NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

BASELINE HYDROGEOLOGY REPORT

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EXECUTIVE SUMMARY

This report provides a description of the baseline hydrogeological conditions for the Sisson project, a proposed tungsten-molybdenum mining development in west-central New Brunswick. The interpretation of the site conditions considered data collected at the project site during hydrogeology, hydrometeorology, geotechnical and geomechanical site investigations (KP 2011a; KP 2012c; KP 2011e; KP 2011f; TerrAtlantic 2010).

The following stratigraphic units will provide pathways for groundwater flow:

- Till: Surficial geology mapping has identified basal and ablation tills up to approximately 10 m thick in the project area that comprise varying amounts of sand, silt, gravel and clay. The ablation till may be more permeable than the basal till.
- Shallow, weathered bedrock: The presence of this zone in the upper 10 to 20 m of rock is based on regional mapping as well as drilling in the project area.
- Deeper bedrock: Deeper bedrock is expected to be less permeable than of the shallow rock based on hydraulic conductivity testing. High take in packer tests intervals within the deposit area may be flawed.
- Fault zones: Hydraulic conductivity testing did not identify elevated hydraulic conductivity values near faults.

Groundwater recharge will occur on higher ground and discharge primarily in the valley bottoms. Regional discharge is likely east toward West Branch Napadogan Brook. The rate of groundwater recharge is estimated as about 8% of the mean annual precipitation of 1350 mm (KP 2012e). The average groundwater flow velocity along the valley bottoms within the overburden and also the bedrock is estimated to be approximately 0.2 m/day.

Groundwater levels are expected to be a subdued reflection of the ground surface with local groundwater flow toward streams and wetlands. During dry periods, the wetlands may influence low flow conditions in streams through the interception, evaportranspiration and storage of water (Stantec 2012). Preliminary watershed modelling work suggests this condition may be occurring (KP 2012e). Short warming periods in the winter result in a component of the winter snowmelt and therefore winter low flows may reflect both surface runoff and groundwater discharge.

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ABBREVIATIONS

intrusive quartz diorite	IQD
intrusive gabbro	IGB
Knight Piésold Ltd.	KP
felsic and mafic tuffs including Felsic tuff with quartz	FTQ
felsic tuff with augen	FTA
mafic tuff	MF
mafic crystal tuff	MCT
mean annual precipitation	MAP
Northcliff Resources Ltd.	Northcliff
Sisson Project	the Project
Stantec Consulting Ltd.	Stantec
wackes and interbedded tuffs and wackes	WKB

1 – INTRODUCTION

1.1 PROJECT DESCRIPTION AND BACKGROUND

The Sisson Project (the Project) is a proposed open pit mine development located in west-central New Brunswick, approximately 60 km northwest of Fredericton (Figure 1.1-1). The site is accessible by road from Fredericton, with local access provided by secondary and forestry roads. The national rail line is located 15 km away and connects the property to deep-sea ports at Saint John and Belledune, within a few hundred kilometres of the deposit.

The deposit is a structurally controlled, intrusion related tungsten-molybdenum deposit that was initially defined through exploration drilling undertaken by Kidd Creek Mines from 1979 to 1982 (Northcliff Resources Ltd., 2012). Subsequent work was carried out by Geodex Minerals Ltd from 2005 to 2010 (Northcliff Resources Ltd. 2012). Northcliff Resources Ltd. (Northcliff) is currently focusing on advancing the Project through feasibility and into permitting. Engineering and environmental studies are being carried out to support feasibility level engineering design and environmental assessment requirements.

Knight Piésold Ltd. (KP) was retained by Northcliff to assist with hydrogeology studies to support engineering and environmental requirements. Stantec Consulting Ltd (Stantec), based in Fredericton, New Brunswick provided support to KP with the collection of groundwater data from monitoring wells installed in 2011 by KP (KP 2012a).

1.2 SCOPE OF REPORT

The objective of this report is to provide a description of the existing groundwater regime in the project area including: the interpretation of aquifers and aquitards; the hydraulic properties of geological units; the rate and direction of groundwater flow; and the expected interaction of groundwater and surface water. The characterization of the groundwater quality is discussed in the report, Baseline Water Quality (KP 2012b).

2 – SITE DESCRIPTION

2.1 PHYSIOGRAPHY AND DRAINAGE

The Project is located in the Miramichi Highlands (Figure 2.1-1), which are characterized by rolling hills and broad valley features. The elevation in the project area ranges from approximately 300 to 350 metres above sea level (masl), with some hills rising to over 400 masl. Stantec (2012) describes the vegetation cover as shaped by a history of extensive commercial logging that has resulted in an area dominated by young forest stands. Wetlands cover about 380 ha (23%) of the project area (Stantec 2012). The wetland areas generally overlie thin organic soil layers that cover saturated, coarse textured overburden that is fed by throughflow (i.e., shallow groundwater flow through unconsolidated overburden) from the surrounding slopes (Stantec 2012).

The Project is located primarily in the Napadogan Brook (west branch) watershed with a small portion of the footprint in the McBean Brook catchment; both streams are tributaries to the Nashwaak River (Figure 2.1-2). The Nashwaak River is a tributary to the Saint John River, which flows south to the Bay of Fundy.

2.2 HYDROMETEOROLOGY

Hydrometeorological data for the Project is presented in the 2011 Hydrometeorology Report by KP (KP 2012c). The following provides a summary of this report.

2.2.1 Climate

Data from regional climate stations operated by the Meteorological Services of Canada (MSC) branch of Environment Canada were used to estimate long-term regional climate patterns at the project site. There are seven active MSC climates stations within a 70 km radius of the Project (Figure 1.1-1). The closest active MSC station is Juniper (8102275), which is located approximately 23 km northwest of the project site, at an elevation of 259 masl. There are 36 complete years of record at the Juniper station. An automated meteorological station was installed in December 2007 at the southern portion of the deposit area, at an elevation of 305 masl (Sisson station) as shown on Figure 2.2-1. Several discrete interruptions in the data collection occurred from 2008 to present.

The regional data indicates there are similar monthly patterns and annual precipitation values and no observable orographic effects in the region. Concurrent precipitation data from the Juniper and Sisson station were compared using a double mass curve analysis. This analysis indicated that the project site has about 27% more precipitation than at the Juniper station. Application of this factor to Juniper`s mean annual precipitation (MAP) of 1136 mm results in a MAP estimate for the project site of 1443 mm. This value is greater than the highest long-term MAP value recorded in the region which is 1297 mm at Hamtown Corner (an inactive station about 37 km from the site at an elevation of 244 m). The high unit runoffs at the Project support the potential for higher precipitation at the site. However, since the site precipitation data is relatively short and incomplete, there is uncertainty in the analysis. The MAP for the site was therefore estimated at 1350 mm using results from baseline watershed modelling being completed for the Project. The letter (KP 2012d) describing this watershed modelling is in Appendix A.

Monthly rainfall and snowfall for the Project was based on the distribution of the precipitation data from Juniper and the MAP of 1350 mm. On average, the precipitation is distributed evenly through the year, with the exception of February which is slightly drier than the other months with a total of 83 mm. Precipitation falls predominantly as snow from January through March and rain from May through September. Precipitation is often mixed rain and snow during April, October, November and December. Snowmelt is expected to begin in late March and continue into April and potentially May.

Long term temperature values were also estimated using data from Juniper. The mean annual temperature is estimated to be 3.3 °C with minimum and maximum monthly mean values of -16.6 °C and 20 °C occurring in January and July, respectively.

2.2.2 Streamflow

There are five active regional streamflow stations operated by the Water Survey of Canada (WSC) in close proximity to the project, Annual flow patterns are very similar at all the WSC stations with lower flows generally occurring during the winters and summer months and higher flows during spring freshet. Narrows Mountain Brook (WSC 01AL004) is considered to have the most similar watershed characteristics to the site (Figure 2.1-2). Data is available from 1972 to 2011 for the Narrows Mountain Brook station.

Streamflow data within the project area are available from five continuous and two intermittent stations established in May 2011 (Figure 2.2-1.). Data were collected from mid-May to the end of November 2011. The hydrographs for the five continuous project stations as well as Narrows Mountain Brook have similar shapes. Long-term data from Narrows Mountain Brook indicates that flows in 2011 were higher than average.

2.2.3 Regional Monitoring and Groundwater Use

The Sciences and Reporting Branch of the New Brunswick Department of Environment prepares a summary of the state of water levels in the province based on precipitation and stream flow data. These provide information on water levels in selected wells used to keep track of groundwater. The information in each report is compared to long-term averages. For 2011, groundwater levels across most of the province were reported to be above normal. The annual summary for 2011 is shown in Figure 2.2-2 for the Miramichi area. The higher than normal groundwater levels (daily averages) are consistent with the higher runoff observed at the project site.

The New Brunswick Department of Environment also operates an online well log system that can be used to identify water wells within a specified area. There were seven water wells within a 15 km radius of the project site identified as summarized in Table 2.2-1 and shown on Figure 1.1-1. Wells with Well Drillers Report Numbers 90865500 and 91400000, plot at the same location on Figure 1.1-1.

2.3 GEOLOGY

2.3.1 Bedrock

The geology summarized in this section is mostly from Rennie (2012), which is generally based on work by Fyffe et al. (2008) and Fyffe and Thorne (2010). The text found in this section is mostly verbatim from the referenced sources.

The regional geological setting of southwest New Brunswick is shown in Figure 2.3-1 and Figure 2.3-2. Mesoproterozoic to Early Cambrian basement rocks are exposed in the southwest and include carbonate and clastic sedimentary rocks of Mesoproterozoic to Neoproterozoic age in the Green Head Group and Neoproterozoic to earliest Cambrian mafic and felsic volcanic rocks and clastic sedimentary rocks in the Belleisle Bay Group. These basement rocks are overlain by variably deformed and metamorphosed stratified sequences that were deposited in continental to marine environments between Early Cambrian and Early Devonian time. Early Cambrian to Silurian sequences are dominated by fine to coarse grained, clastic sedimentary rocks and lesser carbonate sequences which are, in many places, interlayered with mafic and felsic volcanic rocks. The Acadian orogeny occurred from Late Silurian to Late Devonian and resulted in a north-northeast trending belt of plutons and batholiths. The Sisson deposit is situated along the eastern margin of this belt (Figure 2.3-3) with older metavolcanic and metasedimentary rocks to the east (Figure 2.3-4 and Figure 2.3-5). Rock types progress through the following units from west to east based on formational assignment by Fyffe et al. (2008):

- Nashwaak Granite batholith
- Howard Peak Granodiorite with three phases: granodiorite, quartz diorite, and gabbro.
- Turnbull Mountain Formation of the Ordovician Tetagouche Group.
    - This unit comprises tuffaceous volcaniclastic rocks and biotite wackes. It is the main host rock to mineralization in Zone III.
- Cambrian to Early Ordovician Miramichi Group.
    - Dominated by siliceous wackes interbedded with siltstones and quartzites, with minor interbeds of intermediate volcaniclastic rocks.
- Hayden Lake Formation of the Ordovician Tetagouche Group.
    - This unit contains black shales, and felsic and mafic volcanics.
- Push and Be Damned Formation of the Ordovician Tetagouche Group.
    - These are clastic sedimentary rocks located east of the Sisson deposit.

Stratified rocks within the deposit area strike north-northeast and dip steeply to the east (Figure 2.3-6). Rock types were simplified into four major domains in the 2011 Open Pit Site Investigation Report (KP 2012e; Lang 2011) as follows:

- Intrusive: Intrusive quartz diorite (geological code IQD) and intrusive gabbro (IGB).
- Metavolcanic: Felsic and mafic tuffs including Felsic tuff with quartz (FTQ), Felsic tuff with augen (FTA), Mafic tuff (MTF), Mafic crystal tuff (MCT).
- Metasediment: Wackes and interbedded tuffs and wackes (WKB).
- Dykes/Veins.

Weathered rock is widespread in west-central New Brunswick and is an indicator of the fairly limited erosive ability of glaciers that inundated the area (Seaman 2009). However, glacially polished and striated bedrock surfaces are observed, particularly on the harder and less permeable rocks such as fine-grained igneous rocks, wackes and metasedimentary rocks. Bedrock outcrop on the Sisson project site is limited because of the extensive till cover (McClenaghan et al. 2012). Two outcrops were identified about 2 km north of the deposit by McClenaghan et al. (2012).

The north trending contact between the gabbro and the Turnbull Mountain Formation is a vertical fault zone, which ranges from a few to about 20 m in width. It is marked by strong fracturing, local brecciation, and minor gouge seams (Rennie 2012).

2.3.2 Surficial Geology

The surficial geology for west-central New Brunswick is discussed by Seaman and McCoy (2008), Seaman (2009), Fyffe and Thorne (2010), McClenaghan et al. (2012) and Seaman (2012). A summary of these references is provided below. The text found in this section is mostly verbatim from the referenced sources.

West-central New Brunswick has experienced a complex glacial history (Seaman et al. 1993; Seaman 2009). The Quaternary stratigraphy of west-central New Brunswick is shown in Figure 2.3-7. The oldest identified glaciation was the Northumberland Phase, assigned to the Illinoian Glacial Stage. Glacial flow was eastward to east-southeastward (Seaman 2011). The Northumberland Phase was terminated by the Sangamonian Interglacial Stage. This Stage was a climatic period comparable to or warmer than the present Holocene Interglaciation with surface and subsurface processes similar to those of today existing. The Sangamonian was terminated by the regional glaciation of the Wisconsinan Glacial Stage.

The Early to Middle Wisconsinan Stage was dominated by southeast to south-southeast ice flow from the Laurentide Ice Sheet. This glacial event is assigned to the Caledonia Phase. The presence of a surface 'Caledonia till' (informal name) throughout much of west-central New Brunswick is indicated by preserved dispersal trains (Figure 2.3-8). Locally, the Caledonia till contains 'pebbles' to 'boulders' of reworked Northumberland till. It may also contain rounded pebbles derived from reworking of Northumberland Phase glaciofluvial deposits and Sangamonian fluvial deposits.

The termination of the Caledonia Phase occurred when the Laurentide Ice Sheet was completely replaced by Appalachian Glacier Complex ice during the Middle Wisconsinan. The main centre of ice flow migrated from the Notre Dame Ice Divide to the Escuminac Ice Centre. This condition, initiated the Escuminac Phase, and resulted in ice-flow trends that changed from south-southeast to south, south-southwest, southwest, and possibly west-southwest to west (Seaman et al. 1993).

Glacial events subsequent to the Late Glacial Maximum relate to the reorganization of the Appalachian Glacier Complex in response to climatic amelioration and associated glacial margin retreat interspersed with climatic cooling that resulted in local readvances. The Scotian Phase was initiated with retreat of the glacial margin. The southwestward flow from the Escuminac Ice Centre was replaced by east to east-northeast flow.

By the end of the Chignecto Phase, much of New Brunswick was deglaciated (Fyffe and Thorne 2010). However, remnant glaciers reformed or regrew during the Younger Dryas stadial. The Younger Dryas till locally blankets previously deposited tills, where it is between 1 m and 2.5 m thick. Disintegration of the Younger Dryas glacier resulted in the deposition of extensive ablation till deposits (hummocky disintegration moraine) in some areas around the project site (Snow and Coker 1987).

Geodex Minerals excavated an exploration trench over Zone III of the deposit in 2007 (Figure 2.3-4). The trench was oriented east-west and was 100 m long with a maximum width of about 35 m (Seaman and McCoy 2008). Seaman and McCoy (2008) reported the Zone III trench lies near the mapped contact between a large ablation moraine unit in the Sisson Brook valley to the southeast and an area of basal till veneer to the north and west (Figure 2.3-9). Basal lodgment till or basal meltout till were noted by Snow and Coker (1987) in the immediate area of Zone III. Snow and

Coker (1987) and Seaman (2003) noted ablation till and glaciofluvial deposits south and east of Zone III.

Seaman and McCoy (2008) used geochemistry, fabric, and textural characteristics to identify three different basal tills in the trench. McClenaghan et al. (2012) described the three till units as follows:

- Exposed only at the far western edge of the trench is an Illinoian basal lodgement till deposited during the Northumberland Phase by an east-southeast flowing ice sheet. The till is clay-rich and contains abundant weathered granite and metasedimentary clasts.
- Elsewhere in the trench, the bedrock surface is overlain by a sandier Early Wisconsinan lodgement till likely deposited by southeast glacial flow during the Caledonia Phase and possibly reworked by south-southwest glacial flow during the Middle to Late Wisconsinan (Escuminac Phase).
- This Early Wisconsinan lodgement till is blanketed by approximately 1 m to 2.5 m of Younger Dryas (Collins Pond Phase) till, formed during a brief cold period at the very end of the Late Wisconsinan. This Younger Dryas till was deposited by westward flowing ice and has a sandy matrix, formed in part by reworking of Late Wisconsinan glaciofluvial and glaciolacustrine sediments.

There were 13 test pits excavated in the deposit area as part of the 2011 geomechnical program (KP 2012e). KP (2012e) indicated the deposit area is covered with organic top soil that is typically 0 to 1.2 m thick and overlain by gravelly silty sand with trace clay (till). Cobbles and boulders are common and can reach up to 2 m in size.

There were 65 test pits excavated across the project site as part of the 2011 geotechnical program (KP 2012f). This program found similar findings to KP (2012e). Across the site, the topsoil unit ranged from about 0 to 1.4 m in thickness and was comprised of organic materials. The topsoil was underlain by a till unit with varying composition of sand, silt, gravel and clay and a thickness up to about 5 m but generally less than about 2 m. The till was overlain by a sand unit with varying composition of gravel and silt in test pits located along Bird Brook and the small tributaries to the West Branch Napadogan Brook. This unit was typically less than about 0.5 m in thickness and was interpreted as alluvial material.

Simplified geological sections across the project site are provided in the Geotechnical Site Investigation Report (KP 2012f).

3 – GROUNDWATER BASELINE DATA COLLECTION

3.1 DATA COLLECTION

Baseline hydrogeologic data were obtained from groundwater monitoring wells, piezometers and drill-holes completed during hydrogeological, geotechnical and geomechnical site investigations (Figure 3.1-1). Data collection was initiated at the site in 2008 by TerrAtlantic with a geotechnical and hydrogeological drilling program (TerrAtlantic 2010). The main tasks completed during the program are summarized below as:

- Drilling with packer testing and installation of standpipe piezometers. Nested piezometers were installed at 10 sites and a single installation at one site.
- Test trench dewatering and mapping.

During the 2011 hydrogeological site investigation by KP (2012a), the condition of the piezometers installed by TerrAtlantic, were checked by Stantec. A summary of the current condition of the piezometers based on the work by Stantec is in Table 3.1-1. Additional installations were carried out during a 2011 hydrogeological site investigation by KP (KP 2012a) to advance the baseline data collection program. The key work carried out during this investigation included the following:

- Drilling with Standard Penetration Testing (SPT) in overburden and installation of monitoring wells. Clustered (shallow and deep) monitoring wells were installed at five locations and a single installation was completed at one location.
- Well development at the 2011 monitoring wells, in addition to eight of the 2008 standpipe piezometer sites by TerrAtlantic (Table 3.1-1).
- Response testing at the 2011 monitoring wells.
- Installing transducers in the 2011 monitoring wells for long-term water level monitoring.
- Collecting groundwater samples from the 2011 monitoring wells.

Geotechnical and geomechanical site investigations by KP were carried out concurrently with the hydrogeological site investigation in 2011. These investigations are summarized in factual reports by (KP 2012e; KP 2012f). This work included the following activities:

- Drilling with packer testing, and
- Installation of 16 standpipe piezometers.

Table 3.1-2 summarizes the drilling and installation information for the above programs.

3.2 HYDRAULIC CONDUCTIVITY TESTS

3.2.1 Response Tests

As indicated in Section 3.1, the monitoring wells were response tested in 2011 by Stantec. KP analyzed the data. A summary of the response test results at the monitoring wells is presented in Tables 3.2-1. A complete set of analytical plots for the tests is presented in KP (2012).

A total of ten response tests were conducted at the site. There were four tests conducted in overburden and six in bedrock. The hydraulic conductivity from tests in overburden ranged from 5×10^{-6} m/s to 7×10^{-5} m/s, and had a geometric mean of $2\text{x}10^{-5}$ m/s.

Response tests in bedrock were performed in the upper 30 m of rock. Hydraulic conductivities ranged from 8×10^{-5} m/s to 6×10^{-7} m/s and the geometric mean was 1×10^{-5} m/s. The hydraulic conductivity values calculated in the overburden were slightly higher but comparable to those measured in shallow bedrock (Figure 3.2-1).

3.2.2 Packer Tests

As described in Section 3.1, packer tests (Lugeon tests) were conducted during geotechnical drilling in 2008 by TerrAtlantic (TerrAtlantic 2010) and geotechnical and geomechnical drilling in 2011 (KP 2012e; KP 2012f) to measure the hydraulic conductivity of discrete intervals within the bedrock. The results of these tests are presented in Table 3.2-2. The hydraulic conductivities were measured to depths of up to 325 m but were mostly in the upper 200 m. The values ranged from less than $1x10^{-10}$ m/s to $8x10^{-6}$ m/s (Figure 3.2-2). In general, the upper bound of the hydraulic conductivity values generally decreased with depth (Figure 3.2-3). There does not appear to be a relationship between hydraulic conductivity values and rock types (Figure 3.2-4 and Figure 3.2-6).

Relatively high flow rates (greater than 100 L/min) were measured in 11 packer tests at five drill holes in the deposit area (Table 3.2-2). These high flow rates indicate the potential for relatively high hydraulic conductivity values but were not conclusively supported by other available drilling information such as drill circulation losses and observations of the core. Additionally there was one test which showed low take during the first two stages of the Lugeon test followed by higher take during the third and maximum pressure stage at which time the testing was aborted because the flow rates were increasing to a value higher than could be measured. This flow condition observed during this packer test indicates that the higher take is likely not indicative of the bulk permeability of the test interval. Given the uncertainty with the high take tests, the following was recommended:

- Identify the packer tests as high take without assigning an actual hydraulic conductivity value, until there is greater certainty regarding the validity of the testing.
- If required, carry out additional and more than one type of hydraulic testing (e.g. constant head, falling head, lugeon) to better constrain whether the high take results are indicative of the site conditions or were influenced by the testing tool or method.
- Recognize the implications of potentially high hydraulic conductivity values within the deposit area on engineering and environmental studies until additional testing is completed to gain a better understanding of the hydraulic conductivity values.

3.2.3 Exploration Trench Dewatering

The exploration trench (Section 2.3.2) was dewatered by TerrAtlantic (2010) between June 9 and June 13, 2008 to estimate the transmissivity of the relatively shallow bedrock. The total volume of water pumped out at a rate of 25 L/s (333 igpm) in 92 hours was approximately 8,350 m^3. The total volume of the trench was calculated as 7,800 m^3. Once fully dewatered, the inflow rate was measured as about 214 m^3/day (233 igpm). TerrAtlantic (2010) estimated a hydraulic conductivity for shallow bedrock in the trench within the range of 6×10^{-6} m/s to 1.6×10^{-5} m/s based on this dewatering exercise. However, TerrAtlantic (2010) considered this estimate to be high as a result of near surface blast damage.

3.3 GROUNDWATER LEVELS

Groundwater levels were measured immediately following the installation of the monitoring wells. Each monitoring well has a dedicated transducer installed that records the water level each hour.

Transducer data has been collected since late October 2011. Manual measurements are also collected before downloading the transducers during quarterly site groundwater sampling. Stantec collects the measurements and KP analyzed the data. The water level data is presented in the following appendices:

- Appendix B1: Summary of Manual Water levels, and
- Appendix B2: Time Series of Piezometric Elevations.

The time series readings from the groundwater level data indicate that the groundwater system is transient. Groundwater levels were typically lower just before spring runoff and in late fall. The highest groundwater levels were recorded during spring runoff and/or during the early summer rains, as indicated by the correlation between streamflow measured at Narrows Mountain Brook and groundwater elevation. Water levels measured at Narrows Mountain Brook are shown in Figure 3.3-1. Groundwater levels were higher in September 2011 compared to September 2012, which is consistent with wetter than average conditions observed at the project site (Section 2.2.2) and regionally (Section 2.2-1).

Groundwater elevations commonly varied by about 0.5 to 2 m between the seasonal low and seasonal high (Appendix B2). The groundwater level at MW11-03D/S showed the greatest decline during the winter and greatest increase during spring runoff. The groundwater level fluctuations were also flashy, similar to the change in streamflow. The screened intervals for both the deep and shallow installations at MW11-03D/S are within Biotite Wacke. The Rock Quality Designation (RQD) values measured within the screened intervals for these monitoring wells were the lowest recorded for all the monitoring sites (KP 2012a). The greater water level fluctuations may be a result of low storage within the rock and/or weathered bedrock that allows water from surface to more rapidly moved downward. An area of bedrock outcrop was identified in the area which may allow recharge to flow to deeper bedrock (Section 2.3.1).

The water level fluctuations were most muted in MW11-01. This monitoring well is screened across the overburden and bedrock contact. The overburden is comprised of a sand unit overlying a silty sand and had the greatest overburden thickness at this site compared to the other locations. The silty sand unit may be acting as a confining unit and muting the effects of recharge from surface runoff and meteoric recharge. The groundwater level fluctuations were also less pronounced, but to a lesser extent, at MW11-05D/S and MW11-06D/S. The overburden thickness at these sites was also relatively thicker at 12.2 m and 6.6 m. The overburden may also be a controlling factor influencing the transient changes in the water levels at these sites.

At all the sites, the water level in the shallow well had a greater water level fluctuation response then the water level in the deeper well during spring runoff. Downward gradients were observed at MW11-02D/S and MW11-05D/S and upward gradients were observed at MW11-04D/S and MW11-06D/S. During spring melt and summer rains, the gradient is reversed and is downward at MW11-03D/S.

Artesian conditions are present at MW11-04D/S as well as other sites in the deposit area (Appendix B1; TerrAtlantic 2010). This area is characterized by steep slopes surrounding the Sisson Brook valley. Artesian conditions driven by topographical controls typically occur in such a setting.

3.4 GROUNDWATER SPRINGS

Stantec (2012) reported that wetlands within the project area are expected to be areas of groundwater discharge and seepage. Groundwater springs have been observed in the Trouser and Christmas Lake areas (within the McBean catchment, that is south of the deposit area).

4 – HYDROGEOLOGICAL SETTING

The bedrock includes intrusive rocks to the east and metasedimentary and metavolcanic rocks to the west, overlain by overburden with few occurrences of bedrock outcrops. A fault has been interpreted along the contact of the intrusives with the metasedimentary and metavolcanic rocks. No aquifers have been identified as preferential flow paths in the project area. However, the following stratigraphic units will provide paths for groundwater flow:

- Till: Surficial geology mapping has identified basal and ablation tills up to about 10 m in the project area. The till is comprised of varying composition of sand, silt, gravel and clay. The ablation till may be more permeable than the basal till.
- Shallow, weathered bedrock: The presence of this zone in the upper 10 m to 20 m of rock is based on regional mapping as well as drilling in the project area.
- Deeper bedrock: Deeper bedrock is expected to be less permeable than the top of rock based on hydraulic conductivity testing. High take in packer tests intervals within the deposit area may be flawed.
- Fault zones: Faults provide both conduits and barriers to groundwater flow. Conduits are provided through fractured ground adjacent to the fault and barriers are due to fault gouge with the fault itself. Hydraulic conductivity testing has not identified elevated hydraulic conductivities near faults.

Groundwater regimes are commonly defined as regional, intermediate and local systems of groundwater flow. Local flow systems dominants in areas with pronounced local relief and regional systems develop in areas with negligible relief (Freeze and Cherry, 1979). The local relief at the project site suggests that regional flow systems will dominate, with recharge occurring on higher ground and discharging primarily in valley bottoms such as the West Branch Napadogan Brook. Local recharge may be derived from the following areas:

- Weathered rock on hilltops and hillsides: This recharge provides groundwater for deeper bedrock materials and also flow downslope, within the top of rock.
- Valley bottoms. The small valleys along the tributaries to the West Branch Napadogan Brook such as Bird Brook and Sisson Brook include till deposits and sand with varying degrees of gravel, silt and clay deposits. Generally these areas are more likely to be discharge areas. Artesian conditions observed in the deposit area reflect discharging conditions.

There are many small ponds and wetlands in the project area. There may be local discharge into these ponds. During dry periods, the wetlands may influence low flow conditions in streams through the interception, evaportranspiration and storage of water (Stantec 2012). Preliminary watershed modelling work suggests this condition may be occurring (KP 2012e).

The rate of groundwater recharge was estimated as about 8 % of the MAP (1350 mm) based on a watershed model for the project that was calibrated to regional streamflows at Narrows Mountain Brook (KP 2012e). The regional streamflow data currently provides the best approximation of the long-term distribution and volume of flow at the site. As additional precipitation and streamflow measurements (especially low flow measurements) are collected on site, the modelling work may be revised to use site data for calibration. Short warming periods in the winter result in a component of the winter snowmelt and therefore winter low flows may reflect both surface runoff and groundwater discharge.

As at most sites, groundwater levels are expected to be a subdued reflection of the ground surface. Local groundwater flow will be toward local streams and wetlands. Regional discharge is likely east toward West Branch Napadogan Brook. Horizontal groundwater flow gradients in the project area along valley slopes are estimated as about 0.2 m/m and along valley bottoms as 0.01 m/m.

The average groundwater flow velocity within the overburden is 0.2 m/day based on the estimated horizontal gradient (0.01 m/m), a hydraulic conductivity value of 2×10^{-5} m/s and an assumed porosity of 0.1 (Freeze and Cherry, 1979). The average groundwater flow velocity within the bedrock is also 0.2 m/day based on the estimated horizontal gradient (0.01 m/m), a hydraulic conductivity value of 2×10^{-7} m/s and an assumed porosity of 0.001 (Freeze and Cherry, 1979).

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6 – CERTIFICATION

This report was prepared, reviewed and approved by the undersigned.

PROFESSIONAL PROVINCE OF C. H. H. SAFADI # 34954 BRITISH COLUMBIA ENGINEER

January 2, 2013

Prepared:

Cathy Safadi, P.Eng.
Senior Engineer

Reviewed:

for HR (Rod) Smith, P.Eng.
Specialist Geological Engineer / Hydrogeologist

Approved:

Ken Brouwer, P.Eng.
Managing Director

Knight Piésold CONSULTING

TABLE 2.2-1

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF WATER WELLS WITHIN 15 KM RADIUS OF THE PROJECT

Print Jan/02/13 11:24:15

Report Number	Installation Date	Total Depth (m)	Water Level (mbtoc)	Pumping Rate (L/sec)	Depth to Bedrock (m)	Latitude (°N)	Longitude (°E)
16893	28-Feb-07	47.24	9.14	0.5	NA	46.48799	-67.03917
17503	14-May-08	79.25	6.1	1.7	10.97	46.45496	-66.99261
28488	05-Oct-11	NA	0.91	0.8	NA	46.35369	-67.16216
90242700	21-Oct-94	44.81	13.72	0.5	23.16	46.46028	-67.11707
90865500	05-Jun-98	44.2	0	NA	10.97	46.41314	-66.93528
91400000	09-Oct-98	44.2	0	NA	4.27	46.41525	-66.93390
91969500	10-Aug-01	107.29	4.57	0.5	NA	46.32471	-67.15622

M:\1\01\00447\02\A\Data\Task 0600 - Hydrogeology\12- Water Well Inventory\[Sisson Project Area_Water Well Summary .xlsx]Table 2.2-1

NOTES:

1. DATA OBTAINED FROM THE NEW BRUNSWICK DEPARTMENT OF ENVIRONMENT ONLINE WELL LOG DATABASE AVAILABLE AT:http://app.elg-egl.gnb.ca/0375-0001/index.aspx. ACCESSED NOVEMBER 2012.
2. REPORT NUMBER REFERS TO NEW BRUNSWICK WELL DRILLERS REPORT.
3. WELLS WITH REPORT NUMBER 90865500 AND 91400000 PLOT AT THE SAME LOCATION ON THE FIGURE 1.1-1.
4. NA DATA NOT AVAILABLE.
5. mbtoc - METERS BELOW TOP OF CASING.

0	24NOV'12	ISSUED WITH REPORT VA101-447/2-8	DLP	CHS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.1-1

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF THE CONDITION OF TERRATLANTIC 2008 PIEZOMETERS

Print Jan/02/13 11:24:53

Well ID	Shallow/Deep	Date Inspected	Date Developed	Measured Data						Installation Log		Stantec Comments
				Date	Time	PVC Stickup (mags)	Water Level (mbPVC)	Installation Depth (mbPVC)	Installation Depth (mbgs)	Date	Installation Depth (mbgs)	
MP-08-03	Deep	31-Aug-11	Not Completed	-	-	-	-	-	-	11-Sep-08	25.0	No well cap on 1" PVC
MP-08-03	Shallow	31-Aug-11	Not Completed	-	-	-	-	-	-	11-Sep-08	7.5	No well cap on 1" PVC
MP-08-04	Deep	31-Aug-11	Not Completed	-	-	-	-	-	-	11-Sep-08	20.0	Steel casing is damaged, No well cap on 1" PVC
MP-08-04	Shallow	31-Aug-11	Not Completed	-	-	-	-	-	-	11-Sep-08	9.5	Steel casing is damaged, No well cap on 1" PVC
MP-08-05	Deep	30-Aug-11	30-Aug-11	30-Aug-11	9:10	-	Flowing	>30.5	NA	11-Sep-08	30.0	1" PVC, flowing artesian
MP-08-05	Shallow	30-Aug-11	30-Aug-11	30-Aug-11	9:10	-	0	20.68	NA	11-Sep-08	19.7	1" PVC
MP-08-06	Deep	31-Aug-11	31-Aug-11	31-Aug-11	9:22	0.55	10.68	24.17	23.62	11-Sep-08	23.5	1" PVC with friction cap
MP-08-06	Shallow	31-Aug-11	31-Aug-11	31-Aug-11	9:25	0.52	8.98	15.43	14.91	11-Sep-08	15.0	1" PVC with friction cap
MP-08-07	Deep	2-Sep-11	2-Sep-11	2-Sep-11	9:58	0.43	9.54	25.82	25.39	11-Sep-08	23.5	1" PVC with friction cap
MP-08-07	Shallow	2-Sep-11	2-Sep-11	2-Sep-11	10:02	0.48	2.66	12.82	12.34	11-Sep-08	11.0	1" PVC with friction cap
MP-08-08	Deep	2-Sep-11	Not Completed	2-Sep-11	8:17	0.78	5.47	25.58	24.80	11-Sep-08	25.0	2" PVC
MP-08-08	Shallow	2-Sep-11	Not Completed	2-Sep-11	8:19	0.81	1.14	14.52	13.71	11-Sep-08	13.5	1" PVC
MP-08-09	Deep	2-Sep-11	Not Completed	2-Sep-11	8:54	0.50	15.35	25.52	25.02	11-Sep-08	25.0	1" PVC
MP-08-09	Shallow	2-Sep-11	Not Completed	2-Sep-11	8:55	0.51	10.69	12.86	12.35	11-Sep-08	12.0	1" PVC
BB-08-01	Deep	31-Aug-11	Not Completed	31-Aug-11	15:52	0.78	1.14	>30.5	N/A	18-Aug-08	30.7	1" PVC with friction cap
BB-08-01	Shallow	31-Aug-11	Not Completed	31-Aug-11	15:54	0.78	1.05	20.17	19.39	18-Aug-08	19.5	1" PVC with friction cap
BB-08-02	Deep	31-Aug-11	1-Sep-11	31-Aug-11	16:52	0.77	3.97	>30.5	N/A	18-Aug-08	30.6	2" PVC
BB-08-02	Shallow	31-Aug-11	1-Sep-11	31-Aug-11	16:54	0.76	3.95	15.85	15.09	18-Aug-08	16.7	1" PVC
BB-08-03	Deep	Not Completed	Not Completed	-	-	-	-	-	-	18-Aug-08	30.5	Road inaccessible
BB-08-03	Shallow	Not Completed	Not Completed	-	-	-	-	-	-	18-Aug-08	6.1	Road inaccessible
PP-08-01	N/A	31-Aug-11	Not Completed	31-Aug-11	13:59	0.75	2.06	8.47	7.72	18-Aug-08	7.9	1" PVC with friction cap

\\VAN11\Prj_file\1\01\00447\01\A\Data\300 - Geo and Hydrogeo SI\1-Hydrogeo data\6-Historical sites TerrAtlantic\[TerrAtlantic piezometer condition summary.xlsx]Table 3.1-1

NOTES:
1. DATA COLLECTED BY STANTEC.
2. INSTALLATION LOGS FROM TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT PROJECT, NB.
3. mags - METERS ABOVE GROUND SURFACE.
4. mbgs - METERS BELOW GROUND SURFACE.
5. mbPVC - METERS BELOW PVC STICKUP.
6. NA - DATA NOT AVAILABLE.
7. "-" DATA NOT COLLECTED.
8. N/A-NOT APPLICABLE.

0	24NOV'12	ISSUED WITH REPORT VA101-447/2-8	DLP	CHS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold CONSULTING

TABLE 3.1-2

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF DRILLING AND INSTALLATION

Print Jan/02/13 11:25:19

Site Name	Year	Coordinates[1,2] Easting (m)	Northing (m)	Elevation (m)	Dip	Azimuth	Total Depth[3] (m)	Completion Details: Hole Type[4]	Screen Zone From (m)	Screen Zone To (m)	PVC Diameter (in)	PVC Stickup (m)	Geology of Screened Zone	Report Reference
BB-08-01	2008	2,456,132.00	7,490,448.00	297.1	-90	N/A	30.7	PZ - Shallow	14.9	19.5	1	0.78	Granodiorite/Granite	TERRATLANTIC (DECEMBER, 2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT
								PZ - Deep	25.9	30.7	1	0.78	Granodiorite/Granite	
BB-08-02	2008	2,457,408.00	7,489,088.00	309.3	-90	N/A	30.6	PZ - Shallow	13.7	16.7	1	0.76	Granodiorite/Granite	
								PZ - Deep	25.9	30.6	2	0.77	Granodiorite/Granite	
BB-08-03	2008	2,457,230.00	7,487,368.00	306.0	-90	N/A	30.5	PZ - Shallow	3.1	6	NA	NA	Silty SAND with Gravel	
								PZ - Deep	27.5	30.5	NA	NA	Granodiorite/Granite	
PP-08-01	2008	2,457,591.00	7,486,675.00	329.7	-90	N/A	7.9	PZ	4	7.9	1	0.75	Metasedimentary	
MP-08-02	2008	2,457,949.00	7,485,137.00	309.4	-60	80	190.1	DH	N/A	N/A	N/A	NA	N/A	
MP-08-03	2008	2,457,526.00	7,484,796.00	298.0	-90	N/A	25.0	PZ - Shallow	6	7.5	1	NA	Gabbro	
								PZ - Deep	23.4	25	1	NA	Gabbro	
MP-08-04	2008	2,457,735.00	7,485,027.00	304.8	-90	N/A	25.0	PZ - Shallow	6.5	9.5	1	NA	Metavolcanic	
								PZ - Deep	17	20	1	NA	Metavolcanic	
MP-08-05	2008	2,458,315.00	7,484,959.00	315.6	-90	N/A	30.1	PZ - Shallow	16.8	19.8	1	NA	Volcanic Tuff	
								PZ - Deep	27	30	1	NA	Volcanic Tuff	
MP-08-06	2008	2,458,139.00	7,485,561.00	309.6	-90	N/A	24.9	PZ - Shallow	12	15	1	0.52	Metavolcanic	
								PZ - Deep	20.5	23.5	1	0.55	Metavolcanic	
MP-08-07	2008	2,458,255.00	7,485,907.00	292.1	-90	N/A	25.6	PZ - Shallow	8	11	1	0.48	Volcanic Tuff/Metasedimentary	
								PZ - Deep	19	23.5	1	0.43	Metasedimentary	
MP-08-08	2008	2,457,999.00	7,485,585.00	304.2	-90	N/A	25.0	PZ - Shallow	10.7	13.7	1	0.81	Metavolcanic	
								PZ - Deep	22	25	2	0.78	Metavolcanic	
MP-08-09	2008	2,457,772.00	7,485,906.00	345.4	-90	N/A	25.3	PZ - Shallow	9	12	1	0.51	Gabbro	
								PZ - Deep	22	25	1	0.50	Gabbro	
MW11-01	2011	2,455,687.00	7,487,008.00	345.5	-90	N/A	24.4	MW	20.5	23.5	2	0.91	Silty Sand/Granodiorite	KNIGHT PIESOLD (2012), 2011 HYDROGEOLOGY REPORT, REVISION 1. VA101-447/2-8.
MW11-01D[5]	2011	2,455,686.00	7,487,000.00	NA	-90	N/A	38.0	DH	N/A	N/A	N/A	N/A	N/A	
MW11-02S	2011	2,457,130.00	7,484,183.00	293.6	-90	N/A	7.6	MW	5.3	6.8	2	0.92	Cobbles/Gabbro	
MW11-02D	2011	2,457,131.00	7,484,179.00	293.3	-90	N/A	37.3	MW	25.3	28.3	2	0.97	Gabbro	
MW11-03S	2011	2,458,961.00	7,487,546.00	287.8	-90	N/A	9.7	MW	6.1	9.1	2	0.86	Biotite Wacke	
MW11-03D	2011	2,458,955.00	7,487,548.00	287.5	-90	N/A	33.1	MW	18.6	21.7	2	0.97	Biotite Wacke	
MW11-04S	2011	2,459,269.00	7,486,209.00	262.0	-90	N/A	10.8	MW	5.2	8.2	2	0.89	Biotite Wacke	
MW11-04D	2011	2,459,271.00	7,486,209.00	261.3	-90	N/A	35.0	MW	27.3	30.3	2	0.91	Biotite Wacke	
MW11-05S	2011	2,455,148.00	7,489,974.00	309.0	-90	N/A	9.0	MW	5.9	9	2	0.97	Sand and Silt	
MW11-05D	2011	2,455,151.00	7,489,974.00	308.8	-90	N/A	35.4	MW	30.4	33.4	2	1.07	Granodiorite	
MW11-06S	2011	2,457,497.00	7,489,114.00	306.1	-90	N/A	9.2	MW	7.0	8.5	2	1.02	Granodiorite	
MW11-06D	2011	2,457,500.00	7,489,110.00	305.9	-90	N/A	28.9	MW	20.6	23.6	2	0.79	Granodiorite	
MWG11-01	2011	2,456,708.15	7,486,619.75	382.4	-90	N/A	39.7	PZ	8.2	11.3	1	NA	Granite	KNIGHT PIESOLD (2012), 2011 GEOTECHNICAL SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-1.
MWG11-02	2011	2,456,863.84	7,486,565.72	386.3	-90	N/A	30.9	PZ	6.1	9.1	1	NA	Granite	
MWG11-03	2011	2,456,772.24	7,486,669.85	382.2	-90	N/A	39.7	PZ	9.8	12.8	1	NA	Granite	
MWG11-04	2011	2,456,874.58	7,486,436.24	388.4	-90	N/A	30.8	PZ	9.1	12.2	1	NA	Granite	
MWG11-05	2011	2,454,692.04	7,489,483.90	328.3	-90	N/A	42.9	PZ	27.4	30.5	1	0.98	Granite	
MWG11-06	2011	2,455,514.11	7,489,531.88	320.0	-90	N/A	35.4	PZ	29.0	32.0	1	1.42	Granite	
MWG11-07	2011	2,456,238.14	7,489,584.59	323.5	-90	N/A	49.1	PZ	27.4	30.5	1	0.44	Granite	
MWG11-08	2011	2,457,003.70	7,489,421.01	332.8	-90	N/A	32.4	PZ	22.2	25.3	1	0.8	Granite	
MWG11-09	2011	2,457,476.36	7,488,933.87	314.7	-90	N/A	23.5	PZ	9.8	12.8	1	1.02	Granite	
MWG11-10	2011	2,457,771.27	7,488,582.46	340.6	-90	N/A	22.5	PZ	6.1	12.2	1	1.20	Granite	
MWG11-12	2011	2,457,720.89	7,487,541.43	306.0	-90	N/A	35.2	PZ	25.0	28.0	1	1.15	Granite	
MWG11-13	2011	2,457,676.76	7,486,984.73	317.6	-90	N/A	39.6	PZ	30.5	33.5	1	1.04	Granite	
MWG11-14	2011	2,457,325.88	7,486,451.28	336.6	-90	N/A	36.9	PZ	18.3	21.3	1	0.78	Granite	
MWG11-15	2011	2,457,294.17	7,486,176.48	358.6	-90	N/A	30.8	PZ	21.3	24.4	1	0.55	Granite	
MWG11-16	2011	2,454,144.64	7,488,961.36	354.3	-90	N/A	36.6	PZ	27.4	30.5	1	0.76	Granite	
MWG11-17	2011	2,455,819.27	7,489,573.97	321.7	-90	N/A	38.3	PZ	25.9	29.0	1	0.79	Granite	
MWG11-18[5]	2011	2,454,997.82	7,489,479.07	320.8	-90	N/A	39.9	NA	N/A	N/A	N/A	N/A	N/A	
SB-11-006	2011	2,458,063.00	7,485,676.00	305.7	-70	275	201.0	DH	N/A	N/A	N/A	N/A	N/A	KNIGHT PIESOLD (2012), 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2.
SB-11-022G	2011	2,458,317.00	7,485,616.00	299.4	-65	90	216.3	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-023	2011	2,457,491.00	7,485,241.00	313.0	-55	95	282.0	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-024	2011	2,457,686.00	7,485,516.00	319.6	-65	275	129.1	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-025G	2011	2,458,188.00	7,485,410.00	300.8	-65	130	303.3	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-029G	2011	2,458,201.00	7,485,747.00	305.4	-65	320	219.9	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-031	2011	2,457,223.00	7,485,045.00	300.5	-55	45	507.0	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-032G	2011	2,457,994.00	7,485,592.00	304.3	-65	280	321.0	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-033	2011	2,458,384.00	7,485,343.00	308.9	-55	95	135.0	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-034	2011	2,457,583.00	7,484,712.00	296.4	-55	100	441.0	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-035G	2011	2,457,622.00	7,485,342.00	310.2	-65	275	180.0	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-036G	2011	2,457,385.00	7,484,973.00	298.3	-65	230	201.0	DH	N/A	N/A	N/A	N/A	N/A	
SB-11-037G	2011	2,457,920.00	7,485,049.00	314.8	-65	100	210.0	DH	N/A	N/A	N/A	N/A	N/A	

\\VAN11\Prj_file\1\01\00447\02\A\Data\Task 0600 - Hydrogeology\1-Monitoring wells\[Drillhole and Installation Summary.xlsx]Drillhole and Completion

NOTES:
1. NAD83 CSRS NEW BRUNSWICK SDP COORDINATES.
2. COORDINATES WERE SURVEYED IN 2011.
3. DEPTHS ARE TAKEN WITH RESPECT TO GROUND SURFACE. IF HOLE IS INCLINED, DEPTH REFERS TO LENGTH ALONG HOLE.
4. MW = MONITORING WELL, PZ = PIEZOMETER, DH = DRILLHOLE.
5. NO INSTALLATION, HOLE WAS ABANDONED AND BACKFILLED.
6. NA - DATA NOT AVAILABLE.
7. N/A - NOT APPLICABLE.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24NOV'12	ISSUED WITH REPORT VA101-447/2-8	DLP	CHS	KJB

Knight Piésold CONSULTING

TABLE 3.2-1

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF RESPONSE TESTS

Print Jan/02/13 11:30:02

	Monitoring Well	Screen Interval[1]		
		Depth From (mbgs)	Depth To (mbgs)	Hydraulic Conductivity (m/s)
Overburden	MW11-01[2]	20.5	23.5	5E-06
	MW11-02S[2]	5.3	6.8	7E-05
	MW11-05S	5.9	9.0	2E-05
	MW11-06S[3]	7.0	8.5	4E-05
	Overall	**Number of Tests**		**4**
		Minimum		**5E-06**
		Maximum		**7E-05**
		Geometric Mean		**2E-05**
Bedrock	MW11-02D	25.3	28.3	6E-07
	MW11-03D	18.6	21.7	1E-05
	MW11-03S	6.1	9.1	8E-05
	MW11-04D[4]	27.3	30.3	5E-05
	MW11-04S	5.2	8.2	9E-07
	MW11-05D	30.4	33.4	2E-05
	MW11-06D	20.6	23.6	2E-05
	Overall	**Number of Tests**		**7**
		Minimum		**6E-07**
		Maximum		**8E-05**
		Geometric Mean		**1E-05**

M:\1\01\00447\02\A\Data\Task 0600 - Hydrogeology\3-Hydraulic Testing\[K Values Summary Tables.xlsx]Table 3.2-1

NOTES:

1. THE SCREEN INTERVAL WAS USED TO ESTIMATE THE HYDRAULIC CONDUCTIVITY VALUE.
2. WELL SCREENED ACROSS OVERBURDEN-BEDROCK CONTACT.
3. SCREENED IN BEDROCK BUT FILTER PACK EXTENDS INTO OVERBURDEN.
4. THE WELL WAS ARTESIAN AT THE TIME OF TESTING. THE SHUT-IN PRESSURE AND FLOW RATE WERE NOT CONSTRAINED. THE SHUT-IN PRESSURE WAS ASSUMED TO BE AT THE TOP OF THE PVC FOR THIS ANALYSIS.
5. INCLUDES RESPONSE TESTS FROM KNIGHT PIESOLD (2012), 2011 HYDROGEOLOGY REPORT, REVISION 1. VA101-447/2-8.

0	24NOV'12	ISSUED WITH REPORT VA101-447/2-8	DLP	CHS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

TABLE 3.2-2

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF PACKER TESTS

Print Jan/02/13 11:30:02

Drillhole	Test Interval[1]		Packer Test	Geology of Test Interval[2]
	Depth From	Depth To	Hydraulic Conductivity	
	(m)	(m)	(m/s)	
MP-08-02	29.3	189.9	2E-07	MV
	29.3	189.9	2E-07	MV
	62.8	189.9	3E-07	MV
	62.8	189.9	3E-07	MV
	75.0	76.5	5E-06	MV
	75.0	76.5	5E-06	MV
	90.2	91.7	5E-06	MV
	90.2	91.7	5E-06	MV
	103.9	105.5	5E-06	MV
	103.9	105.5	5E-06	MV
	120.7	122.2	5E-06	MV
	120.7	122.2	5E-06	MV
	137.2	138.7	5E-06	MV
MP-08-03	5.2	7.9	7E-06	IP
	7.9	11.0	3E-07	IP
	11.0	14.0	9E-08	IP
	14.0	17.1	2E-08	IP
	17.1	20.1	4E-07	IP
	20.1	23.2	8E-08	IP
	23.2	25.0	2E-06	IP
MP-08-04	6.9	9.2	8E-07	MV
	9.2	11.3	2E-07	MV
	11.3	12.8	4E-09	MV
	12.8	14.3	8E-07	MV
	14.3	15.9	1E-06	MV
	15.9	17.4	4E-07	MV
	17.4	18.9	7E-07	MV
	18.9	20.4	3E-07	MV
	20.4	22.0	2E-09	MV
	22.0	23.5	1E-08	MV
	23.5	25.0	2E-09	MV
MP-08-05	17.7	19.2	6E-06	MV
	19.2	20.7	7E-06	MV
	20.7	23.8	4E-06	MV
	23.8	26.8	1E-09	MV
	26.8	29.9	1E-08	MV

Knight Piésold CONSULTING

TABLE 3.2-2

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF PACKER TESTS

Print Jan/02/13 11:30:02

Drillhole	Test Interval[1]		Packer Test	Geology of Test Interval[2]
	Depth From	Depth To	Hydraulic Conductivity	
	(m)	(m)	(m/s)	
MP-08-06	10.8	11.9	2E-06	MV
	10.8	11.9	3E-06	MV
	11.9	13.4	7E-06	MV
	11.9	13.4	8E-06	MV
	13.4	14.9	1E-07	MV
	13.4	14.9	1E-07	MV
	14.9	16.5	5E-08	MV
	14.9	16.5	3E-08	MV
	16.5	18.0	2E-07	MV
	16.5	18.0	2E-07	MV
	18.0	19.5	2E-07	MV
	18.0	19.5	3E-07	MV
	19.5	21.0	8E-08	MV
	19.5	21.0	9E-08	MV
	21.0	22.6	2E-07	MV
	21.0	22.6	2E-07	MV
	22.6	24.1	1E-06	MV
	22.6	24.1	1E-06	MV
MP-08-07	5.5	8.5	5E-06	MV
	8.5	11.9	2E-07	MV
	11.9	14.9	4E-07	MS
	14.9	17.9	3E-08	MS
	17.9	21.0	7E-09	MS
	21.0	23.9	6E-09	MS
	23.9	25.6	9E-09	MS
MP-08-08	8.8	9.8	8E-07	MV
	9.8	11.3	4E-07	MV
	11.3	12.8	2E-07	MV
	12.8	14.3	3E-07	MV
	14.3	15.9	7E-07	MV
	15.9	17.4	2E-06	MV
	17.4	18.9	7E-06	MV
	18.9	20.4	4E-06	MV
	20.4	22.0	4E-07	MV
	22.0	25.0	6E-09	MV
MP-08-09	1.8	4.9	7E-06	IP
	4.9	7.9	5E-08	IP
	7.9	11.0	3E-08	IP
	11.0	14.0	6E-08	IP
	14.0	17.1	3E-07	IP
	17.1	20.1	2E-07	IP
	20.1	23.2	6E-09	IP
	23.2	25.1	4E-08	IP

Knight Piésold CONSULTING

TABLE 3.2-2

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF PACKER TESTS

Print Jan/02/13 11:30:02

Drillhole	Test Interval[1]		Packer Test	Geology of Test Interval[2]
	Depth From	Depth To	Hydraulic Conductivity	
	(m)	(m)	(m/s)	
BB-08-01	15.5	18.5	1E-07	IP
	18.5	21.6	2E-07	IP
	21.6	24.6	6E-07	IP
	24.6	27.7	3E-07	IP
	27.7	30.7	2E-07	IP
BB-08-02	10.1	11.6	1E-07	IP
	11.0	12.5	1E-06	IP
	12.5	14.0	9E-07	IP
	14.0	15.5	3E-07	IP
	15.5	17.1	4E-07	IP
	17.1	18.6	3E-07	IP
	18.6	20.1	4E-06	IP
	20.1	23.2	5E-07	IP
	23.2	26.2	5E-07	IP
	26.2	29.3	1E-06	IP
	29.3	30.8	9E-08	IP
BB-08-03	8.5	12.3	5E-06	IP
	12.3	15.4	1E-06	IP
	15.4	18.4	2E-06	IP
	18.4	21.5	6E-07	IP
	21.5	24.5	5E-07	IP
	24.5	27.6	1E-06	IP
	27.6	30.6	7E-07	IP
SB-11-022G	129.0	131.0	N/A[3]	MS
	157.0	160.0	HIGH TAKE[4]	MS
	196.3	199.3	2E-09	MV
SB-11-025G	79.3	82.3	HIGH TAKE[4]	MS
	87.3	90.3	HIGH TAKE[4]	MS
	103.0	106.0	<1E-10[5]	MS
	137.8	104.8	8E-07	MS
	144.0	147.0	1E-08	MS
SB-11-029G	86.5	220.0	HIGH TAKE[4]	MS
	108.0	220.0	HIGH TAKE[4]	MS
	210.0	220.0	N/A[3]	MV
	210.0	230.0	N/A[3]	MV
SB-11-032G	52.0	102.0	4E-08	MV
	103.2	150.0	HIGH TAKE[4]	MV
	160.2	207.0	2E-08	MV
	222.0	321.0	6E-10	MV/IP
	273.0	321.0	2E-09	IP

Knight Piésold CONSULTING

TABLE 3.2-2

NORTHCLIFF RESOURCES LTD.
SISSON PROJECT

SUMMARY OF PACKER TESTS

Print Jan/02/13 11:30:02

Drillhole	Test Interval[1]		Packer Test	Geology of Test Interval[2]
	Depth From	Depth To	Hydraulic Conductivity	
	(m)	(m)	(m/s)	
SB-11-035G	13.2	45.0	3E-09	IP
	43.2	90.0	4E-07	IP
	88.2	135.0	7E-08	IP
	133.2	180.0	8E-08	IP
SB-11-036G	16.2	57.0	1E-06	IP
	55.2	105.0	HIGH TAKE[4]	IP
	103.2	159.0	HIGH TAKE[4]	IP
	157.2	201.0	HIGH TAKE[4]	IP
SB-11-037G	19.2	72.0	1E-07	MS
	70.2	117.0	3E-07	MS
	115.2	168.0	HIGH TAKE[4]	MS
	166.2	210.0	HIGH TAKE[4]	MS
MWG11-05	16.2	42.9	N/A[3]	IP
	36.0	39.0	<1E-08[5]	IP
MWG11-06	13.7	35.1	8E-07	IP
	29.0	32.0	3E-06	IP
MWG11-07	16.8	49.1	5E-07	IP
	27.4	30.5	3E-06	IP
MWG11-08	5.5	32.4	2E-07	IP
MWG11-09	9.1	23.5	2E-07	IP
MWG11-10	9.1	22.5	<1E-08[5]	IP
MWG11-12	7.6	32.1	2E-07	IP
MWG11-13	10.7	39.6	N/A[3]	IP
	10.7	13.7	<1E-08[5]	IP
MWG11-14	10.1	36.9	2E-08	IP
	22.3	25.3	3E-07	IP
MWG11-15	N/A	N/A	N/A[3]	IP
MWG11-16	9.1	36.6	1E-07	IP
	27.4	30.5	1E-06	IP
MWG11-17	N/A	N/A	N/A[3]	IP
MWG11-18	10.1	39.9	8E-07	IP
	20.7	23.8	3E-07	IP
Overall	**Number of Tests**		**151**	
	Minimum		**1E-10**	
	Maximum[6]		**8E-06**	
	Geometric Mean[6]		**2E-07**	

M:\1\01\00447\02\A\Data\Task 0600 - Hydrogeology\3-Hydraulic Testing\[K Values Summary Tables.xlsx]Table 3.2-2

NOTES:

1. DEPTHS ARE TAKEN WITH RESPECT TO GROUND SURFACE. IF HOLE IS INCLINED DEPTHS ARE ALONG HOLE.
2. MV = METAVOLCANIC, MS = METASEDIMENTARY, IP = INTRUSIVE PLUTONIC, OV = OVERBURDEN.
3. NO VALUE REPORTED.
4. TEST REPORTED AS HIGH TAKE. SEE KNIGHT PIESOLD (2012) 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2.
5. ASSIGNED A LESS THAN VALUE BASED ON LOW TAKE DURING TESTING.
6. INCLUDES PACKER TESTS FROM KNIGHT PIESOLD (2012), 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012), 2011 GEOTECHNICAL SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-1, AND TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT PROJECT, NB.

0	24NOV'12	ISSUED WITH REPORT VA101-447/2-8	CAS	CHS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

LEGEND:

SISSON ORE BODY

METEROLOGICAL SERVICES OF CANADA (MSC) CLIMATE STATION

WATER WELL

NOTES:

1. BASE MAP: ESRI ARCGIS TOPOGRAPHIC MAPS.

2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 CSRS NEW BRUNSWICK STEREOGRAPHIC.

3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:500,000 FOR 11X17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

4. DATA OBTAINED FROM THE NEW BRUNSWICK DEPARTMENT OF ENVIRONMENT ONLINE WELL LOG DATABASE (NOVEMBER 20, 2012).

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	02JAN'13	ISSUED WITH REPORT	AMD	AMD	CHS	KJB

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SISSON PROJECT

REGIONAL SITE PLAN

Knight Piésold CONSULTING

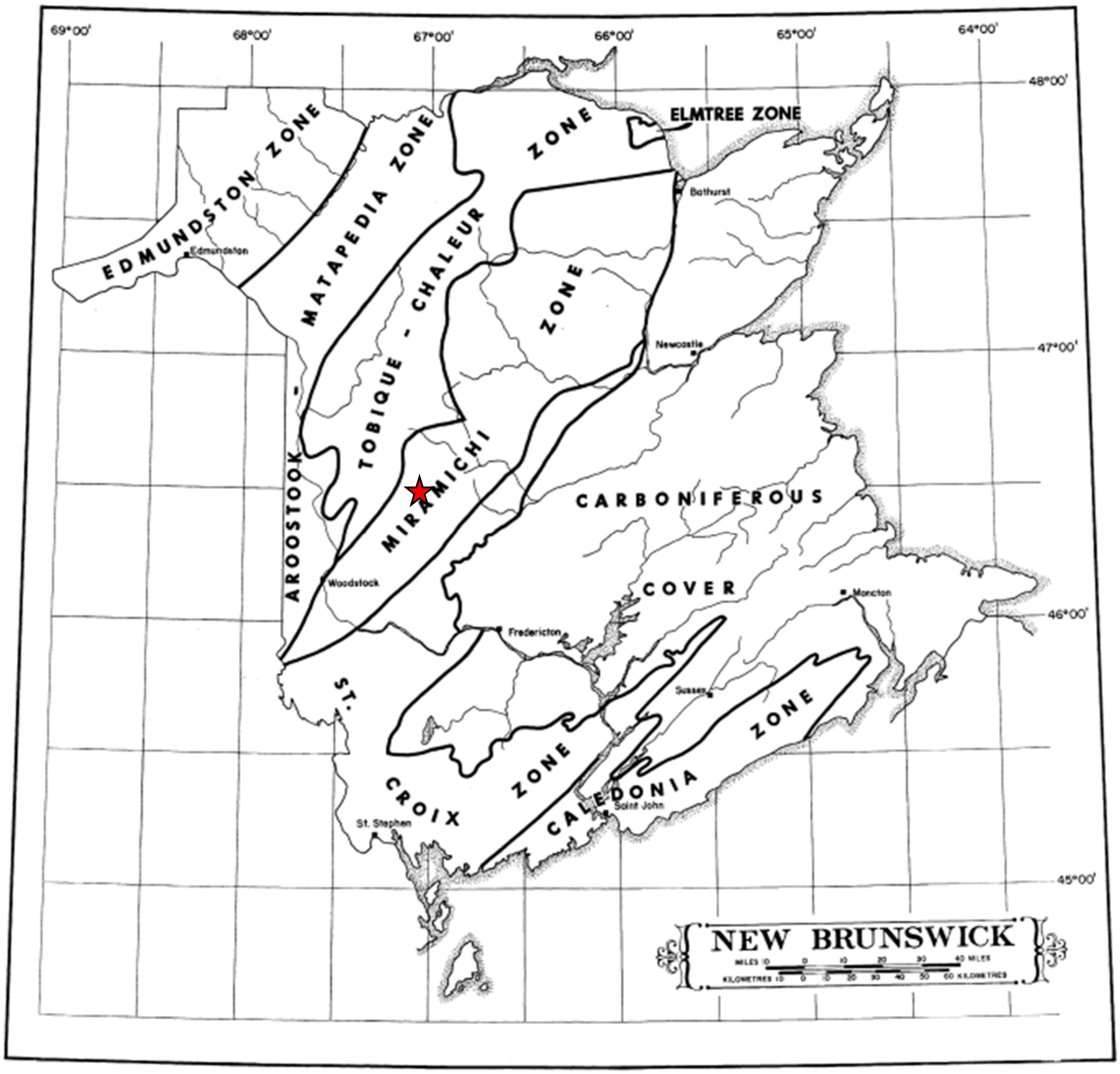
P/A NO. VA101-447/2

REF NO. 8

FIGURE 1.1-1

REV 0

SAVED: M:\1\01\00447\02\A\GIS\Figs\Report 8 - Hydrogeology\RegionalSitePlan.mxd; Jan 02 2013 10:50 AM adinca



★ Approximate Location of Sisson Project

NOTE:
1. MAP FROM NEW BRUNSWICK ENERGY AND MINES AVAILABLE AT:
http://www.gnb.ca/0078/minerals/GSB_Surficial_Mapping-e.aspx. ACCESSED NOVEMBER 2012.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

LANDSCAPE MAP OF NEW BRUNSWICK

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24NOV'12	ISSUED WITH REPORT	CHS	DF	KJB

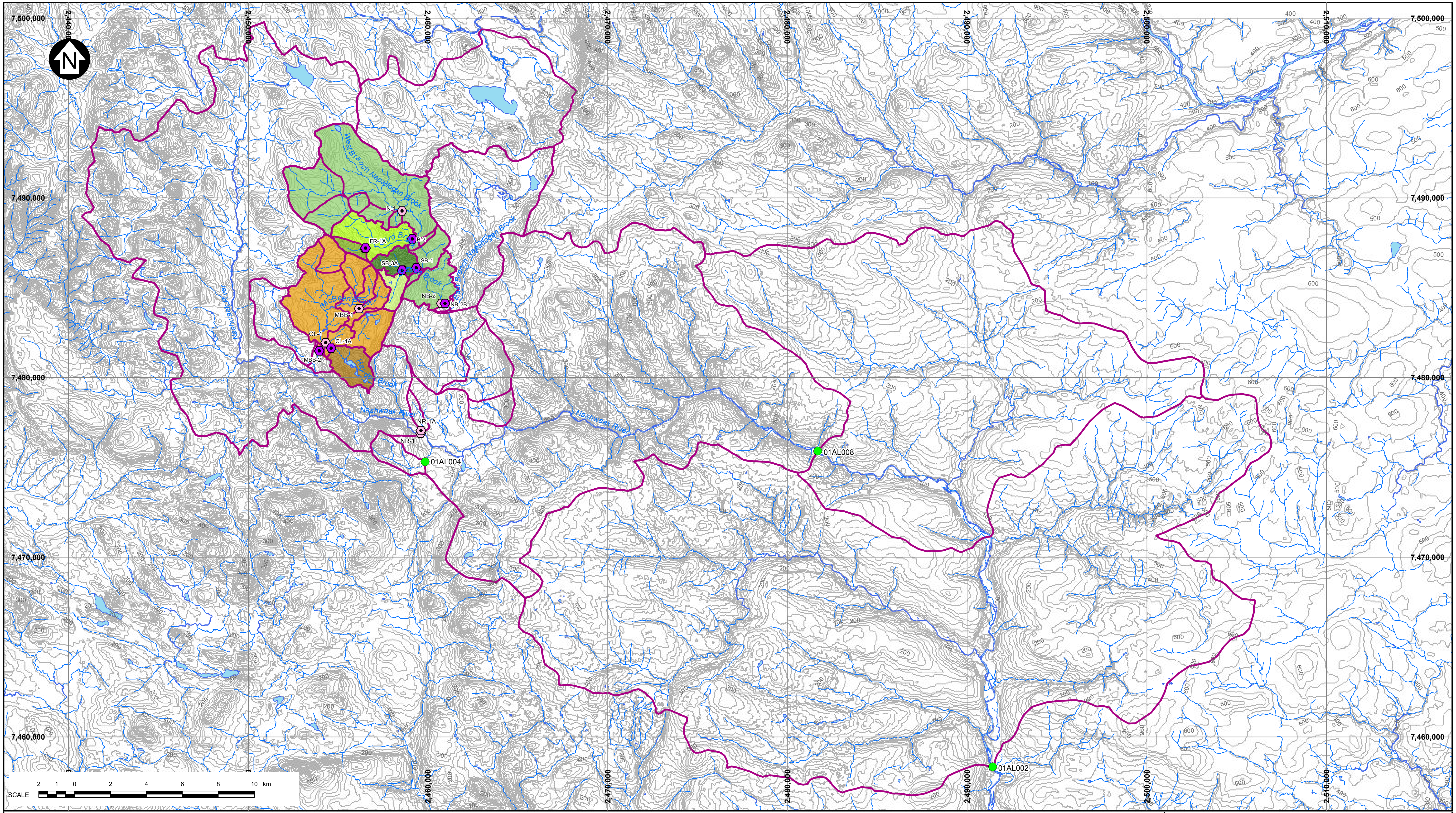
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE 2.1-1

REV 0



LEGEND:

- WATER SURVEY OF CANADA (WSC) GAUGING STATION
- PROJECT STREAMFLOW STATION (ACTIVE)
- PROJECT STREAMFLOW STATION (INACTIVE)
- CONTOUR (10 M)
- RIVER
- LAKE
- WATERSHED BOUNDARY

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	02JAN'13	ISSUED WITH REPORT	AMD	AMD	CMB	KJB

NOTES:

1. BASE MAP: CANADA NTS MAPS.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 CSRS NEW BRUNSWICK STEREOGRAPHIC.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:200,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTOUR INTERVAL IS 10 METRES.
5. WATERSHED BOUNDARIES WERE DELINEATED BASED ON 2 METRE LIDAR CONTOURS AND TRANSPOSED TO NTS MAPS.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

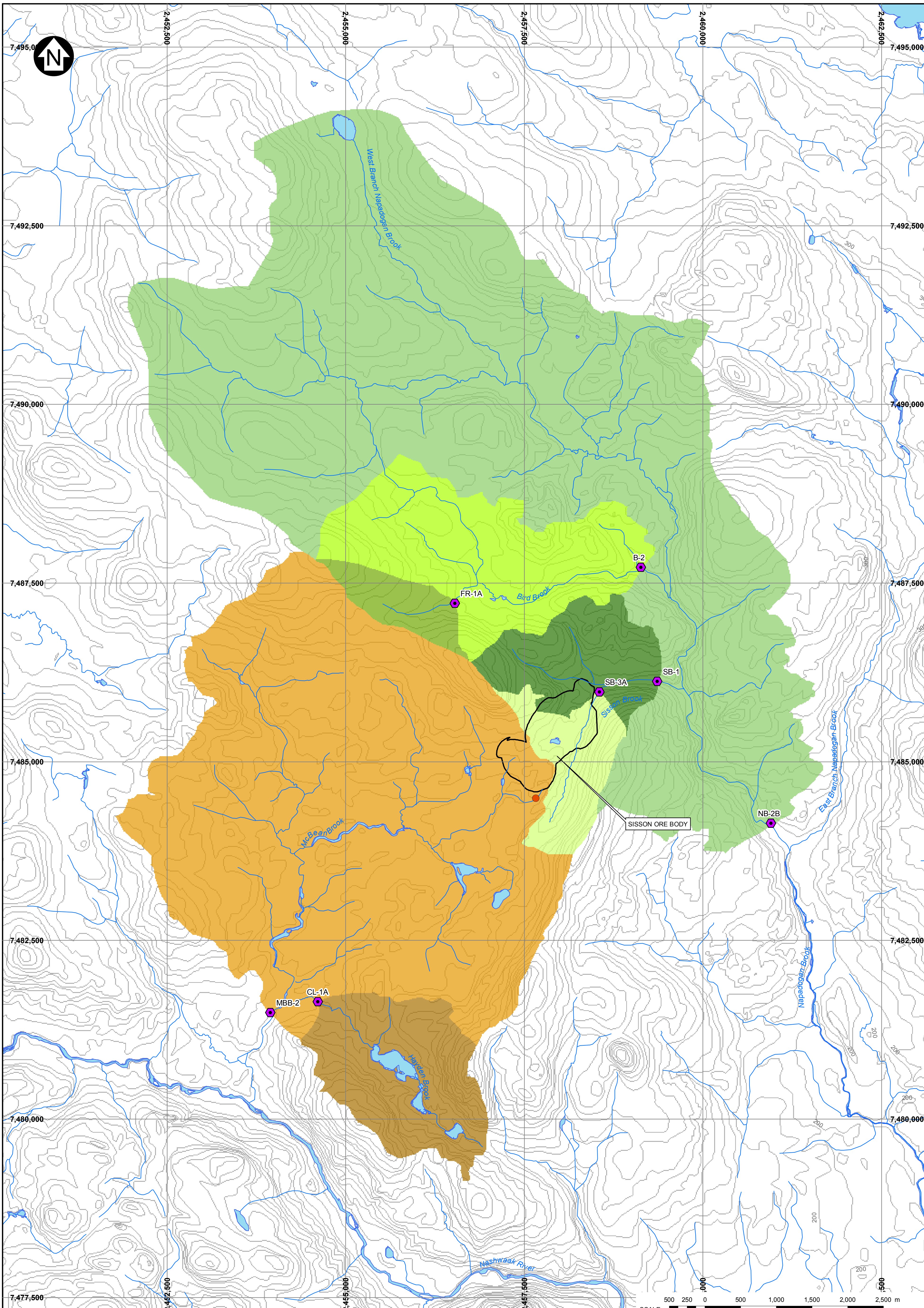
WATERSHED BOUNDARIES

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-447/2	8

FIGURE 2.1-2 REV 0

SAVED: M:\1\01\00447\02\A\GIS\Figs\Report 8 - Hydrogeology\WatershedBoundaries.mxd; Jan 02 2013 10:54 AM adinca



LEGEND:

- CLIMATOLOGY STATION
- PROJECT STREAMFLOW STATION (ACTIVE)
- CONTOUR (10 M)
- RIVER
- LAKE
- PROPOSED PIT

NOTES:

1. BASE MAP: CANADA NTS MAPS.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 CSRS NEW BRUNSWICK STEREOGRAPHIC.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:50,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTOUR INTERVAL IS 10 METRES.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

PROJECT HYDROMETRIC STATIONS

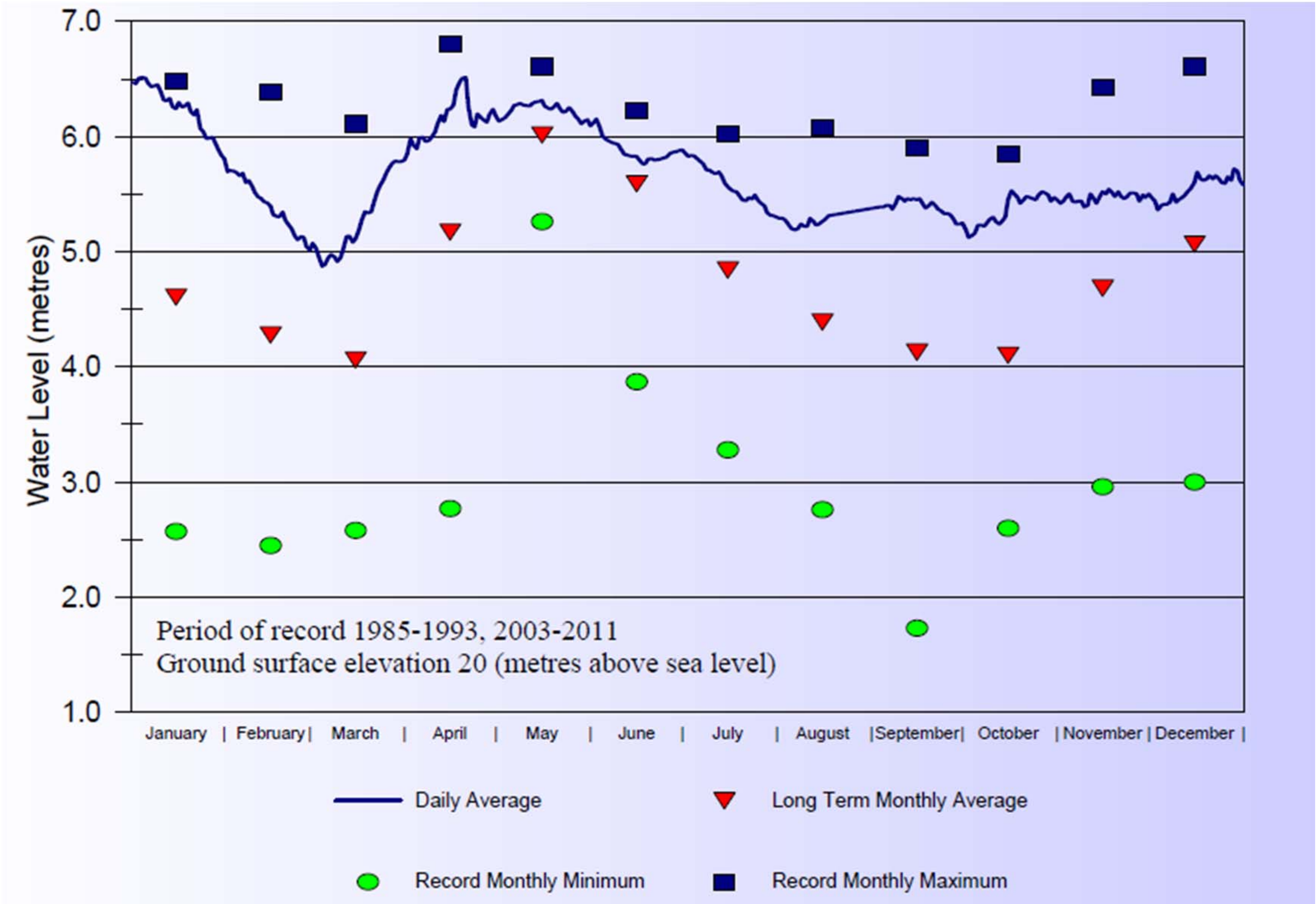
Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-447/2	8

FIGURE 2.2-1 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	02JAN'13	ISSUED WITH REPORT	ALR	AMD	CMB	KJB

SAVED: M:\1\01\00447\02\A\GIS\Figs\Report 8 - Hydrogeology\ProjectHydrometricStations.mxd; Jan 02 2013 10:49 AM adinca



NOTES:
1. GRAPH FROM NEW BRUNSWICK ENERGY AND MINES AVAILABLE AT: http://www.gnb.ca/redirect/0009/0371/0007/2011/0003-e.pdf. ACCESSED NOVEMBER 24, 2012.
2. DAILY AVERAGE IS FOR 2011.

0	24NOV'12	ISSUED WITH REPORT	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

GROUNDWATER LEVELS
MIRAMICHI 2011

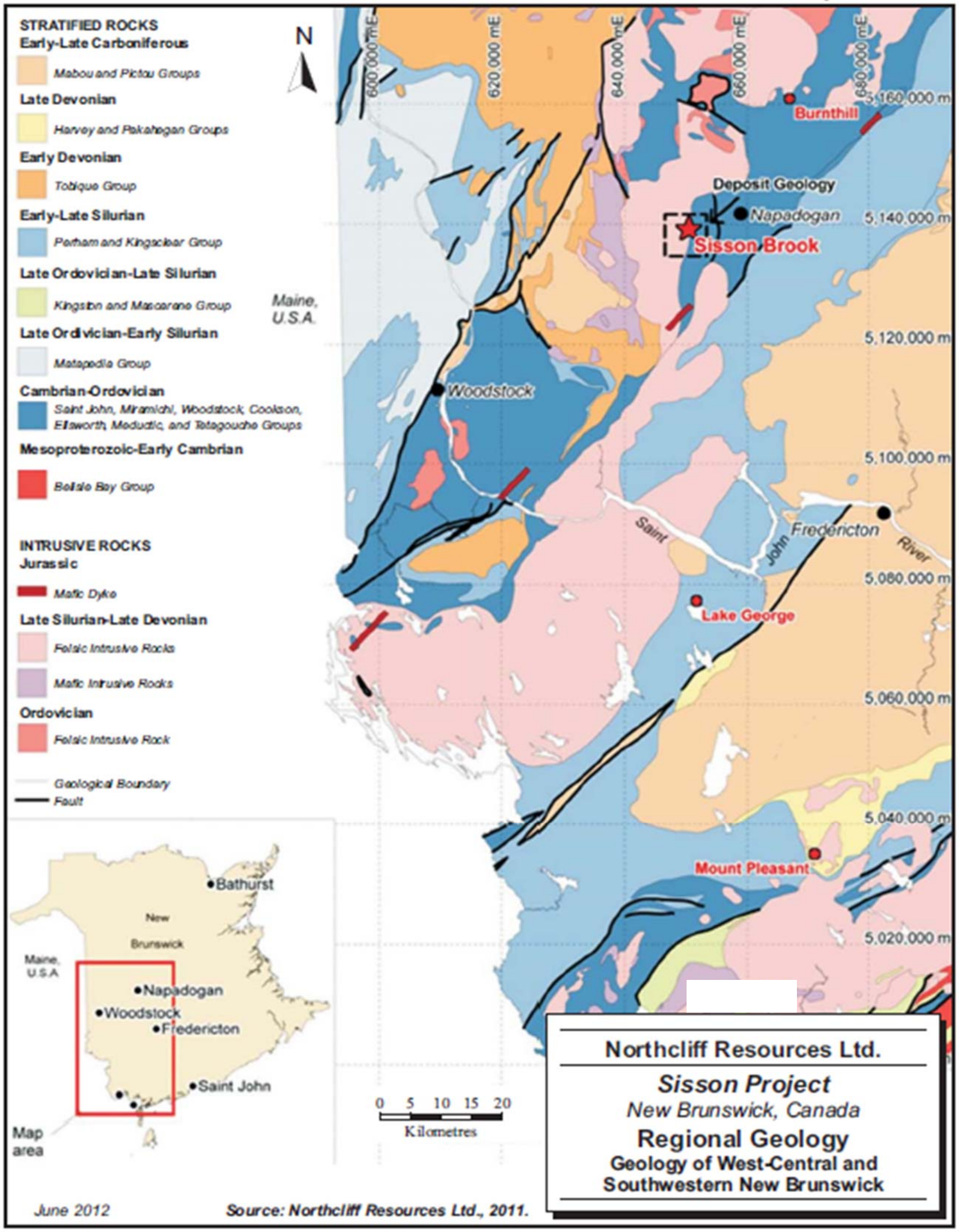
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE 2.2-2

REV 0



NOTE:

1. MAP FROM RENNIE, D.W. 2012. TECHNICAL REPORT ON THE SISSON PROJECT, NEW BRUNSWICK. NI 43-101 REPORT, CANADA.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

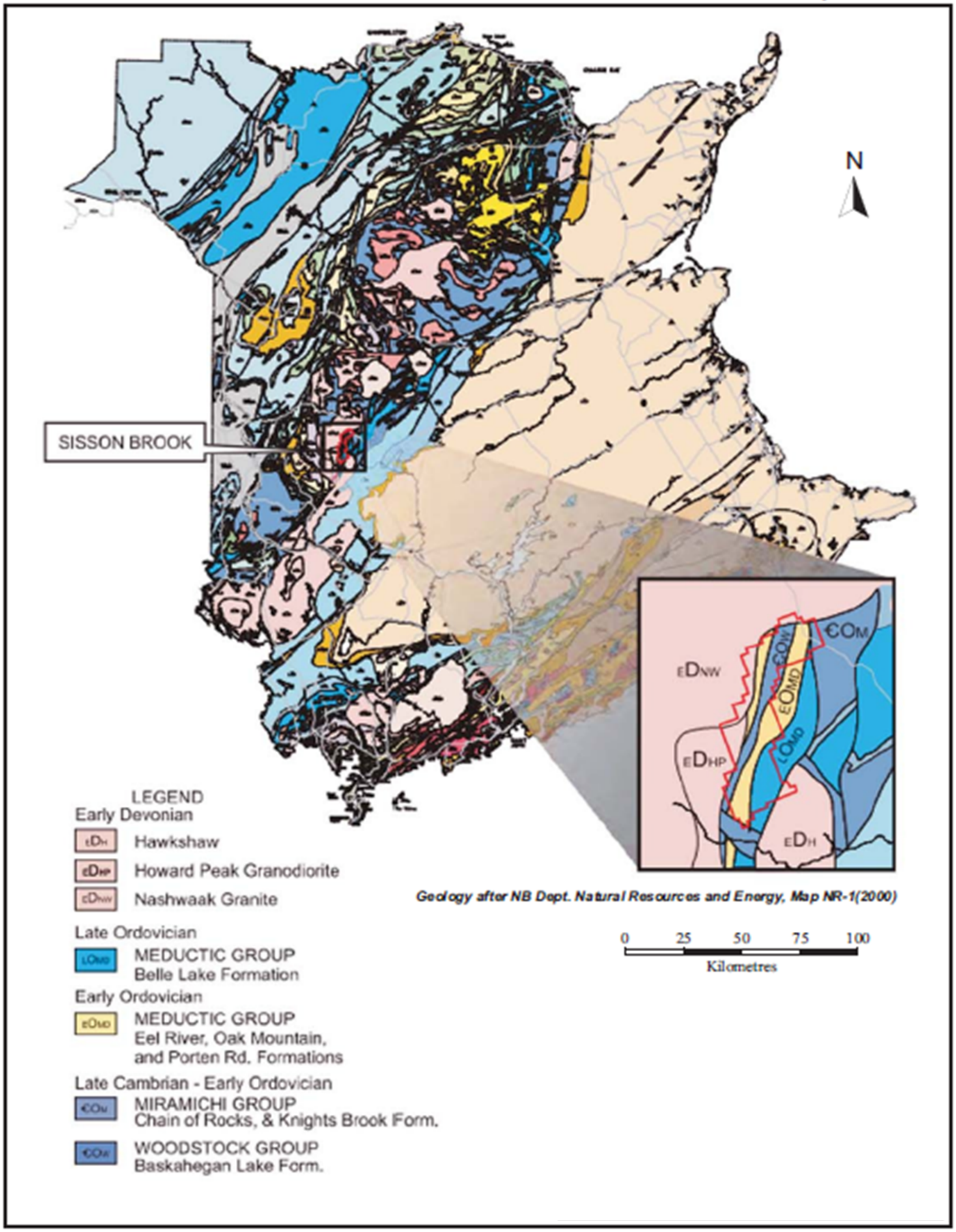
REGIONAL GEOLOGY
GEOLOGY OF WEST-CENTRAL NEW BRUNSWICK

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-447/2	8

FIGURE 2.3-1 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24NOV'12	ISSUED WITH REPORT	CHS	DF	KJB



NOTE:
1. MAP FROM RENNIE, D.W. 2012. TECHNICAL REPORT ON THE SISSON PROJECT, NEW BRUNSWICK. NI 43-101 REPORT, CANADA.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

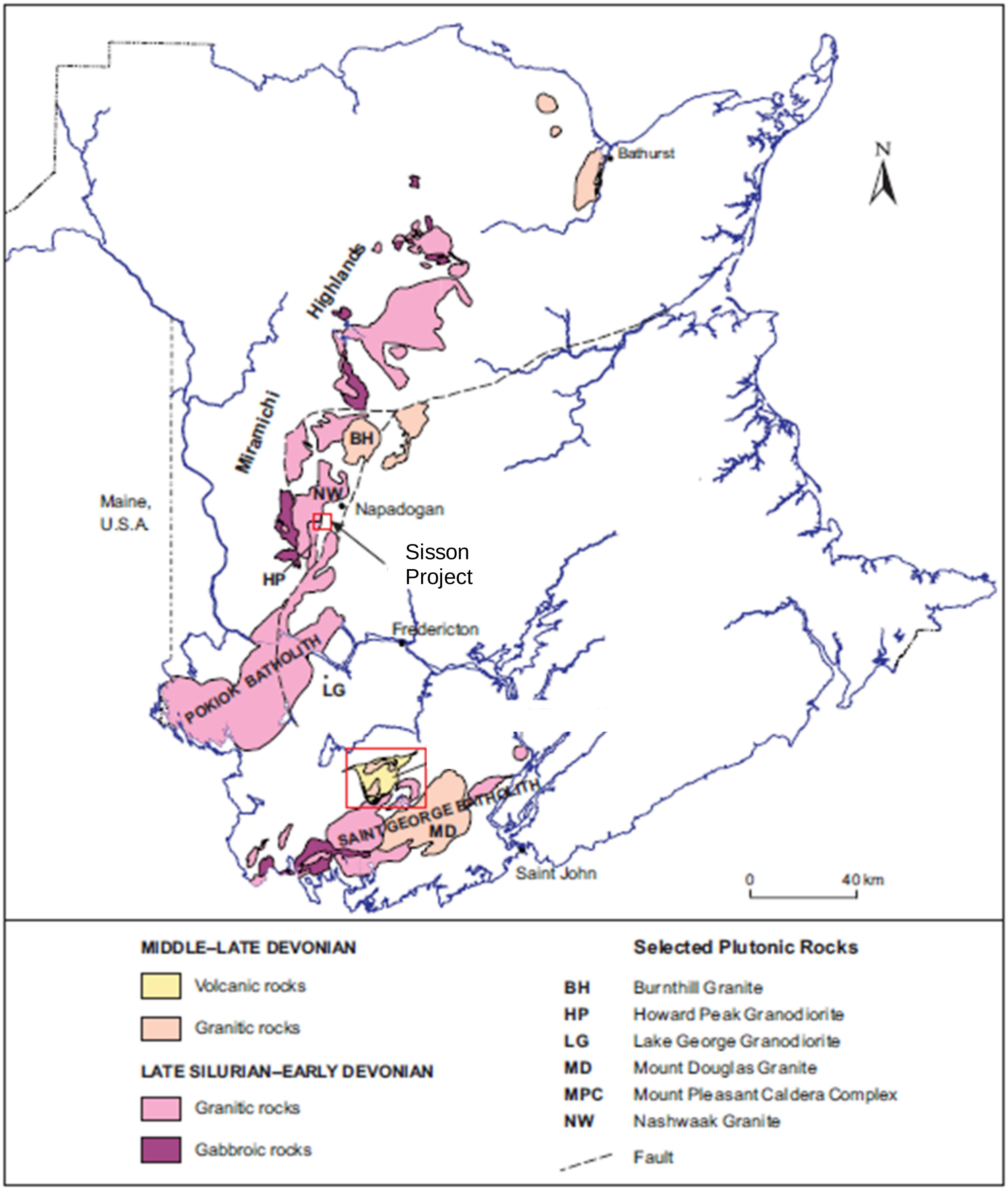
GEOLOGY MAP OF NEW BRUNSWICK

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-447/2	8

FIGURE 2.3-2 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24NOV'12	ISSUED WITH REPORT	CHS	DF	KJB



NOTE:

1. MAP FROM FYFFE, L.R. AND THORNE, K.G. 2010. POLYMETALLIC DEPOSITS OF SISSON BROOK AND MOUNT PLEASANT, NEW BRUNSWICK, CANADA. NEW BRUNSWICK DEPARTMENT OF NATURAL RESOURCES; LANDS, MINERALS AND PETROLEUM DIVISION, FIELD GUIDE NO.3, 68 p.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

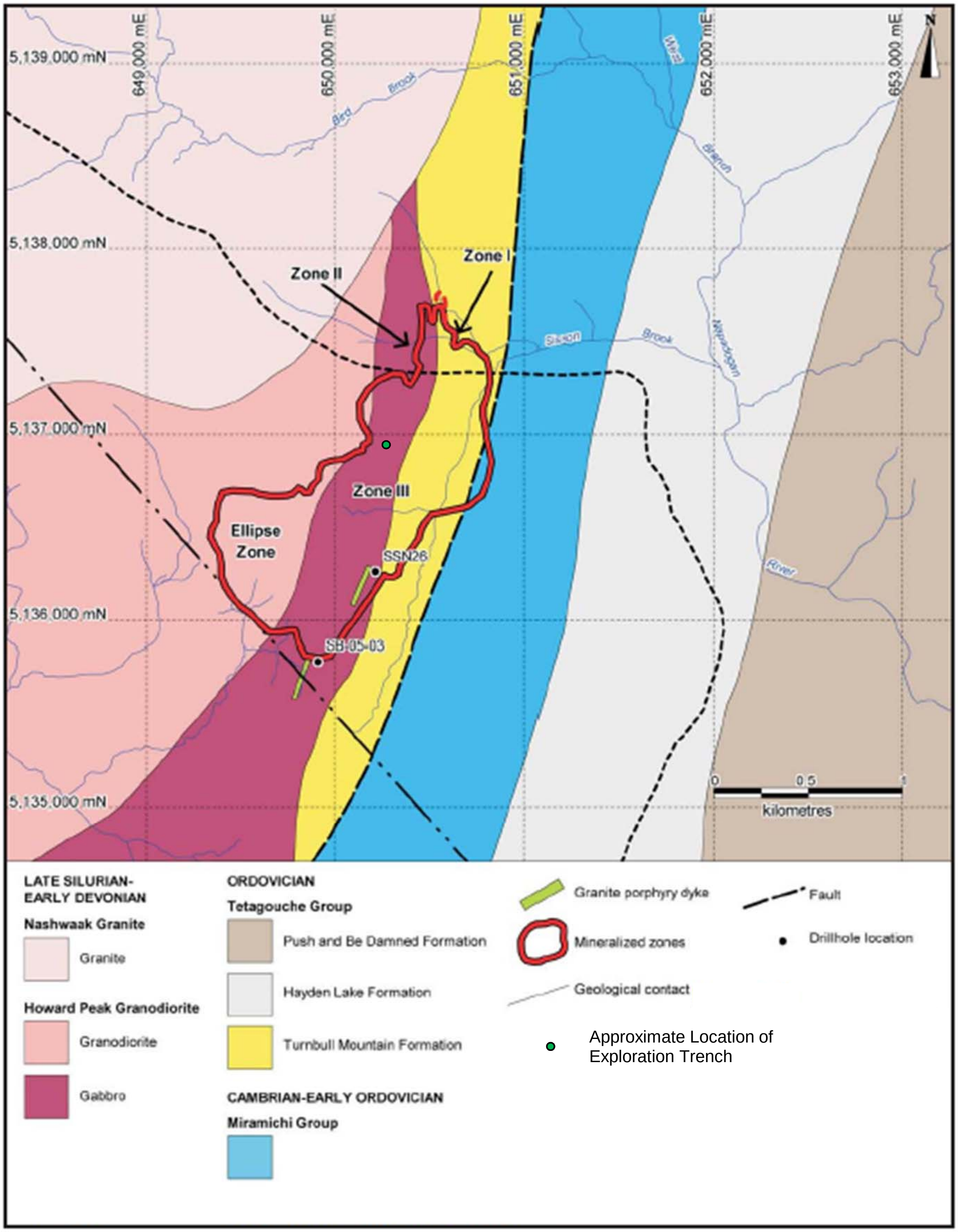
LATE SILURIAN TO LATE DEVONIAN "ACADIAN" PLUTONIC ROCKS

Knight Piésold CONSULTING

P/A NO. VA101-447/2 | REF. NO. 8

FIGURE 2.3-3 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24NOV'12	ISSUED WITH REPORT	CHS	DF	KJB



NOTE:

1. MAP FROM RENNIE, D.W. 2012. TECHNICAL REPORT ON THE SISSON PROJECT, NEW BRUNSWICK. NI 43-101 REPORT, CANADA.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

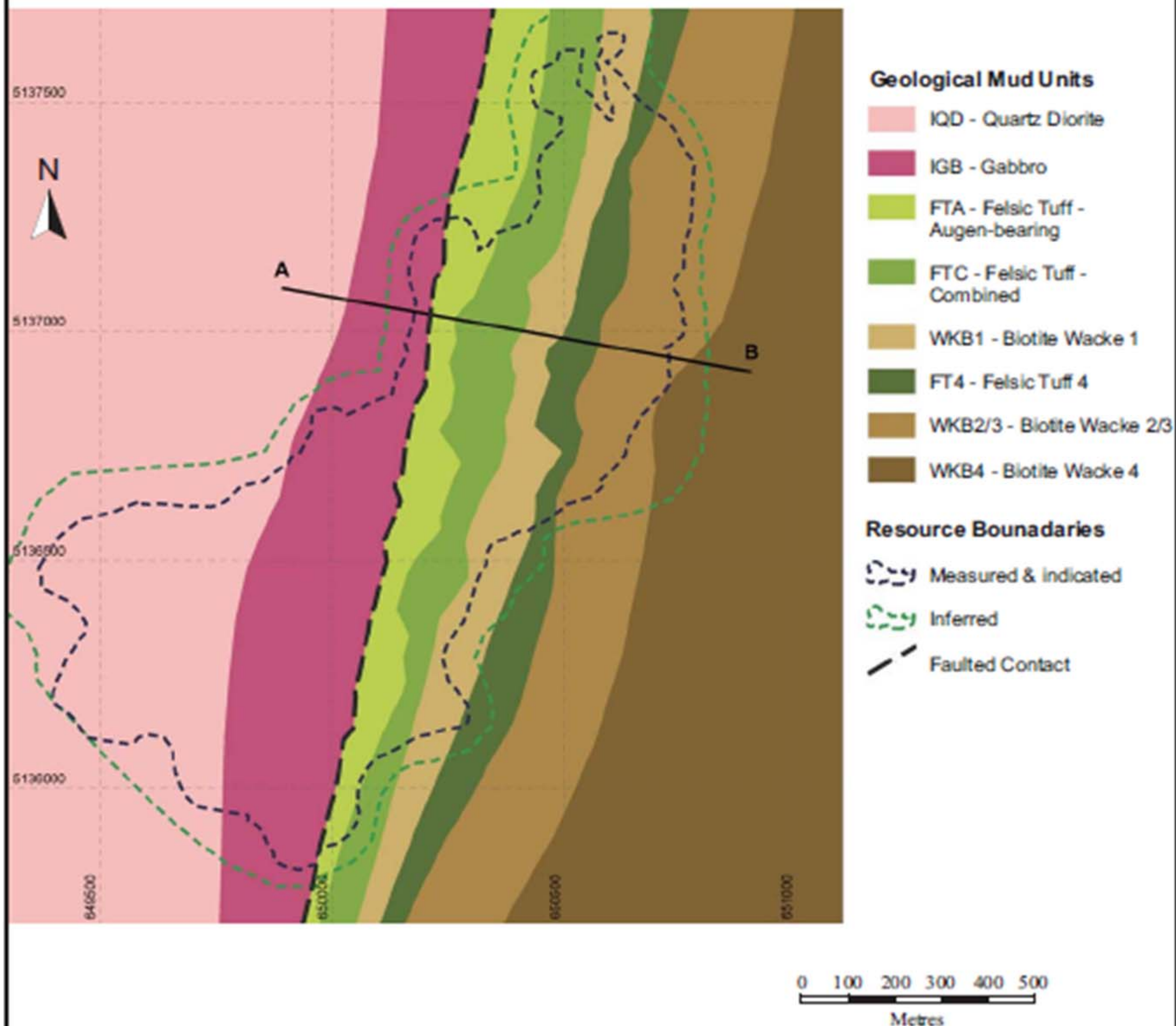
SIMPLIFIED PROPERTY GEOLOGY

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-447/2	8

FIGURE 2.3-4 REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24NOV'12	ISSUED WITH REPORT	CHS	DF	KJB



NOTE:
1. MAP FROM RENNIE, D.W. 2012. TECHNICAL REPORT ON THE SISSON PROJECT, NEW BRUNSWICK. NI 43-101 REPORT, CANADA.

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NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

PLAN OF 3D GEOLOGY MODEL FOR THE SISSON DEPOSIT

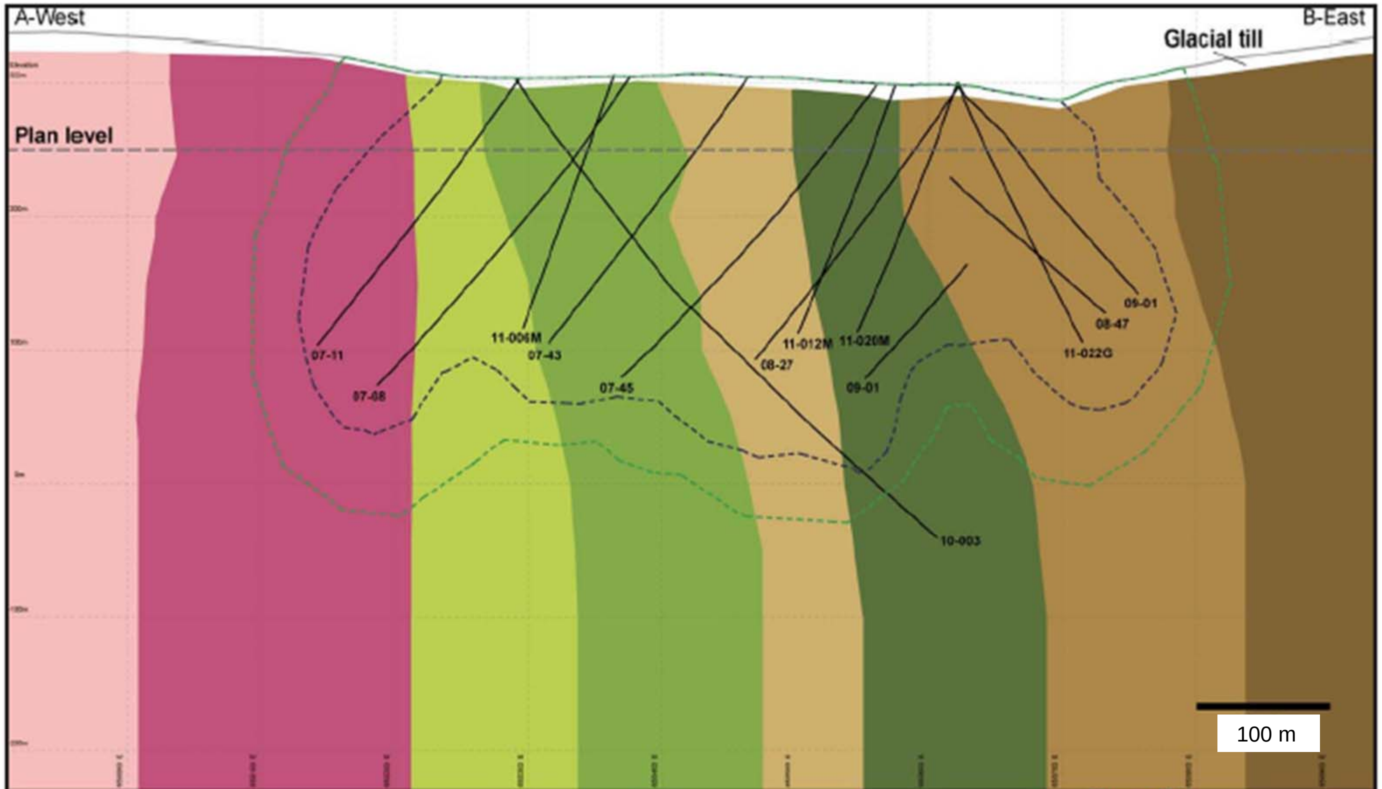
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE 2.3-5

REV 0



June 2012

Source: Northcliff Resources Ltd., 2011

NOTES:

1. SECTION FROM RENNIE, D.W. 2012. TECHNICAL REPORT ON THE SISSON PROJECT, NEW BRUNSWICK. NI 43-101 REPORT, CANADA.
2. SEE FIGURE 2.3-5 SECTION LINE LOCATION AND LEGEND.

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SISSON PROJECT

GEOLOGICAL CROSS SECTION (A-B)

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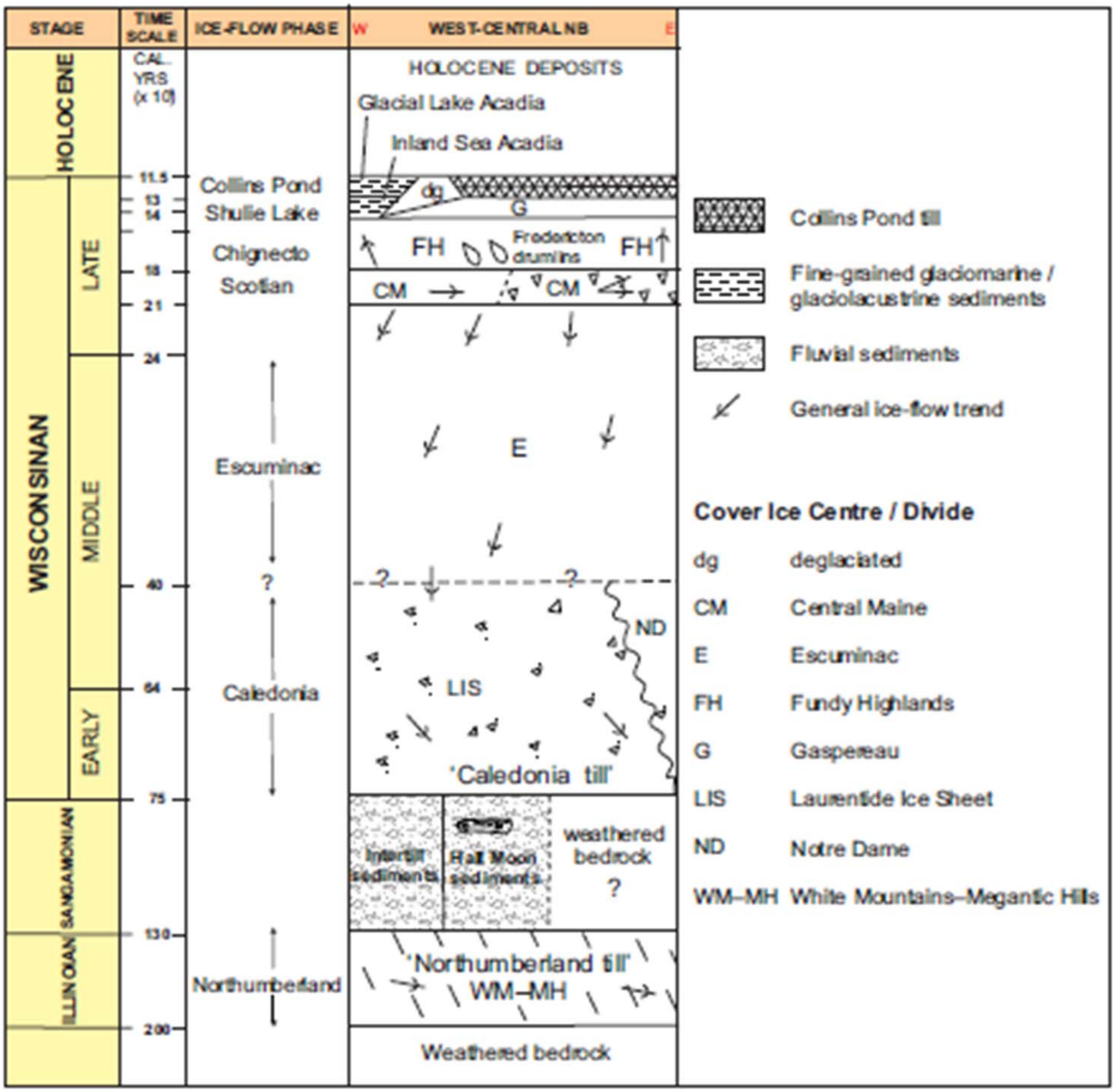
P/A NO. VA101-447/2

REF. NO. 8

FIGURE 2.3-6

REV 0



NOTE:

1. FROM SEAMAN, ALLEN A. 2012. RARE EARTH ELEMENTS AND ASSOCIATED ELEMENTS IN BASAL TILL, WEST-CENTRAL NEW BRUNSWICK, CANADA, NEW BRUNSWICK DEPARTMENT OF ENERGY AND MINES; GEOLOGICAL SURVEY BRANCH. MINERAL RESOURCES REPORT 2012-1: PAPER 1 (CD-ROM), 76 p.

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0	24NOV'12	ISSUED WITH REPORT	CHS	DF	KJB

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SISSON PROJECT

QUATERNARY STRATIGRAPHY GEOLOGY
WEST-CENTRAL NEW BRUNSWICK

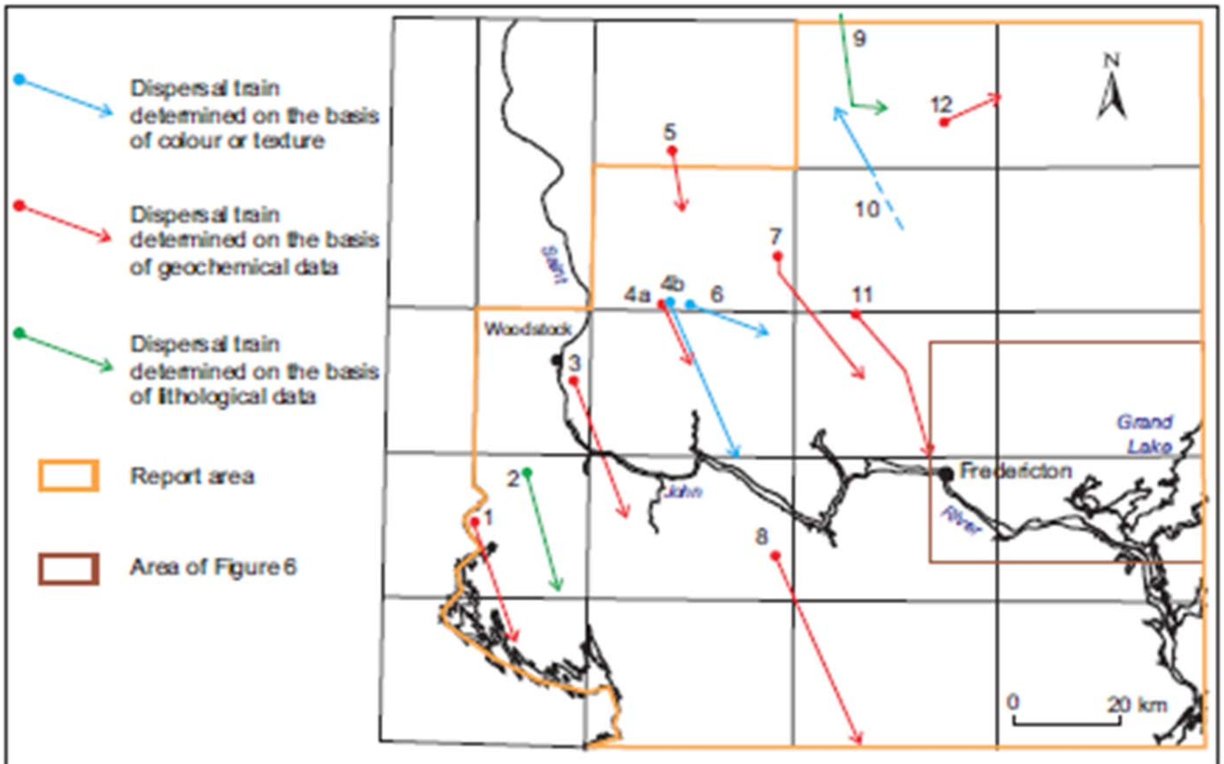
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE 2.3-7

REV 0



	Dispersal Train	Dispersal Indicator
1	Poplar Mountain	gold
2	Oak Mountain	mafic volcanic clasts
3	Connell Mountain	copper
4a	Cloverdale	arsenic and antimony
4b	Cloverdale	reddish till
5	Foreston	lead and zinc
6	Carlisle	reddish till
7	Sisson Brook	bismuth and tungsten
8	Lake George	antimony
9	Clearwater Brook	gabbroic clasts
10	McLean Brook	clayey material
11	Fredericksburg	barium
12	Trout Lake	beryllium and granitic clasts

NOTE:

1. FROM SEAMAN, ALLEN A. 2012. RARE EARTH ELEMENTS AND ASSOCIATED ELEMENTS IN BASAL TILL, WEST-CENTRAL NEW BRUNSWICK, CANADA, NEW BRUNSWICK DEPARTMENT OF ENERGY AND MINES; GEOLOGICAL SURVEY BRANCH. MINERAL RESOURCES REPORT 2012-1: PAPER 1 (CD-ROM), 76 p.

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NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MAJOR GLACIAL DISPERAL TRAINS
WEST-CENTRAL NEW BRUNSWICK

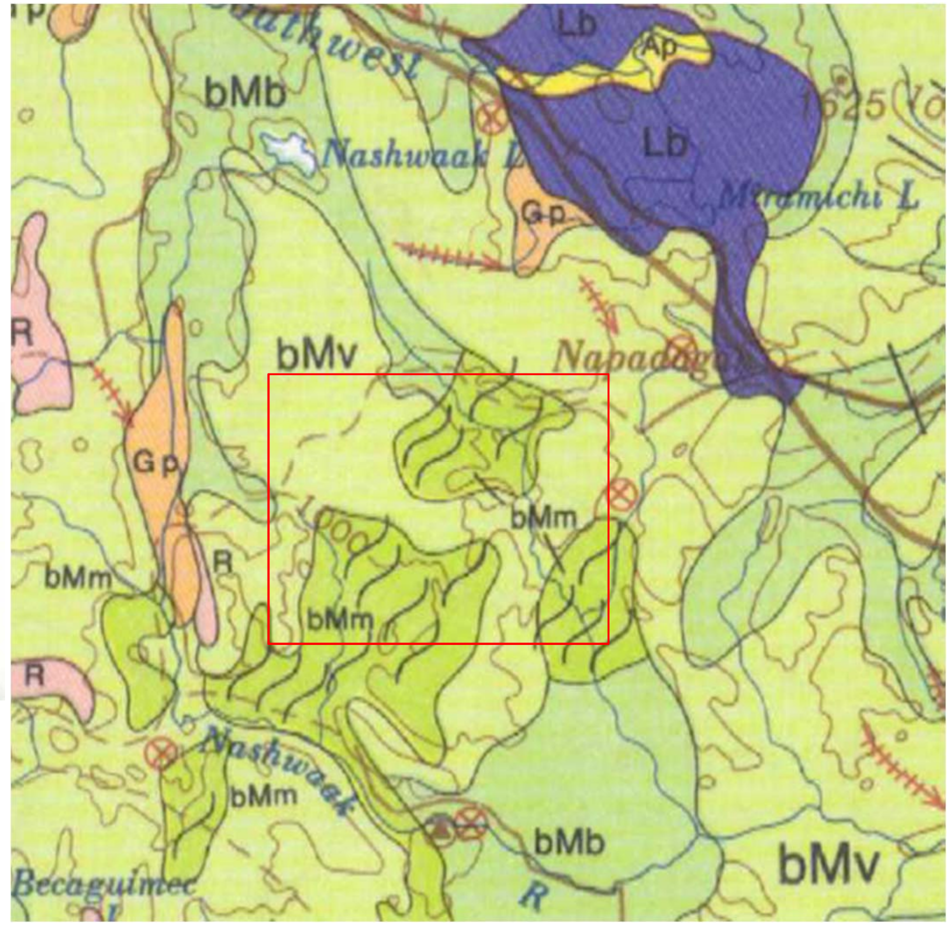
Knight Piésold CONSULTING

P/A NO.	REF. NO.		
VA101-447/2	8	**FIGURE 2.3-8**	REV 0

MORAINAL SEDIMENTS: lodgment till, ablation till, and associated sand and gravel deposited directly by Late Wisconsinan ice or with minor reworking by water

Mm	Hummocky, ribbed, and rolling ablation moraines: loamy ablation till, some lodgment till, minor silt, sand, gravel, and boulders; generally greater than 1.5 m thick aMm - mainly stony till (more than 35% of clasts pebble-sized and larger); bMm - mainly bouldery till (more than 25% of clasts boulder-sized)
Mb / Mv	Blanket and veneer: loamy lodgment till, minor ablation till, silt, sand, gravel, rubble Mb - blanket, generally 0.5 to 3 m thick Mv - discontinuous veneer over rock, less than 0.5 m thick sMb, sMv - mainly sandy till (sand content greater than 50%) aMb, aMv - mainly stony till (more than 35% of clasts pebble-sized and larger) bMb, bMv - mainly bouldery till (more than 25% of clasts boulder-sized)

Approximate Project Location



Kilometres 12 0 12

NOTES:

1. RAMPTON, V.N. 1984: SURFICIAL GEOLOGY NEW BRUNSWICK; GEOLOGICAL SURVEY OF CANADA, MAP 1594A, SCALE 1:500,000.

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SISSON PROJECT

REGIONAL SURFICIAL GEOLOGY

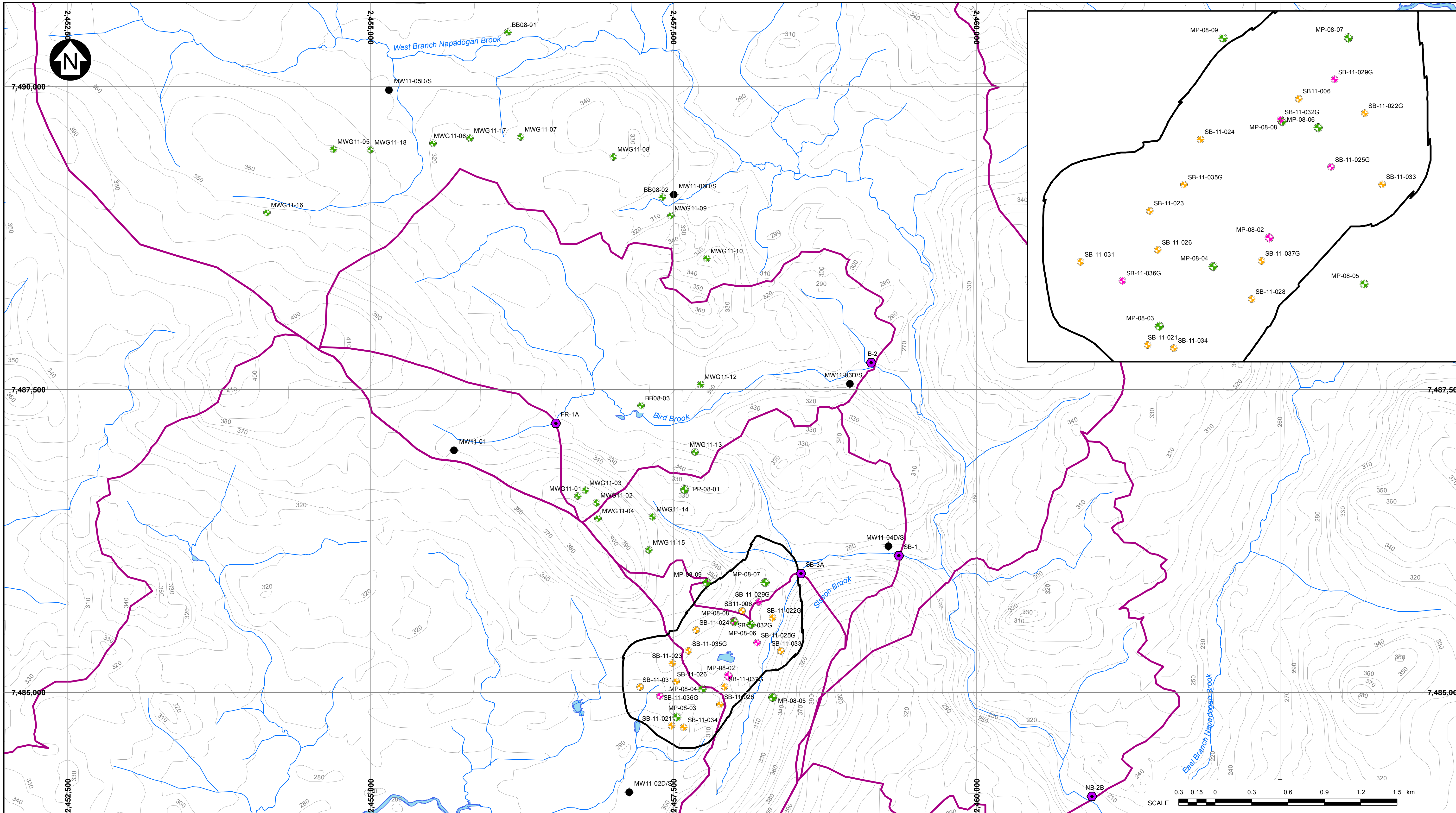
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE 2.3-9

REV 0



LEGEND:

- PROJECT STREAMFLOW STATION (ACTIVE)
- MONITORING WELL
- DRILLHOLE (TELEVIEWER)
- PIEZOMETER
- DRILLHOLE
- LAKE
- PROPOSED MINE FEATURES
- WATERSHED BOUNDARY
- CONTOUR (10 M)
- RIVER/CREEK

NOTES:

1. BASE MAP: CANADA NTS MAPS.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 CSRS NEW BRUNSWICK STEREOGRAPHIC.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:30,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTOUR INTERVAL IS 10 METRES.

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SISSON PROJECT

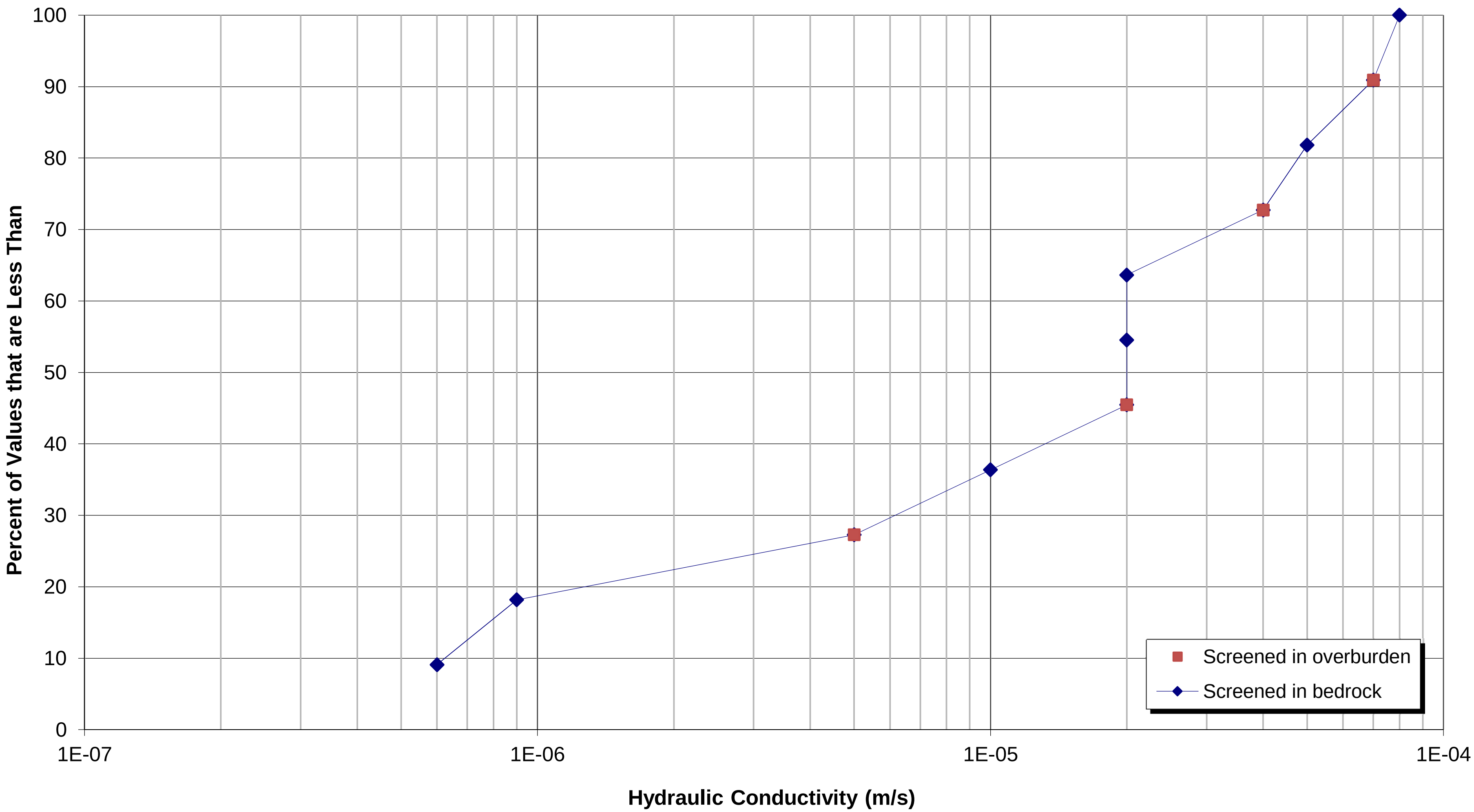
PROJECT SITE PLAN

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-447/2	8

FIGURE 3.1-1 REV 0

SAVED: M:\1\01\00447\02\A\GIS\Figs\Report 8 - Hydrogeology\ProjectSitePlan.mxd, Jan 02,2013 10:28 AM adinca



NOTES:
1. SCREENED INTERVAL INCLUDES FILTER PACK.
2. INCLUDES RESPONSE TESTS FROM KNIGHT PIESOLD (2012), 2011 HYDROGEOLOGY REPORT, REVISION 1. VA101-447/2-8.

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NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

CUMULATIVE DISTRIBUTION OF HYDRAULIC CONDUCTIVITY VALUES FROM RESPONSE TESTS IN MONITORING WELLS

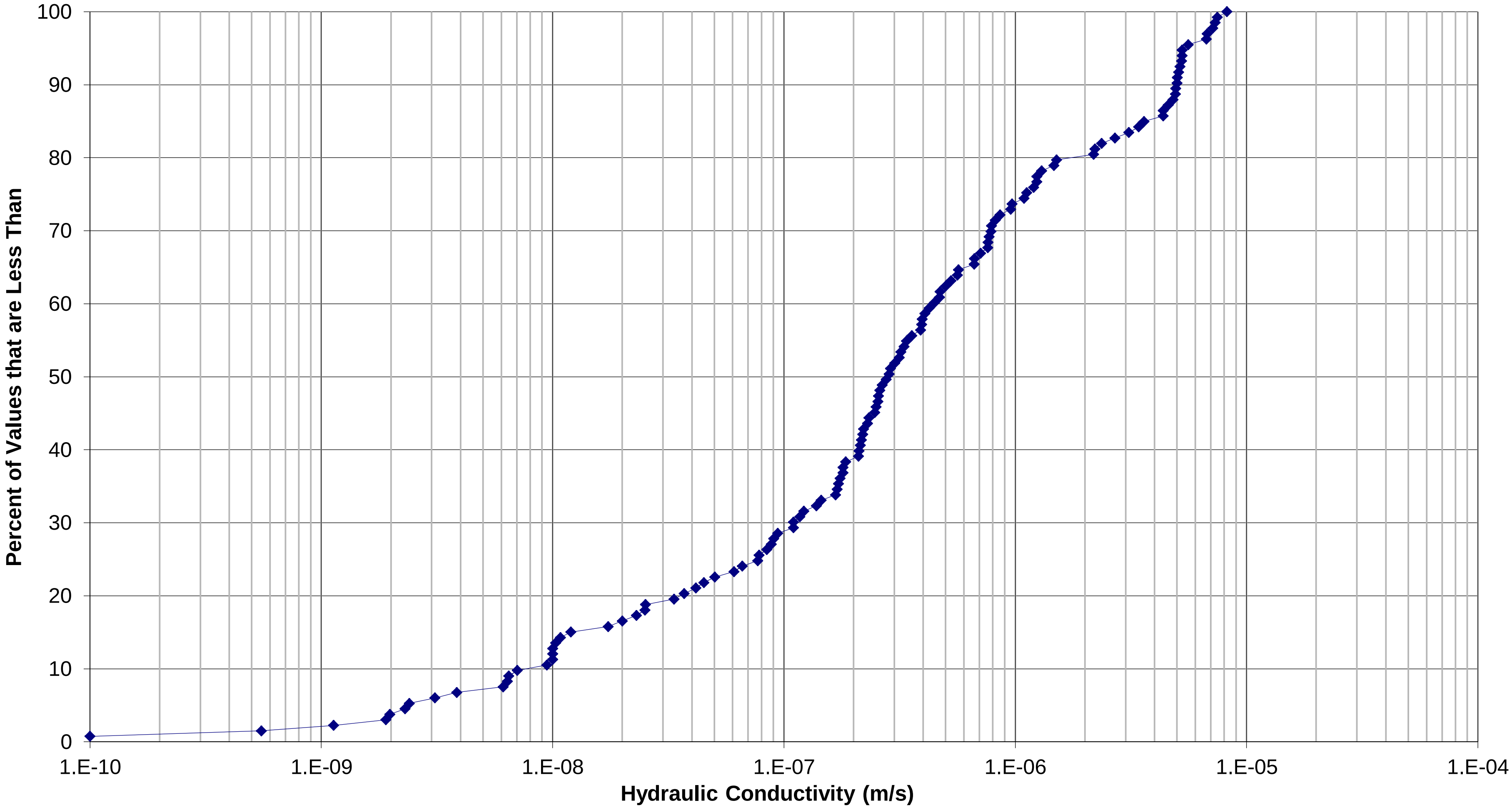
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE 3.2-1

REV 0



NOTES:

1. INCLUDES PACKER TESTS FROM KNIGHT PIESOLD (2012), 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012), 2011 GEOTECHNICAL SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-1, AND TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT PROJECT, NB.
2. PLOT DOES NOT INCLUDE HIGH TAKE TESTS. SEE KNIGHT PIESOLD (2012) 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2,

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
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SISSON PROJECT

CUMULATIVE DISTRIBUTION OF HYDRAULIC CONDUCTIVITY VALUES FROM PACKER TESTS IN DRILLHOLES

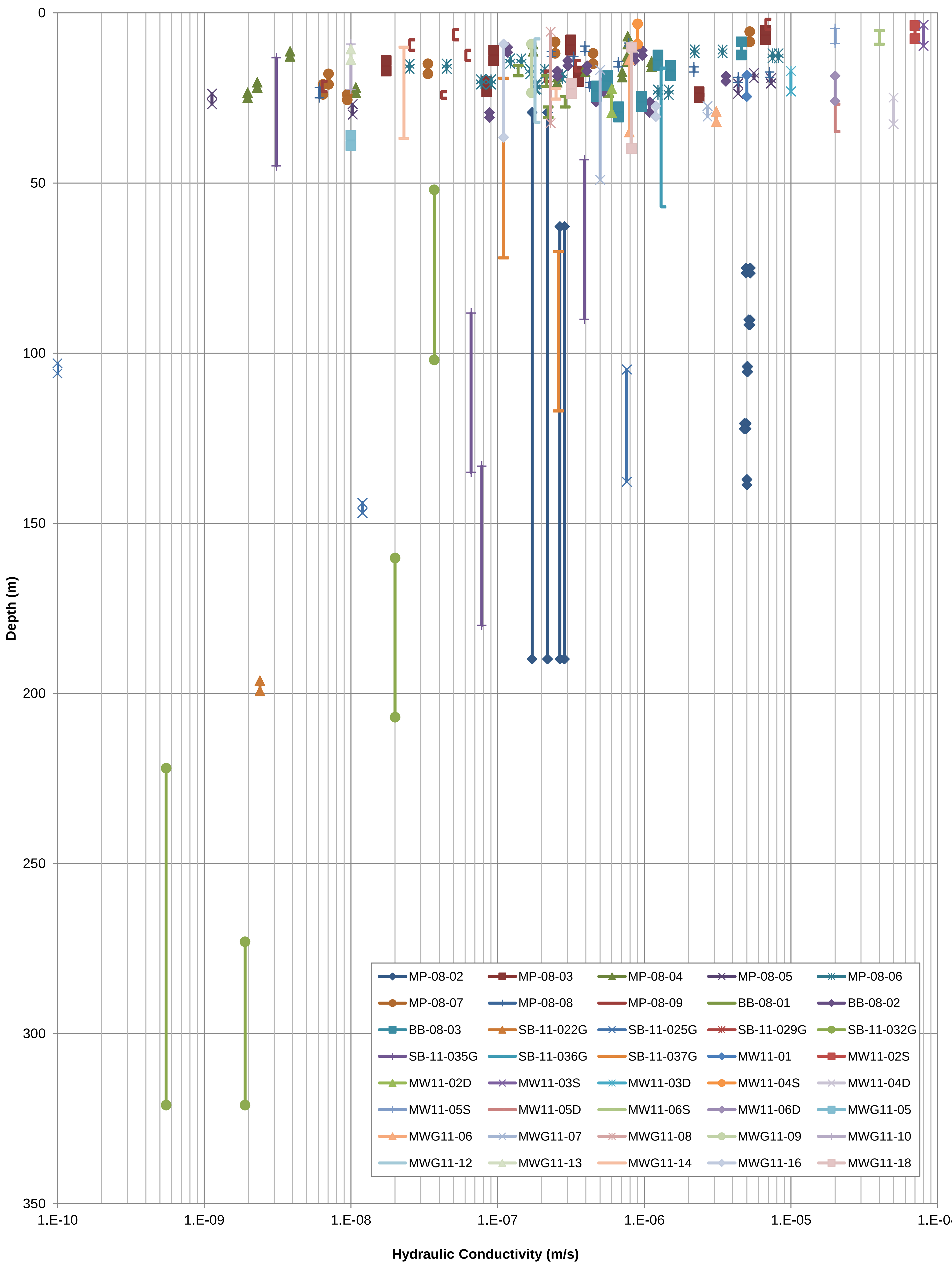
Knight Piésold CONSULTING

P/A NO. VA101-1/1

REF. NO. 8

FIGURE 3.2-2

REV 0



NOTES:

1. INCLUDES RESPONSE TESTS FROM KNIGHT PIESOLD (2012), 2011 HYDROGEOLOGY REPORT, REVISION 1. VA101-447/2-8.
2. INCLUDES PACKER TESTS FROM KNIGHT PIESOLD (2012), 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012), 2011 GEOTECHNICAL SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-1, AND TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINEDEVELOPMENT PROJECT, NB.
3. PLOT DOES NOT INCLUDE HIGH TAKE TESTS. SEE KNIGHT PIESOLD (2012) 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012)
4. LENGTH ALONG HOLE PLOTTED AS DEPTH FOR ANGLED HOLES (SB-11 SERIES).

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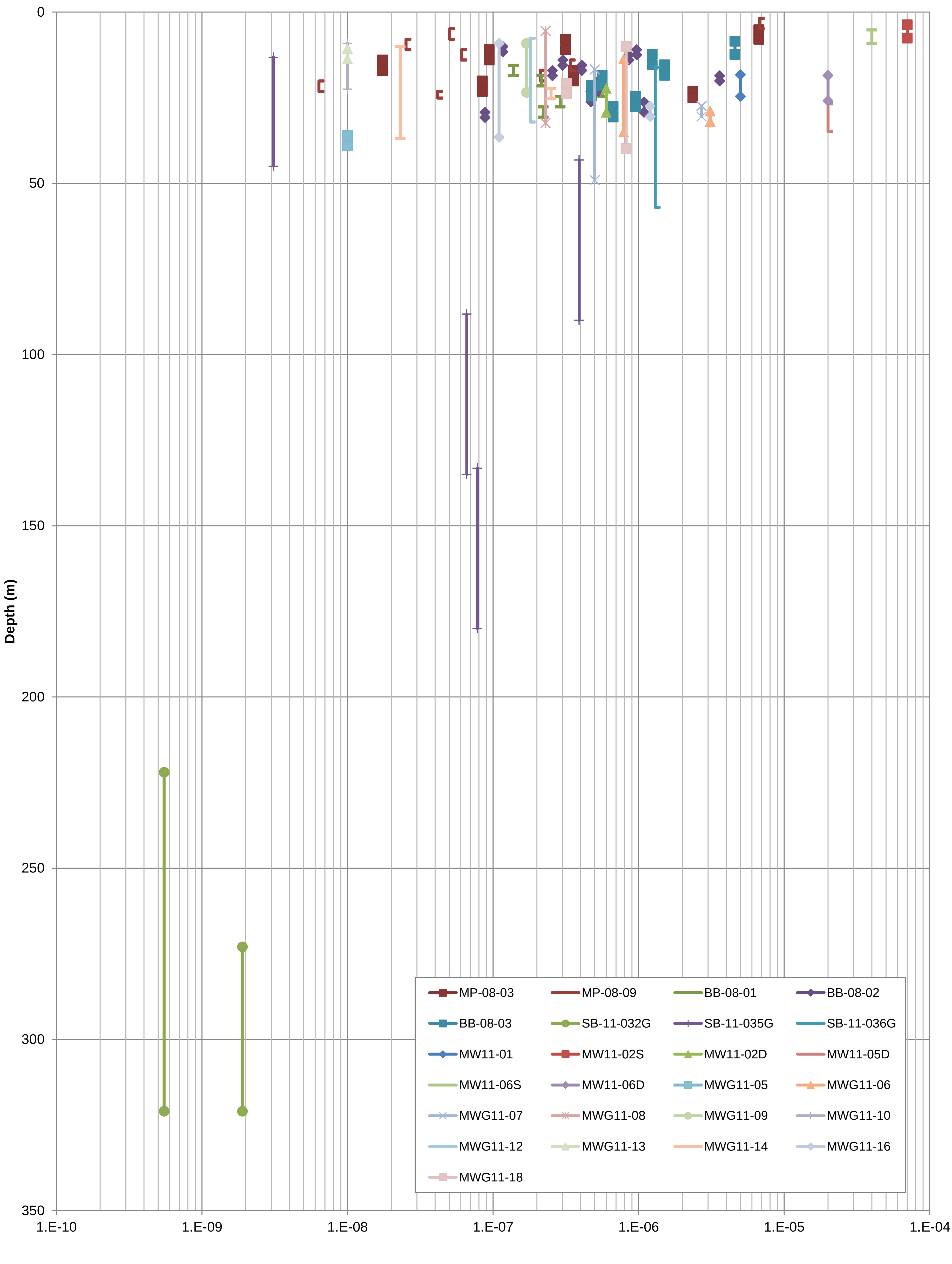
SISSON PROJECT

HYDRAULIC TESTS
RESPONSE AND PACKER TESTS

Knight Piésold CONSULTING

P/A NO. VA101-447/2 | REF. NO. 8

FIGURE 3.2-3 | REV 0



NOTES:

1. INCLUDES RESPONSE TESTS FROM KNIGHT PIESOLD (2012), 2011 HYDROGEOLOGY REPORT, REVISION 1. VA101-447/2-8.
2. INCLUDES PACKER TESTS FROM KNIGHT PIESOLD (2012), 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012), 2011 GEOTECHNICAL SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-1, AND TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT PROJECT, NB.
3. PLOT DOES NOT INCLUDE HIGH TAKE TESTS. SEE KNIGHT PIESOLD (2012) 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012)
4. LENGTH ALONG HOLE PLOTTED AS DEPTH FOR ANGLED HOLES (SB-11 SERIES).

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SISSON PROJECT

HYDRAULIC TESTS
INTRUSIVE PLUTONIC BEDROCK

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-447/2	8

FIGURE 3.2-4 REV 0

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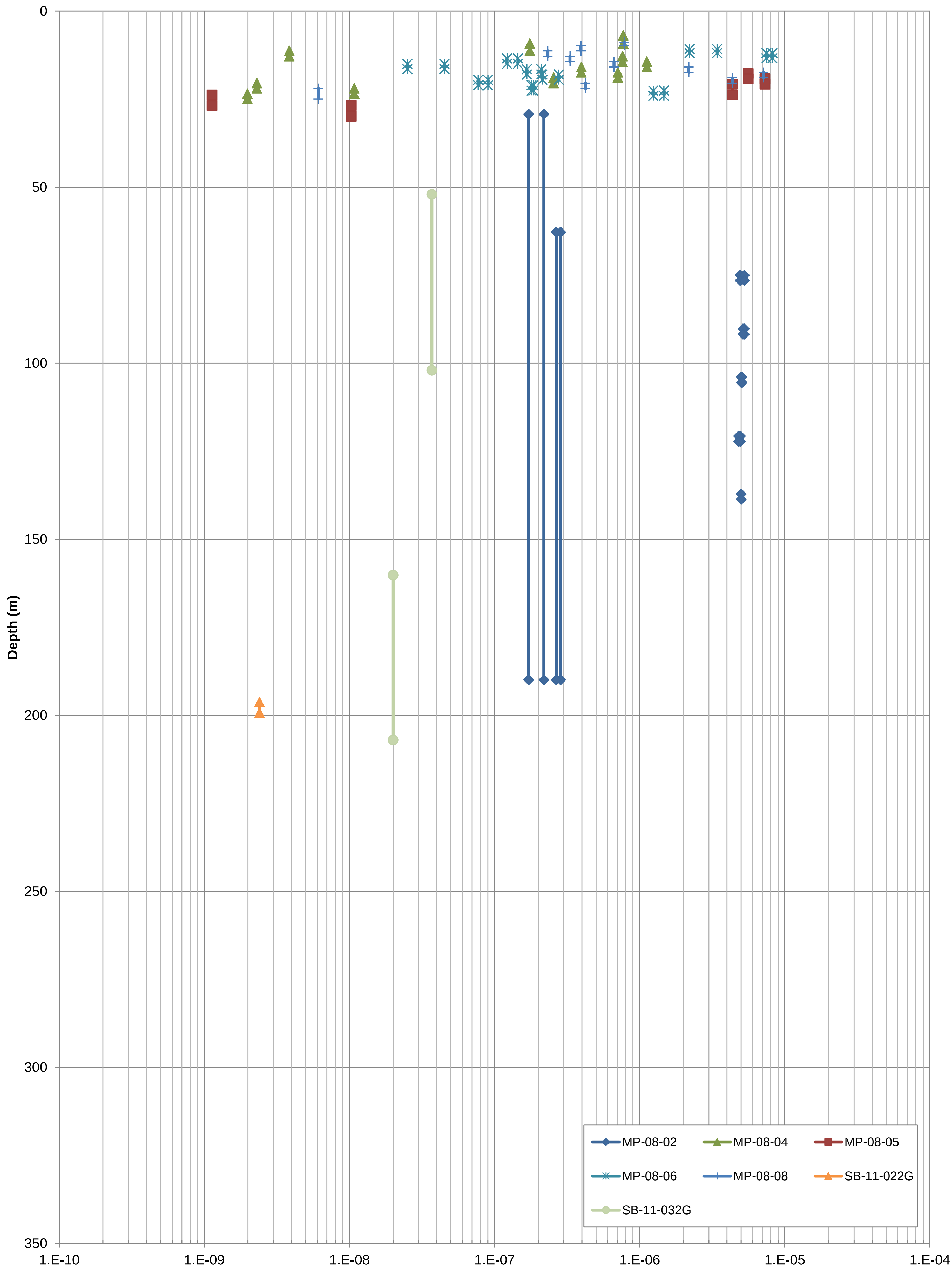

NOTES:
1. INCLUDES RESPONSE TESTS FROM KNIGHT PIESOLD (2012), 2011 HYDROGEOLOGY REPORT, REVISION 1. VA101-447/2-8.
2. INCLUDES PACKER TESTS FROM KNIGHT PIESOLD (2012), 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012), 2011 GEOTECHNICAL SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-1, AND TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT PROJECT, NB.
3. PLOT DOES NOT INCLUDE HIGH TAKE TESTS. SEE KNIGHT PIESOLD (2012) 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012)
4. LENGTH ALONG HOLE PLOTTED AS DEPTH FOR ANGLED HOLES (SB-11 SERIES).

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REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

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SISSON PROJECT

HYDRAULIC TESTS
METAVOLCANIC BEDROCK

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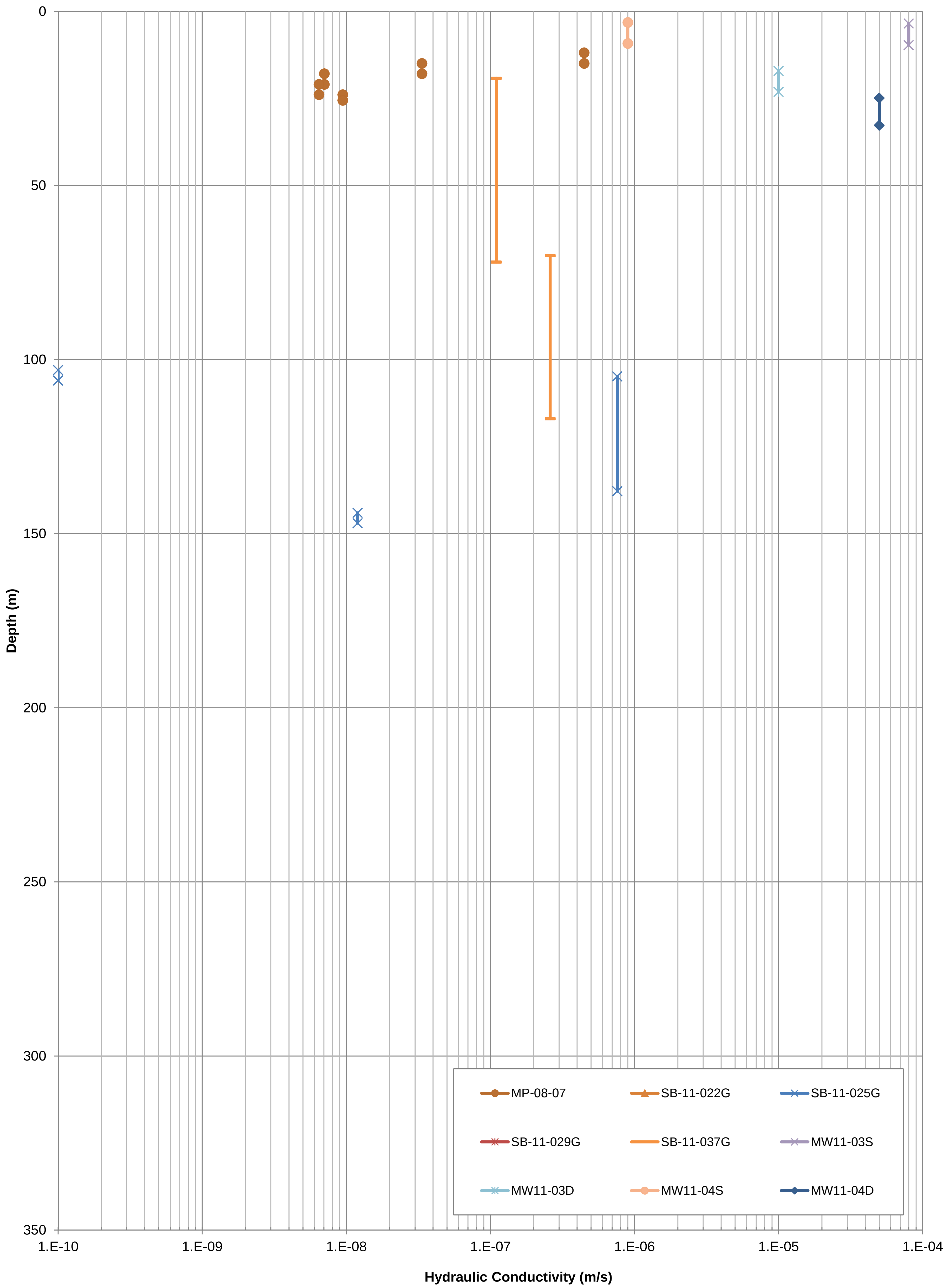
P/A NO. VA101-447/2

REF. NO. 8

FIGURE 3.2-5

REV 0



NOTES:
1. INCLUDES RESPONSE TESTS FROM KNIGHT PIESOLD (2012), 2011 HYDROGEOLOGY REPORT, REVISION 1. VA101-447/2-8.
2. INCLUDES PACKER TESTS FROM KNIGHT PIESOLD (2012), 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012), 2011 GEOTECHNICAL SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-1, AND TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT PROJECT, NB.
3. PLOT DOES NOT INCLUDE HIGH TAKE TESTS. SEE KNIGHT PIESOLD (2012) 2011 PIT SITE INVESTIGATION REPORT, REVISION 0. VA101-447/2-2, KNIGHT PIESOLD (2012)
4. LENGTH ALONG HOLE PLOTTED AS DEPTH FOR ANGLED HOLES (SB-11 SERIES).

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SISSON PROJECT

HYDRAULIC TESTS
METASEDIMENTARY BEDROCK

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P/A NO. VA101-447/2   REF. NO. 8

FIGURE 3.2-6   REV 0

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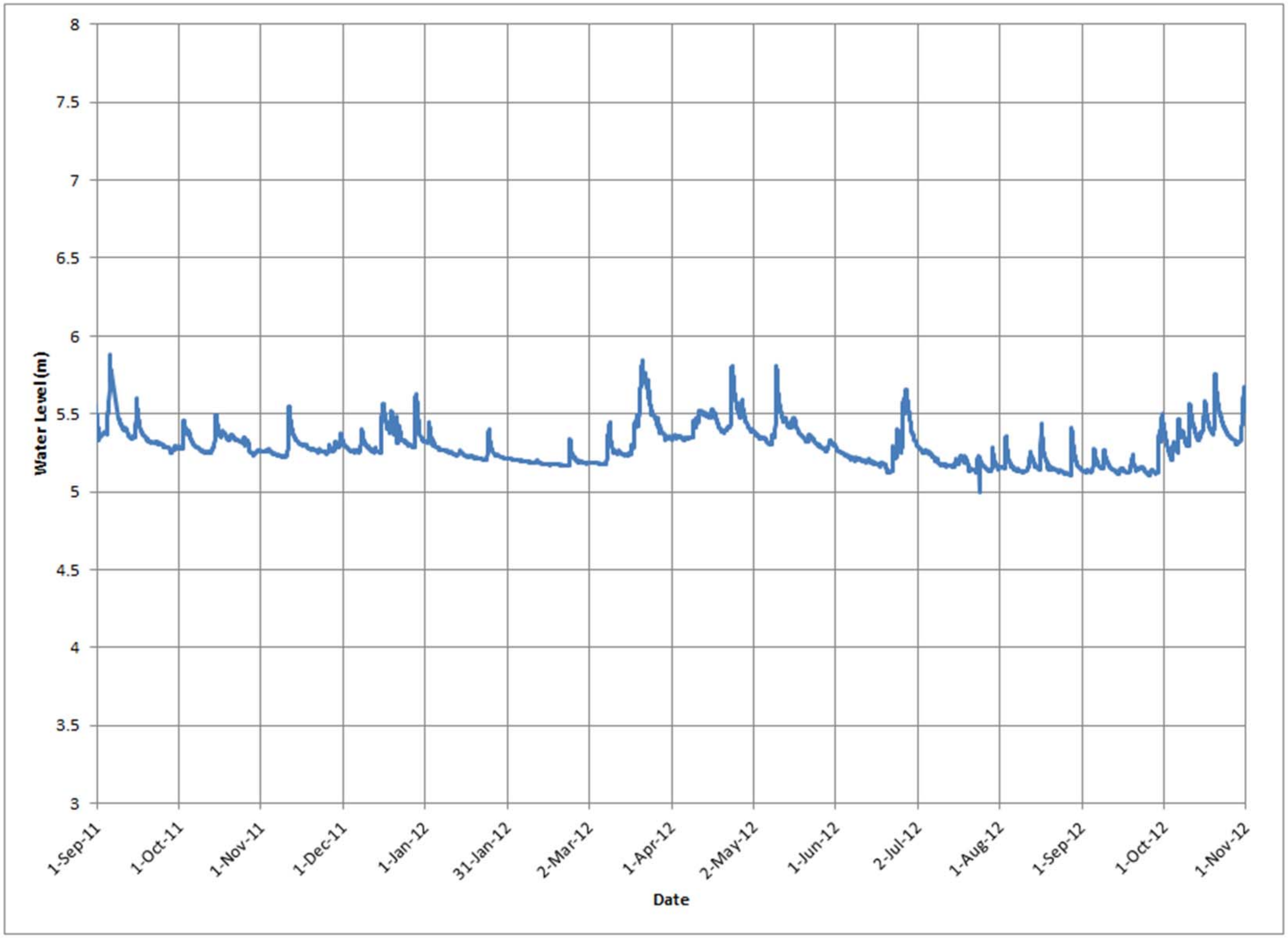

NOTE:

1. WATER LEVEL DATA RETRIEVED FROM ONLINE AT WATER SURVEY CANADA REAL-TIME DATA: http://www.wateroffice.ec.gc.ca/graph/graph_e.html?stn=01AL004. ACCESSED NOVEMBER 2012.

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SISSON PROJECT

WATER LEVELS FOR NARROWS MOUNTAIN BROOK NEAR NARROWS MOUNTAIN (WSC 01AL004)

Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE 3.3-1

REV 0

APPENDIX A

KP LETTER VA12-01435 - JULY 24, 2012

(Pages A-1 to A-43)

July 24, 2012

File No.:VA101-447/2-A.01
Cont. No.:VA12-01435

ISO 9001, ISO 14001
OHSAS 18001

Mr. John Boyle
Vice President Environment & Sustainability
Northcliff Holdings (Canada) Ltd.
15th Floor, 1040 West Georgia Street
Vancouver, BC V6E 4H8

Dear John,

Re: Sisson Project: Baseline Watershed Model Methodology and Results *DRAFT*
Update to VA12-00829 (Issued on May 4, 2012)

1. INTRODUCTION

The Sisson project (Project) is a proposed tungsten/molybdenum open pit mine located in central New Brunswick, approximately 100 km northwest of Fredericton (Figure 1). Knight Piésold Ltd. (KP) was retained by Northcliff Resources Ltd. (Northcliff) to assist with hydrogeology and hydrometeorology studies to support an Environmental Impact Assessment; this scope includes both baseline characterization and project effects assessment. A baseline watershed model was developed to assist with these studies. The purpose of this letter is to describe the methodology, model parameters, assumptions, and results of the baseline watershed model.

The baseline (pre-project) watershed model facilitates the understanding of the baseline site hydrologic parameters and hydrogeological setting and was developed using the site hydrometeorological data as primary inputs. The model was then used as a tool to help refine and constrain the estimated long term average climate parameters. The model and the hydrometeorology study thus inform each other to provide a more defensible understanding of the site conditions.

The baseline model was developed using the data available at the time of reporting and may be revised as additional data are collected. Methods to quantify the level of confidence in the data and results, such as R-squared and Nash-Sutcliffe efficiency values, are presented herein.

PROJECT SETTING

The Project is located primarily in the Napadogan Brook (west branch) watershed with a small portion of the footprint in the McBean Brook catchment; both streams are tributaries to the Nashwaak River (Figure 2). The Nashwaak River is a tributary to the Saint John River, which flows south to the Bay of Fundy. The elevation in the project area ranges from approximately 300 to 350 metres above sea level (masl), with some peaks rising to over 400 masl. Forest cover is mainly deciduous at higher elevations and coniferous at lower elevations. The area has a history of extensive commercial logging. Small lakes and wetlands are found in low-lying areas.

METHOD

A monthly time step, commonly used for hydrologic evaluations (Alley, 1984; Steenhuis et al, 1986), was selected for the watershed modelling. The time step of a hydrologic model depends on the requirements of the study. Time steps can range from portions of a day to months or even years. Shorter time steps are typically required when the objective is to simulate the response of streamflows to shorter term events such as storms. However, the primary purpose of this modelling exercise was to refine estimates of hydrogeological and hydrologic parameters that contribute to streamflows, on a seasonal basis, and therefore monthly time steps are appropriate. The analysis considered the interaction of surface water and groundwater components of the flow system while respecting the constraints imposed by the measured climate and streamflow data. The model was run over a relatively long-term period, as the use of a long-term climate record provides the following:

- Better averages of monthly conditions (e.g., temperature, precipitation)
- Identification of changing climate trends (e.g., dry periods), and
- Opportunity to simulate a long term streamflow record when measured stream flow data are limited.

Ideally, a concurrent long-term climate and streamflow record would be available for model calibration as this provides a higher confidence in the modelling results. The site climate and streamflow records for this watershed modelling assessment are relatively short; however, regional climate and streamflow data were available from stations operated by the Meteorological Services of Canada (MSC) and Water Survey of Canada (WSC), respectively. Both the MSC and WSC are branches of Environment Canada. The regional data currently provides the best approximation of the long-term average conditions at the site. The climate and streamflow records available for this watershed modelling are further discussed in the sections below.

The monthly baseline watershed model was set up using a Microsoft Excel spreadsheet using a semi-distributed method that allowed for adjacent sub-catchments to be chained together. The project area was discretized based on the catchments of the established stream-gauging stations shown on Figures 2 and 3. A sub-catchment area is defined as the catchment contributing to a stream gauge less the area of any defined upstream catchments. The general approach of the modelling was as follows:

- Inputs to each sub-catchment included precipitation within the sub-catchment and inflow (groundwater and surface water) from upstream sub-catchments.
- Precipitation, as rainfall, was distributed amongst the following components:
  - Surface runoff
  - Groundwater recharge, and
  - Evapotranspiration and sublimation.
- Precipitation as snowfall was accumulated until the temperature increased enough to melt the snow and generate snowmelt, at which time it was distributed into the appropriate components as defined above.
- Groundwater and surface water accumulation in storage, and discharge from storage, were modelled using a simple linear reservoir model approach.
- Outputs from each sub-catchment included surface water and groundwater discharge to downstream sub-catchments.

The model parameters were adjusted until the calculated streamflows were in reasonable agreement with the available measured streamflows from regional gauging sites. Calibration was completed for two regional streamflow stations operated by the WSC that are in close proximity to the Project and have a long period of streamflow record; the two stations are discussed in the follow section. The calibrated model parameters were then used to evaluate the goodness of fit to the streamflow measured at the site streamflow stations. The site stations within the Napadogan River catchment were only considered because the footprints of the key project infrastructure, including the proposed open pit and tailings storage facility, are predominantly in this catchment; very little of the proposed project footprint is located in the McBean Brook catchment. The development and calibration of the baseline watershed model to the regional and site streamflow stations are described further in the sections below.

MODEL SET-UP

Discretization

The model study area was divided into the regional and site sub-catchments shown on Figures 2 and 3, respectively. The sub-catchments were defined based on the need to calibrate the model to measured flow rates and volumes at the streamflow stations. The two regional stations were the Nashwaak River (WSC ID 01AL002) and Narrows Mountain Brook (WSC ID 01AL004) gauging sites. The project site stations were B-2, SB-1 and NB-2B. The catchment area contributing to each stream gauge is shown in Table 1.

Climate Data

Meteorological Stations

Meteorological data (monthly total precipitation and monthly mean temperature) have been collected on site at the Sisson Brook station since 2007. However, the use of the site data in the model is limited to the relatively short duration of the time series. As such, regional data from EC climate stations were used to provide a long-term record of site conditions. A comparison was completed between the regional stations and the site station; the EC operated station at Juniper (Station ID 8102275) was considered the most representative of site conditions (KP, 2012). Juniper is approximately 23 km from the site at an elevation of 259 masl and is the closest site with long-term precipitation and temperature records (1969 to present). A data gap exists from 2004 to 2012, with a few smaller gaps within the remaining period of record. Data gaps in the Juniper record were in-filled based on a relationship developed with the EC operated site at Woodstock (Station ID 8105600) that is located about 46 km from the site at an elevation of about 153 masl. The active regional climate stations in close proximity to the site are shown on Figure 4.

Temperature

Temperature data from Juniper were used to provide an estimated long-term monthly average temperature record of the project site conditions using the methodology described in the Meteorological Stations section, above. The monthly temperature data from the Woodstock station were used to in-fill temperature data gaps in the period of record from the Juniper station; the complete data set shown in Table 2 was then applied to the model. A plot of the concurrent periods of records between the Juniper and Woodstock regional stations and the Sisson Brook site station indicated close agreement (Figure 5); therefore, adjustments for elevation or location were not required. Climate normal data (1971 to 2001 for Juniper) were used in the instances when Woodstock data were not available to in-fill missing data gaps in the Juniper record.

Daily maximum temperatures were used to estimate snowmelt, as it is not possible to capture the short periods of warming in the winter that result in a component of the winter snowmelt when using monthly average temperatures. For example, a winter month may have a mean temperature of below freezing, but with one or more days of above-freezing temperatures that lead to snowmelt. The snowmelt would be seen as an increase in the streamflow record during that month, but the model would not be able to simulate the increased flow based on the monthly temperature record.

Precipitation

Precipitation data from Juniper were used to develop a long-term record of site conditions using a similar approach as with the temperature record. Data gaps in the period of record from the Juniper station were in-filled using monthly precipitation data from the Woodstock station that were adjusted using a multiplier of 1.03. This relationship shown on Figure 6 was developed based on a correlation of the concurrent periods of records between the two regional stations. The R-squared calculated for the correlation is 0.67, which reflects the spatial and temporal variation that is generally found between stations as a result of local weather systems and was therefore considered acceptable for use in this analysis. Climate normal data (1971 to 2001 for Juniper) were used in the few instances when Woodstock data were not available to in-fill missing data gaps in the Juniper record.

The precipitation data set based on the Juniper station was increased by a factor of 1.06 in the winter months (October through May) to account for winter snowfall catch-inefficiencies. Precipitation gauge catch inefficiency, or under-catch, results from windblown rain and snow that does not get captured by the measuring instrument. A local precipitation factor of 1.11 was also applied in addition to the catch efficiency factor to the precipitation data for each sub-catchment to account for local site variations from the regional stations. Wetter conditions at the site compared to the regional stations are supported by an analysis of the site and long-term regional data (KP, 2012). The complete data set shown in Table 3 was applied to the model.

Hydrological Processes and Assumptions

Rainfall and Snowfall

The distribution of precipitation as either snow or rainfall was based on the assumption that all precipitation falls as rain if the average monthly temperature is greater than 2°C and all as snow if the average monthly temperature is below -2°C. For temperatures between -2°C and 2°C, the ratio of snow to rain was varied linearly. Manual snow surveys in the winters of 2010-2011 and 2011-2012 were considered in the analysis to provide a general indication of the characteristics of the snowpack (KP, 2012).

Sublimation and Snowmelt

A sublimation rate of 0.39 mm/day was estimated for this analysis and is comparable to the results found by KP (2012). Total potential snowmelt was estimated using a temperature index method; the actual snowmelt was constrained by the available snow after sublimation.

Potential and Actual Evapotranspiration

Evapotranspiration was calculated following the methods of Thornthwaite (1948). The potential monthly evapotranspiration (PET) was estimated based on average monthly temperature. Typically, the PET represents the evapotranspiration for a full vegetation cover on relatively flat tilled ground with saturated soil. The actual evapotranspiration (AET) is calculated as part of a soil water balance in the model and is based on actual moisture availability.

Water available for groundwater recharge and surface runoff

The water available for groundwater recharge and runoff was calculated as the sum of the rainfall and snowmelt for the month, less the evapotranspiration and soil moisture change. This unit value of water (surplus water) was multiplied by the area of the sub-catchment to estimate the total water available for recharge and runoff.

Groundwater recharge

Groundwater recharge was estimated with an adjustable portion of the water available for runoff and recharge to allow variability dependent on surface conditions, soil permeability, and available storage capacity. The water available for recharge and runoff that was not recharged remained as surface water to be either stored or runoff.

Groundwater storage and discharge

A linear reservoir model was used to simulate the storage and release of groundwater. Water assumed to recharge into storage in each sub-catchment was accumulated and released. The rate of release was determined by the product of the average volume of water in storage and an estimated discharge factor that is adjusted during the calibration. The volume of water in storage equals the sum of the storage in the preceding month, plus the volume of water entering the system, less the quantity discharged. A lower discharge factor value results in larger accumulated storage and a more uniform discharge rate. A discharge factor consistent with the site conditions was used.

Groundwater flow between catchments
Groundwater can flow downstream (into the next sub-catchment), or can discharge within the sub-catchment to surface water. Groundwater leaving the sub-catchment was estimated using Darcy's Law by taking the product of estimated values for transmissivity, width, and hydraulic gradient. The remainder was added to surface water within the catchment.

Surface water detention and discharge
Surface water storage was included because several sub-catchment areas included small ponds and wetlands that were not modelled as distinct water bodies. These retention features were simulated with a linear reservoir model similar to groundwater storage and discharge.

Streamflow Data

Measured monthly streamflow records were available for calibrating the model at the following stations and for the following periods:

- Nashwaak River from 1962 to 2011 (data from 2009 to 2011 have not yet been reviewed by WSC)
- Narrows Mountain Brook from 1972 to 2011 (data from 2009 to 2011 have not yet been reviewed by WSC)
- B-2 from June to November 2011
- SB-1 from June to November 2011, and
- NB-2B from June to November 2011.

Streamflow data prior to the start of the precipitation and temperature data set (1969) were not used in the calibration. Spot winter flow measurements collected in February and March 2012 were also available for comparison purposes with the calculated streamflows. The temperature and precipitation data sets were extended to include 2012 data using climate normal from Juniper, which allowed the modelled average monthly flows in 2012 to be compared to the site winter flow measurements.

A longer period of record was generated for streamflow measurement sites B-2, SB-1, and NB-2B based on a ranked linear regression technique with the Narrows Mountain Brook station (KP, 2012). A greater weight was given to the measured flows over the synthetic flows for the purpose of watershed model calibration. However, the synthetic record was reviewed to check that the total volumes and distribution of flows were in the expected range; this check is described in the following section.

RESULTS

Two methods were used to evaluate the goodness of fit between the measured and calculated streamflows: a visual method and the statistical Nash-Sutcliffe efficiency (1970) method. Visual inspection provides useful insight into the adequacy of the results; however, statistical measures provide a more objective approach that complements the visual inspection. The Nash-Sutcliffe Efficiency (NSE) is a commonly adopted statistical measure used in hydrology and was considered appropriate for this analysis.

The cumulative flow and flow duration plots shown on Figures 7 through 10 were generated for the regional stations to visually evaluate the calibration. The good calibration to the regional data reflected by these plots indicates that the input parameters such as precipitation and temperature are well constrained in terms of total volumes and distribution. Monthly measured and calculated streamflows (i.e. hydrographs) are provided for comparison purposes in Appendix A; a NSE value was calculated based on these monthly flows. NSE values of 0.65 and 0.70 were calculated for the Nashwaak River and Narrows Mountain Brook catchments, respectively. The performance rating for NSE values (Moriaisi et al, 2006), is defined below:

- Very good 0.75 < NSE < 1.00
- Good 0.65 < NSE < 0.75
- Satisfactory 0.50 < NSE < 0.65
- Unsatisfactory NSE < 0.50

The NSE performance rating was therefore Good for the model calibration to both the Nashwaak River and Narrows Mountain Brook recorded hydrographs.

The plots of measured and calculated monthly streamflows shown on Figures 11, 12, and 13 were generated to evaluate the calibration of the model to the site streamflow gauging station records. The measured period of record was not long enough to generate cumulative or flow duration plots; however, cumulative and flow duration plots of the synthetic records and the calculated streamflows show that the total volumes and distributions are within the expected range.

Calibrations to the site data were based on the calibrated parameters used for the regional model at Narrows Mountain Brook. The discrepancy between the measured and calculated streamflows, especially during the summer months, is likely a result of the precipitation values used in the model. The precipitation values that drive the calculated flows in the model were based on records from a regional site station and therefore provide a representation of the long term distribution rather than a specific period. Therefore it is expected that for a short-term stream flow record the calibration will not be as good as over a longer period. For example, the August 2011 precipitation value based on the regional station was approximately 55% less than the measured precipitation at the Sisson Brook station (131 mm compared to 241 mm) and this wetter period was not captured for this period of stream flow record in the precipitation data set. However, it would be expected that a calibration using a longer stream flow data set would capture some of the wetter and drier periods so that the long term distribution was simulated. The ability to develop a better calibration to the site data will be possible as additional precipitation and streamflow measurements (especially low flow measurements) are collected on site. The regional streamflow data currently provides the best approximation of the long-term distribution and volume of flow at the site.

The long-term temperature record used in the watershed modelling has a mean annual value of 3.8°C, with minimum and maximum average temperatures occurring in January and July, respectively. The mean annual precipitation was estimated to be about 1360 mm. The calculated mean annual potential evapotranspiration (PET) was estimated at 520 mm based on the model calibration. This value is consistent with the long-term annual PET value estimated by KP (2012), and is within the range of 500 to 600 mm indicated by the map of annual lake evaporation of Canada (NRC 1995). Enhanced AET was applied to 80% of the Nashwaak River sub-catchment, and 75% of the Narrows Mountain Brook sub-catchment as well as the projects site sub-catchments, to account for the low lying wetlands, streams and lakes that are characteristic of the region. The calculated average AET was estimated at about 510 mm in the enhanced AET area and 410 mm in the remaining catchment area. The average annual calculated groundwater component of the stream flow was about 3.3 L/s/km^2 for the Narrows Mountain Brook sub-catchment which was in good agreement with a visual inspection of the daily low flows during the winter months. The groundwater recharge was estimated as about 8 % of the total precipitation.

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Please contact the undersigned with any comments or questions.

Yours truly,
KNIGHT PIESOLD LTD.

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<u>Attachments:</u>

Table 1 Rev 0	Calculated Catchment Areas
Table 2 Rev 0	Monthly Average Temperature Data
Table 3 Rev 0	Monthly Precipitation Data
Figure 1 Rev 0	Project Site Location
Figure 2 Rev 0	Watershed Boundaries
Figure 3 Rev 0	Active Streamflow Stations
Figure 4 Rev 0	Regional Climate Stations
Figure 5 Rev 0	Comparison of Monthly Average Temperature

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TABLE 1

NORTHCLIFF RESOURCES LTD.
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CALCULATED CATCHMENT AREAS

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Stream Gauge	Area (km^2)
01AL002 Nashwaak River	1450
01AL004 Narrows Mountain Brook	4
B-2	7.7
SB-1	5.0
NB-2B	52.6

M:\1\01\00447\02\A\Correspondence\VA12-01435 Baseline Watershed Model - Update to VA12-008289\Attatchments\[Tables 1 to 3 and Figures 1 and Figures 5 to 13.xls]Table 1

NOTES:

1. AREA REPRESENTS THE TOTAL CONTRIBUTING CATCHMENT TO THE STREAM GAUGE.

0	24JUL'12	ISSUED WITH LETTER VA12-01435	CHS	DF	KJB
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TABLE 2

NORTHCLIFF RESOURCES LTD.
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MONTHLY AVERAGE TEMPERATURE DATA

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Temperature (^{o}C)	Average	10th percentile	90th percentile	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Jan	-12.1	-16.0	-9.0	-12.4	-15.8	-14.0	-10.4	-12.2	-13.8	-9.7	-14.6	-16.0	-14.0	-9.6
Feb	-10.5	-13.1	-7.2	-11.2	-11.1	-13.6	-15.6	-11.6	-11.2	-10.4	-11.0	-11.5	-12.9	-12.9
Mar	-4.3	-7.1	-1.3	-4.5	-5.9	-2.9	-6.0	-4.0	-7.3	-4.4	-6.0	-1.3	-7.6	-1.1
Apr	2.9	0.4	5.3	2.5	2.5	3.8	2.2	2.0	0.4	1.7	1.8	-0.4	0.0	2.6
May	10.1	8.4	12.3	10.1	9.5	11.8	8.4	10.1	6.0	10.5	9.0	9.8	11.6	10.7
June	15.2	13.7	16.5	14.9	14.8	13.4	15.1	14.9	15.1	15.3	15.8	13.6	15.2	15.1
July	18.0	16.6	19.9	16.5	19.0	16.7	17.0	18.7	16.6	19.9	17.1	16.9	17.5	18.3
Aug	17.0	15.8	18.6	16.3	16.9	17.9	16.6	17.5	16.7	16.3	15.8	16.5	16.1	14.9
Sept	12.1	10.6	14.3	11.3	10.6	12.0	11.5	11.4	10.8	11.1	11.1	9.9	9.0	10.9
Oct	6.0	4.1	7.7	5.9	5.6	6.9	1.6	5.7	3.0	5.1	6.4	7.7	5.7	5.8
Nov	-0.2	-2.9	1.9	0.9	1.8	-3.6	-3.4	-2.8	0.5	2.9	-4.2	0.5	-2.9	0.8
Dec	-8.2	-12.6	-4.4	-5.7	-11.4	-11.7	-13.8	-8.9	-5.4	-10.4	-13.2	-8.5	-8.8	-8.3
Average	3.8	1.5	6.2	3.7	3.0	3.1	1.9	3.4	2.6	4.0	2.3	3.1	2.4	3.9
Min	-12.9	-16.2	-9.3	-12.4	-15.8	-14.0	-15.6	-12.2	-13.8	-10.4	-14.6	-16.0	-14.0	-12.9
Max	18.2	16.7	19.9	16.5	19.0	17.9	17.0	18.7	16.7	19.9	17.1	16.9	17.5	18.3

Temperature (^{o}C)	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Jan	-11.1	-16.6	-16.2	-9.7	-13.2	-14.8	-11.3	-12.6	-11.8	-11.5	-8.7	-14.3	-12.6	-12.4	-17.4	-9.5
Feb	-12.6	-4.0	-11.8	-9.7	-5.6	-9.2	-11.8	-11.1	-11.0	-12.3	-12.7	-10.6	-11.5	-15.8	-13.7	-13.1
Mar	-5.3	-3.0	-5.6	-2.8	-7.1	-5.6	-5.9	-3.6	-4.4	-6.9	-5.1	-3.2	-7.5	-5.4	-3.6	-3.6
Apr	3.6	3.3	0.3	4.1	3.0	1.1	4.2	5.6	3.4	1.6	3.2	2.7	1.9	3.8	2.8	0.5
May	8.0	10.9	10.3	8.4	9.0	9.0	9.3	9.9	12.0	12.4	8.6	10.5	10.6	9.8	8.4	9.0
June	12.8	15.1	13.9	15.5	14.6	14.2	12.3	14.6	13.7	15.1	16.2	15.4	14.9	14.5	16.6	16.1
July	16.0	18.0	17.7	17.6	18.2	18.2	15.8	17.7	19.4	16.6	17.8	17.4	15.0	17.3	19.7	19.6
Aug	16.2	16.4	14.1	17.1	18.1	16.0	15.0	15.3	17.4	16.3	18.0	17.8	17.1	18.1	16.4	17.3
Sept	9.1	11.0	11.9	13.3	10.8	12.7	9.1	11.5	10.8	12.3	11.5	10.8	12.9	12.5	11.4	10.6
Oct	3.5	4.1	6.1	6.3	6.0	5.5	4.7	6.1	4.2	6.0	6.8	7.3	5.2	3.9	6.9	8.7
Nov	-1.9	-0.4	0.5	0.2	1.0	-2.7	-3.6	-1.6	1.0	-2.3	-0.6	0.3	-2.1	-1.0	1.0	-1.8
Dec	-13.2	-5.1	-5.6	-7.8	-7.3	-12.8	-9.3	-8.2	-10.5	-16.9	-7.2	-10.7	-6.9	-6.9	-7.1	-10.5
Average	2.1	4.1	3.0	4.4	4.0	2.6	2.4	3.6	3.7	2.5	4.0	3.6	3.1	3.2	3.5	3.6
Min	-13.2	-16.6	-16.2	-9.7	-13.2	-14.8	-11.8	-12.6	-11.8	-16.9	-12.7	-14.3	-12.6	-15.8	-17.4	-13.1
Max	16.2	18.0	17.7	17.6	18.2	18.2	15.8	17.7	19.4	16.6	18.0	17.8	17.1	18.1	19.7	19.6

Temperature (^{o}C)	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Jan	-11.7	-12.0	-9.6	-11.8	-11.9	-11.8	-8.9	-14.6	-16.2	-12.6	-6.1	-9.5	-8.3	-14.3	-6.3	-9.2
Feb	-9.6	-11.3	-7.1	-7.1	-9.7	-10.1	-8.3	-13.1	-8.8	-7.4	-7.7	-11.1	-8.6	-7.7	-4.0	-9.0
Mar	-5.2	-7.4	-3.2	-1.3	-1.5	-5.4	-4.4	-5.6	-3.3	-3.8	-1.3	-3.2	-5.7	-3.7	1.5	-2.6
Apr	3.1	1.2	3.9	3.2	2.9	1.9	2.8	0.3	3.8	5.0	5.9	3.0	5.4	5.3	7.7	4.0
May	8.6	7.9	12.6	13.2	9.0	11.9	9.8	9.6	10.6	8.5	12.8	10.6	10.2	11.3	13.2	10.9
June	15.6	15.1	15.1	17.7	14.6	16.5	13.8	15.8	13.7	17.5	18.1	16.4	16.0	15.8	16.4	16.1
July	17.3	17.8	18.8	18.7	17.1	17.7	17.8	17.7	18.4	18.9	20.8	18.5	20.4	17.9	21.4	20.1
Aug	17.2	16.3	16.6	17.1	16.7	18.7	17.6	18.3	18.1	18.7	16.2	17.5	17.6	19.7	19.3	19.1
Sept	12.4	12.3	12.9	16.1	12.0	13.5	13.6	13.8	13.3	14.5	13.6	14.4	13.6	13.4	14.8	15.2
Oct	5.7	4.7	6.1	5.4	5.6	7.3	4.7	6.4	7.7	8.2	6.7	9.6	6.6	5.0	7.3	8.6
Nov	-2.0	-1.6	-1.2	1.9	1.7	1.9	-1.8	0.9	-0.3	1.6	3.5	-0.4	1.4	3.9	1.1	3.9
Dec	-3.8	-8.5	-5.9	-5.7	-9.6	-3.4	-8.1	-5.4	-7.6	-6.7	-4.0	-8.5	-7.1	-6.3	-3.9	-4.3
Average	4.0	2.9	4.9	5.6	3.9	4.9	4.1	3.7	4.1	5.2	6.5	4.8	5.1	5.0	7.4	6.1
Min	-11.7	-12.0	-9.6	-11.8	-11.9	-11.8	-8.9	-14.6	-16.2	-12.6	-7.7	-11.1	-8.6	-14.3	-6.3	-9.2
Max	17.3	17.8	18.8	18.7	17.1	18.7	17.8	18.3	18.4	18.9	20.8	18.5	20.4	19.7	21.4	20.1

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NOTES:

1. TEMPERATURE WAS BASED ON MONTHLY DATA AT THE ENVIRONMENT CANADA OPERATED CLIMATE STATION AT JUNIPER (STATION ID 8102275).. DATA GAPS WERE INFILLED USING MONTHLY DATA FROM THE WOODSTOCK STATION WITH NO ADJUSTMENT APPLIED TO THE DATA. CLIMATE NORMAL DATA (1971 TO 2001 FOR JUNIPER) WERE USED IN THE INSTANCES WHEN WOODSTOCK DATA WERE NOT AVAILABLE.

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TABLE 3

NORTHCLIFF RESOURCES LTD.
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MONTHLY PRECIPITATION DATA

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Total Precipitation (mm)	Average	10 percentile	90 percentile	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
Jan	118	67	179	129	14	71	91	134	77	100	128	66	166	181	56	107	162	108	154
Feb	90	42	148	80	163	145	114	121	60	55	151	93	8	57	26	77	92	78	87
Mar	111	76	155	111	78	126	155	102	129	95	101	110	140	167	146	139	93	125	101
Apr	101	50	165	100	74	42	36	164	180	79	84	68	90	115	88	97	125	179	73
May	107	67	164	106	120	103	105	136	101	125	172	78	86	152	67	100	28	169	199
June	109	68	168	106	82	72	156	91	97	68	79	235	129	108	92	114	142	32	169
July	121	73	178	104	152	93	94	156	145	75	148	83	73	109	240	75	78	153	124
Aug	116	47	192	104	112	72	119	192	94	47	193	135	47	193	78	117	150	120	73
Sept	112	65	159	170	114	47	115	147	128	175	88	115	56	132	153	146	148	74	64
Oct	113	49	200	34	101	104	120	41	72	55	206	202	112	96	131	192	52	69	51
Nov	128	77	174	135	57	114	112	113	103	156	80	72	77	157	128	79	210	253	97
Dec	139	76	207	119	232	112	188	134	78	204	202	158	146	116	132	162	110	174	141
Annual	1,364	1,109	1588	1,299	1,301	1,100	1,404	1,530	1,262	1,234	1,632	1,414	1,130	1,584	1,336	1,404	1,391	1,534	1,333
Min	47	26	73	34	14	42	36	41	60	47	79	66	8	57	26	75	28	32	51
Max	197	155	241	170	232	145	188	192	180	204	206	235	166	193	240	192	210	253	199

Total Precipitation (mm)	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Jan	28	163	104	101	85	137	112	122	114	202	186	179	179	158	186	138
Feb	113	41	19	92	83	47	36	120	93	69	115	115	89	64	68	111
Mar	80	100	85	45	92	41	113	77	82	155	75	120	128	128	180	97
Apr	52	117	47	50	120	110	74	70	141	165	119	132	36	101	52	174
May	93	68	69	59	127	137	115	34	105	146	87	109	164	134	67	112
June	120	83	138	74	64	106	108	118	194	130	61	70	86	91	76	86
July	130	118	78	90	128	169	45	158	116	94	77	210	73	133	63	133
Aug	33	115	64	209	164	219	178	60	121	66	92	45	118	144	101	156
Sept	79	149	176	66	120	114	161	75	123	80	74	96	95	136	227	98
Oct	66	48	94	131	74	212	119	184	173	48	158	121	35	107	124	87
Nov	125	125	125	152	163	113	57	86	122	147	165	129	102	92	155	79
Dec	68	86	76	53	96	166	69	125	182	92	114	264	154	113	130	113
Annual	986	1,212	1,075	1,121	1,316	1,571	1,187	1,228	1,565	1,393	1,322	1,589	1,260	1,398	1,429	1,384
Min	28	41	19	45	64	41	36	34	82	48	61	45	35	64	52	79
Max	130	163	176	209	164	219	178	184	194	202	186	264	179	158	227	174

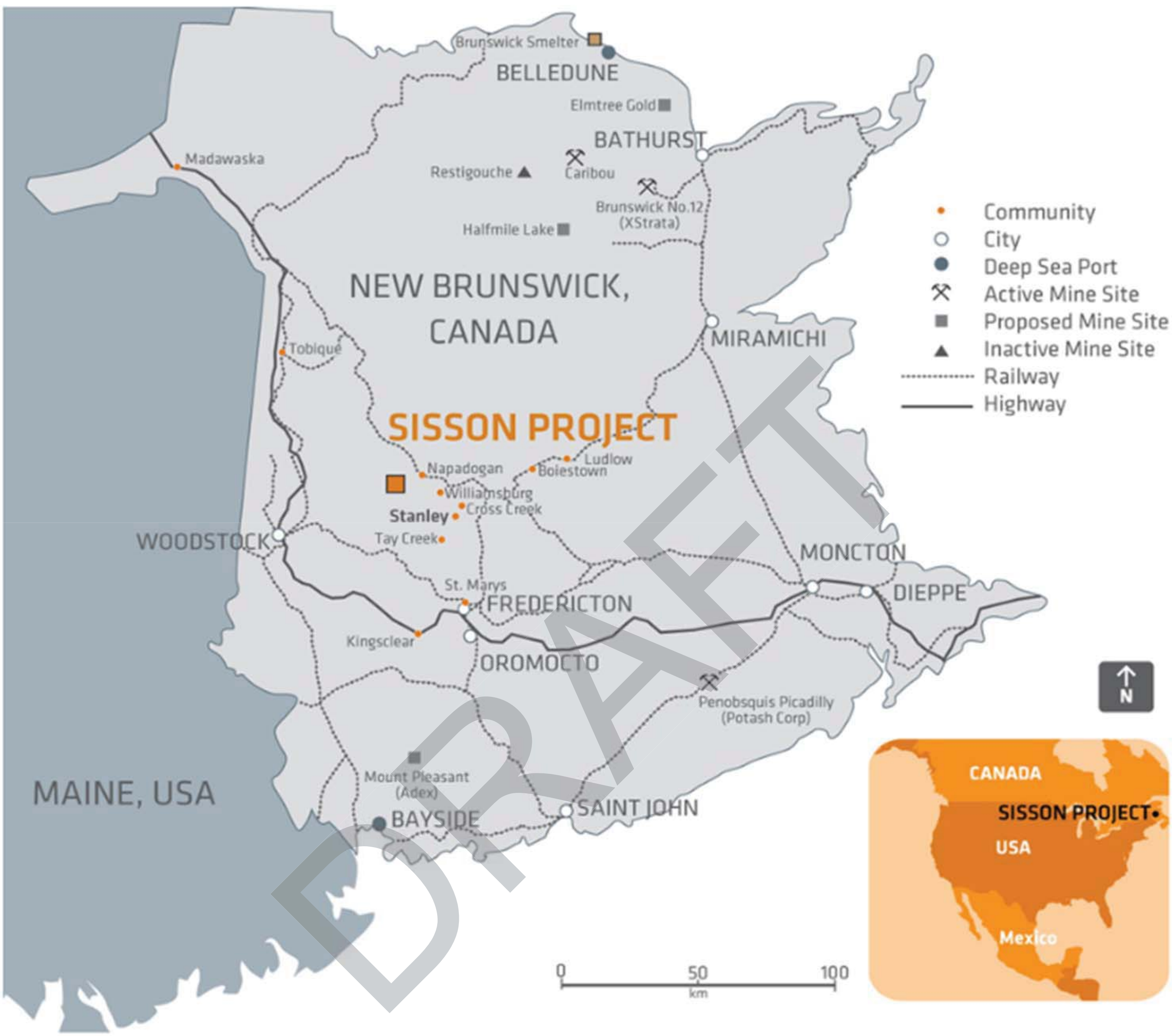
Total Precipitation (mm)	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Jan	57	128	71	70	89	176	111	115	96	112	93
Feb	104	149	128	44	107	77	58	156	147	56	166
Mar	77	130	119	71	177	39	131	151	106	94	169
Apr	69	133	52	100	184	88	156	78	97	92	124
May	85	77	98	93	101	164	57	67	125	79	164
June	75	63	83	75	99	172	69	168	143	150	192
July	100	207	167	92	142	191	61	118	151	89	180
Aug	129	78	113	155	191	71	160	128	48	46	145
Sept	99	128	69	89	142	77	19	150	65	139	107
Oct	78	69	282	70	220	148	83	101	148	134	95
Nov	89	117	162	113	225	176	232	122	154	158	63
Dec	32	124	176	134	208	82	155	241	136	268	128
Annual	995	1,402	1,521	1,107	1,886	1,459	1,292	1,595	1,416	1,416	1,626
Min	32	63	52	44	89	39	19	67	48	46	63
Max	129	207	282	155	225	191	232	241	154	268	192

M:\1\01\00447\02\A\Correspondence\VA12-01435 Baseline Watershed Model - Update to VA12-008289\Attachments\[Tables 1 to 3 and Figures 1 and Figures 5 to 13.xls]Table 3

NOTES:

1. MONTHLY PRECIPITATION WAS BASED ON MONTHLY DATA AT THE ENVIRONMENT CANADA OPERATED CLIMATE STATION AT JUNIPER (STATION ID 8102275). DATA GAPS WERE INFILLED USING MONTHLY DATA FROM THE ENVIRONMENT CANADA OPERATED CLIMATE STATION AT WOODSTOCK (STATION ID 8105600) WITH A MULTIPLIER OF 1.03 APPLIED TO THE DATA. CLIMATE NORMAL DATA (1971 TO 2001 FOR JUNIPER) WERE USED IN THE INSTANCES WHEN WOODSTOCK DATA WERE NOT AVAILABLE.
2. THE PRECIPITATION VALUES WERE INCREASED BY A FACTOR OF 1.06 IN THE WINTER MONTHS (OCTOBER THROUGH MAY) TO ACCOUNT FOR WINTER SNOWFALL CATCH INEFFICIENCIES. A LOCAL PRECIPITATION FACTOR OF 1.11 WAS APPLIED TO ACCOUNT FOR LOCAL SITE VARIATIONS FROM THE REGIONAL STATIONS.

0	24JUL'12	ISSUED WITH LETTER VA12-01435	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. SOURCE: NORTHCLIFF RESOURCES, RETRIEVED APRIL 27, 2012 FROM http://www.northcliffresources.com/s/Disclaimer.asp

NORTHCLIFF RESOURCES LTD.

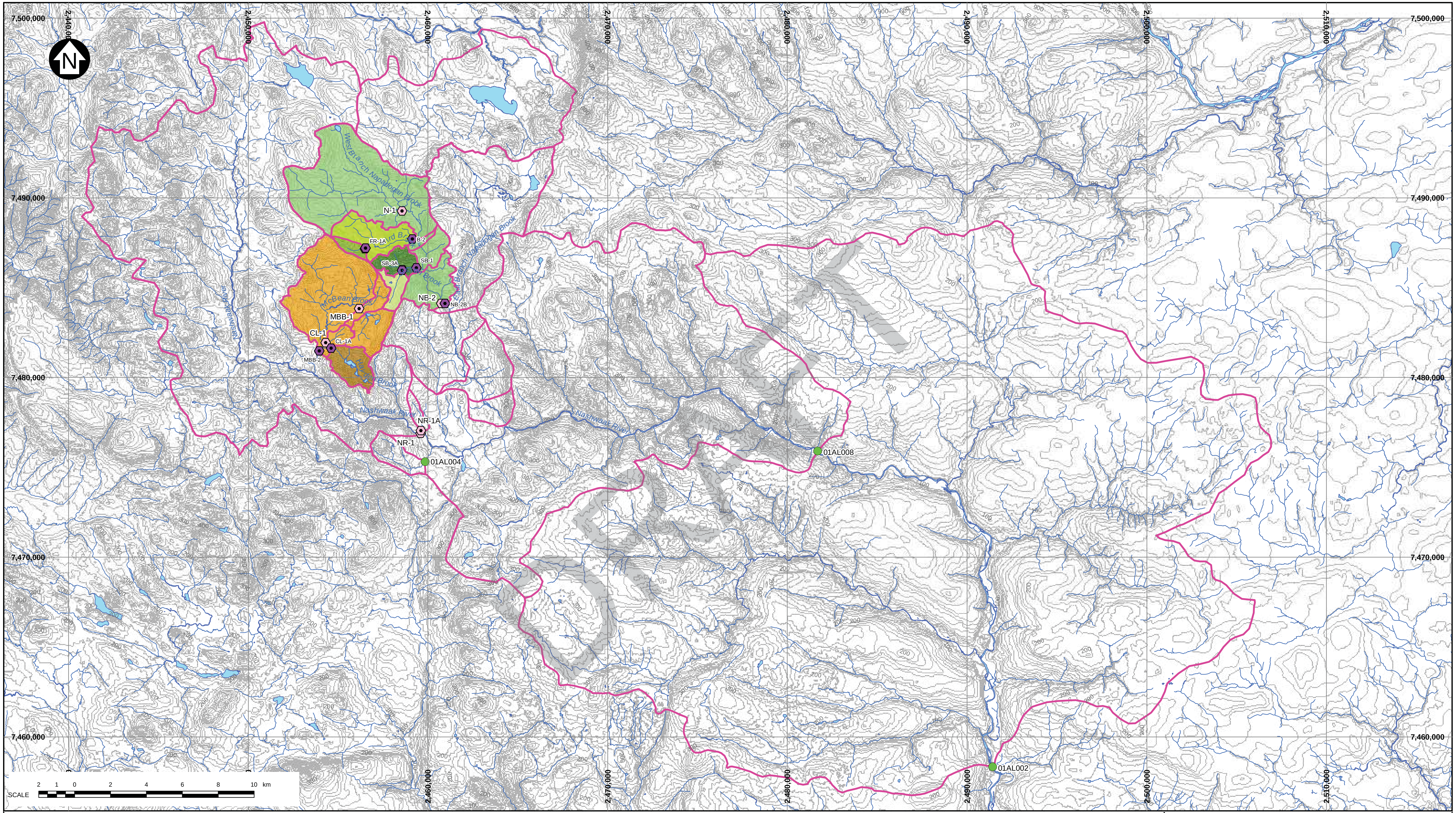
SISSON PROJECT

PROJECT SITE LOCATION

Knight Piésold CONSULTING

P/A NO.	REF. NO.	
VA101-447/2	VA12-01435	
FIGURE 1		REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB



LEGEND:

- WSC STATION
- STREAMFLOW STATION (ACTIVE)
- STREAMFLOW STATION (INACTIVE)
- CONTOUR (10 M)
- RIVER
- LAKE
- WATERSHED BOUNDARY

NOTES:

1. BASE MAP: CANADA NTS MAPS.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 CSRS NEW BRUNSWICK STEREOGRAPHIC.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:200,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTOUR INTERVAL IS 10 METRES.
5. WATERSHED BOUNDARIES WERE DELINEATED BASED ON 2 METRE LIDAR CONTOURS AND TRANSPOSED TO NTS MAPS.

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SISSON PROJECT

WATERSHED BOUNDARIES

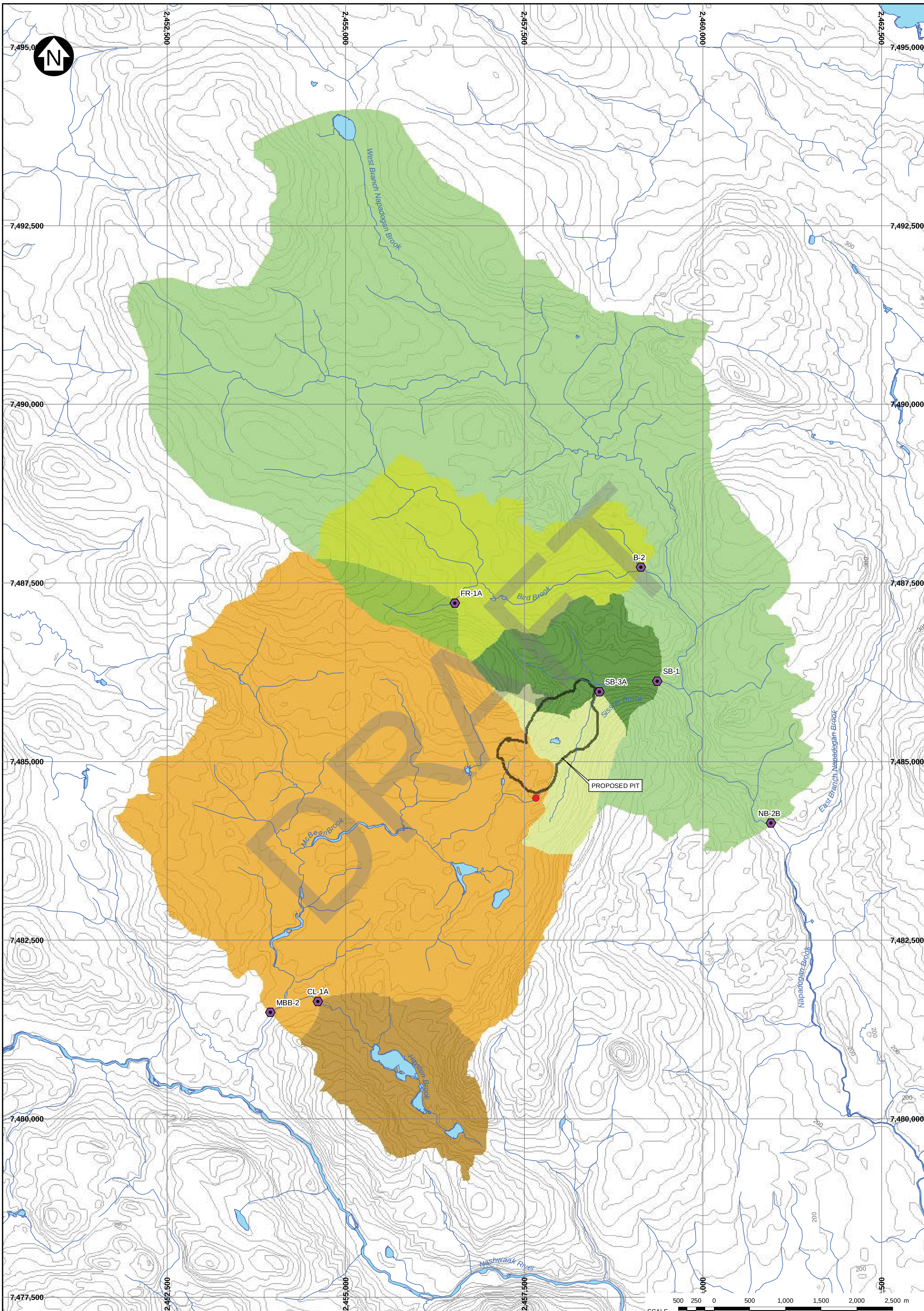
Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-447/2	VA12-01435

FIGURE 2 REV 0

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	19JUL'12	ISSUED WITH LETTER	AMD	AMD	CMB	KJB

KP FIGURE SAVED: M:\1\01\00447\02\A\GIS\Figs\VA12-01435\B09_WatershedBoundaries.mxd, Jul 24, 2012 4:24:41 PM adinca



LEGEND:

- ACTIVE STREAMFLOW STATION
- METEOROLOGICAL STATION
- CONTOUR (10 M)
- RIVER
- LAKE
- PROPOSED PIT

NOTES:

1. BASE MAP: CANADA NTS MAPS.
2. COORDINATE GRID IS IN METRES. COORDINATE SYSTEM: NAD 1983 CSRS NEW BRUNSWICK STEREOGRAPHIC.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:50,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.
4. CONTOUR INTERVAL IS 10 METRES.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	19JUL'12	ISSUED WITH LETTER	ALR	ASM	CMB	KJB

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

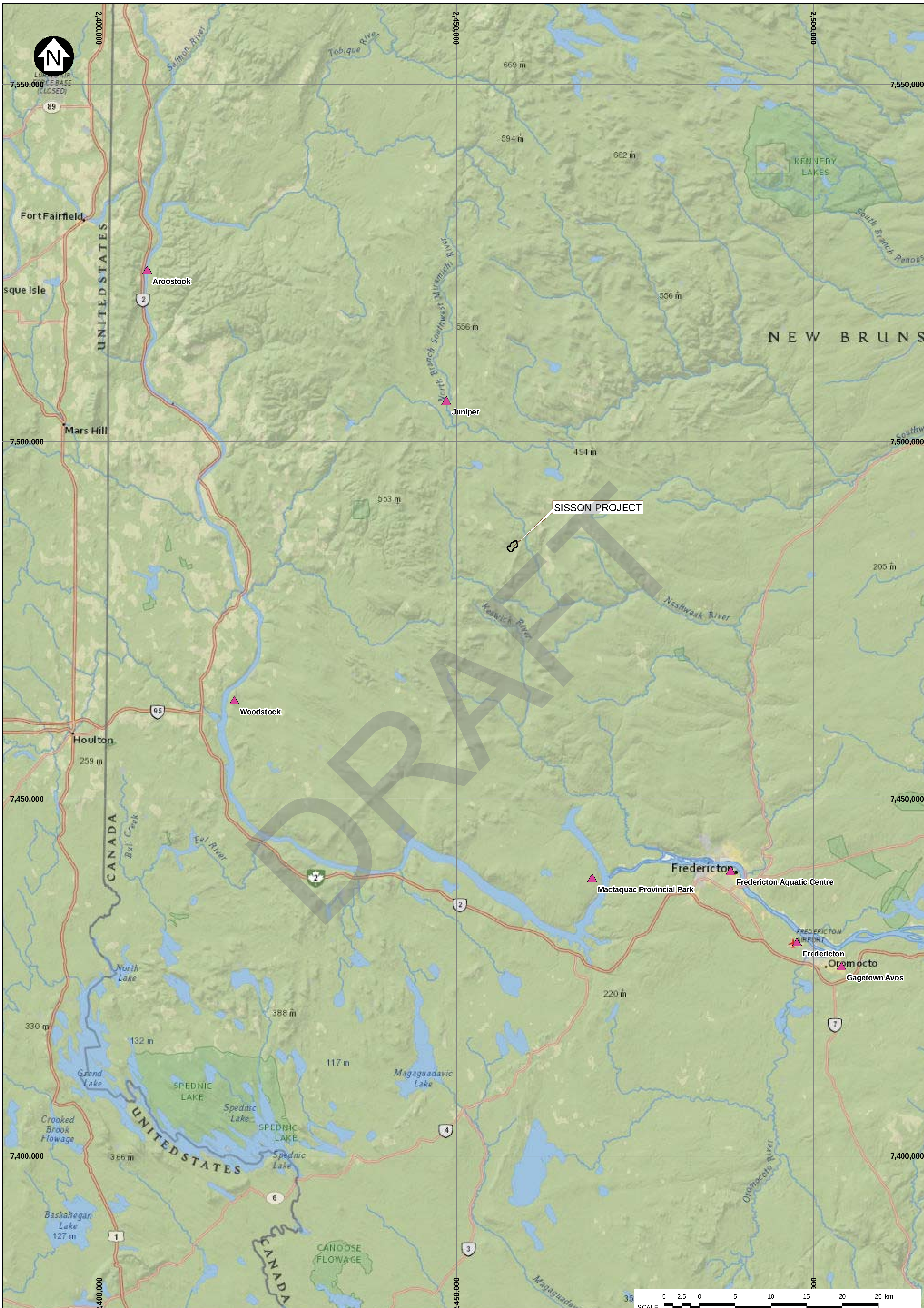
ACTIVE STREAMFLOW STATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-447/2	VA12-01435

FIGURE 3 REV 0

KP FIGURE SAVED: M:\1\01\00447\02\A\GIS\Figs\VA12-01435\B04_HydrologyStations.mxd; Jul 24, 2012 9:46:48 AM; adinca



LEGEND:

▲ METEROLOGICAL SERVICES OF CANADA (MSC) CLIMATE STATION

NOTES:

1. BASE MAP: ESRI ARCGIS TOPOGRAPHIC MAPS.
2. COORDINATE GRID IS IN METRES.
COORDINATE SYSTEM: NAD 1983 CSRS NEW BRUNSWICK STEREOGRAPHIC.
3. THIS FIGURE IS PRODUCED AT A NOMINAL SCALE OF 1:500,000 FOR 11x17 (TABLOID) PAPER. ACTUAL SCALE MAY DIFFER ACCORDING TO CHANGES IN PRINTER SETTINGS OR PRINTED PAPER SIZE.

REV	DATE	DESCRIPTION	DESIGNED	DRAWN	CHK'D	APP'D
0	19JUL'12	ISSUED WITH LETTER	CHS	AMD	CMB	KJB

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

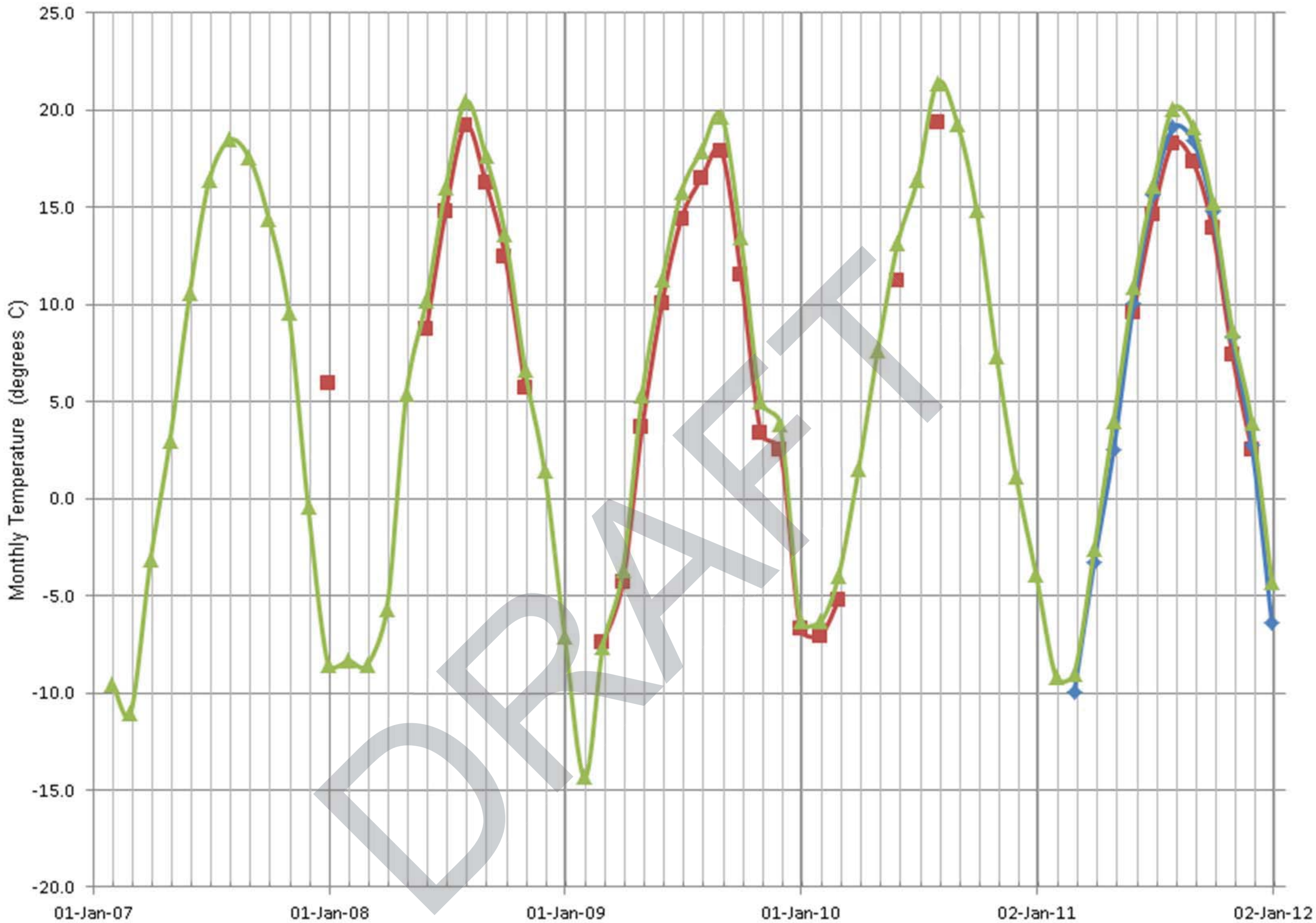
REGIONAL CLIMATE STATIONS

Knight Piésold CONSULTING

P/A NO.	REF NO.
VA101-447/2	VA12-01435

FIGURE 4 REV 0

KP FIGURE SAVED: M:\1\01\00447\02\A\GIS\Figs\VA12-01435\808_Regional\MSC_Stations.mxd; Jul 24, 2012 9:49:18 AM adinca



NOTES:
1. MONTHLY TEMPERATURE WAS PLOTTED AT THE END OF THE RESPECTIVE MONTH.

LEGEND

Sisson Brook — Juniper — Woodstock

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

COMPARISON OF MONTHLY AVERAGE TEMPERATURE

Knight Piésold CONSULTING

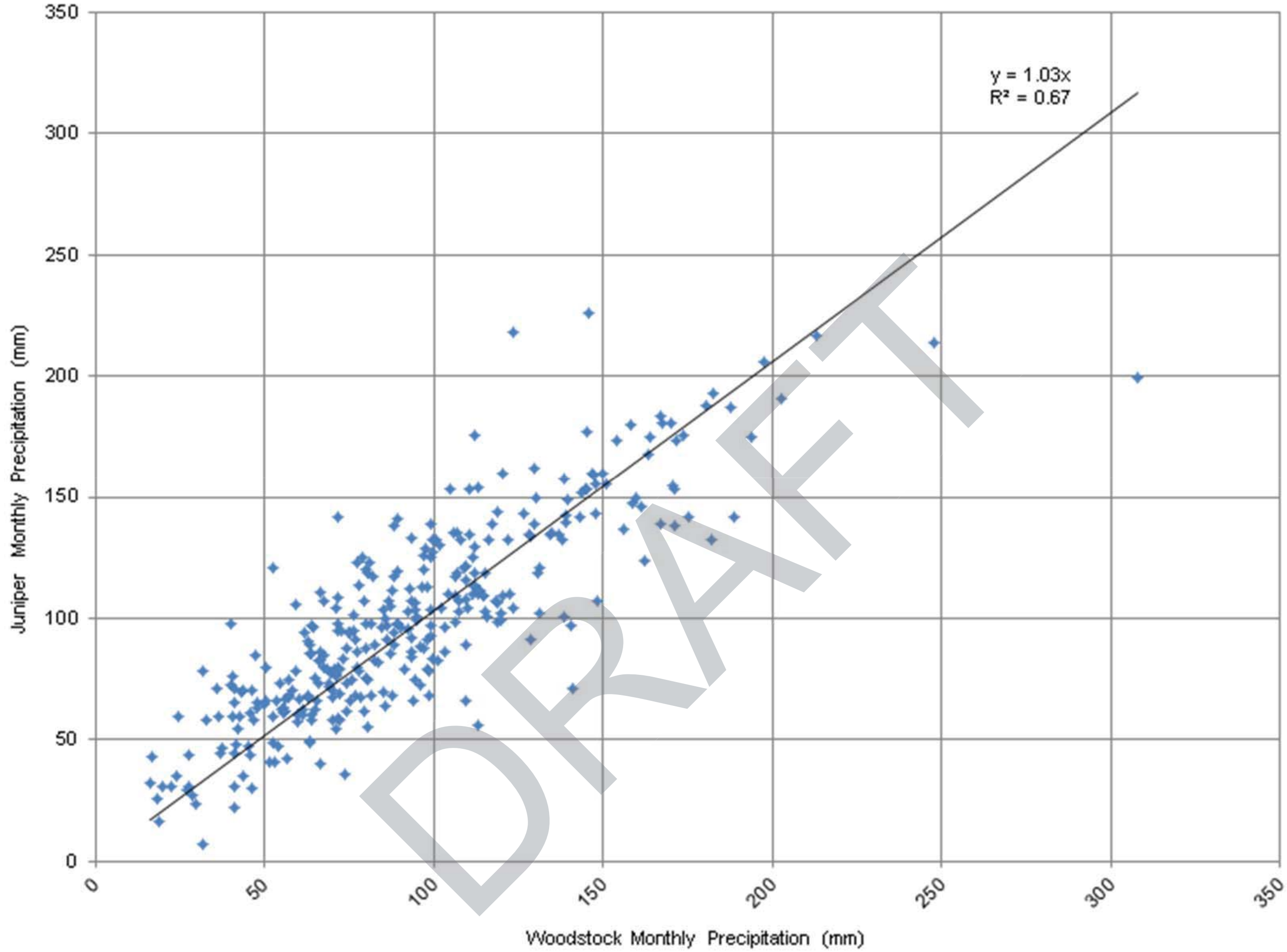
P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 5

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB



NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

PRECIPITATION COMPARISON OF JUNIPER AND WOODSTOCK CLIMATE STATIONS

Knight Piésold CONSULTING

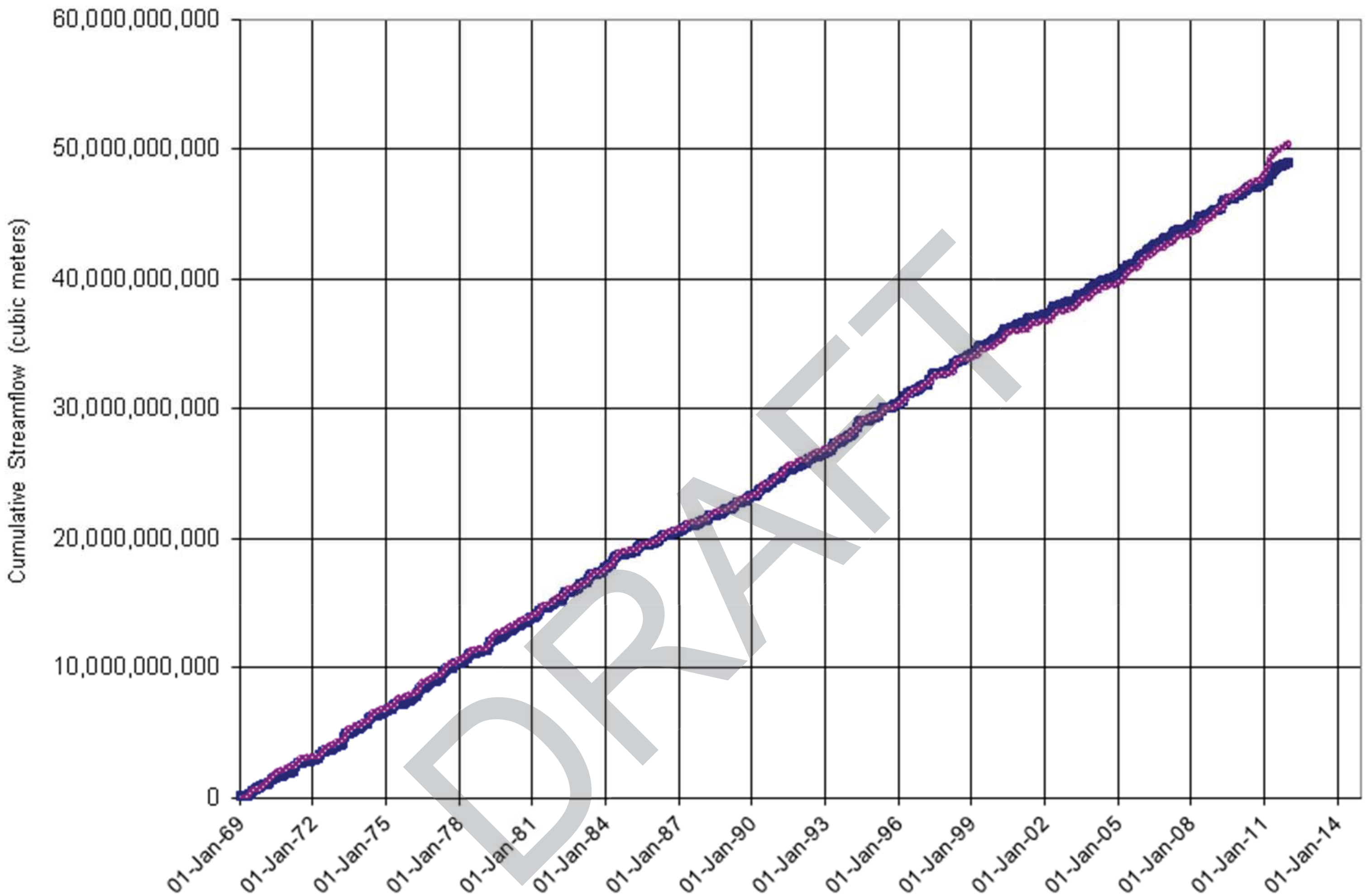
P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 6

REV 0

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



LEGEND

Nashwaak River Calculated

Nashwaak River Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

CUMULATIVE STREAMFLOW (NASHWAAK RIVER)

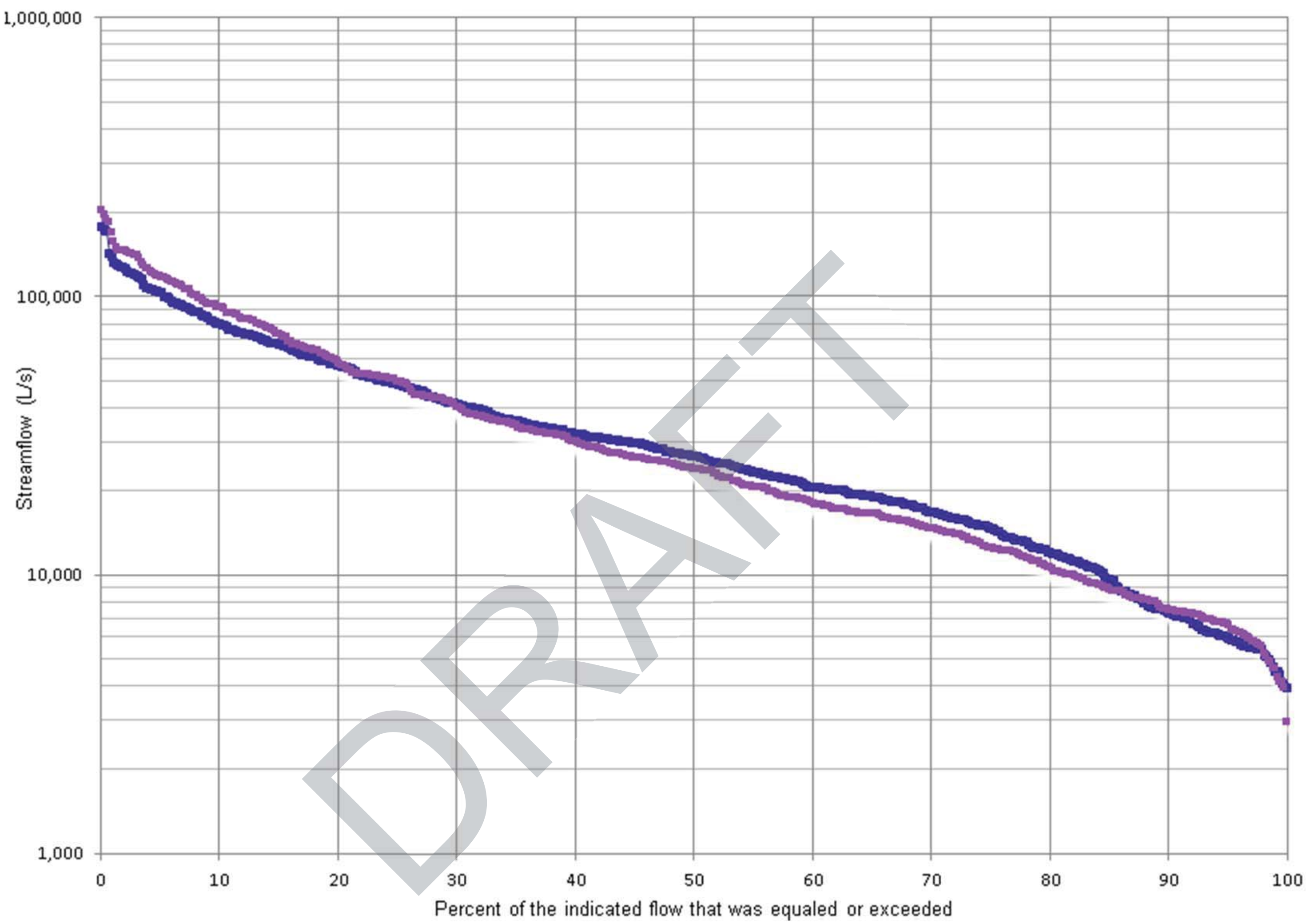
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 7

REV 0



LEGEND

Nashwaak River Calculated

Nashwaak River Measured

NORTHCLIFF RESOURCES LTD,

SISSON PROJECT

FLOW DURATION
(NASHWAAK RIVER)

Knight Piésold CONSULTING

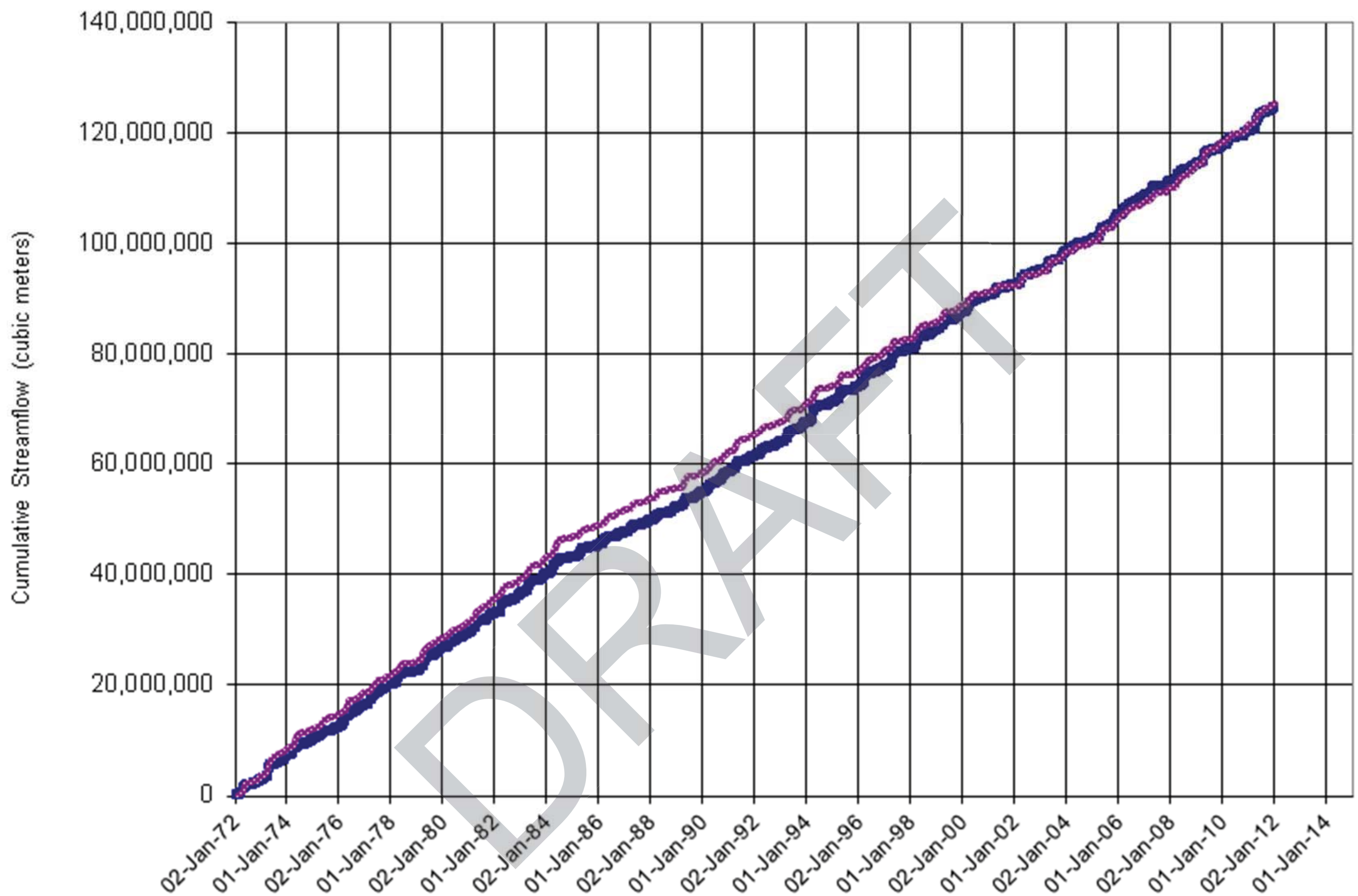
P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 8

REV 0

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24JULY'12	ISSUED WITH LETTER	CHS	DF	KJB



LEGEND

Narrows Mountain Brook Calculated   Narrows Mountain Brook Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

CUMULATIVE STREAMFLOW (NARROWS MOUNTAIN BROOK)

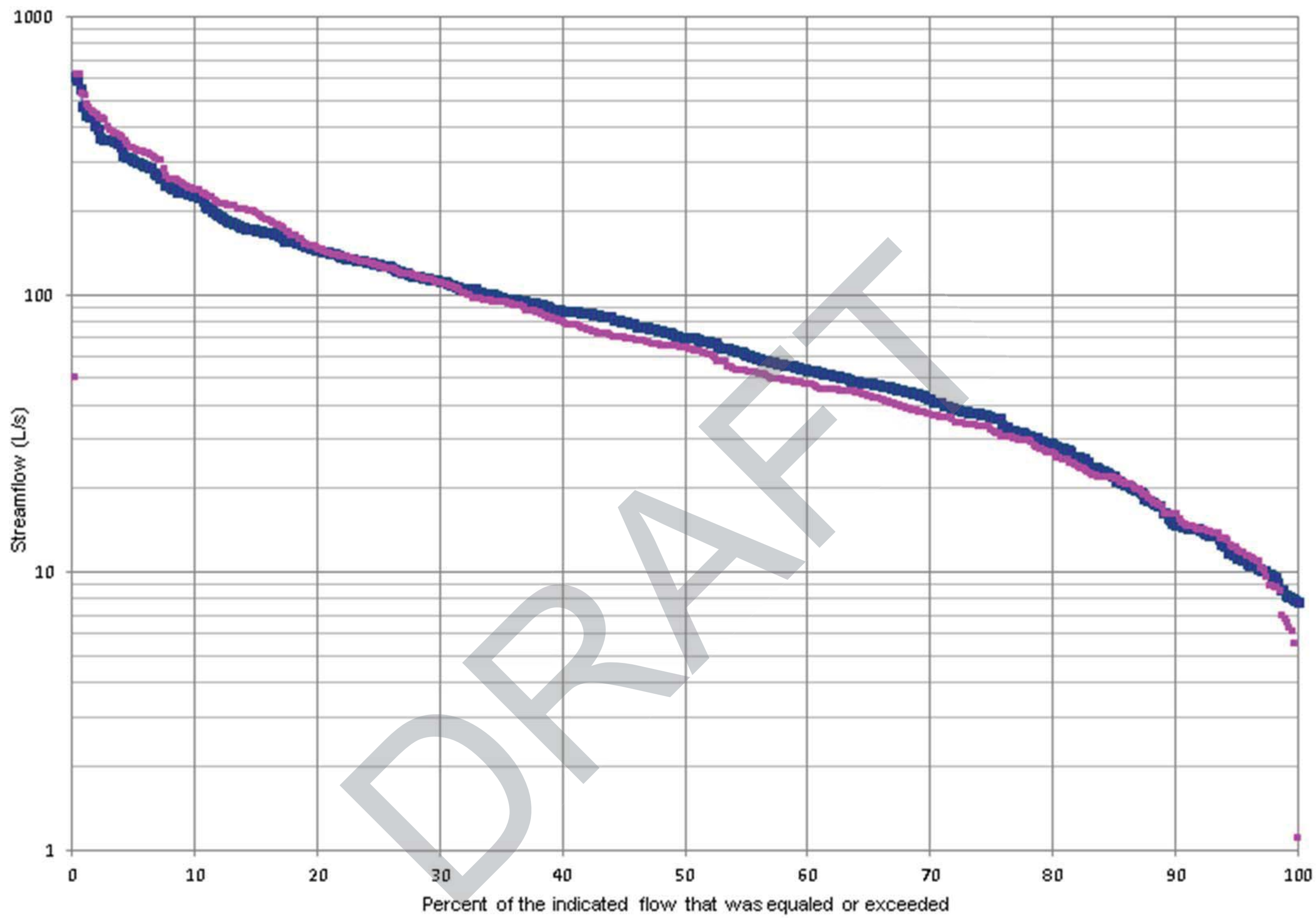
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 9

REV 0



LEGEND

Narrows Mountain Brook Calculated
Narrows Mountain Brook Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

FLOW DURATION
(NARROWS MOUNTAIN BROOK)

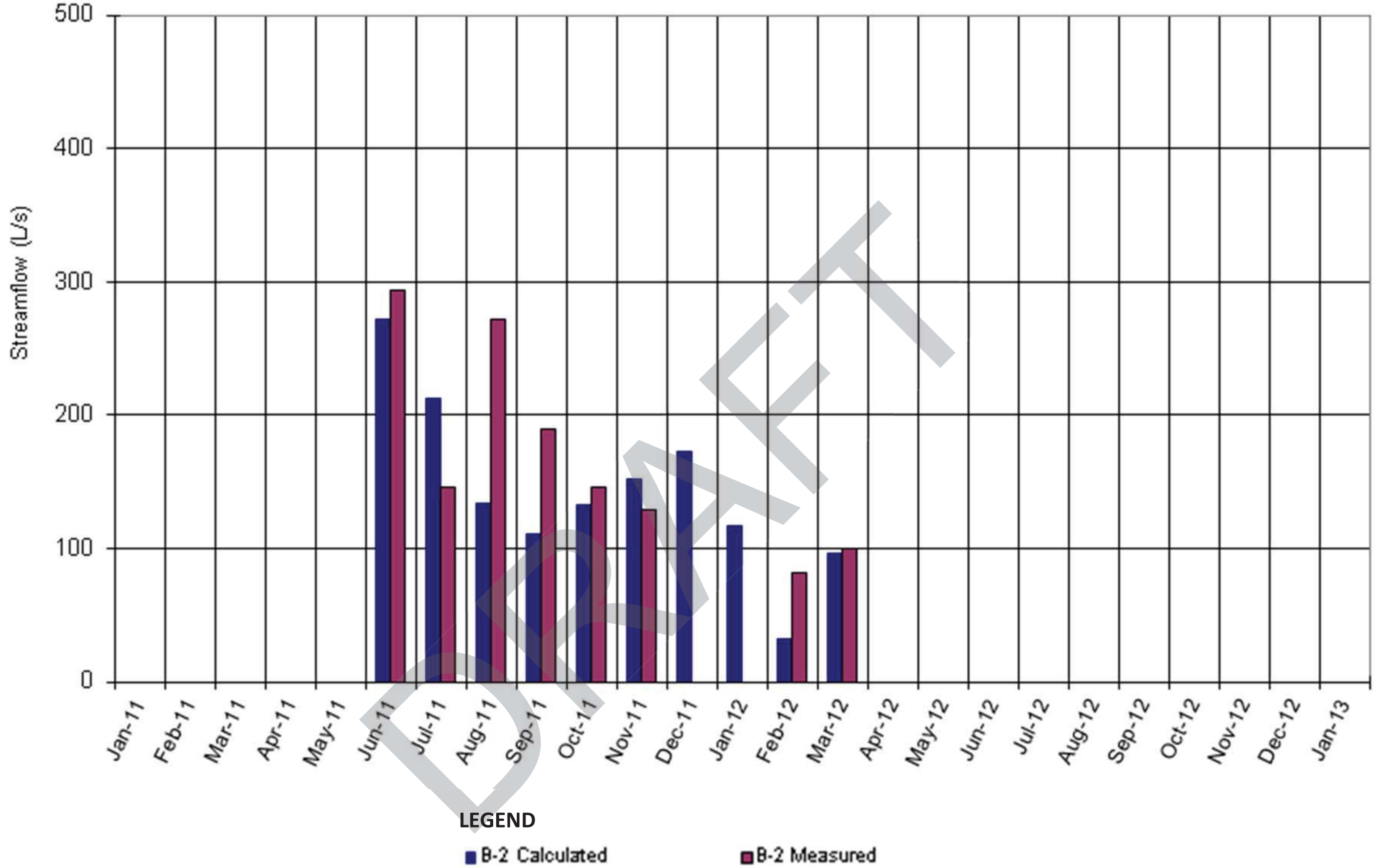
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 10

REV 0



NOTES:

1. MEASURED STREAMFLOWS IN 2012 ARE BASED ON SPOT MEASUREMENTS. CALCULATED STREAMFLOWS ARE MONTHLY.

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MONTHLY STREAMFLOW (B-2)

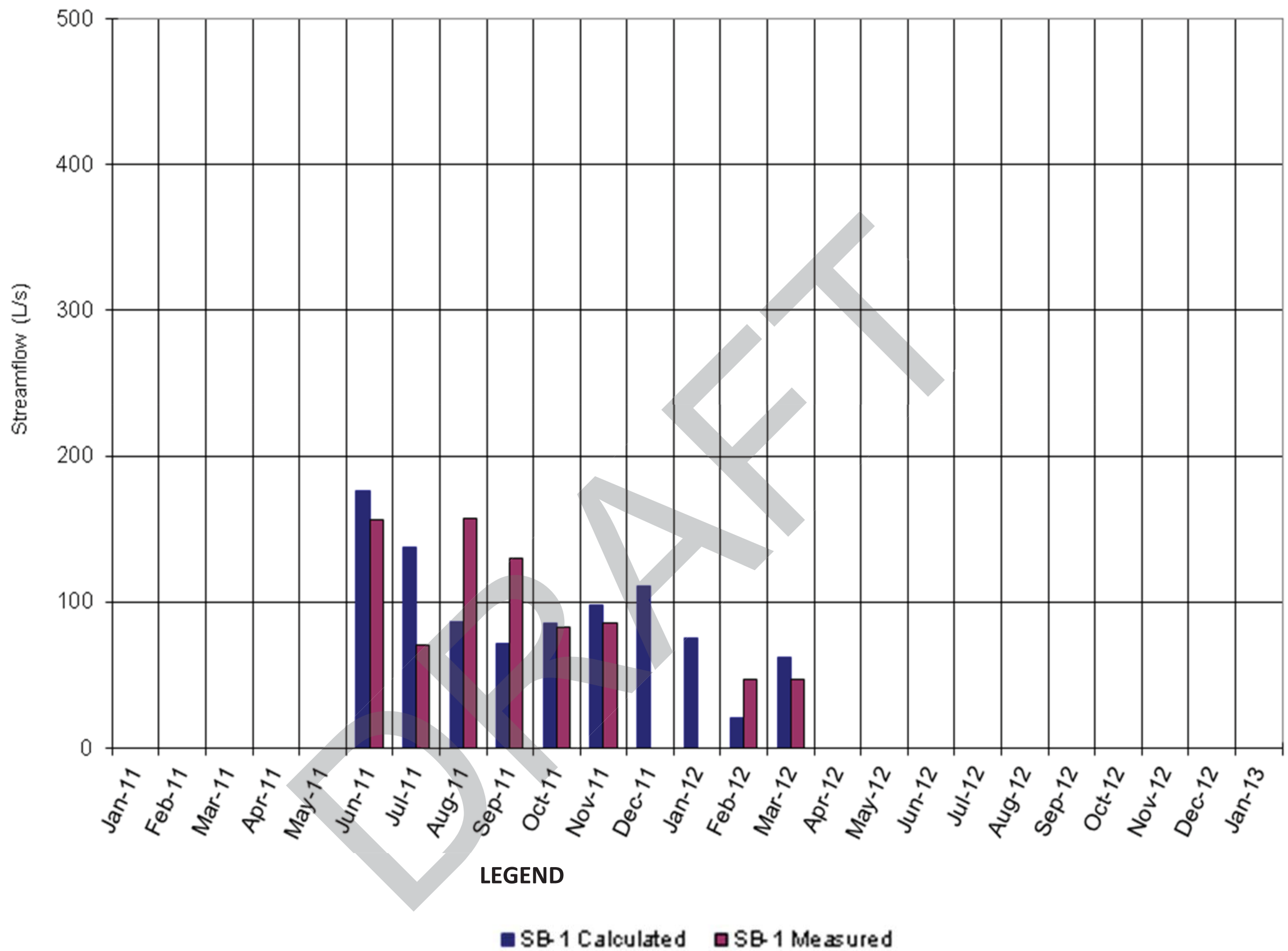
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 11

REV 0



NOTES:

1. MEASURED STREAMFLOWS IN 2012 ARE BASED ON SPOT MEASUREMENTS. CALCULATED STREAM FLOWS ARE MONTHLY.

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SISSON PROJECT

MONTHLY STREAMFLOW (SB-1)

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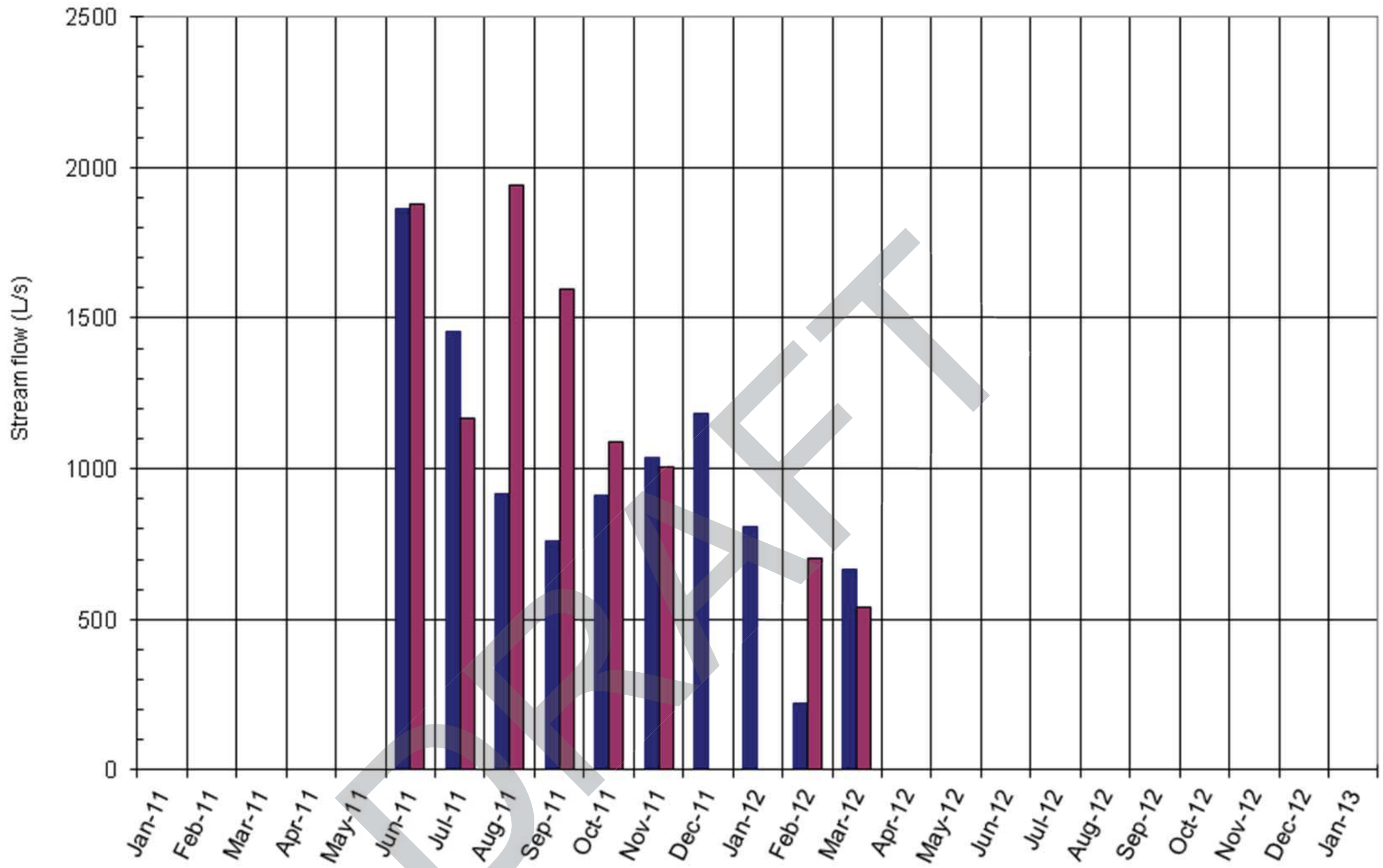
P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 12

REV 0

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



LEGEND

NB-2B Calculated
NB-2B Measured

NOTES:

1. MEASURED STREAMFLOWS IN 2012 ARE BASED ON SPOT MEASUREMENTS. CALCULATED STREAM FLOWS ARE MONTHLY.

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SISSON PROJECT

MONTHLY STREAMFLOW (NB-2B)

Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

FIGURE 13

REV 0

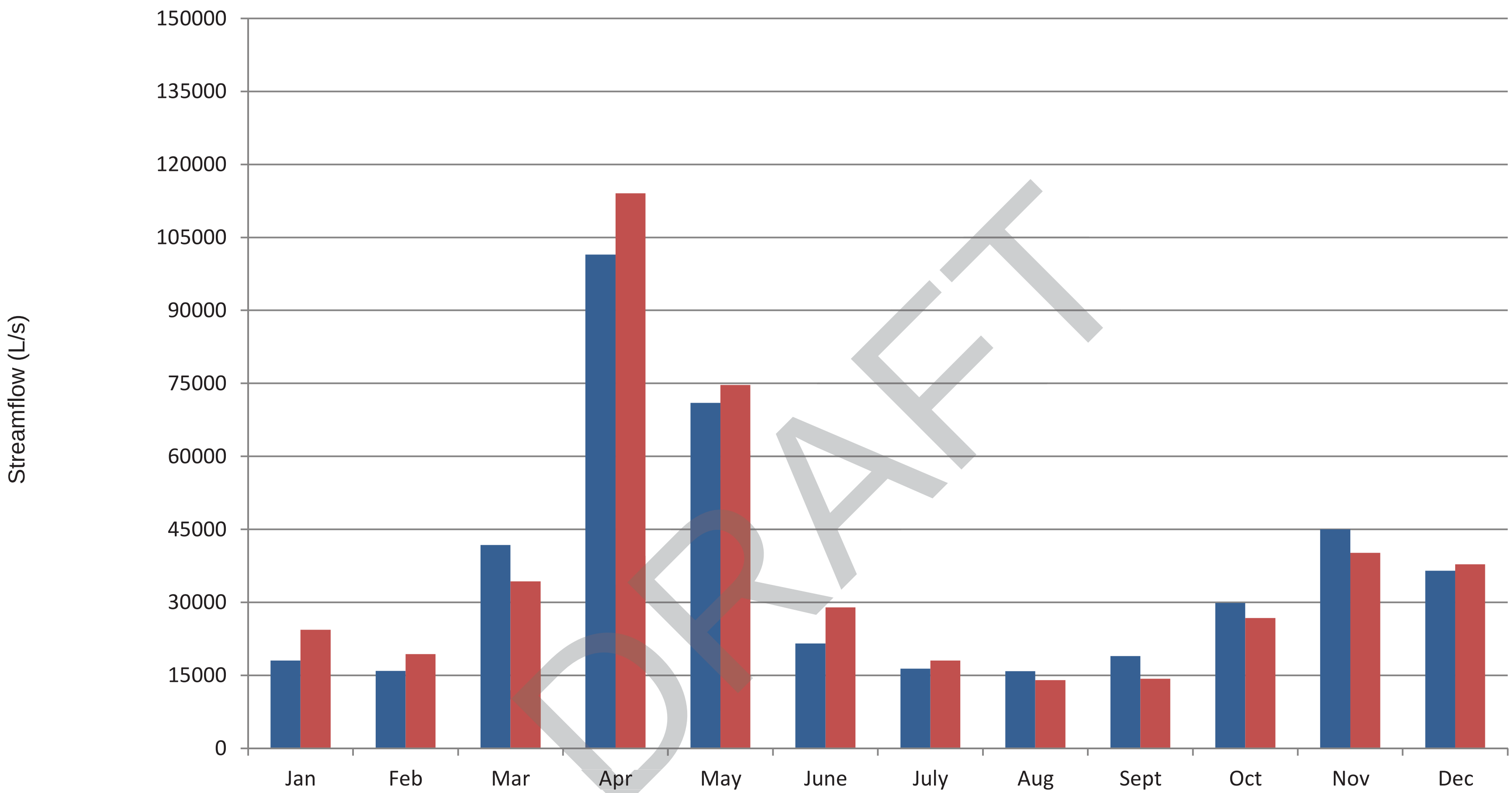
0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

APPENDIX A

MONTHLY STREAM FLOW (NASHWAAK RIVER AND NARROWS BROOK MOUNTAIN

(Pages A-1 to A-18)

VA12-01435
July 24, 2012



LEGEND

■ Calculated ■ Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

AVERAGE ANNUAL STREAMFLOW (NASHWAAK)

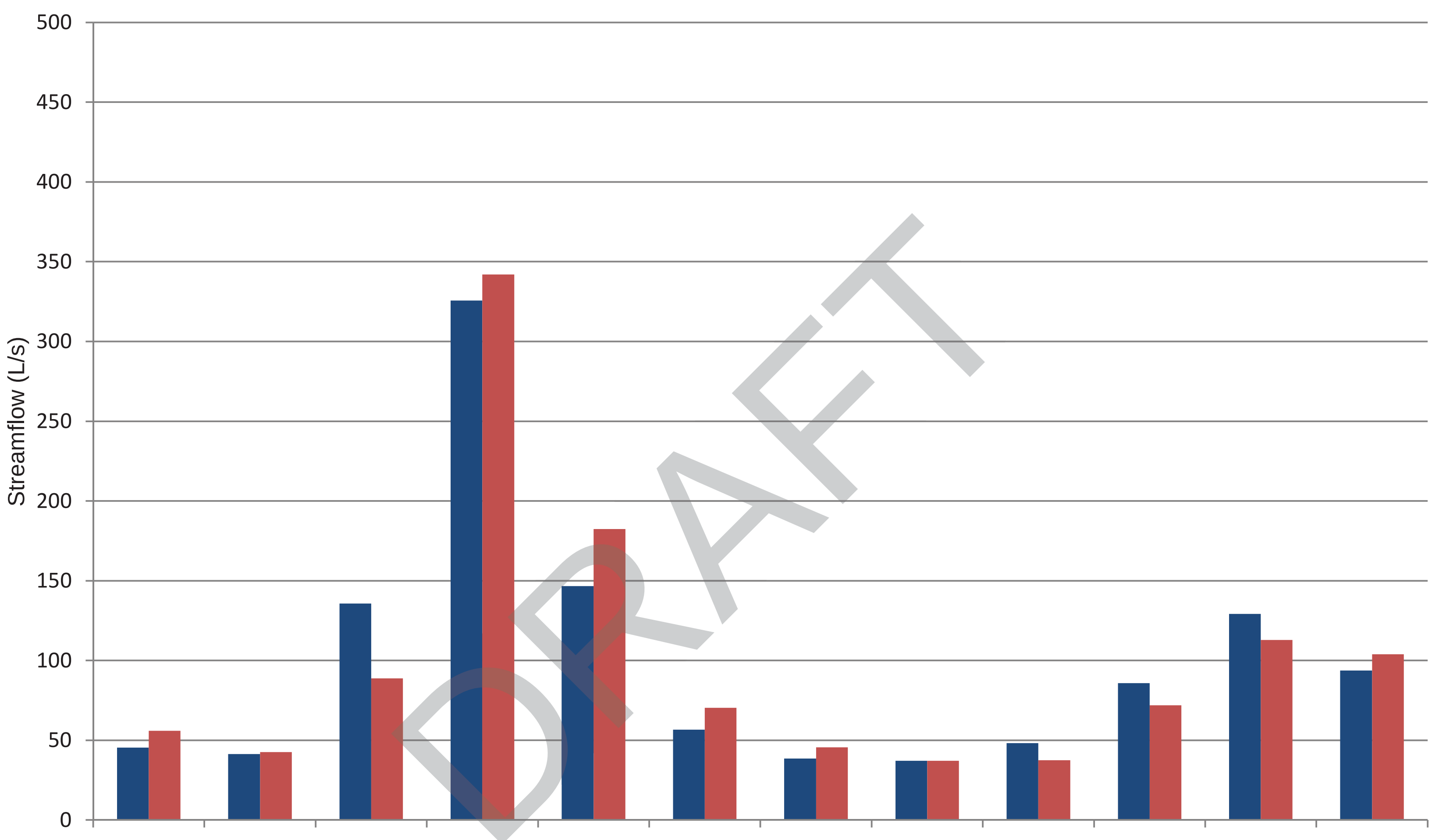
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-1

REV 0



LEGEND

■ Calculated ■ Measured

NORTHCLIFF RESOURCES	
SISSON PROJECT	
AVERAGE ANNUAL STREAMFLOW (NARROWS MOUNTAIN BROOK)	
Knight Piésold CONSULTING	P/A NO. VA101-447/2 — REF. NO. VA12-01435
	APPENDIX A-2 — REV 0

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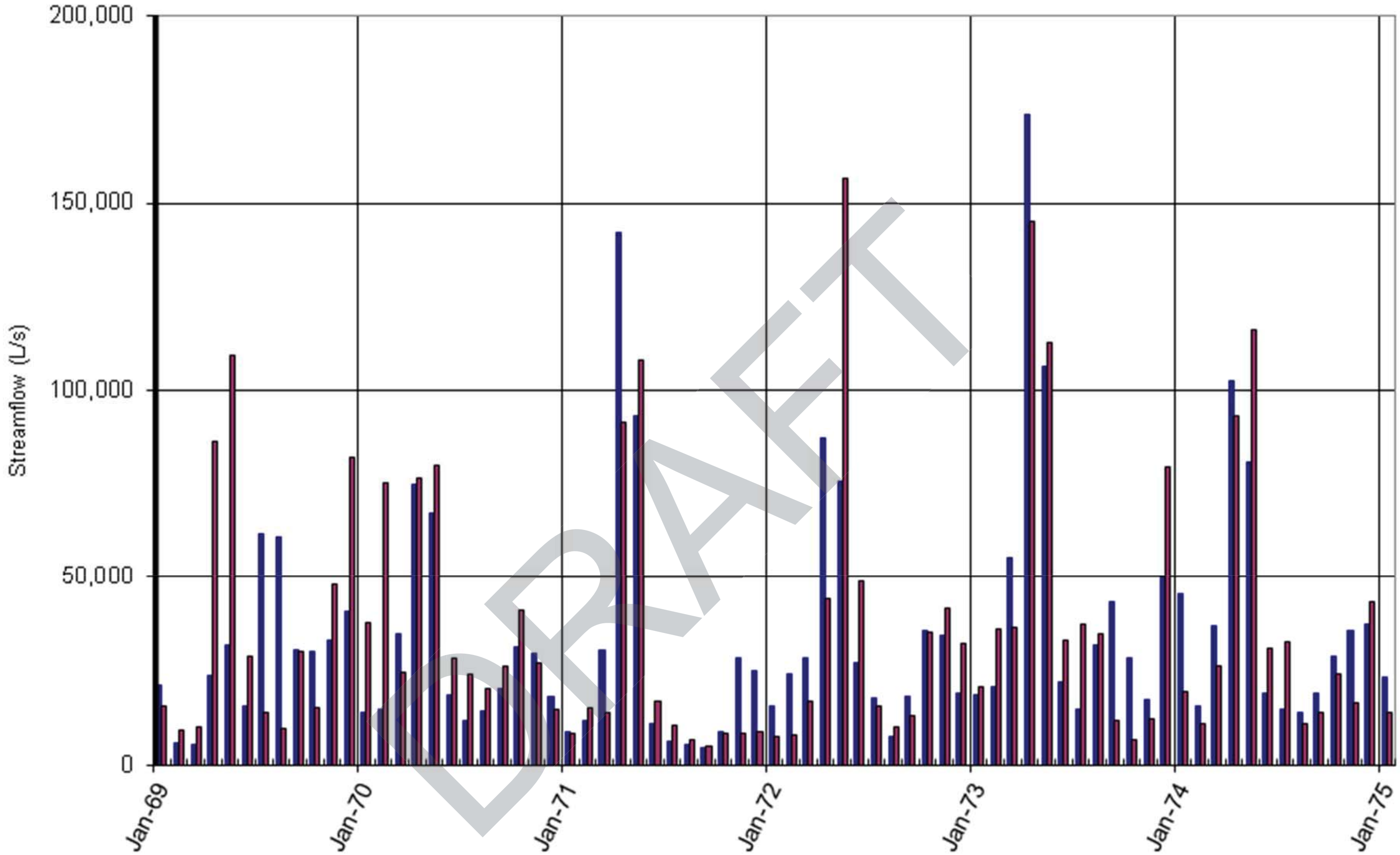
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



LEGEND

Nashwaak Calculated Nashwaak Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NASHWAAK)

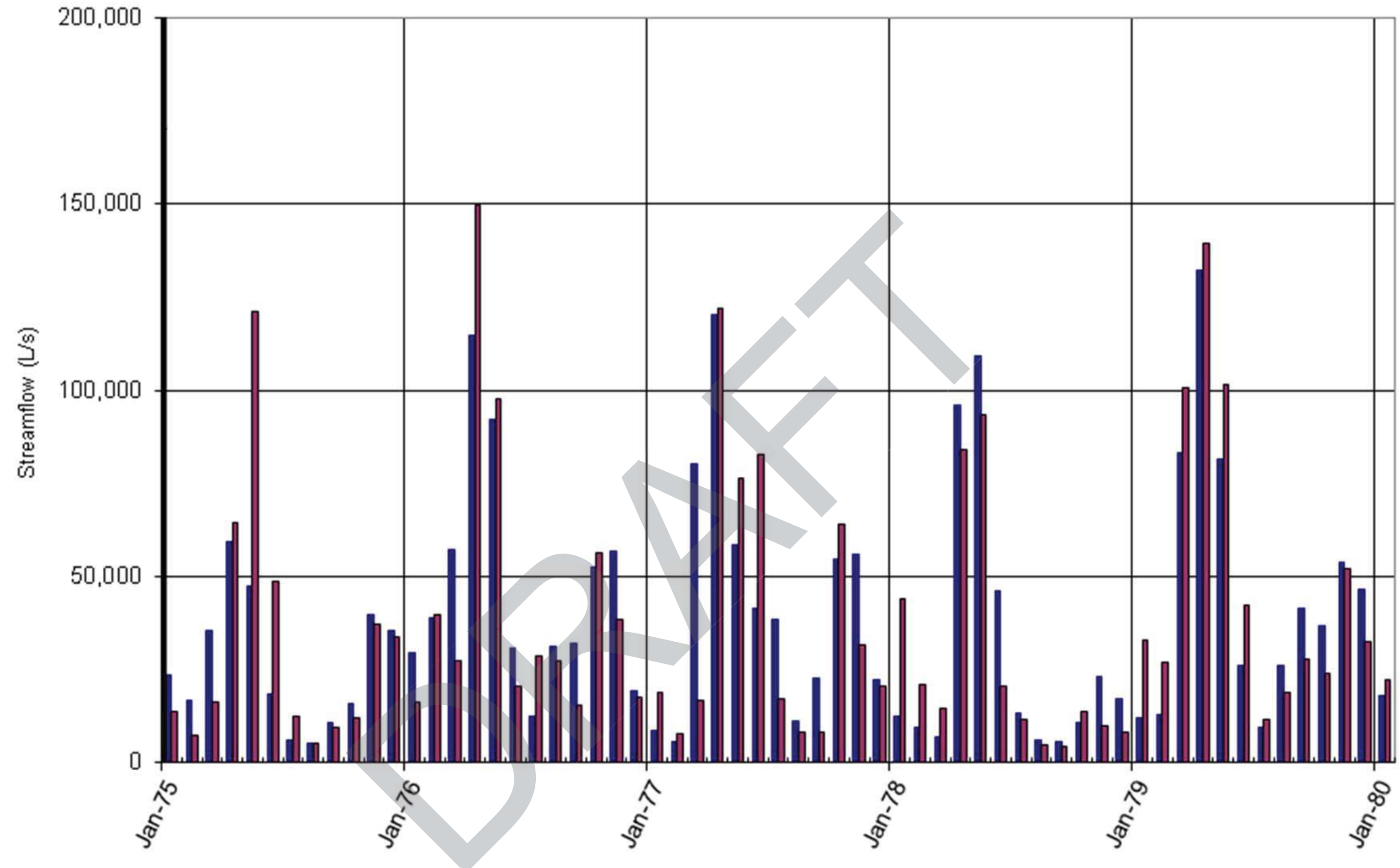
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-3

REV 0



LEGEND

■ Nashwaak Calculated ■ Nashwaak Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NASHWAAK)

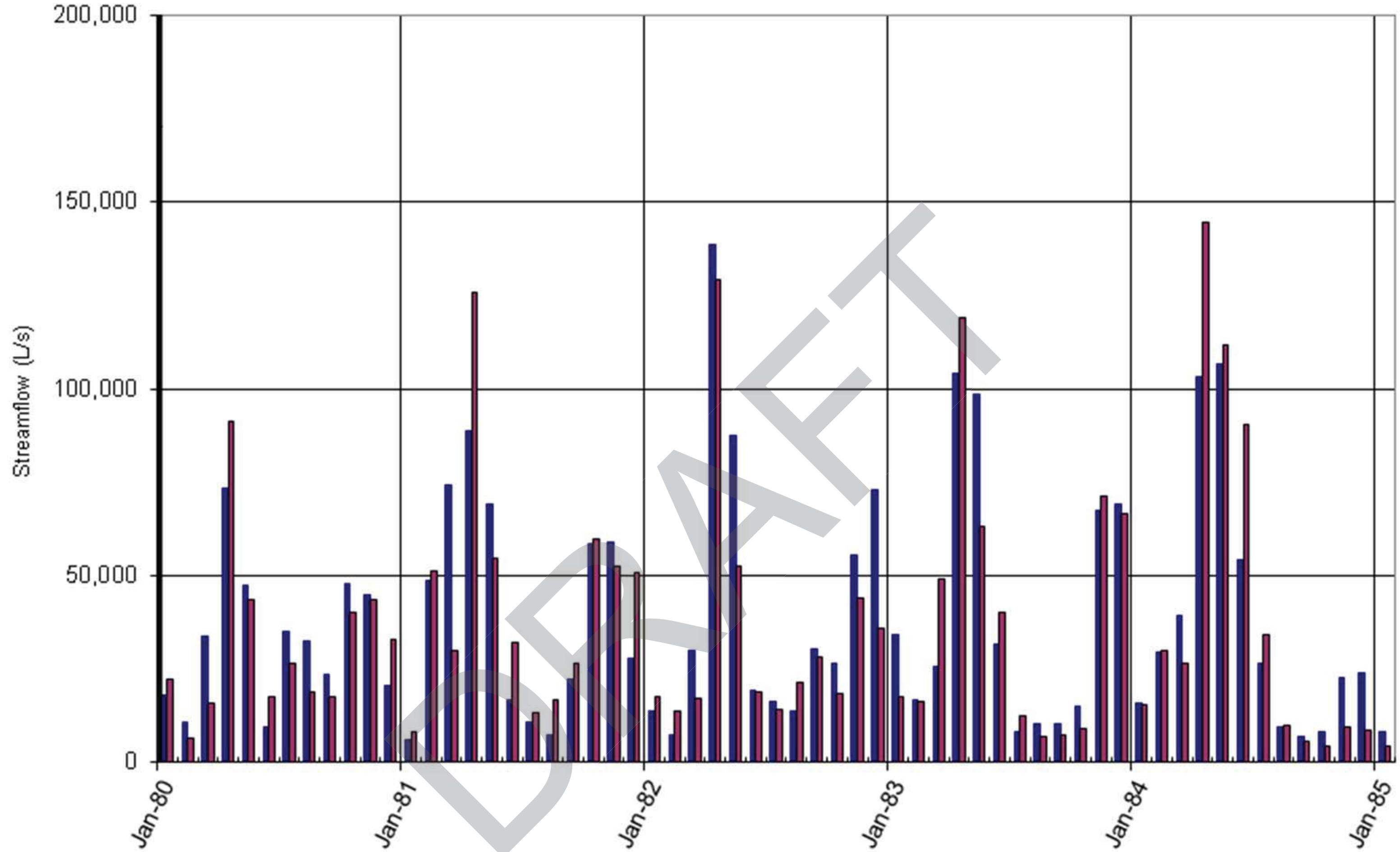
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-4

REV 0



LEGEND

Nashwaak Calculated Nashwaak Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NASHWAAK)

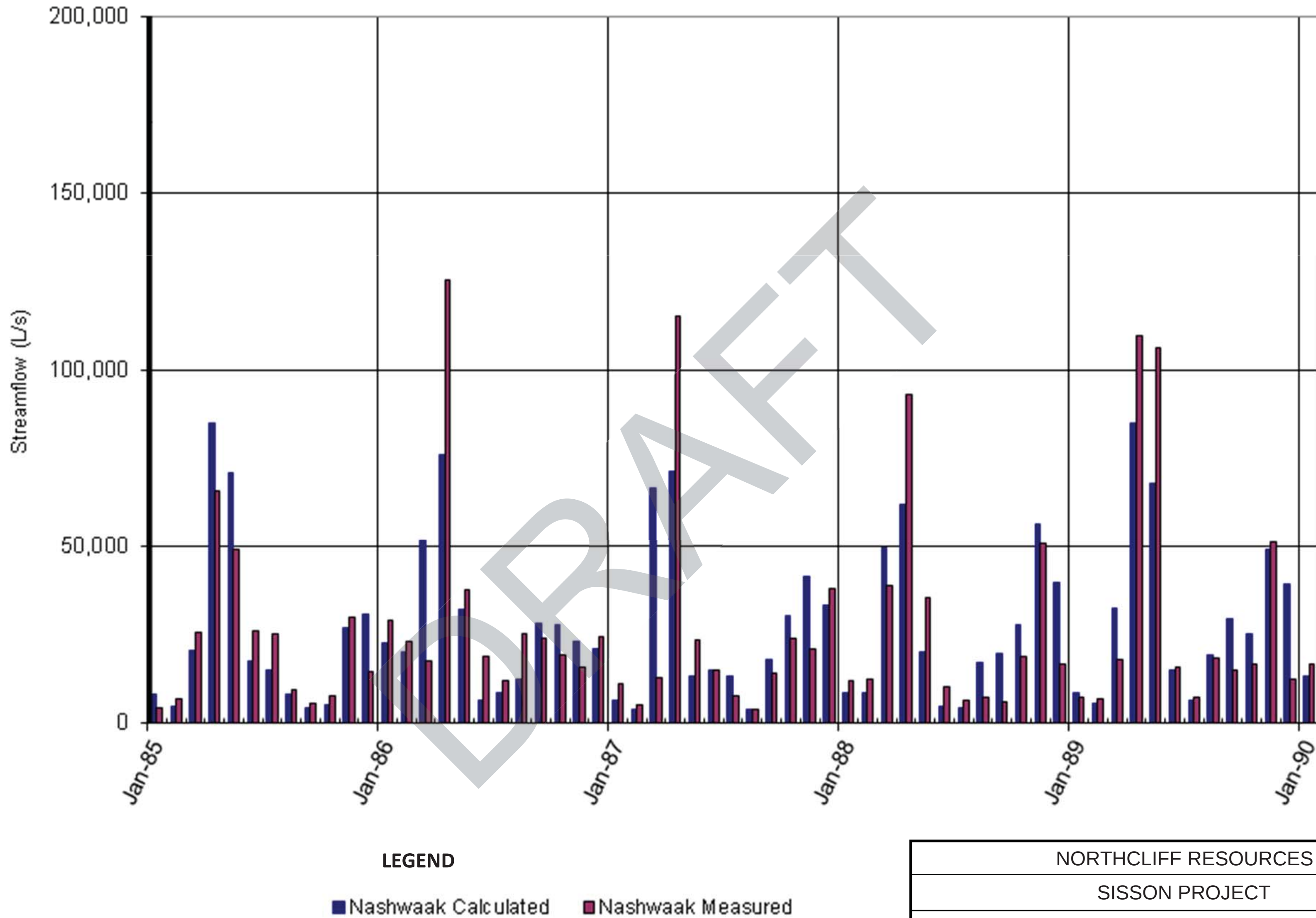
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-5

REV 0



NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NASHWAAK)

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB

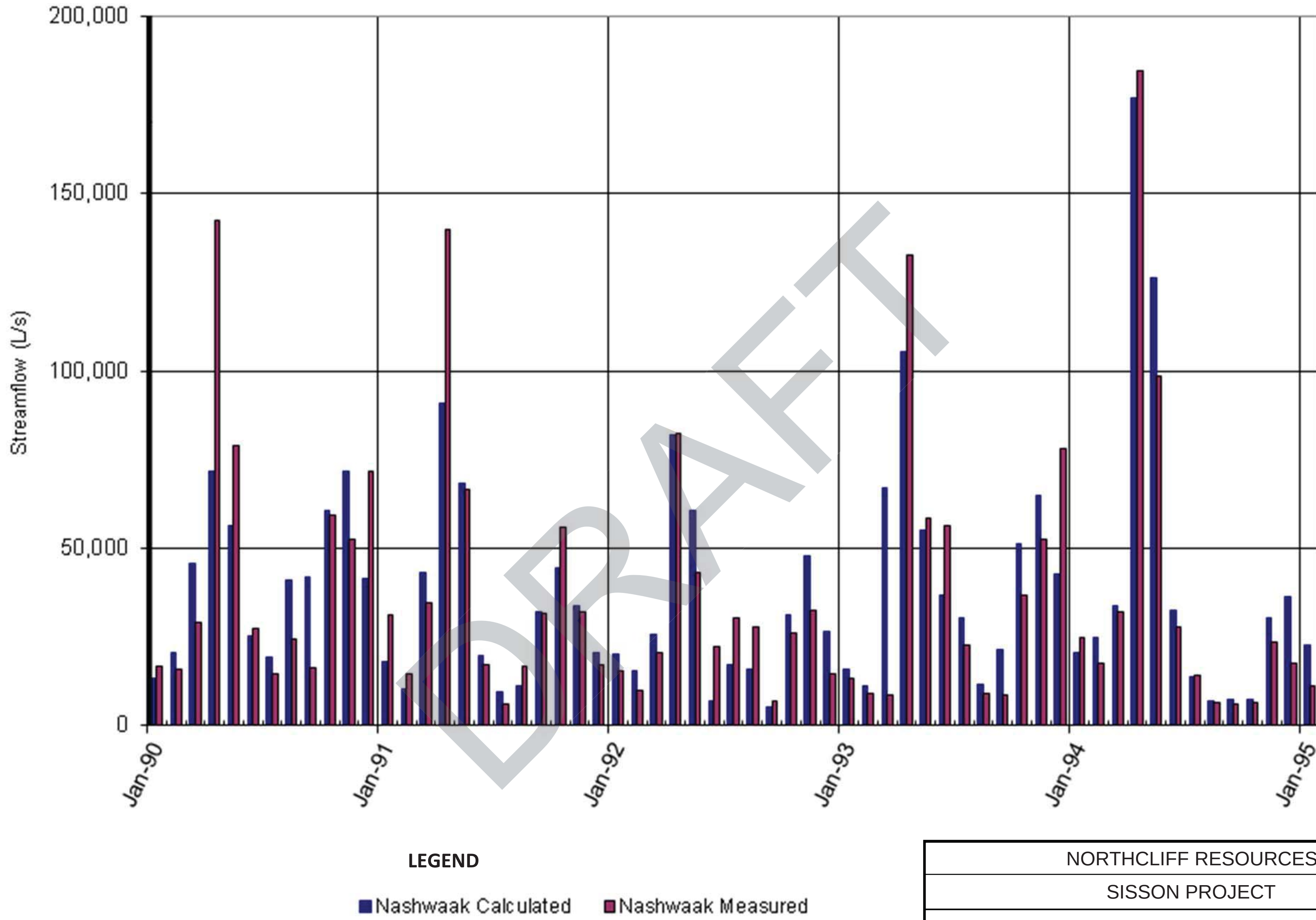
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

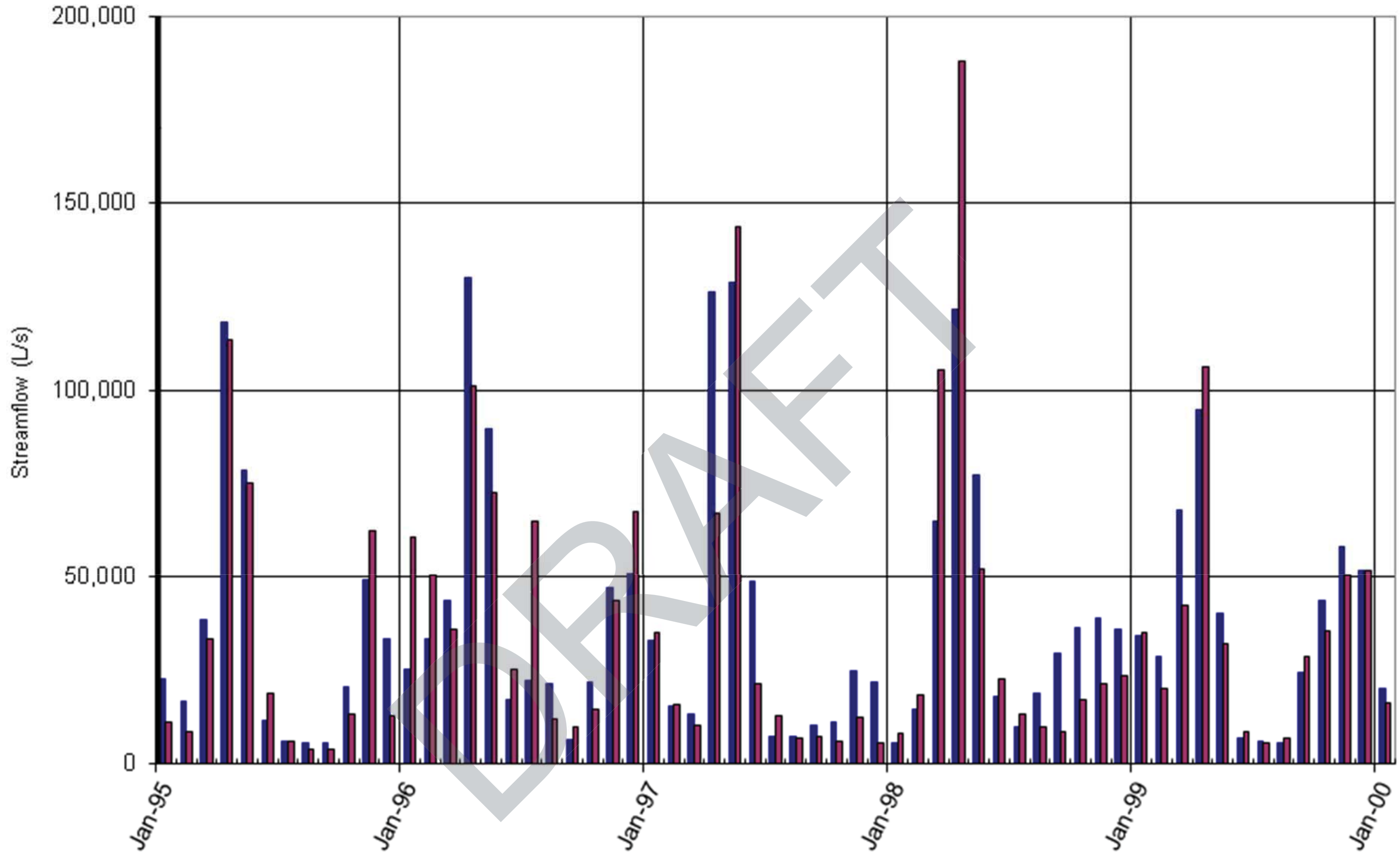
APPENDIX A-6

REV 0



NORTHCLIFF RESOURCES		
SISSON PROJECT		
MONTHLY STREAMFLOW (NASHWAAK)		
Knight Piésold CONSULTING	P/A NO. VA101-447/2	REF. NO. VA12-01435
	APPENDIX A-7	REV 0

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



LEGEND

■ Nashwaak Calculated ■ Nashwaak Measured

NORTHCLIFF RESOURCES

SISSON PROJECT

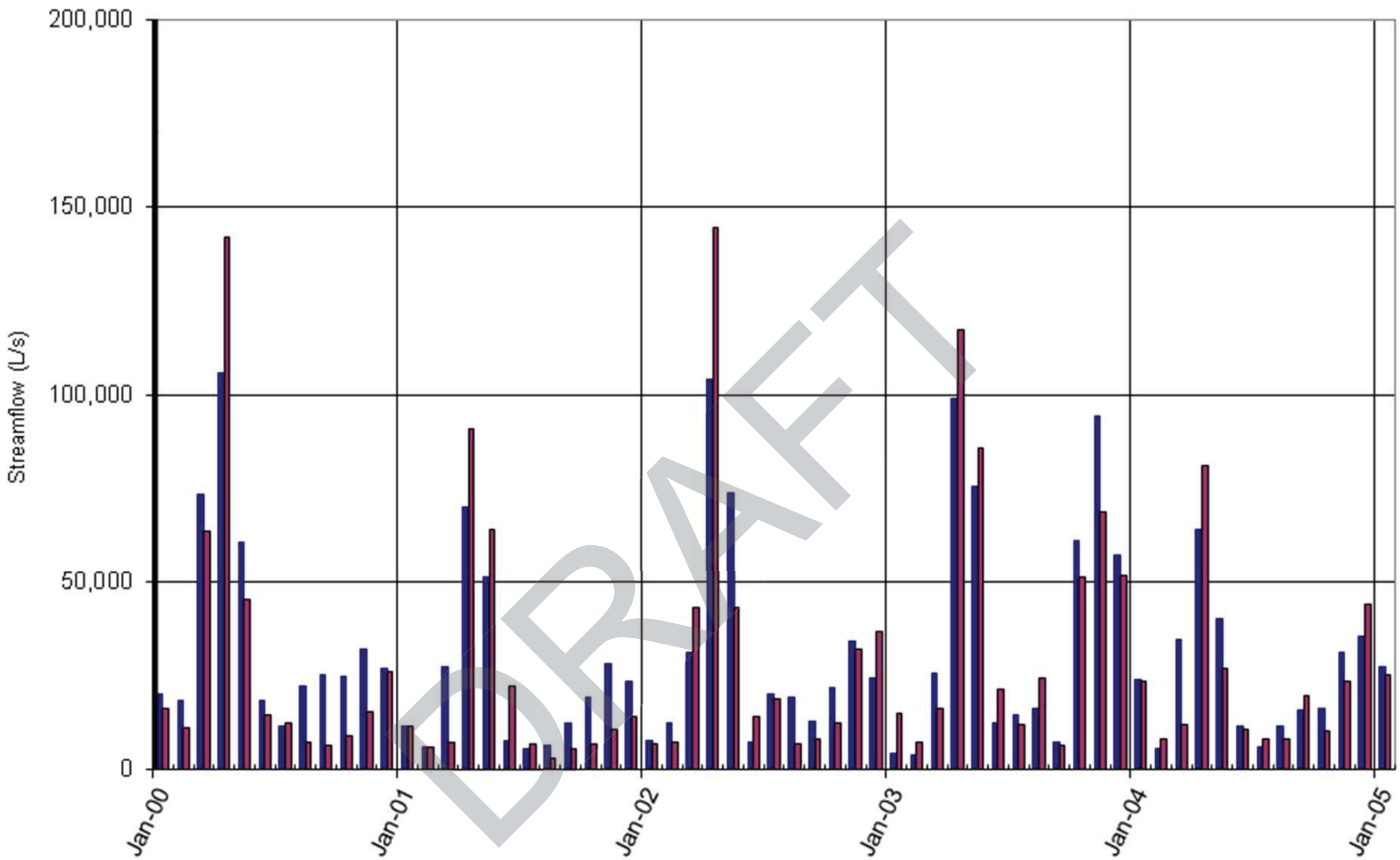
MONTHLY STREAMFLOW (NASHWAAK)

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-447/2	VA12-01435

APPENDIX A-8 REV 0

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

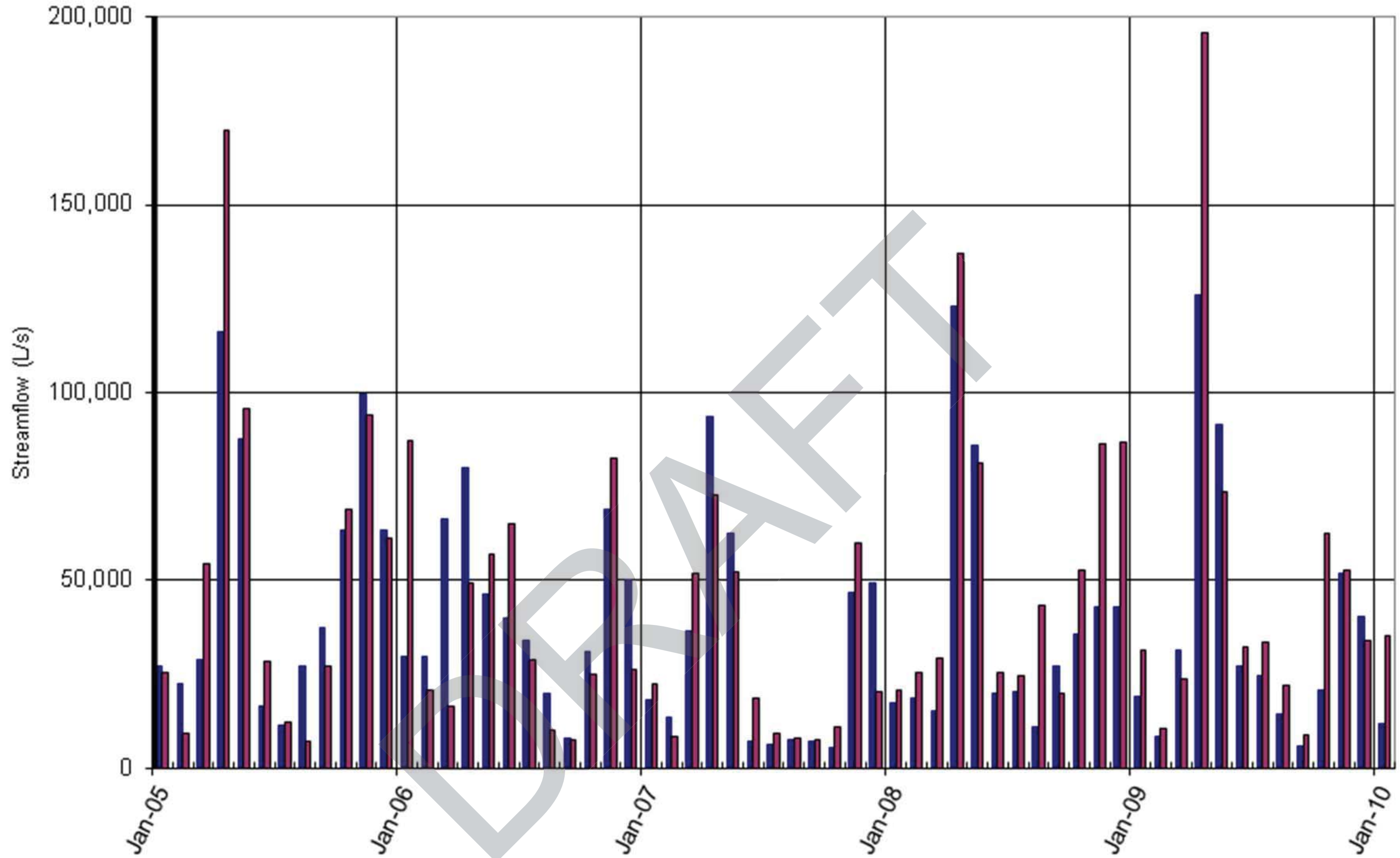


LEGEND

■ Nashwaak Calculated ■ Nashwaak Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES		
SISSON PROJECT		
MONTHLY STREAMFLOW (NASHWAAK)		
Knight Piésold CONSULTING	P/A NO. VA101-447/2	REF. NO. VA12-01435
	APPENDIX A-9	REV 0



LEGEND

■ Nashwaak Calculated ■ Nashwaak Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NASHWAAK)

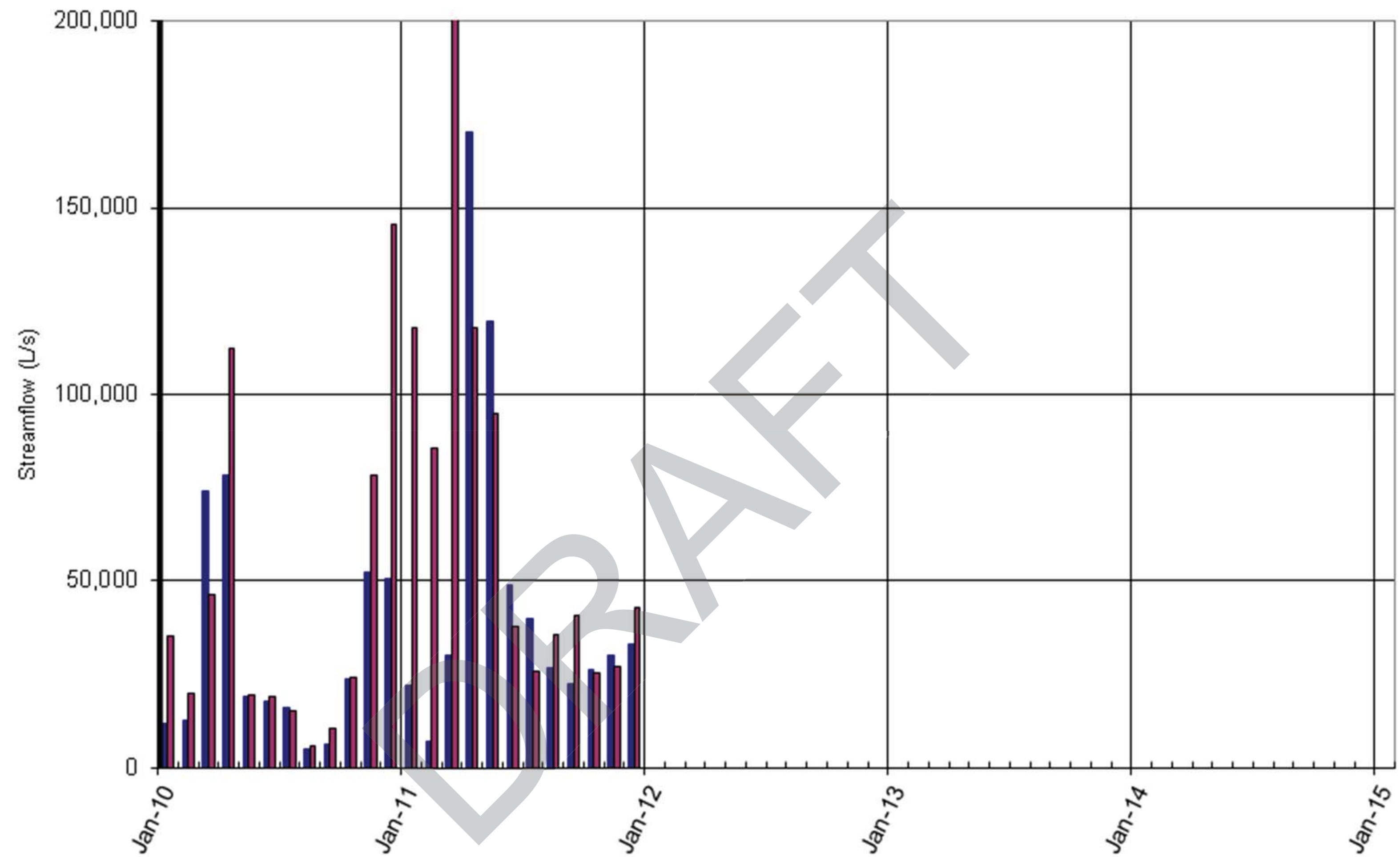
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-10

REV 0



LEGEND

Nashwaak Calculated Nashwaak Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NASHWAAK)

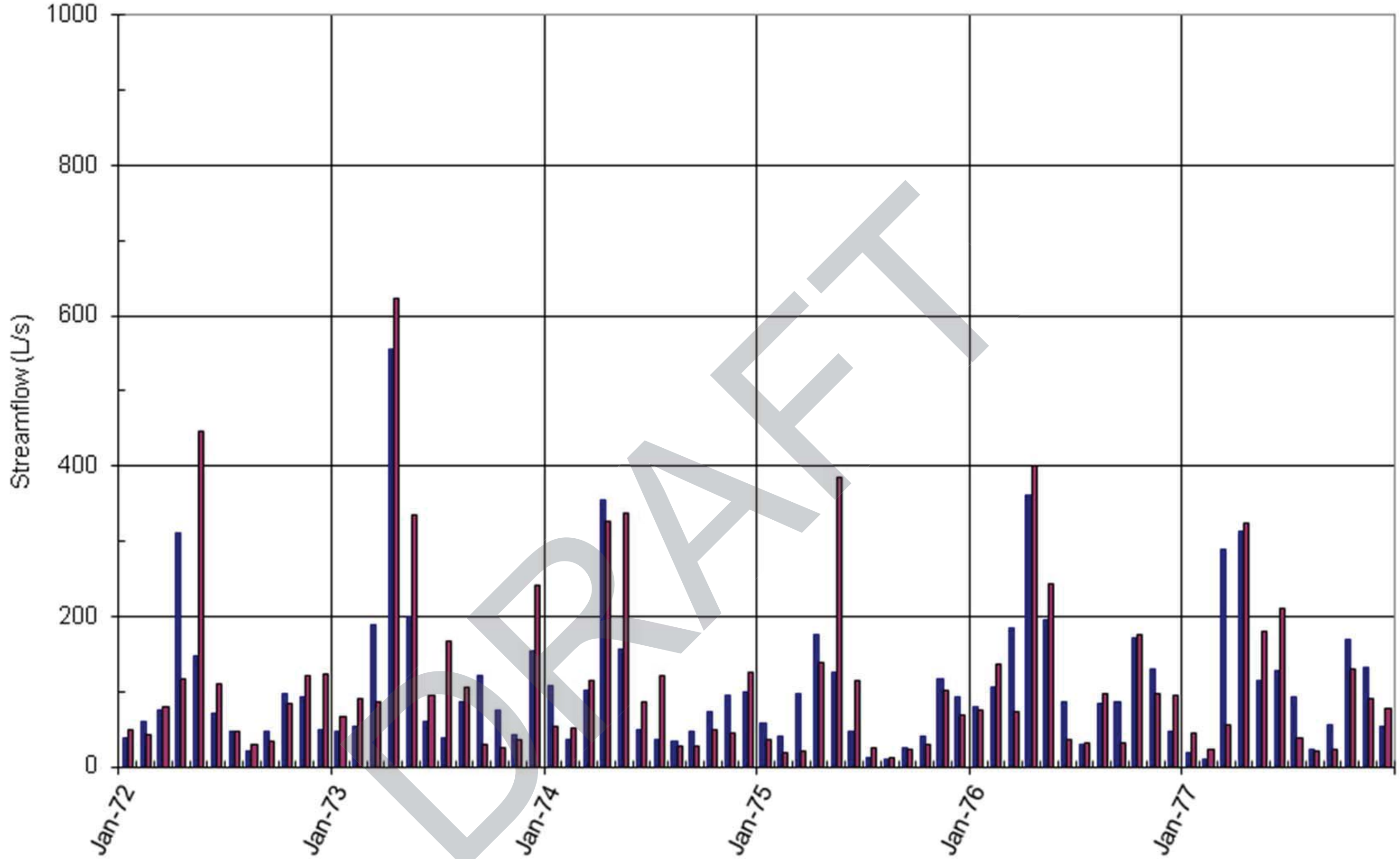
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-11

REV 0



LEGEND

■ Narrows Mountain Brook Calculated ■ Narrows Mountain Brook Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NARROWS MOUNTAIN BROOK)

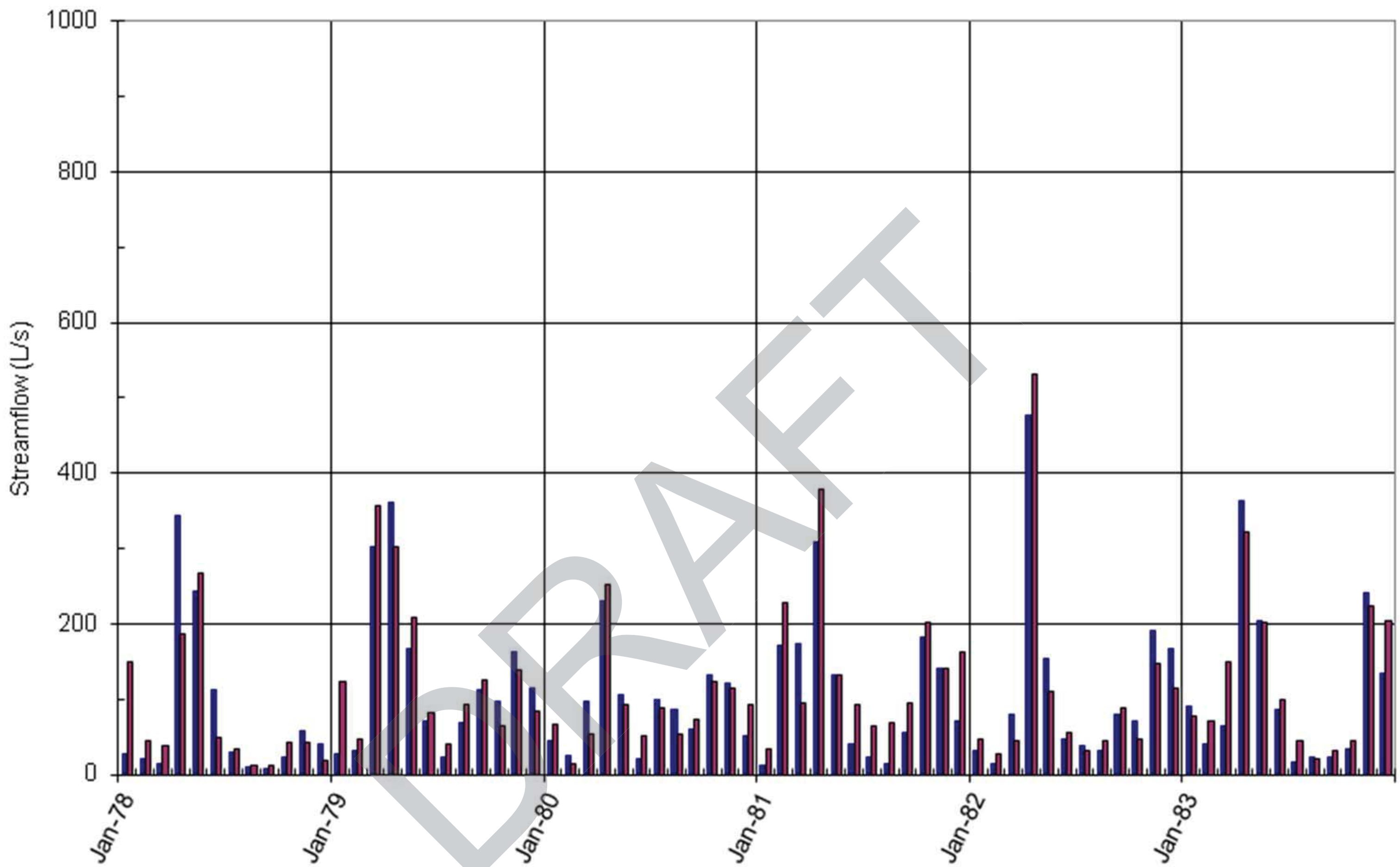
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-12

REV 0



LEGEND

Narrows Mountain Brook Calculated
Narrows Mountain Brook Measured

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB

NORTHCLIFF RESOURCES

SISSON PROJECT

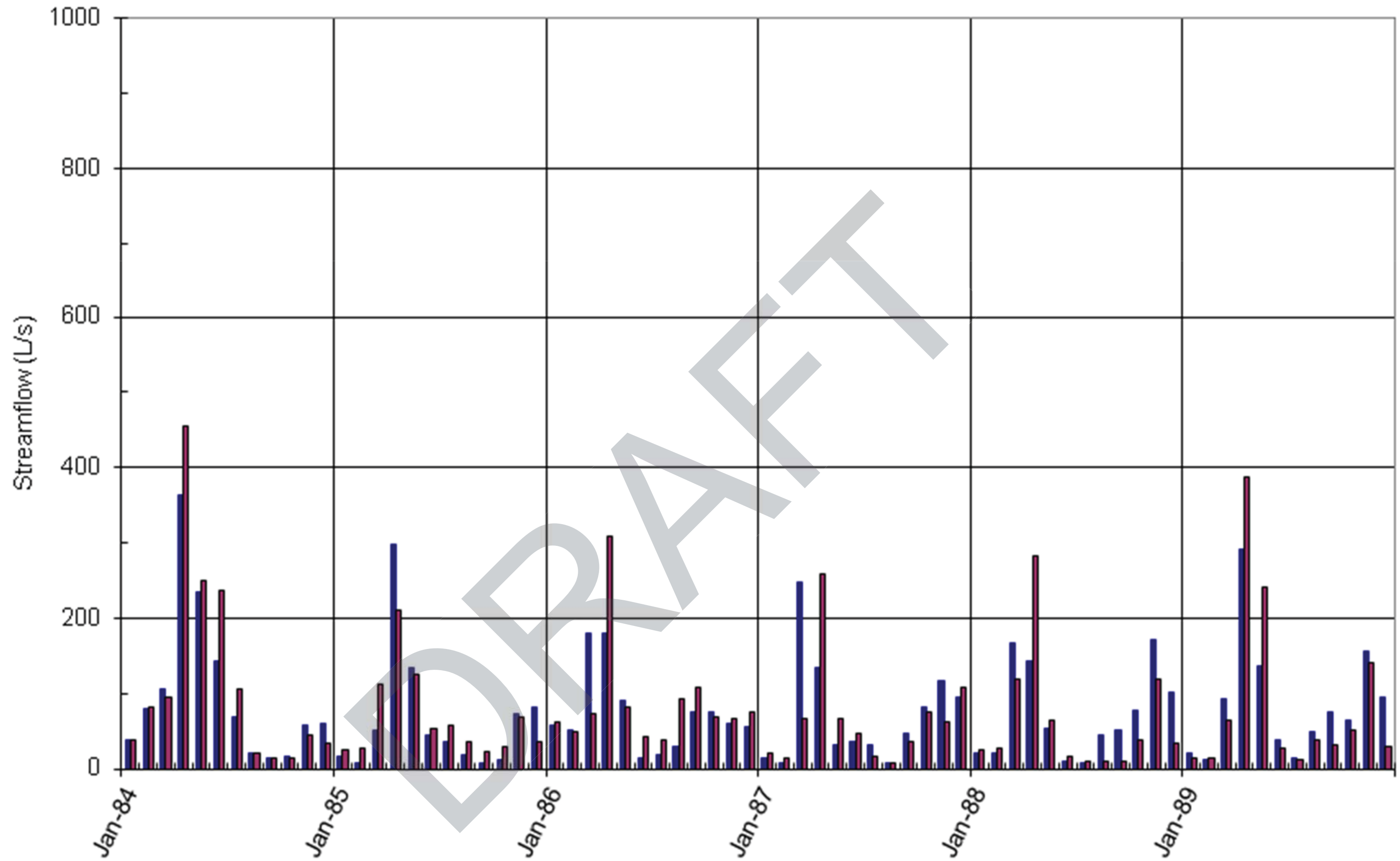
MONTHLY STREAMFLOW
(NARROWS MOUNTAIN BROOK)

Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-13 REV 0



LEGEND

■ Narrows Mountain Brook Calculated ■ Narrows Mountain Brook Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

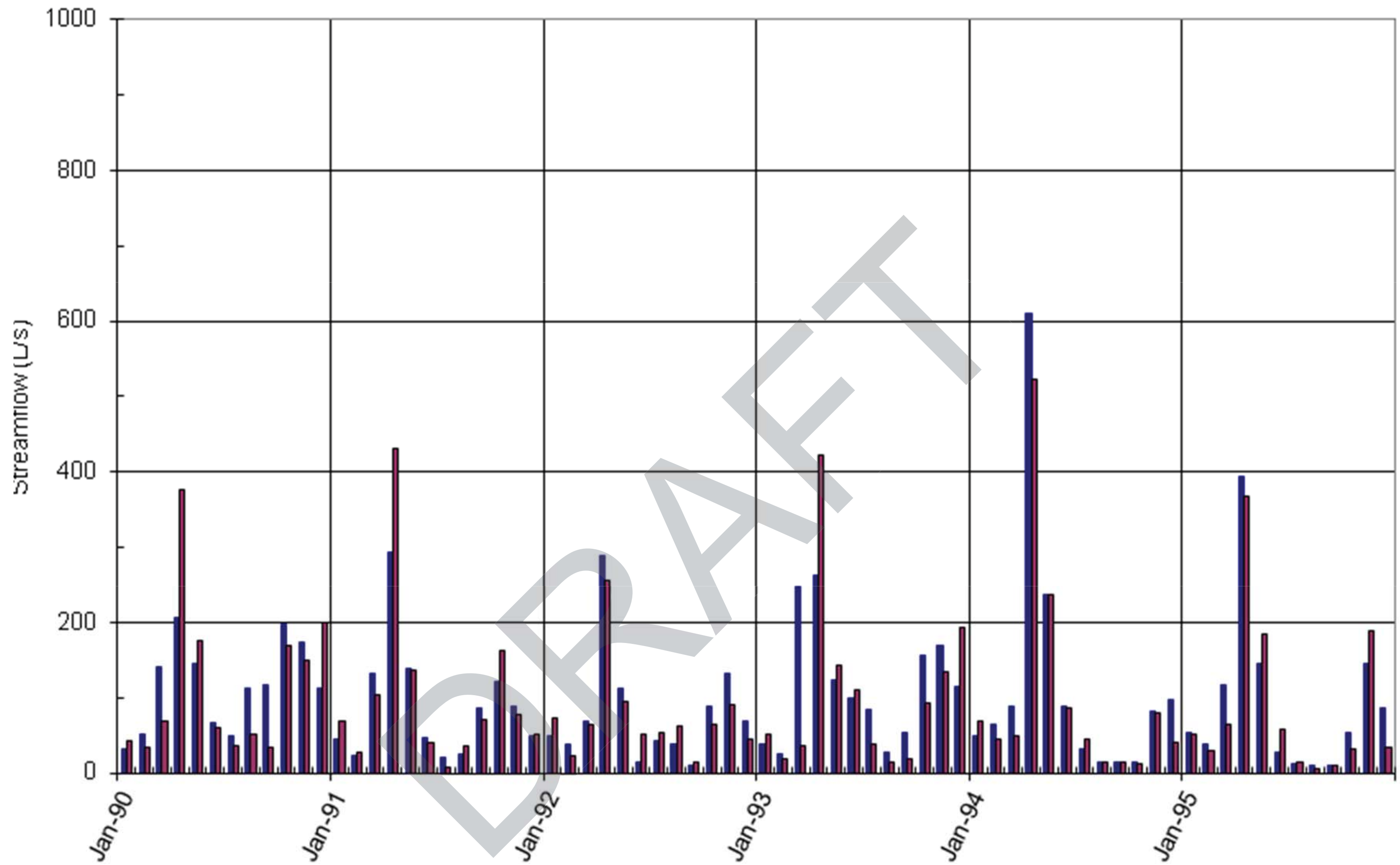
MONTHLY STREAMFLOW (NARROWS MOUNTAIN BROOK)

Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-14 REV 0



LEGEND

■ Narrows Mountain Brook Calculated ■ Narrows Mountain Brook Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NARROWS MOUNTAIN BROOK)

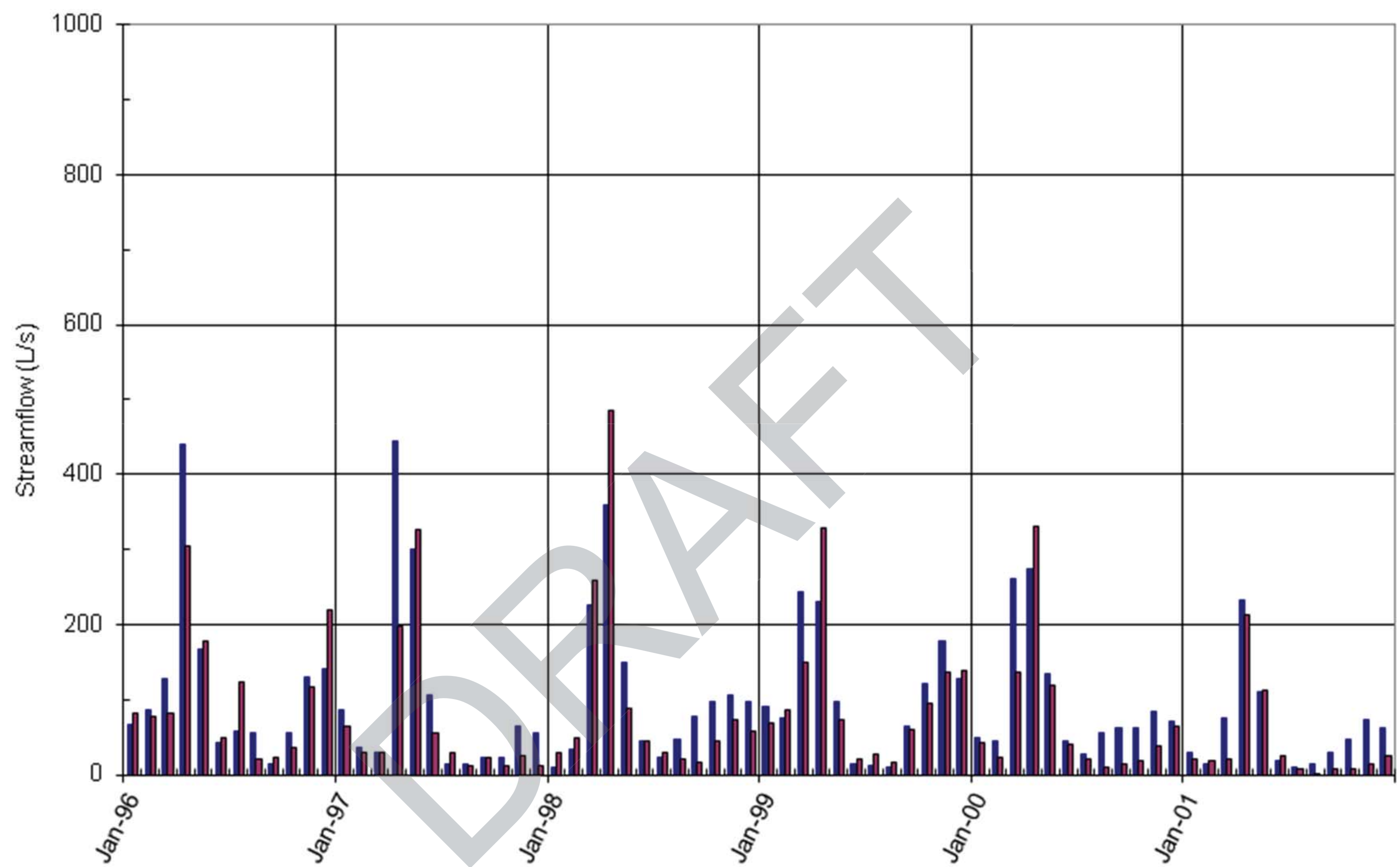
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-15

REV 0



LEGEND

■ Narrows Mountain Brook Calculated ■ Narrows Mountain Brook Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NARROWS MOUNTAIN BROOK)

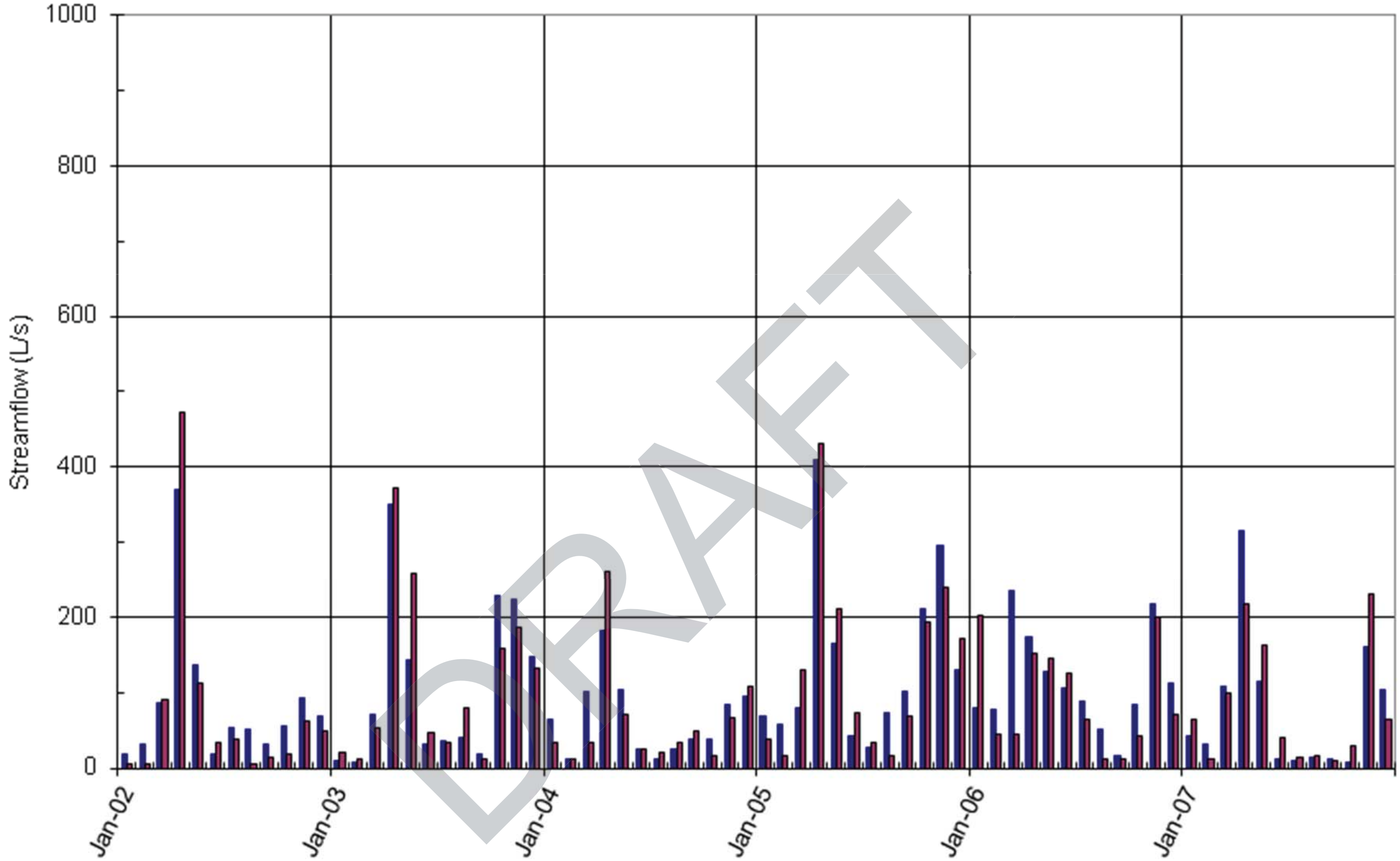
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-16

REV 0



LEGEND

■ Narrows Mountain Brook Calculated ■ Narrows Mountain Brook Measured

NORTHCLIFF RESOURCES

SISSON PROJECT

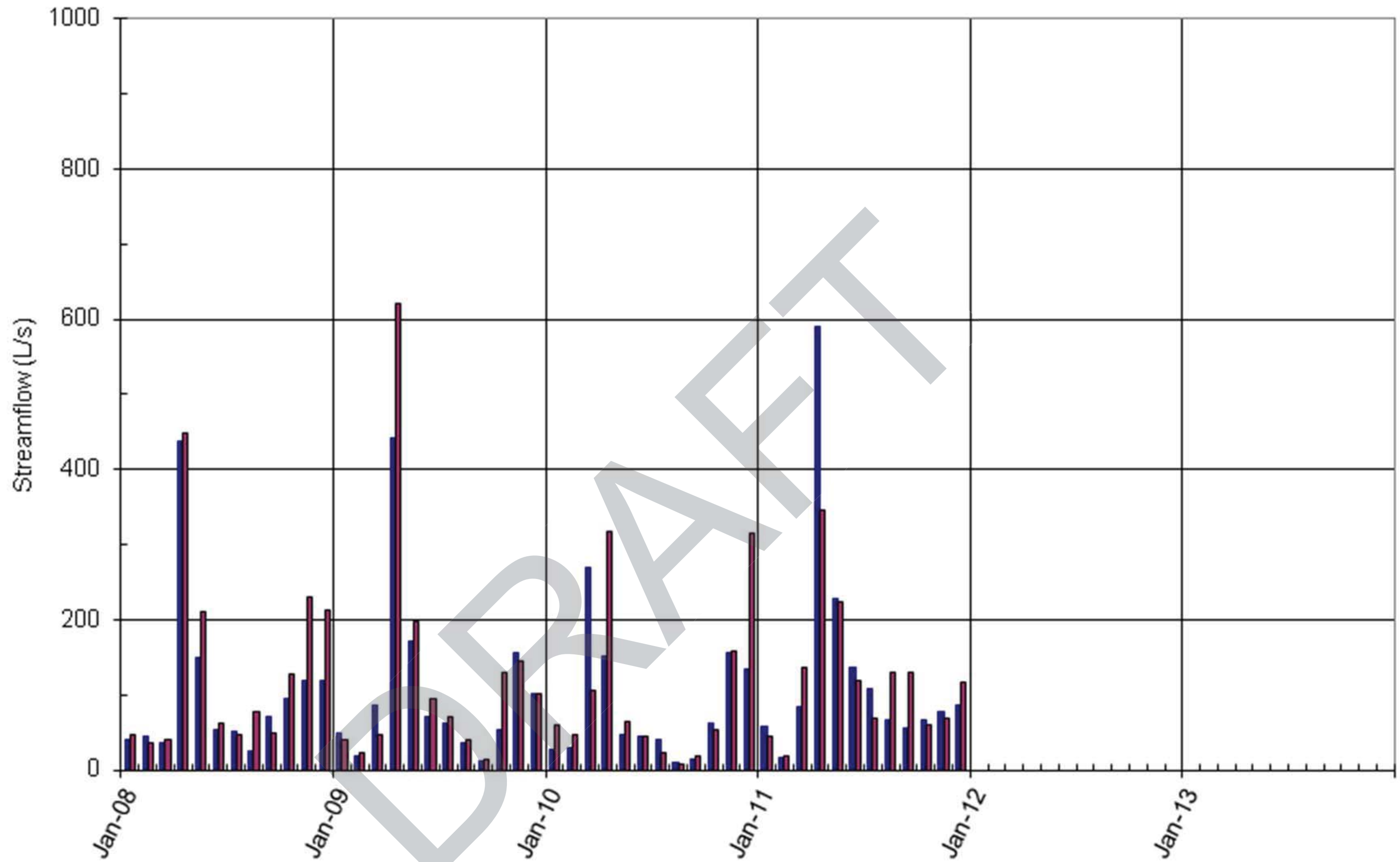
MONTHLY STREAMFLOW (NARROWS MOUNTAIN BROOK)

Knight Piésold CONSULTING

P/A NO.	REF. NO.
VA101-447/2	VA12-01435

APPENDIX A-17 REV 0

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



LEGEND

■ Narrows Mountain Brook Calculated ■ Narrows Mountain Brook Measured

0	24JUL'12	ISSUED WITH LETTER	CHS	DF	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES

SISSON PROJECT

MONTHLY STREAMFLOW (NARROWS MOUNTAIN BROOK)

Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. VA12-01435

APPENDIX A-18

REV 0

APPENDIX B

WATER LEVELS

APPENDIX B1

MANUAL WATER LEVELS

(Pages B1-1 to B2-2)

Knight Piésold CONSULTING

TABLE B1-1

NORTHCLIFF RESOURCES LTD
SISSON PROJECT

SUMMARY OF MANUAL WATER LEVEL MEASUREMENTS (2011 AND 2012)

Print Jan/02/13 16:29:05

Well ID	Shallow/Deep (BB and PP series only)	Ground Surface Elevation	PVC Stickup	Groundwater Levels							Groundwater Elevations						
				Aug 30 - Sept 2, 2011	Sept 28-29, 2011	Oct 26, 2011	Dec 6-9, 2011	March 13-29, 2012	June 20-22, 2012	Sept 9-20, 2012	Aug 30 - Sept 2, 2011	Sept 28-29, 2011	Oct 26, 2011	Dec 6-9, 2011	March 13-29, 2012	June 20-22, 2012	Sept 9-20, 2012
		(masl)	(mags)	(mbPVC)	(mbPVC)	(mbPVC)	(mbPVC)	(mbPVC)	(mbPVC)	(mbPVC)	(masl)	(masl)	(masl)	(masl)	(masl)	(masl)	(masl)
BB-08-01	Shallow	297.14	0.78	1.05	-	-	-	-	-	-	296.87	-	-	-	-	-	-
BB-08-01	Deep	297.14	0.78	1.142	-	-	-	-	-	-	296.78	-	-	-	-	-	-
BB-08-02	Shallow	309.31	0.76	3.946	-	-	-	-	-	-	306.12	-	-	-	-	-	-
BB-08-02	Deep	309.31	0.77	3.966	-	-	-	-	-	-	306.11	-	-	-	-	-	-
BB-08-03	Shallow	306.01	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BB-08-03	Deep	306.01	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PP-08-01	N/A	329.68	0.75	2.063	-	-	-	-	-	-	328.37	-	-	-	-	-	-
MP-08-03	Shallow	298.04	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MP-08-03	Deep	298.04	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MP-08-04	Shallow	304.76	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MP-08-04	Deep	304.76	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MP-08-05	Shallow	315.61	N/A	0	-	-	-	-	-	-	NA	-	-	-	-	-	-
MP-08-05	Deep	315.61	N/A	Artesian	-	-	-	-	-	-	>315.61	-	-	-	-	-	-
MP-08-06	Shallow	309.64	0.52	8.975	-	-	-	-	-	-	301.19	-	-	-	-	-	-
MP-08-06	Deep	309.64	0.55	10.675	-	-	-	-	-	-	299.52	-	-	-	-	-	-
MP-08-07	Shallow	292.07	0.48	2.66	-	-	-	-	-	-	289.89	-	-	-	-	-	-
MP-08-07	Deep	292.07	0.43	9.54	-	-	-	-	-	-	282.96	-	-	-	-	-	-
MP-08-08	Shallow	304.22	0.81	1.135	-	-	-	-	-	-	303.90	-	-	-	-	-	-
MP-08-08	Deep	304.22	0.78	5.465	-	-	-	-	-	-	299.54	-	-	-	-	-	-
MP-08-09	Shallow	345.36	0.51	10.692	-	-	-	-	-	-	335.18	-	-	-	-	-	-
MP-08-09	Deep	345.36	0.50	15.35	-	-	-	-	-	-	330.51	-	-	-	-	-	-
MW11-01		345.51	0.91	N/A	1.75	1.8	1.923	2.2	-	2.486	N/A	344.67	344.62	344.49	344.17	-	343.93
MW11-02S		293.60	0.92	N/A	2.91	3.0	3.173	2.1	-	3.628	N/A	291.61	291.50	291.34	292.38	-	290.89
MW11-02D		293.26	0.97	N/A	2.89	2.908	3.03	2.463	-	3.7	N/A	291.34	291.32	291.20	291.77	-	290.53
MW11-03S		287.78	0.74	N/A	3.002	2.915	2.961	1.495	3.385	4.009	N/A	285.52	285.60	285.56	287.02	285.13	284.51
MW11-03D		287.49	0.81	N/A	2.54	2.451	2.496	1.48	2.896	3.488	N/A	285.76	285.85	285.81	286.82	285.41	284.81
MW11-04S		262.02	0.89	N/A	0.96	1.111	0.993	0.67	1.15	1.351	N/A	261.95	261.80	261.92	262.24	261.76	261.56
MW11-04D		261.30	0.91	N/A	Artesian	Artesian	Artesian	Artesian	Artesian	Artesian	N/A	>262.21	>262.21	>262.21	>262.21	>262.21	>262.21
MW11-05S		309.02	0.97	N/A	2.61	2.53	2.534	2.71	2.719	2.745	N/A	307.38	307.46	307.45	307.28	307.27	307.24
MW11-05D		308.77	1.07	N/A	2.611	2.566	2.59	2.716	2.668	2.712	N/A	307.23	307.27	307.25	307.12	307.17	307.13
MW11-06S		306.13	1.00	N/A	3.14	3.216	3.45	3.861	3.13	3.93	N/A	303.99	303.91	303.68	303.27	304.00	303.20
MW11-06D		305.87	0.76	N/A	2.126	2.27	2.555	2.98	2.15	3.003	N/A	304.50	304.36	304.08	303.65	304.48	303.63
MWG11-01		382.44	N/A	N/A	-	-	-	-	-	-	N/A	-	-	-	-	-	-
MWG11-02		386.33	N/A	N/A	-	-	-	-	-	-	N/A	-	-	-	-	-	-
MWG11-03		382.22	N/A	N/A	-	-	-	-	-	-	N/A	-	-	-	-	-	-
MWG11-04		388.41	N/A	N/A	-	-	-	-	-	-	N/A	-	-	-	-	-	-
MWG11-05		328.28	0.98	N/A	-	-	-	-	-	6.755	N/A	-	-	-	-	-	322.51
MWG11-06		319.99	1.42	N/A	-	-	-	-	-	8.98	N/A	-	-	-	-	-	312.43
MWG11-07		323.47	0.44	N/A	-	-	-	-	-	11.189	N/A	-	-	-	-	-	312.72
MWG11-08		332.81	0.80	N/A	-	-	-	-	-	8.495	N/A	-	-	-	-	-	325.12
MWG11-09		314.65	1.02	N/A	-	-	-	-	-	8.83	N/A	-	-	-	-	-	306.84
MWG11-10		340.61	1.20	N/A	-	-	-	-	-	10.757	N/A	-	-	-	-	-	331.05
MWG11-12		305.98	1.15	N/A	-	-	-	-	-	3.44	N/A	-	-	-	-	-	303.68
MWG11-13		317.60	1.04	N/A	-	-	-	-	-	9.46	N/A	-	-	-	-	-	309.18
MWG11-14		336.57	0.78	N/A	-	-	-	-	-	7.39	N/A	-	-	-	-	-	329.96
MWG11-15		358.57	0.55	N/A	-	-	-	-	-	23.828	N/A	-	-	-	-	-	335.29
MWG11-16		354.29	0.76	N/A	-	-	-	-	-	2.262	N/A	-	-	-	-	-	352.79
MWG11-17		321.69	0.79	N/A	-	-	-	-	-	11.265	N/A	-	-	-	-	-	311.22

M:\1\01\00447\02\A\Data\Task 0600 - Hydrogeology\5-Water Levels\[Summary of Manual Water Level Measurements.xlsx]Manual Water Levels

NOTES:

1. mbPVC - METERS BELOW TOP PVC. STICKUP MEASUREMENT TAKEN DURING AUGUST 30 - SEPTEMBER 2 SITE VISIT
2. masl - METERS ABOVE SEA LEVEL.
3. "-" INDICATES DATA NOT COLLECTED.
4. N/A - DATA NOT APPLICABLE.
5. NA - DATA NOT AVAILABLE.

A	24NOV'12	ISSUED WITH REPORT VA101-447/2-8	DLP	CHS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

Knight Piésold
CONSULTING

TABLE B1-2

NORTHCLIFF RESOURCES LTD
SISSON PROJECT

MANUAL GROUNDWATER LEVELS (2008)

Print Jan/02/13 16:23:53

Well ID	Shallow/Deep	Ground Surface Elevation	Top of Casing Elevation	Groundwater Levels					Groundwater Elevations				
				14-Aug-08	18-Aug-08	19-Aug-08	02-Sep-08	09-Nov-08	14-Aug-08	18-Aug-08	19-Aug-08	02-Sep-08	09-Nov-08
		(masl)	(masl)	(mbPVC)	(mbPVC)	(mbPVC)	(mbPVC)	(mbPVC)	(masl)	(masl)	(masl)	(masl)	(masl)
BB-08-01	Shallow	297.14	297.964	-	1.195	-	-	-	-	296.77	-	-	-
BB-08-01	Deep	297.14	297.954	-	-	1.125	-	-	-	-	296.83	-	-
BB-08-02	Shallow	309.31	310.023	-	-	3.797	-	-	-	-	306.23	-	-
BB-08-02	Deep	309.31	310.033	-	-	3.825	-	-	-	-	306.21	-	-
BB-08-03	Shallow	306.01	306.800	-	-	2.873	3.168	3.263	-	-	303.93	303.63	303.54
BB-08-03	Deep	306.01	306.800	-	-	3.356	3.447	3.499	-	-	303.44	303.35	303.30
PP-08-01	N/A	329.68	330.483	-	2.542	-	-	3.537	-	327.94	-	-	326.95
MP-08-03	Shallow	298.04	298.601	-	2.177	-	-	2.850	-	296.42	-	-	295.75
MP-08-03	Deep	298.04	298.591	-	1.395	-	-	1.685	-	297.20	-	-	296.91
MP-08-04	Shallow	304.76	305.338	-	2.629	-	3.019	3.095	-	302.71	-	302.32	302.24
MP-08-04	Deep	304.76	305.316	-	2.415	-	2.740	2.784	-	302.90	-	302.58	302.53
MP-08-05	Shallow	315.61	316.243	-	Artesian	-	-	2.342	-	>316.24	-	-	313.90
MP-08-05	Deep	315.61	316.166	-	Artesian	-	-	2.273	-	>316.17	-	-	313.89
MP-08-06	Shallow	309.64	310.095	-	9.589	-	7.576	9.850	-	300.51	-	302.52	300.25
MP-08-06	Deep	309.64	310.146	11.280	-	-	11.346	11.457	298.87	-	-	298.80	298.69
MP-08-07	Shallow	292.07	292.592	-	2.957	-	2.695	2.796	-	289.64	-	289.90	289.80
MP-08-07	Deep	292.07	292.545	-	3.096	-	3.361	3.464	-	289.45	-	289.18	289.08
MP-08-08	Shallow	304.22	305.082	3.190	-	-	3.179	3.052	301.89	-	-	301.90	302.03
MP-08-08	Deep	304.22	305.047	-	5.576	-	4.801	4.711	-	299.47	-	300.25	300.34
MP-08-09	Shallow	345.36	345.902	-	2.374	-	12.931	12.945	-	343.53	-	332.97	332.96
MP-08-09	Deep	345.36	345.895	-	15.247	-	16.528	16.509	-	330.65	-	329.37	329.39

M:\1\01\00447\02\A\Data\Task 0600 - Hydrogeology\5-Water Levels\[Summary of Manual Water Level Measurements.xlsx]TerrAtlantic Water Levels

NOTES:

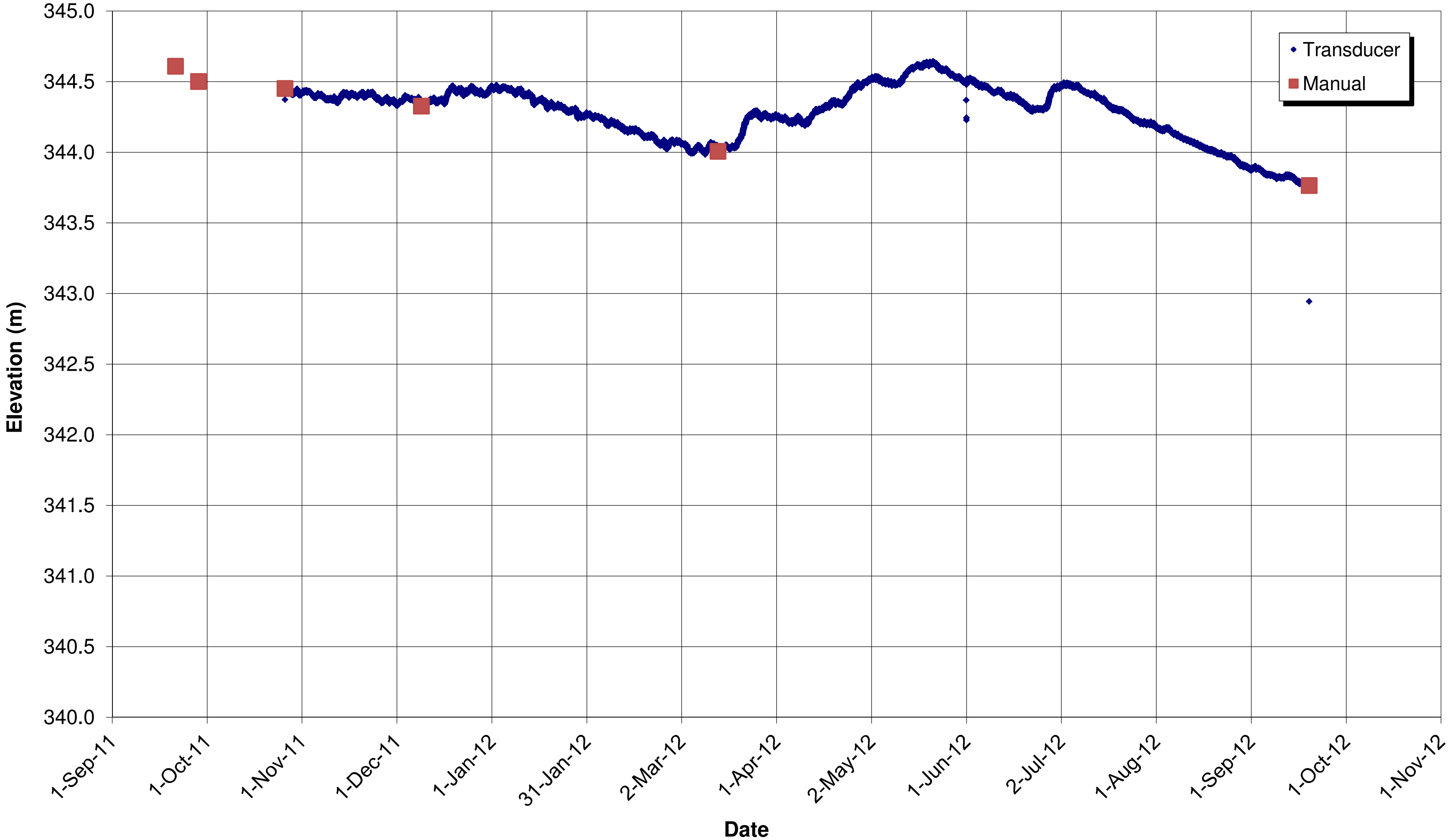
1. DATA TAKEN DIRECTLY FROM TERRATLANTIC (2010), FACTUAL DATA TO SUPPORT THE PRE-FEASIBILITY STUDY GEOTECHNICAL INVESTIGATION SISSON BROOK MINE DEVELOPMENT PROJECT, NB.
2. WATER LEVEL ELEVATION ON DRILLHOLE LOG BB-08-01S ON AUGUST 18, 2008 INDICATES 297.58 m ON SAME DATE.
3. TOP OF CASING ASSUMED TO BE TOP OF PVC STICKUP
4. mbPVC - METERS BELOW PVC STICKUP.
5. masl - METERS ABOVE SEA LEVEL.
6. "-" INDICATES DATA NOT COLLECTED.

A	24NOV'12	ISSUED WITH REPORT VA101-447/2-8	DLP	CHS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

APPENDIX B2

TIME SERIES OF PIEZOMETRIC ELEVATIONS

(Pages B2-1 to B2-6)



NOTE:
1. GROUND ELEVATION IS 345.5 m. SCREENED INTERVAL IS FROM 20.5 m TO 23.5 m.

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MW11-01
GROUNDWATER ELEVATION

Knight Piésold CONSULTING

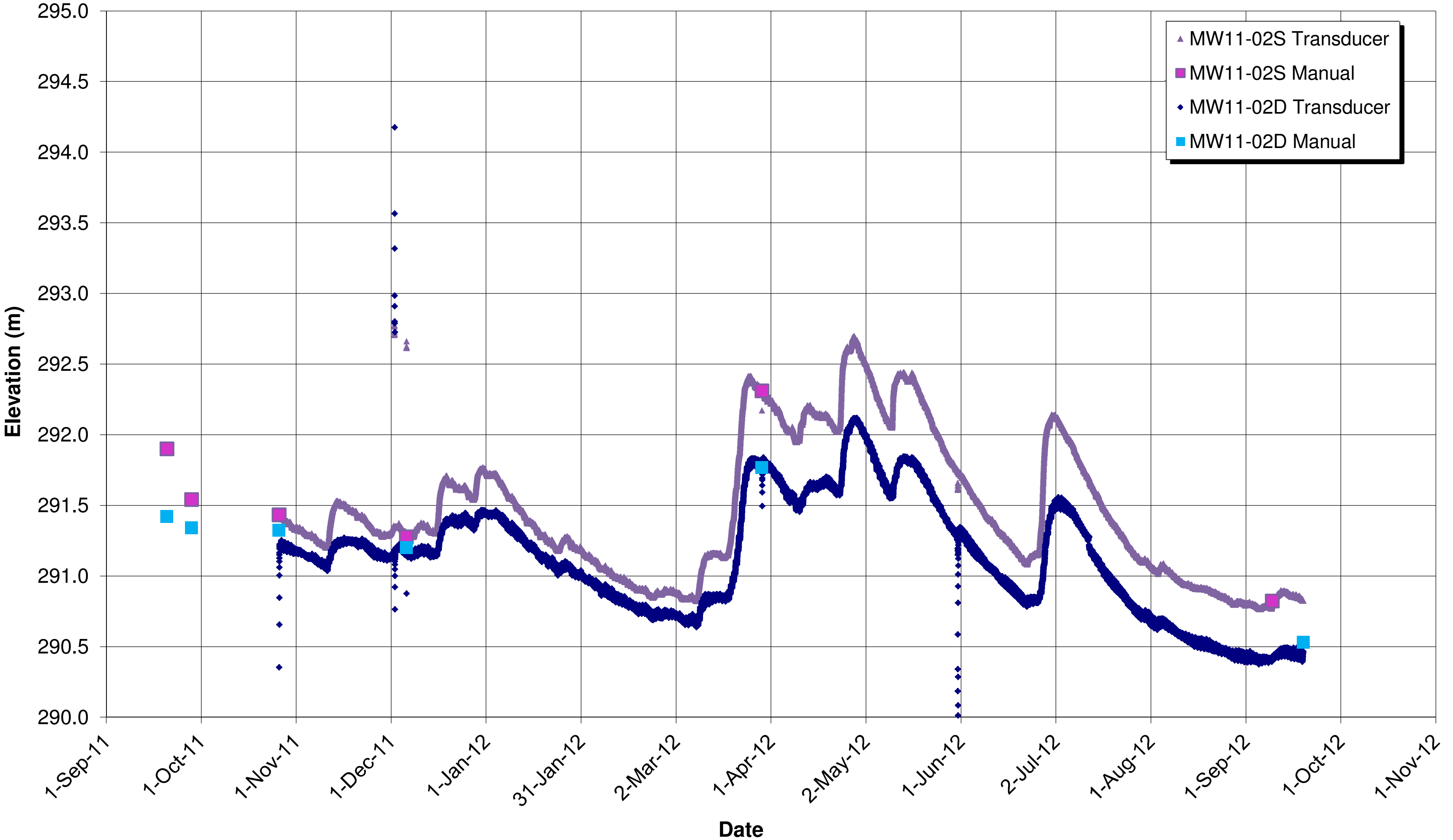
P/A NO. VA101-447/2

REF. NO. 8

FIGURE B2-1

REV A

A	15NOV'12	ISSUED WITH REPORT	CM	CS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D



NOTES:

1. MW11-02S GROUND ELEVATION IS 293.6 m. SCREENED INTERVAL IS 5.3 TO 6.8 mbgs.
2. MW11-02D GROUND ELEVATION IS 293.3 m. SCREENED INTERVAL IS 25.3 TO 28.3 mbgs.

A	15NOV'12	ISSUED WITH REPORT	CM	CS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MW11-02D/S
GROUNDWATER ELEVATION

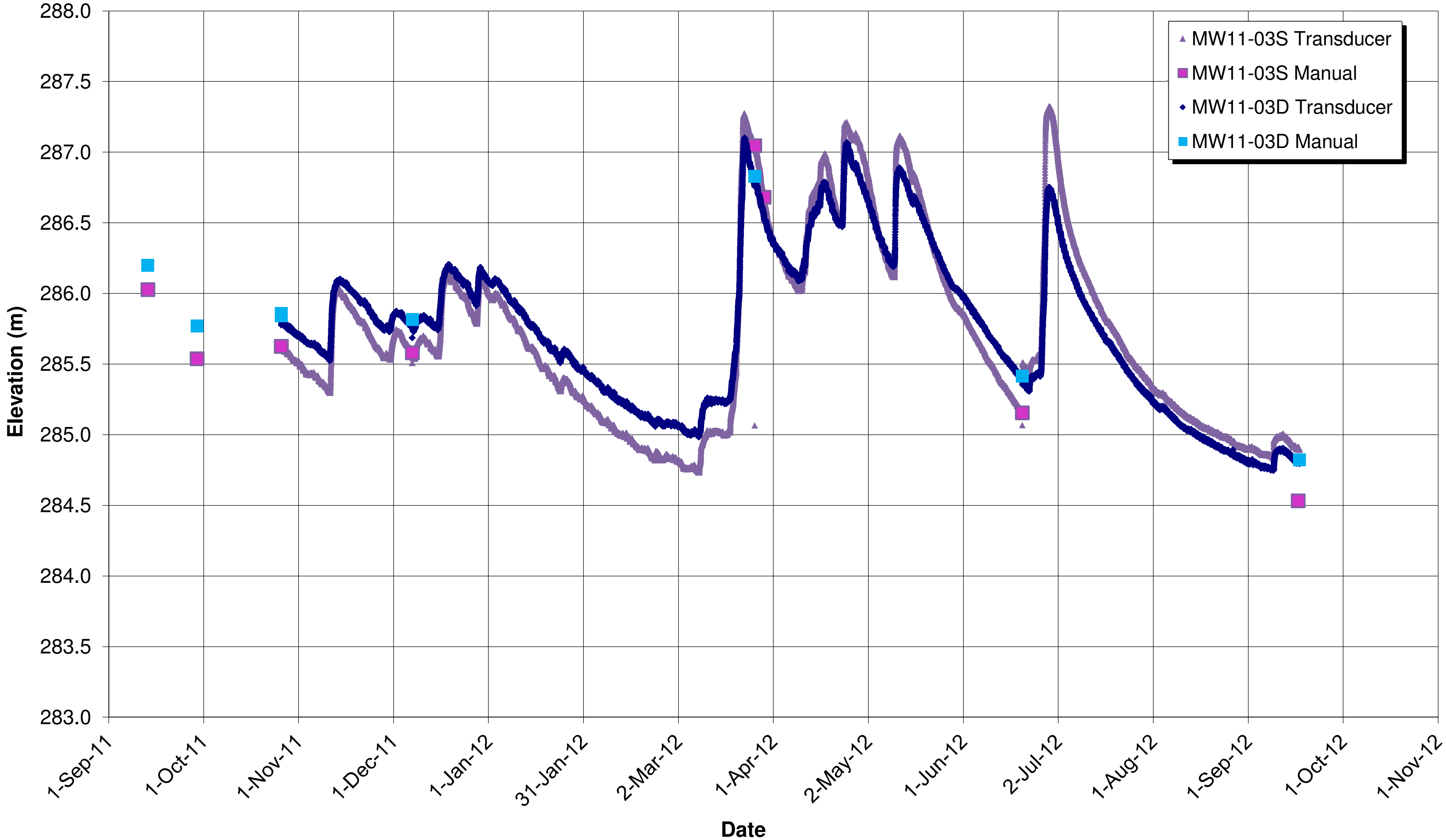
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE B2-2

REV A



NOTES:

1. MW11-03S GROUND ELEVATION IS 287.8 m. SCREENED INTERVAL IS 6.1 TO 9.1 mbgs.
2. MW11-03D GROUND ELEVATION IS 287.5 m. SCREENED INTERVAL IS 18.6 TO 21.7 mbgs.

A	15NOV'12	ISSUED WITH REPORT	CM	CS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MW11-03D/S
GROUNDWATER ELEVATION

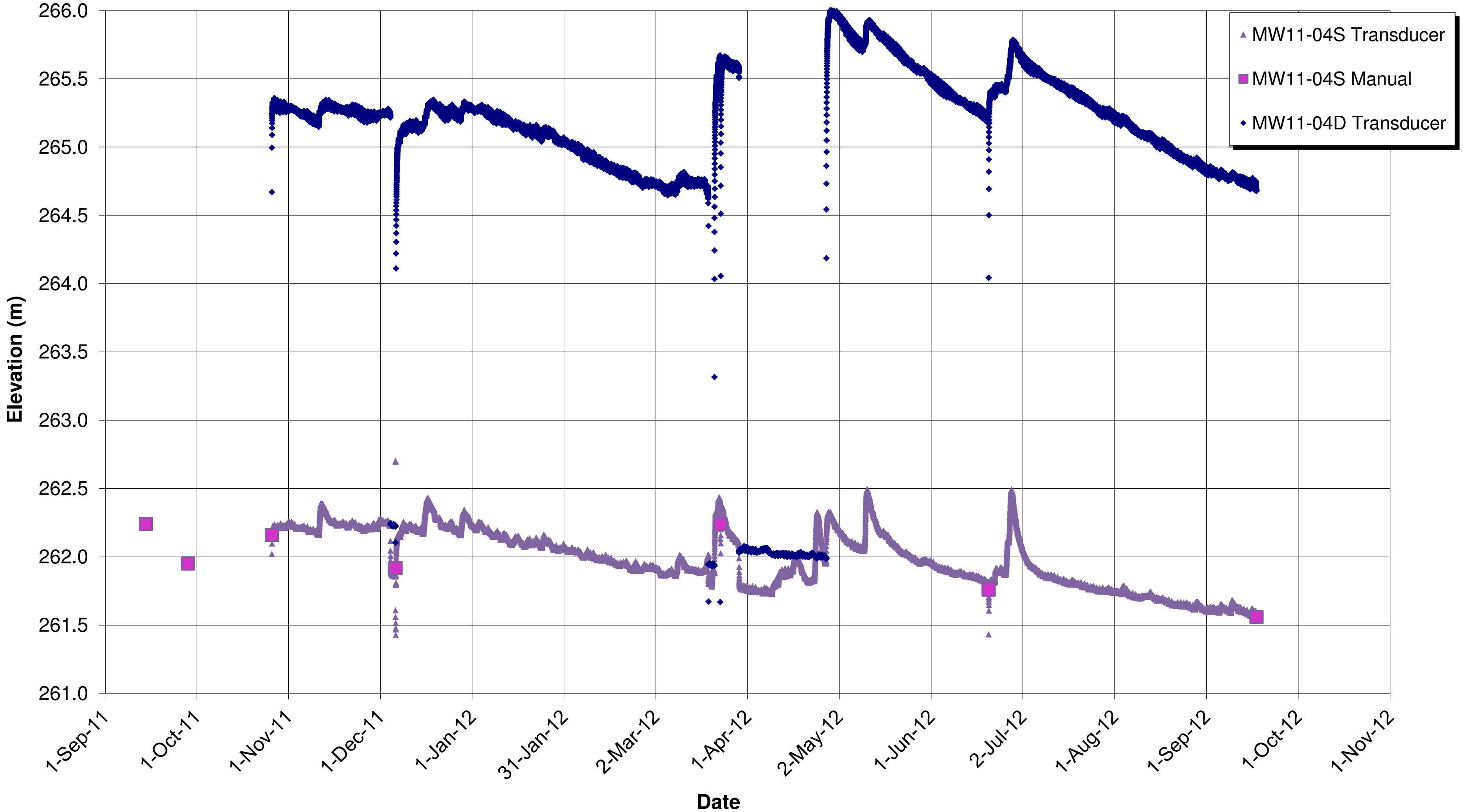
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE B3-3

REV A



NOTES:

1. MW11-04S GROUND ELEVATION IS 262.0 m. SCREENED INTERVAL IS 5.2 TO 8.2 mbgs.
2. MW11-04D GROUND ELEVATION IS 261.3 m. SCREENED INTERVAL IS 27.3 TO 30.3 mbgs.
3. MANUAL SHUT IN PRESSURES AND FLOW RATES WERE NOT RECORDED AT MW11-04D. OBSERVATIONS OF FLOWING CONDITIONS WERE NOTED (APPENDIX B1). PLOT IS BASED ON MEASURED TRANSDUCER INSTALLATION DEPTH.
4. MW11-04D PERIODICALLY PLUGGED WITH CAP DURNG MEASUREMENT PERIOD.
5. DECREASE IN PRESSURE AT MW12-04D FROM LATE MARCH TO MAY 2012 CORRESPONDS WITH STANTEC SITE VISIT IN MARCH TO WELL. TRANSDUCER MAY NOT HAVE BEEN INSTALLED TO PREVIOUS FULL INSTALLATION DEPTH.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
A	15NOV'12	ISSUED WITH REPORT	CM	CS	KJB

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MW11-04D/S
GROUNDWATER ELEVATION

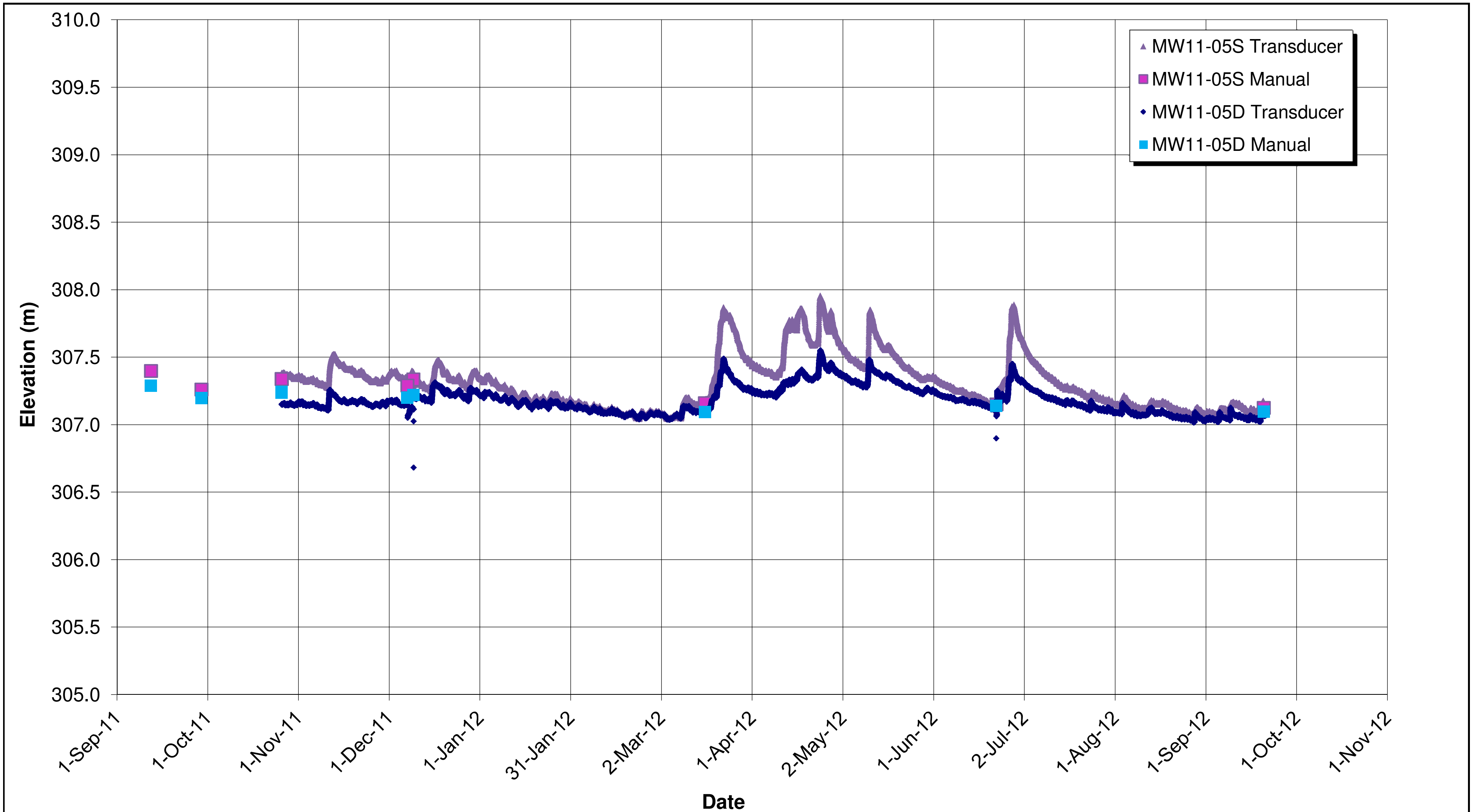
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE B2-4

REV A



NOTES:
1. MW11-05S GROUND ELEVATION IS 309.0 m. SCREENED INTERVAL IS 5.9 TO 9.0 mbgs.
2. MW11-05D GROUND ELEVATION IS 308.8 m. SCREENED INTERVAL IS 30.4 TO 33.4 mbgs.

A	15NOV'12	ISSUED WITH REPORT	CM	CS	KJB
REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MW11-05D/S
GROUNDWATER ELEVATION

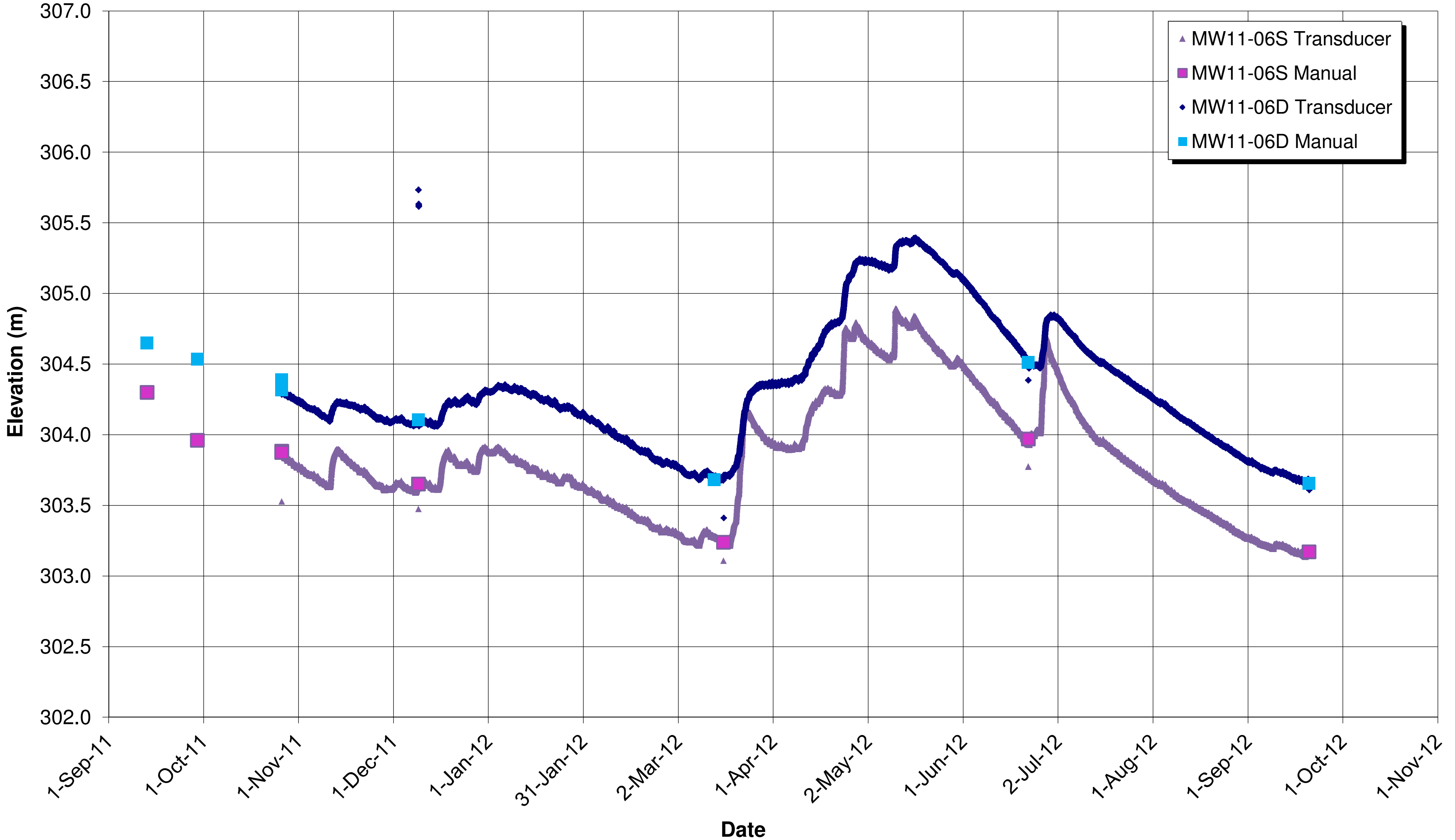
Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE B2-5

REV A



NOTES:

1. MW11-06S GROUND ELEVATION IS 306.1 m. SCREENED INTERVAL IS 7.0 TO 8.5 mbgs.
2. MW11-06D GROUND ELEVATION IS 305.9 m. SCREENED INTERVAL IS 20.6 TO 23.6 mbgs.

REV	DATE	DESCRIPTION	PREP'D	CHK'D	APP'D
A	15NOV'12	ISSUED WITH REPORT	CM	CS	KJB

NORTHCLIFF RESOURCES LTD.

SISSON PROJECT

MW11-06D/S
GROUNDWATER ELEVATION

Knight Piésold CONSULTING

P/A NO. VA101-447/2

REF. NO. 8

FIGURE B2-6

REV A