TRISHUNYA
ADVANCED SURVEYING SERVICES

TECHNICAL GUIDE · GEOSPATIAL SURVEYING

The Ultimate Guide to DGPS Survey

A field-tested reference on Differential GPS surveying: how it works, where it beats RTK and total stations, accuracy budgets, workflow, and how to read your final deliverable with confidence.

Base + Rover Method | **Sub-metre to Centimetre Accuracy** | **10-Page Field Reference**

Prepared by the Trishunya Survey Engineering Desk

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What's Inside This Guide

Ten focused sections take you from the physics of differential correction to reading your final control point report. Use it as a reference before your next survey brief.

HOW TO USE THIS GUIDE

Each section is written to stand alone. If you already understand the fundamentals, jump straight to the accuracy budget, workflow, or checklist sections for direct field use.

What DGPS Actually Is

Differential Global Positioning System, or DGPS, is a method of improving the accuracy of standard GPS positioning by using a fixed reference station with a known, surveyed coordinate. A standalone GPS receiver typically resolves a position to within 3 to 5 metres. That is fine for driving directions. It is not fine for setting a foundation grid, marking a pipeline alignment, or establishing control for a drone survey.

DGPS closes that gap. A base station sits on a known point and continuously compares its GPS-computed position against its true, surveyed position. The difference between the two is the error present in the satellite signal at that moment, caused mainly by the ionosphere, troposphere, and satellite clock drift. That error is broadcast as a correction to one or more rover receivers working nearby, which apply it to their own raw GPS readings in real time or during post-processing.

THE CORE IDEA IN ONE LINE

If two receivers within a reasonable distance of each other are looking at the same satellites at the same moment, they experience nearly identical atmospheric and clock errors. Measure that shared error at a known point, subtract it from the unknown point, and what remains is a far more accurate position.

3-5m	0.3-1m	2-4cm
STANDALONE GPS ACCURACY	TYPICAL SUB-METRE DGPS	RTK-GRADE DGPS, SHORT BASELINE

WHY IT MATTERS FOR SURVEY WORK

Every engineering deliverable, whether it is a topographic map, an orthomosaic, or a set of stakeout points, is only as reliable as the control it is tied to. DGPS is usually the technique that establishes that control on the ground, even on projects that later rely on drones, LiDAR, or total stations for the bulk of the data. It is the layer that anchors everything else to a real-world coordinate system.

> **FIELD NOTE**
>
> On a linear pipeline survey, control points set with DGPS every 300 to 500 metres are what let a drone-derived alignment be trusted for construction. Without that ground truth, an otherwise clean orthomosaic can carry a systematic offset that only shows up once excavation starts.

How Differential Correction Works

The mechanics behind DGPS are straightforward once broken into stages. Understanding them helps a field crew diagnose problems instead of just accepting whatever number the receiver shows.

Stage 1: The Base Station Measures Known Error

The base receiver occupies a point with a precisely known coordinate, either from a national geodetic reference network or from a longer static observation. Because the base already knows exactly where it is, any difference between its GPS-computed position and its true position is, by definition, error in the signal itself.

Stage 2: That Error Becomes a Correction Message

The base packages this error into a correction stream. Two formats dominate practice: RTCM, a compact binary format built for real-time radio or internet transmission, and RINEX, a raw observation format used for post-processing in office software after the field day is done.

Stage 3: The Rover Applies the Correction

The rover receiver, moving across the site, receives this correction either instantly over a radio link or cellular network, or applies it later during post-processing against logged raw data. Either way, the rover's raw position is adjusted by the measured error, and what is left over is the corrected, high-accuracy coordinate.

Real-Time Correction

Corrections stream live via UHF radio or NTRIP over cellular data. The rover shows a corrected coordinate on screen immediately, which is what makes stakeout and live navigation possible.

Post-Processed Correction

Both base and rover log raw observations independently. Correction is applied afterward in office software, generally yielding tighter accuracy since more data and better algorithms are available.

WHY DISTANCE BETWEEN BASE AND ROVER MATTERS

Atmospheric error is not identical everywhere. It is spatially correlated, meaning it is nearly the same for two receivers standing close together, and increasingly different as the distance between them grows. This is why DGPS accuracy degrades gradually with baseline length rather than staying constant regardless of how far the rover strays from base.

Baseline Length	Typical Effect on Accuracy
Under 10 km	Minimal degradation, corrections remain highly reliable
10 to 30 km	Gradual increase in residual error, still usable for most survey grades
Beyond 30 to 50 km	Correction quality drops noticeably; network RTK or CORS becomes preferable

DGPS vs RTK vs Static GPS vs Total Station

These four techniques get confused often, partly because RTK is technically a form of DGPS. The distinctions below matter when deciding what a project actually needs, rather than defaulting to whatever equipment happens to be free that week.

Method	Typical Accuracy	Best Suited For	Key Limitation
Code-based DGPS	0.3 to 1 m	GIS asset mapping, boundary reconnaissance, corridor reconnaissance	Not tight enough for construction stakeout
RTK (carrier-phase DGPS)	1 to 4 cm	Construction stakeout, control networks, cadastral survey	Needs continuous radio or cellular link, range limited
Static GPS	3 to 10 mm	Primary geodetic control, deformation monitoring	Long occupation times, not suited to fast fieldwork
Total Station	1 to 3 mm	Short-range precision layout, indoor or GNSS-obstructed sites	Requires line of sight, slower over large open areas

> *"The right survey method is the one that matches the tolerance the project actually needs. Over-specifying accuracy wastes field hours; under-specifying it costs far more later in rework."*
>
> **Trishunya Survey Engineering Desk**

A PRACTICAL WAY TO DECIDE

- **Choose RTK-grade DGPS** when you need centimetre control across an open site quickly, and a base or network correction signal is available.
- **Choose static GPS** when the point will anchor a permanent reference network and a few hours of occupation time is acceptable.
- **Choose a total station** when GNSS signal is blocked by structures, tree canopy, or tunnels, or when millimetre-level layout is required over short distances.
- **Combine methods** on most real projects. DGPS typically establishes ground control, while a drone, LiDAR sensor, or total station handles dense data capture across the site.

COMMON MISCONCEPTION

"RTK is a completely different technology from DGPS" is a common but inaccurate statement. RTK is a real-time, carrier-phase form of differential correction; it belongs to the same family, just with tighter tolerances and stricter link requirements.

Equipment: Base, Rover, and Correction Links

A DGPS setup is simpler than it looks from the outside. Three components do almost all the work, and each has failure points a crew should know before heading to site.

The Base Receiver

Set over a known or newly established point, usually on a tripod with a tribrach for precise centring. It needs a clear sky view above roughly 15 degrees elevation in all directions, since any obstruction directly affects the quality of every correction it broadcasts to rovers on site that day.

The Rover Receiver

Mounted on a range pole, backpack, or vehicle, the rover moves across the site collecting points. Pole verticality matters more than most crews assume. A pole that is 2 degrees off vertical on a 2 metre pole introduces roughly 7 cm of horizontal error at the ground, which is often larger than the GNSS error itself.

The Correction Link

This is the connection carrying corrections from base to rover. It can be a UHF radio modem, a cellular NTRIP connection to a CORS network, or, for post-processing workflows, no live link at all since both units log independently and are merged in the office afterward.

UHF Radio Link

Reliable in areas with weak cellular coverage. Range is typically 3 to 8 km depending on terrain and antenna height, and it needs no data subscription.

NTRIP / Cellular Link

Connects to a CORS network over mobile data. Effectively unlimited range within network coverage, but depends entirely on signal availability on site.

FIELD ACCESSORIES THAT OFTEN GET OVERLOOKED

- ✓ Bipod or tripod support for the rover pole on longer occupations, to reduce operator fatigue and pole drift
- ✓ Spare batteries for both base and rover units, since a dead base unit halts the entire crew
- ✓ Data logger or field controller with the correct coordinate system and datum pre-loaded before leaving office
- ✓ Tribrach optical or laser plummet checked for collimation before the survey season begins

Accuracy Budget: What Affects Your Numbers

DGPS accuracy is not a single fixed figure; it is the sum of several error sources, some controllable in the field and some not. Understanding the budget helps explain why the same equipment can deliver 2 cm on one day and 8 cm on another.

Error Source	Typical Contribution	Can It Be Controlled?
Ionospheric delay	Higher near equator, midday, solar maximum periods	Partially, by dual-frequency receivers
Multipath (signal bounce off surfaces)	Can add several cm near buildings, water, vehicles	Yes, by choosing clear occupation points
Satellite geometry (PDOP)	Degrades sharply below 6 satellites or high PDOP	Yes, by checking PDOP before occupation
Baseline length to base	Roughly 1 ppm additional error per km of distance	Yes, by placing base stations sensibly
Pole verticality and centring	Several cm on a poorly held or uncalibrated pole	Yes, entirely operator dependent

READING PDOP BEFORE YOU TRUST A POINT

Position Dilution of Precision, or PDOP, describes how favourably satellites are spread across the sky. A tight cluster of satellites gives poor geometry and inflates position error even when signal strength looks fine. Most field controllers display PDOP live; it is worth a habit to check it before logging any control point.

<2
EXCELLENT PDOP

2-4
GOOD, STANDARD SURVEY WORK

>6
POOR, REOCCUPY OR WAIT

PRACTICAL RULE

When PDOP climbs above 6, even a technically "fixed" solution can carry misleading confidence. On critical control points, it is worth waiting 10 to 15 minutes for satellite geometry to improve rather than accepting a shaky fix under time pressure.

VERTICAL VS HORIZONTAL ACCURACY

GNSS-derived vertical accuracy is typically 1.5 to 2 times worse than horizontal accuracy, a consequence of satellite geometry rather than equipment quality. Projects with strict elevation tolerances, such as drainage or solar park grading, often still rely on levelling or total station checks to validate GNSS-derived heights at key points.

Field Workflow, Step by Step

A DGPS survey day follows a consistent sequence regardless of project type. Skipping steps under time pressure is where most rework originates.

Step 1 — Reconnaissance and Base Placement

Identify a base location with an unobstructed sky view, away from large reflective surfaces, and ideally on or near a known reference point. Confirm it will remain undisturbed for the full occupation period.

Step 2 — Base Initialization

Set up the base over the point, confirm centring and levelling, and either input its known coordinate or begin a static occupation to establish one. Start broadcasting or logging corrections.

Step 3 — Rover Calibration Check

Before collecting production data, occupy a known check point with the rover and confirm the coordinate matches within tolerance. This single step catches most systematic errors early.

Step 4 — Production Data Collection

Move through the site collecting control points, boundary points, or feature points as the scope requires, watching PDOP and fix status continuously rather than trusting the screen blindly.

Step 5 — Closing Checks

Reoccupy at least one earlier point at the end of the day to confirm consistency, and shut down base and rover together to keep logged sessions aligned for post-processing.

Step 6 — Office Post-Processing and QA

Download logs, apply corrections if working in post-processed mode, run a least-squares adjustment where applicable, and review residuals before releasing the final coordinate list.

FIELD DISCIPLINE

A ninety-second calibration check at the start of the day has saved more Trishunya field days than any single piece of equipment. It is the cheapest insurance available against a systematic offset going unnoticed until the client asks why the boundary does not match the deed.

Common Field Errors and How to Avoid Them

Most DGPS accuracy complaints trace back to a handful of repeat causes. Recognising them in the field is faster and cheaper than diagnosing them in the office weeks later.

Symptom	Likely Cause	Field Fix
Point looks fixed but is inconsistent on reoccupation	False fix from poor satellite geometry or multipath	Re-observe after moving away from reflective surfaces
Sudden jump in coordinates mid-survey	Loss and reacquisition of correction link	Confirm radio or NTRIP connection status before resuming
Consistent offset across all points	Wrong datum, projection, or antenna height entered	Verify configuration against the check point before continuing
Slow convergence to fixed solution	Long baseline or poor sky visibility at rover	Move base closer or select a more open rover location
Vertical values look unreliable	Antenna height entry error or tilted pole	Re-measure antenna height, use a bipod for steadier holds

THE ANTENNA HEIGHT TRAP

An incorrectly entered antenna height is one of the most common and most avoidable sources of error in DGPS surveys. It shifts every vertical reading by exactly the amount of the mistake, and because it applies uniformly, it can go unnoticed until the data is compared against an independent benchmark. Measuring and re-confirming antenna height at both setup and teardown is a habit worth building into every crew's routine.

FIELD NOTE

On a solar park layout survey, a single mismeasured pole height early in the day, later corrected during the closing check, would have shifted every recorded elevation by the same fixed amount if it had gone unnoticed. The reoccupation step exists precisely to catch errors like this before they reach the deliverable.

ENVIRONMENTAL CONDITIONS TO WATCH

- **Dense canopy or urban canyons:** signal blockage and multipath both increase; consider a total station traverse for affected zones.
- **Solar storms or high ionospheric activity:** dual-frequency receivers help, but expect wider error margins on those days.
- **Heavy rain or moisture on antenna:** generally minor for GNSS signal, but check radio link reliability in wet conditions.

Where DGPS Is Used in the Field

DGPS rarely stands alone as the final deliverable on a modern survey project. Its real value is as the control layer that other techniques and sensors are tied back to, which is why it appears across almost every category of engineering survey work.

Power Transmission Line Survey

Establishes tower footing control and route corridor points that anchor LiDAR or drone-derived profiles along the alignment.

Construction and Stakeout

RTK-grade DGPS lays out grid lines, boundaries, and structural reference points directly on site ahead of excavation.

Linear Projects: Pipeline, Road, Railway

Provides chainage control points along the route, keeping long-distance mapping tied to a single consistent coordinate system.

Solar Park and Land Acquisition

Confirms boundary corners and grading control across large open sites where GNSS visibility is typically excellent.

DGPS AS GROUND CONTROL FOR DRONE AND LIDAR SURVEYS

A drone-based drone survey can capture dense photogrammetric or LiDAR point clouds across hundreds of hectares in a single flight, but that raw data floats in a relative coordinate space until it is tied to real ground control. DGPS-established Ground Control Points, typically spaced every 200 to 500 metres depending on terrain and required accuracy, are what pin the model to true coordinates and let it be checked and trusted against real-world measurements.

HYDROGRAPHIC AND BATHYMETRIC POSITIONING

On underwater survey and hydrographic work, DGPS positions the survey vessel in real time while an echo sounder logs depth, letting every soundings point be tied to a precise horizontal location as the boat moves along its survey lines.

200-500m
TYPICAL GCP SPACING FOR DRONE CONTROL

±2-3cm
ACHIEVABLE HORIZONTAL CONTROL ACCURACY

8+
SURVEY CATEGORIES RELYING ON DGPS CONTROL

Reading Your DGPS Deliverable

Clients receiving a DGPS survey report are often unsure what the columns and codes actually mean. Knowing how to read it makes it far easier to spot problems and ask the right questions.

TYPICAL COORDINATE REPORT COLUMNS

Column	What It Shows
Point ID	Unique identifier for that control or feature point
Easting / Northing	Horizontal position in the project's chosen projection
Elevation	Height, usually reduced to a local or national vertical datum
Fix Type	Fixed, Float, or Autonomous, indicating solution confidence
HRMS / VRMS	Estimated horizontal and vertical error margin for that point
PDOP	Satellite geometry quality at the moment of observation

FIX TYPE: WHY IT IS THE MOST IMPORTANT COLUMN

Fixed Solution

Highest confidence. Ambiguities are resolved to the whole carrier wavelength, giving centimetre-level accuracy on RTK-grade DGPS.

Float Solution

Ambiguities not fully resolved. Accuracy can range from tens of centimetres to a metre or more; treat with caution for final deliverables.

An autonomous solution, meaning no differential correction was applied at all, should never appear in a final control point list. Its presence usually points to a correction link dropout that was not caught during the field day.

WHAT TO ASK YOUR SURVEYOR

Request the fix type and HRMS/VRMS columns alongside coordinates, not just the final easting, northing, and elevation. A clean-looking coordinate table can still hide a handful of float or autonomous points if this information is not included.

COORDINATE SYSTEM AND DATUM

Every deliverable should state the horizontal datum, vertical datum, and projection used, for example WGS84 with a UTM zone, or a national grid system where required by the client. Mixing datums between survey phases is a quiet but serious source of error on multi-year or multi-contractor projects.

Pre-Survey Checklist

A short checklist to run through before mobilising a DGPS crew to site. Print it, pin it to the field vehicle dashboard, or keep it on the controller.

Before Leaving Office

- ✓ Confirm project coordinate system, datum, and projection with the client or engineering lead
- ✓ Charge and pack spare batteries for both base and rover units
- ✓ Load known control point coordinates onto the field controller
- ✓ Check equipment calibration dates, especially tribrach plummets and pole bubbles

On Arrival at Site

- ✓ Select a base location with a clear sky view and no nearby reflective surfaces
- ✓ Confirm correction link, radio or NTRIP, is transmitting before starting production work
- ✓ Run a calibration check against a known point before collecting data

During the Survey

- ✓ Monitor PDOP and fix type continuously, not just at the start
- ✓ Re-measure antenna height if the pole configuration changes mid-day
- ✓ Keep a written log of point IDs and descriptions as backup to the digital record

Before Leaving Site

- ✓ Reoccupy at least one earlier point to confirm consistency
- ✓ Shut down base and rover sessions together for clean post-processing logs
- ✓ Back up raw data to a second device before leaving site