Appendix 2.2A-7

Domestic Wastewater Feasibility and Pre-Design

OPUS DAYTONKNIGHT

New Gold Inc.

Blackwater Project

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1 Introduction

The Blackwater project, owned and operated by New Gold Inc., is a mining exploration site located approximately 160 kilometres southwest of Prince George, B.C. The project is in the advanced exploration phase, with drilling activities expected to be scaled back over the next several months. A Project Economic Assessment (PEA) completed in September 2012, estimated the capital cost of the mine at $1.8 billion. Based upon the positive results of the PEA, New Gold has initiated a Project Feasibility Study, which is scheduled for completion in the last quarter of 2013. This sewage wastewater planning / feasibility study is intended to provide Feasibility Study level information to New Gold with respect to the scope, regulatory requirements, capital and operating costs of sewage treatment and disposal facilities required for the project. It is envisaged that the information will be used to supplement the broader mine Feasibility Study being prepared by AMEC Americas Limited (AMEC).

Construction of the Blackwater Project is anticipated to require approximately two years, beginning approximately 2015 such that mine operation may begin in 2017. The mine will have an operating life of approximately seventeen years, with closure and reclamation in 2033. At various times during the course of construction and operation of the mine, wastewater will be generated from at least three locations on the mine site, including:

- Existing 250 person exploration camp (to be expanded to 400 person capacity)
- 1,200 person (temporary) construction (to be replaced by 500 person permanent camp)
- Mine operations / plant site

New Gold has identified preferred locations for the proposed 1,200 person work camp and mine plant site and has engaged Opus DaytonKnight (ODK) to complete a feasibility study and preliminary design of sewage treatment and disposal facilities servicing the required work camps and plant site. ODK has coordinated this study with the results of an Environmental Impact Study (EIS) completed by Western Water Associated Ltd. (WWA) in September 2013. The EIS evaluated the feasibility of the discharge of treated sewage effluent generated at the construction and operation camp to ground.

ODK has also been engaged by New Gold to provide recommendations for sewer system upgrades required to increase the capacity of the existing camp sewer system to accommodate 400 persons. The intent is that the capacity of the existing camp may be increased to 400 persons as a pre-construction stage, possibly as early as the second half of 2014.

1.1 Blackwater Sewage Background

Shortly after the purchase of the property by New Gold Inc. in April of 2011, a 100 person camp was constructed in order to support exploration activities. The expanded camp was serviced by drilled potable water wells and an on-site sewage disposal system. The sewer system included the system of gravity pipes from the camp buildings, septic tanks and a pump and force main system which pumps effluent a distance of approximately 0.8 kilometers to an in-ground disposal field.

A 'Record of Sewerage System' was filed with Northern Health for the 100 person sewage treatment and disposal system. 100 persons is the approximate limit of sewer system size that can be operated via Record of Sewerage System under the Sewerage System Regulation and the Health Act.

In late 2011 and early 2012 the Blackwater exploration camp was expanded to its current capacity of 250 people, including the installation of two new RBC packaged treatment plant units. The treatment plants increase the quality of the treated effluent from Class D (septic tank) to Class C (45 BOD / 45 TSS) such that the receiving capacity of the septic field increased from 100 persons to 250 persons without construction of additional septic field. The existing camp sewer system was registered with the Ministry of Environment under the Municipal Wastewater Regulation (MWR) in December, 2012 (registration number 105882) and is still in operation.

New Gold proposes to expand the capacity of the existing exploration camp to 400 people for use during the early stages of construction; prior to availability of the larger 1,200 person camp. New Gold expects that an application will be made to the Ministry of Environment in late 2013 to amend the existing MWR registration to increase the effluent discharge rate to the existing septic field in order to allow for the expansion from 250 to 400 people.

Ultimately, the existing ground disposal field will conflict with a waste rock / overburden stockpile site that is proposed as a part of the broader mine site plan. Due to this conflict and the limited capacity of the existing system, new treatment and disposal facilities will be required for domestic sewage generated at the work camps and the mine plant site.

1.2 Project Scope and Objectives

The overall objectives of this study are:

- Identify sewage servicing (collection, treatment, pumping and discharge/reuse) options for the construction camps and mine plant site;
- Identify the technical and cost implications of sewage treatment and disposal options;
- Complete preliminary/conceptual design of the recommended wastewater strategy;
- Provide Feasibility Study level estimates of capital and operation costs for proposed sewage treatment, pumping and disposal infrastructure;
- Provide technical/environmental investigation information that may be included in New Gold's 'whole-of-site' Project Feasibility Study and Environmental Assessment (EA).

In order to achieve the objectives, ODK has undertaken the following:

- Data collection, including preliminary mine drawings, feasibility studies, and survey/LiDAR information;
- Geotechnical information review, including drill hole and test pit logs, reports and drawings;
- Project team meetings, either in person or by teleconference;
- Ministry of Environment meeting;
- Identification and evaluation of camp locations and system options (collection/conveyance, storage, treatment, disposal);
- Preliminary wastewater system permitting investigation;

- Site investigations to gather specific site and soils information and confirm concept feasibility; including coordination of the Environmental Impact Study completed by Western Water Associates Ltd.
- Preliminary/schematic design drawings of preferred option;
- Recommended wastewater strategy construction cost estimate;
- Preparation of preliminary design/feasibility study report and recommendations.

1.3 Approach to Wastewater Treatment and Disposal

As a part of the Environmental Assessment process, New Gold has submitted a Project Description to the Provincial and Federal governments. A stated key objective of the proposed project design is to prevent discharges from the mine to adjacent streams during construction and operation of the mine. In order to achieve this objective, process effluents and site drainage are proposed to be collected and stored in the mines Tailings Storage Facility (TSF) for re-use in the mines ore-processing mill. The Project Description suggested that domestic sewage generated from the site would be treated using a rotating biological contactor (RBC), but did not suggest a method of disposal of the treated sewage effluent. In Northern B.C., it is not uncommon for treated effluent to be disposed of in a TSF (ie. Mt. Milligan Mine, Kemess Mine, etc).

The construction camps (and associated infrastructure) are critical path at the start of mine construction. For the Blackwater project, discharge of treated sewage effluent from the construction camps would require construction of a large temporary “zero discharge” effluent storage lagoon for containment of effluent from the construction camps until such time as construction of the TSF ponds was sufficiently advanced. This construction schedule conflict, in addition to the substantial effluent pumping requirement from the proposed construction / work camp sites to the first phase of TSF dam construction (Dam ‘C’) suggests that, while disposal of effluent to the TSF should be considered for the mine plant site (administration offices, warehouses, truck shop and ore processing facilities), the feasibility of disposing of effluent to ground for the construction and operations work camps needs to be considered. As the approach to the mine’s development is for a zero waste water discharge to adjacent creeks, regardless of the origin of the wastewater (sewage; mine process water), the discharge of treated sewage effluent to Davidson Creek was quickly discounted. Options for sewage wastewater treatment and disposal considered in this study include:

- Disposal of effluent from the construction and operation camp to ground via Rapid Infiltration Basin (RIB)
- Discharge of effluent from the mine plant site to the Tailings Storage Facility for re-use as mine process water

A general comparison of effluent disposal options is illustrated in Table 1 below.

Table 1. Wastewater Management Strategy Comparison Matrix

		Parameter					
Option	Description	Technical Feasibility	Permit Requirements	Conflict with Mine site permitting?	Environmental Risk	Environmental Monitoring Requirements	Cost
1	Discharge to Surface Water (Davison Creek)	Moderate	Stringent	Yes	Higher	Stringent	Moderate-High
2	Storage and Discharge to TSF	Moderate	None	No	Low	As per Mine site wide requirements	High
3	Discharge to Ground	Moderate	Moderate	No	Low-Moderate	Moderate	Low-Moderate

*Green indicates good/less stringent, yellow – moderate, and red – poor

Table 1 illustrates the similarities in the regulatory / technical feasibility of discharge to either the TSF or to ground and reiterates the conflict with the option of discharge to Davidson Creek with mine's broader "zero surface water discharge" objectives.

2 Regulatory Requirements

The provincial and federal governments, either individually or jointly regulate every step in the exploration, planning, construction and operation of a mine. In some instances in the past, the discharge of effluent from sewage treatment facilities has been covered under other forms of permit or regulation from the Province (such as the permit for the tailings storage facility under the Mines Act, etc.); in this instance, the Ministry of Environment (MoE) has confirmed its preference is that each discharge location be separately registered under the Municipal Wastewater Regulation. This will require three separate regulatory / registration processes for each of:

- Expansion of the existing 250 person camp to 400 person capacity for discharge to ground at the existing ground disposal field.
- Treatment and disposal of sewage effluent generated at the work camp(s) to ground via Rapid Infiltration Basin.
- Treatment and disposal of effluent from the plant site to the Tailings Storage Facility.

2.1 Ministry of Environment Municipal Wastewater Regulation Authorization

Sewage systems that discharge effluent volumes in excess of 22,700 litres per day, or that discharge to surface waters, or that use reclaimed effluent for other processes other than discharge to ground or surface water, are regulated by the Environmental Management Act - Municipal Wastewater

Regulation (MWR). Registration under the MWR requires a number of provisions to be met prior to successful registration and authorization for discharge, including:

- Pre-registration meeting;
- Completed application form;
- Administrative information (owner information, operator, etc...);
- Submission of a summary of technical design information, including system description and design drawings and specifications, daily discharge flow, effluent quality expected, etc...;
- Completion of an Environmental Impact Study (EIS);
- Site environmental and effluent monitoring program details; and,
- Development of a system operating plan, including provisions for operator training and certification.

In order to allow for review, referral and consultations with respect to the above requirements, the MoE requires a minimum 3-month consultation/wait period following initial submission of the MWR application. If all the requirements be met, the MoE issues a confirmation of registration of the discharge under the MWR. Following registration, a number of on-going submissions are required, including regular monitoring of discharge flow, effluent quality and receiving environment. Details of the specific MWR requirements for each wastewater treatment and effluent disposal option are discussed further in later sections of the report.

2.2 Environmental Impact Study

Section 18 of the MWR requires that an EIS must be completed as a condition of registration of an effluent discharge under the MWR. As described in Section 1, and in further detail in Seciton 6, an EIS has been completed by WWA in support of this domestic wastewater feasibility study.

A copy of the EIS is included in the Appendices.

2.3 Environmental and Effluent Monitoring Program

In accordance with the EIS, a suitable effluent environmental monitoring program will be implemented at the discharge location (ie. Rapid infiltration basins) and other suitable locations. The environmental monitoring plan will consist generally of surface water and groundwater quality monitoring program and is expected to include regular sampling from groundwater wells and nearby creeks for common polluting parameters. More detail on the specific recommendations for environmental monitoring can be found in the EIS.

2.4 Wastewater System Operating Plan

The MWR outlines the requirement for a wastewater system operating plan. Following the initial MWR submission and detailed system design, an operating plan for the system will be required that will outline, among other items:

- Process descriptions;

- General operation and maintenance practices;
- Operator personnel and contact;
- EOCP requirements;
- Treatment system effluent and environmental monitoring practices and requirements; and
- Spill reporting procedures;

2.5 Operator Training and Certification

Section 47 of the MWR requires that the sewage treatment facilities are operated by persons who:

- Have the education, experience, and qualifications specified in the required Operating Plan;
- Are certified under the EOCP.

New Gold currently employs operators that were certified by the EOCP in 2013. The requirements that were required certification by the EOCP included:

- Minimum of 50 hours of hands-on experience operating a facility/system of equivalent or higher classification;
- Completion of appropriate training for which a minimum of 1.2 Continuing Education Units (CEU) have been awarded by the EOCP.

The level of operator training and certification that is required is directly related to the EOCP System Classification, as described below in Section 2.6. In the long term, due to the simplicity of lagoon operations, the operator training and certification requirements are not expected to vary significantly. In the short term, however, the operator training and certification will require external help and / or greater attention, while the operators gain the required experience. New Gold may be required to either:

- Plan for increased operator training and certification in advance of construction; or
- Plan to contract out the responsibility of operating and maintaining the sewage treatment system during construction until a time when the in-house operators are comfortable.

2.6 EOCP Facility Classification

The EOCP has developed a methodology for providing an indication of the degree of knowledge and training that is required of an operator of a facility. The MoE requires that facility classification be obtained by owners of sewer systems in order to define the required level of operator training and certification. Wastewater facilities are classified based upon a point system which considers the daily design flow, complexity of process operation, variability of influent and effluent requirements and the degree of laboratory process / control that is carried out on site.

Each of the Blackwater wastewater treatment and disposal system(s) will be classified by the Environmental Operators Certification Program (EOCP). Due to its small size and lower level of complexity, the system servicing the existing exploration camp has been certified as a Small Wastewater System (Mechanical) by the EOCP. This classification is generally given to systems servicing a population of less than 500. As described above, the capacity of the system during construction (1,200 persons) which may result in a higher EOCP system classification, which may, in turn require an increased level of operator training or certification.

For all future submissions and notification of system changes, the EOCP's contact information is as follows:

Environmental Operator's Certification Program
Suite 101-224 West 8th Avenue
Vancouver, B.C., V5Y 1N5
Tel: 604-874-4784 Fax: 604-874-4794
Website: www.eocp.org

2.7 MWR Submission Schedule

New Gold has initiated preliminary design and feasibility study work, as well as the EIS, in advance of detailed mine design, such that the design and permitting activities are completed prior to becoming critical path during mine and camp construction. As such, it is proposed that the MWR permitting process is initiated with MoE during the winter of 2013/2014. Submission of the MWR early in the design and overall mine permitting process will allow the submission to get in the MoE's queue, reduce administrative and processing holdups and allow for the consultation period to be initiated.

Following submission of the initial application and documentation (this feasibility study and the draft EIS), detailed system design will be completed. Upon detailed design completion, further documentation, including system drawings, final EIS, system operating plan, and EOCP documentation, can be submitted in order to finalize the MWR registration.

3 Design Criteria

Wastewater design criteria include the anticipated mine development schedule, related manpower estimates and phasing, associated wastewater quantity (volume, flow rate and peaking factor), both raw (influent) quality and required treated (effluent) wastewater quality.

3.1 Mine Development Schedule

Important construction dates relevant to the wastewater strategy are as follows:

Expand existing 250 person camp to 400 person camp:	Year -3 (2014)
1,200 person camp construction:	Year -2 (2015)
Site C TSF construction:	Year -1 to Year 0
Mine operation:	Year 0 to ~ Year 17
500 person camp commissioning (downsize from 1,200):	Year 1 (2018)
400 person camp decommissioning:	Year 1 (2018)
500 person camp operation:	Year 1 to ~ Year 17

3.2 Manpower Estimates

From information provided by New Gold and AMEC, mine site manpower will range from approximately 400 people in late 2014, prior to the beginning of mine construction, to 1600 people during peak construction activities (new 1,200 person camp and existing 400 person camp). Following the completion of construction (year 0-year 1), the 1,200 person camp will be downsized to a 500 person capacity camp to service mine operations for the life of the mine (~16-17 years). The figure below illustrates the expected sitewide manpower distribution from year -3 to year 2.

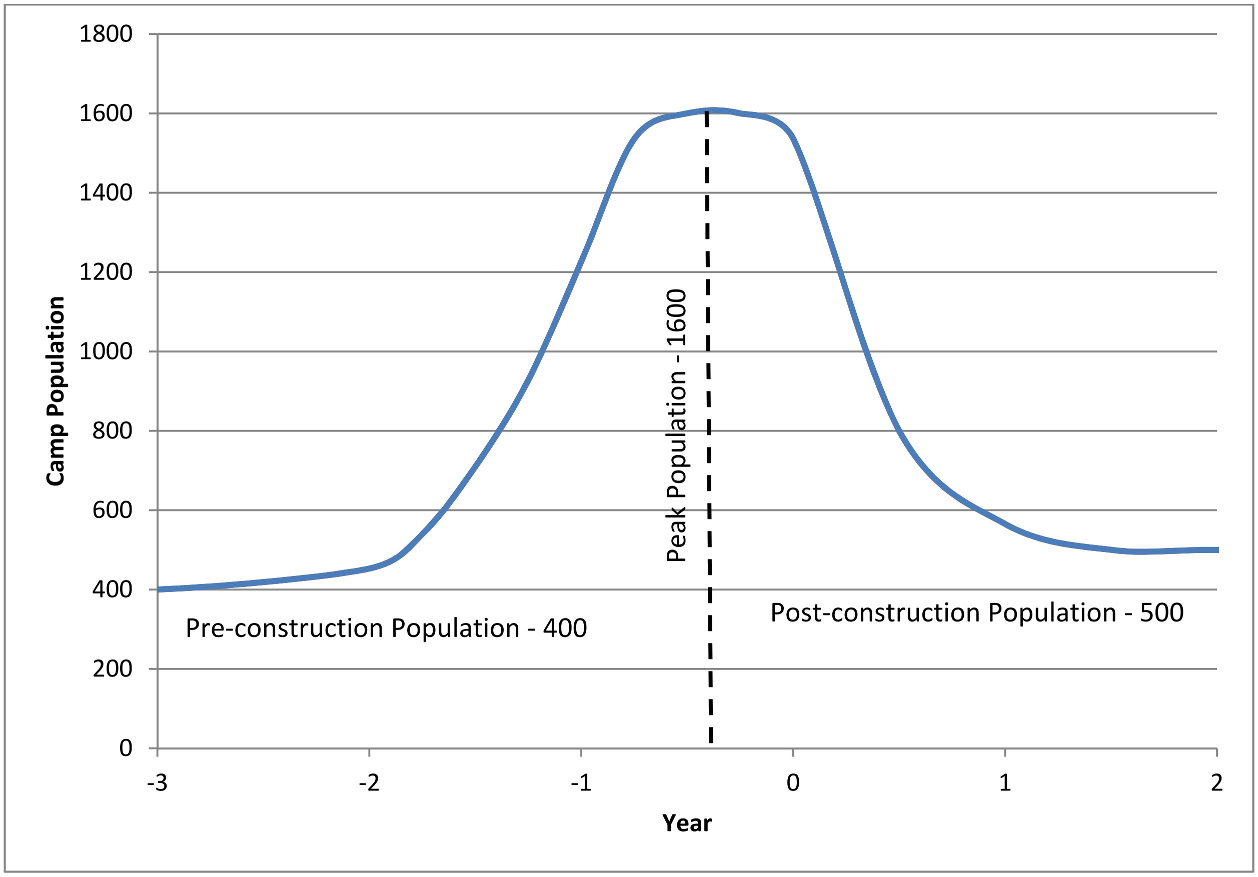


Figure 1 - Minesite Manpower Estimate

3.3 Wastewater Quantity

3.3.1 Per Capita Wastewater Loading

Wastewater quantity is typically estimated using commonly published industrial camp per capita wastewater flows (such as the Sewerage System *Standard Practice Manual*) as 227 L/day. New Gold has operated a camp at the mine site since 2011, and has maintained wastewater flow records since June of 2012. As such, the published theoretical per capita flow rate can be compared to historical records at the site. Figure 2, below, illustrates the per capita wastewater flow of the existing camp between June 2012 and June 2013, and includes the overall average and 30-day moving average.

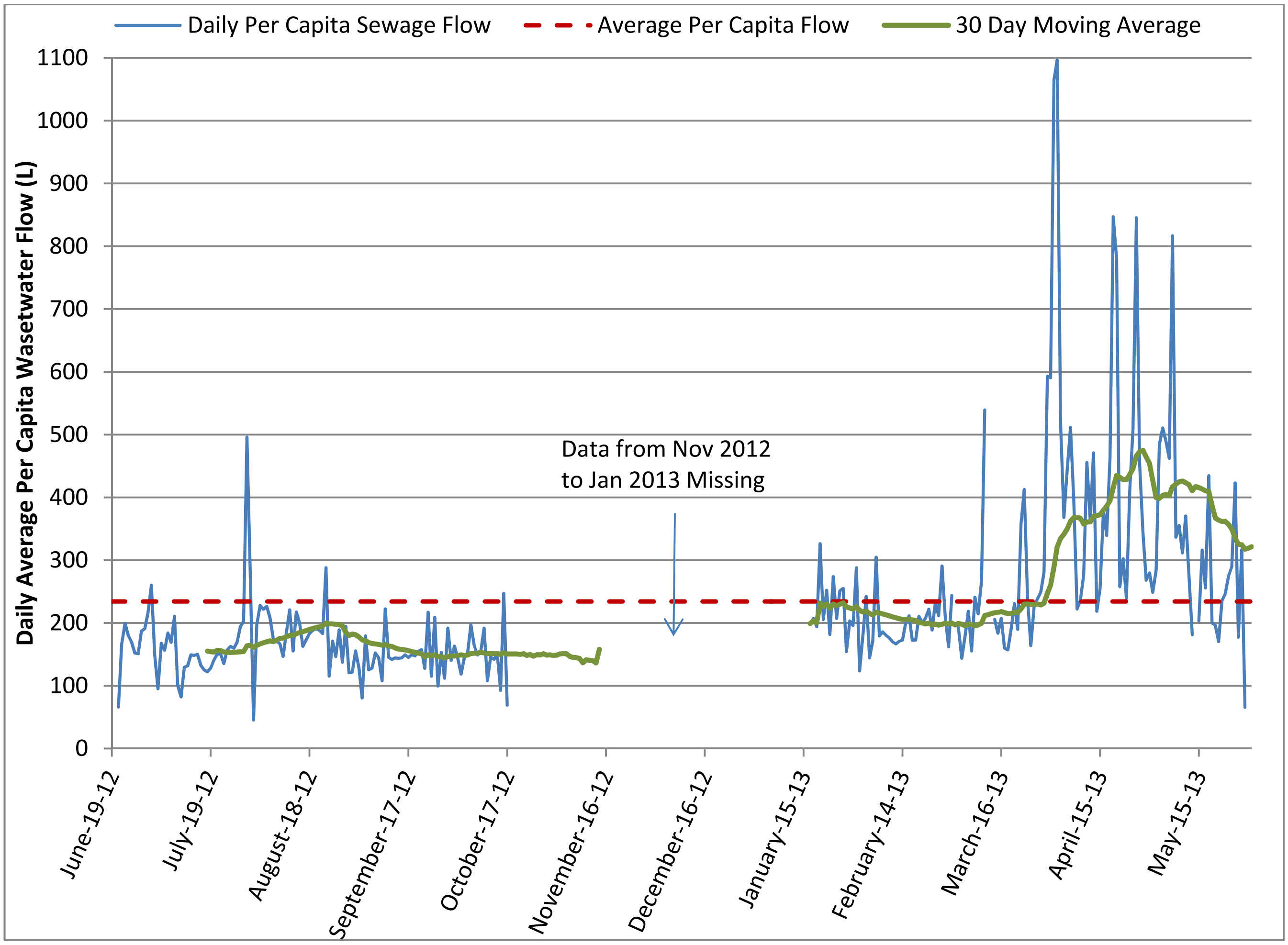


Figure 2 - Existing Blackwater Camp Per Capita Wastewater Production

Figure 2 illustrates an average daily per capita wastewater flow of 234L. From the 30-day moving average, a rise in per capita flow can be observed between late March and late April of 2013, with a gradual decline afterwards. From observations on site, the lift station pumping effluent into the treatment plants (where the flow measurements are taken) was inundated with snowmelt water during this period. The operators reported that significant water was being introduced into the wastewater system in this manner, which may have affected the results of the flow monitoring.

Despite the potential for skewed results due to excessive I&I into the lift station (which has since been rectified) the average per capita wastewater flow of 234 L/day correlates with the published theoretical value of 227 L/day. Taking the I&I issue into account, it is prudent to select a slightly higher value than the published value and consequently a design value of 250 L/cap/day can be considered as an appropriate value for this study.

3.3.2 1,200 / 500 Person Camp – Design Daily Domestic Sewage Flows

Assuming the manpower loading as identified in section 3.2, and the per capita flow rate identified in section 3.3.1, the following graph illustrates the estimated wastewater flows during the life of the mine.

The graph illustrates flows only from the proposed 1,200 / 500 person camp, and does not include flows from the existing 250 person camp (to be upgraded to 400 people).

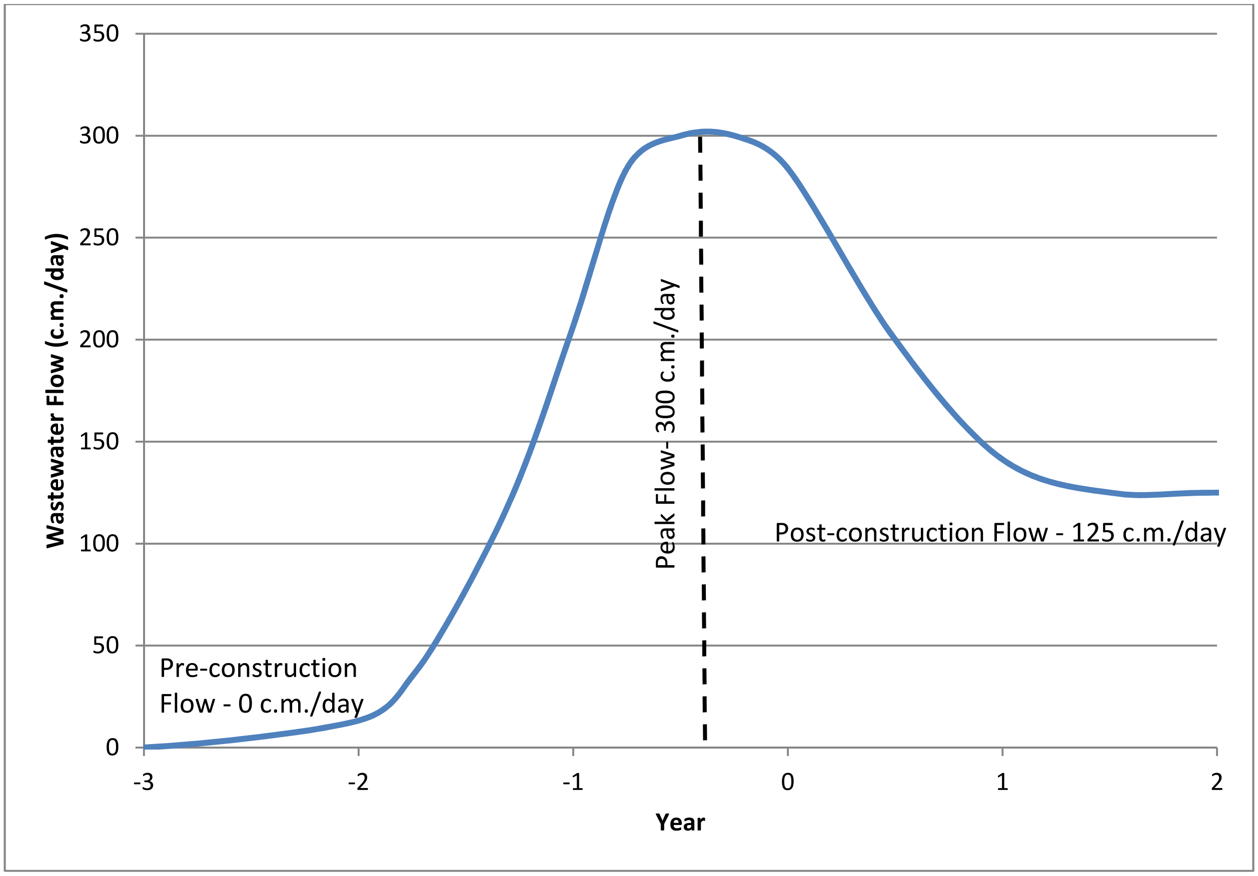


Figure 3 - Estimated 1,200 / 500 Person Camp Wastewater Flow Rate

With a per capita sewage generation of 250 L/c/d, the average daily wastewater flow from the combined 1,200 person camp at peak camp capacity will be 300 m^3. The wastewater treatment and disposal infrastructure serving the proposed work camps have been sized for these daily design flows.

3.3.3 Mine Plant Site – Design Daily Domestic Sewage Flows

The "Sewerage System Standard Practice Manual", the BC Ministry of Health identifies a sewage generation rate of 132 L/c/d for "Heavy Industry Excluding industrial waste, including cafeteria and shower". A design value of 130 L/c/d will be used for planning purposes. Assuming a daily occupancy of 600 people at the mine plant site, a design daily wastewater flow of 78 m^3/day is estimated.

3.3.4 Peaking Factors

In addition to the design daily wastewater flow, outlining the flow distribution characteristics of the contributing population is required, particularly for sizing of the collection, pumping and force main components of the wastewater management system. Accurate evaluation of peak wastewater flows reduces the risk of under-sizing critical components. Camp systems are closed loop plumbing systems, meaning no external water use is expected (vehicle washing, lawn sprinklers, etc...), and as such the water use and wastewater flow characteristics are intrinsically linked – provided Infiltration / Inflow are not contributing factors.

Peak water use records are more readily available than wastewater records, and as such are used as the basis for applying wastewater flow peaking factors. Common peaking factors range from between 2-8 times the average daily wastewater production, depending on overall population serviced (US EPA, US FEMA, and Ontario MoE). Due to the nature of shift work at industrial camps, however, the peaking factor can be expected to be around 10 times the average daily wastewater flow rate for the camps and 5 for the Plant site. The following table identifies the expected peak flow rate from the different mine locations/facilities.

Table 2. Peak Wastewater Flow Rates

Location	Average Daily Flow - m^3/day (L/s)	Peak Wastewater Flow Rate
Plant Site	78.0 (0.90 L/s)	4.5 L/s
Permanent Camp	125.0 (1.45 L/s)	14.5 L/s
Construction Camp	175.0 (2.03 L/s)	20.3 L/s
Camp Sites Total	**300.0 (3.47 L/s)**	**34.7 L/s**

The above peak flows may be used to size sewage collection and pumping systems, if any, located upstream of the sewage treatment site.

3.3.5 Flow Equalization

Rather than attempting to design wastewater treatment and effluent pumping components of the system for peak flows, methods of flow equalization are recommended. In the case of the lagoons, the lagoon basin sizing and flow control affects the equalization. With adequate equalization and flow control, the peak flow into the lift station and to the RIB system is expected to be 2 times the design daily flow, or a total of 6.94L/s.

3.3.6 Design Criteria Summary

In summary, the wastewater for the mine development is expected to be from three separate sources, as follows:

Table 3. Summary of Wastewater Flows

Location	Daily flow (L/cap/day)	Manpower	Total Flow	Peak Flow	Equalized Flow
Plant site	130	600	78 m^3/day	4.5 L/s	N/A
Operations Camp	250	500	125 m^3/day	14.5 L/s	2.9 L/s
Construction Camp	250	700	175 m^3/day	20.3 L/s	4.1 L/s

3.4 Wastewater Quality

3.4.1 Raw Wastewater/Treatment Plant Influent Quality

The selection of the process and equipment to treat the wastewater is dependent on a number of parameters but the most significant aspects are:

- Influent quantity
- Influent quality
- Required effluent quality

The quality criteria of interest in the influent are dictated to a large extent by effluent requirements, which in turn are generally driven by regulatory requirements. The focus influent parameters are the five day Biological Oxygen Demand (BOD_5 or "BOD") and the Total Suspended Solids (TSS or "SS"). Notwithstanding that domestic raw sewage quality is typically (including samples from the Blackwater exploration camp in 2013) in the range of 200 to 250 mg/L BOD, studies have shown the wastewater from work camps can also be of higher strength (404 mg/L BOD, 484 mg/L TSS). This variability in raw influent sewage quality can contribute to poor sewage system performance if not accounted for via sewage pre-treatment and / or treatment system design. To account for this, many designers of wastewater treatment systems for work camps recommend designing the process units on the basis of higher strength influent wastewater with BOD of 450 mg/L and TSS of 450 mg/L.

3.4.1.1 Impact of Domestic Drinking Water Quality

Influent quality has been discussed above with the required effluent quality in the following section. In addition to the general nature of human waste and sewage, the influent quality to a wastewater treatment plant is also dependent on the potable water source quality. In general, the base drinking water quality requirements provide a suitable environment for wastewater treatment processes to occur. There are however, some parameters that provide an inhibiting or nurturing environment for wastewater which are of little or minor concern for drinking water: pH, Chlorides and alkalinity are examples of such parameters. Once the site source water has been established, a review of its constituents should be undertaken to confirm that there are no inhibitors for the wastewater treatment process.

3.4.2 Treated Effluent Quality

In this case, where the target disposal method is 'in-ground' (for the camps) or "reclaimed water re-use" (for the mine plant site), B.C.'s Municipal Wastewater Regulation requires the effluent to achieve a minimum Class C standard. The Class C standard identifies only two parameters to achieve and monitor; these are:

- BOD_5 : 45mg/L
- TSS: 45 mg/L
- Faecal coliform: not specified for ground, median 200 CFU; maximum 1000 CFU
- Turbidity: not specified
- Nitrogen: not specified

Using standard wastewater treatment processes and equipment, the identified targets are not difficult to achieve if the process and equipment are sized and operated properly.

Because the targeted effluent disposal method on this site is by rapid infiltration, it is recommended that the SS be driven instead by site requirements and limited to 20 mg/L. In general, targeting SS of 20 mg/L will by default also produce 20 mg/L BOD.

The USEPA publishes guidelines for the design and use of rapid infiltration basins which are based on primary or secondary treatment - the better the treatment achieved, the smaller the basin size – but limited by the basins' infiltrative capacity. Sizing the basin using the USEPA guidelines for the percolation rate means that 45 mg/L BOD can be accommodated. Using the project parameters but also specifying 20mg/L TSS will reduce basin maintenance requirements and provide a buffer against upsets but (because of minimum size requirements) will not reduce its size.

4 Domestic Sewage Treatment Options

The Project Description submitted by New Gold to the federal and provincial governments suggested that domestic sewage from the work camp(s) would be treated using a Rotating Biological Contactor (RBC) packaged treatment plant. Notwithstanding that RBC's are a common treatment technology (including the existing units currently in use at the Blackwater exploration camp), other options are available for temporary use for the construction camp or for longer term use for the operations camp. A review of wastewater treatment options was completed by ODK, based upon our experience with similar installations in Northern B.C. and information solicited from suppliers of packaged treatment plant equipment.

Because wastewater treatment requirements in a camp setting lend themselves to modular 'packaged' treatment plants, the focus of the review has been on that type of system. The exception is lagoon treatment because it fits well in remote communities where operator qualifications and experience are often lacking. A summary of the results of our review is presented in the table on the following page.

Table 4. Domestic Sewage Treatment - Decision Matrix

Process	Cost	Power	Performance/ Footprint	Operator Qualifications	Operator time demands	Chemical Reqmt's	Total
Aerated Lagoons	4	5	2	5	4	5	**25**
Packed Bed Filter	2	4	4	5	4	5	**24**
RBC	3	5	2	4	5	5	**24**
MBBR	3	3	3	3	4	3	**19**
SBR	3	4	4	3	3	3	**20**
Activated Sludge	5	2	3	2	2	4	**18**
MBR	1	1	5	1	2	1	**11**

NOTE: 5 represents 'most desirable' and 1 'least desirable'.

The table shows that a number of the processes and technologies reviewed would meet project requirements, with similar estimates of benefit when comparing advantages and disadvantages of each. The discussions below describe the sewage treatment approach that ODK recommends for this project.

4.1 Construction and Operations Camp Treatment System - Aerated Lagoons

New Gold had originally planned for the design and construction of two camps – one 1,000 person temporary construction camp, and one 500 person permanent operations camp, for a total peak mine population of up to 1,900 people including the existing 250/400 person camp. Through the CAPEX and OPEX review process, and prior to finalizing the minesite wide feasibility study, New Gold has downsized the construction and operations camp capacity to a total combined maximum population of 1,200 people in an effort to reduce costs (in addition to the existing 250 / 400 person exploration camp). Accordingly, through the draft wastewater feasibility study and New Gold review process, the construction of two 600-person capacity aerated lagoons has emerged as the most preferable sewage treatment option.

Aerated lagoons are a very common method of sewage treatment for small communities in Northern B.C. provided that suitable land area is available and the receiving environment is accepting of Class C effluent (45 mg/L BOD, 45 mg/L TSS). Lagoons also provide one of the simplest methods of operation. Aside from the method of aeration (submerged diffusers with air supplied by blower units or surface aerators) there are few moving / mechanical parts or processes to be monitored by an operator.

In addition to their simplicity and robustness, lagoons have the benefit of storing sludge produced by the biological process. Preliminary calculations show that the aerated lagoon process being considered for this project requires “desludging” roughly every 18 years. By chance this coincides with the design horizon of wastewater requirements for the project and could therefore be dealt with in a closure plan - as opposed to sludge having to be managed as a running cost.

Additionally, lagoons negate the requirement for pre-treatment / balancing storage, as this is managed within the lagoon process itself, thereby deleting an additional process stage recommended for mechanical processes.

The MWR requires that redundancy be built into certain systems within the overall process, as well as the process itself, depending on a range of risk factors. Requirements for redundancy in the case of lagoon treatment systems effectively mean that a two-train system must be constructed. Regardless of the regulation, this would be both prudent and advisable. With the selection of two 600 person aerated lagoons as the preferred treatment strategy, however, redundancy would not exist temporarily (during years -2 to 1), while camp population is at the maximum of 1,200 people. The strategy will require confirmation of suitability with the Ministry of Environment. 140% redundancy (2.4 times the treatment capacity) will exist for the operating life of the mine, however, with a permanent camp population of 500 people.

Should MoE be satisfied with a short-term lack of redundancy, we recommend that aerated lagoons of 1,200 person capacity be constructed to service the temporary and permanent camps. Preliminary design drawings of the proposed parallel 600 person aerated lagoons are included in Appendix A.

4.2 Preliminary Lagoon Site Soils Investigation

The draft Domestic Wastewater Feasibility and Pre-Design study identified the need for further geotechnical investigations at the proposed aerated lagoon site to confirm native soil conditions and the requirement for a HDPE lagoon liner in the absence of suitably low-permeability soils. Since the submission of the draft report, Opus DK has performed a preliminary soils analysis at the site, in order to provide the geotechnical team with more detailed information and identify any glaring issues and potentially problematic site conditions that might exist (excessively gravelly soils, high groundwater, etc...).

In October 2013, five test pits were excavated to a depth of between 7 and 8 metres below ground surface. Soils were dry, and consisted of clay till to approximately 6 metres depth, underlain by sand. No excessively problematic site conditions were encountered, with the presence of suitably deep clay till potentially eliminating the need for a HDPE lagoon liner.

While the preliminary soils investigation was important in gaining a base level understanding of the local soil conditions prior to the onset of winter, a detailed geotechnical investigation is nonetheless recommended. Issues that a geotechnical investigation would identify in further depth include:

- Soil permeability;
- Earthworks / embankment constructability;
- Seasonally high groundwater / drainage issues.

Following the preliminary soils investigation, a detailed geotechnical investigation might further:

- Confirm the site suitability prior to detailed lagoon design and construction;
- Recommend specific design changes to the proposed lagoons (location, orientation, slopes etc...);
- Provide information on site conditions for bidding and construction purposes;
- Make further recommendations on lagoon depth, embankment construction, and the provision for a HDPE liner;

The fall-back position of installation of packaged treatment plants with equivalent 1,200 person capacity could also be considered in the event that construction schedules require the provision of peak sewage treatment capacities in the winter, when earthworks / lagoon embankment construction may be problematic.

4.3 Packaged Treatment Plant – Mine Plant Site

Due to the limited available land area that is expected at the plant site, and lower design flows, the mine plant site lends itself well to sewage service via packaged treatment plant(s). In the case of the Blackwater project, New Gold has the advantage of having the existing RBC units in service at the exploration camp which will become redundant as the mine nears construction completion. Assuming that the construction schedule will allow for decommissioning of the exploration camp sufficiently in advance of commissioning of the mine plant site, we recommend that the RBC units from the exploration plant be relocated for this use.

The supplier of the existing RBC units has stated a design capacity of 46 m^3/day per package treatment plant. The combined capacity of the units of 92 m^3/day compares well to the estimated design flows of 78 m^3/day.

4.3.1 Packaged Treatment Plant Headworks

Wastewater has non-soluble and solids components, the latter of which are ideally settled or screened out before reaching the more sensitive mechanical treatment equipment. This area in the plant is generally termed the ‘inlet headworks’. For the mine plant site, pre-treatment / settling would likely be provided by in ground buried septic tanks. Rather than attempt to relocate existing tanks, we have assumed that new septic tanks (or similar capacity pre-treatment / solids settling) would be installed to service the mine plant site and related buildings.

5 Effluent Pumping System

Treated effluent from the work camp lagoons / WWTP will require pumping in order to be disposed of at the RIB site. The effluent pumping system will include:

- Inlet wet well
- High head effluent pump station
- High pressure effluent forcemain

The effluent pumping system is proposed to be designed to have a capacity for peak, balanced flows of 7.0 L/s.

5.1 Wet well Storage Tank

A wet well is proposed between the discharge piping of the lagoon(s) and packaged treatment plants and the pump station. The wet well will balance inflows from the lagoons will provide constant positive suction head to the pump station, will allow control of pump cycling and will allow for limiting the number of pump starts per hour.

The wet well is proposed to have a volume of approximately 21 m^3. The wet well will provide about 50 minutes of storage volume at an inflow of 7.0 L/s. The estimated dimension of the tank is 3 m diameter x 3 m depth. Of the 3 m depth, 0.5 m will be used as a freeboard/high level alarm, 2 m will be used as the working water depth, and 0.5 m will be used as a low level alarm. The working volume of the manhole is therefore 14.1 m^3.

Based on the above assumption, it is estimated that the tank will be emptied in approximately 34 minutes with one pump running at the maximum inflow rate of 7.0 L/s and 130 minutes at the minimum flow of 1.8 L/s. If the pumps are off for any reason (power outage, maintenance, malfunction, etc), the pump station will have approximately nine minutes from the high level alarm level before overflowing during maximum flows. Provided that the top elevation of the wet well is the same as, or higher than the top embankment of the lagoons, over-flow protection will be provided by the operating freeboard of the lagoon system. Storage volume of approximately 21 days exists in the lagoon freeboard, at average day flow conditions.

5.2 Pump Station Configuration

Based on the size and length of forcemain and the elevation difference between the pump station and the discharge point of the infiltration basins, a system curve was developed as shown below.

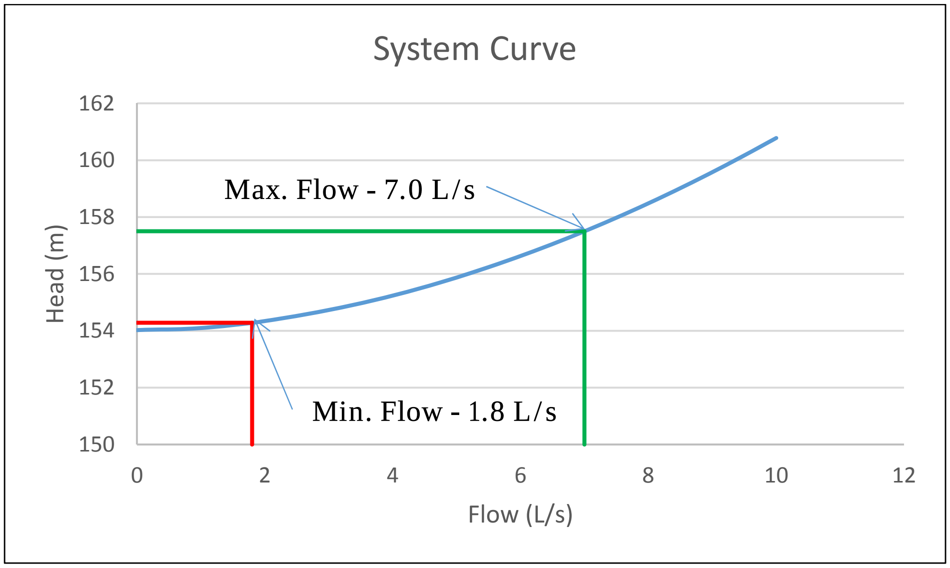


Figure 4 – Pumping System Curve

Based on this system curve and the required operating point it was determined that a two pump system will be used with each pump able to pump in excess of 7.0 L/s. A three pump system is not desired due to added mechanical and control system complexity for a relatively small reduction in pumping volume. Due to the amount of pumping head required, vertical multistage pumps are proposed for the effluent pump station, along with electrical power supply and controls required for the pumps. The pump station and each of its major components will be designed for the immediate capacity of 7.0 L/s and the future capacity of 1.8 L/s with one pump operating.

The new pump station will comprise of the following items:

- An at-grade Matlok building to house the pumping system, piping, lighting, HVAC, electrical distribution and control equipment;
- A duplex pumping system consisting of one operating pump and one standby pump;
- Piping, lighting, HVAC, electrical distribution, and control equipment; and stainless steel piping.
- The pumps will be equipped with soft starters. The soft starter units will reduce the force main from significant cyclic loading when a pump is starting and stopping. Once started, the soft starters will be bypassed and the pump will operate at full speed until commanded to stop.
- The adjacent wet well storage tank will house level monitoring instruments which will be used to control pump start and stop levels.

5.3 Pumping Units

Two Grundfos CR32-7, 30 HP pumps have been selected based on a minimum pumping requirement of 7.0 L/s at 157.5 m TDH, as illustrated by the system / pump curves on the following page. The pumps will be used to pump from the wet well storage tank to the lagoons and operate in a duty-standby configuration.

The pumps will have a slightly higher capacity than required pumping approximately 9.5 L/s. Figure 5, below, shows the proposed pump curve and the preliminary system curve.

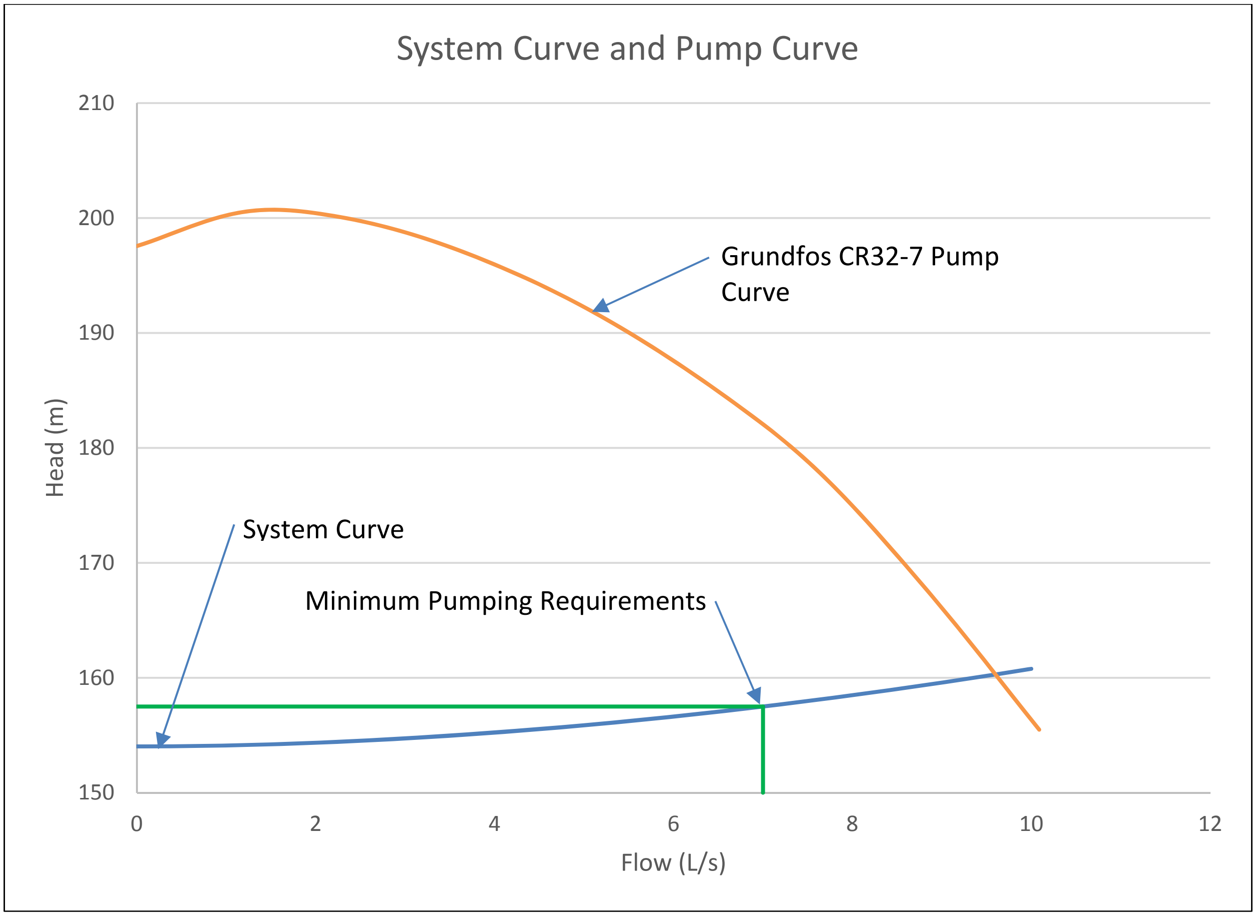


Figure 5 – Pumping System / Pump Curves

5.4 Mechanical Piping and Valves

Mechanical piping and valves will be provided in accordance with the following general requirements:

- Piping will be designed as a class 150 system constructed from schedule 40S stainless steel piping with flanged or grooved piping connections. All fasteners will be stainless steel.

- Suction and discharge piping will contain isolating gate and butterfly valves, drain valves, pressure gauges and pressure transmitters.
- Discharge piping will contain pump check valves, a flowmeter and a pressure relief valve which will relieve high discharge pressure back to the pump station suction header.
- Piping will be arranged such that valves and pumping units are easily removed for service.

5.5 Pump Station Building

The pump station building is proposed to be a pre-fabricated structure which will be designed to suit the local climate. The building will house electrical distribution, power and control equipment, and the pumping system. The building will be preassembled and shipped to site as a complete pumping station. The building will be located at-grade on a concrete pad and connected to piping from the wet well and piping to the ponds. Other building appurtenances will include:

- Interior lighting and exterior lighting on motion sensor control;
- Electric unit heaters;
- Ventilation for air circulation and summer cooling;

We propose to locate the building on a separate site located to the northeast of the lagoons, packaged treatment plants and wet well. The site would be situated an elevation that is 3 meters below the bottom of the wet well, providing positive pressure to the pumps at all times. Additional pump station site works include access road construction, site grading and surfacing, and fencing.

5.6 Pump Station Control

Pumps will be controlled by a PLC with an ultrasonic level transducer and a high level float ball providing liquid level inputs from the wet well storage tank. The pumps will start and stop based on wet well level set points.

When the wet well level rises above the Pump Start Level, the lead pump will accelerate to an operating speed of 100%. When the wet well level falls below the Pump Stop Level the operating pump will decelerate and stop. Upon rising above the Pump Start level, the lead pump will again start. The standby pump will not start unless the lead pump fails to operate. The pumps will be programmed to alternate lead state every time a pumping cycle stops.

A high level alarm float will signify that the pumps are not able to keep up with inflow or have failed and that the wet well is approaching the overflow level.

A flowmeter will be installed on the pump discharge header to confirm pump operation. If a pump has been commanded to start but flow has not exceeded a set value after 30 seconds, then the pump will be stopped and the standby pump will start. The flowmeter will also be used to alarm if flow is too low, signifying a closed valve, or too high, signifying a broken pipe.

Thermometers will be installed between each pump and check valve and used for pump protection. If the liquid temperature exceeds a set value then the pump will be stopped signifying that the pumped liquid is not moving.

Pumps will each be equipped with Hand-Off-Auto selector switches, soft starter, Bypass-Auto selector switches, run hour meters, status display lights and pump current indicators which will be located on the soft starter panel doors. An operator interface will be provided on the control panel which provides a graphical representation of the operating system and access to system operation setpoints.

5.7 Electrical and Instrumentation

A 600 V, 200 A, three phase, underground power service to the pump station will be provided from the treatment plant. This would be connected to the new pump station disconnect located inside of the building.

Station control and monitoring will be achieved using an Allen-Bradley Micrologix 1400 PLC and a 15” operator interface touch panel. Door mounted pilot lights will indicate system status and Hand-Off-Auto selector switches will provide control for the HVAC equipment. The PLC will provide the ability to connect to a local SCADA system. Station alarm monitoring (cellular, telephone, radio communication) is not included.

Additional electrical equipment within the pump station will include:

- Control panel
- Two soft starter panels
- Distribution panelboard and transformer
- Power monitor
- Surge suppressor.

5.8 Pipeline Size and Pressure Rating

A high pressure effluent pipe is proposed to convey the pumped effluent from the pump station to the rapid infiltration basins. The pipeline is approximately 2.1 km long and rises 154 m. Based on the peak flow of 7.0 L/s, and a desire to minimize friction losses and pumping system operating pressure, a 150 mm nominal diameter forcemain pipe is recommended. This diameter pipe results in a line velocity of about 0.4 m/s, a system pressure of 157.5 m (221 psi) and a test pressure of 236 m (332 psi).

Selection of pipe class and size has been based on standard manufactured sizes to allow for availability, rapid delivery and lower costs. Based on the profile of the ground, the pipeline has been divided into two sections where different pipe pressure classes may be recommended. The division of piping sections is due to decreasing static pressures that result at increased elevation; and due to reduced friction losses closer to the end of the pipe. Lower pressure class pipe (HDPE) is less expensive to purchase and can be installed without bedding sand and without having pipe installers enter the trench, resulting in lower costs for this section of force main.

Table 5. Forcemain Pipe Material and Class Selection

Section	Max Dynamic Head (m)	Nominal Diameter (mm)	Pipe Type	Pressure Rating (m)	Inside Diameter (mm)	Length (m)
1	164	150	Cement-Lined Ductile Iron (CLDI)	246	169	1,270
2	75	150	HDPE DR11	113	136	750

The pipeline may, therefore consist of 750 m of 150 mm diameter DR11 HDPE and 1,270 m of 200 mm diameter Class 350 CLDI pipeline. This selection is subject to confirmation following field survey of the alignment. Alternatively, thicker wall, higher pressure class HDPE pipe may also be considered as an option for the lower and middle section of the forcemain alignment, in order to simplify installation up the steeper slopes. This should be considered further during detailed design.

5.9 Freeze Protection

The pipe is proposed to be buried 3.0 m deep and without insulation. The following information was used to estimate the time required to completely freeze the water in the pipe under no flow condition:

- Inlet water temperature 1°C
- Ambient surface temperature -30°C

Based on the Cold Region Utilities Monograph and the above assumed information, it is estimated that the water in the pipe will be completely frozen in approximately 5 days at no flow condition. When there is flow, the pipe will not be completely frozen.

The 2.1 km pipeline has an approximate volume of 38.5 m^3. Based on a working wet well storage tank volume of 14.1 m^3 the pipeline will be flushed out after 2.7 pumping cycles of the wet well. To avoid freezing the pipeline it is recommended to complete three pumping cycles of the wet well each day.

6 Effluent Disposal to Ground (Work Camps)

As discussed in Section 1, treatment with disposal to ground has been identified as the preferred wastewater management strategy for the work camps, provided suitable ground conditions exist on site. In general, effluent disposal to ground is primarily concerned with getting effluent into the ground and away from the site via subsurface flow and ground water recharge. A primary goal is that the effluent moves through unsaturated ground in an acceptable manner that does not present a hazard to public health. Typical situations that present a hazard to public health include insufficient separation from sources of drinking water or sufficient depth to groundwater so that the addition of effluent does not result in ground water mounding and / or seepage of effluent at the ground surface.

As described below, WWA completed a hydrogeological investigation which confirmed the feasibility of effluent disposal via rapid infiltration and suggested that ground disposal of effluent from the 1,200 person work camps should not adversely affect the receiving environment (at the time of the WWA study, the camp population of 1,500 was planned). The hydrogeological investigation, in addition to being a requirement of the EIS for MWR registration, provided information for the basis of the feasibility study and for preliminary design of the RIB system.

6.1 Site Investigations

Section 1.3 recommended that ground disposal was the preferred wastewater management strategy for effluent from the construction and operations work camps. The hydrogeological characteristics are critical to the design and operation of an RIB site, and a proper definition of the subsurface conditions and the underlying groundwater regime is essential. Site evaluation and selection is critical to the success of the project. Important factors are the depth of permeable soils, soil permeability, aquifer transmissivity, depth to ground water, direction of groundwater flow, and distance to receiving environments such as surface water or sources of drinking water.

In order to evaluate the feasibility of this option, and to identify an RIB site, sub-surface site investigations were performed by ODK and WWA. The objective of the investigations was to confirm the suitability of candidate sites for ground disposal of effluent from the construction and operation camps. The approach to the investigations was to delineate a number of areas of permeable, well-drained soils that might be suitable for treated effluent disposal to ground via rapid infiltration basins and to perform on site permeability testing of a preferred site.

As an initial desk top study, existing soils information was compared to the layout of the preliminary mine site in order to identify areas located within a reasonable distance of the work camps that might be suitable for ground disposal. The desk top study included a review of the results of earlier site investigation work completed by ODK, a review of exclusion zone geotechnical investigations completed by KP, and a review of other base geological and topographical maps of the area.

As a result of the desk top study, four candidate sites were identified and an initial field investigation conducted. The initial site visits and test pitting completed by ODK suggested that a site in relatively close proximity to the work camps might be suitable for permeability testing and hydrogeological investigation. Subsequent site visits by WWA, however, raised concerns about the potential for seasonal high groundwater in the area and suggested an alternate site with higher elevation and improved drainage. Notwithstanding that the site is approximately 1.5 km to the south of the work camps, is roughly 140m higher in elevation, and requires increased effluent pumping infrastructure, the soil and drainage conditions were considered to be of sufficient advantage to suggest that the site be evaluated further.

Field work completed by ODK and WWA in June and July, 2013 included:

- Excavation of fourteen test pits in the area of the proposed RIB to delineate the extent of the sand and gravel deposit.
- Drilling of five bore holes with the proposed RIB area to characterize the subsurface soils at greater depths.
- Construction of a trial infiltration basin and completion of a 72 hour pilot RIB loading test to evaluate field permeability of the soils.
- Installation of monitoring wells in the area of the proposed RIB.
- Sampling of pre-discharge / background groundwater and surface water quality for use in EIS submission to MoE.

WWA's analysis of the information gathered from the site confirmed the feasibility of effluent disposal via rapid infiltration at the proposed RIB site and suggested that ground disposal of effluent from the 1,200 person work camps should not adversely affect the receiving environment. A copy of WWA's draft ground disposal feasibility / EIS study is included in the appendices.

6.2 Hydraulic Loading Rate

The process design of RIB systems is generally governed by the infiltration rate into and permeability through the soil to a defined receiving environment (ie. Groundwater recharge, surface water, source of drinking water, etc.)

The US EPA provides recommendations on the suitable hydraulic loading rates for different soil types used for RIB systems. A range of between 6 and 90 m/yr is suggested in the RIB wastewater technology fact sheet. The loading rate applied to the soils at the Blackwater site can be developed by comparing WWA's field testing results to published and recommended rates.

Western Water conducted field infiltration testing by continuously flooding a basin of known area, to observe the infiltrative capacity. Over three days, a basin of 7.6m by 7.6m was flooded with a continuous flow rate of 17 US GPM, or 92.7 m^3/day. The resulting loading rate, which the native soil was observed to accept without negative impacts, was 1.6m/day, or 584 m/year. This loading rate is substantially higher than the range recommended by the EPA, however an adjustment factor of between 10% and 15% is required when utilizing results from a basin flooding test, as in this case. 15% of the observed hydraulic loading rate is 87.6 m/year.

Figure 1.1 in the EPA's Process Design for Land Treatment of Municipal Wastewater Supplement on Rapid Infiltration and Overland Flow identifies an annual hydraulic loading rate for soils of KFS equal to 15 cm/hr (which would suit sandy gravel) between 27 m/year and 180 m/year.

A hydraulic loading rate of 87.6 m/year would therefore be expected to be suitable.

6.3 RIB Dimensions, Layout and Basin Cycling Design

Using a hydraulic loading rate as discussed above, the overall infiltration area required is determined by:

$$A = \frac{(0.0365)(Q)}{(L)}$$

Where A is the area in hectares, Q is the design daily flow in m^3/day, and L is the design hydraulic loading rate in m/year.

For the 1,200 person camp, the overall area required is therefore:

$$A = \frac{(0.0365)(300m^3/day)}{(87.6m/year)} = 0.125 \text{ hectares, or } 1250 \text{ m}^2$$

The EPA Process Design Manual recommends a basin cycle of 1-3 days wetting (application) followed by 5-10 days drying (recovery) for secondary effluent in winter climates. Assuming a wetting to drying ration of 0.33 (application of 3 days, drying of 9 days), a minimum of 4 basins would be required.

The wetting to drying ratio used results in a total 12 day basin cycle with 31 cycles annually. The wastewater loading per cycle is therefore 2.82 m/cycle. For a 3 day wetting cycle, the application rate is 0.94m/day.

The system requires a total infiltrative surface of 1250 m^2. With 4 basins, each basin will be, at a minimum, 312.5 m^2, or roughly 18m by 18m. The basins are expected to be 2.5m deep (1.5m with a 1.0m raised embankment), to allow for some measure of ponding. Higher levels of TSS in effluent can interfere with the capacity of the in-situ soils to accept the effluent. As such, a 0.2m depth layer of clean sands is recommended on the base of the RIBs, which can be removed and replaced as required.

6.4 Intra-cell Piping, Valve Arrangement and Operation

To distribute effluent to the appropriate basin, and to keep the system as simple to operate as possible, we are proposing a valve system whereby each basin has an inlet with gate valve. The valves will be opened alternately, during the respective basin wetting cycle, and closed during drying/recovery stages. The valve arrangement will require operator attention every three days, however will eliminate the need for automatically actuated valves, the required power supply and electrical infrastructure.

Each basin will have a distribution manifold consisting of perforated piping to distribute the effluent evenly to all basin areas. The manifold will be supported above the ground as required.

6.5 Winter / Summer Operation

Requirements for operation of a RIB in the winter differ from the requirements for summer operation. While longer loading and drying cycles in the winter assist in improving the wastewater polishing that occurs in the unsaturated / aerated ground beneath the RIB, the greatest concern with winter operation is ensuring that a bonded ice surface does not form on the bottom of the RIB. Wastewater that is allowed to freeze directly at the ground surface may impede the infiltrative / operating capacity of the system.

Features which may be incorporated into the design in order to alleviate concerns related to freezing include:

- Construction of a ridge and furrow system on the bottom of the RIB that is intended to be used for winter operation. Following the application of effluent, the layer of ice that forms rests on the top of the ridges and forms “ice bridges” that insulate further applications from feezing. This insulating affect is typically improved further in areas where sufficient layers of snowfall accumulate on top of the ice surface. For the required bridging of the ridges to occur, a sufficiently thick layer of ice must be allowed to form before the wastewater infiltrates and allows the ice to drop below the top of the ridges. This may require that a larger than normal dose of effluent be applied to the system in the early winter.

- In some cases, where sufficient snow falls are a regular occurrence, snow fall accumulation alone may insulate both the applied wastewater and the soil at the RIB surface. This is known to occur, for example, at the RIB that is operated at Powder King Ski Resort, in the Pine Pass approximately 200 km north of Prince George.

- Designing one or more of the RIB cells for winter operation, with hydraulic loading rates increased substantially / continuously (without a drying cycle in the winter) so that permanent winter floating ice cover forms. This mode of operation, while potentially possible at the New Gold site, is likely less desirable due to the decreased nitrogen removals and water quality improvements that may occur due to lack of re-aeration of the soil. Notwithstanding that the site selected by WWA is considered low risk; introducing poorly defined operating conditions will result in increased effort on the part of the operators (ie. receiving environment monitoring, etc.)

Given the significant amounts of snowfall reported by New Gold on the site in recent winters, and the high elevation / mountain location, we expect that a combination of ridge and furrow construction along with snowfall retention will ensure that the proposed RIB system will retain more than sufficient capacity for effluent disposal during winter operation.

7 Effluent Disposal to TSF (Mine Plant Site)

The mine plan includes provisions for separate areas for the mine plant site and for other operations buildings such as the truck / maintenance shops and administrative offices that will require provisions for sewage collection, treatment and disposal. Domestic sewage from these buildings is proposed to be treated in a packaged treatment plant and disposed at the TSF. The first phase of TSF and Site C dam is proposed to be constructed at an elevation (1341 meters) that provides options for treatment plant location and effluent outfall alignment will allow for disposal via gravity flow from the packaged treatment plant to the TSF.

7.1 Gravity Sewage Collection

While the mine plant site is proposed to be located on the top of a hill at an approximate elevation of 1425 meters, the truck shop and administrative offices are proposed to be located on an adjacent hill at an elevation of approximately 1415 meters. The two sites are separated by a drainage channel that will require crossing in order that the treatment plant be located such that raw sewage may flow by gravity from buildings to the headworks of the treatment plants.

7.2 400 Person Sewage Treatment Plant Re-Use

As described in Section 4.3, the packaged treatment plant RBC units from the existing exploration camp are expected to have sufficient capacity to provide domestic sewage treatment for the mine plant site, truck shop and administrative offices.

Relocation of the RBC is straight forward but will require some site works including:

- Headworks and / or septic tanks for pre-treatment;
- Construction of a level pad(s) with crushed gravel or concrete base to support the treatment plant units;
- Pipework;
- Electrical supply.

7.3 Effluent Disinfection

While the effluent quality requirements are very similar for the discharge to ground or to the TSF, the potential re-use of water from the TSF presents a greater risk of direct human contact than does discharge to ground. While the potential for human contact / exposure to effluent is expected to be relatively low, the MoE will likely require that the effluent be disinfected in order to achieve the required fecal coliform levels.

Notwithstanding that it was not an explicit requirement for their current use at the exploration camp, the existing RBC units have ultraviolet (U.V.) units lower fecal counts to levels required for discharge to the TSF. Monitoring of the fecal levels of effluent discharged from the existing RBC will confirm whether or not additional measures for effluent disinfection will be required.

7.4 Gravity Effluent Outfall

Based upon estimates of sewage flows, and depending on the final selection of outfall alignment / grade, the outfall may be 100 mm or 150 mm diameter HDPE fused pipe. Depending on other site constraints, the outfall may follow a similar alignment as the proposed mine reclaim water pipeline which will draw re-claimed water from the TSF and pump it to the mine plant site. Once at the TSF, however, it will be beneficial to locate the end of the outfall as far as practical from the reclaim water pump station so that the effluent can achieve dilution and mixing prior to re-use at the plant site.

Generally, due to consistent discharge flow and latent heat of sewage effluent, the risk of freezing of the outfall pipe will be much lower than, say, the domestic water supply or fire protection mains. In order to avoid freezing conditions during extreme cold weather or low flows, however, the outfall should be buried a depth of 1.5m to 2.4m, particularly at road crossings.

8 400 Person Exploration Camp Upgrade

New Gold desires to increase the existing exploration camp capacity from 250 to 400 people, in order to provide overall site capacity during mine construction and reduce the size of the new construction / operations camp from the originally planned 1,500 people to 1,200 people. The exploration camp is expected to remain in service until between years 0 and 1, after which time the sewage treatment plants will be moved to service the plant site facilities (see section 7, above). As identified in sections 1 and 2, an increase in camp capacity triggers a review of the sanitary sewer system, such that recommendations for system improvements, if any, are identified.

8.1 System Description

Raw wastewater is collected from the camp facilities (bunk trailers, kitchen etc…) using buried gravity pipes, before being pre-screened through five 9,080 L concrete septic tanks in series. Effluent from the septic tanks flows by gravity to pump chamber #1, where duplex pumps convey effluent for a dosed feed to the two RBC wastewater treatment plants. Duplex effluent pumps at the end of the treatment process convey the treated wastewater to pump chamber #2. Pump chamber #2 contains duplex effluent pumps which convey effluent to the dosing valve which controls distribution to the sewage disposal field.

8.2 Treatment and Distribution Components

8.2.1 Biological Loading

Two Biodisk–LJ-166 RBC treatment units are in operation. The manufacturer has designed each for an hydraulic load of 47.1 m^3/day (94.2 m^3/day combined) and a biological load of 400 mg/L BOD_5 and 350 mg/L TSS. At this rate and an effluent temperature of 10^0 C, the manufacturer expects treatment to 10 mg/L each of BOD_5 and TSS. In the upgrade from 250 to 400 persons, these factors will remain unchanged.

8.2.2 Hydraulic Loading

8.2.2.1 Existing 250 Person Load

The Standard Hydraulic Load (average day flow) in a work camp setting (BC Ministry of Health, Sewerage System Standard Practice Manual, Table 4.2) is 230 L/person/day. Extrapolating this per capita rate to a 250 person camp gives an average hydraulic loading rate of 57.5 m^3/day.

The recorded average day flow for 2013 to the 10th October was 15.9 m^3/day

8.2.2.2 Proposed 400 Person Load

At the typical hydraulic design rate of 230 L/person/day, an increase of the population to 400 people would see an average total increase in flow to 92 m^3/day.

However, sewerage flow metering records taken from magnetic flow meters at the discharge end of the RBCs show that the average rate for 2013 has been 247 L/person/day. The number of records for 2013 up to 10th October is 261 and the average per capita flow has been exceeded 103 times. It would therefore be prudent to plan for a per capita flow rate of 250 L/person/day for any future planning should they be required, similar to that as recommended in section 3 for the larger, 1,200 person camp.

8.2.3 Septic Tanks / Sewage Pre-Treatment

The primary screening facilities prior to the RBC treatment units currently consist of five septic tanks in sequence, each with a capacity of 9080 L, providing a total of 45.4 m^3 of septic tank storage.

Septic tanks provide a quiescent zone serving five principal purposes:

- Settle out heavier particles and materials (e.g. rags) i.e. settleables;
- Separate out lighter fractions (fats, oils and grease) i.e. floatables;
- Provide biological treatment – breakdown of organic material;
- Sludge and settleables and floatables storage;
- Buffer peak loads.

In providing for the disposal of effluent by septic disposal field, once the waste exceeds that from about 10 people, roughly two days of retention time in the septic tank(s) is required. The septic tanks were originally installed to provide for a 100 person camp (22.7 m^3/day) providing the rational for the 5 tank selection at that time.

It is apparent that to meet the target for septic tank retention time, tankage / pre-treatment volume will have to be increased – ideally to 184 m^3 or 15 additional septic tanks – a difficult situation. With downstream secondary treatment, including clarification and disinfection in place, one might argue against such an increase in volume and promote instead to pump the tanks more frequently. This might be an appropriate response except the principal difficulty being faced by the downstream treatment units is that fats, oils and greases (FOG) has been coating the attached growth process and preventing the system from performing its function.

New Gold would have to undertake a vicious anti-FOG campaign, including indoctrination of all camp personnel, specific kitchen FOG procedures, duplication of grease interceptor devices and possible biological bacteria addition to the collection system, if the required number of tanks is to be reduced.

If satisfactory FOG removal rates were achieved, 8 additional tanks should still be provided for pre-treatment. These would serve the functions principally of storing settleables / floatables (FOG) and load buffering. In this respect, one day's storage (considering the 400 person increase) in conjunction with the anti-FOG campaign would suffice.

There is currently one column of septic tanks. After the additional units are installed, there would be 5 columns, with five rows in the first column and two rows in the balance. Flow would be equally split 5 ways (flow splitter box required) with one-fifth of the total flow passing down each column. Effluent would be directed to PS1, as is currently the case.

Pre-treatment and solids / FOG removal may also be achieved through construction of an earthen settling basin / lagoon, as an alternative to the installation of numerous additional septic tanks. The construction of a settling basin of 184 m^3 in volume may be considerably easier and more cost effective than the installation and arrangement of the tanks. A review of the associated ancillary works (moving of the treatment plants, forcemain/gravity main, and pumping arrangement) and a cost benefit analysis of both options should be undertaken during detailed design.

8.2.4 RBC Treatment

Each Biodisk unit is rated at 47.1 m^3/day. With two units in place, 94.2 m^3/day of effluent can be treated.

The existing camp has capacity for 250 people, the average hydraulic loading rate is 57.5 m^3/day. A camp increase to 400 people would increase the average day flow to 92 m^3/day - also within the RBC treatment capacity available.

The basis of design is for an effluent treatment class C, which requires minimum treatment levels of 45 mg/L for both BOD_5 and TSS.

Monitoring results to-date are as follows:

Table 6. Exploration Camp BOD and TSS results

	2012				2013							
	July	**Sep**	**Nov**	**Dec**	**Jan**	**Feb**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**
BOD	39	32	185	58	48	42	39	51	73	23	26	23
TSS	51	44	176	87	64	40	58	112	68	-	39	-

The average for BOD is 53 mg/L and for TSS is 74 mg/L.

Results fall both within and outside the Class C limits. The non-conforming results are believed to be due to FOG in the treatment units. A grease interceptor was installed downstream of the kitchen in October 2013. Test have not been performed since that time as the RBCs were taken off-line in October 2013 – as camp numbers were below 30 people and scheduled to fall further.

8.2.5 Wastewater Pumping and Disinfection

In terms of the collection, treatment and disposal of wastewater, three sets of pumps are utilised. Their location, function and capacities are noted in the following table.

Table 7. Exploration Camp System Pump Descriptions and Pumping Rates

	Pump Location	**Capacity – as designed (L/s)**	**Preferred Design Rate for 400 persons (L/s)**	**Field Recorded Rates (18 July 2013 1 &2) (16 October 2013 3) (L/s)**
1	Septic Tank Chamber	6.36	5.32	P1 - 3.7

	(Pump Chamber #1)			P2 – 3.8
2	RBC Effluent Chamber (per RBC)	3.16	3.21	RBC1 – 6.4 RBC2 – 5.4
3	Disposal Field Chamber (Pump Chamber #2)	5.42	3.20	P1 – 6.6 P2 – 7.2

(Note: The continuous rate to transfer 92 m^3/day is 1.07 L/s).

Additionally, UV disinfection is provided at the downstream end of each RBC unit (total 2 units). Each UV unit is rated for 3.16 L/s.

A comparison of the existing pump unit and disinfection unit capacities shows that sufficient design provision was made in the 2012 250 person upgrade to permit a 400 person upgrade – as is now planned. Consequently, no upgrades are required to this equipment.

Periodic pump draw-down tests are recommended to ensure there is no undue wear and that no blockages have occurred.

8.3 Disposal Field Capacity

The existing 250 person camp is serviced by treated effluent disposal to ground via an in-ground septic field located approximately 0.8 km to the east of the camp. The field was originally designed to dispose of Class D effluent from the 100 person camp, and upgraded, through the installation of treatment plants, to the disposal of Class C effluent from the current 250 person camp. The overall field size remained the same, with extra capacity achieved through the disposal of higher quality effluent (see May 2012 “Sewage Treatment and Disposal System Operating Plan” report completed by ODK for New Gold). As part of the review process associated with upgrading the camp to 400 people, the hydraulic capacity of the existing septic field was reviewed to determine if improvements are required. The field was compared to sizing guidelines outlined in the MWR, and a field hydraulic loading test was completed.

8.3.1 Field Sizing and Hydraulic Capacity Review

The disposal field consists of a dosed pressurized system, with alternating distribution to six separate infiltration zones. Each zone is composed of six 34m long rows of infiltrator chambers and lateral piping, spaced three to four metres apart for a total zone footprint of 544m^2 and linear length of 205m. The entire field has a footprint of 225m by 16m, or 3600m^2. Undeveloped area for reserve exists both to the north and the east of existing field.

Sizing for design of the disposal field utilised a percolation rate of 15 minutes/25mm. This was based on observations of percolation rates between 5 and 15 minutes/25mm during initial field test pitting, with the actual design having been based on the more conservative values.

During construction of the disposal field, it became apparent that a percolation rate of 2 minutes / 25mm was more suitable for the site conditions. Further, with reference to Western Water Associates Ltd. Environmental Impact Study (EIS) dated December 2011, Sections 3.5, 4.1 and 6.5 commented on the percolation rate of the soils at the disposal field, noting in Section 6.5 that "... for each of the active disposal fields is approximately 6,700 m^3/day, more than two orders of magnitude higher than the design flow of 56 m^3/day." Further to the EIS, the design shows considerable conservatism in issues such as "Potential Down-Grade Receptors" (Section 6.3 - 52 days to closest stream versus 10 required) and Section 6.7 "Assessment of the Potential for Mounding".

The MWR outlines the design requirements for disposal of Class C effluent to soils with percolation rates of 2 minutes / 25mm (Section 78, Table 4). A minimum of 50 lineal metres of drainage pipe per 10 m^3/day of effluent is required. As only 5 of 6 septic field zones are operable (a groundwater spring exists under zone 5, and it has consequently been closed), a total operating drain pipe length of 1025m exists. The MWR requires that 910m of drain pipe is available to dispose of the effluent. At the minimum length and observed percolation rates, the field size allows for the disposal of 102.5 m^3/day of effluent, or an equivalent camp population of 452. Based on the existing size and operation of the field, as well as Western Water Associate's field hydraulic capacity observations, the disposal field is expected to have capacity for the 400 person camp.

8.3.2 Field Hydraulic Loading Test

To further confirm the hydraulic capacity of the existing septic field, Opus DaytonKnight completed a hydraulic loading test by applying the equivalent flow from a 400 person camp (92,000 L/day) to the field continuously for 6 days. The test occurred in October of 2013, and was completed by having New Gold transport water to the pump station preceding the disposal field and recording observations over the course of the 6 days. The effect of the loading test on the field was determined by:

- Monitoring the field for signs of breakout;
- Measuring the standing water depth in the observation ports daily during the test;
- Testing the up gradient and down gradient groundwater wells for the presence of water before and after the test;
- Monitoring the creek down gradient of the disposal field for signs of breakout or daylighting of effluent;

The field exhibited no signs of overloading over the course of the test, and continued to perform admirably, with pertinent observations including:

- No breakout encountered;
- Standing water depth generally reducing in observations ports;
- No groundwater detected in either wells before or after the test;
- No signs of effluent daylighting at the creek;

- Some ponding on the lower section of zone 6 – discovered on day 1 with half the zone consequently shut off for the remainder of the test. No breakout of additional ponding observed around the zone over the course of the test, with the ponded water disappearing.

From observations during the loading test, the field was observed to be suitable for disposal of effluent from the 400 person camp, confirming the field sizing review outlined in section 8.2.1, above.

8.3.3 Reserve Area

The MWR outlines the requirement for an undeveloped reserve area, with 50% design system redundancy. In order to confirm that suitable area and soil types exist near the disposal field for future expansion, if required, Opus DK performed a site visit and witnessed test pits within the limits of the proposed reserve area.

Four test pits were excavated – 2 to the north, 1 to the northeast, and 1 directly to the east of the field- to a minimum depth of 4.5m. All the test pits indicated medium to coarse grained sands and gravels throughout, with no indication of substantial groundwater. The soils in the area would be suitable for supporting further disposal field expansion, should it be required.

8.4 Wastewater Recommendations for 250 to 400 person upgrade

- Undertake a vicious anti-FOG campaign in conjunction with a 'Goslyn' style grease interceptor in the kitchen.

- Increase the number of septic tanks by 8. There would be a total of 5 trains of septic tanks – the first train with 5 units (the existing system) and the remaining 4 trains with 2 tanks in each. Provide a flow splitting chamber to split the camp flows five-ways and so balance the flows to the septic tank trains. Alternatively, construct a pre-treatment settling basin / lagoon of suitable volume for solids and FOG removal.

- Apart from FOG and septic tank / pre-treatment lagoon provisions, make no other alterations to the existing wastewater collection, treatment, disposal and control system and infrastructure.

- Continue to dose to each field at a volume of 3,445 L per dose. In this manner, the dose frequency will increase; from 12 to 15 times a day (250 people) up to 26 to 30 times per day (400 people). The duration of dosing per field will not alter (10.59 minutes) but the at-rest period between doses will decrease from ~ 3.6 hours (250 people) down to 3.2 hours (400 people).

9 Cost Estimates

The PEA estimated the cost of construction of the mine at $1.8 billion. A key objective of the Feasibility Study is the provision of more detailed cost estimates to substantiate or update the previous information.

This wastewater planning and pre-design study has developed the design concepts to a level of detail that provides sufficient information for the preparation of Feasibility Study cost estimates, based upon available site information. The cost estimates have been prepared in 2013 dollars based upon unit costs for each component of the specified civil / sewage treatment, pumping, and disposal works. The unit costs are based upon our experience with other similar projects and information provided by vendors of specific equipment.

The estimates should be considered Class B or C estimates, depending on the work component and the level of detailed information available for each unit component. The estimates will need to be refined to more substantive estimates once further site investigations and detailed design drawings are completed.

9.1 Cost Estimate Definitions

Class “A” estimate: this is a detailed estimate based on the quantity take-off from final drawings and specifications. It is used to evaluate tenders or as a basis of cost control during day-labour construction.

Class “B” estimate: this is prepared after site investigations and studies have been completed and the major systems defined. It is based on the project brief and preliminary design. It is used for obtaining effective project approval and for budgetary control.

Class “C” estimate: this is prepared with limited site information and is based on probable conditions affecting the project. It represents the summation of all identifiable project elemental costs and is used for program planning, to establish a more specified definition of client needs and to obtain preliminary project approval.

Class “D” estimate: this is a preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project, derived from lump sum or unit costs for a similar project. It may be used in developing long term capital plans and for preliminary discussion of proposed capital projects.

Contingency: New Gold has allowed for a contingency in the wider minesite feasibility study, and have advised that it is to be omitted in the Domestic Wastewater Feasibility Study cost estimates.

Construction Risk: an area of uncertainty identified in preparing an estimate which may have an effect on costs. This covers uncertainties such as the quantity or quality of pre-engineering information, variations in construction schedules, and the construction market at the time of project implementation.

Remoteness Factor: Where the site is located between 50 and 300 km from the nearest service center by year-round access, material prices may not be as competitive, transportation time and costs are a consideration, and skilled labour must be housed on site or compensated for travel. The cost to construct and operate infrastructure on the Blackwater site may consequently be affected by its location. While the site is not as remote as many other mine sites (2, on a scale of 1 to 4), the site location will nevertheless be a factor when compared to the cost of projects in Prince George or other developed areas.

9.2 Site Preparation

The wastewater system requires collection and conveyance to the treatment system servicing the 1,200 and future 500 person camps. The treatment system site will require preparation prior to lagoon construction. Preparation will generally consist of tree clearing, grubbing and stripping, followed by pad construction from native materials. The estimated costs for preparation of the 3.5 Hectare area and pad construction is presented in the following table.

Table 8. Site Preparation Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
Clearing and Grubbing	Ha	3.5	$ 16,000.00	$ 56,000
Stripping	Ha	3.5	$ 15,000.00	$ 52,500
Excavation to Embankment	m^3	12000	$ 15.00	$ 180,000
Subtotal Site Preparation				**$ 288,500**

9.3 Collection System

From the temporary and permanent camp sewage collection system (costs of which have been accounted for in the scope of others), raw wastewater will require conveyance via gravity to the proposed treatment site, located approximately 110 metres and 8 metres below the edge of the temporary camp. The cost estimate for the various gravity system components required is presented in the following table, and includes items necessary to control flows to the various treatment systems.

Table 9. Gravity Collection System Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
300mm Diameter PVC	l.m.	120	$ 300.00	$ 36,000
200mm Diameter PVC	l.m.	100	$ 250.00	$ 25,000
Flow Splitting Chambers	ea	1	$ 25,000.00	$ 25,000
Manhole - 3.5m depth	ea	1	$ 12,500.00	$ 12,500
Subtotal Collection System				**$ 98,500**

9.4 Aerated Lagoons – Construction and Operations Camp

The sewage treatment system is proposed to consist of two aerated lagoons in parallel, such that capacity exists during mine construction, and long term system redundancy exists in the case of maintenance and/or repairs during mine operation. Each lagoon train is designed to have treatment capacity for 600 people. The costs associated with earthworks, access, aerators, and electrical/mechanical controls, have all been included in the estimate.

Site conditions will affect the suitability of the site and therefore the cost of construction of the lagoons. Opus DK performed a preliminary soils analysis in the area of the lagoons in October, 2013, consisting of 5 test pits to a depth of approximately 7 metres. Generally, clay till to a depth of 6 metres (underlain by sand) was encountered. Accordingly, an allowance for a lagoon liner has been omitted in the cost estimate. A detailed geotechnical investigation will be required prior to detailed design to confirm the suitability of the soils for embankment construction, to identify groundwater conditions, and to confirm that the HDPE liner will not be required. Estimated costs of the aerated lagoon wastewater treatment system are presented in the table, below.

Table 10. Aerated Lagoon Wastewater Treatment System Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
Excavation to Embankment	m^3	7000	$ 20.00	$ 140,000
Access/Service Road	LS	1	$ 45,000.00	$ 45,000
Weirs and Outlet Structures	LS	1	$ 22,000.00	$ 22,000
Aerators - 4kW	ea	12	$ 12,500.00	$ 150,000
Aerator Support Structure	LS	1	$ 25,000.00	$ 25,000
Aerator Motor Controls	ea	2	$ 14,500.00	$ 29,000
Electrical Control Building and MCC	LS	1	$ 155,000.00	$ 155,000
Power Supply from Permanent Camp	LS	1	$ 150,000.00	$ 150,000
Subtotal Permanent Sewage Treatment System				**$ 716,000**

9.5 Effluent Lift Station

Following treatment via aerated lagoons, the effluent will be conveyed via gravity to a concrete wet well and lift station. The lift station will pressurize the treated effluent for conveyance through the forcemain to the rapid infiltration basins. The cost estimate for the lift station includes all the components of the station itself (pumps, mechanical, building), as well as the wet well, suction line, control panels, and electrical/power supply. Costs associated with the forcemain itself are presented in a separate table.

Table 11. Effluent Lift Station Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
Site Preparation Works	LS	1	$ 100,000.00	$ 100,000
Packaged Building	LS	1	$ 160,000.00	$ 160,000
Concrete Wet Well - 3050mm Pre-cast Manhole	LS	1	$ 60,000.00	$ 60,000
Suction Line (Including Tie-ins) - 150mm Diameter DR 11 HDPE	lm	30	$ 650.00	$ 19,500
Pumps - 30 HP Inline Centrifigal	ea	2	$ 30,000.00	$ 60,000
Mechanical Components (Valves, Fittings, Floats etc...)	LS	1	$ 60,000.00	$ 60,000
Power Supply	LS	1	$ 50,000.00	$ 50,000
MCC/Control Panel	LS	1	$ 150,000.00	$ 150,000
Subtotal Lift Station				**$ 659,500**

9.6 Force Main

A forcemain is required to convey pressurized effluent to the rapid infiltration basins for in-ground disposal. Because of the high static pressure associated with the elevation difference between the camps and RIB site, the forcemain is proposed to be constructed with higher pressure class cement lined ductile iron (CLDI) or HDPE piping.

Table 12. Forcemain Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
Clearing and Grubbing	Ha	3.0	$ 16,000.00	$ 48,000
Stripping	Ha	3.0	$ 15,000.00	$ 45,000
150mm Diameter HDPE Forcemain @ 3.0m Depth	l.m.	2020	$ 325.00	$ 656,500
Subtotal Forcemain				**$ 749,500**

The forcemain is estimated to cost approximately $750,000, and includes supply and installation of the piping.

9.7 Rapid Infiltration Basins

The following table represents the cost estimate associated with construction of the rapid infiltration basins. Site preparation, access road construction, earthworks, piping and valves, and effluent distribution manifolds are included in the estimate, for a total value of $605,000.

Table 13. RIB Construction Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
Clearing and Grubbing	Ha	2.5	$ 16,000.00	$ 40,000
Stripping	Ha	2.5	$ 15,000.00	$ 37,500
Inter-cell Piping - 150mm Diameter HDPE/PVC	lm	170	$ 300.00	$ 51,000
Dosing Control Valves - 150mm Diameter	ea	4	$ 5,000.00	$ 20,000
Excavation to Embankment/RIB Construction	m^3	2,500	$ 22.50	$ 56,250
Cell Distribution Manifold/Ridge Furrow Construction	ea	4	$ 15,000.00	$ 60,000
Replaceable 200mm Sand Layer for TSS Reduction	ea	4	$ 12,000.00	$ 48,000
Access Road				
Excavation to Embankment	m^3	10000	$ 22.50	$ 225,000
Pitrun Subbase	m^3	1500	$ 45.00	$ 67,500
Subtotal Rapid Infiltration Basins				**$ 605,250**

9.8 Plant Site Sewage Treatment and Disposal

The mine plan includes provisions for development of a separate plant site and operations buildings, at a significant distance from the camps. As such, the site requires a separate wastewater management strategy. As the facilities and associated wastewater infrastructure will be in place for the life of the mine, a permanent solution is required.

The location of the facilities is such that treatment with gravity distribution to the tailings storage facility is possible. With the decommissioning of the 400 person camp and existing RBC treatment plants, the feasibility study allows for the relocation and commissioning of the plants to service the plant site.

Table 14. Plant Site Sewage Treatment and Disposal System Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
Relocation of Existing 200 Person RBC Units	LS	1	$ 50,000.00	$ 50,000
Flow Splitting Chamber	ea	1	$ 25,000.00	$ 25,000
Septic Tank	ea	5	$ 4,500.00	$ 22,500
Pad Construction and Access Road	LS	1	$ 50,000.00	$ 50,000
200mm Diameter PVC Gravity Main	lm	750	$ 250.00	$ 187,500
150mm Diameter HDPE Outfall	lm	1650	$ 175.00	$ 288,750
Outlet to TSF	ea	1	$ 10,000.00	$ 10,000
Subtotal Plant Site Sewage System				**$ 633,750**

9.9 250 to 400 Person Exploration Camp Upgrade

A small allowance should be included in the overall cost estimate for wastewater system improvements to the existing 250 person exploration camp, such that the system can support the increase in population to 400. The table, below, illustrates the costs associated with the recommendations outlined in Section 8.

Table 15. Exploration Camp Wastewater System Upgrade Cost Estimate

Description	Unit	Quantity	Unit Price ($)	Amount
Flow Splitting Chamber	ea	1	$ 25,000.00	$ 25,000
Septic Tanks (2,000 Imp. Gallon)	ea	8	$ 4,500.00	$ 36,000
FOG Interceptor and Troubleshooting	LS	1	$ 10,000.00	$ 10,000
Subtotal Exploration Camp Upgrade				**$ 71,000**

9.10 Engineering

In order that construction may start in 2015, immediately following receipt of the required permits, many of engineering designs must be completed in 2014. Several guidelines for estimating engineering fees have been published by organizations such as APEG BC, ACEC, PWGSC, etc. While engineering fees often vary between projects, and can depend on, among other things, overall project value, location, complexity, and permitting requirements, the published values for budgeting purposes are similar, and range from 10 – 15%. For the purpose of the Feasibility Study cost estimates, we have assumed 15%, and have provided a separate estimate for engineering designs and for engineering services during construction.

9.10.1 Planning and Detailed Design

In order that New Gold may budget for advanced engineering designs that are required to be completed in the first half of 2014, a request for a fee proposal from ODK has already been made for the detailed design and MoE permitting of the required sewage treatment, pumping and disposal facilities. The fee proposal was submitted to New Gold in late September, following completion of the Draft Feasibility Study. An allowance for engineering planning and design is included in the cost estimate. Planning and design, following feasibility study and preliminary design, can be expected to include (in brief):

- Review and updating of preliminary design following design team feedback;
- Detailed site reviews of specific system component locations;
- Detailed Geotechnical investigation ns of the lagoon site;
- Detailed design drawings (Issued for Construction) and cost estimates;
- MoE permitting activities, including meetings, MWR submissions, operating plans;
- Preparation of technical specifications related to the works;

- Equipment shop drawing submittal reviews and approvals;
- Communications (team and client meetings etc...).

For preliminary budgeting purposes, an allowance of 10% of the construction value of the project is appropriate for activities related to the engineering planning and detailed design. 10% of the construction value is approximately $370,000.

9.10.2 Construction Services

It is expected that New Gold will engage an EPCM (Engineering Procurement and Construction Management) firm to facilitate construction of the mine. In order that the Engineer of Record maintains an appropriate level of involvement such that construction monitoring and certification of the system can be completed, the engineering budget should include an allowance for construction services.

The construction services engineering budget would allow for continuous site presence, and a percentage (of total wastewater project construction value) of 6% to 7%. Due to the overlapping roles of EPCM personnel and the design engineer (minor and regular site inspections, budgeting and communications, Quality Control and management, etc...), the allowance for direct construction services to be provided by the Engineer of Record might be reduced to approximately 4% of the overall construction value of the works, or approximately $150,000. These engineering construction services do not include survey-layout or contractor quality control documentation (ie, materials / non-destructive testing).

9.10.3 Project Management

Construction of wastewater system works generally would require an allowance for overall project management (approximately 2% of the overall value of the works), however in this case, and as described above, New Gold is expected to engage an EPCM contractor to manage and facilitate construction of the mine. Overall budgeting, contract administration, contractor communications, invoice approvals and other project management items for the overall mine site will be included in the scope of the EPCM contractor. In order to avoid duplicating efforts, an allowance for engineering project management has been omitted for the wastewater system works budget.

9.10.4 Commissioning and System Operation and Monitoring

The MoE allows for a period of commissioning following treatment system construction/installation, which allows for system startup, optimisation, training, and any operational changes required. The commissioning period allows for the operators to become familiar with the system as a whole, and generally requires involvement and guidance from the design engineer. It is prudent to allow for engineering commissioning and startup allowances in the overall budget. We recommend an amount of $40,000, or 1% of the overall wastewater system construction value, be included in the project engineering costs.

9.11 Contingency

The cost estimates from the PEA included a 24% contingency allowance of $346 million. Notwithstanding that the estimates from the Feasibility Study should be of greater definition and accuracy than the PEA, it is still necessary to provide a contingency allowance. In order to account for potential changes in design and/or site conditions (soil, weather, schedule) that can impact cost, a contingency allowance of 20% would be appropriate for feasibility level cost estimates. At New Gold's request, however, we have omitted the contingency allowance, as we understand that contingency for the wastewater works will fall under the overall mine contingency allowance identified in the minesite wide feasibility study.

9.12 Cost Estimate Summary

By combining all the relevant capital costs estimates in Sections 8.2 through 8.11, the overall estimated capital cost of the entire wastewater collection, treatment, pumping, forcemain, and disposal system can be determined. As shown in the table below, the overall cost, including engineering and a remoteness factor, is estimated to be approximately $4.8 million.

Table 16. Construction Cost Estimate Summary

Cost Estimate Summary		
Site Preparation	$	288,500
Collection System	$	98,500
Treatment System - Aerated Lagoons	$	716,000
Lift Station	$	659,500
Forcemain	$	749,500
Rapid Infiltration Basins	$	605,250
Plant Site Treatment and Disposal	$	633,750
250 to 400 Person Exploration Camp Upgrade	$	71,000
Engineering (15%)	$	573,300
Remoteness Factor	$	262,200
Total Estimated Construction Costs (excluding taxes)	**$**	**4,657,500**

10 Annual Operating Costs

To better understand the long term estimated cost of constructing and operating the mine, the operating costs for sewage disposal have been identified for each of the:

- 400 person camp
- 1,200 person construction/500 person permanent camp
- Mine Plant Site

For each site, the number of man hours have been estimated, based on commonly required tasks, and have been averaged over the entire year. The averaging over the year is important, as some of the work, especially in the winter, takes longer to complete. As a result of the longer times needed in the winter, it was assumed that the operator would schedule the major maintenance items to be completed in the spring/summer/fall. Repair allowances have been added to each cost estimate for unexpected operational problems or breakdowns. Given the uncertainty of the experience and capacity of operators available to operate the facilities, the engineering allowance has been increased to assist with operating to ensure the system is operating within the requirements outlined in the regulations. It is envisioned that New Gold staff will continue to operate the system servicing the 250 person camp (to be upgraded to 400 persons), and may elect to hire a contractor to run the 1,200/500 person camp system from years -2 to 0 due to the more complex operational requirements. Following adequate training and experience operating the system with the assistance of hired contractors, New Gold could conceivably operate the aerated lagoon and RIB system for the operating life of the mine.

10.1 400 Person Camp

The 400 man camp is intended to be operated by New Gold from year -2 to year 0, and would be de-commissioned at the end of the mine construction. As a result of the shorter service life, some of the long term maintenance costs can be avoided. Table 14, below illustrates the number of man hours needed to operate the facility within the regulation requirements.

Table 17. 400 Person Camp Operational Requirements

Item	Work Hours
Daily Grease Trap Cleaning	182.5
Daily Control Panel Inspections	182.5
Daily Treatment Plant / Disposal Field Visual Inspections	365
Monthly Septic Tank Inspection / Filter Cleaning	24
Monthly Control Panel Data logging	12
Monthly Effluent Sampling	36
Monthly Treatment Plant Maintenance	36
3 Month Treatment Plant Maintenance	12
6 Month Treatment Plant Maintenance	20
Annual Drawdown Tests	6
Annual Treatment Plant Maintenance	4
Annual Disposal Field and Dosing Valve Inspection / Testing	10
Annual Reporting to Regulators	20
Estimated Annual Man Hours	**910**

Table 18, below, relates the estimated man hours to an estimated operational cost, equipment costs, material costs and support allowances for repairs / technical troubleshooting.

Table 18. 400 Person Camp Operational Costs

Item	Work Hours	Hourly Rate	Amount
Labor			
Annual Man Hours	910	$ 50	**$ 45,500**
Equipment and Materials			
Monthly Lab Testing to Meet Regulations			$ 5,400
RBC Treatment Plant Maintenance - Lubricants			$ 900
Solid Waste Removal and Disposal at Authorized Wastewater Facility			$ 16,380
Allowance for Heavy Equipment	40	$ 250	$ 10,000
Repair Parts Allowance			$ 20,000
Subtotal of Equipment and Materials			**$ 52,680**
Support Allowances for Operating			
Engineering Support	60	$ 130	$ 7,800
Plumber	100	$ 85	$ 8,500
Electrician	50	$ 100	$ 5,000
Subtotal of Support Allowance for Operating			**$ 21,300**
Total Estimated Annual Operating Cost (Say)			**$ 119,000**

10.2 1,200 / 500 Person Camp

The 1,200 man camp is intended to be operated by a Contractor from year -2 to year 1 construction period, with the camp being downsized to 500 people following mine construction (years 1-17). With the wastewater infrastructure being the same for both stages (1,200 and 500 person camps), operator requirements will remain the same following camp downsizing. It is expected that New Gold may wish to undertake system operation following camp downsizing and adequate training and experience while working with hired contractors. Table 19 illustrates the number of man hours needed to operate the facility within the regulation requirements.

Table 19. Permanent Mine Camp Operational Requirements

Item	Work Hours
Daily Lift Station Inspection	365
Daily Lagoon and Rapid Infiltration Basin Inspection / Adjustment	850
Monthly Lift Station Control Panel Data logging	12
Monthly Effluent Sampling	36
Trim Vegetation - Lagoons and Basins (twice per summer)	240
Fence Repairs	10
Annual Lift Station Testing	4
Annual Aerator Testing / Cleaning	24
Annual Reporting to Regulators	30
Estimated Annual Man Hours	**1571**

Table 20 below relates the estimated man hours to an estimated operational cost, equipment costs, material costs and support allowances for repairs / technical troubleshooting.

Table 20. Permanent Mine Camp Operational Costs

Item	Work Hours	Hourly Rate	Amount
Labor			
Annual Man Hours	1571	$ 50	**$ 78,550**
Equipment and Materials			
Monthly Lab Testing to Meet MWR			$ 5,400
Allowance for Heavy Equipment	40	$ 250	$ 10,000
Repair Parts Allowance			$ 20,000
Subtotal of Equipment and Materials			**$ 35,400**
Support Allowances for Operating			
Engineering Support	60	$ 130	$ 7,800
Plumber	100	$ 85	$ 8,500
Electrician	50	$ 100	$ 5,000
Subtotal of Support Allowance for Operating			**$ 21,300**
Total Estimated Annual Operating Cost (Say)		**$**	**135,000**

10.3 Mine Plant Site

The mine plant site is intended to be operated by New Gold from year 0 to year 17, which is the planned life of the mine. This part of the site would consist of gravity sewer mains, packaged treatment plant, and an outfall into the tailings dam. Table 21 illustrates the number of man hours needed to operate the facility within the regulation requirements.

Table 21. Mine Plant Site Operational Requirements

Item	Work Hours
Daily Treatment Plant / Outfall Visual Inspections	547.5
Monthly Control Panel Data logging	12
Monthly Effluent Sampling	36
Monthly Treatment Plant Maintenance	36
3 Month Treatment Plant Maintenance	12
6 Month Treatment Plant Maintenance	20
Annual Pump Tests	4
Annual Treatment Plant Maintenance	4
Annual Reporting to Regulators	20
Estimated Annual Man Hours	**691.5**

Table 22 relates the estimated man hours to an estimated operational cost, equipment costs, material costs and support allowances for repairs / technical troubleshooting.

Table 22. Mine Plant Site Operational Costs

Item	Work Hours	Hourly Rate	Amount
Labor			
Annual Man Hours	691.5	$ 50	**$ 34,575**
Equipment and Materials			
Monthly Lab Testing to Meet Regulations			$ 5,400
Treatment Plant Maintenance - Lubricants			$ 900
Solid Waste Removal and Disposal at Authorized Wastewater Facility			$ 4,680
Allowance for Heavy Equipment	40	$ 250	$ 10,000
Repair Parts Allowance			$ 20,000
Subtotal of Equipment and Materials			**$40,980**
Support Allowances for Operating			
Engineering Support	60	$ 130	$ 7,800
Plumber	100	$ 85	$ 8,500
Electrician	50	$ 100	$ 5,000
Subtotal of Support Allowance for Operating			**$ 21,300**
Total Estimated Annual Operating Cost (Say)		**$**	**97,000**

10.4 Summary of Operational Costs

Table 23 illustrates the estimated annual and total operational costs to be expected during the construction and mining periods.

Table 23. Summary of Estimated Total Annual Costs

Facility	Year	Annual Cost	Total Estimated Cost
400 man Camp	-2 to 0	$ 119,000	$ 238,000
1200 man Camp	-2 to 1	$ 135,000	$ 405,000
Total Cost during Construction Period		**$ 254,000**	**$ 643,000**
Permanent Camp	1 to 17	$ 135,000	$ 2,160,000
Mine Plant Site	0 to 17	$ 97,000	$ 1,649,000
Total Cost during Mining Period		**$ 232,000**	**$ 3,809,000**

11 Summary and Recommendations

11.1 Strategy for Sewage Treatment and Disposal

The recommended strategy for sewage treatment and disposal on the site includes:

- Modification of the sewer system servicing the existing exploration camp in support of increasing camp capacity from 250 persons to 400 persons, with continued discharge of Class C effluent to the existing buried septic field;
- Future relocation of the two RBC packaged treatment plants for use to service the truck shop, administrative buildings and mine plant site, with discharge of Class C effluent (with disinfection) from these buildings to the Tailings Storage Facility via a 1.65 km long gravity outfall pipe;
- Construction of parallel aerated lagoons, each with capacity for 600 persons, to provide service to the total 1,200 persons construction camp and the future 500 person operations camp, with discharge of Class C effluent to ground via Rapid Infiltration Basins;
- Pumping of effluent from the 1,200 person work camp(s) to the Rapid Infiltration Basins via a 150 mm diameter CLDI / HDPE forcemain.

11.2 Cost Estimates

Construction costs for the proposed sewer systems are estimated to be $ 4.7 million, including allowances for Engineering and Remoteness.

Operating costs for the sewer systems are estimated to be $643,000 during the mine construction period, and $3.8 million during the mine operating period, including an allowance for the contracting out of sewage treatment plant operations during construction. The average over the entire 19 year mine activity period is approximately $234,000/year.

11.3 Field Investigations Prior to Detailed Design

The proposed treatment strategy consists of aerated lagoons for short term mine construction and long term operations camps. A preliminary soils analysis in the lagoon area identified clay till soils that may allow for lagoon construction without the installation of a HDPE liner. Prior to detailed design, a detailed geotechnical investigation of the proposed lagoon site is required. We envision that more detailed investigations may occur in the spring of 2014, along with more detailed investigation of the proposed RIB site and along the forcemain alignement, prior to finalizing detailed designs.

11.4 Regulatory Requirements

The Ministry of Environment has confirmed that its preference is that each discharge location be separately registered under the Municipal Wastewater Regulation. This will required three separate regulatory / registration processes for each of:

- Expansion of the existing 250 person camp to 400 person capacity for discharge to ground at the existing ground disposal field;
- Treatment and disposal of sewage effluent generated at the 1,200 / 500 person work camp(s) to ground via Rapid Infiltration Basins;
- Treatment and disposal of effluent from the plant site to the Tailings Storage Facility.

We recommend that this report, upon review and approval from New Gold and AMEC, be submitted to the Ministry of Environment, along with the Environmental Impact Study completed by Western Water Associates Ltd, in support of application to the Ministry of Environment for registration of each of the sewer systems under the Municipal Wastewater Regulation. Submitting the applications (and supporting technical information) sooner, rather than later, is intended to ensure that the project(s) have a place in the Ministry of Environment’s review queue / wait list.

APPENDIX A

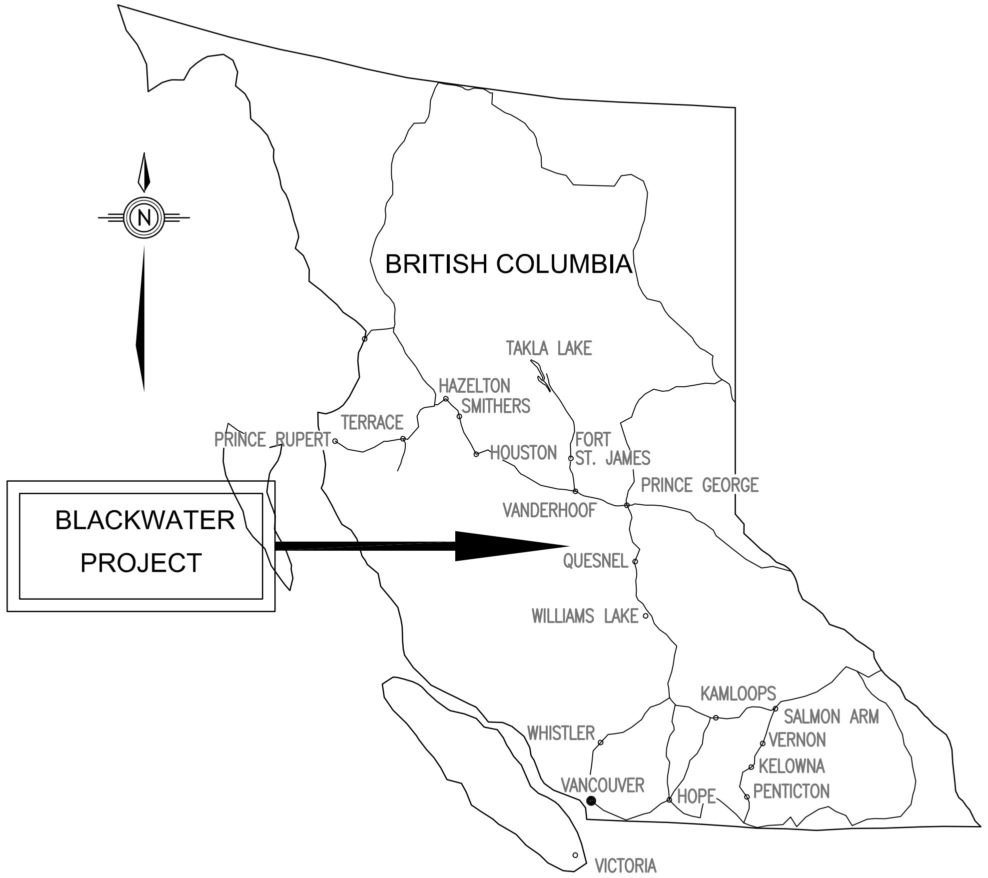
PRELIMINARY DESIGN DRAWINGS

NEW GOLD INC.

BLACKWATER PROJECT

TEMPORARY AND PERMANENT CAMP WASTEWATER SYSTEM

PRELIMINARY DESIGN



LOCATION MAP

DRAWING INDEX

Dwg No.	Rev.	Description
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01	1	SITE PLAN
02	1	FORCEMAIN PLAN AND PROFILE
03	1	AERATED LAGOON SITE PLAN
04	1	AERATED LAGOONS CROSS SECTIONS
05	1	RAPID INFILTRATION BASINS PLAN AND PROFILE
06	1	LIFT STATION

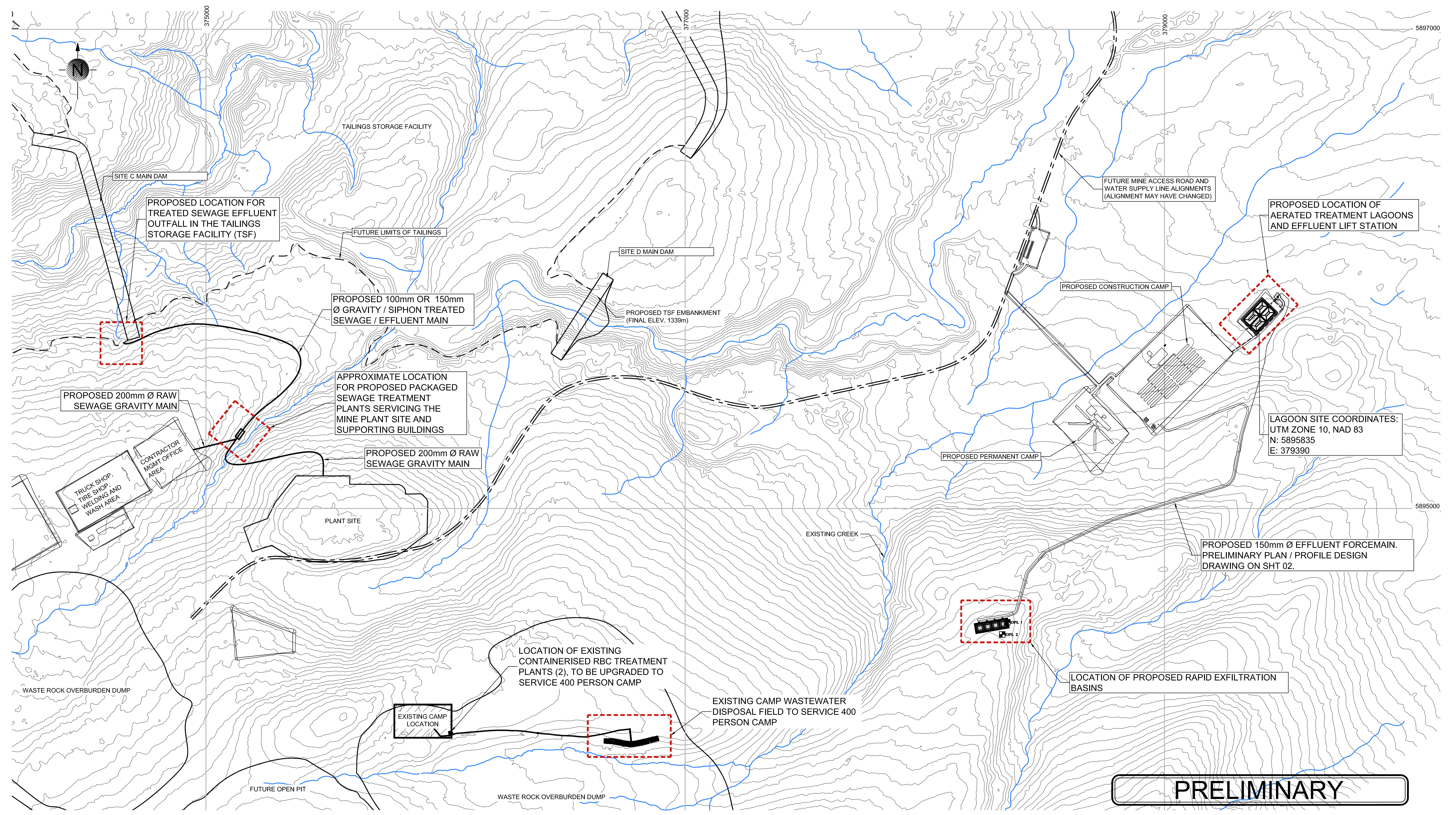
PRELIMINARY

OPUS DAYTONKNIGHT

101 2700 Queensway
Prince George, BC
V2l 1N2, CANADA

Prince George Office
+1 250-562-0058

PROJECT No.:	D-95002.00
DATE:	SEPTEMBER 2013
PROJECT MANAGER:	SRB
DESIGNER:	LDHB/JH
DRAFTSPERSON(S):	LDHB



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Revision	Amendment	Approved	Revision Date
1	PRELIMINARY DESIGN	SRB	SEPT 2013

OPUS DAYTONKNIGHT
Prince George Office
201 - 1110 6TH AVENUE
Prince George, BC
V2L 3M6 CANADA
+1 250 5620038
OPUS

Drawn	Designed	Approved	Revision Date
LDHB	LDHB	SRB	

Project
NEW GOLD INC.
BLACKWATER PROJECT
TEMPORARY AND PERMANENT CAMP WASTEWATER SYSTEM

Sheet
SITE PLAN

Project No.	Scale	Drawing No.	Sheet. No.	Revision
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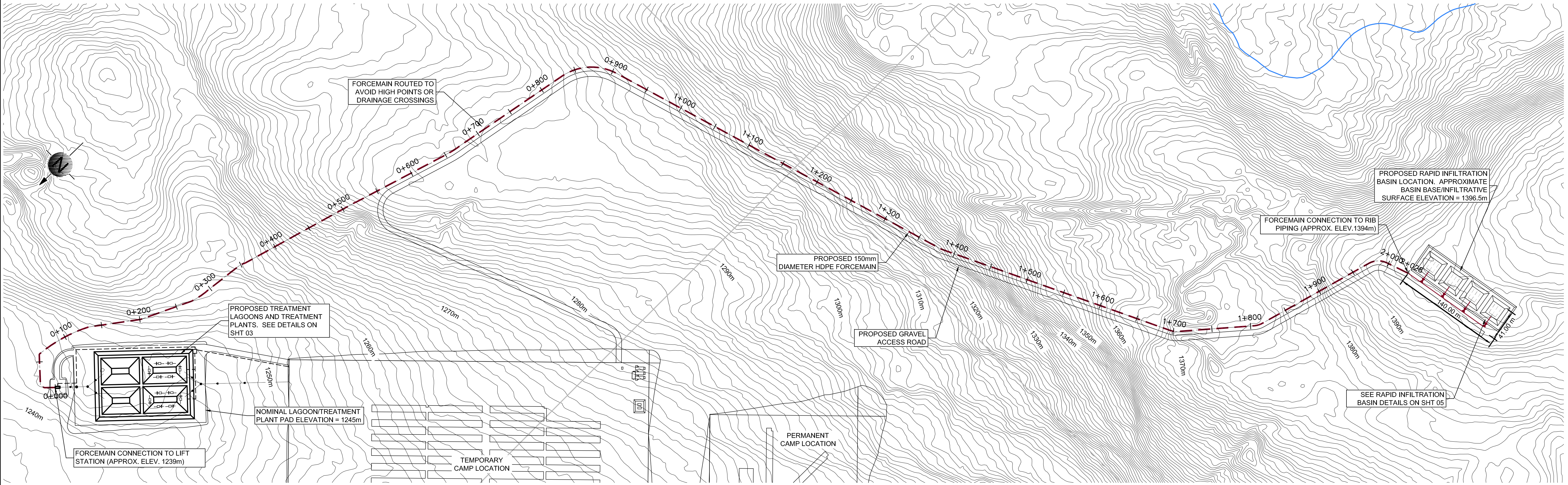

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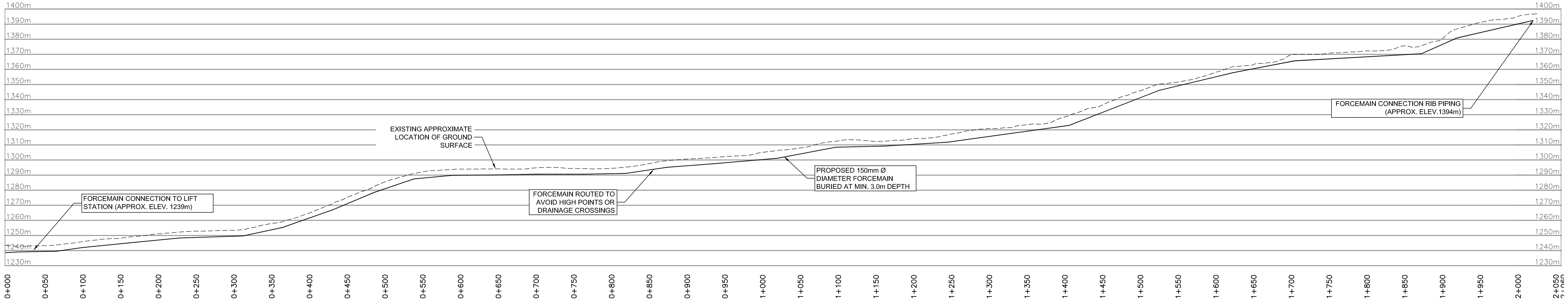

PROFILE
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PRELIMINARY

Revision	Amendment	Approved	Revision Date
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Prince George Office
201 - 1110 6TH AVENUE
Prince George, BC
V2L 3M6 CANADA
+1 250 5620038

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LDHB	LDHB	SRB	

Project No.: D-76002.00
Scale: 1:7500

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BLACKWATER PROJECT
TEMPORARY AND PERMANENT CAMP WASTEWATER SYSTEM

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FORCEMAIN PLAN / PROFILE

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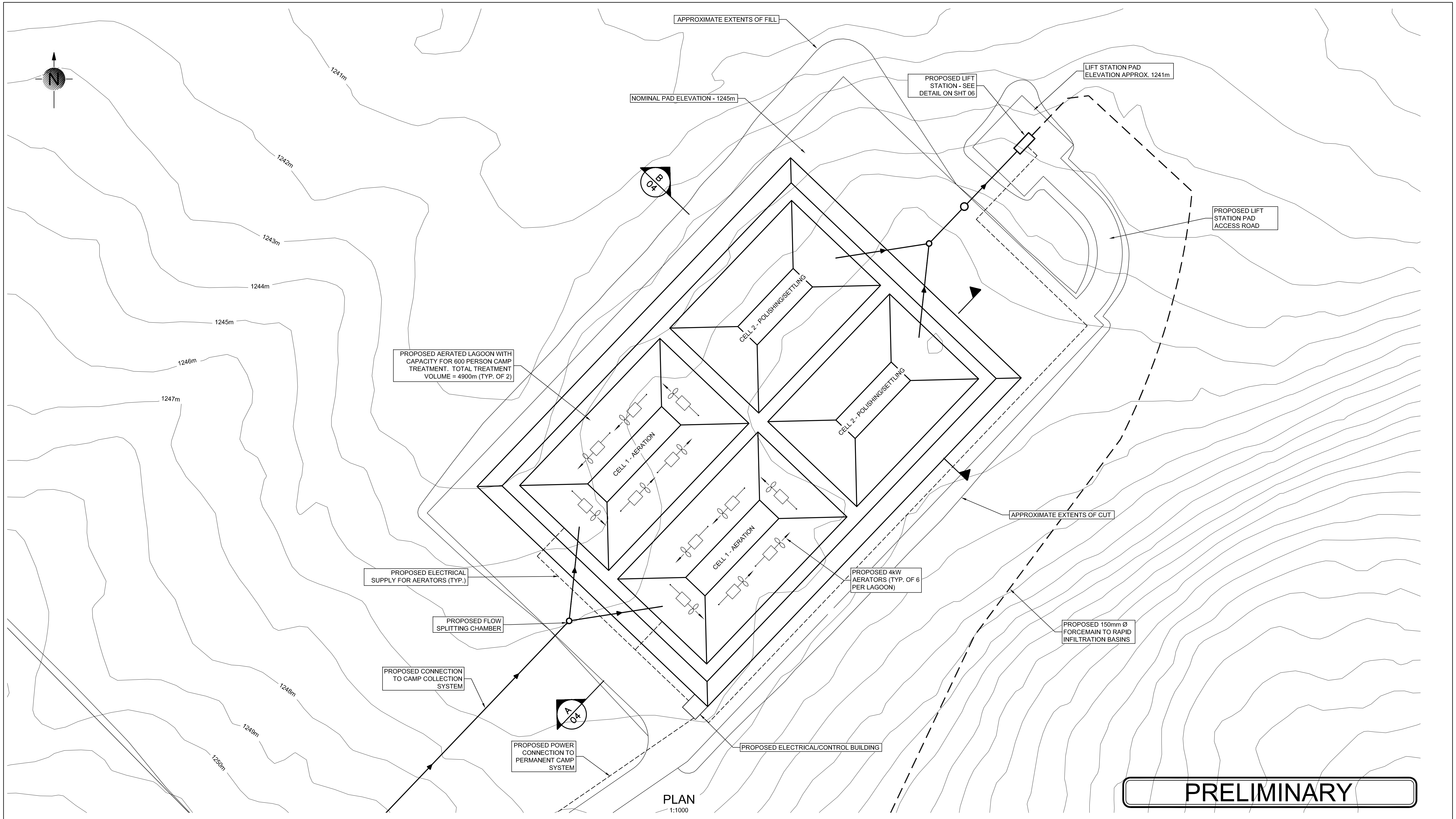

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PRELIMINARY

Revision	Amendment	Approved	Revision Date
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OPUS DAYTONKNIGHT
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Drawn	Designed	Approved	Revision Date
LDHB	SRB	SRB	SEPT 2013

Project No.	Scale
D-95002.00	AS SHOWN

Project
NEW GOLD INC.
BLACKWATER PROJECT
TEMPORARY AND PERMANENT CAMP WASTEWATER SYSTEM

Sheet
AERATED LAGOON SITE PLAN

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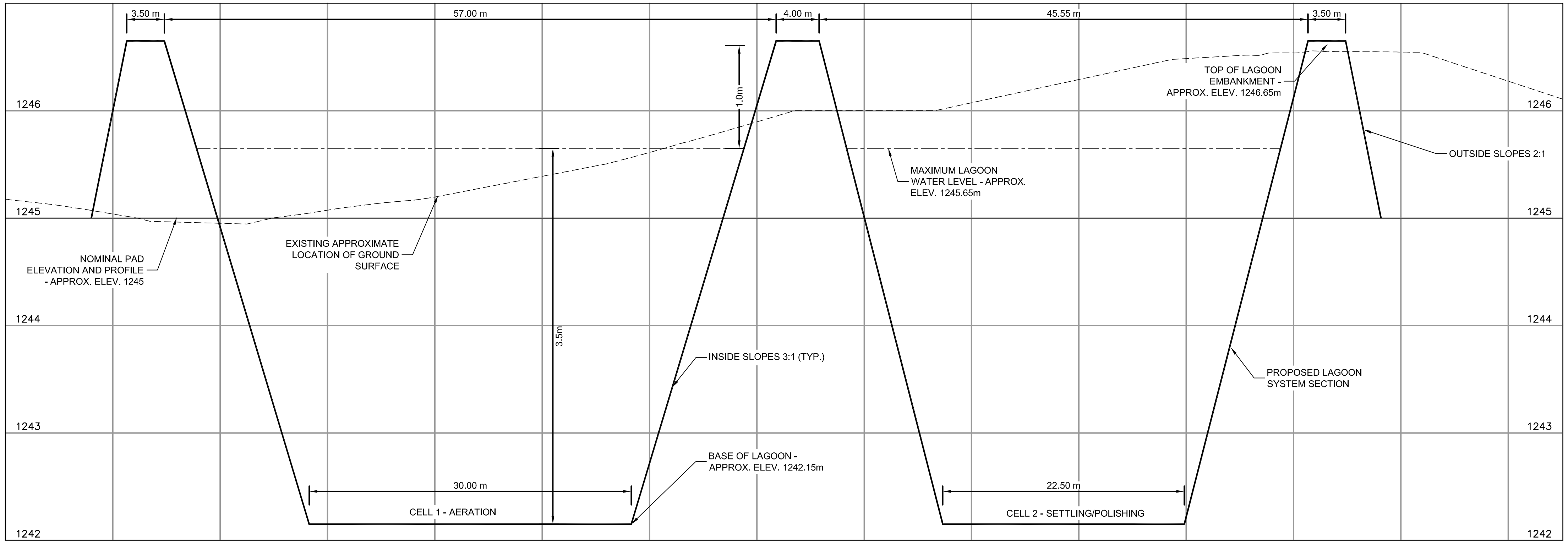

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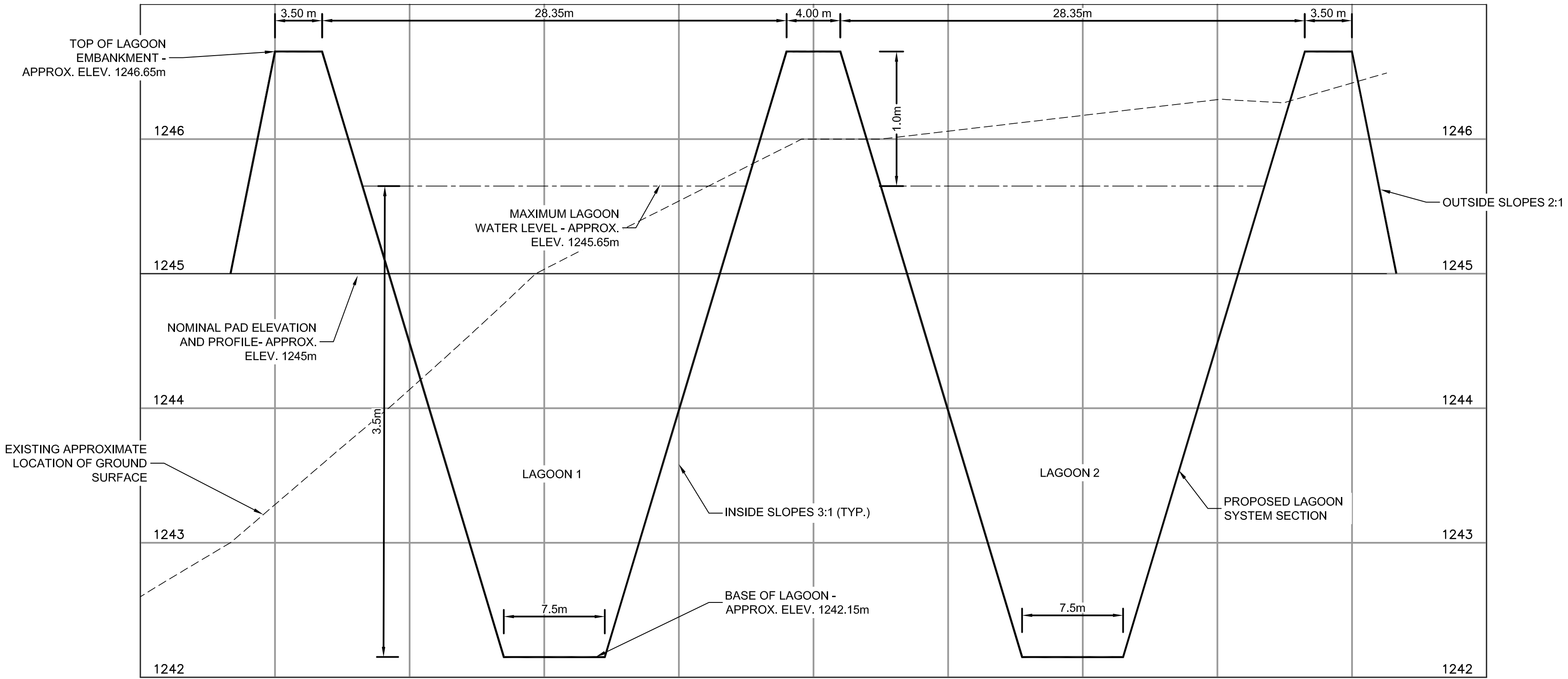

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PRELIMINARY

Revision	Amendment	Approved	Revision Date
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OPUS DAYTONKNIGHT
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Drawn	Designed	Approved	Revision Date
LDHB	SRB	SRB	SEPT 2013

Project No.	Scale
D-95002.00	AS SHOWN

Project
NEW GOLD INC.
BLACKWATER PROJECT
TEMPORARY AND PERMANENT CAMP WASTEWATER SYSTEM

Sheet
LAGOON SECTIONS

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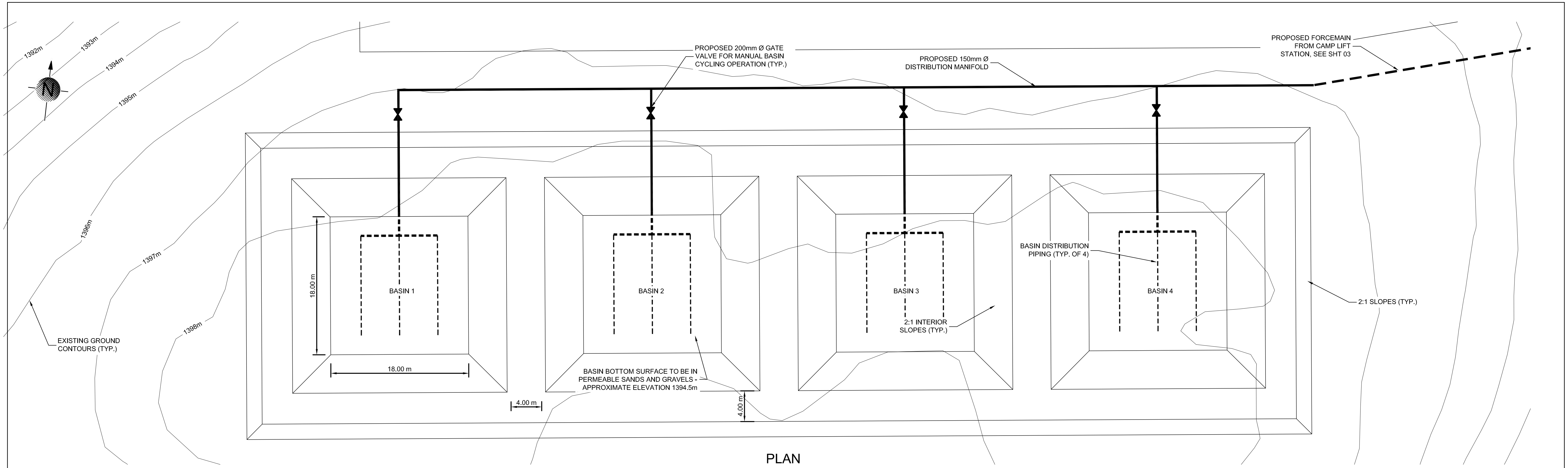

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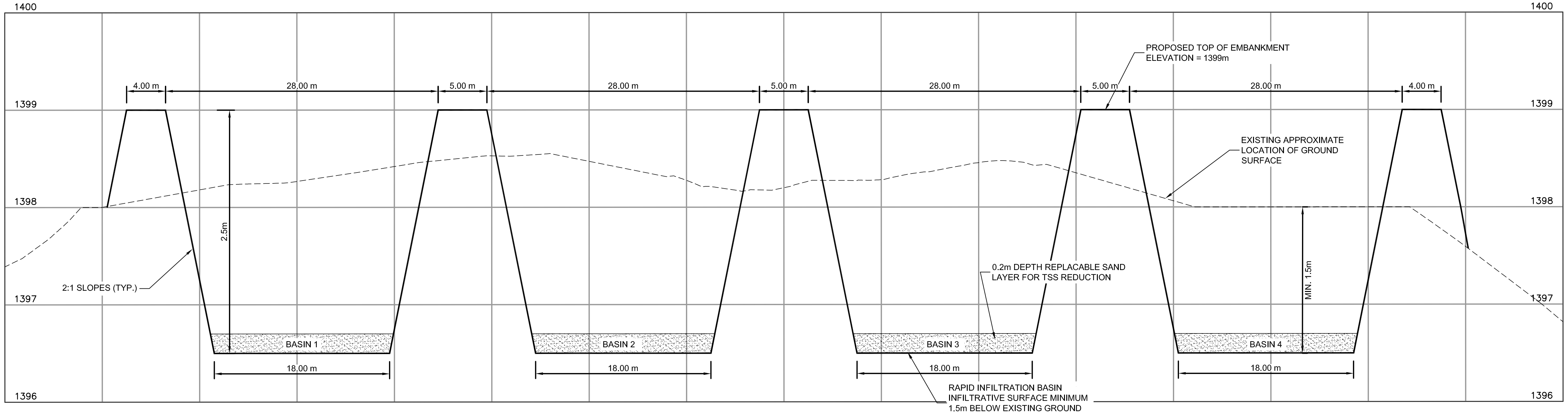

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PRELIMINARY

Revision	Amendment	Approved	Revision Date
1	PRELIMINARY DESIGN	SRB	SEPT 2013

OPUS DAYTONKNIGHT
Prince George Office
201 - 1110 6TH AVENUE
Prince George, BC
V2L 3M6 CANADA
+1 250 5620038

Drawn	Designed	Approved	Revision Date
LDHB	SRB	SRB	SEPT 2013

Project
NEW GOLD INC.
BLACKWATER PROJECT
TEMPORARY AND PERMANENT CAMP WASTEWATER SYSTEM

Sheet
RAPID INFILTRATION BASIN
PLAN AND PROFILE

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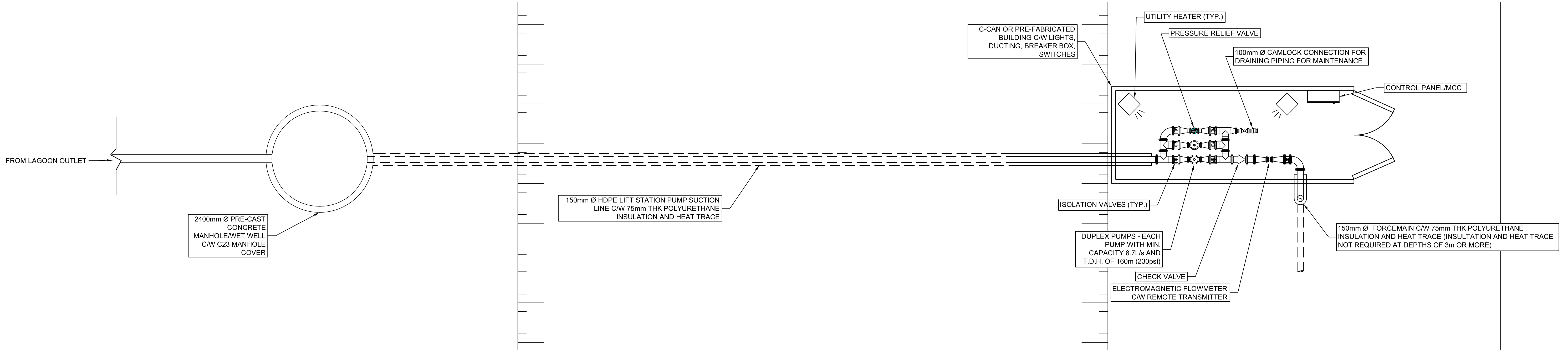

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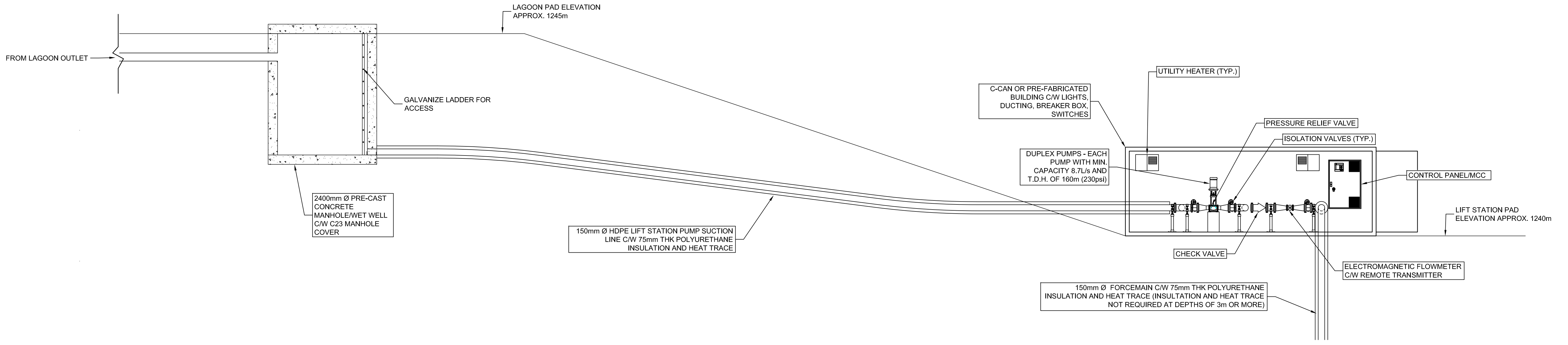

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OPUS DAYTONKNIGHT
Prince George Office
201 - 1110 6TH AVENUE
Prince George, BC
V2L 3M6 CANADA
+1 250 5620038

Drawn	Designed	Approved	Revision Date
LDHB	SRB	SRB	SEPT 2013

Project No.: D-95002.00
Scale: AS SHOWN

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TEMPORARY AND PERMANENT CAMP WASTEWATER SYSTEM

Sheet
EFFLUENT LIFT STATION
GENERAL ARRANGEMENT

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Sheet. No.: 06
Revision: 1

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APPENDIX B

WESTERN WATER ASSOCIATES LTD. ENVIRONMENTAL IMPACT ASSESSMENT

western water
ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

Stage 1 - Environmental Impact Study: Rapid Infiltration Basin Wastewater Disposal for the New Gold Inc. Blackwater Mine Construction Camp near Vanderhoof, B.C.

Prepared for:

New Gold Inc.
Suite 1800, Two Bentall Centre
555 Burrard Street, Box 212
Vancouver, British Columbia
V7X 1M9

December 2013

Project: 13-019-02, Ver 1

Prepared by:

Western Water Associates Ltd.
#106 – 5145 26th Street
Vernon, B.C. V1T 8G4

western water
ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

December 12, 2013

New Gold Inc.
ATTN: Nigel Fisher M.Sc., PMP, Environmental Permitting Specialist
Two Bentall Centre
Suite 1800 - 555 Burrard Street, Vancouver
British Columbia, Canada, V7X 1M9

Via email: Nigel.Fisher@newgold.com

Dear Mr. Fisher:

Re: FINAL REPORT – Stage 1 Environmental Impact Study in Support of Wastewater Disposal via Rapid Infiltration Basin for the proposed Backwater Mining Construction Camp Expansion

Western Water Associates Ltd. (WWAL) is pleased to provide this report on our Stage 1 Environmental Impact Study (EIS) in support of the New Gold Blackwater Mining Camp expansion. The work has been completed within the context of, and meets the requirements of, the B.C. Municipal Wastewater Regulation and its companion guidance document for completing an EIS. This report is suitable for submission to the Ministry of Environment and other approval agencies.

The results of our Stage 1 EIS indicate that disposal of Class C effluent from the proposed 1,200 person construction camp, with a future 400 permanent operations camp, to-ground via rapid infiltration basin (RIB) is feasible and should not adversely affect the receiving environment. Baseline water quality at the site was assessed and indicates that the shallow groundwater regime in the area is not currently showing anthropogenic impact. The Class C effluent proposed for discharge in connection with wastewater treatment is a better alternative to regular septic effluent and on-going monitoring will ensure that the groundwater and surface water down gradient of the proposed RIB meets the appropriate water quality guidelines.

We trust that the professional opinions and advice presented in this document are sufficient for your current requirements. Should you have any questions, or if we can be of further assistance in this matter, please contact the undersigned.

WESTERN WATER ASSOCIATES LTD.

Reviewed by:

B. R. MANWELL
35085

Bryer Manwell, M.Sc., P.Eng.
Hydrogeological Engineer

Douglas Geller, M.Sc., P.Geo.
Senior Hydrogeologist

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1. INTRODUCTION

At the request of New Gold Inc., Western Water Associates Ltd. (WWAL) has completed a Stage I Environmental Impact Study (EIS), a requirement under the Municipal Wastewater Regulation (MWR - 2012), for the planned wastewater system being designed to support the planned 1,200 man construction camp which will be reduced to a 400 man operations camp, at the Blackwater Mine. The Mine is located approximately 100 km south of Vanderhoof, B.C. and 150 km west of Quesnel, B.C (Figure 1). This report is based on the guidelines for completing environmental impact studies as described in the Municipal Sewage Regulation (MSR) companion document (MoE 2000). This Stage I EIS supports a new MWR registration and is considered separate to the existing registration (# 105882), which currently serves a 200 man exploration camp located to the west of the proposed new construction camp location.

New Gold is planning to construct a community wastewater treatment and dispersal system with a maximum daily flow of approximately 300 m^3/day, which would be treated to Class C effluent quality (max BOD$_5$ 45 mg/l and TSS 45 mg/l) supplemented with U.V. disinfection and infiltrated to ground with Rapid Infiltration Basins (RIB). The 300 m^3/day design flow is based on a 1,200 person construction camp and future 400 person permanent camp requiring a treatment and dispersal system capacity of 250 litres per day per person. The plan is to utilize an area south of the proposed construction camp location that has been identified to have suitable soil and site characteristics for RIB disposal.

This report presents the findings of our hydrogeological investigations and Stage I EIS, and is intended to provide the information required to support registration of the new wastewater system under the MWR. Operation of the system at full design capacity (300 m^3/day) is expected to last only a few years before the construction camp is replaced by the long term (17 year expected mine life) 400 man operations camp. Construction of the proposed new wastewater system is not scheduled to occur until the first quarter for 2015.

For a separate feasibility level study, WWAL completed installation and testing of four test water supply wells after the Stage I EIS was completed in the summer of 2013. Three of these test wells are located within the vicinity of the proposed RIB area (Figure 3). The purpose of the test wells were to provide New Gold with an indication of where water supply wells could be located to supply water for the proposed construction camp. Section 6.3 of this report addresses the potential impact to these wells, if they become supply wells for the camp.

Note that the some information in the current report is taken from the EIS written by WWAL for the MSR registration # 105882 for the existing 200 person camp (WWAL 2011). The existing camp and wastewater disposal system are located west of both the proposed construction camp and RIB area.

1.1 Project Location and Description

The New Gold Blackwater Mine is located in the northwestern part of the Cariboo Regional District in a relatively remote area, about 100 km south of Vanderhoof and about 150 km west of Quesnel (Figure 1). The site occupies unsurveyed Crown land and the approximate coordinates of the proposed RIB site are

10U 378,340 E and 5,894,537 N. The entire area surrounding the Blackwater Mine area is undeveloped, except for access, forestry, and exploration roads, the existing camp, and drill pads and other minor land disturbances. The nearest inhabited community appears to be the Kluskus First Nation village located in a remote area west of Quesnel, at Kluskus Lake. This is about 25 kilometres southeast of the site and reachable at times during the year by a road from Nazko. The Kluskus First Nation village is also the location of a reported water well (See Section 2.4).

The approximate location of the Blackwater Mine site is depicted on Figure 1. Figure 2 shows the layout of the site showing pertinent existing and planned onsite features such as the existing camp location, the planned construction camp location and the location of the proposed RIB area. Figure 3 shows the location of the proposed RIB area together with the locations of nearby test water supply wells, test pits and nearby surface water bodies.

1.2 Project Objectives and Scope of Services

The objective of this assessment was to complete a Stage 1 Environmental Impact Study (EIS) in the context of the 2012 Municipal Wastewater Regulation (MWR) and to provide the information required by regulatory authorities to make an informed decision on permitting of the system. The proposed maximum effluent design flow is 300 m^3/day, and the level of effort for this study generally corresponds with the level of effort suggested in the guidance document for greater risk flow >200 m^3/day.

WWAL provided the following services to New Gold Inc., as outlined in our proposal dated April 30, 2013.

1. Attended a pre-registration with the B.C. Ministry of Environment. Confirmed Ministry expectations regarding the Stage 1 EIS and system registration.
2. Reviewed previous reports for investigations completed at the site, as well as available surficial and bedrock mapping, orthophoto coverage, aquifer mapping and well logs at the site.
3. Completed field work July 7th to July 21st, 2013 to conduct the field investigations in support of the EIS. This included the following:
    a. Excavation of 14 test pits which helped delineate the sand and gravel deposit within the proposed RIB disposal area;
    b. Drilling of five boreholes using a sonic drilling rig within the proposed RIB area to further characterize the subsurface;
    c. Constructed a trial infiltration basin, installed a temporary monitoring well next to the basin, and performed a 72 hour Pilot RIB loading test at the proposed RIB area;
    d. Installed four permanent monitoring wells; one upgradient, one cross gradient and two down gradient of the proposed RIB area;
    e. Sampled pre-discharge groundwater and surface water quality at the newly installed monitoring wells and two surface water locations;
4. Analyzed the data collected to develop a conceptual model of groundwater flow beneath the site, calculated travel times in the saturated and unsaturated zone and determined the likely fate of effluent disposed to RIB at the site;

5. Evaluated the potential for groundwater to mound beneath and adjacent to the future infiltration basins;
6. Identified possible down-gradient receptors and evaluated impacts to the receiving environment; and
7. Prepared this report documenting the methods and results of our Stage I Environmental Impact Study.

1.3 Project Contributors

This report was prepared by Bryer Manwell, M.Sc., P.Eng. of Western Water Associates Ltd. (WWAL). Information pertaining to the new water supply wells installed with WWAL oversight and historic camp water supply wells was provided by Knight Piésold. Subsurface investigations in 2013, within the vicinity of the proposed construction camp area, were completed by Opus DaytonKnight and reviewed by WWAL. Sections 2.1 and 2.6 include information that was provided to WWAL by AMEC, environmental consultants for New Gold Inc.

2. SITE DESCRIPTION, GEOLOGIC AND HYDROGEOLOGIC SETTING

The following sections summarize available physiographic and geologic information available for the mine site. Much of this information is regional in scale, and Section 3 of this report provides a description of proposed RIB area-specific conditions.

2.1 Physiography, Vegetation and Wildlife

The Blackwater Camp is located in B.C.'s Central Interior Plateau, at an elevation of approximately 1,450 m asl. This part of the Cariboo-Chilcotin region is characterized by a rolling upland with the land elevation mostly above 1,200 m, which is bisected by east-draining creeks and rivers and a number of elongate lake systems, oriented in mostly east-west or northwest-southwest valleys, with the lakes lying at elevations of approximately 900 to 1,000 m asl. The nearest high point is Mount Davidson, west-southwest of the existing camp, which reaches approximately 1,825 m asl.

The Blackwater Camp is situated in the Engelmann Spruce – Subalpine Fir Moist Very Cold Nechako (ESSFmv) variant. Detailed ecosystem mapping for the project area has not been completed. Based on aerial photo interpretation and plot data from representative sites a general description of the area is given. The area immediately surrounding the camp waste system is characterized by forests, wetlands and riparian areas. The forested area to the north of the camp waste system site appears to be dominated by zonal forests. Zonal forests are typical sites that represent the variant and are characterized by subalpine fir (*Abies lasiocarpa*), hybrid white spruce (*Picea engelmannii var. x glauca*), and lodgepole pine (*Pinus contorta*) in the tree layer. The understory is composed of black huckleberry (*Vaccinium membranaceum*), white-flowered rhododendron (*Rhododendron albiflorum*), five-leaved bramble (*Rubus pedatus*), one-sided wintergreen (*Orthilia secunda*), twinflower (*Linnaea borealis*) and feathermosses (*Pleurozium schreberi*, *Ptilium crista-castrensis* and *Dicranum spp*.).

Several creeks within the Creek 661 watershed flow past both on the east and west sides of the proposed RIB area. The creek located 410 m to the west of the proposed RIB location is tributary to Creek 661 but referred to as Creek 661 within this report. Auro Creek is located approximately 260 m east of the

RIB area. The creeks follow surface topography and flow, generally, from south to north. The riparian areas associated with the creeks area comprise a complex of forest and shrub communities. Forested riparian areas in the ESSFmv are dominated by hybrid white spruce with minor components of subalpine fir and lodgepole pine. The understory is characterized by Indian hellebore (*Veratrum viride*), sitka valerian (*Valeriana sitchensis*), three-leaved foamflower (*Tiarella trifoliata*) and horsetails (*Equisetum spp.*). Shrub riparian areas are dominated by a variety of willow species (*Salix spp*), twinberry (*Lonicera involucrata*), black gooseberry (*Ribes lacustre*), arrow-leaved groundsel (*Senecio triangularis*), tall larkspur (*Delphinium glaucum*) and indian paintbrush (*Castellija miniata*).

The wetland located approximately 600 m to the north of the site is a complex of wet forest, willow shrub, scrub birch (*Betula nana*) and aquatic sedges (*Carex spp.*). Riparian and wetland areas are considered sensitive ecosystems and care must be taken to reduce any impact to these ecosystems. This area lies topographically below the dispersal field and is considered the nearest down gradient environmental receptor.

Species of conservation concern (i.e., red, blue-listed), from surveys of the property, show that the mine site is immediately adjacent to a high elevation ungulate winter range (UWR) polygon for northern caribou (Mgt Unit: U-7-012). This herd belongs to the west-central metapopulation, which is part of the declining Southern Mountain population of woodland caribou. They have been blue-listed provincially and designated as threatened nationally. The wintering area for the Tweedsmuir-Entiako caribou herd (see attached mapping for assistance) is west of the camp; opposite of the cleared area. Special measures such as fencing of any open water area (if applicable) and minimizing winter access snow clearing (if feasible) or push-outs to allow animals off the roads if they are open, should be considered.

The wetland area, located 600 m to the north of the proposed RIB area, has the potential for containing the federal COSEWIC listed threatened and provincially blue-listed olive-sided flycatcher, as well as the federally listed Special Concern and provincially blue-listed Western toad.

At this time it is recommended that Best Management Practices for the protection of amphibians and reptiles and of wetlands in the area (i.e., road use etc.) are implemented to prevent runoff and the discharge of any deleterious substances to the adjacent wetland. In addition, a buffer (recommended 15 m) should be retained around that wetland or any future wetlands encountered as part of land clearing activities and that no clearing should occur during the bird breeding period (approx. May to August) prior to a nest search, as active nests of migratory birds such as the olive-sided flycatcher are protected under the Migratory Birds Convention Act.
(http://www.env.gov.bc.ca/wld/documents/bmp/HerptileBMP_complete.pdf)

2.2 Surficial and Bedrock Geology

A review of geological mapping on the B.C. Water Resources Atlas (BCMoE 2013) indicates most areas on-site are covered by undifferentiated Quaternary deposits, which are likely composed of a mixture of glacial deposits, including morainal deposits, ice-contact sand and gravel, and compact glacial till, with colluvium of varying thickness and re-worked materials of glacial origin along present-day stream courses.

Where the veneer of glacial deposits and colluvium is thin or absent, sporadic outcrops of bedrock occur, but these outcrops are relatively subdued.

Bedrock at the site includes the Middle Jurassic Hazelton Group, including Naglico volcanics, and the Eocene to Oligocene Nechako Plateau Group volcanics. The gold deposits are hosted in volcanic rocks that are described by New Gold's geologists (unpublished information) as northwest dipping felsic and intermediate volcanic pile overlying cretaceous sediments overprinted by silica-sericite-pyrite alteration and unique manganese garnets. The rocks reportedly exhibit highly chaotic stratigraphy and structure.

In regards to understanding the local site hydrogeology and implications for effluent dispersal, the most important aspects of site geology are the nature, extent, thickness and hydraulic properties of the unconsolidated surficial deposits. These site features were characterized during the field investigation described later in this report.

2.3 Hydrogeology

WWAL conducted a search of the B.C. Ministry of Environment Water Resource Atlas (MoE 2013) to find information on aquifer mapping and reported water wells in the area. There are no mapped aquifers or registered wells at the site except the two wells drilled in 2012 by Cariboo Drilling under the direction of WWAL (Bryer Manwell). One of these wells is currently being used for the existing mine camp water supply. Four more, feasibility level, test water supply wells were drilled in August 2013 and three of these wells are located in the vicinity of the proposed RIB area; furthermore, several boreholes and monitoring wells were drilled in the current investigation. Subsurface conditions at these locations will be used to assess groundwater flow beneath the proposed RIB area. Historic test pitting completed by Knight Piésold and Opus DaytonKnight at the Blackwater site and further test pitting completed by WWAL near the RIB area show that groundwater seeps and low permeability soils (glacial till) are present on much of the Blackwater site.

The location chosen for the proposed RIB area (Figures 2 and 3) was unique at the site as no groundwater seeps were observed and the soils were found to be primarily well-drained sand and gravels with trace silt. Note, to the south of the proposed RIB area thin groundwater seeps (windows) were observed during test pitting; however, no seeps were identified in the pits beneath the proposed RIB area. The surficial geology in the vicinity of the field was likely formed as an ice contact and is considered a glacial moraine.

Groundwater flow through the saturated morainal surficial till deposits underlying the proposed RIB area is likely occurring as a subdued replica of topography (Haitjema and Mitchell-Bruker 2005). However, at the Blackwater site we have seen that perched groundwater flow through 'windows' of higher permeability soils is common in the vadose (unsaturated zone). These windows of perched groundwater are dependent on the extent of the compact silt lens which forms laterally discontinuous confining layers. Further discussion on the conceptual model of groundwater flow and effluent fate is provided in Section 6.1 below.

The proposed RIB area is located at the crest between the drainage of two creeks within the Creek 661 basin and as such, groundwater flow in the saturated zone is likely to occur beneath the proposed RIB area from south to north or northeast discharging to Auro Creek (east), or into the wetlands located over 600 m to the north, or recharging the bedrock aquifers below. During site investigations by WWAL a permanent groundwater table was not encountered beneath the RIB area during test pitting or borehole drilling to 30 m (99 ft) below ground surface (bgs). Within test pits located to the south of the proposed RIB area thin discontinuous windows of groundwater flow were observed; however, these seeps were not considered the groundwater table (i.e., continuously flowing aquifers), as dry sediment was observed below the seepage windows (Photo 1).

At MW13-02, located directly north and down gradient of the proposed RIB area, a groundwater table was encountered and a relatively thick unconfined or semi-confined aquifer was identified. MW13-03 was installed in a shallow, creek associated, unconfined aquifer and MW13-04 was installed in a shallow, thin perched aquifer (groundwater flow window) at the down gradient wetlands area.

During the feasibility test water supply well drilling program completed in August 2013 three aquifers were identified in the vicinity of the proposed RIB area. The three aquifers identified during the test well drilling program were as follows:

1. A semi-confined to confined aquifer was located approximately 775 m to the northwest of the proposed RIB area at TW13-01;
2. A confined aquifer was located at TW13-02 1,500 m to the north of the proposed RIB area; and,
3. A bedrock aquifer was located 800 m to the south of the proposed RIB area at TW13-04.

Refer to Figure 2 for well locations.

Photo 1: Thin groundwater seepage window at 3-4 ft bgs in excavation pit (Test Pit 9), July 8, 2013.

2.4 Groundwater Use Near the Proposed RIB Area

The existing Blackwater mining camp is serviced by a well completed in a bedrock aquifer. The well is located at Kilometer 15 on the current mine access road; this well is over 3.5 km directly west of the proposed RIB system, a distance well beyond the minimum 90 meter setback required in the MSR for wells completed in bedrock aquifers.

As mentioned above, three test wells have recently been drilled in the vicinity of the proposed RIB area. The purpose of drilling the wells was to identify the feasibility of sourcing groundwater for the construction camp potable water supply. Potable water for the construction camp will likely be sourced from the confined aquifer located 1,500 m directly north of the RIB area. This area is far beyond the 90 m setback required in the MWR for wells completed in confined aquifers.

Table 2.1 summarizes the basic construction information for the three nearest test water supply wells along with the existing camp supply well. There are two off-site wells reported in the B.C. Water Resources Atlas (BCMoE 2011) that are also shown in Table 2.1. One of these wells reportedly supplies the Kluskus First Nation village at Kluskus Lake and the other appears to be owned by a forestry company. Both off-site wells are more than 20 km from the proposed RIB area. Well logs for the nearby wells are provided in Appendix A.

Table 2.1 Water Well Inventory for Blackwater Mine and Beyond

Well Name and Well Tag or Well Plate Number	Date Drilled	Reported Yield (US gpm)	Total Depth m (ft)	Static Water Level m (ft)	Location relative to RIB	Aquifer Type
TW13-01	July 31, 2013	70	27.4 m (90 ft)	2.5 m (8.3ft)	750 m NE	Surficial Semi-confined to confined
TW13-02	Aug 2, 2013	30	54.8 m (180 ft)	Flowing Artesian	750 m N	Surficial Confided
TW13-04	July 28, 2013	4	121.9 m (400 ft)	4.8 m (15.7 ft)	665 m S	Bedrock
Km 15 Well (Well No 3, 12C) WPN 31679	March 2012	5	76.5 m (251 ft)	18.99 (61.2 ft)	3.4 km W	Bedrock
Km 14 Well (Well No 4, 12D) WPN 31680	March 2012	6	43.9 m (144 ft)	21 m (69 ft)	3.7 km W	Bedrock

Well Name and Well Tag or Well Plate Number	Date Drilled	Reported Yield (US gpm)	Total Depth m (ft)	Static Water Level m (ft)	Location relative to RIB	Aquifer Type
WW11-01 WPN - 31656	June 24, 2011	1.5 (Knight Piésold 2011a)	121.9 m (400 ft)	6.1 m (20 ft)	2.5 km W	Bedrock
WW10-01 WPN 31634	September 4, 2010	8	109.7 m (360 ft)	18.3 m (60 ft)	2.6 km W	Bedrock
Kluskus well WTN 98647	2009	100	20.7 m (68 ft)	3.6 m (12 ft)	~25 km SE	Surficial
TTM Resources WTN 95966	2008	8	64.9 m (213 ft)	57.9 m (190 ft)	~20 km NE	Surficial

2.5 Climate

Climate in the project area is characterized by warm summers and cold winters, with precipitation fairly well distributed throughout the year. Given these conditions, we would expect recharge to the shallow aquifer system would occur in all but the coldest months of winter when the ground is likely frozen and frost penetration is at a maximum. Climate normals for the Environment Canada climate station in Vanderhoof are provided in Table 2.2, below. Note that the Vanderhoof climate station is 600-700 m lower in elevation than the camp site. Thus we would expect the climate at the camp to be markedly cooler than Vanderhoof, with more precipitation, and with a higher proportion of the annual precipitation falling as snow. Table 2.3 provides a summary of site specific precipitation data from Knight Piésold (2013).

Table 2.2 Climate Normals from Environment Canada Station No. 1098D90 (Vanderhoof; Elevation 638 m)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	-9.5	-5.7	0	5.5	10.7	14.2	16.3	15.8	11.1	5.1	-2.6	-8.6	4.4
Rainfall (mm)	5.8	6.4	7.3	21.4	35.2	58	47.3	44.5	40.9	41.6	17.2	5	330.6
Snowfall (mm)	41.5	23.1	15.3	4.2	0.3	0.3	0	0	0.3	7	30.4	43	165.3
Precipitation (mm)	47.3	29.5	22.7	25.6	35.5	58.3	47.3	44.5	41.1	48.6	47.6	48	495.9

Data Source: Environment Canada 2013

Table 2.3 Regional and Blackwater Precipitation Summary (from KP)

Station Name	Period of Record	Elevation (m asl)	Distance from Mine Site (km)		Units
Vanderhoof	1970 - 2012	674	112	**488**	Mm
				100%	% annual
				64%	Mm
				36%	% annual
Tatelkuz	1970 - 1977	914	17	**483**	Mm
				100%	% annual
				55%	Mm
				45%	% annual
Blackwater Low Climate Station[1,2]	2011	1051	15	120.2	Mm
				-	% annual
	2012			405.8	Mm
					% annual

Data from Knight Piésold, 2013.

2.6 Surface Water Receptor Description

As noted above, there are two creeks in the vicinity of the RIB, one located to the east and one to the west (Figure 3). Both creeks are within the Creek 661 watershed and are tributaries to Creek 661 (BC Watershed Atlas Code 100-567134-610692-671007-505659-146920). The creek to the east is referred to locally as Auro Creek, the creek to the west is unnamed. The creeks both flow into Creek 661, which subsequently flows east into Chedakuz Creek, and then northeast into Tatelkuz Lake, which is located about 15 km from the camp. Both streams have stream class orders of S3 (AMEC 2013a), as outlined in the Forest Practices Code "Fish-stream Identification Guidebook." The unnamed stream to the west was assessed during summer of 2011 and had a mean wetted width of 3.55 m and a depth of 0.47 m with a mean stream gradient of 0.75%. During WWAL's field investigation in July 2013, the creek to the west was 2.1 m in width and 0.3 m in depth. Auro Creek, to the east, sampled at the bridge crossing south of the proposed RIB area was 0.9 m in width and 0.2 m depth.

Creek 661 is documented as a fish-bearing stream containing rainbow trout. There have been no red- or blue-listed species documented in this stream. Based on the presence of these streams in proximity to the proposed RIB area, and the presence of groundwater wells nearby, Aquatic Life Guidelines and the federal and provincial drinking water guidelines are the appropriate guidelines to apply with regard to the EIS and the proposed post-discharge monitoring program.

WWAL reviewed the baseline (historic) water quality database provided by AMEC (2013b). No indication of septic related impact was observed in the surface water sampled on the unnamed tributary down gradient of the effluent dispersal field.

3. FIELD INVESTIGATION AND RIB AREA CHARACTERIZATION

The following section provides an overview of the field investigation and site characterization performed at the proposed RIB area in July 2013. The site investigation involved test pitting, borehole drilling, monitoring well drilling, a pilot scale infiltration test and water quality sampling.

3.1 RIB Area Location, Topography and Surface Drainage

The proposed RIB area is located approximately 3.4 km west of the existing mine camp. The entire Blackwater site is known to have generally poor surface drainage; however, the proposed RIB area was selected as a potential RIB site to investigate due to the lack of standing surface water present after extend precipitation events. The RIB area is situated on a relatively flat knob, at 1400 m asl, which forms a small drainage divide separating two streams, both within the Creek 661 watershed drainage. There is approximately 1.5 hectares (3.6 acres) of relatively flat area, which showed acceptable soils for RIB disposal. The proposed RIB area is bordered by steeper slopes of approximately 10% grade to the north, west and east (Figure 3 and 4).

3.2 Surficial Deposits and Stratigraphy

WWAL oversaw the digging of 14 test pits within the vicinity of the proposed RIB area from July 7th to July 9th, 2013. From this initial test pitting program an area approximately 1.5 hectares (3.6 acres) was delineated as exhibiting potentially suitable subsurface conditions for effluent disposal via RIB's. The area appropriate for RIB disposal of effluent is located on the flat terrace, at an elevation of about 1400 m asl, primarily on the north site of the L-Trail (Figure 3 and 4). Table 3.1 summarizes relevant data observed during test pit logging and includes the following:

- test pit name and depth;
- the predominant soil type observed at the test pits;
- the suitability of the test pit area for effluent disposal via rapid infiltration;
- if groundwater seepage was observed within the test pit and at what depth; and,
- the location of the pit relative to the location of the pilot scale RIB loading test.

For a more complete description of the test pits including UTM coordinates, refer to Appendix B. The locations of the test pits relative to the pilot test basin area are provided in Figure 4.

Shallow stratigraphy at the site is glacial outwash and as such is heterogeneous. However, the predominant deposits present are medium to fine sand occurring with a varying amount of silt and gravel. In the proposed RIB area (Figure 4) a silt layer, from 0 to 1.5 m bgs, is present; below this silt layer are sand and gravels with trace silt suitable for RIB disposal.

Table 3.1 Proposed RIB Area Test Pit Summary

Test Pit No.	Total Depth (m)	Predominant soil type below	Suitable for rapid infiltration.	Groundwater seepage observations	Location relative to RIB
TP13-01	5.7	Coarse sand and gravel with trace fines and boulders.	YES	Moist	30 m S
TP13-02	7.01	Coarse sand and gravel with trace silt.	YES	Dry	90 m SSW
TP13-03	7.31	Coarse sand and gravel with trace fines and boulders.	NO	Seepage from 3-4 m	100 m S
TP13-04	6.4	Silt with sand and gravel.	NO	Dry	130 m SSW
TP13-05	1.22	Silty gravel with some sand.	NO	Moist	170 m SW
TP13-06	7.01	Sand and gravel with trace silt.	NO	Dry	140 m SW
TP13-07	7.01	Sand and gravel with silt.	NO	Seepage at 4.2 m	160 m SW
TP13-08	6.4	Sand and gravel with silt.	NO	Dry	165 m SW
TP13-09	6.4	Fine sand and silt.	NO	Seepage from 3-4 m	90 m SW
TP13-10	6.1	Sandy gravel with trace silt.	YES	Wet	90 m WSW
TP13-11	6.1	Gravel with sand with trace silt.	YES	DRY	60 m WSW
TP13-12	4.6	Sand and gravel.	YES	Dry	25 m N
TP13-13	6.4	Sand and gravel with some fines.	YES	Dry	100 m W
TP13-14	5.8	Sand and gravel.	YES	Dry	30 m N

3.3 Boreholes and Monitoring Well Installations

The following section describes the subsurface characterization derived from the drilled boreholes and hand installed monitoring wells. During the July 2013 field investigation nine boreholes were drilled to depths ranging between 15 m (49 ft) and 38 m (126 ft). Monitoring wells were installed at three of the boreholes (RIB BH13-03/ TMW-03, MW13-01 and MW13-02). Two additional monitoring wells were installed, by hand, and with the use of an excavator (MW13-03 and MW13-04). The location of the boreholes and monitoring wells are provided on Figure 3. Subsurface details and monitoring wells information is summarized in Table 3.2. See Appendix B for the full borehole and monitoring well logs.

From logs of the boreholes it is evident that the surficial deposits in the vicinity of the RIB area are heterogeneous as is expected of glacial till. However, we see larger to continuous zones of sand and gravel with trace silt in the area delineated as the proposed RIB area (RIB BH13-03, 04 and 05) compared to the area to the south (RIB BH13-01 and 02 and MW13-01), refer to borehole logs in Appendix B.

Table 3.2 Borehole and Monitoring Well Summary

Monitoring Well/ Borehole ID	Elevation (masl)	Total Depth m (ft)	Static Water Level m (ft)	General Lithology with potential confining layer depth mentioned	Distance from RIB
MW13-01	1408	19.8 m (65 ft)	Dry	Silt and gravel. At 20 m silt, hard compact	353 m SW of RIB (Up gradient)
MW13-02	1330	37.5 m (123 ft)	26.8 m (88 ft)	Fine sand with some silt. At 27-29m Brown silt. Dense	448 m N of RIB (Down gradient)
MW13-03	1310	4.28 m (14 ft)	2.7 m (8.8 ft)	Sand and gravel with some silt	720 m NW of RIB (Down Slope /Cross gradient)
MW13-04	1279	4.2 m (13.6 ft)	1.5 m (5.1 ft)	Sand and silt with some gravel. At 1.5 m, wet sand layer with flow.	900 m N of RIB (Down gradient)
RIB-BH01	1405	30.1 m (99 ft)	n/a	Silt with sand and gravel. At 23 m a dense silt lens.	68 m, SW of RIB
RIB-BH02	1401	15.2 m (50 ft)	n/a	Sand and gravel with some silt.	64 m S of RIB
RIB-BH03	1402	13.7 m (45 ft)	n/a	Sand and gravel with some silt.	3 m N of RIB

Monitoring Well/ Borehole ID	Elevation (masl)	Total Depth m (ft)	Static Water Level m (ft)	General Lithology with potential confining layer depth metioned	Distance from RIB
RIB-BH04	1397	`14.9 M (49 ft)	n/a	Medium to coarse sand with some silt. At 6-7m dense sand and silt.	46 m, W of RIB
RIB-BH05	1400	14.9 m (49 ft)	n/a	Sandy silt with some layers of sand.	74 m, W of RIB

3.4 Groundwater Occurrence and Flow

As mentioned above, a permanent groundwater table was not encountered within 30 m (99 ft) of ground surface at any of the borings drilled at the upper elevations (Figure 3). However, a permanent groundwater table was encountered at the lower elevation wells MW13-02, MW13-03 and MW13-04. These observations hold true with the conceptual model that the upper elevation area (1400 m asl), where the proposed RIB is located, is a groundwater recharge area, whereas the lower elevations, north and east of the proposed RIB area, are groundwater discharge zones.

The heterogeneous nature of the glacial deposits at the Blackwater site represents a complex geological environment, thereby creating complex saturated and unsaturated flow conditions and dynamics. We have seen from test pitting and borehole logs that discontinuous saturated lenses ("windows" of groundwater flow|) exist within the unsaturated (vadose) zone. The presence and movement of these discontinuous saturated lenses is influenced by several factors including lithology, topography, air temperature, precipitation and evapotranspiration. In general there will be greater recharge to the permanent water table occurring after snow melt and after high precipitation events. Groundwater flow in the saturated zone, as mentioned in Section 2.3, will typically occur as a subdued replica of topography. With this is mind, we expect groundwater to move generally from south to north with some divergent (fanning) flow both east and west based on the topography of the site (Figure 3).

3.5 Loading Test on Pilot (Trial) Rapid Infiltration Basin

To evaluate the suitability of the proposed RIB area for effluent infiltration, a 72 hour (three day) loading test on a pilot (trial) basin was completed between July 17th and July 20th, 2013. The trial basin was dug using a Volvo EC 310 excavator, and had dimensions of 7.6 m (25 ft) by 7.6 m (25 ft) to a depth of 1.5 m (5 ft). During excavation the rig remained outside the basin to reduce any soil compaction. The basin was excavated to a depth of 1.5 m (5 ft) to access the sand and gravel formation located below the surface silt layer. Temporary 10 slot, 2" schedule 40 PVC, pipe was used to distribute the water within the test basin

(Photo 1, below). A temporary monitoring well (RIB BH13-03/TMW-03) was installed at a distance of 3 m (10 ft) from the northern edge of the pilot basin to monitor the presence of and/or potential rise in water level during the loading test. The monitoring well was completed at a depth of 7.9 m (26 ft), due to the presence of a layer of dense silt layer at 7.9 m (26 ft). The dense silt layer was taken to be a potential confining layer which could create perched mounding of the loading test water. However, the monitoring well remained dry throughout the entire three day loading test.

The trial basin was loaded continuously at a rate of 93 m^3/day (17 US gpm), or approximately one-third the design flow of the full-scale RIB system. This is equivalent to a loading rate of approximately 1,600L/m^2/day. A total of 279 m^3 (73,700 US gal) of water was infiltrated in the test basin over the 72 hour pilot test.

Water was supplied to the pilot basin from a 5,000 gallon water truck, which in turn received water delivered by a second water truck making runs for water throughout the three day continuous loading test. The second water truck obtained water from an on-site flowing artesian well. The water trucks were operated by a crew from Grandview Water Hauling, based out of Prince George.

The trial basin exhibited adequate hydraulic capacity to infiltrate the water during the test, with minimal pooling of water on the basin floor by the end of the test. As mentioned above, there was no mounded water observed in the adjacent temporary monitoring well (RIB-BH13-03/TMW-03), which was completed just above a possible discontinuous confining layer. Further, the slope, down gradient, east and north of the pilot RIB area, was periodically monitored during the loading test to check for daylighting (surfacing of pilot basin test water) and none was observed. Overall, the results of the trial loading test indicate that wastewater disposal through rapid infiltration basins is feasible at the site.

Photo 2: RIB Pilot Loading Test after two days of loading at 93 m^3/day (17 US gpm), July 19, 2013.

3.6 Soil Permeability and Hydraulic Conductivity

Soil permeability and hydraulic conductivity dictate the fate of effluent as it migrates through the subsurface. An accurate assignment of hydraulic conductivity values for calculating groundwater velocity and travel time to potential receptors within the receiving environment is important.

3.6.1 Vadose (Unsaturated) Zone

To assess flow through the vadose (unsaturated) zone the 72 hour pilot basin test was conducted. From the test we know the subsurface at the pilot test location can be loaded at a rate of 1,655 L/m^2/day this rate is equivalent to 1.44 m/day (1.7X10^{-5} m/s), with porosity assumed to be 0.3; we estimate the unsaturated hydraulic conductivity to be 5.3X10^{-5} m/s.

3.6.2 Saturated Zone

To evaluate hydraulic conductivity in the saturated zone hydraulic testing was carried out at MW13-02, MW13-03 and MW13-04. Further, the hydraulic conductivity values, derived from the 72 hour pumping tests performed on the newly installed water supply test wells were considered. Note, WWAL staff are in the process of reporting for the test wells and data is not available for inclusion in this report. Table 3.3 summarizes the saturated hydraulic conductivity values for the test supply wells and monitoring wells. Appendix C provides details on the solution methods, inputs and outputs for calculation of hydraulic conductivity at the RIB monitoring wells. The saturated hydraulic conductivity values range from 3.0E-5 m/s at TW13-01 to 9.5E-7 m/s at TW13-02. These values are reasonable when compared to literature values for silty (dirty) sand and gravel surficial deposits (Freeze and Cherry 1979).

Table 3.3 Summary of Hydraulic Conductivities for the Surficial Aquifer

Monitoring Well ID	Aquifer Thickness (m)	K (m/s)	Analytical Solution Used
MW13-02	12	1.0E-6	Cooper-Jacob (Aqtesolv)
MW13-03	1.524	1.6E-6	Bouwer-Rice Slug Test
MW13-04	3	8.3E-6	Bouwer-Rice Slug Test
TW13-01	4	3.0E-5	Cooper-Jacob
TW13-02	22.7	9.5E-7	Cooper-Jacob

4. REVIEW OF WASTEWATER SYSTEM DESIGN

Opus DaytonKnight is providing engineering services for the Blackwater permanent and construction camps, with a total capacity of 1,200 people. Opus provided WWAL with information on the proposed wastewater collection, treatment, and conveyance and disposal system. Details are provided in the following sections.

Currently in the preliminary design phase, the proposed system will be designed to accept 300 m^3/day of Class C septic effluent from both camps. The strategy includes allowances for gravity collection to aeration lagoons, with pressurized conveyance to in ground disposal via Rapid Infiltration Basins (RIB). A level of redundancy will be incorporated into both the treatment and disposal portions of the system for regular maintenance and/or troubleshooting.

4.1 Design Flows

When designing the proposed wastewater system, resources are available to quantify the average per capita wastewater flow from the camps. Generally a value of 227 L/cap/day is used as a design basis. In the case of the Blackwater site, accurate wastewater flow records are available from the existing 250 person camp to compare with. Accordingly, a value of 250 L/cap/day is being used as a design flow for the 1,200 person system.

With a per capita sewage generation of 250 L/cap/day, the average daily wastewater flow from the 1,200 person camps will be 300 m^3. The pumping and disposal systems will convey and receive the daily flows, with buffering of hourly peak flows (up to 10 times the daily flow) occurring in the treatment systems located prior to the pump station.

4.2 Treatment Systems and Effluent Quality

The system will be operated in two distinct phases depending on camp population numbers: Phase 1: 1,200 person (300 m^3/day) during construction years -2 to 0, and Phase 2: 400 person (100 m^3/day) during mine operation years 0 to 17. Effluent quality is expected to be similar throughout the project life. Specifics of the treatment systems and phasing is outlined below.

Aerated lagoons generally have high reliability characteristics, when sized correctly, aerated lagoons can produce effluent quality equivalent to MWR Class C. Each lagoon is expected to have a treatment volume of 4,900 m^3, and a minimum residence time of approximately 32 days.

According to MWR Class C effluent characteristics, the effluent from the aerated lagoons will have the following operating parameters:

- Total flow capacity, 500 m^3/day (4 x 125 m^3/day)
- Influent BOD_5, 400 mg/L
- Influent TSS, 350 mg/L
- Effluent $BOD_{5,}$ <45 mg/L
- Effluent TSS, <45 mg/L

4.3 Treated Effluent Lift Station and RIB Disposal

Following treatment via the combined aerated lagoons/packaged treatment plants, the effluent will be pressurized with vertical turbine pumps and conveyed through a 1900 m long forcemain. The location of the RIB is such that a static head of approximately 150 m (213 psi) exists at the lift station. As such, special considerations are required with regard to pump capacity and design, as well as forcemain material and pressure class. The forcemain will discharge at the RIB location into a distribution manifold which will route the flow to the appropriate RIB basin.

4.4 Potential Impact from Wastewater Treatment System Construction

The following section discusses the potential impacts from the construction of the collection, treatment and disposal system. Treated water effluent quality of BOD_5 of less than 45 mg/l and TSS of less than 45 mg/l meet and are expected to exceed the requirements of MSR Class C (max 45/45). The lagoons, considered a permanent system, will be constructed prior to camp construction.

The lagoons and treatment units are proposed to be installed greater than 100 metres from the temporary camp, and 750 metres from the permanent camp, down gradient from the immediate camp site, and outside of the normal zone of day to day camp activities such that we do not expect the treatment system to be a substantial nuisance with respect to issues such as noise, odour, etc. The system is expected to be Reliability Category III. As per MWR Part 3, Division 1, Table 1, the proposed treatment system is expected to meet the Component and Reliability Requirements for Wastewater Facilities. The treatment system will be designed with a level of redundancy such that should any one of the treatment trains be out of service, the system still retains 100% treatment capacity overall.

4.5 RIB Location and Area Requirements

Based on the results of the pilot basin testing, some guidance on the sizing of rapid infiltration basins can be provided. The trial basin was loaded at a rate 64 L/min (17 US gpm), equivalent to 93 m^3/day. The trial basin was approximately 58 m^2, which equates to a loading rate of 1,655 L/m^2/day or 1.7 m^3/day/m^2. Further, from the testing it has been shown that 1.44 m/day or 526 m/year can be infiltrated at the pilot basin based on the results from the loading test.

Annual precipitation is taken into account when sizing the basin area. Using a conservative estimate of 500 mm/year of precipitation at the site (refer to the climate data in Section 2.5), this would amount to a 5 m/ year increased load to the basins.

Using a maximum design flow, for 1,200 persons of 300 m^3/day and dividing by the tested infiltration rate (93 m^3/day), less the infiltration of precipitation, shows that an area of approximately 200 m^2 would be required to infiltrate the full design flow rate. The anticipated number of basins required for operation of the RIB system is four in order to maximize nitrate reduction by employing an alternating wetting and drying cycle. Therefore, at least 200 m^2 X 4 = 960 m^2 or approximately 800 m^2 (0.08 hectare) will be required for the footprint of the four basins.

The MWR requires that rapid infiltration basins receive an effluent that is Class C or better. For this project, an infiltration of a Class C effluent will result in some bio-fouling of soils at and below the infiltrative surface that will decrease the infiltration capacity over time. Further, winter operation has been shown to decrease the infiltrative capacity of soils. Routine maintenance such as mechanical scarification of the soils in basins will help restore infiltration capacity and winter modifications for operation will be employed; however, a safety factor should be built into hydraulic loading rate and basin area.

We recommend a safety factor of 6 X basin sizing, which would result in a total RIB disposal area foot print of approximately 4,800 m^2 (0.48 hectares) including basin sloping, outside embankments or distance between each basin. As mentioned earlier, from the subsurface investigation, approximately 1.5 hectares (3.7 acres) exhibited adequate soils for RIB disposal at the area investigated. Therefore, based on the investigation to-date there appears to be sufficient room within the potential RIB area to meet the requirement of the projected design flow for a 1,200 man construction camp.

5. BASELINE WATER QUALITY ASSESSMENT

Baseline, pre-MWR registered discharge water quality was sampled during the July 2013 field program. The following sections detail the findings from the current water quality assessment.

5.1 Water Sampling Methods

Five water quality samples were collected; three from groundwater and two from surface water during the July 2013 field program. Sampling occurred in accordance with provincial standards (MoE 2003) with the exception of samples for dissolved metals (for MW13-03 and MW13-04) which were not field filtered prior to shipping to the lab as the samples were highly turbid. Therefore, filtering for dissolved metals occurred at the laboratory. Samples were directed into clean, new bottles supplied by the laboratory while wearing nitrile gloves. The samples were stored on ice in coolers and shipped to Caro Analytical in Kelowna, B.C. This discrepancy in sampling protocol is not considered to affect water quality interpretation related to potential impact from sewage. The following parameters were sampled and analyzed:

- Temperature (field)
- Oxidation Reduction Potential (ORP) (field)
- Dissolved metals
- Alkalinity
- Chloride
- Fluoride
- Orthophosphate
- Sulfate
- Nitrate
- Nitrite
- True Colour
- Conductivity
- Ammonia-N
- pH
- phosphorous, total dissolved
- TDS
- UV transmittance
- Turbidity
- Fecal coliform
- Total coliform
- *E. Coli*
- BOD, 5-day

5.2 Discussion of Water Quality Guidelines

The Environmental Impact Study Guideline (MoE 2000) indicates that the applicable water quality guidelines to be met at the property boundary must be assessed. We note that there are no property boundaries as this is all Crown land. However, the water quality guidelines with which to compare groundwater at a site depend on the potential down gradient receptors. The nearby down gradient receptors identified are the test water supply wells and two creeks, as discussed earlier in this report. Therefore, for discussion purposes, baseline water quality results were compared to the BC Approved Water Quality Guidelines for freshwater aquatic life and the Guidelines for Canadian Drinking Water Quality.

5.3 Water Quality Results and Interpretation

The results of the baseline water quality testing are summarized in Table 5.1 below and the water quality database table and complete laboratory reports are provided in Appendix E. Further, exceedances in the water quality guidelines are summarized in Table 5.2. Groundwater down gradient of the RIB is characterized as being fresh with low electrical conductivity, neutral pH and low hardness. Concentrations of dissolved metals are extremely high due to the hydrothermally altered volcanic overburden deposits the shallow creek-associated groundwater is flowing though. Some aquatic life guidelines are exceeded with respect to the presence of dissolved metals (see Table 5.2); however, these exceedances are considered baseline and not associated with anthropogenic influence.

In summary, baseline groundwater quality at the Blackwater Camp down gradient of the proposed RIBs is good, particularly with respect to parameters associated with effluent disposal to ground. We will recommend ongoing groundwater monitoring be performed during the operating life of the wastewater treatment plant to ensure the operation of the system does not adversely impact the potential receptors.

Table 5.1 Baseline Water Quality Summary

Analyte	Guideline		RIB MW13-02	RIB MW13-03	RIB MW13-04	RIB SW-01	RIB SW-02
	BCAWQG AL	GCDWQ MAC/AO					
pH	N [1.16]	NG/6.5 - 8.5	7.87	6.83	7.1	7.06	7.46
Conductivity uS.cm	NG	NG	118	72	163	25	272
Alkalinity (total, as CaCO3)	NG	NG	54	36	38	8	22
Ammonia (total, as N)	Calc [1.25]	NG	0.037	0.7	0.329	<0.02	0.02
Nitrate (as N)	32.8 [1.26]	10/NG	0.07	0.03	<0.010	0.017	<0.014
Nitrite (as N)	Calc [1.28]	1/NG	<0.01	<0.01	<0.010	<0.01	<0.01
Orthophosphate (dissolved, as P)	NG	NG	<0.01	0.04	<0.01	<0.01	<0.01
Phosphorus (total)	N [1.30]	NG	<0.2	0.2	0.6	<0.2	<0.2
Chloride	600 [1.13]	NG/250	0.39	0.63	0.71	<0.10	.64
Sulphate	Calc [1.17]	NG/500[3.3]	4	1.7	33.8	<1.0	1.7
E. coli MPN/100 mL	N [1.22]	0 [2.4]/NG	<1	<1	<3.0	<1	<1
Fecal coliforms MPN/100 mL or CFU/100 ml	N [1.24]	0 [2.6]/NG	<1	<1	<3.0	<1	<1
Total coliforms MPN/100 mL or CFU/100 ml	NG	0 [2.8]/NG	>63	2400	46000	370	190
Aluminum (dissolved)	Calc [1.1]	NG/N[3.1]	0.08	5.83	12	0.11	0.12
Arsenic (dissolved)	0.005 [1.2]	0.01/NG	<0.005	0.006	0.009	<0.005	<0.005
Calcium (dissolved)	NG	NG	14	9	22	3	5
Iron (dissolved)	0.35	NG/0.3	<0.1	3	8.6	0.2	<0.1
Magnesium (dissolved)	NG	NG	3.3	2.6	6.9	0.7	1.3
Sodium (dissolved)	NG	NG/200[3.2]	4.2	3.5	4.6	1.3	2.9

Notes:

1) BCAWQG AL - BC Approved Water Quality Guidelines for freshwater aquatic life
2) BCWWQG AL - Working Water Quality Guidelines for British Columbia for freshwater aquatic life
3) All units are mg/l unless otherwise stated.
4) Cal – Calculated Guideline. The guideline is dependent on the value of one or more other analytes, and is calculated.
5) NG – no guideline
6) N - Narrative type of guideline.

Table 5.2 Summary of Water Quality Exceedances.

Sampling Location	Guideline	Exceedances
RIB MW13-02	GCDWQ MAC	Total coliforms (counts)
	GCDWQ AO	Manganese (dissolved)
RIB MW13-03	BCAWQG AL	Aluminum (dissolved), Arsenic (dissolved), Iron (dissolved), Zinc (dissolved)
	GCDWQ MAC	Total coliforms (counts)
	GCDWQ AO	Colour, Iron (dissolved), Manganese (dissolved),
RIB MW13-04	BCAWQG AL	Aluminum (dissolved), Arsenic (dissolved), Copper (dissolved), Iron (dissolved), Zinc (dissolved)
	GCDWQ MAC	Total coliforms (MPN / PA)
	GCDWQ AO	Colour, Iron (dissolved), Manganese (dissolved)
RIB SW-01	BCAWQG AL	Aluminum (dissolved)
	GCDWQ MAC	Total coliforms (counts)
	GCDWQ AO	Colour
RIB SW-02	BCAWQG AL	Aluminum (dissolved)
	GCDWQ MAC	Total coliforms (counts)
	GCDWQ AO	Colour

6. ENVIRONMENTAL IMPACT ASSESSMENT

This section of the report assesses how wastewater treatment and treated effluent dispersal for the proposed Blackwater mine construction camp could potentially impact the receiving environment. The migration of effluent from the infiltration area to potential down gradientreceptors is identified. Calculations to assess the effects of mounding are not considered in this feasibility level EIS. Mounding was not confirmed in this report because, during the loading test, there was no mounding observed at the temporary monitoring well installed 3 m (10 ft) north of the RIB (see borehole log for RIB BH13-03/TMW-03). Further, we observed no definite and continuous confining layer or groundwater table within 30 m (99ft) of ground surface, below the proposed RIB area, so mounding potential is much lower here than at other sites with shallow bedrock or a high water table.

6.1 Conceptual Model of Effluent Flow

As discussed previously, Class C effluent will be discharged into dug basins and will flow up to a maximum flow rate of 300 m^3/day. The total basin area will be roughly 4,000 m^2 or less in total basin area or 1000 m^2 per basin. Effluent will migrate through the vadose zone on, likely, a three day wetting cycle followed by an approximately 9 day drying cycle. The effluent will renovate as it migrates through the vadose zone and eventually becomes part of the permanent water table and flows in the saturated zone unit groundwater discharges to the wetlands several hundred metres north of the RIB area, to a creek or potentially recharges bedrock below. Figure 5 depicts our conceptual model for groundwater flow and effluent fate down gradient of the proposed RIB area.

6.2 Groundwater Flow Velocity and Travel Times

Given the above model for groundwater and effluent flow, we used the following procedure to estimate groundwater flow velocity and travel time:

1. We used a representative, yet conservative, value of k (hydraulic conductivity) based on the stratigraphy observed in test pits and borehole logs and the results from hydraulic testing at the down gradient wells (Table 3.3).
2. We applied Darcy's Law to estimate Darcy velocity and travel time.

For this analysis, we applied a form of Darcy's Law as follows:

Equation 1…………….. $V = k * i / n$

Where
V = groundwater flow velocity in m/day
k = hydraulic conductivity in m/day
i = hydraulic gradient in m/m
n = estimated soil effective porosity (0.30, Fetter 2001)

The travel time between the base of the dispersal fields and the unnamed tributary south of the dispersal field is the sum of:

1. The vertical travel time in the unsaturated zone between the bottom of the basin and the water table; and
2. The horizontal travel time in the unsaturated zone along the prevailing hydraulic gradient.

The vertical travel time in the unsaturated zone will be on the order of 1.4 m/day. A potential confining layer was observed at RIB BH13-01 at 20 m (65 ft) bgs and the bottom of the RIB was 1.5 m (5 ft) bgs. Distance divided by velocity (18.5 m/4.8 m/day) yields a vertical travel time of at about 4 days. Once the effluent reaches the water table (in this case it is a perched water table), horizontal flow can be calculated using Equation 1 and the following inputs:

- $k = 3 \times 10^{-5}$ m/s (0.4 m/day) [the highest, most conservative, k value is taken from hydraulic testing of down gradient wells, as it will yield the fastest Darcy velocity];
- i = 0.10 (determined assuming the water table is a subdued replica of topography); and
- n = effective porosity estimated at 0.30.

The results of the equation yields a horizontal groundwater velocity of between 0.9 and 1.4 m/day (Table 6.1). Table 6.1 summarizes the horizontal travel times, and shows that effluent subsurface travel times are considerably greater than the 10-day minimum required in the regulation.

Table 6.1 Effluent travel Time Summary

Down gradient receptor	I	n	Saturated k (m/s) 1	V (m/s)	V (m/day)	Distance from the proposed RIB location to Receptor (m)	Travel Time Estimate (days)
Auro Creek (east)	0.2	0.3	3.0E-05	1.6E-05	1.4	262	194
Creek 661 (west)	0.1	0.3	3.0E-05	1.3E-05	1.1	476	437
Water Supply Well TW13-01	0.1	0.3	3.0E-05	1.1E-05	1	770	781
Water Supply Well TW13-02	0.1	0.3	3.0E-05	1.0E-05	0.9	1500	1725

Note (1) saturated hydraulic conductivity was assessed at MW13-02, MW13-03, MW13-04, TW113-01 and TW13-02. 3.0E-05 m/s was taken as the most conservative estimate.

6.3 Potential Down Gradient Receptors

Potential downgradient receptors were identified based on a review of mapping for the area and land use in the area downgradient of the proposed RIB area. Potential down gradient receptors identified include discharge to the two creeks, Creek 661 (west) and Auro Creek (east) and associated aquatic ecosystems. Along with the two test water supply wells, which were installed in August, are the nearest groundwater source wells.

Discharge to Surface Water Groundwater and effluent migrating beneath the proposed RIB area will potentially discharge into Creek 661 or Auro Creek. The streams both flow into Creek 661, which subsequently flows east into Chedakuz Creek, and then northeast into Tatelkuz Lake, located about 15 km from the camp. Assuming groundwater and effluent remain in the ground until discharge into the creeks, the travel time from potential RIB area to the creeks is on the order of 200 to 400 days, during which significant renovation of wastewater will occur. Wastewater from the Blackwater construction camp site will likely have little to no effect on water quality in Tatelkuz Lake.

Potential Discharge to Water Wells The two newly installed water wells are located outside the predicted effluent flow paths. TW13-01 and TW13-02 are over 700 m and 1,500 m away from the RIB, respectively. The predicted subsurface travel time from the RIB to test wells TW13-01 and TW13-02 are 780 days and 1,700 days, respectively. Further, TW13-01 is completed within a semi-confined to confined aquifer and TW13-02 is completed in a confined aquifer.

6.4 Setback Requirements

The MWR stipulates certain setbacks that must be maintained between in-ground disposal areas and certain features. Table 6.2 summarizes relevant setback requirements from the MWR, all of which are thought to be met for the proposed RIB area.

Table 6.2 Minimum Setback Requirements

Feature	Minimum Setback Distance (flow > 37m3/day)	Comments
Property boundary	6 m	The northern property boundary is several kilometers away.
Building drain	10 m	There are no plans to build in the vicinity of the RIB area
Surface water	30 m	Creek 661 and Auro Creek are located at least 30 m from the proposed RIB area
Water wells	300 m (unconfined) 90 m (confined or bedrock)	The two test water supply wells are located at least 700 m from the proposed RIB area.

6.5 Maximum Infiltration Capacity

The Maximum Infiltration Capacity (MIC) is an empirical method typically used to check the reasonableness of infiltration design. The MIC is calculated using the following equation which is based on Darcy's Law:

Equation 2………………… MIC = A * k * CF

Where:
A = infiltration area, 1,250 m^2 recommended area for each basin
k = unsaturated vertical hydraulic conductivity (1.44 m/day)
CF = clogging factor, assumed 0.5

Based on Equation 2, the MIC for each of the RIB's is approximately 875 m^3/day, almost three times the design flow of 300 m^3/day of effluent. This calculation suggests the proposed sizing of the rapid infiltration basins is adequate and the design flow is moderate relative to the soil hydraulic capacity.

6.6 Natural Discharge Capacity

The Natural Discharge Capacity (NDC) is the maximum volume of treated effluent that can seep away from the dispersal area to the area of natural discharge. The NDC depends upon the hydraulic conductivity and thickness of the soil through which seepage will occur, the hydraulic gradient and the width of the seepage zone. NDC is calculated using the following empirical equation, also based on Darcy's Law:

Equation 3……………… NDC = W * T * k * i

Where:
W = width of seepage zone
T = thickness of seepage zone
k = saturated hydraulic conductivity (k = 1 X10^{-5} m/s (2.6 m/day)
i = hydraulic gradient immediately down gradient, estimated at 0.17

For the purposes of this calculation, the width of the seepage zone is 60 m (estimated length of each RIB). The unsaturated thickness of seepage zone is taken to be 90 m (300 ft) based on the elevation of the water table at MW13-02. The results indicate an NDC of about 800 m³/day; which is over two times the design flow.

6.7 Assessment of the Potential for Mounding

The MWR requires an assessment of mounding be made if mounding is considered to be a potential risk. Schedule 4 of the old MSR requires demonstration that infiltration will not result in a mound being generated that could cause effluent or the groundwater table to surface within 30 m of the infiltration site.

As there was no indication of mounding during the July 2013 pilot RIB loading test at the monitoring well RIB BH03/TMW-03, installed at a depth of 7.9 m (26 ft), located approximately 3 m to the north of the pilot test basin (Figure 4).

The potential groundwater mound height above the static water table can be estimated by applying the mounding model in AQTESLOV. AQTESOLV uses the Hantush method (1967) to compute the transient water-table rise (groundwater mounding) beneath a rectangle. The detailed design phase of the EIS will address the potential for mounding about 30 m down gradient to assess the risk of daylighting (renovated effluent surfacing). Based on the presence of a thick unsaturated zone, we do not foresee issues with mounding at the proposed RIB location.

7. CONCLUSIONS

WWAL has completed a feasibility level, Stage 1 Environmental Impact Study to support design and registration of a wastewater treatment system for the Blackwater Mine construction camp. The design flow for the camp is approximately 300 m³/day. Effluent will be treated to Class C effluent (max BOD_5 45 mg/l and TSS 45 mg/l) supplemented with U.V. disinfection with aerated lagoons, and disposed to ground via RIB. Field investigations were completed to assess soil and groundwater conditions at the site. Based on the results of our Stage 1 Environmental Impact Study, we provide the following conclusions:

C1 Soils at the dispersal field site are heterogeneous and primarily consist of medium sand with gravel and silt.

C2 14 test pits were dug in the vicinity of the proposed RIB area and nine boreholes were drilled or excavated. Four dedicated (permanent) monitoring wells were installed; one up gradient ad three down slope. The up gradient well was dry after installation.

C3 No permanent groundwater table was encountered beneath or adjacent to the RIB area during the field investigation (to a depth of 30 m (99 ft)). However, a water table was identified at MW13-02, located at an elevation of approximately 1310 m asl.

C4 Groundwater flows from south to north and is thought to fan out towards the east and west, down gradient of the proposed RIB area with a gradient of 0.1. Estimates of effluent travel time between proposed RIBs and receptors meet MWR requirements for Class C effluent (> 10 days).

C5 Groundwater flow velocity through the unsaturated (vadose) zone was estimated based on the results of a pilot loading test, infiltration rates is on the order of 4 m/day.

C6 The RIB meets the MWR setback requirements.

C7 Baseline Water Quality at the site was assessed and found to be of good quality.

C8 Two creeks, located to the west and east of the proposed RIB area along with two potential test water supply wells were identified as the down gradient receptors.

C9 Class C effluent disposed at the proposed RIB area is not likely to adversely impact the receptors. Further, wastewater from the Blackwater construction camp site will have little to no effect on water quality in down gradient Tatelkuz Lake.

C10 From the Stage I EIS evaluation we have assigned the proposed treatment to be a Reliability Category III.

C11 Further investigation for the Stage 2 EIS phase of the mine construction camp wastewater system will involve gaining a better understanding of the full build-out basin configuration, and settling on an appropriate design hydraulic loading rate for each basin in consultation with the design engineer. Further investigation of the lower terrace, located directly north of the proposed RIB, will also be considered in the Stage 2 EIS. This lower terrace could be used as a potential RIB reserve area. Further, this lower terrace may be appealing as its location relative to the proposed construction camp could reduce the pumping head requirement; thereby, reducing operating costs of the wastewater system.

C12 Two additional wells are proposed for installation during the Stage 2 EIS, these wells will act at century wells to the down gradient receptors. Specifically, one will be installed between the proposed RIB area and TW13-01, a potential potable supply well for the construction camp and a second well will be installed between the proposed RIB and Auro Creek.

8. POST DISCHARGE GROUNDWATER QUALITY MONITORING

The following section details the proposed groundwater quality monitoring that should be implemented during operation of the wastewater system.

8.1 Recommendations for Post-discharge Groundwater Quality Monitoring

The MWR requires ongoing monitoring of the receiving environment, in this case groundwater and surface water, to confirm the effectiveness of water treatment and to ensure that the appropriate water quality guidelines are being met at the property boundary to protect down-gradient receptors.

Based on guidance in the MWR we recommend the following monitoring program:

Tri-annual sampling of the monitoring network at freshet (May-June), during water level recession (September or October) and baseflow (November) of groundwater for the following parameters:

- Field parameters (pH, temperature, ORP and electrical conductivity)
- Alkalinity
- Total nitrate, nitrite and ammonia
- Total and dissolved phosphorous
- Ortho-phosphorous
- Chloride
- Dissolved Metals
- BOD^5 and TSS
- Total coliform, fecal coliform and *E. coli.*

Sampling should be completed by qualified personnel knowledgeable in monitoring well purging and sampling procedures. As a general best practice, we recommend groundwater water levels be measured at each sampling event to assess seasonal changes in the direction of groundwater flow. A qualified hydrogeologist should oversee and review this program annually.

For QA/QC we recommend one triplicate be taken during the annual monitoring program to assess the standard error for each measurable parameter.

We recommend this proposed monitoring network be used for the first full year of monitoring and then re-evaluated by a qualified professional hired by New Gold once the groundwater flow direction is better understood based from the collection of water level data. The final configuration of the monitoring array should be in place by the end of the second year of MWR registered effluent dispersal and monitoring.

A report evaluating the results of the ongoing groundwater monitoring should be submitted to annually the B.C. MoE Regional Officer within 120 days of the end of each calendar year. After two years (i.e. 6 sample events plus the pre-discharge sampling documented in this EIS), the monitoring program should be reviewed and the number of parameters and frequency of monitoring should be reassessed and potentially reduced to annual sampling. This review should be conducted by a qualified professional hired by New Gold. The recommendations should be submitted to the Ministry Regional Officer for approval.

REFERENCES

AMEC. 2013a. Fish and Aquatic Resources, 2011-2012 –Baseline Report - New Gold Blackwater Gold Project. Report N. VE52277 prepared for New Gold Inc.

AMEC. 2013b. Water and Sediment Quality Baseline Report – New Gold Blackwater Gold Project. Report N. VE52277 prepared for New Gold Inc.

British Columbia Ministry of Environment (MoE). 2000. Environmental Impact Study Guidelines- A Companion Document to the Municipal Sewage Regulation. Queen's Printer.

British Columbia Ministry of Environment (MoE). 2003. British Columbia Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples. January 2003: http://www.env.gov.bc.ca/air/wamr/labsys/field_man_03.html

British Columbia Ministry of Environment (MoE). 2013. Water Resources Atlas and Wells Database, accessed on-line at: https://a100.gov.bc.ca/pub/wells/public/common/wellsreport1.jsp

British Columbia Onsite Sewage Association (BCOSSA). 2007. Sewerage System Standard Practice Manual Version 2. September, 2007. Prepared for: B.C. Ministry of Health. Accessed on-line at: http://www.health.gov.bc.ca/protect/pdf/SPM_V2_2007.pdf

Environment Canada 2013. Water Survey of Canada – Historic Data, accessed on-line: http://www.wsc.ec.gc.ca/applications/H2O/index-eng.cfm

Fetter, C.W. 2001. Applied Hydrogeology, Fourth Edition. Prentice-Hall, Upper Saddle River, N.J.

Haitjema H.M. and S. M. Mitchell-Bruker. 2005. Are Water Tables a Subdued Replica of the Topography? Ground Water Journal. Vol. 43, No. 6, pages 781-786.

Health Canada 2010. Guidelines for Canadian Drinking Water Quality. December 2010. Accessed on-line at: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/2010-sum_guide-res_recom/index-eng.php

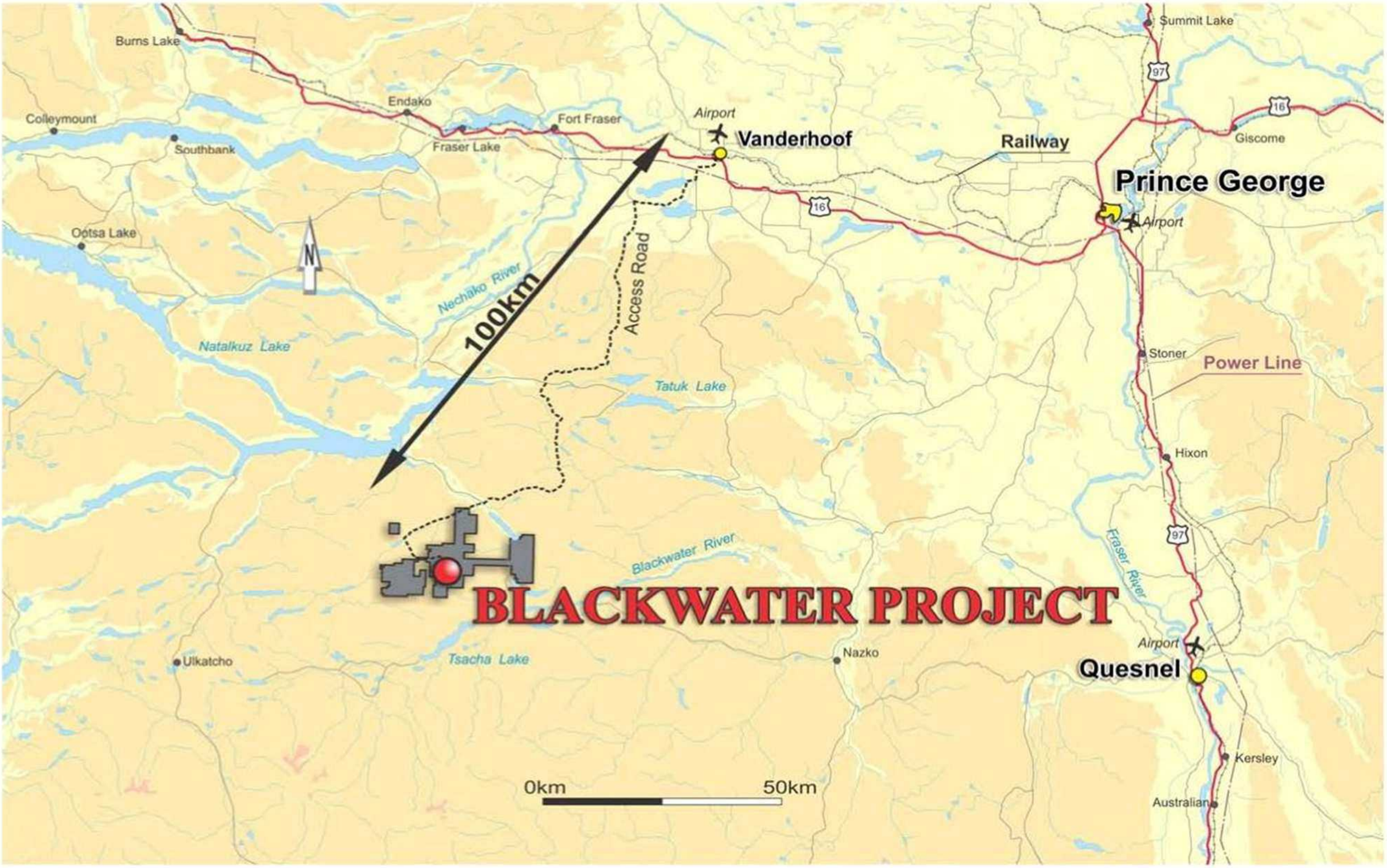
Knight Piésold Ltd. 2011a. Blackwater Gold Project – Safe Yield Estimates for Camp Water Supply. Letter Report to Mr. Peter Marshall (New Gold Inc.), August 8, 2011.

Knight Piésold Ltd. 2013. Preliminary Engineering – Hydrometeorology Report. Report No. VA101 – 4514-1 Rev. 1 prepared for New Gold Inc., February 22, 2013.

Municipal Sewage Regulation (MSR). 2010. B.C. Regulation 129/99 [including amendments up to B.C. Reg 4/2010, January 14, 2010] Queen's Printer

Municipal Wastewater Regulation (MWR). 2012. B.C. Regulation 87/2012, Deposited April 20, 2012.

Western Water Associates Ltd. (WWAL). 2011. Environmental Impact Study: In-Ground Effluent Disposal at the New Gold Inc. Blackwater Mining Camp, near Vanderhoof, B.C. Report No. 11-062-01 prepared for Allnorth / New Gold.



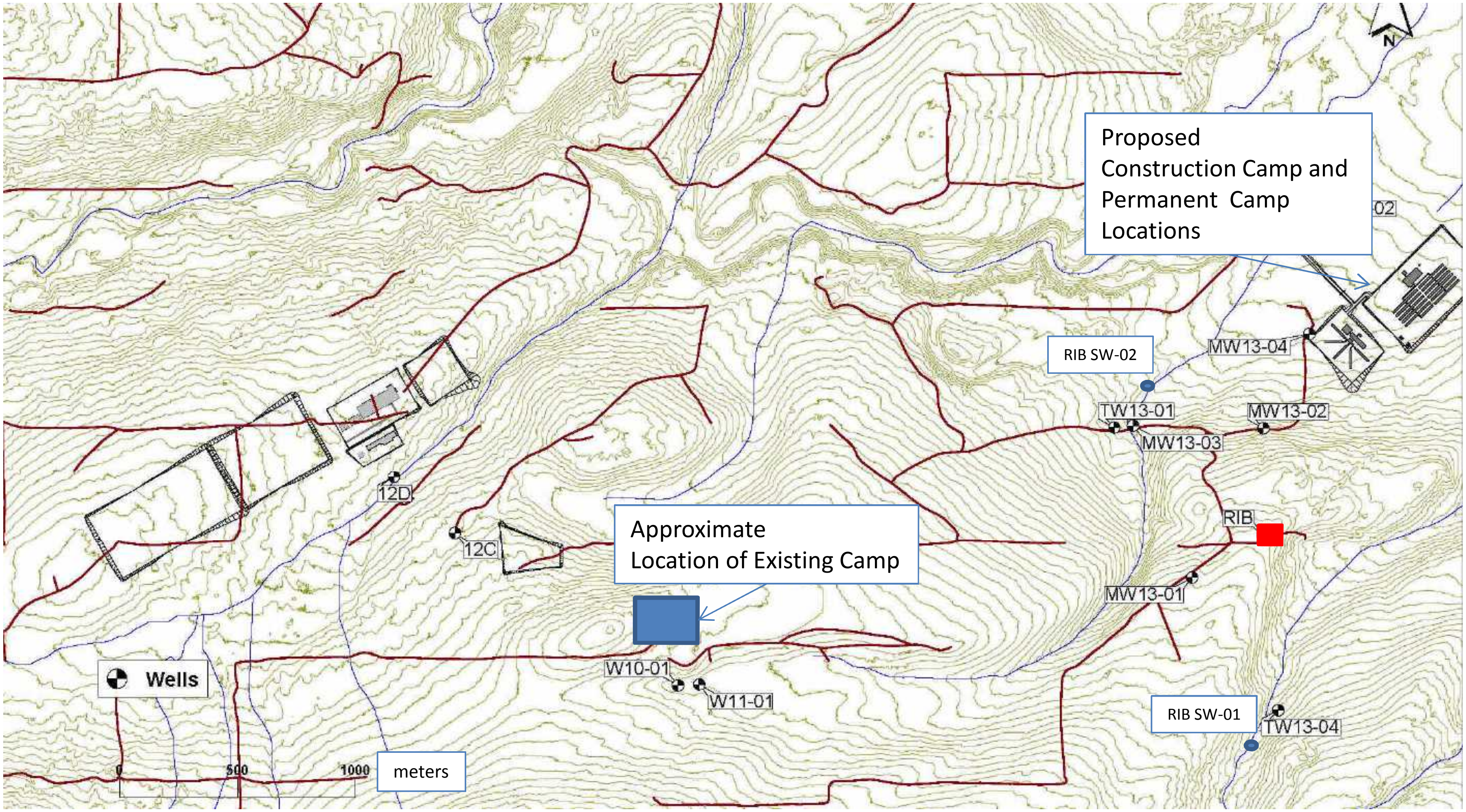
New Gold – Blackwater
Construction Camp MWR - EIS

TITLE

Figure 1: Site Location Map

western water
ASSOCIATES LTD

DRAWN	BRM	DATE	July 2013	PROJECT NO.	13-019-02
CHECKED		SCALE	See figure	DWG. NO.	na
REVIEWED		FILE NO.		FIGURE VERSION NO.	1

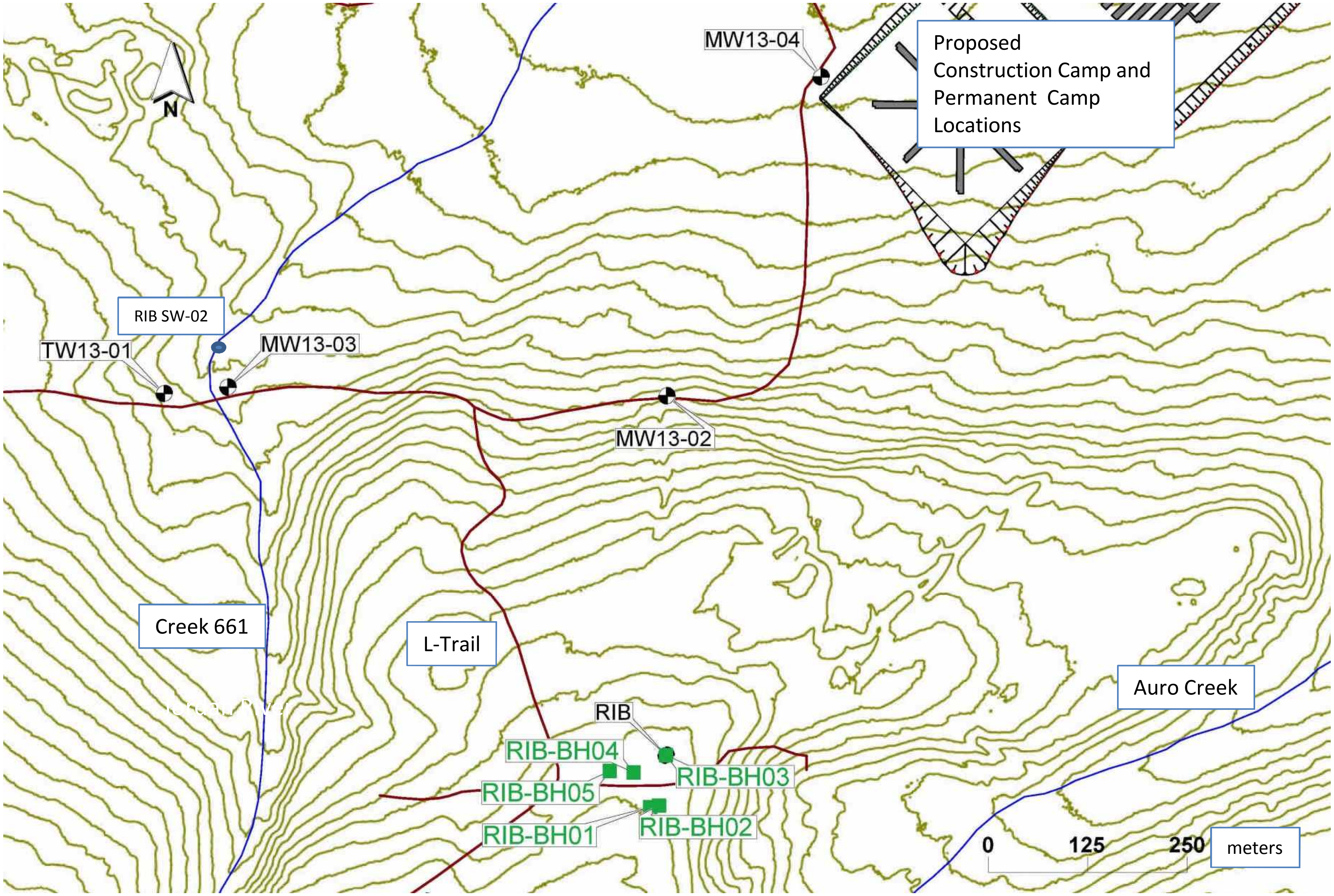


New Gold – Blackwater Construction Camp MWR - EIS

TITLE **Figure 2:** Blackwater Site Map – Including planned mine infrastructure along with existing well locations, the proposed RIB area, surface water bodies, surface water sample sites, 5 m contours and existing trails.

western water ASSOCIATES LTD

DRAWN	BRM	DATE	July 2013	PROJECT NO.	13-019-02
CHECKED		SCALE	See figure	DWG. NO.	na
REVIEWED		FILE NO.		FIGURE VERSION NO.	1

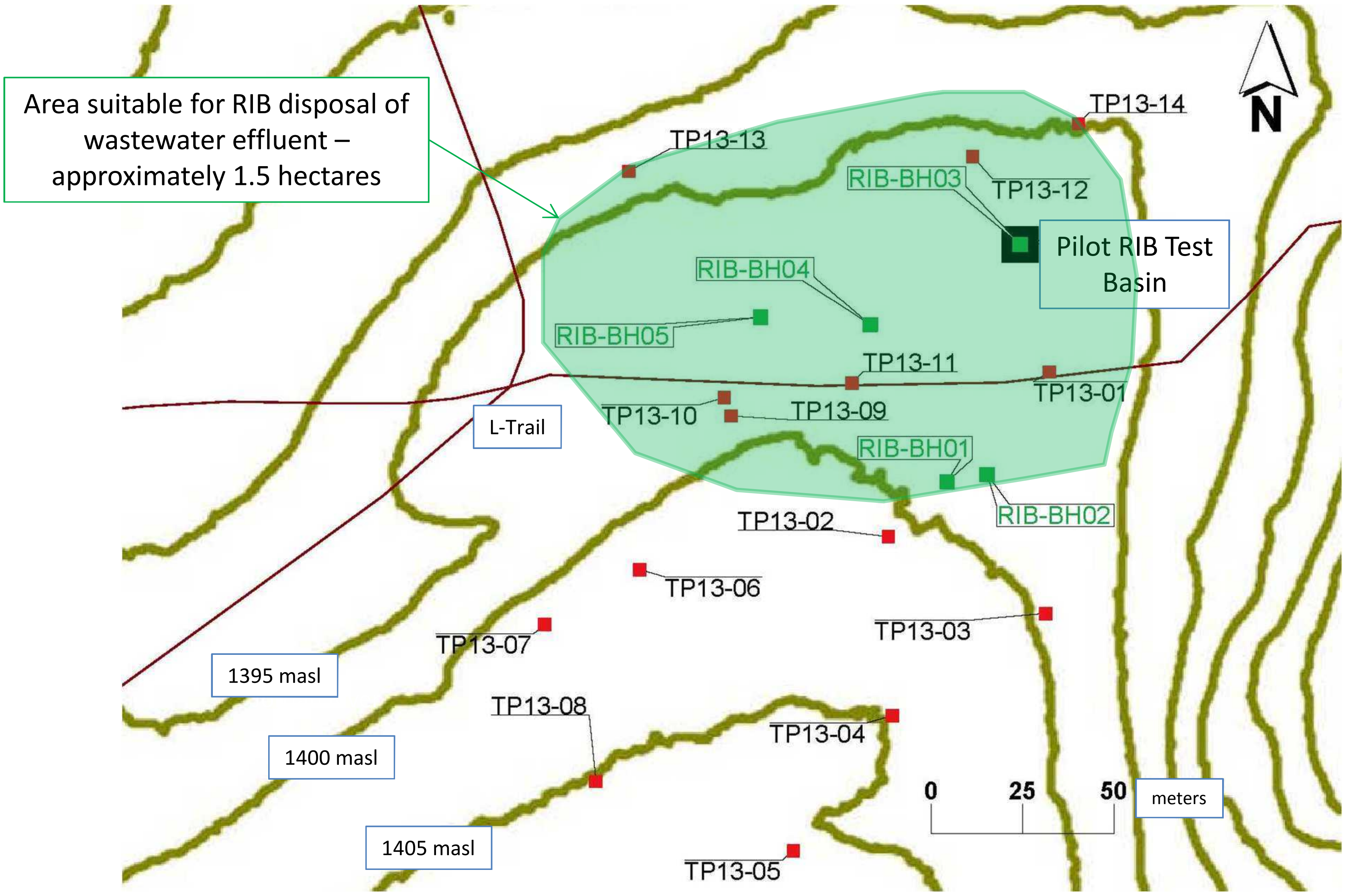


New Gold – Blackwater
Construction Camp MWR - EIS

TITLE **Figure 3:** Proposed RIB Area with Boreholes, Monitoring Wells and Test Supply Well Locations. Contours are 5 m

western water
ASSOCIATES LTD

DRAWN	BRM	DATE	July 2013	PROJECT NO.	13-019-02
CHECKED		SCALE	See figure	DWG. NO.	na
REVIEWED		FILE NO.		FIGURE VERSION NO.	1



Area suitable for RIB disposal of wastewater effluent – approximately 1.5 hectares

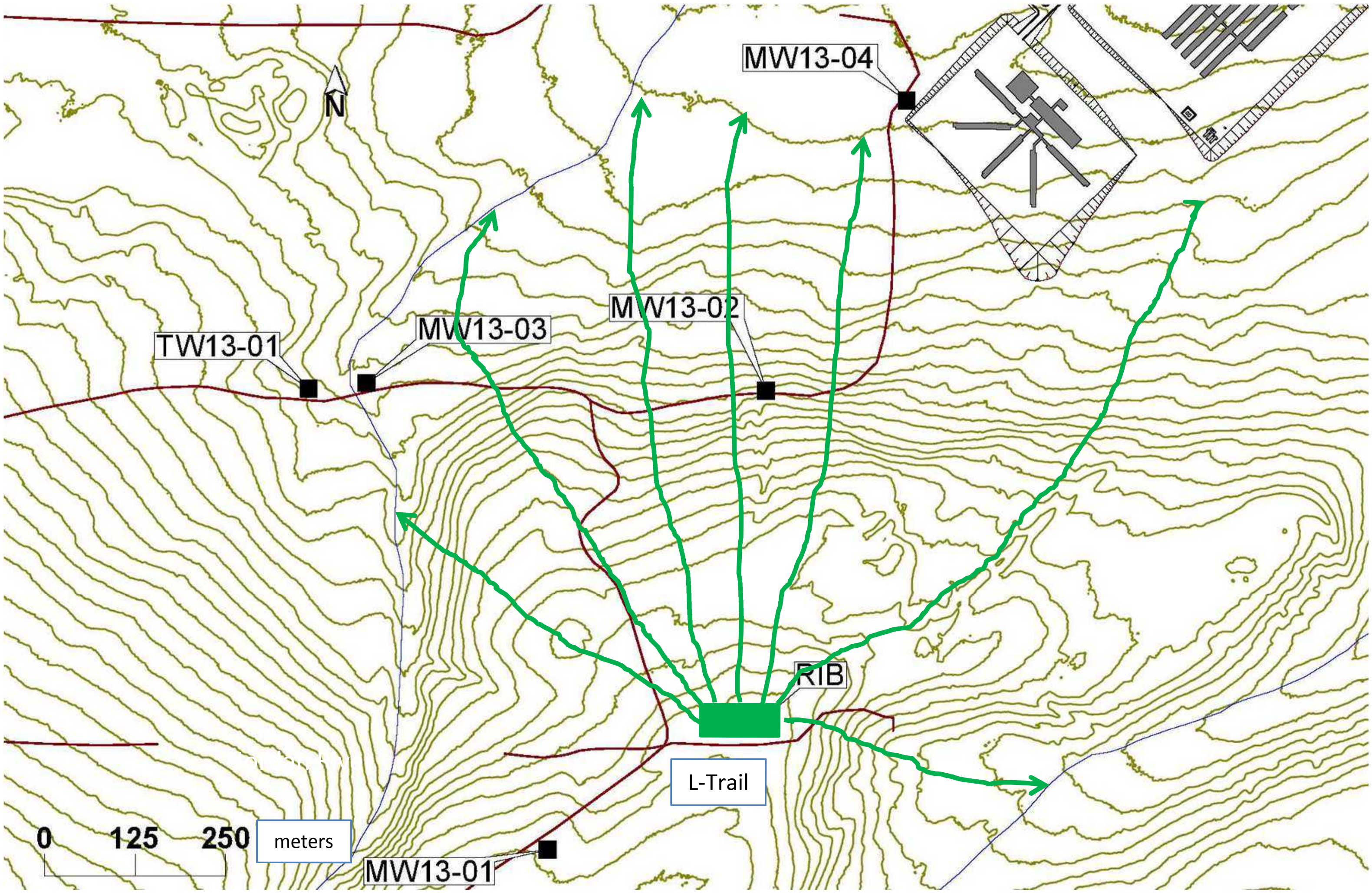
Pilot RIB Test Basin

New Gold – Blackwater Construction Camp MWR - EIS

western water ASSOCIATES LTD

TITLE **Figure 4:** Proposed RIB Area with Test Pit and Borehole Locations. Contours are 5 m and green shaded area is the Area suitable for RIB disposal of wastewater effluent – approximately 1.5 hectares

DRAWN	BRM	DATE	July 2013	PROJECT NO.	13-019-02
CHECKED		SCALE	See figure	DWG. NO.	na
REVIEWED		FILE NO.		FIGURE VERSION NO.	1



New Gold – Blackwater
Construction Camp MWR - EIS

TITLE **Figure 5:** Conceptual Model for RIB Effluent Fate. Green lines represent the predicted flow path of the RIB infiltrated effluent based on topographic gradient.

DRAWN	BRM	DATE	July 2013	PROJECT NO.	13-019-02
CHECKED		SCALE	See figure	DWG. NO.	na
REVIEWED		FILE NO.		FIGURE VERSION NO.	1

western water
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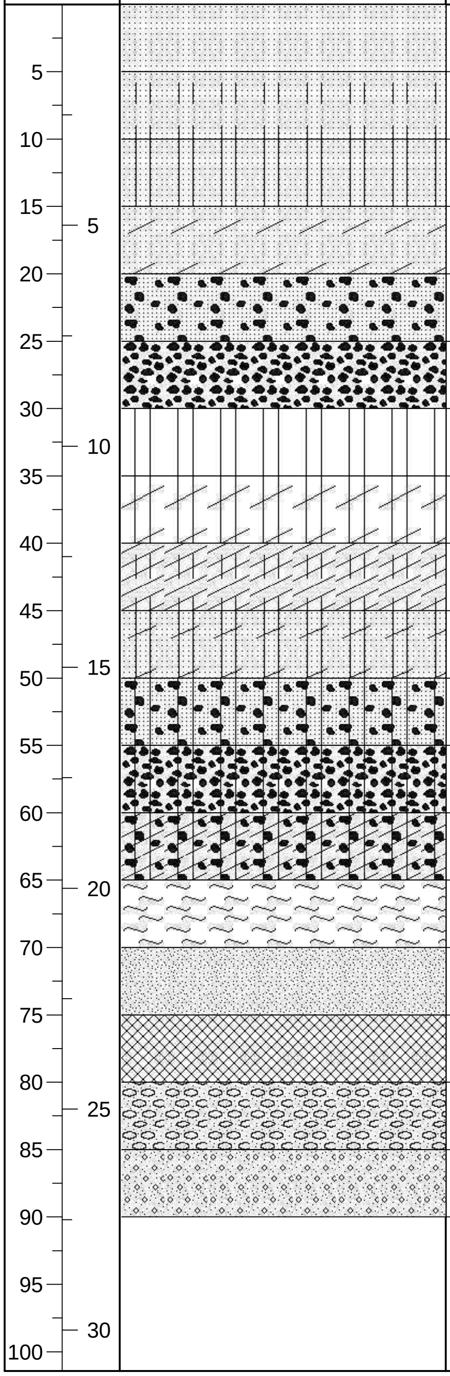
Appendix A

Water Well Logs

Legend for Lithology Symbols **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**

western water
ASSOCIATES LTD

Depth ft/m	Lithological Symbol	Symbol Description



Sand.

Silty sand.

Sandy silt.

Sand and clay.

Sand and gravel.

Gravel and some boulders.

Well sorted silt.

Silt with clay.

Clay with some silt.

Sand with silt and clay.

Sand, silt and gravel.

Silt with gravel.

Silt with clay and gravel.

Topsoil, often with organic material.

Engineered filter pack (10/20 sand size).

Bentonite.

Backfill material. Either clean sand or natural material.

Backfill material. Either clean sand or natural material.

Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Well Number: TW13-01 (WPN 28413) **Client: NewGold - Blackwater**
Project: Feasibility-Water Supply **Project Number: 13-019-01**
Location: On the L Trail, near removed bridge.

western water
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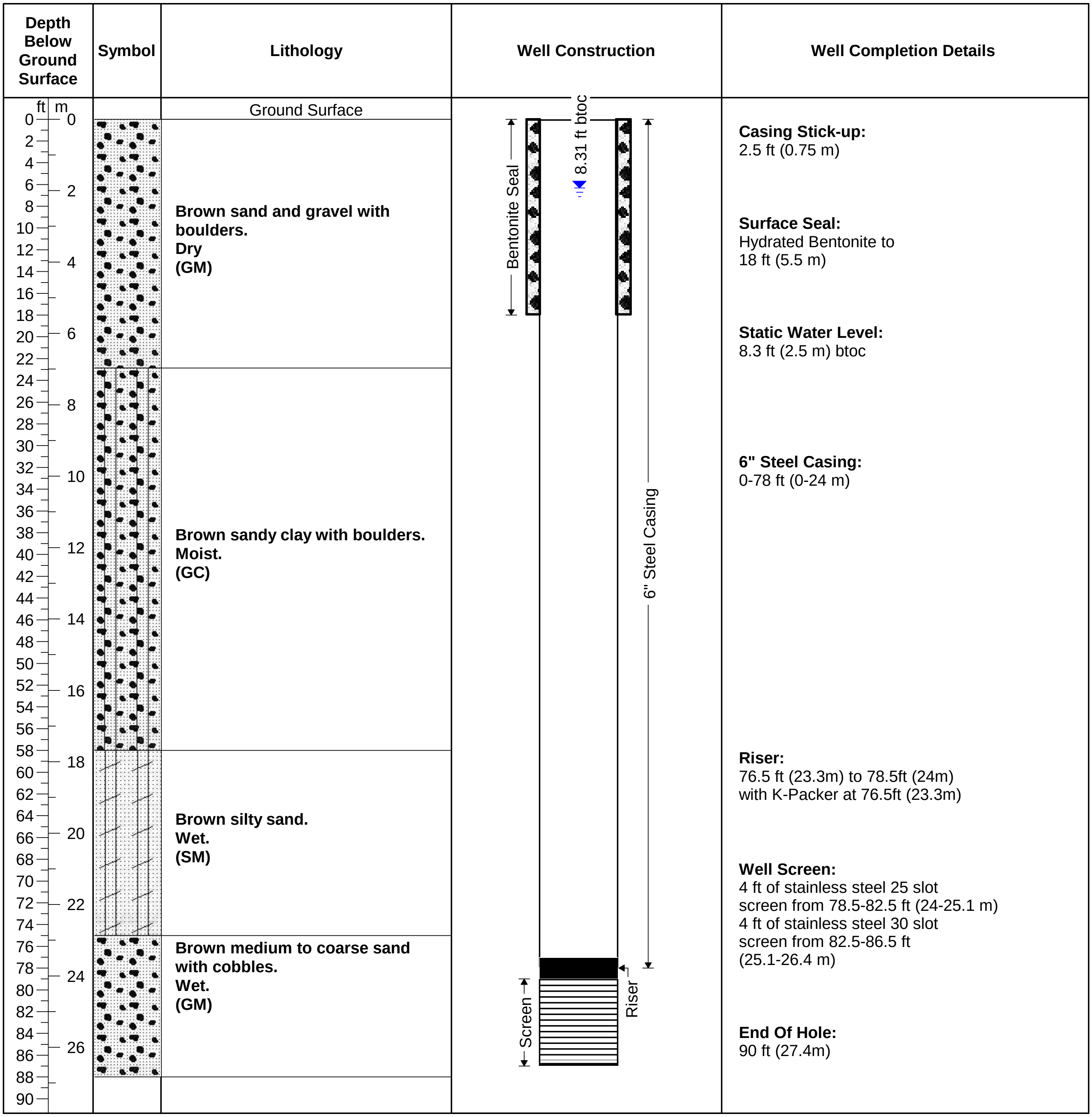


Brown sand and gravel with boulders.
Dry
(GM)

Brown sandy clay with boulders.
Moist.
(GC)

Brown silty sand.
Wet.
(SM)

Brown medium to coarse sand with cobbles.
Wet.
(GM)

Casing Stick-up:
2.5 ft (0.75 m)

Surface Seal:
Hydrated Bentonite to 18 ft (5.5 m)

Static Water Level:
8.3 ft (2.5 m) btoc

6" Steel Casing:
0-78 ft (0-24 m)

Riser:
76.5 ft (23.3m) to 78.5ft (24m) with K-Packer at 76.5ft (23.3m)

Well Screen:
4 ft of stainless steel 25 slot screen from 78.5-82.5 ft (24-25.1 m)
4 ft of stainless steel 30 slot screen from 82.5-86.5 ft (25.1-26.4 m)

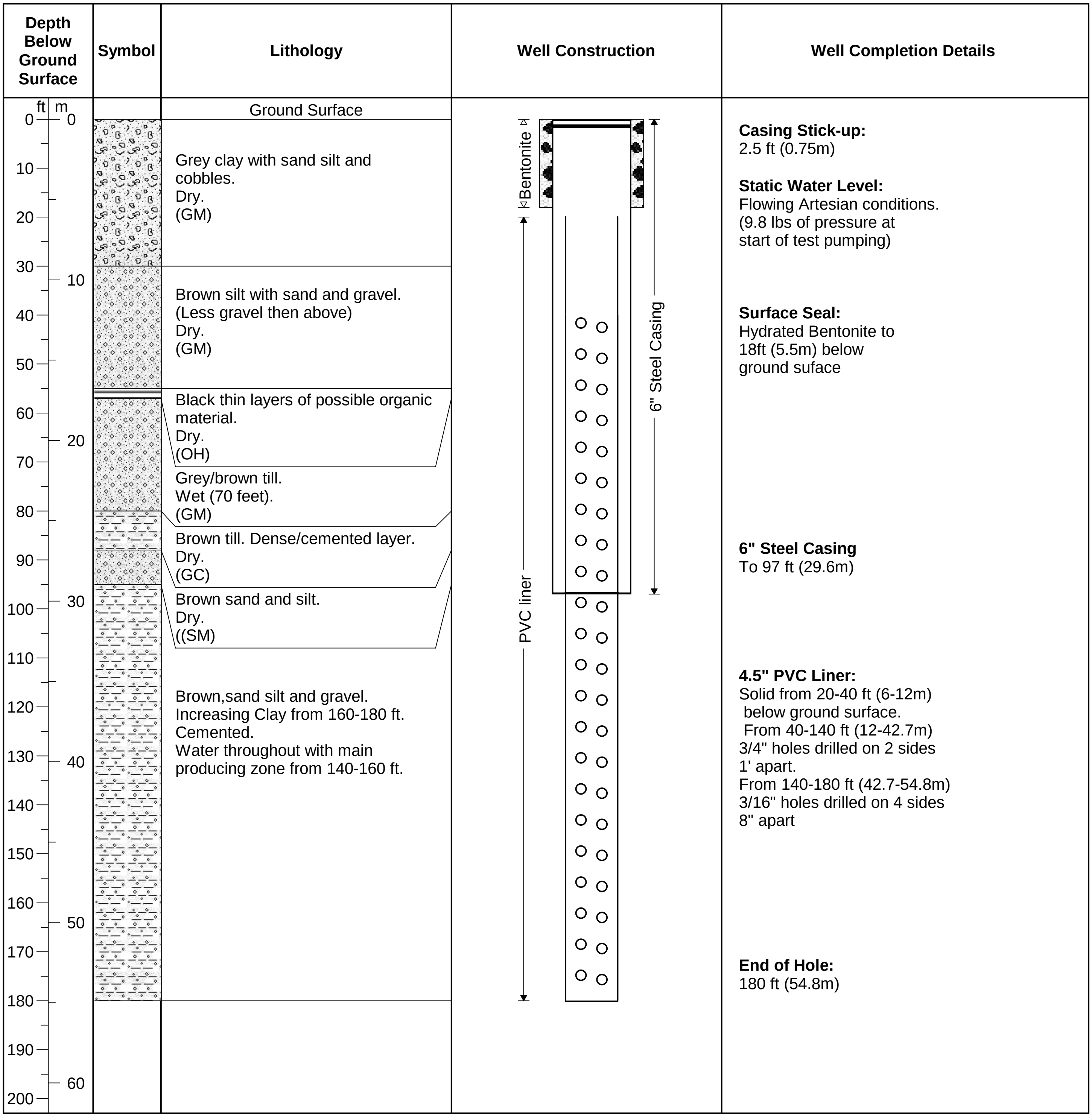
End Of Hole:
90 ft (27.4m)

Coordinates: E 377709 **N 5894991**
Yield: 67.6 USgpm
Elevation: 1312 masl
Logged By: Ryan Rhodes
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Drilling Contractor: Cariboo Drilling
Drilling Method: Air Rotary
Date of Completion: July 31, 2013

Well Number: TW13-02 (WPN 28414) **Client: NewGold-Blackwater**
Project: Backwater Supply Wells **Project Number: 13-019-01**
Location: Northwest of TW13-01 (near future camp)

western water
ASSOCIATES LTD



Lithology

Ground Surface

Grey clay with sand silt and cobbles.
Dry.
(GM)

Brown silt with sand and gravel.
(Less gravel then above)
Dry.
(GM)

Black thin layers of possible organic material.
Dry.
(OH)

Grey/brown till.
Wet (70 feet).
(GM)

Brown till. Dense/cemented layer.
Dry.
(GC)

Brown sand and silt.
Dry.
((SM)

Brown,sand silt and gravel.
Increasing Clay from 160-180 ft.
Cemented.
Water throughout with main producing zone from 140-160 ft.

Well Completion Details

Casing Stick-up:
2.5 ft (0.75m)

Static Water Level:
Flowing Artesian conditions.
(9.8 lbs of pressure at
start of test pumping)

Surface Seal:
Hydrated Bentonite to
18ft (5.5m) below
ground suface

6" Steel Casing
To 97 ft (29.6m)

4.5" PVC Liner:
Solid from 20-40 ft (6-12m)
below ground surface.
From 40-140 ft (12-42.7m)
3/4" holes drilled on 2 sides
1' apart.
From 140-180 ft (42.7-54.8m)
3/16" holes drilled on 4 sides
8" apart

End of Hole:
180 ft (54.8m)

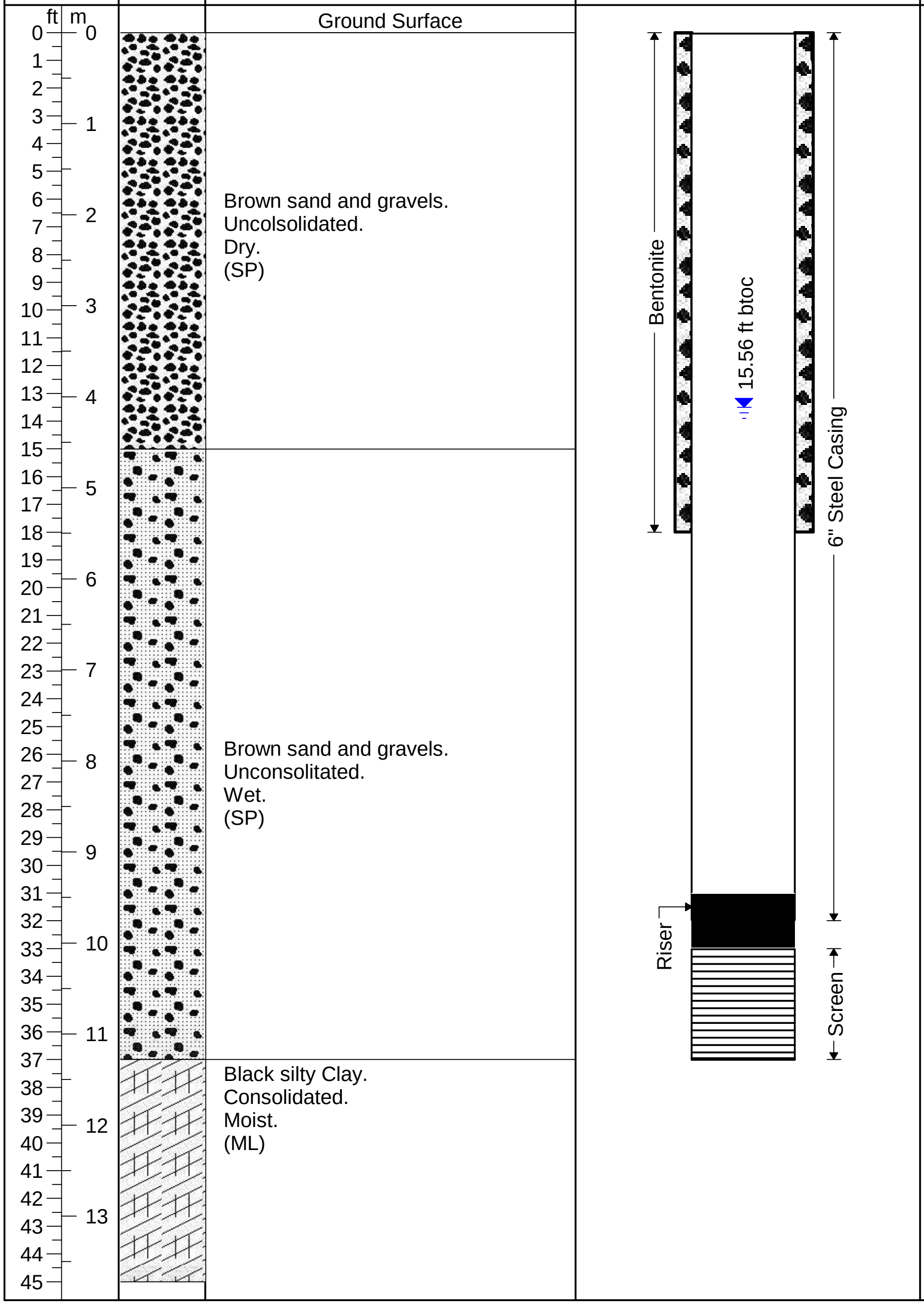
Coordinates: E 378640 **N 5895993**
Yield: 30 USgpm
Elevation: 1249 masl
Logged By: Ryan Rhodes
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Drilling Contractor: Cariboo Drillling
Drilling Method: Air Rotary
Date of Completion: August 02, 2013

Well Number: TW13-03 (WPN 28415) **Client: NewGold - Blackwater**
Project: Feasibility-Water Supply **Project Number: 13-019-01**
Location: 5km east off the C Trail at the 6.5 km mark.

western water
ASSOCIATES LTD

Depth Below Ground Surface	Symbol	Lithology	Well Construction	Well Completion Details



Brown sand and gravels.
Uncolsolidated.
Dry.
(SP)

Brown sand and gravels.
Unconsolitated.
Wet.
(SP)

Black silty Clay.
Consolidated.
Moist.
(ML)

Casing Stick-up:
2.5 ft (0.75m) above
ground surface

Static Water Level:
15.56 ft (4.7m) btoc

Surface Seal:
Hydrated Bentonite to
18 ft (5.5m)

6" Steel Casing:
0-32 ft (0-9.75 m)

Riser:
31-33 ft (9.44-10 m)
with K-Packer at top of
riser

Well Screen:
4 ft of stainless steel 25 slot
screen from 33-37 ft (10-11.27 m)

End of Hole:
Hole Drilled to 45 ft (13.7 m)

Coordinates: E 378492 **N 5900405**
Yield: 70 USgpm
Elevation: 1134 masl
Logged By: Ryan Rhodes
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

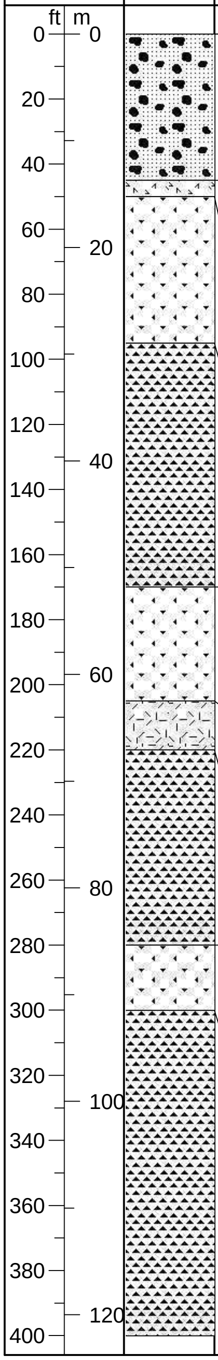
Drilling Contractor: Cariboo Drilling
Drilling Method: Air Rotary
Date of Completion: August 2, 2013

Page 1 of 1

Well Number: TW13-04 (WPN 28412) **Client: NewGold - Blackwater**
Project: Feasibilty-Water Supply **Project Number: 13-019-01**
Location: East of Auro Creek bridge.

western water
ASSOCIATES LTD

Depth Below Ground Surface	Symbol	Lithology	Well Construction	Well Completion Details



Ground Surface

Brown glacial till.
Dry.
(GM)

Red Regolith
(broken bedrock).
Dry.
(BR)

Red bedrock
(Andesite).
Hard.
Dry.
(BR)

Black/Grey bedrock.
Hard.
Wet.
(BR)

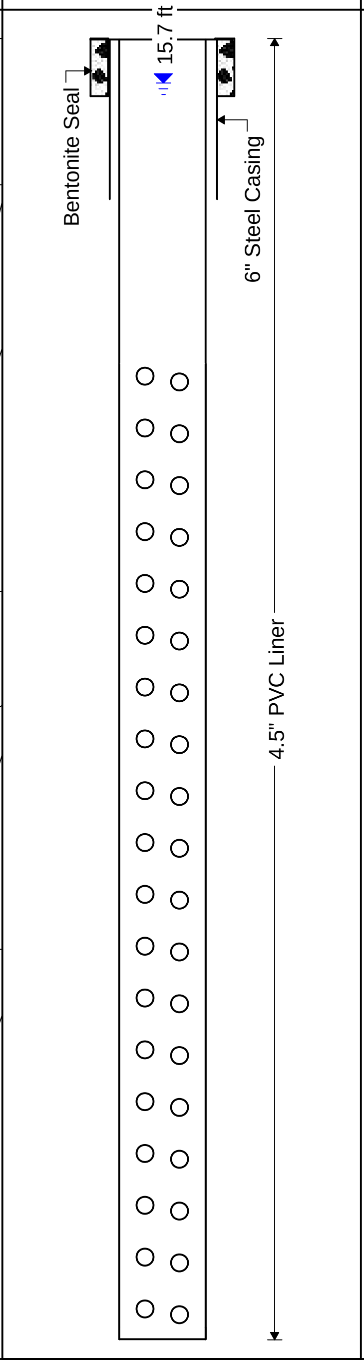
Red bedrock
(Andesite).
Hard.
Wet.
(BR)

Maroon bedrock.
Soft.
Wet.
(BR)

Black bedrock.
Hard.

Red bedrock
(Andesite).
Hard.
Wet.
(BR)

Black bedrock.
Hard.
Wet.
(BR)



Casing Stick-up:
2.5 ft (0.75m)

Surface Seal:
Hydrated Bentonite to
18 ft (5.5m) below ground
surface

Static Water Level:
15.7 ft (4.78m) btoc

6" Steel Casing:
2.5 ft (0.75m) above ground
surface to 50 ft (15.24m) btoc

4.5" PVC Liner:
Solid from 0-50 ft (0-15.2m)

From 50-400 ft (15.2-122m)
3/4" holes drilled in 2 sides 1'
apart

End of Hole:
400 ft (122m)

Coordinates: E 378404 N 5893792
Yield: 4 USgpm
Elevation: 1398 masl
Logged By: Ryan Rhodes
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Drilling Contractor: Cariboo Drilling
Drilling Method: Air Rotary
Date of Completion: July 28, 2013

Borehole / Well Completion Log

Client	Allnorth/NewGold	**Well ID**	Well 3 (TW-12C, WPN 31679)
Project	Blackwater Camp Water Supply	**Project No.**	12-015-03

western water ASSOCIATES LTD Consultants in Hydrogeology and Water Resources Management

Drilling

Drilling Company	*Cariboo Water Wells Ltd.*	Completion Date	*3/13/2012*	Northing	5894847
Drilled by	*Kurt (Doug)*	Drilling Fluid	*None*	Easting	374628
Logged By	*BRM*	Borehole Depth		Surface Elev. (m)	1454
Drill Rig	-	Corehole Dia. (in)		TOC Elev. (m)	1454
Drilling Method	*Air Rotary*	Borehole Dia. (in)	*150 mm (6")*	Stick-up/down	*71.1 cm (28")*

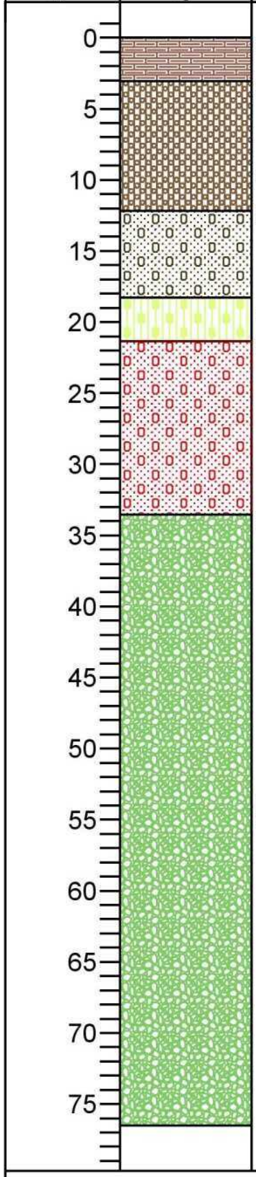
Samples				DTB (mbtoc)	**76.5 m (251 ft)**
Sample Method	*Air Lift*	Sample Interval		DTW (mbtoc)	**17.7 m (58 ft)**

* DTB & DTW measured after well development

Well

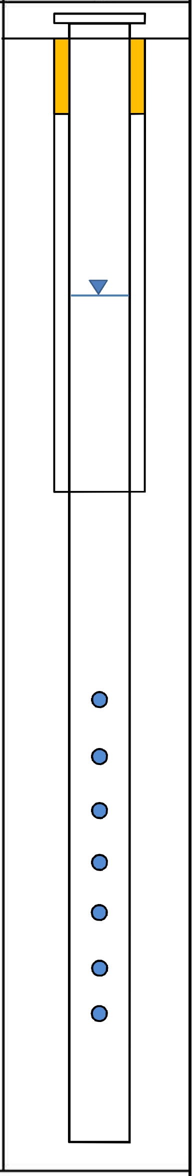
Well Depth (bgs)		Backfill Interval		
Casing Type	*Carbon Steel*	Filter Material	*N/A*	Notes:
Casing Joints		Filter Interval		
Casing Dia. (in)	5" (liner)	Seal Material	*Bentonite*	
Screen Type	*40 Slot*	Seal Interval		
Slot Size (in)		Surface Seal		
Screen Interval	*No screen*	Development	*Air Lift (10 hours)*	
Backfill Material	*None*			

DEPTH (m) **SYMBOL**



SOIL / ROCK DESCRIPTION	***WELL COMPLETION DETAILS***
Dark brown, LOAM, loose, moist	3 ft bentonite surface seal
Brown, SILT, with fine sand and loam, moist.	6 inch casing to 33.5 m (110 ft)
	5 inch steel liner from ground to 76.5 m (251 ft)
trace fines, trace subrounded gravel	
Brown, SAND, with gravel and silt, loose, moist	
	Water level at 17.7 m (58 ft)
Brown, CLAY, with gravel, compact, Wet (approx. 0.5 GPM)	
Brown, SAND, fine sand some gravel, loose, wet.	
Brown, green and pink, BEDROCK, soft, volcanic in origin	
	5" liner perforated between 46.0 m and 70.4 (151 – 231 ft)
Dominant water bearing fractures encountered between 51.8 and 53.4 m (170 - 175 ft)	

Well Constr.



Borehole / Well Completion Log

western water ASSOCIATES LTD
Consultants in Hydrogeology and Water Resources Management

Client Allnorth/New Gold
Well ID Well 4 (TW-12D, WPN 31680)
Project Blackwater Camp Water Supply
Project No. 12-015-03

Drilling

Drilling Company	*Cariboo Water Wells Ltd.*	Completion Date	*3/14/2012*	Northing	*5895448*
Drilled by	*Kurt (Doug)*	Drilling Fluid	*None*	Easting	*374457*
Logged By	*BRM*	Borehole Depth	43.9 m (144 ft)	Surface Elev. (m)	*1433*
Drill Rig	-	Corehole Dia. (in)		TOC Elev. (m)	*1433*
Drilling Method	*Air Rotary*	Borehole Dia. (in)	*150 mm (6")*	Stick-up/down	*92.7 cm (36.5")*

Samples

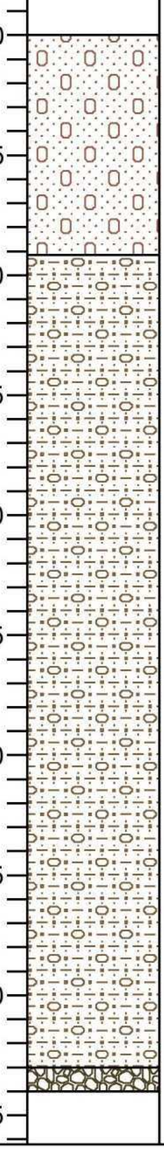
Sample Method	*Air Lift*	Sample Interval	3 m (10 ft)	DTB (mbtoc)	43.9 m (144 ft)
				DTW (mbtoc)	20.1 m (66 ft)

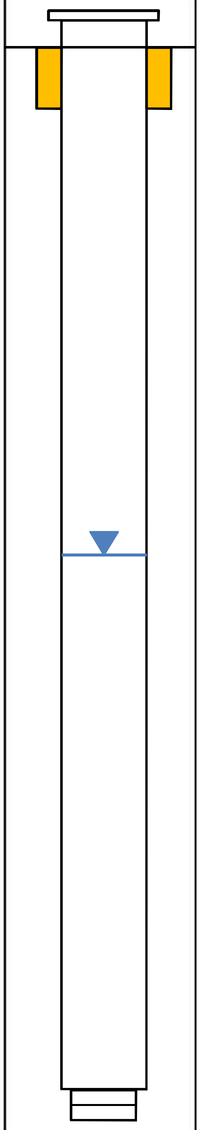
* DTB & DTW measured after well development

Well

Well Depth (bgs)		Backfill Interval		Notes:
Casing Type	*Carbon Steel*	Filter Material	*N/A*	
Casing Joints		Filter Interval		
Casing Dia. (in)	*6"*	Seal Material	*Bentonite*	
Screen Type	*40 Slot*	Seal Interval		
Slot Size (in)		Surface Seal		
Screen Interval	*140.5' -144'*	Development	*Air Lift (4 hours)*	
Backfill Material	*None*			

DEPTH (m)	SYMBOL	SOIL / ROCK DESCRIPTION	WELL COMPLETION DETAILS	Well Constr.
0		Brown, SAND, with well-rounded gravel, loose,		
			6" carbon steel casing that extends from ground surface to 42.1 m (138 ft)	
5			6.1 m (20 ft) bentonite surface seal	
10		Brown, TILL, with silt and fine sand, loose, dry		
15				
20			Depth to water 20.1 m (66 ft)	
25		Same as above but moist		
30				
35			4" K packer between 42.2 m (135.2 ft) and 44.2 m (138.5 ft)	
		Some gravel with silt	2 ft blank between 42.2 m (138.2 ft) and 42.8 m (140.5 ft)	
40			4 ft Johnson 40 slot stainless steel screen between 42.8 m (140.5 ft) and 43.9 m (144 ft). Note: only 3.5 ft of screen is exposed.	
		Bedrock encountered		
45				





Report 1 - Detailed Well Record

Well Tag Number: 95996

Owner: TTM RESOURCES

Address: KLUSKUS FSR ROAD

Area: VANDERHOOF

WELL LOCATION:
Land District
District Lot: Plan: Lot:
Township: Section: Range:
Indian Reserve: Meridian: Block:
Quarter:
Island:
BCGS Number (NAD 27): 093F037243 Well:

Class of Well: Water supply
Subclass of Well: Domestic
Orientation of Well: Vertical
Status of Well: New
Well Use: Water Supply System
Observation Well Number:
Observation Well Status:
Construction Method:
Diameter: inches
Casing drive shoe: Y
Well Depth: 213 feet
Elevation: 3570 feet (ASL)
Final Casing Stick Up: 30 inches
Well Cap Type: WELDED
Bedrock Depth: feet
Lithology Info Flag: Y
File Info Flag: N
Sieve Info Flag: N
Screen Info Flag: N

Site Info Details:
Other Info Flag:
Other Info Details:

Construction Date: 2008-09-22 00:00:00.0

Driller: Cariboo Water Wells
Well Identification Plate Number: 27624
Plate Attached By: DOUG LEMAL
Where Plate Attached: SIDE

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield: 8 (Driller's Estimate) U.S. Gallons per Minute
Development Method: Air lifting
Pump Test Info Flag: N
Artesian Flow:
Artesian Pressure (ft):
Static Level: 190 feet

WATER QUALITY:
Character:
Colour:
Odour:
Well Disinfected: N
EMS ID:
Water Chemistry Info Flag: N
Field Chemistry Info Flag:
Site Info (SEAM):

Water Utility:
Water Supply System Name:
Water Supply System Well Name:

SURFACE SEAL:
Flag: Y
Material: Bentonite clay
Method: Poured
Depth (ft): 18 feet
Thickness (in):
Liner from To: feet

WELL CLOSURE INFORMATION:
Reason For Closure:
Method of Closure:
Closure Sealant Material:
Closure Backfill Material:
Details of Closure:

Screen from	to feet	Type	Slot Size

Casing from	to feet	Diameter	Material	Drive Shoe
0	213	6	Steel	Y

GENERAL REMARKS:
WELL INSPECTION REPORT AVAILABLE FROM PRINCE GEORGE REGIONAL OFFICE.

LITHOLOGY INFORMATION:
From 0 to 6 Ft. Hard DRY grey till
From 6 to 30 Ft. SAND WITH GRAVEL DRY grey
From 30 to 200 Ft. Hard SAND WITH GRAVEL DRY brown
From 200 to 213 Ft. Dense SAND WITH GRAVEL HIGH PRODUCTION grey

- Return to Main
- Return to Search Options
- Return to Search Criteria

Report 1 - Detailed Well Record

Well Tag Number: 98647

Owner: KLUSKUS FIRST NATION

Address:

Area:

WELL LOCATION:
COAST RANGE 4 Land District
District Lot: Plan: Lot:
Township: Section: Range: 4
Indian Reserve: Meridian: Block:
Quarter:
Island:
BCGS Number (NAD 27): 093F008431 Well:

Class of Well: Water supply
Subclass of Well: Domestic
Orientation of Well: Vertical
Status of Well: New
Well Use: Water Supply System
Observation Well Number:
Observation Well Status:
Construction Method:
Diameter: inches
Casing drive shoe: N Y
Well Depth: 68 feet
Elevation: 3183 feet (ASL)
Final Casing Stick Up: 12 inches
Well Cap Type: ALUMINUM
Bedrock Depth: feet
Lithology Info Flag: Y
File Info Flag: N
Sieve Info Flag: N
Screen Info Flag: Y

Site Info Details:
Other Info Flag:
Other Info Details:

Construction Date: 2008-10-23 00:00:00.0

Driller: J. R. Drilling Central Ltd. Partnership
Well Identification Plate Number: 29594
Plate Attached By: KELLY PELLETIER
Where Plate Attached: CASING

PRODUCTION DATA AT TIME OF DRILLING:
Well Yield: 100 (Driller's Estimate) U.S. Gallons per Minute
Development Method:
Pump Test Info Flag: N
Artesian Flow:
Artesian Pressure (ft):
Static Level: 12 feet

WATER QUALITY:
Character:
Colour:
Odour:
Well Disinfected: N
EMS ID:
Water Chemistry Info Flag: N
Field Chemistry Info Flag:
Site Info (SEAM):

Water Utility:
Water Supply System Name:
Water Supply System Well Name:

SURFACE SEAL:
Flag: Y
Material: Bentonite clay
Method: Poured
Depth (ft): 20 feet
Thickness (in):
Liner from To: feet

WELL CLOSURE INFORMATION:
Reason For Closure:
Method of Closure:
Closure Sealant Material:
Closure Backfill Material:
Details of Closure:

Screen from	to feet	Type	Slot Size
56	64		40

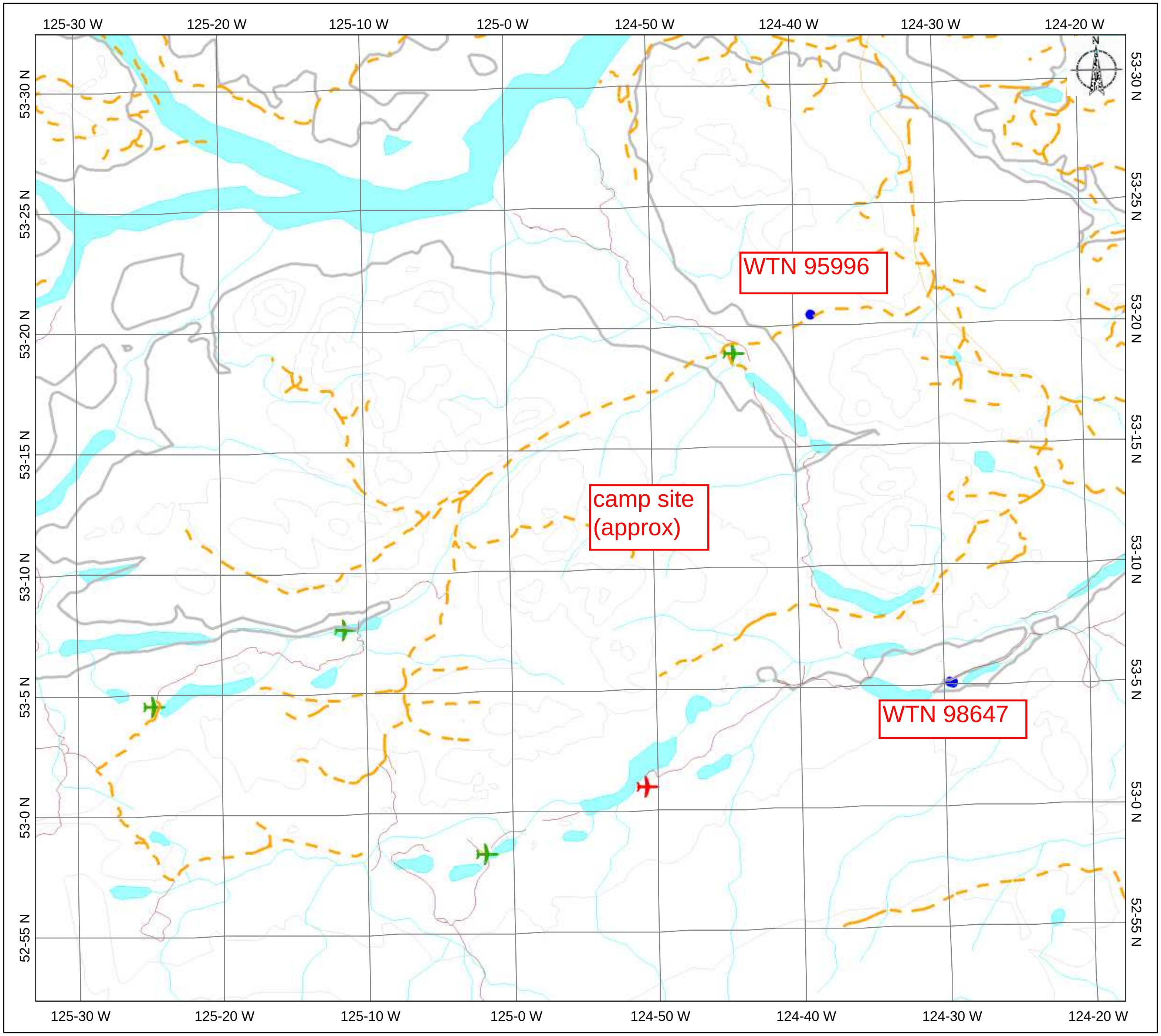
Casing from	to feet	Diameter	Material	Drive Shoe
0	70	8	Steel	Y
0	20	12	Steel	N

GENERAL REMARKS:
DRIVE SHOE BARBER. WELL LOCATIONS & CONSTRUCTION SUPERVISED BY KALA GROUND WATER.

LITHOLOGY INFORMATION:

```
From     0 to    17 Ft.  Dense SAND WITH GRAVEL   MOIST AT 12 FEET grey
From    17 to    39 Ft.  Dense SAND WITH GRAVEL   WET grey
From    39 to    60 Ft.   SAND WITH COARSE GRAVEL   HIGH PRODUCTION grey
From    60 to    70 Ft.   SAND WITH COARSE GRAVEL   HIGH PRODUCTION grey
```

- Return to Main
- Return to Search Options
- Return to Search Criteria



Blackwater Map

Legend

Transportation - Roads, Railroads, etc. (1:250,000)

- Road - Paved lanes 2 or More Divided
- Ferry Route
- Aerial Cableway
- Road (Gravel Undivided) - 1 Lane
- Road (Gravel Undivided) - 2 Lanes
- Road (Paved Undivided) - Not Elevated - 1 Lane
- Road (Paved Undivided) - Not Elevated - 2 Lanes
- Road - Paved lanes 3 or More Undivided
- Road (Unimproved)
- Road - Loose access Dry Weather
- Road (Winter Road)
- Road - Paved lanes 2 Undivided
- Road - Paved lanes 2 Undivided U C
- Road - Paved Divided access Non Standard
- Track - Cart or Tractor
- Causeway (Railway)
- Cut (Roadway)
- Trail
- Tunnel
- Bridge
- Rail Line - Narrow Gauge - Single Track
- Rail Line (Multiple Track)
- Rail Line (Single Track)
- Rail Line - Abandoned Track
- Cable - Telephone
- Line (Transmission) - Electrical
- Line (Transmission) - Electrical - Primary

0 6 12 km.

Scale: 1:430,603

Copyright/Disclaimer

Datum/Projection: NAD83, Albers Equal Area Conic

Key Map of British Columbia

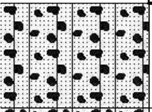
Appendix B

Test Pit, Borehole and Monitoring Well Logs

Test Pit ID: TP13-01 **Client: NewGold - Blackwater**

Project: Feasibility-Waste Water **Project Number: 13-019-02**

Location: On the L Trail, 30 m south of RIB

Depth Below Ground Surface	**Depth (ft)**	**Symbol**	**Lithology**
ft m			Ground Surface
ft: 0 1 2 m: 0	0-2'		Brown loam with sand and gravel (SP)
ft: 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 m: 1 2 3 4 5	2-19'		Brown, coarse sand and gravel, trace fines and some boulders. Unconsolidated and poorly sorted. Moist. (SW)
ft: 20 21 22 23 24 25 m: 6 7			

Coordinates: E 378348 **N 5894502**

Depth: 19 ft (5.8 m)

Elevation: 1396 masl

Logged By: Bryer Manwell

Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold

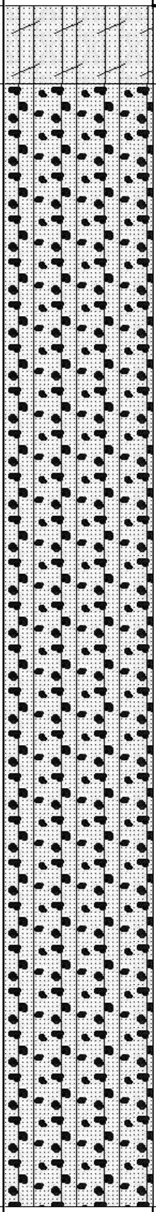
Excavation Method: Volvo EC 310

Date of Completion: July 8, 2013

Test Pit ID: TP13-02 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 90 m south southwest of RIB

western water
ASSOCIATES LTD

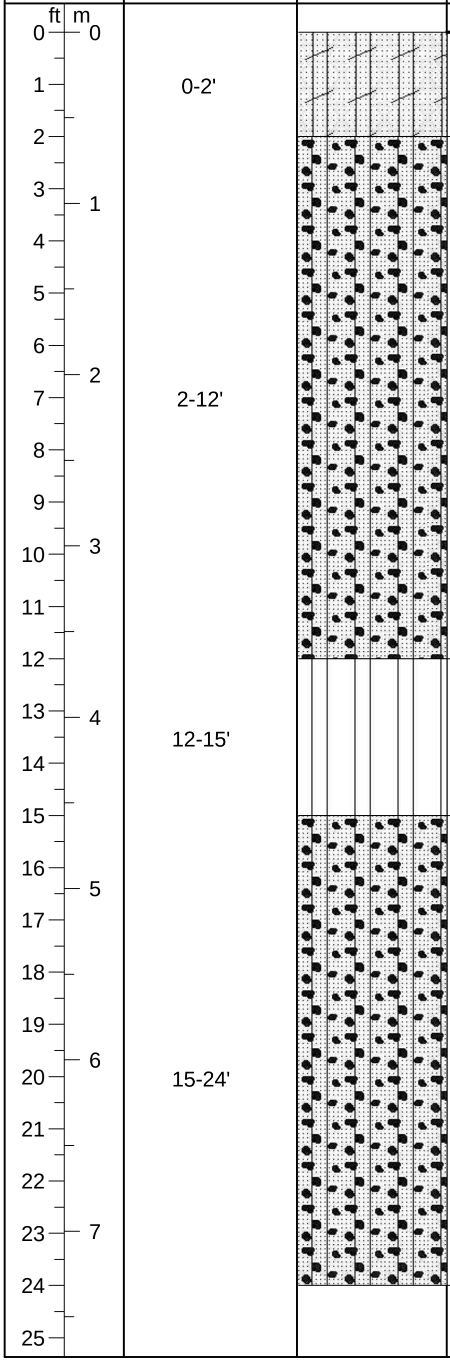
Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft m			Ground Surface
	0-1.5'		Brown Loam
	1.5-23'		Brown, lose sand and gravel. Trace silt; banding-alternating layers of pure clean sand and dirty sand. (SP)



Coordinates: E 378304 **N 5894457**
Depth: 23 ft (7 m)
Elevation: 1396 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TP13-03 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 100 m south of RIB



Depth (ft)	Lithology
	Ground Surface
0-2'	Loam silt, roots, brown loose (OL)
2-12'	Brown sand and gravel, somes fines with occassional boulder. Poorly sorted. (SW) Decent water flow at 11.5 ft (3.5 m) , 2 gal/min).
12-15'	Brown, silt seem. Moist. (ML)
15-24'	Sand and gravel with boulders and some fines (GM)

Coordinates: E 378347 N 5894436
Depth: 24 ft (7.3 m)
Elevation: 1401 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen Checked By: Bryer Manwell

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TP13-04 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 130 m south southwest of RIB

western water
ASSOCIATES LTD

Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft m			Ground Surface
0–2 ft	0-2'	▨	Brown sand and gravel. Loose and dry. (SW)
2–21 ft	2-21'	▩	Brown silt with sand and gravel; homogenous. (SW)
21–25 ft			

Coordinates: E 378305 **N 5894408**
Depth: 21 ft (6.4 m)
Elevation: 1404 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TW13-05 **Client: NewGold - Blackwater**

Project: Feasibility-Waste Water **Project Number: 13-019-02**

Location: On the L Trail, 170 m southwest of RIB

western water
ASSOCIATES LTD

Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft m 0 0			Ground Surface
1	0-1.5'	▨	Loam with roots. (SM)
2 3 1	1.5-4'	●	Gravel, boulders, silt and sand. (GM)
4 5	4-5'	●	Silty gravel with some sand; loose and moist. (GM)

Coordinates: E 378278 **N 5894371**

Depth: 4 ft (1.2 m)

Elevation: 1408 masl

Logged By: Bryer Manwell

Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold

Excavation Method: Volvo EC 310

Date of Completion: July 8, 2013

Test Pit ID: TP13-06 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 140 m southwest of RIB

Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft m			Ground Surface
	0-1.5'		Reddy Brown loam. Topsoil, with roots. (OL)
	1.5-4'		Brown gravel with sand and silty loam. (GM)
	4-6'		Silty
	6-17'		Sand and gravel with some silt (SM)
	17-18'		Silt layer (ML)
	18-23'		Brown Sand and gravel silt Loose with the silt being more dense. (SM)

Coordinates: E 378236 **N 5894448**
Excavator Contractor: NewGold
Depth: 23 ft (7 m)
Excavation Method: Volvo EC 310
Elevation: 1406 masl
Date of Completion: July 8, 2013
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Test Pit ID: TP13-07
Project: Feasibility-Waste Water
Location: On the L Trail, 160 m southwest of RIB

Client: NewGold - Blackwater
Project Number: 13-019-02

western water
ASSOCIATES LTD

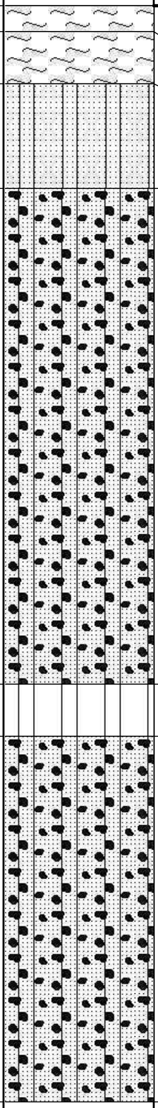
Depth Below Ground Surface (ft / m)	Depth (ft)	Symbol	Lithology
0 / 0			Ground Surface
0–1.5	0-1.5'		Brown loam with roots. (Topsoil) (OL)
1.5–3.5 (1 m)	1.5-3.5'		Brown and red silt. (ML)
3.5–14 (2, 3, 4 m)	3.5-14'		Sand and gravel with silt.
14–17 (5 m)	14-17'		Brown silt. Dense. (ML)
17–23 (6, 7 m)	17-23'		Sand and gravel with silt. (GM)
23–25			

Coordinates: E 378210 **N 5894433**
Depth: 23 ft (7 m)
Elevation: 1407 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TP13-08 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 165 m southwest of RIB

western water
ASSOCIATES LTD



Depth (ft)	Lithology
	Ground Surface
	Topsoil
0.5-1.5'	Grey white (illuvosol)
1.5-3.5'	Grey to Brown silt with sand and gravel (dense) (GM)
3.5-13'	Sand and gravel with silt. Loose. (SM)
13-14'	Brown and grey silt. Dense. (ML)
14-21'	Silt with sand and gravel, All dry. (SM)

Coordinates: E 378224 **N 5894390** **Excavator Contractor: NewGold**
Depth: 21 ft (6.4 m) **Excavation Method: Volvo EC 310**
Elevation: 1404 masl **Date of Completion: July 8, 2013**
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell** **Page 1 of 1**

Test Pit ID: TP13-09 **Client: NewGold - Blackwater**

Project: Feasibility-Waste Water **Project Number: 13-019-02**

Location: On the L Trail, 165 m southwest of RIB

Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft m			Ground Surface
0–0.75 ft	0-0.75'	▨	Mauve Topsoil.
0.75–1.5 ft	0.75-1.5'	▨	Reddy brown loam with fine sand. (ML)
1.5–9 ft	1.5-9'	▨	Brown fine sand with some silt. Dense and moist. (SM)
9–12 ft	9-12'	▨	Ground water seep.
12–18 ft	12-18'	▨	Silt with fine sand. (ML)
18–21 ft	18-21'	▨	fine sand with silt. (SM)

Coordinates: E 378261 **N 5894490**

Depth: 21 ft (6.4 m)

Elevation: 1401 masl

Logged By: Bryer Manwell

Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold

Excavation Method: Volvo EC 310

Date of Completion: July 8, 2013

Test Pit ID: TP13-10 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 90 m southwest of RIB

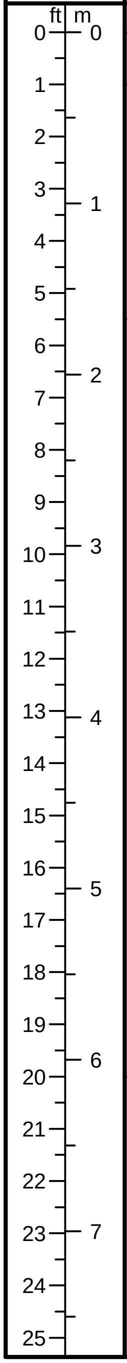
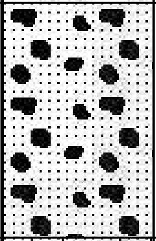
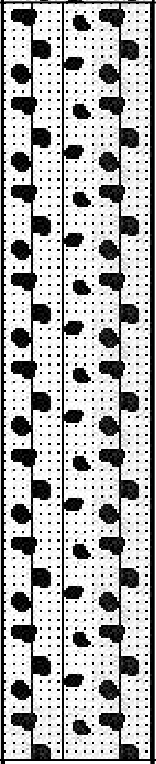
western water
ASSOCIATES LTD

Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft 0 / m 0			Ground Surface
	0-0.75'		Brown and grey topsoil with roots. Loose and dry. (OL)
	0.75-7'		Sand and gravel and silt (GM)
	7-13'		Sandy gravel with trace silt. Dry. (SP)
	13-18'		Silt. Largely dense and wet. (MH)
	18.5-20'		Gravel with coarse sand (GW)

Coordinates: E 378261 **N 5894495**
Depth: 20 ft (6.1 m)
Elevation: 1399 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TP13-11 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 60 m west southwest of RIB

Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
			Ground Surface
	0-1'		Red topsoil with roots (dry)
	1-5.5'		Gravel with sand. (GP)
	5.5-20'		Sand and gravel with trace silt (SW)

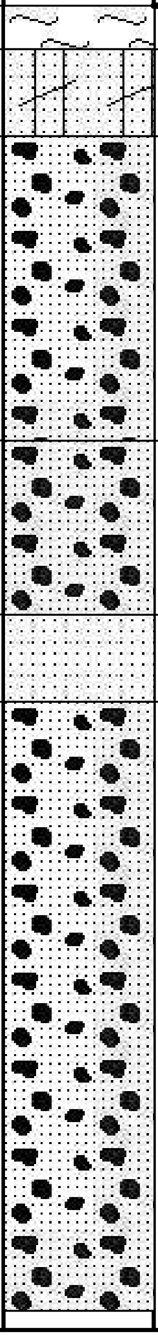
Coordinates: E 378294 **N 5894499**
Depth: 20 ft (6.1 m)
Elevation: 1406 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TP13-12
Project: Feasibility-Waste Water
Location: On the L Trail, 25 m of RIB

Client: NewGold - Blackwater
Project Number: 13-019-02

western water
ASSOCIATES LTD



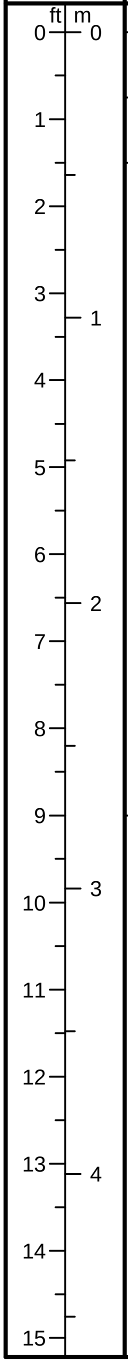
Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft m			Ground Surface
0 0	0-0.5'		Mauve, Thin Topsoil, with roots (OL)
1	0.5-1.5'		Reddy brown loam with fine sand. (ML)
2, 3, 4, 1	1.5-5'		Fine sand with gravel. Loose and dry. (SP)
5, 6, 2	5-7'		Sand and Gravel. (SW)
7	7-8'		Fine sand (SP)
8, 9, 10, 11, 12, 13, 14, 15, 3, 4	8-15'		Fine Sand and Gravel. Loose and dry. (SW)

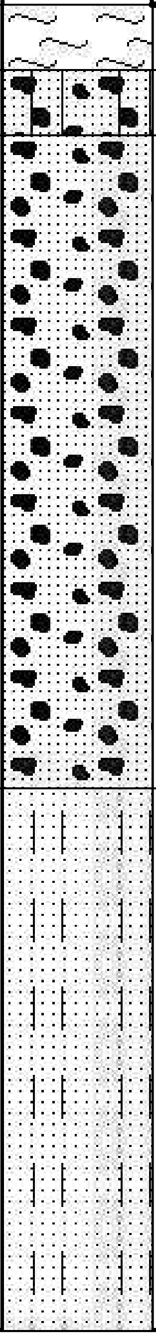
Coordinates: E 378327 N 5894561
Depth: 15 ft (4.6 m)
Elevation: 1399 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen Checked By: Bryer Manwell

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TP13-13 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 100 m west of RIB

western water
ASSOCIATES LTD





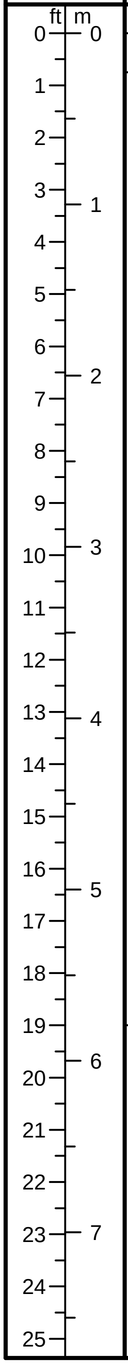
Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
			Ground Surface
	0-0.75'		Red, Brown loam with roots. (OL)
	0.75-1.5'		Silt with sand and gravel. (SM)
	1.5-9'		Sand and gravel with some fines. Loose and dry. (SP)
	9-21'		Coarse to fine sand with trace silt. (SM)

Coordinates: E 378233 N 5894557
Depth: 21 ft (6.4 m)
Elevation: 1395 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen Checked By: Bryer Manwell

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Test Pit ID: TP13-14
Project: Feasibility-Waste Water
Location: On the L Trail, 30 m north of RIB

Client: NewGold - Blackwater
Project Number: 13-019-02



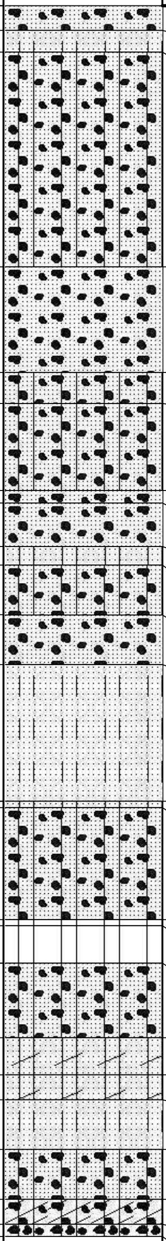
Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
			Ground Surface
	0-0.75'		Red, Brown loam with roots (OL)
	0.75-19'		Sand and gravel (clean). (GW)

Coordinates: E 378356 N 5894570
Depth: 19 ft (5.8 m)
Elevation: 1398 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen Checked By: Bryer Manwell

Excavator Contractor: NewGold
Excavation Method: Volvo EC 310
Date of Completion: July 8, 2013

Bore Hole ID: RIB-BH01 **Client: NewGold-Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: East on the L Trail, 68 m southwest of RIB.

western water
ASSOCIATES LTD



Depth (ft)	Lithology
	Ground Surface
0-2'	Brown coarse sand and gravel with some fines. Loose. Moist. (SW)
	Brown silt with gravel and some sand. Compact and dense. Moist. (GM)
3.75-21'	Grey silt with some gravel and sand. Loose. Dry. (GM)
21-29.5'	Brown coarse to medium sand and gravel with some boulders and trace fines. Loose. Moist. (GW)
29.5-32'	Brown sand and gravel with silt. Compact and dense. Moist. (SW)
32-39'	Brown sand and gravel with silt.Loose. Dry. (SW)
40-43.5'	Brown coarse sand with gravel lense. Dry. (SW)
	Brown sand silt and gravel. Loose. Wet. (SW)
45-49'	Brown silt with gravel and sand. Dense. Moist. (MH)
49-53'	Brown sand and gravel with silt (dirty). Loose. Moist. (GW)
	Brown course sand with trace fines and gravel. Loose. Moist. (SW)
53-64'	Brown silt to clay with medium to fine sand and some gravel. Dense. Moist. (ML)
	Brown silt. Compact confining unit. (ML)
64.5-73.5'	Fine to medium sand with some silt, gravel and cobbles. Loose. Dry. (SW)
74-77'	Brown silt lense. Compact. Dry. (ML)
	Brown silt lense. Compact. Dry. (ML)
77-83'	Brown fine silt with sand and gravel. Loose. (ML)
83-86'	Grey Brown coarse sand and silt. Dense. (SM)
	Grey silt with some fine sand and clay. Dense. Wet. (ML)
88-92'	Grey coarse sand with trace fines and gravel. Wet. (SM)
92-96'	Grey silt with sand and gravel. Loose. Wet. (ML)
96-98'	Grey Brown silt and clay. Very dense. Moist. (ML)
	Fine sand and silt with gravel. Dry. (SM)

Coordinates: E 378320 **N 5894472**
Depth: 99 ft (30.2 m)
Elevation: 1405 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

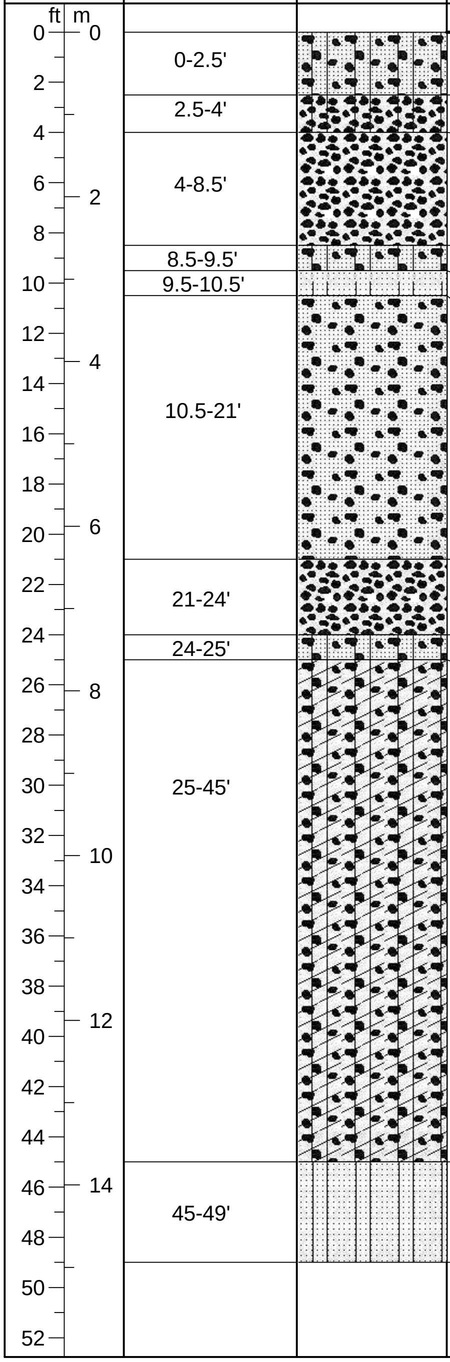
Drilling Contractor: Mudbay (Stephen McAllister)
Drilling Method: DB320-01 (Sonic Drilling)
Date of Completion: July 16, 2013

Bore Hole ID: RIB-BH02 **Client: NewGold - Blackwater**

Project: Feasibility-Waste Water **Project Number: 13-019-02**

Location: East On the L Trail, 64 m South of RIB

western water
ASSOCIATES LTD



Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
			Ground Surface
	0-2.5'		Brown silt with sand and trace gravel. Dry. (ML)
	2.5-4'		Brown silt with trace gravel and some clay. Moist. (ML)
	4-8.5'		Brown gravel with sand and silt. Moist. (GM)
	8.5-9.5'		Brown Silt with sand and gravel. (ML)
	9.5-10.5'		Brown fine sand and trace silt. Moist. (SM)
	10.5-21'		Brown medium to fine sand and gravel with some silt. (SM)
	21-24'		Coarse gravel and coarse sand with some silt. Wet. (GW)
	24-25'		Brown coarse sand and silt with some gravel. Wet. (SM)
	25-45'		Brown sand and gravel with silt. Moist (SW)
	45-49'		Brown sand and gravel with silt. Moist. (SW)

Coordinates: E 378331 **N 5894474**

Depth: 50 ft (15.2 m)

Elevation: 1401 masl

Logged By: Bryer Manwell

Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

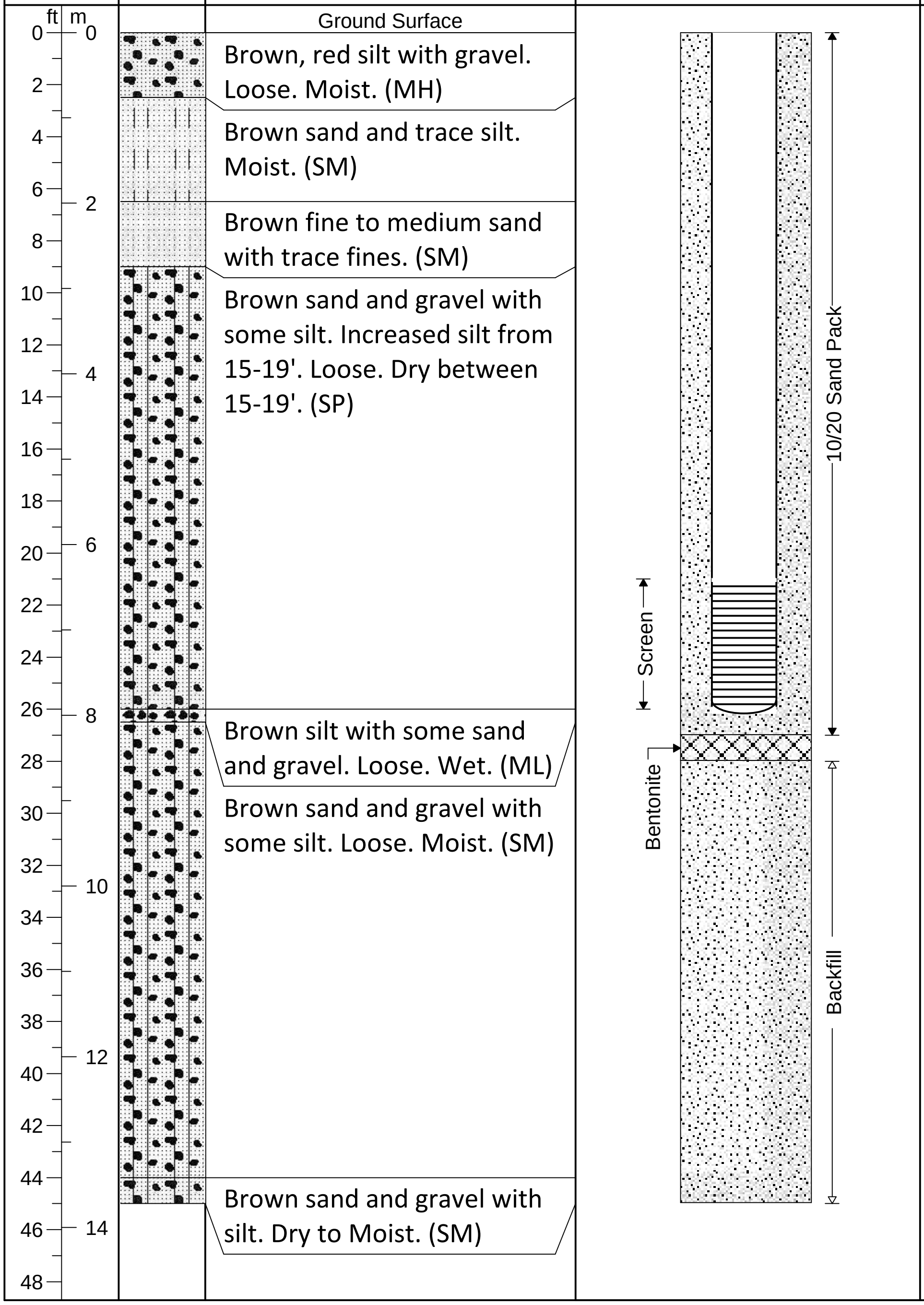
Drilling Contractor: Mudbay (Stephen McAllister)

Drilling Method: DB 320-01 (Sonic drilling)

Date of Completion: July 16, 2013

Bore Hole ID: RIB-BH13-03/ Temporary TMW-03
Project: Feasibility-Waste Water **Client: NewGold - Blackwater**
Location: On L Trail, 3 m North of RIB **Project Number: 13-019-02**

Depth Below Ground Surface	**Symbol**	**Lithology**	**Well Construction**	**Well Completion Details**



Brown, red silt with gravel. Loose. Moist. (MH)

Brown sand and trace silt. Moist. (SM)

Brown fine to medium sand with trace fines. (SM)

Brown sand and gravel with some silt. Increased silt from 15-19'. Loose. Dry between 15-19'. (SP)

Brown silt with some sand and gravel. Loose. Wet. (ML)

Brown sand and gravel with some silt. Loose. Moist. (SM)

Brown sand and gravel with silt. Dry to Moist. (SM)

Casing stick-up:
2.62 ft (0.80 m)

Static water level:
Dry thoughout.

10/20 Sand pack:
0-27 ft (0-8.2 m)

2' Schedule 40 PVC blank:
0-21ft (0-6.4 m)

10 Slot screen:
21-26 ft (6.4-7.9 m)

Bentonite seal:
27-28 ft (8.2-8.5 m)

Backfill:
28-45 ft (8.5-13.7 m)
With clean sand or natural material.

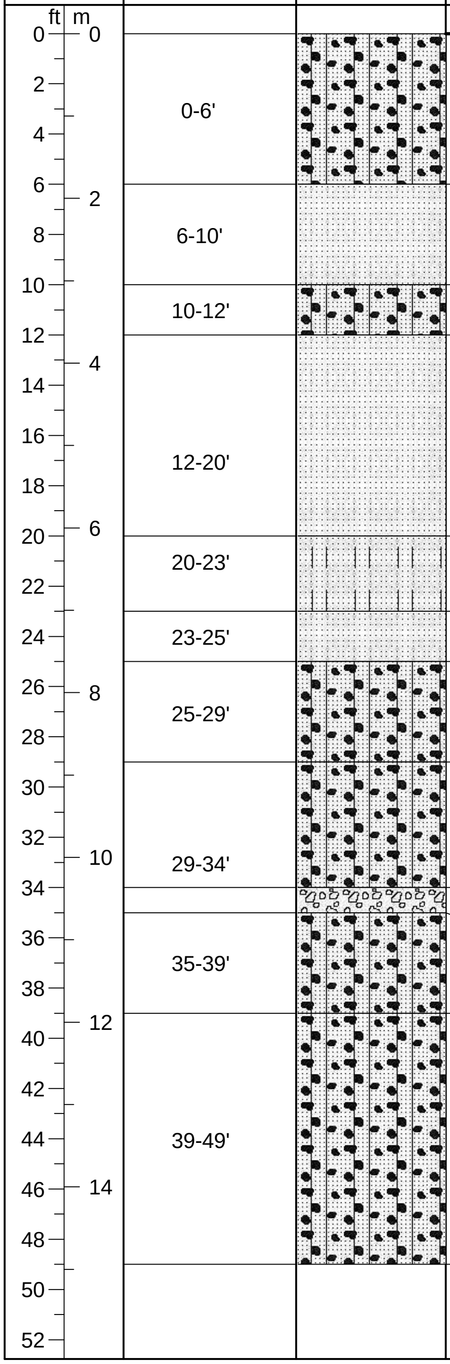
End of Hole:
Hole drilling to 45 ft (13.7 m)

Coordinates: E 378340 **N 5894537**
Static Water Level: Dry
Elevation: 1402 masl
Depth: 45 ft (13.7 m)
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Drilling Contractor: MudBay (Stephen McAllister)
Drilling Method: DB320-01 (Sonic Drilling)
Date of Completion: July 17, 2013
Logged By: Bryer Manwell

Bore Hole ID: RIB-BH04
Client: NewGold - Blackwater
Project: Feasibility-Waste Water
Project Number: 13-019-02
Location: On the L Trail, 46 m west of RIB

western water
ASSOCIATES LTD



Depth (ft)	Lithology
	Ground Surface
0-6'	Brown silt with sand and gravel. Dense. Moist. (ML)
6-10'	Brown medium sand. Clean. Moist. (SP)
10-12'	Brown silt sand and gravel. Moist. (ML)
12-20'	Brown medium to coarse sand. Clean. Loose. Moist. (SP)
20-23'	Brown fine sand and silt. Dense. Moist. (SM)
23-25'	Brown medium to coarse sand. Clean. Loose. Moist. (SP)
25-29'	Grey silt sand and gravel. Loose. Dry. (ML)
29-34'	Brown sand and gravel with some silt. Moist. (GM)
	Boulder
35-39'	Grey silt with sand and gravel. Boulder. Loose. Dry. (ML)
39-49'	Grey boulders with gravel silt and sand. (GW)

Coordinates: E 378299 N 5894515
Depth: 49 ft (14.9 m)
Elevation: 1397 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen Checked By: Bryer Manwell
Drilling Contractor: Mudbay (Stephen McAllister)
Drilling Method: DB 320-01 (Sonic Drilling)
Date of Completion: July 18, 2013

Bore Hole ID: RIB-BH05 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 74 m west of RIB

western water ASSOCIATES LTD

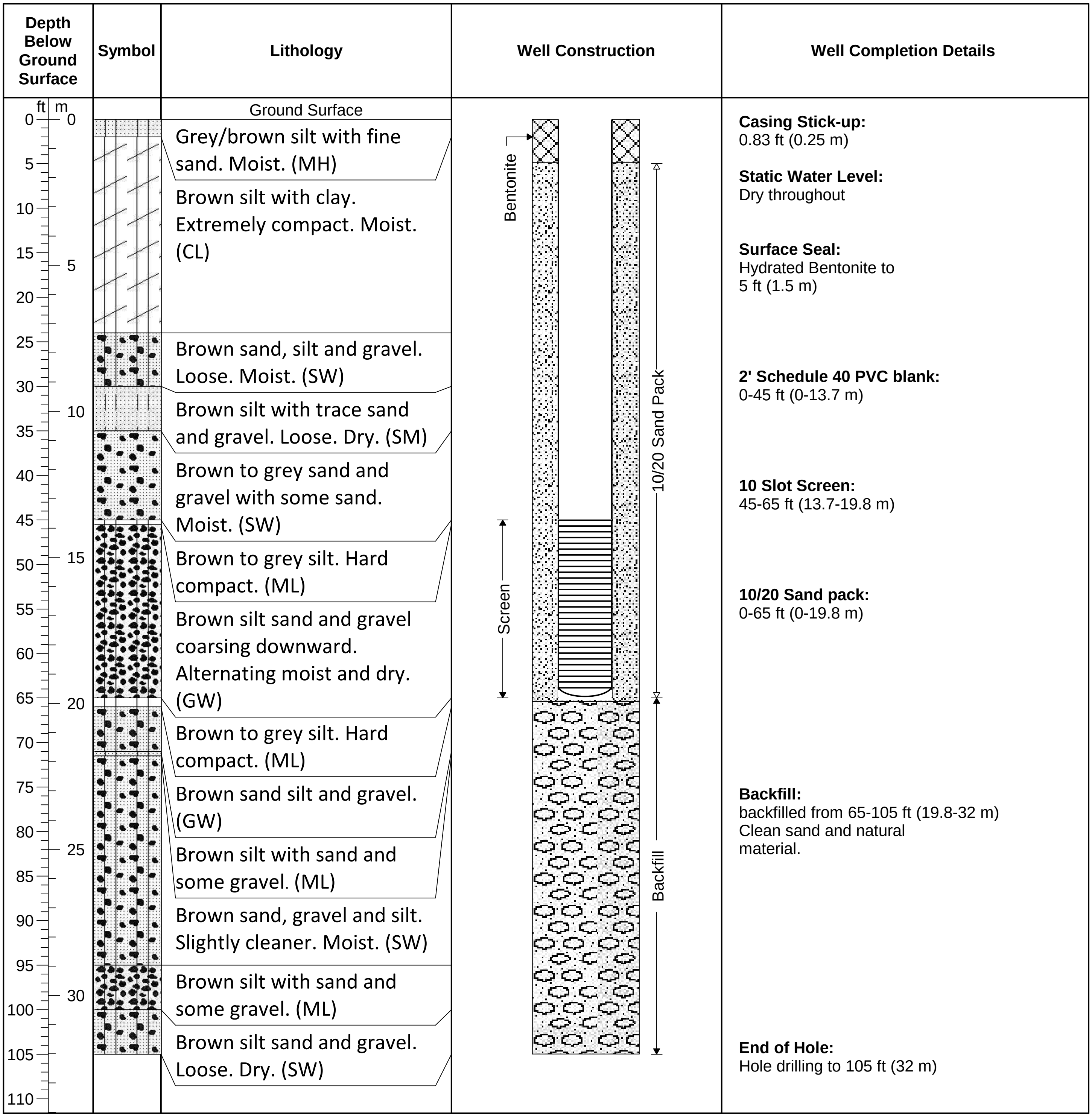
Depth Below Ground Surface	Depth (ft)	Symbol	Lithology
ft m			Ground Surface
	0-10'		Brown silt, sand and gravel. Compact. Moist. (ML)
	10-15'		Brown coarse sand and gravel with fines. Loose. Moist. (SM)
	15-18'		Grey silt and sand. Layers of compact and layers of loose. (ML)
	18-22'		Grey silt and sand.Compact. Dry (ML)
			Red boulder
	22.5-27'		Brown coarse sand and gravel with trace silt. Loose. Moist. (SW)
	27-31'		Grey silt with trace sand and gravel. Compact. Dry. (ML)
	31-37'		Brown medium to coarse sand with fines and gravel. Loose. Moist. (SM)
	37-40'		Gray silt with trace sand and gravel. Dry. (ML)
	40-45'		Grey silt with sand and gravel. Moist. (ML)
	45-49'		Grey sand silt and gravel. (SW)

Coordinates: E 378269 **N 5894517**
Depth: 49 ft (14.9 m)
Elevation: 1400 masl
Logged By: Bryer Manwell
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Drilling Contractor: Mudbay (Stephen McAllister)
Drilling Method: DB320-01 (Sonic Drilling)
Date of Completion: July 18, 2013

Monitoring Well ID: MW13-01 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On the L Trail, 353 m southwest, up gradient of RIB.

western water ASSOCIATES LTD



Lithology

- Grey/brown silt with fine sand. Moist. (MH)
- Brown silt with clay. Extremely compact. Moist. (CL)
- Brown sand, silt and gravel. Loose. Moist. (SW)
- Brown silt with trace sand and gravel. Loose. Dry. (SM)
- Brown to grey sand and gravel with some sand. Moist. (SW)
- Brown to grey silt. Hard compact. (ML)
- Brown silt sand and gravel coarsing downward. Alternating moist and dry. (GW)
- Brown to grey silt. Hard compact. (ML)
- Brown sand silt and gravel. (GW)
- Brown silt with sand and some gravel. (ML)
- Brown sand, gravel and silt. Slightly cleaner. Moist. (SW)
- Brown silt with sand and some gravel. (ML)
- Brown silt sand and gravel. Loose. Dry. (SW)

Well Completion Details

Casing Stick-up:
0.83 ft (0.25 m)

Static Water Level:
Dry throughout

Surface Seal:
Hydrated Bentonite to 5 ft (1.5 m)

2' Schedule 40 PVC blank:
0-45 ft (0-13.7 m)

10 Slot Screen:
45-65 ft (13.7-19.8 m)

10/20 Sand pack:
0-65 ft (0-19.8 m)

Backfill:
backfilled from 65-105 ft (19.8-32 m) Clean sand and natural material.

End of Hole:
Hole drilling to 105 ft (32 m)

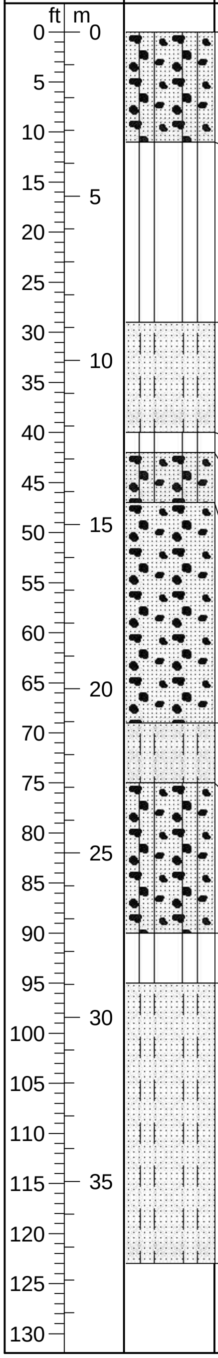
Coordinates: E 378036 **N 5894360**
Static Water Level: Dry
Elevation: 1408 masl
Depth: 65 ft (19.8 m)
Drawn By: Anthony Friesen **Checked By: Bryer Manwell**

Drilling Contractor: Mudbay (Stephen McAllister)
Drilling Method: DB320-01 (Sonic Drilling)
Date of Completion: July 17, 2013
Logged By: Bryer Manwell

Monitoring Well ID: MW13-02 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On L Trail, 448 m north and down gradient of RIB

western water ASSOCIATES LTD

Depth Below Ground Surface	Symbol	Lithology	Well Construction	Well Completion Details



Ground Surface

Brown silt with sand and some gravel. Dense. Moist. (ML)

Brown silt. Very Dense. (ML)

Brown sand with some silt and trace gravel. Loose. Moist. (SW)

Brown Silt . Dense. (ML)

Brown silt, sand and gravel. Loose. Moist. (ML)

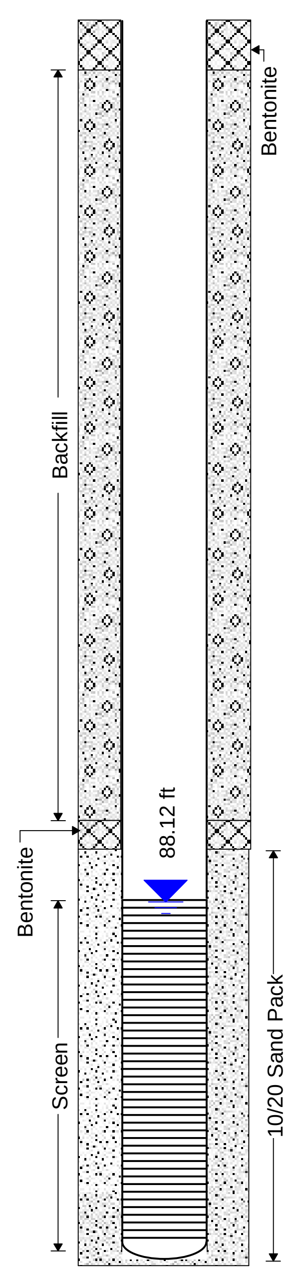
Brown sand, silt and gravel. Loose. Moist. (SW)

Brown sand with silt. Dense. Moist. (SM)

Brown sand with some silt and trace gravel. Loose. Moist. (SW)

Brown silt. Dense. (ML)

Brown fine sand with some silt. Wet. (SW)



Casing Stick-up:
2.3 ft (0.7 m)

Surface Seal:
Hydrated Bentonite to
5 ft (1.5 m)

Static Water Level:
88.1ft (26.8 m)

Backfill:
Backfilled from 5-80 ft (1.5-24.3 m)
Clean sand and natural
material.

2" PVC Blank Liner:
0-88 ft (0-26.8 m)

2" 10 Slot PVC Screen:
88-123 ft (26.8-37.5 m)

Bentonite Seal:
80-83 ft (24.3-25.3 m)

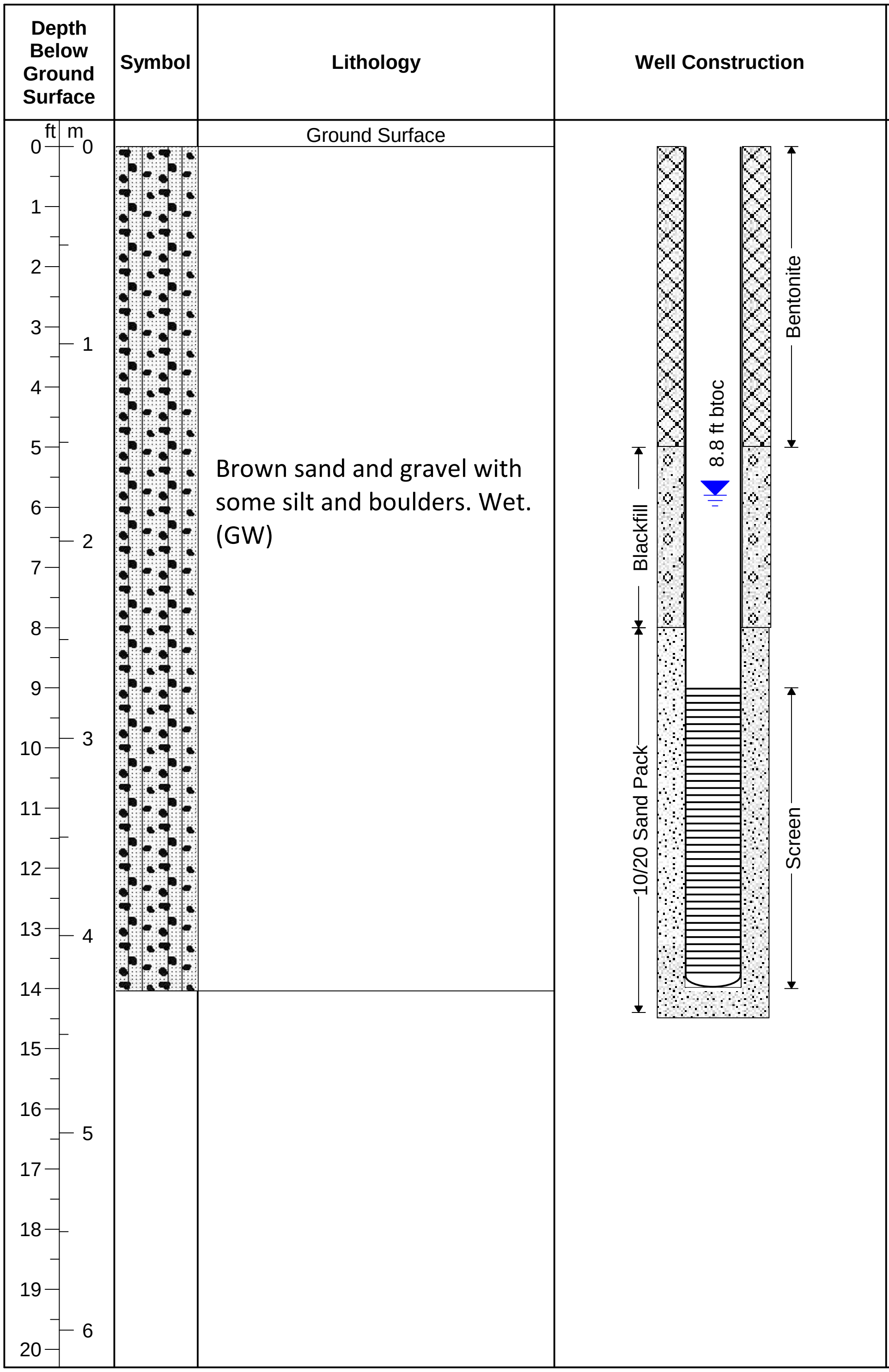
10/20 Sand pack:
83-123 ft (25.3-37.5 m)

End of Hole:
Hole drilling to 123 ft (37.5 m)

Coordinates: E 378375 N 5894701
Static Water Level: 88.1 ft (26.8 m) btoc
Elevation: 1330 masl
Depth: 123 ft (37.5 m)
Drawn By: Anthony Friesen Checked By: Bryer Manwell

Drilling Contractor: Mudbay (Stephen McAllister)
Drilling Method: DB320-01 (Sonic Drilling)
Date of Completion: July 19, 2013
Logged By: Bryer Manwell

Monitoring Well ID: MW13-03 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On L Trail, 720 m northwest downslope/cross gradient of RIB



Brown sand and gravel with some silt and boulders. Wet. (GW)

Well Completion Details

Casing Stick-up:
2.62 ft (0.80 m)

Surface Seal:
Hydrated Bentonite to
5 ft (1.52 m)

Static Water Level:
8.8 ft (2.7 m) btoc

Backfill:
5-8 ft (1.5-2.4 m)
With clean sand or natural
material.

2' Schedule 40 PVC Blank:
0-9 ft (0-2.7 m)

10 Slot Screen:
9-14 ft (2.7-4.2 m)

10/20 Sand pack:
8-14 ft (2.4-4.3 m)

End of Hole:
Hole drilling to 14 ft (4.3 m)

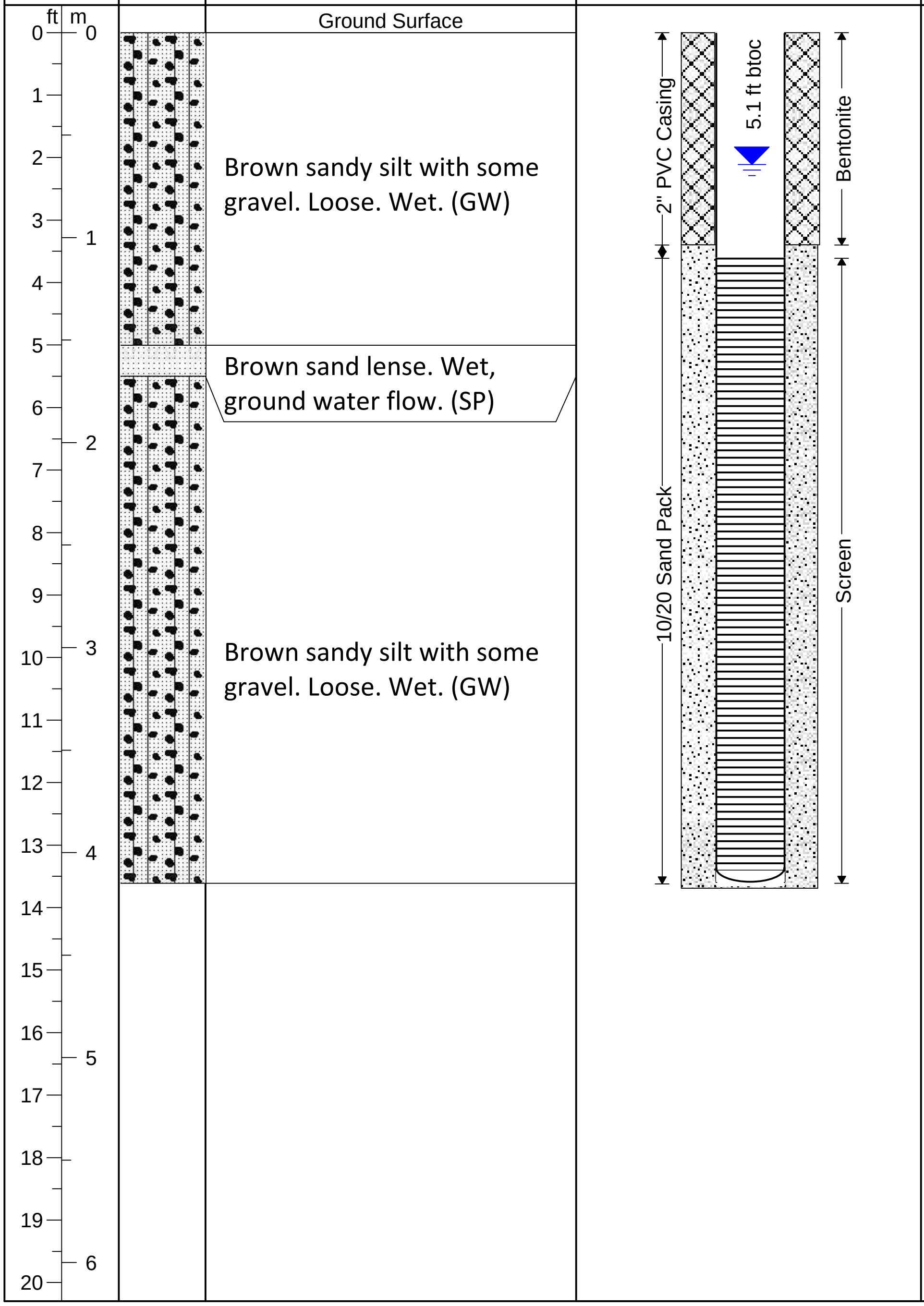
Coordinates: E 377789 N 5894999
Static Water Level: 8.8 ft (2.7 m) btoc
Elevation: 1311 masl
Depth: 14 ft (4.3 m)
Drawn By: Anthony Friesen Checked By: Bryer Manwell

Drilling Contractor: Mudbay (Stephen McAllister)
Drilling Method: DB320-01 (Sonic Drilling)
Date of Completion: July 21, 2013
Logged By: Bryer Manwell

Monitoring Well ID: MW13-04 **Client: NewGold - Blackwater**
Project: Feasibility-Waste Water **Project Number: 13-019-02**
Location: On L Trail, in wetlands 900 m north, down gradient of RIB

western water ASSOCIATES LTD

Depth Below Ground Surface | **Symbol** | **Lithology** | **Well Construction** | **Well Completion Details**



Brown sandy silt with some gravel. Loose. Wet. (GW)

Brown sand lense. Wet, ground water flow. (SP)

Brown sandy silt with some gravel. Loose. Wet. (GW)

Casing Stick-up:
2.72 ft (0.83 m)

Static Water Level:
5.1 ft (1.6 m) btoc

Surface Seal:
Hydrated Bentonite to
3 ft (1.0 m)

2' Schedule 40 PVC blank:
0-3.6 ft (0-1.1 m)

10 Slot screen:
3.6-13.6 ft (1.1-4.1 m)

10/20 Sand pack:
3-13.6 ft (1-4.1 m)

End of hole:
Hole drilling to 13.6 ft (4.1 m)

Coordinates: E 378535 N 5895406
Static Water Level: 5.11 ft (1.6 m) btoc
Elevation: 1279 masl
Depth: 13.6 ft (4.1 m)
Drawn By: Anthony Friesen Checked By: Bryer Manwell

Drilling Contractor: Mudbay (Stephen McAllister)
Drilling Method: DB320-01 (Sonic Drilling)
Date of Completion: July 20, 2013
Logged By: Bryer Manwell

Appendix C

Calculation of Hydraulic Conductivity

Data Set: E:\MW13-02 Final K values.aqt
Date: 08/29/13
Time: 07:42:54

PROJECT INFORMATION

Company: WWAL
Client: NewGold
Project: 13-019-02
Location: Blackwater
Test Date: 21-July-13
Test Well: MW13-02 pumping test

AQUIFER DATA

Saturated Thickness: 12. m
Anisotropy Ratio (Kz/Kr): 1.

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: MW13-02

X Location: 0. m
Y Location: 0. m

Casing Radius: 0.025 m
Well Radius: 0.025 m

Fully Penetrating Well

No. of pumping periods: 261

Pumping Period Data

Time (min)	Rate (gal/min)	Time (min)	Rate (gal/min)
1.	0.3521	132.	0.
2.	0.3521	133.	0.
3.	0.3521	134.	0.
4.	0.3521	135.	0.
5.	0.3521	136.	0.
6.	0.3521	137.	0.
7.	0.3521	138.	0.
8.	0.3521	139.	0.
9.	0.3521	140.	0.
10.	0.3521	141.	0.
11.	0.3521	142.	0.
12.	0.3521	143.	0.
13.	0.3521	144.	0.
14.	0.3521	145.	0.
15.	0.3521	146.	0.
16.	0.3521	147.	0.
17.	0.3521	148.	0.
18.	0.3521	149.	0.

Time (min)	Rate (gal/min)	Time (min)	Rate (gal/min)
19.	0.3521	150.	0.
20.	0.3521	151.	0.
21.	0.3521	152.	0.
22.	0.3521	153.	0.
23.	0.3521	154.	0.
24.	0.3521	155.	0.
25.	0.3521	156.	0.
26.	0.3521	157.	0.
27.	0.3521	158.	0.
28.	0.3521	159.	0.
29.	0.3521	160.	0.
30.	0.3521	161.	0.
31.	0.3521	162.	0.
32.	0.3521	163.	0.
33.	0.3521	164.	0.
34.	0.3521	165.	0.
35.	0.3521	166.	0.
36.	0.3521	167.	0.
37.	0.3521	168.	0.
38.	0.3521	169.	0.
39.	0.3521	170.	0.
40.	0.3521	171.	0.
41.	0.3521	172.	0.
42.	0.3521	173.	0.
43.	0.3521	174.	0.
44.	0.3521	175.	0.
45.	0.3521	176.	0.
46.	0.3521	177.	0.
47.	0.3521	178.	0.
48.	0.3521	179.	0.
49.	0.3521	180.	0.
50.	0.3521	181.	0.
51.	0.3521	182.	0.
52.	0.3521	183.	0.
53.	0.3521	184.	0.
54.	0.3521	185.	0.
55.	0.3521	186.	0.
56.	0.3521	187.	0.
57.	0.3521	188.	0.
58.	0.3521	189.	0.
59.	0.3521	190.	0.
60.	0.3521	191.	0.
61.	0.3521	192.	0.
62.	0.3521	193.	0.
63.	0.3521	194.	0.
64.	0.3521	195.	0.
65.	0.3521	196.	0.
66.	0.3521	197.	0.
67.	0.3521	198.	0.
68.	0.3521	199.	0.
69.	0.3521	200.	0.
70.	0.3521	201.	0.
71.	0.3521	202.	0.

Time (min)	Rate (gal/min)	Time (min)	Rate (gal/min)
72.	0.3521	203.	0.
73.	0.3521	204.	0.
74.	0.3521	205.	0.
75.	0.3521	206.	0.
76.	0.3521	207.	0.
77.	0.3521	208.	0.
78.	0.3521	209.	0.
79.	0.3521	210.	0.
80.	0.3521	211.	0.
81.	0.3521	212.	0.
82.	0.3521	213.	0.
83.	0.3521	214.	0.
84.	0.3521	215.	0.
85.	0.3521	216.	0.
86.	0.3521	217.	0.
87.	0.3521	218.	0.
88.	0.	219.	0.
89.	0.	220.	0.
90.	0.	221.	0.
91.	0.	222.	0.
92.	0.	223.	0.
93.	0.	224.	0.
94.	0.	225.	0.
95.	0.	226.	0.
96.	0.	227.	0.
97.	0.	228.	0.
98.	0.	229.	0.
99.	0.	230.	0.
100.	0.	231.	0.
101.	0.	232.	0.
102.	0.	233.	0.
103.	0.	234.	0.
104.	0.	235.	0.
105.	0.	236.	0.
106.	0.	237.	0.
107.	0.	238.	0.
108.	0.	239.	0.
109.	0.	240.	0.
110.	0.	241.	0.
111.	0.	242.	0.
112.	0.	243.	0.
113.	0.	244.	0.
114.	0.	245.	0.
115.	0.	246.	0.
116.	0.	247.	0.
117.	0.	248.	0.
118.	0.	249.	0.
119.	0.	250.	0.
120.	0.	251.	0.
121.	0.	252.	0.
122.	0.	253.	0.
123.	0.	254.	0.
124.	0.	255.	0.

Time (min)	Rate (gal/min)	Time (min)	Rate (gal/min)
125.	0.	256.	0.
126.	0.	257.	0.
127.	0.	258.	0.
128.	0.	259.	0.
129.	0.	260.	0.
130.	0.	261.	0.
131.	0.		

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: MW13-02

X Location: 0. m
Y Location: 0. m

Radial distance from MW13-02: 0. m

Piezometer
Piezometer Depth: 0. m

No. of Observations: 261

Observation Data

Time (min)	Displacement (m)	Time (min)	Displacement (m)
1.	0.	132.	0.094
2.	0.016	133.	0.093
3.	0.041	134.	0.092
4.	0.056	135.	0.092
5.	0.071	136.	0.091
6.	0.084	137.	0.089
7.	0.097	138.	0.09
8.	0.11	139.	0.089
9.	0.123	140.	0.088
10.	0.137	141.	0.088
11.	0.151	142.	0.088
12.	0.166	143.	0.086
13.	0.18	144.	0.085
14.	0.193	145.	0.085
15.	0.207	146.	0.085
16.	0.22	147.	0.084
17.	0.233	148.	0.083
18.	0.197	149.	0.083
19.	0.211	150.	0.083
20.	0.209	151.	0.083
21.	0.225	152.	0.082
22.	0.243	153.	0.082
23.	0.261	154.	0.081
24.	0.275	155.	0.081
25.	0.29	156.	0.081
26.	0.304	157.	0.08
27.	0.318	158.	0.08

Time (min)	Displacement (m)	Time (min)	Displacement (m)
28.	0.333	159.	0.08
29.	0.347	160.	0.079
30.	0.361	161.	0.079
31.	0.373	162.	0.079
32.	0.383	163.	0.079
33.	0.391	164.	0.078
34.	0.397	165.	0.079
35.	0.406	166.	0.078
36.	0.411	167.	0.078
37.	0.417	168.	0.078
38.	0.422	169.	0.078
39.	0.428	170.	0.077
40.	0.433	171.	0.077
41.	0.437	172.	0.076
42.	0.442	173.	0.076
43.	0.445	174.	0.076
44.	0.448	175.	0.076
45.	0.45	176.	0.075
46.	0.453	177.	0.076
47.	0.457	178.	0.075
48.	0.461	179.	0.075
49.	0.462	180.	0.075
50.	0.466	181.	0.075
51.	0.471	182.	0.075
52.	0.474	183.	0.074
53.	0.481	184.	0.073
54.	0.484	185.	0.074
55.	0.487	186.	0.074
56.	0.491	187.	0.074
57.	0.495	188.	0.074
58.	0.5	189.	0.073
59.	0.505	190.	0.074
60.	0.508	191.	0.074
61.	0.512	192.	0.073
62.	0.516	193.	0.073
63.	0.518	194.	0.073
64.	0.521	195.	0.073
65.	0.523	196.	0.072
66.	0.526	197.	0.073
67.	0.53	198.	0.073
68.	0.533	199.	0.072
69.	0.534	200.	0.072
70.	0.536	201.	0.073
71.	0.539	202.	0.073
72.	0.542	203.	0.074
73.	0.545	204.	0.072
74.	0.547	205.	0.073
75.	0.547	206.	0.072
76.	0.548	207.	0.072
77.	0.551	208.	0.072
78.	0.552	209.	0.072
79.	0.554	210.	0.072
80.	0.554	211.	0.071

Time (min)	Displacement (m)	Time (min)	Displacement (m)
81.	0.558	212.	0.071
82.	0.563	213.	0.071
83.	0.566	214.	0.071
84.	0.566	215.	0.07
85.	0.569	216.	0.071
86.	0.572	217.	0.07
87.	0.573	218.	0.07
88.	0.477	219.	0.07
89.	0.413	220.	0.069
90.	0.371	221.	0.07
91.	0.336	222.	0.071
92.	0.305	223.	0.072
93.	0.282	224.	0.071
94.	0.262	225.	0.07
95.	0.245	226.	0.07
96.	0.231	227.	0.071
97.	0.218	228.	0.071
98.	0.207	229.	0.071
99.	0.197	230.	0.07
100.	0.188	231.	0.07
101.	0.18	232.	0.07
102.	0.172	233.	0.07
103.	0.166	234.	0.07
104.	0.16	235.	0.07
105.	0.156	236.	0.07
106.	0.152	237.	0.07
107.	0.147	238.	0.071
108.	0.142	239.	0.07
109.	0.138	240.	0.071
110.	0.135	241.	0.07
111.	0.132	242.	0.071
112.	0.129	243.	0.071
113.	0.126	244.	0.071
114.	0.123	245.	0.071
115.	0.121	246.	0.071
116.	0.119	247.	0.071
117.	0.116	248.	0.07
118.	0.114	249.	0.07
119.	0.112	250.	0.07
120.	0.109	251.	0.07
121.	0.108	252.	0.07
122.	0.107	253.	0.069
123.	0.104	254.	0.07
124.	0.103	255.	0.07
125.	0.102	256.	0.07
126.	0.101	257.	0.07
127.	0.099	258.	0.069
128.	0.099	259.	0.069
129.	0.098	260.	0.069
130.	0.096	261.	0.069
131.	0.095		

SOLUTION

Pumping Test
Aquifer Model: Unconfined
Solution Method: Cooper-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	0.1221	cm^2/sec
S	8.117E-5	

K = T/b = 0.0001018 cm/sec
Ss = S/b = 6.764E-6 1/m

MW13-03 K-Value calculations using Bouwer Rice Slug-Test Method

Equation Used $K=(r^2((\ln R_e/R)/2L_e)*(1/t)*(\ln(H_o/H_t))$

All of these variable are the same for all tests	r=radius of well casing (m)
	R=radius of the sreen
	Re=effective radius of the of which the head is dissipated (m)
	Le= length of screen (m)
	t= time in seconds of measurement of Ht
	Ho=initial draw down (m)
	Ht=drawdraw at t (m)

Common Variables	
rc	0.025
Re	0.5
R	0.025
Le	1.524
1/t	0.2
Slug-Test 1	
Ho	2.966
Ht	2.929
K (m/sec)	1.50E-06
Slug Test 2	
Ho	2.961
Ht	2.922
K (m/sec)	1.60E-06
Test 3	
Ho	2.954
Ht	2.915
K (m/sec)	1.60E-06

Bower Rice slug-Test Excel Calculations

Variables	Values	Answer
rc	0.025	1.63E-06 m/sec
Re	0.5	
R	0.025	
Le	1.524	
Ho	2.954	
Ht	2.915	
1/t	0.2	

MW13-03/MW13-04 K-Value calculations using Bouwer Rice Slug-Test Method

Equation Used $K=(r^2((\mathrm{ln}R_e/R)/2L_e)*(1/t)*(\mathrm{ln}(H_o/H_t))$

All of these variable are the same for all MW13-03	r=radius of well casing (m)
	R=radius of the sreen
	Re=effective radius of the of which the head is dissipated (m)
	Le= length of screen (m)
	t= time in seconds of measurement of Ht
	Ho=initial draw down (m)
	Ht=drawdraw at t (m)

Common Variables for test 1-3	
rc	0.025
Re	0.5
R	0.025
Le	1.524
1/t	0.2
Slug-Test 1	
Ho	2.966
Ht	2.929
K (m/sec)	**1.50E-06**
Slug Test 2	
Ho	2.961
Ht	2.922
K (m/sec)	**1.60E-06**
Test 3	
Ho	2.954
Ht	2.915
K (m/sec)	**1.60E-06**

Variables for MW13-04	
rc	0.025
Re	0.5
R	0.025
Le	3
1/t	0.0057471
Ho	2.01
Ht	1.69
K (m/sec)	**8.30E-06**

slug-Test Excel Calculatior

Variables	Values
rc	0.025
Re	0.5
R	0.05
Le	3
Ho	2.01
Ht	1.69
1/t	0.0057471

Answer
8.32E-06 m/sec

Appendix D

Site Plan Drawings (to come from ODK)

Appendix E

Water Quality Reports

Blackwater

Water Quality Results

				Sampling Location	RIB MW13-02	RIB MW13-03	RIB MW13-04	RIB SW-01	RIB SW-02
				Date Sampled	21-Jul-13	21-Jul-13	21-Jul-13	21-Jul-13	21-Jul-13
				Lab ID	3071518-01	3071518-02	3071518-03	3071518-04	3071518-05
				Sample Type					
Analyte	**Unit**	**Guideline**							
		BCAWQG AL	**GCDWQ MAC**	**GCDWQ AO**					
Lab Results									
General									
Alkalinity (total, as CaCO3)	mg/L	NG	NG	NG	54	36	38	8	22
Biochemical oxygen demand	mg/L	NG	NG	NG	<10	<10	<10	<10	<10
Chloride	mg/L	600[1.13]	NG	250	0.39	0.63	0.71	<0.10	0.64
Colour	CU	N[1.14]	NG	15	<5	**48**	**150**	**54**	**42**
Conductivity	µS/cm	NG	NG	NG	118	72	163	25	51
Cyanide (total)	mg/L	NG	0.2[2.1]	NG					
Fluoride	mg/L	Calc[1.15]	1.5	NG	0.16	<0.10	<0.10	<0.10	<0.10
Hardness, total (dissolved as CaCO3)	mg/L	NG	NG	NG	48.9	32.2	82.4	9.3	18.7
Hardness, Total (total as CaCO3)	mg/L	NG	NG	NG	51.2	37.6	123	8.6	18
pH		N[1.16]	NG	6.5 - 8.5	7.87	6.83	7.1	7.06	7.46
Sulphate	mg/L	Calc[1.17]	NG	500[3.3]	4	1.7	33.8	<1.0	1.7
Total dissolved solids	mg/L	NG	NG	500	160	220	142	27	42
Total organic carbon	mg/L	N[1.18]	NG	NG	<0.5	14.9	26.2	15.3	10.8
Total suspended solids	mg/L	N[1.19]	NG	NG	46	3820	101	<1	<1
Turbidity	NTU	N[1.20]	N[2.2]	NG	21.7	>4000	287	0.7	0.9
UV transmittance at 254 nm	%	NG	NG	NG	98.3	69.4	25.7	43.5	53.3
Microbiological									
Background Bacteria	CFU/100 mL	NG	NG	NG	>200	>200		>200	>200
E. coli (counts)	CFU/100 mL	N[1.21]	0[2.3]	NG	<1	<1		<1	<1
E. coli (MPN / PA)	MPN/100 mL	N[1.22]	0[2.4]	NG			<3.0		
Fecal coliforms (counts)	CFU/100 mL	N[1.23]	0[2.5]	NG	<1	<1		<1	<1
Fecal coliforms (MPN / PA)	MPN/100 mL	N[1.24]	0[2.6]	NG			<3.0		
Total coliforms (counts)	CFU/100 mL	NG	0[2.7]	NG	**>63**	**2400**		**370**	**190**
Total coliforms (MPN / PA)	MPN/100 mL	NG	0[2.8]	NG			**46000**		
Nutrients									
Ammonia (total, as N)	mg/L	Calc[1.25]	NG	NG	0.037	0.7	0.329	<0.020	0.02
Nitrate (as N)	mg/L	32.8[1.26]	10	NG	0.07	0.03	<0.010	0.017	<0.010
Nitrate + Nitrite (as N) (calculated)	mg/L	32.8[1.27]	10[2.9]	NG	0.07	0.03	<0.014	0.017	<0.014
Nitrite (as N)	mg/L	Calc[1.28]	1	NG	<0.010	<0.010	<0.010	<0.010	<0.010
Orthophosphate (dissolved, as P)	mg/L	NG	NG	NG	<0.01	0.04	<0.01	<0.01	<0.01
Phosphorus (dissolved, by ICPMS/ICPOES)	mg/L	N[1.29]	NG	NG	<0.2	<0.2	<0.2	<0.2	<0.2
Phosphorus (total, by ICPMS/ICPOES)	mg/L	N[1.30]	NG	NG	<0.2	0.2	0.6	<0.2	<0.2
Phosphorus (dissolved, APHA 4500-P)	mg/L	N[1.31]	NG	NG	<0.01	0.07	0.08	0.03	0.03
Potassium (dissolved)	mg/L	NG	NG	NG	0.6	1.8	2.7	<0.2	<0.2
Potassium (total)	mg/L	NG	NG	NG	0.8	1.6	3.3	<0.2	<0.2
Dissolved Metals									
Aluminum (dissolved)	mg/L	Calc[1.1]	NG	N[3.1]	0.08	5.83	12	0.11	0.12
Antimony (dissolved)	mg/L	NG	0.006	NG	0.001	0.001	0.001	<0.001	<0.001
Arsenic (dissolved)	mg/L	0.005[1.2]	0.01	NG	<0.005	0.006	0.009	<0.005	<0.005
Barium (dissolved)	mg/L	NG	1	NG	<0.05	<0.05	0.13	<0.05	<0.05
Beryllium (dissolved)	mg/L	NG	NG	NG	<0.001	<0.001	<0.001	<0.001	<0.001
Bismuth (dissolved)	mg/L	NG	NG	NG	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (dissolved)	mg/L	1.2[1.3]	5	NG	<0.04	<0.04	<0.04	<0.04	<0.04
Cadmium (dissolved)	mg/L	NG	0.005	NG	<0.0001	<0.0001	0.0002	<0.0001	<0.0001
Calcium (dissolved)	mg/L	NG	NG	NG	14	9	22	3	5
Chromium (dissolved)	mg/L	NG	0.05	NG	<0.005	0.005	0.009	<0.005	<0.005
Cobalt (dissolved)	mg/L	0.110[1.4]	NG	NG	<0.0005	0.0012	0.0066	<0.0005	<0.0005
Copper (dissolved)	mg/L	Calc[1.5]	NG	1	<0.002	0.002	0.01	<0.002	<0.002
Iron (dissolved)	mg/L	0.35	NG	0.3	<0.1	**3**	**8.6**	0.2	<0.1
Lead (dissolved)	mg/L	Calc[1.6]	0.01	NG	<0.001	0.005	0.006	<0.001	<0.001
Lithium (dissolved)	mg/L	NG	NG	NG	<0.001	0.002	0.004	<0.001	<0.001
Magnesium (dissolved)	mg/L	NG	NG	NG	3.3	2.6	6.9	0.7	1.3
Manganese (dissolved)	mg/L	Calc[1.7]	NG	0.05	**0.076**	**0.113**	**0.678**	0.007	0.003
Mercury (dissolved)	mg/L	0.000020[1.8]	0.001	NG	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum (dissolved)	mg/L	2[1.9]	NG	NG	0.002	<0.001	<0.001	<0.001	<0.001
Nickel (dissolved)	mg/L	NG	NG	NG	<0.002	0.004	0.018	<0.002	<0.002
Selenium (dissolved)	mg/L	0.0020[1.10]	0.01	NG	<0.005	<0.005	<0.005	<0.005	<0.005
Silicon (dissolved, as Si)	mg/L	NG	NG	NG	6	16	28	<5	5
Silver (dissolved)	mg/L	Calc[1.11]	NG	NG	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Sodium (dissolved)	mg/L	NG	NG	200[3.2]	4.2	3.5	4.6	1.3	2.9
Strontium (dissolved)	mg/L	NG	NG	NG	0.06	0.07	0.11	0.02	0.04
Sulphur (dissolved)	mg/L	NG	NG	NG	<10	<10	<10	<10	<10
Tellurium (dissolved)	mg/L	NG	NG	NG	<0.002	<0.002	<0.002	<0.002	<0.002
Thallium (dissolved)	mg/L	NG	NG	NG	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Thorium (dissolved)	mg/L	NG	NG	NG	<0.001	<0.001	<0.001	<0.001	<0.001
Tin (dissolved)	mg/L	NG	NG	NG	<0.002	<0.002	<0.002	<0.002	<0.002
Titanium (dissolved)	mg/L	NG	NG	NG	<0.05	0.19	0.45	<0.05	<0.05
Uranium (dissolved)	mg/L	NG	0.02	NG	0.0003	0.0016	0.0012	<0.0002	<0.0002
Vanadium (dissolved)	mg/L	NG	NG	NG	<0.01	<0.01	0.02	<0.01	<0.01
Zinc (dissolved)	mg/L	Calc[1.12]	NG	5	<0.04	0.05	0.04	<0.04	<0.04
Zirconium (dissolved)	mg/L	NG	NG	NG	<0.001	0.006	0.018	<0.001	<0.001

Legend for Reports for Blackwater Water Quality Results

<	Less than reported detection limit
>	Greater than reported upper detection limit
A	Absent
BCAWQG AL	BC Approved Water Quality Guidelines for freshwater aquatic life
Calc	Calculated guideline or standard. The guideline or standard is dependent on the value of one or more other analytes, and is calculated from a formula or table.
GCDWQ AO	Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives
GCDWQ MAC	Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations
L	Laboratory reading type (Lab result)
m asl	metres above sea level
N	Narrative type of guideline or standard, or Result Note.
ND	Non-detect. Result is less than lower detection limit.
NG	No Guideline
NR	No Result
NS	No Standard
NT	Not Tested
OG	Overgrown
P	Present
PR	Presumptive
TK	Test kit reading type (Field result)
TNTC	Too numerous to count
▨	Highlighted value has a reported detection limit that is greater than the guideline or standard maximum.
BCAWQG AL	Highlighted value exceeds BCAWQG AL
GCDWQ AO	Highlighted value exceeds GCDWQ AO
GCDWQ MAC	Highlighted value exceeds GCDWQ MAC

Guideline Notes for Reports for Blackwater Water Quality Results

1. Notes for BC Approved Water Quality Guidelines for freshwater aquatic life (BCAWQG AL)

General Notes:

The Water Quality Guidelines (Criteria) Reports by BC Ministry of Environment were used as references for the guidelines. (Internet address: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html). Overview Reports (BC MOE) were used as the references for the guidelines unless the note for specific analyte indicates that the Technical Appendix (BC MOE) was used. / For some parameters, guidelines are specified as two values: the maximum value or the acute criterion, and the 30-day average value or the chronic criterion. The maximum value was used in this report for parameters that have both guideline values.

Note 1.1 for Aluminum (dissolved):

The maximum concentration of dissolved aluminum at any time should not exceed:

1. 0.10 mg/L when the pH is greater than or equal to 6.5
2. The value (in mg/L) determined by the following relationship if pH less than 6.5

Dissolved Aluminum = e (1.209-2.426 (pH) + 0.286 $(pH)^2$)

The 30-day average concentration of dissolved aluminum (based on a minimum of 5 approximately weekly samples) should not exceed:

1. 0.05 mg/L when the median pH over 30 days is greater than or equal to 6.5
2. the value determined by the following relationship at median pH less than 6.5

Dissolved Aluminum = e (1.6-3.327 (median pH) + 0.402 $(\text{median pH})^2$)

Note 1.2 for Arsenic (dissolved):

The recommended guideline is for total arsenic.

Note 1.3 for Boron (dissolved):

The recommended guideline is for total boron.

Note 1.4 for Cobalt (dissolved):

The interim maximum concentration for total cobalt is 110 µg/L to protect aquatic life in the freshwater environment from acute effects of cobalt.

The interim 30-day average concentration for total cobalt (based on five weekly samples) is 4 µg/L to protect aquatic life from chronic effects of cobalt.

Note 1.5 for Copper (dissolved):

The maximum concentration of total copper should not exceed at any time the numerical value (in µg/L) given by the formula "0.094(hardness)+2", where water hardness is reported as mg/L CaCO3.

The 30-day average concentration of total copper (based on a minimum of 5 approximately weekly samples) should not exceed 2 µg/L when average water hardness over the same period (expressed as mg/L CaCO3) is less than 50 mg/L. When average water hardness is greater than 50 mg/L the 30-day average concentration should not exceed the numerical value (in µg/L) given by the formula "0.04(average hardness)", where water hardness is reported as mg/L CaCO3.

Note 1.6 for Lead (dissolved):

The maximum guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO3 is set at 3.0 µg/L. When water hardness exceeds 8.0 mg/L CaCO3 the maximum guideline for lead at any time is given by the following equation:

Maximum Criteria (µg/L) = exp (1.273 ln(hardness) - 1.460).

The 30-day average guideline for total lead in water, when water hardness exceeds 8 mg/L as CaCO3, is as follows:

30-Day Average (µg/L) is less than or equal to 3.31 + exp (1.273 ln (mean hardness) - 4.704).

For hardness less than or equal to 8.0 mg/L there is no 30-day average guideline; hence the maximum concentration of 3.0 µg/L is used.

Note 1.7 for Manganese (dissolved):

The maximum concentration of total manganese in mg/L at any time should not exceed the value as determined by the following relationship:

0.01102 hardness + 0.54

where water hardness is reported as mg/L of CaCO3.

The 30-day mean concentration of total manganese in mg/L should be less than or equal to the value as determined by the following relationship:

0.0044 hardness + 0.605

where water hardness is reported as mg/L of CaCO3.

Note 1.8 for Mercury (dissolved):

The average concentration of total mercury in water as measured over a 30-day period (based on five weekly samples) should not exceed 0.02 µg/L when the methyl mercury (MeHg) constitutes less than or equal to 0.5% of the total mercury concentration. When the proportion of MeHg is greater than 0.5%, the guideline should be adjusted as indicated in the Table 1 and Table 4 of the BC MOE Overview Report - First Update, February 2001.

There is no guideline maximum for total mercury in water, for freshwater aquatic life.

Note 1.9 for Molybdenum (dissolved):

The maximum concentration for total molybdenum is 2 mg/L.
The 30-day average concentration for total molybdenum (based on at least five weekly samples in a period of 30 days) is less than or equal to 1 mg/L.

Note 1.10 for Selenium (dissolved):

To protect freshwater aquatic life from adverse effects, the mean concentration of total selenium should not exceed 2 µg/L.
The mean concentration in the water column is calculated based on at least 5 weekly samples taken over a 30-day period.

Note 1.11 for Silver (dissolved):

The guideline maximum for total silver is:
0.1 µg/L maximum if hardness less than or equal to 100 mg/L
3.0 µg/L maximum if hardness greater than 100 mg/L.
The guideline 30-day average for total silver is:
0.05 µg/L as 30-day mean if hardness less than or equal to 100 mg/L
1.5 µg/L as 30-day mean if hardness greater than 100 mg/L.

Note 1.12 for Zinc (dissolved):

The maximum concentration of total zinc (µg/L) at any time should not exceed 33 µg/L when water hardness is less than or equal to 90 mg/L as CaCO3.
When water hardness exceeds 90 mg/L CaCO3, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:
33 + 0.75 * (hardness - 90)
where water hardness is reported as mg/L of CaCO3.
The 30-day average concentration of total zinc (µg/L) at any time should not exceed 7.5 µg/L when water hardness is less than or equal to 90 mg/L as CaCO3.
When water hardness exceeds 90 mg/L CaCO3, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:
7.5 + 0.75 * (hardness - 90)
where water hardness is reported as mg/L of CaCO3.

Note 1.13 for Chloride:

To protect freshwater aquatic life from acute and lethal effects, the maximum concentration of chloride (mg/L as NaCl) at any time should not exceed 600 mg/L.
To protect freshwater aquatic life from chronic effects, the average (arithmetic mean computed from five weekly samples collected over a 30-day period) concentration of chloride (mg/L as NaCl) should not exceed 150 mg/L.

Note 1.14 for Colour:

30-day average true colour of filtered water samples shall not exceed background levels by more than 5 colour units in clearwater systems or 20% in coloured systems. See BC MOE Overview Report for additional details.

Note 1.15 for Fluoride:

Correction by BC MOE Sept. 2011: The criteria for Fluoride (total) in mg/L is 0.4 as a maximum where the water hardness (as CaCO3) is less than or equal to 10 mg/L. Otherwise use the equation:
LC50 fluoride = -51.73 + 92.57 log10 (Hardness) and multiply by 0.01.
Hardness is as CaCO3 in units mg/L.

Note 1.16 for pH:

pH less than 6.5: No statistically significant decrease in pH from background.
pH from 6.5 to 9.0: Unrestricted change permitted within this range.
pH over 9.0: No statistically significant increase in pH from background.
See BC MOE Overview Report for additional details.

Note 1.17 for Sulphate:

The approved 30-day average (minimum of 5 evenly-spaced samples collected in 30 days) water quality guidelines to protect aquatic life in BC for sulphate are:
128 mg/L at hardness of 0 to 30 mg/L as CaCO3
218 mg/L at hardness of 31 to 75 mg/L as CaCO3
309 mg/L at hardness of 76 to 180mg/L as CaCO3
429 mg/L at hardness 181 to 250 mg/L as CaCO3
Need to determine guideline based on site water for hardness greater than 250 mg/L as CaCO3.
For screening purposes in this report, exceedance were flagged for sulphate greater than 429 mg/L at hardness greater than 250 mg/L as CaCO3.

Note 1.18 for Total organic carbon:

Recommended guideline for total organic carbon (TOC) is 30-day median ± 20% of the median background concentration.

Note 1.19 for Total suspended solids:

Maximum Induced Suspended Sediments - mg/L or % of background:
- 25 mg/L in 24 hours when background is less than or equal to 25;
- Mean of 5 mg/L in 30 days when background is less than or equal to 25;
- 25 mg/L when background is between 25 and 250;
- 10% when background is greater than or equal to 250.

Note 1.20 for Turbidity:

When background is less than or equal to 8 NTU:
- Maximum Induced Turbidity of 8 NTU in 24 hours.
- For sediment inputs that last between 24 hours and 30 days (daily sampling preferred) the mean turbidity should not exceed background by more than 2 NTU.

Maximum Induced Turbidity of 5 NTU when background is between 8 and 50 NTU.
Maximum Induced Turbidity of 10% when background is greater than 50 NTU.

Note 1.21 for E. coli (counts):

The escherichia coli density in fresh and marine waters used for the growing and harvesting of shellfish for human consumption should not exceed a median MPN of 14/100 mL over 30 days, and at least 90% of the samples in a 30-day period should not exceed 43/100 mL.

Note 1.22 for E. coli (MPN / PA):

The escherichia coli density in fresh and marine waters used for the growing and harvesting of shellfish for human consumption should not exceed a median MPN of 14/100 mL over 30 days, and at least 90% of the samples in a 30-day period should not exceed 43/100 mL.

Note 1.23 for Fecal coliforms (counts):

The guideline for fecal coliforms is as follows: “The fecal coliform density in fresh and marine waters used for the growing and harvesting of shellfish for human consumption should not exceed a median MPN of 14/100 mL over 30 days, and at least 90% of the samples in a 30-day period should not exceed 43/100 mL.”

Note 1.24 for Fecal coliforms (MPN / PA):

The guideline for fecal coliforms is as follows: “The fecal coliform density in fresh and marine waters used for the growing and harvesting of shellfish for human consumption should not exceed a median MPN of 14/100 mL over 30 days, and at least 90% of the samples in a 30-day period should not exceed 43/100 mL.”

Note 1.25 for Ammonia (total, as N):

The maximum guideline for ammonia varies as a function of pH and temperature. See Table 3 in Overview Report Update September 2009.
The 30-day average guideline for ammonia varies as a function of pH and temperature. See Table 4 in Overview Report Update September 2009. / The lab pH and field temperature results were used for determining the maximum ammonia for this report. If a lab pH result was not available then the field pH result was used.

Note 1.26 for Nitrate (as N):

The guideline maximum for nitrate (as N) is 32.8 mg/l.
The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.
Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 1.27 for Nitrate + Nitrite (as N) (calculated):

The guideline maximum for nitrate (as N) is 32.8 mg/l.
The 30-day average guideline for nitrate (as N) is 3.0 mg /L. The 30-day average (chronic) concentration is based on 5 weekly samples collected within a 30-day period.
Where nitrate and nitrite are present, the total nitrate+nitrite nitrogen should not exceed these values.

Note 1.28 for Nitrite (as N):

The guideline maximum for nitrite as N is:
0.06 mg/L if chloride less than 2 mg/L
0.12 mg/L if chloride is 2 to 4 mg/L
0.18 mg/L if chloride is 4 to 6 mg/L
0.24 mg/L if chloride is 6 to 8 mg/L
0.30 mg/L if chloride is 8 to 10 mg/L
0.60 mg/L if chloride is greater than 10 mg/L.
The guideline 30-day average for nitrite as N is:
0.02 mg/L if chloride less than 2 mg/L
0.04 mg/L if chloride is 2 to 4 mg/L
0.06 mg/L if chloride is 4 to 6 mg/L
0.08 mg/L if chloride is 6 to 8 mg/L
0.10 mg/L if chloride is 8 to 10 mg/L
0.20 mg/L if chloride is greater than 10 mg/L.

Note 1.29 for Phosphorus (dissolved, by ICPMS/ICPOES):

Streams: None proposed for streams.
Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 1.30 for Phosphorus (total, by ICPMS/ICPOES):
Streams: None proposed for streams.
Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 1.31 for Phosphorus (dissolved, APHA 4500-P):
Streams: None proposed for streams.
Lakes: It is not possible to specify a single phosphorous concentration to achieve protection of aquatic life in lakes. A range of total phosphorous concentrations (5-15 µg/L) is suggested as the criterion which can be used as the basis for site specific water quality objectives.

Note 1.32 for Cobalt (total):
The interim maximum concentration for total cobalt is 110 µg/L to protect aquatic life in the freshwater environment from acute effects of cobalt.
The interim 30-day average concentration for total cobalt (based on five weekly samples) is 4 µg/L to protect aquatic life from chronic effects of cobalt.

Note 1.33 for Copper (total):
The maximum concentration of total copper should not exceed at any time the numerical value (in µg/L) given by the formula "0.094(hardness)+2", where water hardness is reported as mg/L CaCO3.
The 30-day average concentration of total copper (based on a minimum of 5 approximately weekly samples) should not exceed 2 µg/L when average water hardness over the same period (expressed as mg/L CaCO3) is less than 50 mg/L. When average water hardness is greater than 50 mg/L the 30-day average concentration should not exceed the numerical value (in µg/L) given by the formula "0.04(average hardness)", where water hardness is reported as mg/L CaCO3.

Note 1.34 for Lead (total):
The maximum guideline for total lead in water, at a water hardness less than or equal to 8 mg/L as CaCO3 is set at 3.0 µg/L. When water hardness exceeds 8.0 mg/L CaCO3 the maximum guideline for lead at any time is given by the following equation:
Maximum Criteria (µg/L) = exp (1.273 ln(hardness) - 1.460).
The 30-day average guideline for total lead in water, when water hardness exceeds 8 mg/L as CaCO3, is as follows:
30-Day Average (µg/L) is less than or equal to 3.31 + exp (1.273 ln (mean hardness) - 4.704).
For hardness less than or equal to 8.0 mg/L there is no 30-day average guideline; hence the maximum concentration of 3.0 µg/L is used.

Note 1.35 for Manganese (total):
The maximum concentration of total manganese in mg/L at any time should not exceed the value as determined by the following relationship:
0.01102 hardness + 0.54
where water hardness is reported as mg/L of CaCO3.
The 30-day mean concentration of total manganese in mg/L should be less than or equal to the value as determined by the following relationship:
0.0044 hardness + 0.605
where water hardness is reported as mg/L of CaCO3.

Note 1.36 for Mercury (total):
The average concentration of total mercury in water as measured over a 30-day period (based on five weekly samples) should not exceed 0.02 µg/L when the methyl mercury (MeHg) constitutes less than or equal to 0.5% of the total mercury concentration. When the proportion of MeHg is greater than 0.5%, the guideline should be adjusted as indicated in the Table 1 and Table 4 of the BC MOE Overview Report - First Update, February 2001.
There is no guideline maximum for total mercury in water, for freshwater aquatic life.

Note 1.37 for Molybdenum (total):
The maximum concentration for total molybdenum is 2 mg/L.
The 30-day average concentration for total molybdenum (based on at least five weekly samples in a period of 30 days) is less than or equal to 1 mg/L.

Note 1.38 for Selenium (total):
To protect freshwater aquatic life from adverse effects, the mean concentration of total selenium should not exceed 2 µg/L. The mean concentration in the water column is calculated based on at least 5 weekly samples taken over a 30-day period.

Note 1.39 for Silver (total):

The guideline maximum for total silver is:
0.1 µg/L maximum if hardness less than or equal to 100 mg/L
3.0 µg/L maximum if hardness greater than 100 mg/L.
The guideline 30-day average for total silver is:
0.05 µg/L as 30-day mean if hardness less than or equal to 100 mg/L
1.5 µg/L as 30-day mean if hardness greater than 100 mg/L.

Note 1.40 for Zinc (total):

The maximum concentration of total zinc (µg/L) at any time should not exceed 33 µg/L when water hardness is less than or equal to 90 mg/L as CaCO3.

When water hardness exceeds 90 mg/L CaCO3, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:

33 + 0.75 * (hardness - 90)

where water hardness is reported as mg/L of CaCO3.

The 30-day average concentration of total zinc (µg/L) at any time should not exceed 7.5 µg/L when water hardness is less than or equal to 90 mg/L as CaCO3.

When water hardness exceeds 90 mg/L CaCO3, the guideline maximum in µg/L for total zinc is the value determined by the following relationship:

7.5 + 0.75 * (hardness - 90)

where water hardness is reported as mg/L of CaCO3.

2. Notes for Guidelines for Canadian Drinking Water Quality - Maximum Acceptable Concentrations (GCDWQ MAC)

Note 2.1 for Cyanide (total):

The GCDWQ MAC for Cyanide (free) is 0.2 mg/L. A maximum of 0.2 mg/L was used, in this report, to identify exceedances for Cyanide (total) as a means for determining the potential for exceeding the Cyanide (free) guideline.

Note 2.2 for Turbidity:

Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet health-based turbidity limits, as defined for specific treatment technologies. Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters should meet the requirements described in GCDWQ. The health-based turbidity guideline does not apply to secure groundwater sources, i.e., those not under the direct influence of surface water. However, for effective operation of the distribution system, it is good practice to ensure that water entering the distribution system has low turbidity levels of around 1.0 NTU.

Note 2.3 for E. coli (counts):

MAC is none detectable per 100 mL

Note 2.4 for E. coli (MPN / PA):

MAC is none detectable per 100 mL

Note 2.5 for Fecal coliforms (counts):

The GCDWQ does not have a guideline for fecal coliforms. The GCDWQ were revised in 2006 when the guideline for fecal coliforms was deleted, and a guideline for E. coli was added. However the GCDWQ has a guideline for total coliforms that includes the following statement: “The MAC of total coliforms in water leaving a treatment plant in a public system and throughout semi-public and private supply systems is none detectable per 100 mL.” Therefore a guideline of none detectable per 100 mL was used for fecal coliforms for this report.

Note that the Drinking Water Protection Regulation (2003), under the BC Drinking Water Protection Act, has a water quality standard for potable water for fecal coliforms of “No detectable fecal coliform bacteria per 100 ml”.

Note 2.6 for Fecal coliforms (MPN / PA):

The GCDWQ does not have a guideline for fecal coliforms. The GCDWQ were revised in 2006 when the guideline for fecal coliforms was deleted, and a guideline for E. coli was added. However the GCDWQ has a guideline for total coliforms that includes the following statement: “The MAC of total coliforms in water leaving a treatment plant in a public system and throughout semi-public and private supply systems is none detectable per 100 mL.” Therefore a guideline of none detectable per 100 mL was used for fecal coliforms for this report.

Note that the Drinking Water Protection Regulation (2003), under the BC Drinking Water Protection Act, has a water quality standard for potable water for fecal coliforms of “No detectable fecal coliform bacteria per 100 ml”.

Note 2.7 for Total coliforms (counts):

The maximum acceptable concentration (MAC) of total coliforms in water leaving a treatment plant and in non-disinfected groundwater leaving the well is none detectable per 100 mL.

Total coliforms should be monitored in the distribution system because they are used to indicate changes in water quality. Detection of total coliforms from consecutive samples from the same site or from more than 10% of the samples collected in a given sampling period should be investigated.

Note 2.8 for Total coliforms (MPN / PA):

The maximum acceptable concentration (MAC) of total coliforms in water leaving a treatment plant and in non-disinfected groundwater leaving the well is none detectable per 100 mL.

Total coliforms should be monitored in the distribution system because they are used to indicate changes in water quality. Detection of total coliforms from consecutive samples from the same site or from more than 10% of the samples collected in a given sampling period should be investigated.

Note 2.9 for Nitrate + Nitrite (as N) (calculated):

The MAC for Nitrate (as N) is 10 mg/L

3. Notes for Guidelines for Canadian Drinking Water Quality - Aesthetic Objectives (GCDWQ AO)

Note 3.1 for Aluminum (dissolved):

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

Note 3.2 for Sodium (dissolved):

It is recommended that sodium be included in routine monitoring programmes, as levels may be of intrested to authorities who wish to prescribe sodium-restricted diets for their patients.

Note 3.3 for Sulphate:

There may be a laxative effect in some individuals when sulphate levels exceed 500 mg/L

Note 3.4 for Aluminum (total):

This is an operational guidance value, designed to apply only to drinking water treatment plants using aluminum-based coagulants. The operational guidance value of 0.1 mg/L applies to conventional treatment plants, and 0.2 mg/L applies to other types of treatment systems.

Note 3.5 for Sodium (total):

It is recommended that sodium be included in routine monitoring programmes, as levels may be of intrested to authorities who wish to prescribe sodium-restricted diets for their patients.

CARO ANALYTICAL SERVICES

CERTIFICATE OF ANALYSIS

REPORTED TO	Western Water Associates Ltd 106 - 5145 26th Street Vernon, BC V1T 8G4	**TEL** **FAX**	(250) 541-1030 (250) 575-4764
ATTENTION	Bryer Manwell	**WORK ORDER**	3071518
PO NUMBER		**RECEIVED / TEMP**	Jul-24-13 09:10 / 15.0 °C
PROJECT	Blackwater WW	**REPORTED**	Jul-31-13
PROJECT INFO	13-019-02	**COC NUMBER**	14034

General Comments:

CARO Analytical Services employs methods which are conducted according to procedures accepted by appropriate regulatory agencies, and/or are conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts, except where otherwise agreed to by the client.

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Sara Gulenchyn

Issued By: **Sara Gulenchyn For Jennifer Shanko, AScT**
Administration Coordinator, Kelowna

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ANALYSIS INFORMATION

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	3071518
PROJECT	Blackwater WW	**REPORTED**	Jul-31-13

Analysis Description	**Method Reference** (* = modified from) **Preparation**	**Analysis**	**Location**
Alkalinity, total	N/A	APHA 2320 B	Kelowna
Ammonia-N, total colorimetric	N/A	APHA 4500-NH3 G	Kelowna
BOD, 5-day	N/A	APHA 5210 B	Kelowna
Carbon, Total Organic in Water	N/A	APHA 5310 B	Kelowna
Chloride in Water by IC	N/A	APHA 4110 B	Kelowna
Colour, True at 410 nm	N/A	APHA 2120 C *	Kelowna
Conductivity in Water	N/A	APHA 2510 B	Kelowna
Dissolved Metals	APHA 3030 B	APHA 3125 B	Richmond
E. Coli (MPN)	N/A	APHA 9221	Kelowna
E. coli (Partition Method)	N/A	APHA 9222 G	Kelowna
Fecal Coliforms (MF)	N/A	APHA 9222 D	Kelowna
Fecal Coliforms (MPN)	N/A	APHA 9221 E	Kelowna
Fluoride in Water by IC	N/A	APHA 4110 B	Kelowna
Hardness as CaCO3 (CALC)	N/A	APHA 2340 B	Richmond
Nitrate-N in Water by IC	N/A	APHA 4110 B	Kelowna
Nitrite-N in Water by IC	N/A	APHA 4110 B	Kelowna
Orthophosphate as P by IC	N/A	APHA 4110 B	Kelowna
pH in Water	N/A	APHA 4500-H+ B	Kelowna
Phosphorus, Total Dissolved Kjeldahl	N/A	EPA 365.4 (1974) *	Kelowna
Sulfate in Water by IC	N/A	APHA 4110 B	Kelowna
Total Coliforms (by Endo)	N/A	APHA 9222 B	Kelowna
Total Coliforms (MPN)	N/A	APHA 9221 B	Kelowna
Total Dissolved Solids	N/A	APHA 2540 C	Kelowna
Total Recoverable Metals	APHA 3030E *	APHA 3125 B	Richmond
Total Suspended Solids	N/A	APHA 2540 D	Kelowna
Transmissivity at 254nm	N/A	APHA 5910 B	Kelowna
Turbidity	N/A	APHA 2130 B	Kelowna

Note: The numbers in brackets represent the year that the method was published/approved

Method Reference Descriptions:

APHA	Standard Methods for the Examination of Water and Wastewater, American Public Health Association
EPA	United States Environmental Protection Agency Test Methods

Glossary of Terms:

MRL	Method Reporting Limit
<	Less than the Reported Detection Limit (RDL) - the RDL may be higher than the MRL due to various factors such as dilutions, limited sample volume, high moisture, or interferences
%	Percent W/W
CFU/100mL	Colony Forming Units per 100 mL
Color Unit	Colour referenced against a platinum cobalt standard
mg/L	Milligrams per litre
MPN/100mL	Most Probable Number per 100 mL
NTU	Nephelometric Turbidity Units
pH units	pH < 7 = acidic, ph > 7 = basic
uS/cm	Microsiemens per centimeter

SAMPLE ANALYTICAL DATA

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

WORK ORDER 3071518
REPORTED Jul-31-13

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-02 (3071518-01) [Water] Sampled: Jul-21-13						CT4
Anions						
Alkalinity, Total as CaCO3	**54**	1	mg/L	N/A	Jul-24-13	
Chloride	**0.39**	0.10	mg/L	N/A	Jul-24-13	
Fluoride	**0.16**	0.10	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrate as N	**0.070**	0.010	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L	N/A	Jul-24-13	
Phosphate, Ortho as P	< 0.01	0.01	mg/L	N/A	Jul-24-13	
Sulfate	**4.0**	1.0	mg/L	N/A	Jul-24-13	
General Parameters						
BOD, 5-day	< 10	10	mg/L	Jul-24-13	Jul-29-13	
Carbon, Total Organic	< 0.5	0.5	mg/L	N/A	Jul-24-13	
Colour, True	< 5	5	Color Unit	N/A	Jul-25-13	HT
Conductivity (EC)	**118**	2	uS/cm	N/A	Jul-24-13	
Nitrogen, Ammonia as N, Total	**0.037**	0.020	mg/L	N/A	Jul-25-13	HT
pH	**7.87**	0.01	pH units	N/A	Jul-24-13	
Phosphorus, Total Kjeldahl Dissolved	< 0.01	0.01	mg/L	N/A	Jul-24-13	
Solids, Total Dissolved	**160**	5	mg/L	N/A	Jul-24-13	
Solids, Total Suspended	**46**	1	mg/L	N/A	Jul-25-13	
Turbidity	**21.7**	0.1	NTU	N/A	Jul-25-13	HT
UV Transmittance @ 254nm	**98.3**	0.1	%	Jul-25-13	Jul-25-13	
Calculated Parameters						
Hardness, Total (Total as CaCO3)	**51.2**	5.0	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**48.9**	5.0	mg/L	N/A	N/A	
Dissolved Metals						
Aluminum, dissolved	**0.08**	0.05	mg/L	N/A	Jul-26-13	
Antimony, dissolved	**0.001**	0.001	mg/L	N/A	Jul-26-13	
Arsenic, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Barium, dissolved	< 0.05	0.05	mg/L	N/A	Jul-26-13	
Beryllium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Bismuth, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Boron, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Cadmium, dissolved	< 0.0001	0.0001	mg/L	N/A	Jul-26-13	
Calcium, dissolved	**14**	2	mg/L	N/A	Jul-26-13	
Chromium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Cobalt, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Copper, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Iron, dissolved	< 0.1	0.1	mg/L	N/A	Jul-26-13	
Lead, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Lithium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Magnesium, dissolved	**3.3**	0.1	mg/L	N/A	Jul-26-13	
Manganese, dissolved	**0.076**	0.002	mg/L	N/A	Jul-26-13	
Mercury, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Molybdenum, dissolved	**0.002**	0.001	mg/L	N/A	Jul-26-13	
Nickel, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Phosphorus, dissolved	< 0.2	0.2	mg/L	N/A	Jul-26-13	

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-02 (3071518-01) [Water] Sampled: Jul-21-13, Continued						CT4
Dissolved Metals, Continued						
Potassium, dissolved	**0.6**	0.2	mg/L	N/A	Jul-26-13	
Selenium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Silicon, dissolved	**6**	5	mg/L	N/A	Jul-26-13	
Silver, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Sodium, dissolved	**4.2**	0.2	mg/L	N/A	Jul-26-13	
Strontium, dissolved	**0.06**	0.01	mg/L	N/A	Jul-26-13	
Sulfur, dissolved	< 10	10	mg/L	N/A	Jul-26-13	
Tellurium, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Thallium, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Thorium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Tin, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Titanium, dissolved	< 0.05	0.05	mg/L	N/A	Jul-26-13	
Uranium, dissolved	**0.0003**	0.0002	mg/L	N/A	Jul-26-13	
Vanadium, dissolved	< 0.01	0.01	mg/L	N/A	Jul-26-13	
Zinc, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Zirconium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Total Recoverable Metals						
Aluminum, total	**0.79**	0.05	mg/L	Jul-25-13	Jul-26-13	
Antimony, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Arsenic, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Barium, total	< 0.05	0.05	mg/L	Jul-25-13	Jul-26-13	
Beryllium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Bismuth, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Boron, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Cadmium, total	< 0.0001	0.0001	mg/L	Jul-25-13	Jul-26-13	
Calcium, total	**15**	2	mg/L	Jul-25-13	Jul-26-13	
Chromium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Cobalt, total	**0.0008**	0.0005	mg/L	Jul-25-13	Jul-26-13	
Copper, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Iron, total	**1.0**	0.1	mg/L	Jul-25-13	Jul-26-13	
Lead, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Lithium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Magnesium, total	**3.5**	0.1	mg/L	Jul-25-13	Jul-26-13	
Manganese, total	**0.113**	0.002	mg/L	Jul-25-13	Jul-26-13	
Mercury, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Molybdenum, total	**0.002**	0.001	mg/L	Jul-25-13	Jul-26-13	
Nickel, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Phosphorus, total	< 0.2	0.2	mg/L	Jul-25-13	Jul-26-13	
Potassium, total	**0.8**	0.2	mg/L	Jul-25-13	Jul-26-13	
Selenium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Silicon, total	**7**	5	mg/L	Jul-25-13	Jul-26-13	
Silver, total	< 0.0005	0.0005	mg/L	Jul-25-13	Jul-26-13	
Sodium, total	**4.5**	0.2	mg/L	Jul-25-13	Jul-26-13	
Strontium, total	**0.07**	0.01	mg/L	Jul-25-13	Jul-26-13	
Sulfur, total	< 10	10	mg/L	Jul-25-13	Jul-26-13	

SAMPLE ANALYTICAL DATA

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

WORK ORDER 3071518
REPORTED Jul-31-13

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-02 (3071518-01) [Water] Sampled: Jul-21-13, Continued						CT4
Total Recoverable Metals, Continued						
Tellurium, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Thallium, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Thorium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Tin, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Titanium, total	< 0.05	0.05	mg/L	Jul-25-13	Jul-26-13	
Uranium, total	**0.0003**	0.0002	mg/L	Jul-25-13	Jul-26-13	
Vanadium, total	< 0.01	0.01	mg/L	Jul-25-13	Jul-26-13	
Zinc, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Zirconium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Microbiological Parameters						
Coliforms, Total	**≥ 63**	1		Jul-24-13	Jul-25-13	
Background Colonies	**> 200**	200	CFU/100mL	Jul-24-13	Jul-25-13	
Coliforms, Fecal	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	
E. coli	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	

SAMPLE ANALYTICAL DATA

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

WORK ORDER 3071518
REPORTED Jul-31-13

Sample ID: RIB MW13-03 (3071518-02) [Water] Sampled: Jul-21-13 CT4, F1

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Anions						
Alkalinity, Total as CaCO3	**36**	1	mg/L	N/A	Jul-24-13	
Chloride	**0.63**	0.10	mg/L	N/A	Jul-24-13	
Fluoride	< 0.10	0.10	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrate as N	**0.030**	0.010	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L	N/A	Jul-24-13	
Phosphate, Ortho as P	**0.04**	0.01	mg/L	N/A	Jul-24-13	
Sulfate	**1.7**	1.0	mg/L	N/A	Jul-24-13	
General Parameters						
BOD, 5-day	< 10	10	mg/L	Jul-24-13	Jul-29-13	
Carbon, Total Organic	**14.9**	0.5	mg/L	N/A	Jul-24-13	
Colour, True	**48**	5	Color Unit	N/A	Jul-25-13	HT
Conductivity (EC)	**72**	2	uS/cm	N/A	Jul-24-13	
Nitrogen, Ammonia as N, Total	**0.700**	0.020	mg/L	N/A	Jul-25-13	HT
pH	**6.83**	0.01	pH units	N/A	Jul-24-13	
Phosphorus, Total Kjeldahl Dissolved	**0.07**	0.01	mg/L	N/A	Jul-24-13	
Solids, Total Dissolved	**220**	5	mg/L	N/A	Jul-24-13	
Solids, Total Suspended	**3820**	1	mg/L	N/A	Jul-25-13	
Turbidity	**> 4000**	0.1	NTU	N/A	Jul-25-13	HT
UV Transmittance @ 254nm	**69.4**	0.1	%	Jul-25-13	Jul-25-13	
Calculated Parameters						
Hardness, Total (Total as CaCO3)	**37.6**	5.0	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**32.2**	5.0	mg/L	N/A	N/A	
Dissolved Metals						
Aluminum, dissolved	**5.83**	0.05	mg/L	N/A	Jul-26-13	
Antimony, dissolved	**0.001**	0.001	mg/L	N/A	Jul-26-13	
Arsenic, dissolved	**0.006**	0.005	mg/L	N/A	Jul-26-13	
Barium, dissolved	< 0.05	0.05	mg/L	N/A	Jul-26-13	
Beryllium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Bismuth, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Boron, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Cadmium, dissolved	< 0.0001	0.0001	mg/L	N/A	Jul-26-13	
Calcium, dissolved	**9**	2	mg/L	N/A	Jul-26-13	
Chromium, dissolved	**0.005**	0.005	mg/L	N/A	Jul-26-13	
Cobalt, dissolved	**0.0012**	0.0005	mg/L	N/A	Jul-26-13	
Copper, dissolved	**0.002**	0.002	mg/L	N/A	Jul-26-13	
Iron, dissolved	**3.0**	0.1	mg/L	N/A	Jul-26-13	
Lead, dissolved	**0.005**	0.001	mg/L	N/A	Jul-26-13	
Lithium, dissolved	**0.002**	0.001	mg/L	N/A	Jul-26-13	
Magnesium, dissolved	**2.6**	0.1	mg/L	N/A	Jul-26-13	
Manganese, dissolved	**0.113**	0.002	mg/L	N/A	Jul-26-13	
Mercury, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Molybdenum, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Nickel, dissolved	**0.004**	0.002	mg/L	N/A	Jul-26-13	
Phosphorus, dissolved	< 0.2	0.2	mg/L	N/A	Jul-26-13	

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

WORK ORDER 3071518
REPORTED Jul-31-13

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-03 (3071518-02) [Water] Sampled: Jul-21-13, Continued						CT4, F1
Dissolved Metals, Continued						
Potassium, dissolved	**1.8**	0.2	mg/L	N/A	Jul-26-13	
Selenium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Silicon, dissolved	**16**	5	mg/L	N/A	Jul-26-13	
Silver, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Sodium, dissolved	**3.5**	0.2	mg/L	N/A	Jul-26-13	
Strontium, dissolved	**0.07**	0.01	mg/L	N/A	Jul-26-13	
Sulfur, dissolved	< 10	10	mg/L	N/A	Jul-26-13	
Tellurium, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Thallium, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Thorium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Tin, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Titanium, dissolved	**0.19**	0.05	mg/L	N/A	Jul-26-13	
Uranium, dissolved	**0.0016**	0.0002	mg/L	N/A	Jul-26-13	
Vanadium, dissolved	< 0.01	0.01	mg/L	N/A	Jul-26-13	
Zinc, dissolved	**0.05**	0.04	mg/L	N/A	Jul-26-13	
Zirconium, dissolved	**0.006**	0.001	mg/L	N/A	Jul-26-13	
Total Recoverable Metals						
Aluminum, total	**10.8**	0.05	mg/L	Jul-25-13	Jul-26-13	
Antimony, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Arsenic, total	**0.012**	0.005	mg/L	Jul-25-13	Jul-26-13	
Barium, total	**0.09**	0.05	mg/L	Jul-25-13	Jul-26-13	
Beryllium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Bismuth, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Boron, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Cadmium, total	**0.0002**	0.0001	mg/L	Jul-25-13	Jul-26-13	
Calcium, total	**10**	2	mg/L	Jul-25-13	Jul-26-13	
Chromium, total	**0.015**	0.005	mg/L	Jul-25-13	Jul-26-13	
Cobalt, total	**0.0026**	0.0005	mg/L	Jul-25-13	Jul-26-13	
Copper, total	**0.005**	0.002	mg/L	Jul-25-13	Jul-26-13	
Iron, total	**7.6**	0.1	mg/L	Jul-25-13	Jul-26-13	
Lead, total	**0.011**	0.001	mg/L	Jul-25-13	Jul-26-13	
Lithium, total	**0.004**	0.001	mg/L	Jul-25-13	Jul-26-13	
Magnesium, total	**3.3**	0.1	mg/L	Jul-25-13	Jul-26-13	
Manganese, total	**0.260**	0.002	mg/L	Jul-25-13	Jul-26-13	
Mercury, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Molybdenum, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Nickel, total	**0.005**	0.002	mg/L	Jul-25-13	Jul-26-13	
Phosphorus, total	**0.2**	0.2	mg/L	Jul-25-13	Jul-26-13	
Potassium, total	**1.6**	0.2	mg/L	Jul-25-13	Jul-26-13	
Selenium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Silicon, total	**20**	5	mg/L	Jul-25-13	Jul-26-13	
Silver, total	< 0.0005	0.0005	mg/L	Jul-25-13	Jul-26-13	
Sodium, total	**3.5**	0.2	mg/L	Jul-25-13	Jul-26-13	
Strontium, total	**0.07**	0.01	mg/L	Jul-25-13	Jul-26-13	
Sulfur, total	< 10	10	mg/L	Jul-25-13	Jul-26-13	

SAMPLE ANALYTICAL DATA

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

WORK ORDER 3071518
REPORTED Jul-31-13

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-03 (3071518-02) [Water] Sampled: Jul-21-13, Continued						CT4, F1
Total Recoverable Metals, Continued						
Tellurium, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Thallium, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Thorium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Tin, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Titanium, total	**0.29**	0.05	mg/L	Jul-25-13	Jul-26-13	
Uranium, total	**0.0022**	0.0002	mg/L	Jul-25-13	Jul-26-13	
Vanadium, total	**0.02**	0.01	mg/L	Jul-25-13	Jul-26-13	
Zinc, total	**0.14**	0.04	mg/L	Jul-25-13	Jul-26-13	
Zirconium, total	**0.005**	0.001	mg/L	Jul-25-13	Jul-26-13	
Microbiological Parameters						
Coliforms, Total	**2400**	1	CFU/100mL	Jul-24-13	Jul-25-13	
Background Colonies	**> 200**	200	CFU/100mL	Jul-24-13	Jul-25-13	
Coliforms, Fecal	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	
E. coli	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-04 (3071518-03) [Water] Sampled: Jul-21-13						CT4, F1
Anions						
Alkalinity, Total as CaCO3	**38**	1	mg/L	N/A	Jul-24-13	
Chloride	**0.71**	0.10	mg/L	N/A	Jul-24-13	
Fluoride	< 0.10	0.10	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L	N/A	Jul-24-13	
Phosphate, Ortho as P	< 0.01	0.01	mg/L	N/A	Jul-24-13	
Sulfate	**33.8**	1.0	mg/L	N/A	Jul-24-13	
General Parameters						
BOD, 5-day	< 10	10	mg/L	Jul-24-13	Jul-29-13	
Carbon, Total Organic	**26.2**	0.5	mg/L	N/A	Jul-24-13	
Colour, True	**150**	5	Color Unit	N/A	Jul-25-13	HT
Conductivity (EC)	**163**	2	uS/cm	N/A	Jul-24-13	
Nitrogen, Ammonia as N, Total	**0.329**	0.020	mg/L	N/A	Jul-25-13	HT
pH	**7.10**	0.01	pH units	N/A	Jul-24-13	
Phosphorus, Total Kjeldahl Dissolved	**0.08**	0.01	mg/L	N/A	Jul-24-13	
Solids, Total Dissolved	**142**	5	mg/L	N/A	Jul-24-13	
Solids, Total Suspended	**101**	1	mg/L	N/A	Jul-25-13	
Turbidity	**287**	0.1	NTU	N/A	Jul-25-13	HT
UV Transmittance @ 254nm	**25.7**	0.1	%	Jul-25-13	Jul-25-13	
Calculated Parameters						
Hardness, Total (Total as CaCO3)	**123**	5.0	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**82.4**	5.0	mg/L	N/A	N/A	
Dissolved Metals						
Aluminum, dissolved	**12.0**	0.05	mg/L	N/A	Jul-26-13	
Antimony, dissolved	**0.001**	0.001	mg/L	N/A	Jul-26-13	
Arsenic, dissolved	**0.009**	0.005	mg/L	N/A	Jul-26-13	
Barium, dissolved	**0.13**	0.05	mg/L	N/A	Jul-26-13	
Beryllium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Bismuth, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Boron, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Cadmium, dissolved	**0.0002**	0.0001	mg/L	N/A	Jul-26-13	
Calcium, dissolved	**22**	2	mg/L	N/A	Jul-26-13	
Chromium, dissolved	**0.009**	0.005	mg/L	N/A	Jul-26-13	
Cobalt, dissolved	**0.0066**	0.0005	mg/L	N/A	Jul-26-13	
Copper, dissolved	**0.010**	0.002	mg/L	N/A	Jul-26-13	
Iron, dissolved	**8.6**	0.1	mg/L	N/A	Jul-26-13	
Lead, dissolved	**0.006**	0.001	mg/L	N/A	Jul-26-13	
Lithium, dissolved	**0.004**	0.001	mg/L	N/A	Jul-26-13	
Magnesium, dissolved	**6.9**	0.1	mg/L	N/A	Jul-26-13	
Manganese, dissolved	**0.678**	0.002	mg/L	N/A	Jul-26-13	
Mercury, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Molybdenum, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Nickel, dissolved	**0.018**	0.002	mg/L	N/A	Jul-26-13	
Phosphorus, dissolved	< 0.2	0.2	mg/L	N/A	Jul-26-13	

SAMPLE ANALYTICAL DATA

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

WORK ORDER 3071518
REPORTED Jul-31-13

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-04 (3071518-03) [Water] Sampled: Jul-21-13, Continued						CT4, F1
Dissolved Metals, Continued						
Potassium, dissolved	**2.7**	0.2	mg/L	N/A	Jul-26-13	
Selenium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Silicon, dissolved	**28**	5	mg/L	N/A	Jul-26-13	
Silver, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Sodium, dissolved	**4.6**	0.2	mg/L	N/A	Jul-26-13	
Strontium, dissolved	**0.11**	0.01	mg/L	N/A	Jul-26-13	
Sulfur, dissolved	< 10	10	mg/L	N/A	Jul-26-13	
Tellurium, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Thallium, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Thorium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Tin, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Titanium, dissolved	**0.45**	0.05	mg/L	N/A	Jul-26-13	
Uranium, dissolved	**0.0012**	0.0002	mg/L	N/A	Jul-26-13	
Vanadium, dissolved	**0.02**	0.01	mg/L	N/A	Jul-26-13	
Zinc, dissolved	**0.04**	0.04	mg/L	N/A	Jul-26-13	
Zirconium, dissolved	**0.018**	0.001	mg/L	N/A	Jul-26-13	
Total Recoverable Metals						
Aluminum, total	**26.1**	0.05	mg/L	Jul-25-13	Jul-26-13	
Antimony, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Arsenic, total	**0.019**	0.005	mg/L	Jul-25-13	Jul-26-13	
Barium, total	**0.25**	0.05	mg/L	Jul-25-13	Jul-26-13	
Beryllium, total	**0.001**	0.001	mg/L	Jul-25-13	Jul-26-13	
Bismuth, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Boron, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Cadmium, total	**0.0005**	0.0001	mg/L	Jul-25-13	Jul-26-13	
Calcium, total	**30**	2	mg/L	Jul-25-13	Jul-26-13	
Chromium, total	**0.026**	0.005	mg/L	Jul-25-13	Jul-26-13	
Cobalt, total	**0.0151**	0.0005	mg/L	Jul-25-13	Jul-26-13	
Copper, total	**0.029**	0.002	mg/L	Jul-25-13	Jul-26-13	
Iron, total	**28.1**	0.1	mg/L	Jul-25-13	Jul-26-13	
Lead, total	**0.027**	0.001	mg/L	Jul-25-13	Jul-26-13	
Lithium, total	**0.014**	0.001	mg/L	Jul-25-13	Jul-26-13	
Magnesium, total	**11.5**	0.1	mg/L	Jul-25-13	Jul-26-13	
Manganese, total	**1.32**	0.002	mg/L	Jul-25-13	Jul-26-13	
Mercury, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Molybdenum, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Nickel, total	**0.035**	0.002	mg/L	Jul-25-13	Jul-26-13	
Phosphorus, total	**0.6**	0.2	mg/L	Jul-25-13	Jul-26-13	
Potassium, total	**3.3**	0.2	mg/L	Jul-25-13	Jul-26-13	
Selenium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Silicon, total	**42**	5	mg/L	Jul-25-13	Jul-26-13	
Silver, total	< 0.0005	0.0005	mg/L	Jul-25-13	Jul-26-13	
Sodium, total	**5.0**	0.2	mg/L	Jul-25-13	Jul-26-13	
Strontium, total	**0.15**	0.01	mg/L	Jul-25-13	Jul-26-13	
Sulfur, total	< 10	10	mg/L	Jul-25-13	Jul-26-13	

SAMPLE ANALYTICAL DATA

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	3071518
PROJECT	Blackwater WW	**REPORTED**	Jul-31-13

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB MW13-04 (3071518-03) [Water] Sampled: Jul-21-13, Continued						CT4, F1
Total Recoverable Metals, Continued						
Tellurium, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Thallium, total	**0.0002**	0.0002	mg/L	Jul-25-13	Jul-26-13	
Thorium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Tin, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Titanium, total	**0.71**	0.05	mg/L	Jul-25-13	Jul-26-13	
Uranium, total	**0.0025**	0.0002	mg/L	Jul-25-13	Jul-26-13	
Vanadium, total	**0.05**	0.01	mg/L	Jul-25-13	Jul-26-13	
Zinc, total	**0.14**	0.04	mg/L	Jul-25-13	Jul-26-13	
Zirconium, total	**0.008**	0.001	mg/L	Jul-25-13	Jul-26-13	
Microbiological Parameters						
Coliforms, Total (MPN)	**46000**	3.0	MPN/100mL	Jul-24-13	Jul-25-13	HT
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100mL	Jul-24-13	Jul-25-13	HT
E. coli (MPN)	< 3.0	3.0	MPN/100mL	Jul-24-13	Jul-25-13	HT

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB SW 13-01 (3071518-04) [Water] Sampled: Jul-21-13						CT4, F1
Anions						
Alkalinity, Total as CaCO3	**8**	1	mg/L	N/A	Jul-24-13	
Chloride	< 0.10	0.10	mg/L	N/A	Jul-24-13	
Fluoride	< 0.10	0.10	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrate as N	**0.017**	0.010	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L	N/A	Jul-24-13	
Phosphate, Ortho as P	< 0.01	0.01	mg/L	N/A	Jul-24-13	
Sulfate	< 1.0	1.0	mg/L	N/A	Jul-24-13	
General Parameters						
BOD, 5-day	< 10	10	mg/L	Jul-24-13	Jul-29-13	
Carbon, Total Organic	**15.3**	0.5	mg/L	N/A	Jul-24-13	
Colour, True	**54**	5	Color Unit	N/A	Jul-25-13	HT
Conductivity (EC)	**25**	2	uS/cm	N/A	Jul-24-13	
Nitrogen, Ammonia as N, Total	< 0.020	0.020	mg/L	N/A	Jul-25-13	HT
pH	**7.06**	0.01	pH units	N/A	Jul-24-13	
Phosphorus, Total Kjeldahl Dissolved	**0.03**	0.01	mg/L	N/A	Jul-24-13	
Solids, Total Dissolved	**27**	5	mg/L	N/A	Jul-24-13	
Solids, Total Suspended	< 1	1	mg/L	N/A	Jul-25-13	
Turbidity	**0.7**	0.1	NTU	N/A	Jul-25-13	HT
UV Transmittance @ 254nm	**43.5**	0.1	%	Jul-25-13	Jul-25-13	
Calculated Parameters						
Hardness, Total (Total as CaCO3)	**8.6**	5.0	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**9.3**	5.0	mg/L	N/A	N/A	
Dissolved Metals						
Aluminum, dissolved	**0.11**	0.05	mg/L	N/A	Jul-26-13	
Antimony, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Arsenic, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Barium, dissolved	< 0.05	0.05	mg/L	N/A	Jul-26-13	
Beryllium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Bismuth, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Boron, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Cadmium, dissolved	< 0.0001	0.0001	mg/L	N/A	Jul-26-13	
Calcium, dissolved	**3**	2	mg/L	N/A	Jul-26-13	
Chromium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Cobalt, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Copper, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Iron, dissolved	**0.2**	0.1	mg/L	N/A	Jul-26-13	
Lead, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Lithium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Magnesium, dissolved	**0.7**	0.1	mg/L	N/A	Jul-26-13	
Manganese, dissolved	**0.007**	0.002	mg/L	N/A	Jul-26-13	
Mercury, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Molybdenum, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Nickel, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Phosphorus, dissolved	< 0.2	0.2	mg/L	N/A	Jul-26-13	

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB SW 13-01 (3071518-04) [Water] Sampled: Jul-21-13, Continued						CT4, F1
Dissolved Metals, Continued						
Potassium, dissolved	< 0.2	0.2	mg/L	N/A	Jul-26-13	
Selenium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Silicon, dissolved	< 5	5	mg/L	N/A	Jul-26-13	
Silver, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Sodium, dissolved	**1.3**	0.2	mg/L	N/A	Jul-26-13	
Strontium, dissolved	**0.02**	0.01	mg/L	N/A	Jul-26-13	
Sulfur, dissolved	< 10	10	mg/L	N/A	Jul-26-13	
Tellurium, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Thallium, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Thorium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Tin, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Titanium, dissolved	< 0.05	0.05	mg/L	N/A	Jul-26-13	
Uranium, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Vanadium, dissolved	< 0.01	0.01	mg/L	N/A	Jul-26-13	
Zinc, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Zirconium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Total Recoverable Metals						
Aluminum, total	**0.13**	0.05	mg/L	Jul-25-13	Jul-26-13	
Antimony, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Arsenic, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Barium, total	< 0.05	0.05	mg/L	Jul-25-13	Jul-26-13	
Beryllium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Bismuth, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Boron, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Cadmium, total	< 0.0001	0.0001	mg/L	Jul-25-13	Jul-26-13	
Calcium, total	**2**	2	mg/L	Jul-25-13	Jul-26-13	
Chromium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Cobalt, total	< 0.0005	0.0005	mg/L	Jul-25-13	Jul-26-13	
Copper, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Iron, total	**0.2**	0.1	mg/L	Jul-25-13	Jul-26-13	
Lead, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Lithium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Magnesium, total	**0.7**	0.1	mg/L	Jul-25-13	Jul-26-13	
Manganese, total	**0.018**	0.002	mg/L	Jul-25-13	Jul-26-13	
Mercury, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Molybdenum, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Nickel, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Phosphorus, total	< 0.2	0.2	mg/L	Jul-25-13	Jul-26-13	
Potassium, total	< 0.2	0.2	mg/L	Jul-25-13	Jul-26-13	
Selenium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Silicon, total	< 5	5	mg/L	Jul-25-13	Jul-26-13	
Silver, total	< 0.0005	0.0005	mg/L	Jul-25-13	Jul-26-13	
Sodium, total	**1.3**	0.2	mg/L	Jul-25-13	Jul-26-13	
Strontium, total	**0.02**	0.01	mg/L	Jul-25-13	Jul-26-13	
Sulfur, total	< 10	10	mg/L	Jul-25-13	Jul-26-13	

SAMPLE ANALYTICAL DATA

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

WORK ORDER 3071518
REPORTED Jul-31-13

Analyte	**Result /** ***Recovery***	**MRL /** ***Limit***	**Units**	**Prepared**	**Analyzed**	**Notes**
Sample ID: RIB SW 13-01 (3071518-04) [Water] Sampled: Jul-21-13, Continued						CT4, F1
Total Recoverable Metals, Continued						
Tellurium, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Thallium, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Thorium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Tin, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Titanium, total	< 0.05	0.05	mg/L	Jul-25-13	Jul-26-13	
Uranium, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Vanadium, total	< 0.01	0.01	mg/L	Jul-25-13	Jul-26-13	
Zinc, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Zirconium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Microbiological Parameters						
Coliforms, Total	**370**	1	CFU/100mL	Jul-24-13	Jul-25-13	
Background Colonies	**> 200**	200	CFU/100mL	Jul-24-13	Jul-25-13	
Coliforms, Fecal	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	
E. coli	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	

SAMPLE ANALYTICAL DATA

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	3071518
PROJECT	Blackwater WW	**REPORTED**	Jul-31-13

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB SW 13-02 (3071518-05) [Water] Sampled: Jul-21-13						CT4
Anions						
Alkalinity, Total as CaCO3	**22**	1	mg/L	N/A	Jul-24-13	
Chloride	**0.64**	0.10	mg/L	N/A	Jul-24-13	
Fluoride	< 0.10	0.10	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L	N/A	Jul-24-13	
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L	N/A	Jul-24-13	
Phosphate, Ortho as P	< 0.01	0.01	mg/L	N/A	Jul-24-13	
Sulfate	**1.7**	1.0	mg/L	N/A	Jul-24-13	
General Parameters						
BOD, 5-day	< 10	10	mg/L	Jul-24-13	Jul-29-13	
Carbon, Total Organic	**10.8**	0.5	mg/L	N/A	Jul-24-13	
Colour, True	**42**	5	Color Unit	N/A	Jul-25-13	HT
Conductivity (EC)	**51**	2	uS/cm	N/A	Jul-24-13	
Nitrogen, Ammonia as N, Total	**0.020**	0.020	mg/L	N/A	Jul-25-13	HT
pH	**7.46**	0.01	pH units	N/A	Jul-24-13	
Phosphorus, Total Kjeldahl Dissolved	**0.03**	0.01	mg/L	N/A	Jul-24-13	
Solids, Total Dissolved	**42**	5	mg/L	N/A	Jul-24-13	
Solids, Total Suspended	< 1	1	mg/L	N/A	Jul-25-13	
Turbidity	**0.9**	0.1	NTU	N/A	Jul-25-13	HT
UV Transmittance @ 254nm	**53.3**	0.1	%	Jul-25-13	Jul-25-13	
Calculated Parameters						
Hardness, Total (Total as CaCO3)	**18.0**	5.0	mg/L	N/A	N/A	
Hardness, Total (Diss. as CaCO3)	**18.7**	5.0	mg/L	N/A	N/A	
Dissolved Metals						
Aluminum, dissolved	**0.12**	0.05	mg/L	N/A	Jul-26-13	
Antimony, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Arsenic, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Barium, dissolved	< 0.05	0.05	mg/L	N/A	Jul-26-13	
Beryllium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Bismuth, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Boron, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Cadmium, dissolved	< 0.0001	0.0001	mg/L	N/A	Jul-26-13	
Calcium, dissolved	**5**	2	mg/L	N/A	Jul-26-13	
Chromium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Cobalt, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Copper, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Iron, dissolved	< 0.1	0.1	mg/L	N/A	Jul-26-13	
Lead, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Lithium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Magnesium, dissolved	**1.3**	0.1	mg/L	N/A	Jul-26-13	
Manganese, dissolved	**0.003**	0.002	mg/L	N/A	Jul-26-13	
Mercury, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Molybdenum, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Nickel, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Phosphorus, dissolved	< 0.2	0.2	mg/L	N/A	Jul-26-13	

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB SW 13-02 (3071518-05) [Water] Sampled: Jul-21-13, Continued						CT4
Dissolved Metals, Continued						
Potassium, dissolved	< 0.2	0.2	mg/L	N/A	Jul-26-13	
Selenium, dissolved	< 0.005	0.005	mg/L	N/A	Jul-26-13	
Silicon, dissolved	**5**	5	mg/L	N/A	Jul-26-13	
Silver, dissolved	< 0.0005	0.0005	mg/L	N/A	Jul-26-13	
Sodium, dissolved	**2.9**	0.2	mg/L	N/A	Jul-26-13	
Strontium, dissolved	**0.04**	0.01	mg/L	N/A	Jul-26-13	
Sulfur, dissolved	< 10	10	mg/L	N/A	Jul-26-13	
Tellurium, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Thallium, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Thorium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Tin, dissolved	< 0.002	0.002	mg/L	N/A	Jul-26-13	
Titanium, dissolved	< 0.05	0.05	mg/L	N/A	Jul-26-13	
Uranium, dissolved	< 0.0002	0.0002	mg/L	N/A	Jul-26-13	
Vanadium, dissolved	< 0.01	0.01	mg/L	N/A	Jul-26-13	
Zinc, dissolved	< 0.04	0.04	mg/L	N/A	Jul-26-13	
Zirconium, dissolved	< 0.001	0.001	mg/L	N/A	Jul-26-13	
Total Recoverable Metals						
Aluminum, total	**0.17**	0.05	mg/L	Jul-25-13	Jul-26-13	
Antimony, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Arsenic, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Barium, total	< 0.05	0.05	mg/L	Jul-25-13	Jul-26-13	
Beryllium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Bismuth, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Boron, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Cadmium, total	< 0.0001	0.0001	mg/L	Jul-25-13	Jul-26-13	
Calcium, total	**5**	2	mg/L	Jul-25-13	Jul-26-13	
Chromium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Cobalt, total	< 0.0005	0.0005	mg/L	Jul-25-13	Jul-26-13	
Copper, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Iron, total	**0.1**	0.1	mg/L	Jul-25-13	Jul-26-13	
Lead, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Lithium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Magnesium, total	**1.2**	0.1	mg/L	Jul-25-13	Jul-26-13	
Manganese, total	**0.004**	0.002	mg/L	Jul-25-13	Jul-26-13	
Mercury, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Molybdenum, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Nickel, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Phosphorus, total	< 0.2	0.2	mg/L	Jul-25-13	Jul-26-13	
Potassium, total	< 0.2	0.2	mg/L	Jul-25-13	Jul-26-13	
Selenium, total	< 0.005	0.005	mg/L	Jul-25-13	Jul-26-13	
Silicon, total	< 5	5	mg/L	Jul-25-13	Jul-26-13	
Silver, total	< 0.0005	0.0005	mg/L	Jul-25-13	Jul-26-13	
Sodium, total	**2.7**	0.2	mg/L	Jul-25-13	Jul-26-13	
Strontium, total	**0.04**	0.01	mg/L	Jul-25-13	Jul-26-13	
Sulfur, total	< 10	10	mg/L	Jul-25-13	Jul-26-13	

Analyte	Result / *Recovery*	MRL / *Limit*	Units	Prepared	Analyzed	Notes
Sample ID: RIB SW 13-02 (3071518-05) [Water] Sampled: Jul-21-13, Continued						CT4
Total Recoverable Metals, Continued						
Tellurium, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Thallium, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Thorium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Tin, total	< 0.002	0.002	mg/L	Jul-25-13	Jul-26-13	
Titanium, total	< 0.05	0.05	mg/L	Jul-25-13	Jul-26-13	
Uranium, total	< 0.0002	0.0002	mg/L	Jul-25-13	Jul-26-13	
Vanadium, total	< 0.01	0.01	mg/L	Jul-25-13	Jul-26-13	
Zinc, total	< 0.04	0.04	mg/L	Jul-25-13	Jul-26-13	
Zirconium, total	< 0.001	0.001	mg/L	Jul-25-13	Jul-26-13	
Microbiological Parameters						
Coliforms, Total	**190**	1	CFU/100mL	Jul-24-13	Jul-25-13	
Background Colonies	**> 200**	200	CFU/100mL	Jul-24-13	Jul-25-13	
Coliforms, Fecal	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	
E. coli	< 1	1	CFU/100mL	Jul-24-13	Jul-25-13	

Sample / Analysis Qualifiers:

CT4	Client requested bact analysis be run from decanted sample
F1	The sample was not field-filtered and was therefore filtered through a 0.45 um membrane in the laboratory and preserved with HNO3 prior to analysis for dissolved metals.
HT	Sample prepared / analyzed outside of the recommended holding time.

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	3071518
PROJECT	Blackwater WW	**REPORTED**	Jul-31-13

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in “batches” and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk)**: Laboratory reagent water is carried through sample preparation and analysis steps. Method Blanks indicate that results are free from contamination, i.e. not biased high from sources such as the sample container or the laboratory environment
- **Duplicate (Dup)**: Preparation and analysis of a replicate aliquot of a sample. Duplicates provide a measure of the analytical method’s precision, i.e. how reproducible a result is. Duplicates are only reported if they are associated with your sample data.
- **Blank Spike (BS)**: A known amount of standard is carried through sample preparation and analysis steps. Blank Spikes, also known as laboratory control samples (LCS), are prepared from a different source of standard than used for the calibration. They ensure that the calibration is acceptable (i.e. not biased high or low) and also provide a measure of the analytical method’s accuracy (i.e. closeness of the result to a target value).
- **Standard Reference Material (SRM)**: A material of similar matrix to the samples, externally certified for the parameter(s) listed. Standard Reference Materials ensure that the preparation steps in the method are adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Anions, Batch B3G1047										
Blank (B3G1047-BLK1)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Blank (B3G1047-BLK2)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Blank (B3G1047-BLK3)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
Blank (B3G1047-BLK4)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	< 1	1	mg/L							
LCS (B3G1047-BS1)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	98	1	mg/L	100		98	96-108			
LCS (B3G1047-BS2)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	97	1	mg/L	100		97	96-108			
LCS (B3G1047-BS3)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	97	1	mg/L	100		97	96-108			
LCS (B3G1047-BS4)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Alkalinity, Total as CaCO3	99	1	mg/L	100		99	96-108			
Anions, Batch B3G1051										
Blank (B3G1051-BLK1)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L							
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L							
Phosphate, Ortho as P	< 0.01	0.01	mg/L							
Sulfate	< 1.0	1.0	mg/L							

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes

Anions, Batch B3G1051, Continued

Blank (B3G1051-BLK2) Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L							
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L							
Phosphate, Ortho as P	< 0.01	0.01	mg/L							
Sulfate	< 1.0	1.0	mg/L							

Blank (B3G1051-BLK3) Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L							
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L							
Phosphate, Ortho as P	< 0.01	0.01	mg/L							
Sulfate	< 1.0	1.0	mg/L							

Blank (B3G1051-BLK4) Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	< 0.10	0.10	mg/L							
Fluoride	< 0.10	0.10	mg/L							
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L							
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L							
Phosphate, Ortho as P	< 0.01	0.01	mg/L							
Sulfate	< 1.0	1.0	mg/L							

LCS (B3G1051-BS1) Prepared: Jul-24-13, Analyzed: Jul-24-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	15.9	0.10	mg/L	16.0		99	85-115			
Fluoride	4.01	0.10	mg/L	4.00		100	85-115			
Nitrogen, Nitrate as N	3.96	0.010	mg/L	4.00		99	85-115			
Nitrogen, Nitrite as N	1.87	0.010	mg/L	2.00		93	85-115			
Phosphate, Ortho as P	2.12	0.01	mg/L	2.00		106	85-115			
Sulfate	16.1	1.0	mg/L	16.0		100	85-115			

LCS (B3G1051-BS2) Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	15.9	0.10	mg/L	16.0		99	85-115			
Fluoride	4.06	0.10	mg/L	4.00		102	85-115			
Nitrogen, Nitrate as N	3.90	0.010	mg/L	4.00		98	85-115			
Nitrogen, Nitrite as N	2.01	0.010	mg/L	2.00		101	85-115			
Phosphate, Ortho as P	2.00	0.01	mg/L	2.00		100	85-115			
Sulfate	16.2	1.0	mg/L	16.0		101	85-115			

LCS (B3G1051-BS3) Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	15.8	0.10	mg/L	16.0		99	85-115			
Fluoride	4.00	0.10	mg/L	4.00		100	85-115			
Nitrogen, Nitrate as N	3.94	0.010	mg/L	4.00		99	85-115			
Nitrogen, Nitrite as N	1.98	0.010	mg/L	2.00		99	85-115			
Phosphate, Ortho as P	1.96	0.01	mg/L	2.00		98	85-115			
Sulfate	16.1	1.0	mg/L	16.0		101	85-115			

LCS (B3G1051-BS4) Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	15.7	0.10	mg/L	16.0		98	85-115			
Fluoride	4.05	0.10	mg/L	4.00		101	85-115			
Nitrogen, Nitrate as N	3.94	0.010	mg/L	4.00		98	85-115			
Nitrogen, Nitrite as N	2.08	0.010	mg/L	2.00		104	85-115			
Phosphate, Ortho as P	1.91	0.01	mg/L	2.00		95	85-115			
Sulfate	16.1	1.0	mg/L	16.0		101	85-115			

Duplicate (B3G1051-DUP4) **Source: 3071518-03** Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Chloride	0.71	0.10	mg/L		0.71			< 1	10	

Anions, Batch B3G1051, Continued

Duplicate (B3G1051-DUP4), Continued **Source: 3071518-03** Prepared: Jul-25-13, Analyzed: Jul-25-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Fluoride	< 0.10	0.10	mg/L		< 0.10				10	
Nitrogen, Nitrate as N	< 0.010	0.010	mg/L		< 0.010				10	
Nitrogen, Nitrite as N	< 0.010	0.010	mg/L		< 0.010				10	
Phosphate, Ortho as P	< 0.01	0.01	mg/L		< 0.01				20	
Sulfate	33.4	1.0	mg/L		33.8			1	10	

Dissolved Metals, Batch B3G1099

Blank (B3G1099-BLK1) Prepared: Jul-26-13, Analyzed: Jul-26-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Aluminum, dissolved	< 0.05	0.05	mg/L							
Antimony, dissolved	< 0.001	0.001	mg/L							
Arsenic, dissolved	< 0.005	0.005	mg/L							
Barium, dissolved	< 0.05	0.05	mg/L							
Beryllium, dissolved	< 0.001	0.001	mg/L							
Bismuth, dissolved	< 0.001	0.001	mg/L							
Boron, dissolved	< 0.04	0.04	mg/L							
Cadmium, dissolved	< 0.0001	0.0001	mg/L							
Calcium, dissolved	< 2	2	mg/L							
Chromium, dissolved	< 0.005	0.005	mg/L							
Cobalt, dissolved	< 0.0005	0.0005	mg/L							
Copper, dissolved	< 0.002	0.002	mg/L							
Iron, dissolved	< 0.1	0.1	mg/L							
Lead, dissolved	< 0.001	0.001	mg/L							
Lithium, dissolved	< 0.001	0.001	mg/L							
Magnesium, dissolved	< 0.1	0.1	mg/L							
Manganese, dissolved	< 0.002	0.002	mg/L							
Mercury, dissolved	< 0.0002	0.0002	mg/L							
Molybdenum, dissolved	< 0.001	0.001	mg/L							
Nickel, dissolved	< 0.002	0.002	mg/L							
Phosphorus, dissolved	< 0.2	0.2	mg/L							
Potassium, dissolved	< 0.2	0.2	mg/L							
Selenium, dissolved	< 0.005	0.005	mg/L							
Silicon, dissolved	< 5	5	mg/L							
Silver, dissolved	< 0.0005	0.0005	mg/L							
Sodium, dissolved	< 0.2	0.2	mg/L							
Strontium, dissolved	< 0.01	0.01	mg/L							
Sulfur, dissolved	< 10	10	mg/L							
Tellurium, dissolved	< 0.002	0.002	mg/L							
Thallium, dissolved	< 0.0002	0.0002	mg/L							
Thorium, dissolved	< 0.001	0.001	mg/L							
Tin, dissolved	< 0.002	0.002	mg/L							
Titanium, dissolved	< 0.05	0.05	mg/L							
Uranium, dissolved	< 0.0002	0.0002	mg/L							
Vanadium, dissolved	< 0.01	0.01	mg/L							
Zinc, dissolved	< 0.04	0.04	mg/L							
Zirconium, dissolved	< 0.001	0.001	mg/L							

Duplicate (B3G1099-DUP1) **Source: 3071518-02** Prepared: Jul-26-13, Analyzed: Jul-26-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Aluminum, dissolved	5.27	0.05	mg/L		5.83			10	16	
Antimony, dissolved	< 0.001	0.001	mg/L		0.001				21	
Arsenic, dissolved	0.005	0.005	mg/L		0.006				10	
Barium, dissolved	< 0.05	0.05	mg/L		0.05				6	
Beryllium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Bismuth, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Boron, dissolved	< 0.04	0.04	mg/L		< 0.04				13	
Cadmium, dissolved	0.0001	0.0001	mg/L		< 0.0001				24	

QUALITY CONTROL DATA

REPORTED TO Western Water Associates Ltd
PROJECT Blackwater WW

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B3G1099, Continued										
Duplicate (B3G1099-DUP1), Continued	**Source: 3071518-02**			Prepared: Jul-26-13, Analyzed: Jul-26-13						
Calcium, dissolved	8	2	mg/L		9				10	
Chromium, dissolved	0.005	0.005	mg/L		0.005				7	
Cobalt, dissolved	0.0011	0.0005	mg/L		0.0012				12	
Copper, dissolved	0.002	0.002	mg/L		0.002				20	
Iron, dissolved	3.1	0.1	mg/L		3.0			3	10	
Lead, dissolved	0.005	0.001	mg/L		0.005			< 1	14	
Lithium, dissolved	0.002	0.001	mg/L		0.002				15	
Magnesium, dissolved	2.5	0.1	mg/L		2.6			5	9	
Manganese, dissolved	0.107	0.002	mg/L		0.113			5	10	
Mercury, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				20	
Molybdenum, dissolved	< 0.001	0.001	mg/L		< 0.001				16	
Nickel, dissolved	0.002	0.002	mg/L		0.004				14	
Phosphorus, dissolved	< 0.2	0.2	mg/L		< 0.2				23	
Potassium, dissolved	1.5	0.2	mg/L		1.8			14	17	
Selenium, dissolved	< 0.005	0.005	mg/L		< 0.005				23	
Silicon, dissolved	15	5	mg/L		16				10	
Silver, dissolved	< 0.0005	0.0005	mg/L		< 0.0005				20	
Sodium, dissolved	3.3	0.2	mg/L		3.5			5	9	
Strontium, dissolved	0.07	0.01	mg/L		0.07			4	9	
Sulfur, dissolved	< 10	10	mg/L		< 10				27	
Tellurium, dissolved	< 0.002	0.002	mg/L		< 0.002				20	
Thallium, dissolved	< 0.0002	0.0002	mg/L		< 0.0002				12	
Thorium, dissolved	< 0.001	0.001	mg/L		< 0.001				20	
Tin, dissolved	< 0.002	0.002	mg/L		< 0.002				20	
Titanium, dissolved	0.16	0.05	mg/L		0.19				20	
Uranium, dissolved	0.0011	0.0002	mg/L		0.0016			37	11	
Vanadium, dissolved	< 0.01	0.01	mg/L		0.01				14	
Zinc, dissolved	0.05	0.04	mg/L		0.05				11	
Zirconium, dissolved	0.006	0.001	mg/L		0.006			4	20	
Matrix Spike (B3G1099-MS1)	**Source: 3071518-03**			Prepared: Jul-26-13, Analyzed: Jul-26-13						
Antimony, dissolved	0.353	0.001	mg/L	0.400	0.001	88	71-112			
Arsenic, dissolved	0.179	0.005	mg/L	0.200	0.009	85	82-112			
Barium, dissolved	0.94	0.05	mg/L	1.00	0.13	81	80-109			
Beryllium, dissolved	0.094	0.001	mg/L	0.100	< 0.001	94	75-111			
Cadmium, dissolved	0.0950	0.0001	mg/L	0.100	0.0002	95	84-109			
Chromium, dissolved	0.384	0.005	mg/L	0.400	0.009	94	87-115			
Cobalt, dissolved	0.388	0.0005	mg/L	0.400	0.0066	95	85-118			
Copper, dissolved	0.393	0.002	mg/L	0.400	0.010	96	84-121			
Iron, dissolved	2.2	0.1	mg/L	2.00	8.6	NR	71-129			SPK1
Lead, dissolved	0.198	0.001	mg/L	0.200	0.006	96	81-111			
Manganese, dissolved	0.386	0.002	mg/L	0.400	0.678	NR	66-125			SPK1
Nickel, dissolved	0.382	0.002	mg/L	0.400	0.018	91	85-115			
Selenium, dissolved	0.090	0.005	mg/L	0.100	< 0.005	90	77-113			
Silver, dissolved	0.0977	0.0005	mg/L	0.100	< 0.0005	98	52-131			
Thallium, dissolved	0.0996	0.0002	mg/L	0.100	< 0.0002	100	82-111			
Vanadium, dissolved	0.38	0.01	mg/L	0.400	0.02	89	85-111			
Zinc, dissolved	0.94	0.04	mg/L	1.00	0.04	89	85-115			
Reference (B3G1099-SRM1)				Prepared: Jul-26-13, Analyzed: Jul-26-13						
Aluminum, dissolved	0.24	0.05	mg/L	0.233		101	58-142			
Antimony, dissolved	0.054	0.001	mg/L	0.0430		125	75-125			
Arsenic, dissolved	0.417	0.005	mg/L	0.438		95	81-119			
Barium, dissolved	3.33	0.05	mg/L	3.35		99	83-117			
Beryllium, dissolved	0.207	0.001	mg/L	0.213		97	80-120			
Boron, dissolved	1.61	0.04	mg/L	1.74		93	74-117			
Cadmium, dissolved	0.221	0.0001	mg/L	0.224		99	83-117			

QUALITY CONTROL DATA

REPORTED TO	Western Water Associates Ltd	**WORK ORDER**	3071518
PROJECT	Blackwater WW	**REPORTED**	Jul-31-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Dissolved Metals, Batch B3G1099, Continued										
Reference (B3G1099-SRM1), Continued				Prepared: Jul-26-13, Analyzed: Jul-26-13						
Calcium, dissolved	7	2	mg/L	7.69		96	76-124			
Chromium, dissolved	0.439	0.005	mg/L	0.437		100	81-119			
Cobalt, dissolved	0.133	0.0005	mg/L	0.128		104	76-124			
Copper, dissolved	0.886	0.002	mg/L	0.844		105	84-116			
Iron, dissolved	1.3	0.1	mg/L	1.29		102	74-126			
Lead, dissolved	0.114	0.001	mg/L	0.112		102	72-128			
Lithium, dissolved	0.106	0.001	mg/L	0.104		102	60-140			
Magnesium, dissolved	7.1	0.1	mg/L	6.92		102	81-119			
Manganese, dissolved	0.352	0.002	mg/L	0.345		102	84-116			
Molybdenum, dissolved	0.410	0.001	mg/L	0.426		96	83-117			
Nickel, dissolved	0.856	0.002	mg/L	0.840		102	74-126			
Phosphorus, dissolved	0.6	0.2	mg/L	0.495		113	68-132			
Potassium, dissolved	2.9	0.2	mg/L	3.19		90	74-126			
Selenium, dissolved	0.028	0.005	mg/L	0.0331		85	70-130			
Sodium, dissolved	18.9	0.2	mg/L	19.1		99	72-128			
Strontium, dissolved	0.92	0.01	mg/L	0.916		101	84-113			
Thallium, dissolved	0.0398	0.0002	mg/L	0.0393		101	57-143			
Uranium, dissolved	0.264	0.0002	mg/L	0.266		99	85-115			
Vanadium, dissolved	0.85	0.01	mg/L	0.869		98	87-113			
Zinc, dissolved	0.86	0.04	mg/L	0.881		97	72-128			
General Parameters, Batch B3G0996										
Blank (B3G0996-BLK1)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Carbon, Total Organic	< 0.5	0.5	mg/L							
Blank (B3G0996-BLK2)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Carbon, Total Organic	< 0.5	0.5	mg/L							
LCS (B3G0996-BS1)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Carbon, Total Organic	9.2	0.5	mg/L	10.0		92	80-120			
LCS (B3G0996-BS2)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Carbon, Total Organic	9.9	0.5	mg/L	10.0		99	80-120			
General Parameters, Batch B3G1023										
Blank (B3G1023-BLK1)				Prepared: Jul-24-13, Analyzed: Jul-29-13						
BOD, 5-day	< 10	10	mg/L							
Blank (B3G1023-BLK2)				Prepared: Jul-24-13, Analyzed: Jul-29-13						
BOD, 5-day	< 10	10	mg/L							
LCS (B3G1023-BS1)				Prepared: Jul-24-13, Analyzed: Jul-29-13						
BOD, 5-day	214	10	mg/L	198		108	85-115			
LCS (B3G1023-BS2)				Prepared: Jul-24-13, Analyzed: Jul-29-13						
BOD, 5-day	218	10	mg/L	198		110	85-115			
General Parameters, Batch B3G1029										
Blank (B3G1029-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Suspended	< 1	1	mg/L							
Blank (B3G1029-BLK2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Suspended	< 1	1	mg/L							

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
General Parameters, Batch B3G1029, Continued										
Blank (B3G1029-BLK3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Suspended	< 1	1	mg/L							
LCS (B3G1029-BS1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Suspended	50	1	mg/L	50.0		100	85-110			
LCS (B3G1029-BS2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Suspended	49	1	mg/L	50.0		98	85-110			
LCS (B3G1029-BS3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Suspended	49	1	mg/L	50.0		98	85-110			
Reference (B3G1029-SRM1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Suspended	150	1	mg/L	159		94	80-120			
General Parameters, Batch B3G1030										
Blank (B3G1030-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Dissolved	< 5	5	mg/L							
Blank (B3G1030-BLK2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Dissolved	< 5	5	mg/L							
Reference (B3G1030-SRM1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Dissolved	233	5	mg/L	240		97	85-115			
Reference (B3G1030-SRM2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Solids, Total Dissolved	236	5	mg/L	240		98	85-115			
General Parameters, Batch B3G1047										
Blank (B3G1047-BLK1)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	< 2	2	uS/cm							
Blank (B3G1047-BLK2)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	< 2	2	uS/cm							
Blank (B3G1047-BLK3)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	< 2	2	uS/cm							
Blank (B3G1047-BLK4)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	< 2	2	uS/cm							
LCS (B3G1047-BS5)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	1420	2	uS/cm	1410		100	93-104			
LCS (B3G1047-BS6)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	1420	2	uS/cm	1410		101	93-104			
LCS (B3G1047-BS7)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	1430	2	uS/cm	1410		101	93-104			
LCS (B3G1047-BS8)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
Conductivity (EC)	1430	2	uS/cm	1410		101	93-104			
Reference (B3G1047-SRM1)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
pH	6.99	0.01	pH units	7.00		100	98-102			

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
General Parameters, Batch B3G1047, Continued										
Reference (B3G1047-SRM2)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
pH	7.00	0.01	pH units	7.00		100	98-102			
Reference (B3G1047-SRM3)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
pH	6.99	0.01	pH units	7.00		100	98-102			
Reference (B3G1047-SRM4)				Prepared: Jul-24-13, Analyzed: Jul-24-13						
pH	6.99	0.01	pH units	7.00		100	98-102			
General Parameters, Batch B3G1069										
Blank (B3G1069-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Nitrogen, Ammonia as N, Total	< 0.020	0.020	mg/L							
LCS (B3G1069-BS1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Nitrogen, Ammonia as N, Total	10.1	0.020	mg/L	10.0		101	86-111			
General Parameters, Batch B3G1072										
Blank (B3G1072-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	< 0.1	0.1	NTU							
Blank (B3G1072-BLK2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	< 0.1	0.1	NTU							
Blank (B3G1072-BLK3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	< 0.1	0.1	NTU							
Blank (B3G1072-BLK4)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	< 0.1	0.1	NTU							
LCS (B3G1072-BS1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	39.5	0.1	NTU	40.0		99	85-115			
LCS (B3G1072-BS2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	39.5	0.1	NTU	40.0		99	85-115			
LCS (B3G1072-BS3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	40.0	0.1	NTU	40.0		100	85-115			
LCS (B3G1072-BS4)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	39.9	0.1	NTU	40.0		100	85-115			
Duplicate (B3G1072-DUP1)		**Source: 3071518-01**		Prepared: Jul-25-13, Analyzed: Jul-25-13						
Turbidity	24.0	0.1	NTU		21.7			10	15	
General Parameters, Batch B3G1075										
Blank (B3G1075-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Colour, True	< 5	5	Color Unit							
Blank (B3G1075-BLK2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Colour, True	< 5	5	Color Unit							
Blank (B3G1075-BLK3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Colour, True	< 5	5	Color Unit							

QUALITY CONTROL DATA

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Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
General Parameters, Batch B3G1075, Continued										
LCS (B3G1075-BS1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Colour, True	9	5	Color Unit	10.0		92	81-118			
LCS (B3G1075-BS2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Colour, True	9	5	Color Unit	10.0		92	81-118			
LCS (B3G1075-BS3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Colour, True	9	5	Color Unit	10.0		92	81-118			
Duplicate (B3G1075-DUP2)		**Source: 3071518-01**		Prepared: Jul-25-13, Analyzed: Jul-25-13						
Colour, True	< 5	5	Color Unit		< 5				5	
General Parameters, Batch B3G1114										
Blank (B3G1114-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	< 0.1	0.1	%							
Blank (B3G1114-BLK2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	< 0.1	0.1	%							
Blank (B3G1114-BLK3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	< 0.1	0.1	%							
Blank (B3G1114-BLK4)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	< 0.1	0.1	%							
Blank (B3G1114-BLK5)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	< 0.1	0.1	%							
Duplicate (B3G1114-DUP4)		**Source: 3071518-01**		Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	98.3	0.1	%		98.3			< 1	15	
Reference (B3G1114-SRM1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	81.3	0.1	%	79.8		102	90-110			
Reference (B3G1114-SRM2)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	81.2	0.1	%	79.8		102	90-110			
Reference (B3G1114-SRM3)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	81.0	0.1	%	79.8		101	90-110			
Reference (B3G1114-SRM4)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	81.2	0.1	%	79.8		102	90-110			
Reference (B3G1114-SRM5)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
UV Transmittance @ 254nm	81.1	0.1	%	79.8		102	90-110			
General Parameters, Batch B3G1116										
Blank (B3G1116-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Phosphorus, Total Kjeldahl Dissolved	< 0.01	0.01	mg/L							
LCS (B3G1116-BS1)				Prepared: Jul-25-13, Analyzed: Jul-25-13						
Phosphorus, Total Kjeldahl Dissolved	0.56	0.01	mg/L	0.500		112	80-120			
Microbiological Parameters, Batch B3G1001										

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Microbiological Parameters, Batch B3G1001, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Blank (B3G1001-BLK1)				Prepared: Jul-24-13, Analyzed: Jul-25-13						
Coliforms, Total	< 1	1	CFU/100mL							
Coliforms, Fecal	< 1	1	CFU/100mL							
E. coli	< 1	1	CFU/100mL							
Blank (B3G1001-BLK2)				Prepared: Jul-24-13, Analyzed: Jul-25-13						
Coliforms, Total	< 1	1	CFU/100mL							
Coliforms, Fecal	< 1	1	CFU/100mL							
E. coli	< 1	1	CFU/100mL							
Blank (B3G1001-BLK3)				Prepared: Jul-24-13, Analyzed: Jul-25-13						
Coliforms, Total	< 1	1	CFU/100mL							
Coliforms, Fecal	< 1	1	CFU/100mL							
E. coli	< 1	1	CFU/100mL							
Blank (B3G1001-BLK4)				Prepared: Jul-24-13, Analyzed: Jul-25-13						
Coliforms, Total	< 1	1	CFU/100mL							
Coliforms, Fecal	< 1	1	CFU/100mL							
E. coli	< 1	1	CFU/100mL							

Microbiological Parameters, Batch B3G1019

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Blank (B3G1019-BLK1)				Prepared: Jul-24-13, Analyzed: Jul-25-13						
Coliforms, Total (MPN)	< 3.0	3.0	MPN/100mL							
Coliforms, Fecal (MPN)	< 3.0	3.0	MPN/100mL							
E. coli (MPN)	< 3.0	3.0	MPN/100mL							
Blank (B3G1019-BLK2)				Prepared: Jul-24-13, Analyzed: Jul-25-13						
Coliforms, Total (MPN)	< 2.2	3.0	MPN/100mL							
Coliforms, Fecal (MPN)	< 2.2	3.0	MPN/100mL							
E. coli (MPN)	< 2.2	3.0	MPN/100mL							

Total Recoverable Metals, Batch B3G1097

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Blank (B3G1097-BLK1)				Prepared: Jul-25-13, Analyzed: Jul-26-13						
Aluminum, total	< 0.05	0.05	mg/L							
Antimony, total	< 0.001	0.001	mg/L							
Arsenic, total	< 0.005	0.005	mg/L							
Barium, total	< 0.05	0.05	mg/L							
Beryllium, total	< 0.001	0.001	mg/L							
Bismuth, total	< 0.001	0.001	mg/L							
Boron, total	< 0.04	0.04	mg/L							
Cadmium, total	< 0.0001	0.0001	mg/L							
Calcium, total	< 2	2	mg/L							
Chromium, total	< 0.005	0.005	mg/L							
Cobalt, total	< 0.0005	0.0005	mg/L							
Copper, total	< 0.002	0.002	mg/L							
Iron, total	< 0.1	0.1	mg/L							
Lead, total	< 0.001	0.001	mg/L							
Lithium, total	< 0.001	0.001	mg/L							
Magnesium, total	< 0.1	0.1	mg/L							
Manganese, total	< 0.002	0.002	mg/L							
Mercury, total	< 0.0002	0.0002	mg/L							
Molybdenum, total	< 0.001	0.001	mg/L							
Nickel, total	< 0.002	0.002	mg/L							
Phosphorus, total	< 0.2	0.2	mg/L							
Potassium, total	< 0.2	0.2	mg/L							

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Total Recoverable Metals, Batch B3G1097, Continued

Blank (B3G1097-BLK1), Continued Prepared: Jul-25-13, Analyzed: Jul-26-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Selenium, total	< 0.005	0.005	mg/L							
Silicon, total	< 5	5	mg/L							
Silver, total	< 0.0005	0.0005	mg/L							
Sodium, total	< 0.2	0.2	mg/L							
Strontium, total	< 0.01	0.01	mg/L							
Sulfur, total	< 10	10	mg/L							
Tellurium, total	< 0.002	0.002	mg/L							
Thallium, total	< 0.0002	0.0002	mg/L							
Thorium, total	< 0.001	0.001	mg/L							
Tin, total	< 0.002	0.002	mg/L							
Titanium, total	< 0.05	0.05	mg/L							
Uranium, total	< 0.0002	0.0002	mg/L							
Vanadium, total	< 0.01	0.01	mg/L							
Zinc, total	< 0.04	0.04	mg/L							
Zirconium, total	< 0.001	0.001	mg/L							

Duplicate (B3G1097-DUP1) **Source: 3071518-03** Prepared: Jul-25-13, Analyzed: Jul-26-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Aluminum, total	27.4	0.05	mg/L		26.1			5	27	
Antimony, total	< 0.001	0.001	mg/L		< 0.001				24	
Arsenic, total	0.020	0.005	mg/L		0.019				14	
Barium, total	0.26	0.05	mg/L		0.25			5	16	
Beryllium, total	0.001	0.001	mg/L		0.001				20	
Bismuth, total	< 0.001	0.001	mg/L		< 0.001				20	
Boron, total	< 0.04	0.04	mg/L		< 0.04				15	
Cadmium, total	0.0007	0.0001	mg/L		0.0005			25	40	
Calcium, total	31	2	mg/L		30			1	14	
Chromium, total	0.028	0.005	mg/L		0.026			7	17	
Cobalt, total	0.0159	0.0005	mg/L		0.0151			5	17	
Copper, total	0.031	0.002	mg/L		0.029			6	30	
Iron, total	30.7	0.1	mg/L		28.1			9	28	
Lead, total	0.027	0.001	mg/L		0.027			< 1	19	
Lithium, total	0.014	0.001	mg/L		0.014			2	18	
Magnesium, total	12.4	0.1	mg/L		11.5			7	13	
Manganese, total	1.40	0.002	mg/L		1.32			6	19	
Mercury, total	< 0.0002	0.0002	mg/L		< 0.0002				40	
Molybdenum, total	< 0.001	0.001	mg/L		< 0.001				24	
Nickel, total	0.038	0.002	mg/L		0.035			7	33	
Phosphorus, total	0.8	0.2	mg/L		0.6				24	
Potassium, total	3.7	0.2	mg/L		3.3			11	22	
Selenium, total	< 0.005	0.005	mg/L		< 0.005				21	
Silicon, total	45	5	mg/L		42			5	25	
Silver, total	< 0.0005	0.0005	mg/L		< 0.0005				23	
Sodium, total	5.4	0.2	mg/L		5.0			8	17	
Strontium, total	0.16	0.01	mg/L		0.15			6	11	
Sulfur, total	< 10	10	mg/L		< 10				41	
Tellurium, total	< 0.002	0.002	mg/L		< 0.002				31	
Thallium, total	0.0002	0.0002	mg/L		0.0002				21	
Thorium, total	< 0.001	0.001	mg/L		< 0.001				46	
Tin, total	< 0.002	0.002	mg/L		< 0.002				30	
Titanium, total	0.80	0.05	mg/L		0.71			11	60	
Uranium, total	0.0025	0.0002	mg/L		0.0025			< 1	17	
Vanadium, total	0.06	0.01	mg/L		0.05			6	27	
Zinc, total	0.14	0.04	mg/L		0.14				26	
Zirconium, total	0.006	0.001	mg/L		0.008			38	60	

Matrix Spike (B3G1097-MS1) **Source: 3071518-04** Prepared: Jul-25-13, Analyzed: Jul-26-13

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Antimony, total	0.394	0.001	mg/L	0.400	< 0.001	99	81-122			

Total Recoverable Metals, Batch B3G1097, Continued

Analyte	Result	MRL	Units	Spike Level	Source Result	% REC	REC Limit	RPD	RPD Limit	Notes
Matrix Spike (B3G1097-MS1), Continued	**Source: 3071518-04**			Prepared: Jul-25-13, Analyzed: Jul-26-13						
Arsenic, total	0.182	0.005	mg/L	0.200	< 0.005	91	81-119			
Barium, total	0.94	0.05	mg/L	1.00	< 0.05	94	84-113			
Beryllium, total	0.095	0.001	mg/L	0.100	< 0.001	95	77-117			
Cadmium, total	0.0935	0.0001	mg/L	0.100	< 0.0001	93	87-112			
Chromium, total	0.387	0.005	mg/L	0.400	< 0.005	97	88-119			
Cobalt, total	0.395	0.0005	mg/L	0.400	< 0.0005	99	88-118			
Copper, total	0.396	0.002	mg/L	0.400	< 0.002	99	86-126			
Iron, total	2.3	0.1	mg/L	2.00	0.2	100	70-138			
Lead, total	0.197	0.001	mg/L	0.200	< 0.001	98	82-119			
Manganese, total	0.407	0.002	mg/L	0.400	0.018	97	81-125			
Nickel, total	0.390	0.002	mg/L	0.400	< 0.002	97	85-121			
Selenium, total	0.089	0.005	mg/L	0.100	< 0.005	89	73-121			
Silver, total	0.0979	0.0005	mg/L	0.100	< 0.0005	98	83-118			
Thallium, total	0.0984	0.0002	mg/L	0.100	< 0.0002	98	85-115			
Vanadium, total	0.38	0.01	mg/L	0.400	< 0.01	95	86-116			
Zinc, total	0.94	0.04	mg/L	1.00	< 0.04	94	83-123			
Reference (B3G1097-SRM1)				Prepared: Jul-25-13, Analyzed: Jul-26-13						
Aluminum, total	0.30	0.05	mg/L	0.296		102	81-129			
Antimony, total	0.050	0.001	mg/L	0.0505		99	88-114			
Arsenic, total	0.112	0.005	mg/L	0.122		92	88-114			
Barium, total	0.71	0.05	mg/L	0.777		92	72-104			
Beryllium, total	0.045	0.001	mg/L	0.0488		92	76-131			
Boron, total	3.27	0.04	mg/L	3.40		96	75-121			
Cadmium, total	0.0460	0.0001	mg/L	0.0490		94	89-111			
Calcium, total	10	2	mg/L	10.2		97	86-121			
Chromium, total	0.232	0.005	mg/L	0.242		96	89-114			
Cobalt, total	0.0375	0.0005	mg/L	0.0366		103	91-113			
Copper, total	0.488	0.002	mg/L	0.487		100	91-115			
Iron, total	0.5	0.1	mg/L	0.469		100	77-124			
Lead, total	0.188	0.001	mg/L	0.193		97	92-113			
Lithium, total	0.382	0.001	mg/L	0.390		98	85-115			
Magnesium, total	3.3	0.1	mg/L	3.31		100	78-120			
Manganese, total	0.106	0.002	mg/L	0.109		97	90-114			
Mercury, total	0.0045	0.0002	mg/L	0.00456		99	50-150			
Molybdenum, total	0.181	0.001	mg/L	0.197		92	90-111			
Nickel, total	0.234	0.002	mg/L	0.242		97	90-111			
Phosphorus, total	0.3	0.2	mg/L	0.233		112	85-115			
Potassium, total	5.7	0.2	mg/L	5.93		96	84-113			
Selenium, total	0.106	0.005	mg/L	0.115		92	85-115			
Sodium, total	7.7	0.2	mg/L	7.64		100	82-123			
Strontium, total	0.36	0.01	mg/L	0.363		99	88-112			
Thallium, total	0.0764	0.0002	mg/L	0.0794		96	91-114			
Uranium, total	0.0180	0.0002	mg/L	0.0192		94	85-120			
Vanadium, total	0.35	0.01	mg/L	0.376		94	86-111			
Zinc, total	2.26	0.04	mg/L	2.42		93	85-111			

QC Qualifiers:

SPK1	The recovery of this analyte was outside of established control limits. The data was accepted based on performance of other batch QC.

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