imply that low Reynolds number experiments are  
278 unrepresentative in general (Paola et al., 2009), rather, they identify specific  
279 mechanisms (particularly those tied to flow anisotropy, intermittency, turbulence  
280 structure, secondary circulation, bank material strength, and bank–floodplain  
281 exchange) for which regime fidelity becomes more essential.” (revised ms, line  
282 84 to 86).

283 *10. Ln:35 "full spectrum" likewise oversimplifies the matter.”*

284 This paragraph was thoroughly revised and the term “full spectrum” no longer appears.

- 285 • “...capturing the full spectrum of morphodynamic processes...” (original  
286 manuscript, line 35).
- 287 • “...persistent challenge has motivated a research philosophy of process-based  
288 investigation.....” (revised ms, line 27)

289 *11. “Ln:38 other references are needed here, including the (in)famous Paola et al 2009 paper and*  
290 *my 2014 paper, both in ESR. Besides, some indoor facilities are quite large (for instance the*  
291 *USACE wave tank and the BAW river scale model in Germany), so the 'indoor' is irrelevant*  
292 *here. ”*

293 We have included references to Paola et al. (2009) and Kleinhans et al. (2014):

- 294 • “This persistent challenge has motivated a research philosophy of process-based  
295 investigation that spans diverse approaches ... and at scales that range from small  
296 laboratory water tables to field-scale experiments (Paola et al., 2009).” (revised  
297 ms, line 27)
- 298 • “Some of these processes, such as sediment sorting and cohesive effects are scale-  
299 dependent, and are inherently difficult to study at planform scale with existing  
300 facilities (Kleinhans et al., 2014, 2024).” (revised ms, line 34)
- 301 • “In order to preserve the similarity of the processes affecting planform evolution,  
302 researchers have moved from conventional engineering scaling, which is  
303 unfeasible, to more effective relaxed scaling requirements (Paola et al., 2009;  
304 Kleinhans et al., 2014, 2024)” (revised ms, line 37)
- 305 • “...a hydraulically rough bed can conflict with the need for sufficient sediment  
306 mobility (Kleinhans et al., 2014).” (revised ms, line 58)
- 307 • “These effects are scale-dependent and difficult to represent at small scales. As  
308 stated by Kleinhans et al. (2014) (p.44), "no convenient theory is available to scale  
309 bank erosion rate and floodplain sedimentation".” (revised ms, line 77)
- 310 • “These dependencies do not imply that low Reynolds number experiments are  
311 unrepresentative in general (Paola et al., 2009), rather, they identify specific  
312 mechanisms ....” (revised ms, line 83)

313 We agree that the intend is reduced scale and not especially “indoor “, despite having  
314 most of these small scaled lab rivers indoors. We, therefore, changed “indoor” to “small-  
315 scale”. The word “indoor” no longer appears:

- 316 • “Most physical modelling experiments with erodible boundaries are conducted in  
317 ~~indoor~~ small-scaled laboratory flumes (Métivier et al., 2017; Phillips et al.,  
318 2022).” (revised ms, line 52)

319 12. *“Ln:41 Again simplistic. Why not representative? why not representative to a certain degree?  
320 Such representation serves a purpose, so if you want to argue that having low Re is not  
321 representative then a specific process is needed here for which that is relevant. As Paola and  
322 Metivier and I and many others have demonstrated, the Reynolds number is not relevant for  
323 many phenomena. The authors here provide no arguments but basically repeat the dogma from  
324 the engineering scale model world, which has been outdated in geomorphology for about a  
325 quarter of a century. To put it as clear as possible without the intention to be blunt: the fact*

326 *that our meandering and estuarine and deltaic and debris flow experiments violate these rules*  
327 *is the reason that we obtained spectacular results where the classic scale models (including*  
328 *those shown in the recent Crosato and Mosselman paper) fail. This point was well put by Paola*  
329 *et al in 2009 in ESR. ”*

330 We appreciate the detailed clarification and we agree with the critique. That was not our  
331 intent. As detailed in our responses to Comments 1, 3, and 9, we revised the Introduction  
332 to adopt the modern geomorphology perspective that models are simplified  
333 representations, and that the goal is sufficient similarity in the relevant respects for the  
334 process/question, not a universal (dynamic) similarity.

335 We removed the blanket implication that low Reynolds number conditions are inherently  
336 “not representative”. We replaced the general statement with a process-specific framing  
337 e.g., (revised ms, line 37 to 50). To ensure the text is nuanced, we now state explicitly that  
338 low-Re experiments can still be informative and successful:

- 339 • “.... These dependencies do not imply that low Reynolds number experiments are  
340 unrepresentative in general (Paola et al., 2009), rather, they identify specific  
341 mechanisms (particularly those tied to flow anisotropy, intermittency, turbulence  
342 structure, secondary circulation, bank material strength, and bank–floodplain  
343 exchange) for which regime fidelity becomes more essential.” (revised ms, line  
344 83 to 86).

345 We only flag Reynolds constraints in relation to specific mechanisms (sorting/armouring,  
346 fine-sediment exchange, near-bank turbulence) e.g., (revised ms, line 65 to 85).

347 13. “Ln: 44 “Inaccurate predictions” implies a certain purpose, such as engineering scale  
348 modelling of a certain target system where, for instance, measured water levels need to  
349 approximate those in the target within a predetermined accuracy range. However, for the study  
350 of many phenomena such a scaling is not needed and instead other aspects of the experiments  
351 need to be realized.”

352 We removed the “inaccurate predictions” phrasing (original manuscript, line 44) and  
353 revised the text to emphasize that reduced-scale experiments can be highly valuable even  
354 with distortions, and the key issue is not prediction accuracy in an engineering sense, but  
355 whether the processes and transport/resistance regimes relevant to the research question  
356 are adequately represented (see revised ms line 46 to 81 listed in our response to Comment  
357 1).

358 14. *“Ln:46 This depends very much on the dimensions of a natural system that one can have in*  
359 *mind. For example, the Ganges river is about 1000 times wider than the channel in this facility,*  
360 *so from the engineering dogma the scale numbers are off the chart. However, the van Dijk et*  
361 *al. 2012 paper cited by the authors, was the first to produce sustained dynamic meandering*  
362 *with chute cutoffs in the lab, and the occurrence and mechanisms of the chute cutoffs are*  
363 *arguably adequate representations of the same phenomenon in small and large rivers*  
364 *regardless of the geometric scale. By the implicit standards of the authors, however, their own*  
365 *experiment is a terrible representation of large meandering rivers. There are plenty of reasons*  
366 *to disagree with this position: this new facility is suitable and a great addition for a large*  
367 *number of phenomena as argued in Paola et al. 2009 and Kleinhans et al. 2014.”*

368 Again, our intent was not to imply that “representativeness” should be judged by  
369 geometric similarity to a particular river (e.g., the Ganges), nor to suggest that small-scale  
370 experiments are inherently inadequate if they violate classical engineering scaling. We  
371 also agree that the success of studies such as van Dijk et al. (2012) demonstrates that  
372 many planform phenomena (including sustained dynamic meandering and chute cutoffs)  
373 can be represented adequately across a wide range of geometric scales when the relevant  
374 processes and controls are realized.

375 To address this, we revised the text consistent with our responses to Comments 1, 3, 9,  
376 12, and 13. The revised Introduction now frames modelling as achieving sufficient  
377 similarity in the relevant respects for the question being asked, consistent with Paola et  
378 al., 2009 and Kleinhans et al., 2014.

379 We agree, the OERF’s value is not being big enough to match the biggest rivers, but  
380 enabling specific mechanisms that are difficult to represent at reduced scale, particularly  
381 those central to our planned research program (see revised ms line 65 to 85 and line 103  
382 to 110).

383 15. *“Ln:135 This reference is unfortunately not an acceptable reference unless the Dickson thesis*  
384 *is published open onLn for the foreseeable future. Alternatively, the authors provide these*  
385 *descriptions or a summary thereof in an onLn supplement.”*

386 We have clarified that the thesis is publicly available to ensure the reference is accessible  
387 (revised ms, line 207).

388 16. *“Ln:144 I don’t understand how the  $W/D=12$  can be reconciled with the objective of the*  
389 *authors to obtain incipient meandering. The formation of alternate bars requires at least*  
390 *double that  $W/D$  plus a dynamic perturbation on the upstream boundary, especially since this*  
391 *flume has about the same length/ $W$  ratio as that in the van Dijk et al experiments. This*

392 *necessary W/D follows from bar theory and from empirical and experimental evidence. The*  
393 *Crosato and Mosselman paper cited by the authors does not provide this number of W/D=10.*  
394 *Our application of the theory (Kleinhans and van den Berg 2011) indicates that W/D>25 at*  
395 *least.”*

396 Similar to our response to Comment 4 about meandering initiation, we have revised and  
397 clarified our intentions of this study. We have explicitly acknowledged that our width-to-  
398 depth ratio (12) is below the typical threshold for free bars (20-25), citing the suggested  
399 literature. We have, also revised the manuscript to remove the impression that the pilot  
400 run was designed to achieve self-sustained incipient meandering. We state explicitly how  
401 our W/D choice relates to our pilot objective of forced, localized response under  
402 conservative mobility:

403 • “Although bar theory suggests that free, migrating alternate bars typically require  
404  $W/D \gtrsim 20-25$  (Kleinhans and van den Berg, 2011; Kleinhans et al., 2024) and are  
405 rarely observed when  $W/D < 10$  (Crosato and Mosselman, 2020), we selected a  
406 moderate W/D ratio to balance sediment mobility with experimental control. This  
407 design choice was based on the assumption that topographic perturbations can  
408 force bars to develop in channels with W/D ratios below the free-bar threshold  
409 (Redolfi et al., 2021). Furthermore, scaling analyses indicate that small-scale  
410 laboratory channels require W/D ratios approximately 1.5 times larger than their  
411 natural counterparts to reproduce equivalent bar patterns (Kleinhans et al., 2014).  
412 In these initial exploratory runs, we therefore aimed to probe the thresholds for  
413 morphodynamic adjustment by implementing a controlled, incrementally  
414 increased perturbation, while operating within a conservative mobility regime to  
415 avoid a rapid transition to multi-thread behavior.” (revised ms, line 218 to 227)

416 17. *“Ln:156 this history of perturbations is not correct (see Kleinhans et al 2024 for the full story).*  
417 *In the first place, Christian Braudrick based his static perturbation on Friedkin 1945. In the*  
418 *second place, van Dijk et al did not build on this idea of static topographic forcing. Instead,*  
419 *the idea was that in a dynamic meandering river, the topographic dynamics come from*  
420 *upstream, AND nature is full of perturbations in the inflow, sediment influx and directions*  
421 *thereof. We also discovered after conducting the experiments that Lanzoni and Seminara had*  
422 *developed some theory and a numerical meandering model showing the need of such*  
423 *instabilities. This was later mathematically proven by Weiss and Higdon (2022). Critically for*  
424 *the author's paper, this is solid evidence that dynamic meandering in a relatively short flume*  
425 *such as this one requires a large and dynamic upstream perturbation.”*

426 We have corrected the history of perturbations, referencing Friedkin (1945), Lanzoni &  
427 Seminara (2006), and Weiss & Higdon (2022) to provide a more accurate theoretical  
428 context:

- 429 • “Previous experimental studies have used controlled perturbations to [trigger bars](#)  
430 [and bend instabilities](#). The objective is to simulate perturbations in the inflow and  
431 [sediment influx that are observed in nature](#). However, there has been various  
432 [designs for these perturbations in experimental geomorphology](#). Early laboratory  
433 [studies used a static planimetric perturbation by imposing an inflow at a fixed](#)  
434 [angle \(e.g., Friedkin \(1945\); see Kleinhans et al. \(2024\) for historical context\)](#).  
435 [This approach was later adopted in river experiments which aligns with the](#)  
436 [theoretical framework of Lanzoni and Seminara \(2006\)](#). In theory, [bend](#)  
437 [instabilities create disturbances that propagate downstream which require](#)  
438 [persistent upstream forcing to sustain meandering in relatively short flumes; a](#)  
439 [condition later proven mathematically by Weiss and Higdon \(2022\)](#). Based on  
440 [Friedkin \(1945\) simple configuration](#), Braudrick et al. (2009) aligned the entrance  
441 [channel at a small angle to a downstream straight reach, creating a bend that](#)  
442 [seeded flow vorticity, bank erosion, and meander growth](#). Building on this idea,  
443 [While Van Dijk et al. \(2012\) used a transversely movable inlet to impose time-](#)  
444 [varying planform forcing and accelerate meandering](#). In straight channels, other  
445 [work has promoted alternate-bar development by partially blocking the upstream](#)  
446 [entrance \(Nelson et al., 2010\)](#). Here, we used a constructed bar–pool unit near the  
447 [inlet to perturb the flow with the goal of catalyzing bank erosion” \(revised ms,](#)  
448 [line 240 to 252\)](#).

449 18. *“Ln:258 Given the tendency to armouring, the low mobility and the low W/D, and the initial*  
450 *flume runs to create a water-worked bed, it does not come as a surprise that no bars developed.*  
451 *This was also a result in Lanzoni/ 2000 experiments in a 1.5 m wide 50 m long flume, and he*  
452 *needed to increase the mobility to obtain bars, even though he used sediment recirculation*  
453 *rather than the lack of sediment supply in these experiments which inevitably leads to a static*  
454 *state. The extremely interesting behaviour of sediment mixtures is that an initially flat bed*  
455 *responds in two different manners, each with their own timescale: a sedimentological response,*  
456 *in this case armouring, and a morphological response, in this case alternate bars (but similarly*  
457 *in the context of bifurcations in bends that the Dutch did a lot of work on, see review on the*  
458 *effects of armouring in Kleinhans et al. 2012). So I agree with 284 that the sediment mobility*  
459 *needs to be tuned.”*

460 We agree, given the combination of conservative mobility design, relatively low W/D,  
461 initial conditioning (armouring), and the absence of upstream sediment supply, the rapid  
462 sedimentological adjustment is expected to outpace morphological adjustment, making  
463 the lack of bar development unsurprising.

464 As discussed in our responses to Comments 4, 5, and 16 (purpose of the pilot run,  
465 timescales, and W/D mobility choices), we revised the manuscript to make this logic  
466 explicit and to clarify that the initial campaign was a foundational exploration within a  
467 conservative mobility envelope (to avoid runaway multi-thread behavior), rather than an  
468 attempt to bar development:

- 469 • “Rather than targeting sustained free alternate bars or reach-scale incipient  
470 meandering, we tested whether a controlled, localized bed topography  
471 perturbation could generate forced bar-like responses with associated near-bank  
472 forcing and sediment sorting (armouring) under sediment-limited conditions.”  
473 (revised ms, line 209 to 212)
- 474 • “...we selected a moderate W/D ratio to balance sediment mobility with  
475 experimental control ... operating within a conservative mobility regime to avoid  
476 a rapid transition to multi-thread behavior.” (revised ms, line 220 to 227)
- 477 • “...rapid sedimentological adjustment... outpaces longer-timescale  
478 morphological adjustment associated with alternate-bar growth and planform  
479 change, particularly apparent when mobility is limited and upstream sediment  
480 supply is absent (Lanzoni, 2000; Kleinhans et al., 2013).” (revised ms, line 338 to  
481 341)
- 482 • “...recirculation system... to avoid progression toward a supply-limited,  
483 increasingly static and low mobility and armoured state...” (revised ms, line 398  
484 to 400)

485 *19. “Ln:287 If the purpose of these experiments is to represent small streams, then the bank*  
486 *strength is indeed one way to avoid braiding and promote meandering. However, as we*  
487 *demonstrated in our experiments and models, starting with van Dijk et al 2012 and reviewed*  
488 *extensively in the aforementioned 2024 paper, the more likely and more important mechanism*  
489 *needed for meandering is surface cover by vegetation or cohesive sediment on the inner bend.”*

490 We agree that vegetation and cohesive sediment are critical mechanisms for meandering,  
491 particularly for stabilizing the inner bend and preventing cutoffs. While the current  
492 experiment relied on substrate bank strength in a straight channel to test facility  
493 operations, we have explicitly acknowledged this limitation and the necessity of these  
494 factors for future meandering experiments in the OERF. In the revised manuscript, we  
495 outlined that future campaigns will specifically target these mechanisms:

496 • “This paper reports the first of three planned experimental campaigns at the  
497 OERF, which together strive to isolate key controls on bank erosion and planform  
498 adjustment: (study 1) a straight channel with no sediment supply (this study);  
499 (study 2) a sinuous channel with sediment recirculation; and (study 3) a vegetated  
500 sinuous channel with sediment recirculation. We view this paper as a foundational  
501 exploration of the facility’s capabilities and operational challenge, providing  
502 essential lessons for designing subsequent experiments, and sharing these  
503 capabilities to the broader research community.” (revised ms, line 105 to 111).

504 Furthermore, in the “Lessons learned” section, we added a direct acknowledgement of  
505 this requirement and included the suggested references (Van Dijk et al., 2012; Kleinhans  
506 et al., 2024):

507 • “As it is well known that vegetation and cohesive sediments are key mechanisms  
508 for meandering (Van Dijk et al., 2012; Kleinhans et al., 2024), future experiments  
509 should also integrate these factors.” (revised ms, line 392 to 394).

510 20. *“Ln:307 I agree that LSPIV is excellent for this kind of experiments and an appropriate*  
511 *reference is needed here (perhaps work by Wim Uijttewaal from whom we learned it?)”*

512 We have added (Fujita et al., 1998; Lewis and Rhoads, 2015) as references for LSPIV as  
513 a recommended future measurement technique. (revised ms, line 416).

514 21. *“Ln:310 I suggest to attempt structure for motion applied to a set of fixed cameras, which*  
515 *worked well in our past experiments.”*

516 We have added a suggestion to use fixed-camera configurations or structure-from-motion  
517 with better control for future monitoring:

518 • “Given the good site access at the OERF, we plan to evaluate complementary  
519 survey approaches. This including terrestrial laser scanning (TLS) (Heritage and

520 Hetherington, 2007; Brasington et al., 2012; Lague, 2020) and close-range SfM  
521 using global navigation satellite system (GNSS) (e.g., via a camera rigidly  
522 mounted to the GNSS pole or an integrated GNSS-camera unit) (Jaud et al., 2020)  
523 or fixed-cameras configurations. These methods should provide improved  
524 repeatability for targeted sub-reach differencing. TLS or an integrated GNSS-  
525 camera unit are particularly advantageous for resolving steep banks and local  
526 undercutting where nadir UAV imagery can be geometrically weaker.” (revised  
527 ms, line 429 to 435).

528 22. *“Ln:312 I suggest to use biological pest controls such as presented in our papers (Weisscher*  
529 *et al 2022, protocol in the supplementary material)”*

530 Thank you for the suggestion.

531 **Referee 2, Anonymous, DOI: 10.5194/egusphere-2025-4352-RC3**

532 23. *“Overall, I found the manuscript a bit underwhelming in terms of the new science that it*  
533 *presents. However, given the stated goal of introducing the new experimental facility, I have*  
534 *no major reservations with the paper being accepted for publication. Perhaps the largest issue*  
535 *with the current manuscript is that the introduction and initial experimental purpose are*  
536 *somewhat disjoint with the reported results and especially the focus within the results of the*  
537 *velocity measurements. Currently, much of the focus of the initial experiments is on creating a*  
538 *self-formed sinuous or meandering channel, however, this didn't really work out (that's fine,*  
539 *many of my experiments did not) and so the results focus on observed channel change, bed*  
540 *grain size coarsening, and the velocity measurements. It would be worthwhile, in my opinion,*  
541 *to downplay the focus on meandering and reframe the introduction towards what actually*  
542 *happened in the experiment. I am not suggesting rewriting it wholesale, but adding more about*  
543 *what you ended up doing and less about what you wanted to do.”*

544 Thank you for the constructive feedback, suggestions and the recommendation for  
545 publication. We agree with the assessment that the original introduction promised a focus  
546 on meandering that the results did not deliver, creating a disjointed narrative. As noted in  
547 our response to Referee 1 (Comments 1 and 4), we have undertaken a major revision to  
548 realign the introduction and experimental design sections with the actual outcomes. We  
549 specifically focused on facility characterization, sediment sorting (armouring), and the  
550 operational constraints of large-scale outdoor experimentation.

551 We have reframed the manuscript to position this study explicitly as a "foundational  
552 exploration" rather than a meandering experiment. In the revised Introduction, we now  
553 state:

- 554                   • “This paper reports the first of three planned experimental campaigns at the  
555                   OERF, providing a foundational assessment of facility capabilities and operational  
556                   constraints to guide subsequent sinuous and vegetated experiments with sediment  
557                   recirculation.” (revised ms, line 6 to 8)
- 558                   • “We view this paper as a foundational exploration of the facility’s capabilities and  
559                   operational challenges, providing essential lessons for the design of subsequent  
560                   experiments...” (revised ms, line 108 to 110)

561 24. *“I would really like to know, from the authors perspective, what they felt they learned that we  
562 didn't necessarily already know. The measurements that were taken are very nice and the  
563 change in grain size distribution and DEMs of difference are interesting, but overall I am left  
564 with the feeling that we'd be better off doing smaller scale experiments because we still don't  
565 know enough about channels to properly set up and initiate a larger scale experiment. I  
566 remember a conversation with the engineers at SAFL that can be summed up as 'big  
567 experiments come with big logistical problems', that seems to be true here. This isn't to  
568 downplay what is presented, but instead i hope the authors will share more about what they  
569 did learn from their experiments from the science perspective in addition to the lessons they  
570 have already offered. Rather than failing to make a meandering channel, what did we learn  
571 about a mixed grain size no sediment feed channel that we didn't already know? In a sense,  
572 what does this new experiment at large scale say about the previous fixed wall experiments  
573 with mixed sediment transport (particularly, some of the large flume experiments done at  
574 SAFL, CSU in Fort Collins with bars, experiments by Hassan's or Eaton's group in British  
575 Columbia or even Peter Wilcock's original experiments).”*

576                   We sincerely appreciate these insightful questions. We agree with the big logistical  
577                   problems. The more important lesson is the physical confirmation of how sediment  
578                   sorting/mobility can be studied under planform forcing in a way that fixed-wall or small-  
579                   scale experiments cannot fully replicate.

580                   In response, we have revised the manuscript to explicitly articulate the scientific  
581                   motivations and lessons learned from large scale experiments:

- 582                   • “Existing models cannot capture all these relevant processes .... Some of these  
583                   processes, such as sediment sorting and cohesive effects are scale-dependent, and  
584                   are inherently difficult to study at planform scale with existing facilities  
585                   (Kleinhans et al., 2014, 2024).” (revised ms, line 23 to 36)
- 586                   • “In order to preserve the similarity of the processes affecting planform evolution,  
587                   researchers have moved from conventional engineering scaling, which is  
588                   unfeasible, to more effective relaxed scaling requirements (Paola et al., 2009;

589 Kleinhans et al., 2014, 2024). .... To simultaneously satisfy these requirements at  
590 reduced scales, researchers often force deliberate distortions, such as vertical  
591 exaggeration, steepened channel slope, or the use of lightweight sediment  
592 (Gorrick and Rodríguez, 2014), each of which can alter flow dynamics or  
593 sediment transport (e.g., Ashworth et al., 1996; Lu et al., 2013; Kleinhans et al.,  
594 2015).” (revised ms, line 37 to 50).

595 • “Studying planform evolution processes at reduced scale commonly challenges  
596 simultaneous satisfaction of these scaling rules, especially with evolving bed and  
597 banks..... In such setups, a hydraulically rough bed can conflict with the need for  
598 sufficient sediment mobility (Kleinhans et al., 2014). Many experiments therefore  
599 end up bedload-dominated and thus behave morphodynamically more like  
600 gravel-bed rivers (e.g., Van Dijk et al., 2012), while scarcely representing  
601 suspension-dominated sand-bed rivers. This limitation is more evident for  
602 floodplain flow when flow depth is shallower than 1 cm (e.g., Braudrick et al.,  
603 2009) which is likely laminar. Accordingly, floodplain construction and bank  
604 strength that strongly depend on fine-sediment exchange and overbank deposition  
605 tend to be under-represented at small-scale experimentation (Lajeunesse et al.,  
606 2010).” (revised ms, line 51 to 65).

607 • “Investigating scale-dependent processes requires larger-scale research, which is  
608 challenging. Bank erosion is governed by near-bank stresses and turbulence  
609 structure that contribute to sequences of toe scour, undercutting, and mass failure  
610 (Simon et al., 2000; Engel and Rhoads, 2017; Das et al., 2019). For example, Roy  
611 et al. (2020) observed in controlled undercut experiments that near-bank  
612 turbulence intensities peak within the most eroded zone, highlighting how  
613 turbulence strength (i.e., at sufficiently high Reynolds number) can govern bank  
614 erosion rates. In gravel-bed rivers, for example, the near-boundary entrainment is  
615 dominated by turbulent stresses, and the forcing experienced by banks and bed  
616 grains is mediated by large, energetic flow structures rather than by mean flow  
617 alone (Roy et al., 2004; Nikora, 2007). Biota (e.g., vegetation and microbial  
618 effects) and cohesion play a vital role in controlling bank erosion (van Dijk et al.,  
619 2013; Vignaga et al., 2013). These effects are scale-dependent and difficult to

620 represent at small scales. As stated by Kleinhans et al. (2014) (p.44), "no  
621 convenient theory is available to scale bank erosion rate and floodplain  
622 sedimentation". These challenges make meandering experiments typically more  
623 demanding to sustain than braided patterns (e.g, Peakall et al., 2007; Braudrick  
624 et al., 2009). Furthermore, sediment sorting can be scale-dependent. Not only  
625 does scaling down a gravel-sand mixture often force the finer fraction into the  
626 silt-clay range, but viscous effects can then dominate the transport, inhibiting the  
627 non-cohesive sorting and armouring processes that are naturally dominant at the  
628 prototype scale (Hassan et al., 2024). These dependencies do not imply that low  
629 Reynolds number experiments are unrepresentative in general (Paola et al.,  
630 2009), rather, they identify specific mechanisms (particularly those tied to flow  
631 anisotropy, intermittency, turbulence structure, secondary circulation, bank  
632 material strength, and bank–floodplain exchange) for which regime fidelity  
633 becomes more essential.” (revised ms, line 68 to 86).

634 25. *“One of the large challenges with doing mobile channel experiments is in setting the inlet and*  
635 *outlet conditions. Given the considerable knowledge gained with the preliminary experiments,*  
636 *can the authors provide additional comments/thoughts on how they would envision the inlet*  
637 *condition for the sediment recirculation case especially under the condition of a variable flow*  
638 *regime?”*

639 Controlling boundary conditions is indeed one of the most difficult aspects of large-scale  
640 mobile bed and banks modelling, particularly when introducing discharge variability. In  
641 the initial experiments, we used static manual controls (plywood logs).

642 In the revised manuscript, we have expanded the Facility Design (Section 2.1) and  
643 Lessons Learned (Section 4.3) to explicitly describe our vision for these controls under  
644 recirculation and variable flow conditions:

- 645 • “Both the inlet and outlet boundary conditions are implemented using temporary  
646 control structures (e.g., wooden weirs) that can be adjusted in elevation and  
647 geometry to meet experiment-specific targets (e.g., water-surface elevation,  
648 conveyance, and measurement configuration). The downstream control for the  
649 experiments reported here was managed using an adjustable sluice gate  
650 constructed from plywood logs, with the opening tuned to limit backwater effects  
651 in the study reach. To reduce sensitivity of the experimental reach to local

652 scour/deposition at the boundaries, the bed near the inlet and near the outlet is  
653 locally protected with small sections of bed leveled riprap (with protection lengths  
654 adapted to the targeted discharge range and experimental objectives).” (revised  
655 ms, line 148 to 154).

656 • “At the outlet, both bedload and some suspended material will be captured with  
657 reinjection either in a highly mixed zone immediately downstream of the inlet  
658 weir or via a transverse manifold designed to normally distribute sediment across  
659 the channel width. This upgrade should be paired with equipment for quantifying  
660 supply (e.g., inline mass/flux monitoring) and for repeatable sampling of the  
661 injected mixture.” (revised ms, line 163 to 166).

662 • “Other physical improvements to the OERF should include a flow-straightening  
663 diffuser below the entrance cascade to reduce turbulence intensity at the inlet and  
664 a PID-controlled tail-gate weir to reduce downstream backwater effects.” (revised  
665 ms, line 405 to 407).

666 26. *“Ln. 46 - I am all for larger experiments, but can you enlighten the reader here what we stand  
667 to gain through more realistic reynolds numbers? Other than increased secondary flows, how  
668 is a higher reynolds expected to change the morphodynamics. A follow up, how much does  
669 coarse sediment care about secondary flows?”*

670 As addressed in our response to Referee 1 (Comments 1, 3, and 12), we have substantially  
671 reconstructed the Introduction to move beyond a simple bigger is better argument. In the  
672 revised manuscript, we explicitly clarify that "realistic" Reynolds numbers are not just  
673 about secondary circulation, but are critical for enabling specific scale-dependent  
674 mechanisms that govern planform evolution such as near-bank stresses (revised ms, line  
675 68), biota and cohesion (revised ms, line 75), and bank-floodplain exchange (revised ms,  
676 line 85).

677 We agree that coarse grains are less sensitive to viscous effects. However, we argue that  
678 sediment sorting in mixtures (gravel–sand) is sensitive to scale. If a mixture is scaled  
679 down too far, the sand fraction may enter the viscous regime, inhibiting the natural  
680 segregation and armouring processes that regulate mobility:

681 • “... sediment sorting can be scale-dependent. Not only does scaling down a  
682 gravel-sand mixture often force the finer fraction into the silt-clay range, but

683 viscous effects can then dominate the transport, inhibiting the non-cohesive  
684 sorting and armouring processes that are naturally dominant at the prototype scale  
685 (Hassan et al., 2024).” (revised ms, line 80 to 83).

686 27. “Ln. 51 - Within this paragraph, would the authors be amenable to adding the year that the  
687 facilities became operational?”

688 We have added the operational start date (2019) to the text as requested. (revised ms, line  
689 101)

690 28. “Ln. 67 - Not clear to me why Wilcock and Crowe is the citation here. Mixed grain size  
691 transport as developed in this reference has already been shown to work well at the field scale.  
692 You might consider the work from the IGP group here that builds on Metivier et al., (2017)  
693 as they develop substantial theory at very small scales and would require an erodible bank for  
694 larger scale testing. Popovic et al., (year) seems like a better fit here.”

695 We agree. Sentence was removed. (revised ms, line 103)

696 29. “Ln. 88 - Can you provide some input on how long it takes to change out the bed conditions  
697 and what types of labor is required given the facility constraints? For example, does the  
698 sediment bed need to be prepped by hand or can some sort of heavier machinery be involved.”

699 In the revised manuscript (Section 2.1), we have added details on the time and machinery  
700 required for bed preparation and channel reconfiguration:

701 • “Reconfiguring the bed from one experiment to the other typically involves (i)  
702 removing and stockpiling the existing substrate, (ii) placing a new substrate (either  
703 freshly delivered material or a processed fraction of the existing substrate), and,  
704 when needed, (iii) sieving and/or blending using heavy machinery (e.g.,  
705 excavators and a rotary drum screener) under close guidance of the research team.  
706 Survey control (GNSS, total station, and laser levels) is used to set elevations and  
707 slopes, and ground marking is used to guide trenching of the designed channel.  
708 The heavy-machinery phase (substrate handling, rough grading, and placement of  
709 coarse protections) can be completed in up to 3 full days for a typical channel  
710 rebuild, while subsequent manual finishing (e.g., trimming banks and side slopes,  
711 detailing geomorphic features, or local surface conditioning) commonly requires  
712 from 1 to 2 weeks, depending on the required level of geometric detail;  
713 experiments involving vegetation establishment require longer preparation times.  
714 As the facility is not yet winterized, major reconfigurations are generally limited

715 to one primary channel design per operating season (approximately April to  
716 November).” (revised ms, line 137 to 147)

717 30. “Section 2.1 - Is there any ability to change the elevation of the inlet or outlet? Weir adjustment  
718 etc.”

719 We have clarified that the inlet and outlet utilize temporary control structures adjustable  
720 in elevation to manage boundary conditions. (revised ms, line 147 to 154)

721 31. “Section 2.1 - Could you describe how is the outlet condition handled to keep the sediment  
722 bed from eroding or depositing with variable flows?”

723 We have described the sediment trap and the planned recirculation loop to explain how  
724 sediment outflow is handled. revised ms, line 147 to 154 and line 162 to 165

725 32. “Table 1 - Consider adding the shields stress and transport capacity ratio to this table given  
726 the sediment transport focus of the initial experiment.”

727 We have added the Bankfull Shields number and Suspension/washload Transport ratio to  
728 Table 1.

729 33. “Ln. 221 - What is the basis for the critical shields value of 0.045? Is this visually confirmed  
730 or validated from transport measurements?”

731 We have clarified the basis for the critical Shields value of 0.045 as a literature  
732 representative value following Buffington & Montgomery (1997) (revised ms, line 236)

733 34. “Ln. 308 - Given the difficulties with drones, and the relative constrained spatial scale with  
734 good access, do the authors recommend continuing to use drones or would a ground based  
735 TLS unit on a platform be a wiser investment?”

736 We now clarify our recommendation to UAV-SfM and we state that we plan to evaluate  
737 TLS and GNSS-/fixed-camera solutions given the site access and repeatability needs:

- 738 • “Given the good site access at the OERF, we plan to evaluate complementary  
739 survey approaches. This including terrestrial laser scanning (TLS) (Heritage and  
740 Hetherington, 2007; Brasington et al., 2012; Lague, 2020) and close-range SfM  
741 using global navigation satellite system (GNSS) (e.g., via a camera rigidly  
742 mounted to the GNSS pole or an integrated GNSS-camera unit) (Jaud et al., 2020)  
743 or fixed-cameras configurations. These methods should provide improved  
744 repeatability for targeted sub-reach differencing. TLS or an integrated GNSS-  
745 camera unit are particularly advantageous for resolving steep banks and local

746 undercutting where nadir UAV imagery can be geometrically weaker.” (revised  
747 ms, line 429 to 435).

748 35. *“Conclusions - Can you comment (if appropriate) on whether this facility is expected to be*  
749 *open to external collaborations, seeking collaboration or is it primarily for internal use?”*

750 We appreciate the reviewer raising this point. Fostering community engagement is a  
751 primary motivation for publishing this paper. We have added a dedicated statements in  
752 the revised manuscript to make this invitation explicit:

753 • “We view this paper as a foundational exploration of the facility’s capabilities and  
754 operational challenges, providing essential lessons for the design of subsequent  
755 experiments, and sharing these capabilities with the broader research community.  
756 It is hoped that publicizing the OERF’s capabilities will foster research  
757 partnerships to design and conduct future experimental campaigns.” (revised ms,  
758 line 108 to 111).

759 • “Researchers at the OERF encourage collaborative research, and we welcome  
760 external partnerships to co-design and conduct future experimental campaigns.”  
761 (revised ms, line 467 to 468).

762

763 **Once again, we are sincerely grateful to both reviewers for providing these detailed,**  
764 **thoughtful, and constructive comments. The manuscript is much improved as a result.**

765

766 **Added References:**

- 767 Brasington, J., Vericat, D., and Rychkov, I.: Modeling river bed morphology, roughness, and  
768 surface sedimentology using high resolution terrestrial laser scanning, *Water resources research*,  
769 48, 2012.
- 770 Das, V. K., Roy, S., Barman, K., Chaudhuri, S., and Debnath, K.: Study of clay–sand network  
771 structures and its effect on river bank erosion: an experimental approach, *Environmental Earth*  
772 *Sciences*, 78, 591, 2019.
- 773 Engel, F. L. and Rhoads, B. L.: Velocity profiles and the structure of turbulence at the outer bank  
774 of a compound meander bend, *Geomorphology*, 295, 191–201, 2017.
- 775 Friedkin, J. F.: A laboratory study of the meandering of alluvial rivers, United States Waterways  
776 Experiment Station, 1945.
- 777 Fujita, I., Muste, M., and Kruger, A.: Large-scale particle image velocimetry for flow analysis in  
778 hydraulic engineering applications, *Journal of hydraulic Research*, 36, 397–414, 1998.
- 779 Gorrick, S. and Rodríguez, J. F.: Scaling of sediment dynamics in a laboratory model of a sand-  
780 bed stream, *Journal of Hydro-Environment Research*, 8, 77–87, 2014.
- 781 Hassan, M. A., Parker, G., Hassan, Y., An, C., Fu, X., and Venditti, J. G.: The roles of geometry  
782 and viscosity in the mobilization of coarse sediment by finer sediment, *Proceedings of the National*  
783 *Academy of Sciences*, 121, e2409436 121, 2024.
- 784 Heritage, G. and Hetherington, D.: Towards a protocol for laser scanning in fluvial  
785 geomorphology, *Earth Surface Processes and Landforms: The Journal of the British*  
786 *Geomorphological Research Group*, 32, 66–74, 2007.
- 787 Jaud, M., Bertin, S., Beauverger, M., Augereau, E., and Delacourt, C.: RTK GNSS-assisted  
788 terrestrial SfM photogrammetry without GCP: Application to coastal morphodynamics  
789 monitoring, *Remote Sensing*, 12, 1889, 2020.
- 790 Kleinhans, M.: Upstream sediment input effects on experimental dune trough scour in sediment  
791 mixtures, *Journal of Geophysical Research: Earth Surface*, 110, 2005.
- 792 Kleinhans, M. G. and van den Berg, J. H.: River channel and bar patterns explained and predicted  
793 by an empirical and a physics-based method, *Earth Surface Processes and Landforms*, 36, 721–  
794 738, 2011.
- 795 Kleinhans, M. G., Braudrick, C., van Dijk, W. M., Van de Lageweg, W. I., Teske, R., and Van  
796 Oorschot, M.: Swiftness of biomorphodynamics in Lilliput-to Giant-sized rivers and deltas,  
797 *Geomorphology*, 244, 56–73, 2015.
- 798 Kleinhans, M. G., Ferguson, R. I., Lane, S. N., and Hardy, R. J.: Splitting rivers at their seams:  
799 bifurcations and avulsion, *Earth surface processes and landforms*, 38, 47–61, 2013.

800 Kleinhans, M. G., McMahon, W. J., and Davies, N. S.: What even is a meandering river? A  
801 philosophy-enhanced synthesis of multilevel causes and systemic interactions contributing to river  
802 meandering, Geological Society, London, Special Publications, 540, 43–74,  
803 <https://doi.org/10.1144/SP540-2022-138>, 2024.

804 Kleinhans, M. G., van Dijk, W. M., van de Lageweg, W. I., Hoyal, D. C., Markies, H., van  
805 Maarseveen, M., Roosendaal, C., van Weesep, W., van Breemen, D., Hoendervoogt, R., et al.:  
806 Quantifiable effectiveness of experimental scaling of river-and delta morphodynamics and  
807 stratigraphy, *Earth-Science Reviews*, 133, 43–61, 2014.

808 Lague, D.: Terrestrial laser scanner applied to fluvial geomorphology, in: *Developments in earth*  
809 *surface processes*, vol. 23, pp. 231–254, Elsevier, 2020.

810 Lajeunesse, E., Malverti, L., Lancien, P., Armstrong, L., Metivier, F., Coleman, S., Smith, C. E.,  
811 Davies, T., Cantelli, A., and Parker, G.: Fluvial and submarine morphodynamics of laminar and  
812 near-laminar flows: A synthesis, *Sedimentology*, 57, 1–26, 2010.

813 Lanzoni, S.: Experiments on bar formation in a straight flume: 1. Uniform sediment, *Water*  
814 *Resources Research*, 36, 3337–3349, 2000.

815 Lanzoni, S. and Seminara, G.: On the nature of meander instability, *Journal of Geophysical*  
816 *Research: Earth Surface*, 111, 2006.

817 Lewis, Q. W. and Rhoads, B. L.: Resolving two-dimensional flow structure in rivers using large-  
818 scale particle image velocimetry: An example from a stream confluence, *Water Resources*  
819 *Research*, 51, 7977–7994, 2015.

820 Lu, J., Liao, X., and Zhao, G.: Experimental study on effects of geometric distortion upon  
821 suspended sediments in bending channels, *Sedimentary Geology*, 294, 27–36, 2013.

822 Nikora, V.: 3 Hydrodynamics of gravel-bed rivers: scale issues, *Developments in Earth Surface*  
823 *Processes*, 11, 61–81, 2007.

824 Paola, C., Straub, K., Mohrig, D., and Reinhardt, L.: The “unreasonable effectiveness” of  
825 stratigraphic and geomorphic experiments, *Earth-Science Reviews*, 97, 1–43, 2009.

826 Parker, G. and Wilcock, P. R.: Sediment feed and recirculating flumes: Fundamental difference,  
827 *Journal of Hydraulic Engineering*, 119, 1192–1204, 1993.

828 Redolfi, M., Musa, M., and Guala, M.: On steady alternate bars forced by a localized asymmetric  
829 drag distribution in erodible channels, *Journal of Fluid Mechanics*, 916, A13, 2021.

830 Roy, A. G., Buffin-Belanger, T., Lamarre, H., and Kirkbride, A. D.: Size, shape and dynamics of  
831 large-scale turbulent flow structures in a gravel-bed river, *Journal of Fluid Mechanics*, 500, 1–27,  
832 2004.

- 833 Roy, S., Barman, K., Das, V., Debnath, K., and Mazumder, B.: Experimental investigation of  
834 undercut mechanisms of river bank erosion based on 3D turbulence characteristics, *Environmental*  
835 *Processes*, 7, 341–366, 2020.
- 836 Simon, A., Curini, A., Darby, S. E., and Langendoen, E. J.: Bank and near-bank processes in an  
837 incised channel, *Geomorphology*, 35, 193–217, 2000.
- 838 van Dijk, W. M., van de Lageweg, W. I., and Kleinhans, M. G.: Formation of a cohesive floodplain  
839 in a dynamic experimental meandering river, *Earth Surface Processes and Landforms*, 38, 1550–  
840 1565, 2013.
- 841 Venditti, J., Nelson, P., Minear, J., Wooster, J., and Dietrich, W.: Alternate bar response to  
842 sediment supply termination, *Journal of Geophysical Research: Earth Surface*, 117, 2012.
- 843 Vignaga, E., Sloan, D. M., Luo, X., Haynes, H., Phoenix, V. R., and Sloan, W. T.: Erosion of  
844 biofilm-bound fluvial sediments, *Nature Geoscience*, 6, 770–774, 2013.
- 845 Weiss, S. F. and Higdon, J. J.: Dynamics of meandering rivers in finite-length channels: linear  
846 theory, *Journal of Fluid Mechanics*, 938, A11, 2022.
- 847 Wilcock, P. R. and DeTemple, B. T.: Persistence of armor layers in gravel-bed streams,  
848 *Geophysical Research Letters*, 32, 2005.