

VALIDATION EDITION

A Working Copy of the St. Clair River

A high resolution model of the river from Lake Huron to Port Lambton, tested against official gauges, flow records, drifting buoys and past ice jams

- R1** The river model
- R2** Spill tracking
- R3** The Port Huron Float Down
- R4** The live river
- R5** Ice jams
- R6** A 3D model of the Blue Water Bridge
- R7** The riverbed

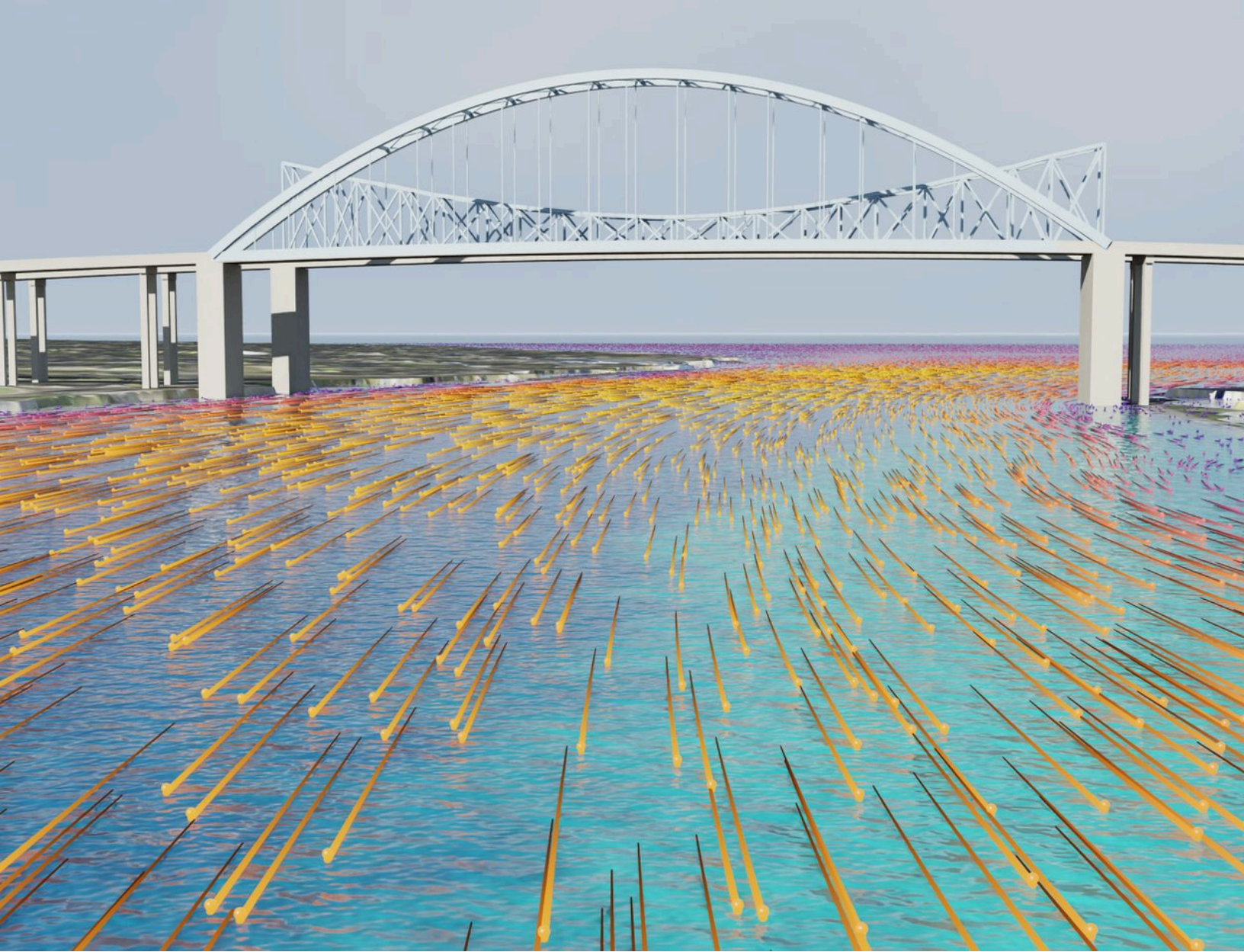
Cover: the model's surface currents for September 28, 2026, as Lake Huron funnels into the river and down past the Blue Water Bridge. Darker lines are faster water.

Tyler W.

IThero Solutions, Sarnia, Ontario

October 2026 | Independent research experiment, not for navigation





Every result in this report is set beside an independent measurement, and the tests the model failed are reported too.

The current under the Blue Water Bridge, looking upstream to Lake Huron. Steady flow of Sept 28, 2026 (5,928 m³/s); 150,000 tracers ride the modelled currents, brighter where the water is faster.

Bridge geometry approximate. Imagery USDA NAIP 2022; terrain USGS 3DEP and NRCan HRDEM. Compiled October 24, 2026. Every number in this document traces to the lab reports.

What this document is

This document sets out the evidence behind IThero's working computer copy of the St. Clair River, from Lake Huron to Port Lambton. It is experimental and not for navigation. It shows each result the model produces and sets it beside an independent measurement made by an agency or a published study: official water level gauges, the US Geological Survey flow record, a boat flow measurement, the measured split of flow around the islands, a 2002 boat survey of the currents across the river, drifting buoys, NOAA's spill reference tables, dye releases, three ice jams and an international study of the riverbed. Each check carries its verdict in the words of the lab report it comes from: pass, partial or fail. The failures are reported with the same care as the passes.

The methods are proprietary. This edition names no software, code, hardware or solver method. A full technical report, with the methods and the lab reports behind every number, is available to partners on request under a confidentiality agreement.

The strongest checked results

- **Water levels, two weeks hour by hour.** From Sept 30 to Oct 14, 2026, driven only by the measured levels at the two ends of the river, the model followed the five gauges in between to within 0.1 to 2.3 cm on average, including one gauge it was never tuned on.
- **How much water.** The flow it works out from water levels alone matched the US Geological Survey record to within 0.4% over the two weeks, and a boat measurement on Oct 5 to within 1.6%.
- **Islands.** It splits the flow around Stag Island and Fawn Island within 2.1 percentage points of US Geological Survey measurements.
- **Far from its tuning.** At a real low flow (November 2012), a real high flow (July 2020) and in October 2000, every independent gauge was within 4.3 cm.
- **A replayed week.** Hour by hour from Oct 14 to 20, 2026, as a live service would have run, it stayed within 2.3 cm of the gauges on average and 0.6% of the measured flow.
- **Spills.** For all 15 release points in NOAA's spill reference tables, arrival times for spills at the surface match within 9, 3 and 4 minutes on the median (first arrival, peak, 90% passed).
- **Surface drift.** Against 173 drifting buoys released by US scientists in October 2000, the model's floats were a median of 40 m from the real buoy after 10 minutes and 118 m after 30 minutes, and reached each kilometre down the river within 9 seconds of the buoy on the median.
- **Ice jams.** From routine gauge records alone it found the 2019 and 2021 jams on the days they were reported, holding back about 1,950 m³/s at their peaks, a third of the river. For the record April 1984 jam it finds 2,200 to 2,730 m³/s held back, against the published 2,700, dated April 7 to 29 against the published April 5 to 29.
- **Riverbed.** Bed stress from the bridge to the first bend of 8.6 to 12.9 Pa across three real flows, against 8 to 13 Pa measured in the 2009 international study.
- **Speed.** Two weeks of river take under an hour of computing on a single graphics card.

How to read it. The scorecard on the next page lists every check. Section 1 describes the river and the model in plain terms, section 2 the checks of the model itself, section 3 six things it can do, each with its own checks and limits, and section 4 the finer 5 m version. Section 5 sets out who it could serve and what comes next, section 6 states plainly what the model is not, and section 7 lists the data and the published work behind it. Every number here traces to IThero's lab reports.

Every check at a glance

The verdicts below are the lab reports' own. Where a test was set after the first results were seen, the report says so, and so does this document. "Average error" is how high or low the model reads overall; "hour to hour" is the typical size of the error once that average is removed.

area	check	measured against	result	verdict
River model	Tuning on 12 steady days	four gauges, a fifth held out	typical error 2.2 cm; held out Dry Dock 2.3 cm low	fit
River model	Two weeks of levels, driven by the measured levels at both ends	five gauges, 336 hours	average error 0.1 to 2.3 cm; hour to hour 1.1 to 2.4 cm	pass at all five
River model	Same two weeks, driven by the measured flow instead	five gauges	average error within 1.9 cm, but misses the hour to hour test	fail
River model	Flow worked out from levels alone	US Geological Survey record, 04159130	0.39% high over two weeks; 3.55% hour to hour	pass
River model	Boat flow measurement, Oct 5, 2026	US Geological Survey boat measurement	6,102 against 6,003 m ³ /s, 1.64% high	pass
River model	Flow split around Stag and Fawn Islands	US Geological Survey, measured 1996 to 2000	within 2.1 percentage points	pass
River model	Currents point by point, five days of May and June 2002, rules set before the run	US Geological Survey and US Army Corps of Engineers boat survey, 3,507 stretches of boat track	speed 2.2% fast; typical error 0.103 m/s (13%); direction within 1.8 degrees on the median. A simple depth based estimate also passes (0.148 m/s). Misses in the 1.1 km below the bridge	pass, 6 of 6
River model	Real low and high flows outside the tuning (2012, 2020), and Oct 2000	gauges	every independent gauge within 4.3 cm	pass
River model	A week replayed hour by hour, Oct 14 to 20, 2026	five gauges, US Geological Survey flow (provisional)	average error 0.0 to 2.3 cm; flow 0.6% low	pass at all five
River model	Still water stays still; the water budget balances	basic physics	both pass at 10 m and 5 m	pass
River model	Same answer at finer cells without retuning	20, 10 and 5 m cells	levels shift by centimetres; each cell size needs its own tuning	fail
River model	5 m version driven by levels, two weeks	five gauges, 337 hours, against the 10 m version over the same hours	lake edge fault fixed Oct 20, retuned Oct 21. Average error 0.2 to 3.0 cm against 0.2 to 2.4 cm at 10 m; hour to hour 0.9 to 2.2 cm, as at 10 m; flow 1.3% low	about as close as 10 m, not closer; Dry Dock just past the 3 cm limit
Spills	Self tests of the virtual dye	exact answers	all 10 pass	pass
Spills	Arrival times, spills at the surface	NOAA TM GLERL-162 tables, 80 cases per measure	median 9, 3 and 4 minutes late (about 10, 3 and 5 with the Sarnia shore release run to 72 hours, Oct 24)	pass on the median
Spills	Single cases	same	a long tail, led by one release near the Canadian shore	does not hold case by case
Spills	Spills at the bottom	same	about 130 minutes early at first arrival	not matched
Spills	2009 dye releases	published travel times	44 to 56 minutes late at first arrival	fail as written

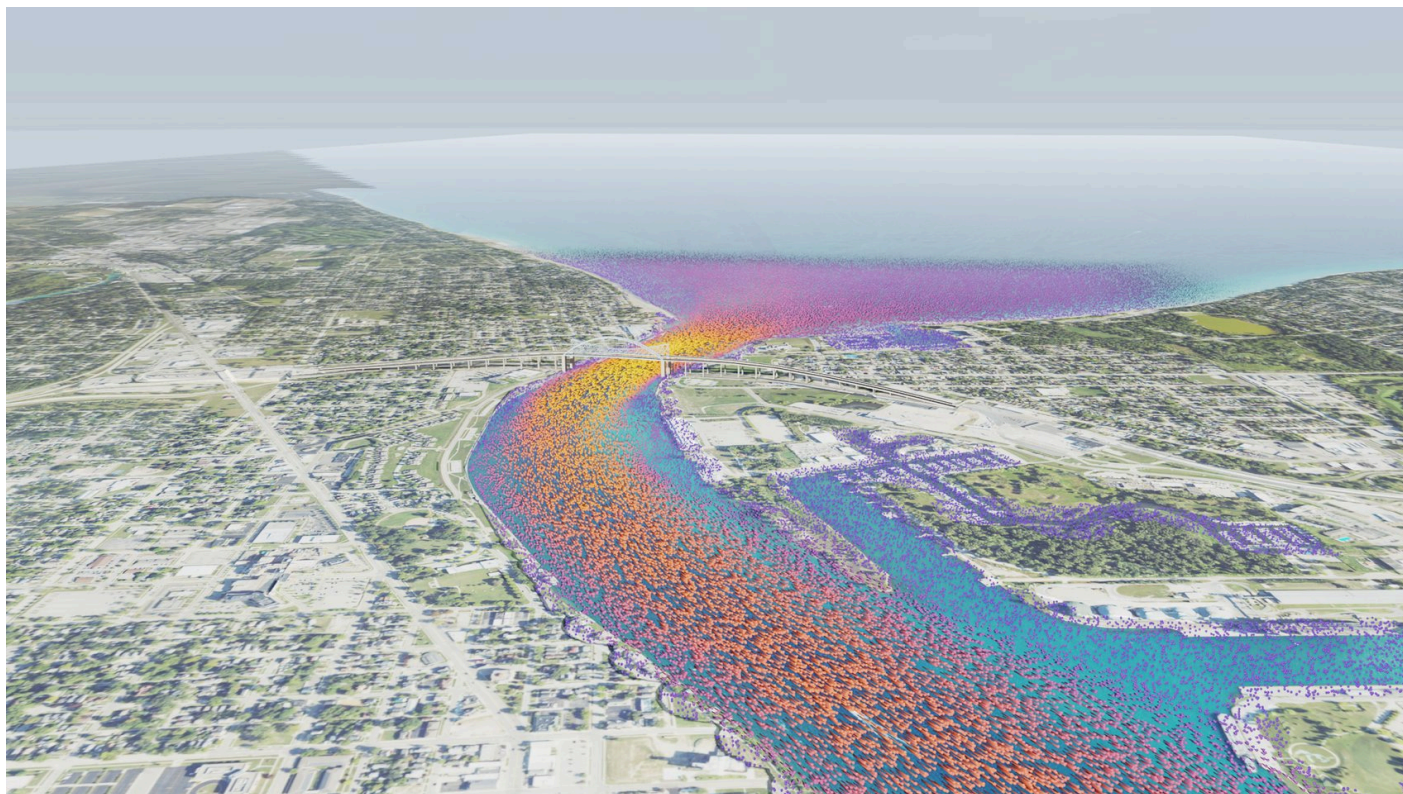
area	check	measured against	result	verdict
Spills	2009 dye releases rerun with surface floats, Oct 24, rule set before the run	same	0.4 minutes early, 12.3 and 20.9 minutes late	holds in part, 2 of 3
Surface drift	Surface current factor of 1.15	173 buoys, Oct 2000	118 m off after 30 minutes; travel time within 9 s	supported
Surface drift	Drift across the river in the two upper bends	same	real buoys crossed, the model's did not	contradicted in part
Surface drift	Wind push on a person	none available	not tested	not tested
Surface drift	Overall			partly validated
Live river	First live run, one hour, Oct 14, 2026	gauges and USGS flow	gauges within 0.7 to 5.8 cm; flow 2.0% high	partly; settled by the replayed week
Ice jams	Open water noise near zero	36 late summer days	12 m ³ /s average, spread 108 m ³ /s	pass in open water
Ice jams	2019 and 2021 jams found on the right days	public reports	about 18 times the open water spread	pass
Ice jams	The gauge pattern places the jam	gauges	resistance below State Police	pass, qualitative
Ice jams	Ice as added resistance, reach by reach	measured flow and five gauges	all 25 jam days matched	pass on 25 of 25
Ice jams	Record April 1984 jam, size and dates	Derecki and Quinn (1986)	2,200 to 2,730 m ³ /s held back, against 2,700; April 7 to 29 against April 5 to 29	pass
Ice jams	Flow under ice from levels alone	US Geological Survey daily flow	about 18% low	partial
3D bridge reach	Flow kept constant along the reach	inflow	within 0.19%	pass
3D bridge reach	Surface speed over average speed	target 1.15 within 0.05	median 1.142	pass
3D bridge reach	Water level fall from Fort Gratiot to Point Edward	gauges, 0.196 m	4.9 cm too much against a 3 cm limit	fail
3D bridge reach	Average speeds against the 2D model	2D model	whole reach yes, bridge reach no	partial
3D bridge reach	Near bed flow turns into the bends	expected direction	right direction everywhere, weak relation	pass weakly
Riverbed	Levels at a real low and high flow, set blind	gauges	within 2.6 and 4.1 cm	pass
Riverbed	Bed stress, reach by reach	2009 international study	upper river matches; about 1 Pa low below the Black River	pass in the upper river, partly below
Riverbed	Gravel armour stays put under river flow	lowest published threshold	largest 0.028 against 0.03	pass
Riverbed	Exposed till passes its erosion threshold	4.2 Pa, measured on a St. Clair sample	33% of its area at typical flow, 47% at high flow	pass
Riverbed	River flow alone cannot advance the gravel tongue	20 m a year advance	no tongue gravel moves under the published threshold	pass, a consistency check

1. The river and the model

1.1 The river

The St. Clair River carries the outflow of Lakes Michigan and Huron, including the water Lake Superior sends them, past Port Huron and Sarnia toward Lake St. Clair. The 2009 international study of the river (IUGLS) describes its upper reach as about 450 m wide and 16 m deep on average, with currents near 2 m/s at the bridge, and gives an average flow of 5,150 m³/s from 1918 to 2008. The real flows in the checks below run from 3,680 m³/s (April 1984, under the record ice jam) to 6,845 m³/s (July 2020, near record high lake levels).

The model covers 42 km of river, from a line 2.5 km out in Lake Huron above the Fort Gratiot gauge down to the Port Lambton gauge. Seven water level gauges sit along it. Two drive the model: Lakeport on Lake Huron (NOAA 9075002) and Port Lambton (Canadian Hydrographic Service 11950). Five lie between them and are used only to check it: Fort Gratiot (NOAA 9014098), Point Edward (Canadian Hydrographic Service 11940), Black River (NOAA 9014090), Dry Dock (NOAA 9014087) and St. Clair State Police (NOAA 9014080). The US Geological Survey measures the river's flow at Port Huron (station 04159130). The delta below Port Lambton is not in the model.



The bridge reach from downstream, looking up the river to Lake Huron. Tracers ride the modelled current, coloured by speed. Look at the lake funnelling into the river at the Blue Water Bridge: the current is fastest (yellow) through the bridge and along the first bend, while the water in the Point Edward basin on the Canadian side, right, barely moves (purple). 2D depth averaged model, steady flow of Sept 28, 2026. Bridge shape approximate. Imagery USDA NAIP 2022; terrain USGS 3DEP and NRCan HRDEM. Experimental, not for navigation.

1.2 What the riverbed is built from

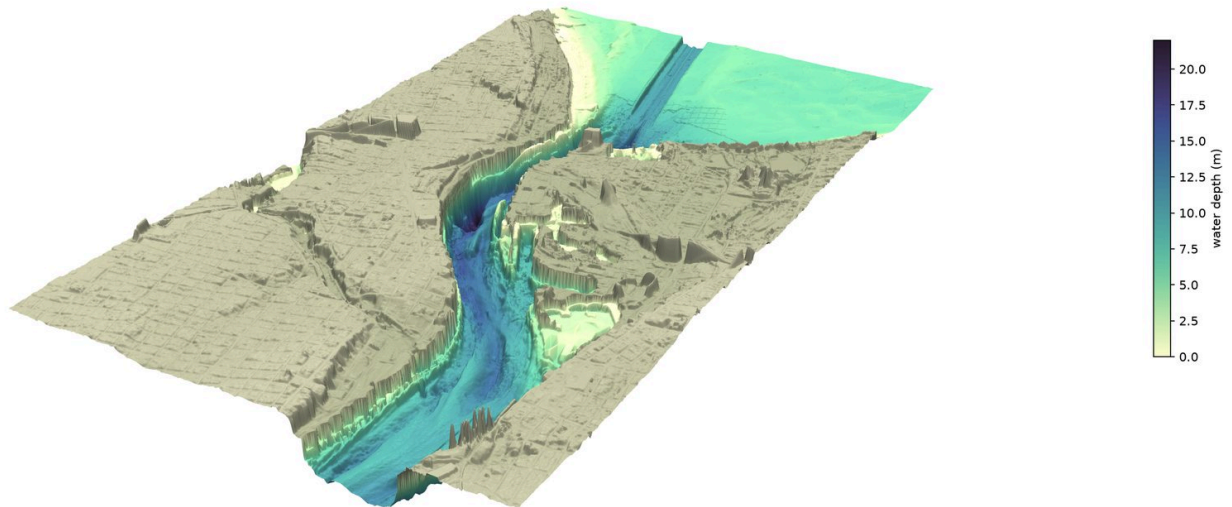
The model runs on a riverbed map made at 1 m from depth surveys by US and Canadian agencies: 15 US Army Corps of Engineers surveys from 2020 to 2026, US Geological Survey grids from 2008, NOAA surveys from 2000, 2006 and 2008, the Canadian Hydrographic Service's NONNA bathymetry, and NOAA nautical charts where nothing newer exists. The banks and both shorelines come from laser scans (US Geological Survey 3DEP and Natural Resources Canada

HRDEM). Where surveys overlap, the newest wins, and every cell keeps a record of which survey and which year it came from. The deepest water in the model is 23.9 m, in the pool about 260 m above the Blue Water Bridge.

Two errors in the first build of the riverbed were found by inspection and fixed before any tuning. One of them, survey lines of two different years alternating every 30 m, acted like artificial dunes on the riverbed and moved the tuned water levels by about 20 cm. It is a reminder that a model's riverbed has to be checked as carefully as its results.

Blue Water Bridge reach: the river leaves Lake Huron

St. Clair River riverbed relative to the mean observed water level (IGLD 1985). Vertical exaggeration 20 times. 5 m cell average of the 1 m master bed.



Sources: USACE eHydro 2026, USGS 2008 0.5 m grid, NOAA surveys, CHS NONNA, NOAA ENC, USGS 3DEP and NRCan HRDEM lidar. (Ithero Solutions, experiment R1).

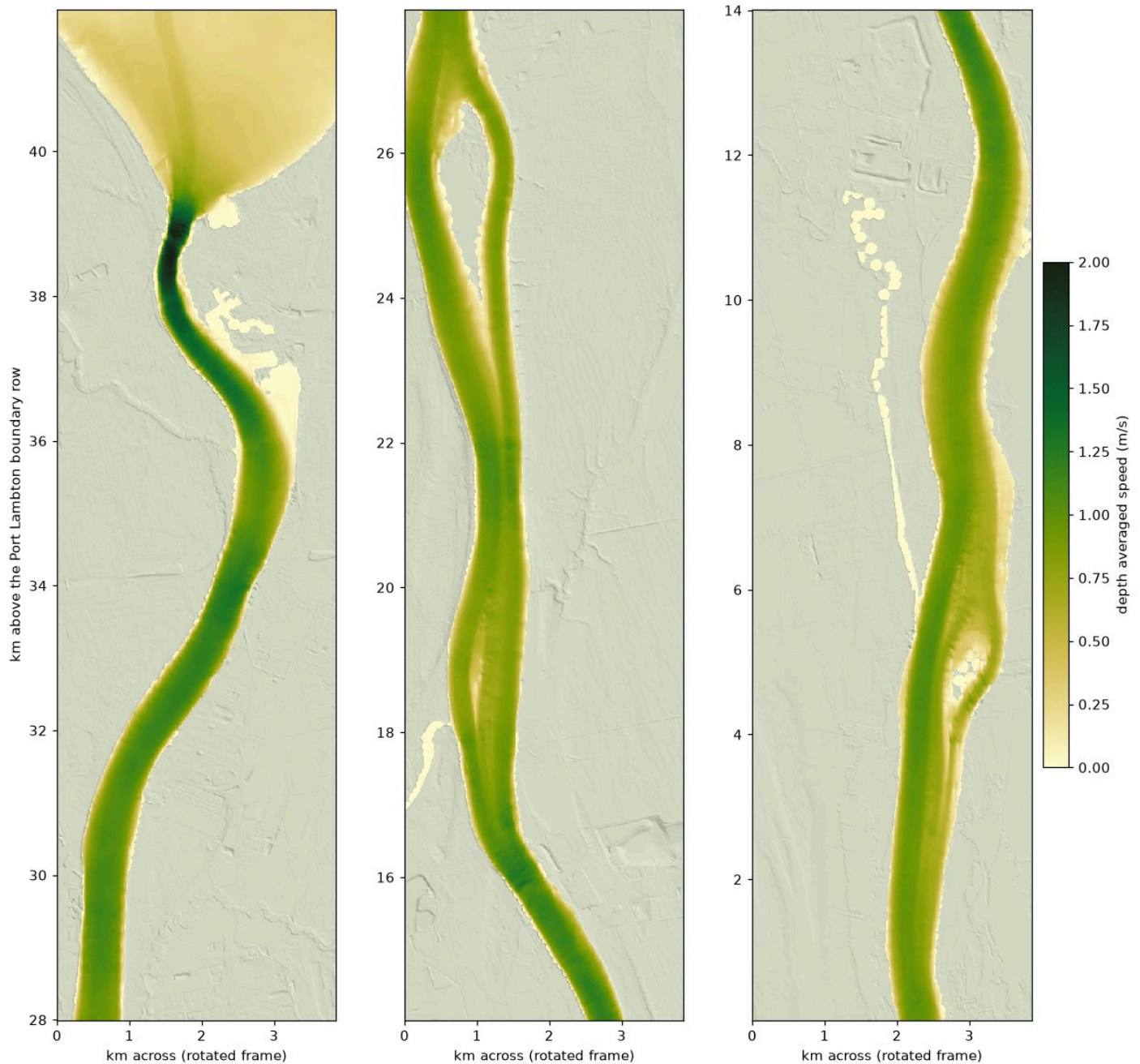
The riverbed the model runs on, at the Blue Water Bridge, where the river leaves Lake Huron. Look at the deep pool at the head of the river (darkest blue, over 20 m) and the shallow shelf of the lake beyond it. Depth below the mean observed water level, 5 m cells averaged from the 1 m riverbed map, height exaggerated 20 times. Sources as printed on the figure.

1.3 Resolution and what it computes

The working model divides the river into square cells 10 m across, about 481,000 cells of water, roughly half a million. A finer version with 5 m cells (1.92 million cells of water) is used for the finest work (section 4). Both are averaged from the same 1 m riverbed, so every resolution sees the same river.

In every cell, many times a second of river time, the model works out how deep the water is and how fast and in which direction it moves. It needs only what the gauges report: the measured water level on Lake Huron and at Port Lambton (or, as a second setup, the measured flow at the top of the river). From those it gives the water level, the current and the river's flow everywhere between them.

It is a 2D depth averaged model. In each cell it computes the current averaged from the water surface down to the riverbed. It does not compute how the current changes with depth: in a real river the surface runs faster than the water near the bottom, and bends set up a slow corkscrew motion across the channel. That is how to read every current in this document unless it says otherwise. It is also why surface drift uses a surface factor (section 3.2), why the model's spills are closest to NOAA's surface releases (section 3.1), and why a separate three dimensional model of the bridge reach was built (section 3.5).



The whole 42 km model on Sept 28, 2026 (5,928 m³/s), in three panels: Lake Huron at the top of the left panel, Port Lambton at the bottom of the right panel. Colour is the current averaged from surface to bed. Look at the fast water at the bridge (darkest green, near 2 m/s), the split around Stag Island in the middle panel, and the slow water along the banks and behind the islands. 2D depth averaged model, 10 m cells.

1.4 Speed

The model runs on a single graphics card. On the same job the card is 206 to 328 times faster than all eight cores of the computer's main processor. In practice:

- two weeks of river take under an hour (58 minutes, with two copies of the river running at once);
- 11 hours of river carried forward to the present take under 3 minutes;
- an hourly live service would need about 9 seconds of computing per hour;

- a whole winter of daily ice checks takes about 15 minutes;
- one wind case for surface drift takes about 4 seconds, all 10 winds about a minute;
- one steady flow for bed stress takes about two minutes.

Speed matters because it decides what can be asked: many spill scenarios at once, every day of a winter, every hour of a week, or a fresh answer on the morning it is needed.

2. How the model itself was checked

Three rules run through these checks. The model is compared only with measurements made by others. At least one gauge is always held out of the tuning, so it can serve as an honest check. And the model is tested on days and flows far from the ones it was tuned on.

2.1 Tuning on 12 steady days

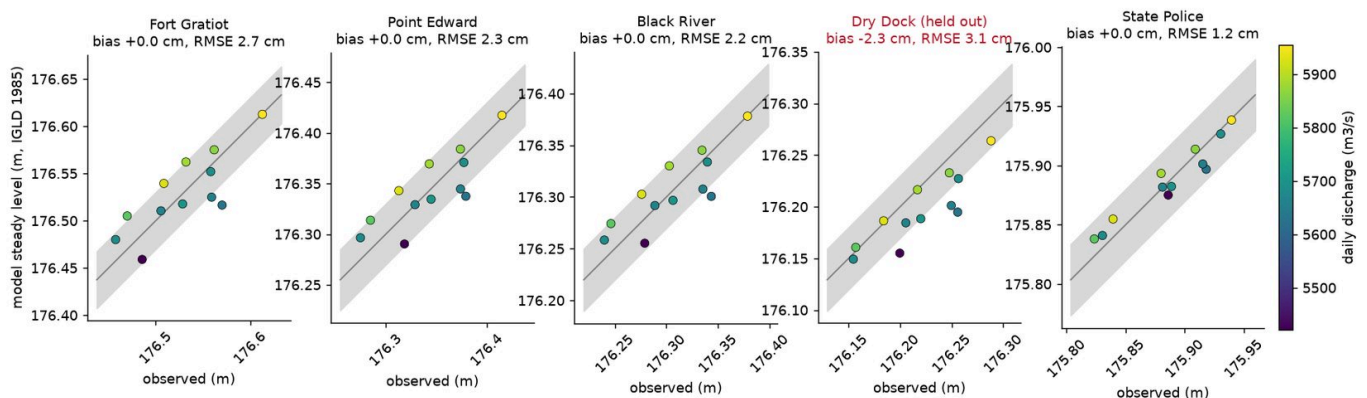
Like every river model, this one has to learn how much the riverbed resists the flow. That resistance was tuned in four reaches, split at Point Edward, the Black River and State Police, each fitted to the gauge at its upstream end. The tuning used 12 steady days between Aug 25 and Sept 29, 2026: days when the US Geological Survey's daily flow was within 2% of the day before, the wind stayed under 8 m/s all day and all five gauges reported. Their flows ran from 5,421 to 5,955 m³/s.

Dry Dock was held out of the tuning entirely. It is never used to adjust the model, so it is a fair test of it.

- Across the 12 days and four tuned gauges the typical error is 2.18 cm, and the average error at each tuned gauge is within 0.04 cm.
- Dry Dock, never used, reads 2.3 cm low on average (typical error 3.1 cm).
- What remains is day to day scatter from wind and slow changes on the lake that a steady day cannot carry, not a lean in one direction.

Dry Dock reads about 2 to 3 cm low in the tunings, the two week reruns and the replayed week, while its neighbours above and below do not. That pattern points to the gauge itself (its reference level or its siting in the slip) rather than to the river model. It is not yet resolved.

Calibration fit on the quasi steady days (grey band: within 3 cm)



Tuning on 12 steady days: each dot is one day's average water level, model (up the side) against gauge (along the bottom), coloured by that day's flow. Dots on the diagonal are perfect and the grey band is within 3 cm. The fifth panel, Dry Dock, was never used in the tuning: its dots sit about 2 cm low, mostly inside the band. 2D depth averaged model, 10 m cells.

2.2 Two weeks of river, hour by hour

The main test is a two week rerun of Sept 30 to Oct 14, 2026, scored hour by hour (336 hours) against the official water level gauges at the five sites between the lake and Port Lambton. The model was started from a tuned state on Sept 28, given two days to settle, and driven only by the measured levels at Lakeport and Port Lambton. Nothing else from the measurements went in.

The pass rule was set before the run: an average error of 3 cm or less, and an hour to hour error no more than half of the gauge's own natural swing over the period (its standard deviation).

gauge	gauge's natural swing (cm)	average error (cm)	hour to hour error (cm)	verdict
Fort Gratiot	8.1	1.6 low	2.4	pass
Point Edward	6.4	0.3 low	2.2	pass
Black River	6.6	0.3 low	1.9	pass
Dry Dock (never used in tuning)	6.2	2.3 low	1.6	pass
St. Clair State Police	5.0	0.1 high	1.1	pass

All five gauges pass, including Dry Dock. The largest average error at any gauge is 2.3 cm.

The same two weeks were also run with the measured flow at the top of the river in place of the lake level. That setup is unbiased (average errors of 0.1 to 1.9 cm, and every steady day within 4 cm), but it **fails** the hour to hour test at all five gauges: at Fort Gratiot, for example, its hour to hour error is 5.0 cm against a natural swing of 8.1 cm. The reason is plain. The flow record carries a few percent of noise from hour to hour, and a 1% error in the flow moves the level at Fort Gratiot by about 2 cm; a flow boundary also cannot follow Lake Huron's own level swings. Driven by levels at both ends, the model has to carry the water surface only between two measured points. That is the setup used for all live work.

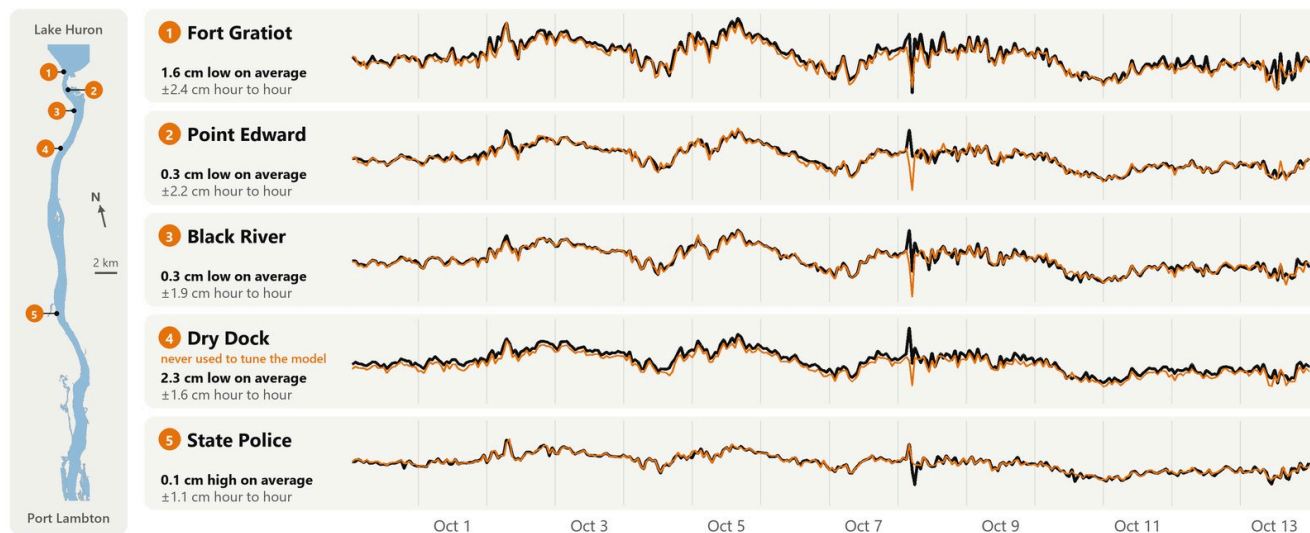
Conditions to keep in mind: the model had no wind in this test (7 of the 336 hours had wind over 8 m/s), and the Lakeport gauge was missing for 63% of the window, so its level was filled from Fort Gratiot plus the difference between the two gauges measured during the tuning period.

The model versus five official gauges

St. Clair River water levels, hour by hour, Sept 30 to Oct 14, 2026

— Measured at the gauge — Computer model 10 cm

Within 2.3 cm on average at all five gauges



Computer model of the St. Clair River. Data: NOAA, Fisheries and Oceans Canada, USGS.

IThero IThero Solutions, Sarnia

Two weeks hour by hour, Sept 30 to Oct 14, 2026: measured water levels (black) against the model (orange) at the five gauges between Lake Huron and Port Lambton, driven only by the measured levels at the two ends. Look at how the orange line follows each rise and fall, including the sharp swing on Oct 8, and at Dry Dock (4), never used to tune the model, which sits 2.3 cm low on average. 2D depth averaged model, 10 m cells.

2.3 How much water: flow from levels alone

Driven only by two water levels, the model also works out how much water the river carries. At the US Geological Survey's measuring section at Port Huron (station 04159130), over the same two weeks:

check	measured	model	difference
Flow record, two weeks, hour by hour	US Geological Survey record		0.39% high on average; 3.55% typical hourly difference
Boat measurement, Oct 5, 2026	6,003 m ³ /s (212,000 cfs)	6,102 m ³ /s	1.64% high, inside the measurement's own 5%

Verdict: **pass**. Single hours vary more than the two week average, as the 3.55% figure shows. The practical meaning is that the river's flow can be worked out from two water level gauges, which makes the model a live cross check on the flow record. Still to do: the same check at higher and lower flows.

2.4 Flow splits around Stag and Fawn Islands

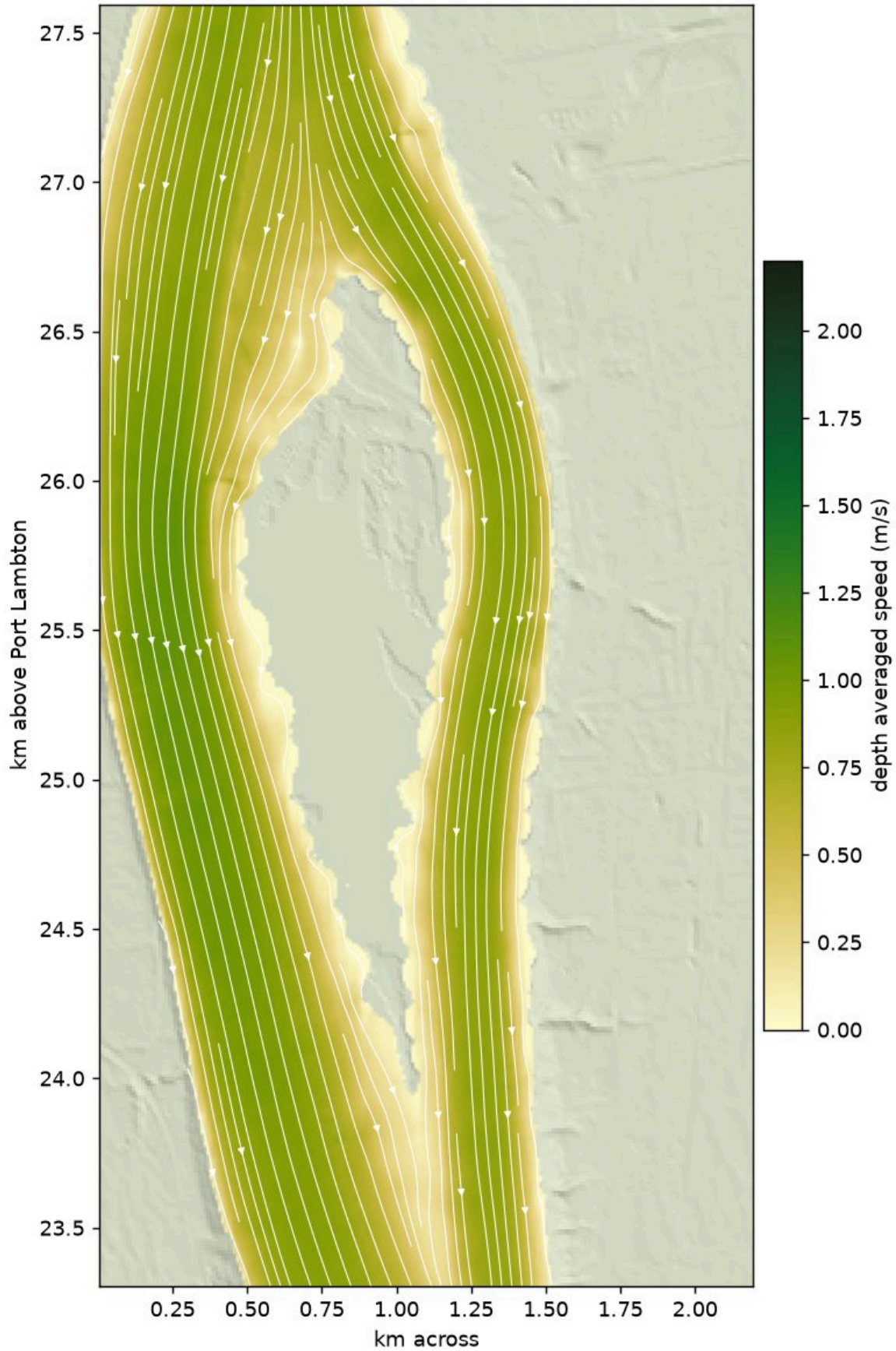
In a steady run at 5,097 m³/s (180,000 cfs), the model divides the river around the two large islands almost as the US Geological Survey measured it (report WRIR 01-4135):

island	model, west / east channel	US Geological Survey, west / east	difference
Stag Island	69.8% / 30.2%	67.8% / 32.3%	2.1 points
Fawn Island	84.6% / 15.4%	82.5% / 17.5%	2.1 points

Verdict: **pass** (the rule was within 3 points). Two cautions for technical readers. The measurements were made from 1996 to 2000, on an older riverbed than the one in the model. And the split is sensitive to the riverbed in the smaller channel: raising or lowering it by 0.5 m shifts the Stag split by about 1.4 points.

Stag Island split, Sept 28, 2026

2D depth averaged model, instantaneous steady state, streamlines in white



Stag Island, where the river splits. Colour is the current averaged from surface to bed; the white lines follow the flow. Look at the wider west channel (left, US side), which carries most of the water, and the narrower, slower east channel. This picture is the flow of Sept 28, 2026; the split checked against the US Geological Survey was run at a steady 5,097 m³/s. 2D depth averaged model, 10 m cells.

2.5 Currents, point by point: a 2002 boat survey

The checks above test water levels, the river's total flow and the split around the islands. This one tests the currents themselves, place by place across the river.

What it was checked against. In May and June 2002, US Army Corps of Engineers and US Geological Survey crews crossed the river by boat at 104 places, from the head of the river to below Port Lambton, twice at each, measuring the current from near the surface to near the bed with acoustic current meters (Holtschlag and Koschik 2003, US Geological Survey Open File Report 03-119). Each measured profile was averaged from surface to bed, the same quantity the model computes, with the thin unmeasured layers at the top and bottom filled by the standard US Geological Survey estimate.

How it was run. The model was run for five of the survey days (May 20, 21, 22 and 23, and June 24, 2002), driven only by each day's measured water levels; the US Geological Survey flow record at Port Huron starts in 2008. Nothing was tuned to the boat data. Model and boat were compared along each boat's own track, in stretches of about 30 m: 3,507 stretches holding 156,187 measured profiles. The places below Port Lambton or within 1 km above it were left out of the headline.

The six rules were written down before any 2002 run or score:

check	pass if	result	verdict
speed, on average	within 10% of the mean measured speed (0.792 m/s)	2.2% fast (0.809 m/s)	pass
speed, median size of the miss	0.10 m/s or less	0.049 m/s	pass
speed, typical error (root mean square)	0.15 m/s and 20% or less	0.103 m/s, 13.0%	pass
direction, where the water runs 0.30 m/s or faster	median within 10 degrees, 80% within 20	median 1.8 degrees, 98.6% within 20	pass
shape of the speed across the river	median correlation 0.70 or more, 75% of passes at 0.50 or more	median 0.93 over 174 passes, all at 0.50 or more	pass
flow through each surveyed section, inside the boat's track	within 5% on average, 80% of sections within 10%	0.7% high on average; 93% of 74 sections within 5%, all within 10%	pass

Verdict: **pass, 6 of 6.** An internal review on Oct 24 corrected how the boat's flow was summed along its track and added the checks below. The rules and their limits did not change, and all six still pass.

What this pass can and cannot show. A simple estimate with no river physics in it also passes all six rules: each boat pass gets the model's own average speed, shared out across the river by depth alone (deeper water runs faster), pointing the average way of the flow on that pass. Its typical error is 0.148 m/s (18.7%), just inside the limit. Direction and flow are close to guaranteed by the shape of the channel and by a flow worked out from levels, so only the typical error separates the model from that estimate, and narrowly. The model is still clearly better: it cuts the typical error from 0.148 to 0.103 m/s, about half the squared error, and it is better in every reach. The fair reading is that the model's currents are right where a simple estimate would be roughly right, and better than that estimate across each section.

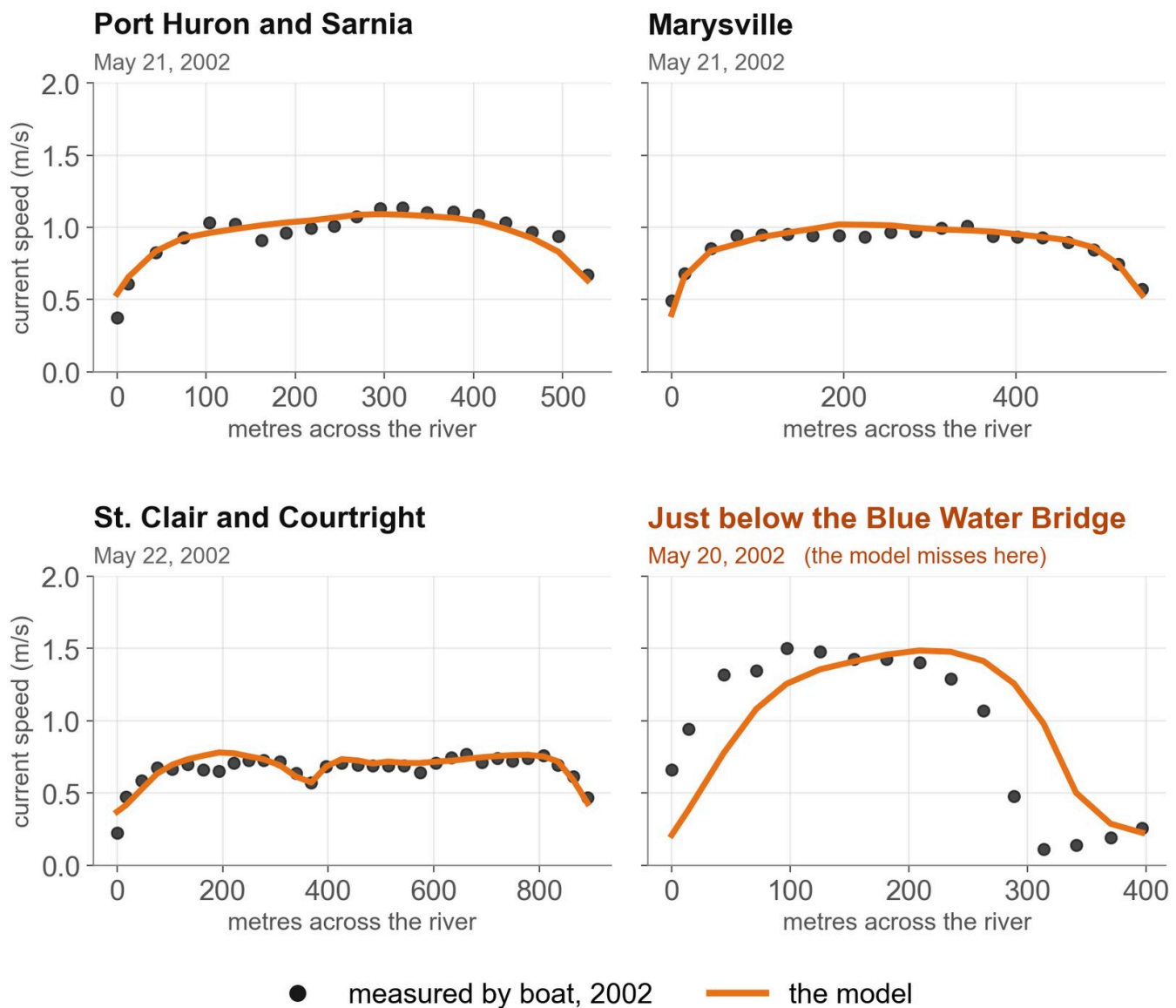
Where it misses.

- **The 1.1 km below the Blue Water Bridge** (May 20). The typical error at each section here is 0.20 to 0.42 m/s, up to 43% of the section's mean speed. The boat found the fastest water hugging the Michigan side more tightly than the model places it: at the two worst sections, within 60 m of the Michigan bank, it measured 0.63 to 1.32 m/s where the model has 0.06 to 0.78. The model's depths there match the soundings, so this is the flow, not the riverbed. It is

the picture the 3D model of the bridge reach suggested (section 3.5). Judged alone, the two upper reaches, from Lake Huron to the Black River, would not meet the typical error limit (0.230 and 0.164 m/s). 87% of the measurements lie below the Black River, and the overall pass rests on them.

- **Below St. Clair State Police** the model runs about 5% fast and carries 3% more flow inside the boat tracks than the boats measured. Roughly half of that fits a flow a little high, partly from the timing of the passes, and half fits a riverbed from the 2020s surveys that is shallower than the river of 2002. The riverbed part is an inference.
- **Islands.** At Stag Island the smaller Canadian channel gets 1.8 to 3.4 percentage points too little of the flow, the same direction as the 1996 to 2000 measurements of section 2.4. At Fawn Island the direction agrees and the size is uncertain.
- **Near the Canadian shore below Point Edward** (looked at after the scores, not one of the rules), the model is about 40% fast in the last 60 m of the passes: 0.19 m/s faster than a measured 0.46 m/s on average. That is fast, but not the three to four times that the drifting buoys of section 3.2 suggested; those buoys moved closer to shore than any boat profile.

Limits. The riverbed in the model is a mosaic of surveys from 2000 to 2026, not the river of 2002. The boats miss the top 0.8 to 0.9 m, the water nearest the bed and the strips to each shore; the layers are filled by the standard estimate, and the shore strips are left out of both sides of the flow comparison. A steady model stands in for surveys that took a working day per reach, while Fort Gratiot moved 4 to 8 cm within each day. Each reach was surveyed on its own days, so reach and day effects cannot be separated. The flows were 4,951 to 5,433 m³/s, with no wind. These are depth averaged currents: the test says nothing about the surface or the bottom water alone. Experimental, not for navigation.



0 m is the Michigan side. Current averaged from surface to bed. Experimental, not for navigation.

Current speed across the river at four places: measured by boat in May 2002 (dots, one boat pass at each place) against the model sampled along the same pass (orange line), from the Michigan side (0 m) toward Ontario. Look at Port Huron and Sarnia, Marysville, and St. Clair and Courtright, where the line follows the dots across the river, and at the panel just below the Blue Water Bridge, where the boat found the fastest water close to the Michigan side and the model places it further out: the model misses there. Current averaged from surface to bed. 2D depth averaged model, 10 m cells, driven by each day's measured water levels. Experimental, not for navigation.

2.6 Real low and high water, outside the tuning

The 12 tuning days had flows of 5,421 to 5,955 m³/s. The model was then run, unchanged, at real flows well outside that range, with Lake Huron from 0.8 m lower to 0.9 m higher than during the tuning. The November 2012 window had Lake Michigan Huron near its record low; the July 2020 window near its record high. The test for 2012 and 2020 was set blind: within 5 cm at every gauge.

Model minus measured window average, cm:

window	flow (m ³ /s)	Fort Gratiot	Point Edward	Black River	Dry Dock	State Police
Nov 1 to 15, 2012	4,773	2.6 high	no data	0.1 high	0.1 low	0.4 low, not independent

window	flow (m ³ /s)	Fort Gratiot	Point Edward	Black River	Dry Dock	State Police
Oct 3 to 5, 2000 (three days)	4,961 to 5,008	2.9 to 4.0 low	no data	3.6 to 4.1 low	3.8 to 4.3 low	0.2 low, not independent
July 1 to 15, 2020	6,845	1.6 low	2.4 low	2.5 low	4.1 low	0.1 high

Every independent gauge is within 4.3 cm. Verdict: **pass**. The errors do not all lean one way (2012 reads high at Fort Gratiot, 2000 and 2020 read low), so they are not a simple offset in the tuning. Where Port Lambton had no record, its level was estimated from State Police, which is why State Police is not an independent check on those days. The October 2000 flow is the average of a few boat measurements that themselves spread from 4,763 to 5,142 m³/s; 2% more flow would close its gap.

2.7 The replayed week, Oct 14 to 20, 2026

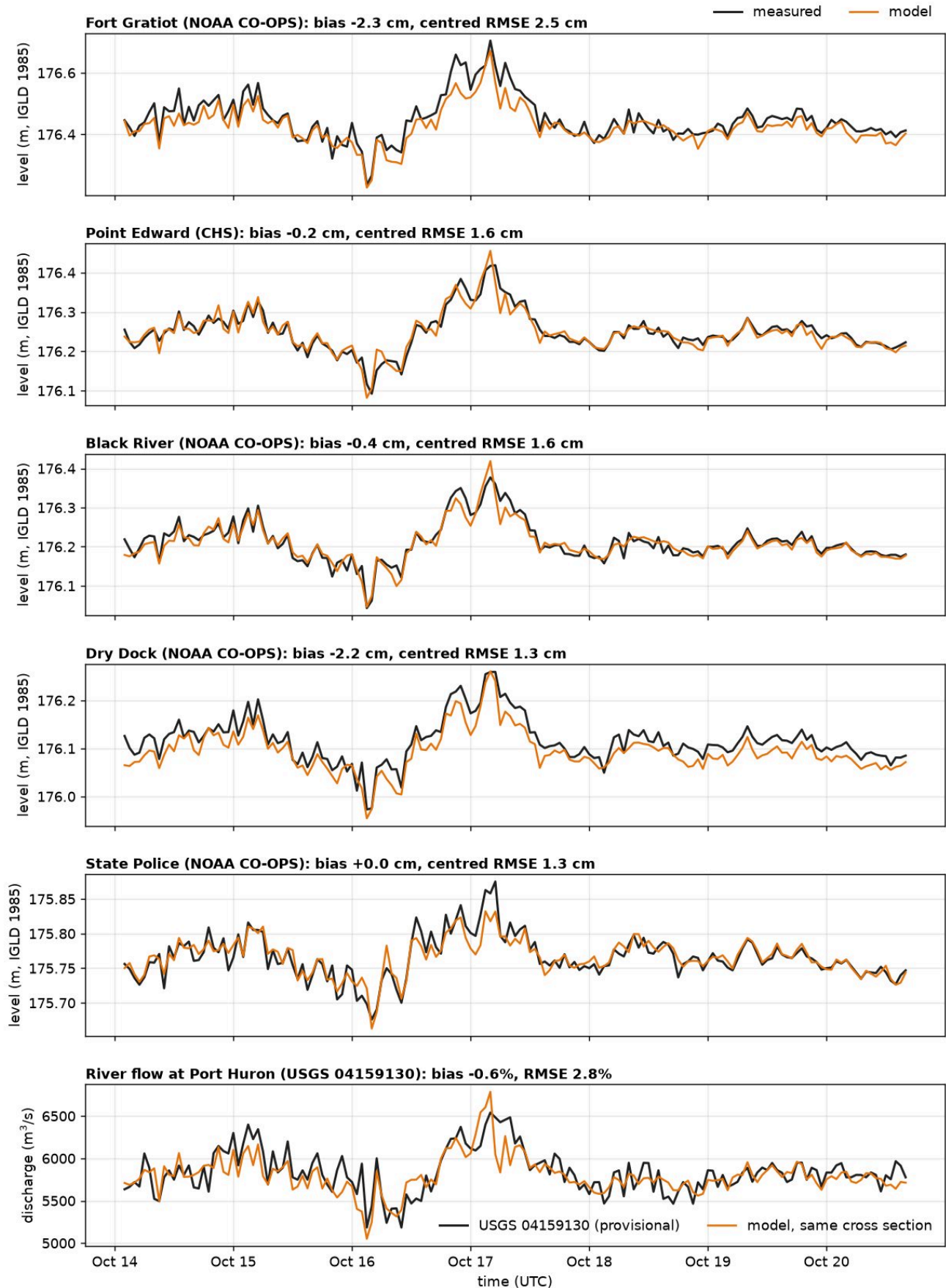
To see what a live hourly service would have reported, the model was carried through a real week hour by hour, exactly as it would run live: 159 hourly readings from Oct 14 02:00 to Oct 20 16:00 UTC, driven by the Lakeport and Port Lambton levels as they were measured. The US Geological Survey flows for these days are still provisional and may be revised.

gauge	average error (cm)	hour to hour error (cm)	largest error (cm)	gauge's natural swing (cm)
Fort Gratiot	2.3 low	2.5	11.7	7.1
Point Edward	0.2 low	1.6	6.3	5.1
Black River	0.4 low	1.6	6.0	5.1
Dry Dock (never used in tuning)	2.2 low	1.3	6.1	4.6
St. Clair State Police	0.0	1.3	4.4	3.1
River flow at Port Huron	0.6% low	2.8% typical		

All five gauges pass the same test as the two week rerun. The model's average flow over the week was 5,800 m³/s against 5,840 m³/s measured. The scores after the first day equal those for the whole week, so there is no lasting effect from the start.

The largest errors came on the big rise: Fort Gratiot rose 47 cm from Oct 16 03:00 to Oct 17 04:00 UTC, and the model followed it but ran low near the peak (11.7 cm low at Fort Gratiot at Oct 16 23:00 UTC). The Lakeport record stopped on Oct 18 and had gaps before then, so 29% of the boundary values were filled from Fort Gratiot plus the same offset as in the tuning period; the filled hours scored no worse than the measured ones.

**R4 scored week: hourly nowcasts 2026-10-14 02:00 to 2026-10-20 16:00 UTC against the gauges
2D depth averaged model, 10 m grid, driven by Lakeport and Port Lambton levels**



The replayed week, Oct 14 to 20, 2026: what an hourly service would have reported (orange) against the five gauges and the US Geological Survey flow at Port Huron (black; provisional). Look at the big rise of Oct 16 to 17, when Fort Gratiot rose 47 cm: the model follows it but runs low near the peak. 2D depth averaged model, 10 m cells, driven by the Lakeport and Port Lambton levels. Experimental, not for navigation.

2.8 Basic correctness

Two checks confirm that the model does what physics requires on the real riverbed, at both 10 m and 5 m (run Oct 20 and 21, 2026):

- **Still water stays still.** With the river filled to one level and both ends held there for a full day, the largest current anywhere is 0.000012 m/s at 10 m and 0.000045 m/s at 5 m, against a limit of 0.0001 m/s, and the surface moves by at most 0.0017 mm, against a limit of 1 mm.
- **The water budget balances.** Over an hour of flowing river, the water in, the water out and the change in storage agree to within 3.3 parts in a billion of the flow (10 m) and 1.6 parts in a billion (5 m), against a limit of one part in ten thousand.

Verdict: **pass** at both resolutions.

3. What it can do, and how each use was checked

Six uses were built on the same checked model. Each answers a practical question, and each was checked separately against its own measurements. Each section below gives the question, the checks, the verdict as the lab report states it, and the limits. The experiment labels (R2 to R7) match the title page.

3.1 Spills (R2)

What it answers. If something spills into the river at a given point and a given flow, when does it reach each line downstream, when does the peak pass, and when has most of it gone by? A spill in this river reaches downstream drinking water intakes within hours. NOAA's spill reference tables (Anderson and Schwab 2014, NOAA TM GLERL-162) cover 30 fixed cases at one flow. The model can run any release point at any flow, 17 spills at once.

How it was checked. A virtual dye is released into the modelled current and carried down the river. It first passed all 10 of its own self tests (a uniform dye stays uniform to within 0.0012%, and no dye is gained or lost to within one part in ten million). Then all 15 release points of NOAA's tables were run at 5,053 m³/s: five points across the river (10, 30, 50, 70 and 90% of the width from the US shore) on each of the Sarnia, Marysville and St. Clair release lines. Two real dye releases from August 2009 (Anderson and Schwab 2012) ran alongside: Aug 19 near the Canadian shore at 5,198 m³/s and Aug 20 near the US shore at 4,740 m³/s (the Aug 18 release matches one of NOAA's cases). Arrival was scored at NOAA's seven lines across the river, from Marysville to just above Marine City, in three ways: first arrival (0.1% of the dye past the line), peak, and 90% passed.

Spills at the surface, against NOAA's surface release tables (80 cases per measure):

measure	median error	median size of the miss	share within 30 minutes
first arrival	9 minutes late (8.6)	22 minutes	70%
peak	3 minutes late (2.7)	14 minutes	75%
90% passed	4 minutes late (3.8)	13 minutes	76%

Line by line, the median peak is 5, 3 and 1 minutes late at the first three lines, on time at the fourth, 1 minute early at the fifth, and 4 and 9 minutes late at the last two. Across the river, the model puts the peak within 0.09 of the river's width of NOAA's position on average.

The long tail. The medians hide a few large misses: the typical size of the error across all cases is 34 minutes (first arrival), 128 minutes (peak) and 565 minutes (90% passed). Most of it comes from one release near the Canadian shore at Sarnia (NOAA's "9" position, released in 6.3 m of water against 10.0 to 12.4 m at the other Sarnia points). Only 43% of that release had crossed the first line when the 16 hour run ended, so its times describe only the part that got through, and NOAA's printed 90% passed times for it are longer than its own trailing edge, which suggests swapped columns in the table. Without that one release (73 cases) the median errors are 10.6, 1.5 and 5.9 minutes, with 74%, 81% and 84% within 30 minutes. The next largest misses are at the peak for another Sarnia release below Stag Island, 100 to 109 minutes early.

On Oct 24 that Sarnia shore release was run on to 72 hours. By then 91 to 95% of it had crossed each line; the model holds it in and by Sarnia Bay and lets it out slowly. With those times in place, the medians become about 10, 3 and 5 minutes (9.7, 3.2 and 5.2), the typical size of the error at 90% passed falls from 565 to 58 minutes, and at the peak it grows from 128 to 143 minutes, because that release's peak now arrives hours after NOAA's.

Spills at the bottom. NOAA's tables also give releases at the riverbed, which travel slower near the bottom. The model reaches them about 130 minutes early at first arrival (84 minutes at the peak, 32 at 90% passed). This is expected: a depth averaged model carries one current for the whole water column, so it sits between NOAA's surface and bottom tables, close to the surface one.

The 2009 dye releases. Travel time to the last line:

release	flow (m ³ /s)	published	model, first arrival	model, peak
Aug 18, 2009, centre of the channel	5,053	6.06 h	6.80 h (44 minutes late)	7.24 h (71 minutes late)
Aug 19, 2009, near the Canadian shore	5,198	6.0 h	6.80 h (48 minutes late)	7.79 h (108 minutes late)
Aug 20, 2009, near the US shore	4,740	6.52 h	7.46 h (56 minutes late)	8.69 h (130 minutes late)

Two reasons are known. The published dye time is a first arrival (it matches NOAA's first arrival for the same case, 6.18 h, not its peak, 6.95 h), and releases near the shore travel slower in a depth averaged model; the release positions are also inferred, because the 2009 paper does not print them.

The surface rerun, Oct 24. The 2009 dye was poured on the surface, and the surface runs faster than the depth average. So all three releases were rerun as floats moving with the surface current (1.15 times the depth average, the factor checked in sections 3.2 and 3.5), 20,000 floats per release, with nothing tuned. The rule was written before the run: first arrival, the time when 1% of the floats have crossed the last line, within 14 minutes of the published time.

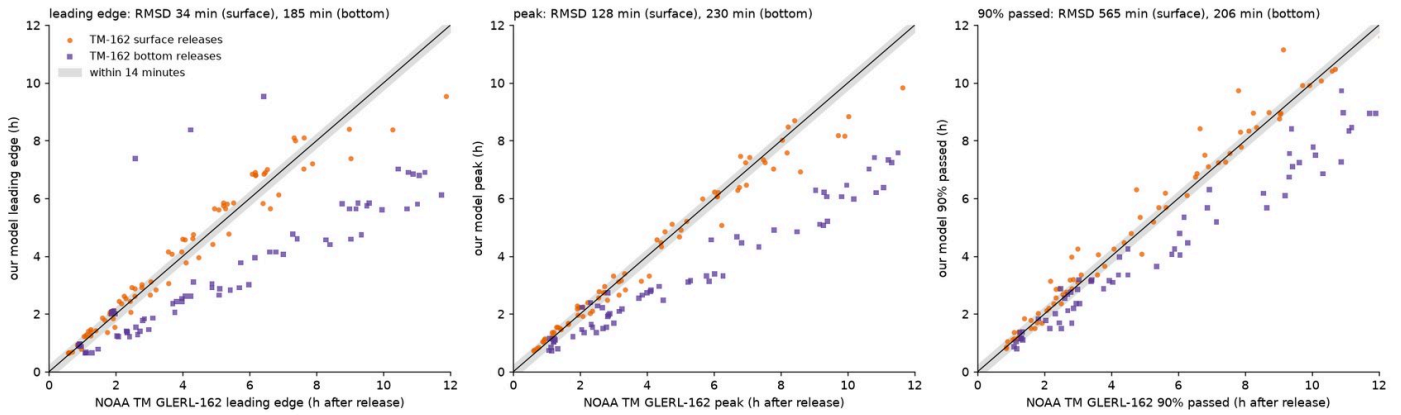
release	published	surface floats, first arrival	difference
Aug 18, 2009, centre of the channel	6.06 h	6.05 h	0.4 minutes early
Aug 19, 2009, near the Canadian shore	6.0 h	6.20 h	12.3 minutes late
Aug 20, 2009, near the US shore	6.52 h	6.87 h	20.9 minutes late

The same floats on the depth averaged current arrive 54 to 82 minutes late, so the surface current closes most of the gap. Verdict: **holds in part**, two of the three releases within 14 minutes. The two shore releases are still late, and the 2009 paper does not print their exact release points.

Verdict, as the report states it. Self tests: **pass**. Surface release tables: **pass on the median**; it does not hold case by case. Bottom release tables: **not matched**. 2009 dye arrival within 14 minutes: **fail as written** for the depth averaged dye; the scored surface rerun of Oct 24 **holds in part** (two of three). All 17 spills in one run, much faster than real time: **pass** (16 hours of river in 4,945 seconds, on a graphics card shared with two other jobs).

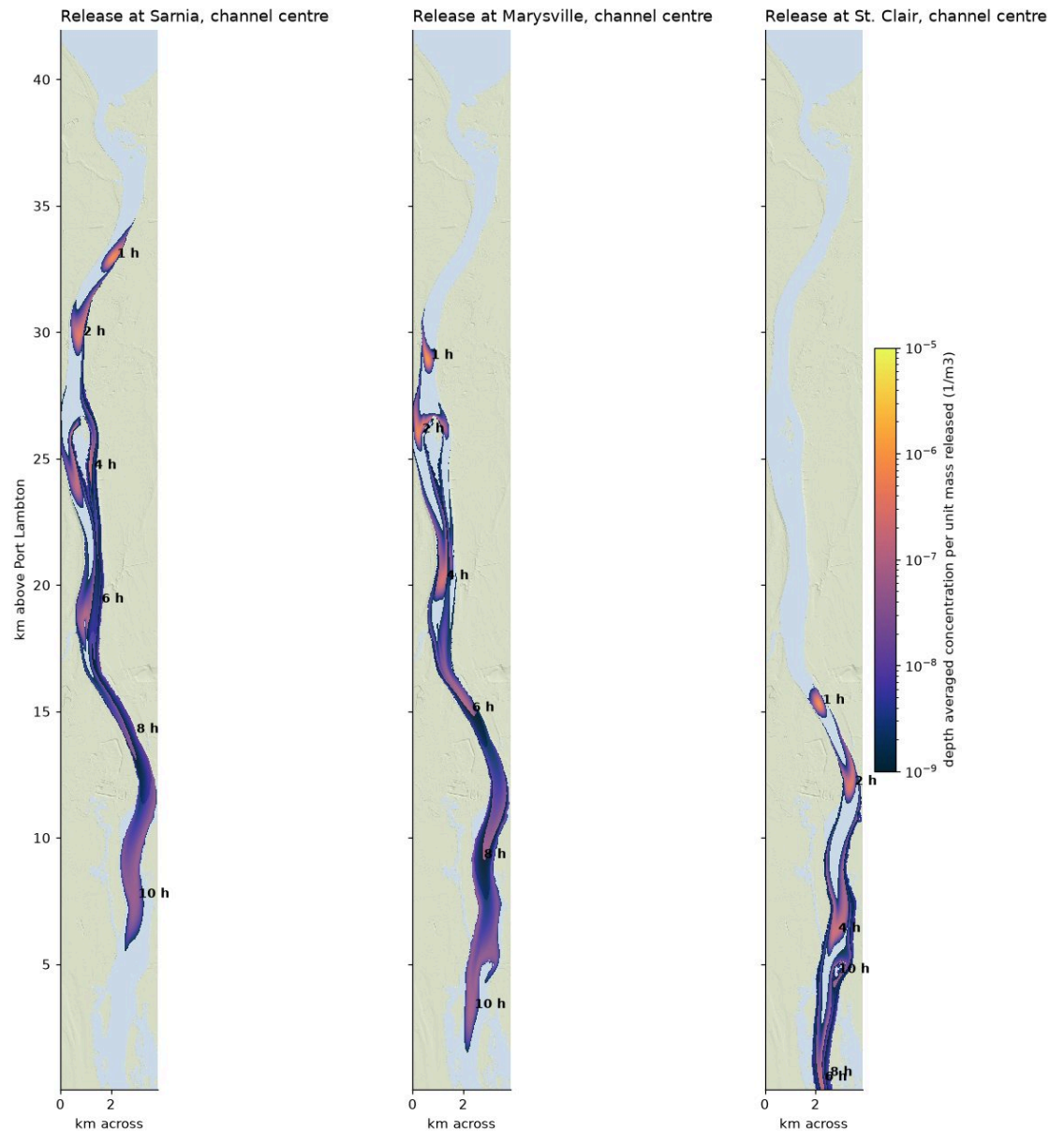
Limits. Steady flow and no wind, as in NOAA's tables. 10 m cells; near shore detail improves at 5 m. A depth averaged dye does not separate surface and bottom spills; floating product needs the surface drift of section 3.2 with a wind push. Single cases can be off by far more than the median. Drinking water intake positions were not used: NOAA's lines stand in for the nearest towns. **For anyone who might rely on spill timing: with the depth averaged current, the model's first arrival is 44 to 56 minutes later than the 2009 dye; with surface floats, two of the three releases arrive within 14 minutes (0.4 minutes early and 12.3 minutes late) and the third 20.9 minutes late.**

R2: spill arrival at transects T1 to T7, 15 release points, 5,053 m³/s. Our 2D depth averaged tracer against NOAA's 3D particle tables.



Spill arrival times for all 15 NOAA release points at seven lines down the river: the model (up the side) against NOAA's spill reference tables (along the bottom), for first arrival, peak and 90% passed. Orange dots are NOAA's surface releases and sit along the diagonal; purple squares are NOAA's bottom releases, which the model reaches early. The grey band is within 14 minutes. 2D depth averaged model, 10 m cells, steady 5,053 m³/s.

R2: where a 1 unit spill is 1 to 10 hours after release, steady 5,053 m³/s, no wind. 2D depth averaged model.



Where a spill released in the centre of the channel is 1 to 10 hours later, for releases at Sarnia, Marysville and St. Clair. Look at how each plume stretches out and splits around the islands as it travels. Concentration per unit released, steady 5,053 m³/s, no wind. 2D depth averaged model, 10 m cells.

3.2 Surface drift (R3)

What it answers. Where does something floating on the surface go, and how fast: debris, a floating product, a person in the water? One use is the Port Huron Float Down, covered briefly below.

How it was checked. In October 2000 the US Geological Survey released drifting buoys on the river and recorded their paths (Holtschlag and Aichele 2001, Open File Report 01-17). The tracks survive only as animations on the report's web pages; IThero recovered them, timed them from the on screen clock and placed them on the map from the charts' printed latitude and longitude lines (median offset from the chart shoreline 3 to 9 m; a working position error of a few tens of metres). Inside the model are 173 tracks from 13 deployments on Oct 3 to 5, 2000, from the Blue Water Bridge to Port Lambton, with 85,452 positions; each track lasts 7 to 84 minutes. Each buoy towed a bucket about 3 feet below it, so the buoys follow the water just under the surface.

The model was run at the flow of each day (boat measurements of 5,008, 4,974 and 4,961 m³/s), and 50 floats were released at each buoy's first position and time. The scores: distance from the real buoy over time, a standard trajectory skill score (Liu and Weisberg 2011; 1 is a perfect match, 0 is no skill), travel time where the buoy crosses lines every 1 km down the river (358 crossings), side to side error, and speed.

model current used	distance from the buoy at 10 / 30 / 60 minutes / track end (m)	skill	travel time error, median	side to side error, typical	speed, model over buoy
depth averaged current, as is	89 / 278 / 492 / 403	0.854	261 s late	52 m	0.90
surface current, 1.15 times the depth average	40 / 118 / 333 / 239	0.926	9 s late	51 m	1.01
surface current plus a 3% wind push	56 / 181 / 741 / 485	0.863	16 s late	121 m	1.04
reference: the model's path at one constant speed	128 / 384 / 683 / 648	0.754			
reference: surface factor fitted on the other two days	45 / 124 / 250 / 221	0.933			

What holds. The surface current is the real gain, and it holds on every day: skill 0.896, 0.946 and 0.939 on Oct 3, 4 and 5, against 0.833, 0.863 and 0.864 for the plain depth average. It also holds out of sample: a factor fitted on two days and used on the third (1.10 to 1.13) scores the same. It beats following the model's path at one constant speed on 82% of tracks, so the modelled speeds carry real information, not just the shape of the channel. The travel time error of 9 s (middle half from 49 s early to 74 s late) is indistinguishable from zero, since the recovered tracks were smoothed between position fixes about 90 s apart. Water levels for October 2000 read 2.9 to 4.3 cm low (section 2.6).

What does not. The real buoys drifted across the river in the two bends below Lake Huron. Below the bridge, 10 of 14 buoys moved more than a tenth of the river's flow toward the US shore (a median shift of 0.23 of the flow); in the reach just below, 9 of 14 moved toward Canada (0.18). The model's floats moved less than 0.02 in both. This is bend flow, the corkscrew motion a depth averaged model does not have. The model is also far too fast in slow water along the shore: four tracks, three of them by Sarnia Bay on the Canadian side, have zero skill, with buoys moving at 0.25 to 0.36 m/s while the model ran at 0.84 to 1.15 m/s. And these drogued buoys in winds of 2 to 4 m/s cannot test how hard the wind pushes a person: the 3% wind push used for people is worse than none for the buoys, which, in the report's words, says the buoys are not people, not that 3% is wrong for people. The gain at the track end is also fragile: most of it comes from Oct 4, and 4 of 13 deployments get worse.

Verdict, as the report states it. Surface current of 1.15 times the depth average: **supported**. Floats keep their place across the river without wind: **contradicted in part**. Wind push on people: **not tested**. Overall: **the drift is partly validated**. The travel down the river is good, the drift across it is not captured, and the wind push on people is untested.

Limits. One flow (about 4,980 m³/s), light winds and drogued buoys; smoothed tracks recovered from animations. Steady currents and a uniform wind. People are treated as passive floats. The side of the river is judged against the middle of the wetted channel, not the surveyed border.

Figure 10 consists of four panels showing model results for oil spill dispersion in the St. Clair River. Each panel displays current speed (m/s) as a color background and oil spill tracks as lines with markers. The panels are:

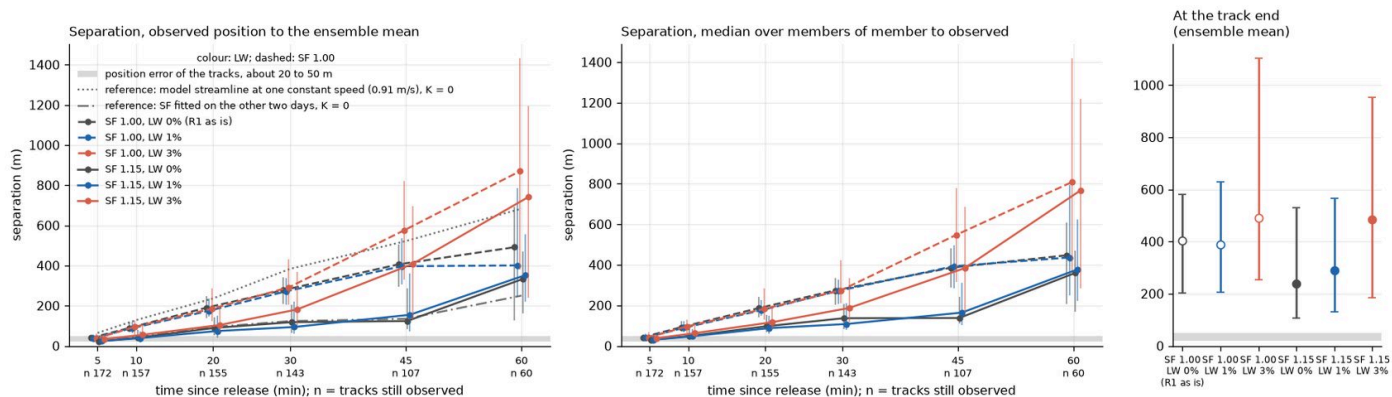
- Upper river: Blue Water Bridge and Port Huron releases**
Oct 3 and Oct 4, 2000: 42 tracks
- Upper river: Sarnia south, Marysville and Stag Island releases**
Oct 3, 2000: 41 tracks
- Lower river: Pine River and St. Clair releases**
Oct 4, 2000: 53 tracks
- Lower river: Marine City and Port Lambton releases**
Oct 5, 2000: 37 tracks

A color bar on the right indicates current speed (m/s) from 0.00 to 2.00. A legend at the bottom explains the symbols:

- real buoy (US Geological Survey, October 2000); open circle where its track ends
- the model's path from the same start; dot where the model is at that time
- water level gauge

St. Clair River experiment. IThero Solutions. Sarnia, Ontario. An independent research experiment, not for navigation.

R3 drifters: separation between observed buoys and modelled floats, pooled over 173 tracks (dots: median; bars: quartiles). SF surface factor on the depth averaged current, LW wind leeway. Fewer tracks last to the later times (n under each tick), so those medians come from the longer tracks only. The grey band is the working position error of the digitised tracks: separations inside it are not resolved. The end separation gain from SF 1.15 comes mostly from Oct 4 (scores file, by_day). 2D depth averaged model.



How far the model's floats end up from the real buoys over time since release (dots: median over tracks; bars: middle half). Solid lines use the surface current (1.15 times the depth average), dashed lines the plain depth average; colour shows the wind push (black none, blue 1%, red 3%). Look at the solid black and blue lines, which stay lowest through the first half hour, and the red lines, which climb fastest. The grey band is the position error of the recovered tracks. 2D depth averaged model.

3.3 The live river (R4)

What it answers. What is the river doing at this moment: the current at named places, the river's flow and the levels at the gauges, worked out from the latest public gauge readings. It shows the present or replays the past; it is not a forecast.

How it was checked. On its first live run, on Oct 14, 2026, the model fetched the newest public data from the US Geological Survey, the Canadian Hydrographic Service and NOAA and carried the river 11 hours forward (01:00 to 12:00 UTC) in 145 seconds. At 12:00 UTC:

item	model	measured
River flow at Port Huron	5,791 m ³ /s	5,677 m ³ /s (2.0% high)
Fort Gratiot	176.419 m	176.477 m
Black River	176.212 m	176.239 m
Dry Dock	176.102 m	176.135 m
St. Clair State Police	175.759 m	175.766 m
Current under the Blue Water Bridge	1.65 m/s (3.2 knots)	not measured

That hour's gauge errors (0.7 to 5.8 cm) were larger than the two week average, so a single hour was not enough. The replayed week (section 2.7) settled it: run hour by hour, the model reproduces that hour within 1 cm and shows it was an hour with a larger than usual miss, not a lasting offset. Over the week all five gauges passed and the flow was within 1% on average.

Currents over the replayed week, read in the channel near each place (the deepest water within 300 m), m/s with knots in brackets:

place	week average	lowest to highest	last hour, Oct 20 16:00 UTC
Blue Water Bridge	1.64	1.36 to 1.89	1.68 (3.3)
Float Down launch, Lighthouse Beach	1.38	1.15 to 1.67	1.43 (2.8)
Sarnia waterfront	1.10	0.98 to 1.25	1.09 (2.1)
Stag Island, west channel	1.02	0.94 to 1.12	1.01 (2.0)
Stag Island, east channel	0.83	0.76 to 0.91	0.82 (1.6)
Marine City	0.86	0.77 to 0.97	0.85 (1.7)
Sombra ferry	0.70	0.63 to 0.79	0.70 (1.4)

These currents are depth averages. The model's currents were checked against a 2002 boat survey from Lake Huron to Port Lambton (section 2.5), at lower flows than this week's; in the 1.1 km below the Blue Water Bridge that survey found the model misplacing the fastest water. **Experimental, not for navigation.**

Cost. The replayed week took 22 minutes for 159 hours of river, about 8.2 seconds of computing per hour on a shared graphics card. An hourly service would need about 9 seconds of computing an hour.

Verdict, as the report states it. The live river has no numbered tests of its own. Runs from public data: **yes**. Fast enough to update every hour: **yes**. Gauge agreement over a week: **all five gauges pass** the same test as the two week rerun. Flow: **within 1%** over the week, against provisional US Geological Survey values.

Limits. It runs on demand; no schedule is running, and an hourly service waits for the go ahead. It is a nowcast with no lead time; a forecast would need forecast lake levels and wind. The week's US Geological Survey flows are provisional. Fort Gratiot read 2.3 cm low over the week (daily averages from 0.7 to 4.1 cm low), more than in the two week rerun;

wind on Lake Huron is one untested candidate. How each named place is matched to the channel still has to be settled before an hourly service.

St. Clair River right now

Tuesday October 20, 12:00 PM Eastern

Current at the Blue Water Bridge

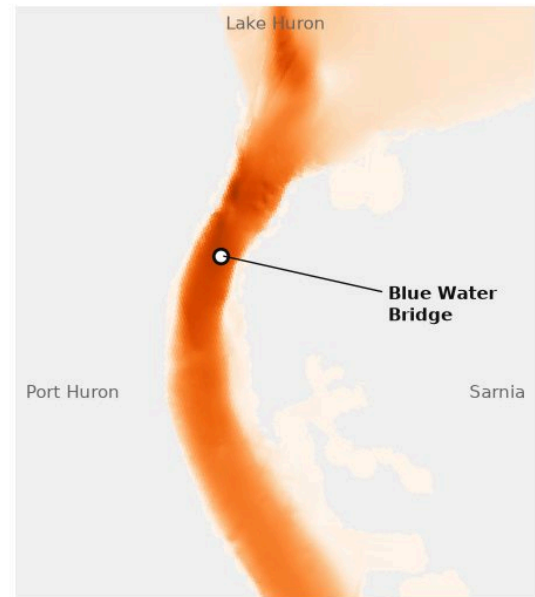
1.7 m/s 3.3 knots

River flow

5,714 m³/s at Port Huron

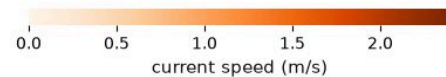
Water level at Point Edward

176.21 m Great Lakes datum (IGLD 1985)



Computer model of the river, checked against the gauges

Data: NOAA, USGS, Fisheries and Oceans Canada. Experimental; not for navigation.



The dashboard tile, made from a replay of Tuesday Oct 20, 2026 at noon Eastern, not a live reading: current at the Blue Water Bridge 1.7 m/s (3.3 knots); river flow 5,714 m³/s (US Geological Survey provisional at that hour: 5,777); water level at Point Edward 176.21 m (measured by the Canadian Hydrographic Service: 176.22 m). The map shows the modelled current in the bridge reach. 2D depth averaged model, 10 m cells. Experimental, not for navigation.

3.4 Ice jams (R5)

What it answers. Did ice hold the river back, on which days, by how much and where? Ice jams on the St. Clair River raise water levels, flood shoreline communities and choke the outflow of Lake Huron.

How it works, in plain terms. For every winter day, the tuned open water model is driven by that day's measured levels on Lake Huron and at Port Lambton. It then shows how much water an ice free river would pass between those two levels. The open water flow minus the measured flow is how much the ice held back. Only routine gauge records go in.

How it was checked.

- **The noise when there is no ice.** On 36 open water days (Aug 19 to Sept 23, 2026) the method reads 12 m³/s on average with a spread of 108 m³/s (5 to 95%: 181 m³/s below to 170 m³/s above), about 2% of the flow. Verdict: **pass in open water.**
- **The 2019 and 2021 jams, found on the right days.**

winter	jam window (over 500 m ³ /s held back)	peak held back	largest rise above the open water model, State Police / Dry Dock / Black River / Point Edward / Fort Gratiot
2019	14 days, Jan 22 to Feb 4	1,972 m ³ /s on Jan 31 (33% of the flow)	38 / 23 / 18 / 18 / 6 cm
2021	11 days, Feb 4 to 14	1,942 m ³ /s on Feb 8 (30% of the flow)	50 / 30 / 21 / 19 / 6 cm

Public reports placed a jam at Port Lambton and between Marine City and Algonac on Jan 21, 2019 (Sarnia News Today and CTV Windsor, Jan 21 to 23, 2019) and a jam at Port Lambton in early February 2021 (Environment and Climate Change Canada, LEVELnews). Both peaks stand about 18 standard deviations above the open water noise, and about 11 above the winter scatter outside the jams. In 2019, on the days with more than 1,000 m³/s held back, the measured flow was 3,760 to 4,290 m³/s while open water would have passed 5,180 to 5,940. Verdict: **pass.**

- **Where the jam sat.** In both winters the rise above the open water model grows downstream and is largest at State Police, the lowest gauge, which places the resistance below State Police, consistent with the reported jams near Port Lambton and Marine City. It cannot pinpoint further, because those jams sat near or below the Port Lambton end of the model. Verdict: **pass, qualitative.**
- **Ice as added resistance, reach by reach.** Each jam day was given its own resistance in each of the four reaches, fitted to the measured flow and the five gauges. This reproduces all 25 jam days, with levels within 1.0 to 1.4 cm (typical) and the flow within 4.4%, against 20.2 cm and 36.1% with open water resistance. In both winters the added resistance sits in the lowest reach, State Police to Port Lambton, at about 1.6 to 2.5 times its open water value; late in the 2019 jam the reach above also rose. Read as a full ice cover on that reach, the implied roughness of the underside of the ice falls inside the published range for breakup jams (US Army Corps of Engineers, Ice Engineering manual) on all but the last three days of the 2019 jam and the last two of 2021, just below it as each jam eased. That is an equivalence, not a measurement: the fit cannot separate the roughness of the ice, its thickness and a partial cover. The two 2021 release days (Feb 13 and 14) were refitted on their own on Oct 21 (flow within 4.1% and every gauge within 1.9 cm); that refit was written after the first fit had been seen. Verdict: **pass on all 25 jam days.**
- **The record jam of April 1984.** Driven by the 1984 gauge levels, the open water model was compared with the coordinated monthly flows (US Army Corps of Engineers, Detroit District):

month	open water model (m ³ /s)	coordinated flow (m ³ /s)	difference (m ³ /s)
March 1984 (from the 15th)	5,729	5,210	519
April 1984	6,412	3,680	2,732

month	open water model (m ³ /s)	coordinated flow (m ³ /s)	difference (m ³ /s)
May 1984 (to the 14th)	6,536	6,000	536

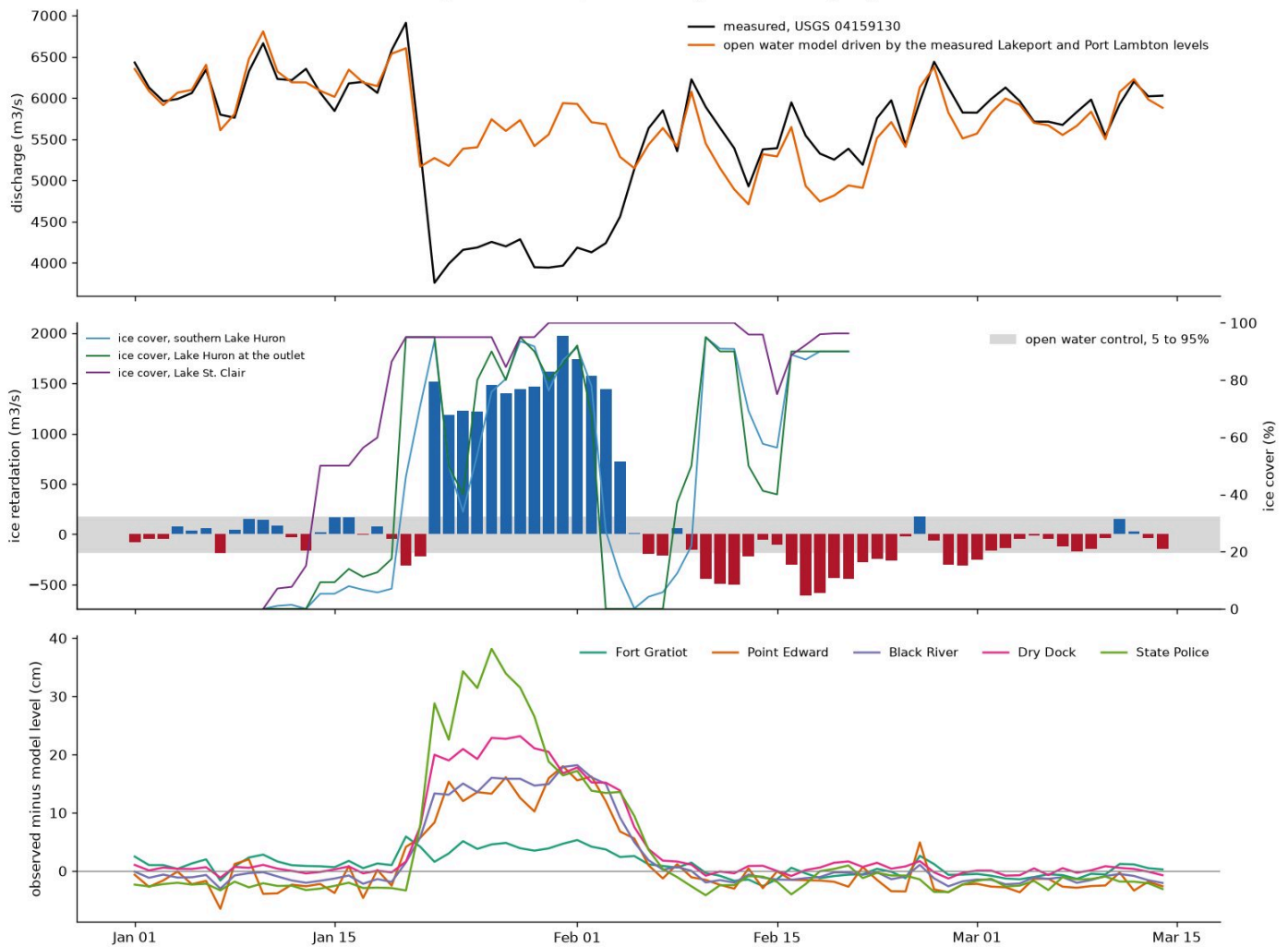
Derecki and Quinn (1986) put the April shortfall at about 2,700 m³/s. The model also runs about 528 m³/s above the coordinated flows in March and May, and May at least had no jam. Removing that offset gives about 2,200 m³/s. The cause of the offset is not known (a riverbed of the 2020s under a river of 1984, the coordinated flows themselves, ice or weeds), so **the April retardation from this model lies between about 2,200 and 2,730 m³/s, against the published 2,700.** The gauges date the jam: the rise above the open water model stays within 12 cm below to 2 cm above until April 6, jumps on April 7 (State Police 33 cm), stays 14 to 46 cm at Dry Dock and State Police through April 29, and is back within 5 cm on April 30. That gives April 7 to 29, against the published April 5 to 29. The rise was nearly as large at Point Edward (up to 29 cm), Black River (36 cm) and Dry Dock (45 cm) as at State Police (46 cm), with Fort Gratiot at 9 cm: the resistance spanned the river from below Point Edward down, as the published account describes. The test (within 20% of 2,700, with dates from the gauges) was written into the run before it was made. Verdict: **pass** on the raw number and the dates; with the March and May offset removed it is 19% low, just inside the 20% band.

- **Flow under ice from levels alone**, without the measured flow: with the reach above Point Edward held at its open water resistance, the flow comes out about 18% low on the 2019 and 2021 jam days (18.1% and 18.4%), with the gauges matched to within 1.2 to 1.8 cm. Verdict: **partial, about 20%.** A better anchor for the top reach is the next step.

Speed. A whole winter of daily checks takes about 15 minutes.

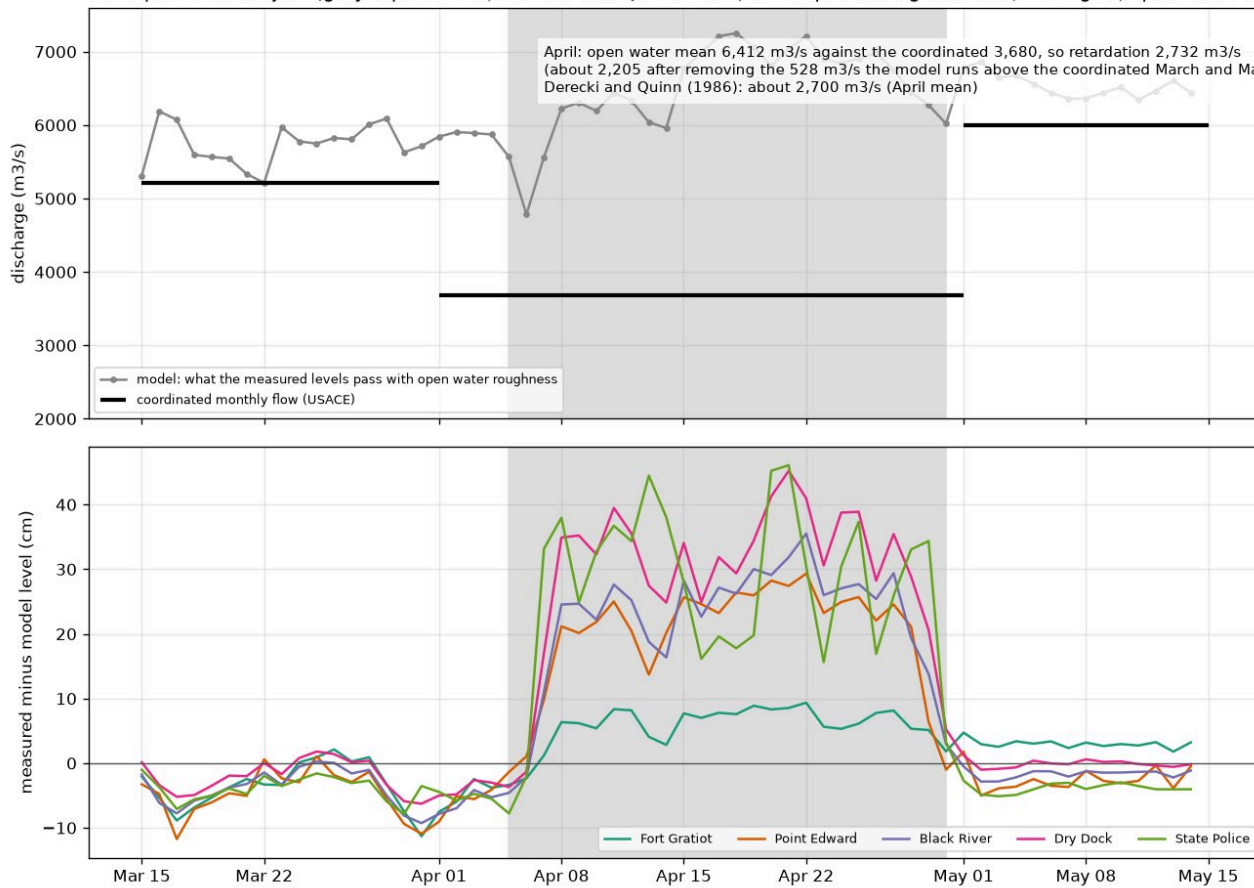
Limits. Upper river only: the delta below Port Lambton is not in the model, and reports placed the 2019 and 2021 jams at Port Lambton and below it. Ice is modelled as extra roughness in each reach, not as individual ice cover. Outside the jams, both winters run negative for days at a time (five stretches of 3 to 8 days; the lowest, Feb 17, 2019, is 611 m³/s below zero), for reasons not yet known: either the winter flow record read high in those weeks, or the river passed more water for the same levels than the late summer resistance allows. No US Geological Survey or Water Survey of Canada flag marks those days, and this section of the river has never been measured by boat under ice. Until they are explained, the jam sizes carry a winter uncertainty of a few hundred m³/s. The sizes have not yet been compared with the Coordinating Committee's monthly ice figures, whose 2019 and 2021 values are not public. Daily averages smooth out a jam that forms within a day. The 1984 run compares daily model flows with monthly coordinated flows.

R5: how much ice held the St. Clair River back, winter 2019. Open water roughness from Stage 2; positive retardation means the river carried less than



Winter 2019. Top: measured river flow (black) against the flow an ice free river would carry between the measured lake and Port Lambton levels (orange). Middle: the difference, how much the ice held back (blue bars, against the grey band of open water noise), with ice cover from NOAA ice charts. Bottom: how far each gauge stood above the open water model. Look at Jan 22 to Feb 4: up to $1,972 \text{ m}^3/\text{s}$ held back, with the rise largest at State Police, the lowest gauge. The red bars after the jam are the unexplained negative stretches. 2D depth averaged model, 10 m cells.

The April 1984 ice jam (grey: Apr 5 to 29, Derecki and Quinn 1986). 2D depth averaged model, 10 m grid, open water roughness.



The record April 1984 jam. Top: the flow the measured 1984 levels would pass in open water (grey dots) against the coordinated monthly flows (black bars); the gap in April is the ice. Bottom: how far each gauge stood above the open water model; the jump on April 7 and the fall on April 30 date the jam. Grey shading: the published jam dates, April 5 to 29 (Derecki and Quinn 1986). 2D depth averaged model, 10 m cells.

3.5 The 3D model of the bridge reach (R6)

What it answers. How the current changes from the surface to the riverbed where Lake Huron enters the river, the fastest water on the river: how much faster the surface runs than the average (which surface drift relies on), how slow the water is near the bottom of the deep pools (which matters for intakes and samplers), where the jet runs below the bridge, and where it pushes hardest on the bed.

What it is. A three dimensional model of the bridge reach only: 4.9 km of river from Lake Huron to 700 m below the Point Edward gauge, filled with 7.3 million water cells (7,301,105) 2 m across, started from the 2D model's steady flow of Sept 28, 2026 (5,928 m³/s). Ninety minutes of flow take about 3 minutes of computing.

How it was checked.

check	target	first version	second version	verdict
Flow along the reach stays equal to the inflow	within 2%	within 0.19% (time average)	within 0.30%	pass
Straight channel test before the river	within 3% of the textbook answer	within 1.2% at three cell sizes	unchanged	pass
Surface speed over depth averaged speed, river median	1.15 within 0.05	1.142 (10 to 90%: 1.08 to 1.29)	1.109	pass
Water level fall from Fort Gratiot to Point Edward	within 3 cm of the observed 0.196 m	0.368 m, 17.2 cm too much	0.245 m, 4.9 cm too much	fail
Average speed against the 2D model, whole reach	within 0.15 m/s	0.108 m/s	0.115 m/s	pass
Average speed against the 2D model, bridge reach	within 15% of 1.01 m/s	0.208 m/s (21%)	0.200 m/s (20%)	fail; overall partial
Shape of the current from surface to bed	expected shape at the river head and bridge; a clear departure in the deep pool	fit quality 0.98 and 0.99; pool departs 52%	pool shape wrong at 2 m, right at 1 m	pass as stated (first version)
Near bed water turns toward the inside of bends	right direction, growing with the bend	right direction everywhere; weak relation (0.35)	similar (0.32)	pass weakly

What it shows.

- **The surface runs about 14% faster than the average.** The median ratio in the river is 1.142, 1.148 where the water runs faster than 1 m/s and 1.114 at the Float Down launch. This supports the 1.15 surface factor that the drifting buoys of section 3.2 also support, from a completely separate direction.
- **Deep pools hide slow water.** In the deep pool below the bridge the jet rides over slow bottom water: the surface runs 1.42 times the average, and the speed near the bed is a quarter of the surface speed. That matters for where intakes and samplers sit in the water column.
- **A narrower jet.** The 3D jet is narrower and peakier than in 2D (2.42 m/s at its fastest against 2.04 m/s) and runs about 100 m further west, toward the Michigan side, below the bridge. The 2002 boat survey (section 2.5) found the fastest water there hugging the Michigan side more tightly than the 2D model places it, which points the same way. The 3D model has not been scored against that survey, made at a lower flow than this run.
- **Bed stress near the bridge.** Within 600 m of the bridge the stress on the bed has a median of 2.3 Pa, a 99th percentile of 17.5 Pa and a maximum of 24.6 Pa. This is for screening only: there is no bed material and no pier geometry in the model, so it is not a scour prediction.

The failure, and its cause. The model loses too much water level through the reach: it needs more fall between Fort Gratiot and Point Edward than the gauges show. Tests on simple channels found the cause. The model represents the river's sloping bed and banks as small steps, and every step adds drag that the real river does not have. The inlet, the outlet, blockage at the bridge and the roughness of the bed were each ruled out. An interim correction in the second version cut the excess from 17.2 cm to 4.9 cm, still over the 3 cm limit, and the report calls it a diagnostic, not a cure. Smooth walls are the fix. Until then, the current structure is to be read as qualitative, the first version is the better source for the surface factor and the shape of the current with depth, and the second for the water level.

Limits. A 3D model of the bridge reach, not of the river. It loses about 5 cm too much water level through the reach, because its walls are built of small steps; smooth walls are the fix. One steady flow, with no wind, ice or waves. Bridge piers, wrecks and the sheet pile wall are not resolved. The 2002 boat survey below the bridge points the same way as the 3D jet, but the 3D model has not been scored against it. (No figure from the 3D model appears in this edition.)

3.6 The riverbed (R7)

What it answers. Where does the water push hardest on the riverbed? Does river flow move the gravel armour that covers much of the bed? Is the exposed glacial till above the Black River mouth at its erosion threshold? Why does the gravel tongue below the bridge creep downstream? These questions matter for the levels of Lake Michigan Huron. The 2009 International Upper Great Lakes Study (IUGLS) found no significant general erosion since 2000, with two local exceptions: exposed till just upstream of the Black River mouth that lowered about 0.5 to 1 m from 2002 to 2007 (about 10 to 20 cm a year), and a gravel tongue below the Blue Water Bridge whose front advances up to 20 m a year.

How it was checked. The model was run at three real flows: Nov 1 to 15, 2012 (4,773 m³/s, Lake Michigan Huron near its record low), Sept 28, 2026 (5,928 m³/s, a typical tuned day) and July 1 to 15, 2020 (6,845 m³/s, near its record high). First, the water levels, with a pass rule set blind: within 2.6 cm at the low flow and 4.1 cm at the high flow at every gauge (section 2.6). Verdict: **pass**. Then the stress on the bed, reach by reach, against the values IUGLS measured from boats and computed with its own model:

reach	4,773 m ³ /s	5,928 m ³ /s	6,845 m ³ /s	IUGLS (2009), at average flow
lake and river head	1.8	2.0	2.1	1 to 2 (boat measurements)
bridge to first bend	8.6	11.2	12.9	8 to 13 local maximum (boat measurements); about 10 maximum (their model)
rest of the upper river	4.3	5.5	6.3	seldom above 6 (their model)
to 1 km below the Black River	2.2	2.9	3.4	3 to 4 (boat measurements)
near Port Lambton	1.6	2.1	2.3	2 to 3 (current meter, their model); under 2 on another page

(Pa, 95th percentile in the main channel.) The model puts the strongest stress where IUGLS measured it, from the bridge to the first bend, at the right size. Verdict: **pass in the upper river, partly below it**: it runs about 1 Pa low below the Black River and near Port Lambton, partly a difference of method (the IUGLS boat values assume a fixed roughness of the bed).

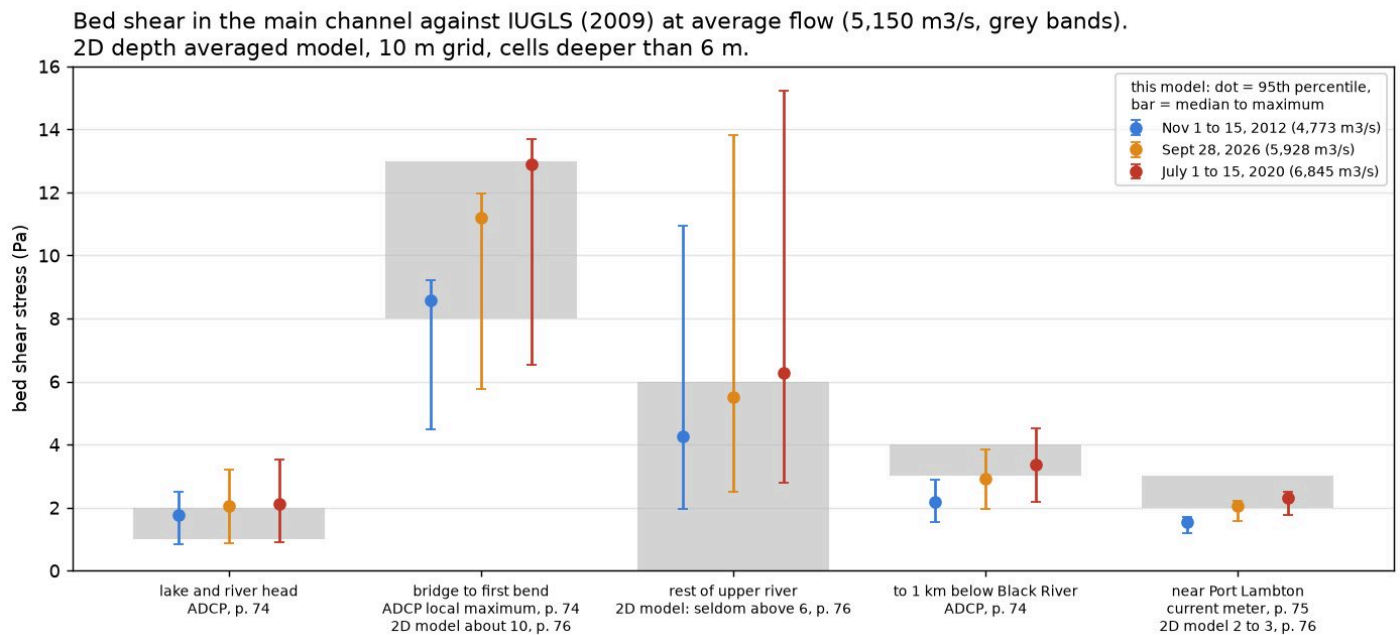
Gravel armour. How hard the flow pulls on the armour gravel compared with its weight (the Shields number) reaches at most 0.020, 0.025 and 0.028 at the three flows, under the lowest published threshold for motion (0.03) and far under the 0.0495 of Wong and Parker (2006). River flow does not move the armour at any flow in this range, the conclusion IUGLS and Liu et al. (2012) reached with a different model. Verdict: **pass**.

Exposed till above the Black River mouth. Against the 4.2 Pa erosion threshold measured on a St. Clair River till sample (Mier and Garcia 2009, as reported by IUGLS), the share of the till area above threshold is 0% at low flow, 33% at typical flow and 47% at high flow (average stress 2.8, 3.5 and 3.8 Pa). Erosion there is consistent with river flow at typical and high water. If the measured lowering came from river flow alone, the till would need an erodibility of 0.008 to 0.039 cm³/N s, inside the resistant to moderately resistant classes of Hanson and Simon (2001). That is an upper bound, because passing ships add stress there too. Verdict: **pass**.

The gravel tongue below the bridge. Under the Wong and Parker threshold, river flow alone moves no gravel on the tongue at any of the three flows; under the lowest threshold only a few cells move, at high flow. The front's advance needs 36 to 60 m³ of gravel per metre of front each year. IUGLS reports that passing ships can raise the stress on the bed 1.5 to 3 times. Tripling the stress where the water is under 15.2 m deep would supply the advance with tens to a few hundred hours of raised stress a year (42 to 70 hours up to 285 to 475, depending on the flow and the threshold), a few minutes to about 19 minutes per deep draft transit at more than 1,500 transits a year. **Passing ships are the likely reason the tongue creeps downstream.** The report calls this a consistency check, not a demonstration: no measurement says how long a transit raises the stress over the bar. Verdict: **pass**.

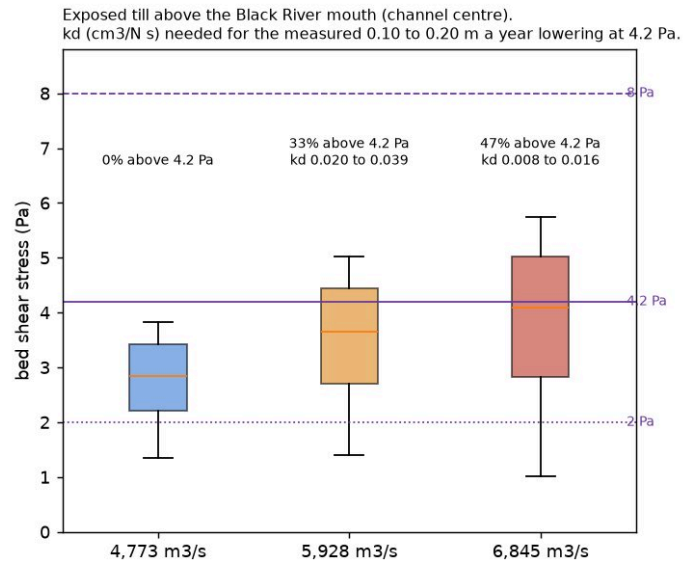
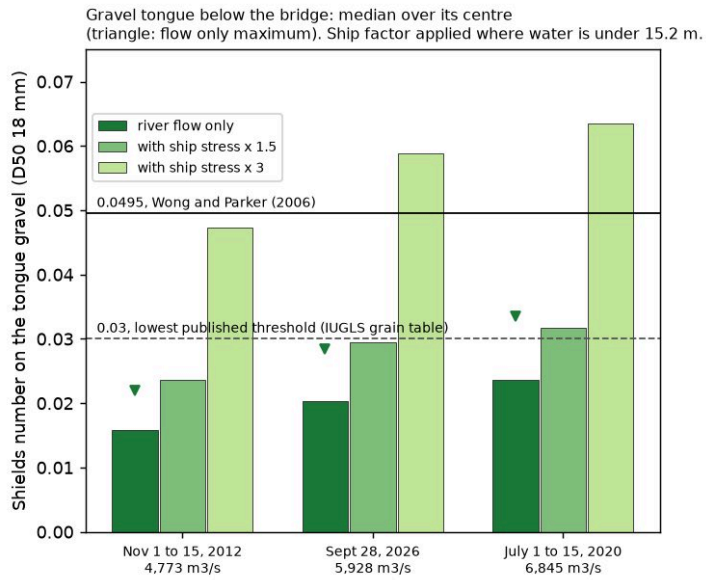
Across the upper river (Fort Gratiot to 2 km below the Black River), the share of the wetted bed above the till threshold of 4.2 Pa is 9.5%, 19% and 23% at the three flows, and above 8 Pa 1.8%, 5.0% and 6.7%. Each steady flow takes about two minutes of computing.

Limits. The model maps stress and thresholds; it does not move the bed. Steady flows only: floods, ice jam releases and ship wakes are not simulated, and the ship factor is applied by hand. Grain sizes are reach values, and the till and the tongue are outlined as boxes, not surveyed outlines. One till sample sets the threshold; regional tests range from under 1 Pa to over 17 Pa. 10 m cells; 5 m would resolve the bars and the furrows in the till. The 2012 Port Lambton level is estimated (about 3 cm uncertain). The pass bands for the bed checks were written after a first look at draft stress maps, so only the level check was fully blind.



Bed stress in the main channel, reach by reach, at three real flows (dots: 95th percentile; bars: median to maximum) against the values of the 2009 international study (grey bands). Look at the bridge to first bend reach, where the model's stress sits inside the measured 8 to 13 Pa, and at the two lowest reaches, where it runs about 1 Pa low. 2D depth averaged model, 10 m cells.

Where the bed has changed. 2D depth averaged model, 10 m grid, steady flows.



Left: how hard the flow pulls on the gravel tongue below the bridge compared with the gravel's weight, for river flow alone (dark green) and with passing ship stress at 1.5 and 3 times (lighter). River flow alone stays under both published thresholds at the median; its maximum (triangles) passes the lower one only at high flow. Right: bed stress over the exposed till above the Black River mouth against its measured 4.2 Pa threshold: none above it at low flow, 33% at typical flow, 47% at high flow. 2D depth averaged model, 10 m cells, steady flows.

4. The finer 5 m version

Cells 5 m across resolve the river's edges, bars and the furrows in the till that 10 m cells blur. The 5 m version is the next step for spills near shore, bed stress maps and anything that depends on the shallows. It has four cells for every one at 10 m, and its status is reported here in full.

What already holds at 5 m.

- **Tuning.** On the same 12 steady days, the 5 m tuning fits as well as the 10 m one: a typical error of 2.21 cm against 2.18 cm, the tuned gauges within 0.2 cm on average and Dry Dock, held out, 2.4 cm low against 2.3 cm. The finer cells need more resistance in the three reaches below Point Edward; the reach that holds the bridge is unchanged.
- **Two weeks driven by the measured flow.** The 5 m rerun of Sept 30 to Oct 14 scores as the 10 m one does: average errors of 0.4 to 2.7 cm low (Dry Dock the largest), and the same hour to hour shortfall that every flow driven run shows (section 2.2). It reproduces the Oct 5 boat flow measurement within 0.75%.
- **Basic correctness.** Still water stays still and the water budget balances at 5 m (section 2.8).

The Oct 20 fault, and the fix. The 5 m version driven by levels, the setup used for live work, failed at first. Within two hours, the level at Fort Gratiot rose 4 to 23 cm above the Lake Huron level set at the model's lake edge, which water flowing out of a lake cannot do; levels ran 14 to 29 cm high and the flow 22% high (6,300 to 7,250 m³/s against about 5,700 measured). The cause was found on Oct 20: a problem in how the model let water in from the lake at 5 m. At the lake edge, in the deep channel, a narrow jet a few cells wide ran away, from 2.6 m/s at 30 minutes to 10.4 m/s by 90 minutes, because a cell that sped up was fed extra water from the lake. At 10 m the larger cells damped it. The fix changes how water enters from the lake so that a cell speeding up no longer draws in extra water. It applies to the 5 m version only: the 10 m model reproduces its earlier results to 0.1 mm and 0.1 m³/s, so every 10 m result in this document stands. (An early form of the fix let still water creep slightly at 5 m; that was corrected on Oct 21, and the still water check now passes.)

The retest after the fix, 36 hours from Sept 28 12:00 to Sept 30 00:00 UTC, against the 10 m model over the same hours:

gauge	5 m after the fix: average error / hour to hour (cm)	10 m: average error / hour to hour (cm)
Fort Gratiot	3.2 low / 1.0	1.4 low / 1.4
Point Edward	2.6 low / 1.1	0.1 low / 1.0
Black River	2.4 low / 0.6	0.1 low / 0.6
Dry Dock (never used in tuning)	4.5 low / 0.6	2.2 low / 0.7
St. Clair State Police	1.5 low / 0.5	0.1 low / 0.5
River flow at Port Huron	3.8% low	2.1% low

The fault is gone: the 5 m version now follows the gauges hour by hour as tightly as the 10 m one (hour to hour errors of 0.5 to 1.1 cm), but reads about 2 cm lower. That offset has the size and direction expected from the fix itself, and the 5 m resistance was tuned before the fix, so retuning the 5 m version under the fixed lake edge is the expected cure.

Retuned, Oct 21. The 5 m version was then retuned under the fixed lake edge on four steady days from late summer, against the same four gauges, with Dry Dock again held out. The average gap at the four tuning gauges fell from 2.8 cm to 1.2 cm, and each now sits within about 2 cm (Fort Gratiot 2.1 low, Point Edward 0.6 high, Black River 0.5 low, St. Clair State Police 0.2 low). Dry Dock, never used in tuning, improved from 4.9 to 3.3 cm low. Flow stayed within about 2% of the measured flow on each of the four days. A check over 85 hours from Sept 28 to Oct 2 then showed the retuned 5 m version following the gauges as closely as the 10 m one: average gaps of 0.2 to 2.1 cm at the four tuning gauges against 0.2 to 1.5 cm at 10 m, the same hour to hour scatter (0.7 to 1.4 cm), Dry Dock 3.1 cm low against 2.5 cm, and flow 2.5% low against 0.8%.

The full two weeks, Oct 24. The retuned 5 m version was then run through the same two weeks as section 2.2, driven by the measured levels at both ends, and scored hour by hour from Sept 30 to Oct 14, 2026 (337 hourly values per gauge) against the 10 m model over the same hours, both scored the same way:

gauge	5 m: average error / hour to hour (cm)	10 m: average error / hour to hour (cm)
Fort Gratiot	2.29 low / 2.15	1.77 low / 2.26
Point Edward	1.09 high / 2.23	0.41 low / 2.16
Black River	0.61 low / 1.79	0.48 low / 1.74
Dry Dock (never used in tuning)	3.02 low / 1.27	2.36 low / 1.29
St. Clair State Police	0.24 high / 0.87	0.18 high / 0.88
River flow at Port Huron	1.33% low / 3.60%	0.43% high / 3.49%

The 10 m figures differ a little from section 2.2 because this check compares the model with one hour averages of the gauge record, which smooth the shortest swings: the hour to hour errors read up to 0.3 cm lower this way, and the average errors agree with section 2.2 within about 0.2 cm.

What the two weeks show. The retuned 5 m version follows the gauges about as closely as the 10 m one: its hour to hour errors are within about 0.1 cm of the 10 m values at every gauge. Its average errors are slightly larger at every gauge, by 0.06 to 0.67 cm, and its flow runs 1.3% low against 0.4% high. It is not better than the 10 m version at these five gauges. Against the pass rule of section 2.2, the hour to hour test passes at all five gauges and the average error test at the four tuned gauges; Dry Dock, never used in tuning, reads 3.02 cm low, just past the 3 cm limit, where the 10 m version reads 2.36 cm low. These gauges test levels and flow only; they do not test what 5 m cells add near the shore. The run took about 4.5 hours of computing for 385 hours of river, two days of settling included, on a graphics card shared with other jobs for part of the time, so it is not a clean speed figure.

5. Who it serves, and what comes next

The St. Clair River is a drinking water source for communities on both shores, a working shipping channel, the outlet of Lakes Michigan and Huron, and home to industry that plans every day for the possibility of a spill. A model that has been tested against the official gauges, the US Geological Survey flow record, a 2002 boat survey of the currents, 173 drifting buoys, NOAA's spill tables and the ice jam record, and that answers in minutes, can serve each of them. The uses below are the ones the lab reports themselves name, with what still has to happen before anyone relies on them.

- **Emergency planning.** Arrival times of a spill at any line down the river, for any release point and flow; likely landing zones for anything floating on the surface, by wind; and, in winter, a daily check of whether ice is holding the river back and in which reach. The model complements the agency tools in use today, including NOAA's spill reference tables; it does not replace them.
- **Industry spill planning and intake protection.** For plants along the river: arrival and duration of a release at downstream lines, at the flow of the day rather than one tabulated flow; the difference between a surface and a dissolved release; and maps of current and bed stress near outfalls, intakes and shore works, as a first look before site specific design.
- **Drinking water operators.** Arrival and duration maps for each intake's reach on both shores, once intake positions are shared privately with IThero. No intake position appears in this document or in any public material.
- **First Nations communities on the river and at the delta.** Spill arrival, ice jam watch and flood levels along their shores. The delta below Port Lambton is not in the model yet, and extending it there is a next step. Any work would be shaped with the communities themselves.
- **Shipping.** Currents through the bridge reach and at named places, and the first numbers on how ship wash may move the gravel bar below the bridge. Experimental, not for navigation.
- **Researchers.** A reach by reach recheck of the riverbed erosion question at any flow in minutes; the river's flow worked out from two water level gauges as a cross check on the flow record; a daily series of ice retardation; and a pointer for resurveys to the two places where change is most likely to show (the till above the Black River mouth and the gravel tongue below the bridge).

What it makes possible next. These are next steps, not existing features.

1. Use the retuned 5 m version where its finer cells matter: bed stress maps that resolve the bars and the furrows in the till, and spills near shore.
2. Switch on an hourly live service when the go ahead is given, starting from the end of the replayed week.
3. A winter ice watch: the same daily method run against live gauges, with its alarm level taken from winter days outside jams.
4. Extend the model into the delta below Port Lambton; reports placed the 2019 and 2021 jams at Port Lambton and below it.
5. Spill runs at 5 m with intake positions held under confidentiality; surface drift for floating product; and the two 2009 shore releases, still 12 and 21 minutes late with surface floats, whose release points the 2009 paper does not print.
6. Forecast lake levels and wind at the boundaries, for lead time rather than the present.
7. Find why the model misplaces the fastest water in the 1.1 km below the Blue Water Bridge, where the 2002 boat survey shows it hugging the Michigan side, and score the 3D bridge reach against the same survey.
8. Measure how hard the wind pushes a person or a tube in real wind.
9. Compare the ice sizes with the Coordinating Committee's monthly figures, and explain the winter negative stretches.
10. Move the bed: a riverbed that changes as gravel and till are carried away, over a full year of flows, with ship wakes.
11. Smooth walls for the 3D model of the bridge reach.

6. What it is not

This model is experimental. It is **not for navigation** and not for safety decisions. It is not a forecast: it shows the present or replays the past. These are IThero's lab reports, not peer reviewed papers; no agency has reviewed or endorsed this work, and the data of the agencies named here were used, not their approval. The documented failures and limits, plainly:

- **Driven by the measured flow instead of levels**, the model misses the hour to hour test at all five gauges. Live work drives it by levels for that reason.
- **Dry Dock reads about 2 to 3 cm low** in the tunings and two week reruns at both resolutions (1.9 to 3.3 cm) and in the replayed week (2.2 cm). The gauge's reference level or siting is suspected; it is not resolved.
- **The answer depends on cell size**. A model tuned at one cell size reads differently, by centimetres, when its cells are made finer without retuning. Each cell size is tuned on its own.
- **The 5 m version** had a fault at the lake edge, found and fixed on Oct 20, and was retuned on Oct 21. Over the full two weeks it follows the gauges about as closely as the 10 m version, not more closely: its average errors are slightly larger at every gauge, Dry Dock reads 3.02 cm low (just past the 3 cm limit), and its flow runs 1.3% low.
- **Spills**. Against the 2009 dye releases, the model's first arrival is 44 to 56 minutes late and its peak 71 to 130 minutes late. A rerun with surface floats, scored against a rule written before it ran, brought two of the three within 14 minutes; the third, near the US shore, is still 21 minutes late. Spills at the bottom are not matched (the model is about 130 minutes early at first arrival). Single cases can be off by far more than the median.
- **Surface drift** is partly validated. The real buoys drifted across the river in the two upper bends and the model's floats did not; the model is three to four times too fast in slow water by Sarnia Bay; the wind push on people is untested.
- **The 3D model of the bridge reach** loses about 5 cm too much water level through the reach (4.9 cm against a 3 cm limit), because its walls are built of small steps; smooth walls are the fix. Below the bridge it places the jet closer to the Michigan side than the 2D model does; the 2002 boat survey points the same way, but the 3D model has not been scored against it.
- **Ice** is modelled as extra roughness in each reach, not individual ice cover. The delta below Port Lambton is not in the model. The winter series runs negative for days at a time for reasons not yet known, which puts a few hundred m³/s of uncertainty on the jam sizes. Flow under ice from levels alone comes out about 18% low. The ice sizes are not yet compared with the Coordinating Committee's figures.
- **The riverbed** does not move in the model: the results are stresses and thresholds, not predicted change. Stress runs about 1 Pa low below the Black River. One till sample sets the threshold, and the bed checks were not fully blind.
- **Currents**, against the 2002 boat survey, pass all six rules set before the run, but so does a simple estimate that shares the model's own average speed across each section by depth; only the typical error separates them (0.103 against 0.148 m/s). The model misplaces the fastest water in the 1.1 km below the Blue Water Bridge (typical error up to 0.42 m/s) and runs about 5% fast below State Police. The survey was made in 2002, on a riverbed older than much of the model's, and the comparison is of depth averaged currents.
- **Conditions not represented**: no wind in the two week rerun; steady flows and no wind in the spill, drift and bed checks; the Lakeport gauge was missing for 63% of the two week window and filled from Fort Gratiot.
- **The riverbed mixes survey years from 2000 to 2026**. The newest surveys read about 0.25 m shallower than 2008 in the federal channel, and part of that may be a difference in reference level.
- **The live view runs on demand only**. No schedule is running. The replayed week's US Geological Survey flows are provisional, and Fort Gratiot read 2.3 cm low over that week, with its largest error (11.7 cm) on the big rise of Oct 16 to 17.
- **The model stops at Port Lambton**. It does not cover the delta or Lake St. Clair.

7. Data sources and credits

Data. Every measurement used is public.

- **NOAA:** water levels from the Center for Operational Oceanographic Products and Services (Lakeport 9075002, Fort Gratiot 9014098, Black River 9014090, Dry Dock 9014087, St. Clair State Police 9014080, Algonac 9014070); depth surveys of 2000, 2006 and 2008 and hourly wind at St. Clair County International Airport from the National Centers for Environmental Information; electronic nautical charts and historical charts from 1946 to 1971; the Great Lakes Environmental Research Laboratory's spill reference tables and Great Lakes ice cover charts.
- **US Geological Survey:** river flow and boat measurements at St. Clair River at Port Huron (04159130); 2008 depth grids; the NOAA 2000 survey as distributed by the US Geological Survey; 3DEP laser scans of the shore; the October 2000 drifting buoys; the Stag and Fawn Island flow splits (WRIR 01-4135); the May and June 2002 boat survey of the currents, made with US Army Corps of Engineers crews (Open File Report 03-119).
- **US Army Corps of Engineers, Detroit District:** depth surveys from 2020 to 2026; the coordinated connecting channel flows from 1900 to the present; the Ice Engineering manual (EM 1110-2-1612).
- **Fisheries and Oceans Canada, Canadian Hydrographic Service:** NONNA bathymetry; water levels at Point Edward (11940) and Port Lambton (11950).
- **Water Survey of Canada:** daily water levels (HYDAT) for Point Edward and Port Lambton.
- **Natural Resources Canada:** HRDEM laser scans of the shore (2017 and 2022).
- **Environment and Climate Change Canada:** LEVELnews; hourly wind at Sarnia Airport.
- **USDA NAIP:** 2022 aerial imagery in the renders.

Published work this edition is checked against or builds on.

- International Upper Great Lakes Study Board (2009). *Impacts on Upper Great Lakes Water Levels: St. Clair River*. Final report to the International Joint Commission. With the technical work it reports, including Mier and Garcia (2009) on the till threshold and Best, Oberg and Czuba (2009) on boat measurements of the bed and flow.
- Anderson, E.J., and Schwab, D.J. (2014). *Spill Reference Tables for the St. Clair River*. NOAA TM GLERL-162.
- Anderson, E.J., and Schwab, D.J. (2012). Contaminant transport and spill reference tables for the St. Clair River. *Marine Technology Society Journal* 46(5), 34 to 47.
- Holtschlag, D.J., and Aichele, S.S. (2001). *Visualization of drifting buoy deployments on St. Clair River near public water intakes, October 3 to 5, 2000*. US Geological Survey Open File Report 01-17.
- Holtschlag, D.J., and Koschik, J.A. (2003). *An acoustic Doppler current profiler survey of flow velocities in St. Clair River, a connecting channel of the Great Lakes*. US Geological Survey Open File Report 03-119.
- Holtschlag, D.J., and Koschik, J.A. (2004). *Hydrodynamic simulation and particle tracking techniques for identification of source areas to public water intakes on the St. Clair Detroit River Waterway*. US Geological Survey Scientific Investigations Report 2004-5072.
- US Geological Survey, Water Resources Investigations Report 01-4135 (flow splits at Stag and Fawn Islands).
- Derecki, J.A., and Quinn, F.H. (1986). Record St. Clair River ice jam of 1984. *Journal of Hydraulic Engineering* 112(12), 1182 to 1193.
- Huang, L., Wang, M., Zhang, F., Ma, X., and Yuan, P. (2026). GPU accelerated high resolution modeling of local scour at river canal crossings. *Engineering Applications of Computational Fluid Mechanics* 20(1), 2696659.
- Liu, Y., and Weisberg, R.H. (2011). Evaluation of trajectory modeling in different dynamic regions using normalized cumulative Lagrangian separation. *Journal of Geophysical Research* 116, C09013.
- Liu, X., Parker, G., and others (2012). Sediment mobility and bed armoring in the St Clair River. *Earth Surface Processes and Landforms* 37(9), 957 to 970.

- Czuba, J.A., and others (2011). Bed morphology, flow structure, and sediment transport at the outlet of Lake Huron and in the upper St. Clair River. *Journal of Great Lakes Research* 37(3), 480 to 493.
- Wong, M., and Parker, G. (2006). Reanalysis and correction of bed load relation of Meyer Peter and Mueller using their own database. *Journal of Hydraulic Engineering* 132(11), 1159 to 1168.
- Hanson, G.J., and Simon, A. (2001). Erodibility of cohesive streambeds in the loess area of the midwestern USA. *Hydrological Processes* 15(1), 23 to 38.
- Foster, D.S., and Denny, J.F. (2009). *Quaternary Geologic Framework of the St. Clair River between Michigan and Ontario, Canada*. US Geological Survey Open File Report 2009-1137.
- Bennion, D. (2009). *Statistical and Spatial Analysis of Bathymetric Data for the St. Clair River, 1971 to 2007*. US Geological Survey Scientific Investigations Report 2009-5044.
- US Army Corps of Engineers (2002). *Ice Engineering*. EM 1110-2-1612.
- Event reports used to date the ice jams: Sarnia News Today and CTV Windsor (January 2019); Environment and Climate Change Canada, LEVELnews (March 2021). For the 2016 Float Down: CTV News, Global News, Sarnia News Today and Maclean's (August 2016).

No code, data or figures from these works were copied; every number compared against is cited in the lab reports. Built with the help of artificial intelligence. Every number in this document traces to IThero's lab reports, which record the tests that failed as well as those that passed. Experimental, not for navigation.

Contact. Tyler W., IThero Solutions, Sarnia, Ontario. itherosolutions.ca

The full technical report, with the methods and the lab reports, is available to partners on request under a confidentiality agreement.