Yukon Government

Indian and Northern Affairs Canada
Affaires indiennes et du Nord Canada

PROJECT DESCRIPTION
ABANDONED CLINTON CREEK ASBESTOS MINE

STAGE 2 (2003) CLINTON CREEK CHANNEL STABILIZATION

Submitted by:
Government of Yukon
Energy, Mines and Resources
Abandoned Mines Project Office

Prepared In conjunction with

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Yukon Region, Waste Management Program

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1.0 Introduction

1.1 OBJECTIVES

Under the direction of the joint Yukon Government-DIAND Abandoned Mines Project Office we are proposing the continuation of channel stabilization at the abandoned Clinton Creek Asbestos Mine. The stabilization of the creek channel will be achieved by constructing additional *gabion weirs* [1] below the outflow of Hudgeon Lake, a reservoir created by a massive slope failure of waste rock in 1974.

Concerns with respect to the physical conditions at the site have existed since the closure of mine operations in 1978 and the site and creek channel have been monitored by DIAND Water Resources on a regular basis. Recent investigations (Royal Roads University, 1999; UMA, 1999 and 2000) have confirmed the observations by DIAND Water Resources that continuing down-cutting of the Clinton Creek channel and erosion of the unstable waste rock may cause the waste rock dam to fail. A sudden breach of the landslide dam and subsequent flooding could expose individuals, property and the downstream environment to various degrees of risk.

The physical instability and environmental issues at the Clinton Creek Mine have been discussed with the Department of Fisheries and Oceans, Yukon Salmon Committee, Tr'on Dëk Hwëch'in, the former DIAND Land and Water Resources, now the Yukon Government Departments of Environment and Energy, Mines and Resources, and other stakeholders. The consensus of these consultations was that the stabilization of the outflow channel near the reservoir is a priority to reduce the immediate threat of a breach. The construction of several gabion structures presents a cost-effective solution (UMA, 2002). To remediate 350 metres of the Clinton Creek channel downstream of the outlet, approximately six gabion structures will have to be constructed (drop structure no.1 was built in 2002) and waste rock slopes along the creek channel will have to be graded.

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[1] *Gabion Structures* are arrays of rock-filled baskets of wire mesh, designed to reduce and disperse the destructive force of fast flowing water.

1.2 BACKGROUND

The abandoned Clinton Creek asbestos mine is located about 100 km northwest of Dawson City, Yukon, 9 km upstream of the confluence of Clinton Creek and the Forty Mile River. The mine site is accessible from Dawson City via the Top of the World Highway, the Clinton Creek road, and an access road from the former Clinton Creek town site. From 1968 to 1978, the Cassiar Asbestos Corporation Ltd. extracted approximately 12 million tonnes of serpentine ore from the bedrock and produced 60 million tonnes of waste rock and 10 million tonnes of tailings. Ore was taken from open pits located on the south side of Clinton Creek and transported via a cable tramway to the mill site on a ridge on the north side of the Clinton Creek valley. The asbestos fibre was then transported by truck to Cassiar, B.C. for further processing. Waste rock and tailings were deposited on valley slopes near the open pits and the mill respectively. The affected mine site area consists of three open pits (Porcupine, Creek and Snowshoe), two waste rock dumps (Porcupine and Clinton Creek) and a tailings pile on the west side of Porcupine creek (**Figure 1**).

A significant slope failure of the Clinton Creek Dump occurred in 1974, blocking the natural drainage of Clinton Creek and creating a land slide dam and a reservoir now referred to as Hudgeon Lake. The surface area of Hudgeon Lake has been estimated at 115 ha, the maximum depth at 27 m, and the volume at 12 million cubic metres of water (Royal Roads University, 1999). Waste rock placement and instabilities also blocked the natural drainage of Porcupine Creek, creating a small reservoir upstream. The tailings deposited near the mill site also failed and two lobes created partial and intermittent blockage of Wolverine Creek. Both Porcupine and Wolverine creeks are tributaries to Clinton Creek.

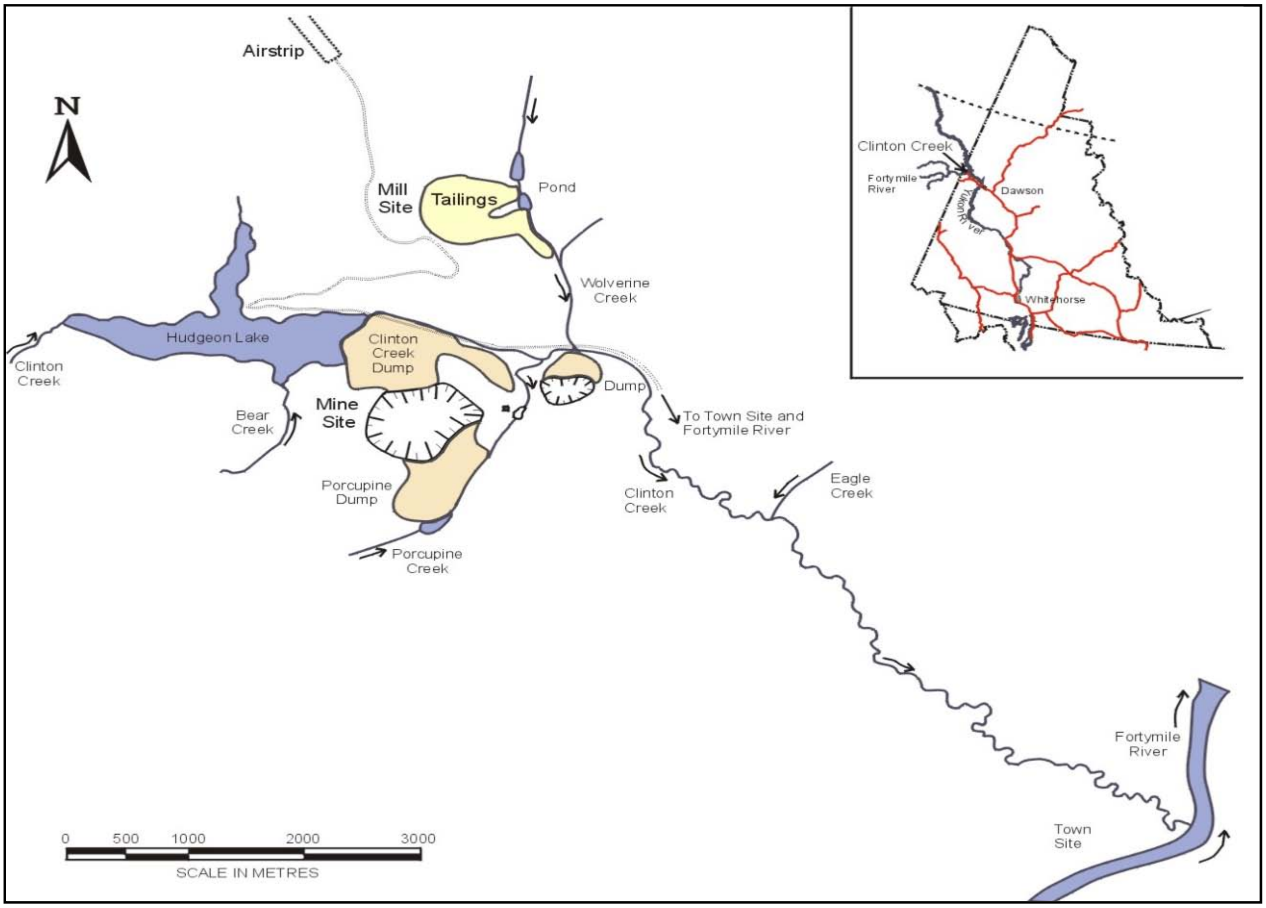

Figure 1: Location Plan (Royal Roads University, 1999)

During 1998/99, DIAND Waste Management initiated an extensive environmental review and a risk assessment (Royal Roads University, 1999 and UMA, 2000). The studies concluded that existing and future conditions at the abandoned Clinton Creek Asbestos Mine have the potential to expose individuals, property and the environment to various degrees of risk associated with downstream flooding, channel sedimentation and chronic redistribution of eroded waste rock and tailings. These risks can be broadly placed into public safety and ecological and health risk categories as presented by DIAND Waste Management and UMA Engineering Ltd. at a public information session in Dawson City, Yukon in 2001:

Public Safety

In terms of public safety, the level of risk downstream of the mine site has been categorized as high, medium or low based on the severity of flooding in each zone. The inherent risk to humans and the potential for loss-of-life is dependent upon the likelihood of exposure (occupancy) within these zones. The potential for loss-of-life is greatest immediately downstream of the mine site in the area potentially inundated by a breach of the waste rock pile, or within the Wolverine Creek valley in the event of a breach of tailings blockage. Farther downstream along Clinton Creek, the risks are reduced, as the high water levels will be confined to the creek valley below the road where human exposure is less likely. The risk is considered low at the next most likely downstream area of occupancy in the vicinity of the Clinton Creek Town-site where the valley widens considerably.

Ecological and Health Risks

Aquatic life and mammals downstream of the mine site are potentially at risk from the redistribution of eroded waste rock and tailings. The largest risk is believed to be from a sudden breach of the waste rock dam resulting in fisheries and habitat loss through downstream smothering and flooding. The impact of asbestos fibres in water on aquatic life has not been ascertained and is not well researched. Available literature does suggest however, that water-borne asbestos has little if any toxicity to aquatic organisms or mammals through the ingestion of water. Chronic risks from the mobilization and release of dissolved metals or other substances to the water appear to be unlikely.
Human health risks associated with possible inhalation of asbestos fibres during occasional site visits have not been quantified although it has been recognized that a crust formed on the surface of the tailings has reduced air-borne transmission of fibres.

Actions by DIAND Waste Management to date have included the direct notification of all known stakeholders and some media coverage. Warning signs are installed at key highway and access road locations to notify travellers and other users in the area of the potential hazard. As the lead agency, DIAND Waste Management actively worked with other government departments and consultants to investigate possible mitigation methods, which led to the construction of the first drop structure and modification work at the outlet of Hudgeon Lake in 2002. The first phase of stream channel stabilization was successfully undertaken in the fall of 2002 at the Hudgeon Lake outlet. The work was completed under a Contribution Agreement between DIAND and the Tr'on Dëk Hwëch'in First Nation with the use of local work force and sub-contractors. Site supervision was provided by UMA Engineering and DIAND Waste Management.

1.3 Waste Rock Movement

The instability of the Clinton Creek waste rock dump has been recognized while the mine was still in operation and records of waste rock movement exist from 1976 until 1986. Routine site inspections and waste rock movement monitoring carried out in 1999, 2000 and 2001 have indicated that the Clinton Creek waste rock dump has still not reached equilibrium conditions (GEO-Engineering Ltd., 2000). Horizontal movements over time are summarized in **Figure 2**.

Over the two year period from July 1999 to June 2001, annual horizontal movements ranging from one to eleven centimetres, or an average annual rate of seven centimetres were observed. Over the same time period, the average rate of vertical settlement appears to be in the order of seven centimetres. The movements confirm previous observations that waste rock pile movements are small (in comparison to movements prior to 1986) and may be referred to as creep movements.

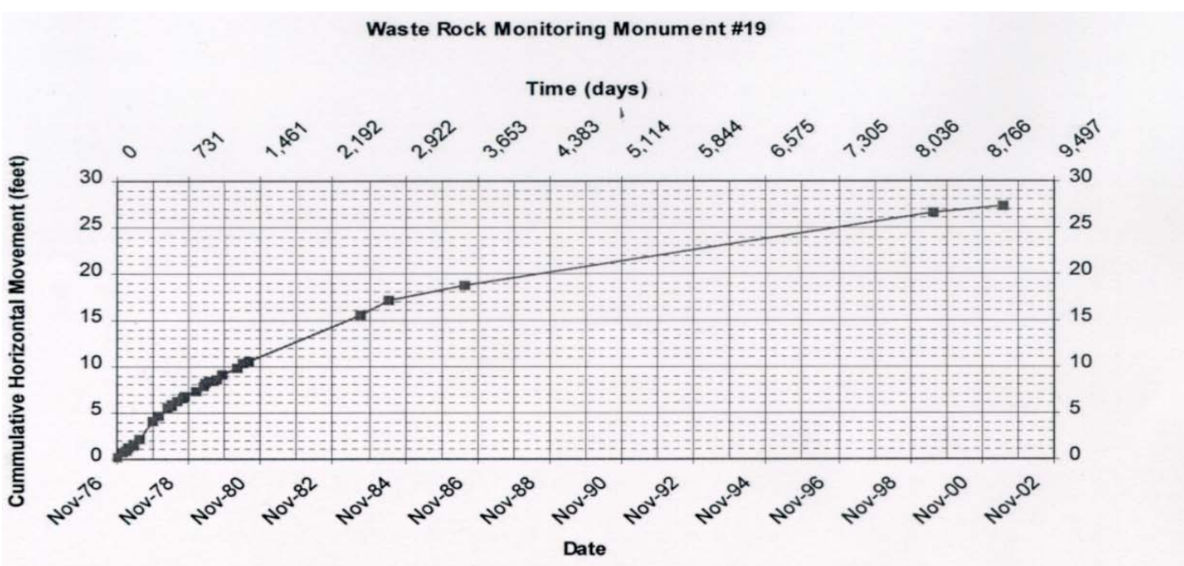

Figure 2: Waste Rock Dump Movements (UMA Engineering Ltd., 2002)

Channel stabilization measures must accommodate anticipated creep movements. The stabilization of the waste rock may however, be deferred until the channel stabilization is complete and additional data for waste rock movement becomes available.

Because the channel stabilization works involve partial infilling of the existing channel, it is possible that the observed horizontal creep movements may be reduced or possibly halted (UMA, 2002).

1.4 Creek Channel

It is believed that the most immediate concern with respect of the potential for a catastrophic breach of the waste rock is the integrity (stability) of the existing creek channel at the Hudgeon Lake outlet. Comparing creek channel profiles in 1986, 1999 and 2001, it is clear that continued channel erosion is deepening (down-cutting) the channel a distance of about 500 m from just downstream of the outlet (**Figure 3**).

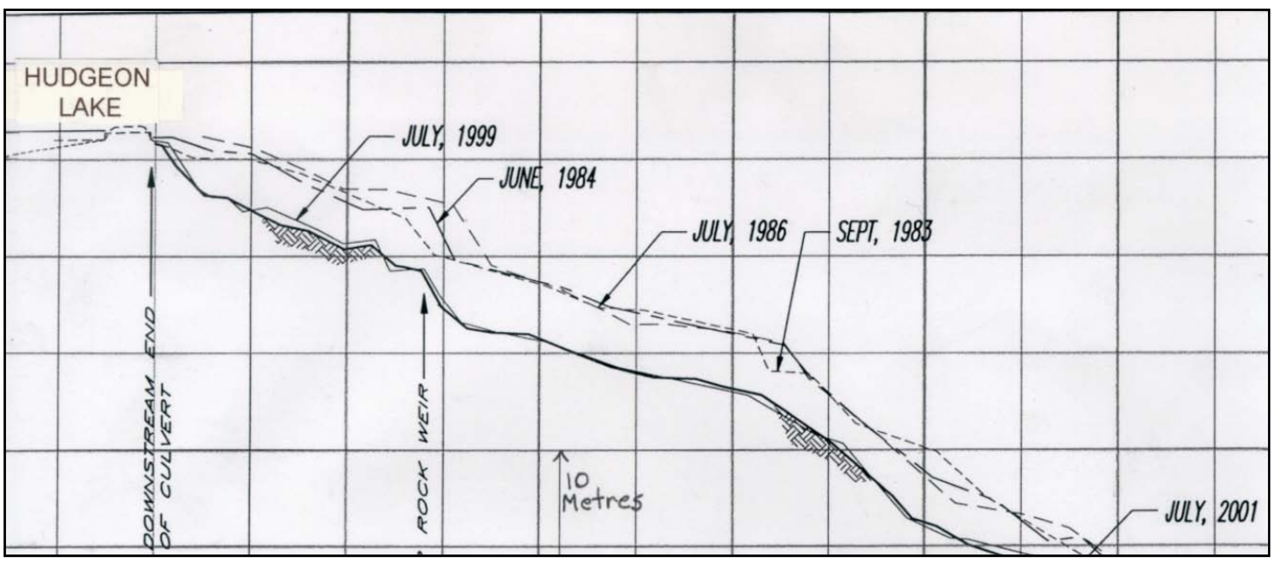

Figure 3: Clinton Creek Channel Profiles (modified from UMA Engineering Ltd., 2002)

The existing channel through the waste rock dump is approximately 800 m long and up to 18 m below the existing road near the middle of the waste rock dump. Side slopes on the waste rock are generally at or steeper than one horizontal to one vertical (1H:1V). The creek has cut its way into the bedrock consisting of clay shale (argillite) from about 350 m downstream of the outlet to the lower reaches of the channel through the waste rock. The waste rock is generally a well graded material consisting of silt, sand, gravel, cobbles and occasional boulders.

As down-cutting continues, the toe of the waste rock pile is undercut and localized slope instabilities develop. The unstable waste rock slumps into the channel and temporarily blocks the flow of the creek. In most instances, this material is quickly overtopped and transported and deposited downstream. As the down-cutting gradually retrogresses towards the outlet however, conditions may quickly develop where normal flow and /or an overtopping event could trigger a full scale breach of the waste rock. The consequences of a breach and rapid draining of Hudgeon Lake are discussed in UMA's Risk Assessment Report (UMA, 2000).

1.5 Land Tenure

The abandoned Clinton Creek Mine Site is on private property with the land title under Cassiar Asbestos (Lot 102, Group 1101). **Figure 4** (next page**)** shows the approximate extent of the property in relation to Hudgeon Lake and the proposed construction area.

Placer claims at the confluence of Wolverine Creek and Clinton Creek have expired and no renewals have been filed with the Dawson mining recorder as of June 27, 2002.

Throughout the property there are a number of quartz claims, mostly held by the Cassiar Mining Corporation. At this time however, there are no mining or exploration activities taking place in the area.

1.6 2003 Program

The 2003 work program will be managed by the Government of Yukon, Energy, Mines and Resources, Abandoned Mines Project Office. In order to maintain continuity on the project DIAND Yukon Region, Waste Management Program will be available to provide expertise as required throughout the life of the project. Under the Health and Safety Plan the program of sampling for airborne asbestos fibres will be continued in 2003. DIAND Waste Management will be responsible for procuring and rental of necessary air sampling equipment, recommending a sampling plan (sample locations and frequency), and sample analysis.

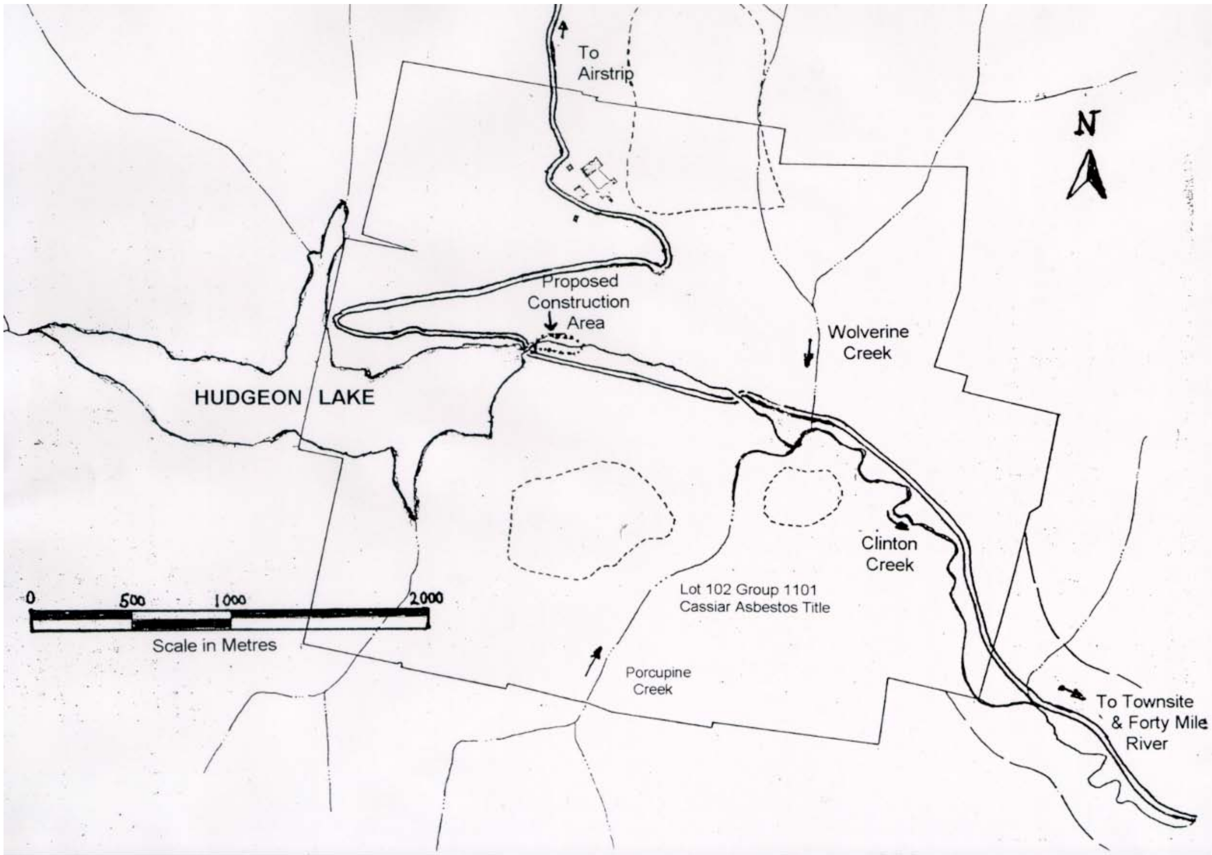

Figure 4: Property line of Lot 102 and location of proposed construction area (DIAND Waste Management, 2002).

2.0 Channel Design

2.1 Hydrology

Based on a regional hydrology study (UMA, 2000), the 100- and 200- year frequency floods for Clinton Creek were estimated from regional unit discharges. The 100- and 200-year floods were plotted in a log-normal graph from which the 50- and 25-floods were estimated by interpolation. The drainage area and estimated discharges are shown in **Table 1**.

Parameter	Clinton Creek
Drainage Area (km^2)	117
25-year flood (m^3/s)	28.9
50-year flood (m^3/s)	33.8
100-year flood (m^3/s)	39.0
200-year flood (m^3/s)	44.5

Table 1: Drainage Area and Discharges for Clinton Creek

To maintain minimum flow from Hudgeon Lake during the construction period, a low-flow estimate for the month of August was obtained from DIAND Water Resources. A water level gauge has been in operation at several locations along Clinton Creek since 1978. The mean unit runoff from Hudgeon Lake for the three lowest flow days for August was calculated based on eight years of data and a lake drainage area of 126.2 km^2. The minimum mean flow amounts to **0.199 m^3/s**.
The Abandoned Mine Project Office suggests maintaining the minimum flow from Hudgeon Lake through pumping or siphoning past the construction area in order to maintain aquatic habitats in the downstream portions of Clinton Creek. A rock weir will have to be constructed below the construction area where water from the lake will re-enter the creek channel, in order to avoid erosion and an increase of sedimentation.

2.2 Gabion Weirs

The recommended channel stabilization work involves flattening of the channel grade through the use of gabion drop structures (see **Photograph 1**). Gabion structures are preferred over rigid structures because of their flexibility that allows them to undergo deformation while remaining structurally sound, which is an important consideration given the observed creep movements of the waste rock. Gabion structures are simple to construct with conventional construction equipment, using material available at the mine site. The only materials requiring transportation over a long distance are the gabion baskets and geotextile.

Photograph 1: Gabion Structure

The drop structures at Clinton Creek are to be constructed from 0.5 x 1.0 x 3.0 m gabion baskets placed empty on geotextile, above gravel bedding. The baskets are tied together with wire and machine filled with cobbles. The gabions are placed as steps, which provide energy dissipation between each step as the water travels through the structure. The weir at the top of a structure creates a constriction that reduces the water surface draw-down immediately upstream to control the channel flow velocity along that length of channel. An end sill prevents a floor jet during high discharges (see **Figures 5a** and **5b**).

As the weir and end sill are made of gabions, a part of the channel flow will pass through the gabions rather than over them. As a result, neither the weir nor the end sill will cause any significant ponding of water. In fact, during low flows, the water surface may be below the top of the gabions i.e. between the cobbles. Because there will be a small flow of water through the gabions most of the time, it is important that the gabions sit on a geotextile and gravel bedding layer to prevent the loss of fine grained material below the baskets. Some sand and gravel will be washed through the channel, in particular during spring runoff. The finer material will become trapped between the cobbles in the gabion baskets further stabilizing the structure.

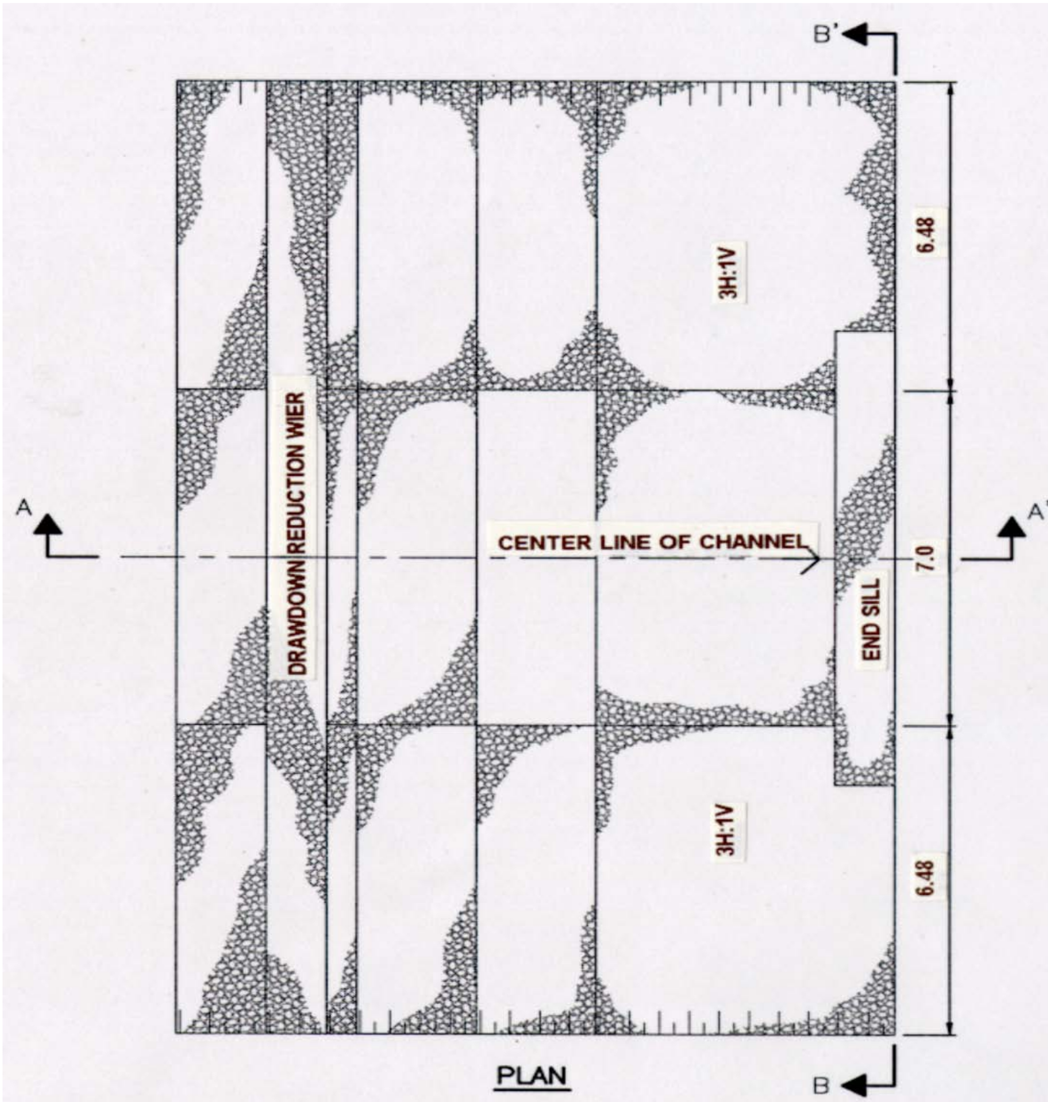

Figure 5a: Top view of a gabion structure as designed for Clinton Creek (UMA, 2002)

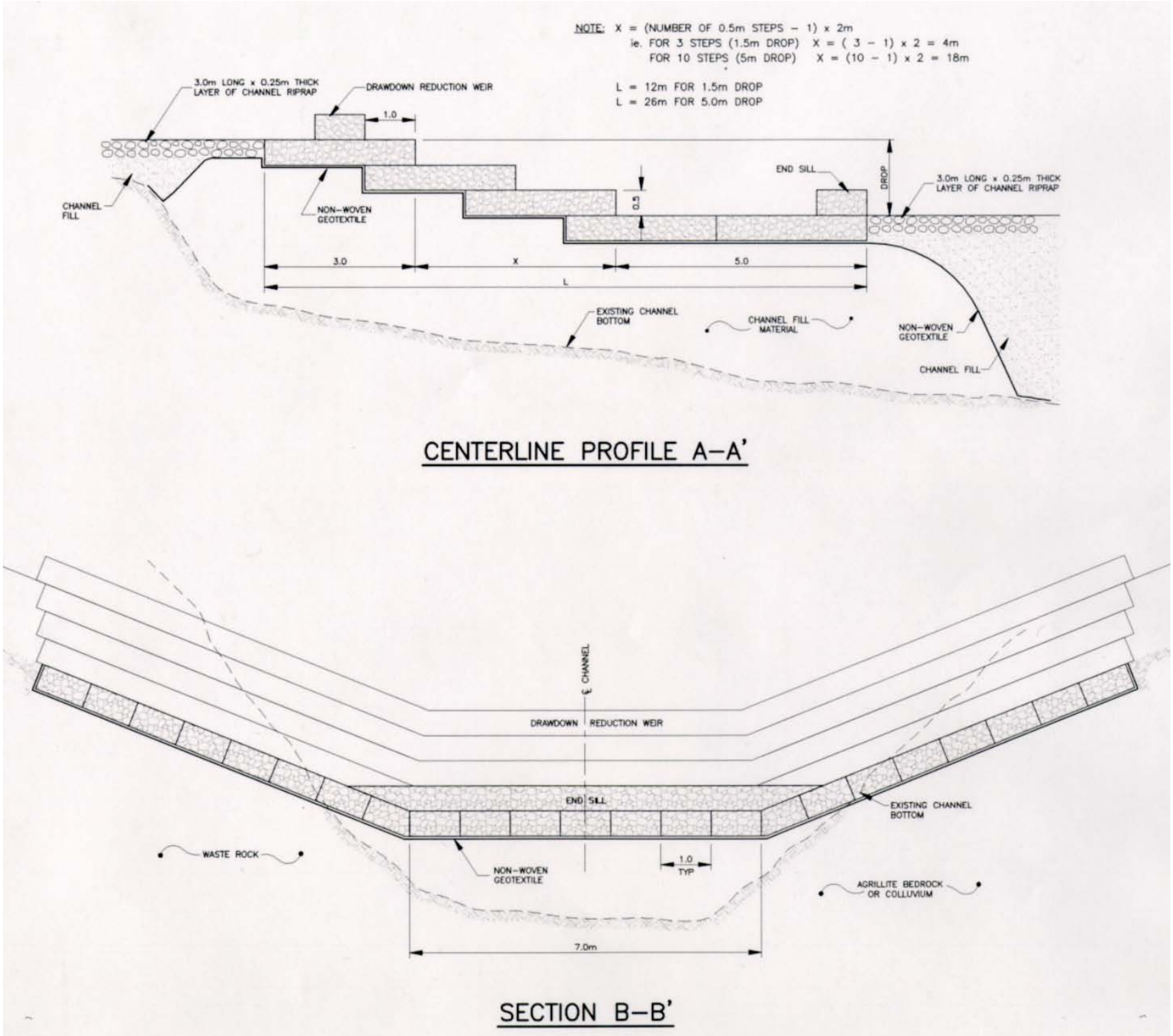

Figure 5b: Profiles of gabion structure as designed for Clinton Creek (UMA, 2002)

2.3 Channel Capacity

The estimated 25-year flood (28.9 m^3/s) was used for the design of the channel stabilization works for the waste rock pile. However, the discharge of the 25-year flood at the Hudgeon Lake outlet will be smaller due to the flood attenuation caused by Hudgeon Lake, resulting in a higher level of protection. Based on the design discharge and 3H:1V side slopes, the new channel geometry will have a bed width of 7.0 m and depth of flow of 2.0 m for a profile grade of 0.00101 m/m. With the dimensions of the individual gabion baskets used for the grade control structures, the freeboard at the control structures will be approximately 0.2 m or sufficient to confine a 50-year flood within an armoured control section.

3.0 Stabilization of Lake Outlet

3.1 Construction Events 2002

The construction of the first gabion structure and re-shaping of the lake outlet took place between August 28 and October 4, 2002. The general construction events required to complete the work included:

- improve road (site access) from the bridge over the Fortymile River to the mine site;
- production of gabion fill material;
- construction of a diversion pipe to route the flow from Hudgeon Lake around the work area;
- construction of a cofferdam across the outlet at Hudgeon Lake;
- fish salvage from remaining ponds in the creek channel;
- creek channel preparation which included removal of the two culverts from the lake outlet, removal of debris and vegetation from the channel and moving some boulders to facilitate construction of the gabion drop structure(s);
- backfilling, compacting and shaping the creek channel to the design grades;
- construction of gabion drop structures;

- re-grading of the outlet from Hudgeon Lake and installing a gabion mat and ford crossing;
- restoring flow over the lake outlet and into Clinton Creek and removal of diversion pipe;
- site restoration.

Due to the potential for airborne asbestos fibres to be present during construction, a Health and Safety Plan was developed to minimize the exposure of the people on-site to airborne asbestos fibres until the test results from air quality samples were available. The test results indicated that the levels of airborne fibres were well below the allowable limit of 0.5 fibres per ml (or: 0.5 f/cc) for an 8 hour exposure period.

A Letter of Advice was provided by the Department of Fisheries and Oceans respecting the proposed work. The advice given required that the work be conducted in a manner to minimize the release of sediment to downstream waters and that deleterious substances, and specifically lubricants, coolants and fuels be used, transferred and stored in such a manner that they are not and do not become deposited in fish bearing waters. In addition, the work had to be conducted in a manner to prevent harmful alteration, disruption or destruction of fish habitat.

3.2 CONSTRUCTION CHALLENGES

The greatest challenge was how to divert the flow from Hudgeon Lake around the work area in the creek channel while maintaining a minimum flow of 0.2 m^3 per second in Clinton Creek downstream of the work area. A diversion pipe was constructed to overcome this challenge. The diversion consisted of 180 metres of 600 mm diameter culvert pipe laid in a trench that was graded at a slope of 1.5 percent.

The capacity of this pipe was significantly lower than the original Hudgeon Lake outlet capacity. The problems associated with the difference in capacity are related to the level of the lake and allowable lake storage. With regard to lake storage and lake level, it was not desirable to raise the lake level significantly above normal water levels due to the increased potential for seepage and/or piping to occur downstream of the outlet. Compounding this problem was the need for storage volume while the construction work was underway that is, it would not be desirable to have to let water run through a partially completed channel because the lake level was getting too high. These problems were avoided by drawing down Hudgeon

Lake before building the cofferdam. This was largely achieved by cleaning out the inlet side of the two culverts located in the original lake outlet. A maximum allowable water level was chosen based on the high water mark visible along the lake shoreline. A 400 mm diameter overflow pipe fitted with a valve was also installed in the cofferdam that could be used to increase the flow out of the lake, if required.

Subsequent to installing the cofferdam and running the diversion pipe, the level of the lake increased at a rate of about 4 cm/day early in the project but decreased to about 1 cm/day near the latter part of September. During the construction period there was never a need to let water flow through the overflow pipe. The performance of the diversion pipe was more than adequate although there were some minor issues with leakage from the culvert couplers. The water leaking from the couplers was prevented from flowing along the trench by installing three check dams in the trench where leakage was the greatest. No more problems were encountered with the diversion pipe after installing the check dams.

Another problem encountered was seepage from the toe of the waste rock pile at the lower level of the drop structure. This problem was overcome by building a granular blanket drain under the floor of the lower level of the drop structure.

Photograph 1: Completed drop structure at outlet of Hudgeon Lake (UMA, 2002)

3.3 Specifications for Channel Stabilization (Stage 2)

The draft version of specifications for stage 2 of the Clinton Creek channel stabilization are attached in **Appendix A**. This includes information on List of Material Suppliers, Labour and Equipment Rate Schedules, Work Schedules, Material Quantities, Specifications, Health and Safety Plan, Materials and Specialty Tools Information, Siphon and Gravity Pipe Flow Capacities, Clinton Creek Hydrographs, Drawings.

4.0 References

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