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Qualitative and Comparative Analysis of Stormwater management in the Tan Brook Watershed

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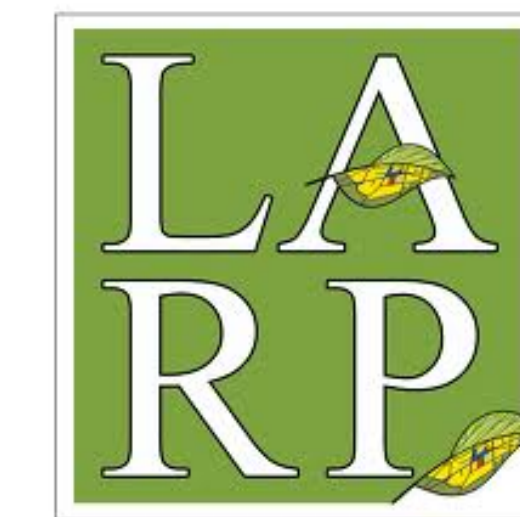
Abstract

The Tan Brook Watershed is both a daylighted and diverted underground stream that runs through the Town Center of Amherst and the campus of UMass Amherst. Various stormwater management practices have been used to infiltrate stormwater runoff from streets, lots, buildings and/or vehicles. These systems are custom-designed relative to the surrounding permeability of the soil, vegetation and geographical topography. Some systems have higher success rates than others.

Objective of Research

- Evaluate the sites where it is daylighted and analyze success/failure rate.
- Compare different types of sites (Residential, Institutional and Public)
- Produce resourceful maps and information for future analysis and beginning processes of rehabilitation.
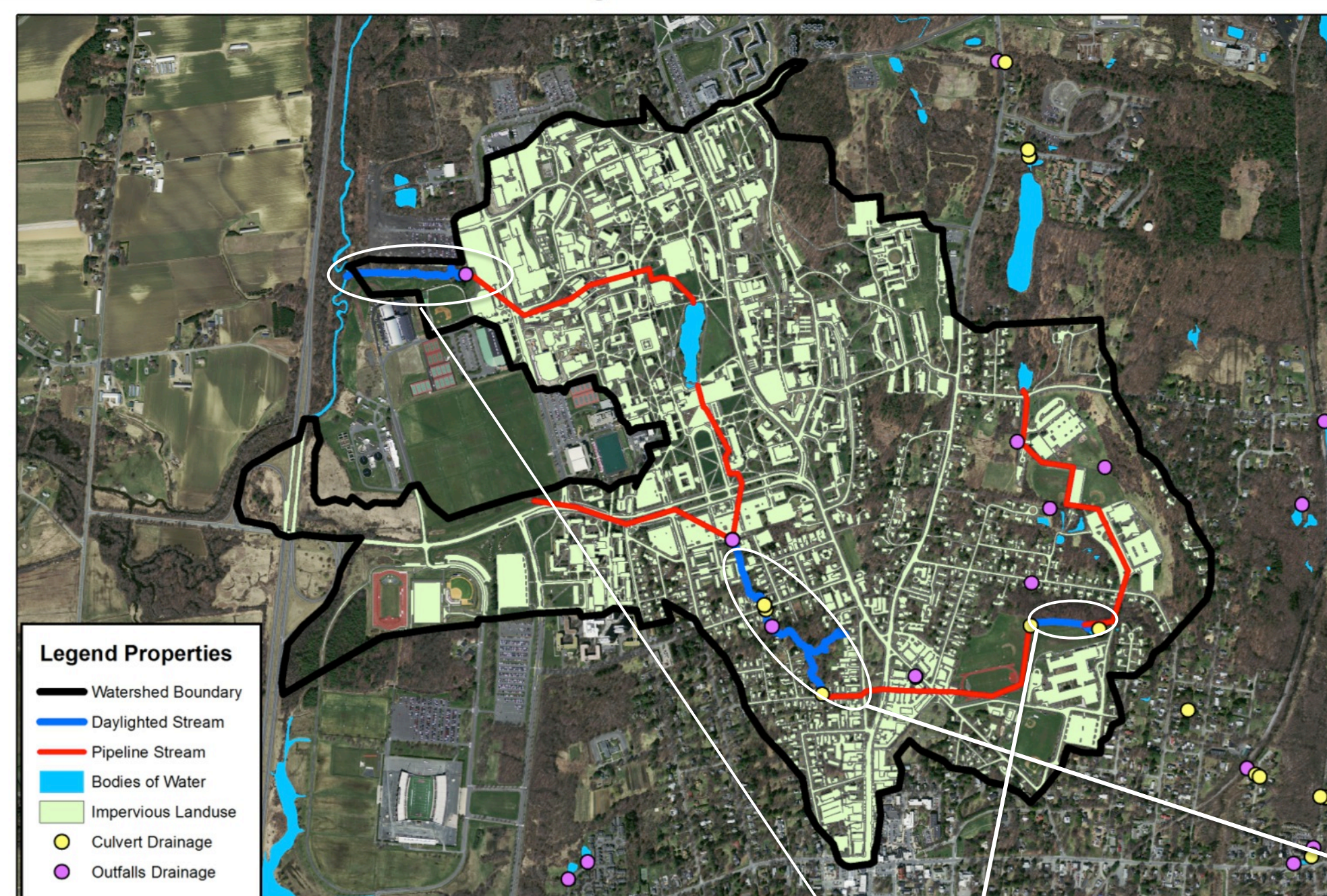
Methods

- Three different types of land use sites were chosen to analyze
  - Residential, Institutional and Recreational
- Used GIS Software to produce informative maps
- On field analysis of water flow, presence of pollution, buffer zones, run-off, wildlife, vegetation, erosion, and/ or infiltration systems
- Drew additional information from past thesis projects, scholarly articles, journals and case studies.

References

- Bernhardt, Emily S., and Margaret A. Palmer. "Restoring Streams in an Urbanizing World." *Freshwater Biology* 52.4 (2007): 738-51. Print.
- Palmer, Margaret A., Richard F. Ambrose, and N. Leroy Poff. "Ecological Theory and Community Restoration Ecology." *Restoration Ecology* 5.4 (1997): 291-300. Print.
- Palmer, M.a., E.s. Bernhardt, J. D. Allan, P.s. Lake, G. Alexander, S. Brooks, J. Carr, S. Clayton, C. N. Dahm, J. Follstad Shah, D. L. Galat, S. G. Loss, P. Goodwin, D.d. Hart, B. Hassett, R. Jenkinson, G.m. Kondolf, R. Lave, J.l. Meyer, T.k. O'donnell, L. Pagano, and E. Sudduth. "Standards for Ecologically Successful River Restoration." *Journal of Applied Ecology* 42.2 (2005): 208-17. Print.

Recreational Site

Conclusions

- Stream restoration would be ideal, but not necessarily possible. There is an abundant amount of development surrounding, on top of and even underneath the stream for it to ever be completely restored.
- Annual or monthly clean ups through UMASS student organizations or ARHS clubs would be a great way to expand on the awareness of the Tan Brook but also its necessity to the community.
- Increasing infiltration systems, storm water management, trenches or swales would supplement the quality of the stream.
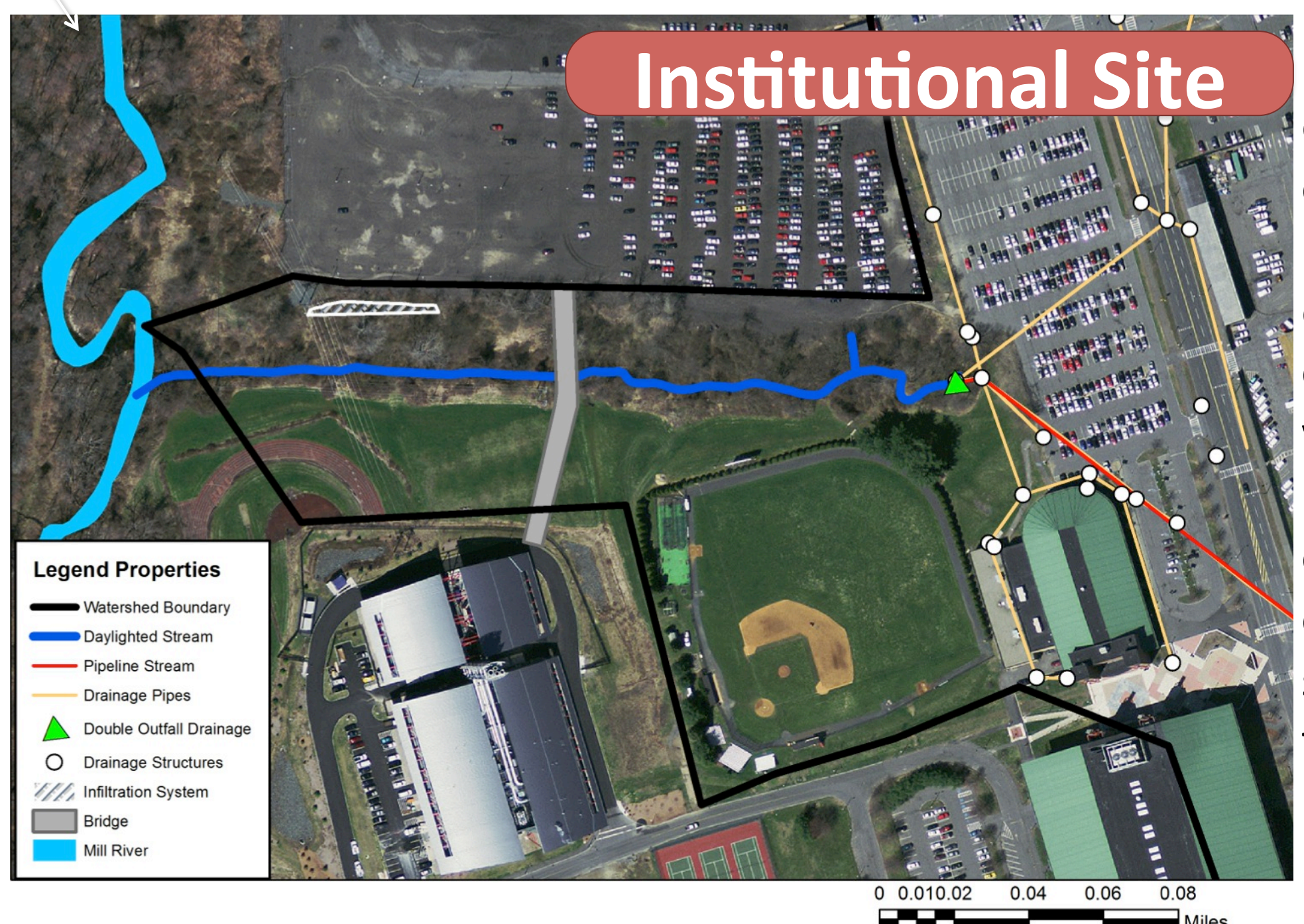
Observations

The recreational site is located between Amherst Middle and High School, it had the most gradual velocity of water flow, was also extremely visible from ground plain and had swampy and wetland wildlife, such as skunk cabbage. Surrounding land was notably over flooding in a meandering form going a distance up to 30+ feet from the direct stream. Over flooding is a result of the rapid snow melt and heavy rainfall preceding the on field research. High levels of pollution, most likely from nearby visiting Amherst High School Students. Retention pond incorporates four visible culvert drainage pipes and is fenced off.

The residential site researched begins on McClellan Street and ends at the Visitors Parking lot on the Umass Amherst Campus. The velocity and volume of the stream were the greatest of all the three. The stream ranged from 7'- 4' from the ground plain. Cement and rip rap erosion control systems are being implemented right at the site where the stream becomes daylighted. High levels of erosion as the streams meanders through the residential site, numerous trees fallen over and others on the verge of toppling over. Pool-riffle effect filters the stream throughout residential neighborhoods. Significant amount of litter, especially after snowmelt. The wildlife surrounding the stream is weedy and lifeless, since the swamp is below the ground plain. There is direct sites of run off from Fearing street into the stream, without any stormwater management system. Divergent drainage system separates the stream into two pipelined courses; one directed towards the campus pond and the other towards the sports fields by Mullins Center where erosion issues have arisen where swales have collapsed.
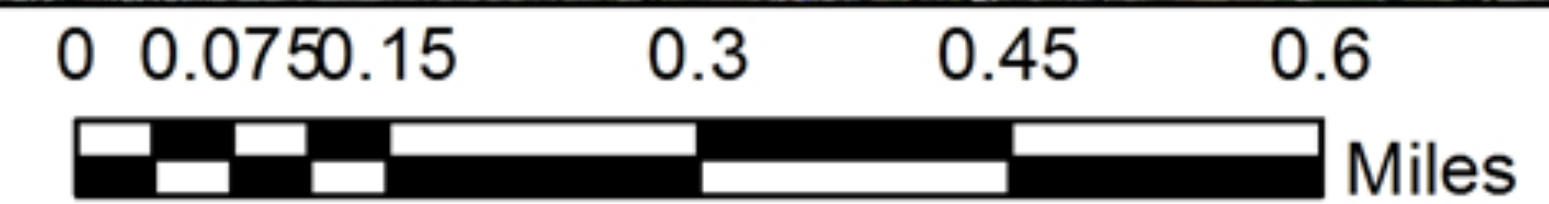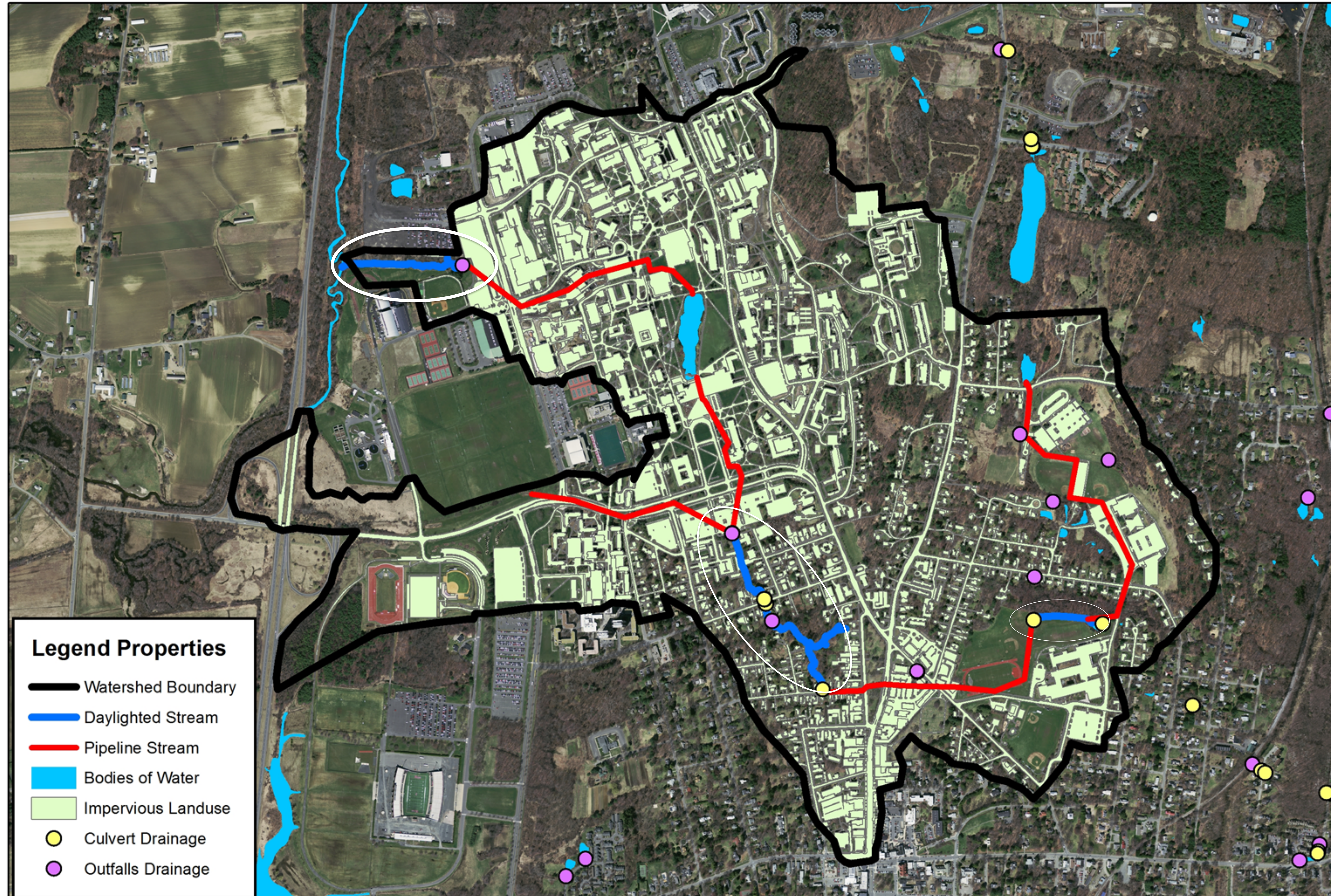
The institutional site is located in the back parking lot of the Mullins Center on campus. Where the stream becomes daylighted there is a convergent outfall drainage system, that connects the pipelined Tan Brook stream and excessive polluted run-off from impervious surfaces on campus through manhole drains. Infiltration trenches have been implemented to reduce contamination. Stream is of a cloudy hue, and has a medium velocity. The stream contains slabs of concrete that may have been purposely put to augment a pool-riffle affect. A bridge was constructed in 2010 that connects the back parking lot to the campus power plant, which increases the direct run-off into the stream. Infiltration trenches frame the stream on the parking lot frontier. Stream is approximately 4'–6' from the groundplain.

Residential Site

Institutional Site

Stormwater Drainage in the Tan Brook Watershed

Legend Properties

— Watershed Boundary
— Daylighted Stream
— Pipeline Stream
■ Bodies of Water
■ Impervious Landuse
● Culvert Drainage
● Outfalls Drainage

0 0.0750.15   0.3   0.45   0.6
Miles

N

Institutional Site: University of Massachusetts Amherst

Legend Properties

▬▬	Watershed Boundary
▬▬	Daylighted Stream
▬▬	Pipeline Stream
▬▬	Drainage Pipes
▲	Double Outfall Drainage
○	Drainage Structures
▨	Infiltration System
▥	Bridge
▬	Mill River

0 0.01 0.02   0.04   0.06   0.08
Miles

N

Highlights of Observations
- Various manhole drainage systems collect water run-off from surrounding campus area
- Pipelined stream (Red Line) runs underneath front parking lot of the Mullins Center.
- Two outfall drainage systems bring the two stream courses together
- The stream that comes from the surrounding run-off was a bright orange color
- Rock trench infiltration system
- Flow coming from the outfall is high in velocity but slows down when filtering through the rocks

Institutional Site: University of Massachusetts Amherst
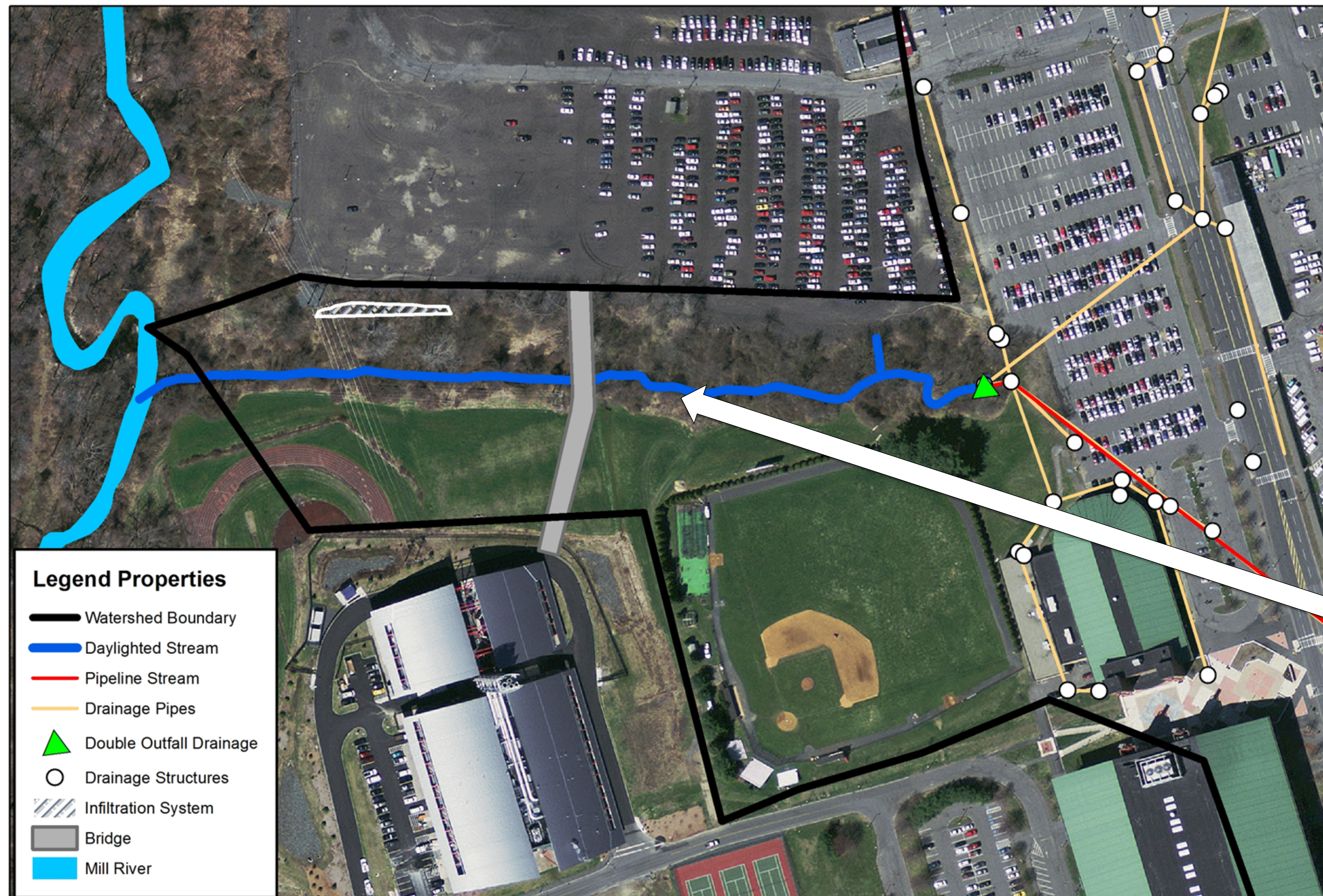
Highlight of Observations
- Slabs of concrete framed either the edges of the stream of were just placed throughout the stream
- Concrete helps erosion control
- Stream was cloudy and had a lower velocity and volume, before and after snowmelt

Legend Properties
- Watershed Boundary
- Daylighted Stream
- Pipeline Stream
- Drainage Pipes
- Double Outfall Drainage
- Drainage Structures
- Infiltration System
- Bridge
- Mill River

0   0.010.02   0.04   0.06   0.08
Miles

N

Institutional Site: University of Massachusetts Amherst

Highlight of Observations:
- Addition of bridge connection Power Plant to back parking lot of the Mullin's Center in 2010.
- Direct run off from parking lot (shown in picture)
- Infiltration system established on the border of the parking lot and the buffer zone of the stream

Legend Properties

▬	Watershed Boundary
▬	Daylighted Stream
▬	Pipeline Stream
▬	Drainage Pipes
▲	Double Outfall Drainage
○	Drainage Structures
▨	Infiltration System
▬	Bridge
▬	Mill River

0 0.01 0.02 0.04 0.06 0.08 Miles

N

Recreational Site: Amherst Regional High School

Legend Properties

|	
▬▬▬	Watershed Boundary
▬▬▬	Daylighted Stream
▬▬▬	Pipeline Stream
■	Retention Pond
●	Manhole Drainage
●	Culvert Drainage

Highlights of Observations:
- Retention pond (pictured below) fenced off, with 4+ culvert drainage pipes that introduce runoff from surrounding streets, vehicles, buildings, homes, etc.
- Pollution amount is very high
- Frozen over at the time of picture, but after snowmelt was overflowing which resulted in the bordering area to be over flooding
- Affected greatly by the changes in weather
- Fields adjacent were also flooded and muddy

Recreational Site: Amherst Regional High School
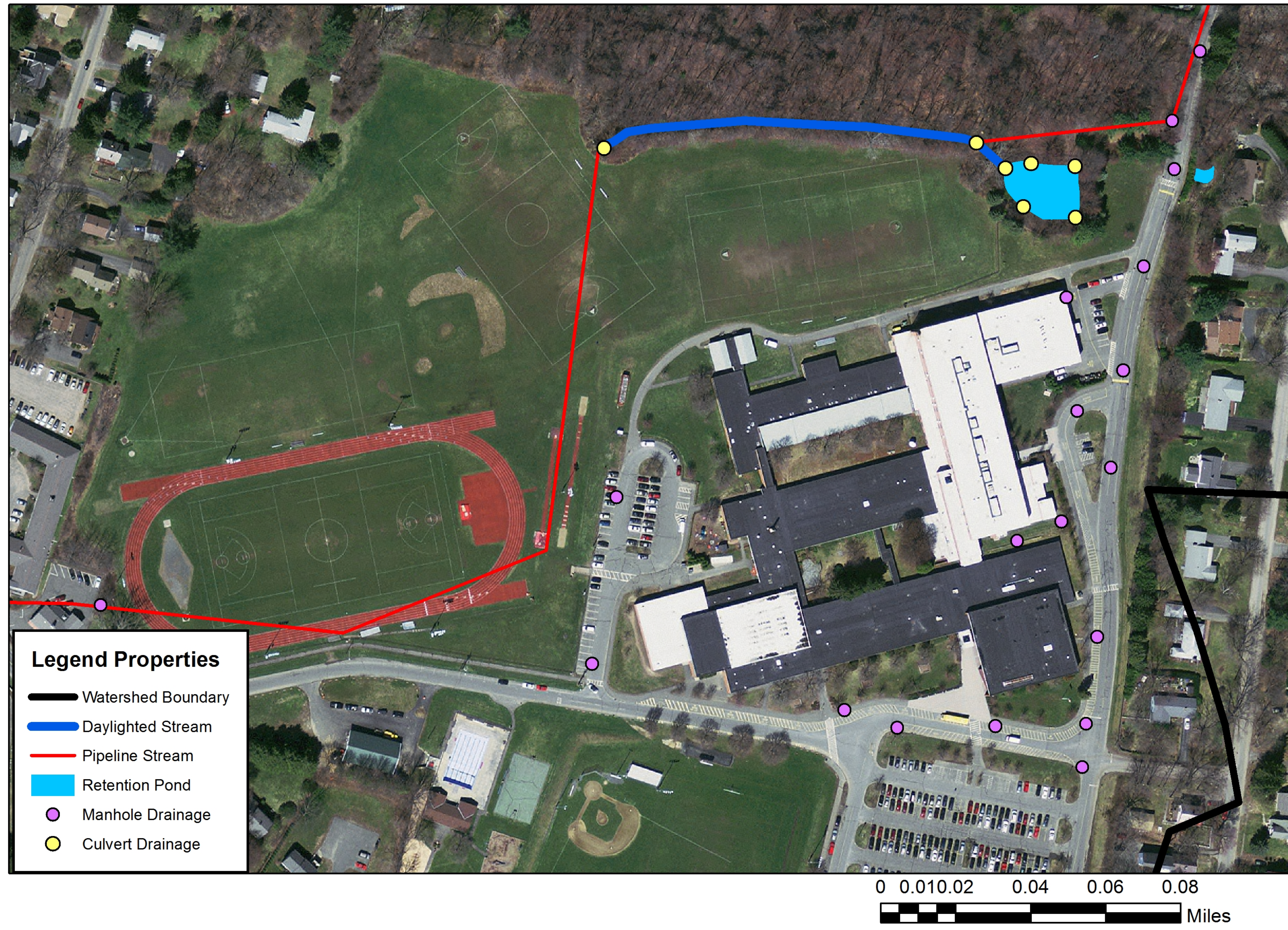
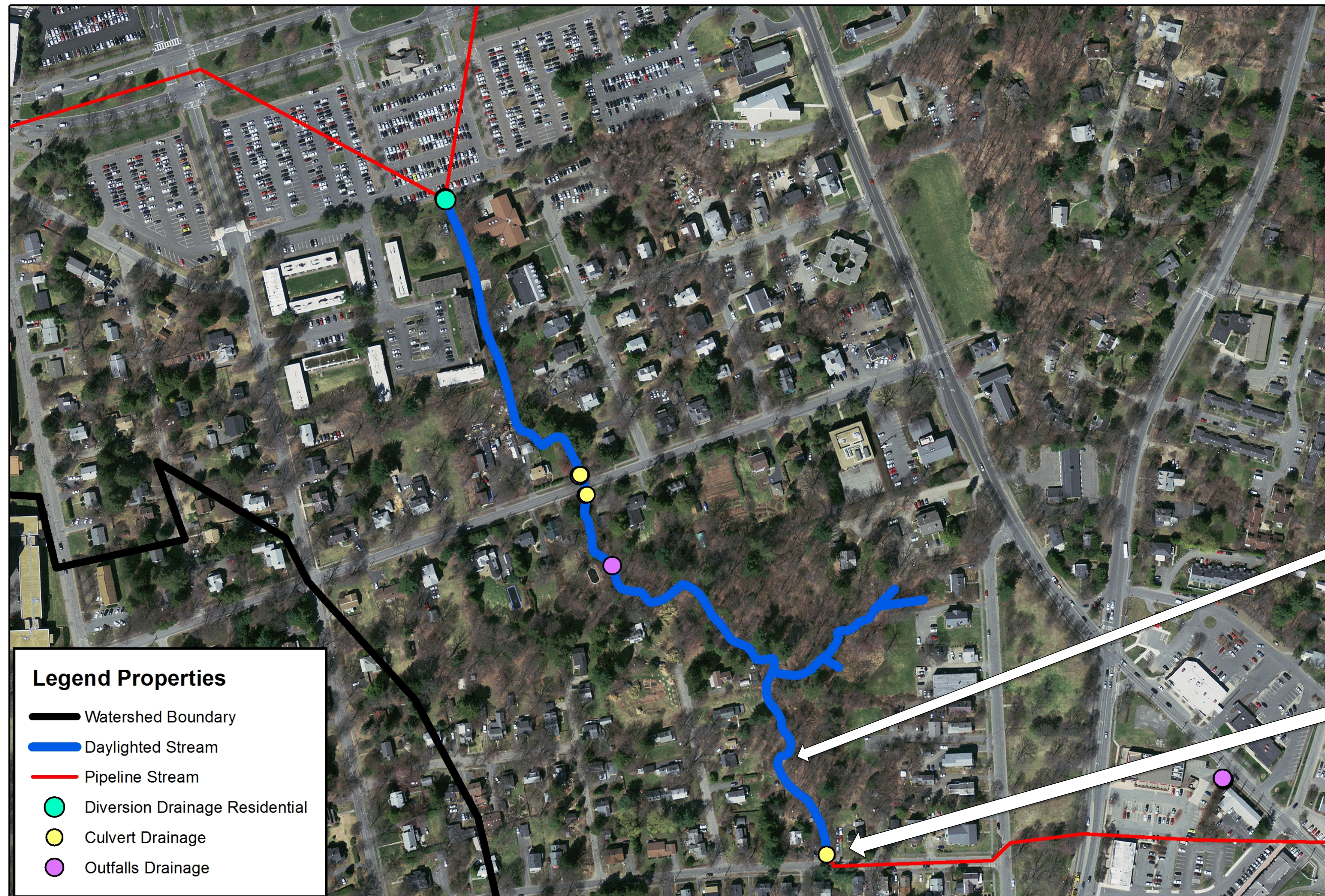

Highlight of Observations
- Wetland habitat is prominent(skunk cabbage and moss)
- Pollution is extremely high, most like because of its use by high school/middle school students
- Riffle-pool effect filters stream
- Stream is very low in both velocity and volume
- No observable aquatic wildlife
- Snowmelt resulted in flooding of surrounding area, meandering underground floor up to 30 ft+ from stream

Legend Properties
- ———— Watershed Boundary
- ———— Daylighted Stream
- ———— Pipeline Stream
- ▮ Retention Pond
- ● Manhole Drainage
- ● Culvert Drainage

0 0.010.02   0.04   0.06   0.08
Miles

N

Residential Site: McClellan Street, Amherst MA

Legend Properties

▬▬	Watershed Boundary
▬▬	Daylighted Stream
▬▬	Pipeline Stream
●	Diversion Drainage Residential
●	Culvert Drainage
●	Outfalls Drainage

0 0.02 0.04   0.08   0.12   0.16
Miles

N

Highlight of Observations:
- Culvert outfall added in 1978
- Direct run-off from road into stream
- Rock trench infiltration system
- Riffle-pool effect throughout stream
- Velocity was fastest at this site
- Volume was largest
- Erosion was extremely prominent, having 10+ almost on the verge of falling
- Substantial amount of pollution
- Adjacent residential homes were less then 10 feet from direct stream
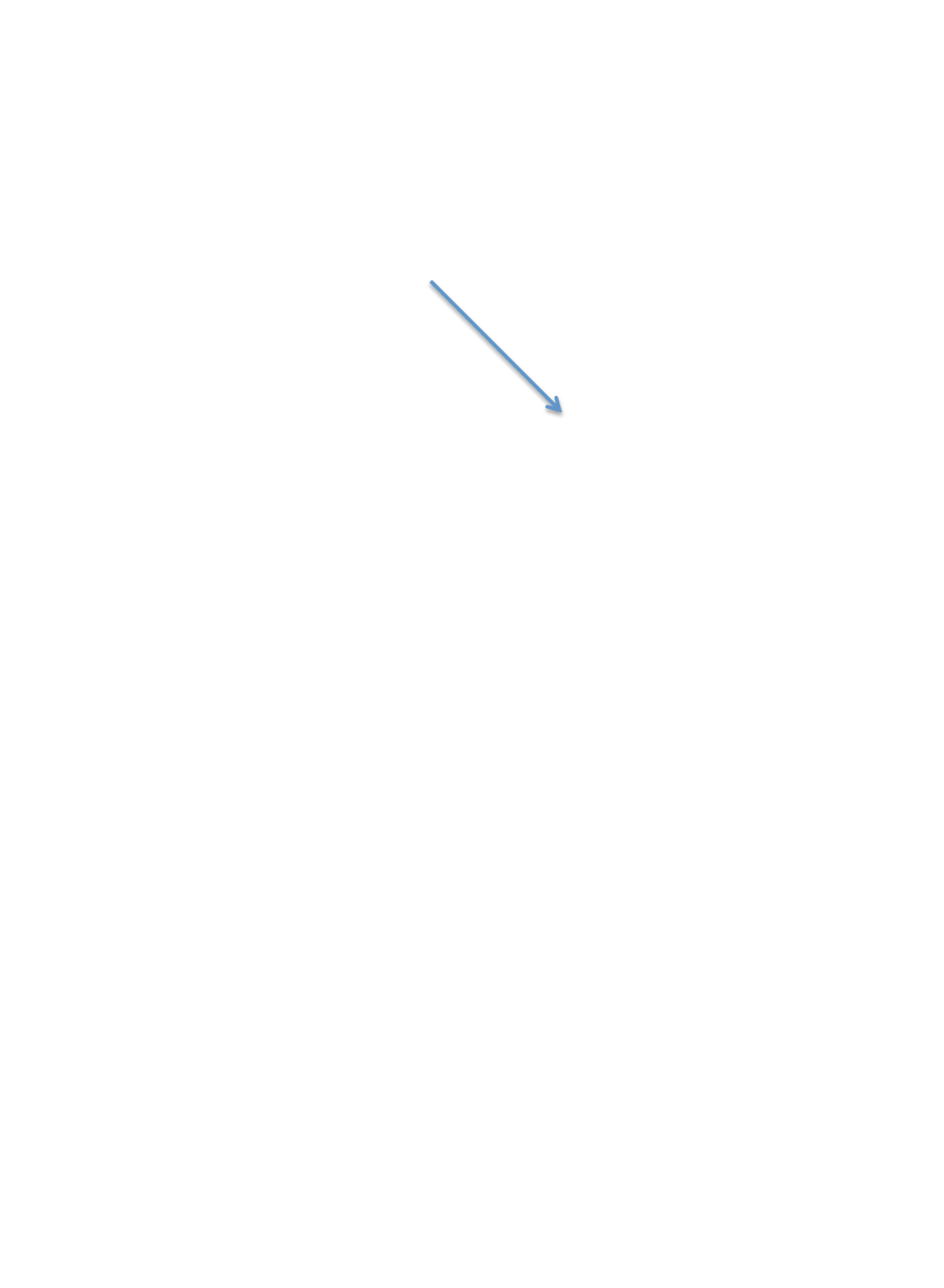
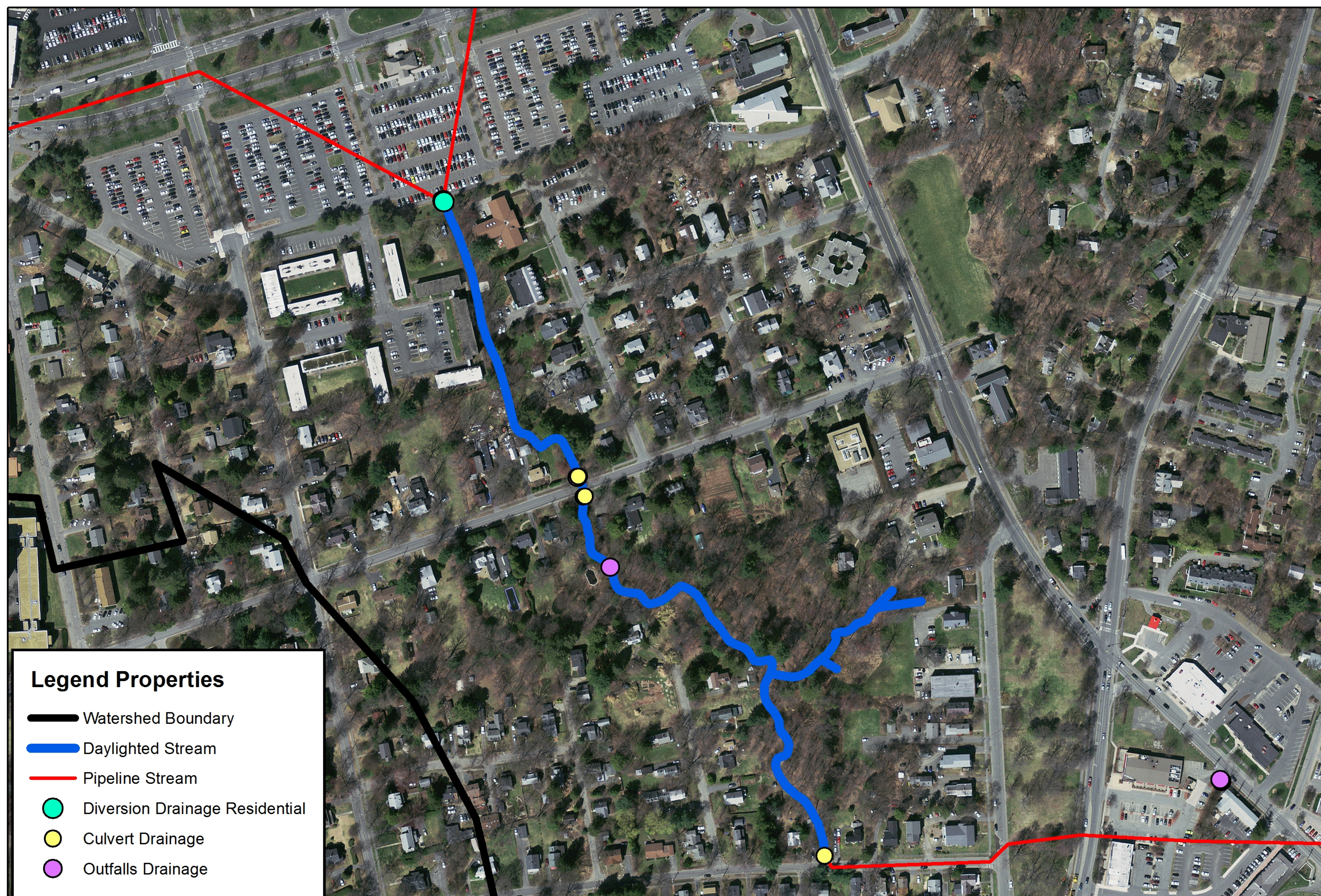# Residential Site: Fearing Street, Amherst MA
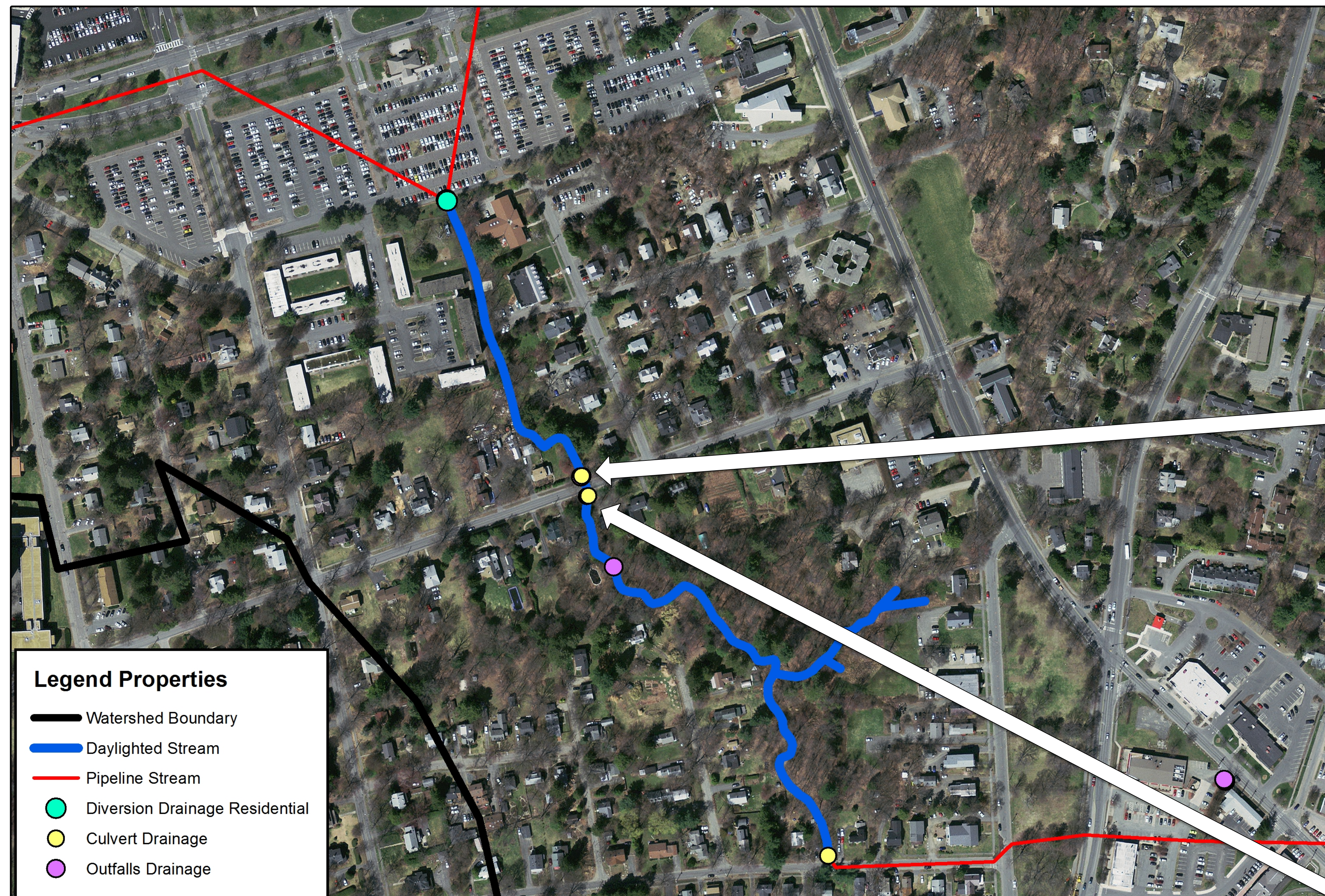
Legend Properties

▬	Watershed Boundary
▬	Daylighted Stream
▬	Pipeline Stream
●	Diversion Drainage Residential
●	Culvert Drainage
●	Outfalls Drainage

0 0.02 0.04   0.08   0.12   0.16
Miles

N

Highlights of Observations:
- Snowmelt uncovered high amount of litter and pollution
- Two culvert outfall drainage systems run the stream underneath the road
- Absolutely no infiltration or drainage system on south side of street (Image to the right) run-off from street was directly flowing into stream
- Wetland wildlife framed the area around the site
- Turns into a stream with two different piped streams (parking lot the stream diverges)
- Rocks border the stream and yards for slight erosion control

Residential Site: Visitors Parking lot Umass Amherst

Legend Properties

― Watershed Boundary
― Daylighted Stream
― Pipeline Stream
● Diversion Drainage Residential
● Culvert Drainage
● Outfalls Drainage

0 0.02 0.04   0.08   0.12   0.16
Miles

N

Highlights of Observations:
- This was the end of the daylighted stream that runs through the residential neighborhoods
- Once it reaches the edge of the visitors parking lot on the Umass Campus it gets piped.
- On the image to the bottom right the right side is Umass property and the left is private property. On the left was erosion control through rip rap erosion control whereas on the other side no type of erosion control was being practiced.
- Wet land habitat was visible on private property side
- The divergent streams (top right image) are directed, one towards the sport fields by the Mullin's Center and the other towards the Campus pond (which is the direction of the stream).
- The stream that goes towards the Mullins Center has resulted in the collapse of vegetative swales