# Drone Use Along with Spatially Balanced Sampling and Route Optimization for Rapid Monitoring of Reclaimed Areas[1]

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**Abstract:** Monitoring reclamation projects is essential to satisfy needs of various stakeholders and to provide information about the status of the reclamation effort. On oil and gas well pads in Wyoming, reclamation monitoring efforts have traditionally been done using qualitative visual estimates or quantitative line point intercept methods along vegetation transects[3]. While visual estimates can be done rapidly, they are subject to high rates of observer bias and error. Line point intercept (LPI) methods are time intensive, subject to high error rates, and transect placement is often based on an individual's judgement which may be highly subjective. Additionally, LPI data is often not linked accurately to a geographical location and is not repeatable should data need additional scrutiny after collection. More recently, handheld imagery has been utilized to reduce observer bias, provide geographical information, and reduce data collection time almost 10-fold. In this study, I introduce the use of drone technology to monitor vegetation and show that it is ~4 times faster in the field than handheld image collection. The travelling salesperson algorithm is used to optimize points which are generated using a spatially balanced sampling design called Balanced Acceptance Sampling (BAS) and the drone is pre-programmed to fly a path to these points to collect imagery. The imagery is comparable to handheld imagery and further advantages of this method will be discussed.

**Additional Key Words:** Vegetation Monitoring, SamplePoint, Travelling Salesperson Problem, Unmanned Aerial System, UAS, UAV.

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3. Work reported here was conducted near 44.3483° N; 106.6989° W.