# Unmanned Aerial Vehicles for use in Construction & Stormwater Site Inspections

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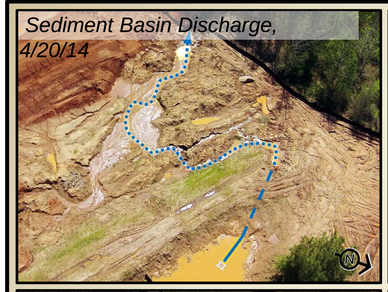
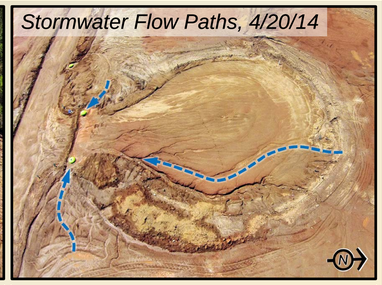
## BACKGROUND

Remote sensing with UAVs has the potential to provide high quality aerial imagery and data that can assist Qualified Credential Inspectors in performing focused, strategic site assessments in an efficient and effective manner. UAVs are economical and flexible in acquiring aerial data (i.e. photographs, videos, and elevation data) and can be pre-programmed with flight patterns to objectively capture data over construction areas being inspected. UAV based remote sensing enables user-controlled image acquisition and bridges the gap in scale and resolution between ground observations and imagery acquired from conventional manned aircrafts and satellites.


*Sediment Basin Discharge, 4/20/14*


*Stormwater Flow Paths, 4/20/14*


*Offsite Runoff, 4/10/14*


*Corrective Actions, 4/20/14*

## APLLICATIONS

Aerial images can be used to quickly identify problem areas and discharge concerns within the site leading the inspector to conduct further investigation on-foot. Damaged perimeter controls, sediment plumes, rogue runoff paths, and sediment accumulation on- or off-site will be evident from high resolution aerial photos and videos. The following specific applications have been identified:

- ❑ Construction Documentation
- ❑ Site Inspections of Erosion & Sediment Control Practices
- ❑ Soil Erosion Quantifications
- ❑ Erosivity Risk and Prediction
- ❑ Stockpile & Basin Storage Vol.
- ❑ Vegetative Establishment & Site Stabilization Assessments
- ❑ Wetland Mitigation
- ❑ Owner Complaints & Litigation

## PHOTOGRAMMETRIC ANALYSIS

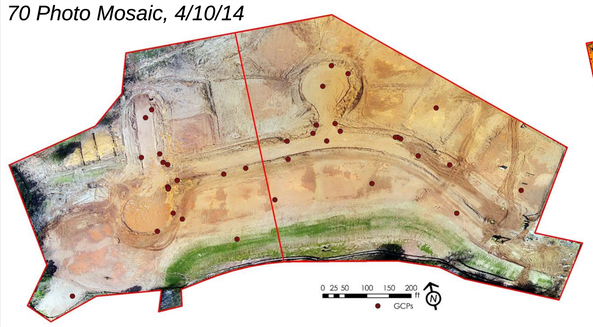
Photogrammetric mosaics convey a scaled representation of the entire project site. All major features of the site are available on one image that allows a user to identify areas of concern. The scaled mosaic allows length and area measurements to be taken to quantify various parameters (i.e. rill and gully lengths, project perimeter lengths, stabilized vs. unstabilized areas, etc.). These measurements can be used to determine material quantities required to protect or stabilize an area (i.e. seed and mulch quantities, perimeter control lengths, etc.). Post-processing photogrammetry software has the capability of automatically constructing three dimensional textured models using digital photos of the site. Surface meshes can be exported as a digital elevation model (DEM) for further topographic analysis in GIS software. The figure below shows a region of the site that was converted to a DEM. Contours were created on ESRI® ArcMap™ to further characterize the slopes. With the addition of ground control points, highly accurate DEMs can be created and analyzed between flight dates to measure volumes of erosion and sedimentation that may have occurred on the construction site being monitored.


*DJI Phantom Vision 2*

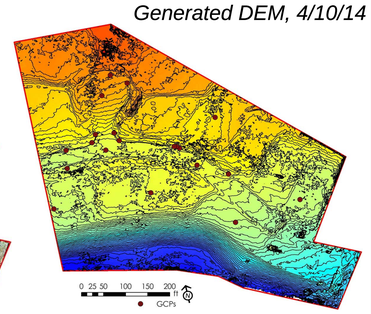
## EROSIVITY RISKS AND PREDICTIONS

Watershed simulation models are widely used in evaluating hydrological responses from various land use and land management practices. DEM's can be used to characterize topographic features that will be conducive to conveying runoff. GIS hydrology tools can be applied to delineate sub-basins and runoff flow reaches and paths. Furthermore, likelihood indicator models can be used to produce probabilistic surfaces that indicate the risk of excessive runoff accumulation. The use of these tools with an accurate DEM representation, can provide designers guidance on which erosion and sediment control practices to specify for various site characteristics based on expected stormwater runoff conditions on the current site topography. These tools can be used in pre-planning and design to develop a project specific predictive model for potential erosion and sediment control deficiencies and failures.

*70 Photo Mosaic, 4/10/14*




*Generated DEM, 4/10/14*



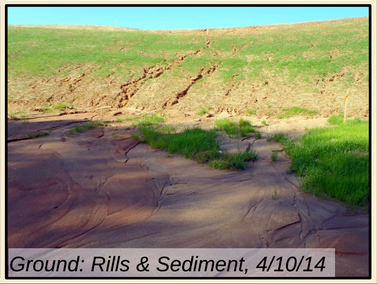

## SITE STUDY

A proof of principle study was conducted on a 25 acre residential development construction site located in Auburn, Alabama. the site's proximity to sensitive areas. A low to moderate level of poorly implemented and maintained erosion and sediment control practices were applied to the site. A DJI Phantom Vision 2 quadcopter was used to conduct six total flights over the course of four months. Flights typically followed a period of major rainfall events. High resolution images were captured using the UAV's built in 14 megapixel camera. The quadcopter was flown at an elevation of 150 ft (45.7 m) during all flights and was used to capture images with approximately 70% overlap.


*Aerial: Gully Formation, 4/10/14*


*Ground: Gully Formation, 4/10/14*


*Aerial: Rills & Sediment, 4/10/14*


*Ground: Rills & Sediment, 4/10/14*

## ASSESSMENT

One major advantage of using aerial imagery to supplement inspections, is the unique above-ground perspective that is generated. An advantage noted in this study was the ability for an inspector to identify the locations where runoff concentrates to the mouth of the rill formations. A UAV user can pinpoint problem locations and recommend an install of appropriate practices to prevent further erosion along the slope. Another noted advantage in using aerial imagery for inspections, is the identification of stormwater flow paths that can be easily seen carved into the terrain. Identification of stormwater runoff routes can help identify which areas within the construction site are most susceptible to erosion and sedimentation.


*Initial Roadway Grading, 3/8/14*


*Rill Erosion Following Heavy Rainfall Events, 3/30/14*


*Roadway Base Layer Installed, 5/1/14*


*Roadway & Vertical Construction Phase, 6/30/14*