Appendix 1:

TECHNICAL MEMORANDUM

To: Russell Urban-Mean, The Chazen Companies

From: Candice Constantine and Keith Kantack, Inter-Fluve Engineering, PLLC

Date: May 10, 2019

Re: Task 4: Poesten Kill Watershed and Flood Mitigation Assessment: Geomorphic Assessment and Review of Potential Flood Management Options

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Executive Summary

Inter-Fluve Engineering was contracted by The Chazen Companies (Chazen) to assist in completing a flood mitigation assessment and developing a strategy for increasing flood resilience in the Poesten Kill watershed in Rensselaer County, New York. Inter-Fluve's role in the project focuses on characterizing the relevant geomorphic processes occurring the basin and identifying flood mitigation alternatives related to channel and floodplain geomorphology and function. Our approach was to build on existing knowledge and work by reviewing existing data and consulting with stakeholders followed by a targeted reconnaissance-level field assessment. Fieldwork was focused on areas with known flooding issues and histories of flood damages as well as opportunity areas where project implementation may provide flood mitigation benefits.

The Poesten Kill and its main tributary, the Quacken Kill, originate in the uplands of the Rensselaer Plateau and flow generally west towards the Hudson River, which the Poesten Kill empties into at Troy, New York. As the streams descend the western escarpment of the plateau, they transition from steep, confined channels to gently sloping channels with broader floodplains. This transition induces deposition, which has had a persistent flood impact in the communities located along the base of the escarpment. This natural predilection for deposition of sediments along the base of the escarpment is exacerbated by a legacy of artificial channel modification including dredging, straightening, and clearance for agriculture. Another persistent challenge is recurring erosive damage to road infrastructure along the steep reaches of the escarpment.

Based on our findings, we recommend a watershed-wide approach to flood risk management that is tailored to the unique landscape attributes of the Poesten Kill watershed;

- Measures in the headwaters area of the plateau should focus on increasing flood storage and detention;
- Measures along the steep channels of the escarpment should be aimed at increasing resilience of road infrastructure, slowing flows, and reducing erosion; and

- Measures in the lowlands at the base of the escarpment should focus on floodplain and channel restoration, including relocation of vulnerable development types and restrictions on future development.

We provide site-specific examples of this strategy for a select number of locations included in the targeted field assessment along with broader, watershed-wide recommendations.

Introduction

BACKGROUND

The Poesten Kill watershed, an approximately 96 square-mile area, is located in Rensselaer County of the Hudson Valley region, New York (Figure 1a, Appendix A). The region experiences high intensity precipitation events (i.e., more than two inches in 24 hours) that produce damaging floods. This project is a joint effort by a number of stakeholders, including local town governments, the Rensselaer Plateau Alliance (RPA), Trout Unlimited, the New England Interstate Water Pollution Control Commission (NEIWPCC), and the New York State Department of Environmental Conservation's Hudson River Estuary Program (HREP), to explore opportunities to improve flood resiliency in the Poesten Kill watershed. Inter-Fluve's role is to characterize the relevant geomorphic processes occurring in the watershed and identify flood mitigation and community resilience alternatives related to channel and floodplain geomorphology and function. This technical memo summarizes our review of existing data, geomorphic field assessment, and recommendations.

ASSESSMENT SCOPE

The scope of our assessment includes:

- Review of existing data, including publicly available aerial imagery, GIS data, anecdotal information, and existing reports to develop an understanding of geologic context, watershed history, and basin-scale watershed processes;
- Completion of a field assessment to collect data in targeted areas and investigate reach-scale processes; and
- Identification of measures to improve flood resilience through the restoration of geomorphic form and function.

Figures and field data referenced or generated for this study are included in the following appendices:

- Appendix A – Existing Data - Figures produced for the project by RPA;
- Appendix B – Recommendations - Concept plans for select recommendations; and
- Appendix C – Field Data Collection Sheets.

Existing Data Review and Basin-Scale Analysis

GEOLOGICAL SETTING

The Poesten Kill watershed is underlain by the Rensselaer greywacke on the Rensselaer Plateau, and by the black shale and limestone of the Nassau formation in its lower reaches[1]. Both units are Cambrian in age. The current landscape was shaped by tectonic activity during the Taconic Orogeny (440 million years ago) and by repeated glaciations in the Pleistocene, the most recent concluding less than 20,000 years ago. The watershed is dominated by the plateau and its western boundary which forms a steep escarpment, dividing the watershed in half (Figure 1).

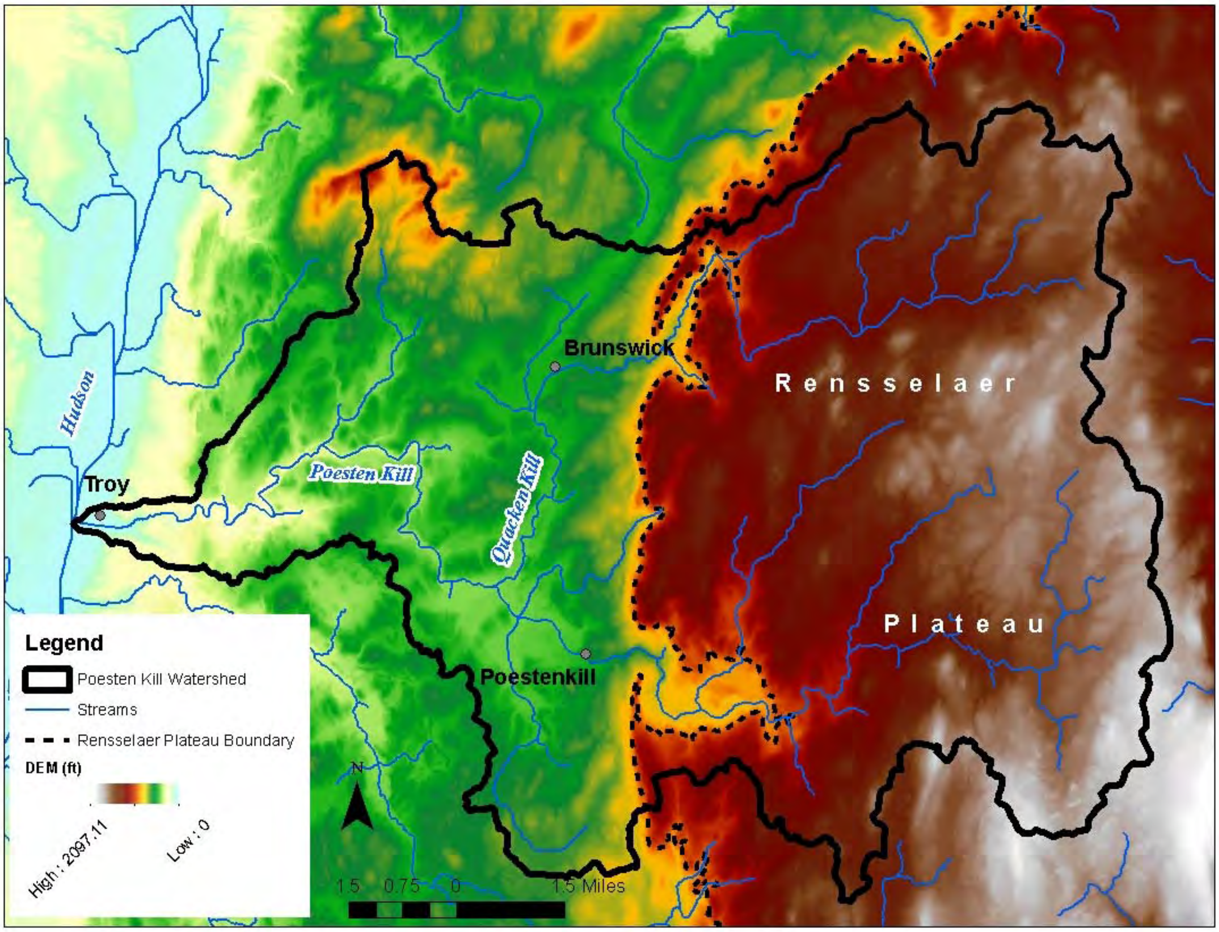

Figure 1. Map of Poesten Kill watershed with digital elevation model (DEM) and shaded relief map. The watershed is outlined in black. The Rensselaer Plateau is the elevated land (colored red/white) delineated by a dashed black line. DEM from USGS/CUGIR.

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[1] Source: New York State Education Department (NYSED). http://www.nysm.nysed.gov/research-collections/geology/gis

The Poesten Kill and its primary tributary, the Quacken Kill, occupy narrow valleys formed in bedrock and surficial deposits of material associated with Pleistocene glacial activity including till, kame deposits, and outwash sands and gravels. Alluvial deposits (sand to gravel) are mapped along the downstream, low-gradient reaches of the mainstem Poesten Kill along with terraces of lacustrine deposits near the mouth of the creek (Figure 4, Appendix A). Descriptions of the primary surficial geology units found in the watershed are provided below[2].

> *Recent alluvium* – Oxidized fine sand to gravel. Permeable. Generally confined to floodplains within valleys. In larger valleys, may be overlain by silt. Subject to flooding. Thickness 1 to 10 meters.
> *Till* – Variable texture (boulders to silt), usually poorly sorted sand-rich diamicton. Deposition beneath glacier ice. Permeability varies with compaction. Variable thickness (1 to 50 meters).
> *Kame deposits* – Coarse to fine gravel and/or sand, includes kames, eskers, kame terraces, kame deltas, ice contact, or ice cored deposition. Lateral variability in sorting, texture and permeability. May be firmly cemented with calcareous cement. Variable thickness (10 to 30 meters).
> *Outwash sand and gravel* – Coarse to fine gravel with sand. Proglacial fluvial deposition. Well-rounded and stratified, generally finer texture away from ice boarder. Permeable. Variable thickness (2 to 20 meters).

LAND USE / LAND COVER

Primary land cover types in the majority rural watershed[3] are forest (64%), which dominates the uplands on the plateau, and agriculture (14%) found in the lowlands (Figure 3, Appendix A). Numerous wetlands are mapped along watercourses and in low-lying areas (Figure 2b, Appendix A), with wetland cover totaling approximately 7% of the watershed and open water, primarily reservoirs, another 2%. Four percent of the watershed is currently classed as low to high intensity development with an additional 5% shown as developed open space. The remaining 4% of land cover comprises barren land, grassland, and shrub/scrub.

Where allowed to grow, riparian buffers of forest and wooded wetland help to stabilize banks, provide a source of large wood to the system, help protect watercourses from the impacts of adjacent land uses, and provide shade and cover for aquatic species. In the Poesten Kill watershed, intact riparian buffers are most common along headwater tributaries on the plateau. On the plateau, the narrow valleys along the mainstem Quacken Kill and Poesten Kill have been developed for residential use and transportation infrastructure, and thus riparian buffers have been compromised to make room for homes and roads. In lowland areas to the west of the plateau, both development

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[2] http://www.nysm.nysed.gov/research-collections/geology/gis. Accessed September 12, 2018.
[3] As provided in the U.S. Geological Survey's National Land Cover Database (2011). https://www.mrlc.gov/nlcd2011.php

and agricultural practices have encroached into riparian buffers along many reaches of the mainstem channels and their tributaries. A brief review of historical photographs dating back to the 1950s indicates that riparian cover has improved somewhat since then when the lowlands were nearly entirely farmed right up to the tops of the channel banks[4].

FLOOD AND CHANNEL DYNAMICS

The landscape of the Poesten Kill watershed is dominated by a prominent topographic step defined by the western boundary of the Rensselaer Plateau (Figure 2). This topographic control accounts for many of the patterns of flood and sediment transport dynamics observed in the watershed. The upper reaches of the Poesten Kill and Quacken Kill that originate on the plateau and flow west down the escarpment, are characterized by steep and confined channels with small floodplains. Slopes along the mainstem channels are on the order of 100 ft/mile or 0.02 (Table 1), with higher slopes occurring locally and along tributaries. The combination of high slope and confinement is capable of generating flood flows with sufficient velocity and depth to erode and transport the abundant sediment present in the surficial deposits forming the hillslopes adjacent to the channels as well as other debris (e.g., large wood). This is reflected in anecdotal descriptions of the damages experienced during Tropical Storm Irene which included blocking of culverts and catastrophic failure of associated road infrastructure such as the damage to Route 2 near the intersection with Stuffle Street in Grafton (Quacken Kill), Plank Road in Poestenkill (Poesten Kill), and Fifty Six Road in Petersburg (Potter Creek).

Table 1. Channel slopes along the Poesten Kill and Quacken Kill

Reach	Slope	ft/mile
Quacken Kill Upper: Dunham Reservoir to Brunswick	0.021	111
Quacken Kill Lower: Brunswick to confluence with Poesten Kill	0.0036	19
Poesten Kill Upper: Dyken Pond to Poestenkill Village at Quacken Kill confluence	0.018	96
Poesten Kill Lower: Downstream of Poestenkill Village	0.0097	51

These steep upland reaches transition abruptly onto the broad plain at the base of the plateau, and channel slopes reduce dramatically (Figure 2 and Table 1). When flows reach this break in slope, they slow and expand onto the floodplain, resulting in a rapid reduction in sediment transport capacity and abrupt deposition of sediment. During Tropical Storm Irene, deposition of substantial volumes of sediment along the Quacken Kill in the village of Brunswick and the Poesten Kill in the village of Poestenkill damaged soccer fields and residential property and filled the channels, reducing conveyance capacity and forcing more flow overbank.

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[4] Historical aerial imagery via NETRonline www.historicaerials.com/viewer . Accessed October 13, 2018.

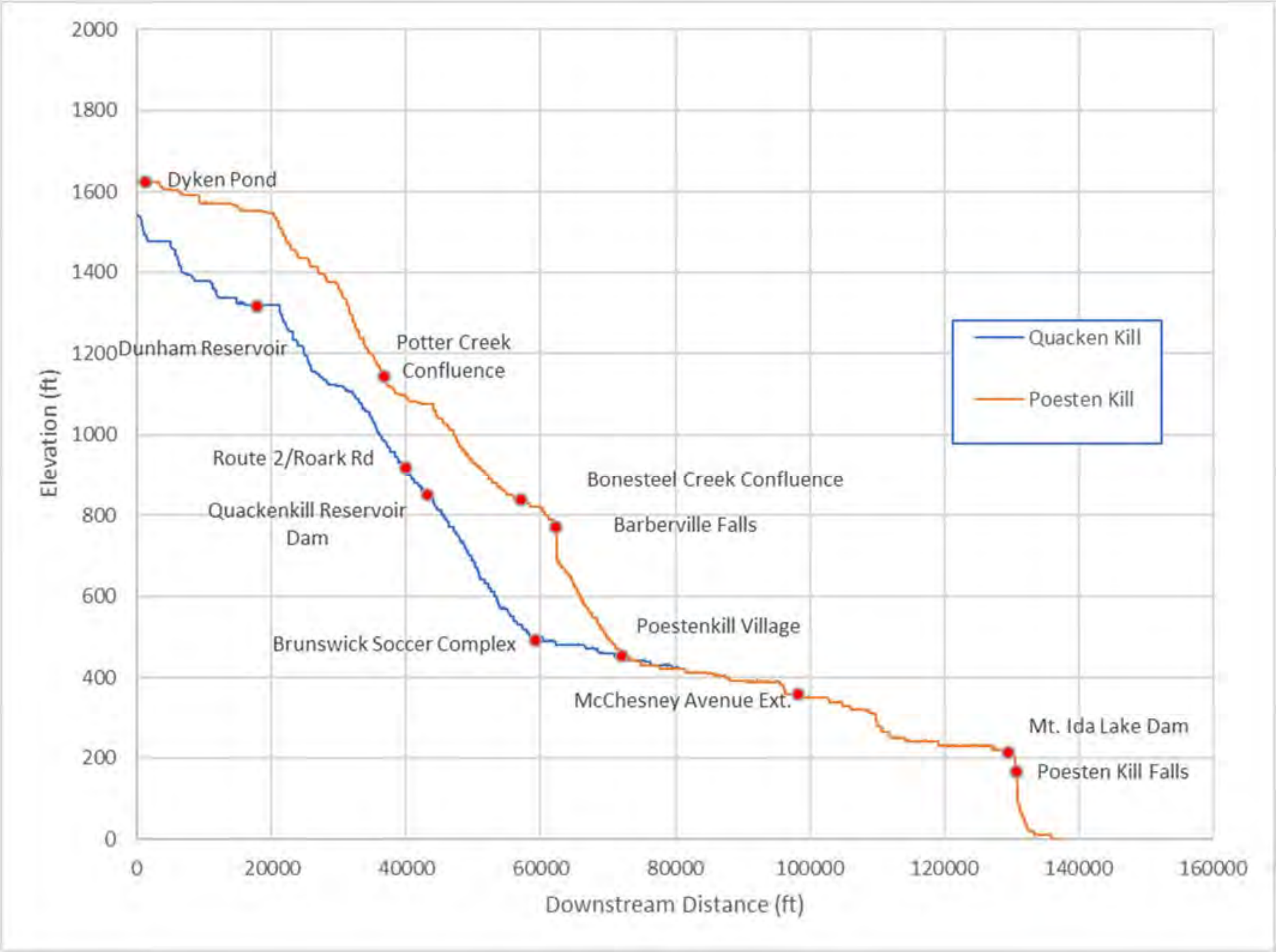

Figure 2. Longitudinal profiles of the Poesten Kill and Quacken Kill, from the headwaters to the confluence with the Hudson River. Points of interest referenced in the report are shown along the profile as red dots. Elevation data derived from 10-meter DEM (CUGIR).

Throughout the watershed, there is evidence that a combination of dredging, berming, and straightening has been a typical management response to these flood and sediment impacts. This approach has resulted in entrenched and over-wide channels that are disconnected from adjacent floodplains, which may serve to reduce the flood risk to properties in the immediate vicinity of the activity but is likely to exacerbate flood peaks in downstream reaches.

The Poesten Kill flows into the Hudson River at Troy. The confluence is downstream of the federal dam and thus within the limits of the Hudson River Estuary.

Studies of climate change impacts in the northeastern U.S. have documented and continue to anticipate a shift toward more extreme precipitation events and higher peak flood flows. For example, Horton et al. (2014) found that the amount of precipitation falling in the heaviest storm events increased by over 70% between 1958 and 2010. Thus, under current climate change projections, flooding and flood-related impacts in the watershed are likely to intensify. Adaptation is necessary to avoid increasingly significant impacts.

ECOLOGY

According to RPA, the plateau is the fifth largest forested area in New York. Forest types include Appalachian oak-pine, deciduous wetland, evergreen northern hardwood, evergreen plantation, oak, successional hardwood, and sugar maple mesic forests[5]. The watershed provides habitat to fisher, bear, bobcat, moose, porcupine, hermit thrush, and black-throated blue warbler among many other animals as well as rare plants. A complete list of vegetative and animal species can be found on the RPA's website[6].

The New York Audubon Society has recognized the relatively unfragmented forested tract of the Rensselaer Plateau extending from Grafton Lakes State Park in the Poesten Kill watershed in the north to Cherry Plain State Park and the Capital District Wildlife Management Area in the south as an Important Bird Area[5]. The forest is home to an abundance and diversity of birds, including many at-risk species.

Poesten Kill watershed has historically been home to a healthy fish population. Presently there are brook trout (*Salvelinus fontinalis)* in both the Quacken Kill and Poesten Kill. The mainstem of the Poesten Kill is also home to brown trout (*Salmo trutta*). However, according to Trout Unlimited[7], many pools, which are critical habitat for trout, have been destroyed by recent dredging in the river. In addition to brown and brook trout, the watershed is also home to lower trophic level aquatic organisms such as dace, minnows, crayfish, and macroinvertebrates.

As a tributary to the Hudson River Estuary, the Poesten Kill watershed falls within the scope of the recently published Hudson River Comprehensive Restoration Plan (Parters Restoring the Hudson, 2018). The existing conditions assessment included in the plan is limited to the estuary and 200 meters upstream of the first barrier on each tributary; however, the plan outlines several restoration goals and actions that are applicable to tributary watersheds such as removing barriers to aquatic organism passage, improving resilience of native plant and animal communities, reducing excess sediment delivery to the estuary, and improving stormwater management. Other goals and actions such as watershed education are transferrable.

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[5] Audubon Important Bird Areas, Rensselaer Forest Tract. https://www.audubon.org/important-bird-areas/rensselaer-forest-tract?site=ny&nid=5341&site=ny&nid=5341

[6] Rensselaer Plateau Alliance, Wildlife. https://www.rensselaerplateau.org/wildlife

[7] Bob Davis, Trout Unlimited, personal communication on October 4, 2018.

Geomorphic Field Assessment

Two Inter-Fluve geomorphologists conducted field surveys on August 20 and 21, 2018, accompanied for a day by a hydrogeologist from Chazen and several local representatives. One geomorphologist returned on April 17, 2019 to get a closer look at some sites during leaf-out conditions. Our intention was to inspect a number of sites (Figure 3) that exemplify the range of challenges and opportunities that exist within the watershed rather than cover the entire 96 square miles, which includes over 90 miles of perennial streams.

Observations made and data collected in the field are summarized below and include photos and the field data collection sheets within Appendix C. Flows during the field assessment were well above the median daily discharge due to a high flow event two days earlier generated by a 2-inch precipitation event. Using the nearby USGS streamflow gage on the Hoosic River (gage number 01334500) as a reference (Figure 4), flows during the survey were roughly one quarter of the peak flow event two days prior, which was roughly one tenth of the flow experienced during Tropical Storm Irene in 2011.

Sites are listed below in order from upstream to downstream, first along the Quacken Kill and then along the Poesten Kill. References to right and left bank are from the standard perspective of looking downstream.

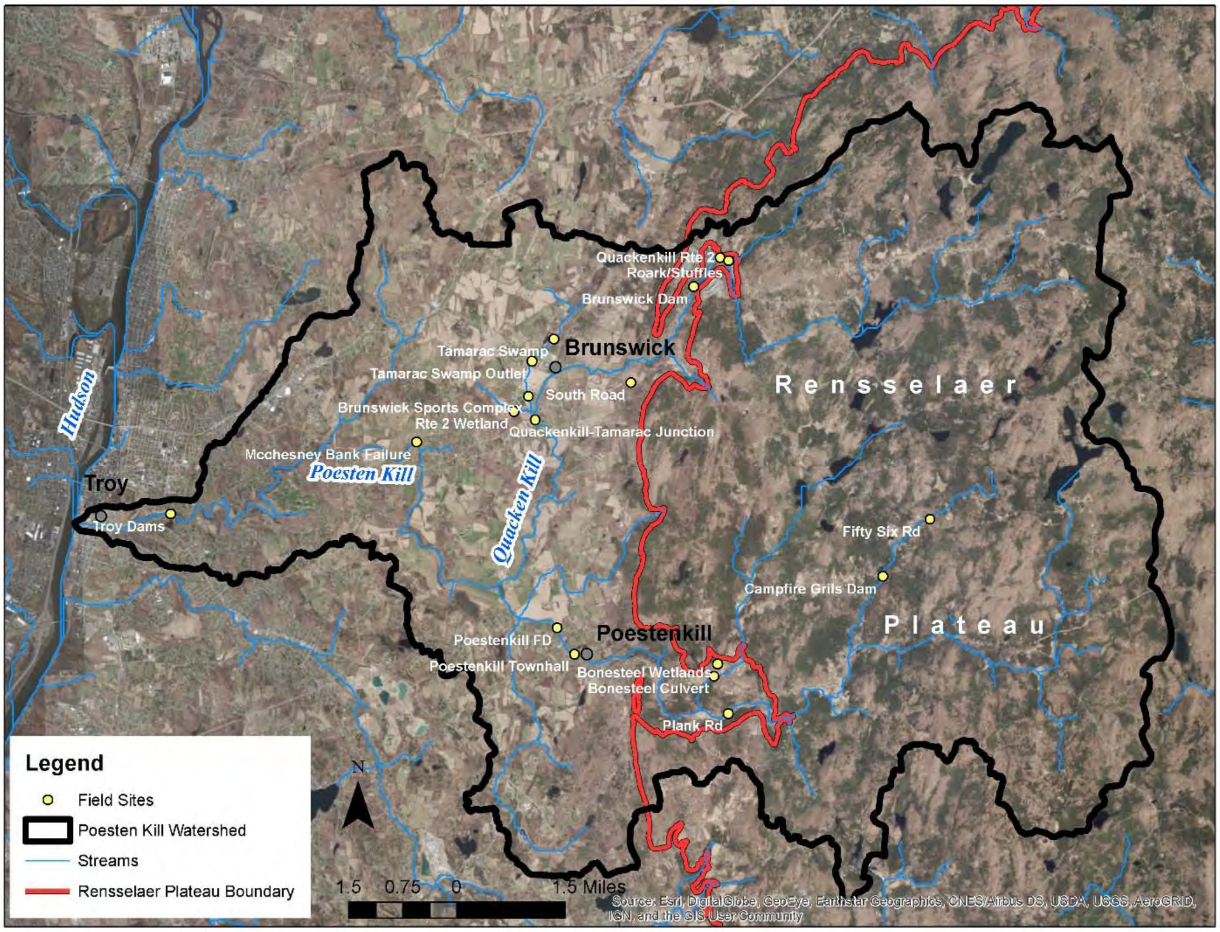

Figure 3. Map of Poesten Kill watershed with field sites labeled. The Rensselaer Plateau escarpment is delineated by a red line.

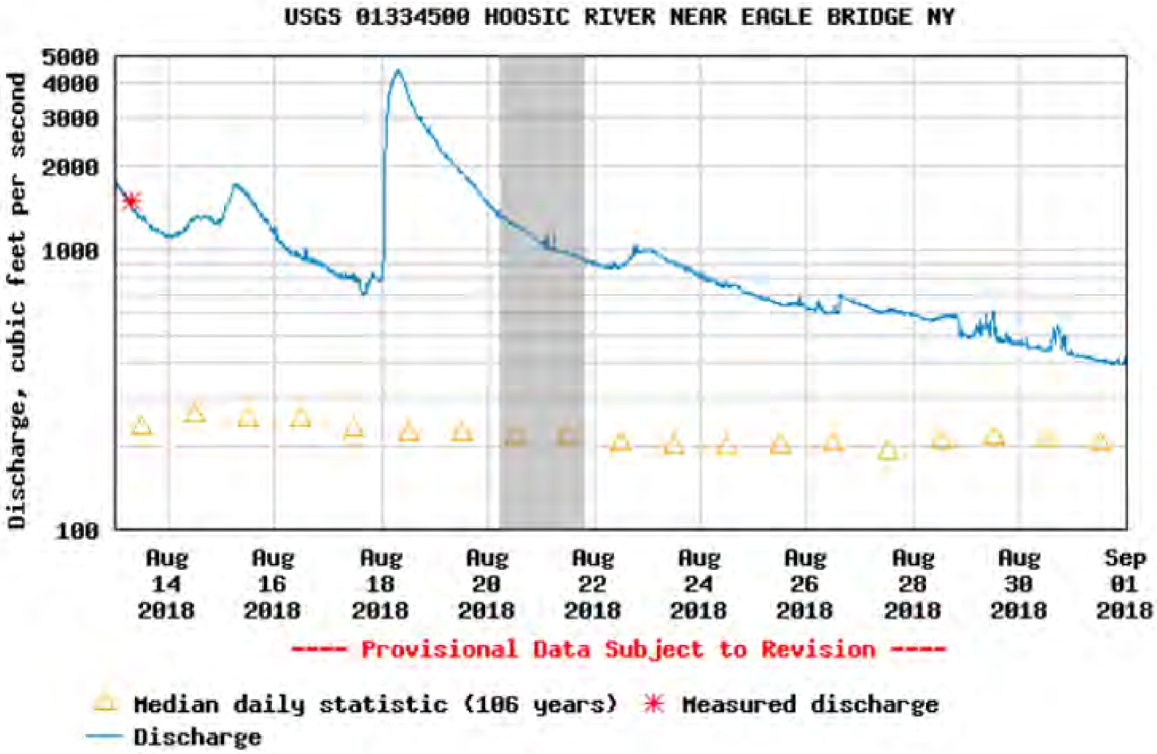

Figure 4. Hydrograph of the Hoosic River in Rensselaer County, a representative gage near the Poestenkill watershed. An approximately 2-inch rain storm produced the high flow event on August 18, 2018. The field survey occurred on August 20 and 21 (shaded in grey) while flows remained well above the median daily discharge. Plot generated at the USGS Surface-Water Daily Data for the Nation website https://waterdata.usgs.gov/nwis/dv?.

ROUTE 2 AT INTERSECTION WITH STUFFLE STREET AND ROARK ROAD CROSSING

A tributary of the Quacken Kill crosses under New York State Route 2 near the intersection with Stuffle Street in Grafton. The drainage area at this point is 2.3 square miles. This site is located on the steep escarpment of the Rensselaer Plateau. The tributary is steep and confined as it approaches Route 2 where it flows into a 4.5-foot wide, 4-foot high concrete box culvert (Figure 5). The stream approaches the culvert at an angle, resulting in a situation that is hydraulically inefficient with the potential for scour by impinging flow against the right bank. A residence on Stuffle Street is located within 10 to 20 feet of the top of the right bank. The culvert, wingwalls, channel banks, and Route 2 road embankment show signs of relatively recent repairs. Anecdotal information and a subsequent conversation with the Town of Brunswick[8] confirm that high flows during Tropical Storm Irene overtopped the culvert and washed out Route 2 at this location, interrupting access and causing substantial damage to the highway. It appears that the original culvert was repaired when the highway was rebuilt but was not replaced with a larger structure with a more hydraulically favorable orientation. Woody debris was observed on the road embankment slope above the headwall, indicating that more recent high flow events than Irene have caused water to back up behind the culvert.

Approximately 300 feet downstream, the tributary crosses under Roark Road through a similarly sized box culvert. Both the Route 2 and Roark Road culverts have concrete bottoms, are perched at their downstream ends, and have been classified as moderate (Route 2) and severe (Roark Road) barriers to aquatic organism passage[9]. Along this section, bankfull width is on the order of 30 feet, and the channel exhibits step-pool morphology dominated by boulders and cobbles with smaller material such as gravel deposited in pools. The channel appears stable through this section, showing no signs of either aggradation nor incision or bank erosion. Between Route 2 and Roark Road, the stream flows through a 4.5-foot wide, 5-foot high box culvert associated with a road crossing that is no longer in use (Figure 6). A substantial build-up of debris was present along the upstream face of the embankment on the date of our inspection. The valley bottom topography in the area suggests that when the culvert is blocked, flow overtops the stream and runs onto Roark Road, possibly affecting access and residences on Roark Road. Approximately 100 feet downstream of Roark Road, the stream empties into the Quacken Kill (Figure 7) and flows under Route 2. The Route 2 bridge has an approximately 40-foot span.

At the time of the survey, the inspected box culverts were roughly one-quarter full, and high-water marks indicated that they were nearly full during the storm that occurred just prior to our field investigation. Given that flows during the survey were only one quarter of the recent summer high-flow event, it suggests that the culverts are overwhelmed during normal high flow events such as

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[8] Bill Bradley, Town of Brunswick, personal communication on August 28, 2018.

[9] North Atlantic Aquatic Connectivity Collaborative https://www.streamcontinuity.org/cdb2/naacc_search_crossing.cfm

the annual flood as well as during extreme precipitation events. This area is outside the extent of existing FEMA flood mapping.

Figure 5. Tributary culvert entrance beneath Route 2 near intersection with Stuffle Street in Grafton. Note concrete repairs to wingwalls and headwall and rip rap repair to right bank. White arrow indicates debris most likely deposited during a recent high flow event when flow backed up behind the culvert.

Figure 6. Looking upstream at relic culvert from a disused road crossing of the Quacken Kill tributary between Route 2 and Roark Road

Figure 7. Quacken Kill immediately upstream of the Route 2 bridge at Paltisch Road and downstream of the Stuffle Street tributary confluence

QUACKEN KILL RESERVOIR DAM

The Quacken Kill Reservoir Dam (Figure 8), owned by the City of Troy, is located along Route 2 on the Quacken Kill approximately 0.75 mile downstream of the Roark Road site. The drainage area at this point is 18 square miles. According to the New York State Inventory of Dams[10], the run-of-the-river dam is 200 feet wide and 25 feet high with a 60-foot-wide concrete spillway and was built in 1905 for public water supply. The impoundment extends approximately 750 feet upstream during low flow and is 150 feet across at its widest point. A steep valley wall rises up from the reservoir on river right. Route 2 runs through the valley above the reservoir on river left. During a high flow event, the reservoir likely provides a trivial amount of flow retention due to its run of the river design. There does not appear to have been any flooding of Route 2 related to the presence of the dam during Tropical Storm Irene. However, large volumes of coarse sediment were delivered to the impoundment, reducing storage capacity of the reservoir.

The water supply facilities of the dam are no longer in use, and we understand that the City has split the parcel and is currently in negotiations to sell both parcels to neighboring quarries. NYS DEC Division of Water, Bureau of Flood Protection and Dam Safety was unable to locate the latest dam inspection report when contacted for this study.

ROUTE 2 DOWNSTREAM OF QUACKEN KILL RESERVOIR DAM

The channel downstream of the dam is generally steep with a boulder bed and step-pool morphology. The channel is constrained to the narrow valley and runs adjacent to Route 2, crossing under the road at a few locations. Where valley width allows, the channel is flanked by low forested floodplain areas that show signs of recent inundation.

This portion of the channel is the source area for the coarse sediment that ends up deposited in the lowland reaches through Brunswick (see Tamarac Road Area below). While we noted bank erosion in some areas, there does not appear to be an issue with widespread vertical or lateral instability. Material is likely derived from the gradual reworking of glacial surficial deposits along the entire length of the channel and tributaries and delivered downstream during flood events.

At two locations, the road surface dips down and sits nearly level with the top of bank (Figure 9). These locations appear to have been dredged and may be particularly vulnerable to flooding and damage. Where residential properties along Route 2 abut the stream, debris including construction materials and trash was found in the channel and along the banks.

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[10] http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1130

Figure 8. Quacken Kill Reservoir Dam

Figure 9. Looking upstream along the Quacken Kill as it runs along Route 2

SOUTH ROAD

Rensselaer County[11] raised the issue of repeated washout and repairs of an incised drainage ditch running along South Road in Brunswick (Figure 10). This site is located near the bottom of the escarpment, just upstream of Brunswick Soccer Complex. The road and ditch, which have been cut into a steep hillside, intercept overland flow paths, small intermittent hillside drainages, and shallow subsurface stormflow (i.e. shallow groundwater moving through soil) that would have otherwise discharged to a low-lying wetland area at the bottom of the hillside as shown in Figure 11. The wetland is not currently shown in mapping by USFWS or NYS DEC. The wetland would naturally drain to the south, and its current outflow is via a 1-foot-diameter culvert under a low spot on South Road. During the survey, there was evidence that the recent rain storm had washed gravel and cobbles out of the ditch and across the road at the bottom of the hill. The material cleaned off the road and out of the ditch at the base of the slope has been piled up along the sides of the ditch to

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[11] Linda von der Heide, Rensselaer County Planning, email correspondence on July 16, 2018.

form berms. Another berm has been constructed near the outlet of the wetland to prevent water backing up behind the culvert from overtopping the road.

Figure 10. Incised ditch along South Road, Brunswick

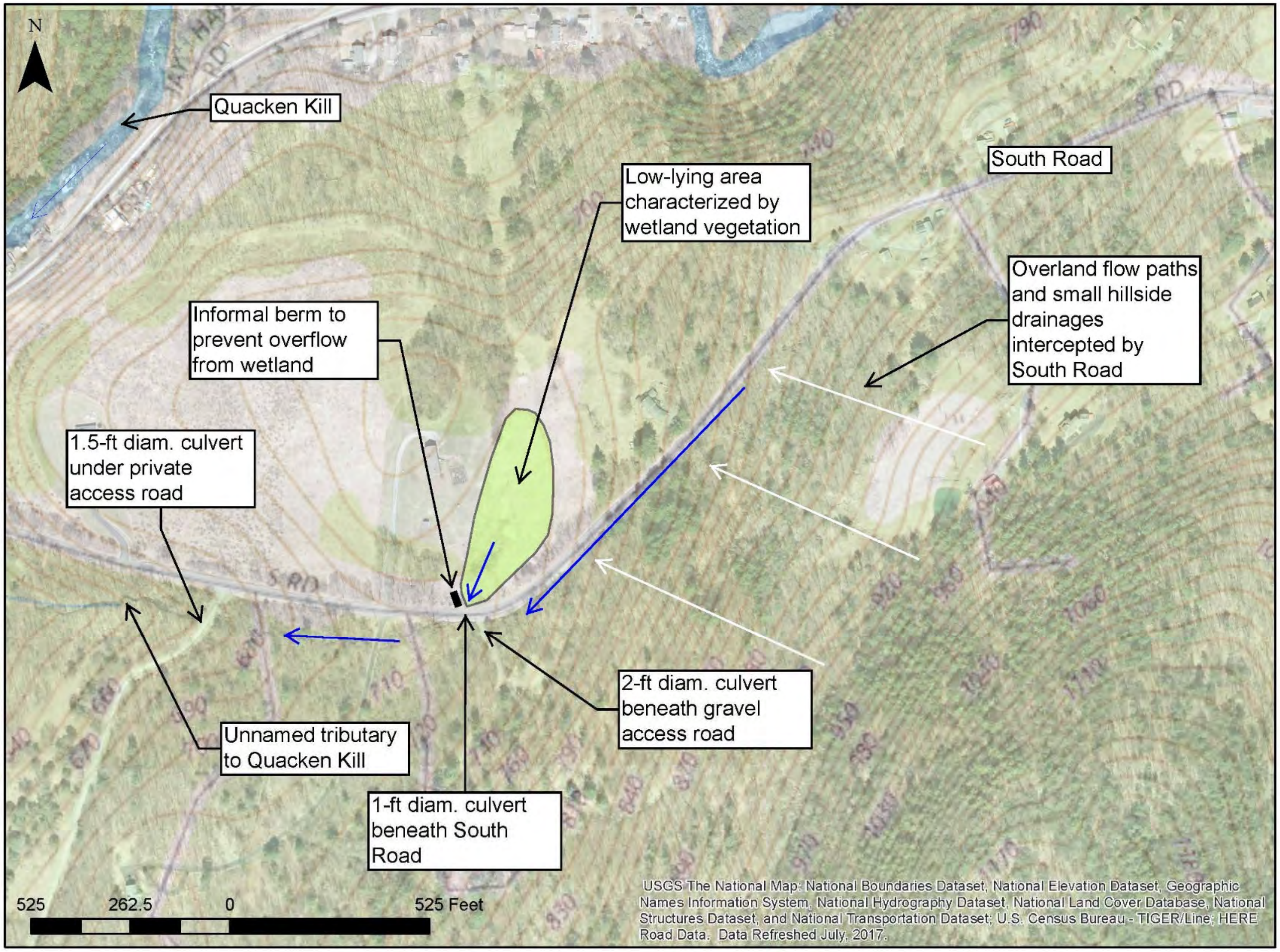

Figure 11. South Road, Brunswick, showing interception of overland flow paths and intermittent hillside channels by South Road, channelized flow along the road ditch (blue arrows) and into an unnamed tributary to the Quacken Kill. Approximate extent of low-lying area of wetland vegetation shown in green. Data sources: 2017 Rensselaer County high-resolution digital orthoimagery (NYS Office of Information Technology Services, GIS Program Office, 2017) and USGS topo map (source data listed on map).

TAMARAC ROAD AREA

The Brunswick Soccer Complex is located at the toe of the escarpment coming off the Rensselaer Plateau and immediately downstream of the New York State Route 351 bridge (Figure 12). The drainage area at the soccer complex is 21 square miles. During Tropical Storm Irene, large volumes of coarse sediment were deposited in the channel and on the floodplain at the complex. The floodplain was cleared and the channel dredged and the material placed at the top of the right bank to form a berm between the channel and the soccer complex. The top of the berm sits an estimated 2 to 4 feet above floodplain level.

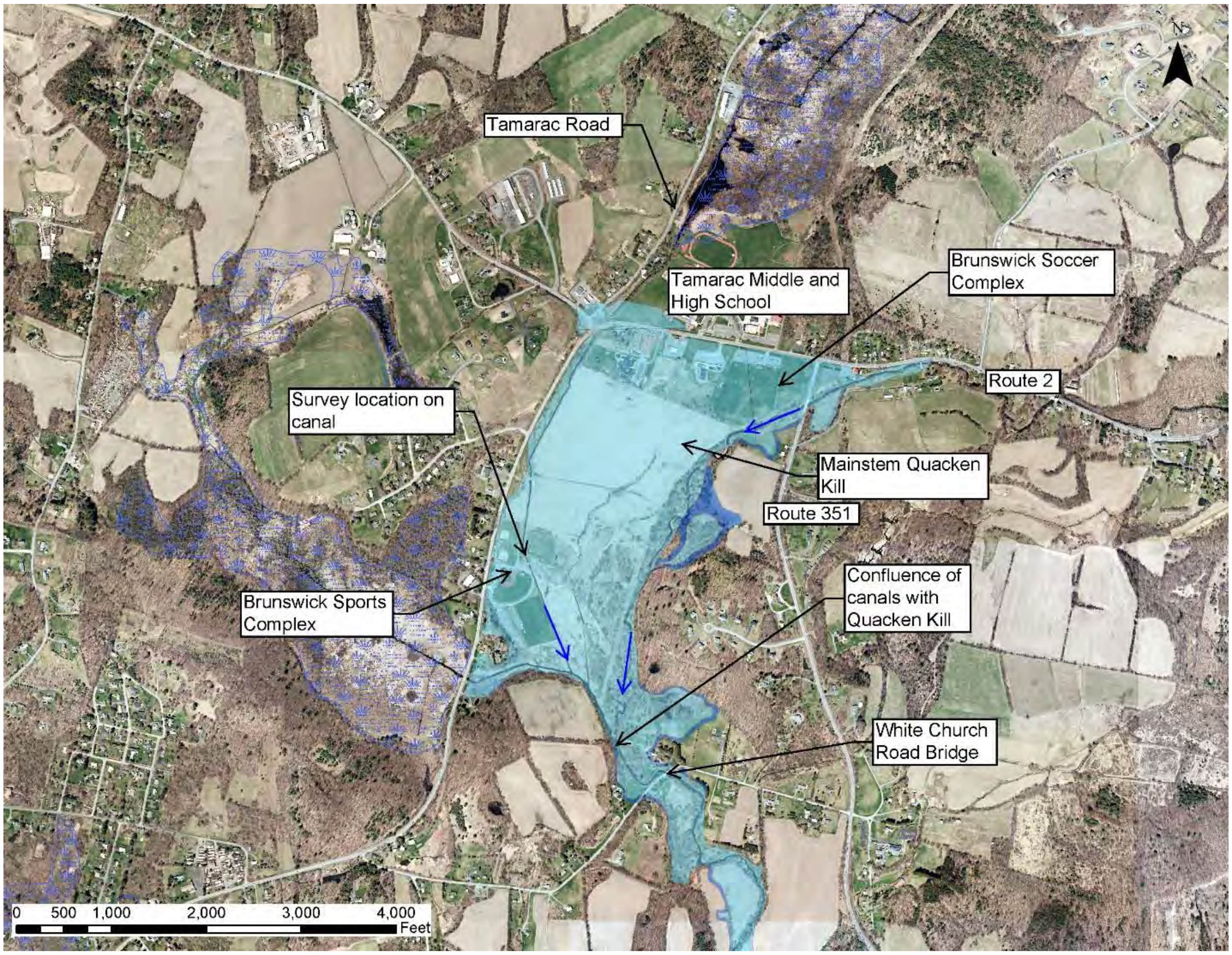

Figure 12. Tamarac Road area in Brunswick showing mainstem Quacken Kill, wetlands and drainage canals. Blue arrows indicate flow direction. Freshwater wetlands mapped by the New York Department of Environmental Conservation (NYS DEC wetlands) and FEMA 1% annual chance (light blue) and 0.5% annual chance (dark blue) flood extents are shown. Basemap imagery is 2017 Rensselaer County high-resolution digital orthoimagery (NYS Office of Information Technology Services, GIS Program Office, 2017).

A tributary of the Quacken Kill flows through a wetland draining a low-lying area at the toe of the escarpment between the Tamarac Middle and High School and Tamarac Road in Brunswick (Figure 12). The drainage area at this point is 3.6 square miles. At the outlet of this wetland, the flow enters an earthen canal that conveys the water along a farm field and through the Brunswick Sports Complex. In total, the canal runs nearly a mile to the confluence with the Quacken Kill. The canal is trapezoidal and measures approximately 22 feet wide and has been dredged to a depth of approximately 5 to 6 feet below the surrounding floodplain surface (Figure 13). The bed is muddy and weedy with no bedforms present. Flow on the day of the survey was approximately 1.7 feet deep and sluggish despite observations of moderate flow and flow velocities in other channels on the day of the survey.

Figure 13. At the Brunswick Sports Complex on Route 2, looking upstream at the tributary draining wetlands along Tamarac Road

Additional canals were dug to drain other wetland areas in the same vicinity (Figure 12). Further investigation of the downstream canal and its confluence with the Quacken Kill (see White Church Road section) indicates that sediment deposition and flow depths along the Quacken Kill control base level and drainage of the canals and wetlands. At the time of the survey, moderate flow in the Quacken Kill caused a backwater effect in the canals such that discharge from the canals was relatively low. This suggests that during flood events, water is held in the wetlands and along the canals until flow levels in the Quacken Kill have dropped, allowing these low-lying areas to drain. This is consistent with FEMA mapping which shows the entire floodplain between the canal and the Quacken Kill within the limits of flooding during a 100-year event.

We surveyed an approximately 1,000-foot-long reach of the Quacken Kill upstream of the White Church Road Bridge to the confluence with the drainage canals. The drainage area at this point is 26.6 square miles Along this reach, the channel has a bankfull width of approximately 50 feet and a bankfull depth of approximately 4 feet. The channel appears stable, showing no signs of persistent aggradation or erosion. The bed is composed predominantly of gravel and cobbles, with a median grain size of approximately 1.5 inches. Deep pools are found on the outsides of channel bends and associated with occasional large wood elements, but the channel otherwise has a consistent depth from bank to bank, with no pronounced thalweg. The channel sits in a broad valley with forested floodplain along both banks. More detailed observations are included in the data sheets in Appendix C.

A large mid-channel bar has formed at the confluence where the drainage canal empties into the Quacken Kill (Figure 14). The cross section at this location is locally relatively wide, which causes flood flows from the Quacken Kill to slow and deposit bed material, building the bar. Evidence of recent flattening of the vegetation growing on the bar indicates that although flow in the Quacken Kill was still moderate at the time of the survey, it had receded since the peak of the runoff following the 2-inch precipitation event. As discussed in the previous section, moderate flow in the Quacken Kill appeared to be causing a backwater effect in the upstream drainage canals (Figure 14B). Surface flow velocity in the Quacken Kill was estimated in the field to be approximately 4 ft/s; surface flow velocity along the drainage canal was negligible.

Figure 14. (A) Looking downstream across the mid-channel bar at the confluence of the drainage canal on right and mainstem Quacken Kill on left. (B) Drainage canal where it enters Quacken Kill showing backwater effect as a result of moderate flow level in the Quacken Kill.

FIFTY SIX ROAD AND THE CAMPFIRE GIRLS DAM

Near the intersection of Fifty Six and North Roads, Potter Creek, a tributary of the Poesten Kill flows over the privately owned Campfire Girls Dam. The drainage area at this point is 3.8 square miles. This site is located on the escarpment of the plateau. According to the New York State Inventory of Dams, the concrete gravity and earthen run of the river structure was built in 1926 and is 65 feet wide and nine feet high with a 40-foot-wide concrete spillway. The area of the impoundment is approximately 5.5 acres. At the base of the spillway, Potter Creek passes under North Road through two large, round corrugated metal culverts, both perched on the downstream end (Figure 15A). During Tropical Storm Irene, high flows over the dam washed out North Road, leaving the original culvert and part of the concrete headwall. The Town of Poestenkill installed a second culvert when they repaired the road following the flood. The actual benefit in terms of flow conveyance is likely limited because of the close proximity to the spillway where substantial turbulence and complex hydraulics make flow entrance into the culverts highly inefficient. The twin culverts would also be prone to blockage by debris transported over the dam in a flood.

Improvements were also made to the earthen embankment portion of the dam on river left following Tropical Storm Irene. The embankment on river right exhibits bare soil, extensive tree growth, and animal burrowing, suggesting that it may remain vulnerable to damage during future extreme events (Figure 15B).

Approximately one mile upstream of the Campfire Girls Dam, Potter Creek flows under Fifty Six Road through twin 36-inch PVC culverts (Figure 16). The creek overtopped the road at this location during Tropical Storm Irene and destroyed a section of the road. The current configuration of the twin culverts plus an additional overflow culvert on the right bank was reconstructed by the Town of Poestenkill as a like-for-like replacement of what was in place prior to Irene. High-water marks from the recent precipitation event indicated that the culverts had been flowing more than half full.

Figure 15. (A) Campfire Girls Dam taken from North Road. The culverts carrying flow from the base of the spillway under the road are visible in the foreground. (B) View of a portion of the earthen embankment on river right.

Figure 16. Outlets of twin 36-inch culverts on Potter Creek at Fifty Six Road, approximately one mile upstream of Campfire Girls Dam

PLANK ROAD

Plank Road runs through the narrow Poesten Kill valley along the face of the Rensselaer Plateau escarpment east from the hamlet of Poestenkill upstream past Barberville Falls to the headwaters of the watershed. Residences are located along the road where the valley is locally wide enough for limited property development; these areas correspond with local reductions in channel gradient. Multiple bridge crossings and the close proximity of the road and homes to the stream channel mean that Plank Road, similar to Route 2 along the Quacken Kill, is particularly vulnerable to the effects of extreme flood events. During Tropical Storm Irene, abundant coarse sediment sized from gravel to boulders was deposited in the channel, Plank Road was washed out, and private residences were damaged. The stream was subsequently dredged and material piled onto the top of the left bank to form a berm (Figure 17).

Figure 17. Looking upstream at the Poesten Kill as it flows along Plank Road upstream of Barberville Falls and the Blue Factory Road bridge. Bed material dredged from the channel has been piled up at the top of the bank on river left (right side of photo).

BONESTEEL CREEK WETLANDS

Bonesteel Creek is a primary tributary of the Poesten Kill upstream of its confluence with the Quacken Kill. This site is also located on the escarpment. Upstream of Columbia Hill Road near the intersection with Blue Factory Road, Bonesteel Creek flows through an approximately 55-acre mapped wetland situated in a small valley underlain by outwash sands and gravels. The drainage area at this point is 8.3 square miles. A tributary enters the wetland from the north. Aerial photographs show drainage ditches dug through the wetland (Figure 18). A portion of the wetland is currently protected under a conservation easement through the Wetlands Reserve Program of the U.S. Natural Resources Conservation Service (NRCS).

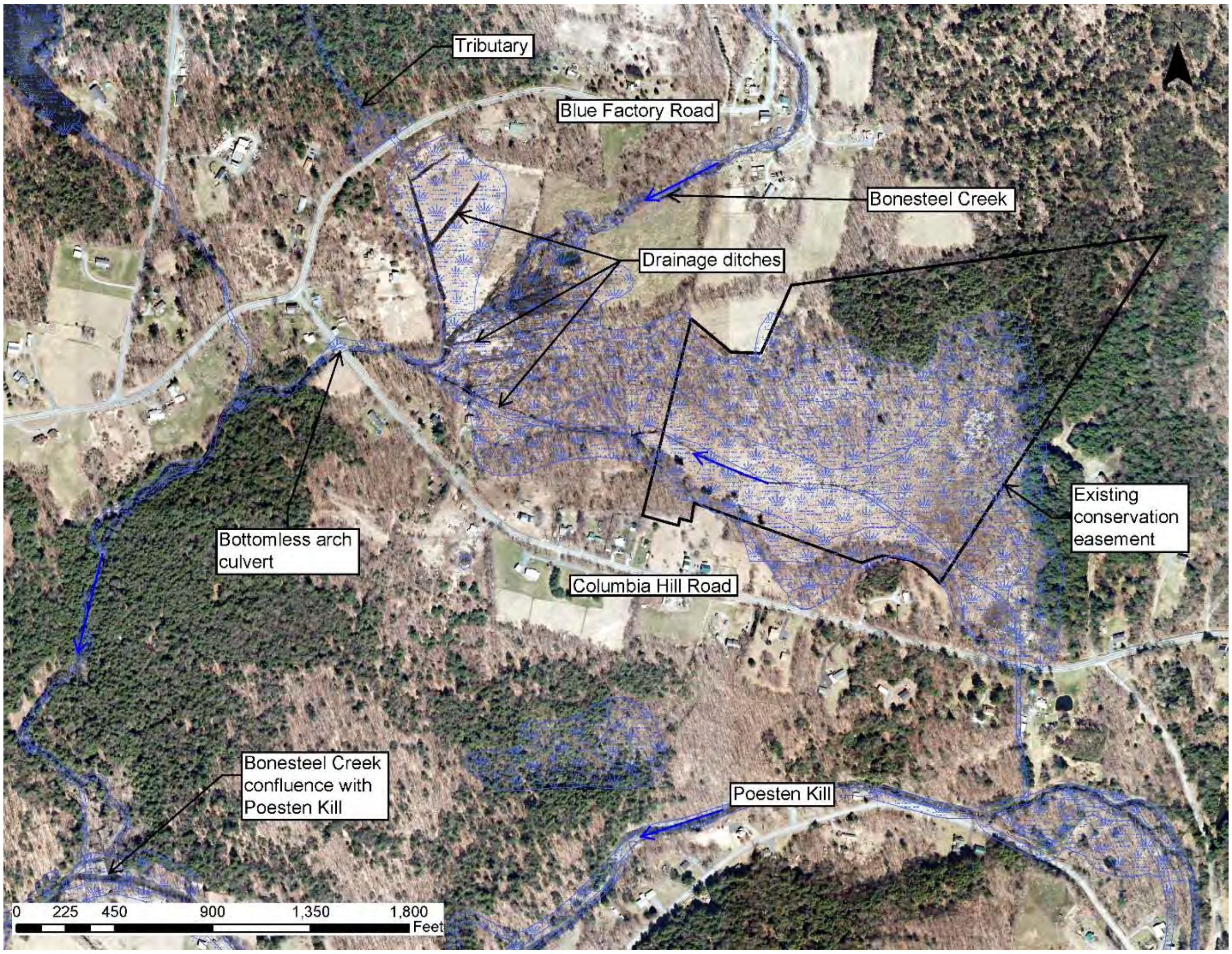

Figure 18. Wetlands (light blue shading) along Bonesteel Creek upstream of Columbia Hill Road showing drainage ditches. Black polygon is an existing conservation easement held by NRCS. Data sources: 2017 Rensselaer County high-resolution digital orthoimagery (NYS Office of Information Technology Services, GIS Program Office, 2017), National Wetlands Inventory (U.S. Fish and Wildlife Service), NYS DEC wetlands, and National Conservation Easement Database.

Channel flow resumes at the outlet of the wetland (Figure 19), approximately 350 feet upstream of the Columbia Hill Road culvert. The channel here is approximately 20 feet wide with a floodplain corresponding to bankfull conditions that narrows toward the culvert. The channel bed is composed of cobbles and gravel, and an existing riffle appears to provide the grade control for outflow from the wetland. Floodplain vegetation includes a combination of mature trees and herbaceous species, and evidence of recent activity suggests that the understory is actively managed and cleared. Hence, roughness elements such as large wood and boulders are scarce both in the channel and on the floodplain, with the wetland draining relatively unimpeded. Rensselaer County replaced the culvert under Columbia Hill Road with a large bottomless arch following washout of the road during Tropical Storm Irene.

Figure 19. Downstream end of Bonesteel Creek wetland located upstream of Columbia Hill Road

POESTENKILL VILLAGE

Just downstream of Poestenkill village, an approximately 700-foot-wide floodplain is situated between the Poestenkill Fire Company and the mainstem of the Poesten Kill (Figure 20), approximately 0.5 mile upstream of the Quacken Kill confluence. The drainage area at this point is 38 square miles. The reach extending from here approximately one mile upstream to the White Church Road (Route 351) bridge is located at the stream's abrupt transition from higher to lower gradient (Figure 2), in an area prone to deposition. Large volumes of coarse sediment were deposited in this reach during Tropical Storm Irene, and some low-lying properties were flooded. Following the flood, and historically during other large magnitude events, the channel was dredged and straightened along much of its length with the dredged material used to construct a berm at the top of the left bank (Figure 21). Review of historical photographs suggests that dredging and straightening has been part of the management strategy along this reach since at least the 1950s[12].

Gradient declines through this reach from approximately 0.01 ft/ft at the Route 351 bridge and flattening out at approximately 0.005 ft/ft at the fire station. In the channel near the station, bankfull width and depth were measured to be approximately 50 feet and 3.6 feet, respectively. The channel is oversized, and bankfull depth was estimated based on the elevation of a top of small floodplain bench on river right and indicators such as the top elevation of persistent granular erosion and bottom elevation of perennial vegetation growth. The top of the berm on river left sits approximately 2 to 3 feet higher than estimated bankfull and 1 to 2 feet above floodplain level (Figure 21). The bed is composed of mostly gravel and cobbles, with a median grain size of approximately 2 inches. The combination of lower gradient and oversized dimensions has made this stretch of the channel particularly prone to deposition. Dredging has also resulted in low complexity in flow and habitat; some alternating bars are present, but the reach is generally devoid of other features such as deep pools, overhanging banks, and large wood that would serve as habitat for fish and other aquatic species.

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[12] Historical aerial imagery via NETRonline www.historicaerials.com/viewer . Accessed October 13, 2018.

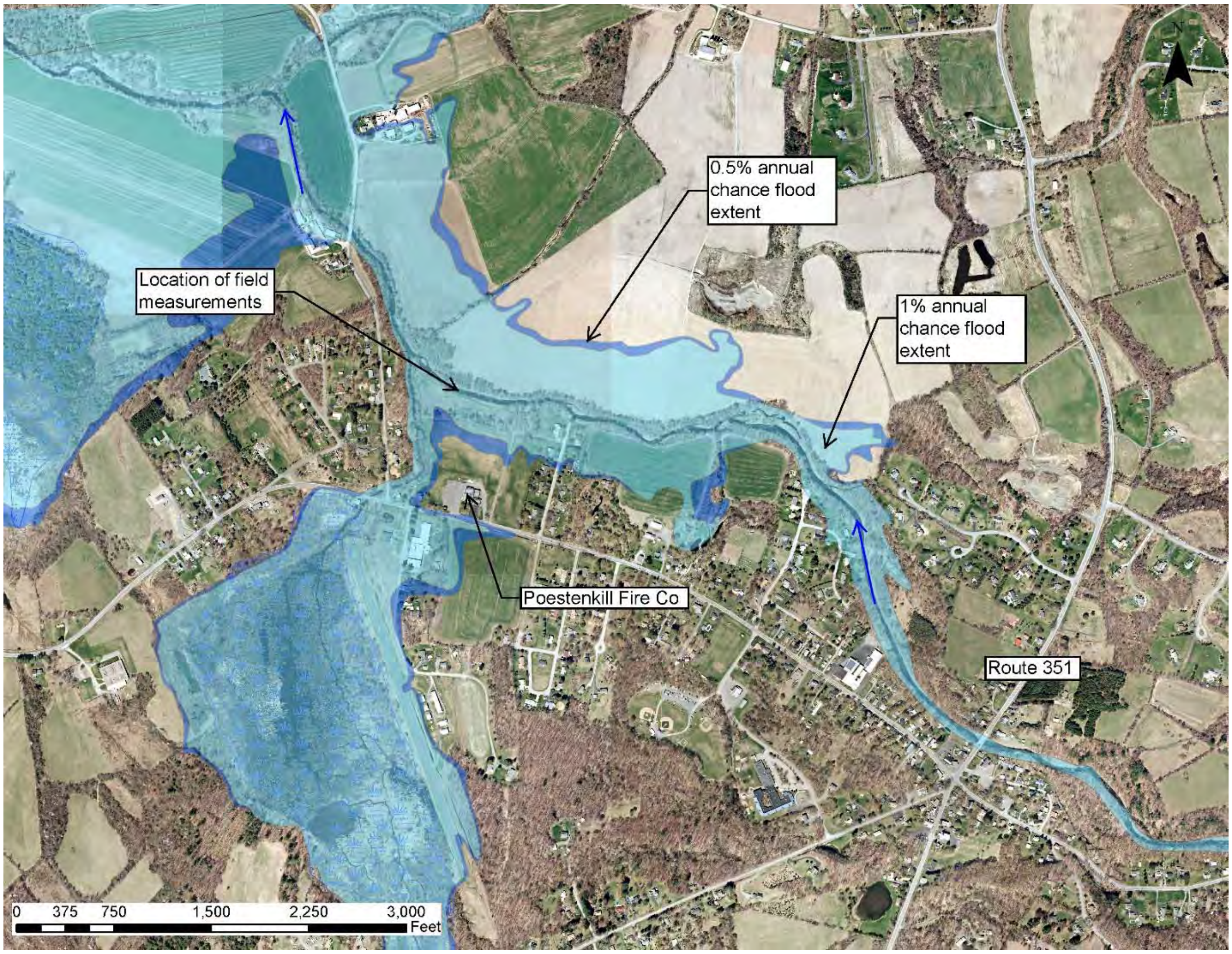

Figure 20. Mapped flood extents along the Poesten Kill at the Poestenkill Fire station. Data sources: 2017 Rensselaer County high-resolution digital orthoimagery (NYS Office of Information Technology Services, GIS Program Office, 2017) and FEMA flood extents.

Figure 21. Looking upstream along the Poesten Kill channel at the Poestenkill Fire Station. Dredging and construction of a berm from dredged gravel has disconnected the channel from its floodplain on river left (right side of photo). A lower floodplain bench is visible on river right (left side of photo) adjacent to farm fields.

MCCHESNEY AVE EXTENSION BLUFF EROSION

We observed the eroding bluff forming the right bank of the Poesten Kill at McChesney Ave Extension, and County-owned road, in Brunswick. The drainage area at this point is 84.2 square miles. Analysis of aerial imagery shows that the eroding face has been present since at least 1952[13]. In that time, the bluff has been steadily retreating. The failing portion of the bluff is an approximately 100 feet tall and 400 feet long section of the bank along an outside bend in the river. The eroding material is mapped as till, and the face of the slope is unvegetated and poorly consolidated, with rills and gullies dissecting the surface (Figure 22). During precipitation events, the bluff is likely a notable source of sediment, via erosion at the toe by elevated flow in the Poesten Kill and mobilization of sediment down the face of the slope by surface runoff. Numerous deposits of coarse sediment observable in the channel downstream of the bend were likely derived from this

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[13] Historical aerial imagery via NETRonline www.historicaerials.com/viewer . Accessed October 13, 2018.

source. In addition to water quality issues created by high sediment loading, continued bank retreat poses a threat to McChesney Ave Extension and a residence at the top of the scarp. Currently the top of the eroding face is 20 to 30 feet from the road.

The Town of Brunswick has been visually monitoring bank retreat over a number of years and has confirmed that retreat continues to occur at a steady rate[14]. The County extended the guard rail along the road at the top of the bluff in summer 2018 to improve road user safety. No other improvements are planned at the site and no formal monitoring program is in place.

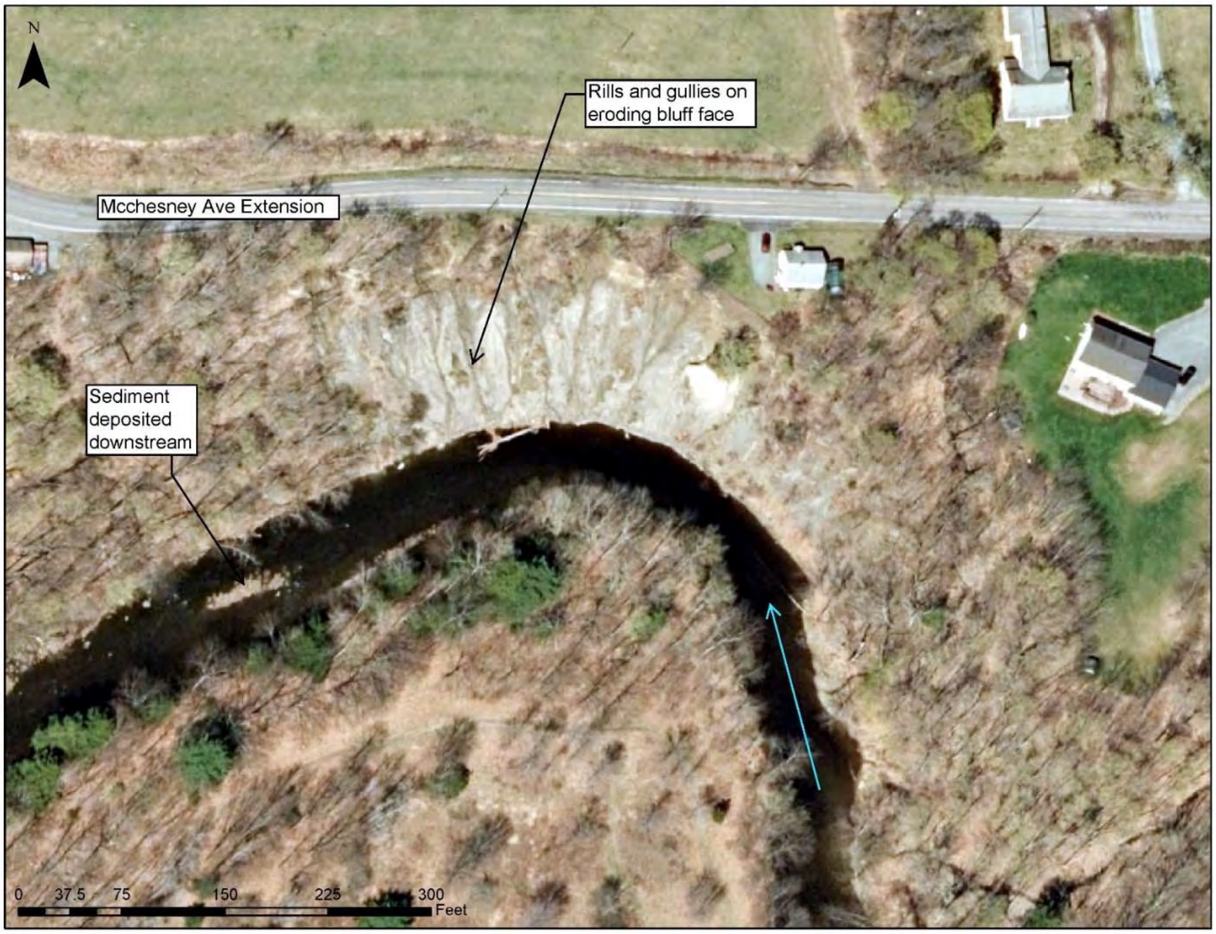

Figure 22. Eroding bluff at Mcchesney Ave Extension in Brunswick. Blue arrow indicates flow direction in the Poesten Kill. Data source: 2017 Rensselaer County high-resolution digital orthoimagery (NYS Office of Information Technology Services, GIS Program Office, 2017).

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[14] Bill Bradley, Town of Brunswick, personal communication on November 9, 2018.

IDA LAKE DAM

Ida Lake Dam is located on the Poesten Kill within the City of Troy. It is one of two dams owned by the City; the second being Mt Ida Falls Dam located approximately 1,100 feet downstream at the head of the Poesten Kill Gorge. Originally constructed in 1912, the 135-foot-long, 12-foot-high timber spillway structure was reconstructed in 2000-01 after it breached in 1998 (CDM Smith, 2012). The dam sustained damage during Tropical Storm Irene, and a recent inspection revealed structural issues that raise concerns about the possibility of a future breach and sudden inundation of downstream areas (Schnabel Engineering, 2018). In the short term, the lake will be drained in a controlled manner by removing the central portion of the spillway to avoid sudden failure. The City is exploring long-term options including; dam removal, replacement with a more resilient, non-timber structure, and replacement with a more resilient structure at a lower elevation[15].

Summary and Recommendations

The watershed's location on either side of the edge of the Rensselaer Plateau is the primary influence on the flood dynamics in the watershed. The upper watershed is a source of runoff that is rapidly conveyed through narrow valleys incised into the face of the steep escarpment forming the western boundary of the plateau. Sediment mobilized along the escarpment is deposited at the base of the escarpment during large flood events, forcing flow out of banks.

Land-use modifications and human activities further affect flooding and its consequences. Development within the narrow valleys of the escarpment has constrained the Quacken Kill and Poesten Kill, reduced riparian buffers, increased runoff, and increased potential for flood damages. Roads crossings frequently restrict flows and are vulnerable to failure when blocked or overtopped. In lowland areas, development and agricultural practices occupy floodplains and encroach into riparian buffers, and channel maintenance practices have left channels disconnected from floodplains reducing flood storage and increasing conveyance of flood flows further downstream.

We recommend an approach to increasing flood resilience that is tailored to the landscape and the different processes dominating various parts of the watershed. This "nature-based" strategy is ecologically sound and results in lasting, cost-saving solutions because it focuses on working with natural stream processes rather than trying to suppress or control them through post-flood maintenance actions.

In the headwaters on the plateau, opportunities should be sought to store water on floodplains, in wetlands, and utilizing existing flood storage of existing dam infrastructure. Forest cover should be

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[15] More information about the Ida Lake Dam Project can be found on the City's project website: http://www.troyny.gov/departments/engineering-department/engineering-projects/mount-ida-dam-project/

maintained and expanded to help maximize interception and evapotranspiration and slow runoff. Riparian buffers should be encouraged to help stabilize banks and slow flood flows.

In the steep reaches on the plateau and along the escarpment, efforts should focus on improving the ability of roads, road crossings, and other infrastructure to withstand the passage of large floods without extensive damage or catastrophic failure and on slowing flows and reducing erosion. Road crossings should be upsized to pass larger flows and debris to avoid catastrophic failure. Relic or redundant structures such as dams, weirs, and culverts that no longer serve a purpose should be removed, prioritizing those that could fail catastrophically. Best management practices (BMPs) should be implemented to intercept road drainage, slow runoff, and reduce gullying and erosion along steep road sections. Roughness should be added to the channel in the form of large wood grade control structures where appropriate to slow flows, enhance the limited floodplain storage that is available, and trap coarse sediment. Finally, if significant point sources of coarse sediment are identified, ecologically sensitive bank stabilization projects should be implemented as appropriate.

In the western lowlands, vulnerable development types should be encouraged to relocate outside flood-prone areas where possible, and future development should be restricted to higher ground. In reaches within natural zones of deposition, steps should be taken to give the channel room to aggrade, build bars, and shift position. Repeated dredging operations should be minimized to reduce adverse impacts to in-stream habitat and maintain more natural cross-section conditions. Overwide channels formed by dredging can cause further instability by exacerbating aggradation through reduced flow depths and velocities compared with a naturally formed channel. Floodplains and wetlands should be maintained, protected, and enhanced to store and slow floodwaters. Artificial barriers and restrictions that elevate upstream flood levels should be removed.

Table 2 provides examples of the strategy described above that are focused on the sites included in the field assessment in addition to watershed-wide recommendations. Sketches for selected projects are provided in Appendix B. The concepts may and should, however, be applied as appropriate to other opportunities and problem areas within the watershed to achieve a comprehensive approach that is expected to have a measurable effect.

The following projects are limited to resilience alternatives related to channel and floodplain geomorphology and function; other alternatives, including reservoir operations and other infrastructure-related work will be presented in the wider report by Chazen. We recognize that the project list is by nature incomplete in that it does not cover all possible actions that could be taken at every site within the watershed. These project examples have been provided as a starting point, and the list should be expanded as more information is gathered and opportunities are identified.

Table 2. Project alternatives to improve resilience by addressed channel and floodplain geomorphology and function

Location of example project	Description	Figure in Appendix B
Route 2/ Roark Road (escarpment)	Replace the Route 2 and Roark Road tributary crossings with structures sized to the channel and adequate to pass extreme floods, including debris generated during extreme floods. Remove relic culvert at disused crossing between Route 2 and Roark Road. Project would reduce the risk of flood damages, improve local resilience to flooding, and reduce risk of public safety.	
Quacken Kill Reservoir Dam (escarpment)	Confirm structural integrity of dam and investigate feasibility of removal to eliminate maintenance and the risk of failure and to restore the channel and aquatic organism passage. Alternatively, maintain a robust inspection schedule and make repairs as necessary to ensure the integrity of the structure.	
Quacken Kill along Route 2 (escarpment)	Evaluate low-lying stretches of Route 2 for flooding issues and raise the road if necessary to reduce risk and eliminate need for dredging. Install valley-spanning engineered large wood structures where opportunities exist to increase floodplain storage, slow flows, control grade in the channel, and trap coarse sediment. Implement bioengineered bank erosion control projects where appropriate to stabilize coarse sediment.	
South Road (escarpment)	Install regularly spaced ditch relief culverts to intercept road drainage and route flows into an existing wetland. Regrade and repair the road ditch. Replace the culvert under South Road at the outlet to the wetland with an appropriately sized structure and construct a berm to prevent overflow from the wetland onto the road. Consider raising the road over approximately 300 feet at the crossing to prevent overtopping. Confirm adequate sizing of downstream culverts. The project would reduce flood damages, increase the resilience of the road, and slow runoff.	Concept 1

Location of example project	Description	Figure in Appendix B
Tamarac Road area (lowlands)	Relocate the Brunswick Soccer Complex away from the toe of the escarpment and the main Quacken Kill channel. Remove the berm at the existing complex and restore floodplain connectivity. Enhance the existing floodplain to increase flood storage and conveyance. Relocate power lines outside of floodplain enhancement area. Relocation and floodplain enhancement would require land purchase and should be supported by further investigation and hydraulic study.	
Campfire Girls Dam (plateau)	Remove Campfire Girls Dam and replace culvert under North Road with a larger structure to improve resilience, reduce the risk of failure, and reduce risk to public safety.	
Fifty Six Road (plateau)	Replace twin culverts with an appropriately sized structure to improve resilience of the road.	
Plank Road (plateau/escarpment)	Carry out a more detailed geomorphic assessment to investigate point sources of coarse sediment and define limits of depositional reaches. Address sediment generation at source using ecologically sensitive methods. Establish and enhance riparian buffers. Design crossings to pass debris and use bioengineering techniques to stabilize the streambanks at road embankments. Inform residents of options for buy outs or individual property protection.	
Bonesteel Creek wetlands (plateau)	Increase flood retention in existing wetlands by blocking artificial drainage ditches, re-meandering channels, and/or installing wood or boulders and enhancing floodplain roughness to slow outflow. Lateral and longitudinal extents should be designed to prevent outflanking during high flows. Expand the existing conservation easement to include the entire wetland.	Concept 2 (two options)

Location of example project	Description	Figure in Appendix B
Poestenkill Village (lowlands)	Buy out properties susceptible to repeat flooding, and rehabilitate the channel through re-meandering, appropriate sizing, and installation of measures to introduce hydraulic complexity and facilitate sediment transport. Remove berms, reconnect floodplains, and expand riparian buffers. Channel design should be supported by further investigation and hydraulic study. Concept 3 as shown in Appendix B is focused on the land immediately adjacent to the Poestenkill Fire Company. Extending the concept upstream to Route 351 will require property acquisition.	Concept 4
Mcchesney Ave Extension (lowlands)	Establish a monitoring program and carry out a geotechnical investigation to assess the risk of failure. Depending on the results, consider options for eliminating the hazard such as implementing a bluff stabilization project or relocating the road.	
Watershed-wide	Educate the community about the watershed’s geologic, geomorphic, and hydrologic context. Explain the natural processes at work and how these are likely to be exacerbated with climate change. Work with landowners to curb unsustainable practices such as dredging and berming.	
Watershed-wide	Complete additional field-based geomorphic assessments along reaches of the Quacken Kill, Poesten Kill, and tributaries not included in this study to identify point sources of coarse sediment and additional opportunities for restoration and enhancement. Address sediment generation at source, where appropriate, using ecologically sensitive methods.	
Watershed-wide	Create an inventory of roads that contribute to flood peaks by intercepting and concentrating runoff. Systematically develop and implement BMPs to slow runoff and reduce erosion.	

Location of example project	Description	Figure in Appendix B
Watershed-wide	Expand and formalize training and resources for the public and county and municipal staff that focus on flood resilience and natural systems solutions and management practices that support watershed resilience. Among other sources of information and ideas are Vermont's Rivers and Roads and Flood Ready Vermont programs, or Maine Audubon's Stream Smart program.	
Watershed-wide	Establish and advertise a stream buffer program or advertise existing programs such as the Hudson River Estuary Program's Trees for Tribs to assist private landowners in developing and implementing planting plans.	
Watershed-wide	Establish conservation easements to protect and restore priority riparian corridors, wetlands, and forested areas. Support the program with a study that prioritizes parcels for easement acquisition.	
Watershed-wide	Via the New York State Hemlock Initiative, partner with NYS DEC and Cornell University Cooperative Extension to hold a Hemlock Woolly Adelgid (HWA) workshop to educate public and private landowners and managers on the importance of hemlock trees in local forests, the threat presented by HWA, and how landowners can identify and manage HWA infestations.	

Location of example project	Description	Figure in Appendix B
Watershed-wide	Establish a watershed alliance to lead the development of a watershed plan that dovetails with the Hudson River Comprehensive Restoration Plan (Partners Restoring the Hudson, 2018), incorporates the recommendations from this study, and expands recommendations beyond flood risk management. The role of an alliance may also include raising awareness about critical issues, educating the public, monitoring streams, and completing stream improvement and clean-up projects. RPA has established a committee to assist with the current project; the possibility of transitioning this committee into a watershed organization should be explored.	

References

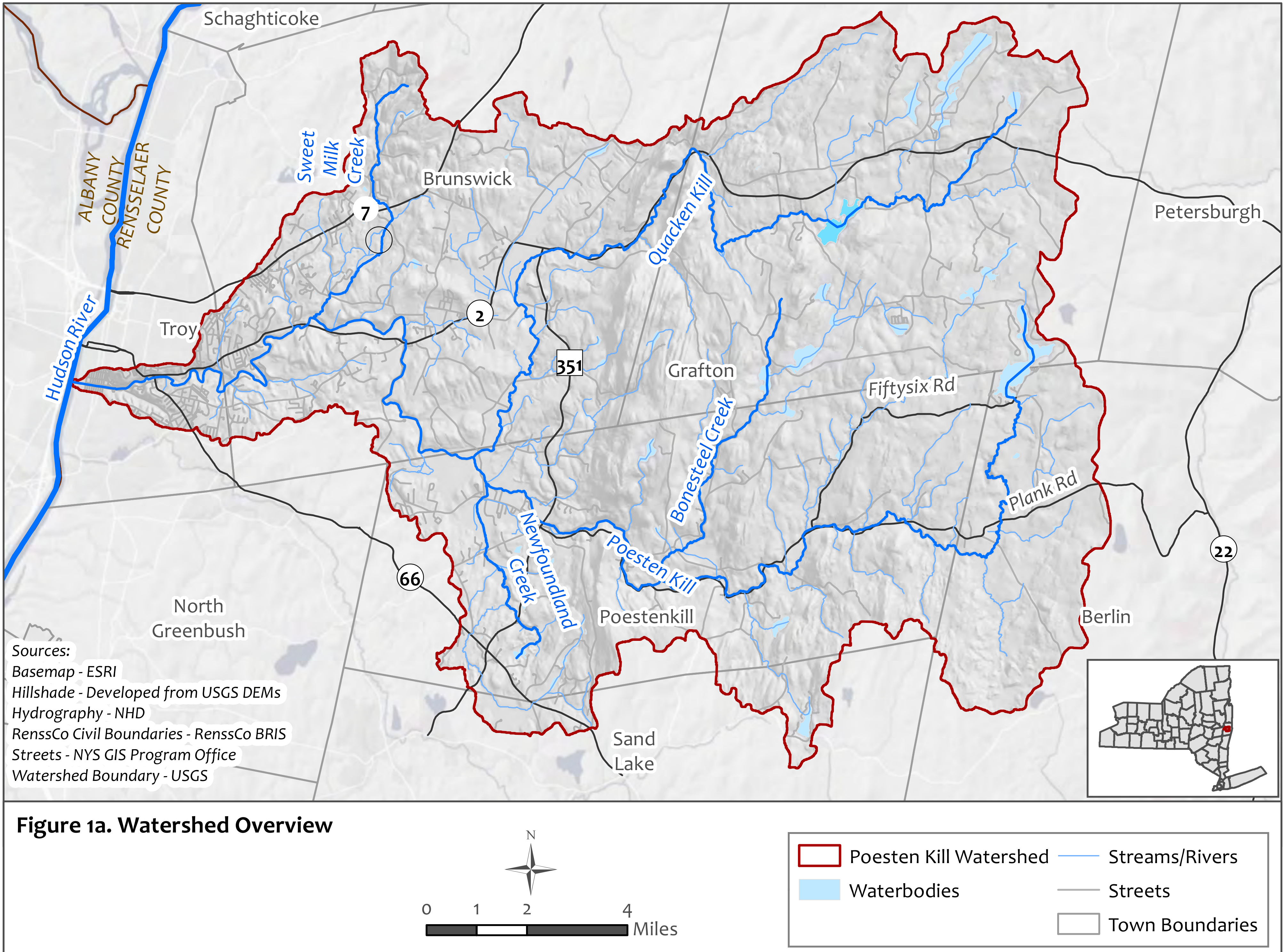
CDM Smith, 2018. Ida Lake Dam Engineering Assessment & Recommendations. May 2012.

Horton R, Yohe G, Easterling W, Kates R, Ruth M, Sussman E, Whelchel A, Wolfe D, Lipschultz F, 2014. Ch. 16: Northeast. Climate Change Impacts in the United States: The Third National Climate Assessment. Melillo JM, Richmond TC, Yohe GW (eds). U.S. Global Change Research Program. 16-1-nn.

Partners Restoring the Hudson, 2018. Hudson River Comprehensive Restoration Plan: Recommendations for the New York-New Jersey Harbor & Estuary Program Action Agenda and the New York State Hudson River Estuary Action Agenda. New York, NY. The Nature Conservancy.

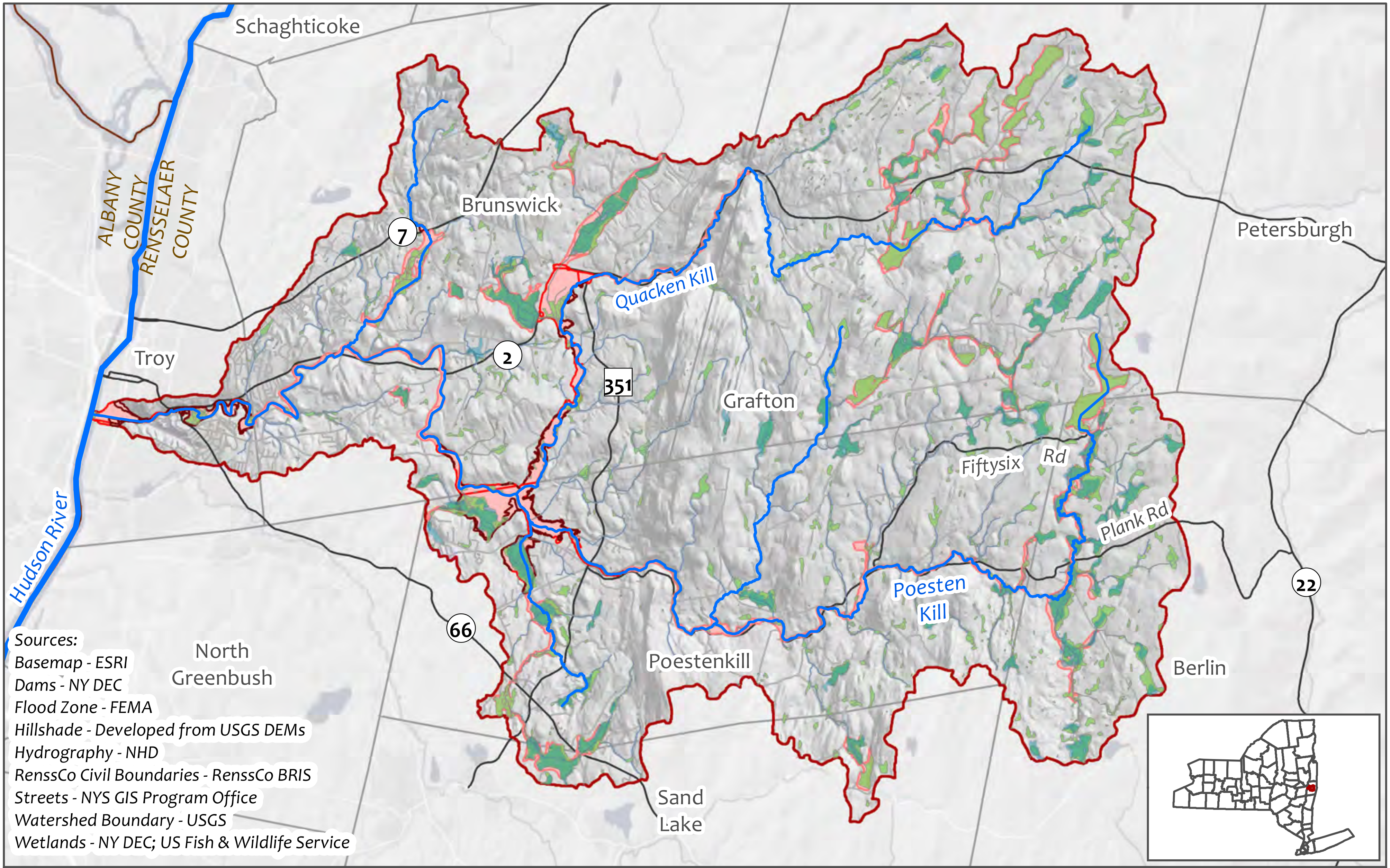
Schnabel Engineering, 2018. Letter to Chris Wheland, Superintendent of Public Utilities, City of Troy, Subject: Recommendation for Lake Lowering, Ida Lake Dam Structure Inspection, NYS ID: 226-1391. September 19, 2018.

Appendix A – Existing Data



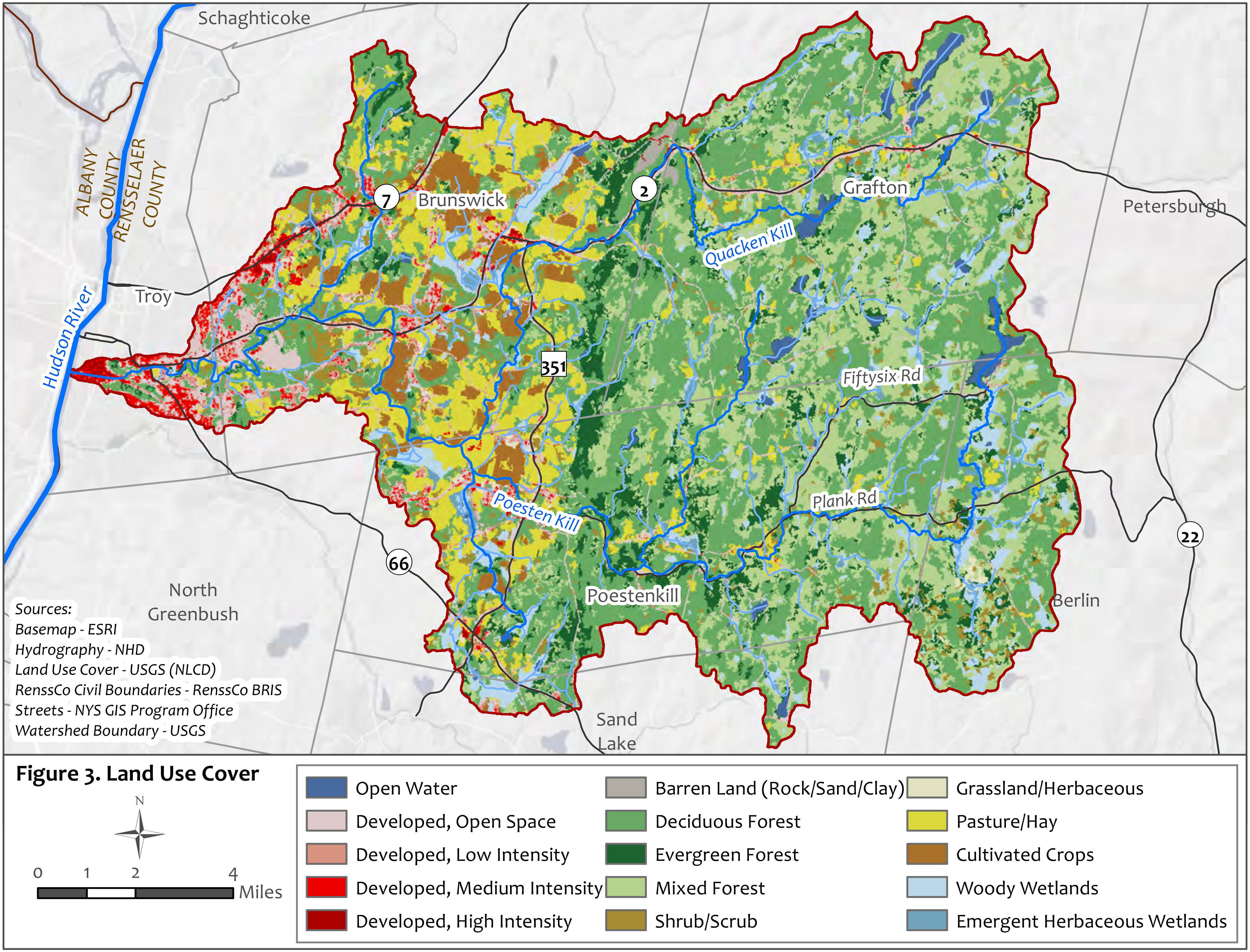
Sources:
Basemap - ESRI
Hillshade - Developed from USGS DEMs
Hydrography - NHD
RenssCo Civil Boundaries - RenssCo BRIS
Streets - NYS GIS Program Office
Watershed Boundary - USGS

Figure 1a. Watershed Overview



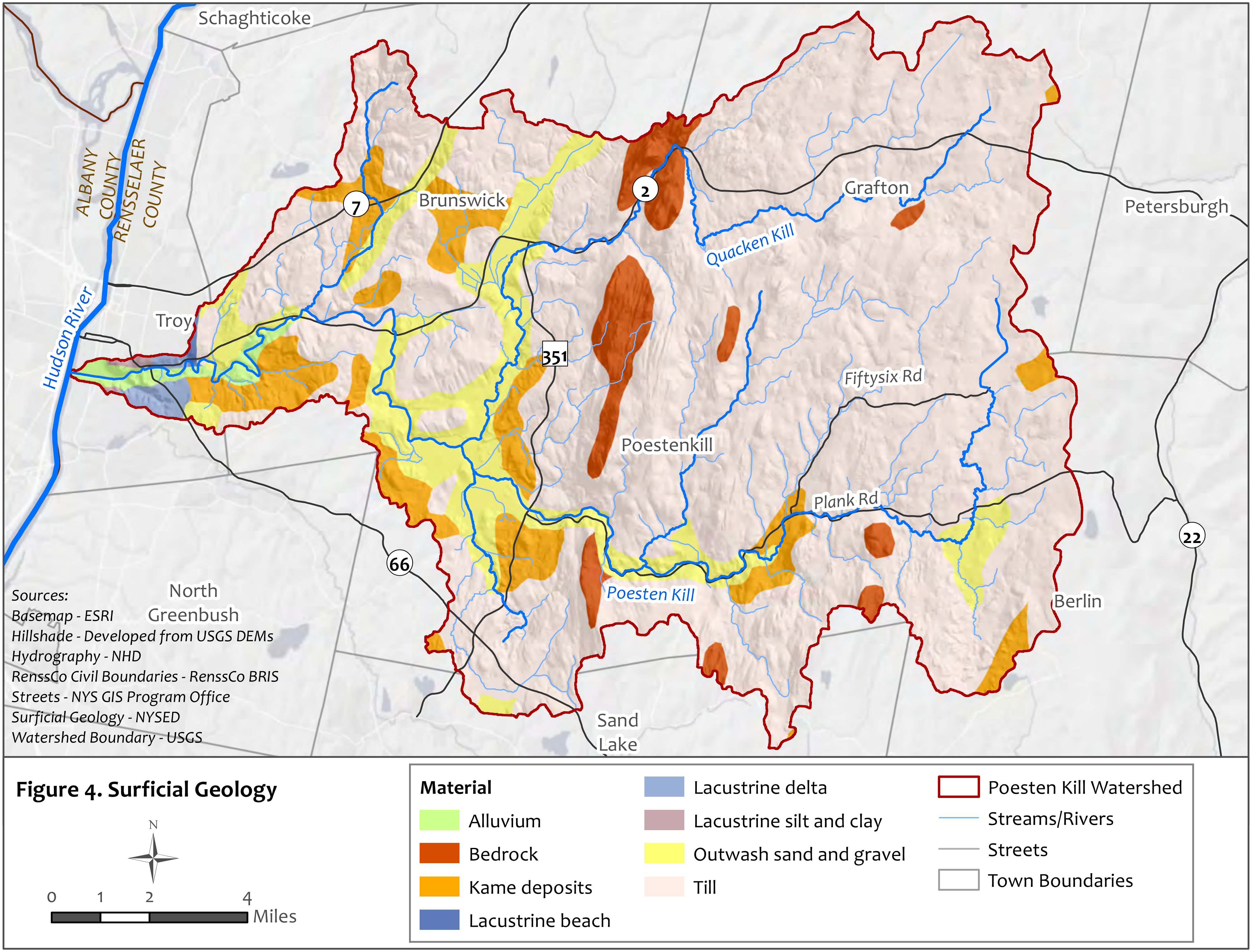
Sources:
Basemap - ESRI
Dams - NY DEC
Flood Zone - FEMA
Hillshade - Developed from USGS DEMs
Hydrography - NHD
RenssCo Civil Boundaries - RenssCo BRIS
Streets - NYS GIS Program Office
Watershed Boundary - USGS
Wetlands - NY DEC; US Fish & Wildlife Service

Figure 2b. NWI and NY DEC Wetlands



Sources:
Basemap - ESRI
Hydrography - NHD
Land Use Cover - USGS (NLCD)
RenssCo Civil Boundaries - RenssCo BRIS
Streets - NYS GIS Program Office
Watershed Boundary - USGS

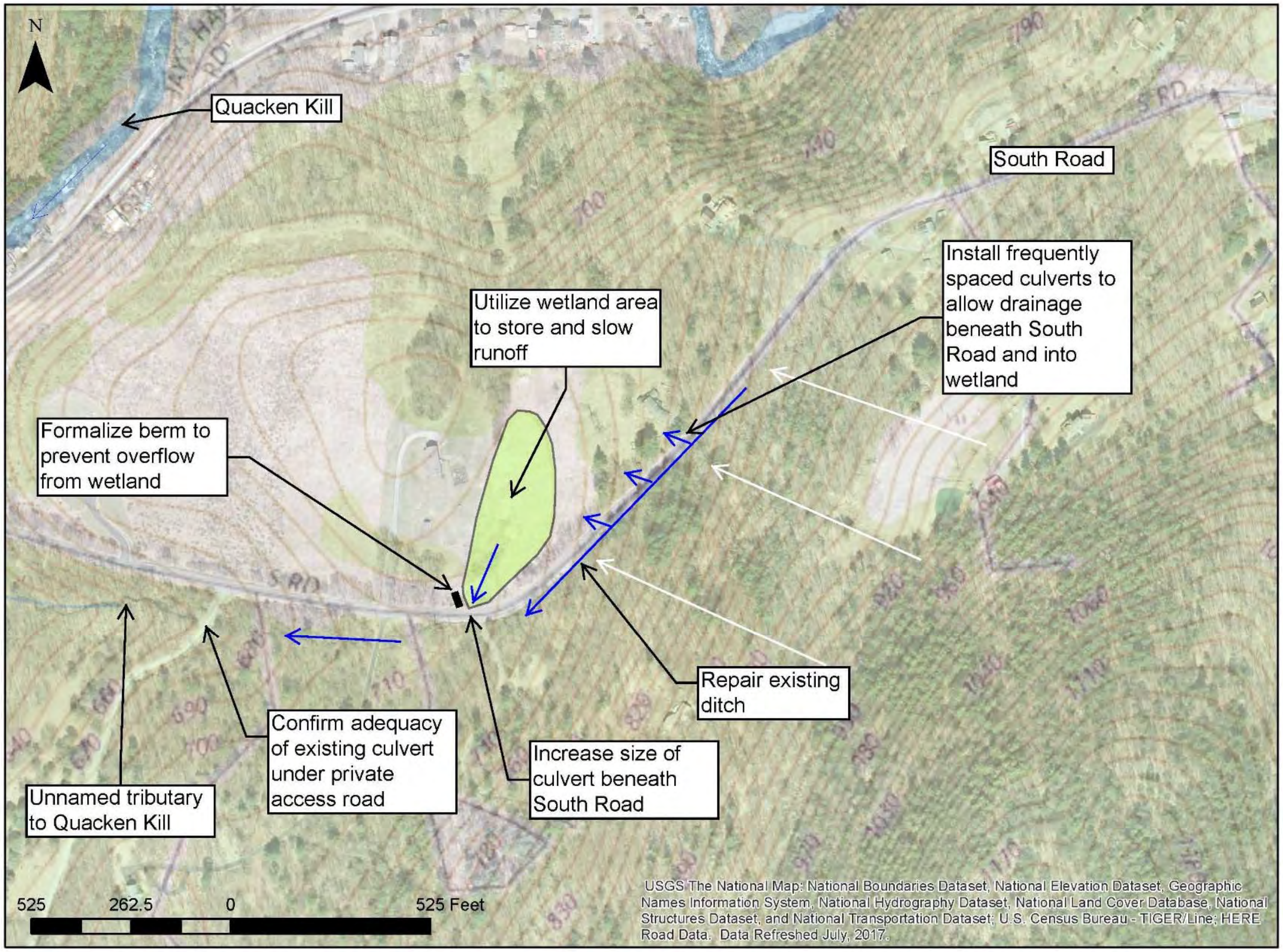
Figure 3. Land Use Cover



Sources:
Basemap - ESRI
Hillshade - Developed from USGS DEMs
Hydrography - NHD
RenssCo Civil Boundaries - RenssCo BRIS
Streets - NYS GIS Program Office
Surficial Geology - NYSED
Watershed Boundary - USGS

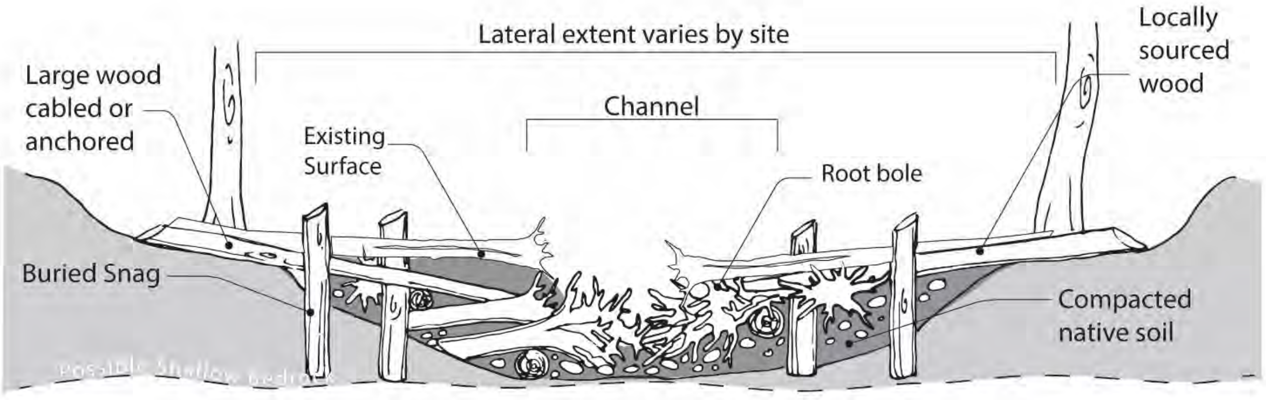
Figure 4. Surficial Geology

Appendix B – Recommendations



USGS The National Map: National Boundaries Dataset, National Elevation Dataset, Geographic Names Information System, National Hydrography Dataset, National Land Cover Database, National Structures Dataset, and National Transportation Dataset; U.S. Census Bureau - TIGER/Line; HERE Road Data. Data Refreshed July, 2017.

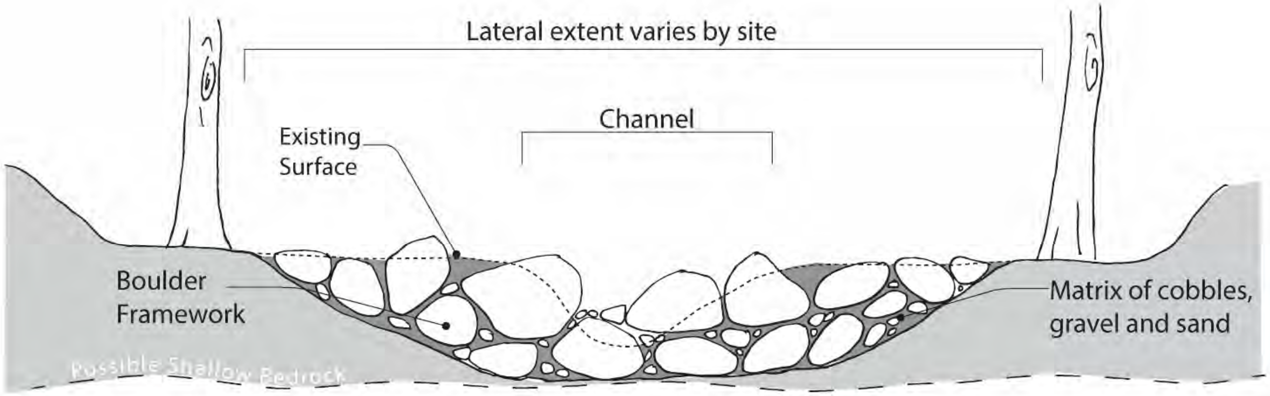
Concept 1. Road drainage improvements at South Road, Brunswick, to reduce interception of flow by road, utilize natural wetland area, and reduce the rate of runoff. Data sources: 2017 Rensselaer County high-resolution digital orthoimagery (NYS Office of Information Technology Services, GIS Program Office, 2017) and USGS topo map (source data listed on map).



2a- Large Wood Cross-Sections N.T.S.

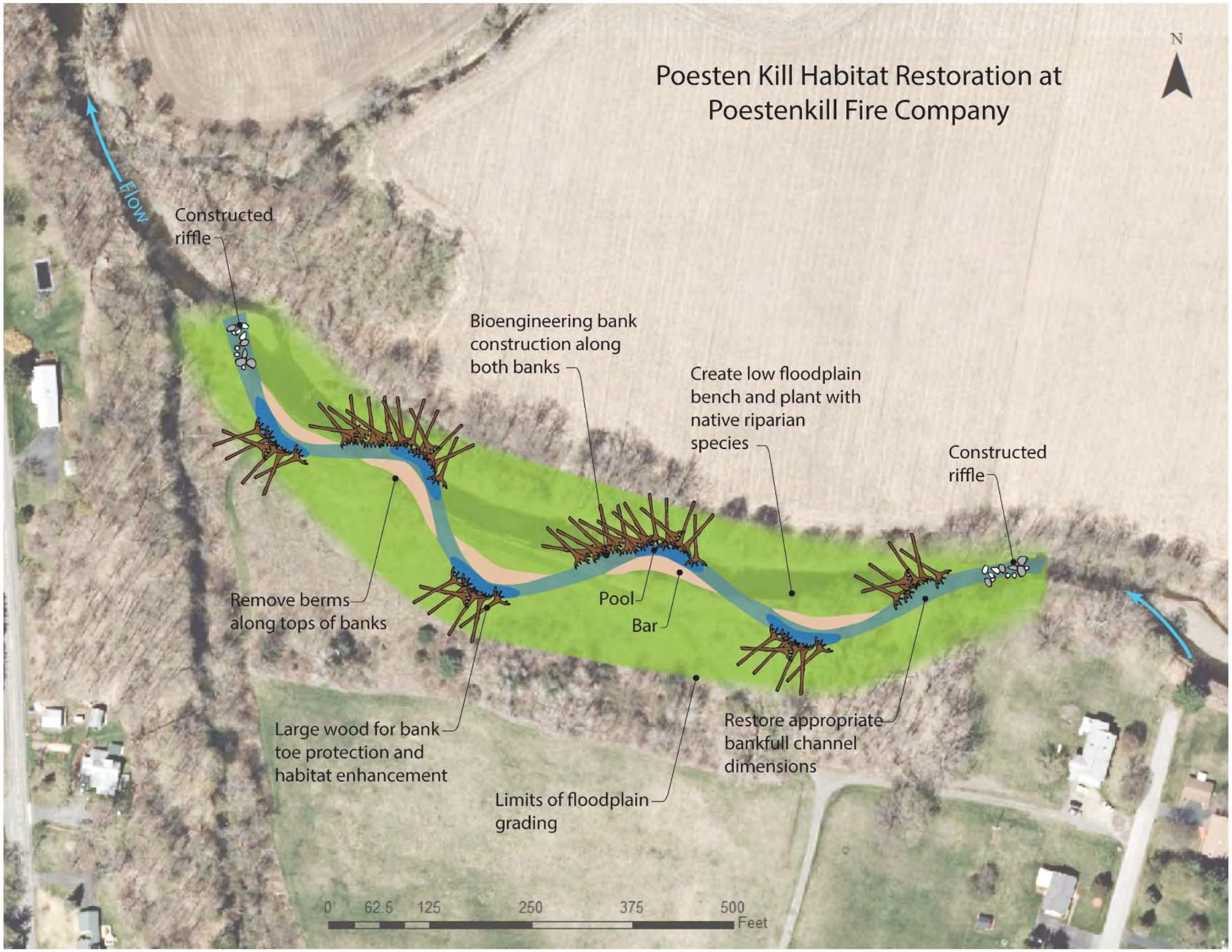
Replace native bed and bank material with large wood and root boles within a matrix of native soil

Concept 2. Option a: Measure to increase flood retention within wetlands on Bonesteel Creek using large wood



<u>2b- Boulder Cross-section N.T.S.</u>
Replace native bed and bank material with well-graded mixture of river rock, boulder and sand

Concept 3. Option b: Measure to increase flood retention within wetlands on Bonesteel Creek using rock



Concept 4. Measures to improve resilience, enhance floodplain function, and restore in-stream habitat in the Poesten Kill at the Poestenkill Fire Company. 2017 aerial imagery of Rensselaer County from NYS Office of Information Technology Services, GIS Program Office.

Appendix C – Field Data Collection Sheets

Channel Reconnaissance Form

Date: 8/21/18
Stream/Drainage: Poesten Kill
Stream Reach ID: Behind Firehouse
Field Team: CC KK

Station ______ to ______

General Channel Conditions

Channel Shape (check)
- ☐ Rectangular
- ☐ Shallow Rectangular
- ☐ Irregular
- ☑ Trapezoidal
- ☐ Parabolic
- ☐ Other ____________

Sediment Particle Size Estimate		
	D_{50}	D_{max}
Banks	Silt/clay to	dredge spoils of cobble/gravel
Bars	N/A	
Bed	1-2 inches	

Bar Types (circle): Alternate lateral, Point / transverse, [✓ None], Mid-channel, Point / mid, Point / alternate

At moderate flow.
At low flow, some alternate bars

Fluvial Geomorphic Conditions

Vertical Stability *degradation/aggradation*	Dredged
Lateral stability *deposition, erosion*	Stable.
Channel evolution (Schumm) Stage/description:	
Erosion (excessive/site specific)	Some localized erosion of dredged material piled on left bank

Dominant bank erosion types (circle any that apply)	*Fluvial*	Undercut / cantilever	[✓ Selective erosion of noncohesive laters]	Dry flow	Seepage
	Gravitational	Rotational	Planar	Wedge	

Bank composition	*Notes (shape/character):* left bank is steep. Dredged material piled up here	*Consolidation / Aggregation:*
Terrace/Valley	*Valley form –* Wide valley unconfined.	*Condition –*
Altered state (human) - dams, bridges, canoe landings, parks, etc.	Bridges. Widespread dredging	
Bankfull/Channel forming flow indication	Line of active erosion on left bank. bench on right bank	

Sediment Impacts

Riffle sediment type		Pool sediment type	
Sorting / Imbrication	Imbricated		

Bars / depositional features

Sediment type/size	Cobble / gravel
Mid, [✓ alternate], braided	
Bar vegetation (type, age)	Sedges
Floodplain soils	Sandy loam
Overbank deposition	Entrenched since dredging. No recent evidence

Riparian Vegetation and Floodplain

Root coverage of banks (%)	<50
Width of veg. riparian corridor*	10-20 ft
Canopy coverage (%)	25 (within corridor)

** Verify with orthoquad data*

Canopy structure: (check one)

none = anthro / maintained (lawn, field, pasture)	✓
low = single canopy layer	✓ (within corridor)
medium = at least two canopy layers	
high = multiple canopy layers	

Primary veg forms present: (%)

grasses/forbs	50
woody species	50
bare/other	
exotic/invasive species	Japanese knotweed

Woody species present	% of total tree community
Cottonwood, sycamore, maple	

Tree Stand Age (if applicable)

Station	*Species*	*Age*	*Notes / Location within XS*

Habitat

LWD density (pieces / 100 ft)	0	General habitat notes: little diversity. straight reach with thalweg and infrequent lateral bars wood has been removed
Residual pool	None	
Undercut bank	very few	
Riffle / Other	one approx	300-400 ft upstream **SVAP Score =**

Channel Stability Form

Reach stability		1-2 Degrading		3 Stable		4-5 Aggrading
Estimated sediment mobility (D50 moves at:)	<2yr Q		2-10 yr		>10 yr	
Substrate consolidation	Strong, gravels/cobble		Strong, gravels		Weak, sand/silt	
Bank failure mechanism	High banks, grav. collapse, variable channel width		Localized surficial erosion, constant width		Low banks, overflows, surficial erosion	
Bar development	Poorly formed		Narrow, vegetated		Wide (>1/2 channel length), unveg.	
Bank erosion extent	Extensive		Local erosion/pools		Extensive bar pressure	
Relative Width:Depth ratio	Low		Average		High	
Channel pattern	Single thread		Single thread		Multiple thread/braided	
Average bank slope	<3:1		>3:1			
Vegetative bank protection	Poor		Extensive		Poor	
Field stability rating (add all cells)/9	=					

Representative cross-section sketch

Bankfull width = 52 ft

Bankfull depth = 3.6 ft.

Floodplain width = See LiDAR

Channel Class =

Water depth (at survey) = 1.9 ft @ thalweg

Water width (at survey) = 36 ft

Station:

Station:

Channel Reconnaissance Form

inter·fluve

Date: 8/21/2018

Stream/Drainage: Quacken Kill

Stream Reach ID: Mainstem u/s of White Church

Field Team: CC, KK

200' D/s of Tam Junct.

Station ☐ to ☐

General Channel Conditions

Channel Shape (check)

- ☐ Rectangular
- ☐ Shallow Rectangular
- ☐ Irregular
- ☑ Trapezoidal
- ☐ Parabolic
- ☐ Other ________

Sediment Particle Size Estimate		
	D_{50}	D_{max}
Banks	Silt-Gravel	3"
Bars		
Bed	1-2" cobble-Sand	6-8"

Bar Types (circle): Alternate lateral; [✓ Mid-channel]; Point / transverse; [✓ Point / mid]; None; Point / alternate

Fluvial Geomorphic Conditions

Vertical Stability *degradation/aggradation*	stable or mildly aggrading
Lateral stability *deposition, erosion*	Stable
Channel evolution (Schumm) Stage/description:	
Erosion (excessive/site specific)	Localized, e.g. cut bank at jct.
Dominant bank erosion types (circle any that apply)	*Fluvial*: [✓ Undercut / cantilever]; Selective erosion of noncohesive laters; Dry flow; Seepage *Gravitational*: Rotational; Planar; Wedge
Bank composition	*Notes (shape/character):* Silt - Gravel *Consolidation / Aggregation:*
Terrace/Valley	*Valley form –* broad flood plain *Condition –*
Altered state (human) - dams, bridges, canoe landings, parks, etc.	Bridge @ white church rd, wall along cut bank leading into bridge
Bankfull/Channel forming flow indication	

Velocity 20' in 5s. → 4 ft/sec (approx)

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Sediment Impacts

Riffle sediment type		Pool sediment type	
Sorting / Imbrication	Bed is imbricated, sand beneath light armor. all mobile in Q_2		

Bars / depositional features

Sediment type/size	
Mid, alternate, braided	
Bar vegetation (type, age)	
Floodplain soils	
Overbank deposition	

Riparian Vegetation and Floodplain

Root coverage of banks (%)	75
Width of veg. riparian corridor*	100 - 200'
Canopy coverage (%)	40%

** Verify with orthoquad data*

Canopy structure: (check one)

none = anthro / maintained (lawn, field, pasture)	
low = single canopy layer	
medium = at least two canopy layers	✓
high = multiple canopy layers	

Primary veg forms present: (%) mature trees, with forbs

grasses/forbs	
woody species	
bare/other	
exotic/invasive species	

Woody species present	% of total tree community
maple, black walnut	

Tree Stand Age (if applicable)

Station	*Species*	*Age*	*Notes / Location within XS*

Habitat

LWD density (pieces / 100 ft)	< 1	General habitat notes: pools on channel bends, not otherwise. some banks undercut
Residual pool	few →	
Undercut bank		
Riffle / Other	sporadic gentle riffle	***SVAP Score =***

Channel Stability Form

Reach stability		1-2 Degrading		3 Stable		4-5 Aggrading
Estimated sediment mobility (D50 moves at:)	<2yr Q		2-10 yr		>10 yr	
Substrate consolidation	Strong, gravels/cobble		Strong, gravels		Weak, sand/silt	
Bank failure mechanism	High banks, grav. collapse, variable channel width		Localized surficial erosion, constant width		Low banks, overflows, surficial erosion	
Bar development	Poorly formed		Narrow, vegetated		Wide (>1/2 channel length), unveg.	
Bank erosion extent	Extensive		Local erosion/pools		Extensive bar pressure	
Relative Width:Depth ratio	Low		Average		High	
Channel pattern	Single thread		Single thread		Multiple thread/braided	
Average bank slope	<3:1		>3:1			
Vegetative bank protection	Poor		Extensive		Poor	
Field stability rating (add all cells)/9	=					

Representative cross-section sketch

Bankfull width = 52'

Bankfull depth = 4'

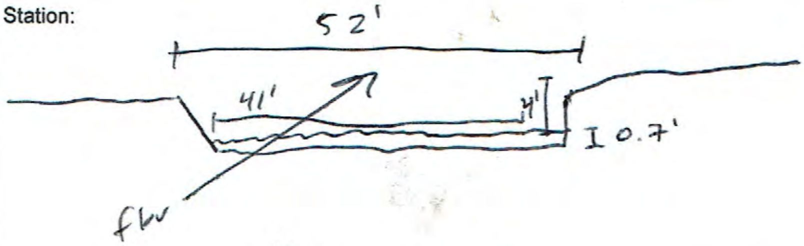
Floodplain width =

Channel Class =

Water depth (at survey) = 0.7

Water width (at survey) = 41'

Station:



consistent depth across channel, no defined thalweg or low flow channel

41 x 0.7 x 4 ~ 50-100 cfs

4 days post 2" rain event

Station:

Channel Reconnaissance Form

Date	8/21/18
Stream/Drainage	Trib to Quacken Kill
Stream Reach ID	Roark Rd.
Field Team	CC KK

Station ______ to ______

General Channel Conditions

Channel Shape (check)
- ☐ Rectangular
- ☑ Shallow Rectangular
- ☐ Irregular
- ☑ Trapezoidal
- ☐ Parabolic
- ☐ Other ____________

Sediment Particle Size Estimate		
	D_{50}	D_{max}
Banks		
Bars		
Bed	Boulder to gravel	

Bar Types (circle): Alternate lateral, Point / transverse, None, [✓ Mid-channel] limited, Point / mid, Point / alternate

Fluvial Geomorphic Conditions

Vertical Stability *degradation/aggradation*	No evidence
Lateral stability *deposition, erosion*	Stable
Channel evolution (Schumm) Stage/description:	
Erosion (excessive/site specific)	None
Dominant bank erosion types (circle any that apply)	*Fluvial*, [✓ Undercut / cantilever], Selective erosion of noncohesive laters, Dry flow, Seepage *Gravitational*, Rotational, Planar, Wedge
Bank composition	*Notes (shape/character):* root-bound boulders & cobbles *Consolidation / Aggregation:*
Terrace/Valley	*Valley form –* Confined *Condition –*
Altered state (human) - dams, bridges, canoe landings, parks, etc.	culverts u/s Rte 2 & d/s Roark Rd.
Bankfull/Channel forming flow indication	undercutting of ~~bank~~ bank; top of right bank at floodplain

Sediment Impacts

Riffle sediment type	Boulders, cobble	Pool sediment type	gravel
Sorting / Imbrication	Imbrication		

Bars / depositional features

Sediment type/size	Boulders, cobble
Mid, alternate, braided	
Bar vegetation (type, age)	
Floodplain soils	thin & rocky
Overbank deposition	gravels & woody debris on right bank floodplain

Riparian Vegetation and Floodplain

Root coverage of banks (%)	80
Width of veg. riparian corridor*	20ft either side
Canopy coverage (%)	75%

** Verify with orthoquad data*

Canopy structure: (check one)

none = anthro / maintained (lawn, field, pasture)	
low = single canopy layer	
medium = at least two canopy layers	✓
high = multiple canopy layers	

Primary veg forms present: (%)

grasses/forbs	✓
woody species	✓
bare/other	
exotic/invasive species	None

Woody species present	% of total tree community
Maple, oak	

Tree Stand Age (if applicable)

Station	*Species*	*Age*	*Notes / Location within XS*

Habitat

LWD density (pieces / 100 ft)	3-5
Residual pool	✓
Undercut bank	✓
Riffle / Other	✓

General habitat notes:
High variability in flow & sediment types
root-bound undercut banks.
Residual pools ~~1ft~~ 0.5ft. - 1ft
riffles & step pools.

SVAP Score =

Channel Stability Form

Reach stability		1-2 Degrading		[✓ 3 Stable]		4-5 Aggrading
Estimated sediment mobility (D50 moves at:)	<2yr Q		2-10 yr	✓	>10 yr	
Substrate consolidation	Strong, gravels/cobble	✓	Strong, gravels		Weak, sand/silt	
Bank failure mechanism	High banks, grav. collapse, variable channel width		Localized surficial erosion, constant width	✓	Low banks, overflows, surficial erosion	
Bar development	Poorly formed		Narrow, vegetated	✓	Wide (>1/2 channel length), unveg.	
Bank erosion extent	Extensive		Local erosion/pools	✓	Extensive bar pressure	
Relative Width:Depth ratio	Low		Average	✓	High	
Channel pattern	Single thread		Single thread	✓	Multiple thread/braided	
Average bank slope	<3:1	✓	>3:1			
Vegetative bank protection	Poor		Extensive	✓	Poor	
Field stability rating (add all cells)/9	=					

Representative cross-section sketch

Bankfull width = 27.5 ft	Floodplain width = 20 ft (right bank)	Water depth (at survey) = 0.5 ft
Bankfull depth = 1.8 ft	Channel Class =	Water width (at survey) = 21.5 ft

Station:

b.f. =
width 19 ft

f.p.w = 10 ft

w.d. = 0.5 ft

ww. = 16 ft

b.f. d. = 1.5 ft

Station: 4.5 ft wide by 5 ft deep. - relict box culvert b/t Rte 2 & Roark Rd.

Channel Reconnaissance Form

inter·fluve

Date	8/21/18
Stream/Drainage	trib to Quacken Kill
Stream Reach ID	Sports Complex
Field Team	CC KK

Station ______ to ______

General Channel Conditions

Channel Shape (check)

- ☐ Rectangular
- ☐ Shallow Rectangular
- ☐ Irregular
- ☐ Trapezoidal
- ☐ Parabolic
- ☐ Other ______________

Sediment Particle Size Estimate		
	D_{50}	D_{max}
Banks		
Bars		
Bed		

Bar Types (circle): Alternate lateral / Point / transverse / None / Mid-channel / Point / mid / Point / alternate

Fluvial Geomorphic Conditions

Vertical Stability *degradation/aggradation*	Dredged / incised and stable
Lateral stability *deposition, erosion*	Stable banks
Channel evolution (Schumm) Stage/description:	
Erosion (excessive/site specific)	None

Dominant bank erosion types (circle any that apply)	*Fluvial*	Undercut / cantilever	Selective erosion of noncohesive laters	Dry flow	Seepage
	Gravitational	Rotational	Planar	Wedge	

Bank composition	*Notes (shape/character)*:	*Consolidation / Aggregation*:
Terrace/Valley	*Valley form* – Wide, flat valley	*Condition* –
Altered state (human) - dams, bridges, canoe landings, parks, etc.	Sports complex, farm fields	
Bankfull/Channel forming flow indication		

Sediment Impacts

Riffle sediment type	N/A	Pool sediment type	
Sorting / Imbrication	NO bedforms		

Bars / depositional features

Sediment type/size	
Mid, alternate, braided	
Bar vegetation (type, age)	
Floodplain soils	
Overbank deposition	Incised / dredged N/A

Riparian Vegetation and Floodplain

Root coverage of banks (%)	100
Width of veg. riparian corridor*	None
Canopy coverage (%)	0

** Verify with orthoquad data*

Canopy structure: (check one)

none = anthro / maintained (lawn, field, pasture)	✓
low = single canopy layer	
medium = at least two canopy layers	
high = multiple canopy layers	

Primary veg forms present: (%)

grasses/forbs	100
woody species	
bare/other	
exotic/invasive species	

Woody species present	% of total tree community
N/A	

Tree Stand Age (if applicable)

Station	*Species*	*Age*	*Notes / Location within XS*

Habitat

LWD density (pieces / 100 ft)		General habitat notes:
Residual pool		
Undercut bank		
Riffle / Other		***SVAP Score =***

Channel Stability Form N/A

Reach stability		1-2 Degrading		3 Stable		4-5 Aggrading
Estimated sediment mobility (D50 moves at:)	<2yr Q		2-10 yr		>10 yr	
Substrate consolidation	Strong, gravels/cobble		Strong, gravels		Weak, sand/silt	
Bank failure mechanism	High banks, grav. collapse, variable channel width		Localized surficial erosion, constant width		Low banks, overflows, surficial erosion	
Bar development	Poorly formed		Narrow, vegetated		Wide (>1/2 channel length), unveg.	
Bank erosion extent	Extensive		Local erosion/pools		Extensive bar pressure	
Relative Width:Depth ratio	Low		Average		High	
Channel pattern	Single thread		Single thread		Multiple thread/braided	
Average bank slope	<3:1		>3:1			
Vegetative bank protection	Poor		Extensive		Poor	
Field stability rating (add all cells)/9	=					

Representative cross-section sketch

Bankfull width = 22 ft	Floodplain width = Wide, see LiDAR	Water depth (at survey) = 1.7 ft
Bankfull depth = 3.8 ft	Channel Class =	Water width (at survey) = 12.5 ft

Station: bankfull not really applicable.
dredged canal through fields
left bank floodplain elev. approx 1-2 ft higher than bankfull
along [illegible]

Station:

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Appendix 2:

Table A. Select Descreet Projects - Peak Discharge Summary

			Outlet Control Dimensions (ft)		Peak Discharge (cfs)											
Storage Area ID	Drainage Area (sq mi)	Storage Area (ac.)	Opening Length	Height	100-yr Pre	100-yr Post	Peak Flow Reduction	Flow Benefit	200-yr Pre	200-yr Post	Peak Flow Reduction	Flow Benefit	500-yr Pre	500-yr Post	Peak Flow Reduction	Flow Benefit
AP-6	1.06	57.5	10	3	122.3	56.7	65.6	46.36%	164.3	82.7	81.6	50.33%	206.3	109.7	96.6	53.17%
AP-14*	8.33	45	25	3	718.6	317.9	400.7	44.24%	947.1	740.1	207	78.14%	1183.1	1089.3	93.8	92.07%
AP-29	5.24	54.9	15	4	171.9	132.6	39.3	77.14%	229.8	169.9	59.9	73.93%	289.7	214.2	75.5	73.94%
G-31*	5.25	36.3	15	5	191.8	142.4	49.4	74.24%	261.2	189.5	71.7	72.55%	333	243.4	89.6	73.09%
G-32	2.65	32.2	12	4.5	169	110.2	58.8	65.21%	228.2	144.4	83.8	63.28%	289.7	183.3	106.4	63.27%
G-35	1.93	19	15	5.5	190	183.7	6.3	96.68%	249.3	242.7	6.6	97.35%	310.9	303.2	7.7	97.52%
T-8	0.55	55.3	10	2	46.5	11.7	34.8	25.16%	62.3	18.1	44.2	29.05%	78.9	25.5	53.4	32.32%
T-11	1.31	30.5	10	3	154.5	134.3	20.2	86.93%	202.2	176.2	26	87.14%	251	240.6	10.4	95.86%
T-12*	1.55	27.8	10	4	134.8	93.3	41.5	69.21%	179.2	127.3	51.9	71.04%	227.1	211.6	15.5	93.17%
T-16A	2.73	170.3	20	3	206.3	156.1	50.2	75.67%	277.3	198.3	79	71.51%	351.9	248.3	103.6	70.56%
T-16B			20	3	156.1	79.9	76.2	38.73%	198.3	118.2	80.1	42.63%	248.3	152.2	96.1	43.25%
T-16C			15	3	79.9	35.6	44.3	17.26%	118.2	64.7	53.5	23.33%	152.2	95.2	57	27.05%
T-20*	4.53	67.6	25	3	191.9	164.8	27.1	85.88%	261	211.5	49.5	81.03%	332.4	261.2	71.2	78.58%
T-24*	9.2	61.1	12	4	296.8	151.7	145.1	51.11%	404.7	202.4	202.3	50.01%	516.5	260.9	255.6	50.51%
T-27	2.67	58.7	15	5	400.8	353.1	47.7	88.10%	513.2	443.3	69.9	86.38%	623	618.1	4.9	99.21%
Dunham	9.5	100	100	5	153.8	23	130.8	14.95%	210.2	27.4	182.8	13.04%	269.8	31.5	238.3	11.68%
Kersch	0.066	8.2	5	2	21	11.2	9.8	53.33%	29.3	16.3	13	55.63%	35.1	10.7	24.4	30.48%

*Wetlands are directly downstream of other potential project wetland areas and the cumulative benefit would exceed the individual benefit summarized above

Appendix 3:

HEC-HMS Peak Discharge Summary Table - Existing Condition

Hydrologic Element	Drainage Area	100 yr Peak Discharge	200 yr Peak Discharge	500 yr Peak Discharge
Bonesteel Creek Reach 1	5	413.8	554.5	702.9
Bonesteel Creek Reach 2	2.24	178	235.2	293.9
Bonesteel Trib-Trib 1	1.46	169.2	227.2	285.2
Junction-11	36.86	2916.4	3863.3	4892.8
Junction-15	3.8	342.3	445.1	559.6
Junction-19	49.48	3819.3	5053	6384.2
Junction-20	80.57	5669.9	7495.7	9464.9
Junction-21	7.87	797.1	1065.7	1343.1
Junction-22	24.77	1662.8	2191.6	2763.7
Junction-24	92.07	6371.3	8416.1	10616.1
Junction-25	97.47	6445.8	8515.8	10742.6
Junction-5	19.72	1698.2	2268	2866.8
Junction-5A	9.21	1041.3	1396.8	1754.5
Junction-7	34.7	2753.4	3650	4626.2
Junction-9	6.46	548.1	729.5	926.4
Newfoundland Creek Reach1	1.13	230.4	307.5	371.5
Poesten Kill Reach 4	1.3	65.7	87.5	109.8
Poesten Kill Reach 5	3.54	116.1	155.3	195.7
Poesten Kill Trib-Trib5	0.86	103.4	135.5	167.8
Poestenkill Reach 1	6.11	682.8	911.8	1147.1
Poestenkill Reach 2	5.59	391.2	526.9	668.8
Poestenkill Reach 3	6.28	376.9	500.7	627.2
Poestenkill Reach 6	0.09	2.7	3.6	4.5
Poestenkill Reach 8	5.4	74.5	99.7	126.5
Poestenkill Reach7	6.3	144.2	193	244.3
Poestenkill Trib - Trib 6	4.92	395.3	530.4	672.5
Poestenkill Trib Trib 1	2.98	244.5	322.6	403.1
Poestenkill Trib Trib2	2.3	205.4	270.5	337.7
Poestenkill Trib Trib3	2.67	265.6	348.3	434.4
Poestenkill Trib-Trib 7	3.1	361.4	485	608.9
Quacken Kill - Reach 1	6.02	596.2	796.8	1006.1
Quacken Kill - Reach 2	13.33	511.5	683.2	859.9
Quackenkill Reach2A	6.23	185	247.5	312.4
Quackenkill Trib-Trib A	1.85	226.1	304.5	381.1
Quackenkill Trib-Trib1	3.57	424.7	555.4	689.4
Sweet Mill Creek	5.2	558.4	731.7	910.6

HEC-HMS Peak Discharge Summary Table - Post Condition (Wetland Control Devices and Dunham Reservoir Management)

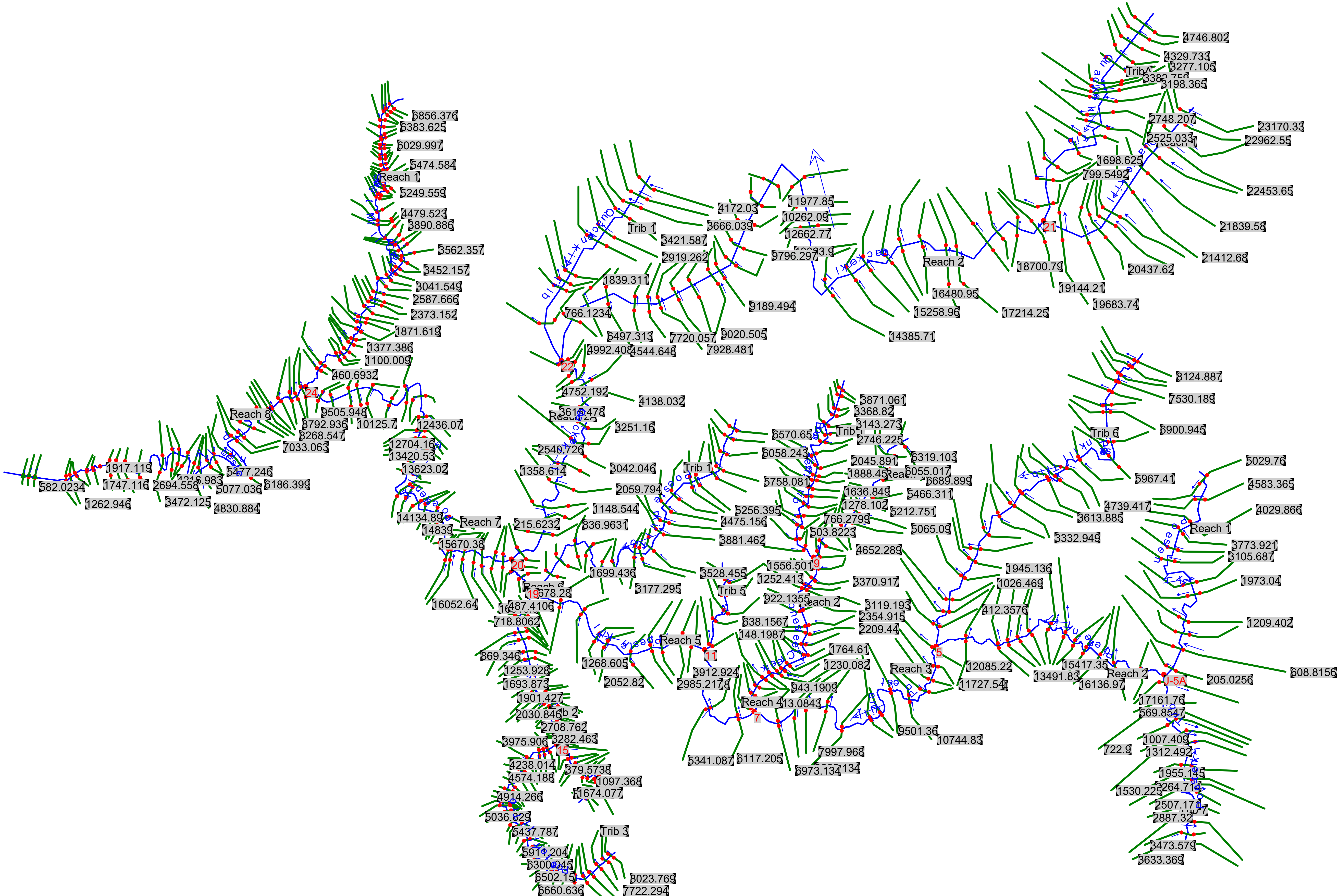
Hydrologic Element	Drainage Area	100 yr Peak Discharge	200 yr Peak Discharge	500 yr Peak Discharge
AP-14	8.33	317.9	740.1	1089.3
AP-14 Watershed	8.33	718.6	947.1	1183.1
AP-29	5.24	132.6	169.9	214.2
AP-29 Watershed	5.24	171.9	229.8	289.7
AP-6	1.06	56.7	82.7	109.7
AP-6 Watershed	1.06	122.3	164.3	206.3
Bonesteel Creek Reach 1	4.45	368.3	493.5	625.6
Bonesteel Creek Reach 2	0.37	29.4	38.8	48.5
Bonesteel Trib-Trib 1	0.4	46.3	62.2	78.1
Dunham Reservoir	10.28	52.4	61.5	92
Dunham Watersehd	2.41	39	53.3	68.4
G-31	5.2	150.5	197.2	250.8
G-31 Watershed	2.55	93.1	126.9	161.7
G-32	2.65	110.2	144.4	183.3
G-32 Watershed	2.65	169	228.2	289.7
G-35	1.93	183.7	242.7	303.2
G-35 Watershed	1.93	190	249.3	310.9
Junction-11	43.2856	2320	3437.1	4685.6
Junction-15	3.8	342.3	445.1	559.6
Junction-19	59.6556	3222.5	4621.5	6172.3
Junction-20	91.5256	4424.8	6200.1	8165.9
Junction-21	7.87	397.2	514.3	655.2
Junction-22	25.55	1014.6	1327.6	1676.7
Junction-24	103.0256	5132.8	7127.3	9324.1
Junction-25	108.4256	5207.3	7227	9450.5
Junction-5	19.6856	951.3	1290.2	1816.1
Junction-5A	9.2	190.9	267.1	431
Junction-7	41.1256	2157.1	3223.9	4419
Junction-9	6.46	481.5	654.1	837.9
Kersch	0.0656	11.4	16.6	20.9
kersch watershed	0.0656	21.3	29.7	35.5
Newfoundland Creek Reach1	1.13	230.4	307.5	371.5
Poesten Kill Reach 4	1.3	65.7	87.5	109.8
Poesten Kill Reach 5	3.54	116.1	155.3	195.7
Poesten Kill Trib-Trib5	0.86	103.4	135.5	167.8
Poestenkill Reach 2	5.5	384.9	518.4	658
Poestenkill Reach 3	6.28	376.9	500.7	627.2
Poestenkill Reach 6	0.09	2.7	3.6	4.5
Poestenkill Reach 8	5.4	74.5	99.7	126.5
Poestenkill Reach7	6.3	144.2	193	244.3
Poestenkill Trib - Trib 6	3.37	270.8	363.3	460.6
Poestenkill Trib Trib 1	2.98	244.5	322.6	403.1
Poestenkill Trib Trib2	0.81	72.3	95.3	118.9
Poestenkill Trib Trib3	2.67	265.6	348.3	434.4
Quacken Kill - Reach 1	0.82	81.2	108.5	137
Quacken Kill - Reach 2	9.77	374.9	500.7	630.2
Quackenkill Reach2A	6.23	185	247.5	312.4
Quackenkill Trib-Trib A	1.85	226.1	304.5	381.1
Quackenkill Trib-Trib1	3.57	424.7	555.4	689.4
Sweet Mill Creek	5.2	565.5	739	918
T-11	1.31	134.3	176.2	240.6
T-11 Watershed	1.31	154.5	202.2	251
T-12	1.55	101.4	137	260.8
T-12 Watershed	0.24	20.8	27.8	35.2
T-16 Watershed	2.73	206.3	277.3	351.9
T-16A	2.73	156.1	198.3	248.3
T-16B	2.73	79.9	118.2	152.2
T-16C	2.73	35.6	64.7	95.2
T-20	4.53	81	126.5	177.3
T-20 Watershed	1.8	76.3	103.7	132.1
T-24	9.2	190.9	267.1	431
T-24 Watershed	2	64.5	88	112.3
T-27	2.67	217.4	295.8	359.2
T-27 Watershed	2.67	248.2	331.4	419.4
T-8	0.55	19.7	29.9	41.4
T-8 Watershed	0.55	55.6	74.3	93.8

HEC-HMS Peak Discharge Summary Table - Post Condition (Wetland Control Devices Only)

Hydrologic Element	Drainage Area	100 yr Peak Discharge	200 yr Peak Discharge	500 yr Peak Discharge
Junction-20	91.5256	4738.2	6640.2	8722.1
Kersch	0.0656	11.4	16.6	20.9
T-12 Watershed	0.24	20.8	27.8	35.2
T-27 Watershed	2.67	248.2	331.4	419.4
Poestenkill Trib - Trib 6	3.37	270.8	363.3	460.6
T-20 Watershed	1.8	76.3	103.7	132.1
T-16B	2.73	79.9	118.2	152.2
T-16C	2.73	35.6	64.7	95.2
T-20	4.53	81	126.5	177.3
Junction-5A	9.2	190.9	267.1	431
T-16A	2.73	156.1	198.3	248.3
kersch watershed	0.0656	21.3	29.7	35.5
T-27	2.67	217.4	295.8	359.2
T-24 Watershed	2	64.5	88	112.3
T-11 Watershed	1.31	154.5	202.2	251
Poestenkill Reach 2	5.5	384.9	518.4	658
T-12	1.55	101.4	137	260.8
T-24	9.2	190.9	267.1	431
T-16 Watershed	2.73	206.3	277.3	351.9
T-11	1.31	134.3	176.2	240.6
Junction-5	19.6856	951.3	1290.2	1816.1
AP-14 Watershed	8.33	718.6	947.1	1183.1
AP-14	8.33	317.9	740.1	1089.3
T-8 Watershed	0.55	55.6	74.3	93.8
AP-6	1.06	56.7	82.7	109.7
AP-6 Watershed	1.06	122.3	164.3	206.3
Bonesteel Creek Reach 1	4.45	368.3	493.5	625.6
Bonesteel Trib-Trib 1	0.4	46.3	62.2	78.1
T-8	0.55	19.7	29.9	41.4
Junction-9	6.46	481.5	654.1	837.9
Poestenkill Reach 3	6.28	376.9	500.7	627.2
Junction-7	41.1256	2157.1	3223.9	4419
Poesten Kill Reach 4	1.3	65.7	87.5	109.8
Bonesteel Creek Reach 2	0.37	29.4	38.8	48.5
Poesten Kill Trib-Trib5	0.86	103.4	135.5	167.8
Junction-11	43.2856	2320	3437.1	4685.6
AP-29 Watershed	5.24	171.9	229.8	289.7
AP-29	5.24	132.6	169.9	214.2
Newfoundland Creek Reach1	1.13	230.4	307.5	371.5
Poestenkill Trib Trib3	2.67	265.6	348.3	434.4
Junction-15	3.8	342.3	445.1	559.6
Poesten Kill Reach 5	3.54	116.1	155.3	195.7
Poestenkill Trib Trib 1	2.98	244.5	322.6	403.1
Poestenkill Trib Trib2	0.81	72.3	95.3	118.9
Junction-19	59.6556	3222.5	4621.5	6172.3
G-35 Watershed	1.93	190	249.3	310.9
G-31 Watershed	2.55	93.1	126.9	161.7
Quackenkill Trib-Trib A	1.85	226.1	304.5	381.1
G-32 Watershed	2.65	169	228.2	289.7
G-31	5.2	150.5	197.2	250.8
Quacken Kill - Reach 1	0.82	81.2	108.5	137
G-32	2.65	110.2	144.4	183.3
Dunham Watersehd	2.41	39	53.3	68.4
Junction-21	7.87	397.2	514.3	655.2
Dunham Reservoir	10.28	365.9	501.6	648.2
Quacken Kill - Reach 2	9.77	374.9	500.7	630.2
G-35	1.93	183.7	242.7	303.2
Quackenkill Trib-Trib1	3.57	424.7	555.4	689.4
Junction-22	25.55	1328.1	1767.7	2232.9
Quackenkill Reach2A	6.23	185	247.5	312.4
Poestenkill Reach 6	0.09	2.7	3.6	4.5
Poestenkill Reach7	6.3	144.2	193	244.3
Sweet Mill Creek	5.2	558.4	731.7	910.6
Junction-24	103.0256	5439.7	7560.6	9873.4
Poestenkill Reach 8	5.4	74.5	99.7	126.5
Junction-25	108.4256	5514.1	7660.3	9999.9

HEC-HMS Peak Discharge Summary Table - Post Condition (Dunham Reservoir Management Only)

Hydrologic Element	Drainage Area	100 yr Peak Discharge	200 yr Peak Discharge	500 yr Peak Discharge
Junction-20	82.98	5175.8	7237.1	9346
Junction-5	19.72	1698.2	2268	2866.8
Poestenkill Trib-Trib 7	3.1	361.4	485	608.9
Junction-7	34.7	2753.4	3650	4626.2
Poesten Kill Reach 5	3.54	116.1	155.3	195.7
Poestenkill Trib - Trib 6	4.92	395.3	530.4	672.5
Newfoundland Creek Reach1	1.13	230.4	307.5	371.5
Junction-15	3.8	342.3	445.1	559.6
Poesten Kill Reach 4	1.3	65.7	87.5	109.8
Poestenkill Trib Trib3	2.67	265.6	348.3	434.4
Poestenkill Trib Trib2	2.3	205.4	270.5	337.7
Junction-11	36.86	2916.4	3863.3	4892.8
Junction-5A	9.21	1041.3	1396.8	1754.5
Bonesteel Creek Reach 1	5	413.8	554.5	702.9
Bonesteel Creek Reach 2	2.24	178	235.2	293.9
Poesten Kill Trib-Trib5	0.86	103.4	135.5	167.8
Junction-9	6.46	548.1	729.5	926.4
Poestenkill Trib Trib 1	2.98	244.5	322.6	403.1
Bonesteel Trib-Trib 1	1.46	169.2	227.2	285.2
Poestenkill Reach 3	6.28	376.9	500.7	627.2
Poestenkill Reach 2	5.59	391.2	526.9	668.8
Poestenkill Reach 1	6.11	682.8	911.8	1147.1
Junction-19	49.48	3819.3	5053	6384.2
Quacken Kill - Reach 2	13.33	511.5	683.2	859.9
Quackenkill Trib-Trib A	1.85	226.1	304.5	381.1
Quacken Kill - Reach 1	6.02	596.2	796.8	1006.1
Junction-21	7.87	797.1	1065.7	1343.1
Dunham Reservoir	10.28	253.7	727.2	1133.8
Dunham Watershed	2.41	39	53.3	68.4
Quackenkill Trib-Trib1	3.57	424.7	555.4	689.4
Junction-22	27.18	1168.8	1933	2644.9
Quackenkill Reach2A	6.23	185	247.5	312.4
Sweet Mill Creek	5.2	558.4	731.7	910.6
Poestenkill Reach7	6.3	144.2	193	244.3
Poestenkill Reach 6	0.09	2.7	3.6	4.5
Junction-24	94.48	5877.2	8157.5	10497.3
Poestenkill Reach 8	5.4	74.5	99.7	126.5
Junction-25	99.88	5951.7	8257.2	10623.8



Reach 1
6856.376
6383.625
6029.997
5474.584
5249.559
4479.523
3890.886
3562.357
3452.157
3041.549
2587.666
2373.152
1871.619
1377.386
1100.009
460.6932
24
Reach 8
9505.948
8792.936
8268.547
7033.063
10125.7
12436.07
12704.16
13420.53
13623.02
582.0234
1917.119
1747.116
1262.946
2694.558
3472.125
5477.246
5077.036
4830.884
6186.399
14134.89
14839
Reach 7
15670.38
16052.64
Trib 1
4172.03
3666.039
3421.587
2919.262
1839.311
766.1234
6497.313
4992.408
4544.648
7720.057
7928.481
9020.505
9189.494
22
4752.192
4138.032
3251.16
2540.726
1358.614
3042.046
2059.794
1148.544
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215.6232
20
1699.436
3177.295
19
487.4106
718.8062
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1253.928
1693.873
1901.427
2030.846
2708.762
3282.463
3975.906
15
4238.014
4574.188
379.5738
1097.368
1674.077
4914.266
5036.829
5437.787
5910.204
6300.045
6502.15
6660.636
7181.453
Trib 3
8023.769
7722.294
1268.605
2052.82
Reach 5
11
3912.924
2985.2178
5341.087
6117.205
11977.85
10262.09
12662.77
9796.297
Reach 2
16480.95
15258.96
14385.71
17214.25
18700.79
21
19144.21
19683.74
20437.62
21412.68
21839.58
22453.65
23170.33
22962.55
2748.207
2525.033
1698.625
799.5492
4746.802
4329.733
3277.105
3198.365
Trib 1
3528.455
Trib 5
638.1567
148.1987
6570.653
6058.243
5758.081
5256.395
4475.156
3881.462
1556.501
1252.413
922.1355
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3370.917
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Reach 4
7
7997.968
6973.134
6319.103
6055.017
6689.899
5466.311
5212.751
5065.09
Reach 3
9501.36
10744.83
5
12085.22
11727.54
13491.83
15417.35
16136.97
Reach 2
412.3576
1026.469
1945.136
3332.949
3613.885
4739.417
5967.41
Trib 6
6900.945
7530.189
8124.887
5029.76
4583.365
4029.866
Reach 1
3773.921
3105.687
1973.04
1209.402
608.8156
J-5A
205.0256
17161.76
569.8547
1007.409
1312.492
722.9
1955.145
3264.714
1530.225
2507.171
2887.32
3473.579
3633.369

HEC-RAS Summary Table - Post Condition Reach 8 (w/o Dunham Reservoir)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)		WS. Elevation Benefit (ft)
Reach 8	9084.866	100 YR	5439.7	328.97	340.54	335.49	340.57	0.00017	1.4	3879.23	653.48		-0.76
Reach 8	9084.866	200 YR	7560.6	328.97	342.19	336.05	342.22	0.000147	1.52	4963.31	661.32		-0.59
Reach 8	9084.866	500 YR	9873.4	328.97	343.74	336.44	343.79	0.000135	1.65	5997.52	666.58		-0.47
Reach 8	8904.993	100 YR	5439.7	324.05	340.2		340.37	0.000683	3.36	1619.79	204.11		-0.74
Reach 8	8904.993	200 YR	7560.6	324.05	341.81		342.03	0.000915	3.77	2004.57	266.24		-0.58
Reach 8	8904.993	500 YR	9873.4	324.05	343.34		343.6	0.000896	4.06	2429.41	283.94		-0.47
Reach 8	8792.936	100 YR	5439.7	322.64	340.21		340.24	0.000127	1.4	3884.43	525.96		-0.74
Reach 8	8792.936	200 YR	7560.6	322.64	341.83		341.87	0.000129	1.59	4746.53	533.89		-0.6
Reach 8	8792.936	500 YR	9873.4	322.64	343.39		343.44	0.00013	1.77	5579.1	538.32		-0.47
Reach 8	8546.203	100 YR	5439.7	318.6	326.24		326.67	0.002369	5.26	1034.16	171.68		-0.67
Reach 8	8546.203	200 YR	7560.6	318.6	327.73		328.26	0.002292	5.84	1293.77	178.33		-0.54
Reach 8	8546.203	500 YR	9873.4	318.6	329.17		329.8	0.00223	6.34	1556.19	185.27		-0.45
Reach 8	8339.744	100 YR	5439.7	315.29	320.7	320.7	323.01	0.018456	12.17	446.81	97.86		-0.54
Reach 8	8339.744	200 YR	7560.6	315.29	321.86	321.86	324.68	0.017472	13.47	561.32	100.62		-0.45
Reach 8	8339.744	500 YR	9873.4	315.29	323.01	323.01	326.3	0.016598	14.54	679.04	103.75		-0.34
Reach 8	8268.547	100 YR	5439.7	304.66	313.47	314.47	317.63	0.027594	16.35	332.73	60.62		-0.83
Reach 8	8268.547	200 YR	7560.6	304.66	315.46	316.43	319.44	0.028683	16	472.58	92.56		-0.47
Reach 8	8268.547	500 YR	9873.4	304.66	316.46	317.52	321.06	0.030202	17.21	573.81	104.8		-0.26
Reach 8	8134.045	100 YR	5439.7	283.79	288.66	291.18	297.26	0.086827	23.53	231.2	58.57		-0.45
Reach 8	8134.045	200 YR	7560.6	283.79	289.85	292.7	299.42	0.07638	24.82	304.58	63.88		-0.48
Reach 8	8134.045	500 YR	9873.4	283.79	291.01	294.18	301.5	0.066009	25.98	380.04	65.77		-0.33
Reach 8	8031.935	100 YR	5439.7	280.22	287.23	287.23	289.88	0.017843	13.06	416.41	78.69		-0.61
Reach 8	8031.935	200 YR	7560.6	280.22	288.59	288.59	291.81	0.016947	14.4	525.11	81.55		-0.49
Reach 8	8031.935	500 YR	9873.4	280.22	289.96	289.95	293.66	0.016295	15.45	639.06	86.05		-0.4
Reach 8	7403.166	100 YR	5439.7	253.84	270.44	258.83	270.48	0.000081	1.48	3680.42	321.55		-1.11
Reach 8	7403.166	200 YR	7560.6	253.84	272.85	259.52	272.89	0.00009	1.69	4483.71	346.95		-0.82
Reach 8	7403.166	500 YR	9873.4	253.84	275.25	260.22	275.31	0.000099	1.84	5362.77	390.62		-0.63
Reach 8	7175.604	100 YR	5439.7	251.87	260.89		261.29	0.00227	5.06	1074.98	183.97		-0.93
Reach 8	7175.604	200 YR	7560.6	251.87	262.95		263.37	0.001681	5.16	1464.33	193.37		-0.76
Reach 8	7175.604	500 YR	9873.4	251.87	265.02		265.45	0.001368	5.26	1878.18	206.42		-0.63
Reach 8	7033.063	100 YR	5439.7	250.07	260.16		260.46	0.001315	4.43	1228.32	167.87		-1.01
Reach 8	7033.063	200 YR	7560.6	250.07	262.37		262.71	0.001108	4.7	1607.75	175.19		-0.79
Reach 8	7033.063	500 YR	9873.4	250.07	264.52		264.9	0.000976	4.96	1989.8	180.45		-0.64
Reach 8	6186.399	100 YR	5439.7	244.23	258.96		258.96	0.00001	0.47	11548.02	1240.15		-1.08
Reach 8	6186.399	200 YR	7560.6	244.23	261.31		261.32	0.00001	0.52	14489	1257.39		-0.81
Reach 8	6186.399	500 YR	9873.4	244.23	263.54		263.54	0.000009	0.57	17316.07	1282.93		-0.66
Reach 8	5477.246	100 YR	5439.7	240.03	258.33		258.39	0.000161	1.87	2908.72	300.32		-1.1
Reach 8	5477.246	200 YR	7560.6	240.03	260.71		260.78	0.000157	2.07	3643.72	315.17		-0.8
Reach 8	5477.246	500 YR	9873.4	240.03	262.94		263.02	0.000158	2.26	4360.9	332.81		-0.65
Reach 8	5291.141	100 YR	5439.7	237.73	249.13		249.75	0.002167	6.3	862.84	97.16		-1.33
Reach 8	5291.141	200 YR	7560.6	237.73	251.33		252.08	0.002432	6.96	1085.86	114.77		-0.49
Reach 8	5291.141	500 YR	9873.4	237.73	252.68		253.63	0.003496	7.82	1261.97	148.29		-0.38
Reach 8	5077.036	100 YR	5439.7	237.53	249.13		249.19	0.000251	1.94	2797.35	385.82		-1.42
Reach 8	5077.036	200 YR	7560.6	237.53	251.48		251.54	0.000195	2.04	3713.99	394.34		-0.53
Reach 8	5077.036	500 YR	9873.4	237.53	252.9		252.98	0.000215	2.31	4279.56	404.66		-0.4
Reach 8	4830.884	100 YR	5439.7	235.14	248.23		248.24	0.000023	0.66	8270.51	982.93		-1.6
Reach 8	4830.884	200 YR	7560.6	235.14	250.72		250.73	0.00002	0.7	10841.03	1079.41		-0.48
Reach 8	4830.884	500 YR	9873.4	235.14	252.03		252.04	0.000024	0.81	12276.15	1115.38		-0.36
Reach 8	4216.983	100 YR	5439.7	231.5	246.96		247.06	0.000662	2.49	2181.69	426.95		-1.92
Reach 8	4216.983	200 YR	7560.6	231.5	249.72		249.8	0.000318	2.21	3422.12	462.86		-0.41
Reach 8	4216.983	500 YR	9873.4	231.5	250.87		250.96	0.000349	2.49	3962.29	479.17		-0.31
Reach 8	4059.872	100 YR	5439.7	230.41	246.84	236.09	246.91	0.000148	2.05	2655.83	222.12		-1.89
Reach 8	4059.872	200 YR	7560.6	230.41	249.58		249.64	0.000281	1.96	3848.9	565.79		-0.41
Reach 8	4059.872	500 YR	9873.4	230.41	250.71		250.79	0.000319	2.19	4508.24	619.83		-0.31

Reach 8	3942.972	100 YR	5439.7	230.25	243.9		243.92	0.000206	1.33	4187.73	871.37		-0.54
Reach 8	3942.972	200 YR	7560.6	230.25	245.16		245.19	0.00024	1.42	5455.12	1158.39		-0.35
Reach 8	3942.972	500 YR	9873.4	230.25	246.07		246.1	0.000236	1.55	6522.84	1199.12		-0.26
Reach 8	3472.125	100 YR	5439.7	227.99	239.72		239.78	0.00049	1.86	2918.11	711.43		-0.51
Reach 8	3472.125	200 YR	7560.6	227.99	240.83		240.9	0.00043	2.04	3710.81	717.2		-0.45
Reach 8	3472.125	500 YR	9873.4	227.99	241.97		242.05	0.000383	2.18	4538.22	728.71		-0.34
Reach 8	2694.558	100 YR	5439.7	227.07	235.14		235.17	0.000167	1.44	3845.03	634.63		-0.56
Reach 8	2694.558	200 YR	7560.6	227.07	236.64		236.68	0.000157	1.61	4807.18	650.4		-0.45
Reach 8	2694.558	500 YR	9873.4	227.07	237.81		237.86	0.000166	1.81	5573.07	654.42		-0.36
Reach 8	2381.125	100 YR	5439.7	226.84	232.8		232.82	0.00017	1.14	4803.1	1115.91		-0.8
Reach 8	2381.125	200 YR	7560.6	226.84	235.13		235.14	0.000081	1.02	7469.08	1175.03		-0.44
Reach 8	2381.125	500 YR	9873.4	226.84	236.26		236.28	0.000082	1.13	8811.39	1215.76		-0.33
Reach 8	2233.088	100 YR	5439.7	213.62	232.75		232.77	0.000085	1.02	5569.02	931.13		-0.8
Reach 8	2233.088	200 YR	7560.6	213.62	235.1		235.11	0.000064	0.98	7983.1	1104.81		-0.43
Reach 8	2233.088	500 YR	9873.4	213.62	236.22		236.24	0.000068	1.11	9243.24	1128.08		-0.34
Reach 8	2107.736	100 YR	5439.7	213.48	229.33		229.49	0.000731	3.14	1732.99	254.89		-0.87
Reach 8	2107.736	200 YR	7560.6	213.48	232.35		232.46	0.000782	2.63	2879.13	591.96		-0.37
Reach 8	2107.736	500 YR	9873.4	213.48	233.33		233.46	0.000749	2.85	3469.48	611.93		-0.31
Reach 8	1917.119	100 YR	5439.7	199.21	207.04	204.96	207.99	0.005292	7.81	696.24	114.57		-0.59
Reach 8	1917.119	200 YR	7560.6	199.21	208.35	206.02	209.59	0.005519	8.9	849.03	117.62		-0.51
Reach 8	1917.119	500 YR	9873.4	199.21	209.64	207.09	211.15	0.005648	9.85	1002.24	120.61		-0.38
Reach 8	1747.116	100 YR	5439.7	74.28	78.78	78.78	80.68	0.019643	11.06	491.94	131.3		-0.44
Reach 8	1747.116	200 YR	7560.6	74.28	79.73	79.73	82.06	0.018247	12.26	616.91	132.53		-0.33
Reach 8	1747.116	500 YR	9873.4	74.28	80.63	80.63	83.42	0.017576	13.4	736.85	133.69		-0.28
Reach 8	1615.422	100 YR	5439.7	51.25	55.68	58.19	64.09	0.095581	23.27	233.73	66.24		-0.43
Reach 8	1615.422	200 YR	7560.6	51.25	56.66	59.64	66.53	0.085836	25.21	299.96	69.05		-0.41
Reach 8	1615.422	500 YR	9873.4	51.25	57.64	60.93	68.62	0.080776	26.59	371.36	75.07		-0.31
Reach 8	1382.411	100 YR	5439.7	27.13	46.43	33.78	46.49	0.000144	2.05	2650.85	213.43		-1.29
Reach 8	1382.411	200 YR	7560.6	27.13	49.17	35.38	49.26	0.000149	2.33	3244.68	219.67		-1.19
Reach 8	1382.411	500 YR	9873.4	27.13	51.84	36.86	51.94	0.000154	2.57	3843.38	228.63		-0.64
Reach 8	1262.946	100 YR	5439.7	20.83	43.57		43.67	0.0003	2.63	2069.3	196.41		-1.19
Reach 8	1262.946	200 YR	7560.6	20.83	46.08		46.21	0.000346	2.88	2626.92	244.87		-1.12
Reach 8	1262.946	500 YR	9873.4	20.83	48.54		48.67	0.000397	2.94	3359.18	341.23		-0.6
Reach 8	1171.695	100 YR	5439.7	17.36	36.6		36.74	0.000565	3.01	1804.24	223.08		-1.09
Reach 8	1171.695	200 YR	7560.6	17.36	38.89		39.05	0.000508	3.24	2333.3	238.71		-0.75
Reach 8	1171.695	500 YR	9873.4	17.36	40.78		40.97	0.000505	3.53	2797	250.44		-0.56
Reach 8	582.0234	100 YR	5439.7	6.23	22.98		23.41	0.001028	5.3	1068.99	238.87		-0.49
Reach 8	582.0234	200 YR	7560.6	6.23	24.05		24.68	0.001465	6.54	1468.34	528.04		-0.35
Reach 8	582.0234	500 YR	9873.4	6.23	24.94		25.71	0.001763	7.47	2057.87	822.33		-0.25
Reach 8	468.3845	100 YR	5439.7	5.29	22.84		23.08	0.000556	3.94	1421.69	311.41		-0.47
Reach 8	468.3845	200 YR	7560.6	5.29	23.86		24.21	0.00077	4.85	2007.78	684.34		-0.34
Reach 8	468.3845	500 YR	9873.4	5.29	24.71		25.14	0.000933	5.55	2633.27	760.09		-0.23
Reach 8	363.373	100 YR	5514.1	3.57	22.52	13.94	22.82	0.001001	4.81	1904	813.87		-0.51
Reach 8	363.373	200 YR	7660.3	3.57	23.61	15.86	23.89	0.001002	5	2869.07	937.75		-0.35
Reach 8	363.373	500 YR	9999.9	3.57	24.49	17.58	24.75	0.001002	5.16	3821.69	1275.17		-0.25

HEC-RAS Summary Table - Post Condition Reach 8 (w/Only Dunham Reservoir Management)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	WS. Elevation Benefit
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)
Reach 8	9084.866	100 YR	5877.2	328.97	340.9	335.67	340.93	0.000163	1.43	4117.14	654.82	0.1	-0.4
Reach 8	9084.866	200 YR	8157.5	328.97	342.61	336.16	342.64	0.000144	1.56	5240.96	663.9	0.1	-0.17
Reach 8	9084.866	500 YR	10497.3	328.97	344.14	336.55	344.18	0.000132	1.68	6262.53	667.24	0.1	-0.07
Reach 8	8904.993	100 YR	5877.2	324.05	340.55		340.74	0.000743	3.47	1693.47	216.71	0.22	-0.39
Reach 8	8904.993	200 YR	8157.5	324.05	342.22		342.45	0.000921	3.86	2115.81	273.3	0.24	-0.17
Reach 8	8904.993	500 YR	10497.3	324.05	343.73		344	0.000884	4.13	2541.5	286.88	0.24	-0.08
Reach 8	8792.936	100 YR	5877.2	322.64	340.57		340.6	0.000128	1.44	4072.18	528.15	0.09	-0.38
Reach 8	8792.936	200 YR	8157.5	322.64	342.25		342.29	0.000129	1.64	4969.52	535.08	0.09	-0.18
Reach 8	8792.936	500 YR	10497.3	322.64	343.78		343.84	0.00013	1.81	5793.24	539.45	0.1	-0.08
Reach 8	8546.203	100 YR	5877.2	318.6	326.57		327.02	0.002351	5.39	1089.81	173.12	0.38	-0.34
Reach 8	8546.203	200 YR	8157.5	318.6	328.11		328.67	0.002279	5.99	1362.04	180.04	0.38	-0.16
Reach 8	8546.203	500 YR	10497.3	318.6	329.55		330.2	0.002222	6.45	1627.11	188.31	0.39	-0.07
Reach 8	8339.744	100 YR	5877.2	315.29	320.95	320.95	323.37	0.018281	12.48	470.8	98.44	1.01	-0.29
Reach 8	8339.744	200 YR	8157.5	315.29	322.17	322.17	325.11	0.017125	13.75	593.3	101.38	1	-0.14
Reach 8	8339.744	500 YR	10497.3	315.29	323.29	323.29	326.7	0.016523	14.81	708.74	104.86	1	-0.06
Reach 8	8268.547	100 YR	5877.2	304.66	313.83	315.16	318.1	0.026685	16.58	354.56	61.51	1.22	-0.47
Reach 8	8268.547	200 YR	8157.5	304.66	315.84	316.69	319.82	0.029896	16.01	509.43	103.17	1.27	-0.09
Reach 8	8268.547	500 YR	10497.3	304.66	316.67	317.79	321.48	0.030229	17.59	596.7	105.37	1.3	-0.05
Reach 8	8134.045	100 YR	5877.2	283.79	288.84	291.51	298.01	0.088112	24.29	241.92	58.94	2.11	-0.27
Reach 8	8134.045	200 YR	8157.5	283.79	290.2	293.11	299.84	0.071081	24.91	327.51	64.46	1.95	-0.13
Reach 8	8134.045	500 YR	10497.3	283.79	291.29	294.62	302.07	0.064582	26.34	398.49	66.23	1.89	-0.05
Reach 8	8031.935	100 YR	5877.2	280.22	287.51	287.53	290.3	0.017824	13.42	438.04	79.27	1.01	-0.33
Reach 8	8031.935	200 YR	8157.5	280.22	288.93	288.94	292.31	0.016874	14.76	552.86	82.26	1	-0.15
Reach 8	8031.935	500 YR	10497.3	280.22	290.3	290.3	294.13	0.016223	15.7	668.77	87.57	1	-0.06
Reach 8	7403.166	100 YR	5877.2	253.84	270.98	258.98	271.02	0.000083	1.52	3855.15	327.65	0.08	-0.57
Reach 8	7403.166	200 YR	8157.5	253.84	273.43	259.72	273.48	0.000092	1.74	4686.51	350.29	0.08	-0.24
Reach 8	7403.166	500 YR	10497.3	253.84	275.78	260.39	275.84	0.0001	1.88	5570.85	395.3	0.09	-0.1
Reach 8	7175.604	100 YR	5877.2	251.87	261.34		261.74	0.002095	5.07	1158.9	185.94	0.36	-0.48
Reach 8	7175.604	200 YR	8157.5	251.87	263.48		263.9	0.001597	5.2	1567.34	196.7	0.33	-0.23
Reach 8	7175.604	500 YR	10497.3	251.87	265.55		265.99	0.001308	5.28	1988.17	209.75	0.3	-0.1
Reach 8	7033.063	100 YR	5877.2	250.07	260.66		260.97	0.00125	4.48	1312.52	169.52	0.28	-0.51
Reach 8	7033.063	200 YR	8157.5	250.07	262.92		263.28	0.001076	4.79	1704.18	176.53	0.27	-0.24
Reach 8	7033.063	500 YR	10497.3	250.07	265.06		265.45	0.000951	5.03	2088.03	181.78	0.26	-0.1
Reach 8	6186.399	100 YR	5877.2	244.23	259.51		259.51	0.00001	0.48	12233.07	1244.12	0.03	-0.53
Reach 8	6186.399	200 YR	8157.5	244.23	261.87		261.87	0.00001	0.54	15193.13	1264.11	0.03	-0.25
Reach 8	6186.399	500 YR	10497.3	244.23	264.09		264.1	0.000009	0.58	18031.84	1291.24	0.03	-0.11
Reach 8	5477.246	100 YR	5877.2	240.03	258.9		258.95	0.000159	1.91	3080.27	305.91	0.11	-0.53
Reach 8	5477.246	200 YR	8157.5	240.03	261.26		261.34	0.000158	2.14	3819.13	318	0.11	-0.25
Reach 8	5477.246	500 YR	10497.3	240.03	263.49		263.57	0.00016	2.31	4546.88	339.5	0.11	-0.1
Reach 8	5291.141	100 YR	5877.2	237.73	250.08		250.66	0.00187	6.15	955.74	99.48	0.35	-0.38
Reach 8	5291.141	200 YR	8157.5	237.73	251.67		252.49	0.00257	7.25	1125.39	116.65	0.41	-0.15
Reach 8	5291.141	500 YR	10497.3	237.73	253		254	0.003733	8.01	1310.87	156.5	0.49	-0.06
Reach 8	5077.036	100 YR	5877.2	237.53	250.14		250.19	0.000192	1.84	3189.41	389.49	0.11	-0.41
Reach 8	5077.036	200 YR	8157.5	237.53	251.85		251.92	0.000201	2.11	3860.77	395.69	0.12	-0.16
Reach 8	5077.036	500 YR	10497.3	237.53	253.23		253.32	0.00022	2.38	4415.98	406.03	0.13	-0.07
Reach 8	4830.884	100 YR	5877.2	235.14	249.44		249.45	0.000018	0.62	9487.82	1034.23	0.04	-0.39
Reach 8	4830.884	200 YR	8157.5	235.14	251.06		251.07	0.000021	0.73	11207.03	1088.76	0.04	-0.14
Reach 8	4830.884	500 YR	10497.3	235.14	252.34		252.35	0.000025	0.84	12621.71	1120.69	0.04	-0.05
Reach 8	4216.983	100 YR	5877.2	231.5	248.53		248.59	0.000333	2.04	2875.13	452.41	0.14	-0.35
Reach 8	4216.983	200 YR	8157.5	231.5	250.01		250.09	0.000329	2.29	3555.41	465.97	0.15	-0.12
Reach 8	4216.983	500 YR	10497.3	231.5	251.13		251.24	0.000358	2.57	4089.34	482.16	0.16	-0.05
Reach 8	4059.872	100 YR	5877.2	230.41	248.37		248.43	0.000298	1.85	3181.1	535.62	0.13	-0.36
Reach 8	4059.872	200 YR	8157.5	230.41	249.86		249.93	0.000289	2.03	4009.8	570.99	0.14	-0.13
Reach 8	4059.872	500 YR	10497.3	230.41	250.97		251.05	0.000329	2.25	4672.19	632.42	0.15	-0.05

Reach 8	3942.972	100 YR	5877.2	230.25	244.14		244.17	0.00021	1.36	4398.51	890.13	0.11	-0.3
Reach 8	3942.972	200 YR	8157.5	230.25	245.41		245.44	0.000238	1.45	5737.61	1166.44	0.12	-0.1
Reach 8	3942.972	500 YR	10497.3	230.25	246.29		246.33	0.000234	1.58	6786.71	1199.7	0.12	-0.04
Reach 8	3472.125	100 YR	5877.2	227.99	239.97		240.02	0.000472	1.9	3091.57	712.45	0.16	-0.26
Reach 8	3472.125	200 YR	8157.5	227.99	241.15		241.21	0.000416	2.07	3937.18	723.87	0.16	-0.13
Reach 8	3472.125	500 YR	10497.3	227.99	242.26		242.34	0.000373	2.21	4746.5	729.83	0.15	-0.05
Reach 8	2694.558	100 YR	5877.2	227.07	235.41		235.44	0.000169	1.49	4014.48	636.19	0.1	-0.29
Reach 8	2694.558	200 YR	8157.5	227.07	236.95		237	0.000159	1.66	5012.22	651.45	0.1	-0.14
Reach 8	2694.558	500 YR	10497.3	227.07	238.11		238.17	0.000168	1.86	5769.76	655.83	0.11	-0.06
Reach 8	2381.125	100 YR	5877.2	226.84	233.21		233.23	0.000148	1.12	5258.72	1125.03	0.09	-0.39
Reach 8	2381.125	200 YR	8157.5	226.84	235.44		235.46	0.00008	1.05	7833.29	1176.35	0.07	-0.13
Reach 8	2381.125	500 YR	10497.3	226.84	236.54		236.56	0.000083	1.15	9156.24	1233.83	0.07	-0.05
Reach 8	2233.088	100 YR	5877.2	213.62	233.16		233.18	0.000083	1.03	5956.11	955.78	0.07	-0.39
Reach 8	2233.088	200 YR	8157.5	213.62	235.4		235.42	0.000065	1.02	8326.68	1115.12	0.07	-0.13
Reach 8	2233.088	500 YR	10497.3	213.62	236.5		236.52	0.000069	1.14	9561.65	1132.17	0.07	-0.06
Reach 8	2107.736	100 YR	5877.2	213.48	229.82	219.06	229.97	0.000735	3.16	1860.11	272.45	0.21	-0.38
Reach 8	2107.736	200 YR	8157.5	213.48	232.61		232.73	0.000773	2.69	3035.07	597.3	0.21	-0.11
Reach 8	2107.736	500 YR	10497.3	213.48	233.59		233.72	0.00074	2.9	3625.03	617.8	0.21	-0.05
Reach 8	1917.119	100 YR	5877.2	199.21	207.33	205.18	208.34	0.005336	8.05	729.7	115.24	0.56	-0.3
Reach 8	1917.119	200 YR	8157.5	199.21	208.7	206.33	210.01	0.00556	9.17	889.7	118.42	0.59	-0.16
Reach 8	1917.119	500 YR	10497.3	199.21	209.96	207.36	211.54	0.005686	10.09	1040.88	121.35	0.61	-0.06
Reach 8	1747.116	100 YR	5877.2	74.28	78.98	78.98	80.98	0.019353	11.34	518.36	131.56	1.01	-0.24
Reach 8	1747.116	200 YR	8157.5	74.28	79.97	79.97	82.43	0.018023	12.57	649.2	132.84	1	-0.09
Reach 8	1747.116	500 YR	10497.3	74.28	80.86	80.86	83.77	0.017384	13.66	768.22	133.99	1.01	-0.05
Reach 8	1615.422	100 YR	5877.2	51.25	55.88	58.49	64.65	0.093646	23.76	247.38	66.83	2.18	-0.23
Reach 8	1615.422	200 YR	8157.5	51.25	56.95	59.99	67.01	0.08449	25.44	320.68	71.9	2.12	-0.12
Reach 8	1615.422	500 YR	10497.3	51.25	57.9	61.25	69.09	0.077998	26.83	391.3	75.91	2.08	-0.05
Reach 8	1382.411	100 YR	5877.2	27.13	47.08	34.07	47.15	0.000144	2.11	2791.12	214.83	0.1	-0.64
Reach 8	1382.411	200 YR	8157.5	27.13	49.99	35.96	50.07	0.000148	2.38	3424.44	222.21	0.11	-0.37
Reach 8	1382.411	500 YR	10497.3	27.13	52.37	37.13	52.48	0.000158	2.65	3965.12	229.65	0.11	-0.11
Reach 8	1262.946	100 YR	5877.2	20.83	44.18		44.29	0.000314	2.68	2194.73	210.5	0.15	-0.58
Reach 8	1262.946	200 YR	8157.5	20.83	46.84		46.97	0.000368	2.88	2831.02	277.76	0.16	-0.36
Reach 8	1262.946	500 YR	10497.3	20.83	49.03		49.17	0.000393	2.97	3529.11	350.21	0.17	-0.11
Reach 8	1171.695	100 YR	5877.2	17.36	37.13		37.28	0.000546	3.05	1924.54	227.35	0.19	-0.56
Reach 8	1171.695	200 YR	8157.5	17.36	39.42		39.59	0.000503	3.31	2461.89	242.02	0.18	-0.22
Reach 8	1171.695	500 YR	10497.3	17.36	41.25		41.45	0.000514	3.6	2914.65	256.96	0.19	-0.09
Reach 8	582.0234	100 YR	5877.2	6.23	23.22		23.7	0.001131	5.6	1133.15	298.48	0.27	-0.25
Reach 8	582.0234	200 YR	8157.5	6.23	24.29		24.98	0.001559	6.82	1606.85	583.66	0.32	-0.11
Reach 8	582.0234	500 YR	10497.3	6.23	25.16		25.94	0.00179	7.6	2243.32	848.7	0.34	-0.03
Reach 8	468.3845	100 YR	5877.2	5.29	23.06		23.33	0.00061	4.17	1513.17	495.5	0.21	-0.25
Reach 8	468.3845	200 YR	8157.5	5.29	24.1		24.47	0.00082	5.06	2173.68	716.22	0.24	-0.1
Reach 8	468.3845	500 YR	10497.3	5.29	24.91		25.35	0.000967	5.7	2785.67	761.47	0.26	-0.03
Reach 8	363.373	100 YR	5951.7	3.57	22.77	14.36	23.06	0.001002	4.86	2108.18	834.03	0.25	-0.26
Reach 8	363.373	200 YR	8257.2	3.57	23.86	16.31	24.13	0.001001	5.05	3107.13	1012.08	0.25	-0.1
Reach 8	363.373	500 YR	10623.8	3.57	24.7	18.09	24.96	0.001	5.2	4099.07	1410.29	0.26	-0.04

HEC-RAS Summary Table - Post Condition Reach 8

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width		WS. Elevation Benefit
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)
Poesten Kill	Reach 8	9084.866	100 YR	5132.8	328.97	340.28	335.33	340.31	0.000176	1.38	3708.35	652.98		-1.02
Poesten Kill	Reach 8	9084.866	200 YR	7127.3	328.97	341.87	335.98	341.91	0.00015	1.5	4756.36	658.55		-0.91
Poesten Kill	Reach 8	9084.866	500 YR	9324.1	328.97	343.39	336.36	343.43	0.000138	1.62	5759.88	665.98		-0.82
Poesten Kill	Reach 8	8904.993	100 YR	5132.8	324.05	339.94		340.11	0.000661	3.27	1568.26	200.45		-1
Poesten Kill	Reach 8	8904.993	200 YR	7127.3	324.05	341.5		341.71	0.00091	3.71	1923.25	260.96		-0.89
Poesten Kill	Reach 8	8904.993	500 YR	9324.1	324.05	342.99		343.24	0.000907	4	2329.8	281.31		-0.82
Poesten Kill	Reach 8	8792.936	100 YR	5132.8	322.64	339.95		339.98	0.000127	1.37	3748.45	524.34		-1
Poesten Kill	Reach 8	8792.936	200 YR	7127.3	322.64	341.52		341.56	0.000129	1.56	4579.94	533		-0.91
Poesten Kill	Reach 8	8792.936	500 YR	9324.1	322.64	343.03		343.08	0.00013	1.73	5387.29	537.3		-0.83
Poesten Kill	Reach 8	8546.203	100 YR	5132.8	318.6	326.01		326.42	0.002384	5.16	994.18	170.63		-0.9
Poesten Kill	Reach 8	8546.203	200 YR	7127.3	318.6	327.44		327.95	0.002306	5.74	1242.48	177.03		-0.83
Poesten Kill	Reach 8	8546.203	500 YR	9324.1	318.6	328.83		329.44	0.002245	6.24	1493.92	183.29		-0.79
Poesten Kill	Reach 8	8339.744	100 YR	5132.8	315.29	320.52	320.52	322.74	0.01865	11.96	429.18	97.42		-0.72
Poesten Kill	Reach 8	8339.744	200 YR	7127.3	315.29	321.63	321.63	324.35	0.017633	13.23	538.83	100.08		-0.68
Poesten Kill	Reach 8	8339.744	500 YR	9324.1	315.29	322.75	322.75	325.93	0.016679	14.29	652.42	102.76		-0.6
Poesten Kill	Reach 8	8268.547	100 YR	5132.8	304.66	313.22	314.11	317.28	0.028296	16.18	317.29	59.98		-1.08
Poesten Kill	Reach 8	8268.547	200 YR	7127.3	304.66	315.03	316.19	319.19	0.02701	16.37	435.43	78.21		-0.9
Poesten Kill	Reach 8	8268.547	500 YR	9324.1	304.66	316.27	317.26	320.66	0.029926	16.81	554.74	104.32		-0.45
Poesten Kill	Reach 8	8134.045	100 YR	5132.8	283.79	288.53	290.96	296.72	0.085767	22.96	223.57	58.31		-0.58
Poesten Kill	Reach 8	8134.045	200 YR	7127.3	283.79	289.54	292.41	299.26	0.083485	25.02	284.88	63.38		-0.79
Poesten Kill	Reach 8	8134.045	500 YR	9324.1	283.79	290.75	293.85	301.01	0.067794	25.69	362.88	65.35		-0.59
Poesten Kill	Reach 8	8031.935	100 YR	5132.8	280.22	287.02	287.02	289.58	0.018034	12.84	399.65	78.24		-0.82
Poesten Kill	Reach 8	8031.935	200 YR	7127.3	280.22	288.32	288.32	291.44	0.017098	14.15	503.67	80.99		-0.76
Poesten Kill	Reach 8	8031.935	500 YR	9324.1	280.22	289.63	289.63	293.25	0.016467	15.26	611.1	84.58		-0.73
Poesten Kill	Reach 8	7403.166	100 YR	5132.8	253.84	270.05	258.73	270.09	0.00008	1.44	3555.55	317.12		-1.5
Poesten Kill	Reach 8	7403.166	200 YR	7127.3	253.84	272.39	259.39	272.44	0.000089	1.65	4327.5	342.88		-1.28
Poesten Kill	Reach 8	7403.166	500 YR	9324.1	253.84	274.73	260.07	274.78	0.000097	1.81	5160.05	381.03		-1.15
Poesten Kill	Reach 8	7175.604	100 YR	5132.8	251.87	260.57		260.96	0.002411	5.05	1016.26	182.58		-1.25
Poesten Kill	Reach 8	7175.604	200 YR	7127.3	251.87	262.54		262.95	0.001769	5.15	1385.22	191.14		-1.17
Poesten Kill	Reach 8	7175.604	500 YR	9324.1	251.87	264.55		264.97	0.001429	5.24	1780.57	203.41		-1.1
Poesten Kill	Reach 8	7033.063	100 YR	5132.8	250.07	259.81		260.11	0.001336	4.38	1170.82	164.41		-1.36
Poesten Kill	Reach 8	7033.063	200 YR	7127.3	250.07	261.94		262.27	0.001141	4.65	1532.05	173.75		-1.22
Poesten Kill	Reach 8	7033.063	500 YR	9324.1	250.07	264.03		264.4	0.001001	4.9	1901.54	179.25		-1.13
Poesten Kill	Reach 8	6186.399	100 YR	5132.8	244.23	258.58		258.58	0.000011	0.46	11083.24	1237.94		-1.46
Poesten Kill	Reach 8	6186.399	200 YR	7127.3	244.23	260.85		260.86	0.00001	0.51	13914.55	1253.8		-1.27
Poesten Kill	Reach 8	6186.399	500 YR	9324.1	244.23	263.03		263.04	0.000009	0.56	16671.37	1275.4		-1.17
Poesten Kill	Reach 8	5477.246	100 YR	5132.8	240.03	257.95		258	0.00016	1.84	2795.16	295.8		-1.48
Poesten Kill	Reach 8	5477.246	200 YR	7127.3	240.03	260.25		260.31	0.000158	2.04	3498.89	312.82		-1.26
Poesten Kill	Reach 8	5477.246	500 YR	9324.1	240.03	262.44		262.51	0.000157	2.22	4195.51	326.74		-1.15
Poesten Kill	Reach 8	5291.141	100 YR	5132.8	237.73	248.86		249.44	0.002118	6.14	836.24	96.48		-1.6
Poesten Kill	Reach 8	5291.141	200 YR	7127.3	237.73	251.05		251.76	0.002209	6.76	1054.89	108.13		-0.77
Poesten Kill	Reach 8	5291.141	500 YR	9324.1	237.73	252.35		253.27	0.003367	7.68	1214.81	142.76		-0.71
Poesten Kill	Reach 8	5077.036	100 YR	5132.8	237.53	248.83		248.89	0.000256	1.91	2681.97	384.74		-1.72
Poesten Kill	Reach 8	5077.036	200 YR	7127.3	237.53	251.19		251.25	0.000192	1.98	3598.35	393.28		-0.82
Poesten Kill	Reach 8	5077.036	500 YR	9324.1	237.53	252.56		252.64	0.000212	2.25	4142.82	401.82		-0.74
Poesten Kill	Reach 8	4830.884	100 YR	5132.8	235.14	247.93		247.94	0.000023	0.64	7975.93	974.4		-1.9
Poesten Kill	Reach 8	4830.884	200 YR	7127.3	235.14	250.45		250.46	0.00002	0.68	10548.56	1071.88		-0.75
Poesten Kill	Reach 8	4830.884	500 YR	9324.1	235.14	251.71		251.72	0.000023	0.79	11920.33	1106.74		-0.68
Poesten Kill	Reach 8	4216.983	100 YR	5132.8	231.5	246.65		246.75	0.000706	2.5	2051.15	419.16		-2.23
Poesten Kill	Reach 8	4216.983	200 YR	7127.3	231.5	249.48		249.55	0.000313	2.15	3311.27	460.47		-0.65
Poesten Kill	Reach 8	4216.983	500 YR	9324.1	231.5	250.57		250.67	0.000347	2.44	3821.51	475.84		-0.61

Poesten Kill	Reach 8	4059.872	100 YR	5132.8	230.41	246.54		246.6	0.000143	1.98	2588.33	221.17		-2.19
Poesten Kill	Reach 8	4059.872	200 YR	7127.3	230.41	249.34		249.4	0.000279	1.92	3713.8	563.05		-0.65
Poesten Kill	Reach 8	4059.872	500 YR	9324.1	230.41	250.42		250.49	0.000303	2.15	4332.45	588.25		-0.6
Poesten Kill	Reach 8	3942.972	100 YR	5132.8	230.25	243.69		243.72	0.0002	1.31	4011.14	834		-0.75
Poesten Kill	Reach 8	3942.972	200 YR	7127.3	230.25	244.96		244.98	0.000238	1.39	5218.54	1124.46		-0.55
Poesten Kill	Reach 8	3942.972	500 YR	9324.1	230.25	245.87		245.9	0.000238	1.52	6286.16	1197.94		-0.46
Poesten Kill	Reach 8	3472.125	100 YR	5132.8	227.99	239.54		239.6	0.000504	1.84	2791.79	710.62		-0.69
Poesten Kill	Reach 8	3472.125	200 YR	7127.3	227.99	240.6		240.67	0.000442	2.01	3545.97	714.88		-0.68
Poesten Kill	Reach 8	3472.125	500 YR	9324.1	227.99	241.72		241.79	0.000392	2.14	4350.79	727.7		-0.59
Poesten Kill	Reach 8	2694.558	100 YR	5132.8	227.07	234.96		234.99	0.000164	1.4	3729.28	633.56		-0.74
Poesten Kill	Reach 8	2694.558	200 YR	7127.3	227.07	236.4		236.44	0.000155	1.56	4651.65	649.25		-0.69
Poesten Kill	Reach 8	2694.558	500 YR	9324.1	227.07	237.55		237.6	0.000164	1.76	5400.51	653.5		-0.62
Poesten Kill	Reach 8	2381.125	100 YR	5132.8	226.84	232.36		232.38	0.000214	1.2	4308.35	1105.92		-1.24
Poesten Kill	Reach 8	2381.125	200 YR	7127.3	226.84	234.89		234.9	0.000081	1	7186.85	1173.45		-0.68
Poesten Kill	Reach 8	2381.125	500 YR	9324.1	226.84	236		236.02	0.000082	1.1	8504.34	1203.68		-0.59
Poesten Kill	Reach 8	2233.088	100 YR	5132.8	213.62	232.3		232.31	0.000092	1.04	5158.53	887.59		-1.25
Poesten Kill	Reach 8	2233.088	200 YR	7127.3	213.62	234.86		234.87	0.000063	0.96	7718.31	1099.48		-0.67
Poesten Kill	Reach 8	2233.088	500 YR	9324.1	213.62	235.97		235.99	0.000067	1.08	8958.12	1124.26		-0.59
Poesten Kill	Reach 8	2107.736	100 YR	5132.8	213.48	228.73		228.89	0.000716	3.23	1588.14	219.17		-1.47
Poesten Kill	Reach 8	2107.736	200 YR	7127.3	213.48	232.14	219.78	232.24	0.000789	2.59	2752	581.31		-0.58
Poesten Kill	Reach 8	2107.736	500 YR	9324.1	213.48	233.11		233.23	0.000755	2.8	3333.46	607.39		-0.53
Poesten Kill	Reach 8	1917.119	100 YR	5132.8	199.21	206.82	204.8	207.73	0.005269	7.64	671.78	114.07		-0.81
Poesten Kill	Reach 8	1917.119	200 YR	7127.3	199.21	208.1	205.81	209.27	0.005486	8.7	818.82	117.03		-0.76
Poesten Kill	Reach 8	1917.119	500 YR	9324.1	199.21	209.34	206.83	210.79	0.005639	9.65	966.01	119.91		-0.68
Poesten Kill	Reach 8	1747.116	100 YR	5132.8	74.28	78.64	78.64	80.47	0.019793	10.85	473.1	130.8		-0.58
Poesten Kill	Reach 8	1747.116	200 YR	7127.3	74.28	79.55	79.55	81.79	0.018429	12.02	592.93	132.29		-0.51
Poesten Kill	Reach 8	1747.116	500 YR	9324.1	74.28	80.43	80.43	83.11	0.017608	13.12	710.62	133.43		-0.48
Poesten Kill	Reach 8	1615.422	100 YR	5132.8	51.25	55.54	57.96	63.66	0.096288	22.86	224.58	65.84		-0.57
Poesten Kill	Reach 8	1615.422	200 YR	7127.3	51.25	56.46	59.34	66.08	0.087743	24.88	286.52	68.49		-0.61
Poesten Kill	Reach 8	1615.422	500 YR	9324.1	51.25	57.44	60.63	68.07	0.081467	26.15	356.54	74.45		-0.51
Poesten Kill	Reach 8	1382.411	100 YR	5132.8	27.13	44.01	33.57	44.1	0.000251	2.4	2140.44	208.05		-3.71
Poesten Kill	Reach 8	1382.411	200 YR	7127.3	27.13	48.66	34.98	48.74	0.000148	2.27	3133	218.07		-1.7
Poesten Kill	Reach 8	1382.411	500 YR	9324.1	27.13	51.32	36.66	51.41	0.000151	2.5	3723.36	227.61		-1.16
Poesten Kill	Reach 8	1262.946	100 YR	5132.8	20.83	40.13		40.29	0.000296	3.19	1610.69	108.83		-4.63
Poesten Kill	Reach 8	1262.946	200 YR	7127.3	20.83	45.62		45.74	0.000339	2.83	2515.67	235.91		-1.58
Poesten Kill	Reach 8	1262.946	500 YR	9324.1	20.83	48.06		48.19	0.000392	2.92	3197.55	325.37		-1.08
Poesten Kill	Reach 8	1171.695	100 YR	5132.8	17.36	34		34.2	0.00043	3.58	1433.41	104.81		-3.69
Poesten Kill	Reach 8	1171.695	200 YR	7127.3	17.36	38.47		38.63	0.000514	3.19	2234.24	236.13		-1.17
Poesten Kill	Reach 8	1171.695	500 YR	9324.1	17.36	40.38		40.57	0.000501	3.46	2697.4	247.97		-0.96
Poesten Kill	Reach 8	582.0234	100 YR	5132.8	6.23	22.79		23.19	0.000956	5.09	1028.76	188.65		-0.68
Poesten Kill	Reach 8	582.0234	200 YR	7127.3	6.23	23.86		24.46	0.001382	6.32	1376.12	477.53		-0.54
Poesten Kill	Reach 8	582.0234	500 YR	9324.1	6.23	24.74		25.49	0.001721	7.31	1900.15	765.26		-0.45
Poesten Kill	Reach 8	468.3845	100 YR	5132.8	5.29	22.66		22.88	0.000515	3.78	1379.25	195.53		-0.65
Poesten Kill	Reach 8	468.3845	200 YR	7127.3	5.29	23.68		24.02	0.000731	4.69	1888.37	664.72		-0.52
Poesten Kill	Reach 8	468.3845	500 YR	9324.1	5.29	24.53		24.94	0.000902	5.4	2492.22	758.81		-0.41
Poesten Kill	Reach 8	363.373	100 YR	5207.3	3.57	22.32	13.63	22.63	0.001002	4.78	1746.63	801.82		-0.71
Poesten Kill	Reach 8	363.373	200 YR	7227	3.57	23.42	15.52	23.71	0.001002	4.97	2696.72	923.35		-0.54
Poesten Kill	Reach 8	363.373	500 YR	9450.5	3.57	24.3	17.15	24.56	0.001001	5.12	3588.22	1164.45		-0.44

HEC-RAS Summary Table - Existing Condition Reach 8

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Poesten Ki	Reach 8	9084.866	100 YR	6371.3	328.97	341.3	335.81	341.33	0.000157	1.45	4378.93	656.32	0.1
Poesten Ki	Reach 8	9084.866	200 YR	8416.1	328.97	342.78	336.21	342.82	0.000142	1.57	5358.79	664.54	0.1
Poesten Ki	Reach 8	9084.866	500 YR	10616.1	328.97	344.21	336.56	344.26	0.000132	1.68	6310.83	667.36	0.1
Poesten Ki	Reach 8	8904.993	100 YR	6371.3	324.05	340.94		341.14	0.000835	3.58	1780.71	238.28	0.23
Poesten Ki	Reach 8	8904.993	200 YR	8416.1	324.05	342.39		342.63	0.000922	3.89	2163.86	276.08	0.24
Poesten Ki	Reach 8	8904.993	500 YR	10616.1	324.05	343.81		344.07	0.000882	4.14	2561.95	287.41	0.24
Poesten Ki	Reach 8	8792.936	100 YR	6371.3	322.64	340.95		340.99	0.000128	1.49	4278.35	530.38	0.09
Poesten Ki	Reach 8	8792.936	200 YR	8416.1	322.64	342.43		342.47	0.000129	1.66	5064.24	535.59	0.1
Poesten Ki	Reach 8	8792.936	500 YR	10616.1	322.64	343.86		343.91	0.00013	1.82	5832.15	539.65	0.1
Poesten Ki	Reach 8	8546.203	100 YR	6371.3	318.6	326.91		327.39	0.002339	5.54	1149.98	174.68	0.38
Poesten Ki	Reach 8	8546.203	200 YR	8416.1	318.6	328.27		328.84	0.002271	6.05	1391.54	180.77	0.38
Poesten Ki	Reach 8	8546.203	500 YR	10616.1	318.6	329.62		330.27	0.002219	6.47	1640.77	188.89	0.39
Poesten Ki	Reach 8	8339.744	100 YR	6371.3	315.29	321.24	321.24	323.77	0.017824	12.75	499.75	99.14	1
Poesten Ki	Reach 8	8339.744	200 YR	8416.1	315.29	322.31	322.31	325.3	0.017008	13.87	606.72	101.69	1
Poesten Ki	Reach 8	8339.744	500 YR	10616.1	315.29	323.35	323.35	326.78	0.016512	14.86	714.29	105.07	1
Poesten Ki	Reach 8	8268.547	100 YR	6371.3	304.66	314.3	315.76	318.58	0.026068	16.59	384.09	65.41	1.21
Poesten Ki	Reach 8	8268.547	200 YR	8416.1	304.66	315.93	316.8	320.01	0.029916	16.2	519.58	103.43	1.27
Poesten Ki	Reach 8	8268.547	500 YR	10616.1	304.66	316.72	317.84	321.56	0.030219	17.66	601.1	105.48	1.3
Poesten Ki	Reach 8	8134.045	100 YR	6371.3	283.79	289.11	291.9	298.57	0.090501	24.67	258.26	62.69	2.14
Poesten Ki	Reach 8	8134.045	200 YR	8416.1	283.79	290.33	293.28	300.11	0.07029	25.09	335.45	64.66	1.94
Poesten Ki	Reach 8	8134.045	500 YR	10616.1	283.79	291.34	294.71	302.18	0.064345	26.41	401.94	66.31	1.89
Poesten Ki	Reach 8	8031.935	100 YR	6371.3	280.22	287.84	287.85	290.76	0.017492	13.71	464.55	79.97	1
Poesten Ki	Reach 8	8031.935	200 YR	8416.1	280.22	289.08	289.09	292.52	0.016783	14.89	565.38	82.58	1
Poesten Ki	Reach 8	8031.935	500 YR	10616.1	280.22	290.36	290.36	294.21	0.016187	15.74	674.27	87.7	1
Poesten Ki	Reach 8	7403.166	100 YR	6371.3	253.84	271.55	259.17	271.59	0.000086	1.58	4044.83	333.71	0.08
Poesten Ki	Reach 8	7403.166	200 YR	8416.1	253.84	273.67	259.8	273.72	0.000093	1.76	4772.85	351.7	0.08
Poesten Ki	Reach 8	7403.166	500 YR	10616.1	253.84	275.88	260.42	275.93	0.000101	1.89	5607.96	395.62	0.09
Poesten Ki	Reach 8	7175.604	100 YR	6371.3	251.87	261.82		262.22	0.001955	5.11	1247.76	188	0.35
Poesten Ki	Reach 8	7175.604	200 YR	8416.1	251.87	263.71		264.13	0.001562	5.22	1612.75	198.15	0.32
Poesten Ki	Reach 8	7175.604	500 YR	10616.1	251.87	265.65		266.08	0.001298	5.29	2008.72	210.36	0.3
Poesten Ki	Reach 8	7033.063	100 YR	6371.3	250.07	261.17		261.49	0.001206	4.55	1399.1	171.2	0.28
Poesten Ki	Reach 8	7033.063	200 YR	8416.1	250.07	263.16		263.52	0.001061	4.82	1746.41	177.12	0.27
Poesten Ki	Reach 8	7033.063	500 YR	10616.1	250.07	265.16		265.56	0.000947	5.04	2106.23	182.03	0.26
Poesten Ki	Reach 8	6186.399	100 YR	6371.3	244.23	260.04		260.04	0.00001	0.49	12896.47	1247.95	0.03
Poesten Ki	Reach 8	6186.399	200 YR	8416.1	244.23	262.12		262.12	0.00001	0.54	15504.31	1267.07	0.03
Poesten Ki	Reach 8	6186.399	500 YR	10616.1	244.23	264.2		264.2	0.000009	0.58	18163.65	1292.77	0.03
Poesten Ki	Reach 8	5477.246	100 YR	6371.3	240.03	259.43		259.49	0.000159	1.96	3244.13	308.64	0.11
Poesten Ki	Reach 8	5477.246	200 YR	8416.1	240.03	261.51		261.58	0.000158	2.16	3897.17	319.25	0.11
Poesten Ki	Reach 8	5477.246	500 YR	10616.1	240.03	263.59		263.68	0.00016	2.32	4581.31	340.73	0.11
Poesten Ki	Reach 8	5291.141	100 YR	6371.3	237.73	250.46		251.09	0.00196	6.41	993.59	100.42	0.36
Poesten Ki	Reach 8	5291.141	200 YR	8416.1	237.73	251.82		252.66	0.002667	7.36	1142.92	119.02	0.42
Poesten Ki	Reach 8	5291.141	500 YR	10616.1	237.73	253.06		254.06	0.003772	8.04	1319.97	157.83	0.49
Poesten Ki	Reach 8	5077.036	100 YR	6371.3	237.53	250.55		250.6	0.000193	1.9	3348.42	390.97	0.11
Poesten Ki	Reach 8	5077.036	200 YR	8416.1	237.53	252.01		252.08	0.000203	2.14	3923.87	396.27	0.12
Poesten Ki	Reach 8	5077.036	500 YR	10616.1	237.53	253.3		253.38	0.000221	2.39	4440.75	406.28	0.13
Poesten Ki	Reach 8	4830.884	100 YR	6371.3	235.14	249.83		249.83	0.000019	0.65	9888.61	1049.73	0.04
Poesten Ki	Reach 8	4830.884	200 YR	8416.1	235.14	251.2		251.21	0.000022	0.74	11366.35	1092.8	0.04
Poesten Ki	Reach 8	4830.884	500 YR	10616.1	235.14	252.39		252.4	0.000025	0.84	12683.63	1121.46	0.04
Poesten Ki	Reach 8	4216.983	100 YR	6371.3	231.5	248.88		248.95	0.000329	2.1	3035.34	455.39	0.14
Poesten Ki	Reach 8	4216.983	200 YR	8416.1	231.5	250.13		250.22	0.000335	2.33	3613.83	469.21	0.15
Poesten Ki	Reach 8	4216.983	500 YR	10616.1	231.5	251.18		251.28	0.00036	2.58	4111.72	482.68	0.16
Poesten Ki	Reach 8	4059.872	100 YR	6371.3	230.41	248.73		248.78	0.000294	1.89	3372.97	543.18	0.13
Poesten Ki	Reach 8	4059.872	200 YR	8416.1	230.41	249.99		250.05	0.000292	2.06	4080.29	574.34	0.14
Poesten Ki	Reach 8	4059.872	500 YR	10616.1	230.41	251.02		251.1	0.00033	2.26	4701.17	633.43	0.15

Poesten Ki	Reach 8	3942.972	100 YR	6371.3	230.25	244.44		244.46	0.000219	1.39	4675.64	946.76	0.11
Poesten Ki	Reach 8	3942.972	200 YR	8416.1	230.25	245.51		245.54	0.000238	1.47	5854.09	1169.84	0.12
Poesten Ki	Reach 8	3942.972	500 YR	10616.1	230.25	246.33		246.37	0.000233	1.59	6836.7	1199.81	0.12
Poesten Ki	Reach 8	3472.125	100 YR	6371.3	227.99	240.23		240.29	0.000456	1.94	3282.2	713.47	0.16
Poesten Ki	Reach 8	3472.125	200 YR	8416.1	227.99	241.28		241.35	0.00041	2.09	4032.45	725.99	0.16
Poesten Ki	Reach 8	3472.125	500 YR	10616.1	227.99	242.31		242.39	0.000372	2.22	4785.83	730.04	0.15
Poesten Ki	Reach 8	2694.558	100 YR	6371.3	227.07	235.7		235.74	0.000171	1.54	4201.65	637.91	0.1
Poesten Ki	Reach 8	2694.558	200 YR	8416.1	227.07	237.09		237.13	0.00016	1.69	5100.3	651.9	0.1
Poesten Ki	Reach 8	2694.558	500 YR	10616.1	227.07	238.17		238.23	0.000168	1.87	5809.07	656.21	0.11
Poesten Ki	Reach 8	2381.125	100 YR	6371.3	226.84	233.6		233.62	0.000135	1.12	5695.94	1133.72	0.09
Poesten Ki	Reach 8	2381.125	200 YR	8416.1	226.84	235.57		235.58	0.00008	1.06	7984.75	1180.62	0.07
Poesten Ki	Reach 8	2381.125	500 YR	10616.1	226.84	236.59		236.61	0.000083	1.16	9223.03	1241.19	0.07
Poesten Ki	Reach 8	2233.088	100 YR	6371.3	213.62	233.55		233.57	0.000083	1.05	6334.39	984.54	0.07
Poesten Ki	Reach 8	2233.088	200 YR	8416.1	213.62	235.53		235.55	0.000066	1.03	8469.95	1117.69	0.07
Poesten Ki	Reach 8	2233.088	500 YR	10616.1	213.62	236.56		236.58	0.00007	1.14	9622.58	1132.91	0.07
Poesten Ki	Reach 8	2107.736	100 YR	6371.3	213.48	230.2	219.35	230.36	0.000732	3.24	1965.31	276.08	0.21
Poesten Ki	Reach 8	2107.736	200 YR	8416.1	213.48	232.72		232.84	0.00077	2.71	3100.86	599.54	0.21
Poesten Ki	Reach 8	2107.736	500 YR	10616.1	213.48	233.64		233.77	0.000739	2.9	3655.72	619.45	0.21
Poesten Ki	Reach 8	1917.119	100 YR	6371.3	199.21	207.63	205.45	208.71	0.005415	8.33	764.95	115.95	0.57
Poesten Ki	Reach 8	1917.119	200 YR	8416.1	199.21	208.86	206.45	210.19	0.00555	9.26	908.46	118.79	0.59
Poesten Ki	Reach 8	1917.119	500 YR	10616.1	199.21	210.02	207.41	211.61	0.005694	10.13	1048.11	121.49	0.61
Poesten Ki	Reach 8	1747.116	100 YR	6371.3	74.28	79.22	79.22	81.31	0.018851	11.6	549.3	131.87	1
Poesten Ki	Reach 8	1747.116	200 YR	8416.1	74.28	80.06	80.06	82.58	0.018094	12.73	661.1	132.95	1.01
Poesten Ki	Reach 8	1747.116	500 YR	10616.1	74.28	80.91	80.91	83.83	0.017348	13.71	774.13	134.05	1.01
Poesten Ki	Reach 8	1615.422	100 YR	6371.3	51.25	56.11	58.82	65.24	0.091309	24.24	262.86	67.49	2.17
Poesten Ki	Reach 8	1615.422	200 YR	8416.1	51.25	57.07	60.14	67.22	0.08438	25.55	329.4	73.29	2.12
Poesten Ki	Reach 8	1615.422	500 YR	10616.1	51.25	57.95	61.32	69.18	0.077651	26.89	394.82	76.05	2.08
Poesten Ki	Reach 8	1382.411	100 YR	6371.3	27.13	47.72	34.4	47.79	0.000145	2.18	2928.17	216.11	0.1
Poesten Ki	Reach 8	1382.411	200 YR	8416.1	27.13	50.36	36.08	50.45	0.000146	2.4	3508.24	223.05	0.11
Poesten Ki	Reach 8	1382.411	500 YR	10616.1	27.13	52.48	37.19	52.59	0.000159	2.66	3990.62	229.87	0.11
Poesten Ki	Reach 8	1262.946	100 YR	6371.3	20.83	44.76		44.87	0.000323	2.75	2319.41	219.21	0.15
Poesten Ki	Reach 8	1262.946	200 YR	8416.1	20.83	47.2		47.33	0.000381	2.87	2934.52	298.77	0.16
Poesten Ki	Reach 8	1262.946	500 YR	10616.1	20.83	49.14		49.28	0.000393	2.98	3567.25	353.4	0.17
Poesten Ki	Reach 8	1171.695	100 YR	6371.3	17.36	37.69		37.84	0.000529	3.1	2053.29	231.34	0.18
Poesten Ki	Reach 8	1171.695	200 YR	8416.1	17.36	39.64		39.81	0.000503	3.35	2514.64	243.36	0.18
Poesten Ki	Reach 8	1171.695	500 YR	10616.1	17.36	41.34		41.55	0.000516	3.61	2940.04	259.09	0.19
Poesten Ki	Reach 8	582.0234	100 YR	6371.3	6.23	23.47		24	0.001241	5.92	1213.24	333.91	0.28
Poesten Ki	Reach 8	582.0234	200 YR	8416.1	6.23	24.4		25.09	0.001593	6.93	1667.91	616.9	0.32
Poesten Ki	Reach 8	582.0234	500 YR	10616.1	6.23	25.19		25.97	0.001798	7.63	2274.44	850.65	0.34
Poesten Ki	Reach 8	468.3845	100 YR	6371.3	5.29	23.31		23.6	0.000664	4.4	1646.42	594.61	0.21
Poesten Ki	Reach 8	468.3845	200 YR	8416.1	5.29	24.2		24.58	0.00084	5.14	2244.48	732.52	0.24
Poesten Ki	Reach 8	468.3845	500 YR	10616.1	5.29	24.94		25.39	0.000975	5.73	2810.9	761.7	0.26
Poesten Ki	Reach 8	363.373	100 YR	6445.5	3.57	23.03	14.81	23.32	0.001002	4.9	2337.39	890.82	0.25
Poesten Ki	Reach 8	363.373	200 YR	8515.8	3.57	23.96	16.49	24.23	0.001002	5.06	3211.73	1048.25	0.26
Poesten Ki	Reach 8	363.373	500 YR	10742.6	3.57	24.74	18.17	24.99	0.001	5.21	4148.32	1433.6	0.26

Appendix 4:

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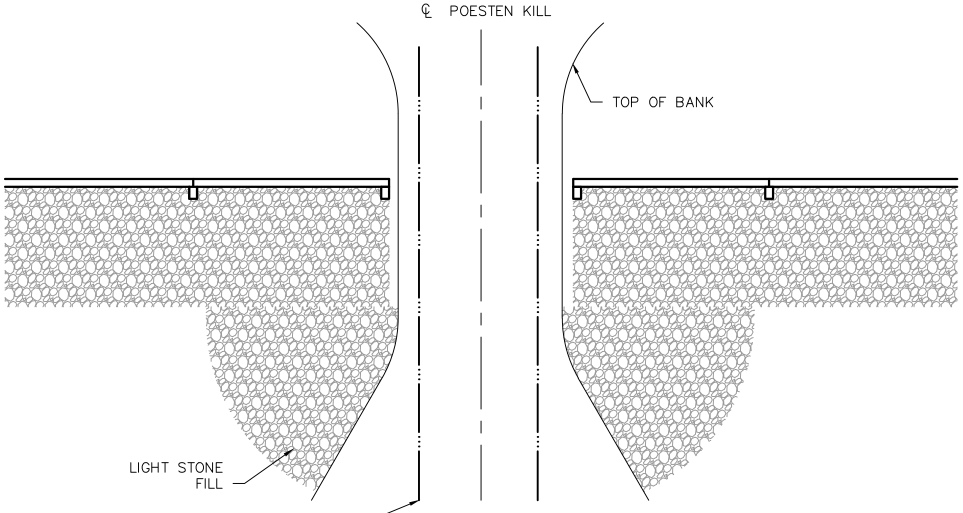
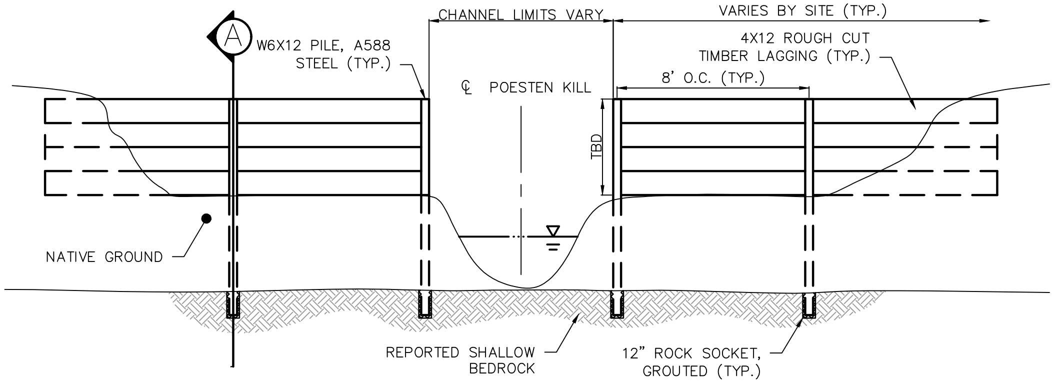
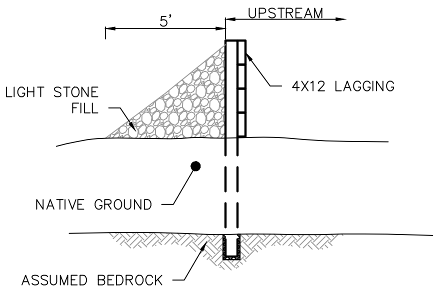


PLAN VIEW





SECTION A-A

A **STREAM SECTION - DIKE ELEVATION**

SCALE: NOT TO SCALE

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Poughkeepsie, New York 12601
Phone: (845) 454-3980

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Chattanooga Tennessee Office:
427 E. 5TH ST. (Suite 201)
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RPA POESTEN KILL FLOOD MITIGATION STUDY

PILE & LAGGING / NO BERM

POESTEN KILL WATERSHED, RENSSELAER COUNTY, NEW YORK

design	chked
FBM	MAC
date	scale
6/21/19	N.T.S.

project no.
41822.00

sheet no.
DETAIL A

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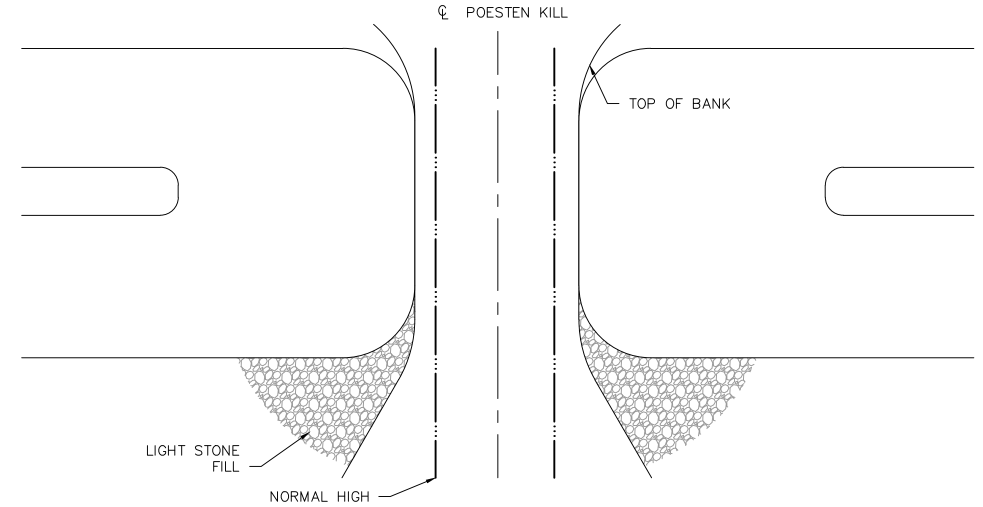

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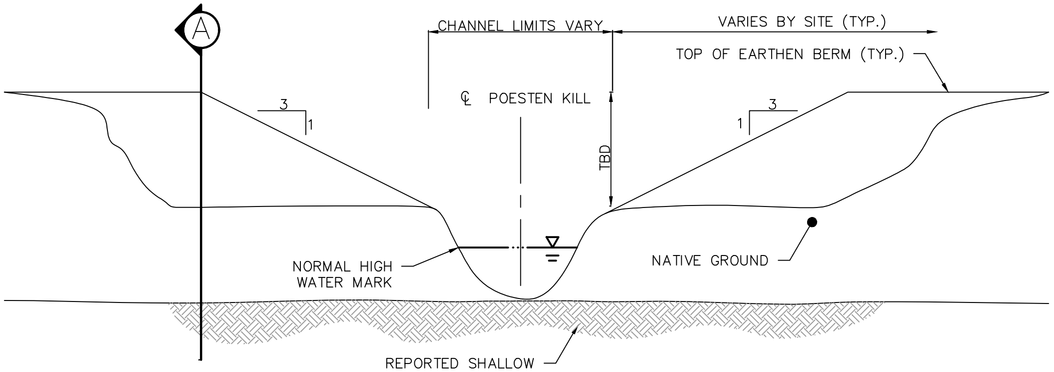

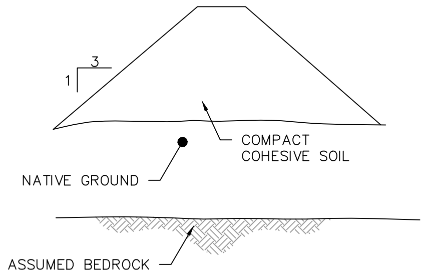

SECTION A-A

B

STREAM SECTION - DIKE ELEVATION

SCALE: NOT TO SCALE

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Nashville, Tennessee 37212
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Chattanooga, Tennessee 37403
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RPA POESTEN KILL FLOOD MITIGATION STUDY

EARTHEN BERM (NO CORE)

POESTEN KILL WATERSHED, RENSSELAER COUNTY, NEW YORK

design	chked
FBM	MAC
date	scale
6/21/19	N.T.S.

project no.
41822.00

sheet no.
DETAIL B

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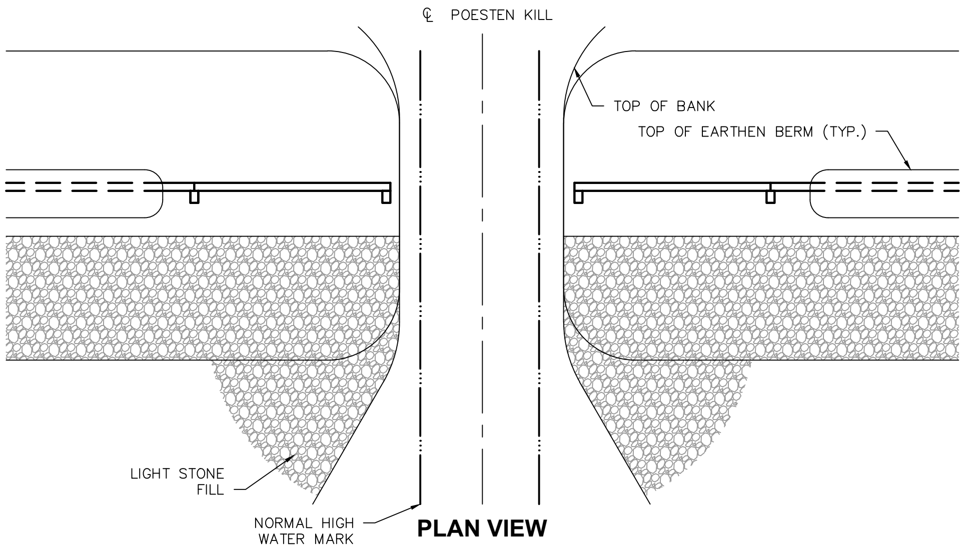

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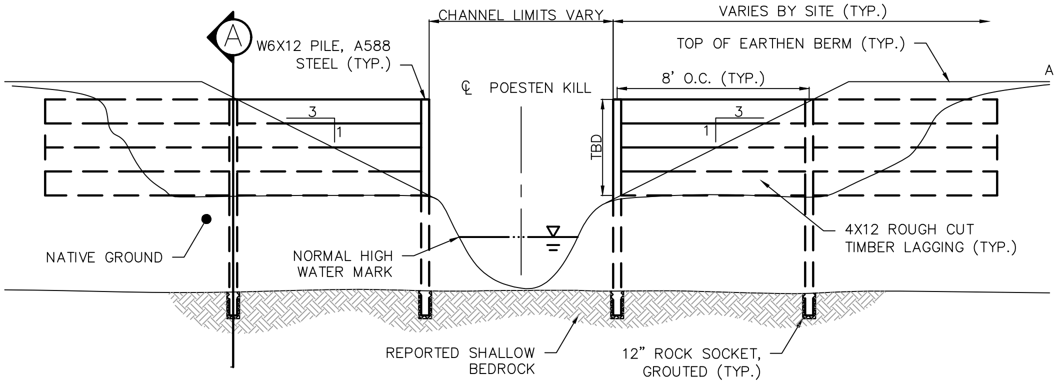

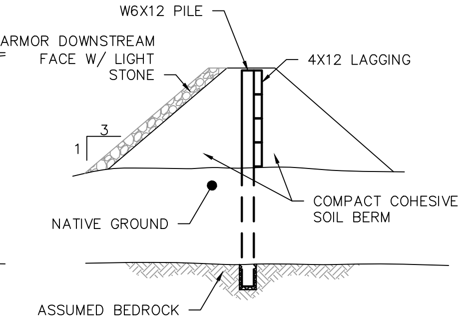

SECTION A-A

C STREAM SECTION - DIKE ELEVATION

SCALE: NOT TO SCALE

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RPA POESTEN KILL FLOOD MITIGATION STUDY

PILE & LAGGING / WITH BERM

POESTEN KILL WATERSHED, RENSSELAER COUNTY, NEW YORK

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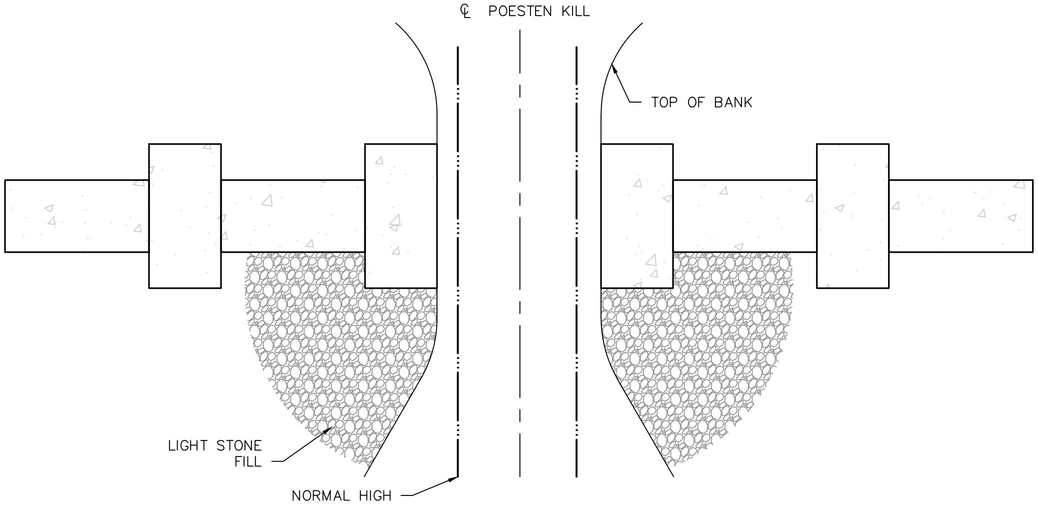
date	scale
6/21/19	N.T.S.

project no.
41822.00

sheet no.
DETAIL C



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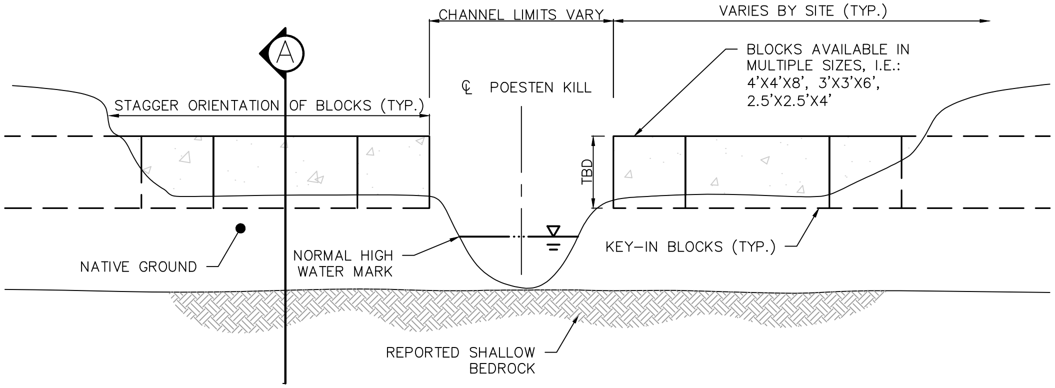

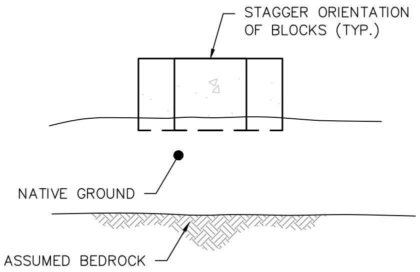

SECTION A-A

D STREAM SECTION - DIKE ELEVATION

SCALE: NOT TO SCALE

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Phone: (845) 454-3980

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Chattanooga Tennessee Office:
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Chattanooga, Tennessee 37403
Phone: (423) 241-6575

RPA POESTEN KILL FLOOD MITIGATION STUDY

PRE-CAST CONCRETE GRAVITY BLOCK

POESTEN KILL WATERSHED, RENSSELAER COUNTY, NEW YORK

design	chked
FBM	MAC
date	scale
6/21/19	N.T.S.

project no.
41822.00

sheet no.
DETAIL D

Drawing Name: Z:\projects\41800-41899\41822_00 RPA Poesten Kill Flood Management Study\DWG\DETAILS-BERM.dwg Date Printed: Jun 21, 2019, 2:11pm

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Dutchess County Office
Phone: (845) 454-3980

547 River Street, Troy, NY 12180
Phone: (518) 273-0055 Fax: (518) 273-8391
Web: www.chazencompanies.com

North Country Office
Phone: (518) 812-0513

RPA - Poestenkill NEWIIPIC

41822.00

Date: April 24, 2019
REVISED June 28, 2019

WETLAND RESTRICTING DIKES (Each)

Description	QTY	Unit	Unit Price	Total Cost
Method A - Pile & Lagging/No Berm				
Mobilization	1	LS	$2,000.00	$2,000.00
14 - W6x12 Posts @ 6' long = 72 lb ea.	1,008	LB	$3.00	$3,024.00
Timber Lagging -	1,400	Bd. Ft	$5.00	$7,000.00
Install Piles	2	Day	$2,500.00	$5,000.00
Light Stone Fill	80	CY	$50.00	$4,000.00
Erosion & Sediment Control	1	LS	$1,500.00	$1,500.00
			Total Method A	***$22,524.00***
Method B - Earthen Berm w/ No Core				
Mobilization	1	LS	$2,000.00	$2,000.00
Light Stone Fill	20	CY	$50.00	$1,000.00
Earthen Embankment-in-Place	100	CY	$60.00	$6,000.00
Seed & Mulch	1	LS	$250.00	$250.00
Plantings	8	LS	$400.00	$3,200.00
Topsoil	150	SY	$40.00	$6,000.00
Erosion & Sediment Control	1	LS	$1,500.00	$1,500.00
			Total Method B	**$19,950.00**
Method C - Pile & Lagging w/ Berm				
Mobilization	1	LS	$2,000.00	$2,000.00
14 - W6x12 Posts @ 6' long = 72 lb ea.	1,008	LB	$3.00	$3,024.00
Timber Lagging -	1,400	Bd. Ft	$5.00	$7,000.00
Install Piles	2	Day	$2,500.00	$5,000.00
Light Stone Fill	35	CY	$50.00	$1,750.00
Earthen Embankment-in-Place	100	CY	$60.00	$6,000.00
Seed & Mulch	1	LS	$250.00	$250.00
Plantings	8	LS	$400.00	$3,200.00
Topsoil	150	SY	$40.00	$6,000.00
Erosion & Sediment Control	1	LS	$1,500.00	$1,500.00
			Total Method C	**$35,724.00**
Method D - Pre-Cast Concrete Gravity Block				
Mobilization	1	LS	$2,000.00	$2,000.00
36x36x72 block, In-Place	18	Each	$300.00	$5,400.00
Light Stone Fill	20	CY	$50.00	$1,000.00
Site Prep	1	LS	$2,000.00	$2,000.00
Erosion & Sediment Control	1	LS	$1,500.00	$1,500.00
			Total Method D	***$11,900.00***
Annual Maintenance - All Options (Each) - (2 man-days+time on equipment)				**$1,300.00**
Engineering Design & Environmental Permitting (Each Site)				***$18,000.00***
AVERAGE PROJECT BUDGET, EACH SITE				***$40,524.50***

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[1] *Estimate is an opinion of probable construction costs based on approximate dimensions from the final design drawings.*

[2] *Assumes a mean length of dyke = 100'*

[3] *Assumes that the work of each site will not require a publicly bid contract*

[4] *Assumes that the average height of the dyke is 3.5'*

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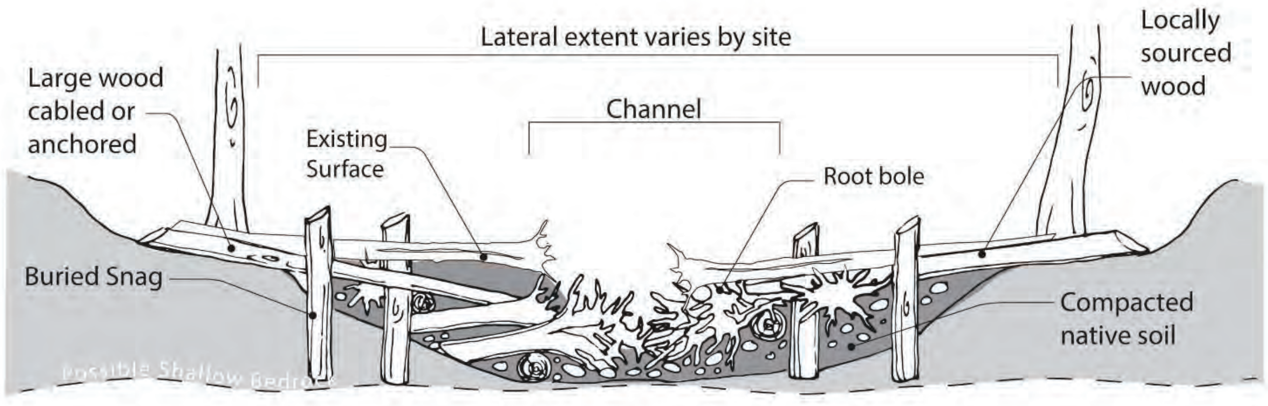
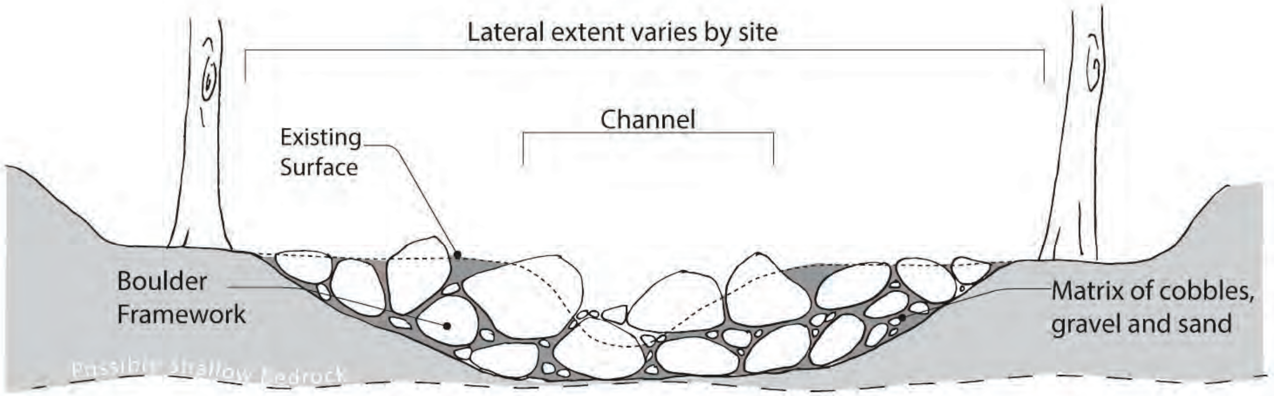
Interfluve Design 1



<u>2a- Large Wood Cross-Sections N.T.S.</u>
Replace native bed and bank material with large wood and root boles within a matrix of native soil

Concept 2. Option a: Measure to increase flood retention within wetlands on Bonesteel Creek using large wood

Interfluve Design 2

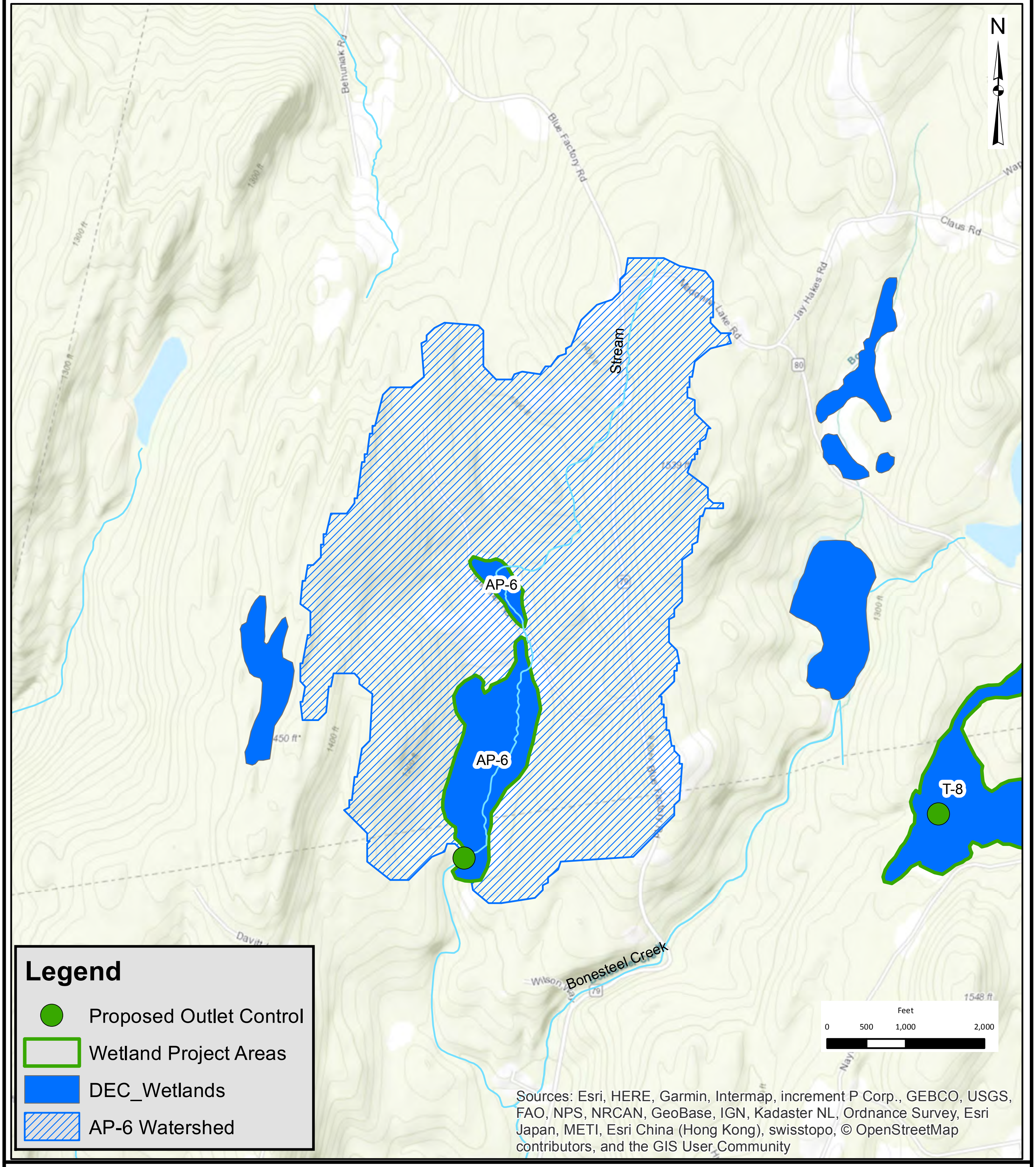


2b- Boulder Cross-section N.T.S.

Replace native bed and bank material with well-graded mixture of river rock, boulder and sand

Concept 3. Option b: Measure to increase flood retention within wetlands on Bonesteel Creek using rock

Appendix 5:



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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RPA Poesten Kill Flood Mitigation Study

AP-6 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
Date: 06/20/19
Scale: 1:20,000
Project: 41822.00
Figure: 1

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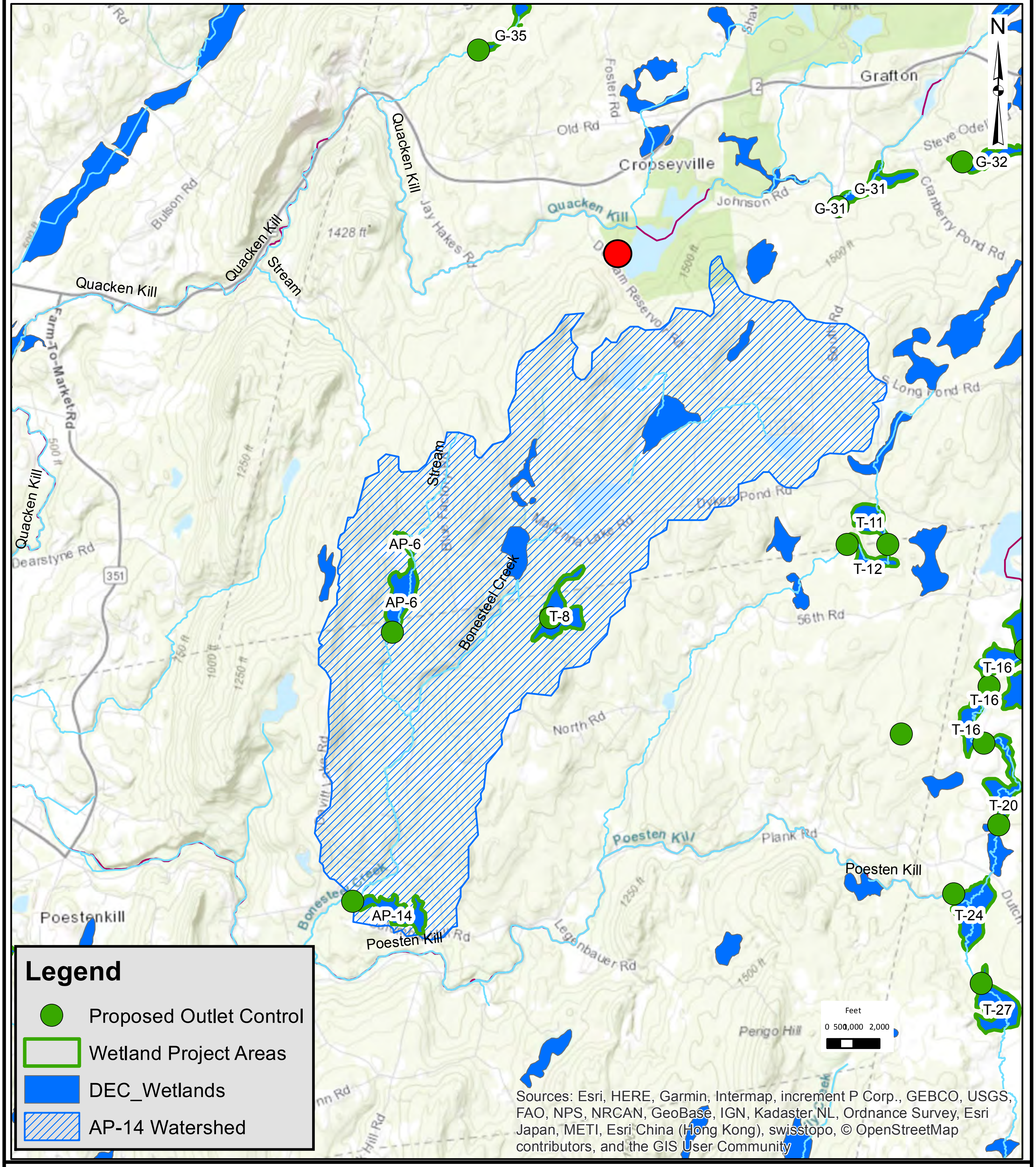

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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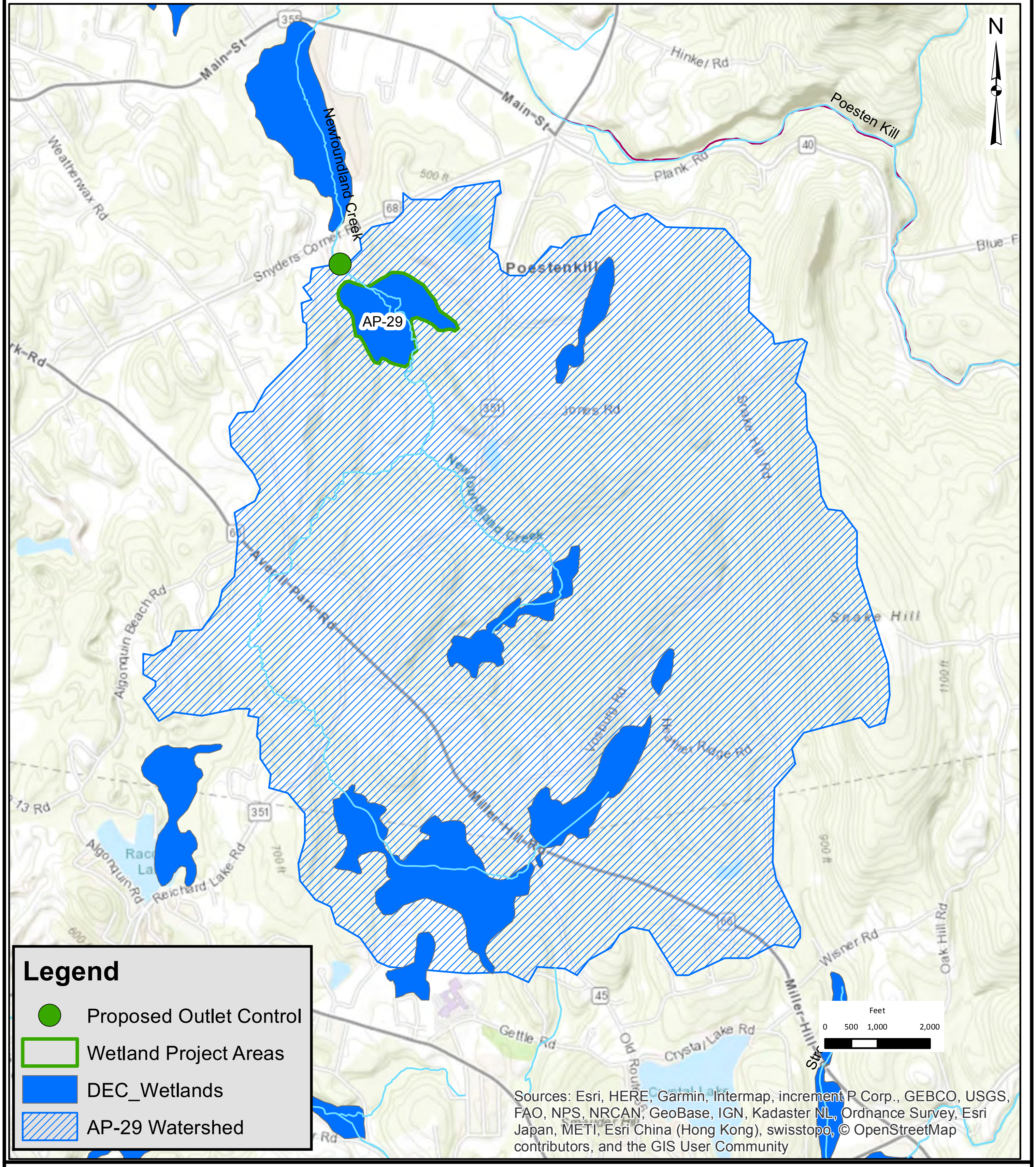
RPA Poesten Kill Flood Mitigation Study

AP-14 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
Date: 06/20/19
Scale: 1:60,000
Project: 41822.00
Figure: 1



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RPA Poesten Kill Flood Mitigation Study

AP-29 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn:	JLB
Date:	06/20/19
Scale:	1:30,000
Project:	41822.00
Figure:	1

Map Document: (R:\0\standards\Gis\ChazenGIS\8X11P_MinimalChazenAddress.mxt)
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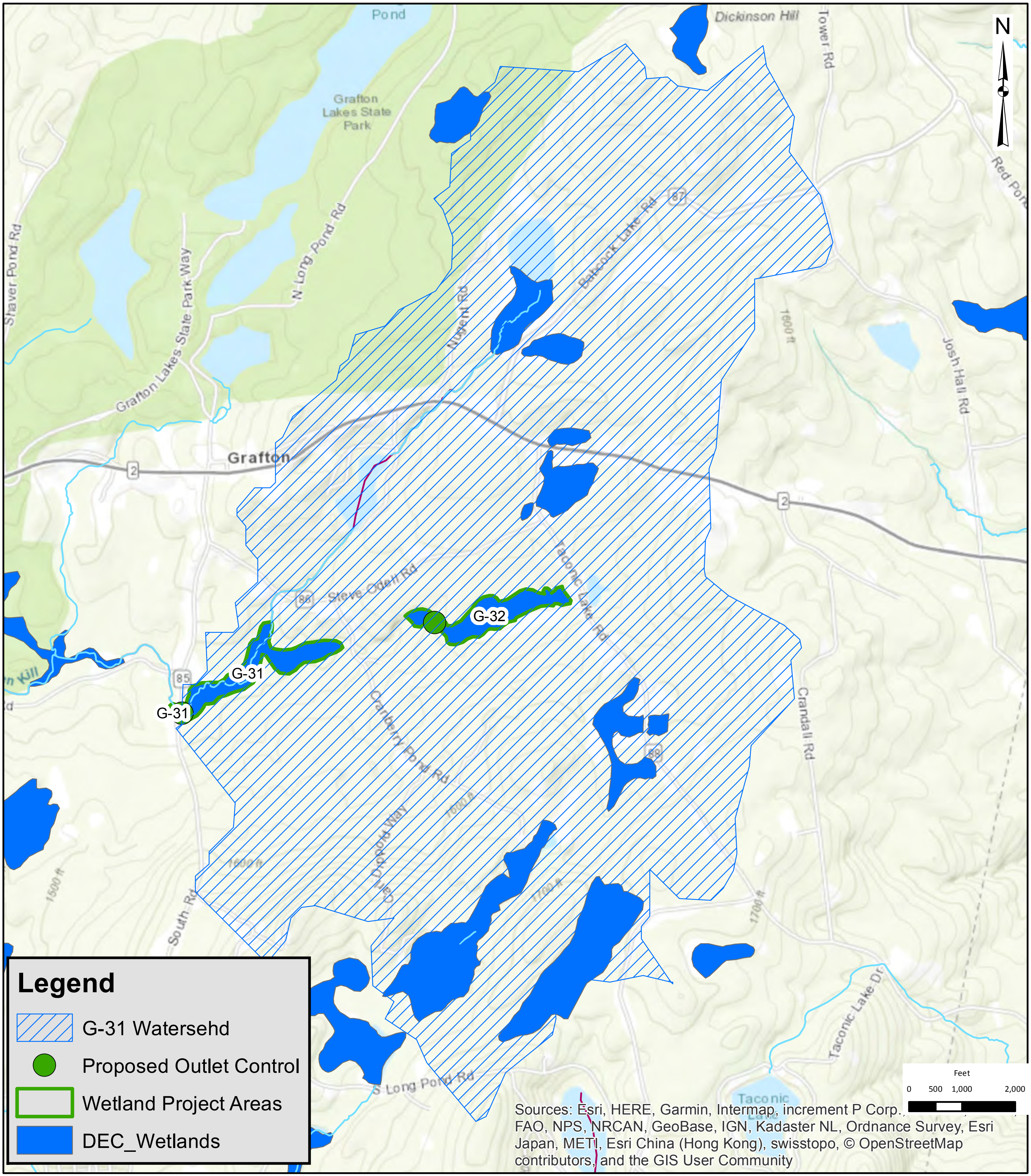

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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RPA Poesten Kill Flood Mitigation Study

Wetland G-31

Poesten Kill Watershed, Rensselaer County, New York

Drawn:	JLB
Date:	06/20/19
Scale:	1:30,000
Project:	41822.00
Figure:	1

Map Document: (R:\0\standards\Gis\ChazenGIS\8X11P_MinimalChazenAddress.mxt)
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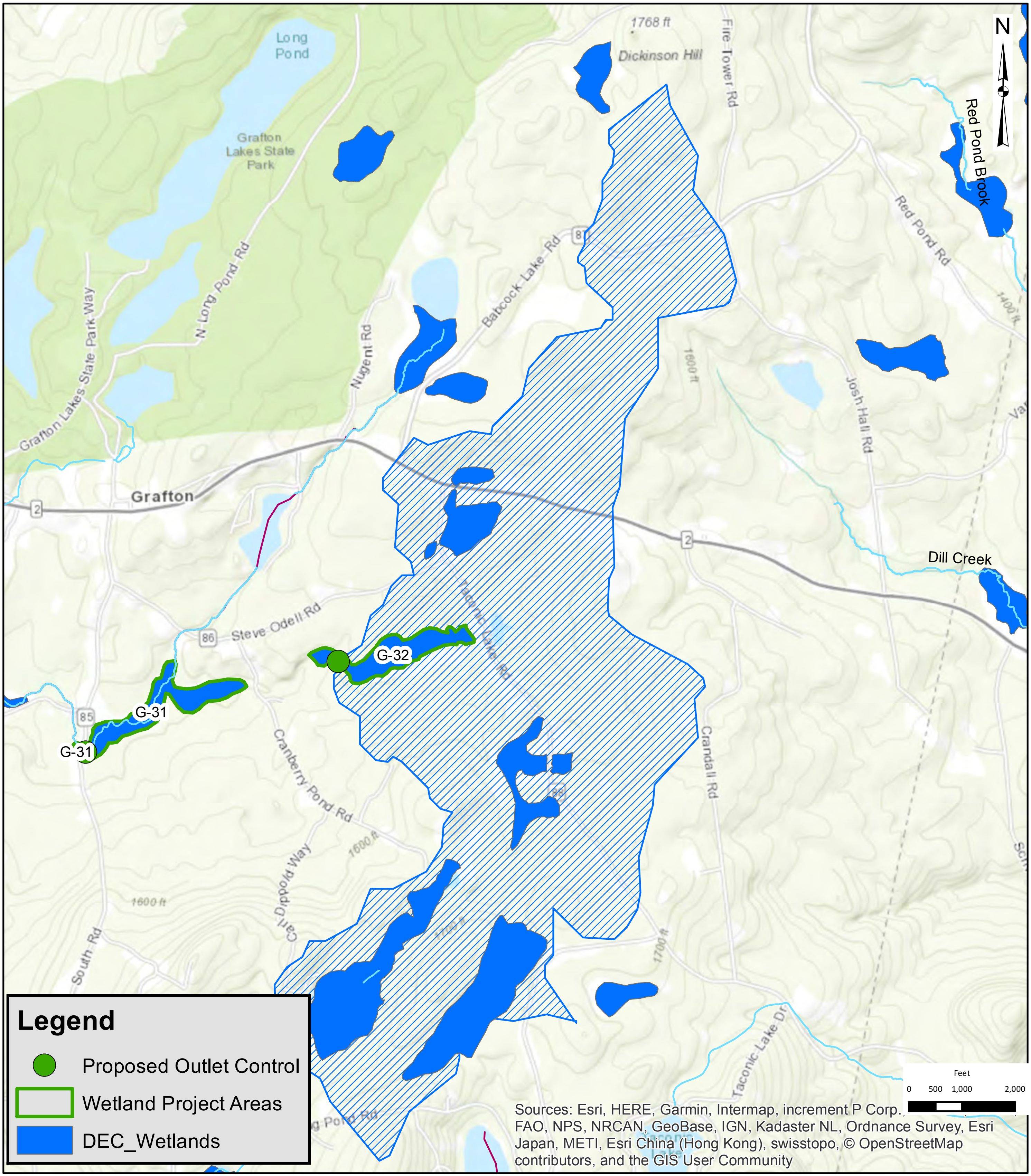

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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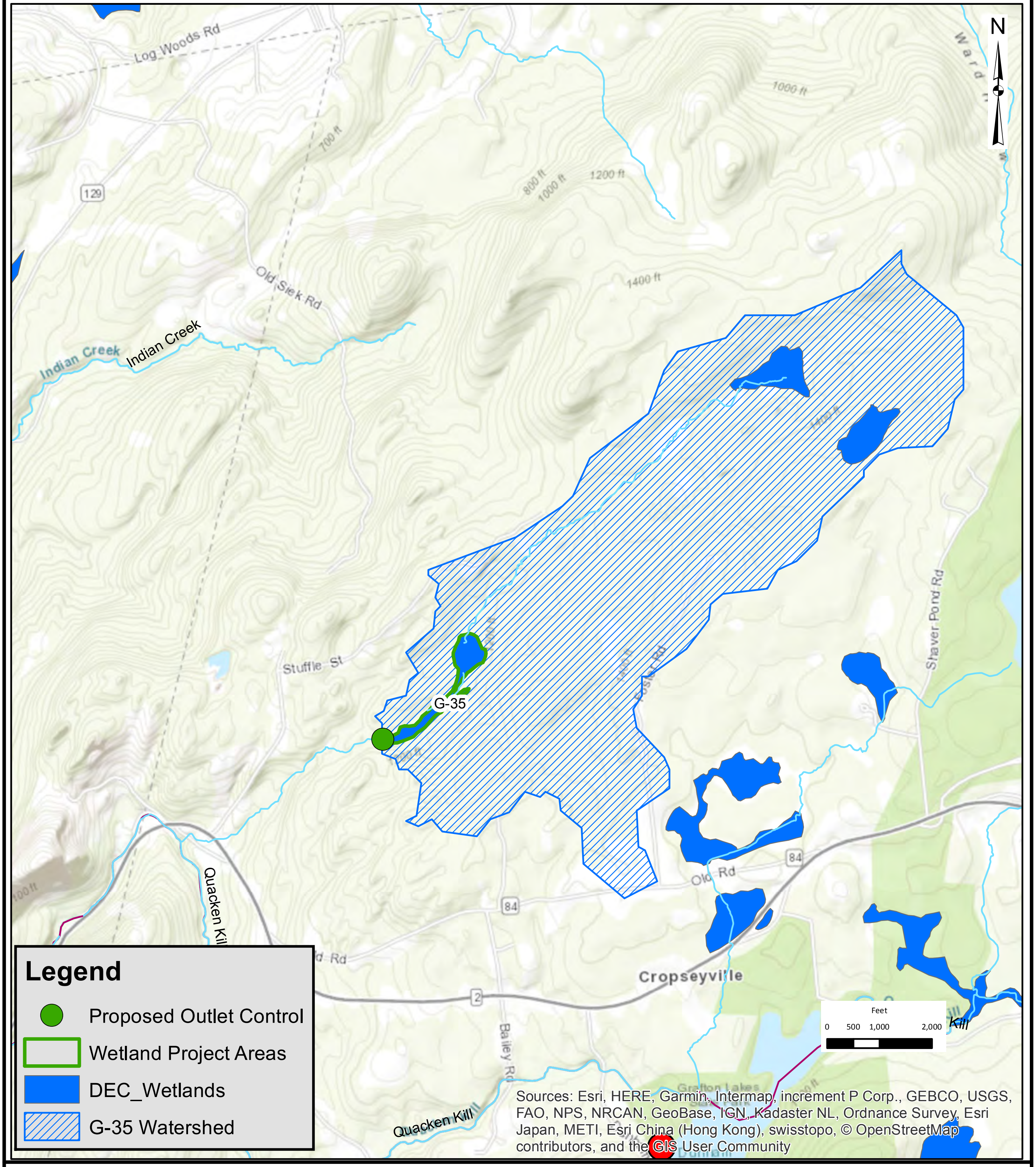
RPA Poesten Kill Flood Mitigation Study

Wetland G-32

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
Date: 06/20/19
Scale: 1:30,000
Project: 41822.00
Figure: 1



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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RPA Poesten Kill Flood Mitigation Study

G-35 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn:	JLB
Date:	06/20/19
Scale:	1:30,000
Project:	41822.00
Figure:	1

Map Document: (R:\0\standards\Gis\ChazenGIS\8X11P_MinimalChazenAddress.mxt)
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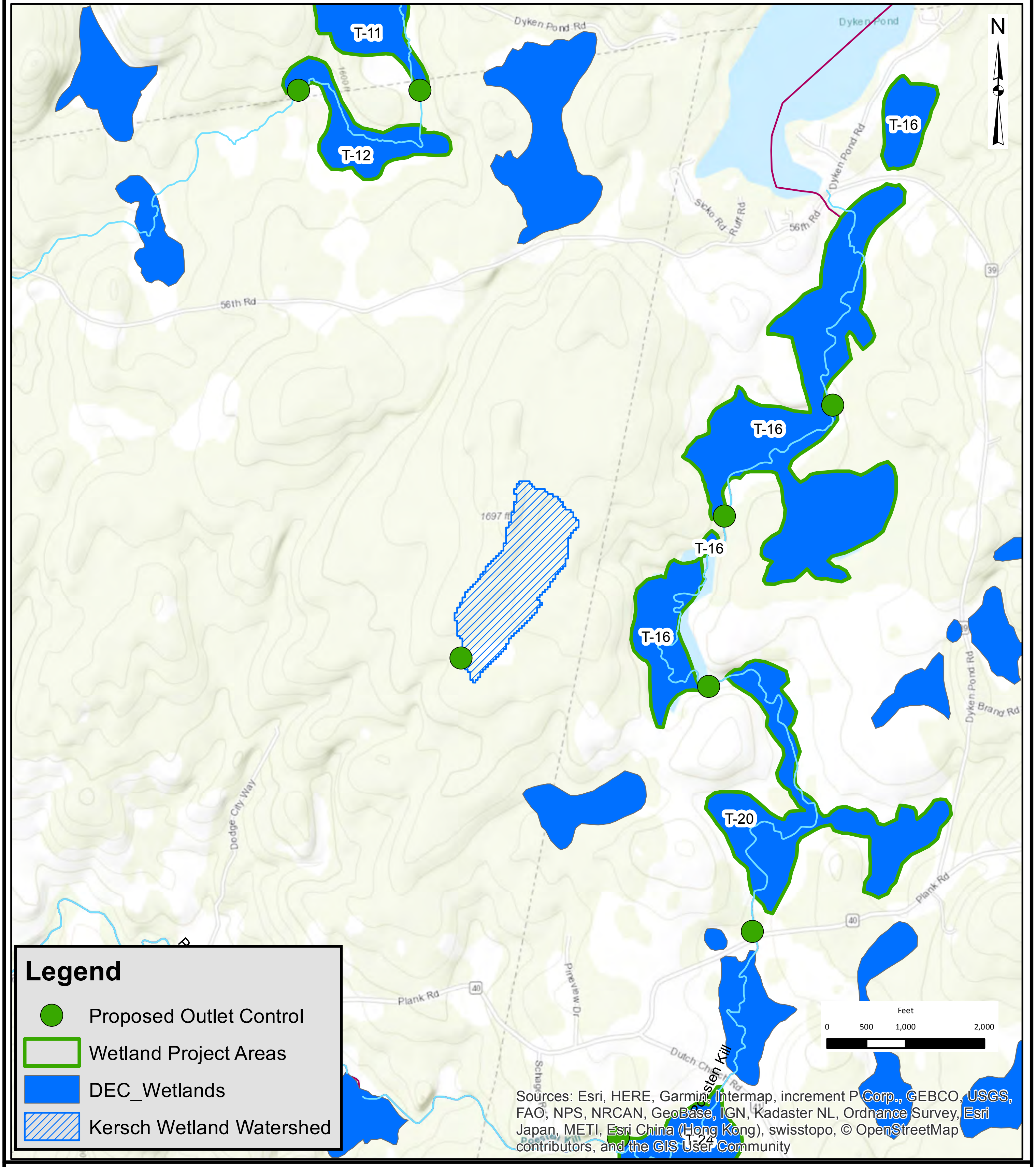

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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Kersch Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
Date: 06/20/19
Scale: 1:20,000
Project: 41822.00
Figure: 1

Map Document: (R:\0\standards\Gis\ChazenGIS\8X11P_MinimalChazenAddress.mxt)
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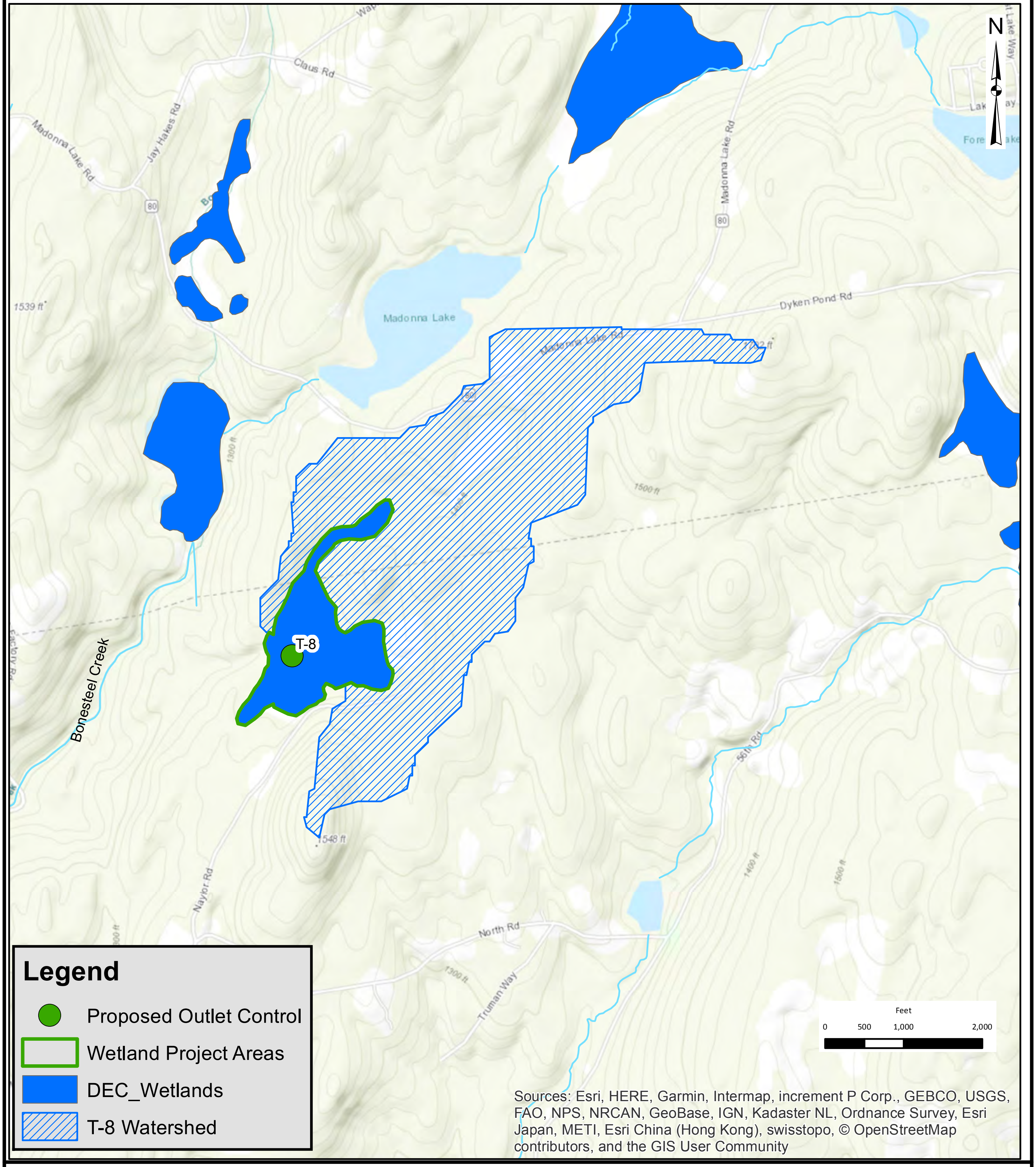

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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RPA Poesten Kill Flood Mitigation Study

T-8 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
Date: 06/20/19
Scale: 1:20,000
Project: 41822.00
Figure: 1

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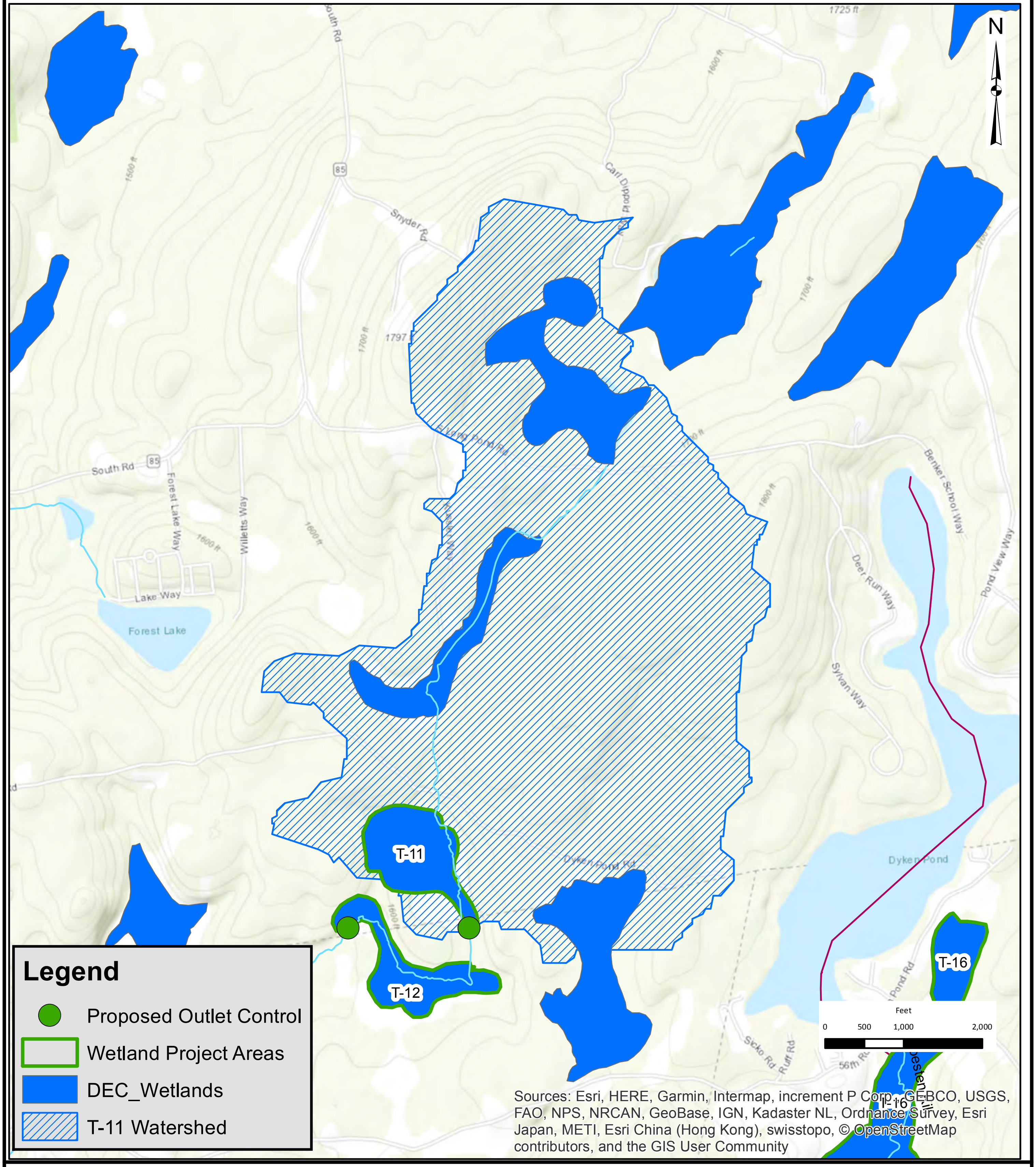

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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RPA Poesten Kill Flood Mitigation Study

T-11 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn:	JLB
Date:	06/20/19
Scale:	1:20,000
Project:	41822.00
Figure:	1

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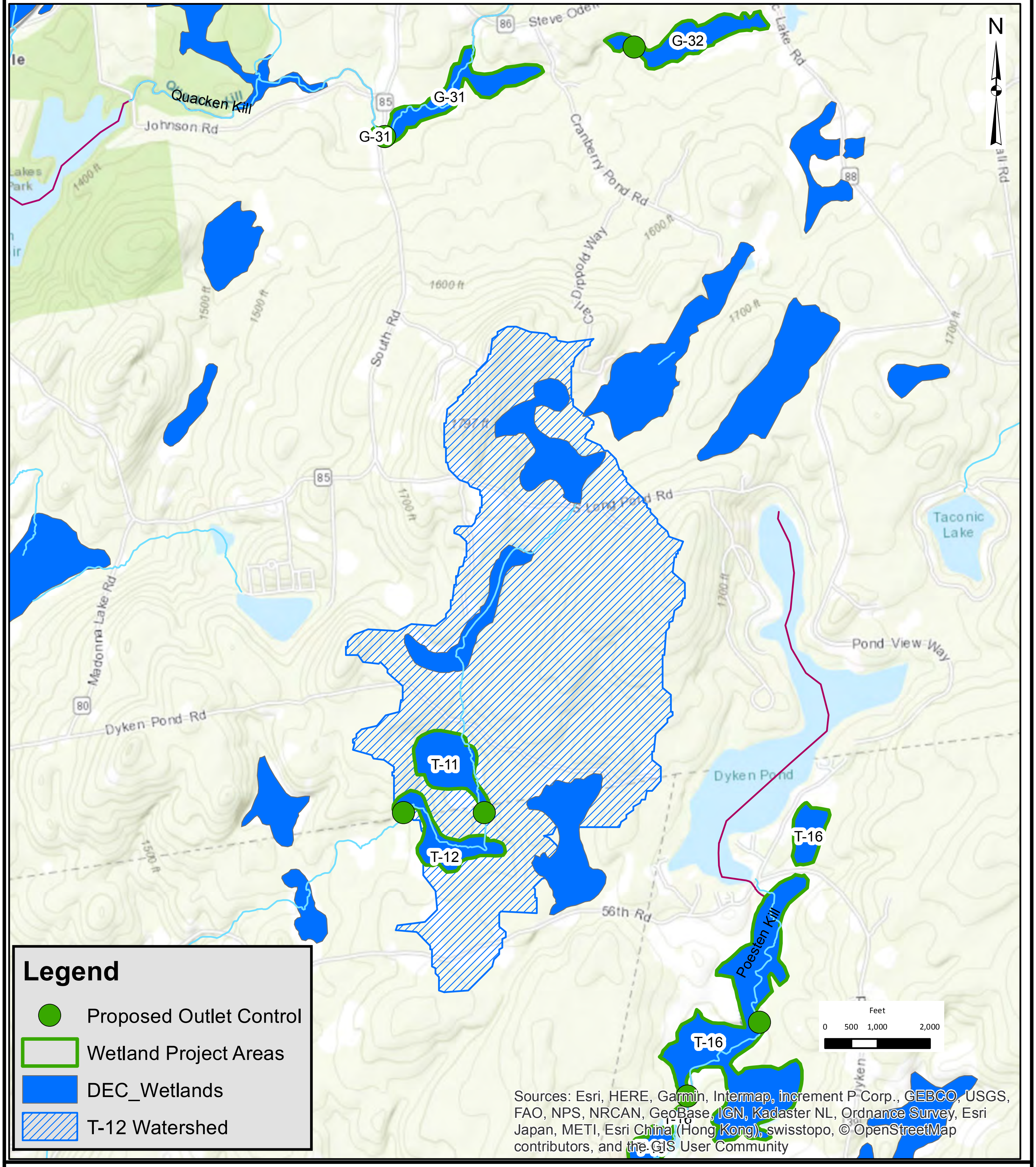

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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RPA Poesten Kill Flood Mitigation Study

T-12 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn:	JLB
Date:	06/20/19
Scale:	1:30,000
Project:	41822.00
Figure:	1

Map Document: (R:\0\standards\Gis\ChazenGIS\8X11P_MinimalChazenAddress.mxt)
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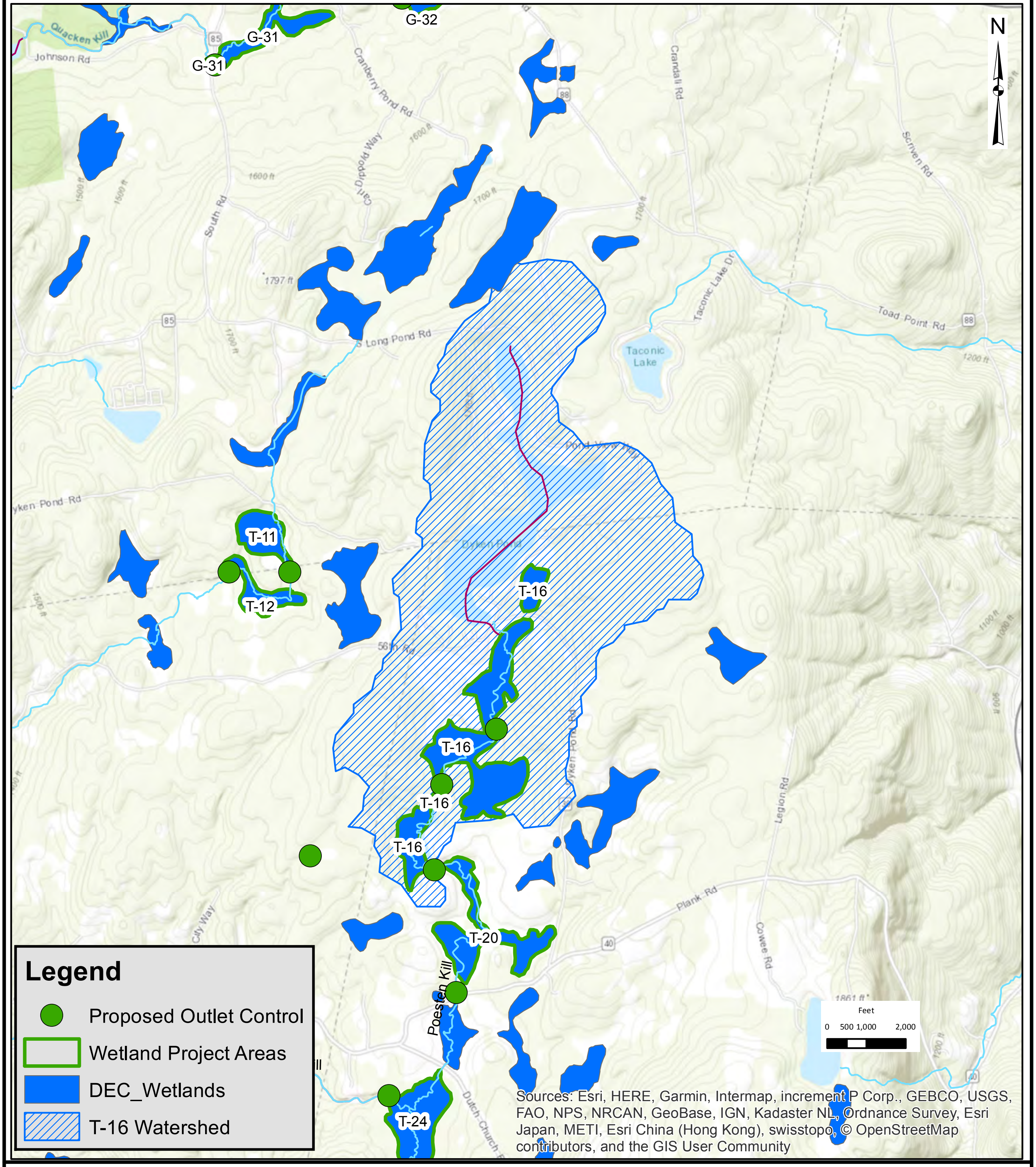

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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T-16 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
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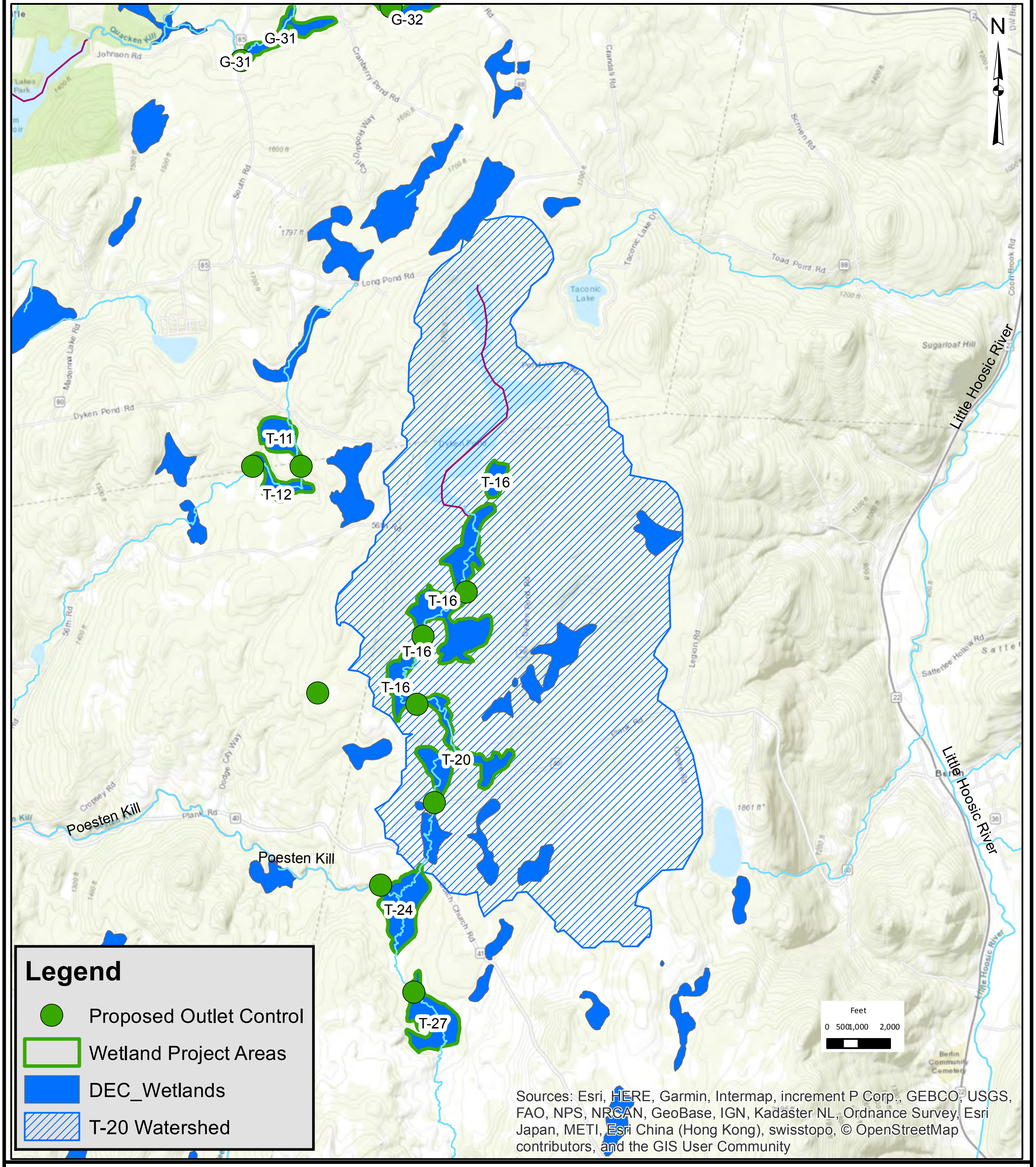

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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T-20 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
Date: 06/20/19
Scale: 1:50,000
Project: 41822.00
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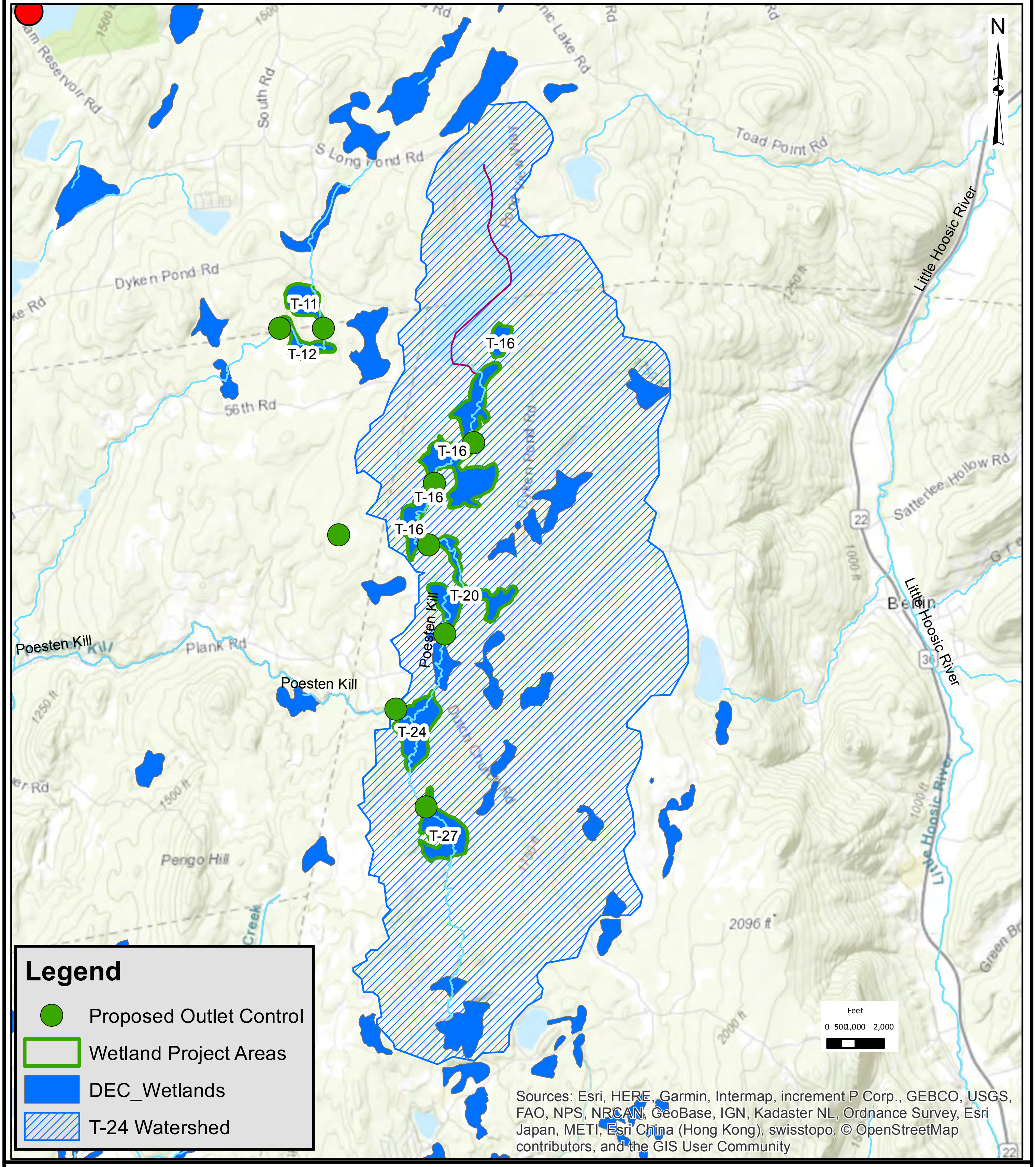

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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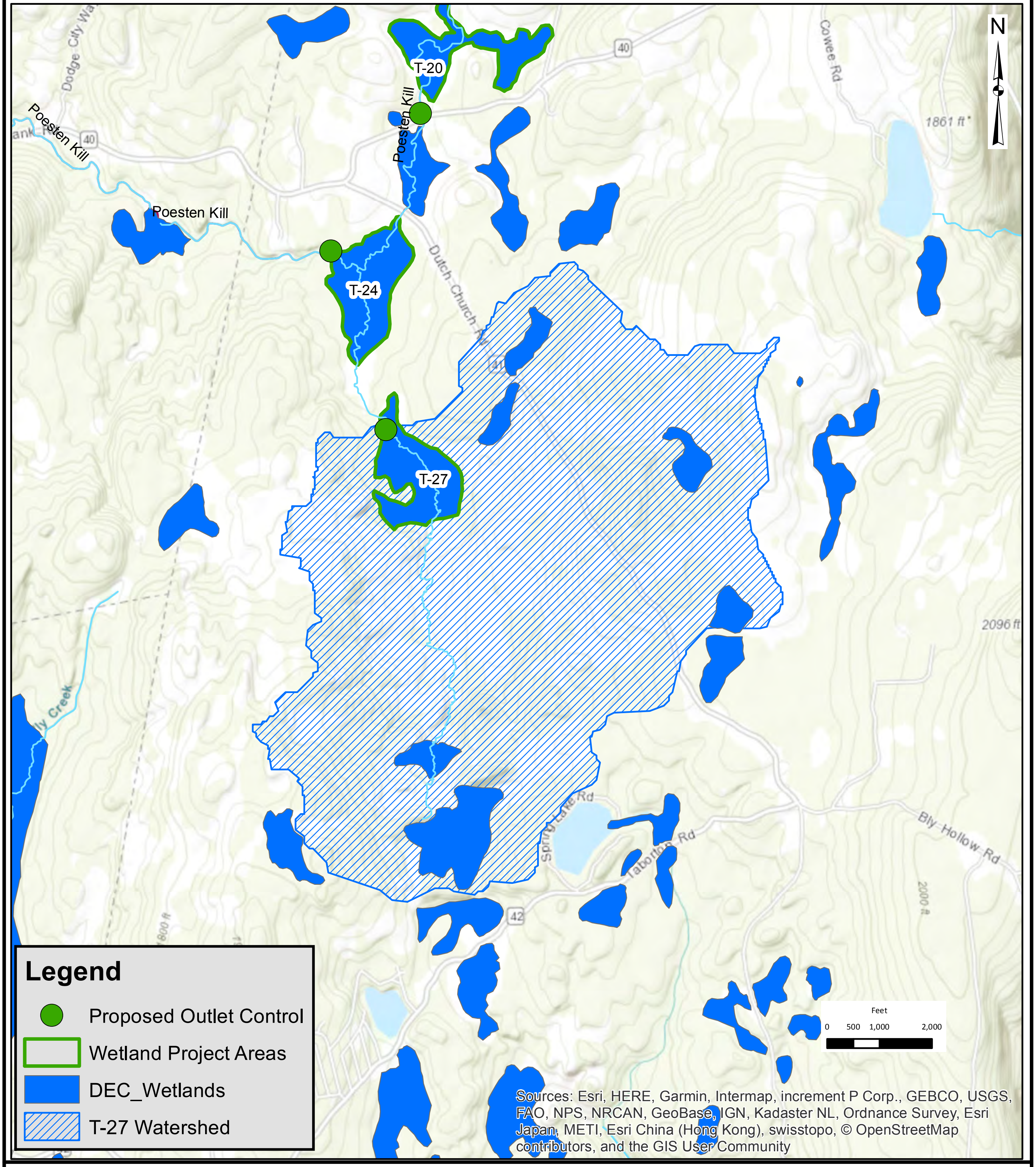
RPA Poesten Kill Flood Mitigation Study

T-24 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn:	JLB
Date:	06/20/19
Scale:	1:55,000
Project:	41822.00
Figure:	1



Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

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RPA Poesten Kill Flood Mitigation Study

T-27 Wetland

Poesten Kill Watershed, Rensselaer County, New York

Drawn: JLB
Date: 06/20/19
Scale: 1:30,000
Project: 41822.00
Figure: 1

Map Document: (R:\0\standards\Gis\ChazenGIS\8X11P_MinimalChazenAddress.mxt)
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Appendix 6:

Sign-in / Attendance Lists for RPA Poesten Kill Watershed Flood Management Project Meetings

A. June 28, 2018 sign in list
B. December 11, 2018 sign in list
C. April 24, 2019 attendance list
D. May 23, 2109 attendance list (NYSDEC and Chazen additional; not listed)
E. July 18? 2019 attendance list (to be added)

Name	Organization	phone	email
BOB CROWLEY	RENSSELAER LAND TRUST	518-283-7364	CROWLEY RH@AO Co
Sarah Parks	RPA	302-584-7748	sparks@ amalaconsulting.co
Jim Bonesteel	RPA	518-712-9211	jim@rensselaer plateau.org
Bob DAVIS	HOMEWATERS TROUT UNLIMITED	518-441-7306	rwdavis1979 e-w
Dorothy Surprise	Homewaters-trout unlimited	518-641-9660	Homewaterstu @gmail.com
INGRID GUNDRUM	SUPERVISOR TOWN of GRAFTON	518 788 5100	supervisor gundrum@ albany-twcbc com
Pat Poleto	ASSIST. TO SUPERVISOR TOWN of BRUNSWICK	518 279-3461	Poleto@TownofBRUNSWIC OR
Linda vonder Heide	Rensselaer County Planning	518-270 2921	LvonderHeide @rensco. co
Steve Strichman	CITY of TROY	518-279-7166	Steven.strichman troyny.gov @
Jeff Briggs	RPA	518-283-1926	jbriggs200@nycap rr.co
Megan Lung	Hudson River Estuary Program / NEIWPCC	845-633-5449	megan.lung@dec.ny.g
Candice Constantine	Inter-Fluve	617-909-7569	cconstantine@ interfluve.com
Russell Urban-Mead	Chazen	845 486 1551	rum@chazen companies.co
Jessica Brown	Chazen	(518) 266-7344	JBrown@chaze comp.co

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Conservation Through Community

Please Sign In (Please print clearly)

1	Name: Russell Urban-Mead How did you hear about us? email	☐ I want to stay in touch e-mail: rum@chazencompanies.com phone: 914 456 1995	Address: 284 Mills Cross Rd Staatsburg NY 12580
2	Name: Chris von Schilgen How did you hear about us? email	☐ I want to stay in touch e-mail: phone:	Address: 308 Dunham Rd Cropseyville, NY 12052
3	Name: Dan von Schilgen How did you hear about us? email	☐ I want to stay in touch e-mail: phone:	Address:
4	Name: Alene Onean How did you hear about us?	☒ I want to stay in touch e-mail: lene.onean@gmail.com phone: 3149102334	Address: 27 Holloway Ave All Park NY 12018
Committee 5	Name: MARK Russo How did you hear about us? via Mark Heffron / Friends of Ida lake	☒ I want to stay in touch e-mail: russomc@Gmail.com phone: 646-226-1201	Address: 12 Linden Ave Troy 12180
6	Name: Linda von der Heide How did you hear about us? Jim's e-mall	☐ I want to stay in touch e-mail: phone:	Address: 1600 Seventh Avenue Troy NY 12182
7	Name: Anasha Cummings How did you hear about us? Facebook	☑ I want to stay in touch e-mail: anasha.cummings@troyny.gov phone: (518) 406-8636	Address: 16 Hutton St. Troy NY 12180
8	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
9	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
10	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:

russomc@gmail.com

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2	Name: Jessica Brown How did you hear about us? Post card	☒ I want to stay in touch e-mail: Jbrown@chazencompanies.com phone: (518) 266-7344	Address: 547 River St. Troy, NY 12180
3	Name: Alicia Flint How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
4	Name: Amelia Flint How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
5	Name: Harold VanSlyke How did you hear about us? ?	☒ I want to stay in touch e-mail: vanslykebelt@gmail.com phone:	Address:
6	Name: Anthony Albano How did you hear about us? Post Card	☐ I want to stay in touch e-mail: phone:	Address:
7	Name: Tom RUSSELL How did you hear about us?	☒ I want to stay in touch e-mail: HOBIEYO@AOL.COM phone:	Address:
8	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
9	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
10	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:

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1	Name: MARCIA HOPPLE How did you hear about us? email	☐ I want to stay in touch e-mail: mhopple@nycap.rr.com phone: 518 283 5353	Address: 174 Hinheeka Poestenkill, NY 12140
2	Name: Robert Renee Kardelky How did you hear about us? Advertiser	☐ I want to stay in touch e-mail: Kardelky1@yahoo.com phone: (518) 326-3020	Address: 900 Plank Rd Averill Park NY 12018
3	Name: Robert Morrell How did you hear about us? Advertiser	☐ I want to stay in touch e-mail: phone:	Address:
4	Name: Walter Kersch How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
5	Name: Luke Raiter How did you hear about us? FaceBook	☐ I want to stay in touch e-mail: phone:	Address: 693 Ble Factory Rd Averill Park NY
6	Name: Dorothy Surprise How did you hear about us? email	☒ I want to stay in touch e-mail: QuiltBugtoo@gmail.com phone: 518.641.9660	Address: 39 McKinley Way Apt C9 Wynantskill, NY 12198
7	Name: Bob DAVIS How did you hear about us? email	☒ I want to stay in touch e-mail: RWDAVIS1979@gmail.com phone: 518-441-7306	Address: 486 N. Nassau Rd Averill Park, NY 12018
8	Name: ROBERT WAGNER How did you hear about us? BOB DAVISE	☐ I want to stay in touch e-mail: phone: 852 2836	Address: 79 GARFIELD RD POESTENKILL NY 12140
9	Name: Howie Cushing How did you hear about us? Advertsin	☐ I want to stay in touch e-mail: CCSHNG3@AOL.COM phone: 5186942961	Address: 96 JONES RD POESTENKILL N.Y. 12140
10	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:

Please Sign In (Please print clearly)

1	Name: Shari Gibbs How did you hear about us? RPA	☑ I want to stay in touch e-mail: sdgibbs66@gmail.com phone: 518 928·8877	Address: 287 Hidley Rd Wynantskill, NY 12198
2	Name: Dick Gibbs How did you hear about us? RPA	☑ I want to stay in touch e-mail: dickgibbshf@gmail.com phone: 518 225-7371	Address: " ↑
3	Name: Jeff Briggs How did you hear about us? RPA	☐ I want to stay in touch e-mail: jbriggs200@nycap.rr.com phone: (518) 283-1926	Address: 332 Weatherwax Rd Poestenkill, NY
4	Name: PAUL BARRINGER How did you hear about us? ADVERTISER	☐ I want to stay in touch e-mail: PBARRINGER@POESTENKILLNY.COM phone: 518 283-5100 X102	Address: 38 DAVIS DR POESTENKILL NY 12144
5	Name: Megan Lung How did you hear about us? NYS DEC	☑ I want to stay in touch e-mail: phone:	Address:
6	Name: A. Hohenstein How did you hear about us? friend	☐ I want to stay in touch e-mail: phone:	Address: Troy
7	Name: T. J. Kennedy How did you hear about us? Facebook	☒ I want to stay in touch e-mail: TKean56@gmail.com phone: 5184290489	Address: 235 Stow Ave Troy NY
8	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
9	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
10	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:

Please Sign In (Please print clearly)

1	Name: Nina de Waal Malefyt How did you hear about us? email	☐ I want to stay in touch e-mail: dewaalmalefyt@gmail.com phone:	Address: 5 Bayberry Circle Poestenkill
2	Name: Louise Wagner How did you hear about us? Mark	☐ I want to stay in touch e-mail: phone:	Address:
3	Name: KEITH WAGNER How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address: 185 GARFIELD RD POESTENKILL, NY 12140
4	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
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RPA Poesten Kill committee meeting, April 24, 2019

Attendees

- Jim Bonesteel, RPA
- Dan Morse, RPA
- Bob Davis (Trout Unlimited)
- Marcia Hopple, assisting with Poestenkill NRI update
- Jeff Briggs (RPA)
- Linda VonDerHeide (Rensselaer County)
- Jim de Waal Malefyt (RPA)
- Rob Morrell (DEC)
- Trevor Brady (DEC)
- Kristina Younger (Rensselaer Land Trust)
- Brian Buchanan (Hudson Estuary Program)
- Russell Urban-Mead, Chazen

entered 5/24/19 DM

Rensselaer Plateau Alliance
Conservation Through Community

Community Meeting - Poesten Kill Flood Mitigation Study - May 23, 2019

Please sign in (please print clearly) – thank you!

✓ 1	Name: Paul Barringer How did you hear about us?	☐ I want to stay in touch e-mail: pBARRINGER @ POESTENKILLNY.COM phone: 518 283-5100 x102	Address: 38 DAVIS DR. POESTENKILL NY 12140
✓ 2	Name: KIM HOPPER How did you hear about us?	☐ I want to stay in touch e-mail: kimhopper46@gmail.com phone:	Address: 32 Balsam Way Cropseyville, NY 12052
✓ 3	Name: JIM LENNON How did you hear about us?	☑ I want to stay in touch e-mail: jim.lenn49@GMAIL.COM phone:	Address: 41 BALSAM WAY CROPSEYVILLE NY 12052
✓ 4	Name: JUDE BUTLER How did you hear about us?	☐ I want to stay in touch e-mail: ROSS4JB@JUNO.COM phone: 518-283-1373	Address: 181 FIFTY-SIX RD AVERILL PARK 12018
✓ 5	Name: MARCIA HOPPLE How did you hear about us?	☐ I want to stay in touch e-mail: You have phone:	Address: You have
6	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
7	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
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entered 5/24/19 DM

Rensselaer Plateau Alliance
Conservation Through Community

Community Meeting - Poesten Kill Flood Mitigation Study - May 23, 2019

Please sign in (please print clearly) – thank you!

1	Name: Ray Morris How did you hear about us? e-mail	☐ I want to stay in touch e-mail: phone:	Address: Morris way & 4 Spring lanbin blvd. Wynantskill NY 12198
2	Name: Angela & Nick Petitti How did you hear about us? e-mail	☐ I want to stay in touch e-mail: apetitti@nycap.rr.com phone:	Address: 259 Madonna Lake Rd Cropseyville, NY 12052
3	Name: MIKE HOGAN How did you hear about us? BOB DAVIS	☑ I want to stay in touch e-mail: MMHFLP@ AOL. COM phone: 518 2793821	Address: 426 GARFIELD RD TROY NY 12180
4	Name: Bob DAVIS How did you hear about us? HOMEWATERS TU	☐ I want to stay in touch e-mail: phone:	Address: 486 NO. NASSAU RD. AVERILL PARK NY.
5	Name: Joe Auslander How did you hear about us? Home Waters TU	☒ I want to stay in touch e-mail: revphysherman@twc.com phone: 518-545-1771	Address: P.O. Box 388 West Sand Lake NY 12196
6	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
7	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
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entered 5/24/19 DM

Rensselaer Plateau Alliance
Conservation Through Community

Community Meeting - Poesten Kill Flood Mitigation Study - May 23, 2019

Please sign in (please print clearly) – thank you!

2	1	Name: Mofie How did you hear about us? Advertiser	☐ I want to stay in touch e-mail: GerryA597@aol.com phone:	Address:
✓	2	Name: Brant Card How did you hear about us? meetings	☐ I want to stay in touch e-mail: brantcard@msn.com phone: 209-8684	Address: 50 Pawling Ave Troy
✓	3	Name: Dorothy Surprise How did you hear about us?	☐ I want to stay in touch e-mail: QUILTBUGtoo@gmail.com phone:	Address: 39 McKinley WAY C9 Wynantskill, NY 12198
/	4	Name: MAtter Kersel How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
/	5	Name: Julia Cavicchi How did you hear about us? Garrett	☒ I want to stay in touch e-mail: jcavicch@skidmore.edu phone: 240-888-0209	Address:
	6	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
	7	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
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Rensselaer Plateau Alliance
Conservation Through Community

Community Meeting - Poesten Kill Flood Mitigation Study - May 23, 2019

Please sign in (please print clearly) – thank you!

1	Name: Chris von Schilgen How did you hear about us? e-mail	☐ I want to stay in touch e-mail: phone:	Address:
2	Name: Linda vonder Heide How did you hear about us? E-Mail	☐ I want to stay in touch e-mail: phone:	Address:
3	Name: Jeff Briggs How did you hear about us? word of mouth	☐ I want to stay in touch e-mail: phone: 283-1926	Address: Weatherwax Rd Poestenkill
4	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
5	Name: How did you hear about us?	☐ I want to stay in touch e-mail: phone:	Address:
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Appendix 7:

Meeting Summary

Project Title: Rensselaer Plateau Alliance – Posten Kill Watershed Green Design Flood Mgt.
Chazen Project Number: 41822.00

Meeting Date, Time: Friday February 1, 2019 at 1-2:30PM
Meeting Location: NYSDEC Region 4 Offices, with HREP staff participating by phone
Summary Writer: Barbara Beall
Issue Date: February 14, 2019

Attending:

Attendee:	Representing:
Jeff Briggs	Rensselaer Plateau Alliance (RPA)
Russell Urban-Mead	The Chazen Companies
Barbara Beall	The Chazen Companies
Andy Dangler	US Army Corps of Engineers Upstate Field Office
Kate Kornak	NYSDEC Region 4 Deputy Regional Permit Admin.
Derek Thorsland	NYSDEC Region 4 Water Quality/Stream Engineer
Tom Blanchard	NYSDEC Region 4 Floodplain Mgt. Dam Safety
Georgette Walters	NYSDEC Region 4 Wetland Permits
Trevor Brady	NYSDEC Region 4 Stream Permits
Scott Cuppett	HREP
Megan Lung	HREP

Summary:

Discussion

- Project Overview: Russell Urban-Mead began with a discussion of the project. Project is to explore options to manage the next big flood in the Posten Kill Watershed. Hurricane Irene beat the watershed up. Have a grant to study how landscape features might be used to management flood. There may be a dam/relocation function of the floodplain. The Rensselaer Plateau has a unique geography with 2,000 acres of wetlands at higher elevations in the floodplain. They are wetland areas generally constrained by an outlet that links by small streams in a forested landscape. Goal is to work with nature to provide greater detention and drain out time in order to desynchronize flooding. There is not a single wetland that can solve this problem. When the flow comes down the watershed, it becomes a much larger problem in Troy and downstream in the watershed when the Posten Kill jumps its banks and floods.

- Jeff Briggs and Rensselaer Plateau Alliance: Jeff lives in the watershed. He is a retired wetland professional. He is looking at a way to detain water in a wetland with sidewall control device. While retaining water in one wetland may not make a large difference, retaining water in a series of wetlands will likely make a large difference. Retaining water over 25 acres for a 25-year storm event made a 40% reduction in flows.

- Modeling to Date: One model was run using a wingwall constrained to a 25-year flood flow resulting in 3 to 4 days of inundation by a couple of feet. It is hoped that the there can be a series of these projects in the floodplain. This is a blue-sky discussion of whether this represents a possible solution to downstream flooding. Doing this on 12 wetlands would make a meaningful impact based on modeling. It could then become a repeatable cost-effective action that everyone understands from a permitting perspective. Model used Dyken Pond and NYSDEC Wetland T-16 as an example. Would use wingwalls at the downstream outlet of the wetland to narrow the outlet. There are existing steep sidewalls in this area. Would have the wingwall marry into the landscape. NYSDEC asked what about downstream flow over the temporary spillway. What does this mean to the stream downstream of the spillway. Jeff explained that at the Heckleman Site, the project is a sill on bedrock, and throughout most of the Bonesteel Creek, the wetlands outlet on a bedrock sill – most outlets of wetlands above 1,000 feet appear to be bedrock control features at stream outlet. Newfoundland Creek is a bit broader and flatter but may have a rocky bottom in the stream. NYSDEC concerned about anything that concentrates flow and causes downcutting in the channel. Explained that the outlet would be somewhere in the 2-foot tall detention wall, so there is not significant erosive threat. It was noted that at least around NYSDEC Wetland T-16, the land rises quickly from the wetland, so increased area of flooded land may not be that large.

- Non-Regulation by Dam Safety and Corps of Engineers: It is a shallow structure. It is not tall enough to be a “dam” under NYSDEC Dam Safety Regulations (dams are at 6 foot). Corps stated that if the structure is in uplands outside of any wetland area or any Ordinary High Water Mark (OHWM) of a stream, the activity is not regulated by the US Army Corps of Engineers. The OHWM typically/often forms around the 2-year flow line.

- Owner Permission: The RPA will need to have property owner’s permission for this work. Discussed the need to research the flooding limits under different scenarios to ensure that individuals upstream of the structure know that there may be a larger area of their property flooded at a lower storm interval to obtain permission for this work. There may be additional floodplain areas upstream of the weirs. FEMA or other agencies may need to evaluate downstream flood zones. Group recommended use of beaver pipes to keep beaver from enhancing dam aspect of weir following construction.

- NYSDEC Permits: Kate mentioned that there will be a need for Article 15 and Article 24 permits for this work (protected streams and Freshwater Wetlands). Landowner sign-off on permit applications. Need to ensure that there are no homes that would be impacted by inundation.

- Donation of Lands to NYS: Some of these lands may become the NYSDEC ownership as a result of conservation deeds to the State. There needs to be a discussion of maintenance requirements if the weirs and lands will ultimately be owned by the NYSDEC.

- Watersheds of Quacken Kill and Posten Kill Stem: Those have different watersheds, but during Hurricane Irene they peaked at the same time, with two flooding streams coming together creating a downstream super flood. This project may desynchronize the release of these two streams, reducing downstream damage. A lot of rain in one part of the overall Posten Kill Watershed versus in another part of the watershed has much different results on downstream flooding. They way they come together varies. In Hurricane Irene there was a "perfect storm" where everything broke loose.

- Unintended Consequences – Aquatic Fauna Movement: Scott Cuppett asked if this would result in unintended consequences or be detrimental to rock stabilization. Will the project funnel water into a narrow channel? Will the project create unintended barriers between different wetlands? There is the potential for the weir to serve as a deterrent to aquatic life movement. Identified Georgette Walters in Region 4 as someone to speak to. Chris Edmare also would be involved in reviewing potential impacts to Dyken Pond, the outlet trout stream and regulated wetland.

- Factors to be Reviewed in Permitting: Trevor is an Article 15 specialist. The following factors were identified for review in permitting a small model project:

  - Models – understand the flows upstream and downstream of the location.

  - Individual Group of Projects versus Whole Watershed - 95 square miles, 45 square miles 5% impoundment. There is a cumulative beneficial impact downstream from a group of projects. Any one project is insufficient to make a difference. Should there be a concentrated effort on 6 to 12 projects or

  - Local public interest benefit that outweighs detriment to wetland - If there is no great retention for flood abatement overall in the floodplain, what is the abatement. Should the project review more micro-scale benefits such as the downstream road which was blown out in Hurricane Irene during the flood event.

  - Blockage of Aquatic Organisms - Will the weir act as a debris trap? Will they encourage beaver to create a blockage to aquatic organism passage? Is there a way to raise the elevation to not block movement?

  - Custody - Who will evaluate, maintain, watch for barrier issues over the long-term.

  - Adjacent wetlands – In the surrounding upland woods, are there depressional wetlands that serve as vernal pools. Will those areas now be open for flooding and fish predation. Will some wetlands like that be stranded?

  - Grade Control/Scour protection/Changes in Wetland and Stream Function - Will there be a change in flow dynamics that could increase erosive factors at the weir. Would there be a head cut at the wetland? Need to identify if there will be changes in wetland functions from an increased frequency/duration of flooding? Is the substrate bedrock or soil? Is there a need for erosion control?

- Article 15 (Stream Disturbance) Permitting Standards: Reasonable and necessary. Will the project meet the standard if there is a subset of mitigation areas versus all the mitigation areas?

- Article 24 Freshwater Wetland) Permitting Standards: Under the Uniform Procedures Act, this would be a major project. Would need to review and issue permits in 60 days or so. Loot at the entire project in global scope or pieces at time. Will the permits be issued for a long-enough time frame to allow them to be constructed? Need to look at Posten Kill benefits versus Troy benefits. Georgette on Article 24"

    - Not a typical project.

    - Open-minded with all questions.

    - Trevor agreed. Modeling to understand S&E issues

    - Regulatory standpoint – Will this increase effluent in wetlands. Will the flood retention modify the Dissolved Oxygen in streams? Is there a difference between a natural and an enhanced function? Is there aquatic organism impediment issues? Provide enough information to analyze.

    - Trevor stated that frequency of storm events helpful to have so one can make a reasonable prediction of how often the weir structure will be activated. Will it be every 25 years or 4x/year? Historical data for frequency of storms.

    - Russell asked if the concept for a 100 year to a 25-year storm flows – if we modify 25-year flows, don't see impacts, increase to 50- or 100-year events. It is still a huge benefit. Model to find out storm events and what happens. Use in a pragmatic way. Make sure you are evaluating the migratory corridors not just in the stream but in the areas of the weir.

    - Megan Lung stated not opposed to effluent into wetland due to dissipation factors up to a 50-year storm. Look at the benefit of a multi-factor hydraulic model.

- Discuss maybe modeling one system, where there is a good handle on existing conditions, look at storm events, sediment load on wetlands, cuts in stream channel, vegetation dying back? Model and implement one system and watch what happens. Have the first project be a demonstration project.

Meeting adjourned (2:15 PM)

From: Brady, Trevor M (DEC) [mailto:trevor.brady@dec.ny.gov]
Sent: Monday, May 06, 2019 8:16 AM
To: Jim Bonesteel <jim@rensselaerplateau.org>
Cc: Jacobson, Roy (DEC) <roy.jacobson@dec.ny.gov>
Subject: Rensselaer Plateau Alliance Meeting

Hi Jim,

Thank you for providing me with the opportunity to attend the April 24, 2019 meeting of the Poesten Kill Watershed Flood Mitigation Committee. To recap, the purpose of the meeting was to discuss the Poesten Kill Watershed Flood Mitigation projects currently under evaluation by Chazen Companies and the Renssalaer Plateau Alliance. As I stated during the meeting the Region 4 Bureau of Ecosystem Health's (R4 BEH) role in this process will be to provide regulatory review if, and when the projects reach the application for permit stage. Currently, Chazen Companies has identified 15 unique potential locations for the proposed "dry dam" flood retention devices. The identified locations are situated within multiple New York State Department of Environmental Conservation protected resources including 13 Fresh Water Wetlands and multiple Protected Streams. The R4 BEH has not to date received any official application materials or preliminary plans for review. As such, The R4 BEH has not developed any opinion on the potential benefit or impacts of the proposed devices.

During the meeting I also reiterated (originally detailed during the February 1, 2019 pre-application meeting) some of the elements that the R4 BEH would be looking for in any eventual application packet for one of these projects. These include:

What alternatives to the proposed project were evaluated, and the outcome.

A description of the anticipated benefit of each of these structures.

Hydraulic/Sediment Modeling that demonstrates and predicts the before and after conditions of the stream (upstream and downstream) and wetland in relation to the addition of the flood retention devices.

Flood frequency data and the anticipated frequency and duration of artificial retention of flood waters.

Predictive Inundation Mapping which demonstrates what level of flood abatement will be achieved through the addition of the devices.

Evaluate and describe the need for grade control near the proposed "dry dams".

“Dry Dam’ inspection and maintenance methods and schedules.

Please understand that this list is by no means exhaustive and the review process may likely identify the need for more details. Thank you again for the opportunity to discuss these details in person. Please don’t hesitate to contact the Region 4 Bureau of Ecosystem Health with any questions or concerns that you may have.

Trevor Brady
Biologist 1 (Ecology)

New York State Department of Environmental Conservation
65561 State Highway 10 Stamford NY 12167-9503
P: 607-652-2524 | F: 607-652-2342| trevor.brady@dec.ny.gov

www.dec.ny.gov | |

Appendix 8:

Benefit Cost Ratios
Poesten Kill Flood Management Strategies

			Proposed Project		Protective Benefit if Project is Constructed		BCR
			Project	Cost	Description	Benefit*	
Poesten Kill Creek	Quacken Kill	Upper Quacken Kill	Manage Dunham Reservoir with pre-storm drawdowns	$20,000	Downstream peak flood control protects Route 2, socccer fields, and two bridges in Brunswick	$3,000,000	**150**
			Outlet Control, Wetland G-31	$40,000	Reduces flow into Dunham Reservoir, protects 2 local culverts, a few homes, & Brunswick benefits	$3,250,000	**81.25**
			Outlet Control, Wetland G-32	$40,000	Reduces flow into Dunham Reservoir, protects 1 local culvert, a few homes, & Brunswick benefits	$3,250,000	**81.25**
		Quacken Kill on Escarpment	Outlet Control, Wetland G-35	$40,000	Reduces stress on Route 2 culvert, at Stuffle Street	$500,000	**12.5**
			Detailed study of Route 2/Suffle Road culvert and G-35 for resilience	$50,000	May demonstrate that Route 2 culvert is stable, with or without needing G-35 outlet control	$500,000	**10**
			Replace Route 2 culvert at Stuffle, Grafton	$500,000	Larger culvert would prevent a future unexpected failure. This work may be unnecesary based on detailed study and/or an outlet control on G-35.	$500,000	**1**
			Install series of culverts on South Road, Brunswick	$150,000	Limits flooding on South Road and restores overland flow to a wetland area	$150,000	**1**
		Lower Quacken Kil	Remove Soccerfield berms, Brunswick	$100,000	Allows natural stream flow but exposes soccer field to debris damage	-$200,000	**-2**
			Increase span on Dearstyne Rd Bridge, Brunswick	$1,000,000	protects this bridge during a future storm	$1,000,000	**1**
			Increase span on White Church Road, Brunswick	$1,000,000	protects this bridge during a future storm	$1,000,000	**1**
	Upper Poesten Kill	Newfoundland Creek	Outlet Control, Wetland AP-29	$40,000	Protects road culverts and reduces flooding near Rensselaer County Airport and Route 355	$500,000	**12.5**
			Streambed Restoration for prioritized 3,000 linear feet, Poestenkill	$900,000	Stabilizes sediment and restore ecological value in priority reaches	$900,000	**1**
			Outlet Control, Kersch Property	$15,000	Pilot test of small Wetland Outlet Control Structure, NWI wetland, so no NYSDEC permits neeeded	$15,000	**1**
			Protect select structures in Poestenkill with berms or buyouts	$500,000	Facilitates flood zone and protects structures and occupants	$500,000	**1**
		Bonesteel Creek	Outlet Control, Wetland AP-6	$40,000	Protects property and culverts along Blue Factory Hill Road, and improves benefit of AP-14 control	$80,000	**2**
			Outlet Control, Wetland T-8	$40,000	Protects property and culverts along Blue Factory Hill Road, and arrests peak flow entering AP-14	$80,000	**2**
			Outlet Control, Wetland AP-14	$40,000	Arrests Peak flow entering the Poesten Kill just above Poestenkill, limiting stream and property damage. Benefit greater with AP-6 and T-8 controls	$2,500,000	**62.5**
		Potter Creek	Outlet Control, Wetland T-11	$40,000	Reduces peak storm flows on 56 Road and North Road culverts	$500,000	**12.5**
			Outlet Control, Wetland T-12	$40,000	Reduces peak storm flows on 45 Road culvert	$500,000	**12.5**
			Upsize North Road Culverts, Poestenkill	$300,000	Avoid future culvert failure, work likely unnecessary if T-11 and T-12 flood peaks are managed.	$300,000	**1**
			Upsize Fifty Six Road Culvert, Poestenkill	$300,000	Avoid future culvert failure, , work likely unnecessary if T-11 and T-12 flood peaks are managed.	$300,000	**1**
		Poesten Kill Eastern headwaters	Outlet Controls, Wetland T-16 (warrants 3 control installs)	$100,000	Reduce flow leaving Dyken Pond protecting both Plank Road and Dutch Church Road culverts, and properties and Poesten Kill along Plank Road	$1,000,000	**10**
			Outlet Controls, Wetland T-20	$40,000	Reduce flow leaving Dyken Pond protecting both Plank Road and Dutch Church Road culverts, and properties and Poesten Kill along Plank Road. Works best with T-16.	$1,000,000	**25**
			Outlet Control, Wetland T-24	$40,000	Reduce flow flooding properties along Plank Road, works best with T-16, 20, and 27	$1,000,000	**25**
			Outlet Control, Wetland T-27	$40,000	Reduce flooded properties along Plank Road approaching Poestenkill, works best with T-24	$1,000,000	**25**
			Monitor McChesney Ext. Slope Erosion	$15,000	Annual monitoring may suggest mitigation is not needed	$1,500,000	**100**
			Mitigate McChesney Ext. Slope Erosion	$1,500,000	benching and stream redirection to stabilize slope	$1,500,000	**1**

A project is considered cost-effective when the BCR is 1.0 or greater

* most benefit estimates reflect alleviated future storm damage costs

Chazen Companies
July 3, 2019