Surface-Return Peaks and Channel Sources

Scientific and Engineering Release Notes for `wepp_261026`

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Release scope: This report describes changes made after `wepp_260803` through `wepp_261026` in the University of Idaho's `wepp-forest` fork of WEPP. It is not a release note for the upstream USDA WEPP model.

Abstract

WEPP 261026 inherits an hourly surface-return peak estimator with explicit component transport, bounded channel-source construction, channel-profile continuation and a correction to source-sample normalization. The changes address two distinct problems: returned water concentrated into a short rainfall-excess duration at the hillslope, and an existing indexing defect that could amplify a small separated rainfall component into an unrealistic channel pulse. This report explains the legacy and revised calculations, their hydrological and sediment consequences, and their operating limits. The evidence supports a bounded engineering release, not a routing rewrite, complete conservation closure or demonstrated agreement with field observations. The 261026 addition classifies late dry-day soil return as return-only SRC3 without changing physical hillslope peaks. It also inherits the 261021 calendar, water-allocation, channel-source and outlet-publication repairs.

AI authoring disclosure: This report was prepared with AI authoring assistance from OpenAI Codex, including source and evidence analysis, prose drafting, figure preparation, original explanatory code and document checks. AI assistance does not constitute independent scientific review or publication approval; the review status is recorded separately.

This new edition updates the 261010 revision-2 report. Historical simulations, figures and return levels retain their original executable identities. They have not been relabeled as 261026 experiments. The inherited 261021 repairs and the new late-return metadata correction are described separately below. The owner authorized preparation of release 261026 on October 26, 2026; release gates and scoped scientific, implementation and disclosure reviews are complete. The release and re-versioning request is the owner authorization for this edition; the technical reviews were performed by independently tasked AI assistance, not a human peer-review panel. Document publication and binary vendoring do not authorize deployment. NSERL has not agreed to public release of the WEPP source; this report contains detailed technical descriptions and newly authored explanatory stubs, not legacy source listings. No NSERL endorsement is implied.

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1 261026 release update and evidence boundaries

`wepp_261026` adds a narrowly scoped producer correction to the 261021 physical-water and calendar repairs. A dry-day execution can skip IRS, then create surface return during the later hourly soil-water balance. Previously, the resulting EVENT carried positive volume but zero duration, zero peak and inactive component metadata. The 261021 channel-duration check correctly rejected this ambiguous source. Replays with 260803 and 261010 hillslope executables also produced it: the producer defect was not introduced by the 261010 release, and the 261021 stop exposed rather than created it.

1.1 A source classification repair, with unchanged physical peaks

The correction captures the terminal OFE's 24 hourly return amounts after the existing late water-balance call. Eligibility requires continuous hourly execution, no contour, no preceding runoff or duration, no rain, melt or irrigation flags, and no already active mixed source. Positive late surface return is serialized as return-only SRC3 with the authoritative terminal `runvol` in cubic meters. That volume is already spatially integrated; it must not be multiplied by hillslope area again. A separate daily-reset flag avoids activating the IRS physical-peak calculation. Daily reset and invalid volume/weight rejection are executable regression requirements.

The legacy EVENT, physical hillslope peak, erosion calculation and other hillslope outputs remain unchanged. In particular, these late events still have zero physical hillslope peak. This is an intentional boundary of the repair, not evidence that the actual event has zero instantaneous discharge. Mixed sources, contour cases and daily water-balance production are outside this new eligibility path. The PASS schema remains component version 3.

1.2 Accepted effective-support limitation

For nonnegative hourly weights w_h with positive sum, the existing consumer uses, for these zero-storm-duration return-only events,

$$T_s = 3600\,\frac{\sum_{h=1}^{24} w_h}{\max_h w_h}, \qquad q_s = \frac{V_c}{T_s}.$$

For the general return path the support is also bounded below by the supplied storm duration; that lower bound is zero in the newly repaired cases. It places this constant-rate block at midnight and integrates interval overlap, including a partial last interval. This preserves the caller's assigned volume within floating-point arithmetic and printed input precision. It does not recover hourly occurrence, travel time or a physical peak. The source metadata may have more precision than the legacy EVENT volume used by the caller; validation distinguishes those quantities instead of demanding false identity.

The three retained incident witnesses have support approximately 4.72, 6.41 and 1.27 hours, although their nonzero hourly bins are 15–20, 16–23 and 20–21, respectively. Moving the block to those hours would introduce another timing convention. Literal-hour forcing was already rejected during the historical investigation because it produced late pulses and enlarged recession behavior. The owner accepted the existing midnight-support approximation for this bounded release. No source guard was disabled and no arbitrary rainfall duration or peak was inserted.

1.3 New evidence and its limits

The portable primary fixture contains three OFEs and nine calendar years (2016–2024; 3,288 daily records per hillslope). Its first late-return source is approximately 155.439362 m^3; the legacy EVENT

prints 155.44 m^3. The isolated candidate completed all 491 hillslopes and 211 channels for the primary watershed. A fresh same-context 261021 baseline reproduced the zero-duration stop. All 2,946 non-PASS hillslope files and all legacy PASS records matched exactly; only two SRC3 records changed. The channel output contained 693,768 finite daily rows, with no negative reported fields in that check. These counts establish completeness and the scoped metadata change; they are not an independent watershed conservation proof.

Host versus archived production comparisons initially differed in small non-target values. That failed comparison was retained. A paired worker-container replay of the primary source reproduced the archived baseline exactly, and the candidate changed only the intended SRC3 record. No tolerance was widened to conceal runtime differences. The final release gate record below separately identifies tests performed with the dated executable pair.

Native source probes exercise generated, early, late and uniform return weights at 60, 600, 997 and 3,600 second steps; they test actual CHRQIN/MIXRETURN integration, daily reset, serialized binary32 round trips, and rejection of nonfinite, negative or empty operands. These are numerical contract checks, not calibration against observed streamflow.[26] The second affected watershed was also regenerated with the actual dated 261026 pair inside the production worker container. All 491 hillslopes and 211 channels completed nine years with empty watershed stderr. A fresh paired 261021 baseline reproduced the original duration stop. Exactly three SRC3 records changed (hillslopes 1, 327 and 394); all 2,946 other hillslope files and all legacy PASS records matched. The complete output check found 693,768 finite channel daily rows, no negative reported fields, and outlet dates through December 31, 2024. This is artifact and execution evidence, not an observational comparison or a universal water-closure claim.

1.4 Inherited repairs and retained scientific uncertainty

The 261021 artifact-revision-2 source is inherited: Gregorian execution and PASS date validation, whole-hillslope groundwater initialization, terminal hourly infiltration allocation, overlap-integrated flat sources, local and groundwater channel assembly, accepted MC outlet publication, live-state eligibility, exact fixed-point acceleration, and current-plane scratch reset. The detailed accounting section later in this report explains these changes. The old 261010 short-flat-source limitation is superseded by the 261021 repair.

Two coupling limits remain open: accepted signed withdrawals between soil and routing, and clipping of raw negative discharge. Muskingum–Cunge storage authority is unchanged. Neither this release nor a successful watershed run establishes universal physical closure, observational validity, or comprehensive sediment and nutrient validation. The historical figures retain their actual build identities. They show Topanga, Rattlesnake and Cedar results and return levels from those earlier experiments, not new 261026 simulations.

1.5 Current operational contract and identities

Select the paired `wepp_261026` and `wepp_261026_hill` executables and regenerate every contributing hillslope PASS before watershed execution. Do not combine different release tags. Roads and Ag-Fields composition must retain component-v3 operands. No binary default or production deployment is changed by this release. The existing runtime banner is retained; use sidecar source identities and binary hashes to identify the dated pair.

Both profiles were built sequentially with pinned system gfortran from the verified default branch `wepp_260430_negmeltfix_comparator`. The exact model source checkpoint is:

`b73e93b19a724d1991d341d38a18d11e742231bd`

Watershed SHA-256

`a6351d371030f702be5eb0d727d8e7181eeb9d60e9ddf6ce05d9616e5d759d48`

Hillslope SHA-256

`0955134900c63378d7990a1c36a477dd9056e4c7db8de7528a9b486192f6976d`

Required current gates use committed resources or reproducibly generated outputs. External project replays are supplementary acceptance evidence. The native release suite passed 534 tests, the permanent hillslope watchlist passed all 12 cases, and both profiles passed host smoke, artifact policy and runtime provenance checks. An initial unpinned Homebrew compiler run failed in test-built channel executables; the complete required system-compiler run passed without exclusions. The seven generated incident checks pass. Post-vendor host and container smokes pass for both profiles. The post-vendor compatibility set passed 89 tests with one existing skip. The production native readers produced 16 retained Parquet files, all with finite floating-point values: 1,614,408 hillslope PASS rows, the same number of watershed PASS rows, and 693,768 channel daily rows. The replay harness was corrected to perform the normal output promotion and version-manifest steps; these were harness omissions, not model changes. The broad WEPPpy ledger covers every one of 11,941 collected test nodes: 11,791 passed and 150 were skipped under their existing conditions, with one additional module skipped during collection. Execution was segmented after interrupting the slow soil matrix; no collected test was excluded. Old release choice expectations were updated to include 261026, and the new choice persists on an older project without rewriting its configuration. A browser test passed when pointed to the already installed browser cache. All observed failures have later passing results in the retained ledger. Document checks verify all 13 figures, numerical anchors, identities and page bounds, with no embedded files or JavaScript. The historical 261010 gate table is not a substitute for these current gates. Scientific review here means an independently tasked AI reviewer with stated scope, not human peer review or institutional endorsement.

Historical 261010 foundation

The following methods and validation sections preserve the 261010 investigation and its numerical results. Statements about "the release" in these retained sections refer to 261010; the 261026 scope and subsequent repairs are identified in the opening update and inherited-repairs section. In particular, the 261021 short flat-source repair supersedes the old substep flat-source limitation.

2 Release Scope and Main Conclusions

The aim is to correct an anomalous surface-return peak calculation without materially degrading established streamflow, timing, event behavior, stability or workflows relative to `wepp_260803`. Cedar Creek comparisons retain 10 cm initial random roughness. Other comparisons retain their own frozen project inputs; the 10 cm setting is not imposed on every watershed or burn class. Exact parity is neither required nor desirable for erroneous peaks.

The original Topanga investigation began with inverted frequent-event peak estimates: the modeled undisturbed 2-year peak exceeded the burned peak. The historical report also showed that ordering at 5 and 10 years. Section 17 returns to that practical question with 2- and 5-year outlet runoff, sediment

and peak comparisons for Topanga and Rattlesnake. The historical configurations and the matched release comparisons are distinguished rather than treated as one controlled experiment.

Principal findings. Hillslope return peaks now use WEPP's calculated hourly return maximum, added to an independently recomputed rainfall-only peak. Erosion receives these physical inputs, not merely corrected reports. The channel interface separates the components and uses a deliberately simple return-source approximation. Channel state is retained across daily calls. Finally, source normalization counts the positive-time samples actually delivered, correcting the Topanga January 18, 1993 outlet peak from 707.63910 to 12.50683 $m^3 s^{-1}$. Ordinary-event consequences, including large individual sediment changes, remain important findings rather than being erased by the release decision.[6, 11]

The complete Cedar record preserves hillslope-derived yield: the candidate and 261009 both give 1,267,735,665.682 m^3, only 0.393 m^3 above 260803. The final sampled outlet integral is 0.001008% above 260803 but 0.049858% below 261009. The remaining integral–ledger discrepancy is close to the 260803 discrepancy, not zero. This distinction is central: unchanged water production does not establish unchanged routed representation or accounting closure.[12]

2.1 Three Different Baselines

Baseline	Meaning in this report
Source-change baseline	260803 source `f24c957e3` to 261010 source `7471bb5e9`. The net implementation change covers 14 non-binary files under `src/`; two tracked executables are build products.
Immediate predecessor	261009 source `5a01758b7`. The sole subsequent model-code change is the CHRQIN normalization correction. Earlier scientific changes must not be attributed to that final edit.
Behavioral reference	260803 with matched physical inputs, with 261009 retained as a diagnostic comparator. Comparisons are model-to-model unless explicitly stated otherwise; no new field calibration is claimed.
Previous long-form report	This is the first report in this document series. Earlier Markdown release summaries and work-package studies provide evidence but are not silently relabeled as a prior public edition.

The old 261007 SURPEAK/channel-patch bundle is not layered into 261010. The shipped code descends from the accepted hourly MIXPEAK/component-v3 candidate. Daily-mean physical-peak substitutions, endpoint-based support rules and broader routing reconstructions were not retained. A concise disposition of these alternatives appears in Section 12.

2.2 Reader-Facing Change Map

ID	Shipped change or coordinated change	Account
RN-01	Hourly mixed-flow physical peak; isolate native rainfall calculation	Section 5
RN-02	Event-lifetime producer state and diagnostic hooks	Sections 5.6, 6
RN-03	In-band PASS v3 records, header/version handling and daily clearing	Section 7

ID	Shipped change or coordinated change	Account
RN-04	Caller-volume partition and bounded return-source support	Section 8
RN-05	Channel-profile retention and grid transfer between daily calls	Section 9
RN-06	Positive-time rainfall-source normalization	Section 10
RN-07	Native reader and Roads/AgFields component-preserving composition	Section 11
RN-08	Build linkage, sidecars, paired binaries and withdrawn-version handling	Section 22
RN-09	Committed regressions, discovery/resource policy, evidence packaging	Section 23
RN-10	Concurrent WEPPpy disturbed roughness revision and published benchmarks; not a binary parameter change	Section 19

The internal change register maps every changed implementation file to these IDs and accounts for documentation, archived experiments and build products separately. This report does not reproduce restricted source to establish coverage. Routine names, equations and state descriptions provide the technical account. New code listings are original explanatory Python written for this report, with their relationship to production explicitly limited.

2.3 What Does Not Change

The water-balance scheduling, rainfall-routing equations, soils, roughness inputs, channel routing recurrence and coefficient-selection algorithms are not rewritten. No new model parameter, rainfall-fraction threshold, runtime flag, companion transport file or cross-day hillslope-source reservoir is introduced. The numerical banner remains 2020.500; dated executable names and sidecars distinguish releases. Capacities and general project defaults are unchanged. These statements concern the binary change; the independent WEPPpy roughness update is described separately.

3 Engineering Strategy and Scope

The simplest scientifically defensible correction, with bounded regression risk. WEPP couples runoff generation, erosion, sediment transport and channel routing through legacy numerical methods and shared interfaces. A locally reasonable change can therefore alter processes well beyond its intended target. Attempting to resolve every related inconsistency within one release would enlarge the change surface and make its consequences harder to diagnose and validate.

This release favors targeted corrections and explicit approximations over comprehensive model reconstruction. The objective is to correct demonstrated defects while preserving useful baseline behavior, not to achieve exact conservation, universal numerical convergence or a fully resolved hydrograph where the model does not calculate one. The baseline is a behavioral reference, not an authority that requires preservation of erroneous peaks.

Simplicity constrains implementation complexity; it does not justify discarding water, concealing accounting discrepancies or retaining a serious regression. Acceptance considers the magnitude, frequency, affected conditions and practical consequences of changes in runoff, peaks, timing, erosion and sediment

delivery. Aggregate agreement alone is insufficient when individual events show consequential departures. Model-to-model agreement also does not establish agreement with field observations.

The implemented choices distinguish calculated quantities, approximations and validation evidence:

- **Calculated quantities.** MIXPEAK uses existing hourly return depths and an independently recomputed rainfall-only peak. It retains the water-balance runoff quantity; it does not invent a time-resolved mixed hydrograph.
- **Explicit approximations.** Adding component peaks assumes their coincidence. Channel return delivery uses bounded, constant-rate support, not the literal timing of the hourly return buckets. PASS v3 carries the component information needed for that separation, while the channel routing recurrence is retained. Channel-profile continuation and the normalization repair address identified defects without reconstructing the routing system.
- **Observed evidence.** The comparisons below test water yield, routed discharge, timing and sediment consequences separately. Close Cedar record totals coexist with event-level departures and a nonzero integral–ledger discrepancy; neither is hidden by aggregate fit statistics.

Remaining limitations are documented separately from the defects addressed. They are not automatically prerequisites for this release, nor are they declared harmless merely because a broader repair would be difficult. Broader changes require their own scientific justification and validation. This strategy supports a bounded engineering correction, not a claim of complete physical or numerical closure.

4 Scientific Context and Terminology

WEPP's published surface-hydrology documentation distinguishes rainfall excess, runoff volume, runoff duration and peak discharge; hydrological outputs supply erosion calculations. Its peak methods include a kinematic-wave solution and an approximation to that solution.[1] The channel-routing literature for WEPP describes numerical kinematic-wave and Muskingum–Cunge alternatives and the importance of discretization.[3] Those references establish context, not validation of the new return rule. The implementation-specific account below is based on the shipped-source audit and retained experiments.[6]

An *overland flow element* (OFE) is an element of a hillslope profile. Surface return here is water delivered back to the surface by the modeled soil-water calculation. It is not synonymous with rainfall excess and is not a new water source added by the estimator. The hourly return buckets are calculated model quantities, not measured within-day hydrographs. The word "event" may mean a model record/date or a selected multi-day analysis window; neither automatically identifies a complete isolated storm.

Use R for final runoff depth, S for surface-return depth, and A for the applicable area. Depths are in metres; p denotes a depth-rate peak in $\mathrm{m\,s^{-1}}$. Volumes are V in $\mathrm{m^3}$ and volume-rate peaks are Q in $\mathrm{m^3\,s^{-1}}$. Multiplication by A converts matching-area depth quantities to volume quantities. A rate in $\mathrm{m\,s^{-1}}$ is multiplied by 3.6×10^6 to report $\mathrm{mm\,h^{-1}}$. Definitions and interface units are collected in Appendix A.

Three distinct durations: $D_{\mathrm{eff}} = R/p$ is an equivalent rectangular duration used by hillslope erosion bookkeeping; T_r is the existing rainfall/storm support supplied to channel reconstruction; and T_s is the local support chosen for returned water. None by itself establishes the actual timing of a mixed hydrograph. The time-of-concentration scalar `tcs` is a further, separate quantity.

5 Hourly Surface-Return Peak Estimation

5.1 Legacy Concentration Mechanism

The legacy IRS path computes surface surplus after water balance, maps it to the runoff-depth basis, and can augment rainfall-excess ordinates by an amount proportional to returned depth divided by rainfall-excess duration. It then uses the existing peak procedure. A sizeable returned depth can consequently be represented over a short rainfall-excess period. This is a mismatch of source volume and representative duration, not proof of an unusually intense rainstorm. The final peak affects physical calculations downstream.

In the two reproduced H106 Ksat-35 cases, approximately 33.690 and 40.075 mm of runoff coexist with legacy peaks of 240.274 and 274.596 $\mathrm{mm\,h^{-1}}$. The revised peaks are approximately 1.605 and 2.038 $\mathrm{mm\,h^{-1}}$ with runoff unchanged. These are targeted mutation reproductions, not measured Cedar flood peaks. Their small but positive rainfall contribution matters: a pure-return-only correction would miss the original triggers.[7]

5.2 Separation After Water Balance

The producer operates only on single-OFE, non-contoured, continuous-hourly cases with positive surface return. It takes final runoff depth R from `runtmp` and returned-water depth S from `surpls`, on the same area basis. In the eligible single-OFE setting the general equivalent-plane scaling does not introduce an unresolved multi-OFE area mapping. Define

$$R_r = R - S, \qquad V_r = AR_r, \qquad V_s = AS. \tag{1}$$

Finite R and S, positive S, and $R \geq S$ are checked. Hourly return depths s_h must be finite and nonnegative with a positive sum. Invalid separation is rejected; a small positive rainfall contribution is not rounded to zero or removed using a return-dominance threshold.

5.3 Independent Rainfall-Only Peak

MIXPEAK does not subtract a return rate from an already contaminated combined peak. For $R_r > 0$, it calls the existing applicable rainfall-only procedure with R_r and the native rainfall/routing operands. The approximation branch uses APPMTH; the alternate branch uses HDRIVE. Exactly zero R_r produces zero physical rainfall peak. The water-balance calculation is not repeated.

HDRIVE and its callees use shared integration and random-number scratch. The helper saves and restores the integration arrays, counts/time step, coefficient scratch and random-state values around that call. Otherwise an apparently local peak correction could alter later calculations by advancing shared state. Branch selection follows the existing approximation and rainfall-input conditions rather than a new fitted criterion. The legacy route can still execute, but its final combined peak is replaced when this eligible component calculation is active.[6]

5.4 Combination, Duration and Bounds

Let p_r be the independently calculated rainfall peak and s_h the existing hourly returned depth in metres. The pre-floor mixed-flow estimator is

$$p_s = \max_{h=1,\ldots,24} \frac{s_h}{3600}, \qquad p = p_r + p_s. \tag{2}$$

Rainfall and hourly return peaks are assumed to coincide. Return receives no additional hillslope attenuation in this estimator. The sum is an upper envelope of these two specified component peaks under that coincidence assumption, not a guarantee about unresolved subhourly return peaks or true field discharge. Low rainfall volume alone does not establish a low rainfall peak; its calculation is retained.

The existing physical floor sets a peak below 3.6×10^{-8} to 3.63×10^{-8} $\mathrm{m\,s^{-1}}$. IRS then obtains $D_{\mathrm{eff}} = R/p$ and retains the existing 86400 s cap. Later peak bookkeeping recomputes a rate from runoff and effective duration with the existing OFE-area mapping. Thus the final published peak need not equal the unbounded sum if a legacy floor/cap engages. A duration cap can raise the reassigned rate to the equivalent one-day mean; it must not be described as discarded volume or as an unconstrained new physical estimate.

The rainfall operand sent to the channel is separately protected by the existing floor/cap convention. For positive R_r, let p_r^* denote its floor-adjusted value, and define

$$D_r^* = \min(86400, R_r/p_r^*), \qquad Q_r^I = AR_r/D_r^*. \tag{3}$$

For exactly zero rainfall, $Q_r^I = 0$. This interface operand is not a manufactured physical rainfall component: p_r in Equation 2 remains zero for pure return. Nor is D_r^* the storm-support field T_r.

5.5 Eligibility and Continuity

No-return cases follow the baseline producer path. Multi-OFE, contoured and non-hourly cases are outside the targeted producer correction, not claimed fixed by inference. With positive return, every positive R_r is retained. As its independently calculated peak tends to zero, Equation 2 tends to p_s; this algebra does not guarantee that all native branches or legacy floors are continuous. Native tests include vanishing rainfall and return, pure return, no-return controls and support endpoints. A proof of continuity of the entire legacy model is not an acceptance prerequisite.

5.6 Event Lifetime and Observability

The new producer common block holds an active flag, rainfall/return depths, physical and interface peaks and 24 hourly values for the current event. Initialization and the continuous day loop reset this state. Consumer-side arrays are cleared before assembling or reading each day's sources. This prevents an active source packet from a previous event being reused when a later event has no eligible return.

Existing opt-in observation infrastructure receives mixed depths, component peaks, final duration/peak, hydraulic quantities and derived concentration time/alpha diagnostics. The release does not add a new user flag. Observer neutrality is tested against standard outputs; the act of logging is not assumed harmless without comparison.

6 Why Erosion and Sediment Can Change

WEPP's erosion calculation is coupled to hydrological and hydraulic inputs, not just to annual runoff volume.[2] In the inspected release, XINFLO uses the physical peak in runoff and shear-related hydraulic quantities; PARAM applies duration-dependent factors; SLOSS uses effective duration when integrating loads and delivery. Correcting the peak can therefore change hydraulic radius, width, effective friction and erosion even while runoff volume remains the same. These are model consequences, not a reporting patch.

Neither direction of sediment change proves accuracy by itself. Lower artificial peaks can reasonably reduce detachment/transport inputs, but changes to duration, thresholds, deposition and channel history need not produce a uniform decrease in exported sediment. The report distinguishes gross erosion or detachment, hillslope delivery and outlet export throughout.

For physical context, the published hillslope formulation makes rill detachment capacity depend on excess soil shear stress:

$$D_{\text{cap}} = K_r(\tau_f - \tau_c), \qquad D_f = D_{\text{cap}}(1 - G/T_c), \tag{4}$$

in the detachment domain $\tau_f > \tau_c$ and $G < T_c$. Here K_r is rill erodibility, τ_f and τ_c are applied and critical stress, and G and T_c are load and transport capacity on the same unit-width basis. Deposition is a different regime. Peak-driven hydraulics can change the threshold regime and transport capacity, while effective duration changes the time over which rates contribute to delivery. These published relationships explain why volume parity alone cannot establish sediment parity; they are background science, not new equations introduced by this release.[2]

The legacy `tcs` formula and overland alpha calculation are retained. Their values can nevertheless respond indirectly to changed hydraulic inputs, including effective Manning behavior. The PASS alpha uses concentration time in seconds, physical peak and area divided by runoff volume, with its existing minimum bound. Saying "no tcs formula change" is not a claim that every tcs or alpha value is identical. Importantly, the return-only support introduced below is local to source assembly: it is not written into erosion duration, storm duration, tcs or alpha. In CHRQIN's exponential construction the internal shape time is $T_r/2.67$, not an imposed new tcs smoothing time.

Soil-water scheduling, snow processes and nutrient equations are not directly rewritten by these changes. Their presence in the executable does not constitute independent validation of every coupled output; nutrient consequences were not a separate acceptance study for this release.

7 PASS v3: An Explicit Component Contract

One combined peak, duration and volume cannot in general distinguish a short rainfall event from soil water returned over a longer period. Replacing only that combined peak can make the existing reconstruction inconsistent with the water it is expected to deliver. The release therefore uses in-band component information in the existing PASS transport, not a companion file or a guessed decomposition in the watershed consumer.[7, 10]

The leading marker is `WEPP_PASS_COMPONENTS 3`. Extended hillslope EVENT records have an accompanying `SRC3` record. Its date and active flag identify either an inactive packet or an active 27-value payload:

Payload	Meaning	Units/interpretation
V_r	Non-return runoff volume	m^3
Q_r^I	Protected rainfall-only peak operand	$\text{m}^3\,\text{s}^{-1}$
V_s	Returned-water volume	m^3
$w_1, \ldots, w_{24}$	Nonnegative hourly return weights	Relative weights

The producer initially writes hourly depths as weights. Native composition can instead produce volume weights. The v3 consumer uses ratios of these weights, so their common scale is immaterial. Their hour positions are retained as provenance but *do not prescribe v3 channel forcing times.* This is an intentional versioned interpretation, not a hidden serialization change.

Master files include a dated `SOURCES3` count and ordered active source records keyed by hillslope index. Initialization and reading are wired through INFILE, WSHPAS and WSHRED. Header handling accepts legacy input contracts for compatibility, accepts v3, and rejects unsupported component versions rather than guessing offsets. Reading legacy syntax is not authorization to mix builds in a new watershed simulation.

Parsers check record arity, dates, counts, source order/bounds and numeric validity. Active values must be finite and nonnegative with a nonempty return component; zero rainfall volume cannot carry a nonzero rainfall peak. The record tokenizer does not accept list-directed null/repeat/slash conventions as a fallback. The existing EVENT-selection logic, including its runoff threshold, is not replaced with a new universal event definition.

8 Bounded Return-Source Construction

8.1 Volume Allocation Comes First

The watershed caller may allocate only a portion V_c of the hillslope's surface volume to a particular top or lateral source. For an active packet, CHRQIN partitions that caller volume using the serialized proportions:

$$V_{r,c} = V_c \frac{V_r}{V_r + V_s}, \qquad V_{s,c} = V_c \frac{V_s}{V_r + V_s}. \tag{5}$$

This preserves the caller's total; it does not add another copy of hillslope water. Existing caller allocation semantics are retained. The component peak operand is not silently rescaled into a new invented rainfall hydrograph.

8.2 An Hourly Ceiling, Not Literal Hourly Timing

Let $W = \sum_h w_h > 0$, $w_{\max} = \max_h w_h > 0$, and let T_r be the existing storm support in seconds. Define

$$T_{\mathrm{eq}} = 3600 \frac{W}{w_{\max}}, \qquad T_s = \max(T_r, T_{\mathrm{eq}}), \qquad q_s = \frac{V_{s,c}}{T_s}. \tag{6}$$

The return source is a rectangle starting at the existing computational event origin and ending at T_s. Since $T_s \geq T_{\mathrm{eq}}$,

$$q_s \leq \frac{V_{s,c} w_{\max}}{3600 W}. \tag{7}$$

This ceiling refers to the allocated *return component*, not total rainfall-plus-return inflow or outlet discharge. The rate need not attain the hourly maximum. Return timing is redistributed onto a scalar support anchored to an existing computational clock; it is not recovered from an observed mixed hydrograph or from the positions of the original hourly buckets.

For routing interval $[(i-1)\Delta t, i\Delta t]$, assembly adds its overlap mean:

$$\bar{q}_{s,i} = q_s \frac{\max\{0, \min(i\Delta t, T_s) - (i-1)\Delta t\}}{\Delta t}. \tag{8}$$

On a grid covering the support, these interval means represent exactly the allocated rectangular-source volume before downstream processing, apart from floating-point arithmetic. Partial final cells are not silently truncated. At initial setup the zero-time boundary receives the initial rate; subsequent days retain the caller's existing aggregate boundary convention.

The 24 nonnegative weights imply $3600 \leq T_{\mathrm{eq}} \leq 86400$ seconds. The implementation rejects invalid operands or support beyond the available day rather than clipping water or introducing a new cross-day source store. Existing storm support and the full source grid still need to satisfy their contracts. Volume consistency of this assembly alone does not guarantee volume consistency through every downstream operator.

8.3 Why the Hourly Bins Are Not Used Literally

The investigation found that daily scheduling can concentrate modeled return in the last hourly bucket. The hour receives consequences of daily bookkeeping, including late ET/residue and redistribution operations; it is not simply an arbitrary "whatever remains" bucket with independently known physical timing. In a read-only Cedar population of 61,645 eligible return records, 4,450 had at least 90% of their return in hour 24, but those records represented only 0.67% of eligible return volume. Thus a small aggregate volume share could still create conspicuous event pulses. These are descriptive population bins, not eligibility thresholds.[9]

Keeping literal hourly timing produced problematic next-day pulses in ordinary controls. A global routing-mode switch, moving ET, repeating percolation, or attributing a residue release directly to returned-water parcels would change other assumptions without a demonstrated bounded benefit. The selected rule preserves the hourly physical estimator while permitting a coarser channel representation. It is an explicit simplicity-versus-timing-fidelity decision.

8.4 Original Explanatory Stub

The following is original Python authored by Codex for this report, not a legacy listing or a production substitute. It illustrates Equations 6–8. It omits legacy boundary handling, rainfall reconstruction, caller allocation, serialization precision and the routing solver. Inputs are already valid, positive-return operands. The companion examples are checked independently of any watershed claim.

```
def return_rectangle(volume_m3, weights, storm_s, step_s, steps):
    """Illustrate the v3 support rule and interval-overlap means."""
    if len(weights) != 24 or min(weights) < 0 or max(weights) <= 0:
        raise ValueError("Expected 24 nonnegative, nonempty weights")
    if volume_m3 <= 0 or not 0 <= storm_s <= 86400 or step_s <= 0:
        raise ValueError("Expected positive volume and a valid day/grid")
    support = max(storm_s, 3600 * sum(weights) / max(weights))
    if support > 86400 or steps * step_s < support:
        raise ValueError("Support must fit the represented day/grid")
    rate = volume_m3 / support
    means = []
    for i in range(1, steps + 1):
        overlap = max(0, min(i * step_s, support) - (i - 1) * step_s)
        means.append(rate * overlap / step_s)
    return support, means
```

Listing 1: Original return-rectangle illustration; not WEPP production code.

9 Channel State Across Daily Calls

The old daily initialization retained boundary information but reconstructed internal channel discharge by drawing a straight line between inlet and outlet. Different internal profiles can have the same

endpoints. Replacing the profile can therefore alter subsequent routed discharge even when the next day's forcing is unchanged. This is distinct from source timing and source-volume normalization.[8]

The new CHRSTATE helper stores each channel's final nodal discharge profile and segment count after routing. On the next call, an equal grid restores nodes exactly. If the uniform grid changes, interior nodes are linearly interpolated in normalized reach distance. For old segment count n_o and new node j on n_n segments, let $x = jn_o/n_n$, $k = \lfloor x \rfloor$ and $\lambda = x - k$; the transfer uses

$$q_j^{\text{new}} = (1-\lambda)q_k^{\text{old}} + \lambda q_{k+1}^{\text{old}}. \tag{9}$$

The downstream endpoint is preserved. The caller's current upstream boundary remains authoritative, and an initialization call resets saved state. This bounded interpolation does not create an extremum between the bracketing old values, but it is not a storage-conservative remap theorem.

In native 48-hour diagnostics, daily restart errors for a 3600 m^3 last-hour source reached roughly -1121 m^3 on a lateral case and +2414 m^3 on a top case, depending on routing method. Same-grid retention reproduced uninterrupted native trajectories in the tested controls. These are synthetic diagnostic results, not observed watershed errors or proof of universal convergence. The repair preserves channel routing memory, not a new hillslope reservoir.

10 CHRQIN Rainfall-Source Normalization

10.1 The Existing Reconstruction Contract

CHRQIN supplies top or lateral source rates from volume, peak and support. For rainfall volume exceeding its existing small absolute threshold, it uses the provided support T_r and peak operand. In the active component case, these are the rainfall volume allocation and Q_r^I, not the combined physical MIXPEAK peak. One legacy branch is flat when volume is at least approximately peak times support. The other constructs a double exponential.

For $a = V_{r,c}/(Q_r^I T_r)$, the routine solves

$$1 - \exp(-u) = au, \qquad t_c = T_r/2.67, \tag{10}$$

and defines rates proportional to

$$r(t) = \begin{cases} Q_r^I \exp[(u/t_c)(t - t_c)], & t \le t_c, \\ Q_r^I \exp[-u(t - t_c)/(T_r - t_c)], & t_c < t \le T_r. \end{cases} \tag{11}$$

The configured pointwise path samples this shape and scales it to its supplied volume. A separate existing cell-average path is not replaced by this release. The delivered sampled maximum need not equal Q_r^I after normalization; continuous shape identities do not automatically survive finite sampling.

10.2 The Indexing Error and Its Correction

Write $S_q = \sum_{i=1}^{n} r_i$ for the positive-time samples that contribute to the chosen integral, at interval Δt. On the initialized path the old normalizer removed the first positive-time sample even though the addition loop still delivered it. When the remaining sum was positive,

$$B_{\text{old}} = \Delta t(S_q - r_1), \quad V_{\text{represented,old}} = V_{r,c}\frac{S_q}{S_q - r_1}. \tag{12}$$

If nearly all sampled shape lies in r_1, the factor can become enormous. If the remaining denominator vanishes, the scale-application guard can instead suppress the source. Floating-point cancellation can aggravate the symptom, but increasing precision alone does not repair inconsistent sample accounting.

The correction retains every positive-time sample in the denominator. A time-zero sample is subtracted only on the path where it was accumulated:

$$B_{\text{new}} = \Delta t S_q, \qquad q_i = V_{r,c}\, r_i / B_{\text{new}}. \tag{13}$$

This is not a global change to the initialization flag and not a peak cap. It applies to ordinary rainfall-source reconstructions using this branch as well as active component sources. The flat branch, existing absolute volume threshold and short-support limitations remain. No universal closure assertion follows from the local identity.[11]

10.3 Captured Topanga Operands

For H101 on January 18, 1993, the allocated rainfall component was only 0.090845406 m^3 within 274.970 m^3 total surface volume. Its peak operand was 0.0014701501 $m^3\,s^{-1}$, support 1440 s and interval 600 s. The unscaled first sample was approximately 3.059043×10^{-4} $m^3\,s^{-1}$, while the next was only 5.54092×10^{-11} $m^3\,s^{-1}$. The faulty single-precision denominator was approximately 3.49246×10^{-8} m^3, producing a multiplier of about 2.60 million. Native routine probes reproduced source pulses near 796 and 185 $m^3\,s^{-1}$ from H101 and H234, before channel routing.

The earlier combined-volume operands took a different branch, so a legacy defect became conspicuous only after component separation. Read-only observer instrumentation reproduced 293 output files exactly over 45 years. The pulses were already present at headwater sources; channel-state carry was not their origin. Correctness therefore required repairing this arithmetic boundary, not zeroing small rainfall, discarding the hourly estimator or reconstructing the routing architecture.

11 Native Composition and Workflow Compatibility

The paired native reader/combiners support legacy syntax and component v3, reject experimental/unknown component versions, and preserve ordinary public Parquet columns. Roads metadata operations preserve the leading version marker and climate identity. AgFields reads modeled area and climate after the marker rather than using stale fixed offsets. No Python physical-composition fallback silently drops the new operands.[10]

Roads applies additive scaling; AgFields applies existing represented-area weights. Active V_r and V_s are scaled and summed. Rainfall peaks use the existing triangular peak-combination procedure with source concentration times. Inactive sources contribute legacy volume and peak as an unsplit component; the combiner does not infer unsupported return fractions. Each active return weight vector is normalized, multiplied by represented V_s, and accumulated by hour. Zero-area sources contribute nothing; zero aggregate return produces an inactive record.

Existing combined EVENT volume/peak/duration, tcs, alpha and sediment rules remain in place. The channel consumes separately combined source operands; composition does not rerun hillslope erosion. This aggregate construction is not exact superposition of separately routed source hydrographs. Its support and timing assumptions remain the bounded v3 approximation.

12 Alternatives Not Shipped

Alternative	Disposition and reason
Pure-return-only eligibility	Demonstrated a subset, but missed original return-dominated triggers with small positive rainfall. No return-fraction threshold was introduced to disguise that boundary.
Daily-mean physical return peak	Not retained. It discards the hourly estimator used for physical erosion; favorable routing alone does not justify it.
Support from the last return endpoint	Rejected: a tiny late contribution could impose an hours-long support/timing change. The 43.484 mm rainfall control with 0.01 mm late return remains a relevant boundary test.
Literal hourly channel forcing alone	Produced problematic late pulses and recession enlargement. State continuation fixed a separate restart error but did not by itself remove those source-timing effects.
New source carry, water-balance rescheduling or general routing rewrite	Not part of the bounded release. No unvalidated soil-water change or new transport architecture is used to obtain favorable totals.
Old 261007 repair bundle	Superseded, not silently accumulated. The net shipped-source audit identifies the implementation actually released.

13 Evaluation Design and Interpretation

The governing standard was a demonstrated correction of the original peak anomaly without material degradation relative to 260803 under matched inputs. No new calibration, roughness workaround, universal convergence requirement or strict zero-residual tolerance was introduced. Materiality was assessed through magnitude, frequency, affected conditions and practical consequences; ambiguous scientific decisions remained with Roger Lew.

The evidence combines native-routine probes, generated full-period watersheds, same-build hillslope/-PASS regeneration, observer-neutrality checks, small-input mutation experiments and a canonical disturbed matrix. These are different forms of evidence. An isolated arithmetic identity is not watershed validation; high model-to-model agreement is not observed-flow skill. The release binaries match the studied candidate after removing debug data and GNU build identity, with executable code and runtime data retained in the comparison. Fresh release checks supplement that equivalence.[17]

Study	Extent	Question answered
H106 native triggers	Two Ksat-35 cases; Ksat/no-return controls	Physical peak correction at the producer, not only a lower outlet peak.
Topanga	Burned/undisturbed; 284 hills each; 1980–2024	Localization and correction of the January 1993 source inflation, with full-record consequences.
Rattlesnake	Burned/undisturbed; 73 hills each; 100 synthetic years	Independent watershed compatibility and ordinary-event sensitivity to normalization.
Cedar Creek	864 hills, 371 channels; 1980–2003	Yield, routed-discharge sampling, ledger discrepancies, events, timing and sediment under matched inputs.

Study	Extent	Question answered
Mutation census	140 hills in each of two scenarios; 1980–2024	Sensitivity to small conductivity/cover perturbations within the corrected model.
Disturbed matrix	96 cases; four soils, four severities, six vegetation types; 100 synthetic years	Parameterization expectations on one common slope/climate, including young forest, not universal severity ranking.

Use fresh matching-build passes in simulations; reader backward compatibility does not justify substituting old PASS files. Diagnostic observer output was compared with uninstrumented standard output before interpretation. Retained failed branches and incomplete attempts are distinguished from passing results.

13.1 Volume, Peak and Timing Measurements

Daily hillslope streamflow from totalwatsed is converted to volume as depth times contributing area divided by 1000 when depth is in millimetres. The watershed EBE outlet volume is a separate daily ledger. Cedar's sampled integral uses the 144 positive-time discharge samples per day:

$$V_{\text{sampled},d} = 600 \sum_{i=1}^{144} Q_{d,i}, \qquad G_d = V_{\text{sampled},d} - V_{\text{ledger},d}. \tag{14}$$

Samples, including the 86400-second endpoint, remain assigned to the printed simulation day. This reproduces the comparison convention; it is not exact continuous integration. Report both $\sum_d G_d$ and $\sum_d |G_d|$, because opposite daily discrepancies can cancel.

Extra digits in comparison tables preserve recorded output identities; they do not imply sub-cubic-metre physical accuracy over decades. Printed sampling, rounding, discretization and the model's assumptions limit interpretation.

Peak comparisons distinguish internally reported maxima and maxima of printed samples. First-argmax timing can jump between nearly equal crests or rounded plateaus. Flow centroids use all sampled discharge in the selected window; they are not automatically storm travel times. Event windows include background flow unless stated otherwise. NSE, KGE and R^2 are descriptive comparisons of model outputs, not automatic acceptance gates or field validation scores. Definitions are given in Appendix B.[4, 5]

14 Mutation Study: Figures 1–3

The companion investigation by Lew, *Small-Mutation Screening of WEPP Hillslope Peak Flow: Remediation Strategies and Validation Findings*, version 0.2 (October 6, 2026), explains the original Topanga census, perturbation design and earlier remediation assessment.[13] It is historical context: its earlier candidate and unresolved Cedar routing results are not the shipped 261010 implementation or its final validation. The results and Figures 1–3 below describe the retained 261010 candidate study.

All 280 unmutated controls and 1088 eligible mutations completed, plus ten uninstrumented H106 checks of observer neutrality. The design retains first-horizon conductivity factors 0.99/1.01 and paired initial interrill/rill-cover changes of -0.01/+0.01. Thirty-two originally excluded cover mutations remain excluded rather than clipped. All nonmutated inputs, including frozen roughness, stay unchanged.[14]

Both axes in the following figures use the validated candidate: one axis is unmutated input and the other mutated input. They are *not* corrected versus 260803 plots. The report renderer changes layout only; input-ledger hashes, filters, marker meanings and counts are checked against the retained study. The candidate's event and sediment ledgers match 261009 exactly, and the release's executable equivalence establishes applicability to 261010.

The outer ledger has 225,658 hillslope/date/mutation rows: 225,042 paired events, 320 unmutated-only and 296 mutated-only rows. Missing events are not zero-filled. An event can appear for multiple perturbations, so these are not independent storm counts. Sediment is the original EBE hillslope-delivery metric in kg/m, not gross detachment or watershed export.

Metric	Eligible pairs	Beyond 2× guides	Beyond 5× guides	Outside axes
Runoff	218,974	453	34	86
Sediment delivery	129,496	329	72	0
Peak flow	200,984	966	209	179

The twofold guides mean ratios below 0.5 or above 2; fivefold guides mean below 0.2 or above 5. They are inherited descriptive guides, not thresholds invented to accept the release. Existing nonlinear sensitivity remains: 966 eligible peak pairs lie beyond twofold guides, including 543 with surface return and 423 without it. Small input perturbations can change event behavior even in a successfully repaired release.

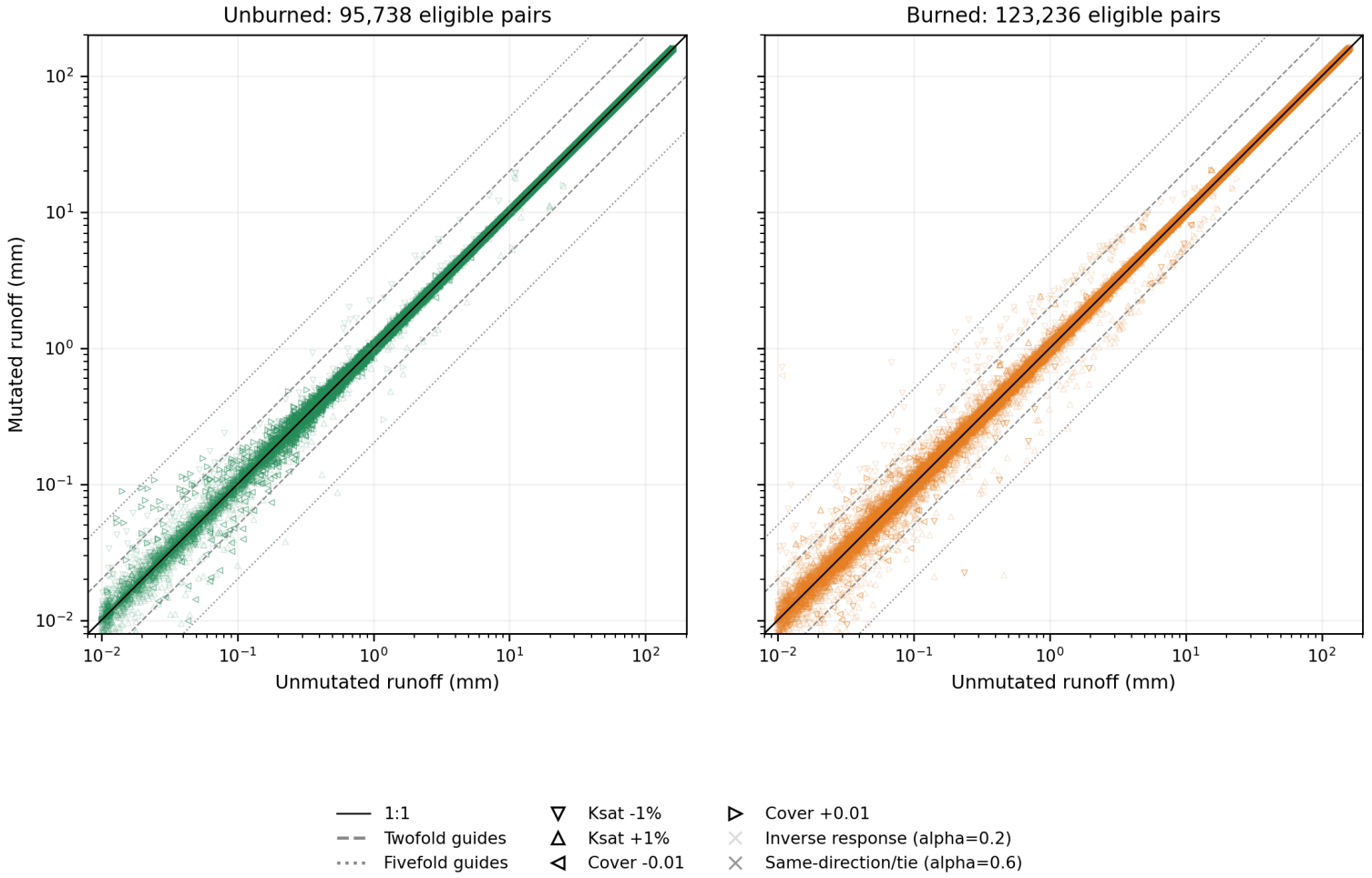


Figure 1: Runoff sensitivity within the corrected candidate, with full 1980–2024 histories. Both events must be present; unmutated runoff is at least 0.01 mm and mutated runoff is positive. Original axes span 0.008–200 mm. The 86 eligible pairs outside the displayed limits remain in the statistics. Triangles identify conductivity/cover directions; opacity distinguishes inverse responses from same-direction responses and ties. Layout-only rerender of retained observations, not new simulations or a cross-version comparison.

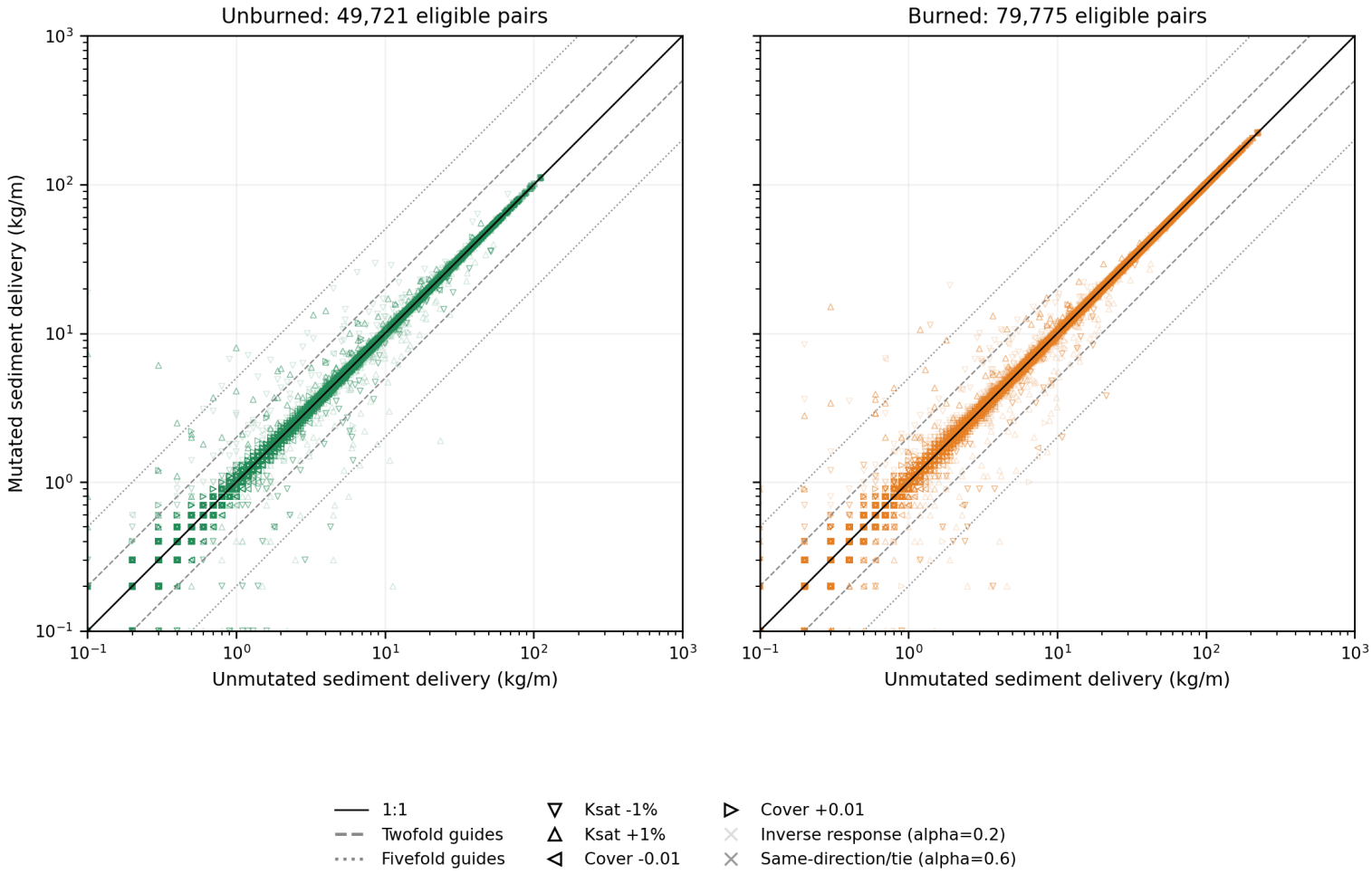


Figure 2: Hillslope sediment-delivery sensitivity in kg/m, the report's erosion metric. Both printed deliveries must be positive. There are also 540 unmutated-positive-only and 583 mutated-positive-only records, retained outside this paired-positive plot. The EBE 0.1 kg/m precision produces visible steps and many ties. This is not a plot of gross detachment or channel sediment export.

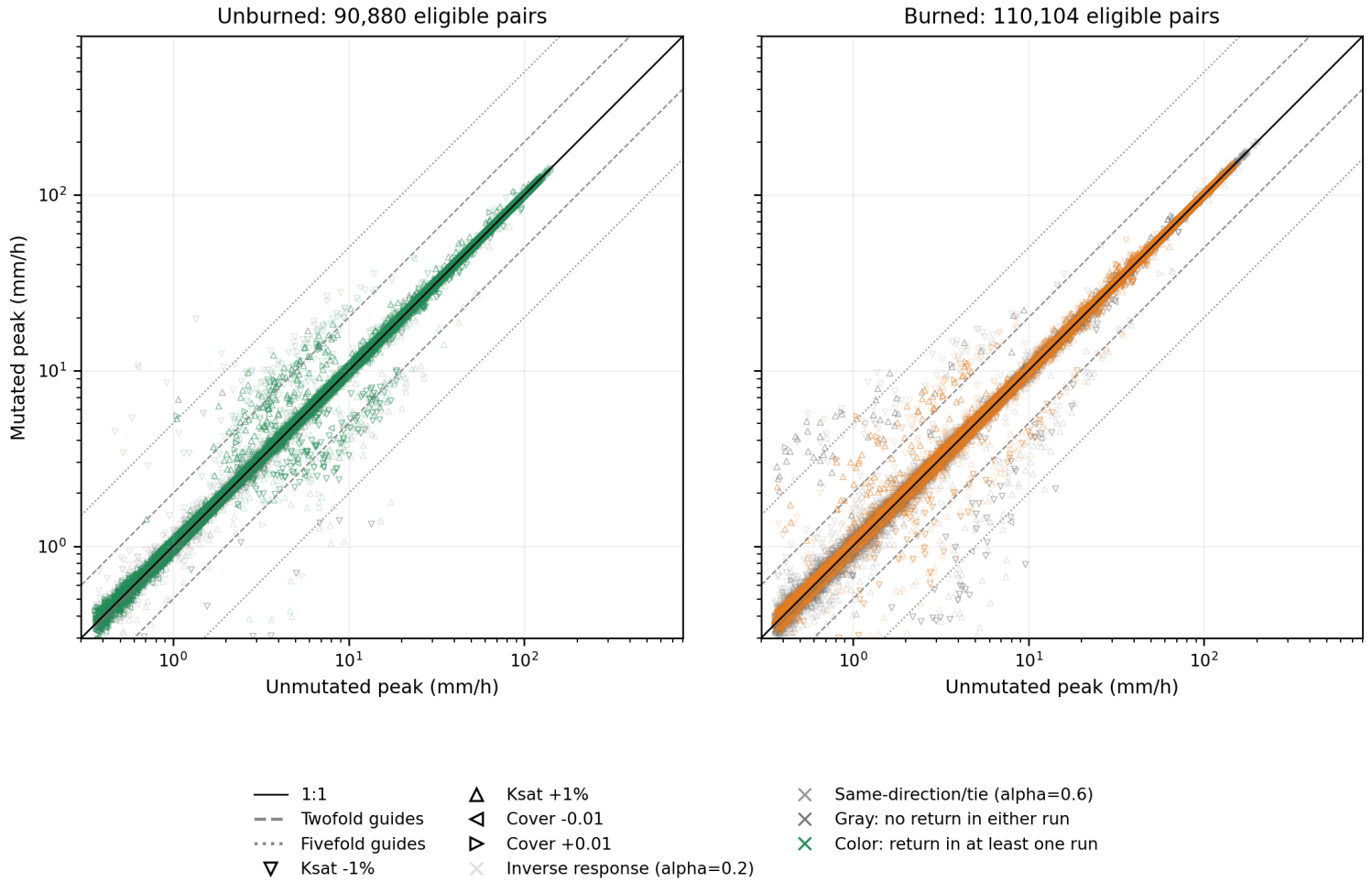


Figure 3: Peak-flow sensitivity within the corrected candidate. Both events must be present; unmutated peak is at least 0.36 mm h^{-1} and mutated peak is positive. Axes span 0.3–800 mm h^{-1}; 179 eligible pairs outside the axes remain counted. Gray denotes no return in either run; color denotes return in at least one. The hourly physical estimator is retained, not replaced by a daily mean. Both axes use the same corrected implementation.

15 Topanga: Target Correction and Its Boundary

The January 18, 1993 GridMET case was initially investigated as an outlier, not presumed defective solely from a burned/unburned reversal. Matching inputs, the 260803 comparison, native source probes and observer-neutral traces then established the normalization mechanism. Roger judged the roughly 708 $m^3\,s^{-1}$ result physically unacceptable at this location. This is a diagnosis supported by implementation evidence, not an assumption that every unusual peak is wrong.

Scenario	Build	Outlet volume (m^3)	Peak ($m^3\,s^{-1}$)	Sediment (kg)
Burned	260803	213215.02	106.42034	212686.55
Burned	261009	213282.16	76.03957	222187.20
Burned	Candidate	213281.84	35.72905	223117.84
Undisturbed	260803	219667.84	27.85154	39192.88
Undisturbed	261009	218608.19	707.63910	26789.54
Undisturbed	Candidate	219692.70	12.50683	27201.02

The corrected undisturbed volume is +0.0113% versus 260803. Its peak occurs at 1800 s instead of 1200 s in 261009. Removing the manufactured source pulse is the evidence of repair; a lower outlet peak by itself would not have been sufficient. Candidate watershed output for this study was peak-only, so it does not provide a new full subdaily recession or integral–ledger audit. The figure below connects daily maxima, not hydrograph samples.[11]

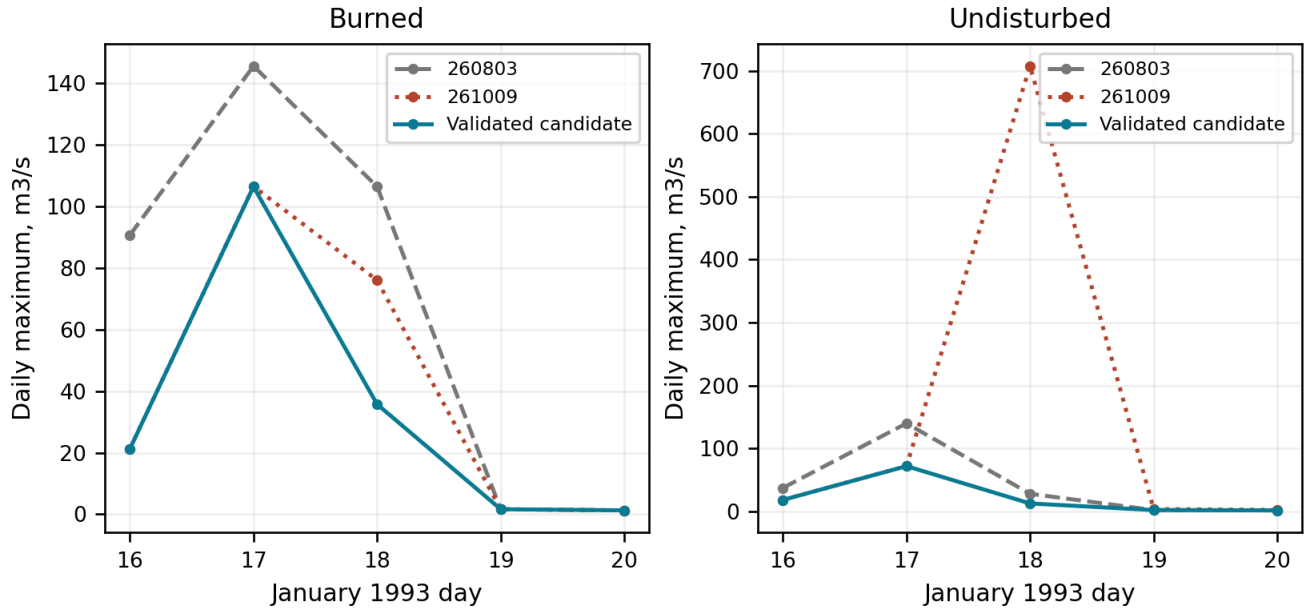


Figure 4: Retained January 1993 daily peak comparison. The candidate label identifies the studied, pre-packaging executable; runtime equivalence to the 261010 release is documented. Lines between daily maxima must not be read as a continuous subdaily hydrograph.

16 Independent Watershed and Ordinary Events

Both Topanga scenarios and both Rattlesnake scenarios completed with 714 fresh hillslope runs in the candidate comparison. Topanga covers 45 years; Rattlesnake covers 100 synthetic years. Signed full-record changes versus 260803 are:

Case	Reported outlet volume change (%)	Outlet sediment change (%)
Topanga burned	-0.0000510	+1.30014
Topanga undisturbed	-0.0000501	-0.61171
Rattlesnake burned	-0.0000002	+0.49250
Rattlesnake undisturbed	+0.0000001	+1.98547

These aggregate values do not establish that individual events are unchanged. For burned Rattlesnake synthetic year 40, May 15, both released comparators have a 44.54780 $m^3 s^{-1}$ peak; the candidate gives 20.21181 $m^3 s^{-1}$ (-54.6%). Volume changes only from 28250.79 to 28250.22 m^3. The twelve EVENT source packets that date are inactive for mixed-return transport. This establishes an ordinary legacy-source-path consequence; an inactive packet is not by itself proof of physically zero return in every unsupported producer mode.

The following sediment examples also have essentially unchanged event volume:

Burned Rattlesnake event	Both older builds (kg)	Candidate (kg)	Difference (kg)
Year 41, May 28	140954.78	621811.88	+480857.10
Year 89, June 6	438143.62	99119.68	-339023.94

All checked hillslope sediment fields match 261009 across the 146 Rattlesnake hillslope runs. The differences arise downstream, but a unique channel transport/storage explanation was not isolated. An adjacent-storm redistribution explanation is not established merely by its plausibility. Year-41 sediment export increases 19.746%; year 89 decreases 13.837% versus 261009, despite the full-record incremental sediment change of only +0.346%. These findings remain disclosed through promotion.[11]

Correcting a known source-accounting defect is justified independently of whether a legacy number is reproduced. It also affects practical peak and sediment interpretation. Roger explicitly authorized the release after the follow-up studies; that decision is not evidence that these individual sediment magnitudes have been confirmed against observations.

17 Two- and Five-Year Outlet Return Levels

17.1 Why These Intervals Matter

The original Topanga inquiry was motivated by inverted frequent-event peak flows. Elliot's July 2026 report gives approximate 2-year peaks of 68 $m^3 s^{-1}$ burned and 81 $m^3 s^{-1}$ undisturbed; its 5-year values are 91 and 110 $m^3 s^{-1}$, respectively (Table 8). These historical values identify the initiating concern, not the baseline operands for the tables below. The older projects and configurations differ from the later paired release runs.[19]

The matched 260803 runs below already have burned peaks above undisturbed peaks at both intervals. Thus the present tables show release behavior and changes in the scenario contrast; they do not by themselves prove that changing only the executable resolves the original historical inversion. Nor is burned-above-undisturbed ordering a universal physical requirement or a substitute for the mechanism evidence elsewhere in this report.

17.2 Method and Quantities

The tables use the existing WEPPcloud *Continuous Time Analysis* (CTA) order-statistic helper with its Gringorten option, the entire record, and no excluded years or months. They are not fitted annual-maximum flood curves. Each metric, scenario and build is ranked independently; entries on the same row need not describe the same storm. With N records over Y years, the implemented plotting position is $T_r = (N + 1)/[(r - 0.44)(N/Y)]$. The helper selects the largest rank whose plotting position is at least the requested interval.[20]

Runoff is the watershed-outlet EBE daily volume expressed as an equivalent depth: $V/(10A)$ mm for V in m^3 and report area A in hectares. It is not hillslope totalwatsed yield or a new hydrograph integral. **Sediment** is daily outlet export in metric tonnes (kg/1000), not hillslope erosion, channel detachment or tonnes per year. **Peak** is the outlet EBE maximum discharge in $m^3 s^{-1}$.

261010 equivalent denotes the retained, same-build hillslope/watershed candidate whose runtime equivalence to the packaged release is documented. These are new calculations from preserved outputs, not newly executed 261010 watershed simulations. The 261009 diagnostic comparator, selected dates, record order, raw quantities and alternative first-two-years-excluded/no-Gringorten results are retained in the evidence CSV; they are not mixed into these tables. Printed precision is for reproducibility, not a claim of physical accuracy.

17.3 Topanga / Palisades

GridMET 1980–2024: 45 years, 16,437 records per scenario/build, report area 972.029631 ha. The 2- and 5-year labels select ranks 22 and 9, corresponding to plotting positions of about 2.087 and 5.257 years.

		Burned		Undisturbed	
Measure	Years	260803	261010 equiv.	260803	261010 equiv.
Runoff (mm)	2	70.7048	70.7048	65.8420	65.8382
Runoff (mm)	5	88.1059	88.0964	85.1418	85.1418
Sediment (t)	2	1198.4694	1235.7097	315.6543	331.1000
Sediment (t)	5	1532.1716	1623.1184	413.0783	465.0841
Peak ($m^3 s^{-1}$)	2	189.00145	161.09906	175.78200	111.09779
Peak ($m^3 s^{-1}$)	5	239.10179	214.04485	218.10080	163.90913

17.4 Rattlesnake

100 synthetic years, 36,525 records per scenario/build, report area 673.745301 ha. The 2- and 5-year labels select ranks 50 and 20, corresponding to about 2.018 and 5.113 years. The existing two records labeled year 100, December 22 are retained in their original order, not deduplicated or repaired. These dates are synthetic model years, not observed calendar dates.

		Burned		Undisturbed	
Measure	Years	260803	261010 equiv.	260803	261010 equiv.
Runoff (mm)	2	5.4394	5.4393	3.8333	3.8333
Runoff (mm)	5	6.4481	6.4481	4.9338	4.9338
Sediment (t)	2	420.4755	421.2387	1.4222	1.4447
Sediment (t)	5	497.1918	498.7941	1.7617	1.8690
Peak ($m^3\,s^{-1}$)	2	9.84958	9.52914	0.31632	0.31603
Peak ($m^3\,s^{-1}$)	5	15.38192	13.99882	0.39908	0.39897

17.5 Interpretation and Remaining Limits

Burned runoff, sediment and peaks exceed undisturbed values at both intervals in both matched builds and both watersheds. Topanga's burned peaks decrease 14.76% and 10.48% at 2 and 5 years versus 260803; undisturbed peaks decrease 36.80% and 24.85%. Rattlesnake's burned peaks decrease 3.25% and 8.99%; its undisturbed peaks decrease approximately 0.092% and 0.028%. Outlet runoff-depth levels are nearly unchanged: the largest absolute relative change among these comparisons is approximately 0.011%.

Sediment return levels do not necessarily track full-record export. Topanga's 2-/5-year sediment levels rise 3.11%/5.94% burned and 4.89%/12.59% undisturbed versus 260803. The last change is from 413.0783 to 465.0841 t, about 52.01 t, even though undisturbed full-record export decreases 0.612%. Rattlesnake's corresponding changes are +0.18%/+0.32% burned and +1.58%/+6.09% undisturbed; the latter 5-year difference is about 0.1073 t. These upper-tail changes are reported explicitly rather than obscured by aggregate agreement. Independent ranking can select different dates after a correction; return levels are not same-event percentage changes.

The full-record settings here also differ from the earlier Rattlesnake table that excluded two years and disabled Gringorten. For example, that earlier 98-year runoff comparison gave roughly 5.4363/7.0984 mm burned at 2/5 years; it must not be read as a model change from the 100-year values above. Topanga here uses GridMET, not the separate synthetic-climate project.

The results address the frequent-event question that initiated the work, while the original peak mechanism, the January 1993 defect, event-level sediment departures and remaining source/timing limits require their own evidence. Correct ordering alone establishes neither observational accuracy nor universal numerical closure.[20]

18 Cedar Creek: Complete Yield and Discharge Comparison

The complete 1980–2003 record contains 8766 days, 864 hillslopes and 371 channels, with frozen 10 cm initial random roughness. Fresh candidate and 261009 runs regenerated 1728 hillslopes; their 6048 standard hillslope files match exactly. Native conversion accepted 7,573,824 PASS and 16,690,464 WAT records per build with no rejected records. Both watersheds completed.

18.1 Water Volumes and Accounting

Full-record measure (m^3)	260803	261009	Candidate
Hillslope streamflow	1,267,735,665.289	1,267,735,665.682	1,267,735,665.682
Outlet daily ledger	1,272,337,716.46	1,272,337,716.29	1,272,337,711.84
Sampled outlet integral	1,266,448,890.30	1,267,093,408.92	1,266,461,659.92
Integral minus ledger	-5,888,826.16	-5,244,307.37	-5,876,051.92
Sum of absolute daily gaps	6,441,305.44	5,849,097.91	6,380,525.06

Candidate totalwatsed matches 261009 on every day. The largest daily yield difference versus 260803 is 0.217 m^3. The reported outlet ledger changes -4.62 m^3 over the full record versus 260803 and -4.45 m^3 versus 261009. Sampled outlet volume changes +12,769.62 m^3 (+0.001008%) versus 260803, and -631,749.00 m^3 (-0.049858%) versus 261009. Annual sampled-volume changes range -0.02413% to +0.04228% against 260803 and -0.08420% to -0.03010% against 261009.[12]

The normalization repair therefore causes a small systematic reduction in represented discharge relative to 261009, not only a change of day assignment. It does not reduce hillslope water production. Its signed integral–ledger gap is 12,774.24 m^3 smaller in magnitude than 260803's, and absolute daily gaps sum to 0.944% less. Relative to 261009, however, signed-gap magnitude grows 631,744.55 m^3 and absolute daily gaps grow 9.086%. Much of that release's apparent accounting improvement is lost when the incorrect source weighting is repaired. This is not a claim of restored conservation.

The remaining approximately 4.602 million m^3 difference between channel ledger and hillslope yield is also distinct from the sampled-integral gap. Neither is explained simply by saying that flow moved across midnight. Existing discrepancies are retained as limitations, not automatically made prerequisites for a routing reconstruction campaign.

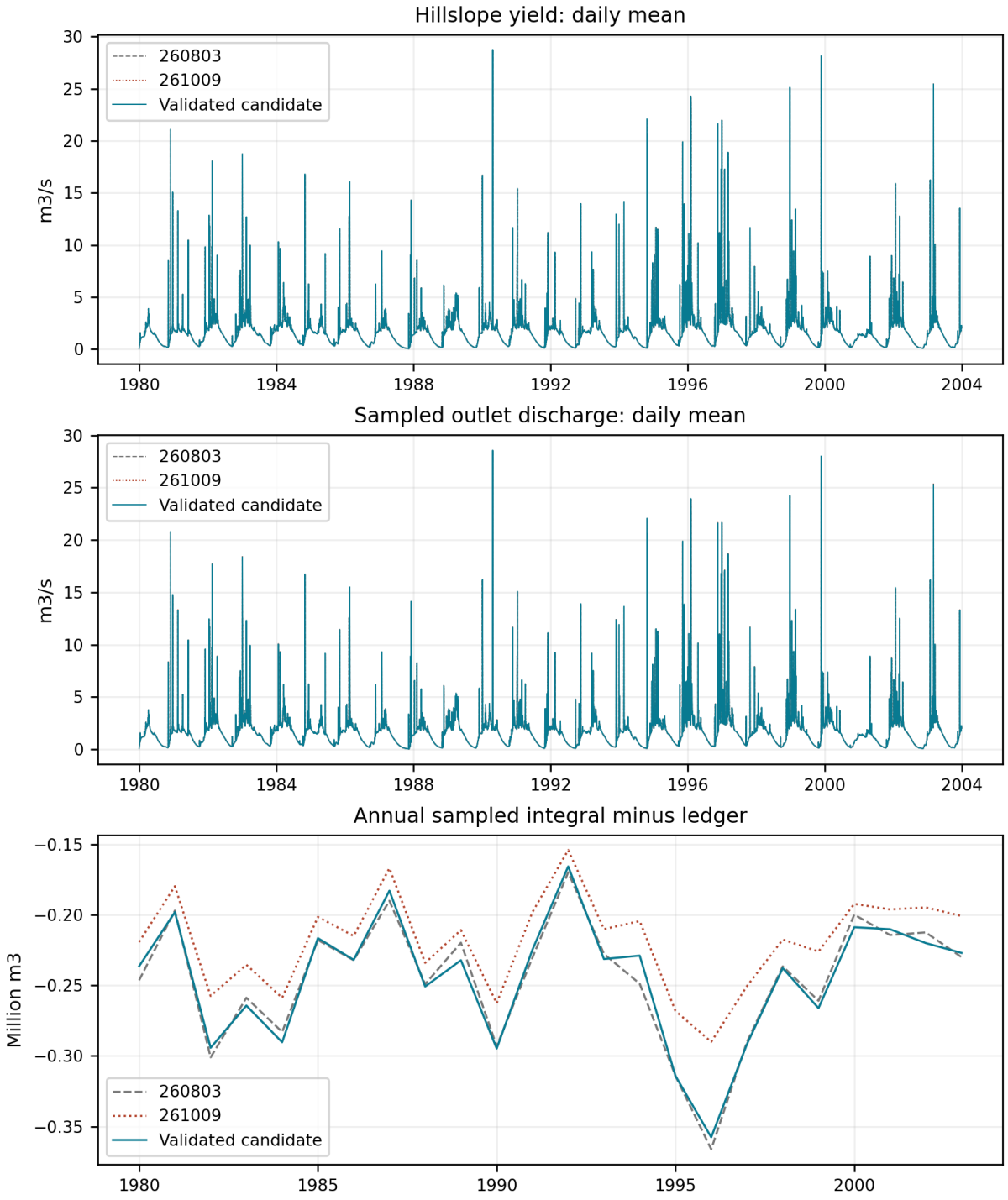


Figure 5: Cedar's complete record. The first two panels are daily means derived from hillslope yield and sampled outlet discharge, respectively; the third shows annual sampled-integral minus ledger volume. Closely overlapping series do not erase the accounting differences tabulated in the text. Original study build labels are retained.

18.2 Events, Recessions and Small Changes

For October 25–30, 1994, sampled volume is +4524.18 m^3 (+0.179%) versus 260803. The sampled peak changes 50.5 to 46.2 $m^3\,s^{-1}$ with unchanged first-peak time; the centroid is 20.82 minutes later. October 28 volume increases only 220.20 m^3 (+0.573%), and its gap improves from -7260.18 to -7172.74 m^3. The earlier large recession enlargement is not reintroduced in this control. The full-window gap is nevertheless worse than 261009's: -17918.33 rather than -10929.95 m^3. Relative to 261009, event volume changes -0.275%, peak -0.2 $m^3\,s^{-1}$ and centroid +0.47 minutes.

The pre-existing screen selects 322 seven-day windows from 260803 daily-mean peaks, using seven-day spacing and 0.1 $m^3\,s^{-1}$ prominence, then retaining three days before and after each peak. These are selection conventions, not new acceptance tolerances or universal storm boundaries. Window-volume changes range -0.154% to +0.619% versus 260803, with centroid shifts -4.38 to +20.78 minutes. Versus 261009, volumes range -0.374% to unchanged and centroids -1.26 to +2.44 minutes.

The retained 1991 small-event window is unchanged. The 1990 and 1998 windows change +0.355% and +0.619% in volume versus 260803, with centroid changes -2.23 and -0.76 minutes. Across all days, the largest baseline-relative absolute daily-volume change is +6720 m^3 on February 7, 1996, from 2,061,960 to 2,068,680 m^3. The largest incremental reduction versus 261009 is 6900 m^3 on February 8, 1996, from 1,959,780 to 1,952,880 m^3.

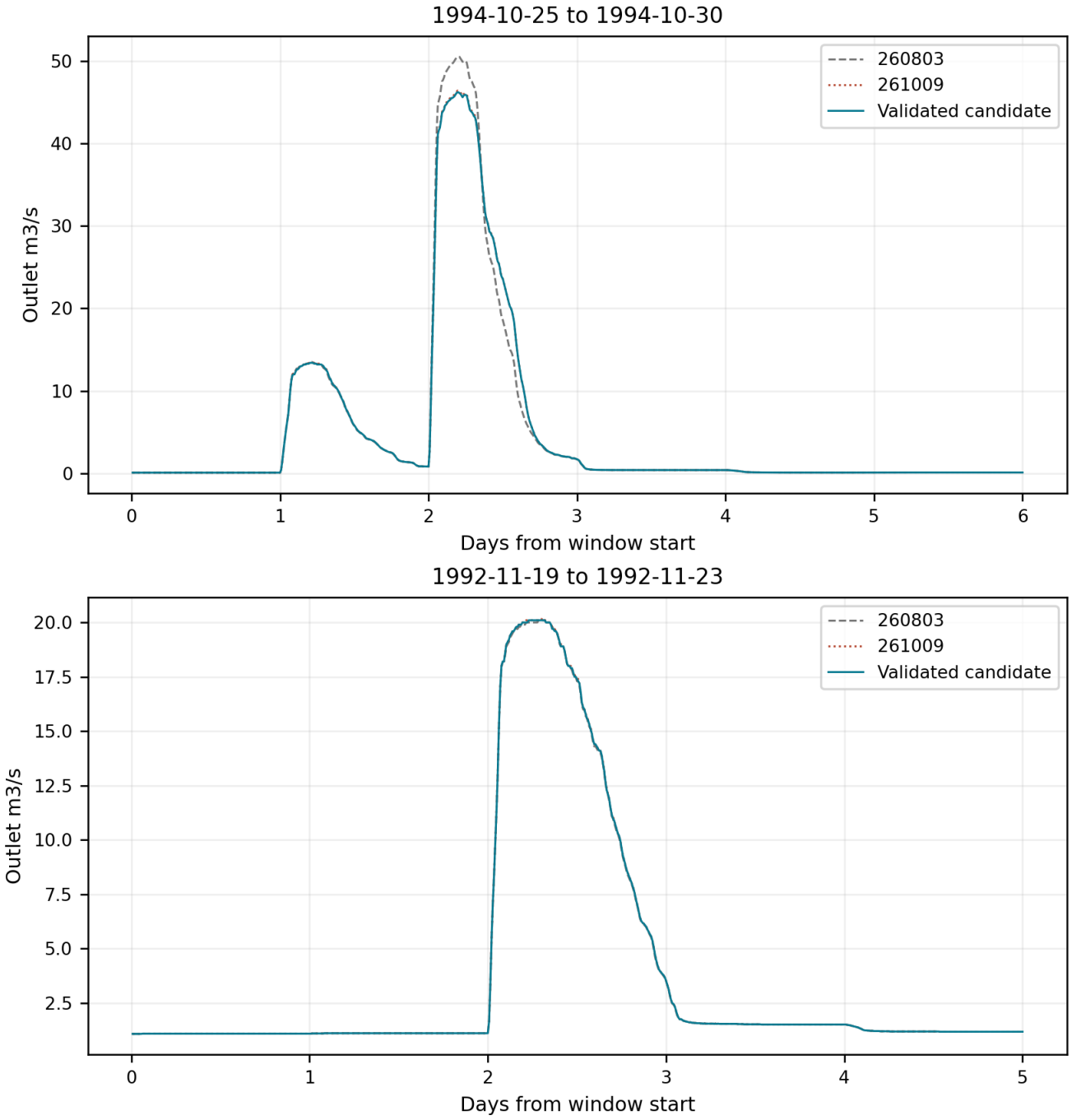


Figure 6: Retained Cedar October 1994 and November 1992 windows. Curves are 600-second output samples, not daily maxima. The comparison includes the complete frozen antecedent record. The selected windows are a consistent diagnostic, not a claim that every panel isolates one complete physical storm.

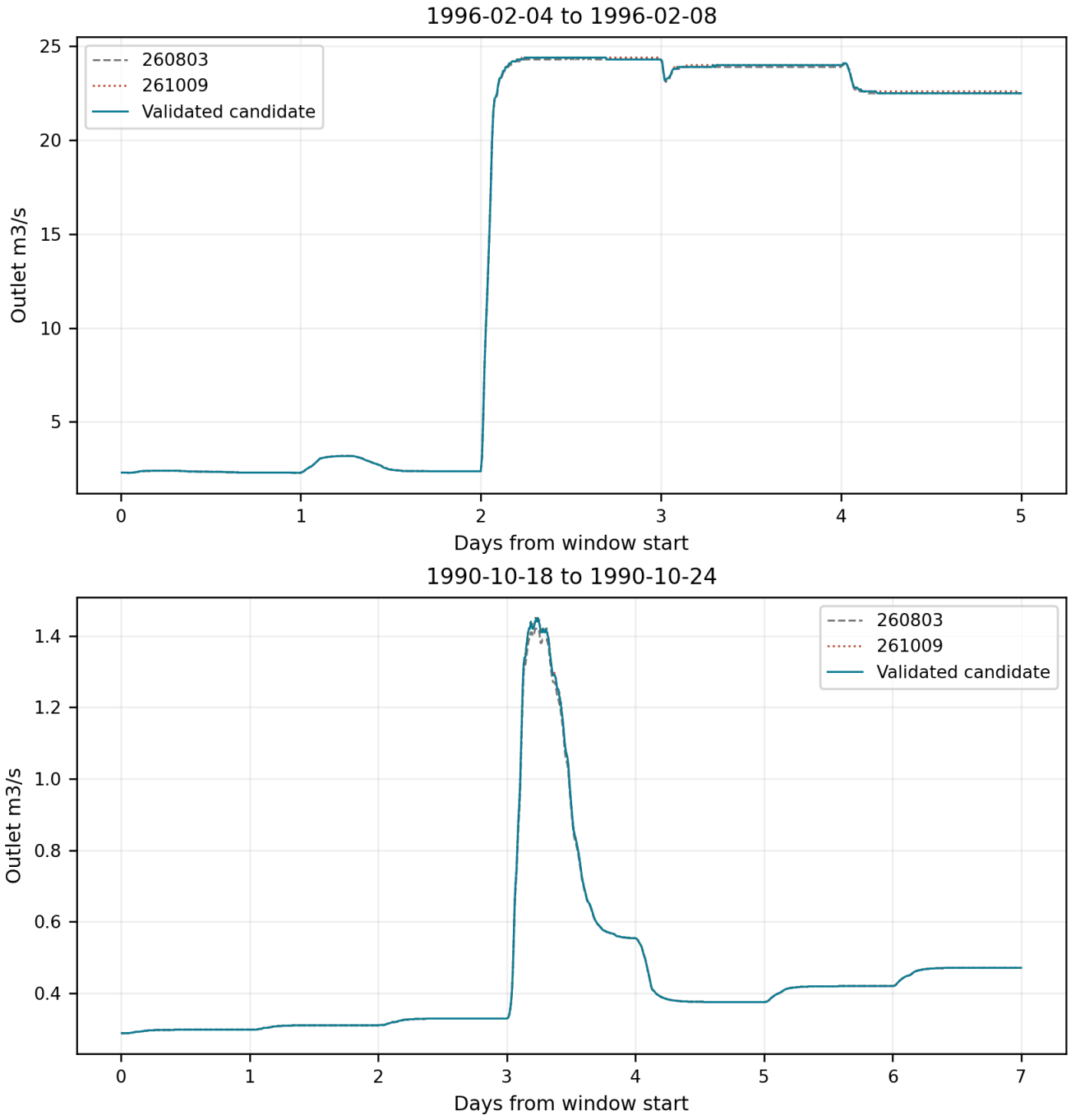


Figure 7: Retained Cedar February 1996 and October 1990 windows. The large event has a broad, rounded crest; the smaller control helps expose changes that full-record water totals alone would not identify.

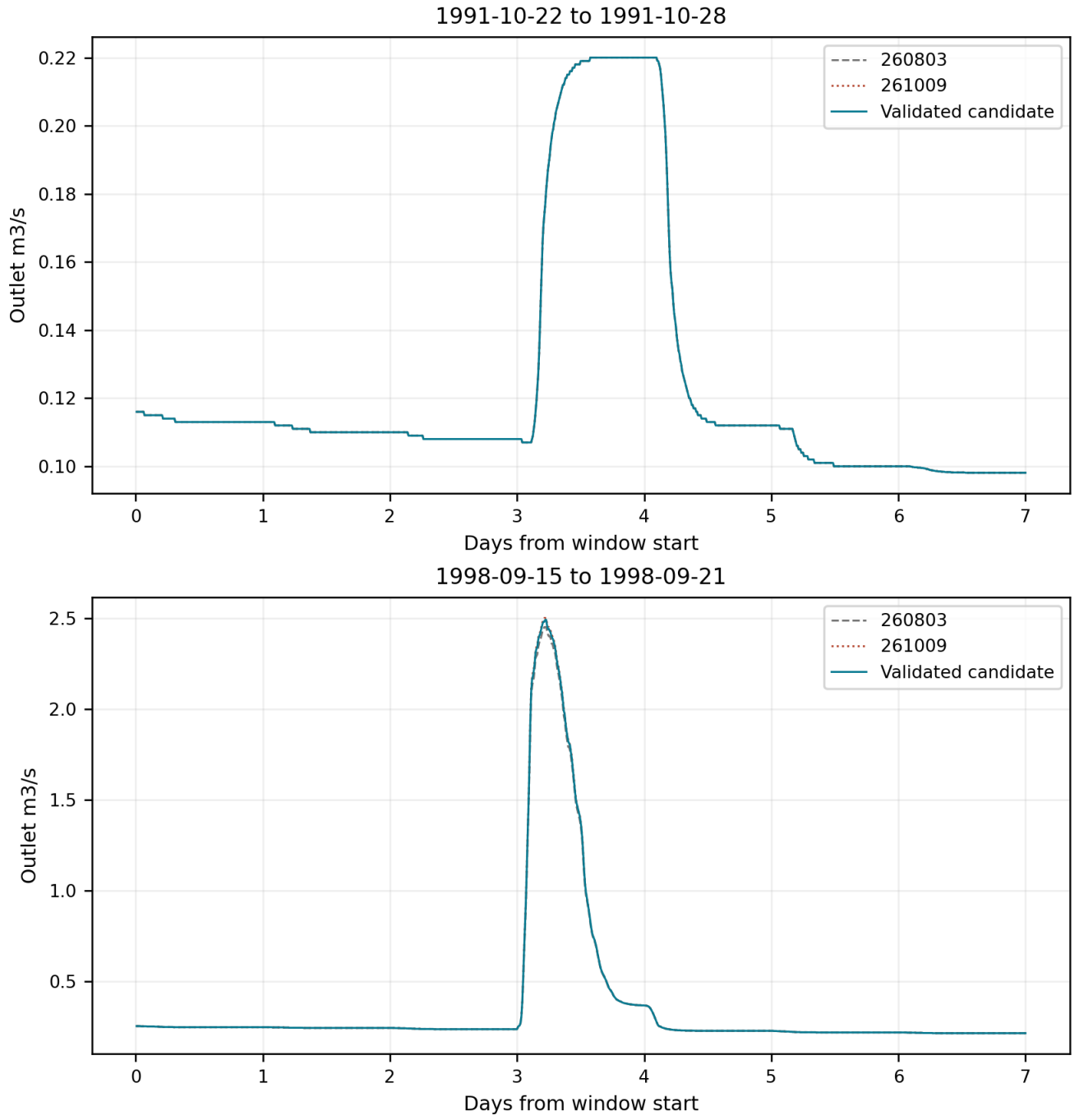


Figure 8: Retained Cedar smaller-event controls. The October 1991 window is unchanged; the September 1998 window retains a small volume and timing difference. Both comparisons use unchanged forcing and parameters.

18.3 Why First-Peak Times Can Mislead

The largest first-maximum shift in the window screen is -1220 minutes versus 260803 in late November 1984, while peak magnitude changes 3.94 to 3.93 $m^3\,s^{-1}$ and the centroid shifts -0.68 minutes. The candidate has equal printed maxima on both November 27 and 28; the baseline's slightly higher maximum occurs on the latter day. This is selection between near-equal crests, not a 20-hour translation of the whole hydrograph.

In the February 1996 retained window, the first maximum moves -320 minutes versus 260803, but the centroid shifts -0.29 minutes. Both printed maxima are 24.4 $m^3\,s^{-1}$; the baseline has 11 tied samples and the candidate 66. The timing audit preserves these facts rather than silently replacing an unfavorable peak-time statistic with a favorable centroid.

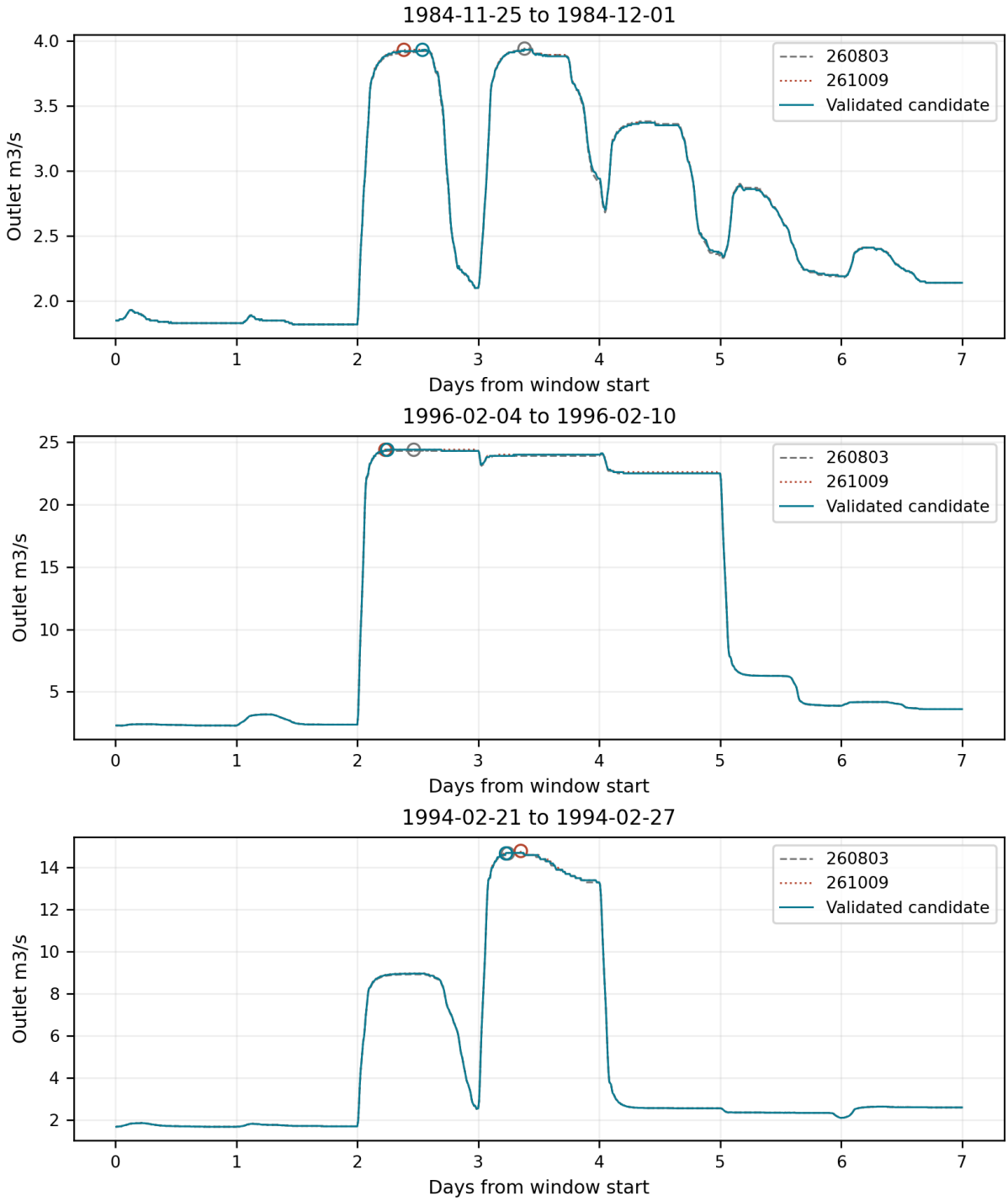


Figure 9: Timing audit. Markers identify the first printed maximum. Small changes to near-equal crests or rounded plateaus can move this selected time without a comparable movement of the whole hydrograph. This ambiguity is reported, not used as a blanket dismissal of timing effects.

At printed precision, 3348 days contain changed samples versus 261009; daily peaks decrease on 1038 days and increase on none. Of 1,262,304 samples, 67,080 decrease and 182 increase, with extremes -0.20 and +0.01 $m^3 s^{-1}$. No new positive sample appears on a previously zero sample. Across 2909 all-OFE dry-weather days, the net volume difference is -1679.04 m^3 versus 260803 and -1701.60 m^3 versus 261009. These counts do not certify the absence of every possible recession-shape change.

Daily-volume NSE/KGE/R^2 versus 260803 are approximately 0.999996/0.999013/0.999997; subdaily NSE is 0.999318. The practical conclusion rests on magnitudes, conditions, the event checks and examined timing ambiguities, not on these fit values alone.

18.4 Final-Release Sediment Readback

The following values were read for this document from the already completed Cedar runs, not from a new simulation. Hillslope delivery and channel erosion are sums of printed annual report fields; outlet export is summed from EBE. The measures have different roles and precision and are not an independently closed sediment budget.[12, 18]

Reported full-record quantity (kg)	260803	261009	Candidate
Hillslope delivery	62336.8	57898.0	57898.0
Channel erosion	442190.7	437916.7	437027.7
Outlet sediment export	202652.51	204130.91	203706.71

The final candidate changes hillslope delivery by -7.12%, reported channel erosion by about -1.17% and outlet export by about +0.52% versus 260803. The earlier +0.73% outlet figure described the 261009/v3 parent and must not be silently assigned to 261010. Identical hillslope delivery versus 261009 does not require identical channel export; source shape and channel sediment history can change. These totals do not settle the independent Rattlesnake event-level consequences in Section 16.

19 Disturbed Rankings and Parameterization Context

The canonical matrix uses four soil textures, four severity states and six vegetation types, including young forest, under one common 100-year synthetic McKenzie Bridge climate and an 87.9 m steep profile. Young, deciduous and mixed forest share generic forest burn templates. The release-build rerun completed 96 simulations plus three completion checks; all 768 output files match the validated candidate.[15]

Across the 24 soil/vegetation combinations, full-record weak ordering unburned $\leq$ low $\leq$ moderate $\leq$ high holds for runoff in 23/24, delivered sediment in 24/24 and largest event peak in 18/24. Exceptions remain: sandy-loam tall grass for runoff, and the four clay-loam forest types plus clay-loam and sandy-loam tall grass for maximum peak. Ranking exceptions are findings, not automatic implementation defects.

The current WEPPpy low-severity forest roughness of 6 cm is a separate parameterization revision, not a hidden binary change or a calibration aid used in Cedar. It replaces 4 cm in a shared template and four extended-lookup rows, aligning low burn with the other burned-forest defaults. The targeted assessment removed 17 sandy-loam low-over-moderate sediment inversions and was adopted as correction of a parameter inconsistency, not a claim that less sediment is inherently worse or better. Existing project-local overrides are not automatically migrated.[16]

The sandy-loam mature-forest sequence retains mean annual runoff of 92.7, 119.8, 121.3 and 376.4 mm and maximum peaks of 0.020084, 0.170380, 0.173370 and 0.313510 $m^3\,s^{-1}$ across the four severity states. This helps set expectations for these inputs; it does not establish universal burn ordering, accuracy under other climates/slopes, or observational sediment skill. Mutation inputs retain their historical frozen roughness, while this matrix uses adopted defaults. The two designs are not interchangeable.

20 Inherited 261021 repairs: water quantities and control volumes

An overland-flow element (OFE) is a segment of a hillslope with its own soil, slope and management. Several OFEs can pass surface and subsurface water downslope before the hillslope delivers water to a channel. A depth printed for one OFE is therefore not automatically an independent contribution to the watershed outlet. The audit first established the spatial basis, time interval and producer of each quantity, then compared the quantities at successive interfaces. The process terminology follows the WEPP hydrology and water-balance documentation; the corrections below are implementation decisions of this fork, rather than new results attributed to that documentation [1, 21].

Let $A_i = w_i \ell_i$ be local OFE area in m^2, and let $A_H = \sum_i A_i$ be hillslope area. For a local daily depth d_i in mm,

$$V_d = 10^{-3} \sum_i A_i d_i, \qquad \overline{d}_H = \frac{\sum_i A_i d_i}{A_H}. \tag{15}$$

This is the correct spatial reduction for precipitation, local soil-water stocks, evapotranspiration components, and deep percolation. An annual flux sums daily volumes; a stock is an endpoint or time average with an explicitly stated meaning, not a sum of daily storage depths. Actual areas are required: rounded descriptions such as "60/40" cannot replace the areas in the model.

Daily evapotranspiration is the sum of plant transpiration, soil evaporation and residue evaporation, $ET_i = E_{p,i} + E_{s,i} + E_{r,i}$. Deep percolation Dp_i leaves the soil column. Where the groundwater option is active, that same volume enters the modeled groundwater reservoir. It must not be counted both as a loss from the combined soil–groundwater domain and again as its later baseflow. Deep seepage from groundwater is a separate external export.

For ordinary constant-width, serial OFEs in this native source, the water-balance writer reports surface runoff using two different denominators:

$$Q_i = 1000\, r_i \frac{L_{\mathrm{eff},i}}{L_{\mathrm{cum},i}}, \qquad QOFE_i = 1000\, r_i \frac{L_{\mathrm{eff},i}}{\ell_i}. \tag{16}$$

Here r_i is the native runoff depth in m and each length is in m. Thus $10^{-3} Q_i A_{\mathrm{cum},i} = 10^{-3} QOFE_i A_i$ for this geometry. These are two representations of the flux crossing the same OFE boundary. Summing either representation over all OFE boundaries double-counts water that continues downslope. The terminal boundary supplies the hillslope export. General contour/variable-width layouts and other executable lineages require their own producer check; column names alone cannot establish this identity.

The terminal lateral depth is expressed on the terminal local area and may already contain upstream lateral water. Multiply it by that area once, then divide by whole-hillslope area only if a whole-hillslope depth is desired. The native PASS writer already performs the depth-to-volume conversion. Within an OFE balance, however, incoming surface water and lateral inflow remain necessary terms. Their cancellation occurs only when adjoining OFE control volumes are combined (Figure 10).

A complete external balance also needs changes in soil liquid, frozen water, snow, interception, groundwater and channel states, plus applicable irrigation, drainage and impoundment terms. Unknown initial stocks were not set to zero. PASS contains selected delivered volumes; event-selection omissions must

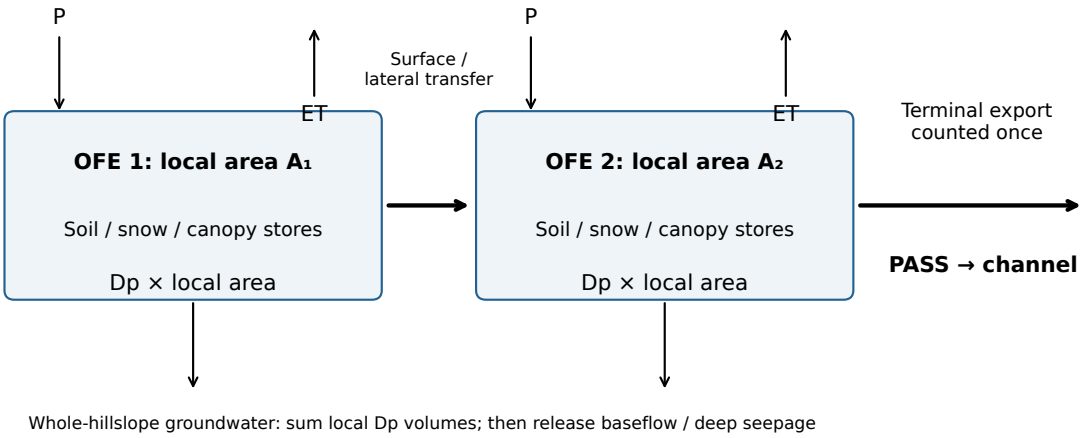


Figure 10: Original accounting diagram. ET and deep percolation use local area; surface and lateral transfers between OFEs are internal to the hillslope. Only the terminal export enters the downstream boundary once. Dp becomes internal recharge when the soil and groundwater are audited together.

be measured separately from transfer errors. Daily printed WAT rows do not identify the internal soil timestep: both daily and hourly calculations produce daily rows. The empty `wepp_ui.txt` marker selects the hourly implementation. The audit exercised both implementations, with single, equal, unequal and three-OFE layouts [22, 23].

20.1 One Gregorian calendar and validated daily streams

RN-261021-01–03. Continuous hillslope execution, master-PASS assembly and watershed execution now use one proleptic Gregorian calendar, including synthetic climate years beginning at 1:

$$\mathrm{leap}(y) = (4 \mid y) \ \wedge \left[(100 \nmid y) \ \vee \ (400 \mid y)\right]. \tag{17}$$

The previous execution loops explicitly added a day at common-century years 100, 200 and 300 even though the climate calendar did not. The extra model iteration consumed the following weather record and could assign subsequent fluxes to the wrong date. Year 400 correctly retains February 29. For years 1–400, the correct count is 146,097 days, rather than 146,100 iterations under the former schedule. Figure 11 shows the deterministic schedule difference; it is not a measured one-day hydraulic travel time.

The climate reader still buffers up to ten daily records, but now records how many complete lines were actually read. End-of-file cannot make untouched buffer slots into valid weather. Every requested continuous day must match the expected year and day. Duplicate, reordered, invalid or incomplete records fail explicitly instead of silently advancing. Blank trailing lines are not weather. CLIGEN-style records must contain complete whitespace-separated numeric fields; Fortran list-directed null, repetition, slash termination and comment syntax are rejected because they can leave fields unassigned despite a successful read. Breakpoint climate headers receive corresponding completeness/date checks.

Both hillslope-to-master and master-to-watershed ASCII PASS headers are checked, including `EVENT`, `SUBEVENT` and `NO EVENT`. Checking only runoff days would leave dry-day misalignment undetected. Single-storm calendar behavior is unchanged. The CLIGEN source was inspected and its Gregorian output checked; CLIGEN was not modified. The separate HBP schema-2 fixed-slot reader investigation is not part of these ASCII component-v3 binaries (RN-261021-16–17).

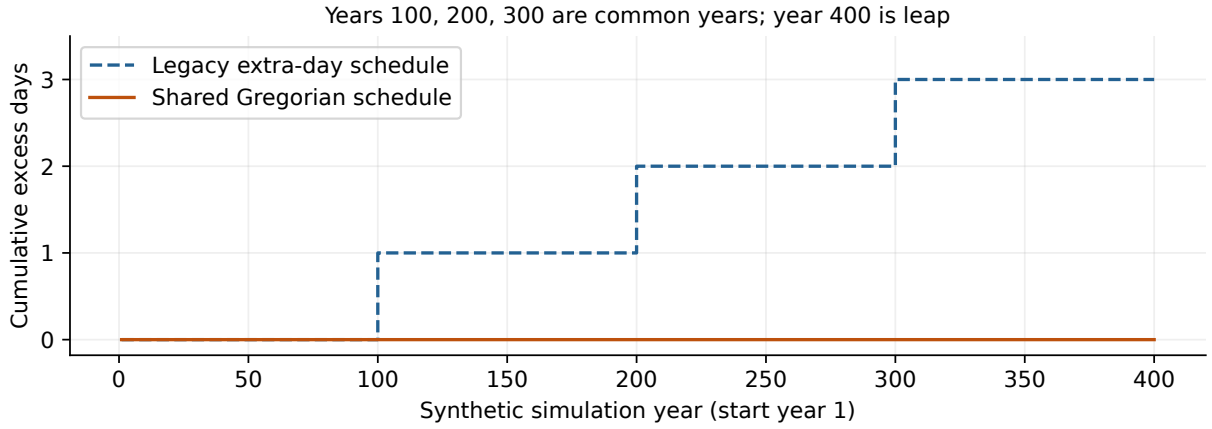


Figure 11: Analytical calendar consequence of the old and revised rules for synthetic years 1–400. The native validation independently completes all 146,097 Gregorian days with matching date keys. The revised line represents zero extra scheduled days; it does not quantify a hydrologic flux difference.

20.2 Whole-hillslope groundwater initialization

RN-261021-04. Initial groundwater depth g_0 in mm is a hillslope quantity. The revised initial volume is $G_0 = 10^{-3} g_0 A_H$ in m^3. Previously it was overwritten while visiting the OFEs and ultimately used the last OFE's area. With nonzero initial groundwater, merely splitting an otherwise equivalent hillslope changed the reservoir inventory.

Initialization now occurs once, at the first OFE on the first simulated day, before recharge accumulation. Prior baseflow/deep-seepage withdrawals and the recharge accumulator are reset there. The established daily recurrence is preserved:

$$R_d = \sum_i A_i Dp_{i,d}^{(\mathrm{m})}, \tag{18}$$

$$G_d = G_{d-1} + R_d - B_{d-1} - D_{d-1}, \tag{19}$$

$$B_d = k_b G_d, \qquad D_d = k_s G_d. \tag{20}$$

G_d is the daily pre-withdrawal reservoir coordinate, R_d recharge, B_d baseflow and D_d deep seepage, all in m^3; k_b, k_s are the configured fractions per daily update. The prior-day withdrawal convention has not been replaced by a same-day recurrence. An ordinary new calendar year does not reinitialize the reservoir.

For 10,000 m^2, $g_0 = 100$ mm, $k_b = 0.04$ and zero first-day recharge, the correct first baseflow is 40 m^3 for every partition. Native legacy probes returned 16 m^3 for a 60/40 split and 20 m^3 for a 20/30/50 split (Figure 12). Zero-initial-storage controls and unchanged soil WAT outputs isolate this initialization correction from a change to percolation physics.

20.3 Bounded allocation of signed hourly infiltration

RN-261021-05. An hourly signed input f in m must be assigned to actual layer liquid stores before existing percolation. The old traversal stopped when the remaining magnitude fell below 10^{-5} m. For a three-layer 0.3 m tilled profile, an input of 10^{-6} m assigned only about $3.33333332 \times 10^{-7}$ m to storage. Repeating that decision over hours loses the remainder independently of the later ET or Dp equations.

Positive input retains the existing tilled-layer weights. Traversal is bounded by the number of soil layers, and the last eligible layer receives the complete remainder before percolation. There is no new

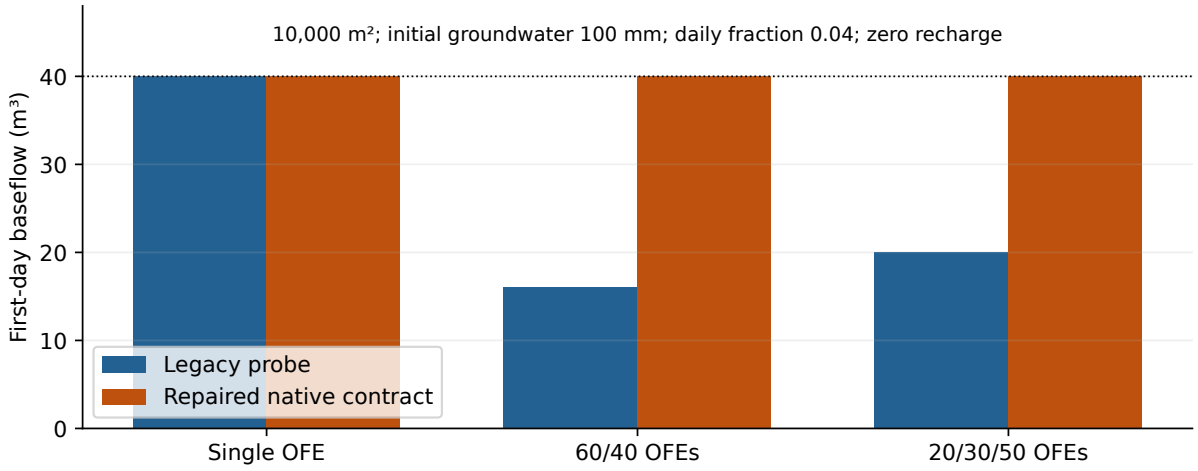


Figure 12: Native groundwater initialization controls. Legacy first-day baseflow depends on terminal-OFE area. The revised native tests recover the same 40 m^3 for all three layouts, with the same total area, initial depth, release fraction and zero recharge. Bars are rounded to the displayed precision.

runoff conversion or evaporation correction. For negative input, the demand $W = -f$ is compared with original available liquid:

$$A_\ell = \sum_{j=1}^{N_\ell} \max(S_j, 0), \qquad W \le A_\ell. \tag{21}$$

S_j is the native liquid store in layer j, expressed as an equivalent depth in m; frozen water is not made available by this calculation. Each weighted withdrawal is bounded by the remaining liquid in that layer. A second bounded top-down pass uses liquid left in earlier layers if the first pass could not place the full demand. A single proportional pass was rejected because it can leave feasible demand unassigned while earlier layers remain wet.

The original binary32 stores and demand are promoted to binary64 for inventory comparison and working allocation, then final stores are cast once. Exact inventory exhaustion empties the eligible stores explicitly. This prevents a binary32 subtraction remainder, such as -4.66×10^{-10} m after removing 0.03 m from three 0.01 m layers, from being interpreted as a genuine shortage. No tolerance fitted to that example is used. An actually excessive withdrawal or nonzero final unallocated remainder fails with day/OFE/hour context. This failure is an explicit unsupported state, not an instruction to reduce the upstream physical flux silently.

Final conversion still has ordinary finite-precision error. The independent stress audit bounded it by final-store half-ULPs and a conservative binary64 operation-count bound. All 3,473 feasible heterogeneous profiles completed with nonnegative stores and zero unallocated remainder; the largest storage change residual was 3.8932×10^{-9} m. These allocation results do not establish that a later channel can supply every daily soil-derived sink.

20.4 Flat hydrograph cells conserve the selected source volume

RN-261021-06; inherited normalization RN-261021-18. CHRQIN reconstructs hillslope surface delivery from selected volume V in m^3, supplied peak q_p in $m^3\ s^{-1}$ and duration T in s. The flat branch is selected when the volume reaches or exceeds the supplied peak–duration product, subject to the existing branch comparison. The old rule added q_p only at endpoints inside T. It both lost fractional final cells and failed when $V \neq q_p T$.

The revised flat source preserves V and supplied support $[0, T]$:

$$q_f = V/T, \qquad \overline{q}_n = \frac{q_f}{\Delta t} \max[0, \min(n\Delta t, T) - (n-1)\Delta t], \quad n \geq 1. \tag{22}$$

Thus $\Delta t \sum_{n=1}^{N} \overline{q}_n = V$ apart from representation rounding, even if $T < \Delta t$. The recalculated flat rate can exceed the supplied peak: that is the stated resolution of an inconsistent flat volume/peak/duration triple, not a newly calculated hydrologic peak. Extending duration would instead alter the supplied temporal support and was not chosen. Rate and overlap endpoints use binary64, with one cast when each cell mean is added. Forming each endpoint independently avoids repeated binary32 subtraction error on non-divisor grids.

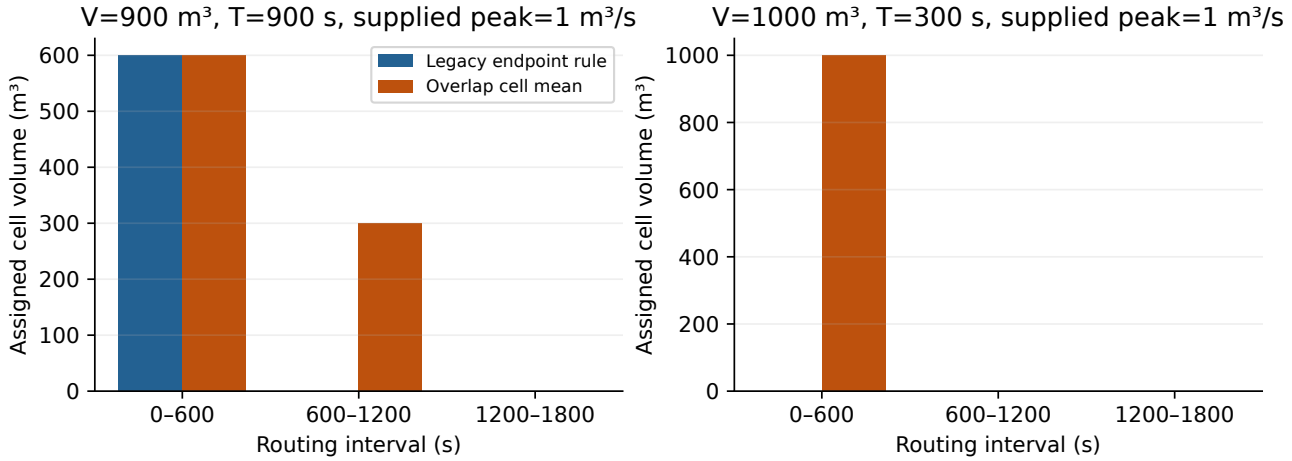


Figure 13: Analytical illustrations of the source-cell repair at 600 s resolution, using configurations covered by native regression controls. A 900 s event loses its final half-cell under endpoint selection. A 300 s event lies entirely inside the first routing cell and previously supplies no positive-time sample. The overlap rule preserves each declared volume. These bars are source-cell volumes, not a claim about the downstream MC point-value quadrature.

Reconstructed rainfall or untyped source volume above the existing negligible-volume threshold requires finite $0 < T \leq 86{,}400$ s; invalid duration fails before division. The physical day, rather than a rounded $N\Delta t$, defines the upper limit. Index zero supplies an initial boundary value and does not add a source-cell volume. Continuing days preserve their established endpoint carry. Separate return-flow support and the existing exponential reconstruction remain unchanged. The earlier 261010 exponential sample normalization is the baseline, not a new change in this reissue.

20.5 Local water and deferred baseflow enter the intended channel

RN-261021-08–09. A channel's lateral source combines side-hillslope surface delivery, lateral subsurface delivery, admitted baseflow and local channel exchange. With the convention that positive transmission T_c removes channel water into the soil, its daily net local term is $V_{\text{local}} - T_c$. Negative transmission can represent water released by the channel soil process; its sign is not, by itself, an input error.

The old positive-source branch could depend on a side-hillslope surface hydrograph even when no such hydrograph existed. Positive local water was then absent from the rate array. The correction extends the existing uniform non-surface representation to that case, provided neither side impoundment supplies positive volume. A daily net amount V_L is represented by $V_L/86{,}400$ m^3 s^{-1} before division by channel

length. The latter division changes the lateral-rate units to $m^2\ s^{-1}$ for spatial routing. Positive side-surface reconstruction is retained, so mixed local water can still inherit side-hillslope timing. Positive impoundment release timing is explicitly excluded from this new eligibility condition.

WSHCQI already defers groundwater below the configured contributing-area threshold and admits it at the first qualifying channel. WSHCHR now adds exactly that admitted deferred volume to the top rate array as a uniform daily rate. It does not add all upstream baseflow again: groundwater already present in routed upstream discharge is not a new source. The former separate initial-outlet addition was removed because the same volume is now present in the initial inlet. Native first-day 100 m^3 baseflow controls and 100→0→200 m^3 sequences verify initialization and endpoint carry; three-channel threshold controls verify admission once. These source fixes apply to the existing KW3 and MC4/5 assembly paths without replacing their routing equations.

20.6 Live interior state and a usable MC4 recession reference

RN-261021-07. A dry inlet and dry previous outlet do not imply an empty channel. The former MC execution guard could skip a step while interior nodal discharge remained nonzero, leaving the next profile at initialized zero. The revised guard also checks the complete retained interior. It runs the unchanged recurrence for nonzero state, including negative or subnormal values; it introduces no small-state deletion threshold.

RN-261021-11–12. MC4 normally selects a reference discharge before restoring the previous interior profile. When the boundary-derived reference falls into the existing $q_{\mathrm{ref}} \le 10^{-8}\ m^3\ s^{-1}$ branch, the selected $K = X = 0$ gives recurrence coefficients $(1, 1, -1)$. With zero forcing, spatial induction gives $q_j^n = -q_j^{n-1}$: an even number of daily steps restores the same profile indefinitely rather than transporting it.

Only MC4 now reuses its last valid positive reference when the ordinary reference is degenerate *and* retained interior state is live. The cache is per channel, reset at simulation initialization, and is not overwritten by a degenerate reference. A read-only state query occurs before grid selection. Ordinary positive-reference selection, no-history cases, MC5 and KW3 are unchanged. Deriving a new reference from interior amplitude was rejected as a broader, unnecessary coordinate change in the controlled recession.

Even with a valid reference, finite-precision recurrence can reach a tiny fixed profile. At native 60 s resolution, one measured recession retained $2.8025969 \times 10^{-45}\ m^3\ s^{-1}$ at all 101 nodes. Rather than deleting that state, an MC4-only optimization copies future states after proving an exact fixed point: all remaining inlet/lateral forcing is bitwise constant, two consecutive complete raw profiles are bitwise identical, and the accepted outlet values used by the execution guard are also bitwise identical. With fixed daily coefficients, the next deterministic step has identical inputs; induction establishes the repeated result. Signed zero and subnormals are preserved by bit comparisons, not numeric equality. MC5 is excluded because its coefficients can vary during the day. A future forcing change prevents early copying.

20.7 Publish and transfer the accepted MC outlet integral

RN-261021-10. MC routing produces raw nodal discharge and an accepted outlet series Q_n after the existing small/negative-rate clipping rule. The old daily outlet volume was separately inferred from a geometric storage balance, then the reported ending storage was adjusted to close that balance. It could disagree with the discharge series actually passed downstream.

For MC4/5, the daily volume now uses the accepted full-precision outlet array:

$$V_{\text{out}} = \Delta t \left[\sum_{n=1}^{N} Q_n + \tfrac{1}{2}(Q_0 - Q_N) \right]. \tag{23}$$

The accumulation is binary64 before the final native storage conversion. This volume supplies the channel report, daily runoff volume and downstream volume transfer. The initial endpoint participates in peak metadata as well. A case with positive Q_0 and zero subsequent rates therefore has a positive half-step integral rather than zero reported export. Unlike a source-cell sum, this trapezoid legitimately includes the initial endpoint.

The existing Manning-derived geometric storage remains independently calculated. It is not replaced by a residual-derived store, so the printed geometric balance may no longer be zero. KW3 retains its previous publication convention. Public columns and units are unchanged, but MC volumes and balance residuals have changed meaning in this precise respect. Rate/volume consistency does not certify source availability or undo clipping.

20.8 Receiving-channel working variables have local lifetimes

RN-261021-21. Channel output arrays indexed by watershed element can overlap slots subsequently used as channel-plane working arrays. A completed upstream channel could therefore leave a positive runoff value in the next channel's working slot. On a dry day the rainfall-excess routine was skipped, allowing that inherited value to alter the receiving soil's infiltration. Similarly, a wet day with no local rainfall excess could retain another channel's local-runoff value and publish a fictitious local source.

WSHDRV now initializes the receiving plane's `runoff` and `chnrun` immediately after WSHCQI has consumed preserved element transfers, and before optional WSHIRS and soil water balance. No soil store or MC state is reset. The existing wet-event and surface-return gates remain in force; final output restoration still uses its preserved element results. Real local runoff is recomputed normally. The location states the ownership boundary explicitly: WSHCQI uses preserved element-transfer arrays, not these two scratch fields, and the subsequent local runoff/soil operations own their new values. Resetting them after those operations would erase a newly calculated local result.

These corrections can alter runoff hydraulics and the water supplied to erosion and sediment transport, even though no detachment, transport-capacity or deposition formula is changed [2]. Likewise, corrected soil inputs can change later ET and Dp without changing their process equations. No blanket sediment, nutrient, snow or impoundment parity is inferred from water-only controls; quantitative evidence and limits follow below.

21 Historical 261010 limitations and gates

The release is a bounded repair with a deliberately limited claim. It corrects two demonstrated implementation mechanisms and provides a workable interface for the hourly physical estimator. It does not establish exact mixed-flow timing, universal numerical conservation or observational validity for all hydrological and sediment quantities.

1. **Hourly means do not resolve subhourly return peaks.** Coincidence of rainfall and return maxima is assumed in the physical estimator. Its scope does not extend by assertion to multi-OFE or contoured producers.

2. **Return forcing is intentionally coarser than its input weights.** V3 uses their equivalent support, not their within-day positions. The support starts on a computational clock. It is neither a recovered mixed hydrograph nor an additional hillslope routing calculation.

3. **Local assembly and downstream integration differ.** The legacy lateral point-mode operator can average adjacent source ordinates even when return assembly supplies interval means. Earlier native probes showed 3300 of a 3600 m^3 last-hour source before midnight and 300 m^3 in the next first interval under that interpretation; a cold-start first-hour example gave 3900 m^3. These were controlled source-operator diagnostics, not Cedar water-loss estimates. No global mode switch was bundled to remove them.

4. **Short-support and flat-branch defects are not comprehensively repaired.** Fixing the normalization denominator does not make every supplied peak/volume/duration combination simultaneously attainable on a finite grid. The regression set explicitly retains an existing substep flat-source limit.

5. **State transfer is not storage normalization.** Equal-grid profile retention is exact for saved nodal discharge; changed-grid interpolation is bounded but does not prove exact water storage conservation.

6. **Sediment response remains nonlinear and incompletely explained.** The large Rattlesnake event changes require visibility in application decisions. The release decision does not establish that their absolute magnitudes are observationally correct or merely shifts between adjacent storms.

7. **Validation coverage is finite.** Three watersheds, targeted controls, one canonical soil/cover matrix and a mutation census do not cover all channel geometries, forcing resolutions, managements, coupled chemistry or impoundment behavior. The report does not claim such coverage.

The practical standard is not served by retaining known source inflation to improve an unrelated aggregate discrepancy, nor by using a favorable aggregate fit to dismiss a consequential event. Roger's promotion decision followed the recorded studies. Future contradictory evidence should trigger a focused reassessment with the original results preserved, not undocumented calibration or cumulative patches to obtain an attractive metric.[17]

22 Historical 261010 artifacts and operating record

The dated pair is `wepp_261010` and `wepp_261010_hill`. Both were built with system gfortran 13.3 from source `7471bb5e9` on the verified default branch, `wepp_260430_negmeltfix_comparator`. The source-state decision is distinct from the subsequent artifact/documentation commit. Full identities appear in Appendix D. The original runtime banner is retained; it is not the sole way to identify a dated build.

The build links MIXPEAK, component transport/assembly and CHRSTATE into both executables. Watershed and hillslope builds are performed sequentially because their build rules select shared include profiles. An earlier concurrent mixed-profile attempt produced an invalid watershed capacity profile and was rejected; it is not hydrological evidence. Capacity includes were restored and verified without a capacity-contract change.

The existing paired native reader supports component v3 and retains public Parquet schemas. The reader/composition implementation is associated with source `c3d8481d1c7d`; the binary sidecars pin its

packaged artifact identity. No additional native-reader algorithm change accompanies the final CHRQIN normalization edit.

22.1 Historical 261010 selection instructions

The never-deployed 261009 binary pair and sidecars were removed from WEPPpy at Roger's request; historical results and Forest release artifacts remain identified as 261009. A local project that explicitly selects that removed name was instructed at that time to select 261010 and regenerate every contributing hillslope PASS with the matching build. There is no hidden alias, cross-release PASS swap or automatic project migration. Roads and AgFields combinations require matching versions and component-preserving native composition.

General project defaults were not switched by this vendoring action, and no production deployment was performed. Changing a binary selection does not automatically rewrite project-local management/soil overrides. Users adopting the independent low-burn roughness revision must review regenerated inputs separately from the binary change.

22.2 Source and Documentation Publication

This document explains legacy implementation details through prose, equations and interface descriptions. Such explanations and original code we author are explicitly allowed under the release-note authoring policy. It does not embed legacy source, mixed-origin diffs or raw source attachments. The Python listing is independently authored for this report and is clearly illustrative.

The original 261010 report was approved and published separately. Its publication and gate history below is retained as historical evidence, not as certification of the current build. Current 261026 gates and identities appear in the opening update. The 261021 flat-source correction supersedes the historical short-flat limitation above; signed exchange and clipping remain unresolved.

23 Quality Gates and Reproducibility

Required gates use committed inputs or reproducibly generated outputs from committed inputs. Private project directories are supplementary scientific evidence, not prerequisites that a new checkout cannot satisfy. Historical replay gates requiring retired private resources remain retired.

Check	Recorded release result
Maintained Forest suite	163 passed
Committed-resource hillslope watchlist	12/12 passed
Forest host smokes and runtime provenance	Both executables passed
Post-vendor host/container smokes and provenance	Both executables passed
WEPPpy runner/output/interchange	114 passed; one existing skip
Fresh 261010 disturbed matrix	99 passed, including 96 simulations
Report freshness, route coefficients, Usersum rendering	63 passed
Artifact policy and scoped documentation checks	Passed

The native sample-normalization regression failed in six targeted cases before the fix; the combined focused source/return/state checks passed afterward. The complete maintained suite includes those checks. Default pytest discovery now targets `tests/`; otherwise archived research modules introduced

duplicate names and missing research dependencies during collection. No maintained numerical test was excluded or weakened to obtain a pass.

Supplementary exact-release validation regenerated 140 hills for the full 1980–2024 period. Plain, Roads additive and AgFields weighted watershed cases completed all 45 years. Native hillslope conversion accepted 2,301,180 records with zero rejection. Doubling a selected source through additive composition doubled its supplied volume from 195011.111 to 390022.222 m^3; the 0.3/0.7 weighted composition retained 195011.111 m^3. These are interface controls, not calibrated disturbed or Roads scenario predictions.

Incomplete checks remain distinguishable from successful ones. An optional additional committed-fixture watershed could not start because three required topology/channel/impoundment files were absent; 301 hillslope runs had completed. That attempt is unavailable, not passed, and no private substitute or invented topology was introduced. One WEPPpy interchange test skips because its static PASS dataset is absent. The full unrelated WEPPpy suite was not run for this handoff. Early command/environment failures and an analysis-only column-name error were corrected and retained separately from valid results.[17]

The figures and tables in this report identify their actual study cohort and baseline. They are not newly simulated outputs. The report's retained input inventory records data and figure identities; local raw project data may be needed to reproduce the studies, but not to compile this self-contained document or understand its reported conclusions.

A Symbols, Units and Interface Semantics

Symbol/field	Units	Meaning and caution
R, S, R_r	m	Final runoff, return and non-return depths on one area basis.
p_r, p_s, p	$m\,s^{-1}$	Rainfall, maximum hourly return and combined physical depth-rate peaks before legacy final bookkeeping.
V_r, V_s	m^3	Serialized component volumes.
V_c	m^3	Surface volume allocated by the watershed caller to this source.
Q_r^I	$m^3\,s^{-1}$	Rainfall-only interface operand after existing floor/cap conventions; not necessarily the reconstructed sampled maximum.
w_h	relative	Twenty-four finite nonnegative return weights; common scale cancels in the v3 support ratio. Hour positions are not v3 forcing times.
D_{eff}	s	Equivalent runoff/peak duration used in erosion bookkeeping.
T_r, T_s	s	Existing rainfall support and local return-only support, respectively. Neither alone establishes actual event timing.
`tcs`	h	Existing concentration-time scalar; may change indirectly with hydraulics although its formula is unchanged.
`oalpha`	dimensionless	Existing ratio involving concentration time, peak, area and volume, with its legacy minimum bound.
`nt0`	index	Caller initialization convention. Zero includes a time-zero boundary; one starts at the first positive-time sample.

Symbol/field	Units	Meaning and caution
`qs` profile	$m^3\,s^{-1}$	Channel nodal discharge state, not a new stored hillslope-return volume.
G_d	m^3	Sampled outlet integral minus the reported daily outlet ledger. A signed sum can hide cancellation; also inspect absolute daily gaps.

B Descriptive Fit Metrics

For reference series x_i and candidate series y_i, the retained analysis uses the following familiar definitions, with r the Pearson correlation:

$$\mathrm{NSE} = 1 - \frac{\sum_i (y_i - x_i)^2}{\sum_i (x_i - \bar{x})^2}, \tag{24}$$

$$\alpha = \sigma_y/\sigma_x, \qquad \beta = \bar{y}/\bar{x}, \tag{25}$$

$$\mathrm{KGE}_{2009} = 1 - \sqrt{(r-1)^2 + (\alpha-1)^2 + (\beta-1)^2}, \qquad R^2 = r^2. \tag{26}$$

Undefined constant/zero-reference cases require explicit handling, not a fabricated perfect score. The reference here is normally another model run, not observed discharge. Correlation, variability and mean agreement are different properties, and their aggregate combination does not replace event-level examination.[4, 5]

C Implementation Coverage

The complete net non-binary `src/` difference between the identified 260803 and 261010 source states is mapped below. The internal audit also accounts for tests, tools, documentation and retained release artifacts. Source paths are identifiers, not links exposing restricted code.

Component	Change IDs	Responsibility
`mixpeak.for`	RN-01, RN-02	Physical component peaks, rainfall-only call/state isolation, interface operand and reset helper.
`irs.for`	RN-01, RN-02	Eligibility, producer invocation and physical peak replacement before retained duration/reassignment behavior.
`cmixprod.inc`	RN-02	Current-event producer state.
`contin.for`	RN-02	Daily reset and hydraulic observations.
`inidat.for`	RN-02, RN-03	Producer/consumer initialization.
`mixpass.for`	RN-03, RN-04	Headers, validation, serialization, master records, daily clear and bounded return assembly.
`cmixsrc.inc`	RN-03	Current-day source operands and flags.
`infile.for`	RN-03	Master header interpretation.
`wshpas.for`	RN-03	Extended hill/master writers and ingestion, plus derived-scalar observations.

Component	Change IDs	Responsibility
`wshred.for`	RN-03	Daily clear and master source consumption.
`chrqin.for`	RN-04, RN-06	Component allocation, rainfall/source selection, return call and corrected normalization.
`chrstate.for`	RN-05	Saved channel profile and bounded grid transfer.
`wshchr.for`	RN-05	Restore/save calls around existing routing.
`makefile`	RN-08	Matching linkage in watershed and hill executables.

The immediate 261009-to-261010 model delta is confined to RN-06. Companion RN-07/RN-10 changes belong to the reader/WEPPpy integration and parameterization records, not additional undisclosed Fortran files. RN-09 accounts for captured regressions, observer tests, resource/discovery policy and documentation. Historical artifact retention is not a claim that every experimental binary or patch is part of the selected release.

D Release Identity and Evidence Index

Selected model source

`7471bb5e981d14d0b8c1cdb88a16af305aed1b67`

Watershed executable SHA256

`1dd1ca75cf53f9a0606cf5a598312d4e680e161df631156360d4a20dbcb6f17e`

Hillslope executable SHA256

`d8ea3a07a29ef1e754c5362bd7931cc3a93486d75faa32df5c5f2e821c22d698`

Paired native reader artifact SHA256

`06319303a2337cc75a3c57eb594161565d8a2af1d58cee18c17abcfe6eea8cf8`

Paired native reader source

`c3d8481d1c7dcaf59dceb37d9ea2e860b89f4307`

Studied candidate watershed SHA256

`0eb062812786064b230091ac0144f7502bc225964ea982dd76ebfc68abc6b76d`

Studied candidate hillslope SHA256

`219be50ac94a7ffa01589eb22251586caea53d5e856f7af0feaea2c12fa6433a`

Common normalized watershed SHA256

`d3b5fb0fb75fa1fbe0777e234388404239dcfd0b88dea09f2c7172a139a59df5`

Common normalized hillslope SHA256

`5a65377c5f923de3d0fbb9db4e608408fe06f159f6a874f57afafa4c75ceab89`

The studies distinguish original candidate hashes from packaged release hashes. Binary equivalence excludes debug data and GNU build identity only, not runtime code or data. These are historical 261010 identities. The current 261026 identities appear in the opening update, and its PDF and authoring inputs are frozen separately from the model artifacts.

The project evidence references below identify retained records rather than claiming public availability

of private source or raw project data. The report contains the principal equations, tables, figures, interpretation and limits needed to understand the release without opening those repositories. No source-code attachment is embedded in the PDF.

References

[1] Stone, J.J., Lane, L.J., Shirley, E.D., and Hernandez, M. (1995). Hillslope Surface Hydrology. Chapter 4 in *USDA–Water Erosion Prediction Project: Hillslope Profile and Watershed Model Documentation*, NSERL Report 10. `https://www.ars.usda.gov/ARSUserFiles/50201000/WEPP/chap4.pdf`.

[2] Foster, G.R., Flanagan, D.C., Nearing, M.A., Lane, L.J., Risse, L.M., and Finkner, S.C. (1995). Hillslope Erosion Component. Chapter 11 in *USDA–Water Erosion Prediction Project: Hillslope Profile and Watershed Model Documentation*, NSERL Report 10. `https://www.ars.usda.gov/ARSUserFiles/50201000/WEPP/chap11.pdf`.

[3] Wang, L., Wu, J.Q., Elliot, W.J., Dun, S., Lapin, S., Fiedler, F.R., and Flanagan, D.C. (2010). Implementation of channel-routing routines in the Water Erosion Prediction Project (WEPP) model. *SIAM Mathematics for Industry: Challenges and Frontiers (MI09)*, pp. 120–127. `https://research.fs.usda.gov/treesearch/40457`.

[4] Nash, J.E., and Sutcliffe, J.V. (1970). River flow forecasting through conceptual models, Part I: A discussion of principles. *Journal of Hydrology*, 10(3), 282–290. `https://doi.org/10.1016/0022-1694(70)90255-6`.

[5] Gupta, H.V., Kling, H., Yilmaz, K.K., and Martinez, G.F. (2009). Decomposition of the mean squared error and NSE performance criteria: Implications for improving hydrological modelling. *Journal of Hydrology*, 377(1–2), 80–91. `https://doi.org/10.1016/j.jhydrol.2009.08.003`.

[6] WEPP Forest project record (2026-10-10). Shipped-source audit, 260803 source `f24c957e3` to 261010 source `7471bb5e9`; source/component tests and release-sidecar identities. Internal implementation evidence; legacy source not reproduced in this document.

[7] WEPP Forest project record (2026-10-08, with subsequent promotion decisions). *Return support feasibility contract* and *Return-support v3 feasibility result*. Native source controls, H106 reproductions, matching-build watershed and interface evidence. Historical experiment status is superseded by the documented release decision, not by alteration of the retained measurements.

[8] WEPP Forest project record (2026-10-08). *Hourly routing: midnight diagnosis and implementation results*. Native 48-hour restart, grid-transfer and source-operator diagnostics; no claim of universal storage conservation.

[9] WEPP Forest project record (2026-10-08). *Return alternatives assessment*. Eligible Cedar return population, hourly timing/scheduling evidence and bounded source-rule alternatives.

[10] WEPPpy/wepppyo3 project records (2026-10-09–10). *PASS components v3 release compatibility* and *PASS components v3 integration*. Native reader/composition contracts and generated plain/Roads/AgFields evidence.

[11] WEPPpy project records (2026-10-10). *Mechanism Located: CHRQIN Sample Normalization* and *CHRQIN Normalization Candidate Results*. Retained Topanga/Rattlesnake source probes, observer-neutrality checks, paired outputs, event/annual statistics and limitation records.

[12] WEPPpy project record (2026-10-10). *Cedar Hillslope Yield and Channel Discharge*. Fresh paired 24-year simulations, totalwatsed conversion, sampled outlet series, ledgers, event/timing audits and provenance.

[13] Lew, R. (2026). *Small-Mutation Screening of WEPP Hillslope Peak Flow: Remediation Strategies and Validation Findings*. Version 0.2, October 6, 2026. University of Idaho; prepared with agentic coauthor support from OpenAI Codex. Companion investigation covering the original census and earlier remediation evidence, not final 261010 validation. Download the companion investigation report (PDF).

[14] WEPPpy project record (2026-10-10). *Candidate Mutation and Disturbed Ranking Studies*. Frozen 1980–2024 mutation census, event/sediment ledgers, observer checks, figure filters and exact 261009 comparisons.

[15] WEPPpy project record (2026-10-10). *Disturbed Parameterization: Current Canonical Results*. Fresh 261010 96-case report and source/output provenance.

[16] WEPPpy ADR-0083 (2026-10-09). *Low-Severity Forest Initial Random Roughness*. Decision provenance, 112-run targeted assessment and linked broader sensitivity study; parameterization change separate from model binaries.

[17] WEPP Forest and WEPPpy release records (2026-10-10). *WEPP 261010 Release Validation*, release handoff and ADR-0084, *CHRQIN Source Normalization and WEPP 261010*. Exact artifact identities, required and supplementary checks, skips/unavailable attempts, executable equivalence and release authorization.

[18] This report, revision 1 (2026-10-10). Additional read-only Cedar sediment summary from the retained 260803, 261009 and candidate annual/EBE output files. Input hashes, parsing method and numeric results are retained with the authoring evidence; no new model simulation was performed.

[19] Elliot, W. (July 2026). *Topanga Watershed Analyses: Before and After the Palisades Fire*. Supplied investigation report, 18 pages, Table 8. Historical working configurations; not a matched 260803/261010 comparison.

[20] This report, revision 2 (2026-10-12). Read-only CTA/Gringorten calculations from hash-verified Topanga and Rattlesnake outlet records. Retained candidate outputs were reconverted from receipt-verified EBE files; matched 260803 and 261009 snapshots, selected ranks/dates and 144 return-level rows are preserved with the authoring evidence. No new model simulations were performed.

[21] Savabi, M.R., and Williams, J.R. (1995). Water Balance and Percolation. Chapter 5 in *USDA–Water Erosion Prediction Project: Hillslope Profile and Watershed Model Documentation*, NSERL Report 10. Historical process documentation; not a description of every later hourly implementation or of this release's allocation repair. `https://www.ars.usda.gov/ARSUserFiles/50201000/WEPP/chap5.pdf`.

[22] WEPP Forest/WEPPpy project records (2026-10-20–21). *Consumer Audit: Local Depths, Internal Transfers and Outlet Volumes*; native writer/readback and controlled hillslope/PASS accounting. Primary implementation evidence, including version-specific Q/QOFE interpretation. The original comparison workbook lacked producing executable and input decks; it is not treated as a reproducible model validation.

[23] WEPP Forest/WEPPpy project records (2026-10-21). *Watershed Physical Water Repair*: native source audit through `d354e3c99`, allocation/source/publication regressions, paired generated replays, Gregorian date checks, and channel-plane initialization controls. The report's change register

maps each repair to its primary retained evidence. These are engineering and numerical checks, not observed watershed calibration.

[24] WEPP Forest/WEPPpy project records (2026-10-21). *MC Continuity and Interface Review*; full-node geometric/algebraic controls; variable-coefficient, source, clipping and grid-transition ledgers; retained-state and fixed-point ablations. Independent mathematical derivations are reproduced in this report, without restricted legacy source listings.

[25] WEPP Forest/WEPPpy project record (2026-10-21). *Cedar Creek 261010–Physical-Water Repair Comparison*. Fresh matched 24-year simulations with 864 hillslopes and 371 channels, same-build PASS provenance, full outlet readback, independent daily/annual/event audit and aggregate-yield conversion. Sanitized numeric evidence and original figure-generation code accompany this review edition. Figures are model comparisons, not observational validation or third-party endorsements.

[26] Project release evidence (2026). Late hourly return source classification, portable nine-year fixture and paired watershed replays; WEPP 261026. Model source `b73e93b19`; independent source, numerical-linkage and scientific-scope review records dated October 26. Internal retained evidence, not independent observational validation. WEPPpy ADR-0107 records the owner's acceptance of the existing midnight effective-support approximation.