Small Public Water System Assessment
Yukon Government Maintained Buildings

WESTERN REGION

Project No. 1260002.003

March 2006

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Submitted To:

Property Management Agency
Government of Yukon

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APPENDICES

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1.0 INTRODUCTION

1.1 Scope of Work and Terms of Reference

The scope of work for this project was to conduct professional assessments of the wells, water systems and water sources for Government of Yukon maintained buildings in the "Western Region" as defined in the Request for Proposal (RFP) "Small Public Water Drinking Water System Assessment – Yukon Government Maintained Buildings – 2005". The RFP, and the EBA project team's proposal (EBA, February 2005) formed the Terms of Reference (TOR) for this study. In accordance with the TOR, the assessments were comprehensive and the reporting includes information, observations, comments, recommendations and plans/sketches for the water sources, infrastructure and distribution systems. The recommendations include Class D cost estimates to upgrade water systems to meet the new draft regulations - ***Draft Guidelines for Part III – Small Public Drinking Water Systems***. Comparison of well construction with the ***Canadian Groundwater Association Guidelines for Water Well Construction,*** and comparison of water quality results with the ***Guidelines for Canadian Drinking Water Quality*** are included for each system. This report provides a summary of the assessment results and recommendations and costs for the Western Region.

1.2 Authorization

The project team consisting of EBA Engineering Consultants Ltd. (EBA), Dayton and Knight Ltd. (D&K) and Aqua Tech Service and Supply (ATSS) was authorized to complete the work program in accordance with the TOR. EBA, as the consulting team representative, signed a contract (GN04556521-40319) with the Property Management Agency (PMA) of the Government of Yukon (YTG) on March 8th 2005 to provide consulting services to conduct the Small Public Drinking Water Assessments as per the submitted proposal, fees and disbursements.

1.3 Public Drinking Water System Regulations and Guidelines

Since the tragedy of the Walkerton water supply contamination issue, jurisdictions across Canada have adopted the "Source to Tap, Multi-barrier" approach in assessing, planning and designing water supply systems. The Yukon has followed in step with the rest of Canada in the development of several key guidelines for regulation. The following two draft drinking water guidelines for regulation to be enacted under the ***Public Health and Safety Act*** (Yukon), were released in April 2004:

- ***Public Drinking Water Systems Regulations***; and,

- ***Bulk Delivery of Drinking Water Regulations***.

As well, the Yukon Government has recently developed ***Draft Guidelines for Part III – Small Public Drinking Water Systems***, which were referenced during this study. *We understand* that these draft guidelines are still under review.

Each of these draft regulations specify requirements in the areas of source protection, training, permitting, engineering assessments, equipment, disinfection and treatment, operation and maintenance, sampling and analysis, record-keeping, and emergency planning. All remedial measures and feasibility assessments completed in this study are consistent with the requirements of Yukon legislation.

The ***Canadian Drinking Water Quality Guidelines*** (CDWQG) are referenced for the analysis of water quality data. These guidelines are amended periodically, and the most recent version (April 2004) was used for this study.

1.4 Methodology

The following sections describe the methodology used for completing the scope of work in accordance with the Terms of Reference.

1.4.1 Meeting #1: Project Kick-off

A project "Kick-Off" meeting was held on March 16th, 2005 following award of the contract to introduce the project team members and discuss the Terms of Reference. EBA representatives Ryan Martin and Matt Pye, ATSS representative Bert Albisser, and YTG representatives Tom Renwick and Nick Barnett attended the meeting. The civil/mechanical engineering representatives of the team (D&K) attended by teleconference. Project team introductions, access to background information (water quality results, well records), proposed mapping, schedule and billing was discussed.

1.4.2 Information Collection and Review

The assessment began with the compilation and review of all relevant information including previous reports, site plans, air photos, well logs, pump testing results and water quality data.

An evaluation of all existing water quality information available from a previous study (***Collection of Water Samples for Bacteriological Testing, Chemical and Physical Parameter Testing – Various Locations, Yukon – YTG Contract 2004****)* was undertaken prior to the field program. The purpose of this review was to identify wells that may be impacted by various potential sources of contamination in order to determine the additional water quality parameters necessary to evaluate treatment/disinfection options. The available water quality information was assessed for compliance with the ***Guidelines for Canadian Drinking Water Quality criteria***. EBA prepared a letter dated April 7th, 2005 for YTG Property Management Agency titled ***Recommendations for Additional Analytical – Small Public Drinking Water System Assessments – Government of Yukon Maintained Buildings – 2005***. The letter provided recommendations and estimated costs for additional sampling, field chemistry and laboratory analyses.

1.4.3 Meeting #2: Pre-Assessment

Following the collection and review of available information pertaining to the subject water systems, a meeting was held in Whitehorse with YTG, EBA and ATSS representatives on May 5, 2005. Each of the regional managers attended.

The findings of the analytical review were discussed, with particular attention given to the recommendations for additional water quality sampling. Laboratory and courier cost estimates for the additional analyses were presented at the meeting, along with contact information for personnel involved in the project.

Specific aspects of the field program were discussed including site access and the standardized reporting format for each system. Also, the sequence of regions to be evaluated was determined based on priority of expected high-risk deficiency upgrades and level of risk. It was decided that the first region to be assessed would be the Whitehorse Region, followed by the Eastern Region, Western Region and the Northern Region.

1.4.4 Assessment Team

For system assessment, a project field team consisting of an EBA hydrogeologist (Ryan Martin, P.Eng.), an EBA Field Technician (Luke Lebel) and one senior Aqua Tech personnel (Bert Albisser) was utilized. The primary responsibility of EBA personnel during the field assessments was the evaluation of well construction and location. All potential sources of contamination within 150 m of subject wells with specific attention to the 30 m surrounding the well were identified during the system assessments.

The primary responsibility of Aqua Tech personnel (Bert Albisser) during the field assessments was the accurate documentation of the distribution and treatment/disinfection systems, including general condition and maintenance requirements. Aqua Tech personnel provided a preliminary evaluation of the system to EBA and D&K and assisted with detailed evaluation and development of recommendations.

D&K personnel provided technical advice by correspondence, as needed during the water system assessments, and were not required to visit the sites.

1.4.5 Wellhead Inspections and Water Supply Source Evaluations

For each of the subject wells, the field investigation began with a site reconnaissance to assess general site conditions, topography, surface drainage patterns and exposed sediments. The major focus of the reconnaissance was identification of potential sources of contamination that may not have been previously identified through research prior to the field assessment. Separation distances were measured to all potential sources of contamination within 150 m of the well, including septic fields, sewage lagoons, cemeteries, landfills, buildings, roads, fuel storage tanks and other sources of potential contamination. This information is presented in the individual sections for each water system on digital, scaled site plans developed for the subject sites. Groundwater flow directions are inferred where possible within the report based on topography and proximity to surface water bodies, as well as previous work.

Following the site reconnaissance, a detailed inspection of the water supply system was undertaken. Where possible, the following information was obtained for each well:

- Wellhead construction, enclosure, piping, cleanliness and the buildings served;
- GPS coordinates at each wellhead;
- GPS coordinates for septic fields or other potential contaminant sources within 150 m of each wellhead;
- Digital photographs of wellheads and any potential contaminant sources;
- Surface completion details relevant to the security and operation of the well;
- Assessment of all well enclosures;
- Completion of wellhead check lists for each well incorporating the following items:

- Compliance with the ***Canadian Groundwater Association Guidelines for Water Well Construction***, including existence of casing seals (if possible) and height of casing above ground surface;
- Casing type and diameter;
- Type and condition of well cap;
- Potential for ponding of surface drainage at wellhead;
- Qualitative description of water quality concerns if possible (e.g. staining, odours);
- Description of system deficiencies and digital photographs illustrating deficiencies;
- Wellhead accessibility for rehabilitation, pump removal, inspections, etc.;
- Site sketch illustrating location of well in relation to buildings and nearby potential contaminant sources within 150 m (as described above, information will be transferred to a digital site plan modified from an air photo base plan); and,
- Water level measurements, and the depth of the well measured where possible.

During the well inspections, water quality samples were collected as required, to augment existing water quality information available for the subject systems.

1.4.6 Distribution and Treatment System Evaluations

Aqua Tech personnel documented the existing water supply distribution and treatment/disinfection systems. Where possible, the following information was collected for each system:

- Type and condition of pump, including make and model;
- Type and condition of controls;
- Type and condition of distribution piping, fittings and connections;
- Type and condition of water treatment systems, including make and model;
- Type and condition of disinfection systems, including make and model;
- Type and condition of freeze protection; and,
- Digital photographs illustrating piping, controls and treatment/disinfection systems, including deficiencies and general layout.

This information is presented on system schematics of the complete water supply systems, along with supporting tables that include all pertinent information related to the water supply source, well, distribution and treatment/disinfection systems. This information is presented in an individual appendix assigned for each site.

In addition to the above information, on-site water testing was performed for systems with operational chlorine disinfection systems. This was done using a chlorine test kit capable of reading in the range of 0.0-to 3.5 mg/L free chlorine. Chlorinated systems were assessed for compliance with the ***Draft Guidelines for Part III – Small Public Drinking Water Systems***, which requires a free chlorine residual of 0.4 mg/L for bulk water delivery, and a minimum of 0.2 mg/L for piped water distribution systems servicing five or more connections. Field parameters such as pH, electrical conductivity (EC), Total Dissolved Solids (TDS) and temperature were also obtained at all sites.

1.4.7 Draft Report Preparation and Cost Estimates for Western Region

This report includes the assessment results and recommendations for upgrades to address deficiencies in a prioritized manner as requested in the Terms of Reference. Deficiencies are identified with respect to the requirements stipulated in the ***Canadian Groundwater Association Guidelines for Water Well Construction*** and the ***Draft Guidelines for Part III – Small Public Drinking Water Systems***. Upgrades are recommended to address these deficiencies, in addition to other improvements that may be warranted. Where appropriate, alternative upgrade options are provided. All recommendations include Class D cost estimates, and are classified according to the following three categories:

- Priority 1: Recommended upgrades and estimated costs to address potential immediate risk deficiencies (high hazards);
- Priority 2: Recommended upgrades and estimated costs to address remaining potential medium and high risk deficiencies (medium and high hazards); and,
- Priority 3: Recommended upgrades for typically low risk issues (low hazards), or recommended mechanical and functional upgrades and estimated costs.

The water system deficiencies identified during this study are typically hazard conditions, where risk could exist if there is exposure. For simplicity within the document, a “high risk”, implies that there is a high hazard condition (e.g. no cap on casing) that could pose a high risk if there was an exposure event (e.g. surface water or vermin entering casing). Likewise, other levels of risk and exposure are also referred to in the same manor.

The Draft Report for the Western Region Assessments was submitted to PMA in September 2005. This final report has been updated to make it relevant to the revised draft SPDWSR, to include some additional assessment work that has been completed since the draft reports were submitted, and to make editorial and formatting changes where required. In accordance with the TOR, two copies of this final report have been prepared for PMA. One copy is also maintained at the EBA Whitehorse office. PDF copies of the report in its entirety have also been provided on compact disk to PMA.

1.4.8 Nomenclature and Report Format

This study involved collecting, compiling and reviewing a large amount of data. In labeling the data, EBA used the YTG building numbering classification for system, well and sample names. Where a well served more than one building, the sample name consisted of the both building numbers that the well serves.

Originally there were to be 16 water systems to be assessed in the Western Region. The Western Region includes the communities on the Alaska Highway west of Whitehorse (Haines Junction, Destruction Bay, Burwash Landing and Beaver Creek). During the work program, two additional systems (Blanchard Grader Station on the Haines Road, and the Haines Junction Air Tanker Base) were added. This report includes water systems servicing 18 buildings, which are reported in 18 independent sections (Section 4 through Section 21).

The Property Management Agency has a number of individual clients, and therefore, the report was structured so that individual reports could be extracted and compiled for each client to maintain privacy and efficiency. The systems assessed included fire halls, schools, grader stations, administrative offices, various living quarters for YTG employees, and an RCMP detachment. The report is structured such that there is a separate section for each system. Supporting assessment data was tabulated and provided in a separate appendix for each system. Appendix numbers correspond to the section of the report for each of the systems (e.g. Section 4 has supporting data provided in Appendix A4). Supporting tables were named after the system for which they provide data. Each summary table has the building number followed by the table number and each figure has the building number followed by the figure number. The report is also provided as PDF digital files for each site including the report section and appendix for each system.

2.0 DISCUSSION OF PROPOSED AND EXISTING GUIDELINES

The proposed ***Guidelines for Part III – Small Public Drinking Water Systems*** are currently under development by YTG Environmental Health and Social Services (EHSS). In accordance with the Terms of Reference, these proposed guidelines (November 23, 2004) were used to determine compliance issues with respect to the systems assessed under this program. Since the completion of the draft reports for each Region, these guidelines were amended to a draft dated December 22nd, 2005. Accordingly, the final reports were also amended to reflect the latest draft of these guidelines. The most relevant sections of these draft Guidelines (December 22nd, 2005) as well as the Canadian Groundwater Association Guidelines for Water Well Construction pertaining to this study are summarized below:

- "Small public drinking water system" means a drinking water system which has:
  a) less than 15 direct service connections to a piped distribution system; or
  b) less than 5 delivery sites on a trucked distribution system.

- GUDI is an acronym for well water or groundwater under the direct influence of surface water.

- Well water under the direct influence of surface water means the water source for a well has been determined to be GUDI, using the Yukon's Assessment for Well Water or Groundwater under the Direct Influence of Surface Water (GUDI), published by Queen's Printer (Draft, December 22nd, 2005).

- According to Draft guidelines initial screening protocol, if a water source does not meet any one of the below criteria, the source shall be either identified as GUDI, or as potentially GUDI with further confirmatory assessment to be carried out:
  - Vulnerable location or type – the water system shall not be:
    a) A spring, infiltration gallery, shallow collector system or artificial recharge system;
    b) A well with a production zone less than 15m below the ground surface;
    c) A well in an unconfined aquifer; or
    d) A well completed in fractured or karst bedrock exposed at or near the land surface.
  - Proximity to surface water – the water source shall not be located within 60 m of any permanent, or intermittent or seasonal surface water body, including ponds, slough, lakes, rivers, streams, canals, lagoons, or any other surface water feature.
  - Well Construction – At a minimum, the well shall meet the requirements of the most recent version of the *Guidelines for Water Well Construction*, published by the Canadian Ground Water Association.
  - Water quality – The raw water from the source shall not exhibit evidence of contamination by or from surface water (i.e., significant occurrence of insects,

insect parts, microorganisms such as *E. coli,* algae, *Giardia*, *Cryptosporidium*, or viruses; or significant and rapid shifts in water characteristics such as turbidity, temperature, conductivity, temperature, conductivity, pH or chemistry that closely correlate to weather or surface water conditions).

- An owner is responsible for the supply and delivery of safe drinking water to the users.

- The owner is responsible for the maintenance and upgrade of the small public drinking water system, as necessary, for the purpose of providing safe drinking water to its users.

- An owner of a small water system that obtains drinking water from a groundwater source shall:
    a) Unless otherwise determined based on results of a comprehensive hydrogeological study, ensure that the drinking water well is located a minimum distance of:
        i. 15 metres from a septic tank, sewage holding tank or contained privy;
        ii. 30 metres from a soil absorption system, pit privy, or other potential sources of pollution that may pose a health and safety risk;
        iii. 120 metres from a solid waste site, dump, or cemetery; and,
        iv. 300 metres from a sewage lagoon or pit.
    b) Use a well, located and constructed in accordance with criteria that meets or exceeds those outlined in the Canadian Groundwater Association Guidelines for Water Well Construction.

- The owner of a small public water system that obtains water from a surface water source, or uses a well under the direct influence of surface water, shall ensure provision of treatment consisting of filtration and disinfection, or other treatment capable of producing a safe drinking water.

- An owner upon selecting a drinking water source shall consider a source that is
    - most likely to produce drinking water of a quality that meets the Guidelines for Canadian Drinking Water Quality, and
    - is least likely to be subject to municipal, industrial and agricultural contamination, and/or other types of contamination resulting from human activities within the watershed.

- If Chlorine disinfection of the small public drinking water system is required, the owner shall ensure that the free chlorine residual concentration throughout the plumbing or piped distribution system is no less than 0.2 mg/L.

- An owner of a small public water system shall ensure that the infrastructure protecting the wellhead, pumphouse, storage tank and/or water treatment plant is designed and secured so as to prevent the unauthorized access by humans or entrance of animals.

- Particularly relevant requirements of the Canadian Groundwater Association Guidelines for Water Well Construction are provided below:
    a) Section 3.7: The casing of any drilled well shall project not less than 500 mm above the established ground surface; and,
    b) Section 4.1 and 4.2: The Guidelines for Water Well Construction consider that properly installed water tight casing must have a 50 mm (2") thick bentonite, or bentonite grout seal to effectively prevent the entrance of surface water into an aquifer, and to prevent the intermixing of formation water.

There are many other pertinent requirements involving permitting, application, system operators, seasonal facility start up procedures, well decommissioning, water holding tank cleaning, bulk water delivery, approvals to construct or modify etc. with the draft ***Part 3 – Small Public Drinking Water Systems Regulations (SPDWSR)***. PMA should ensure that all water systems serving YTG maintained buildings that fall under this regulation are in compliance with the final version in it's entirety.

A meeting to discuss the implications of the draft regulations on the assessment of these systems was arranged between Ryan Martin, and an Environmental Health Officer from YTG Environmental Health and Social Services (EHSS) on Thursday June 9th. Key points discussed in the meeting are provided below:

1) It is the intent of the draft SPDWSR that all wells that do not have a surface casing complete with a sanitary surface seal (grout or bentonite seal) and intact casing to 6 m may be under the direct influence of surface water, which would necessitate further assessment (as per the GUDI guidelines) or adequate disinfection.

2) The maximum acceptable concentration (MAC) for arsenic within the Canadian Drinking Water Quality Guidelines is currently under review by Health Canada. The proposed guideline is low (0.005 mg/L) compared with the existing MAC (0.025 mg/L). The EHSS health officer felt that there was a very high probability of the lower guideline being passed at any time in the near future. She indicated that there would likely be a grace period of at least one year for systems to come into compliance. This will have an impact on the treatment requirements for many water supply systems in the Yukon.

3.0 APPROACH TO WATER TREATMENT/ DISINFECTION

Drinking Water Officers in some jurisdictions in BC are adopting the "4,3,2,1,0, Dual Treatment" approach. This "multi-barrier" approach for water treatment requires 4-log (99.99%) removal of bacteria and viruses, 3-log (99.9%) removal/inactivation of *Giardia*, 2-log (99%) removal/inactivation of *Cryptosporidium*, turbidity less than 1 NTU, no total and fecal coliform and dual treatment (filtration and disinfection for example). This is the approach that the project team recommends for treatment system design for upgrades to the Yukon Small Water Systems. We understand that there is insufficient budget to implement all suggested upgrades immediately. Consequently, we recommend that a phased approach to treatment should also be implemented, by mitigating the highest risk with the best value as described below.

According to Dayton and Knight, Health Authorities in BC understand the realities of limited financial resources faced by small water systems. In such cases, the Health Authorities in BC may accept a multi-phase treatment approach starting with some type of primary disinfection initially, followed by additional upgrades as funds become available until full treatment (if required) is achieved. This report has been prepared with the assumption that YTG Environmental Health and Social Service would be amenable to this phased approach. For example, where a water system requires wellhead upgrades and disinfection treatment such as filtration followed by UV (based on preliminary suitability, water quality and system characteristics), we have typically recommended a phased approach with an assigned level of priority as described previously. For this example, the Priority 1 upgrades may include shock chlorination (disinfection) of the well and water system, installing a properly sealed well cap and installing a NSF/ANSI 55- certified UV system. These UV systems (with appropriate raw water quality that in some cases may require pretreatment) are certified to provide 4-log (99.99%) inactivation of *E. coli*, and 2-log (99%) inactivation of cryptosporidium and *Giardia*. This interim Priority 1 upgrade measure would mitigate most risk, however, would not provide 3-log inactivation of *Giardia*, nor dual treatment. During subsequent Priority 2 upgrades for the example system above (which would happen at a later date as funds become available), the NSF 61 filtration system (to 1 micron - absolute) would be installed in advance of the filter, and the wellhead would be upgraded (e.g., casing extension, surface seal installation). This is a practical approach to mitigate the highest risks with the funding available on a priority basis.

Input from drinking water authorities in the Yukon regarding this proposed approach is recommended. For example, on a case-by-case basis, drinking water authorities may agree to treatment without the requirement for filtration to 1 micron (absolute), which would enable 3-log inactivation of *Giardia*. For comparison, the City of Whitehorse does not currently provide filtration to the 3-log level, even though it obtains water from a surface water source.

The installation of water treatment systems are not entirely regulated in Canada and the last word relies with the Health authorities. Health Canada recommends that water treatment systems be NSF certified. The NSF designation for UV systems is ANSI/NSF 55, while filtration is ANSI/NSF 61, and RO systems conform to NSF/ANSI 58. It was not within the scope of this project to design water treatment systems, but rather to identify deficiencies, and to provide class level cost estimates for upgrade alternatives. Where treatments system suggestions are provided herein, they are conceptual based on preliminary information available at this time, and to be used for estimating cost of upgrade alternatives. For all treatment system upgrades, it would be prudent to involve a water treatment engineer in system component selection, and to consult with the local health authorities in the process of system design. For all upgrade options, it has been recommended to budget for a 20% engineering cost for final system design.

4.0 BUILDING 3440: BLANCHARD GRADER STATION

4.1 Description of Existing Water Supply System

Building 3440, the Blanchard Grader Station and Building 3441, the Blanchard Living Complex, are currently served by a water supply system that delivers water from a well of unknown depth. Midnight Sun Drilling Company (MSD) drilled the well, however, neither MSD nor YTG have been able to provide a log for this well. The well is located in an enclosure off the maintenance room of the grader station. The well location and other details about the surrounding area are provided in Figure 3440-A in Appendix A4. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 8
- Northing: 6653029
- Easting: 396549

There is no treatment or disinfection system for the water supplying the maintenance garage. As such, the kitchen area in the lounge of the Grader station receives untreated water. The water system that supplies the living complex is equipped with a NSF 61 filtration system that is followed by a UV disinfection system and a reverse osmosis treatment system. The treatment system is located in the maintenance garage and post-treatment water is stored in a 5000 L water storage tank before being piped to the living complex. A schematic detailing the water supply system is provided as Figure 3440-B in Appendix A4.

4.2 Description of Existing Wastewater Systems

Septic effluent from both the maintenance garage and the living complex is piped to a communal discharge system north of both the maintenance garage and living complex. The septic discharge system is greater than 80 m cross-gradient from the well. A site plan showing the septic system is given by Figure 3440-A in Appendix A4.

4.3 Water Quality Results

4.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Blanchard Grader Station water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon

Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3440-1 in Appendix A4. Coliform bacteria and *E. coli* were reported as absent in each of the nine samples for which results are provided.

Potability

Water samples were previously collected from the Blanchard Grader Station water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3440-2 in Appendix A4. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination. The following observations were made:

- The raw water quality results indicated that all health based and aesthetic objectives were met for the parameters analyzed;
- The untreated water quality results indicated that the groundwater from this well is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) of the untreated water was 198 mg/L during the first sampling event, and is considered very hard. During the second sampling event the hardness (as $CaCO_3$) was 102 mg/L, and is considered moderately hard.

4.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Blanchard Grader Station included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC);
- Extractable Petroleum Hydrocarbon (EPH) to determine any potential impacts of hydrocarbon contamination; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additionally, as no water quality data was taken previously from the living quarters water system, a sample was obtained for potability analysis.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 29, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3440-2 in Appendix A4 and the laboratory reports are included in Appendix B. Items to note are:

- The analyses done on the water from the living complex reported the pH to be 6.10, which is below the CDWQG aesthetic objective lower limit of 6.5. Field chemistry done at the time of sampling, however, reported the pH to be 7.86. This shows that the pH at the point of use is likely within the CDWQG aesthetic objective; and,
- Water quality analysis reported no other exceedences of CDWQG MACs or aesthetic objectives.

4.3.3 Indicators of Potential Contamination

Analytic results for EPH indicated EPH concentrations below laboratory detection limits.

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample are also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the Blanchard Grader Station is under the influence of surfacewater sources or septic wastes.

4.4 Conceptual Hydrogeology

There is no well log available for review for this well or for any other wells in the area. The direction of groundwater flow in the vicinity of the site as inferred from topographical maps and aerial photographs is likely westerly towards the Blanchard River.

4.5 Potential Contaminant Sources

Potential contaminant sources from observations made during the water system assessment are compiled in field notes in Appendix A4. Photos of potential contaminant sources are also provided in Appendix A4.

Potential contaminant sources within 30 m of the wellhead are:

- An above ground fuel storage tank (AST) at 21 m;
- An above ground fuel storage tank (AST) at 24 m; and,
- A fueling area at 21 m.

In addition, a tar emulsion above ground storage tank is located 31 m away from the wellhead, and bulk fuel storage tank is located at 36 m. The bulk fuel tank is located within a secondary containment berm to contain spillage/ leaks. The closest portion of a septic system to the wellhead is a septic line located 30 m away. The closest septic field is approximately 80 m away from the wellhead.

4.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites. During the site assessment, however, it was noted that there are monitoring wells located downgradient of the bulk fuel storage area. The purpose of these monitoring wells is unknown, however their existence indicates the completion of some sort of environmental investigation, likely related to the bulk fuel storage. As the bulk fuel storage area is inferred to be significantly downgradient of the water supply well, the risk of drinking water contamination from any existing contamination in the area is considered to be low.

4.6 Identified Water System Deficiencies and Associated Risk

4.6.1 High and Medium Risk Deficiencies

- There is no treatment or disinfection on the water system supplying the maintenance garage;
- There is a vehicle fueling area located approximately 21 m upgradient from the well;
- There is no well log available to review well construction and lithology; and,
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because the completion depth is unknown, and the well construction does not meet the requirements of the CGWA Guidelines for Water Well Construction.

4.6.2 Low Risk Deficiencies

- The wellhead is only approximately 150 mm above grade, but is located in an appropriately constructed enclosure with a low risk of flooding, and is approximately 450 mm above the floor of the enclosure.

4.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

4.7.1 Priority 1

- Re-plumb the treated water to provide potable water to dedicated taps in the bathroom and kitchen area of the maintenance garage.
- A further attempt should be made to obtain the well record to assess aquifer and well vulnerability. If a well record cannot be obtained, the overall well depth should be determined at the very least.

4.7.2 Priority 2

- As indicated previously, two large Enviro Tanks and a fueling area are located approximately 20 m in a direction that is inferred to be upgradient of the well. Although the tanks are double walled, and there is a secondary containment tray beneath the fuel pumps, it is evident that vehicles are re-fueled in front of this fueling area. There is a risk of overfilling, and potential contamination of the subsurface and aquifer that provides water to the buildings at the site. It would be prudent to relocate the fueling area downgradient, or cross gradient and at least 60 m from well to protect the water quality.

4.7.3 Priority 3

- To limit potential contaminants entering the wellhead, or traveling down the outside of the casing, it is recommended that the casing be extended to 500 mm above grade, and the concrete floor elevation be raised to grade.

4.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

4.8.1 Priority 1

- It is estimated that materials and labour to upgrade the plumbing such that the kitchen area and washroom sink within the maintenance garage can be supplied with treated (filtered, UV and RO) water, would cost in the order of $250 for materials and labour.

4.8.2 Priority 2

- To relocate the Enviro-tanks to an area that is at least 60 m west, or 30 m south of the well location would cost approximately **$600.**

4.8.3 Priority 3

- To extend the wellhead to at least 500 mm above grade, and to raise the elevation of the concrete floor to grade level, would cost in the order of **$400** for materials and labour.

5.0 BUILDING 3443: HAINES JUNCTION INITIAL ATTACK BASE

5.1 Description of Existing Water Supply System

Building 3443, the Haines Junction Initial Attack Base is currently on bulk water delivery supplied by the Village of Haines Junction. The water source is from a very deep drilled well that obtains groundwater from a deep well-protected aquifer. The Attack Base system uses a large underground water storage tank that is located approximately 9 m from the building. The location of the underground water storage tank and other details about the surrounding area are provided in Figure 3443-A in Appendix A5. The coordinates of the tank fill, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 8
- Northing: 6740373
- Easting: 359760

The water is treated at the source and field chemistry results show that the residual chlorine concentration was 0.01 mg/L at the time of the water system assessment. A schematic detailing the water supply system is provided as Figure 3443-B in Appendix A5.

The initial attack base warehouse is located on the same property and also uses water from a delivered source. Water is delivered to an 800 L water storage tank that is located in the kitchen of the warehouse building. The water is treated at the source and field chemistry indicated that the residual chlorine concentration was 0.07 mg/L at the time of the water system assessment. A schematic detailing the water supply system for the warehouse is provided by Figure 3443-C in Appendix A5.

5.2 Description of Existing Wastewater Systems

Septic effluent from the initial attack base building is discharged to an in ground disposal septic system located south west of the initial attack base. The septic tank is approximately 28 m likely downgradient from the water storage tank and the field is located greater than 30 m from the underground tank. A site plan showing the septic system is given by Figure 3443-A in Appendix A5.

5.3 Water Quality Results

5.3.1 Water Quality Results from Previous Sampling

Bacteriological

Two samples were collected from the Haines Junction Initial Attack Base water system between May 2005 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3443-1 in Appendix A5. Coliform bacteria and *E. coli* were reported as absent in both samples for which results are provided.

Potability

There are no previous water quality results reported for this site.

5.3.2 Identification of Additional Analytical Testing Required

As there were no previous water quality results reported for this site, a drinking water package was collected to determine general water quality. Other additional analytical for the Haines Junction Initial Attack Base that was identified to be included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, temperature and residual chlorine concentrations.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 26, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3443-2 in Appendix A5 and the laboratory reports are included in Appendix B.

- At 0.0203 mg/L, the arsenic concentration was below current CDWQG MAC of 0.025 mg/L, but in exceedence of the proposed MAC of 0.005 mg/L;

- The field pH at 8.66 was slightly higher than the aesthetic objective of 8.5, this is considered to be within the margin of error of the instrument; and
- The laboratory water quality results indicated that there no were other exceedences of CDWQG health based guidelines or aesthetic objectives for the parameters analyzed.

5.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the Haines Junction area. Nitrate and nitrite concentrations for this sample were also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the source groundwater is obtained is under the influence of surfacewater sources or septic wastes.

5.4 Conceptual Hydrogeology

This system is on water delivery, and obtains water from the Village of Haines Junction municipal well source. The village well is completed in a highly confined artesian aquifer, the well is screened from 361.9 to 369.2 m below ground. The highly confined nature of the aquifer that the well is completed in, and the presence of a thick sequence of fine grained confining material provides significant protection from surficial sources of contamination in the vicinity of the wellhead.

5.5 Potential Contaminant Sources

A water system assessment was not done at the community well and there is no information on potential contaminant sources within close proximity of the water source. EBA has previously completed hydrogeological assessment work for the Village of Haines Junciton, and at the time of this work (July 2003), there were no potential contaminant sources within at least 60 m of the community water supply.

At the site, there are some potential contaminant sources located within 30 m of the underground water storage tank, however, they are considered to pose very limited risk to the water quality within the underground storage tank.

5.6 Identified Water System Deficiencies and Associated Risk

5.6.1 High and Medium Risk Deficiencies

The following deficiencies were identified as high or medium risk for the initial attack base main building water system:

- The water system is equipped with an underground water storage tank, and the fill pipe and access is located in a pit below grade;
- It was reported during the water system assessment *(personal comm. John Farynowski)* that there is not a proper seal between the main tank and the manhole extension. When the water tank is over-filled into the manhole extension so that the improper seal is submerged, soil and other material can infiltrate into the water storage tank potentially bringing deleterious substances into the tank; and
- The residual chlorine concentration at the point of use was detected to be 0.01 mg/L at the time of the water system assessment, below the required minimum residual chlorine concentration at point of use of 0.2 mg/L.

The following deficiencies were identified to be high or medium risk for the initial attack base warehouse:

- The residual chlorine concentration at the point of use was detected to be 0.07 mg/L at the time of the water system assessment, below the required minimum residual chlorine concentration at point of use of 0.2 mg/L.

5.6.2 Low Risk Deficiencies

- The fill pipe and vent for the warehouse are constructed of ABS piping as opposed to PVC, and are not suitable for drinking water; and
- The arsenic concentration in the delivered water for both water systems is in exceedence of the proposed MAC.

5.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

5.7.1 Priority 1

Two options have been presented to mitigate High risks associated with the existing condition of the underground water storage tank. These include:

Option 1: Abandon the tank, and install a new tank inside the existing building. It is possible the existing tank is significantly large for the water demand for the building. The excess capacity may be the cause of the low residual chlorine concentration observed. Installation of a smaller tank inside the building may mitigate the tank construction and the low residual chlorine.

Option 2: Properly seal the manhole to the tank with fiberglass, and extend the manhole to above ground surface to ensure that flooding cannot occur. Steam clean the tank to remove aromatics that may be associated with curing of the fiberglass during the upgrade.

With both of these options, the tanks must be inspected and cleaned on a regular basis.

5.7.2 Priority 2

To mitigate the low residual chlorine concentration, the residual chlorine concentration in the potable water system must be increased. This may be achieved through ensuring the delivered free residual chlorine concentration is at least 0.4 mg/L. Alternately, to ensure proper disinfection if it is not possible to maintain adequate chlorine concentrations at the point of use, a UV disinfection system could be installed.

5.7.3 Priority 3

The fill pipe and vent pipe for the water holding tank in the warehouse building should be replaced with PVC piping, and the overflow should be re-plumbed to ensure that the pipe effectively prevents overflow within the building.

When the proposed revised MAC for arsenic comes into effect, it is likely that the Village of Haines Junction will be required to install a Point of Entry arsenic removal system such as an ion exchange to ensure that the arsenic concentration is maintained below 0.005 mg/L.

5.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

5.8.1 Priority 1

- Option 1: A 2000 L water storage tank, and sufficiently sized jet pump, assuming that an addition to the building will not have to be built, would cost approximately **$3,000** including installation; or
- Option 2: Properly sealing the fill pipe, manhole and extending them to above grade with a proper enclosure would likely cost in the order of **$2,000**.

5.8.2 Priority 2

- If the residual chlorine issue can be resolved by ensuring that the chlorine concentration of the delivered water is greater than 0.4 mg/L, or, through Option 1 – installing a smaller tank, then there will be no additional cost associated with this deficiency. In the event that it is not possible to maintain residual free available concentrations above 0.2 mg/L at the point of use, it may be prudent to install a UV disinfection system. Based on the water quality, it appears that pretreatment would not be required. An appropriately sized UV system with a 5-micron pre-filter (NSF 61) would cost in the order of **$2,200** installed.

5.8.3 Priority 3

- To replace the existing ABS piping with PVC, and install the overflow properly would cost approximately **$200** installed.
- It is assumed that there would be no cost associated with the elevated arsenic concentration, as this would be dealt with at the source.

6.0 BUILDING M0131: BEAVER CREEK RCMP DETACHMENT

6.1 Description of Existing Water Supply System

Building M0131, the Beaver Creek RCMP Detachment is currently served by a water supply system that delivers water from a 30.5 m deep well. The well is located in a pit approximately 20 m northwest of the RCMP detachment building. The well location and other details about the surrounding area are provided in Figure M0131-A in Appendix A6. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6916890
- Easting: 506480

There is no treatment or disinfection system for the water supplying this system. There is a 900 L water storage tank located in a room in the rear of the detachment that was installed when a water line between the well and the building froze during a previous winter. A schematic detailing the water system is provided as Figure M0131-B in Appendix A6.

6.2 Description of Existing Wastewater Systems

The septic system for this site was not located during the water system assessment. There are septic lines that were observed to have entered the ground underneath the detachment, but it is unknown in what direction they went and there are neither septic pump outs nor clean-outs observed on the property.

6.3 Water Quality Results

6.3.1 Water Quality Results from Previous Sampling

Bacteriological

Three samples were collected from the Beaver Creek RCMP Detachment water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table M0131-1 in Appendix A6. Coliform bacteria and *E. coli* were reported as absent in each of the three samples for which results are provided.

Potability

Water samples were previously collected from the Beaver Creek RCMP Detachment water system on September 28, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results are summarized in Table M0131-2 in Appendix A6. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination as detailed below:

- The turbidity during the first sampling event was 1.7 NTU (the CDWQG MAC is 1.0 NTU). During the second sampling event, however, the turbidity was below the CDWQG MAC;
- The manganese concentration during the first sampling event was reported as 0.05 mg/L, which is equal to the CDWQG aesthetic objective of 0.05 mg/L, but was reported as 0.044 mg/L during the second sampling event, below the CDWQG aesthetic objective;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- Although not above the MAC, copper was elevated with respect to general groundwater quality for the Beaver Creek area;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 241 mg/L during the first sampling event and 247 mg/L during the second sampling event, which is considered very hard.

6.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Beaver Creek RCMP Detachment that was identified to be included during the water system assessments is detailed below:

- As there had previously been an exceedence of the CDWQG MAC for turbidity, a sample was taken to re-test for turbidity;
- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 27, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table M0131-2 in Appendix A6 and the laboratory reports are included in Appendix B.

- The water quality results from addition analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

6.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be relatively low, however, may be elevated above normal background ranges for groundwater in the Beaver Creek area. Nitrate and nitrite concentrations, however, for this sample were low and within the normal background range for this area. These water quality results alone are inconclusive regarding whether the aquifer from which the groundwater is obtained for the Beaver Creek RCMP Detachment is under the influence of surfacewater sources or septic wastes.

6.4 Conceptual Hydrogeology

The log for this well indicates that the well is completed at a depth of 30.5 m within a gravel aquifer. The lithology indicates interbedded gravel, clay and silt overlying the aquifer, with permafrost encountered from 4.3 to 17.1 m. This is consistent with most well logs in the area, which indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The variability of sediments overlying the aquifer indicates limited protection from surficial sources of contamination. A hydrogeological study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

6.5 Potential Contaminant Sources

Potential contaminant sources identified during the water system assessment are compiled in field notes in Appendix A6. Photos of potential contaminant sources are also provided in Appendix A6. There are no known potential sources of contamination within 30 m of the wellhead. Two monitoring wells, however, were noted to exist approximatly 25 m east of the well. The purpose of these monitoring wells should be determined, and the water quality results (if any) for groundwater sampling from these wells should be reviewed.

The following potential sources of contamination are located within 60 m of the wellhead:

- Two above ground fuel storage tanks (AST) at 34 m;
- An above ground fuel storage tank (AST) at 48 m; and,
- A pump island at 60 m.

Additionally the Alaska Highway is located 48 m away from the well. No indications of the location of a septic system were observed within the well vicinity at the time of site inspection and it is unlikely that a septic system exists within 30 m of the well. However, this should be confirmed.

6.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

6.6 Identified Water System Deficiencies and Associated Risk

6.6.1 High and Medium Risk Deficiencies

- Poor wellhead completion (located in a pit below grade, pit is subject to flooding);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association’s Well Construction Guidelines);
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it does not meet the requirements of the Guidelines for Water Well Construction;
- The exact location of the septic field and its proximity to the well is unknown;
- There are monitoring wells on the property and the purpose is unknown; this may indicate the presence of existing or former soil and/or groundwater contamination;

- The pressure tanks are constructed of galvanized steel and do not meet present plumbing code; and,
- There is no treatment or disinfection system.

6.6.2 Low Risk Deficiencies

- Although the copper concentration was not in exceedence of the CDWQG MAC, copper was elevated with respect to general groundwater quality for the Beaver Creek area; and,
- There has been a previous CDWQG MAC exceedence of turbidity, but the most recent sampling events reported turbidity less than the CDWQG MAC.

6.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

As mentined previously, it is important to detemine the location of the on-site sewage disposal system, and to investigate the purpose, and history of the groundwater monitoring wells observed on the site.

6.7.1 Priority 1

- The wellhead completion should be improved by raising the well casing to a minimum of 500 mm above ground level and retrofitting a proper surface-seal to 3 m below grade. Once the wellhead is upgraded, the well and water system should be shock chlorinated;
- Disinfection such as an NSF/ANSI 55 approved UV disinfection system should be installed. This is a conceptual design recommendation based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications; and
- The source of the water that was observed to be ponded at the bottom of the well pit should be identified, if it is resulting from a leak, the well should be repaired.

6.7.2 Priority 2

- Filtration to 1 micron absolute (NSF 61) should be installed in advanced of the disinfection system.

6.7.3 Priority 3

- Continue to monitor copper concentrations and turbidity; and
- Replace the galvanized pressure tanks with a bladder pressure tank that meets code.

6.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

6.8.1 Priority 1

- Standard wellhead improvements with a pitless unit installation and surface seal retrofit would cost approximately **$5000**; and,
- The proposed UV disinfection system would cost in the order of **$2,500** installed. Based on the observed hardness, a pretreatment softening system would likely be required **($2000**).

6.8.2 Priority 2

- The UV system previously described in Priority 1 would be installed with a 5-micron pre-filter (NSF 61). A 1-micron (absolute) NSF 61 filtration system (NSF 61) to be installed between the 5-micron and the UV system would cost approximately **$1000**.

6.8.3 Priority 3

- It is presumed that routine monitoring of copper concentrations and turbidity would be completed under operation and maintenance costs.
- The cost to remove and replace the galvanized pressure tanks with a bladder pressure tank would cost approximately **$2,000** with materials and labour.

7.0 BUILDING M0133: BEAVER CREEK RCMP RESIDENCE

7.1 Description of Existing Water Supply System

Building M0133, the Beaver Creek RCMP Residence, is currently served by a water supply system that delivers water from a 37.4 m deep well. The well is located in an enclosure off from basement of the residence. The well location and other details about the surrounding area are provided in Figure M0133-A in Appendix A7. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6917199
- Easting: 506150

The water system is equipped with an in-line filter and a water softener, however, at the time of the assessment, the softener was being bypassed and was not functioning. The system is not equipped with a disinfection system. A schematic detailing the well supply system is provided as Figure M0133-B in Appendix A7.

There is an abandoned well located in the same enclosure as the well that is currently in use. The abandoned well was not equipped with a proper cap and was open.

7.2 Description of Existing Wastewater Systems

The septic tank that serves the residence is located approximately 20 m west of the well, and the septic effluent discharge field is located approximately 40 m down slope from the well. Although the effluent field is downslope from the well, conceptual hydrogeology (outlined in a following section) indicates that it may be hydraulically upgradient. A site plan showing the septic system is given by Figure M0133-A in Appendix A7.

7.3 Water Quality Results

7.3.1 Water Quality Results from Previous Sampling

Bacteriological

Four samples were collected from the M0133 Beaver Creek RCMP Residence water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table M0133-1 in Appendix A7. Coliform bacteria and *E. coli* were reported as absent in each of the four samples for which results are provided.

Potability

Water samples were previously collected from the M0133 Beaver Creek RCMP Residence water system on September 23, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table M0133-2 in Appendix A7. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination as follows:

- The turbidity of the water during the June 15th, 2005 sampling event was reported at 2.28 NTU, which is in exceedence of the CDWQG MAC of 1.0 NTU;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 151 mg/L during the first sampling event, and is considered hard. During the second sampling event the hardness (as $CaCO_3$) was 141 mg/L, and is also considered hard.

7.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the M0133 Beaver Creek RCMP Residence that was identified to be included during the water system assessments is detailed below:

- As there had previously been an exceedence of the CDWQG MAC for turbidity, a sample was taken to re-test for turbidity;
- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 27, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table M0133-2 in Appendix A7 and the laboratory reports are included in Appendix B. The water quality results from additional analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

7.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Although below the MAC, the chloride concentrations were elevated compared to normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample were low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the M0133 Beaver Creek RCMP Residence is under the influence of surfacewater sources or septic wastes. Road salting on the highway adjacent to the well could result in elevated chloride concentrations.

7.4 Conceptual Hydrogeology

The log for this well indicates that the well is completed at a depth of 37.4 m within a gravel aquifer. The lithology indicates mostly gravel with variable till and silty sediments. This is consistent with most well logs in the area, which indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The static water level the abandoned well was measured to be 12.1 m below the top of the casing and approximately 13.7 m below grade. The presence of variable interbedded fine grained material overlying the aquifer indicates limited protection from surficial sources of contamination. A study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

7.5 Potential Contaminant Sources

Potential contaminant sources identified during the water system assessment are compiled in field notes in Appendix A7. Photos of potential contaminant sources are also provided in Appendix A7.

Potential contaminant sources within 30 m of the wellhead are:

- An indoor fuel storage tank (AST) at 3 m;
- An abandoned well approximately 1 m from the well that is currently not in use; and
- A septic Tank at 20 m (note that sewage regulation allows tank to be within 15 m).

In addition, the septic field is located 40 m away from the well.

7.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

7.6 Identified Water System Deficiencies and Associated Risk

7.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in an enclosure below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because does not meet the requirements of the Guidelines for Water Well Construction.
- The well is located within 30 m of potential sources of contamination including: an abandoned well that is not equipped with a proper cap and is located within 1 m of the current well, and an AST located in the basement of the building; and,
- There is no disinfection system.

7.6.2 Low Risk Deficiencies

- There had been a previous CDWQG MAC exceedence for turbidity, but the most recent sampling event reported turbidity below the CDWQG MAC;

- The plumbing installation was observed to be unprofessional, and the softener discharge is not to code;
- The water softener was not functioning at the time of the water system assessment;
- The in-line filter was observed to need replacing; and,
- There is an indoor fuel storage tank located in the basement of the residence, however, because the floor is concrete the potential risk of impact to the well from a spill or leak event is considered minimal.

7.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

7.7.1 Priority 1

- An NSF/ANSI 55 approved UV disinfection system (or equivalent) should be installed. This is a conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications; and
- The abandoned well should be properly decommissioned by backfilling it with grout or bentonite, and welding a cover over the casing.

7.7.2 Priority 2

- The wellhead at M0131 should be extended to a minimum of 500 mm above the surrounding grade, and the well pit should be backfilled with a low-permeability material to provide a surface seal around the well casing. A surface sanitary seal (grout or bentonite) should be installed as deep as possible during wellhead improvements.

7.7.3 Priority 3

- Upgrade plumbing to meet code;
- Repair water softener, and replace filter; and,
- Install secondary containment tray around AST.

7.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

7.8.1 Priority 1

- It would cost approximately **$2,200** for supply and installation of a UV disinfection system; and
- Proper decommissioning of the abandoned well would cost in the order of **$1,000** for materials and labour.

7.8.2 Priority 2

- Standard wellhead upgrades (casing extension, sanitary seal, plumbing and electrical extensions, and insulation and heat trace as necessary) would cost approximately **$4,000**; and,
- Installation of NSF 61 NSF 61 filtration system (to 1 micron absolute) would cost in the order of **$500.**

7.8.3 Priority 3

- It is estimated that the recommended plumbing upgrades would cost approximately **$100**;
- To repair the water softener (replace media), and replace filter would cost approximately **$600** for materials and labour; and
- To supply and install a secondary containment tray around the AST would cost approximately **$500.**

8.0 BUILDING M0134: BEAVER CREEK RCMP RESIDENCE

8.1 Description of Existing Water Supply System

Building M0134, a RCMP Residence in Beaver Creek, is currently served by a water supply system that delivers water from a well of unknown depth. The well is located in a pit approximately 3 m from the residence building. The well location and other details regarding the surrounding area are provided in Figure M0134-A in Appendix A8. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6917131
- Easting: 506146

The water system is equipped with a water softener and an in-line filter, but both were reportedly not functioning properly at the time of the water system assessment. There is no disinfection system present. A schematic detailing the water supply system is provided as Figure M0134-B in Appendix A8.

8.2 Description of Existing Wastewater Systems

There is a septic tank located west of the residence approximately 28 m northwest of the well. Septic effluent is discharged to the west of the tank in a septic field beginning at approximately 34 m from the well. Figure M0134-A in Appendix A8 gives a site plan showing the septic system.

8.3 Water Quality Results

8.3.1 Water Quality Results from Previous Sampling

Bacteriological

Four samples were collected from the M0134 Beaver Creek RCMP Residence water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table M0134-1 in Appendix A8. Coliform bacteria and *E. coli* were reported as absent in each of the four samples for which results are provided.

Potability

Water samples were previously collected from the M0134 Beaver Creek RCMP Residence water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3440-2 in Appendix A4. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination as follows:

- The water quality results indicated that all health based and aesthetic objectives were met for the parameters analyzed;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 149 mg/L during the first sampling event and 140 mg/L during the second sampling event, and is considered hard.

8.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the M0134 Beaver Creek RCMP Residence that was identified to be included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 27, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table M0134-2 in Appendix A8 and the laboratory reports are included in Appendix B. The water quality results from additional analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

8.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample are also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the M0134 Beaver Creek RCMP Residence is under the influence of surfacewater sources or septic wastes.

8.4 Conceptual Hydrogeology

There is no log available for this well. Most of the wells in the Beaver Creek indicate coarse sand and gravel with cobbles and small boulders to depths of at least 30 m. The well logs also indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The variability of sediments in the Beaver Creek area indicates limited aquifer protection from surficial sources of contamination. A study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

8.5 Potential Contaminant Sources

Potential contaminant sources identified during the water system assessment are compiled in field notes in Appendix A8. Photos of potential contaminant sources are also provided in Appendix A8.

Potential contaminant sources within 30 m of the wellhead are:

- An indoor fuel storage tank (AST) 3 m from the wellhead.

In addition, a septic tank is located 28 m away from the wellhead, and a septic field is located 34 m away.

8.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

8.6 Identified Water System Deficiencies and Associated Risk

8.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in a pit below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction; There is no well log available to review well construction and/or lithology;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence because the well depth is unknown and the well construction does not meet the requirements of the Guidelines for Water Well Construction; and,
- There is no disinfection system.

8.6.2 Low Risk Deficiencies

- The in-line filter and water softener are both in poor condition. Water quality results and observations made during the water system assessment conclude that the water softener is not functioning properly; and,
- The softener drain is not installed to code.

8.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

8.7.1 Priority 1

- An NSF/ANSI 55 approved UV disinfection system should be installed. This is a conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

8.7.2 Priority 2

- The wellhead at M0134 should be extended to a minimum of 500 mm above the surrounding grade, and the well pit should be backfilled with a low-permeability material to provide a surface seal around the well casing. A surface sanitary seal (grout or bentonite) should be installed as deep as possible during wellhead improvements.

8.7.3 Priority 3

- Upgrade plumbing to meet code;
- Repair water softener, and replace filter; and,
- Install secondary containment tray around AST.

8.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

8.8.1 Priority 1

- It would cost approximately **$2,200** for supply and installation of the recommended UV disinfection system.

8.8.2 Priority 2

- Standard wellhead upgrades (casing extension, sanitary seal, plumbing and electrical extensions, and insulation and heat trace as necessary) would cost approximately **$4,000**.
- Installation of NSF 61 NSF 61 filtration system (to 1 micron absolute) would cost in the order of **$500.**

8.8.3 Priority 3

- It is estimated that the recommended plumbing upgrades would cost approximately **$100**;
- To repair the water softener (replace media), and replace filter would cost approximately **$600** for materials and labour; and,
- To supply and install a secondary containment tray around the AST would cost approximately **$500.**

9.0 BUILDING 3100: NELNAH BESSIE JOHN SCHOOL

9.1 Description of Existing Water Supply System

Building 3100, Nelnah Bessie John School in Beaver Creek, is currently served by a water supply system that delivers water from a 21.6 m deep well. The well is located in a pit adjacent to the school, approximately 2 m from the building. The well location and other details about the surrounding area are provided in Figure 3100-A in Appendix A9. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6916849
- Easting: 506143

The water system is equipped with a pellet chlorinator that is installed on the wellhead, however, at the time of the assessment, it was not functioning properly as it was discharging some pellets into the wellhead enclosure (some appeared to be discharging into the well as designed). This water system is also equipped with a water softener and an activated carbon filter for treatment. Field chemistry completed during the water system assessment indicated that the residual chlorine concentration was approximately 0.07 mg/L.

A schematic detailing the well supply system is provided as Figure 3100-B in Appendix A9.

There is an abandoned well located approximately 1 m from the current well. The abandoned well did not have a proper cap.

9.2 Description of Existing Wastewater Systems

The school's septic tank is located approximately 22 m north of the well on the north side of the school as indicated in Figure 3440-A. The location of the septic effluent discharge field is unknown but it is likely located north of the tank. The location of the septic disposal system should be confirmed prior to making final decisions regarding water supply system upgrades.

9.3 Water Quality Results

9.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Nelnah Bessie John School water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3100-1 in Appendix A9. Coliform bacteria and *E. coli* were reported as absent in each of the nine samples for which results are provided.

Potability

Water samples were previously collected from the School water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3100-2 in Appendix A9. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination as follows:

- The water quality results indicated that all health based and aesthetic objectives were met for the parameters analyzed;
- The water quality results indicated low hardness, calcium, and magnesium, and high potassium, indicating that the water softening system is functioning properly; and,
- The hardness (as $CaCO_3$) reported from both sampling events was indicated to be less than 1 mg/L, and the water is considered very soft.

9.3.2 Identification of Additional Analytical Testing Required

Additional analytical for Nelnah Bessie John School that was identified to be included during the water system assessments is detailed below:

- Trihalomethane parameters (THMs) and other disinfection by-products are formed when chlorine disinfectants react with naturally occurring organic matter in the source water. THMs were analyzed, as there is an existing chlorine disinfection system.

- Similar to THMs, Haloacetic Acid (HAA) can be present in chlorinated drinking water as a disinfectant byproduct. HAA analysis has been included due to the presence of the chlorination system.
- Total organic carbon (TOC);
- Extractable Petroleum Hydrocarbons (EPH) and Polycyclic Aromatic Hydrocarbons (PAH) to determine if there are any indications of hydrocarbon contamination; and,
- Measurements in the field for total dissolved solids, conductivity, pH, temperature and the residual chlorine concentration.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 28, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3100-2 in Appendix A9 and the laboratory reports are included in Appendix B. Items to note are:

- Laboratory results for THMs and HAAs indicated concentrations below analytical detection limits;
- Screening for EPH and PAH did not indicate any parameter above the laboratory detection limits; and
- The water quality results from additional analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

9.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample were also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for Nelnah Bessie John School is under the influence of surfacewater sources or septic wastes.

9.4 Conceptual Hydrogeology

There is no log available for this well, however, it is reportedly 21.6 m deep with a static water level at approximately 11 m below grade. Most of the well logs in the Beaver Creek area indicate coarse sand and gravel with cobbles and small boulders to depths of at least 30 m. The well logs also indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The variability of sediments in the Beaver Creek area indicates limited aquifer protection from surficial sources of contamination. A study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

9.5 Potential Contaminant Sources

Potential contaminant sources identified during the water system assessment are compiled in field notes in Appendix A9. Photos of potential contaminant sources are also provided in Appendix A9. Potential sources of contamination within 30 m of the wellhead are:

- An underground fuel storage tank (UST) at approximately 1 m; and
- A septic field potentially within 30 m (exact location unknown).

An additional source of contamination is an abandoned and uncapped well that is located approximately 1 m from the existing well.

9.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

9.6 Identified Water System Deficiencies and Associated Risk

9.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in a pit below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential sources of contamination including an underground fuel storage tank located 1 m from the well;

- There is an open, abandoned well located approximately 1 m from the current well;
- The septic tank is located approximately 22 m from the well, and although the exact location of the septic field is unknown, it may be within 30 m;
- There is no well log available to review well construction and/or lithology;
- The pellet chlorination system on the wellhead has not been properly installed. It was observed that a large number of the chlorine pellets do not drop into the well but fall into well pit instead;
- Field chemistry reported that the residual chlorine concentration was 0.07 mg/L, below the required minimum of 0.2 mg/L; and,
- The configuration of the treatment system does not meet current standards.

9.6.2 Low Risk Deficiencies

- The heat-trace installation does not meet code.

9.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

9.7.1 Priority 1

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the Nelnah Bessie John School water supply system. Priority 1 remedial recommendations include:

- Properly decommissioning the abandoned well adjacent to the well that currently serves the building;
- Priority 1 upgrades to eliminate immediate risk would also involve upgrading the existing disinfection system to ensure that adequate disinfection is provided. Two options are presented below:
  - The first option would involve the installation of retention tanks and a proportional feed chlorine injection system with a flow meter, a chemical feeding pump, day tank, injection piping, spill containment deck and appurtenances.
  - The second option presented for Priority 1 upgrades would involve the installation of a UV disinfection system with NSF/ANSI 55 certification.

There are conceptual options based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

Some additional assessment is required prior to determining final Priority 2 options. These include obtaining a well log to determine well construction, and determining the exact location of the septic field and the distance to the well.

9.7.2 Priority 2

Priority 2 recommended upgrades include the removal of the UST located adjacent to the well. The UST should be replaced with a double walled above ground storage tank (AST) located at a safe distance from the well. Observations should be made and confirmatory sampling completed to confirm whether the existence of the UST has impacted soils in the vicinity of the tank, which could ultimately impact on the groundwater and water quality.

Pending the results of the UST removal, the confirmed location of the septic tank, and the well construction, the following options are presented:

Option 1: Upgrade Existing Well

- Option 1 is presented in consideration that the UST removal confirms that there is no potential impact of hydrocarbons on water quality, that the septic field is greater than 30 m from the well, and that the well construction (screen construction etc.) are adequate to warrant further capital investment in upgrades to this well. For this option, Priority 2 upgrades would include “standard wellhead upgrades” including extending the well to at least 500 mm above grade and installing a commercial pitless unit. A surface sanitary seal (grout or bentonite) to at least 3 m below grade should be retrofitted around the well and then the ground should be graded to promote surface drainage away from the wellhead. For this option, it is also recommended that a NSF 61 NSF 61 filtration system (to 1 micron absolute) be installed in advance of the disinfection system installed as Priority 1.

Option 2a: New Water Well Construction

- Options 2a and 2b are presented for the scenario that further assessment supports the fact that the existing well should not be used for a long-term option. Option 2a considers the installation of a new well to serve only the School. For this option, it is recommended that a new well should be drilled and the current well be decommissioned. It is recommended that a new well be installed to meet the following conditions:
  - The well should be equipped with a surface seal to at least 6 m and the casing should be extended above grade (500 mm) within a lockable enclosure that is inaccessible to animals and unauthorized personnel;

- o The well must be located at a distance greater than 30 m from any potential source of contamination, including the above ground storage tank and all parts of the septic system;
- o The water from the new well must meet all CDWQG health based guidelines. If there are any exceedences in the CDWQG health-based guidelines then a treatment system must be designed and installed as necessary. A disinfection system may be recommended.

Option 2a: New Cluster Well Construction

- Option 2b presents the option of a cluster well installation to provide water supply to the Pool building, Recreational Centre, and the School. The advantages would include combined savings on capital costs, and reduced life cycle costs.

9.7.3 Priority 3

- Upgrade of heat trace to meet code would be completed with Priority 2 option 1, and would not be necessary for the scenario presented option 2 or 3.

9.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

9.8.1 Priority 1

- The cost to decommission the abandoned well is estimated to be approximately **$1,000** for materials and labour, and should be completed regardless of which disinfection treatment system is chosen.
- The estimated cost for a proportional feed chlorine injection system with appurtenances, and included disinfection of the well and water system is in the order of **$7,000**.
- The estimated cost for an NSF/ANSI 55 certified UV disinfection system including disinfection of the well and water system by superchlorination would cost approximately **$2,500.**

Therefore, with the options presented, Priority 1 upgrades would range from **$3,500** to **$8,000** including materials and labour.

9.8.2 Priority 2

Priority 2 upgrade options to mitigate long-term risk and meet the proposed regulation are presented below:

Option 1: The cost associated with upgrading the existing well (pending the results of additional assessment) is estimated to cost approximately **$5,000**. The estimated cost for removal of the UST adjacent to this well is approximately **$6,000**. Installation of an adequately sized NSF 61 NSF 61 filtration system to 1 micron absolute would cost approximately **$500**. Therefore, the total cost for Option 1 Priority 2 upgrades is **$11, 500** for materials and labour.

Option 2: The cost associated with the construction of a new well to meet the proposed regulations, and drilled to approximately 30 m in depth would cost in the order of **$31,200** including hook-up. Proper decommissioning of the existing well would cost approximately **$1000.** Therefore, the total cost for Option 2 Priority 2 upgrades is **$32, 200** for materials and labour.

Option 3: The shared cost for construction of a cluster well that would serve the recreational hall and pool, assuming that the well would be constructed to meet the proposed regulations, and would be 30 m deep, and including 80 m of distribution piping would cost approximately **$26,800** including half of the drilling costs and the full costs for distribution.

9.8.3 Priority 3

- The cost for heat trace upgrade is included in Priority 2 Option 1, and not necessary in the event that Option 2 or 3 are chosen.

10.0 BUILDING 3102: BEAVER CREEK FIRE HALL

10.1 Description of Existing Water Supply System

Building 3102, the Beaver Creek Fire Hall, is currently served by a water supply system that delivers water from a 34.0 m deep well. In addition to serving the fire hall, the well also serves the Beaver Creek Public Library, which is located within the same building. The wellhead is located in the main garage of the fire hall and was not equipped with a proper cap at the time of the assessment (there was only a cloth placed over the top of the casing). The well location and other details about the surrounding area are provided in Figure 3102-A in Appendix A10. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6916938
- Easting: 506369

There is no treatment or disinfection system for this system. Water is delivered to an approximately 12 000 L water storage tank which is at grade, and a 4800 L elevated water storage tank for fire protection. A schematic detailing the well supply system is provided as Figure 3102-B in Appendix A10.

10.2 Description of Existing Wastewater Systems

There is a septic tank or a leach pit located to the west of the fire hall approximately 16 m from the well. It is unknown if there is an effluent discharge field present on the property. Conceptual hydrogeology (outlined in a following section) indicates that the septic system is likely upgradient from the well. A site plan showing the septic system is given by Figure 3102-A in Appendix A10.

10.3 Water Quality Results

10.3.1 Water Quality Results from Previous Sampling

Bacteriological

Eight samples were collected from the Beaver Creek Fire Hall water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3102-1 in Appendix A10. Coliform bacteria and *E. coli* were reported as absent in each of the eight samples for which results are provided.

Potability

Water samples were previously collected from the Beaver Creek Fire Hall water system on September 28, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3102-2 in Appendix A10. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination as follows:

- The turbidity during the first sampling event was 2.3 NTU, and during the second sampling event to be 2.57 NTU, both of which are above the CDWQG MAC of 1.0 NTU;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- Although the copper concentration was not in exceedence of the CDWQG MAC, copper was elevated with respect to regional groundwater quality for the Beaver Creek area;
- Although the lead concentration was not in exceedence of the CDWQG MAC, lead was elevated with respect to regional groundwater quality for the Beaver Creek area;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 198 mg/L during the first sampling event, and is considered very hard. During the second sampling event the hardness (as $CaCO_3$) was 170 mg/L, and is also considered very hard.

10.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Beaver Creek Fire Hall maintenance building that was identified to be included during the water system assessments is detailed below:

- As the turbidity had previously indicated a CDWQG MAC exceedence, a sample was taken to re-test for turbidity;
- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC);

- Extractable Petroleum Hydrocarbons (EPH) to determine if there are any indications of hydrocarbon contamination; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 28, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3102-2 in Appendix A10 and the laboratory reports are included in Appendix B.

- At 2.69 NTU, the turbidity was reportedly in exceedence of the CDWQG MAC of 1.0 NTU;
- The screening for EPH did not indicate any parameter above detection limits; and,
- The water quality results from additional analytical sampling indicated that all other health based and aesthetic objectives were met for the parameters analyzed.

10.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be relatively low, however, may be elevated above normal background ranges for groundwater in the Beaver Creek area. Nitrate and nitrite concentrations, however, for this sample were low and within the normal background range for this area. These water quality results alone are inconclusive regarding whether the aquifer from which the groundwater is obtained for the Beaver Creek Fire Hall is under the influence of surfacewater sources or septic wastes. Road salting on the highway adjacent to the well could result in elevated chloride concentrations.

10.4 Conceptual Hydrogeology

There was no driller's log available for review. Most of the wells in the Beaver Creek area indicate coarse sand and gravel with cobbles and small boulders to depths of at least 30 m. The well logs also indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The variability of sediments in the Beaver Creek area indicates limited aquifer protection from surficial sources of contamination. A study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

10.5 Potential Contaminant Sources

Potential contaminant sources identified during the water system assessment are compiled in field notes in Appendix A10. Photos of potential contaminant sources are also provided in Appendix A10. Potential sources of contamination within 30 m of the wellhead are:

- A above ground fuel storage tank (AST) located at 3.5 m;
- A septic tank or leach pit at 16 m; and,
- Fuel and chemical handling and vehicle parking within very close proximty to the wellhead.

In addition a neighbouring septic field is located 47 m away from the wellhead, and an outhouse is located 34 m away.

10.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

10.6 Identified Water System Deficiencies and Associated Risk

10.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the well (located in fire hall garage only 40 mm above grade, there is no cap on the casing);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- There is no well log available to review well construction or lithology;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because the depth of the well is unknown and the well construction does not meet the requirements of the Guidelines for Water Well Construction;
- Well is located within 30 m of potential contaminant sources, including an AST at 3.5 m, a leach pit located at approximately 16 m, and garage activities immediately adjacent to the wellhead;

- Turbidity has exceeded the CDWQG MAC in each water quality analysis for which results are provided;
- The pressure tanks are constructed of galvanized steel and do not meet present standards;
- The plumbing configuration does not meet standards and appeared to be aging and in a state of disrepair;
- There is no treatment or disinfection system; and
- There is no backflow prevention between the elevated fire protection tank and the domestic system.

10.6.2 Low Risk Deficiencies

- Although the copper concentration was not in exceedence of the CDWQG MAC, copper was elevated with respect to general groundwater quality for the Beaver Creek area;
- Although the lead concentration was not in exceedence of the CDWQG MAC, lead was elevated with respect to general groundwater quality for the Beaver Creek area; and,
- It is unlikely that the supports for the elevated water storage tank are earthquake or collision proof.

10.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

10.7.1 Priority 1

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the Fire Hall and Library water supply system. Priority 1 remedial recommendations include:

- The casing should be extended to at least 500 mm above the concrete floor grade, and if not already completed, a proper fitting well cap must be installed;
- The plumbing system should be re-plumbed such that the domestic water comes of the system prior to entering the tank;
- Backflow prevention should be installed to prevent backflow from the water tanks to the domestic system;

- The well and water system should be superchlorinated; and
- Disinfection treatment such as an NSF/ANSI 55 certified UV system should be installed. This is a conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

10.7.2 Priority 2

Priority 2 upgrade options to mitigate long-term risk and meet the proposed regulation are presented below:

Option 1: New Well Construction

- For this option, it is recommended that a new well should be drilled and the current well be decommissioned. It is recommended that a new well be installed to meet the following conditions:
  - The well should be equipped with a surface seal to at least 6 m and the casing should be extended above grade (500 mm) within a lockable enclosure that is inaccessible to animals and unauthorized personnel;
  - The well must be located at a distance greater than 30 m from any potential source of contamination, including the above ground storage tank and all parts of the septic system;
  - The water from the new well must meet all CDWQG health based guidelines. If there are any exceedences in the CDWQG health-based guidelines then a treatment system must be designed and installed as necessary. A disinfection system may be recommended.

Option 2: New Cluster Well Construction

- Option 2 presents the option of a cluster well installation to provide water supply to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall. The advantages would include combined savings on capital costs, reduced life cycle costs, added control and system security, and reduced maintenance requirements. For this option, it is assumed that a heated building enclosure would be constructed to house the well and treatment system.

10.7.3 Priority 3

- Ongoing monitoring of copper and lead concentrations.

10.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

10.8.1 Priority 1

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- Casing extension and well cap installation - **$600;**
- Re-plumb so that domestic comes off of piping prior to tank, and install double check valve for backflow protection - **$500;**
- Well and water system superchlorination - **$200;** and
- UV system installation with required pre-filtration - **$2,400.**

The estimate total cost for Priority 1 recommended upgrade is estimated at **$3,700** including materials and labour.

10.8.2 Priority 2

Option 1: New Well Construction

- The estimated cost for the Option 1 which includes the construction of a new well to serve the Fire Hall and Library building is approximately **$30,000** for drilling, testing and hook-up, assuming that the well would be approximately 30 m deep and constructed as described above.

Option 2: New Cluster Well Construction

- The estimated cost for Option 2, consisting of a cluster well installation to provide water supply from a central well to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall would be in the order of **$25,000** per system. This estimated capital cost includes supplies and labour for well construction, testing, treatment and distribution piping.

10.8.3 Priority 3

- It is assumed that the cost for ongoing monitoring would be included as routine sampling for ongoing water system operation.

11.0 BUILDING 3121: BEAVER CREEK VISITOR RECEPTION CENTRE

11.1 Description of Existing Water Supply System

Building 3121, the Beaver Creek Visitor Reception Centre (VRC) is currently served by a water supply system that delivers water from a well located in pit in the reception centre parking lot and is approximately 6 m from the building. The well location and other details about the surrounding area are provided in Figure 3121-A in Appendix A11. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6916712
- Easting: 506373

There is no treatment or disinfection system for the water supply to this building. A schematic detailing the well supply system is provided as Figure 3121-B in Appendix A11.

11.2 Description of Existing Wastewater Systems

There is a septic tank located south of the VRC approximately 18 m from the well. Septic effluent is discharged to ground via a septic field to the south of the tank approximately 33 m from the well. Conceptual hydrogeology (outlined in Section 10.4) indicates that the septic system is likely upgradient from the well. A site plan showing the septic system is given by Figure 3121-A in Appendix A11.

11.3 Water Quality Results

11.3.1 Water Quality Results from Previous Sampling

Bacteriological

Two samples were collected from the Beaver Creek Visitor Reception Centre water system between May and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3121-1 in Appendix A11. Coliform bacteria and *E. coli* were reported as absent in both samples for which results are provided.

Potability

Water samples were previously collected from the Beaver Creek VRC water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in

Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3121-2 in Appendix A11. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination as follows:

- The water quality results indicated that all health based and aesthetic objectives were met for the parameters analyzed;
- Though they did not exceed the CDWQG aesthetic objectives, chloride and nitrate concentrations were found to be elevated with respect to general groundwater quality in the Beaver Creek area;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 335 mg/L during the first sampling event and 346 mg/L during the second sampling event and is considered very hard.

11.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Beaver Creek VRC that was identified to be included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC);
- As nitrates and chlorides were found to be elevated, samples were taken to test for nutrients and indicators of potential surfacewater or septic sources including chloride, nitrate, nitrite, and ammonia; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 27, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3121-2 in Appendix A11 and the laboratory reports are included in Appendix B.

- The chloride concentration was 29.5 mg/L, which is elevated with respect to the general groundwater quality in the Beaver Creek area;

- The nitrate concentration was 5.17 mg/L, which is elevated with respect to the general groundwater quality in the Beaver Creek area; and
- The water quality results from additional analytical sampling indicated that all other health based and aesthetic objectives were met for the parameters analyzed.

11.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be 23.7 mg/L during the first sampling event, 32.7 mg/L during the second sampling event, and 29.5 mg/L during the most recent sampling event. Chloride concentrations were above the normal background ranges for groundwater in the area. Nitrate concentrations were reported to be 2.9 mg/L during the first sampling event, 4.95 mg/L during the second sampling event, and 5.17 mg/L during the most recent sampling event. Nitrate concentrations were above the normal background ranges for groundwater in the area. These water quality results suggest that the aquifer from which the groundwater is obtained for the Beaver Creek VRC may be under the influence of surfacewater sources or septic wastes.

11.4 Conceptual Hydrogeology

There is no log available for this well. Most of the wells in the Beaver Creek area indicate coarse sand and gravel with cobbles and small boulders to depths of at least 30 m. The well logs also indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The variability of sediments in the Beaver Creek area indicates limited aquifer protection from surficial sources of contamination. A study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

11.5 Potential Contaminant Sources

Potential contaminant sources identified during the water system assessment are compiled in field notes in Appendix A11. Photos of potential contaminant sources are also provided in Appendix A11.

Potential contaminant sources within 30 m of the wellhead are:

- An above ground fuel storage tank (AST) at 19 m.

The wellhead is located in the parking lot at the visitor reception centre, and is potentially subject to fuel and/or sewage spills from automobiles and recreational vehicles. The Alaska Highway (19 m) has also been identified as a potential contaminant source. The closest location of effluent discharge with respect to the well is a septic field located 33 m upgradient from the wellhead.

11.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

11.6 Identified Water System Deficiencies and Associated Risk

11.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in a pit below grade);
- Poor location of the well (located in the reception centre parking lot where it may be subject to fuel and sewage spills from automobiles and recreational vehicles);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because the depth of the well is unknown and the well construction does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential sources of contamination, including an above ground fuel storage tank at 19 m and an active parking lot;
- The septic system is for the visitor reception centre is located upgradient from the well. The nearest point of the effluent discharge field is 33 m upgradient;
- Water quality results report elevated concentrations of nitrates and chlorides, and may indicate that the aquifer from which ground water is obtained for this site is under the influence of surfacewater or septic sources. A likely source is the septic system directly upgradient from the well; and,
- There is no treatment or disinfection system.

11.6.2 Low Risk Deficiencies

- The pump control system is not up to standards; and,
- The pressure switch is located too far away from the pressure tank.

11.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

11.7.1 Priority 1

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the VRC. Priority 1 remedial recommendations include:

- The casing should be extended to at least 500 mm above the base of the well pit, and a localized near surface bentonite seal installed immediately around the wellhead, while leaving the remainder of the base of the well pit for drainage;
- The well and water system should be superchlorinated; and
- A disinfection treatment consisting of filtration to 1 micron absolute, and a UV system that is NSF/ANSI certified should be installed. Pretreatment (softening) will likely be required. This is a conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

11.7.2 Priority 2

Priority 2 upgrade options to mitigate long-term risk and meet the proposed regulation are presented below:

<u>Option 1: New Well Construction</u>

- For this option, it is recommended that a new well should be drilled and the current well be decommissioned. It is recommended that a new well be installed to meet the following conditions:
  - o The well should be equipped with a surface seal to at least 6 m and the casing should be extended above grade (500 mm) within a lockable enclosure that is inaccessible to animals and unauthorized personnel;

- The well must be located at a distance greater than 30 m from any potential source of contamination, including the above ground storage tank and all parts of the septic system;
- The water from the new well must meet all CDWQG health based guidelines. If there are any exceedences in the CDWQG health-based guidelines then a treatment system must be designed and installed as necessary. A disinfection system may be recommended.

Option 2: New Cluster Well Construction

- Option 2 presents the option of a cluster well installation to provide water supply to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall. The advantages would include combined savings on capital costs, reduced life cycle costs, added control and system security, and reduced maintenance requirements. For this option, it is assumed that a heated building enclosure would be constructed to house the well and treatment system.

11.7.3 Priority 3

- Priority 3 deficiencies would be mitigated with Priority 2 upgrades.

11.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

11.8.1 Priority 1

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- Casing extension and well cap installation - **$600;**
- Re-plumb so that domestic comes off of piping prior to tank, and install double check valve for backflow protection - **$500;**
- Well and water system superchlorination - **$200;** and
- UV system installation with required pre-filtration - **$2,400.**
- Softener system for pre-treatment **- $2,000.**

The estimated total cost for Priority 1 recommended upgrades is estimated at **$3,900** including materials and labour.

11.8.2 Priority 2

Option 1: New Well Construction

- The estimated cost for the Option 1 which includes the construction of a new well to serve the Fire hall and Library building is approximately **$30,000** for drilling, testing and hook-up, assuming that the well would be approximately 30 m deep and constructed as described above.

It is recommended that the existing well be kept plumbed in to the fire storage tanks for back-up water supply.

Option 2: New Cluster Well Construction

- The estimated cost for Option 2, consisting of a cluster well installation to provide water supply from a central well to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall would be in the order of **$25,000** per system. The estimated capital costs include supplies and labour for well construction, testing, treatment and distribution piping.

It is recommended that the existing well be kept plumbed in to the fire storage tanks for back-up water supply.

12.0 BUILDING 3122: BEAVER CREEK SWIMMING POOL

12.1 Description of Existing Water Supply System

Building 3122, the Beaver Creek Swimming Pool, is currently served by a water supply system that delivers water from a 19.2 m deep well. The well is located in an underground enclosure directly adjacent to the nearby Beaver Creek Community Club building, which is served by the same well. The well location and other details about the surrounding area are provided in Figure 3122-A in Appendix A12. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6916774
- Easting: 506150

There is no treatment or disinfection system for the water supplying this system. A schematic detailing the well supply system is provided as Figure 3122-B in Appendix A12.

12.2 Description of Existing Wastewater Systems

The septic tank that serves the community club is located south of the building approximately 20 m from the well and the effluent field is located to the south of the tank approximately 22 m from the well. The septic tank that serves the swimming pool is located to the east of the building and effluent is discharged in a septic field to the south of the tank. The swimming pool septic system is approximately 50 m from and likely downgradient from the well, but the community club septic system is likely up or cross gradient from the well. A site plan showing the septic systems is given by Figure 3122-A in Appendix A12.

12.3 Water Quality Results

12.3.1 Water Quality Results from Previous Sampling

Bacteriological

One sample was collected from the Beaver Creek Swimming Pool water system in June 2005 and was tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3122-1 in Appendix A12. Coliform bacteria and *E. coli* were reported as absent in the sample.

Potability

Water samples were previously collected from the Beaver Creek Swimming Pool water system on June 15, 2005. The samples were submitted to ALS Environmental in Vancouver, BC for analyses included in their drinking water package. The results of these analyses are summarized in Table 3122-2 in Appendix A12. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination.

- The water quality results indicated that all health based and aesthetic objectives were met for the parameters analyzed;
- At 0.432 mg/L, the copper concentration is elevated above the normal copper concentrations in groundwater for the Beaver Creek area;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 194 mg/L, and is considered very hard.

12.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Beaver Creek Pool that was identified to be included during the water system assessments is detailed below:

- A sample was taken to retest for turbidity;
- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 27, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3122-2 in Appendix A12 and the laboratory reports are included in Appendix B. The water quality results from additional analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

12.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the Beaver Creek area. Nitrate and nitrite concentrations for this sample were also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the Beaver Creek Swimming Pool is under the influence of surfacewater sources or septic wastes.

12.4 Conceptual Hydrogeology

The log for this well indicates that the well is completed at a depth of 19.2 m within a gravel aquifer. The lithology indicates mostly gravel with some interbedded fine grained material from 2.4 to 5.4 m. This is consistent with most well logs in the area, which indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The limited presence of fine grained material indicates that this well is most likely completed within a unconfined or semi- confined aquifer with limited protection from surficial sources of contamination. A study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

12.5 Potential Contaminant Sources

Potential contaminant sources from observations made during the water system assessment are compiled in field notes in Appendix A12. Photos of potential contaminant sources are also provided in Appendix A12.

Potential contaminant sources within 30 m of the wellhead are:

- An above ground fuel storage tank (AST) at 20 m; and
- A septic field located at 22 m.

12.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

12.6 Identified Water System Deficiencies and Associated Risk

12.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in a pit below grade);
- There is no surface sanitary seal (grout or bentonite seal) as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it does not meet the requirements of the Guidelines for Water Well Construction.
- The well is located within 30 m of potential sources of contamination, including an above ground fuel storage tank at 20 m and a septic discharge field at 22 m, both of which are upgradient from the well; and,
- There is no treatment or disinfection system present.

12.6.2 Low Risk Deficiencies

- The copper concentration is elevated above normal background concentrations for the Beaver Creek area, and may signify leaching from copper pipes; and,
- It was observed during the water system assessment that two of the pressure tanks are leaking slightly.

12.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

12.7.1 Priority 1

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the Beaver Creek Pool and Community Hall. Priority 1 remedial recommendations include:

- The casing should be extended to at least 500 mm above the base of the well pit, and a localized near surface bentonite seal installed immediately around the wellhead, while leaving the remainder of the base of the well pit for drainage.
- The well and water system should be superchlorinated.
- Disinfection treatment consisting of filtration to 1 micron absolute, and a proportional feed chlorination system with retention tanks and necessary appurtenances should be installed. These are conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

12.7.2 Priority 2

Priority 2 upgrade options to mitigate long-term risk and meet the proposed regulation are presented below:

Option 1: New Well Construction to Serve Community Hall and Pool

- For this option, it is recommended that a new well should be drilled and the current well be properly decommissioned. There is no potential well location on the site that complies with recommended setback distances, therefore, it makes sense to drill to the west of the community centre to obtain a water supply for both buildings. The existing plumbing between the Community Centre and Pool could be utilized. It is recommended that the new well be installed to meet the following conditions:
  - The well should be equipped with a surface seal to at least 6 m and the casing should be extended above grade (500 mm) within a lockable enclosure that is inaccessible to animals and unauthorized personnel;
  - The well must be located at a distance greater than 30 m from any potential source of contamination, including the AST and all parts of the septic system; and
  - The water from the new well must meet all CDWQG health based guidelines. If there are any exceedences in the CDWQG health-based guidelines then a treatment system must be designed and installed as necessary.

Option 2: New Cluster Well Construction

- Option 2 presents the option of a cluster well installation to provide water supply to the School, Community Hall and Pool. The advantages would include combined savings on capital costs, reduced life cycle costs, added control and system security, and reduced maintenance requirements.

12.7.3 Priority 3

- Copper concentrations should be monitored as part of routine operation and maintenance.
- The pressure tanks should be replaced with an adequately sized bladder pressure tank during Phase 2 upgrades.

12.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

12.8.1 Priority 1

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- Casing extension and well cap installation **- $700;**
- Well and water system superchlorination **- $200;** and,
- Filtration to 1 micron absolute and a proportional chlorine system with retention tanks- **$8,500.**

The estimate total cost for Priority 1 recommended upgrades are estimated at **$9,400** including materials and labour.

12.8.2 Priority 2

Option 1: New Well Construction

- The estimated cost for the Option 1 which includes the construction of a new well to serve the Pool and Community Centre is approximately **$32,400** for drilling, testing and hook-up, assuming that the well would be approximately 30 m deep and constructed as described above.

  It is recommended that the existing well be kept plumbed in to the fire storage tanks for back-up water supply.

Option 2: New Cluster Well Construction

- The cost for construction of a cluster well that would serve the recreational hall and pool, assuming that the well would be constructed to meet the proposed regulations, and would be 30 m deep, and including 80 m of distribution piping would cost approximately **$17,400** including half of the drilling costs and the costs for distribution to the Community Centre. The existing water line between the Community Centre and the pool would be utilized.

12.8.3 Priority 3

- The cost for routine monitoring of copper concentrations should be included under operation and maintenance costs; and
- Upgrades to the plumbing system, pressure tank and pump controls are covered with Priority 2 costs.

13.0 BUILDING 3123: BEAVER CREEK GRADER STATION

13.1 Description of Existing Water Supply System

Building 3123, the Beaver Creek Grader Station maintenance garage, is currently served by a water supply system that delivers water from a 32.8 m deep well. The well is located in a pit at the northeast end of the grader station. The well location and other details about the surrounding area are provided in Figure 3123-A in Appendix A13. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6916580
- Easting: 506318

There is an inline filter (5 micron cartridge) present, but there is otherwise no treatment or disinfection system for the water supplying the grader station maintenance garage. A schematic detailing the well supply system is provided as Figure 3123-B in Appendix A13.

13.2 Description of Existing Wastewater Systems

There is a septic tank present at the southeast corner of the building approximately 20 m from the well. Septic effluent is discharged to an in ground disposal field south of the tank approximately 34 m from the well and potentially upgradient of the well. There is a rock pit that is used to drain the garage sumps located approximately 34 m south that is also potentially up gradient from the well. There is also an old abandoned septic tank and field approximately 22 m north and likely downgradient from the well. A site plan showing the septic system is provided as Figure 3123-A in Appendix A13.

13.3 Water Quality Results

13.3.1 Water Quality Results from Previous Sampling

Bacteriological

Eight samples were collected from the Beaver Creek Grader Station water system between October 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3123-1 in Appendix A13. Coliform bacteria and *E. coli* were reported as absent in each of the eight samples for which results are provided.

Potability

Water samples were previously collected from the Beaver Creek Grader Station water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3123-2 in Appendix A13. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination. Details are summarized below:

- The water quality results indicated that all health based and aesthetic objectives were met for the parameters analyzed;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 97.3 mg/L during the first sampling event, and is considered moderately hard. During the second sampling event the hardness (as $CaCO_3$) was 152 mg/L, and is considered very hard.

13.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Beaver Creek Grader Station maintenance building that was identified to be included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC);
- Extractable Petroleum Hydrocarbons (EPH) and Polycyclic Aromatic Hydrocarbons (PAH) to determine if there are any indications of hydrocarbon contamination; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 27, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3123-2 in Appendix A13 and the laboratory reports are included in Appendix B. The following items are of note:

- EPH and PAH concentrations were below analytical detection limits; and,
- The water quality results from additional analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

13.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample were low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the Beaver Creek Grader Station is under the influence of surfacewater sources or septic wastes.

13.4 Conceptual Hydrogeology

The log for this well indicates that the well is completed at a depth of 32.8 m within a fine sand and gravel aquifer. The well lithology indicates the presence of variable interbedded fine grained material from 11.6 to 29.6 m. This is consistent with the lithology for most wells in the Beaver Creek area which typically indicate coarse sand and gravel with cobbles and small boulders to depths of at least 30 m. The well logs also indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The interbedded nature of the fine sediments which persist in the area provides limited aquifer protection from surficial sources of contamination. A study previously completed in the Beaver Creek area by EBA determined that the direction of groundwater flow in the vicinity of the site is north to northeasterly.

13.5 Potential Contaminant Sources

Potential contaminant sources from observations during the water system assessment are compiled in field notes in Appendix A13. Photos of potential contaminant sources are also provided in Appendix A13.

Potential contaminant sources within 30 m of the wellhead are:

- An underground fuel storage tank (UST) at 22 m;
- An above ground used oil EnviroTank (AST) at 7 m;

- A cold mix asphalt mix pile at 7.5 m;
- An abandoned septic field located at 22m.

In addition, industrial activities take place in close proximity to the well. There is also a rock pit located approximately 34 m away from the wellhead. Various scrap metal and parts are located around the site. The current septic field (in use) is located 34 m away and upgradient from the well.

13.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

13.6 Identified Water System Deficiencies and Associated Risk

13.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the well (located in a PWF wooden enclosure and casing only extends 100 mm above grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential sources of contamination, including an above ground used oil storage tank at 7 m and an asphalt cold mix pile at 8 m;
- There is a former rock pit or septic leach pit located 22 m upgradient from the well;
- It was reported by grader station employees that there had previously been a break in the septic line or discharge line to the rock pit (they were unsure which) within 30 m of the well; and,
- There is no treatment or disinfection system.

13.6.2 Low Risk Deficiencies

- There were no low-risk deficiencies identified for this site. All deficiencies are considered either high or medium risk.

13.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

13.7.1 Priority 1

Additional assessment would be prudent to confirm the location of the leak in the septic or rock pit discharge line, and to repair the leak as required. As well, to mitigate immediate risk issues, it is recommended that the following be completed:

- Superchlorinate the well and water system, and install a chlorination tap at the wellhead for future disinfection; and,
- Install a properly sized NSF/ANSI 55 certified UV system with a 5 micron pre-filter (NSF 61). These are conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

13.7.2 Priority 2

Several options have been presented for consideration for Priority 2 upgrades to mitigate longer-term risks.

Option 1: Upgrade Existing Well and Relocate Potential Contaminant Sources

To rehabilitate the existing well, and ensure that it provides safe drinking water for the long-term, it is recommended that the following work be completed:

- Standard wellhead upgrades to raise casing to at least 500 mm above grade and retrofit a surface sanitary seal (grout or bentonite as deep as possible);
- Relocate AST;
- Relocate UST;
- Relocate cold mix asphalt pile; and,
- Decommission former leach pit.

Option 2: Construct New Well to Serve Facility

This second option proposes that a new well be drilled to serve the facility, and that the existing well be properly decommissioned. It is recommended that the new well be installed to meet the following conditions:

- The well should be equipped with a surface seal to at least 6 m and the casing should be extended above grade (500 mm) within a lockable enclosure that is inaccessible to animals and unauthorized personnel;
- The well must be located at a distance greater than 30 m from any potential source of contamination, including the above ground storage tanks and all parts of the septic system;
- The water from the new well must meet all CDWQG health based guidelines. If there are any exceedences in the CDWQG health-based guidelines then a treatment system must be designed and installed as necessary.

Option 3: New Cluster Well Construction

Option 3 presents the alternative of a cluster well installation to provide water supply to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall. For this option, it is assumed that a heated building enclosure would be constructed to house the well and treatment system. Advantages of this option relative to the other options presented is that it would offer combined savings on capital costs, reduced life cycle costs, additional system security, and reduced maintenance requirements.

13.7.3 Priority 3

No Priority 3 mitigative options have been identified.

13.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

13.8.1 Priority 1

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- Install chlorination tap on wellhead - **$200**
- Well and water system superchlorination - **$200.**

- Filtration to 1 micron absolute filtration and UV disinfection system- **$3,000.**

The estimate total cost for Priority 1 recommended upgrade is estimated at **$3,400** including materials and labour.

13.8.2 Priority 2

Option 1: Wellhead Upgrades

Option 1 estimated costs are provided below:

- The estimated cost for standard wellhead upgrades is approximately **$5,000.**
- A Class D estimate of the cost to relocate all potential contaminant sources within 30 m of well would be in the order of **$15,000**.

Option 2: New Well Construction

The estimated cost for the Option 1 which includes the construction of a new well to serve the Pool and Community Centre is approximately **$30,000** for drilling, testing and hook-up, assuming that the well would be approximately 30 m deep and constructed as described above.

Option 3: New Cluster Well Construction

The estimated cost for Option 2, consisting of a cluster well installation to provide water supply from a central well to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall would be in the order of **$25,000** per system. The estimated capital costs include supplies and labour for well construction, testing, treatment and distribution piping.

14.0 BUILDING 3125: BEAVER CREEK AIR TERMINAL BUILDING

14.1 Description of Existing Water Supply System

Building 3125, the Beaver Creek Airport Terminal Building, is currently served by a water system that sources water from a well of unknown depth. The well is located in a pit approximately 2 m east of the terminal building. The well location and other details about the surrounding area are provided in Figure 3125-A in Appendix A14. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6919562
- Easting: 507085

There is no treatment or disinfection system for the water supplying this building. A schematic detailing the well water supply system is provided as Figure 3440-B in Appendix A14.

14.2 Description of Existing Wastewater Systems

A septic tank that serves the terminal building is located on the east side of the building approximately 5 m north of the tank. Effluent is discharged to an in ground sewage disposal system approximately 54 m northwest of the well. Conceptual hydrogeology for the area indicates that the effluent disposal field is likely downgradient from the well. A site plan showing the septic system is given by Figure 3125-A in Appendix A14.

14.3 Water Quality Results

14.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Beaver Creek Airport Terminal Building water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3125-1 in Appendix A14. *E. coli* bacteria were reported as absent in each of the nine samples for which results are provided, but one sample, taken November 17, 2004, tested positive for total coliform bacteria. More recent samples have not had Total coliform bacteria present.

Potability

Water samples were previously collected from the Beaver Creek Airport Terminal Building water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for analyses included in their drinking water packages. The results of these analyses are summarized in Table 3125-2 in Appendix A14. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify potential indicators of contamination.

- The turbidity was 4.1 NTU during the first sampling event and 3.29 NTU during the second sampling event. In both cases the turbidity was in exceedence of the CDWQG MAC of 1.0 NTU;
- Review of the water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- Review of the water quality results indicated that the groundwater is a calcium magnesium bi-carbonate sulphate type water; and,
- The hardness (as $CaCO_3$) was 137 mg/L during the first sampling event and 126 mg/L during the second sampling event, and is considered to be moderately hard.

14.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Beaver Creek Airport Terminal Building that was identified to be included during the water system assessments is detailed below:

- As turbidity was previously in exceedence of the CDWQG MAC, a sample was taken to re-test for turbidity;
- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC);
- EPH to determine if there are any signs of hydrocarbon contamination; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample obtained during the water system assessment on July 27, 2005 was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3125-2 in Appendix A14 and the laboratory reports are included in Appendix B.

- At 11.7 NTU, turbidity was in exceedence of the CDWQG MAC of 1.0 NTU;
- Concentrations of extractable petroleum hydrocarbons (EPH) were below analytical detection; and,
- All other health based and aesthetic objectives were met for the parameters analyzed.

14.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and can be considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample were also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the airport building is under the influence of surfacewater sources or septic wastes.

14.4 Conceptual Hydrogeology

There was no driller's well log available for review for this well. Most of the wells in the Beaver Creek area indicate coarse sand and gravel with cobbles and small boulders to depths of at least 30 m. The well logs also indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The variability of sediments in the Beaver Creek area indicates limited aquifer protection from surficial sources of contamination. A study had been previously completed in the Beaver Creek area by EBA, and it was determined that the direction of groundwater flow is north to northeasterly.

14.5 Potential Contaminant Sources

Potential contaminant sources from observations during the assessment are compiled in field notes in Appendix A14. Photos of potential contaminant sources are also provided in Appendix A14.

Potential contaminant sources within 30 m of the wellhead are:

- An above ground fuel storage tank (AST) at 5 m;
- Oil drums;
- Aircraft parking area;
- Vehicle parking area;
- Jet fuel storage area; and,
- Septic tanks located approximately 5 m from the well.

Additionally, septic discharge lines that run between the tank and the field are located within 10 m of the well and the septic field is approximately 54 m from the well.

14.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch identified that on April 30, 2004, 3 L to 5 L of diesel fuel spilled on the south side of the terminal building when a tank overfilled. It is considered unlikely that this impacted on the groundwater quality at the site. No other spill records or contaminated sites issues were identified for this site.

14.6 Identified Water System Deficiencies and Associated Risk

14.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in a pit below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential contaminant sources, including an above ground fuel storage at 5 m, aircraft and vehicle parking within 10 m, and oil and aviation fuel drum storage within 30 m;
- Although the septic field is located greater than 30 m likely downgradient from the well, the septic tank is located 5 m from the well which contravenes the proposed

Part III Small Public Drinking Water Guideline, and the existing Yukon Public Sewage Regulation which requires a 15 m setback;
- Total coliform bacteria were reported as present in one previous sampling event;
- Three independent sampling events reported turbidity to be above the CDWQG MAC. The most recent sampling event reported turbidity to be 11.7 NTU; and,
- There is no treatment or disinfection system present.

14.6.2 Low Risk Deficiencies

- There are no low-risk deficiencies associated with this site. All deficiencies are either high or medium risk.

14.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

14.7.1 Priority 1

Recommended Priority 1 upgrades to mitigate immediate risk to the Beaver Creek Airport water system are summarized below:
- Confirm depth of well;
- Superchlorinate well and water system;
- Install chlorine tap at wellhead for future disinfection;
- Install an appropriately sized filtration (to 1 micron absolute) and NSF/ANSI 55 certified UV disinfection system. Based on water quality data it appears that pretreatment to ensure proper UV operation will not be required. These are conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

14.7.2 Priority 2

Two potential options to mitigate potential long-term risk to the Beaver Creek Airport water system are presented below:

Option 1: Upgrade and Rehabilitate Well, Relocate Potential Contaminant Sources

The option of upgrading, rehabilitating and relocating potential contaminant sources is presented below:

- Camera well to determine well construction and condition;
- Chemically clean (pending camera investigation results);
- Standard wellhead upgrades consisting of a pitless unit installation, extending the casing to at least 500 mm above grade, and retrofitting of a surface sanitary seal (grout or bentonite to at least 3 m in depth);
- Relocate AST; and,
- Relocate septic tank.

Option 2: Construct New Well to Serve Airport Facility

This second option proposes that a new well be drilled to serve the airport, and that the existing well be properly decommissioned. It is recommended that the new well be installed to meet the following conditions:

- The well should be equipped with a surface seal to at least 6 m and the casing should be extended above grade (500 mm) within a lockable enclosure that is not inaccessible to animals and unauthorized personnel;
- The well must be located at a distance greater than 30 m from any potential source of contamination, including the above ground storage tanks and all parts of the septic system;
- The water from the new well must meet all CDWQG health based guidelines. If there are any exceedences in the CDWQG health-based guidelines then a treatment system must be designed and installed as necessary.

14.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

14.8.1 Priority 1

Priority 1 costs are summarized below:

- The estimated cost for labour to superchlorinate the well and water system is approximately **$200**;
- Installation of a chlorine tap at wellhead for future disinfection would cost approximately **$200**;

- It is estimated that the installation of an appropriately sized NSF 61 filtration system (to 1 micron absolute) and an NSF/ANSI 55 certified UV disinfection system would cost **$3,000.**

14.8.2 Priority 2

Priority 2 costs for each option presented above are as follows:

Option 1: Upgrade and Rehabilitate Well, Relocate Potential Contaminant Sources

Option 1 estimated costs are provided below:

- The estimated cost for standard wellhead upgrades is approximately **$5,000;**
- The estimated cost to camera, redevelop and clean the well is **$3000**; and,
- A Class D estimate of the cost to relocate all potential contaminant sources within 30 m of well would be in the order of **$15,000**.

Option 2: Construct New Well to Serve Airport Facility

The estimated cost for the Option 1 which includes the construction of a new well to serve the Airport Terminal Building is approximately **$30,000** for drilling, testing and hook-up, assuming that the well would be approximately 30 m deep and constructed as described above.

The existing treatment system (Priority 1) would be utilized for water system disinfection for each of the options presented above.

15.0 BUILDING 3964: BEAVER CREEK HEALTH CENTRE

15.1 Description of Existing Water Supply System

Building 3964, the Beaver Creek Health Centre, is currently served by a water supply system that delivers water from a well of unknown depth. The well is located in a pit approximately 3 m east of the health centre. The well location and other details about the surrounding area are provided in Figure 3964-A in Appendix A15. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6916660
- Easting: 506315

There is no treatment or disinfection system for the water supplying this site. A schematic detailing the well supply system is provided as Figure 3964-B in Appendix A15.

15.2 Description of Existing Wastewater Systems

Septic effluent is discharged to a septic system on the west side of the health centre. The septic tank is located approximately 20 m northwest of the well. The exact location of the septic field is unknown, however, it is likely that it is within 30 m of the well. Conceptual hydrogeology indicates that the septic system is likely cross-gradient from this well. There is also an abandoned septic tank or rock pit approximately 45 m south of the well on the Beaver Creek Grader Station property, and a septic field serving the Visitor Reception Centre approximately 42 m northeast and downgradient from the well. A site plan showing the existing wastewater system is given by Figure 3964-A in Appendix A15.

15.3 Water Quality Results

15.3.1 Water Quality Results from Previous Sampling

Bacteriological

Ten samples were collected from the Beaver Creek Health Centre water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3964-1 in Appendix A15. Both *E. coli* and Total Coliform were reported as absent in each of the ten samples for which results are provided.

Potability

Water samples were previously collected from the Beaver Creek Health Centre water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for analyses included in their drinking water packages. The results of these analyses are summarized in Table 3964-2 in Appendix A14. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify potential indicators of contamination as detailed below:

- During the first sampling event turbidity was 1.6 NTU, in exceedence of CDWQG MAC of 1.0 NTU. Turbidity at the time of the second sampling event, however, was less than the CDWQG MAC;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 234 mg/L during the first sampling event and 255 mg/L during the second sampling event, and is considered very hard.

15.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Beaver Creek Health Centre that was identified to be included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 29, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3964-2 in Appendix A15 and the laboratory reports are included in Appendix B. The water quality result from additional analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

15.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Nitrate and nitrite concentrations were reported to be low and within the normal background range for the area. Chloride concentrations, although were not in exceedence of the CDWQG aesthetic objective, were elevated above normal background concentrations in the Beaver Creek area. Water quality results suggest that the aquifer from which the groundwater is obtained for the Beaver Creek Health Centre may be under the influence of surfacewater sources or septic wastes. It should also be noted that a well on an adjacent property at the Beaver Creek Visitor Reception Centre had reported both chlorides and nitrates elevated above normal background concentrations for the area.

15.4 Conceptual Hydrogeology

There is no log available for review for this well. Most of the wells in the Beaver Creek area indicate coarse sand and gravel with cobbles and small boulders to depths of at least 30 m. The well logs also indicate that discontinuous lenses of finer-grained sediments persist throughout the area, but in general the sediments are dominated by coarse alluvium. Some discontinuous permafrost is also interpreted to persist throughout the Beaver Creek area. The variability of sediments in the Beaver Creek area indicates limited aquifer protection from surficial sources of contamination. A study had been previously completed in the Beaver Creek area by EBA, and it was determined that the direction of groundwater flow is north to northeasterly.

15.5 Potential Contaminant Sources

Potential contaminant sources from observations during the water system assessment are compiled in field notes in Appendix A15. Photos of potential contaminant sources are also provided in Appendix A15.

Potential contaminant sources within 30 m of the wellhead are:

- An effluent discharge field as close as 18 m (exact location unknown);
- An indoor fuel storage tank at 20 m;
- Various fuel, oil and paint drums on the Grader Station property at 20 m.

In addition, an asphalt mix pile is located approximately 40 m south from the wellhead on the Grader Station property.

15.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

15.6 Identified Water System Deficiencies and Associated Risk

15.6.1 High and Medium Risk Deficiencies

High and medium risk deficiencies are summarized as follows:

- Poor surface completion of the wellhead (located in a pit below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential sources of contamination, including a fuel storage tank at approximately 20 m and fuel, oil, and paint drums at 20 m;
- The closest point of the effluent discharge field for the health centre is likely 18 m cross gradient from the well;
- Water quality reported chloride above normal background concentrations for the area, and suggest that the well may potentially be under the influence of surfacewater or septic sources; and,
- There is no treatment or disinfection system.

15.6.2 Low Risk Deficiencies

- The heat trace as not been installed to code. There is no thermostat, no ground fault indicator (GFI), and the heat trace does not appear to be working properly;
- There is no pressure gauge on the system; and,
- There was a previous exceedence of turbidity.

15.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

15.7.1 Priority 1

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the Beaver Creek Health Centre Building. Priority 1 remedial recommendations include:

- The casing should be extended to at least 500 mm above the base of the well pit, and a localized near surface bentonite seal installed immediately around the wellhead, while leaving the remainder of the base of the well pit for drainage.
- The well and water system should be superchlorinated.
- Disinfection treatment consisting of filtration to 1 micron absolute, and a UV system that is NSF/ANSI certified should be installed. Pretreatment will likely be required for proper UV performance. Alternatively, a proportional feed chlorination system with retention tanks and appurtenances could be installed. These are conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

15.7.2 Priority 2

Priority 2 upgrade options to mitigate long-term risk and meet the proposed regulation are presented below:

<u>Option 1: New Well Construction</u>

For this option, it is recommended that a new well should be drilled and the current well be decommissioned. It is recommended that a new well be installed to meet the following conditions:

- The well should be equipped with a surface seal to at least 6 m and the casing should be extended above grade (500 mm) within a lockable enclosure that is not inaccessible to animals and unauthorized personnel;
- The well must be located at a distance greater than 30 m from any potential source of contamination, including the above ground storage tank and all parts of the septic system;
- The water from the new well must meet all CDWQG health based guidelines. If there are any exceedences in the CDWQG health-based guidelines then a treatment system must be designed and installed as necessary. A disinfection system may be recommended.

<u>Option 2: New Cluster Well Construction</u>

Option 2 presents the option of a cluster well installation to provide water supply to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall. The advantages would include combined savings on capital costs, reduced life cycle costs, added control and system security, and reduced maintenance requirements. For this option, it is assumed that a heated building enclosure would be constructed to house the well and central treatment system.

15.7.3 Priority 3

Priority 3 upgrades include:

- Install pressure guage on system if option 1 of Priority 2 is chosen. Consider completing this at the same time as Priority 2 upgrades.

15.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

15.8.1 Priority 1

The exact location of the septic field should be confirmed.

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- Casing extension and localized sanitary surface seal - **$600**;
- Well and water system superchlorination - **$200**; and,
- UV system installation with required pre-filtration and softener pre-treatment - **$5,400.** Alternatively, a proportional feed chlorination system with retention tanks and appurtenances could be installed for approximately **$7,000.**

The total cost for Priority 1 recommended upgrade is estimated at **$3,400** including materials and labour.

15.8.2 Priority 2

Since the well is likely within 30 m of the septic field, and elevated chloride may indicate that there is potential influence of surfacewater or septic waste, it is recommended for the long-term that a new water source be obtained. Two options are presented below:

Option 1: New Well Construction

The estimated cost for the Option 1 which includes the construction of a new well to serve the Health Centre building is approximately **$30,000** for drilling, testing and hook-up, assuming that the well would be approximately 30 m deep and constructed as described above.

Option 2: New Cluster Well Construction

The estimated cost for Option 2, consisting of a cluster well installation to provide water supply from a central well to the Grader Station, Health Centre, Visitor Reception Centre and Fire Hall would be in the order of **$25,000** per system. The estimated capital costs include supplies and labour for well construction, testing, treatment and distribution piping.

16.0 BUILDING 3201: BURWASH LANDING AIRPORT BUILDING

16.1 Background and Description of Existing Water Supply System

Building 3201, the Burwash Landing Airport Building, is currently served by a water supply system that delivers water from a 10.5 m deep well. The well is located outside in a wooden enclosure adjacent to the airport building. At the time of the assessment, the well was not equipped with a proper watertight and vermin-proof cap. The well location and other details about the surrounding area are provided in Figure 3201-A in Appendix A16. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6805564
- Easting: 605217

There is no treatment or disinfection system for the water supplying this system. A schematic detailing the well water supply system is provided as Figure 3201-B in Appendix A16.

16.2 Description of Existing Wastewater Systems

The septic tank that serves this building is located east of the building approximately 23 m southeast of the well. Septic effluent is discharged to the southeast of the tank approximately 40 m from the well. A site plan showing the septic system is given by Figure 3201-A in Appendix A16.

Reportedly the former septic system consisted of a septic holding tank within the basement of the building. The tank reportedly discharged through a pipe across the existing driveway. According to Nick Barnett, PMA, the sewer discharge pipe was found to be broken and leaking at a location beneath the driveway (Personal Comm., Nick Barnett).

16.3 Water Quality Results

16.3.1 Water Quality Results from Previous Sampling

Bacteriological

Eleven samples were collected from the Burwash Landing Airport building water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3201-1 in Appendix A16. Two out of the eleven samples reported positive results for total coliform bacteria.

Reportedly, an additional water sample collected from the system on July 14th, 2005 also tested positive for Total Coliform Bacteria (Personal Comm., Nick Barnett). We understand that this system is currently under a boil water advisory, and signs are posted.

Potability

Water samples were previously collected from the Burwash Landing Airport Building water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3201-2 in Appendix A16. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination as follows:

- During the first sampling event the copper concentration was 1.12 mg/L, which is in exceedence of the CDWQG MAC of 1.0 mg/L. The copper concentration during the second sampling event was 0.793 mg/L, which, although is not in exceedence of the CDWQG MAC, is elevated;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- Chloride and nitrate concentrations, although were not in exceedence of CDWQG aesthetic objectives, were found to be elevated and may indicate influence by surfacewater or septic sources;
- The water quality results indicated that the groundwater from which this system receives its water supply is a calcium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 334 mg/L during the first sampling event and 329 mg/L during the second sampling event, and is considered very hard.

16.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Burwash Landing Airport Building that was identified to be included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;

- Total organic carbon (TOC);
- As the copper concentration had previously exceeded the CDWQG MAC, samples were taken for total and dissolved copper;
- Since there was evidence of elevated chloride and nitrate, samples were taken to analyze for nitrate, nitrite, chloride, and ammonia;
- Extractable Petroleum Hydrocarbons (EPH) to determine if there are any signs of hydrocarbon contamination; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 28, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3201-2 in Appendix A16 and the laboratory reports are included in Appendix B. Details are:

- Additional analytical sampling reported that the nitrate concentration was elevated with respect to expected background concentrations for the Burwash Landing area;
- The concentration of total copper in the water was reported to have been 0.645 mg/L, and the reported concentration of dissolved copper was 0.647 mg/L. Although the copper concentration was not in exceedence of the CDWQG MAC of 1.0 mg/L, it was elevated and very close to the MAC; and,
- The EPH screening did not indicate any petroleum hydrocarbons above detection limits.

16.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Nitrate concentrations for this sample were reported in three independent sampling events to be elevated above expected background concentrations for the Burwash area. Reported nitrate concentrations are not likely within the normal background range for this area. There were also two bacteriological results from between September 2004 and June 2005 that had reportedly tested positive for total coliform. Chloride concentrations were slightly elevated, in the range of 5 mg/L for the three sampling events, and are likely above background chloride concentrations for the region. Considering that water quality results show elevated nitrates and chlorides, and also positive total coliform results, indicators of potential contamination would suggest that the aquifer from which the groundwater is obtained for the Burwash Landing Airport Building may be under the influence of surfacewater sources or septic wastes.

The closest point of the existing septic field is approximately 40 m downgradient from the well, and although the septic tank and sewer service lines are within 30 m of the well, it is not likely that this is the cause of high nutrients in the water system. One potential cause of the elevated nitrates and chlorides is the poor surface completion of the well. The well is located in a wooden enclosure containing fiberglass insulation. This type of enclosure is especially subject to inhabitation by rodents. At the time of the water system assessment there were mouse feces and other evidence of rodents in the wellhead enclosure. The well is also equipped with a jet pump rather than a submersible pump. Because of the depth of the well it was required that two drop pipes be installed as opposed to only one. Having two drop-pipes in the well makes it difficult to find a proper double-holed well cap to install on the well casing, and likely due to this, there was no well cap present. Because the well is open without a cap on the casing, and because the wellhead enclosure is constructed in a manner such that it is appealing to rodents for habitation, it is likely that the well is subject to animals and animal feces falling directly into the well. It is possible that the elevated nitrate and chloride concentration, as well as the positive bacteriological results for total coliform, is being caused by fecal matter and/or decaying rodent carcasses in the well.

Another potential cause of elevated chloride and nitrate may be resulting from the former leak of the sewer discharge pipe. We understand that this leak was repaired in 1989 and a new in-ground sewage disposal system was installed.

16.4 Conceptual Hydrogeology

There is no log available for this well. Most wells in the Burwash area are completed in a 30 m to 50 m deep confined aquifer. The general lithology of the area indicates 30 m to 50 m of fine grained sediments overlying the aquifer, discontinuous permafrost has also been identified. The well is completed at a depth of 10.51 m with a static water level 8.55 m below grade. Unlike most wells in the Burwash area, this well is most likely completed in an unconfined aquifer located in permeable sediments interbedded within the fine grained, surficial material. The shallow depth of the aquifer and probable lack of a confining layer make it somewhat susceptible to surficial sources of contamination. Groundwater flow direction in the vicinity is likely north towards Kluane Lake.

16.5 Potential Contaminant Sources

Potential contaminant sources from observations during the site investigation are compiled in field notes located in Appendix A16. Photos of potential contaminant sources are also provided in Appendix A16.

Potential contaminant sources within 30 m of the wellhead include:

- One above ground fuel storage tank (AST); and,
- An abandoned well located beside the existing well.

In addition, there is a septic tank located approximately 23 m away from the wellhead, a septic field is located at 40 m. There is also a bulk fuel storage area located approximately 80 m southeast and crossgradient from the well.

16.5.1 Spills Records and Contaminated Sites Search Results

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any recorded spill events or contaminated sites issues for this site or neighbouring sites.

16.6 Identified Water System Deficiencies and Associated Risk

16.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the well (located in a wooden enclosure with fiberglass insulation, wellhead is open, subject to access by rodents and rodent feces, wellhead is at grade). Note that the wellhead was temporarily sealed with plastic and tape, however, this is not considered to be an adequate long-term solution;
- There is no surface sanitary seal;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it is a vulnerable type (unconfined aquifer), has a production zone less than 15 m below grade, and does not meet the requirements of the Guidelines for Water Well Construction;
- There are at least three bacteriological results that reported positive total coliform within the past year;
- Water quality results indicated elevated (above expected background concentrations) nitrates and chlorides, suggesting that there may be impact of this shallow aquifer from septic or surface sources of contamination;

- There is a previous exceedence of the CDWQG MAC for copper. Most recent result is not above MAC, but is elevated above expected background concentrations;
- Well is located within 30 m of potential sources of contamination, including an above ground fuel storage tank at 8 m and an abandoned well at 1 m from the current well;
- The well is a shallow well and is likely completed in an unconfined aquifer that is susceptible to surface sources of contamination; and,
- There is no treatment or disinfection.

16.6.2 Low Risk Deficiencies

- There are no low-risk deficiencies associated with this site. All deficiencies are considered either high or medium risk.

16.7 Mitigative Options for Deficiencies

Following the high-risk deficiencies identified by EBA at the time of the water system assessment, PMA retained EBA to coordinate the drilling, construction and testing of a new well to serve the Burwash Landing Airport Building. The construction of the well is documented in a report to PMA entitled "Well Completion Report- Burwash Landing Airport Terminal Building" (EBA, 2005). Included in this report are recommendations pertinent to maintaining the safety of the new water supply well. All deficiencies presented in the above report were addressed through the drilling of a new well, and through decommissioning of the old wells. Therefore, mitigative options and associated costs to address former deficiencies have not been included in this final report.

The new well is currently temporarily connected with above ground piping. Once the ground has thawed, it would be prudent to re-plumb the well and install piping with adequate freeze-protection below grade. It is estimated that the cost to complete the well hook-up will be in the order of **$5,000**. It is also recommended that an NSF/ANSI approved UV disinfection system be installed (Priority 2) in keeping with the multi barrier approach. This system would cost in the order of **$2,200** installed.

17.0 BUILDING 3204: BURWASH LANDING FIRE HALL

17.1 Description of Existing Water Supply System

Building 3204, the Burwash Landing Fire Hall, is currently served by a water supply system that delivers water from an approximately 39.2 m deep well. The well is located in an enclosure off from the fire hall. The well location and other details about the surrounding area are provided in Figure 3204-A in Appendix A17. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6804037
- Easting: 607068

There is no treatment or disinfection system for the water supplying this system. The water system splits to serve the domestic system and the fire truck fill. There are two approximately 5000 L water storage tanks to store water used for fire fighting. A schematic detailing the water supply system is provided as Figure 3204-B in Appendix A17.

17.2 Description of Existing Wastewater Systems

The building is equipped with a sewage eduction tank located to the east of the fire hall. The eduction tank is approximately 15 m east and likely downgradient from the well. A site plan showing the septic system is given by Figure 3204-A in Appendix A17.

17.3 Water Quality Results

17.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Burwash Landing Fire Hall water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3204-1 in Appendix A17. Coliform bacteria and *E. coli* were reported as absent in each of the nine samples for which results are provided.

Potability

Water samples were previously collected from the Burwash Landing Fire Hall water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for detailed potability analyses. The results of these analyses are summarized in Table 3204-2 in Appendix A17. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify potential indicators of contamination.

- Previous sampling reported the turbidity to be 11.1 NTU, which is in exceedence of both the CDWQG aesthetic objective of 5.0 NTU and MAC of 1.0 NTU;
- The first sampling event reported the arsenic concentration to be 0.0055 mg/L, which although is not in exceedence of the current CDWQG MAC, is in exceedence of the proposed new MAC of 0.005 mg/L. The second sampling event, however, reported the arsenic concentration to be 0.00432 mg/L, which is below the proposed MAC;
- The first sampling event reported the iron concentration to be 0.45 mg/L, which is above the CDWQG aesthetic objective of 0.3 mg/L. Supplementary sampling, however, reported the iron concentration to be 0.154 mg/L, below the CDWQG aesthetic objective;
- The first sampling event reported the manganese concentration to be 0.059 mg/L, which is above the CDWQG aesthetic objective of 0.05 mg/L. The second sampling event, however, reported the manganese concentration to be 0.0467 mg/L, below the CDWQG aesthetic objective;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- The water quality results indicated that the groundwater from which this system receives its water supply is a sodium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 115 mg/L during the first sampling event and 117 mg/L during the second sampling event, and is considered moderately hard.

17.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Burwash Landing Fire Hall that was identified to be included during the water system assessments is detailed below:

- As turbidity had been in exceedence of the CDWQG MAC, a sample was taken to re-test for turbidity;

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 29, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3204-2 in Appendix A17 and the laboratory reports are included in Appendix B.

- At 4.01 NTU, the turbidity was in exceedence of the CDWQG MAC of 1.0 NTU; and,
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed.

At the time of the water system assessment, the water was very turbulent and a strong odour was noticed due to sulphide off-gasing.

17.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample were also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the Burwash Landing Fire Hall is under the influence of surfacewater sources or septic wastes.

17.4 Conceptual Hydrogeology

There was no log available for review for this well. Well logs for the nearby community wells (500 m away) indicate that the wells are drawing water from a deep confined intrapermafrost aquifer overlain by 42 m to 47 m of frozen clay and silt. Recharge to this aquifer is likely melting snow and glaciers, and precipitation on the eastern flank of the Kluane Range. At a depth of 39 m, the fire hall well is most likely completed within the same aquifer. The inferred presence of a significant confining layer provides protection of the aquifer from surfice sources of contamination. Groundwater flow direction in this area is expected to be north to northeast towards Kluane Lake.

17.5 Potential Contaminant Sources

Potential contaminant sources from observations during the water system assessment are compiled in field notes in Appendix A17. Photos of potential contaminant sources are also provided in Appendix A17.

Potential contaminant sources within 30 m of the wellhead include:

- One above ground fuel storage tank (AST).
- A sewage eduction tank is located 15 m away from the well.

17.5.1 Spills Records and Contaminated Sites Search Results

It was reported that on November 10, 1998, a spill occurred at a gas station in Burwash Landing near this site. Approximately 3800 L of diesel fuel spilled from Burwash Fuels when a valve was left on and the fuel ran down approximately 400 m towards Kluane Lake likely within 100 m of the fire hall well.

Due to the proximity of the spill to the site, and the inferred confined and protected nature of the aquifer (based on an understanding of the lithology from other well logs for the area), it is not antipated that this is a cause of concern to the water quality delivered from this well.

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any other recorded spill events or contaminated sites issues for this site or neighbouring sites in close proximity.

17.6 Identified Water System Deficiencies and Associated Risk

17.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in an enclosure below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;

- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because the well depth is unknown, and the well construction does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential contaminant sources, including an above ground fuel storage tank at 4 m;
- The turbidity has been reported to be in exceedence of the CDWQG MAC. Turbidity has been reported to be as high as 11.1 NTU; and,
- There is no treatment or disinfection system.

17.6.2 Low Risk Deficiencies

- It has been reported that a spill had occurred at Burwash Fuel with discharge possibly coming within 100 m of the well;
- There is a sewage eduction tank located 15 m from the well; and,
- The heat trace installation is not up to standards.

17.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

17.7.1 Priority 1

An attempt should be made to locate the well log for this well to verify well construction and aquifer vulnerability.

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the Burwash Landing Fire Hall. Priority 1 remedial recommendations include:

- The casing should be extended to at least 500 mm above the base of the well pit.
- The well and water system should be superchlorinated, and a chlorination tap installed at the wellhead to facilitate future superchlorination.
- Disinfection treatment consisting of filtration to 1 micron absolute, and a UV system that is NSF/ANSI certified should be installed. Alternatively, a proportional feed chlorination system with retention tanks and appurtenances could be installed. These are conceptual design recommendations based on the information available

for planning and budgeting purposes. Engineering input will be required for final system specifications.

17.7.2 Priority 2

All significant issues addressed through Priority 1 upgrades, and therefore, there are no Priority 2 upgrades required.

17.7.3 Priority 3

Priority 3 upgrades would include replacing the heat trace to meet the electrical code. A certified electrician should complete this work.

17.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

17.8.1 Priority 1

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- Casing extension - **$500**;
- Well and water system superchlorination and installation of chlorination tap- **$400**; and,
- UV system installation with filtration to 1 micron absolute would cost approximately **$3,000** including materials and labour**.** It is not anticipated that pre-treatment (i.e. softening) would be required for optimum UV performance.

Consideration should be given to completing a camera investigation and well cleaning and re-development at the time of the upgrades. The sulphur odour and off gassing could be a result of biological activity (biofouling) within the well screen and aquifer formation.

17.8.2 Priority 3

The estimated cost for an electrician to rewire and install the heat trace to code is approximately **$500.**

18.0 BUILDING 3171: KLUANE LAKE SCHOOL

18.1 Description of Existing Water Supply System

Building 3171, Kluane Lake School, is currently served by a water supply system that delivers water from an approximately 31.7 m deep well. The well is located in pit approximately 5 m from the school. The well location and other details about the surrounding area are provided in Figure 3171-A in Appendix A18. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6792831
- Easting: 617972

The water system is equipped with a duplex water softener and an activated carbon filter, and is also equipped with a pellet chlorination system that is installed on the wellhead. Field chemistry done at the time of the water system assessment reported a residual chlorine concentration of 0.00 mg/L for both raw and treated water, indicating that the either the chlorination system is likely not functioning properly, or that all chlorine is removed by the activated carbon vessel. A schematic detailing the well supply system is provided as Figure 3171-B in Appendix A18.

18.2 Description of Existing Wastewater Systems

Kluane Lake School is serviced by a community sewage disposal system. The community effluent tanks and discharge fields are located greater than 60 m cross gradient and downgradient from this well.

18.3 Water Quality Results

18.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Kluane Lake School water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3171-1 in Appendix A18. Coliform bacteria and *E. coli* were reported as absent in each of the nine samples for which results are provided.

Potability

Water samples were previously collected from the Kluane Lake School water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3171-2 in Appendix A18. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination.

Water quality results indicated a significantly varying degree of hardness. The first sampling event reported the hardness (as $CaCO_3$) to be 1.8 mg/L, while the second sampling event reported the hardness to be 446 mg/L. There was also a significant change in the total dissolved solids reported in water quality results. Water quality results likely indicate that a water softener that was operational during the first sampling event would not have been functioning properly during the second sampling event, or that a raw water sample was collected during the second sampling event.

- The turbidity during the second sampling event was 1.1 NTU, which is in exceedence of the CDWQG MAC of 1.0 NTU;
- The total dissolved solids during the first sampling event was 680 mg/L, and during the second sampling event to be 528 mg/L, both of which are in exceedence of the CDWQG aesthetic objective of 500 mg/L;
- The manganese concentration during the second sampling event was 0.0974 mg/L, which is in exceedence of the CDWQG aesthetic objective of 0.05 mg/L;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed; and,
- The water quality results indicated that the groundwater from which this system receives its water supply is a magnesium bicarbonate type water.

18.3.2 Identification of Additional Analytical Testing Required

Additional analytical for Kluane Lake School that was identified to be included during the water system assessments is detailed below:

- As turbidity had previously been in exceedence of the CDWQG MAC, a sample was taken to re-test for turbidity;
- Total and dissolved manganese as there had been a previous exceedence of the CDWQG aesthetic objective;

- Total organic carbon (TOC); and
- Measurements in the field for total dissolved solids, conductivity, pH, temperature and residual chlorine concentration.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 29, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3440-2 in Appendix A4 and the laboratory reports are included in Appendix B.

- The water quality results from additional analytical sampling indicated that all health based and aesthetic objectives were met for the parameters analyzed.

18.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample are also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for Kluane Lake School is under the influence of surfacewater sources or septic wastes.

18.4 Conceptual Hydrogeology

The log for this well indicates that the well is completed at a depth of 30.8 m within a sand aquifer. Overlying the aquifer is approximately 30.1 m of fine grained silt and till. The static water level at the time of drilling was 7.6 m below grade. This is consistent with most well logs in the Destruction Bay area, which typically indicate 25 m to 50 m of fine grained silt overlying a confined sand and gravel aquifer. The presence of 30 m of fine grained material overlying the aquifer provides protection from surficial sources of contamination. The expected direction of groundwater flow in the vicinity of the site is likely east to northeast towards Kluane Lake.

18.5 Potential Contaminant Sources

Potential contaminant sources from observations during the water system assessment are compiled in field notes in Appendix A18. Photos of potential contaminant sources are also provided in Appendix A18.

Potential contaminant sources within 30 m of the wellhead are:

- An above ground fuel storage tank (AST) at 26 m; and,
- An underground fuel storage tank (UST) at 9 m.

A significant number of scrap cars are located approximately 30 m away from the wellhead. Septic lines are located at 10 m and 30 m away from the wellhead, the closest in ground sewage disposal system is located greater than 60 m away.

18.5.1 Spills Records and Contaminated Sites Search Results

The Environment Canada Environmental Protection Branch did identify recorded spill events near this site as detailed below:

On September 26, 2003, approximately 500 L of diesel fuel spilled at the Yukon Electrical Company complex in Destruction Bay due to a faulty vent. The spill had reportedly been cleaned up but the soil was reportedly not removed.

There had been multiple spill events of raw sewage due to failures with the community sewage system in Destruction Bay. On two occations in 1993, a mechanical failure caused approximately 37 800 L and 11 340 L of raw sewage to spill. The sewage had in both cases reportedly flowed over the ground surface and ponded near Kluane Lake. Additionally, four recorded spill events occurred in 1995 and 1996 caused by leaking or broken sewer mains, spilling raw sewage in the Destruction Bay area. Two events recorded spills of approximately 200 L each, but the other two events spilled an unknown amount.

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any other recorded spill event or any contaminated sites issues for this site or neighbouring sites. Spill records are provided in Appendix A18.

18.6 Identified Water System Deficiencies and Associated Risk

18.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in a pit below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential sources of contamination, including an underground fuel storage tank at 9 m, an above ground fuel storage tank at 26 m, and scrap vehicles at approximately 30 m;
- Field chemistry indicated that the chlorination system was not functioning at the time of the water system assessment; and,
- The configuration of the water treatment system does not allow for a residual chlorine concentration at the point of use.

18.6.2 Low Risk Deficiencies

- There had been raw sewage spill events reported for the community sewage system;
- There had been as previous CDWQG MAC exceedence for turbidity;
- The total dissolved solids concentration has been reported to be in exceedence of the CDWQG aesthetic objective;
- Water quality indicates that the water softener may not always be functional; and,
- There had been a previous exceedence of the CDWQG aesthetic objective for manganese, however, with a functioning softener, this should not be an issue.

18.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

18.7.1 Priority 1

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the Kluane Lake School. Priority 1 remedial recommendations include:

- The casing should be extended to at least 500 mm above the base of the well pit, or as high as possible, and a temporary near surface sanitary seal should be installed around the well casing;
- The well and water system should be superchlorinated, and a chlorination tap installed at the wellhead to facilitate future superchlorination;
- Disinfection treatment consisting of a proportion feed chlorine injection system with appropriately sized retention tanks and appurtenances should be installed. The selection of this disinfection system is to ensure adequate residual chlorine within the distribution system. It has also been selected in consideration that the recommended upgrade option for the water supply serving the adjacent Fire hall would be to connect to this treated system; and,
- The activated carbon should be removed from the vessel and replaced with a multimedia bed.

These are conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

18.7.2 Priority 2

Priority 2 upgrades to protect the water supply system in the long-term are provided below:

- Standard wellhead upgrades consisting of a pitless unit installation, extending the casing to at least 500 mm above grade, and retrofitting of a surface sanitary seal (grout or bentonite to at least 3 m in depth);
- Installation of a commercial sized stainless steel duplex water NSF 61 filtration system with 5 micron followed by 1 micron absolute; and,
- Replace AST with a doubled walled “EnviroTank” type UST and relocate to at least 30 m from well.

18.7.3 Priority 3

All lower risk deficiencies indicated previously should be mitigated through Priority 1 and Priority 2 upgrades.

18.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

18.8.1 Priority 1

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- The proposed casing extension would cost in the order of **$500**;
- Well and water system superchlorination and installation of chlorination tap is estimated to cost **$400**; and,
- The cost for installation of proportional feed chlorine injection system with retention tanks including materials and labour would cost approximately **$8,000**.

18.8.2 Priority 2

The estimated costs for the recommended Priority 2 upgrades are provided below:

- Standard wellhead upgrades with pitless unit, casing extension, retrofitted sanitary seal would cost approximately **$5,000**;
- Removal of UST and replacement with double walled AST would cost in the order of **$5,000** (class D and depending on extent of potential soil contamination),
- The cost for installation of a commercial stainless steel NSF 61 filtration system as previously indicated, including materials and labour, would cost approximately **$2,900**.

19.0 BUILDING 3172: DESTRUCTION BAY FIRE HALL

19.1 Description of Existing Water Supply System

Building 3172, the Destruction Bay Fire Hall, is currently served by a water supply system that delivers water from an approximately 31.4 m deep well. The well is located in a pit approximately 5 m from the fire hall. The well location and other details about the surrounding area are provided in Figure 3172-A in Appendix A19. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6792050
- Easting: 617956

There is no treatment or disinfection system for the water supplying this system. The water system splits to supply the domestic system and the system for fire fighting use. The system for fire fighting use is equipped with an elevated 22,500 L water storage tank. A schematic detailing the well supply system is provided as Figure 3172-B in Appendix A19.

19.2 Description of Existing Wastewater Systems

The Destruction Bay Fire Hall uses a community sewage collection system. Community sewage discharge fields are located greater than 100 m down gradient and approximately 100 m cross gradient.

19.3 Water Quality Results

19.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Destruction Bay Fire Hall water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3172-1 in Appendix A19. *E. coli* bacteria were reported as absent in each of the nine samples for which results are provided, however, the sample tested on February 17, 2005, reported positive for total coliform bacteria. Results provided by YTG indicate that samples collected since February 17th, have not have total coliform present.

Potability

Water samples were previously collected from the Destruction Bay Fire Hall water system on October 19, 2004 and June 16, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3172-2 in Appendix A19. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination. Items of note are detailed below:

- The turbidity had been reported to be 53.5 NTU during the first sampling event and 11.0 NTU during the second sampling event. Both sampling events reported turbidity in exceedence of the CDWQG MAC of 1.0 NTU and aesthetic objective of 5.0 NTU;
- The colour during the first sampling event was greater than 60 CU, which is in exceedence of CDWQG aesthetic objective of 15 CU;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;
- The water quality results indicated that the groundwater from which this system receives its water supply is a magnesium bicarbonate sulphate type water; and,
- The hardness (as $CaCO_3$) was 308 mg/L during the first sampling event and 312 mg/L during the second sampling event, and is considered very hard.

19.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Destruction Bay Fire Hall that was identified to be included during the water system assessments is detailed below:

- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC);
- Turbidity and color; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 28, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3172-2 in Appendix A19 and the laboratory reports are included in Appendix B.

- At 3.04 NTU, turbidity was in exceedence of the CDWQG MAC of 1.0 NTU; and,
- The water quality results from additional analytical sampling indicated that all other health based and aesthetic objectives were met for the parameters analyzed.

19.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and are considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample were also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the Destruction Bay Fire Hall is under the influence of surfacewater sources or septic wastes.

19.4 Conceptual Hydrogeology

The log for this well indicates that the well is completed at a depth of 29.9 m within a sand aquifer. Overlying the aquifer is approximately 29.8 m of interbedded clay and till. The static water level at the time of drilling was 7.6 m below ground. This is consistent with most well logs in the Destruction Bay area, which typically indicate 25 m to 50 m of fine grained material overlying a confined sand and gravel aquifer. The presence of a fine grained confining layer provides some aquifer protection from surficial sources of contamination. The expected direction of groundwater flow in the vicinity of the site is likely east to northeast towards Kluane Lake.

19.5 Potential Contaminant Sources

Potential contaminant sources from observations during the water system assessment are compiled in field notes in Appendix A19. Photos of potential contaminant sources are also provided in Appendix A19.

Potential contaminant sources within 30 m of the wellhead are:

- An above ground fuel storage tank (AST) at 1 m; and,
- An underground fuel storage tank (UST) at 18 m.

Other potential contaminant sources in the vicinity of the wellhead are a number of scrap cars are located approximately 20 m away from the wellhead, an above ground fuel storage tank located at 39 m, and septic lines located within 30 m of the wellhead.

19.5.1 Spills Records and Contaminated Sites Search Results

The Environment Canada Environmental Protection Branch did identify recorded spill events near this site as summarized below:

On September 26, 2003, approximately 500 L of diesel fuel spilled at the Yukon Electrical Company complex in Destruction Bay due to a faulty vent. The spill had reportedly been cleaned up but the soil was reportedly not removed.

There had been multiple spill events of raw sewage due to failures with the community sewage system in Destruction Bay. On two occations in 1993, a mechanical failure caused approximately 37 800 L and 11 340 L of raw sewage to spill. The sewage had in both cases reportedly flowed over the ground surface and ponded near Kluane Lake. Additionally, four recorded spill events occurred in 1995 and 1996 caused by leaking or broken sewer mains, spilling raw sewage in the Destruction Bay area. Two events recorded spills of approximately 200 L each, but the other two events spilled an unknown amount.

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any other recorded spill event or any contaminated sites issues for this site or neighbouring sites. Spill records are provided in Appendix A19.

19.6 Identified Water System Deficiencies and Associated Risk

19.6.1 High and Medium Risk Deficiencies

- Poor wellhead construction (located in a pit below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because it does not meet the requirements of the Guidelines for Water Well Construction;
- The well is within 30 m of potential sources of contamination, including an above ground fuel storage tank at 2 m, an underground fuel storage tank at 18 m, and scrap cars within 20 m;
- There had been raw sewage spill events reported for the community sewage system;
- A recent bacteriological sample reported a positive total coliform count;
- The turbidity has been reported to be consistently above the CDWQG MAC of 1.0 NTU. Turbidity has been reported to be as high as 53.5 mg/L; and,
- There is no treatment or disinfection system.

19.6.2 Low Risk Deficiencies

- The color had previously exceeded the CDWQG aesthetic objective; and,
- It is unlikely that the supports for the elevated water storage tank are earthquake or collision proof.

19.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

When considering potential upgrades, the costs were compared between completing the necessary upgrades to the Fire Hall wellhead and installation of treatement in order to provide safe domestic water at this site versus plumbing the domestic system into the Kluane School system. In light of the very poor water quality provided by the Fire hall well, all treatment options would include significant capital costs for pre-treatment (softening and filtration for turbidty reduction). Combined with these costs, the water treatment costs, the cost for disinfection, standard wellhead upgrades, and relocation of the AST adjacent to the well are far in excess of the option of plumbing the domestic water system into the adjacent school. This option would also provide reduced maintenance requirements and therefore, reduced life cycle costs. The remedial options presented below assume that plumbing the upgraded School well into the domestic water supply for the Fire hall would be logisticaly feasible. Should PMA wish to consider other options, these could be provided. The option presented assumes that minor upgrades would be completed to the Fire hall well to protect the integrity of the aquifer, and that this well would remain in service to provide water for fire fighting requirements.

19.7.1 Priority 1

Until such time as the water system is plumbed into the adjacent school water system, it is recommended that appropriate signage be posted indicating that the water is not treated and should not be used for drinking purposes. PMA should consult with Environmental Health and Social Services to ensure that the wording on the advisory is appropriate. In the interim, until Priority 2 upgrades are completed, it is recommended that a bottled water station be provided by PMA.

19.7.2 Priority 2

The following Priority 2 upgrades are recommended to provide safe drinking water to the Destruction Bay Fire Hall:

- Following Priority 1 upgrades to the adjacent Kluane School water supply system, it is recommended that a new service line consisting of 1 inch insulated and heat traced pipe should be installed below grade between the School and the Fire Hall. The system should be re-plumbed so that the domestic water supply and the fire fighting supply are independent. An option for emergency back-up use of the domestic water for fire fighting purposes should be considered.
- The well casing should be extended to at least 500 mm above grade and the portion of the well pit that is below grade should be backfilled with a low permeability material such as bentonite or grout.

19.7.3 Priority 3

All risks with respect to the safety of the drinking water supply would be mitigated through Priority 2 upgrades.

19.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

19.8.1 Priority 1

The cost would be minimal to provide appropriate advisory, and provide a bottled water station.

19.8.2 Priority 2

The estimated cost to complete the recommended Priority 2 upgrades are summarized below:

- A service line installed as recommended would cost approximately **$3,600** for materials and labour;
- Plumbing modifications would cost approximately **$200** for materials and labour.
- The minor well upgrades described above are estimated to cost in the order of **$1,000.**

20.0 BUILDING 3186: DESTRUCTION BAY GRADER STATION

20.1 Description of Existing Water Supply System

Building 3186, the Destruction Bay Grader Station, is currently served by a water supply system that delivers water from a well located in the grader station garage. There is also an abandoned well located less than a meter away from the current well, and is not equipped with a proper cap and was open at the time of the assessment. The well locations and other details regarding the site are provided in Figure 3186-A in Appendix A20. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6792596
- Easting: 617886

There is no treatment or disinfection system for the water supplying this system. There is a sign posted in the washroom stating “Contaminated Water, Do Not Consume” and it appeared that bottled water is provided. A schematic detailing the well supply system is provided as Figure 3186-B in Appendix A20.

20.2 Description of Existing Wastewater Systems

There are three Septic effluent disposal systems that were identified during the water system assessment. There is a septic tank near the northeast corner of the building, located approximately 23 m east and downgradient from the well. This tank likely serves the domestic sewage system, and effluent is likely discharged to an in ground disposal system southeast of the tank. There is a leach pit located near the northwest corner of the building, approximately 13 m northeast and likely downgradient from the well, and it likely serves the sump in the wash pad. There is a rock pit located off from the southeast side of the building that likely serves the sumps in the garage, and it is approximately 17 m east and cross-gradient from the well. A site plan showing the septic systems is provided as Figure 3186-A in Appendix A20.

20.3 Water Quality Results

20.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Destruction Bay Grader Station water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3186-1 in Appendix A20. Coliform bacteria and *E. coli* were reported as absent in each of the nine samples for which results are provided.

Potability

Water samples were previously collected from the Destruction Bay Grader Station water system on October 19, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3186-2 in Appendix A20. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination. Items are note were:

- During the first sampling event, the arsenic concentration was reported as 0.0329 mg/L, which is in exceedence of the current CDWQG MAC of 0.025 mg/L. The arsenic concentration was reported as 0.0184 mg/L during the second sampling event, which although is not in exceedence of the current CDWQG MAC, is in exceedence of the proposed new MAC of 0.005 mg/L;
- The turbidity was 21.1 NTU during the first sampling event and 12.7 NTU during the second sampling event, and was in both cases in exceedence of the CDWQG MAC of 1.0 NTU and aesthetic objective of 5.0 NTU;
- The colour during the first sampling event was greater than 60 CU;
- The iron concentration was 2.94 mg/L during the first sampling event and 1.34 mg/L during the second sampling event, and was in both cases in exceedence of the CDWQG aesthetic objective of 0.3 mg/L;
- The manganese concentration was 0.165 mg/L during the first sampling event and 0.137 mg/L during the second sampling event, and was in both cases in exceedence of the CDWQG aesthetic objective of 0.05 mg/L;
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed;

- The water quality results indicated that the groundwater from which this system receives its water supply is a magnesium bicarbonate type water; and,
- The hardness (as $CaCO_3$) was 399 mg/L during the first sampling event and 350 mg/L during the second sampling event, and is considered extremely hard.

20.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Destruction Bay Grader Station that was identified to be included during the water system assessments is detailed below:

- The full suite of total and dissolved metals, including vanadium, as there had been exceedences of arsenic, iron, and manganese;
- Turbidity and colour;
- Silica and phosphate to determine potential for a point of entry arsenic removal system;
- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC);
- Extractable Petroleum Hydrocarbons (EPH) and Polycyclic Aromatic Hydrocarbons (PAH) to determine if there are any signs of hydrocarbon contamination; and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 28, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3186-2 in Appendix A20 and the laboratory reports are included in Appendix B.

- At 0.0353 mg/L, the reported total arsenic concentration was in exceedence of the CDWQG MAC of 0.025 mg/L. The dissolved arsenic concentration was 0.0217 mg/L, signifying that a large portion of the arsenic concentration can be attributed to dissolved particles;
- At 23.0 NTU, the turbidity was in exceedence of the CDWQG MAC of 1.0 NTU
- At 2.20 mg/L, the total iron concentration was in exceedence of the CDWQG aesthetic objective of 0.3 mg/L. The dissolved iron concentration was 0.033 mg/L, signifying that the iron content can be mainly attributed to suspended solids;
- At 0.238 mg/L, the total manganese concentration was in exceedence of the CDWQG aesthetic objective of 0.05 mg/L. The dissolved manganese concentration

was 0.201 mg/L, signifying that the manganese content can be mainly attributed to dissolved particles;

- The screening for EPH and PAH indicated that each of the parameters analyzed was below analytical detection limits and CDWQG; and,
- Water quality results from additional analytical sampling reported that all other health based and aesthetic objectives were met for the parameters analyzed.

20.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were reported to be low and can be considered to be within the normal background ranges for groundwater in the area. Nitrate and nitrite concentrations for this sample were also low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the Destruction Bay Grader Station is under the influence of surfacewater sources or septic wastes.

20.4 Conceptual Hydrogeology

There was no log available for review for this well. The direction of groundwater flow as inferred from topographical maps and aerial photographs is likely east to northeasterly towards Kluane Lake.

20.5 Potential Contaminant Sources

Potential contaminant sources from observations during the water system assessment are compiled in field notes in Appendix A20. Photos of potential contaminant sources are also provided in Appendix A20.

Potential contaminant sources within 30 m of the wellhead are:

- A leach pit at approximately 13 m;
- Rock pit at 17 m;
- Underground fuel storage tank at less than 25 m;
- Used antifreeze drums at 7 m; and,
- An above ground used oil storage tank at 9 m.

In addition, a tar emulsion above ground storage tank is located 45 m upgradient from the wellhead, and a tar or creosote above ground storage tank is located at 55 m upgradient.

There is a fuel pumping area located approximately 36 m upgradient fromt the well. The septic tank that serves the grader station is 23 m away, and the location of the septic discharge field associated with this tank is unknown, but may be within 30 m. The underground fuel storage tank is located somewhere under the concrete floor of the grader station maintenance garage, but the exact location is unknown.

20.5.1 Spills Records and Contaminated Sites Search Results

The Environment Canada Environmental Protection Branch did identify recorded spill events near this site.

On September 26, 2003, approximately 500 L of diesel fuel spilled at the Yukon Electrical Company complex in Destruction Bay due to a faulty vent. The spill had reportedly been cleaned up but the soil was reportedly not removed.

There had been multiple spill events of raw sewage due to failures with the community sewage system in Destruction Bay. On two occations in 1993, a mechanical failure caused approximately 37 800 L and 11 340 L of raw sewage to spill. The sewage had in both cases reportedly flowed over the ground surface and ponded near Kluane Lake. Additionally, four recorded spill events occurred in 1995 and 1996 caused by leaking or broken sewer mains, spilling raw sewage in the Destruction Bay area. Two events recorded spills of approximately 200 L each, but the other two events spilled an unknown amount.

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any other recorded spill event or any contaminated sites issues for this site or neighbouring sites. Spill records are provided in Appendix A20.

20.6 Identified Water System Deficiencies and Associated Risk

20.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the wellhead (located in a corner of the maintenance garage, does not extend the required 500 mm above grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- There is no log available to review lithology and construction;

- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because the completion depth is unknown and the well construction does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located within 30 m of potential contaminant sources including an underground fuel storage tank, used antifreeze drums, a waste oil storage tank, and industrial activities;
- There are two Septic effluent leach pits located within 30 m of the well. The septic tank is located approximately 23 m from the well, and although the exact location of the septic field is unknown it may be within 30 m of the well;
- There is an uncapped abandoned well located less than 1 m from the current well;
- Turbidity has consistently been above both the CDWQG MAC of 1.0 NTU and aesthetic objective of 5.0 NTU. The most recent sampling event reported turbidity to be 23.0 NTU;
- Arsenic has been reported to be above the current CDWQG MAC of 0.025 mg/L. The most recent sampling event reported the arsenic concentration to be 0.0353 mg/L; and,
- There is no treatment or disinfection system.

20.6.2 Low Risk Deficiencies

- The well is within 60 m and downgradient from a tar tank and a tar or creosote tank;
- The water system is very old and in disrepair;
- Colour had previously exceeded the CDWQG aesthetic objective of 15 CU. The most elevated colour was greater than 60 CU;
- The iron concentration has consistently been in exceedence of the CDWQG aesthetic objective of 0.3 mg/L. The most elevated reported iron concentration was 2.94 mg/L; and,
- The manganese concentration has consistently been in exceedence of the CDWQG aesthetic objective of 0.05 mg/L. The most recent sampling event reported the manganese concentration to be 0.238 mg/L.

20.7 Mitigative Options for Deficiencies

To address the high-risk deficiencies identified by EBA in the Draft report for this water system, PMA coordinated the drilling, construction and testing of a new well to serve the Destruction Bay Grader Station. The construction of the well is documented in a report to PMA entitled “Well Completion Report- Destruction Bay Grader Station” (EBA 2005). The well completion report also included details of decommissioning of an abandoned well and recommendations pertinent to maintaining the safety of the new water supply well.

The new well has not yet been commissioned, therefore the following interim mitigative measures are provided until the new well is hooked up to the supply system.

20.7.1 Priority 1

- The new well should be connected to the building water supply system, and the existing well should be properly decommissioned as soon as weather permits;
- An NSF/ASNI 55 certified UV treatment system (or equivalent) should be installed to provide disinfection. Pretreatment will likely be required. Engineering input from a qualified water treatment consultant should be obtained for final system design.
- The new well must be sampled for bacteriological results prior to use as a potable water supply;
- PMA should continue to provide drinking water via a bottled water station until the new well is hooked-up; and,
- Consult with EHSS to ensure that the existing advisory is adequate.

20.7.2 Priority 3

The existing well should be properly decommissioned once the new well is commissioned.

20.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

20.8.1 Priority 1

Connection of the new water supply well is estimated to cost in the order of **$7,400** assuming that the well is connected with a pitless adapter.

20.8.2 Priority 2

A suitable treatment/disinfection system would likely cost in the order of **$3,700**, assuming **$2,200** for the UV disinfection, and **$1,500** for a residential size water softener.

20.8.3 Priority 3

The cost associated with decommissioning the existing water wells is estimated at approximately **$1,000**.

21.0 BUILDING 3957: DESTRUCTION BAY HEALTH CENTRE

21.1 Description of Existing Water Supply System

Building 3957, the Destruction Bay Health Centre, is currently served by a water supply system that delivers water from an approximately 68.9 m deep artesian well. In addition to serving the health centre, the well also serves two nursing residences (referred to as Nursing Residence #1 and Nursing Residence #2). The well is located in a pumphouse near Nursing Residences # 1. The well location and other details about the surrounding area are provided in Figure 3957-A in Appendix A21. The coordinates of the wellhead, as measured by a handheld GPS device, were recorded as:

- UTM ZONE 7
- Northing: 6792941
- Easting: 617983

The system is equipped with a water softener, a pH neutralizer, and a colour removal system. The treatment system is located in one of the nursing residences and is piped to the health centre. Nursing residence #2 was formerly served by an independent well, but that well has been abandoned and this residence is currently served by this well. The reason for the well abandonment is unknown. Proper infrastructure connecting Nursing Residence # 2 to this water system was not completed at the time of the water system assessment, but was temporarily connected through a garden hose from Nursing Residence # 1. Nursing Residence # 1, in addition to other treatment mentioned, is equipped with a reverse osmosis treatment system at the point of use in the kitchen. A schematic detailing the well supply system is provided as Figure 3957-B in Appendix A21.

21.2 Description of Existing Wastewater Systems

All three buildings served by this water system use a community sewer collection system. There is a community septic field located approximately 65 m east and downgradient from the well, and another community septic field located approximately 75 m northwest and potentially upgradient from the well. A site plan showing both community septic fields is given by Figure 3957-A in Appendix A21.

21.3 Water Quality Results

21.3.1 Water Quality Results from Previous Sampling

Bacteriological

Nine samples were collected from the Destruction Bay Health Centre water system between September 2004 and June 2005 and were tested for total coliform and *E. coli* by Yukon Environmental Health Services using the presence/absence test method. Results are tabulated in Table 3957-1 in Appendix A21. Coliform bacteria and *E. coli* were reported as absent in each of the nine samples for which results are provided.

Potability

Water samples were previously collected from the Destruction Bay Health Centre water system on September 21, 2004 and June 15, 2005. The samples were submitted to Northwest Labs in Surrey, BC and ALS Environmental in Vancouver, BC for potability analyses. The results of these analyses are summarized in Table 3957-2 in Appendix A21. EBA reviewed the analytical results to compare them with the Canadian Drinking Water Quality Guidelines (CDWQG) to observe general water quality, identify and recommend additional sampling and analytical, and to identify indicators of potential contamination.

- The arsenic concentration during the first sampling event was 0.0148 mg/L, and 0.114 mg/L during the second sampling event, which although is not in exceedence of the current CDWQG MAC of 0.025 mg/L, is in exceedence of the proposed new MAC of 0.005 mg/L;
- The pH was 8.79 during the first sampling event and 8.68 during the second sampling event, and is in exceedence of the CDWQG aesthetic objective of 8.5;
- The water quality results indicated that the groundwater from which this system receives its water supply is highly mineralized. Although the low hardness indicates that the water softener is functioning properly, the most recent sampling event reported that the total dissolved solids concentration as 525 mg/L, which is in exceedence of the CDWQG aesthetic objective of 500 mg/L; and,
- The water quality results indicated that all other health based and aesthetic objectives were met for the parameters analyzed.

21.3.2 Identification of Additional Analytical Testing Required

Additional analytical for the Destruction Bay Health Centre that was identified to be included during the water system assessments is detailed below:

- Total and dissolved arsenic as arsenic had been in exceedence of the new proposed CDWQG MAC;
- Total and dissolved vanadium, as well as silica and phosphate to determine potential for a point of entry arsenic removal system;
- UV absorbance and UV transmissivity, as well as tannins and lignin, to determine potential for UV treatment as a disinfection option for this water system;
- Total organic carbon (TOC); and,
- Measurements in the field for total dissolved solids, conductivity, pH, and temperature.

Additional Analytical Results

A water sample was obtained during the water system assessment on July 28, 2005, and was submitted to ALS Environmental in Vancouver, BC for analysis. These results are summarized in Table 3957-2 in Appendix A21 and the laboratory reports are included in Appendix B.

- The total arsenic concentration was 0.012 mg/L, which is above the proposed maximum acceptable concentration of 0.005 mg/L. Since the dissolved arsenic concentration was 0.0119 mg/L, the arsenic concentration can be entirely attributed to dissolved particles; and,
- The water quality results from additional analytical sampling indicated that all other health based and aesthetic objectives were met for the parameters analyzed.

21.3.3 Indicators of Potential Contamination

Chloride, nitrate and nitrite concentrations can indicate impacts from surfacewater sources or septic waste. Chloride concentrations were slightly elevated, however, this may be a result of the water treatment system. Raw water quality results were not available for review. Nitrate and nitrite concentrations for this sample were low and within the normal background range for this area. These water quality results do not suggest that the aquifer from which the groundwater is obtained for the Beaver Creek Health Centre is under the influence of surfacewater sources or septic wastes.

21.4 Conceptual Hydrogeology

The log for this well indicates that the well was originally drilled to a depth of 25.2 m and completed within a gravel aquifer. Several years later it appears that the well was deepened to 68.9 m and completed within a confined artesian aquifer. The well log indicates variable gravel, silt, clay and till with a significant confining layer from 46.9 to 60.3 m. This is the only know artesian well in the Destruction Bay area. The depth of this well, presence of a confining layer, and artesian flow indicate that there is significant protection from surficial sources of contamination. The expected direction of groundwater flow in the vicinity of the site is likely east towards Kluane Lake.

21.5 Potential Contaminant Sources

Potential contaminant sources from observations during the water system assessment are compiled in field notes in Appendix A21. Photos of potential contaminant sources are also provided in Appendix A21.

Potential contaminant sources within 30 m of the wellhead are:

- An indoor fuel storage tank at 20 m; and,
- An above ground fuel storage tank at 26 m.

In addition an abandoned well is located on the property. The closest portion of a septic system to the well is a septic field located at 65 m.

21.5.1 Spills Records and Contaminated Sites Search Results

The Environment Canada Environmental Protection Branch did identify recorded spill events near this site.

On September 26, 2003, approximately 500 L of diesel fuel spilled at the Yukon Electrical Company complex in Destruction Bay due to a faulty vent. The spill had reportedly been cleaned up but the soil was reportedly not removed.

There had been multiple spill events of raw sewage due to failures with the community sewage system in Destruction Bay. On two occations in 1993, a mechanical failure caused approximately 37 800 L and 11 340 L of raw sewage to spill. The sewage had in both cases reportedly flowed over the ground surface and ponded near Kluane Lake. Additionally, four recorded spill events occurred in 1995 and 1996 caused by leaking or broken sewer mains, spilling raw sewage in the Destruction Bay area. Two events recorded spills of approximately 200 L each, but the other two events spilled an unknown amount.

The Government of Yukon Environmental Programs Branch and Environment Canada Environmental Protection Branch did not identify any other recorded spill event or any contaminated sites issues for this site or neighbouring sites. Spill records are provided in Appendix A21.

21.6 Identified Water System Deficiencies and Associated Risk

21.6.1 High and Medium Risk Deficiencies

- Poor surface completion of the well (located in an enclosure below grade);
- There is no surface sanitary seal (grout or bentonite seal as required by the Canadian Groundwater Association's Guidelines for Water Well Construction;
- By definition of the Draft Yukon GUDI Assessment Guideline, the well is potentially under the direct influence of surface water because does not meet the requirements of the Guidelines for Water Well Construction;
- The well is located approximately 60 m downgradient from a community septic field; and,
- There is no disinfection system.

21.6.2 Low Risk Deficiencies

- The well is within 30 m of an above ground fuel storage tank located in Nursing Residence #1, however, since the well is 26 m away and in a building, it is considered to pose minimal risk;
- The well is located approximately 36 m downgradient from an underground fuel storage tank;
- The arsenic concentration, although not in exceedence of the current MAC, has consistently been in exceedence of the proposed new CDWQG MAC of 0.005 mg/L. The most elevated reported concentration was 0.0148 mg/L;

- The pH has consistently been in exceedence of the CDWQG aesthetic objective of 8.5 and elevated above the normal background pH for the region. Field measurements reported the pH to be 9.11. This is likely caused over-adjustments by the pH neutralizer, and the pH would likely drop if the neutralizer were properly adjusted;
- At 525 mg/L, the most recent previous sampling event reported the total dissolved solids concentration to be in exceedence of the CDWQG aesthetic objective of 500 mg/L; and,
- The NSF 61 filtration system has not been installed to code.

21.7 Mitigative Options for Deficiencies

Mitigative options were developed to address the deficiencies identified in the previous section. Deficiencies are categorized by recommended level of priority (with Priority 1 being most critical).

It is assumed that a proper water distribution line has been installed to Nursing Residence #2 to replace the garden hose connection that was observed at the time of the assessment. If this is not completed, it should be done as soon as possible.

21.7.1 Priority 1

The following recommendations are provided in order to mitigate deficiencies that are of immediate concern for the Destruction Bay Health Centre Building and Nursing Residences. Priority 1 remedial recommendations include:

- Superchlorinate the well and water system, and install a chlorination tap at the wellhead for future disinfection; and,
- Install filtration (to 1 micron absolute) and NSF/ANSI 55 certified UV disinfection system in Nursing Residence # 1 to provide disinfected water to all buildings.
- Bring filter installation to code (NSF 61) by ensuring proper air gaps on drains and restraint on tanks. Adjust pH neutralizer to bring pH down to below 8.5 pH units.

These are conceptual design recommendations based on the information available for planning and budgeting purposes. Engineering input will be required for final system specifications.

21.7.2 Priority 2

Priority 2 upgrade options to mitigate long-term risk and meet the proposed regulation would include standard wellhead improvements consisting of a pitless unit installation, extending the casing to at least 500 mm above grade, and retrofitting of a surface sanitary seal (grout or bentonite to at least 3 m in depth).

21.7.3 Priority 3

For Priority 3 upgrades, it is recommended that point of use RO systems be installed in the Health Centre and Nursing Residence # 2 and to provide drinking water that will meet proposed PMAC for arsenic and lower TDS.

21.8 Cost Estimates for Mitigative Options

Engineering costs for mitigative options are estimated to be 20% of construction costs, and would include inspection and completion reporting. The costs for materials and labour (not including engineering) are provided in the sections below. An additional contingency allowance of 20% is suggested for budgetary purposes.

21.8.1 Priority 1

The estimated costs for the recommended Priority 1 upgrades are detailed below:

- Installation of a chlorine tap on the wellhead, and superchlorination of the well and water system would cost approximately **$400** for materials and labour.
- A UV system and filtration would cost approximately **$3,000**.
- Alterations to the filtration system and adjustment of the pH neutralizer would cost in the order of **$200**.

21.8.2 Priority 2

Standard wellhead upgrades with a pitless unit and retrofitting of a surface seal would cost approximately **$5,000** for materials and labour.

21.8.3 Priority 3

Point of use Reverse Osmosis systems could be installed for approximately **$700** per system for a total of **$1,400** including materials and labour.

22.0 SUMMARY

The project team assessed the small public drinking water systems for 18 Government of Yukon maintained buildings in the Western Region in July 2005 in general accordance with the Terms of Reference and the project team's proposal. Key findings of this study are discussed below.

Based on water quality results provided from previous studies or collected during this study, most wells assessed in the Western Region did not have exceedences of health-based parameters, or indicators of potential contamination from human or animal wastes.

In total, nine water systems have had turbidity higher than the CDWQG maximum acceptable concentration (MAC) of 1 NTU, however, only five systems had a turbidity greater than 1 NTU during the most recent sampling events. Turbidity should be as low as possible, and consistently be below 1 NTU; however, it can exceed this level occasionally. Follow-up sampling is recommended for the systems where turbidity was above 1 NTU during the most recent sampling events.

Based on the information provided to EBA from past bacteriological sampling events, *E. coli* bacteria (a type of faecal coliform) have not been identified in any of these water systems on the dates sampled.

The presence of total coliform bacteria can be a potential indicator of bacterial and/or viral contamination. In the Western Region, three of the water systems that are currently in use have at some time in the past six months had total coliform bacteria present in the samples collected. Total coliform bacteria are an indicator organism, and do not necessarily indicate water contamination by faecal waste; however the presence or absence of these bacteria in drinking water is often used to determine whether water disinfection is working properly, or whether treatment is required. We understand that YTG has commissioned routine sampling programs for the presence of total coliform and *E. coli* bacteria, and most water systems are sampled on a monthly basis. Water sources in which total coliform have been identified as present in the past year should be considered with caution. It is recommended that these systems be sampled for the presence of faecal coliform and *E. coli* in the near future.

The arsenic concentrations in drinking water sampled from the Destruction Bay Grader Station were above the existing maximum acceptable concentration (MAC). There are advisories posted at this location indicating that the water should not be consumed. Water sources from five other water systems (Haines Junction Initial Attack Base, Attack Base Maintenance Shop, and the Destruction Bay Nursing Station and Nursing Residences) that are currently utilized for drinking water have concentrations of arsenic that exceed the proposed guideline and will require treatment or use of an alternate source of drinking water when these proposed guidelines come into effect.

In general, well construction for the wells serving the small public drinking water systems for YTG maintained buildings does not meet the current construction standards or the requirements of the proposed guidelines. Each of the wells assessed have not been completed with surface sanitary seals (bentonite or bentonite grout) between the well casing and the formation within at least the top 6 m of the well completion. Additionally, many wells are completed in pits below grade, which makes them potentially susceptible to surface sources of contamination. The proposed guidelines require that all water supplied by wells that do not have properly constructed wells, or wells without grout seals within the top 6 m would either require treatment consisting of both filtration and disinfection, or further GUDI assessment (Phase 2 and/or 3) to ensure that these systems are not at risk. Most of the water systems assessed do not have filtration or disinfection and as such, this has been identified as a high-risk deficiency. In addition, many wells assessed have potential sources of contamination located within 30 m of the wells.

Class D estimates of costs to mitigate identified deficiencies are provided in each section, and are summarized in Table 4.

The multi-barrier approach to safe drinking water includes the protection of drinking water at its source, adequate treatment, a clean distribution system operated by competent personnel and comprehensive testing of water quality. During this study, the project team evaluated the well construction and potential contaminant sources in the vicinity of wells to assess the level of protection of the drinking water at its source, additionally the condition and adequacy of the treatment and distribution systems were evaluated. It was not within the scope of work to evaluate the operations, maintenance and testing programs for these systems, however, these are key to the multi-barrier approach and will be required by the proposed small public drinking water system regulations. It was obvious from this assessment that operator training and routine maintenance of the existing water systems needs improvement. Table 5 provides as summary of the level of risk assessed to each water system in consideration of the identified risk and existing barriers of protection (a "multi-barrier" approach). Risk factors included:

- Any parameter above a CDWQG maximum acceptable concentration (not including elevated turbidity or coliform presence);

- Indicators such as elevated turbidity, presence of coliform, or elevated chloride, nitrate or nitrite.
- Potential sources of bacteriological and/or viral contaminants within 30 m of the wellhead; and,
- The level of risk due to public accessibility of the well (public buildings, schools, residences etc.).

Risk mitigating factors that were considered included:

- Favorable hydrogeological conditions;
- Good well construction;
- Primary disinfection treatment (e.g., filtration to less than 1 micron absolute or membrane filtration, etc.); and,
- Secondary disinfection treatment (e.g., chlorination or UV treatment).

Priority was assessed based on the level of public accessibility to the buildings and their water systems. Systems that provide drinking water to publicly accessible buildings and employee residences were assessed as an overall Priority level of 1 (highest priority), while systems that are not publicly accessible were assigned a Priority level of 2 or 3 depending on the amount of use of the building and water system. The priority assessment presented in Table 5 can be used as a tool to assist PMA in prioritizing system upgrades. This prioritization system is illustrated in the following matrix:

Matrix 1: Illustration of "Priority 1 – High Risk Systems"

Overall risk based on multi-barrier approach	Priority Level based on public accessibility		
	Priority 1	**Priority 2**	**Priority 3**
High	**Priority 1 – High Risk**	Priority 2 – High risk	Priority 3 – High risk
Medium	Priority 1 – Medium Risk	Priority 2 – Medium risk	Priority 3 – Medium risk
Low	Priority 1 – Low Risk	Priority 2 – Low risk	Priority 3 – Low risk

As indicated in the matrix provided above, those buildings with water systems that were identified as having an overall high-risk, and serve public buildings or employee residences (Priority 1) should be addressed first from a cost benefit perspective. These systems we refer to as "Priority 1 – High Risk". All deficiencies (with the exception of some Priority 3 upgrades which are purely mechanical/operational and do not pose a health risk) for each system should ultimately be addressed in order to mitigate health risk. It is suggested that all Priority 1 upgrades for all systems be completed as soon as possible. In general, we recommend that the best approach to mitigate risk would be to install disinfection treatment systems (Priority 1), and to carry out well improvements as soon as possible thereafter (Priority 2).

The Priority 1, High-risk Sites for the Western Region include:

- M0131: Beaver Creek RCMP Detachment;
- 3100: Nelnah Bessie John School;
- 3102: Beaver Creek Fire Hall and Library;
- 3121: Beaver Creek Visitor Reception Centre;
- 3122: Beaver Creek Swimming Pool;
- 3125: Beaver Creek Airport Terminal Building; and,
- 3964: Beaver Creek Health Centre.

Installation of treatment systems will result in increased operation and maintenance costs for these systems. YTG should consider for budgetary purposes that the equivalent of a full time water system operator, with adequate training, would be required to coordinate the operation, maintenance and routine testing of these systems. Requirements of the proposed Guidelines for Small Public Drinking Water Systems, and any other applicable guideline or regulation should be implemented diligently within the "multi-barrier" approach.

A general recommendation for operation and maintenance for systems where upgrades are not immediately implemented that would mitigate significant risk is to inspect and disinfect (superchlorinate with 200 mg/L chlorine solution) every water well, tank and distribution system on a bi-annual basis (every 6 months).

23.0 RECOMMENDATIONS AND CONCLUSIONS

The recommended upgrade options presented within this report should be evaluated by YTG with regard to risk, preference and cost. Priority 1 upgrades should be completed as soon as possible. All Priority 2 upgrades should also be completed as soon as budget and scheduling permits in the future. Priority 3 conditions should be monitored to check if and when they may worsen to a Priority 2 or 1 situation. In consideration of building priority, YTG PMA should start by commissioning the implementation of Priority 1 upgrades recommended for systems that are identified as "Priority 1-High-risk". Addressing Priority 1 deficiencies at other systems with an overall "lower risk" should follow based on level of risk until all Priority 1 upgrades are complete.

Two in-use wells (3102- Beaver Creek Fire Hall and 3201- Burwash Landing Airport) were found to be without well caps, and are therefore, were very vulnerable to the entrance of vermin, insects and other foreign objects. This put them at risk of potential exposure to bacteria, viruses and/or protozoa. This was brought to the attention of PMA in August, following the assessments. A new well has subsequently been drilled and commissioned at 3201 – Burwash Landing Airport. If not already completed, PMA should ensure that the Beaver Creek Fire Hall has a properly fitted cap installed as soon as possible.

It is recommended that interim alternate sources of drinking water be provided for the following buildings, until such time as the Priority 1 upgrades have been implemented:

- 3102: Beaver Creek Firehall and Library
- 3172: Destruction Bay Firehall; and,
- 3186: Destruction Bay Grader Station;

For these systems, it is recommended that YTG PMA consult with YTG EHSS to determine the best approach to issuing advisories and implementing interim measures (boiled water advisories or provision of bottled water).

It is recommended that additional assessment be completed for some systems as soon as possible. This would include:

- 3440: Blanchard Camp – Attempt to obtain well log, confirm purpose of monitoring wells;
- 3442: Haines Junction Initial Attack Base – Monitor residual chlorine concentrations;
- M0131: RCMP Detachment: Determine location of septic system and purpose of monitoring wells;

- M0134: RCMP Residence - Attempt to obtain well log;
- 3100: Nelnah Bessie John School - Attempt to obtain well log, confirm location of septic field;
- 3102: Beaver Creek Fire hall - Attempt to obtain well log and confirm location of septic field;
- 3121: Beaver Creek Visitor Reception Centre - Attempt to obtain well log;
- 3123: Beaver Creek Grader Station - Confirm location of break in septic and/or rock pit discharge line and repair;
- 3125: Beaver Creek Airport - Attempt to obtain well log, camera investigation of well;
- 3964: Beaver Creek Health Centre - Attempt to obtain well log, confirm location of septic field;
- 3204: Burwash Fire hall - Attempt to obtain well log; and,
- 3171: Kluane Lake School – Ensure pellet chlorinator is functional.

24.0 LIMITATIONS

Conclusions and recommendations presented in this report are based on the wellhead inspections, water supply source evaluations and distribution and treatment system evaluations as described in the previous sections. The project team attempted to identify all water system deficiencies in the amount of time allocated for each assessment, while working within the constraints of the scope, budget and accessibility. It is possible that some deficiencies or risks have not been identified within the level of effort this project afforded. EBA bears no responsibility for undiscovered deficiencies due to project limitations on level of effort. This report has been prepared for the exclusive use of the Government of Yukon. This report has been prepared in accordance with generally accepted hydrogeological and environmental engineering practices. For further limitations regarding the use of this report, reference should be made to the EBA Environmental Report - General Conditions attached, which form a part of this report.

25.0 CLOSURE

EBA trusts this report meets your present requirements. If you have questions or concerns, please do not hesitate to call the undersigned.

Respectfully submitted;
EBA Consultants Ltd.

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TABLES

TABLE 1: SUMMARY OF HISTORICAL BACTERIOLOGICAL RESULTS

Building #	Building Name	Number of Sampling Events	Time Period over which Sampling was Done	Any Positive Total Coliform Results? (yes or no)	Fraction of Positive Total Coliform Results vs. Total Sampling Events	Any positive E.Coli results? (yes or no)	Most Recent Sampling Event Available for EBA Review	Is Most Recent Result Positive?
Haines Junction and Surrounding Area								
3440	Blanchard Grader Station	9	Sept-04 to Jun-05	no	0/9	no	16-Jun-05	no
3443	Haines Junction Initial Attack Base	2	May -05 to Jun-05	no	0/2	no	16-Jun-05	no
Beaver Creek								
M0131	Beaver Creek R.C.M.P Detachment	3	Sept-04 to Jun-05	no	0/3	no	16-Jun-05	no
M0133	Beaver Creek R.C.M.P. Residence	4	Sept-04 to Jun-05	no	0/4	no	16-Jun-05	no
M0134	Beaver Creek R.C.M.P. Residence	4	Sept-04 to Jun-05	no	0/4	no	16-Jun-05	no
3100	Nelnah Bessie John School	9	Sept-04 to Jun-05	no	0/9	no	16-Jun-05	no
3102	Beaver Creek Fire Hall	8	Sept-04 to Jun-05	no	0/8	no	16-Jun-05	no
3121	Beaver Creek Visitor Reception Centre	2	May -05 to Jun-05	no	0/2	no	16-Jun-05	no
3122	Beaver Creek Swimming Pool	1	June-05	no	0/1	no	16-Jun-05	no
3123	Beaver Creek Grader Station	8	Oct-04 to Jun-05	no	0/8	no	16-Jun-05	no
3125	Beaver Creek Air Terminal Building	9	Sept-04 to Jun-05	**yes**	1/9	no	16-Jun-05	no
3964	Beaver Creek Health Centre	9	Sept-04 to Jun-05	no	0/9	no	16-Jun-05	no
Burwash Landing								
3201	Burwash Landing Airport Building	11	Sept-04 to Jun-05	**yes**	2/11	no	16-Jun-05	no
3204	Burwash Landing Fire Hall	9	Sept-04 to Jun-05	no	0/9	no	16-Jun-05	no
Destruction Bay								
3171	Kluane Lake School	9	Sept-04 to Jun-05	no	0/9	no	16-Jun-05	no
3172	Destruction Bay Fire Hall	9	Sept-04 to Jun-05	**yes**	1/9	no	16-Jun-05	no
3186	Destruction Bay Grader Station	9	Sept-04 to Jun-05	no	0/9	no	16-Jun-05	no
3957	Destruction Bay Health Centre	9	Sept-04 to Jun-05	no	0/9	no	16-Jun-05	no

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Table 2: Water Quality Results

SOURCE:	Building 3440 - Blanchard Grader Station				Building 3443 - Haines Junction Initial Atack Base		Building M0131 - Beaver Creek RCMP Detachment			Building M0133 - Beaver Creek RCMP Residence			Building M0134 - Beaver Creek RCMP Residence			Building 3100 - Nelnah Bessie John School			Building 3102 - Beaver Creek Fire Hall			GCDWQ Criteria		
Location/ Resident	Haines Road				Haines Junction		Beaver Creek			Beaver Creek			Beaver Creek			Beaver Creek			Beaver Creek					
Address																								
Treatment	None			Filtration, softener, RO	None		None			Filtration			None			Water softener, activated carbon filter			None					
Disinfection	None			UV disinfection	None		None			None			None			Chlorination			None					
Source of Water	On-site well				Water delivery		On-site well			On-site well			On-site well			On-site well			On-site well					
Purpose of Sampling	Base Line	Base Line	Additional Analytical	Additional Analytical	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical			
Sample Location	Grader Station	Grader Station	Grader Station	Living Complex		Kitchen tap			Kitchen tap			Kitchen tap			Kitchen tap			Arts room sink			Library washroom sink			
Date Sampled	21-Sep-04	15-Jun-05	29-Jul-05	29-Jul-05		26-Jul-05	Sept-28-04	15-Jul-05	27-Jul-05	23-Sep-04	15-Jun-05	27-Jul-05	23-Sep-04	15-Jun-05	27-Jul-05	21-Sep-04	15-Jun-05	28-Jul-05	Sep-28-05	15-Jun-05	28-Jul-05	**Limit**	**Upper Limit**	
Physical Tests *(ALS)*																						**AO**	**MAC**	**AO**
Colour (CU)	<5.0	<5.0	-	<5.0		<5.0	5	<5.0	-	<5	<5.0	-	<5	<5.0	-	<5	<5.0	-	5	<5.0	-			15
Conductivity (uS/cm)		218	-	2.8		251		471	-		309	-		310	-		456	-		401	-			
Total Dissolved Solids	212	124	-	<10		164	259	291	-	171	189	-	164	188	-	265	296	-	214	227	-			500
Hardness CaCO3	198	102	-	<0.66		12.3	241	247	-	151	141	-	149	140	-	<0.9	<0.66	-	198	170	-	AO >200 = poor, > 500 unacceptable[A]		
pH	8.09	8.17	-	**6.10**		8.04	8.14	8.21	-	8.21	8.25	-	8.21	8.24	-	8.08	7.87	-	8.17	7.79	-	6.5		8.5
Turbidity (NTU)	0.3	0.4	-	0.64		0.70	**1.7**	0.86	0.5200	0.4	**2.28**	0.360	0.5	0.84	-	0.2	0.41	-	**2.3**	**2.57**	**2.69**		1	5
UV Absorbance			<0.0050	-		0.0080			0.0230			0.0050			0.0080			-			0.0210			
% UV Transmittance			99.3	-		98.2			94.8			98.9			98.2			-			95.3			
Dissolved Anions *(ALS)*																								
Alkalinity-Total CaCO3	163	89.7	-	1.9		108	217	222	-	128	138	-	119	131	-	164	174	-	179	196	-			
Chloride Cl	5.7	8.59	-	<0.50		1.21	10.4	10.9	-	1.1	0.83	-	<0.5	1.08	-	2.4	2.24	-	7.8	9.14	-			250
Fluoride F	<0.05	0.028	-	<0.020		0.217	0.05	0.055	-	<0.05	0.057	-	<0.05	0.06	-	0.05	0.076	-	<0.05	0.061	-		1.5	
Silicate SiO4			-	-		-			-			-			-			-			-			
Sulphate SO4	30.4	10.4	-	<0.50		15.3	24	24.6	-	32.6	35.2	-	32.6	35.3	-	24.6	26.0	-	21.5	21.3	-			500
Nitrate Nitrogen N	0.5	<0.10	-	<0.10		<0.10	0.2	0.15	-	0.2	0.22	-	0.2	0.22	-	0.5	0.8	-	0.1	<0.10	-		10	
Nitrite Nitrogen N	<0.05	<0.10	-	<0.10		<0.10	0.05	<0.10	-	<0.05	<0.10	-	<0.05	<0.10	-	<0.05	<0.10	-	<0.05	<0.10	-		3.2	
Ammonia Nitrogen N			-	-		-			-			-			-			-			-			
Total Phosphate PO4			-	-		-			-			-			-			-			-			
Total Metals *(ALS)*																								
Aluminum T-Al	<0.005	<0.010	-	<0.010		<0.010	0.005	<0.010	-	<0.005	<0.010	-	<0.005	<0.010	-	<0.005	<0.010	-	<0.005	<0.010	-		0.1	
Antimony T-Sb	<0.0002	<0.00050	-	<0.00050		<0.00050		<0.00050	-	<0.0002	<0.00050	-	<0.0002	<0.00050	-	<0.0002	<0.00050	-	<0.0002	<0.00050	-		0.006	
Arsenic T-As	0.0005	0.0006	-	<0.00010		*0.0203*	0.0014	0.00108	-	0.0012	0.00093	-	0.0011	0.00095	-	0.0004	0.00028	-	0.001	0.00097	-		0.025	
Barium T-Ba	0.039	0.066	-	<0.020		0.024	0.049	0.046	-	0.017	<0.020	-	0.017	<0.020	-	0.001	<0.020	-	0.041	0.038	-		1	
Boron T-B	0.023	<0.10	-	<0.10		0.12	0.025	<0.10	-	0.027	<0.10	-	0.026	<0.10	-	0.005	<0.10	-	0.019	<0.10	-		5	
Cadmium T-Cd	<0.00001	<0.00020	-	<0.00020		<0.00020	0.00001	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	-		0.005	
Calcium T-Ca		30.3	-	<0.10		3.92		79.0	-		45.2	-		44.9	-		<0.10	-		52.2	-			
Chromium T-Cr	0.001	<0.0020	-	<0.0020		<0.0020	0.0008	<0.0020	-	0.0006	<0.0020	-	0.0007	<0.0020	-	<0.0005	<0.0020	-	0.0006	<0.0020	-		0.05	
Copper T-Cu	0.032	0.0484	-	0.107		0.0098	0.792	0.661	-	0.053	0.0494	-	0.153	0.139	-	0.016	0.0265	-	0.804	0.748	-		1	
Iron T-Fe	0.01	<0.030	-	<0.030		<0.030	0.13	0.079	-	0.03	<0.030	-	0.03	<0.030	-	<0.01	<0.030	-	0.16	0.142	-			0.3
Lead T-Pb	0.0004	0.0011	-	0.0011		<0.0010	0.0015	0.0039	-	<0.0001	<0.0010	-	<0.0001	<0.0010	-	<0.0001	<0.0010	-	0.0037	0.0065	-		0.01	
Magnesium T-Mg		6.38	-	<0.10		0.61		12.2	-		6.86	-		6.8	-		<0.10	-		9.54	-			
Manganese T-Mn	<0.005	<0.0020	-	<0.0020		<0.0020	**0.05**	0.0437	-	<0.005	<0.0020	-	<0.005	<0.0020	-	<0.005	<0.0020	-	0.008	0.003	-			0.05
Mercury T-Hg		<0.00020	-	<0.00020		<0.00020		<0.00020	-		<0.00020	-		<0.00020	-		<0.00020	-		<0.00020	-		0.001	
Potassium T-K		2.66	-	0.45		0.39		1.76	-		1.24	-		1.25	-		154	-		1.54	-			
Selenium T-Se		0.0017	-	<0.0010		<0.0010		<0.0010	-		<0.0010	-		<0.0010	-		<0.0010	-		<0.0010	-		0.01	
Sodium T-Na		<2.0	-	<2.0		57.3	3.7	3.0	-		2.8	-		2.7	-		<2.0	-		2.7	-			200
Uranium T-U	<0.0005	0.00075	-	<0.00010		<0.00010	0.0005	0.00032	-	<0.0005	0.00035	-	<0.0005	0.00035	-	<0.0005	<0.00010	-	<0.0005	0.00021	-		0.02	
Vanadium T-V			-	-		-			-			-			-			-			-			
Zinc T-Zn	0.175	0.057	-	<0.050		<0.050	0.657	0.881	-	0.021	<0.050	-	0.003	<0.050	-	0.003	<0.050	-	0.192	0.153	-			5
Dissolved Metals																								
Aluminum D-Al			-	-		-			-			-			-			-			-		0.1	
Antimony D-Sb			-	-		-			-			-			-			-			-		0.006	
Arsenic D-As			-	-		-			-			-			-			-			-		0.025	
Barium D-Ba			-	-		-			-			-			-			-			-		1.0	
Boron D-B			-	-		-			-			-			-			-			-		5	
Cadmium D-Cd			-	-		-			-			-			-			-			-		0.005	
Calcium D-Ca			-	-		-			-			-			-			-			-			
Chromium D-Cr			-	-		-			-			-			-			-			-		0.05	
Copper D-Cu			-	-		-			-			-			-			-			-			1.0
Iron D-Fe			-	-		-			-			-			-			-			-			0.3
Lead D-Pb			-	-		-			-			-			-			-			-		0.01	
Magnesium D-Mg			-	-		-			-			-			-			-			-			
Manganese D-Mn			-	-		-			-			-			-			-			-			0.05
Mercury D-Hg			-	-		-			-			-			-			-			-		0.001	
Potasium D-K			-	-		-			-			-			-			-			-			
Selenium D-Se			-	-		-			-			-			-			-			-		0.01	
Sodium D-Na			-	-		-			-			-			-			-			-			200
Uranium D-U			-	-		-			-			-			-			-			-		0.02	
Vanadium D-V			-	-		-			-			-			-			-			-			
Zinc D-Zn			-	-		-			-			-			-			-			-			5.0
Trihalomethanes																								
Bromodichloromethane			-	-		-			-			-			-			<0.0010			-			
Bromoform			-	-		-			-			-			-			<0.0010			-			
Chloroform			-	-		-			-			-			-			<0.0010			-			
Dibromochloromethane			-	-		-			-			-			-			<0.0010			-			
Total Trihalomethanes			-	-		-			-			-			-			<0.0040			-			
Organic Parameters																								
Tannin and Lignin			<0.10	-		<0.10			0.10			<0.10			<0.10			-			0.20			
Total Organic Carbon C			0.81	-		0.78			1.42			1.03			0.72			0.84			0.98			
Haloacetic Acids																								
Bromoacetic Acid			-	-		-			-			-			-			<0.0020			-			
Bromochloroacetic Acid			-	-		-			-			-			-			<0.0020			-			
Chloroacetic Acid			-	-		-			-			-			-			<0.020			-			
Dibromoacetic Acid			-	-		-			-			-			-			<0.0020			-			
Dichloroacetic Acid			-	-		-			-			-			-			<0.0020			-			
Trichloroacetic Acid (TCA)			-	-		-			-			-			-			<0.0020			-			
Polycyclic Aromatic Hydrocarbons																								
Acenaphthene			-	-		-			-			-			-			<0.000050			-			
Acenaphthylene			-	-		-			-			-			-			<0.000050			-			
Acridine			-	-		-			-			-			-			<0.000050			-			
Anthracene			-	-		-			-			-			-			<0.000050			-			
Benz(a)anthracene			-	-		-			-			-			-			<0.000050			-			
Benzo(a)pyrene			-	-		-			-			-			-			<0.000010			-		0.00001	
Benzo(b)fluoranthene			-	-		-			-			-			-			<0.000050			-			
Benzo(g,h,i)perylene			-	-		-			-			-			-			<0.000050			-			
Benzo(k)fluoranthene			-	-		-			-			-			-			<0.000050			-			
Chrysene			-	-		-			-			-			-			<0.000050			-			
Dibenz(a,h)anthracene			-	-		-			-			-			-			<0.000050			-			
Fluoranthene			-	-		-			-			-			-			<0.000050			-			
Fluorene			-	-		-			-			-			-			<0.000050			-			
Indeno(1,2,3-c,d)pyrene			-	-		-			-			-			-			<0.000050			-			
Naphthalene			-	-		-			-			-			-			<0.000050			-			
Phenanthrene			-	-		-			-			-			-			<0.000050			-			
Pyrene			-	-		-			-			-			-			<0.000050			-			
Quinoline			-	-		-			-			-			-			<0.000050			-			
Extractable Hydrocarbons																								
EPH10-19			<0.30	-		-			-			-			-			<0.30			<0.30			
EPH19-32			<1.0	-		-			-			-			-			<1.0			<1.0			
LEPH			-	-		-			-			-			-			<0.30			-			
HEPH			-	-		-			-			-			-			<1.0			-			
Field Chemistry (EBA)																								
pH			**8.59**	7.86		**8.66**			7.99			8.34			8.31			8.12			8.04	6.5		8.5
TDS (ppm)			83	<1		127			174			51			149			230			200			500
EC (uS/cm)			175	<1		253			291			104			308			460			400			
Temperature (°C)			7.3	16.4		21.4			10.9			7.8			9.6			6.0			16.4			
Free Available Chlorine						0.01												0.07						

Notes:

A. Guidelines indicated for hardness are not CDWQG, rather they are general aesthetic guidelines - exceedences are indicated in yellow highlighting .

Italics and underline indicates exceedence of proposed MAC (ie. arsenic)

Bold with Yellow highlighting indicates exceedence of CDWQG Aesthetic Objective (AO)

Bold Underline with Yellow highlighting indicates exceedence of CDWQG MAC

Results are expressed as milligrams per litre except for pH and Colour (CU), Conductivity (umhos/cm),Temperature (°C) and Turbidity (NTU)

< = Less than the detection limit indicated.

AO = Aesthetic Objective

MAC = Maximum Acceptable Concentration (Health Based)

- = not tested

Table 2: Water Quality Results

SOURCE:	Building 3121- Beaver Creek Visitor Reception Centre			Building 3122 - Beaver Creek Swimming Pool		Building 3123 - Beaver Creek Grader Station			Building 3125 - Beaver Creek Air Terminal Building			Building 3964 - Beaver Creek Health Centre			Building 3201 - Burwash Landing Airport Building			Building 3204 - Burwash Landing Fire Hall			GCDWQ Criteria		
Location/ Resident	Beaver Creek			Beaver Creek		Beaver Creek			Beaver Creek			Beaver Creek			Burwash Landing			Burwash Landing					
Address																							
Treatment	None			None		Filtration			None			None			None			None					
Disinfection	None			None		None			None			None			None			None					
Source of Water	On-site well			On-site well		On-site well			On-site well			On-site well			On-site well			On-site well					
Purpose of Sampling	Base Line	Base Line	Additional Analytical	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical			
Sample Location			Washroom tap		Pool changing room tap			Kitchen tap			Washroom tap			Washroom tap			Kitchen tap			Washroom tap			
Date Sampled	21-Sep-04	15-Jun-05	27-Jul-05	15-Jun-05	27-Jul-05	21-Sep-04	15-Jun-05	27-Jul-05	21-Sep-04	15-Jun-05	27-Jul-05	21-Sep-04	15-Jun-05	27-Jul-05	21-Sep-04	15-Jun-05	28-Jul-05	21-Sep-04	15-Jun-05	28-Jul-05	Lower Limit	Upper Limit	
Physical Tests *(ALS)*																					AO	MAC	AO
Colour (CU)	<5	<5.0	-	<5.0	-	<5.0	<5.0	-	7	<5.0	-	<5	<5.0	-	<5	<5.0	-	10	<5.0	-			15
Conductivity (uS/cm)		709	-	404	-		363	-		290	-		515	-		622	-		365	-			
Total Dissolved Solids	351	427	-	231	-	109	222	-	156	171	-	259	316	-	370	402	-	206	218	-			500
Hardness CaCO3	335	346	-	194	-	97.3	152	-	137	126	-	234	255	-	334	329	-	115	117	-	AO >200 = poor, > 500 unacceptable[A]		
pH	8.05	8.09	-	8.13	-	8.24	8.17	-	8.29	8.16	-	8.06	8.13	-	7.95	8.20	-	8.38	8.26	-	6.5		8.5
Turbidity (NTU)	0.5	0.42	-	0.26	0.72	0.3	0.36	-	**4.1**	**3.29**	**11.7**	**1.6**	0.74	-	0.40	0.64	-	**9.8**	**11.1**	**4.01**		1	5
UV Absorbance			0.0180		0.0110			0.007			0.0060			0.0130			0.119			0.0700			
% UV Transmittance			95.9		97.5			98.4			98.6			97.0			76.0			85.1			
Dissolved Anions *(ALS)*																							
Alkalinity-Total CaCO3	286	297	-	183	-	91	155	-	120	118	-	191	218	-	243	247	-	148	165	-			
Chloride Cl	23.7	32.7	29.5	2.68	-	5.7	3.08	-	<0.5	0.62	-	17.4	16.2	-	6.6	4.23	4.36	1.2	1.15	-			250
Fluoride F	<0.05	0.036	-	0.052	-	<0.05	0.057	-	<0.05	0.059	-	<0.05	0.048	-	0.18	0.238	-	0.18	0.257	-		1.5	
Silicate SiO4			-		-			-			-			-			-			-			500
Sulphate SO4	26.0	28.6	-	33.0	-	9.73	34.0	-	28.9	32.6	-	32.4	37.1	-	89.8	99.3	-	42.2	39.0	-			
Nitrate Nitrogen N	2.9	4.95	5.17	0.71	-	<0.1	0.60	-	0.2	0.22	-	0.6	0.61	-	1.7	1.44	1.59	0.1	<0.10	-		10	
Nitrite Nitrogen N	<0.05	<0.10	<0.0010	<0.10	-	<0.05	<0.10	-	<0.05	<0.10	-	<0.05	<0.10	-	<0.05	<0.10	<0.0010	<0.05	<0.10	-		3.2	
Ammonia Nitrogen N			<0.020		-			-			-			-			0.020			-			
Total Phosphate PO4			-		-			-			-			-			-			-			
Total Metals *(ALS)*																							
Aluminum T-Al	<0.005	<0.010	-	<0.010	-	<0.005	<0.010	-	<0.005	<0.010	-	<0.005	<0.010	-	0.006	<0.010	-	0.047	0.017	-			
Antimony T-Sb	<0.0002	<0.00050	-	<0.00050	-	<0.0002	<0.00050	-	<0.0002	<0.00050	-	<0.0002	<0.00050	-	0.0003	<0.00050	-	<0.0002	<0.00050	-		0.006	
Arsenic T-As	0.0008	0.00069	-	0.00048	-	0.0007	0.00036	-	0.0006	0.00041	-	0.0003	0.00026	-	0.0006	0.00037	-	*0.0055*	0.00432	-		0.025	
Barium T-Ba	0.123	0.120	-	0.041	-	0.067	0.033	-	0.011	<0.020	-	0.052	0.050	-	0.038	0.025	-	0.018	<0.020	-		1	
Boron T-B	0.029	<0.10	-	<0.10	-	0.009	<0.10	-	0.026	<0.10	-	0.027	<0.10	-	0.062	<0.10	-	0.504	0.41	-		5	
Cadmium T-Cd	0.00001	<0.00020	-	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	-		0.005	
Calcium T-Ca		108	-	63.8	-		48.6	-		39.3	-		83.0	-		91.9	-		22.0	-			
Chromium T-Cr	0.002	<0.0020	-	<0.0020	-	<0.0005	<0.0020	-	0.0005	<0.0020	-	0.0011	<0.0020	-	0.0008	<0.0020	-	0.0006	<0.0020	-		0.05	
Copper T-Cu	0.012	0.0094	-	0.432	-	0.011	0.0295	-	0.059	0.102	-	0.140	0.0678	-	**1.12**	0.793	0.645	0.017	0.0034	-		1	
Iron T-Fe	0.04	<0.030	-	<0.030	-	0.03	<0.030	-	0.27	0.209	-	0.15	0.052	-	0.02	0.059	-	**0.45**	0.154	-			0.3
Lead T-Pb	0.0006	<0.0010	-	0.0014	-	0.0004	<0.0010	-	0.0014	0.0010	-	0.0013	0.0040	-	0.0004	0.0012	-	0.001	<0.0010	-		0.01	
Magnesium T-Mg		18.6	-	8.50	-		7.42	-		6.67	-		11.6	-		24.2	-		15.0	-			
Manganese T-Mn	<0.005	<0.0020	-	<0.0020	-	<0.005	<0.0020	-	0.014	0.0090	-	0.008	0.0096	-	<0.005	<0.0020	-	**0.059**	0.0467	-			0.05
Mercury T-Hg		<0.00020	-	<0.00020	-		<0.00020	-		<0.00020	-		<0.00020	-		<0.00020	-		<0.00020	-		0.001	
Potassium T-K		2.43	-	1.17	-		1.05	-		1.08	-		1.45	-		4.42	-		2.79	-			
Selenium T-Se		<0.0010	-	<0.0010	-		<0.0010	-		<0.0010	-		<0.0010	-		0.0011	-		0.0014	-		0.01	
Sodium T-Na	4.7	4.5	-	3.7	-	1.5	2.9	-	3.0	2.5	-		5.0	-	5.9	5.3	-	34.4	37.2	-			200
Uranium T-U	<0.0005	0.00053	-	0.00035	-	<0.0005	0.00030	-	<0.0005	0.00030	-	<0.0005	0.00037	-	0.0024	0.00220	-	<0.0005	0.00015	-		0.02	
Vanadium T-V			-		-			-			-			-			-			-			
Zinc T-Zn	0.084	0.056	-	<0.050	-	0.058	0.140	-	1.47	1.02	-	0.485	0.176	-	0.012	<0.050	-	0.011	<0.050	-			5
Dissolved Metals																							
Aluminum D-Al			-		-			-			-			-			-			-			
Antimony D-Sb			-		-			-			-			-			-			-			
Arsenic D-As			-		-			-			-			-			-			-			
Barium D-Ba			-		-			-			-			-			-			-			
Boron D-B			-		-			-			-			-			-			-			
Cadmium D-Cd			-		-			-			-			-			-			-			
Calcium D-Ca			-		-			-			-			-			-			-			
Chromium D-Cr			-		-			-			-			-			-			-			
Copper D-Cu			-		-			-			-			-			0.647			-			
Iron D-Fe			-		-			-			-			-			-			-			
Lead D-Pb			-		-			-			-			-			-			-			
Magnesium D-Mg			-		-			-			-			-			-			-			
Manganese D-Mn			-		-			-			-			-			-			-			
Mercury D-Hg			-		-			-			-			-			-			-			
Potasium D-K			-		-			-			-			-			-			-			
Selenium D-Se			-		-			-			-			-			-			-			
Sodium D-Na			-		-			-			-			-			-			-			
Uranium D-U			-		-			-			-			-			-			-			
Vanadium D-V			-		-			-			-			-			-			-			
Zinc D-Zn			-		-			-			-			-			-			-			
Trihalomethanes																							
Bromodichloromethane			-		-			-			-			-			-			-			
Bromoform			-		-			-			-			-			-			-			
Chloroform			-		-			-			-			-			-			-			
Dibromochloromethane			-		-			-			-			-			-			-			
Total Trihalomethanes			-		-			-			-			-			-			-			
Organic Parameters																							
Tannin and Lignin			0.11		0.21			0.14			<0.10			0.10			0.13			0.31			
Total Organic Carbon C			1.54		1.17			0.89			0.90			1.41			7.14			11.6			
Haloacetic Acids																							
Bromoacetic Acid			-		-			-			-			-			-			-			
Bromochloroacetic Acid			-		-			-			-			-			-			-			
Chloroacetic Acid			-		-			-			-			-			-			-			
Dibromoacetic Acid			-		-			-			-			-			-			-			
Dichloroacetic Acid			-		-			-			-			-			-			-			
Trichloroacetic Acid (TCA)			-		-			-			-			-			-			-			
Polycyclic Aromatic Hydrocarbons																							
Acenaphthene			-		-			<0.000050			-			-									
Acenaphthylene			-		-			<0.000050			-			-			-			-			
Acridine			-		-			<0.000050			-			-			-			-			
Anthracene			-		-			<0.000050			-			-			-			-			
Benz(a)anthracene			-		-			<0.000050			-			-			-			-			
Benzo(a)pyrene			-		-			<0.000010			-			-			-			-		0.00001	
Benzo(b)fluoranthene			-		-			<0.000050			-			-			-			-			
Benzo(g,h,i)perylene			-		-			<0.000050			-			-			-			-			
Benzo(k)fluoranthene			-		-			<0.000050			-			-			-			-			
Chrysene			-		-			<0.000050			-			-			-			-			
Dibenz(a,h)anthracene			-		-			<0.000050			-			-			-			-			
Fluoranthene			-		-			<0.000050			-			-			-			-			
Fluorene			-		-			<0.000050			-			-			-			-			
Indeno(1,2,3-c,d)pyrene			-		-			<0.000050			-			-			-			-			
Naphthalene			-		-			<0.000050			-			-			-			-			
Phenanthrene			-		-			<0.000050			-			-			-			-			
Pyrene			-		-			<0.000050			-			-			-			-			
Quinoline			-		-			<0.000050			-			-			-			-			
																	-			-			
Extractable Hydrocarbons																							
EPH10-19			-		-			<0.30			<0.30			-			<0.30			-			
EPH19-32			-		-			<1.0			<1.0			-			<1.0			-			
LEPH			-		-			<0.30			-			-			-			-			
HEPH			-		-			<1.0			-			-			-			-			
Field Chemistry (EBA)																							
pH			7.82		8.05			8.01			8.31			7.68			7.95			Undetectable due to turbulence	6.5		8.5
TDS (ppm)			352		203			186			127			297			284						500
EC (uS/cm)			700		403			370			251			593			575						
Temperature (°C)			7.8		6.9			13.9			17.5			14.7			4.8						
Free Available Chlorine																							

Notes:

A. Guidelines indicated for hardness are not CDWQG, rather they are general aesthetic guidelines - exceedences are indicated in yellow highlighting

Italics and underline indicates exceedence of proposed MAC (ie. arsenic)

Bold with Yellow highlighting indicates exceedence of CDWQG Aesthetic Objective (AO)

Bold Underline with Yellow highlighting indicates exceedence of CDWQG MAC

Results are expressed as milligrams per litre except for pH and Colour (CU), Conductivity (umhos/cm), Temperature (°C) and Turbidity (NTU)

< = Less than the detection limit indicated.

AO = Aesthetic Objective

MAC = Maximum Acceptable Concentration (Health Based)

- = not tested

Table 2: Water Quality Results

SOURCE:	Building 3171 - Kluane Lake School			Building 3172 - Destruction Bay Fire Hall			Building 3186 - Destruction Bay Grader Station			Building 3957 - Destruction Bay Health Centre			GCDWQ Criteria		
Location/ Resident	Destruction Bay			Destruction Bay			Destruction Bay			Destruction Bay					
Address															
Treatment				None			None			Water softener, pH neutralizer and colour remover					
Disinfection	Chlorination (no residual)			None			None			None					
Source of Water	On-site well			On-site well			On-site well			On-site well					
Purpose of Sampling	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical	Base Line	Base Line	Additional Analytical			
Sample Location			Arts room sink												
Date Sampled	21-Sep-05	Jun-15-05	28-Jul-05	19-Oct-05	16-Jun-05	28-Jul-05	19-Oct-05	Jun-15-05	28-Jul-05	21-Sep-05	Jun-15-05	28-Jul-05	**Lower Limit**	**Upper Limit**	
Physical Tests *(ALS)*													**AO**	**MAC**	**AO**
Colour (CU)	<5	<5.0	-	**>60**	<5	<5.0	**>60**	6.0	5.8	<5	<5.0	-			15
Conductivity (uS/cm)		830	-		672	-		749	-		810	-			
Total Dissolved Solids	**680**	**528**	-	389	413	-	452	492	-	490	**525**	-			500
Hardness CaCO3	1.8	446	-	308	312	-	399	350	403	<0.9	<3.3	-	AO >200 = poor, > 500 unacceptable[A]		
pH	8.36	8.33	-	8.42	8.43	-	8.20	8.36	-	**8.79**	**8.68**	-	6.5		8.5
Turbidity (NTU)	0.3	**1.08**	0.41	**53.5**	**11.0**	**3.04**	**21.1**	**12.7**	**23.0**	0.6	0.45	-		1	5
UV Absorbance			-			0.077			0.08			0.0080			
% UV Transmittance			-			83.8			82.8			98.2			
Dissolved Anions *(ALS)*															
Alkalinity-Total CaCO3	292	295	-	245	231	-	291	247	-	121	122	-			
Chloride Cl	1.3	1.06	-	6.1	1.04	-	0.9	0.79	-	8.9	7.68	-			250
Fluoride F	0.18	0.269	-	0.31	0.327	-	0.25	0.276	-	0.14	0.208	-		1.5	
Silicate SiO4			-			-			15.7			14.4			
Sulphate SO4	165	184	-	109	150	-	127	181	-	169	190	-			500
Nitrate Nitrogen N	<0.1	<0.10	-	<0.01	<0.10	-	0.07	<0.10	-	<0.1	<0.10	-		10	
Nitrite Nitrogen N	<0.05	<0.10	-	<0.005	<0.10	-	<0.005	0.31	-	<0.05	<0.10	-		3.2	
Ammonia Nitrogen N			-			-			-			-			
Total Phosphate PO4			-			-			0.109			0.0238			
Total Metals *(ALS)*															
Aluminum T-Al	0.034	<0.010	-	<0.005	<0.010	-	0.008	0.023	0.305	<0.005	<0.050	-			
Antimony T-Sb	<0.0002	<0.00050	-	<0.0002	<0.00050	-	<0.0002	<0.00050	<0.00050	<0.0002	<0.0025	-		0.006	
Arsenic T-As	0.0043	0.00373	-	0.0007	0.00081	-	**0.0329**	*0.0184*	**0.0353**	*0.0148*	*0.0114*	*0.0120*		0.025	
Barium T-Ba	0.002	0.021	-	0.022	<0.020	-	0.306	0.206	0.307	<0.001	<0.10	-		1	
Boron T-B	1.27	1.04	-	1.48	1.14	-	1.14	0.99	1.22	1.31	1.28	-		5	
Cadmium T-Cd	<0.00001	<0.00020	-	<0.00001	<0.00020	-	<0.00001	<0.00020	<0.00020	<0.00001	<0.0010	-		0.005	
Calcium T-Ca		67.4	-		38.5	-		47.5	56.6		<0.50	-			
Chromium T-Cr	0.0008	<0.0020	-	0.0017	<0.0020	-	<0.001	<0.0020	<0.0020	<0.0005	<0.010	-		0.05	
Copper T-Cu	0.002	<0.0010	-	<0.001	<0.0010	-	0.0003	0.0192	0.0069	0.006	0.190	-		1	
Iron T-Fe	<0.01	0.190	-	0.09	0.291	-	**2.94**	**1.34**	**2.20**	0.04	0.207	-			0.3
Lead T-Pb	0.0002	<0.0010	-	0.0007	<0.0010	-	0.0003	<0.0010	<0.0010	0.001	0.0064	-		0.01	
Magnesium T-Mg		67.5	-		52.4	-		56.2	66.1		<0.50	-			
Manganese T-Mn	<0.005	**0.0974**	<0.0050	0.029	0.0479	-	**0.165**	**0.137**	**0.238**	<0.005	<0.010	-			0.05
Mercury T-Hg		<0.00020	-		<0.00020	-		<0.00020	<0.00020		<0.00020	-		0.001	
Potassium T-K		5.82	-		5.37	-		4.02	4.49		222	-			
Selenium T-Se		<0.0010	-		0.0026	-		<0.0010	<0.0010		<0.0050	-		0.01	
Sodium T-Na	19.1	27.2	-	31.3	30.9	-	20.9	22.2	24.7	4.8	22.9	-			200
Uranium T-U	<0.0005	0.00131	-	0.0008	0.00072	-	<0.0005	<0.00010	<0.00010	<0.0005	<0.00050	-		0.02	
Vanadium T-V			-			-			0.033			<0.030			
Zinc T-Zn	0.010	<0.050	-	0.008	<0.050	-	0.019	<0.050	<0.050	0.007	<0.25	-			5
Dissolved Metals *(ALS)*															
Aluminum D-Al			-			-			<0.010			-		0.1	
Antimony D-Sb			-			-			<0.00050			-		0.006	
Arsenic D-As			-			-			*0.0217*			*0.0119*		0.025	
Barium D-Ba			-			-			0.290			-		1.0	
Boron D-B			-			-			1.22			-		5	
Cadmium D-Cd			-			-			<0.00020			-		0.005	
Calcium D-Ca			-			-			54.2			-			
Chromium D-Cr			-			-			<0.0020			-		0.05	
Copper D-Cu			-			-			0.0022			-			1.0
Iron D-Fe			-			-			0.033			-			0.3
Lead D-Pb			-			-			<0.0010			-		0.01	
Magnesium D-Mg			-			-			64.9			-			
Manganese D-Mn			<0.0050			-			0.201			-			0.05
Mercury D-Hg			-			-			<0.00020			-		0.001	
Potasium D-K			-			-			4.67			-			
Selenium D-Se			-			-			<0.0010			-		0.01	
Sodium D-Na			-			-			24.5			-			200
Uranium D-U			-			-			<0.00010			-		0.02	
Vanadium D-V			-			-			<0.030			<0.030			
Zinc D-Zn			-			-			<0.050			-			5.0
Trihalomethanes															
Bromodichloromethane			-			-			-			-			
Bromoform			-			-			-			-			
Chloroform			-			-			-			-			
Dibromochloromethane			-			-			-			-			
Total Trihalomethanes			-			-			-			-		0.1	
Organic Parameters															
Tannin and Lignin			-			0.23			0.46			<0.10			
Total Organic Carbon C			2.15			7.02			3.64			0.52			
Haloacetic Acids															
Bromoacetic Acid			-			-			-			-			
Bromochloroacetic Acid			-			-			-			-			
Chloroacetic Acid			-			-			-			-			
Dibromoacetic Acid			-			-			-			-			
Dichloroacetic Acid			-			-			-			-			
Trichloroacetic Acid (TCA)			-			-			-			-			
Polycyclic Aromatic Hydrocarbons															
Acenaphthene			-			-			<0.000050			-			
Acenaphthylene			-			-			<0.000050			-			
Acridine			-			-			<0.000050			-			
Anthracene			-			-			<0.000050			-			
Benz(a)anthracene			-			-			<0.000050			-			
Benzo(a)pyrene			-			-			<0.000010			-		0.00001	
Benzo(b)fluoranthene			-			-			<0.000050			-			
Benzo(g,h,i)perylene			-			-			<0.000050			-			
Benzo(k)fluoranthene			-			-			<0.000050			-			
Chrysene			-			-			<0.000050			-			
Dibenz(a,h)anthracene			-			-			<0.000050			-			
Fluoranthene			-			-			<0.000050			-			
Fluorene			-			-			<0.000050			-			
Indeno(1,2,3-c,d)pyrene			-			-			<0.000050			-			
Naphthalene			-			-			<0.000050			-			
Phenanthrene			-			-			<0.000050			-			
Pyrene			-			-			<0.000050			-			
Quinoline			-			-			<0.000050			-			
Extractable Hydrocarbons															
EPH10-19			-			-			<0.30			-			
EPH19-32			-			-			<1.0			-			
LEPH			-			-			<0.30			-			
HEPH			-			-			<1.0			-			
Field Chemistry (EBA)															
pH			8.48			**8.60**			8.39			**9.11**	6.5		8.5
TDS (ppm)			**575**			203			376			414			500
EC (uS/cm)			1158			620			748			836			
Temperature (°C)			8.7			13.9			9.3			21.7			
Free Available Chlorine			0.00												

Notes:

A. Guidelines indicated for hardness are not CDWQG, rather they are general aesthetic guidelines - exceedences are indicated in yellow highlighting .

Italics and underline indicates exceedence of proposed MAC (ie. arsenic)

Bold with Yellow highlighting indicates exceedence of CDWQG Aesthetic Objective (AO)

Bold Underline with Yellow highlighting indicates exceedence of CDWQG MAC

Results are expressed as milligrams per litre except for pH and Colour (CU), Conductivity (umhos/cm),Temperature (°C) and Turbidity (NTU)

< = Less than the detection limit indicated.

AO = Aesthetic Objective

MAC = Maximum Acceptable Concentration (Health Based)

- = not tested

eba

TABLE 4: SUMMARY OF OBSERVED DEFICIENCIES AND ESTIMATE COSTS
SMALL PUBLIC DRINKING WATER SYSTEMS

Building #	Building Name	HIGH AND MEDIUM RISK DEFICIENCIES	RECOMMENDED PRIORITY 1 MITIGATION	PRIORITY 1 ADDITIONAL ASSESSMENT	PRIORITY 1 COSTS				RECOMMENDED PRIORITY 2 - MITIGATION	PRIORITY 2 - ADDITIONAL ASSESSMENT	PRIORITY 2 - COSTS				LOW RISK DEFICIENCIES	RECOMMENDED PRIORITY 3 - MITIGATION	PRIORITY 3 - COSTS				
					Labour and Materials	Engineering	Contingency	Subtotal			Labour and Materials	Engineering	Contingency	Subtotal			Labour and Materials	Engineering	Contingency	Subtotal	Total
3440	Blanchard Grader Station	No treatment or disinfection for the maintenance garage. No well log. Fueling area 21 m upgradient.	Re-plumb treated water to serve potable water in maintenance garage.	Obtain well log and confirm purpose of monitoring wells	$250	$50	$50	$350	Move fueling area downgradient from well.		$600	$120	$120	$840	Wellhead not 500 mm above grade.	Extend wellhead 500 mm above grade. Raise floor to grade.	$400	$80	$80	$560	$1,750
3443	Haines Junction Initial Attack Base	Tank and manhole not properly sealed and susceptible to deleterious substances entering tank when overfilled. FAC low at both systems.	Option 1: Install smaller water delivery tank in building, and abandon existing tank.	Monitor FAC concentrations	$2,000	$400	$400	$2,800	Option 1: Ensure FAC is 0.4mg/L at time of delivery. Initiate testing program at both buildings.		$0	$0	$0	$0	Fill pipe and vent at warehouse ABS piping. Arsenic in exceedence of PMAC.	Replace ABS piping with PVC.	$200	$40	$40	$280	$3,080
			Option 2: Properly seal manhole to tank. Steam tank to remove aromatics.		$1,500	$300	$300	$2,100	Option 2: In the event that FAC concentrations cannot be maintained above 0.2 mg/L, a UV disinfection system should be installed.		$2,200	$440	$440	$3,080							$5,460
M0131	Beaver Creek RCMP Detachment	Poor wellhead completion. No surface seal. Location of septic system unknown. Purpose of monitoring wells unknown. Galvanized pressure tanks. No treatment or disinfection.	Standard wellhead upgrades. Install NSF 55 UV disinfection. Pretreatment likely required.	Determine location of septic system and purpose of monitoring wells	$9,500	$1,900	$1,900	$13,300	Install filtration to 1 micron absolute		$500	$100	$100	$700	Elevated copper. Galvanized pressure tanks. Turbidity previously high.	Monitor copper concentration. Replace galvanized pressure tanks with bladder pressure tank.	$2,000	$400	$400	$2,800	$16,800
M0133	Beaver Creek RCMP Residence	Poor wellhead completion. No surface seal. Located 1 m from an uncapped well. No functioning treatment or disinfection.	Install UV disinfection. Decommission abandoned well.	None	$3,200	$640	$640	$4,480	Standard wellhead upgrades. Install filtration to 1 micron absolute.		$4,500	$900	$900	$6,300	Softener and filter malfunctioning. Indoor fuel storage tank near well. Previous exceedence of turbidity. Plumbing reportedly unprofessional.	Install secondary containment around indoor AST. Repair softener and filter. Upgrade plumbing.	$1,200	$240	$240	$1,680	$12,460
M0134	Beaver Creek RCMP Residence	Poor wellhead construction. No surface seal. No well log. No functioning treatment or disinfection.	Install UV disinfection.	Obtain well log.	$2,200	$440	$440	$3,080	Standard wellhead upgrades. Install filtration to 1 micron absolute		$4,500	$900	$900	$6,300	Softener and filter malfunctioning. Softener drain not installed properly. Indoor AST near well.	Install secondary containment around indoor AST. Repair softener and filter. Upgrade plumbing.	$1,200	$240	$240	$1,680	$11,060
3100	Nelnah Bessie John School	Poor wellhead construction. No surface seal. No well log. UST 1m from well. Uncapped abandoned well 1m from well. Septic tank at 22 m, field may be within 30 m. Chlorination system not properly installed. Poor configuration of treatment system.	Decommission abandoned well. Upgrade chlorination system (Option 1), or replace with UV (Option 2).	Obtain well log. Confirm location of septic field.	$8,000	$1,600	$1,600	$11,200	Option 1: Standard wellhead upgrades. Remove UST and install AST at safe location relative to the water supply. This option contingent on location of septic field, and whether contamination exists around UST. This option could include either of the Priority 1 options presented for disinfection. Install filtration to 1 micron absolute.		$11,500	$2,300	$2,300	$16,100	Heat trace not properly installed.	Upgrade heat trace. Included with Priority 1.	$0	$0	$0	$0	$27,300
									Option 2a: Decommission existing well in install new dedicated well to serve School. This option could include either of the Priority 1 options presented for disinfection.		$32,200	$6,440	$6,440	$45,080		Mitigated by Priority 1 and 2 upgrades.	$0	$0	$0	$0	$45,080
					$3,500	$700	$700	$4,900	Option 2b: Decommission well, and install well to serve the School, Pool and Rec. centre. This option considers that cost for treatment is born by Rec Centre and Pool (required anyhow). UV system could be installed at another PMA site.		$28,000	$5,600	$5,600	$39,200		Mitigated by Priority 1 and 2 upgrades.	$0	$0	$0	$0	$41,600
3102	Beaver Creek Fire Hall	Poor wellhead completion. No well cap. No surface seal. No well log. Within 30 m of potential contaminant sources including AST and septic leach pit. Plumbing not to code and in disrepair. No treatment or disinfection.	Extend well casing and install well cap, re-plumb so that domestic water comes off system prior to tank, install backflow prevention, superchlorinate well and system, install treatment and UV (NSF/ANSI 55), no backflow prevention.	Attempt to locate well log. Tank should be cleaned through regular operation and maintenance. Chemicals and batteries stored on top of tank should be removed.	$3,700	$740	$740	$5,180	Option 1: New well to service building. Leave existing well plumbed into fire storage tanks only for back-up.		$30,000	$6,000	$6,000	$42,000	Elevated copper and lead (not above standards). Storage tank supports unlikely earthquake or collision proof.	Ongoing monitoring of copper and lead concentrations	Not included	$0	$0	$0	$47,180
									Option 2: Community Well (to tie in with Grader Stn, Health Centre and Firehall). Leave existing well plumbed into fire storage tanks only for back-up. Note: lower life cycle costs and easier operation and maintenance.		$25,000	$5,000	$5,000	$35,000							$40,180
3121	Beaver Creek Visitor Reception Centre	Poor wellhead completion. No surface sanitary seal. Poor location of well - in parking lot where may be subject to fuel and/or sewage spills from automobiles and recreational vehicles). Within 30 m of AST and septic field. No treatment or disinfection.	Improve plumbing in building (bring to code). Extend well casing as high as possible in well pit. Put localized (temporary) near surface sanitary seal around wellhead and crown away from casing (but leave gravel for drainage in most of base of well pit), Install filtration (1 micron absolute,) and UV disinfection (NSF/ANSI 55). Pretreatment (softener) likely required.	Attempt to obtain well log	$6,000	$1,200	$1,200	$8,400	Option 1: New well to service building		$30,000	$6,000	$6,000	$42,000	The pump control system is not up to standards and the pressure switch is located too far away from the pressure tank.	Upgrades included with Priority 2 upgrades	$0	$0	$0	$0	$50,400
									Option 2: Community Well (to tie in with Grader Stn, Health Centre and Firehall). Note: Lower life cycle costs and easier operation and maintenance.		$25,000	$5,000	$5,000	$35,000							$35,000
3122	Beaver Creek Swimming Pool	Poor wellhead completion, no sanitary seal, well is within 30 m of septic field, no treatment or disinfection.	Plumbing repairs. Extend well casing and install well cap as high as possible and install temporary well sanitary seal, superchlorinate well and system, install treatment to include filtration to 1 micron and chlorination system with appropriately sized retention tanks.	None	$9,400	$1,880	$1,880	$13,160	Option 1: Drill a new well to serve Rec centre and pool. It is not considered feasible to drill a new well on the pool property, so the well would have to located west of the Rec. centre.		$32,400	$6,480	$6,480	$45,360	Plumbing in disrepair (leaking and sweating). Pressure tanks require replacement.	Mitigated by Priority 1 and 2 upgrades	$0	$0	$0	$0	$58,520
									Option 2: Drill a new well to serve the Rec centre, pool and school.		$17,400	$3,480	$3,480	$24,360							$37,520

TABLE 4: SUMMARY OF OBSERVED DEFICIENCIES AND ESTIMATE COSTS
SMALL PUBLIC DRINKING WATER SYSTEMS

Building #	Building Name	HIGH AND MEDIUM RISK DEFICIENCIES	RECOMMENDED PRIORITY 1 MITIGATION	PRIORITY 1 ADDITIONAL ASSESSMENT	PRIORITY 1 COSTS				RECOMMENDED PRIORITY 2 - MITIGATION	PRIORITY 2 - ADDITIONAL ASSESSMENT	PRIORITY 2 - COSTS				LOW RISK DEFICIENCIES	RECOMMENDED PRIORITY 3 - MITIGATION	PRIORITY 3 - COSTS				
					Labour and Materials	Engineering	Contingency	Subtotal			Labour and Materials	Engineering	Contingency	Subtotal			Labour and Materials	Engineering	Contingency	Subtotal	Total
3123	Beaver Creek Grader Station	Wellhead casing does not extend as far above grade as required, No sanitary seal. Well is within 30 m of used oil storage tank and cold mix pile, UST etc.. Reported potential breach of septic discharge of sump waste discharge line upgradient of well.	Install chlorination tap, superchlorinate well and water system, install filtration and UV disinfection system.	Confirm location of break in septic/ or rock pit line, and repair as necessary.	$3,400	$680	$680	$4,760	Option 1: Standard wellhead upgrades, plus relocate potential contaminant sources within 30 m (cold mix, AST, UST).		$20,000	$4,000	$4,000	$28,000	None identified		$0	$0	$0	$0	$32,760
									Option 2: Drill new well to serve building with proper construction and in good location with respect to potential contaminant sources.		$30,000	$6,000	$6,000	$42,000							$46,760
									Option 3: Connect to community well system to serve other YTG buildings in area (health centre, Visitor reception centre, Fire Hall).		$25,000	$5,000	$5,000	$35,000							$39,760
3125	Beaver Creek Airport Terminal Building	Poor surface completion of wellhead, no sanitary seal, located within 30 m of AST - vehicle parking, and septic tank, turbidity is elevated.	Install chlorination tap, superchlorinate well and water system, install filtration and UV disinfection system.	Attempt to locate log.	$3,400	$680	$680	$4,760	Option 1: Standard wellhead upgrades, well cleaning and redevelopment (to reduce turbidity), plus relocate septic tank and replace AST with Envirotank.	Camera investigation of well if cannot find well log. Confirm depth of well.	$23,000	$4,600	$4,600	$32,200			$0	$0	$0	$0	$36,960
									Option 2: Install new well to serve building. Use existing treatment system.		$30,000	$6,000	$6,000	$42,000			$0	$0	$0	$0	$42,000
3964	Beaver Creek Health Centre	Poor wellhead completion. No surface sanitary seal. Within 30m of AST and septic field. Elevated chloride (with respect to background concentration), No treatment or disinfection.	Extend well casing as high as possible in well pit. Put localized (temporary) near surface sanitary seal around wellhead and crown away from casing, Superchlorinate wellhead, Install filtration (1 micron absolute,) and UV disinfection (NSF/ANSI 55). Pretreatment (softener) likely required.	Attempt to locate well log. Confirm location of septic field.	$6,200	$1,240	$1,240	$8,680	Option 1: New well to service building		$30,000	$6,000	$6,000	$42,000	No pressure guage on the system, heat trace is not to code.	Install pressure guage. Consider completing at same time as Priority 1.	$100	$20	$20	$140	$50,820
									Option 2: Community Well (to tie in with Grader Stn, Health Centre and Firehall). Note: Lower life cycle costs and easier operation and maintenance.		$25,000	$5,000	$5,000	$35,000							$43,820
3201	Burwash Landing Airport Building	Poor surface completion of the well, there is no surface sanitary seal; three recent positive total coliform results; elevated nitrates and chlorides, within 30 m of potential sources of contamination, the well is a shallow well and is likely completed in an unconfined aquifer that is susceptible to surface sources of contamination; and, there is no treatment or disinfection.	Following recommendations made in EBA's draft report a new well has been drilled and commissioned. The abandoned and former wells have both been decommissioned.	None required.	$5,000	$1,000	$1,000	$7,000	Install UV disinfection.		$2,200	$440	$440	$3,080	None identified.		$0	$0	$0	$0	$10,080
3204	Burwash Landing Fire Hall	Poor wellhead completion, no sanitary seal, well is within 30 m of AST (5 m), turbidity is high, no treatment or disinfection.	Extend casing to 500 mm above grade, install chlorination tap, superchlorinate well and water system, install filtration and UV disinfection system.	Attempt to locate well log.	$3,900	$780	$780	$5,460	None required.		$0	$0	$0	$0	Heat trace not properly installed.	Replace heat trace (to be completed by certified electrician)	$500	$100	$100	$700	$6,160
3171	Kluane Lake School (Destruction Bay)	Poor surface completion at wellhead, no surface sanitary seal, well is within 30 m of UST (9m) and AST (26 m).	Extend well casing as high as possible in well pit. Put localized (temporary) near surface sanitary seal around wellhead and crown away from casing, Superchlorinate well and water system. Install proportional feed chlorine injection system. Exchange carbon with multimedia bed.	None	$8,900	$1,780	$1,780	$12,460	Complete standard wellhead upgrades to pitless unit, replace UST with double walled AST, Install stainless steel commercial filtration system.		$12,900	$2,580	$2,580	$18,060	Historical raw sewage spills for community sewage system, previous exceedence of turbidity, TDS above AO objective, softener not always functional, previous exceedence of manganese (likely when softener not functioning).	Priority 1 and 2 mitigation plus routine monitoring and maintenance should mitigate all low risks.	$0	$0	$0	$0	$30,520
3172	Destruction Bay Fire Hall	Poor wellhead construction, lack of surface sanitary seal, within 30 m of potential sources of contamination, including an above ground fuel storage tank, an underground fuel storage tank, and scrap cars; a recent bacteriological sample reported a positive total coliform count; turbidity has been reported to be consistently above the CDWQG MAC of 1.0 NTU. There is no treatment or disinfection system	Post an advisory indicating that water is not fit for consumption. Provide bottled water station.	None	Minimal	$0	$0	$0	Plumb treated water supply (following upgrades) from Kluane School into the domestic supply for Fire Hall. Complete minor wellhead improvements to protect aquifer.		$4,800	$960	$960	$6,720	The color had previously exceeded the CDWQG aesthetic objective; and, supports for the elevated water storage tank are earthquake or collision proof	Priority 1 and 2 mitigation plus routine monitoring and maintenance should mitigate all low risks associated with the water supply. Safety of elevated tank to be addressed separately.	$0	$0	$0	$0	$6,720
3186	Destruction Bay Grader Station	Poor well construction, poor well siting, poor water quality, many potential contaminant sources.	Following recommendations made in EBA's draft report a new well has been drilled, however it has not yet been commissioned. Connect new well. Provide bottled water and ensure that existing advisories are adequate in interim.	None	$7,400	$1,480	$1,480	$10,360	Provide treatment and disinfection to new well as required.		$3,700	$740	$740	$5,180	Aesthetically poor water quality.	Decommission existing well.	$1,000	$200	$200	$1,400	$16,940
3957	Destruction Bay Health Centre	Poor surface completion of the well; no surface sanitary seal, the well is located approximately 60 m downgradient from a community septic field; and there is no disinfection system.	Install chlorination tap, superchlorinate well and water system, install filtration and UV disinfection system.	None	$3,600	$720	$720	$5,040	Standard wellhead upgrades with pitless unit.		$5,000	$1,000	$1,000	$7,000	Aesthetically poor water quality (TDS), and arsenic above PMAC.	Install point of use RO systems in the Health Centre and Nursing Residence #2.	$1,400	$280	$280	$1,960	$14,000

TABLE 5: OVERALL ASSESSED LEVEL OF RISK TO EXISTING WATER SUPPLY SYSTEMS USING MULTI-BARRIER APPROACH

		RISK INDICATORS				RISK MITIGATORS				OVERALL RISK AND PRIORITY		
Well System ID #	**Building Name**	**Exceedence of MAC other than total coliform or turbidty**	**Poor Quality Indicators (turbidity, coliform, nutrients)**	**Potential Bacteriological Contaminants within 30 m[A]**	**Public Accessibility or Residence**	**Favourable Hydrogeological Conditions**	**Well Construction (surface casing, driven casing in tight formation etc..)**	**Disinfection Treatment (primary)**	**Disinfection Treatment (secondary)**	**Overall Risk**	**Rationale/ Comments**	**Priority 1, 2 or 3**
3440	Blanchard Grader Station (and living complex)	No	Yes - elevated chloride	No	Yes	? - No Log	No	Yes- filtration (living quarters only)	Yes- UV disinfection (living quarters only)	Low - Moderate	Risk would be reduced to low if treated supply to Garage	1
3443	Haines Junction Initial Attack Base	No	No	No	No	System is on water delivery	System is on water delivery, but poor tank construction	Water delivery- treated at source	Water delivery- treated at source, FAC low	High	Risk would be reduced if tank is replaced or repaired	3
M0131	R.C.M.P. Detachment	No	Yes- turbidity, elevated chloride	Unknown	Yes	Variable fine grained material	No- well seal, Yes- driven in tight formation	No	No	High	Risk but minimal mitigation	1
M0133	Beaver Creek R.C.M.P. Residences	No	No	No	Residence	Variable fine grained material	No- well seal, Yes- driven in tight formation	No	No	Moderate	Limited risk, and some mitigation	1
M0134	Beaver Creek R.C.M.P. Residences	No	Yes- turbidity (1/3)	No	Residence	Likely variable fine grained material	No	No	No	Moderate	Limited risk, and some mitigation	1
3100	Nelnah Bessie John School	No	No	Unknown	Yes	?- No Log	No	Yes- activated carbon filter/ chlorination	No	High	Risk but minimal mitigation. FAC is low, and pellet chlorinators are not reliable for sustained disinfection.	1
3102	Beaver Creek Firehall (Well also serves library)	No	Yes - turbidity, elevated chloride	Unknown	Yes- well also serves library	? - No Log	No	No	No	High	Risk, but no mitigation	1
3121	Visitor Reception Center	No	Yes - elevated chloride, nitrate	No	Yes	? - No Log	No	No	No	High	Risk, but no mitigation	1
3122	Beaver Creek Swimming Pool	No	No	Yes	Yes	Yes - Till	No- well seal, Yes- driven in tight formation	No	No	High	Risk with inadequate mitigation	1
3123	Beaver Creek Grader Station	No	Yes - elevated chloride	Yes (former field at 22 m)	No	Variable fine grained material	No- well seal, Yes- driven in tight formation	No	No	High	Risk with inadequate mitigation	3
3125	Beaver Creek Airport Terminal Building	No	Yes- turbidity, 1/9 total coliform	No	Yes	? - No Log	No	No	No	High	Risk, but no mitigation	1
3964	Beaver Creek Health Center	No	Yes- turbidity	Unknown but likely	Yes	? - No Log	No	No	No	High	Risk, but no mitigation	1
3201	Burwash Airport (Well in use at time of assessment)	No	Yes - elevated chloride, 2/11 positive total coliform	No septic, but former breach, and open casing.	Yes	? - No Log	No	No	No	High	Risk, but no mitigation for old well. Note new well has been drilled and connected which would change this risk designation.	1
3204	Burwash Firehall	No	Yes - turbidity	No	No	?- No Log	No	No	No	Moderate	Some risk, some mitigation	3
3171	Destruction Bay School (Kluane Lake School)	No	Yes- turbidity	No	Yes	Yes- confined aquifer	No- well seal, Yes- driven in tight formation	Yes - Pellet Chlorinator, may not be functioning?	No	Moderate	Some risk, some mitigation	1
3172	Destruction Bay Firehall	No	Yes- turbidity, 1/9 total coliform	No	No	Yes- confined aquifer	No- well seal, Yes- driven in tight formation	No	No	Moderate	Some risk, some mitigation	3
3186	Destruction Bay Grader Station	Yes - Arsenic	Yes- turbidity	No	No	? - No Log	No	No	No	Low	Risk is low as long as advisories in effect and water not used for drinking.	3
3957	Destruction Bay Health Center	No	No	No	Yes	Yes- confined aquifer, artesian well	No- well seal, Yes- driven in tight formation	No	RO in Nursing Residence 1	Low - Moderate	Low risk, and some mitigation	1

A - Generally refers to liquid disposal within 30 m of wellhead

FIGURES

APPENDIX A

APPENDIX B