LiDAR vs Photogrammetry for Restoration Mapping

A product-neutral field guide for choosing the right tool, surface model, and validation workflow

Public guidance version for website, LinkedIn, training, and outreach use

Primary message

Photogrammetry and LiDAR are complementary tools. Photogrammetry is usually strongest for visual mapping and visible-surface products. LiDAR is usually strongest when the required product is terrain: ground under vegetation, floodplain shape, drainage, cross-sections, bare-earth models, and repeat monitoring.

This guidance is written for restoration mapping, stream and floodplain projects, habitat work, earthwork monitoring, and field training. It removes project-specific names and product-specific platform names so it can be used as a neutral public-facing reference.

The goal is to reduce arguments between “pro-photogrammetry” and “pro-LiDAR” positions. The better question is not which technology is best in general. The better question is: which method produces the most defensible surface for the specific application?

Important limitation

This document is technical guidance, not a licensed survey certification, engineering design document, or legal accuracy guarantee. Project-specific deliverables should always be reviewed against the required coordinate system, vertical datum, tolerance, surface definition, and applicable professional standards.

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1. Executive summary

Photogrammetry and LiDAR both produce useful geospatial products, but they do not observe the world in the same way. Photogrammetry reconstructs surfaces from overlapping imagery. It is excellent when the surface is visible, textured, well-lit, and controlled. LiDAR directly measures ranges to objects and can often capture ground returns through gaps in vegetation, making it valuable for terrain, drainage, floodplain, and restoration monitoring work.

A common misunderstanding is that photogrammetry can produce a "DEM," so LiDAR is unnecessary. Photogrammetry can absolutely create strong elevation products. The issue is not whether an elevation raster can be produced; the issue is what surface the raster represents. Is it the visible surface, a stockpile surface, a roof/canopy surface, filtered bare earth, or a defensible ground model under vegetation?

For restoration work, LiDAR is most valuable when the project needs terrain intelligence: bank geometry, swales, floodplain tie-ins, cross-sections, ground under grass or brush, repeat monitoring, and bare-earth terrain products. Photogrammetry remains extremely useful for visual context, orthomosaics, documentation, and visible-surface measurements.

Practical recommendation

Use photogrammetry when the main deliverable is visual documentation or a visible-surface model. Use LiDAR when the main deliverable is a bare-earth terrain product, ground under vegetation, drainage interpretation, cross-sections, floodplain shape, or repeatable restoration monitoring.

2. First principles: choose by application, not by sensor loyalty

The best workflow starts with the question being asked. If the question is "What does the site look like from above?" photogrammetry may be the most efficient and familiar answer. If the question is "What is the shape of the ground, floodplain, bank, swale, or drainage surface?" LiDAR often provides a stronger starting point.

Project question	Photogrammetry is usually stronger when...	LiDAR is usually stronger when...	Practical direction
Visual orthomosaic or documentation	The main need is an image map and the site is visible and well lit.	3D context is also needed, or image products need to be paired with terrain.	Photogrammetry first; add LiDAR when terrain or 3D analysis is part of the scope.
Bare-earth terrain or DTM	Ground is open, exposed, textured, and not hidden by vegetation.	Grass, brush, trees, or mixed objects obscure the ground surface.	LiDAR first for restoration topo, drainage, floodplain, and vegetated terrain.
Stream/floodplain restoration	The goal is visual context, public communication, and surface condition documentation.	The goal is bank geometry, cross-sections, swales, floodplain tie-ins, and monitoring.	Use both when possible: imagery for context, LiDAR for terrain.
Submerged channel bottom	Imagery may show water surface or shallow visual clues only.	Standard topographic LiDAR should not be treated as bathymetry.	Use field survey or bathymetric methods where underwater terrain matters.

3. DEM, DSM, DTM, and volume calculations

Many disagreements disappear when the surface model is named correctly. "DEM" is often used casually to mean any elevation raster, but technical users should define whether the product is a visible-surface model or a bare-earth terrain model.

Term	Plain-language meaning	Common uses	Common mistake
DSM - Digital Surface Model	The visible top surface: ground where open, plus vegetation, roofs, vehicles, stockpiles, and other objects.	Stockpile volumes, canopy/structure height, visual surface modeling, obstruction analysis.	Using a DSM as if it were bare earth.
DTM - Digital Terrain Model	The terrain/ground surface after removing buildings, vegetation, and non-ground objects as much as the data allows.	Contours, drainage, floodplain analysis, cross-sections, cut/fill, restoration monitoring.	Assuming automatic classification is perfect without QA.
DEM - Digital Elevation Model	Often a broad term; many agencies use it to mean a bare-earth grid. Always define the intended surface.	Agency elevation products, terrain grids, hydrology, mapping, modeling.	Failing to state whether DEM means bare earth or visible surface.
CHM - Canopy Height Model	Height difference between a surface model and a ground model.	Vegetation structure, canopy height, habitat metrics, fuels/forestry analysis.	Creating it from a weak ground model.

3.1 Volume calculations: choose the correct surface first

Volume calculations are not automatically photogrammetry jobs or LiDAR jobs. They are surface-comparison jobs. The correct sensor depends on whether the required surface is the visible top surface, a bare-earth ground surface, a design surface, or a canopy/structure surface.

Volume / surface task	Photogrammetry fit	LiDAR fit	Practical guidance
Stockpile or material pile volume	Often excellent when the pile surface is visible, textured, and safe to image from multiple angles.	Also useful where texture is poor, lighting/shadow is difficult, edges are complex, or safety limits flight geometry.	Use photogrammetry confidently for clean exposed piles. Use LiDAR for low texture, shadows, safety, or complex edges.
Cut/fill against design grade	Good on open construction surfaces with consistent control and visible ground.	Stronger where vegetation, debris, or uneven ground hides the true surface.	Compare the correct surfaces: ground-to-design, not vegetation-top-to-design.
Floodplain or stream restoration earthwork	Useful for visible context and exposed surfaces.	Preferred for terrain, banks, swales, cross-sections, and floodplain tie-ins.	Use LiDAR terrain products with image context.
Canopy or habitat structure	Can create a visible canopy surface if imagery matches well.	Stronger for vertical structure and canopy/ground separation where returns allow.	Use LiDAR for structure; use multispectral/imagery when plant condition is the question.

Volume rule

For stockpiles, a DSM may be exactly what is needed because the pile surface is the object being measured. For drainage, contours, floodplain grading, and cut/fill to design, a bare-earth DTM/DEM is usually the safer surface.

4. Photogrammetry-created elevation models: strengths and cautions

Photogrammetry can produce dense point clouds, DSMs, textured meshes, orthomosaics, and terrain models through classification or filtering. In open, visible, well-textured terrain with good overlap and measured checkpoints, photogrammetric elevation products can be very strong.

The caution is that photogrammetry reconstructs what the camera can see and match between images. If the ground is hidden by grass, brush, trees, water, deep shadows, low texture, or moving vegetation, the model may represent the visible surface rather than the true ground. That does not mean the product is wrong; it means the surface must be named honestly.

Photogrammetry elevation model - pros	Photogrammetry elevation model - cons / cautions
Excellent visual detail and easy-to-understand orthomosaic context.	Cannot directly measure ground hidden by vegetation, water, debris, or shadows.
Efficient for exposed stockpiles, pads, roads, construction surfaces, and visible terrain.	A “terrain” model may be a filtered estimate rather than directly observed bare earth.
Strong public communication product; clients understand imagery quickly.	Low texture, glare, moving vegetation, or poor lighting can weaken image matching.
Good for repeat visual documentation when flight settings are consistent.	Accuracy claims need checkpoints, consistent datum/units, and careful QA.

5. LiDAR-created terrain models: strengths and cautions

LiDAR measures 3D returns from surfaces and can often record multiple returns through vegetation gaps. This makes it especially useful for bare-earth terrain, drainage, floodplain structure, bank geometry, cross-sections, and repeat monitoring. LiDAR also supports colorized point clouds, classified point clouds, bare-earth DEM/DTM products, hillshades, and contours when processed correctly.

LiDAR is not magic. Ground classification still requires review. Water and wet reflective surfaces can create voids or noise. Coordinate systems, vertical datums, base/correction settings, and checkpoints still matter. A clean-looking point cloud can still be wrong if the reference system is wrong.

LiDAR terrain model - pros	LiDAR terrain model - cons / cautions
Stronger starting point for bare-earth terrain under grass, brush, or partial canopy.	Water, wet mud, and reflective surfaces can cause voids/noise; do not treat standard topographic LiDAR as bathymetry.
Excellent for floodplain shape, swales, banks, drainage, cross-sections, and terrain monitoring.	Ground classification is not automatically perfect; visual QA is required.
Point clouds retain 3D evidence and allow multiple downstream products.	Files can be large and may need downsampling for sharing.
Measured checkpoints can provide independent validation of the terrain product.	Coordinate-system or vertical-datum mistakes can look like sensor error.

6. Application roadmap for pilots and technicians

Use this table as a first-pass decision guide. It is not meant to prove one method is always better. It is meant to help teams choose the correct tool for the requested deliverable.

Application / primary question	Photogrammetry fit	LiDAR fit	General direction
Orthomosaic / visual documentation	Best familiar deliverable; strong visual detail; efficient to share.	Useful support layer when 3D terrain is also needed.	Photogrammetry first; add LiDAR if terrain/3D is part of scope.
Bare-earth topo, contours, DTM	Good on open, visible, controlled ground.	Stronger when vegetation, brush, or mixed objects obscure ground.	LiDAR first for defensible terrain in restoration settings.
DSM / visible surface model	Excellent for roofs, stockpiles, exposed surfaces, and visible features.	Also strong for 3D geometry and object height when paired with DTM.	Either can work; define the surface.
Stockpile / material volume	Often efficient and accurate for visible, textured piles.	Useful for low texture, shadows, safety constraints, or complex edges.	Photogrammetry for clean piles; LiDAR for difficult conditions.
Cut/fill / design comparison	Good on clean construction surfaces.	Stronger where existing ground must be defended under vegetation or mixed terrain.	Use LiDAR when bare-earth ground matters.
Stream restoration / bank geometry	Strong visual context and public communication.	Strong terrain, banks, floodplain tie-ins, cross-sections, and monitoring.	Use both when possible.
Feeder swales / drainage discovery	Can show wet lines and vegetation patterns.	DTM/hillshade can reveal subtle terrain patterns.	LiDAR first; field verify candidate features.
Vegetation / habitat structure	Good for visual cover; multispectral helps plant-health questions.	Better for vertical structure and canopy/ground separation.	LiDAR for structure; imagery/spectral data for plant condition.

7. Linear versus multi-angle scan patterns

Many LiDAR systems allow different scan patterns. A linear scan pattern is typically the baseline for broad, open terrain mapping because it tends to produce a consistent point distribution and clean surface footprint. A multi-angle or star-style pattern can be useful where vegetation, banks, brush, or complex edges may benefit from multiple viewing directions.

Scan pattern	General purpose	Strengths	Watch-outs
Linear scan pattern	Baseline terrain mapping and topo/DTM work.	Consistent point distribution; cleaner footprint; good for open terrain, swales, roads, pads, and broad topo.	May not provide as much multi-angle behavior around dense vegetation or complex vertical edges.
Multi-angle / star-style scan pattern	Vegetation, forest, dense edges, banks, and complex geometry.	Multiple scan angles may improve side-looking returns and vegetation/edge behavior.	Can create more irregular edge artifacts and may reduce usable density in some open-terrain datasets.

Validation-trial takeaway

In a small controlled validation trial over the same area, both scan patterns processed successfully. The linear pattern produced a cleaner usable footprint and higher density. The multi-angle pattern was usable but showed more irregular edge artifacts. For open topo and drainage terrain, use linear as the baseline. Reserve multi-angle scanning for vegetation or complex edge conditions where it adds demonstrable value.

8. Ground control points and checkpoints

Ground control points and checkpoints are related, but they are not the same. A control point is used to adjust or constrain a model. A checkpoint is held out as an independent test of the result. Public-facing reports should make this distinction clear.

Workflow	How measured points are used	Primary risk if used poorly	Recommended opinion
Photogrammetry	Control points are commonly marked in images to improve georeferencing and alignment. Checkpoints independently test the final result.	Using every measured point as control leaves no independent accuracy check.	Use well-distributed control when required, but reserve independent checkpoints.
LiDAR	The point cloud is primarily georeferenced through GNSS/RTK or PPK, IMU/POS trajectory, scanner calibration, and processing. Points should usually be used first as checkpoints.	Using points to hide a coordinate-system, datum, or correction problem can mask the real issue.	Use measured points first as independent checks. Use control only after confirming datum, units, base/correction quality, and a consistent bias.
Training / public demonstration	Measured points show the workflow is being checked against field evidence, not accepted blindly.	Reports can sound more accurate than they are if checkpoints and control points are not separated.	Say clearly what was used as control and what was held out as independent check data.

Practical rule

For the first LiDAR workflow on a new project, call measured points checkpoints first, not GCPs. Process the LiDAR data, compare against independent checkpoints, then decide whether any control adjustment is justified.

9. Product-neutral validation trial: practical lessons

A controlled field validation compared a linear scan pattern and a multi-angle scan pattern over the same test area using the same boundary, similar height, the same coordinate system, and the same checkpoint file. The goal was workflow validation and scan-mode comparison, not final survey certification.

Run	Positioning status	Density result	Checkpoint note	Interpretation
Linear baseline point cloud	100% position fix; 100% post-processed fix in the report.	Average density 157 pts/m2; 1:500 non-conforming grid ratio 0.26%.	5 checkpoints listed; residual/RMSE fields were not populated.	Successful baseline; higher density than multi-angle baseline.
Linear ground/DEM	100% position fix; 100% post-processed fix in the report.	Ground average density 148 pts/m2; 1:500 non-conforming grid ratio 0.57%.	5 checkpoints listed; residual fields were not populated.	Successful ground classification and terrain model; cleanest usable footprint.
Multi-angle baseline point cloud	100% position fix; 100% post-processed fix in the report.	Average density 141 pts/m2; 1:500 non-conforming grid ratio 0.63%.	5 checkpoints listed; residual fields were not populated.	Successful baseline; lower density than linear.
Multi-angle ground/DEM	100% position fix; 100% post-processed fix in the report.	Ground average density 133 pts/m2; 1:500 non-conforming grid ratio 0.90%.	5 checkpoints listed; residual fields were not populated.	Successful terrain model; central classification comparable, but more ragged edges.

Validation caveat

This trial supports a practical scan-pattern decision, but it should not be presented as a final accuracy certification because checkpoint residual/RMSE fields were not populated in the processing reports. Future paid deliverables should include a clear checkpoint residual workflow or downstream accuracy check before making accuracy claims.

10. Recommended public-facing language

The following language is intentionally plain and product neutral. It can be used in website copy, LinkedIn posts, proposal introductions, and training discussions.

Topic	Suggested language
LiDAR vs photogrammetry	Photogrammetry is excellent for visual mapping; LiDAR is strongest when we need terrain and 3D structure. For restoration work, the best result often comes from using both.
DEM vs DSM	A DSM is the top visible surface. A DTM or bare-earth DEM is the ground surface after vegetation and structures are removed. Many disagreements disappear once we state which surface is being delivered.
Photogrammetry elevation products	Photogrammetry can produce excellent elevation surfaces when the surface is visible, textured, and well controlled. It is not automatically a bare-earth model when vegetation, water, or objects hide the ground.
LiDAR value statement	LiDAR can create a colorized point cloud, ground-classified surface, DEM/DTM, hillshade, contours, and cross-sections that support restoration interpretation and monitoring.

Topic	Suggested language
Water limitation	Standard topographic LiDAR is not bathymetric LiDAR. Low water helps because more ground may be exposed, but submerged channel bottom should be checked by field survey or other appropriate methods.
Validation discipline	Measured points should not all be used to force a model. Some points should be held out as independent checks so the project can report how the model compared to field measurements.

10.1 Short website or LinkedIn excerpt

Post-ready excerpt

Photogrammetry and LiDAR should not be treated as competing religions. They answer different questions. Photogrammetry is often the best tool for visual maps and visible-surface documentation. LiDAR becomes the stronger tool when the project needs bare-earth terrain, drainage, floodplain shape, cross-sections, or ground under vegetation. The key is to define the surface first: DSM, DTM, DEM, or volume surface. Once the surface is defined, the sensor choice usually becomes obvious.

11. Source notes

These notes support the general technical terminology used in this public-facing guidance. Software behavior, sensors, and project specifications vary; project teams should confirm current workflows, coordinate systems, vertical datums, and applicable standards before relying on outputs for formal deliverables.

Reference	Used for
USGS: What is a digital elevation model?	Bare-earth DEM terminology and agency-style elevation language.
NEON: What is a CHM, DSM and DTM?	Plain-language distinction between canopy, surface, and terrain models.
ASPRS Positional Accuracy Standards for Digital Geospatial Data	General professional context for reporting positional accuracy and validating geospatial products.
Internal product-neutral validation notes	Scan-pattern comparison, density results, checkpoint handling, and restoration-mapping decision guidance.

Closing takeaway

For restoration mapping, introduce LiDAR as a terrain and monitoring tool. Keep photogrammetry as the strong visual-map workflow. The most defensible projects state the surface being delivered, document the coordinate system and vertical datum, reserve independent checkpoints, and choose the sensor based on the application.