# WEPP 261029

Consolidated scientific and engineering release report

Roger Lew • University of Idaho rogerlew@uidaho.edu

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Water accounting, sediment delivery and revegetation compatibility

**Document purpose.** This is the single consolidated reading source for changes introduced through all seven artifact revisions of WEPP 261029. It replaces the need to read the earlier release report and supplements in sequence. Earlier issued PDFs remain immutable historical evidence, not additional required reading.

**Release boundary.** The current Linux executables are locally vendored; production deployment and a default-executable change are not claimed. This edition is a newly authored synthesis for owner review. Earlier report approvals do not constitute independent review of this edition.

**Authorship and assistance.** Roger Lew is the release-report contact. OpenAI Codex assisted with the consolidation, evidence cross-checks, original figures and document preparation. Historical independent AI reviews are engineering controls, not human scientific peer review or institutional endorsement.

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# 1 Stakeholder overview

WEPP 261029 corrects water accounting, hourly return-flow timing, infiltration, erosion and sediment routing; improves numerical stability and fixed-width reporting; fixes soil-coefficient ownership in multi-element hillslopes; and restores specialized 9005 soil and RAP revegetation support. This document brings the original release and all six subsequent revisions into one account.

These corrections can change runoff, evapotranspiration, storage, peak flow and sediment yield. Some effects are large, and their direction depends on the case. They are not a new calibration or a guarantee of agreement with observations. The recorded release status is a locally vendored, undeployed Linux pair. Neither production deployment nor a change to the default executable is claimed.

## 1.1 The most consequential change: sediment delivery

In the retained 24-year Cedar comparison, revision 2 delivered **517.816 tonnes** of sediment to the watershed outlet, versus **180.137 tonnes** in the original 261029 release: **337.679 tonnes more, a 187.456% increase (2.87 times the old result)**. The evidence identifies lost incoming transport at erroneous channel boundaries as a major mechanism. On the five largest daily increases examined, channel-bed erosion decreased. The change cannot be described as a small stability fix, even though aggregate water changed very little.

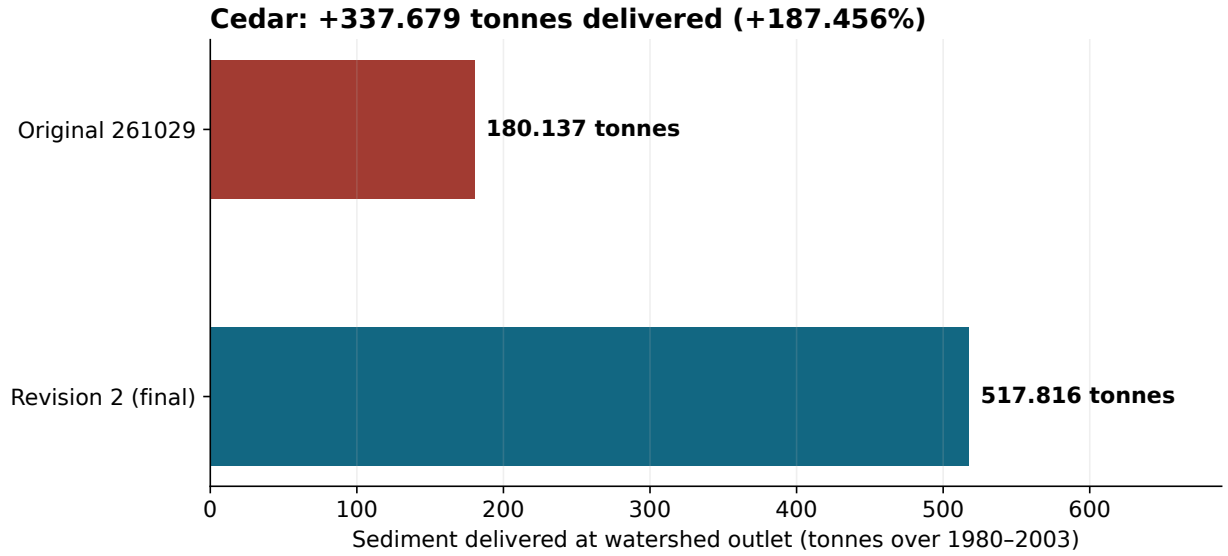



Figure 1: Cedar outlet sediment, 1980–2003. Exact totals are 180,137.20 and 517,815.77 kg. These are model-to-model results for original 261029 versus final revision 2, not measured sediment and not a new revision-7 run. Source E2.

## 1.2 What stakeholders should take away

| Question | Answer |
|---|---|
| Why can sediment change so much with nearly unchanged water? | Sediment routing can incorrectly remove incoming mass even when the water routing still completes. Fixing that transfer changes downstream delivery without requiring a comparable increase in runoff. |

| Question | Answer |
|---|---|
| Is higher sediment necessarily more accurate? | The repaired numerical boundaries satisfy targeted physical limits and traced source accounting. Field agreement and a complete watershed sediment budget are not established by that evidence. |
| Does this affect only Roads? | No. Shared hillslope and channel routines affect general watershed simulations. Cedar, Disturbed, heterogeneous-soil and configured application cases expose different consequences. |
| Are all seven revisions new calibrations? | No. Most changes correct implementation, ownership or numerical evaluation. The specialized revegetation port deliberately retains its reference scientific behavior. |
| Can old and new results be compared by filename? | No. The same release name was reused before deployment. Use artifact revision, exact hashes and matched hillslope/pass/watershed chains. |

# 2 Why channel sediment delivery changed so much

## 2.1 What an artificial channel sink means

A channel receives sediment from upstream channels and adjacent hillslopes, exchanges sediment with its bed, and exports the remaining load. Over an event, a useful bookkeeping relation is

$$M_{out} = M_{upstream} + M_{lateral} + M_{erosion} - M_{deposition}.$$

All terms here are event masses on the same channel basis. An artificial sink is a loss introduced by the calculation rather than justified by the modeled bed exchange. It is not a mapped reservoir, conservation practice or newly discovered physical sediment trap. The old code could classify incoming transport as lost/deposited because its hydraulic or sediment boundary was wrong.

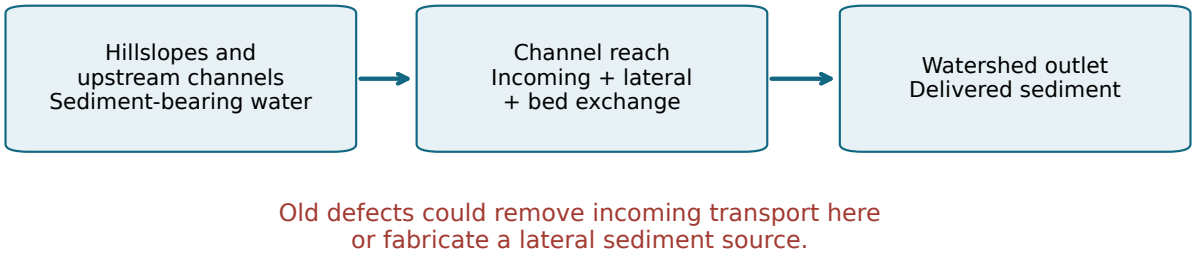



Figure 2: Conceptual channel mass pathway, not a measured budget or a reconstruction of a particular network. The defect sits between sediment supply and downstream delivery; correcting it does not imply new hillslope erosion.

## 2.2 Defect 1: almost-all-upstream water was treated as no upstream flow

For modern soils, an existing guard activates when the upstream-to-lateral water volume ratio exceeds 100,000. It removes an extreme virtual upstream length to avoid problematic geometry. The old guard left a positive lateral hydraulic operand, so the next routine interpreted the simplified geometry as all-lateral flow and set the channel inlet discharge to zero. Almost all of the actual water had come from upstream, yet the sediment calculation lost that hydraulic support.

Revision 2 selects the intended **all-top (all-upstream) limit**: the segment inlet and outlet discharge equal the represented peak. The ratio threshold, physical channel length, actual event water and supplied sediment masses are preserved. Immediately below the threshold, the upstream fraction is about 0.99998996; above it, the corrected limit is 1 rather than 0. This is a bounded approximation, not a new calibrated channel-flow model.

## 2.3 Defect 2: constant-discharge deposition lost its entering load

The constant-discharge branch separately mishandled incoming sediment and omitted positive lateral sediment supply when effective lateral hydraulic flow was zero. A production-consumer control, with prescribed geometry/capacity and zero bed detachment, supplied **2.2064 lb/s** against **1 lb/s** transport capacity. The old routine returned 1 lb/s for a range of small positive settling velocities and zero at

zero settling. Neither result preserved the entering boundary in the zero-settling limit. Adding a lateral source term alone would not fix that error.

For a constant-width approximation, let $G$ be sediment load rate (lb/s), $T$ transport capacity (lb/s), $S$ lateral sediment supply per channel length (lb/s/ft), and $\lambda = v_s W_{avg}/Q$ the settling coefficient (1/ft). The retained depositing equation is

$$\frac{dG}{dx} = \lambda(T - G) + S.$$

For a segment of length $d$, linearly varying capacity with endpoints $T_0, T_d$, $z = \lambda d$, $E = e^{-z}$ and $R = (1 - e^{-z})/z$, the revised evaluation is

$$G(d) = G_0 E + T_0(R - E) + T_d(1 - R) + SdR, \qquad R(0) = 1.$$

It preserves two indispensable limits: at zero distance, $G = G_0$; at zero settling, $G = G_0 + Sd$. Capacity is not an instantaneous clip on incoming mass: with no settling or detachment, sediment does not disappear merely because incoming load exceeds equilibrium transport capacity. Stable small-argument series and actual endpoint capacities avoid cancellation and negative endpoint loads without clipping sediment.

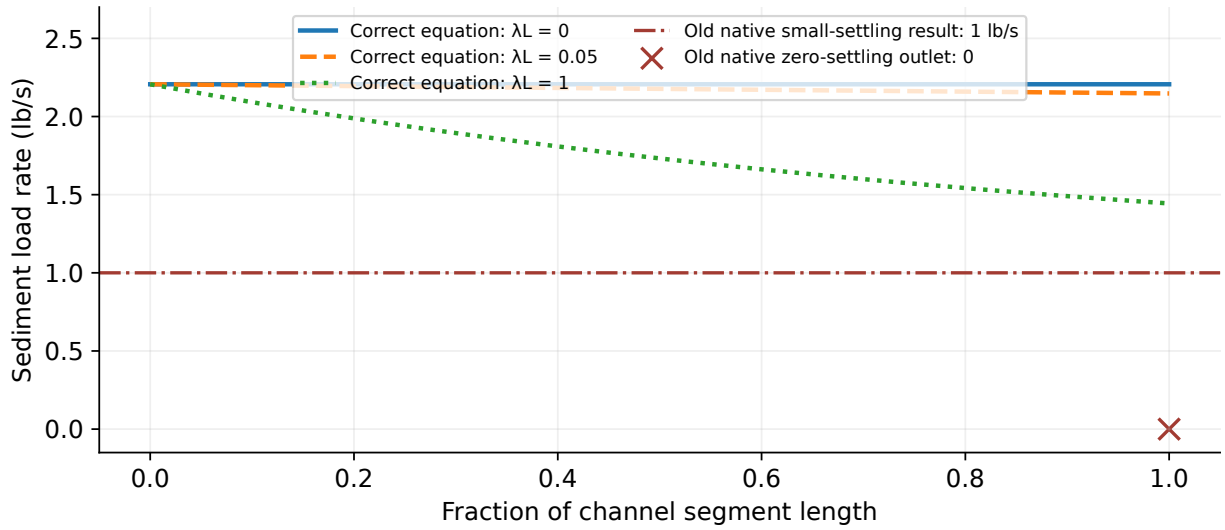



Figure 3: Illustration of the repaired equation with G0 = 2.2064 lb/s, constant capacity 1 lb/s and no lateral supply. Curves are analytical illustrations at the labeled dimensionless settling strengths, not new native runs. The old-result line and zero-settling cross come from the retained native control. Source E2.

## 2.4 Direct channel evidence: thousands of kilograms stopped disappearing

On Cedar channel 235, 1990 day 117, the preceding hillslope-repair control received 7,827.98 kg and exported zero. Its inlet discharge was zero even though its outlet peak was about 836 ft$^3$/s. With the corrected hydraulic limit, the channel exported 7,825.85 kg and signed bed exchange was about $-1.2 \times 10^{-5}$ kg. The small inlet/outlet numerical difference must not be labeled measured deposition or claimed as exact closure; the native routing and conversion conventions remain.

Other examined events had approximately 3,903 kg of former deposition in channel 318 and 8,114 kg in channel 266 (the latter on 1994 day 300); both fell to near zero. These are diagnostic comparisons to the pre-channel-repair control and its corrected candidate, not independent sediment sources to sum at the outlet.

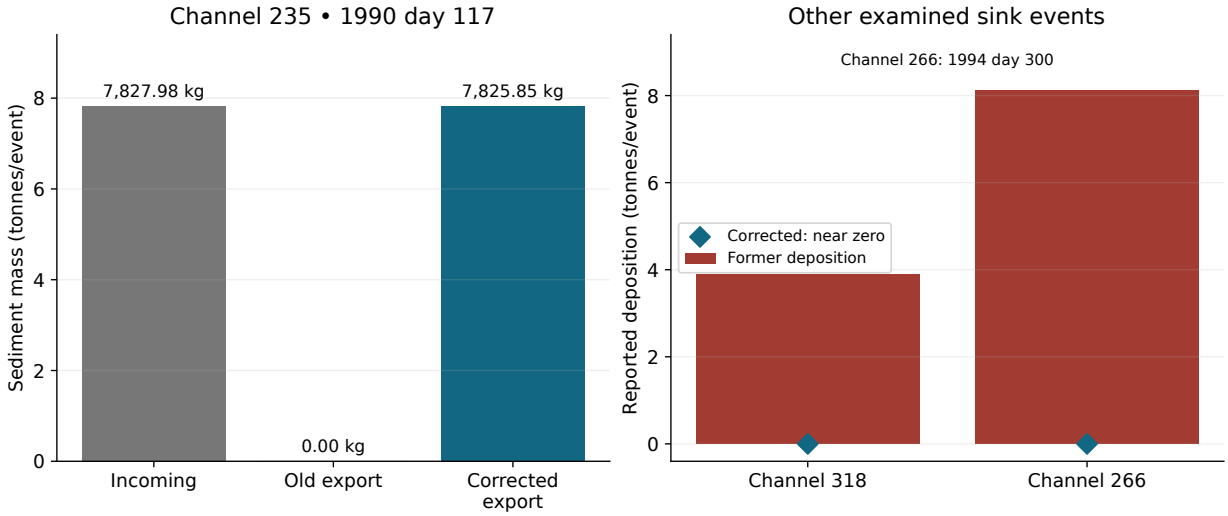



Figure 4: Paired channel diagnostics. Left: channel 235 retains almost all incoming transport after correction. Right: former deposition at two other examined sinks becomes near zero. The displayed zeros in the right panel mean near zero at the scale of tonnes. Channel 318's date is not specified by this summarized evidence. Source E2.

The paired attribution panel examined the five largest daily export increases and their preceding days. On all five peak dates, summed per-class bed erosion **decreased by about 18.6–37.1 kg**. This supports recovered incoming transport as the mechanism on those dates; it does not establish that bed erosion decreased everywhere or on every day.

## 2.5 A separate error created sediment; that was removed too

The old lateral-source calculation multiplied concentration by an effective hydraulic lateral volume instead of pairing each actual source's concentration with its own sediment-bearing water volume. On channel 235, 1985-11-06, an actual 1.84519248 kg lateral supply became approximately 136,060 kg internally. Revision 2 computes each particle-class source from the actual supplies, $M_k = \sum_j V_j C_{jk}$, and distributes it over the represented channel span and positive event duration. Sediment-free baseflow or subsurface water cannot create sediment mass merely by contributing to effective hydraulic flow.

The corrected integrated value is 1.84517222 kg, consistent with the retained lateral conversion factor 0.9999889824804826. The separate top-source convention is 1.0008053888. Those small historical unit discrepancies are explicitly retained; they are different from the orders-of-magnitude source error. Invalid source duration or span remains an invalid routing domain, not evidence of conservation.

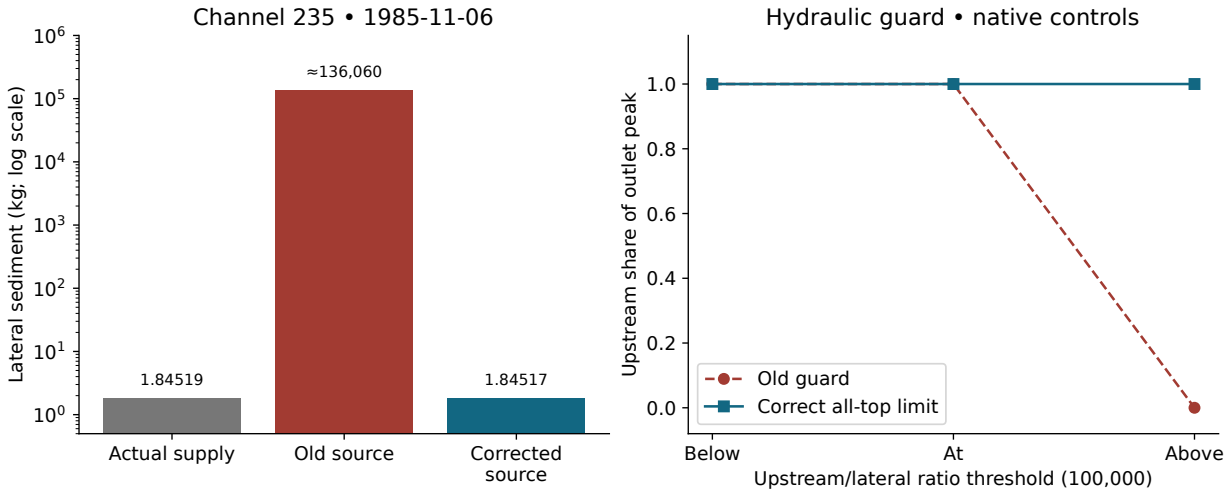



Figure 5: Two distinct mechanisms, with different directions of effect. Left: removal of fabricated lateral sediment (logarithmic mass axis). Right: restoration of the upstream hydraulic fraction above the existing ratio guard. Values below and at the threshold remain unchanged. Source E2 and its native defect controls.

Removing this source amplification alone **reduced** outlet sediment by about 3.217% relative to the hillslope-repair candidate. Correcting the transport losses then produced the much larger net increase. The release does not simply add sediment, relax a cap or tune erosion coefficients upward.

### 2.6 Magnitude, frequency and the final accepted pair

| Evidence level | Retained result | Interpretation |
|---|---|---|
| Original release to final revision 2; 1980–2003 Cedar | 180,137.20 → 517,815.77 kg; +187.456% | Material cumulative change in predicted sediment delivery. |
| Annual final revision-2 changes versus original | -0.303% to +1,286.54% | Period-average change is not a uniform multiplier for individual years. |
| Pre-final corrected channel candidate | Sediment changed on 3,231 of 8,766 days | Broad temporal effect, not one isolated bad event. |
| Same pre-final comparison | August total 143.38 → 28.32 kg; November 14,577.19 → 70,908.77 kg | Some seasonal totals decrease while others increase sharply. These are the diagnostic comparison, not a newly recomputed final-pair monthly table. |
| Final pair versus that candidate | Total differs by -0.01 kg; one printed daily value changes | The final near-critical-shear repair does not reverse the recovered-transport explanation. |
| Original to final water total | +313.78 $m^3$, or +0.00002475% | Small aggregate water change does not imply small sediment change. |

| Evidence level | Retained result | Interpretation |
|---|---|---|
| Final intermediate particle transfers | Zero negative/nonfinite records across all 24 years | Strong numerical sign/finiteness evidence, not complete watershed mass closure. |

The final revision-2 audit checked 16 detail dates, 5,936 channel-events and 29,680 source-class records. Maximum normalized lateral-source residual was $1.8392 \times 10^{-7}$ after the retained conversion factor; maximum normalized local signed-bed closure residual was $3.5307 \times 10^{-8}$. These are local and panel checks, not a full watershed sediment budget. The final shared Yalin-factor repair eliminated small negative intermediate transfers that aggregation and printed output precision had concealed.

**Practical interpretation.** Old results can substantially understate sediment delivery in affected cases even when their runoff totals appear reasonable. The correction warrants re-examining conclusions based on the old executable, with a matched rerun and explicit version provenance. It does not supply a universal adjustment factor, measured-sediment calibration, or a 187% prediction for other watersheds or later revisions. No complete Cedar revision-7 rerun is claimed by this document.

# 3 Which build this describes

The name `wepp_261029` was retained through seven authorized replacements before deployment. The filename and WEPP banner alone therefore do not identify a build. The current pair uses source commit `e0abe0581f77c6f66917e90daf8f8f429e9315c8`, system GNU Fortran 13.3.0, and the existing `2020.500` model banner.

| Executable | Revision-7 SHA256 |
|---|---|
| `wepp_261029` | `4a9da3980d1a9249e566626c01de920de7dba508 8ec25324dc1c6dd6eff8c825` |
| `wepp_261029_hill` | `210d48da09ff60707ba2404dd32af1f0a74e9543 7d2cb900c5408121141a1936` |

The changes below are cumulative relative to 261026, including retained portability work. Revision numbers identify when changes entered this release; users do not need to assemble the separate reports to understand the current behavior.

# 4 Water accounting, return flow and evapotranspiration

**Local inputs survive negative-balance handling (revision 1).** Daily and hourly water balance retain the complete local water inputs when handling a negative net exchange. Previously, that branch could discard local contributions. The existing daily positive-only allocation remains; negative daily infiltration is not an additional water stock that ET can independently debit.

**Hourly upstream return water follows its available hourly support (revision 1).** The routed return-water debit is apportioned over the existing upstream hourly support instead of being assigned without regard to that timing. This is a proportional timing approximation, not a new travel-time or hydrograph solver.

**ET uses the updated soil stock once (revision 1).** The Penman–Monteith consumer no longer applies a duplicate daily infiltration adjustment after soil-water allocation and percolation. Root-zone water accumulates across the rooted layers instead of being replaced by an evaporation-zone estimate. Both daily and hourly callers use these corrections; plant parameters are not recalibrated.

**Current event state and late return flow are carried correctly (revision 2).** Event processing requires current parameter readiness, and late local source water receives its own duration metadata. A blanket duration reset was rejected. Hourly connected melt is weighted over the daily contributing footprint, and upstream infiltration-storage subtotals reset once per contributor, preventing repeated counting. The contributing topology is unchanged.

**Equivalent-plane geometry and recession infiltration are corrected (revision 3).** Equivalent-plane calculations preserve the caller's zero-origin length array and align coefficients to their intended elements without changing the connected hydraulic length. Recession infiltration removes an extra unity cutoff and keeps the existing positive-rate branches continuous through that boundary. This shared calculation affects ordinary, contour and watershed infiltration consumers; a dedicated complete contour-event empirical fixture was not established.

## 4.1 Water-accounting mechanism and timing scope

The signed soil exchange begins as $F = L + R$, where $L$ is the full local input (rainfall after interception, existing adjustment, melt and irrigation) and $R$ is the area-adjusted runoff exchange. In the retained

first-year/day-9 trace, $L = 38.576386$ mm and $R = -61.153371$ mm, giving $F = -22.576984$ mm. Resetting $F$ to runoff terms alone asked storage to fund an additional 38.576386 mm. The inventory guard exposed the inconsistency; weakening that guard was not the repair.

For an eligible downstream, non-channel, non-contour OFE with daily $F < 0$, let $S_h$ be upstream return depth in hour $h$ on the receiving OFE's area, $L_h$ lateral subsurface input, $A = \sum_h S_h > 0$, $B = \min(A, -F)$ and $N = 24$. Hourly exchange is

$$x_h = (F + B)/N + (1 - B/A)S_h + L_h.$$

Its sum remains $F + A + \sum_h L_h$. If return water covers the withdrawal, the routed share follows the available hourly return rather than imposing a soil debit before that water arrives. Any residual negative exchange still needs real soil inventory. Other eligibility cases retain the previous expression. Binary64 accumulation feeds the existing binary32 allocator with one conversion. This allocates a known schedule; it does not infer travel time or borrow future water through an unmet-demand ledger.

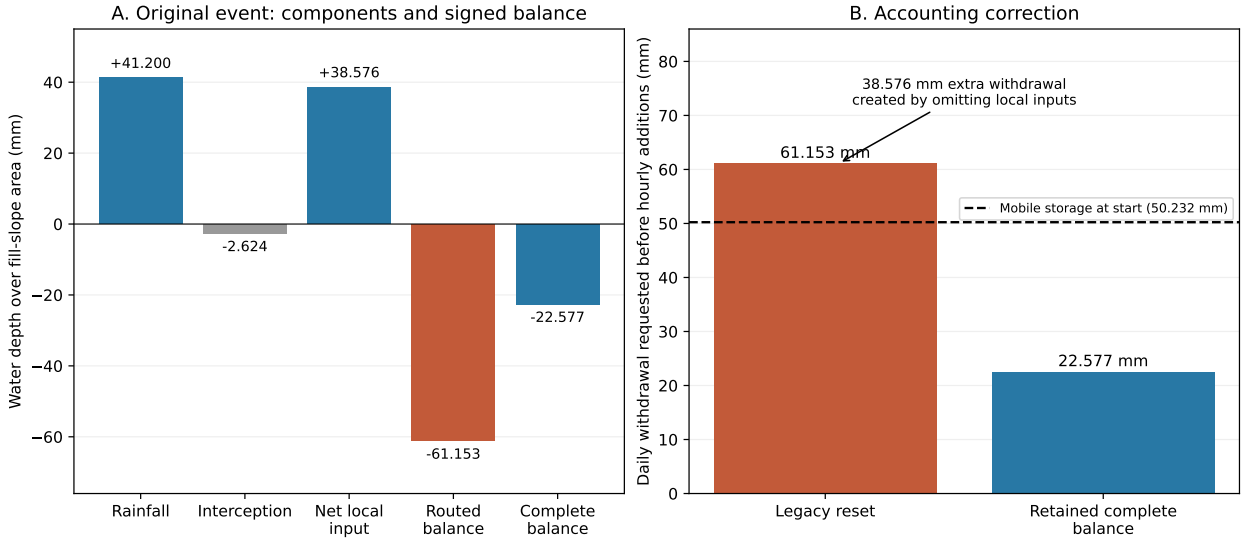



Figure 6: Retained daily local-input control: the negative-branch reset discards positive local input and enlarges the requested withdrawal. These are accounting depths, not measured infiltration or a complete daily storage budget. Source E1; original release figure reused unchanged.

Current soil stocks are already updated when Penman–Monteith ET is called. Removing the duplicate $1000F$ adjustment prevents that input or withdrawal from being applied a second time. The traced old case produced a stress coefficient about -203.18 and plant ET -164.9572 mm/day; the corrected full history reported 0.81 mm/day on that element/date. This is an availability repair, not output clipping. The alternative EVAP method remains unchanged.

Root water is $W_r = 1000 \sum_i f_i s_i$ mm, where $s_i$ is layer mobile water in meters and $f_i$ is the rooted fraction of that layer. Keeping the accumulated fully rooted layers when adding the terminal partial layer separates root uptake from the surface evaporation zone. Shallow roots, exact boundaries, partial layers and roots beyond the profile were tested. Daily negative exchange remains unallocated by the positive-only daily allocator and must not be independently subtracted in ET; universal daily signed-exchange closure is not claimed.

# 5 Erosion, deposition and channel sediment

**Stable evaluation of the existing equations (revision 2).** Hillslope deposition carries the intended upstream state and uses stable divided exponentials and endpoint limits. Particle sorting retains the upstream load and full forward-wet integral through singular limits. These are equation-preserving repairs, not clipping of negative sediment or a general repair of invalid geometry.

Channel sediment sources are normalized over their represented span and event duration. The existing large-top-flow guard selects the all-top hydraulic limit. Constant-discharge channel deposition preserves endpoints and handles mixed particle classes and precision limits. Existing cohort, onset and width approximations, and the positive lateral-inflow branch, remain.

The shared hillslope/channel Yalin transport-capacity factor uses double-precision intermediates and a stable small-argument series to avoid cancellation near critical shear. Shields excess-shear allocation, units, coefficients, the transport-capacity floor and sand weighting remain unchanged.

**Complete, bounded sediment integration (revision 4).**

- Deposition endpoint searches stay within bounds after unsafe Newton trials.
- Nonempty erosion intervals are integrated even when they contain no grid point; the first transition, upstream state and capacity/forcing partitions are retained.
- Ordinary fourth-order Runge–Kutta integration remains, with exponential-midpoint continuation for the supported stiff cases.
- Deposition, erosion and routing use consistent polynomial capacity evaluation with double intermediates and explicit rounding boundaries.
- Routing carries actual inflow and transition load; the limiting formula is reserved for exactly zero inflow.
- Wet/dry coordinate handling no longer mutates coordinates as a side effect.
- Rounded zero-denominator guards retain the correct limiting sign for nonnegative slopes in both affected parameter coefficients.

These changes repair demonstrated numerical failures while retaining explicit limits on terminal-capacity precision and particle-fraction interpretation.

## 5.1 Why the later sediment repairs matter

For normalized hillslope distance $x$, load $L$, capacity $C$, rill detachment capacity $R$ and interrill supply $\theta$, the erosion equation remains $L' = R + \theta - (R/C)L$ on positive capacity. A nonempty physical interval must be integrated even if it contains no output grid point. A retained failing interval $[0, 0.00941210799]$ omitted about $1.13575 \times 10^{-5}$ of normalized interrill load while later particle mixing still counted that source.

The repaired integration starts from the actual upstream state and locates the first capacity crossing, partitioning at capacity zeros and $C' = \theta$. Ordinary RK4 remains; a sampled $hR/C > 0.1$ or unsafe stage quotient invokes the supported exponential-midpoint continuation for the same equation. With midpoint $A = R + \theta$ and $B = R/C$, the step is

$$L_{n+1} = e^{-Bh} L_n + \frac{A}{B}(1 - e^{-Bh}),$$

with its continuous $B = 0$ limit. Step doubling checks convergence; unsupported nonconvergence fails explicitly. The switch is a numerical criterion, not a universal physical error bound. Capacity uses consistent double Horner evaluation, with deliberate native rounding when comparing to native loads.

For deposition, $G = \phi(C - L)/(x + q)$ and $L' = G + \theta$. The boundary term is not the whole derivative when interrill supply exists. Actual nonzero inflow and load must survive transitions; a small positive boundary term cannot be clipped merely to reset load to capacity. Wet coordinates remain owned by the caller; direct dry terminal derivatives are unsupported, while the deposition routine owns terminal zero load. Unsupported singular rates fail explicitly. These repairs preserve existing equations and do not recalibrate soil erodibility.

Mixed particle classes retain the erosion/capacity handoff: an undercapacity class transports its incoming load and source until it reaches capacity, rather than acquiring bed erosion from a deposition formula. Existing cohort/onset/width approximations and positive-lateral-flow equations remain. Near-critical-shear Yalin evaluation retains its coefficients and floor while avoiding cancellation.

# 6 Interception, snow, frozen water and soil reporting

**Conservative interception allocation (revision 5).** Canopy and residue stores are allocated from the represented water supply using error-free arithmetic expansions. Simply switching to double precision was insufficient. Daily/hourly balance and runoff checking share the corrected remainder, while primitive supply and effective-plane budgets, signed guards and furrow ownership stay distinct. Both executables link the strict-arithmetic helper without a new external dependency.

**Explicit complete-snowpack exhaustion (revision 5).** When melt executes its existing complete-pack cap, the receiving routine debits the complete depth only when it can establish ownership of that same pack. Partial melt, negative or zero return, and unmatched-pack paths retain their behavior. No new epsilon, infiltration threshold or ET formula is introduced.

**Donor-limited frozen-water restoration (revision 5).** Underfunded liquid restoration is capped by the existing fine-ice donor; the remaining deficit is preserved for delayed conversion. Funded arithmetic remains unchanged. This is a bounded water-restoration correction, not a frost-energy or thermal recalibration.

**Readable numeric output (revisions 1 and 5).** Peak runoff and soil-water `Sm` retain their seven-character fields. Overflow cases use reduced decimal precision or scientific notation instead of unreadable stars; ordinary values retain their previous bytes. The `Sm` change affects display, not stored water. Downstream readers must accept scientific notation.

## 6.1 Consequences of the bounded snow and frozen-water repairs

The snow repair carries the identity of the pack that reached the existing melt cap. Full depth is debited only for a matching current pack, including a narrowly checked no-addition density recomputation. It does not introduce a tolerance to silently zero small residuals. Signed water-equivalent representation effects remain explicit. The freeze repair caps restoration by available fine ice and leaves the reference deficit for the subsequent water-conversion consumer.

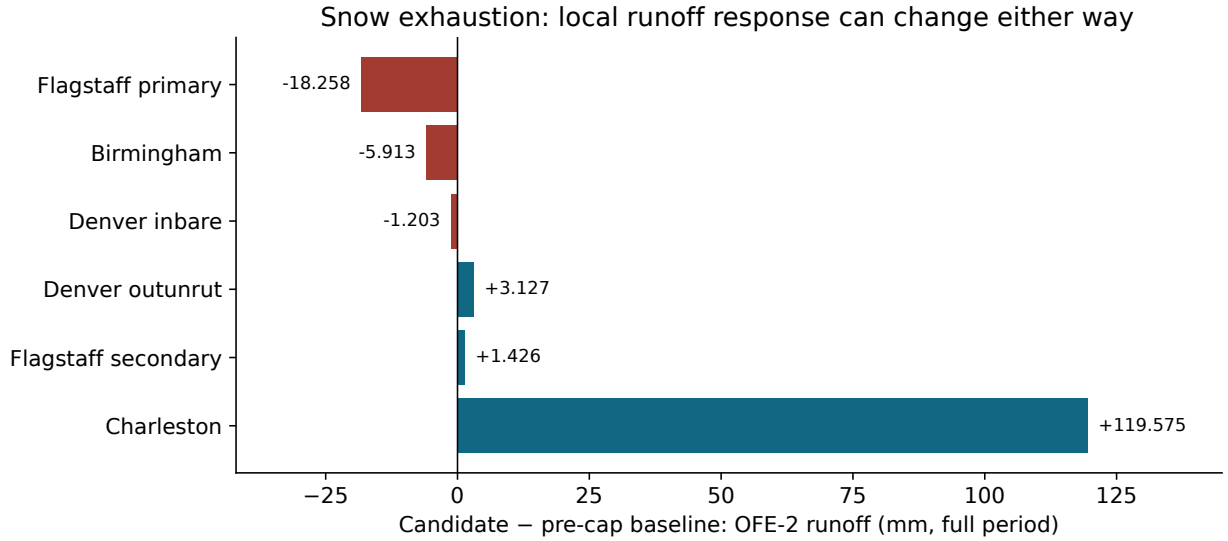



Figure 7: Isolated snow-exhaustion comparisons against the pre-cap candidate, not cumulative revision-7 changes. All values are full-period local OFE-2 runoff depths; they are not additive watershed discharge. Exact case values are retained in source E5.

In Charleston, the largest daily surface-export increase was 34.902768095 mm, accompanied by 35.738348961 mm more incoming surface runon; local melt changed only 0.0000186265 mm that day. This demonstrates why a small initiating local change cannot be used to bound the eventual runoff response. Charleston and Birmingham leaf-area index differed on 5,508 and 4,419 days respectively. Denver outunrut had a day-132 plant-ET difference of +3.862566839 mm and soil-ET difference of -2.136194322 mm. Existing stress, canopy and demand conventions amplify some responses; this release does not endorse or redesign that physiology.

Interception uses conservative allocation from represented supply, not a global increase in water availability. Primitive and effective-plane budgets remain distinct; strict expansion arithmetic addresses signed cancellation that a double-only alternative did not resolve. Neither this repair nor readable Sm output changes retention defaults, rock physics or thermal calibration.

## 7 Correct coefficients for each soil layer and hillslope element

**FC/HK ownership repair (revision 6).** An overland flow element (OFE) is a successive portion of a hillslope. Field-capacity water depth (FC) and the unsaturated-conductivity exponent (HK) were indexed by layer alone, so initializing another OFE could overwrite values used with the first OFE's water state.

Both coefficients now retain layer and OFE identity throughout daily/hourly water balance, percolation, tile drainage and lateral-flow consumers. Formulas, thresholds, initialization timing and retention defaults are unchanged. The internal memory-layout change requires a clean build and a matched binary pair. It does not add coefficient refresh after tillage or density changes.

Revision 5's demonstrated wrong-owner defect is repaired here; its historical correctness HOLD must not be read as an unrepaired revision-7 defect. Conversely, repairing ownership does not prove unrestricted scientific validity.

Penman–Monteith capacity and mapped plant selection were also verified: this release already supports

32 hillslope and 15,000 watershed plant definitions and uses the intended mapped plant index. No new PMET formula or missing-name fallback was introduced. Findings from the older kernelized checkout do not describe this release's arrays.

## 7.1 Ownership evidence and magnitude

The revised coefficients are $FC_{i,p} = d_{i,p}(\theta_{FC,i,p} - \theta_{dry,i,p})$ and $HK_{i,p} = -2.655/\log_{10}(FC_{i,p}/UL_{i,p})$, with the existing nonpositive ratio guard retained. Here $i$ is soil layer, $p$ is OFE, $d$ is layer thickness, and $UL$ the existing upper water-storage quantity. The change is the identity of the operands, not a new constitutive relationship.

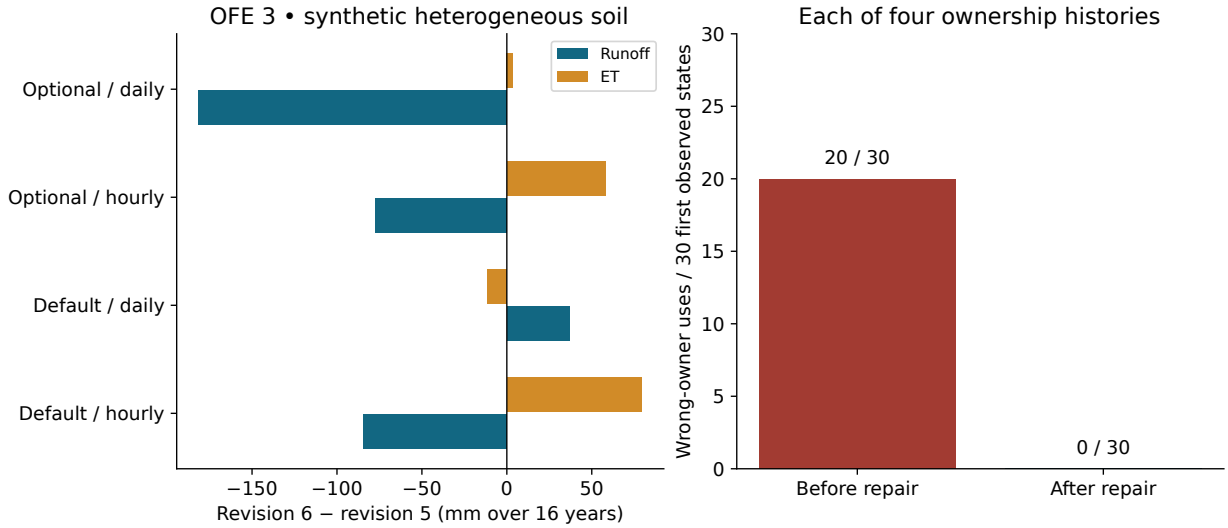



Figure 8: Synthetic 16-year heterogeneous-soil controls, revision 6 minus revision 5. Left: local OFE-3 runoff and ET changes differ by time step and retention preparation. Right: all four histories correct 20 wrong-owner consumer states among 30 first-observed states. The observer does not trace every use over time. Source E6.

| Retention preparation / mode | Runoff change (mm) | ET change (mm) | Deep percolation change (mm) | Terminal stock change (mm) |
|---|---|---|---|---|
| Default / hourly | -84.692 | +79.380 | +11.378 | +3.330 |
| Default / daily | +36.875 | -11.220 | -2.241 | -14.930 |
| Optional / hourly | -77.369 | +58.200 | +8.432 | +3.640 |
| Optional / daily | -181.334 | +3.570 | +1.860 | +11.880 |

Runoff, ET and deep percolation are 16-year totals at OFE 3; stock is the terminal printed Total-Soil difference. Internal lateral transfers are not shown, so these columns are not a closed budget. Optional retention is an experimental input preparation, not a new release default. Six ordinary single/repeated-material controls retained exact bytes; those controls alone could not reveal wrong-owner coefficients in heterogeneous soils. Scheduled tillage, later density changes and missing-density generalization were not newly validated.

# 8 Specialized soils and RAP revegetation

**Reference-preserving support (revision 7).** The seven-field version-9005 soil header is read correctly, including texture, unburned saturated conductivity and lower effective conductivity; one restrictive-layer record is consumed per OFE. The earlier generic reader could misbind fields and consume that record twice.

Adjusted 9005 soils use the specialized reference's cover-dependent and saturation-dependent conductivity, feeding layers 1 and 2. The reference's ordered saturation factors remain, including the effective 0.9801 saturated boundary. No new FC/HK refresh schedule or unrelated CO2 subsystem is imported.

Continuous daily/hourly RAP simulation reads a calendar and six cover bands per OFE/year: tree, shrub, perennial, annual, litter and bare percentages. The first four form total vegetation. `cancov.txt` activates the mode; `simfire.txt` selects the transformed forest rule. Supplied fire dates use Gregorian dates; absent dates retain the fresh reference state. Allocation follows compiled capacities instead of historical 20-OFE/50-year limits. Missing, malformed, extra or nonfinite activated inputs fail explicitly. Single-event RAP is unsupported and rejected. Watershed routing consumes the matched hillslope passes without applying RAP again.

Growth, residue burn-down, initialization, cutting and fire behavior deliberately preserve the specialized reference. This includes recurring fire-anniversary comparisons, different canopy comparison/assignment bands, crop-wide root-depth mutation and logarithm-domain behavior. Canopy can increase, root behavior can depend on OFE processing order, and domain violations can fail. These are retained scientific semantics, not newly validated ecological assumptions. Ordinary growth, PMET mappings and revision-6 coefficient ownership remain intact.

# 9 Portability, bounds and engineering changes

The release retains a portable real32 math baseline: most float functions use double evaluation followed by one real32 conversion, with deterministic Fortran sine/cosine kernels and a 0.0001 absolute error budget. Native double calls remain system-libm calls. Plant COMMON dimensions are aligned and unread 30-year scratch arrays are retired. Windows source profiles remain in the source history, but this release delivers and validates a Linux pair, not a new Windows executable.

Opt-in diagnostic markers, permanent defect controls, expanded watchlist cases, source/binary provenance and build checks accompany the numerical repairs. The build workflow restores watershed includes after hillslope builds. Diagnostic parity checks verify ordinary outputs with observation enabled and disabled. Dense traces need isolated directories and can exceed NFS timeouts.

# 10 What changed in comparison runs

The examples below retain their actual comparison baselines. They are not a single cumulative revision-7 benchmark and should not be added together.

| Comparison | Observed consequence |
|---|---|
| Revision 2 versus original 261029, 24-year Cedar | Outlet sediment increased from 180,137.20 to 517,815.77 kg (+187.456%), attributed to recovered incoming transport at former artificial channel sinks. This is not measured-sediment calibration. |

| Comparison | Observed consequence |
|---|---|
| Revision 3 versus revision 2, Cedar | Sediment decreased to 517,670.63 kg (-0.02803%); a smaller event changed by -46.74%, demonstrating that period totals can hide large event differences. |
| Revision 4 versus revision 3, Cedar | Water/soil outputs were identical; sediment changed by +1.20 kg over 24 years. |
| Final revision-5 Disturbed comparison | Outlet volume changed by +0.08 $m^3$ and sediment by +1.71 kg; individual peak differences reached 0.00545 $m^3/s$. Snow/rain classification and internal water states also changed. |
| Revision 6 versus revision 5, synthetic heterogeneous three-OFE histories | With default retention, OFE-3 cumulative runoff changed -84.692 mm hourly and +36.875 mm daily over 16 years. These are local diagnostics, not watershed-depth or full-budget closure measures. |
| Revision 7 versus revision 6, six ordinary controls | Ordinary output bytes matched exactly; this establishes bounded compatibility, not identity for all projects. |

Snow exhaustion also produced material responses: in the isolated Charleston comparison, OFE-2 full-period runoff increased about 119.575 mm and leaf-area index differed on 5,508 days. Existing demand, stress and canopy carry can amplify small initiating water changes; this release does not revise that physiology.

The latest retained Roads magnitude screen remains **744 of 840 passed, 96 failed**. Earlier physical/accounting test completion is not magnitude acceptance. These are historical results, not a fresh revision-7 Roads campaign.

## 11 Validation and remaining limits

Revision 7 records 1,750 passing native tests, 31 passing watchlist cases, both host smokes, artifact-policy and ELF/provenance checks. Specialized coverage includes eight complete 16-year daily/hourly histories, each with 17,532 unique finite water rows and exact observer parity, plus four 9005 histories without RAP. The compiled-reference/candidate suite has 295 checks; the focused reader suite has 27, including two added after the full-suite run. Focused counts overlap and must not be added to the native total.

Installed matched hillslope-to-watershed runners and eight post-vendoring tests pass. A complete configured 72-hillslope, 235-OFE, 35-year disposable-project workflow generated 576 declared outputs and 3,004,240 unique finite raw water rows, six interchange datasets and successful report readback. Synthetic RAP inputs demonstrate engineering coverage, not observed vegetation calibration. The original project's 1,536 file hashes remained unchanged.

The revision-6 application supplement corrected an earlier incomplete preparation that omitted enabled baseflow/UI companion inputs. Complete preparation produced 504 outputs, with revision 5 and 6 identical on the same 363 inputs; 433 outputs differed from the partial-preparation context. That result must not be generalized to heterogeneous projects or attributed solely to the binary change.

Remaining limitations include:

- No universal water-conservation, soil-capacity ordering, thermal-energy closure or field-calibration claim. Earlier negative infiltration/recession diagnostics and bounded source/particle checks do

not establish global budget closure.
- No new retention default, universal rock-fragment dilution, porosity multiplier, engineered-road armor response or global frost-policy change. Optional retention integration and RUSLE provenance diagnostics are separate application work; they do not constitute new native physics or broad acceptance.
- The existing graphics disturbance-age field overflows at 10,000 days. The configured revision-7 run had 734,107 asterisk cells exclusively in that field, including summary rows. Water interchange/reports do not consume it; other graphics numeric fields and emitted water fields were finite.
- Optional `InterceptionStorage` is not emitted by this native writer and remains null in interchange. All-zero phosphorus tests do not validate positive phosphorus transport.
- Reviews recorded for these revisions are independent AI engineering reviews, not institutional endorsement or human scientific peer review. This consolidated edition does not inherit the approval of the earlier reports.

## 12 Using or reproducing this release

Keep the hillslope and watershed executables, JSON sidecars and generated passes from the same revision. When rerunning, regenerate the complete contributing hillslope-to-watershed chain; do not mix old same-name executables or historical passes with revision 7. Preserve old binaries and their outputs for comparison or rollback. Record hashes with results.

This pair uses legacy ASCII `H*.pass.dat`, PASS component version 3 and the process-mode `pass_pw0` workflow; HBP is not supported. Existing output field widths, parameter defaults and saved project results are not silently changed. There is no bulk project regeneration, installed Rust promotion, default switch or production deployment associated with this documentation update.

## 13 Evidence provenance and archival references

No new model simulations were run for this editorial consolidation. Figures transcribe retained final or explicitly labeled diagnostic measurements, or illustrate stated equations. Results are not silently promoted from an earlier artifact to revision 7. The release baseline is source commit `b73e93b19a724d1991d341d38a18d11e742231bd` (261026); the main sediment comparison baseline is original 261029, which is a different reference.

| ID | Retained source | Use in this report |
|---|---|---|
| E1 | Original 261029 release report and native accounting/timing controls | Local-input, hourly timing, ET, rooted-water and portability account. |
| E2 | Revision-2 report; final U10 scientific receipt and native defect controls | Final Cedar total, hydraulic guard, source amplification, deposition limits and diagnostic sink attribution. |
| E3 | Revision-3 report and final scientific acceptance | Equivalent-plane and recession changes; Cedar -0.02803% and smaller-event example. |
| E4 | Revision-4 report and source change register | Bounded roots, interval support, stiffness, capacities, boundary loads and parameter-sign repair. |
| E5 | Revision-5 report and final-source change register | Interception, snow, freezing, Sm, Disturbed effects, Roads failure and historical ownership HOLD. |

| ID | Retained source | Use in this report |
|---|---|---|
| E6 | Revision-6 report and complete-application supplement | FC/HK correction, PMET validation, heterogeneous controls and corrected application-preparation attribution. |
| E7 | Revision-7 report, evidence register and paired JSON sidecars | Specialized reference consumers, exact current identity, current validation and retained limits. |

The internal source-coverage map accounts for every changed `src/` path between the baseline and revision-7 source. Tests, tools, release metadata and research records are grouped as supporting engineering changes; their presence does not make an experiment shipped model behavior. Public figures contain no raw source, private input decks or executable attachments.

The consolidated narrative above is self-contained. The following immutable reports identify the historical evidence used to prepare it; reading them is not required to understand the release. Their individual approval records remain specific to those editions:

- Original release report (revision 1)
- Sediment and event-state repairs (revision 2)
- Equivalent-plane and recession repairs (revision 3)
- Bounded sediment integration (revision 4)
- Interception, snow and frozen-water repairs (revision 5)
- Layer/OFE coefficient ownership (revision 6)
- Specialized revegetation compatibility (revision 7)

# 14 Complete change map

This map states the disposition of each released change family and the associated supporting work. The original revisions are provenance labels; the preceding process sections describe the current cumulative behavior.

| Change family | Introduced | Current disposition and affected components |
|---|---|---|
| Complete local-input balance | 1 | Retained in daily/hourly soil-water calculations; no weakened inventory guard. |
| Proportional hourly return timing | 1 | Retained for eligible downstream OFEs; no new travel-time solver. |
| Updated-stock ET; rooted-layer accumulator | 1 | Retained in EVAPPM; alternative EVAP unchanged. |
| Peak serialization | 1 | Overflow-only precision reduction; seven-character field retained. |
| Portable real32 math and deterministic trigonometry | Carryover in 1 | Retained in both Linux roles; no new Windows artifact. |
| Plant COMMON capacity and unused scratch arrays | Carryover in 1 | Bounds aligned; unused 30-year storage retired. |
| Current event readiness and late-source duration | 2 | Retained in continuous event and pass production. |
| Connected hourly melt; upstream storage subtotal | 2 | Corrected support and contributor counting; topology unchanged. |
| Stable hillslope deposition and sorting | 2 | Entering load and integrals retained through singular limits. |
| Actual channel lateral sediment sources | 2 | Each physical source retains its own volume/concentration pairing. |
| All-top hydraulic guard limit | 2 | Upstream support restored above existing ratio threshold. |
| Constant-discharge channel deposition and mixed classes | 2 | Boundary, distributed source, endpoint capacity and erosion handoff retained. |
| Shared Yalin factor | 2 | Stable double-intermediate/series evaluation; coefficients and floor retained. |
| Equivalent-plane origin | 3 | Caller length origin and coefficient alignment preserved. |
| Recession continuity | 3 | Extra unity cutoff removed in shared QINF; domain limits retained. |
| Bounded deposition endpoint | 4 | Same equation; fallback bounded to supported physical interval. |
| Erosion interval/first-transition support | 4 | Nonempty grid-free intervals integrated from fixed upstream state. |
| Stiff integration | 4 | Ordinary RK4 plus supported converged exponential continuation. |
| Shared capacity and rounding | 4 | Consistent polynomial evaluation and explicit native comparison rounding. |
| Actual inflow, boundary load and wet coordinates | 4 | Exact-zero limit only; no side-effect coordinate shift or clipping. |
| PARAM denominator sign | 4 | Correct limiting sign for nonnegative slopes in both coefficient guards. |

| Change family | Introduced | Current disposition and affected components |
|---|---|---|
| Conservative interception | 5 | Strict arithmetic helper and shared consumer remainder; budget bases distinct. |
| Sm serialization | 5 | Numeric overflow fallback; ordinary bytes and model storage unchanged. |
| Snow exhaustion | 5 | Full debit only for owned complete-pack cap; partial/unmatched paths retained. |
| Frozen-water restoration | 5 | Existing ice bounds restoration; residual conversion remains downstream. |
| Layer/OFE FC/HK ownership | 6 | All identified balance, percolation, drain/lateral readers and writers updated. |
| PMET mapping/capacity | Verified in 6 | Conformance verified in selected source; no new PMET equation or fallback. |
| 9005 soil consumer | 7 | Seven fields, one restrictive record per OFE; specialized layer hydraulics. |
| RAP calendar/cover allocation | 7 | Strict six-band input and compiled-capacity allocation; continuous modes only. |
| Specialized growth/fire/residue/cutting | 7 | Reference sequence retained; ordinary growth and no unrelated CO2 import. |
| Diagnostics, tests, provenance and build workflow | 1–7 | Opt-in observation, permanent controls, broader watchlist, exact identities and include restoration. |
| Windows source profiles | Carryover | Source retained; no new native Windows release or parity claim. |
| Rock, retention, thermal and physiological investigations | Supporting research | No global rock multiplier, retention default, frost recalibration or physiology rewrite shipped. |
| RUSLE provenance and optional retention application work | Separate application changes | Diagnostics/local opt-in evidence described; not additional native release physics. |
| Deployment, default switch and bulk regeneration | None | Not performed by this release-note consolidation. |

## 15 Reproducibility and document identity

The current executable source and hashes are listed in "Which build this describes." Build inputs, numerical evidence and figure-generation sources are retained internally with this document edition. A separate document manifest records the final PDF hash and the source-file hashes; a PDF cannot contain its own final checksum without changing it.

Use the final PDF as the single stakeholder narrative. Preserve the paired binary sidecars and historical validation receipts as the authorities for executable identity and individual test results. This distinction avoids silently converting an editorial consolidation into a new binary release or a claim of new scientific validation.