SAMPLE Verification Engagement Report

> ***This is a fictional sample.*** *Customer, project, and findings are invented to demonstrate the structure, tone, and content depth of a real USD 2,000 / 5-day Hydrata Verification Engagement. All names and identifiers have been generalised.*

Cover page

HYDRATA VERIFICATION ENGAGEMENT Advisory Report

Project: Floodplain Update — Reach A (illustrative) **Customer:** Major consultancy (anonymised) **Engagement reference:** HVE-2026-014 (illustrative) **Date of report:** illustrative **Lead analyst:** Lead Analyst, Hydrata **Engagement period:** Day 0 (intake) → Day 5 (delivery)

> *This report is an advisory review of the submitted hydraulic model. Hydrata is not the engineer-of-record for this project and does not certify the model for any regulatory purpose.*

Executive summary

Headline assessment: YELLOW FLAG — model is fundamentally sound; **two material findings require remediation before submission**, and a third requires either remediation or explicit documentation in the engineer's report.

Key findings (5):

1. **Mass balance: PASS.** Total volume conservation error 0.4% over the 36-hour simulation — well under FEMA's typical 1% expectation.
2. **Mesh quality: YELLOW.** Overbank mesh resolution near the western floodplain edge averages 280 m² mean cell area, coarse relative to the 1 m DEM resolution and the 0.6 ft mean overbank depth. **Likely affects floodplain extent at the western limit.**
3. **Sensitivity: YELLOW.** Peak 100-yr stage at the regulatory cross-section (XS 4750) shifts +0.82 ft when overbank Manning's n is increased 20% (0.075 → 0.090). **Above the 0.5 ft Hydrata acceptance threshold and FEMA's typical sensitivity tolerance.**
4. **Jurisdictional compliance: PARTIAL.** No formal sensitivity analysis is included in the submitted documentation. **FEMA's 2024 MT-2 guidance update requests this for any LOMR involving 2D models.**
5. **Boundary conditions: PASS WITH NOTE.** Downstream rating curve extends to 619.0 ft NAVD88; submitted peak WSEL 618.4 ft uses 96% of the rating curve range — close to the upper bound but within tolerance.

Recommendations (5, prioritised):

1. **MUST FIX:** refine 2D mesh in the western overbank to mean cell area ≤ 100 m² between stations 4500 and 5200 (re-run required; expect ~+0.2 ft change in WSEL at XS 4750 based on sensitivity).
2. **MUST FIX:** include a Manning's n sensitivity analysis (±20%) in the engineer's report per FEMA 2024 MT-2 guidance.
3. **SHOULD FIX:** narrow the overbank Manning's n calibration range OR document the 0.82 ft uncertainty explicitly in the BFE rationale.
4. **SHOULD CONFIRM:** extend downstream rating curve to ≥620.0 ft NAVD88 to provide headroom above peak WSEL.
5. **NICE TO HAVE:** add a break line along the western channel bank between stations 4400 and 5400 to better resolve the channel-overbank transition.

Hydrata sign-off: Lead Analyst, Hydrata.

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§1. Engagement scope

Reviewed:

- Engine: HEC-RAS 6.6 (RAS Mapper output)
- Geometry file: `ReachA_2026.g03`
- Plan file: `Existing_100yr.p01` (active scenario at time of submission)
- Flow file: `Existing_100yr.u01`
- Boundary file: `Existing_100yr.b01`
- Output: `Existing_100yr.p01.hdf` (62.4 MB)
- Terrain: `Terrain/ReachA_LiDAR_2024.tif` (1 m, NAVD88, EPSG:6346 IL East ftUS)
- Land cover: `LandCover/NLCD_2021_Manning.tif` (LUT supplied)

Not reviewed:

- Plan files other than `Existing_100yr.p01` (six other plans present — not in scope per intake)
- 1D bridge / culvert calibration steps (not in this submission)
- Hydrology basis (HEC-HMS upstream model) — outside hydraulic verification scope
- Calibration against gauge data (no gauge data was supplied)
- The MT-2 narrative document itself (engineer's report) — this review covers the model only

Outputs of interest declared at intake:

- 100-yr peak WSEL at regulatory cross-section XS 4750 (target: ≤618.5 ft NAVD88 per ordinance)
- Floodplain extent (western edge) for revised SFHA boundary

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§2. Model information

Property	Value
Engine	HEC-RAS 6.6
2D engine option	Full Momentum (Shallow Water Equations)
2D flow areas	1 ("Reach A 2D Area")
Total 2D cells	47,832
Mean cell area	142 m²
Min / max cell area	18 m² / 4,210 m²
Simulation window	t = 0:00 → t = 36:00 (36 hours)
Computational interval	2.0 seconds (variable, target Courant 1.0)
Output mapping interval	5 minutes
Boundary inflow	Upstream hydrograph at station 8400 (peak 14,200 cfs at t = 8h, 100-yr design event)
Boundary outflow	Normal Depth slope downstream at station 0 (slope = 0.00045) — *replaced with rating curve in revision; see §3.3*
Land cover	NLCD 2021 → Manning's n LUT (channel 0.035, forested overbank 0.075, developed 0.045)
Terrain CRS	EPSG:6346 (NAD83(2011) / Illinois East ftUS) — match
Vertical datum	NAVD88 ft (stated; verified against published gauge datum)

Reproducibility check: Hydrata re-ran `Existing_100yr.p01` on the engagement analyst workstation in HEC-RAS 6.6. Run completed in 47 minutes. Peak WSEL at XS 4750 reproduced as 618.42 ft NAVD88 vs. customer-quoted 618.41 ft NAVD88. **Reproducibility confirmed.**

§3. Findings

§3.1 Mass balance — PASS

Quantity	Value	Threshold	Result
Total volume in (boundaries + initial)	84.6M m³	n/a	—
Total volume out (downstream BC)	84.3M m³	n/a	—
Volume retained at end (storage)	0.0M m³	n/a	—
Total mass-balance error	**0.4%**	< 1.0%	Pass
Peak per-timestep error	1.2%	< 5.0%	Pass
Negative depth events	0	= 0	Pass

Comment: mass conservation is well-controlled. No instability events. Volume accounting closes within numerical noise.

Plot: see Appendix A1 (mass balance timeseries).

§3.2 Mesh quality — YELLOW FLAG

Metric	Value	Target	Result
Total cell count	47,832	informational	—
Channel cells across thalweg	5–7	≥ 4	Pass
Cell aspect ratio (max in critical zone)	3.2	< 4	Pass
Refinement around 2 culverts	6 cells / opening	≥ 4	Pass
Western overbank mean cell area (sta 4500–5200)	**280 m²**	< 100 m² in critical zones	Yellow
Mesh holes / disconnected regions	0	0	Pass
Break lines along channel banks	Present east bank only	Both banks	Yellow

Discussion. Mesh resolution in the western overbank between stations 4500 and 5200 is ~3× coarser than recommended for the depth regime in this reach. The overbank in this segment is shallow (mean depth 0.6 ft, 75th-percentile 1.1 ft) over a flat agricultural landscape; coarse cells in shallow water tend to over-spread the floodplain because each cell's wet/dry transition averages across a larger area. This is the most likely contributor to the western SFHA boundary uncertainty raised in the customer's intake.

The east bank has a break line that resolves the channel-overbank transition cleanly. The west bank lacks this break line; cells straddle the bank, which contributes ~0.15 ft of artificial smoothing in the WSEL profile at the bank.

Recommendation: refine cells to mean area ≤ 100 m² in the sta 4500–5200 western overbank, and add a west-bank break line. Re-run; expect WSEL at XS 4750 to shift ~+0.2 ft (estimated from §3.4 sensitivity; verify on re-run).

Map: see Appendix A2 (mesh + break lines on terrain hillshade).

§3.3 Boundary conditions — PASS WITH NOTE

Boundary	Type	Setting	Comment
Upstream (sta 8400)	Hydrograph	100-yr design (14,200 cfs peak)	Sourced from HEC-HMS upstream model. Within Hydrata scope to accept.
Downstream (sta 0)	Normal Depth slope	0.00045	Originally Normal Depth; **replaced with rating curve in revision per customer note**. Rating curve extends 600.0 → 619.0 ft NAVD88

Note: the rating curve upper bound (619.0 ft) is 0.6 ft above the simulated peak WSEL at the downstream face (618.4 ft). This is within tolerance (>1% headroom) but tight. If a future scenario raises peak WSEL by >0.5 ft, the rating curve will need to be extended to avoid extrapolation.

§3.4 Parameter sensitivity — YELLOW FLAG

Sensitivity sweep on 4 critical parameters × 2 variations = 8 runs (executed in parallel on Hydrata local workstation; total wall-clock 5h 30m). Output of interest: peak WSEL at XS 4750.

Sensitivity matrix:

Parameter	Baseline	−20% run	+20% run	ΔWSEL @ −20% (ft)	ΔWSEL @ +20% (ft)
Channel Manning's n	0.035	0.028	0.042	−0.31	+0.39
Overbank Manning's n	**0.075**	0.060	0.090	−0.58	**+0.82**
Upstream hydrograph peak	14,200 cfs	11,360 cfs	17,040 cfs	−0.46	+0.51
Downstream rating curve stage offset	baseline	−20%	+20%	−0.04	+0.05

Acceptable Δ: < 0.5 ft (Hydrata default; consistent with FEMA's typical tolerance for MT-2) **Alarming Δ:** > 1.0 ft

Finding: the +0.82 ft response of peak WSEL to a +20% increase in overbank Manning's n is **above Hydrata's 0.5 ft acceptance threshold**. This indicates the model's headline output is meaningfully sensitive to a parameter that is itself derived from a land-cover lookup (NLCD 2021), which has documented uncertainty of ±25% in forested overbank classes.

Implication for the consultant: either (a) tighten the overbank Manning's n calibration with field reconnaissance / aerial review of the western reach, or (b) explicitly document the ±0.8 ft uncertainty band in the engineer's report and propose the conservative end as the BFE.

Sensitivity matrix: see Appendix A3 (full table + plot).

§3.5 Jurisdictional compliance — PARTIAL

Comparison against FEMA MT-2 LOMR submission checklist (extract — full table in Appendix B):

Checklist item	Status	Evidence / gap
Hydrology basis documented	Met	HEC-HMS report cited (not reviewed here)
100-yr and 500-yr discharges tabulated	Met	Table 2 in engineer's report
HEC-RAS version stated	Met	"HEC-RAS 6.6", section 3.1
2D mesh quality stated	Partial	Cell count cited, distribution not
BFE delineated on workmap	Met	Drawing C-201
Floodway analysis	N/A	No floodway revision in this LOMR
Annotated profile plots	Met	Drawing C-301, C-302
Manning's n sensitivity analysis	**Not met**	**Not present in submission. FEMA 2024 MT-2 guidance update requests this for any 2D-model LOMR.**
Effective vs revised model comparison	Met	Table 4 in engineer's report
PE seal + cert	Met	Drawing cover sheet

Finding: the absence of a formal sensitivity analysis is the single most material jurisdictional gap. Given the §3.4 finding (overbank Manning's n drives a 0.82 ft WSEL response), this section IS the analysis that should be added — combined with calibration narrative or explicit uncertainty documentation.

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§4. Recommendations

#	Priority	Action	Why	Estimated effort (consultant)
1	**MUST FIX**	Refine 2D mesh in western overbank (sta 4500–5200) to mean cell area ≤ 100 m². Add west-bank break line. Re-run `Existing_100yr.p01`.	Resolves the §3.2 mesh quality finding and is expected to shift WSEL at XS 4750 by ~+0.2 ft (verify on re-run). Most defensible path to a stable western SFHA boundary.	4–8 hours
2	**MUST FIX**	Add a Manning's n sensitivity analysis (±20%, channel and overbank) to the engineer's report per FEMA 2024 MT-2 guidance.	Closes the §3.5 jurisdictional gap. The §3.4 sensitivity matrix in this advisory report can be cited as the basis (with consultant's own re-runs validating).	8–16 hours including re-runs
3	**SHOULD FIX**	Either tighten overbank Manning's n via field reconnaissance OR document the ±0.8 ft uncertainty band in the BFE rationale.	The §3.4 sensitivity is above Hydrata's 0.5 ft acceptance. FEMA reviewers can be expected to flag this. Documenting it pre-empts pushback.	4–24 hours (depends on reconnaissance scope)
4	**SHOULD CONFIRM**	Extend downstream rating curve from 619.0 ft to ≥620.0 ft NAVD88.	§3.3 — provides safety margin against rating-curve extrapolation in future plans.	1–2 hours
5	**NICE TO HAVE**	Add east-side flow obstruction representation if any new development is anticipated within the SFHA after submission.	Not directly responsive to a §3 finding; raised because the eastern reach has greater development pressure per project narrative.	4 hours

§5. Sign-off

This Verification Engagement was conducted by Hydrata Pty Ltd as an advisory review of the hydraulic model submitted by the customer for the Floodplain Update — Reach A project, FEMA LOMR submission.

Hydrata is not the engineer-of-record for this project and does not certify the model for any regulatory purpose. The findings and recommendations above are offered for the consultant's consideration. The consultant remains solely responsible for the model, its calibration, and any submission to the Federal Emergency Management Agency or other regulator.

This report is valid as of the date below and applies only to the model files specified in §1. Subsequent revisions of the model are outside the scope of this engagement; a re-verification engagement is available on request.

Signed: Lead Analyst, Hydrata Pty Ltd Chartered Professional Engineer (CPEng, Engineers Australia, NPER NSW) Engagement reference: HVE-2026-014 (illustrative) Report date: illustrative

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Appendix A — Raw outputs

A1. Mass balance timeseries

[In the actual PDF: stacked plot — Volume In (m³) and Volume Out (m³) on top axis; cumulative storage (m³) on middle; per-timestep mass-balance error (%) on bottom. X-axis: simulation time, 0–36 hours.]

Reading: total volume in 84.6M m³, total volume out 84.3M m³, residual 0.4%. Peak per-step error 1.2% at t = 7h 50m (rising limb of inflow hydrograph) — within tolerance.

A2. Mesh + break lines on terrain hillshade

[Map: 2D mesh outline coloured by cell area (yellow ≤100m², orange 100–500m², red >500m²), overlaid on 1m hillshade. Annotations show channel centerline, east-bank break line, and the absent west-bank break line (sta 4500–5200, highlighted).]

A3. Sensitivity matrix

(Full table — see §3.4 for selected results.)

Run ID	Parameter	Variation	WSEL XS 4750 (ft NAVD88)	Δ from baseline (ft)
baseline	n/a	n/a	618.42	0.00
s1	Channel Manning's n	−20% (0.028)	618.11	−0.31
s2	Channel Manning's n	+20% (0.042)	618.81	+0.39
s3	Overbank Manning's n	−20% (0.060)	617.84	−0.58
s4	**Overbank Manning's n**	**+20% (0.090)**	**619.24**	**+0.82**
s5	Upstream peak Q	−20% (11,360 cfs)	617.96	−0.46
s6	Upstream peak Q	+20% (17,040 cfs)	618.93	+0.51
s7	Downstream rating offset	−20%	618.38	−0.04
s8	Downstream rating offset	+20%	618.47	+0.05

Appendix B — Jurisdictional checklist (full)

(FEMA MT-2 LOMR — full mapping. Extract shown in §3.5.)

FEMA MT-2 checklist item	Status	Evidence / gap	Severity if not met
PE seal on engineer's report	Met	Drawing C-001	Critical
Hydrology basis documented	Met	HEC-HMS report cited	Critical
100-yr discharge	Met	Table 2	Critical
500-yr discharge	Met	Table 2	Required for revised FIS
HEC-RAS engine + version	Met	§3.1 of engineer's report	Critical
2D engine option (DW vs SWE) stated	Partial	Implied "SWE" but not stated explicitly	Medium
2D flow area boundary clearly defined	Met	Drawing C-201	Critical
Mesh cell count + size statistics	Partial	Count yes; statistics no	Medium
Cross-section locations on workmap	Met	Drawing C-201	Critical
BFE delineated	Met	Drawing C-201	Critical
Floodway analysis	N/A	No floodway revision	n/a
Annotated profile plots (regulatory cross-sections)	Met	Drawings C-301, C-302	Critical
Manning's n sensitivity analysis	Not met	Not present	**High — FEMA 2024 update flagged**
Effective vs revised model comparison	Met	Table 4	Critical
Topographic data source documented	Met	"1m LiDAR 2024" cited	Critical
Topographic vertical datum stated	Met	NAVD88 ft	Critical
Land cover / Manning's n source documented	Met	NLCD 2021 LUT	Critical
Boundary condition rationale	Partial	Upstream BC documented; downstream rating curve construction not	Medium

Overall jurisdictional status: PARTIAL — 1 critical-severity gap (sensitivity analysis), 3 medium-severity items recommended for inclusion.

Appendix C — Engagement metadata

Item	Value
Engagement reference	HVE-2026-014 (illustrative)
Engagement type	Verification Engagement (5-day flat-fee)
Customer	Major consultancy (anonymised)
Customer contact	(redacted)
Project name	Floodplain Update — Reach A (illustrative)
Submission target	FEMA MT-2 LOMR
Engine reviewed	HEC-RAS 6.6, 2D Full Momentum SWE
Plan(s) reviewed	`Existing_100yr.p01` (1 plan)
Day 0 (intake + payment)	illustrative
Day 5 (delivery)	illustrative
Analyst hours (actual)	9.5
Compute used	~6 CPU-hours local + 0 cloud
Compute cost	$0 (local)
Lead analyst	Lead Analyst, Hydrata
QA review	(none on this engagement; first-engagement learning baseline)
Re-verification offered	Yes — $1,000 flat after consultant remediation

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— END OF SAMPLE REPORT —