

**DATE** October 23, 2014**REFERENCE No.** 1114220046-511-TM-Rev1-4600**TO** Derek Holmes  
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dchorley@golder.com**HYDROGEOLOGICAL CHARACTERIZATION  
MCNAB VALLEY AGGREGATE PROJECT (DRAFT)**

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**1.0 INTRODUCTION**

BURNCO Rock Products Ltd. (BURNCO) and 0819042 BC Ltd. are proposing to construct and operate the McNab Valley Aggregate Project (“the Project”) on their 320 ha property in McNab Valley, which is located on the northern shore of Thornbrough Channel, immediately north of Gambier Island and northeast of the Town of Gibsons (Figure 1). Current Project plans include mining aggregate resources from an approximately 77 ha portion of the property situated approximately 500 m from the marine foreshore and extending northward approximately 600 m toward the southern banks of McNab Creek (Figure 2). The proposed extraction footprint will be positioned entirely within the gently sloping valley floor terrain and will be bounded to the west by a north-south aligned forest service road, to the south by a BC Hydro transmission corridor and to the east and north by McNab Creek. Terrain immediately west of the forest service road is comprised of steep, east-facing slopes that extend several hundred metres above the valley floor. Similarly steep and elevated, west-facing slopes are also positioned along the eastern margin of the valley floor, along the eastern shore of McNab Creek. All proposed property development components; including a marine load-out facility and processing operations, together with site geological and hydrologic setting are described in more detail in the separate documents (Golder, 2010; Golder, 2011, Golder 2014).

This technical memorandum provides a factual characterization of hydrogeological conditions and associated interpretations relating to the Project area. The primary source of information for the characterization was Golder’s 2010 subsurface exploration and testing program, which included direct examination of the valley floor geology and construction of a permanent groundwater monitoring network to facilitate both groundwater quality determinations and continuous groundwater hydraulic monitoring. A surface water monitoring network was also established at the site in 2010 to support the overall hydrogeological characterization objectives. This characterization utilized continuous water level and temperature data collected from the site monitoring network until the end of 2012. A conceptual understanding of site hydrogeological conditions that was developed based on the available site data and characterization is presented in the final section of this memorandum.



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## **2.0 SITE EXPLORATION AND TESTING PROGRAM**

### **2.1 Initial Planning and Site Audit**

A Golder senior hydrogeologist attended the site on May 12, 2010 to perform an audit of existing monitoring wells and to examine drilling rig access requirements over the valley floor area, as required to support planning for the subsequent exploratory drilling program.

The audit focused on locating and assessing five monitoring wells (designated MW05-1 through MW05-5) identified in a Thurber Engineering Ltd. (Thurber) report dated April 24, 2008 (Thurber, 2008). The MW05 series of wells were originally constructed under the supervision of EBA Engineering Consultants Ltd. (EBA) staff at the approximate locations shown on Figure 2. Thurber's report included copies of EBA's original records of stratigraphy encountered during drilling of four monitoring wells (MW05-1 through MW05-4), including completion details for single 50-mm diameter PVC standpipe piezometers constructed within each borehole.

Golder staff located EBA wells MW05-1, MW05-2 and MW05-5 in the field. The length of each monitoring well standpipe was manually measured to confirm the wells were not in-filled with sediment or debris and/or broken at some depth below ground. On that basis, they were considered potentially viable as monitoring wells to be utilized for the on-going hydrogeological characterization. EBA wells MW05-3 and MW05-4 were not located in the field and were presumed to have been destroyed, as indicated on Figure 2.

Golder's reconnaissance-level site survey included visual examination of a deep, steep-sided, man-made channel excavated on an approximately north-south alignment through the central portion of the valley floor (Figure 2). The watercourse bed was estimated to be approximately 7 m below the adjacent valley floor, at a location approximately 100 m north of the BC Hydro corridor. The depth increased to a maximum of approximately 10 m near the northern terminus, at a location approximately 500 m north of the transmission corridor (Figure 2). This deeply excavated channel is referred to as Watercourse 2 (WC 2).

Watercourse 2 bed and steep banks were observed to be generally comprised of rounded to sub-rounded, gravel and cobble-sized rock fragments that were almost completely lacking vegetation. Groundwater seepage was observed in the eastern bank of the watercourse at a location approximately 20 m downstream from the northern terminus. The groundwater discharge point was positioned approximately 1 m above the channel bed and the discharge rate was estimated to be 0.1 L/s (litres per second). A calibrated probe was used to measure basic water chemistry parameters at both the discharge point and also within the watercourse. The resulting electrical conductivity (EC) data and pH data exhibited minor variance, ranging from 13  $\mu$ /cm (micro Siemens per centimetre) to 19  $\mu$ S/cm and pH=6.10 to 6.17, respectively.

### **2.2 Exploratory Drilling and Monitoring Well Construction**

During the period of June 14 to 19, 2010, Golder engineering and hydrogeology field staff supervised drilling of five (5) exploratory boreholes to a maximum depth of 49.4 m-bg (metres below ground) below the valley floor at locations either within or adjacent to the proposed extraction area (Figure 2). The boreholes were designated DH10-01, DH10-02, DH10-05, DH10-06 and DH10-07. A description of the geological strata encountered during drilling, along with an interpretation of the overall valley floor geology, is provided in Golder's separate technical memorandum (Golder, 2010). In general, the entire valley floor is confirmed to be a fan-delta structure comprised of thick sequences of granular glaciofluvial sediments that are locally overlain with modern alluvial sediments. Neither till nor bedrock was encountered during drilling.

The June 2010 exploratory boreholes were drilled using a sonic drilling rig operated by Beck Drilling and Environmental Services Ltd. Golder field staff supervised the conversion of the five boreholes to “nested” monitoring wells by installing two (2) 32-mm diameter PVC standpipe piezometers in each borehole. At each drilling location, a minimum 1.5 m long section of machine-slotted screen was installed at the base of the borehole with a solid pipe section extending fully to ground surface. A second 1.5 m long (minimum) screen section was installed at considerably shallower depths in each borehole. The annular space between the borehole wall and both PVC screens was backfilled with clean silica sand. A continuous column of bentonite chips was installed between the screens and also from ground surface to within approximately 1.0 m of the top of the upper screens. All wells were completed with fully grouted, lockable steel boxes. All standpipes were completed with vented slip-on PVC caps.

The completed monitoring wells were labelled using the above-noted DH-10 series designations, with an additional letter suffix “S” to identify the shallow standpipes and a “D” label to identify the deeper standpipes. A summary of all strata encountered during drilling, along with monitoring well construction details, is provided in hydrogeological cross sections (A-A through D-D) on Figures 4, 5, 6 and 7. The north-south and east-west orientations of the hydrogeological cross section lines are shown on Figure 3.

### 2.3 Initial Well Development and In-Situ Hydraulic Testing

During the period of June 30 to July 12, 2010, Golder staff completed standardized development of the five new DH10 series monitoring wells and three EBA MW05 series monitoring wells, to improve the hydraulic connectivity of the wells to the surrounding geological strata and remove water from the wells that was potentially affected by the drilling process. The development methodology included incremental removal of water from each well while monitoring basic chemical parameters (i.e., temperature, pH, electrical conductivity and dissolved oxygen) and water physical parameters such as turbidity and colour. The development process continued until a specified minimum volume of water was removed from each well and the water chemistry had stabilized, as indicated by both the water chemical parameters and physical parameters.

Golder field personnel conducted standardized *in-situ* hydraulic tests (i.e., single well response tests) in the five DH10 series multi-level wells (shallow and deep) and two MW05 series wells. Prior to each test, automated pressure transducers with data logging devices were programmed to record at a 1-second interval and installed at the bottom of each monitoring well. Anticipating a relative rapid hydraulic response in these monitoring wells, rising head tests were completed using a pneumatic assembly attached to the upper end of each PVC pipe to initially displace the well water column downward and allow upward recovery upon rapid release of the applied pressure. Transducer data was then downloaded from the monitoring devices for office-based analysis.

The hydraulic conductivity ( $K$ ) of the granular sediments positioned adjacent to all monitoring well screens was estimated through analysis of the *in-situ* hydraulic testing data in AQTESOLV®, a commercially available software package for aquifer test analysis. The resulting  $K$  estimates from all deep and shallow monitoring wells were relatively consistent and ranged from  $1 \times 10^{-4}$  m/s and  $2 \times 10^{-3}$  m/s, except at DH10-6d in the northwest portion of the site where  $K$  of  $3 \times 10^{-7}$  m/s was measured in a silty horizon near the bedrock/overburden interface. Nine out of thirteen tests that were conducted at the site exhibited oscillatory response, which is characteristic of higher-permeability materials and consistent with the estimated values of hydraulic conductivity. Hydraulic conductivity estimated in all tests was less than the hydraulic conductivity estimated for the filter pack used in well construction. Details of this analysis are presented in Attachment A.

## 2.4 Groundwater and Surface Water Monitoring Program

On July 9 and 12, 2010 Golder staff installed individual pressure transducers with automated dataloggers in all DH10 series monitoring wells (both shallow and deep) and also in MW05-02 and MW05-05. All devices were programmed to record water pressures and temperature in a synchronized manner at a 15-minute interval. Since initial installation, the recorded data has been downloaded at regular intervals, with the last download occurring in October 2014. All resulting water level data were converted to equivalent elevations (as metres geodetic) using monitoring well collar elevations provided by a Registered BCLS. The resulting continuous groundwater elevation record for the period of July 2010 to October 2014 is provided on Attachment B.

Four surface water monitoring stations were installed at the site on August 11, 2010. Stations SW10-01 and SW10-02 were installed in McNab Creek at a locations east of monitoring wells DH10-06 and DH10-02, respectively (Figure 2). Stations SW10-03 and SW10-04 were installed in WC 2 at locations near the northern terminus and at the outlet of a large steel arch culvert near the BC Hydro corridor (Figure 2). The four surface water monitoring stations (i.e., SW's) were instrumented with automated pressure transducers programmed and synchronized to record water pressures at 15-minute intervals, coincident with the monitoring well devices. Each SW was also outfitted with a graduated staff gauge surveyed by a Registered BCLS. The automated pressure transducers were downloaded on regular intervals until October 2014 and the resulting water level data converted to equivalent elevations using the staff gauges as datum. The resulting continuous elevation record for surface waters in both McNab Creek and WC 2 are summarized in Attachment C, for comparison with other monitoring data.

Groundwater and surface water temperature data for a period between July 2010 and October 2014 are provided in Attachment D and Attachment E.

Interpreted groundwater elevation contours, based on manual measurements obtained on August 11, 2010 and February 1, 2011 are shown on Figure 8 and Figure 9, respectively. The interpreted groundwater surface (i.e., water table) for August 11, 2010 is also shown in hydrogeological cross sections A-A through D-D (Figures 4 through 7).

## 2.5 Groundwater Chemistry

Golder field staff obtained groundwater quality samples from all DH10 series monitoring wells (shallow and deep) and wells MW05-2 and MW05-3, during the 3-day period commencing July 20, 2010. Well MW05-1 was not selected for groundwater quality sampling due to the consistently high turbidity reported for that well, which was attributed to the presence of silty sediments adjacent to the well screen. For comparative purposes, surface water quality samples were also obtained directly from McNab Creek at stations SW10-01 and SW10-02 and also from WC 2 at station SW10-03. Groundwater quality sampling from the same locations was conducted again during the November 29-30, 2012 and February 17-19, 2014 site visits.

Golder's standard environmental sampling field procedures and protocols were employed during monitoring well sampling and surface water sampling, including maintenance of chain-of-custody (CoC) documentation. All wells were initially purged through removal of a minimum specified volume of water, while basic field parameters were monitored using a calibrated multi-probe. Water samples were obtained using containers provided by a CAEAL accredited laboratory. All containers were stored in refrigerated coolers and delivered to the laboratory within 24 hours of sampling. Each sample was assigned a unique sample control number (SCN) prior to submission to the ALS analytical laboratory under protocols that did not identify the sampling locations.

The requested analyses included a range of parameters based generally on BC *Water Quality Guidelines for the Protection of Aquatic Life* (AL Guidelines), to facilitate a relative comparison of surface water and groundwater quality. Analytical results of all samples are presented in the geochemical characterization.

### 3.0 GROUNDWATER CHARACTERIZATION

Groundwater and surface water monitoring and testing at the site between June 2010 and October 2014, together with interpretation of site geological and hydrological conditions (Golder, 2010, Golder 2014) provides sufficient information to develop characterization of the groundwater regime within the examined portion of the valley floor.

#### 3.1 Hydrostratigraphy

The results of site investigations allow delineation of main hydrostratigraphic units that are present at the site: valley fill aquifer, till and bedrock. The granular glaciofluvial and alluvial sediments that were encountered during drilling are inferred to act as a thick unconfined aquifer. This drilling confirmed that this unit is at least 50 m thick: however, the geophysical investigations (Frontier, 2011) suggest that near the valley center its thickness could potentially exceed 100 m. As presented on Figure 10, single-well response testing conducted in the valley fill aquifer indicate that the aquifer hydraulic conductivity is relatively high and ranging between  $1 \times 10^{-4}$  m/s and  $2 \times 10^{-3}$  m/s. This is consistent with the description of sediments encountered during drilling of DH series boreholes and test-pitting. Figure 10 also shows approximate estimates of hydraulic conductivity based on grain size analysis of samples obtained from the two deepest boreholes completed at the site (DH10-1 and DH10-2). These estimates are generally higher than the values obtained from the single-well-response testing, possibly due to washing-out of fines during sample collection. Nevertheless, both the single-well-response data and grain size data indicate that the hydraulic conductivity of the valley fill aquifer is likely decreasing with depth. The geometric mean of single-well-response tests conducted between 0 to 20 m depth interval and 20 m to 50 m depth interval is approximately  $4 \times 10^{-4}$  m/s and  $2 \times 10^{-4}$  m/s, respectively. Although vertical hydraulic conductivity has not been measured at the site, it is also considered likely that aquifer materials are anisotropic (i.e. vertical hydraulic conductivity is less than the horizontal hydraulic conductivity) due to interbedded and cross-bedded structures associated with the aquifer depositional environment.

Glacial till has been observed in the upper portion of the McNab valley, outside both the area that is considered for the aggregate extraction and where the monitoring well network has been installed. This unit is not continuous and of unknown thickness. Hydrogeological properties of the till have not been measured at the site; however, based on values published in the literature (Maidment, 1992) its hydraulic conductivity is considered to be lower (perhaps on the order of  $10^{-6}$  m/s to  $10^{-7}$  m/s) than those estimated for the valley fill aquifer.

No *in-situ* testing has been conducted in bedrock that underlies and flanks the valley fill aquifer. As discussed in Golder (2010), to the east of the McNab Creek valley bedrock has a predominately granodiorite composition; whereas, to the west metamorphic rocks (meta-argillite, slate, and siltstone) dominate. Considering these bedrock types, their bulk hydraulic conductivity is likely at least 3 orders of magnitude less than those estimated for the valley fill aquifer (Maidment, 1992). Consequently, groundwater fluxes in the valley fill aquifer are likely considerably higher than fluxes in the underlying bedrock. The hydrogeological properties of a possible fault structure that may parallel McNab Creek valley is also not know. However, the hydrogeological significance of this fault structure, if it exists, would only be high relative to the groundwater flow system in the valley fill aquifer if it is laterally continuous, highly permeable and of considerable width.

## 3.2 Groundwater Flow Directions and Gradients

Groundwater elevations recorded during the entire July 2010 to October 2014 monitoring period, as presented in Attachment B, exhibited consistently higher elevations during wet winter months and lower elevations during the remainder of the year. Increases in groundwater elevation in response to winter precipitation were recorded in all monitoring wells; however, the magnitude of these increases varied throughout the site. The greatest increases of up to 5 m were observed in wells located closer to the west boundary of the valley fill aquifer (MW05-1, DH10-01, DH10-06, and DH10-07). The lowest increases, those not exceeding approximately 2 m, were observed in remaining observation wells which are all located closer to the east portion of the property near to McNab Creek. These lower increases compare relatively well with the range of creek level fluctuations observed during winter months (Attachment C), which suggest that the hydraulic head increases in the eastern portion of the site are probably controlled to a larger degree by the creek level than by direct recharge. In the western portion of the site direct recharge from rainfall events and run-off from the bedrock slope west of the site appears to be the main controlling factor in seasonal head fluctuations. Run-off from the bedrock slope is considered to be a significant component of this recharge because observed increases in hydraulic heads in this portion of the site exceed increases that could reasonably be expected from direct precipitation upon the valley fill sediments only. For example, during the period preceding October 9, 2010 no precipitation had been recorded at the site, which was followed by 129.8 mm of rain on October 9 and 10, 2010. This rainfall, assuming 100% infiltration and a specific yield in the range of 0.2 to 0.3 in the valley fill aquifer, would have resulted in at most 0.65 m raise in water table elevation. However approximately a 1.85 m rise in water level had been observed in well DH10-07S during this period and similar increases have been recorded in other wells in the western portion of the site. This net increase in observed hydraulic heads is attributed to run-off from the bedrock slope to the west of the property that infiltrates the portion of the valley floor where these monitoring wells are installed.

Despite these seasonal and short-term variations in hydraulic heads, the relative groundwater levels in the monitoring wells have remained constant. Therefore, groundwater flow directions and associated hydraulic gradients are interpreted to be similar throughout the summer (dry) and winter (wet) months.

### 3.2.1 Horizontal Gradients

Manual groundwater measurements obtained on August 11, 2010 (Figure 8) are considered to be generally representative of the groundwater regime during summer (dry) seasons. On that basis, the valley floor groundwater regime is interpreted to be characterized by an overall southward flow direction at gradients of 2% to 3% below the extreme northern end of the examined area (Figures 6 and 7). The gradients become progressively lower (i.e., flatter) toward the southern end of the valley floor (Figure 6). Within the central and southern portions of the valley floor, the groundwater regime is characterized by convergent southwestward and southeastward flow, toward WC 2 (Figures 4, 5 and 8). The convergent flow is interpreted to be result of the hydraulic influence of the deeply excavated channel, which represents an artificial groundwater drainage pathway that has reduced groundwater levels in areas directly adjacent to the watercourse and altered both groundwater flow directions and flow gradients. The monitoring data indicates that, following construction of WC 2, permanent reductions of approximately 2 m to 3 m have potentially occurred within the central and northern reaches.

Hydraulic head data obtained on February 1, 2012 (Figure 9) are considered to be generally representative of the groundwater regime during winter (wet) seasons. The groundwater flow pattern presented on this figure is generally similar to the one observed during the summer months; however, the hydraulic heads are overall higher, in particular in the west portion of the valley fill aquifer. This results in overall steepening of hydraulic gradients between the MW05-5 in the west and WC 2 that intersects the center of the aquifer.

### 3.2.2 Vertical Gradients

Upward groundwater flow gradients were identified in groundwater elevation data for all DH10 series monitoring wells. These upward hydraulic gradients persisted for the entire monitoring period between June 2010 and October 2014, independently from the summer (dry) and winter (wet) seasons. Specifically, groundwater elevations in each of the relatively deep (D) standpipes exceeded groundwater elevations measured in the corresponding shallow (S) standpipes. For example, on August 11, 2010 the magnitude of the water level elevation difference ranged from 0.25 m at DH10-02 to 2.65 m at DH10-01 (Attachment B). The elevation differences are particularly evident in the consistent vertical separation of DH10 (D) and DH10 (S) hydrographs summarized on Figure 8. The elevation differences are indicative of groundwater gradients that include a component of vertical flow. Accordingly, groundwater originating from the deeper valley floor sediments is partially conveyed upward, but not vertically upward, into the overlying shallower sediments.

The relatively higher groundwater elevations measured in deep monitoring wells are representative of regional-scale hydraulic influences. These include the presence of large upland recharge areas comprised of exposed bedrock that extends under the McNab Valley floor and likely conveys water under high piezometric pressure to the deeper valley floor sediments. Conversely, groundwater elevations measured in the relatively shallowly buried (i.e., near surface) valley floor sediments are more representative of localized hydraulic influences such as McNab Creek stage (Section 3.2), recharge of incident rainfall and to a lesser extent by intermittent pressure gradients related to tidal stage (Section 3.4). Lastly, these upward gradients are accentuated by WC 2, which lowered the hydraulic heads in the shallow portion of the aquifer from the pre-construction levels.

### 3.3 Surface Water-Groundwater Hydraulic Connectivity

During periods of very low or zero precipitation, water flowing within WC 2 will likely be comprised entirely of groundwater seepage/discharge originating directly from sediments exposed within the banks and/or bed of the watercourse. Therefore, surface water levels recorded at SW10-03 during the relatively dry July-September 2010 monitoring period are considered representative of groundwater levels in the immediate vicinity of the watercourse. It is on this basis that the SW10-03 monitoring data were utilized to construct the groundwater contours depicted on Figure 8 and in the hydrogeological cross sections (Figures 4 through 7).

Elevation data from the combined surface water and groundwater monitoring program indicate that the sediments underlying the valley floor have a direct hydraulic connection to McNab Creek. This is evident in the data for both SW10-01 and SW10-02, which correlate very strongly with the groundwater elevation contours interpolated between DH10-06 to DH10-05 and between DH10-05 to DH10-02, respectively. The August 11, 2010 groundwater contours (Figure 9) indicate that water from McNab Creek flows southward (overall) into the valley floor sediments from both the east-west aligned and north-south aligned creek reaches that bound the valley floor area. This interpretation is also generally supported through a comparison of water chemistry in McNab Creek with water chemistry in both WC 2 and shallow DH10 series monitoring wells. For example, the EC of groundwater from all shallow monitoring wells and WC 2 typically range from 9  $\mu\text{S}/\text{cm}$  to 45  $\mu\text{S}/\text{cm}$ , which are low values and are characteristic of surface water and/or groundwater that has not resided within sediments for a significant duration. Similarly, dissolved oxygen concentrations in the shallow DH10 monitoring wells ranged from 6.3 mg/L (milligrams per litre) to 10.2 mg/L, which are relatively high concentrations and are more characteristic of surface water. Dissolved oxygen concentrations in groundwater from deep monitoring wells DH10-01, DH10-05 and DH10-06 were measured in 2010 at approximately 1.9 mg/L, 0.6 mg/L and 0.1 mg/L, respectively. These comparatively low values (see Section 3.3) are considered more

characteristic of groundwater that has resided within sediments and/or bedrock for a relatively long duration. Therefore, the relatively low dissolved oxygen concentrations support an interpretation that groundwater present in the deep valley floor sediments originates in part from sources other than surface water directly conveyed from McNab Creek.

Water loss from McNab Creek to the valley fill aquifer is further supported by the continuous temperature data that has been collected from the site monitoring well network (Attachment D). When this information is compared to the continuous temperature record obtained from the surface water monitoring stations (Attachment E), it is possible to trace the movement of the thermal front through this aquifer in response to seasonally high temperatures in McNab Creek typically observed in the summer months. For example, water temperature in McNab creek at station MC-US reached approximately 12.4°C at the beginning of September 2011 and then gradually declined to approximately 2.0°C in mid-January 2012, exhibiting a near sinusoidal pattern of higher summer and lower winter temperatures. A similar pattern, albeit shifted in time, can be distinguished in monitoring wells that are located downgradient of this monitoring station. For example, a peak temperature of 9.7°C was recorded in DH10-05s on September 4, 2011 (33 day time lag) and then a peak temperature of 9.2°C was observed in DH10-01s (59 day time lag). This temperature pattern is most likely associated with advective heat transport from this reach of McNab Creek in a south direction and towards WC 2. The warmer creek water entering the aquifer in the general vicinity of station MC-US is flowing south towards WC 2.

The temperature data was also used to calculate bulk hydraulic conductivity of the valley fill aquifer between well DH10-5s and McNab Creek to the north. Utilizing the methodology presented by Constantz and Thomas (1996) and considering that the average hydraulic gradient measured between station MC-US and DH10-05s of 2.9% throughout September 2011, this bulk hydraulic conductivity was calculated to be about  $7 \times 10^{-4}$  m/s. This value, which falls within the range of hydraulic conductivity estimated for the upper portion of the aquifer based on single-well-response testing and grain size analysis (Figure 10) further supports the interpretation that McNab Creek provides significant recharge to the valley fill aquifer. Overall, majority of this recharge is expected to enter the underlying aquifer in the north portion of the alluvial fan and the segment of McNab Creek that is oriented in the west-east direction.

### 3.4 Tidal Influence and Saltwater Intrusion

Small diurnal fluctuations that correlate with tidal trends can be discerned in the groundwater elevation data for the three monitoring wells located closest to the marine foreshore. These include MW05-5 and both the shallow and deep standpipes in DH10-02 and DH10-07. For example, groundwater elevation increased in MW05-5 on August 12, 2010 by approximately 0.1 m in response to the high tide elevation (i.e., 1.34 m) reported for this day.

On rare occasions between July and September of each monitoring year, tidal elevations exceeded groundwater elevations in DH10-07 (shallow and deep) and MW05-5 during high tide (Attachment B). During these high tide intervals, there is an inferred northward gradient between the tidal regime and the inland groundwater regime in the immediate vicinity of the shoreline. However, the duration of the landward gradient is inherently less than the corresponding periods of southward gradient associated with lower tidal position. Accordingly, the net groundwater flow direction during the entire monitoring period is confirmed to be southward toward the marine foreshore, despite the observed tidal influence in the nearest monitoring wells.

In coastal setting, intrusion of saltwater into the near shore sediments is expected due to density difference between fresh groundwater originating from on-shore recharge sites and seawater. Monitoring data from three near-shore monitoring wells MW05-5, DH10-02 and DH10-07 indicated that the TDS in groundwater samples

obtained from these wells does not exceed 27 mg/L. Considering that the sea water typically has a TDS on the order of 35,000 mg/L the datapag from these wells indicates that the saltwater wedge, if present at this distance from the shoreline, is located at greater depths than approximately -30 m elevation. This observation is further supported by analytical calculations based on methodology presented in Domenico and Schwartz (1990) that show that, due to the relatively high groundwater flow in the alluvial sediments, the saltwater wedge could be depressed to the depth of the overburden/bedrock contact within 50 m to 150 m of the ocean shore. The salt water interface will deflect groundwater flow in the sediments upwards towards discharge sites on the foreshore.

### 3.5 Site Conceptual Model

A conceptual hydrogeological model is a representation of the groundwater regime that organizes and simplifies the site hydrogeology, so that it can be modelled. The conceptual model must retain enough complexity such that it accounts, to the degree required to meet project objectives, for the groundwater flow behavior. The conceptual model is then used in the development of a numerical groundwater model of the site.

Figure 11 presents a schematic representation of the conceptual hydrogeological model used for the Project. Based on the information presented in the preceding sections, this model assumes that the unconsolidated sediments underlying the site form a relatively permeable unconfined aquifer. This valley fill aquifer is bounded at depth and laterally by bedrock and locally north of the site by glacial till, both of which are considered to be much less permeable than the aquifer. The hydraulic conductivity of the valley fill aquifer to a depth of approximately 20 m is inferred to be in the mid  $10^{-4}$  m/s range; whereas, at greater depth somewhat lower values are anticipated, likely in the low  $10^{-4}$  m/s range. Considering observations made during drilling and general depositional setting, the aquifer is likely anisotropic with vertical hydraulic conductivity less than horizontal.

Water table elevation and groundwater flow conditions in the valley fill aquifer are controlled by several hydrogeological boundaries. The dominant recharge source for this aquifer is McNab Creek, which appears to have good hydraulic connection to the aquifer and is a losing stream. Other sources of recharge include inputs from direct precipitation, run-off from bedrock slopes west of the aquifer, and inflow from bedrock at depth. The main discharge from this aquifer is occurring to Howe Sound, WC 2, and possibly the lower reaches of McNab Creek and other minor surface water features adjacent to the ocean shoreline. These hydrogeological boundaries result in the groundwater flow pattern that is generally from north to south, and converging near the site center where WC 2 is located. Due to seasonal variability in precipitation and McNab Creek stage, seasonal water table fluctuations are on the order of few meters; nevertheless, the overall groundwater flow pattern throughout the year is similar in the wet and dry seasons. Although the aquifer is bounded to the south by Howe Sound, the effects of ocean tides and saltwater intrusion are limited to the area in close proximity to the shoreline.

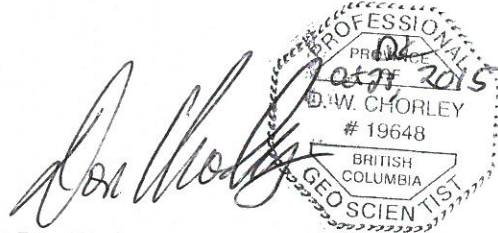
## 4.0 CLOSURE

We trust that the information presented in this technical memorandum is sufficient for your current requirements. Should you have any questions or require clarification, please do not hesitate to contact the undersigned at 604-296-4200.

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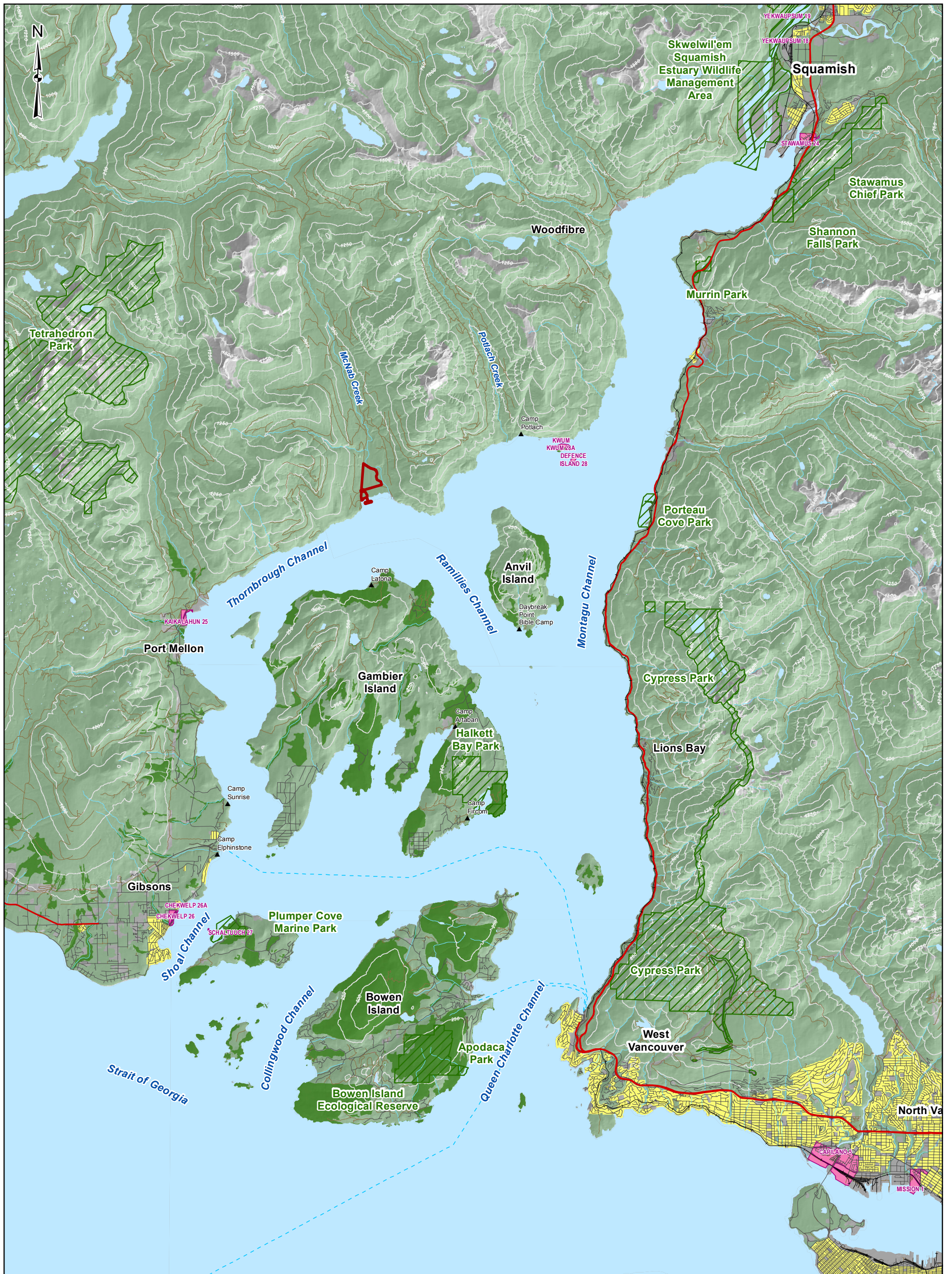
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Attachments: Figure 1 – Project Location  
Figure 2 – Groundwater and Surface Water Monitoring Network  
Figure 3 – Hydrogeological Cross Section Lines  
Figure 4 – Hydrogeological Cross Section A-A'  
Figure 5 – Hydrogeological Cross Section B-B'  
Figure 6 – Hydrogeological Cross Section C-C'  
Figure 7 – Hydrogeological Cross Section D-D'  
Figure 8 – Interpreted Water Table Contours (August 11, 2010)  
Figure 9 – Interpreted Water Table Contours (February 2012)  
Figure 10 – Summary of Hydraulic Conductivity Testing  
Figure 11 – Conceptual Hydrogeological Model

Attachment A – Hydraulic Conductivity Testing  
Attachment B – Hydraulic Head Monitoring  
Attachment C – Surface Water Level Monitoring  
Attachment D – Groundwater Temperature Monitoring  
Attachment E – Surface Water Temperature Monitoring

## 5.0 REFERENCES

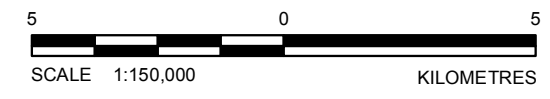
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- Golder. 2014. BURNCO Aggregate Project: Surface Water Hydrological Baseline (DRAFT). September 29, 2014. Submitted to BURNCO Rock Products Ltd.
- Maidment, David R. 1992. *Handbook of Hydrology*. McGraw-Hill, New York.
- Thurber Engineering Ltd. 2008. McNab Creek Gravel Deposit. April 24, 2008. Report to BURNCO Rock Products Ltd. 3 p. Appendices A, B, C and D.



Path: X:\Project Data\BC\MapNab\Figures\WXD\Hydrogeology\Appendix\_5.6A\BURNCO\_HYDROGEOLOGY\_Figure\_01\_Location\_of\_Burnco\_Aggregate\_Project.mxd

LEGEND	
	Project Area
	Park / Protected Area
	Sensitive Environmental Area
	Vegetation
	Indian Reserve
	Residential Area
	Waterbody
	Highway
	Road
	Resource Road
	Railway
	Watercourse
	Ferry
	Contour (250m)
	Camp

**REFERENCE**  
 Parks/protected areas and sensitive areas from the Province of British Columbia. Elevation and indian reserves from Geobase. Base data from CanVec. Projection: UTM Zone 10 Datum: NAD 83

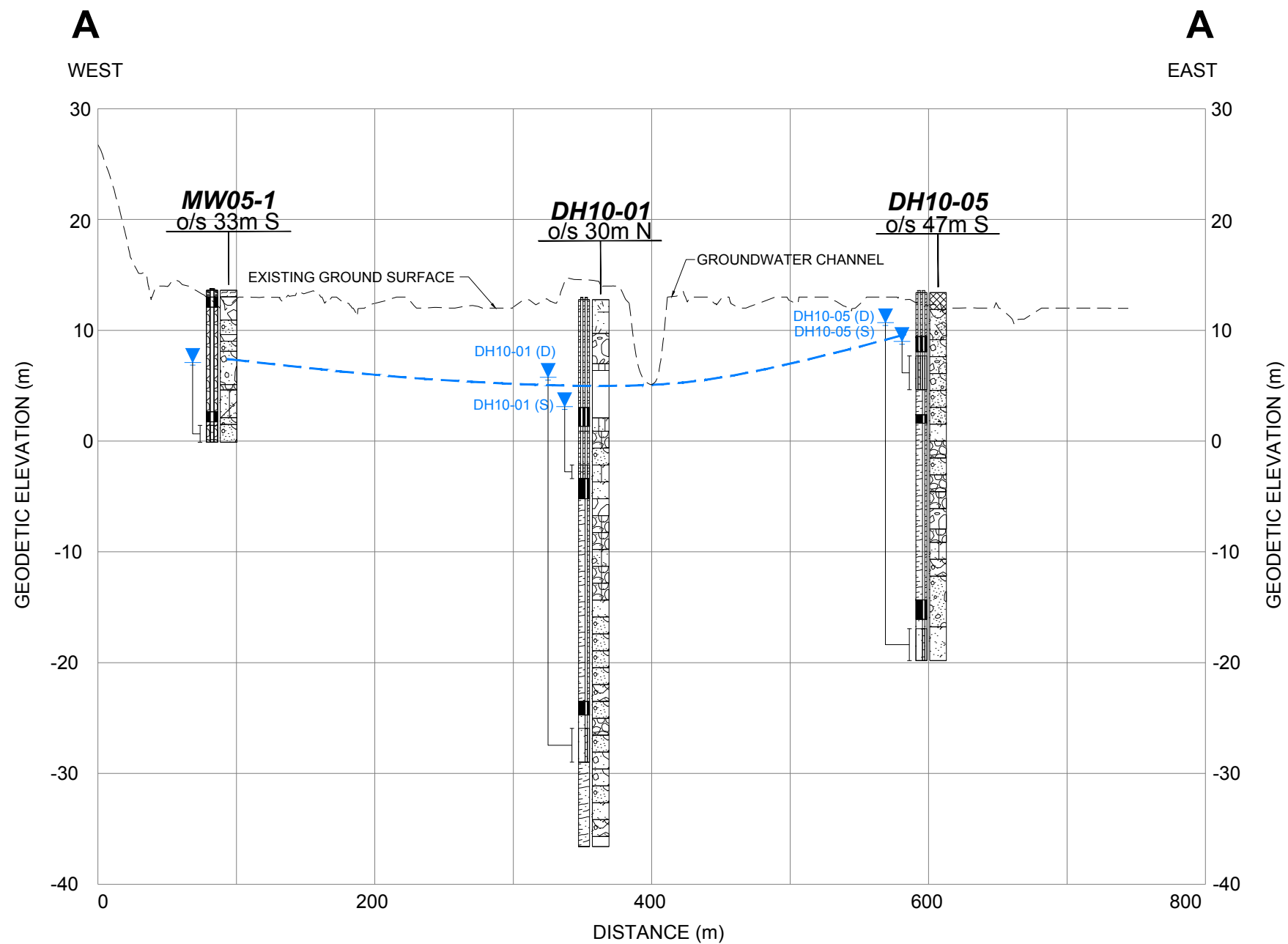


PROJECT		BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.	
TITLE		LOCATION OF BURNCO AGGREGATE PROJECT	
PROJECT NO. 11-1422-0046		PHASE No.	
DESIGN	MD	02 Nov. 2012	SCALE AS SHOWN
GIS	DL	10 Mar. 2016	REV. 5
CHECK	AS	10 Jun. 2014	<b>FIGURE 1</b>
REVIEW	AC	10 Jun. 2014	









**LEGEND**

- DH10-07** — DENOTES TEST HOLE
- o/s 5m N** — DENOTES OFFSET AND DIRECTION FROM CROSS SECTION LOCATION
- DENOTES SOIL STRATIGRAPHY OBSERVED AT TEST HOLE LOCATION
- DENOTES MONITORING WELL INSTALLATION(S)  
(FOR DETAILED DESCRIPTIONS OF SOIL STRATIGRAPHY AND MONITORING WELL INSTALLATIONS REFER TO RECORD OF BOREHOLE LOGS)
- DENOTES GROUNDWATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES MONITORING WELL SCREEN INTERVAL
- DENOTES SURFACE WATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES INTERPRETED WATER TABLE POSITION ON AUGUST 11TH, 2010.

**NOTES**

- 1) MONITORING WELL AND STAFF GAUGE ELEVATIONS (TIDAL DATUM) PROVIDED BY PETER M GORDON LAND SURVEYING INC.
- 2) WATER ELEVATIONS BASED ON MANUAL MEASURED OBTAINED AUGUST 11TH, 2010.

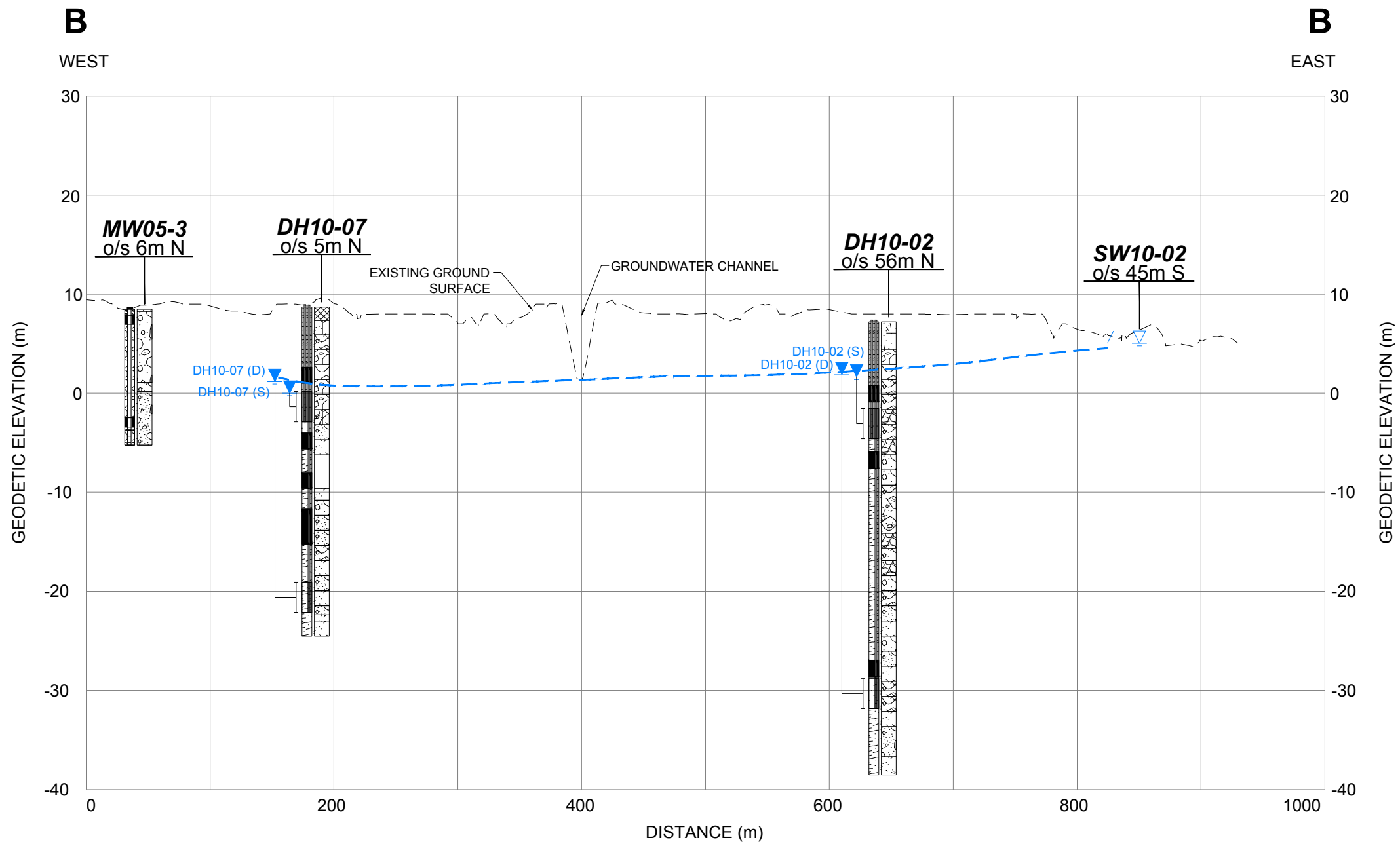


2013-02-13	ISSUED FOR DRAFT REPORT	MM	SSS	AM	WZ
REV	DATE	DES	CADD	CHK	RVW
PROJECT					
BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.					
TITLE					
<b>HYDROGEOLOGICAL CROSS SECTION A-A'</b>					
PROJECT No.	1114220046-4600	FILE No.	1114220046-4600-01		
DESIGN	MM	05OCT10	SCALE	AS SHOWN	
CADD	SSS	12OCT10			
CHECKED	AM	07FEB13			
REVIEW	WZ	08FEB13			



**FIGURE 4**

M:\Bor-Canada\Projects\2011\42211-1422-0046\Drawings\Phase 4600\114220046-4600-01.dwg | Layout: HYDROGEOLOGICAL CROSS SECTION A-A' | Modified: sarns 09/22/2014 11:32 AM | Plotted: sarns 09/22/2014



**LEGEND**

- DH10-07** — DENOTES TEST HOLE
- o/s 5m N** — DENOTES OFFSET AND DIRECTION FROM CROSS SECTION LOCATION
- DENOTES SOIL STRATIGRAPHY OBSERVED AT TEST HOLE LOCATION
- DENOTES MONITORING WELL INSTALLATION(S)  
(FOR DETAILED DESCRIPTIONS OF SOIL STRATIGRAPHY AND MONITORING WELL INSTALLATIONS REFER TO RECORD OF BOREHOLE LOGS)
- DENOTES GROUNDWATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES MONITORING WELL SCREEN INTERVAL
- DENOTES SURFACE WATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES INTERPRETED WATER TABLE POSITION ON AUGUST 11TH, 2010.

**NOTES**

- 1) MONITORING WELL AND STAFF GAUGE ELEVATIONS (TIDAL DATUM) PROVIDED BY PETER M GORDON LAND SURVEYING INC.
- 2) WATER ELEVATIONS BASED ON MANUAL MEASURED OBTAINED AUGUST 11TH, 2010.

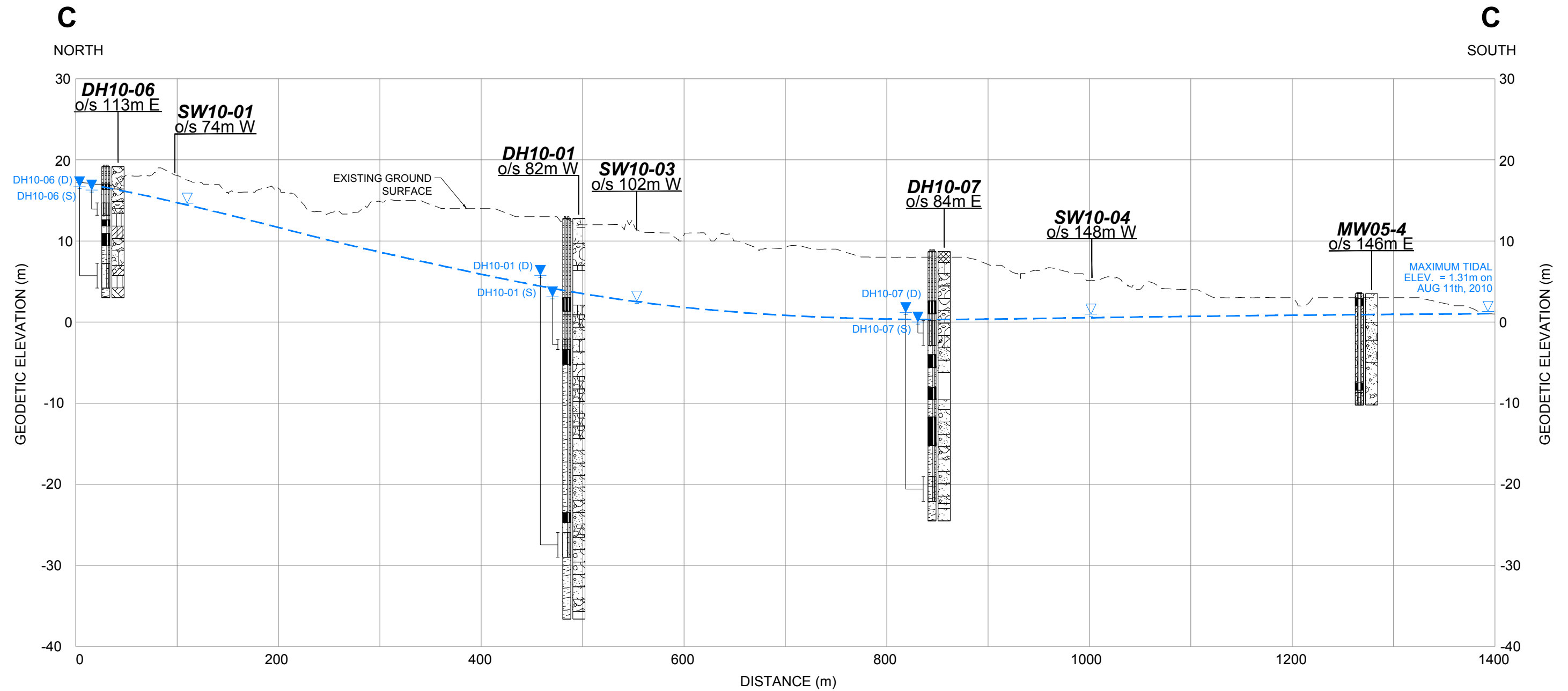


2013-02-13	ISSUED FOR DRAFT REPORT	MM	SSS	AM	WZ
REV	DATE	DES	CADD	CHK	RVW
PROJECT					
BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.					
TITLE					
<b>HYDROGEOLOGICAL CROSS SECTION B-B'</b>					
PROJECT No.	1114220046-4600	FILE No.	1114220046-4600-02		
DESIGN	MM	05OCT10	SCALE	AS SHOWN	
CADD	SSS	12OCT10			
CHECKED	AM	07FEB13			
REVIEW	WZ	08FEB13			



**FIGURE 5**

M:\Bor-Canada\Projects\2011\42211-1422-0046\Drawings - Phase 4600\114220046-4600-02.dwg | Layout: HYDROGEOLOGICAL CROSS SECTION B-B' | Modified: 09/22/2014 11:16 AM | Plotted: 09/22/2014



**LEGEND**

- DH10-07** o/s 5m N — DENOTES TEST HOLE
- DH10-07** o/s 5m N — DENOTES OFFSET AND DIRECTION FROM CROSS SECTION LOCATION
- DENOTES SOIL STRATIGRAPHY OBSERVED AT TEST HOLE LOCATION
- DENOTES MONITORING WELL INSTALLATION(S)  
(FOR DETAILED DESCRIPTIONS OF SOIL STRATIGRAPHY AND MONITORING WELL INSTALLATIONS REFER TO RECORD OF BOREHOLE LOGS)
- DENOTES GROUNDWATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES MONITORING WELL SCREEN INTERVAL
- DENOTES SURFACE WATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES INTERPRETED WATER TABLE POSITION ON AUGUST 11TH, 2010.

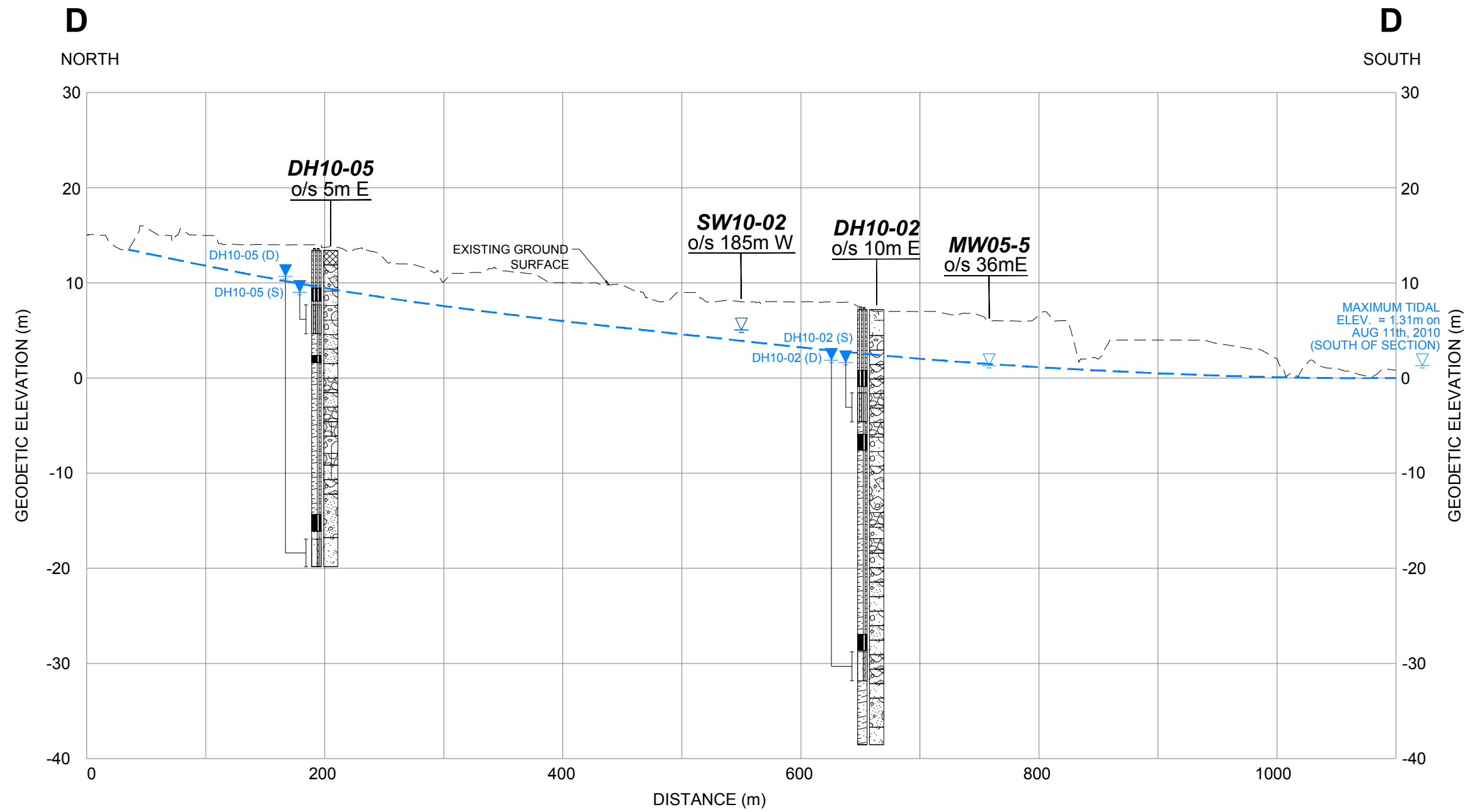
**NOTES**

- 1) MONITORING WELL AND STAFF GAUGE ELEVATIONS (TIDAL DATUM) PROVIDED BY PETER M GORDON LAND SURVEYING INC.
- 2) WATER ELEVATIONS BASED ON MANUAL MEASURED OBTAINED AUGUST 11TH, 2010.



REV	DATE	REVISION DESCRIPTION	MM	SSS	AM	WZ
			DES	CADD	CHK	RVW
PROJECT						
BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.						
TITLE						
<b>HYDROGEOLOGICAL CROSS SECTION C-C'</b>						
PROJECT No. 1114220046-4600			FILE No. 1114220046-4600-03			
DESIGN	MM	05OCT10	SCALE AS SHOWN			
CADD	SSS	12OCT10				
CHECKED	AM	07FEB13				
REVIEW	WZ	08FEB13				
						<b>FIGURE 6</b>

M:\Bor-Cambria\Projects\2011\42211-1422-0046\Drafting - Phase 4600\114220046-4600-03.dwg | Layout: HYDROGEOLOGICAL CROSS SECTION C-C' | Modified: 09/22/2014 11:33 AM | Plotter: scone 09/22/2014



**LEGEND**

- DH10-07** — DENOTES TEST HOLE
- o/s 5m N** — DENOTES OFFSET AND DIRECTION FROM CROSS SECTION LOCATION
- DENOTES SOIL STRATIGRAPHY OBSERVED AT TEST HOLE LOCATION
- DENOTES MONITORING WELL INSTALLATION(S)  
(FOR DETAILED DESCRIPTIONS OF SOIL STRATIGRAPHY AND MONITORING WELL INSTALLATIONS REFER TO RECORD OF BOREHOLE LOGS)
- DENOTES GROUNDWATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES MONITORING WELL SCREEN INTERVAL
- DENOTES SURFACE WATER MEASUREMENT ON AUGUST 11TH, 2010.
- DENOTES INTERPRETED WATER TABLE POSITION ON AUGUST 11TH, 2010.

**NOTES**

- 1) MONITORING WELL AND STAFF GAUGE ELEVATIONS (TIDAL DATUM) PROVIDED BY PETER M GORDON LAND SURVEYING INC.
- 2) WATER ELEVATIONS BASED ON MANUAL MEASURED OBTAINED AUGUST 11TH, 2010.



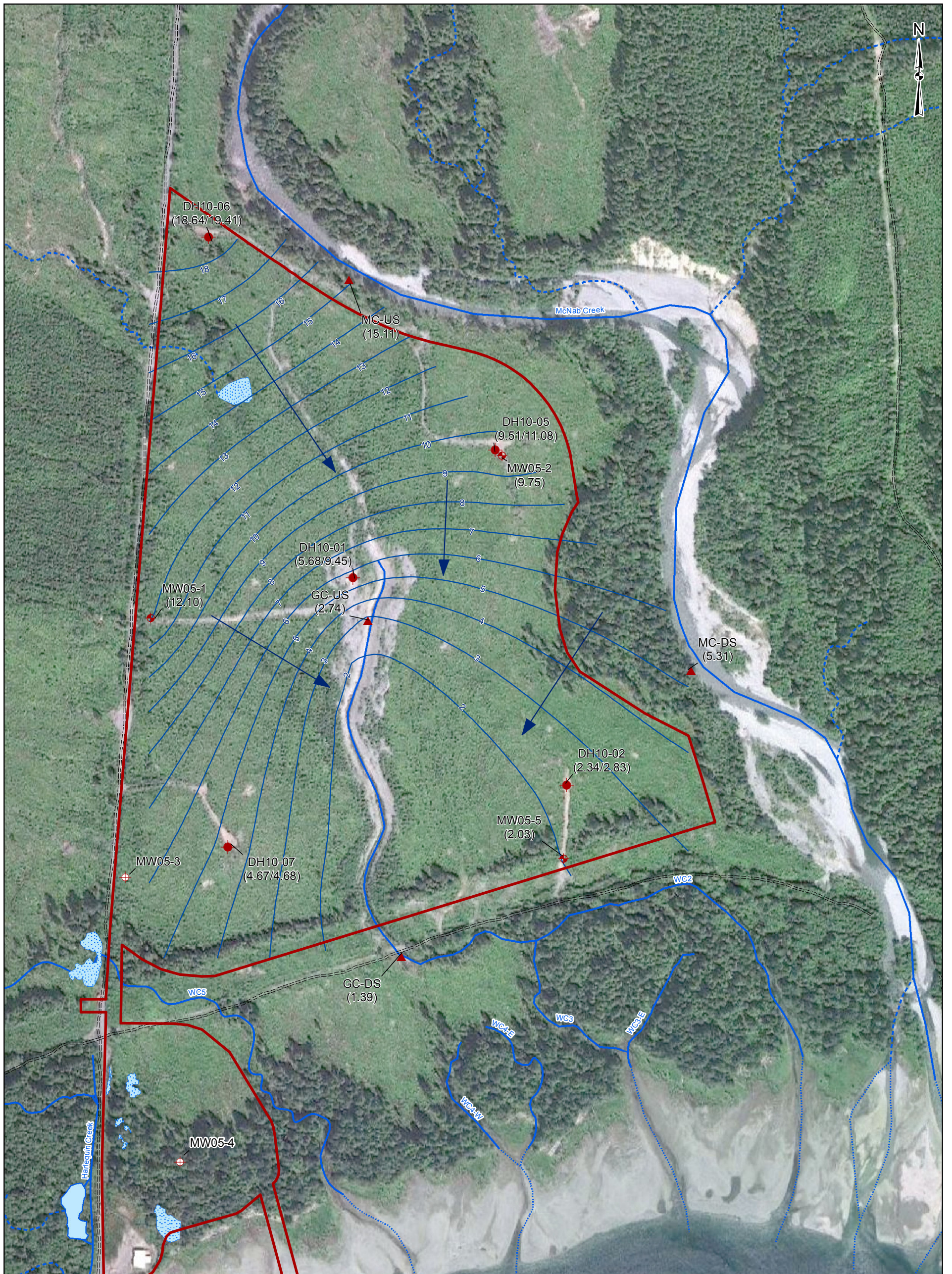
2013-02-13	ISSUED FOR DRAFT REPORT	MM	SSS	AM	WZ
REV	DATE	DES	CADD	CHK	RVW
PROJECT					
BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.					
TITLE					
HYDROGEOLOGICAL CROSS SECTION D-D'					
PROJECT No.	1114220046-4600	FILE No.	1114220046-4600-04		
DESIGN	MM	05OCT10	SCALE	AS SHOWN	
CADD	SSS	12OCT10			
CHECKED	AM	07FEB13			
REVIEW	WZ	08FEB13			



**FIGURE 7**

M:\Bor-Canada\Projects\2011\42211-1422-0046\Drawings - Phase 4600\114220046-4600-04.dwg | Layout: HYDROGEOLOGICAL CROSS SECTION D-D' | Modified: 09/22/2014 11:34 AM | Plotter: sarnie 09/22/2014





**LEGEND**

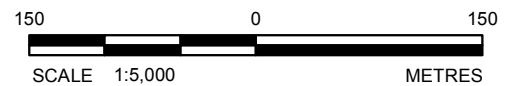
- ◆ Monitoring Well with Two Nested Standpipe Piezometers (Golder, 2010)
- ▲ Surface Water Monitoring Station (Golder, 2010)
- ◆ Monitoring Well with One Standpipe Piezometer (EBA, 2005)
- ⊕ Destroyed Monitoring Well (EBA, 2005) - Approximate location shown
- ▶ Interpreted Water Flow Direction
- Project Area
- Low Lying Wetted Area
- Beaver Impounded Wetted Area
- Interpreted Water Table Contour (m)
- Permanent / Perennial Watercourse
- Intermittent Watercourse
- Intertidal Watercourse
- Road (Existing)

DH10-01 — Well/Station Label  
 (5.68/9.45) — Deep Piezometer (if applicable)  
 — Shallow Piezometer

Water Elevations in Metres  
 Recorded Feb. 2, 2012.

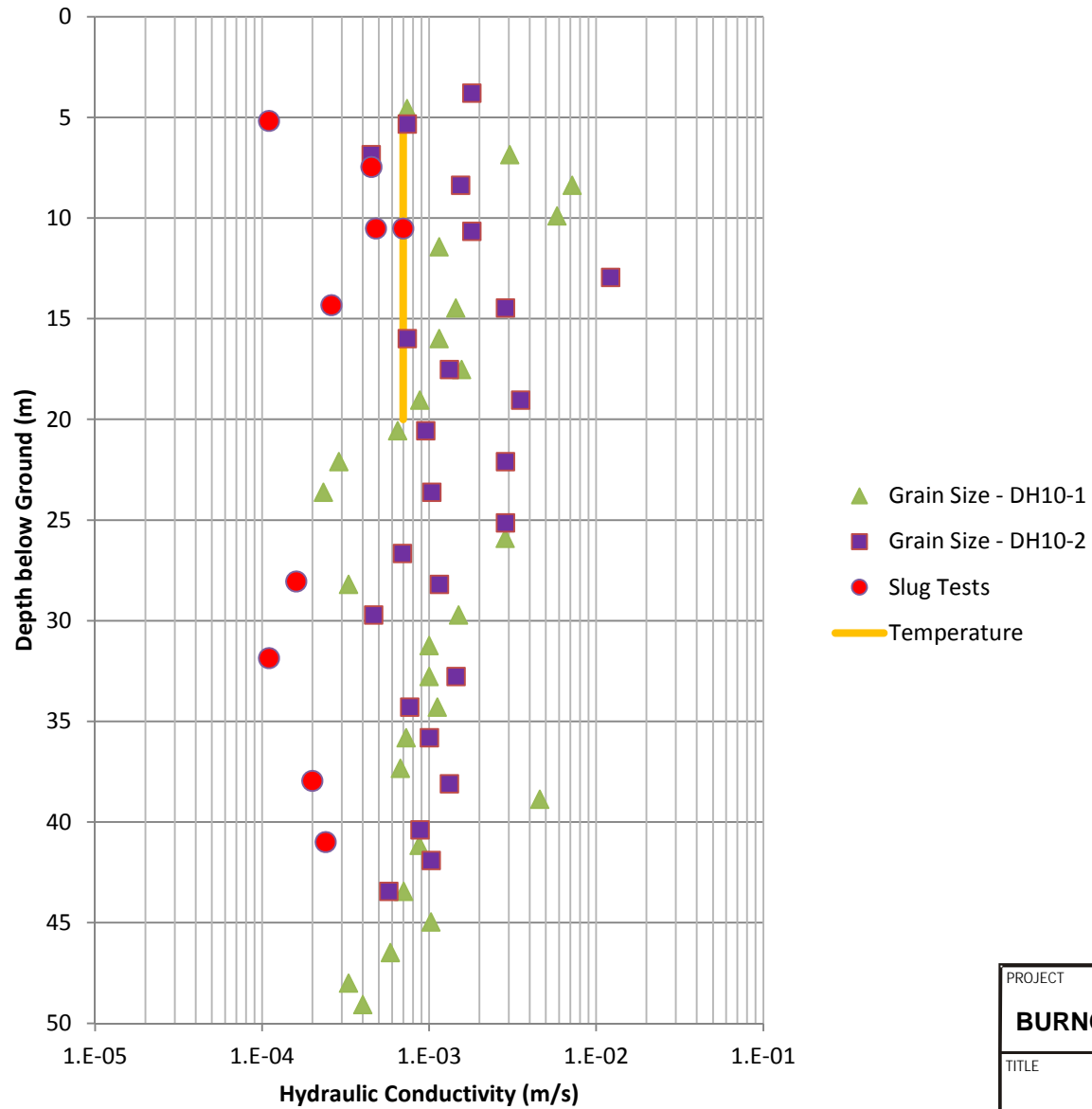
**REFERENCE**

Watercourses from the Province of British Columbia and field data. Base features from the Province of British Columbia. Additional detailed site features provided by McElhanney. Well locations surveyed by Peter Gordon Surveys. Base Imagery from Google Maps 20100807. Projection: UTM Zone 10 Datum: NAD 83



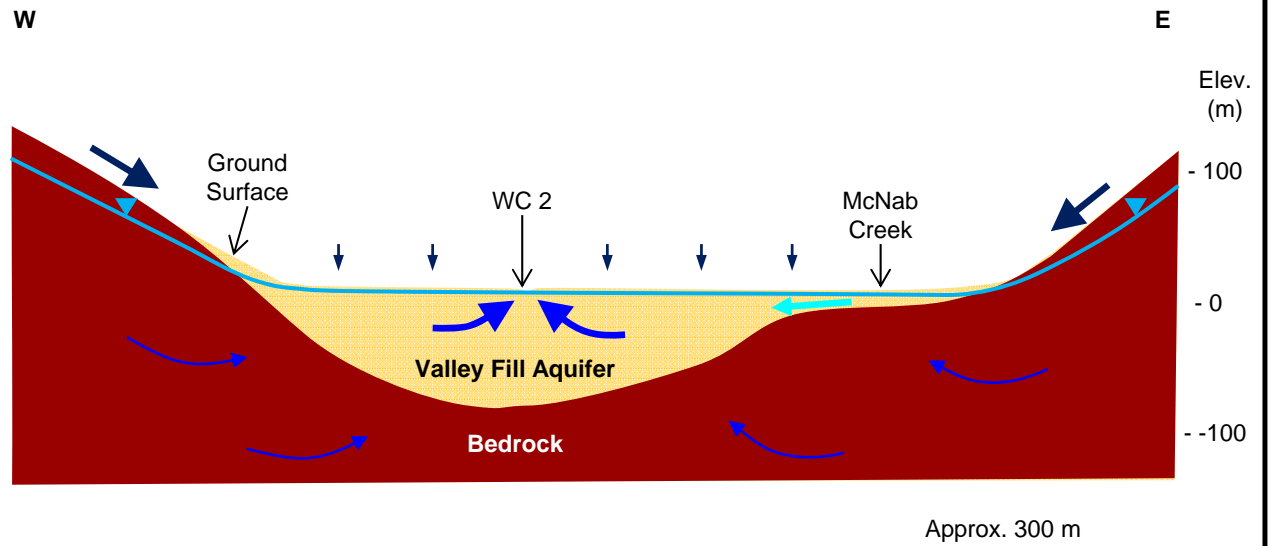
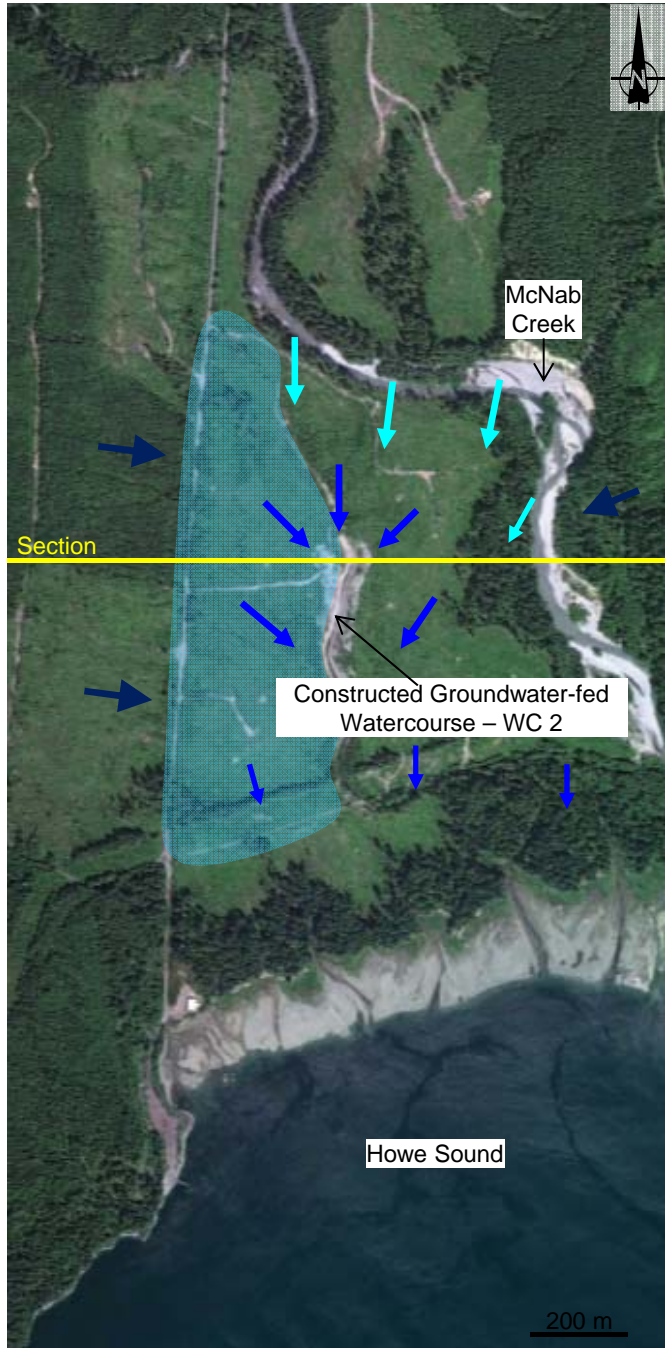
PROJECT		BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.	
TITLE		<b>INTERPRETED WATER TABLE CONTOURS FEB. 2, 2012</b>	
PROJECT NO. 11-1422-0046		PHASE No. 4600	
DESIGN	MM	05 Oct. 2010	SCALE AS SHOWN
GIS	DL	10 Mar 2016	REV. 1
CHECK	AM	07 Feb 2013	<b>FIGURE 9</b>
REVIEW	WZ	07 Feb 2013	





PROJECT						<b>BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.</b>					
TITLE											
<b>SUMMARY OF HYDRAULIC CONDUCTIVITY TESTING</b>											
PROJECT No. 11-1422-0046						PHASE No. 4600					
DESIGN	WZ	22OCT14	SCALE	As Shown	REV.						
CADD	WZ	22OCT14									
CHECK	DWC	22OCT14									
REVIEW	DWC	22OCT14	<b>FIGURE 10</b>								





**Legend**

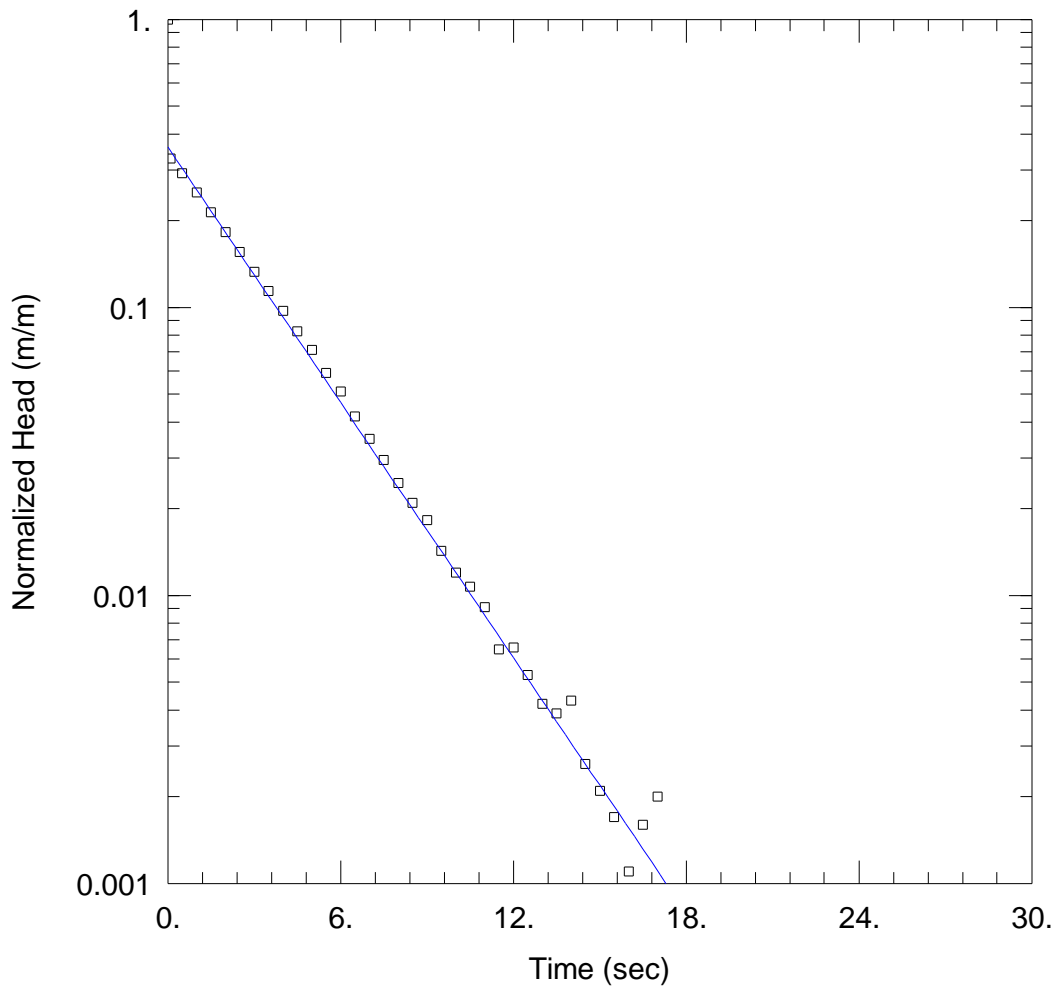
- Stream Loss
- Groundwater Flow Direction
- Direct Precipitation
- Run-off from Bedrock
- Area of Run-off Infiltration
- Watertable

PROJECT				
<b>BURNCO ROCK PRODUCTS LTD. BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.</b>				
TITLE				
<b>CONCEPTUAL HYDROGEOLOGICAL MODEL</b>				
PROJECT No. 11-1422-0046			PHASE No. 4600	
DESIGN	WZ	22OCT14	SCALE	As Shown REV.
CADD	WZ	22OCT14		
CHECK	DWC	22OCT14	<b>FIGURE 11</b>	
REVIEW	DWC	22OCT14		





**ATTACHMENT A**  
**Hydraulic Conductivity Testing**



WELL TEST ANALYSIS

Data Set: O:\...\MW5-2.aqt  
 Date: 02/07/13

Time: 14:35:42

PROJECT INFORMATION

Company: Golder Associates  
 Client: BURNCO  
 Project: 11-1422-0046  
 Location: McNab  
 Test Well: MW5-2  
 Test Date: 25/05/10

AQUIFER DATA

Saturated Thickness: 1.52 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW5-2)

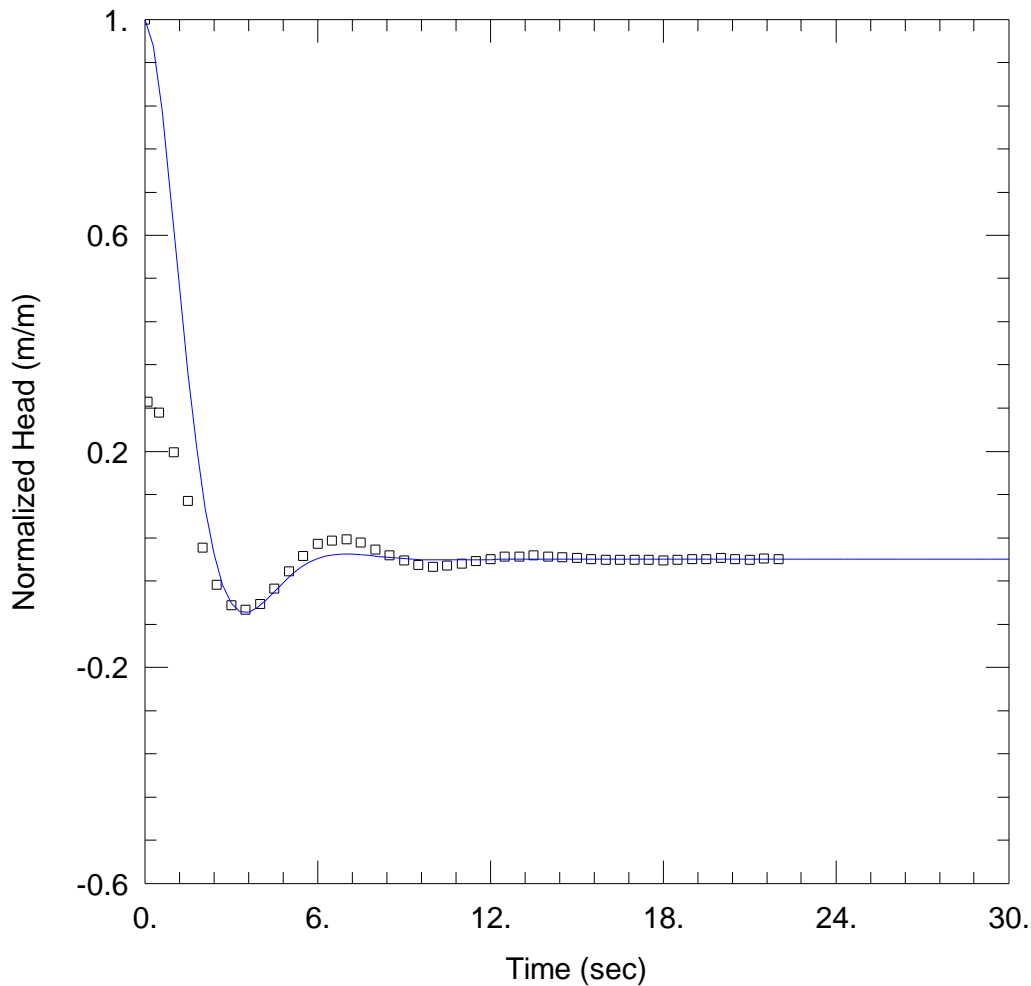
Initial Displacement: 1. m  
 Total Well Penetration Depth: 11.01 m  
 Casing Radius: 0.025 m

Static Water Column Height: 1. m  
 Screen Length: 1.52 m  
 Well Radius: 0.076 m

SOLUTION

Aquifer Model: Unconfined  
 K = 0.00023 m/sec

Solution Method: Bouwer-Rice  
 y0 = 0.36 m



### WELL TEST ANALYSIS

Data Set: O:\...\MW5-5.aqt

Date: 02/07/13

Time: 15:35:17

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: MW5-5

Test Date: 01/06/10

### AQUIFER DATA

Saturated Thickness: 0.375 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (MW5-5)

Initial Displacement: 0.493 m

Static Water Column Height: 10.31 m

Total Well Penetration Depth: 10.31 m

Screen Length: 1.52 m

Casing Radius: 0.025 m

Well Radius: 0.076 m

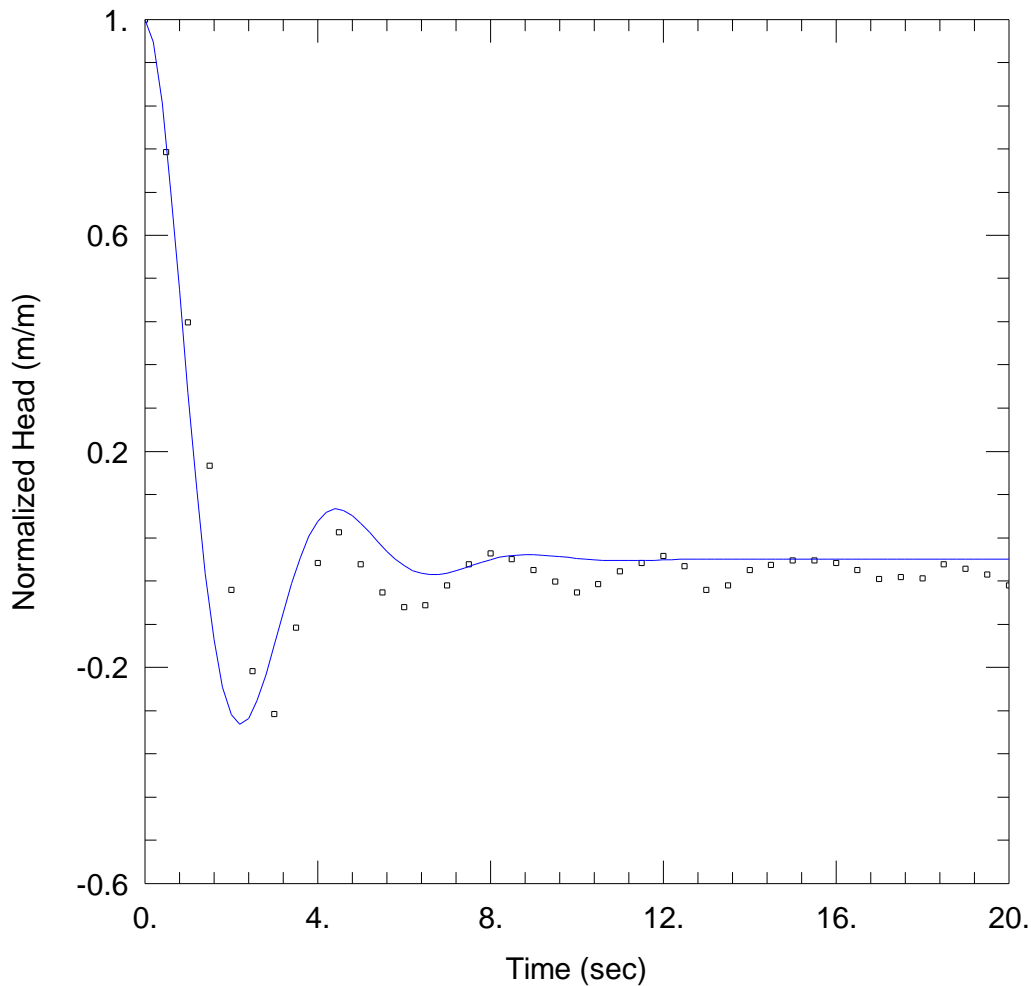
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 0.002 m/sec

Le = 7.8 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-01s.aqt

Date: 02/07/13

Time: 14:56:23

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-01 S

Test Date: 05/07/10

### AQUIFER DATA

Saturated Thickness: 5.71 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-01s)

Initial Displacement: 0.046 m

Static Water Column Height: 5.71 m

Total Well Penetration Depth: 5.71 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

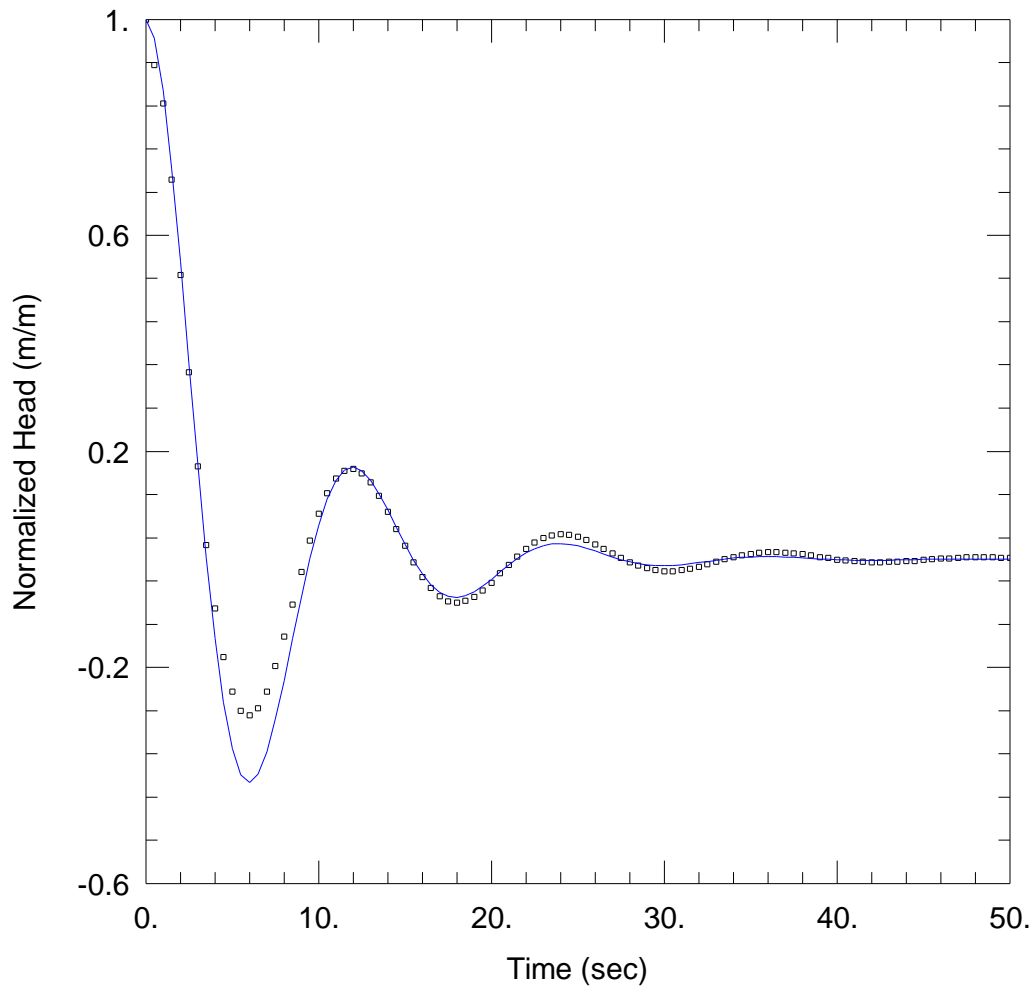
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 0.00026 m/sec

Le = 4.28 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-01d.aqt

Date: 02/07/13

Time: 14:55:40

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-01 D

Test Date: 05/07/10

### AQUIFER DATA

Saturated Thickness: 3.05 m

Anisotropy Ratio (Kz/Kr): 0.1

### WELL DATA (DH10-01d)

Initial Displacement: 2.54 m

Static Water Column Height: 35.35 m

Total Well Penetration Depth: 35.35 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

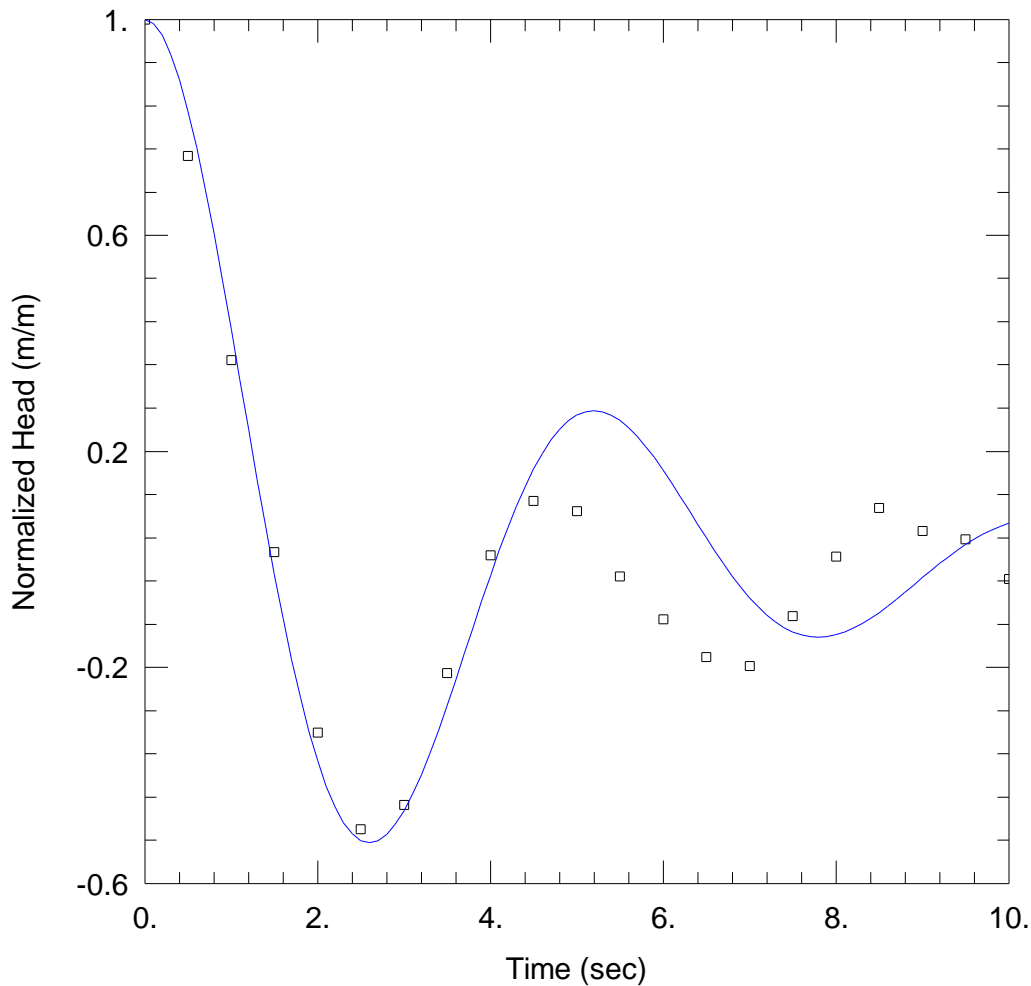
### SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 0.00024 m/sec

Le = 32.9 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-02s\_2.aqt

Date: 02/07/13

Time: 14:53:23

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-02 S

Test Date: 9/07/10

### AQUIFER DATA

Saturated Thickness: 8.5 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-02\_shallow)

Initial Displacement: 0.038 m

Static Water Column Height: 8.5 m

Total Well Penetration Depth: 8.5 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

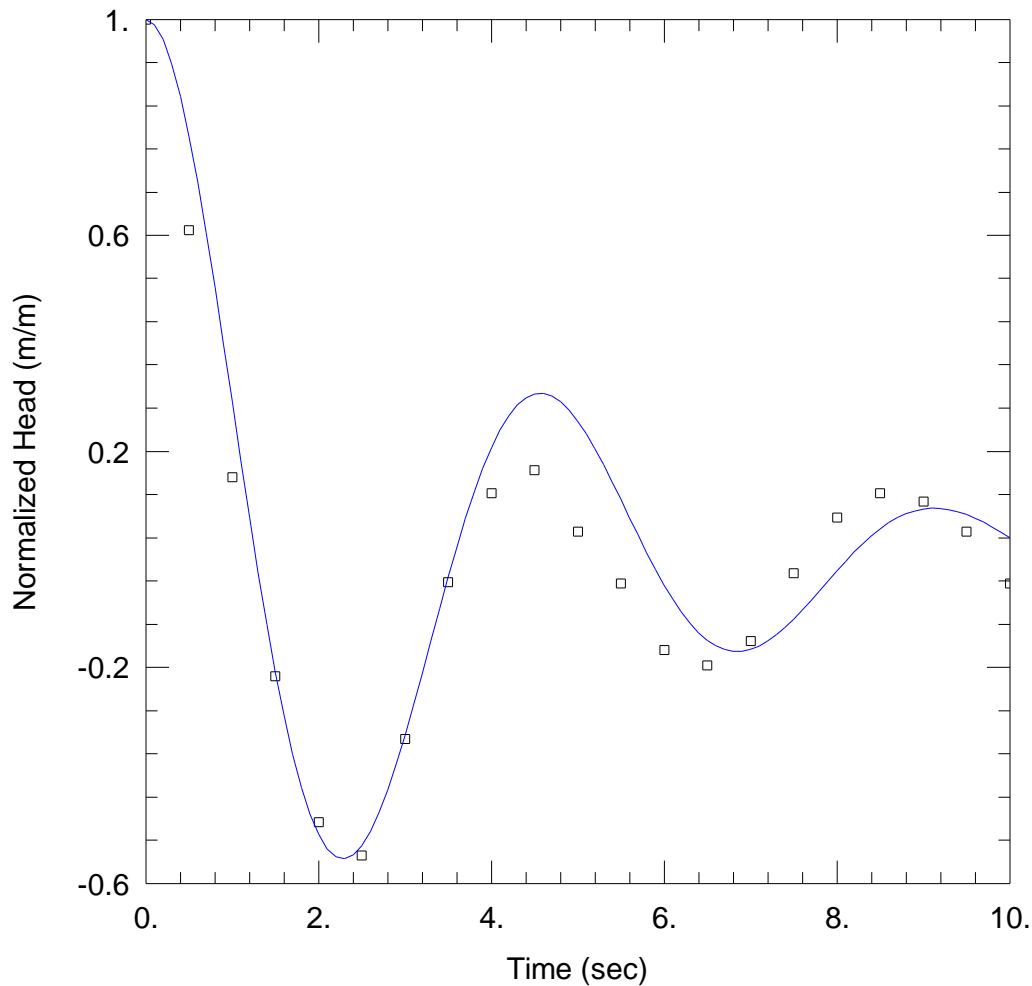
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 0.00042 m/sec

Le = 6.44 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-02s\_3.aqt

Date: 02/07/13

Time: 14:51:32

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-02 S

Test Date: 9/07/10

### AQUIFER DATA

Saturated Thickness: 8.5 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-02\_shallow)

Initial Displacement: 0.031 m

Static Water Column Height: 8.5 m

Total Well Penetration Depth: 8.5 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

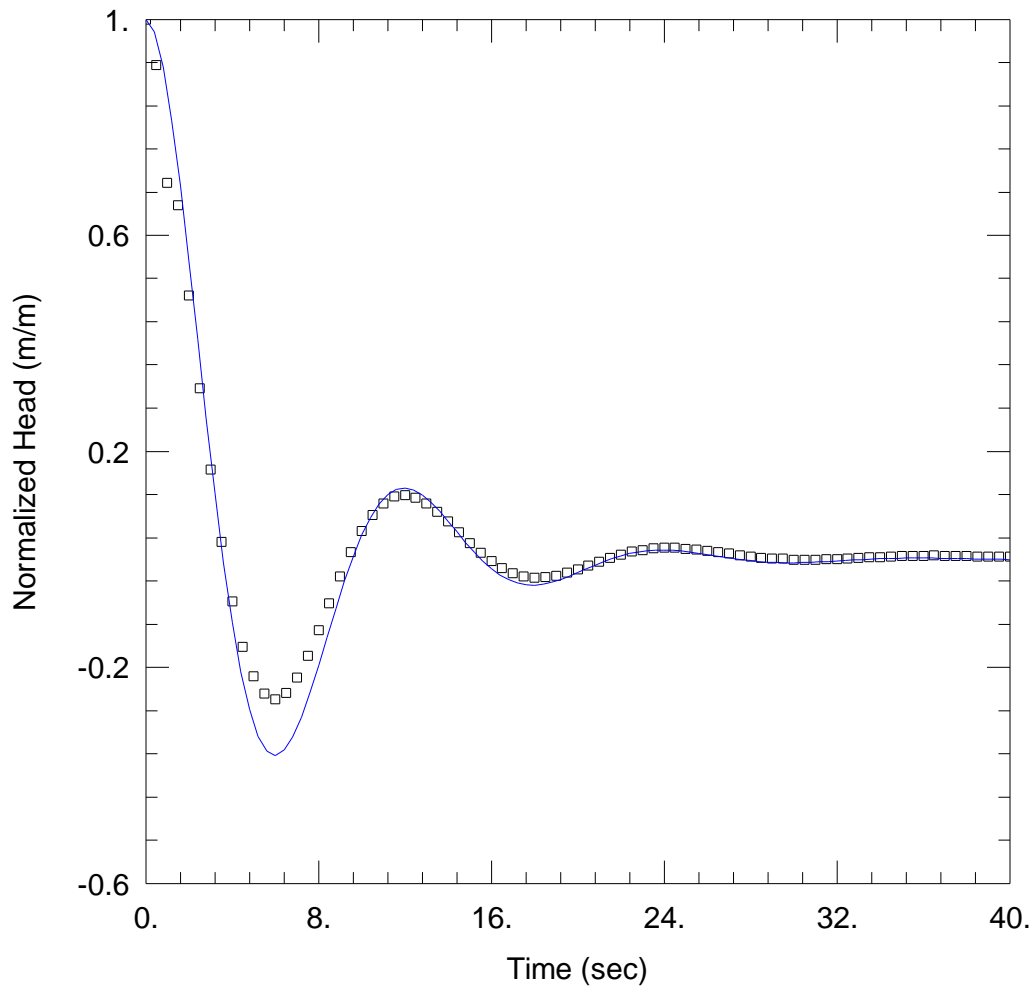
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 0.00053 m/sec

Le = 5. m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-02d.aqt

Date: 02/07/13

Time: 14:57:07

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-02 D

Test Date: 9/07/10

### AQUIFER DATA

Saturated Thickness: 3.05 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-02\_deep)

Initial Displacement: 1.5 m

Static Water Column Height: 33.71 m

Total Well Penetration Depth: 33.71 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

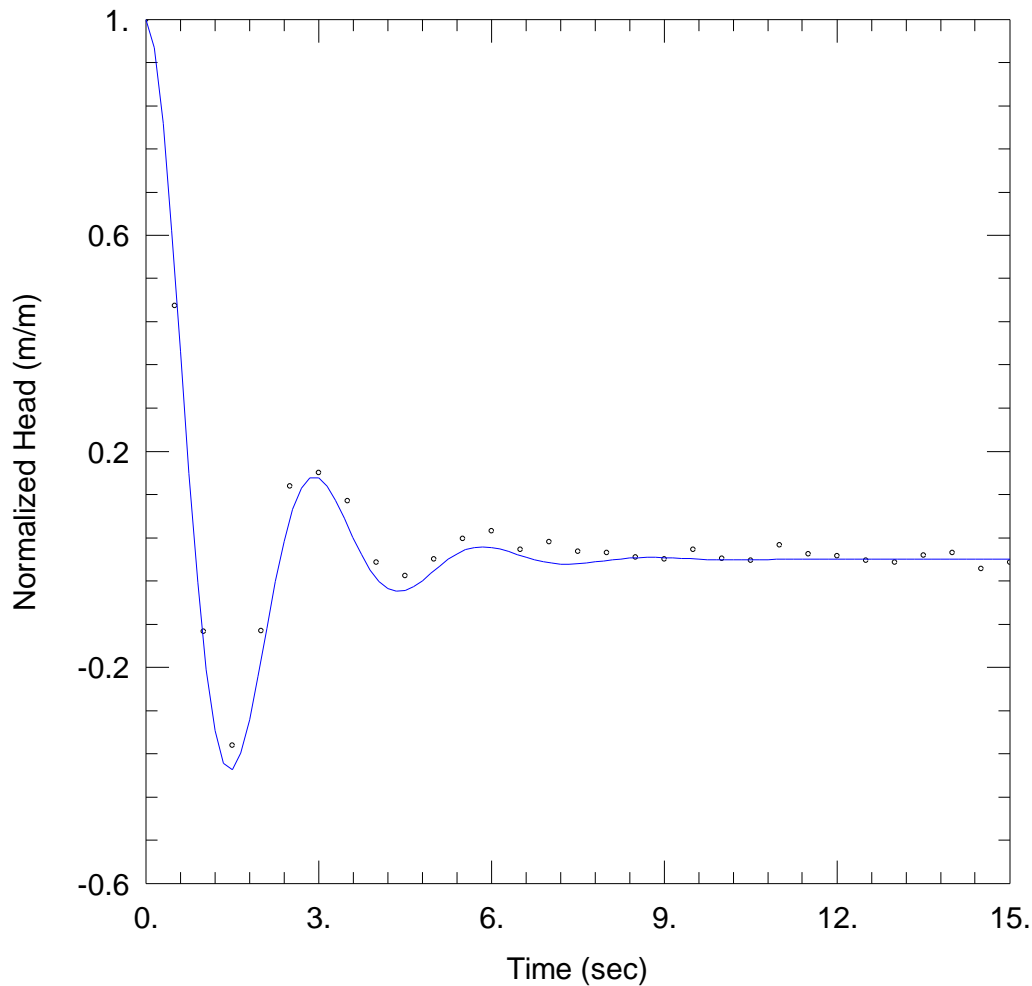
### SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 0.0002 m/sec

Le = 32.1 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-05s\_1.aqt

Date: 02/07/13

Time: 15:00:58

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-05 S

Test Date: 30/06/10

### AQUIFER DATA

Saturated Thickness: 4.41 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-05\_shallow)

Initial Displacement: 0.05 m

Static Water Column Height: 4.41 m

Total Well Penetration Depth: 4.41 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

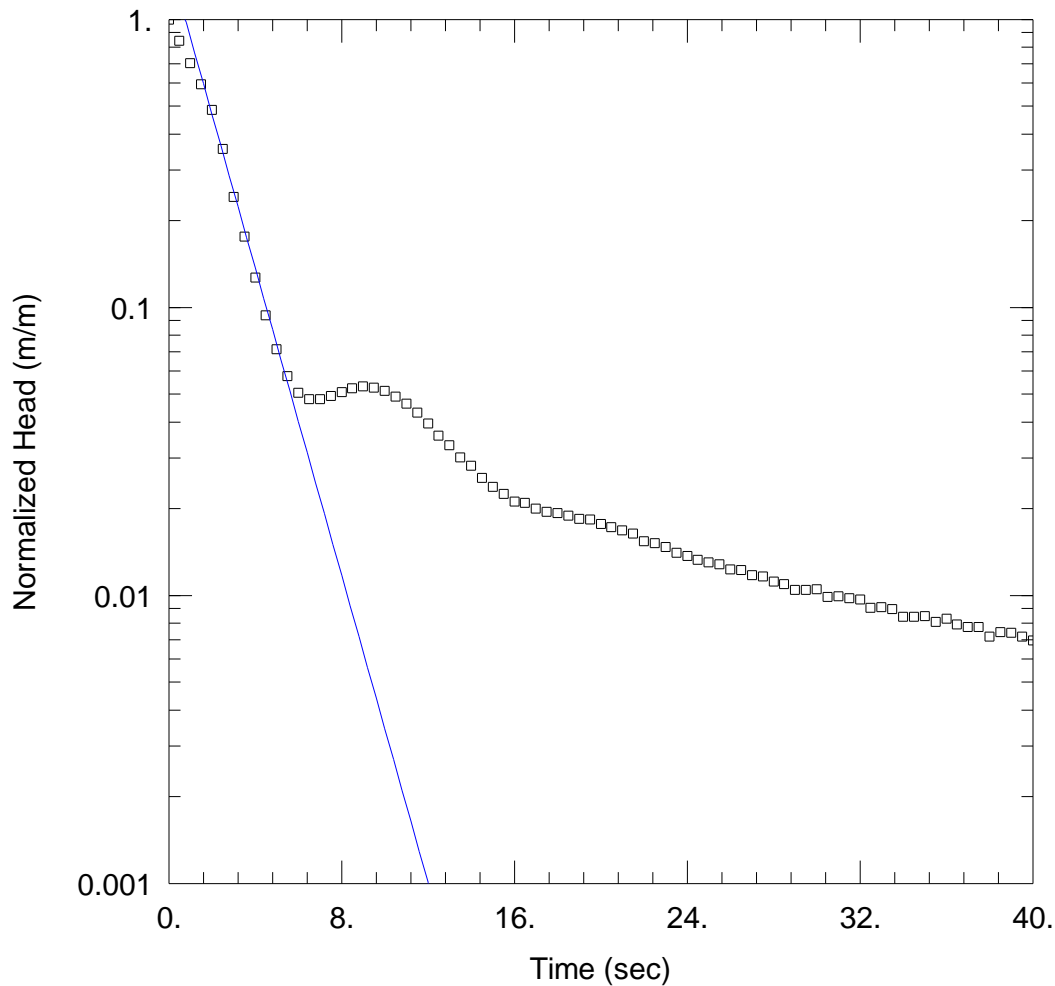
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 0.00045 m/sec

Le = 1.95 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-05d\_3.aqt

Date: 02/07/13

Time: 15:11:01

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-05 D

Test Date: 12/07/10

### AQUIFER DATA

Saturated Thickness: 3.05 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-05d)

Initial Displacement: 3.5 m

Static Water Column Height: 30.64 m

Total Well Penetration Depth: 30.64 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

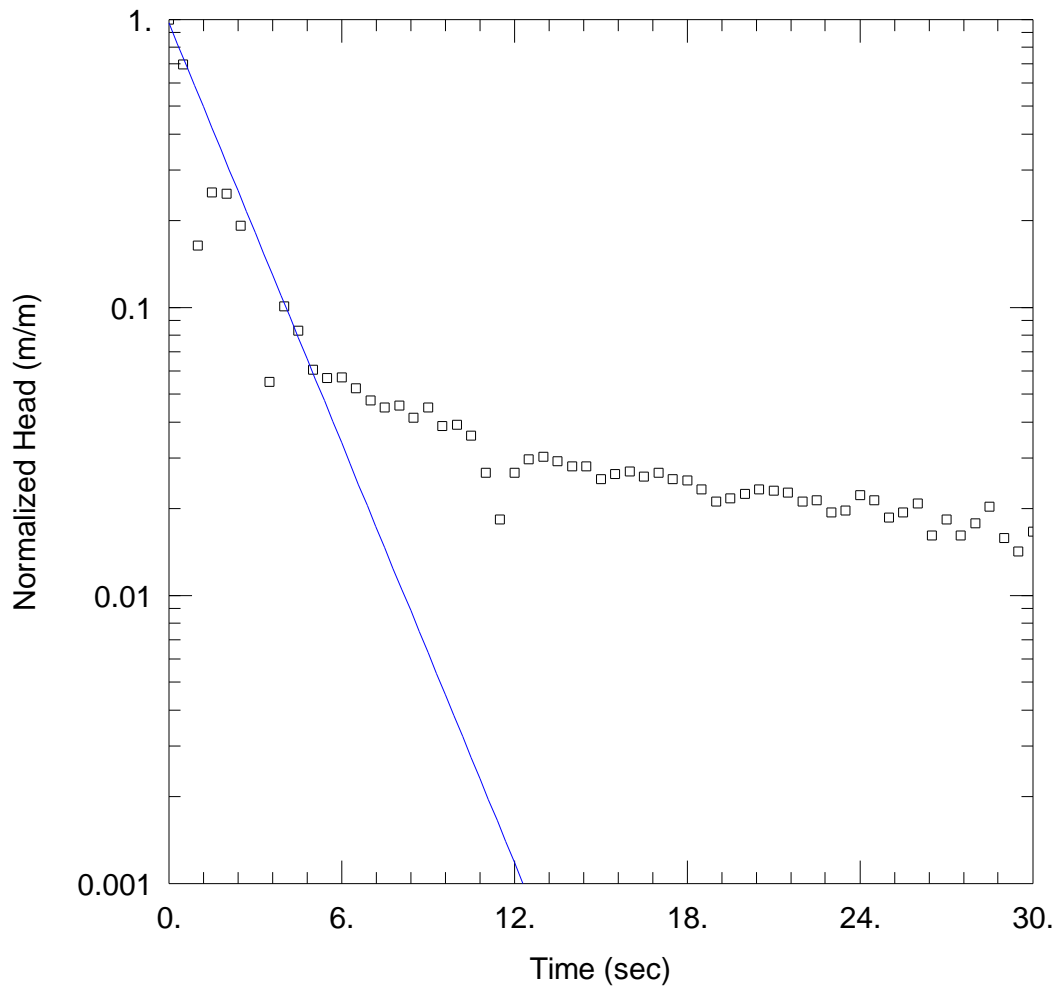
### SOLUTION

Aquifer Model: Confined

Solution Method: Hvorslev

K = 0.00012 m/sec

y0 = 5.6 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-06s.aqt

Date: 02/07/13

Time: 15:13:16

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-06 S

Test Date: 30/06/10

### AQUIFER DATA

Saturated Thickness: 3.23 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (New Well)

Initial Displacement: 0.36 m

Static Water Column Height: 3.23 m

Total Well Penetration Depth: 3.23 m

Screen Length: 1.52 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

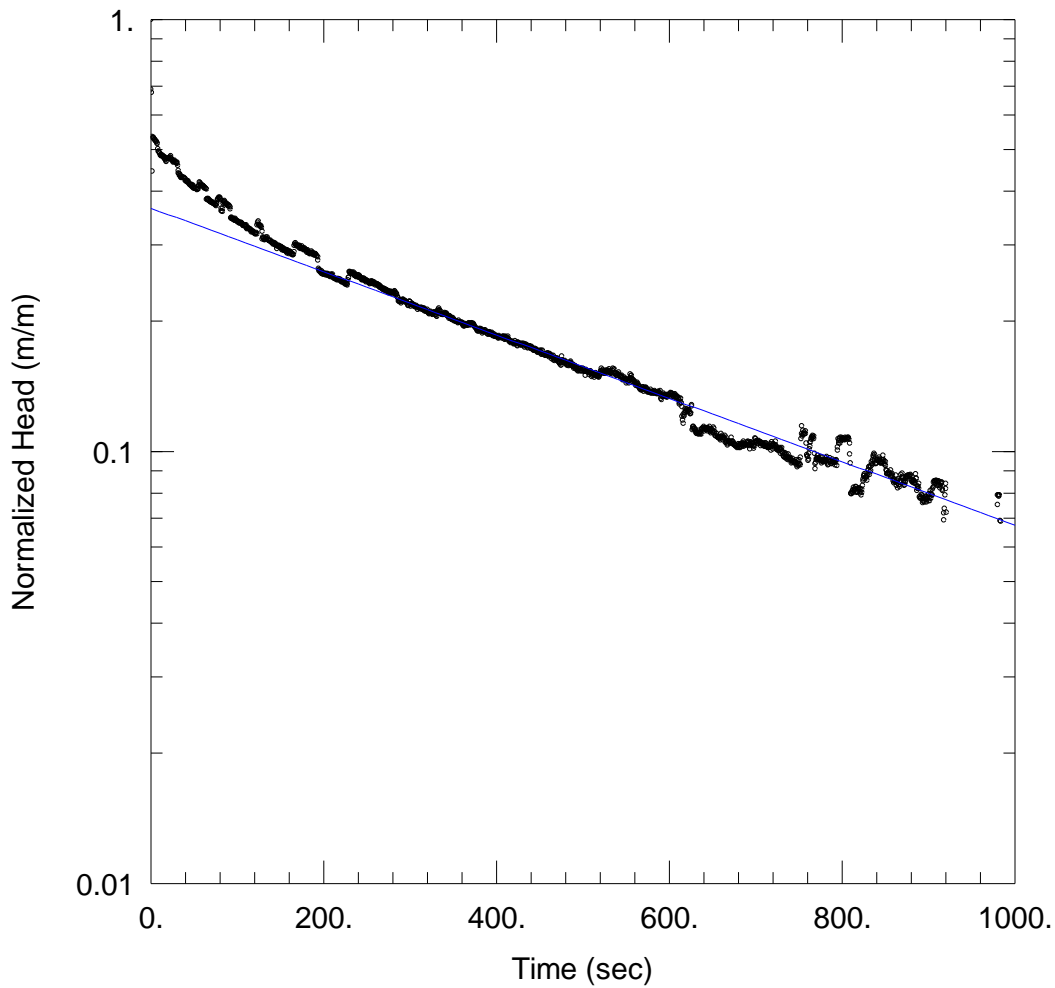
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.00011 m/sec

y0 = 0.35 m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-06d.aqt  
 Date: 02/07/13

Time: 15:16:23

### PROJECT INFORMATION

Company: Golder Associates  
 Client: BURNCO  
 Project: 11-1422-0046  
 Location: McNab  
 Test Well: DH10-06 D  
 Test Date: 30/06/10

### AQUIFER DATA

Saturated Thickness: 3.05 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-06d)

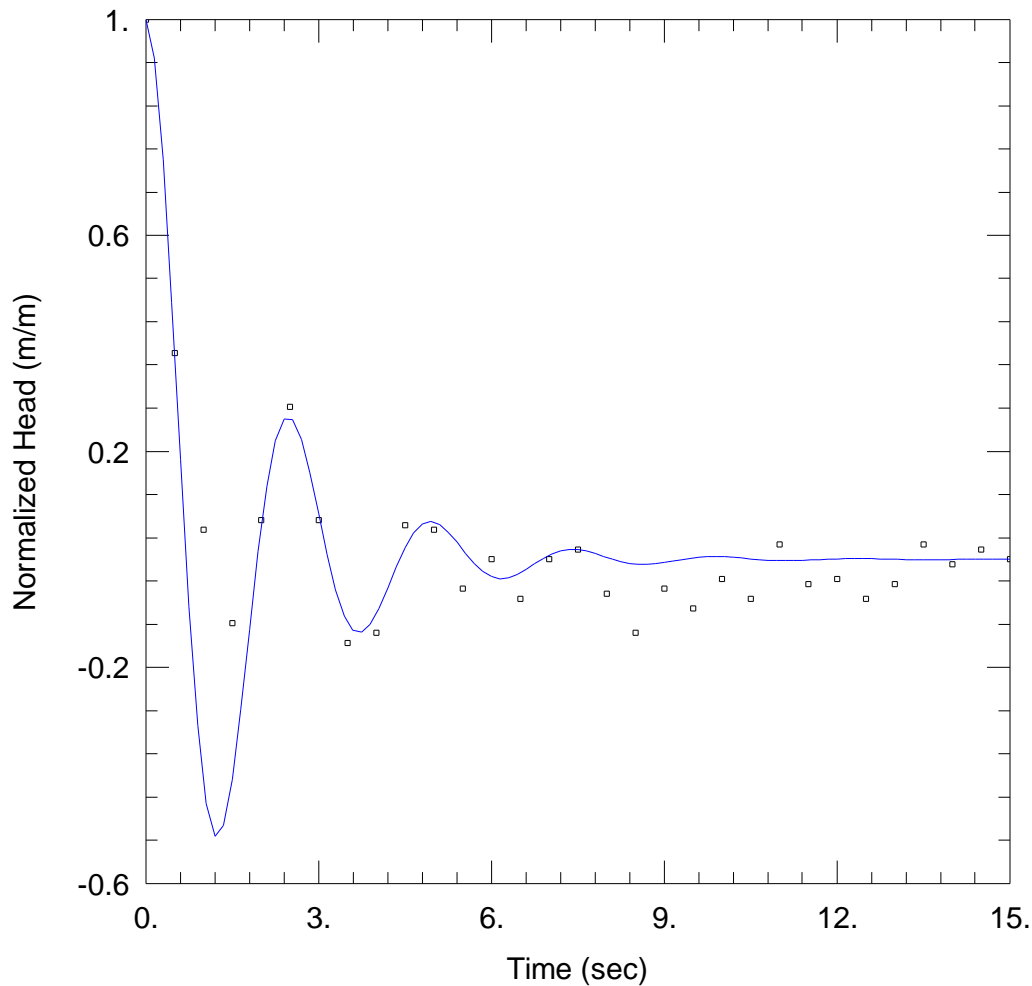
Initial Displacement: 0.52 m  
 Total Well Penetration Depth: 11.98 m  
 Casing Radius: 0.015 m

Static Water Column Height: 11.58 m  
 Screen Length: 3.05 m  
 Well Radius: 0.076 m

### SOLUTION

Aquifer Model: Confined  
 $K = 3.3E-7$  m/sec

Solution Method: Hvorslev  
 $y_0 = 0.19$  m



### WELL TEST ANALYSIS

Data Set: O:\...\DH10-07s.aqt

Date: 02/07/13

Time: 15:31:47

### PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-07 S

Test Date: 9/07/10

### AQUIFER DATA

Saturated Thickness: 3.82 m

Anisotropy Ratio (Kz/Kr): 1.

### WELL DATA (DH10-07\_shallow)

Initial Displacement: 0.011 m

Static Water Column Height: 3.82 m

Total Well Penetration Depth: 3.82 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

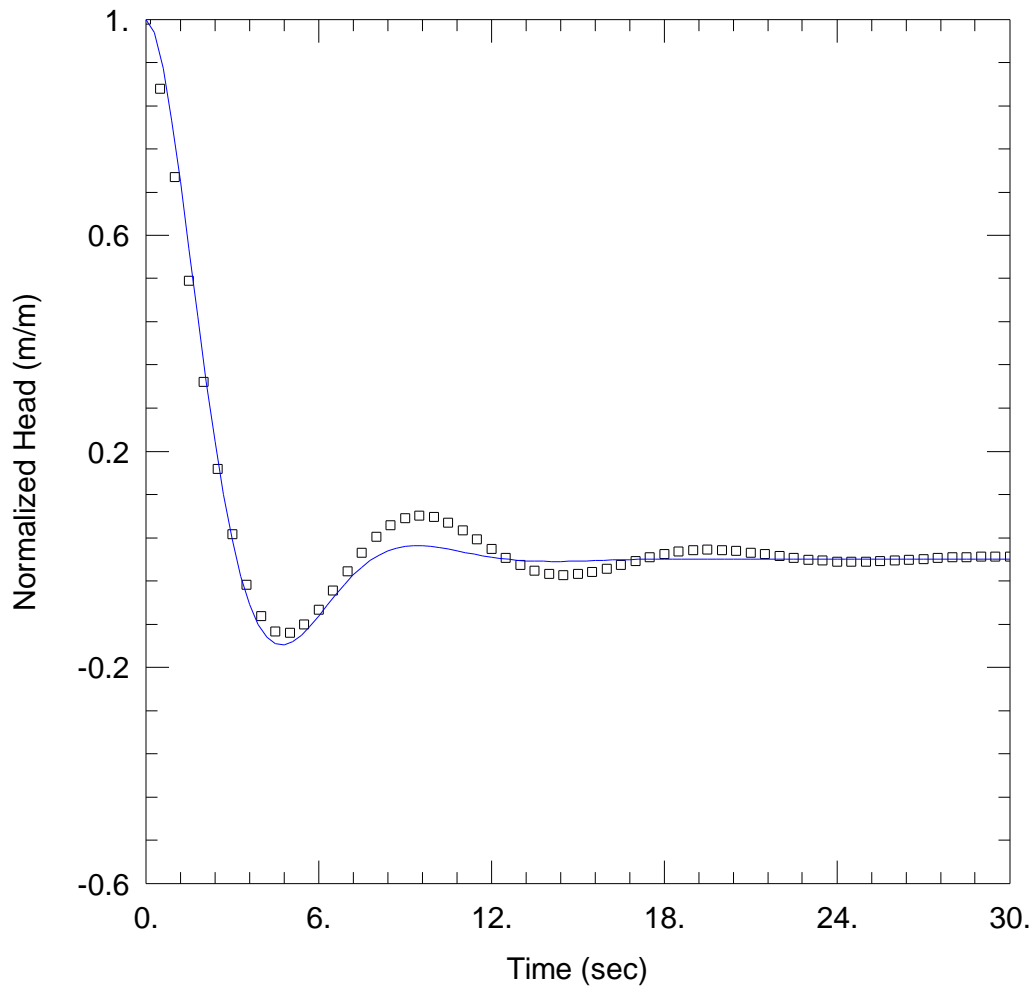
### SOLUTION

Aquifer Model: Unconfined

Solution Method: Springer-Gelhar

K = 0.0007 m/sec

Le = 1.45 m



WELL TEST ANALYSIS

Data Set: O:\...\DH10-07d.aqt

Date: 02/07/13

Time: 15:33:46

PROJECT INFORMATION

Company: Golder Associates

Client: BURNCO

Project: 11-1422-0046

Location: McNab

Test Well: DH10-07 D

Test Date: 05/07/10

AQUIFER DATA

Saturated Thickness: 3.05 m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (DH10-07d)

Initial Displacement: 2.59 m

Static Water Column Height: 23.11 m

Total Well Penetration Depth: 23.11 m

Screen Length: 3.05 m

Casing Radius: 0.015 m

Well Radius: 0.076 m

SOLUTION

Aquifer Model: Confined

Solution Method: Butler

K = 0.00016 m/sec

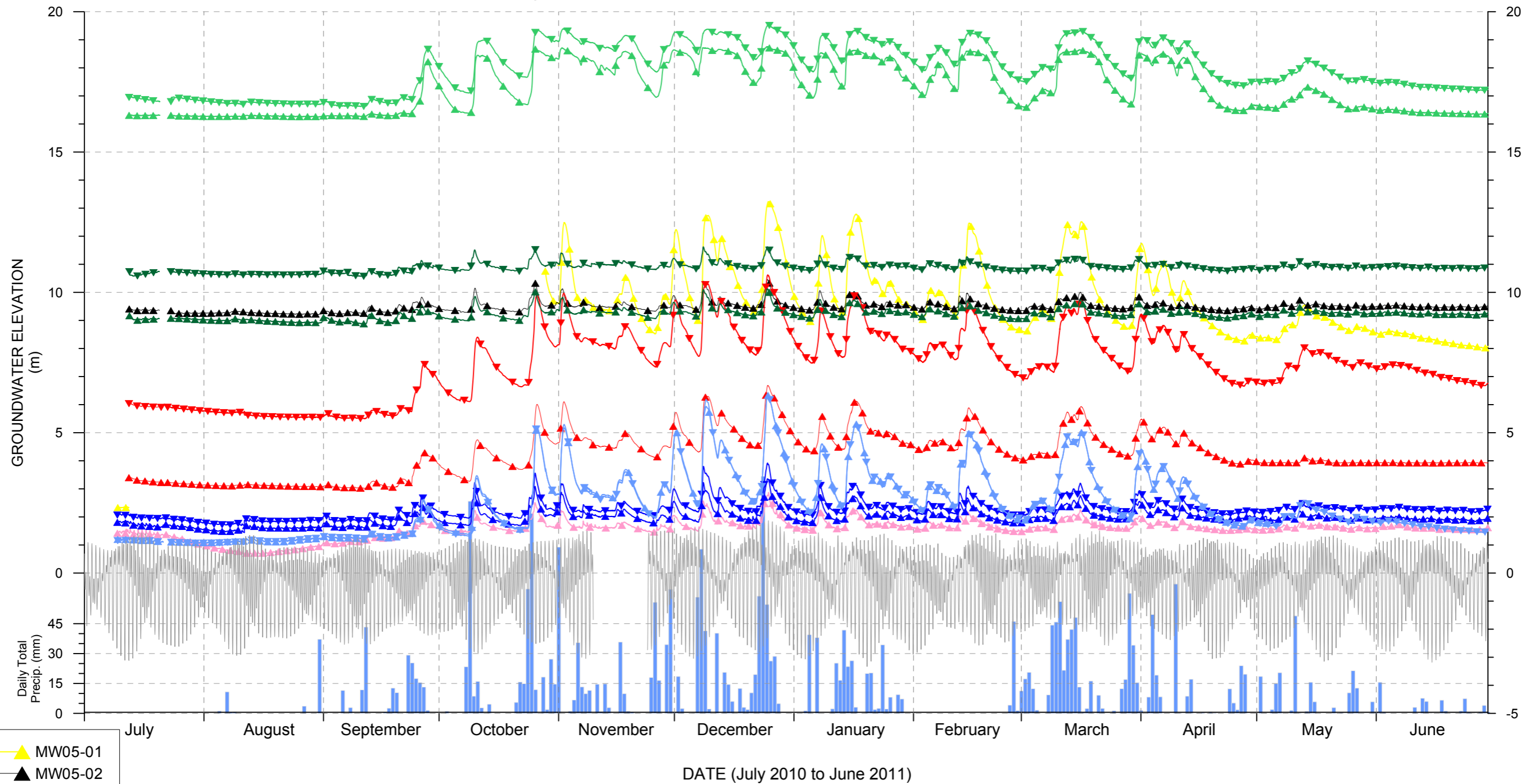
Le = 16.43 m



**ATTACHMENT B**  
**Hydraulic Head Monitoring**

# GROUNDWATER LEVEL MONITORING

July 2010 to June 2011



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

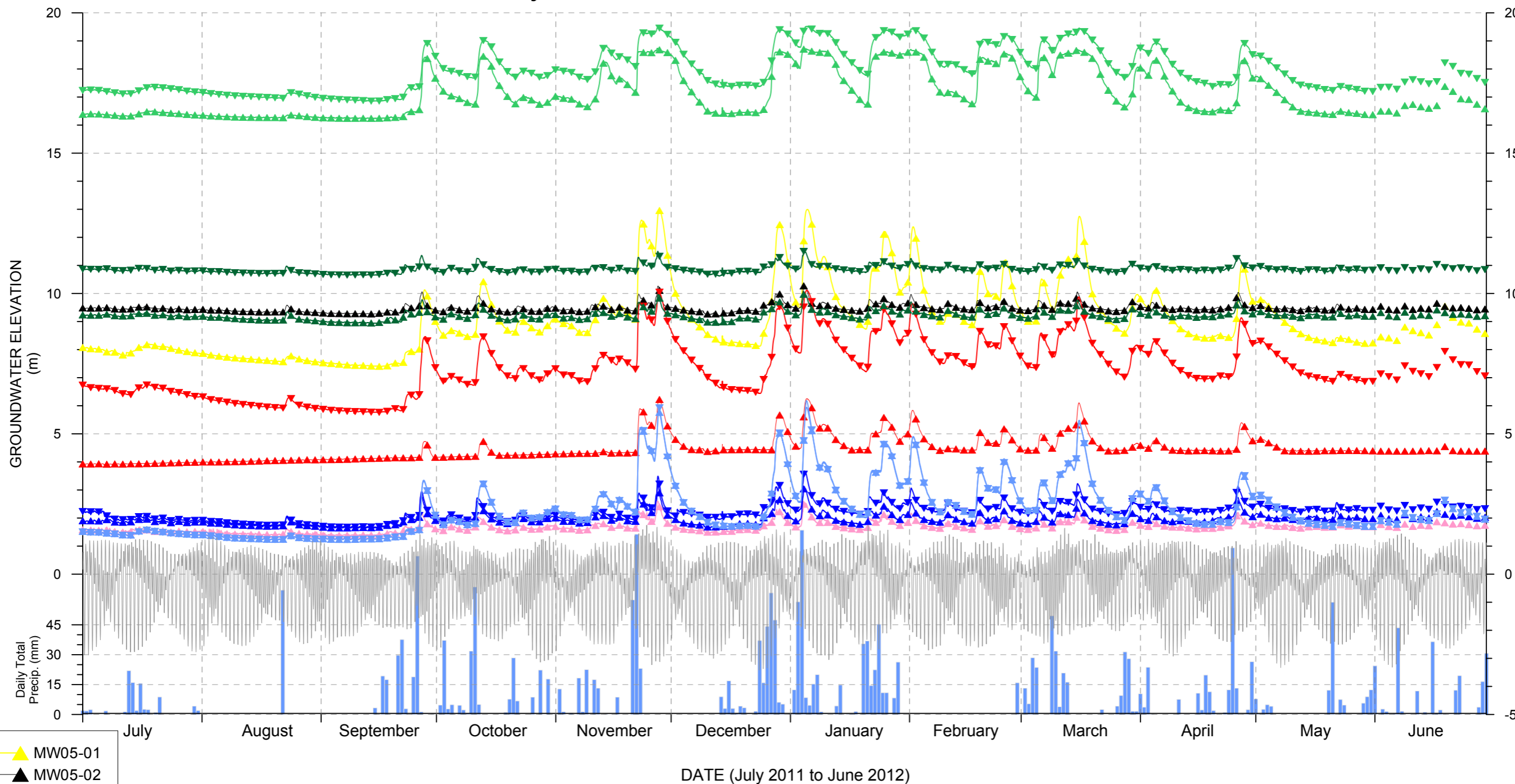


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

Fig. B1

# GROUNDWATER LEVEL MONITORING

July 2011 to June 2012



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

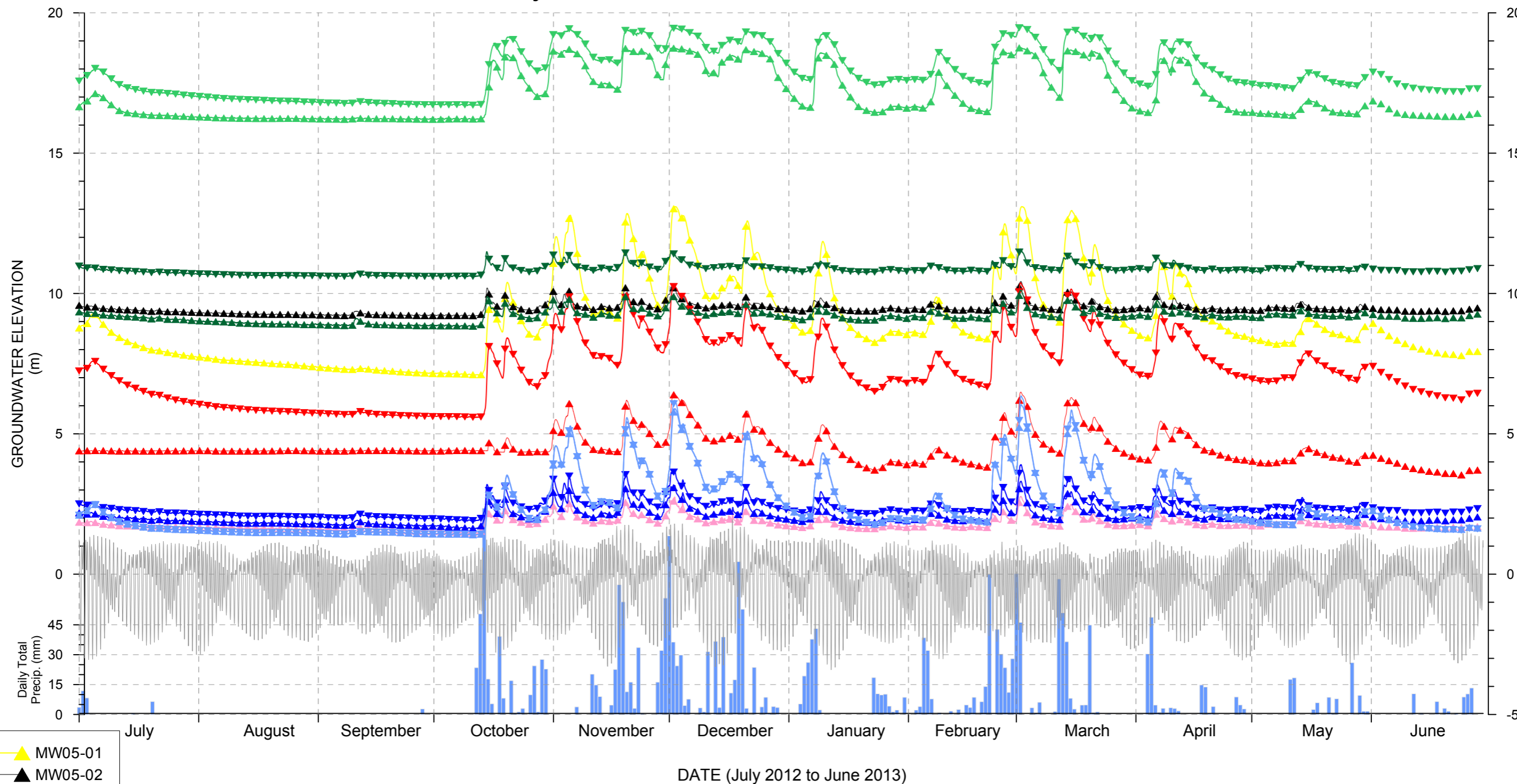


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

Fig. B2

# GROUNDWATER LEVEL MONITORING

July 2012 to June 2013



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

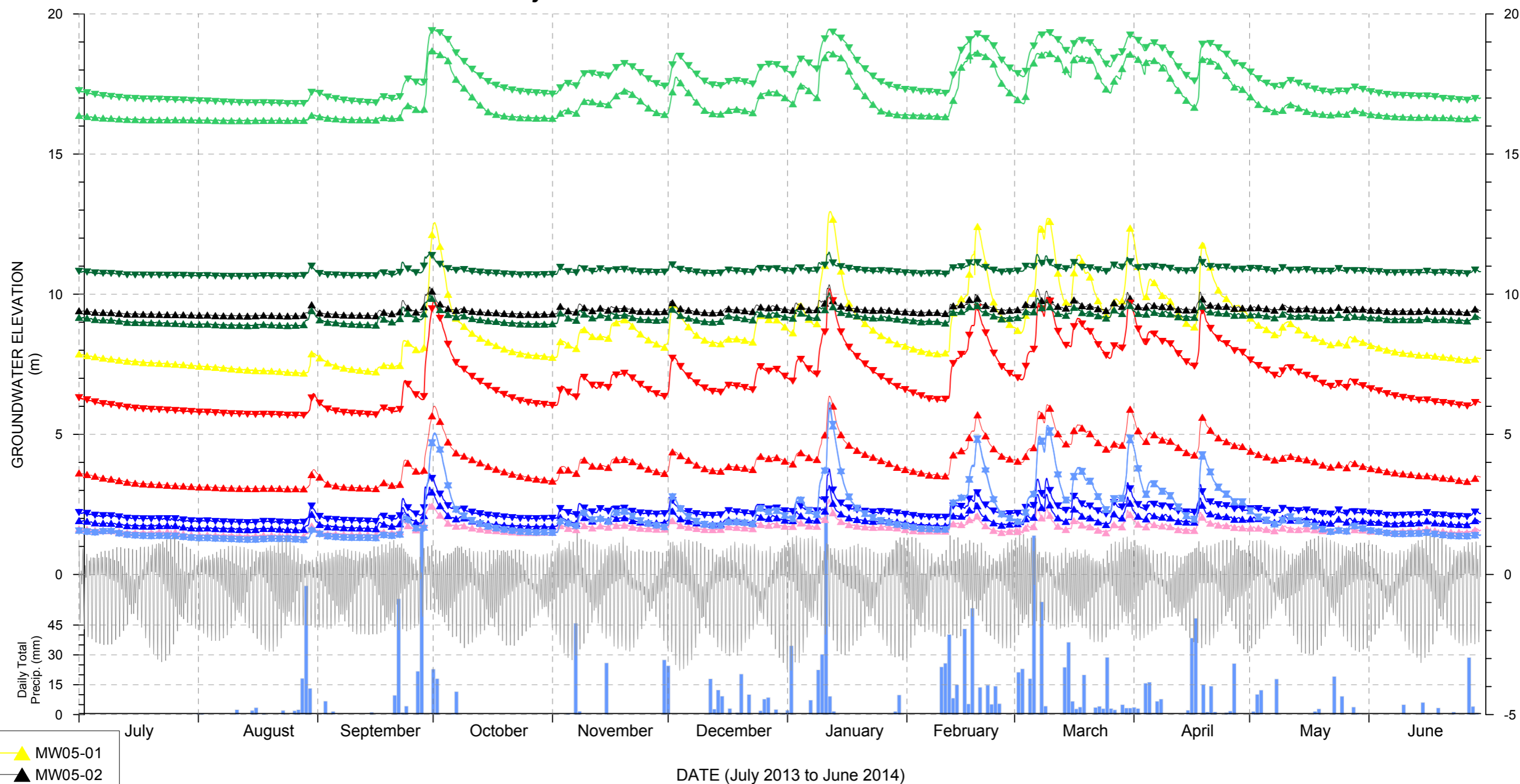


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

Fig. B3

# GROUNDWATER LEVEL MONITORING

July 2013 to June 2014



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

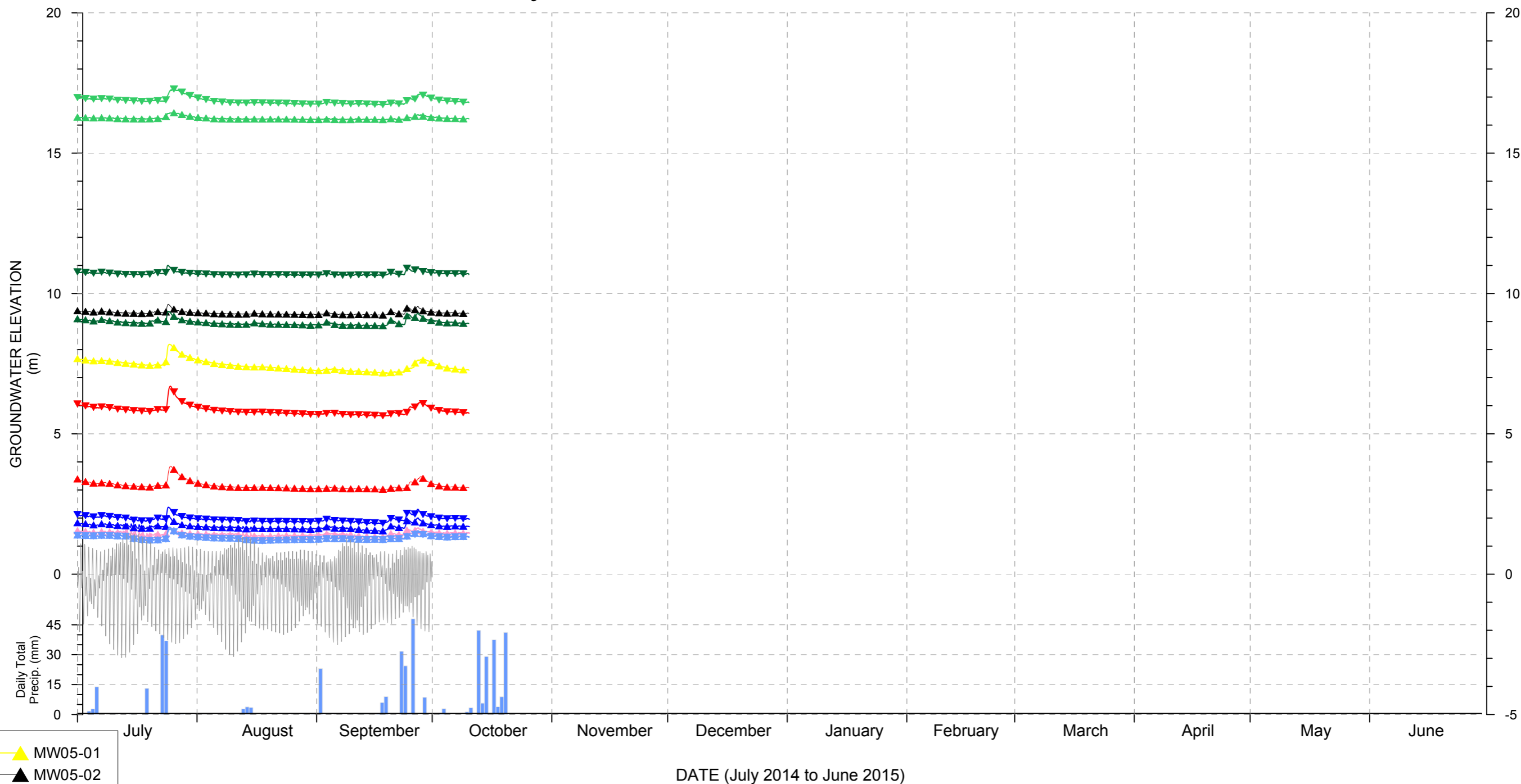


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 MCNAB VALLEY AGGREGATE PROJECT  
 HOWE SOUND, BC

Fig. B4

# GROUNDWATER LEVEL MONITORING

July 2014 to June 2015



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▼ DH10-01D
- ▲ DH10-01S
- ▼ DH10-02D
- ▲ DH10-02S
- ▼ DH10-05D
- ▲ DH10-05S
- ▼ DH10-06D
- ▲ DH10-06S
- ▼ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012



HYDROGEOLOGICAL CHARACTERIZATION  
 BURSCO ROCK PRODUCTS LTD.  
 MCNAB VALLEY AGGREGATE PROJECT  
 HOWE SOUND, BC

Fig. B5

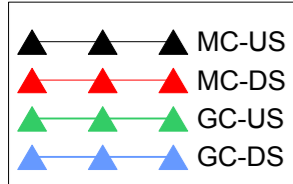
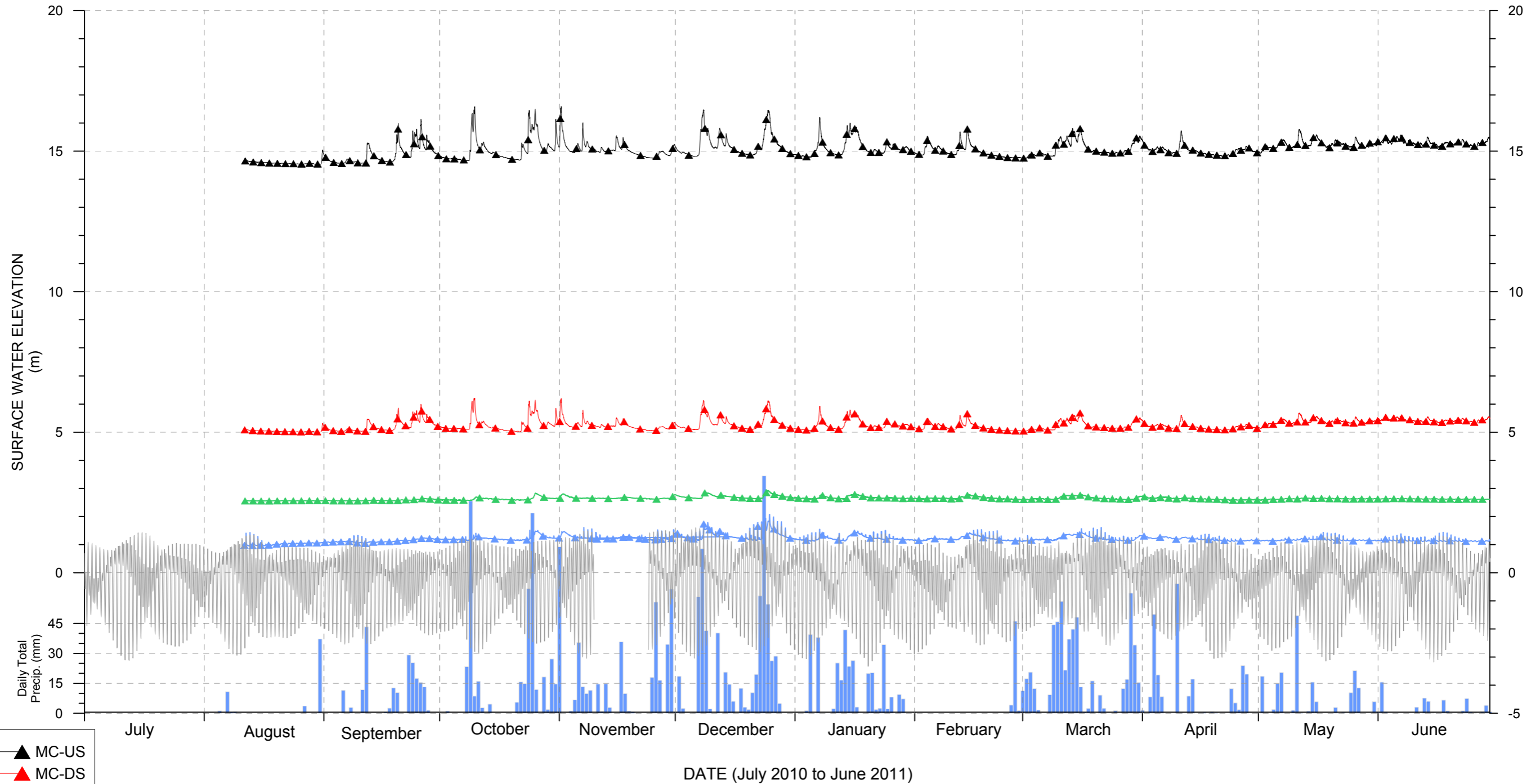


# **ATTACHMENT C**

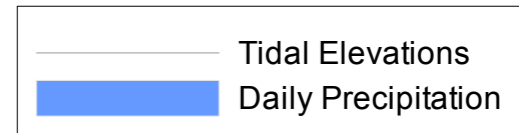
## **Surface Water Level Monitoring**

# SURFACE WATER LEVEL MONITORING

*July 2010 to June 2011*



NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion



Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

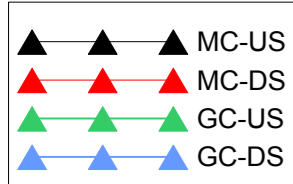
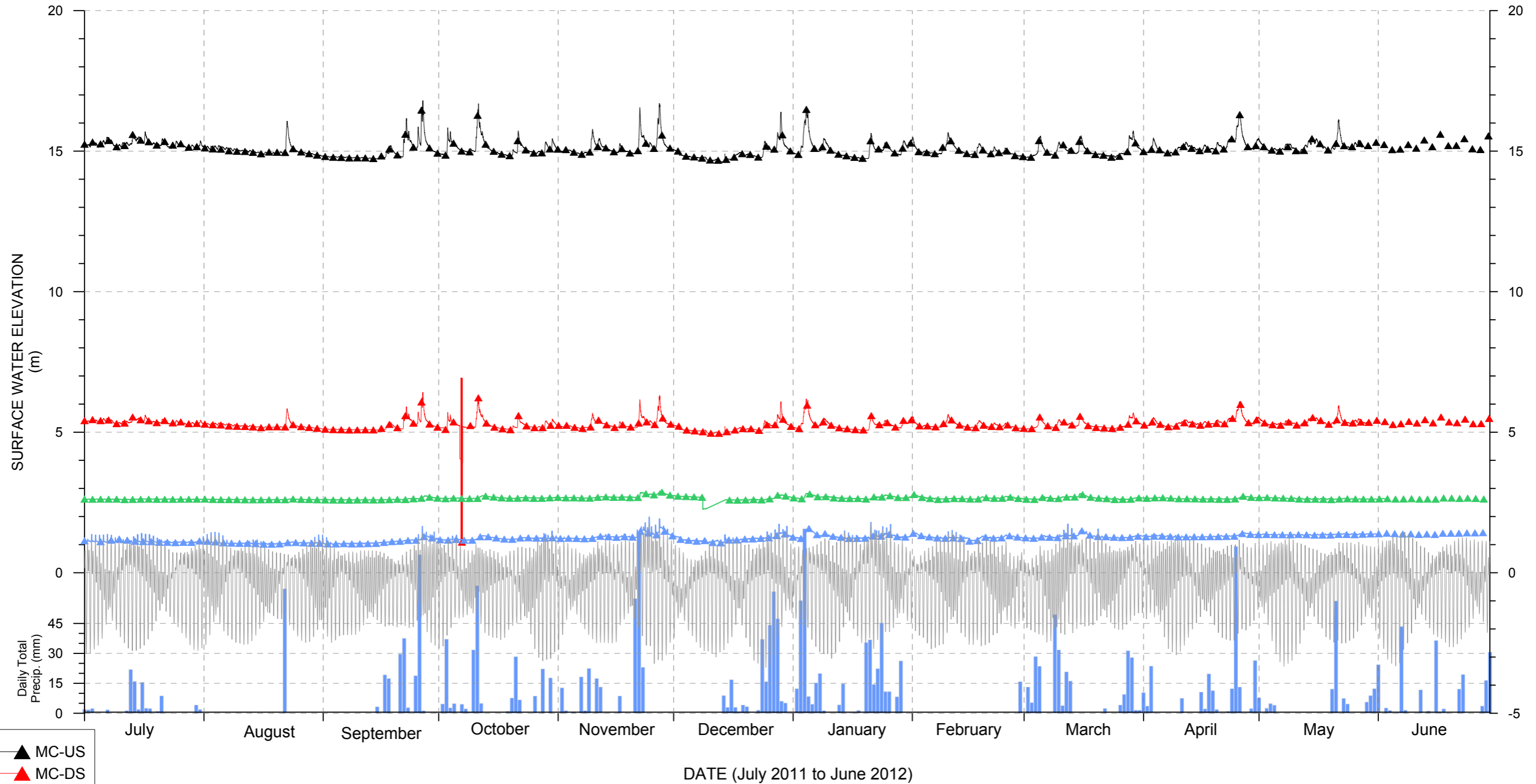


HYDROGEOLOGICAL CHARACTERIZATION  
**BURNCO ROCK PRODUCTS LTD.**  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

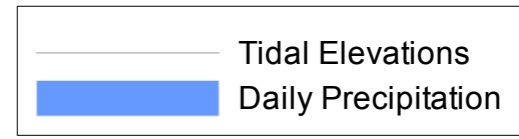
**Fig. C1**

# SURFACE WATER LEVEL MONITORING

*July 2011 to June 2012*



NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion



Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

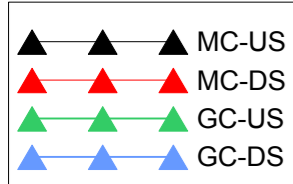
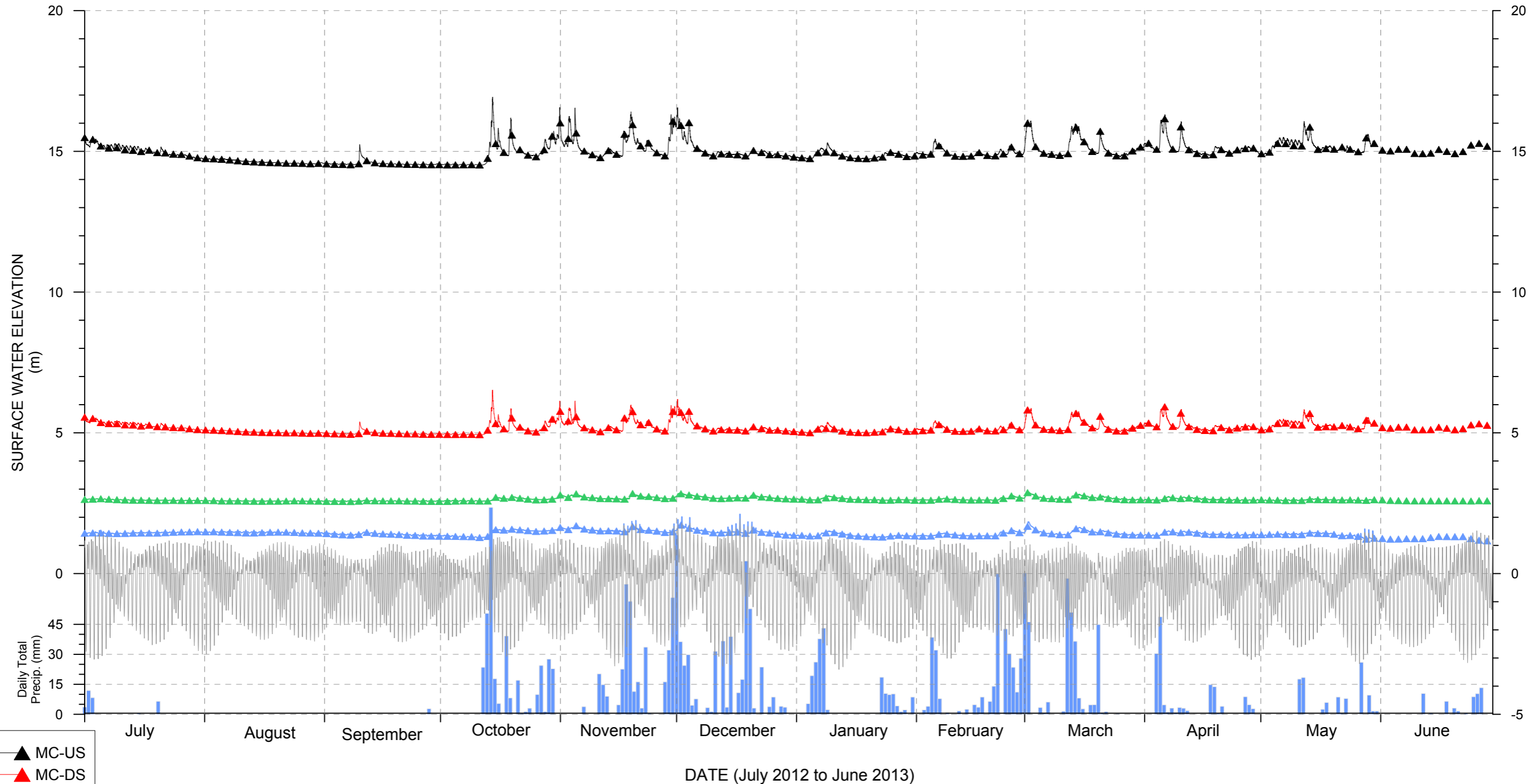


**HYDROGEOLOGICAL CHARACTERIZATION**  
**BURNCO ROCK PRODUCTS LTD.**  
**BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.**

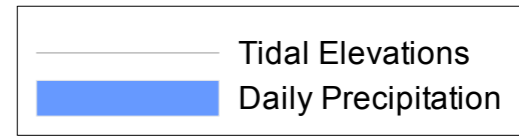
**Fig. C2**

# SURFACE WATER LEVEL MONITORING

July 2012 to June 2013



NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion



Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

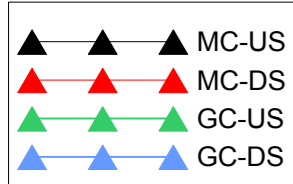
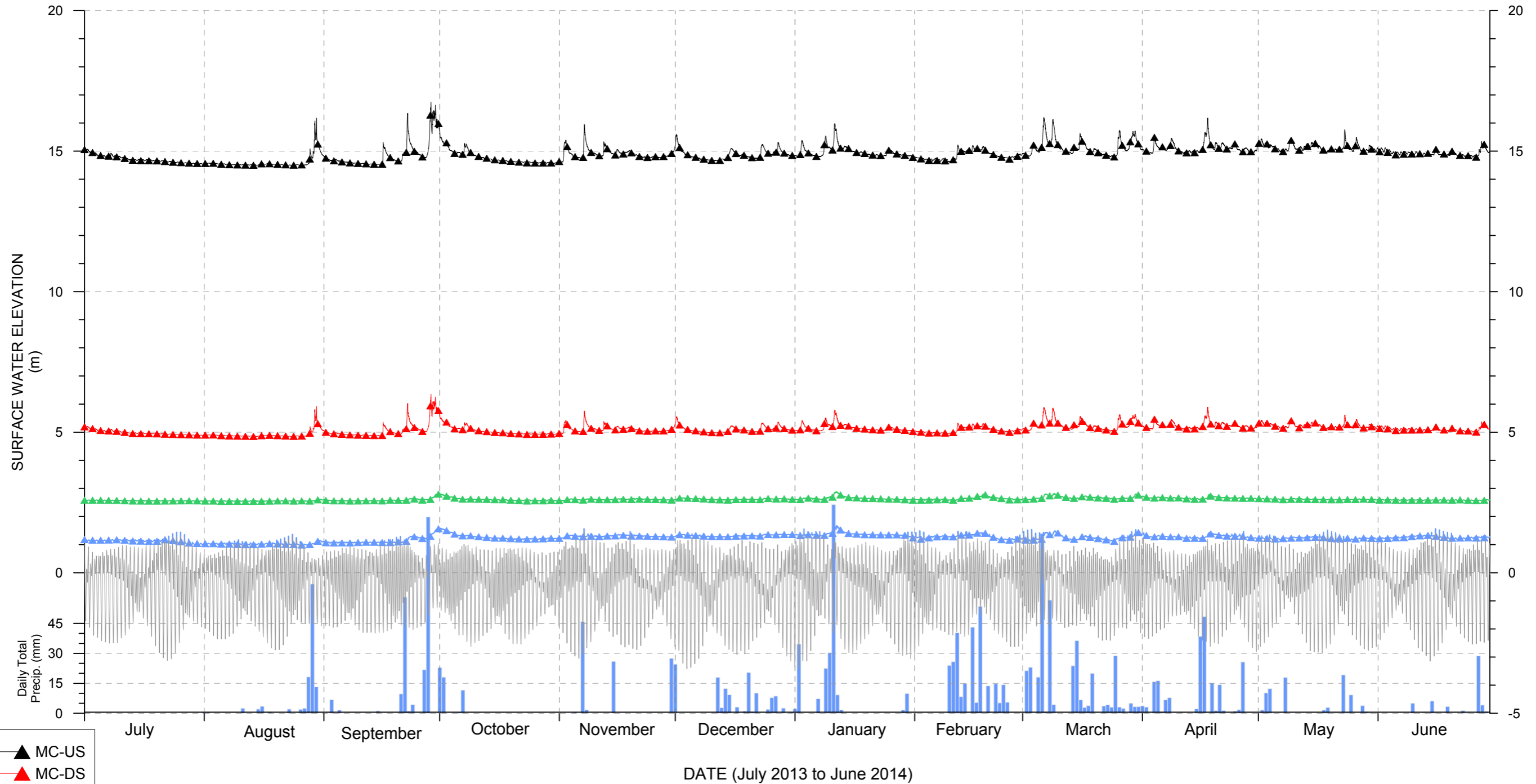


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

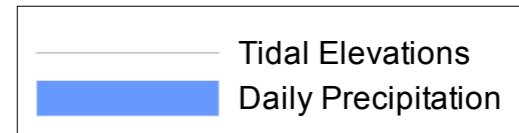
Fig. C3

# SURFACE WATER LEVEL MONITORING

*July 2013 to June 2014*



NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion



Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

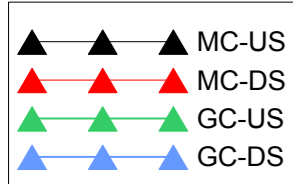
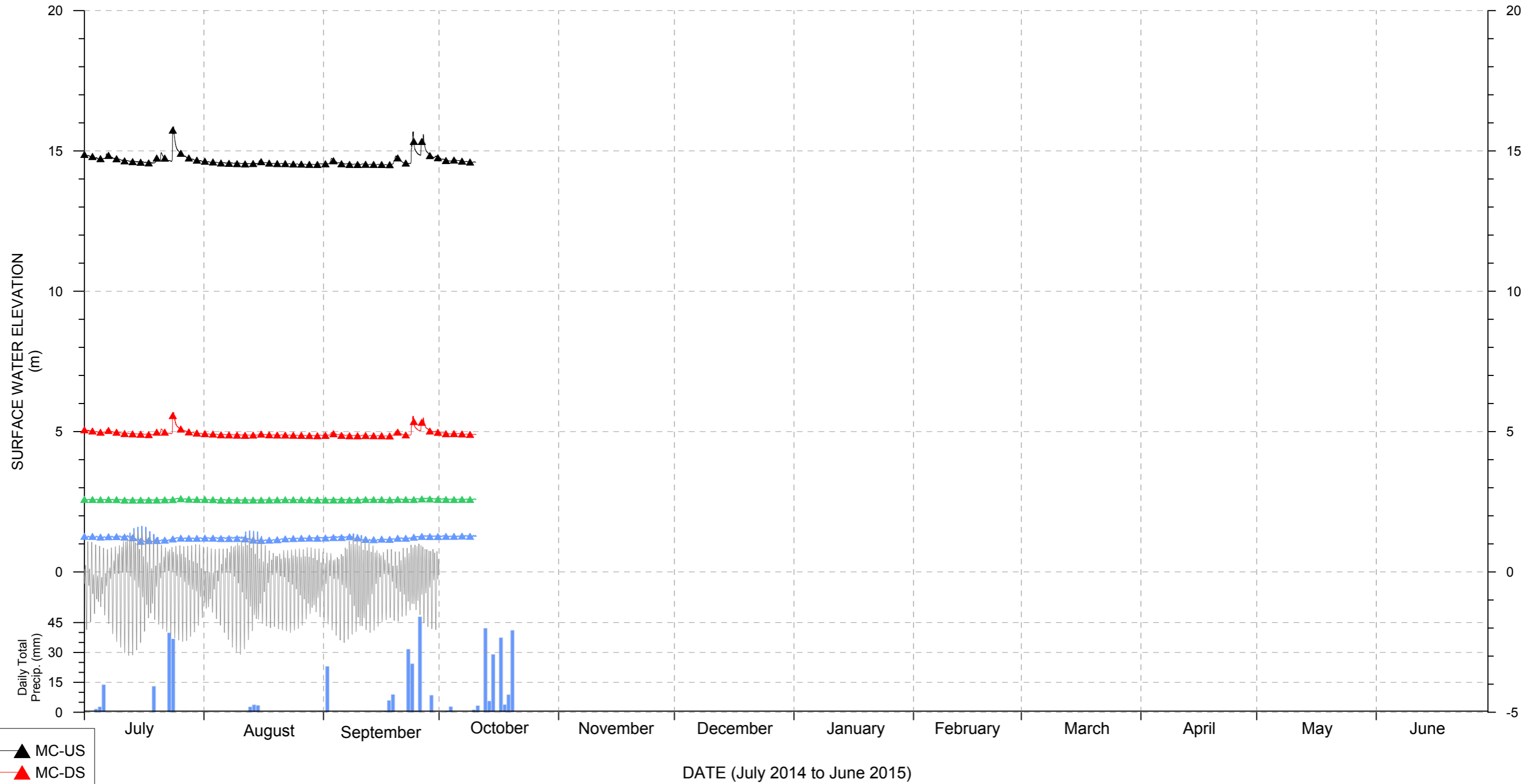


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 MCNAB VALLEY AGGREGATE PROJECT  
 HOWE SOUND, BC

**Fig. C4**

# SURFACE WATER LEVEL MONITORING

July 2014 to June 2015



NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water level/elevation data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 48 hour interval  
 5) Geodetic elevations derived from tidal datum conversion



Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012



HYDROGEOLOGICAL CHARACTERIZATION  
 BURSCO ROCK PRODUCTS LTD.  
 MCNAB VALLEY AGGREGATE PROJECT  
 HOWE SOUND, BC

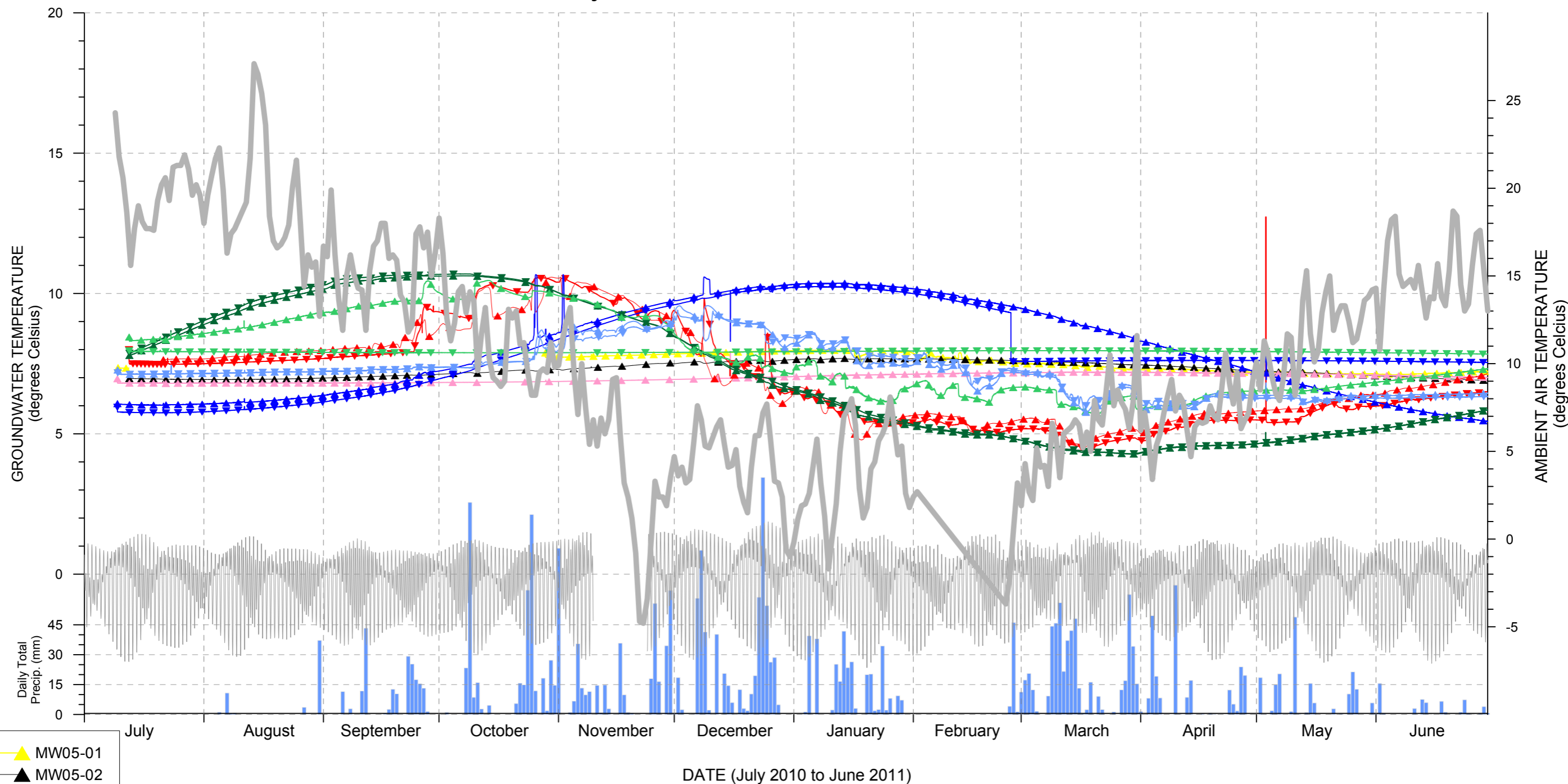
Fig. C5



**ATTACHMENT D**  
**Groundwater Temperature Monitoring**

# GROUNDWATER TEMPERATURE MONITORING

July 2010 to June 2011



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 — Mean Temperature  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

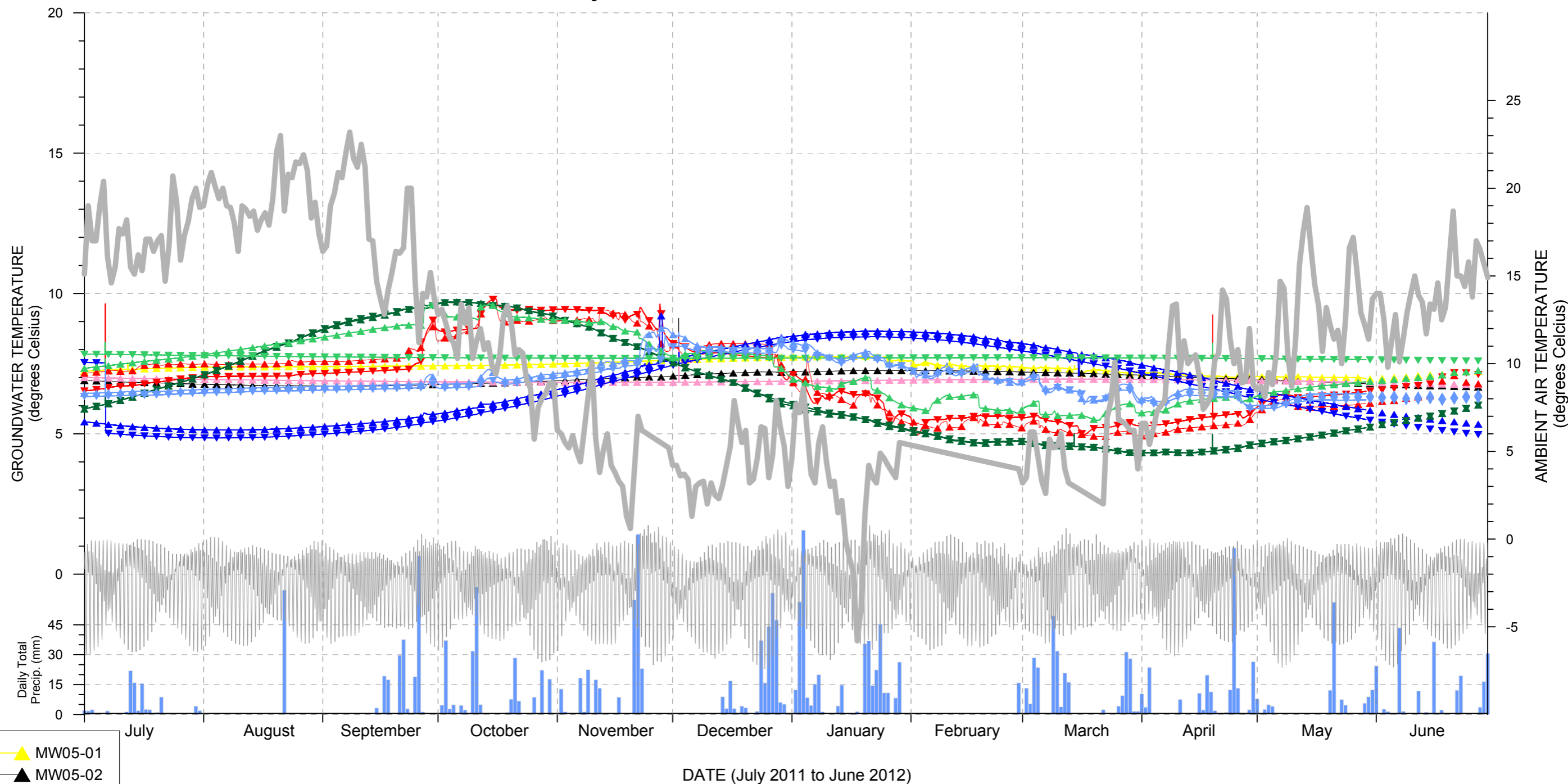


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

Fig. D1

# GROUNDWATER TEMPERATURE MONITORING

July 2011 to June 2012



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 — Mean Temperature  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

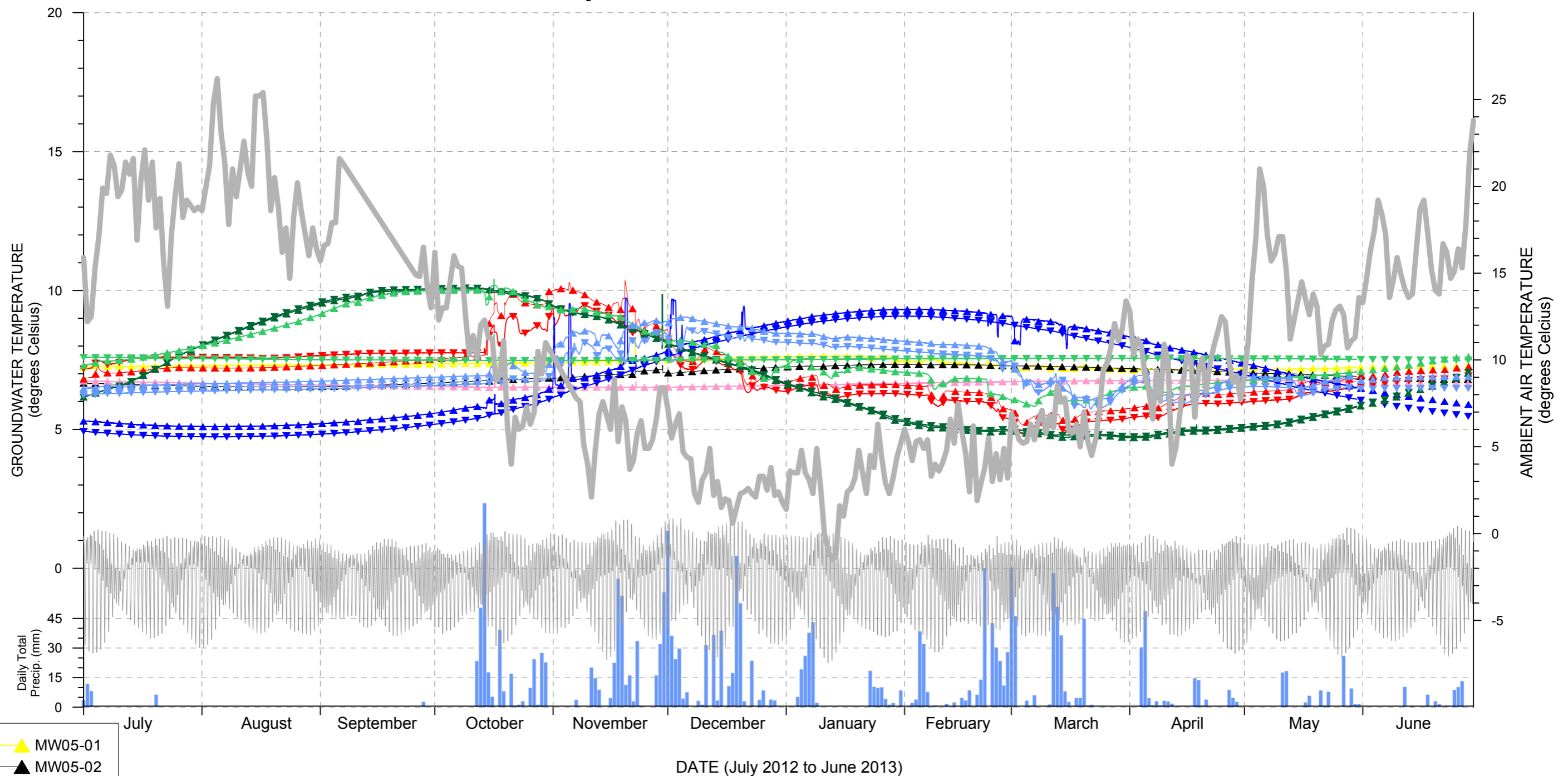


HYDROGEOLOGICAL CHARACTERIZATION  
**BURNCO ROCK PRODUCTS LTD.**  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

**Fig. D2**

# GROUNDWATER TEMPERATURE MONITORING

July 2012 to June 2013



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 — Mean Temperature  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

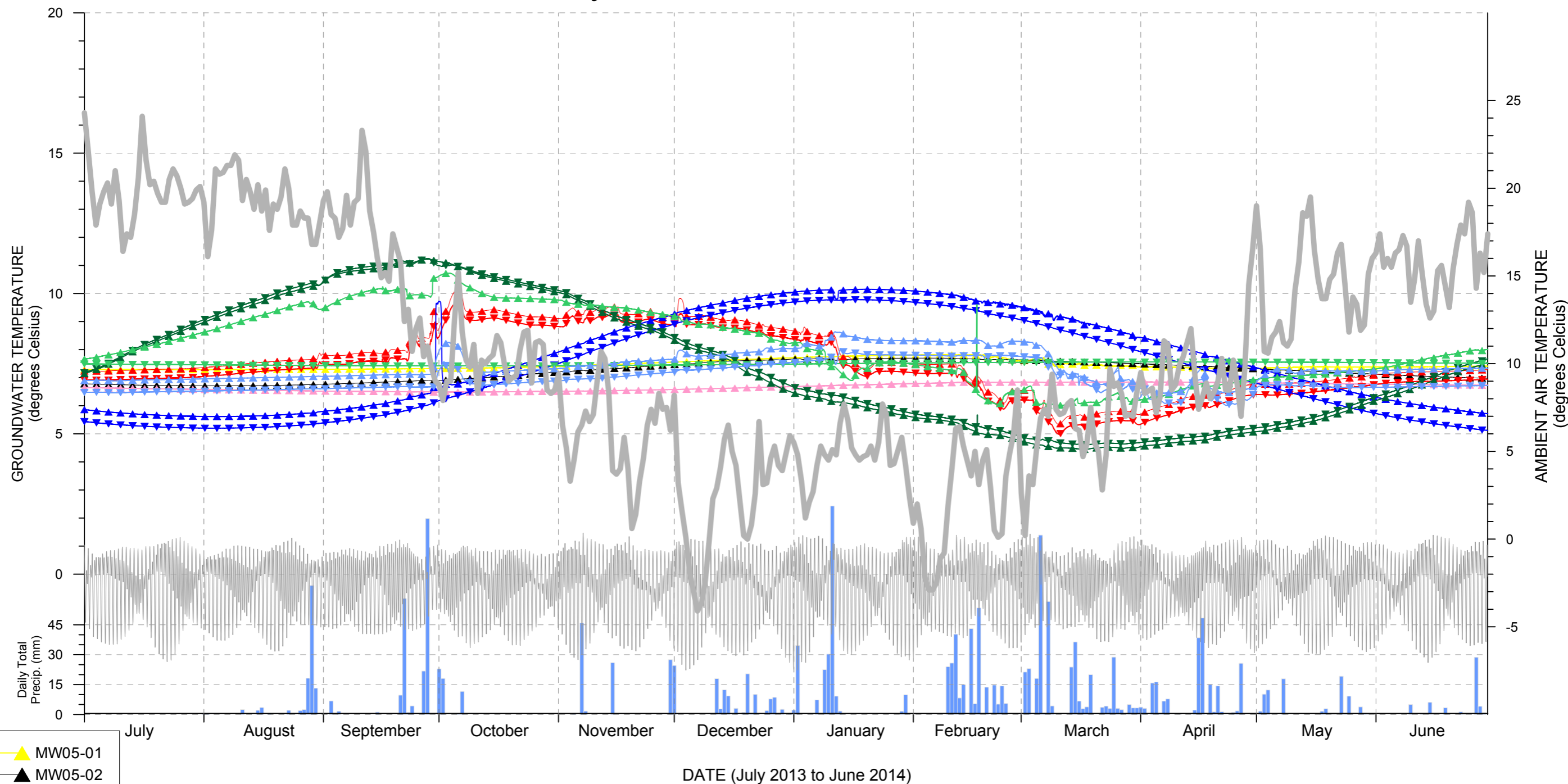


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

Fig. D3

# GROUNDWATER TEMPERATURE MONITORING

July 2013 to June 2014



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▲ DH10-01D
- ▲ DH10-01S
- ▲ DH10-02D
- ▲ DH10-02S
- ▲ DH10-05D
- ▲ DH10-05S
- ▲ DH10-06D
- ▲ DH10-06S
- ▲ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 — Mean Temperature  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

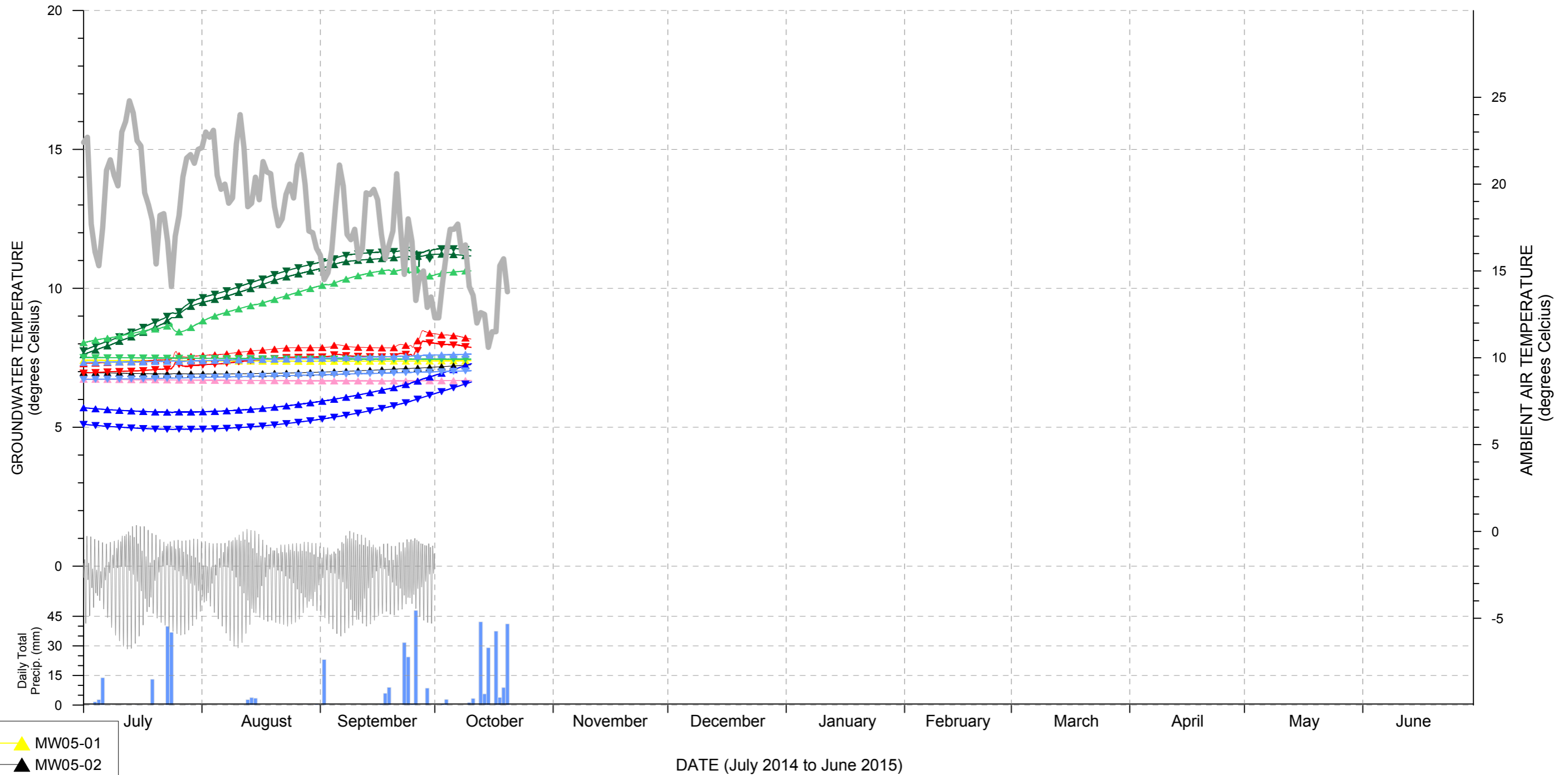


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 MCNAB VALLEY AGGREGATE PROJECT  
 HOWE SOUND, BC

Fig. D4

# GROUNDWATER TEMPERATURE MONITORING

July 2014 to June 2015



- ▲ MW05-01
- ▲ MW05-02
- ▲ MW05-05
- ▼ DH10-01D
- ▲ DH10-01S
- ▼ DH10-02D
- ▲ DH10-02S
- ▼ DH10-05D
- ▲ DH10-05S
- ▼ DH10-06D
- ▲ DH10-06S
- ▼ DH10-07D
- ▲ DH10-07S

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated pressure transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 — Mean Temperature  
 ■ Daily Precipitation

Project No. 11-1422-0046/4600  
 Drawn AM  
 Reviewed WZ  
 Date September 2012



HYDROGEOLOGICAL CHARACTERIZATION  
 BURSCO ROCK PRODUCTS LTD.  
 MCNAB VALLEY AGGREGATE PROJECT  
 HOWE SOUND, BC

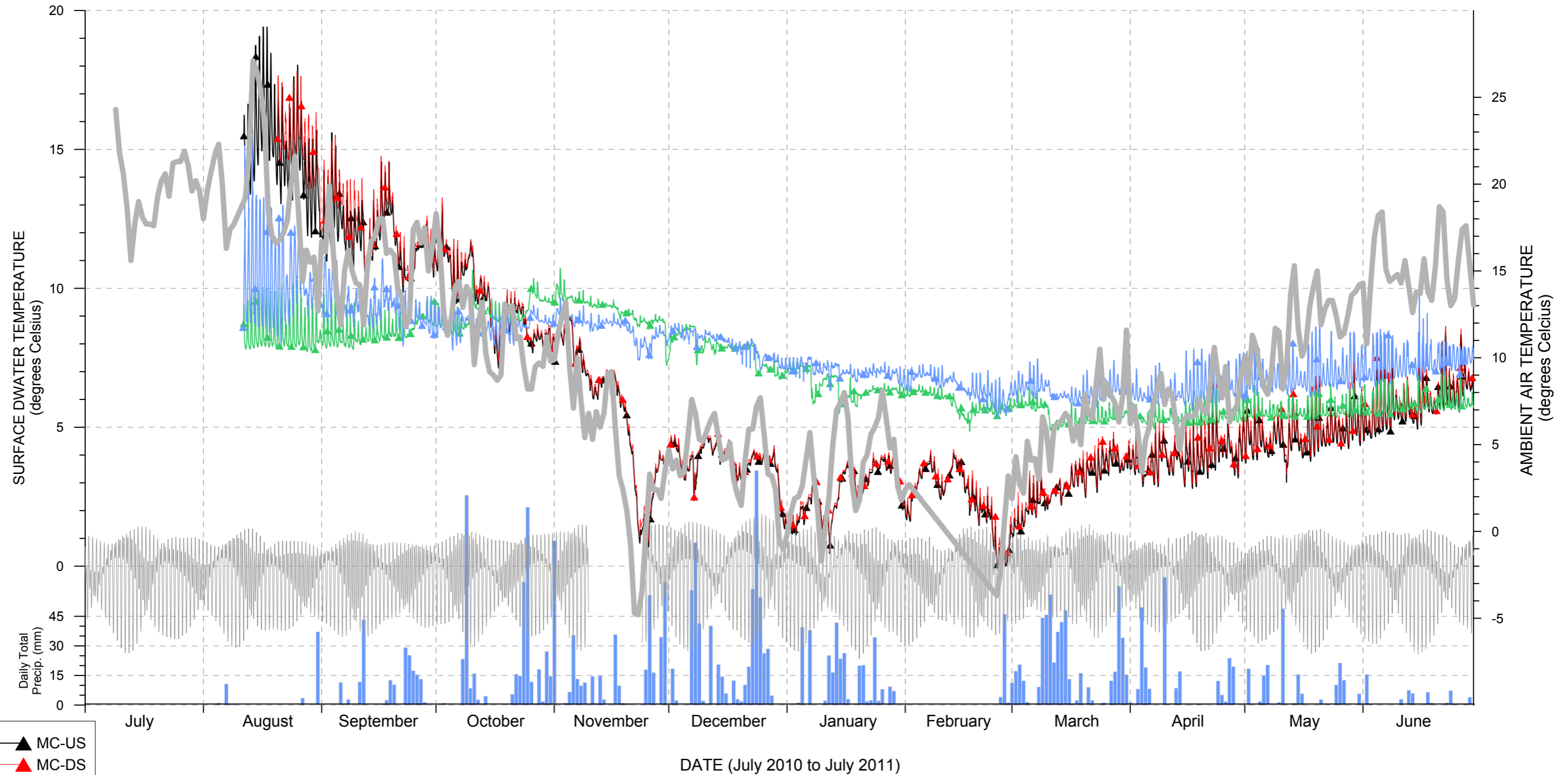
Fig. D5



**ATTACHMENT E**  
**Surface Water Temperature Monitoring**

# SURFACE WATER TEMPERATURE MONITORING

## July 2010 to June 2011



- ▲ MC-US
- ▲ MC-DS
- ▲ GC-US
- ▲ GC-DS

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

- Tidal Elevations
- Mean Temperature
- Daily Precipitation

Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

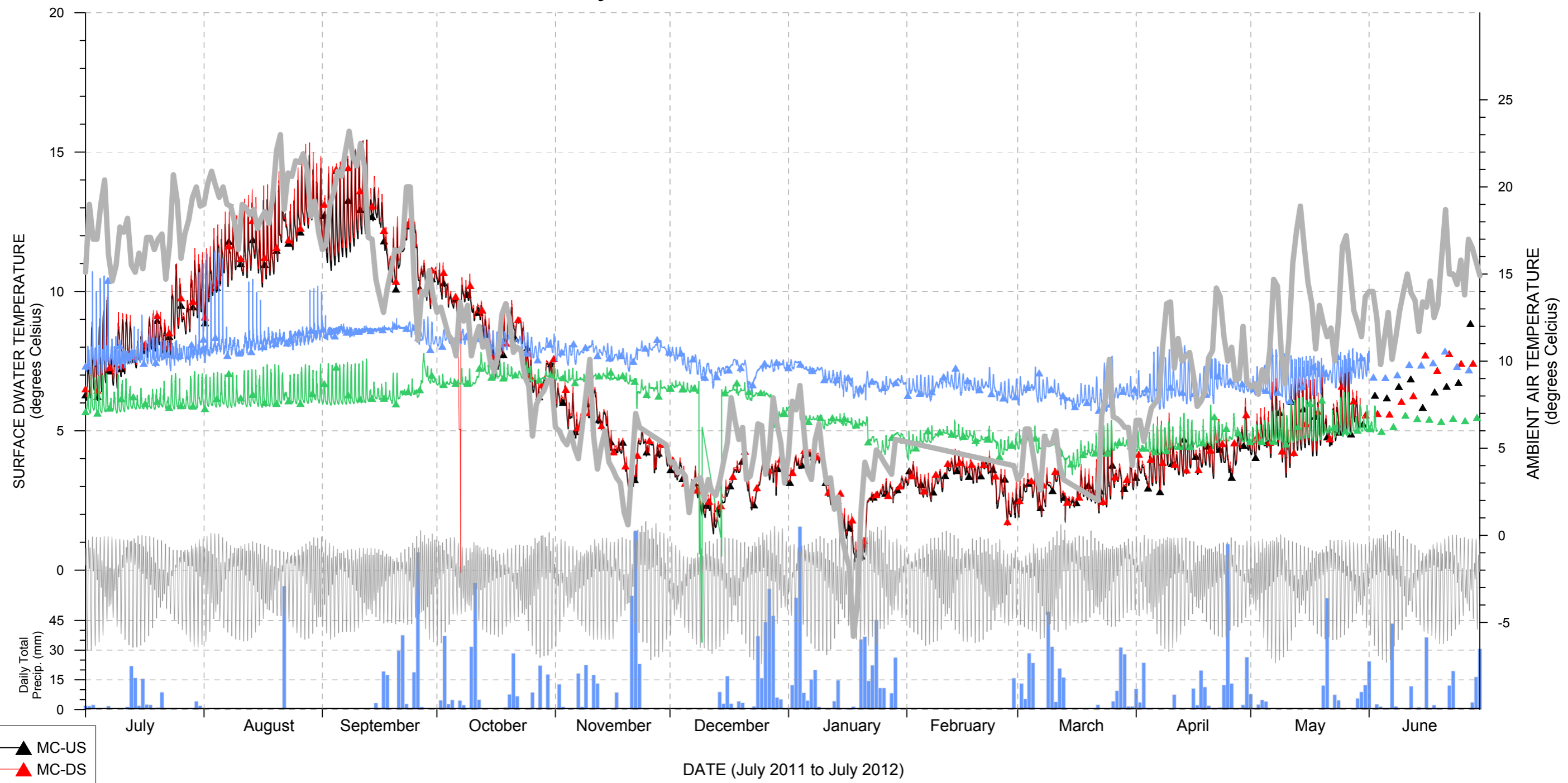


HYDROGEOLOGICAL CHARACTERIZATION  
 BURNCO ROCK PRODUCTS LTD.  
 BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.

**Fig. E1**

# SURFACE WATER TEMPERATURE MONITORING

## July 2011 to June 2012



▲ MC-US  
 ▲ MC-DS  
 ▲ GC-US  
 ▲ GC-DS

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All water temperature data from automated transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

— Tidal Elevations  
 — Mean Temperature  
 ■ Daily Precipitation

Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

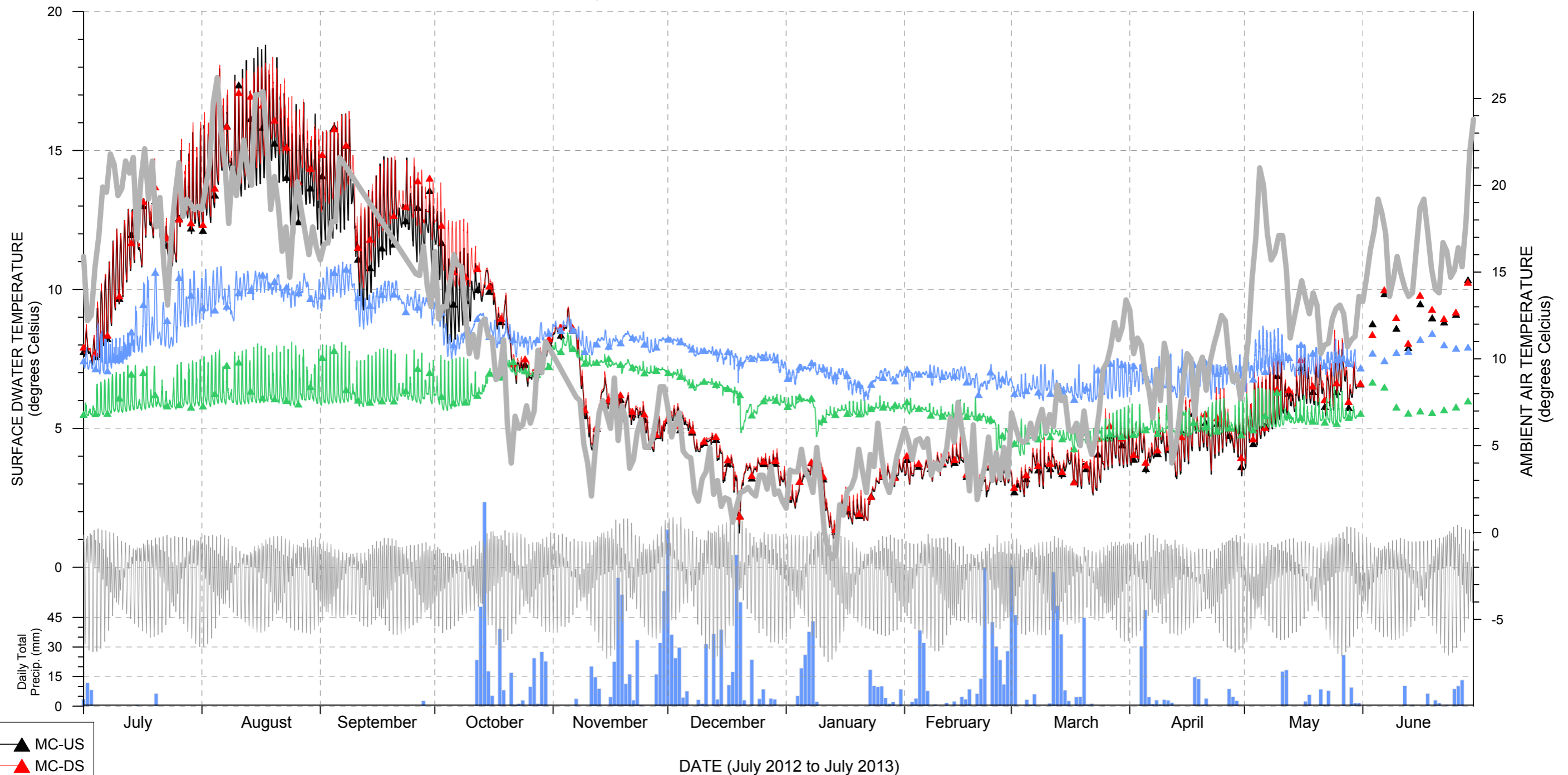


**HYDROGEOLOGICAL CHARACTERIZATION**  
**BURNCO ROCK PRODUCTS LTD.**  
**BURNCO AGGREGATE PROJECT, HOWE SOUND, B.C.**

**Fig. E2**

# SURFACE WATER TEMPERATURE MONITORING

## July 2012 to June 2013



- ▲ MC-US
- ▲ MC-DS
- ▲ GC-US
- ▲ GC-DS

NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion

- Tidal Elevations
- Mean Temperature
- Daily Precipitation

Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

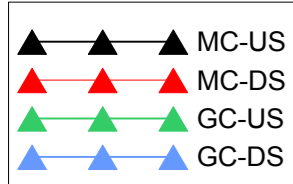
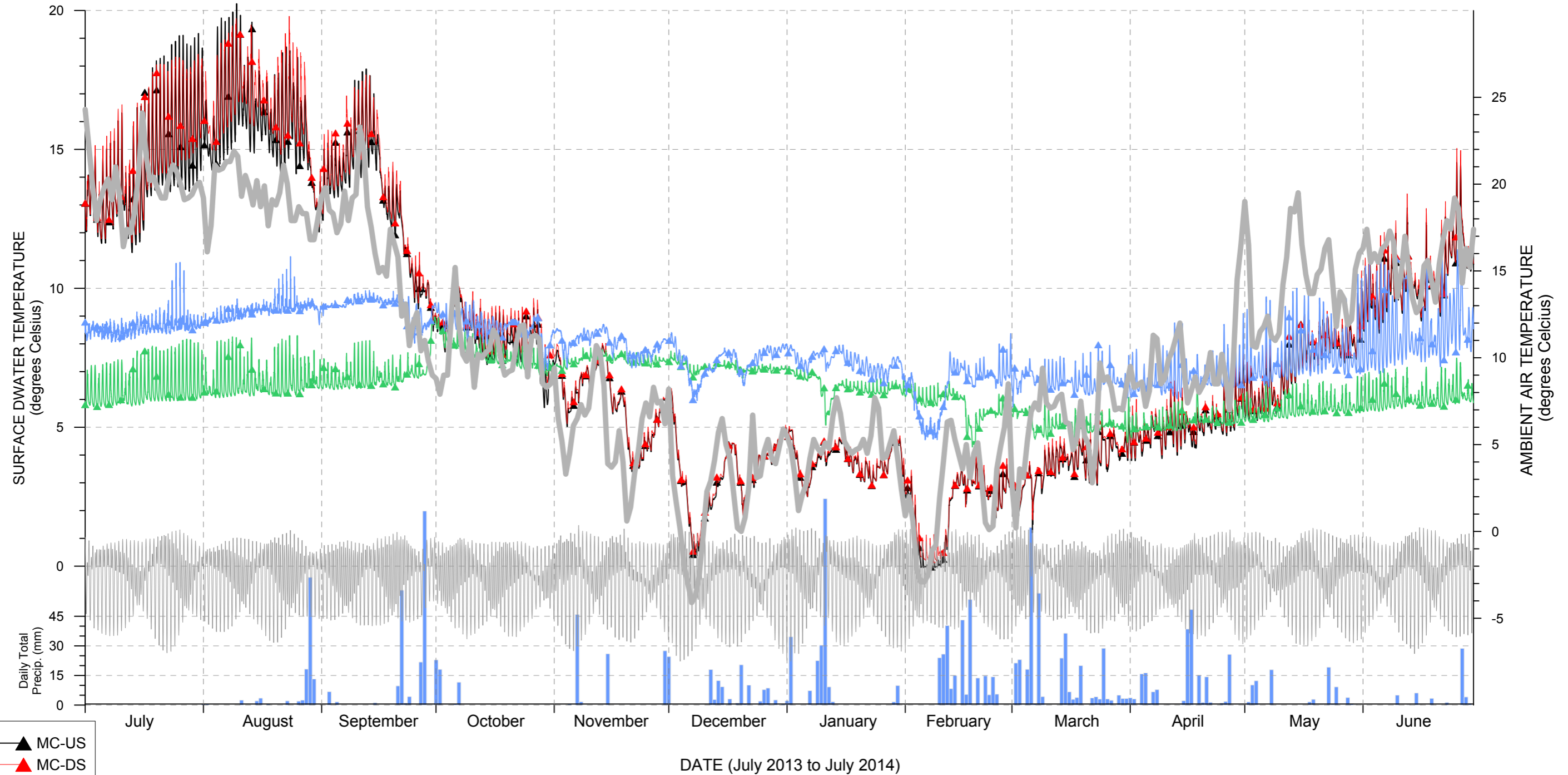


**HYDROGEOLOGICAL CHARACTERIZATION**  
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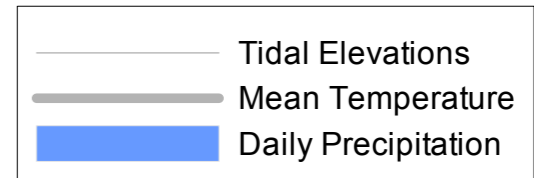
**Fig. E3**

# SURFACE WATER TEMPERATURE MONITORING

## July 2013 to June 2014



NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion



Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012

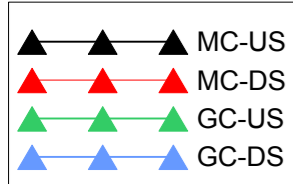
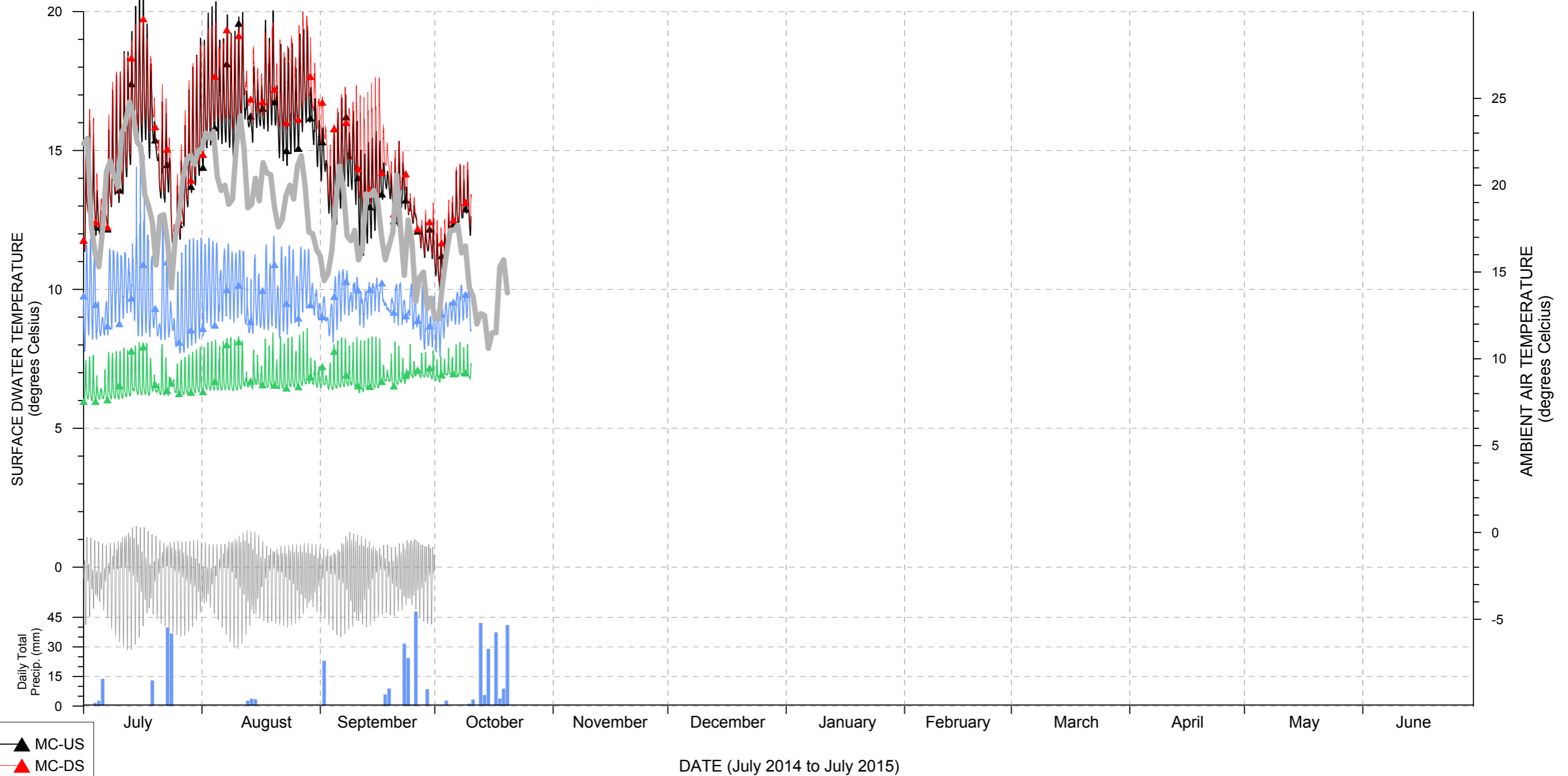


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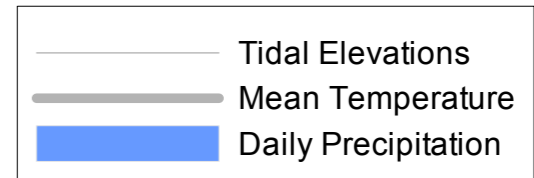
**Fig. E4**

# SURFACE WATER TEMPERATURE MONITORING

July 2014 to June 2015



NOTES: 1) Monitoring well and staff gauge elevations (tidal datum) provided by Gordon Peter M Land Surveying Inc  
 2) Precipitation data from Environment Canada's Port Mellon Station (#1046322)  
 3) All temperature data from automated transducers recording at 15-minute interval (solid line)  
 4) Line symbols = automated data value at 72 hour interval  
 5) Geodetic elevations derived from tidal datum conversion



Project No. 11-1422-0046/4500  
 Drawn AM  
 Reviewed WZ  
 Date September 2012



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Fig. E5