APPENDIX 5.2.7-A

Groundwater Modeling of Possible Hydrological Impact of Dewatering the Proposed Star and Orion South Pits 2012 Update (SRK 2010)

Groundwater Modeling of Feasibility Dewatering Requirements for Star and Orion South Pits and Possible Hydrogeological Impact

Report Prepared for

Shore Gold, Inc.

Report Prepared by

SRK Consulting (U.S.), Inc.
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1 Introduction

This report presents the results of a hydrogeological study completed by SRK Consulting (U.S.), Inc. (SRK) as part of a Feasibility Study to define the dewatering requirements for two proposed pit excavations for the Star - Orion South Diamond Project, in Saskatchewan, Canada, and to characterize possible hydrogeological impacts to the shallow groundwater system and to the surface-water bodies in the vicinity of the project.

This report updates the following previous reports:

- Preliminary Hydrogeologic Evaluation of Fort a La Corne JV Project Area And Predicted Ground-Water Conditions During Mining (HCI,2005);
- Pre-Feasibility Level Hydrogeologic Investigation of Fort a La Corne JV Project Area (HCI, 2007);
- Pre-Feasibility Level Hydrogeologic Investigation of Star Kimberlite Area (HCI,2007);
- A Preliminary Groundwater Flow Model for Star Kimberlite Project and Predicted Inflow to Proposed Open Pit and Associated Drawdowns (HCI, 2006);
- Preliminary Groundwater Modeling Results of Possible Hydrological Impacts of Dewatering of The Proposed Star and Orion South Pits (SRK, 2009a);
- Predicted Impact on Stream Flow Due to Proposed Dewatering for the Star-Orion South Diamond Project: (SRK, 2009b); and
- Groundwater Modeling of Possible Hydrological Impact of Dewatering of Proposed Star and Orion South Pits, (SRK, 2010).

This report is based on the above reports, and also on additional hydrogeological field data collected from the Star Kimberlite area in 2009 - 2010 by Shore Gold, SRK, and Clifton Associates, including the results of:

- Hydrogeological and geotechnical drilling in the vicinity of the proposed Orion South pit;
- Installation of additional stand-pipe and grouted-in piezometers including a stand-pipe piezometer on the south side of the Saskatchewan River;
- Slug testing in eight new piezometers within surficial sands (upper and lower);
- Water level measurements in new and existing piezometers;
- Stream flow measurements in creeks and ravines in the vicinity of the project; and
- A 20-day pumping test from a prototype dewatering well installed into the Mannville Group sandstone.

Based on these data SRK has updated the existing groundwater flow model (SRK, 2010b) using the commercially available finite-difference code Visual MODFLOW-SURFACT (SWS, 2010 and HGL, 2006). Significant changes compared to the 2010 model include:

- Simulation of the Upper Mannville Sandstone unit as less conductive compared to the Lower Mannville sandstone unit based on results of the 2010 pump test;
- More detailed simulation of the paleochannel (extent, properties, and boundary conditions);
- Improved steady-state calibration of the model to measured water levels (required changes in vertical hydraulic conductivity values and lateral boundary conditions);
- Transient calibration of the model to 20-day pumping test data and subsequent groundwater recovery data;
- Incorporation of new Feasibility level pit plans for the Star and Orion South pits which are different from simulated in 2010 model;

- Simulation of dewatering wells as real pumping well cells, with constant rate until water levels reached a freeboard elevations. These pumping cells were switched to constant head /drain cells to maintain water levels at freeboard elevation at the late stages of mining of both pits;
- Optimization of the number and location of dewatering wells in time and space to minimize their number and operating cost for pit dewatering;
- Simulation of the Orion South pit lake infilling ; Predictions were completed by using the re-calibrated groundwater flow model as follows:
  - Passive inflow to proposed pits;
  - Number and location of required dewatering wells, their pumping rates and residual passive inflow to the pits;
  - Schedule of installation of dewatering wells;
  - Power cost for the proposed dewatering system;
  - Propagation of drawdowns during the proposed dewatering;
  - Orion South Pit lake infilling; and
  - Impact of groundwater discharge to the Saskatchewan River and creeks (during both pit excavations and infilling of pit lake).
- Sensitivity analyses of the impact of proposed dewatering to shallow groundwater and surface water bodies were completed by using the re-calibrated groundwater flow model, by varying key parameters of the model.

2 Hydrogeological Conditions and Conceptual Groundwater Flow Model

2.1 Results of Hydrogeological Studies Completed in 2005, 2006-2007, 2008, and 2010

Hydrogeological investigations in the vicinity of the Star, Orion South, and Orion North Kimberlites were completed during the period of 2005-2010 as parts of various studies of individual kimberlites.

2.1.1 2005 Hydrological Study

In 2005, HCI jointly with SRK conducted a conceptual level of investigation of the hydrogeologic framework of the Fort a la Corne Joint Venture (FALC JV) project area (HCI, 2005). That investigation included:

- Drilling using a Vibrasonic drill rig, and conducting slug tests in six shallow (42m-72m deep) piezometers completed into the overburden; and
- Coring (using a conventional core rig) and conducting hydraulic tests (airlift recovery, packer injection, and falling head) in three deeper piezometers completed into:
  - The Colorado Group shale (150-05-014H, 160m deep);
  - The 140/141 – Orion South Kimberlite (140-05-55H, 249m deep); and
  - The very top of the Mannville sandstone (150-05-014H, 249m deep).

Locations of these boreholes are shown in Figure 1. Hydrogeological testing was performed as follows:

- Airlift recovery – 6 intervals;
- Packer injection – 16 intervals; and
- Falling head tests in piezometers – 10 tests.

The hydrogeological units were characterized to a depth of about 250m as follows:

Unit	Number of Tests
Upper Sand	1
Upper Clay/Silt	1
Lower Sand	1
Lower Clay/Silt	1
Till	12
Colorado Group Shale	4
Upper Part of Mannville Sandstone	3
Kimberlite	9

Results of hydraulic testing are summarized in Table 1 in HCI (2007).

Fourteen piezometers were installed to monitor water levels (some two-level). Measured water levels are shown in Table 13 of HCI (2007).

2.1.2 2006-2007 Hydrogeological Study

The 2006-2007 hydrogeological investigation was completed by HCI as part of a Pre-Feasibility study for the FALC JV project (HCI, 2007). The field program included the construction and testing of four pumping wells and 15 piezometers primarily at two sites, 1) west of the proposed Orion North pit during the study period, and 2) about 2km southwest of the Star Kimberlite. Each site included two pumping wells, one in the shallow glacial drift (till) and one in the deep bedrock (Mannville Group). Borehole production (or spinner) logs and pumping tests were conducted in the pumping wells and produced data on hydraulic properties of the most important hydrostratigraphic units – upper and lower till and upper and lower parts of the Mannville sandstone. Groundwater samples were collected during pumping tests from pumping wells in the Mannville Group and the shallow groundwater system. Detailed results of this comprehensive investigation are described in HCI (2007) and are not repeated in this report.

2.1.3 2008 Hydrogeological Study

Three coreholes were drilled in the vicinity of the Star Kimberlite (SHP-08-004C, SHP-08-006C, and SHP-08-008C, Figure 1) ranging in depth from 220m to 250m, and packer testing was completed in six intervals per corehole. Measured hydraulic conductivity values in successful tests are shown in Figure 2 of SRK (2009a). After testing was completed, two-level standpipe piezometers were installed.

Additionally, strings of four grouted-in vibrating wire transducers (per hole) were installed in three geotechnical holes SHP-08-007C, SHP-08-009C, and SHP-08-0010C (see Figure 1 for locations) with drilled depths of 128m to 146m. Water level and vertical hydraulic gradient measurements were taken at these locations. The 2008 hydrogeological investigations were completed as part of the Pre-feasibility Study of the Star Diamond Project.

2.1.4 2010-2011 Hydrogeological Study

Feasibility level hydrogeological studies in 2010 were completed in conjunction with geotechnical investigations at Orion South. Two standpipe piezometers were installed in vertical geotechnical coreholes SRK-GT-10-01 and SRK-GT-10-03 within the Mannville Group. Vertical pilot hole SRK-GT-10-09 was drilled in the vicinity of the location for the prototype dewatering well and a string of vibrating-wire transducers was installed as multi-level monitoring points for the long-term pumping test (two deep transducers were installed within the Mannville Group at depths of 204m and 271m, two shallow transducers - within the Colorado Group shale at depths of 145m and 165m).

Shore Gold installed an additional 15 piezometers to measure water levels within the shallow groundwater system in areas of catchment divides between major creeks and ravines. Slug tests were completed in eight of these to define the hydraulic conductivity of the surficial sand and silt units. Additionally, standpipe piezometer GT-10-001C within the Mannville Group, was constructed prior to this pumping test at a distance about 800m to the south of the Saskatchewan River to monitor drawdown across the river.

Shore Gold installed two shallow stand-pipe piezometers PC11-004 (7m deep) and PC11-005 (25m deep) in May 2011 within the paleochannel area. Water levels were measured at about 1.1m below ground surface, confirming that surficial sands above the paleochannel are completely disconnected from the Mannville sandstone, where the water level is expected to be at a depth of 35m-40m.

Locations of new piezometers installed in 2010 and 2011 are shown in Figure 1.

2.1.5 Construction of Orion South Pumping Well

A dewatering well (140-10-089RC) south of the Orion South kimberlite was constructed in October 2010.This pumping well was originally intended to serve as both a pumping well for a regional aquifer test, and as a “prototype” for future dewatering wells.

Reverse-flood rotary drilling was performed by Encore Coring & Drilling Inc., of Alberta. SRK and Johnson Screens personnel assisted in the design of the well; on-site supervision of drilling and well construction was provided by SRK and Shore Gold personnel. Drilling began on 17 August 2010. Significant difficulties were initially encountered with setting casing within the surficial sands and till, however, as shown in Figure 3, the construction resulted in an upper well consisting of 36-in, 24-in, and 22-in surface casings telescoped to 127m bgs (about 10m into the Colorado Group Shale). The upper casings were specified to be of mild steel, with 12.7mm (0.5-in) wall thicknesses.

The borehole was extended into the Colorado Group shale and the Mannville sandstone with a nominal 20-in borehole to 325m, at which depth the hole was terminated on 11 October 2010. The 20-in borehole was stopped short of the design depth by 57m, due to caving and sanding conditions. The well was stopped short of the bottom of the Mannville and the fractured carbonates, however, all future wells will have to penetrate to those depths to effectively dewater the proposed pits.

No calliper logging was done in the unstable borehole; well construction began early on 12 October. An SRK hydrogeologist arrived on site late on 12 October to observe and help with well construction activities and to conduct subsequent well logging. Well string installation was completed on 14 October. It was reported that during the installation, the screen/casing string stopped temporarily on an obstruction at a depth of about 224m. It was also reported that throughout the installation, the hold-back pressure gauge did not exceed 10,000 decanewtons. As the final casing joint started down, the hold-back pressure suddenly increased to 23,000 decanewtons.

The pre-packed well screen consisted of a 316-stainless steel Johnson Screen 12x14 Munipak with slot size of 3mm (0.012-in), providing an open area of 9.8%. Packing material consists of 20/40 Carbolite. The upper well casing consists of nominal 12-in, low-carbon steel pipe with 10mm (0.4-in) wall thickness. A dielectric coupling was used between the stainless screen and the low-carbon steel casing to prevent corrosion. A tremie pipe was used to place bentonite chips on top of two cement baskets. The top of the bentonite seal was measured at 183m bgs (Figure 3). A steel tremie pipe was then used to place cement grout in the annulus above the bentonite seal, in multiple lifts.

Well development activities began on 16 October, using a double seal swab/surge block on the drill rods. While initially running in the swabbing tool, it was found that the inside of the well was obstructed at a depth of 284m bgs, well short of the 316m bottom of the installed screen and sump. Initially, it was believed that the fine sand of the Mannville Formation passed through the screen, and accumulated on the bottom of the well. Based on that assumption, well development proceeded as planned.

Initial well development consisted of flushing the well of easily removed polymer and sediment. Bleach was then used to remove the remaining polymer. The first batch of bleach/water solution, consisting of 55 gallons of bleach per 5m^3 of water, was placed at three intervals along the lengths of the screen section from the top down. This solution was left in the well for 10 hours, while each screen section from the bottom of the well to the top was surged for approximately 15 minutes each.

The drill rods were placed at the bottom of the (accessible) well and 26m^3 of fresh water was flushed through the well to remove the deflated polymer. This procedure was then repeated a second time to ensure further removal of the deflated polymer.

In an effort to remove the supposed fine sand at the bottom of the well, airlifting was performed with a spade attachment. After several hours, an inspection of the discharge area found several pieces of well screen scattered on the ground. Based on the screen fragments, and on the anomalous changes in pull-back weight noticed by the drillers during the well installation, it was concluded that the well screen had collapsed at approximately 287m bgs, about 247m below the static water level. (The screen collapse strength was rated at 268 psi, equivalent to about 190m of water.) Shore Gold, SRK, Encore Drilling, and Johnson Screens concurred that the highly viscous drilling fluid maintained in the hole most likely prevented fluid from entering the very-fine pre-packed screen as it was being lowered (accounting for the minimal pull back weight, as the string “floated” down). The impact of the screen on the obstruction at 224m may also have weakened the screen at one or more points. In order to make use of the upper part of the well, 5m of bentonite pellets were placed inside the well from the blockage at 287m bgs, to 283m bgs. Airlift development of the salvaged upper well was continued for an additional 36 hours, terminating on 20 October.

Following development of the upper, salvageable portion of the well, SRK conducted spinner and EC/temperature logging within the accessible screen interval. Results of the logging are presented in Figure 4 and show two prolific water producing zones, between 250m bgs and 255m bgs (upper part of Lloydminster Formation), and between 270m bgs and 280m bgs (Cummings Formation).

On 21 October 2010 a 1,000 gpm, multi-stage submersible pump was installed in the well on 6-in steel riser pipe. On 22 October, SRK attempted to conduct a step-drawdown test to measure well efficiency. However, because relatively thin-walled 6-in HDPE discharge pipe had been used from the wellhead to the discharge shaft, Shore Gold’s sonic flow meter proved to be unreliable. At each increase in flow, the diameter of the pipe would expand, causing incorrect readings in the sonic device. Data from the step test are not considered to be valid.

2.1.6 2010 Long-Term Pumping Test

A 20-day pumping test was initiated at an average pumping rate of about 900 gpm. Changes in water levels were measured in 19 stand-pipe piezometers and grouted-in transducers located at distances ranging from 53m to 5,776m away from the pumping well. Locations of the pumping well and monitoring wells are shown in Figure 5. Figure 6 shows the measured pumping rate, and Figure 7 shows the measured drawdown during the 20-day pumping test and the subsequent recovery of more than 32 days. Measured drawdown in the stand-pipe piezometers were corrected for changes in barometric pressure.

Interpretation of the results of the long-term pumping test was completed by groundwater modeling. Calibration of the model to transient conditions observed during 20-day pumping test is described below in Section 3.4.

The results of the completed long-term pumping test from the Mannville Sandstone indicate:

- Ability to pump up to 1000 gpm from a single dewatering well from the Mannville Group (drawdown within deep groundwater system was about 13m; 43m in the pumping well);
- Uniform lateral propagation of drawdown to the south and to the north;

- Propagation of drawdown to the south of the Saskatchewan River confirming an absence of hydraulic connection between the river and the deep groundwater system (drawdown of 0.6m was measured in piezometer GT-10-001c located about 800m to the south of the river);
- Lower part of the Mannville Group is significantly more permeable than the upper part (horizontal hydraulic conductivity 3m/day and 0.01m/day, respectively);
- Vertical anisotropy within the Mannville Group (ratio K_h:K_v is about 30:1); and
- Very limited hydraulic connection between the Mannville Group and the Colorado Group shale, with questionable vertical propagation of drawdown within the Colorado Group shale.

2.2 Hydrostratigraphic Framework and Conceptual Groundwater

The hydrogeology of the project area essentially comprises two water-bearing systems:

- The shallow surficial sands, silts/clays, till, and a basal boulder/gravel unit; and
- The deep sandstones of the Mannville Group and underlying carbonates of the Souris River Formation.

The two water-bearing systems are subdivided by the Colorado Group shale, a confining layer of low permeability.

2.2.1 Shallow Groundwater System

The shallow groundwater system includes three fairly distinct units:

- Surficial sand –unconsolidated, silty to fine-grained sand which covers most of the project area. This unit consists of the upper and lower sand layers separated by surficial silt/clay. The upper sand layer averages about 10m – 15m in thickness. It receives recharge from precipitation and is in direct hydraulic connection with surface water bodies. Measured hydraulic conductivity values (*K*) from slug tests in piezometers are shown in Table 1 and range from 0.8m/d to 28.5m/d with average *K* of about 12m/d (geomean *K* of 9.4m/d). A 72 hour pumping test was completed in 2006, which estimated a *K* value of 364.6m/d. However, SRK did not have details of this test and has not used this extremely high *K* value in the current analysis. The lower sand layer also averages 7m – 12m in thickness and where present particularly in the Orion South Kimberlite area is generally separated by a 7m – 8m thick silty clay layer. Although not in direct hydraulic connection with surface water bodies it is assumed that recharge occurs through precipitation and infiltration from surface source. The hydraulic conductivity of the lower surficial sand was measured during slug tests in 2010 (*K* values are shown in Table 1) and ranged between 0.008m/d and 0.3m/d with an average *K* of about 0.2m/d (geomean *K* of 0.1m/d);
- Surficial silt – a highly variable unit consisting primarily of silt, and mostly interbedded with very fine-grained sand and clay. The sequence usually lies below the surficial sand or maybe separated into two layers by the lower sand layer. It has a combined thickness of 15m to 28m at various sites. From the 2005 and 2007 investigations, it is known to have a significantly lower *K* than the upper surficial sand layer. Hydraulic conductivity values of the surficial silt, measured during slug tests, range from 0.009m/d to 0.025m/d with an average *K* of about 0.06m/d (geomean *K* of 0.03m/d); and
- Till – a glacially deposited silt and clay containing variable amounts of sand and gravel-sized particles of overall relatively low *K*. This unit also contains interbedded sand and/or gravel with locally higher K. Hydraulic conductivity values were estimated from two 3-day pumping tests, packer injecting and airlift tests in coreholes, and slug tests in piezometers. Results are summarized in Table 2 and Figure 2a. Measured horizontal hydraulic conductivity values differ by about five orders of magnitude (from 3×10^{-5}m/d to 1.5m/day) indicating the variable hydraulic properties of the till. These data also indicate that the upper part of the till unit is slightly more permeable than the lower part. In 2007, two pumping tests were conducted in wells PW-3 and PW-1, fully screened in the till unit (Orion North and southwest from the Star), yielding average *K* values of 0.03m/d and 0.4m/d, respectively (HCI, 2007).

It should be noted that the vertical hydraulic conductivity values of all hydrogeological units within the shallow groundwater system have not been evaluated in the field, and were defined during groundwater model calibration to the measured water levels. The water level elevations significantly decrease with depth, indicating a high vertical anisotropy ratio for the silt and till units ($K_h >> K_v$).

2.2.2 Confining Layer

The confining layer (Colorado Group Formation) is an approximately 80m thick (ranging from 73 to 85m) sequence of interbedded marine shales and siltstones which overlies the Mannville Group. Kimberlite “fingers,” from 3m to 15m thick, occur within the Colorado Group Formation in the vicinity of major kimberlites.

Horizontal hydraulic conductivity values (K_h) were measured during packer injection tests in three coreholes within 7 intervals, and varied from 4 x 10^{-5}m/d in the area outside of the kimberlite to 0.015m/d in coreholes intersecting kimberlite “fingers”. Results are shown in Table 3 and Figure 2b indicating an average K_h of 0.003m/d (geomean value of 0.0004m/d).

Laboratory tests of hydraulic conductivity of the shale unit were completed in 2010 from three samples extracted from corehole OVB-10-207C. Measured K values for the Colorado Group shale (from K=3x10^{-6}m/d to K=2x10^{-5}m/day, with average K= 8x10^{-6}m/d) are lower than estimated from packer testing in the field.

A pumping test in well PW-4, in the vicinity of the Orion North, indicated no drawdown in point piezometers completed in the Colorado Group shale 25m and 70m above the tested interval (HCI, 2007).

However, drawdowns were monitored in point piezometers within the Colorado Group shale during the PW-2 pumping test. PW-2 is in the Mannville sandstone southwest from the Star Kimberlite and was installed approximately 10m and 60m above the pumping interval (maximum drawdown of 0.8m and 0.5m, respectively (HCI, 2007). This indicates increasing permeability of the Colorado Group Formation in this area. The University of Saskatchewan has recently been contracted to conduct a multiyear study into the characteristics of the Colorado Group shale, including permeability.

A long-term pumping test from prototype dewatering well140-10-089RC indicates very small and questionable drawdown in two grouted-in transducers installed in well SRK-GT10-09 at the distance of 53m from the pumping well (Figure 7c). These two transducers were installed at depths of 26m and 46m above the top of the Mannville Group.

The confining layer (Colorado Group shale) has been locally removed by erosion from the paleochannel located immediately north of the Orion North kimberlite (Figure 1) and has been replaced by fluvial layers of sand and gravel. This may result in a possible hydraulic connection between the shallow and deep groundwater systems in this area and may provide recharge to the deeper aquifer.

2.2.3 Deep Groundwater System

The deep groundwater system as defined for this investigation is comprised of the Mannville Group and the uppermost part of the Souris River Formation. The Mannville Group is comprised of seven sandstone members containing variable amounts of sand and silt (and minor clay) but also showing differences in cementation and the occurrence of interbeds of shale and coal.

These sandstones include the members of the Cantuar formation as follows (from top to bottom):

- Waseca;
- Sparky;
- General Petroleum;
- Rex;
- Lloydminster;
- Cummings; and
- Dina.

Detailed geological descriptions of each member at the Orion South and the Star sites are provided in the SRK geotechnical report (SRK, 2010a).

Comprehensive hydraulic testing of the Mannville Group was completed by HCI (2007) in two pumping wells PW-2 (Star area) and PW-4 (Orion North) screening the entire group from these seven sandstone members. Locations of the pumping wells are shown in Figure 1. The duration of pumping was 7 days, with monitoring of changes in water levels in numerous multilevel piezometers. Results of the pumping tests indicated significant transmissivity of the Mannville Group, varying from 185m^2/d at the Orion North to 263m^2/d at the Star (thicknesses were 125m and 157m, respectively). Estimated average horizontal hydraulic conductivity values of the entire Mannville Group were 1.5m/d and 1.7m/d.

The spinner logs of pumping wells PW-2 and PW-4 in the Star and Orion North Kimberlite areas (HCI, 2007) indicate that the lower 30m to 40m part the Mannville Group (Lloydminster, Cummings, and Dina members) is much more permeable than the remainder of the group. The upper part of the Mannville Group (Waseca, Sparky, General Petroleum, and Rex members) was tested also in 4 coreholes (in total, nine intervals) indicating lower than average *K* values. Horizontal hydraulic conductivity values for the upper part of the Mannville Group ranged from 0.0001m/d to 0.08m/d with an average *K*=0.01m/d.

All measured *K* values within the Mannville Group are shown in Table 4 and Figure 2c.

The total thickness of the Mannville Group varies from 125m at Orion North to 159m at Orion South and 157m at Star.

It should be noted that there is a significant variability in the thickness of these sandstone members especially within the more permeable lower part of the Mannville Group. For example, the thickness of the lowermost Dina member of Cantuar Formation varies (SRK, 2010a) as follows:

Orion North kimberlite area – 5m,
Orion South kimberlite area – 74m,
Star kimberlite area – 14m.

The Souris River Formation consists of Devonian-age alternating sequences of limestones and marlstones. The upper several meters of the carbonates are probably fractured and relatively permeable (based on the spinner log of PW-4 at the Orion North area (HCI, 2007) and should be considered to be part of the deep groundwater system. The entire Souris River Formation is reported to be between 320m and 500m thick in the project area according to the geological model developed by Shore Gold, and is most likely less permeable at depth.

2.2.4 Conceptual Groundwater Model

SRK's conceptual groundwater model of the Fort a la Corne area has shallow and deep groundwater systems subdivided by a confining layer. Infiltration from precipitation recharges the shallow groundwater system. A significant part of this water discharges back into the creeks and ravines through the layer of surficial sand. The deep groundwater system also receives recharge from the shallow groundwater system due to the differences in hydraulic head and the existence of a vertical downward gradient (measured water levels in shallow and deep piezometers used for model calibration are shown in Tables 5 and 6, respectively). The Saskatchewan River is a major surface water body within the hydrologic study area, with the river bed being located within the lower till. Shallow groundwater discharges into the river during pre-mining conditions.

During mining conditions the major sources of inflow to the proposed pits would be:

- Groundwater storage of the shallow groundwater system (during initial stage of pit excavations);
- Groundwater storage of the deep groundwater system (during late stage pit excavations);
- Direct inflow from precipitation; and
- Inflow from the Saskatchewan River (most likely very limited) through the lower till and by recharge of the Mannville Group through the overlying Colorado Group shale (during mining conditions when hydraulic gradient would be reversed by the Mannville dewatering system).

3 Numerical Groundwater Flow Model

As with the 2010 model, SRK applied the commercially available finite-difference code Visual MODFLOW-SURFACT (SWS, 2010 and HGL, 2006) to update a regional groundwater flow model to simulate possible impacts of proposed dewatering of the Star and Orion South open pits. This code has been chosen because of the necessity to simulate two water tables during dewatering of the Mannville Group in the vicinity of the proposed two open pits.

The model is described below.

3.1 Grid Discretization and Model Boundaries

The groundwater model domain encompasses approximately 1,015 square km in the vicinity of the proposed mine, and the finite-difference grid contains 169,920 cells (118 rows and 72 columns) within 20 layers (Figures 8 through 12). The grid is more finely discretized in the area of the proposed open pits in order to:

- Refine numerical simulations of hydraulic heads and flows near the area of flow convergence (i.e. the pit drain cells); and
- More reasonably represent the geometry of the proposed pits, hydrogeologic units in the vicinity of the pits, and surface water bodies.

The horizontal dimensions of cells range from 200m to 1,800m. In the area of the proposed pits the size of cells is 200m. The vertical dimensions of cells vary from 1m to 250m.

Outer model boundaries were chosen at significant distances from the proposed open pits: 17.5km to 21km to the south, 17.5km to 14km to the north, 14.5km to 13.5km to the west and 14.5km to 15.5km to the east (from the Star and Orion South pits, respectively), in order to reduce the influence of boundaries on simulated drawdown during the mine-dewatering simulations. Additionally, the general head boundary (GHB) conditions (McDonald, M.G. and Harbaugh, A.W., 1988, SWS, 2010) were assigned along the outer model boundaries within the Mannville Group at distances of: 50km (northern and southern) and 35km (western and eastern). Assigned specified heads along these boundaries are shown in Figure 8. The total number of GHB cells is 1,871.

The bottom of the model has variable thickness (605m to 805m) and was assigned as a no-flow boundary.

3.2 Simulation of Hydrogeological Features

3.2.1 Simulation of Hydrogeology

In the finite-difference method, hydraulic properties are assigned to the cells, and hydraulic heads and fluxes are associated with their centers. Therefore, every cell in the model is assigned to a model “zone”, as depicted in plan-view on Figures 9 and 10. Each model zone has values for horizontal (K_h) and vertical ($K_v K_v$) hydraulic conductivity, specific storage (S_s), and specific yield (S_y) based on historic aquifer testing data. Specific yield is only utilized if the water table occurs within a cell of the model.

As described above, the two major hydraulically connected groundwater systems were incorporated into the model as 1) a shallow overburden groundwater system, and 2) deep groundwater system hosted by the Mannville Group and Souris River Formation. Both hydraulically connected groundwater systems and the confining layer between them were further subdivided into fifteen hydrogeological zones shown in Figures 9 through 12.

Hydraulic properties used in the model for these 15 hydrogeological units are shown in Table 7.

Shallow groundwater system

The shallow groundwater system is represented by seven units:

- Upper surficial sand;
- Upper surficial silt/clay;
- Lower surficial sand;
- Lower surficial silt/clay;
- Upper till;
- Lower till; and
- Uppermost till within Saskatchewan River valley.

The first six hydrogeological units are regionally distributed. Assessment of the hydraulic conductivity values (in the horizontal direction) are shown in Table 7. The seventh unit – the uppermost till within the Saskatchewan River valley – was incorporated into the model to improve model calibration. Its hydraulic properties were assumed to be the same as for the upper till unit.

The shallow groundwater system is represented in the model by the first eight numerical model layers.

Deep groundwater system

The deep groundwater system is represented by two Mannville Group units (upper and lower sandstones) and by two Souris River Formation units (the uppermost and base). Distribution of horizontal hydraulic conductivity within the entire Mannville Group, simulated by five numerical model layers, assumes that the Upper part of the Mannville Group (Waseca, Sparky, General Petroleum, and Rex Formations) is less permeable (K_h=0.01m/d) compared to the Lower part (Lloydminster, Cummings, and Dina) with K_h=3m/d). This assumption is based on the results of:

- Spinner logging completed in pumping wells PW-2 and PW-4 (HCI, 2007);
- Spinner logging completed in a prototype dewatering well (140-10-089RC) south of the Orion South kimberlite; and
- Long-term pumping test from the prototype dewatering well (140-10-089RC).

Decreasing hydraulic conductivity with depth within the Souris River Formation (shown in Table 7) is assumed based on general geological considerations.

The Colorado Group Formation, separating the shallow and deep groundwater systems, is represented by a single shale unit numerically subdivided by four model layers.

Two other hydrogeological units – kimberlite and till within the paleochannel – were incorporated into the groundwater model based on Shore Gold’s regional geological model. Only the three largest kimberlites – Star, Orion South, and Orion North – were incorporated into the current version of the model.

The vertical hydraulic conductivity values of all hydrogeological units are obtained from calibration of the model and general geological assumptions.

Storage parameters are assigned based on the interpretation of results from the long-term pumping test of well 140-10-089RC, from pumping tests completed in 2007 (PW-1 through PW-4; HCI, 2007), and from SRK experience from projects in similar hydrogeological conditions.

3.2.2 Simulation of Rivers and Creeks

One major river (Saskatchewan River) and several smaller creeks and ravines (subdivided into 14 stream zones) that regulate groundwater flow within the Star-Orion South project area were incorporated into the numerical groundwater model, as shown in Figure 8. The Saskatchewan River, with average yearly flow of about 567m^3/s, is simulated by specified head (or constant head equal to 360mamsl) cell values applied in the first layer of the model (total number of cells is 172). The specified head cells allow surface water to be hydraulically connected to the groundwater without any restrictions (or leakance factor).

The other stream zones, with average yearly flow varying from 500m^3/d to 27,800m^3/d, are simulated by combinations of drain cells and seepage face cells (RSF4 package of MODFLOW-SURFACT code, HGL, 2002) with simulated groundwater discharge according to the equations:

$$Q_s = \begin{cases} C_L \bullet (H - Z), & \text{if } H>Z \\ 0, & \text{if } H<Z \end{cases} \qquad (1)$$

Where:

Q_s = groundwater discharge to creek/ravine (m^3/d);

H = hydraulic head (m);

Z = surface elevation (m); and

C_L= leakance or conductance (m^2/d) depending on actual size of cell and its hydraulic conductivity.

Drain cells were used to simulate the courses of major creeks and ravines in the vicinities of the proposed pits. Seepage face cells were used to simulate their valleys with smaller tributaries and springs.

The locations of used drain and seepage face cells for simulation of the different creek/ravine courses and valleys are shown in Figure 8.

3.2.3 Simulation of Recharge from Precipitation

Recharge from precipitation is applied to the first saturated cell (the uppermost active layer) within the model domain by using yearly averaged rates. There are two different recharge zones, as follows:

Zone	Recharge (mm/year)	Percent of Precipitation
1 – Upper Surficial Sand	20	4.2%
2 – Silt/Clay, Lower Surficial Sand and Upper Till	5	1.02%

Average yearly precipitation is about 468mm/year, based on climate records at Prince Albert station. Locations of simulated zones of recharge are shown on Figure 9.

It should be noted that all cells within the first layer of the model were specified as seepage face cells to simulate creeks and ravines in peripheral parts of the model with large model cells (discussed in Section 3.2.2). These seepage face cells are features of the MODFLOW-SURFACT code (HGL, 2002) allowing rejection of recharge to the groundwater system if simulated heads exceed the ground surface elevation. In the latter case, instead of "recharge-in", "recharge-out" is simulated as runoff. This means that:

- The recharge rates of 20mm/year and 5mm/year specified above were applied in the areas where the simulated water table is below ground surface; and
- These areas and total recharge value can vary in time during transient simulations depending on hydraulic stress applied to the groundwater system.

3.3 Steady-State Calibration to Pre-Mining Conditions

The steady state calibration of the model to the measured water levels (shown in Tables 5 and 6) and stream base flows was completed by adjusting:

- Recharge rate;
- Vertical hydraulic conductivity values of all units;
- Horizontal hydraulic conductivity of till units; and
- Hydraulic heads for GHB along model boundary within the Mannville Group.

Figure 13 shows the distribution of measured vs. simulated water levels under steady state conditions. This figure shows the quality of calibration line by hydrogeological units (Figure 13a through Figure 13d). Calibration of the vertical hydraulic gradients measured at the Orion North and Star pumping test sites is shown in Figure 13e. Figure 13 indicates that calculated groundwater levels are reasonably well calibrated to measured values especially for surficial sand/silt units and the Mannville Group (Figures 13b and 13d). The model simulates water levels in till and shale higher than measured (Figure 13c) indicating that the model limits groundwater discharge to the Saskatchewan River and to other surface-water bodies (where these units are exposed in their valleys and ground surface depressions). However, the model very well simulates the vertical hydraulic gradient far away from the river at the Orion North site (red dashed line in Figure 13e).

Hydraulic conductivity values calibrated in this model to measured water levels were changed compared to the values used in the SRK 2010 model (SRK, 2010b, Table 7) as follow:

Horizontal Hydraulic Conductivity

- Lower surficial sand – decreased from 0.05m/d to 0.03m/d;
- Uppermost till within Saskatchewan River valley – increased from 0.05m/d to 0.1m/d;
- Upper till – decreased from 0.05m/d to 0.03m/d;
- Lower till – increased from 0.006m/d to 0.018m/d, and
- Paleochannel (lower part) – increased from 0.004m/d to 0.1m/d.

Vertical Hydraulic Conductivity

- Upper surficial silt/clay – decreased from 0.005m/d to 0.0005m/d;
- Lower surficial silt/clay – decreased from 0.005m/d to 0.0001m/d; and
- Paleochannel (lower part) – increased from 0.00006m/d to 0.001m/d.

Hydraulic conductivity within the Mannville sandstone was re-distributed based on results of a 20-day pumping test, as discussed in Section 3.4

SRK is of the opinion that results of the steady state calibration of the model shown in Figure 13 of this report were improved compared to the SRK 2010 model (SRK, 2010b, Figure 8).

Figure 14 shows the simulated water table and the direction of groundwater flow; Figure 15 shows simulated potentiometric levels within the upper part of the Mannville Group under pre-mining conditions.

Modeled components of the groundwater budget for pre-mining conditions are shown in Table 8, and include:

- Recharge to the groundwater system of 45,800m^3/d;
- Groundwater discharge to the Saskatchewan River and other creeks and ravines of 32,900m^3/d;
- Groundwater inflow to the northern boundary within the Mannville Group of 1,300m^3/d;
- Groundwater outflow within the Mannville Group of 14,200m^3/d; and
- Groundwater discharge to surface water bodies within the model domain compared to measured stream base flows is shown in Table 8.

3.4 Transient Calibration to 20-day Pumping Test Data

The transient calibration of the model was adjusted to include the changes in water levels recorded during a 20 day pumping test followed by 32 days of groundwater recovery. The pump test well 140-10-089RC was completed within the Mannville sandstone and was screened across the entire upper part and across about 30m of the lower part of the Mannville Group (construction of the well is shown in Figure 3). The well was simulated by a vertical column of cells numerically linked together by applying high vertical hydraulic conductivity (K_v=10m/d), allowing simulation of the same water level within the linked vertical cells. This vertical column of cells represented the screened interval shown in Figure 3 and pumping was simulated by the “well” option with constant pumping rate per simulated time step. Locations and screen intervals of monitoring wells used in the pumping test, and measured maximum drawdown values are shown in Table 9.

Comparison of measured and calculated drawdowns in the pumping well and 11 monitoring wells is shown in Figures 16a through 16i. Comparison of measured and modeled pumping rates is shown in Figure 16j. Simulated drawdown within the Mannville sandstone at the end of the pumping test is shown in Figure 17, and indicates uniform propagation of the drawdown in all directions, with drawdown contour of 0.5m at the distance of 6.7km from the pumping well.

It should be noted that the regional groundwater flow model was additionally discretized in the vicinity of the pumping well both laterally and vertically (shown in Figure 17) to better match distances to close-by monitoring wells and their screen locations.

The transient calibration target was to match drawdown slopes in log-time scale which define transmissivity of the Mannville sandstone (or pumped unit). A reasonable transient calibration of the model to measured changes in water levels was achieved under a distribution of hydraulic parameters as follows:

- Horizontal hydraulic conductivity of the upper Mannville K_h=0.01m/d;
- Horizontal hydraulic conductivity of the lower Mannville K_h=3m/d;
- Anisotropy ratio K_h:K_v= 30:1; and
- Specific storage of the Mannville sandstone $S_s=3x10^{-6}\ m^{-1}$.

It should be noted that under the currently used hydraulic conductivity values of the Colorado Group shale (Kh=0.0004m/d and K_v= 0.00006m/d) the model predicts larger propagation of drawdown into this unit above the Mannville sandstone at the end of the pumping test than measured (shown in Figures 16j and 16h) in the string of grouted-in transducers immediately above the pumping well. However, drawdown measured in piezometer SHP-08-06 (upper) in the Star kimberlite area is larger than simulated (shown in Figure 16i). This fact can be explained by potential hydraulic connection from the Mannville sandstone through the existing (currently flooded) underground shaft excavated within the Star kimberlite.

SRK is of the opinion that this 3-D numerical regional groundwater flow model is reasonably well calibrated to existing hydrogeological data, and is suitable for feasibility level predictive simulations to evaluate the dewatering requirements at FS level and the possible impacts to groundwater and surface water bodies as a result of the dewatering of two proposed pits.

3.5 Simulation of Open Pits

Open pits were simulated using drain cells, which extract groundwater from the model depending on water-level elevation and leakance. Flow to the drain cells was calculated according to:

$$Q_d = \begin{cases} C_L \text{ x } (H - Z_d), \text{ if } H > Z_d \\ 0, \text{ if } H < Z_d \end{cases} \qquad (2)$$

Where:

Q_d = inflow to drain cell (m^3/d);

H = hydraulic head (m);

Z_d= elevation of bottom of pit (m); and

C_L= leakance factor or conductance (m^2/d).

SRK has incorporated into the model phase-based pit plans provided by Shore Gold for both the proposed Star and Orion South pits and for each phase of the mining, annual pit bottom elevations were also provided.

It should be noted that the new pit plans differ significantly to those used in the 2010 model (SRK, 2010b) and can be described as follow:

- The Star pit will be excavated first. The Orion South pit will start in Year 10 and continue through Year 17 when both pits will be excavated simultaneously. The Orion South pit will then continue excavation through Year 24 while the Star pit will be backfilled starting in Year 18;

- Elevation of the ultimate bottom of the Star pit is 100 mamsl (75m lower than in 2010 pit plans); and
- Elevation of the ultimate bottom of the Orion South pit is 145 mamsl (45m higher than in 2010 pit plans).

A total number of drain cells of 1,294 and 817, respectively, were used to simulate in space and time the excavation of the Star and Orion South pits. The locations of the drain cells used to simulate excavation of the pits are shown in Figure 18. The simulated elevations of the bottoms of both pits over time are shown in Figure 19. The leakance factor was assigned to be 10,000m^2/d for the all drain cells simulating pit excavations.

Backfilling of the Star pit (after excavation is completed in Year 17) during the excavation of the Orion South pit was simulated by turning off drain cells and by incorporating of backfill material with increased hydraulic conductivity values compared to the bedrock excavated during the mining. Backfilling of the Star pit was simulated instantaneously in Year 18 under the assumption that in reality the water table would be below the top of the backfilled material and that elevation would increase in time.

3.6 Simulation of Dewatering Wells

The groundwater flow model simulates dewatering wells completed into the Mannville Sandstone as “pumping centers” or cells within the finite-difference grid at which a specified amount of water is withdrawn or a specified water level is maintained by removing water. SRK simulated a total of 30 such pumping centers:

- Eighteen (18) dewatering wells - on the perimeter of Star pit;
- Five (5) – Star in-pit dewatering wells; and
- Seven (7) dewatering wells - on perimeter of Orion South pit (northern part).

Their locations and schedules of operation are shown on Figure 18. Each pumping centre was simulated by a vertical column of cells numerically linked together by applying high vertical hydraulic conductivity (K_v=10m/d), allowing simulation of the same water level within the linked vertical cells. This vertical column of cells represents the screened intervals of dewatering wells within the Mannville Group only (i.e., below the Colorado Group shale and above the Souris River carbonates).

The groundwater withdrawal by dewatering wells is simulated with a constant pumping rate (Q_w=1,000 gpm) until water levels in the wells are above freeboard elevation (30m above the bottom of the Mannville sandstone units for perimeter wells and 20m – for in-pit wells). Pumping rates were switched to constant head fluxes when water levels in pumping wells reach freeboard elevations. To account for well interaction and to avoid injecting water instead of pumping, constant head fluxes were switched to Qw=0 when water levels were below bottom of the Mannville sandstone. Mathematically groundwater withdrawal by the pumping wells was simulated as follows:

$$Q_w = \begin{cases} Q_{const}, & \text{if } H>H_f \\ C_L \times (H_f - H), & \text{if } Z<H<H_f \\ 0, & \text{if } H<Z \end{cases} \qquad (3)$$

Where:

Q_w = pumping rate (m^3/d);

H = hydraulic head (m);

Q_{const} = constant initial pumping rate (m^3/d);

H_f = freeboard elevation in pumping well (m);

Z = elevation of bottom of the Mannville sandstone; and

C_L= leakance or conductance (assigned to be 10,000m^2/d),

It should be noted that there is a naturally occurring limiting factor for the effectiveness of the dewatering system at the proposed Star pit. This factor is the presence of the relatively tight limestone unit at the base of the relatively permeable Mannville sandstone sequence. The ultimate bottom of the proposed Star pit will be only about 15m above the bottom of the Mannville sandstone. The lower *K* of the limestone will diminish the potential hydraulic efficiency of the dewatering wells during later pit life, since it limits the available drawdown. Thus, in order to realistically simulate conventional dewatering wells in the numerical model, an assumption has to be made regarding the amount of “freeboard” that will occur in a well. The freeboard (as used in this investigation) is the amount of saturated thickness of the sandstone immediately adjacent to the wellbore that cannot be dewatered due to well inefficiencies (or “well losses”) and natural hydraulic limits such as the formation of a seepage face on the wellbore surface.

SRK, based on experience in similar hydrogeologic settings and considering that that the lower part of the Mannville Group contains the most transmissivity, has assumed that the freeboard in the dewatering wells around the proposed pit will be about 30m. When the model-calculated water level in a simulated pumping centre around the pit reaches the elevation of 30m above the top of the limestone unit, a constant head was “fixed” at the elevation of 30m above the top of limestone, regardless of the elevation of the pit bottom.

A slightly smaller freeboard of 20m was used for the Star in-pit dewatering wells. These wells will need to be placed into operation at a later stage in the excavation of the Star pit and at a lower elevation and a closer distance to the bottom of the pit to reduce residual passive inflow.

The ultimate bottom of the proposed Orion South Pit will be about 34m above the bottom of the Mannville sandstone and dewatering wells would not have such a limiting factor as for the Star pit.

3.7 Simulation of Orion South Pit Lake Infilling

Pit Lake infilling for Orion South was simulated by replacing the cells with hydraulic properties of the excavated units within the ultimate pits by a new hydrogeological unit (pit lake) with hydraulic properties as follow:

- Hydraulic conductivity $K = K_h = K_v$ = 100m/d;
- Specific yield S_y = 1; and
- Specific storage S_s = 1/b (m^{-1}), where b is thickness of numerical model layer.

This approach numerically allows simulation of groundwater recovery when pumping wells are turned off, and the forming of a lake (water body) within the ultimate pits. High *K* values allow simulation of the same hydraulic heads within cells representing the pit lake cells, and high storage parameters allow representation of the approximate stage/volume relationship of pit lakes based on grid discretization. Modeled vs. planned volumes of pit lakes, considering existing discretization of the numerical groundwater model, are shown in Figure 28.

Backfill material within the Star pit was simulated with parameters *K*=0.01 m/d, S_y=0.03, and S_s=10^{-5} m^{-1} during Orion South pit lake infilling.

Recharge rates in the Orion South pit lake area were adjusted in order to simulate the precipitation, evaporation and runoff effects during the pit lake infilling. The following parameters were used with this propose:

- Annual precipitation of 468mm (AMEC, 2010);
- Annual pond evaporation of 699mm (AMEC, 2010);
- Coefficient to transform pond evaporation to pit lake evaporation – 0.7;
- Runoff catchment area around Orion South pit of 3,768,000m^2;
- Surface runoff of 30mm (6.4%) (AMEC, 2010);
- Orion pit lake area of 3,400,000m^2;
- Orion Pit area 3,853,000m^2; and
- Runoff within pit – 25% of precipitation (117mm/year).

Based on these parameters a new recharge rate of 28mm/year was applied to the Orion South pit lake during infilling simulations.

3.8 Modifications of Groundwater model used in This Study

SRK used 8 modifications of the model described above to simulate:

- Steady-state pre-mining conditions;
- 20-day pumping test (additional lateral discretization was added in vicinity of the pumping well);
- Mining conditions during Years 1 through 15 when groundwater withdrawal from all Star perimeter dewatering wells was simulated by constant pumping rates;
- Mining conditions during Years 16 and 17 when groundwater withdrawal from all Star perimeter dewatering wells was simulated under constant head conditions;
- Mining conditions during Years 18 and 19 when a) Star pit was instantaneously backfilled; b) groundwater withdrawal from all Star perimeter dewatering wells was simulated under constant head conditions; and c) groundwater withdrawal from all Orion South perimeter dewatering wells was simulated by constant pumping rates starting in Year 19; and
- Mining conditions during Years 20 and 24 when all Star and Orion South dewatering wells are simulated by constant heads corresponded to freeboard elevations;
- Post-mining transient conditions for the Orion pit lake infilling; and
- Post-mining steady-state conditions.

These modifications mostly relate to the necessity to switch the constant flux regime of pumping to constant head in the dewatering wells during mining, and to simulate the 20-day pumping test, pit excavation, backfilling, pit lake infilling, and steady-state pre-mining and post-mining conditions.

4 Predictive Simulations

The 3-dimensional groundwater-flow model described above was used to make predictive simulations of:

- Passive inflow to proposed pits;
- Dewatering requirements and residual passive inflows; and
- Propagation of drawdowns during proposed dewatering.

4.1 Predicted Passive Inflow to Pits

Predictive numerical simulations were conducted for both totally passive inflow conditions (i.e., without any dewatering) and for conditions with an active dewatering system. The simulations were implemented by incorporating the pit plans (discussed in Section 3.5) for the proposed pits, and dewatering “wells” into the groundwater flow model (shown in Figure 18). Passive inflow is the amount of ground water that would enter the excavation without implementation of any active dewatering system (e.g., pumping wells, drainholes, etc.) to intercept some or all of the water. The amount of water that still enters an excavation after active dewatering is implemented is referred to as residual passive inflow (RPI). Generally, the goal of an active dewatering system is to reduce RPI to an amount that is inconsequential relative to the mining operations.

The predicted passive inflows to the proposed Star and Orion South pit over the life of the mine, again with no active dewatering, are shown on Figure 20 and Table 10. The numerical simulations predict that the maximum passive inflow would be about 78,600m^3/d for the deeper Star pit (ultimate bottom elevation of 100 mamsl) and 17,700m^3/d for the Orion South pit (ultimate bottom elevation of 145 mamsl) at the end of their excavations.

Although active dewatering will be implemented for the Star project, SRK typically conducts this simulation of totally passive inflow as a basis for evaluating the overall efficiency of the dewatering system.

4.2 Predicted Required Dewatering and Residual Passive Inflow

Results of the predictions of active dewatering of the proposed Star and Orion South pits are shown in Figure 20 and Table 10. Predicted water levels in Star and Orion South dewatering wells vs. pit elevations are show in Figures 21 and 22, respectively. The model predicts:

- Eighteen Star perimeter dewatering wells will be required to operate from Year 5, when necessary power will be available on the site, through Year 17 (end of excavation of the Star pit). These 18 perimeter wells need to continue to be in operation for dewatering of the Orion South pit through Year 24 (end of mine life);
- Five in-pit dewatering wells need to be installed within the Star pit at lower benches and to be in operation from Year 15 through Year 17 to minimize residual passive inflow when the pit will be excavated within the permeable part of Lower Mannville sandstone unit. These in-pit dewatering wells should be in operation through Year 19 during the initial stage of backfilling of the Star pit. The necessity of installation of these wells can be explained by the fact that the ultimate pit bottom elevation of the Star pit would be 15m above top of low permeable limestone and perimeter dewatering well with freeboard elevation of 30m would not be able to reduce the RPI during later stage of pit excavation;
- Seven Orion South perimeter wells will be required to operate from Year 19 through Year 24 in addition to the 18 Star perimeter dewatering wells. These wells should be drilled at the northern

extent of the Orion South pit and intercept additional groundwater from the shallow hydrogeological system if some leakage through the paleochannel occurs;

- Total pumping from the dewatering wells of as much as 98,100m^3/d for the Star and 120,00m^3/d for the Orion South pits. The latter value includes total pumping rate from continuing pumping of Star wells plus up to 38,200m^3/d from additional Orion South dewatering wells; and
- RPI of up to 18,700m^3/d for the Star and 15,200m^3/d for the Orion South, occurring when pit bottom elevations are above the top of the Mannville Group; most of this inflow will occur from the surficial sand at the beginning of the excavations or from the major "push-backs" at the ground surface. RPI from the Mannville Sandstone is predicted to be 3,000m^3/d and 2,000m^3/d for the Star and Orion South, respectively, during excavation their deepest parts.

Active dewatering was simulated only from the Mannville pumping wells (their locations around both the Star and Orion South pit are shown in Figure 18). The current model does not simulate active dewatering of the overburden, based on the assumption that water from the shallow groundwater system would be collected passively by an in-pit sump dewatering system.

The simulated water budget at the end of mining and its changes compared to pre-mining conditions are shown in Table 11. The budget indicates that sources of groundwater to be extracted by dewatering wells and an in-pit dewatering system would come from:

	Star	Orion South
Groundwater storage (mainly Mannville Group)	62%	58%
Groundwater inflow from lateral model boundaries within Mannville Group	29%	30%
Shallow groundwater system due to reduction of groundwater discharge to the surface-water bodies	8%	11%
Intersecting additional recharge to shallow groundwater system	1%	1%

The first two components (a total of 88%-92% of inflow to the dewatering wells and both pits) come from the deep groundwater system. The last two components (a total of 9%-12% of inflow to the dewatering wells and both pits) come from the shallow groundwater system by direct inflow to the proposed pits and by recharging the depressurized Mannville Group through the Colorado Group shale. It should be noted that the current model simulates an increase of recharge to the groundwater system during mining by about 1%. This can be explained by using seepage face cells within the uppermost layer of the model to simulate groundwater discharge to creeks and ravines in peripheral parts of the model with large model cells (discussed in Section 3.2.3). Recharge slightly increases in time due to a lowering of the water table due to mining in the areas where groundwater discharge was simulated during pre-mining conditions.

4.3 Calculation of Power Cost

The power costs were based on the pumping and RPI rates and lifts generated by the groundwater flow model. An electrical power unit cost of CND$0.05 per kilowatt-hour (kW-hr) has been used in the calculations.

Power costs for pumping were derived from:

$$\text{Cost} = \frac{[(Q_1 \, \text{xTDH}_1) + (Q_2 \, \text{xTDH}_2)]\text{x}365\text{x}24\text{xC}}{8{,}810 \text{ x } E_m \text{ x} E_p} \qquad (4)$$

where:

Cost = power cost ($/year),
C = power cost ($/Kw-hr),
Q_1 = discharge from dewatering wells (m^3/d),
Q_2 = discharge from RPI (m^3/d),
TDH_1 = total dynamic head for well discharge (m),
TDH_2 = total dynamic head for RPI discharge (m),
E_p = pump efficiency, and
E_m = motor efficiency.

The pumping energy requirements for the dewatering wells were calculated by multiplying the total pumping rate from all wells (Q_1) by the average total dynamic head (TDH_1) required to lift it to surface and move it through a pipeline as predicted by the groundwater flow model during each year, as shown in Table 12. The pumping energy requirements for removing the residual passive inflow from sumps in the bottoms of the pits (Q_2) was calculated by multiplying the RPI rate by the head required to lift water to the ground surface and move it through a pipeline (TDH_2), also shown in Table 12. The system was assumed to operate 24 hrs per day and 365 days per year. Pump and motor efficiencies were each assumed to be 85%.

It was estimated that 909.4 and 125.7 million Kw-hr will be required for dewatering of the Star and Orion South pits, respectively, with total operational costs of CAD$51.8 million.

4.4 Predicted Impact on Water Levels

Predicted water levels influencing the proposed dewatering system at the end of excavation of the Star and Orion South kimberlite are shown in Figure 23 and 24 for the upper and lower Mannville, respectively. Predicted drawdowns at the end of the mining are shown in:

Figure 25a – within surficial sand,

Figure 25b – within upper till,

Figure 26a – within lower till,

Figure 26b – within Colorado Group shale,

Figure 27a – within upper Mannville sandstone, and

Figure 27b – within lower Mannville sandstone.

The model predicts that the 1m contour of drawdown within the uppermost surficial sand as a result of pit dewatering will propagate to a maximum distance to the west of about 4.1km and to the east about 4.6km away from the both pits, and would be controlled by Caution and English Creeks. The 1-m drawdown contour will propagate 7.4km to the north from the center of Orion South pit and will be limited by the Saskatchewan River to the south. The drawdown extent within the Mannville Group, a confined groundwater system, will propagate beyond the model boundaries.

4.5 Predicted Infilling of Orion South Pit Lake

When the Orion South pit excavation and backfilling of the Star pit are completed (after 24 years of mining), all dewatering wells around the pits will be turned off and the pits will begin to fill with ground water to form a "pit lake". Using a modeling approach described in Section 3.7 and the stage-volume relationship for the Orion South pit shown in Figure 28, the numerical model predicted the rate at which the pit will fill with ground water and the position of the recovered water table over time. The predicted Orion South pit lake elevations over time are shown on Figure 29.

It is predicted that the water level will be at an elevation of about 388 mamsl (after 95% of pit lake infilling) about 315 years after mining ends.

The hydrologic influence of the Orion South pit on both the deep and shallow groundwater systems will continue throughout the period of pit infilling, more than 350 years. Predicted long-term steady state elevation of the Orion South pit lake is 406 mamsl.

The predicted groundwater inflow to the Orion South pit lake is shown in Figure 30. The model predicts a larger amount of groundwater flowing to the Orion South pit lake from the deep groundwater system (maximum inflow rate of 19,000m^3/d). Although most of the water discharged into the pit lake will come from the Mannville Group, the shallow aquifer system will also discharge into the pit lake at the average rate of about 1,000m^3/d.

4.6 Predicted Impact on Rivers and Creeks

The model-calculated groundwater budget at the end of mining is shown in Table 11 and indicates the reduction of groundwater discharge to the surface water bodies. The maximum reduction of groundwater discharge to the ravines and creeks in the vicinity of the proposed pits is predicted to occur during Orion South pit lake infilling from 10 to 33 years after mining ceases. Table 13 shows the maximum magnitude of impacts and when (in years after mining ceases) it is predicted to occur. This table compares maximum simulated impact to the creeks with simulated flow during pre-mining conditions and measured monthly low flows during the period from 2005 through 2010. Figure 31 shows the predicted reduction of groundwater discharge into the major creeks in time.

Maximum potential impact to the creeks is predicted as follow:

- English Creek – up to 2,360m^3/d (or 41% of pre-mining groundwater discharge);
- Caution Creek – up to 1,430m^3/d (or 64% of pre-mining groundwater discharge);
- Creeks within the Eastern Zone up to 1,100m^3/d;
- 101 Ravine – up to 590m^3/d (or 50% of pre-mining simulated groundwater inflow);
- Stream G (located southwest from the Saskatchewan River) up to 570m^3/d;
- Creeks within Northeast Zone up to 530m^3/d;
- Creeks within the Western Zone – up to 490m^3/d; and
- Stream F (located south from the Saskatchewan River) – up to 360m^3/d.

Predicted impact to the shallow groundwater system during long-term post-mining steady-state conditions is shown in Figure 32 as simulated drawdown compared to pre-mining steady-state conditions. The results of completed simulations indicate that the extent of the 1m contour of drawdown within the upper saturated layer of the model will propagate up to 4km to the west, 2.5km to the east, will be limited the English creek and the Saskatchewan River valleys to the north and south, and stay there in perpetuity.

4.7 Results of Sensitivity Analyses

The following additional simulations were completed as part of sensitivity analyses on model predictions of impacts to the shallow groundwater system and surface water bodies, as a function of key parameters of the model:

- Scenario 1 – Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3;
- Scenario 2 – Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3; and
- Scenario 3 – General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions.

The first two scenarios evaluate the possible range of impact based on vertical connection between the shallow and deep groundwater systems. The third scenario evaluates the effect of lateral boundaries of the Mannville Group on predicted impact parameters.

Results of sensitivity analyses for Scenarios 1 through 3 are shown:

- On pre-mining water level comparison graphs - in Figures 33 through 35 for Scenario 1, 2, and 3 respectively (it should be noted that the model was not calibrated to measured water levels for these scenarios);
- On predicted dewatering requirements - in Figure 36;
- On predicted drawdowns at end of mining within:
  - Uppermost saturated layer and upper hart of Mannville Sandstone - in Figures 37a and 37b for Scenario 1; in Figures 39a and 39b for Scenario 2; in Figure 41a and 41b for Scenario 3; and
  - Upper and Lower Till (lower parts) - in Figures 38a and 38b for Scenario 1; in Figures 40a and 40b for Scenario 2; in Figure 42a and 42b for Scenario 3.
- On components of the groundwater budget at end of mining – Tables 14 through 16; and
- On predicted impact to the surface water bodies from proposed active dewatering – in Figure 43 and Table 17.

The results of sensitivity analyses indicate that:

- Increasing vertical hydraulic conductivity of the Colorado Group shale and lower till will increase recharge to the deep groundwater system from the shallow system and as a result, the model predicts:
  - Increasing total average dewatering rate by a factor of about 1.1;
  - Propagation of drawdown within the shallow groundwater system almost to the edge of the model the model domain (shown in Figure 37a); and
  - Decreasing groundwater discharge to the creeks from 170m^3/d to 3,660m^3/d (average 84%).
- Decreasing vertical hydraulic conductivity of the Colorado Group shale and lower till will significantly decrease recharge to the deep groundwater system from the shallow system, and as a result the model predicts:
  - Decreasing total average dewatering rate by a factor of about 1.05;
  - Very limited propagation of drawdown within shallow the groundwater system (shown in Figure 39a); and
  - Decreasing groundwater discharge from 120m^3/d to 1,350m^3/d (average 21%).
- Replacing GHB conditions along the model domain within the Mannville Group by no-flow will slightly increase recharge of the deep groundwater system from the shallow, and as a result the model predicts:
  - The total average dewatering rate will not have a significant change;

- Intermediate propagation of drawdown within the shallow groundwater system (shown in Figure 41a); and
- Decreasing groundwater discharge from 340m^3/d to 3,550m^3/d (average 61%).

Results of the completed analyses indicate that predictions of change to water levels within the shallow groundwater system, and impact to the creeks and, ravines are very sensitive to vertical hydraulic conductivity of shale and lower till units and less sensitive to the model boundary conditions used within the Mannville Group.

SRK is of the opinion that the Base Case scenario used is conservative, but reasonable, and the sensitivity analysis shows that it is far more likely for this groundwater model to over predict impacts than to under predict them.

5 Predicted Quality of Mine Water Discharge

Although a prediction of quality of mine water discharge was not part of the investigation completed by SRK, these aspects were discussed in HCI evaluations completed in 2005 and 2007.

In HCI (2005), the potential effects of high chloride concentrations in mine water were discussed in detail. Specifically, HCI concluded based on preliminary water sampling and laboratory analyses, that the mine water discharge would have a very high sodium adsorption ratio (SAR). The analyses of samples collected from wells PW-2 and PW-4 completed into the Mannville sandstone during the 2007 field investigation confirm this conclusion. According to the predictions of the groundwater flow model, the mine water discharge will be a mixture of about 90 percent discharge water from the dewatering wells screened in the Mannville sandstone and ten percent RPI. At different times, the RPI will consist of water from the surficial sand and surficial silt, sand/gravel interbeds within the till, Colorado Group mudstones, and the Mannville sandstone. The chemical composition of the RPI will be a mixture of various sources and will, in general, have lower concentrations of sodium and chloride than the ground water from the Mannville Group. Because the discharge from the Mannville dewatering wells will be the major component of the Mannville water discharge, it can be conservatively assumed that the chemistry of the discharge water will be essentially the same as that from the Mannville.

Table 18 shows groundwater chemistry measured from the prototype dewatering well during the 20-day pumping test. Thus, as shown in Table 18, the mine water discharge will have a TDS of about 4,000mg/L, a sodium concentration of about 1,200mg/L, and a chloride concentration of about 1,600mg/L to 1,700mg/L.

6 Conclusions

A groundwater flow model of the Star-Orion South Diamond Project area was updated in 2011. Significant changes as compared to the 2010 model include:

- Simulation of upper Mannville Sandstone unit as less conductive as compared to the lower Mannville sandstone unit;
- More detailed simulation of the paleochannel (extent, properties, and boundary conditions);
- Improved steady-state calibration of the model to measured water levels (required changes in vertical hydraulic conductivity values and lateral boundary conditions);
- Transient calibration of the model to a 20-day pumping test and subsequent groundwater recovery data;
- Incorporation of new feasibility-level pit plans for the Star and Orion South pits, which are different to those plans simulated in the 2010 model;
- Simulation of dewatering wells as real pumping well cells with constant pumping rate until water levels reach freeboard elevations. These pumping cells were switched to constant head /drain cells to maintain water levels at a freeboard elevation during the late stages of mining of both pits;
- Optimization of the number and location of dewatering wells in time and space to minimize their number and the operating cost for pit dewatering; and
- Predictions were completed by using the re-calibrated groundwater flow model, and additionally to the previous 2010 model (SRK 2010b) include:
  - Number and location of required dewatering wells, their pumping rates and residual passive inflow to the pits;
  - Schedule of installation of dewatering wells;
  - Power cost for proposed dewatering system;
  - Propagation of drawdowns during proposed dewatering;
  - Orion South Pit lake infilling; and
  - Impact of groundwater discharge to the Saskatchewan River and creeks (during both pit excavations and infilling of pit lake).

Predictions of the updated groundwater flow model include dewatering requirements as follows:

- Eighteen Star perimeter dewatering wells will be required to operate from Year 5 when necessary power will be available on the site, through Year 17 (end of excavation of the Star pit). These 18 perimeter wells need to continue to operate for dewatering of the Orion South pit through Year 24 (end of mine life);
- Five in-pit dewatering wells need to be installed within the Star pit at lower benches, and be in operation from Year 15 through Year 17, to minimize residual passive inflow when the pit will be excavated within the permeable part of Lower Mannville sandstone unit. These in-pit dewatering wells should be in operation through Year 19 during initial stage of backfilling of Star pit;
- Seven Orion South perimeter wells will be required to operate from Year 19 through Year 24 in addition to 18 Star perimeter dewatering wells;
- Total pumping from the dewatering wells of as much as 98,100m^3/d for the Star and 120,00m^3/d for the Orion South pits. The latter value includes total pumping rate from continuing pumping of Star wells plus up to 38,200m^3/d from additional Orion South dewatering wells;
- RPI of up to 18,700m3/d for the Star and 15,200m3/d for the Orion South, occurring when pit bottom elevations are above the top of the Mannville Group; most of this inflow will occur from the surficial sand at the beginning of the excavations or from the major “push-backs” at the ground surface. RPI from the Mannville Sandstone is predicted to be 3,000 and 2,000 m3/day for the Star and Orion South, respectively, during excavation their deepest parts;

- Power requirements for the Mannvile pumping system to dewater the Star and Orion South pits were estimated to be 909.4 and 125.7 million Kw-hr, respectively, with a total operational cost of CAD$51.8 million;
- A significant drawdown, from 70m to 250m, will be created within the Mannville Group which will cause propagation of an extensive cone of drawdown within the shallow groundwater system, due to increasing vertical recharge through the Colorado Group shale and where the shale was eroded by a paleochannel. The model predicts that the 1m contour of drawdown within the uppermost surficial sand as a result of pit dewatering will propagate to a maximum distance to the west of about 4.1 km and to the east about 4.6 km away from both pits, and would be controlled by Caution and English Creeks. The 1-m drawdown contour will propagate 7.4 km to the north from the center of Orion South pit and will be limited by the Saskatchewan River to the south;
- Pit dewatering will reduce groundwater discharge to the creeks and ravines in the project area. The model predicts that reduction of groundwater discharge into the creeks and ravines might average 53% compared to the pre-mining conditions, and this reduction will occur during the relatively long period of mining and pit lakes infilling;
- Orion South pit lake will be formed after mining ceases. It will take about 315 years to fill in the pit lake by groundwater to the level of 95%. It will take more than 350 years to reach new steady state post-mining conditions. Water level within the pit lake is predicted to be 406 mamsl at steady state post-mining conditions; and
- Formation of Orion South pit lake, hydraulically connecting the shallow and deep groundwater systems, will change water levels within the upper surficial sand during long-term post-mining conditions. The extent of the 1m contour of drawdown within the upper saturated layer of the model will propagate up to 3km to the west, 2km to the east, will be limited English Creek and the Saskatchewan River valleys to the north and south, and will stay there in perpetuity. The model also predicts small but permanent impacts to the creeks and ravines compared to pre-mining conditions as follows:
  - 101 Ravine – about 20m^3/d;
  - Caution Creek – about 10m^3/d; and
  - English Creek – about 250m^3/d.
- Results of completed analyses indicate that predictions of the change to water levels within the shallow groundwater system, and impact to the creeks and, ravines are very sensitive to vertical hydraulic conductivity of shale, till, and silt units and less sensitive to the model boundary conditions used within the Mannville Group. SRK is of the opinion that the Base Case scenario used is conservative, but reasonable, and the sensitivity analysis shows that it is far more likely for this groundwater model to over predict impacts than to under predict them.

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7 References

AMEC, 2010, Star-Orion South Diamond Project Environmental Impact Statement, report submitted to Shore Gold Inc., December.

Clifton Associates Ltd., 2009, *Geotechnical Investigation Star Kimberlite Fort a la Corne*, Saskatchewan: report submitted to Shore Gold Inc., March.

Freyberg, D.L., 1988, *An exercise in ground-water model calibration and prediction: Ground Water*, v, 26, no. 3, pp. 350-360.

Golder Associates, 2006, *Report on baseline surface water monitoring for the Fort a la Corne Joint Venture advanced exploration program 2005*: report submitted to De Beers Canada Inc., May.

Golder Associates, 2008, *Draft report on baseline surface water monitoring for the Fort a la Corne Joint Venture advanced exploration program 2007:* report submitted to Shore Gold Inc., May.

Hydrologic Consultants, Inc., 2005, *Preliminary hydrogeologic evaluation of Fort à la Corne JV project area and predicted ground-water conditions during mining: report* submitted to SRK Consulting, November.

Hydrologic Consultants, Inc., 2006, *Preliminary ground-water flow model for Star kimberlite project and predicted inflow to proposed open pit and associated drawdowns: technical memorandum* submitted to Shore Gold, March 31.

Hydrologic Consultants, Inc., 2007, 2006-2007 *Pre-Feasibility level hydrogeologic investigation of Fort a la Corne JV project area: report* submitted to Shore Gold, Inc. and Newmont Mining Corporation, June.

Hydrogeologic, Inc., 2006, *MODFLOW-SURFACT Software (version 3.0).*

McDonald, M.G. and Harbaugh, A.W., 1988, A modular three-dimensional finite-difference ground-water flow model: U.S. Geological Survey Techniques of Water-Resources Investigations, book 6, chap. A1, 586p.

Schlumberger Water Services, 2010, *Visual MODFLOW Premium (version 2010.1)*.

SRK, 2009a, *Groundwater modeling of possible hydrological impact of dewatering of proposed Star and Orion South pits: report* submitted to Shore Gold, Inc., August.

SRK, 2009b, *Predicted impact on stream flow due to proposed dewatering for the Star-Orion South diamond project: technical memorandum* submitted to Shore Gold, Inc., November, 26.

SRK, 2010a, *Pit Slope Design for the Orion South and Star Kimberlite Deposits: draft report* submitted to Shore Gold, Inc., October.

SRK, 2010b, *Groundwater modeling of possible hydrological impact of dewatering of proposed Star and Orion South pits, 2010 Update: report* submitted to Shore Gold, Inc., November.

Tables

Table 1: Measured Hydraulic Conductivity Values of Upper and Lower Surficial Sands and Silts

Hydro-geological Unit	Well ID	Location		Screen Elevation (mamsl)		Type of test	Hydraulic Conductivity K (m/d)
		Northing	Easting	From	To		
Upper Surficial Sand	Pumping Well	5,900,717	513,594	8.84	11.98	72 hour pump test	346.5
	Observation Well	5,900,725	513,594	8.53	11.58		
	PZ-06-01	5,897,431	514,656	ND	ND	Falling/rising head	9.6
	PZ-06-05 (1)	5,896,989	514,760	ND	ND	Falling/rising head	12.2
	PZ-06-05 (2)	5,896,989	514,760	ND	ND	Falling/rising head	10.1
	PZ-06-06	5,896,926	514,891	ND	ND	Falling/rising head	13.2
	PZ-06-07	5,896,866	514,803	ND	ND	Falling/rising head	18.1
	PZ-06-08	5,896,886	515,098	ND	ND	Falling/rising head	5.3
	PZ-06-09	5,896,820	515,158	ND	ND	Falling/rising head	3.5
	PZ-06-10	5,897,280	514,792	ND	ND	Falling/rising head	26.6
	PZ-06-11	5,897,296	514,897	ND	ND	Falling/rising head	28.5
	PZ-06-12	5,897,038	515,299	ND	ND	Falling/rising head	3.5
	PZ-06-13	5,896,844	514,961	ND	ND	Falling/rising head	26.3
	OVB-10-402U	5,898,909	517,814	5.5	8.5	Slug test	17.3
	OVB-10-404U	5,900,222	517,814	5.4	8.4	Slug test	8.0
	OVB-10-406U	5,900,998	518,026	2.8	5.8	Slug test	0.8
	OVB-10-408U	5,901,807	518,129	5.4	8.4	Slug test	1.1
	Average hydraulic conductivity value						**12.3**
	Geomean value of hydraulic conductivity						**9.4**
	Value of horizontal hydraulic conductivity used in groundwater model						**10.0**
Lower Surficial Sand	OVB-10-402L	5,898,909	517,814	13.5	16.5	Slug test	0.1
	OVB-10-404L	5,900,222	517,814	19.8	22.8	Slug test	0.008
	OVB-10-406L	5,900,998	518,026	24.4	27.4	Slug test	0.3
	OVB-10-408L	5,901,807	518,129	28.1	31.1	Slug test	0.3
	Average hydraulic conductivity value						**0.2**
	Geomean value of hydraulic conductivity						**0.1**
	Value of horizontal hydraulic conductivity used in groundwater model						**0.1**
Surficial Silt	PZ-15 Lower	5,903,213	511,084	32	36	Slug test	**0.12**
	PZ-8-Upwer	5,903,501	513,466	31.7	36.3	Slug test	0.15
	PZ-5-Lower	5,895,809	512,646	22.6	27.1	Slug test	0.009
	141-05-041H	513,477	5,901,002	18	21	Slug test	0.025
	140-05-054H	513,890	5,900,796	30	33	Slug test	0.013
	Average hydraulic conductivity value						**0.06**
	Geomean value of hydraulic conductivity						**0.03**
	Value of horizontal hydraulic conductivity used in groundwater model						**0.05**

Table 2: Measured Hydraulic Conductivity of Till Unit

Well ID	Screen Interval		Hydraulic Conductivity, K (m/d)	Type of Test
	From	To		
140-05-054H	38	44	0.0077	FHT
141-05-041H	41	50	0.041	FHT
140-05-055H	53	61	0.0029	ART
150-05-014H	72	80	*0.000064*	PIT
140-05-055H	78	88	0.72	ART
150-05-014H	80	90	0.000064	PIT
140-05-055H	88	97	*0.000064*	PIT
140-05-055H	90	93	0.000034	FHT
150-05-014H	90	96	0.013	ART
150-05-014H	96	104	0.019	PIT
140-05-055H	97	106	0.0001	PIT
150-05-014H	104	114	0.00022	PIT
PZ-14	67	71.6	0.0012	FHT
PZ-14a	102.11	111	0.017	FHT
PZ8-Lower	40.8	59.1	0.15	FHT
PZ4-Upper	59.7	69.7	1.5	FHT
PZ4-Lower	88.4	97.8	0.00009	FHT
SHP-08-008C	41.2	55.5	0.016	PIT
SHP-08-008C	53.2	79.5	0.007	PIT
SHP-08-004C	54.5	81	0.13	PIT
PW-3	38.4	108.5	0.03	3 days Pump Test
PW-1	29.6	97.5	0.35	3 days Pump Test

Notes:

PIT - Packer injecting test

FHT - Falling head test

ART - Airlift test

Italicized values are assumed based on no measured take reading

Table 3: Measured Hydraulic Conductivity of Colorado Group Shale

Test Hole	Tested Interval		Method of Testing	Estimated Hydraulic Conductivity K, m/d	Location	Hydraulic Conductivity K, m/d used for averaging
	from	to				
150-05-014H	114	123	PIT	NMT	Outside of Kimberlite	*0.000044*
	123	144	PIT	0.000044		0.000044
	129	132	FHT	0.00038		0.00038
	144	165	PIT	NMT		*0.000044*
SHP-08-006C	93.7	120	PIT	0.00079	Crossing kimberlite fingers	0.00079
	119.2	145.5	PIT	0.015		0.015
SHP-08-004C	102.7	130.5	PIT	0.0056		0.0056
Average Hydraulic Conductivity of Colorado Group Shale K, m/d						**0.0031**
Geomean of K of Colorado Group Shale, m/d						**0.0004**

Notes:

PIT - Packer injecting test

FHT - Falling head test

NMT - No measurable take

Assumed values of K are italicized

Table 4: Measured Hydraulic Conductivity of Mannville Formation

Well ID	Screen Interval (m)		Hydraulic Conductivity, K (m/d)	Type of Test
	From	To		
PW-2	187.7	344.2	1.68	7 Day Pump Test
PW-4	189	372	1.48	7 Day Pump Test
150-05-014H	165	207	0.004	ART
150-05-014H	221	245	0.0048	FHT
150-05-014H	228	249	0.08	ART
SHP-08-004C	172.70	198.0	0.0001	PIT
SHP-08-004C	197.20	223.5	0.0008	PIT
SHP-08-004C	224.20	250.5	0.002	PIT
SHP-08-006C	200.00	225.0	0.0001	PIT
SHP-08-008C	164.20	187.5	0.0005	PIT
SHP-08-008C	197.20	220.5	0.001	PIT

Notes: 0.010366667

PIT - Packer injecting test 0.001321458

FHT - Falling head test

ART - Airlift test

Table 5: Measured Water Levels in Shallow Piezometers Used for Model Calibration

Location	Well ID	Coordinates		Elevation of Pipe (mamsl)	Screen Elevation (mamsl)			Hydrogeological Unit in Numerical Model	Measured Water Level used for Model Calibration (mamsl)
		Easting	Northing		From	To	Type		
140/141 Kimberlite	140-05-054H	513,901	5,900,806	444.2	407	401	SP	Upper Till	421.8
					415	412	SP	Lower Surficial Sand	438.3
					423	418	SP	Lower Surficial Sand	438.5
	140-05-055H	513,409	5,900,613	445.0	355	352	SP	Lower Till	388.9
147 Site	PZ-8	513,466	5,903,501	449.7	409	391	SP	Upper Till	438.0
					418	413	SP	Lower Surficial Sand	441.5
East Ravine Road	OVB-10-302R	515,473	5,898,818	439.4	424		GI TXD	Upper Surficial Sand	423.9
					412		GI TXD	Lower Surficial Silt/Clay	419.1
					405		GI TXD	Lower Surficial Silt/Clay	423.4
	OVB-10-304R	515,476	5,899,898	434.0	426		GI TXD	Upper Surficial Sand	426.0
					411		GI TXD	Lower Surficial Silt/Clay	422.9
					404		GI TXD	Lower Surficial Silt/Clay	418.8
Former Debeers Camp Site	FAC-05-002W	511,429	5,903,118	451.2	446	443	SP	Upper Surficial Sand	448.6
	FAC-05-003W	511,396	5,902,863	451.7	448	445	SP	Upper Surficial Sand	448.7
	FAC-05-004W	511,537	5,902,887	450.3	446	443	SP	Upper Surficial Sand	448.5
Lars Road	OVB-10-205P	510,147	5,897,689	442.3	429	426	SP	Upper Surficial Sand	437.7
	OVB-10-205R	510,144	5,897,687	442.38	410		GI TXD	Lower Surficial Silt/Clay	420.9
					369		GI TXD	Lower Till	404.8
					335		GI TXD	Lower Till	387.1
					324		GI TXD	Colorado Group Shale	388.1
Lars Road	OVB-10-205U	510,151	5,897,689	442.4	440	438	SP	Upper Surficial Sand	438.3
	OVB-10-207R	510,638	5,898,578	445.8	409		GI TXD	Lower Surficial Clay	425.8
					373		GI TXD	Lower Till	395.0
					332		GI TXD	Lower Till	387.7
					327		GI TXD	Colorado Group Shale	388.7
Melfort Ferry Road	OVB-10-402P	517,799	5,898,909	423.0	409	406	SP	Lower Surficial Silt/Clay	418.0
	OVB-10-402U	517,795	5,898,908	423.2	418	415	SP	Upper Surficial Sand	417.6
	OVB-10-404P	517,802	5,900,216	432.7	413	410	SP	Lower Surficial Silt/Clay	425.7
	OVB-10-404U	517,797	5,900,218	432.7	427	424	SP	Upper Surficial Sand	430.2
	OVB-10-406P	518,010	5,901,000	439.2	415	412	SP	Upper Surficial Sand	433.5
	OVB-10-406U	518,009	5,900,994	439.2	436	433	SP	Upper Surficial Sand	433.7
	OVB-10-408P	518,103	5,901,795	439.7	412	409	SP	Lower Surficial Silt/Clay	435.5
	OVB-10-408U	518,112	5,901,804	439.7	434	431	SP	Upper Surficial Sand	436.7
Orion North Pump Test Site	PW-3	511,102	5,903,204	450.1	415	342	PW	Till	435.6
	PW-12	511,120	5,903,196	450.2	411		GI TXD	Upper Surficial Sand	437.2
					384		GI TXD	Upper Till	435.1
					358		GI TXD	Lower Till	433.5
	PZ-14	511,138	5,903,188	450.4	383	379	SP	Upper Till	436.2
	PZ-14A	511,147	5,903,184	450.4	349	339	SP	Lower Till	433.6
	PZ-15	511,084	5,903,213	450.2	418	414	SP	Upper Surficial Silt/Clay	440.3
					445	441	SP	Upper Surficial Sand	448.5
Orion South Perimeter	140-05-056H	513,858	5,901,017	444.1	439	436	SP	Upper Surficial Sand	440.3
	140-10-080C	513,551	5,899,935	441.2	408		GI TXD	Lower Surficial Silt/Clay	429.3
					366		GI TXD	Upper Till	401.4
					337		GI TXD	Lower Till	385.5
					326		GI TXD	Colorado Group Shale	386.1
	140-10-085C	514,181	5,900,589	448.7	403		GI TXD	Lower Surficial Clay	419.4
					365		GI TXD	Upper Till	394.7
					336		GI TXD	Lower Till	386.3
					328		GI TXD	Kimberlite	385.5
	140-10-80P	513,551	5,899,948	441.0	360	357	SP	Lower Till	388.1
	140-10-81P	513,115	5,900,229	441.9	421	418	SP	Lower Surficial Sand	438.1
	140-10-81U	513,118	5,900,223	441.9	435	432	SP	Upper Surficial Sand	438.8
	140-10-84P	514,115	5,900,999	448.8	421	418	SP	Lower Surficial Sand	437.3

Table 5: Measured Water Levels in Shallow Piezometers Used for Model Calibration

Location	Well ID	Coordinates		Elevation of Pipe (mamsl)	Screen Elevation (mamsl)			Hydrogeological Unit in Numerical Model	Measured Water Level used for Model Calibration (mamsl)
		Easting	Northing		From	To	Type		
Orion South Perimeter	140-10-84U	514,113	5,900,994	449.1	436	433	SP	Upper Surficial Sand	438.9
	140-10-86P	514,053	5,900,190	442.9	418	415	SP	Lower Surficial Sand	435.1
	140-10-86U	514,058	5,900,199	442.9	432	429	SP	Upper Surficial Sand	437.0
	141-05-041H-1	513,445	5,901,223	447.3	421	415	SP	Lower Surficial Sand	439.7
					429	426	SP	Upper Surficial Silt/Clay	440.4
	141-10-094C	512,734	5,900,593	447.1	408		GI TXD	Lower Surficial Silt/Clay	425.2
	141-10-094C	512,734	5,900,593	447.1	363		GI TXD	Upper Till	387.8
					340		GI TXD	Lower Till	388.5
					329		GI TXD	Colorado Group Shale	400.1
	141-10-096C	513,585	5,901,410	444.2	409		GI TXD	Lower Surficial Silt/Clay	429.4
					375		GI TXD	Upper Till	411.0
					335		GI TXD	Lower Till	391.5
					328		GI TXD	Kimberlite	389.7
	141-10-95P	512,673	5,901,110	446.7	420	417	SP	Lower Surficial Sand	440.3
	141-10-95U	512,673	5,901,110	446.7	437	434	SP	Upper Surficial Sand	440.4
	OVB-10-201R	509,250	5,896,020	440.5	412		GI TXD	Lower Surficial Silt/Clay	423.0
					373		GI TXD	Lower Till	409.0
					322		GI TXD	Colorado Group Shale	398.8
					315		GI TXD	Colorado Group Shale	396.6
Star Site	SHP-08-007C	514,454	5,896,600	420.7	387		GI TXD	Upper Till	406.6
					369		GI TXD	Lower Till	388.6
	SHP-08-009C	514,242	5,897,851	436.2	396		GI TXD	Upper Till	418.0
					346		GI TXD	Lower Till	368.9
	SHP-08-010C	515,693	5,896,298	412.1	382		GI TXD	Upper Till	400.2
					369		GI TXD	Upper Till	399.4
					335		GI TXD	Lower Till	377.4
					297		GI TXD	Colorado Group Shale	379.3
Star Site (2007)	PZ-06-01	514,640	5,897,421	424.1	420		GI TXD	Upper Surficial Sand	419.5
	PZ-06-05	514,730	5,896,998	421.1	416		GI TXD	Upper Surficial Sand	418.2
	PZ-06-06	514,874	5,896,921	423.3	414		GI TXD	Upper Surficial Sand	417.4
Star Site (2007)	PZ-06-07	514,787	5,896,861	421.1	416		GI TXD	Upper Surficial Sand	416.8
	PZ-06-08	515,080	5,896,877	421.1	417		GI TXD	Upper Surficial Sand	417.0
	PZ-06-09	515,136	5,896,813	420.8	417		GI TXD	Upper Surficial Sand	416.6
	PZ-06-11	514,880	5,897,295	422.3	417		GI TXD	Upper Surficial Sand	418.2
	PZ-06-12	515,281	5,897,030	420.8	417		GI TXD	Upper Surficial Sand	415.5
	PZ-06-13	514,942	5,896,836	420.9	415		GI TXD	Upper Surficial Sand	416.8
Star West Pump Test Site	PW-1	512,628	5,895,793	431.3	402	334	PW	Till	398.6
	PZ-2	512,663	5,895,824	431.3	392		GI TXD	Upper Till	403.7
					371		GI TXD	Lower Till	401.9
					338		GI TXD	Lower Till	399.0
	PZ-4	512,672	5,895,832	430.9	343	333	SP	Lower Till	385.4
					371	362	SP	Lower Till	399.0
	PZ-5	512,646	5,895,809	431.3	409	404	SP	Lower Surficial Silt/Clay	405.0
Paleo-Channel	PC-11-004	512,206	5,906,293	452.2	448.2	445.2	SP	Upper Surficial Sand	450.1
	PC-11-005	512,207	5,906,289	452.2	427.8	424.8	SP	Lower Surficial Sand	450.2

Notes: SP - Standpipe Piezometer
GI TXD - Grouted-In Transducers
PW - Pumping Well

Table 6: Measured Water Levels in Deep Piezometers Used for Model Calibration

Location	Well ID	Coordinates		Elevation of Pipe (mamsl)	Screen Elevation (mamsl)			Hydrogeological Unit in Numerical Model	Measured Water Level used for Model Calibration (mamsl)
		Easting	Northing		From	To	Type		
140/141 Kimberlite	140-05-055H	513,409	5,900,613	445.1	233	209	SP	Kimberlite	399.1
	150-05-014H	510,914	5,901,754	456.1	235	211	SP	Upper Mannville	406.7
					327	324	SP	Colorado Group Shale	405.2
147 site	PZ-7	513,474	5,903,494	450.0	202		GI TDX	Upper Mannville	405.2
					170		GI TDX	Lower Mannville	402.3
					150		GI TDX	Lower Mannville	407.3
					112		GI TDX	Souris River	403.8
Orion North Pump Test Site	PW-4	511,089	5,903,209	449.9	261	78	PW	Mannville	409.7
	PZ-11	511,111	5,903,200	450.1	325		GI TDX	Colorado Group Shale	380.8
					280		GI TDX	Colorado Group Shale	396.3
					194		GI TDX	Upper Mannville	400.9
					170		GI TDX	Upper Mannville	406.2
					143		GI TDX	Lower Mannville	404.2
					102		GI TDX	Souris River	404.7
	PZ-13	511,129	5,903,192	450.7	152	142	SP	Lower Mannville	410.3
					194	189	SP	Upper Mannville	410.9
Orion South	SRK-GT10-03	513,102	5,900,714	445.1	298	349	SP	Kimberlite	402.8
	SRK-GT10-09	513,579	5,899,551	442.9	172		GI TDX	Upper Mannville	389.8*
					239		GI TDX	Upper Mannville	385.7*
					278		GI TDX	Colorado Group Shale	387.8*
					298		GI TDX	Colorado Group Shale	387.1*
	140-10-089RC	513,532	5,899,575	442.0	154	252	PW	Mannville	ND
Star Site	SHP-08-006C	514,455	5,896,611	420.7	233	180	SP	Kimberlite	391.0
					303	274	SP	Colorado Group Shale	398.2
	SHP-08-007C	514,454	5,896,600	420.7	327		GI TDX	Colorado Group Shale	378.4
					300		GI TDX	Colorado Group Shale	385.9
	SHP-08-008C	514,247	5,897,861	436.2	234	174	SP	Upper Mannville	409.6
					307	276	SP	Kimberlite	414.4
	SHP-08-009C	514,242	5,897,851	436.2	306		GI TDX	Kimberlite/Colorado Group Shale	369.1
					286		GI TDX	Kimberlite/Colorado Group Shale	375.5
Star West Pump Test Site	PW-2	512,621	5,895,786	431.3	244	43	PW	Mannville	397.2
Star West Pump Test Site	PZ-1	512655	5895817	431.3	302		GI TDX	Colorado Group Shale In vicinity of Star Kimberlite	390.1
					272		GI TDX	Colorado Group Shale In vicinity of Star Kimberlite	388.3
					230		GI TDX	Upper Mannville	391.3
					170		GI TDX	Upper Mannville	391.1
					117		GI TDX	Lower Mannville	394.2
					67		GI TDX	Souris River	392.1
	PZ-3	512637	5895801	431.9	124	115	SP	Lower Mannville	396.8
					179	174	SP	Upper Mannville	397.1
South to Saskatchewan River	GT-10-001c	516743.8	5894774.3	404.0	124	184	SP	Mannville	395.4

Notes:
SP - Standpipe Piezometer
GI TXD - Grouted-In Transducers
PW - Pumping Well
* - Questionable data; do not use for steady state model calibration

Table 7: Hydraulic Properties of Hydrogeologic Units Used in Model

Hydrogeologic Unit	Horizontal Hydraulic Conductivity K_h (m/day)	Vertical Hydraulic Conductivity K_v (m/day)	Anisotropy Ratio	Specific Storage S_s (m^{-1})	Specific Yield S_y ( )	Comments
Upper Surficial Sand	10	10	1	1.E-06	0.2	K_h values are based on results of slug tests in piezometers constructed in 2005-2010 (Table 1)
Upper Surficial Silt/Clay	0.05	0.0005	100	1.E-04	0.15	
Lower Surficial Sand	0.1	0.01	10	1.E-04	0.15	
Lower Surficial Silt/Clay	0.03	0.0001	300	1.E-04	0.15	
Uppermost Till within Saskatchewan River Valley	0.1	0.001	100	1.E-04	0.1	Assumed based on model calibration to pre-mining water levels
Upper Till	0.03	0.0001	300	1.E-04	0.1	K_h is based on data from 2 pump tests, airlift, packer injecting, and falling head tests (Table 2 and Figure 2a) and results of model calibration to pre-mining water levels (Figure 13)
Lower Till	0.018	0.00006	300	1.E-04	0.1	
Colorado Group Shale	0.0004	0.00006	7	1.E-05	0.01	K_h is based on packer injecting tests in testholes at Orion South and Star completed in 2005 and 2008, respectively (Table 3 and Figure 2b) and results of model calibration to pre-mining water levels (Figure 13)
Sandstone (Upper part of Mannville Fm)	0.01	0.00033	30	3.E-06	0.02	Hydraulic conductivity values and storage parameters are based on results of 20-day pumping test from prototype dewatering well (Table 9, Figures 7 and 16)
Sandstone (Lower part of Mannville Fm)	3	0.1	30	3.E-06	0.02	
Uppermost Limestone (Souris River Fm)	0.01	0.001	10	1.E-06	0.01	K_h=0.01 m/day is based on data from PW4 pump test
Limestone (Souris River Fm)	0.001	0.0001	10	1.E-06	0.005	K values are assumed to be low
Till within Paleochannel	0.018	0.00006	300	1.E-05	0.1	K values are calibrated to simulate water table near the ground surface
Paleochannel (lower part)	0.1	0.001	100	1.E-05	0.1	Assumed based on geological data and model calibration
Kimberlite	0.0002	0.0002	1	1.E-06	0.01	K is based on hydraulic testing in borehole 140-05-055H (Orion South) in 2005
Back Fill in Star Pit	0.01	0.01	1	5.E-06	0.03	Assumed parameter

Note: K_v are obtained as from calibration of model to pre-mining water levels

Table 8: Simulated Groundwater Budget for Pre-Mining Steady State Conditions

Budget Component		Simulated Flow		Measured Stream Base Flow	
		Inflow (m^3/d)	Outflow (m^3/d)	2009 (m^3/d)	2010 (m^3/d)
Recharge		45,800	-		
Groundwater Discharge to River and Creeks	Saskatchewan River	-	3,400	ND	ND
	Stream A- Caution Creek	-	2,230	27,821	10,700
	Stream B- 101 Ravine	-	1,180	4,579	518
	Stream C- East Ravine	-	600	7,862	2,851
	Stream D - English Creek	-	5,700	15,034	4,147
	Stream E – West Ravine	-	150	778	778
	Creeks within Northeastern Zone	-	1,270	ND	ND
	Small Creeks Between Zone C and D	-	1,240	ND	ND
	Small Creeks Between Zone A and B	-	260	ND	ND
	Creeks within Eastern Zone	-	2,470	ND	ND
	Creeks within Western Zone	-	1,300	ND	ND
	Stream F - South from Saskatchewan River	-	570	ND	ND
	Stream G - Southwest from Saskatchewan River	-	1,610	ND	ND
	All other Creeks in Model Domain	-	10,940	ND	ND
Total River and Creeks		0	32,920		
Outer Model Boundaries	Northern	1,310	0		
	Southern	0	7,650		
	Western	0	2,580		
	Easttern	0	3,940		
	PaleoChanel Western	0	10		
	PaleoChanel Eastern	0	10		
Total Outer Model Boundaries		1,310	14,190		
Grand Total		**47,110**	**47,110**		

Note: Components of groundwater budget are rounded

Table 9: Maximum Drawdown Measured during 20-day Pumping Test

Location	Well ID	Coordinates		Elevation of Pipe (mamsl)	Screen Elevation (mamsl)			Hydrogeological Unit in Numerical Model	Measured Water Level used for Model Calibration (mamsl)	Distance from Pumping Well (m)	Maximum Drawdown (m)
		Easting	Northing		From	To	Type				
140/141 Kimberlite	140-05-055H	513,409	5,900,613	445.1	233	209	SP	Kimberlite	399.1	1,046	3.33
	150-05-014H	510,914	5,901,754	456.1	235	211	SP	Upper Mannville	406.7	3,406	1.16
					327	324	SP	Colorado Group Shale	405.2	3,406	No Drawdown
Orion North Pump Test Site	PW-4	511,089	5,903,209	449.9	261	78	PW	Mannville	409.7	4,379	1.34
	PZ-13	511,129	5,903,192	450.7	152	142	SP	Lower Mannville	410.3	4,343	1.61
					194	189	SP	Upper Mannville	410.9	4,343	1.21
Orion South	SRK-GT10-03	513,102	5,900,714	445.1	298	349	SP	Kimberlite	402.8	1,217	4.51
	SRK-GT10-09	513,579	5,899,551	442.9	172		GI TDX	Upper Mannville	389.8*	53	13.41
					239		GI TDX	Upper Mannville	385.7*	53	4.46
					278		GI TDX	Colorado Group Shale	387.8*	53	0.21 ?
					298		GI TDX	Colorado Group Shale	387.1*	53	0.17 ?
	140-10-089RC	513,532	5,899,575	442.0	154	252	PW	Mannville	397.8	0	49.14
Star Site	SHP-08-006C	514,455	5,896,611	420.7	233	180	SP	Kimberlite	391.0	3,104	No Drawdown
					303	274	SP	Colorado Group Shale	398.2	3,104	0.73
	SHP-08-008C	514,247	5,897,861	436.2	234	174	SP	Upper Mannville	409.6	1,857	0.52
					307	276	SP	Colorado Group Shale	414.4	1,857	No Drawdown
Star West Pump Test Site	PZ-3	512637	5895801	431.9	124	115	SP	Lower Mannville	396.8	3,878	2.33
					179	174	SP	Upper Mannville	397.1	3,878	1.46
South to Saskatchewan River	GT-10-001c	516743.8	5894774.3	404.0	124	184	SP	Mannville	395.4	5,776	0.69

Notes:
SP - Standpipe Piezometer
GI TXD - Grouted-In Transducers
PW - Pumping Well
* - Questionable data; did not use for steady state model calibration

Table 10: Predicted Dewatering Requirements

Year	Star Pit							Orion South Pit						
	Pumping Rate from Dewatering Wells (m^3/day)		Inflow to Pit (m^3/day)					Pumping Rate from Dewatering Wells (m^3/day)		Inflow to Pit (m^3/day)				Total Dewatering Requirements
	Perimeter	In-Pit	Passive Inflow	Residual Passive Inflow			Total Dewatering Requirements	Perimeter	In-Pit	Passive Inflow	Residual Passive Inflow			
				Total	from above Mannville	from Mannville					Total	from above Mannville	from Mannville	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	6,022	6,022	6,022	0	6,022	0	0	0	0	0	0	0
2	0	0	7,539	7,539	7,539	0	7,539	0	0	0	0	0	0	0
3	0	0	7,759	7,759	7,759	0	7,759	0	0	0	0	0	0	0
4	0	0	10,979	10,979	10,979	0	10,979	0	0	0	0	0	0	0
5	98,118	0	6,987	6,835	6,835	0	104,953	0	0	0	0	0	0	0
6	98,118	0	6,454	5,851	5,851	0	103,969	0	0	0	0	0	0	0
7	98,118	0	6,000	4,940	4,794	147	103,058	0	0	0	0	0	0	0
8	98,118	0	12,702	11,426	11,379	47	109,544	0	0	0	0	0	0	0
9	98,118	0	11,988	10,207	10,034	173	108,325	0	0	0	0	0	0	0
10	98,118	0	10,943	8,846	8,797	49	106,964	0	0	3,357	3,357	3,357	0	3,357
11	98,118	0	12,742	10,091	10,037	55	108,209	0	0	6,384	6,384	6,384	0	6,384
12	98,118	0	12,577	8,724	8,595	128	106,842	0	0	5,951	5,951	5,951	0	5,951
13	98,118	0	9,642	5,437	5,426	11	103,555	0	0	6,180	6,180	6,180	0	6,180
14	98,118	0	10,524	6,148	6,147	1	104,266	0	0	7,358	7,358	7,358	0	7,358
15	98,118	17,723	62,764	5,203	5,200	3	121,044	0	0	5,422	5,422	5,422	0	5,422
16	93,363	7,587	70,535	7,406	4,440	2,966	108,355	0	0	4,870	4,870	4,870	0	4,870
17	91,239	6,882	78,624	18,738	15,828	2,910	116,859	0	0	4,129	4,129	4,129	0	4,129
18	83,632	11,783	0	0	0	0	95,416	0	0	9,589	9,592	9,592	0	9,592
19	81,830	10,829	0	0	0	0	92,659	38,158	0	12,824	12,778	12,778	0	50,935
20	81,942	0	0	0	0	0	81,942	34,444	0	12,190	12,103	12,029	74	46,547
21	81,923	0	0	0	0	0	81,923	32,512	0	9,008	9,030	9,029	1	41,542
22	80,537	0	0	0	0	0	80,537	31,474	0	10,134	10,173	10,167	6	41,648
23	79,341	0	0	0	0	0	79,341	30,663	0	8,523	8,244	8,244	0	38,907
24	78,060	0	0	0	0	0	78,060	29,284	0	17,721	8,223	6,184	2,039	37,507

Note: Yearly average values are shown

Table 11: Simulated Groundwater Budget for End of Mining Conditions

Budget Component		Pre-Mining		End of Star Mining		End of Orion South Mining		End of Star Mining		End of Orion South Mining	
		Flow		Flow		Flow		Change in Flow		Change in Flow[1)]	
		Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	IN (m^3/d)	OUT (m^3/d)	IN (m^3/d)	OUT (m^3/d)
Recharge		**45,800**		**46,450**		**46,960**		**-650**		**-1,160**	
Groundwater Discharge to River and Creeks	Saskatchewan River		3,400		1,480		1,030		1,920		2,370
	Stream A- Caution Creek		2,230		1,500		1,090		730		1,140
	Stream B- 101 Ravine		1,180		970		830		210		350
	Stream C- East Ravine		600		120		40		480		560
	Stream D - English Creek		5,700		4,770		4,150		930		1,550
	Stream E – West Ravine		150		0		0		150		150
	Creeks within Northeastern Zone		1,270		1,070		940		200		330
	Small Creeks Between Zone C and D		1,240		960		770		280		470
	Small Creeks Between Zone A and B		260		80		80		180		180
	Creeks within Eastern Zone		2,470		1,960		1,650		510		820
	Creeks within Western Zone		1,300		1,140		1,000		160		300
	Stream F - South from Saskatchewan River		570		460		350		110		220
	Stream G - Southwest from Saskatchewan River		1,610		1,480		1,330		130		280
	All other Creeks in Model Domain		10,940		8,860		7,400		2,080		3,540
Total River and Creeks			**32,920**		**24,850**		**20,660**		**8,070**		**12,260**
Outer Model Boundaries	Northern	1,310	0	4,250	0	4,790	0	-2,940	0	-3,480	0
	Southern	0	7,650	1,190	50	1,830	0	-1,190	7,600	-1,830	7,650
	Western	0	2,580	3,690	0	4,630	0	-3,690	2,580	-4,630	2,580
	Eastern	0	3,940	8,410	0	9,430	0	-8,410	3,940	-9,430	3,940
	Eastern Part of Paleochannel	0	10	20	0	30	0	-20	10	-30	10
	Western Part of Paleochannel	0	10	0	0	10	0	0	10	-10	10
Total Outer Model Boundaries		**1,310**	**14,190**	**17,560**	**50**	**20,720**	**0**	**-16,250**	**14,140**	**-19,410**	**14,190**
Groundwater Storage				65,910		64,420					
Dewatering	Star Pit RPI				5,560		0				
	Orion South Pit RPI				2,290		5,140				
	Pumping Rate from Star Dewatering Wells				97,170		77,470				
	Pumping Rate from Orion South Dewatering Wells				0		28,830				
Total Dewatering Rate					**105,020**		**111,440**				
Grand Total		**47,110**	**47,110**	**129,920**	**129,920**	**132,100**	**132,100**				

Table 12: Calculation of Power Costs for Dewatering of Star and Orion South Pits

Year	Pit Elevation (mamsl)		Residual Passive Inflow (RPI) (m^3/day)			Pumping Rate from Mannville Dewatering Wells (m^3/day)				TDH for RPI (m)		TDH for Dewatering Wells (m)			Power (Kw-hr)		Total Cost (CAD$)
	Star	Orion South	Star	Orion South	Total	Star Perimeter Wells	Star In-Pit Wells	Orion South	Total	Star	Orion South	Star Perimeter Wells	Star In-Pit Wells	Orion South	Star	Orion South	
0	430		0		0	0			0								
1	400		6,022		6,022	0			0	60					497,261		$24,863
2	385		7,539		7,539	0			0	75					778,145		$38,907
3	370		7,759		7,759	0			0	90					961,087		$48,054
4	310		10,979		10,979	0			0	150					2,266,544		$113,327
5	295		6,835		6,835	98,118			98,118	165		263			37,022,335		$1,851,117
6	265		5,851		5,851	98,118			98,118	195		286			40,182,067		$2,009,103
7	205		4,940		4,940	98,118			98,118	255		300			42,243,199		$2,112,160
8	205		11,426		11,426	98,118			98,118	255		309			45,753,855		$2,287,693
9	190	450	10,207		10,207	98,118			98,118	270	30	315			46,336,296		$2,316,815
10	190	428	8,846	3,357	12,203	98,118			98,118	270	52	320			46,454,566	240,255	$2,334,741
11	190	416	10,091	6,384	16,476	98,118			98,118	270	64	324			47,450,606	562,309	$2,400,646
12	175	405	8,724	5,951	14,675	98,118			98,118	285	75	327			47,615,616	614,276	$2,411,495
13	175	385	5,437	6,180	11,617	98,118			98,118	285	95	331			46,789,841	807,981	$2,379,891
14	175	350	6,148	7,358	13,506	98,118			98,118	285	130	334			47,517,174	1,316,353	$2,441,676
15	145	325	5,203	5,422	10,625	98,118	17,723		115,841	315	155	353	373		59,050,915	1,156,500	$3,010,371
16	100	300	7,406	4,870	12,275	93,363	7,587		100,949	360	180	353	373		52,974,105	1,206,342	$2,709,022
17	100	265	18,738	4,129	22,866	91,239	6,882		98,121	360	215	354	373		57,247,821	1,221,580	$2,923,470
18		265		9,592	9,592	83,632	11,783		95,416		215	354	373		46,805,949	2,838,250	$2,482,210
19		250		12,778	12,778	81,830	10,829	38,158	130,816		230	355	373	338	45,533,361	21,773,819	$3,365,359
20		190		12,103	12,103	81,942		34,444	116,386		290	354		340	39,908,951	20,926,138	$3,041,754
21		190		9,030	9,030	81,923		32,512	114,435		290	354		341	39,916,772	18,840,301	$2,937,854
22		190		10,173	10,173	80,537		31,474	112,011		290	354		341	39,266,520	18,838,878	$2,905,270
23		190		8,244	8,244	79,341		30,663	110,004		290	354		342	38,706,435	17,710,039	$2,820,824
24		145		8,223	8,223	78,058		29,284	107,343		335	355		343	38,102,306	17,614,407	$2,785,836
AVERAGE			**8,362**	**7,586**	**10,664**	**91,558**	**10,961**	**32,756**	**104,125**	**TOTAL**					**909,381,727**	**125,667,429**	**$51,752,458**

Assumptions:

1) Cost, CAD$/Kw-hr = 0.05

2) Freeboard elevation in dewatering wells is 30 m above bottom of Mannville Group

3) Additional well loses are 20 m of head

4) Additional pipe pressure loses are 30 m of head

5) Pump efficiency is 85%

6) Motor efficiency is 85%

Table 13 - Maximum Impact to Rivers and Creeks During Mining and Post-Mining Conditions

Stream	Measured Monthly Low Flow				Simulated Pre-Mining Groundwater Discharge	Maximum Impact to Stream			
	2005	2007	2009	2010			Percent of Pre-Mining Groundwater Discharge	Years after Mining Began	Years after Mining Ceased
	(m^3/d)	(m^3/d)	(m^3/d)	(m^3/d)	(m^3/d)	(m^3/d)			
Saskatchewan River	ND	ND	ND	ND	3,400	2,410	71%	26	2
Stream A- Caution Creek	16,502	15,379	27,821	10,700	2,230	1,430	64%	34	10
Stream B- 101 Ravine	4,320	1,814	4,579	518	1,180	590	50%	45	21
Stream C- East Ravine	4,406	4,925	7,862	2,851	600	Will Be destroyed by Star pit excavation			
Stream D - English Creek	9,072	7,430	15,034	4,147	5,700	2,360	41%	48	24
Stream E – West Ravine	ND	ND	778	778	150	Will Be destroyed by Star pit excavation			
Creeks within Northeastern Zone	ND	ND	ND	ND	1,270	530	42%	54	30
Small Creeks Between Zone C and D	ND	ND	ND	ND	1,240	740	60%	47	23
Small Creeks Between Zone A and B	ND	ND	ND	ND	260	250	96%	57	33
Creeks within Eastern Zone	ND	ND	ND	ND	2,470	1,100	45%	46	22
Creeks within Western Zone	ND	ND	ND	ND	1,300	490	38%	39	15
Stream F - South from Saskatchewan River	ND	ND	ND	ND	570	360	63%	41	17
Stream G - Southwest from Saskatchewan River	ND	ND	ND	ND	1,610	570	35%	49	25
All other Creeks in Model Domain	ND	ND	ND	ND	10,940	5,060	46%	40	16

ND : Not Determined

Table 14: Results of Sensitivity Analysis - Simulated Groundwater Budget for End of Mining Conditions for Scenario 1

Budget Component		Pre-Mining Flow		End of Star Mining Flow		End of Orion South Mining Flow		End of Star Mining Change in Flow		End of Orion South Mining Change in Flow	
		Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	IN (m^3/d)	OUT (m^3/d)	IN (m^3/d)	OUT (m^3/d)
Recharge		**46,700**		**47,890**		**48,120**		**-1,190**		**-1,420**	
Groundwater Discharge to River and Creeks	Saskatchewan River		5,080		920		0		4,160		5,080
	Stream A- Caution Creek		1,910		310		70		1,600		1,840
	Stream B- 101 Ravine		1,030		300		70		730		960
	Stream C- East Ravine		630		40		0		590		630
	Stream D - English Creek		5,540		3,350		2,230		2,190		3,310
	Stream E – West Ravine		140		0		0		140		140
	Creeks within Northeastern Zone		1,110		810		590		300		520
	Small Creeks Between Zone C and D		1,210		400		170		810		1,040
	Small Creeks Between Zone A and B		230		0		0		230		230
	Creeks within Eastern Zone		2,340		1,250		830		1,090		1,510
	Creeks within Western Zone		1,080		660		430		420		650
	Stream F - South from Saskatchewan River		170		30		10		140		160
	Stream G - Southwest from Saskatchewan River		640		250		140		390		500
	All other Creeks in Model Domain		7,560		2,790		1,470		4,770		6,090
Total River and Creeks			**28,670**		**11,110**		**6,010**		**17,560**		**22,660**
Outer Model Boundaries	Northern	730	0	2,530	0	3,090	0	-1,800	0	-2,360	0
	Southern	0	9,250	0	2,860	0	2,200	0	6,390	0	7,050
	Western	0	3,750	700	220	1,470	80	-700	3,530	-1,470	3,670
	Eastern	0	5,720	3,380	0	4,390	0	-3,380	5,720	-4,390	5,720
	Eastern Part of Paleochannel	0	20	0	0	0	0	0	20	0	20
	Western Part of Paleochannel	0	20	0	10	0	10	0	10	0	10
Total Outer Model Boundaries		**730**	**18,760**	**6,610**	**3,090**	**8,950**	**2,290**	**-5,880**	**15,670**	**-8,220**	**16,470**
Groundwater Storage				89,550		89,240					
Dewatering	Star Pit RPI				4,980		0				
	Orion South Pit RPI				1,770		5,300				
	Pumping Rate from Star Dewatering Wells				123,100		96,480				
	Pumping Rate from Orion South Dewatering Wells				0		36,230				
Total Dewatering Rate					**129,850**		**138,010**				
Grand Total		**47,430**	**47,430**	**144,050**	**144,050**	**146,310**	**146,310**				

Table 15: Results of Sensitivity Analysis - Simulated Groundwater Budget for End of Mining Conditions for Scenario 2

Budget Component		Pre-Mining		End of Star Mining		End of Orion South Mining		End of Star Mining		End of Orion South Mining	
		Flow		Flow		Flow		Change in Flow		Change in Flow	
		Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	IN (m^3/d)	OUT (m^3/d)	IN (m^3/d)	OUT (m^3/d)
Recharge		**44,950**		**45,150**		**45,270**		**-200**		**-320**	
Groundwater Discharge to River and Creeks	Saskatchewan River		2,530		2,060		1,860		470		670
	Stream A- Caution Creek		2,590		2,500		2,370		90		220
	Stream B- 101 Ravine		1,330		1,300		1,270		30		60
	Stream C- East Ravine		670		180		90		490		580
	Stream D - English Creek		6,200		6,090		5,890		110		310
	Stream E – West Ravine		220		10		10		210		210
	Creeks within Northeastern Zone		1,370		1,370		1,330		0		40
	Small Creeks Between Zone C and D		1,370		1,280		1,130		90		240
	Small Creeks Between Zone A and B		310		140		180		170		130
	Creeks within Eastern Zone		2,530		2,580		2,500		-50		30
	Creeks within Western Zone		1,440		1,430		1,420		10		20
	Stream F - South from Saskatchewan River		790		790		770		0		20
	Stream G - Southwest from Saskatchewan River		2,200		2,190		2,180		10		20
	All other Creeks in Model Domain		14,280		13,740		13,360		540		920
Total River and Creeks			**37,830**		**35,660**		**34,360**		**2,170**		**3,470**
Outer Model Boundaries	Northern	2,070	0	5,360	0	5,750	0	-3,290	0	-3,680	0
	Southern	0	6,050	3,740	0	4,200	0	-3,740	6,050	-4,200	6,050
	Western	0	1,220	5,880	0	6,530	0	-5,880	1,220	-6,530	1,220
	Eastern	0	1,920	11,550	0	12,220	0	-11,550	1,920	-12,220	1,920
	Eastern Part of Paleochannel	0	0	40	0	40	0	-40	0	-40	0
	Western Part of Paleochannel	0	0	20	0	20	0	-20	0	-20	0
Total Outer Model Boundaries		**2,070**	**9,190**	**26,590**	**0**	**28,760**	**0**	**-24,520**	**9,190**	**-26,690**	**9,190**
Groundwater Storage				55,220		56,670					
Dewatering	Star Pit RPI				6,430		0				
	Orion South Pit RPI				2,910		4,880				
	Pumping Rate from Star Dewatering Wells				81,960		66,830				
	Pumping Rate from Orion South Dewatering Wells				0		24,630				
Total Dewatering Rate					**91,300**		**96,340**				
Grand Total		**47,020**	**47,020**	**126,960**	**126,960**	**130,700**	**130,700**				

Table 16: Results of Sensitivity Analysis - Simulated Groundwater Budget for End of Mining Conditions for Scenario 3

Budget Component		Pre-Mining		End of Star Mining		End of Orion South Mining		End of Star Mining		End of Orion South Mining	
		Flow		Flow		Flow		Change in Flow		Change in Flow	
		Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	Inflow (m^3/d)	Outflow (m^3/d)	IN (m^3/d)	OUT (m^3/d)	IN (m^3/d)	OUT (m^3/d)
Recharge		**44,700**		**45,820**		**46,560**		**-1,120**		**-1,860**	
Groundwater Discharge to River and Creeks	Saskatchewan River		4,540		1,990		1,320		2,550		3,220
	Stream A- Caution Creek		2,860		1,850		1,260		1,010		1,600
	Stream B- 101 Ravine		1,470		1,180		990		290		480
	Stream C- East Ravine		810		150		50		660		760
	Stream D - English Creek		7,010		5,720		4,810		1,290		2,200
	Stream E – West Ravine		240		10		0		230		240
	Creeks within Northeastern Zone		1,620		1,320		1,080		300		540
	Small Creeks Between Zone C and D		1,500		1,110		860		390		640
	Small Creeks Between Zone A and B		350		100		100		250		250
	Creeks within Eastern Zone		3,190		2,430		1,900		760		1,290
	Creeks within Western Zone		1,540		1,330		1,120		210		420
	Stream F - South from Saskatchewan River		880		770		600		110		280
	Stream G - Southwest from Saskatchewan River		2,420		2,180		1,880		240		540
	All other Creeks in Model Domain		16,270		12,400		9,710		3,870		6,560
Total River and Creeks			**44,700**		**32,540**		**25,680**		**12,160**		**19,020**
Outer Model Boundaries	Northern	0	0	0	0	0	0	0	0	0	0
	Southern	0	0	0	0	0	0	0	0	0	0
	Western	0	0	0	0	0	0	0	0	0	0
	Eastern	0	0	0	0	0	0	0	0	0	0
	Eastern Part of Paleochannel	0	0	0	0	0	0	0	0	0	0
	Western Part of Paleochannel	0	0	0	0	0	0	0	0	0	0
Total Outer Model Boundaries		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Groundwater Storage				90,330		85,020					
Dewatering	Star Pit RPI				5,750		0				
	Orion South Pit RPI				2,540		4,830				
	Pumping Rate from Star Dewatering Wells				95,320		73,710				
	Pumping Rate from Orion South Dewatering Wells				0		27,360				
Total Dewatering Rate					**103,610**		**105,900**				
Grand Total		**44,700**	**44,700**	**136,150**	**136,150**	**131,580**	**131,580**				

Table 17 - Sensitivity Analysis - Maximum Impact to Rivers and Creeks During Mining and Post-Mining Conditions

Stream	Maximum Impact to Stream							
	Base case		Scenario 1		Scenario 2		Scenario 3	
	(m^3/d)	Percent of Pre-Mining Groundwater Dischange	(m^3/d)	Percent of Pre-Mining Groundwater Dischange	(m^3/d)	Percent of Pre-Mining Groundwater Dischange	(m^3/d)	Percent of Pre-Mining Groundwater Dischange
Saskatchewan River	2,410	71%	5,080	100%	800	32%	3,310	73%
Stream A- Caution Creek	1,430	64%	1,820	95%	590	23%	2,060	72%
Stream B- 101 Ravine	590	50%	1,000	97%	210	16%	810	55%
Stream C- East Ravine	Will Be destroyed by Star pit excavation							
Stream D - English Creek	2,360	41%	3,660	66%	1,350	22%	3,550	51%
Stream E – West Ravine	Will Be destroyed by Star pit excavation							
Creeks within Northeastern Zone	530	42%	660	59%	230	17%	900	56%
Small Creeks Between Zone C and D	740	60%	1,160	96%	540	39%	990	66%
Small Creeks Between Zone A and B	250	96%	230	100%	130	42%	340	97%
Creeks within Eastern Zone	1,100	45%	1,680	72%	400	16%	1,810	57%
Creeks within Western Zone	490	38%	730	68%	170	12%	770	50%
Stream F - South from Saskatchewan River	360	63%	170	100%	120	15%	560	64%
Stream G - Southwest from Saskatchewan River	570	35%	560	88%	190	9%	1,150	48%
All other Creeks in Model Domain	5,060	46%	6,300	83%	2,590	18%	9,670	59%

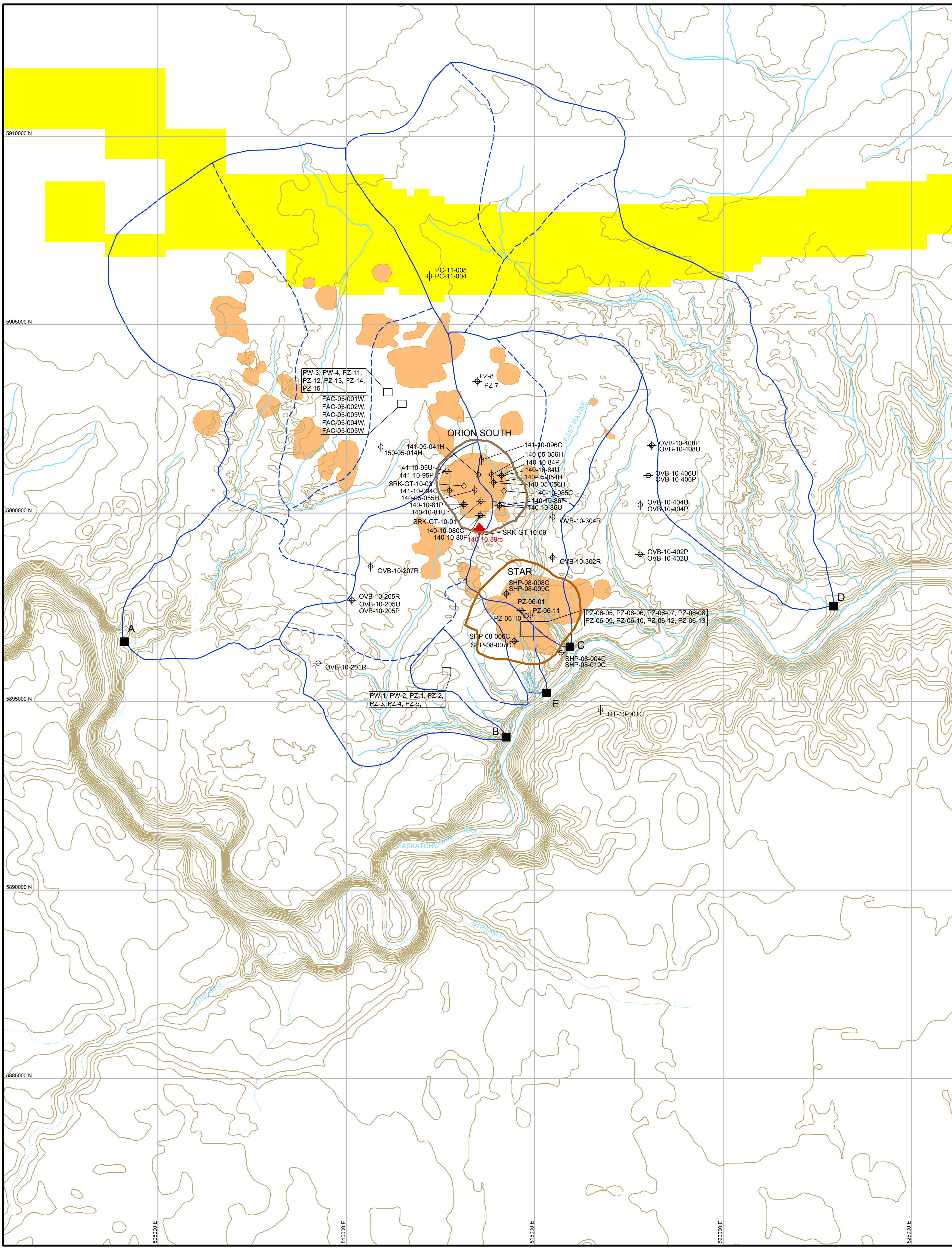
ND : Not Determined

Table 18: Groundwater Chemistry Measured during 20-day Pumping Test

Sample #			#10064	#10065	#10066	#10067	#10068	#10071	#10072	#10073	#10074
Date			26-Oct-10	29-Oct-10	2-Nov-10	4-Nov-10	7-Nov-10	11-Nov-10	12-Nov-10	14-Nov-10	14-Nov-10
Analyte	**Units**	**MIEPR**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**	**Results**
Aluminum	mg/L		0.021				0.005		0.0021		0.0024
Antimony	mg/L		<0.002				<0.002		<0.0002		<0.0002
Arsenic	ug/L	500	<1				<1		0.3		0.2
Barium	mg/L		0.013				0.011		0.010		0.010
Beryllium	mg/L		<0.001				<0.001		<0.0001		<0.0001
Bicarbonate	mg/L		473	476	477	477	474	474		474	
Boron	mg/L		2.1				2.0		2.0		1.9
Cadmium	mg/L		<0.0001				<0.0001		0.00001		0.00001
Calcium	mg/L		138	136	133	133	136	134		134	
Carbonate	mg/L		<1	<1	<1	<1	<1	<1		<1	
Chloride	mg/L		1600	1600	1600	1560	1600	1700		1700	
Chromium	mg/L		<0.005				<0.005		<0.0005		<0.0005
Cobalt	mg/L		0.001				<0.001		0.0001		0.0001
Copper	mg/L	0.3	0.010				0.005		0.0032		0.0024
Fluoride	mg/L		2.2	2.2	2.3	2.2	2.2	2.3		2.5	
Hydroxide	mg/L		<1	<1	<1	<1	<1	<1		<1	
Iron	mg/L		0.36				0.29		0.24		0.23
Lead	mg/L	0.2	<0.001				<0.001		0.0005		0.0003
Magnesium	mg/L		47	46	45	45	46	45		45	
Manganese	mg/L		0.099				0.092		0.087		0.086
Molybdenum	mg/L		<0.001				<0.001		0.0002		0.0001
Nickel	mg/L	0.5	0.002				<0.001		0.0005		0.0005
Nitrate	mg/L		<0.04	<0.04	<0.04	<0.04	<0.04	<0.04		<0.04	
P. Alkalinity			<1	<1	<1	<1	<1	<1		<1	
pH	pH units		7.82	7.82	7.82	7.88	7.79	7.74		7.73	
Phosphorus	mg/L		0.06				0.06		0.05		0.05
Potassium	mg/L		57	57	58	58	57	56		56	
Selenium	mg/L		<0.001				<0.001		0.0003		0.0002
Silver	mg/L		<0.0001				<0.0001		<0.00001		<0.00001
Sodium	mg/L		1190	1210	1270	1250	1210	1210		1220	
Specific conductivity	µS/cm		6420	6530	6470	6530	6450	6160		6180	
Strontium	mg/L		2.6				2.5		2.50		2.48
Sulfate	mg/L		740	750	740	750	750	740		740	
Sum of ions	mg/L		4240	4280	4320	4270	4270	4360		4370	
Thallium	mg/L		<0.002				<0.002		<0.0002		<0.0002
Tin	mg/L		<0.001				<0.001		<0.0001		<0.0001
Titanium	mg/L		<0.002				<0.002		0.0002		<0.0002
Total alkalinity	mg/L		388	390	391	391	389	389		389	
Total dissolved solids	mg/L		3960	3960	3970	3960	3950	3950		3950	
Total hardness	mg/L		537	528	517	517	528	519		519	
Uranium	ug/L	2500	<1				<1		<0.1		<0.1
Vanadium	mg/L		<0.001				<0.001		0.0002		0.0002
Zinc	mg/L	0.5	0.16				0.021		0.014		0.011

Figures

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling.Report.2011-07\2CS016.004.Fig.1.Rev.A.Base.Map.Hydrogeological.Study.Area.2011-06-15.dwg



LEGEND

EXISTING GROUND CONTOURS X 2m INTERVAL
CREEKS / STREAMS
KIMBERLITE
APPROXIMATE EXTENT OF PALEOCHANNEL
MAJOR WATERSHED BOUNDARY
SUB-WATERSHED BOUNDARY
E STREAMFLOW MONITORING STATION
HYDROGEOLOGICAL WELL / TEST HOLE
ORION SOUTH PROTOTYPE DEWATERING WELL
ULTIMATE PIT BOUNDARY

N

0 500 1000 1500 2000 2500
Scale in Metres

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STAR-ORION SOUTH DIAMOND PROJECT

BASE MAP OF HYDROGEOLOGICAL STUDY AREA

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.1.Rev.A.Base.Map.Hydrogeological.Study.Area.2011-06-15.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JUNE 2011	VU	1	A

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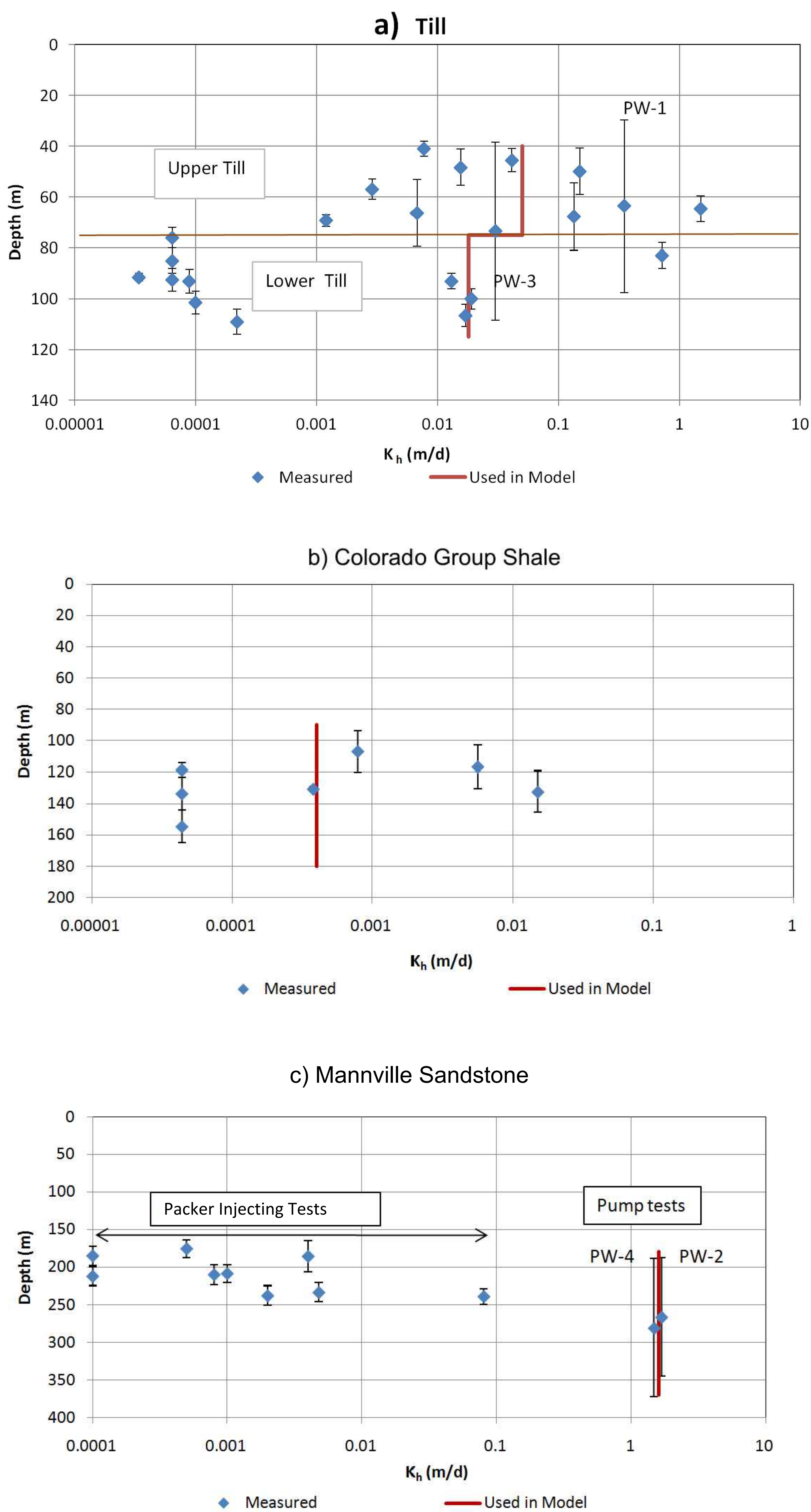
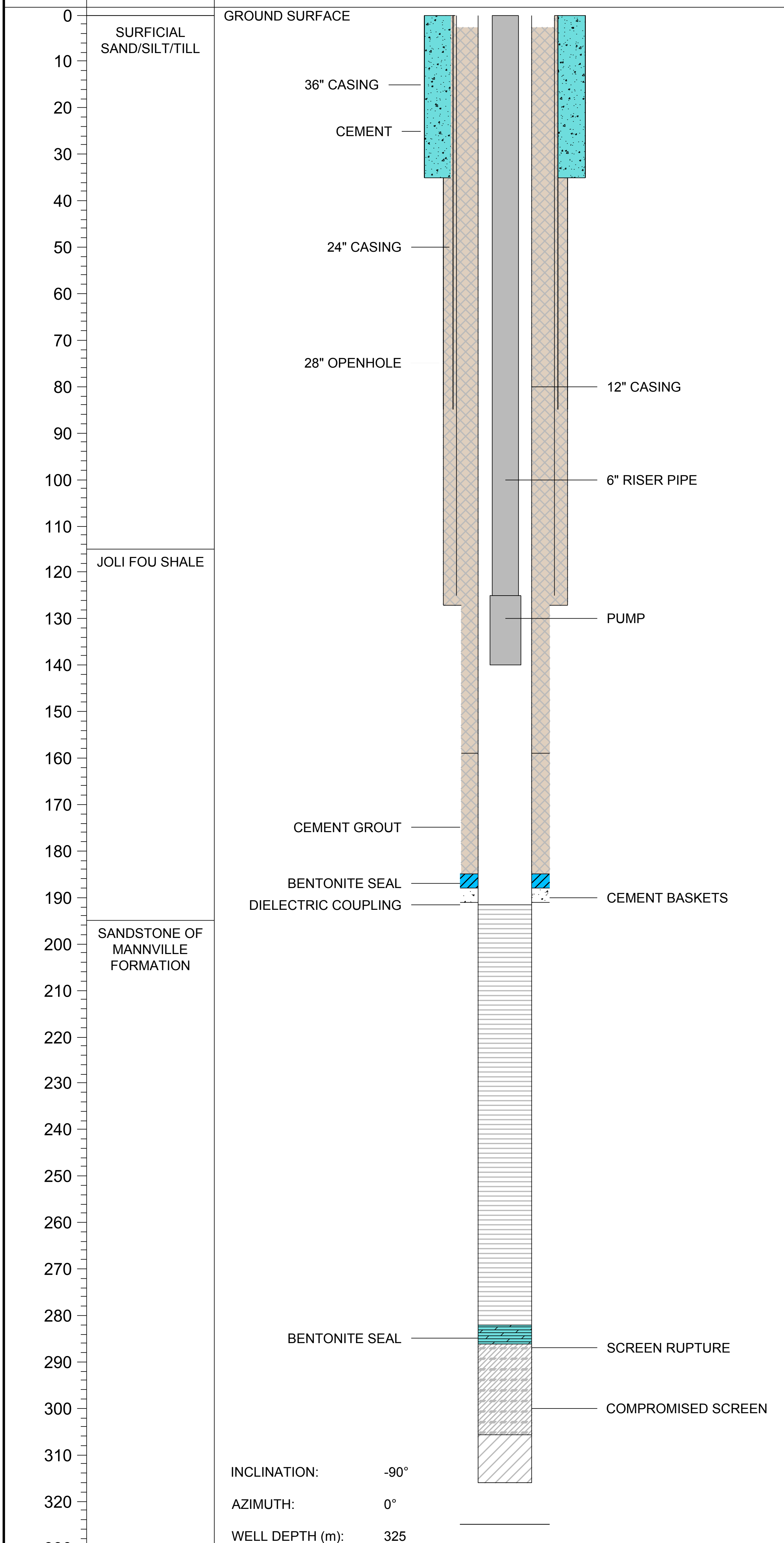


srk consulting	Shore Gold Inc.	STAR-ORION SOUTH DIAMOND PROJECT
		MEASURED HYDRAULIC PARAMETERS DURING 2005-2010 HYDROGEOLOGICAL STUDIES
SRK JOB NO.: 2CS016.040 / TASK 0240	SASKATCHEWAN, CANADA	DATE: JULY 2011
FILE NAME: 2CS016.004.Fig.2.Rev.A.Measured.Hydraulic.Parameters.2005-2010.2011-06-15.dwg		APPROVED: VU
		FIGURE: 2
		REVISION NO. A

PROJECT No:	2CS016.005	DATE:	OCTOBER 2010
SITE:	FORT A LA CORNE	CONTRACTOR:	ENCORE DRILLING
CLIENT:	SHORE GOLD		

DEPTH (M)	LITHOLOGY
0–115	SURFICIAL SAND/SILT/TILL
115–195	JOLI FOU SHALE
195–330	SANDSTONE OF MANNVILLE FORMATION

WELL CONSTRUCTION DIAGRAM



COMMENTS

- 0-35m 36" STEEL CASING
- 0-85m 24" STEEL CASING
- 0-125m 22" STEEL CASING
- 0-35m CEMENT BETWEEN 24" AND 36" CASING
- 0-127m 28" OPENHOLE
- PROBLEM BACKFILING BETWEEN 22" AND 24" CASING. APPROX 5m OF CEMENT IN BOTTOM OF 22" CASING
- 125-325m 20" OPENHOLE
- 0-191m 12" STEEL WELL CASING
- 183-188m BENTONITE SEAL ABOVE CEMENT BASKETS
- 188-190m TWO CEMENT BAKETS
- 191-191.5 DI-ELECTRIC COUPLING
- 191.5-307.5m 316 STAINLESS STEEL JOHNSON SCREEN 12 x 14 MUNIPAK: 3mm SLOTS AND 20/40 PACKING MATERIAL
- NATURAL SAND BACKFILL
- 282.5-287m BENTONITE SEAL INSIDE OF WELL SCREEN ABOVE COLLAPSED SECTION
- 287-316.5 COMPROMISED WELL SCREEN
- 307.5-316.5 STAINLESS STEEL SUMP
- 316.5-325m SUMP

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CONSTRUCTION OF PROTOTYPE DEWATERING WELL AS BUILT

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.3.Rev.A.const. Prototype.Dewatering.Well.2011-06-02.dwg

SASKATCHEWAN, CANADA

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	3	A

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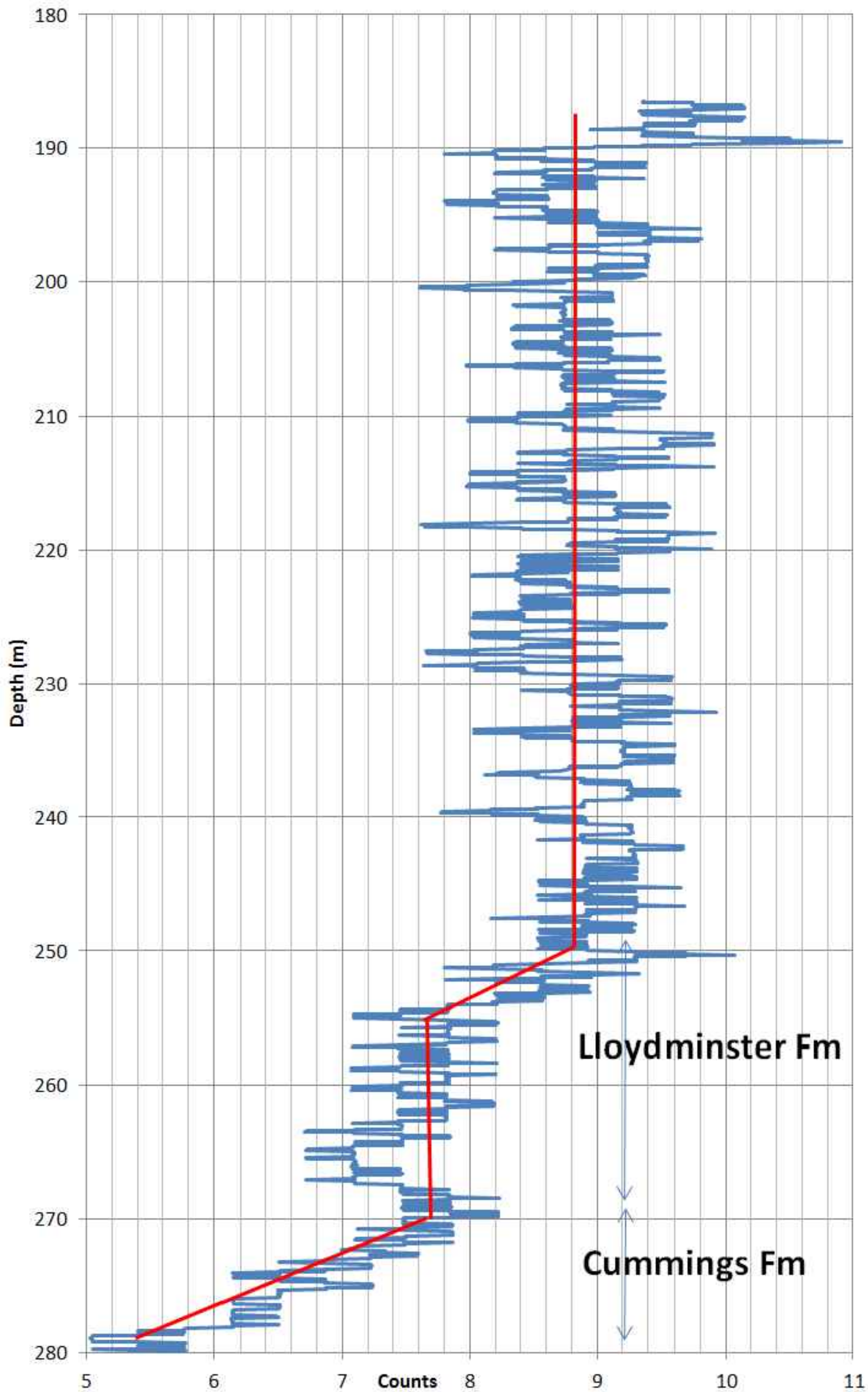

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STAR-ORION SOUTH DIAMOND PROJECT

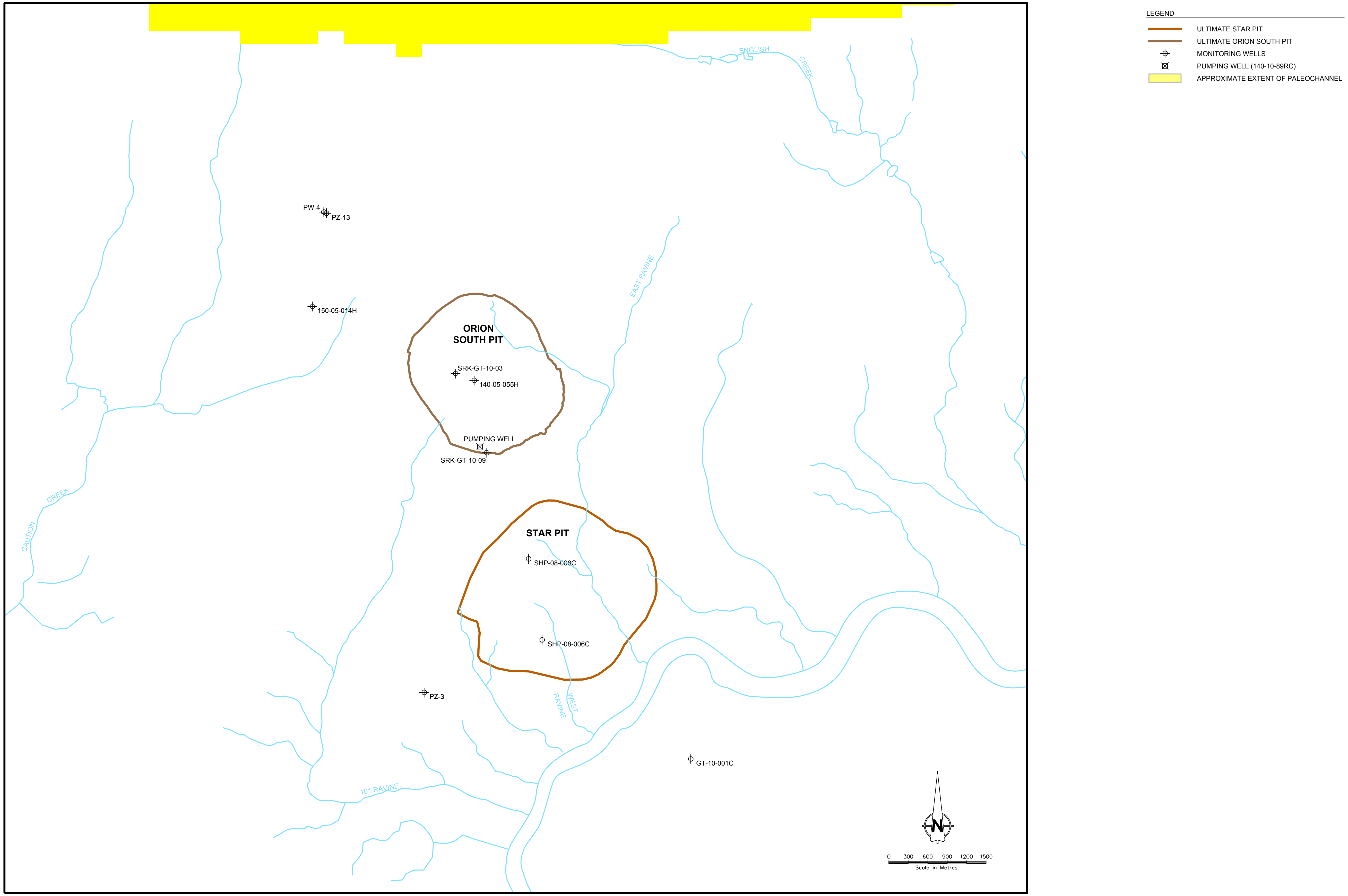
RESULTS OF COMPLETED SPINNER LOGGING IN PROTOTYPE DEWATERING WELL

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.4.Rev.A.Results.Completed.Spinner.2011-06-02.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	4	A



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STAR-ORION SOUTH DIAMOND PROJECT

LOCATION OF MONITORING WELLS USED DURING 20-DAY PUMPING TEST

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.5.Rev.A.Locations.of.Monitoring.Wells.2011-06-03.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	5	A

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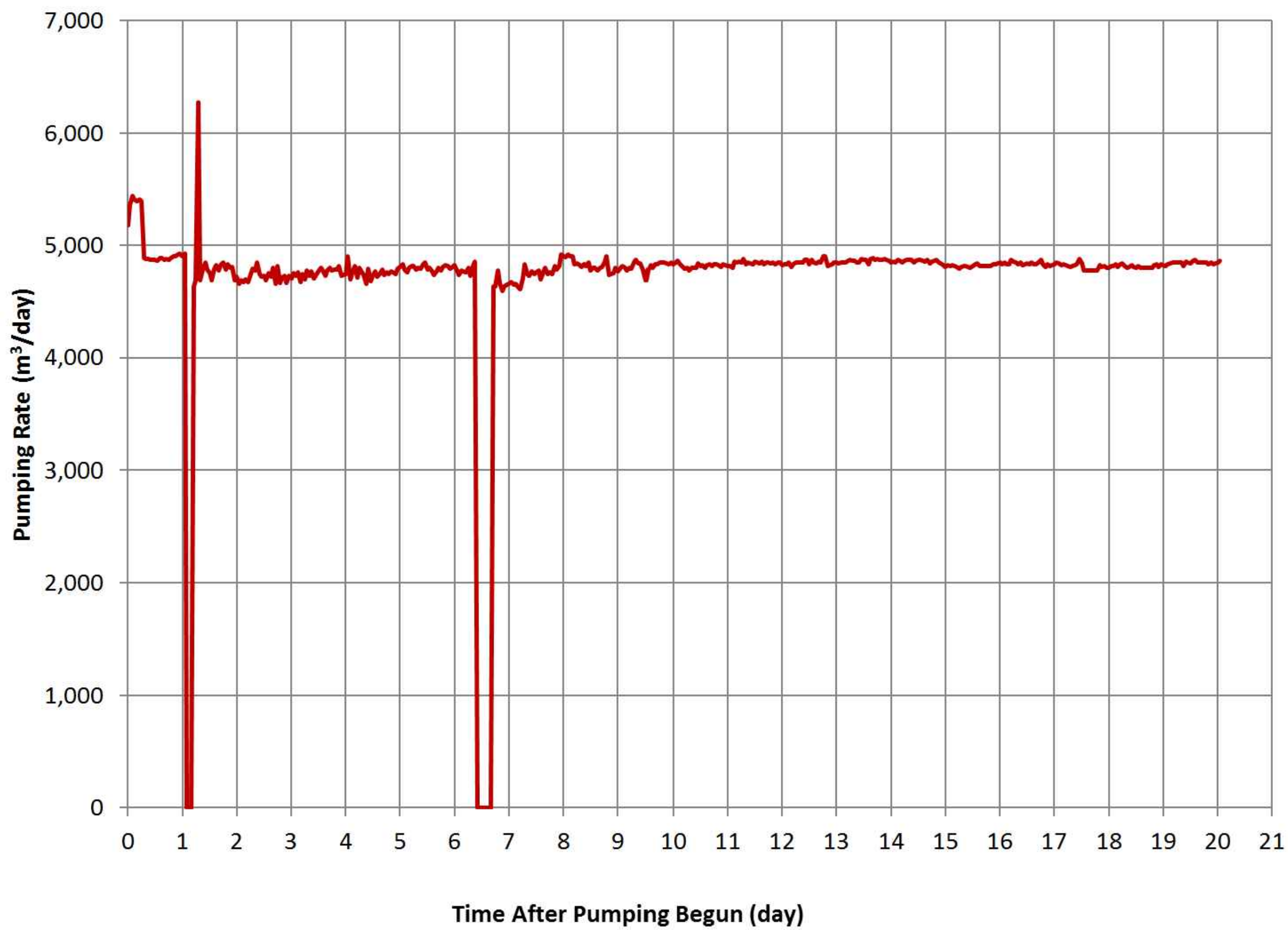
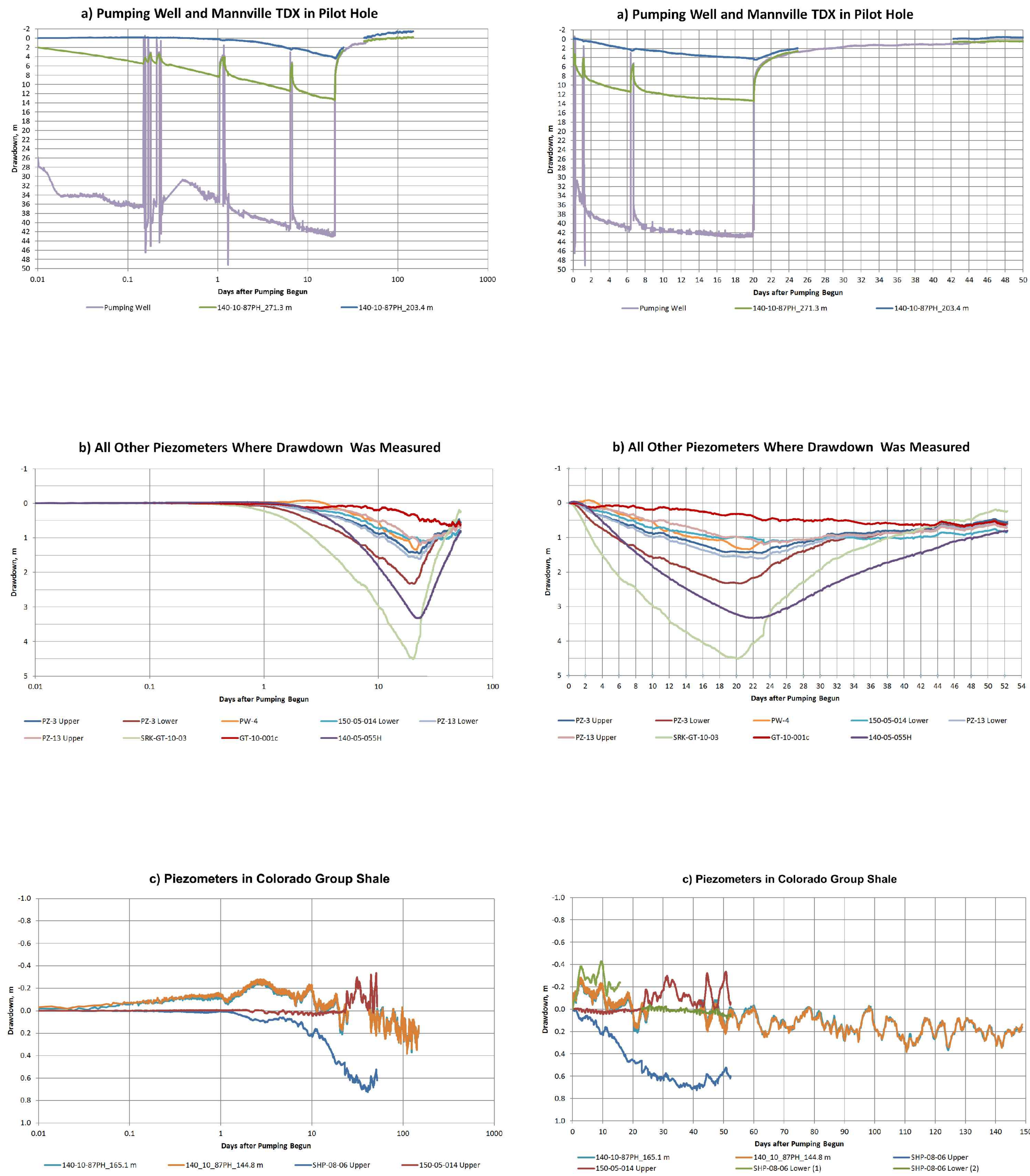


srk consulting	Shore Gold Inc.	STAR-ORION SOUTH DIAMOND PROJECT
		PUMPING RATE MEASURED DURING 20-DAY PUMPING TEST
SRK JOB NO.: 2CS016.040 / TASK 0240	SASKATCHEWAN, CANADA	DATE: JULY 2011 · APPROVED: VU · FIGURE: 6 · REVISION NO. A
FILE NAME: 2CS016.004.Fig.6.Rev.A.Pumping.Rate.Measured.Prototype..2011-06-02.dwg		



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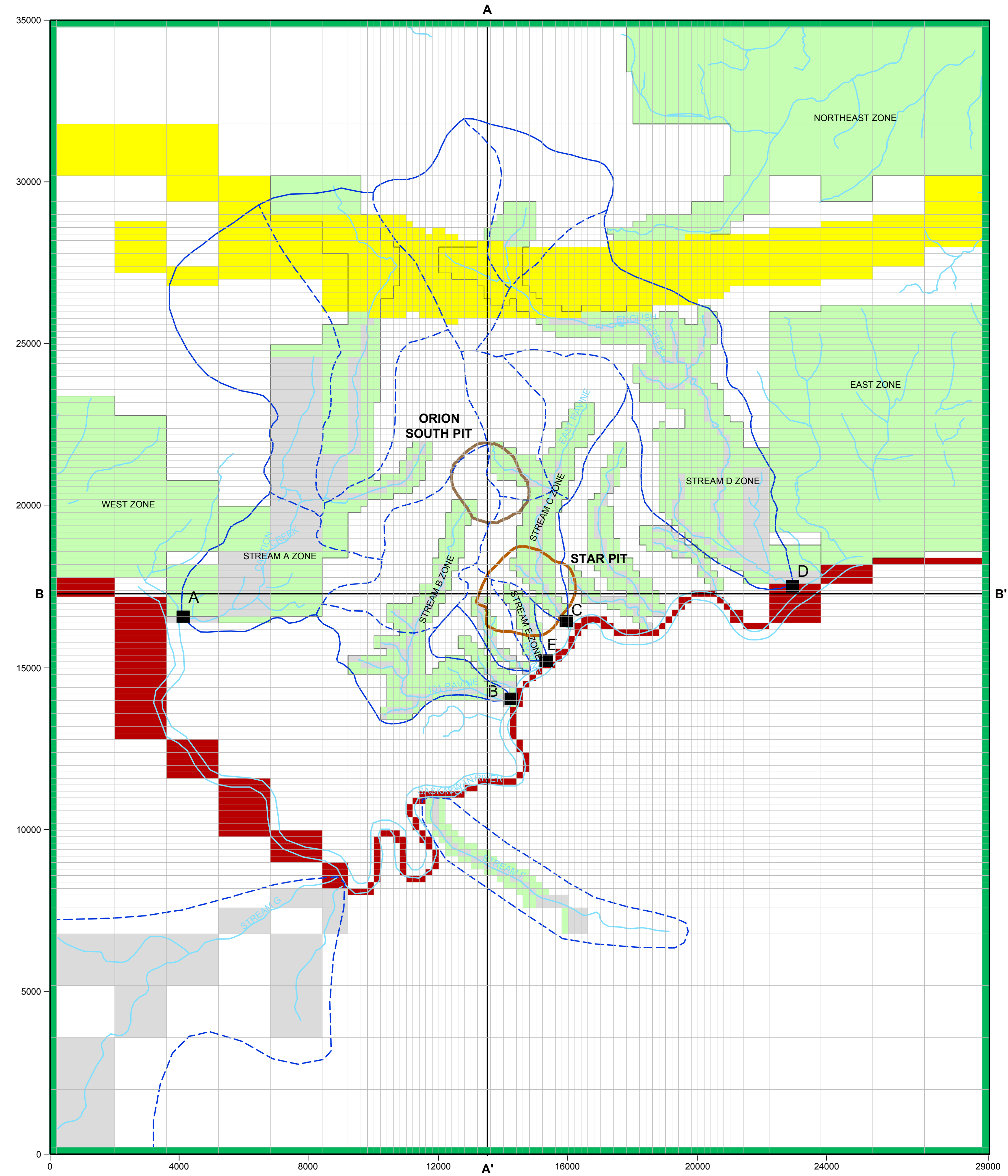
STAR-ORION SOUTH DIAMOND PROJECT

MEASURED DRAWDOWN DURING 20-DAY PUMPING TEST

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240	DATE: JULY 2011	APPROVED: VU	FIGURE: 7	REVISION NO. A

FILE NAME: 2CS016.004.Fig.7.Rev.A.Measured.DD.During.20-Day.Test.2011-06-02.dwg



LEGEND

- EXISTING GROUND CONTOURS X 10m INTERVAL
- CREEKS / STREAMS
- MAJOR WATERSHED BOUNDARY
- SUB-WATERSHED BOUNDARY
- CONSTANT HEAD
- AREA WHERE GROUNDWATER DISCHARGE TO CREEK IS SIMULATED BY SEEPAGE CELLS (THE AREA IN STREAM G IS THE SAME AS DRAIN CELLS)
- DRAIN CELLS TO SIMULATED CREEKS AND RAVINES (LAYER 1 ONLY)
- GENERAL HEAD BOUNDARY CONDITIONS APPLIED WITHIN MANNVILLE FORMATION (LAYER 13 TO 17) AS FOLLOWS:

General Head Boundary	Distance (km)	Head (mamsl)
Western	35	from 400 to 300
Eastern	35	from 400 to 300
Southern	50	300
Northen	50	450

- STAR PIT
- ORION SOUTH PIT
- LINE OF CROSS-SECTION
- APPROXIMATE EXTENT OF PALEOCHANNEL
- B STREAMFLOW MONITORING STATION

NOTE

1. FINITE-DIFFERENCE GRID IS SHOWN IN MODEL COORDINATES.
2. NO FLOW BOUNDARY ASSIGNED TO LAYER 1 TO 12 AND 18, 19, 20.
3. GENERAL HEAD BOUNDARY CONDITIONS ARE APPLIED TO PALEOCHANNEL AT WESTERN AND EASTERN MODEL BOUNDARIES.

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STAR-ORION SOUTH DIAMOND PROJECT

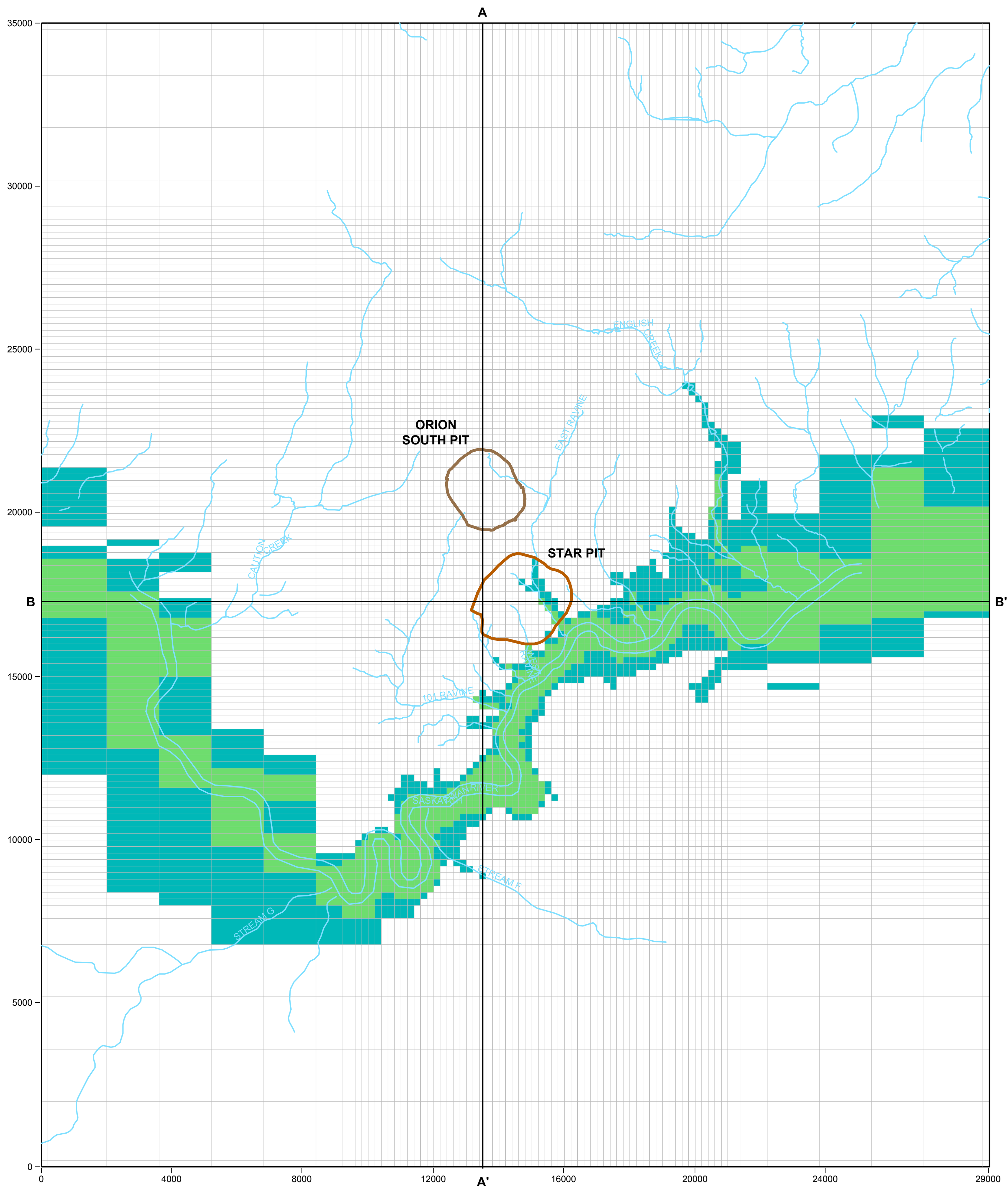
MAP VIEW OF FINITE-DIFFRENCE GRID SHOWING DIFFERENT HYDROGEOLOGICAL FEATURES AND BOUNDARY CONDITIONS INCORPORATED INTO MODEL

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.8.Rev.A.Map.View.Finite.Diff.2011-06-02.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	8	A

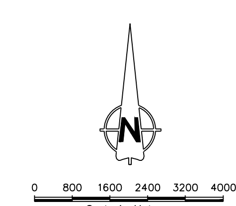


LEGEND

- CREEKS / STREAMS
- LINE OF CROSS-SECTION
- UPPER SURFICIAL SAND, R = 20mm / YEAR
- TILL ADJACENT TO SASKATCHEWAN RIVER, R = 5mm / YEAR
- LOWER SURFICIAL SILT / CLAY, R = 5mm / YEAR
- STAR PIT
- ORION SOUTH PIT

NOTE

FINITE-DIFFERENCE GRID IS SHOWN IN MODEL COORDINATES



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STAR-ORION SOUTH DIAMOND PROJECT

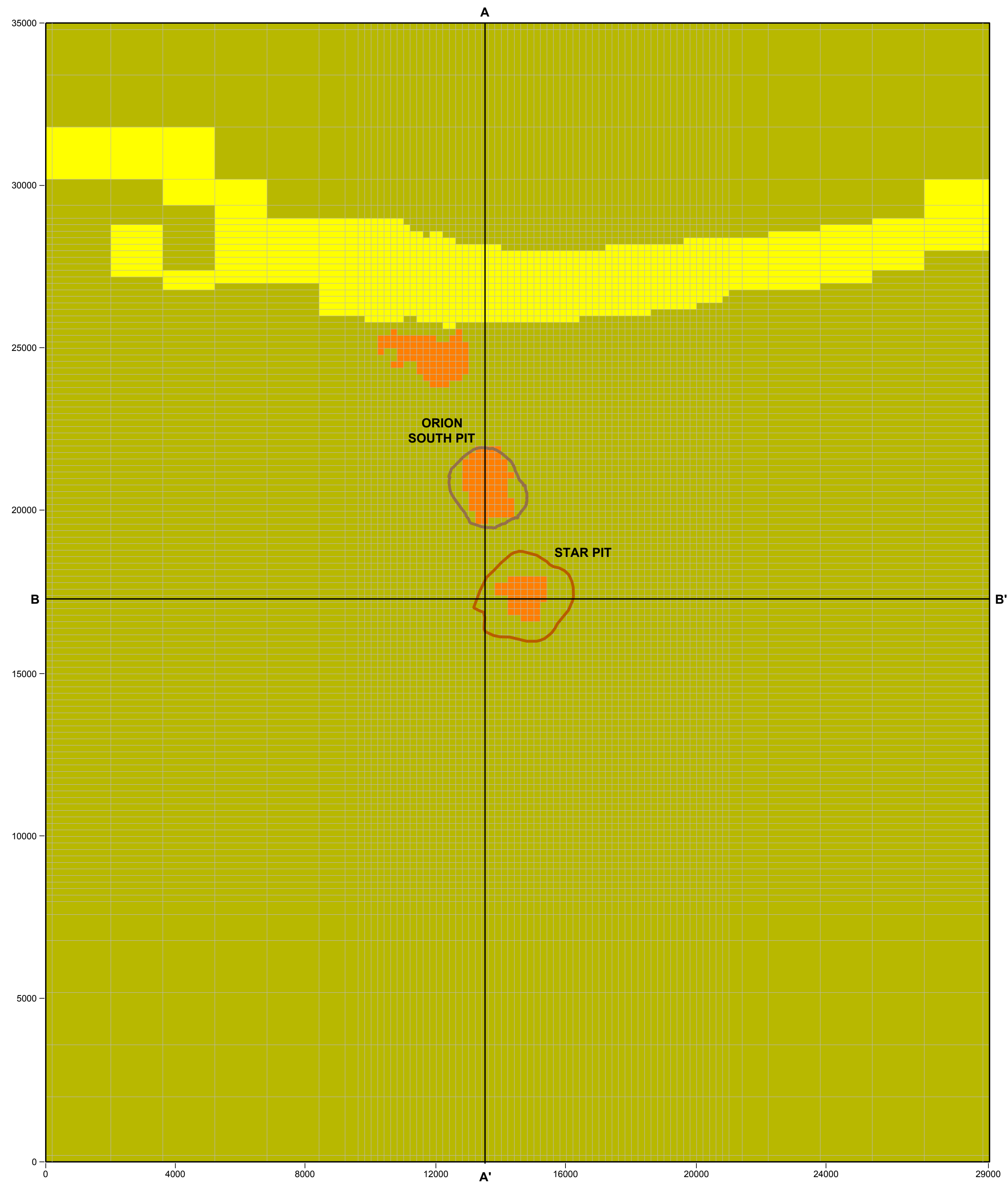
GEOLOGY AND RECHARGE SIMULATED IN UPPERMOST LAYER OF NUMERICAL GROUNDWATER FLOW MODEL

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.9.Rev.A.Geology.and.Recharge.Sim.2011-06-02.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	9	A

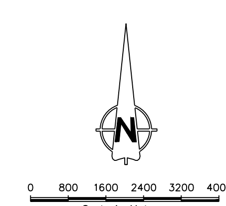


LEGEND

(line)	LINE OF CROSS-SECTION
(olive)	SHALE (Joli Fou Fm)
(yellow)	TILL WITHIN PALEOCHANNEL
(orange)	KIMBERLITE
(line)	STAR PIT
(line)	ORION SOUTH PIT

NOTE

FINITE-DIFFERENCE GRID IS SHOWN IN MODEL COORDINATES



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SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.10.Rev.A.Geology.Simulate.inLayer.10.2011-06-02.dwg

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SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

GEOLOGY SIMULATED IN LAYER 10 OF NUMERICAL GROUNDWATER FLOW MODEL

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	10	A

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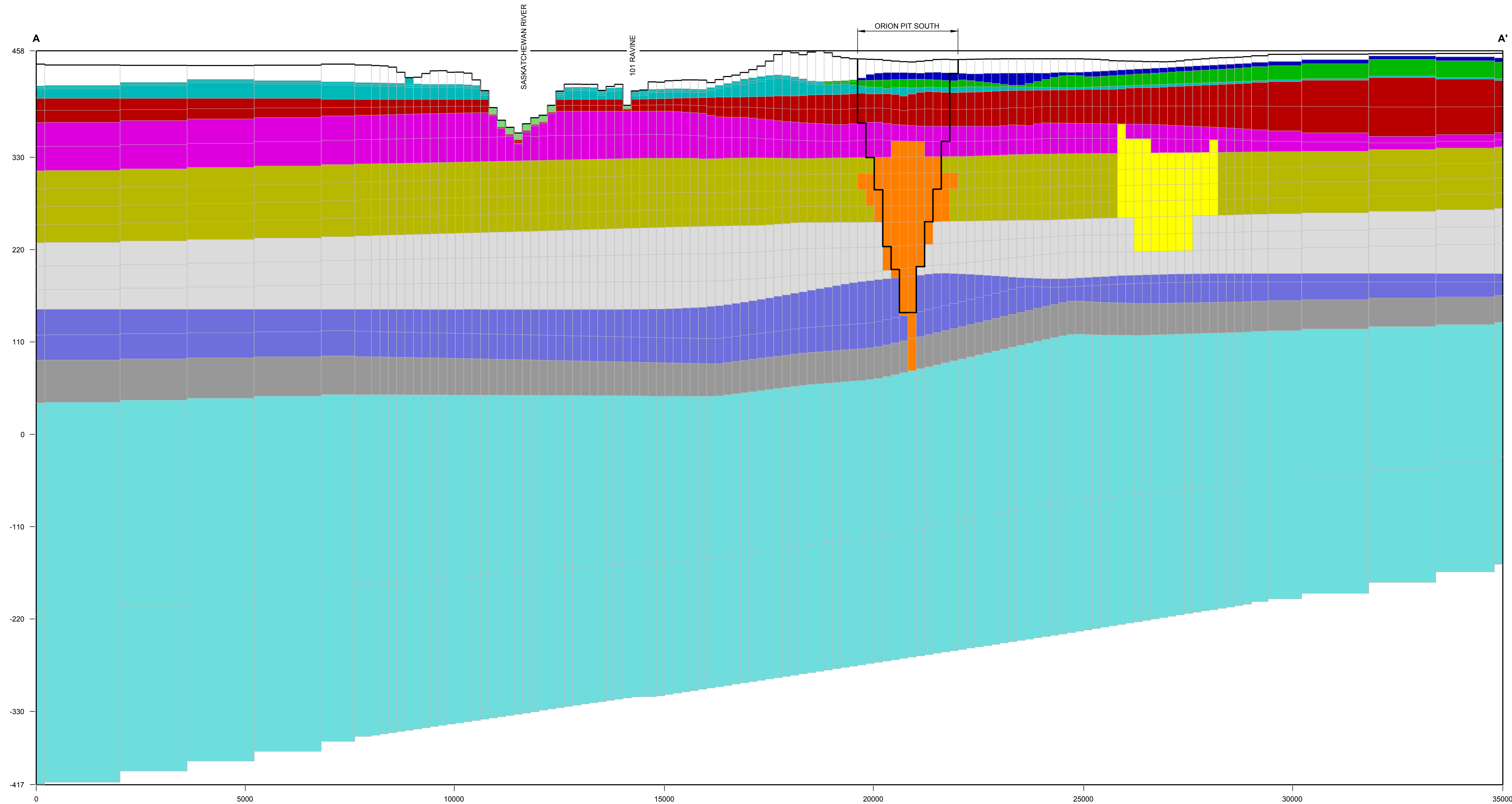

LEGEND

- UPPER SURFICIAL SAND
- UPPER SURFICIAL SILT / CLAY
- LOWER SURFICIAL SAND
- LOWER SURFICIAL SILT / CLAY
- UPPER TILL
- LOWER TILL
- UPPERMOST TILL WITHIN SASKATCHEWAN RIVER
- COLORADO GROUP SHALE
- UPPER SANDSTONE (Mannville Group)
- LOWER SANDSTONE (Mannville Group)
- UPPERMOST LIMESTONE (Souris River Fm)
- LIMESTONE (Souris River Fm)
- TILL WITHIN PALEOCHANNEL
- KIMBERLITE

0 500 1000 1500 2000 2500
Scale in Metres

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STAR-ORION SOUTH DIAMOND PROJECT

MODEL CROSS SECTION A-A'

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.11.Rev.A.Model.Cross.Section.A-A'.2011-06-02.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	11	A

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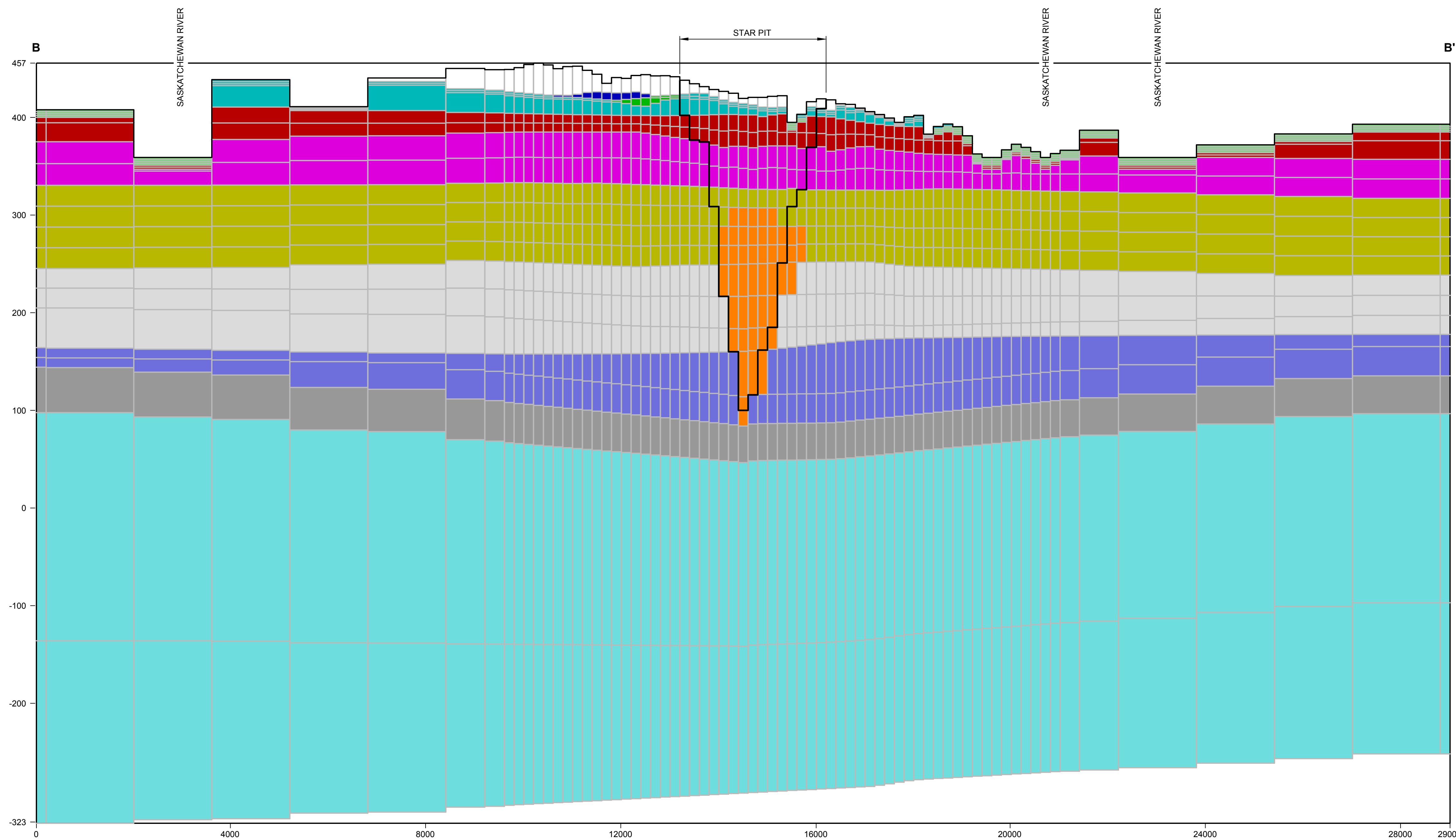

LEGEND

- UPPER SURFICIAL SAND
- UPPER SURFICIAL SILT / CLAY
- LOWER SURFICIAL SAND
- LOWER SURFICIAL SILT / CLAY
- UPPER TILL
- LOWER TILL
- UPPERMOST TILL WITHIN SASKATCHEWAN RIVER
- COLORADO GROUP SHALE
- UPPER SANDSTONE (Mannville Group)
- LOWER SANDSTONE (Mannville Group)
- UPPERMOST LIMESTONE (Souris River Fm)
- LIMESTONE (Souris River Fm)
- KIMBERLITE

0 500 1000 1500 2000 2500
Scale in Metres

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STAR-ORION SOUTH DIAMOND PROJECT

MODEL CROSS SECTION B-B'

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.12.Rev.A.Model.Cross.Section.B-B'.2011-06-02.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	12	A

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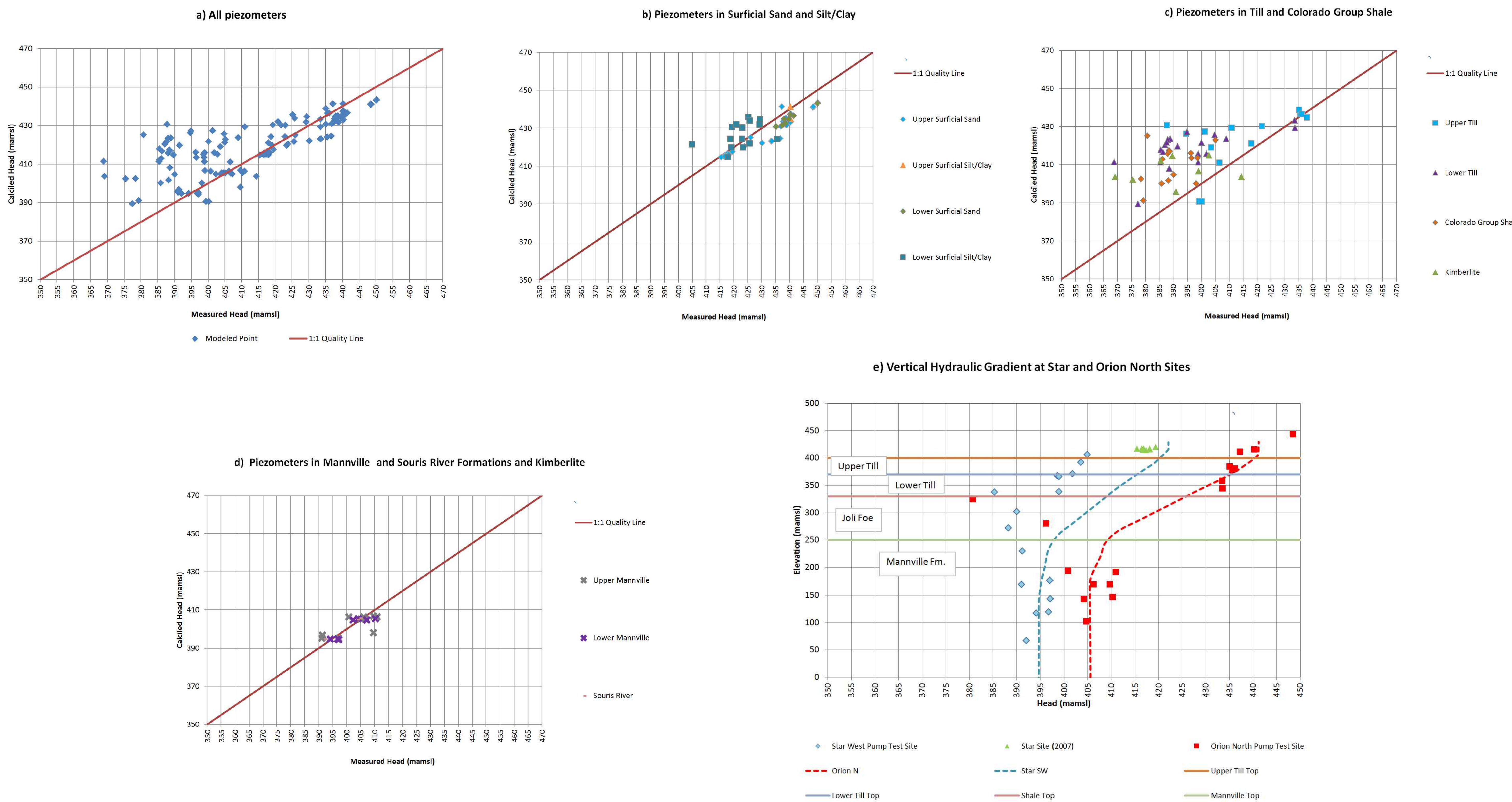

srk consulting	Shore Gold Inc.	STAR-ORION SOUTH DIAMOND PROJECT
		RESULTS OF CALIBRATION OF MODEL TO MEASURED PRE-MINING LEVELS
SRK JOB NO.: 2CS016.040 / TASK 0240	SASKATCHEWAN, CANADA	DATE: JULY 2011 · APPROVED: VU · FIGURE: 13 · REVISION NO. A
FILE NAME: 2CS016.004.Fig.13.Rev.A.Results.of.Calib.to.Model.2011-06-02.dwg		

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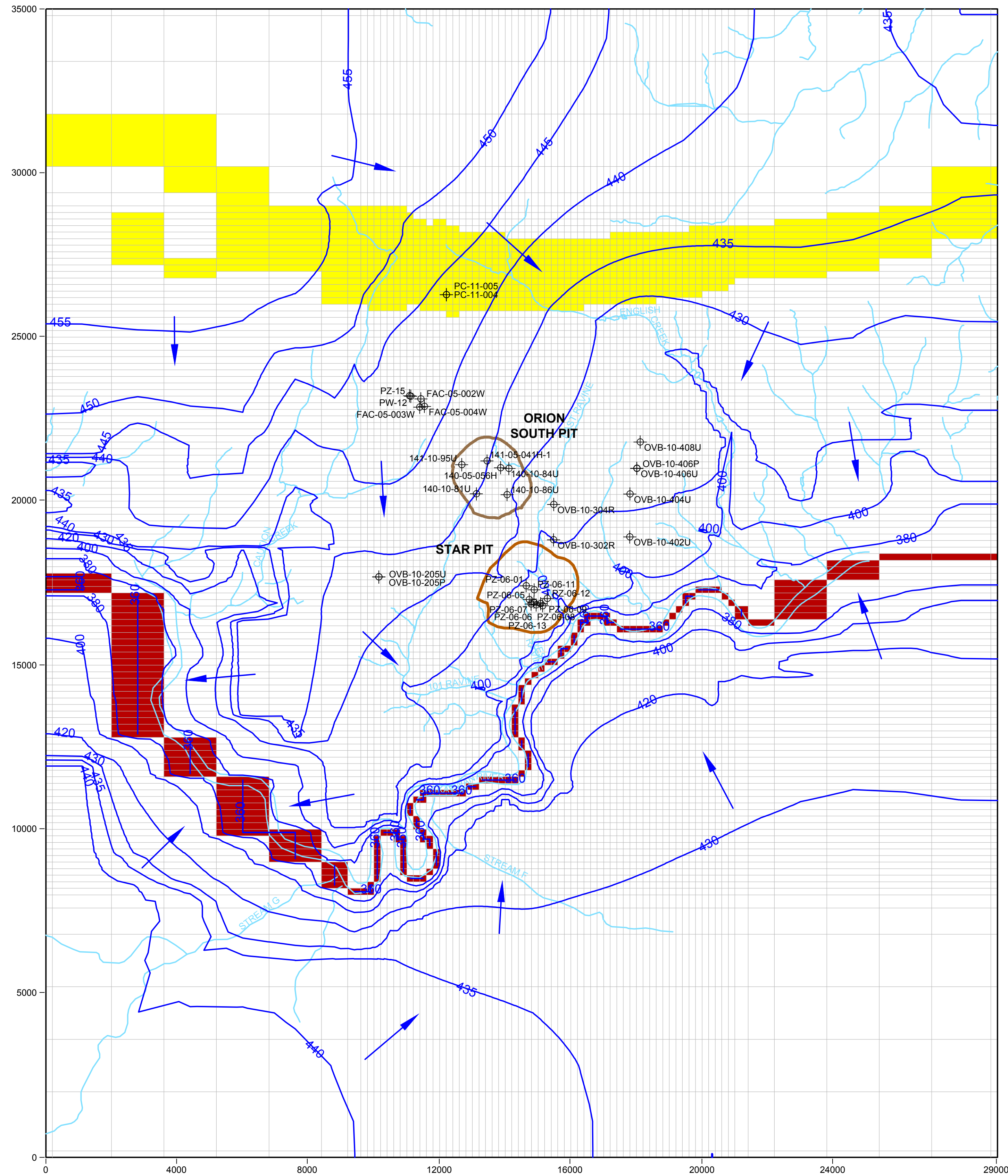
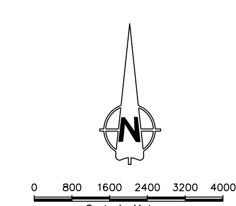


LEGEND

- WATER TABLE ELEVATIONS (mamsl)
- STAR PIT
- ORION SOUTH PIT
- DIRECTION OF GROUNDWATER FLOW
- PIEZOMETER IN UPPER SURFICIAL SAND
- RIVER CELLS
- APPROXIMATE EXTENT OF PALEOCHANNEL

NOTE

FINITE-DIFFERENCE GRID IS SHOWN IN MODEL COORDINATES



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FILE NAME: 2CS016.004.Fig.14.Rev.A.Sim.Water.Table.Pre-Mine.2011-06-03.dwg

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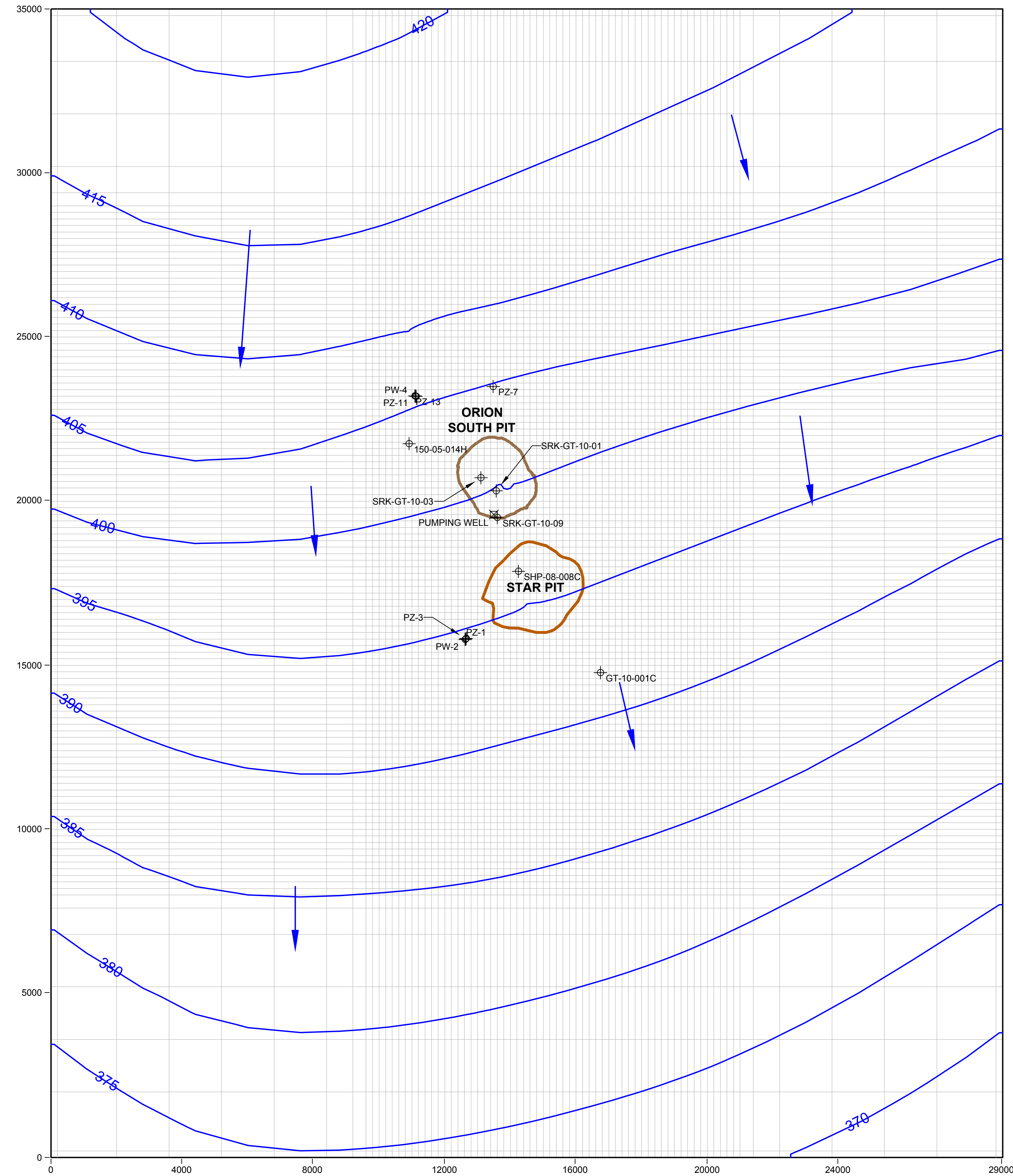
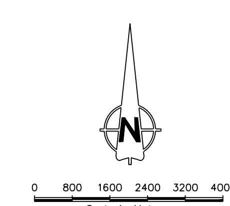
STAR-ORION SOUTH DIAMOND PROJECT

SIMULATED WATER TABLE UNDER PRE-MINING CONDITIONS

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	14	A





LEGEND

- 410 — POTENTIOMETRIC LEVELS (mamsl)
- STAR PIT
- ORION SOUTH PIT
- DIRECTION OF GROUNDWATER FLOW
- PIEZOMETER IN MANNVILLE GROUP
- PROTOTYPE DEWATERING WELL

WELL / POINT #	OBSERVED WATER LEVEL
150-05-014H	407
PW-2	397
PW-4	410
PZ-1	391
PZ-11	404
PZ-13	411
PZ-3	397
PZ-7	405
SHP-08-008C	410
GT-10-001C	395
SRK-GT-10-03	403

NOTE

FINITE-DIFFERENCE GRID IS SHOWN IN MODEL COORDINATES

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STAR-ORION SOUTH DIAMOND PROJECT

SIMULATED POTENTIOMETRIC LEVEL WITHIN MANNVILLE SANDSTONE (LOWER LAYER) UNDER PRE-MINING CONDITIONS

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.15.Rev.A.Sim.Potentiometric.Level.2011-06-03.dwg

SASKATCHEWAN, CANADA

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	15	A

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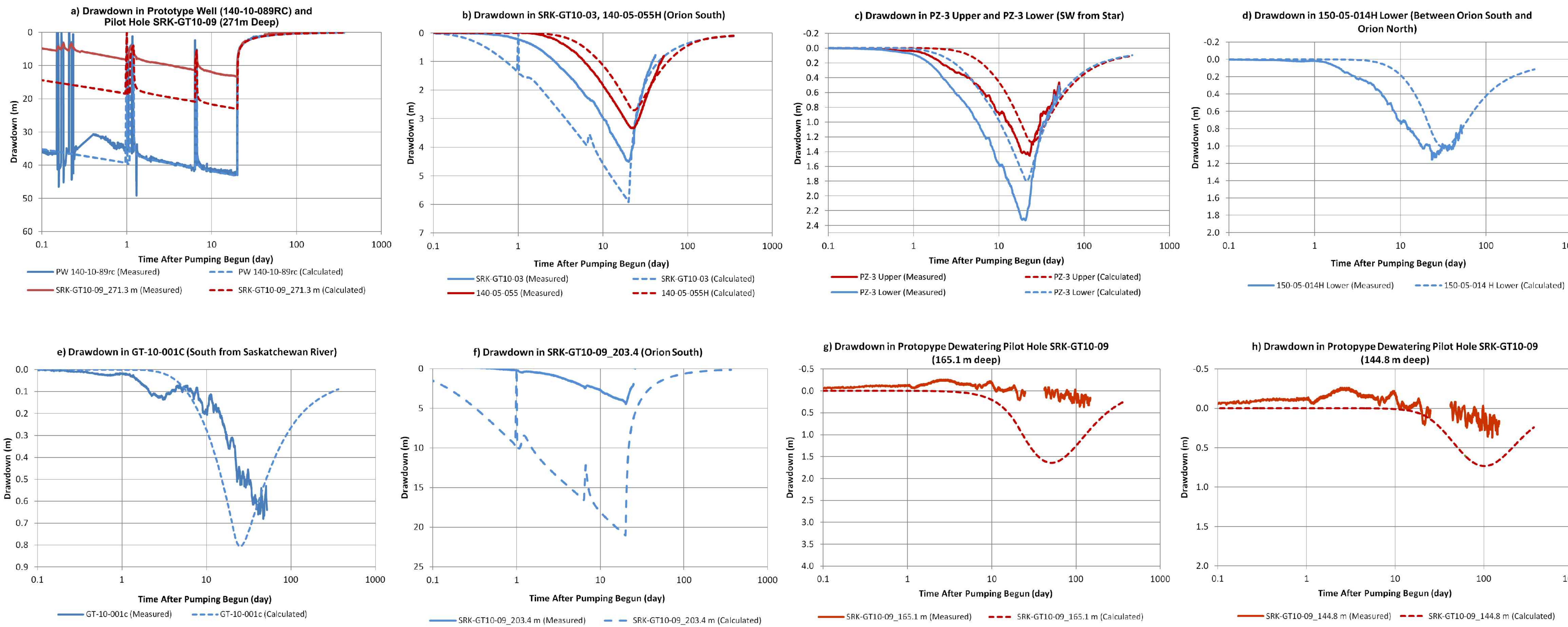

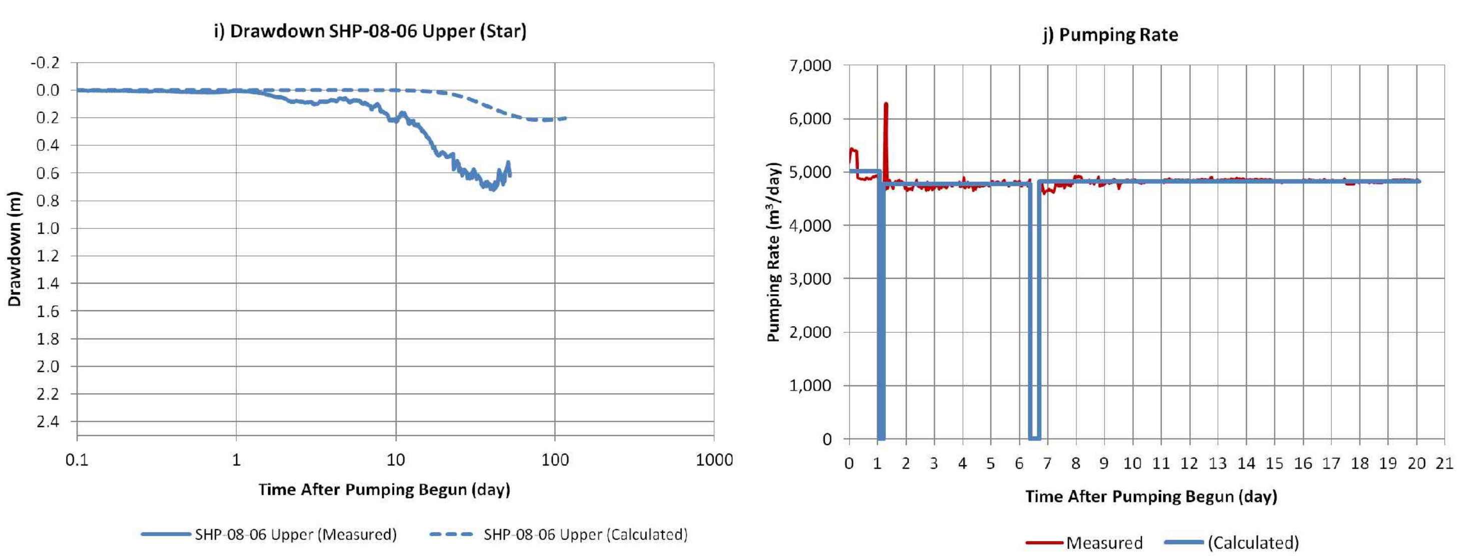

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SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.16.Rev.A.Results.of.Calibration..2011-06-02.dwg

SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF CALIBRATION OF MODEL TO MEASURED DRAWDOWN DURING 20-DAY PUMPING TEST

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	16	A

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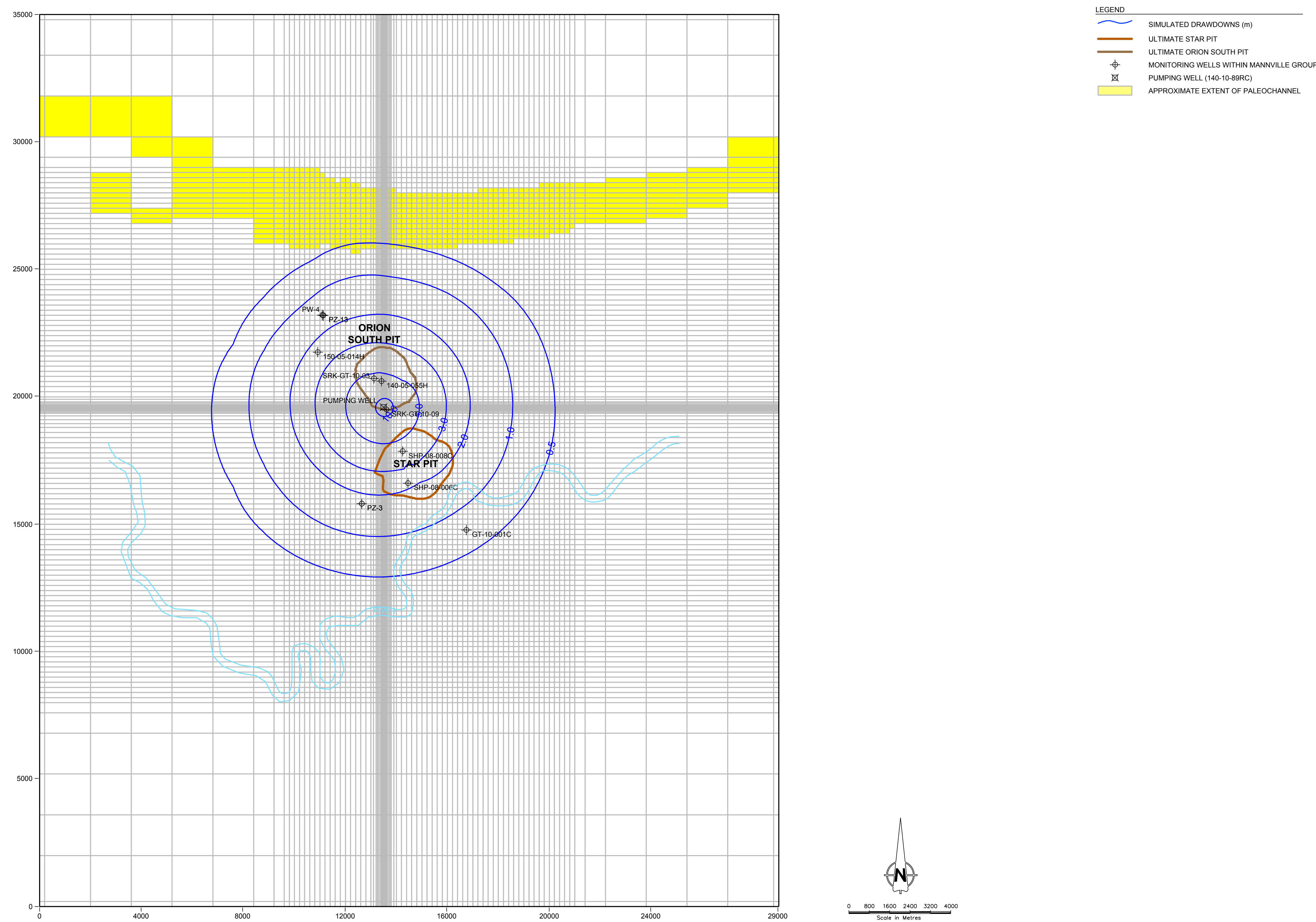

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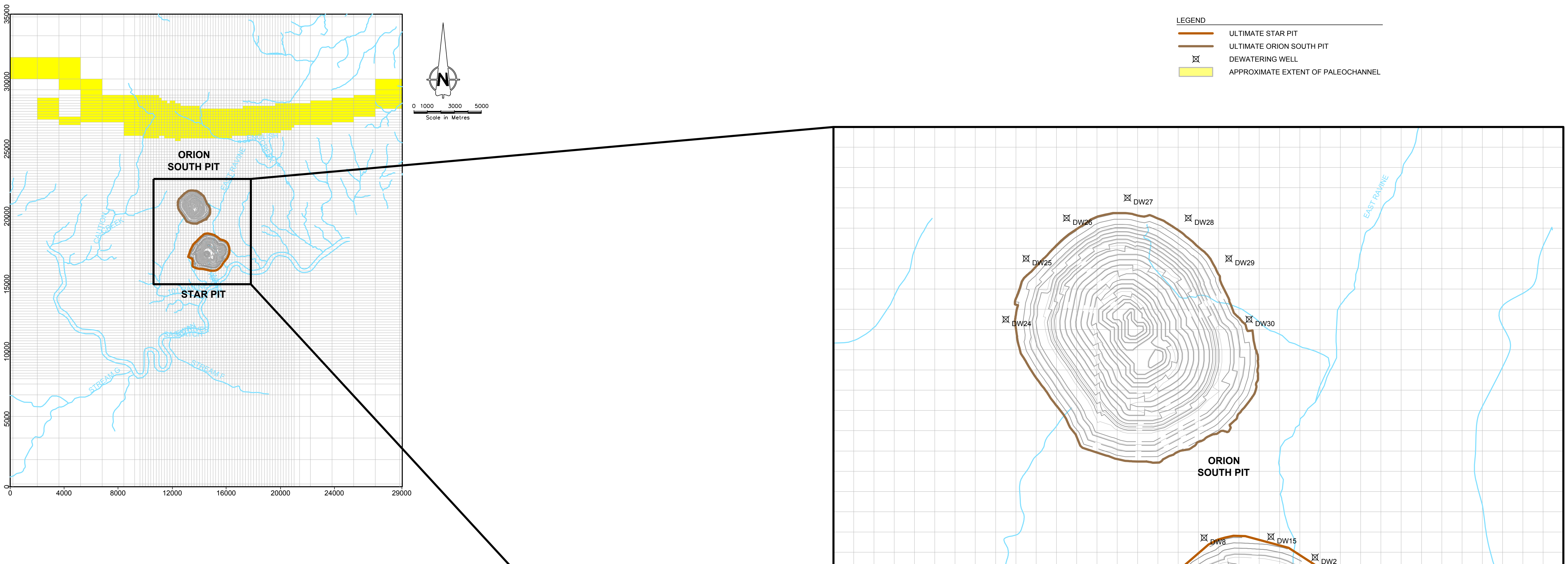
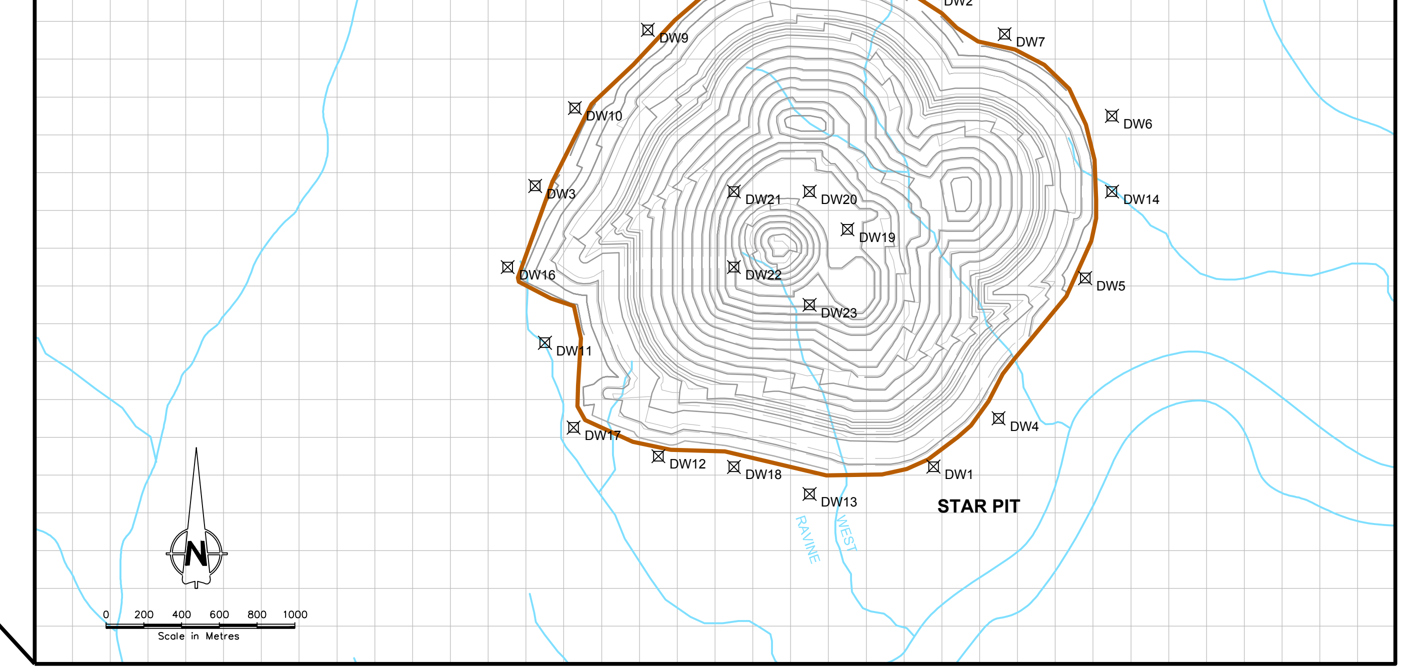
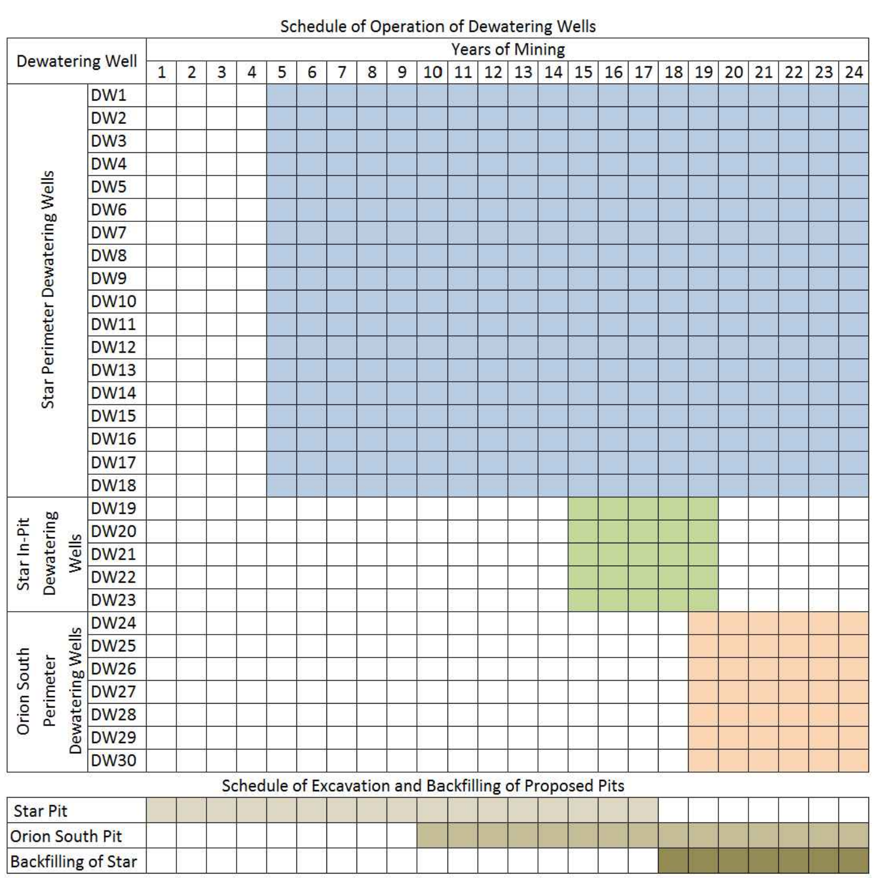
FILE NAME: 2CS016.004.Fig.17.Rev.A.Results.of.Calibration.Model.2011-06-03.dwg		**SIMULATED DRAWDOWN WITHIN MANNVILLE SANDSTONE (LOWER LAYER) AT END OF 20-DAY PUMPING TEST**

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	17	A



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STAR-ORION SOUTH DIAMOND PROJECT

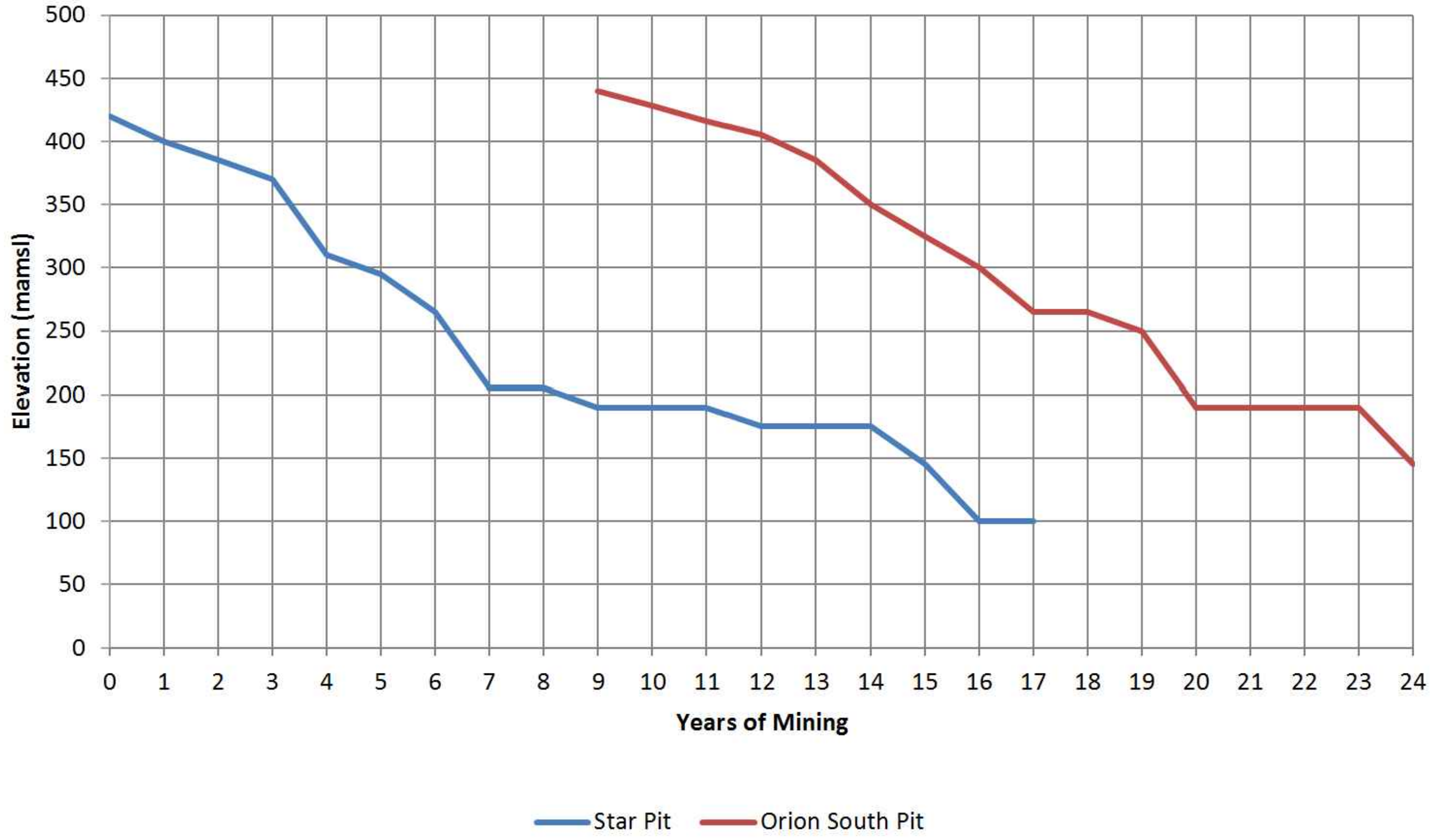
MAP VIEW OF PROPOSED OPEN PITS AND DEWATERING WELLS WITHIN FINITE-DIFFERENCE GRID

SASKATCHEWAN, CANADA

SRK JOB NO.:	2CS016.040 / TASK 0240
FILE NAME:	2CS016.004.Fig.18.Rev.A.Map.View.Open.Pits.and.Dewatering.Wells.2011-06-03.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	18	A

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling.Report.2011-07\2CS016.004.Fig.19.Rev.A.Sim.Bottom.Elev.2011-06-02.dwg



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Shore Gold Inc.

STAR-ORION SOUTH DIAMOND PROJECT

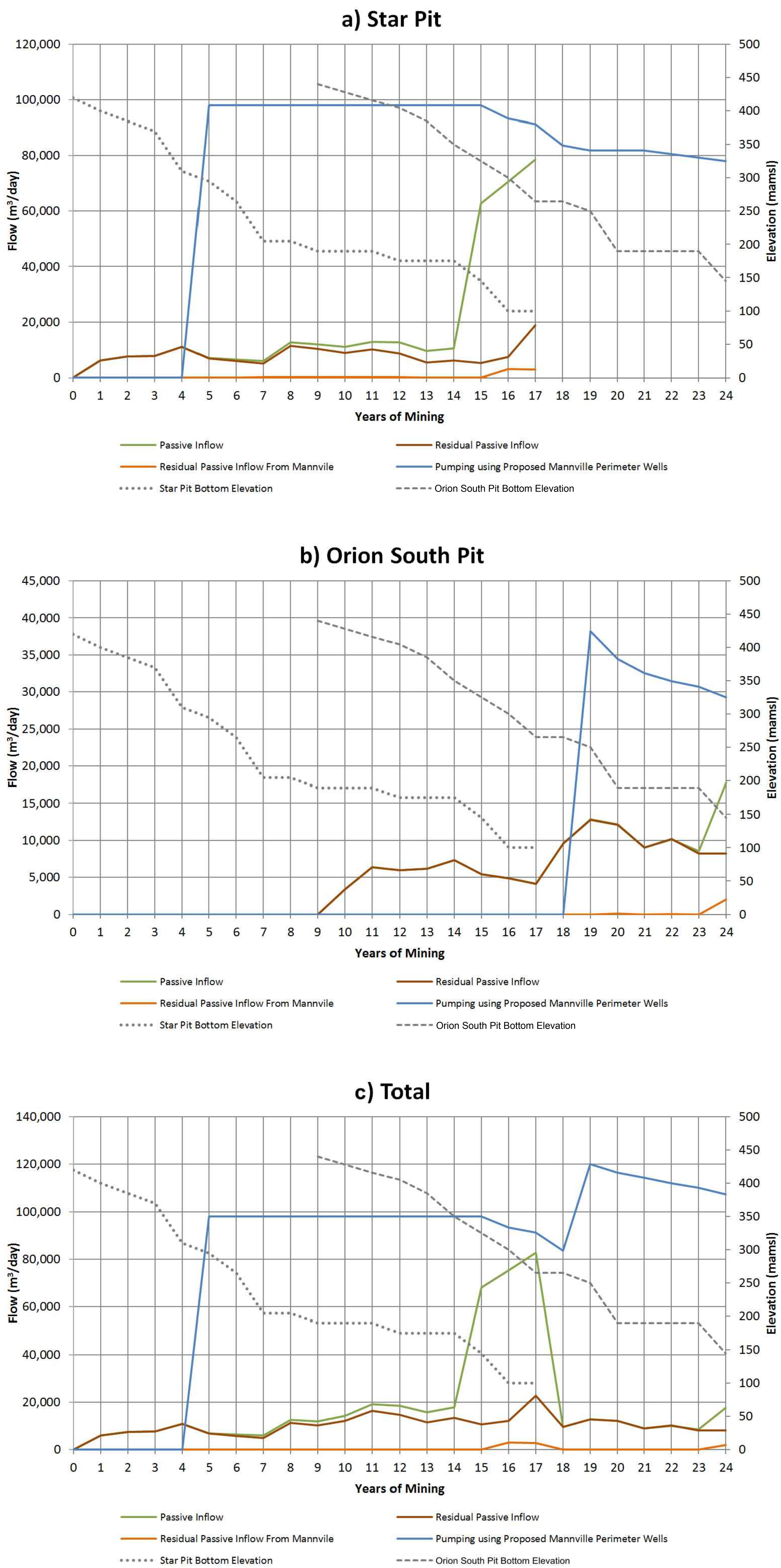
SIMULATED BOTTOM ELEVATIONS OF STAR AND ORION SOUTH PITS VS. TIME

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.19.Rev.A.Sim.Bottom.Elev.2011-06-02.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	19	A



srk consulting

Shore Gold Inc.

STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED PASSIVE INFLOW, PUMPING USING PROPOSED MANNVILLE WELL DEWATERING SYSTEM, AND RESIDUAL PASSIVE INFLOW

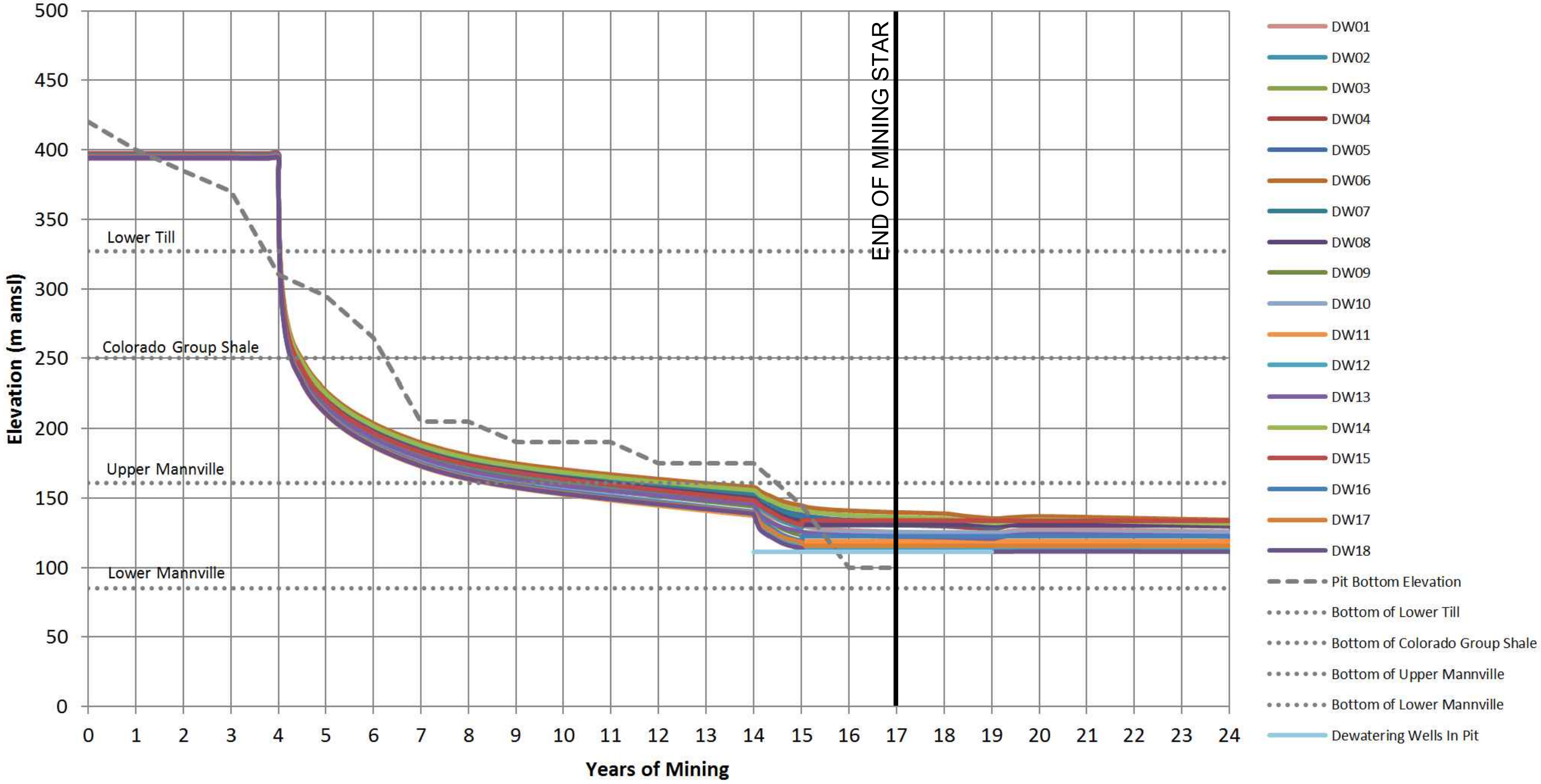
SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.20.Rev.A.Predicted.Passive.Inflow.2011-06-02.dwg

SASKATCHEWAN, CANADA

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	20	A

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling.Report.2011-07\2CS016.004.Fig.21.Rev.A.Predicted.Dewatering.2011-06-02.dwg



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STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED WATER LEVELS IN STAR PERIMETER DEWATERING WELLS OVER TIME

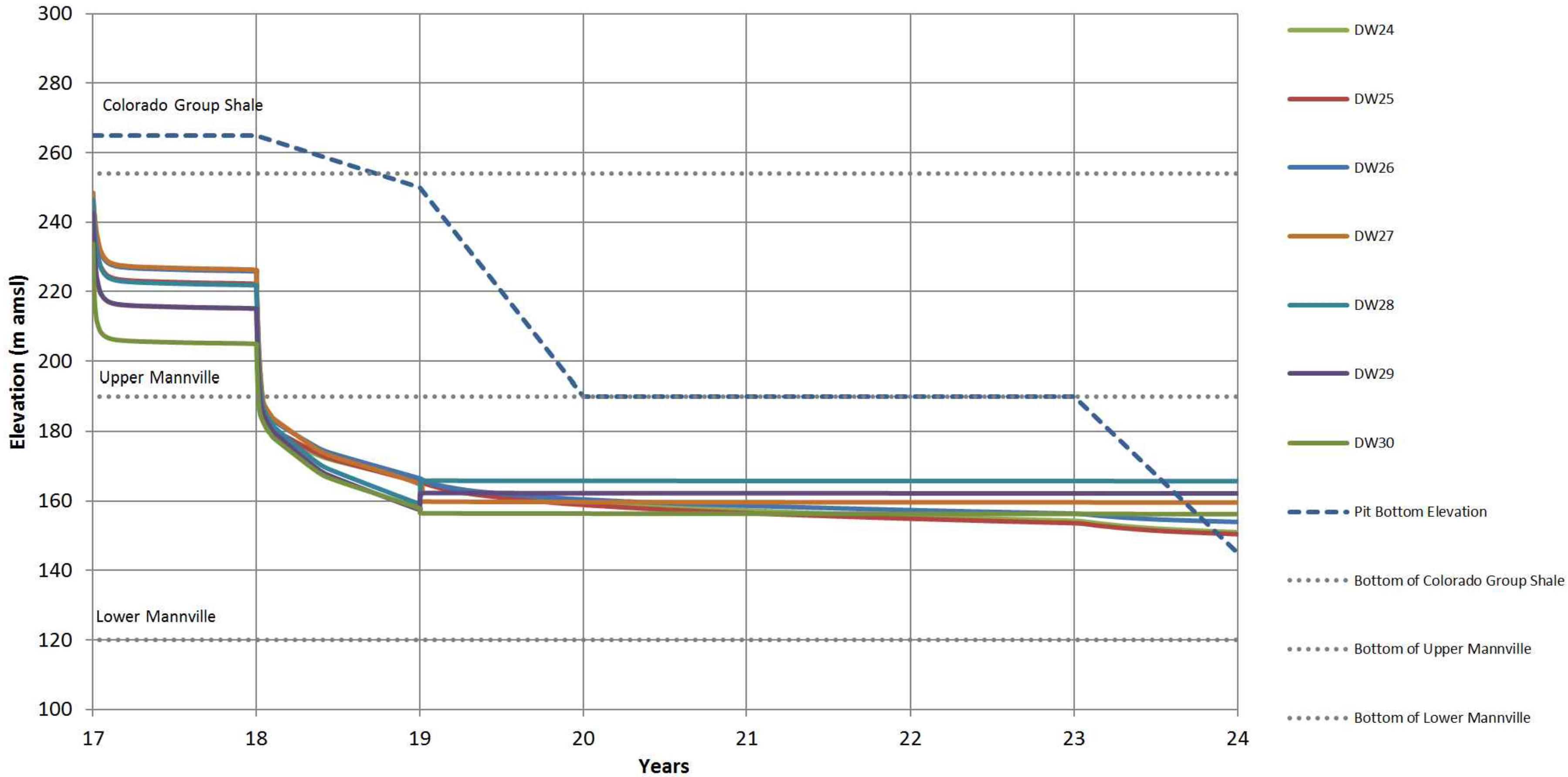
SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.21.Rev.A.Predicted.Dewatering.2011-06-02.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	21	A

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling.Report.2011-07\2CS016.004.Fig.22.Rev.A.Predicted.Orion.Dewatering.2011-06-02.dwg



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SRK JOB NO.: 2CS016.040 / TASK 0240

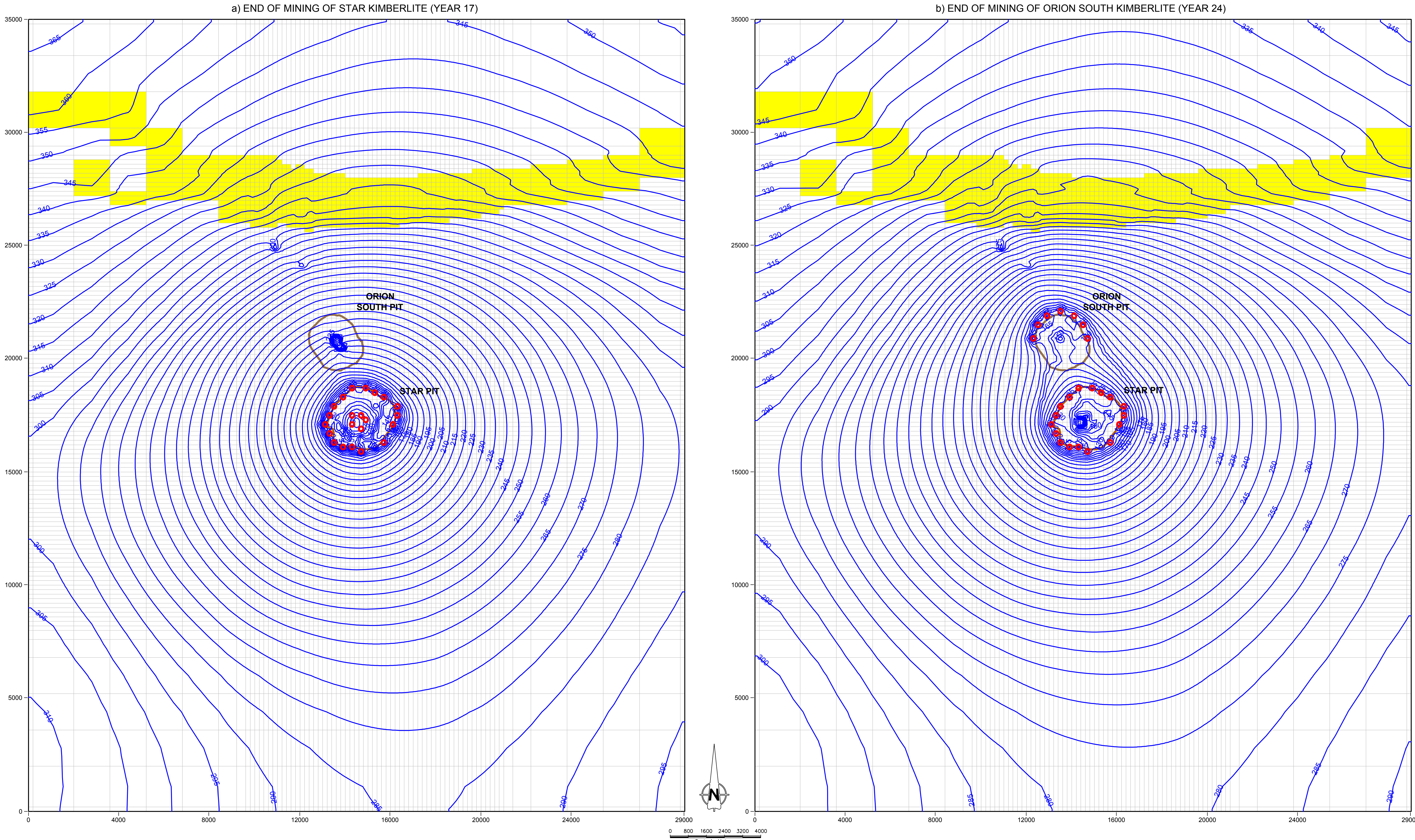
FILE NAME: 2CS016.004.Fig.22.Rev.A.Predicted.Orion.Dewatering.2011-06-02.dwg

SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED WATER LEVELS IN ORION SOUTH PERIMETER DEWATERING WELLS OVER TIME

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	22	A



LEGEND

- PREDICTED WATER LEVELS (mamsl)
- ULTIMATE STAR PIT
- ULTIMATE ORION SOUTH PIT
- DEWATERING WELL
- APPROXIMATE EXTENT OF PALEOCHANNEL

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STAR-ORION SOUTH DIAMOND PROJECT

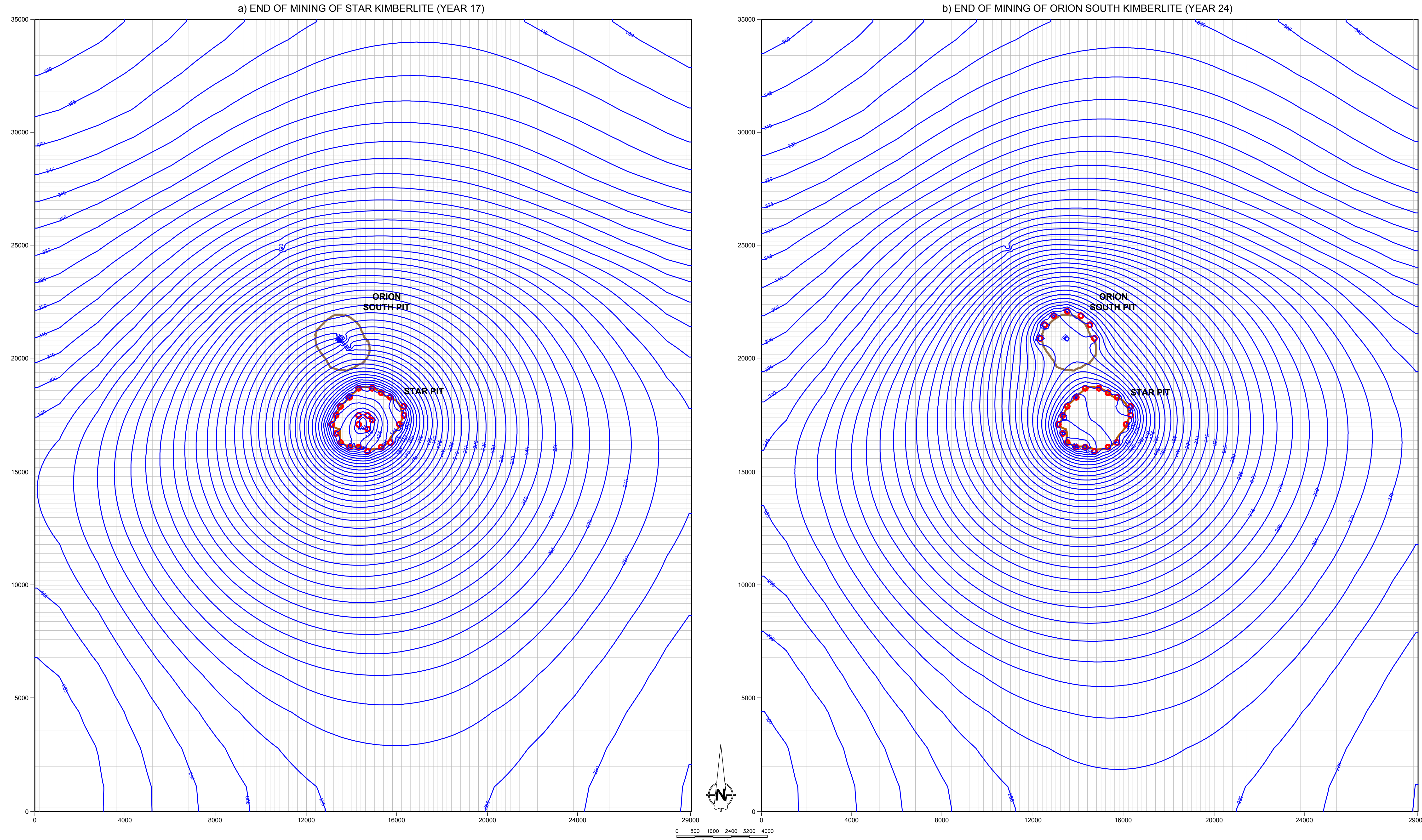
PREDICTED WATER LEVELS WITHIN UPPER MANNVILLE AT END OF MINING OF STAR AND ORION SOUTH KIMBERLITES

SASKATCHEWAN, CANADA

SRK JOB NO.:	2CS016.040 / TASK 0240
FILE NAME:	2CS016.004.Fig.23.Rev.A.Predicted.Water.Levels.End-of-Mining.2011-06-03.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	23	A

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling Report 2011-07\2CS016.004 Fig.23.Rev.A.Predicted Water Levels End-of-Mining.2011-06-03.dwg



LEGEND

- PREDICTED WATER LEVELS (mamsl)
- ULTIMATE STAR PIT
- ULTIMATE ORION SOUTH PIT
- DEWATERING WELL

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SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.24.Rev.A.Predicted.Water.Lower.Mannville.2011-06-03.dwg

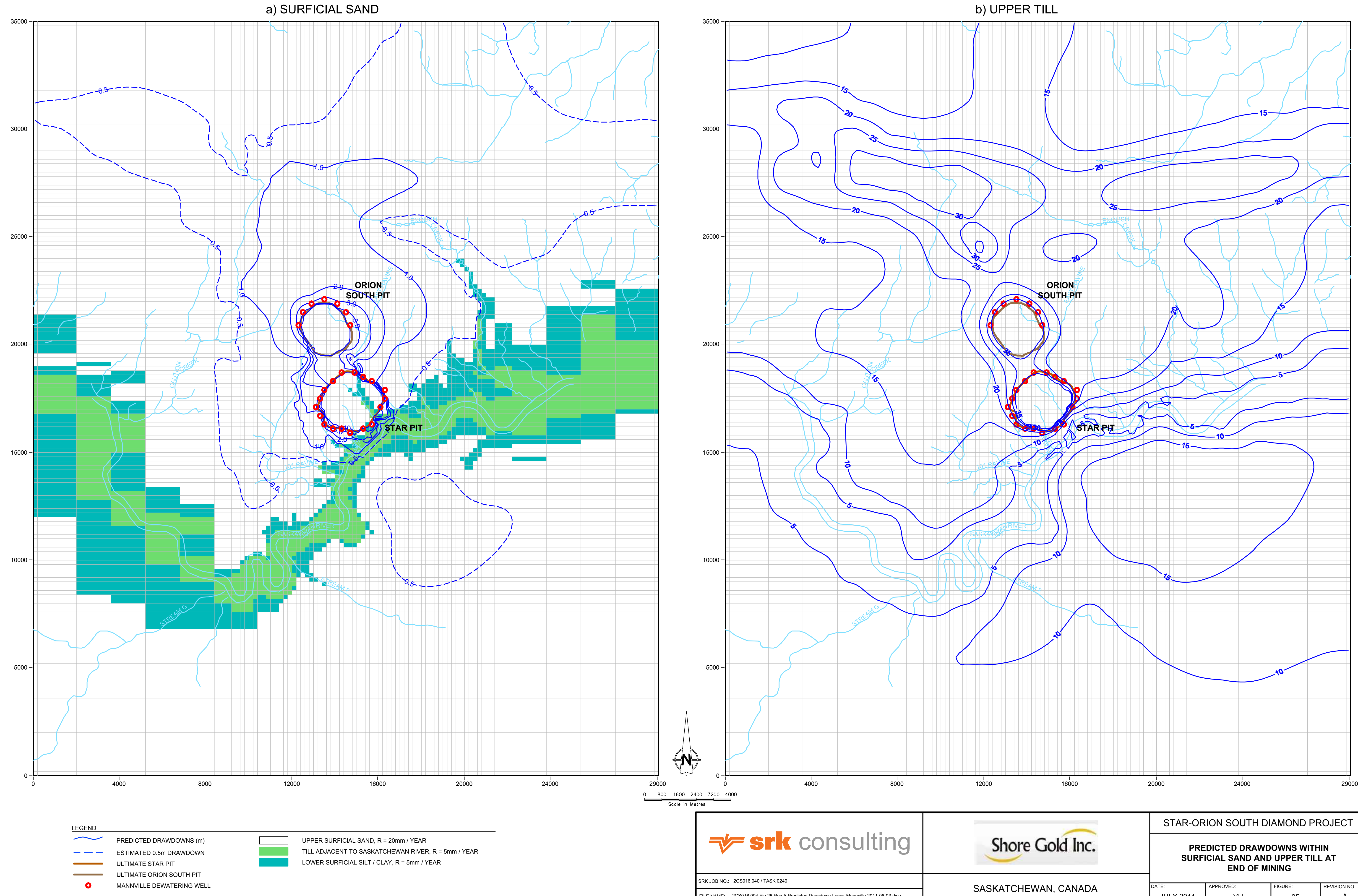
SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED WATER LEVELS WITHIN LOWER MANNVILLE AT END OF MINING OF STAR AND ORION SOUTH KIMBERLITES

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	24	A

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling Report 2011-07\2CS016.004 Fig.24.Rev.A.Predicted Water Lower Mannville.2011-06-03.dwg



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STAR-ORION SOUTH DIAMOND PROJECT

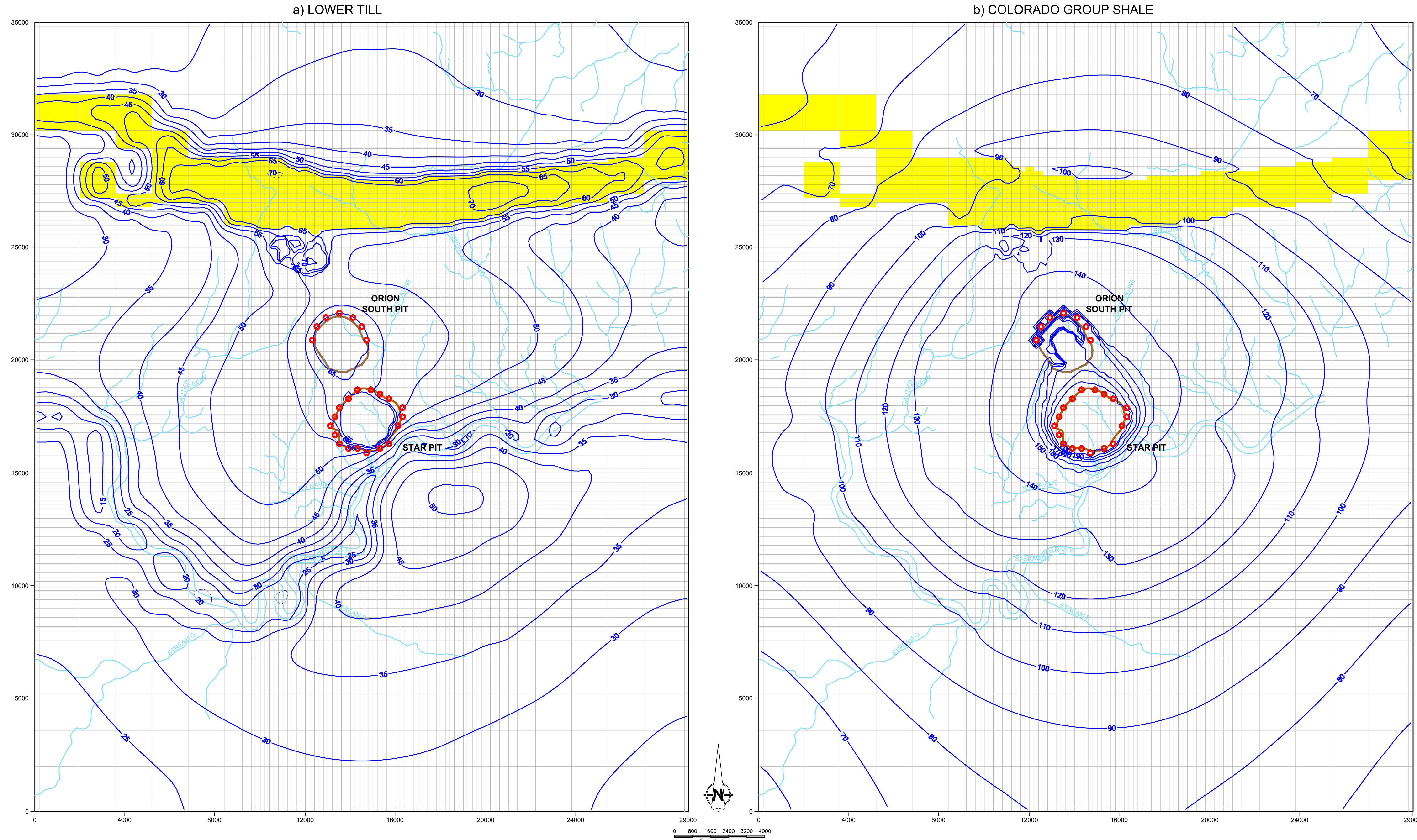
PREDICTED DRAWDOWNS WITHIN SURFICIAL SAND AND UPPER TILL AT END OF MINING

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.25.Rev.A.Predicted.Drawdown.Lower.Mannville.2011-06-03.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	25	A



LEGEND

- PREDICTED DRAWDOWNS (m)
- ESTIMATED 0.5m DRAWDOWN
- ULTIMATE STAR PIT
- ULTIMATE ORION SOUTH PIT
- MANNVILLE DEWATERING WELL
- APPROXIMATE EXTENT OF PALEOCHANNEL

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Shore Gold Inc.

STAR-ORION SOUTH DIAMOND PROJECT

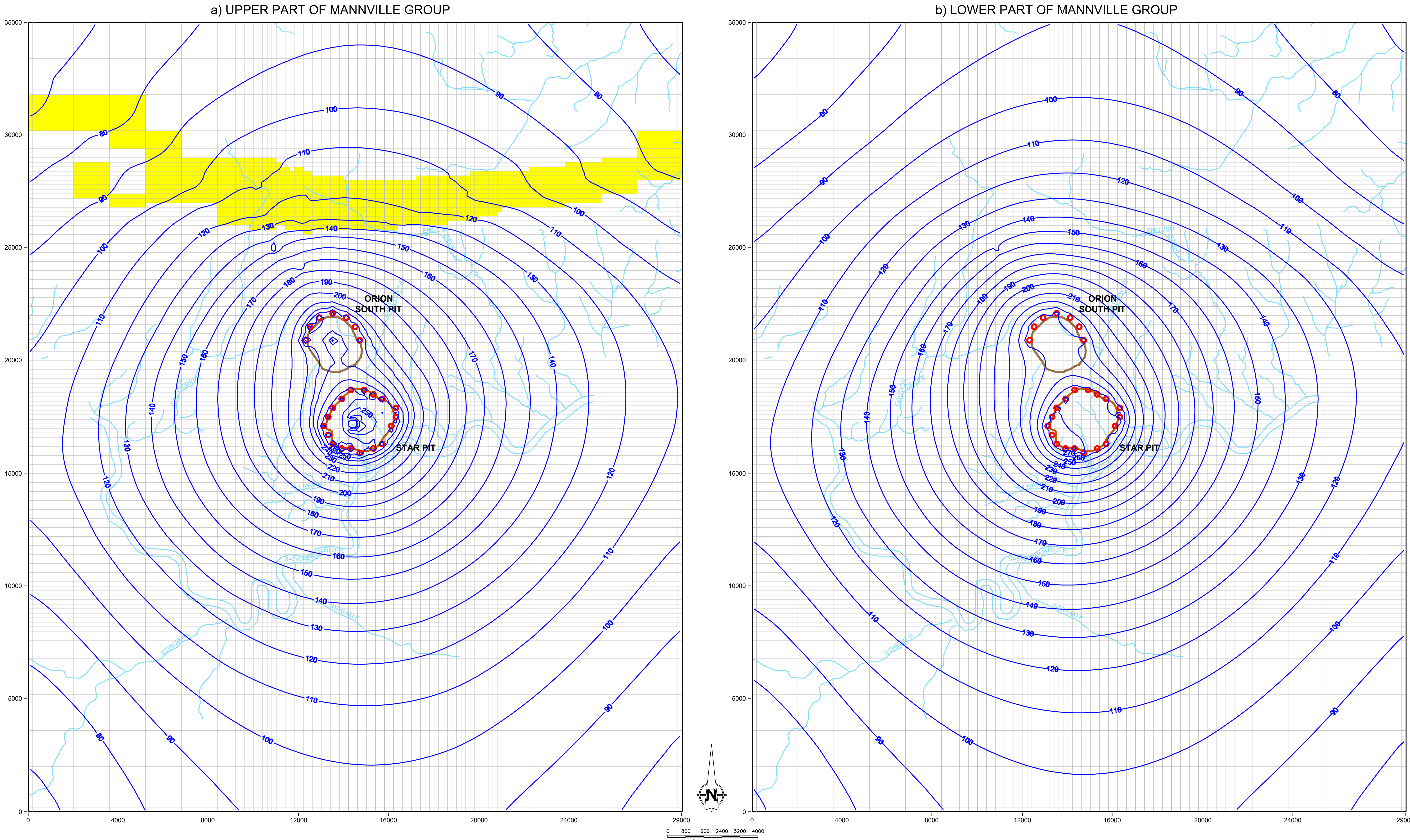
PREDICTED DRAWDOWNS WITHIN LOWER TILL AND COLORADO GROUP SHALE AT END OF MINING

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.26.Rev.A.Pred.DD.Lower.Till.and.Joli.Fou.2011-06-03.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	26	A



LEGEND

- PREDICTED DRAWDOWNS (m)
- ULTIMATE STAR PIT
- ULTIMATE ORION SOUTH PIT
- MANNVILLE DEWATERING WELL
- APPROXIMATE EXTENT OF PALEOCHANNEL

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STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED DRAWDOWNS WITHIN UPPER AND LOWER PARTS OF MANNVILLE GROUP AT END OF MINING

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240	DATE: JULY 2011	APPROVED: VU	FIGURE: 27	REVISION NO. A
FILE NAME: 2CS016.004.Fig.27.Rev.A.Pred.DD.Star.Mannville.2011-06-04.dwg				

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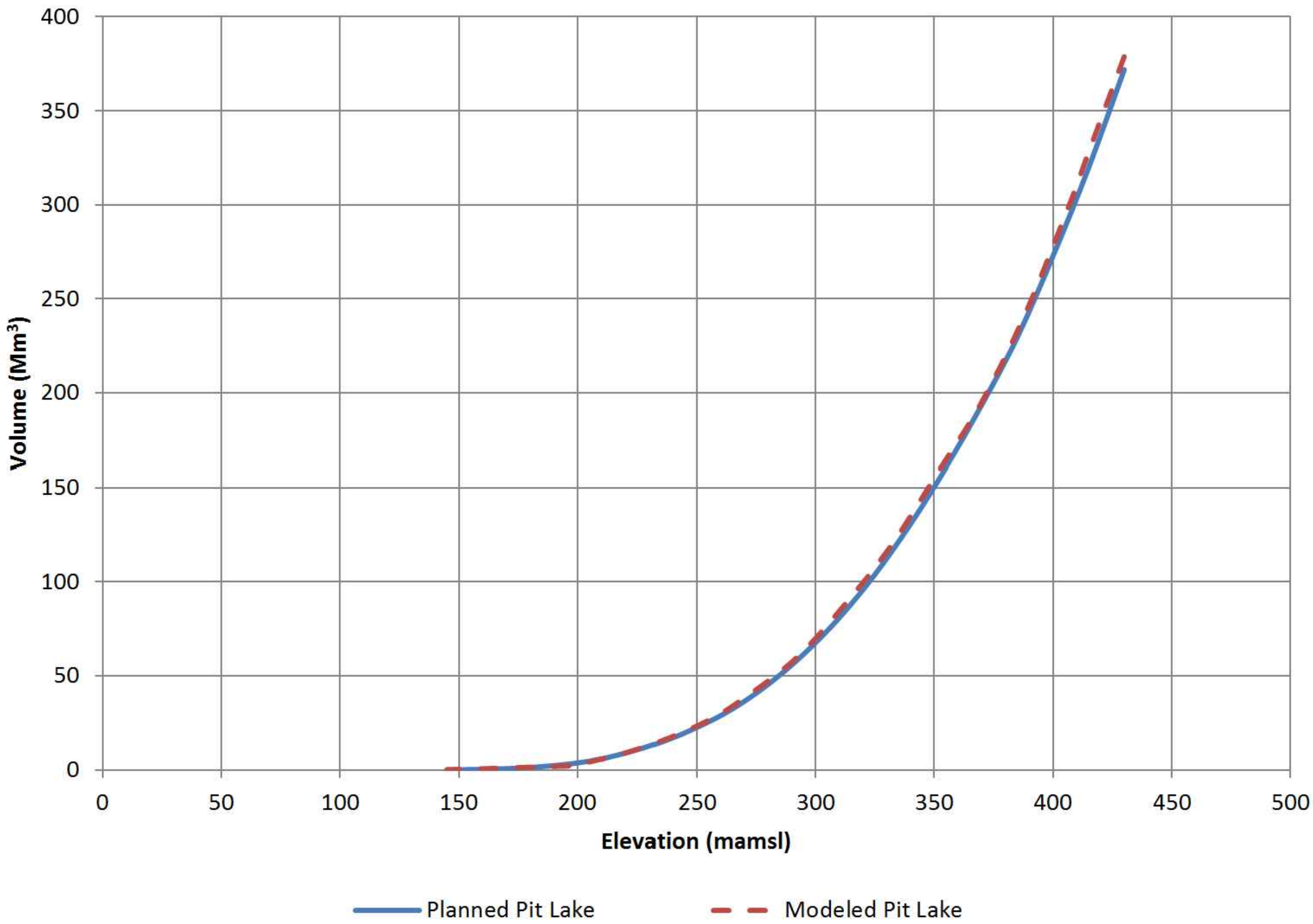

srk consulting	Shore Gold Inc.	STAR-ORION SOUTH DIAMOND PROJECT
		VOLUMES OF ORION SOUTH PIT LAKE (PLANNED VS. MODELED)
SRK JOB NO.: 2CS016.040 / TASK 0240	SASKATCHEWAN, CANADA	DATE: JULY 2011 · APPROVED: VU · FIGURE: 28 · REVISION NO. A
FILE NAME: 2CS016.004.Fig.28.Rev.A.Volumes.of.Orion.Pit.Lakes.2011-06-02.dwg		

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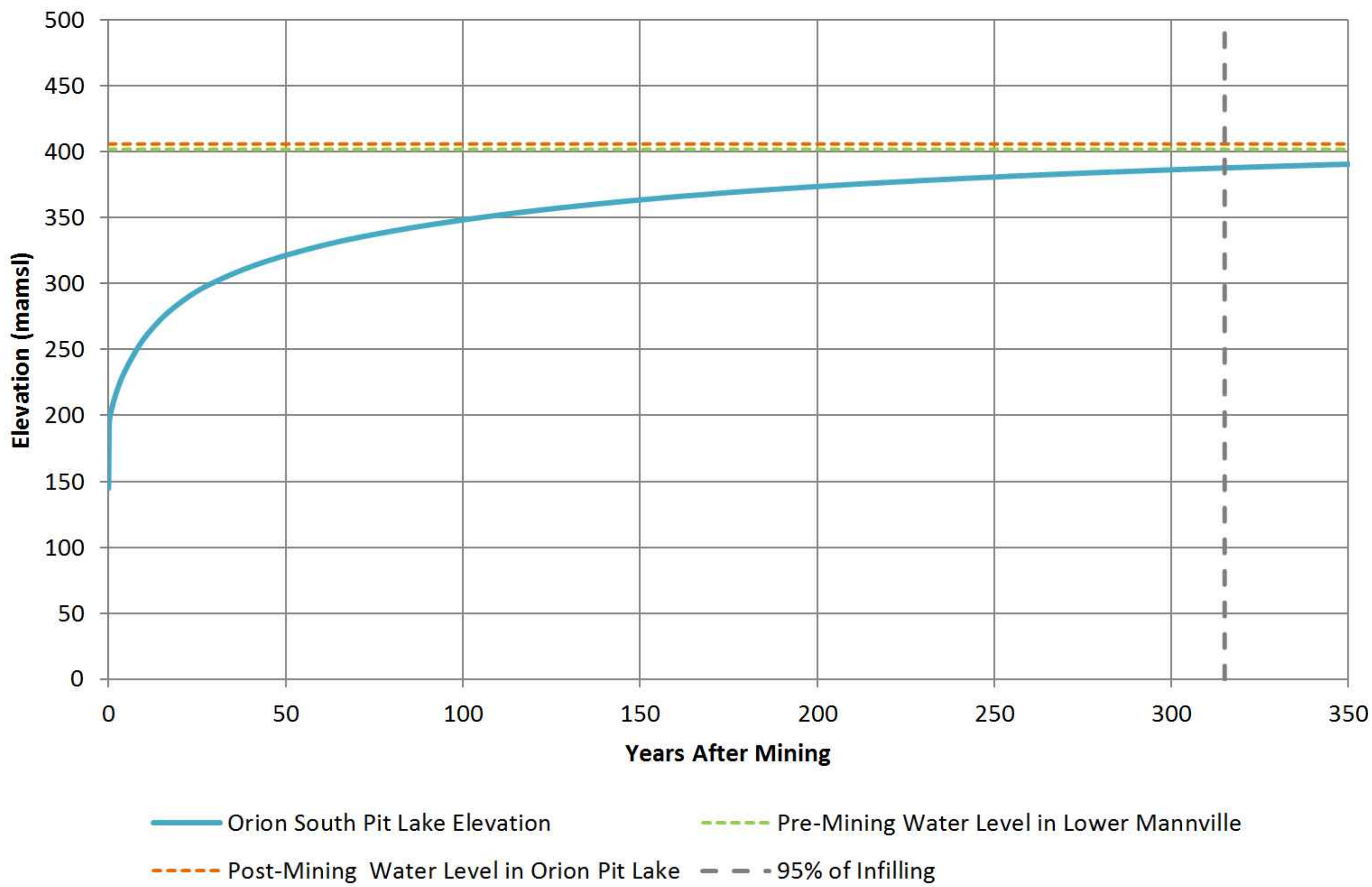

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STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED ORION SOUTH PIT LAKE ELEVATION

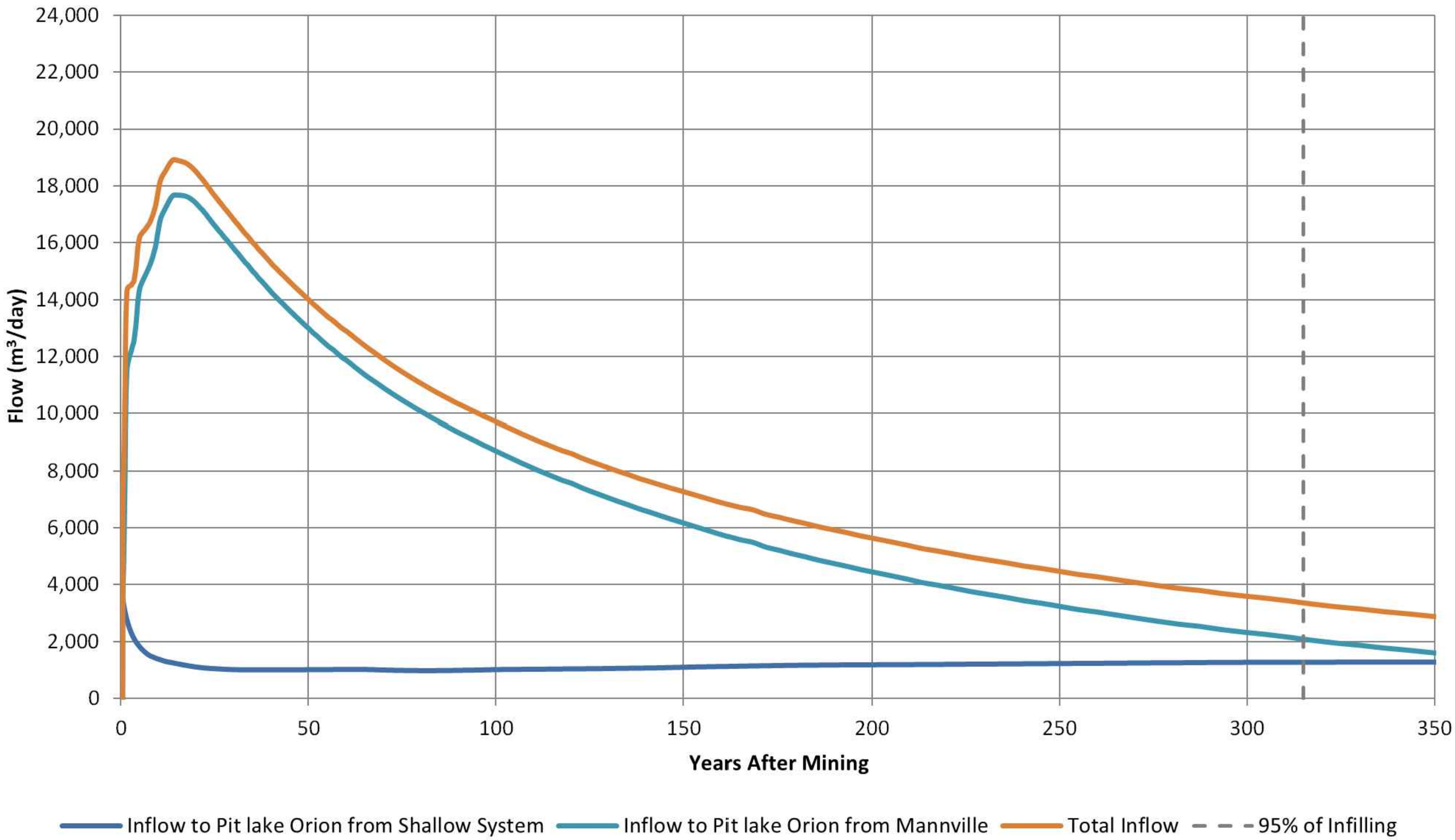
SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.29.Rev.A.Pred.Orion.South.Elev.2011-07-14.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	29	A

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling.Report.2011-07\2CS016.004.Fig.30.Rev.A.Pred.GW.Inflow.Orion.2011-07-14.dwg



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STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED GROUNDWATER INFLOW INTO ORION SOUTH PIT LAKE DURING ITS INFILLING

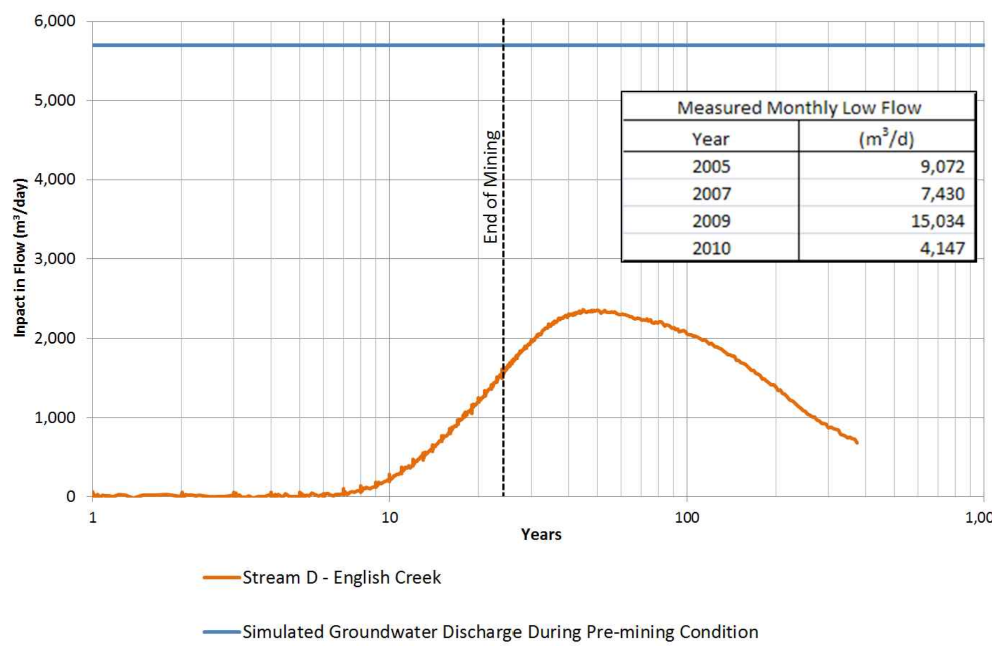
SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.30.Rev.A.Pred.GW.Inflow.Orion.2011-07-14.dwg

SASKATCHEWAN, CANADA

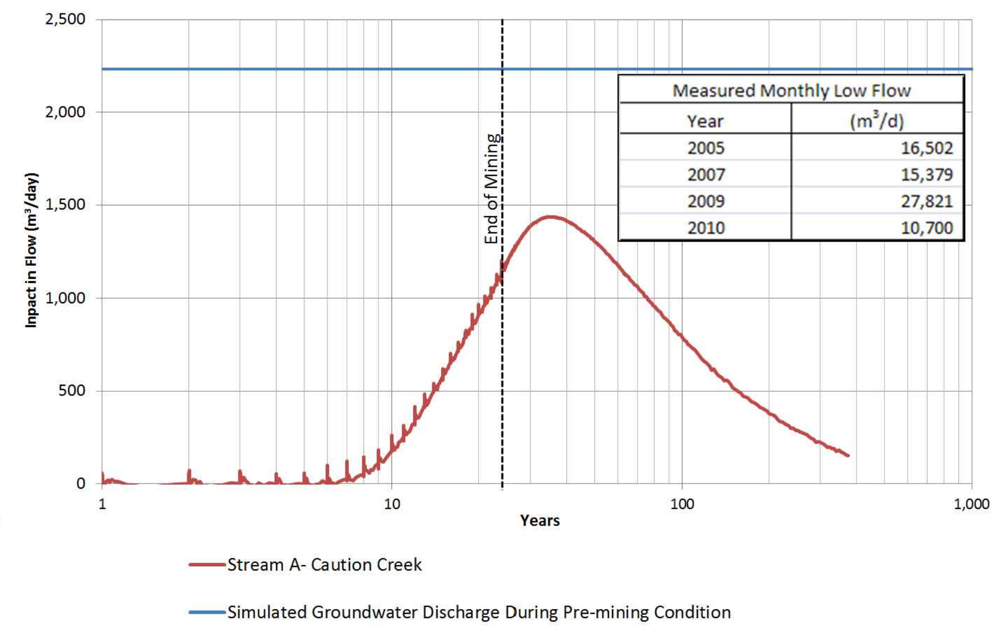
DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	30	A

a) Stream D - English Creek



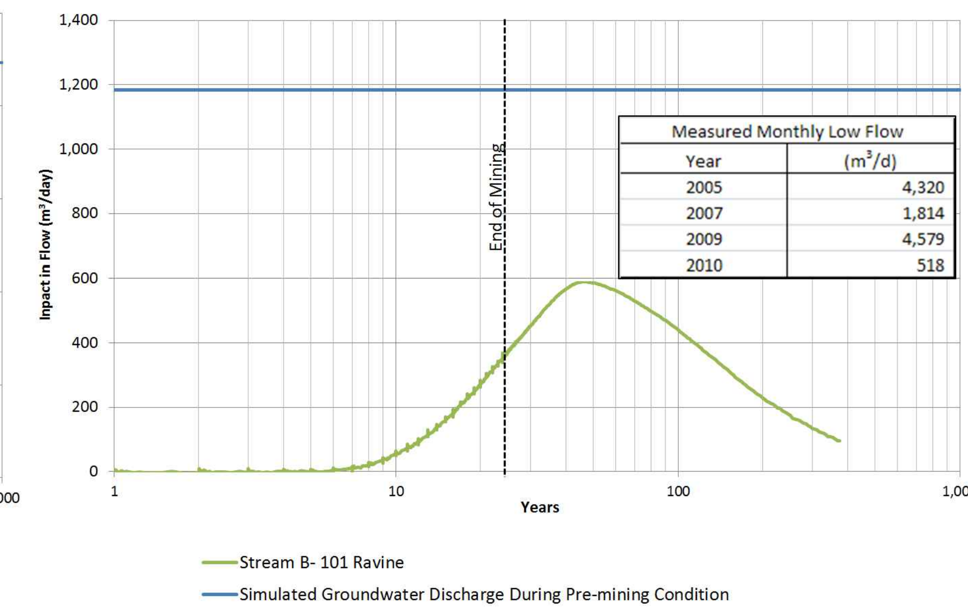
Measured Monthly Low Flow	
Year	(m^3/d)
2005	9,072
2007	7,430
2009	15,034
2010	4,147

b) Stream A - Caution Creek



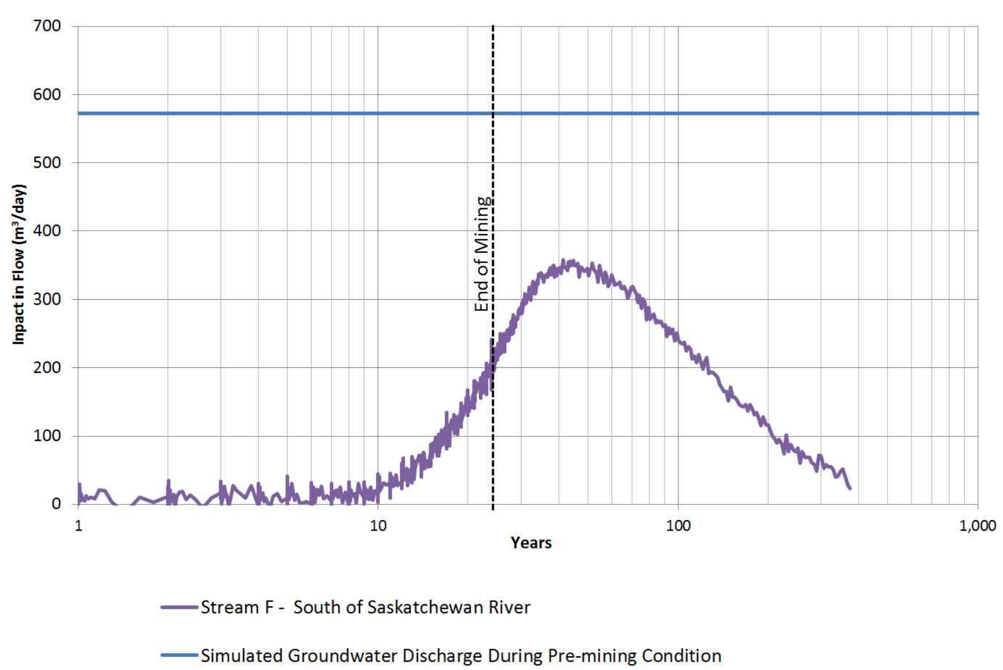
Measured Monthly Low Flow	
Year	(m^3/d)
2005	16,502
2007	15,379
2009	27,821
2010	10,700

c) Stream B - 101 Ravine Creek

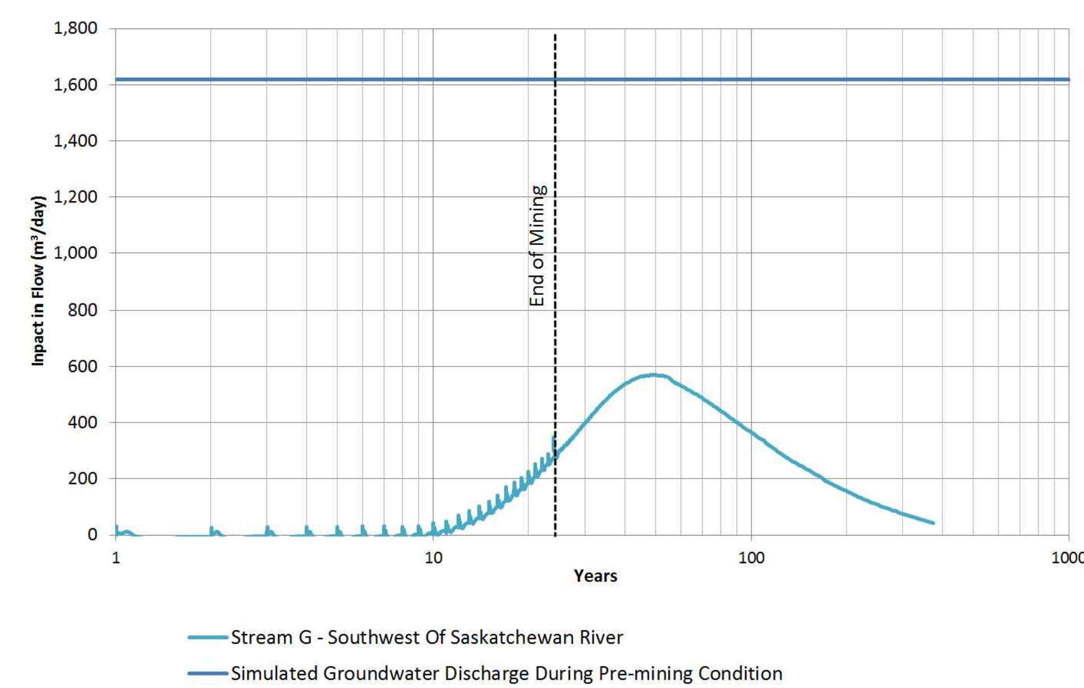


Measured Monthly Low Flow	
Year	(m^3/d)
2005	4,320
2007	1,814
2009	4,579
2010	518

d) Stream F - South of Saskatchewan River



e) Stream G - Southwest of Saskatchewan River



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STAR-ORION SOUTH DIAMOND PROJECT

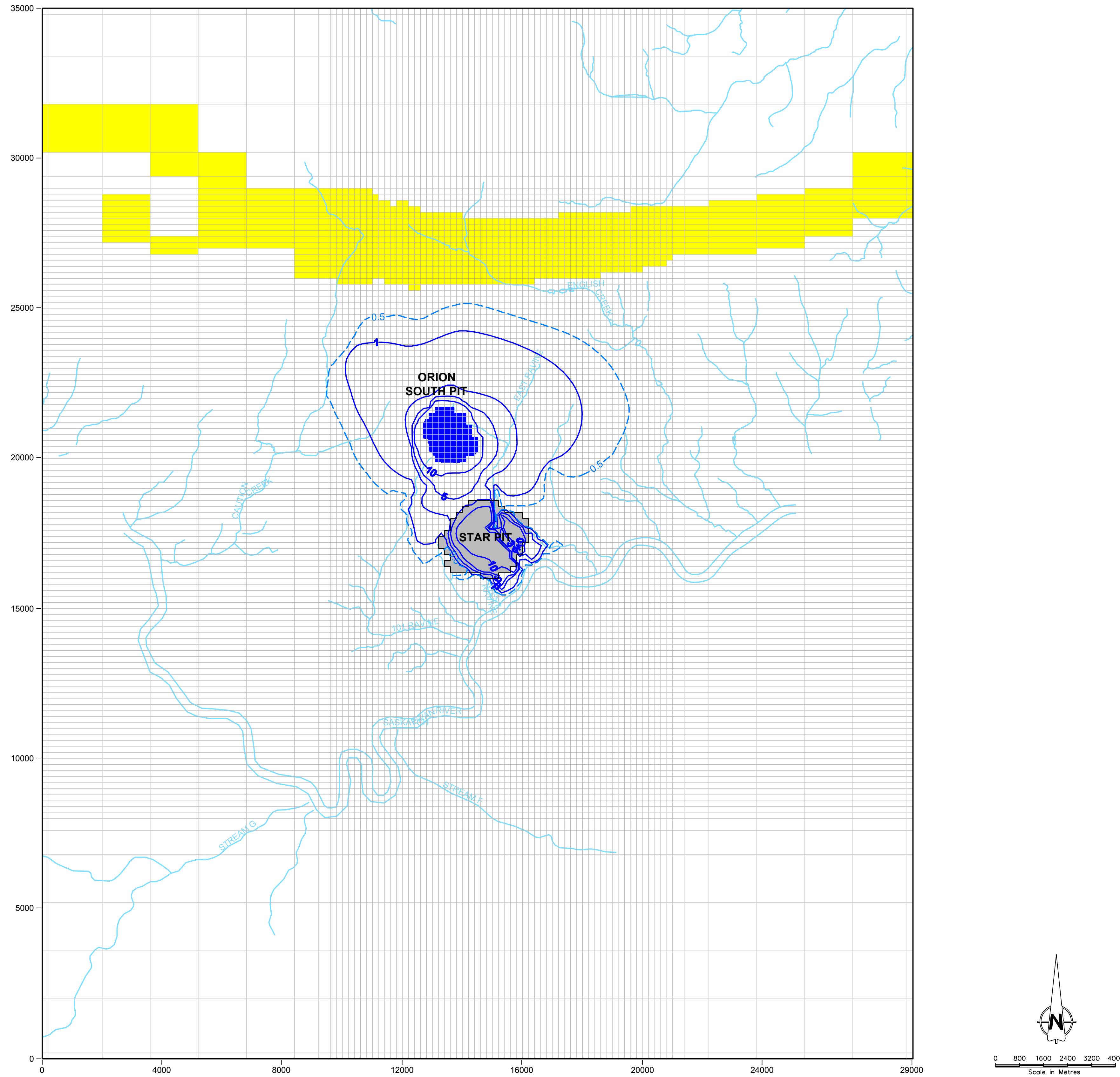
PREDICTED IMPACT TO SURFACE WATER BODIES FROM PROPOSED ACTIVE DEWATERING

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.31.Rev.A.Pred.Impact.to.Surface.Water.2011-07-14.dwg

SASKATCHEWAN, CANADA

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	31	A



LEGEND

- PREDICTED CHANGE IN WATER TABLE (m)
- ESTIMATED 0.5m PREDICTED CHANGE IN WATER TABLE (m)
- ORION SOUTH PIT LAKE
- BACKFILL IN STAR PIT
- APPROXIMATE EXTENT OF PALEOCHANNEL

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SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.32.Rev.A.Pred.Change.in.Water.Table.2011-07-19.dwg

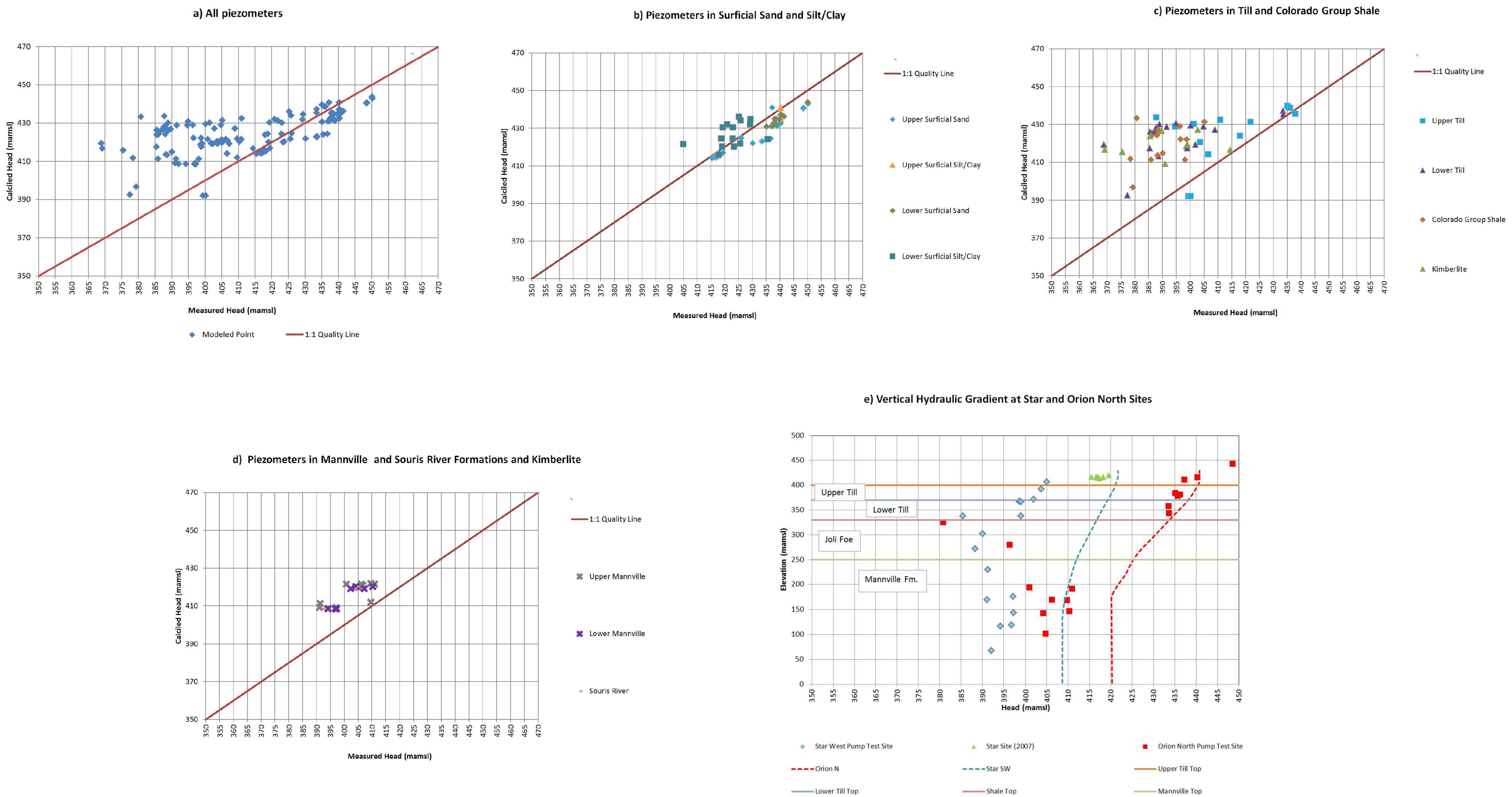
Shore Gold Inc.

SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

PREDICTED CHANGE IN WATER TABLE AT POST-MINING STEADY-STATE CONDITIONS

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	32	A



# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

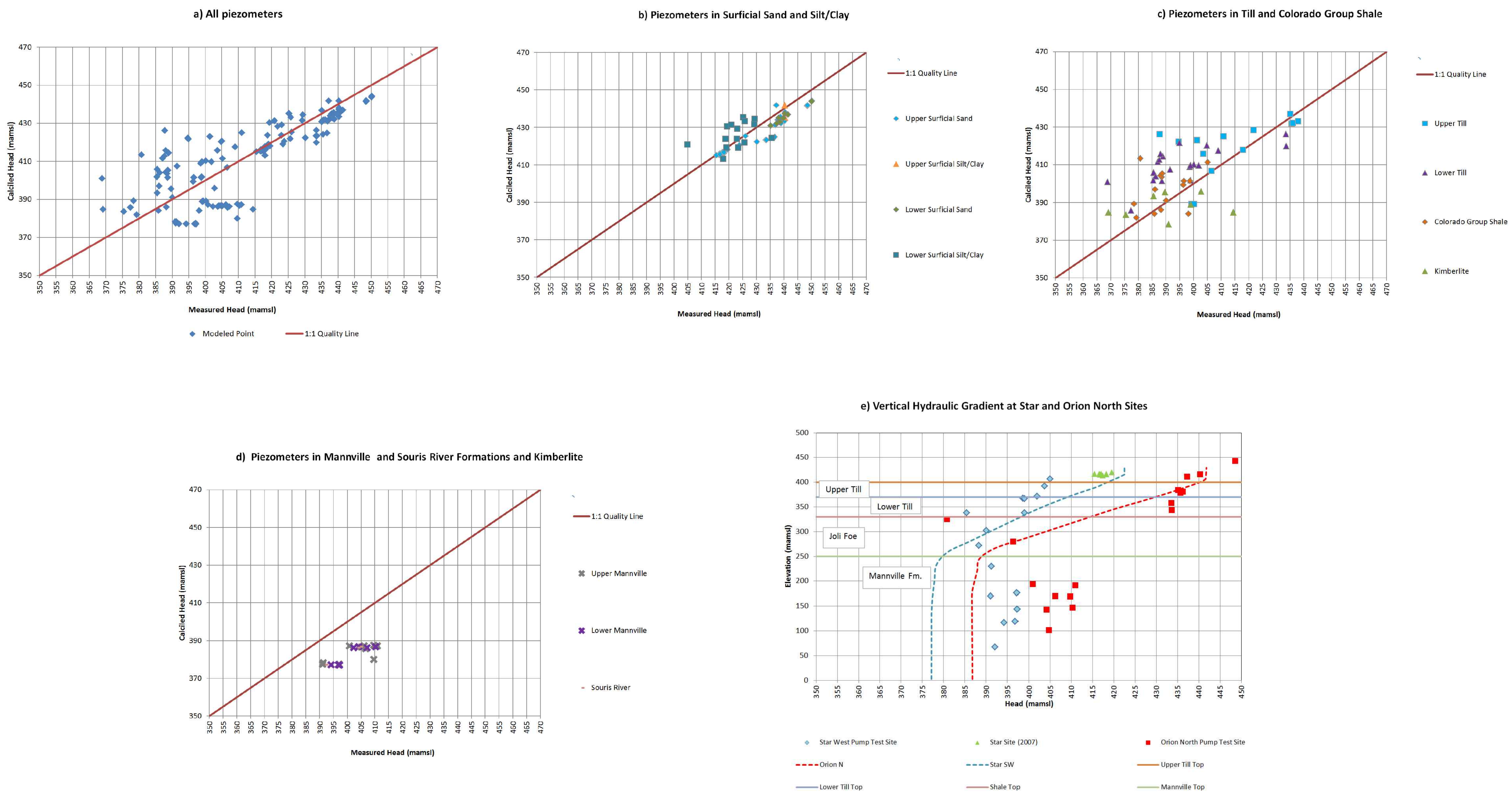
RESULTS OF SENSITIVITY ANALYSIS - COMPARISON MEASURED AND SIMULATED PRE-MINING WATER LEVELS FOR SCENARIO 1

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.33.Rev.A.Results.Sensitivity.Pre-Mine-Scenario1.2011-07-19.dwg

SASKATCHEWAN, CANADA

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	33	A



# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF SENSITIVITY ANALYSIS - COMPARISON MEASURED AND SIMULATED PRE-MINING WATER LEVELS FOR SCENARIO 2

SASKATCHEWAN, CANADA

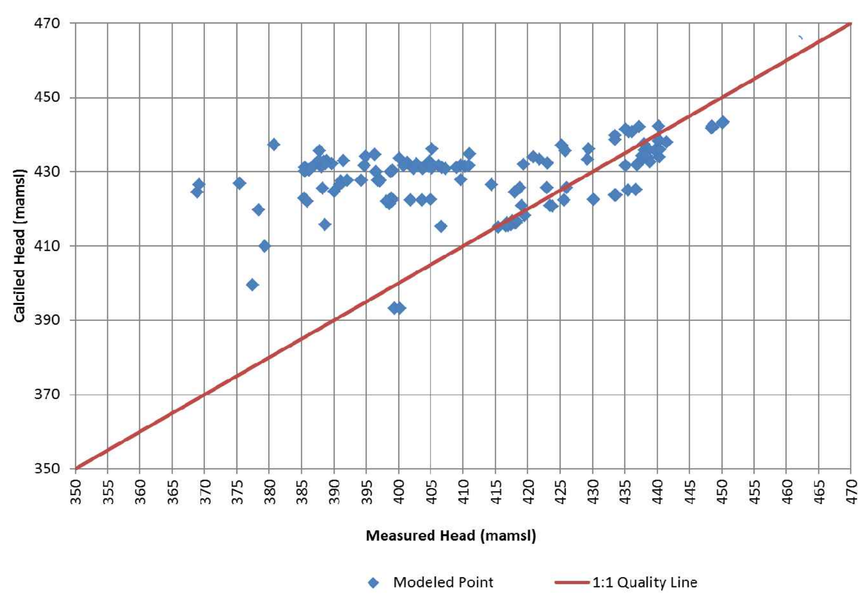
SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.34.Rev.A.Results.Sensitivity.Pre-Mine-Scenario2.2011-07-19.dwg

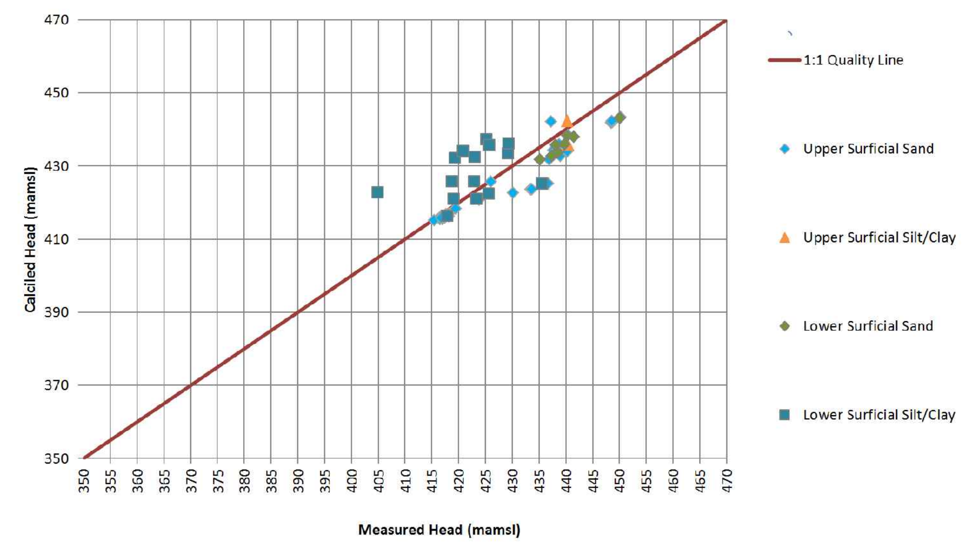
DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	34	A

T:\Star Kimberlite Canada\2CS016.004_Star-Orion_South\040_AutoCAD\Figures\Modeling Report 2011-07\2CS016.004.Fig.34.Rev.A.Results.Sensitivity.Pre-Mine-Scenario2.2011-07-19.dwg

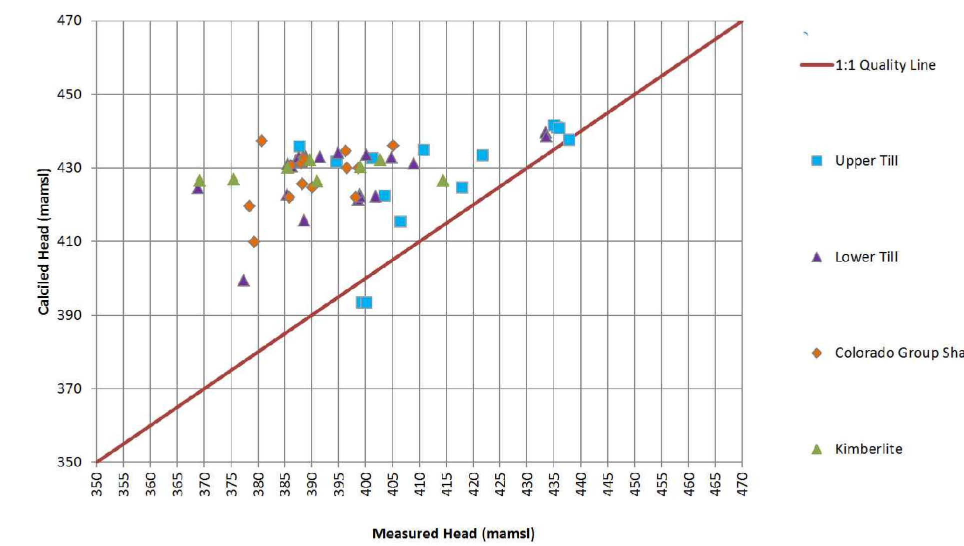
a) All piezometers



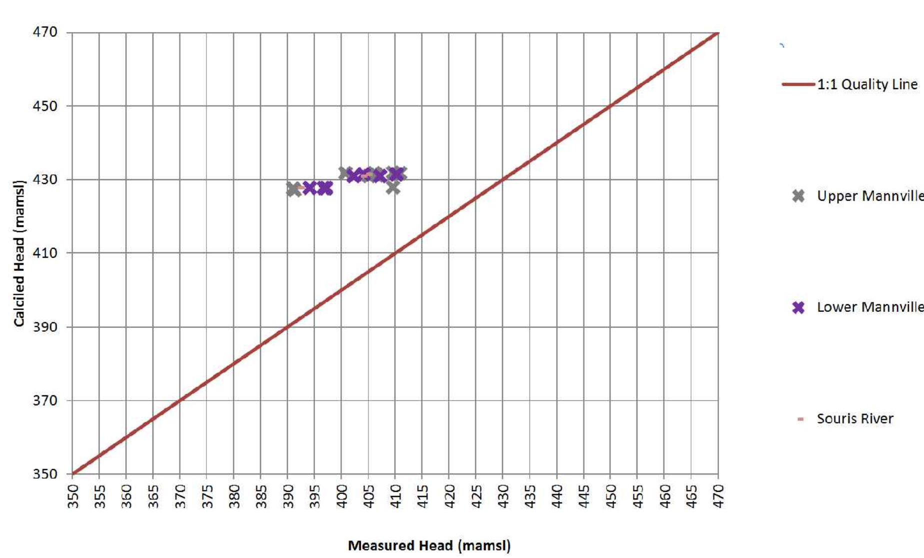
b) Piezometers in Surficial Sand and Silt/Clay



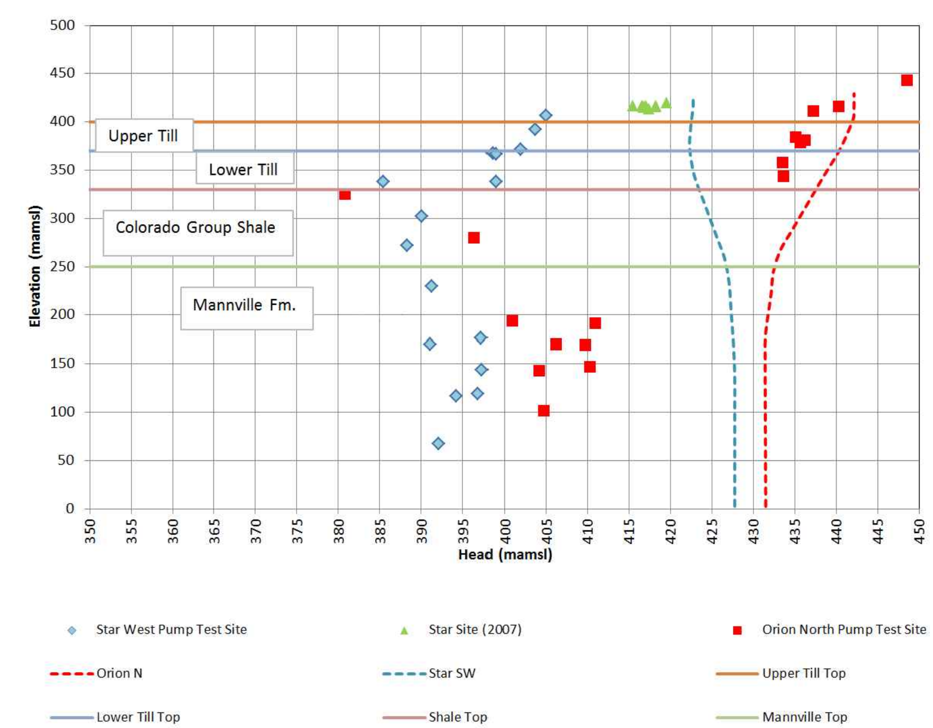
c) Piezometers in Till and Colorado Group Shale



d) Piezometers in Mannville, Souris River Formations and Kimberlite



e) Vertical Hydraulic Gradient at Star and Orion North Sites



# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

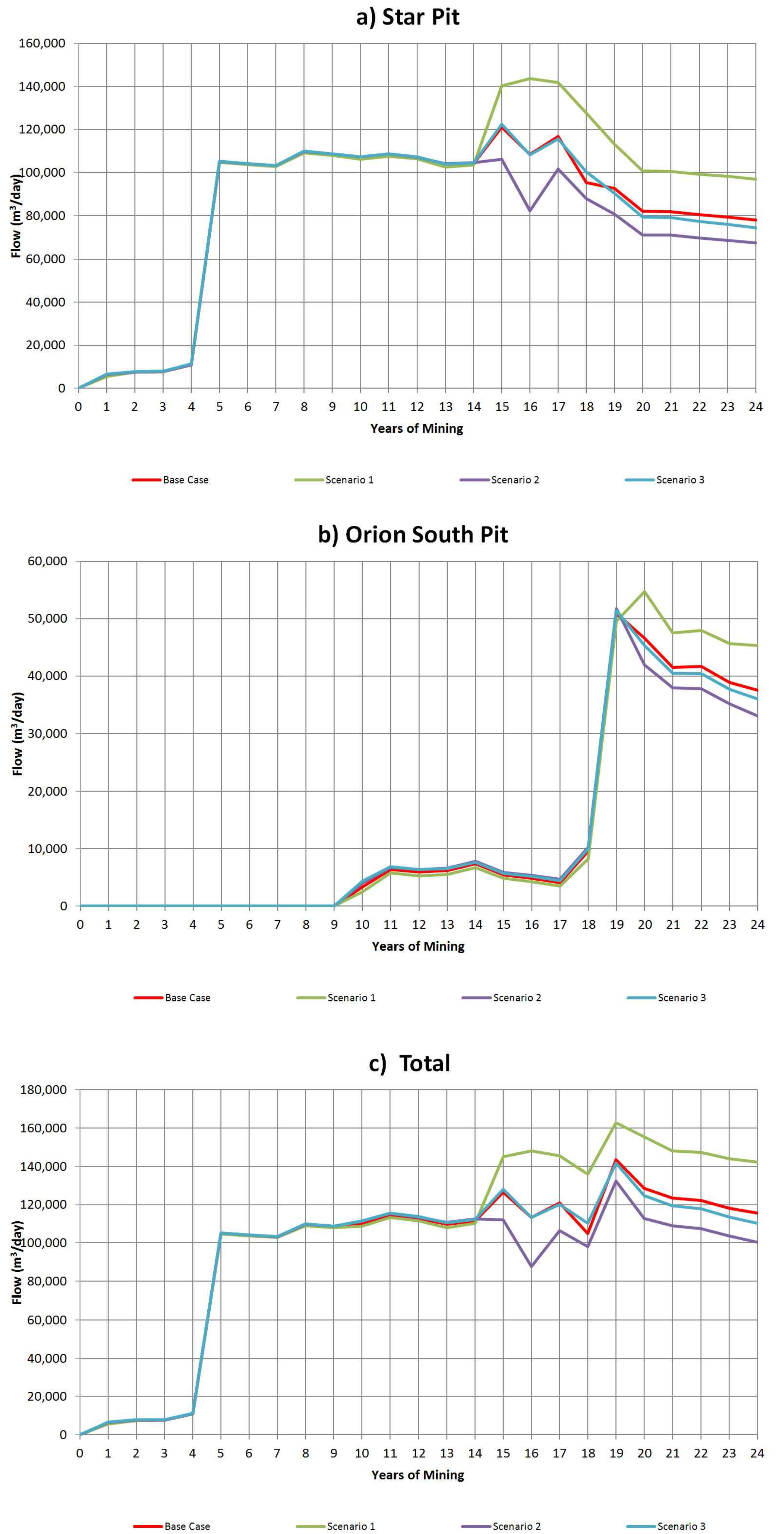
RESULTS OF SENSITIVITY ANALYSIS - COMPARISON MEASURED AND SIMULATED PRE-MINING WATER LEVELS FOR SCENARIO 3

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.35.Rev.A.Results.Sensitivity.Comparison.Scenario2.2011-07-19.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	35	A



# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

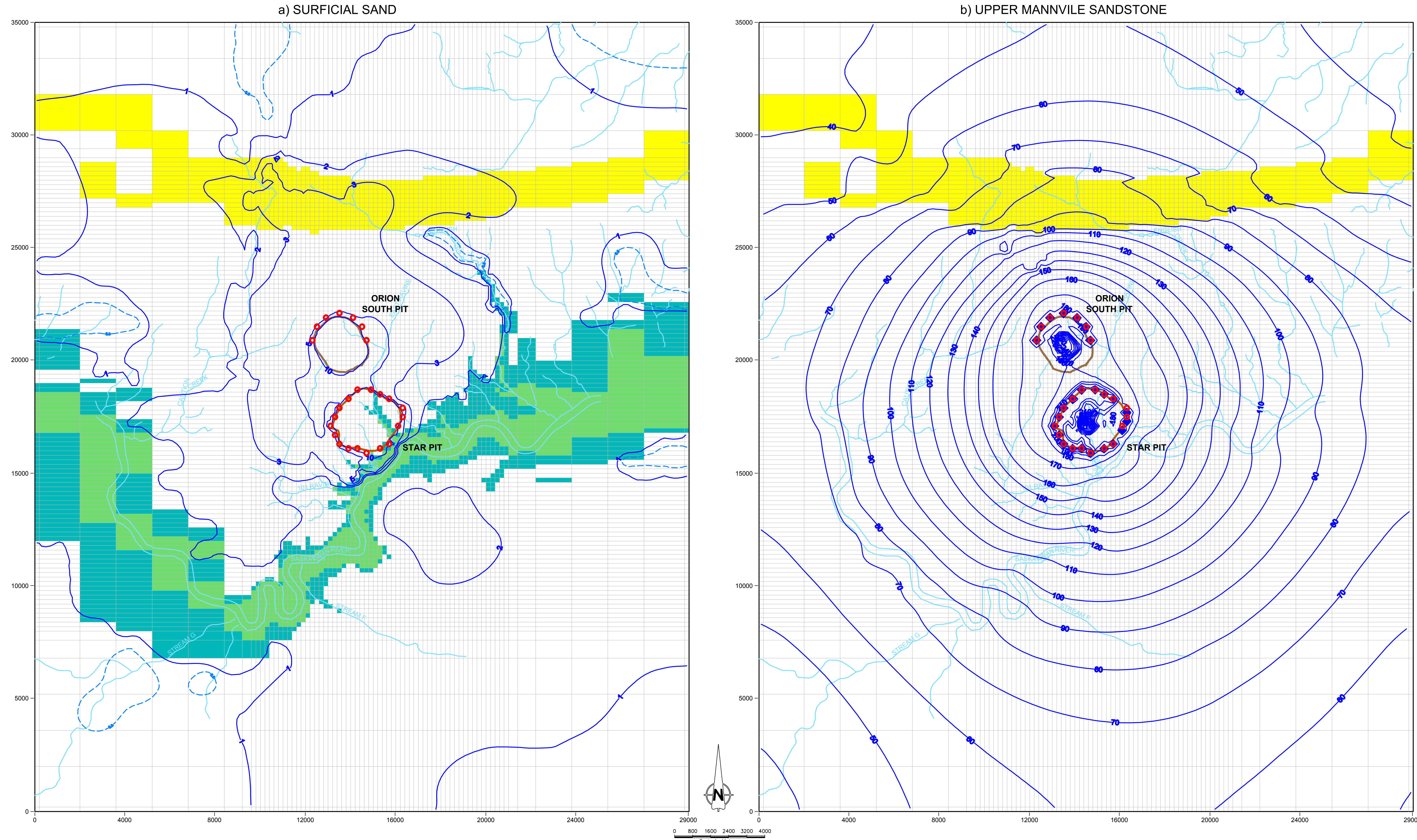
RESULTS OF SENSITIVITY ANALYSIS - PREDICTED DEWATERING REQUIREMENTS

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.36.Rev.A.Results.Sensitivity.Pred.Dewatering.2011-07-19.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	36	A



LEGEND

	PREDICTED DRAWDOWNS (m)
	ESTIMATED 0.5m DRAWDOWN
	ULTIMATE STAR PIT
	ULTIMATE ORION SOUTH PIT
	MANNVILLE DEWATERING WELL
	APPROXIMATE EXTENT OF PALEOCHANNEL
	UPPER SURFICIAL SAND, R = 20mm / YEAR
	TILL ADJACENT TO SASKATCHEWAN RIVER, R = 5mm / YEAR
	LOWER SURFICIAL SILT / CLAY, R = 5mm / YEAR

# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF SENSITIVITY ANALYSIS - PREDICTED DRAWDOWN WITHIN UPPERMOST SATURATED LAYER AND UPPER PART OF MANNVILLE SANDSTONE AT END OF MINING (SCENARIO 1)

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.37.Rev.A.Results.Scenario.1.2011-07-14.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	37	A

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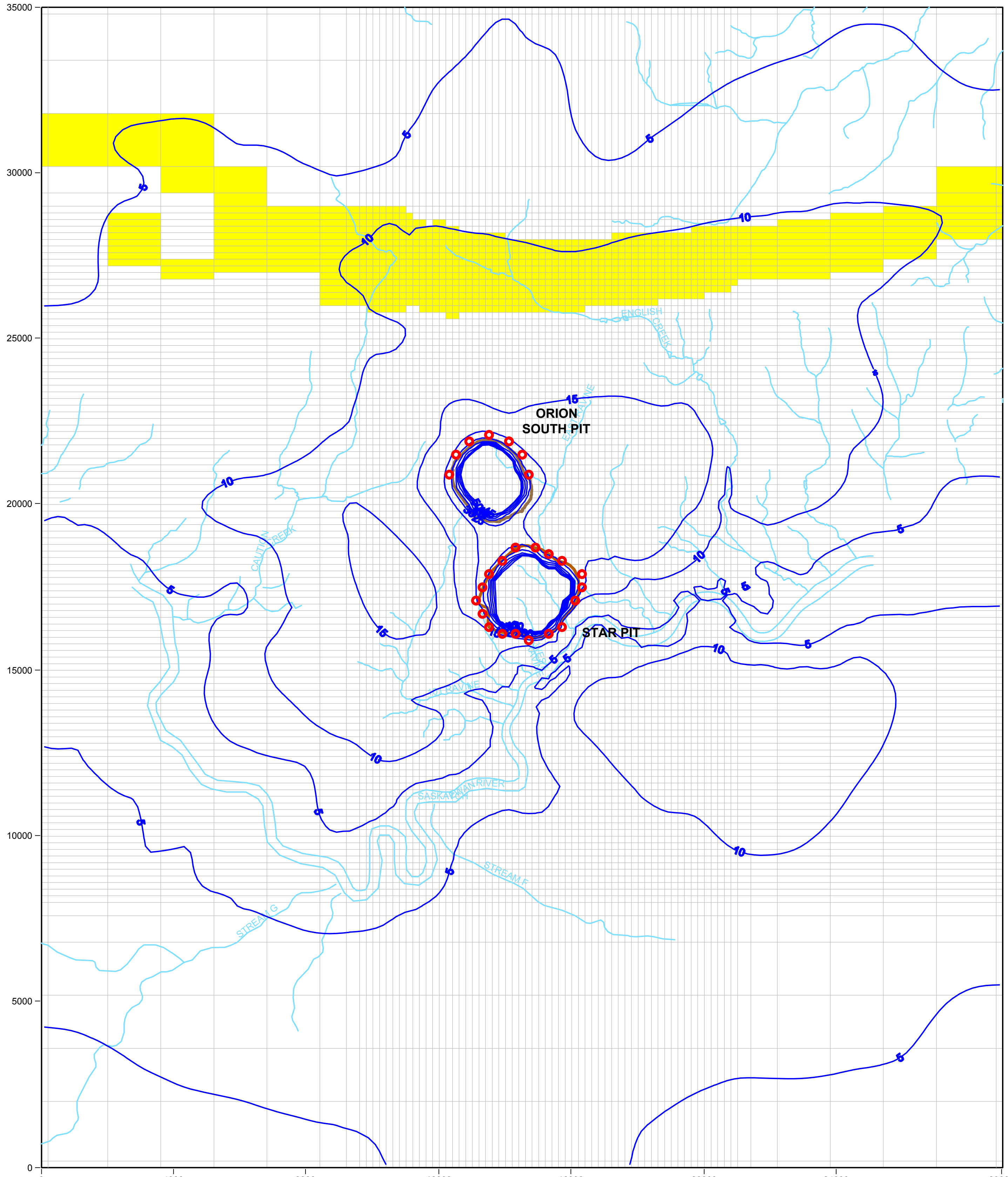
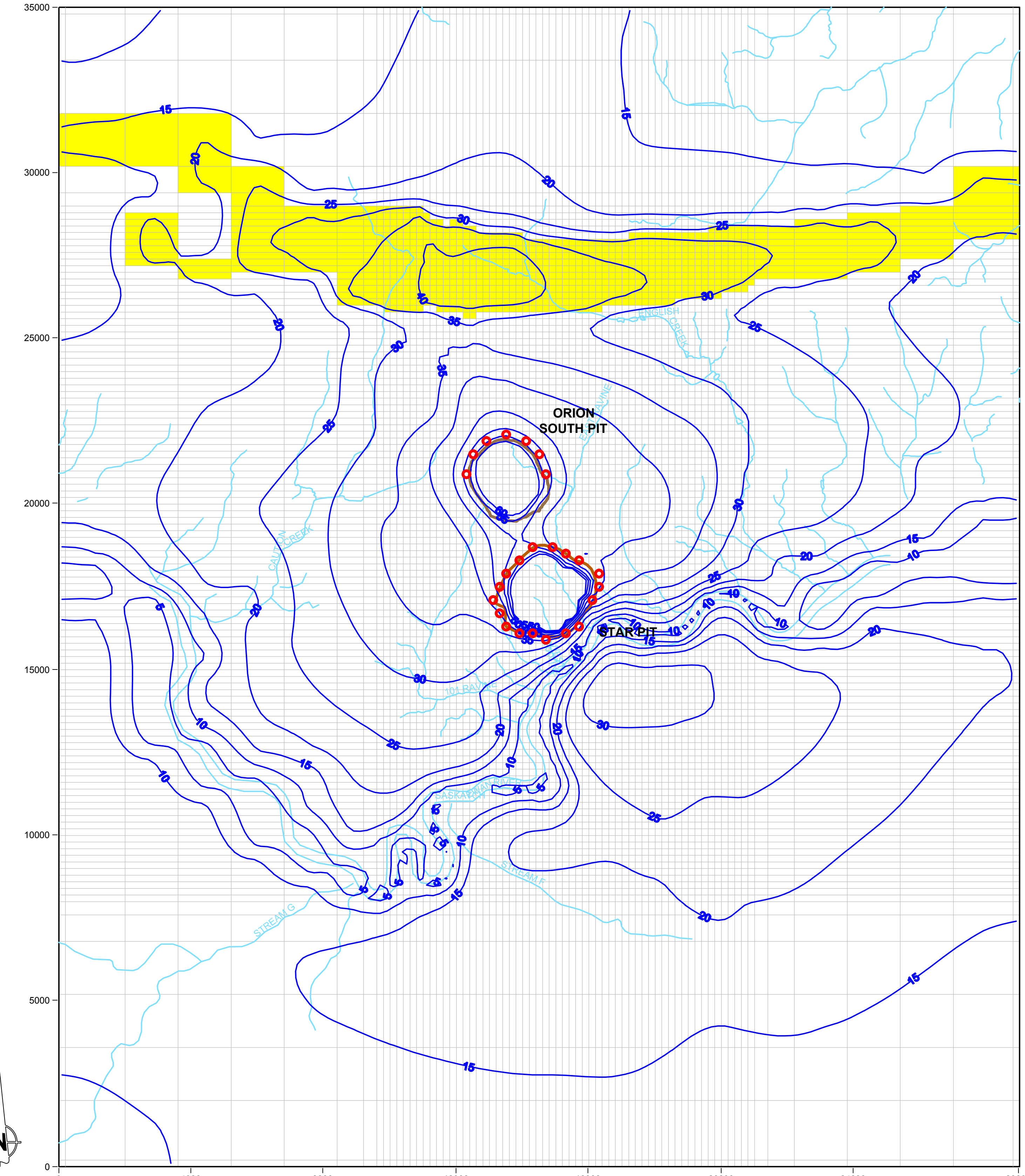
a) LOWER TILL



b) UPPER TILL



0 800 1600 2400 3200 4000
Scale in Metres

LEGEND

- PREDICTED DRAWDOWNS (m)
- ESTIMATED 0.5m DRAWDOWN
- ULTIMATE STAR PIT
- ULTIMATE ORION SOUTH PIT
- MANNVILLE DEWATERING WELL
- APPROXIMATE EXTENT OF PALEOCHANNEL

# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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SRK JOB NO.: 2CS016.040 / TASK 0240

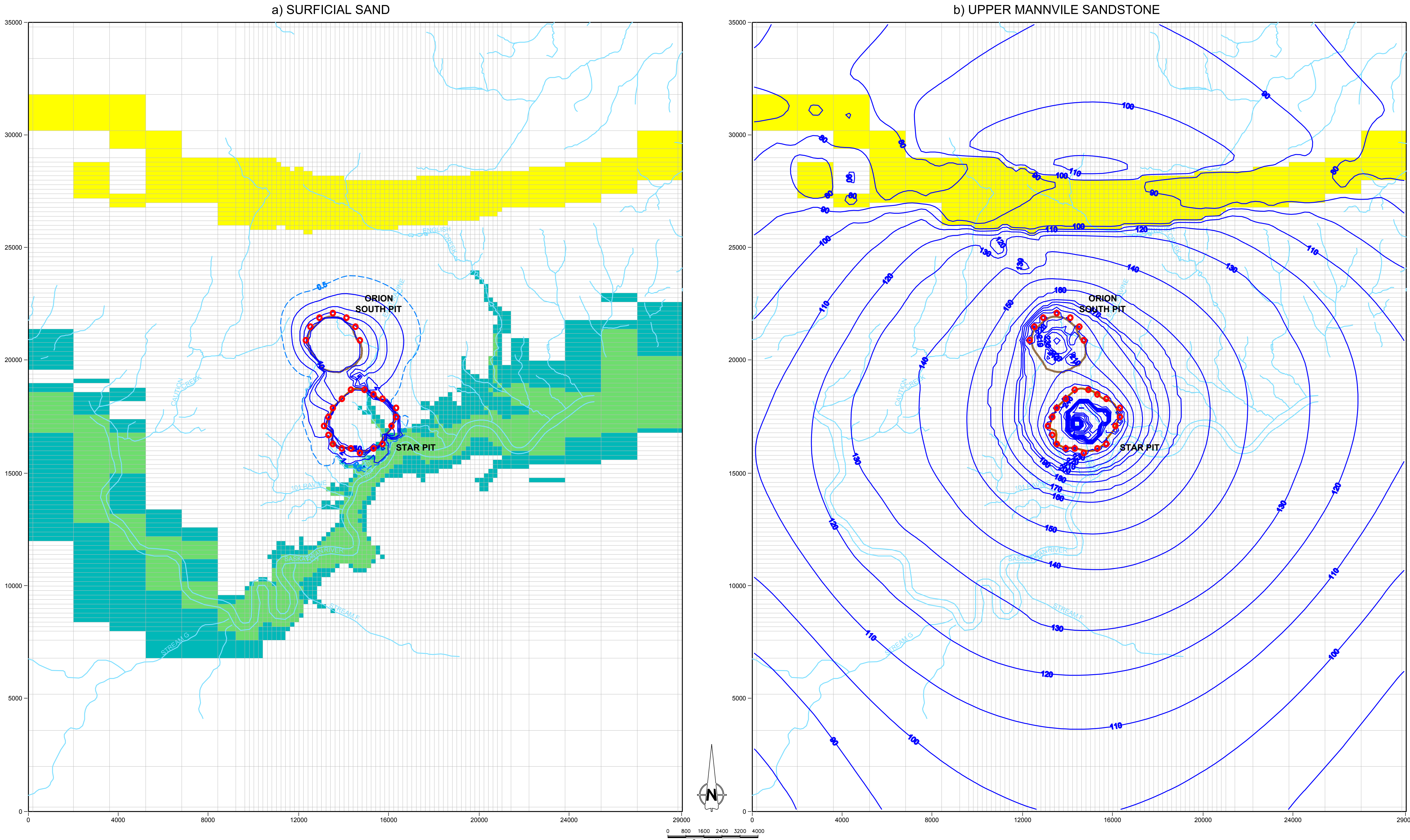
FILE NAME: 2CS016.004.Fig.38.Rev.A.Results.Scenario.2.2011-07-19.dwg

SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF SENSITIVITY ANALYSIS - PREDICTED DRAWDOWN WITHIN UPPER AND LOWER TILL AT END OF MINING (SCENARIO 1)

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	38	A



LEGEND

PREDICTED DRAWDOWNS (m)	UPPER SURFICIAL SAND, R = 20mm / YEAR
ESTIMATED 0.5m DRAWDOWN	TILL ADJACENT TO SASKATCHEWAN RIVER, R = 5mm / YEAR
ULTIMATE STAR PIT	LOWER SURFICIAL SILT / CLAY, R = 5mm / YEAR
ULTIMATE ORION SOUTH PIT	
MANNVILLE DEWATERING WELL	
APPROXIMATE EXTENT OF PALEOCHANNEL	

# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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SRK JOB NO.: 2CS016.040 / TASK 0240

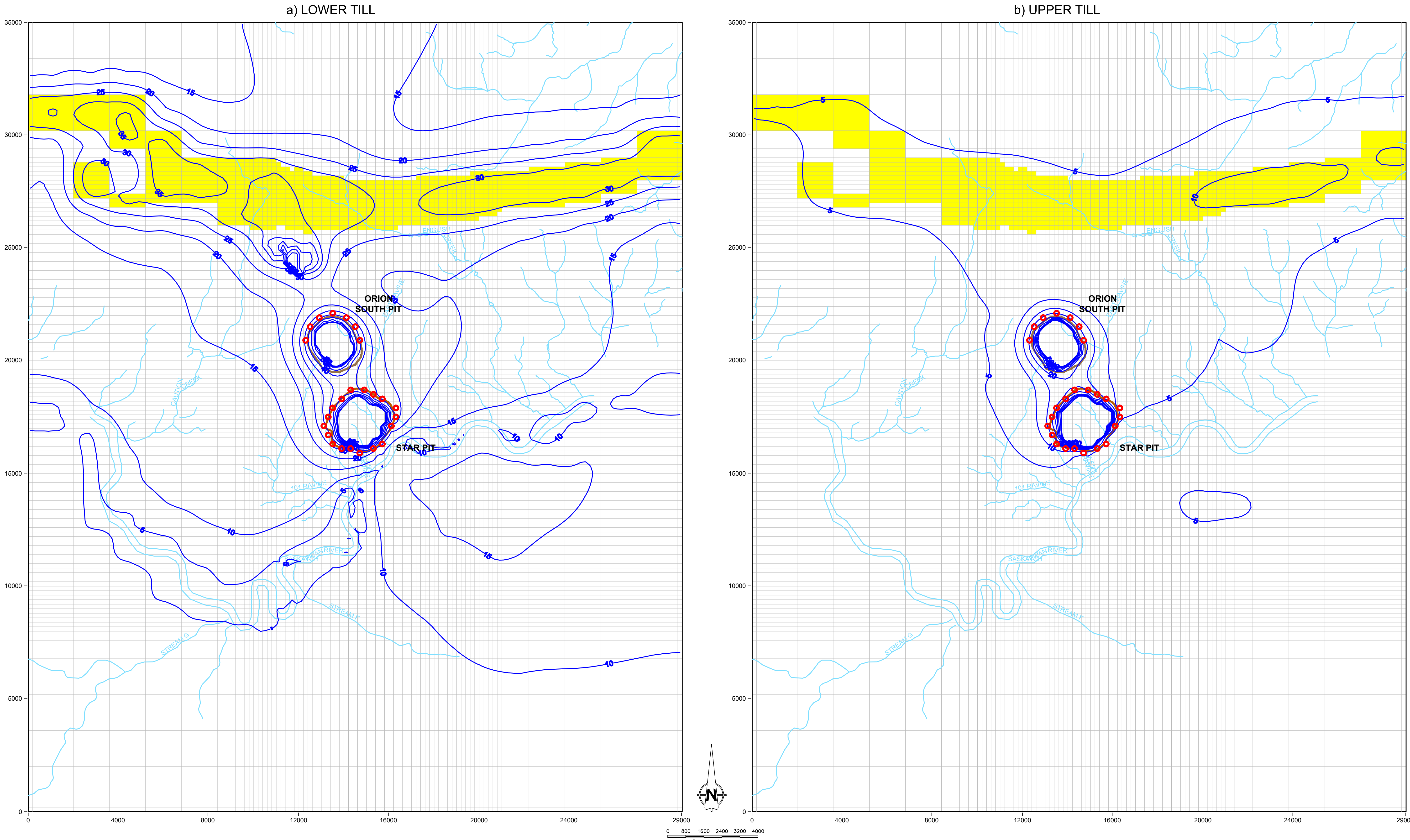
FILE NAME: 2CS016.004.Fig.39.Rev.A.Results.Scenario.2.2011-07-14.dwg

SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF SENSITIVITY ANALYSIS - PREDICTED DRAWDOWN WITHIN UPPERMOST SATURATED LAYER AND UPPER PART OF MANNVILLE SANDSTONE AT END OF MINING (SCENARIO 2)

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	39	A



LEGEND

- PREDICTED DRAWDOWNS (m)
- ESTIMATED 0.5m DRAWDOWN
- ULTIMATE STAR PIT
- ULTIMATE ORION SOUTH PIT
- MANNVILLE DEWATERING WELL
- APPROXIMATE EXTENT OF PALEOCHANNEL

# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF SENSITIVITY ANALYSIS - PREDICTED DRAWDOWN WITHIN UPPER AND LOWER TILL AT END OF MINING (SCENARIO 2)

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.40.Rev.A.Results.Scenario.2.2011-07-19.dwg

SASKATCHEWAN, CANADA

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	40	A

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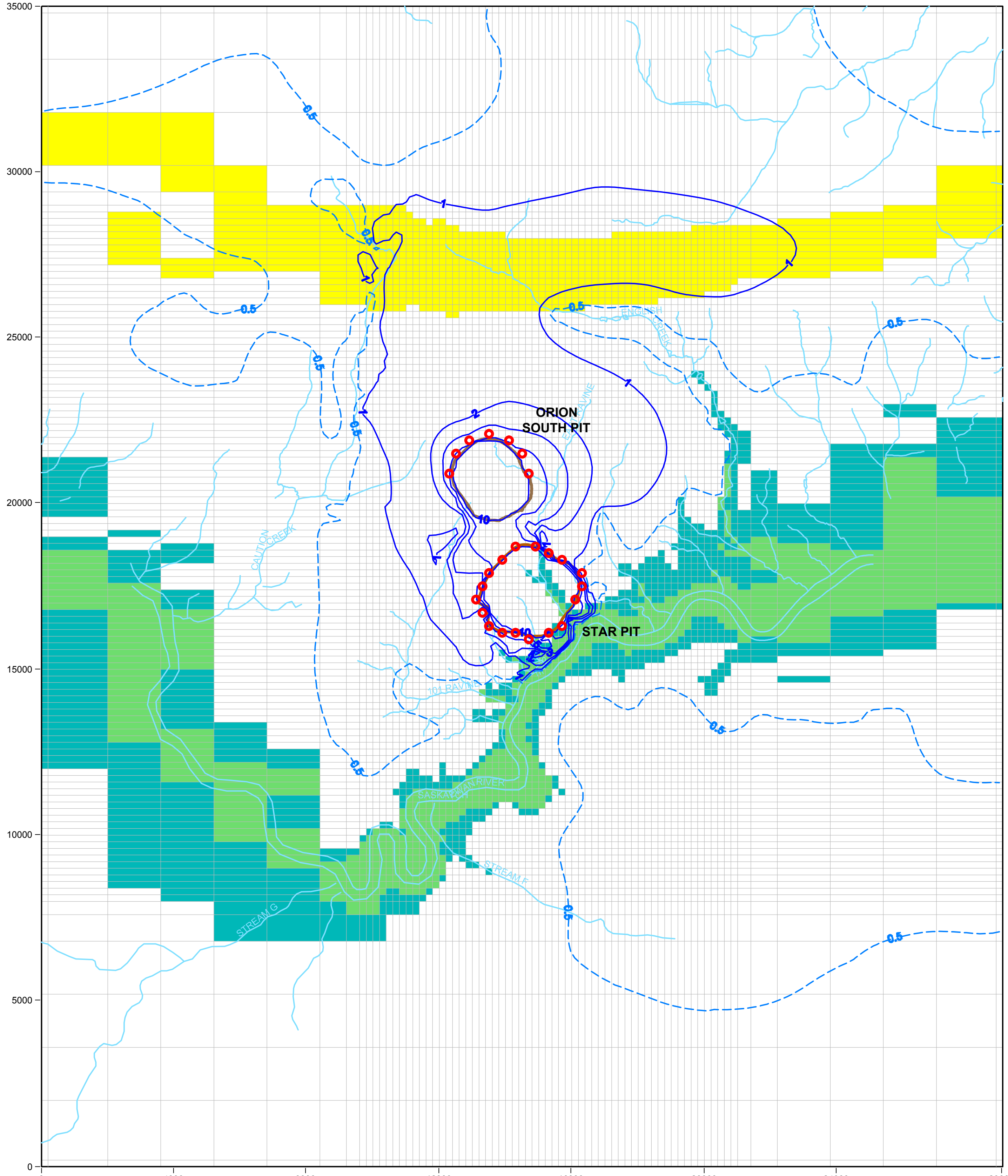
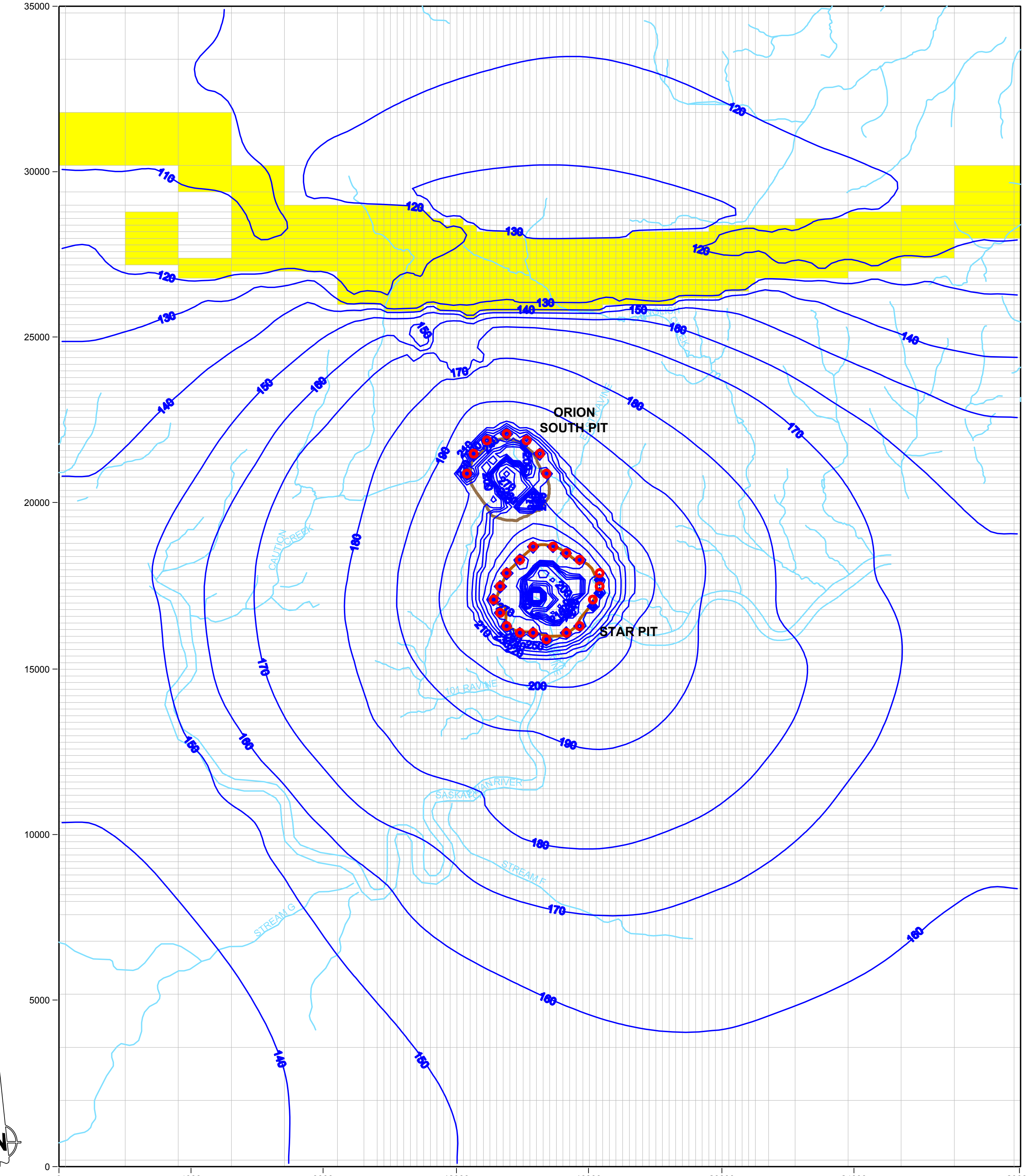
a) SURFICIAL SAND



b) UPPER MANNVILE SANDSTONE



0 800 1600 2400 3200 4000
Scale in Metres

LEGEND

	PREDICTED DRAWDOWNS (m)		UPPER SURFICIAL SAND, R = 20mm / YEAR
	ESTIMATED 0.5m DRAWDOWN		TILL ADJACENT TO SASKATCHEWAN RIVER, R = 5mm / YEAR
	ULTIMATE STAR PIT		LOWER SURFICIAL SILT / CLAY, R = 5mm / YEAR
	ULTIMATE ORION SOUTH PIT		
	MANNVILLE DEWATERING WELL		
	APPROXIMATE EXTENT OF PALEOCHANNEL		

# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

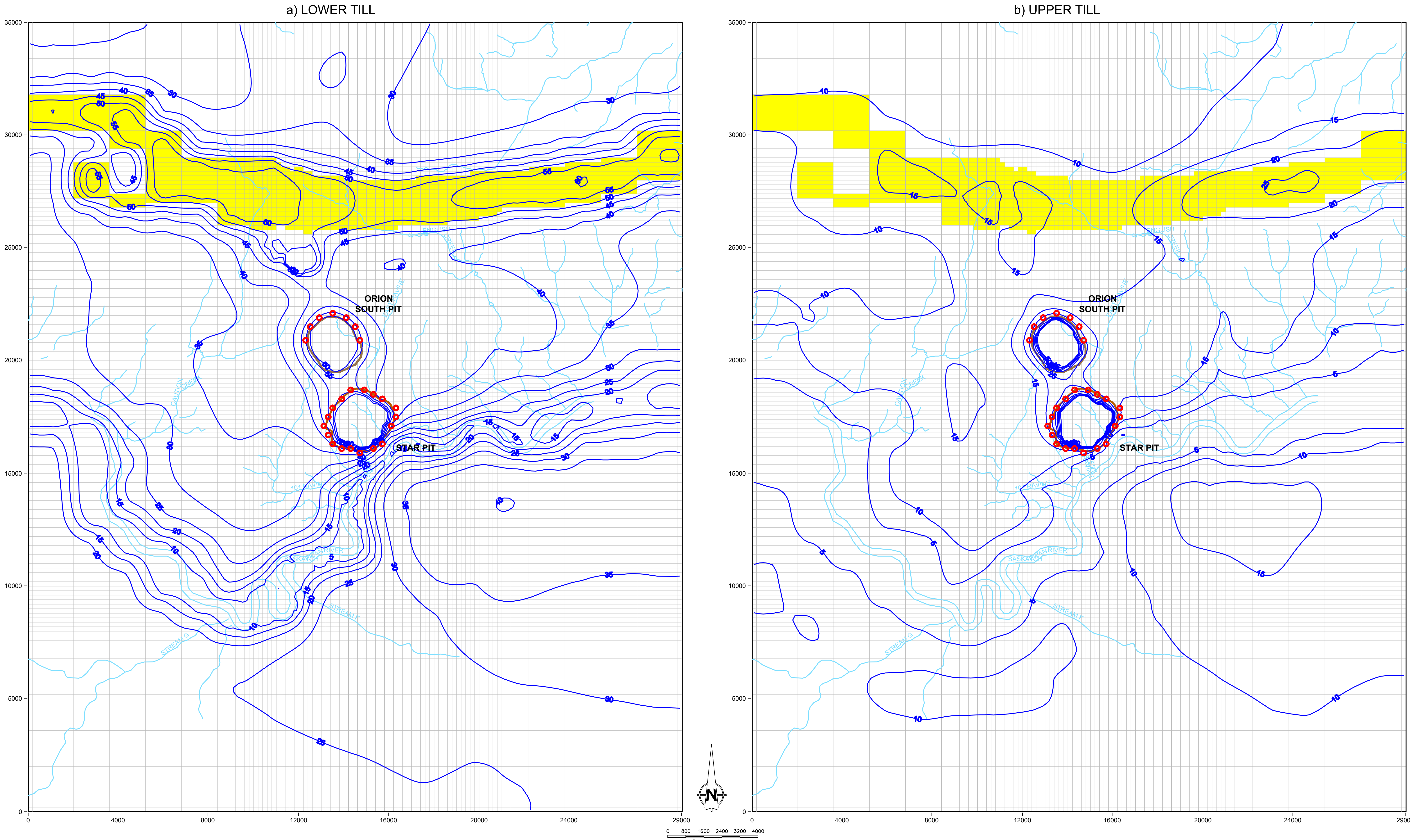
RESULTS OF SENSITIVITY ANALYSIS - PREDICTED DRAWDOWN WITHIN UPPERMOST SATURATED LAYER AND UPPER PART OF MANNVILLE SANDSTONE AT END OF MINING (SCENARIO 3)

SASKATCHEWAN, CANADA

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.41.Rev.A.Results.Scenario.3.2011-07-14.dwg

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	41	A



LEGEND

- PREDICTED DRAWDOWNS (m)
- ESTIMATED 0.5m DRAWDOWN
- ULTIMATE STAR PIT
- ULTIMATE ORION SOUTH PIT
- MANNVILLE DEWATERING WELL
- APPROXIMATE EXTENT OF PALEOCHANNEL

# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF SENSITIVITY ANALYSIS - PREDICTED DRAWDOWN WITHIN UPPER AND LOWER TILL AT END OF MINING (SCENARIO 3)

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.42.Rev.A.Results.Scenario.3.2011-07-19.dwg

SASKATCHEWAN, CANADA

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	42	A

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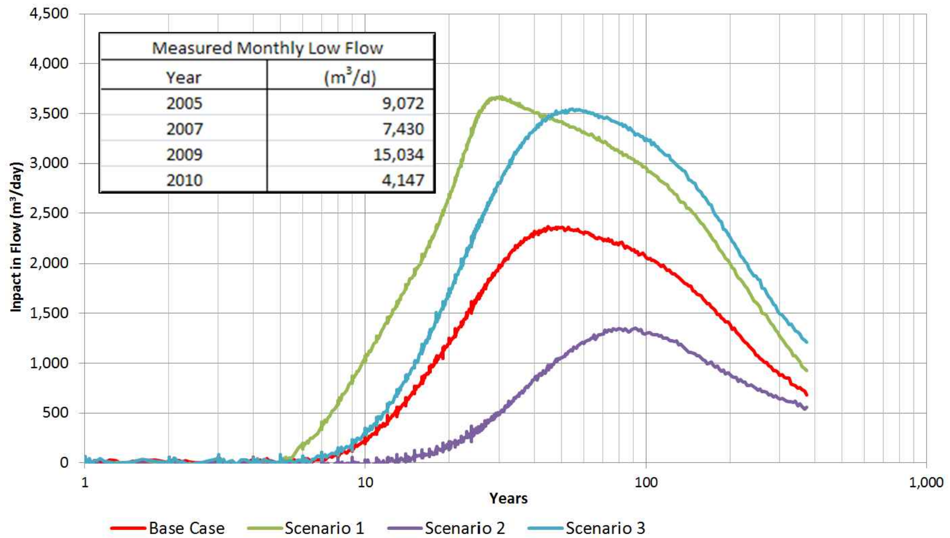
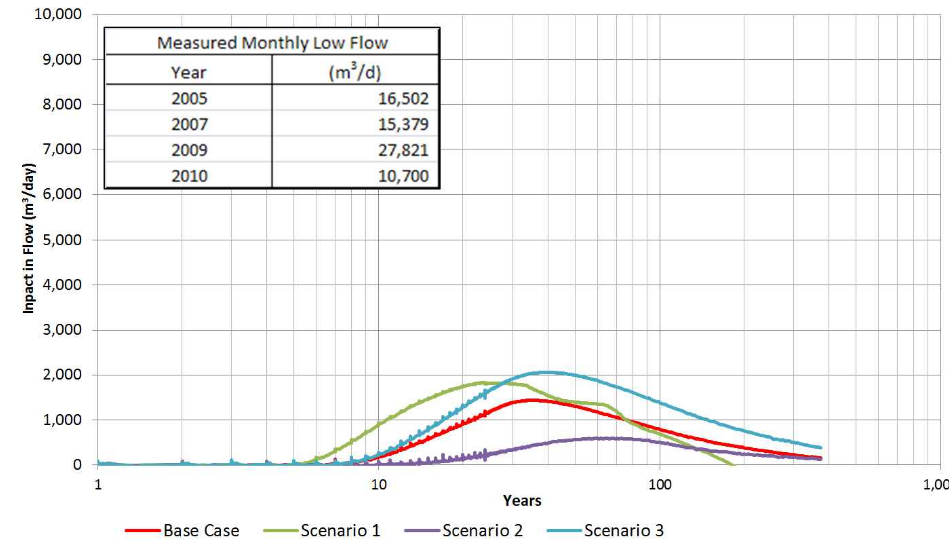
a) Stream D - English Creek



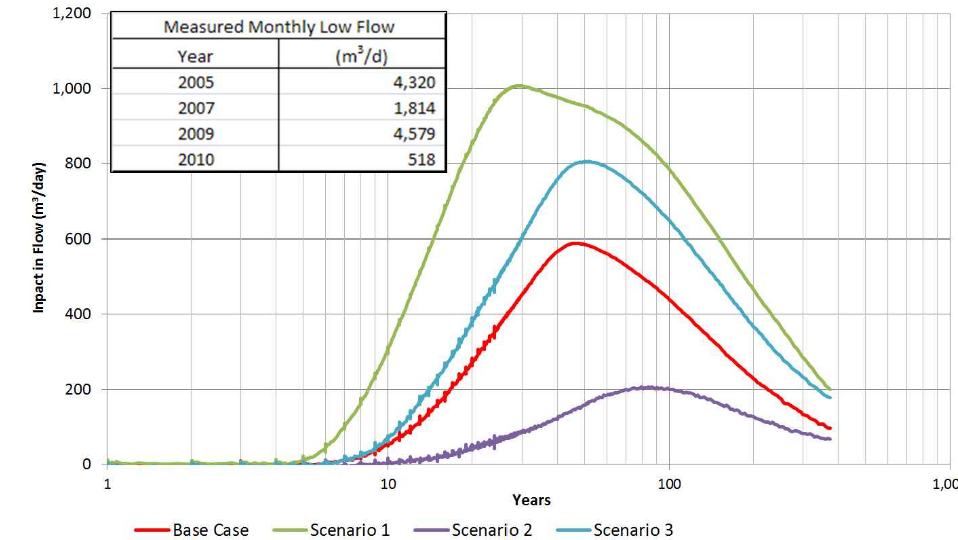
Measured Monthly Low Flow	
Year	(m^3/d)
2005	9,072
2007	7,430
2009	15,034
2010	4,147

b) Stream A - Caution Creek



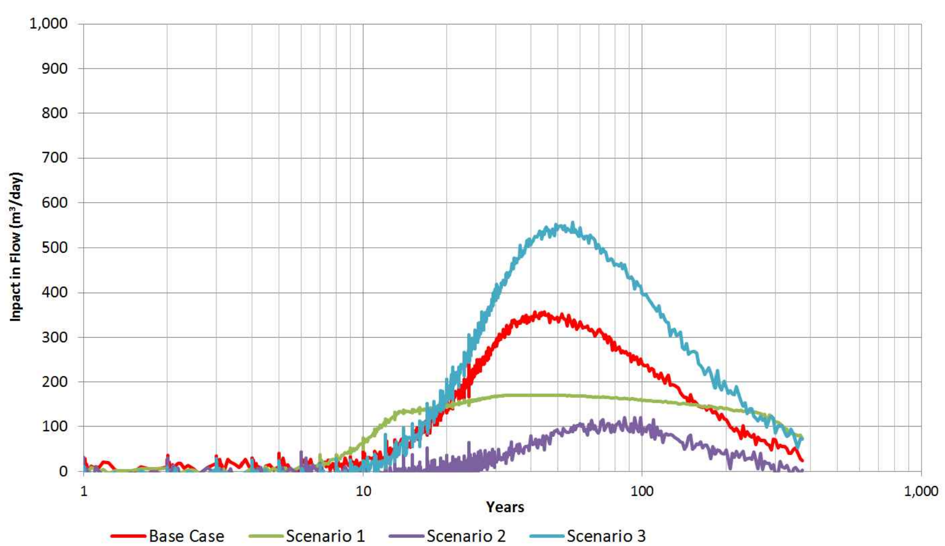
Measured Monthly Low Flow	
Year	(m^3/d)
2005	16,502
2007	15,379
2009	27,821
2010	10,700

c) Stream B - 101 Ravine Creek

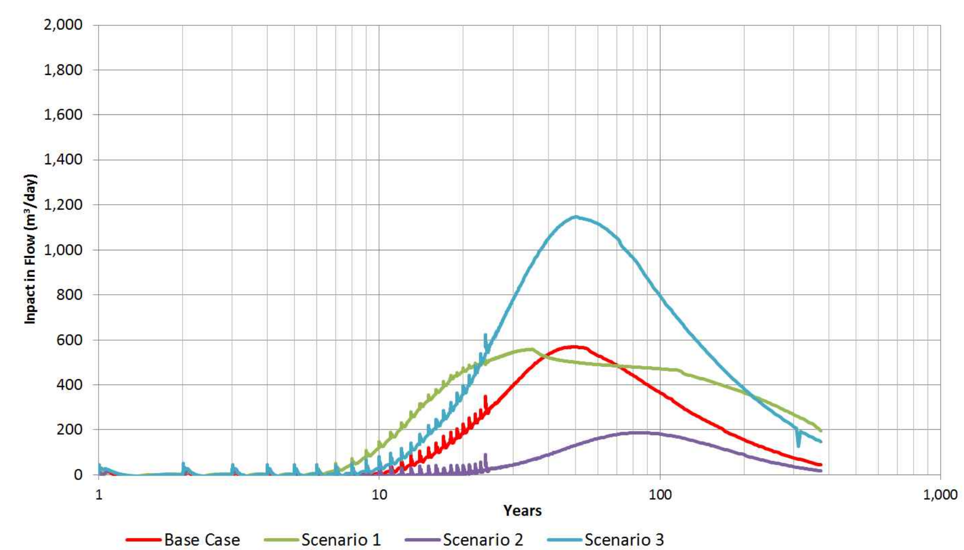


Measured Monthly Low Flow	
Year	(m^3/d)
2005	4,320
2007	1,814
2009	4,579
2010	518

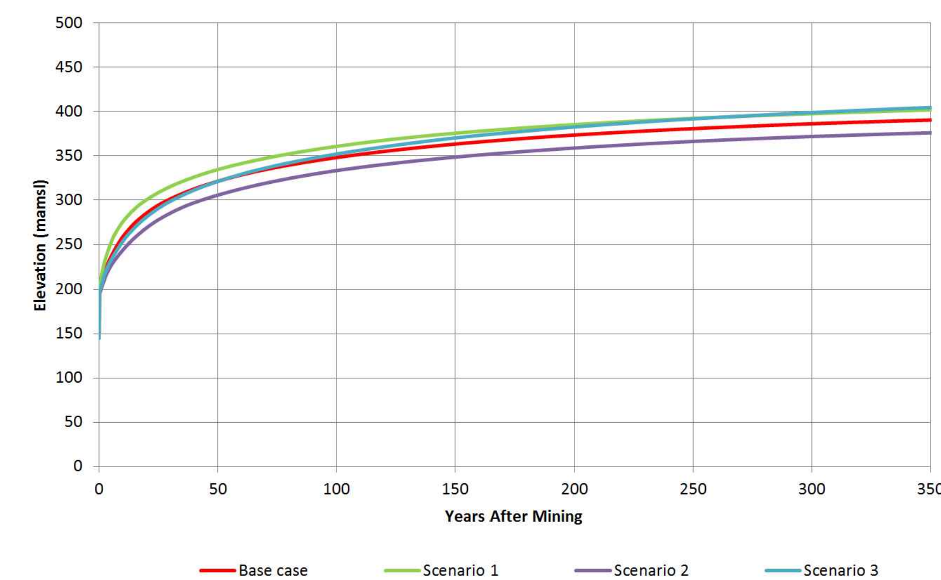
d) Stream F - South of Saskatchewan River



e) Stream G - Southwest of Saskatchewan River



f) Predicted Orion South Pit Lake Elevations



# Scenario	Description
Scenario 1	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were increased by factor of 3
Scenario 2	Vertical hydraulic conductivity of the Colorado Group shale, till, and silt units were decreased by factor of 3
Scenario 3	General head boundary conditions within the Mannville Group were replaced by no-flow boundary conditions

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Shore Gold Inc.

SRK JOB NO.: 2CS016.040 / TASK 0240

FILE NAME: 2CS016.004.Fig.43.Rev.A.Results.Active.Dewatering.2011-07-19.dwg

SASKATCHEWAN, CANADA

STAR-ORION SOUTH DIAMOND PROJECT

RESULTS OF SENSITIVITY ANALYSIS - PREDICTED IMPACT TO SURFACE WATER BODIES FROM PROPOSED ACTIVE DEWATERING

DATE:	APPROVED:	FIGURE:	REVISION NO.
JULY 2011	VU	43	A

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