

Supplementary Material for

Recovering a Black Cemetery: Automated Mapping of Hidden Gravesites using an sUAV and GIS in East End Cemetery, Richmond, VA

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Introduction

This supporting information file includes the specific details on methodology associated with running each ArcGIS Pro tool mentioned in the methods section of the main text and a link, username and password to an online map containing an exaggerated hillshade layer (we note, as highlighted below, we did not exaggerate the hillshade in our analysis: Z-factor = 1, but do solely for display purposes); the final burial depressions layer from the sink analysis, and locations of uncovered and mapped grave markers.

S1. ArcGIS Pro Tool parameterizations:

1. *Hillshade:*

Azimuth: 365 deg

Altitude: 45 deg

Shadow Modelling: “No shadows”

Z-factor: 1

2. *Flow Direction Analysis:*

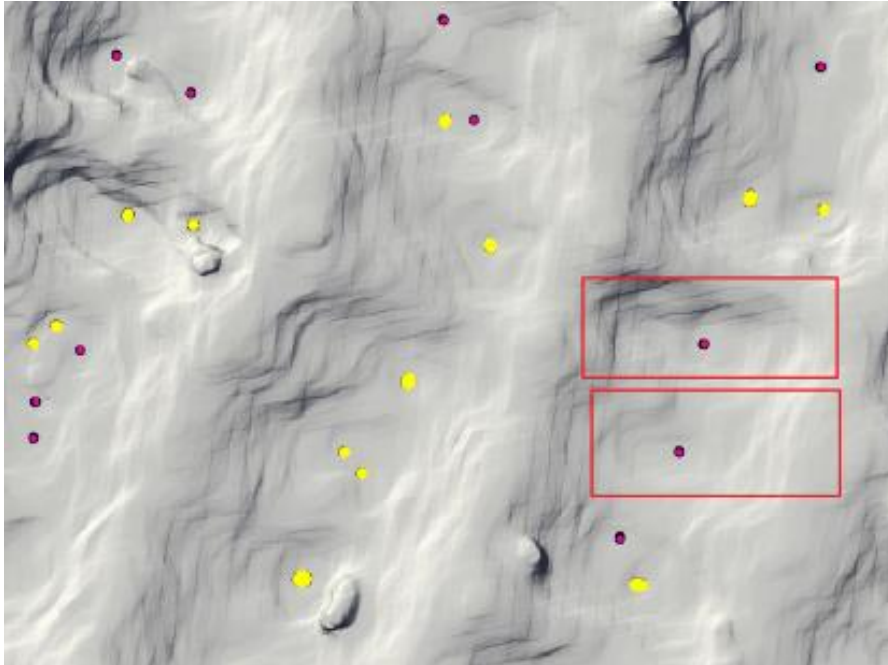
Flow Direction Type: D8

Force all cells outward: Normal

3. *Aggregate Points (15 cm):*

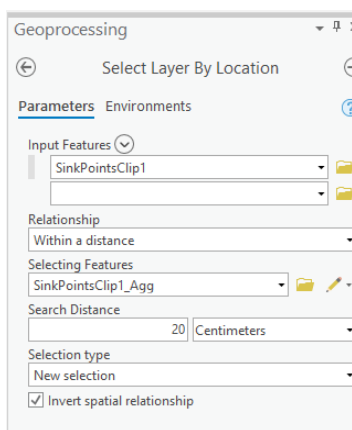
Aggregation Distance: 15 cm

The *Aggregate Points* tool takes regions where three or more points are within a pre-specified “aggregation distance” of each other (in our case, 15 cm), and generates a polygon layer using the points as vertices. Thus, we then used the *Feature to Point* tool to convert the aggregation polygons back into single points, ensuring that the “Inside” box on the tool was checked to ensure that the resulting single point would fall within the bounds of the initially aggregated points.



SFigure 1. Hillshade of a zoomed in region of East End Cemetery where yellow points were regions where there were three or more clusters of points, and thus aggregated together, where as the pink points, highlighted both in and out of the red rectangles were locations where there were one or two sink points features. Thus, both the yellow point and pink point features required a merger to create one sink points layer.

We note, however, that the *Aggregate Points* tool can only create polygons from clusters of 3 or more points. In order to preserve the single and double sink-point data (see pink points in SFigure 1), the *Select Layer by Location* tool was run on the pre-aggregation sink points layer. We first selected all points within 20 cm of the points layer created using the *Aggregate Points* tool, and then inverted the selection and **clipped** the layer to these selected points (SFigure 2). This procedure, then, highlighted all of the single point and double point clusters that had been left behind during the aforementioned 15 cm *Aggregate Points* run. This layer was then **merged** with the results of the 15 cm *Aggregate Points* output to create one feature class layer.



SFigure 2. The Select Layer by Location tool parameters used to create the layer of points left behind by the Aggregate Points tool.

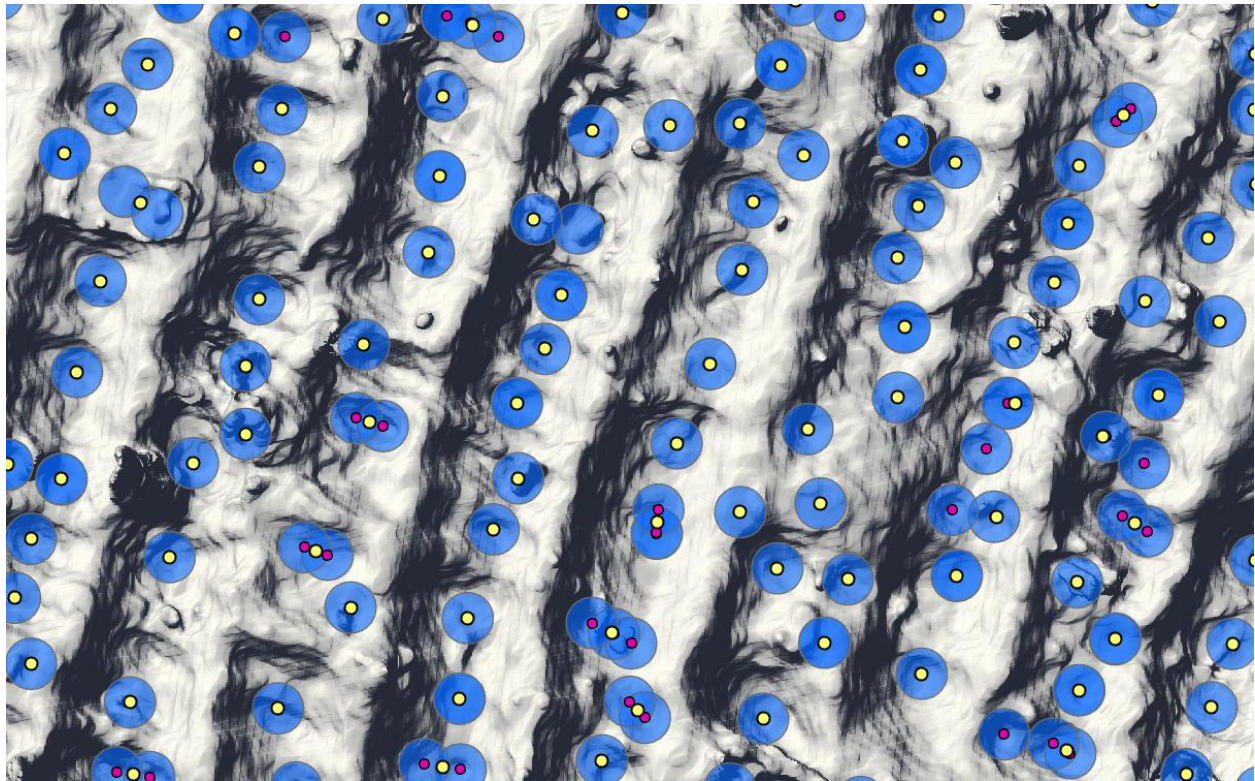
4. *Aggregate Points (1 m):*
Aggregation Distance: 100 cm

We performed the same procedure as highlighted above to re-capture and single and double points again missed by the aggregation process, this time utilizing an inverse selection distance of 110 cm.

5. *Buffer (Explode, Feature to Point)*
Buffer
Distance: 50 centimeters
Method: Planar
Dissolve Type: Dissolve all output features into a single feature

These buffers are dissolved into one feature class because we are looking for overlapping buffers, so we dissolve the output features into a single feature class. We then **explode** this one feature into multiple features, which allows for the merger of two overlapping buffer zones into one features, and then use the *Feature to Points* to create points at the center of each buffer features (SFig 3)

Before Step 5 was run, we had 18,307, and after we had a final 8,201 points.



*SFigure 3. Zoomed in hillshade (exaggerated by 5 times) of East End Cemetery with the original 18,307 points in pink, the 0.5 meter buffers around those points in blue, and the resulting 8,201 points after the buffer feature layer was **exploded** into multiple features and the Feature to Point tool was run.*

S2. Link to online map of results: <https://arcg.is/TX4Hz>

Username: EEC2021_urichmond

Password: Cemetery2021\$