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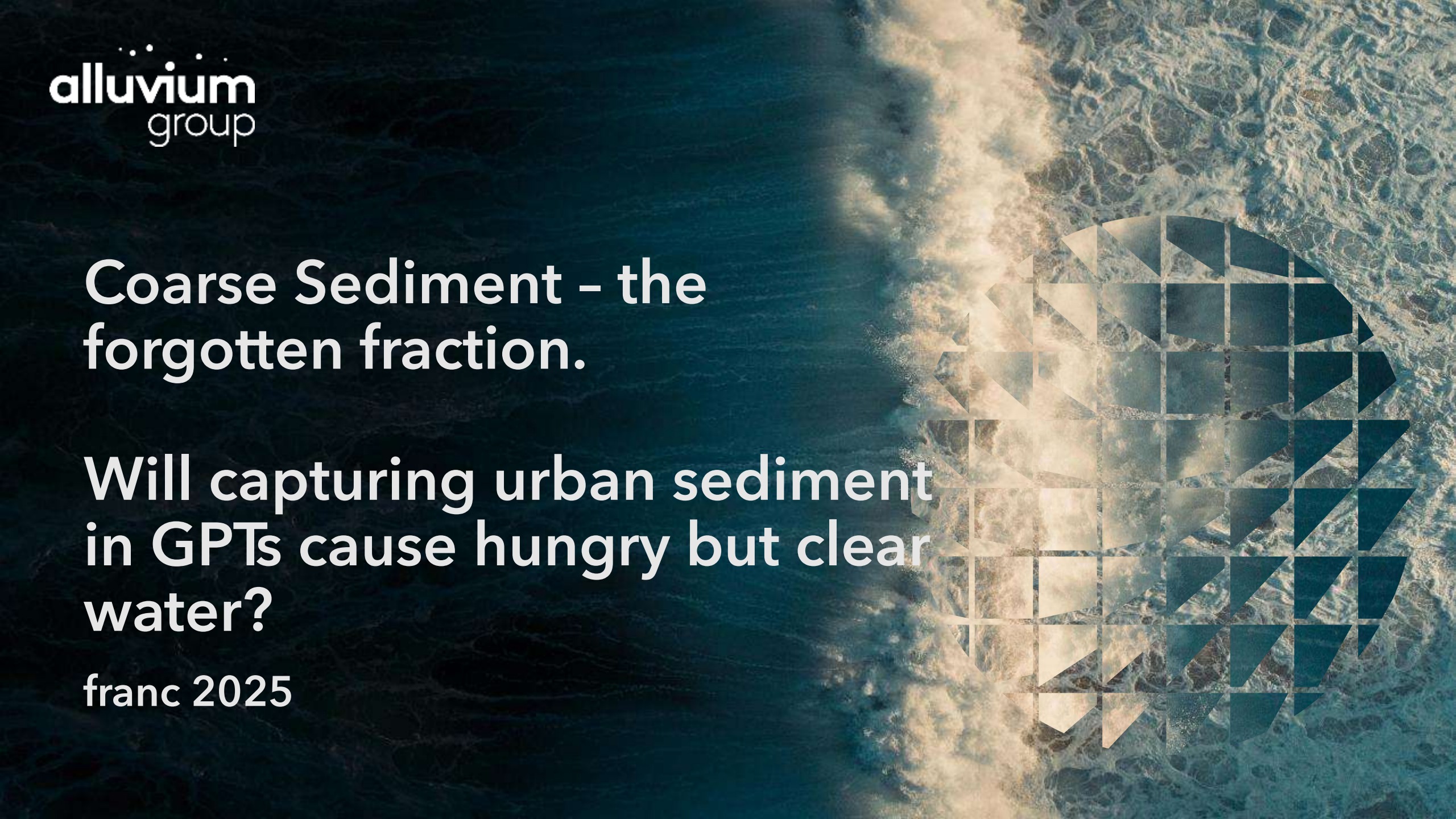
Coarse Sediment – the forgotten fraction.

Will capturing urban sediment in GPTs cause hungry but clear water?

franc 2025



Acknowledgement of Country

The Alluvium Group recognises and acknowledges the unique relationship and deep connection to Country shared by Aboriginal and Torres Strait Islander people, as First Peoples and Traditional Owners of Australia. We pay our respects to their Cultures, Country and Elders past and present.

Artwork by Melissa Barton. This piece was commissioned by Alluvium and tells our story of caring for Country, through different forms of waterbodies, from creek lines to coastlines. The artwork depicts people linked by journey lines, sharing stories, understanding and learning to care for country and the waterways within.

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Presentation overview:

- The project objective
- Why I think this work is worth sharing
- Project method
- Findings
- Applicability to other work

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Project objective:

Develop a detailed sediment budget for Gwawley Creek and use it to determine:

- How it would change with the installation of proprietary GPTs on six sub catchments
- Whether this would translate to ‘hungry water’ unacceptable erosion
- Whether this would help this issue of fine sediment deposition in the downstream embayment.

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Why do I think this work is worth sharing:

- Share a review of the data behind the MUSIC TSS input and treatment parameters and what grain classes they reflect
- Present a bespoke application of a common tool
- Share our findings on the impacts of GPTs on the sediment regime in a Sydney creek
- A reminder of the role of applied geomorphology in urban streams

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Project method

Define reaches and landforms

- Field assessment
- GIS analysis
- Preliminary hydraulic assessment

Build a conceptual model

- Define a hypothesis

Calculate a detailed sediment budget

- Hydrology
- Sediment export
- Sediment transport potential
- Sediment change by reach

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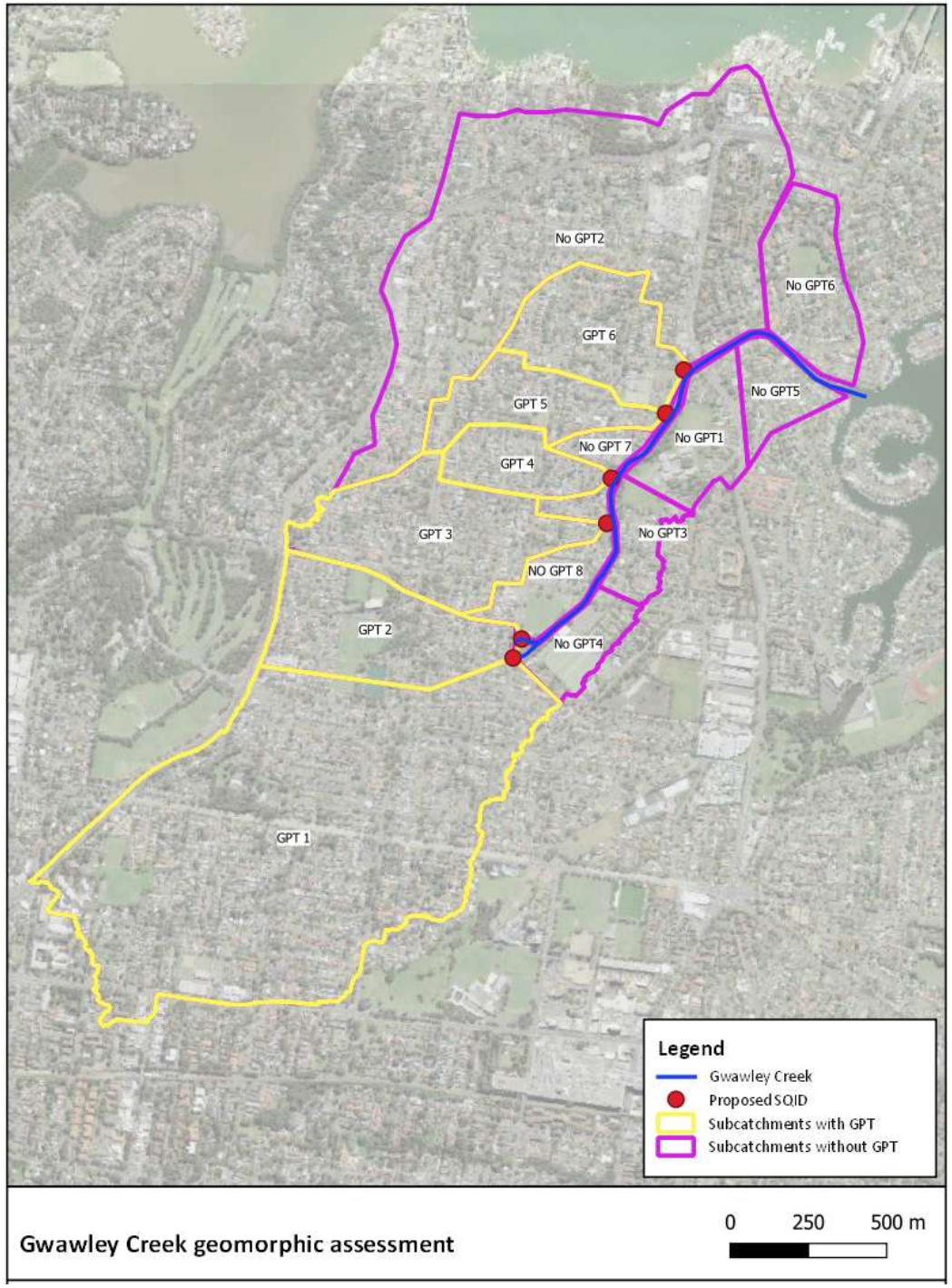
The setting


No GPT2
No GPT6
GPT 6
No GPT5
GPT 5
No GPT1
No GPT 7
GPT 4
GPT 3
No GPT3
NO GPT 8
GPT 2
No GPT4
GPT 1
Legend
Gwawley Creek
Proposed SQID
Subcatchments with GPT
Subcatchments without GPT
Gwawley Creek geomorphic assessment
0
250
500 m

Step 1: Reach definition

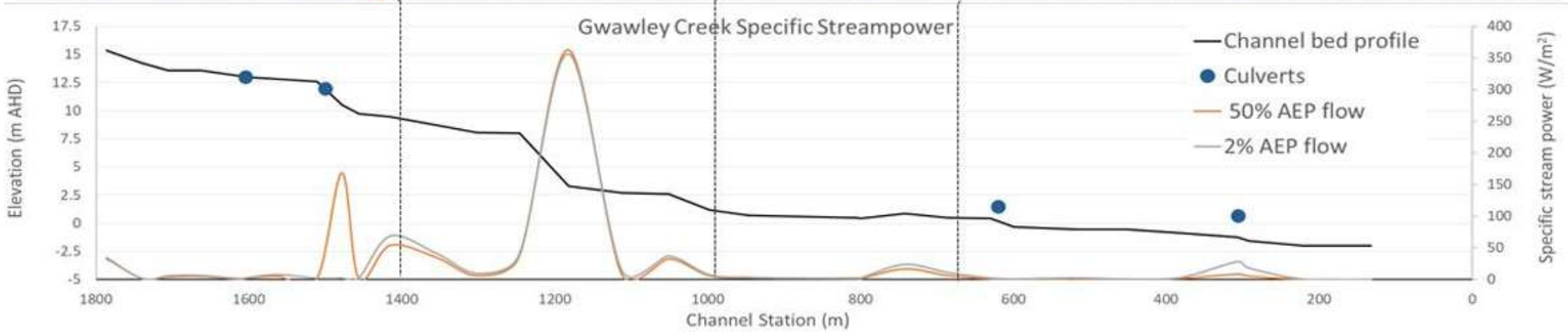
Reach 1
Sediment storage dominates
Sediment supply >> transport capacity
Bed and banks sensitive to change in sed supply

Reach 2
Sediment transport dominates
Sediment supply << transport capacity
Banks moderately sensitive to change in sed supply

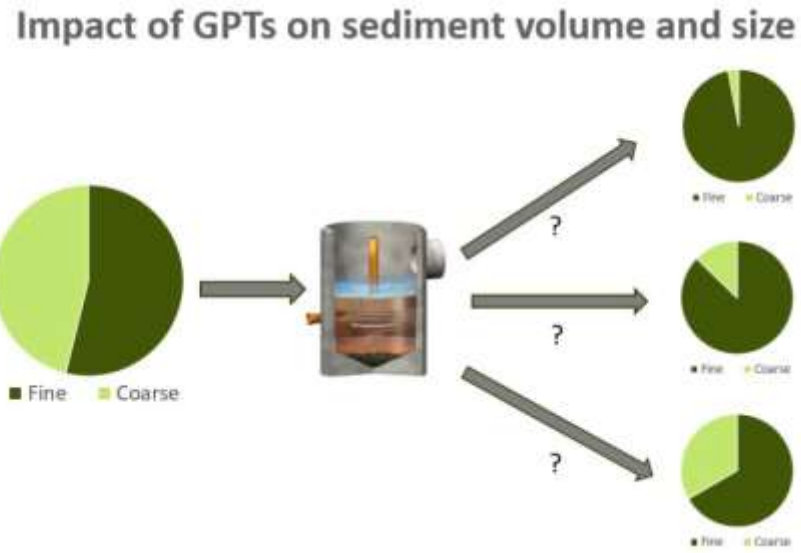
Reach 3
Bedload sediment deposited
Sediment supply ~ transport capacity
Banks and bed moderately sensitive to change in sed supply

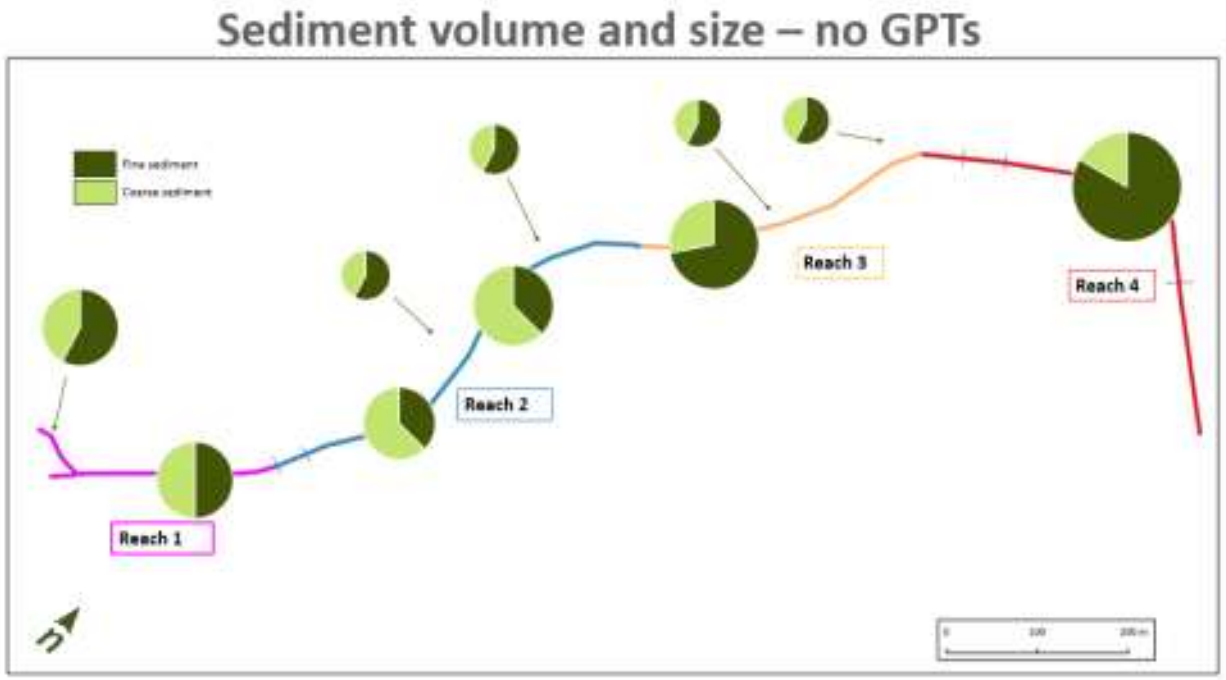
Reach 4
Sediment deposition dominates
Sediment supply >> transport capacity
Bed moderately sensitive to change in sed supply

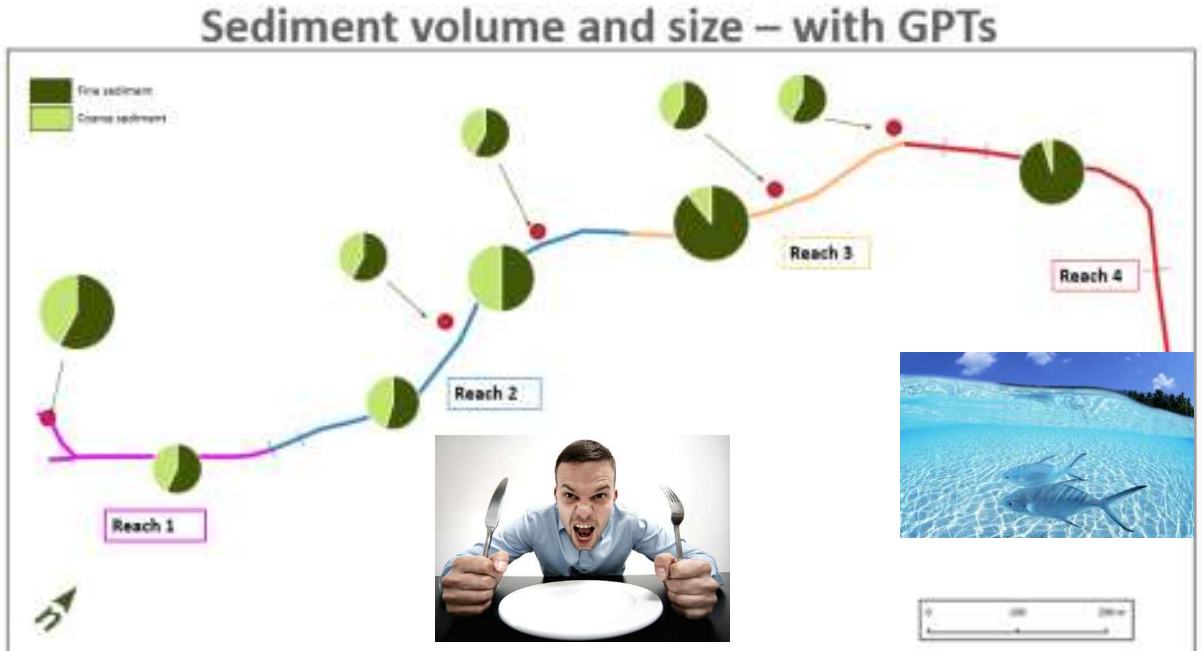
Step 1: Defined reaches



Step 2: Conceptual model hypothesis







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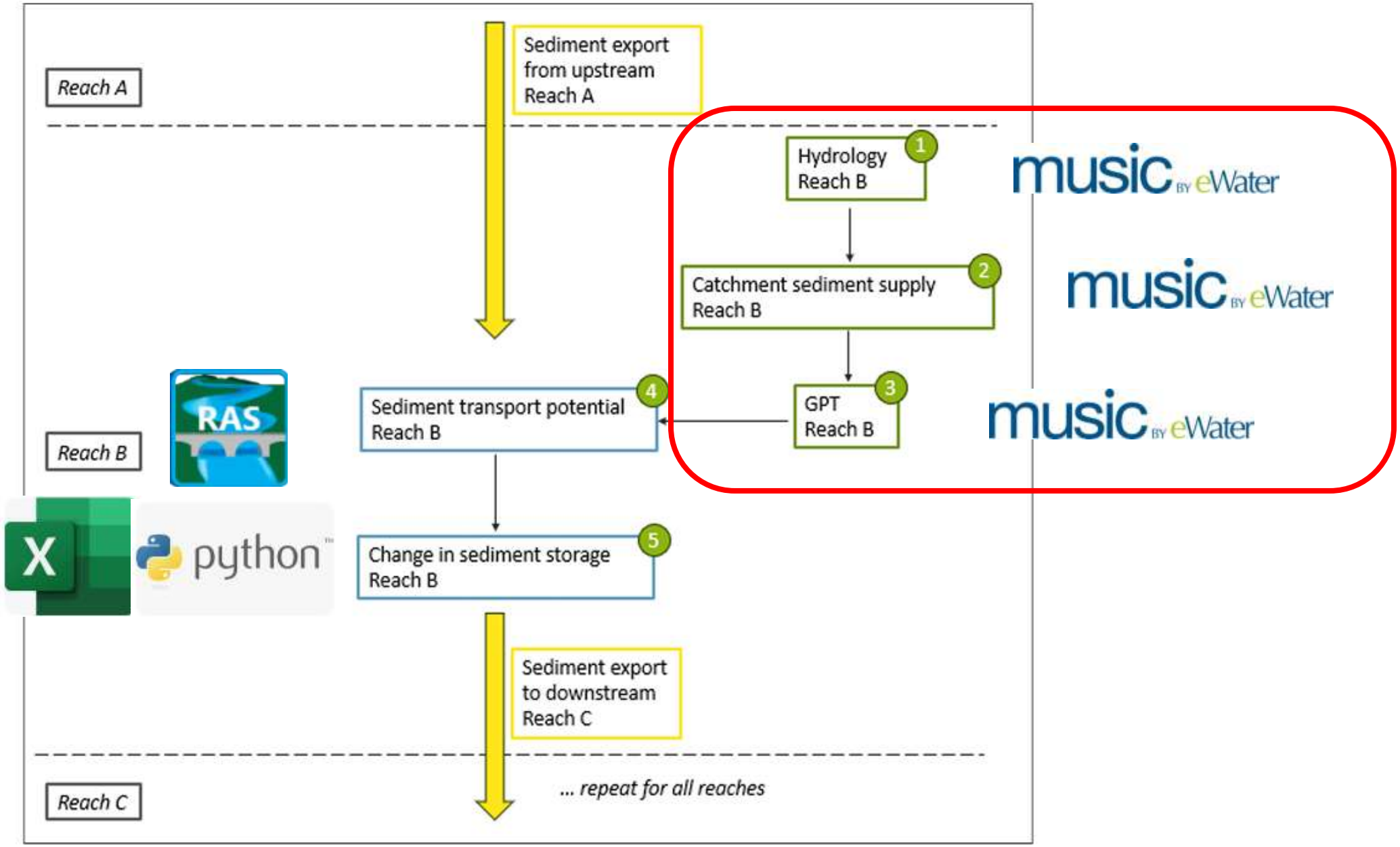
Step 3 – Detailed sediment budget



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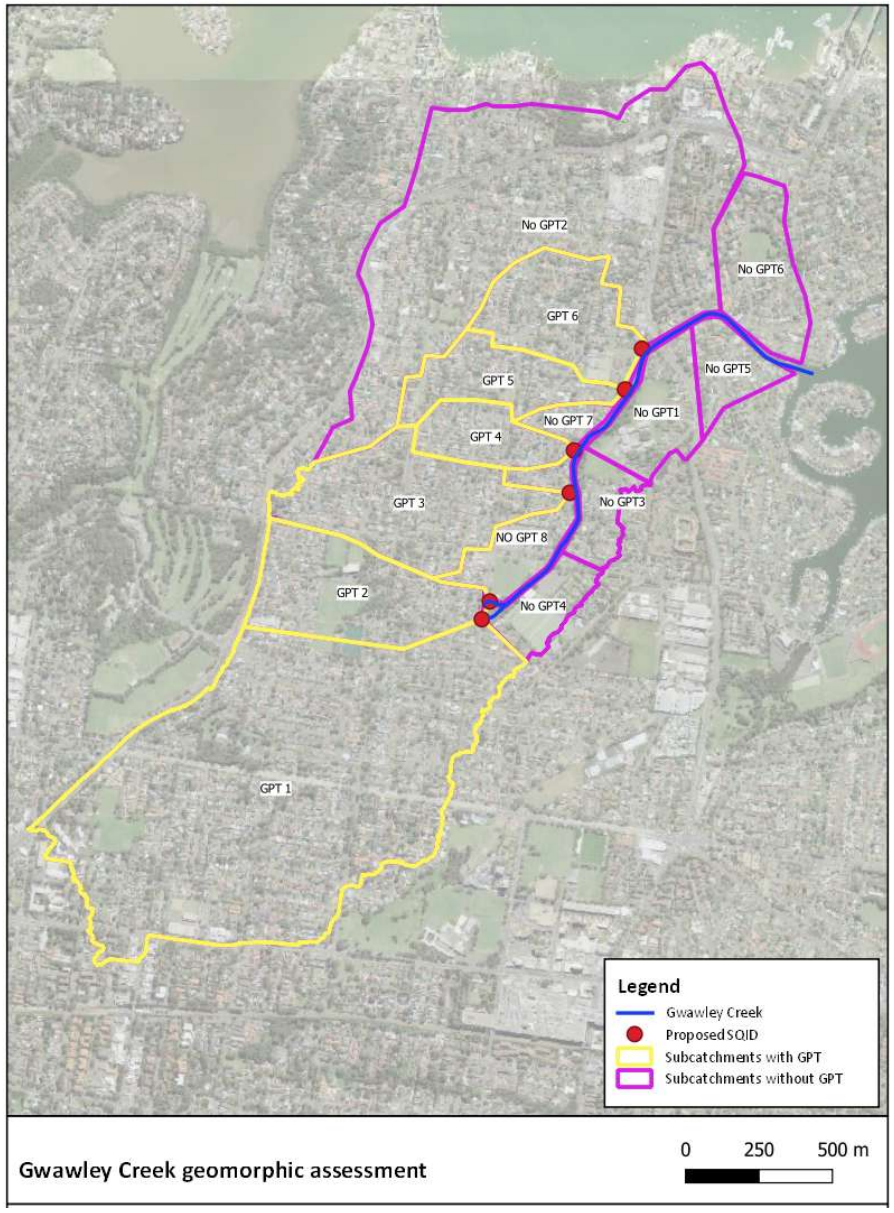
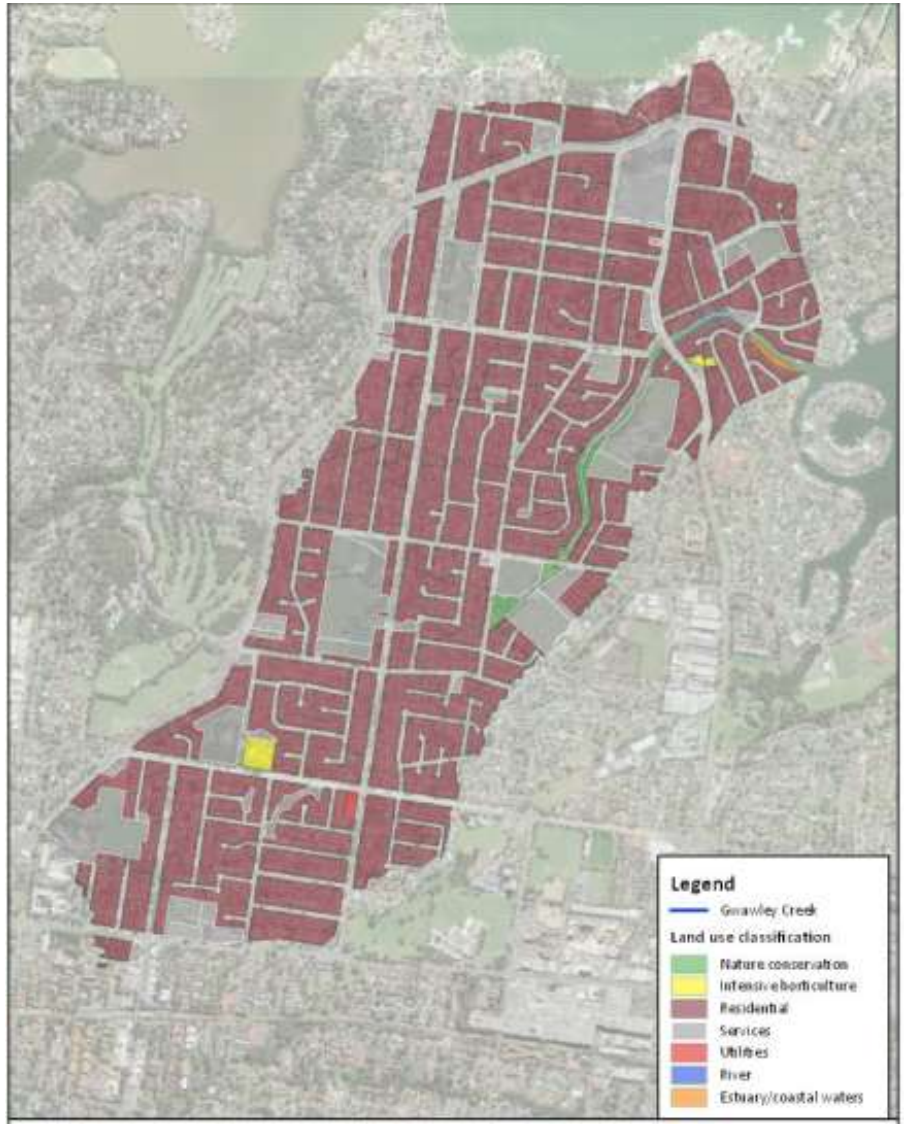
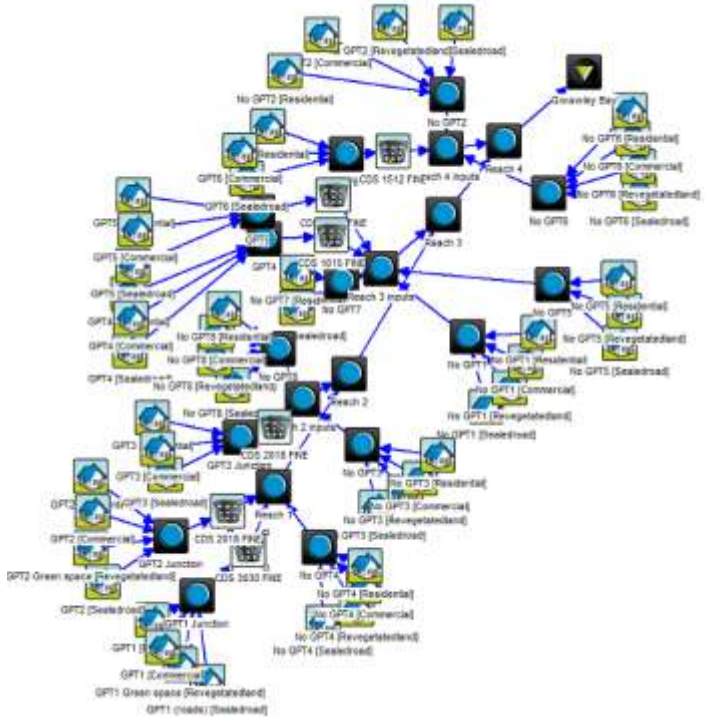
Step 3a –Hydrology

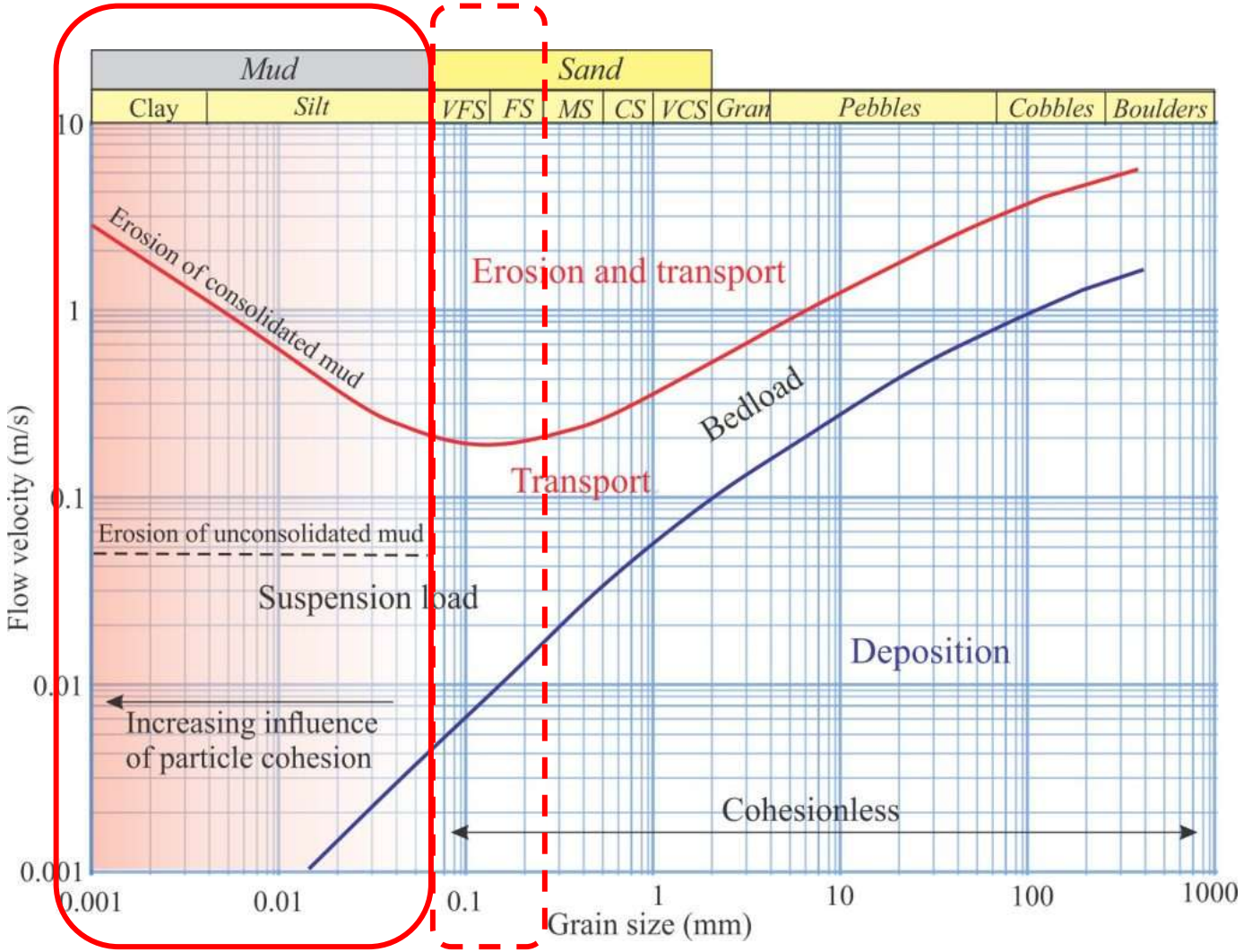


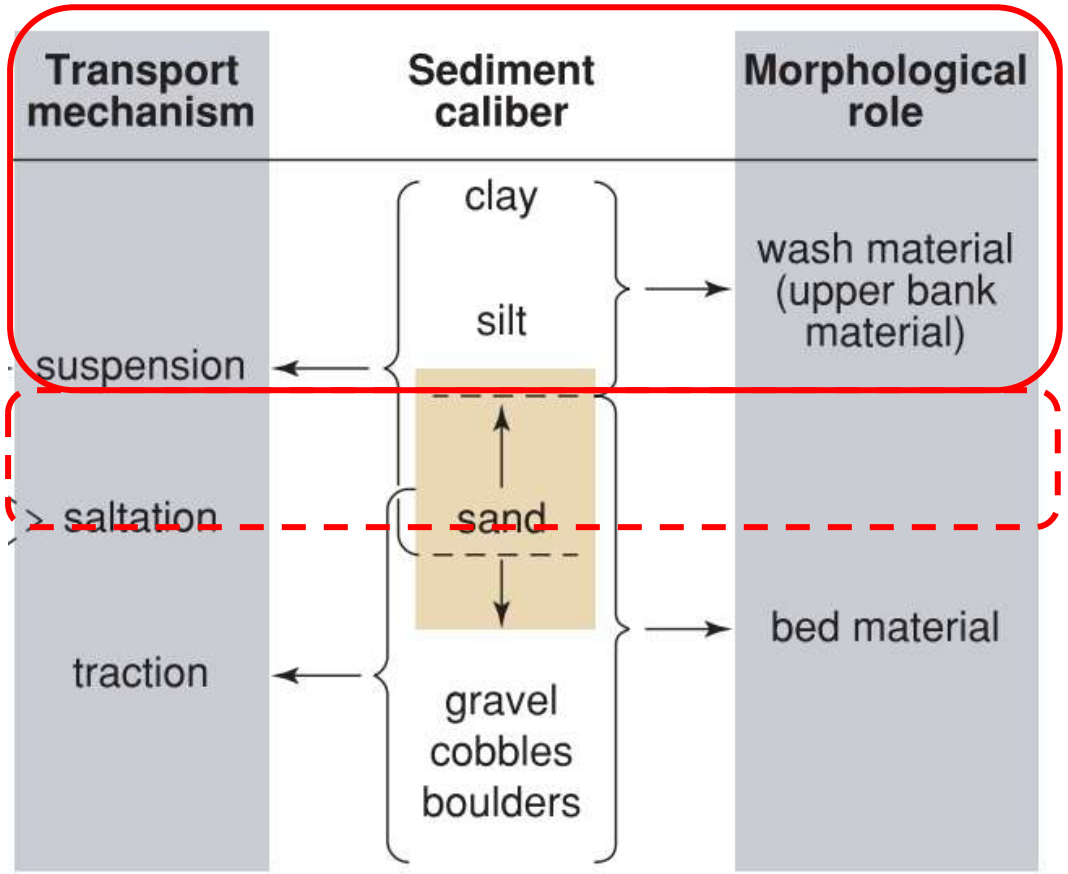




Step 3b – catchment sediment supply - Modes of sediment transport

Suspended Solids Means fine clay or silt particles suspended in the water as a result of the motion of water or as colloids, resulting in turbidity.





Step 3b – catchment sediment supply

Table 8 - Measured TSS proportions for each particle size (BCC, 2006)

<0.45 µm	0.45-10 µm	11-24 µm	25-42 µm	43-93 µm	94-149 µm	150-299 µm	300-749 µm
-	4	4	39	25	12	11	5

fine coarse

clay silt sand gravel

Texture	Australian standard Particle size range (mm)
Coarse sand	0.2-2
Fine sand	0.02-0.2
Silt	0.002-0.02
Clay	< 0.002

Consistent with the grain sizes represented in core logs in the bay, plus the observations of channel lining sediment sizes.

Step 3b – catchment sediment supply

Catchment type		Fine sediment (log mg/L)	Coarse sediment (log mg/L)
Residential	Baseflow	0.67[A]	0.72[A]
	Stormflow	1.85[A]	1.9[A]
Commercial	Baseflow	0.48[A]	0.53[A]
	Stormflow	1.83[A]	1.88[A]
Revegetated Land	Baseflow	0.82[B]	0.87[B]
	Stormflow	1.62[B]	1.67[B]
Roads	Baseflow	0.87[B]	0.98[B]
	Stormflow	2.10[B]	2.15[B]

[A] BCC, 2006, [B] MUSIC defaults

Differed slightly from the MUSIC default, which is based on work by Fletcher, et al 2014. The reason for changing it was to link it to the PSD data we had (BCC, 2004)

Table 10. Overall TSS export rates from catchment with comparative examples from other studies

Reach	Model TSS export rate (kg/ha/year)	Median TSS export rate for urban catchments[1] (kg/ha/year)	Ewey Creek catchment TSS export rate[2] (kg/ha/year)
Reach 1	1,112	Max 2000 Median 300	1,184
Reach 2	1,251		
Reach 3	1,111		
Reach 4	1,188		

[A] Fletcher et. el., 2004, [B] Sellers, 2017

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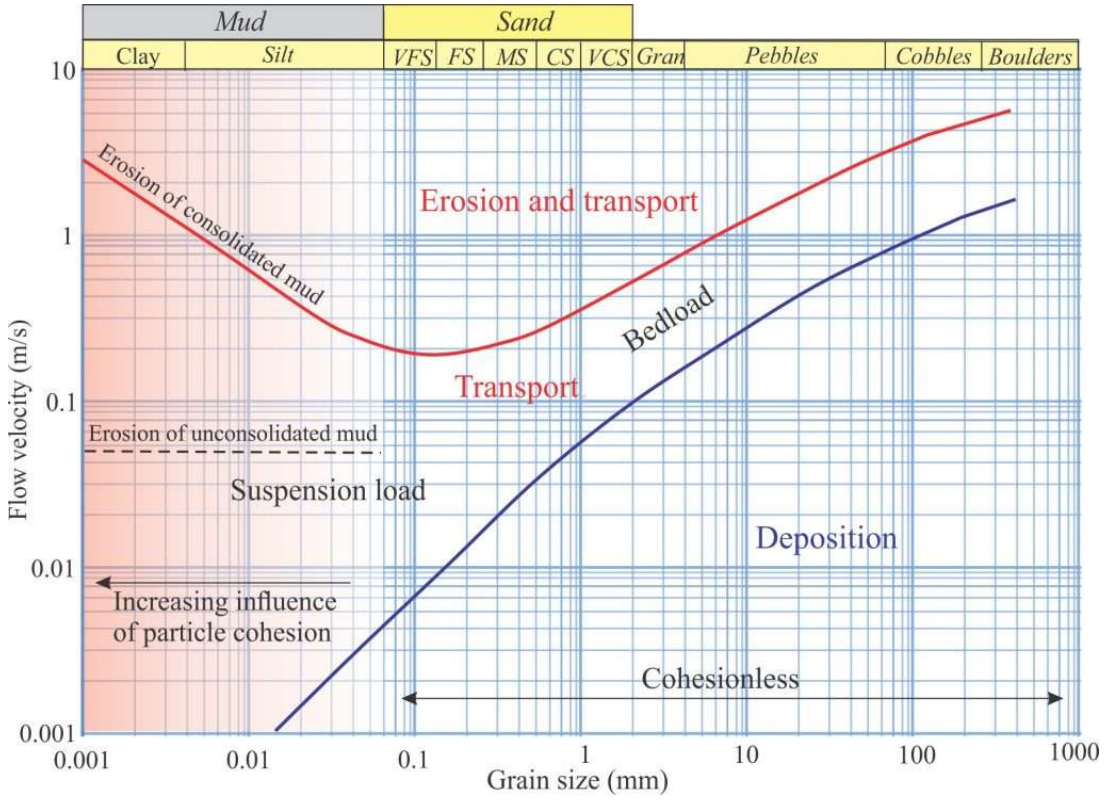
Step 3c – GTP capture efficiency

Fine sediment: Nothing at concentrations less than 75 mg/L, then 70% up until the system bypasses as recommended by the NSW MUSIC Modelling Guidelines.

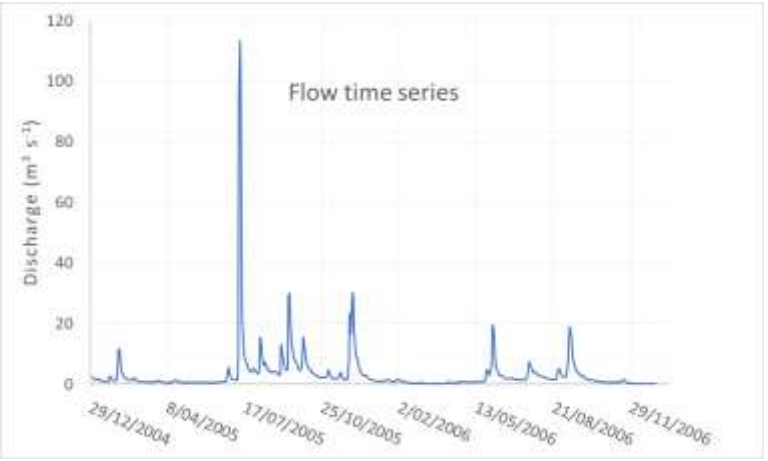
Coarse sediment: 100% up to the treatable flow rate

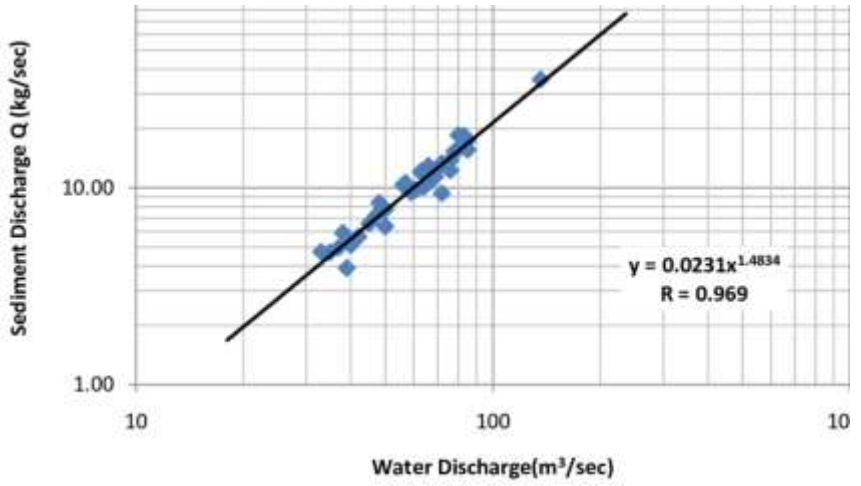
Treatable flow rate: 90% of the total volume of flow past the unit, as recommended in the NSW MUSIC Modelling Guidelines.

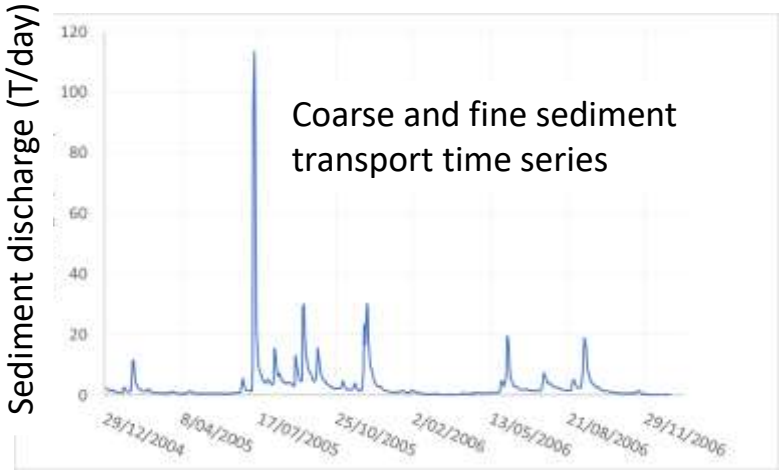


Step 3d – Sediment budget

Discharge data + Rating curve = Sediment transport potential time series







RAS

Using Yang (1974) sediment transport equation

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Step 3d – Sediment budget

1 **Sediment Supply**

Catchment sediment supply (GPT alters)

Sediment from upstream reaches

-

2 **Change in sediment storage**

Erosion of bed and banks

Deposition

=

3 **Sediment transported to downstream reaches**

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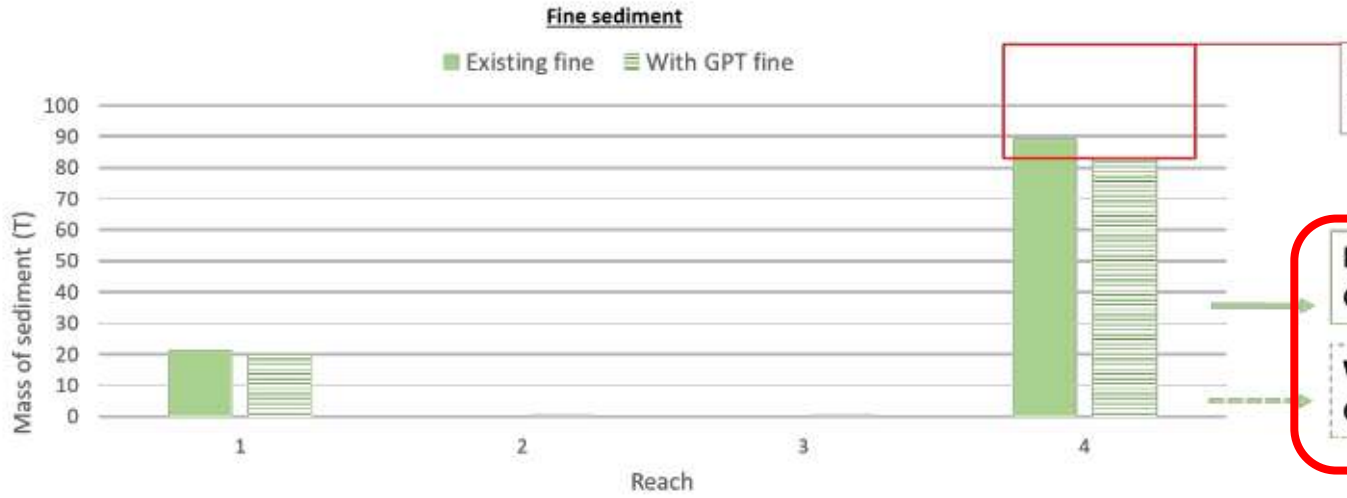
Findings: A budget expressed as change in sediment storage

INPUT

Existing in:
1,879 T

GPT in:
1,810 T

CHANGE IN STORAGE



OUTPUT

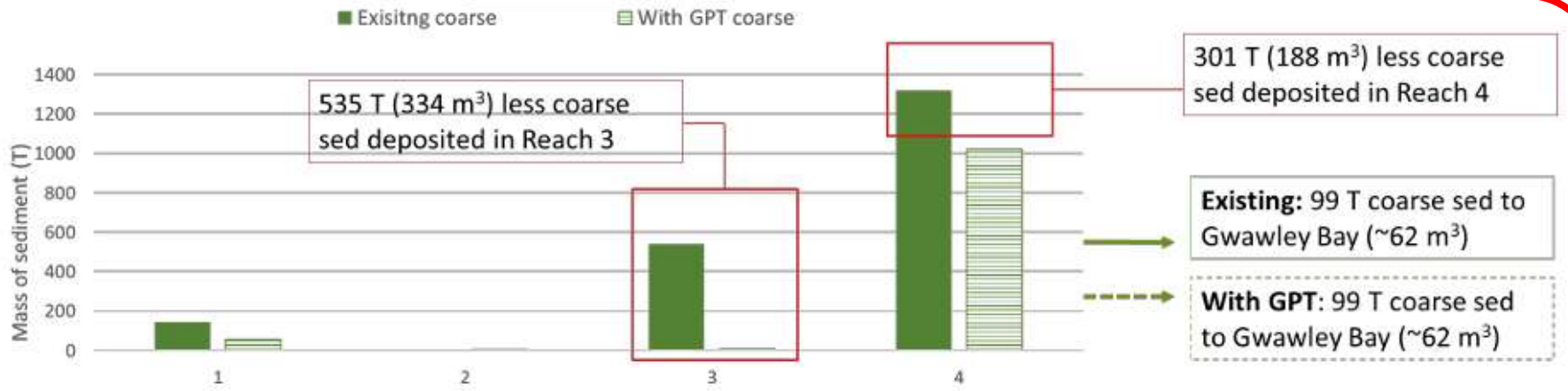
6.5 T (~4 m^3) less fine sed deposited in Reach 4

Existing: 1766 T fine sed to Gwawley Bay (~1103 m^3)

With GPT: 1708 T fine sed to Gwawley Bay (~1067 m^3)

Existing in:
2,109 T

GPT in:
1,182 T



301 T (188 m^3) less coarse sed deposited in Reach 4

Existing: 99 T coarse sed to Gwawley Bay (~62 m^3)

With GPT: 99 T coarse sed to Gwawley Bay (~62 m^3)

Sensitivity testing

Scenario description	Implications
50% increase in catchment sediment supply	**GPTs prevent an additional 32 T of fine sediment** from accumulating in reach 4 under high-sediment supply conditions, but this decrease does **not cause a meaningful change** in bed elevation. Increase in catchment sediment supply overwhelms the impact of GPTs and **accentuates existing pattern of deposition in Gwawley Creek**
50 % decrease in catchment sediment supply	Large decrease in catchment sediment supply **unlikely to trigger sustained erosion** in any reach under current channel conditions. **Impact of GPTs is has no meaningful impact on sediment storage** when catchment sediment supply is very low
Removal of instream and bank vegetation (erosion resistance thresholds) from the sediment budget model	**Removal of bank and instream vegetation is likely to trigger sustained erosion** of fine sediment from reaches 1 -3. Most of the sediment eroded form reaches 1-3 is deposited in reach 4.

Applicability to other studies:

- A detailed understanding of the grain sizes that MUSIC is likely representing
- Source nodes to estimate or check the finer and coarser sediment loads expected from catchments
- A basis for other bespoke applications of MUSIC.
- A work flow for similar sediment budget exercises, including re-use of the code

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Acknowledgements:

- Sutherland Shire Council
- Erin Sellers – client at SSC for the project
- The Alluvium project team: Alex Sims, Lisa Walpole, Tony Weber and Ross Hardie

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Thank you