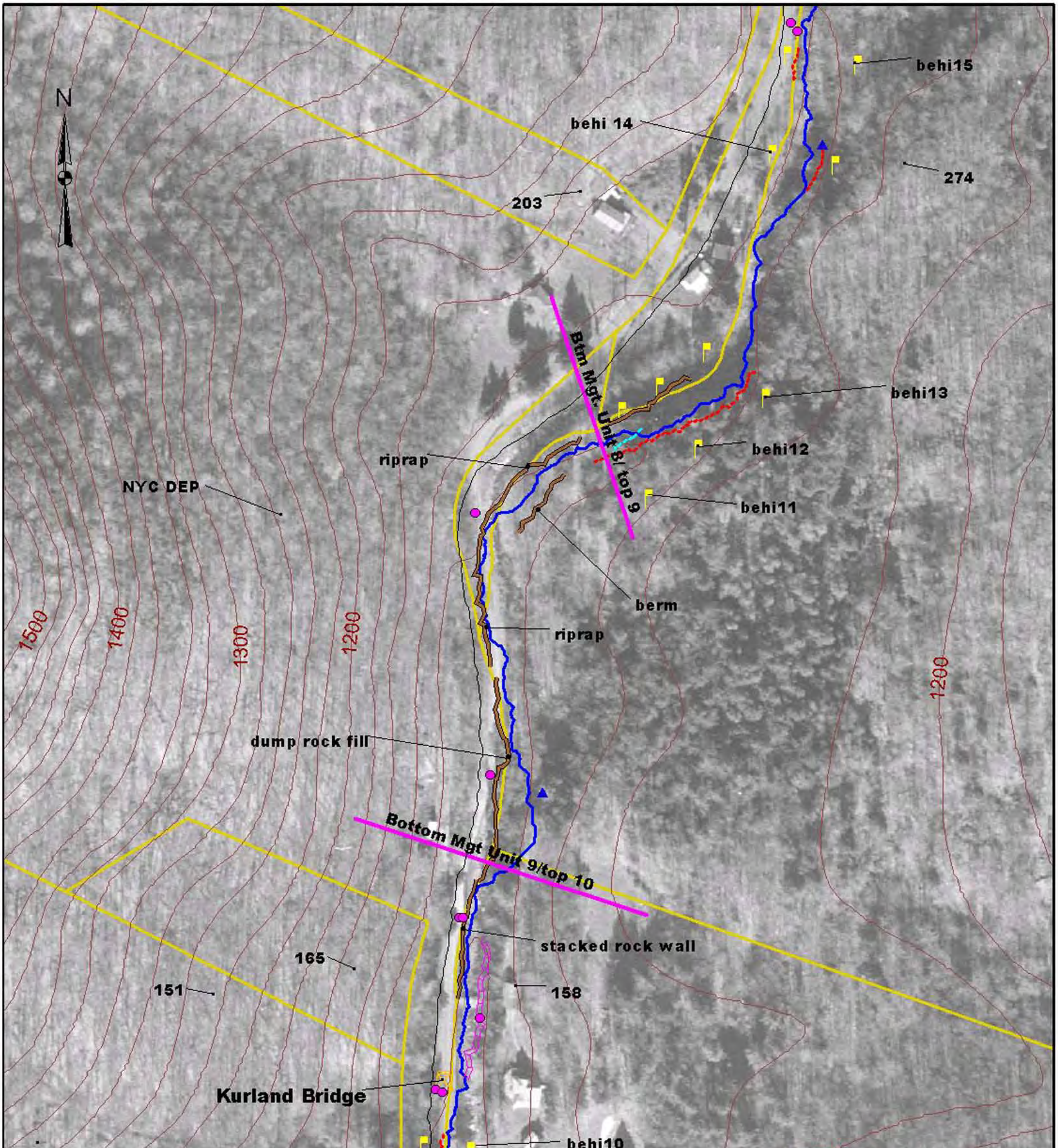

Broadstreet Hollow Management Unit 9

Contour Interval 20 feet

50 0 50 100 150 200 Feet

Scale 1:2,400

GIS Parcel, Contour and Wetland coverages are edited and provided by NYC DEP, 2000, UTM NAD 27, Zone 18 North, meters. Aerial Photography provided by UCSWCD & NYC DEP November 2001. All other coverages were developed using GPS in the UTM, Zone 18 North projection, NADCON (Conus), datum. GPS data collected 2001, by UCSWCD & NYC DEPSMP.

Note: G.I.S. data are approximate according to their scale and resolution. Data may be subject to error and are not a substitute for on-site inspection or survey. Parcel coverages are based on Ulster County Real Property tax maps 2000 and may not reflect actual surveyed property boundaries.

LEGEND

- 247 Street Address/911 code
- Greene parcels
- Ulster parcels
- Land fills
- Managment units
- Stream Center (Thalweg)
- Culvert
- Wetland
- Clay exposure
- Revetment
- Eroding bank
- Tributary
- Behi pin
- Bridge
- Broadstreet Hollow Road
- Knotweed

Broadstreet Hollow Management Unit 9

General Description:

This Management Unit (MU9), located in Ulster County, NY, is approximately 815 feet long, beginning below the Foss property at 202 Broadstreet Hollow Road just upstream from a sharp bend in the road[1] (Photos 1 and 2). MU9 extends downstream to the southwesterly portion of the Cahill/Hidaka property at 244 Broadstreet Hollow Road, just upstream from the location where the stream enters a long straight section right along the road[1&2] (see Broadstreet Hollow MU10). MU9 is characterized by several hundred feet of eroding bank and approximately 900 feet of stream bank stabilization and hardening measures, or *revetments*, covering almost the entire length of the right bank (looking downstream) between the stream and Broadstreet Hollow Road[3]. The left bank, opposite the road, is primarily unaltered and undeveloped, with healthy streamside, or *riparian*, vegetation so the stream isn't entirely out of balance, or *unstable*.

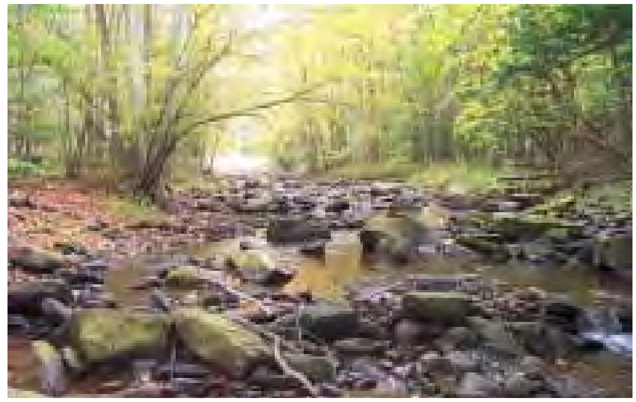

Photo 1. Looking upstream from the bottom of MU9, note grassy floodplain bench areas to the right (see discussion below).

Photo 2. Looking upstream into a meander bend near the top of MU9, large boulder rip-rap shown along road embankment, wooded floodplain area on the opposite side (see discussion below).

The structural shape, or *morphology*, of the stream (i.e., slope, width and depth) shifts in this unit, creating smaller sections, or *reaches*, with discrete morphologic character, or *stream type*[5]. The valley in MU9, while steep and close to the stream on the road side (primarily due to road fill and revetments), widens out on the opposite side producing predominantly non-*entrenched* stream shape. Typically stable stream types associated with this type of valley are relatively narrow, with riffles and pools, and stream banks formed into low benches, or *discontinuous floodplains*, that function as overflow areas during floods and provide areas for healthy riparian vegetation. MU9 lacks these discontinuous floodplains almost entirely on the right bank along the road, but maintains these features on the left bank in non-bermed areas.

I. Flooding and Erosion Threats

A. Infrastructure and Private Property

There are three properties (land parcels) associated with MU9; two of the parcels lie adjacent to the stream. The New York City Department of Environmental Protection

(NYC DEP) owns one of the parcels adjacent to the stream. There are no structures near the stream in MU9[1&2].

Stream assessment data for 2001 show the centerline of Broadstreet Hollow Road ranges from 20 and 75 feet from the deepest part of the stream channel, or the stream *thalweg*. All bank hardening techniques used in MU9 are directly related to maintenance of road fill, or embankment, protection from stream erosion in floods. Additional stream bank stabilization work has been performed in this unit as recently as 1996, following the January 1996 flood.

<u>MU9 Culverts</u>

Two culverts were found in MU9 during the *stream assessment survey* conducted in 2001. One of them provides a road crossing for a small perennial (flows year round) side stream, or *tributary*, to the main channel (Photo 3). *Confluence* areas (where two streams join) tend to be unstable by nature's design, as the smaller stream delivers pulses of flood waters and sediment to the main stream[3].

Photo 3. Looking upstream into tributary culvert under Broadstreet Hollow Road. Stream flow in the main channel (behind viewer) is from right to left.

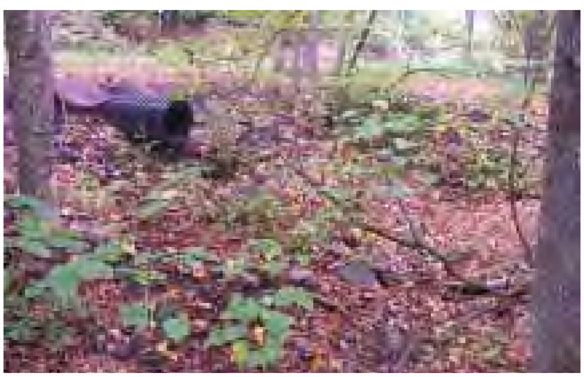

Photo 4. New culvert, right bank, MU9 – road above, Broadstreet Hollow stream behind and to the right of the viewer.

The second culvert, replaced in 2002, was dry at the time of the survey (Photo 4). Culvert flow under flooding conditions was not documented, though both culvert outlets appeared in relatively good condition, with no apparent immediate threat to stream bank or road fill stability. The new culvert could benefit from additional vegetation at the outlet, to dissipate energy of concentrated water flow, and encourage sediment deposition and nutrient or road runoff reduction, or attenuation[7] (see also water quality discussion below). Water currently falls from some height above the stream bank, and may have greater erosive potential as it falls and hits the stream bank below[5].

B. History of Stream Work

Approximately 900 feet, or 54%, of the stream banks in MU9 have been altered or hardened (Table 1)[3]. Quarried boulder rip-rap comprises the greatest length of revetment used along the road in the unit, and remains primarily under-vegetated (Photos 5). Augmenting rip-rap areas with *bioengineering*, or re-vegetation, should be considered to improve bank stability and enhance riparian functions in these areas. Bare banks and un-vegetated rip-rapped areas store heat from the sun, and can increase stream temperature by contact with stream flow and rain runoff. Additionally, they do not afford any shading to the stream or stream banks that keeps water temperatures low. Elevated aquatic temperatures may adversely affect water quality and stream ecology. Un-vegetated rip-rap in this unit should be "inter-planted" (planting small shrub or tree species between the rocks to provide some vegetative cover without compromising the structural integrity of the wall) with a mixture of native riparian species to improve shade and cover conditions for aquatic habitat, as well as to improve bank stability and reduce the need for ongoing bank stabilization work that causes or increases stream ecosystem disturbances[7].

Photo 5. Looking upstream at large boulder rip-rap along road embankment, constructed following January 1996 flood.

Table 1. Altered Banks*
Broadstreet Hollow MU9.[2]
*based on linear feet of both sides of stream bank.

Revetment Type	Length	Percent of Unit
~~boulder rip-rap~~	~~450 feet~~	~~27~~
dumped rock fill	330 feet	20
berm	120 feet	7
Total revetment	**900 feet**	**54%**

Photo 6. Berm on the left bank, opposite the road, near the top of MU11. Berm viewed looking toward the stream (flow toward the viewer), land surface sloping downward to the right into the floodplain.

The 120-foot berm on the left bank near the top of the unit appears to be material pushed into that area in response to 1996 (and perhaps earlier) flooding damages to the road embankment [3] (Photo 6). This practice of "cleaning" the gravel out of a stream in this way is thought to increase flood capacity by creating a larger stream channel.

Unfortunately, berms such as these generally do not offer much if any protection from flooding (there are no structures on the floodplain, and the berm is uneven) and can cause stream entrenchment and higher flood level, or stage, upstream and downstream by preventing floodwaters from flowing over the floodplain, cutting off an important function of these flat areas.

Floodplains function to reduce flood velocity, increase absorption of floodwaters, encourage deposition of silt and fine sediments (keeping them from being washed further downstream) and decrease flood stage, or height, in downstream areas[5]. The majority of Broadstreet Hollow stream floodplains consist of small, low, discontinuous floodplain benches that perform the important floodplain functions in small mountain streams. Because this particular berm is on the inside and upstream end of a large stream meander, it can cause acceleration of flows around the outside of the bend, putting more pressure on the road embankment on the right bank. Therefore, removal or restructuring of this berm should be considered to add floodplain function to this area and increase protection for the road[3].

Finally, the lower portion of MU9 is characterized by a long straight stretch of stream, with dumped rock fill on the right bank along the road embankment, and a long area of floodplain and floodplain benches, on the left bank opposite the road. Dumped rock fill comprises the rest of the bank revetment on the road side of the stream, much of which continues to wash or fall into the stream during and following flood events, and typically remains an ongoing maintenance problem for Town and County Highway Departments.

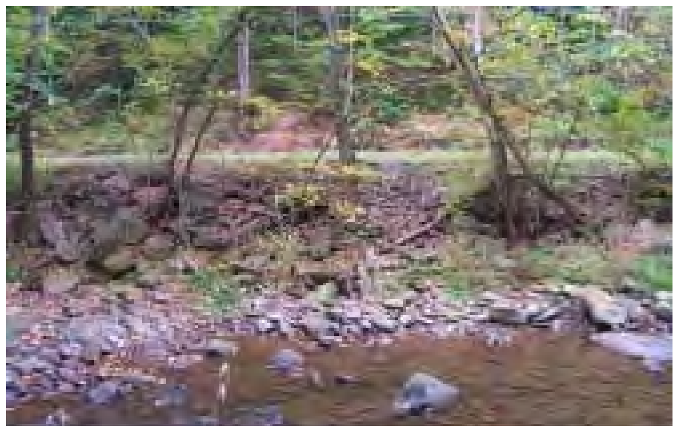

Photo 7. Dumped rock fill, along road fill/embankment on right bank, MU9 Stream flow is from right to left

The dumped rock fill extends for approximately 330 feet at the downstream end of MU9 (Photo 7). Broadstreet Hollow stream can transport very large rocks, or *sediment*, along the stream bed (sediment in transport is called *bedload*). The size of sediment in dumped rock fill is often smaller than the bedload. As a result, rocks on the bank continue to wash downstream over time, needing periodic replacement. Continuing disturbance of the bank area prevents streamside, or *riparian*, trees and other vegetation from becoming established[7]. Further, some riparian tree species become stressed and weakened when their trunks are buried, so existing trees that may be providing some bank protection are eventually killed by ongoing maintenance, reducing long-term bank stability, as well as compromising other important habitat and aesthetic benefits. Alternatives to dumped rock fill should be considered, to reduce maintenance costs and preserve riparian areas (see Stream Bank Stabilization Methods and Alternatives section)[3].

C. Exposed Banks

Stream assessment conducted in 2001 did not reveal any significant eroding or exposed banks that currently warrant stabilization or monitoring. One area of minor bank erosion was noted, associated with the berm on the left bank near the top of the unit, but this does not currently threaten the road or any other structures and would be mitigated by berm removal or restructuring. No monumented monitoring cross-sections have been installed to document the extent or rate of potential erosion, as the stream assessment survey in 2001 showed erosion to be minor.

II. Water Quality

A. Sediment

The stream assessment conducted in 2001 did not reveal any significant areas of bank erosion, or any *clay exposures* in MU9 that could contribute to water quality impairment from clay and silt, or *sediment*, sources.

B. Landfills/Dumping Sites

The stream assessment conducted in 2001 did not reveal any current dumping sites in or near the stream in MU9 that could contribute to water quality impairment from leaching of toxic materials.

C. Other Water Quality Issues

Investigation of other possible sources of contamination was not part of the stream assessment conducted in 2001. However, no evidence was found for *nutrient* or *pathogen* contamination in the stream (i.e., odors or discolored water). Any runoff of water from the road and culverts that may contain salts or other pollutants was not specifically investigated. Compromised vegetated streamside or *riparian buffer* areas, particularly between the stream and the road along the rip-rapped right bank, could reduce the capacity of the stream banks to assimilate, or slow the input of, contaminants to the stream[7].

Photo 8. Looking upstream into the mouth of the lower tributary, (main stream behind the viewer, running left to right). Note gentle slope, and fine sediment deposited in the foreground in a side channel running left to right, parallel to the main stream.

Another small tributary enters the main channel on the left just upstream from the downstream end of the unit, into a broad flat floodplain area uncharacteristic of most of the Broadstreet Hollow valley, showing the unique character of stream confluences (Photo 8). This tributary, unlike the one culverted from the right under the road upstream, appears to carry primarily fine sediments once it reaches the valley bottom and enters the main stream. Because this small stream runs fairly flat along the valley bottom after it descends from the hillside, the energy of the stream is reduced, allowing much of the fine sediment to drop out, or deposit, on the floodplain (the process itself forming the floodplain flat over hundreds of years). This reduces the amount of fine sediment added to the main stream, and increases the stability of this confluence area. Though this was not specifically investigated as part of the stream assessment survey, this area may provide localized valuable wetland habitat and potential water quality improvement functions.

III. Stream Ecology

A. Aquatic habitat and populations

No specific aquatic habitat or population monitoring was conducted in MU9 as part of the stream assessment survey in 2001. However, as part of the stream restoration demonstration project completed in MU3 in 2000, fish and aquatic insect population data have been gathered yearly since 1998 within the stable reference reach (MU1), the project site (MU3) and the control reach (MU17). These data show the Broadstreet Hollow self-supports, without stocking, populations of all three common trout species (rainbow, brook and brown) as well as a healthy and diverse community of aquatic insects[9]. The impact that stream bed and bank instability has on these aquatic organisms or their communities is unknown.

B. Riparian Vegetation

The stream assessment conducted in 2001 did not investigate specific streamside (riparian) plant species or density, other than to note areas of insufficient or stressed vegetation that could affect stream stability, flooding or erosion threats, water quality or aquatic habitat for trout species. Based on these general observations, riparian vegetation throughout MU9 is insufficient to provide the full benefits of a healthy riparian zone, primarily on the right bank along the road. As mentioned above, the road is at most 75 feet from the stream thalweg throughout MU9, and over half of the bank length is hardened or bermed. The area between the stream in the road is commonly narrow, and generally steep, making vegetation both more difficult to support as well as more important for maintaining stream bank and road fill stability and preserving other riparian vegetative benefits. Existing riparian vegetation between the road and the stream can be stressed by ongoing road runoff, snowplow side-cast, and ongoing maintenance of revetments. Under-vegetated areas in the vicinity of rip-rap, berms, dumped rock fill and road fill sections in this reach should be vegetated with a mixture of native riparian species, including trees, shrubs and grasses, to improve shade, cover and water temperature conditions for aquatic habitat[9], as well as to improve bank stability and reduce the need for bank stabilization work that could cause or increase stream ecosystem disturbances[3].

The east side of the stream, opposite the road (the left bank) contains generally more healthy riparian vegetation, with wooded valley bottom areas and grasses in the under-story on the floodplain or floodplain benches.

No *Japanese Knotweed* [7], a non-native, *invasive* plant was noted in this unit at the time of the assessment survey, though source populations of this plant have been documented upstream, increasing the potential for colonization of disturbed or under-vegetated areas in MU9.

[1]Broadstreet Hollow Management Unit 9 Map
[2]Broadstreet Hollow Management Unit 9 Workbook.
[3]Stream Bank Stabilization Methods and Alternatives
[4]BEHI Monitoring Cross Section Workbooks and BEHI Score Summary
[5]Stream Dynamics Discussion
[6]Attachment ___: USGS
[7]Riparian Vegetation Management
[8]Stream Stability Restoration Projects, Techniques and Contact Information
[9]Habitat Requirements for Trout
[10]Broad Street Hollow Geology