

Carleton Stream TMDL

Carleton Stream TMDL



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1. DESCRIPTION OF WATERBODY, POLLUTANT OF CONCERN, POLLUTANT SOURCES AND PRIORITY RANKING

Description of Waterbody and Watershed

Carleton Stream is a small coastal stream located in the town of Blue Hill, Hancock County, Maine, Figure 1. The entire stream drains approximately 10.3 square miles and flows through forested hills and four Great Ponds before reaching Salt Pond, which flows into Blue Hill Bay. Landuse in the watershed is dominated by forest with sparse residential development along the shoreline of the Great Ponds. The channel form of the stream varies between low gradient sandy areas to moderate gradient areas with boulder and cobble substrate that are capable of supporting native brook trout (*Salvelinus fontinalis*). The channel width ranges from 4 – 17 meters, with a depth that ranges between 0.5- 1.5 m in depth (AMEC, 2001).

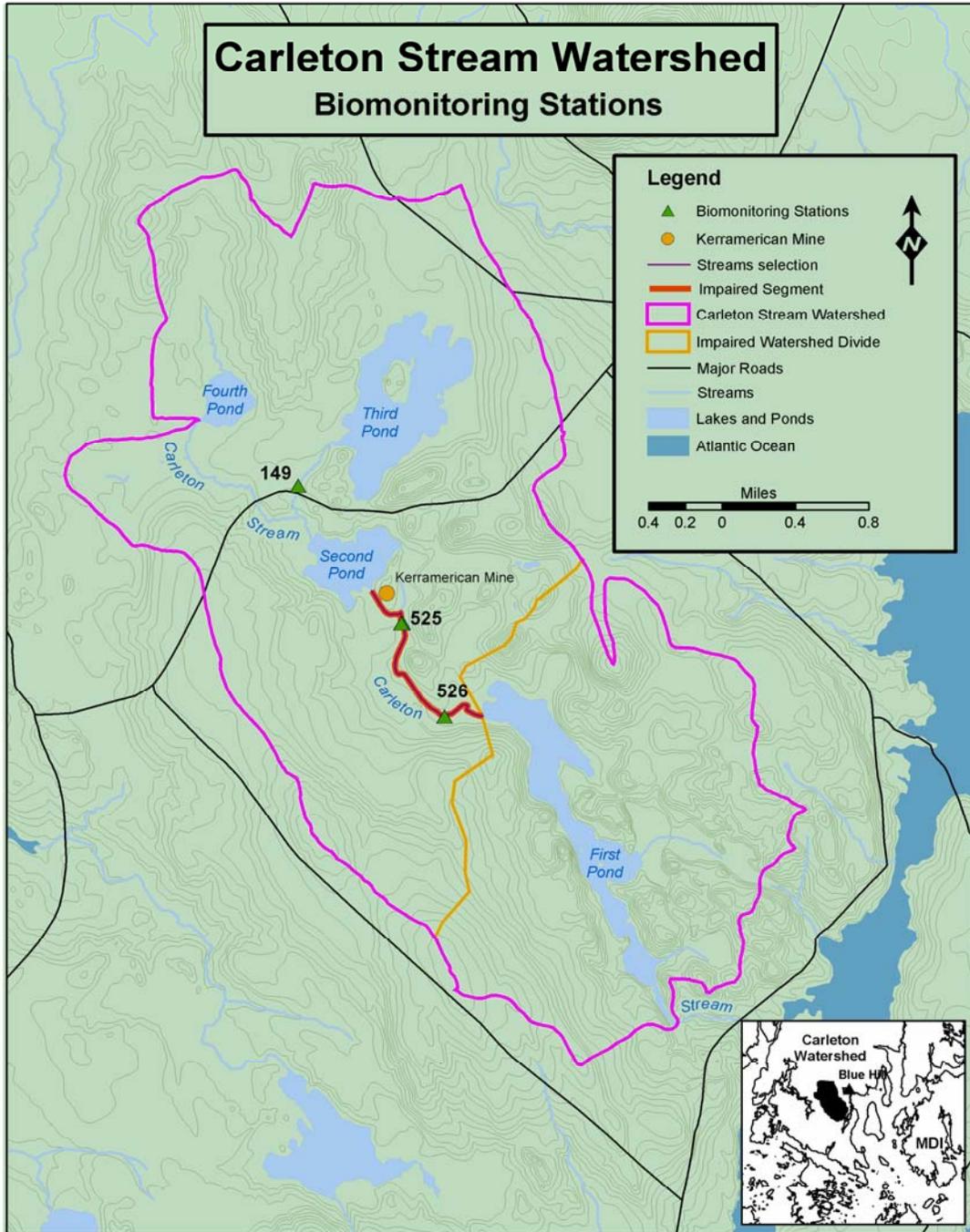
Historical landuse in the watershed included farming, tree harvesting and copper mining. The first mines were opened in the 1879 and shaft mines proliferated in the area until 1883 (Rand, 1958), when ore prices dropped (Wood). Commercial mining for copper was revived briefly in 1917 and for periods during the 1960s. The Black Hawk mine was a large underground mine that operated from 1972 until 1977 to produce an estimated 1,000,000 tons of zinc-copper-lead ore (ME Geological Survey, 1996). The Black Hawk Mine (now known as the Kerramerican Mine) is located adjacent to Second Pond and Carleton Stream, Figure 1. The legacy of mining includes the export of toxic metals into the aquatic environment.

Descriptive Land Use Information

Figure 2 displays the distribution of landuse throughout the watershed. Landuse descriptions were derived from 'Maine_Combo', a GIS map layer developed by Maine Department of environmental Protection (MEDEP) staff that combines data from Maine Gap Analysis (GAP) and USGS Multi Resolution Landcover Characterization (MRLC) coverages. Both MRLC and GAP are based on 1992 LandSat TM satellite imagery and the metadata for Maine_Combo are maintained by MEDEP's GIS Unit. Table 1 and Figure 3 clearly show the domination of forested land cover, followed by open freshwater, with smaller amounts of residential development. The Kerramerican Mine Site shows up as low density residential development and covers a large area on the southeastern shore of Second Pond.

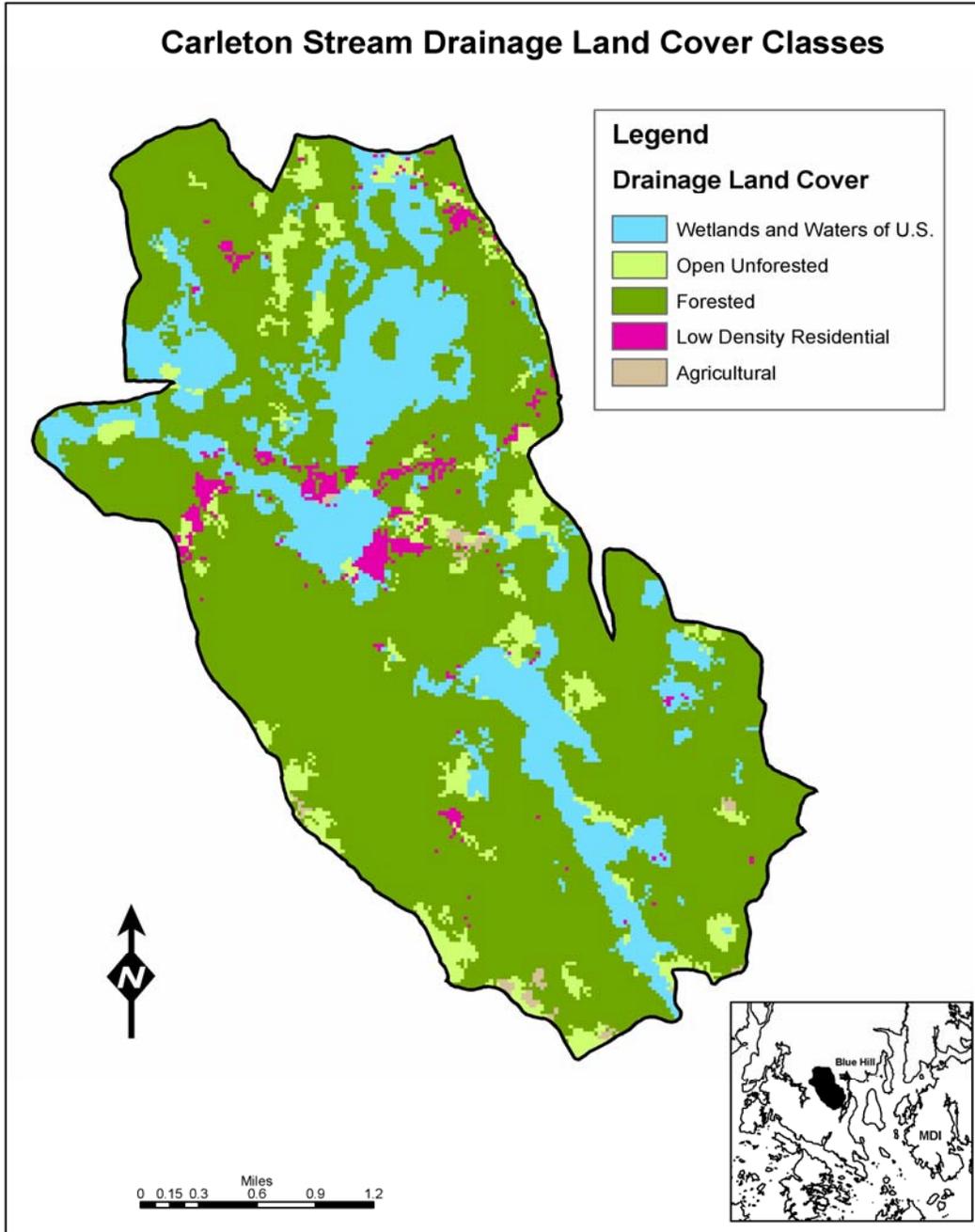
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Figure 1. Impaired segment of Carleton Stream, location of the Kerramerican Mine Site (formerly the Black Hawk Mine) & MEDEP's Biomonitoring stations.



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Figure 2. Carleton Stream landuse map based on 'Maine_Combo', maintained in MEDEP's GIS Layers.

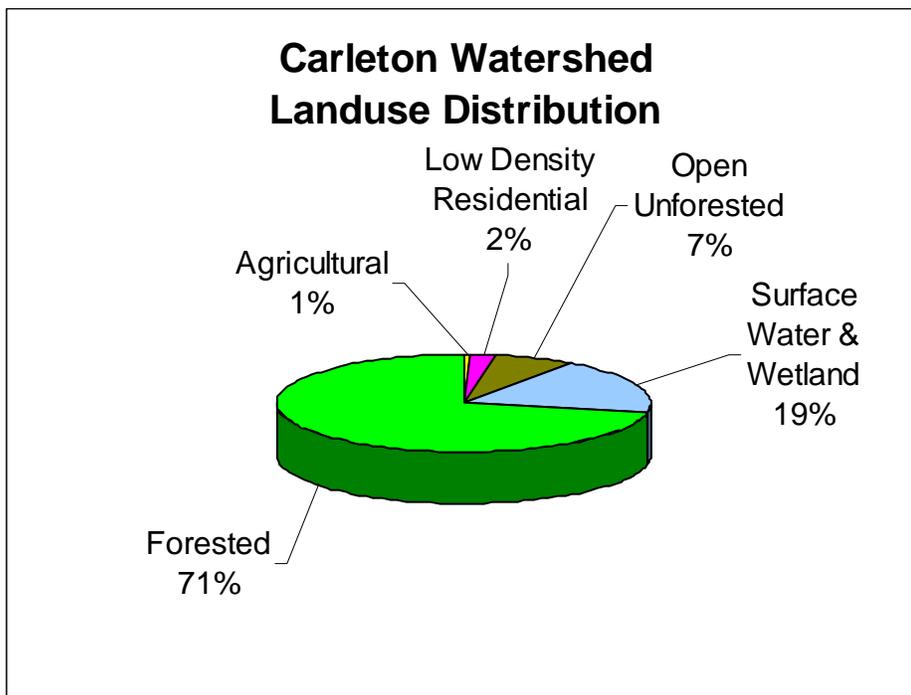


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Table 1. The acreage of dominant landuse categories in Carleton Stream watershed.

Landuse Category	Acres
Agricultural	34
Low Density Residential	143
Open Unforested	467
Surface Water & Wetland	1226
Forested	4703

Figure 3. The relative contributions of dominant landuses in Carleton Stream watershed.



Pollutant Sources & Description of Impairments

The stream is impaired by non-point source runoff from old mine sites and other workings, with the largest mine, the Kerramerican Mine as an important source of metals. Metals concentrations are mostly non-detects and do not exceed Maine's Statewide Water Quality Criteria (SWQC) in Carleton Stream upstream of Second Pond, and above the influence of the Kerramerican Mine Site, (AMEC, 2001). The Kerramerican Mine, ceased operation in the 1977 and mine rock and tailings continued to influence stream quality through both stormwater runoff and groundwater discharge.

MEDEP biologists documented high metals values and impacts to the stream biota from 1978 until 1981 (Mower, B. 1981). Upon termination of the mining operations and pursuant to a permit issued by MEDEP, Kerramerican sought to cover tailings and minimize surface runoff to control the export of metals. MEDEP approved the closure in 1985. Follow up aquatic investigations continued to find

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impacts to aquatic biota through the 1990's, which are documented in MEDEP's Biomonitoring Retrospective (Davies, et. al.1999). Aquatic life sampling above the mine has consistently attained Class A or B standards (Table 2, Figure1).

In 2000, at the request of the MEDEP, the former owners of Kerramerican Mine Site (Kerramerican Inc.) initiated an investigation to investigate conditions at the Site with the intent to correct and upgrade the previous closure efforts using current methods and technologies. MEDEP's Bureau of Remediation and Waste Management oversaw and reviewed the investigations and the proposed remediation plan. A description of the responsibilities of the Uncontrolled Sites Program can be found at <http://www.state.me.us/dep/rwm/rem/staff.htm#suhssu>. In a Project Review memo, MEDEP Biologist, Leon Tsomides (Tsomides, L. 2001) stated that Class C aquatic life standards were attained below the mine in 2000 for the first time (Table 2). At the same time, chemical sampling for cadmium, copper, lead and zinc all exceeded Maine's SWQC (Table 3).

Table 2. MEDEP Stream Biomonitoring sampling locations (Figure 1) and results, Carleton Stream.

Sampling Station	Site Description and Location (ordered upstream to downstream)	Statutory Class	Sampling Result	Dates Sampled
149	Below Third Pond; 12 m above Rt 176-15 crossing	Class B	Class A	1991, 1996
			Class B	2000
150, S525, S526	Below Second Pond and mine site	Class C	Non-Attainment	1991, 1994, 1996
			Class C	2000

Pollutants of Concern & Sampling Results

This TMDL addresses five heavy metals (Cd, Cu, Fe, Pb, Zn), which were monitored in the stream from 2000 to 2002 as part of Kerramerican Mine Site remedial investigations (AMEC, 2001) and a MEDEP site visit. All five of these metals exceeded Maine's SWQC during at least one sampling event. Table 3 summarizes the data collected from five stations within the impaired stream segment during 2000 and 2001 (Appendix I, Figure A1). The samples were collected five times during all four seasons and the complete data set used in the TMDL is listed in Appendix I, Table A1. The average values listed in Table 3 are calculated using the actual measurements and minimum detection limits are substituted for non-detects. Other water quality parameters were measured, including nitrate, total phosphorus and total suspended solids, but no impairments are listed for these parameters.

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Table 3. Summary of aqueous metals from five sites within the 1.3-mile impaired stream segment, over five sampling events in 2000 and 2001.

Summary of Measured Aqueous Metals in Impaired Segment					
Metals in mg/L					
<u>Sampling Results</u>	Cadmium Cd	Copper Cu	Iron Fe	Lead Pb	Zinc Zn
Minimum Value	Non-Detect	Non-Detect	0.126	Non-Detect	0.288**
Maximum Value	0.0033**	0.045**	1.04*	0.002*	2.1**
Average Values	0.0013**	0.0183**	0.5001	0.0014*	0.9316**
Minimum Detection Limits	0.0001	0.001	0.001	0.001	0.001

****Exceeds Maine's Statewide Water Quality Criteria, Criteria Maximum Concentration (CMC)**

*** Exceeds Maine's SWQC, Criteria Continuous Concentration (CCC)**

Impaired Stream Segment & Study Area

The 303 (d) listed segment of Carleton Stream is a 1.3 mile stretch of Class C water between Second Pond and First Pond (Figure 1). The first documented violations of Maine's water quality criteria for zinc and copper precede 1981 and have been documented as recently as 2001. Past exceedences of aquatic life criteria had improved by 2000, when the stream segment met Class C biological criteria for macroinvertebrates (Table 2). Stream segments upstream of Second Pond are statutory Class B and have consistently attained water quality criteria for both metals and aquatic life (AMEC, 2001; Davies, et. al., 1999).

Priority Ranking and Listing History

The large numbers of streams listed for nonpoint source pollution on the 303(d) list requires Maine to set priority rankings based on a variety of factors. Factors include the severity of degradation, the time duration of the impairment, and the opportunities for remediation. Maine has set priority rankings for 303(d) listed streams by TMDL completion date, and has designated Carleton Stream for completion in 2004.

Carleton Stream priority ranking was raised in 2000, when Kerramerican Inc. initiated a new remediation process with MEDEP's Bureau of Remediation and Waste Management. Implementing the final MEDEP approved remediation plan offers the best available option to reduce the influx of metals and potentially restore Carleton Stream.

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Atmospheric Deposition

Atmospheric deposition of metals that fall within a watershed will reach a stream through runoff from land deposited material, and direct contact with rain and dry airborne material that settles on the stream surface. It is assumed that the soil buffers and adsorbs most atmospherically deposited metals before they reach the stream through the runoff processes (except in watersheds sensitive to acidification). Regionally, our knowledge of atmospheric deposition of trace metals in flowing freshwaters is relatively limited.

Natural Background Levels

Carleton Stream is statutory Class B upstream of Second Pond and all investigations in the upper watershed indicate this region meets Maine's ambient water quality criteria and aquatic life criteria. The legacy of historical mining activity in the upper watershed appears to be minimal given that sampling upstream of Second Pond meets SWQC for metals (AMEC, 2001). The upper watershed often met Class A criteria for aquatic life (Table 2), which indicates relatively natural habitat conditions and may represent the natural background levels. As is true of all watersheds with a history of human habitation, it is not pristine, but relatively healthy as indicated by the Class A aquatic life attainment.

Even with the detailed site-specific environmental inventories available for the Carleton Stream watershed, nonpoint source loading may have resulted from human related activities. It is very difficult to separate natural background from the total nonpoint source load (USEPA, 1999) and the information would not add value to the analysis for these TMDLs.

2. DESCRIPTION OF THE APPLICABLE WATER QUALITY STANDARDS AND NUMERIC WATER QUALITY TARGET

Maine State Water Quality Standard

The impaired segment of Carleton Stream is classified as a Class C stream under Maine's Water Classification Program. Water quality standards and water quality classification of all surface waters of the State of Maine have been established by the Maine Legislature (Title 38 MRSA 464-467). By definition, discharges to Class C waters may cause some changes to aquatic life, provided that the receiving water supports indigenous fish and maintains the function and structure of the resident biological community.

Designated Uses and Antidegradation Policy

The lower segment of Carleton Stream is listed as Class C water and does not attain classification due to pollution from toxics and nonpoint sources associated with mine drainage. Class C and its designated uses are defined under Maine's Water Quality Classification Program, Maine Revised Statutes, Title 38, Article 4-A. Class C waters are generally designated for: drinking water supply after treatment; fishing and recreation in and on the water; industrial process and cooling; hydro-electric

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power generation; navigation; and habitat for fish and aquatic life. Maine’s antidegradation policy states, “Existing in-stream water uses and level of water quality necessary to protect those existing uses must be maintained and protected.” Additionally, MEDEP must consider aquatic life, wildlife, recreational use and social significance when determining ‘existing uses’.

Numeric Water Quality Target

Numeric metals targets were chosen from Maine’s SWQC. SWQC are the maximum allowable amounts of specified toxic pollutants allowed instream to protect designated uses specified through Maine’s Water Classification Program. These aqueous or water column criteria were adopted from EPA and designed to protect aquatic life. SWQC lists both Criteria Chronic Concentration (CCC) and Criteria Maximum Concentration (CMC) and the CCC are typically lower than CMC and chosen as a conservative basis for TMDL loading comparisons. Using the CCC as TMDL endpoints should insure the stream will achieve Class C ambient water quality standards.

Table 4. Metals criteria from Maine’s Statewide Water Quality Criteria (SWQC), these criteria represent total metals and are based on a hardness standard of 20 mg/L. Criteria Chronic Concentration (CCC) and Criteria Maximum Concentration (CMC) are aqueous values in ppm or mg/L.

<u>Criteria</u> <u>Type-</u>	Cadmium Cd	Copper Cu	Iron Fe	Lead Pb	Zinc Zn
CCC	0.000321	0.00299	1	0.00041	0.0271
CMC	0.000638	0.00389	No Criteria	0.010523	0.0299

3. LOADING CAPACITY - LINKING WATER QUALITY AND POLLUTANT SOURCES

Loading Capacity & Linking Pollutant Loading to a Numeric Target

The loading capacity is the mass, of metal, that Carleton Stream can receive over time and still meet numerical water quality targets. Loading capacity is expressed as an annual load rather than a daily load to normalize the spatial and temporal variation associated with instream metal concentrations. Combinations of several calculations link the water column values from sample measurements to the calculated load capacity based on numeric targets. Table 5 lists the loading targets for comparisons in subsequent TMDL analysis, the annual load assimilative capacity is a combination of streamflow volume and Maine’s CCC. Appendix I describes the calculations used to convert concentrations and the estimated discharge (Dudley, 2004) into loading values. Basing the loading capacity on Maine’s SWQC sets the metal allotment for existing and future nonpoint sources to ensure support for existing and designated uses.

Table 5. The loading capacity is based on numerical water quality targets which are expressed in kg/yr for each TMDL metal and is the product of the estimated mean annual flow for the impaired segment and Maine’s SWQC-CCC.

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		Metals				
<u>SWQC-CCC</u>	Units	Cd	Cu	Fe	Pb	Zn
Allowable Concentration	mg/L	0.0003	0.003	1	0.0004	0.0271
Load Capacity^{1.}	kg/yr	5.3	49.4	16520	6.8	447.7

1. Based on a estimated annual mean discharge of 524 L/s

Supporting Documentation - TMDL Approach

The TMDL approach includes measuring various environmental parameters and developing a water quality model to predict pollutant loadings and reductions that will insure attainment of Maine’s water quality standards.

The Carleton Stream TMDL metals analysis is based primarily on data collected as part of remedial investigations designed to assess the environmental impact of the Kerramerican Mine Site (AMEC, 2001). Historical aqueous metals data in the watershed go back to the 1970’s and 1980’s, but the datum used in TMDL has been collected since 2000 and reflects recent conditions. These data were collected under an approved quality assurance plan and the reporting records contain quality control data and certificates of analysis. The data were collected under the guidance of AMEC Earth & Environmental Limited and is part the public record compiled by MEDEP’s Division of Site Investigation and Remediation, Bureau of Hazardous Material & Solid Waste Control while developing a mine site remediation plan. Sampling procedures and quality assurance documents can be found in Remedial Investigations Report (AMEC, 2001).

The TMDL analysis calculates the existing metals load based on measured aqueous concentrations and estimated annual mean flow, according to a USGS methodology (Dudley, 2004). Metals concentrations and discharge estimates used to calculate existing loads for the TMDL equation are contained in Appendix I. The TMDL spreadsheet model then compares the existing metals load to the allocated load and computes the reduction needed to achieve water quality criteria for all nonpoint source pollutants of concern.

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Strengths and Weaknesses

The TMDL uses a spreadsheet analysis of existing metals loads and target loads. Metals loads and reductions for Carleton Stream were computed using basic conversions and spreadsheet comparisons.

Strengths:

- Spreadsheet comparisons are a commonly accepted practice in water quality management
- Makes best use of available water quality monitoring data
- The simplified spreadsheet approach likely estimates needed reductions as well as more complex models that rely on a series of unsubstantiated assumptions
- Data were collected over the entire year so the annual load estimate reflects data collected throughout the year

Weaknesses:

- Metals concentrations are extremely variable in flowing conditions and difficult to accurately depict
- The spreadsheet approach using annual loads over simplifies the complex fluctuations in loads based on ambient conditions

Critical Conditions

The loading capacity for Carleton Stream is set to protect water quality and support uses during critical conditions, which is defined as environmental conditions that induce a stress response in aquatic life. Environmentally stressful conditions may occur throughout the year and depend on the biological requirements of the life stage of resident aquatic organisms. Traditionally, summer low flow periods are considered critical for aquatic organisms due the combination of low velocity, high temperatures and low dissolved oxygen. While organisms are under stress due to these conditions, their community may not be able to withstand the addition of toxic metals that discharge from the mine site.

All aquatic organisms that reside in the stream confront harsh winter conditions and winter often determines the success or failure of native salmonid species, such as brook trout, which have been observed in Carleton Stream. Seasonally low flows occur in the winter and native fish are under stress as they compete for limited winter habitat, as defined by water velocity and unembedded substrate. Additionally trout eggs are incubating in the gravel during the winter and have specific velocity and dissolved oxygen requirements that may be compromised by low flow conditions. Some species of stoneflies emerge and develop during the winter and remain vulnerable. The chronic addition of toxic metals during otherwise vulnerable conditions diminishes survival.

Critical condition is complex in flowing water and a major consideration in using an average annual load approach for these metal TMDLs. It is likely that metals are chronically discharged from the mine site, but the concentrations fluctuate depending on the interaction between surface runoff and groundwater discharges. In addition, these discharge processes are subject to a wide range of factors that include antecedent rainfall, seasonal temperature regimes, geological conditions and growing conditions.

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TMDL Loading Calculations

The loads for all existing non-point source (including stormwater) metals in the impaired segment of Carleton Stream are listed in Table 6. The site-specific loads are then averaged into one load for the purposes of further TMDL analysis. Appendix I lists the TMDL calculations used for the results presented in Tables 5 through 8. The annual loads, based on estimated instream values, are derived by combining streamflow volume with the measured aqueous concentrations. An annual time frame provides a mechanism to address the daily and seasonal variability associated with non-point source loads. As previously mentioned, it was not possible to separate natural background from nonpoint pollution sources in this watershed because of the limited and general nature of the available information.

Table 6. Summary of the average of measured metal concentrations and the calculated nonpoint source loads based on the annual mean flow, for the impaired stream segment.

		Metals				
<u>In-Stream Measurements</u>	Units	Cd	Cu	Fe	Pb	Zn
Average Aqueous Concentrations	<i>mg/L</i>	0.0013	0.0183	0.5001	0.0014	0.9316
Existing Load ^{1.}	<i>kg/yr</i>	21.6	303	8262	23.5	15389

1. Based on a estimated annual mean discharge of 524 L/s

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The following table compares these existing metal loads to the loading capacities, or TMDL endpoints listed in Table 5. The comparison results in an estimate of the metals reductions needed to achieve compliance with Maine’s SWQC in the impaired stream segment. The percent reductions will be applied to load and waste load allocations.

Table 7. Comparison of TMDL load allocations and the measured or existing metal loads in Carleton Stream, and the percent reductions required achieving SWQC.

<u>Reductions Needed to Achieve SWQC</u>					
<u>Metals</u>					
<u>Loads in kg/yr</u>	Cd	Cu	Fe	Pb	Zn
<i>Existing Loads</i>	21.6	303	8262	23.5	15389
<i>Load Capacity</i>	5.3	49.4	16520.0	6.8	447.7
<i>% Reduction*</i>	75	84%	0%	71%	97%

****%Reduction= [(Existing Load- Load Capacity)/Existing Load] * 100***

4. LOAD ALLOCATIONS (LA’s)

The load allocation (LA) for each of the candidate metals in Carleton Stream is listed in Table 5. On an annual basis, the LA represents the stream’s assimilative capacity allocated to only non-point sources of metals. All pollutant sources in these calculations are assigned LAs, representing non-point sources from roadways and mine drainage inputs for which there are no associated discharge or general permits. The reported LA’s represent all the sites within the impaired stream segment that is downstream of Second Pond and upstream of First Pond.

5. WASTE LOAD ALLOCATIONS (WLA's)

No portion of the Carleton Stream watershed is regulated under Maine’s National Pollution Discharge Elimination System (NPDES). The drainage from the mine site enters the stream via surface runoff and groundwater discharge and is not defined as a point source discharge. Therefore the waste load allocation is defined as 0 for all the metals in the existing runoff.

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Table 8. Load Allocations and Waste Load Allocations for each metal in the TMDL.

<u>Loads in kg/yr</u>	<u>Metals</u>				
<u><i>TMDL = LA + WLA</i></u>	Cd	Cu	Fe	Pb	Zn
<i>Load Allocations (LA)</i>	5.3	49.4	16520.0	6.8	447.7
<i>Waste Load Allocations (WLA)</i>	0	0	0	0	0
<i>Loading Capacity (TMDL)</i>	5.3	49.4	16520.0	6.8	447.7

6. MARGIN OF SAFETY (MOS)

An implicit margin of safety was incorporated into the Carleton Stream TMDL through the selection of Maine’s SWQC for the numeric water quality target, which is designed to protect the spectrum of aquatic life. Additionally, the choice of Criteria Chronic Concentration (CCC), which are typically lower than Criteria Maximum Concentration (CMC) from the SWQC provides the most conservative basis for the TMDL loading capacity. Using the CCC as TMDL endpoints should insure the stream will continue to achieve Class C benthic community standards.

Modeling the metals individually provides an additional implicit margin of safety, which represents a conservative modeling assumption.

7. SEASONAL VARIATION

Seasonal variation is considered in the allowable annual loads of metals which protect macroinvertebrates and other aquatic life under the influence of seasonal fluctuations in environmental conditions such as flow, runoff and pH. All unregulated streams in Maine experience seasonal fluctuations in flow, which influences the concentration of metals. Typically high flows occur during spring and fall and low flow occur during the summer and winter. Snow and rainfall runoff may contribute metals, while large volumes of runoff may also dilute instream metals concentrations, depending on the source.

The major consideration for impact on aquatic life is the seasonal fluctuation of pH, which causes considerable variability in metal solubility through time, although this variability is greater for some metals (Cu, Zn) than for those that are less mobile (Pb). The iron concentration in the system is such that the dissolved concentration is saturated at all sites, and thus dependent on the pH, and that a large proportion of other metals are adsorbed to the iron precipitates. The pH fluctuates seasonally based on watershed processes, rainfall and increases in flow.

Iron concentration measured during the low flow period, August, exceeded the Maine’s CCC, probably due to lack of dilution. Since the iron was below the chronic criteria during other seasons, it does not

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exceed the criteria chronically, so no reductions are required by the TMDL. This has the additional effect of reducing concentrations of other metals in the water column, because of the greater adsorption surface presented by the increased concentration of iron precipitates

8. MONITORING PLAN FOR TMDLS DEVELOPED UNDER THE PHASED APPROACH

Addressing the problems described in the TMDL will require future assessments of the impaired segment to determine the effectiveness of the 'Remedial Action Plan' for the Kerramerican Mine Site (MACTEC, 2004). Water quality monitoring will be conducted to gauge effectiveness of engineered design solutions, as recommended in the 'Implementation Plans' section.

As restoration plans proceed, MEDEP will check on the progress towards attainment of Maine's SWQC with both aqueous samples and biological monitoring evaluations. Also, MEDEP's Biomonitoring Unit will check on water quality status or improvement in the future under the existing rotating basin sampling schedule.

9. IMPLEMENTATION PLANS and REASONABLE ASSURANCES

The goal of this TMDL assessment on Carleton Stream is to use existing water quality data to define loading estimates for metals impairments and set water quality targets. The aqueous metals reductions listed in the TMDL Allocations, in Table 7, represent averages over the year (given the seasonal variation of runoff and ambient pH conditions), and demonstrates the need to reduce aqueous metal concentrations as the key to water quality restoration. The load reductions provide a guide for remediation plans and engineered solutions that will lower the content of metal in runoff and groundwater reaching the stream.

This TMDL also coincides with the development of a 'Remedial Action Plan' (RAP) for the Kerramerican site (MACTEC, 2004), which will substantially reduce the export of metals to the stream. Remediation of the Site is required under Maine's Uncontrolled Hazardous Substances Site Law (38MRSA Section 1361 et seq). The Uncontrolled Sites Program within the MEDEP's Bureau of Remediation & Waste Management is currently reviewing and negotiating the technical aspects of the RAP to insure an effective approach for site restoration. Appendix II contains a memo by Project Manager, Fredrick King, to the U.S. Army Corps, which reviews the current status of the plan. Final approval of the plan by MEDEP is contingent on resolving outstanding wetlands issues.

The RAP is an extensive technical document supported by a series of environmental assessments designed to produce effective and practical geo-technical solutions for the site. Implementation of the engineering solutions in the RAP will provide the best available reasonable assurance of improving water quality within the stream. Given the mining history and geo-chemical nature of this area it will prove difficult to meet SWQC, however, this effort is an important and necessary step to restoring Carleton Stream and ultimately meeting SWQC after a long history of non-attainment.

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10. PUBLIC PARTICIPATION

Public participation in the Carleton Stream TMDL development is ensured through several avenues. A preliminary review draft TMDL was prepared and distributed to:

- MEDEP reviewers-
 - Dave Courtemanch, David Miller, Paul Mitnik and Barry Mower, Division of Environmental Assessment, Bureau of Land and Water
 - Hank Aho and Fredrick King, Bureau of Remediation and Waste Management

- Watershed stakeholder organizations-
 - John Bannister, Selectmen, Blue Hill
 - Liz Petterson, District Manager, Hancock County Soil and Water Conservation District
 - Richard Schwenger, Regional Reclamation Manager, Kerramerican. Inc
 - Sean Mahoney, Attorney for Kerramerican. Inc., Verrill & Dana
 - Marine Environmental Research Institute (MERI), Blue Hill

Paper and electronic forms of the *Carleton Stream TMDL, Draft Report* were made available for public review through several avenues. The report was posted on the MEDEP Internet Web site and a notice was placed in the 'legal' advertising of local newspapers. The following ad was printed in the Sunday editions of the Portland Press Herald and the Bangor Daily on July 18th and July 25th. The ad was also printed in the weekly Ellsworth American during the weeks of July 15th and July 22nd. The U.S. Environmental Protection Agency (Region I) and interested public was provided a 14 day period to respond with draft comments (July 27th through August 10th, 2004).

PUBLIC NOTICE FOR CARLETON STREAM-In accordance with Section 303(d) of the Clean Water Act, and implementation regulations in 40 CFR Part 130 – the Maine Department of Environmental Protection has prepared a Total Maximum Daily Load (TMDL) report (DEPLW 2004- 0666) for toxic metals found in Carleton Stream, located in Blue Hill, in Hancock County. This TMDL report estimates non-point source loadings of metals and the reductions needed to restore the stream below the Kerramerican Mine Site to meet Maine's Water Quality Criteria.

A Public Review draft of the report may be viewed at the Maine DEP Offices in Augusta (Ray Building, Hospital St., Rt. 9) or on-line at: <http://www.state.me.us/dep/blwq/comment.htm>.

Send all written comments – by August 2, 2004, to Melissa Evers, Stream TMDL's, Maine DEP, State House Station #17, Augusta, ME 04333 or email: melissa.evers@maine.gov

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Review Comments

All MEDEP reviewers had editorial comments that were incorporated into the final draft that strengthened the presentation of the information. The Bureau of Remediation and Waste Management provided comments that clarified technical aspects concerning the development of the 'Remedial Action Plan' for the mine site.

A representative of Kerramerican, Inc., Jeffrey Brandow of MACTEC Engineering and Consulting submitted a letter with technical comments. All comments were considered and discussed between Mr. Brandow and MEDEP technical staff, then incorporated into this revision, where appropriate. The following summarizes the response to substantive technical concerns:

- Kerramerican maintains that SWQC exceedances of zinc and copper measured in Second Pond and in the stream between Second Pond and First Pond result from metal sources other than the Kerramerican Mine Site. Since no comprehensive assessment of metal sources beyond the Site exists, it is difficult to quantify the relative contribution of other sources and the existence of other sources is acknowledged in the report.
- Kerramerican has measured flow in the impaired stream segment that is about half of the flow used in the TMDL calculations. Kerramerican believes that their measurements are more representative of average annual flow and the TMDL calculations overestimate the annual metals loads. This is a valid concern, if Kerramerican measurements accurately estimate average annual flows. The comments state that the flow was measured monthly, but more information is needed to understand how well the monthly measurements characterized high volume runoff events and there is no reference to a discharge monitoring system designed to accurately estimate average annual flow.
- Kerramerican has also calculated zinc loadings using an alternative modeling approach and estimated a much lower load than the TMDL estimated. Kerramerican recalculated the load reduction based on the lower load and flow estimate and the reduction needed to achieve SWQC remains at the 97% listed for zinc in Table 7.

Carleton Stream TMDL

LITERATURE

- AMEC Earth & Environmental Limited. 2001. Remedial Investigation Report, Former Kerramerican Mine, Blue Hill, Maine. AMEC, Mississauga, Ontario.
- Davies, S., Tsomides, L., DiFranco, J., Courtemanch, D. 1999. Biomonitoring Retrospective: Fifteen Year Summary for Maine Rivers and Streams. DEPLW1999-26, Maine Dept. Environmental Protection, Augusta, ME. 190 pp.
- Dudley, R.W. 2004. Estimating Monthly, Annual, and Low 7-Day, 10-Year Streamflows for Ungaged Rivers in Maine. U.S. Geological Survey, Water-Resources Scientific Investigations Report 2004-5026, 22 pages.
- Evers, M. 2004. Carleton Stream Project Files. Maine Dept. Environmental Protection, Augusta, ME.
- MACTEC Engineering and Consulting, Inc. 2004. Remedial Action Plan for the Former Kerramerican Mine, Blue Hill, Maine. MACTEC, Portland, Maine.
- Maine Geological Survey, Maine Department of Conservation. 1996. History of Metal Mining in Maine (accessed in 2004).
<<http://www.state.me.us/doc/nrimc/pubedinf/factsht/economic/minehist.htm>>
- Mower, B. 1981. Memo on Kerramerican Discharge. Maine Dept. Environmental Protection, Augusta, ME.
- Rand, John. 1958. Maine Metal Mines and Prospects, Mineral Resources Index No. 3. Dept. of Economic Development, August, ME.
- Tsomides, L. 2001. Project Review Memo on Kerramerican Mine, Environmental Report. Maine Dept. Environmental Protection, Augusta, ME.
- U.S. Environmental Protection Agency. 1999. Regional Guidance on Submittal Requirements for Lake and Reservoir Nutrient TMDLs. US-EPA Office of Ecosystem Protection, New England Region, Boston, MA.
- Woocock, T., Evers, M., 2003. Goosefare Brook TMDL, Final Report. DEPLW 2002- 0544, Maine Dept. Environmental Protection, Augusta, ME. 38pp.
- Wood, Esther. A Brief History of Blue Hill. (accessed in 2004).
<<http://www.bluehillme.com/pgs/history.html>>

Carleton Stream TMDL

Appendix I. Sampling Information & Computational Methods for Allocations

Sampling Information

Five sampling stations were located along the 1.3 mile impaired segment Carleton Stream, Figure A1. Grab water samples were taken during all four seasons and according to protocols listed in the Quality Assurance Plan in Remedial Investigations Report, Former Kerramerican Mine, Blue Hill, Maine, Site (AMEC, 2001). MEDEP staff, Melissa Evers, took additional grab samples during a site visit in December of 2001, these samples were analyzed at the State of Maine's Health and Environmental Testing Lab, Augusta. All collection dates and data used in the TMDL summaries and calculations are listed in Table A1. For each metal, aqueous concentrations are summarized into an average value for the entire segment, to estimate an represent an average load.

Mean Annual Flow Estimation, Q:

TMDL loading estimates are a product of aqueous concentration and flow volumes. Annual mean flow was estimated according to a recently published USGS methodology entitled, Estimating Monthly, Annual, and Low 7-Day, 10-Year Streamflows for Ungaged Rivers in Maine, (Dudley, 2004). The flow regression equation requires input of watershed area, which was estimated using existing Maine Drainage Divides (maintained by Maine's Office of GIS) and further dividing the watershed at the end of the 1.3 mile segment, where Carleton flows in First Pond, Figure A1.

Input Variables:

- Drainage Area= A
 - Carleton Stream A=6.74 square miles (Figure A1)
- Mean Winter Precipitation=pptW
 - Ellsworth Rainfall data from 1932- 1992, pptW=11.56 inches
- $Q=1.151(A)^{0.991} 10^{0.023(\text{pptW})} = 18.45 \text{ ft}^3/\text{sec}$
- Convert Dishcarge from ft^3/sec to L/sec, **Q= 524 L/sec**

Carleton Stream TMDL

Appendix I. Sampling Information & Computational Methods for Allocations

Computational Methods for Allocations

All pollutant sources are calculated as one existing load, representing non-point and stormwater or general watershed runoff. The allocations for a given station will include the entire watershed, upstream of the end of the impaired segment. For all metals in the TMDL, loads were calculated for aqueous concentrations from both measured samples and Maine's Statewide Water Quality Criteria, Criteria Chronic Concentration.

Appendix I. Sampling Information & Computational Methods for Allocations

Load Calculations:

- **Aqueous Concentration (mg/L) * Discharge (L/seconds) = Load (mg/seconds)**
- **Load in 'mg/seconds' converts to 'kg/year'**

Load Reduction Calculation:

- **$[(EL-LC)/EL] * 100 = \% \text{ Reduction}$**
- EL = Existing In-Stream Load
- LC = Loading Capacity from Maine's SWQC

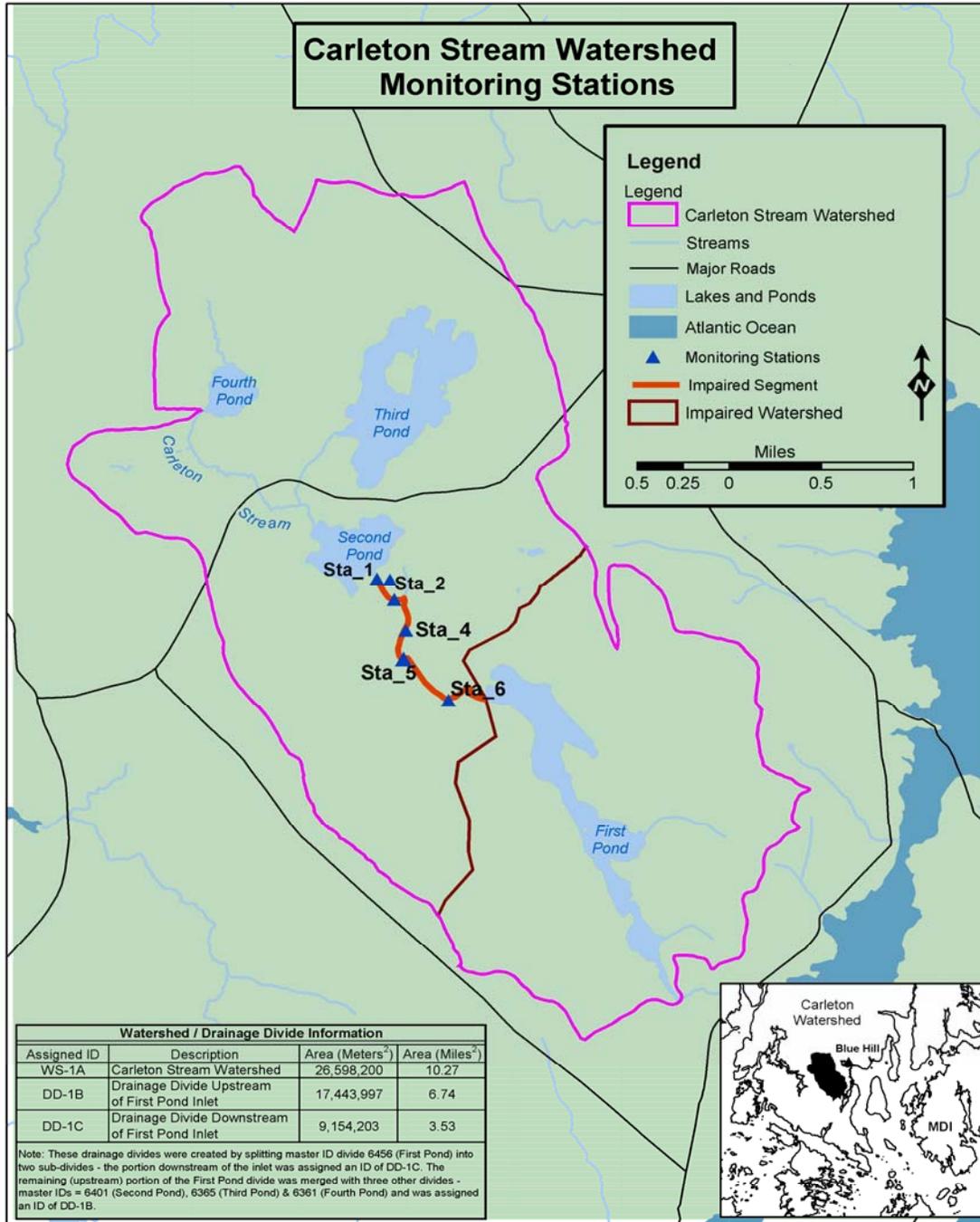
TMDL Allocations:

- **TMDL = LA + WLA + MOS**
- TMDL = LC = Loading Capacity
- LA = Non-Point Source Load Allocations
- WLA = Point Source or Regulated Stormwater Waste Load Allocations

Carleton Stream TMDL

Appendix I. Sampling Information & Computational Methods for Allocations

Figure A1. Sampling station locations and Carleton Stream watershed drainage divides for the end of the 1.3-mile impaired segment, where Carleton flows into First Pond.



Carleton Stream TMDL

Appendix I. Sampling Information & Computational Methods for Allocations

Table A1. Sampling Data used in TMDL calculations, used in load estimates presented in Tables 5 through 8 (Source: AMEC, 2001 & Evers, 2004).

Date Collected Units			Metals						
			Cadmium mg/L	Copper mg/L	Iron mg/L	Lead mg/L	Mercury mg/L	Nickel mg/L	Zinc mg/L
<i>Station #</i>		<i>MDL</i>	<i>0.0001</i>	<i>0.001</i>	<i>0.001</i>	<i>0.001</i>	<i>0.0001</i>	<i>0.005</i>	<i>0.001</i>
1	02/14/01		0.001	0.017	0.398	0.001	ND	ND	0.57
2			0.002	0.02	0.765	0.002	ND	ND	0.51
4			0.002	0.019	0.761	0.002	ND	ND	0.5
5			0.002	0.02	0.87	0.002	ND	ND	0.516
6			0.001	ND	0.439	ND	ND	ND	0.439
1	11/01/01		ND	0.045	0.234	ND	ND	ND	1.48
2			0.0028	0.034	0.601	0.002	ND	ND	1.3
4			0.0033	0.024	0.589	0.002	ND	ND	1.61
5			0.0028	0.021	0.462	0.002	ND	ND	1.49
6			0.0016	0.011	0.357	ND	ND	ND	0.825
1	08/21/00		0.0008	0.019	0.206	ND	ND	ND	0.621
2			0.0007	0.014	1.04	0.002	ND	ND	0.759
4			0.0005	0.014	0.817	0.001	ND	ND	0.581
5			0.0004	0.014	0.769	0.002	ND	ND	0.43
6			0.0002	0.011	0.486	0.001	ND	ND	0.288
2	03/23/00		0.0003	0.012	0.126	ND	ND	ND	0.33
4			0.0013	0.024	0.214	ND	ND	ND	0.8
5			0.0013	0.024	0.206	ND	ND	ND	0.76
6			0.0007	0.016	0.162	ND	ND	ND	0.47
1	12/01/01			0.016				ND	0.41
2				0.024				ND	1.2
4				0.016				ND	2
5				0.028				ND	2.1
6				0.007				ND	2
6				0.007				ND	1.3
Average values			0.0013	0.0183	0.5001	0.0014	ND	ND	0.9316

Carleton Stream TMDL

Appendix II. Bureau of Remediation & Waste Management Correspondence

From: King, Frederick D, MEDEP
Sent: Thursday, July 08, 2004 3:32 PM
To: 'Peter Tishbein', US Army Corp
Cc: Aho, Hank
Subject: Information on the Remedial Investigation of the Kerramerican Mine Site, Blue

Hank Aho asked me to provide you with specific information that you requested last Friday regarding the Kerramerican site investigation.

Kerramerican Inc. began a Remedial Site Investigation of the Kerramerican Mine Site in 2000 with a review of data collected over five years by the Maine Department of Environmental Protection (DEP) in coordination with the EPA site evaluation program for Superfund. The Department prepared a draft scoring package for inclusion of the site on the National Priorities List in 1999. Noranda Inc., the parent of Kerramerican, Inc. was notified of the potential listing of the site in late 1999 and opted to remediate the minesite under the State's Uncontrolled Site Program (the State's Superfund Program).

AMEC Earth & Environmental Limited was retained by Kerramerican in 2000 to conduct and coordinate the Remedial Investigation and draft the final report. The Remedial Investigation (RI) consisted of an Environmental Investigation, a Fishery Resource Investigation, a Hydrogeologic Investigation, an Environmental Geochemical Investigation, a Screening Level Ecological Risk Assessment and a Human Health Risk Assessment. The DEP reviewed each of these elements of the RI in-house using appropriate staff specialists. The environmental geochemical study was sent out for external review by a geochemist under contract with the Department. The bulk of the portions of the RI were reviewed in 2002. Reviews consisted of comments and suggested revisions. Several portions of the RI underwent two or three revisions before final acceptance. DEP approved the Final Remedial Investigation Report package in December 2002.

Kerramerican retained the Minesite Drainage Assessment Group (MDAG) to conduct an environmental geochemical study of the Kerramerican Mine in 2000. MDAG conducted a seasonal monitoring program collecting samples in March, August and November 2000. The MDAG report was received in October 2001 and reviewed as part of the Site Investigation.

Kleinschmidt Energy and Water Resources Consultants conducted a fishery resource investigation of the Carleton Stream watershed which included the Third, Second and First Ponds in 2001. They concluded that the fish assemblages of these waters are typical to those found throughout eastern Maine and are similar to shallow water ponds and streams not exposed to mine related or other large scale industrial activities within an approximate 25 mile radius of Blue Hill. The existence of a naturally sustained wild brook trout population (which are sensitive to impaired water quality) in Carleton Stream and in the First Pond below the minesite was suggested by Kleinschmidt to indicate that water quality was not radically impaired.

Carleton Stream TMDL

Appendix II. Bureau of Remediation & Waste Management Correspondence

DEP received a draft Feasibility Study (FS) report prepared by AMEC Earth & Environmental Limited in October 2001. This report did not meet the Department's requirements in format and content and was scrapped. Kerramerican turned over the responsibility for drafting the FS to their on scene coordinator with assistance from an environmental legal specialist from their local legal representative. DEP reviewed and commented on several draft versions of the FS in 2002 and 2003. The final draft of the FS was received in June 2003. Final approval of the FS was delayed to early June 2004 pending possible last minute changes to the remediation plan.

A draft Remedial Action Plan prepared by Mactech Engineering and Consulting Inc. was received in May 2003 and was reviewed in-house by DEP environmental engineers. DEP staff met with Mactech engineers a number of times in late 2002 and 2003 in Augusta and twice onsite in Blue Hill. Mactech submitted a revised Remedial Action Plan in March 2004 which has been reviewed. A final version of the Remedial Action Plan will be submitted and reviewed for final approval when final details of the remediation are worked out.

The above is my interpretation of what Hank asked me to provide to you. Please let me know if you need more information.