Arctic Brook, Birch Stream, Capehart Brook and Shaw Brook Watersheds

(City of Bangor-Penobscot County)

Stream Corridor Survey - Summary Report

Survey Date: August 2009
Report Date: March 2010

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ACKNOWLEDGEMENTS

We would like to thank a number of people and organizations for assistance with completing this stream corridor survey including:

- City of Bangor
- Americorps NCCC (National Civilian Community Corps)
- Maine DEP- Southern, Central and Eastern Maine Office staff
- Gene Weldon- Lane Construction

BACKGROUND

Arctic Brook is a small urban stream (0.18 miles in length) located in the City of Bangor. Birch Stream is also a small urban stream (0.5 miles in length) located entirely in Bangor. Capehart Brook (0.46 miles in length) is a small urban stream located entirely in Bangor. These three streams drain directly to the Kenduskeag River which flows into the Penobscot River. Shaw Brook (3.91 miles in length) is a larger urban stream. It's upper reaches are located in Bangor and middle/lower reaches are located in the towns of Hermon and Hampden. Shaw Brook drains to Souadabscook Stream that then flows into the Penobscot River.

All four streams are assigned as Class B waters. According to the DEP 2008 "Integrated Water Quality Monitoring and Assessment Report", Arctic Brook, Capehart Brook and Shaw Brook are "Category 5-A: Rivers and Streams Impaired by Pollutants other than those listed in 5-B through 5-D (TMDL required)". Birch Stream is a "Category 4-A: Rivers and Streams with Impaired Uses, TMDL Completed". All four streams are on DEP's Chapter 502, "Urban Impaired" streams list.

Over the period of August 18-August 20, 2010, DEP staff, City of Bangor staff, and Americorps staff conducted a Stream Corridor Survey (Level 1) of Shaw Brook. On August 21, 24 and 25 2010, Americorps staff conducted a Stream Corridor (Level 1) of Arctic Brook, Birch Stream and Capehart Brook. This survey is comprised of stream habitat survey and rapid geomorphic assessment techniques. The following presents the findings of that survey, which should help to increase the information and understanding about the brook for those involved in the survey.

Background information about the purpose, history, and methods of Stream Corridor Surveys (Level 1) is presented in Appendix A. Please note that these techniques are conducted fairly rapidly, and in a mostly qualitative (as opposed to quantitative) manner, so the results contained in this report should be viewed as a first-cut, screening-level of information. More intensive, quantitative study of the stream's condition may be necessary.

RESULTS AND DISCUSSION

Notes:

(1) Results and Discussion are broken down by stream and stream tributary reaches. Those reaches included:

- Arctic Brook Reaches "A1, A2, A3 & A4" (1229, 1230, 1231 & 1232);
- Birch Stream Reaches "A1 & A2" (1233 & 1234);
- Capehart Brook Reaches "A1, A2 & A3" (1235, 1236 & 1237)
- Shaw Brook Reaches "A1, A2/A3, A4, A5, A6 & A7" (1238, 1239, 1240, 1241, 1242 & 1243)
- Shaw Brook Tributary Reaches "B1b, B1a, B2b, B2a" (1244, 1245, 1246, & 1247)

(2) Various maps and aerial photograph images showing reach locations, scoring/ranking of various habitat conditions and sources of potential pollution, local surficial geology, and nearby land cover are contained in Appendix B.

(3) Analyses made in this report assume that a coldwater fishery supporting brook trout and other native coldwater aquatic life is the desired, natural condition for the stream of interest. The design of the survey methods and analyses are biased towards small to medium-sized wadeable streams and rivers.

Land Use, Geology, and Terrain

An Overview of the Typical Relationship between Local Land Use and Stream Conditions

Stream watersheds that are relatively undeveloped tend to have better water quality conditions, in-stream and riparian habitats, and healthier aquatic organism communities than those in heavily developed or urbanized watersheds, or watersheds dominated by agricultural lands (especially if they lack adequate, healthy, vegetated riparian buffers). In general, urban land uses degrade stream conditions because their impervious surfaces (e.g., roads, parking lots, rooftops) prevent rainwater from slowly infiltrating into the ground and instead cause it to flow quickly over these hard surfaces and pick up pollutants such as metals and hydrocarbons from automobiles, eroded soil/sediments from construction activities and winter sanding, and fertilizers and pesticides from lawn care. Additionally, stream sections in urban areas generally are "flashier" since they receive larger volumes of overland stormwater runoff within a given amount of time than those undeveloped watersheds. For a more detailed discussion of these land-use effects, refer to the Center for Watershed Protection (2003) or Allan and Castillo (2007) referenced at the end of this report.

Arctic Brook Reaches A1, A2, A3 & A4
Arctic Brook reaches flow through woods, residential and commercial developed areas within a narrow valley. The local surficial geology is primarily till-a heterogeneouse mixture of sand, silt, clay and stones. The stream begins above Grandview Avenue, runs along and crosses I-95, and then drains into Kenduskeag Stream.

Birch Stream Reaches A1 & A2
Birch Stream's watershed includes the airport, commercial and high intensity residential land use. The stream flows within a narrow valley that includes a waterfall. Local surficial geology is mostly glacialmoraine (fine-grained)- composed of silt, clay and minor amounts of gravel. The stream begins at the Airport Mall and ends at its confluence with Kenduskeag Stream.

Capehart Brook Reaches A1, A2 & A3
Capehart Brook flows through a somewhat narrow valley. The local surficial geology of reaches A1 and A2 is primarily esker. Eskers are composed of gravel and sand which may include minor amounts of till. "Portions of many eskers below the marine limit are partly or entirely buried by glaciomarine deposits."[1] The local surficial geology of reach A3 is glacial moraine (fine-grained). The watershed includes a high intensity residential area in the upper watershed-between Ohio Street and Finson Road. The brook then flows through a wooded area before draining into Kenduskeag Stream.

1 Maine DEP GIS Surficial Geology Data Layer

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Shaw Brook Reaches A1, A2/A3, A4, A5, A6 & A7
The local surficial geology of Shaw Brook mainstem is mostly glacialmoraine (fine-grained) with a small amount of esker. Reaches A1, A2/A3, A4 and A5 flow through a narrow valley, reach A6 is in a wide valley, and reach A7 flows through a somewhat narrow valley. Land use in the Shaw Brook watershed is mostly commercial and industrial which varies from low to high intensity use. The brook begins above Route 2 draining a small portion of the airport, flows through a fairly heavy commercial area that includes a railroad yard, it then crosses under Interstate 95, and goes through a wooded area before flowing into Souadabscook Stream.

Shaw Brook Tributary Reaches B1a, B1b, B2a, & B2b
Reaches B1a and B1b flow through a narrow valley, and reaches B2a and B2b through a wide valley. The local surficial geology of reaches B1a and B2a is glacialmoraine (fine-grained), B1b is esker and B2b is till. The brook begins in old agricultural fields adjacent to Colbrook Industrial Park-the brook is channelized through this area. It flows through woods crossing two roads, a railroad bed and Interstate 95. It flows along I-95, crosses Colbrook Road and then flows into Shaw Brook. Land use through this area includes commercial development and limited residential.

Streamside (Riparian) Vegetation and Temperature Conditions

Shading of river and stream waters by riparian vegetation is important to the health of coldwater fish species (e.g., brook trout and Atlantic salmon) and other aquatic organisms (e.g., aquatic insects and other macroinvertebrates) for a variety of reasons including the fact that cold water has the ability to retain more dissolved oxygen and create less physiological stress on aquatic organisms than warm water (Allan and Castillo, 2007). Healthy streamside vegetation (especially shrubs and trees) help bind streambank soils together, which helps to resist erosion, and also helps filter out stormwater pollutants that are washing over the land towards streams and other waterbodies. For these reasons, this survey included a rapid assessment of the stream's riparian vegetation conditions.

The stream assessment riparian zone protocols and scoring used in this study are somewhat biased towards smaller streams having mature forest canopies overhead. Some reaches may be fairly wide or they were heavily affected by past or current beaver activities (which often results in frequently flooded riparian areas and floodplains, and thus frequent die-off of riparian trees and shrubs). Thus, scoring for these conditions tended to be in the mid-to-low range even though riparian conditions appeared to be natural (Table 1). There were some locations that appeared to be truly impacted or degraded due to human activities, and those areas are specified below.

Arctic Brook Reaches A1, A2, A3 & A4
These reaches scored between 3 (fair) and 4 (poor). Reach A1 is only 25% shaded and reach A3 is 50% shaded. Reaches A2 and A4 are 75% shaded although A4 is wide (20 feet average). The watershed is highly developed including residential, commercial and highway development which encroaches on the stream. Natural streamside cover is noted to be severe in reach A3.

Birch Stream Reaches A1 & A2
Both reaches scored 4 (poor)-reach A1 is 25% shaded and A2 is 50% shaded. Reach A1 has a wide channel (10-15 feet) and from photos and notes appears to be widened along with being eroded. Reach A2 is also wide (18-20 feet) and similarly appears to be widened with severe bank erosion. Natural streamside cover is also noted as being severe.

Capehart Brook Reaches A1, A2 & A3
These reaches scored fair (A1 & A2) to poor (A3). Reach A1 is 6 feet wide and is 75% shaded. This reach is wide at the confluence, which along with severe degraded streamside cover contribute to fair score. Reach A2 is 75 % shaded with a channel width of 9 feet. Reach A3 is 25% shaded and only 4 feet wide-notes indicate trees are present and lawn common (photos show grassed/open area).

Shaw Brook Reaches A1, A2/A3, A4, A5, A6 & A7
These reaches scored good (A2/A3) to fair (A1, A3, A4, A5, A6 & A7). Reach A1 is 75% shaded with a 12 foot wide channel-photos show wide area at mouth. The streamside plant cover is severely degraded which affected the score. A2/A3 is 75% shaded. Reaches A4 and A5 are 50% shaded and have a 10 foot wide average channel. Reach A5 includes open and beaver habitat areas with trees present (not common) which affects the shading. Reach A6 is only 25% shaded due to open areas and effects of beaver activity. Reach A7 is 75% shaded-the lower score is due to pavement/structures common in the riparian area.

Shaw Brook Tributary Reaches B1a, B1b, B2a, & B2b
Reaches B1b and B2a scored good, B1a fair and B2b poor. The lower score for reach B1a is due to pavement/structures common in the riparian area. Reach B2b (25% shaded) is mostly open and flows through old agricultural fields with little woods.

Stream Bottom[1], Streambank, and Channel Conditions

Typically, communities of coldwater fish (i.e., salmonids such as brook trout) and other aquatic organisms (i.e., aquatic insects and other macroinvertebrates) in streams and small rivers are more diverse and robust in streams and rivers having a diverse array of habitats – especially those containing riffles, with gravel and/or cobble substrates, and pools, formed by scouring action behind boulders and downed pieces of large wood (i.e., tree trunks, logs) or other stream processes (Allan and Castillo, 2007). Gravels and cobbles provide fairly stable anchoring/attachment sites for a diversity of macroinvertebrates, algae, and aquatic plants. Because of the spaces typically found between gravels and cobbles that are not embedded (not clogged with sediments), these types of substrates also provide well-oxygenated spawning (egg-laying) sites for salmonids and excellent habitat for macroinvertebrates to crawl through and cling to. Large pieces of wood in streams and small rivers help form pools and provide cover (important habitat needs of salmonids; Flebbe and Dolloff, 1995) as well as trap leaves and twigs, which are an important food source for macroinvertebrates – a common food source for fish. In low-gradient sections of streams and small rivers dominated by fine sediment particles (e.g., sand, silt, or clay) on the stream bottom, large wood can be critical towards the maintenance of diverse communities since it is essentially the only stable substrate available to aquatic organisms (Smock et al., 1989; Allan and Castillo, 2007).

The surficial geology of the Bangor streams is primarily glaciomoraine (silt, clay, minor amounts of gravel-commonly a clayey silt) and till (heterogeneous mixture of sand, silt, clay and stones). These types of substrates, even when natural, tend not to score very well (Table 2). As for the reaches being dominated by exposed bedrock and associated weathered bedrock materials, such as boulders and rubble, these conditions probably are a result of historical, massive, glacial scouring activity that occurred throughout much of Maine. (A professional geologist is needed to verify this condition for the Bangor Streams' watershed.) The widespread presence of exposed bedrock on river and stream bottom can often be a major control on the types, shapes, and elevations of channel found throughout the watershed.

[1] Stream bottom (substrate) material size classes:

Size Class	Millimeters	Inches	Approximate Relative Size
Bedrock	> 2048	> 80	Bigger than a car ; (a.k.a. ledge)
Boulder*	> 256	> 10.1	Bigger than a basketball
Cobble	64 – 256	2.5 - 10.1	Tennis ball to basketball
Gravel	2 – 64	0.08 – 2.5	Peppercorn to tennis ball
Sand	0.06 – 2.00	0.002 – 0.08	Salt to peppercorn
Silt	< 0.06	< 0.002	Finer than salt

* Some scientists break out another group within the boulder category as "Rubble", which range from approximately from 10 to 20 inches in diameter (i.e., small boulders; larger than a basketball but smaller than a beach ball).

Arctic Brook Reaches A1, A2, A3 & A4
Reach A1 has a stream bottom dominated by silt/clay/mud. It has only deadwater and run habitats present and the water was shallow which may be a barrier to fish movement. Other issues include severe mud, silt or sand entering the reach and culverts draining to it. Reach A2 has a bottom composed primarily of silt/clay/mud and gravel. There are a variety of habitats present, but a number of impacts including severely eroded banks, garbage in the reach, severe mud/silt or sand entering and culverts/debris impeding fish movement. Reach A3 has stream bottom dominated by coarse gravel with minor amounts of fine gravel. Only deadwater and run habitats were present and numerous issues noted-undercut banks, severe bank erosion and natural streamside bank cover degradation, severe mud/silt or sand entering the reach, culverts and debris may impede fish movement and six culverts flow into the reach. All the reaches have many to plentiful large wood present.

Birch Stream Reaches A1 & A2
Reach A1 has a stream bottom composed of silt/clay/mud, cobble, rubble and boulder-larger particles were halfway embedded. Only riffle habitats were present and there were few large pieces of wood present. Several issues were noted including a large area (20 ft) of bank length eroded exposing the sewer line, the stream was generally eroded through the reach and culverts may impede fish movement. Reach A2 has stream bottom that is bedrock with minor amounts of gravel, cobble and boulder. A variety of habitats were present, substrate embeddedness low and large wood noted as being somewhat present. Particular problems included severe natural streamside degradation, severe bank erosion and waterfalls impede fish movement.

Capehart Brook Reaches A1, A2 & A3
Reach A1 has a stream bottom composed primarily of cobble with minor amounts of sand, gravel and rubble. Habitat consists of pools and riffles, substrate embeddedness was low, and there are many pieces of large wood. Problems include severely degraded natural streamside plant cover, severe bank erosion, road/trail dumping sand/silt in reach and culverts (perched culvert) may impede fish passage. Reach A2 is dominated by cobble with minor amounts of gravel and rubble. Habitat consists of pools and riffles, embeddedness is low and large wood was plentiful. Problems include common undercut banks and, garbage in and along the reach. Reach A3 is dominated by fine gravel with minor amounts of sand and coarse gravel. Substrate embeddedness is low and many pieces of large wood noted. Only run habitats were present and garbage is common along and in the stream.

Shaw Brook Reaches A1, A2/A3, A4, A5, A6 & A7
Reach A1 has a stream bottom composed of primarily silt, clay and mud with minor amounts of sand, gravel, cobble, rubble, boulder and bedrock. Habitat includes pools, runs and deadwater; substrate embeddedness is low and large wood plentiful. Issues include severely degraded natural streamside plant cover, severe bank erosion, severe mud, silt or sand and ditches entering the reach, and debris dam may impede fish passage. Reach A2/A3 has a stream bottom composed mostly of silt/clay/mud and cobble. A variety of habitats are present, substrate embeddedness is low and large wood plentiful.

Reach A4 has a stream bottom composed of primarily silt/clay/mud, gravel and cobble. A variety of habitats and many large pieces of wood were present. Reach A5 has stream bottom composed of primarily silt/clay/mud and sand. It has a variety of habitats, low substrate embeddedness and few large pieces of wood. Reach A6 is primarily silt/clay/mud and sand bottom. This reach is low gradient with lots of beaver activity. Habitats include pools, runs and deadwaters; the substrate is not embedded and large wood is few. Problems include severe mud/silt/sand entering the reach, and the natural direction of the stream was altered 90 degrees. There are also undersized culverts at access road. Reach A7 has primarily a silt/clay/mud bottom. Habitats include pools and runs and there is plentiful large wood. Problems include severe mud/silt/sand entering the stream and culverts filled with debris.

Shaw Brook Tributary Reaches B1a, B1b, B2a, & B2b
Reach B1a has a stream bottom composed of primarily silt/clay/mud and coarse gravel. There are a variety of habitats present, low embeddedness and plentiful large wood. Problems include beaver dams and perched culverts may impede fish passage. Reach B1b has a stream bottom of primarily silt/clay/mud. Habitats include riffles and runs and there is plentiful large wood. Culverts may impede fish passage. Reach B2a also has a stream bottom of predominantly silt/clay/mud. Habitats include pools, riffles and runs and there is plentiful large wood. Issues include perched culverts and gravel washed into stream at crossing. Reach B2b has a silt/clay/mud bottom. Habitat is runs and deadwaters and there was no large woody debris noted. This reach runs through old agricultural fields with little woods and the reach appears to have been straightened.

Water Quality and Potential Pollution Sources and Problems

Water quality problems including occasional to plentiful heavy coating of algae, filamentous algae and turbid conditions were noted particularly in Arctic, Birch and Capehart Brooks. Birch Stream has been extensively monitored by DEP and the City of Bangor. DEP is also currently monitoring Shaw Brook. All of the Bangor Streams are urbanized streams and have water quality problems. For Birch Stream, the water quality issues and causes are well documented. Ongoing and additional monitoring of Arctic Brook, Capehart Brook and Shaw Brook are encouraged.

Arctic Brook Reaches A1, A2, A3 & A4
Potential sources of pollution noted in Reach A1 were mud, sand or silt entering the reach and three culverts draining to the reach. Occasional heavy coating of brownish-greenish algae was present in Reach A2. Potential pollution problems include severe collapsed/eroded banks, garbage adjacent to and in the stream, asphalt in the stream, and a ditch enters the reach. The water appeared turbid in Reach A3 and occasional

brownish/greenish filamentous algae was noted in this reach and Reach A4. Potential pollution problems in Reach A3 are highways and culverts impacting the stream, severe natural streamside plant cover degraded and collapsed/eroded banks, severe garbage adjacent to and in the stream and pipe(s) entering the reach. In Reach A4, erosion throughout the reach and about 20 feet of stream was eroded exposing the sewer line.

Birch Stream Reaches A1 & A2
Plentiful attached aquatic plants and heavy coating of brownish-greenish algae and filamentous algae were all present in Reaches A1 and A2. Potential pollution problems in A1 are severe collapsed/eroded banks, severe garbage adjacent to and in the stream, severe mud-silt or sand enters the stream and pipes/ditches enter the stream. In Reach A2, natural streamside plant cover is severely degraded and collapsed/eroded banks are severe.

Capehart Brook Reaches A1, A2 & A3
Plentiful attached aquatic plants and plentiful light coating of brownish algae were noted in Reach A1. Potential pollution problems include severely degraded natural streamside plant cover and severe collapsed/eroded banks. Additionally ditches enter the stream and dirt road/trail dumps sediment in the stream. Occasional brownish-greenish filamentous algae was noted as being present in Reach A2. Potential pollution problems are severe garbage adjacent to and in the stream, and pipes and ditches enter the stream. In Reach A3, plentiful attached and floating aquatic plants, plentiful light coating of brownish-greenish algae and brownish mats of algae were all noted. Potential pollution issues include severe garbage adjacent to and in the stream, residential areas adjacent to reach and runoff from roads.

Shaw Brook Reaches A1, A2/A3, A4, A5, A6 & A7
Potential pollution problems noted in Reach A1 were severely degraded natural streamside plant cover, severe collapse/eroded banks, large parking area near stream, eroding ditches dumping sediment in stream and much to all of bank eroded. Reach A2/A3 has mud, silt or sand entering the stream. No significant problems were noted for Reach A4. Reach A5 had occasional greenish filamentous and mats of algae. Pipes and ditches enter the stream here. Reach A6 had plentiful aquatic plants and greenish filamentous algae. Mud, silt or sand entering the stream was noted as severe and pipes/ditches enter the stream. Reach A7 had occasional greenish mats of algae. Potential pollution problems are severe mud, silt or sand entering the stream; swale enters the stream, and there is a parking lot and storage facility adjacent to the stream.

Shaw Brook Tributary Reaches B1a, B1b, B2a, & B2b
Pavement/structures common in the riparian zone; mud, silt or sand enters the stream and pipe enters the stream were noted as potential pollution problems in Reach B1a. For Reach B1b, potential problems include severe garbage adjacent to the stream and I-95 runoff as the stream flows adjacent to I-95 and the exit ramp. Water appeared turbid in Reach B2a. Potential pollution issues are road, railroad and I-95 crosses the reach; and mud, silt or sand enters the stream. Plentiful attached aquatic plants were noted in Reach B2b. This reach flows through old agricultural fields and is open.

Visual Biological Survey

In Arctic Brook, amphibians and mammals (signs) were observed, but no fish. Waterfowl, mammals and rare small fish observed in Birch Stream. Amphibians and mammals were noted in Capehart. From rare small fish to abundant small and medium fish were noted in various reaches. Amphibians, reptiles, waterfowl and mammals were all noted in Shaw Brook. Fish were noted throughout the various reaches from rare to abundant small fish in upper reaches to abundant small to large fish in lower reaches. In the Shaw Brook tributary, amphibians and waterfowl were noted. From none to abundant small fish were observed in the various reaches.

(Note: Fish population surveys using quantitative methods [e.g., electroshocking, snorkeling] were not conducted in this study. Fish observations simply were noted if they occurred while surveyors were examining stream habitat conditions.)

Rapid Geomorphic Assessment (RGA)

Arctic Brook Reaches A2 and A3 are in "an adjustment" geomorphic phase and A4 is "in transition or stressed". Aggradation (i.e. accumulating or infilling excess sediment) is the primary geomorphic process occurring. Both Birch Stream reaches are in adjustment. The primary process A1 is experiencing is aggradation and A2 is widening. Capehart Reach A1 is in adjustment (primary process is widening) and Reach A2 is also in adjustment (primary process is aggradation). Shaw Brook Reaches A1, A2/A3 and A4 are all in adjustment. The primary processes are aggradation for Reaches A1 and A4, and planform adjustment (i.e. channel is becoming more straight or curvy, or cutting new side channels) for A2/A3. Reaches A5 and A7 are in transition or stressed with primary processes being widening for A5 and aggradation for A7. Shaw Brook tributary Reach B1a is in transition or stressed with primary process being aggradation.

(Note: These are preliminary geomorphic assessments meant to flag potentially problematic areas, and are not professional-level, detailed assessments.)

TABLES

Legend and Notes About Scores in Tables

1 = problems not apparent / conditions appear to be in very good
2 = minor problem / conditions appear to generally be good
3 = moderate problem / conditions appear to generally be fair
4 = major problem / conditions appear to generally be poor
5 = severe problem / conditions appear to generally be very poor

These preliminary scores are based upon best professional judgment after reviewing the available information such as volunteer field notes, photographs, and other observational data (including maps and aerial photographs).

Table 1. Streamside (riparian) vegetation and temperature conditions for the different survey reaches within the Bangor Streams' watershed: This vegetation zone is important for shading of the stream and bank stability. Shade conditions may be natural for wide areas especially where the riparian zone appears pretty well vegetated [including tall trees].

Reach ID	Stream Name	Streamside (Riparian) Vegetation and In-Stream Temperature Conditions	Preliminary Score
A1	Arctic Brook	--- 25% shaded; (channel width estimated to be 1 ft); trees, bushes, grasses common in the riparian zone; lawn and pavement/structures are present in riparian zone and along the stream.	4
A2	Arctic Brook	--- 75% shaded; (channel width not noted- is less than 6 ft since described as narrow channel); Trees and bushes common in riparian zone, but lawn, bare soil and pavement/structures also present in riparian zone and along the stream edge; natural streamside plant cover is degraded.	3
A3	Arctic Brook	--- 50% shaded; (channel width estimated to be 5 ft); trees, bushes and pavement/structures common in riparian zone; lawns and structures present along stream; streamside plant cover is severely degraded.	4
A4	Arctic Brook	--- 75% shaded; (channel width is much wider-estimated to be 20 ft); trees, bushes common in riparian zone; lawn, gravel/sand, and pavement/structures also present; lawn and structures present along stream; streamside plant cover degraded.	3
A1	Birch Stream	--- 25% shaded; (channel width estimated to be 15-20 ft); bushes, gravel/sand and structures are common in the riparian zone; trees and lawn are present in riparian zone; lawns and structures are present along the stream; natural streamside plant cover is degraded.	4
A2	Birch Stream	--- 50% shaded; (channel width estimated to be 18-20 ft); trees, bushes, grasses and boulders common in riparian zone; lawn, gravel/sand and pavement/structures are also present in riparian zone; lawn and structures present along the stream; natural streamside plant cover is severely degraded.	4
A1	Capehart Brook	--- 75% shaded; (channel width estimated to be 6 ft); trees, bushes, grasses and boulders are common in the riparian zone; gravel/sand and structures are present in the riparian zone; natural streamside plant cover is severely degraded.	3
A2	Capehart Brook	--- 75% shaded: (channel width estimated to be 9 ft); trees and grasses/ferns are common in the riparian zone; fields and pavement/structures are present in riparian zone; structures present along the stream; natural streamside plant cover is degraded.	3
A3	Capehart Brook	--- 25% shaded; (channel width estimated to be 4 ft); trees, bushes, grasses, gravel/sand, pavement/structures present in the riparian zone and lawn is common; structures are present along the stream.	4
A1	Shaw Brook	--- 75% shaded; (channel width estimated to be 12 ft); trees, bushes, grasses are common in the riparian zone; natural streamside plant cover is severely degraded.	3
A2/A3	Shaw Brook	--- 75% shaded; (channel width estimated to be 10 ft); trees, bushes, grasses common in riparian zone; structures are present along the stream.	2
A4	Shaw Brook	--- 50% shaded; (channel width estimated to be 10 ft); trees, bushes, grasses common in riparian zone.	3
A5	Shaw Brook	--- 50% shaded; (channel width estimated to be 10 ft); trees, bushes, grasses, gravel/sand and pavement/structures present in the riparian zone.	3

A6	Shaw Brook	--- 50% shaded; (channel width estimated to be 10 ft); trees, bushes, grasses, gravel/sand and pavement/structures present in riparian zone.	3
A7	Shaw Brook	--- 75% shaded; (channel width estimated to be 1 ½ ft); trees, bushes, and pavement/structures common in riparian zone; grasses, bare soil, gravel/sand are present in riparian zone.	3
B1a	Shaw Brook Trib	--- 75% shaded; (channel width estimated to 6 ft); trees, bushes, grasses and pavement/structures common in riparian zone; structures are present along the stream.	3
B1b	Shaw Brook Trib	--- 100% shaded; (channel width estimated to be 5 ft); trees, bushes, grasses are common in riparian zone; gravel/sand, pavement/structures and fields present in riparian zone; structures present along the stream.	2
B2a	Shaw Brook Trib	--- 75% shaded; (channel width estimated to be 4 ft); trees and bushes common in riparian zone; grasses, pavement/structures and fields present in riparian zone.	2
B2b	Shaw Brook Trib	--- 25% shaded; (channel width estimated to be 6 ft); riparian zone consists of primarily field-trees and bushes are present; field is common along the stream and structures are present.	4

Table 2. Stream bottom, streambank, and channel conditions for the different survey reaches within the Bangor Streams' watershed. Stream bottom condition scores are based upon ecological requirements of cold water fish and aquatic macroinvertebrates. *Notes:* [a] Note that many of these stream bottom conditions appear to a result of *natural* factors such as geology and large channel size in some cases. (See text in the Results and Discussion section for comments on possible geologic and topographic factors influencing stream bottom and channel conditions.) [b]Substrates were considered "not embedded" if the stream bottom was all bedrock, sand, or silt (i.e., it lacked any gravel, cobbles, rubble, or boulders). * "Hanging culverts" impede fish movement upstream and downstream; they can also cause channel morphology problems such as sedimentation (upstream) and excessive bank scour (downstream).

				Preliminary Scores	
Reach ID	**Stream Name**	**Stream Bottom Conditions [a, b]**	**Streambank and Channel Conditions *** (other than stream bottom substrate)	**Stream Bottom [a]**	**Streambank & Channel**
A1	Arctic Brook	*Dominant substrate*: silt/clay/mud *Minor substrate*: sand *Trace substrate*: gravel, cobble *Substrate embeddedness*: none *Large wood presence*: plentiful	Deadwater and run habitats present. Mud, silt or sand entering the stream severe. Shallowness of water may be barrier to fish movement. Three culverts drain into stream.	3	5
A2	Arctic Brook	*Dominant substrate*: n/a *Minor substrate*: silt/clay/mud, gravel *Trace substrate*: cobble, boulder *Substrate embeddedness*: low *Large wood presence*: many	A variety of habitats present. Banks severely eroded. Garbage common along and in the stream channel. Mud , silt or sand entering the stream severe. Culvert(s) and debris impede fish movement.	3	4
A3	Arctic Brook	*Dominant substrate*: coarse gravel *Minor substrate:* fine gravel *Trace substrate*: silt/clay/mud, sand, cobble, rubble, boulder *Substrate embeddedness*: low *Large wood presence*: plentiful	Deadwater and run habitats present. Undercut banks common. Natural streamside plant cover degradation and bank erosion severe. Garbage common along and in the stream channel. Mud, silt or sand entering the stream severe. Culvert(s) and debris impede fish movement. Six culverts on highway side of stream flow into stream.	2	5
A4	Arctic Brook	*Dominant substrate*: n/a *Minor substrate*: sand, gravel, cobble, rubble, boulder *Trace substrate*: silt/clay/mud, bedrock *Substrate embeddedness*: low *Large wood presence*: few	Only riffles habitat present. About 20 feet of bank length eroded exposing sewer pipe. Stream generally eroded through the reach. Culvert(s) impede fish movement.	3	4
A1	Birch Stream	*Dominant substrate*: n/a *Minor substrate*: silt/clay/mud, gravel, cobble, rubble, boulder *Trace substrate*: n/a *Substrate embeddedness*: high *Large wood presence*: halfway	Variety of habitats present-pools, riffles, runs. 2 pools ≥ 2 ft deep. Undercut bank common. Bank erosion severe. Garbage common along and in the stream. Mud, silt or sand entering the stream severe.	4	4
A2	Birch Stream	*Dominant substrate*: Bedrock *Minor substrate*: gravel, cobble, boulder *Trace substrate*: silt/clay/mud, sand, rubble	Variety of habitats present-pools, riffles, runs and cascades. 2 pools ≥ 2 ft. Natural streamside plant	2	4

		Substrate embeddedness: low *Large wood presence*: somewhat	cover severely degraded. Bank erosion severe. Waterfalls impede fish movement.		
A1	Capehart Brook	*Dominant substrate*: cobble *Minor substrate*: sand, gravel, rubble *Trace substrate*: boulder, bedrock *Substrate embeddedness*: low *Large wood presence*: many	Habitat consists of pools and riffles. Undercut banks common. Natural streamside plant cover severely degraded. Bank erosion severe. Dirt road/trail dumping sand/silt into stream. Culvert(s) impede fish passage.	2	4
A2	Capehart Brook	*Dominant substrate*: cobble *Minor substrate*: gravel, rubble *Trace substrate*: sand, boulder, bedrock *Substrate embeddedness*: low *Large wood presence*: plentiful	Habitat consists of pools and riffles. Undercut banks common. Garbage common along and in the stream.	2	3
A3	Capehart Brook	*Dominant substrate*: fine gravel *Minor substrate*: sand, coarse gravel *Trace substrate*: silt/clay/mud, cobble, rubble *Substrate embeddedness*: low *Large wood presence*: many	Runs are the only habitat present. Garbage common along and in the stream.	3	4
A1	Shaw Brook	*Dominant substrate*: silt, clay, mud *Minor substrate*: sand, gravel, cobble, rubble, boulder, bedrock *Trace substrate*: n/a *Substrate embeddedness*: low *Large wood presence*: plentiful	Habitat includes pools, runs and deadwater. Undercut banks common. Natural streamside plant cover severely degraded. Bank erosion severe. Mud, silt or sand and ditches entering the stream severe-source eroded ditches. Debris dams impede fish passage.	3	5
A2/A3	Shaw Brook	*Dominant substrate*: n/a *Minor substrate*: silt/clay/mud, cobble *Trace substrate*: gravel, rubble, boulder, bedrock *Substrate embeddedness*: low *Large wood presence*: plentiful	Variety of habitats present- pools, riffles, runs and deadwater. Undercut banks common.	3	2
A4	Shaw Brook	*Dominant substrate*: n/a *Minor substrate*: silt/clay/mud, gravel, cobble *Trace substrate*: sand, rubble, boulder *Substrate embeddedness*: n/a *Large wood presence*: many	Variety of habitats present- pools, riffles, runs and deadwater. Undercut banks common.	3	2
A5	Shaw Brook	*Dominant substrate*: n/a *Minor substrate*: silt/clay/mud, sand *Trace substrate*: gravel, cobble, rubble, boulder *Substrate embeddedness*: low *Large wood presence*: few	Variety of habitats present- pools, riffles, runs and deadwater.	4	2
A6	Shaw Brook	*Dominant substrate*: n/a *Minor substrate*: silt/clay/mud, sand *Trace substrate*: gravel *Substrate embeddedness*: not embedded *Large wood presence*: few	Habitat includes pools, runs and deadwater. Mud/silt/sand entering the stream severe. Natural direction of stream altered 90 degrees. Lots of beaver activity- low gradient sandy-muddy stream.	4	4
A7	Shaw Brook	*Dominant substrate*: silt/clay/mud *Minor substrate*: n/a *Trace substrate*: sand/gravel *Substrate embeddedness*: not embedded *Large wood presence*: plentiful	Habitat consists of pools and runs. Mud/silt/sand entering the stream severe. Culverts filled with debris impeding fish passage.	4	5
B1a	Shaw Brook Trib	*Dominant substrate*: n/a *Minor substrate*: silt/clay/mud, coarse gravel,	Habitat includes pools, riffles and runs. Beaver dams and perched	3	3

		cobble *Trace substrate*: sand, fine gravel, rubble, boulder *Substrate embeddedness*: low *Large wood presence*: plentiful	culverts impeding fish passage.		
B1b	Shaw Brook Trib	*Dominant substrate*: silt/clay/mud *Minor substrate*: n/a *Trace substrate*: sand, gravel *Substrate embeddedness*: not embedded *Large wood presence*: plentiful	Habitat consists of riffles and runs. Culverts impede fish passage.	4	3
B2a	Shaw Brook Trib	*Dominant substrate*: silt/clay/mud *Minor substrate*: n/a *Trace substrate*: sand, gravel, cobble, rubble, boulder *Substrate embeddedness*: not embedded *Large wood presence*: plentiful	Habitat consists of pools, riffles, runs. Perched culverts impede fish passage. Gravel washed into stream at crossing.	4	3
B2b	Shaw Brook Trib	*Dominant substrate*: silt/clay/mud *Minor substrate*: n/a *Trace substrate*: n/a *Substrate embeddedness*: not embedded *Large wood presence*: none	Habitat is runs and deadwater only. Fields common along most of the stream reach. It appears that the stream has been straightened likely for former agricultural use.	5	4

Table 3. Water quality issues and potentially significant pollution problems/sources for the different survey reaches within the Bangor Streams' watershed. *Notes*: [a] (Water quality notes and scores are based upon qualitative volunteer observations only. No actual quantitative measurements were made. Sites were given a preliminary score of "NAI" [no apparent impact] if no negative water observations were noted for a particular river reach. A score of "?" indicates that follow-up water quality monitoring or observations may be needed to verify issues that are noted here.

				Preliminary Scores	
Reach ID	**Stream Reach Name**	**Water Quality Issues [a]**	**Potentially Significant Sources of Pollution**	**Water Quality [a]**	**Potential Pollution Problem**
A1	Arctic Brook	Additional water quality monitoring encouraged on Arctic Brook.	Mud, silt, or sand entering the stream noted as severe. Three culverts drain into the stream.		5
A2	Arctic Brook		Banks collapsed/eroded noted as severe. Garbage adjacent to and in the stream severe-asphalt in stream noted. Ditch enters the stream. Occasional heavy coating of brownish/greenish algae present.		5
A3	Arctic Brook		Water appeared turbid. Highway and culverts impact stream. Natural streamside plant cover severely degraded and banks collapsed/eroded noted as severe. Garbage adjacent to and in the stream severe. Pipe(s) entering the stream. Attached aquatic plants plentiful. Occasional brownish/greenish filamentous algae present.		5
A4	Arctic Brook		Occasional brownish/greenish filamentous algae present. About 20 feet of stream eroded exposing sewer line. Erosion throughout reach.		5
A1	Birch Stream	Birch Stream has been extensively monitored by DEP and the City of Bangor.	Banks collapsed/eroded noted as severe. Garbage adjacent to and in the stream severe. Mud, silt or sand entering the stream severe. Pipe(s) and ditches enter the stream. Plentiful attached aquatic plants. Plentiful heavy coating of brownish/greenish algae and filamentous algae.		5
A2	Birch Stream		Natural streamside plant cover severely degraded and banks collapsed/eroded noted as severe. Plentiful attached aquatic plants. Plentiful heavy coating of brownish/greenish algae and greenish filamentous algae.		5
A1	Capehart Brook	Additional water quality monitoring encouraged on Capehart Brook.	Natural streamside plant cover severely degraded and banks collapsed/eroded noted as severe. Ditches enter the stream-dirt road and trail dumps sediment into stream. Plentiful attached aquatic plants. Plentiful light coating of brownish algae.		5

A2	Capehart Brook		Garbage adjacent to and in the stream severe. Pipe(s) and ditches enter the stream. Occasional brownish-greenish filamentous algae.		4
A3	Capehart Brook		Garbage adjacent to and in the stream severe. Plentiful attached and floating aquatic plants. Plentiful light coating of brownish/greenish algae and brownish mats of algae. Residential area adjacent to stream and runoff from roads.		5
A1	Shaw Brook	(note water quality monitoring is being done by DEP-three stations on main stem and one on trib)	Natural streamside plant cover severely degraded and banks collapsed/eroded noted as severe. Large parking area near the stream. One side of stream has eroding ditches dumping sediment into stream. Much to all of bank eroded.		5
A2/A3	Shaw Brook		Mud, silt or sand enters the stream. No other significant water quality issues noted.		3
A4	Shaw Brook		No significant water quality issues noted.		2
A5	Shaw Brook		Pipes and ditches enter the stream. Occasional greenish filamentous and mats of algae.		3
A6	Shaw Brook		Mud, silt or sand entering the stream noted as severe. Pipes and ditches enter the stream. Plentiful aquatic plants and greenish filamentous algae.		4
A7	Shaw Brook		Mud, silt or sand entering the stream noted as severe. Swale enters the stream. Occasional greenish mats of algae. Parking lot and storage facility adjacent to stream.		4
B1a	Shaw Brook Trib		Pavement/structures common in the riparian zone. Mud, silt or sand enters the stream. Pipe enters the stream.		5
B1b	Shaw Brook Trib		Garbage adjacent to the stream severe. Section of stream runs adjacent to I-95 off ramp. Monitoring done by DEP indicates high conductivity likely due to chloride.		4
B2a	Shaw Brook Trib		Water appearance is turbid. Mud, sand or silt enters the stream. Road and railroad cross the reach as well as I-95.		3
B2b	Shaw Brook Trib		Stream flows through extensive fields (old agricultural area?). Plentiful attached aquatic plants.		3

Table 4. Rapid geomorphic assessment (RGA) conditions for the different survey reaches within the Bangor Streams' watershed. "Degradation" indicates that the river channel is incising or downcutting to a lower elevation, "Aggradation" indicates that the river channel is accumulating excess deposits of sediments, and "Planform" indicates that the river channel is becoming more straight or sinuous/curvy or it is cutting new side channels. 1^o = primary; 2^o = secondary.

Reach ID	Stream Reach Name	1^o Geomorphic Process	2^o Geomorphic Process	Notes	Preliminary Score
A1	Arctic Brook	Aggradation	Widening	In-regime	2
A2	Arctic Brook	Aggradation	Widening	In adjustment	4
A3	Arctic Brook	Aggradation	Widening	In adjustment	4
A4	Arctic Brook	Aggradation	Degradation	In transition or stressed	3
A1	Birch Stream	Aggradation	Degradation	In adjustment	4
A2	Birch Stream	Widening	Degradation	In adjustment	4
A1	Capehart Brook	Widening	Degradation	In adjustment	4
A2	Capehart Brook	Aggradation	Widening	In adjustment	4
A3	Capehart Brook	Aggradation	Widening	In regime	2
A1	Shaw Brook	Aggradation	Widening	In adjustment	4
A2/A3	Shaw Brook	Planform Adjustment	Widening	In adjustment	4
A4	Shaw Brook	Aggradation	Planform adjustment	In adjustment	4
A5	Shaw Brook	Widening	Aggradation	In transition or stressed	3
A6	Shaw Brook	Aggradation	Widening	In regime	2
A7	Shaw Brook	Aggradation	Widening	In transition or stressed	3
B1a	Shaw Brook Trib	Aggradation	Widening	In transition or stressed	3
B1b	Shaw Brook Trib	Aggradation	Widening	In regime	2
B2a	Shaw Brook Trib	Aggradation	Planform adjustment	In regime	2
B2b	Shaw Brook Trib			RGA form not completed-noted that stream stable in this reach	--

Table 5. Summary of scores and (preliminary) overall condition for the different survey reaches within the Bangor Streams' watershed. "RGA" = rapid geomorphic assessment. "NAI" = no apparent impact. "?" indicates that follow-up water quality monitoring or observations may be needed to verify issues that are earlier in the report.

Reach ID	Stream Reach Name	Riparian / Temperature	Stream Bottom	Streambank / Channel	Water Quality	Potential Pollution Problem	RGA	Overall Condition
A1	Arctic Brook	4	3	5		5	2	4
A2	Arctic Brook	3	3	4		5	4	4
A3	Arctic Brook	4	2	5		5	4	4
A4	Arctic Brook	3	3	4		5	3	4
A1	Birch Stream	4	4	4		5	4	4
A2	Birch Stream	4	2	4		5	4	4
A1	Capehart Brook	3	2	4		4	4	3
A2	Capehart Brook	3	2	3		4	4	3
A3	Capehart Brook	4	3	4		5	2	4
A1	Shaw Brook	3	3	5		5	4	4
A2/A3	Shaw Brook	2	3	2		3	4	3
A4	Shaw Brook	3	3	2		2	4	3
A5	Shaw Brook	3	4	2		3	3	3
A6	Shaw Brook	3	4	4		4	2	3
A7	Shaw Brook	3	4	5		5	3	4
B1a	Shaw Brook Trib	3	3	3		5	3	3
B1b	Shaw Brook Trib	2	4	4		4	2	3
B2a	Shaw Brook Trib	2	4	4		4	2	3
B2b	Shaw Brook Trib	4	5	4		3	--	4

CONCLUSIONS AND SUGGESTED NEXT STEPS

Local municipalities, local land conservation groups, and regional conservation organizations should be encouraged to preserve riparian and floodplain lands in order to maintain a healthy river system. Additionally, local and regional conservation groups should consider implementing best management practices on sources of pollutants to the river such as eroded soil, winter sand, and lawn care chemicals, as identified in this report.

Riparian Areas

Efforts to preserve or restore riparian vegetation in the watershed would serve many functions including:

- Providing shade and, thus, cool water temperatures (important to native aquatic life).
- Contributing leaves (a food source for aquatic insects which are, in turn, a food source for fish) and fallen large wood (which promotes in-stream habitat diversity).
- Stabilizing streambanks.
- Acting as a filter for pollutants carried by stormwater runoff.

Consider working with landowners where riparian vegetation corridors (buffers) are narrow in width, lacking tall trees, and where one wouldn't expect repeated natural flooding due to beaver activity. Some suggested sites revisit for potential improvements in riparian conditions include:

Stream Crossings, Culverts, and Bridges

Stream crossings, especially culverts, could be improved or replaced over time in order to create better opportunities for fish such as brook trout to have a better chance to be able to migrate upstream and downstream.

(Fish typically prefer natural stream bottom materials such as cobbles, or corrugated metal, on the bottom of culverts or other stream crossings because they help to break-up high velocity flows.)

Erosion Control and Other Issues

Keep in mind that streams and rivers move and migrate over time. Erosion is a natural process in flowing waters. That said, some erosion can be quite severe and often attributed to human activities in the watershed. Reducing the addition of eroded soils and sediments from land uses up in the watershed often is an important step towards reducing stream and river habitat degradation and destabilization. Also, in some cases, streambank stabilization in certain areas is beneficial in areas where the banks are extremely unstable and most likely a result of human activities upstream or immediately adjacent to the stream. Generally, stabilization with riparian tree and shrub plantings is recommended over other stabilization techniques. In some cases, other types of best management practices (BMPs) are needed (e.g., road turnouts into vegetated buffers, resurfacing of roads, more aggressive street sweeping of winter sand). Consult with experienced stream restoration and soil conservation professionals before embarking on restoration or conservation activities.

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