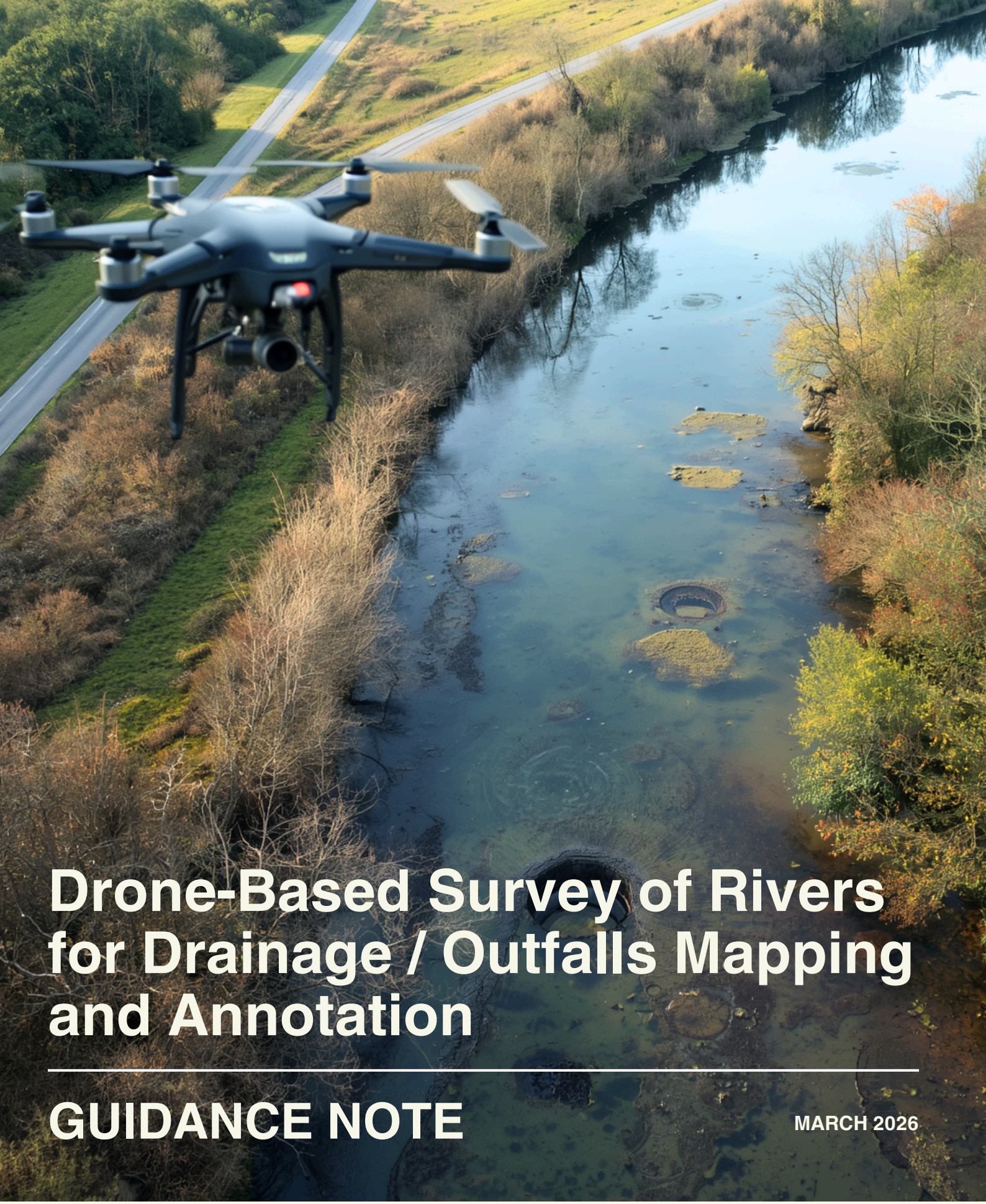


Drone-Based Survey of Rivers for Drainage / Outfalls Mapping and Annotation

GUIDANCE NOTE

MARCH 2026

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Image generated using AI

Background

A project reg. **"Aerial Survey and Development of GIS-Based Visualization Dashboard with Analytical Module and Geotagged Videography of Drainage System (Natural & Manmade) for River Ganga"** was undertaken. The objective of the project was to develop a GIS-based web application for the identification and geotagging of large, medium, and small drains/outfalls discharging into rivers. The application also facilitated **visualisation** and **analytics of 2D/3D photogrammetry data and videos**, providing a comprehensive spatial understanding. The total coverage area of the project was approximately 2,200 sq. km, extending 200 meters on either side of the Ganga River. The outcome is the development of a **Drain Decision Support System** (Drain DSS) to effectively map, analyse and monitor river pollution sources/outfalls.

Based on the learnings, a **Guidance Note** for Drone-Based Survey for Drainage Mapping and Annotation has been finalized and is enclosed for reference. The document prescribes **standardised technical parameters** for drone-based aerial surveys, including flight altitude, camera orientation, image overlap, speed, data capture specifications and processing workflow to generate high-resolution geospatial datasets such as ortho mosaic imagery, Digital Terrain Models (DTM) and GIS-based drainage layers.

States may use this document while undertaking any drone-based mapping and videography of rivers/drainage systems for mapping of drains/outfalls. After completion of the aerial survey, the acquired datasets, including high-resolution orthophotos, GIS layers and video documentation of the surveyed stretches, may kindly be integrated with the City/State level Drain Dashboard and the national database, maintained by the National Mission for Clean Ganga (NMCG).

I. Objective

The objective of this guidance note is to define the methodology and technical parameters for conducting drone-based aerial surveys for drainage mapping. The survey will generate high-resolution geospatial datasets including orthomosaic imagery, Digital Terrain Models (DTM), and GIS-based drainage networks with annotation to support planning, monitoring, and decision-making.



II. Drone Flight Planning Parameters

II.I Mapping Flight Parameters

Sl. No.	Parameter	Specification
1.	Flying Height	80 meters Above Ground Level (AGL)
2.	Camera Angle	-90° (Nadir Orientation)
3.	Forward Overlap	90%
4.	Side Overlap	90%
5.	Drone Speed	25–30 km/hr
6.	Image Capture Rate	1 image per second
7.	Ground Sampling Distance (GSD)	Approximately 5 cm
8.	Flight Pattern	Double grid flight pattern

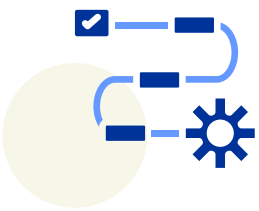
The mission shall be planned using standard mission planning software, where the Area of Interest (AOI) is defined and automated flight paths are generated to maintain constant altitude and required image overlap. Ground Control Points (GCPs) shall be established using high-accuracy GNSS equipment to ensure positional accuracy of the outputs.

III. Videography Flight Parameters

Sl. No.	Parameter	Specification
1.	Flying Height	70–80 meters AGL
2.	Camera Angle	-45° to -55° (Oblique)
3.	Video Resolution	4K
4.	Frame Rate	30 fps
5.	Video Format	MP4 / H.264

The drone flightpath shall follow the drainage corridor with multiple passes along both sides of the drainage channel to ensure full visual coverage.

IV. Data Processing Workflow



- Image alignment and aero-triangulation
- Dense point cloud generation
- Digital Surface Model generation
- Digital Terrain Model extraction
- Orthomosaic generation
- Drainage feature extraction and GIS mapping

V. Deliverables

V.I Ortho-mosaic



Sl. No.	Parameter	Specification
1.	Ground Sampling Distance	~5 cm
2.	Horizontal Accuracy	≤ 10 cm (withGCPs)
3.	Projection	WGS84 / UTM
4.	Format	GeoTIFF

The ortho-mosaic shall be a seamless, distortion-free aerial image suitable for GIS analysis, feature extraction, and drainage mapping.

V.II Digital Terrain Model (DTM)

Sl. No.	Parameter	Specification
1.	Resolution	10 cm
2.	Vertical Accuracy	≤ 15 cm
3.	Format	GeoTIFF / DEM

The Digital Terrain Model represents the bare-earth terrain after removing vegetation and structures from the point cloud. It is used for terrainanalysis, watershed generation, and drainage delineation.

V.III Drainage Mapping Deliverables

- Drainage centerline shapefile
- Drainage polygon layer
- Attribute table containing drainage annotations

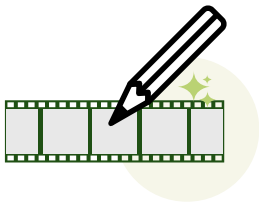
Drainage shall be classified based on width as follows:



Sl. No.	Category	Width
1.	Small Drainage	Less than 1 meter
2.	Medium Drainage	1–3 meters
3.	Large Drainage	More than 3 meters

VI. Video Annotation for Drainage

Sl. No.	Parameter	Specification
1.	Resolution	4K
2.	Frame Rate	30 fps
3.	Format	MP4
4.	Geotagging	Enabled
5.	Annotation	Timestamp-based

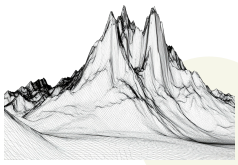


Annotations shall include:

- Drainage path and connectivity
- River name first letter_District name 3 letters_Chainage_Right or left (R/L) side_drain type(S/M/L) e.g. G_ALI_323+340_RL

VII. Final GIS Deliverables

- Orthomosaic imagery(GeoTIFF)
- Digital Terrain Model (DTM)
- Drainage network shapefile
- Drainage classification layer
- Annotated drone video
- Survey methodology and accuracy report



Watershed Generation:

DTM data is used to automatically generate streamlines. The mainstream is then used as a reference to delineate the drainage line.

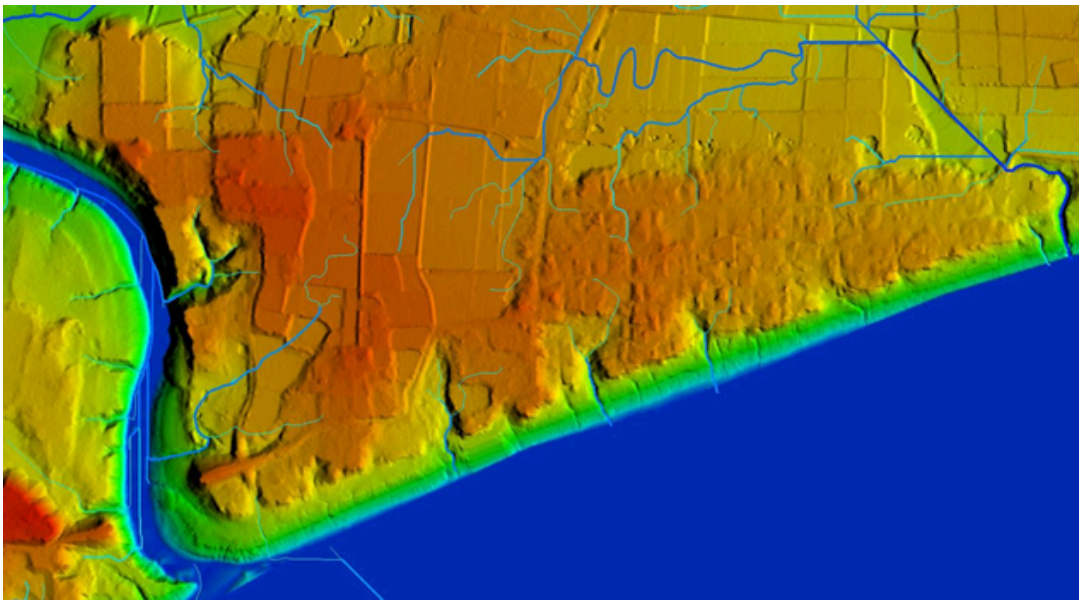


Figure 01: Watershed Generation

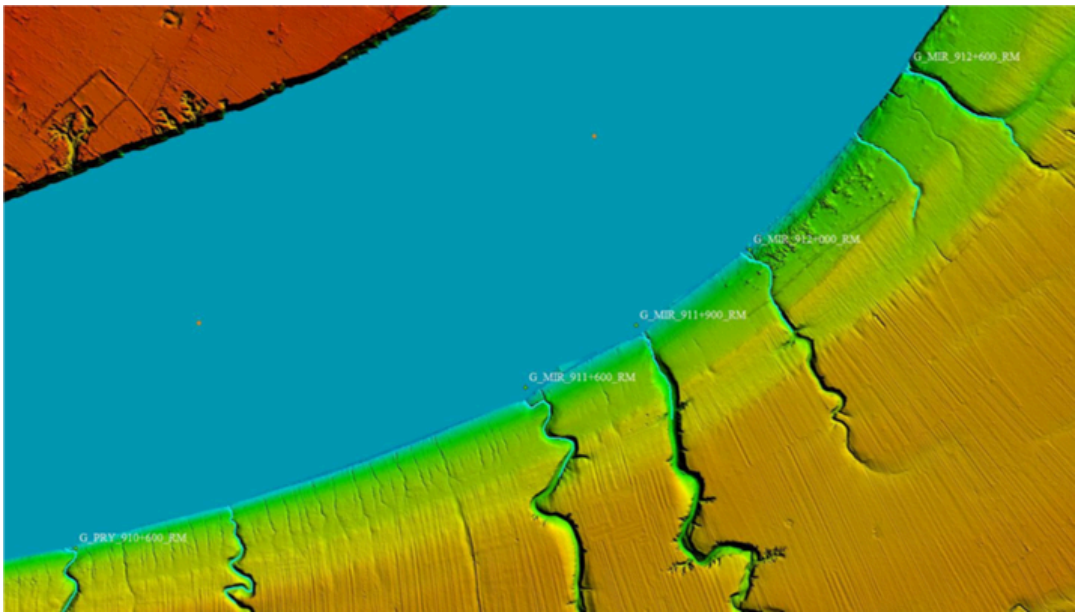


Figure 02: Capture drainage line from DTM

Drainage Classification by Width:

Classification of drainage channels should be done into three categories based on their measured width:

1. For small drainage, width: Less than 1 meter
2. For medium drainage, width: 1 meter to 3 meters
3. For large drainage, width: More than 3 meters



Figure 03: Small Drainage



Figure 04: Medium Drainage



Figure 05: Large Drainage

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