Work Summary: Devising optimal pipeline networks

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Objectives

Building on our initial efforts to construct a set of optimized pipeline networks connecting biogas sources in Duplin county to existing natural gas pipelines, our goal here was to compute the aggregate volume of gas passing through each pipeline segment. This, in turn, would allow us to compute the minimum diameter each pipeline segment would have to be, and from that the cost to construct the overall network.

We again applied our technique to three pipeline scenarios, each differ on how they connect to the existing network (single connection point vs. multiple) and on the order in which they are added (sorted by least cost to connect vs. random).

Methods

We computed aggregate flows were computed by converting the pipeline configuration to a directional graph, with edges identified as segments occurring between any bifurcation along the pipeline network. Edges along the upstream periphery of the graph, i.e., those linking biogas sources to the network, were assigned weights equal to their annual biogas production. All other edges, i.e. those just transporting biogas downstream, were assigned a weight of zero. (**code**).

We then iterated through each junction in this graph, identified all upstream edges, and tallied the sum weights, which would equal the total upstream biogas volume. The pipeline segment immediately upstream of this junction was assigned that value, thus giving us a feature class whereby each pipeline segment was tagged with the aggregate upstream annual volume of biogas that would flow through it (**code**).

Once volume of each segment was determined, we computed the pipeline diameter required to allow that volume to pass using a feed flow rate function determined:

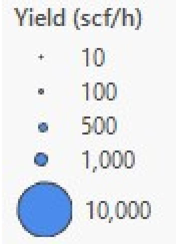
$$diameter(in.) = 0.0506 * flowrate(scf/h)^{0.3942}$$

And from diameter we computed cost as:

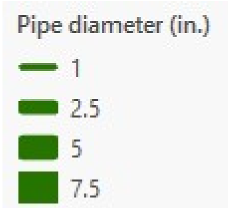
$$Pipeline\ cost(\$/mi) = 10829 * diameter(in.)^{0.4854}$$

Pipeline Results

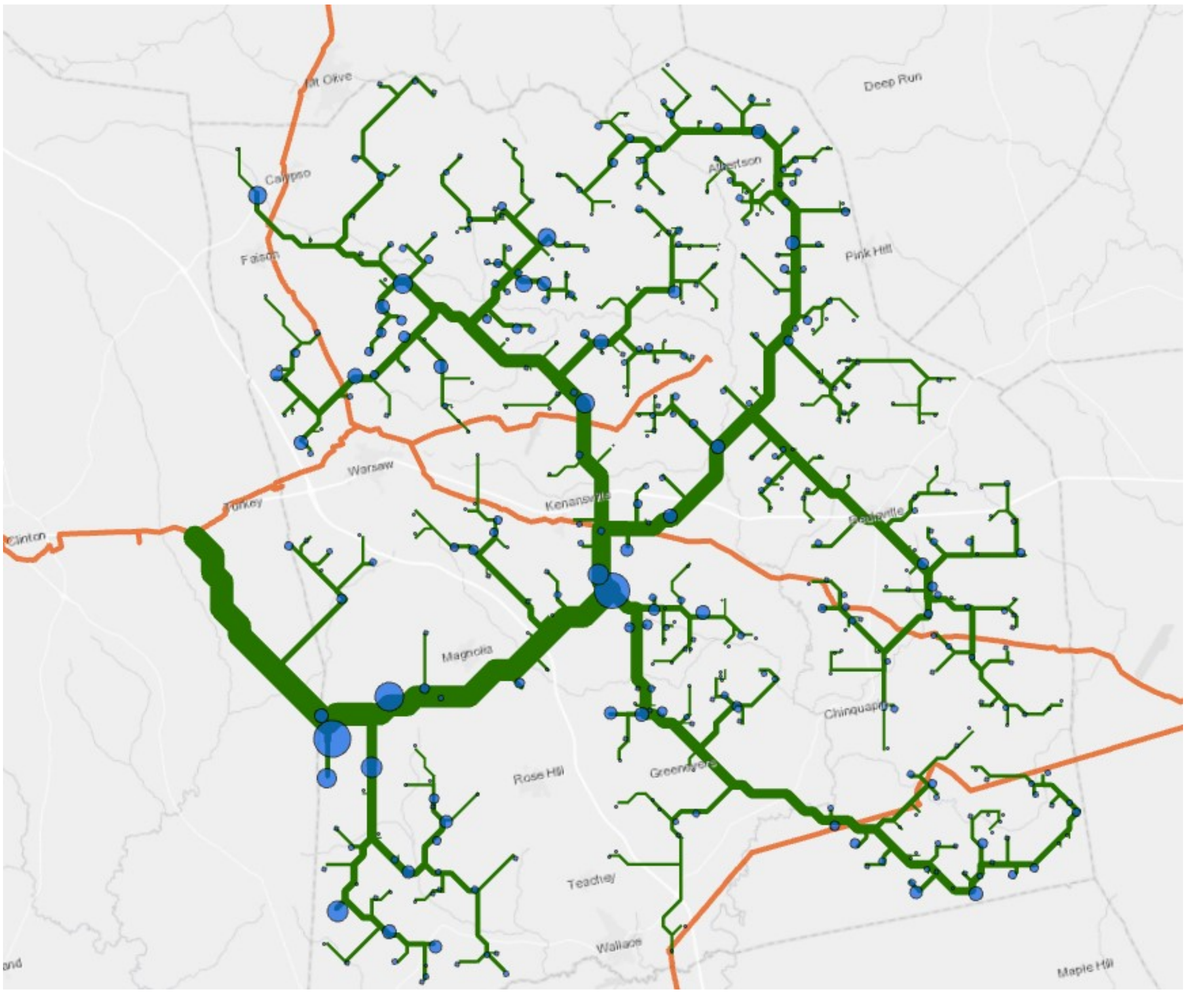
The figures below show the diameter of pipeline required for each network configuration. The existing natural gas pipeline network is shown in orange. Biogas sources are shown as blue circles with the size proportional to the amount of biogas yield.



Pipelines are shown in green, with thicknesses proportional to their diameter:



1. Single connection point.



2. Multiple connection point

3. Random order