

# GROUND TARGETS

## A Guide for Establishing New GCPs

### Introduction

This document is a guide for establishing new ground targets in a project area prior to a satellite survey project. Once established, ground targets can be surveyed and used as ground control points (GCPs) for future survey projects.

This document is in line with the [USGS](#) methodology for ground controls.

### About GCPs

A ground control point (GCP) is a physical Target on the ground that has been accurately surveyed by a qualified GPS surveyor. GCPs can be used for calibration and alignment future surveys.

In general, the vertical accuracy of mapping and surveying projects increases with the density of GCPs. However, the relationship between GCP density and survey accuracy is not directly linear.

There are several other factors that also influence survey accuracy. These include, but are not limited to, the satellite photo angles and the reliability of survey data for GCPs.

Using photos from Maxar's WorldView satellites, it is possible to produce surveys that are engineering-grade even with no GCPs.

With the addition of reliable GCPs, we can improve the vertical accuracy of our survey data to better than 15 cm RMSE.



# Establishing New GCPs

To establish a GCP in a project area, follow these steps:

## Step 1: Determine the Number of Targets within the Project Area

An experienced survey provider or engineering consultant can help determine the number of Targets to construct within your project area.

## Step 2: Choose Target Locations

Each Target location should be:

- on **low-grade terrain** (less than 20% slope)
- in areas of **sparse or no vegetation**
- **20 m or more away** from abrupt changes in elevation (e.g. cliff) or infrastructure (e.g. buildings)

## Step 3: Establish Targets

Construct a physical target on the ground. See *Ground Target Guidelines on page 5*.

## Step 4: Use Pre-Existing Project Survey Benchmarks (if possible)

If an existing project survey Benchmark was previously used, all new Targets must be surveyed relative to that Benchmark.

For Benchmarks, accuracy should be better than 10 cm (in x, y, and z).

## Step 5: Record GPS Data

For each Target, record the GPS data while simultaneously recording the GPS data for the Benchmark. See *Recording Guidelines on page 4*.



# Submitting Your Control Data

When you submit your ground control data, please supply these two types of information.

## A. Benchmark and Target Information

For each Target and Benchmark, please provide the following information.

Based on this information, PhotoSat can confirm the accuracy of the Benchmark and Targets that are to serve as the reference for future survey projects.

Item	Remarks
<b>Equipment</b>	<b>Base:</b> Make and model number of the benchmark dual frequency geodetic quality GPS receiver and antenna  <b>Rover:</b> Make and model number of the ground control point dual frequency geodetic quality GPS receiver and antenna
<b>Photograph</b>	Digital photographs of the GPS antennas taken from 3 different angles while the Benchmark and the Target is being surveyed
<b>Recording Time</b>	Simultaneous GPS recording at the survey Benchmark and the ground control Target
<b>Data Format</b>	Raw GPS data for both the base and the rover in either RINEX or Compact RINEX format (provide one file for each occupation of each point)
<b>Antenna Height</b>	<b>Base:</b> Height of the base GPS antenna reference point (ARP) above the Benchmark  <b>Rover:</b> Height of the rover GPS ARP above the bare ground surface at the centre of the ground control Target
<b>ARP to APC</b>	<b>Base:</b> Distance between the antenna reference point (ARP) and the antenna phase centre (APC) for the base  <b>Rover:</b> Distance between the antenna reference point (ARP) and the antenna phase centre (APC) for the rover

## B. Survey Coordinate Data

In addition, please provide a spreadsheet containing the following survey coordinate data.

	A	B	C	D	E	F	G	H	I	J
1	RINEX Filename	Site ID	Antenna ARP Height	UTM East	UTM North	East	North	Ellipsoidal	Orthometric Elevation	Ground Target Description
2				WGS84		Project Projection and Datum			Height above Sea Level (EGM2008 Geoid)	
3	<Benchmark>.15o									
4	<Target 1>.15o									
5	<Target 2>.15o									
6	<Target 3>.15o									
7	<Target n>.15o									
8										
9										





## Recording Guidelines

Follow these guidelines when conducting the survey of each Target.

### Project Survey Benchmarks

Targets must be surveyed relative to a Benchmark. If there is no pre-existing survey Benchmark on the project, one of the newly established GCPs may be used as the Benchmark. This point will serve as the Benchmark for all future topography projects.

For more information, review these guidelines:

**International Association of Oil & Gas:** [Guidelines for GNSS Positioning](#)

**Natural Resources Canada:** [On-line Precise Point Positioning](#)

### Survey Method and Accuracy

Each Target may be surveyed with a total station using laser theodolite or differential GPS. For each Target, the survey must meet these accuracy requirements:

- accurate to at least 10 cm (in x, y, and z), relative to the Benchmark
- elevations must represent the mean elevation of the ground within 3 m of the centre of the Target

### Minimum Recording Time

To achieve 10 cm accuracy, Benchmarks and Targets must be surveyed simultaneously for a minimum time.

	Total Survey Time	Remarks
<b>Benchmarks</b>	10 hrs (minimum) 24 hrs (Oil & Gas)	--
<b>Targets</b>	30 min + (1 min per km*)	*Distance between the Target and the Benchmark

# Ground Target Guidelines

Follow these guidelines when constructing new ground Targets.

## Number of Targets

For projects up to 100 km<sup>2</sup>, we usually request three ground control Targets accurate to 10 cm within the project area.

One ground control Target is sufficient to match the stereo satellite photos for the topography project. The other points are used to confirm the accuracy of the first control point.

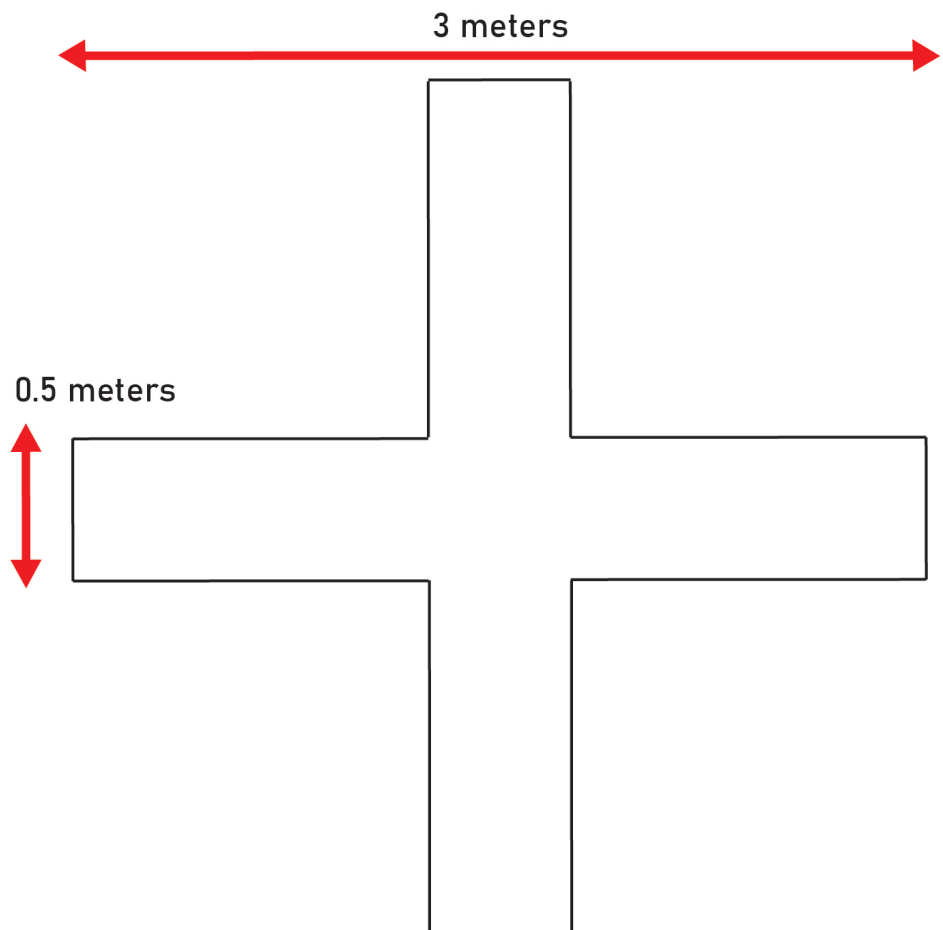
## Ground Target Site

Effective ground control Targets are built on areas of level ground with sparse or no vegetation. In addition, they are located at least 20 m away from buildings, trees, and abrupt changes of terrain elevation (e.g. cliff).

## Target Appearance and Size

To be clearly visible in each orthophoto, the Target should be constructed out of a durable material in a colour that contrasts well with the ground.

The dimensions should be as shown below.

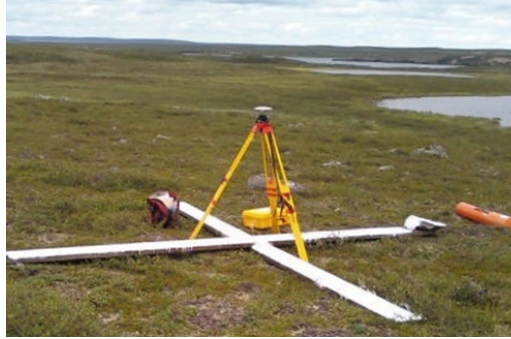


# Examples of Ground Targets

These are some examples of ground targets.

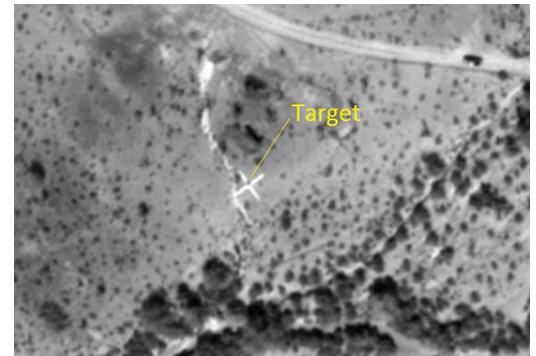
## Example 1: Wooden Boards

This Target is well constructed, using crossed white boards. The colour of the boards creates a good contrast against the ground, and it can be clearly seen in the orthophoto (right). The GPS equipment is correctly placed in this photo.



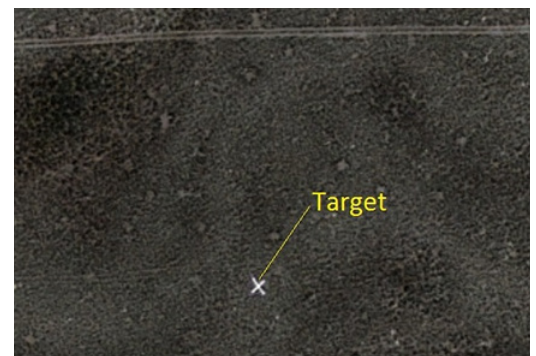
## Example 2: Long-Armed X with Rocks

This Target is well constructed from light-coloured rocks, which contrast well with the ground. Because the arms are long, the Target is easy to see in the greyscale orthophoto (right). To improve this Target, the GPS equipment should be on the ground, not on top of the monument.



## Example 3: White Tarp

Though the tarp creates a good contrast against the ground, both soil and fabrics can be easily disturbed by wind. To improve this Target, rocks could be used to anchor the tarp, instead of soil. Lastly, the GPS equipment should be visible in the photo.





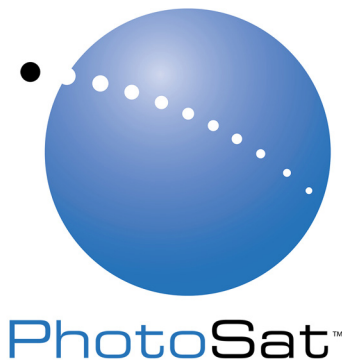
### Example 4: Short-Armed X with Rocks

This Target is not well constructed. The colour of the rocks creates a good contrast against the ground. However, the short arms are difficult to identify in the orthophoto (right). To improve this target, the arms should be longer and narrower. The survey equipment should be visible above the target in the photo.



### Example 5: Orange Plastic

This Target is not well constructed. The orange material does not contrast well against the ground, and it is difficult to see in the orthophoto (right). To improve this Target, a light-coloured material (e.g. light-coloured rocks, planks, etc.) should be used. The arms should be longer, with parallel sides.



### Contact Us

For more information about establishing GCPs, contact us:

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### Learn More

To see our [Accuracy Studies](#), visit our website.