PHASE 1 CONCEPTUAL RECOMMENDATIONS MEMORANDUM

To: Quaker Hill Homeowner's Association Board
From: Joe Arizzi, P.E.
Date: 08/02/2021
Subject: Quaker Hill Homeowner's Association – Drainage Evaluation

PROJECT UNDERSTANDING

Quaker Hill Homeowner's Association (HOA), "QH", approached Kimley-Horn to perform an overland drainage analysis for areas draining to its existing storm sewer network to analyze surface drainage patterns visually present, and propose potential solutions along Phase 1 of the Project Area (Figure 1). The objective of this analysis is to delineate existing drainage patterns across the entire Project Area, evaluate the capacity of existing infrastructure in Phase 1, and propose conceptual recommendations for Phase 1 to the QH Board. No hydraulic analysis or conceptual recommendations will be developed for Phase 2 at this time.

ANALYSIS

Data Collection and Review

The existing design drawings provided by QH provides design data documenting the slope, diameter, length, and material used for storm sewer infrastructure servicing the various properties that fall under QH's management. Note that these drawings are not As-Built record drawings; As-Built record drawings document the true constructed parameters (elevations, lengths, materials, etc), therefore actual hydraulic data may deviate from the information available in these plans (e.g. slopes may be slightly different in the field than what the plans show). In addition, the plans do not provide the following information:

- Inverts of the storm structures
- Profiles of the storm sewer
- Wet pond design data

Existing Hydrologic Analysis

Kimley-Horn generated the hydrology for the drainage area to all storm sewer inlets which ultimately drain into QH's storm sewer system (Figure 1). These delineations were made using LIDAR data and verified in the field to reflect actual conditions. Land cover was based on publicly available GIS data from the City of Alexandria to reflect present day impervious, turf and forested areas; these categories are used to estimate the runoff anticipated during a storm event based on the soil type and land cover. All land cover was cross-referenced against aerial imagery and observations made in the field to ensure an accurate representation of the drainage characteristics of the contributing drainage areas.

Existing Hydraulics Analysis

All peak discharges from the drainage areas were calculated using present day rainfall data derived from NOAA Atlas 14; this process is consistent with the design standards within the City of Alexandria and the State of Virginia. In order to develop an approximate model of the storm sewer system, the invert elevations at each storm structure had to be estimated to supplement the data available in the provided design drawings. Invert elevations were estimated throughout the network working downstream to upstream, starting with the outfall at the existing wet pond. The elevation as this location was estimated using LIDAR data, and known slopes and pipe lengths were used to estimate the inverts at each upstream structure. This analysis assumed that there is no drop (elevation change) at manholes or inlets throughout the network.

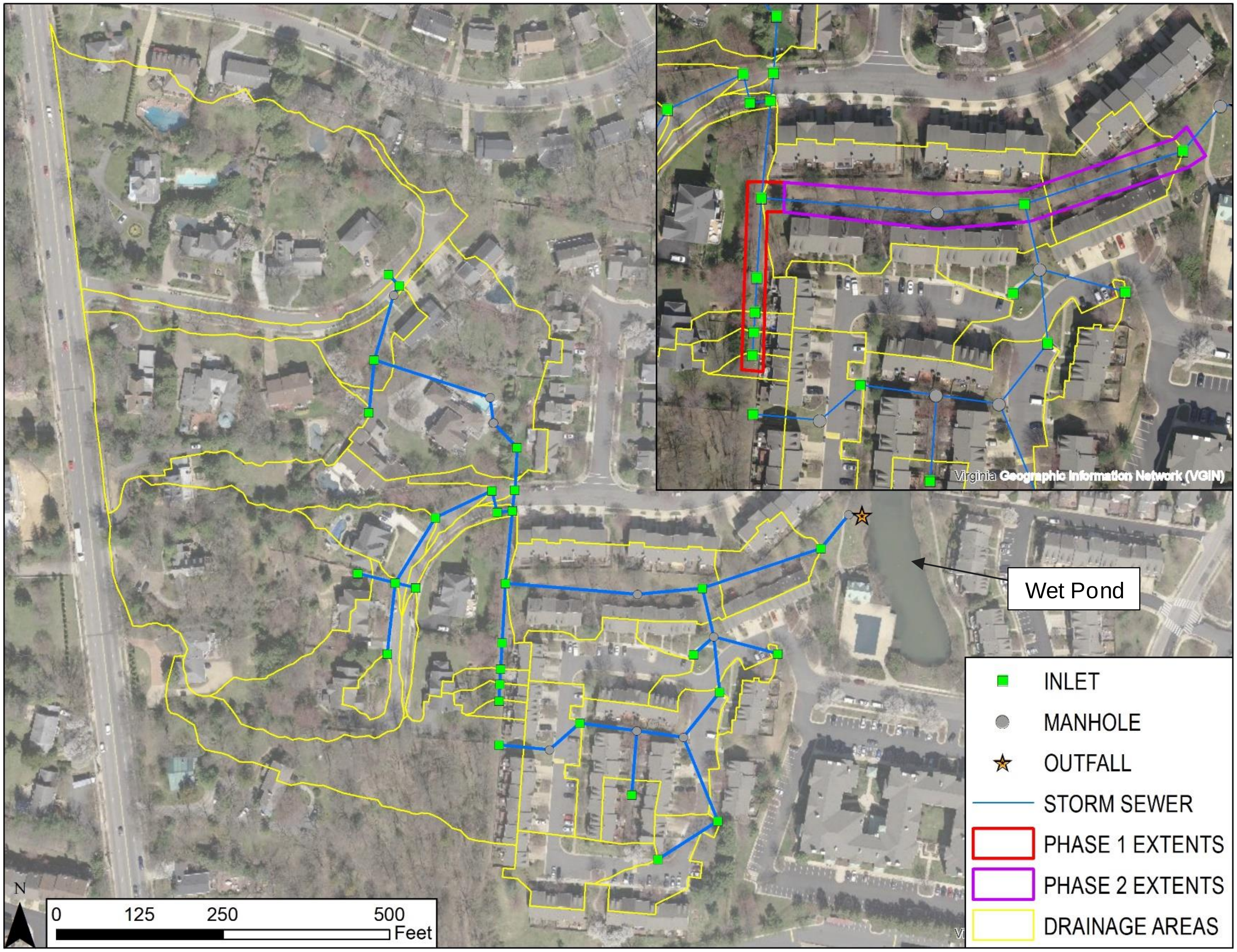

Figure 1: Extents of Analysis

RESULTS AND RECOMMENDATIONS

Existing Conditions Analysis

The existing contours reflect that drainage upstream of the yard inlet (Str. 106, Figure 2) has the potential to bypass the inlet because the current landscape does not provide any detention to maximize flow into the storm sewer at this location. Drainage which does not immediately enter the yard inlet may bypass the system and exacerbate issues downstream. In addition, extending from the south behind the townhomes is a 4" trench drain which appears to be non-functional due to evidence of standing water in the pipe during the site visit. These drains were intended to collect runoff from the adjacent residences directly to the yard inlet, but that flow is now being conveyed overland.

Existing infrastructure within the storm sewer system was modeled to Str. 106 using StormCAD modeling software. Hydraulic impacts along the downstream system, along with those from the storm sewer servicing Quaker Hill Drive, were estimated based on the peak discharges from the respective contributing drainage areas. No information was provided related to the water surface elevation in the wet pond for various storm events, therefore the tailwater condition was estimated to be consistent with a partially submerged outfall. Design data was not available for the connecting storm sewer systems outside of QH, therefore those systems were modeled using best available data from the City of Alexandria's public sewer database.

The results of this analysis demonstrated that the existing storm sewer system may be at its maximum capacity - and potentially over capacity - based on present day land cover conditions and the hydrologic and hydraulic analysis. As shown in Figure 3, the hydraulic grade line (the water surface elevation in the storm sewer) during the 10-year 24-hour storm event is generally at or above the crown of the storm sewer pipe. In general, this is sufficient for the design of any present-day storm sewer; current design standards require that the 10-year 24-hour storm event be contained within the storm sewer system, which the existing model supports. That being said, no information was available for this analysis to model the impacts of the water surface elevation in the wet pond on the storm sewer system. During storm events, the water surface elevation in this pond creates a tailwater condition which will impact the conveyance capacity of the storm sewer system. Depending on the water surface elevation in the pond, the hydraulic grade line in the storm sewer could be higher or lower; therefore, understanding the water surface elevation in the downstream wet pond during the 10-year 24-hour storm event, along with modeling the remainder of the storm sewer system (Phase 2), is necessary to fully estimate the capacity of the existing storm sewer system.

Recommendations

Based on the hydrologic and hydraulic analysis, it appears that the key drivers behind the existing drainage issues within Phase 1 are poor drainage patterns which allow water to bypass Str. 106, and the non-functional trench drain; therefore, the recommendations to address the concerns at Str. 106 are:

1. Regrade the area surrounding Str. 106 to convert the inlet from being flush with the downstream grade, to a 6" – 12" sump (Figure 2). These improvements will allow the inlet to maximize its capture and reduce the volume of overland runoff flowing downstream.
2. Remove and replace the trench drain inlets (Figure 4). Regrade the trail such that the trench drain inlets are slightly depressed instead of on-grade, increasing the amount of flow being captured in these inlets.
3. Remove the existing trench drain system and replace it with a new system (Figure 4). Reroute some of the drainage from Str. 106 to Str. 102 to redistribute runoff. Preliminary alignments based

on LIDAR data indicate that the pipes can likely discharge at grade, eliminating the need for concrete work at either inlet.

4. Reinforce the area immediately surrounding Str. 106 with a stone blanket to address erosion concerns (Figure 5). Plant a landscaping buffer around this area to improve the aesthetic. Create a trail around Str. 106 that connects the north and south to help keep the inlet and stone blanket out of sight.

Next Steps

Depending on what improvements QH decides to proceed with, and the desired timeline for the completion of this work, next steps may involve the following:

- Phase 1 Construction Phase
  - Topographical Survey (survey extents are recommended to include both Phase 1 and Phase 2)
  - Design Drawings
  - Construction Administration: On-site coordination with the Contractor to discuss the proposed improvements and to ensure the work is completed per design.
- Phase 2 Design Phase
  - Coordination with the City of Alexandria for the record plans documenting the wet pond design data
  - Hydraulic Modeling of the downstream storm system, including the system serving Quaker Hill Drive
  - Conceptual Phase Memorandum
- Phase 2 Construction Phase
  - Design Drawings
  - Construction Administration: On-site coordination with the Contractor to discuss the proposed improvements and to ensure the work is completed per design.

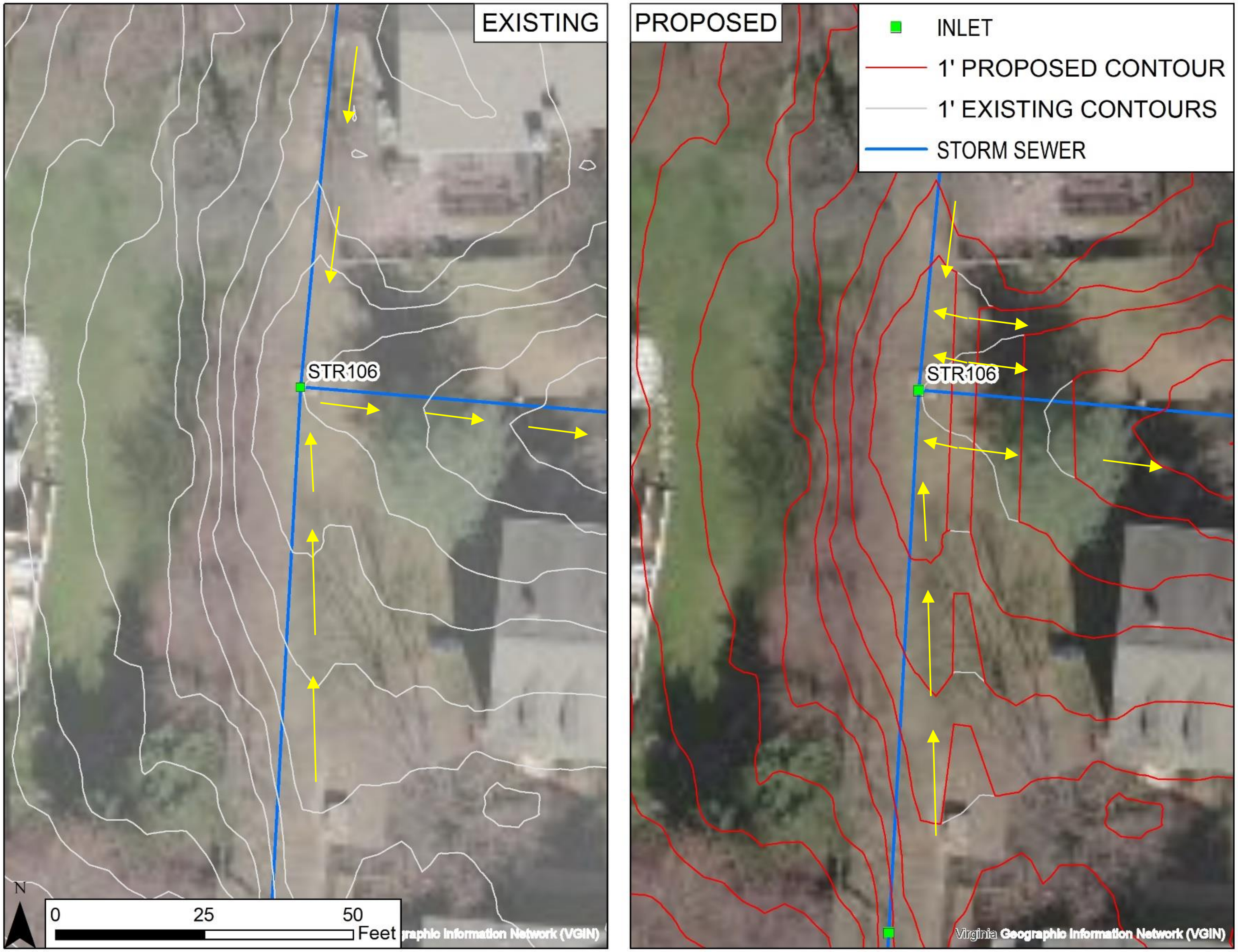

Figure 2: Proposed Grading Improvements

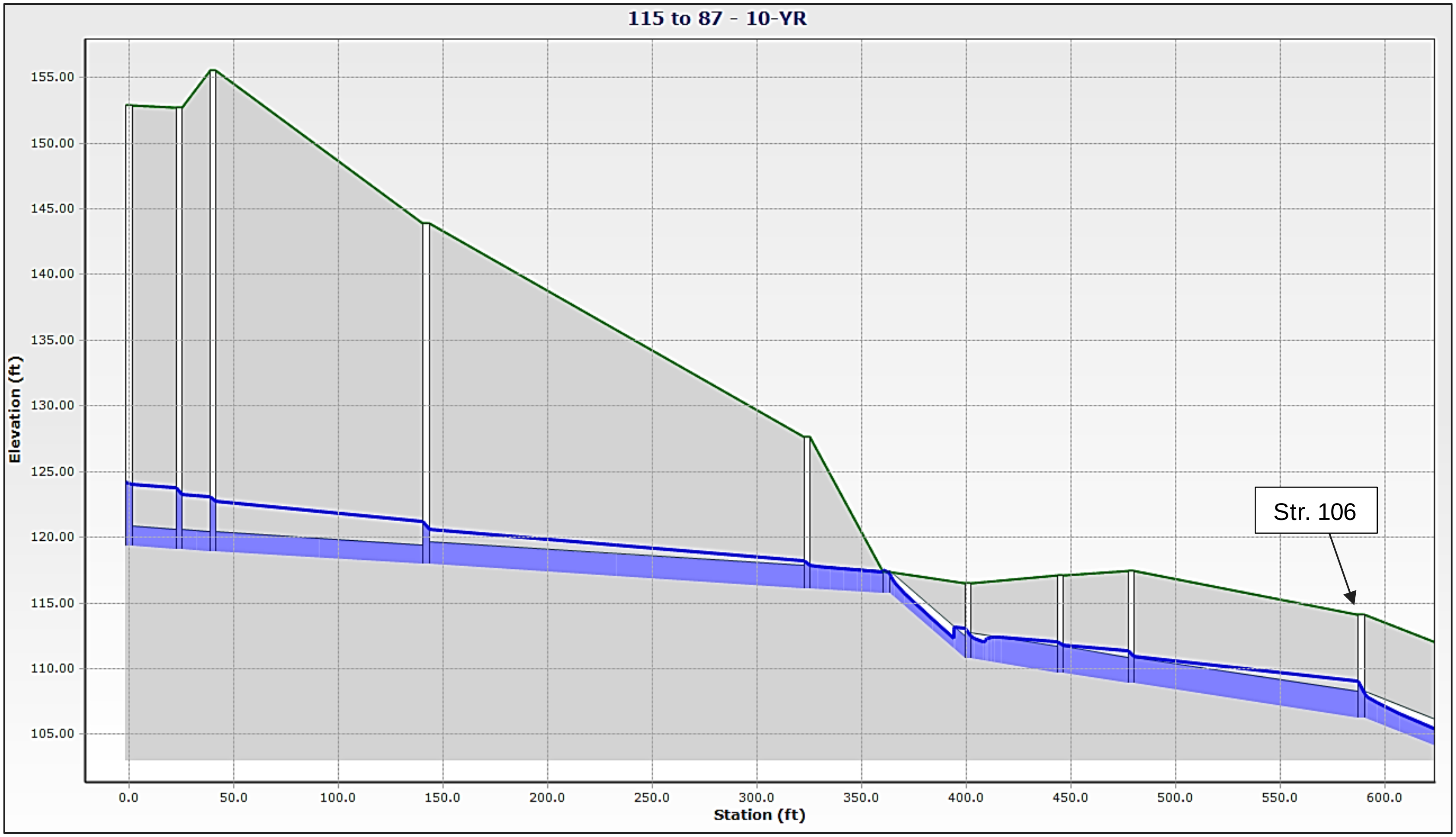

Figure 3: Hydraulic Modeling Results - Phase 1

Figure 4: Proposed Storm Sewer Improvements

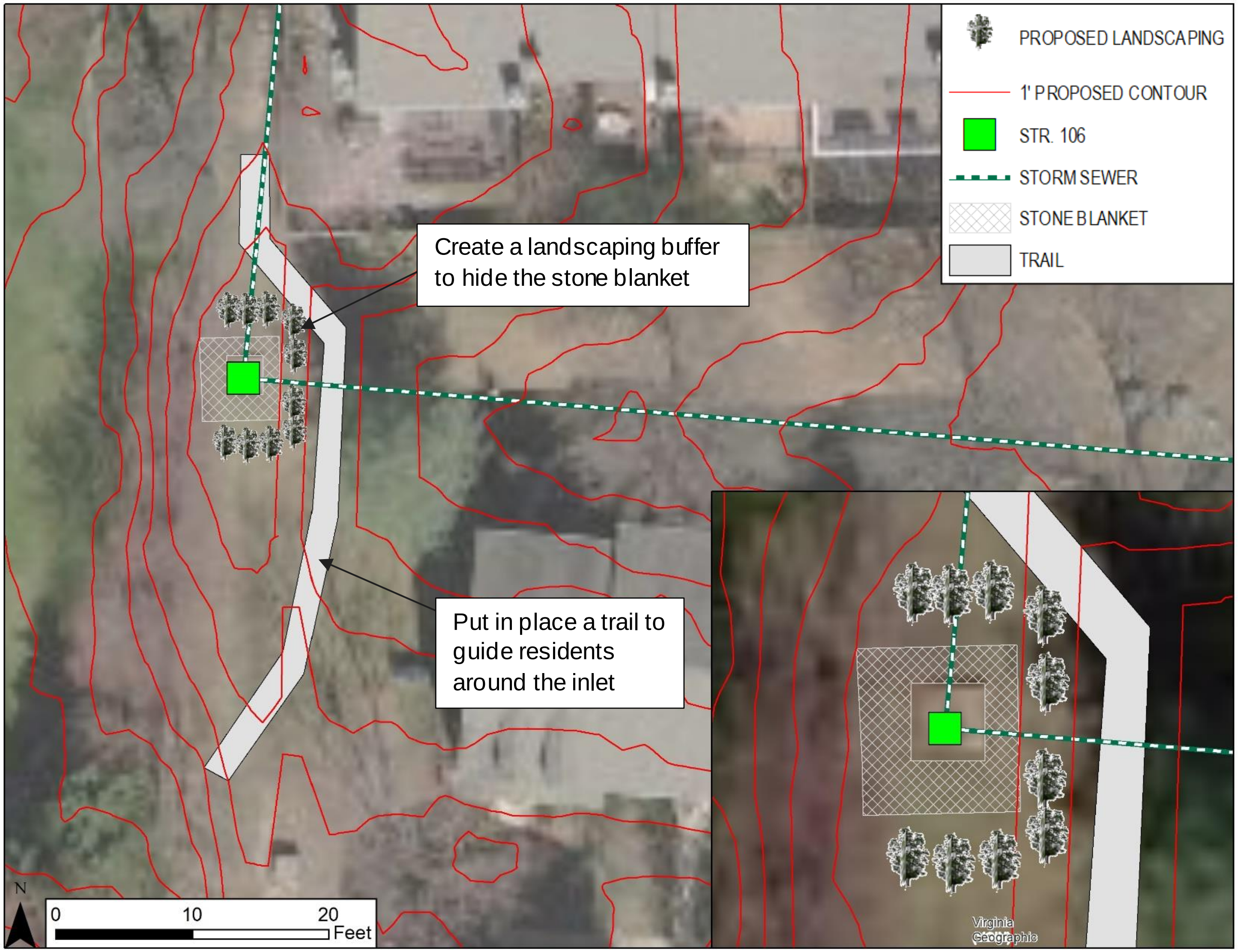

Figure 5: Proposed Landscaping Improvements