

**Agency of Natural Resources
Department of Environmental Conservation**

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MEMORANDUM

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Thru: Peter LaFlamme, WQD Director
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From: Richard Levey, Environmental Scientist
Date: October 05, 2008

Subject: Summary of Biological and Chemical assessments conducted in 2005 & 2007 within the Lamoille River and Missisquoi River watersheds in Lowell and Eden Vermont.

VTDEC Biomonitoring and Aquatic Studies Section (BASS) has conducted biological, chemical and physical assessments at 23 sites within the Lamoille River and Missisquoi River watersheds. The 13 sites located within the Lamoille River watershed are located on Hutchins Brook, Dark Branch and the Gihon River. The 10 sites within the Missisquoi River watershed are located on Burgess Branch and tributaries, Corez Pond and the Lowell Mine Pit Pond. All of the sites assessed are in close proximity to the Eden/Lowell Asbestos Mine.

These assessments were intended to address potential impacts to the aquatic biota, surface waters and streambed sediment related to asbestos mine tailings being transported down into the Lamoille River and Missisquoi River watersheds.

This summary includes the 2005 findings previously reported from the May 13th, 2005, August 24th and August 25th, 2005 assessments conducted by VTDEC (See VTDEC Memo's to McVeigh dated June 23, 2005, December 19, 2005 and July 14, 2006). All biological and water chemistry samples were collected following procedures described in VTDEC R.A.LaRosa Laboratory QA Plan Section 7.2.

The biological and chemical assessments conducted within the Lamoille River and Missisquoi River watersheds show that aquatic biota is degraded in both watersheds and there is significant evidence that the stressors are coming from tailing piles located within the Hutchins Brook (Lamoille) and Burgess Branch (Missisquoi) watersheds. The stream station locations and descriptions are given in **Table 1**, with approximate locations illustrated in **Figure 1** and **Figure 2**.

The biological, chemical and physical assessments conducted at the 23 sites within the Lamoille River and Missisquoi River watersheds are presented in **Table 2**. Macroinvertebrate and fish communities were sampled to assess the biological integrity of the streams at 15 and 13 sites respectively. Surface water chemistry samples were collected from 21 sites. Streambed sediment samples for metals analysis and asbestos type and quantity analysis were collected at 19 and 20 of the sites respectively. A total of 31 fish (whole fish and fillet) representing 6 sites were analyzed for metals. In addition, habitat observations and measures were taken at sites to help discern the potential stressors on the aquatic community.

Table 1: Location of biological and chemical assessments conducted within the Lamoille River and Missisquoi River watersheds in Eden and Lowell, Vermont. (RM refers to river mile, Datum Nad 27).

Location	Station (RM)	Description	Latitude	Longitude	Drainage Area (km ²)	Elev. (ft)
			Decimal Degrees			
Hutchins Brook	3.1	Control – located above Eden Tailing Trib.	44.75972	72.54972	0.2	1778
Hutchins Brook Tailing Trib.	0.1	Located 150 meters below Eden Tailing Pile	44.75944	72.54833	0.2	1784
Hutchins Brook	2.8	Below confluence with Tailing Trib.	44.75694	72.54806	0.4	1601
Hutchins Brook	2.1	Above wetland	44.74750	72.54250	1.1	1367
Hutchins Brook Trib 2	0.5	Control	44.74697	72.54607	0.4	1350
Hutchins Brook Pond	1.8	Beaver Pond below wetland tailing depositional area	44.74382	72.54421	2.0	1348
Hutchins Brook	1.6	Below Beaver Pd outlet	44.74267	72.54419	2.2	1325
Hutchins Brook	0.1	Located above confluence of Dark Branch	44.73018	72.53079	4.4	1141
Dark Branch	3.3	Located 0.5 miles below Lowell Piles	44.74959	72.53012	1.0	1245
Dark Branch Pond	2.4	Beaver Pond on Dark Branch	44.73833	72.52970	3.1	1167
Dark Branch	1.5	Located below confluence of Hutchins Brook	44.72960	72.53041	10.2	1140
Dark Branch	0.1	Located above confluence with Gihon River	44.71280	72.53452	12.7	1059
Gihon River	14.5	Located below confluence of Dark Branch	44.71159	72.53442	31.2	1050
Burgess Branch	2.6	Located 2.5 miles below Mine Site	44.78675	72.48916	39	1090
Burgess Branch	5.0	Located above Mines Rd	44.76972	72.51972	6.1	1158
Corez Pond - North	5.8	Adjacent Lowell Tailing Pile w/ some Riparian zone	44.76081	72.52271	-	1184
Corez Pond - South	6.0	Adjacent Lowell Tailing Pile w/ no Riparian zone	44.76697	72.52551	-	1184
Burgess Branch Trib 8	0.3	Control	44.46398	72.30516	1.0	1239
Burgess Branch Trib 9	0.3	Control	44.46187	72.30581	0.5	1115
Burgess Branch Trib 10	0.1	Located 50 meters above confluence with Burgess Branch	44.77056	72.51889	0.1	1152
Burgess Branch Trib 11	0.4	Located on site adjacent Mine Roads and drainage	44.76361	72.52611	1.9	1266
Lowell Tailing Pile Flow	5.1	Newly eroded fine tailings	44.76473	72.52289	-	1170
Lowell Mine Pit Pond	0.1	Mine Pit on site	44.76697	72.52551	-	1174

Figure 1: Biological and Chemical Sampling Locations 2005 & 2007 within the Lamoille River and Missisquoi River watersheds in Eden/Lowell, Vermont.

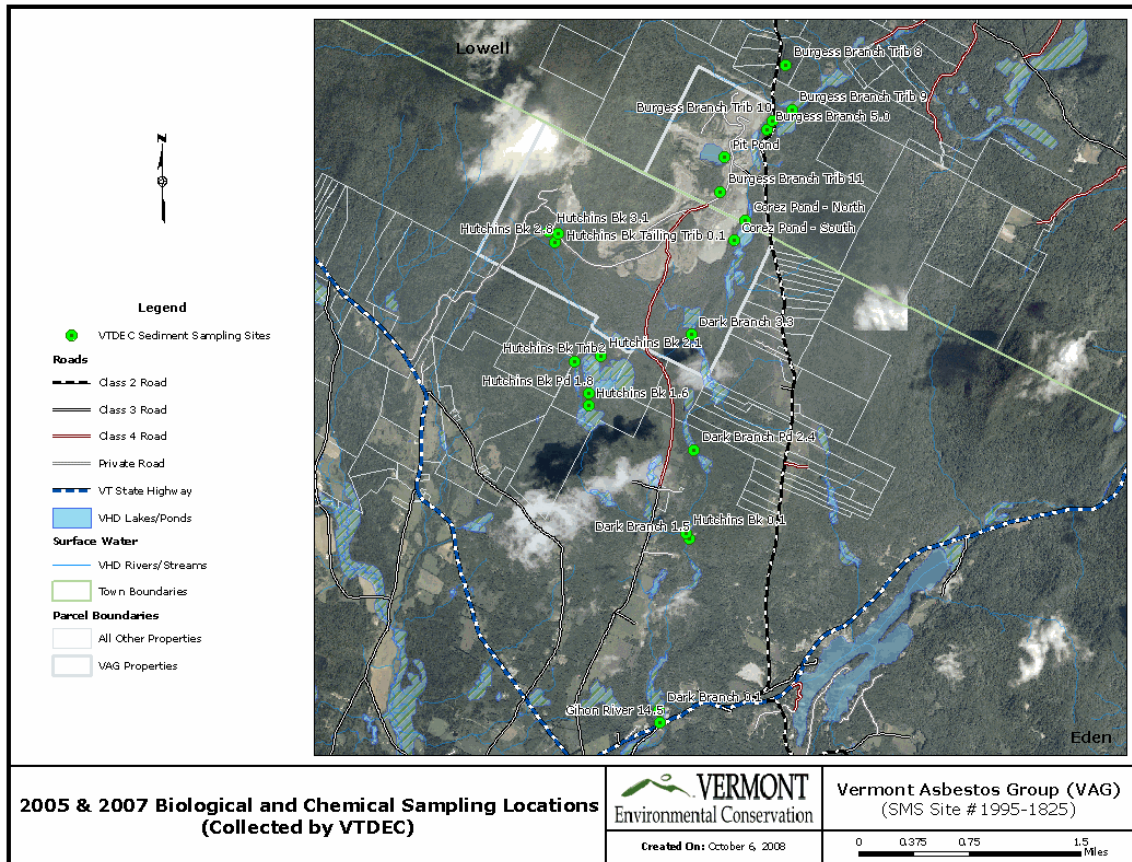


Figure 2: 1:12,000 Scale Map showing approximate locations of biological and chemical assessments conducted within the Hutchins Brook and Burgess Branch watershed.



Table 2: Biological, chemical and physical assessments conducted at sites within the Lamoille River and Missisquoi River watersheds in Eden and Lowell, Vermont.

Location	Station (RM)	Biological Community		Chemistry		Fish Tissue (Metals)	Streambed Sediment (Asbestos fibers)
		Macro	Fish	Surface Water	Streambed Sediment (Metals)		
Hutchins Brook	3.1	X	X	X	X		X
Hutchins Brook Tailing Trib.	0.1	X	X	X	X		X
Hutchins Brook	2.8	X		X	X		X
Hutchins Brook	2.1	X	X	X		X	X
Hutchins Brook Trib 2	0.5	X	X	X	X		X
Hutchins Brook Pond	1.8			X	X		X
Hutchins Brook	1.6			X	X		X
Hutchins Brook	0.1	X	X			X	
Dark Branch	3.3	X	X	X	X	X	X
Dark Branch Pond	2.4			X	X		X
Dark Branch	1.5	X	X			X	
Dark Branch	0.1			X	X		
Gihon River	14.5	X	X	X	X	X	X
Burgess Branch	2.6	X	X	X	X		X
Burgess Branch	5.0	X	X	X	X	X	X
Corez Pond - North	5.8			X	X		X
Corez Pond - South	6.0			X	X		X
Burgess Branch Trib 8	0.3	X	X	X	X		X
Burgess Branch Trib 9	0.3	X	X	X	X		X
Burgess Branch Trib 10	0.1	X		X	X		X
Burgess Branch Trib 11	0.4	X	X	X	X		X
Lowell Tailing Pile Flow	5.1			X			X
Lowell Mine Pit Pond	0.1			X	X		X
Total Assessments		15	13	21	19	6	20

Biological Assessments:

Macroinvertebrate Community:

Of the 15 stream sites sampled within the Lamoille River and Missisquoi River watersheds all but two are considered Small High Gradient (SHG) streams based on their drainage area size, elevation and substrate or gradient (**Table 1**). The drainage area of many of these sites is very small (<2km²) and therefore best professional judgment and information from local reference streams were used to help make assessment determinations at the sites. Burgess Branch 2.6, and the Gihon River 14.5, are larger and are considered Medium High Gradient (MHG) streams. Macroinvertebrate Kick Net samples were collected and processed in the laboratory using VTDEC standard operating procedures.

Macroinvertebrate community metrics used to evaluate the biological integrity of the reaches of both stream types sampled are presented in **Table 3**. VTDEC applies eight community metrics, which measure community structural and functional attributes, to determine if a stream is supporting its Water Quality Aquatic Life Uses (ALU), (VTDEC Biocriteria Guidance Document February, 2004). The 15 sites sampled within Lamoille River and Missisquoi River watersheds are managed as Class “B” waters (VT Water Quality Standards 2008). As such the Class B biocriteria thresholds for each stream type were applied to determine compliance with VT WQ Standards Aquatic Life Use criteria (ALU).

Table 3: Macroinvertebrate Community metrics from 15 stream sites sampled within the Lamoille River and Missisquoi River watersheds. Five of the eight community metrics used to determine if a stream is supporting its Water Quality Aquatic Life Uses (ALU) are shown. Data shown in bold print indicates metric at or below Class “B” fair-good threshold for the stream type. Assessment rating and Class B Pass/Fail/ Indeterminate (P/F/I) status are also shown. An asterisk in the station field indicates local control stream not directly receiving water from the mine site.

Location	Station (RM)	Sampling Date	Metrics					Class B Pass/Fail/I
			Density	Richness	EPT-R	BI	EPT/Chiro	
Hutchins Bk.	3.1*	8/24/2005	2372	40	20	2.49	0.61	Excellent/ Pass
		9/14/2007	478	38	19	1.87	0.75	
Hutchins Bk. Tailing Trib	0.1	8/24/2005	543	17	5.0	7.15	.02	Poor/ Fail
		9/14/07	271	17	3.0	2.88	0.02	
Hutchins Brook	2.8	8/24/2005	124	23	9.0	2.38	0.66	Poor/ Fail
Hutchins Brook	2.1	5/13/2005	85	20	9.0	4.05	0.32	Poor / Fail
		9/13/2007	90	15.5	10.5	6.28	0.28	
Hutchins Bk Trib 2	0.5*	5/13/2005	957	45	23	2.36	0.74	Excellent/ Pass
		9/13/2007	541	48.5	27	1.45	0.95	
Hutchins Bk	0.1	9/13/2007	1758	51	22	2.96	0.81	Excellent/Pass
Dark Branch	1.5	9/13/2007	4244	60	33	3.34	0.84	Excellent/Pass
Dark Banch	3.3	9/17/2007	639	31	14	2.24	0.9	Good -Fair
Gihon River	14.5	9/06/2007	1596	58	30	3.17	0.74	Excellent/Pass
Burgess Branch	2.6	9/06/2007	885	57	33	3.16	0.83	Excellent/Pass
Burgess Branch	5.0	8/25/2005	2492	29	15	4.79	0.93	Good/I
		9/14/2007	1594	31.5	13	4.45	0.94	Fair/ Fail
Burgess Branch Trib 8	0.3*	9/17/2007	730	42.5	23.5	2.34	0.91	Excellent
Burgess Branch Trib 9	0.3	9/17/2007	318	45.5	18.5	2.21	0.76	Good
Burgess Branch Trib. 10	0.1	8/25/2005	7488	43	18	5.53	0.24	Fair/ Fail
Burgess Branch Trib. 11	0.4	8/25/2005	670	28	11	4.01	0.72	Fair/ Fail
		9/14/2007	897	25	9	4.26	0.89	

Lamoille River Watershed:

The macroinvertebrate community present at the two control sites within the Hutchins Brook watershed - **Hutchins Brook Trib. 2 and Hutchins Brook 3.1** - were given an overall assessment rating of excellent based on samples collected in 2005 and 2007. This rating indicates biological condition well above the Class B minimal expectations for the SHG stream type.

The macroinvertebrate community present at **Hutchins Brook 2.1, Hutchins Brook 2.8 and Hutchins Bk. Tailing Trib.** were given an overall assessment rating of poor and were well below the Class B minimal expectations for the SHG stream type. The primary biometrics that were found to be degraded, resulting in the “poor” condition at these sites were: 1) Very low density of macroinvertebrates present 2) very low richness (number of taxa) 3) very low number of EPT taxa (sensitive species) present 4) low EPT/EPT Chiro Ratio (dominance of community by tolerant taxa). Low density, richness and a dominance of the community by a few tolerant taxa is generally a community fingerprint that indicates either a toxic or sediment stress at the site.

Hutchins Brook 0.1, the lowest site sampled on Hutchins Brook was given an overall assessment rating of excellent based on metrics. This site is located approximately 3.0 miles downstream from the Eden Tailing Pile.

Dark Branch 1.5 was given an overall assessment rating of excellent. The upper **Dark Branch 3.3** site was given an overall rating of good-fair, an indeterminate ALU support finding.; overall taxa richness and number of EPT taxa were just below expectation for Class B. The Ephemeroptera (mayflies - a very WQ sensitive order) comprised less than 3 percent of the community, very low for the stream type, which averages 23% Ephemeroptera in the reference condition.

The **Gihon River 14.5** was the most downstream site sampled within the Lamoille River watershed and scored very well, with an overall assessment rating of excellent.

Missisquoi River Watershed

Burgess Branch 2.6, the lowest site sampled on Burgess Branch, was given an **overall assessment rating of excellent**. This site is located approximately 2.5 miles downstream from the Eden/Lowell Mine.

The macroinvertebrate community present at **Burgess Branch 5.0** was assigned an **overall assessment rating of good/indeterminate in 2005, and fair /fail in 2007**. The biometric EPT Richness was low and the Biotic Index was elevated, with both metrics below the Class B minimal expectations for the SHG stream type.

The macroinvertebrate communities present at **Burgess Branch Trib. 10 and Trib. 11** were given an **overall assessment rating of fair** and were below the Class B minimal expectations for the SHG stream type. The primary biometrics that were found to be degraded at these sites were elevated BI and low EPT/Chiro at Burgess Branch Trib. 10, and low number of EPT taxa at Burgess Branch Trib. 11.

Fish Community:

A backpack DC electrofishing unit was used to stun fish for identification and enumeration. Depending on the drainage area of each site either the Vermont Mixed Water or the Vermont Coldwater Index of Biotic Integrity (IBI) index was used to evaluate the fish assemblage health. As discussed within the macroinvertebrate section, of the 13 stream sites sampled for fish within the Lamoille River and Missisquoi River watersheds all but two (Burgess Branch 2.6, and Gihon 14.5) are considered Small High Gradient (SHG) streams and were assessed using the coldwater IBI. The drainage areas of many of these sites are very small (<2km²) and may not support the minimum number of two fish species to apply a coldwater IBI. Therefore best professional judgment and information from local reference streams were used to help make assessment determinations at the sites. Data from larger streams (the Gihon River and the Dark Branch 1.5) were assessed using the Mixed Water IBI. Fish Community metrics and IBI scores from 13 stream sites sampled within the Lamoille River and Missisquoi River watersheds are presented in **Table 4**.

Lamoille River Watershed

No fish were collected at **Hutchins Brook 3.1**. The drainage area of this site was very small and the stream at this point may have been intermittent and therefore unable to support fish.

Numerous salamanders were observed.

Hutchins Brook Tailing Trib. also supported no fish. At 0.2 km² ; the drainage was very small and may have been naturally devoid of fish.

Hutchins Brook 2.1 was located immediately above a wetland where brook trout had been observed yet only two trout were sampled at this site. The site was judged in “poor ” condition because of so few trout collected.

Hutchins Brook Trib 2. Two species of fish were collected from this 0.4 km² Site, 14 blacknose dace and 4 brook trout. This would be in the expected range of a stream that meets Class B standard.

The Hutchins Brook 0.1 site scored a 33 out of a possible 45 (“good”) for the fish community. Total fish density from one electrofishing pass was high but most of the numbers were represented by the tolerant species blacknose dace, leading to an over dominance of this species accounting for the less than perfect score. The community assessment passed the Class B standard for the fish community.

Dark Branch 3.3 was dominated by brook trout with the remaining numbers made up of blacknose dace. The site scored an “excellent” (CWIBI of 42), easily passing the Class B standard.

Dark Branch 1.5 scored a 33 (“good”). Again, over-dominance of the tolerant blacknose dace pushed the evaluation downward, but not to where it failed the class B standard.

The Gihon River 14.5 site supported a fish assemblage in “excellent” condition. The five resident species were in balance, with no species dominating and were well represented by intolerant brook trout and slimy sculpin.

Missisquoi River Watershed

Only four brook trout were sampled at **Burgess Branch 2.6**. In addition, 191 blacknose dace were counted, indicating degradation generally from high nutrients or increased water temperatures. The site scored 24/45 -“poor”- and failed to meet the Class B standard for the fish community.

Burgess Branch 5.0 - Because only a single species was recorded (brook trout) no IBI could be applied. However, 19 trout were collected representing multiple age classes, which indicates a healthy habitat. As a result, the site is judged as passing the Class B standard.

No fish were collected at **Burgess Branch Trib. 8**. The drainage area of the site was 1.0 km² , probably large enough to support at least brook trout.

Burgess Branch Trib. 9 - Six brook trout were collected at this site, which drained one-half the land area of tributary 8. A stream site with a drainage area this small is a marginal habitat for any fish. Six brook trout represents a result that would be in the expected range of a stream of that size that meets the Class B standard.

Burgess Branch Trib. 11 – The drainage area at this site was only 0.1 km² - most likely too small to support any fish species.

Table 4: Fish community metrics from 13 stream sites sampled within the Lamoille River and Missisquoi River watersheds. Index of Biotic Integrity Scores and resulting Vermont WQS narrative assessments and “pass/ fail” status for Class B Vermont WQS are also given. An * indicates that no IBI was calculated and the assessment is based on best professional judgement.

Location	RM	IBI	Species collected	Species Richness	Density (#/100m ²)
Hutchins Brook	3.1	*	None	0	0
Hutchins Brook tailing Tributary	0.1	*	None	0	0
Hutchins Brook	2.1	* (poor)	brook trout-2	1	2.0
Hutchins Brook tributary 2	0.5	* (good)	blacknose dace -14 brook trout 4	2	22.5
Hutchins Brook	0.1	33 (good)	blacknose dace- 147 pumpkinseed-3 creek chub-20 slimy sculpin-2 white sucker-9 longnose dace-1 brook trout-5	7	80.6
Dark Branch	3.3	42 (excellent)	brook trout -38 Blacknose dace-4	2	74.4
Dark Branch	1.5	35 (good)	blacknose dace-317 Slimy sculpin-3 brook trout-33 White sucker -1 creek chub-18	5	29.5
Gihon River	14.5	43 (excellent)	blacknose dace-80 Longnose dace -30 Slimy sculpin-74 Creek chub-20 brook trout-54 Smallmouth bass-1	6 5-resident	23.5
Burgess Branch	5.0	* (good)	brook trout-19	1	5.2
Burgess Branch	2.6	24 (poor)	blacknose dace-191 Brook trout -4	2	18.3
Burgess Branch tributary 8	0.3	*	None	0	0
Burgess Branch tributary 9	0.3	* (good)	Brook trout-6	1	4.2
Burgess Branch tributary 11	0.4	*	None	0	0

Streambed Sediment Analysis for Asbestos Type and Quantity

Streambed sediment samples from 20 sites were submitted to KD Associates Inc., of South Burlington, Vt. for analysis of asbestos type and quantity. Results are presented in **Table 5**.

Analysis for asbestos type and quantity (visual area estimate and /or point count) was performed by EPA test method 600/R-93/116, utilizing Polarized Light Microscopy (PLM) and dispersion staining techniques. Sediment samples were collected from the streambed or pond bottom with collections targeting the smaller size substrate (sand, gravel). At several of the sites sampled in 2005, a second sediment sample was submitted for analysis consisting of the streambed sediment collected during the macroinvertebrate sampling.

The percent chrysotile detected in the macroinvertebrate sediment samples was substantially higher at the impacted sites than the passively collected streambed samples. This is likely due to the fact that the streambed substrate is vigorously disturbed during the macroinvertebrate collection and as such these samples represent sediment which is easily mobilized and swept downstream during sampling. The higher levels of chrysotile detected in this sediment may also be more reflective of the macroinvertebrate exposure to sediment which is mobilized during stream freshet events.

Chrysotile fibers were also readily observed in the stream on leaf packs and woody debris and on stream bank vegetation exposed to high stream flows during freshet events at several of the sites, in the Hutchins Brook and Burgess Branch watersheds.

Chrysotile fiber concentrations within the Lamoille River watershed ranged from “no detection” at 5 sites - Hutchins Brook Trib. 2, Hutchins Bk. 3.1, Dark Branch 2.4 & 3.3 and the Gihon River 14.5, - to a high of 86 percent at the Hutchins Brook Tailing Tributary. Chrysotile levels were also concentrated (>10%) at Hutchins Brook 2.1 and 2.8, Hutchins Brook Pond 1.8, and Corez Pond – South. Chrysotile fiber concentrations within the Missisquoi River watershed ranged from “no detection” at Burgess Branch 2.6 and Burgess Branch Tributaries 8, 9 and 10, to over 40 percent at Burgess Branch 5.0 and Burgess Branch Trib.11. The presence and concentrations of chrysotile fibers observed within the Lamoille River and Missisquoi River watersheds appears to be indicative of the mine tailing piles potential to impact these watersheds.

Table 5: Results of Streambed Sediment Analysis for Asbestos Type and Quantity at 20 sites within Lamoille River and Missisquoi River watersheds. Data shown in bold print indicates concentrated levels (>10%) of chrysotile fiber observed.

Location	Station (RM)	Sampling Date	Streambed Sediment Percent Chrysotile	Streambed Sediment from Macroinvertebrate Collection
Hutchins Brook	3.1	8/24/2005	<1%	
		9/14/2007	1.3%	
Hutchins Bk. Tailing Trib	0.1	8/24/2005	14.5%	86.0 %
		9/14/2007	14.5%	
Hutchins Brook	2.8	8/24/2005	4.8%	3.3%
		8/14/2007	9.5%	
Hutchins Brook	2.1	5/13/2005	3.3%	14.0%
Hutchins Bk Trib 2	0.5	5/13/2005	<1%	<1%
		9/13/2007	0.3%	
Hutchins Brook Pond	1.8	8/14/2007	38.8%	
Hutchins Brook	1.6	8/14/2007	4.5%	
Dark Branch Pond	2.4	8/13/2007	No Detection	
Dark Branch	3.3	9/17/2007	0.8%	
Gihon River	14.5	9/06/2007	No Detection	
Burgess Branch	2.6	9/06/2007	No Detection	
Burgess Branch	5.0	8/25/2005	18.0 %	
		9/14/2007	43.5 %	
Corez Pond - South	6.0	8/25/2005	7.3 %	
		8/15/2007	73.0 %	
Corez Pond - North	5.8	8/15/2007	No Detection	
Burgess Branch Trib. 8	0.3	9/17/2007	No Detection	
Burgess Branch Trib. 9	0.3	9/17/2007	No Detection	
Burgess Branch Trib. 10	0.1	8/25/2005	0.8%	
		8/15/2007	0.3 %	
Burgess Branch Trib. 11	0.4	8/25/2005	2.3%	
		9/14/2007	42.3%	
Lowell Tailing Pile Flow	5.1	8/15/2007	80.3%	
Lowell Mine Pit Pond	0.1	8/15/2007	82.8%	

Preliminary data suggest that the presence of elevated metals in the sediment at these sites appears to be correlated with the concentration of chrysotile fibers observed in the stream sediment. Metals (Ni, Co, Cr, Mn, and Mg), particularly nickel and chromium, are present in high concentrations within the chrysotile fiber structure. Once the chrysotile fiber is exposed to pH <8.0 the magnesium is leached from the fiber and the trace metals are subsequently released.

Chrysotile levels above 10 percent are considered concentrated levels (KD Assoc. Inc, personal communication) and are indicative of a product (mineral) that has been beaten apart or crushed.

The Vermont Department of Health (VDOH) defines “asbestos-containing” material – as material that contains any type

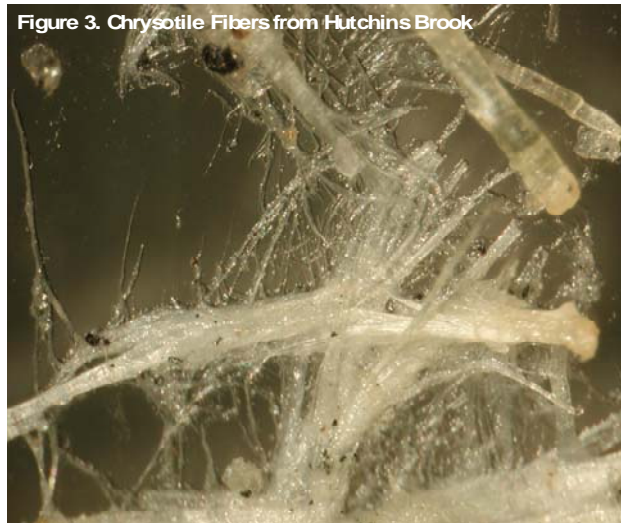


Figure 3. Chrysotile Fibers from Hutchins Brook

of asbestos in an amount greater than 1 percent by weight or area either alone or mixed with other fibrous or non-fibrous materials. The VDOH’s Asbestos Regulatory Program regulates asbestos abatement projects for materials containing greater than 1 percent asbestos.

The effects of asbestos fibers (**Figure 3**) on aquatic biota have not been investigated in any detail. EPA Ambient Water Quality “Aquatic Life” Criteria for Asbestos, states, “there is no appropriate data on the effects of asbestos on aquatic organisms available at this time; therefore no criterion can be derived for asbestos.”

Trace metal uptake in native fish, exposed to very high chrysotile concentrations in a stream have been reported with significant levels of nickel and manganese in the epiaxial muscle (Schreier et al. 1987).

Chrysotile concentrations in streams are highly variable depending on the proximity to source area and river flow regime. Concentrations of 1 million to 1 billion fibers/liter are typical in most rivers draining asbestos-bearing bedrock (Schreier 1987). The EPA Drinking water standard for asbestos is 7 million fibers per liter (7MFL).

Water Quality:

Results of water chemistry measures - pH, alkalinity, conductivity, color, chlorides, sulfates, nutrients: Total Phosphorus (TP), Dissolved Phosphorus (TDP), Total Nitrogen (TN), Nitrate + Nitrite (NOX) - and physical parameters related to sediment stress - Turbidity, and Total Suspended Solids (TSS) - are summarized in **Table 6** for the 13 Lamoille River watershed sites and **Table 7** for the 10 Missisquoi River watershed sites .

Water samples were also tested for dissolved and total metals. **Table 8 and Table 9** summarizes the results by watershed for the following metals analyzed: Calcium, Magnesium, Sodium, Potassium, Aluminum, Antimony, Arsenic, Beryllium, Cadmium, Chromium, Cobalt, Manganese, Nickel, Silver, Iron, Lead, Selenium, Zinc and Total Hardness.

Conductivity and alkalinity values were considerably higher than would be expected for small high gradient streams at many of the sites. In the Lamoille River watershed the highest alkalinity and conductivity was observed at the Hutchins Brook Tailing Trib., 360 mg/L CaCO₃ and 679 umho respectively. Dark Branch 3.3 had strikingly similar measurements for alkalinity and conductivity of 343 mg/L CaCO₃ and 620 umho.

Within the Missisquoi River watershed, Burgess Branch Trib. 11 and Burgess Branch 5.0 both had alkalinities and conductivities in the 300 mg/l CaCO₃ and 600 umho range.

The pH values were also considerably higher than would be expected and exceeded VT Water Quality Standards criteria (pH 6.5 – 8.5) with pH values greater than pH 8.5 at several sites including: Hutchins Brook Tailing Trib.; Hutchins Brook 2.8; Burgess Branch Trib.11; Burgess Branch 5.0; and the Mine Pit Pond.

Magnesium levels were elevated at several sites in the Lamoille River and Missisquoi River watersheds. Magnesium values exceeded 50 mg/l at Hutchins Brook Tailing Trib., Hutchins Brook 2.8, Dark Branch 3.3, Burgess Branch Trib. 11 and Burgess Branch 5.0. The highest magnesium values were observed at Hutchins Tailing Trib. and Dark Branch 3.3 at 93.6 mg/l and 82.5 mg/l respectively.

The high magnesium levels are likely related to the presence of chrysotile fibers at these sites. Chrysotile fibers exhibit significant solubility in contact with dilute acids or aqueous medium; at

pH < 10, magnesium leaches from the outer layers (Atkinson 1973). The high levels of magnesium are likely contributing to the elevated pH values observed.

Nickel concentrations (dissolved) in the water column ranged from below detection (<5 ug/l) to a high of 77 ug/l at Hutchins Brook 2.1. Several sites had elevated values (19.4 ug/l – 77 ug/l) including Hutchins Brook Tailing Trib., Hutchins Brook 2.8, Hutchins Brook Pond 1.8, Hutchins Brook 1.6 and Burgess Branch 5.0.

The highest nickel concentration observed (77 ug/l) at Hutchins 2.1 is above the National Ambient Water Quality Criteria and Chronic Ecotox Thresholds for dissolved nickel of 52 ug/l (hardness 100mg/l). Adjusting this chronic threshold value for the hardness observed at Hutchins Brook 2.1 (hardness 156 mg/l CaCO₃) would raise this hardness dependent metal's chronic threshold value from 52 ug/l to 75 ug/l.

Arsenic concentrations (dissolved) exceeded the VDOH Drinking Water Guidance value of 10 ppb at the Hutchins Brook Tailing Trib.site and Hutchins Brook Trib. 2. The VT Water Quality Standards for Protection of Human Health for arsenic were exceeded at all of the sites sampled except the control Hutchins Brook 3.1 and Corez Pond-North. The VTWQS for the Protection of Human Health for arsenic are 0.02 ug/l (exposure includes ingestion of both water and contaminated organisms) and 1.5 ug/l (exposure from ingestion of organism only, no water exposure).

Table 6: Concentrations of surface-water chemistry at 13 sites within the Lamoille River watershed. The pH data shown in bold exceeds Vermont Water Quality Standards criteria range of pH 6.5 – 8.5.

Location	Station	SampleDate	pH	Alk mg/l	Cond umho	Color	Turb NTU	TSS mg/l	TP ug/l	TDP ug/l	TCI mg/l	TSO4 mg/l	TN mg- N/l	TNOX mg- N/l
Hutchins Brook	3.1	8/24/2005	8.09	57.8	118	5	0.21	3.5	<5	5.09	<0.2	4.55	0.34	0.3
		8/14/2007	7.65	48.8	103	10	<0.2	1.28	<5	<5	<2	3.97	0.46	0.39
		9/14/2007	7.72	46.3	99.2	7.5	<0.2	-	<5	<5	<2	4.14	0.44	0.39
Hutchins Bk Tailing Trib.	0.1	8/24/2005	9.16	360	679	12.5	0.33	1.7	12.00	11	0.2	38.2	0.68	0.63
		8/14/2007	9.01	312	576	10	0.35	1.17	11.40	10.7	<2	27.1	0.6	0.48
		9/14/2007	9.05	335	518	12.5	<0.2	-	11.30	12.7	<2	34.4	0.7	0.66
Hutchins Brook	2.8	8/24/2005	8.95	216	430	7.5	1.01	1.9	14.00	7.3	<0.2	20.1	0.52	0.46
		8/14/2007	8.83	211	412	-	-	1.84	8.64	11.2	<2	17.3	0.54	0.44
Hutchins Brook	2.1	5/13/2005	8.39	87.6	241	10	<0.2	1.4	5.20	<5	0.36	7.93	0.33	0.29
		8/14/2007	8.44	134	278	7.5	0.55	<1	5.73	<5	<2	10.7	0.5	0.4
		9/13/2007	8.40	140	260	15	0.26	-	7.54	<5	<2	11.1	0.51	0.44
Hutchins Brook Trib 2	0.5	5/13/2005	8.03	42.4	93.8	10	<0.2	<1	8.83	<5	<0.2	5.00	0.15	0.12
		9/13/2007	8.19	61.3	124	15	0.25	-	6.10	5.6	<2	3.55	0.21	0.1
		8/14/2007	7.87	63.5	136	-	0.91	2.79	14.00	6.83	<2	4.66	0.24	0.14
Hutchins Brook	1.8	8/14/2007	7.64	-	318	55	2.69	1.87	14.90	7.08	<2	1.9	0.25	0.05
Hutchins Brook	1.6	8/14/2007	7.91	166	315	55	2.38	2.29	12.10	6.51	<2	1.8	0.22	0.05
Hutchins Brook	0.1	9/13/2007	8.29	102	192	25	0.77	-	8.61	6.35	<2	2.34	0.21	0.05
Dark Branch	3.3	8/13/2007	8.37	343	620	20	0.63	1.6	10.30	8.68	<2	10.1	0.44	0.22
		9/17/2007	8.34	333	503	-	<0.2	-	9.93	7.32	<2	10.5	0.5	0.33
Dark Branch	2.4	8/13/2007	7.63	104	212	55	3.62	2.4	18.80	11.9	<2	4.26	0.29	0.05
Dark Branch	1.5	9/13/2007	7.92	91.5	177	40	1.23	-	18.20	10.4	2.8	4.28	0.25	0.06
Dark Branch	0.1	8/15/2007	7.64	75.6	173	-	1.08	1.15	12.50	9.83	3.87	5.23	0.25	0.08
Gihon River	14.5	8/15/2007	7.77	50.2	133	-	1.01	2.92	10.50	7.17	6.14	5.03	0.24	0.09
		9/6/2007	7.43	51.7	143	15	0.82	-	7.80	7.38	8.34	5.74	0.24	0.1
Summary Statistics														
		Minimum	7.43	42.4	93.8	5	0.21	<1	5.20	<5	<0.2	1.8	0.15	0.05
		Maximum	9.16	360	679	55	3.62	3.5	18.80	12.7	8.34	38.2	0.7	0.66
		Median	8.14	102	212	12.5	0.79	1.77	10.50	7.17	-	5.13	0.335	0.255

Table 7: Concentrations of surface-water chemistry at 10 sites within the Missisquoi River watershed. The pH data shown in bold exceeds Vermont Water Quality Standards criteria range of pH 6.5 – 8.5.

Location	Station	SampleDate	pH	Alk mg/l	Cond umho	Color	Turb NTU	TSS mg/l	TP ug/l	TDP ug/l	TCI mg/l	TSO4 mg/l	TN mg- N/l	TNOX mg- N/l	
Burgess Branch	2.6	8/13/2007	8.31	93.5	207	25	0.96	<1	7.51	<5	<2	9.57	0.32		
		9/6/2007	8.18	123	264	20	2.73		5.12	<5	<2	14.1	0.32	0.2	
Burgess Branch	5.0	8/25/2005	8.58	278	566	5	0.23	<1	7.4	7.3	4.8	29.2	0.43	0.32	
		8/15/2007	8.53	246	495	12.5	0.86	1.43	7.03	5	3.31	22.8	0.5	0.37	
		9/14/2007	8.74	230	403	-	0.35		8.57	6.73	2.36	22.1	0.46	0.39	
Burgess Branch Trib 8	0.3	8/13/2007	7.80	43.5	98.3	15	1.44	5.87	10.2	7.37	<2	5.08	0.23	0.11	
		9/17/2007	7.78	47	106	15	0.34		12	7.92	<2	5.72	0.23	0.12	
Burgess Branch Trib 9	0.3	8/13/2007	7.65	68.9	149	25	3.51	<1	8.77	6.29	<2	4.42	0.24	0.12	
		9/17/2007	7.53	48.9	104	15	0.37		<5	<5	<2	4.74	0.33	0.26	
Burgess Branch Trib 10	0.1	8/25/2005	8.61	194	446	10			6.77	8.04	0.2	38.9	0.66	0.53	
		8/15/2007	8.25	138	312	12.5	0.2	<1	5.15	<5	<2	23.6	0.52	0.4	
Burgess Branch Trib 11	0.4	8/24/2005	9.15	339	612	7.5	0.32	1.07	6.58	<5	0.2	16.2	0.62	0.46	
		8/15/2007	9.15	240	432	-	0.3	<1	5.97	<5	<2	9.46	0.56	0.05	
		9/14/2007	9.31	281	415	15	0.2		<5	6.35	<2	11.2	0.64	0.57	
Corez Pond – North	5.8	8/25/2005	8.21	89	225	15	1.69	1.5	12	6.9	8.3	10.7	0.44	0.08	
		8/15/2007	8.31	91.6	217	30	3.08	4.49	16.5	10.2	5.72	11.1	0.54	0.05	
Corez Pond – South	6.0	8/15/2007	8.25	93.8	225	30	2.59	3.44	17.1	5.44	5.54	11.5		0.05	
Lowell Mine Pit Pond	0.1	8/25/2005	9.21	201	402	7.5	0.21	<1	<5	<5	<0.2	22.5	0.4	0.36	
		8/15/2007	9.07	200	379	5	0.22	<1	10.1	<5	<2	19.8	0.39	0.31	
Summary Statistics			Minimum	7.53	43.5	98.3	5	0.2	<1	<5	<5	0.2	4.4	0.23	0.05
			Maximum	9.31	339	612	30	3.5	5.87	17.1	10.2	8.3	38.9	0.66	0.57
			Median	8.31	138	312	15	0.36	1.46	7.4	5.8	4	11.5	0.435	0.28

Table 8: Concentrations of surface-water metal chemistry at 13 sites within the Lamoille River watershed.

Location	Station	Sample Date	Total Calcium (mg/L)	Dissolved Calcium (mg/L)	Total Magnesium (mg/L)	Dissolved Magnesium (mg/L)	Total Sodium (mg/L)	Dissolved Sodium (mg/L)	Total Potassium (mg/L)	Dissolved Potassium (mg/L)	Dissolved Aluminum (ug/L)
Hutchins Brook	3.1	8/24/2005		8.49		9.04		0.45		0.15	
		8/14/2007	6.76	7.02	7.78	8.66	0.43	0.48	0.14	0.16	
		9/14/2007	7.07	7.49	7.42	7.93	0.44	0.46	0.13	0.15	
Hutchins Bk Tailing Trib.	0.1	8/24/2005		7.81		93.6		1.12		0.73	
		8/14/2007	6.52	6.45	83.2	82	0.83	0.83	0.62	0.62	<10
		9/14/2007	6.94	6.81	88.8	89.6	1.02	0.94	0.71	0.69	
Hutchins Brook	2.8	8/24/2005		9.12		53.2		0.78		0.44	
		8/14/2007	7.11	7.12	53.3	54.4	0.68	0.68	0.44	0.45	
Hutchins Brook	2.1	5/13/2005		7.58		18.6		0.54		0.26	
		8/14/2007	8.43	8.21	32.7	31.5	0.73	0.71	0.34	0.34	
		9/13/2007		8.7		31.4		0.7		0.34	<10
		9/13/2007		9.13		33.4		0.73		0.36	19
Hutchins Brook Trib 2	0.5	5/13/2005		11.5		4.26		0.44		0.28	
		8/14/2007	15.7	16.2	6.13	6.23	0.52	0.53	0.27	0.28	
		9/13/2007		13		7.98		0.46		0.29	12
		9/13/2007		11.8		7.54		0.43		0.27	32
Hutchins Brook	1.8	8/14/2007	9.47	9.96	36	37.2	0.52	0.55	0.27	0.28	<10
Hutchins Brook	1.6	8/14/2007	9.63	9.76	36.3	37.3	0.52	0.54	0.28	0.29	<10
Hutchins Brook	0.1	9/13/2007		9.43		18.9		0.65		0.38	<10
		9/13/2007		10.7		21		0.71		0.42	11
Dark Branch	3.3	8/13/2007	15.2	15	22.6	82.5	1.01	0.98	1.98	1.95	24
		9/17/2007		14.2		74.6		0.96		1.79	16
		9/17/2007		14.8		77.6		1		1.85	23
Dark Branch Pond	2.4	8/13/2007	7.92	7.93	22.4	22.4	1.29	1.31	0.64	0.66	
Dark Branch	1.5	9/13/2007		10.1		17.2		1.86		0.45	<10
		9/13/2007		10.6		16.9		1.53		0.44	34
Dark Branch	0.1	8/15/2007	10.5	10.6	13.2	13.7	2.01	2.08	0.4	0.41	
Gihon River	14.5	8/15/2007	7.78	7.97	7.71	8.12	3.98	4.22	0.34	0.37	<10
		9/6/2007		9.08		8.56		5.23		0.39	<10
Summary Statistics	minimum		6.52	6.45	6.13	4.26	0.43	0.43	0.13	0.15	11
	maximum		15.7	16.2	88.8	93.6	3.98	5.23	1.98	1.95	34
	median		7.92	9.13	22.6	21	0.73	0.71	0.34	0.38	21

Table 8(continued): Concentrations of surface-water metal chemistry at 13 sites within the Lamoille River watershed.

Location	Station	Sample Date	Total Antimony (ug/L)	Dissolved Antimony (ug/L)	Total Arsenic (ug/L)	Dissolved Arsenic (ug/L)	Dissolved Beryllium (ug/L)	Total Cadmium (ug/L)	Dissolved Cadmium (ug/L)	Total Chromium (ug/L)	Dissolved Chromium (ug/L)
Hutchins Brook	3.1	8/24/2005	<10	<1	0.86	0.85	<1	<1	<1	<5	<5
		8/14/2007	<10	<10	0.86	0.85	<1	<1	<1	<5	<5
		9/14/2007	<10	<10	1.05	1.04	<1	<1	<1	<5	<5
Hutchins Bk Tailing Trib.	0.1	8/24/2005	<10	<1	13.1	13.1	<1	<1	<1	<5	<5
		8/14/2007	10.1	10.3	12	11.1	<1	<1	<1	5.54	<5
		9/14/2007	11.7	11.9	13.1	13.6	<1	<1	<1	5.54	<5
Hutchins Brook	2.8	8/24/2005	<10	<10	8.58	8.58	<1	<1	<1	<5	<5
		8/14/2007	<10	<10	9.59	9.52	<1	<1	<1	<5	<5
Hutchins Brook	2.1	5/13/2005	<10	<10	3.49	3.49	<1	<1	<1	<5	<5
		8/14/2007	<10	<10	12.2	12.4	<1	<1	<1	<5	<5
		9/13/2007	<10	<10	11.6	11.6	<1	<1	<1	<5	<5
		9/13/2007	<10	<10	11.6	11.6	<1	<1	<1	<5	<5
Hutchins Brook Trib 2	0.5	5/13/2005	<10	<10	3.63	3.63	<1	<1	<1	<5	<5
		8/14/2007	<10	<10	13.1	8.06	<1	<1	<1	<5	<5
		9/13/2007	<10	<10	11.2	11.2	<1	<1	<1	<5	<5
		9/13/2007	<10	<10	11.5	11.5	<1	<1	<1	<5	<5
Hutchins Brook	1.8	8/14/2007	<10	<10	8.51	5.46	<1	<1	<1	<5	<5
Hutchins Brook	1.6	8/14/2007	<10	<10	7.02	5.8	<1	<1	<1	<5	<5
Hutchins Brook	0.1	9/13/2007	<10	<10	2.32	2.32	<1	<1	<1	<5	<5
		9/13/2007	<10	<10	2.43	2.43	<1	<1	<1	<5	<5
Dark Branch	3.3	8/13/2007	10	10	2.53	2.48	<1	<1	<1	<5	<5
		9/17/2007	<10	<10	1.77	1.77	<1	<1	<1	<5	<5
		9/17/2007	<10	<10	1.74	1.74	<1	<1	<1	<5	<5
Dark Branch Pond	2.4	8/13/2007	<10	<10	3.75	3.11	<1	<1	<1	<5	<5
Dark Branch	1.5	9/13/2007	<10	<10	2.28	2.28	<1	<1	<1	<5	<5
		9/13/2007	<10	<10	2.65	2.65	<1	<1	<1	<5	<5
Dark Branch	0.1	8/15/2007	<10	<10	2.76	2.66	<1	<1	<1	<5	<5
Gihon River	14.5	8/15/2007	<10	<10	1.95	1.57	<1	<1	<1	<5	<5
		9/6/2007	<10	<10	1.47	1.47	<1	<1	<1	<5	<5
Summary Statistics	minimum		10	10.3	0.86	0.85	-	-	-	5.54	-
		maximum	11.7	11.9	13.1	13.6	-	-	-	5.54	-
		median	10.1	11.1	7.02	3.49	-	-	-	5.54	-

Table 8 (continued): Concentrations of surface-water metal chemistry at 13 sites within the Lamoille River watershed.

Location	Station	Sample Date	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Manganese (ug/L)	Dissolved Manganese (ug/L)	Total Nickel (ug/L)	Dissolved Nickel (ug/L)	Total Silver (ug/L)	Dissolved Silver (ug/L)	Total Iron (ug/L)	Total Lead (ug/L)
Hutchins Brook	3.1	8/24/2005		<10		<5		<5		<1		
		8/14/2007	<10	<10	<5	<5	<5	<5	<1	<1	<50	<1
		9/14/2007	<10	<10	<5	<5	<5	<5	<1	<1	<50	<1
Hutchins Bk Tailing Trib.	0.1	8/24/2005		<10		<5		35		<1		
		8/14/2007	<10	<10	<5	<5	23.3	19.6	<1	<1	<50	<1
		9/14/2007	<10	<10	<5	<5	30.6	21	<1	<1	102	<1
Hutchins Brook	2.8	8/24/2005		<10		<5		40.8		<1		
		8/14/2007	<10	<10	<5	<5	26.9	25.1	<1	<1	74.4	<1
Hutchins Brook	2.1	5/13/2005		<10		<5		28.7		<1		
		8/14/2007	<10	<10	<5	<5	73.9	70.6	<1	<1	<50	1
		9/13/2007		<10		<5		67.4		<1		
		9/13/2007		<10		5.66		76.9		<1		
Hutchins Brook Trib 2	0.5	5/13/2005		<10		<5		<5		<1		
		8/14/2007	<10	<10	5.95	21.6	<5	<5	<1	<1	<50	<1
		9/13/2007		<10		<5		<5		<1		
		9/13/2007		<10		9.5		<5		<1		
Hutchins Brook Pond	1.8	8/14/2007	<10	<10	247	218	25.6	20.7	<1	<1	1320	<1
Hutchins Brook	1.6	8/14/2007	<10	<10	193	137	23.2	19.4	<1	<1	1020	<1
Hutchins Brook	0.1	9/13/2007		<10		8.84		5.17		<1		
		9/13/2007		<10		18.1		5.53		<1		
Dark Branch	3.3	8/13/2007	<10	<10		5.34		6.75			113	
		9/17/2007		<10		<5		6.4				
		9/17/2007		<10		9.44		6.74				
Dark Branch Pond	2.4	8/13/2007	<10	<10	160	134	<5	<5	<1	<1	729	<1
Dark Branch	1.5	9/13/2007		<10		17		<5		<1		
		9/13/2007		<10		44.6		<5		<1		
Dark Branch	0.1	8/15/2007	<10	<10	66.6	49.2	<5	<5	<1	<1	340	<1
Gihon River	14.5	8/15/2007	<10	<10	59	22.6	<5	<5	<1	<1	263	<1
		9/6/2007		<10								
Summary Statistics	minimum		-	-	5.95	5	23.2	5.17	-	-	74.4	-
	maximum		-	-	247	218	73.9	76.9	-	-	1320	-
	median		-	-	113.3	18.1	26.25	20.85	-	-	301.5	-

Table 8(continued): Concentrations of surface-water metal chemistry at 13 sites within the Lamoille River watershed.

Location	Station	Sample Date	Total Selenium (ug/L)	Total Zinc (ug/L)	Total Hardness (mg/L)
Hutchins Brook	3.1	8/24/2005			
		8/14/2007	0.01	<50	48.9
		9/14/2007	<5	<50	48.2
Hutchins Bk Tailing Trib.	0.1	8/24/2005			
		8/14/2007	0.68	<50	359
		9/14/2007	<5	<50	383
Hutchins Brook	2.8	8/24/2005			
		8/14/2007	0.41	<50	237
Hutchins Brook	2.1	5/13/2005			
		8/14/2007	0.28	<50	156
		9/13/2007			
		9/13/2007			
Hutchins Brook Trib 2	0.5	5/13/2005			
		8/14/2007	0.1	<50	64.6
		9/13/2007			
		9/13/2007			
Hutchins Brook	1.8	8/14/2007	0.01	<50	172
Hutchins Brook	1.6	8/14/2007	0.12	<50	174
Hutchins Brook	0.1	9/13/2007			
		9/13/2007			
Dark Branch	3.3	8/13/2007			
		9/17/2007			
		9/17/2007			
Dark Branch Pond	2.4	8/13/2007	0.1	<50	112
Dark Branch	1.5	9/13/2007			
		9/13/2007			
Dark Branch	0.1	8/15/2007	0.2	<50	80.6
Gihon River	14.5	8/15/2007	0.13	<50	51.2
		9/6/2007			
Summary Statistics	minimum		0.01	-	48.2
	maximum		0.68	-	383
	median		0.125	-	134

Table 9: Concentrations of surface-water metal chemistry at 10 sites within the Missisquoi River watershed.

Location	Station	Sample Date	Total Calcium (mg/L)	Dissolved Calcium (mg/L)	Total Magnesium (mg/L)	Dissolved Magnesium (mg/L)	Total Sodium (mg/L)	Dissolved Sodium (mg/L)	Total Potassium (mg/L)	Dissolved Potassium (mg/L)	Dissolved Aluminum (ug/L)
Burgess Branch	2.6	8/13/2007	7.84	8.18	20.9	22	1.36	1.43	0.66	0.69	22
	2.6	9/6/2007		10.2		28.2		1.71		0.75	<10
Burgess Branch	5.0	8/25/2005		17.7		64.6		3.3		1.3	<10
	5.0	8/15/2007	13.8	13.7	59.5	61.7	2.47	2.49	1.2	1.21	<10
	5.0	9/14/2007	12.3	12.5	55.7	56.5	2.15	2.18	1.39	1.44	<10
Burgess Branch Trib 8	0.3	8/13/2007	7.27	7.24	6.61	6.59	1	1.52	0.35	0.35	20
	0.3	9/17/2007	8.58	8.54	7.22	7.19	1.57	1.54	0.36	0.34	17
Burgess Branch Trib 9	0.3	8/13/2007	8.48	8.34	12.8	12.5	1.32	1.31	0.52	0.52	11
	0.3	9/17/2007	6.01	6.4	8.88	8.99	0.96	0.97	0.55	0.54	14
Burgess Branch Trib 10	0.1	8/25/2005		7.28		53.5		1.23		3.11	
	0.1	8/15/2007	5.36	5.37	35.3	36.9	0.88	0.93	2.23	2.26	
Burgess Branch Trib 11	0.4	8/24/2005		12.5		82.7		0.88		1.47	
	0.4	8/15/2007	6.78	6.91	60.4	59.8	0.5	0.52	0.89	0.93	
	0.4	9/14/2007	8.05	8.39	70.8	69	0.59	0.62	1.17	1.22	
Corez Pond - North	5.8	8/25/2005									
	5.8	8/15/2007	8.94	9.03	18.5	19.4	4.07	4.27	0.65	0.61	
Corez Pond - South	6.0	8/15/2007	9.14	9.24	19.7	20.1	4.1	4.18	0.61	0.61	
Lowell Tailing Pile Flow	5.1	8/15/2007	1.86	1.81	50.4	51	2.75	2.87	0.72	0.76	
Lowell Mine Pit Pond	0.1	8/25/2005		6.86		49.7		0.54		2.22	
	0.1	8/15/2007	7	7.04	48.4	49.8	0.5	0.51	2.09	2.15	
Summary Statistics											
		Minimum	1.86	1.81	6.61	6.59	0.5	0.51	0.35	0.34	11
		Maximum	13.8	17.7	70.8	82.7	4.1	4.27	2.23	3.11	22
		Median	7.945	8.34	28.1	49.7	1.34	1.43	0.69	0.93	17

Table 9 (continued): Concentrations of surface-water metal chemistry at 10 sites within the Missisquoi River watershed.

Location	Station	Sample Date	Total Antimony (ug/L)	Dissolved Antimony (ug/L)	Total Arsenic (ug/L)	Dissolved Arsenic (ug/L)	Dissolved Beryllium (ug/L)	Total Cadmium (ug/L)	Dissolved Cadmium (ug/L)	Total Chromium (ug/L)	Dissolved Chromium (ug/L)
Burgess Branch	2.6	8/13/2007	<10	<10	1.07	0.92	<1	<1	<1	<5	<5
	2.6	9/6/2007				<1	<1	<1	<1	<5	<5
Burgess Branch	5.0	8/25/2005		<10		2.28	<1		<1		<5
	5.0	8/15/2007	<10	<10	2.7	2.68	<1	<1	<1	<5	<5
	5.0	9/14/2007	<10	<10	2.91	2.95	<1	<1	<1	<5	<5
Burgess Branch Trib 8	0.3	8/13/2007	<10		1	0.48		<1	<1	<5	<5
	0.3	9/17/2007	<10		<1	<1		<1	<1	<5	<5
Burgess Branch Trib 9	0.3	8/13/2007	<10		0.93	0.95		<1	<1	<5	<5
	0.3	9/17/2007	<10	<10	<1	<1	<1	<1	<1	<5	<5
Burgess Branch Trib 10	0.1	8/25/2005				1.74	<1		<1		<5
	0.1	8/15/2007	<10	<10	1.21	1.18	<1	<1	<1	<5	<5
Burgess Branch Trib 11	0.4	8/24/2005				5.49	<1		<1		<5
	0.4	8/15/2007	<10	<10	4.49	4.34	<1	<1	<1	<5	<5
	0.4	9/14/2007	<10	<10	5.52	5.38	<1	<1	<1	<5	<5
Corez Pond - North	5.8	8/25/2005									
	5.8	8/15/2007	<10	<10	0.62	0.59	<1	<1	<1	<5	<5
Corez Pond - South	6.0	8/15/2007	<10	<10	0.65	0.61	<1	<1	<1	<5	<5
Lowell Tailing Pile Flow	5.1	8/15/2007	<10	<10	1.2	1.02	<1	<1	<1	6.57	<5
Lowell Mine Pit Pond	0.1	8/25/2005		<10		9.08	<1		<1		<5
	0.1	8/15/2007	<10	<10	8.92	8.99	<1	<1	<1	<5	<5
Summary Statistics											
		Minimum	-	-	0.62	0.48	-	-	-	6.57	-
		Maximum	-	-	8.92	9.08	-	-	-	6.57	-
		Median	-	-	1.205	2.01	-	-	-	6.57	-

Table 9 (continued): Concentrations of surface-water metal chemistry at 10 sites within the Missisquoi River watershed..

Location	Station	Sample Date	Total Copper (ug/L)	Dissolved Copper (ug/L)	Total Manganese (ug/L)	Dissolved Manganese (ug/L)	Total Nickel (ug/L)	Dissolved Nickel (ug/L)	Total Silver (ug/L)	Dissolved Silver (ug/L)	Total Iron (ug/L)	Total Lead (ug/L)
Burgess Branch	2.6	8/13/2007	<10	<10	25.7	20.6	<5	<5	<1	<1	254	<1
	2.6	9/6/2007		<10								
Burgess Branch	5.0	8/25/2005		<10		22		11.3		<1		
	5.0	8/15/2007	<10	<10	24.4	19.6	16.6	10.6	<1	<1	103	<1
	5.0	9/14/2007	<10	<10	23.1	17.7	13.6	8.15	<1	<1	128	<1
Burgess Branch Trib 8	0.3	8/13/2007	<10	<10	21.2	8.13	<5	<5	<1	<1	129	<1
	0.3	9/17/2007	<10	<10	20.1	8.96	<5	<5	<1	<1	135	<1
Burgess Branch Trib 9	0.3	8/13/2007	<10	<10	157	142	<5	<5	<1	<1	914	<1
	0.3	9/17/2007	<10	<10	55.6	47.8	<5	<5	<1	<1	332	<1
Burgess Branch Trib 10	0.1	8/25/2005		<10		<5		<5		<1		
	0.1	8/15/2007	<10	<10	<5	<5	<5	<5	<1	<1	914	<1
Burgess Branch Trib 11	0.4	8/24/2005		<10		12.5		5.93		5.49		
	0.4	8/15/2007	<10	<10	8.61	7.73	8.65	7.07	<1	<1	<50	<1
	0.4	9/14/2007	<10	<10	10.6	10.4	5.28	<5	<1	<1	<50	<1
Corez Pond - North	5.8	8/25/2005										
	5.8	8/15/2007	<10	<10	25.7	5.06	5.74	<5	<1	<1	111	<1
Corez Pond - South	6.0	8/15/2007	<10	<10	24.2	<5	5.46	5.12	<1		89.6	<1
Lowell Tailing Pile Flow	5.1	8/15/2007	<10	<10	7.06	<5	21.7	<5	<1	<1	89.9	<1
Lowell Mine Pit Pond	0.1	8/25/2005		<10		<5		<5		<1		
	0.1	8/15/2007	<10	<10	<5	<5	<5	<5	<1	<1	<50	<1
Summary Statistics												
		Minimum	-	-	7.06	5.06	5.28	5	-	5.49	<50	-
		Maximum	-	-	157	142	21.7	11.3	-	5.49	914	-
		Median	-	-	23.65	15.1	8.65	7.07	-	5.49	119.5	-

Streambed Sediment Chemistry

Streambed sediment samples were collected from Hutchins Brook Tailing Trib. and from two locations on Corez Pond in August 2005 for metals analysis. Results are presented in **Table 10**. Chromium and nickel sediment concentrations severely exceeded Consensus-Based PEC (Probable Effect Concentration) Sediment Quality Guidelines (SQGs) from MacDonald et al (2000) at the Hutchins Brook Tailing Trib. and the Corez Pond-South site. Chromium values were 1,200mg/kg and 1,570 mg/kg, more than 10 times greater than the Consensus-Based SQGs PEC criterion of 111 mg/kg. Nickel values were 2,780 mg/kg and 3,400 mg/kg, more than 60 times greater than the Consensus-Based SQGs PEC criterion of 22.7 mg/kg.

Additional streambed sediment characterization was completed in 2007 by the United States Geological Survey(USGS). USGS Headquarters in Reston, Virginia provided analytical services for 22 streambed sediment samples collected by VTDEC in August 2007. The streambed sediment samples were analyzed for 42 major, minor, and trace elements determined by ICP-AES and ICP-MS. **Table 11** presents results of the streambed sediment analysis. The streambed sediment samples were collected using USGS Sediment Sampling Protocols. A 30 increment composite streambed sediment sample was collected from the streambed cross section and wet sieved to less than 2mm. At the USGS Lab, the dry sample was shake-sieved thru 80 mesh (180 micron) and analysis conducted on the less-than-180 u fraction.

Streambed concentrations of chromium and nickel severely exceeded Consensus-Based PEC (Probable Effect Concentration) Sediment Quality Guidelines (SQGs) from MacDonald et al (2000) at the Hutchins Brook Tailing Trib., Hutchins Brook 2.8, Burgess Branch 5.0, Burgess Branch Trib. 11, Corez Pond -South and the Lowell Mine Pit Pond sites. Chromium values at these sites ranged from 1080 mg/kg to a high of 1890 mg/kg at the Hutchins Tailing Trib. site. These values were similar to the 2005 streambed sediment chemistry results summarized above, and were 10-17 times greater than the Consensus-Based SQGs PEC chromium criteria of 111 mg/kg.

Nickel concentrations at these sites ranged from 1440 mg/kg at Burgess Branch 5.0 to a high of 2120 mg/kg at the Hutchins Brook Tailing Trib., exceeding the Consensus-Based SQGs PEC of 48.6 mg/kg by a factor of 30-44.

Chromium, nickel and iron sediment concentrations observed at the Corez Pond–South site greatly exceeded levels observed at the Corez Pond–North site in 2005. This is likely due to the proximity and direct access that the Lowell tailing piles have to the Corez Pond–South site (Figure 5). There is a road and a small amount of wooded riparian area between the tailing pile and the Corez Pond–North site. Recently stone berms have been constructed as part of a Time Critical Removal Action (EPA) to prevent tailings from continuing to flow into Corez Pond and the adjacent wetlands.

Figure 5: A: 1:12,000 Scale Map showing approximate locations of sediment sampling at Corez Pond–South and Corez Pond–North sites. B: Corez Pond–South site (arrow indicates approximate sediment sampling location).

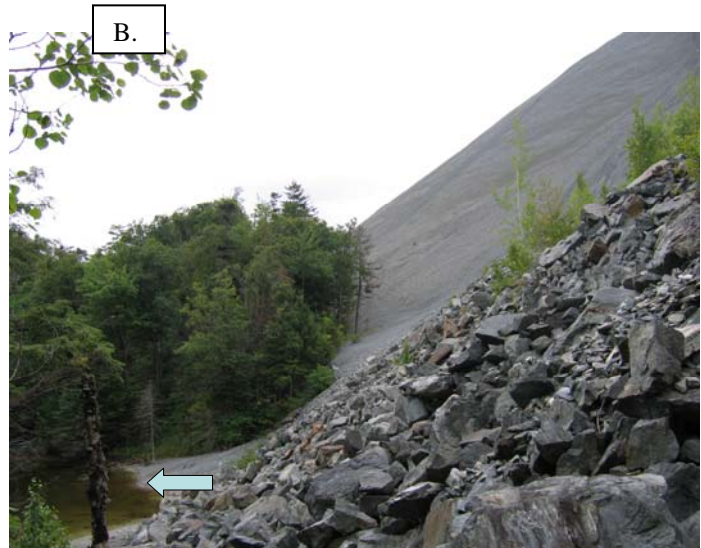
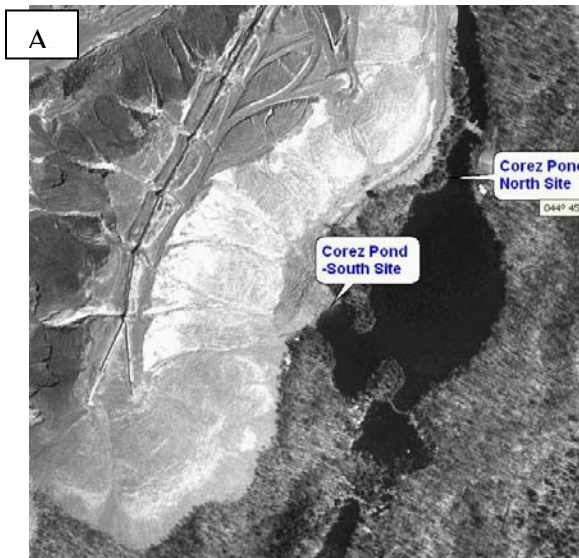


Table 10: Streambed Sediment Chemistry Results from Hutchins Bk. Tailing Trib. and Corez Pond sites. Sediment samples were collected on August 24th and 25th 2005. Bolded values exceed Consensus-Based Sediment Quality Threshold Effect Guidelines (TEC) MacDonald et al (2000) and the NOAA ER-L Criteria for Iron.

Parameter	Hutchins Brook Tailing Trib. RM 0.1	Corez Pond (South)	Corez Pond (North)	Consensus-Based Sediment Quality Guidelines (TEC) MacDonald et al (2000).
Barium	4.14 mg/kg	4.16 mg/kg	21.1 mg/kg	NC
Beryllium	0.03 mg/kg	<0.1 mg/kg	0.13 mg/kg	NC
Cadmium	0.05 mg/kg	<0.1 mg/kg	0.12 mg/kg	0.99 mg/kg
Chromium	1,200 mg/kg	1,570 mg/kg	42.1 mg/kg	43.4 mg/kg
Copper	17.0 mg/kg	25.6 mg/kg	<11.0 mg/kg	31.6 mg/kg
Iron	33,700 mg/kg	38,400 mg/kg	19,700 mg/kg	20,000 mg/kg*
Lead	5.63 mg/kg	4.02 mg/kg	7.24 mg/kg	35.8 mg/kg
Nickel	2,780 mg/kg	3,400 mg/kg	78.9 mg/kg	22.7 mg/kg
Zinc	19.5 mg/kg	35.2 mg/kg	35.5 mg/kg	121 mg/kg

*National Oceanographic and Atmospheric Administration Effects Range Low (ER-L)

The extremely high levels of chromium, nickel and iron observed in the streambed sediment at the Hutchins Brook Tailing Trib., Hutchins Brook 2.8, Burgess Branch 5.0, Burgess Branch Trib. 11, Corez Pond -South and the Lowell Mine Pit Pond sites appear to be reflective of the presence of milled chrysotile fibers in the streams and pond and are likely coming from the adjacent tailing piles. Studies have shown that milled chrysotile fibers are enriched in metals by factors ranging from 1.3 to greater than 15. Chromium and nickel concentrations are many times higher than in crude fibers and iron content is increased by more than 100 percent (Barbeau et al. Environment Research 1985).

A review of reported nickel concentrations in sediment and soil reveals that typical background concentrations are in the range of 16 -75 mg/kg. However, sediment collected within 10 km of smelters in Sudbury, Ontario yield very high levels of nickel (2,500-4,490 mg/kg) very similar to our findings at many of the sites within the Hutchins Brook and Burgess Branch watersheds. (Eisler in USGS Synoptic Review of Nickel Hazards 1998).

Typical background concentrations of chromium in sediments and soil are in the range of 1 – 140 mg/kg. Elevated chromium concentrations can be found in the vicinity of industrial operations and municipal waste treatment facilities. Concentrations below electroplating plants can range from 1,420 – 54,300 mg/kg (Eisler USGS Synoptic Review of Nickel Hazards 1986).

Table 11: Streambed Sediment Chemistry analyzed by USGS Laboratory for 42 major, minor, and trace elements determined by ICP-AES and ICP-MS. Consensus-Based Sediment Quality Guidelines (TEC) MacDonald et al (2000) shown for As, Cd, Cr, Cu, Pb, Ni and Zn. Columns for these metals are also shaded and severe exceedances are bolded.

Site Name	Station (RM)	Al %	Ca %	Fe %	K %	Mg %	Na %	S %	Ti %	Ag ppm	As ppm	Ba ppm	Be ppm	Bi ppm	Cd ppm	Ce ppm	Co ppm	Cr ppm
Hutchins Bk 3.1	3.1	5.68	2.07	5.45	1.01	7.25	1.02	0.02	0.27	<1	51	243	0.9	0.07	0.3	23	41.4	374
Hutchins Bk Tailing Trib 0.1 A	0.1	1.64	0.62	6.63	0.24	18.3	0.37	0.05	0.06	<1	122	66	0.2	0.05	<0.1	10.5	93	1470
Hutchins Bk Tailing Trib 0.1 B	0.1	1.25	0.52	7.76	0.15	19.5	0.27	0.05	0.04	<1	128	41	0.1	<0.04	<0.1	5.67	98.9	1890
Hutchins Bk 2.8	2.8	1.02	0.52	6.83	0.11	21.4	0.17	0.06	0.03	<1	152	29	0.2	<0.04	<0.1	4.79	107	1680
Hutchins Bk Trib2	0.5	7.79	1.35	5.05	1.48	2.19	1.92	0.01	0.51	<1	88	369	1.6	0.1	0.2	43	21.2	183
Hutchins Bk Pd 1.8	1.8	4.18	1.05	4.83	0.78	7.51	0.82	0.12	0.2	<1	109	232	0.7	0.14	0.2	21.5	43.8	532
Hutchins Bk 1.6	1.6	5.88	1.46	4.62	1.09	4.16	1.33	0.02	0.29	<1	65	323	1.1	0.08	0.2	23.2	38.7	348
Dark Branch 3.3 A	3.3	4.08	0.6	2.4	0.79	0.82	1.2	0.01	0.25	<1	5	230	0.7	0.12	<0.1	23.9	7.2	68
Dark Branch 3.3 B	3.3	5.44	1.2	3.46	1.07	1.77	1.3	0.01	0.3	<1	14	287	1	0.12	0.1	28.3	14.7	143
Dark Branch Pd 2.4	2.4	4.45	1.11	2.97	0.83	1.01	1.09	0.07	0.35	<1	21	266	0.9	0.1	0.3	37.5	11.8	113
Dark Branch 0.1	0.1	4.23	1.08	2.31	0.74	1.11	1.28	0.03	0.36	<1	8	236	0.7	0.05	<0.1	19.3	8.8	113
Dark Branch 0.1 Dup	0.1	4.26	1.14	2.35	0.73	1.09	1.27	0.02	0.34	<1	8	231	0.8	0.06	<0.1	23.5	9.5	114
Gihon River 14.5	14.5	5.2	1.53	3.79	0.93	2.01	1.27	0.02	0.33	<1	11	256	0.8	0.09	<0.1	22.3	14.6	212
Burgess Branch 2.6	2.6	4.7	0.92	2.75	0.95	1.07	1.24	0.01	0.33	<1	6	264	0.9	0.11	<0.1	23.5	9.4	95
Burgess Branch 5.0	5.0	1.83	0.52	4.68	0.32	19.2	0.33	0.02	0.08	<1	6	79	0.3	0.04	<0.1	6.9	67.4	1080
Burgess Branch Trib 8	0.3	5.25	1	3.23	1.07	1.09	1.28	0.02	0.32	<1	12	331	1.2	0.13	0.3	36.3	14.6	94
Burgess Branch Trib 9	0.3	5.6	0.94	4.07	1.25	1.21	1.25	<0.01	0.34	<1	7	325	1.2	0.14	0.1	30	13.2	106
Burgess Branch Trib 10	0.1	4.96	1.07	3.39	0.97	1.61	1.25	0.02	0.32	<1	13	268	1.1	0.11	0.2	36.1	16.4	122
Burgess Branch Trib 11 A	0.4	0.67	0.74	6.12	0.02	24.3	0.03	0.02	0.01	<1	7	6	<0.1	<0.04	<0.1	1.21	95.7	1420
Burgess Branch Trib 11 B	0.4	0.67	0.68	7.14	0.02	23.7	0.03	0.02	0.02	<1	5	6	<0.1	<0.04	<0.1	1.06	111	1560
Corez Pond – South	6.0	0.74	0.86	6.03	0.03	23.5	0.03	0.04	0.02	<1	28	10	<0.1	<0.04	<0.1	1.49	91.6	1390
Lowell Mine Pit Pond	0.1	1.26	1.29	6.4	0.12	21.7	0.14	0.03	0.05	<1	18	31	0.1	0.05	<0.1	4.18	93.1	1380
Consensus Based TEC											9.79				0.99			43.4
Summary Statistics																		
Minimum		0.67	0.52	2.31	0.02	0.82	0.03	0.01	0.01		5	6	0.1	0.04	0.1	1.06	7.2	68
Maximum		7.79	2	7.76	1.48	24.3	1.92	0.12	0.51		152	369	1.6	0.14	0.3	43	111	1890
Median		4.24	1.02	4.65	0.78	3.17	1.14	0.02	0.28		13.5	234	0.8	0.1	0.2	22.6	29.9	280

. **Table 11 (continued):** Streambed Sediment Chemistry analyzed by USGS Laboratory for 42 major, minor, and trace elements determined by ICP-AES and ICP-MS. Consensus-Based Sediment Quality Guidelines (TEC) MacDonald et al (2000) shown for As, Cd, Cr, Cu, Pb, Ni and Zn. Columns for these metals are also shaded and severe exceedances are bolded..

Site Name	Station (RM)	Cs ppm	Cu ppm	Ga ppm	In ppm	La ppm	Li ppm	Mn ppm	Mo ppm	Nb ppm	Ni ppm	P ppm	Pb ppm	Rb ppm	Sb ppm	Sc ppm	Sn ppm	Sr ppm
Hutchins Bk 3.1	3.1	<5	31	11.7	0.04	10.6	24	965	0.54	3.4	529	340	8.6	40.9	3.45	18.7	0.7	68.9
Hutchins Bk Tailing Trib 0.1 A	0.1	<5	20.5	3.13	<0.02	4.1	6	896	0.17	1	1900	120	6.8	9.4	13	7.9	1.2	21.3
Hutchins Bk Tailing Trib 0.1 B	0.1	<5	15.8	2.07	<0.02	2.1	3	976	0.07	0.6	2120	90	4.8	5.5	16.1	7	0.6	14.4
Hutchins Bk 2.8	2.8	<5	9.2	1.89	<0.02	1.9	2	892	0.13	0.4	2060	70	3.3	4.7	11.5	7.6	0.6	9.9
Hutchins Bk Trib2	0.5	<5	27	17.6	0.06	21	31	1200	1.14	11.5	111	800	11	62.2	0.43	17.9	1.5	92.5
Hutchins Bk Pd 1.8	1.8	<5	34.9	8.1	0.03	11.9	19	1930	0.57	3.5	848	580	15	32.9	5.63	11	1.6	63
Hutchins Bk 1.6	1.6	<5	16.3	12.5	0.04	12.1	25	2980	0.59	5.1	599	400	8.4	47.7	2.5	15.3	1.4	81.1
Dark Branch 3.3 A	3.3	<5	14.4	7.34	0.03	9.2	16	365	0.89	4	62.3	270	8.8	28.9	0.28	5.5	0.6	95
Dark Branch 3.3 B	3.3	<5	40.8	10.4	0.04	15.6	23	961	0.56	4.7	139	430	8.7	41.4	0.39	11.4	0.9	90.4
Dark Branch Pd 2.4	2.4	<5	14.8	9.7	0.03	20.6	19	1310	0.5	6.6	79.1	660	13.9	34.9	0.42	9.6	1.6	105
Dark Branch 0.1	0.1	<5	7	8.11	0.02	10.2	15	691	0.14	6.6	67.8	400	6.6	29	0.28	8.2	0.8	102
Dark Branch 0.1 Dup	0.1	<5	9	8.73	0.03	11.9	15	681	0.21	6.2	65.9	440	8.7	28.5	0.26	9.6	0.8	104
Gihon River 14.5	14.5	<5	23.2	9.89	0.03	11	22	1050	0.32	5.6	134	420	8.5	35.8	0.43	11.3	1.5	105
Burgess Branch 2.6	2.6	<5	16.2	8.79	0.03	12	19	688	0.4	5.5	62.7	380	8.2	36.9	0.26	8.3	0.7	101
Burgess Branch 5.0	5.0	<5	11.3	3.15	<0.02	4.3	7	768	0.06	1.3	1440	100	2.6	11.8	0.35	7.8	0.3	25.9
Burgess Branch Trib 8	0.3	<5	19.9	12.4	0.04	16.5	23	1570	1.83	6.7	67	500	12	46.2	0.21	11.4	1.2	103
Burgess Branch Trib 9	0.3	<5	23.1	11.7	0.04	13.8	25	888	0.7	5.6	50.8	380	10.6	50.2	0.23	11.7	1.2	97.2
Burgess Branch Trib 10	0.1	<5	37.3	10.4	0.04	19.6	20	878	0.42	5.2	110	440	10.4	39.9	0.24	10.7	0.9	93.7
Burgess Branch Trib 11 A	0.4	<5	7.5	1.03	<0.02	0.5	<1	789	0.19	0.2	1960	<50	1	0.9	0.38	7.9	0.1	4.2
Burgess Branch Trib 11 B	0.4	<5	11	1.21	<0.02	<0.5	<1	839	0.31	0.3	2050	<50	1.3	0.9	0.4	8.5	0.3	4.4
Corez Pond – South	6.0	<5	12.8	1.24	<0.02	0.8	1	919	0.11	0.3	2070	50	2.3	1.3	1.41	8.3	0.4	5.3
Lowell Mine Pit Pond	0.1	<5	51.2	2.33	<0.02	1.9	3	855	0.21	0.8	1880	70	6.9	4.7	0.76	9.8	2.5	16.6
Consensus Based TEC			31.6								22.7		35.8					
Summary Statistics																		
	Minimum		7	1.03	0.02	0.5	1	365	0.06	0.2	50.8	50	1	0.9	0.21	5.5	0.1	4.2
	Maximum		51.2	17.6	0.06	21	31	2980	1.83	11.5	2120	800	15	62.2	16.1	18.7	2.5	105
	Median		16.2	8.4	0.035	11	19	894	0.36	4.35	334	390	8.4	30.95	0.41	9.6	0.85	85.7

. **Table 11 (continued):** Streambed Sediment Chemistry analyzed by USGS Laboratory for 42 major, minor, and trace elements determined by ICP-AES and ICP-MS. Consensus-Based Sediment Quality Guidelines (TEC) MacDonald et al (2000) shown for As, Cd, Cr, Cu, Pb, Ni and Zn. Columns for these metals are also shaded and severe exceedances are bolded..

Site Name	Station (RM)	Te ppm	Th ppm	Tl ppm	U ppm	V ppm	W ppm	Y ppm	Zn ppm	Se ppm	C %	CO2 %	CRBNT_C %	Hg ppm
Hutchins Bk 3.1	3.1	<0.1	2.8	0.2	0.8	128	0.5	11.8	81	0.2	0.81	0.07	0.02	0.02
Hutchins Bk Tailing Trib 0.1 A	0.1	<0.1	0.9	<0.1	0.3	49	1.3	2.9	48	<0.2	0.58	0.95	0.26	0.02
Hutchins Bk Tailing Trib 0.1 B	0.1	<0.1	0.5	<0.1	0.2	46	1.3	1.7	59	<0.2	0.49	0.88	0.24	0.02
Hutchins Bk 2.8	2.8	<0.1	0.4	<0.1	0.2	39	1.3	1.6	36	<0.2	0.53	1.02	0.28	0.03
Hutchins Bk Trib2	0.5	<0.1	4.6	0.3	1.6	170	0.6	17.2	103	<0.2	0.93	0.05	0.01	0.02
Hutchins Bk Pd 1.8	1.8	<0.1	2.4	0.2	0.8	86	5.4	8.4	71	0.5	5.44	0.17	0.05	0.1
Hutchins Bk 1.6	1.6	<0.1	2.7	0.3	0.8	126	3.9	11.7	73	0.3	1.04	0.12	0.03	0.02
Dark Branch 3.3 A	3.3	<0.1	3.1	0.1	1	51	0.4	7.5	34	<0.2	0.44	0.02	0.01	0.02
Dark Branch 3.3 B	3.3	<0.1	4	0.2	0.9	100	0.5	12.8	60	<0.2	0.64	0.04	0.01	0.02
Dark Branch Pd 2.4	2.4	<0.1	4.4	0.2	1.6	74	0.6	14.1	60	0.4	3.93	0.07	0.02	0.05
Dark Branch 0.1	0.1	<0.1	2.3	0.1	0.8	69	0.3	10.5	41	<0.2	0.8	0.02	0.01	0.01
Dark Branch 0.1 Dup	0.1	<0.1	2.3	0.1	0.9	69	0.3	11.2	41	<0.2	0.73	0.03	0.01	0.02
Gihon River 14.5	14.5	<0.1	3	0.2	0.9	106	0.3	11.4	60	<0.2	0.4	0.03	0.01	0.01
Burgess Branch 2.6	2.6	<0.1	2.9	0.2	0.8	73	0.3	10.3	47	<0.2	0.27	0.02	0.01	<0.01
Burgess Branch 5.0	5.0	<0.1	0.9	<0.1	0.7	51	0.5	3.1	34	<0.2	0.26	0.35	0.1	0.01
Burgess Branch Trib 8	0.3	<0.1	3.7	0.2	1.2	88	0.4	13.7	70	0.2	0.96	0.05	0.01	0.02
Burgess Branch Trib 9	0.3	<0.1	4	0.3	1.1	99	0.4	13.2	56	0.2	0.27	0.01	<0.003	0.01
Burgess Branch Trib 10	0.1	<0.1	4.1	0.2	1.3	91	0.3	13.8	59	<0.2	0.6	0.03	0.01	0.02
Burgess Branch Trib 11 A	0.4	<0.1	<0.2	<0.1	<0.1	38	0.9	0.6	33	<0.2	0.38	1.03	0.28	0.02
Burgess Branch Trib 11 B	0.4	<0.1	<0.2	<0.1	<0.1	41	0.8	0.8	36	<0.2	0.32	0.83	0.23	0.02
Corez Pond – South	6.0	<0.1	<0.2	<0.1	0.2	42	1.1	0.8	34	<0.2	0.94	1.07	0.29	0.02
Lowell Mine Pit Pond	0.1	<0.1	0.5	<0.1	0.9	53	0.8	2.4	78	<0.2	0.58	0.8	0.22	0.03
Consensus Based TEC									121					
Summary Statistics														
Minimum				0.1	0.2	0.1	0.2	0.6	0.3	0.2	0.26	0.01	0.01	0.01
Maximum				0.3	4.6	170	5.4	170	103	17.2	5.44	1.07	0.29	0.1
Median				0.2	0.9	69	0.6	11.2	48	0.4	0.59	0.07	0.02	0.02

Fish Tissue Analysis

Trace metals such as manganese and nickel have been found to be elevated in fish exposed to asbestos rich sediments (Schreier 1987). VTDEC collected 31 Brook Trout from 6 sites for metals analysis in 2007. The site locations, number of fish caught, size class and type of analysis are shown in **Table 12**. The fish were frozen whole and stored at VTDEC R.A.LaRosa Laboratory. The fish were relinquished to Superfund Technical Assessment and Response Team III (START) personnel and were sent to a Delivery of Analytical Services (DAS) laboratory for metal analysis. Analytical results of the fish samples indicated the presence of 18 metals at concentrations above the Contract Required Quantitation Limit (CRQL). Results of the fish tissue analysis are reported in **Table 13** (Whole Fish) and **Table 14** (Fillet).

These data have not been evaluated to address issues associated with risk assessment. The highest value of manganese reported in the whole fish analysis was 19.4 mg/kg from the Gihon River 14.5 site. This concentration of manganese appears to be on the upper end for whole fish analysis conducted below asbestos-rich sediment in a similar study (Schreier 1987).

Whole fish analysis from the Burgess Branch 5.0 site yielded the highest concentration of nickel observed, 4.5 mg/kg. Burgess Branch 5.0 also had high levels of chrysotile fiber in the streambed sediment (43.5%) and the streambed sediment concentrations of nickel were 1440 mg/kg, exceeding the Consensus-Based SQGs TEC 22.7 mg/kg nearly 60-fold.

Mouth deformities were observed on 2 “wild” Brook Trout collected at the Gihon River 14.5 (Figure 6), These fish were included in the fish tissue analysis. This type of anomaly does appear to be very rare in “wild” fish (pers.comm. VT Department of Fish and Wildlife Fish Pathologist). Metal toxicity can cause this type of anomaly.

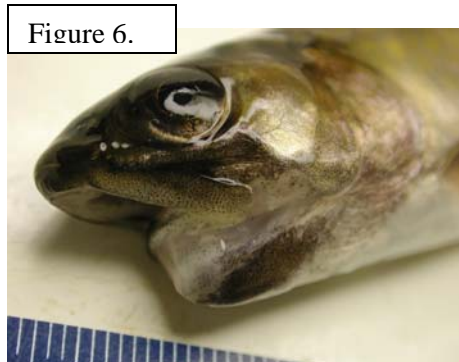


Table 12: VTDEC Fish Collections for Metals Analysis - 2007

Location	Sample Date	Fish Type	Number of Fish Caught	Fish Size Range	Analysis Method (conc. level)	Fillet/Whole Sample	Number of Fish per Analyses
Gihon River 14.2	9/6/2007	Brook Trout	7	4.0-7.0"	6010C (Med)	Whole	3
					6020 (Low)	Fillet	4
Dark Branch 1.5	9/13/2007	Brook Trout	6	4.0-6.0"	6010C (Med)	Whole	3
					6020 (Low)	Fillet	3
Dark Branch 3.3	9/17/2007	Brook Trout	5	4.0-6.0"	6010C (Med)	Whole	2
					6020 (Low)	Fillet	3
Hutchins Brook 0.1	9/13/2007	Brook Trout	5	4.0-6.0"	6010C (Med)	Whole	2
					6020 (Low)	Fillet	3
Hutchins Brook 2.1	9/13/2007	Brook Trout	2	5.0-6.0"	6010C (Med)	Whole	1
					6020 (Low)	Fillet	1
Burgess Branch 5.0	9/14/2007	Brook Trout	6	6.5 - 8.0"	6010C (Med)	Whole	3
					6020 (Low)	Fillet	3
Totals			31		6010C (Med)	Whole	14
					6020 (Low)	Fillet	17

Table 13: Whole Fish Tissue Metals Analysis

SITE: Vermont Asbestos Group
CASE: 0767F SDG: D18694
LABORATORY: COMPUCHEM

**DATA SUMMARY TABLE 1
WHOLE FISH TISSUE ANALYSIS
mg/kg**

SAMPLE NUMBER: SAMPLE LOCATION: LABORATORY NUMBER: PERCENT SOLIDS:		D18694 Burgess 5.0 1474601 NA	D18695 Burgess 5.0 1474602 NA	D18696 Dark 1.5 1474603 NA	D18697 Dark 1.5 1474604 NA	D18698 Dark 3.3 1474605 NA	D18699 Dark 3.3 1474606 NA	D18700 Dark 3.3 1474607 NA	CRQL (mg/kg)	
INORGANIC ANALYTES	METHOD	INSTRUMENT DETECTION LIMITS (mg/kg)							CRQL (mg/kg)	
ALUMINUM	P	2.99	4.0 J	12.9 J	3.2 J	2.8 U	14.1 J	2.8 U	5.1 J	20
ANTIMONY	P	0.39	0.71 U	0.66 U	0.64 U	0.57 U	0.68 U	0.47 U	0.55 U	6
ARSENIC	P	0.30	0.28 UJ	0.32 J	0.42 J	0.28 UJ	0.30 UJ	0.28 UJ	0.29 UJ	1
BARIUM	P	0.03	0.23 J	0.35 J	0.40 J	0.19 J	0.38 J	0.32 J	0.46 J	20
BERYLLIUM	P	0.020	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5
CADMIUM	P	0.080	0.05 UJ	0.05 UJ	0.05 UJ	0.05 UJ	0.05 UJ	0.05 UJ	0.05 UJ	0.5
CALCIUM	P	1.52	6400	7440	6730	3950	2810	3930	6970	500
CHROMIUM	P	0.07	0.65 J	2.1	0.32 U	0.32 U	0.34 U	0.30 U	0.41 U	1
COBALT	P	0.20	0.19 UJ	0.18 UJ	0.19 UJ	0.19 UJ	0.20 UJ	0.19 UJ	0.19 UJ	5
COPPER	P	0.10	0.99 J	1.0 J	0.64 J	0.50 J	0.58 J	1.1 J	1.2 J	2.5
IRON	P	2.12	30.9	140	13.4	9.1 U	50.5	6.6 U	30.4	10
LEAD	P	0.23	0.21 U	0.21 U	0.22 U	0.22 U	0.23 U	0.22 U	0.22 U	1
MAGNESIUM	P	1.23	373 J	557	298 J	274 J	201 J	225 J	285 J	500
MANGANESE	P	0.03	3.3	6.6	7.8	4.3	10.0	1.6	3.8	1.5
NICKEL	P	0.09	0.97	4.5	0.09 U	0.09 U	0.11 J	0.09 U	0.11 J	4
POTASSIUM	P	0.84	3000	3200	2720	3090	1220	1730	2320	500
SELENIUM	P	0.42	0.40 J	0.49 J	0.45 J	0.45 J	0.42 J	0.40 J	0.40 J	3.5
SILVER	P	0.12	0.11 U	0.11 U	0.12 U	0.11 U	0.12 U	0.11 U	0.11 U	1
SODIUM	P	23.0	871	820	772	713	480 J	480 J	986	500
THALLIUM	P	0.48	0.45 UJ	0.44 UJ	0.47 UJ	0.45 UJ	0.48 UJ	0.45 UJ	0.46 UJ	2.5
VANADIUM	P	0.06	0.06 U	0.06 J	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	5
ZINC	P	0.11	16.1	19.3	27.1	19.9	17.6	17.8	27.8	6

ANALYTICAL METHOD
P - ICP = Inductively Coupled Plasma

NOTE: J = QUANTITATION IS ESTIMATED DUE TO LIMITATIONS IDENTIFIED
IN THE QUALITY CONTROL REVIEW (DATA REVIEW).
U = VALUE IS NON-DETECTED.
UJ = VALUE IS NON-DETECTED AND DETECTION LIMIT IS ESTIMATED.
mg/kg = milligrams per kilogram

RESULTS ARE REPORTED ON A WET WEIGHT BASIS.

Table 13: Whole Fish Tissue Metals Analysis –Continued

SITE: Vermont Asbestos Group
CASE: 0767F SDG: D18694
LABORATORY: COMPUCHEM

**DATA SUMMARY TABLE 1
WHOLE FISH TISSUE ANALYSIS
mg/kg**

SAMPLE NUMBER: SAMPLE LOCATION: LABORATORY NUMBER: PERCENT SOLIDS:		D18731 Gihon R. 1474608 NA	D18732 Gihon R. 1474609 NA	D18733 Gihon R. 1474610 NA	D18734 Hutchins 0.1 1474611 NA	D18736 Hutchins 0.1 1474612 NA	CRQL (mg/kg)	
INORGANIC ANALYTES	METHOD	INSTRUMENT DETECTION LIMITS (mg/kg)						
ALUMINUM	P	2.99	3.0 U	4.7 J	3.6 J	3.0 U	28.1	20
ANTIMONY	P	0.39	0.71 U	0.52 U	0.57 U	0.43 U	0.58 U	6
ARSENIC	P	0.30	0.30 UJ	0.28 UJ	0.30 UJ	0.30 UJ	0.30 UJ	1
BARIUM	P	0.03	0.27 J	0.36 J	0.34 J	0.25 J	0.04 J	20
BERYLLIUM	P	0.020	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.5
CADMIUM	P	0.080	0.06 UJ	0.05 UJ	0.08 UJ	0.05 UJ	0.05 UJ	0.5
CALCIUM	P	1.52	3530	9000	6030	4090	740	500
CHROMIUM	P	0.07	0.30 U	0.36 U	0.30 U	0.28 U	0.22 U	1
COBALT	P	0.20	0.20 UJ	0.18 UJ	0.20 UJ	0.20 UJ	0.20 UJ	5
COPPER	P	0.10	0.56 J	0.67 J	0.97 J	0.64 J	0.62 J	2.5
IRON	P	2.12	12.2 U	12.3 U	24.5 J	10.2 U	4.7 U	10
LEAD	P	0.23	0.23 U	0.21 U	0.23 U	0.23 U	0.23 U	1
MAGNESIUM	P	1.23	277 J	297 J	288 J	247 J	209 J	500
MANGANESE	P	0.03	5.5	8.1	19.4	3.1	0.35 J	1.5
NICKEL	P	0.09	0.09 U	0.08 U	0.09 U	0.09 U	0.09 U	4
POTASSIUM	P	0.84	2820	2790	2930	2390	2920	500
SELENIUM	P	0.42	0.55 J	0.59 J	0.60 J	0.42 J	0.42 J	3.5
SILVER	P	0.12	0.12 U	0.11 U	0.12 U	0.12 U	0.12 U	1
SODIUM	P	23.0	640	760	847	712	602	500
THALLIUM	P	0.48	0.48 UJ	0.44 UJ	0.48 UJ	0.48 UJ	0.48 UJ	2.5
VANADIUM	P	0.06	0.06 U	0.05 U	0.06 U	0.06 U	0.06 U	5
ZINC	P	0.11	21.6	24.9	25.2	22.9	11.6	6

ANALYTICAL METHOD
P - ICP = Inductively Coupled Plasma

NOTE: J = QUANTITATION IS ESTIMATED DUE TO LIMITATIONS IDENTIFIED
IN THE QUALITY CONTROL REVIEW (DATA REVIEW).
U = VALUE IS NON-DETECTED.
UJ = VALUE IS NON-DETECTED AND DETECTION LIMIT IS ESTIMATED.
mg/kg = milligrams per kilogram

RESULTS ARE REPORTED ON A WET WEIGHT BASIS.

Table 14: Fillet Fish Tissue Metals Analysis

SITE: Vermont Asbestos Group
CASE: 0767F SDG: D18676
LABORATORY: COMPUCHEM

**DATA SUMMARY TABLE 1
FILLET FISH TISSUE ANALYSIS
mg/kg**

SAMPLE NUMBER:		D18676	D18677	D18678	D18679	D18680	D18681	D18682		
SAMPLE LOCATION:		Burgess 5	Burgess 5	Burgess 5	Dark 1.5	Dark 1.5	Dark B. 1.5	Dark B.3.3		
LABORATORY NUMBER:		1474701	1474702	1474703	1474704	1474705	1474706	1474707		
PERCENT SOLIDS:		NA	NA	NA	NA	NA	NA	NA		
INORGANIC ANALYTES	METHOD	INSTRUMENT DETECTION LIMITS (mg/kg)							CRQL (mg/kg)	
ANTIMONY	ICP/MS	0.0058	0.12 U	0.15 U	0.16 U	0.12 U	0.069 U	0.029 U	0.029 U	1
ARSENIC	ICP/MS	0.00575	0.13 UJ	0.16 UJ	0.10 UJ	0.19 UJ	0.18 UJ	0.13 UJ	0.098 UJ	0.5
BARIUM	ICP/MS	0.0042	0.10 J	0.21 J	0.16 J	0.14 J	0.13 J	0.036 J	0.099 J	5
BERYLLIUM	ICP/MS	0.00445	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.022 U	0.5
CADMIUM	ICP/MS	0.00175	0.009 U	0.009 U	0.010 J	0.009 J	0.009 U	0.009 U	0.009 U	0.5
CHROMIUM	ICP/MS	0.00255	0.013 UJ	0.013 UJ	0.10 J	0.012 UJ	0.013 UJ	0.013 UJ	0.013 UJ	1
COBALT	ICP/MS	0.0135	0.078 J	0.068 U	0.068 U	0.068 U	0.068 U	0.068 U	0.067 U	0.5
COPPER	ICP/MS	0.00275	.53 U	0.82 J	0.83 J	0.74 J	0.91 J	0.43 U	0.81 J	1
LEAD	ICP/MS	0.00145	0.008 U	0.012 U	0.028 U	0.015 U	0.016 U	0.007 U	0.011 U	0.5
MANGANESE	ICP/MS	0.0027	0.71 J	0.79 J	1.5 J	1.3 J	2.0 J	0.28 J	0.29 J	0.5
NICKEL	ICP/MS	0.0079	0.71 J	0.43 J	0.52 J	0.066 J	0.072 J	0.059 J	0.058 J	0.5
SELENIUM	ICP/MS	0.01745	0.52 UJ	0.58 UJ	0.71 UJ	0.60 UJ	0.62 UJ	0.45 UJ	0.42 UJ	2.5
SILVER	ICP/MS	0.00205	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.010 U	0.5
THALLIUM	ICP/MS	0.0024	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.012 U	0.5
VANADIUM	ICP/MS	0.00635	0.042 UJ	0.042 UJ	0.042 UJ	0.041 UJ	0.042 UJ	0.042 UJ	0.041 UJ	0.5
ZINC	ICP/MS	0.01445	9.2 J	10.3 J	8.8 J	14.2 J	13.0 J	14.0 J	12.2 J	1

ANALYTICAL METHOD
ICP/MS = Inductively Coupled Plasma/Mass Spectrometry

NOTE: J = QUANTITATION IS ESTIMATED DUE TO LIMITATIONS IDENTIFIED IN THE QUALITY CONTROL REVIEW (DATA REVIEW).
U = VALUE IS NON-DETECTED.
UJ = VALUE IS NON-DETECTED AND DETECTION LIMIT IS ESTIMATED.
mg/kg = milligrams per kilogram
NA = Not Analyzed

RESULTS ARE REPORTED ON A WET WEIGHT BASIS.

Table 14: Fillet Fish Tissue Metals Analysis -Continued

SITE: Vermont Asbestos Group
CASE: 0767F SDG: D18676
LABORATORY: COMPUCHEM

**DATA SUMMARY TABLE 1
FILLET FISH TISSUE ANALYSIS
mg/kg**

SAMPLE NUMBER:		D18683	D18684	D18685	D18686	D18687	D18688	D18689		
SAMPLE LOCATION:		Dark B.3.3	Dark B.3.3	Gihon R.	Gihon R.	Gihon R.	Gihon R.	Hutchins 0.1		
LABORATORY NUMBER:		1474708	1474709	1474710	1474711	1474712	1474713	1474714		
PERCENT SOLIDS:		NA	NA	NA	NA	NA	NA	NA		
INORGANIC ANALYTES	METHOD	INSTRUMENT DETECTION LIMITS (mg/kg)							CRQL (mg/kg)	
ANTIMONY	ICP/MS	0.0058	1.3	0.028 U	0.028 UJ	0.029 UJ	0.029 UJ	0.27 UJ	0.039 U	1
ARSENIC	ICP/MS	0.00575	0.028 UJ	0.13 UJ	0.12 UJ	0.22 UJ	0.20 UJ	0.28 UJ	0.18 UJ	0.5
BARIUM	ICP/MS	0.0042	0.024 J	0.14 J	0.087 J	0.077 J	0.086 J	0.082 J	0.18 J	5
BERYLLIUM	ICP/MS	0.00445	0.022 U	0.022 U	0.022 UJ	0.022 UJ	0.022 UJ	0.022 UJ	0.022 U	0.5
CADMIUM	ICP/MS	0.00175	0.009 U	0.008 U	0.009 UJ	0.009 UJ	0.009 UJ	0.009 UJ	0.016 J	0.5
CHROMIUM	ICP/MS	0.00255	0.012 U	0.012 UJ	0.012 UJ	0.013 UJ	0.013 UJ	0.013 UJ	0.18 J	1
COBALT	ICP/MS	0.0135	0.066 U	0.066 U	0.084 J	0.088 J	0.12 J	0.11 J	0.088 U	0.5
COPPER	ICP/MS	0.00275	0.013 U	0.72 J	0.42 UJ	0.58 UJ	0.94 J	1.0 J	0.60 U	1
LEAD	ICP/MS	0.00145	0.007 U	0.011 U	0.010 UJ	0.016 UJ	0.013 UJ	0.010 UJ	0.018 U	0.5
MANGANESE	ICP/MS	0.0027	0.013 UJ	1.1 J	2.0 J	0.85 J	1.6 J	0.52 J	1.8 J	0.5
NICKEL	ICP/MS	0.0079	0.039 UJ	0.34 J	0.099 J	0.054 J	0.075 J	0.040 J	0.18 J	0.5
SELENIUM	ICP/MS	0.01745	0.085 UJ	0.54 UJ	0.69 UJ	0.58 UJ	0.95 UJ	1.0 UJ	0.51 UJ	2.5
SILVER	ICP/MS	0.00205	0.010 U	0.010 U	0.010 UJ	0.010 UJ	0.010 UJ	0.010 UJ	0.010 U	0.5
THALLIUM	ICP/MS	0.0024	0.012 U	0.012 U	0.012 UJ	0.012 UJ	0.012 UJ	0.012 UJ	0.012 U	0.5
VANADIUM	ICP/MS	0.00835	0.041 U	0.041 UJ	0.041 UJ	0.042 UJ	0.042 UJ	0.042 UJ	0.042 UJ	0.5
ZINC	ICP/MS	0.01445	0.070 U	13.2 J	8.2 J	10.2 J	13.4 J	18.0 J	16.8 J	1

ANALYTICAL METHOD
ICP/MS = Inductively Coupled Plasma/Mass Spectrometry

NOTE: J = QUANTITATION IS ESTIMATED DUE TO LIMITATIONS IDENTIFIED IN THE QUALITY CONTROL REVIEW (DATA REVIEW).
U = VALUE IS NON-DETECTED.
UJ = VALUE IS NON-DETECTED AND DETECTION LIMIT IS ESTIMATED.
mg/kg = milligrams per kilogram
NA = Not Analyzed

RESULTS ARE REPORTED ON A WET WEIGHT BASIS.

Table 14: Fillet Fish Tissue Metals Analysis -Continued

SITE: Vermont Asbestos Group
CASE: 0767F SDG: D18676
LABORATORY: COMPUCHEM

**DATA SUMMARY TABLE 1
FILLET FISH TISSUE ANALYSIS
mg/kg**

SAMPLE NUMBER: D18692
SAMPLE LOCATION: Hutchins 2.1
LABORATORY NUMBER: 1474715
PERCENT SOLIDS: NA

INORGANIC ANALYTES	METHOD	INSTRUMENT DETECTION LIMITS (mg/kg)		CRQL (mg/kg)
ANTIMONY	ICP/MS	0.0058	0.10 U	1
ARSENIC	ICP/MS	0.00575	0.15 UJ	0.5
BARIUM	ICP/MS	0.0042	0.057 J	5
BERYLLIUM	ICP/MS	0.00445	0.022 U	0.5
CADMIUM	ICP/MS	0.00175	0.009 U	0.5
CHROMIUM	ICP/MS	0.00255	0.072 J	1
COBALT	ICP/MS	0.0135	0.068 U	0.5
COPPER	ICP/MS	0.00275	0.85 J	1
LEAD	ICP/MS	0.00145	0.018 U	0.5
MANGANESE	ICP/MS	0.0027	0.14 J	0.5
NICKEL	ICP/MS	0.0079	0.11 J	0.5
SELENIUM	ICP/MS	0.01745	0.47 UJ	2.5
SILVER	ICP/MS	0.00205	0.010 U	0.5
THALLIUM	ICP/MS	0.0024	0.012 U	0.5
VANADIUM	ICP/MS	0.00835	0.042 UJ	0.5
ZINC	ICP/MS	0.01445	11.4 J	1

ANALYTICAL METHOD

ICP/MS = Inductively Coupled Plasma/Mass Spectrometry

J = QUANTITATION IS ESTIMATED DUE TO LIMITATIONS IDENTIFIED IN THE QUALITY CONTROL REVIEW (DATA REVIEW).
U = VALUE IS NON-DETECTED.
UJ = VALUE IS NON-DETECTED AND DETECTION LIMIT IS ESTIMATED.
mg/kg = milligrams per kilogram
NA = Not Analyzed

RESULTS ARE REPORTED ON A DRY WEIGHT BASIS.

Summary:

In summary, the biological and/or chemical assessments conducted at 23 sites within the Lamoille River and Missisquoi River watersheds in 2005 and 2007 show that the aquatic biota, water quality and streambed sediment quality is degraded in both watersheds and there is significant evidence that the stressors are coming from the Eden/Lowell mine tailing piles located within the Hutchins Brook and Burgess Branch watersheds.

- 1) In the Lamoille River watershed, the macroinvertebrate communities at Hutchins Brook Tailing Trib., Hutchins Brook 2.8, and Hutchins Brook 2.1 are in poor condition due to low density, low richness and low EPT richness and are all significantly below the Class “B” biocriteria guidance used by the VTDEC for SHG type streams. All other sites in the watershed were judged to meet ALU requirements with regard to the macroinvertebrate community.
- 2) In the Missisquoi River watershed, the macroinvertebrate communities at Burgess Branch 5.0, Burgess Branch Trib. 11 and Burgess Branch Trib. 10 are in fair condition due to low richness, low EPT richness and high Biotic Index and are all below the Class “B” biocriteria guidance used by the VTDEC for SHG type streams. All other sites in the watershed were judged to meet ALU requirements with regard to the macroinvertebrate community.
- 3) Fish Community assessments were conducted at 13 sites. The drainage areas of many of these sites are very small (<2km²) and did not support the minimum number of two fish species to apply a coldwater IBI. Hutchins Brook 2.1 was located immediately above a wetland where brook trout had been observed yet only two trout were sampled at this site. The site was judged in “poor” condition because of so few trout collected. Burgess Brook 2.4 and Burgess Brook trib. 8 were also assessed as “poor” due to over-dominance by black nose dace and absence of fish respectively. All other sites were judged to meet ALU support requirements with respect to the fish community.
- 4) The streambed sediment at Hutchins Brook Tailing Trib., Hutchins Brook 2.8, Hutchins Brook 2.1, Hutchins Brook Pond 1.8, Burgess Branch 5.0, Burgess

Branch Trib. 11, Corez Pond- South and the Lowell Mine Pit Pond all contain significant levels of chrysotile asbestos fibers (9.5 – 86 percent).

- 5) Surface water chemistry indicated that magnesium and/or nickel levels were elevated at 10 of the sites sampled. Lamoille River watershed sites included: Hutchins Brook Tailing Trib., Hutchins Brook 2.8, Hutchins Brook 2.1, Hutchins Brook Pond 1.8, Hutchins Brook 1.6 and Dark Branch 3.3. Missisquoi River watershed sites included: Burgess Branch 5.0, Burgess Branch Trib. 11, Corez Pond- South and the Lowell Mine Pit Pond.
- 6) Water column nickel concentrations were significantly elevated at Hutchins Brook Tailing Trib., Hutchins Brook 2.8 and Hutchins Brook 2.1. The highest dissolved nickel concentration observed was 77 ug/l-Ni at Hutchins 2.1 slightly exceeding the Vermont Water Quality Standards and the EPA National Ambient Water Quality Criteria for chronic toxicity for dissolved nickel of 75 ug/l (hardness adjusted to 156 mg/l CaCO₃).
- 7) Streambed concentrations of chromium and nickel severely exceeded Consensus-Based PEC (Probable Effect Concentration) Sediment Quality Guidelines (SQGs) at the Hutchins Brook Tailing Trib., Hutchins Brook 2.8, Burgess Branch 5.0, Burgess Branch Trib. 11, Corez Pond -South and the Lowell Mine Pit Pond sites. Chromium values at these sites ranged from 1080 mg/kg to a high of 1890 mg/kg at the Hutchins Tailing Trib.site, exceeding the Consensus-Based SQGs PEC chromium of 111 mg/kg by 10-17-fold. Nickel concentrations at these sites ranged from 1440 mg/kg at Burgess Branch 5.0 to a high of 2120 mg/kg at the Hutchins Brook Tailing Trib., exceeding the Consensus-Based SQGs TEC of 48.6 mg/kg by a factor of 30-44.

The preliminary data collected provide evidence linking the tailing piles within the Hutchins Brook and Burgess Branch watersheds both directly and indirectly to chemical and physical biological stressors identified during these assessments. Elevated levels of chrysotile-fibers and associated metals in the water column and streambed sediment, and the resulting poor macroinvertebrate community assessments are likely the result of the tailing piles eroding asbestos bearing materials into adjacent waterways.

These assessments conclude that the tailing piles located within the Hutchins Brook and Burgess Brook watersheds are impacting the waterways, and numerous sites currently are below Class “B” biocriteria guidance used by the VTDEC for SHG streams.

We recommend further monitoring within the Lamoille River and Missisquoi watersheds watersheds to include water chemistry, streambed sediment chemistry, bioassays, fish tissue metals analysis, water column asbestos fiber analysis, fish and macroinvertebrate surveys and physical assessments. Monitoring additional sites within these watersheds will be imperative to clearly delineate the zone of disturbance.

