Holistic Watershed Management for Existing and Future Land Use Development Activities: Opportunities for Action for Local Decision Makers: Phase 2 –FDC Application Modeling (FDC 2A Project)

SUPPORT FOR SOUTHEAST NEW ENGLAND PROGRAM (SNEP) COMMUNICATIONS STRATEGY AND TECHNICAL ASSISTANCE

Factsheets

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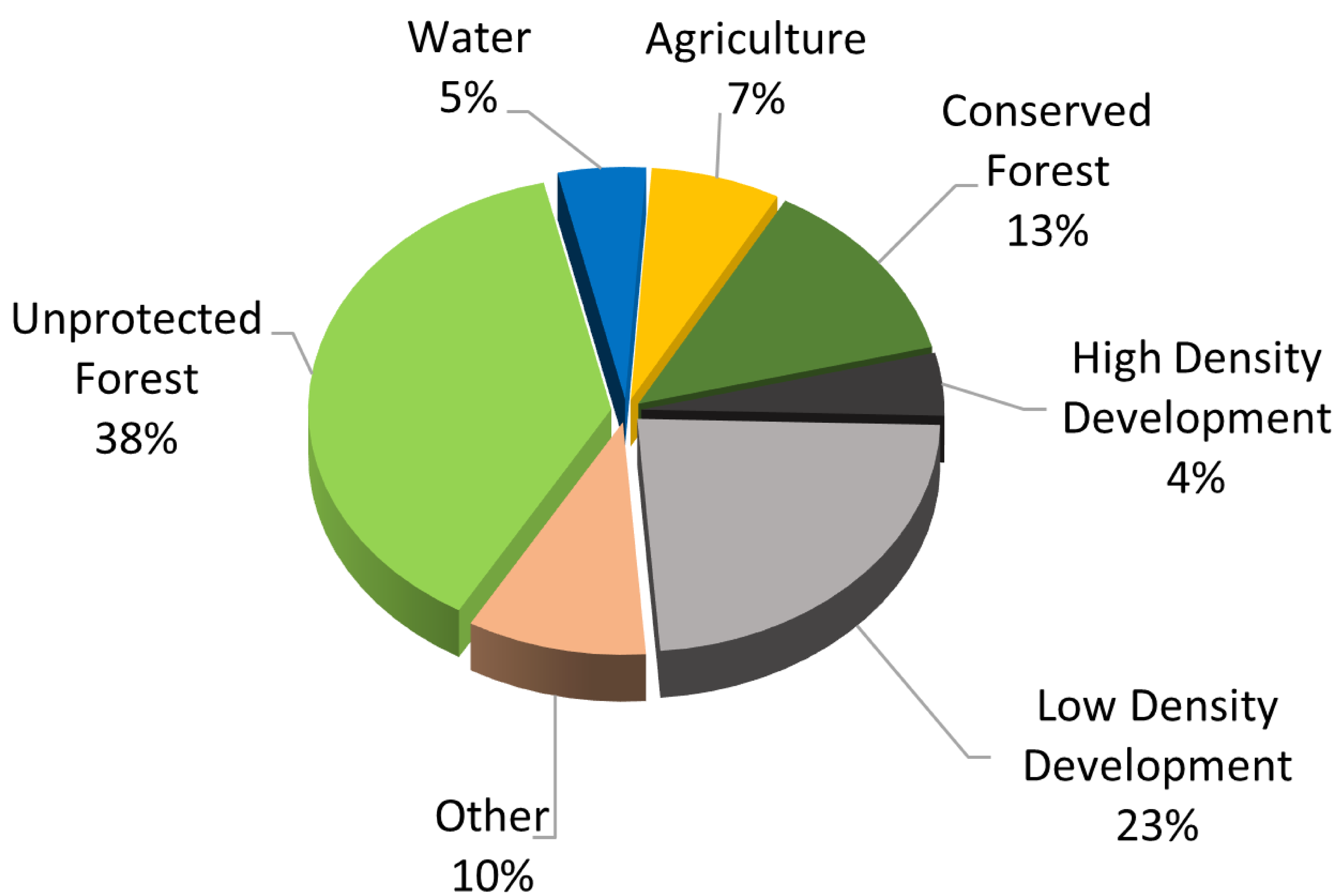
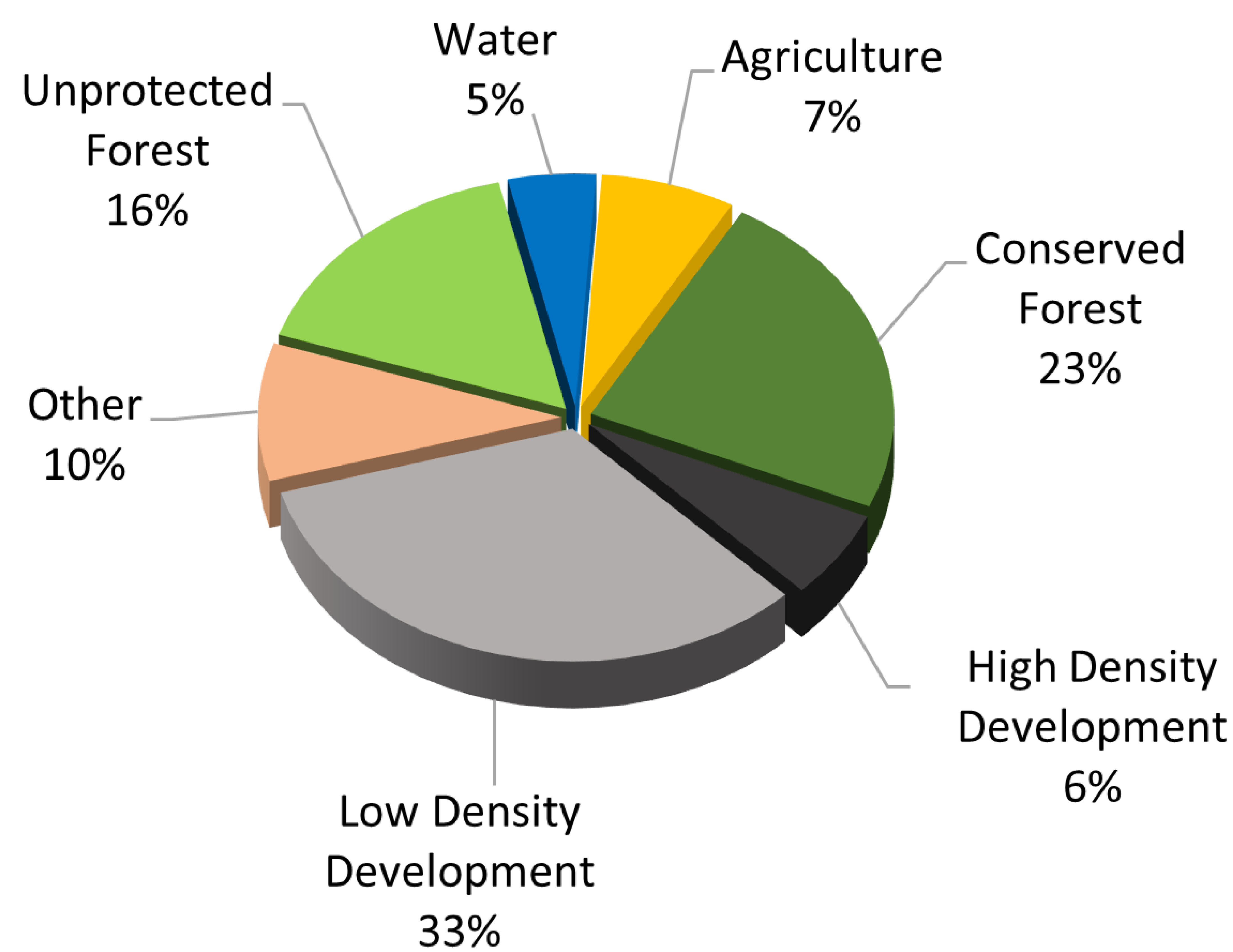
Future Landscape in the Taunton River Watershed

Future land use based on Business-as-Usual trends project continued conversion of forests into developed land use types[1].
The Taunton River watershed is projected to lose 57% of it's unprotected forests, primarily to residential development.

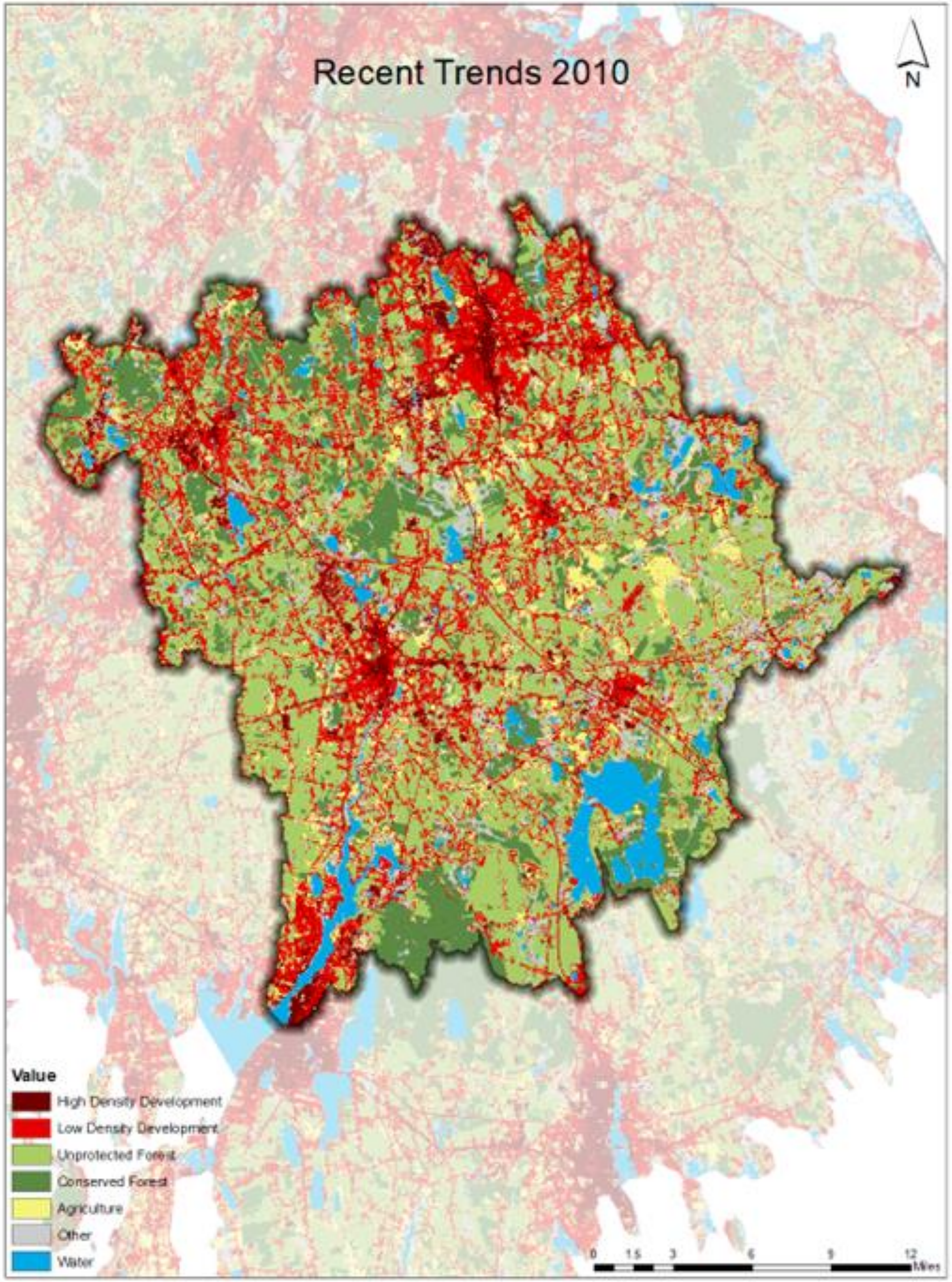
Recent Trends 2010



Recent Trends 2060



[1]Thompson, J.R., Plisinski, J.S., Olofsson, P., Holden, C.E., Duveneck, M.J., 2017. Forest loss in New England: A projection of recent trends. PLoS One 12. https://doi.org/10.1371/JOURNAL.PONE.0189636


Recent Trends 2010
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High Density Development
Low Density Development
Unprotected Forest
Conserved Forest
Agriculture
Other
Water
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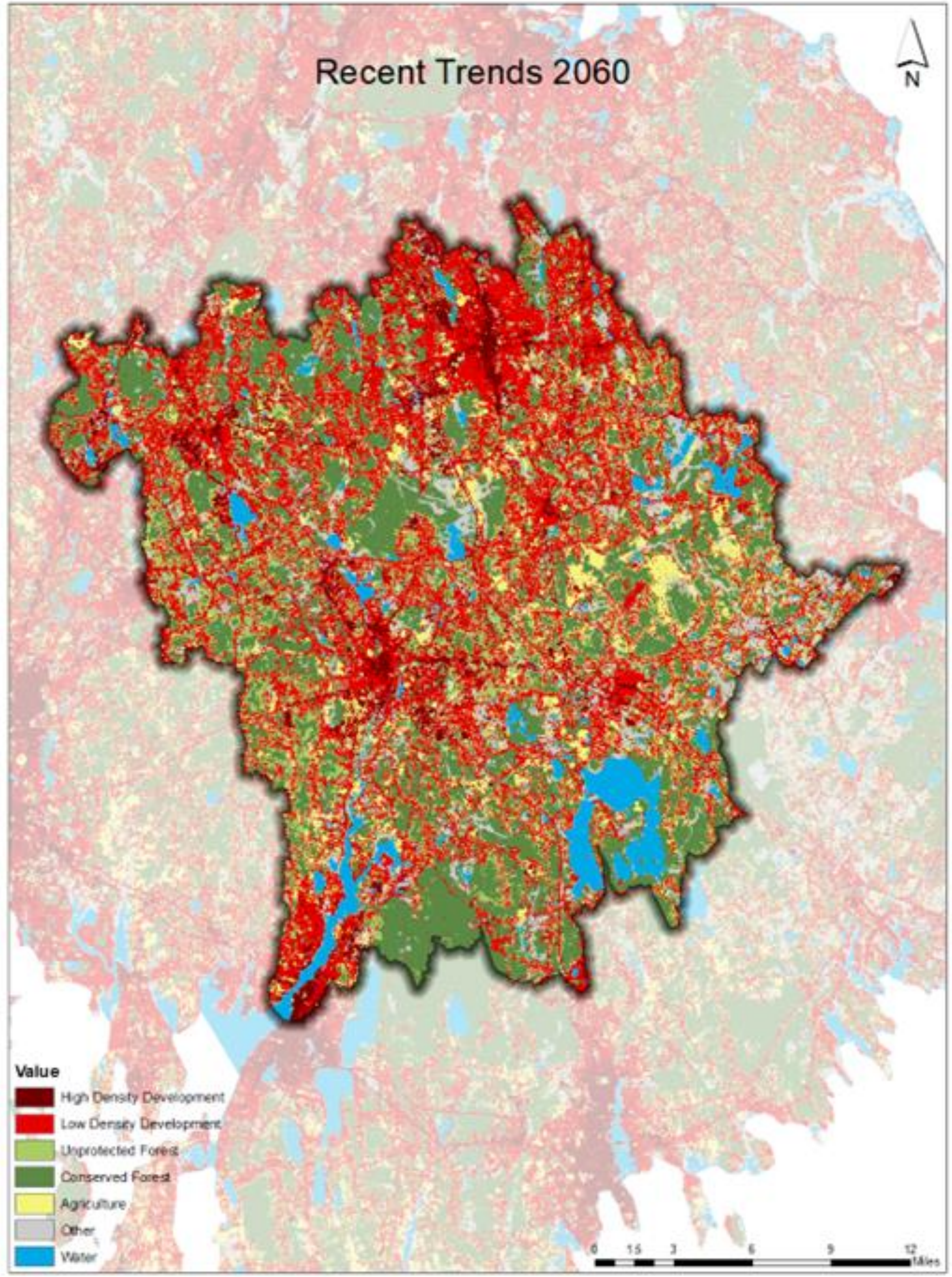
Miles

Recent Trends 2060
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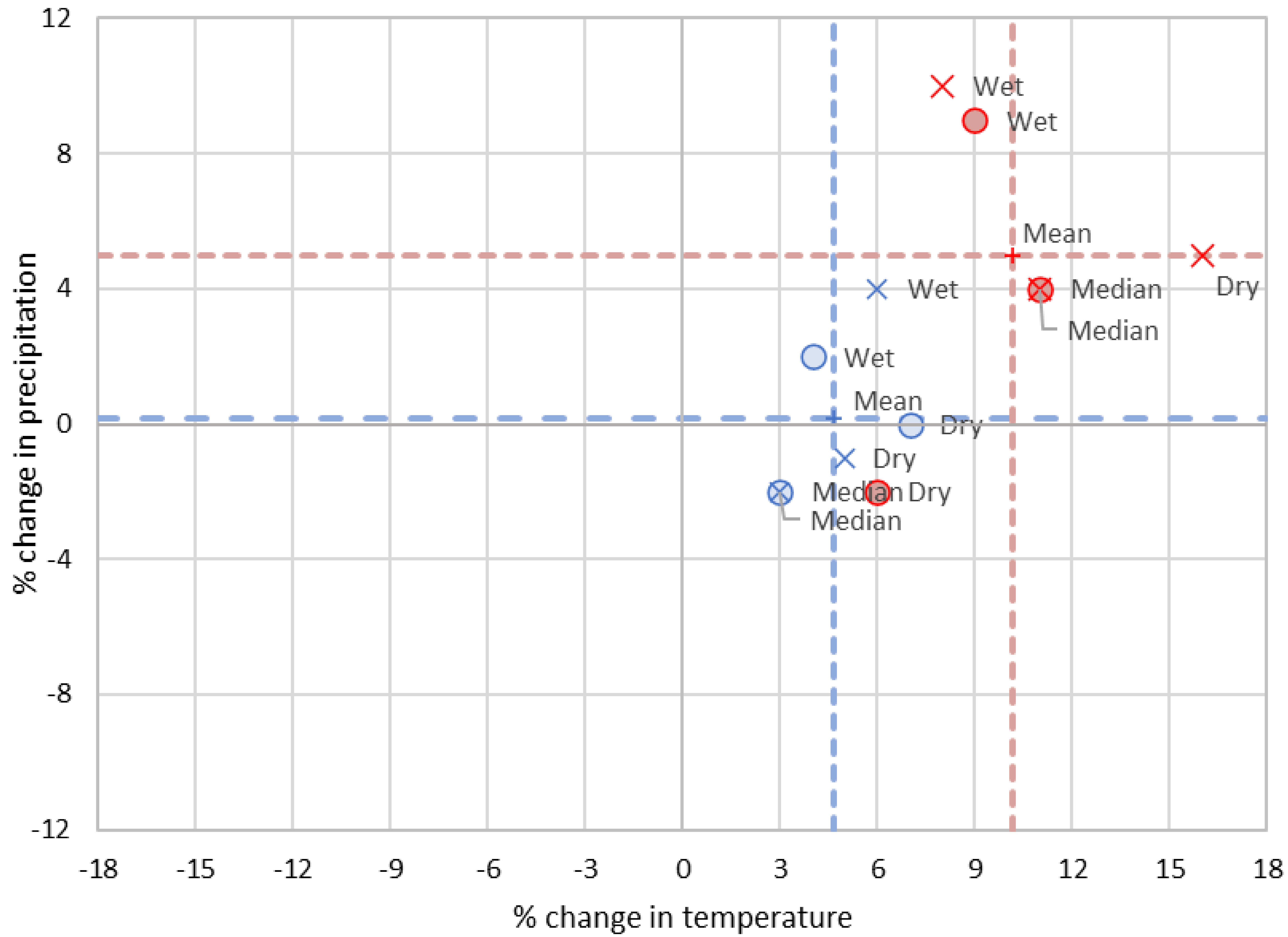
Miles

Future Climate Impact

Future climate projections can vary widely based on the Global Circulation Model (GCM) and Relative Concentration Pathway (RCP) used. This project used models based on RCP8.5 (increasing carbon emissions based on historic rates) that increased precipitation from 4%-10% and temperature by 8%-16%.

These climate projections align with those from the Massachusetts Climate Change Report[2], which estimates annual precipitation increases of 5-8% by 2064. While annual average precipitation is projected to increase, summer months are expected to become drier leading to ecodeficits (flows lower than current conditions); winters are expected to have increased precipitation rates[3].



RCP	Scenario [1]	Ecosuplus Model	Ecodeficit Model
RCP 4.5	Dry	hadgem2-cc-1	mpi-esm-mr-1
	Median	bcc-csm1-1-m-1	bcc-csm1-1-m-1
	Wet	bcc-csm1-1-1	miroc-esm-chem-1
RCP 8.5	Dry	inmcm4-1	miroc-esm-1
	Median	cesm1-cam5-1	cesm1-cam5-1
	Wet	cesm1-bgc-1	mri-cgcm3-1

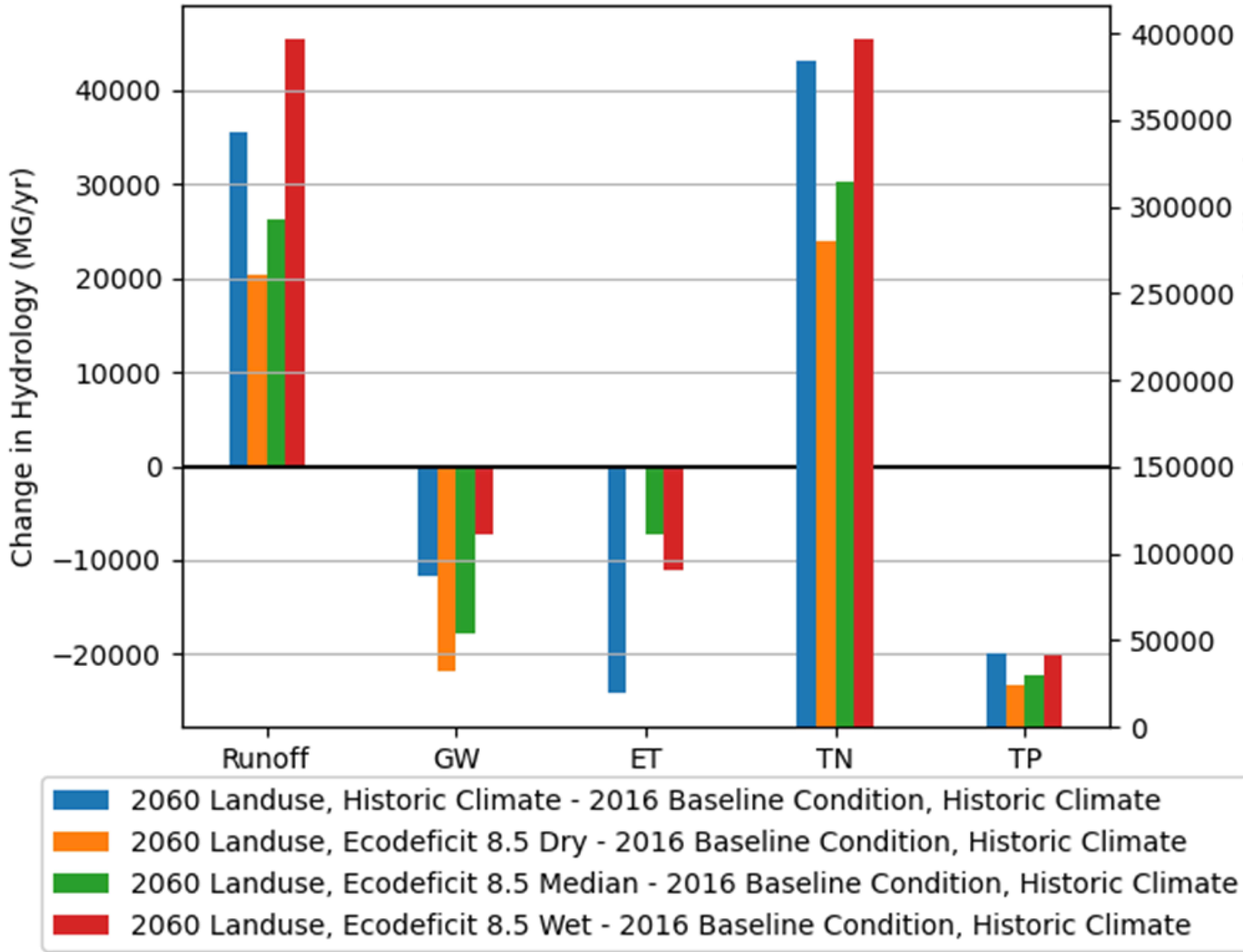
1: Dry, Median, and Wet correspond to the 20th, 50th, and 80th percentile hydrological responses. Models chosen for FDC Phase 2 are highlighted in yellow.

[2]MA EOEE, 2011. Climate Change Adaptation Report.
[3]Hayhoe, C.P., Wake, T.G., Huntington, L., Luo, M.D., Schrawtz, J., Sheffield, E., Wood, E., Anderson, B., Bradbury, A., Degaetano, T.J., Wolfe, D., 2006. Past and Future Changes in Climate and Hydrological Indicators in the U.S. Northeast. Clim Dyn 28, 381–707. https://doi.org/10.1007

Changes to Hydrology and Water Quality Under Future Conditions

Across the Taunton River watershed, increased future impervious cover, regardless of future climate conditions, increases runoff volume and nutrient loads while decreasing groundwater recharge (GW) and evapotranspiration (ET).

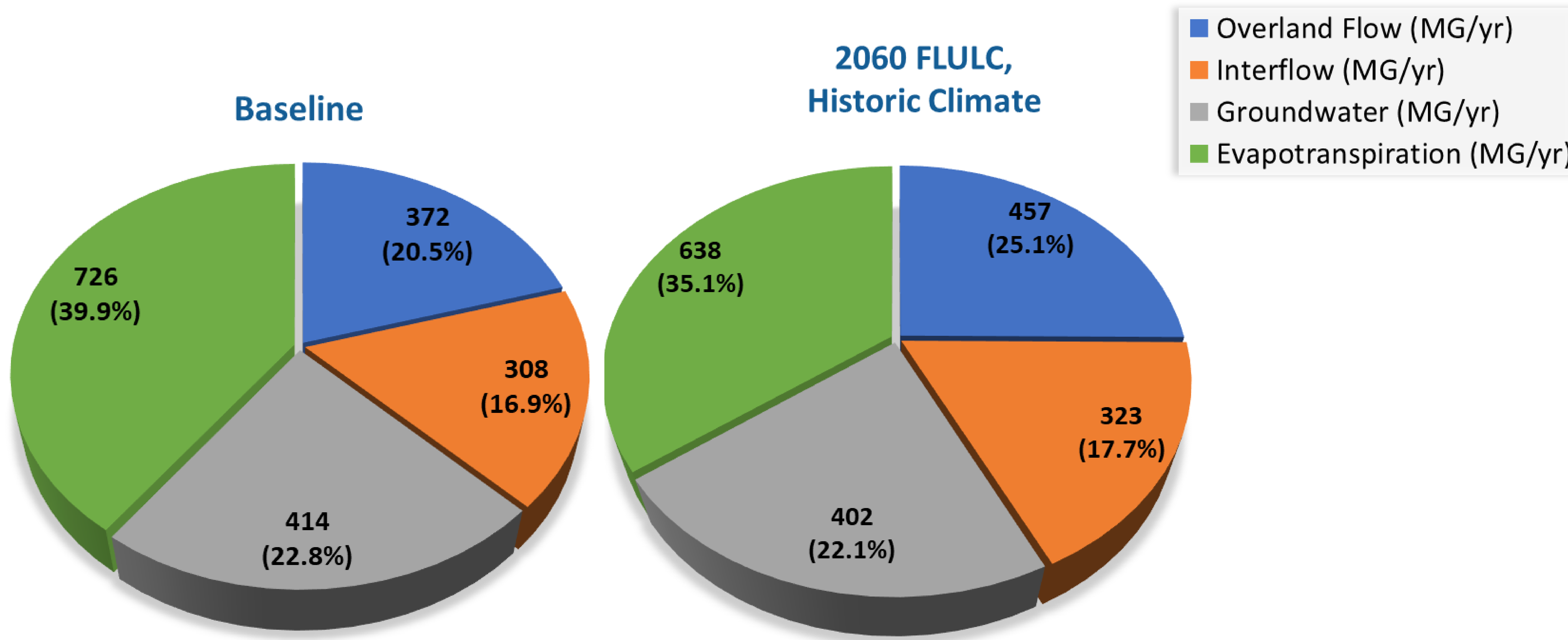
The amount of precipitation in a particular climate change model (wet, median, or dry) can amplify or dampen the change in hydrology and water quality compared to future land use alone (e.g., a wet future climate has more runoff than a dry one).

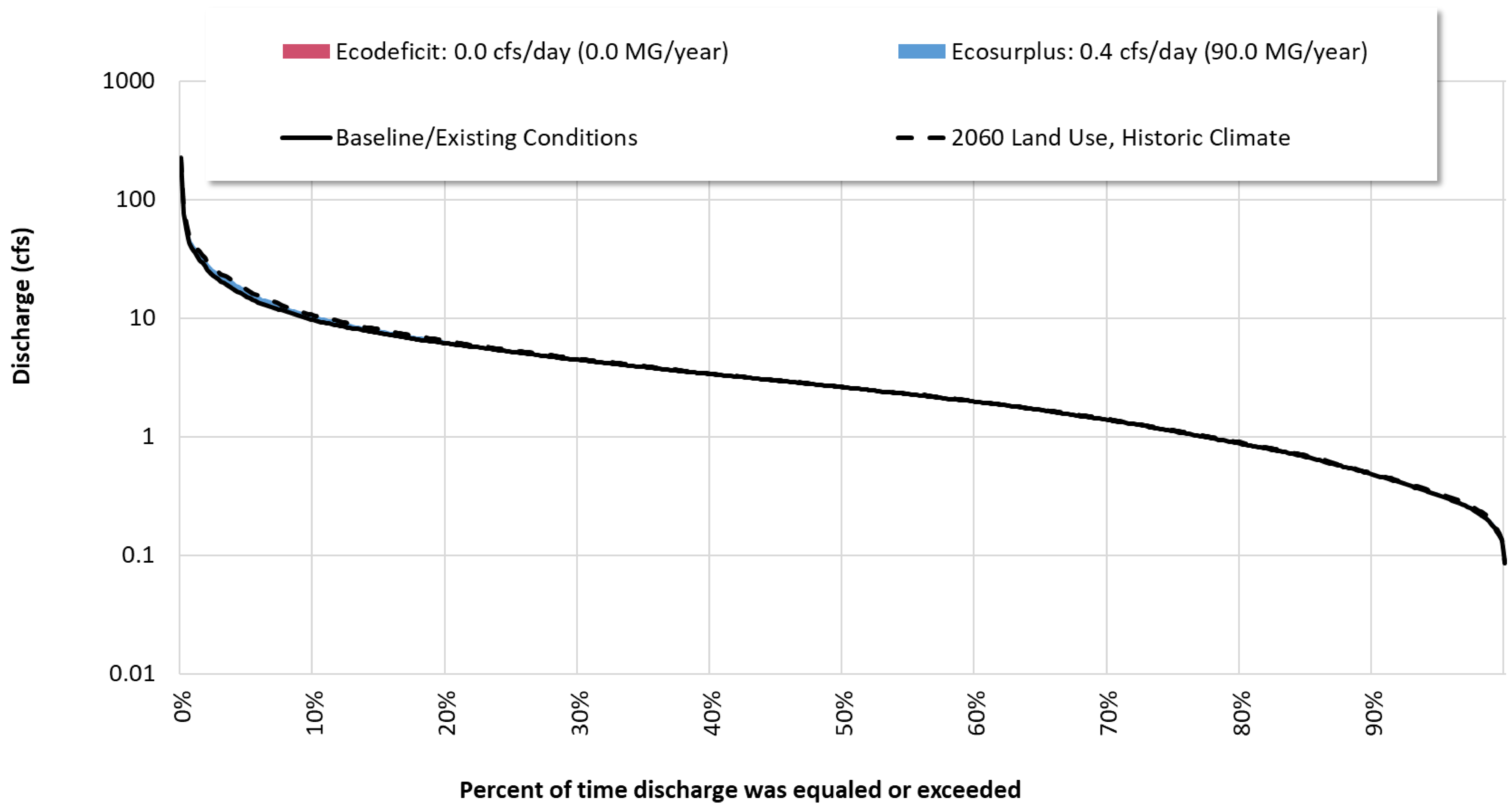


Future Land Use Impacts on a Small Urbanized Catchment

Future land use impacts on hydrology and water quality for the Upper Hodges Brook, a small urbanized subwatershed, largely match those of the Taunton River Watershed.

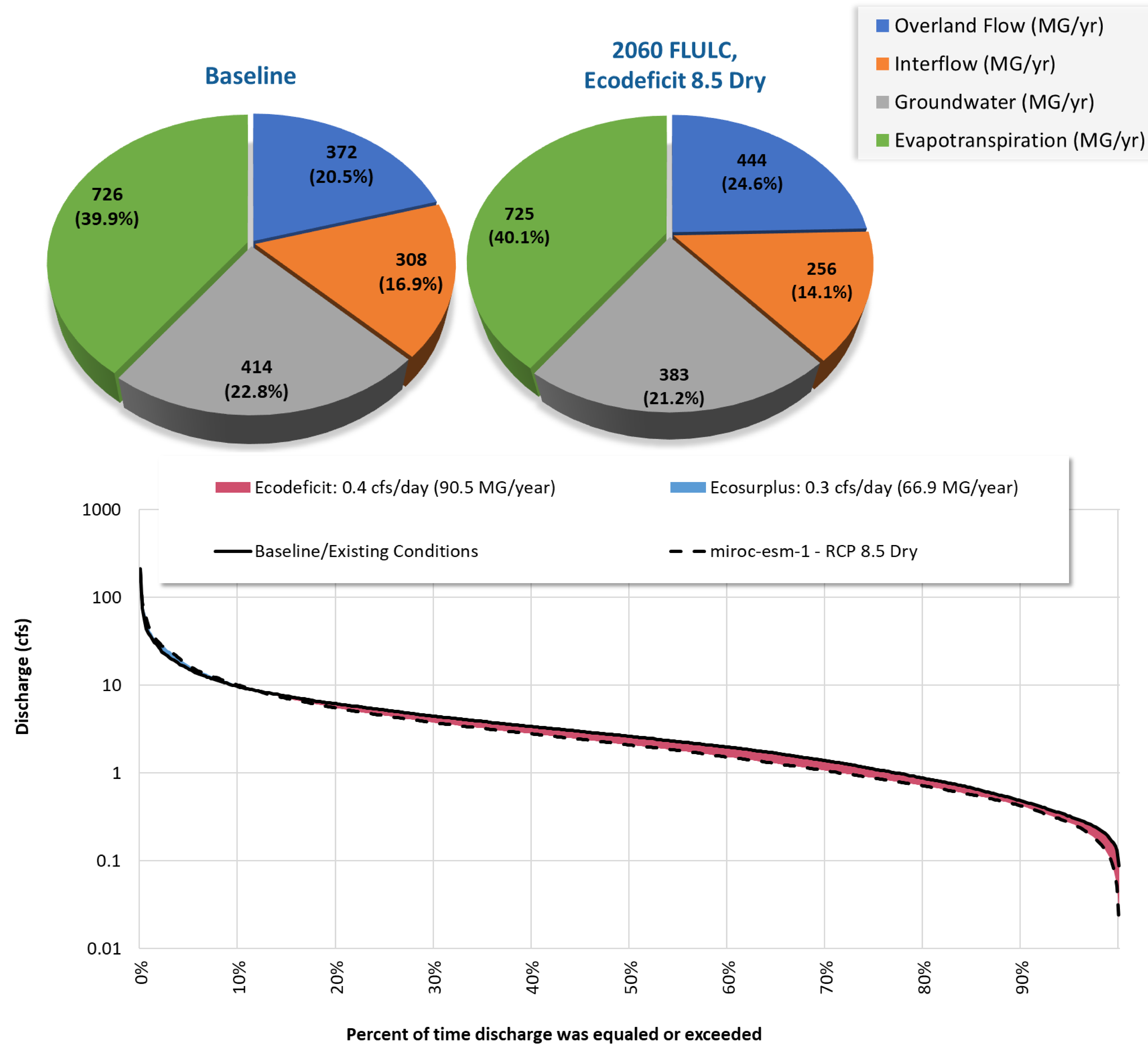
When only future land use is considered, greater amounts of impervious cover increases flows across the FDC. Decreased evapotranspiration is one of the main drivers leading to increased runoff.





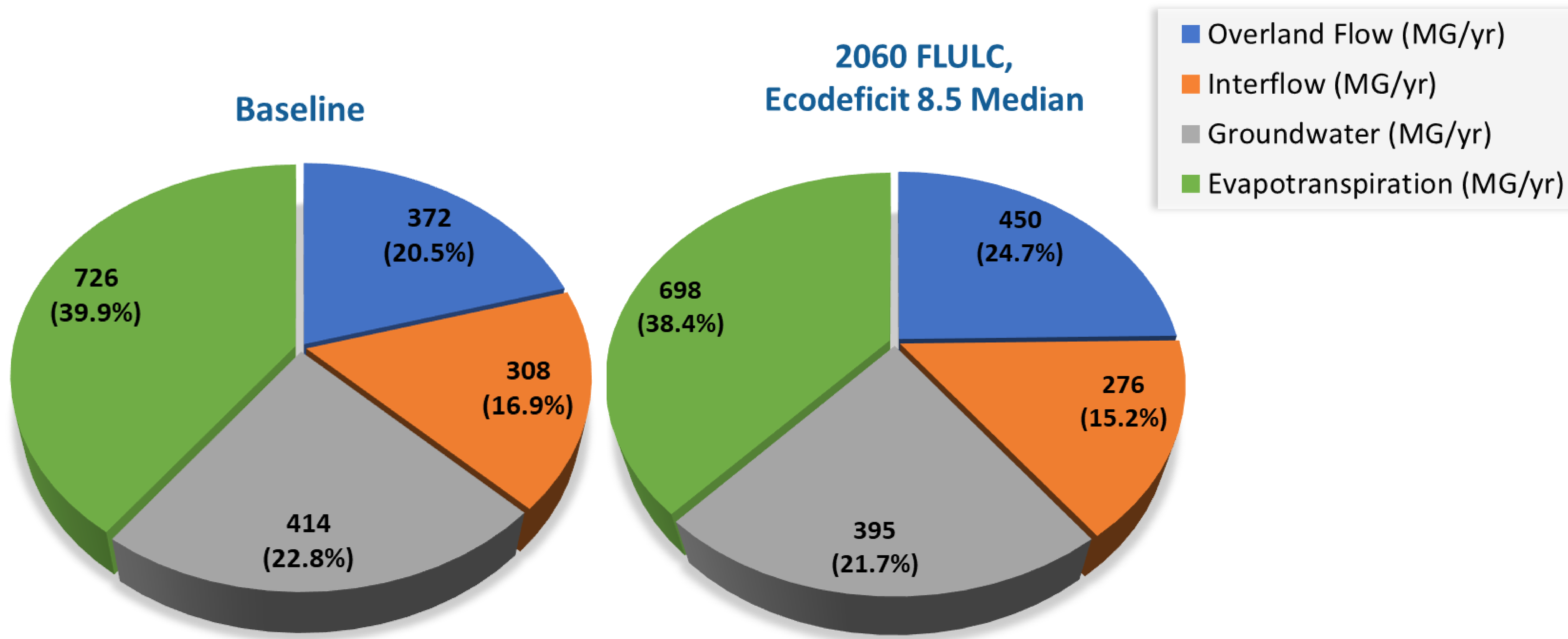
Future Land Use and Climate Impacts on a Small Urbanized Catchment

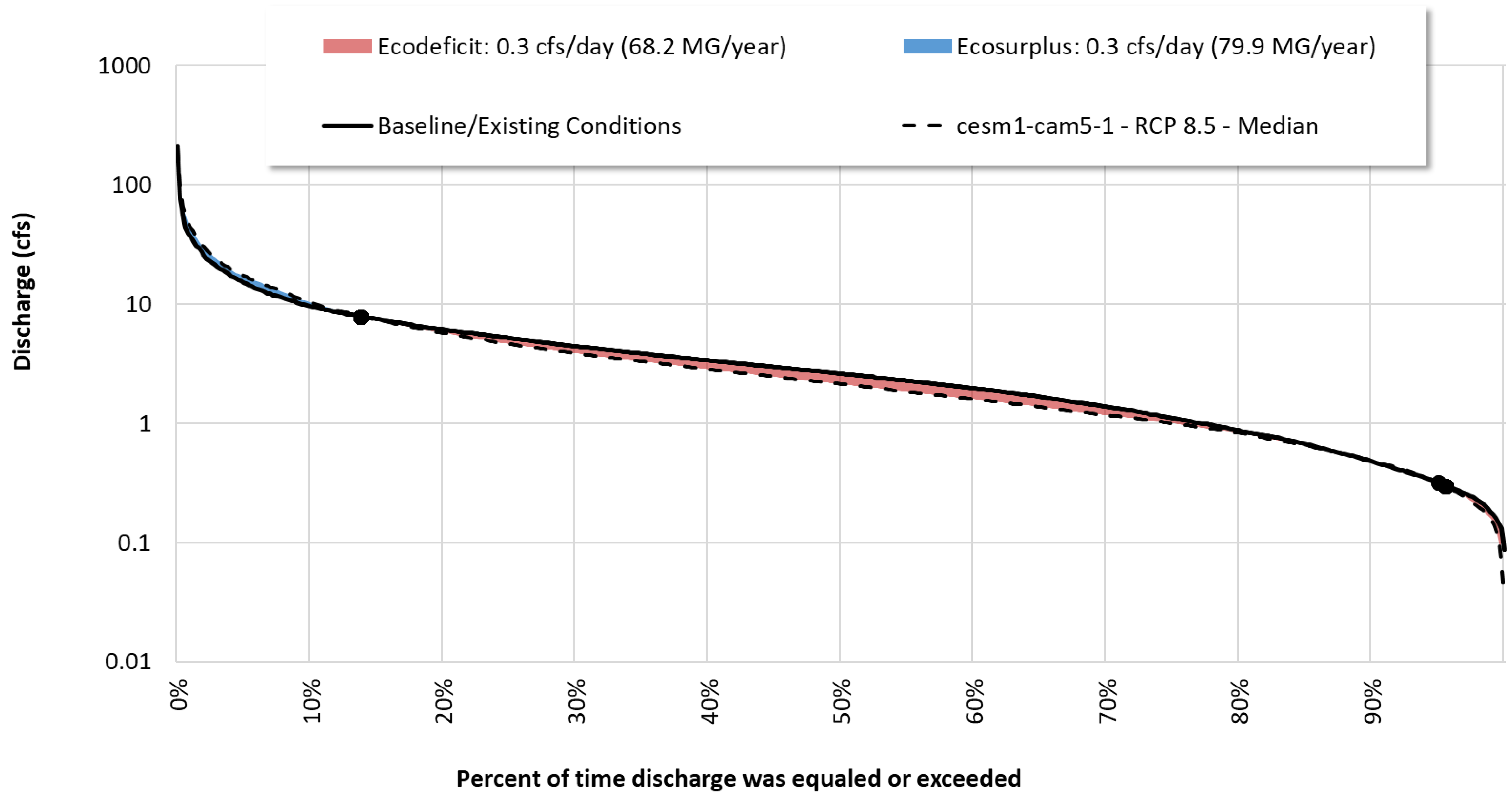
When simulated with the Ecodeficit dry future climate scenario, the Upper Hodges Brook experiences ecodeficits across all but the highest 10% of flows. Reduced moderate to low flows can negatively impact aquatic habitats while greater high flows can increase erosion and sediment loads.



Future Land Use and Climate Impacts on a Small Urbanized Catchment

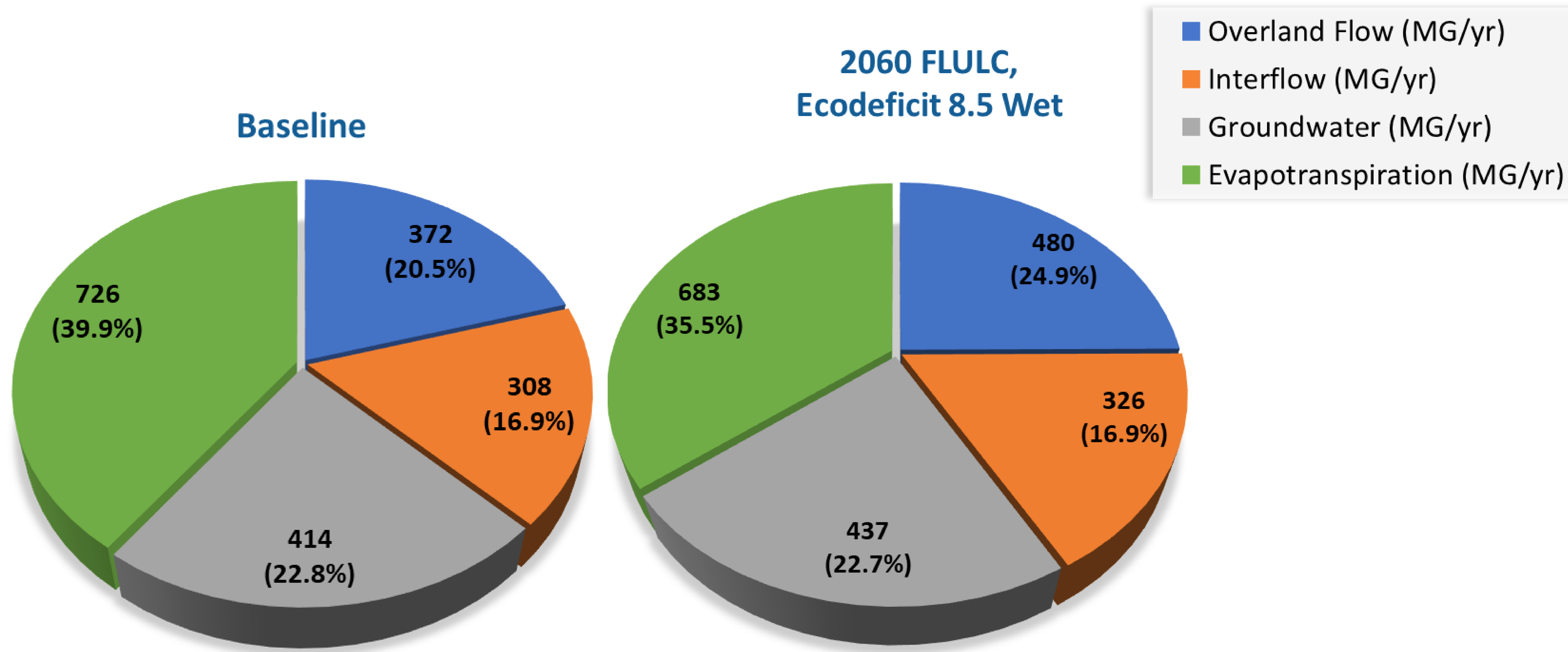
When simulated with the Ecodeficit median future climate scenario, the Upper Hodges Brook experiences ecodeficits across most moderate and low flows. Ecosurpluses are experienced across the highest 15% of flows.

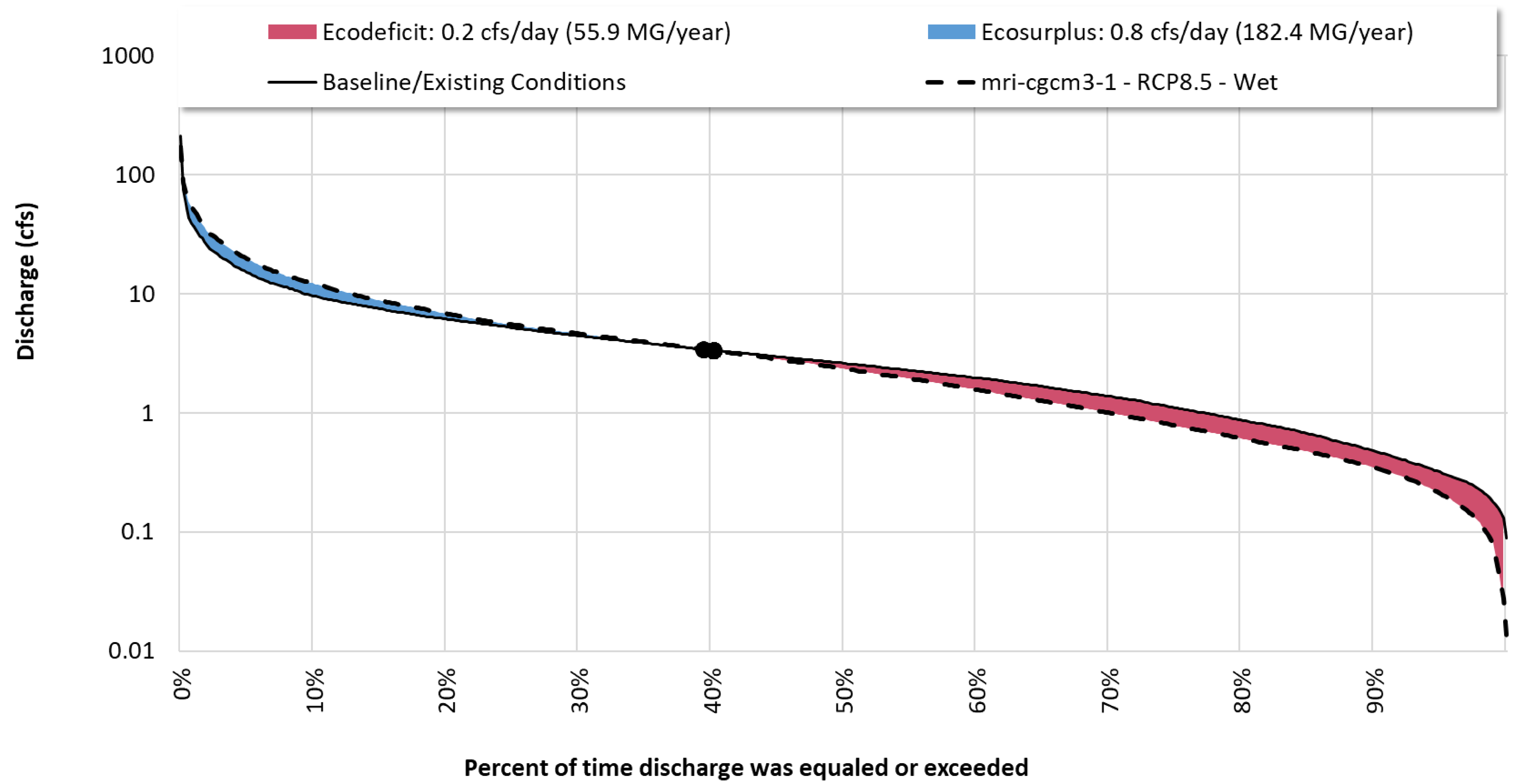




<u>Future Land Use and Climate Impacts on a Small Urbanized Catchment</u>

Despite increased impervious cover, the Wet future climate scenario has similar interflow and groundwater as the baseline historical conditions. The highest 40% of flows have ecosurpluses while the lowest 60% of flows have ecodeficits.

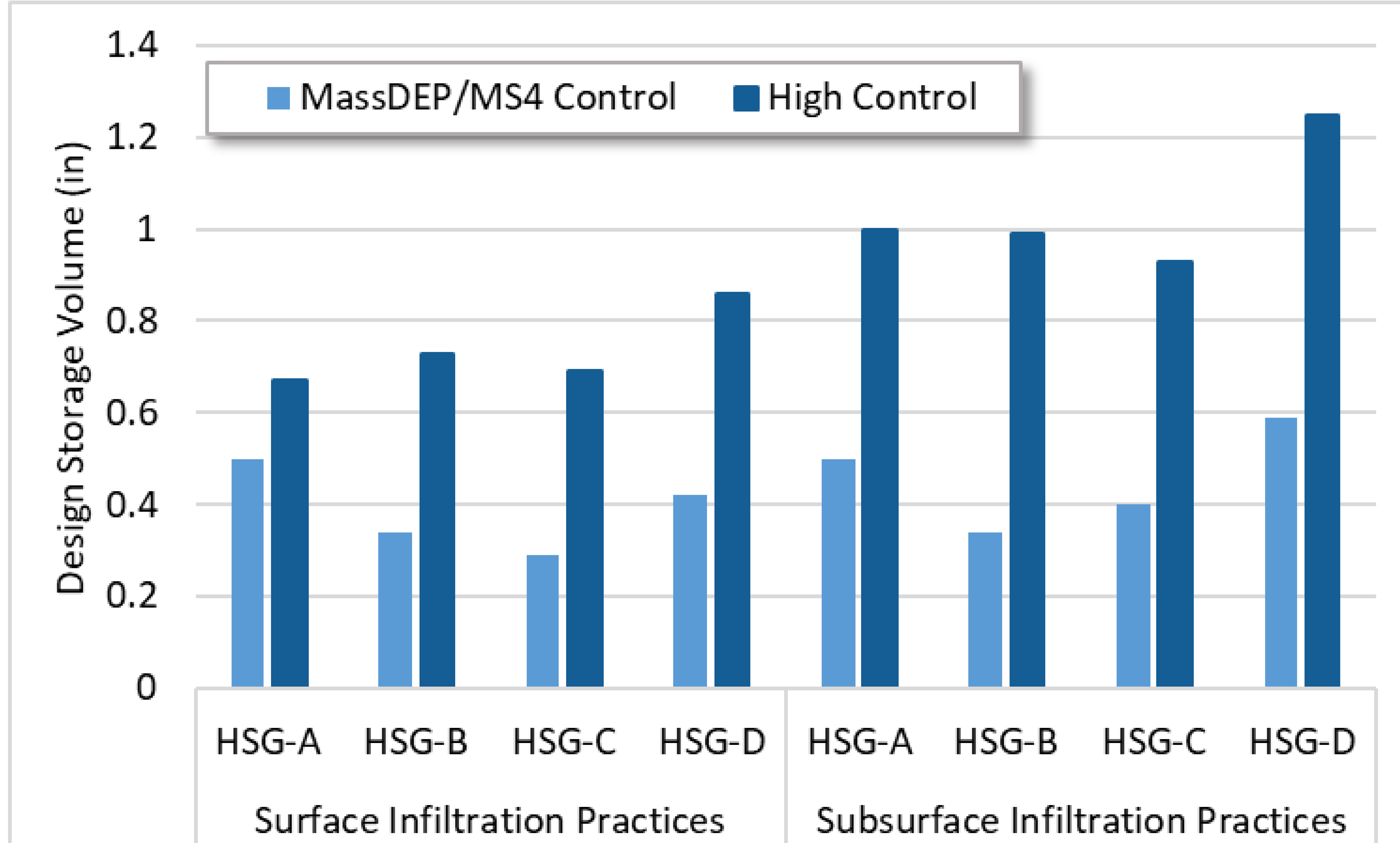


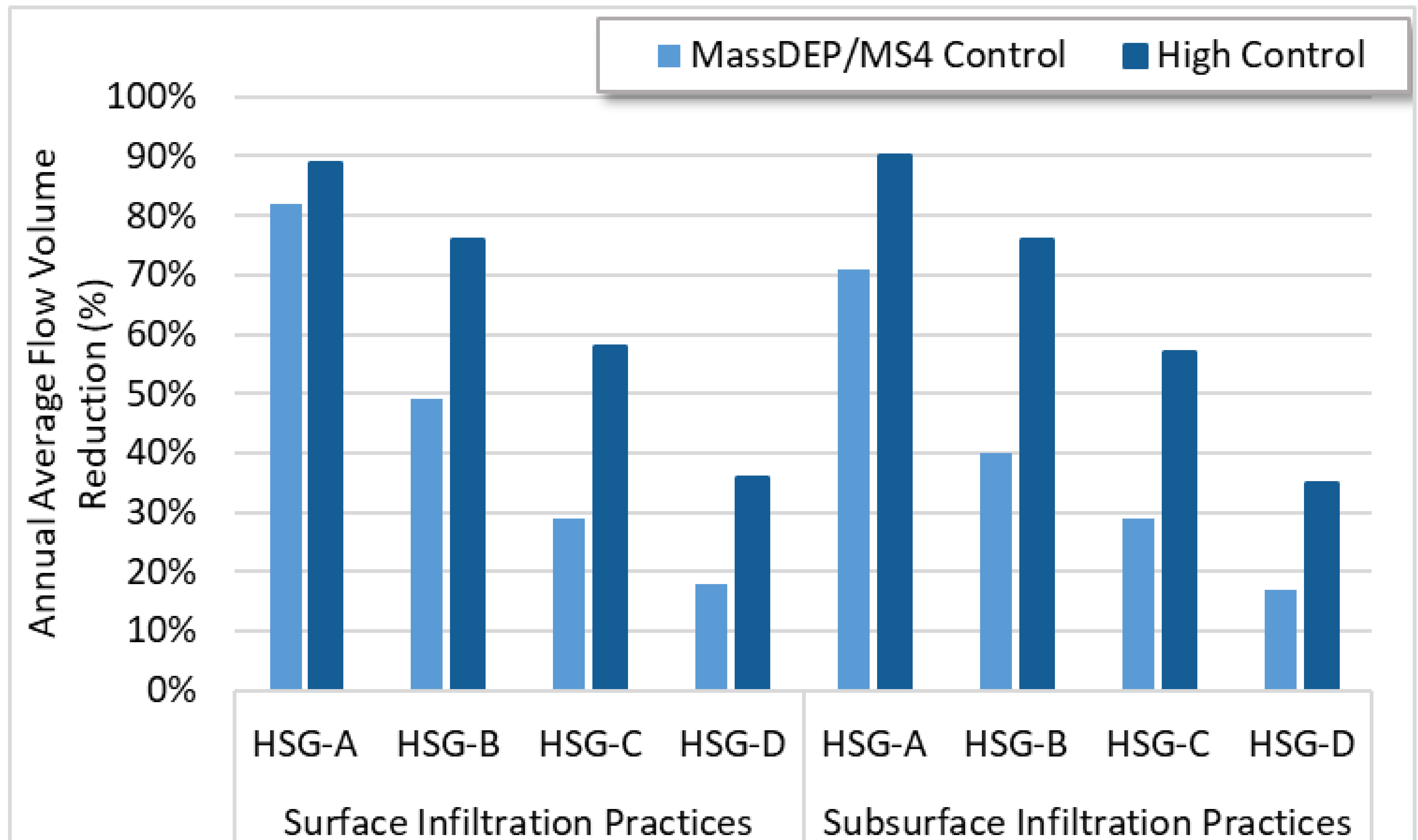


Next-Generation SCM Design and Treatment Efficiency

Current MassDEP and MS4 control standards require specific capture depths that aim to reduce TP by 60% and TSS by 90%. SCMs were sized to meet these targets using a Design Storage Volume (DSV). These current standards may not provide enough treatment to protect water quality with continued development and climate change.

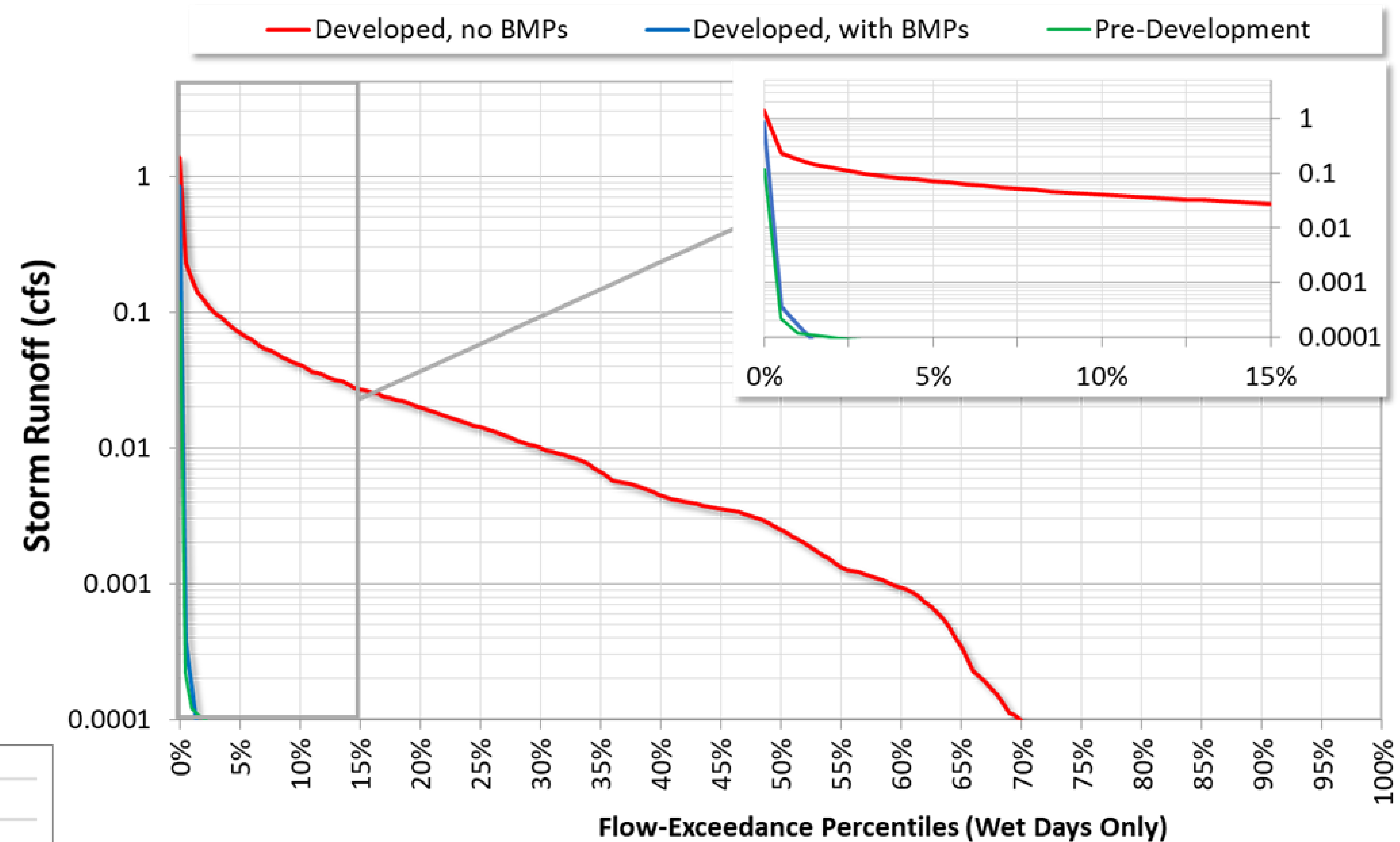
The next-generation of SCMs were sized to meet predeveloped recharge conditions with no net increase in nutrient export. These SCMs achieve high control performance, even under future climate conditions.

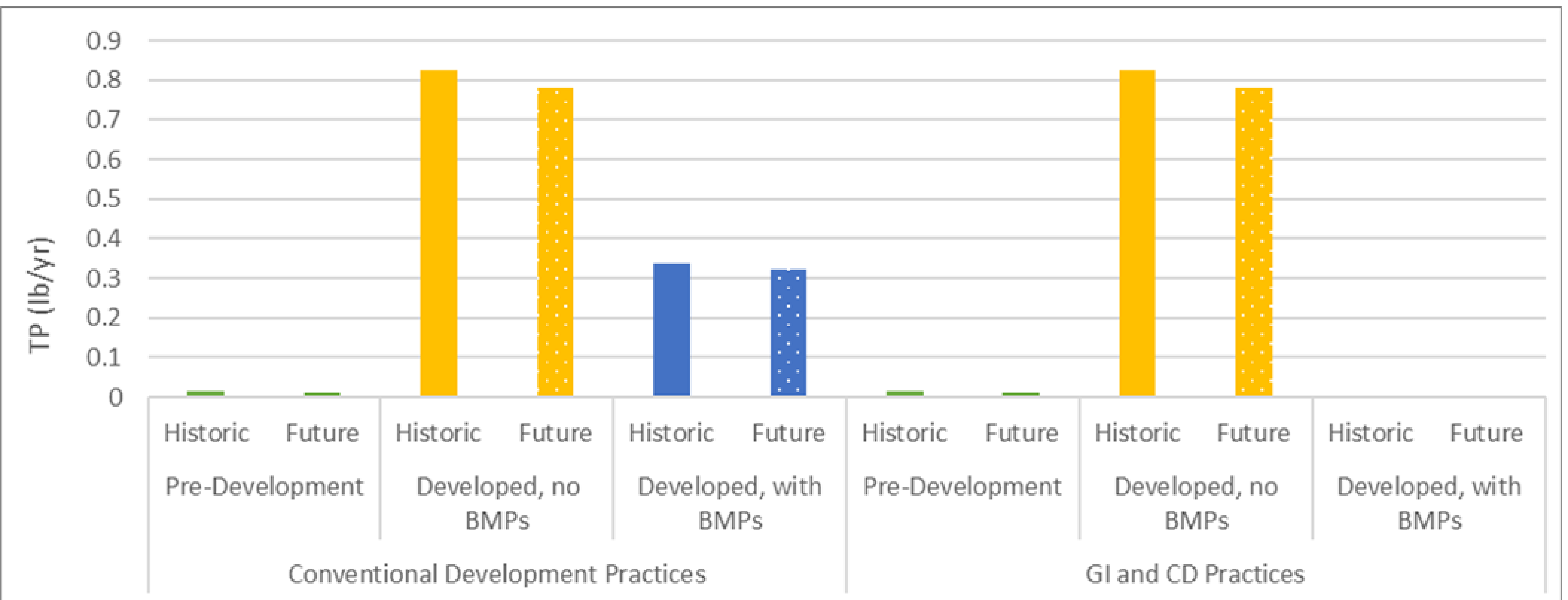


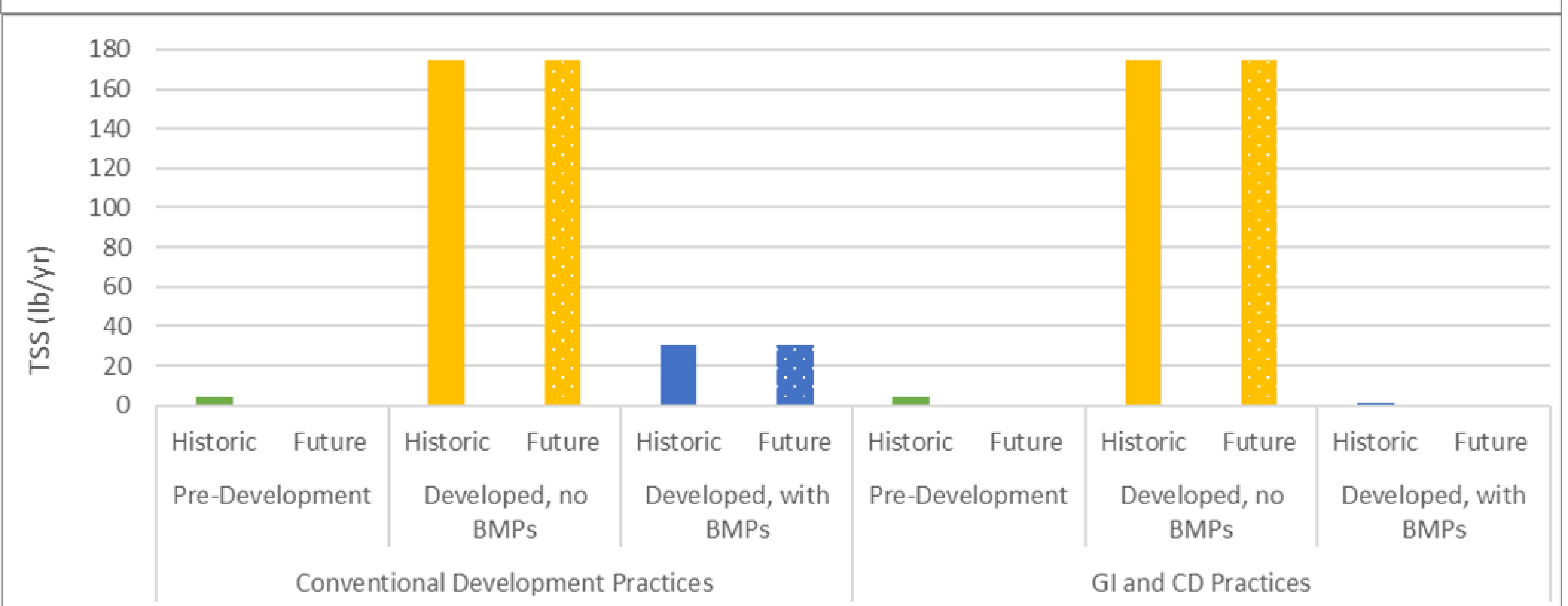


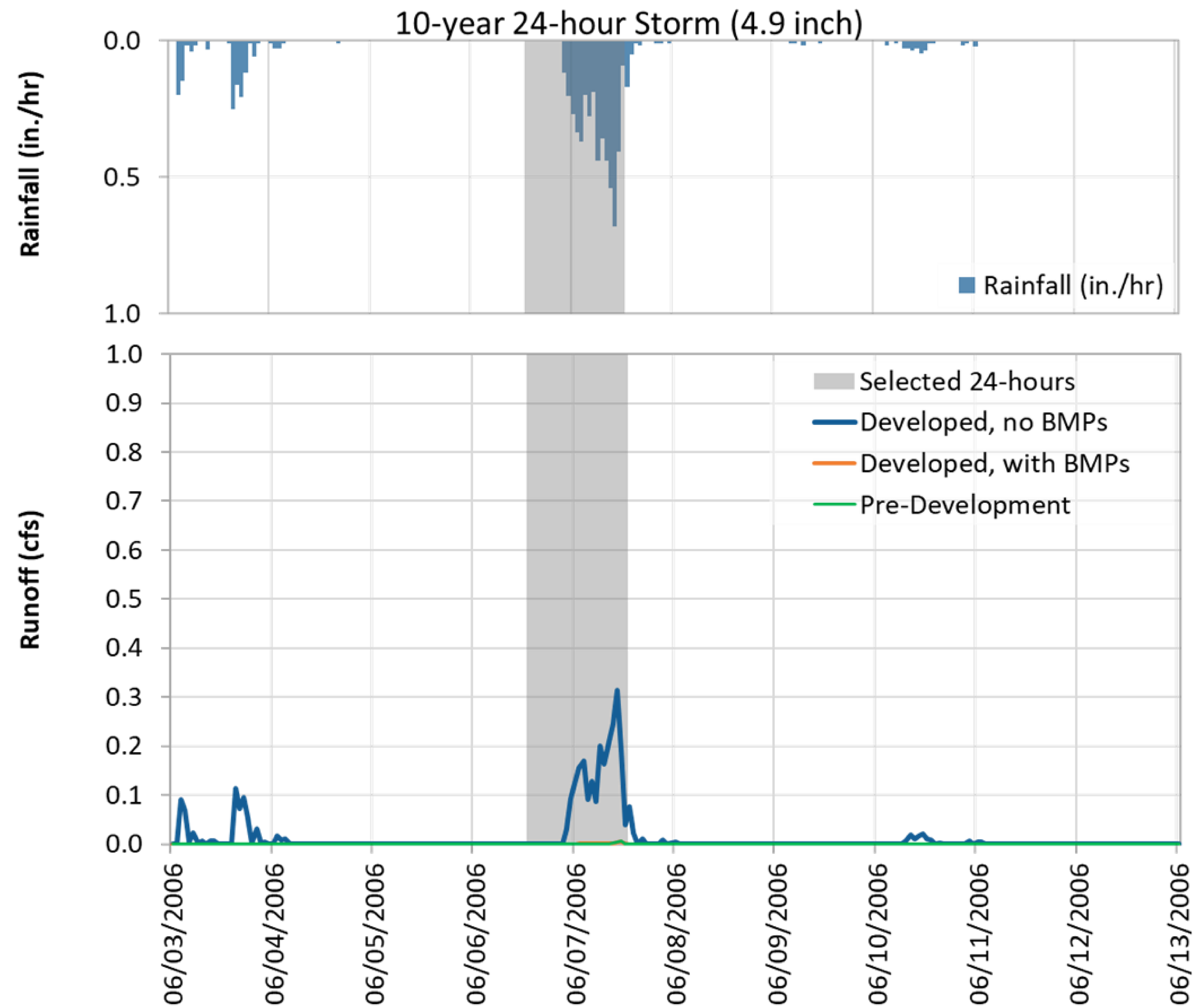
Site-Scale Stormwater Management with Green Infrastructure and Conservation Development Practices

When conservation development practices are configured as a system at the site-scale, near predevelopment hydrology can be achieved, peak flows attenuated, and pollutants controlled.



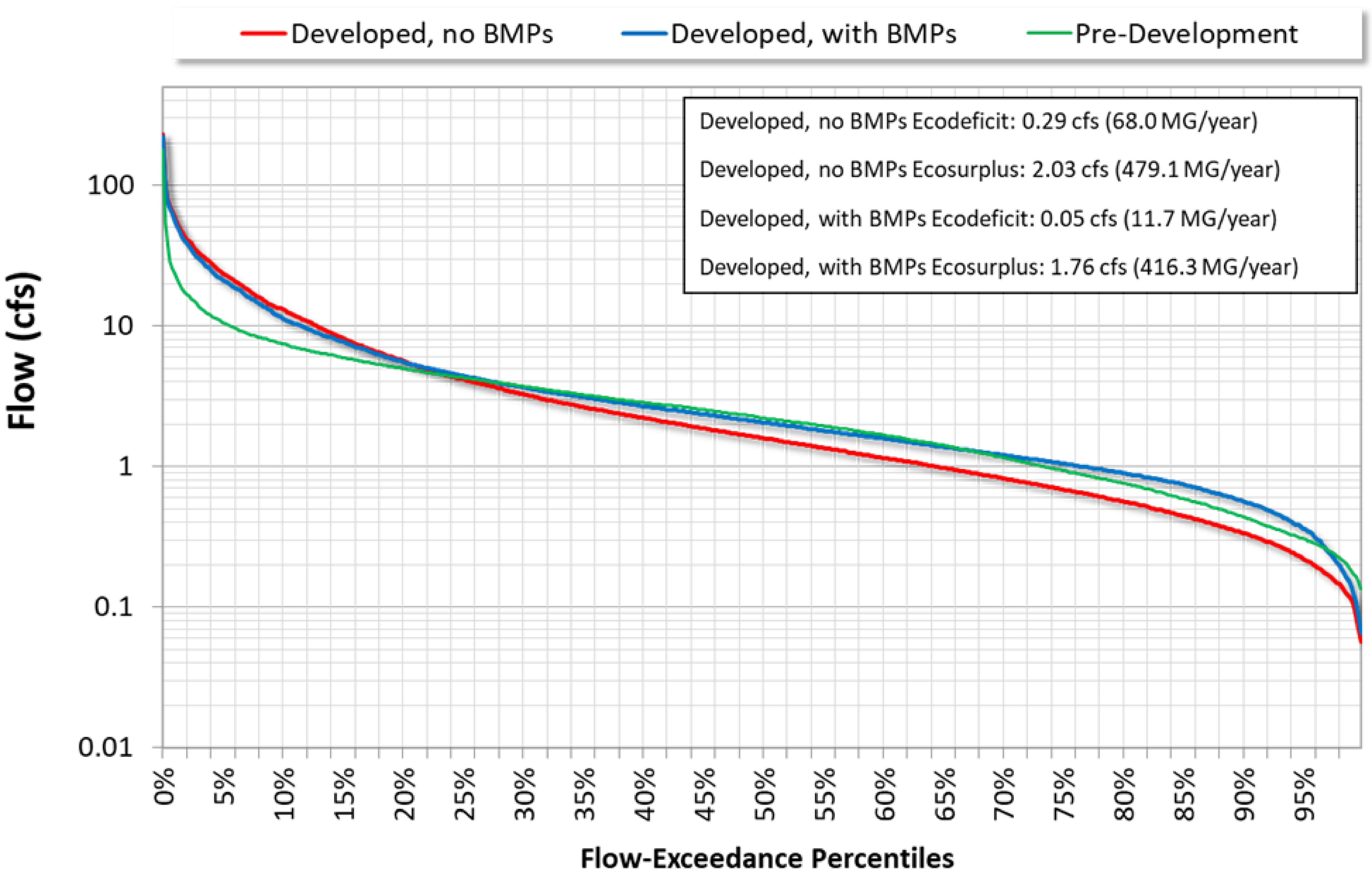




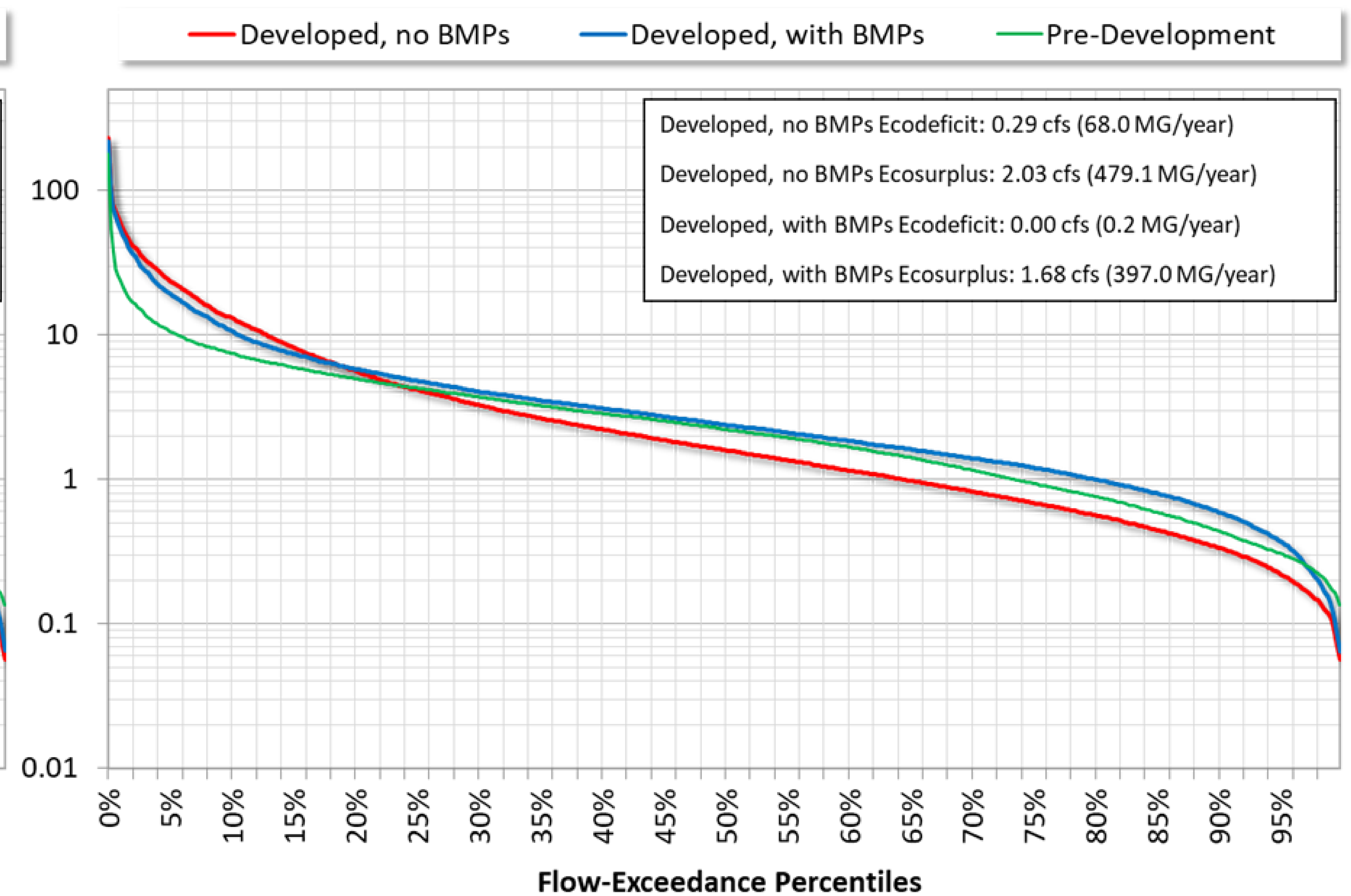


Watershed-Scale SCM Treatment Efficiency

The Upper Hodges Brook subwatershed as a simulation test-bed for next-generation SCM evaluation. These High control level SCMs provide benefits across the entire flow regime; the FDCs below show that High control SCMs reduce ecodeficits caused by future land use and climate and are closer to predevelopment hydrology, especially at high flow rates.



Flow duration curve with **MS4 control** SCMs treating 80% of the Upper Hodges Brook subwatershed's impervious cover under historic LULC and climate conditions



Flow duration curve with **High control** SCMs treating 80% of the Upper Hodges Brook subwatershed's impervious cover under future LULC and climate conditions

Watershed-Scale SCM Treatment Efficiency

As well as providing flow regime benefits for a small urbanized watershed, Conservation Development practices (High control SCMs and regulations that require treating flow from 80% of impervious cover) the watershed's TP load is reduced by 48% compared to 14% for the Business-as-Usual scenario (MS4 control SCMs and 30% of IC area treated) while accounting for future land use and climate.