APPENDIX 22

Groundwater Model Report

EAGLE GOLD PROJECT

Groundwater Model Report

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LIST OF ACRONYMS

ADR .... adsorption, desorption, and recovery

BP .... before present

DEM .... digital elevation model

DGDC .... Dublin Gulch diversion channel

EP .... Eagle Pup

Gpm .... gallons per minute

HLF .... Heap Leach Facility

HPGR .... high pressure grinding rolls

km .... kilometre

m asl .... meters above sea level

m^2 .... square metres

m^3/d .... cubic metres per day

mbg .... meters below grade

mg/L .... milligrams per litre

MWTP .... Mine Water Treatment Plant

NBLM .... Nevada Bureau of Land Management

NRMS .... normalized root mean square

PG .... Platinum Gulch

PLS .... Pregnant Leach Solution

SA .... study area

USGS .... United States Geological Survey

WRSA .... waste rock storage area

DEFINITION OF MODEL TERMS

BAS .... Basic Model Package

BCF4 .... Coefficient of Rainfall: Precipitation

BTN1 .... basic transport model package

DRN .... Coefficient of Snowmelt

FWL4 .... fracture-well model package

HCN1 .... Specific-head concentration boundary model package

STR .... Coefficient of Rain

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1 INTRODUCTION

1.1 Objectives

This groundwater modeling study was undertaken on behalf of Victoria Gold Corp. (VIT) to support the Eagle Gold Project Proposal, particularly the water management strategies and water-related effects assessments. This modeling study was developed and calibrated using a three-dimensional groundwater flow model to simulate groundwater flow for the Eagle Gold Project Site (Site) and vicinity. The model was used to evaluate potential changes to groundwater conditions associated with the proposed mining activities. Specifically, the objectives were to:

- Simulate groundwater flow with recharge packages simulating seasonal/monthly fluctuations in precipitation values to product baseline conditions of the groundwater flow system in the Dublin Gulch Basin.
- Evaluate mining operations effects on groundwater flow by: 1) simulating specific proposed mining operations (i.e., topographical changes, water removal, change in recharge conditions, and Dublin Gulch realignment); and 2) comparing results of modified mining operations model to baseline conditions.
- Predict the adequacy of the proposed water supply scenario.
- Evaluate post mining closure effects on groundwater flow by removing proposed water supply removal activities and comparing results of modified post-mining model to baseline conditions.
- Simulate an upset condition from the heap leach facility (HLF) (a leak through the liner) and evaluate contaminant transport.
- Simulate a recharge condition from beneath the waste rock storage areas (WRSA) and evaluate potential effects on groundwater and surface water.

1.2 Study Area Background

The Eagle Gold Project (Project) lies within the Mayo Mining District of central Yukon. The Project facilities and study area (SA) are located approximately 45 km north-northwest from Mayo (Figure 1.2-1). The SA lies within the Dublin Gulch and Eagle Creek watersheds which are tributaries to Haggart Creek. The SA and groundwater model domain includes all of the lower portions of the Dublin Gulch and Eagle Creek watersheds, plus portions of adjacent Haggart Creek.

2 PHYSICAL SETTING

2.1 Regional and Local Climate

The Project site lies within the Mayo Lake-Ross River Eco-region in central Yukon. Regionally, the St. Elias mountain range to the west is the dominant physical feature affecting climate. Moist Pacific maritime air masses are often blocked by the St. Elias range, which tends to reduce air temperatures and precipitation, particularly during the fall and winter. The SA is characterized by a “continental” type climate with moderate annual precipitation and a large temperature range. Winters are long with moderate snowfall and summers are short with periodic rainstorm events, with the majority of snowmelt occurring in May and contributing to high freshet flows.

Two weather stations are located at the Project. The Potato Hills station (1,420 m asl) is located in the alpine area of the site and the Camp location (823 m asl) is located in the lower valley near the existing camp (Figure 2.1-1). Historical temperature data exist for the Potato Hills station from 2007 – 2010 (data collection is on-going) and for the Camp station from 1993 – 1996 and 2009 – 2010 (data collection on-going) (Stantec 2010a). The parameters measured at both stations include: air temperature, rainfall (tipping bucket), wind speed and direction, barometric pressure, and relative humidity.

Longer term data records are available from a number of stations in central Yukon, including stations in Mayo, Elsa, Keno Hill, Klondike and Dawson that are all within 150 km of the SA (Stantec 2010a).

Historical onsite climate data from 1993 to 1996 and 2007 to 2010 were compared to historic regional climate data to provide information on temporal climatic variability and to develop estimated long-term climate values for the project site. The mean annual temperature at the site is estimated at -3°C, with an annual range of approximately 70°C from +30°C to -40°C for the period of record. Temperature ranges have reached as great as 98°C at regional stations in the past (Stantec 2010a).

Based on an evaluation of on-site and regional data, the estimated mean annual precipitation at the SA is estimated to range from 345 mm in the lower valley (at the Camp station) to 449 mm in the upper headwaters (at the Potato Hills station), reflecting the orographic effect of elevation on precipitation. Data summaries and estimates for annual rainfall, snowfall, storm events, evaporation, and wind trends are described in Stantec (2010a and 2010b).

2.2 Regional and Local Physiography

The SA is located in the Mayo Lake-Ross River Ecoregion, which encompasses the Stewart, Macmillan, and Pelly plateaus, a subdivision of the Yukon Plateau physiographic subdivision. Terrain consists of rolling upland plateaus and small mountain groups with nearly level tablelands dissected by deeply cut generally broad U-shaped valleys (Rescan 1997).

Haggart Creek drains to the South McQuesten River which ultimately reaches the Yukon River via the Stewart River. Topographic elevations of the SA range from approximately 760 m above mean sea level along Haggart Creek to over 1,500 m asl at the Dublin Gulch divide.

Portions of the Haggart Creek valley and the lower Dublin Gulch valley have been extensively reworked due to a long history of placer mining and exploration. These works have rerouted several of the drainages in the lower valley, including Eagle Pup and Stuttle Gulch while forming the existing Eagle Creek channel, which now discharges into Haggart Creek downstream of Platinum and Gil Gulches.

2.3 Regional and Local Geology

The SA was extensively glaciated during the Pleistocene period, although some topographically high areas protruded above the ice and were not affected by glaciation. Bond's (1998) surficial geology map of the Dublin Gulch area shows the extent of previous glaciations. Regionally, the past two glacial periods are known as the McConnell (approximately 23,000 to 29,000 years before present [BP]) and the Reid (190,000 to 310,000 years BP) (Bond 1998; LeBarge, et al., 2002). The McConnell glacier advanced from the east, locally along the South McQuesten River valley but did not extend to Haggart Creek. The Reid glaciation advanced from the north and east, locally along Lynx Creek valley and then up into the Haggart Creek valley with a small ice tongue into the Dublin Gulch valley, extending as far east as Stewart Gulch (Bond 1998). Older glaciations overtopped the Dublin Gulch headwater area.

The effect of the varying spatial extent of glaciations is a landscape with varying age. As a result, higher elevations are covered by a variably-weathered saprolite with depths varying from less than one meter to several tens of metres. The surficial material in the lower reaches of Bawn Boy, Olive, and Stewart Gulches consist of alluvial material. In the lower reaches of Dublin Gulch and Eagle Pup placer-mining tailings are present. South in the Dublin Gulch valley and along the Haggart Creek valley wall there is a till blanket covered with a colluvial veneer. Where Dublin Gulch meets Haggart Creek an alluvial fan is present. South of the fan additional placer tailings as well as glaciofluvial complexes exist (complexes include: deposits associated with ice contact environments, buried ice, re-sedimented till, and glaciolacustrine sediments). Alluvial fan deposits exist where tributaries flow into Haggart Creek (Bond 1998; LeBarge, et al., 2002) (Figure 2.3-1).

Permafrost was observed in various locations in site trenches, along road cuts and in natural exposures. Extensive thermal degradation was also observed in places. The extent of the discontinuous permafrost is inferred based on surficial expression, so the extent is not well defined and thermal degradation of permafrost may be affecting groundwater movement. The distribution of permafrost is described in more detail in Stantec (2010c).

Deeper bedrock geology of the central Yukon is characterized by extensive, northward directed thrust sheets formed in the early Cretaceous. There are three main thrust sheets: the easternmost Dawson Thrust, the central Tombstone Thrust, and the westernmost Robert Service Thrust. The latter has Upper Proterzoic to Lower Cambrian Hyland Group rocks in its hanging-wall and Mississippian Keno Hill Quartzite in its footwall. The SA is situated in the hanging wall of the Robert Service Thrust. Hyland Group rocks are lithified continental margin sediments comprised of mudstone, siltsone, quartzite, phyllite, schist, and minor carbonate. To the west of the SA, Cambrian to Devonian continental margin sediments overlie the Hyland Group.

Deformation related to the thrusting resulted in the widespread development of foliation, and phyllitic to schistose fabric is common. A series of regional scale gentle folds deformed the foliation. Locally, the McQuesten anticline caused Cretaceous aged intrusions, which range from syenite to granodiorite in composition in the Selwyn Basin clastic rocks. Mineral deposits and occurrences are associated with these intrusions and are generally vein, shear, or skarn related (Rescan 1997).

The SA is underlain by deformed Upper Proterozoic to Lower Cambrian clastic rocks of the Hyland Group which have been intruded by Cretaceous age Tombstone suite stocks, dykes, and sills. Alteration and gold-tungsten mineralization are directly associated with this intrusion.

Generally, the bedrock in the SA is dominated by a northeast elongated granodiorite stock which measures up to approximately 2 km in width and approximately 5.5 km in length, and extends from Platinum Gulch to Potato Hills, (Figure 2.3-2). The stock has intruded and metamorphosed the surrounding host metasediment, and is well jointed and fractured. Near the intrusive contact the metasediments have been altered resulting in an apparent hardening of the rock. The metasediment is generally strongly foliated, and generally dipping to the southwest at approximately 30 degrees, as well as heavily jointed (Knight Piésold 1996a,1996b).

2.4 Local Hydrogeology

2.4.1 Hydrostratigraphic Units

Local hydrostratigraphy beneath the SA has been characterized by the drilling of borings and installation of groundwater monitoring wells as part of previous investigative phases in 1995 and 1996 (Knight Piesold 1996a, GeoViro 1996), and 2009 and 2010 (Stantec 2010d). In addition, the model domain hydrostratigraphy as well as conceptual groundwater flow movement has been characterized in Stantec (2010d).

Surficial material in the SA generally consists of a thin cover of organic soils underlain by colluvium, followed by either metasedimentary or granodiorite weathered bedrock. The surficial material thickness and physical properties varies substantially throughout the SA.

The surficial deposits consist of undifferentiated colluvium and alluvium material that are extensive throughout the SA and generally consist of loose, angular to sub-rounded gravelly silt or gravelly sand material, with clasts of metasedimentary or granodiorite origin (depending on location). Observed colluvium thicknesses ranged from 0.2 m to 15.2 m.

The lower portions of the Dublin Gulch valley and adjacent Haggart Creek Valley are flanked by till. Till is exposed on the lower south valley wall near the valley mouth and was observed to be covered with a thin veneer of glaciofluvial and glaciolacustrine materials, and capped by colluvial material of varying thickness. This material was observed to be weathered and cemented in part. Distal to Dublin Gulch the till pinches out, following the contour of the valley wall. The colluvial to till sequence was observed to be approximately 20 m deep in Haggart Creek Valley south of Dublin Gulch, and is expected to be deeper, based on observations made along the east side of lower Haggart Creek.

In the middle of the Dublin Gulch valley the fluvial materials were extensively reworked by placer mining operations. Large stockpiles of washed sands, gravels, and fine-grained deposits (i.e., settling ponds) were present, with Dublin Gulch and Eagle Pup flowing along the valley sides of the reworked material. In general, the placer deposits consist of graded sands and gravels with cobbles and trace boulders, and are typically comprised of sub-rounded metasediment and granodiorite clasts.

There are two bedrock types found on site: metasediment and granodiorite. Recorded depths to bedrock in the SA ranged from 0 m to over 20 m. The distinction between colluvium and weathered bedrock was often subtle, as the two materials can be similar in character. For this reason depths to bedrock noted in the 2009 borehole logs in Stantec (2010d) are sometimes approximate (it is assumed the same for historic field program).

2.4.2 Groundwater Occurrence

Groundwater occurrence has been measured in the monitoring well network throughout the SA infrequently during both 1995 and 1996, and from 2008 to present. There are over 45 monitoring wells that are still active (Figure 2.1-1). Generally groundwater has been observed deeper (approximately >6 m to 45 m below grade [mbg]) at higher elevations and shallow (approximately <6 mbg) to artesian in lower elevations and in valley bottoms. Although the monitoring wells have not been measured frequently enough to observe seasonal effects, groundwater levels are expected to have seasonal trends related to the spring freshet and fall rainstorms.

Groundwater elevations within each monitoring well have been generally consistent between measurement dates, although there were exceptions in the following monitoring wells: MW96-23, MW96-17b, MW96-19, DH96-146, MW96-1, MW96-2, MW96-7b; these had higher groundwater elevations in 2009 than 1996. Groundwater levels monitored in 2009 were at lower elevations than 1996 measurements in MW96-25 and GT96-26. Monitoring wells DH95-105, DH95-144, and MW96-9a had large variations in groundwater elevations; however these variations were not consistent (Stantec 2010d).

Groundwater elevations measured in the upper elevations of Ann Gulch were relatively deep (8.6 to 15.1 mbg) in 2009, with water levels apparently too low to provide baseflow, as the gulch was dry. Water was observed seeping out from the gulch along the road cut along Dublin Gulch, during July through October (Stantec 2010d).

In the center of Dublin Gulch groundwater was relatively shallow (2.5 to 4.6 mbg) in the placer tailings (MW09-DG1, MW09-DG2, and DH95-152). Further east groundwater was deeper (6.6 to 14.9 mbg), in the fluvial material and till bluffs, as the gradient of the groundwater steepened towards Haggart Creek (MW09-DG4 and MW09-DG5). Groundwater elevations taken in 1995 and 2009 from DH95-152 are similar.

Groundwater elevations in the upper portions of the Platinum Gulch basin were observed to be deep (60 mbg in DH95-108) in the upper basin and were relatively shallow (26 mbg in MW96-23, in 1996, and 9 mbg in MW96-25) at lower elevations. Seeps and springs were observed in road cuts near MW96-23, MW96-25, and near Haggart Creek.

In the Stuttle Gulch basin monitoring wells were located in the upper (DH95-105, DH95-106, MW96-16a, MW96-16b, MW96-17a, MW96-17b, MW96-18, and MW96-19) and lower basin (MW09-STU1 and MW09-STU2). In the upper portions of the basin water levels ranged between 15 and 46 mbg in the deeper monitoring wells, while water levels were shallower (i.e., 3.5 mbg) in the lower basin wells. Artesian conditions were observed in MW09-STU2, located in the lower part of the basin. Water levels taken in the same monitoring wells in 1995, 1996, and 2009 were similar in most wells, with the exception of water level in MW96-19 which was shallower (Stantec 2010d).

The Eagle Pup basin has three sets of nested wells: MW96-13a, MW96-13b, MW96-14a, MW96-14b, MW96-15a, and MW96-15b, and one single well (DH95-151). Water levels ranged between 3 and 6 mbg in the shallow zone, while they ranged between 7 and 19 mbg in the deep monitoring wells; the data indicated that downward vertical gradients existed at that time of measurement at these locations.

The monitoring well in the Stewart Gulch basin is located near the lower reaches of the gulch; water levels were observed to be approximately 7 mbg.

There are two monitoring wells in the Olive Gulch basin, one completed in bedrock on the upper reaches of the gulch, and one completed in fluvial material in the lower reaches. The monitoring well in the upper reaches had water levels that fluctuated between 6 and 7 mbg, while water levels in the lower reaches were shallower at 2 and 3 mbg.

Depths to water in the Bawn Boy Gulch basin wells were relatively shallow, ranging between 0.5 mbg to 10 mbg. The depths to water generally deepened further from the gulch, as in MW96-1 and MW96-2, where water levels ranged from 12 mbg and 45 mbg; these wells are located near the groundwater divide with the Lynx Creek watershed. Generally, water levels measured in 2009 are similar to measured levels from 1995 and 1996.

2.4.3 Aquifer Characterization

The results of hydraulic testing of the site are variable, generally ranging in the surficial deposits from 10^{-3} m/s to 10^{-7} m/s and from 10^{-5} m/s – 10^{-8} m/s for bedrock. The variable hydraulic conductivity in the surficial geologic material is expected for the varying surficial geological facies including placer, colluvial, alluvial, fluvial, and till deposits. The variable hydraulic conductivity seen in the bedrock is typical of fractured crystalline rock, which showed decreasing hydraulic conductivity with depth. The test data did not demonstrate a measureable difference in the hydraulic conductivities of granodiorite and metasedimentary rock. For a more detailed summary of hydraulic testing results see Stantec (2010d).

2.5 Overview of Proposed Mining Operations

VIT proposes to develop a bulk tonnage, low grade, heap leachable gold deposit on its Eagle Gold property. The Project will involve open pit mining at a production rate of approximately 9 million ton per year ore and 9 million ton per year waste. Current mineable reserves of leachable ore are 66 million tons at 0.82 g/t average head grade. The open pit will be developed using standard drill and blast technology. Ore will be removed from the open pit by haul truck and delivered to the first stage crushing plant (the primary crusher), situated on the north side of the open pit rim. Waste rock will be removed from the open pit by haul truck and delivered to one of two waste rock storage areas (Platinum Gulch or Eagle Pup) or will be used as haul road and infrastructure construction fill.

Ore will be crushed to an average of 5 mm particle size in a 3-stage crushing process. The first two crushing stages (primary and secondary) are located on the north rim of the open pit, while the third crushing stage (high pressure grinding rolls, HPGR) is located closer to the toe of the HLF. Ore is conveyed from the secondary crusher to the HPGR crusher by covered conveyor. After the HPGR crushing stage, ore is transported by covered conveyor into the HLF area and is stacked on the heap leach pad by mobile stacking equipment.

Gold extraction will utilize sodium cyanide heap leaching technology. Similar processing was employed in Yukon at the Brewery Creek mine in the late 1990s, and has been employed successfully in other cold climates elsewhere in the world. Process solution containing cyanide will be applied to the ore to extract gold, and collected by the pad leachate collection and recovery system. The pad will consist of a double liner system in the upper reaches of the facility, and a triple liner in the lower reaches of the facility. A leak detection and recovery system will be situated under the entire HLF.

The Project HLF is located within Ann Gulch and extends across the Dublin Gulch valley, and will include a leach pad with in-heap solution storage and events ponds to contain solution in the event of higher than normal precipitation.

Gold bearing pregnant leach solution (PLS) will be pumped from the HLF to the gold recovery plant. Gold recovery from pregnant leach solutions will be by activated carbon adsorption and pressurized caustic desorption followed by electrowinning onto steel wool and on-site smelting to gold bullion (process referred to as the ADR process: adsorption, desorption, recovery). The gold barren leach solution after the carbon columns is re-circulated back to the HLF. Under all normal operating conditions, process solution will be recycled and will not be discharged from the facility. Specific pertinent features that could result in important effects on the hydrogeologic system and how they were represented in the model are listed below.

2.5.1 Open Pit

Gold-bearing ore and barren waste rock will be removed from the Eagle deposit by conventional blast, shovel and truck mining. The open pit will be excavated on the relatively steep northwest-facing hillside located in an area that includes parts of Stuttle Gulch, Platinum Gulch, and Eagle Pup drainage basins (Figure 2.5-1). As a result of the steep topography, the excavation will have a high southeast wall and a short northwest wall, with a relatively small pit. The maximum depth of the open pit at closure will be approximately 75 m. The area of the open pit will grow from 166,000 m^2 to 640,000 m^2 during the Project. The median elevation of the open pit will decrease as the pit deepens from 1,230 m asl to 1,163 m asl during operations.

Depressurization of the open pit walls is required to maintain the stability of the open pit walls. Pit slope stability analyses (BGC 2010a) indicate that depressurization requirements will be driven by the bench scale of the open pit. Complete depressurization must be attained for an area extending approximately 50 m behind the excavated bench face to achieve sufficient stability. This will be accomplished using horizontal drains and perimeter wells beginning in the first year of construction. The total groundwater discharge rate is predicted to be low, ranging from approximately 38 m^3/d in Year 7 to approximately 429 m^3/d in Year 3 (Figure 21[1] in BGC [2010b]; Crozier 2010, pers. comm.; Section 5.2-1 in Stantec [2010b]).

2.5.2 Waste Rock Storage Areas

Barren waste rock will be deposited in one of two WRSAs or utilized in the construction of various mine facilities. The Platinum Gulch Waste Rock Storage Area (PG WRSA) will be located in the Platinum Gulch drainage basin (Figure 2.5-1) and will hold approximately 2,900,000 m^3 of waste rock deposited from the Open Pit during the first three years of operations. The size of the PG WRSA will increase from approximately 4% (60,000 m^2) of the Platinum Gulch basin area at its confluence with Eagle Creek in Year 1 of operations to a maximum size of approximately 24% (330,000 m^2) of the basin in Year 3, while increasing in volume from 500,000 m^3 to 4,800,000 m^3. The PG WRSA will not be added to after Year 3.

The Eagle Pup (EP) WRSA (Figure 2.5-1), which will be located in the Eagle Pup drainage basin, will hold approximately 26,500,000 m^3 of waste rock by the end of operations. The EP WRSA will be used during all of the operations phase. The size of the EP WRSA will increase from approximately 9% of the Eagle Pup basin area (120,000 m^2) in the first year of operations to a maximum size of approximately 63% (800,000 m^2) of the basin in the last year, while increasing in volume from 1,000,000 m^3 to 26,500,000 m^3.

Although both WRSAs will be unlined, they will be constructed with groundwater drainage systems that extend beneath the rock piles along existing drainages. The drainage systems will consist of Type 1 and Type 2 rock drains (URS/Scott Wilson 2010). Type 1 drains will be the up-gradient section excavated into rocky alluvium. Type 2 drains will be excavated into bedrock and filled with drain rock and will be located as the down-gradient section feeding a seepage collection pond, It is expected that the down-gradient Type 2 rock drain will collect groundwater, and both drains will collect water that has passed through the WRSA and near-surface meteoric water originating upslope of the WRSA.

2.5.3 Heap Leach Mining Facility

The majority of the HLF will be located in the Ann Gulch drainage basin with the base of the HLF extending into a portion of the lower Dublin Gulch valley (Figure 2.5-1). The HLF footprint area will grow from 283,000 m^2 in the first year of operations to 785, 530 m^2 at the end of operations. Crushed

[1] Assumes the added values for pit inflows and well intake beginning in first year of construction.

ore will be delivered and stacked on a lined solution collection pad. Process solution containing cyanide will be applied to the ore to extract gold, and collected by the leachate collection and recovery system (LCRS). The pad will consist of a double liner system in the upper reaches of the facility, and a triple liner in the lower reaches of the facility. A leak detection and recovery system (LDRS) will be situated under the entire HLF. A groundwater drainage system will be installed beneath the HLF to prevent uplift pressures developing beneath the liner. The drainage system comprises a network of pipes placed in gravel-filled trenches. These systems are described in more detail in Sections 4 and 5 of the Project Proposal.

2.5.4 Other Mine Facilities

Dublin Gulch Realignment. A portion of Dublin Gulch will require re-alignment around the proposed heap leach facility (HLF) to convey non-contact (i.e., from undisturbed basins or areas) streamflow past the HLF and divert the water to the Eagle Creek drainage downstream of the project (Figure 2.5-1). The Dublin Gulch diversion channel (DGDC) will be approximately 2.6 km long.

Water Supply Wells. One or more water supply wells will be installed to provide camp and mining process water needs. The potable well(s) will most likely be completed within the unconsolidated shallow aquifer near the camp site, while the wells for process make-up water will most likely be installed adjacent to the adsorption and recovery plant near the HLF (Figure 2.5-1).

3 MULTI-LAYER NUMERICAL GROUNDWATER MODEL

3.1 Hydrogeologic Setup

A conceptual model was developed based on previous site investigations to interpret the various factors that would influence the development and use of the model. The sections above describe the geologic and hydrogeologic characteristics within the model domain, and the conceptual movement of groundwater within the area encompassed by the groundwater flow model. The conceptual model also served to identify potential data gaps, as well as the various assumptions used in the numerical model. Information generated from the conceptual model was then used to develop the numerical groundwater flow model described in the following sections.

3.2 Model Setup

3.2.1 Overview of Model

The modeling software package Groundwater Vistas^{TM} was used to facilitate model development. Groundwater Vistas^{TM} is a fully integrated modeling platform that uses the United States Geological Survey (USGS) Modular Three-Dimensional Finite Difference Groundwater Flow Model MODFLOW (McDonald and Harbaugh 1988) and MODDFLOW-SURFACT (Hydrologic Inc. 1996) to simulate groundwater flow and contaminant transport. The Groundwater Vistas^{TM} modeling platform contains a number of pre-processors and post-processors that are used for data preparation, data manipulation, and preparation of MODFLOW-SURFACT output data as input for various plotting and contouring packages.

The groundwater modeling code, MODFLOW-SURFACT/MODHMS, is based on the widely-used USGS MODFLOW code. MODFLOW-SURFACT/MODHMS has effectively addressed the primary shortcomings and limitations of the USGS public domain versions of MODFLOW by extending the physical modeling capabilities of the standard USGS MODFLOW code for subsurface flow calculations and enhancing the robustness and efficiency using superior numerical schemes. More information on Groundwater Vistas and the use of different MODFLOW packages is found in Appendix C.

3.2.2 Discretization of Dublin Gulch

The model was vertically discretized into five layers, which was horizontally subdivided into grids composed of cells utilizing uniform 25-meter by 25-meter cell spacing. The lateral extent of the model domain includes a 300 column by 200 row grid (7.5 km by 5 km).

3.3 Model Configuration and Domain

The model domain grid was oriented in an east to west direction consistent with the predominant regional direction of groundwater and surface water flow within the Dublin Gulch Basin. Model cells located outside the basin were designated as no-flow cells. The model domain is presented on Figure 3.3-1.

The vertical extent of the model domain consists of various units of unconsolidated deposits in the surficial geology of the basin (Layer 1), a weathered bedrock zone (Layer 2), and bedrock units consisting of metasediment and granodiorite (Layers 3 through 5). Representative cross sectional views of the model thickness are presented on Figures 3.3-2 and 3.3-3.

3.3.1 Discretization of Aquifer Properties

Discretization of aquifer properties involves assigning aquifer property values to each cell within the model domain. Discrete aquifer properties include: hydraulic conductivity, storativity, top elevations and bottom elevations. Values for these data were determined from field observations, drill logs, and aquifer pumping data, where available and as summarized in Stantec (2010e). Discretization of aquifer properties involved a series of steps. These steps involved:

- Estimation of layer/model thicknesses from topographical data and results of field investigations
- Estimation of hydraulic conductivity/transmissivity values from aquifer pump test data and published values for aquifers with similar characteristics

- Estimation of storativity based on available lithologic information from previous and current phases of l investigations.

3.3.2 Elevation/Thickness of Model Layers

Top and bottom layer elevations, are required to simulate groundwater flow in the layer. For Layer 1, top and bottom elevations were based on the site digital elevation model (DEM) and boring log data. In areas where little or no data were available, interpreted surfaces were extended so as to provide complete coverage of the model domain.

For Layer 2, thickness was based on the extent of highly weathered bedrock as indicated in boring logs from previous drilling investigations. Layers 3 through 5 thicknesses were based partially on the general description of the spatial extent of the granodiorite and metasediment rocks from exploration studies (and as summarized in the Project Proposal), and designed to represent a sufficient thickness of bedrock to achieve the model objectives, or a depth of 1,300 m.

3.3.3 Hydraulic Conductivity and Storativity

Hydraulic conductivity and storativity values were assigned to each model cell to simulate hydrostratigraphic characteristics of each layer. The hydraulic conductivity values used are based on the result of hydraulic tests (i.e., packer tests, recovery tests and aquifer pumping tests) performed within the basin. The results of these tests are summarized in Stantec (2010d) and BGC (2010b). Areas where hydraulic tests were not performed were assigned hydraulic conductivity values based on boring logs and published estimates for aquifer materials. In addition, to provide a complete coverage of the model domain, interpreted hydraulic conductivity values were extended to areas of the model domain where little or no data were available.

For Layer 1, configuration of several hydraulic conductivity and storativity zones were based on interpretation of surficial geology from data collected during previous site investigations. Generally, hydraulic conductivity zones in Layer 1 were configured to approximate mapped surficial geology as presented on Figure 3.3-4.

For Layers 2 through 5, hydraulic conductivity zones were based on interpretation of subsurface geology from previous site investigations. Much like Layer 1, hydraulic conductivity zones in Layers 2 through 5 were configured based on mapping of the metasediment formation and granodiorite intrusion as depicted on Figures 3.3-5 and 3.3-6.

Zones for each unconsolidated deposit, weathered bedrock and bedrock were set within the mathematical model based on estimated hydraulic conductivity and storativity values determined from hydraulic testing. The hydraulic conductivity and storativity zones were configured in the model to approximate the extent of each unit based on interpretation of field investigations conducted at the site to date. Although test data did not demonstrate a measureable difference in the hydraulic conductivities of granodiorite and metasedimentary rock, separate hydraulic conductivity zones for each were set to differentiate each during model calibration. Hydraulic conductivity and storativity values utilized for the model are presented on Table 3.3-1.

Table 3.3-1: Hydraulic Conductivity and Storativity Parameter Values

Parameter	Zone	Value	Sensitivity Analysis	
			Minimum	Maximum
Layer 1				
K_X[1]	11	50	2.50E+01	1.00E+02
K_X[1]	20	12	6.00E+00	2.40E+01
K_X[1]	30	7.5	3.75E+00	1.50E+01
S[2]	44	0.1	–	–
Layer 2				
K_X[1]	40	0.8	4.00E-01	1.60E+00
K_X[1]	41	0.2	1.00E-01	3.00E-01
K_X[1]	42	0.9	4.50E-01	1.80E+00
S[2]	44	0.0001	1.00E-03	1.00E-05
Layers 3 through 5				
K_X[1]	50/60/70	0.001	5.00E-04	5.00E-03
K_X[1]	51/61/71	0.001	5.00E-04	5.00E-03
S[2]	3/4/5	0.00001	1.00E-06	1.00E-04

NOTES:
[1] Hydraulic Conductivity Values in meters/day
[2] Storativity values dimensionless

3.3.4 Boundary Conditions

Groundwater flow conditions along the perimeter boundary of the model domain were largely defined from existing well data, topographic features, and the hydrogeologic evaluation study. The approximate east-west center of the model coincides with the Dublin Gulch channel. The majority of the extent of the model domain to the north and south was defined by Dublin Gulch drainage basin ridgelines and assumed to be hydraulic divides in the upper two layers of the model. At these locations, no flow boundaries were assigned.

Additional boundary conditions were added to portions of the model perimeters where groundwater enters or leaves the basin as subsurface flow from bedrock areas are simulated using general head boundaries and stream reaches along the perimeter of the model. The boundary conditions for the model are illustrated in Figures 3.3-7 through 3.3-9.

3.3.5 Areal Recharge

Areal recharge from precipitation was based on average precipitation data, historical regional sources and SA climate data sources as summarized in Stantec (2010a, 2010b). Recharge rates were assigned to the uppermost active node within each vertical column in the model domain. Computed recharge rates accounted for precipitation, evapotranspiration, and orographic effects. For orographic effects, zonation of recharge rates was limited to every 100 m of elevation difference (Figure 3.3-10). The recharge package was not utilized during model calibration for two reasons:

- The steady-state model was calibrated to data collected in late August. No precipitation was recorded during this period.
- The transient state model was calibrated to data collected during the June 17 – 18, 2010 aquifer pumping test. Again, no precipitation was recording immediately prior to or during the test.

The recharge package was utilized to evaluate seasonal fluctuations during various mining scenarios, as described in Section 4.1.5.

3.3.6 Streams

The STR of MODFLOW (Appendix C) was used to simulate the creek-aquifer interaction for streams within the model domain. Stream reaches were assigned to the nodal cells through which the basin creeks flow. Streamflow data was available from stream gauges located in Haggart Creek, Eagle Pup and Dublin, Cascallen, Bawn Boy, Olive, Stewart, Stuttle, and Ann Gulches. Stream elevation and flow data collected from 23 stream gauges on August 20, 2009 were used as. STR package input parameters and calibration targets for the model. Streamflow data used for the model is described and summarized in Stantec (2010b). Other data (stream width and bottom elevation) were estimated from the topographic map of the SA.

3.4 Model Calibration

Once the groundwater flow model was constructed, model calibration simulations were performed. Model verification runs were then performed to evaluate the model's ability to simulate stress conditions. Each of these components is discussed in this section.

Groundwater flow model calibration is the process in which uncertain model parameters, such as hydraulic conductivity, layer elevations, areal recharge, and boundary conditions are systematically adjusted until the difference between calibration targets and simulated output values are within acceptable limits. Because of the complexity of hydrogeologic systems, initial estimates of aquifer parameters typically do not produce a suitable correlation between predicted and observed conditions during initial model runs. To improve the correlation, an iterative process of adjusting model input parameters is conducted, until a reasonable match between the predicted and observed values is achieved. During the calibration process, targets are established for evaluating the quality of model calibration. Targets used for this groundwater model included:

- Hydraulics head elevations for SA groundwater monitoring wells
- Stream flow discharge rates
- Water balance discrepancies.

At total of 20 monitoring wells and 23 stream gauges were utilized during steady state and transient modeling scenarios (Figure 2.1-1). Monitoring wells and stream gauges were located throughout the model SA and represent conditions in each sub basin. Locations of monitoring wells, stream gauges, and four additional target nodes within model domain are shown on Figures 3.4-1 and 3.4-2.

3.4.1 Steady-State

Calibration of the groundwater flow system was initially based on a set of steady-state hydraulic conditions. Once a reasonable steady-state match was achieved between predicted and observed hydraulic conditions, a transient calibration simulation was performed. The model was calibrated to measured water levels and stream flow discharges collected in late August 2009. During calibration of the model, parameters including the layer bottom elevations, hydraulic conductivity values and boundary conditions were modified. The groundwater flow model was modified until a reasonable correlation between observed water level measurements and calculated hydraulic head was achieved.

3.4.2 Transient Simulation – Aquifer Pumping Test

As previously stated, sufficient historical records were not available to conduct a basin wide transient calibration simulation. However, an aquifer pumping test conducted June 17 and 18, 2010 provided sufficient data to conduct a transient simulation within Layer 1 on the model (Stantec 2010f). Transient model runs were performed using the hydraulic head data from the final steady-state calibration run as the initial conditions. The pumping test well was simulated operating at 10 to 40 gpm for a period of 36 hours. Predicted drawdown values were calculated for each observation well, and were compared to observed drawdown values.

4 MINING OPERATION SIMULATIONS

The primary purpose of the groundwater flow model was to evaluate the potential effects of mining activities and post-mining conditions on the hydrogeologic system within the Dublin Gulch valley. Details of the methodology used to simulate the various project facilities are presented below.

4.1 Model Setup

4.1.1 Waste Rock Storage Areas

The PG WRSA and EP WRSA are designed with high permeability rock drains overlying low permeability bedrock to prevent meteoric water from accumulating below the WRSAs; these drains are conservatively assumed (i.e., as having the maximum effect on groundwater in the Dublin Gulch valley) to be effective in eliminating recharge into the underlying bedrock. Thus, recharge zones within the WRSAs were given a value of zero for the entire simulation time. In addition, stream cells representing gulches within the WRSAs were removed.

4.1.2 Open Pit

The excavation of the open pit will result in substantial topographic changes in the basin and less direct recharge to the basin due to depressurization and dewatering activities.[2] These changes were incorporated into the model by modifying topography to match the proposed open pit footprint elevations and assigning drain package cells to simulate dewatering activities. Drain cells were assigned a water level elevation equivalent to the proposed elevation of the open pit floor and assigned a high hydraulic conductivity/conductance value to allow free flow of water. Water collected by the drain cells were reintroduced into the model at the approximate location of the lower Dublin Gulch channel and also added to the stream flow of Eagle Creek.

In addition, to conservatively simulate the maximum effect dewatering of the open pit would have on Dublin Gulch, recharge zones within the open pit were given a value of zero for the entire simulation time, and stream cells representing gulches within the open pit were removed.

4.1.3 Heap Leach Facility (HLF)

Construction and operation of the HLF will result in major changes to the physiography of Ann Gulch. Further, due to the double and triple-liner designs and groundwater drain system at the base of the HLF, direct recharge to the basin will be effectively eliminated. These changes were incorporated into the model by modifying topography to match the proposed HLF footprint elevations and assigning drain package cells to the footprint floor. Drain cells were assigned an elevation equivalent to the HLF bottom. Drain cells were assigned a water-level elevation equivalent to the proposed elevation of the HLF bottom and assigned a high hydraulic conductivity/conductance value to allow free flow of water. Water collected by the drain cells was reintroduced into the model at the approximate location of the lower Dublin Gulch channel and also added to the stream flow of Eagle Creek.

To conservatively simulate the maximum effect the removal of water within the HLF would have on Dublin Gulch, recharge zones within the HLF were given a value of zero for the entire simulation time, and stream cells representing flow of Ann Gulch were removed.

In addition to existing target points, four additional target nodes (i.e., a hypothetical piezometer), identified as HL1, HL2, HL3, and HL4, were added to the target set for the operations and post-closure phases, and for the upset conditions along the north side of Dublin Gulch Creek beneath and downstream of the proposed HLF. The purpose of these additional nodes were to provide further predicted hydraulic head levels along the area most that would be most likely effected by the HLF.

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[2] BGC (2010b) provides a more site-specific analysis of the proposed depressurization and dewatering program.

4.1.4 Other Mine Facilities

Dublin Gulch Realignment. The relocation and conveyance of stream flow from Dublin Gulch was represented in the model by realigning the stream cells representing Dublin Gulch to match the proposed diversion structure.

4.1.5 Recharge Package

Recharge rates were based on the assumptions as described in Section 3.3.5 Areal Recharge. Recharge rates for each recharge scenario and corresponding elevation are presented in Table 4.1-1. Zonation of recharge zones are presented on Figure 3.3-10.

Table 4.1-1: Groundwater Flow Model Recharge Zones

Zone	Month	Top Elevation Zone (m ASL)	Average Year	Wet Year	Dry Year	Average Year	Wet Year	Dry Year
			Average Daily Recharge Rate (m/d) per Month			Average Daily Recharge Rate (m/d) per Year		
1	October	1,375 – 1,475	0.000563	0.000906	0.000191	0.00104	0.00197	0.00025
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			
	January		0.000000	0.000000	0.000000			
	February		0.000000	0.000000	0.000000			
	March		0.000000	0.000000	0.000000			
	April		0.000701	0.001129	0.000238			
	May		0.005721	0.009508	0.001876			
	June		0.001887	0.003926	0.000338			
	July		0.001326	0.003159	0.000098			
	August		0.000927	0.002246	0.000066			
	September		0.001354	0.002725	0.000158			
2	October	1,275 – 1,375	0.000534	0.000860	0.000187	0.00097	0.00185	0.00024
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			
	January		0.000000	0.000000	0.000000			
	February		0.000000	0.000000	0.000000			
	March		0.000000	0.000000	0.000000			
	April		0.000659	0.001061	0.000231			
	May		0.005360	0.008895	0.001822			
	June		0.001749	0.003677	0.000327			
	July		0.001230	0.002974	0.000096			
	August		0.000867	0.002124	0.000066			
	September		0.001272	0.002585	0.000153			

Zone	Month	Top Elevation Zone (m ASL)	Average Year	Wet Year	Dry Year	Average Year	Wet Year	Dry Year
			Average Daily Recharge Rate (m/d) per Month			Average Daily Recharge Rate (m/d) per Year		
3	October	1,175 – 1,275	0.000506	0.000814	0.000184	0.00091	0.00173	0.00023
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			
	January		0.000000	0.000000	0.000000			
	February		0.000000	0.000000	0.000000			
	March		0.000000	0.000000	0.000000			
	April		0.000618	0.000994	0.000224			
	May		0.005011	0.008299	0.001767			
	June		0.001613	0.003426	0.000317			
	July		0.001133	0.002784	0.000093			
	August		0.000805	0.001999	0.000065			
	September		0.001190	0.002442	0.000149			
4	October	1,075 – 1,175	0.000479	0.000769	0.000180	0.00084	0.00161	0.00023
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			
	January		0.000000	0.000000	0.000000			
	February		0.000000	0.000000	0.000000			
	March		0.000000	0.000000	0.000000			
	April		0.000578	0.000928	0.000217			
	May		0.004675	0.007721	0.001713			
	June		0.001481	0.003174	0.000306			
	July		0.001037	0.002590	0.000091			
	August		0.000744	0.001869	0.000064			
	September		0.001107	0.002297	0.000145			
5	October	975 – 1,075	0.000452	0.000725	0.000177	0.00078	0.00150	0.00022
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			
	January		0.000000	0.000000	0.000000			
	February		0.000000	0.000000	0.000000			
	March		0.000000	0.000000	0.000000			
	April		0.000540	0.000865	0.000211			
	May		0.004350	0.007161	0.001660			
	June		0.001352	0.002922	0.000296			
	July		0.000942	0.002392	0.000088			
	August		0.000682	0.001737	0.000063			
	September		0.001024	0.002149	0.000140			

Zone	Month	Top Elevation Zone (m ASL)	Average Year	Wet Year	Dry Year	Average Year	Wet Year	Dry Year
			Average Daily Recharge Rate (m/d) per Month			Average Daily Recharge Rate (m/d) per Year		
6	October	875 – 975	0.000426	0.000682	0.000173	0.00072	0.00138	0.00021
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			
	January		0.000000	0.000000	0.000000			
	February		0.000000	0.000000	0.000000			
	March		0.000000	0.000000	0.000000			
	April		0.000502	0.000803	0.000204			
	May		0.004037	0.006620	0.001608			
	June		0.001227	0.002671	0.000286			
	July		0.000849	0.002192	0.000086			
	August		0.000622	0.001603	0.000063			
	September		0.000941	0.002000	0.000136			
7	October	775 – 875	0.000401	0.000639	0.000170	0.00066	0.00127	0.00021
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			
	January		0.000000	0.000000	0.000000			
	February		0.000000	0.000000	0.000000			
	March		0.000000	0.000000	0.000000			
	April		0.000466	0.000743	0.000198			
	May		0.003736	0.006099	0.001556			
	June		0.001106	0.002424	0.000276			
	July		0.000759	0.001990	0.000083			
	August		0.000562	0.001467	0.000062			
	September		0.000859	0.001849	0.000132			
8	October	N/A	0.000401	0.000639	0.000170			
	November		0.000000	0.000000	0.000000			
	December		0.000000	0.000000	0.000000			

4.1.6 Well Package

The well package was utilized to represent proposed water supply wells within the model domain. Proposed daily usages for camp and process make-up water were used to evaluate the effects of pumping and whether proposed pumping rates would be sustainable.

The well package was also utilized to represent leakage from the HLF for the upset condition and infiltration for evaluating the WRSA recharge condition. An injection rate with a prescribed cyanide concentration was entered into cells that represented leakage beneath the HLF. For cells that represented infiltration beneath the WSRAs, an injection rate with a prescribed mineral concentration was entered.

4.1.7 Model Scenarios

A baseline model scenario (no modifications to basin) was compared to modeled scenarios that incorporated proposed alterations required for proposed mining activities. Each model scenario was selected to evaluate effects of the operation on the hydrogeologic system within Dublin Basin.

To be conservative, the mining scenario assumed an 8-year operation of mining activities at maximum build-out. Subsequently, the post-closure scenario assumed all operations had ceased, and that the effects of the topographical and surface water alterations remained (e.g. no recharge in areas of HLF and WSRAs would continue to be diverted/removed by the drains).

4.1.8 Sensitivity Analysis

A sensitivity of model performance and predictions was conducted to evaluate changes to model predictions based on changes in the hydraulic conductivity and storativity values. Hydraulic conductivity and storativity were selected because:

1. These represent parameters with values that have the most potential to vary across the SA
2. Changes in values to these parameters have the most effect on the model results
3. Changes in values to these parameters have the most effect on results as it relates to the purpose of this study.

To evaluate the sensitivity of each parameter, hydraulic conductivity used in the calibrated model were varied +/-0.5 times the value, and storativity values used in the calibrated baseline model were varied +/- one order of magnitude. Values of hydraulic conductivity and storativity used for the sensitivity analysis are included on Table 4.1-2.

Table 4.1-2: Steady State Model Calibration Results

Target/Well Location	Site Coordinates (x,y)		Model Layer	Observed Target/Drawdown (meters)	Computed Target/Drawdown (meters)	Residual Target/Drawdown (meters)
MW09-AG1	459425.4	7101949	2	1,002.270	1,000.415	1.916
MW09-AG2	459784.6	7101981	2	993.670	1,002.962	-9.241
MW09-DG2	458992.3	7100877	1	821.490	815.784	5.827
MW09-DG4	458284.1	7101111	1	779.630	774.134	5.510
MW09-DG5	458396.8	7100606	1	798.270	782.610	15.674
DH95-152	459198.3	7100917	1	828.090	830.453	-2.228
MW96-17b	460489.7	7099563	2	1,283.560	1,275.750	1.462
MW96-18	460520	7099488	2	1,313.170	1,310.366	-1.224
MW96-13b	460003.6	7100925	2	966.310	963.735	5.076

Target/Well Location	Site Coordinates (x,y)		Model Layer	Observed Target/Drawdown (meters)	Computed Target/Drawdown (meters)	Residual Target/Drawdown (meters)
MW96-14b	460187.3	7100617	1	971.210	972.781	-0.517
MW96-14a	460192.3	7100604	1	973.100	975.213	-1.341
MW96-15b	459762.8	7101024	2	933.750	930.000	5.198
MW09-OG2	462098.7	7100265	2	1,325.610	1,319.512	-0.653
MW09-OG3	461222.8	7101552	1	1,062.560	1,060.321	2.292
DH95-146	463337	7101285	2	1,334.760	1,340.125	-6.891
MW96-23	459643.2	7099234	2	984.770	970.210	-1.725
MW09-DG1	459325.8	7101010	1	836.640	836.778	-0.136
MW09-Stu1	459770.2	7100648	2	952.070	948.190	7.838
MW09-Stu2	459229.1	7100750	1	855.840	855.807	0.144
DH95-144	463758.6	7101546	2	1,384.630	1,380.990	0.075
Normalized Root Square Mean =						0.02
Normalized Root Square Mean Percent =						0.0204

In addition, a sensitivity analysis was conducted on recharge values by using predicted values for wet and dry years. The wet, average and dry years were defined as the 5%, 50% and 95% exceedances corresponding to the 1.055, 2 and 20-year return intervals. The rationale for using these hydroclimatic conditions is summarized in Stantec (2010b) and is based on several factors including the risk of the precipitation frequency and magnitude occurring within the project life.

Values of recharge used for the sensitivity analysis are included on Table 4.1-2. The sensitivity analysis of the model is typically based on observations of model performance during the calibration of the steady-state simulations. A sensitivity analysis was conducted by simulating different values for the recharge, hydraulic conductivity, and storativity.

For hydraulic conductivity, values were raised and lowered by a factor of 2. For storativity, values were raised and lowered by a factor of 10. For recharge, values were raised and lowered based on anticipated precipitation during wet and dry years.

Results of the sensitivity analysis are presented in Appendix B.

5 RESULTS OF MINING MODEL RESULTS

Results of modeling baseline, operations and post-closure conditions were compared to assess potential impacts to the hydrogeologic system within Dublin Gulch valley. Graphs depicting predicted groundwater elevation variations between baseline, operations, and post-closure phases are presented in Appendix A.

5.1 Steady-State

A series of changes in the hydraulic conductivity values, bottom elevations and subsurface inflow from the bedrock margins were implemented into the model to achieve an acceptable calibration match between predicted and observed hydraulic head and stream flows. As the changes in the aquifer properties for the different layers in the model domain progressed, lesser variations from target values were observed. Simulated groundwater elevation contours for the final calibration run are provided in Figure 5.1-1. Residuals for hydraulic head and stream flow (flux) targets are presented on Figures 5.1-2 and 5.1-3. Positive residuals indicate targets where simulated head/flow values were less than observed values. Negative residuals indicate targets where simulated head/flow values are greater than observed values.

Based on a comparison of observed and calculated hydraulic head and stream flux values:

- Groundwater flow conditions simulated in the final calibrated model are representative of the field conditions observed in the SA.
- Plots of residuals on Figures 5.1-2 and 5.1-3 do not indicate the presence of an areal bias.
- Calibrated flow model achieved an acceptable water balance discrepancy of less than 0.01%.

A typical measurement of the adequacy of calibration for hydraulic heads is the normalized root mean squared value of the calibration residuals (NBLM 2008). The normalized root mean square for calibration of hydraulic heads was 2%, which according to NBLM (2008) is within acceptable ranges. Hydraulic head results for the steady state model calibration are presented on Table 4.1-2 and Figure 5.1-4.

5.2 Transient

Table 5.2-1 summarizes the results of the transient model calibration runs. In general, a good correlation between predicted and observed drawdown values was achieved. The largest discrepancy between predicted and observed drawdown values occurred for MW10-OBS-1. The predicted value (0.158 m) overestimates the observed value (0.095 m). Comparison of the other verification targets show a reasonable match between predicted and observed drawdown values. Figures 5.2-1 and 5.2-2 present observed and predicted drawdown values. In addition, the calibrated flow model achieved an acceptable water balance discrepancy of less than 0.01%.

Table 5.2-1: Transient Model Calibration Results

Time (days)	Observed Target/Drawdown (meters)	Computed Target/Drawdown (meters)	Residual Target/Drawdown (meters)
OBS2 Layer 1, Site Coordinates (x,y) (458405.8, 7101120)			
0.00	0.000	0.002	-0.002
0.04	0.019	0.002	0.016
0.08	0.035	0.005	0.030
0.13	0.047	0.009	0.038

Time (days)	Observed Target/Drawdown (meters)	Computed Target/Drawdown (meters)	Residual Target/Drawdown (meters)
0.17	0.067	0.015	0.052
0.21	0.085	0.021	0.063
0.25	0.089	0.029	0.060
0.29	0.097	0.036	0.061
0.33	0.104	0.043	0.061
0.38	0.109	0.050	0.059
0.42	0.114	0.056	0.057
0.46	0.116	0.062	0.054
0.50	0.118	0.068	0.050
0.54	0.117	0.073	0.044
0.58	0.119	0.078	0.041
0.63	0.120	0.083	0.037
0.67	0.120	0.088	0.033
0.71	0.121	0.092	0.029
0.75	0.126	0.096	0.029
0.79	0.126	0.100	0.026
0.83	0.128	0.104	0.024
0.88	0.130	0.108	0.022
0.92	0.128	0.111	0.017
0.96	0.131	0.114	0.017
1.00	0.134	0.117	0.016
1.04	0.135	0.120	0.015
1.08	0.136	0.123	0.012
1.13	0.137	0.126	0.011
1.17	0.140	0.128	0.012
1.21	0.143	0.131	0.012
1.25	0.129	0.133	-0.004
1.29	0.074	0.130	-0.057
1.38	0.072	0.120	-0.048
1.42	0.063	0.114	-0.052
1.46	0.062	0.109	-0.047
1.50	0.063	0.104	-0.041
1.54	0.060	0.099	-0.039
1.58	0.057	0.095	-0.038
1.63	0.056	0.091	-0.035

Time (days)	Observed Target/Drawdown (meters)	Computed Target/Drawdown (meters)	Residual Target/Drawdown (meters)
1.67	0.055	0.088	-0.033
1.71	0.054	0.084	-0.030
1.75	0.052	0.081	-0.029
1.79	0.054	0.079	-0.024
1.83	0.054	0.076	-0.022
1.88	0.053	0.074	-0.021
1.92	0.055	0.071	-0.017
OBS1 Layer 1, Site Coordinates (x,y) (458443.1, 7101102)			
0.00	0.000	0.002	-0.002
0.04	0.004	0.002	0.002
0.08	0.010	0.005	0.005
0.13	0.012	0.010	0.002
0.17	0.020	0.016	0.003
0.21	0.026	0.025	0.001
0.25	0.031	0.034	-0.003
0.29	0.040	0.043	-0.003
0.33	0.042	0.052	-0.010
0.38	0.047	0.060	-0.013
0.42	0.050	0.067	-0.016
0.46	0.053	0.073	-0.020
0.50	0.057	0.080	-0.022
0.54	0.061	0.085	-0.024
0.58	0.063	0.091	-0.028
0.63	0.064	0.096	-0.032
0.67	0.064	0.101	-0.037
0.71	0.067	0.105	-0.039
0.75	0.068	0.110	-0.042
0.79	0.069	0.114	-0.045
0.83	0.073	0.118	-0.045
0.88	0.076	0.122	-0.046
0.92	0.078	0.125	-0.047
0.96	0.080	0.128	-0.048
1.00	0.083	0.131	-0.048
1.04	0.083	0.134	-0.051
1.08	0.088	0.137	-0.049

Time (days)	Observed Target/Drawdown (meters)	Computed Target/Drawdown (meters)	Residual Target/Drawdown (meters)
1.13	0.090	0.139	-0.050
1.17	0.095	0.142	-0.047
1.21	0.092	0.144	-0.052
1.25	0.095	0.146	-0.051
1.29	0.079	0.140	-0.061
1.38	0.080	0.125	-0.045
1.42	0.071	0.118	-0.047
1.46	0.070	0.111	-0.041
1.50	0.071	0.106	-0.035
1.54	0.069	0.100	-0.031
1.58	0.067	0.096	-0.029
1.63	0.065	0.092	-0.027
1.67	0.063	0.088	-0.025
1.71	0.062	0.085	-0.023
1.75	0.060	0.082	-0.021
1.79	0.060	0.079	-0.019
1.83	0.060	0.076	-0.016
1.88	0.059	0.074	-0.015
1.92	0.060	0.072	-0.012

Summary Statistics	Residual Target/Drawdown (meters)
Residual Mean	-0.009
Res. Std. Dev.	0.034
Sum of Squares	0.117
Abs. Res. Mean	0.031
Min. Residual	-0.061
Max. Residual	0.063
Range in Target Values	0.143
Std. Dev./Range	0.236

5.2.1 Operations Phase

Model simulations indicate groundwater elevations will continue to fall throughout the proposed 8-year operations phase. By the end of operations, groundwater elevations within the proposed mining areas within the Dublin Gulch valley are predicted to change the most in Eagle Pup, Stuttle, and Platinum Gulches. The greatest effects to water table elevation are predicted to occur within the open pit area and downgradient of the open pit (water table decreasing between 40 to 105 m). The water table in areas outside the open pit but still within Eagle Pup, Stuttle, and Platinum Gulch are predicted to decrease by 10 to 20 m. Gulches located upgradient of the proposed mining activities and groundwater levels in the area of Haggart Creek are expected to have minor to negligible changes due to the mining activities.

In isolated areas where natural occurring streams have been diverted and/or eliminated, the groundwater model indicates a rise in groundwater level. This is observed near the location below the HLF at the confluence of Ann Gulch and Dublin Gulch (target h2) and midway up Eagle Pup Gulch (target wells MW-14a and MW-14b) at the downgradient edge of the proposed Eagle Pup WSRA. This is most likely the result of the realignment of gaining streams. Due to alterations in stream flow, groundwater does not contribute to streams and as such the groundwater table is predicted to be higher. Plotting of modeling results in the form of groundwater contours indicates the general flow of groundwater within Dublin Gulch will be westerly toward Haggart Creek and remain relatively consistent with pre-mining. Groundwater flow and drawdown during mining operations are presented on Figures 5.2-3 and 5.2-4.

5.2.2 Water Supply

To evaluate water supply scenarios for the proposed mine, the following assumptions were incorporated into the model:

- Water usage per person is estimated at 300 litres per day and a maximum number of 400 persons would be using water at the mining site. Based on this, maximum water supply requirements for the camp would be approximately 120 m^3/d.
- Supplemental process water requirements are assumed to be approximately 310 m^3/day.

Based on this, maximum required water supply would not require a sustainable pumping rate above 430 m^3/d.

Model scenarios were set up to evaluate pumping from a well constructed within Layer 1 (representing alluvial material) and assigned a pumping rate of 430 m^3/d. Based on model results, this pumping rate is sustainable.

5.2.3 Post-closure Phase

For the post-closure phase, water supply from pumping from wells is presumed to be discontinued. To be conservative in predicting worst-case long-term effects on groundwater in the Dublin Gulch valley, the following assumptions were made:

- Drains beneath the HLF and within the open pit were assumed to be fully functional for post closure
- Recharge into the subsurface from precipitation would not occur in the areas of the WRSAs, open pit, and HLF.

In most cases, post-closure predictions indicate that water levels will stabilize within a year of ending the operations phase. Areas within areas around and downgradient of the open pit and HLF will recover partially, but will not return to baseline due to continued drainage of precipitation in the areas of the HLF and WSRAs, and drainage of precipitation and sidewall seepage within the open pit. Post-mining groundwater flow is presented on Figure 5.2-5.

5.2.4 Sensitivity Analysis Results

Results of sensitivity analysis conducted on the model are presented in Appendix B. Generally, the results of the sensitivity analysis indicate the following:

- Greater water table declines were predicted during operations for sensitivity runs that incorporated lower hydraulic conductivity values, lower storativity values and lower recharge values.
- Less water table declines were predicted during operations for sensitivity runs that incorporated higher hydraulic conductivity values, higher storativity values and higher recharge values.
- Changes in hydraulic conductivity have the most effect on model predictions as it relates to groundwater elevations and effects of mining activities on the groundwater table.
- Of the target hydraulic heads utilized for the model, the greatest effect on predicted hydraulic heads due to changes in input values was predicted at locations in the vicinity of the proposed open pit and HLF. Effects on target hydraulic heads outside these areas (upgradient gulches, Haggart Creek) indicated relatively small changes in predicted values.

5.2.5 Upset Conditions

To evaluate the result of liner leak in the HLF and subsequent release of solution into groundwater, the following was assumed:

- Concentration of cyanide solution would be 200 mg/L
- An irrigation rate of 48,000 m^3/day of cyanide solution.

Further, it was assumed that a 25 m length of drain and containment pad would be breached in three areas, one for each side on the downgradient location of the HLF. Each breach would leak at a rate of approximately 62.5 m^3/d. The dimensions of this condition are partly a function of grid spacing of the model (25 m by 25 m). Given the design and redundancy in drainage controls, the magnitude of leakages described here are not considered to be representative of what type of leakage could occur from the HLF. However, the above-described ultraconservative assumptions provide a means to evaluate how a leak might travel downgradient without being discovered and mitigated.

This was based on the total amount of cyanide solution applied/square meter, and was represented in the model by simulating an introduction of solution via a constant rate boundary condition cells (well package) adjacent and downgradient of the HLF while injecting into Layer 1 of the model at a rate of 62.5 m^3/d at a concentration of 200 mg/L. The model was simulated for a period consistent with the proposed mining operations (approximately eight years). To be conservative, no degradation or adsorption of the solution was assumed.

The scenario assumed that failed drain sections resulted in release of the cyanide solution beneath the HLF pad. Under this scenario, the wells were placed beneath the HLF pad. Based on model results of this scenario, concentrations of cyanide solution above 0.001 mg/L would be confined to Layers 1 and 2 of the model (representing the overburden and weathered bedrock strata). In addition:

- Assuming one year of constant release and no mitigation efforts, concentrations of cyanide solution in groundwater were predicted to reach the proposed vicinity of the mine water supply well within one year at an average concentration of approximately 0.002 mg/L (Figure 5.2-6). If the release was continuous throughout the length of operations and no mitigation efforts were conducted, concentrations at the proposed water supply well vicinity would increase over the next eight years to an average concentration of approximately 4.6 mg/L before stabilizing.
- Assuming two years of constant release and no mitigation efforts, groundwater impacted with cyanide solution is predicted to migrate to areas within the lower portion of Dublin Gulch Creek and Haggart Creek at concentrations at concentrations below 1 mg/L (Figure 5.2-7).
- If the release is continuous throughout the length of operations and no mitigation efforts are conducted, cyanide solution in groundwater was predicted to approach 20 mg/L in at the Dublin Gulch and Haggart Creek confluence after 10 years (Figures 5.2-8). The extent of the 0.0001 mg/L isoconcentration contour would extend down Haggart Creek approximately 2 km from the mouth of Dublin Gulch.
- After 20 years, the extent would be very similar to the extent after 10 years (Figure 5.2-9).
- Measureable effects to deeper groundwater in the weathered bedrock and lower aquifer zones was not predicted.

Model predictions of the above described upset condition are presented on Figures 5.2-6 through 5.2-9.

5.2.6 WSRA Recharge Condition

For both WRSA rock drains during the operations phase, it was conservatively assumed that the rock drains below the WRSA would capture all recharge through the pile and transmit the flow to the seepage collection pond, thus there would be no direct recharge under the WRSA. This assumption is reasonable based on the relatively low permeability of the underlying bedrock and the positive vertical gradients that have been observed in the area of the proposed drains.

Although it was assumed above that the rock drains would intercept all water and there would be no recharge, additional modeling was conducted to evaluate the down-gradient effects on water quality should some of this water recharge into the subsurface. The evaluation included the following:

- To represent recharge, cells beneath sections of the WSRAs were assumed to have a constant recharge rate of 8.4 x 10-5 m^3/d (approximately 1% of the expected net precipitation in the areas of the WSRA) with a unit concentration value of 100. Recharge cell locations are shown in Figure 5.2-10.

- Transport was assumed to begin at the start of operations and continue for 10 years after mining activities ceased (to the end of closure and reclamation). During this time, recharge and concentration into Layer 2 was considered to be constant.
- To add into the conservancy of the simulation, no retardation or degradation rates were assumed.

Results of the model are presented in Figures 5.2-11 to 5.2-16 and indicate that:

- Injected water would migrate towards Haggart Creek via either Platinum Gulch or lower Dublin Gulch.
- Groundwater with the injected solution would enter only the uppermost hydrostratigraphic unit of the model (Layer: surficial alluvium, placer deposits, and till) but would not migrate downward into deeper model layers.
- By the time groundwater beneath the WSRAs migrated to Dublin or Haggart Creek, attenuation effects (i.e., advection and dispersion transport) would have reduced the initial seepage concentrations to less than 1% in most areas and would not exceed 4%.

6 SUMMARY

Overall, the general groundwater flow patterns within the Dublin Gulch valley will remain similar to baseline conditions. While areas above the lower Dublin Gulch valley (e.g. Eagle Pup, Stuttle, Platinum Gulches) are expected to have the water table drop substantially, the overall water table within the Dublin Gulch valley is expected to drop between 2 and 15 m.

Water supply predictions are based on data collected from a 24-hour pumping test. However, the presence of hydraulic boundaries not observed during the pumping test and the design of the well could limit the amount of water that can be pumped from a single location. Additional well yield tests should be conducted to further evaluate sustainable pumping rates.

Scenarios modeled for this assessment were conducted using very conservative assumptions, specifically:

- During operations and post-closure, model inputs assumed that recharge to areas within the open pit, HLF, and WSRAs would continue to be drained prior to infiltrating to the subsurface. In actuality, some recharge through precipitation and/or seeps will likely occur. Based on this, the model is most likely overpredicting groundwater drawdown in both the mining scenarios and post-mining scenarios.
- Large drawdowns were predicted in the upper eastern portion of the drainage basin (areas that correspond to site areas above Cascadian and Bawn Boy Gulches); however, this is most likely a function of model domain boundaries and is not expected to occur.

- Cyanide migration from the HLF and migration of leached water from the WSRA did not consider retardation or degradation. In actuality, retardation and/or degradation is likely to occur. Based on this, the model is likely over predicting the concentration values and migration rate of cyanide and WRSA affected water. Further, the assumptions regarding lack of mitigation are not realistic. Groundwater monitoring will be on-going, and any indication of cyanide in groundwater would be mitigated by installing wells which would be used for process make-up water during operations and sent to detoxification plant and treatment during reclamation phase.

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8 FIGURES

Please see the following pages.

Data Sources; Government of Canada, Victoria Gold Corp.

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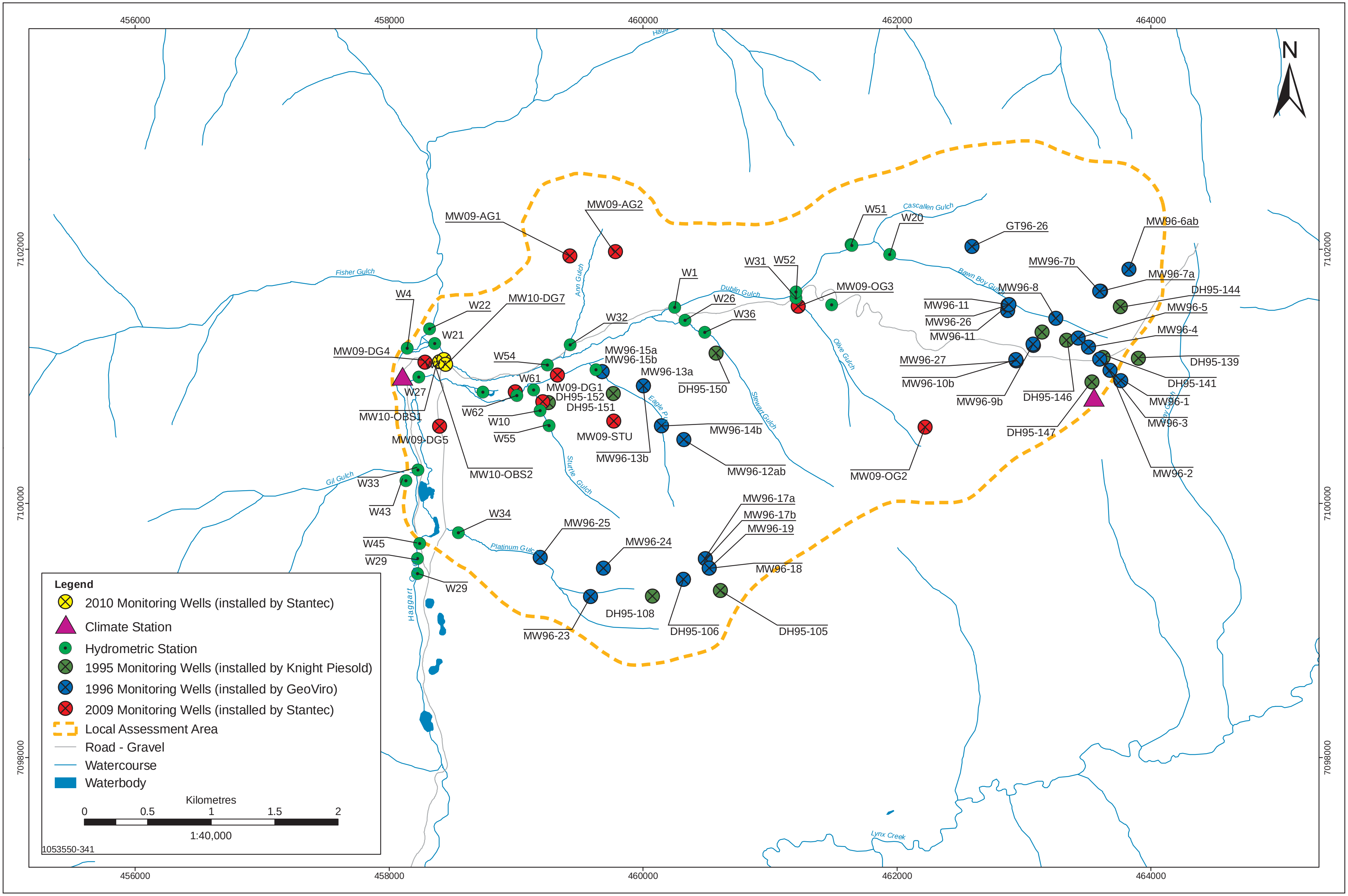
Victoria GOLD CORP

SITE LOCATION MAP
EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 8-November-2010	FIGURE NO. 1.2-1



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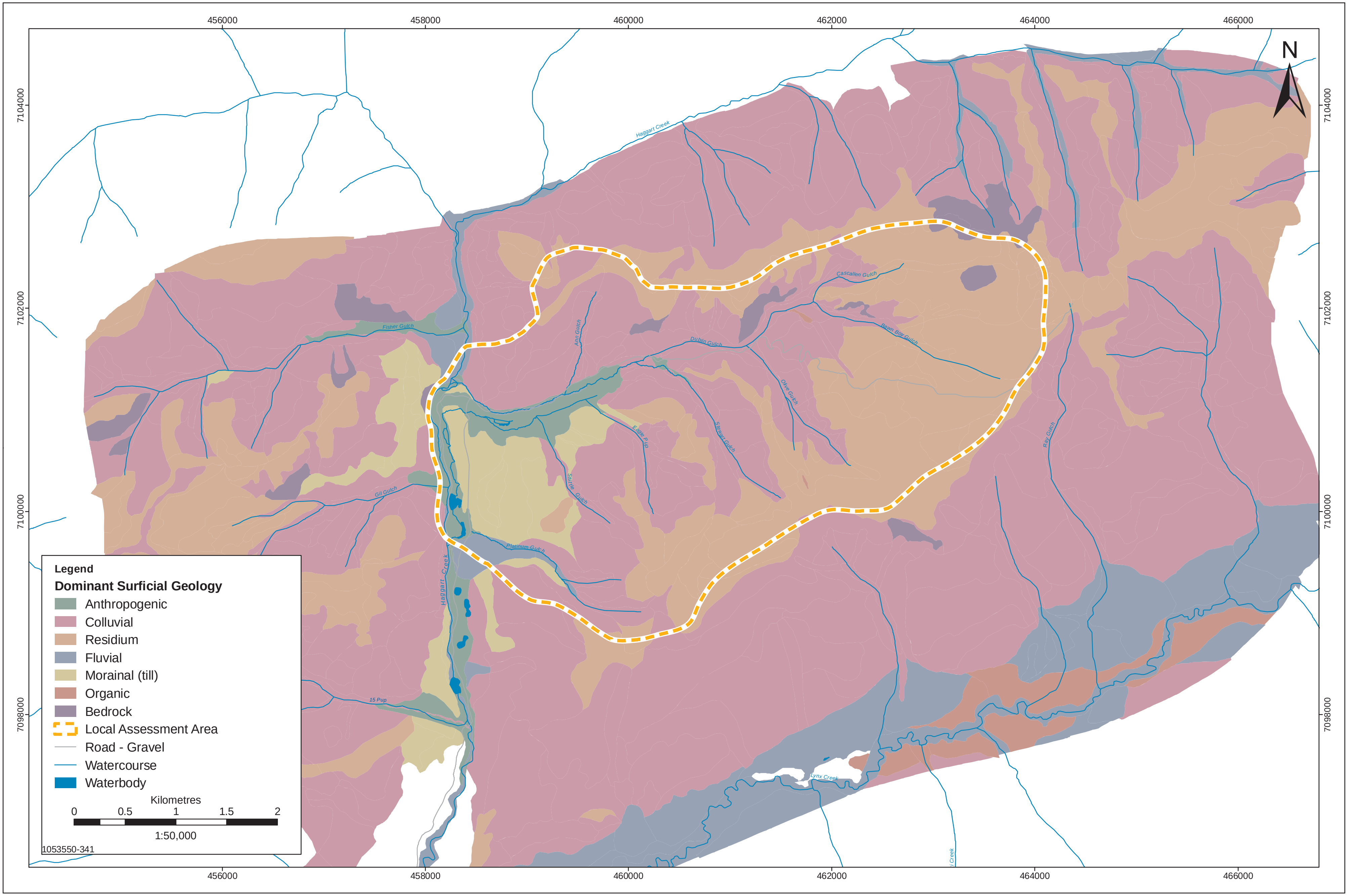
Victoria GOLD CORP

CLIMATE, HYDROMETRIC AND GROUNDWATER MONITORING LOCATIONS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
17-November-2010	2.1-1



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SURFICIAL GEOLOGY MAP

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
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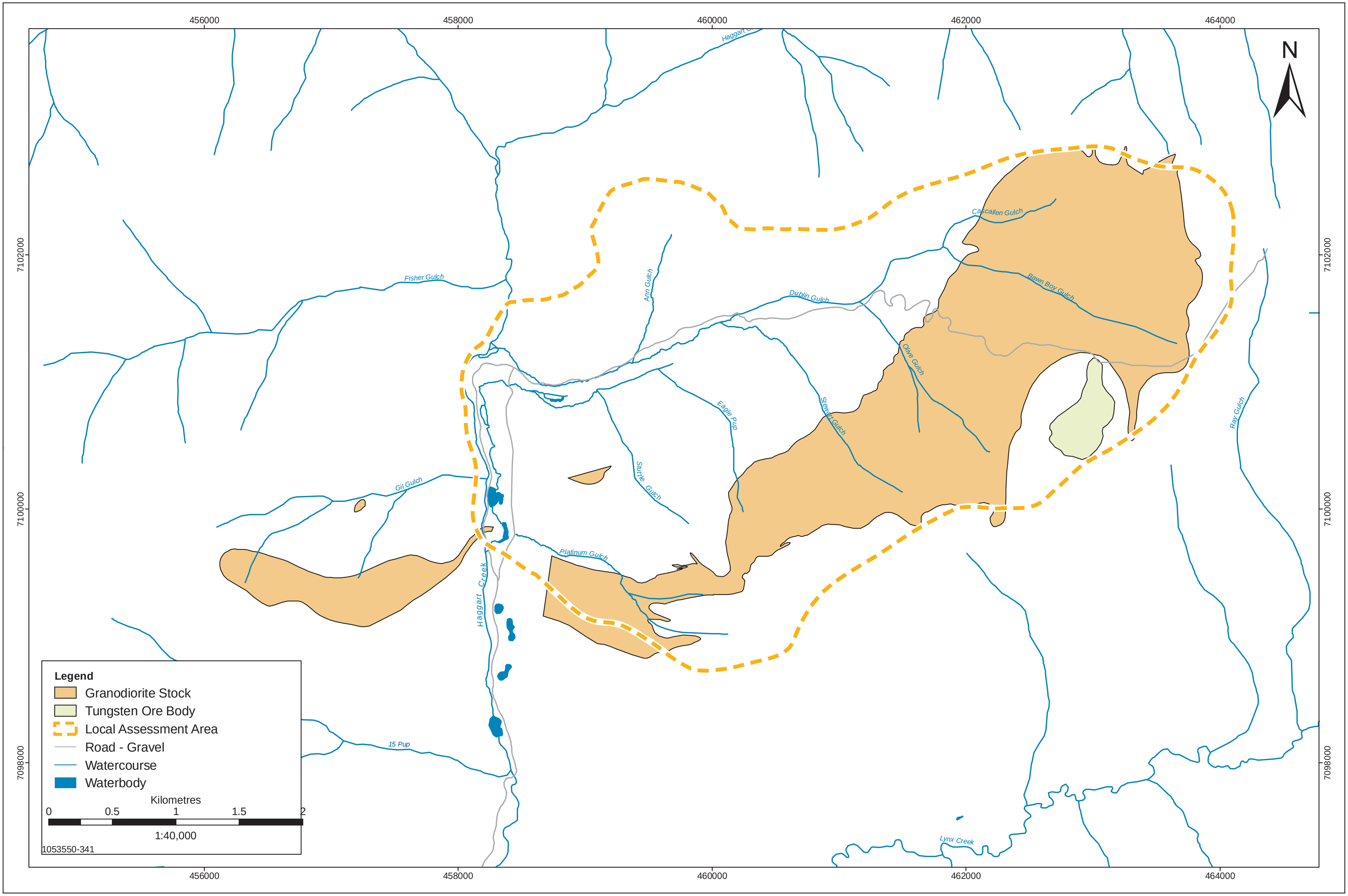

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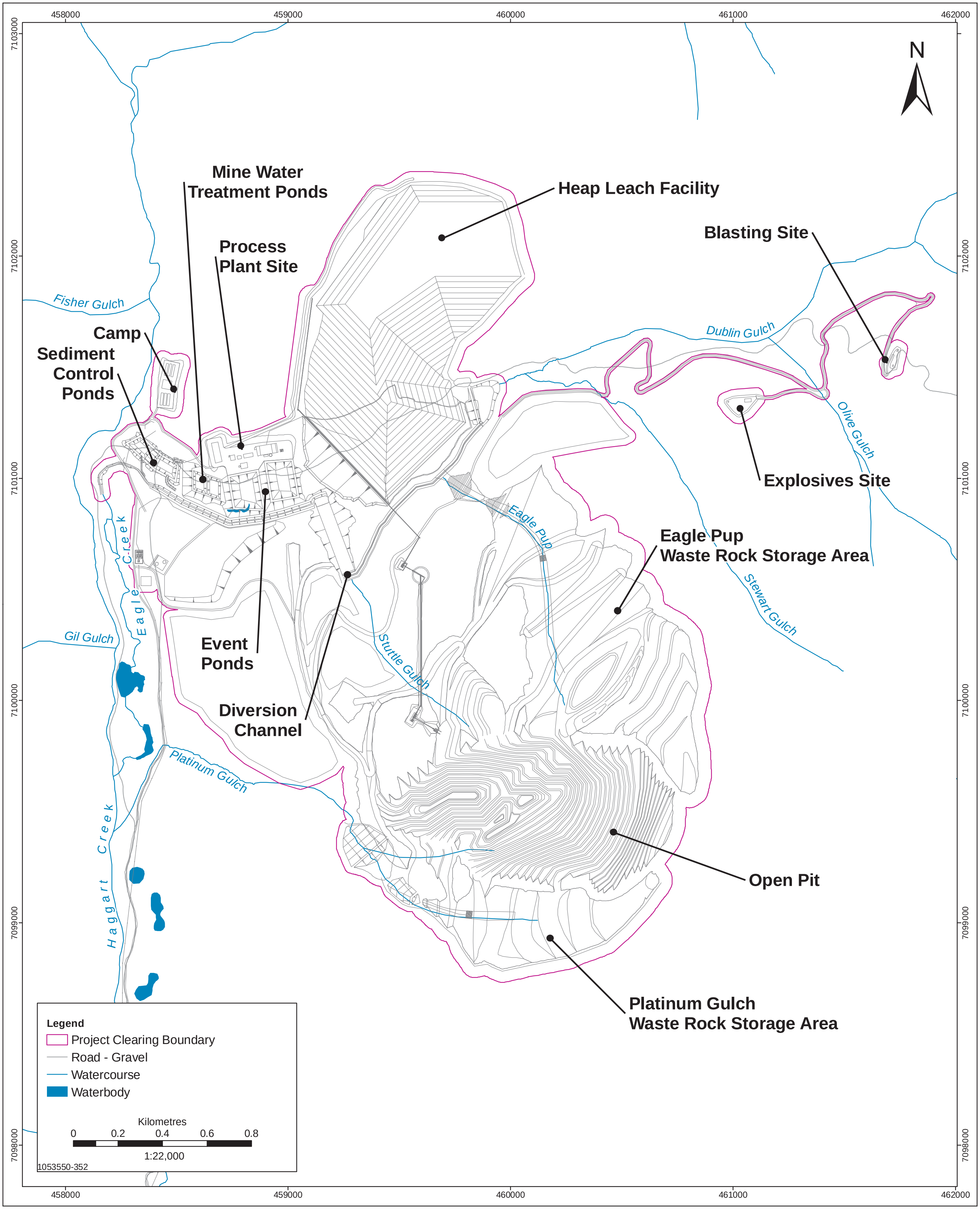
BEDROCK GEOLOGY MAP

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 17-November-2010	FIGURE NO. 2.3-2



Data Sources; Government of Canada, Victoria Gold Corp.

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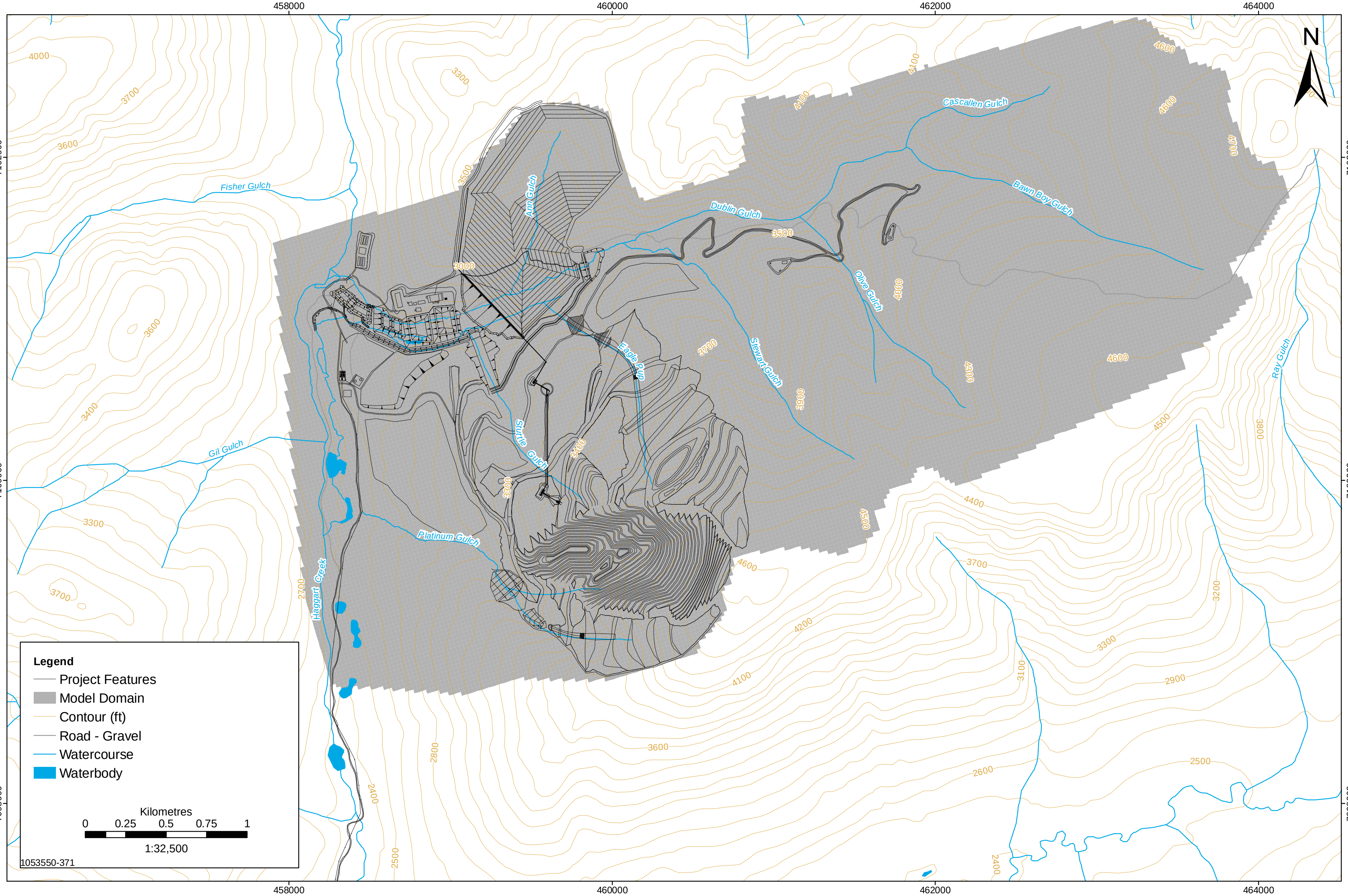
Victoria GOLD CORP

SITE FACILITIES LAYOUT WITH DRAINAGES

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
17-November-2010	2.5-1



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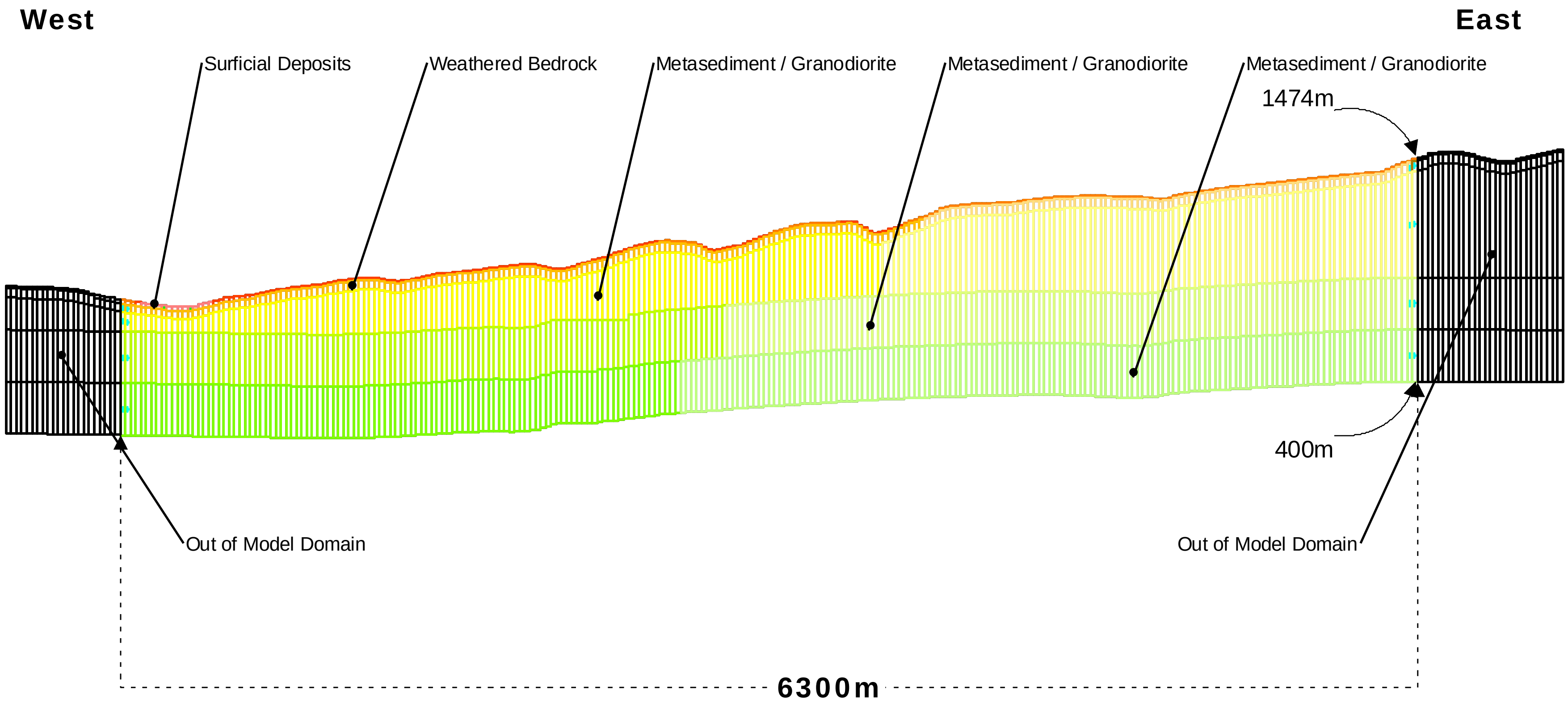
GROUNDWATER MODEL DOMAIN

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
19-November-2010	3.3-1

Cross Section Along Row 95



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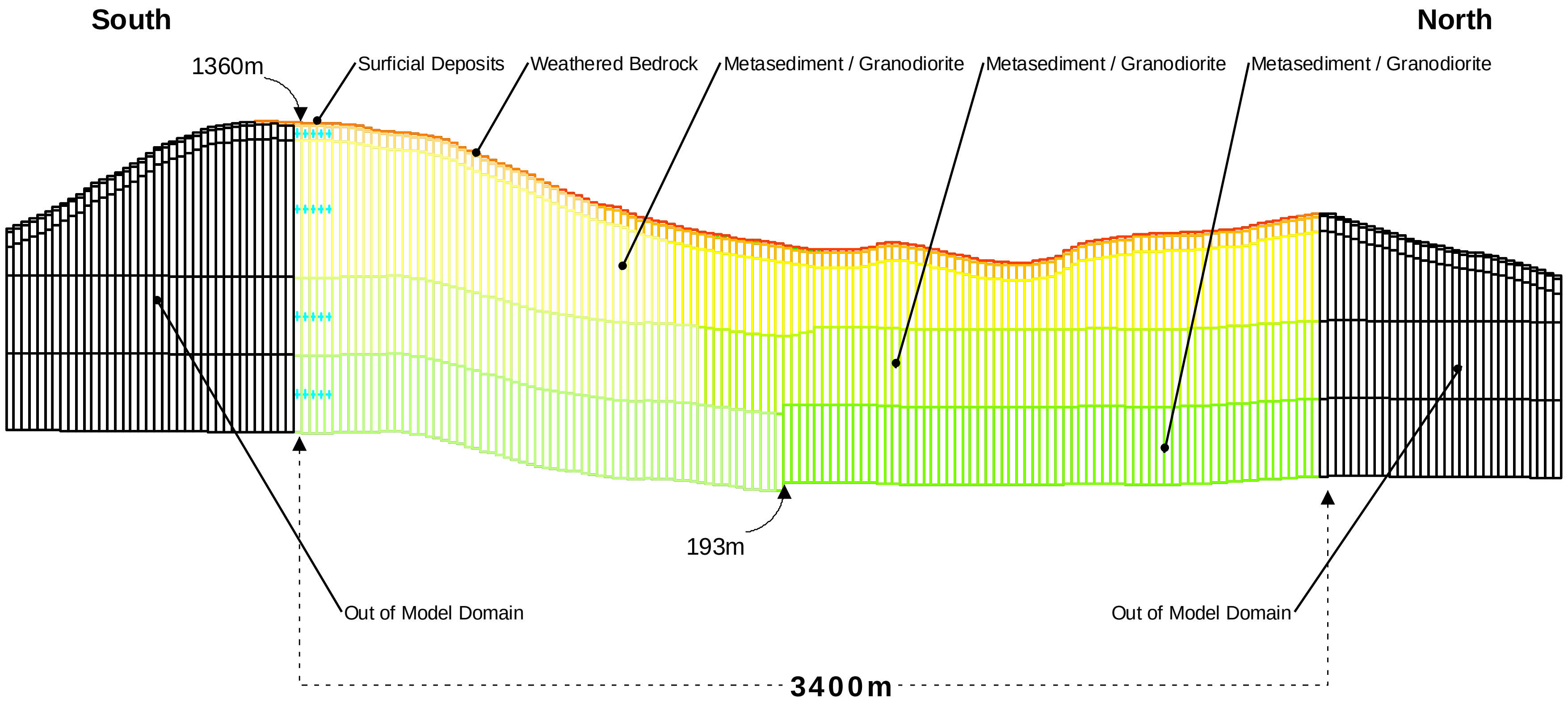
GROUNDWATER MODEL CROSS SECTION EAST TO WEST

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 05-December-2010	FIGURE NO.: 3.3-2

Cross Section Along Column 109



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GROUNDWATER MODEL CROSS SECTION SOUTH TO NORTH

EAGLE GOLD PROPERTY
YUKON TERRITORY

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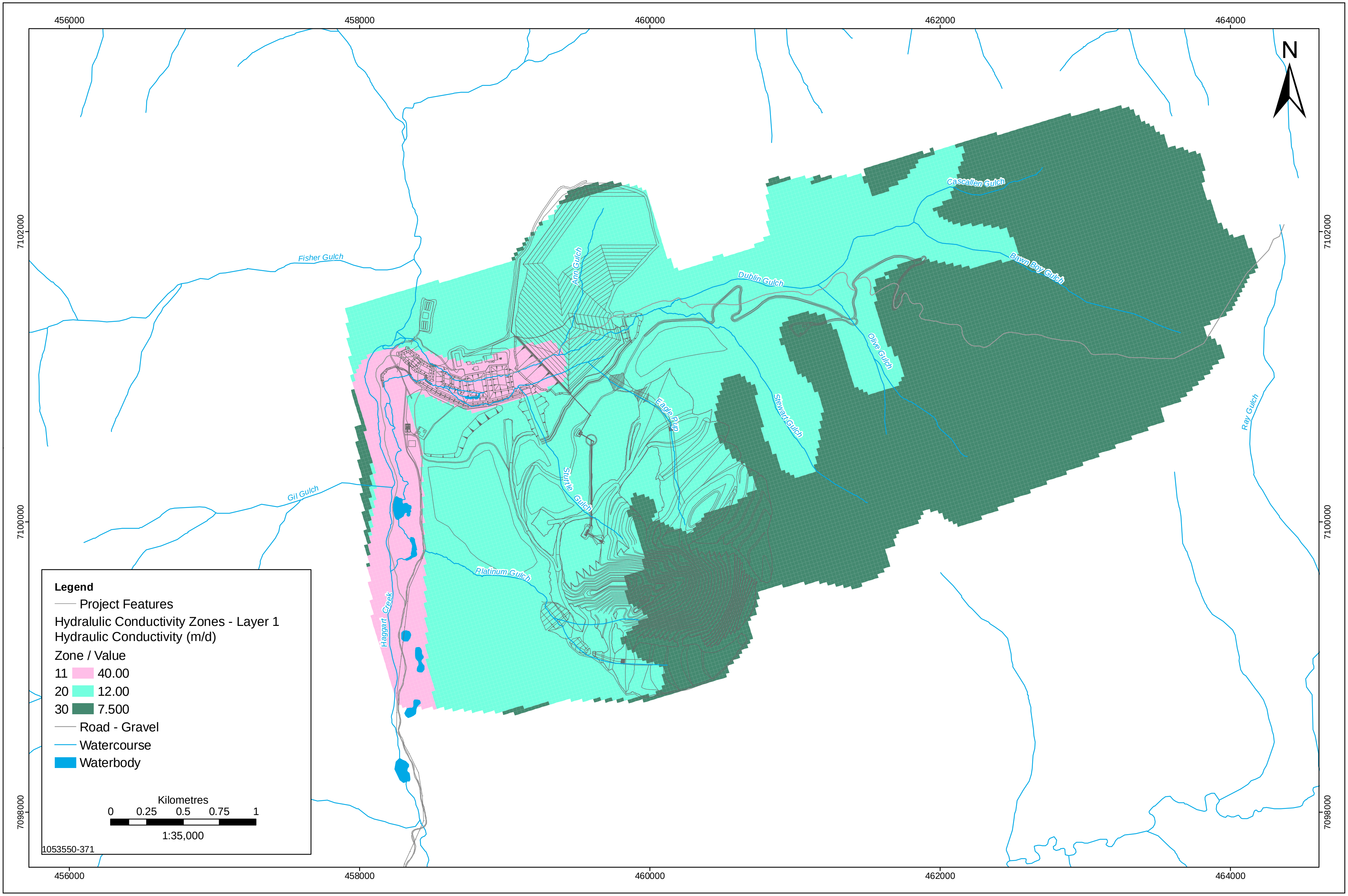
DATE: 03-December-2010	FIGURE NO.: 3.3-3



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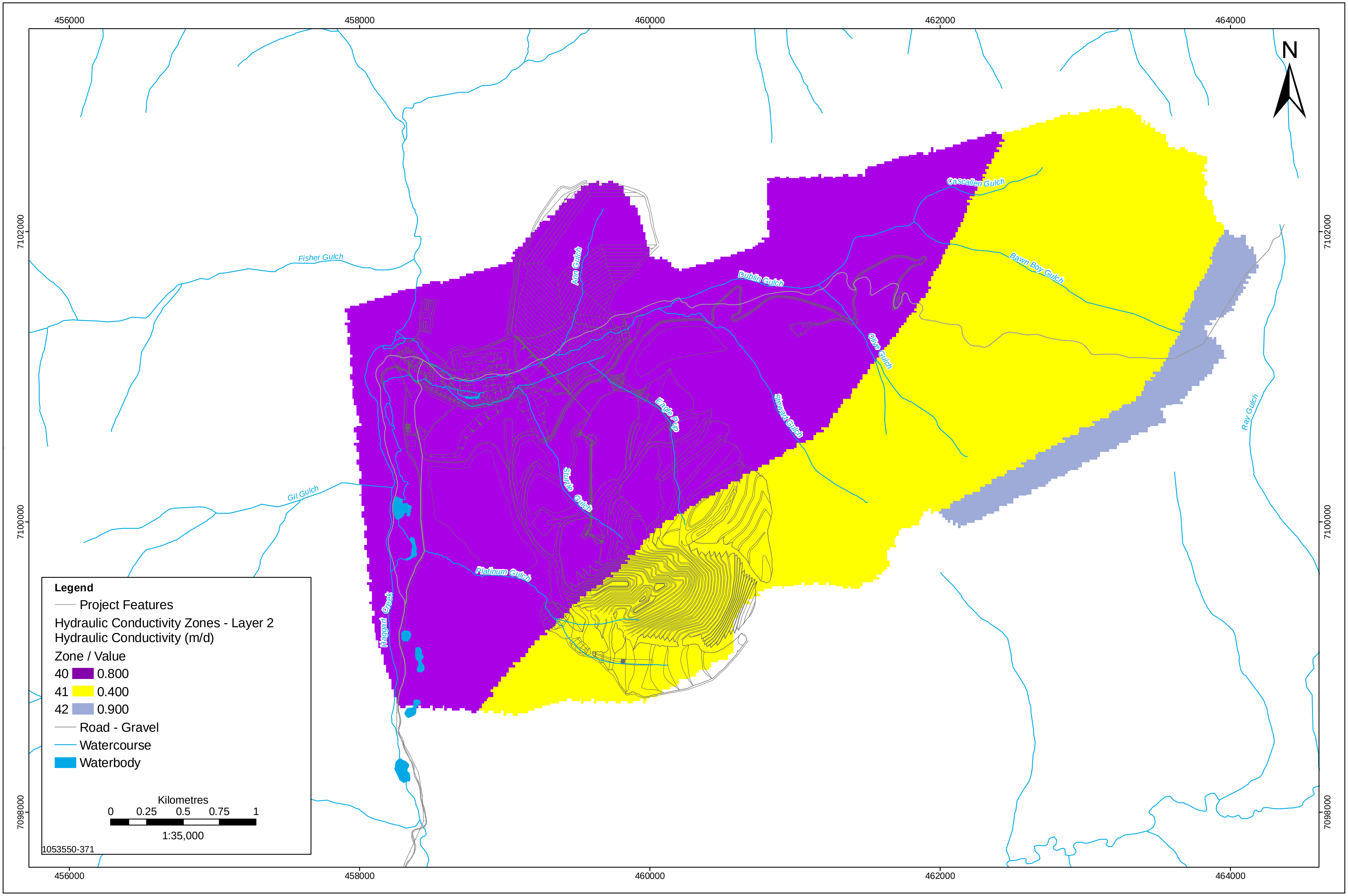
HYDRAULIC CONDUCTIVITY ZONATION LAYER 1

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 19-November-2010	FIGURE NO. 3.3-4



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HYDRAULIC CONDUCTIVITY ZONATION LAYER 2

EAGLE GOLD PROPERTY
YUKON TERRITORY

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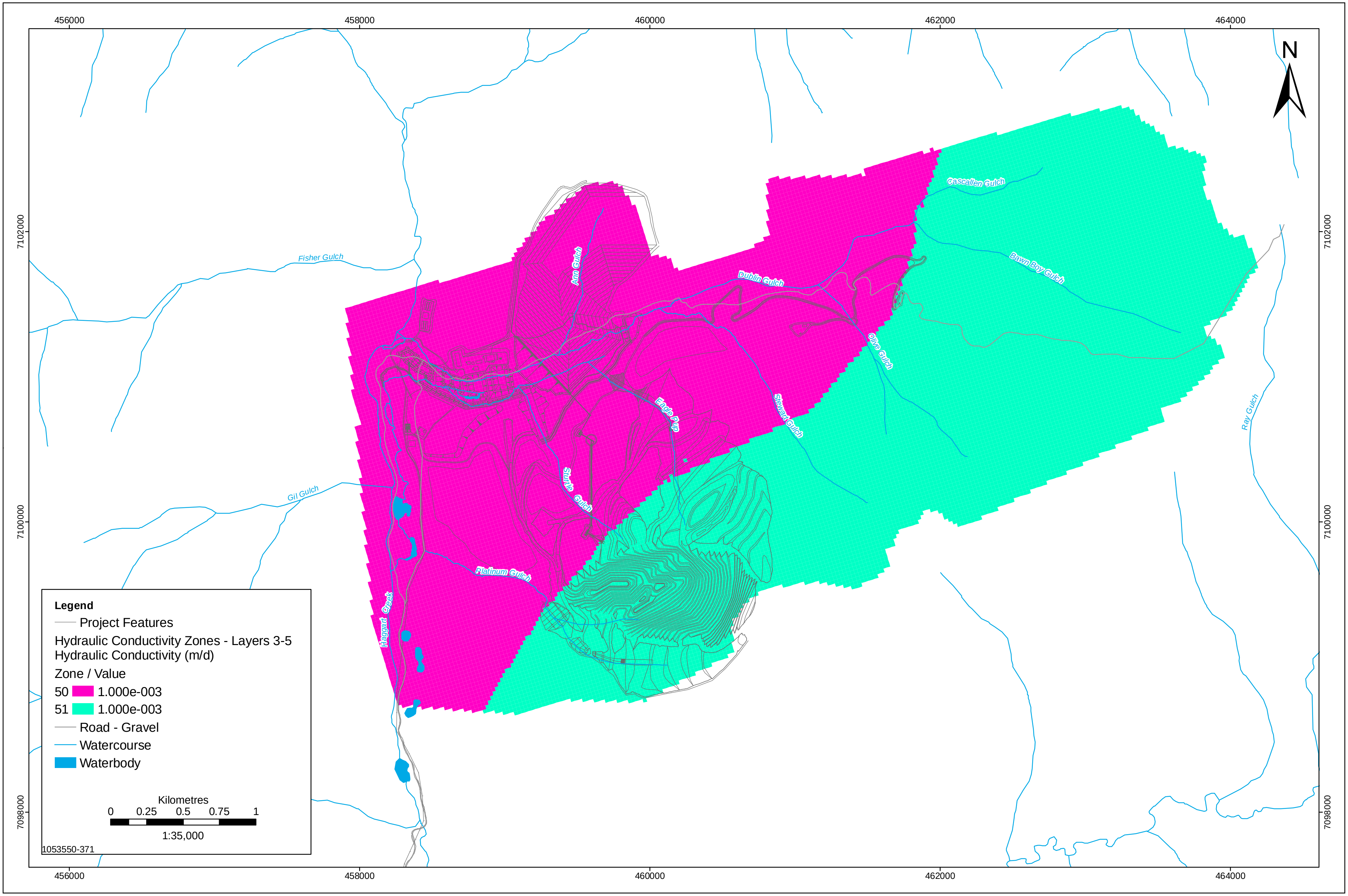
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
19-November-2010	3.3-5



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HYDRAULIC CONDUCTIVITY ZONATION LAYER 3 THROUGH 5

EAGLE GOLD PROPERTY
YUKON TERRITORY

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DATUM	CHECKED BY
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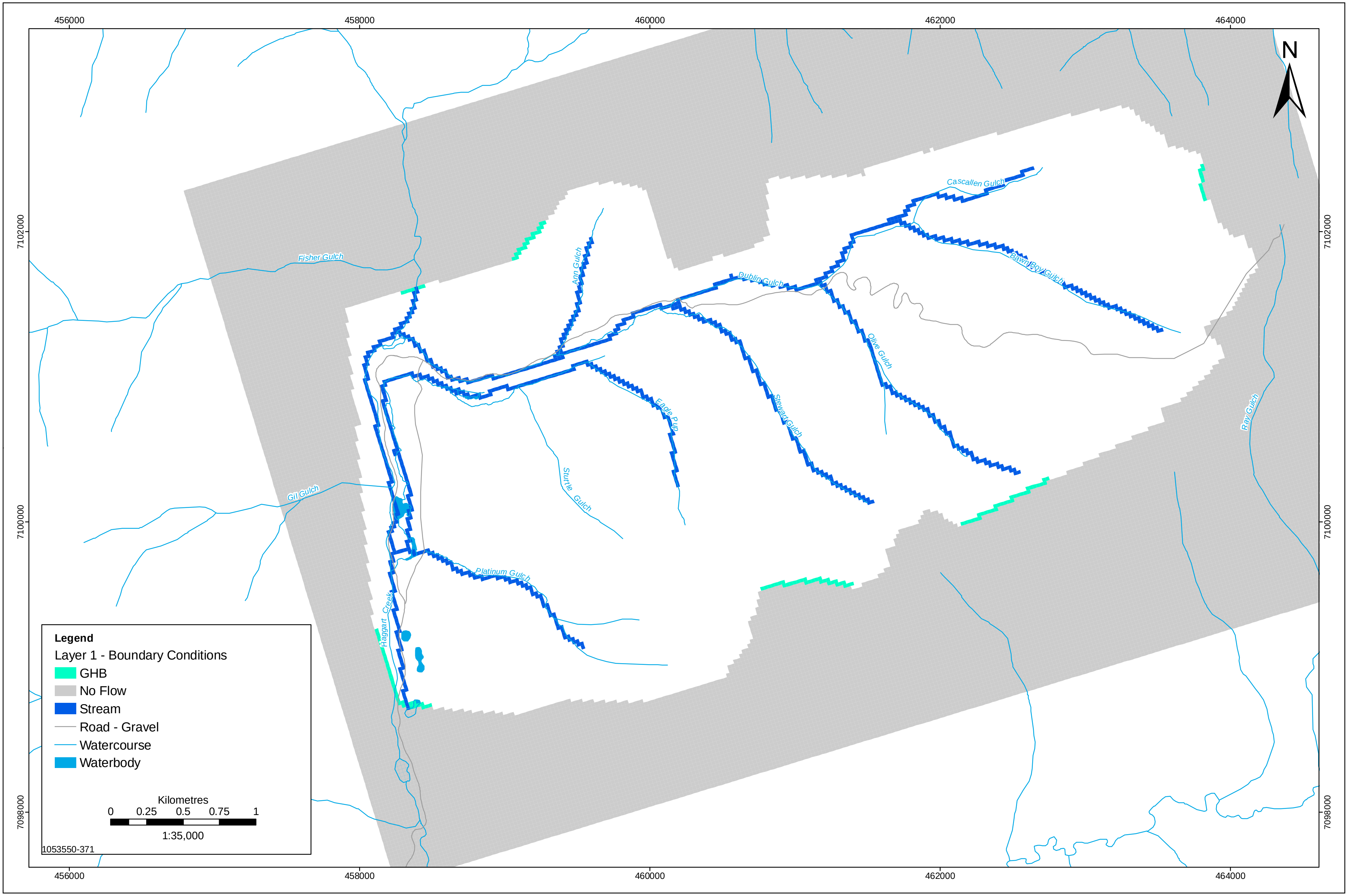
19-November-2010	3.3-6



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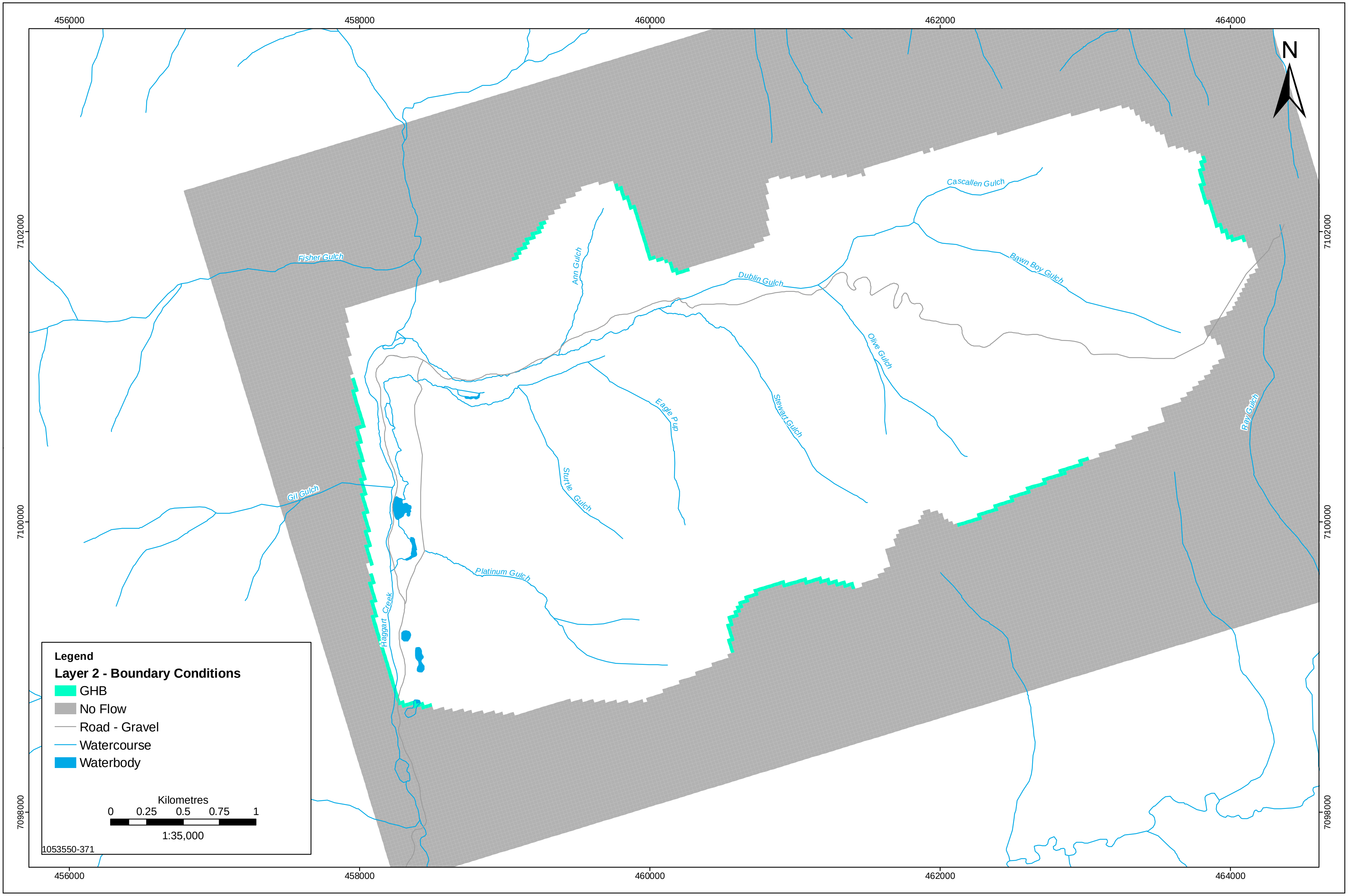
BOUNDARY CONDITIONS LAYER 1

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 20-November-2010	FIGURE NO.: 3.3-7



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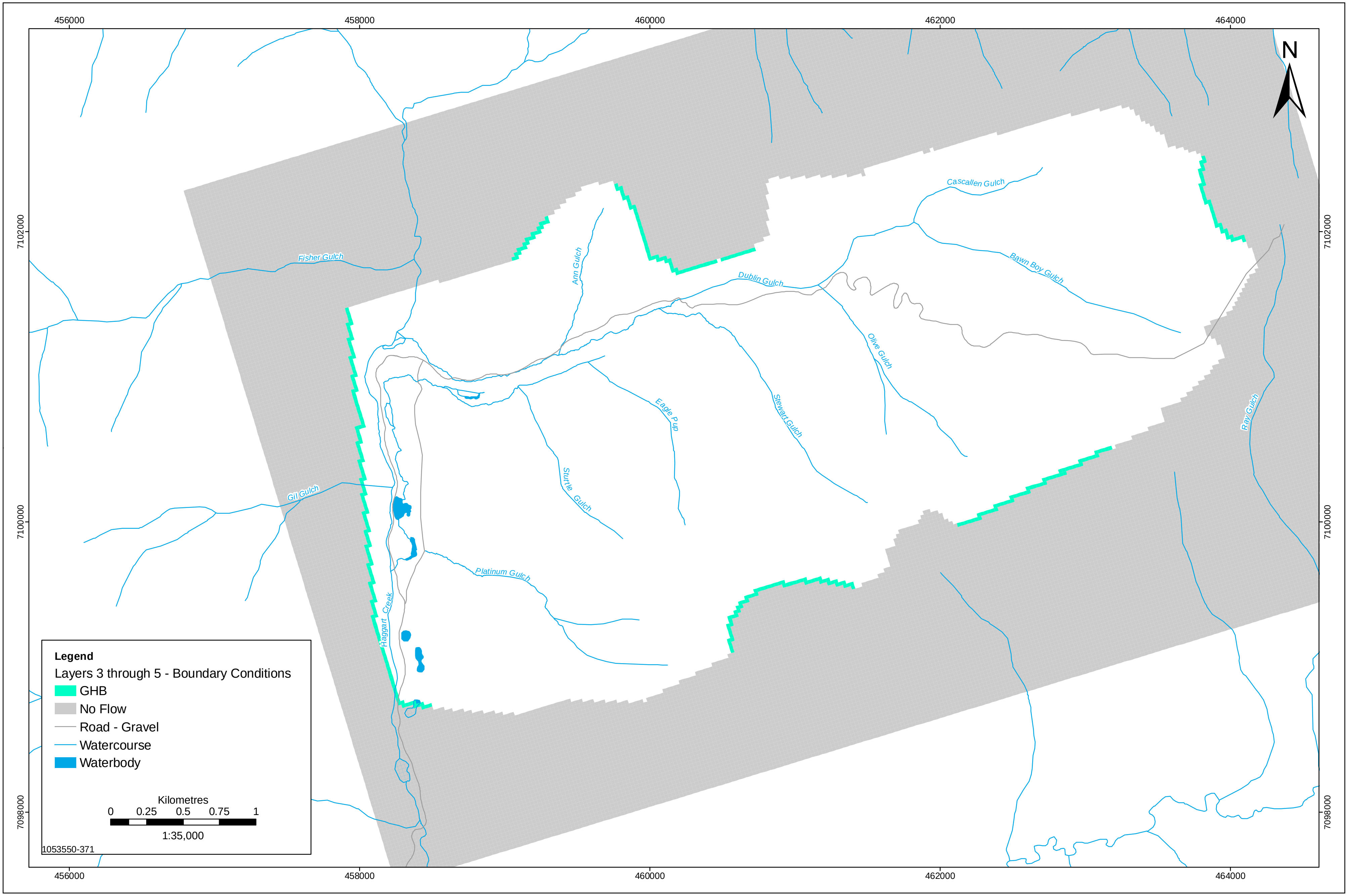
BOUNDARY CONDITIONS LAYER 2

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 20-November-2010	FIGURE NO. 3.3-8



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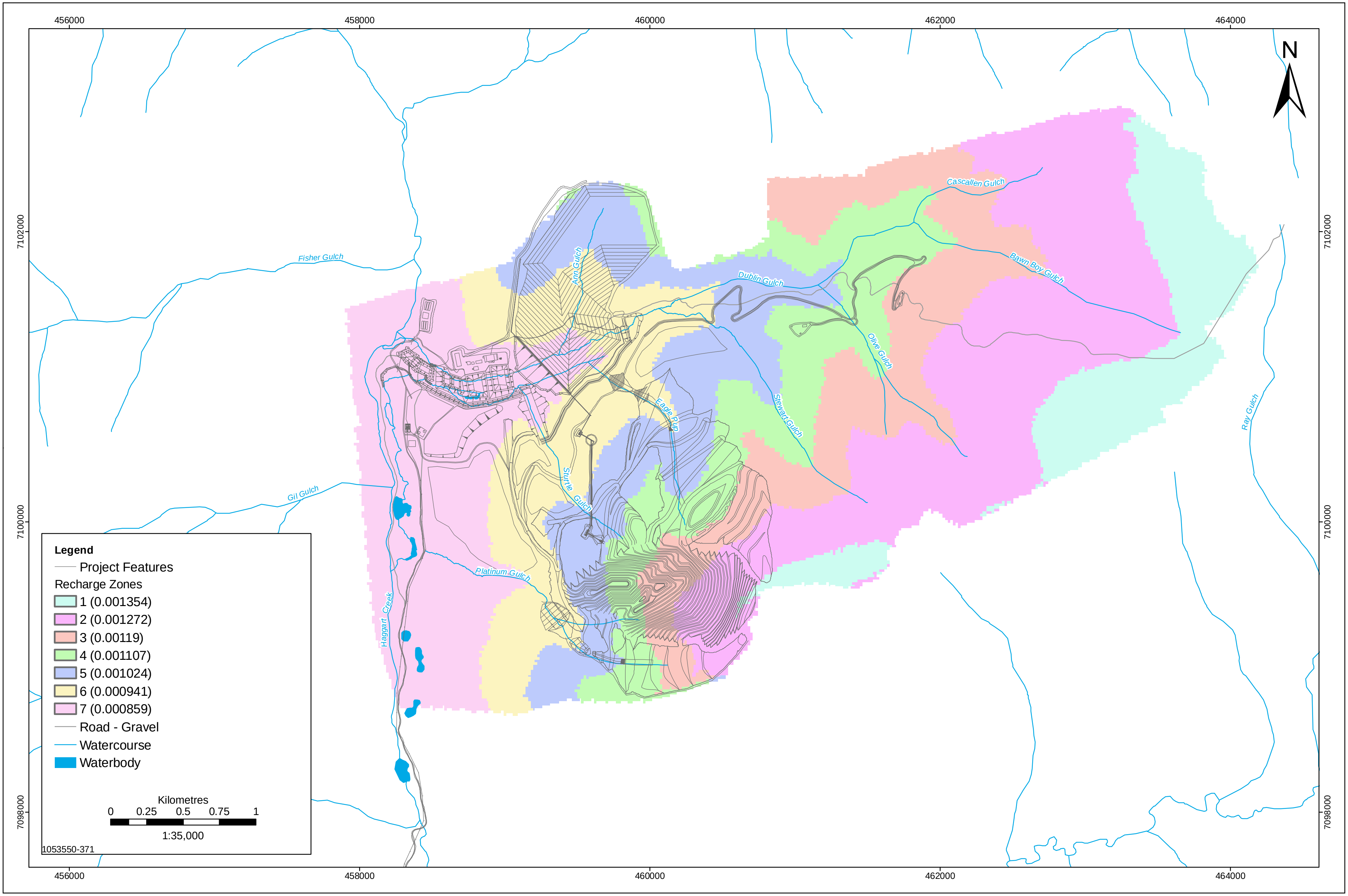
BOUNDARY CONDITIONS LAYERS 3 THROUGH 5

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 20-November-2010	FIGURE NO. 3.3-9



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RECHARGE ZONES
LAYER 1

EAGLE GOLD PROPERTY
YUKON TERRITORY

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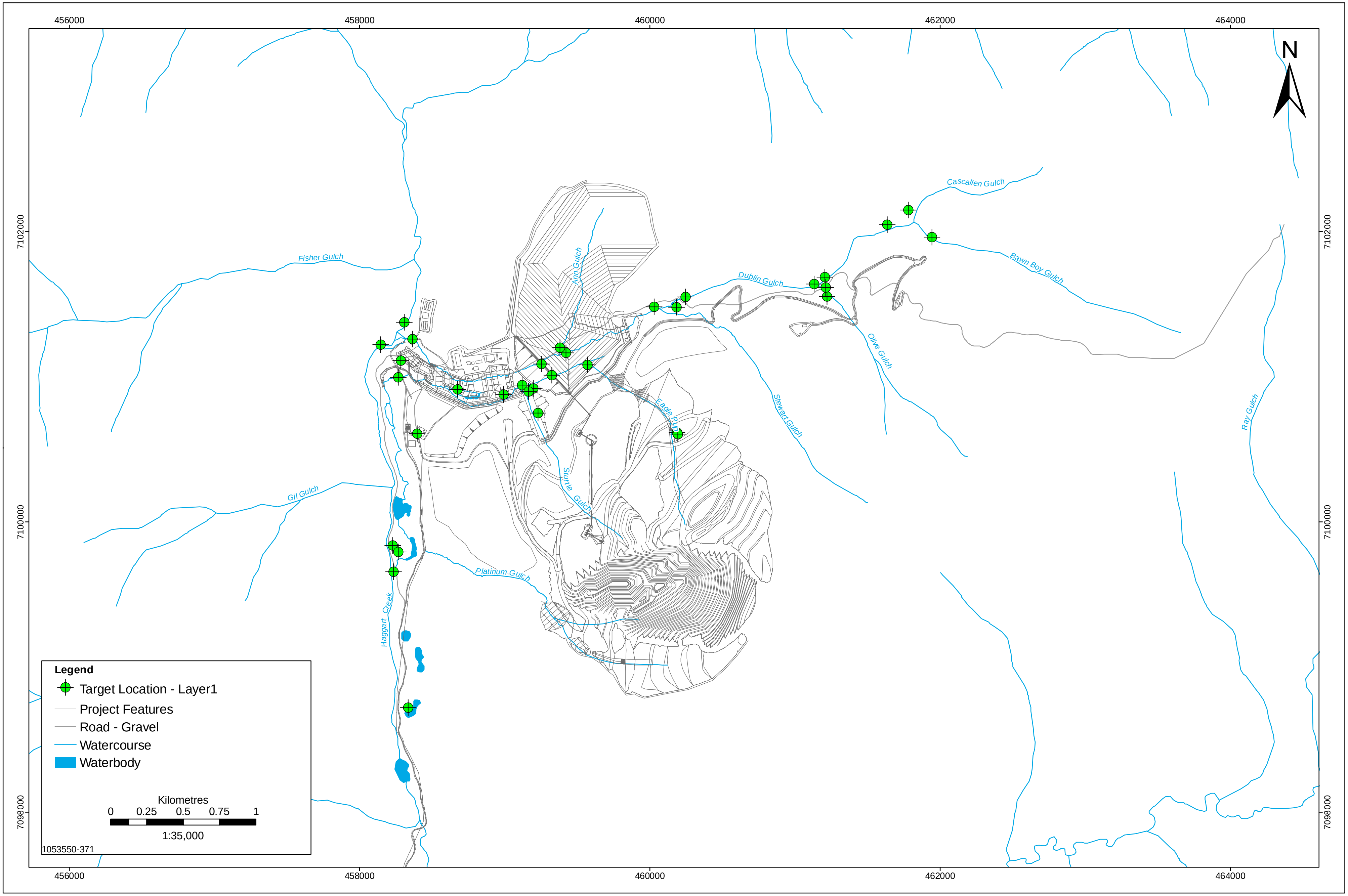
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
15-November-2010	3.3-10



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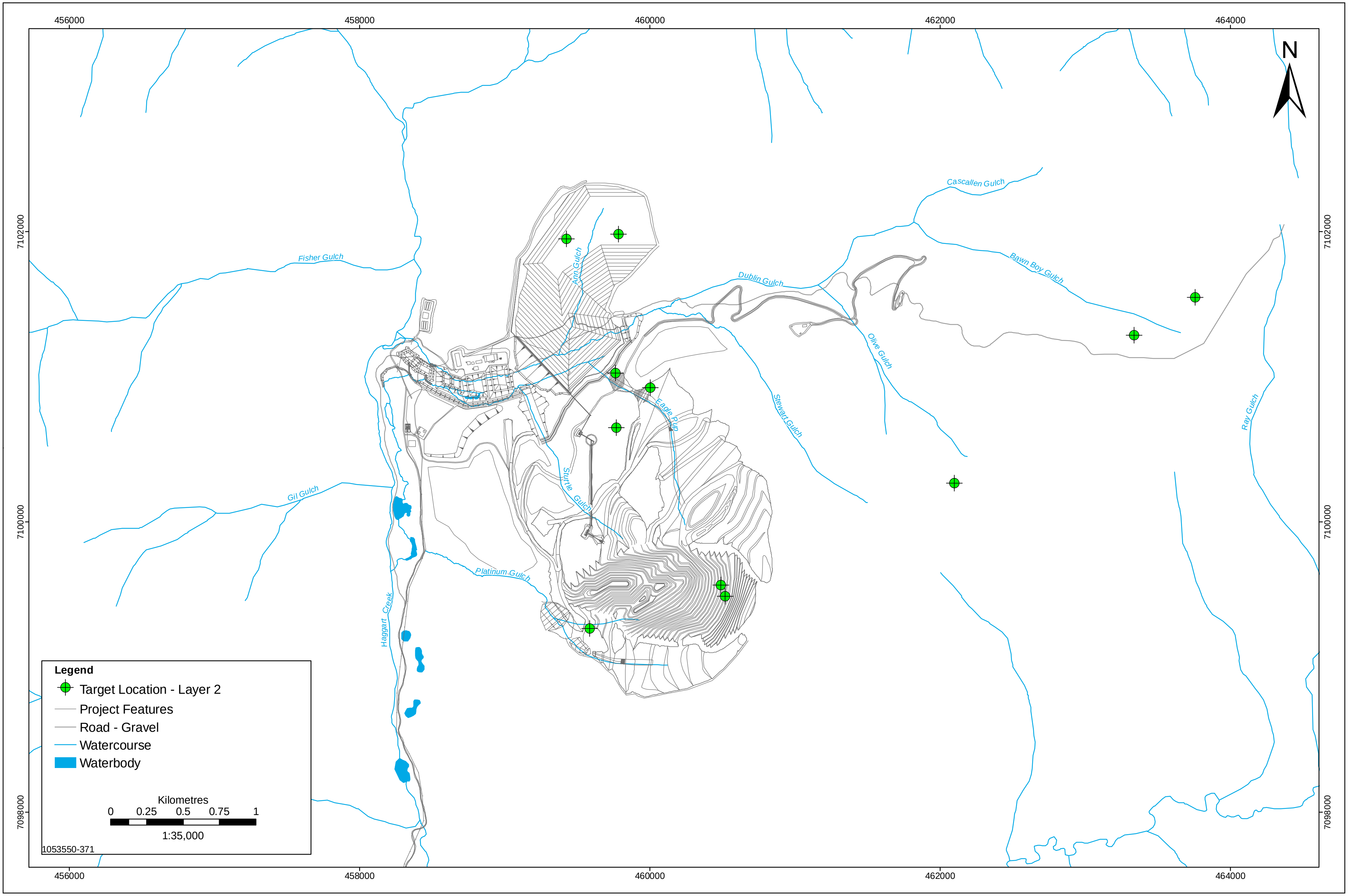
Victoria GOLD CORP

TARGET LOCATIONS
LAYER 1

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 19-November-2010	FIGURE NO. 3.4-1



Data Sources; Government of Canada, Victoria Gold Corp.

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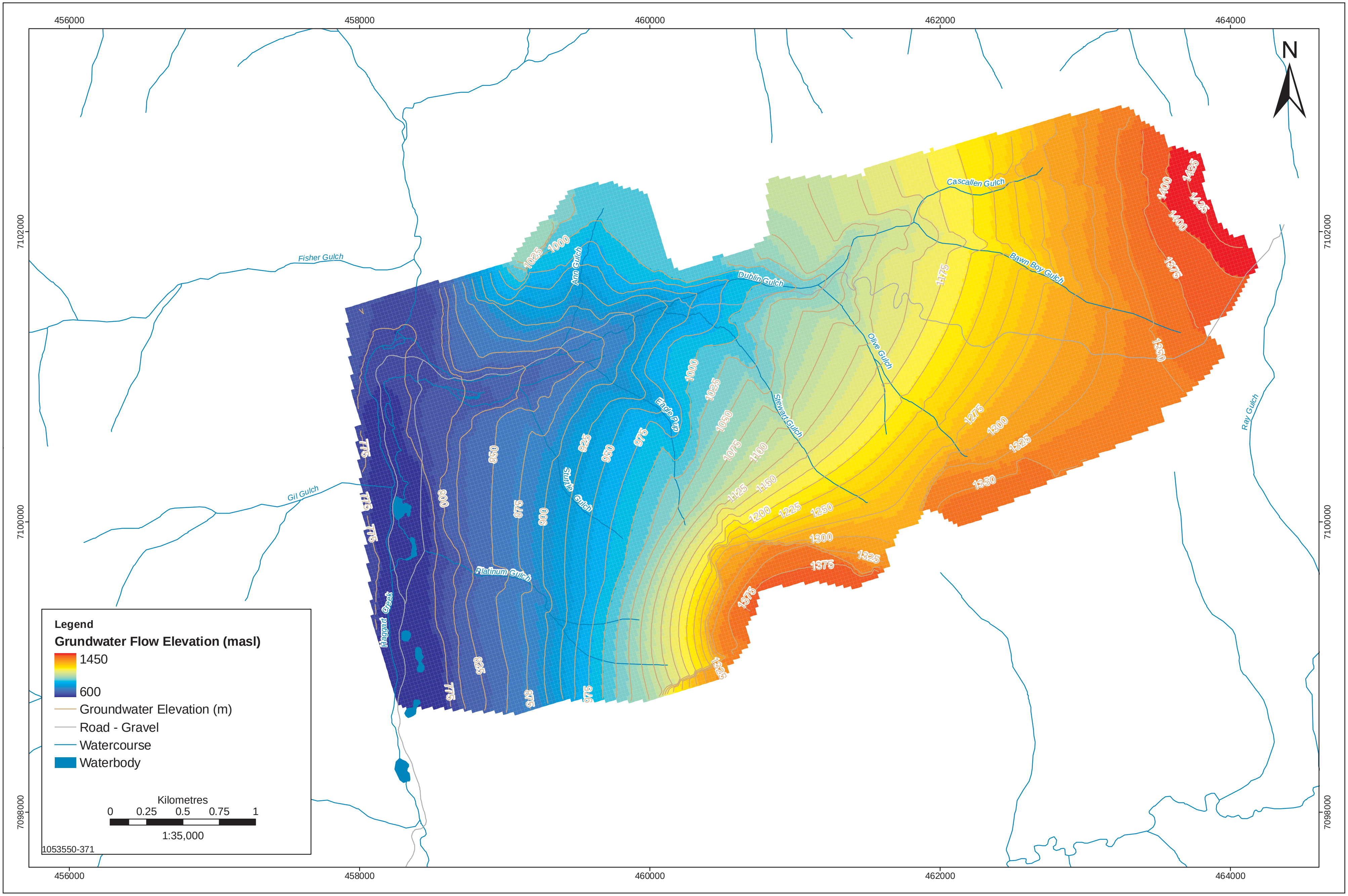
Victoria GOLD CORP

TARGET LOCATIONS
LAYER 2

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
19-November-2010	3.4-2



Data Sources; Government of Canada, Victoria Gold Corp.

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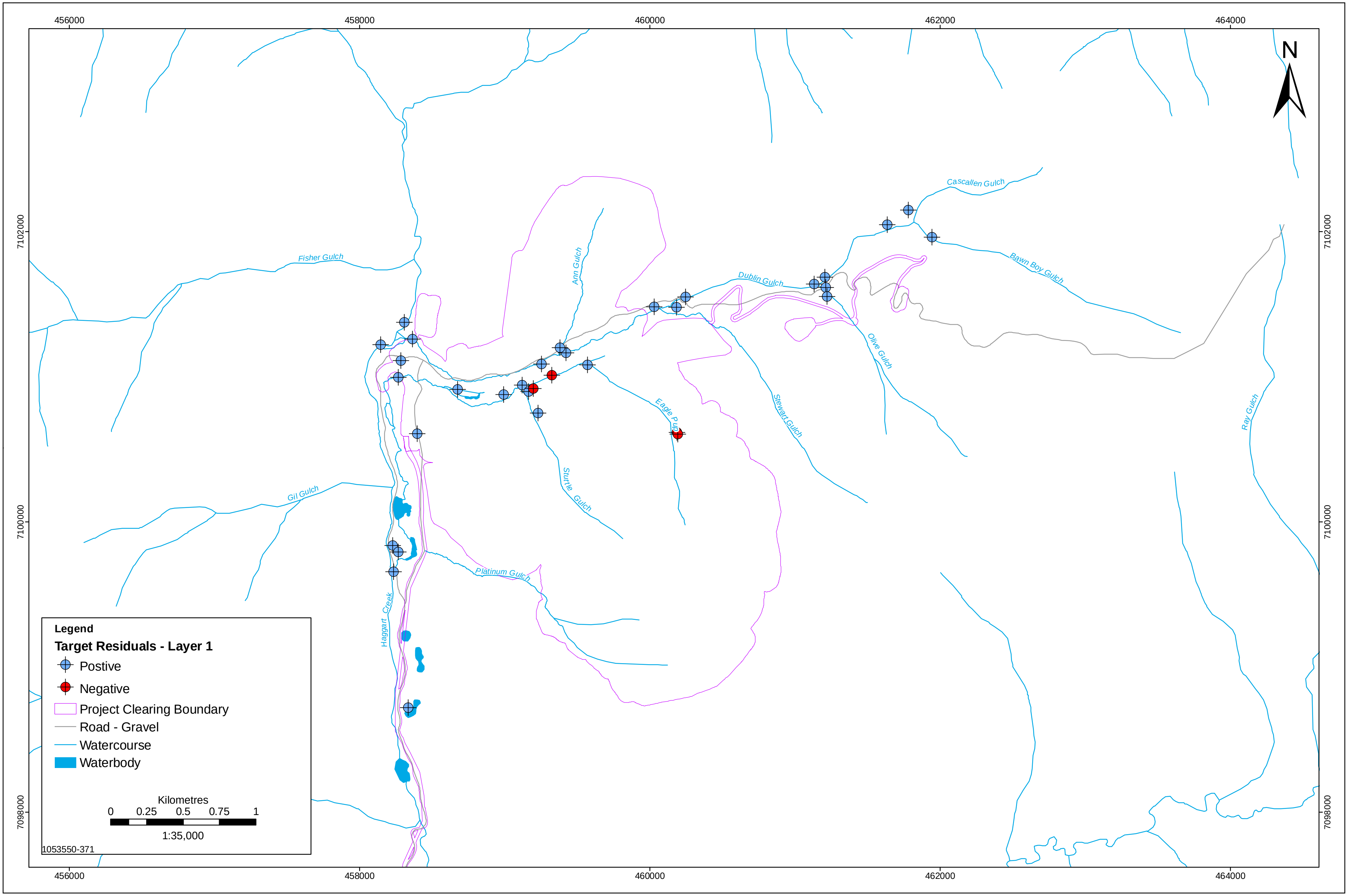
MODELED GROUNDWATER ELEVATIONS BASELINE

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
19-November-2010	5.1-1



Data Sources; Government of Canada, Victoria Gold Corp.

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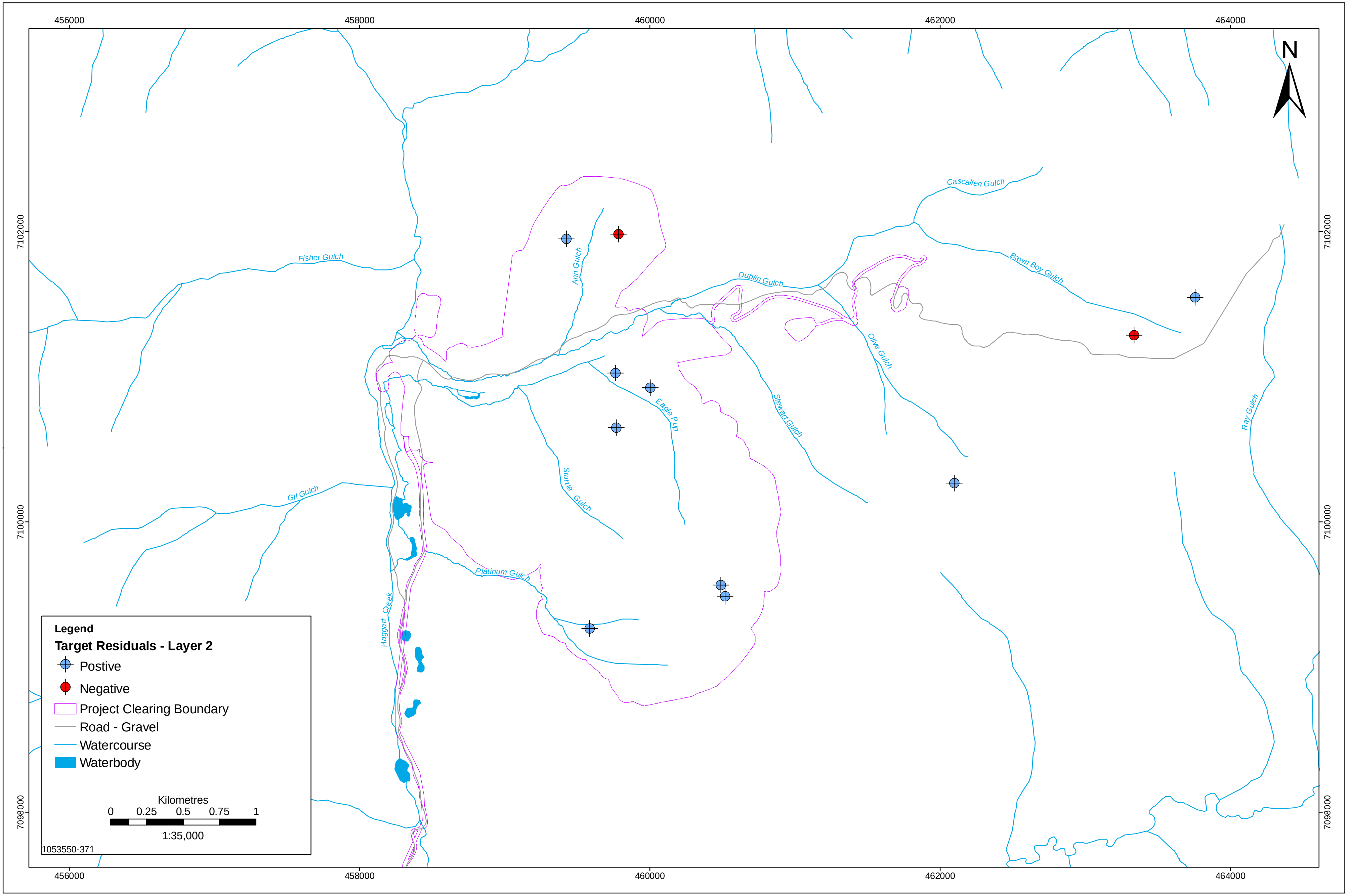
Victoria GOLD CORP

TARGET RESIDUALS
LAYER 1

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 19-November-2010	FIGURE NO. 5.1-2



Data Sources; Government of Canada, Victoria Gold Corp.

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Victoria GOLD CORP

TARGET RESIDUALS
LAYER 2

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM NAD 83	CHECKED BY RS
DATE 19-November-2010	FIGURE NO. 5.1-3

Figure 5.1-4: Steady State Model Calibration Results

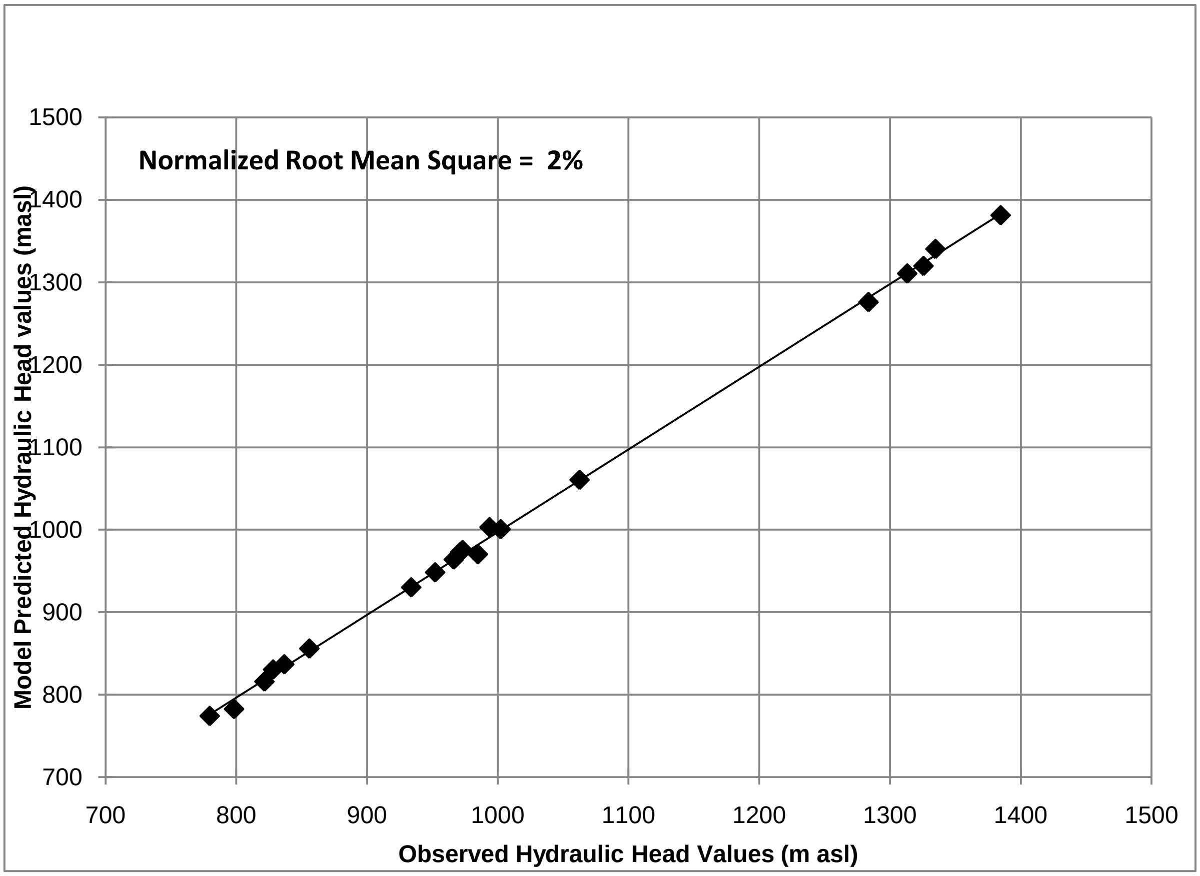


Figure 5.2-1: Transient Model Calibration Results for MW10-OBS-1

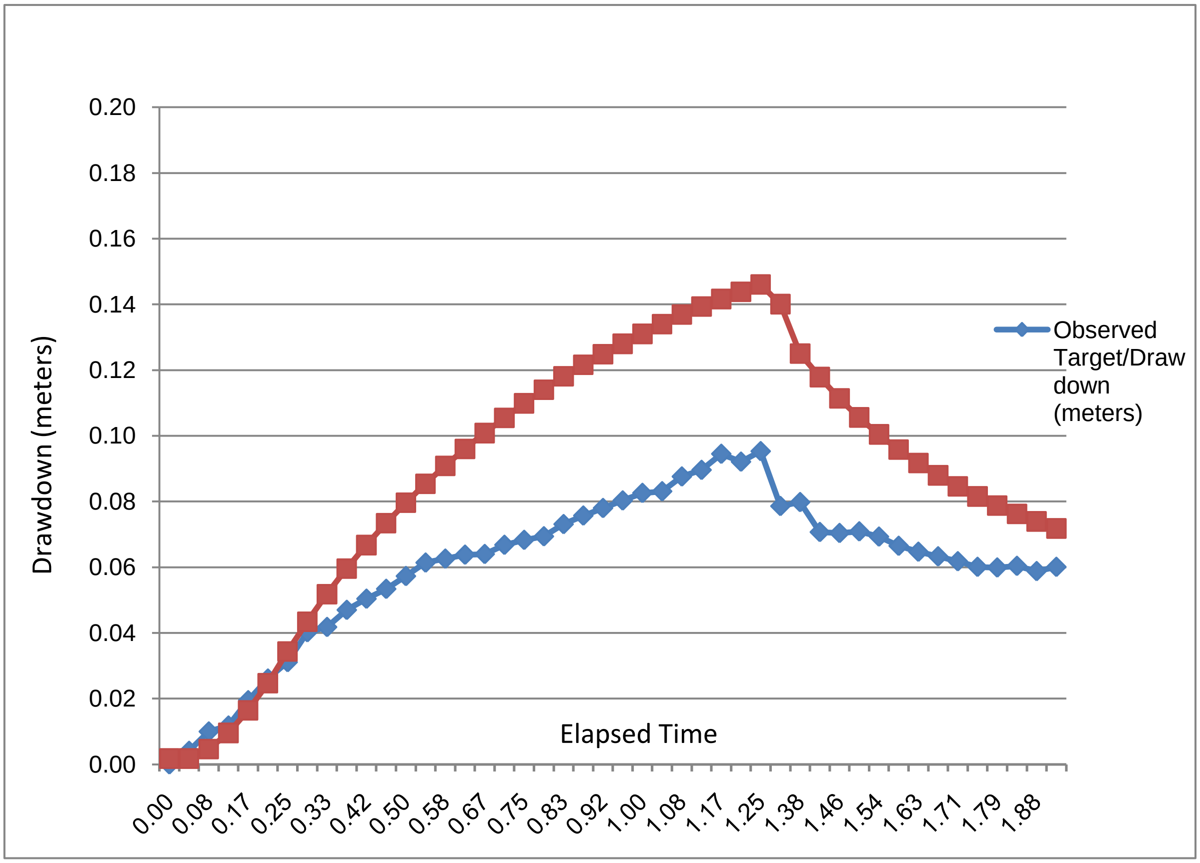
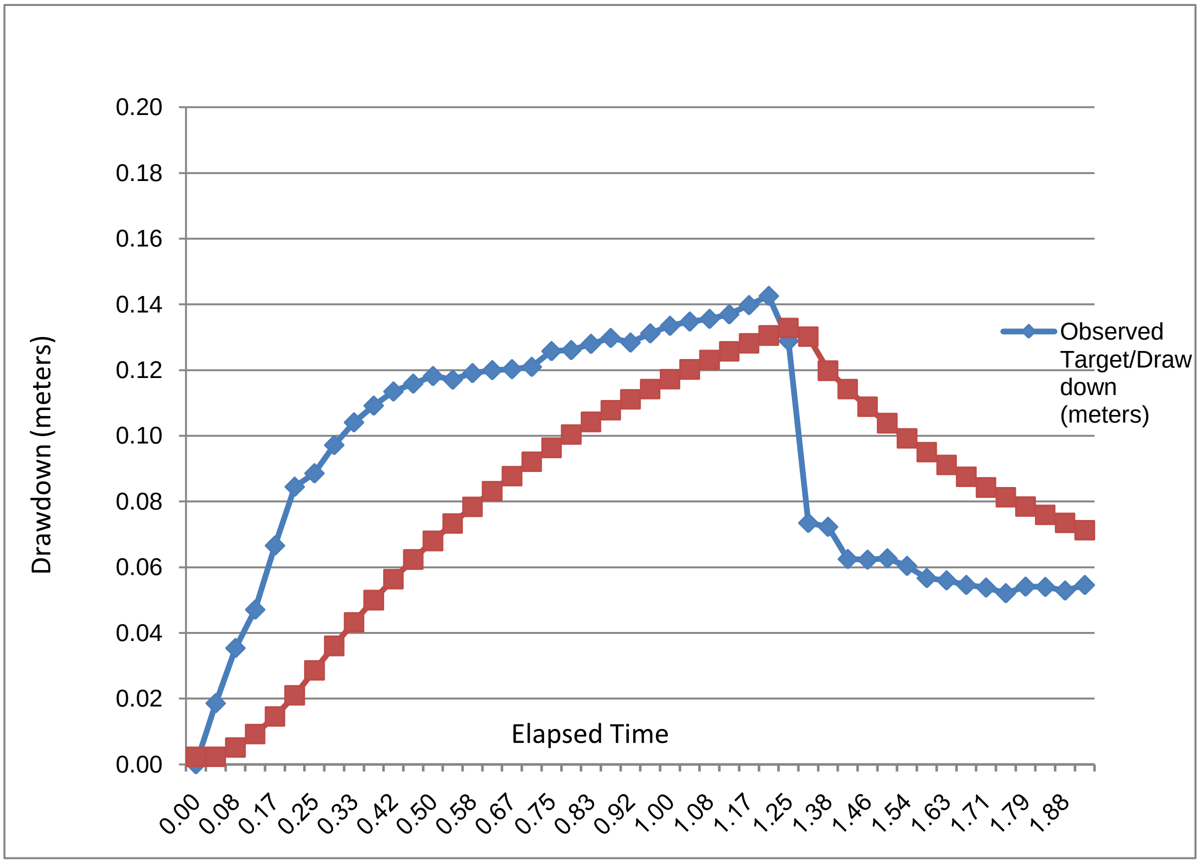
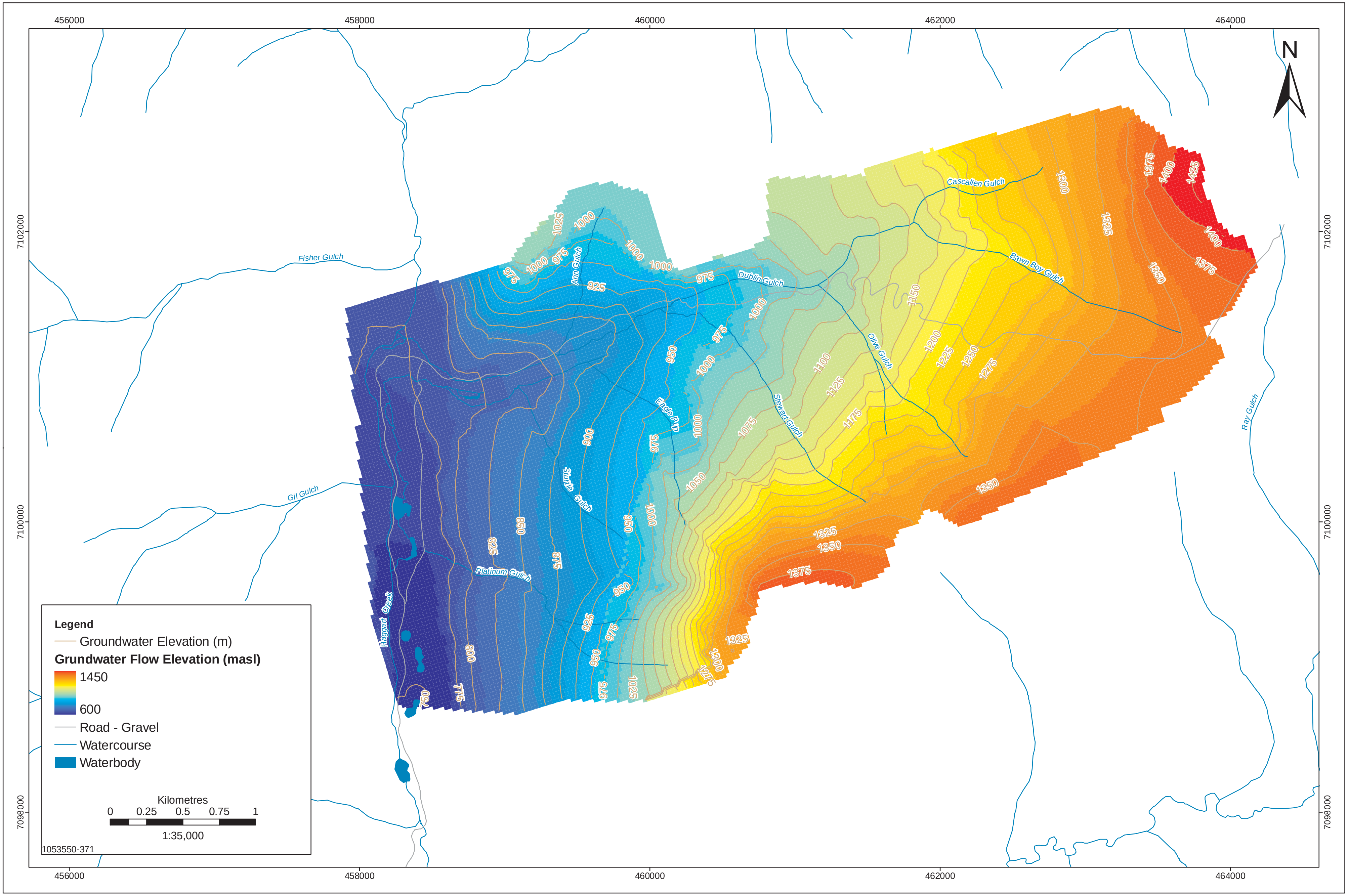


Figure 5.2-2: Transient Model Calibration Results for MW10-OBS-2





Data Sources; Government of Canada, Victoria Gold Corp.

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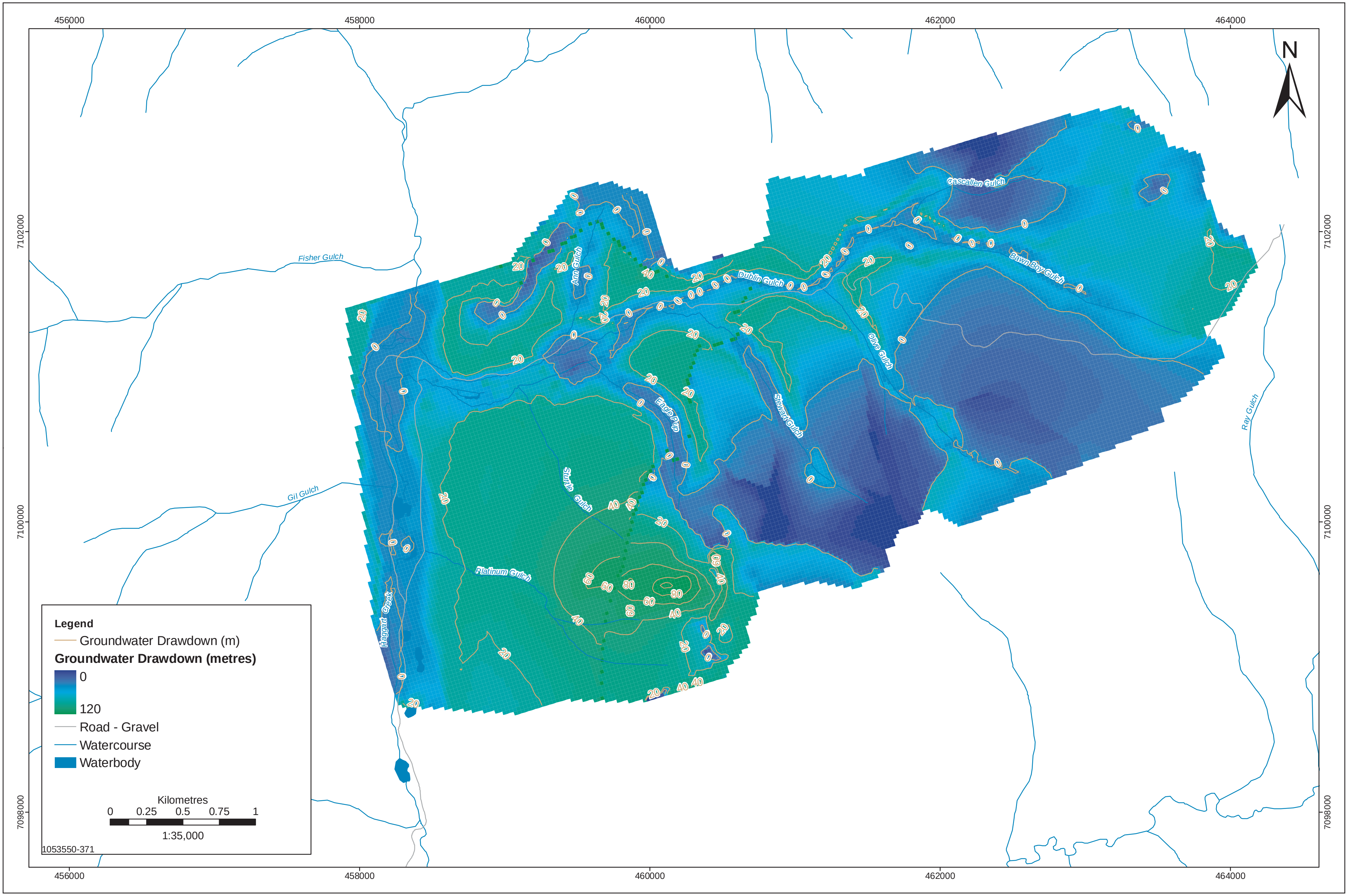
Victoria GOLD CORP

MODELED GROUNDWATER ELEVATIONS OPERATION

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 19-November-2010	FIGURE NO. 5.2-3



Data Sources; Government of Canada, Victoria Gold Corp.

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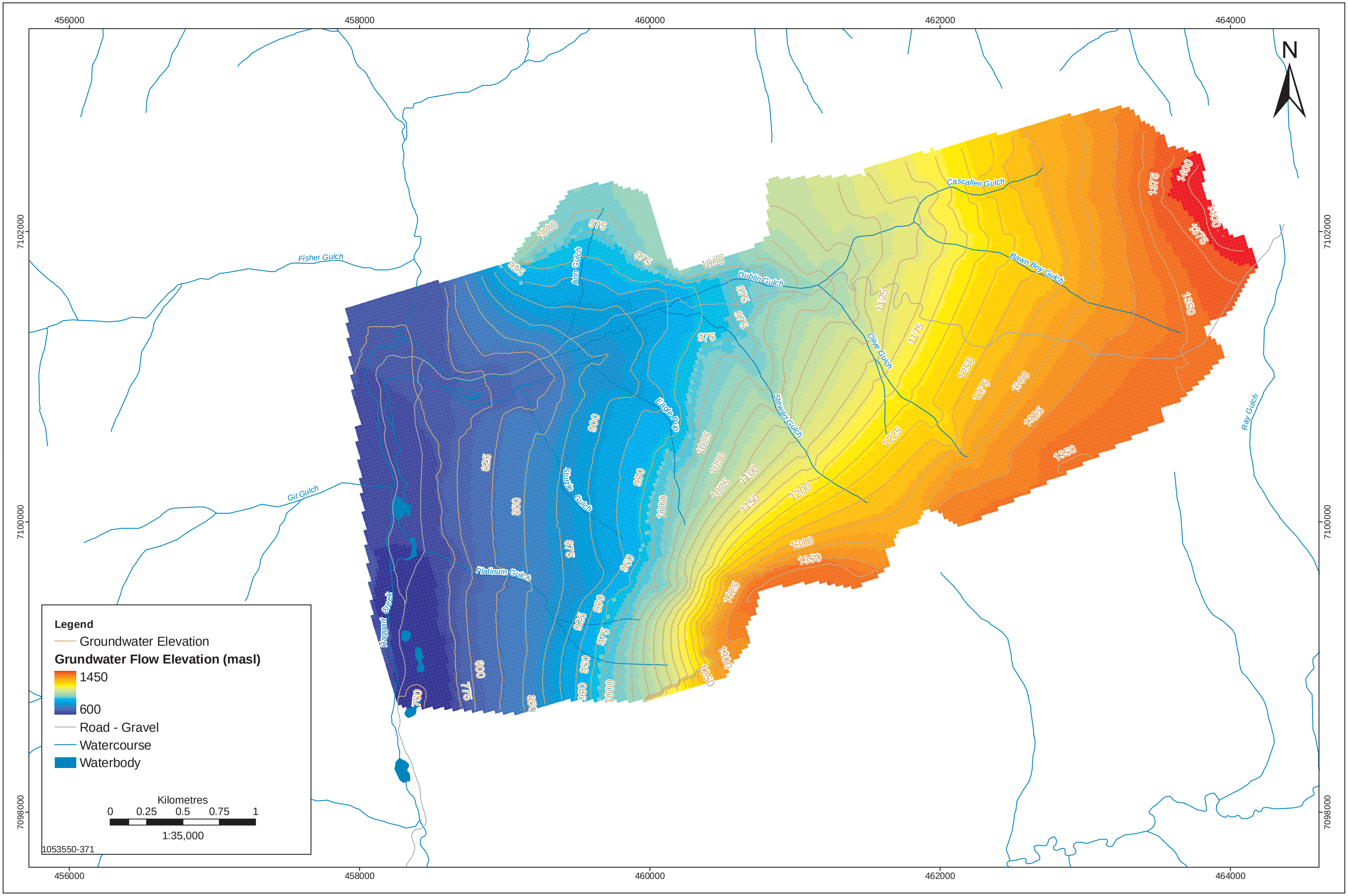
Victoria GOLD CORP

MODELED GROUNDWATER DRAWDOWN OPERATION

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 19-November-2010	FIGURE NO. 5.2-4



Data Sources; Government of Canada, Victoria Gold Corp.

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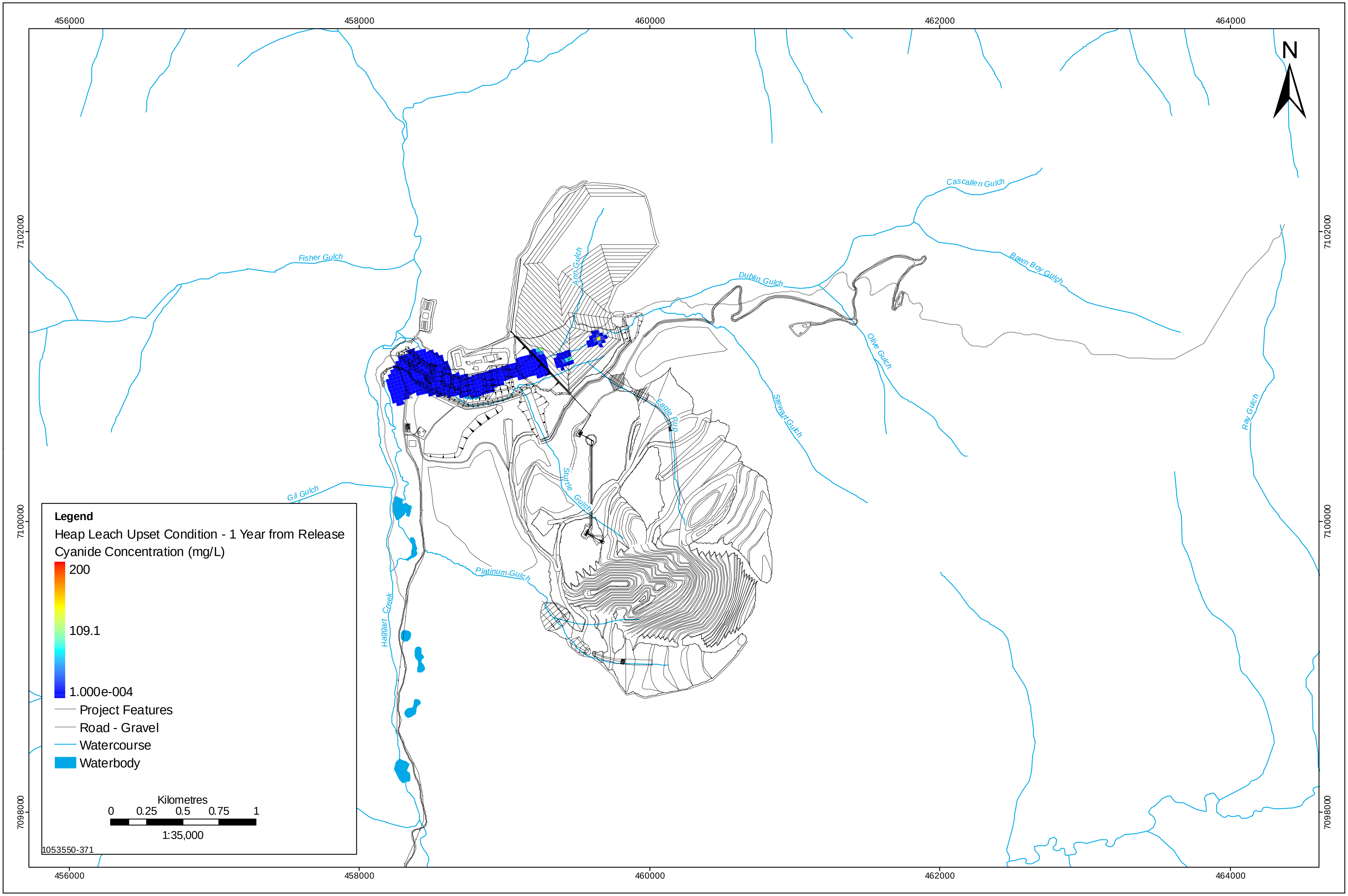
Victoria GOLD CORP

MODELED GROUNDWATER ELEVATIONS POST-CLOSURE

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
19-November-2010	5.2-5



Data Sources: Government of Canada, Victoria Gold Corp.

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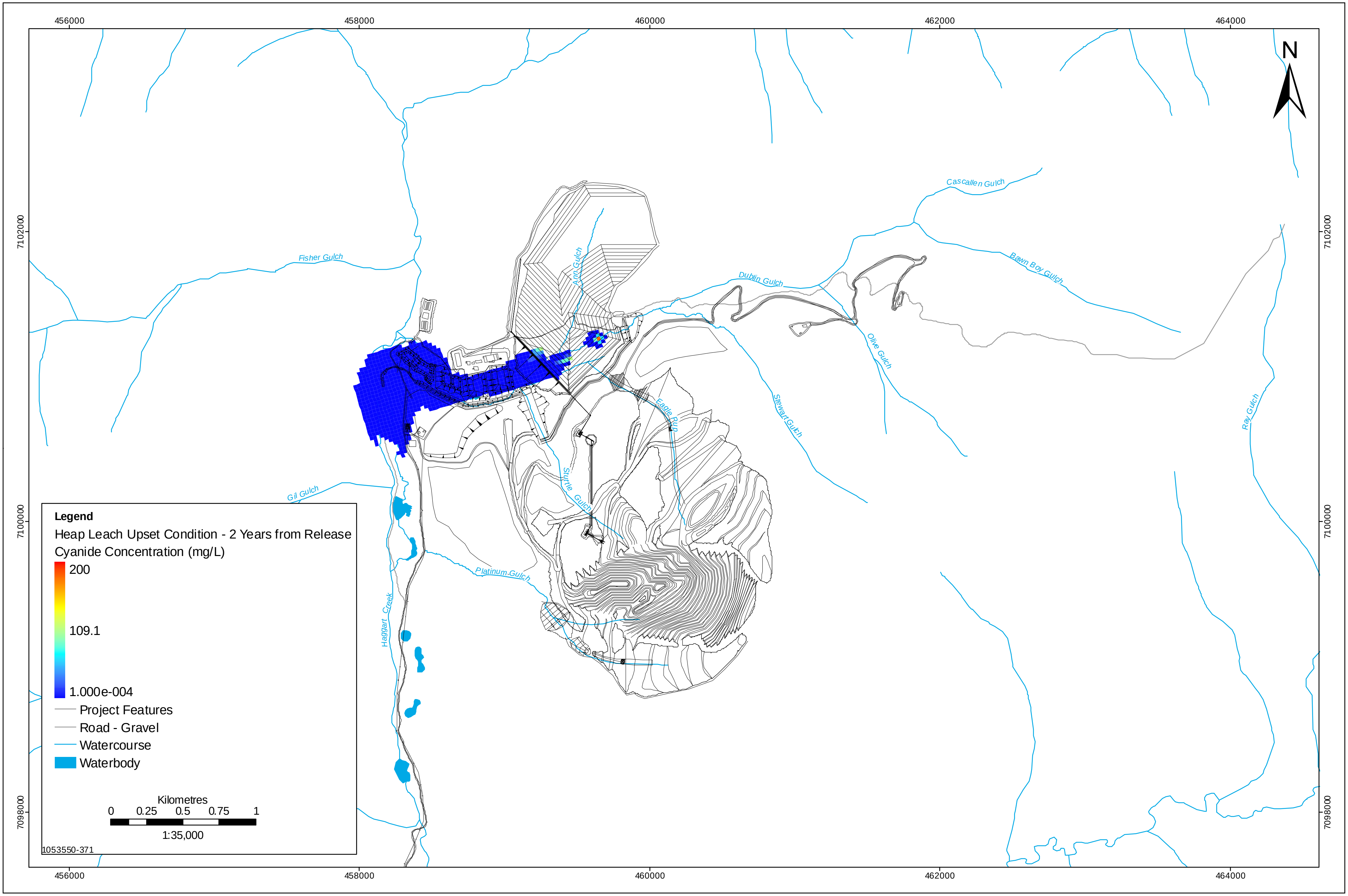
Victoria GOLD CORP

HEAP LEACH FACILITY UPSET CONDITION
LAYER 1 - YEAR 1

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 02-December-2010	FIGURE NO. 5.2-6



Data Sources: Government of Canada, Victoria Gold Corp.

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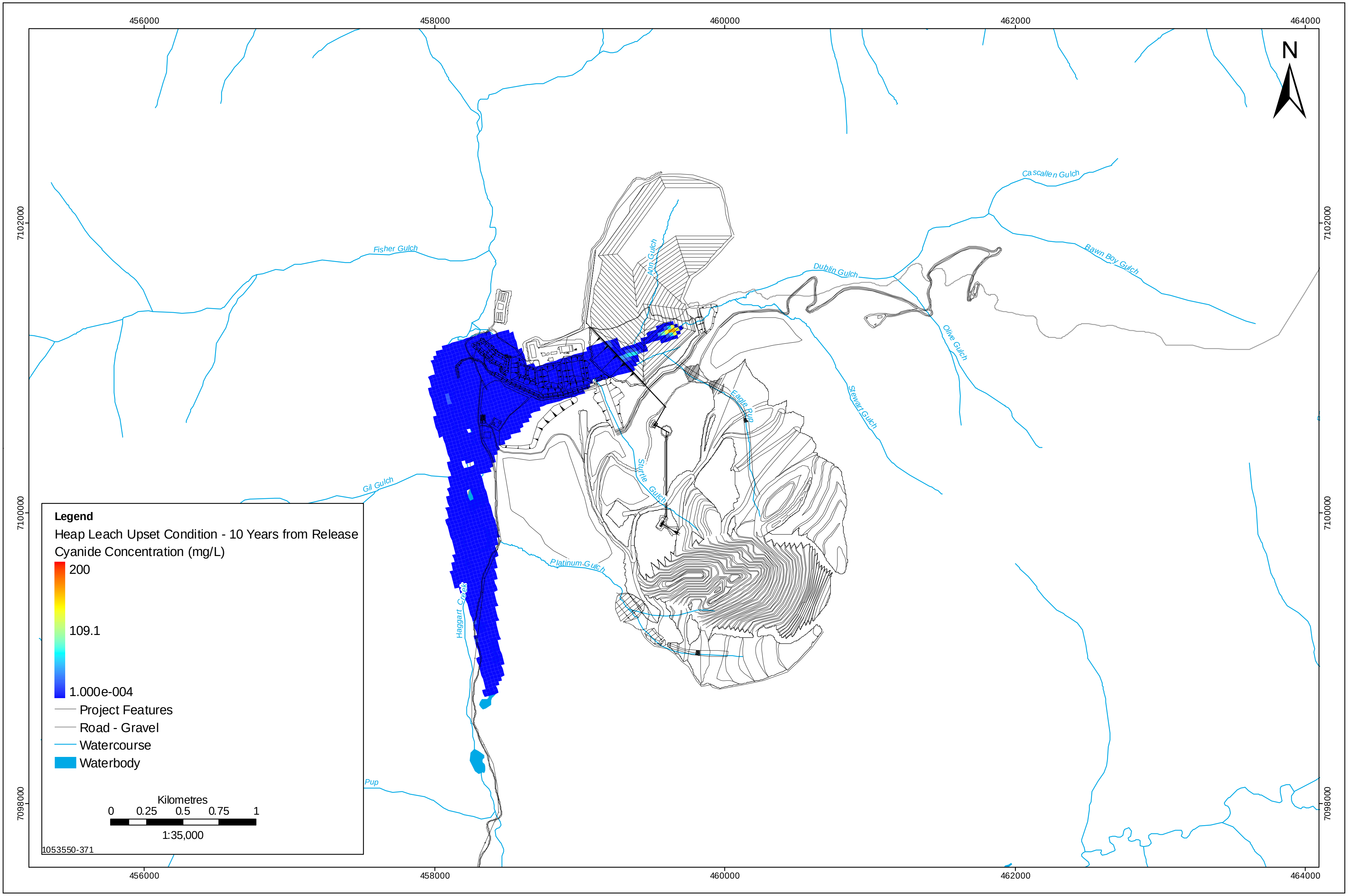
Victoria GOLD CORP

HEAP LEACH FACILITY UPSET CONDITION
LAYER 1 - YEAR 2

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 02-December-2010	FIGURE NO. 5.2-7



Data Sources: Government of Canada, Victoria Gold Corp.

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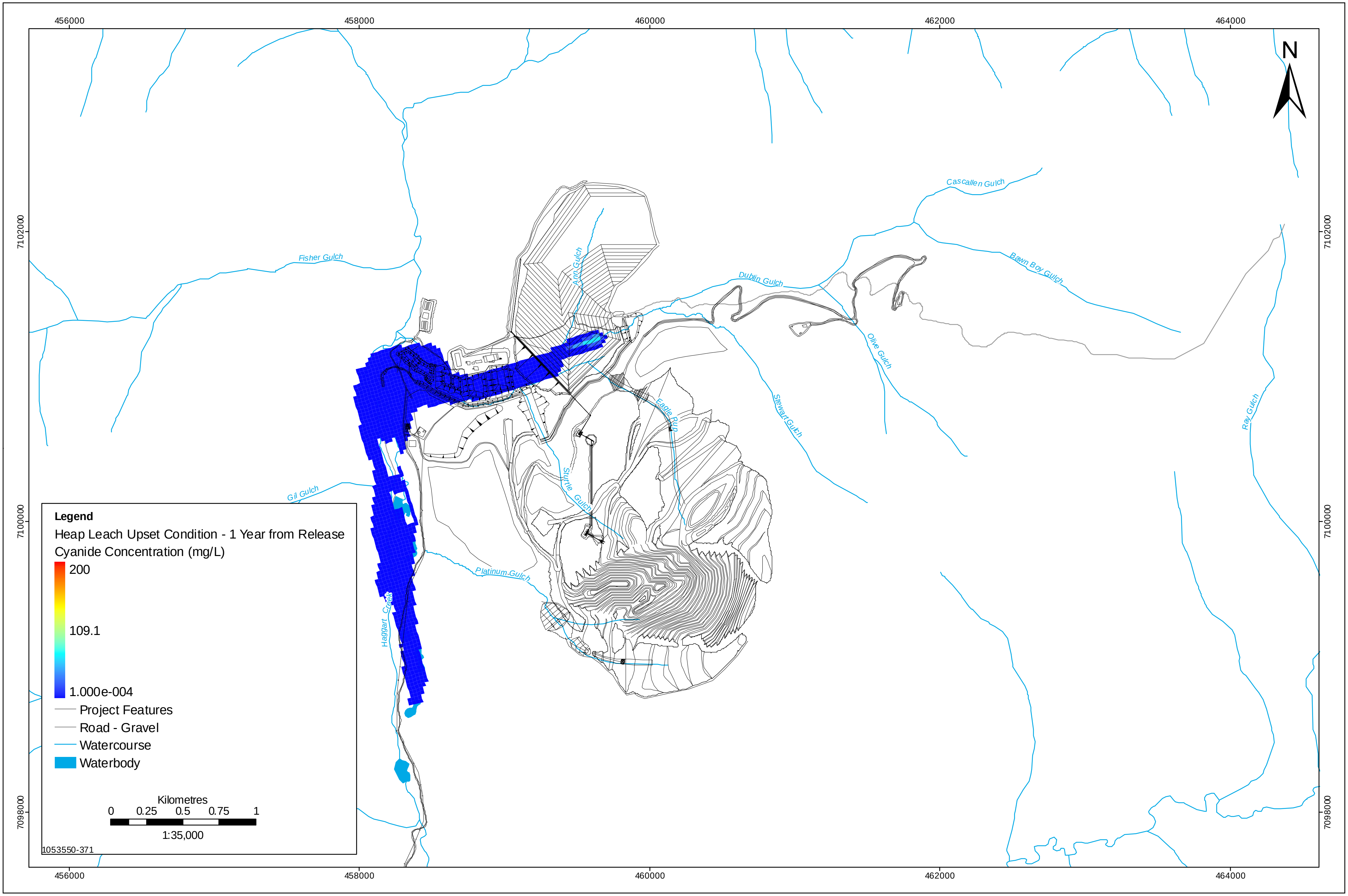
Victoria GOLD CORP

HEAP LEACH FACILITY SEEPAGE SCENARIO
LAYER 1 - YEAR 10

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
02-December-2010	5.2-8



Data Sources: Government of Canada, Victoria Gold Corp.

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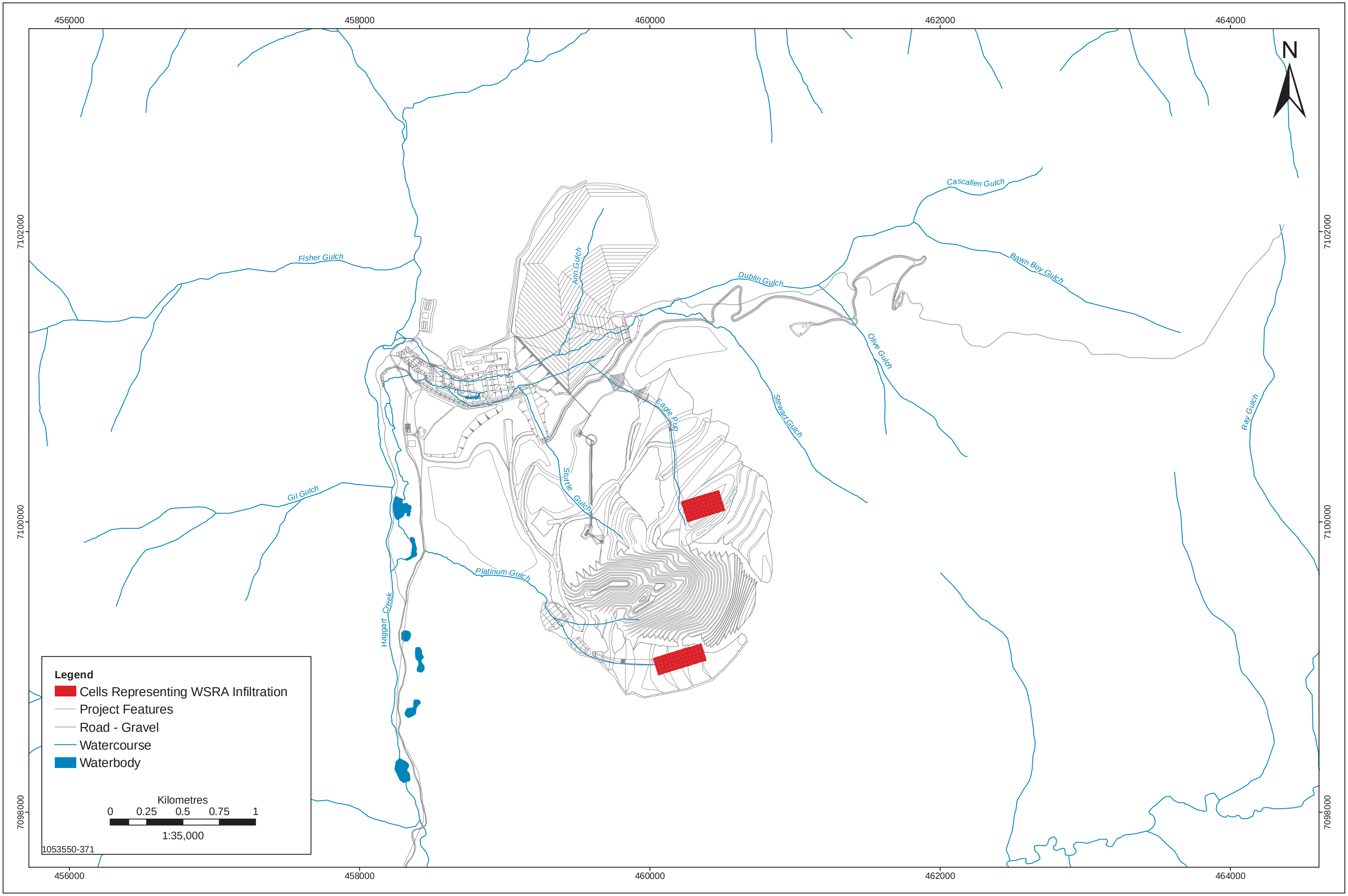
Victoria GOLD CORP

HEAP LEACH FACILITY UPSET CONDITION
LAYER 1 - YEAR 20

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
02-December-2010	5.2-9



Data Sources; Government of Canada, Victoria Gold Corp.

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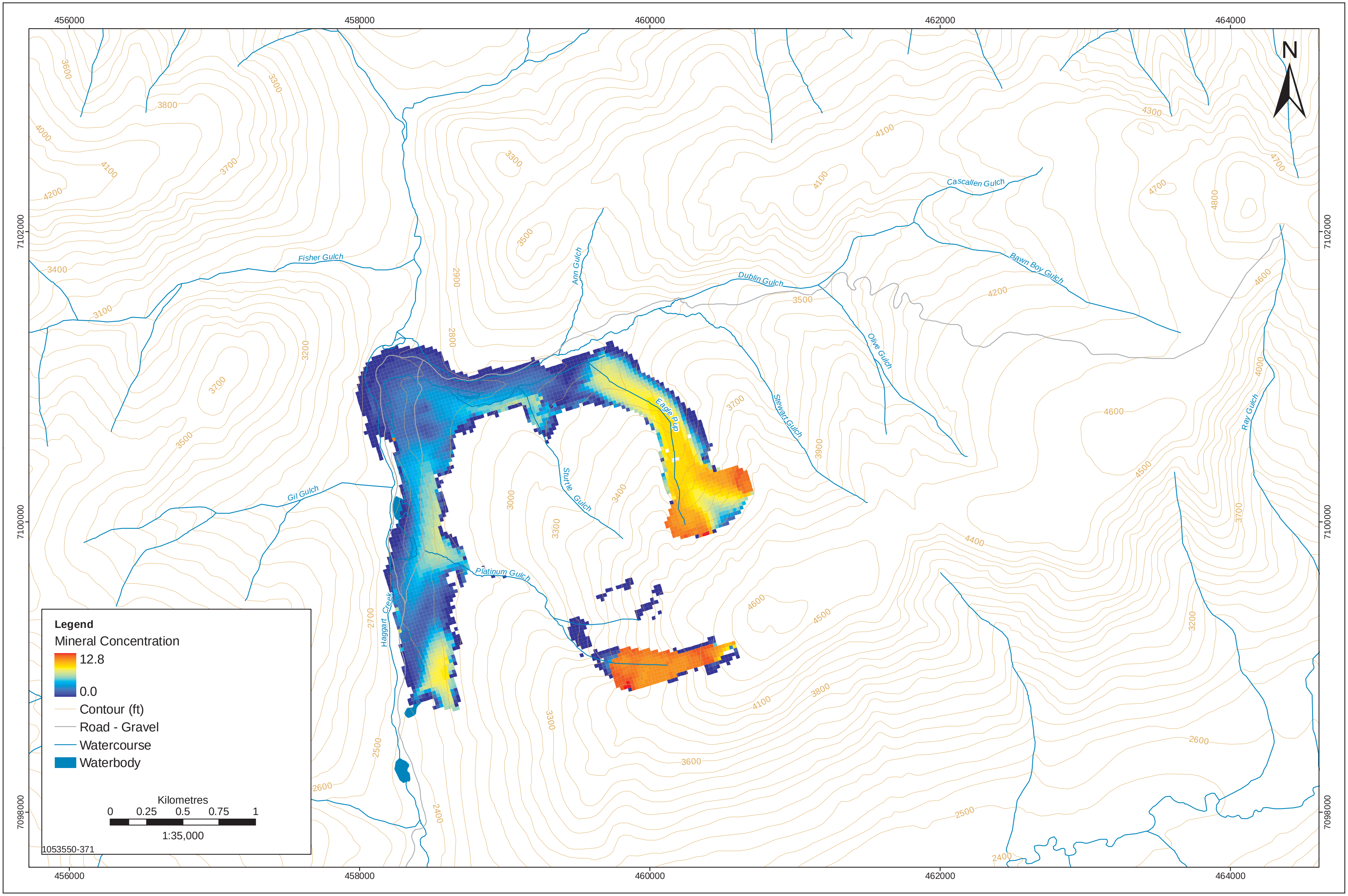
Victoria GOLD CORP

WASTE ROCK STORAGE AREAS RECHARGE CONDITION
LAYER 2 - RECHARGE CELL LOCATIONS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION: UTM - ZONE 8	DRAWN BY: LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 15-November-2010	FIGURE NO. 5.2-10



Data Sources; Government of Canada, Victoria Gold Corp.

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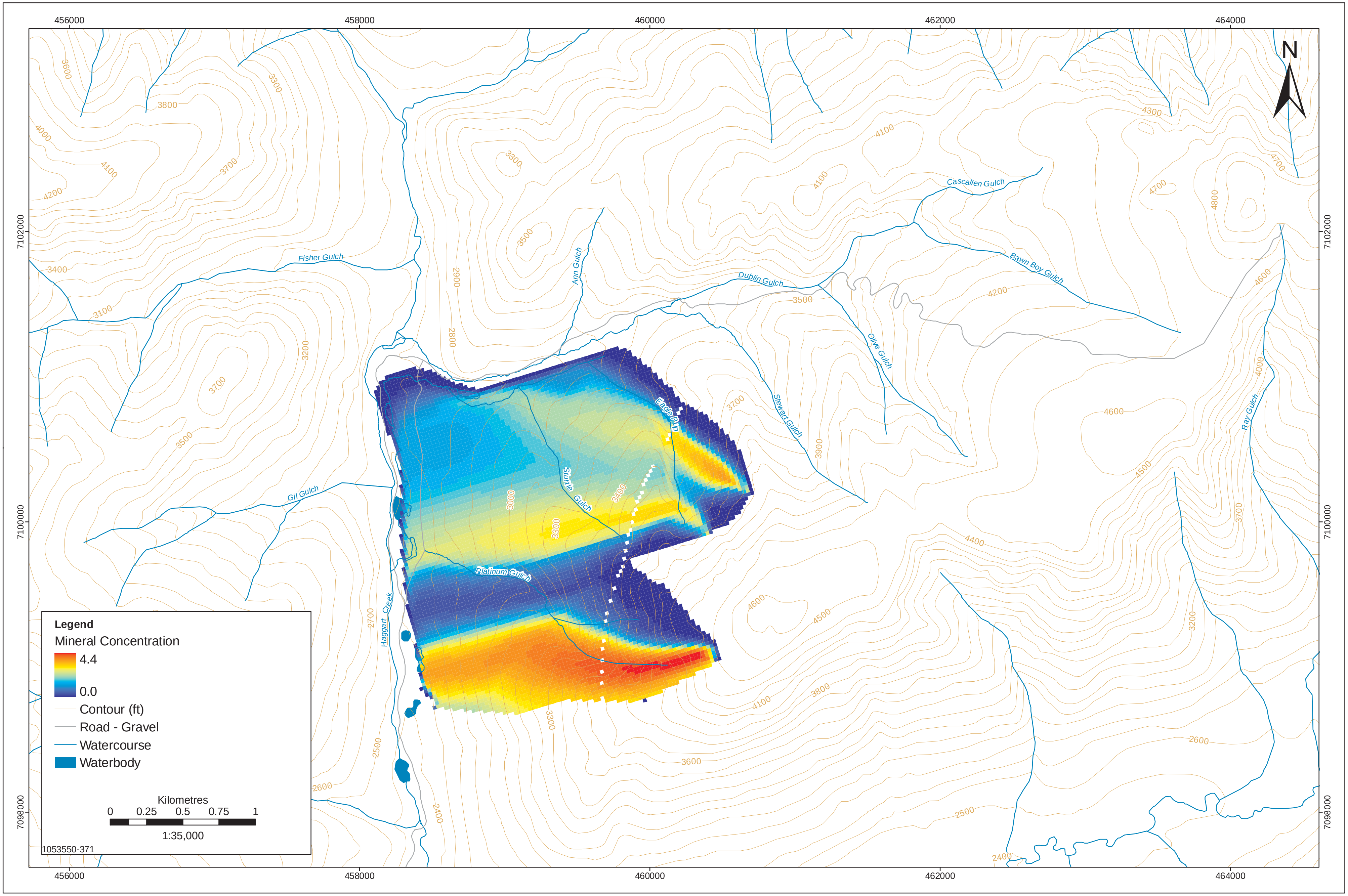
Victoria GOLD CORP

WASTE ROCK STORAGE AREAS RECHARGE CONDITION
LAYER 1 - 2 YEARS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION UTM - ZONE 8	DRAWN BY LS
DATUM NAD 83	CHECKED BY RS
DATE 15-November-2010	FIGURE NO. 5.2-11



Data Sources; Government of Canada, Victoria Gold Corp.

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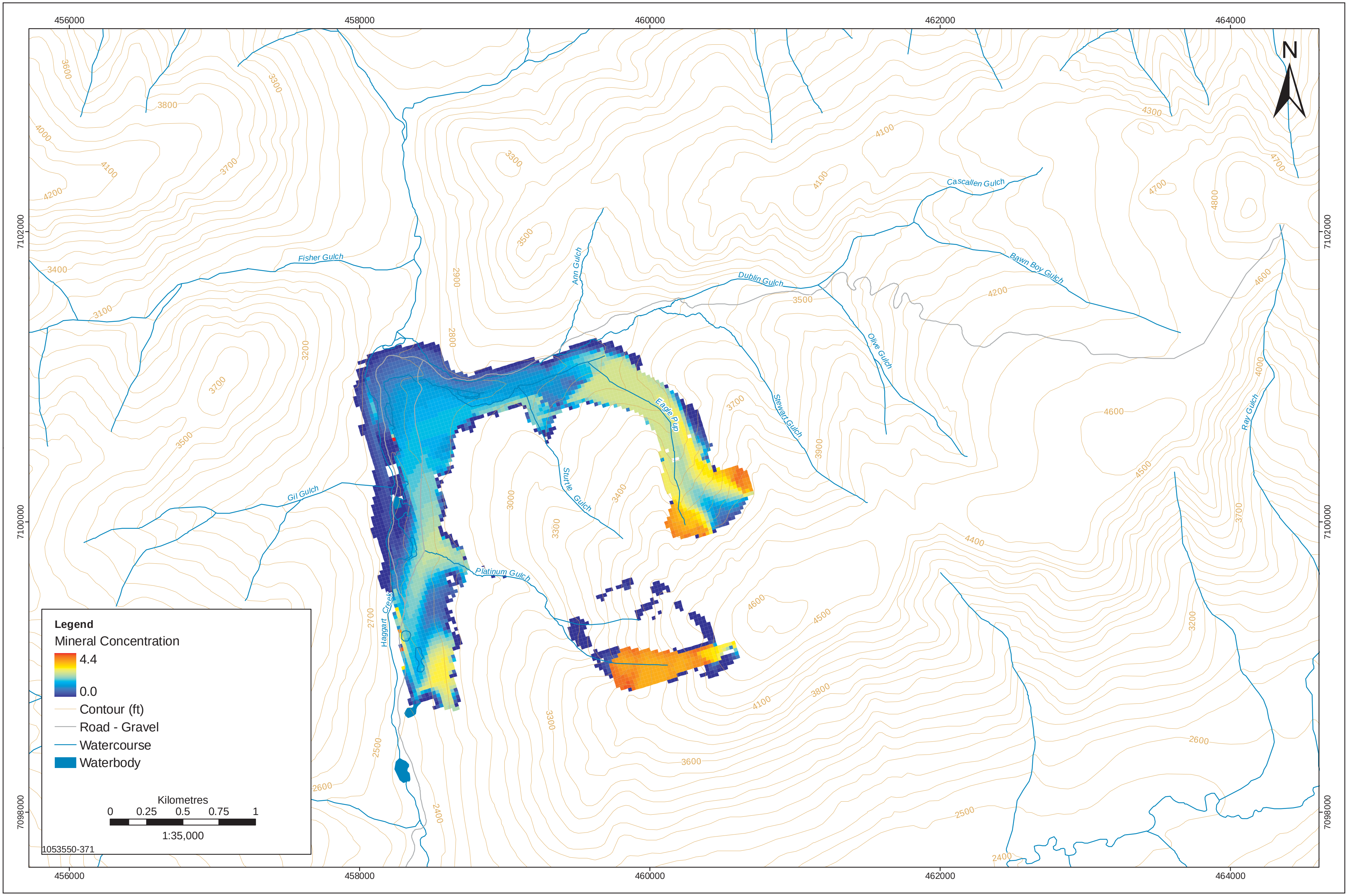
Victoria GOLD CORP

WASTE ROCK STORAGE AREAS RECHARGE CONDITION
LAYER 2 - 2 YEARS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM: NAD 83	CHECKED BY: RS
DATE: 15-November-2010	FIGURE NO.: 5.2-12



Data Sources; Government of Canada, Victoria Gold Corp.

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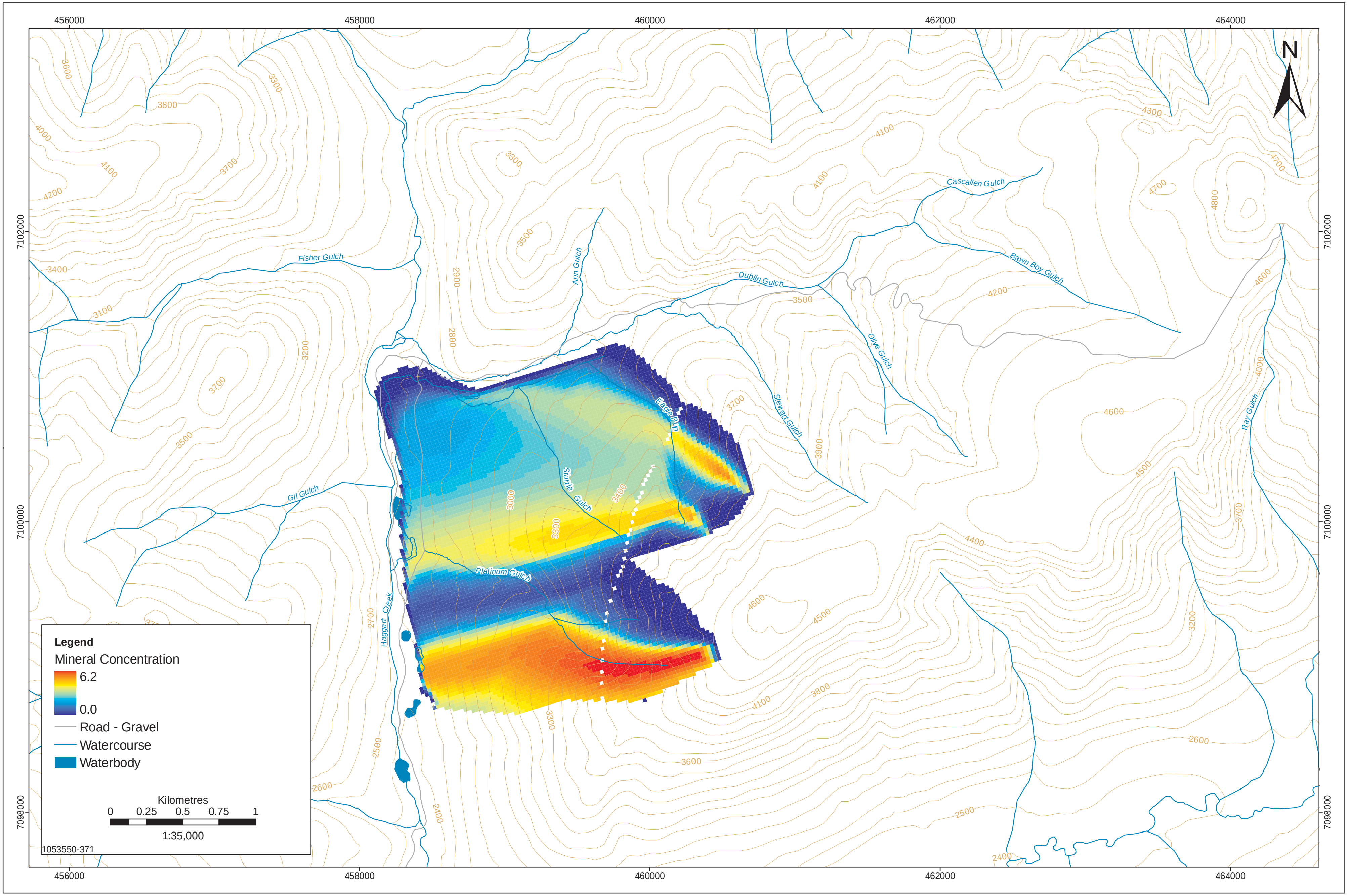
Victoria GOLD CORP

WASTE ROCK STORAGE AREAS RECHARGE CONDITION
LAYER 1 - 9 YEARS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
15-November-2010	5.2-13



Data Sources; Government of Canada, Victoria Gold Corp.

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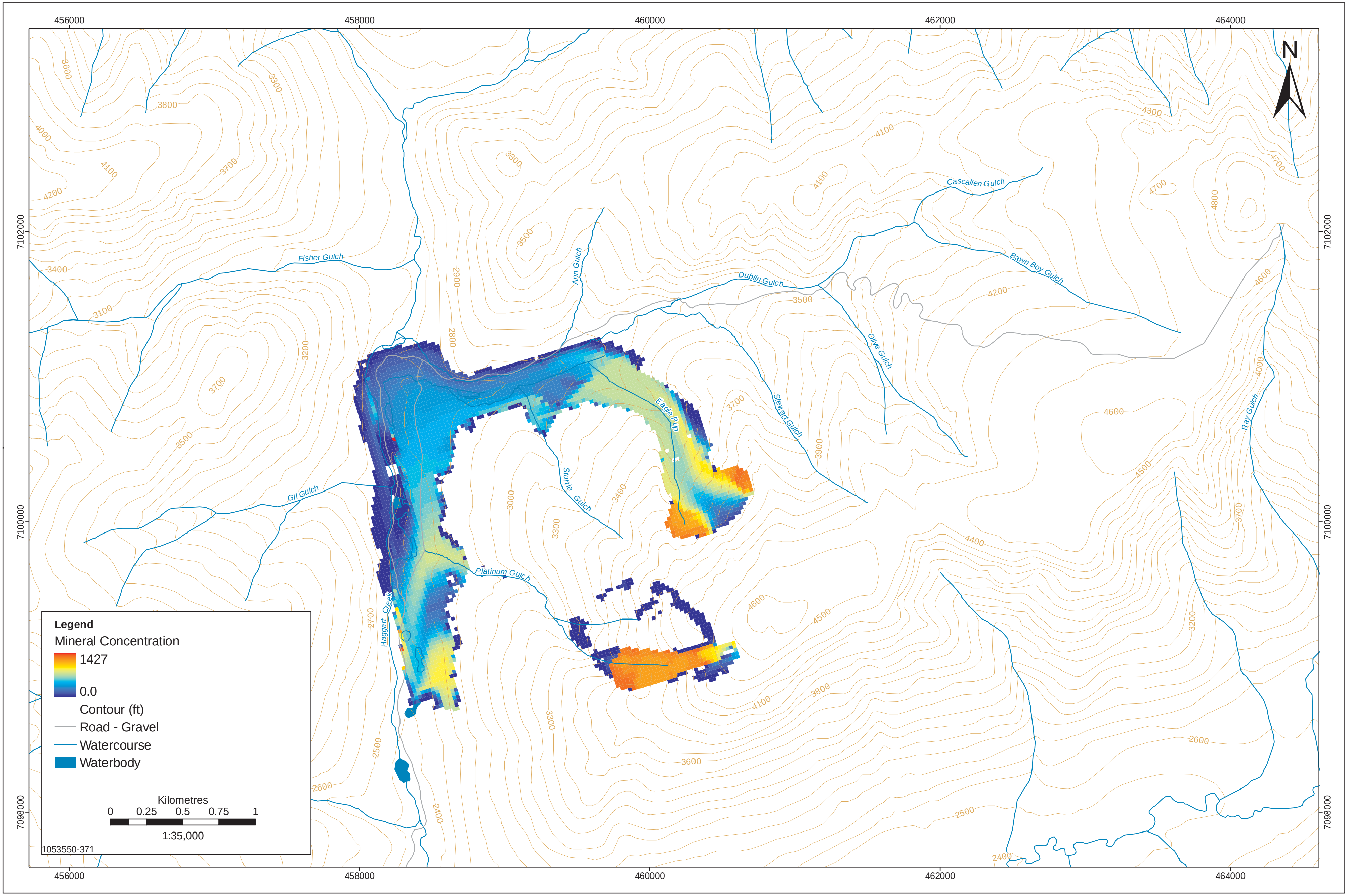
WASTE ROCK STORAGE AREAS RECHARGE CONDITION
LAYER 2 - 9 YEARS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM NAD 83	CHECKED BY RS
DATE 15-November-2010	FIGURE NO. 5.2-14



Data Sources; Government of Canada, Victoria Gold Corp.

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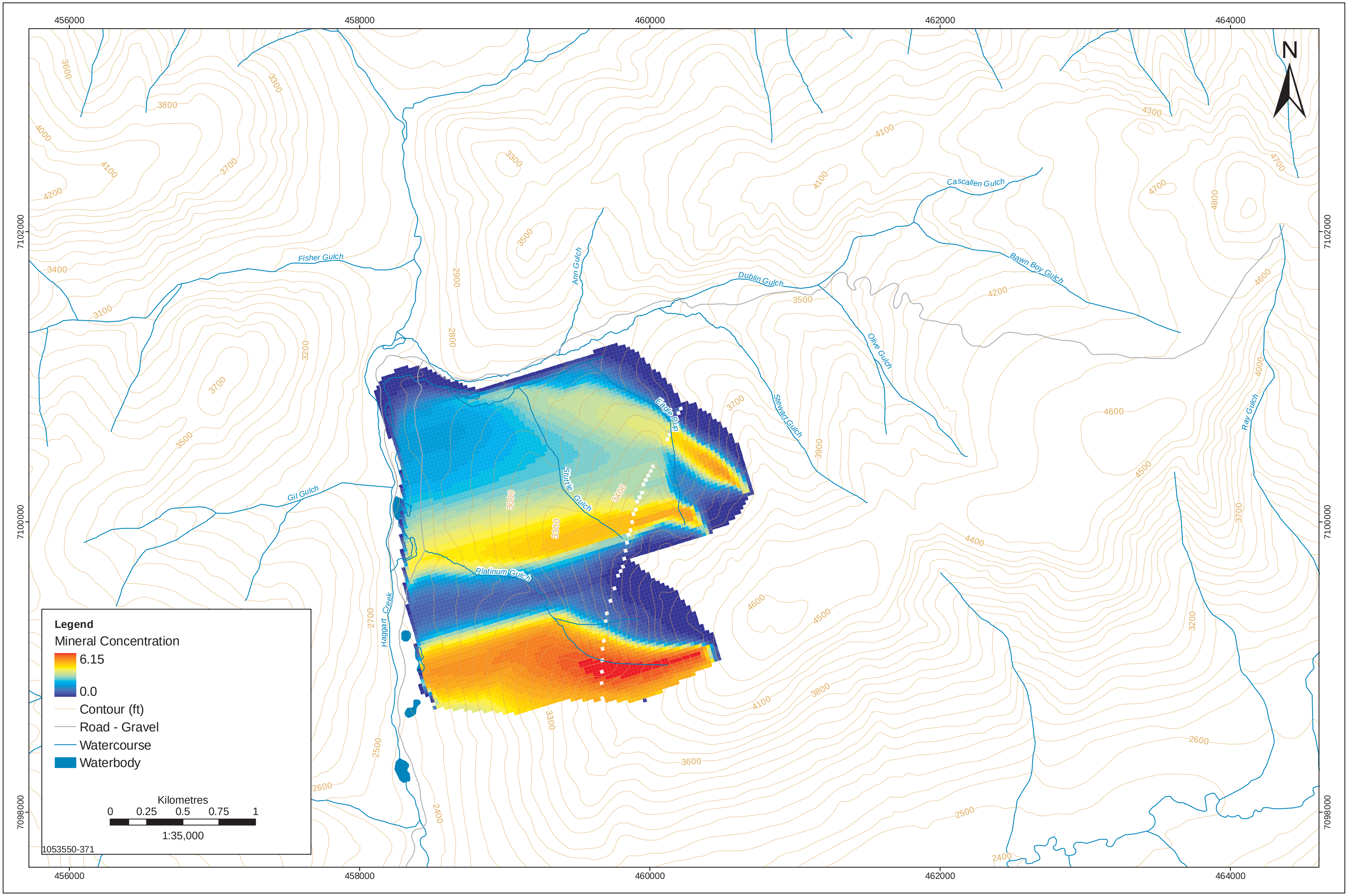
Victoria GOLD CORP

WASTE ROCK STORAGE AREAS RECHARGE CONDITION
LAYER 1 - 19 YEARS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
15-November-2010	5.2-15



Data Sources; Government of Canada, Victoria Gold Corp.

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Victoria GOLD CORP

WASTE ROCK STORAGE AREAS RECHARGE CONDITION LAYER 2 - 19 YEARS

EAGLE GOLD PROPERTY
YUKON TERRITORY

PROJECTION	DRAWN BY
UTM - ZONE 8	LS
DATUM	CHECKED BY
NAD 83	RS
DATE	FIGURE NO.
15-November-2010	5.2-16

APPENDIX A

Comparison Graphs
Predicted Groundwater Elevations for Baseline, Operation and Post-closure Scenarios

Figure A1-1: Predicted Mean Annual Groundwater Elevations during Operation – Dublin Gulch Wells

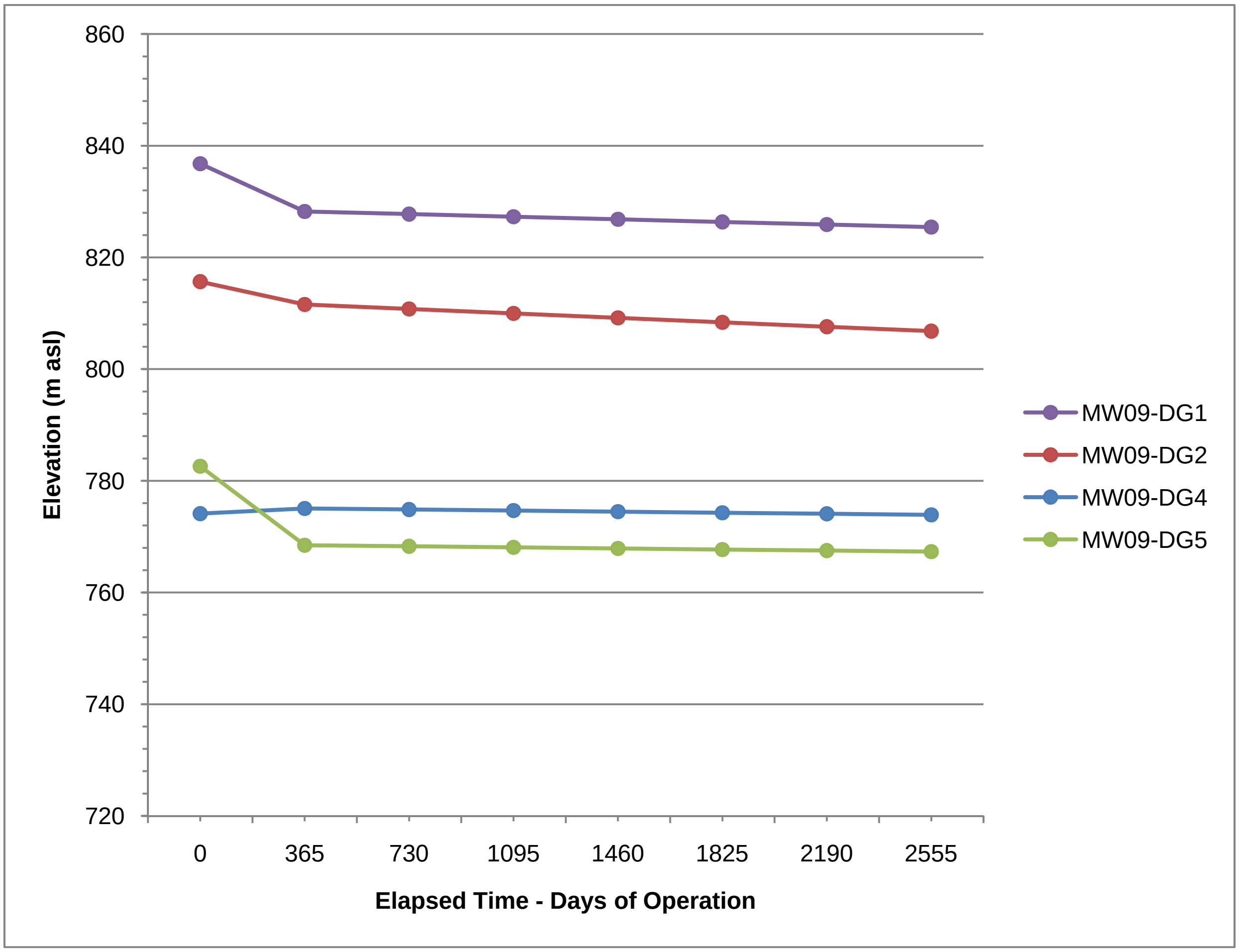


Figure A1-2: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-DG1

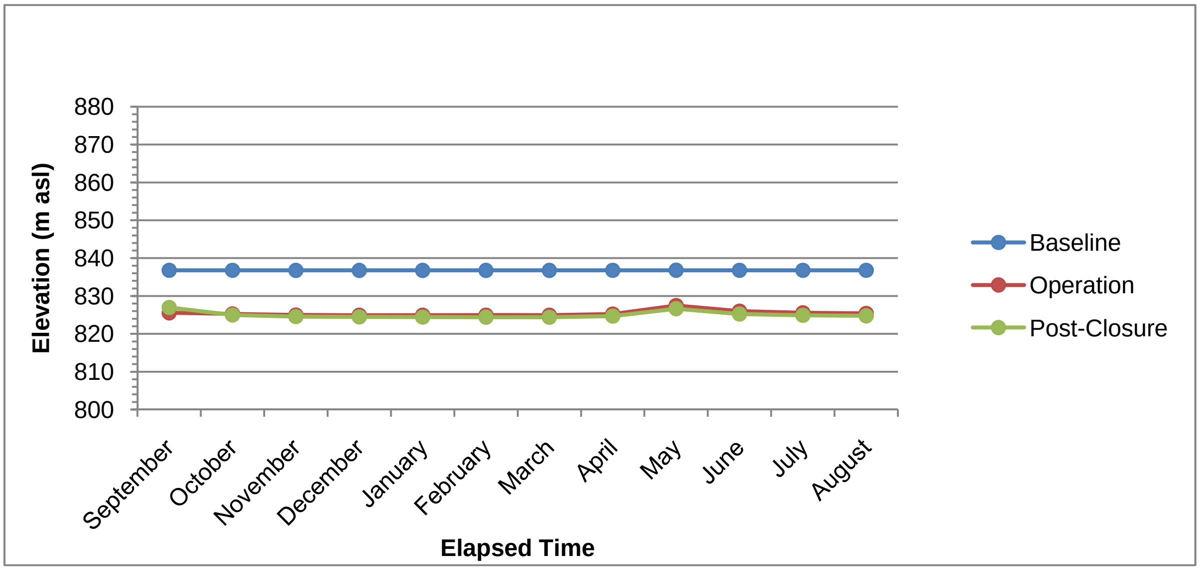


Figure A1-3: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-DG2

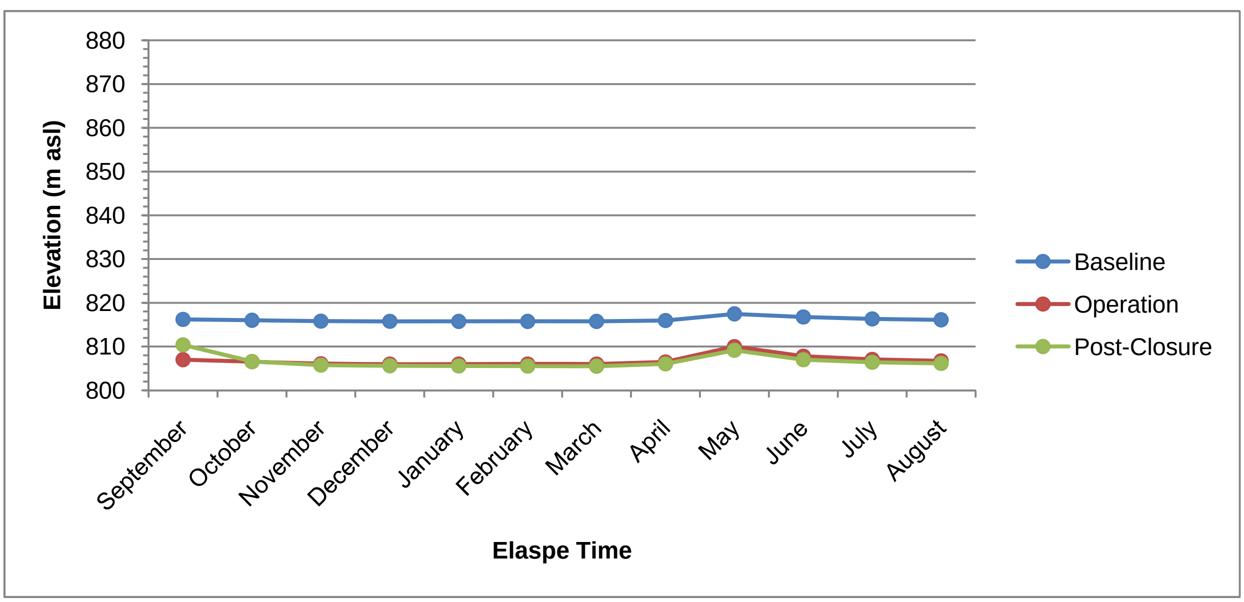


Figure A1-4: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-DG4

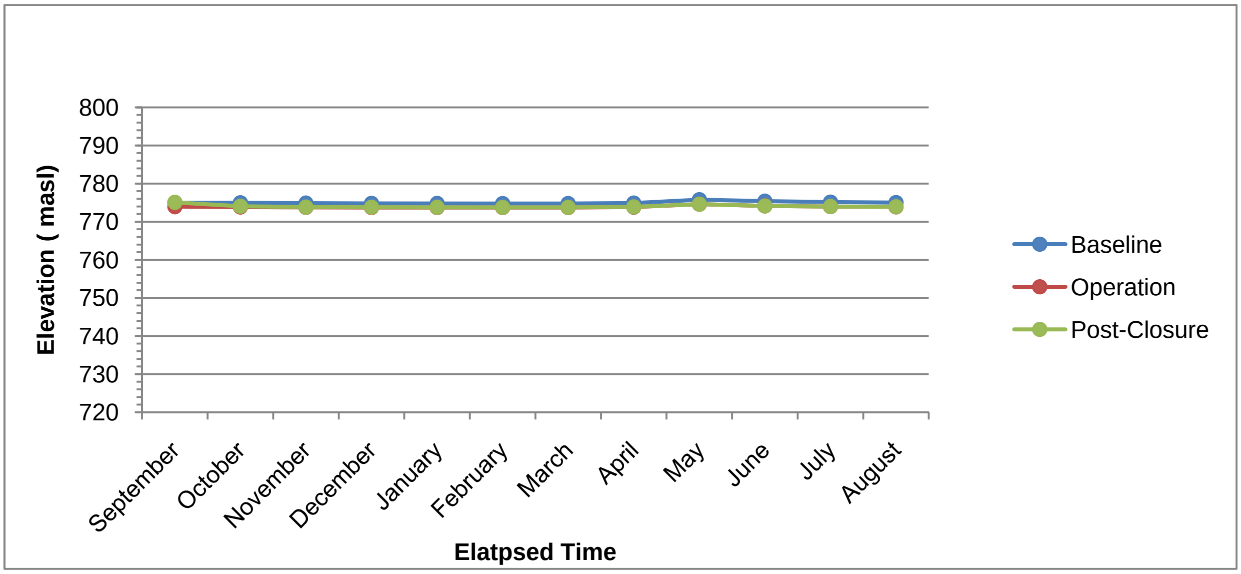


Figure A1-5: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-DG5

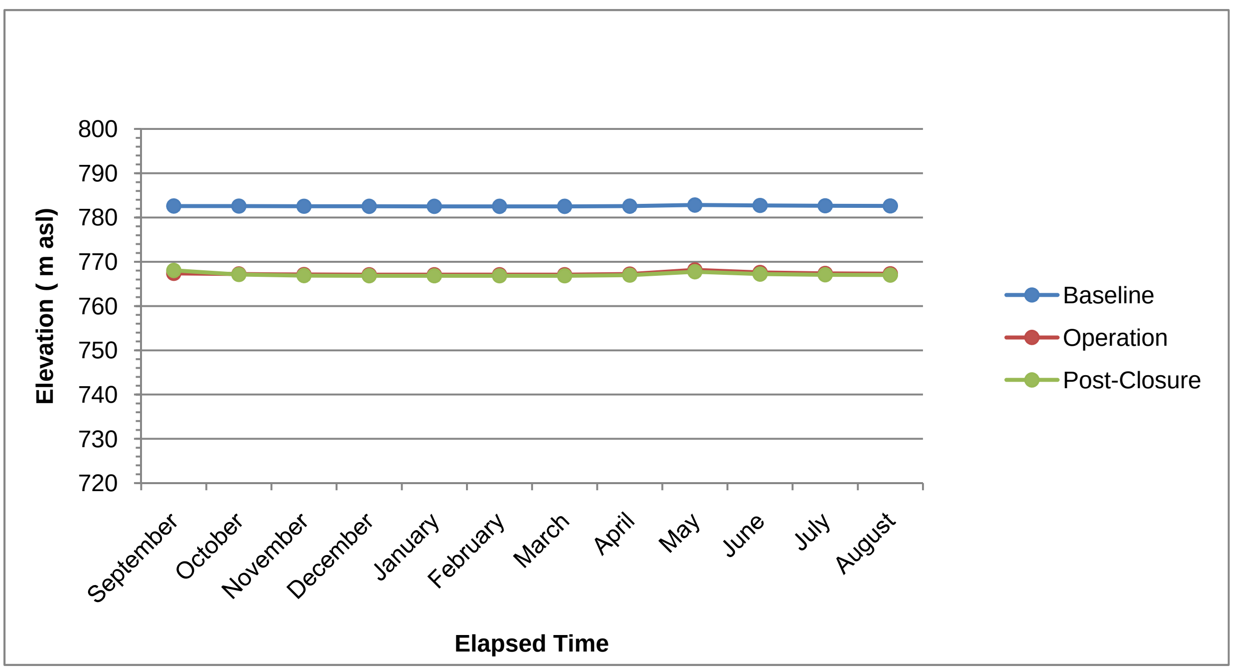


Figure A2-1: Predicted Mean Annual Groundwater Elevations during Operation – Eagle Pup Wells

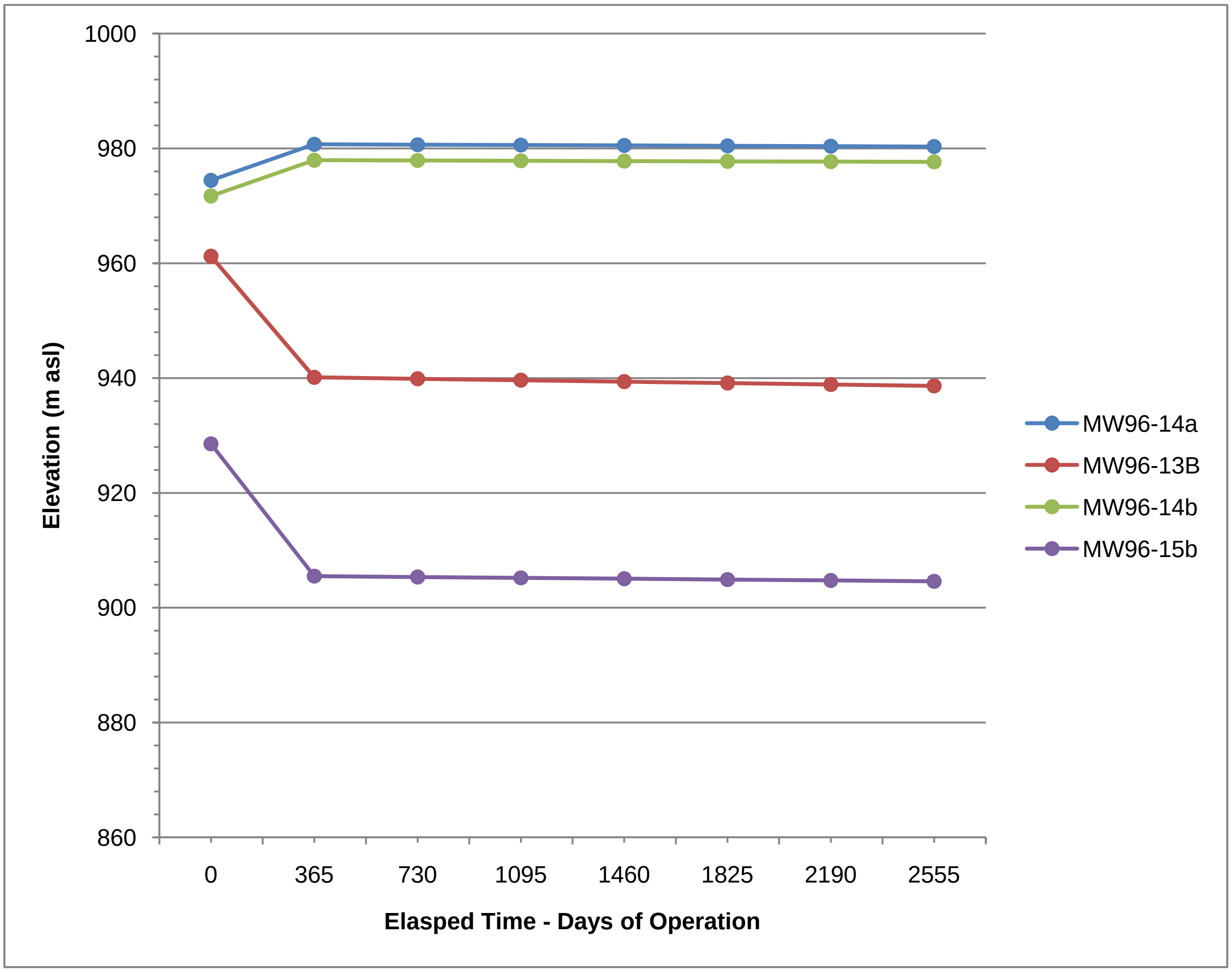


Figure A2-2: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW96-13b

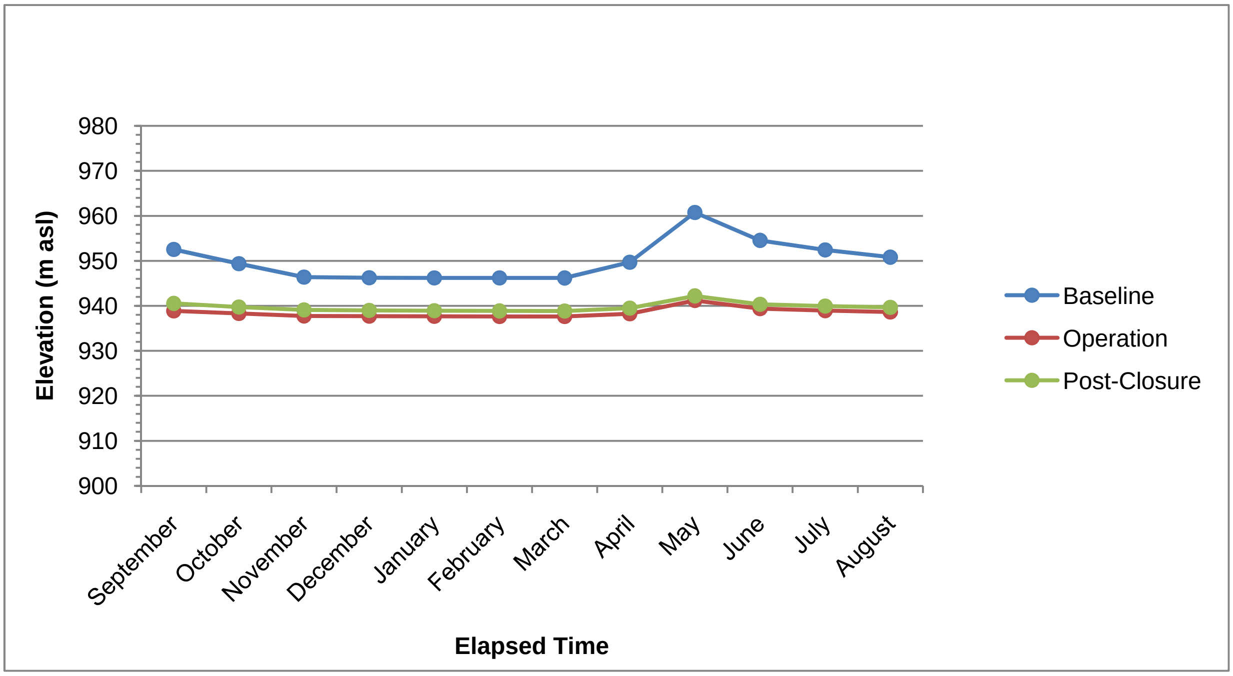


Figure A2-3: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW96-14a

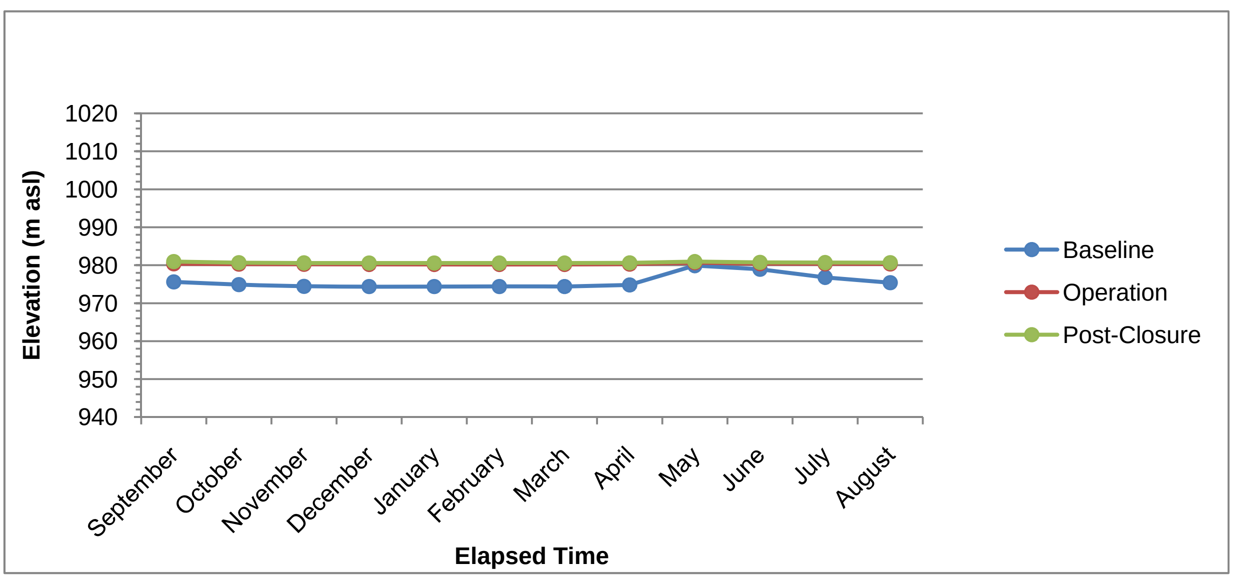


Figure A2-4: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW96-14b

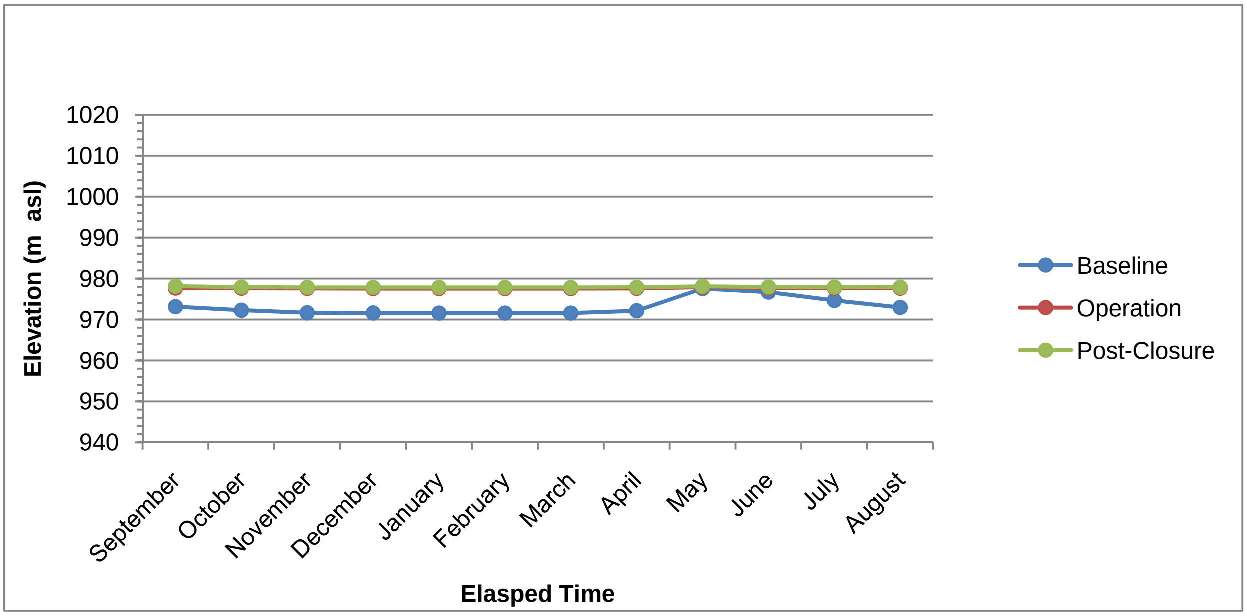


Figure A2-5: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW96-15b

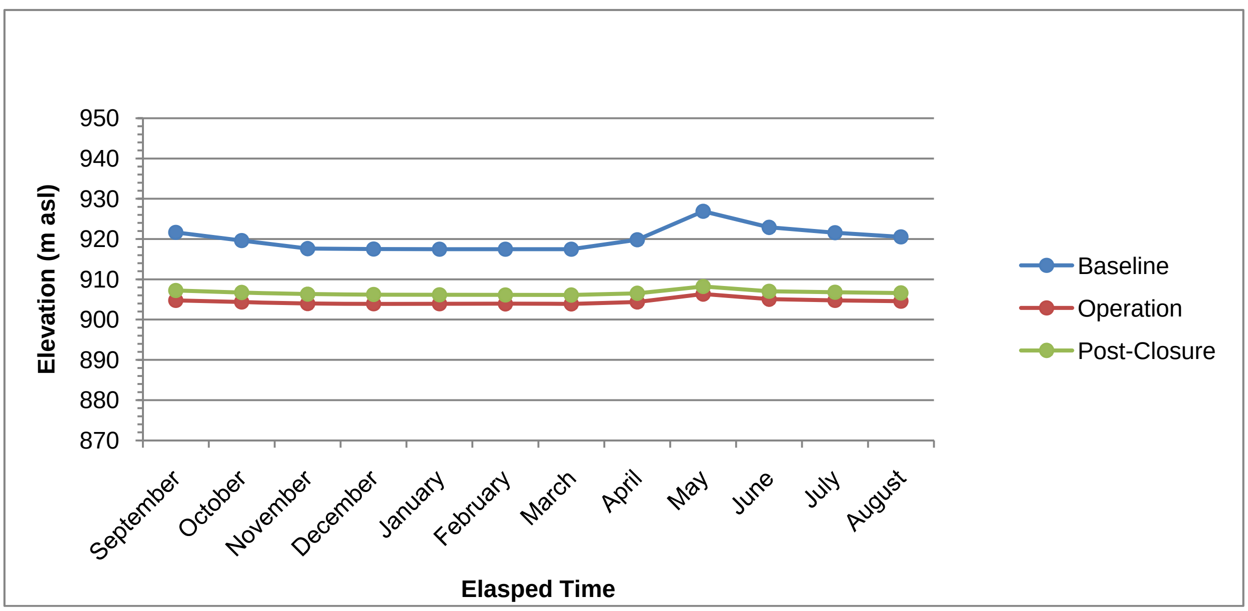


Figure A3-1: Predicted Mean Annual Groundwater elevations during Operation – Stuttle Gulch Wells

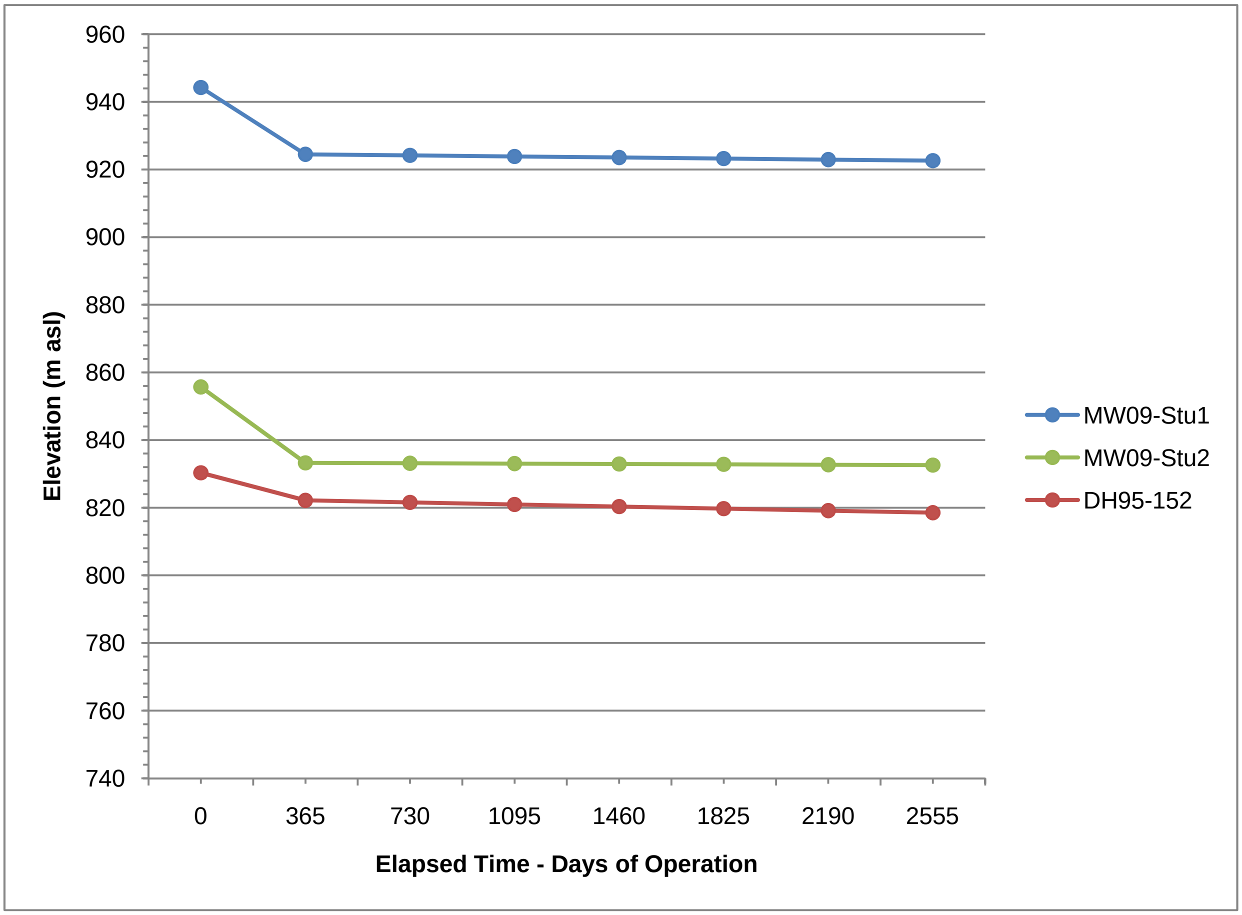


Figure A3-2: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: DH95-152

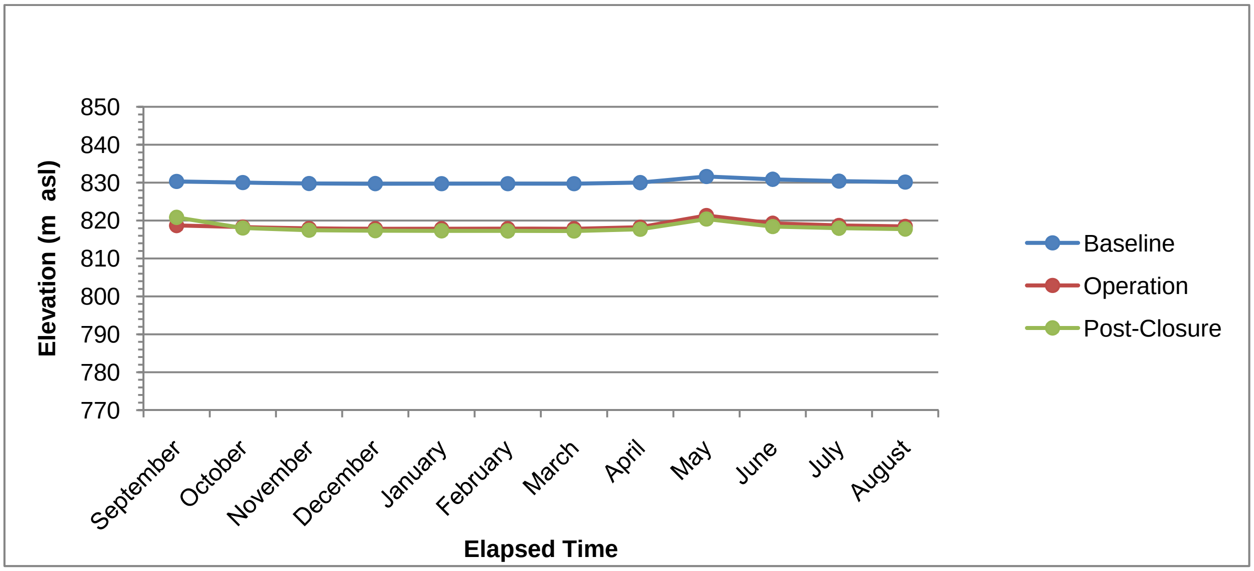


Figure A3-3: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-Stu1

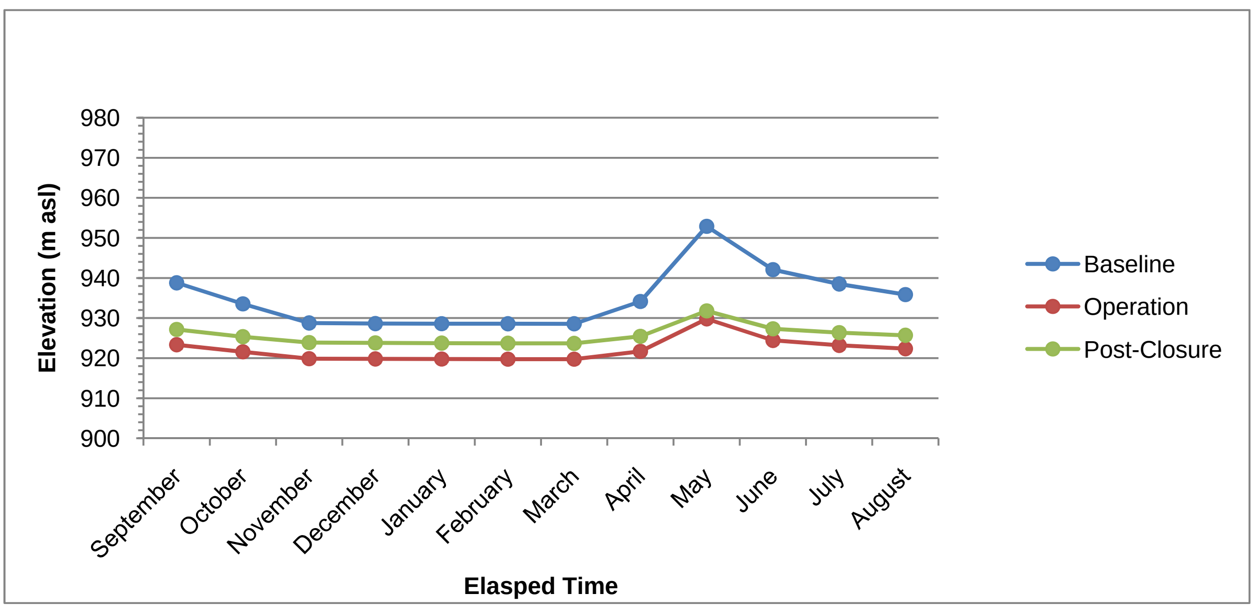


Figure A3-4: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-Stu2

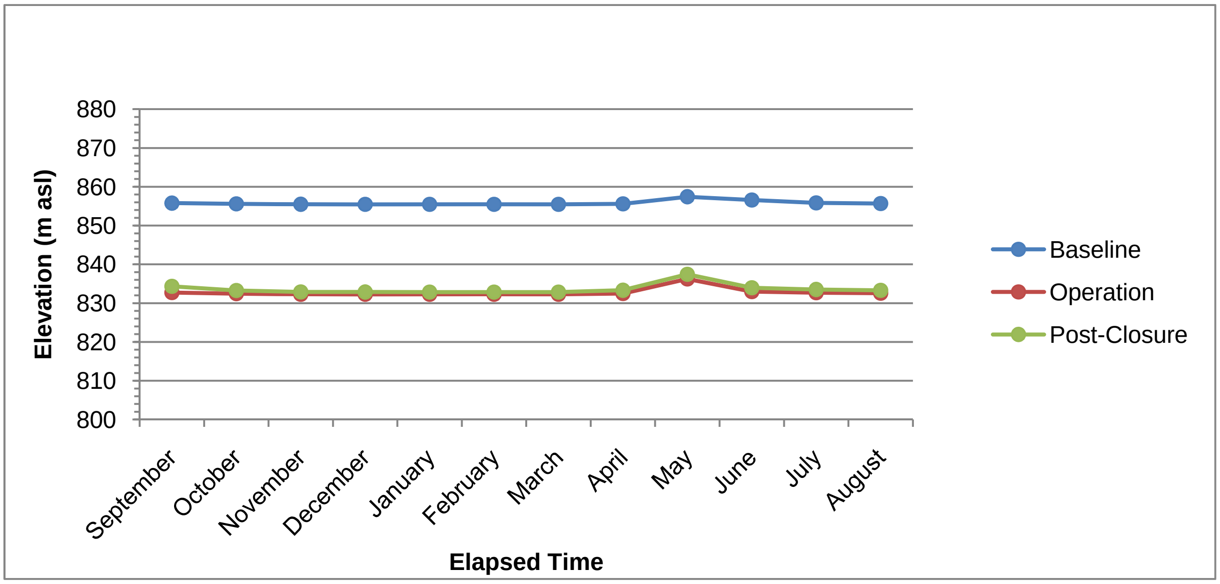


Figure A4-1: Predicted Mean Annual Groundwater Elevations during Operation – Ann Gulch Wells

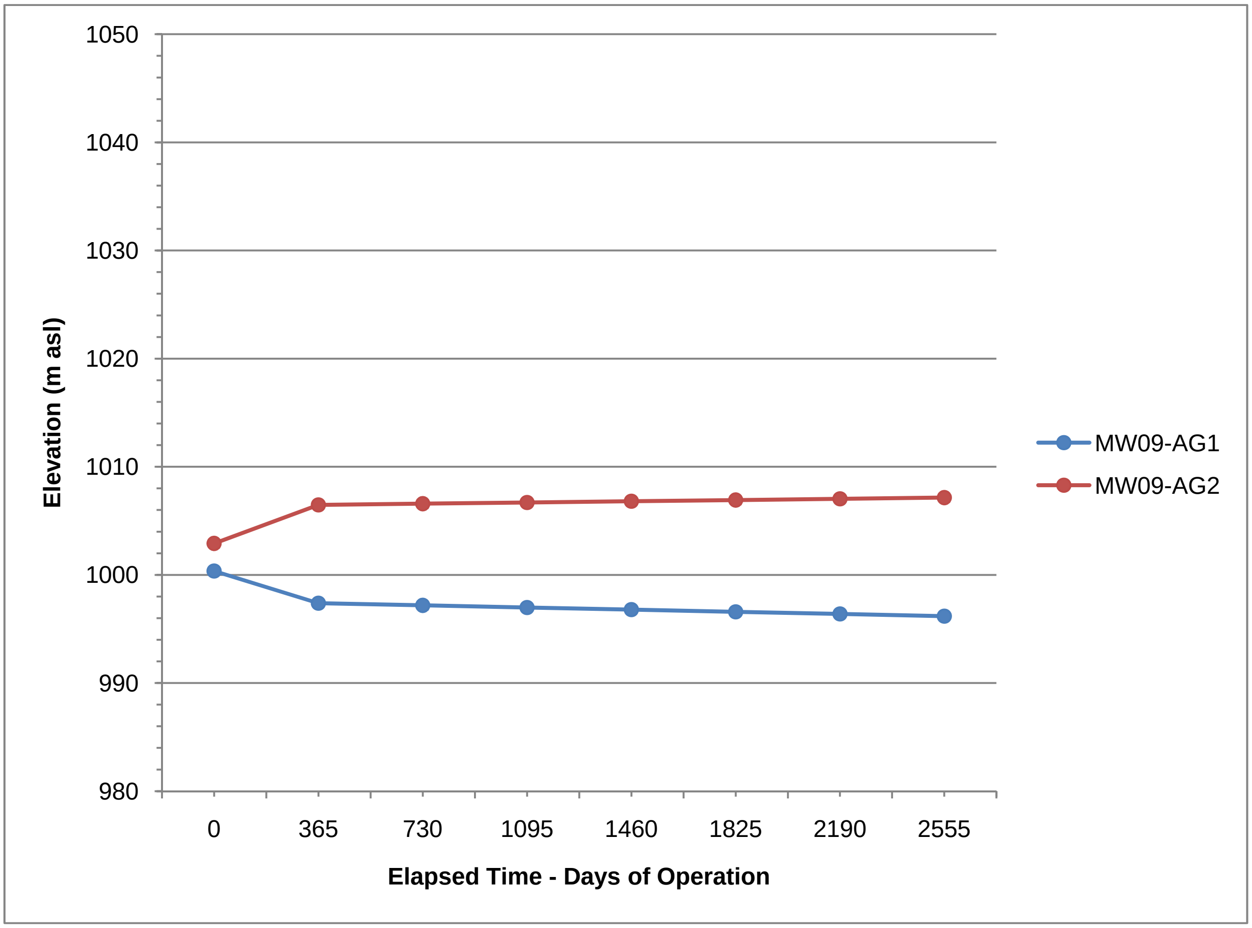


Figure A4-2: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-AG1

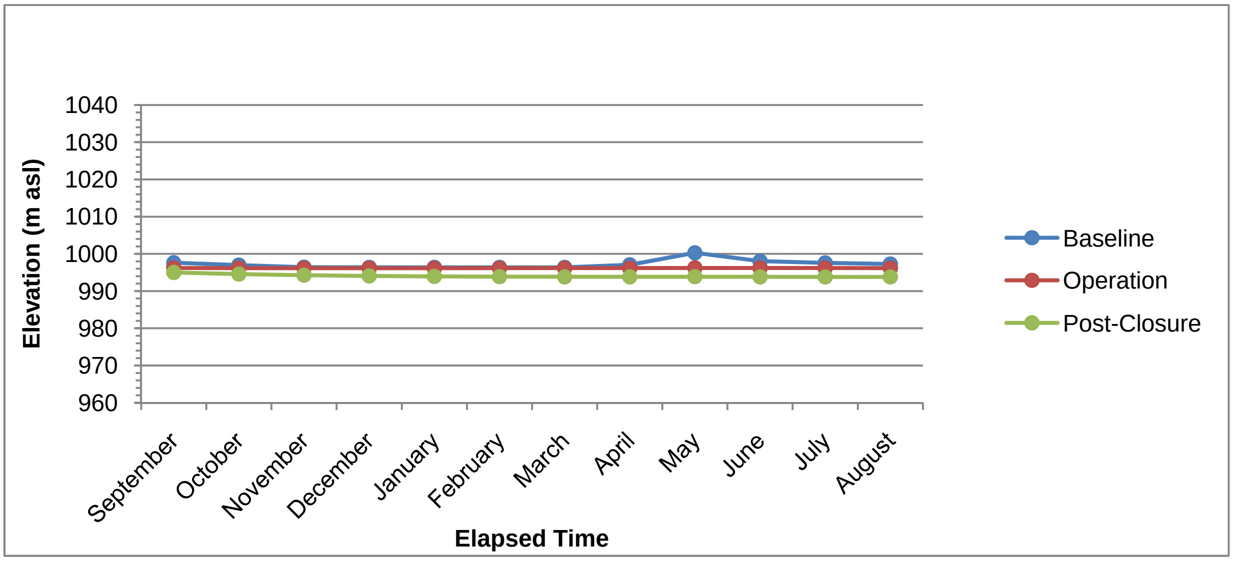


Figure A4-3: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW09-AG2

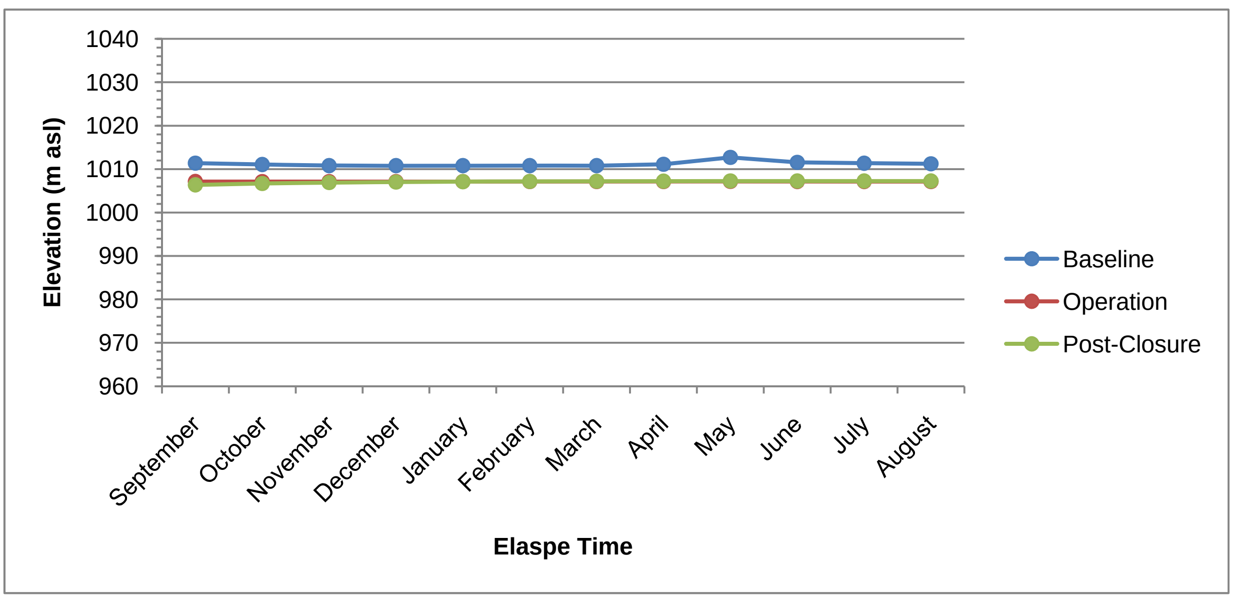


Figure A5-1: Predicted Mean Annual Groundwater elevations during Operation – Platinum Gulch Wells

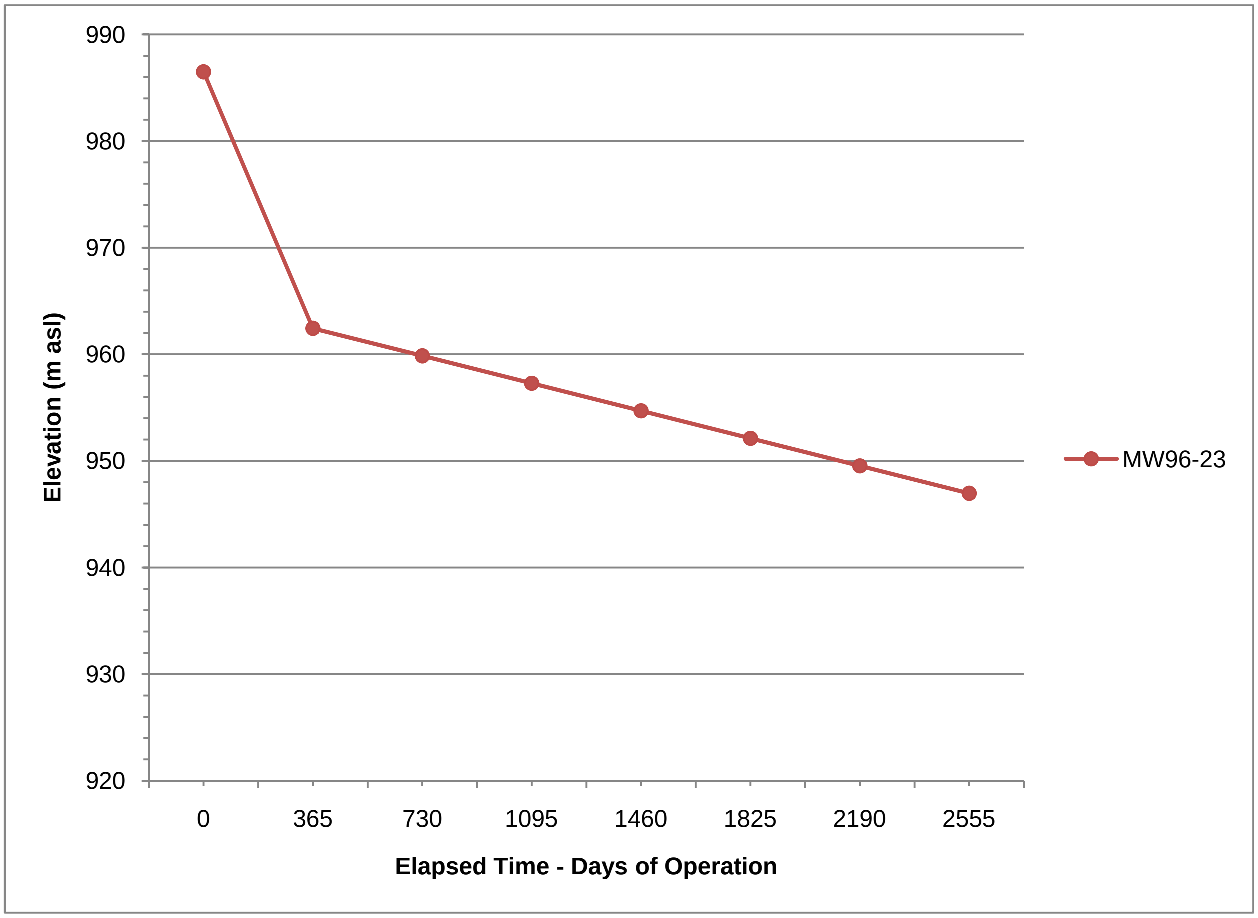


Figure A5-2: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW96-23

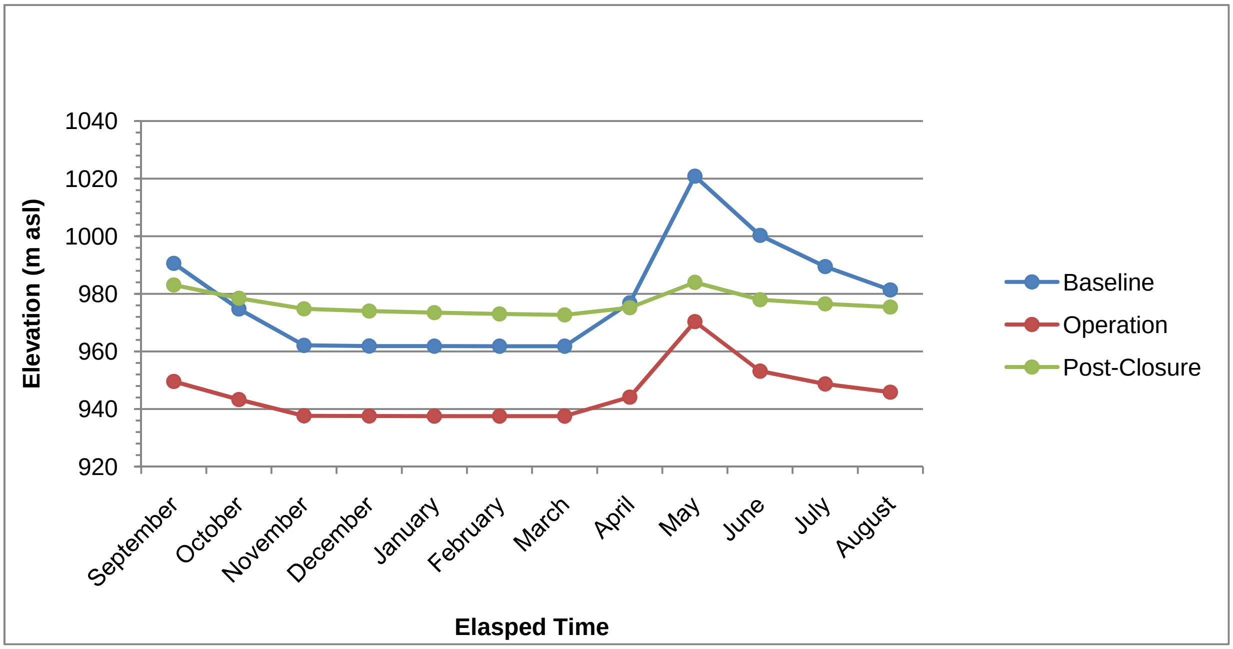


Figure A6-1: Predicted Mean Annual Groundwater Elevations during Operation – Open Pit Area Wells

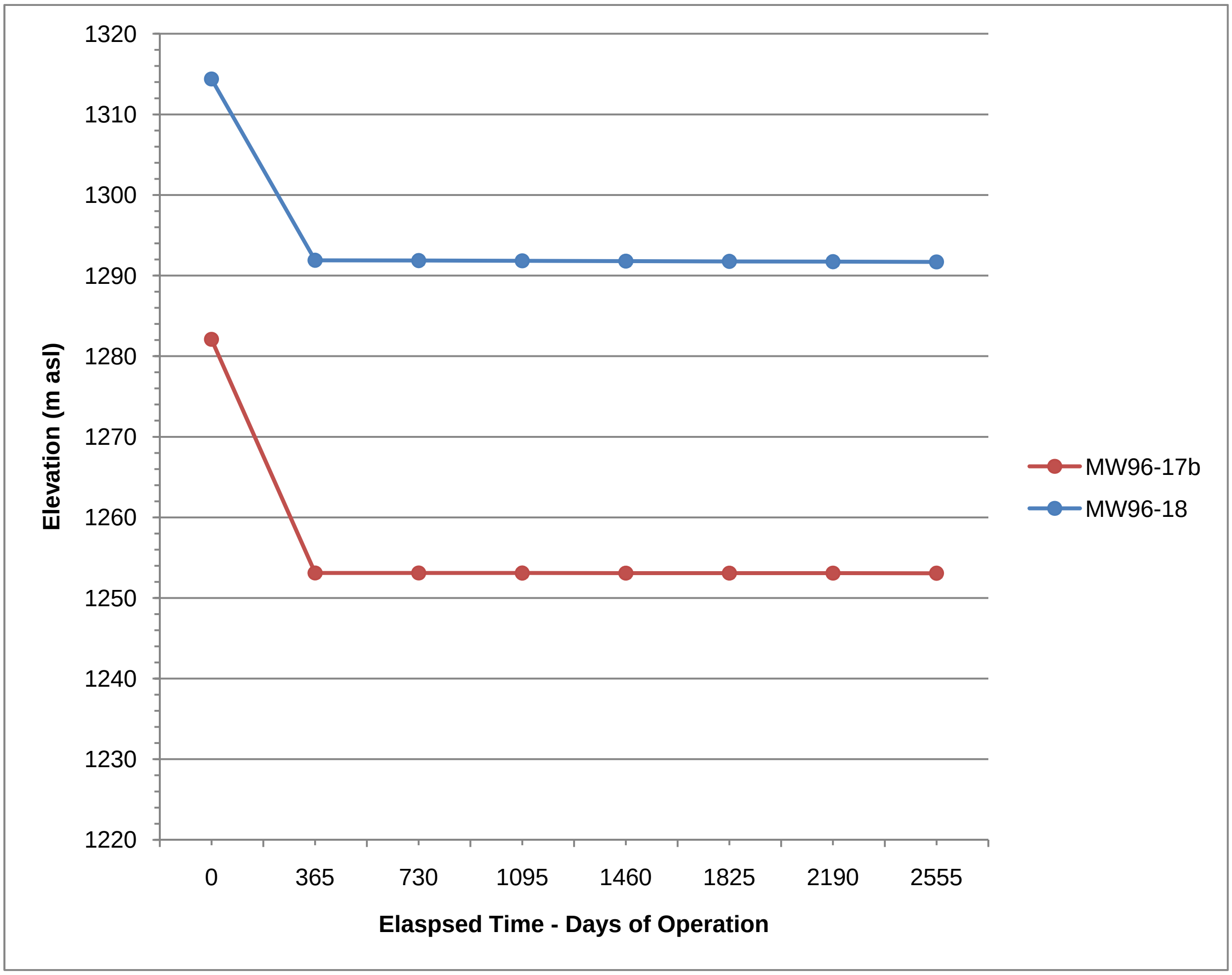


Figure A6-2: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW96-17b

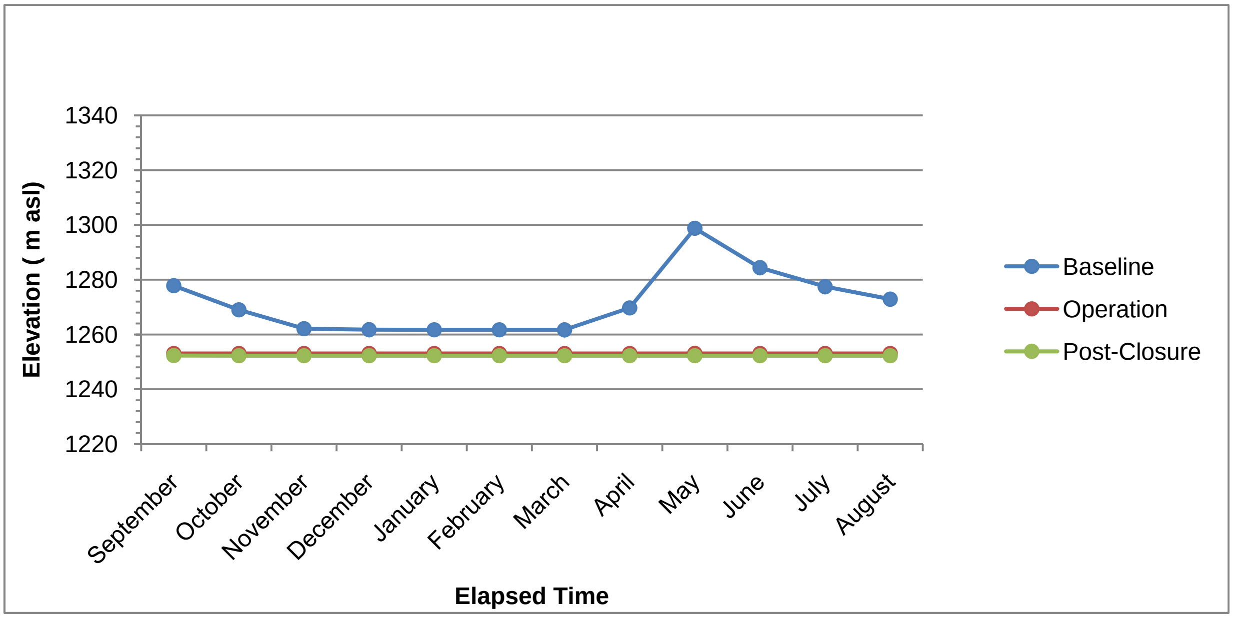


Figure A6-3: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: MW96-18

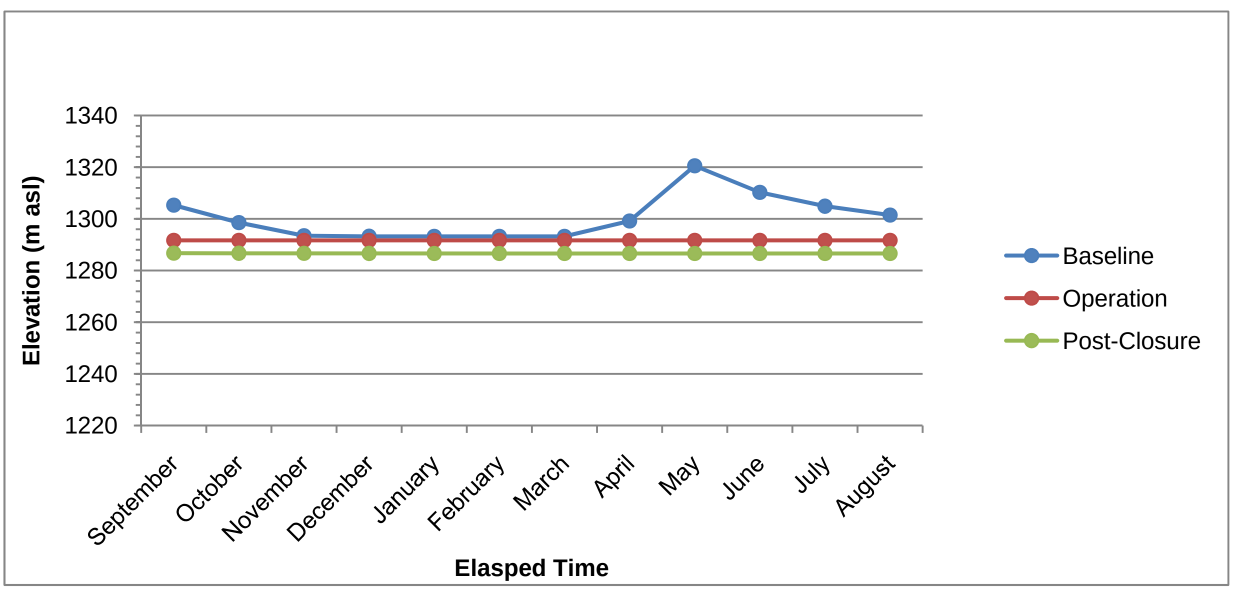


Figure A7-1: Predicted Mean Annual Groundwater Elevations during Operation – Hypothetical Heap Leach Wells

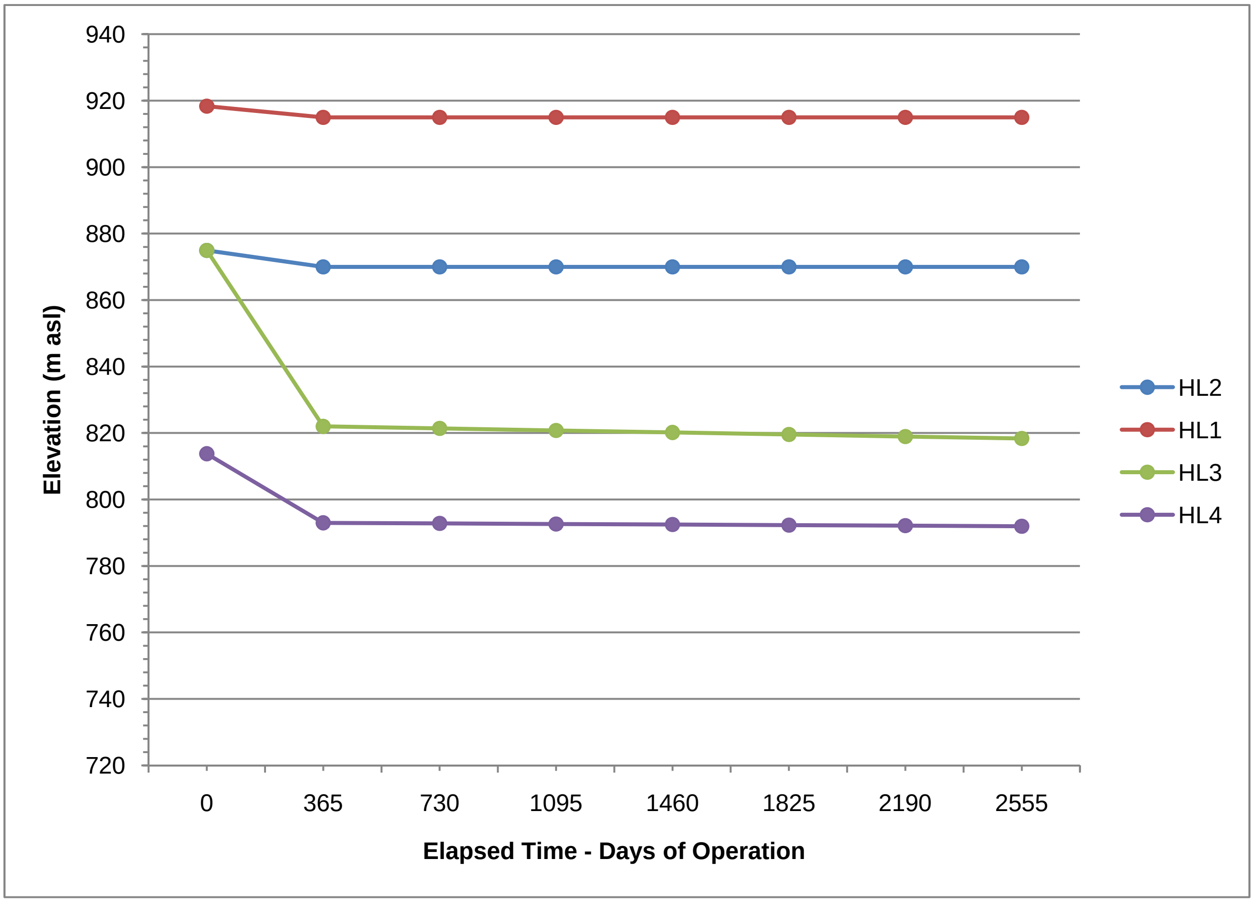


Figure A7-2: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: HL1

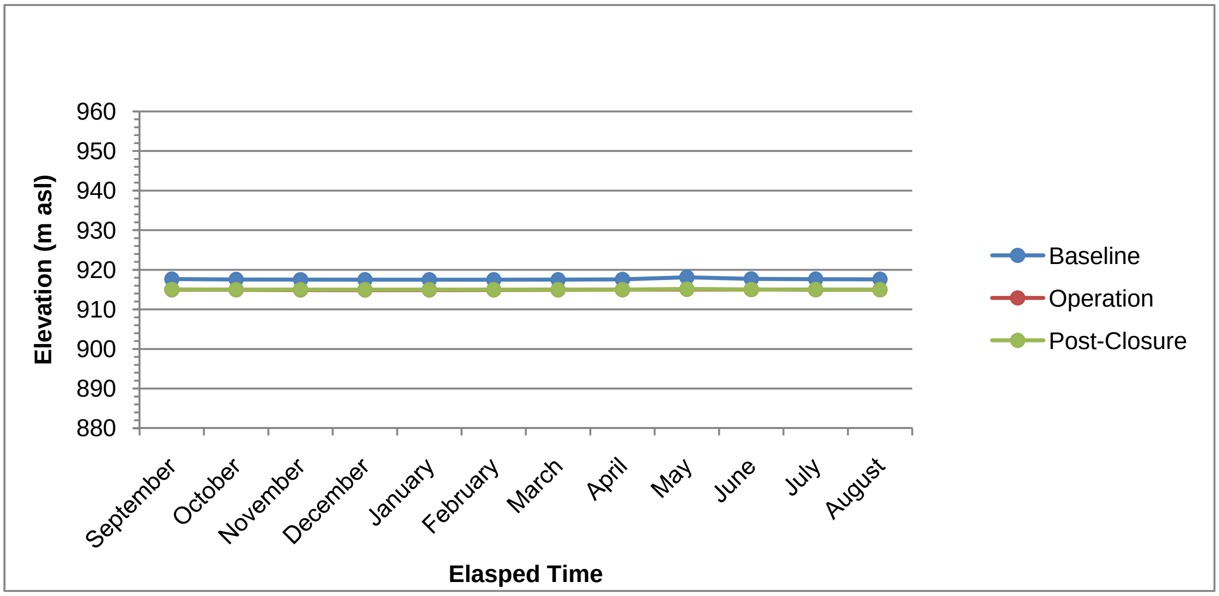


Figure A7-3: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: HL2

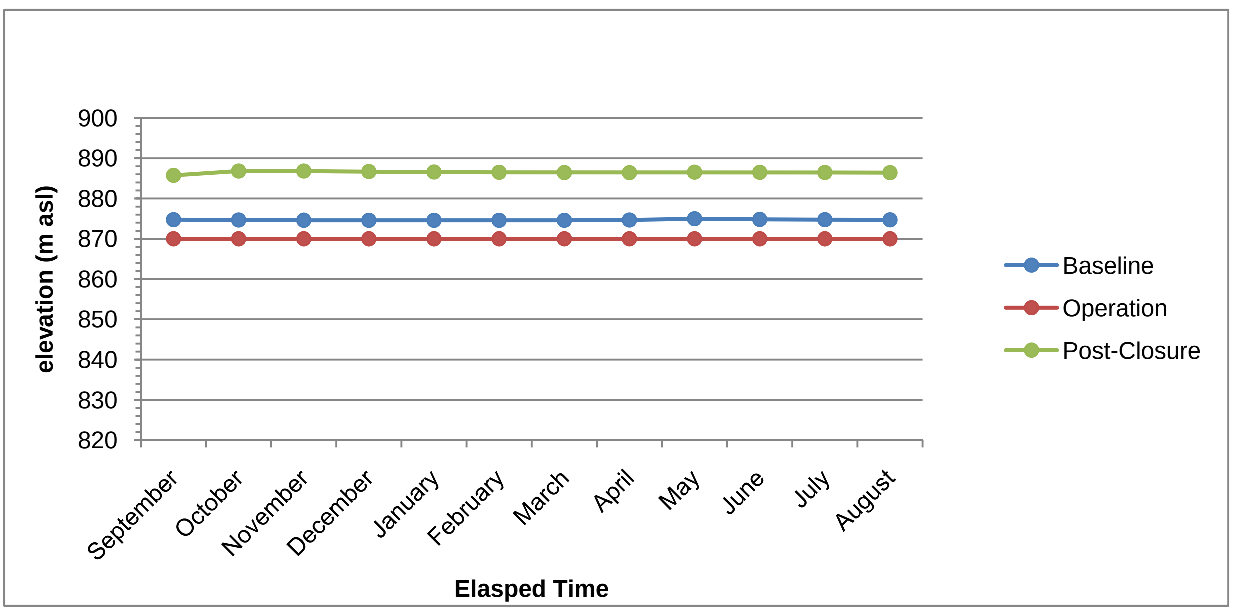


Figure A7-4: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: HL3

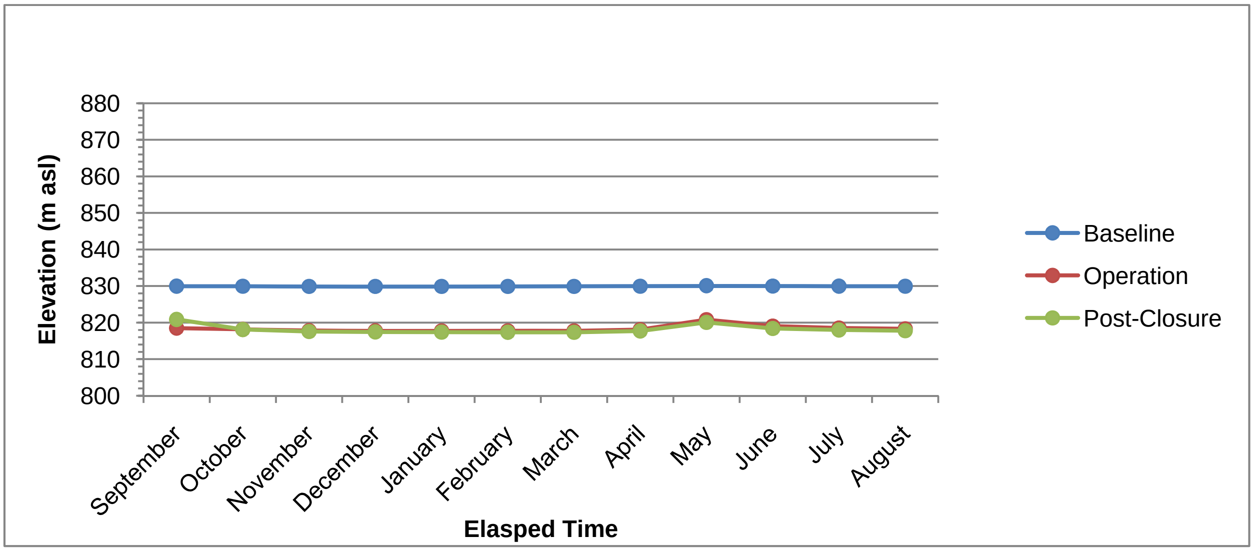
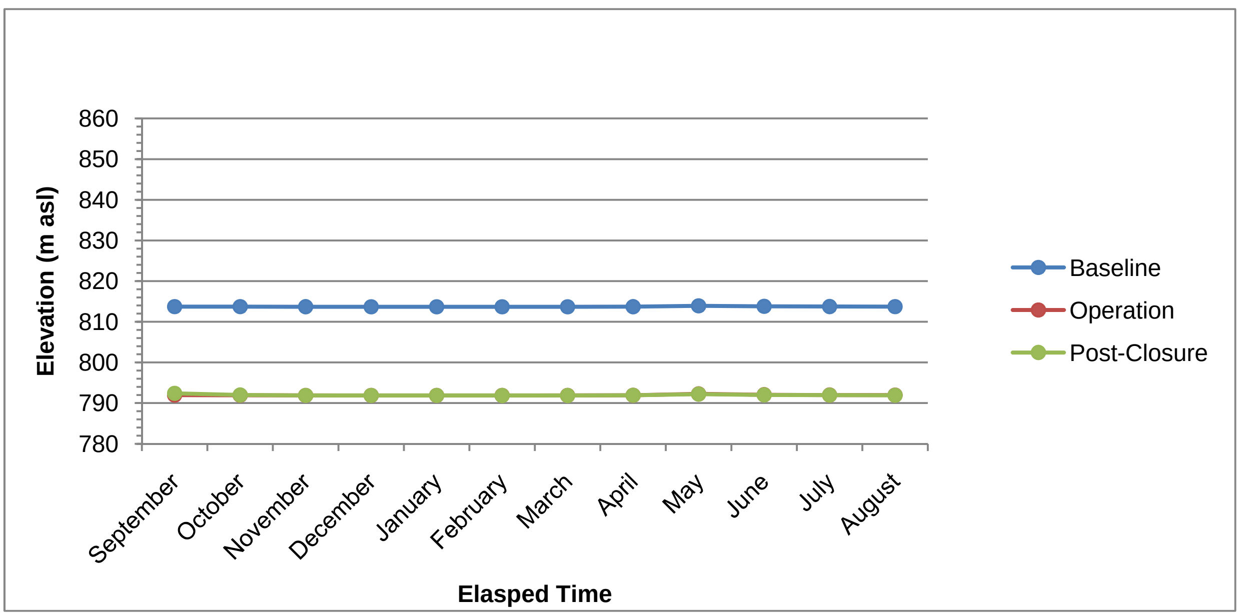


Figure A7-5: Comparison of Predicted GW Elevations for Baseline, Operation, and 30 Years Post-closure: HL4



APPENDIX B

Sensitivity Analysis Results

Figure B1-1: Computed Groundwater Elevations – Well MW09-DG1

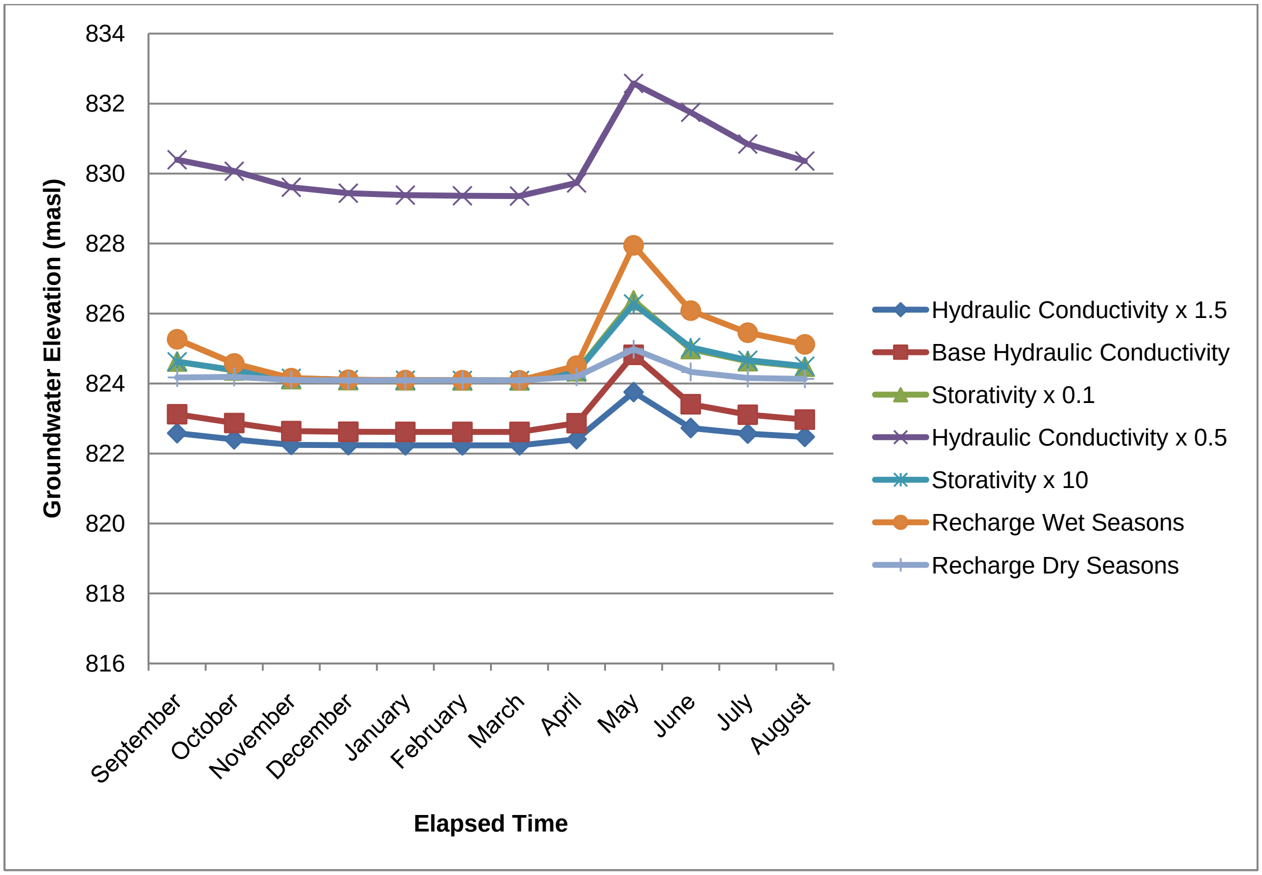


Figure B1-2: Computed Groundwater Elevations – Well MW09-DG2

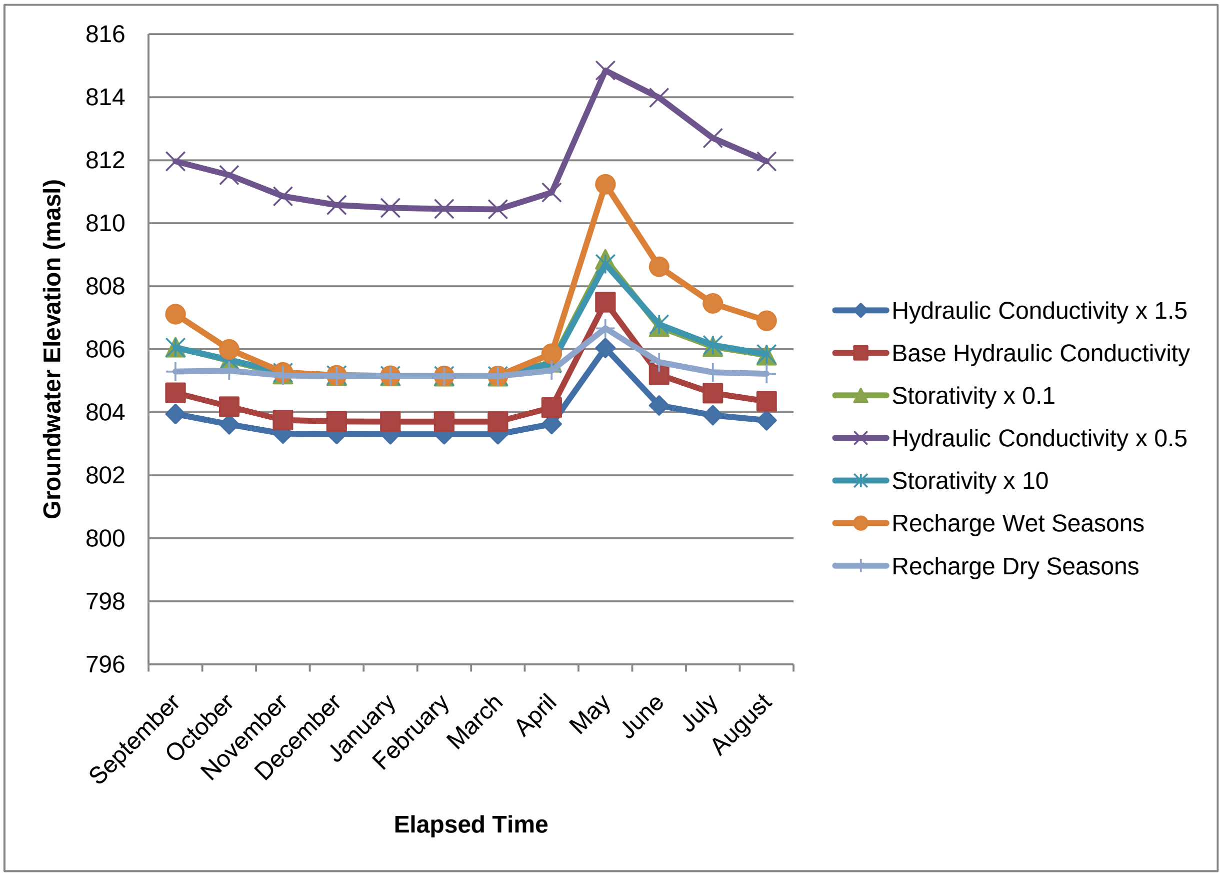


Figure B1-3: Computed Groundwater Elevations – Well MW09-DG4

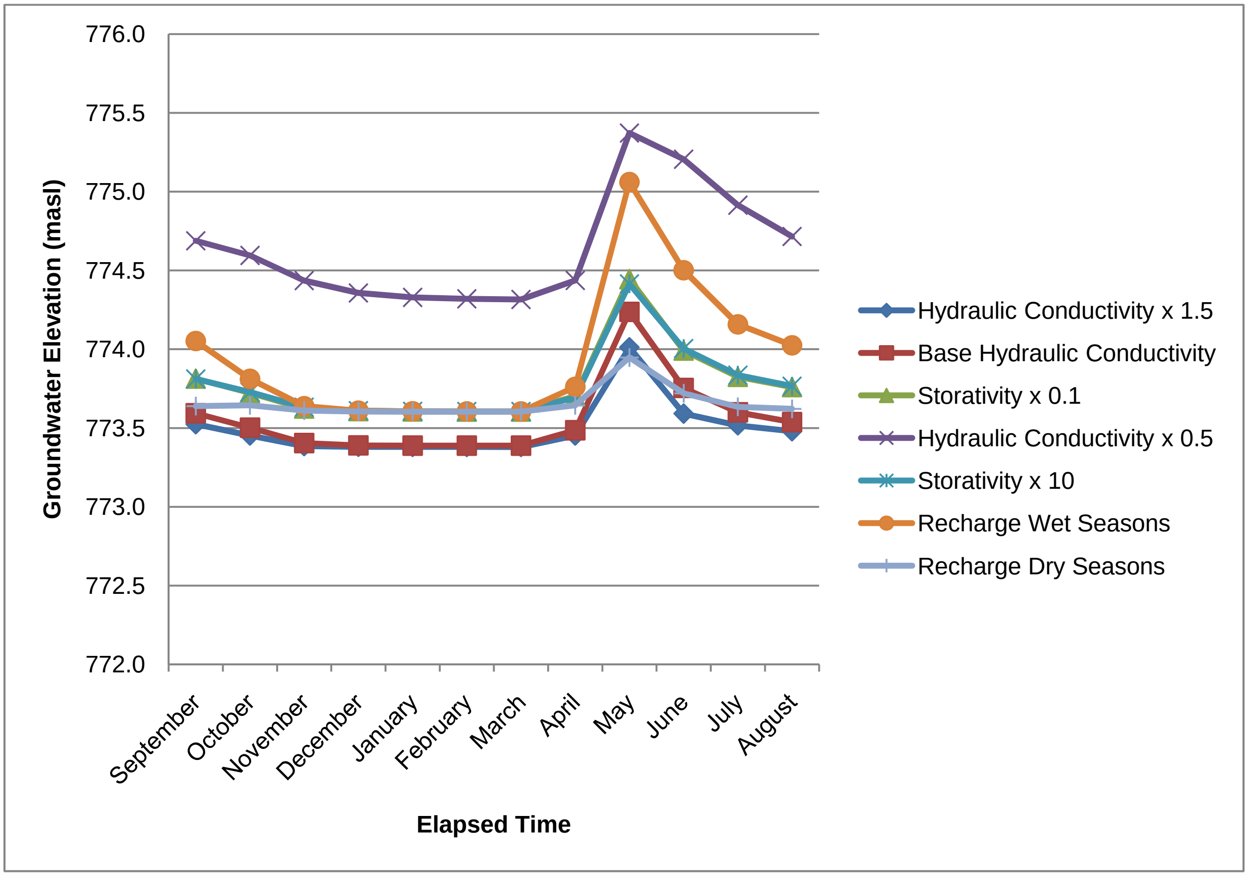


Figure B1-4: Computed Groundwater Elevations – Well MW09-DG5

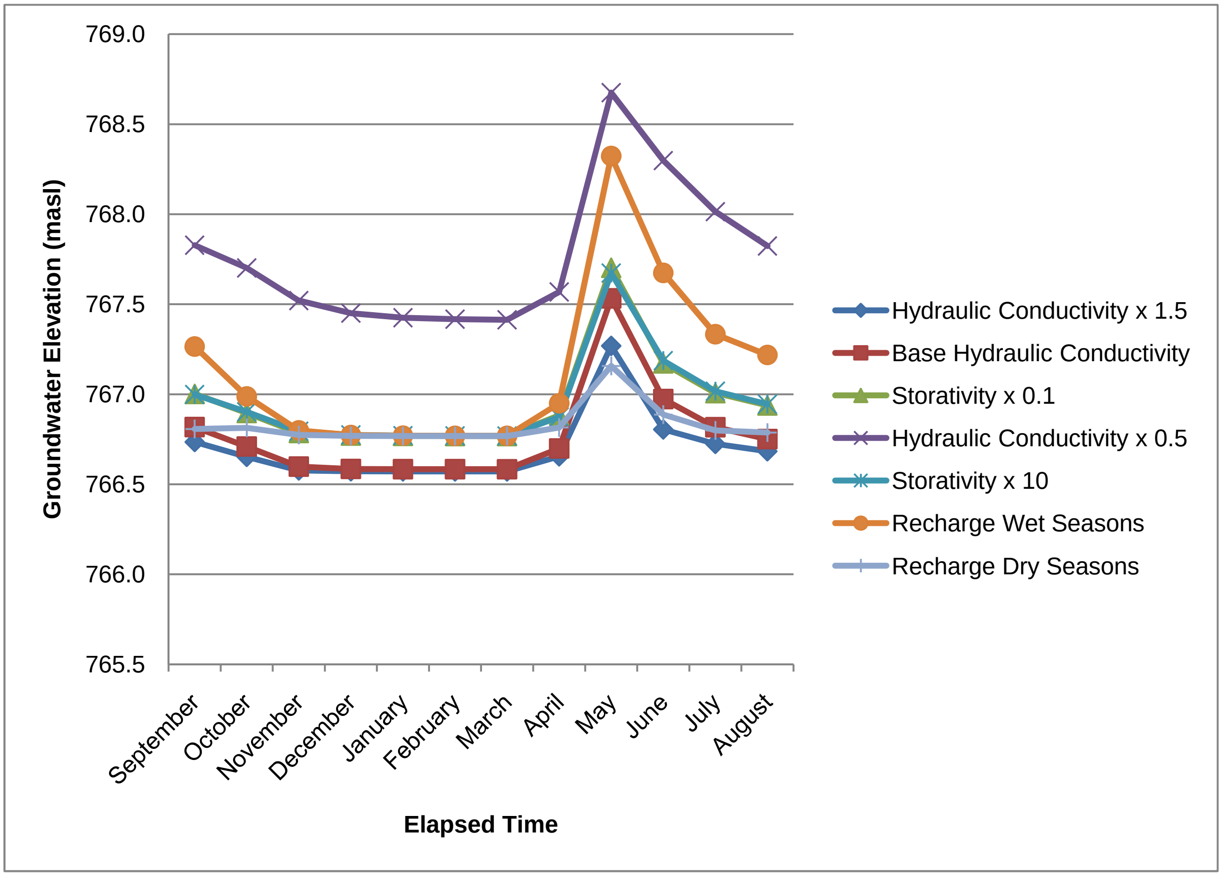


Figure B2-1: Computed Groundwater Elevations – Well MW96-13b

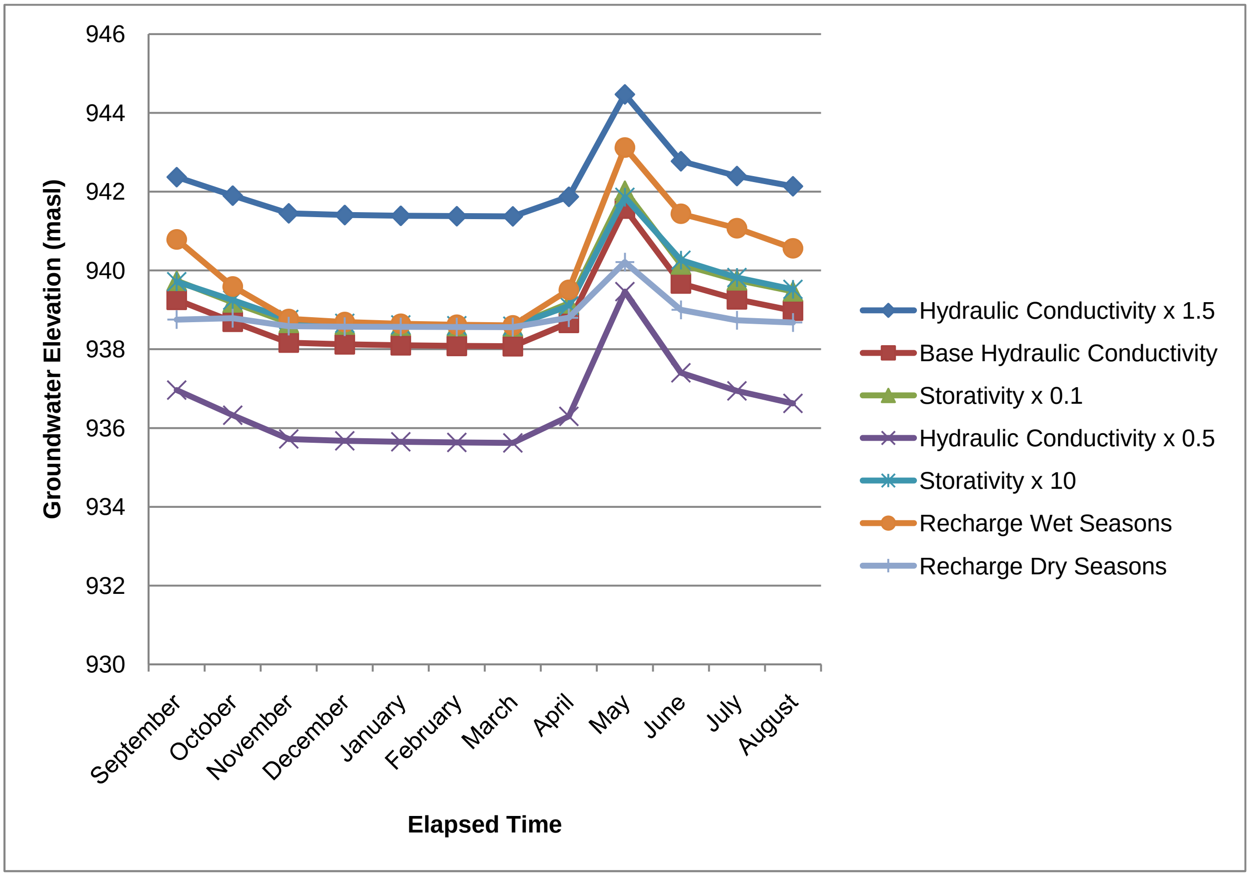


Figure B2-2: Computed Groundwater Elevations – Well MW96-14a

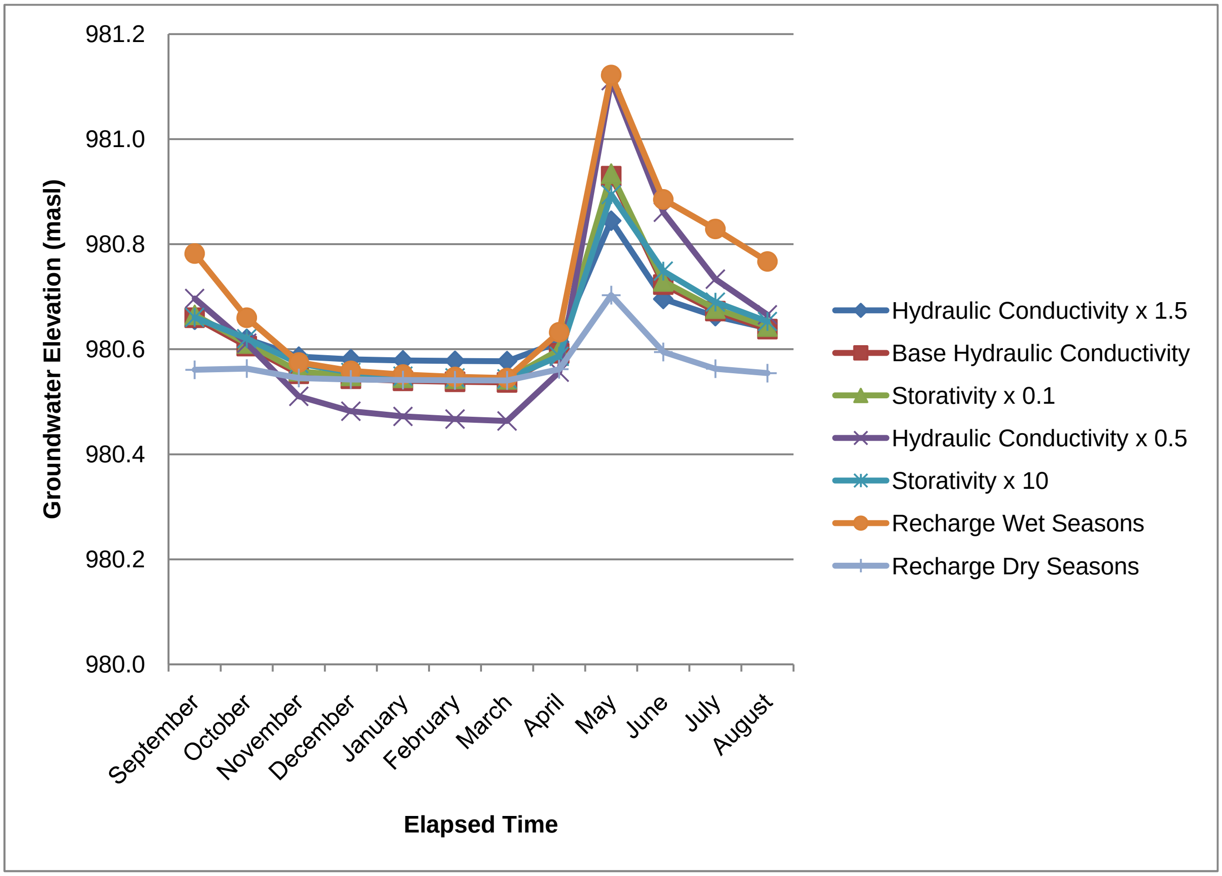


Figure B2-3: Computed Groundwater Elevations – Well MW96-14b

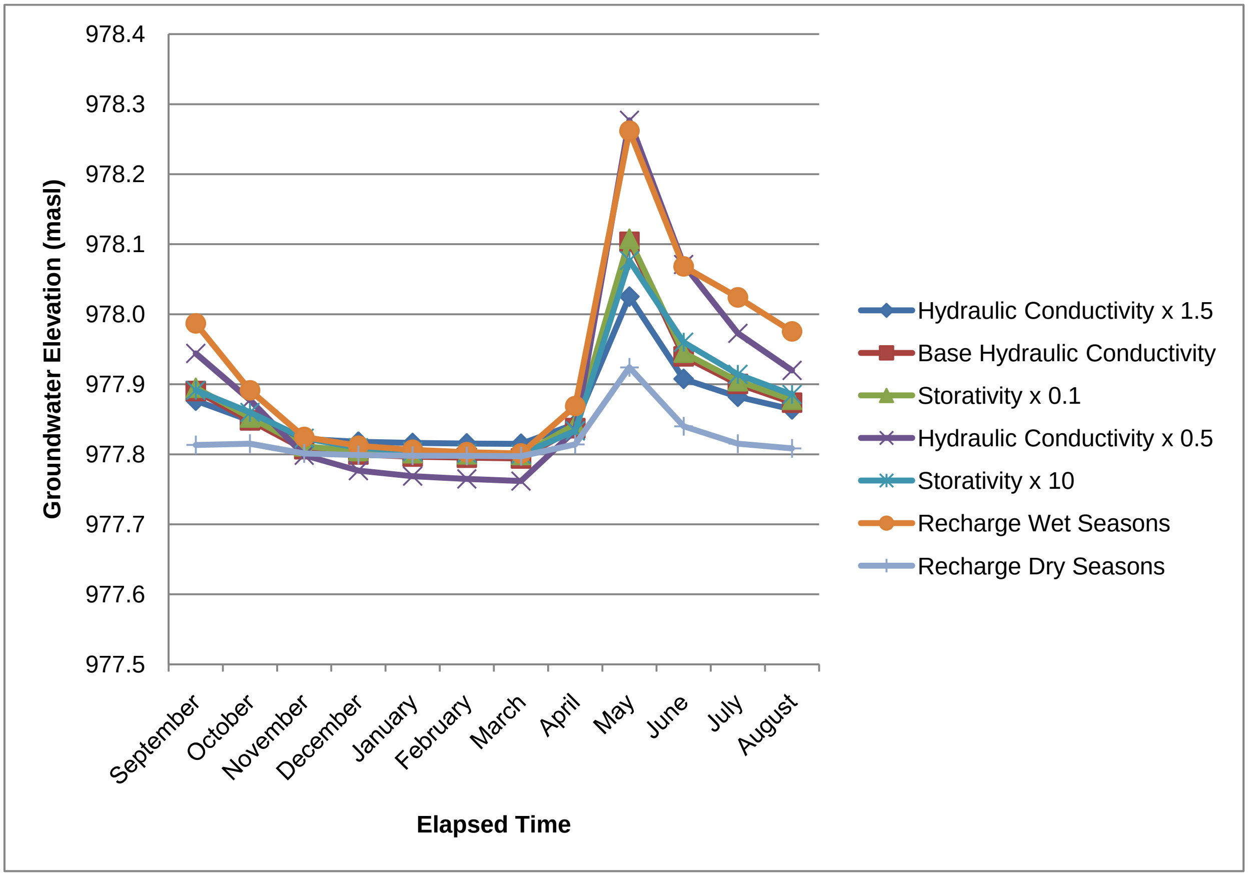


Figure B2-4: Computed Groundwater Elevations – Well MW96-15b

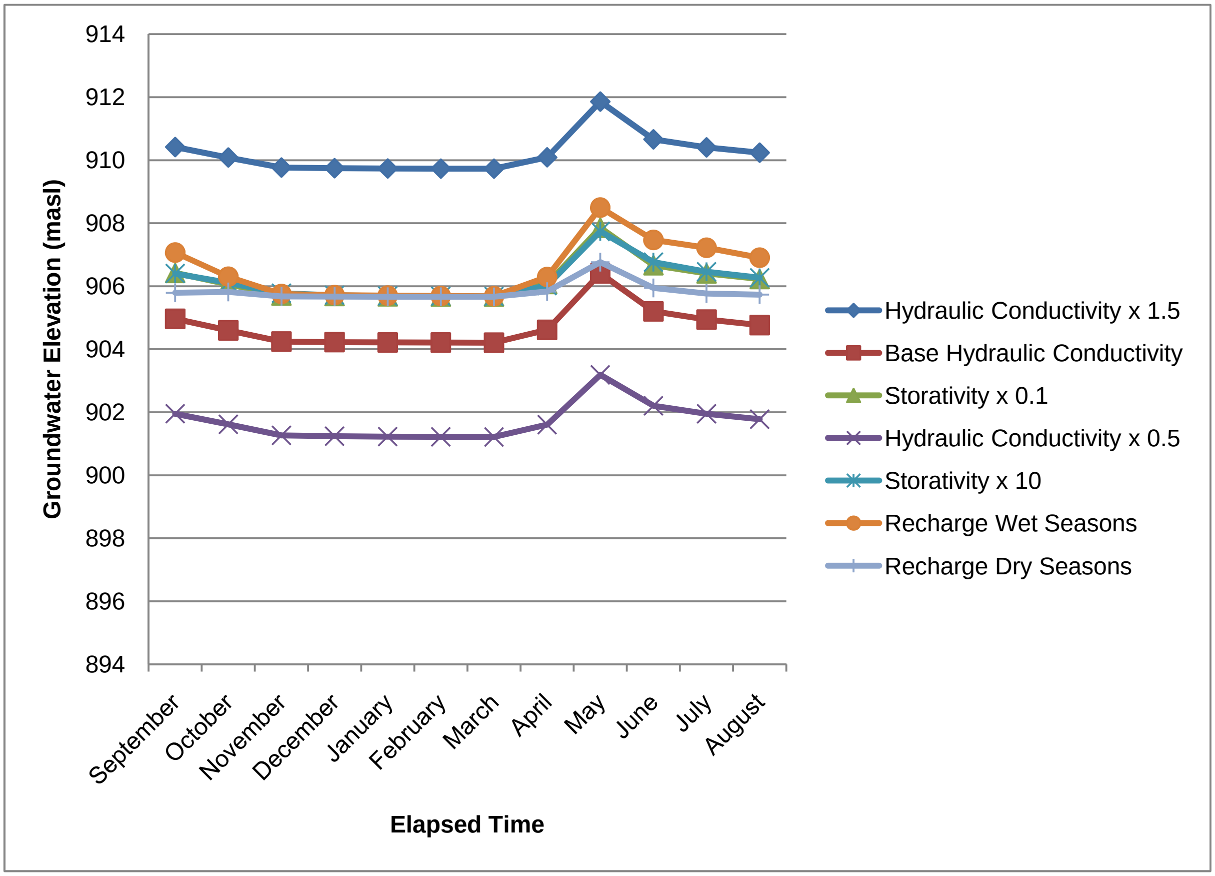


Figure B3-1: Computed Groundwater Elevations – Well DH95-152

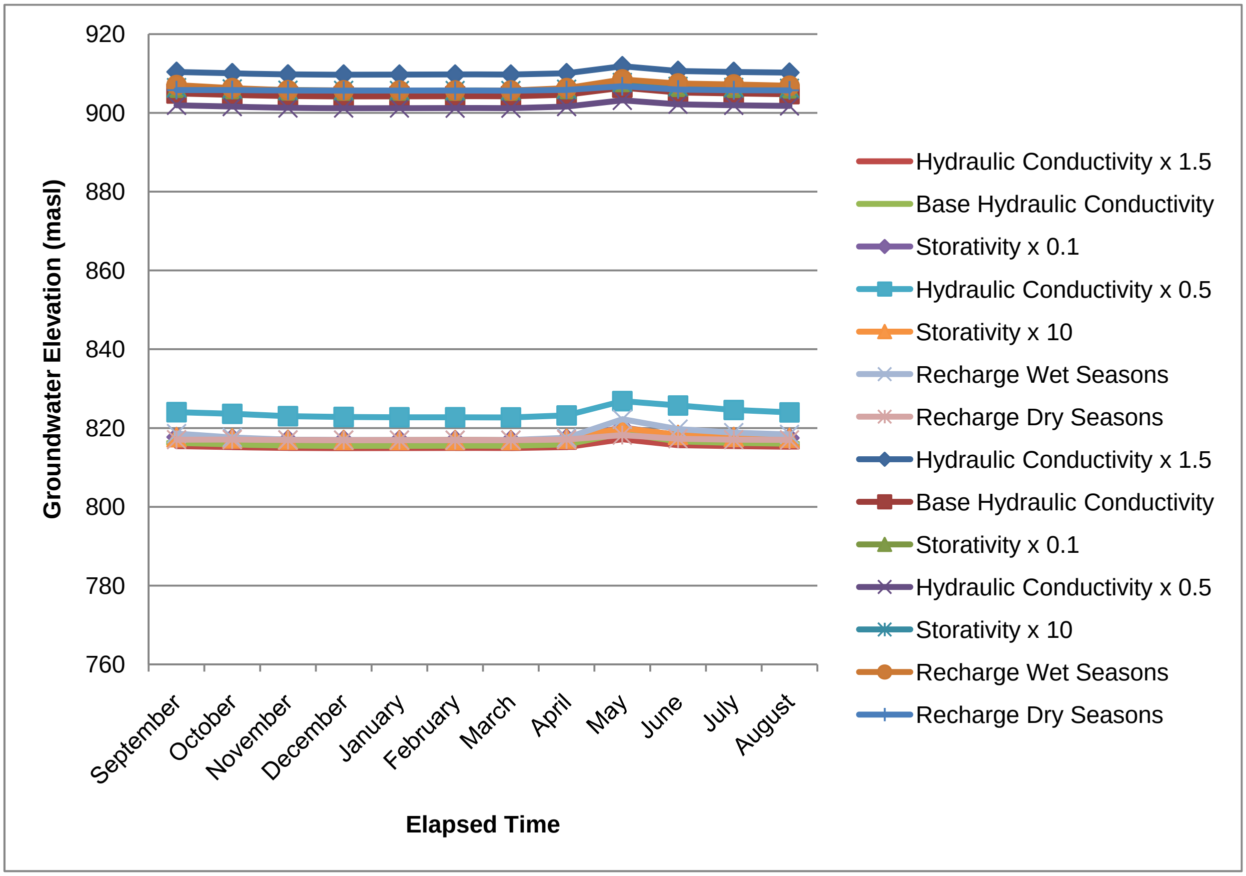


Figure B3-2: Computed Groundwater Elevations – Well MW09-Stu1

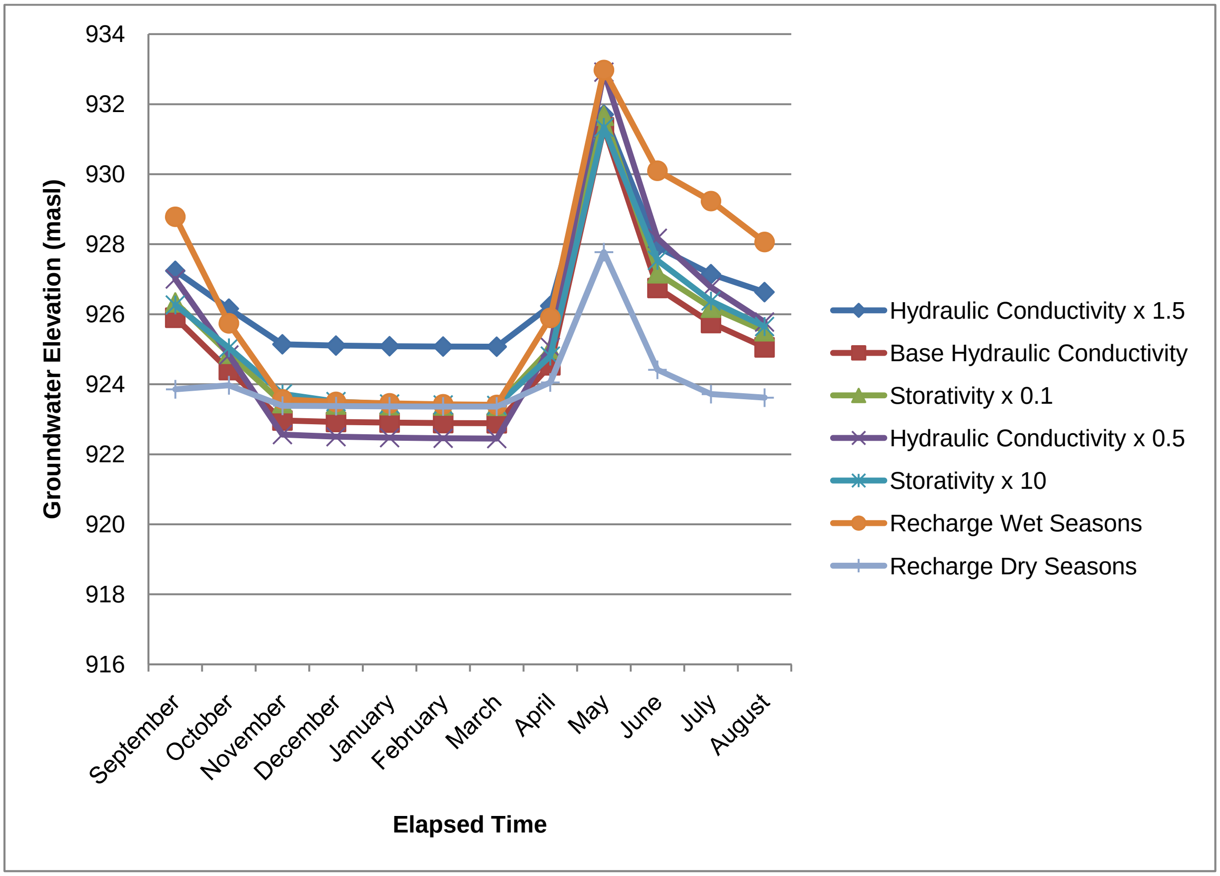


Figure B3-3: Computed Groundwater Elevations – Well MW09-Stu2

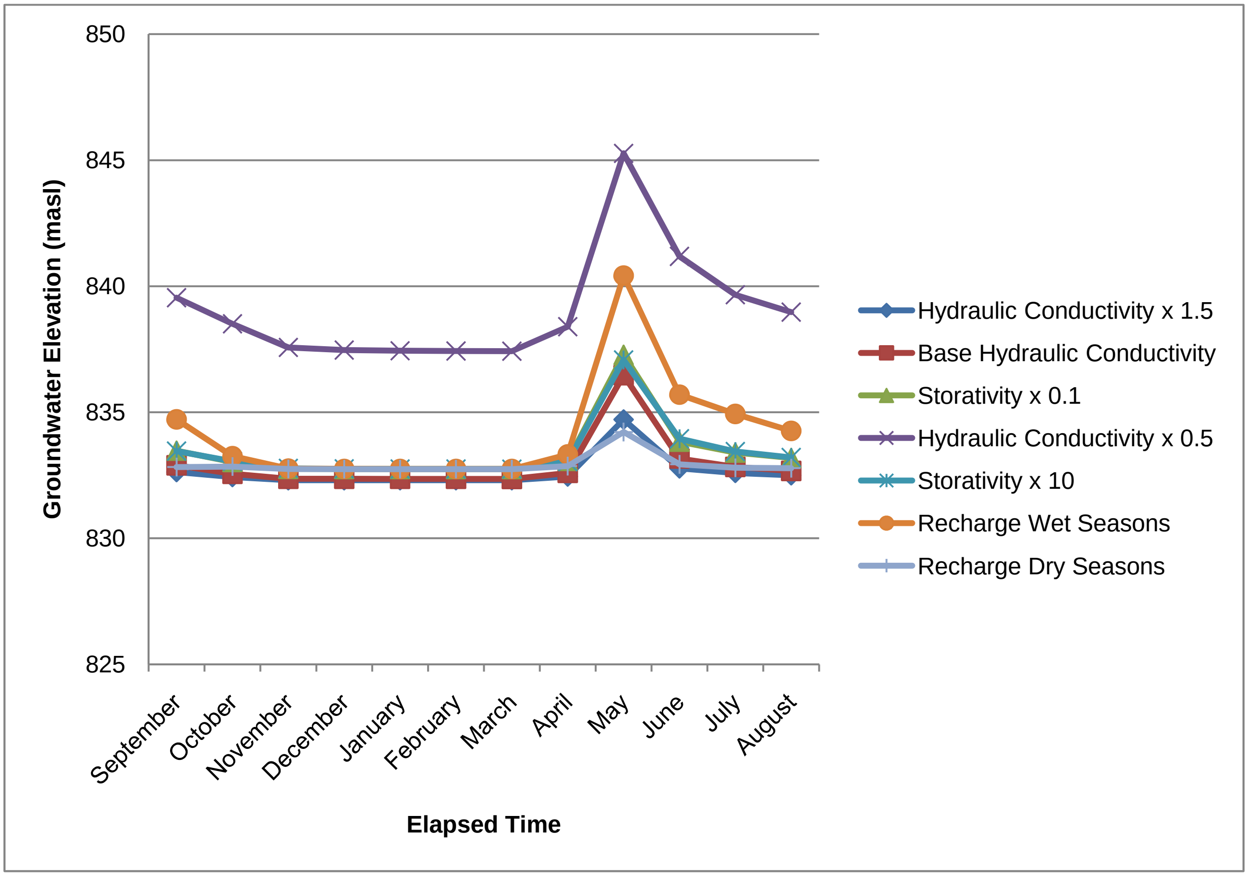


Figure B4-1: Computed Groundwater Elevations – Well MW09-AG1

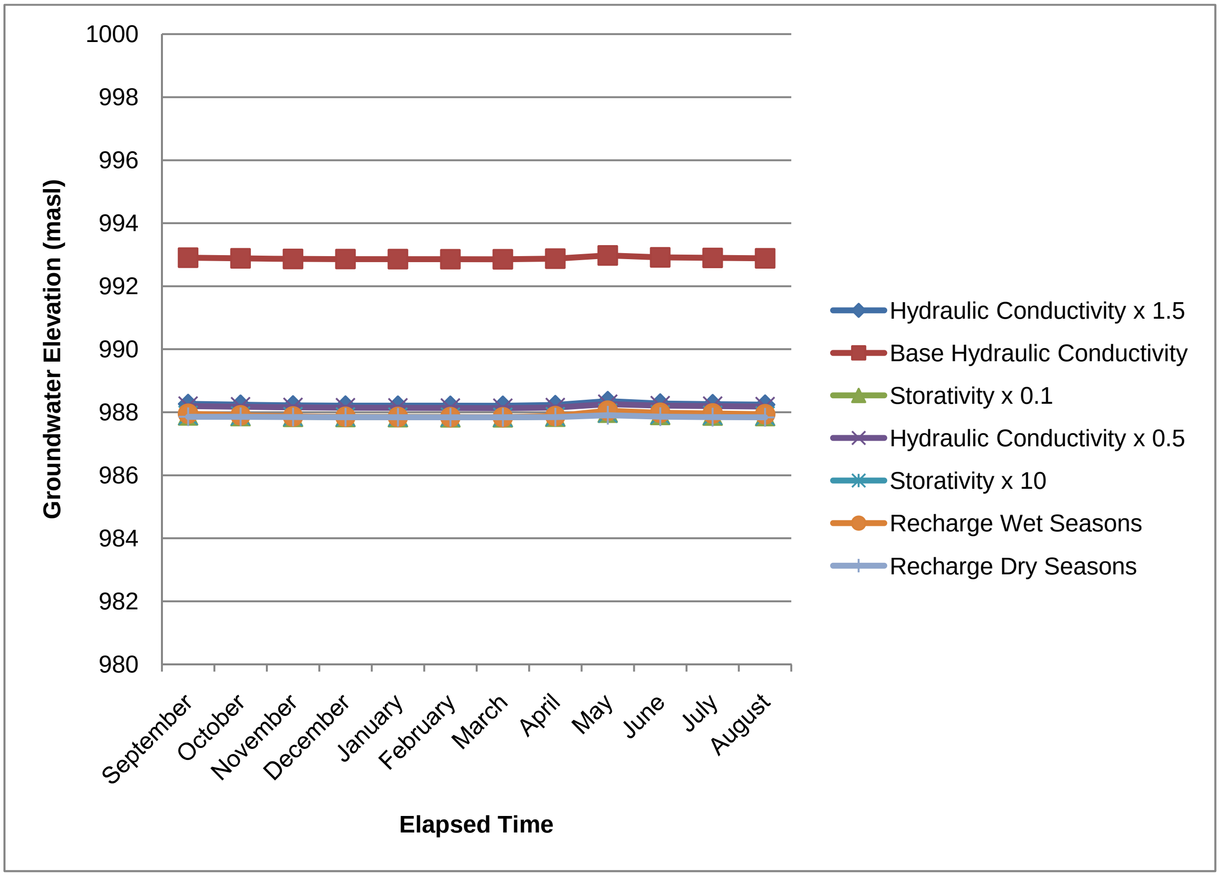


Figure B4-2: Computed Groundwater Elevations – Well MW09-AG2

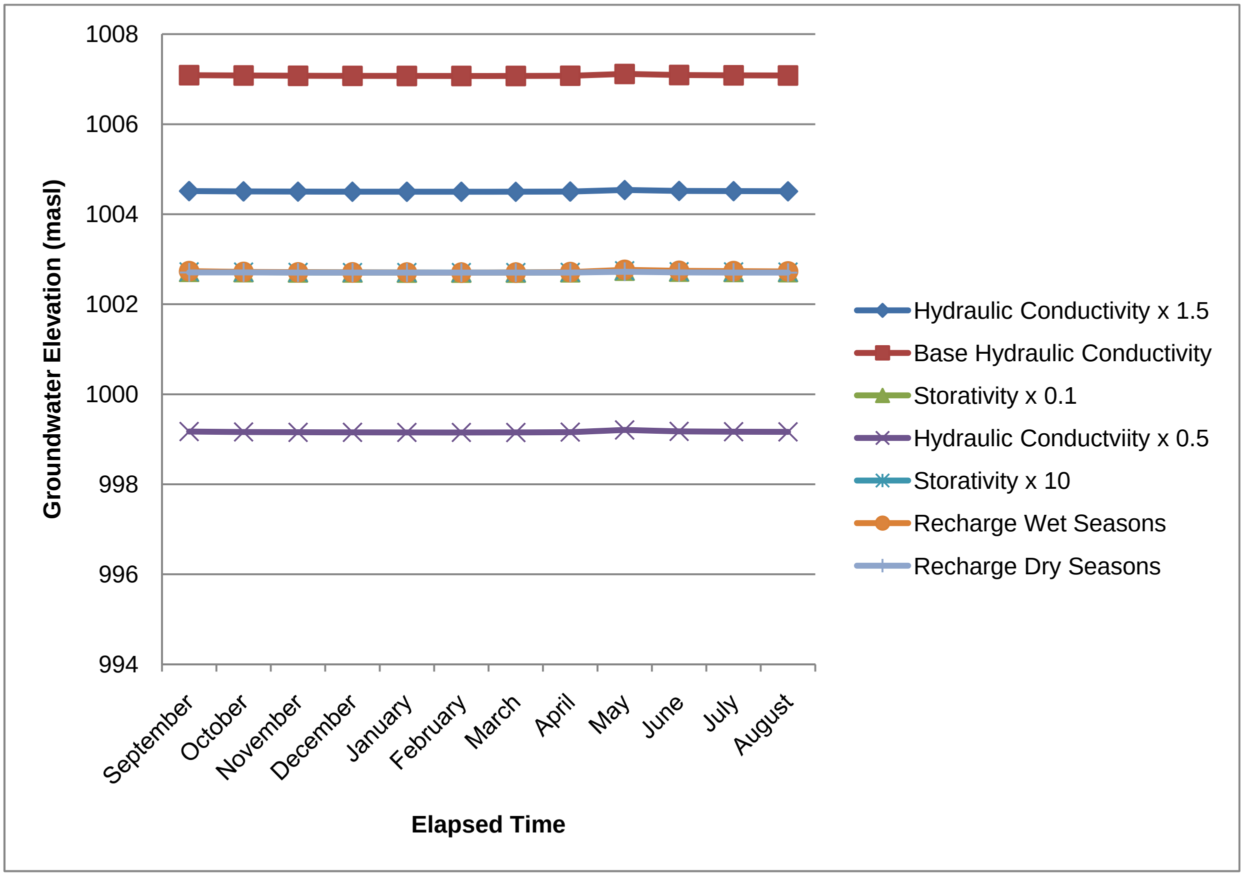


Figure B5-1: Computed Groundwater Elevations – Well MW96-23

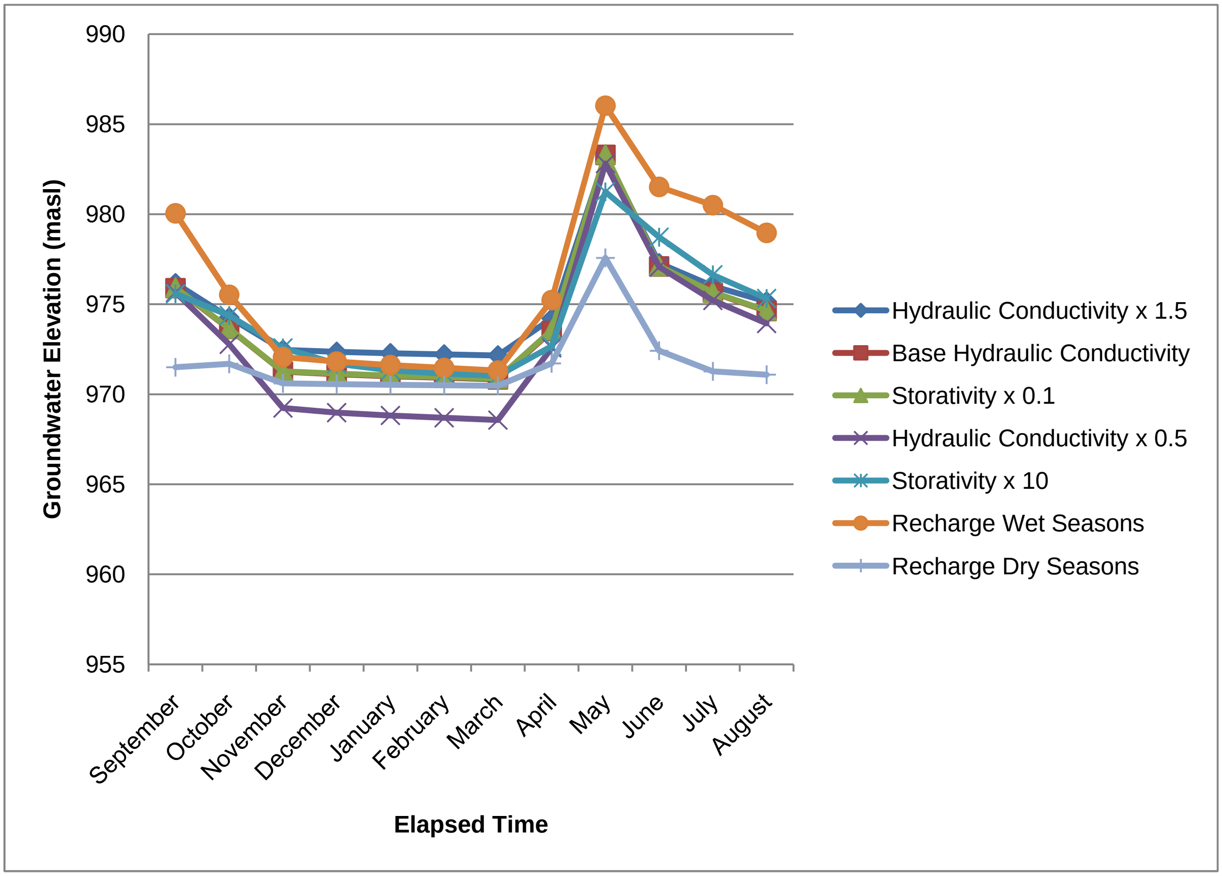


Figure B6-1: Computed Groundwater Elevations – Well MW96-17b

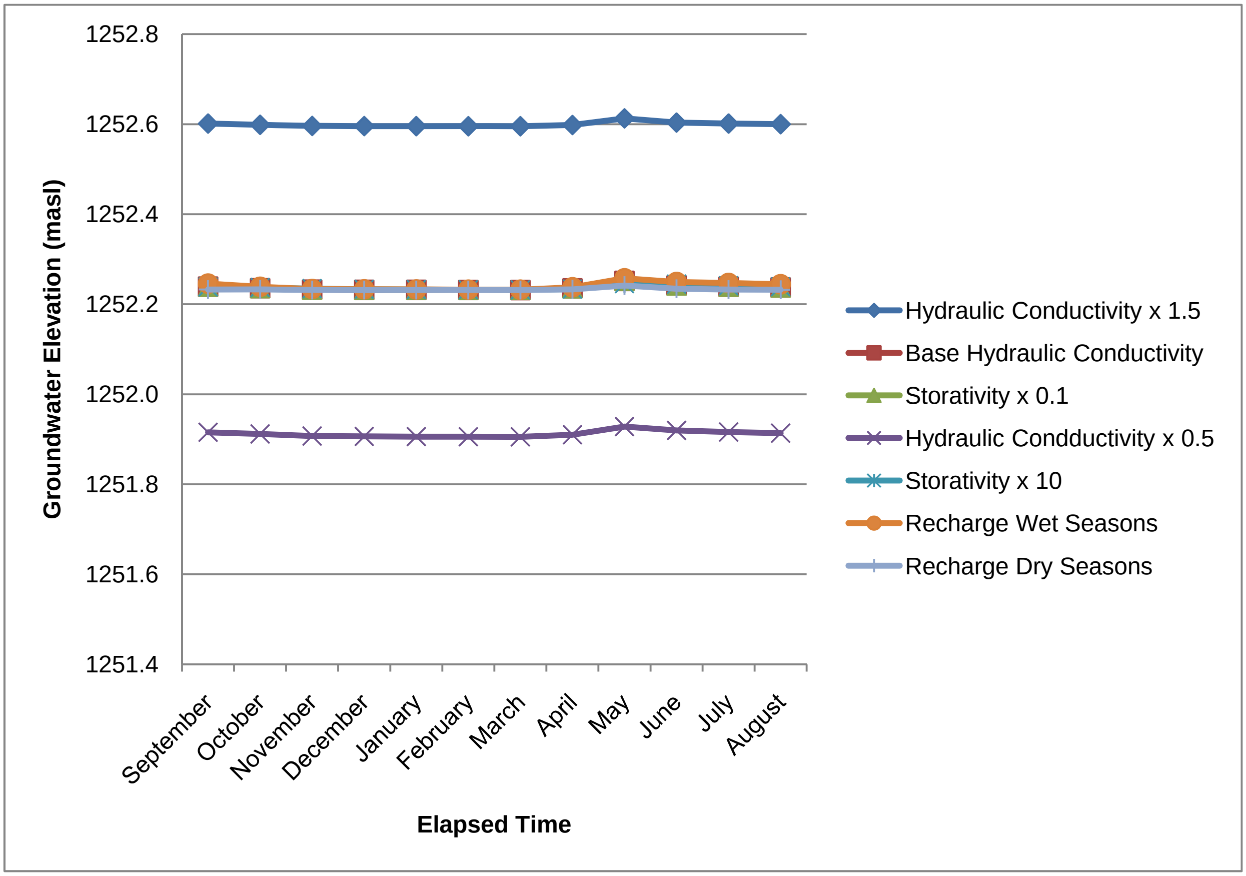


Figure B6-2: Computed Groundwater Elevations – Well MW96-18

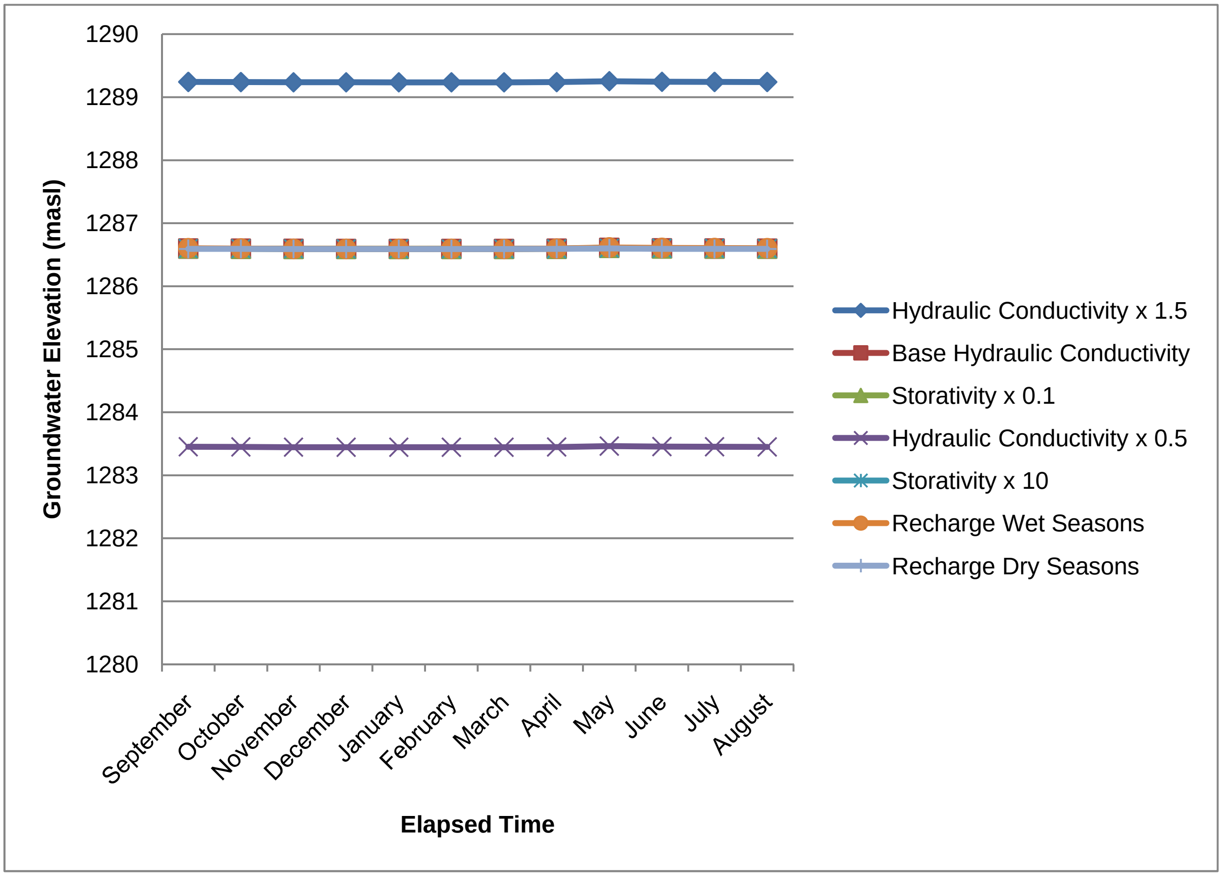


Figure B7-1: Computed Groundwater Elevations – Target hl1

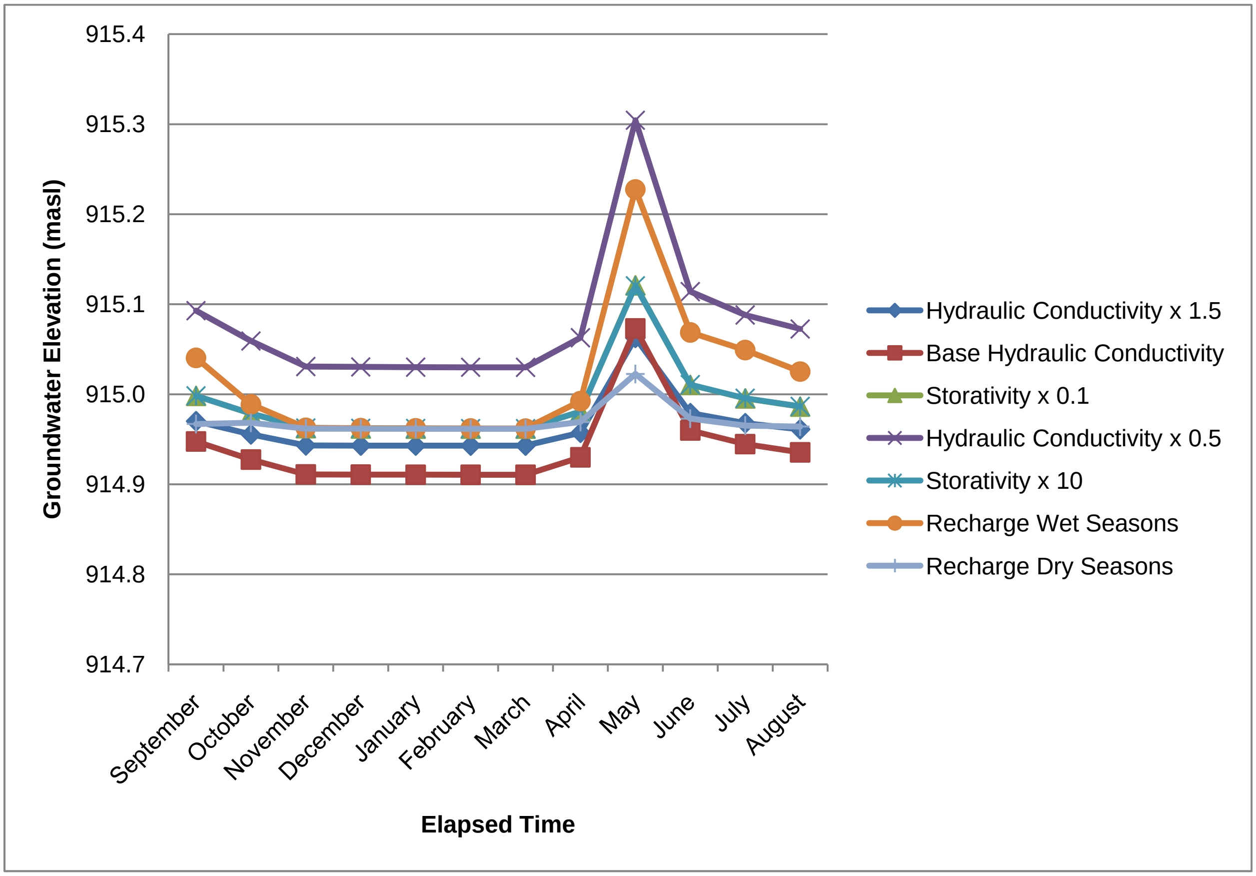


Figure B7-2: Computed Groundwater Elevations – Target hl2

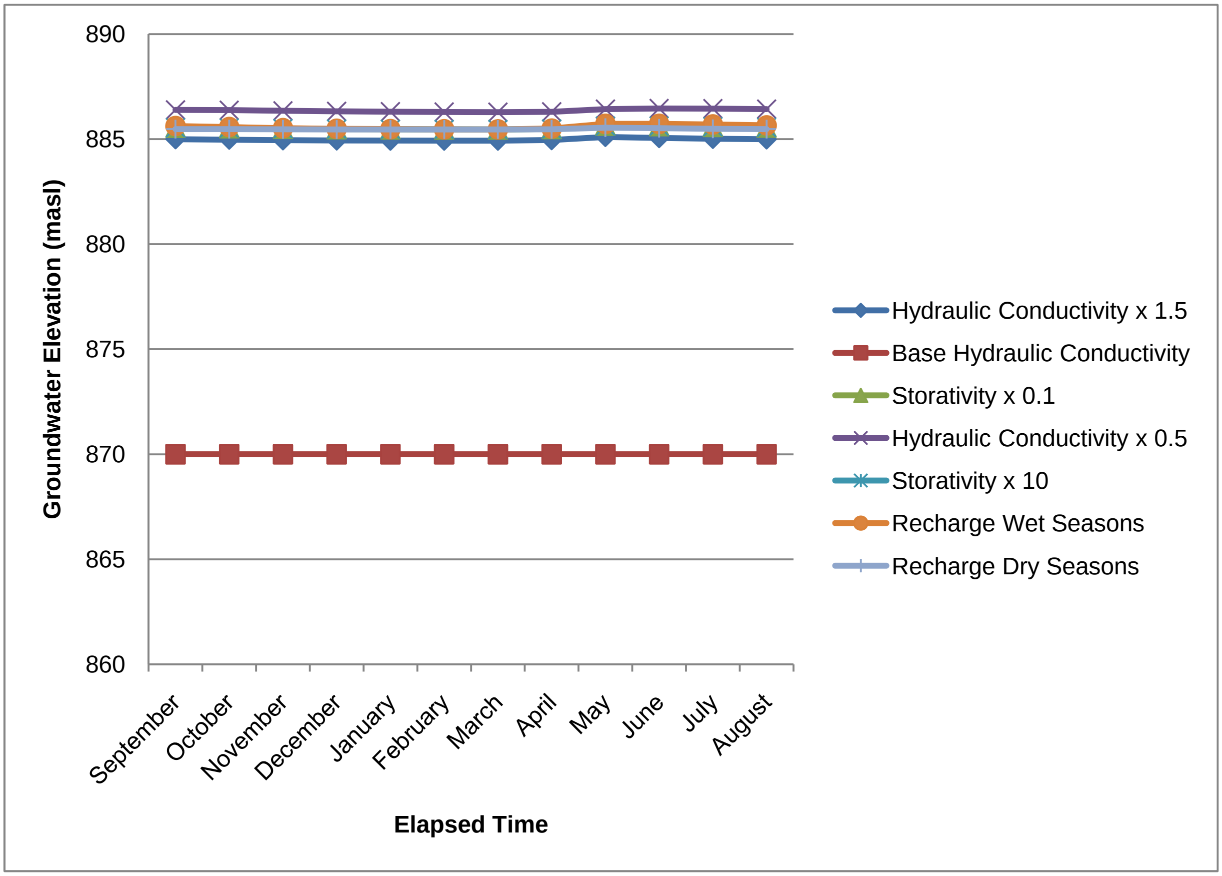


Figure B7-3: Computed Groundwater Elevations – Target hl3

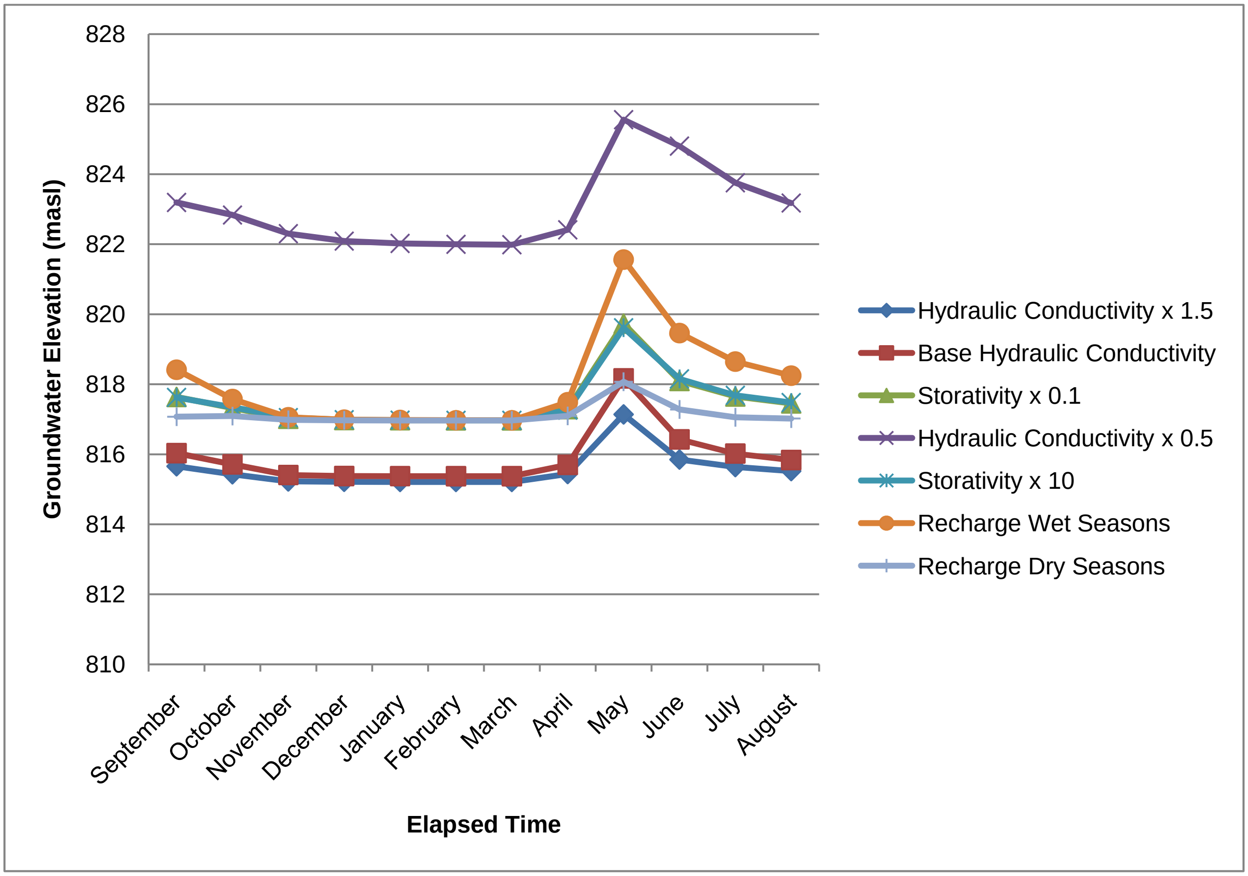


Figure B7-4: Computed Groundwater Elevations – Target hl4

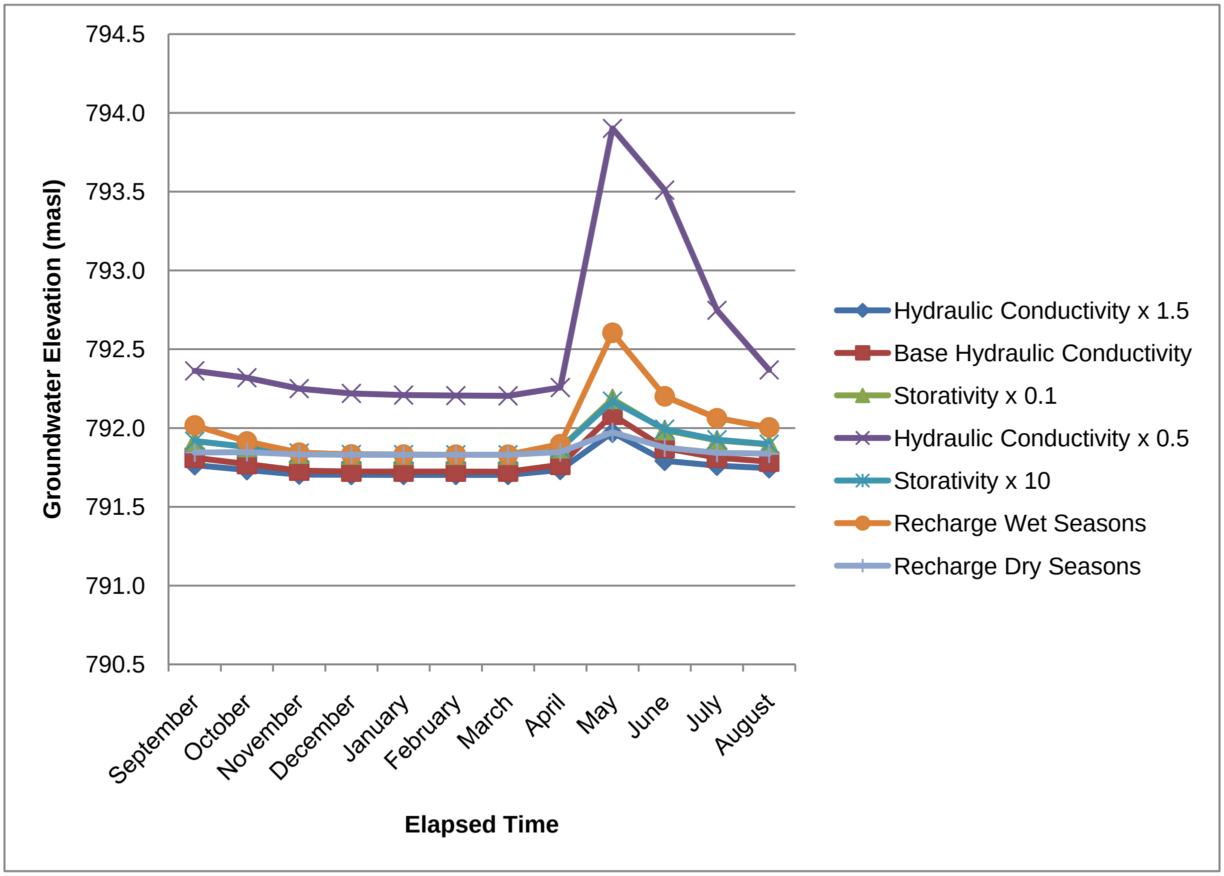
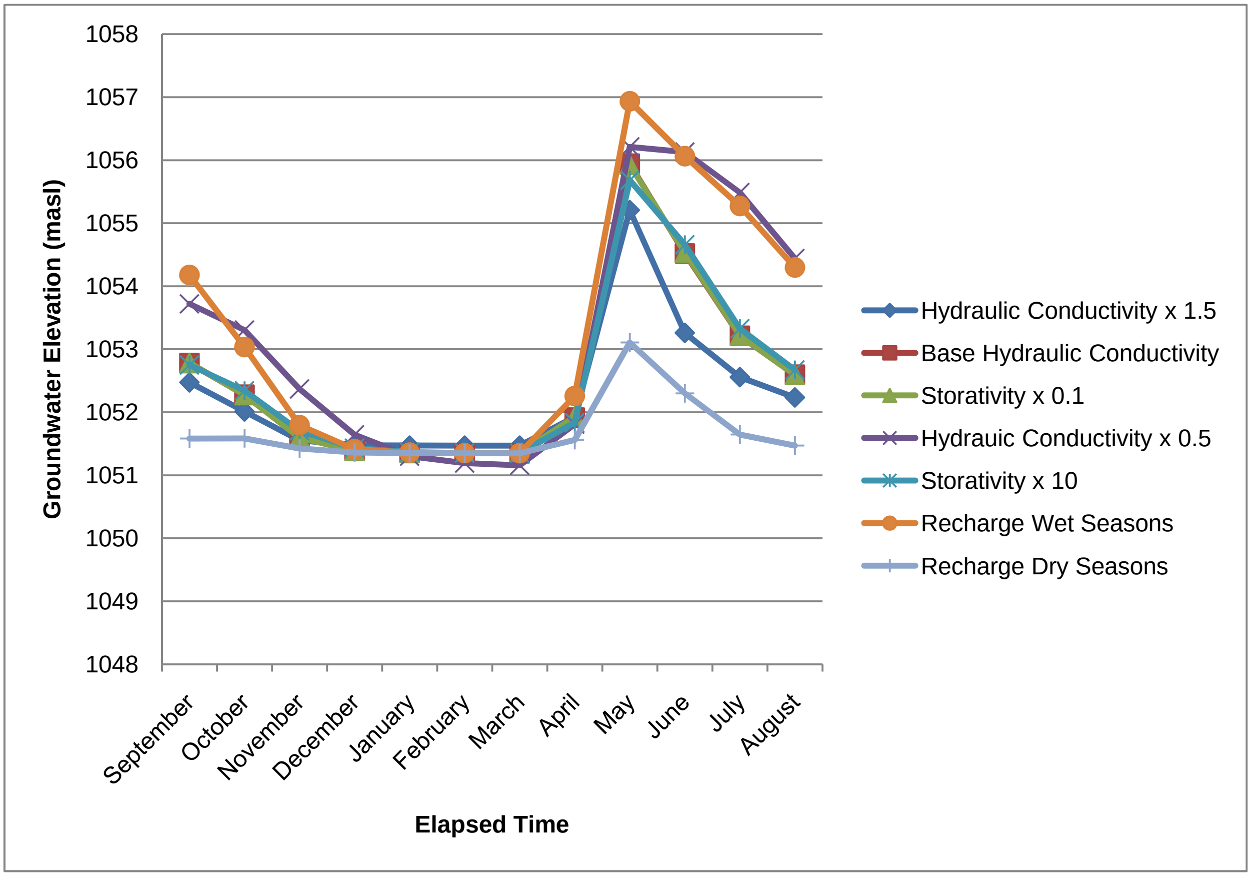


Figure B8-1: Computed Groundwater Elevations – Well MW09-OG3



APPENDIX C

Groundwater Vistas

Groundwater Vistas^{TM} allows the visual development of the model, as well as the assignment of different aquifer parameters to each finite-difference cell of the model domain. Changes to and discretization of aquifer propertieqs can be performed directly on-screen without going into complex data set files. Groundwater Vistas^{TM} simulates groundwater flow within the selected model domain, and provides output consisting of the hydraulic head distribution and flow terms associated with each finite-difference cell within the model domain.

All Groundwater Vistas^{TM} simulations require the use of different MODFLOW packages, depending upon the boundary conditions or the various external stresses that need to be simulated for a given model domain. The following MODFLOW and MODFLOW-SURFACT packages were incorporated into the model:

The Basic (BAS) Package

The primary package used for model initialization, layer definition, initial potentiometric conditions, water budget balance, and definition of the types of simulations. The BAS package reads data on the number of rows, columns, layers, and stress periods, on the major options to be used, and on the location of input data for those options, allocates space in computer memory for model arrays, reads data specifying initial and boundary conditions, reads and implements data establishing the discretization of time, sets up the starting head arrays for each time step, calculates an overall water budget, and controls model output according to using specification.

The Drain (DRN) Package

The DRN package is designed to simulate the effects of features that remove water from the aquifer at a rate proportional to the difference between the head in the aquifer and some fixed head or elevation, so long as the head in the aquifer is above the at elevation, but which have no effect if the head falls below that level.

The Stream (STR) Package

The STR package is designed to simulate the interaction between surface streams and groundwater. The STR package tracks the flow in one or more streams which interact with groundwater and limits the amount of groundwater recharge to the available streamflow. The amount of leakage into or out of the stream is calculated on the basis of the head difference between the stream and aquifer and a conductance term.

The Block-Centered Flow (BCF4) Package

The BCF package specifies the hydraulic properties and elevation controls used to determine flow through between cells. The BCF4 Package additionally includes the capability of handling complete drying and re-wetting of grid cells using a pseudo-soil water retention functions (Pseudo-soil functions) to account for vertical flow components throughout the domain and delayed yield response. Instead of shutting off cells when the water table drops below the cell bottom as in previous versions of MODFLOW, the Pseudo-soil functions are automatically generated to reduce the unsaturated flow problem to one of seeking the water table level. The formulation has been designed to provide accurate delineation of the water table and capture the delayed yield response of an unconfined system to pumping and recharge. MODFLOW-SURFACT does have dry cells, only those cells are not inactive. In dry cells, it writes the heads calculated for the dry cell", which will be equal to the water-table head with no recharge. With recharge, it will be slightly higher than that to allow for the recharge to go down to the water table.

The Recharge Seepage-Face (RSF4) Package

The RCH package in MODFLOW is used to simulate the areal recharge to the model domain, primarily through infiltration or precipitation. The RSF4 Package additionally includes the ability to specify a ponding elevation representing the upper boundary of the water table. The ponding elevation effectively represents the maximum water table elevation, whereby the recharge entering the system is automatically reduced in order to prevent the water table rising above the specified ponding elevation. The reduced amount of recharge is then presented in the mass balance (water balance) of the model as recharge outflow, which would represent the amount of water that would be required to be removed (pumped) to lower the water table to the specified ponding elevation (water table).

The Fracture-Well (FWL4) Package

The FWL4 Package allows simulation of a pumping well that is screened across multiple model layers. The FWL4 package connects the grid cells intersecting the well screen by representing the pumping well as a one dimensional finite diameter fracture tube spanning the length of the well screen. An extraction rate for the pumping well is specified and the water is effectively removed from the bottom of the well screen. The volumetric fluxes from each individual cell associated with the well are automatically calculated according to the length of the well screen in the cell and the transmissivity of the cell at each time step. This approach ensures the total extraction rate from the pumping well is always honored unless the water table drops below the bottom of the well screen (i.e. the entire well goes dry).

For simulation of potential transportation of contaminant in groundwater, MODFLOW-SURFACT/ MODHMS maintains complete compatibility between the flow and transport analyses. MODFLOW-SURFACT/MODHMS conducts a transport simulation using all of the MODFLOW data set. The transport computational subroutines incorporated into the model for the contaminant transport simulations included:

Basic Transport Package (BTN1)

The BTN1 package reads the basic model parameters (e.g. dispersivities, retardation coefficient and degradation rates) required for the transport simulation, and performs contaminant transport analyses for single component or multicomponent contaminants.

To be conservative, contaminant transport simulations assumed no retardation coefficient (no sorption to matrix).

Specified-head Concentration Boundary Package (HCN1)

The HCN1 package reads the boundary condition data for those cells where the hydraulic head is prescribed in the respective flow simulation.