

EXECUTIVE SUMMARY
Berry Brook Watershed Management Plan
City of Dover, NH
September 2, 2008

INTRODUCTION

This Watershed Management Plan (hereafter referred to as the “Plan”) was prepared by The Louis Berger Group, Inc. (Berger) to provide the City of Dover, New Hampshire (hereafter referred to as the “City”) with a review and recommendations for improvements to water quality for Berry Brook and its watershed area. This Plan was prepared in accordance with the April 17, 2006 contract with the City, following meetings and correspondence with City officials and the NH Department of Environmental Services (NHDES); site inspections; a preliminary public input meeting on June 19, 2006; a public information meeting on April 10, 2008; and review and evaluation of collected watershed data.

The approximately 0.9-mile long brook is located on the west side of downtown Dover and flows north to south into the Cocheco River (refer to **Figure 1 – Locus Map**). The watershed is approximately 164 acres in size (Maguire, 2000). The Berry Brook watershed is nearly fully built-out with the majority of uses being medium density residential housing (refer to **Figure 2 – Watershed Overview Plan**). The brook is exposed for the majority of its length, but includes several culverted roadway crossings (Roosevelt Avenue; Ash, Hough and Sixth Streets), as well as two longer culverted sections: one on City property north of the water treatment plant (WTP) (approximately 900 feet long), and a second through industrial/commercial property between Maple Street and Horne Avenue.

The headwaters of Berry Brook begin in an approximate 4-acre wetland depression. The brook runs through the wetlands, culverts, a well-defined topographic valley (approximately 700 feet); and then through a broader floodplain upstream of Sixth Street, before discharging under Sixth Street to wetlands adjacent to the Cocheco River (**Figure 2**).

PLAN GOALS

The goals of this Plan are:

- To provide the City with effective measures to bring the brook into compliance with EPA and NHDES water quality standards;
- To outline costs associated with recommended best management practices (BMPs) implementation;
- To recommend measures to address existing flooding problems experienced in the vicinity of Sixth Street
- To provide an inventory of the ecological integrity of the stream system;
- To recommend measures to address ecological impairments that exist within the watershed.
- To meet EPA and NHDES requirements;
- To be used to assist the City in making informed decisions on recommended BMPs, for improving water quality within the Berry Brook watershed area; and



- To be used to assist the City in pursuing potential funding sources to implement the recommended BMPs.

BERRY BROOK WATER QUALITY

Berry Brook is classified as Class B waters. Berry Brook is not supporting use by aquatic life based on a NHDES assessment of benthic macroinvertebrate monitoring. The source of this impairment is listed primarily as urbanization which means that impervious surfaces no longer allow rain runoff to soak into the ground and large, uncontrolled contaminant-laden volumes of runoff flow directly into the brook.

The core indicator used to assess if Berry Brook (a stream $\leq 4^{\text{th}}$ order) meets aquatic life use is a biological assessment based on benthic macroinvertebrates (NHDES, 2005). Berry Brook received the lowest mean values for macroinvertebrate total abundance, Ephemeroptera, Plecoptera, and Trichoptera (EPT) abundance, and EPT taxa richness during the USGS macroinvertebrate study (Deacon et al., 2005). Berry Brook has been placed on the NHDES 2006 Section 303(d) list for Threatened or Impaired Waters (see <http://www.des.state.nh.us/wmb/was/documents/2006-NP-Sources.pdf>) for impairments of aquatic life and primary contact recreation.

E. Coli bacteria monitoring has shown that for Primary Contact Recreation, the bacteria concentrations (specifically in 2006) are resulting in poor water quality. The water quality data indicate that bacteria concentrations exceed the water quality standard during rain events.

Also, in 2006 Berger and the USGS observed “iron-rich bacteria blanketing the stream bed” in Berry Brook from the WTP site to the brook’s mouth at the Cocheco River, south of Sixth Street. Based on observations in the field and a review of City drinking water well data in the vicinity, it was determined that this iron is from groundwater discharging into the brook and its tributaries. The iron may at least partially be responsible for the impairment of the macroinvertebrate community.

The macroinvertebrate impairment is likely a result of elevated nutrient loads and/or the occurrence of iron-depositing bacteria. It appears that stormwater runoff is the largest contributor to the bacteria and nutrient impairment in the watershed. Also, water quality data indicate that while more data should be collected, the level of chlorides and the concentration of dissolved oxygen may potentially be attaining the standards.

RECOMMENDED BEST MANAGEMENT PRACTICES (BMPs)

BMPs for Bacteria Removal and Natural Resources Improvements:

As a result of the aforementioned evaluation, the stormwater BMPs recommended to reduce the *E. Coli* bacteria content and to improve the identified natural resources of the brook are summarized below, in **Table A – Recommended BMPs for Bacteria Removal and Natural Resources Improvements** (listed in suggested order of priority):



TABLE A – Recommended BMPs for Bacteria Removal and Natural Resources Improvements			
Priority	BMP#	Location	BMP Description
1	Low Impact BMPs	127 Private Properties	Install on-site rain barrels, etc. for on-site use of rainwater from roofs and other impervious area.
2	17	Brook STA 0+00 through STA 13+00	Establish conservation easements along brook.
3	N/A	Multiple locations along brook.	Streambank Restoration.
4	16	Berry Brook Headwaters	Expose brook after remove stockpiled materials, restore natural streambed; and create wetlands and detention area.
5	1	Hannaford Supermarket	Install Aqua-Filter™ System @ influent of 36-inch pipe.
6	3	Crescent Avenue	Remove Existing structure and create vegetated swale.
7	23	Confluence with River.	<ol style="list-style-type: none"> 1. Re-grade brook to flow to southwest former location. 2. Encase existing sewer in concrete. 3. Replace existing northerly 36-inch RCP.
8	4	Glencrest Avenue	Shim/overlay street to direct runoff to existing isolated infiltration basin.
9	7	Redden Street Ext.	Rip-rap entrance to and re-grade grassed swale and surrounding area; direct runoff to small proposed infiltration basin.
10	12	Maple Street Industrial site.	<ol style="list-style-type: none"> 1. Install bio-filtration islands. 2. Regularly pickup debris & trash. 3. Clean out on-site catchbasins. 4. Seal dumpster and compactor (or cover) and cover all stored materials. 5. Eliminate any non-stormwater, non-permitted discharges to brook.
11	14	Horne Street School	<ol style="list-style-type: none"> 1. Replace pavement with porous pavement with appropriate base material. 2. Install rain barrels and rain gardens. 3. Student demonstration project with school district, city, UNH and NHDES.
12	8	Redden St. Ext.	Clean out pipe & install vegetated swale.



TABLE A – Recommended BMPs for Bacteria Removal and Natural Resources Improvements (cont.)			
Priority	BMP#	Location	BMP Description
13	11A	Horne Street (south of Ash Street)	Infiltration within roadway ROW.
14	18	Corner of Ash & Horne Streets	Repair sides slopes of tributary and headwall; remove 36" CMP & restore channel.
15	18A	#48 Horne Street	Install Detention Basin on Lot #35-32A on Redden Street.
16	City	Throughout	Update & Enforce Pet Waste Program
17	City	City Regulations	Add specific regulations governing stormwater management and new/re-development and subdivisions within brook watershed.
18	21	Sixth Street residences	Do not mow within 15-feet of brook.

The following is recommended relative to all pet waste and debris throughout the watershed management area:

- develop, implement and enforce City regulations relative to the ‘pick-up’ and proper disposal requirements for pet waste and debris;
- remove the pet waste specifically found behind #62 Maple Street, and restore the area to its natural vegetative state. This area should also be installed with appropriate signage to discourage pet access adjacent to the brook;
- send an information package to all watershed property owners relative to pet waste and debris disposal within the watershed area, as well as into catch basins;
- coordinate a public information meeting and activities for all watershed property owners to emphasize the need for waste/debris control for the brook, to re-introduce the City’s “Pet Waste” initiative, and provide suggestions for personal property housekeeping; and
- re-stencil all catch basins within the watershed “No Dumping” and fish symbol.

BMPs FOR MAINTENANCE

As a result of the aforementioned evaluation, the stormwater BMPs recommended for general maintenance purposes and to reduce total suspended solids (TSS) from entering the brook are summarized below in **Table B – Recommended BMPs for Maintenance and TSS Reduction.**



Table B – Recommended BMPs for Maintenance and TSS Reduction		
BMP#	Location	BMP Description
5	Roosevelt Avenue	Add curbing, catchbasins, and associated piping; and shim/overlay roadway.
6	Lowell Avenue	Evaluate , inspect & clean existing drainage system; Install catch basins and piping; and shim/overlay and curb pavement.
10	STA 7+00 (12" CMP)	Install a reinforced concrete or masonry headwall, and rip-rap apron.
13	Near Snow Avenue	Fill in ditches with compacted gravel and re-vegetate; add rip-rap on steep slopes.
19	Ash Street Crossing	Verify culvert capacity; reconstruct 'low point' for closed catch basin installation or paved/treatment swales; reconstruct/replace up and downstream headwalls; replace culvert with an open-bottomed concrete box or arch culvert; and remove debris and stabilize sideslopes.
20	Hough Street Crossing	Verify culvert capacity; reconstruct 'low point' for closed catch basin installation or paved/treatment swales; reconstruct/replace up and downstream headwalls; replace culvert with an open-bottomed concrete box or arch culvert; and remove debris and stabilize sideslopes.

PRIVATE PROPERTY OWNER RECOMMENDATIONS

It is also recommended that the property owners within the watershed be informed of small low impact methods that will reduce, reuse, and/or treat stormwater runoff from their properties, prior to discharging to Berry Brook. These include:

- Rain Barrels and Cisterns;
- Rain Gardens, Planter and Strip;
- Drywells (with and without structures);
- Permeable/Porous paving (e.g. porous asphalt, block pavers and plastic grid pavers);
- Bioretention Areas;
- Vegetated Filter Strips;
- Vegetated Buffers;
- Vegetated Wet or Dry Swales;
- Infiltration Trenches/Basins;
- Level Spreaders;
- Rooftop Greening;
- Landscape Design Standards for Stormwater Treatment;
- Decorative Planters; and
- Tree Box Filters.



The possible cost sharing of these low impact methods between the private property owner and the City, was also discussed at the April 10th meeting, as well as possible funding through an NHDES/EPA grant. A “training day” for the property owners with handout information on these low impact methods.

POLLUTANT LOAD ANALYSIS

A pollutant loading analysis was also performed for the Berry Brook. This analysis was based on the fact that there have been numerous watershed studies throughout the country that have correlated the percentage of Impervious Cover (IC) (a.k.a. “Impervious Area (Ia)”) to the ultimate health of a watershed. According to studies, it is reasonable to rely on the surrogate measure of % IC to represent the combination of pollutants that can contribute to aquatic life impacts (Connecticut DEP, 2007). The required pollutant load reductions needed to meet a 10% and 13% IC threshold was determined, using a modification to the NHDES “Simple Method for Determining Pollutant Load Resulting from Stormwater Run-off” (Schueler, T., 1987 and NHDES).

The analysis was performed by first identifying the critical BMPs (“Engineered BMPs”) and study points (points of interest, POI) within the watershed and defining the sub-catchment boundaries for each study point. The area, land-use dominance, and impervious fraction of each sub-catchment were determined. The Simple Method was then applied, using the sub-catchment areas, land-use and impervious fraction. The removal efficiencies for the recommended BMPs were applied as appropriate to the existing conditions, offering stormwater treatment.

Pollutant loading analysis was performed applying both the loading reductions for the “Engineered BMPs” and using one or a combination of the “Low Impact BMPs (e.g assuming the use of on-site rain barrels and rain gardens to capture roof drainage), as described in Section 5.0 of the Plan. Various supplemental analysis were performed to determine what combination of Engineered and Low Impact BMPs would be successful in meeting the 10% or 13% Ia thresholds for the overall Berry Brook watershed for the parameters analyzed. It was determined, as described in Section 6.0 of the Plan, that applying all of the recommended Engineered BMPs, along with at least two-thirds (2/3) of the residences plus the Horne Street School implementation of the aforementioned Low Impact BMPs, the thresholds are met.

CONCEPTUAL COST ESTIMATES

Conceptual cost estimates for the implementation of the recommended higher priority BMPs included in **Table A** are summarized, below, in **Table C – BMP Conceptual Construction Cost Estimates**:



Table C – BMP Conceptual Construction Cost Estimates			
Priority	BMP#	Location	Conceptual Cost
1	Low Impact BMPs	127 ± Private Properties	\$124,314
2	17	Brook STA 0+00 through STA 13+00 (Survey/legal)	\$25,000*
3	Streambank Restoration	Multiple locations along brook.	N/A**
4	16	Berry Brook Headwaters	\$630,000
5	1	Hannaford Supermarket	\$126,000
6	3	Crescent Avenue	\$11,000
7	23	Confluence with River.	\$84,000
8	4	Glencrest Avenue	\$43,000
9	7	Redden Street Ext.	\$6,800
10	12	Maple Street Industrial site.	\$14,000
11	14	Horne Street School	\$328,000
12	8	Redden Street	\$3,500
13	11A	Horne Street (south of Ash Street)	\$14,150
14	18	Corner of Ash & Horne Streets	\$110,000
15	City	Pet Waste Program - Throughout watershed	Capital Budget
16	18A	#48 Horne Street	\$37,000
17	City	City Regulations	\$1,500(legal)*
18	21	Sixth Street residences	N/A (by owners)
		TOTAL =	\$1,558,264

* Assumed.

** As there are multiple locations that require streambank restoration at various levels of repair, a conceptual cost estimate for this BMP cannot be developed at this time. Additional field information and design is required.



WATER QUALITY MONITORING AND EVALUATION

It is recommended (see below) that the City first implement several of the higher priority BMPs in order to reduce loading of bacteria and nutrients to the brook from the more obvious sources. Water quality monitoring should then evaluate if the brook is still impaired and is meeting State regulations. A proposed monitoring and evaluation plan is included in this Plan. NHDES approval of the final proposed monitoring plan is recommended.

NHDES has also recommended that the approved monitoring plan be added to NHDES' Volunteer River Assessment Program (VRAP) (see <http://www.des.state.nh.us/wmb/vrap/> for more information).

FUNDING SOURCES

Federal and State grants and loans that may be available for the implementation of the Berry Brook recommended BMPs, were also researched and are summarized in the Plan.

It is recommended that the City of Dover pursue any and all funding sources through Federal and State agencies for funding assistance in implementing the recommended Berry Brook Watershed Management Plan Best Management Practices.

SUMMARY OF RECOMMENDATIONS

Upon evaluation and careful consideration of all of the collected data the following summary of recommendations are provided to the City. Refer to the Plan, **Section 11.0**, for further details:

1. Implement the higher priority BMPs as summarized in **Table A** to reduce bacteria and nutrients, and improve natural resources within the watershed.
2. Implement the BMPs as summarized in **Table B** for maintenance purposes.
3. All closed catchbasins and culverts discharging to the brook should be cleaned out, at least on an annual basis.
4. The school district should not use any pesticides and use only low phosphorous fertilizers at the Horne Street School property, to further improve the brook's water quality.
5. The City should determine the source of the dry weather flow found discharging from the 12-inch PVC pipe at #35 Redden Street.
6. It is recommended that the City improve its regulations, procedures, public involvement, and enforcement relative to pet waste and debris; and clean up the pet waste found behind #62 Maple Street, and restore the area to its natural state.
7. It is recommended that the property owners within the watershed be informed of small, low impact methods that will reduce, reuse, and/or treat stormwater runoff from their properties, prior to discharging to Berry Brook, e.g. rain barrels, rain gardens, etc.



8. The City of Dover Zoning, Land Use, Subdivision and Site Plan regulations, and the Stormwater Management Plan (SMP) are recommended to be revised to include specific pollution prevention BMPs, per proposed (or Final) Env-Wq 1500, relative to new or re-developments and subdivisions within the Berry Brook watershed area on private properties, regardless of the size of the disturbed area proposed.
9. Improve the pet waste and debris removal policies throughout the watershed management area, as described in Section 5.9 of the Plan, and implement and enforce them through changes to the City Land Use and Zoning Regulations.
10. Drainage/maintenance easements should be obtained by the City from all of the property owners along Berry Brook to allow for repair and continued maintenance of the brook and its sideslopes.
11. Prepare a Monitoring and Evaluation Plan for NHDES review and approval, for evaluation of implemented BMP performance.
12. The approved Monitoring and Evaluation Plan also needs to be added to NHDES Volunteer River Assessment Program (VRAP).
13. The City of Dover should pursue any and all funding sources through Federal and State agencies, for implementing the recommended BMPs.

