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Utah State UNIVERSITY

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Using an Integrated, Remote-Sensing Methodology to Evaluate the Effects of Dam Operations on Fine-Grained Sediment Storage and Sand Bar Restoration in the Eastern Grand Canyon

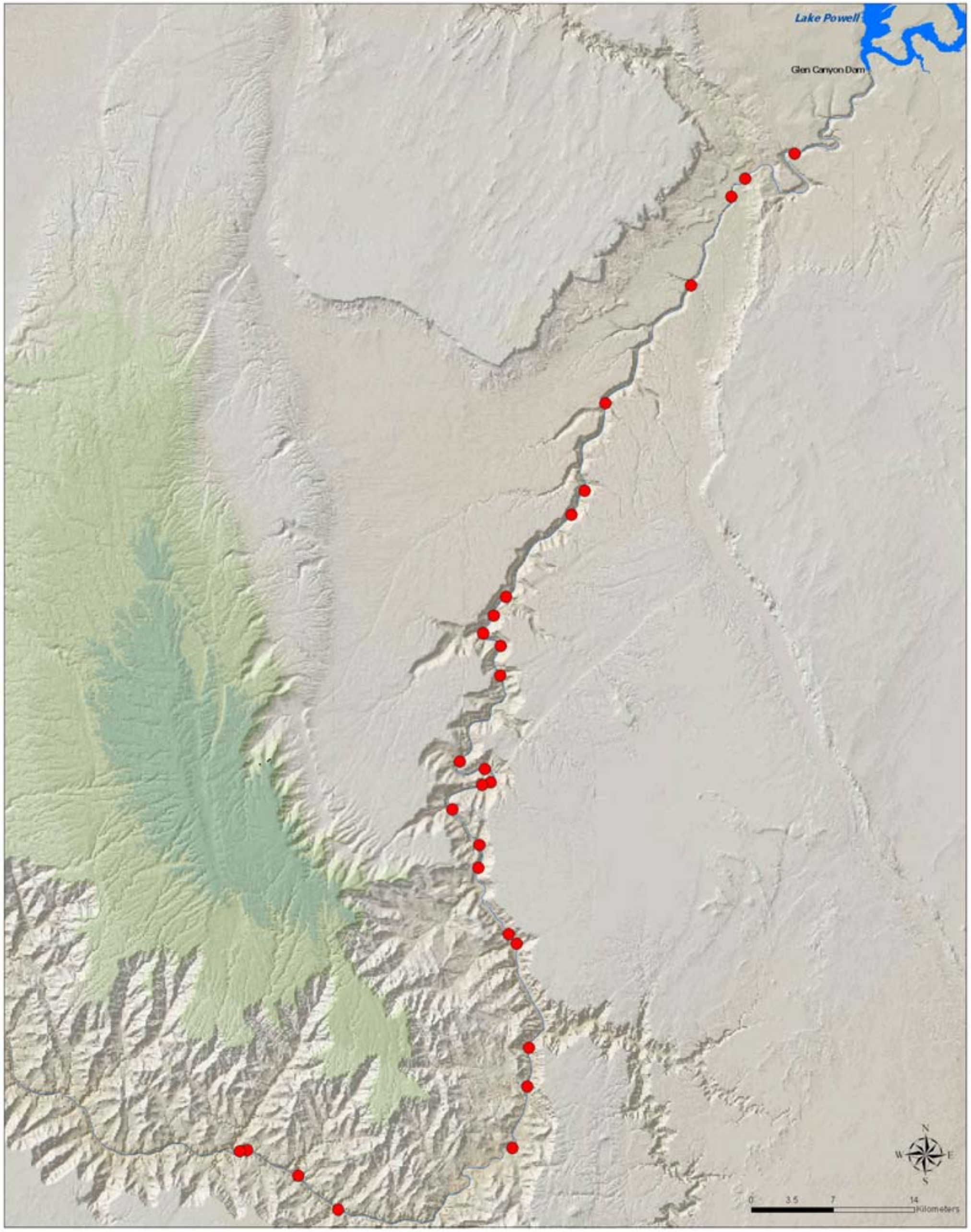
Fine-Grained Integrated Sediment Team (FIST)

Primary Goals

- **Determine changes in sand storage in the Colorado River Ecosystem, including changes in sand bar morphology, volume, area and grain-size in selected bars and reaches.**
- **Relate observed changes to dam releases and tributary sediment input.**
- **Provide advice on timing, magnitude, duration and ramping rates for artificial floods.**

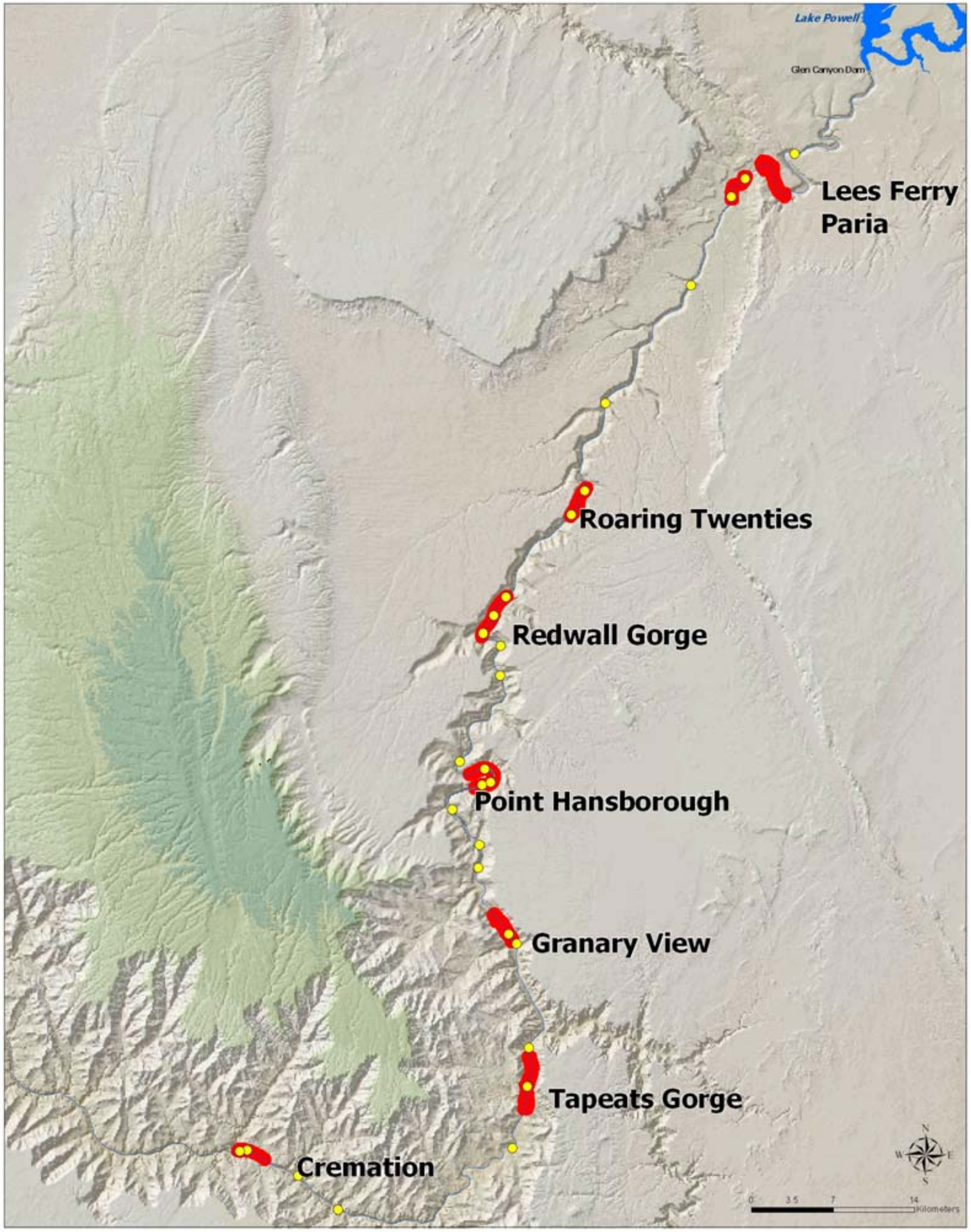
Fine-Grained Sediment-Storage Monitoring

- Prior to 2000, sediment monitoring in the Eastern Grand Canyon had been limited to 27 eddy bars.
- Sediment surfaces were constructed from 1000s of survey points collected on the bars using standard survey equipment.
- Because of system variability, these were deemed inadequate for extrapolating system-wide sand-storage changes.



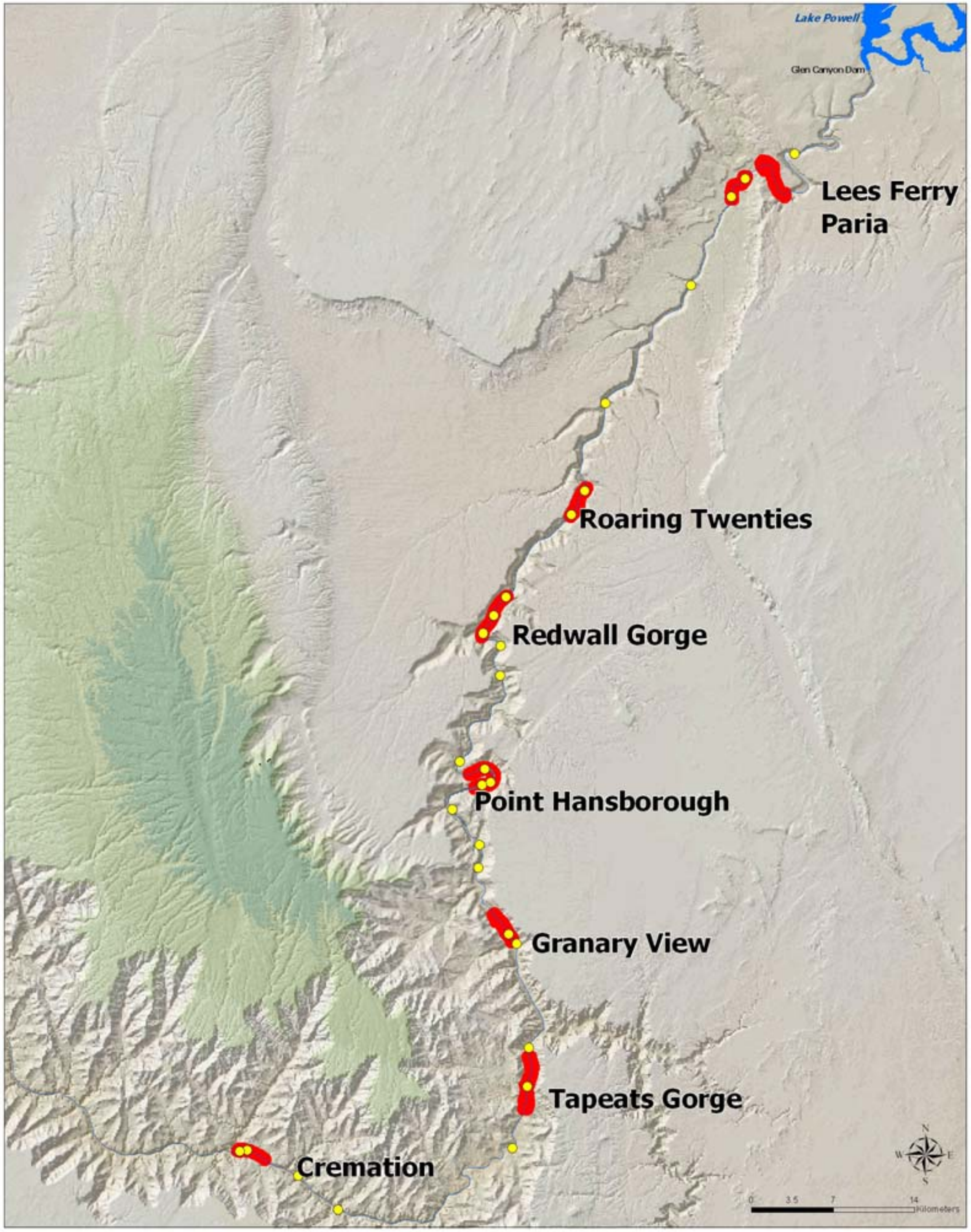
The Reach-Based Approach

- In 2000, these monitoring beaches were supplemented with 8 FIST study reaches, ranging from 3 to 5 kilometers in length.
- The goal is to better understand changes in sand storage over longer reaches for sand budgeting and for verifying conceptual and quantitative model simulations.



Methods

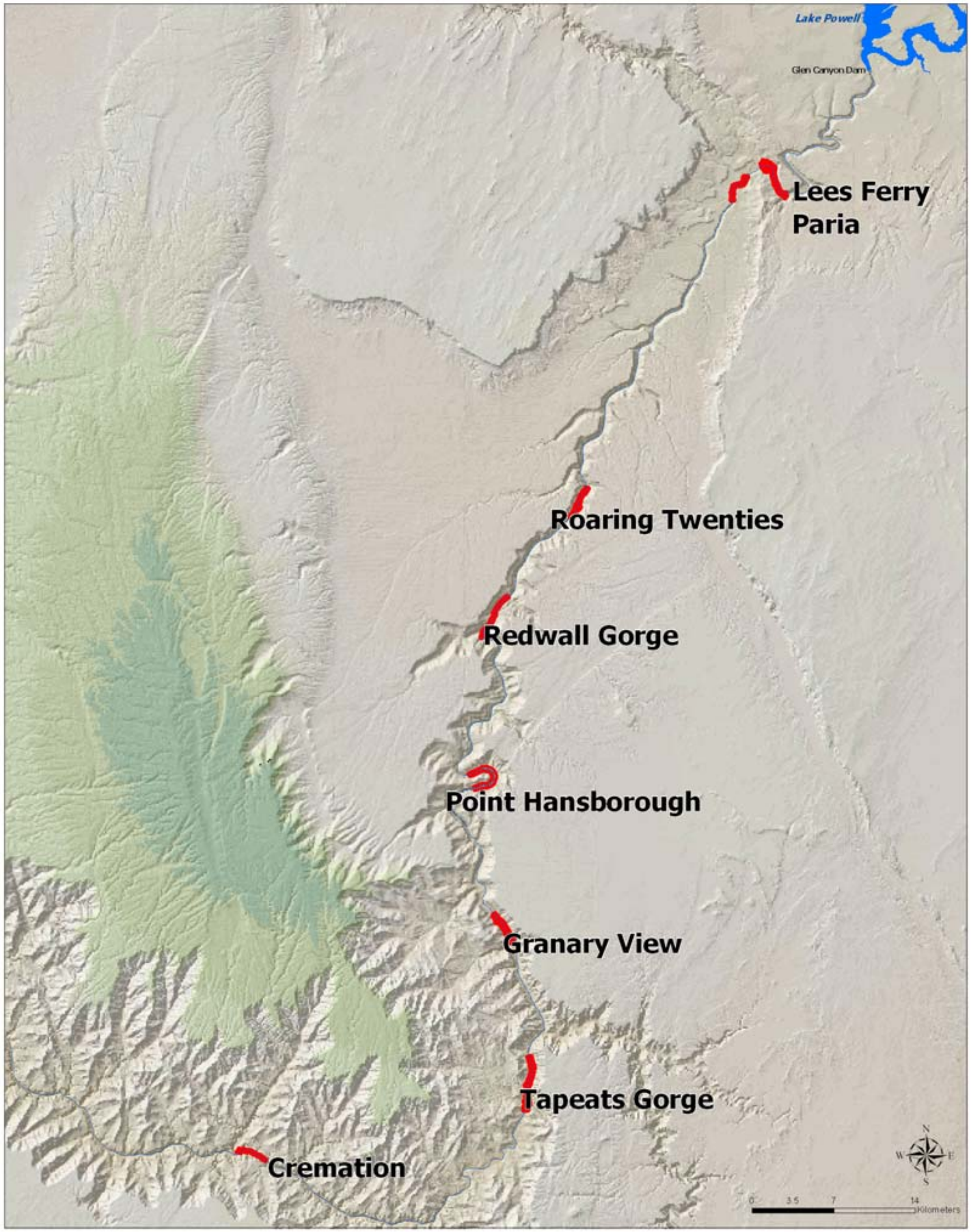
- Construct composite topographic surfaces for each monitoring time period.
- Determine the composition of these sediment surfaces.
- Quantify volumetric and compositional sediment changes by geomorphic zone (channel, eddies, channel margin) and stage between time periods.



Composite Topographic Surfaces

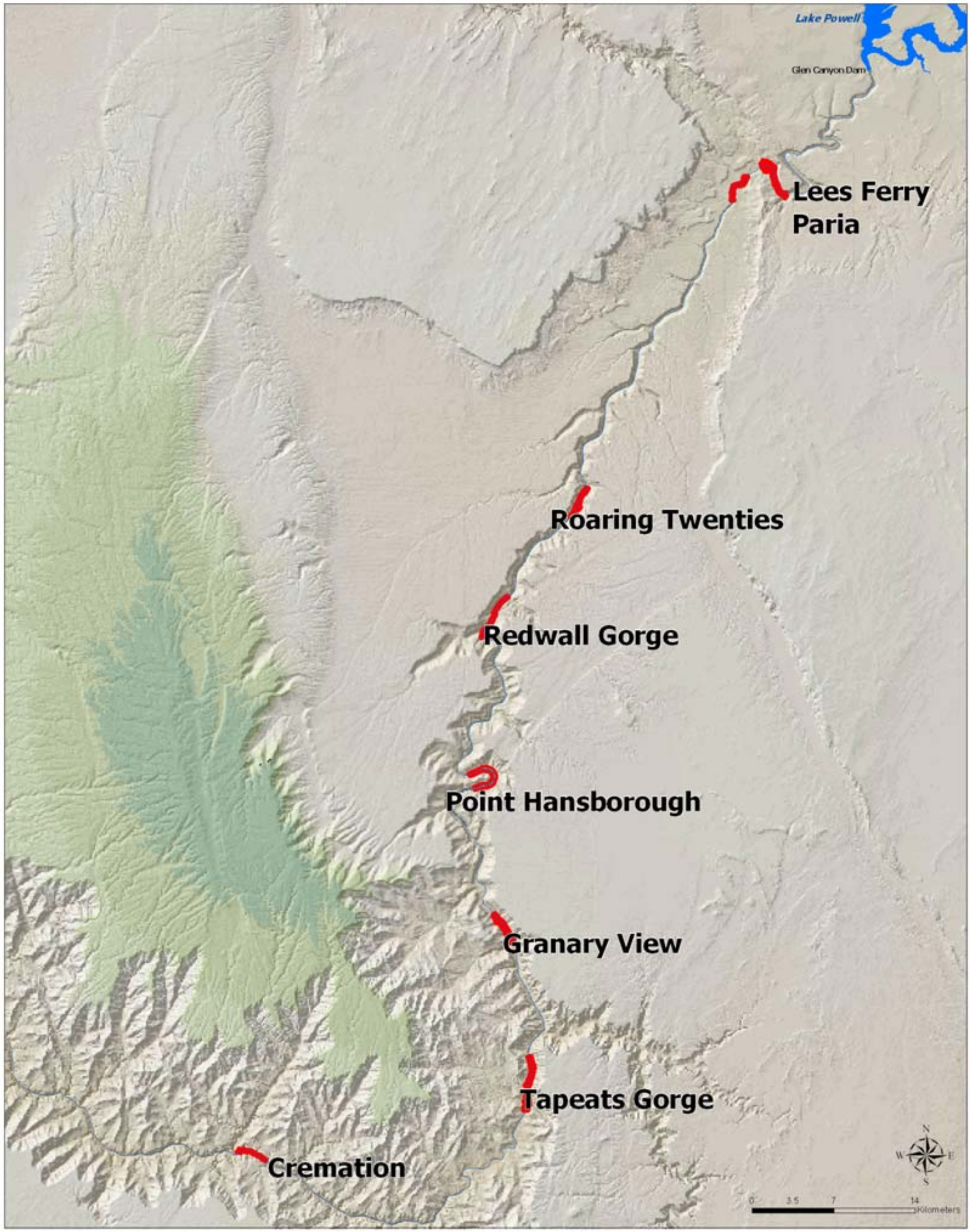
Topographic surfaces are constructed from a combination of...

- Ground-based field surveys
- Hydrographic field surveys (multi-beam)
- Photogrammetrically derived topographic data
- Topographic data determined from LiDAR.



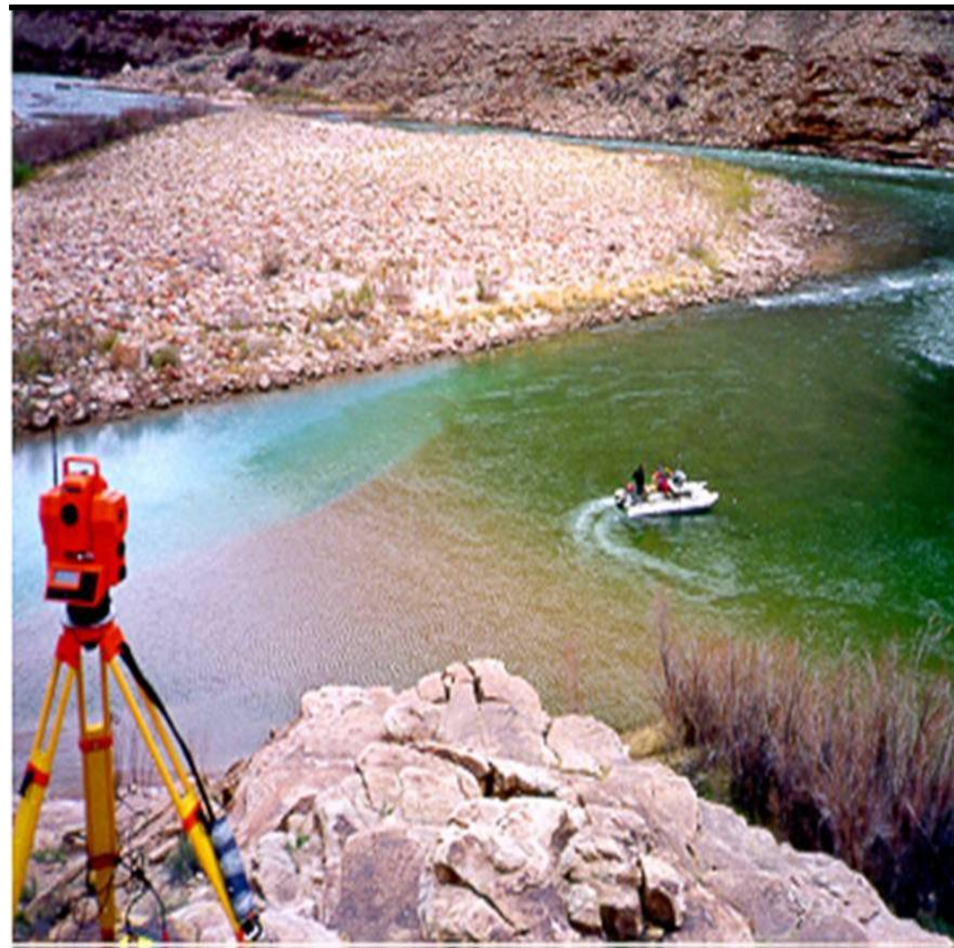
Data collected with each of these methods were designed to meet GCMRC's horizontal and vertical accuracy standards.

- Horizontal accuracy of better than 30 cm.
- Vertical accuracy of better than 25 cm.

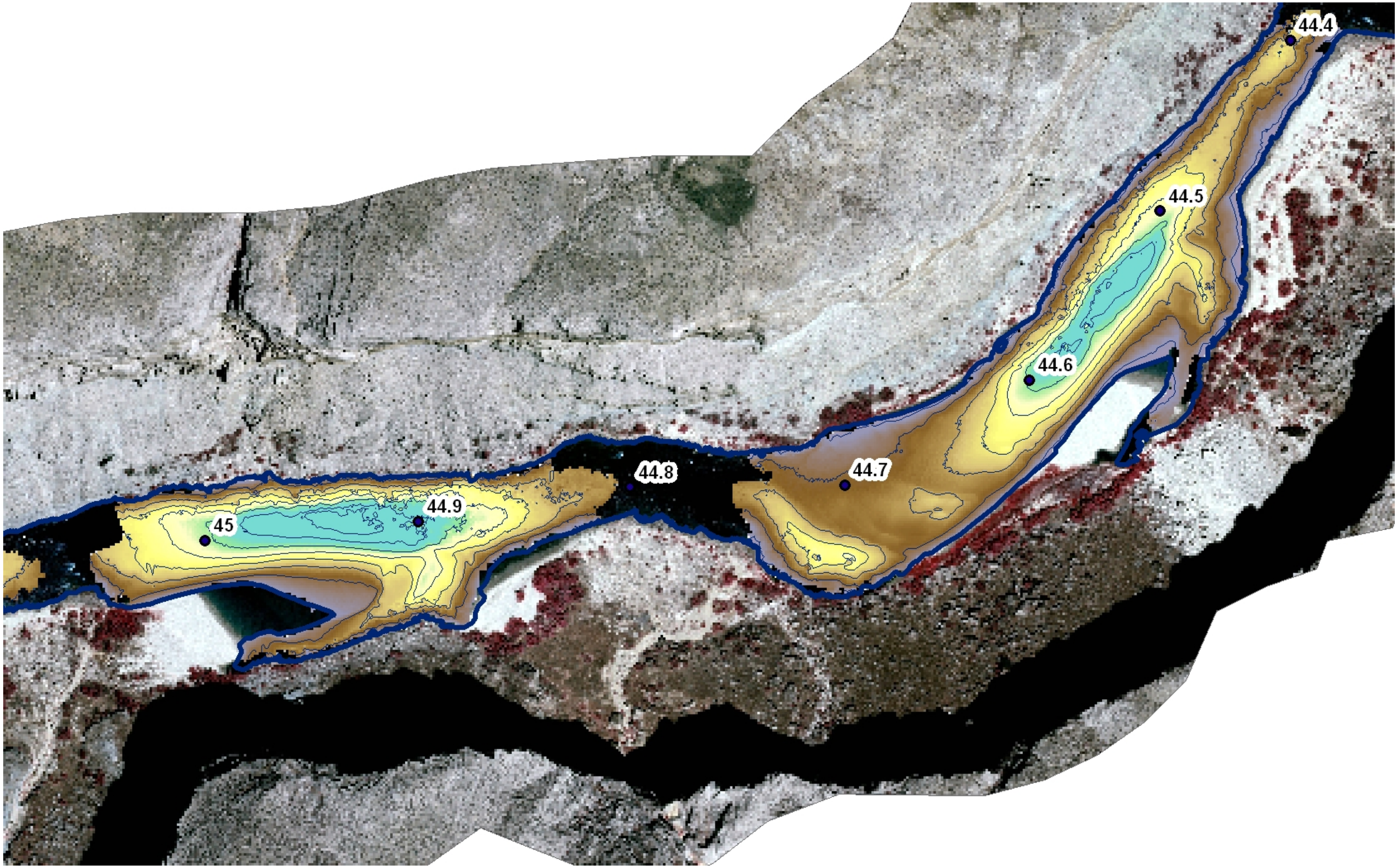


Hydrographic Field Surveys

- Collect elevations of surfaces below a stage of 8,000 ft3/s.
- Spatial resolution of ~ 25 cm or 16 points per square meter for large areas.
- Horizontal accuracy better than 15 cm.
- Vertical accuracy better than 15 cm.

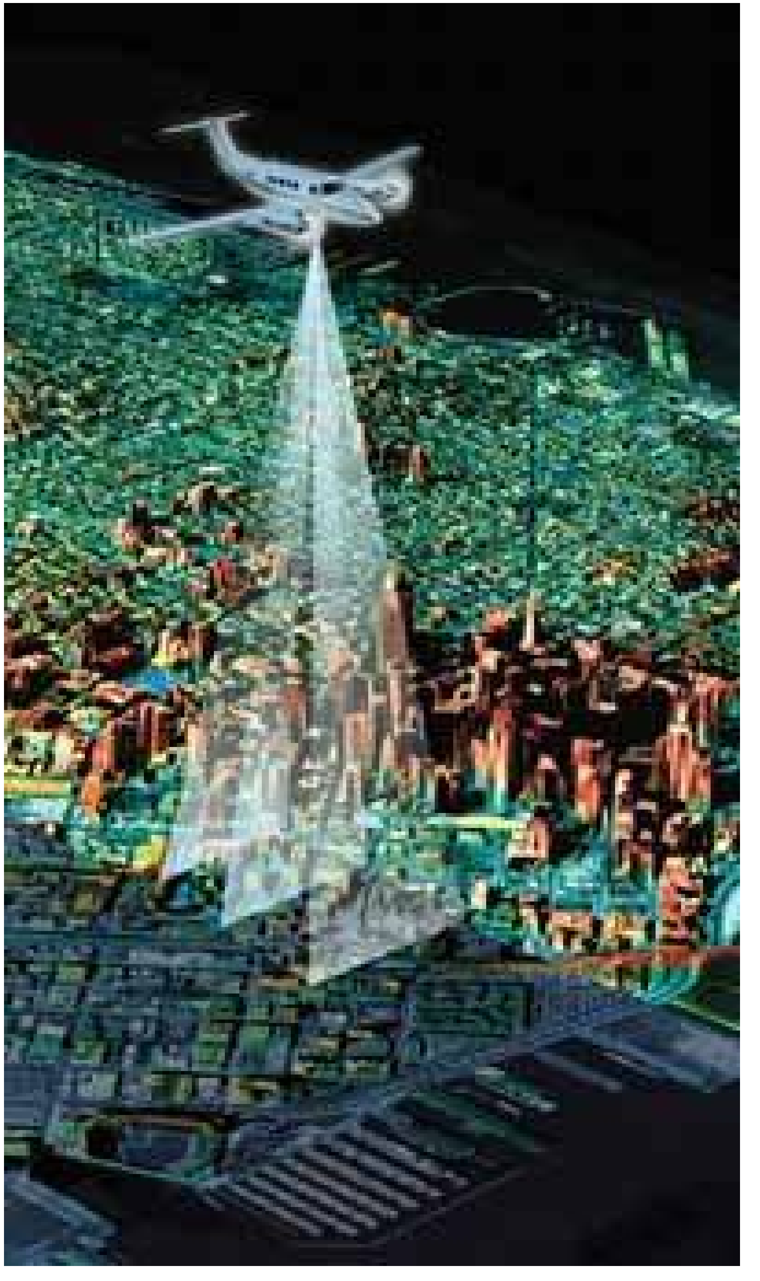


Hydrographic Survey Surface: 12/04

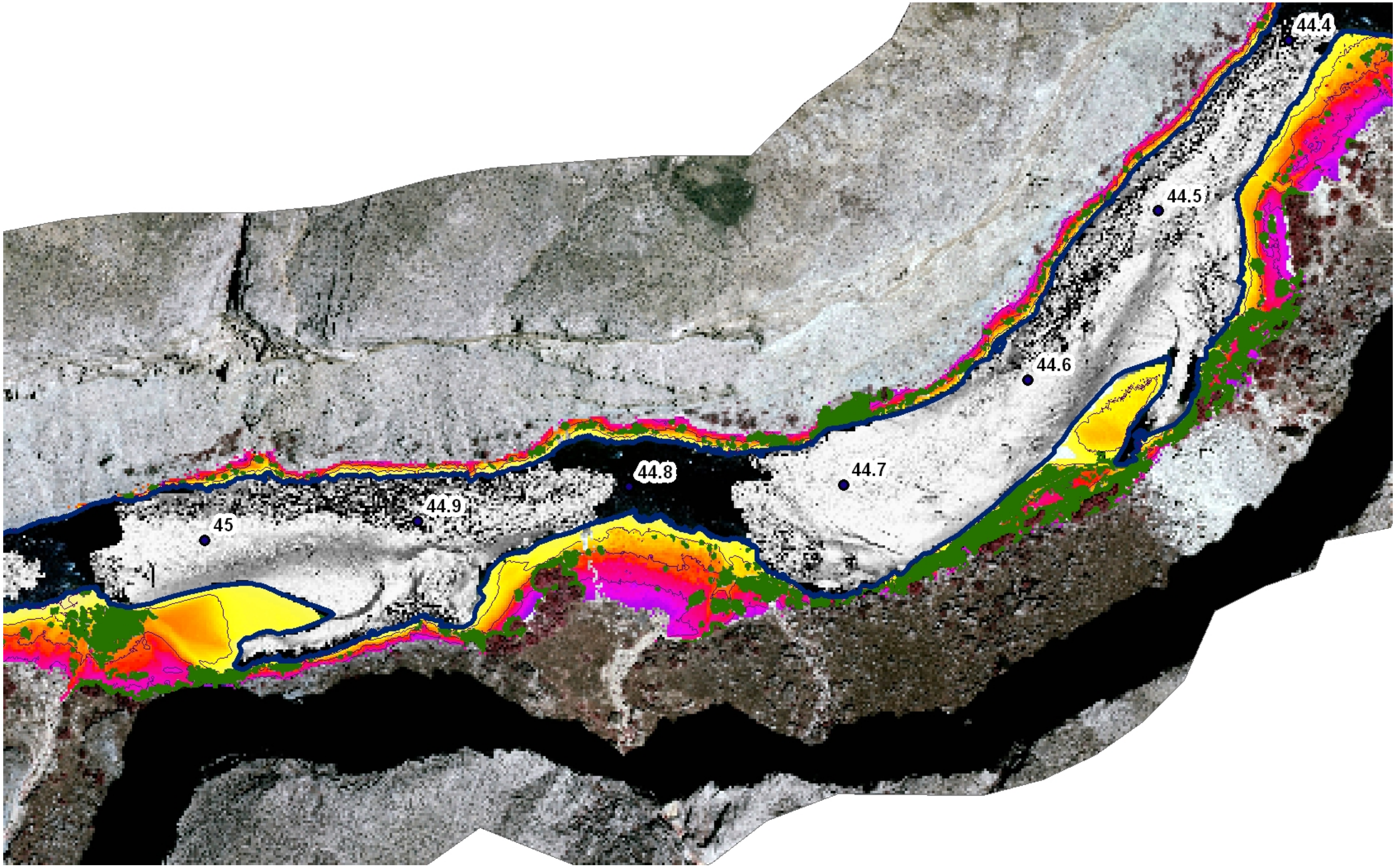


LiDAR

- Collect elevations of surfaces above a stage of 8,000 ft3/s.
- Spatial resolution of ~ 50 cm or 4 to 9 points per square meter for large areas.
- Unadjusted vertical accuracy less than 25 cm (comparisons to Ground-Based Field Surveys).
- Adjusted vertical accuracy less than 10 cm (adjusted based on RMSE of Ground Survey differences).



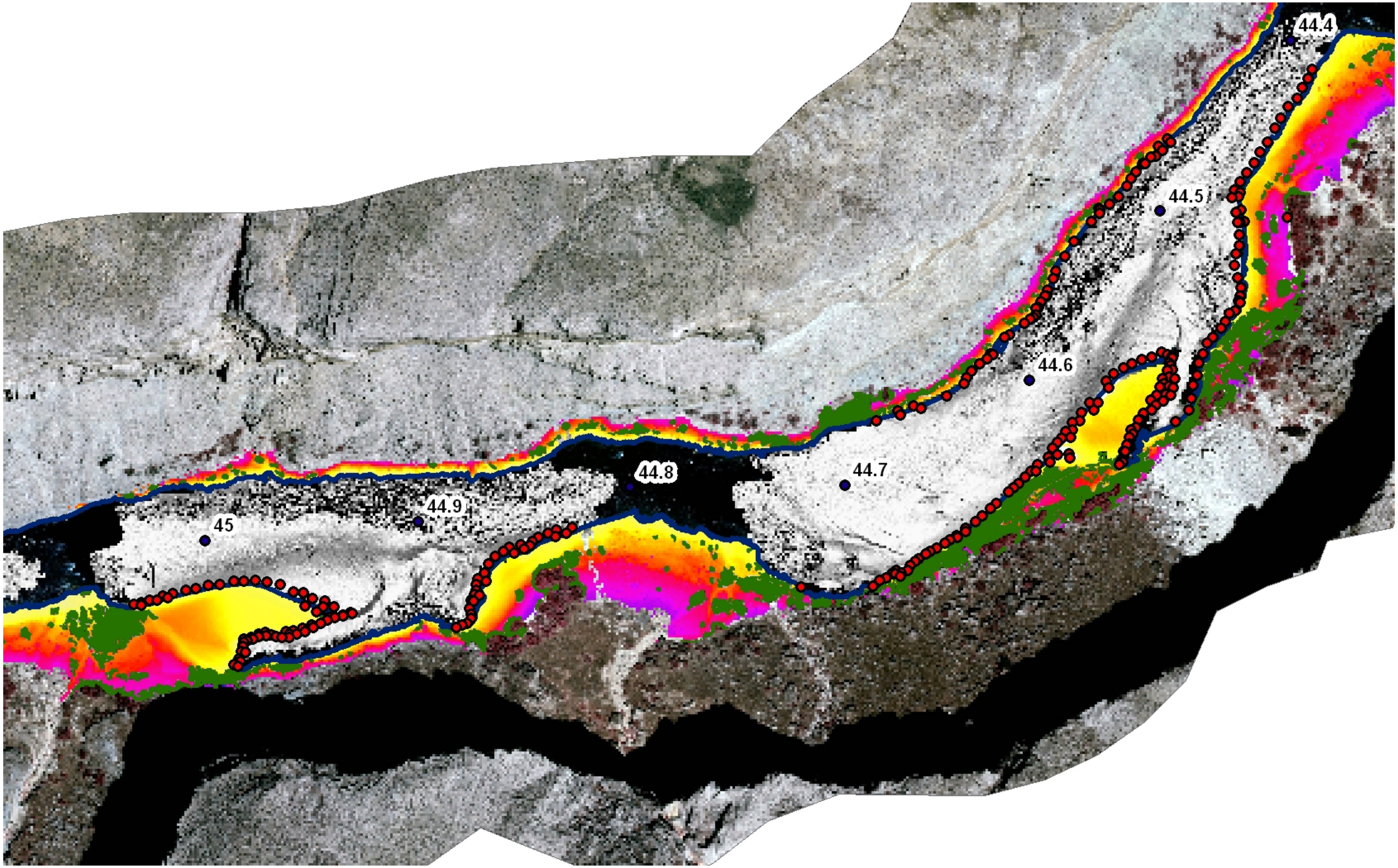
LiDAR Surface: 12/04



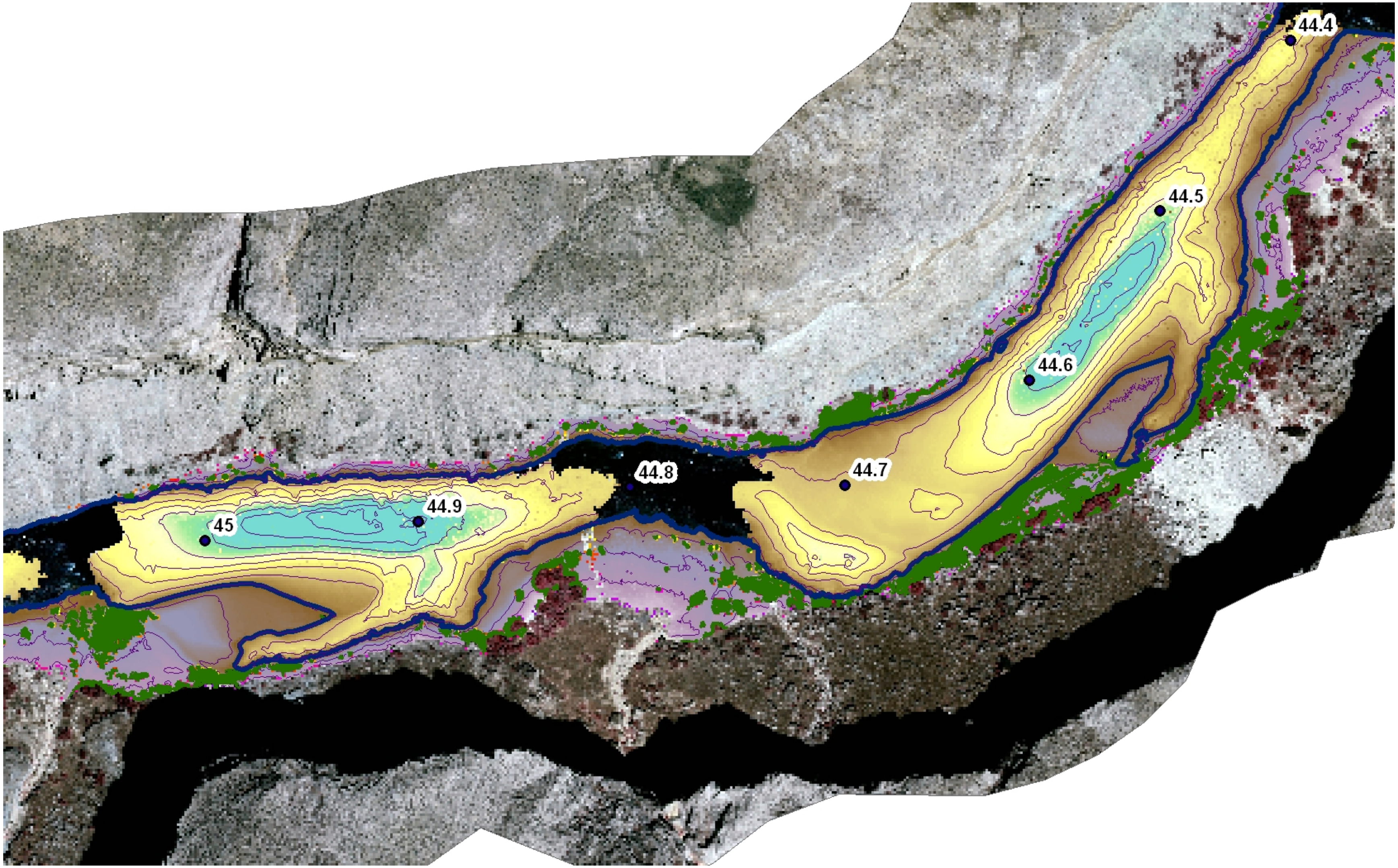
Ground-Based Field Surveys

- Tied to an improved survey-control network
- Provide ground control for LiDAR and Multi-Beam operations.
- Provide data in shallow water areas not covered by LiDAR and Multi-Beam.
- Horizontal accuracy of 5 to 10 cm.
- Vertical accuracy of 3 to 5 cm.
- Spatial resolution of 1 point per 25 to 100 square meters for small areas.

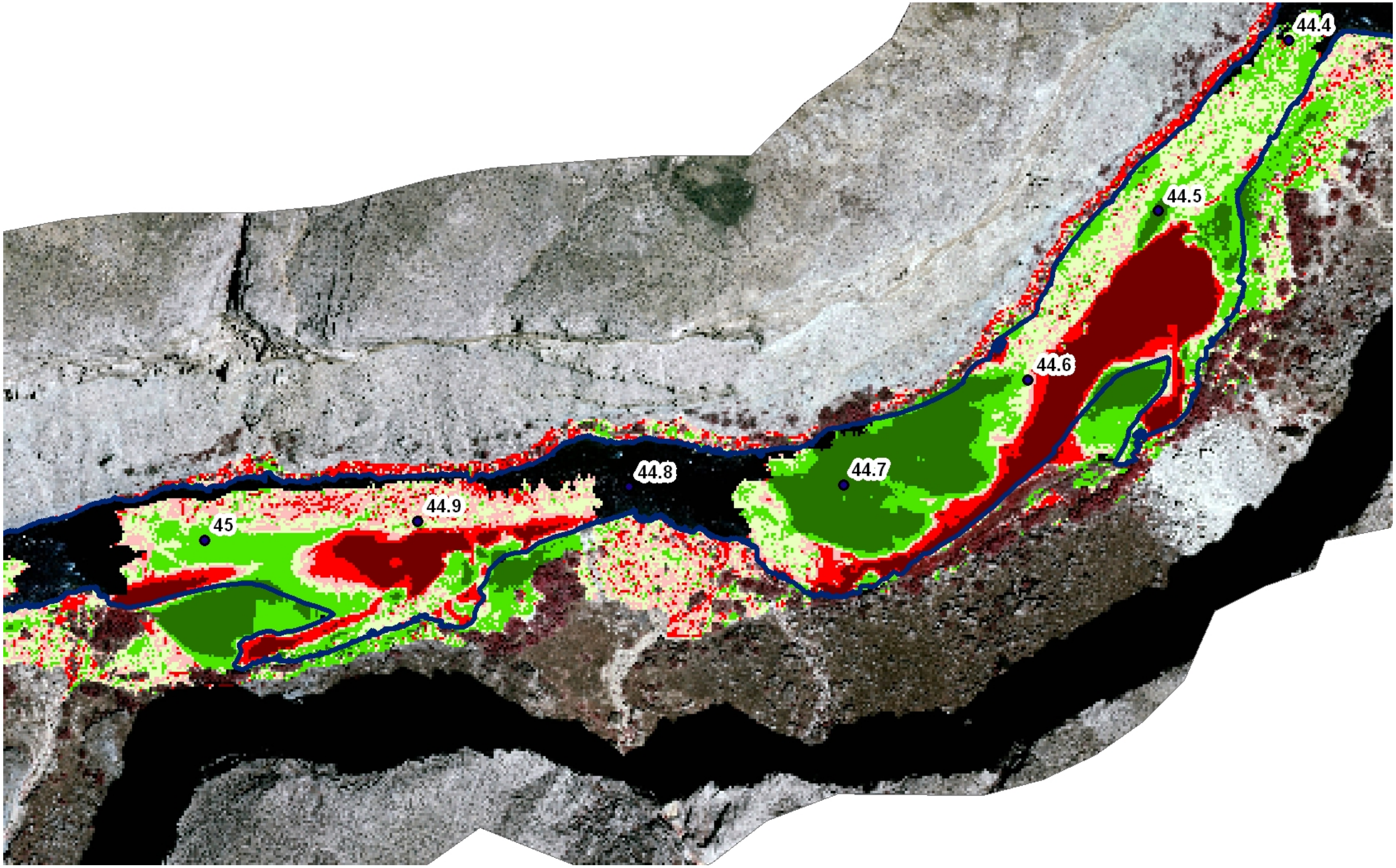
Shallow-Water Connection Between LiDAR and Multi-Beam: 12/04



Final Composite Surface: 12/04



Quantify Volumetric Change Between Time Periods: 11/04 to 12/04



Surface composition

Surface classification by sediment size…How much sand?

- An underwater microscope (the flying eyeball) that performs in-situ analyses of bed-sediment grain size.
- Bed-texture classification from Multi-Beam.
- Acoustic classification from back scatter.

Surface Texture