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# Greenland Meadows LID Case Study: Water Quality



Greenland Meadows is a retail shopping center built in 2008 by Newton, Mass.-based New England Development in Greenland, N.H.

The development is located on a 56-acre parcel and includes three one-story retail buildings (Lowe's Home Improvement, Target, and a supermarket), paved parking areas

Greenland Meadows features the largest porous asphalt and gravel wetland installation in the Northeast.

consisting of porous asphalt and non-porous pavements, landscaping areas, a large gravel wetland, as well as advanced stormwater management facilities.

The total impervious area of the development – mainly from rooftops and non-porous parking areas – is approximately 25.6 acres, considerably more as compared to pre-development conditions. Prior to this development, the project site contained an abandoned Sylvania light bulb factory with the majority of the property vegetated with grass and trees.

Framingham, Mass.-based Tetra Tech Rizzo provided site drainage engineering, which included the design of two porous asphalt installations covering a total of 4.5 acres along with a sub-surface gravel wetland. The University of New Hampshire (UNH) Stormwater Center provided design guidance, LID project review, and oversight with the LID installations.





## ADDRESSING ENVIRONMENTAL ISSUES

During the project permitting stage, concerns arose about potential adverse water quality impacts from the project. The development would increase the amount of impervious surface on the site resulting in a higher amount of stormwater runoff compared to existing conditions.

The development is located immediately adjacent to Pickering Brook, an impaired waterway that connects to the Great Bay. One group that was particularly interested in the project's approach to managing stormwater was the Conservation Law Foundation (CLF), an environmental advocacy organization.



## LID SYSTEM FUNCTIONALITY

The two porous asphalt drainage systems – one in the main parking lot and one in the eastern parking area – serve to attenuate peak flows, while the aggregate reservoirs, installed directly below the two porous asphalt placements, serve as storage for the underlying sand filter.

Runoff from the sand filter, which itself provides extended detention and filtration, flows through perforated underdrain pipes that converge to a large gravel wetland on the west side of the site. The gravel wetland is designed as a series of flow-through treatment cells providing an anaerobic system of crushed stone with wetland soils and plants. This innovative LID design works to remove pollutants as well as mitigate the thermal impacts of stormwater.

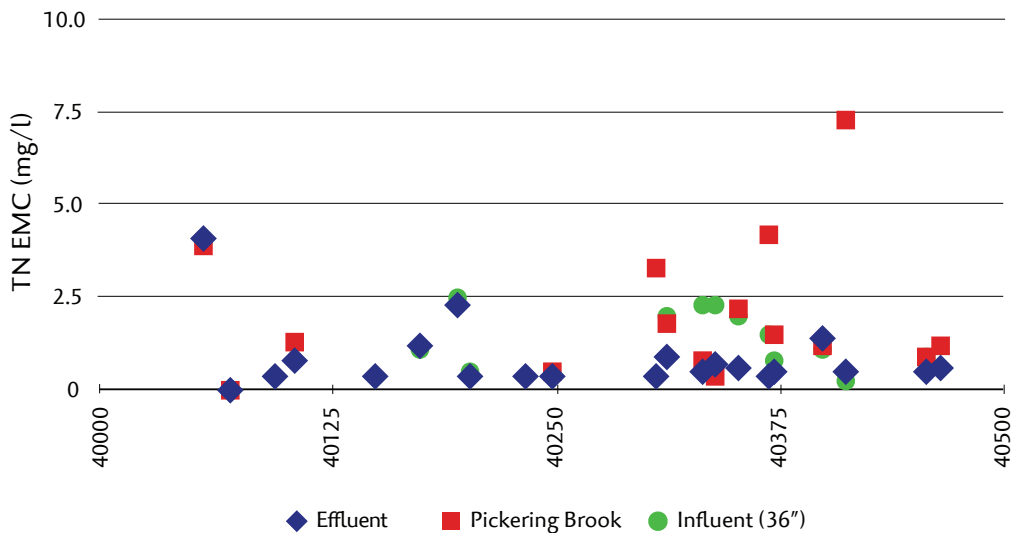


## WATER QUALITY MONITORING

A four-phase wet weather flow monitoring program involving the use of automated samplers was implemented at the Greenland Meadows site in order to assess background conditions for Pickering Brook, evaluate stormwater quality runoff from the project site, and determine the resultant water quality of Pickering Brook downstream from Greenland Meadows. This effort is also being done to assess treatment system performance with respect to effluent concentrations (pre- and post-construction) and upstream receiving water conditions.

The first three phases of monitoring were completed between July of 2007 and October 2010 and included:

- pre-construction monitoring (phase one),
- construction activity monitoring (phase two), and
- one year of post-construction monitoring (phase three).



The fourth phase is currently underway and will include four years of monitoring to determine the long-term performance of the system. Runoff constituent analyses routinely include total suspended solids (TSS), total petroleum hydrocarbons-diesel (TPH-D), total nitrogen ( $\text{NO}_3$ ,  $\text{NO}_2$ ,  $\text{NH}_4$ , TKN), and total metals (Zn). Additional analytes such as total phosphorus and ortho-phosphate have been added due to their relative importance in stormwater effluent characteristics.





|                               | POST-CONSTRUCTION | PRE-CONSTRUCTION | PICKERING BROOK |
|-------------------------------|-------------------|------------------|-----------------|
| <b>Total Suspended Solids</b> | 3 mg/L            | 5 mg/L           | 53 mg/L         |
| <b>Total Nitrogen</b>         | 0.50 mg/L         | 0.55 mg/L        | 1.35 mg/L       |
| <b>Total Phosphorus</b>       | 0.005 mg/L        | 0.05 mg/L        | .145 mg/L       |

### WATER QUALITY PERFORMANCE

To date, the median TSS, TN, and TP concentrations for the post-construction treated runoff are below pre-construction monitoring concentrations and significantly below concentrations found in the receiving waters of Pickering Brook. The results are depicted above.

Monitoring results indicate that the stormwater management systems are operating well and are providing a high level of treatment for runoff originating from a high contaminant load commercial site, offering significant protection to the impaired receiving waters of Pickering Brook.

Water quality results show that effluent pollutant levels leaving the site at the gravel wetland are typically at or below ambient stream concentrations across a wide range of contaminants. In addition, baseflow benefits, while not yet quantified, are observed discharging in a manner similar to shallow groundwater discharge, providing a nearly continuous source of cool, clean baseflow from the site.

