

INTRODUCTION

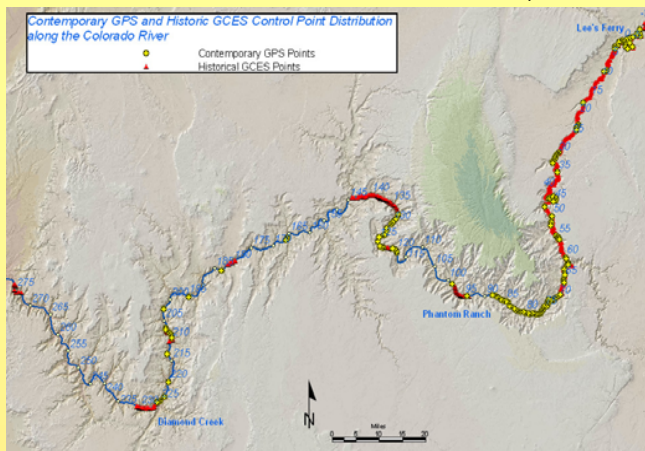
The Survey department's mission is to provide survey support for spatial measurement and referencing of scientific data collected in the Colorado River ecosystem by GCMRC programs. The Survey department establishes and maintains accurate geographic control in the Canyon that is essential for accurate geo-referencing of remotely sensed data and spatial analysis of resource data using modern image processing and GIS technologies. These technologies are critical to the integration and analysis of the diverse scientific data that have been collected in the Canyon over the past 15 years. Products requiring accurate positional control include precise sample location coordinates, topographic maps, river channel maps and cross sections, digital elevation models, and digital terrain models. This information provides the basis for spatial analysis of data within the ecosystem using GIS software that in turn provides area and volumetric change detection capabilities of resources.

Scientists use the control points to establish geographic coordinates for research sites as well as all other research related mapping in the Grand Canyon.

DEVELOPMENT OF A CONTROL POINT DATABASE

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Control Point distribution along the Colorado River between Glen Canyon Dam and Diamond Creek. Red marks signify points with historic GCES coordinate values, while yellow marks signify points with GPS derived coordinate values.



Control Points are used to geo-reference a variety of data collected in the canyon.

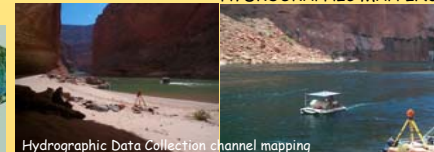
REMOTE SENSING



TOPOGRAPHIC MAPPING



HYDROGRAPHIC MAPPING



Hydrographic Data Collection channel mapping

CONTROL POINTS



The control network is the positional infrastructure for all surveying, mapping, and remote sensing operations in the Grand Canyon implemented by GCMRC. Mapping projects require up to 2-centimeter local accuracy and 5-centimeter accuracy overall.



Control Points are located both, near the river, or a short hike or scramble up from the river.



GPS Technology or Conventional Survey methods are used to geo-reference Control Points.

Various types of control points found along the Colorado River. Note the X's are difficult to see on light colored rock and hard rocks (metamorphic or granite), and the quality of incision varies.



Examples of multiple control points located within meters of each other. Note middle photo of control points located within 10 cm of each other.

CONTROL POINT DATABASE

Motive for Establishing a Control Point Database

- Assign each control point a unique point identifier.
- Provide a reference to historical geographic coordinates.
- Update historical geodetic coordinates to modern, universal datum.
- Update point descriptions and site descriptions.
- Provide control point precision and accuracy statistics to researchers.
- Provide researchers and contractors a resource to independently geo-reference collected field data.

GCMRC Control Point Naming Convention

Describes point location based on:

- general location,
- point mile up or down river, and
- side of river

GCMRC Name	General Location	River Mile	River Side
GL-01045L	Glen Canyon	-1.045	Left
MC055802L	Marble Canyon	55.805	Left
GR225565R	Grand Canyon	225.565	Right

Database Input Page

Database Products

- Printed Output of Control Point Information
- Printed Output of Control Point Images
- Printed Control Point Atlas on Aerial Photographs*
- Digital Control Point Atlas
- Web Interface to access Control Point Database
- Other needed products

*Note two names associated with the GPS point. A site visit verified the existence of only one point at the GPS location, and verified the non-existence of the upstream point (GR132218R located at the bottom of the photo).

Control Point Descriptions

GCES Descriptions associated a project or a person to a control point rather than detailing information about the location of the point. Updated GCMRC descriptions detail directions on how to find the point using distances and bearings to obvious landmarks.

GCES Descriptions

GCMRC Name	GCES Description
GR088021R	USGS Brass Cap
MC002131R	GS-F2bolt
MC032089R	Protiva X
MC043699L	Jeff's US crack
MC043701L	Jeff's DS crack in rock
MC044914L	#356 US Willie's
MC055671R	IVO ID PT

Updated GCMRC Descriptions

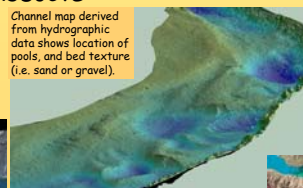
Point Description
3CM X 3CM CHELSEA "X" ON EDGE OF BLOCKY BASALT OUTCROP AT GROUND LEVEL. APPROXIMATELY .75 METER EAST OF EDGE. VERY VISIBLE X. Fd X IN BASALT LEDGE DS GALLOWAY

Site Description
ON DEBRI FAN OF DUBINDORF AT BASE OF BASALT OUTCROP IMMEDIATELY DOWNSTREAM OF DRY WASH THAT OUTPUTS AT TOP OF RAPID, ON RIVER SIDE OF PRONOUNCED TRAIL 25 METERS NORTH OF WASH AND 44 METERS EAST OF RIVER.

DATA PRODUCTS

Geo-referenced airphoto maps are used for classification analysis, monitoring analysis, and locating study sites.

Control Points are used to geo-reference aerial photography and/or verify accuracy of geo-referenced aerial photography.



Digital Elevation Models derived from remotely sensed orthophotography and/or lidar data requiring control points for geo-referencing.



Printed Output



Database Images



Control Point Atlas

