NORFOLK GAS WELL MANAGEMENT
NORFOLK COUNTY, ONTARIO

Prepared for:
NORFOLK COUNTY

Prepared by:
MATRIX SOLUTIONS INC.

Version 1.0
December 2021
Guelph, Ontario

Unit 7B, 650 Woodlawn Rd. W
Guelph, ON, Canada N1K 1B8
T 519.772.3777 F 226.314.1908
www.matrix-solutions.com

NORFOLK GAS WELL MANAGEMENT

NORFOLK COUNTY, ONTARIO

Prepared for Norfolk County, December 2021

reviewed by

Louis-Charles Boutin, B.Sc.
Principal

Steve Shikaze, M.Sc., P.Eng. (ON)
Senior Hydrogeological Engineer

CONTRIBUTORS

Name	Job Title	Role
Louis-Charles Boutin, B.Sc.	Principal	Primary author
Steve Shikaze, M.Sc., P.Eng. (ON)	Senior Hydrogeological Engineer	Primary reviewer
Ronan Drysdale, M.Sc., G.I.T.	Geoscientist-in-Training	Co-author, data processing, and modelling
Cam Baker, M.Sc., P.Geo.	Senior Geologist	Secondary reviewer, OGSR record review, project direction
Jeff Melchin, M.Sc., P.Geo.	Hydrogeologist	Co-author

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	07-Sept-2021	Draft	31976-551 Norfolk R 2021-09-07 draft V0.1.docx	Issued to client for review
V0.2	15-Nov-2021	Draft revised	31976-551 Norfolk R 2021-11-15 draft V0.2.docx	Issued to client for review
V1.0	20-Dec-2021	Final	31976-551 Norfolk R 2021-12-20 final V1.0.docx	Issued to client

EXECUTIVE SUMMARY

In Big Creek valley, Ontario there are hundreds of active, inactive (i.e., suspended and/or legacy wells of unknown status), plugged (i.e., abandoned) petroleum wells. These wells have the potential to contribute to discharge of sulphur-rich waters at ground surface or in the subsurface, which could in turn infiltrate into domestic use aquifers. The sulphur-rich waters present a significant risk to local ecosystems and human health.

More specifically, Norfolk County owns a parcel of land on which a well is currently flowing. This well is referred to as the Forestry Farm Road well (FFR well [F006207]). The main objectives for this project were:

- to improve the understanding of geological and hydrogeological conditions that result in flowing sulphur-rich wells in Big Creek valley, particularly near the FFR well (F006207)
- to support the assessment of future remediation options

Through discussion with landowners in the vicinity of the project area, a timeline of historical flowing conditions of the petroleum wells was compiled, with a range of estimated flow rates at each location.

The geological and hydrogeological understanding was advanced through the analyses of well records held by the Oil, Gas and Salt Resources Library (OGSR), integration of site-specific information, review of regional geological maps of the bedrock, field investigation at the Spanjers' property, and the construction and application of a numerical model of groundwater flow.

The measured water levels in the upper bedrock can be interpreted as meeting the definition of an artesian zone in Big Creek valley, in which water levels are believed to be higher than ground surface elevation. The review of 278 OGSR well library records allowed Matrix Solutions Inc. to summarize their status and revealed that 76% (209) of the wells have been plugged/abandoned, while 25% (69) remain unplugged, in the Big Creek valley within 500 m either side of the interpreted artesian zone. This exercise also allowed for better characterization of the plugging age, which is the main indicator that was used to define potential well integrity conditions. Both sets of information were used for well susceptibility to flowing conditions.

A numerical model of groundwater flow was constructed, based on existing hydrogeological studies. The modelling tool was calibrated and deemed to adequately represent measured hydraulic heads in the overburden and the Dundee Formation aquifer, and historical estimated flow rates at known flowing and recently plugged wells.

The numerical model was used to assess the radius of influence from historical well plugging, estimate the relative risk between petroleum wells, and assess the potential impacts of different remedial scenarios that were identified through a workshop with the Norfolk County technical project team.

Four remediation options were assessed as corrective measures to the release of hydrogen sulphur in the air, and stresses to the vegetation in Big Creek valley. Those remediation options span from well abandonment to capture and treatment of sulphur-rich groundwater. Through this assessment, the time and cost of each option was estimated to help inform decision makers.

From this hydrogeological assessment, the following conclusions are made regarding the Dundee Formation hydrogeological system in Big Creek valley:

- The Dundee Formation aquifer is highly transmissive and, based on historical estimated flowing rates, could sustain up to 3,800 m^3/day per well, with a simulated decrease of 1 m in water levels extending up to 2 km from each well.
- Results from the model indicate that changes in water levels from historic flowing wells do not eliminate the presence of the artesian zone. In other words, water levels remained above the ground surface prior to and post plugging activities. Model results also suggest that the integrity of the well casing and plug or plugs play important roles in the susceptibility of a well become flowing.
- The assessment of remediation options indicated that the most cost- and time-effective solution (Option 1) is also the best long-term technical solution:
  - Option 1: abandonment of FFR well (F006207) would result in marginal water level increases assuming no other groundwater is currently discharging underground in shallow overburden aquifers. This option would meet Norfolk Country's requirements under the *Oil, Gas and Salt Resources Act* and eliminate environmental impacts at the FFR well (F006207) location
- Although Option 2 (capture and treatment of flowing water at the FFR well [F006207]) would be effective, there are significant capital cost and time required to implement the remediation. Also, the ongoing costs for maintenance and monitoring are recurring and, therefore, this option is interpreted as not to be a viable long-term solution.
- For the two last remedial options evaluated, the drilling of relief wells near the FFR well (F006207) (Option 3) and the Relief well (F020148) (Option 4) was assessed. The objective with these options is to capture and treat as much groundwater as possible from the Dundee Formation aquifer, to create a regional low in water levels (i.e., a sink), similar to water level conditions that existed prior 2015, when the Relief well (F020148) was active. These two options have the most effect on regional water levels. Although regional water levels within the Dundee Formation would be decreased, simulated results from the numerical model suggest it would not be sufficient to bring the water levels below ground surface, other than locally. At known flowing wells, these scenarios would likely reduce discharge rates, but are unlikely effective measures to eliminate all the flow discharging to surface or air quality impacts from exsolving hydrogen sulphur. Those options would likely require an environmental assessment and, in addition to highest capital and ongoing cost, would take the most time to implement.

TABLE OF CONTENTS

IN-TEXT FIGURES

IN-TEXT TABLES

FIGURES

APPENDICES

1 INTRODUCTION

Norfolk County owns a parcel of land on which a previously abandoned gas well is currently discharging sulphur-rich groundwater to ground surface (i.e., flowing well). This well is referred to as the Forestry Farm Road well (FFR well [F006207]). In October 2020, Norfolk County requested proposals to complete a hydrogeological investigation to support the assessment of remedial options. Norfolk County mandated Matrix Solutions Inc. to complete the hydrogeological assessment, and the present report summarizes the key findings.

1.1 Project Background

In 1966, a natural gas well that was drilled in 1911 and plugged the following year began flowing to surface near Big Creek in the Norfolk County. This well, Well F005427, was officially titled "Dominion Natural Gas #399 - W.W. Carroll #1," adjacent to Big Creek, west of the hamlet of Silver Hill, Ontario. This well is referred to herein as the Original well (F005427) (Figure 1). The Original well (F005427) was successfully plugged in January 1968, but this resulted in the flooding of sulphur water into other gas wells in the vicinity of the Original well (F005427). To remedy the situation and relieve the flooding of nearby gas wells, in September 1968, a Relief well (F020148) was drilled next to the Original well (F005427) to allow artesian flow of sulphur-rich groundwater to discharge into Big Creek via a steel pipe; referred to herein as the Relief well (F020148) (Figure 1). In 1985, the corroded steel pipe was leaking and was replaced by a plastic line laid below the creek's water level to control the smell of hydrogen sulphide exsolving from the sulphur-rich groundwater.

In 2006, the Ontario Ministry of Natural Resources and Forestry (MNRF) initiated its Abandoned Works Program to locate and plug petroleum wells that were left unplugged by defunct operators (Carter et al. 2014).

In 2010, complaints of the direct discharge to the creek from the Relief well (F020148) lead to the Ontario Government (Ontario Ministry of the Environment, Conservation and Parks [MECP] and MNRF) to undertake an investigation into the situation. Sampling and isotopic analysis of the discharge determined that the Lucas and Dundee formations were the source of the water (Carter et al. 2014). In 2015, the MECP ordered the MNRF to abandon the Relief well (F020148) to prevent further discharge of sulphur water. As was experienced in 1968, artesian flow of sulphur water at other gas wells began in the Big Creek valley (Figure 1).

Between 2009 and 2019, a total of nine non-flowing oil and gas wells were plugged, in the vicinity of the FFR well (F006207). In addition to the non-flowing wells, five flowing wells were plugged during the same period. Flow of sulphur water from the FFR well (F006207) began in 2017, soon after the Teichroeb well (T012512) was plugged (Figure 1). The plugging of the Relief (F020148), Grant (T009949), Morrison (T008725), Teichroeb (T012512), and Wulleman (T012545) wells likely contributed to the flowing or intermittent flowing of at least two wells and one other site in the area; the FFR well (F006207) and the Edwards well (F005318), and Spanjers' Spring (Figure 1). In this report, the Spanjers' Spring is associated to the Oil, Gas and Salt, Resources Library (OGSR) record S000003, although, based on personal communications (Kuri 2021, Pers. Comm.) with library personnel, there is no evidence a well was drilled at S000003 and might be a reference to "a show" that should be tracked. Table A and Figure 2 show a timeline of plugging and flowing events.

TABLE A History of Flowing Wells in the Big Creek Valley

Date	Event
1911	Original well (F005427) drilled December 18, 1911 (OGSRL 2021a).
1912	Original well (F005427) plugged (OGSRL 2021a).
1912 to 1966	Original well (F005427) unknown flowing conditions.
1968	Original well (F005427) was plugged on January 1, 1968 (OGSRL 2021a). A well approximately 200 m east of Original well (F005427) and Grant well (T009949) drilled in 1957 (OGSRL 2021b), started flowing shortly after Original Well was plugged. Relief well (F020148) was drilled near Original well (F005427) on September 10, 1968 (OGSRL 2021c). The Grant well (T009949) stopped flowing shortly after the Relief well (F020148) began flowing.
2015	Relief well (F020148) was plugged on March 31, 2015 (OGSRL 2021c).
2015 to 2017	After Relief well (F020148) was plugged, Wulleman well (T012545) and Teichroeb well (T012512) began flowing, along with the Grant well (T009949) and Morrison well (T008725).
2017	Teichroeb well (T012512) was plugged on June 30, 2017 (OGSRL 2021d), and not long after Spanjers' Spring well (S000003) and FFR well (F006207) begin flowing. Grant well (T009949) and Morrison well (T008725) were plugged on September 15 and October 23, 2017 (OGSRL 2021b; OGSRL 2021e), respectively, and shortly after Edwards well (F005318) begins to flow. Wulleman well (T012545) was plugged on November 3, 2017 (OGSRL 2021f); however, no additional flowing wells are identified.
2018 to 2021	The FFR well (F006207), Spanjers' Spring (S000003), and Edwards well (F005318) continued to flow to this date. In March 2020, a monitoring well drilled by Norfolk County (T012616) was drilled and flowed briefly, prior to be abandoned. In October 2021, a field inspection was conducted at Spanjers' Spring (S000003).

The conditions resulting in artesian flow of sulphur water from petroleum wells are not unique to the Big Creek valley. To the west, in the Big Otter Creek valley, there are similar occurrences of artesian sulphur water flows over an area extending from Tillsonburg, Ontario to Port Burwell, Ontario. Over the past 40 years, several petroleum wells with artesian flows of sulphur-rich water have been plugged or re-plugged by the MNRF in southwestern Ontario.

The sulphur water emerging from flowing wells can result in the release of hydrogen sulphide gas. The dissolved hydrogen sulphide exsolves from groundwater creating a distinct "rotten egg" odour at low concentrations (<30 parts per million [ppm]). The hydrogen sulphide gas presents a health hazard to humans and livestock in the area proximal to the well. Prolonged exposure to concentrations ranging from 20 to 500 ppm, as occurs around the FFR well (F006207) located on Norfolk County property, can cause various respiratory symptoms. Immediately loss of consciousness and rapid to immediate death can occur when exposure to hydrogen sulphide concentrations greater than 500 ppm (WorkSafeBC 2010).

Discharging sulphur water to ground surface has led to public and environmental concerns in Big Creek valley. Human health concerns have resulted in road closures and evacuations. The flowing wells create the potential for hydrogen sulphide to reach confined spaces, such as basements and water treatment systems, through surface and subsurface pathways. Also, as is evidenced by the degradation of vegetation in the area immediately around the FFR well (F006207), sulphur water discharged to surface water features can present an ecological risk.

1.2 Project Objectives and Scope

The objective of this hydrogeological study is to improve the understanding of geological and hydrogeological conditions that result in sulphur-rich water flowing from petroleum wells in Big Creek valley, specifically around the FFR well (F006207), located on Norfolk County property. The improved understanding will support:

- the evaluation of potential future remediation scenarios
- the assessment of potential impacts of previous well plugging initiatives
- the assessment of the potential area that may be affected by flowing gas wells

The scope of this study is to:

- compile relevant hydrogeological information
- compile historical information related to flowing wells timeline from discussions with stakeholders
- construct and calibrate a numerical model of groundwater flow
- support the assessment of impacts from previous well plugging activities and defined potential future remediation scenarios.

2 PHYSICAL SETTING AND GEOLOGY

2.1 Study Area

The study area is 186 km^2 (Figure 1), extending 19 km from just north of the Town of Powells Corners, Ontario to the south of the Town of Walsingham, Ontario, and 12.3 km east to west. Big Creek flows southward along a meandering course through the study area. The study area was selected to encompass the area of observed flowing wells and cover a portion of the Big Creek watershed.

2.2 Physical Setting

The ground surface in the study area gently slopes southward toward Lake Erie. Surface elevation declines from a high of approximately 250 m above sea level (asl) in the northern portion of the study area to 200 m asl in the south (Figure 3). Big Creek and its tributaries are deeply incised and form valleys ranging in width from approximately 500 m in the north to over 1 km in the southern part of the study area, with an approximate incision depth of 20 m. The lowest point of the valley in the study area, located approximately 500 m northwest of Walsingham, is at an elevation of approximately 175 m asl.

2.3 Overburden Geology

The descriptions of the overburden sediments in the Big Creek valley and surrounding area are summarized in Table B, in descending order, from youngest to oldest. The main units are described following the table.

TABLE B Overburden Geology Underlying the Study Area

Unit	Description
Norfolk Sand Plain	Fine- to medium-grained sand with trace gravel deposited in large proglacial lake. Blanket of sand at surface across the study area.
Wentworth Drift	Laminated clay and silt with ice-rafted debris, debris flow deposits, fine-grained lodgement till. Forms the core of the Paris and Galt moraines.
Upper Interstitial Sediment	Coarse-grained glaciolacustrine sediment deposits in a shallow preglacial lake. Dips toward the Lake Erie basin.
Port Stanley Drift	Fine-grained package of laminated silty clay to sand (with common ice rafted debris) interbedded with clay-rich diamict. Forms core of recessional moraines west of Big Creek valley.
Lower Interstitial Sediment	Very fine- to medium-grained sand with variable silt content.
Port Stanley Drift/ Catfish Creek Drift	Interlaminated silty clay, clayey silt, sandy silt, and silty sand layers (with ice rafted debris) interbedded with clay-rich diamict beds.

Adapted from *Long Point Region Tier Three Water Budget and Local Area Risk Assessment* (Matrix 2015)

The uppermost overburden unit that forms the ground surface in much of the study area and surrounding area is the Norfolk Sand Plain (NSP). The NSP is spatially extensive and can reach thicknesses of greater than 20 m in some areas south of Delhi, Ontario. The sand plain formed when the water in the Erie Basin rose, and a large expanse of deltaic sand was deposited in a series of glacial lakes that inundated the study area (Chapman and Putnam 1984). The NSP is comprised of primarily fine- to medium-grained sand with some silt and gravel.

Below the NSP lies the Wentworth Drift (WWD). The WWD is comprised of laminated clay and silt with ice-rafted debris, debris flow deposits, fine-grained lodgement till. These sediments form the cores of the Paris and Galt moraines.

The interstitial sediments which are divided into upper and lower deposits. The lower interstitial sediments divide the Port Stanley Drift (PSD) and are comprised of very fine- to medium-grained sand with variable silt content. Capping the PSD are the upper interstitial sediments, comprised of coarse-grained glaciolacustrine sediment deposited in a shallow preglacial lake. The upper sediments dip toward the Lake Erie basin.

The PSD in the study area was subdivided into the upper and lower portions with the lower PSD being similar in composition to the Catfish Creek Drift (CCD; Barnett 1998b). The upper PSD is comprised of fine-grained laminated silty clay to sand interbedded with clay-rich diamict. The lower and upper PSD form the core of recessional moraines west of the Big Creek valley. The PSD has a maximum thickness of 76 m within the area surrounding Big Creek and likely forms a confining layer above the bedrock aquifer over parts of the study area (Barnett 1998b).

The lowermost overburden unit is the CCD, which is the oldest of the overburden units that rest on bedrock in the study area. It was deposited in the Late Wisconsinan Period, approximately 23,000 years before present (Barnett 1998a) and is comprised of clayey-silt to silty sand diamict (till) and minor stratified sediments. Based on the regional studies of Barnett (1998b; 1982) the CCD is believed to have a maximum thickness of 2.5 m in the study area and to be overlain by the lower PSD.

2.4 Bedrock Geology

A sequence of Paleozoic bedrock formations underlies the study area. In descending order, from most recent to oldest, the formations are listed in Table C.

TABLE C Bedrock Geology Underlying the Study Area

Formation	Description
Dundee	Light brown-grey, fossiliferous limestone and minor dolostones. Medium to thickly bedded and microcrystalline
Lucas	Brown, microcrystalline limestones and dolostones that are often sandy and contain evaporite beds
Onondaga	Cherty, fossiliferous limestones
Bois Blanc	Grey-Brown, crystalline, cherty, fossiliferous limestones and dolostones. Often thin- to medium-bedded and fine- to medium-grained
Bass Islands	Brown-grey, dolostones Often argillaceous, bituminous, crystalline, variably laminated, and contains minor fossil content
Salina	Brown-buff-grey, characterized by evaporites (i.e., halite, gypsum, and anhydrite), shales, and carbonates (dolostone and limestone)

Adapted from *Long Point Region Tier Three Water Budget and Local Area Risk Assessment* (Matrix 2015)

The Dundee Formation is the youngest formation that occurs and subcrops in the study area. The formation is comprised predominantly of limestones and, to a lesser extent, dolostones, which are medium- to thickly-bedded (Armstrong and Carter 2010). The upper surface of the Dundee Formation (i.e., the bedrock overburden interface) is interpreted to have a higher degree of fractures and possible karst. Within the study area, the Dundee Formation thickness ranges from less than 2 m to 47 m. Near the FFR well (F006207), the thickness of the Dundee Formation is approximately 45 m.

The Lucas Formation is characterized by brown, microcrystalline limestones and dolostones that are often sandy and contain evaporite beds (Armstrong and Carter 2010, Barnett 1982a). Regionally, near Ingersoll, Ontario, the Lucas Formation was identified in a quarry and further refined into the Anderdon Member limestone and the Anderdon Member sandy limestone (Armstrong and Carter 2010). Where the Anderdon Member limestone is fine-grained with thin to medium bedding, the Anderdon Member sandy limestone is notably sandier and coarser grained with thicker bedding (Armstrong and Carter 2010). Near Ingersoll the formation is 47 m thick, and in Norfolk County the unit pinches out completely (Armstrong and Carter 2010).

The Onondaga Formation, which is laterally equivalent to the Amherstburg Formation to the north (Armstrong and Carter 2010), is primarily composed of limestones (Armstrong and Carter 2010). The formation is cherty and fossiliferous but also characterized as argillaceous (contains clay sediments) in some areas (Armstrong and Carter 2010, Barnett 1982a).

The Bois Blanc Formation is characterized by limestones and dolostones that are grey-brown, cherty, and fossiliferous (Barnett 1982; Armstrong and Carter 2010). The formation is fine to medium grained and thin to medium bedded (Armstrong and Carter 2010).

The Bass Islands Formation is comprised predominantly of dolostone and characterized as brown to grey, bituminous, argillaceous (containing clay sediments), very-fine to fine crystalline with minor fossil content (Armstrong and Carter 2010). Within the study area, the thickness of this formation is generally 15 m thick.

The Salina Formation is comprised predominantly of evaporites (i.e., halite, gypsum, and anhydrite), shales, and carbonates. The shallow units of the formation change from carbonate-dominated to evaporite-dominated and the relative proportion of shale increases as well (Armstrong and Carter 2010).

3 HYDROGEOLOGY

3.1 Previous Modelling and Geological Studies

As part of this study, existing geological and hydrogeological data were compiled and interpreted to develop a refined conceptualization of the hydrogeology in the study area. To date, many groundwater investigations have been conducted which encompasses the study area. The following studies were considered for this work:

- *Long Point Region Tier Three Water Budget and Local Area Risk Assessment* (Matrix 2015): this study refined the geology and hydrogeology in the Long Point Source Protection Region, with a focus and goal of evaluating the long-term sustainability of the water supply resources in the Delhi, Simcoe, and Waterford areas. This work included the refinement, calibration, and application of an existing FEFLOW groundwater flow model developed for the Tier Two Water Budget and Subwatershed Stress Assessment (AquaResource 2009a, 2009b) and the development of a new integrated groundwater/surface water model using MIKE SHE. Ultimately, potential threats to water quantity were identified within newly delineated groundwater vulnerable areas.

- *WHPA Delineation, Vulnerability Scoring, and Threats Assessment, Town of Delhi, Norfolk County, Lake Erie Source Protection Region* (Matrix 2018): this study applied the Long Point Tier Three groundwater flow model and used local refinements in the Delhi area to delineate Wellhead Protection Areas [WHPAs] using particle tracking, assess aquifer vulnerability, and identify water quality threats to drinking water sources within the WHPAs.

- *WHPA Delineation, Issue Contributing Area Delineation, and Threats Assessment for the Otterville Well Field* (Matrix 2019): this study used the Long Point Tier Three model that was updated as part of the Delhi WHPA Delineation, Vulnerability Scoring and Threats Assessment (Matrix 2018) and refined and calibrated it locally in the area of the Otterville municipal wells. The objectives were to delineate WHPAs and an issue contributing area for the Otterville municipal wells through additional local refinements and complete a water quality threats assessment. In this present study, this numerical model is referred to as the Otterville model.

- Ontario Geological Survey 3D Paleozoic Bedrock Model (GRS019; Carter et al. 2019): this geological model was used to build the surface elevation of the main bedrock units considered for this study numerical model construction. Additional refinement to the top-of-bedrock surface was performed in the vicinity of the FFR well (F006207) to reflect local observed geological conditions during the drilling of the Norfolk County monitoring well (Figure 4).

3.2 Regional Groundwater Flow System

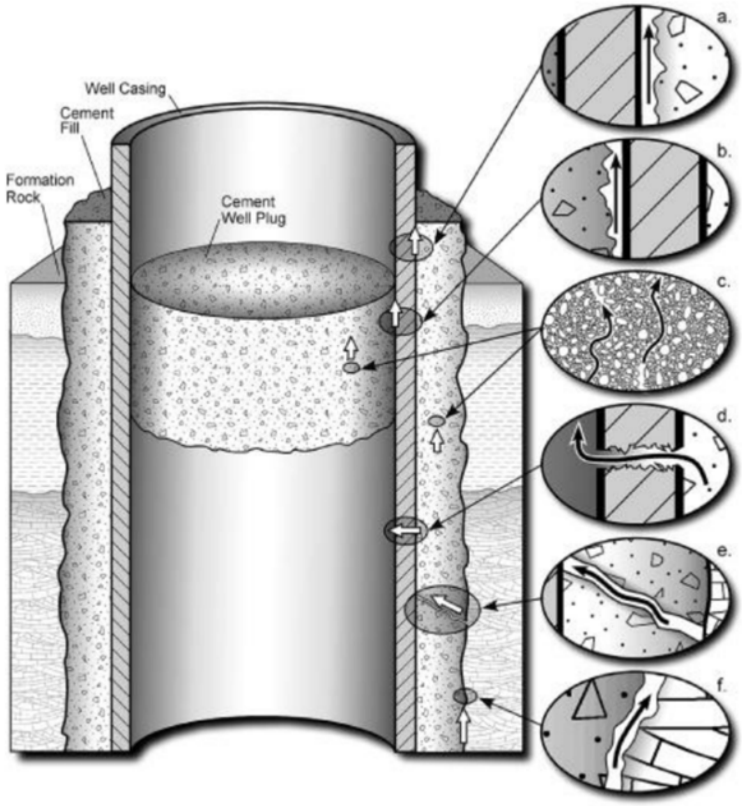
To a large extent, the regional groundwater flow reflects the ground surface topography in the overburden. Groundwater moves from areas of high hydraulic head to areas of low hydraulic head, generally following topographic relief, unless it is impeded by geologic conditions or local changes in relief, such as stream valleys that intersect the water table. In areas where rivers, streams, or wetlands intersect the water table, groundwater discharges into the stream or river and contributes baseflow to the surface water feature. Understanding the movement of groundwater through the subsurface and through interactions with surface water features requires an understanding of the three-dimensional (3D) geometry of aquifers (water bearing units) and aquitards (confining units) as well as the location of significant recharge areas.

Overburden aquifers in the study area are interpreted to be the surficial NSP and the upper and, to some extent, the lower interstitial sediments, while the aquitards are interpreted to be the finer-grained WWD, PSD, and CCD. The NSP is a spatially extensive unconfined aquifer that lies at ground surface across much of the regional area and, therefore, is interpreted to be where shallow groundwater recharge occurs. Overburden aquifers that lie at depth tend to be more localized. As mentioned previously, the PSD has a maximum thickness of 76 m within the area surrounding Big Creek and, therefore, likely forms a confining layer above the bedrock aquifer over parts of the study area (Barnett 1998b).

Bedrock aquifers are seldom used where overburden aquifers are thick and transmissive. The Dundee Formation is considered a productive aquifer, although water quality is sulphurous (Armstrong and Carter 2010). The Lucas Formation is a productive bedrock aquifer as well due to the presence of fractures or karst-related porosity and, like the Dundee Formation, can contain elevated concentrations of sulphur (Armstrong and Carter 2010).

3.3 Presence of Hydrogen Sulphide in the Dundee Formation

Hydrogen sulphide (H_2S) and sulphate (SO_4) have been recorded at some petroleum, and water wells in the study area. The regional geochemistry information was compiled from Carter (2014), Singer et al. (2003), and Hamilton (2015), and presented on Figures 5a and 5b. Hydrogen sulphide and sulphate are generally present in groundwater in the upper bedrock aquifers in Norfolk County. Due to the limited number of data points, the understanding of the spatial distribution within the upper bedrock aquifers is limited, but the distribution may be influenced by the depositional environments and natural geological processes (Carter et al. 2019). The source of sulphurous water in the Dundee Formation aquifer is interpreted to be coming from the gypsum ($CaSO_4 \cdot 2H_2O$) present in the rock composition. Work by Smal (2016), as reported by Jackson et al. (2020), have hypothesized that methane (CH_4) associated with the oil and gas reservoir(s) could reduce the sulphate to produce sulphur (S) in the groundwater from the Dundee Formation aquifer. Low concentrations of methane occur naturally in the Dundee Formation aquifer, but the hypothesis is that the main source of methane would be coming from Silurian-aged gas reservoir (at approximately 250 m below the base of the Dundee Formation near FFR well [F006207]) in the Clinton-Cataract Group (Armstrong and Carter 2010) migrating through various types of preferential pathways, including open or poorly sealed petroleum well bores, to the Dundee Formation aquifer (Figure A).



a. between casing and cement; b. between cement plug and casing; c. through the cement pore space because of cement degradation; d. through casing as a result of corrosion; e. through fractures in cement; and f. between cement and rock

FIGURE A Potential Preferential Pathways (taken from Celia et al. 2004) Diagrammatic Representation of Possible Leakage Pathways Through an Abandoned Well

3.4 Groundwater Flow in the Dundee Formation Aquifer

As noted in Section 2.3, the Dundee Formation is overlain by a thick package of layered silt and clay (PSD) that separates near surface aquifers (namely the NSP and Interstitial Sediments aquifers) from the bedrock system. As a result, the Dundee Formation is interpreted to be a confined bedrock aquifer.

Regionally, a sulphur water zone exists in the bedrock at a depth of 30 to 450 m in southern Ontario (Carter et al. 2014). This zone extends beneath Norfolk County and consists primarily of the Dundee Formation within the study area. The upper surface of the Dundee Formation (i.e., the bedrock-overburden interface) is permeable due to fractures and possible karst. The enhanced permeability of the Dundee Formation at the bedrock contact allows for lateral groundwater flow. Vertical fractures or corroded or improperly plugged wells can create vertical hydraulic connections between flow zones in the Dundee Formation and deeper units (Section 3.3; Figure A). This permeability allows the sulphur water in the Dundee Formation to travel laterally as is evidenced by the historic flooding of nearby gas wells following initial plugging of the Original well (F005427) in 1968.

This cause-and-effect pattern was repeated between 2015 to 2020, when the plugging of one gas well resulted in the initiation of flow from another gas well located in the artesian zone with existing pathways to ground surface.

Groundwater in the Dundee Formation in the study area is likely recharged regionally from north of the study area. Groundwater infiltration from the overburden sequence is interpreted to flow along the regional flow path from the Niagara Escarpment southward toward Lake Erie. The interpreted equipotential hydraulic head distribution within the upper bedrock (Dundee Formation) is provided in Figure 6. It is interpreted that the bulk of the groundwater flows south, with a smaller portion of the groundwater flow converging toward Big Creek valley, in locations where the PSD is thinner due to the incision in Big Creek valley. Big Creek valley is creating a natural preferential pathway toward near surface aquifers and/or surface water features.

Figure 7 presents the areas within Big Creek valley, where the interpreted equipotential hydraulic heads in the upper bedrock are higher than the ground surface. This area is defined herein as the artesian zone. The extent of the artesian zone lies within Big Creek valley and its tributaries and is wider toward the southern portion of the study area.

The presence of artesian conditions combined with compromised petroleum wells with preferential pathways (Section 3.3.; Figure A) can lead to flowing wells. Corroded casings, abandoned boreholes, aging lead plugs, and plugs composed of wood/rubble are contributing factors to flowing wells and preferential pathways between the Dundee Formation aquifer and the ground surface.

3.5 Spanjer's Spring Field Investigation

Matrix conducted a field investigation in October 2021 at the Spanjers' property to collect water samples, measure water levels in the existing well on the property, and search for evidence of the existence of a well casing at the S000003 location. Little information is provided in the OGSR Library record on the S000003 location, and there is currently no evidence that a steel casing exists and/or there is a natural breach through the PSD aquitard confining unit that is responsible for the sulphur groundwater discharge to surface. Based on a personal communication with a representative of the OGSR Library (Kuri 2021, Pers. Comm.), the absence of the letter "F" in the well record unique identifier could indicate the absence of completed work at this location. Given that the area was flooded at the time of the visit due to rainfall events, the investigation for the presence of a casing was inconclusive. Based on the global positioning system coordinates, the separation between the spring and the documented S000003 location is approximately 20 m. During the field investigation, intermittent gas bubbling and occasional odours of sulphur were noticed at the spring location, providing evidence of sulphur groundwater discharging. Groundwater chemistry results from a sample of water collected at the spring show dissolved sulphate levels of 50.0 to 53.0 mg/L and major ions and cations with greater concentrations than expected for surface water. Given the area was flooded at the time of sampling, it is recognized that the analytical results from those samples are not representative of the discharging groundwater but are another line of evidence of discharging sulphur groundwater. The absence of a washout or sinkhole was noted during the field investigation, which could indicate a minor to moderate flux of groundwater discharge. In summary, although it was impossible to assess the presence/absence or remains of a casing at the S000003 location, the separation between the spring and the S000003 location is relatively small (i.e., the S000003 location accuracy is estimated to 10 m in the well record). Further investigation will be required to confirm the presence/absence of a casing at the S000003 location under optimal site conditions.

Finally, Spanjers' domestic well (WWIS: W7047368) is known to exist in the vicinity of the Spanjers' Spring (S000003). This well is completed within the upper bedrock, and it was reported that the hydrogen sulphur concentrations and water levels have increased since the Relief well (F020148) was abandoned (Hamilton 2021, Pers. Comm.). It is noted that in October 2021, the water level was 2.75 m below the top of casing and, therefore, not currently under artesian conditions.

4 POTENTIAL FOR FUTURE FLOWING WELLS

As discussed in Section3.4, potential flowing wells are located within the artesian zone of the Dundee Formation aquifer (Figure 7; i.e., where water levels are above ground surface). The second condition that is required for a flowing well is the presence of a pathway connecting the Dundee Formation aquifer to ground surface and/or near surface shallow aquifers.

To assess the potential of future flowing wells in the study area, 278 well records in the Big Creek valley within 500 m either side of the interpreted artesian zone (Figure 7) were assessed from the online files of the OGSR Library. The objective was to investigate factors influencing the presence of pathways, such as potential for corrosion based on the age of the well, presence or absence of plugs, plugging material, and age of the plug. Based on these records, the wells are grouped into one of four well status categories:

- **Abandoned**: wells for which a plugging record is on file at the OGSR Library
- **Active**: wells currently in production
- **Suspended**: wells recently in production that are not currently producing oil or gas
- **Unknown**: wells for which it cannot be determined if plugging was or was not completed (i.e., there is no record of plugging)

A summary of the well status is shown in Table D. Approximately 76% (209) of the wells have been abandoned (i.e., plugged) over the period extending from approximately 1910 to 2020. Roughly 25% (69) of the wells remain open (unplugged), either because they are in production (active) or are suspended pending a decision to resume production or they have an unknown status. Most of wells with unknown status were drilled in the early decades of the twentieth century and records are lacking.

TABLE D Well Status in Big Creek Valley

Well Status	Within the Artesian Zone (Big Creek Valley)	Within 500 m of the Artesian Zone	Total Number of Wells
Abandoned	76	133	209
Active	14	18	32
Suspended	7	6	13
Unknown	10	14	24
TOTAL	**107**	**171**	**278**

The method of well abandonment has varied over the last century, as plugging practices and regulations have changed. Some generalized observations gleaned from the online plugging records allow the wells to be grouped into four time periods that share common abandonment methods.

For the period spanning 1910 to the mid-1960s, the standard method of well abandonment was the use of lead and/or wood plugs over bridges. Between 1910 and 1945 the number of plugs placed in a well ranged from two to four, with the plugs capped by a relatively thin interval of some combination of gravel, stone, sand and/or cement. The thickness of cement was typically on the order of 0.5 to 1 m. The wellbore above the uppermost plug, which is frequently some depth below the bedrock surface, was filled with one or more of stone, sand, clay, or cuttings. Wells plugged in this period account for approximately 10% of the reviewed abandonment records.

From 1945 to the mid-1960s, the means of abandonment remained the same; however, it was common for between four and seven plugs to be set in the well. Five wells, including the FFR well (F006207), had between eight and ten plugs, with gravel, stone, sand and/or cement caps placed on the plugs. The thickness of the cement was commonly in the 1 to 3 m range (i.e., 2 to 4 bags of cement). Again, the portion of the well above the top plug was filled with stone, sand, clay and/or cuttings. Wells abandoned in this 20-year period makeup approximately 30% of the records reviewed.

In the mid- to late-1960s, abandonment of the wells was largely accomplished using cement plugs over bridges, although in some wells this was done in combination with stone fill over bridges. It was common for wells abandoned in this period to have between five to seven plugs; however, some wells had as few as two or as many as eight. Cement intervals were commonly thicker than in earlier years with 10 to 20 plus bags of cement frequently placed over the plugs. Wells were cemented to within several metres of the bedrock surface, the upper limit being at or near the base of the surface casing. Above this level, the wellbore was filled with one or more of stone, sand, clay and/or cuttings. Wells abandoned in this relatively brief period makeup approximately 20% of the records reviewed.

Between the late-1960s to 2000 saw the plugging of approximately 36% of the reviewed wells. The majority were plugged between 1969 and 1988; only one well was abandoned in the 1990s.

The number of plugs installed in a well was frequently between four and seven with the range being one to eight. The thickness of cemented intervals forming the plugs is regularly in the 20 to 40 m range, a significant increase over earlier time periods. Stone fill was still used over bridges in a limited number of wells. Plugging records for a several wells indicate that the intervals between cement runs were filled with water or stone. In contrast with earlier abandonment practice, most wells were filled with cement several to tens of metres above the bedrock surface. Above this the remainder of the well drilled through overburden was filled to the ground surface with stone, sand, clay and/or cuttings.

The post-2000 period has seen the abandonment of approximately 14% of the wells in the vicinity of the FFR well (F006207). Abandonment practices are similar to the previous period with the number of plugs ranging from one to seven, with four to five plugs per well being common. Most plugs consist of thick intervals of cement with the cement fill continuing to near the ground surface (i.e., to within ~1.5 m below ground surface [bgs]). It is not uncommon during this period for the entire depth of the well to be filled with cement. As a result of regulations enacted, sulphate resistant cement was used in the well abandonment (MNRF 2002, API 2019).

5 NUMERICAL SIMULATION OF THE GROUNDWATER FLOW SYSTEM

Numerical models of groundwater flow are developed to represent interpreted hydrogeological unit geometries, material properties, and boundary conditions influencing the groundwater flow dynamics. The purpose of groundwater flow modelling is to represent the 3D groundwater flow directions across the study area. The model development objectives include:

- representing available historical flow-related field data (e.g., water levels and estimated hydraulic conductivities)
- simulating relevant groundwater flow processes (e.g., recharge, heterogeneity reflecting stratigraphy in 3D, discharge locations)
- simulating historical stresses to the hydrogeological system (e.g., flowing wells)
- providing a refined understanding of the groundwater flow directions in the Dundee Formation aquifer and water budget
- supporting the evaluation of potential future remediation scenarios, the assessment of potential impacts of previous well plugging initiatives, and the assessment of the potential area that may be affected by flowing gas wells

5.1 Modelling Approach and Software Selection

This work assumes that a representative elementary volume (Bear 1972) of the porous medium exists and can represent the effective hydraulic behavior of the medium.

Groundwater flow in the subsurface was simulated using the 3D FEFLOW v.7.2 simulator developed by DHI-WASY GmbH (DHI 2019). FEFLOW v.7.2 was used to solve for mass conservative groundwater flow within variably saturated porous media using finite element discretization of the media.

5.2 Model Mesh and Layering

The model domain for this study extends 14.2 km north to south, 12.3 km west to east, and vertically from ground surface to the top of the Bass Island Formation, a maximum depth of 175.3 m bgs. The total area is approximately 186 km^2. The model domain considers:

- area of observed flowing wells
- regional flow system for overburden and bedrock
- surface and groundwater divides
- interpreted regional groundwater inflow from northeast, and outflow to the south

The model mesh consists of 12 layers, which represent the units from the overburden and bedrock geology (Figures 8 and 9).

The finite element numerical model mesh was discretized horizontally and vertically throughout the model domain. Increased horizontal mesh discretization was used near surface water features and oil and/or gas wells. Increased discretization results in an increased number of nodes and elements required to represent the model geometry. The increased number of nodes in the model increases the computational effort and model run times, the degree of discretization was chosen to provide necessary refinement while balancing the need for model computational efficiency.

The smallest elements of the two-dimensional (2D) mesh are 3 m on a side and are in the vicinity of the FFR well (F006207). The largest elements are 400 m on a side and are in the vicinity of the model domain's perimeter. The nodal spacing of the mesh was sufficiently detailed to represent the location of potential flowing wells and surface water features.

The stratigraphic layering of the geologic members (hydrogeological units) is represented in the FEFLOW mesh using slices. Slices are surfaces that define the top and bottom contacts of each model layer and vertically discretize the model domain. The slices are continuous surfaces that slope and conform to the geological/hydrogeological units. The numerical model uses 13 slices (12 model layers) to represent all hydrogeologic units.

In the construction of this numerical model, the bottom of the model was set to the top structure of the Salina Group, which was taken from Ontario Geological Survey 3D Paleozoic Bedrock Model (Carter et al. 2019). As described earlier, the overburden surface elevations are consistent with the Otterville model. The top of the bedrock surface used in this study came from Ontario Geological Survey 3D Paleozoic Bedrock Model, with local refinement in vicinity of the FFR well (F006207). All other bedrock unit top structure surfaces are consistent with the Ontario Geological Survey 3D Paleozoic Bedrock Model.

5.3 Boundary Conditions

Boundary conditions are used to represent locations where groundwater enters or leaves the model domain. Groundwater is conceptualized to enter the model domain mainly through recharge from precipitation. Groundwater leaves the model domain through lateral groundwater flow and discharge to surface water features. Groundwater can also leave the model through well boundary conditions that represent known OGSR flowing well locations. The bottom of the model is treated as a no-flow (impermeable) boundary.

5.3.1 Recharge

Net groundwater recharge was assigned to each element on the top slice of the model as a flux, representative of average annual net groundwater recharge condition. The recharge is consistent with the Otterville model with a spatially distributed recharge ranging from 0 to 946 mm/year. The total recharge rate applied throughout the model domain is 163,750 m^3/day, equivalent to an average recharge rate of 322 mm/year.

5.3.2 Interior Boundary Conditions

Big Creek, Silverthorne Creek, Cranberry Creek, Trout Creek, and their tributaries were assigned constant head boundary conditions set to the ground surface elevation derived from the digital elevation model (Figure 8). These boundary conditions represent areas where groundwater can exist the model domain.

5.3.3 Model Perimeter Boundary Conditions

Perimeter boundary conditions were assigned to nodes along sections of the model perimeter where groundwater was interpreted to leave the domain on slice 4 (top of the upper Interstitial Sediment) and slice 7 (top of bedrock/contact aquifer) as shown in Figure 8. Constant head boundary conditions were used to specify the groundwater elevation at these locations; the values applied were based interpreted regional groundwater flow directions, and simulated Otterville model hydraulic heads.

5.4 Hydraulic Properties

The hydraulic conductivities and specific storage values for the unconsolidated sediments from the Otterville model were used as initial values in this study, with a few variations:

- The high discretization of the upper interstitial sediments of the Otterville model was reduced and combined into a single layer.

- The hydraulic conductivity of the PSD was reduced to be more reflective of low-permeability materials. In addition, the unit was divided into two distinct zones: a western zone, where the upper Interstitial Sediment is absent, and an eastern zone, where the upper Interstitial Sediment is present. The frontier between those zones is defined as the base of the upper interstitial sediments, as shown on Figure 9.

5.5 Model Calibration

The calibration of a numerical model of groundwater flow is an iterative process of testing groundwater flow understanding, or hypotheses, about the flow components of the conceptual site model. Although the current numerical model has some differences in material properties, layer structures, and model domain with the existing Otterville model, the calibration objective of this study was to obtain a similar or improved match to observed hydraulic heads compared to the Otterville model. In addition to hydraulic heads, the magnitude and timing of flowing wells were considered part of the calibration targets.

During the calibration process, horizontal and vertical hydraulic conductivities were adjusted based on learnings from each simulation of steady-state water levels and transient discharging rates at flowing well locations. Adjustments were made within the bounds of field measurements and literature data for similar environments to improve fit between observed and simulated water levels and flow conditions.

Details on model calibration data, simulated hydraulic heads, the spatial distribution of misfit, and calibrated estimated hydraulic parameters are provided as part of Appendix A.

One of the guiding principles for model calibration is to achieve quantitative and qualitative performance metrics, through the definition of model-specific criteria based on the desired predictions of interest. Given the purpose and objectives of this study, as discussed in Section 1.2, both qualitative and quantitative performance metrics are described in this section.

Qualitative performance measures can be defined as the ability of the model to reproduce expected system behavior and/or modelling standards that are not necessarily captured within any quantitative performance metrics. In other words, this is the verification of the model using different data types.

Qualitative performance measures that were considered include:

- consistency between mapped and modelled hydrogeologic unit structure
- consistency of parameter values with field/laboratory measurements and literature estimates
- mass balance and model convergence with an acceptable error
- consistency between interpreted and simulated groundwater level contours and flow directions

- consistency between the recharge and groundwater discharge areas

The above quality performance measures are met with the current model. Figure 10 provides a comparison between the interpreted and simulated equipotential contour map. Generally, the interpreted and simulated hydraulic heads are in good agreement.

Calibrated parameters values (provided in Appendix A) are within expected ranges. The calibrated horizontal hydraulic conductivity for the Dundee Formation aquifer is 1.2×10^{-4} m/s, representative of a productive aquifer.

Quantitative measures that can be used for assessing model performance to reproduce observations are summarized in Table E and are defined as the following:

- Root mean square (RMS): provides a measure of variation that considers measurement accuracy.
- Normalized RMS (NRMS): RMS divided by the total range (maximum minus minimum measured value). This percentage value allows the goodness-of-fit in one model to be compared to another, regardless of the scale of the model.
- Mean absolute error: represents the precision of the model.
- Mean error: represents the average difference between all measured and simulated values. The sign of the residuals indicates the bias of the model; positive indicates model underestimating heads, and negative indicates model overestimating heads.

In this study, the leading quantitative performance measure is the RMS for hydraulic heads. The RMS performance measure was applied to overburden and upper bedrock wells (WWIS bedrock wells) water levels.

TABLE E Calibration Statistics - Simulated vs Measured Water Levels

Well Group	Number of Wells	Root Mean Squared (m)	Normalized Root Mean Squared (%)	Mean Absolute Residual (m)	Mean Residual (m)
Otterville Model - Overburden Calibration Targets	252	5.7	10.5	4.6	-1.7
Water Wells Information System - Upper bedrock wells	38	8.9	23.3	7.5	4.3

The RMS in the Otterville model for overburden calibration targets within the current numerical model domain was 7.9 m and through this calibration effort was reduced to 5.7 m. WWIS upper bedrock water wells are interpreted to be completed in the Contact and/or Dundee Formation aquifers. The WWIS reported water levels are interpreted to have relatively high uncertainty and, therefore, were expected to have a higher RMS value. These RMS values are considered acceptable values and the steady-state model is considered to be representative of groundwater flow conditions.

As discussed in Appendix A, the simulated hydraulic head within the upper bedrock tends to be higher than measured in the Big Creek valley centre. Although, near the FFR well (F006207), the measured hydraulic head within the Dundee Formation aquifer obtained during drilling of the Norfolk County monitoring well (T012616) was 16 m above ground surface at a depth of 33.5 m, equivalent to 209.5 m asl. The numerical model simulated hydraulic head at this location is 207.6 m asl, resulting in a difference between simulated and measured of -1.9 m.

As part of the history matching of flowing wells, the numerical model was able to reproduce the magnitude of estimated flow rates at known flowing wells (Figures 11a and 11b). All flowing wells were simulated using a fixed head to the ground elevation, with a maximum constraint to estimated flow rates. The transient simulation results indicated that for all wells, the simulated water levels are higher than ground surface (within the artesian zone), consistent with the conceptual model. During flowing events, the magnitude of flowing rates exceeded the upper bounds of the estimated flow rates, except the Teichroeb well (T012512), which was closer to the lower bound of the estimated flow rates. It is noted that the FFR well (F002607) responded to the plugging event from the Relief well (F020148) and Teichroeb well (T012512).

The transient simulation results of historical plugging events suggest the increased hydraulic heads in the Dundee Formation aquifer surrounding a plugged well is generally less than 2.5 m as shown in Figure B. Water levels at most known flowing wells remained above ground surface during the transient simulation. Based on this understanding, the pathway from the Dundee Formation to the ground surface is representing an important factor in well susceptibility to experience flowing conditions.

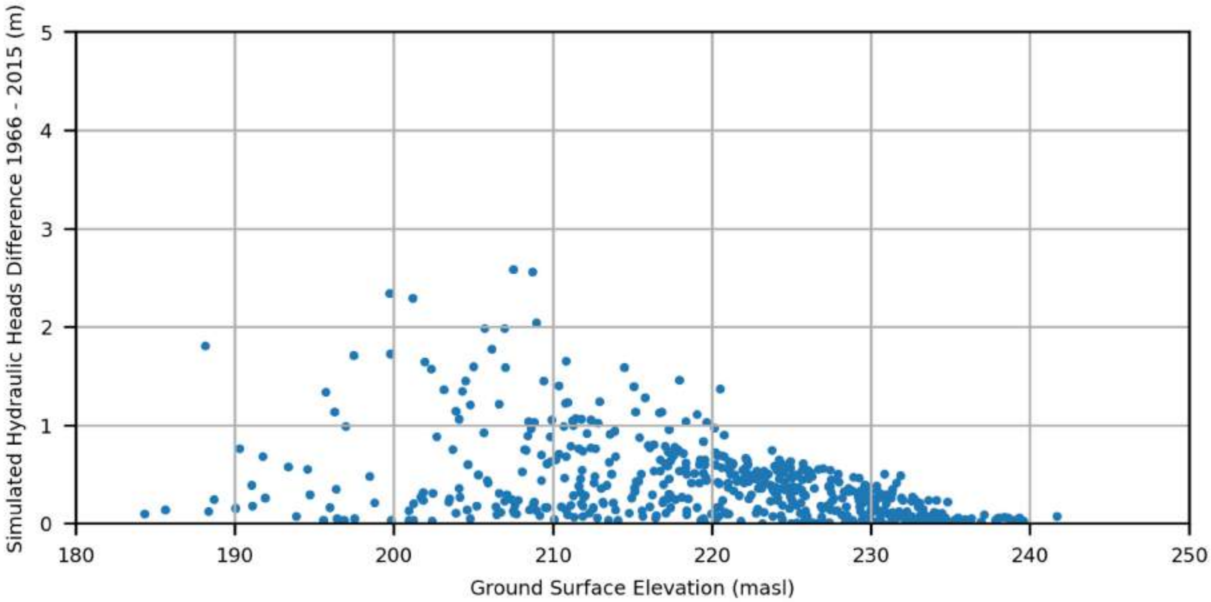


FIGURE B Simulated Heads Difference in the Dundee Formation Aquifer Between Years 2015 and 1966 at Oil, Gas and Salt Resources and Water Well Information System Wells

5.6 Data Gaps

Data gaps can be defined as data for components of the hydrogeological system that are missing but have the potential to increase the confidence level and/or accuracy of the answer to specific questions. In this study, the following data gaps were identified:

- Discharge rates from flowing wells were estimated and not precisely measured with flow meter. In addition, discharge rates from flowing wells are expected to have some seasonal variations.

- Discharge rates from flowing wells were estimated at surface. The proportion of water discharging belowground surface were not considered in the reported discharge rates.

- The hydraulic conductivity in fractured porous rock can vary spatially. The difference in discharge rate at surface between the FFR well (F006207) (55 m^3/day) and the Norfolk County monitoring well (T012616) (1,635 m^3/day) may be related to a difference in the hydraulic conductivity of the aquifer. Although, given the FFR well (F006207) has casing and plugs within the borehole, it is currently impossible to differentiate if the difference in discharge rate measured is caused by a difference in hydraulic conductivity or the partial hydraulic isolation (e.g., pathway) that prevents complete hydraulic connectivity with the Dundee Formation aquifer. This point can be made at every OGSR well, which contributes to the uncertainty into the in situ hydraulic conductivity of the Dundee Formation aquifer.

- No continuous water levels are recorded from the Dundee Formation aquifer at locations of OGSR wells. No transient water level response was monitored during a plugging event and/or a pumping test. This information would reduce the uncertainty in the radius of influence of plugging events (e.g., spatial extent of measured change in water levels), the hydraulic conductivity, and specific storage of the Dundee Formation aquifer.

- Flowing wells may have compromised casings between the Dundee Formation aquifer and the ground surface leading to a loss of sulphur-water into other overburden formations. Groundwater quality is unknown in overburden aquifers in the vicinity FFR well (F006207).

5.7 Model Assumptions

Models are guided by the available site data. Where data is lacking or approximate, assumptions are made. For this model the following assumptions were made:

- All known flowing wells represent the total number of flowing wells in the model domain. Unknown flowing wells are not represented.

- For each flowing well, it is assumed that the estimated discharge rate at surface is the sum of the Dundee Formation aquifer groundwater that reaches ground surface. In other words, no preferential pathway exists between the Dundee Formation aquifer and the shallower overburden aquifers.

- A Representative Elementary Volume exists within the Dundee Formation aquifer at the scale of the investigation. Therefore, the equivalent porous media modelling approach is appropriate for estimating the flow within the fractured porous bedrock.

5.8 Model Limitations

Models are simplified representations of real-world systems and are subject to uncertainty and limitations in available data. The model can predict general system behavior, but not specific outcomes. Based on groundwater production from currently flowing wells, the model offers an accurate predication of the water levels response if specific wells are plugged or if additional relief wells are completed.

The numerical model of groundwater flow is limited in predicting the location of the well(s) that may begin flowing, if one or more of the currently producing wells are plugged, due to the unknown conditions of borehole, casing and plugs integrity at each OGSR well location.

6 MODEL APPLICATION

A numerical model of groundwater flow was constructed and calibrated to represent the study area. The combined steady-state and transient calibration approach maximizes the value of the hydrogeological data collected to date. The model has been shown to be a good representation of the groundwater flow system based on quantitative and qualitative performance criteria.

This section describes the application of the model to estimate the impacts of previous well plugging, the relative risk of flowing conditions between petroleum wells and the potential impacts of future remediation scenarios.

6.1 Impacts of Previous Well Plugging

A transient simulation to represent historical plugging events was performed during the calibration process. During this simulation, the flowing wells were set with a maximum discharge rate constraint of the maximum estimated flowing rates (Figure 2). To conservatively estimate the radius of influence of the previous well plugging, the transient simulation was run again, but this time without any maximum discharge rate constraint at the plugged wells. As a result, the simulated rates were generally higher than estimated values. This overestimation could represent the portion of groundwater potentially discharging in the subsurface, assuming the calibrated Dundee Formation aquifer transmissivity is representative of field conditions. It can also be influenced by the simulated hydraulic heads being potentially higher than measured near Big Creek valley centre. The results are summarized on Figure 12 for three distinctive periods:

- <u>October 2014:</u> Relief well (F020148) was flowing.
- <u>January 2017:</u> Grant well (T009949), Morrison well (T008725), Teichroeb well (T012512), and Wulleman well (T012545) were flowing.
- <u>December 2020:</u> FFR well (F006207), Edwards well (F005318), and Spanjers' Spring (S000003) were flowing.

Under these upset conditions, the simulated change in water level greater than 1 m is generally within a 2 km radius. The radius of influence was the smallest when the Relief well (F020148) was flowing in 2014, and the largest in 2017, when multiple flowing wells were contributing to the cumulative impact. As discussed in the transient calibration section of this report (Section 5.5), water levels at most known flowing wells remained above ground surface during the transient simulation, suggesting the increase in water levels alone is not sufficient to explain why other wells started flowing. The integrity of the casing and plugs between the Dundee Formation to the ground surface is an important factor in well susceptibility to flowing conditions.

6.2 Relative Risk of Flowing Conditions

The risk of each petroleum well to develop flowing conditions was ranked by using the Compromise Approach to aggregate and compare the combined risks of each identified criterion. This approach is a standard multi-criteria decision analysis (MCDA) method, which uses a measure of distance to an ideal solution (Hwang and Yoon 1981). The criteria used for this aggregation were the simulated water levels above ground surface in the Dundee Formation aquifer, and the date of the latest plugging event. The weights assigned to the criteria are presented in Table F.

The Compromise Approach gives a normalized distance from an ideal solution. An ideal well would have a simulated water level below ground surface and the plugging would have had occurred in 2019. This ideal well would have a normalized expected risk of 0 and represent the lowest possible risk ranking in this analysis. The worst possible scenario would be where the well has the highest simulated water level above ground surface and a plugging event prior to 1965. As described in Section 4, plugging requirements changed after 1965, and as such, all wells pre-1965 are assumed to have the same higher risk when assessing date of plugging. Wells where the date of plugging was unknown were assumed to be pre-1965. In this worst possible scenario, the well would have a normalized expected risk of 1 and would represent the highest risk ranking possible in this analysis.

TABLE F Compromise Approach Criteria Weighting

Criteria	Weight	Lower Limit	Upper Limit	Unit
Dundee Fm. Water Level Above Ground Surface	1	-11	20	m
Plugging Event Date	1	Pre-1965	2019	year

Figures 13a and 13b present the relative risk scores and ranking of petroleum and water wells in the study area, given the selected criteria and ranking methodology. The wells with the highest relative risk are located near Big Creek valley, in the centre of the study area. Wells that were recently plugged have relatively low risk compared to the currently flowing wells and the Original well (F005427), which was plugged in 1968.

6.3 Assessment of Remediation Options

As part of the current scope of work, Matrix provided technical support in the assessment of potential remediation options. The remediation options that are discussed in this report were chosen by the project's technical committee along with Norfolk County staff. The selected remediation options are deemed comprehensive, as they cover a wide range of technically feasible options.

The objective of the assessment of remediation options was to provide a screening level evaluation of potential impacts on water levels, risk to other OGSR wells, the time required for construction, and an estimate of capital and ongoing costs. A total of four remediation scenarios were considered for this report and details are provided in the following sections.

6.3.1 Option 1: Plugging the Forestry Farm Road Well (F006207)

The first option is the plugging of the FFR well (F006207), located on a parcel of land owned by Norfolk County. A successful well abandonment would eliminate environmental and health concerns, as it would eliminate groundwater discharging to surface and the presence of exsolving hydrogen sulphide gas into the air. Based on the definitions found in the *Oil, Gas and Salt Resources Act* (OGSRA), if a well is orphaned, the owner of the land on which the work is situated is considered as the operator. This also designates the landowner as responsible for those wells if an order to plug the well or decommission a facility is released by an inspector (Section 7.0.1 OGSRA). Based on the law, two conditions can lead to an order:

> *(a) the inspector is of the opinion that the well or facility represents a hazard to the public or to the environment; or (b) any activity relating to the well or facility has been suspended. 2006, c. 19, Sched. P, s. 4 (7).*

To Matrix's knowledge, such an order was not received by Norfolk County at the time of this report, but the plugging of the FFR well (F006207) would eliminate Norfolk County's environmental liability for this parcel of land.

This remedial option would not address the issue at other known flowing wells in the study area and would potentially increase discharge rates at these wells. Based on the assumption that the FFR well (F006207) estimated flowing rate is 55 m^3/day, the predicted change in water level would be less than 0.3 m within a radius of approximately 10 m around the FFR well (Figure 14), which would result in a marginal impact on water levels from neighboring petroleum wells.

It is important to note that the historical flow rate at the FFR well (F006207) is marginal in comparison to the conditions observed during the drilling of the Norfolk County monitoring well (estimated at 1,100 m^3/day; 300 gallons per minute) and historical flow rates encountered at the Relief well (F020148) and Teichroeb well (T012512) (Figure 2). The proportion of sulphur groundwater currently discharging underground into shallow aquifers is currently unknown, and therefore, the resulting change to the groundwater system could be greater. The relatively low flow rate from the FRR well (F006207) may be due to the fact that one or more of the eight plugs used to abandon the well in 1956 may have failed. If this is the case, further failure of plugs over time, could increase flow to surface. Assuming existing pathways from the Dundee Formation to surface, upset conditions were simulated and presented in Figure 12 (right panel; December 2020) and should be considered as a potential outcome from the abandonment of the FFR well (F006207).

Matrix, in consultation with drilling contractors, estimated the screening level time and cost for the implementation of this option to provide a range in the level of effort. Based on this information, the estimated cost for plugging the FFR well (F006207) would be less than $500,000 for capital cost, and the work could be completed within few months (Figure 15).

6.3.2 Option 2: Capture and Treat Forestry Farm Road Well (F002607)

This second option consists of capturing sulphur water flow to surface from the FFR well (F006207), and with a treatment unit, remove the hydrogen sulphur prior to the release of the water to surface. The removal of hydrogen sulphur would eliminate impacts to the air quality and stressed vegetation in vicinity of the FFR well (F006207). This remediation option would maintain the status quo, and therefore, it would likely not have any negative impact (i.e., increase) on the water levels within the Dundee Formation aquifer. The treatment unit would be designed with a capacity equivalent to the maximum reported flowing rate of approximately 55 m^3/day. Further characterization of the flow rates would be warranted prior to designing a solution; nevertheless, a mobile treatment unit could be relatively easy to install. The capital cost for such a mobile system is estimated to be less than abandonment costs from Option 1, and depending on the required capacity of the system, it could be installed in less than 6 months. The maintenance and operation ongoing cost would be recurrent until a different remediation option is implemented, given it not expected that the FFR well (F006207) will stop flowing in the future.

This remedial option is not a regional solution, as known flowing wells such as the Spanjers' Spring (S000003) and Edwards well (F005318) will remain flowing. Because this option does not take any corrective measures into the subsurface, casing corrosion and cement deterioration will be ongoing and, therefore, could lead in increased flowing rates over time and increased costs.

6.3.3 Options 3 and 4: Drill New Relief Well - Capture and Treat

For the two last remedial options, the drilling of relief wells near the FFR well (F006207; Option 3) and the Relief well (F020148; Option 4) was assessed. The objective with these options is to capture and treat as much groundwater as possible from the Dundee Formation aquifer to create a regional low in water levels (i.e., a sink), similar to water level conditions that existed prior 2015 when the Relief well (F020148) was active. These two options have the most effect on regional water levels, as shown in Figure 14, ten petroleum wells with a relative risk greater than 0.7 are present in the radius of influence of the 1 m change in water level for Option 4 (FFR well F006207), whereas 14 petroleum wells have a relative risk greater than 0.7 for Option 5 (Relief well F020148). Although regional water levels within the Dundee Formation would be decreased, simulated results from the numerical model suggest it would not be sufficient to bring the water levels below ground surface, other than locally. The susceptibility for petroleum wells to become flowing would remain present, although slightly reduced. These scenarios would likely reduce discharge rates at known flowing wells but are unlikely effective measures to eliminate all of the flow discharging to surface or air quality impacts from exsolving hydrogen sulphur.

Based on the numerical model, the predicted capacity of the proposed relief wells would be on the order of 3,800 m^3/day for each well, which is consistent with historical estimated flowing rates at the Relief well (F020148) and Teichroeb well (T012512; Figure 2). For this work, it is assumed that Options 3 and 4 would require an environmental assessment, given it could be defined as a municipal infrastructure (*Environmental Assessment Act*). The environmental assessment process can take up to 2.5 years to obtain an approval. Once approval is received, an additional period of 1 to 2 years would be required for the treatment facility to be designed, after which the remedial option would be operational. For this screening level cost assessment, these options represent the highest capital costs and ongoing cost (Figure 15). The combined capital and ongoing costs for these two options is expected to be in the order of multi-millions of dollars, although a formal cost estimate was not part of this scope of work.

7 SUMMARY AND CONCLUSIONS

The main objectives for this project were to improve the understanding of geological and hydrogeological conditions resulting in flowing sulphur-rich petroleum wells in Big Creek valley, particularly near the FFR well (F006207) located on Norfolk County property, and to support the assessment of future remediation options.

The geological and hydrogeological understanding was advanced through the analysis of petroleum well records, integration of site-specific information, review of regional geological maps of the bedrock, and the construction and application of a numerical model of groundwater flow.

The review of OGSR well library records allowed better characterization of the plugging age, the main indicator that was used to define potential well integrity conditions. The interpretation of measured water levels allowed the definition of an artesian zone in Big Creek valley, in which water levels are believed to be higher that the ground surface elevation. Both sets of information were used for well susceptibility to flowing conditions.

A numerical model of groundwater flow was constructed, based on existing hydrogeological studies. The tool was calibrated and deemed to adequately represent measured hydraulic heads in the overburden and the Dundee Formation aquifer and historical estimated flow rates at known flowing and recently plugged wells.

The use of the numerical model allowed estimation of the radius of influence from historical well plugging and assessment of the impacts on regional water levels.

The simulated hydraulic heads within the Dundee Formation were used to create a simulated artesian zone. The simulated artesian conditions combined with the OGSR Library well record plugging date information were used to compute relative risk of flowing conditions. Most of the petroleum wells located near Big Creek valley centre are ranked amongst the highest risk.

Four remediation options were assessed as corrective measures to the release of hydrogen sulphur in the air and stresses to the vegetation in Big Creek valley. Those remediation options span from well abandonment to capture and treatment of sulphur-rich groundwater. Through this assessment, the time and cost of each option was estimated to help inform decision-makers.

From this hydrogeological assessment, the following conclusions can be made regarding the Dundee Formation hydrogeological system in the Big Creek valley:

- The Dundee Formation aquifer is highly transmissive and, based on historical estimated flowing rates, could sustain up to 3,800 m^3/day per well (Figure 2; Relief well [F020148]), with a simulated decrease of 1 m in water levels extending up to 2 km from each well.

- Results from the model indicate that changes in water levels from historic flowing wells do not eliminate the presence of the artesian zone. In other words, water levels remained above the ground surface prior to and post plugging activities. Model results also suggest that the integrity of the well casing and plug or plugs play important roles in the susceptibility of a well become flowing.

- A total of 89 wells were ranked based on their relative flowing risk within the simulated artesian zone (Figure 13a and 13b).

- The simulated change in water levels from historical flowing wells is deemed insufficient to eliminate the presence of the artesian zone and is indicative that well casing and plug integrity is an important factor in the susceptibility of a well in developing flowing conditions.

- The assessment of remediation options indicated that most cost and time effective solution is also the best long-term technical solution:

    - Option 1: Abandonment of FFR well (F006207) would result in marginal water level increases assuming no other groundwater is currently discharging underground in shallow overburden aquifers. This option would meet Norfolk County's requirements under the *Oil, Gas and Salt Resources Act* and eliminate environmental impacts at the FFR well (F006207) location but would not address the issues from other flowing wells in the Big Creek valley area.

- Although Option 2 (capture and treatment of flowing water at the FFR well [F006207]) would be effective there are significant capital cost and time required to implement the remediation. Also, the ongoing costs for maintenance and monitoring are recurring and, therefore, interpreted not to be a viable long-term solution.

- Finally, as for any investigation, assumptions, data gaps and limitations have been identified. The Dundee Formation lacks continuous water levels monitoring, and aquifer testing to reduce uncertainty in key hydrogeological parameters such as the transmissivity and storativity, which in return would reduce uncertainty in the magnitude and radius of influence from predictive simulations.

8 REFERENCES

American Petroleum Institute (API). 2019. *Cements and Materials for Well Cementing*. API Specification 10A. Twenty-fifth Edition, March 2019. March 2019.

AquaResource Inc. (AquaResource). 2009a. *Tier Two Water Quantity Stress Assessment, Long Point Region, Catfish Creek and Kettle Creek*. Prepared for the Lake Erie Source Protection Region. Month 2009. 2009.

AquaResource Inc. (AquaResource). 2009b. *Integrated Water Budget Report, Long Point Region, Catfish Creek and Kettle Creek*. Prepared for the Lake Erie Source Protection Region. Month 2009. 2009.

Armstrong D.K. and T.R. Carter. 2010. "The subsurface Paleozoic stratigraphy of southern Ontario." In: *Ontario Geological Survey, Special Volume 7*. 301 p. 2010.

Barnett P.J. 1998a. *Quaternary Geology, Long Point–Port Burwell Area*. Ontario Geological Survey, Report 298, 143p. 1998.

Barnett P.J. 1982a. *Quaternary Geology of the Tillsonburg Area, Southern Ontario*. Ontario Geological Survey, Report 220, 87p. 1982.

Bear J. 1972. *Dynamics of Fluids in Porous Media*. American Elsevier, New York. 1972.

Carter T.R. et al. 2019. *A Three-dimensional Geological Model of the Paleozoic Bedrock of Southern Ontario*. Geological Survey of Canada, Open File 8618; Ontario Geological Survey, Groundwater Resources Study 19. 2019.

Carter T.R. et al. 2014. *Aquifer Systems in Southern Ontario: Hydrogeological Considerations for Well Drilling and Plugging*. Canadian Society of Petroleum Geologists and Canadian Well Logging Society, Geoconvention 2014, abstract. Calgary, Alberta. 2014. http://www.geoconvention.org/archives/2014abstracts/298_GC2014_Aquifer_Systems_in_Southern_Ontario.pdf

Chapman L.J. and D.F. Putnam. 1984. *The Physiography of Southern Ontario*. Third Edition. Ontario Geological Survey, Special Volume 2. Accompanied by Map 2715 (coloured), scale 1:600,000. Ontario Ministry of Natural Resources. Toronto, Ontario. July 9, 1984, 270 p. 1984. https://open.canada.ca/data/en/dataset/d22354e8-cb01-5262-aed5-1de48d1ffb0a

Hamilton S.M. 2021. Senior Science Leader for Geochemistry, Ontario Geological Survey. June 2021.

Hamilton S.M. 2015. *Ambient Groundwater Geochemistry Data for Southern Ontario, 2007-2014*. Ontario Geological Survey, Miscellaneous Release-Data 283-Revised.

Hwang C. and K. Yoon. 1981. *Multiple Attribute Decision Making: Methods and Applications A State-of-the-Art Survey*. Springer-Verlag Berlin Heidelberg. ISBN 978-3-540-10558-9. 1981.

Jackson R.E. et al. 2020. "Investigating the Origin of Elevated H2S in Groundwater Discharge from Abandoned Gas Wells, Norfolk County, Ontario." *Geoconvention 2020* 2020.

Kuri F. 2021. Consultant. Email. July 8, 2021.

Matrix Solutions Inc. (Matrix). 2019. *Wellhead Protection Area Delineation, Issue Contributing Area Delineation, and Threats Assessment for the Otterville Well Field*. Prepared for County of Oxford. 2019.

Matrix Solutions Inc. (Matrix). 2018. *WHPA Delineation, Vulnerability Scoring, and Threats Assessment, Town of Delhi, Norfolk County, Lake Erie Source Protection Region*. Prepared for Grand River Conservation Authority. Guelph, Ontario. March 2018.

Matrix Solutions Inc. (Matrix). 2015. *Long Point Region - Tier Three Water Budget and Local Area Risk Assessment*. Prepared for Lake Erie Source Protection Region. Waterloo, Ontario. April 2015.

MIKE Powered by DHI (DHI). 2019. *FEFLOW (Version 7.2)*. Interactive Graphics-based Finite Element Simulation System for Subsurface Flow and Transport Processes. Released March 1, 2019.

Ministry of Natural Resources and Forestry (MNRF). 2002. *Oil, Gas and Salt Resources of Ontario Provincial Operating Standards*. Version 2.0. https://www.ontario.ca/document/oil-gas-and-salt-resources-ontario-provincial-operating-standards

Oil, Gas, & Salt Resources Library (OGSRL). 2021a. *F005427 Well Card*. Accessed March 2021. 2021. Oil, Gas & Salt Resources Library (OGSRL). 2021a. T009949 Well Card. Accessed March 2021. 2021. http://www.ogsrlibrary.com/wellcards/wellcard.php?l=F005427

Oil, Gas, & Salt Resources Library (OGSRL). 2021b. *T009949 Well Card*. Accessed March 2021. 2021. Oil, Gas & Salt Resources Library (OGSRL). 2021b. T009949 Well Card. Accessed March 2021. 2021. http://www.ogsrlibrary.com/wellcards/wellcard.php?l=T009949

Oil, Gas, & Salt Resources Library (OGSRL). 2021c. *F020148 Well Card*. Accessed March 2021. 2021. Oil, Gas & Salt Resources Library (OGSRL). 2021c. F020148 Well Card. Accessed March 2021. 2021. http://www.ogsrlibrary.com/wellcards/wellcard.php?l=F020148

Oil, Gas, & Salt Resources Library (OGSRL). 2021d. *T012512 Well Card*. Accessed March 2021. 2021. Oil, Gas & Salt Resources Library (OGSRL). 2021e. T012512 Well Card. Accessed March 2021. 2021. http://www.ogsrlibrary.com/wellcards/wellcard.php?l=T012512

Oil, Gas, & Salt Resources Library (OGSRL). 2021e. *T008725 Well Card*. Accessed March 2021. 2021. Oil, Gas & Salt Resources Library (OGSRL). 2021f. F006207 Well Card. Accessed March 2021. 2021. http://www.ogsrlibrary.com/wellcards/wellcard.php?l=T008725

Oil, Gas, & Salt Resources Library (OGSRL). 2021f. *T012545 Well Card*. Accessed March 2021. 2021. Oil, Gas & Salt Resources Library (OGSRL). 2021d. T012545 Well Card. Accessed March 2021. 2021. http://www.ogsrlibrary.com/wellcards/wellcard.php?l=T012545

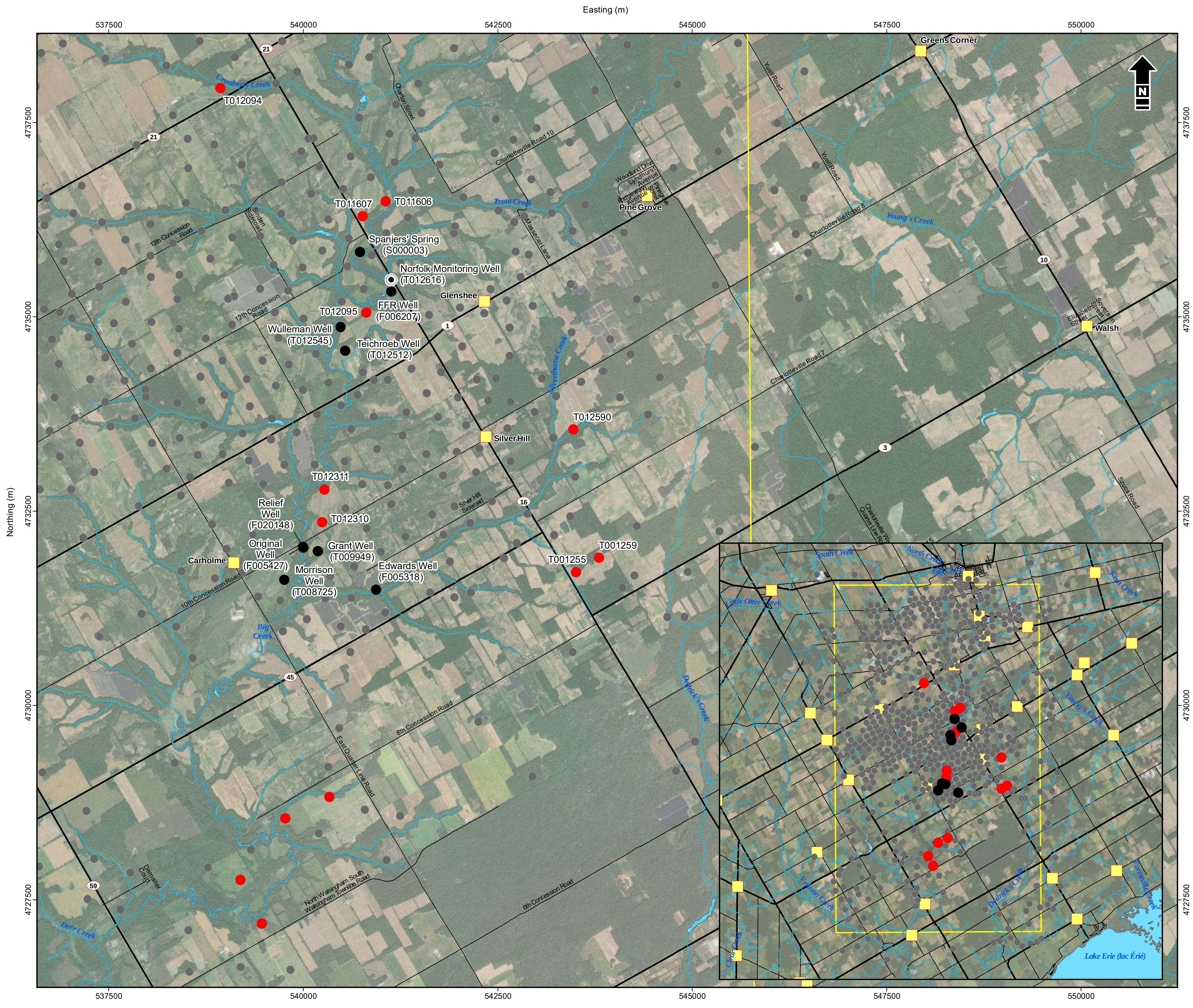
Ontario Geological Survey (Peter J Barnett). 1998b. *Quaternary Geology, Long Point-Port Burwell Area*. 1998.

Ontario Ministry of Natural Resources (Peter J Barnett). 1982b. *Quaternary geology of the Tillsonburg area, southern Ontario*. 1982.

Singer S.N. et al. 2003. *The Hydrogeology of Southern Ontario*. Second Edition. Environmental Monitoring and Reporting Branch, Ministry of the Environment. Toronto, Ontario. 2003.

Smal C.A. 2016. “Regional Groundwater Geochemistry on the Niagara Peninsula.” Master of Science thesis. Schol of Geography and Earth Sciences. McMaster University. Hamilton, Ontario. 305 pp. 2016.

WorkSafeBC. 2010. *Hydrogen Sulfide in Industry*. Prepared for CompanyName. February 2010.



Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

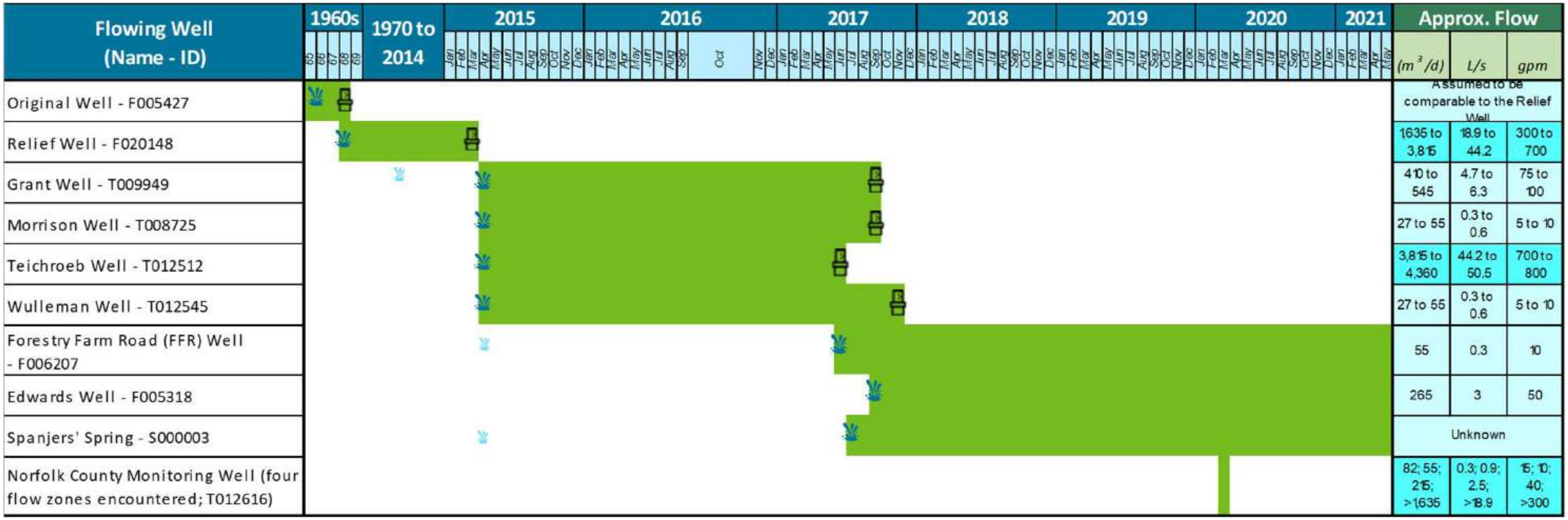
Norfolk County
Norfolk Gas Well Management Project

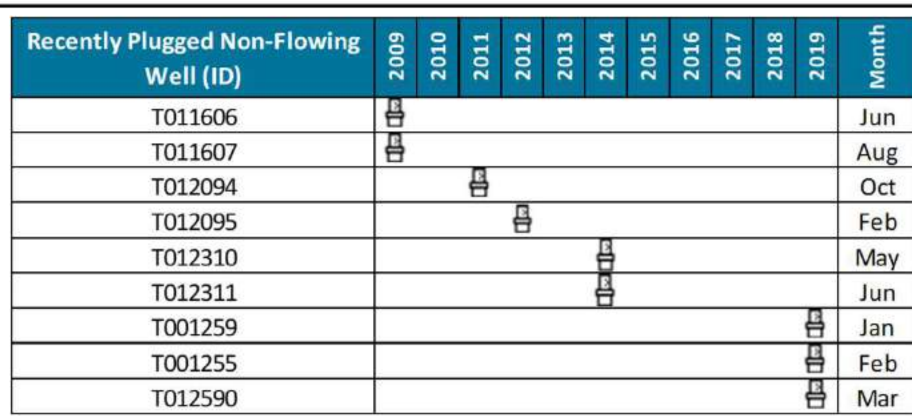
Study Area

Date:	Project:	Submitter:	Reviewer:
September 2021	31976	J. Melchin	L. Boutin

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure
1





Well/spring began to discharge sulfur water at ground surface

Potential intermittent discharge of sulfur water at ground surface

Well/spring discharging sulfur water at ground surface

Plugging event

[1]T009949 may have been discharging small volumes of water at surface whilst Relief Well was operational.
[2]F006207 and the Spanjers' Spring were intermittently discharging water between 2015 and 2017.
[3]FFR well inferred by Bradco Drilling and Norfolk staff to be flowing at a similar rate to low flows at monitoring well (~10 gpm).
[4]T008725 Morrison well casing is reported to be cap with steel plate, and not abandoned. From personal communications with stakeholders.
[5]*The method(s) for measuring the flow rates is not known. Rates were provided via personal communications with stakeholders.*

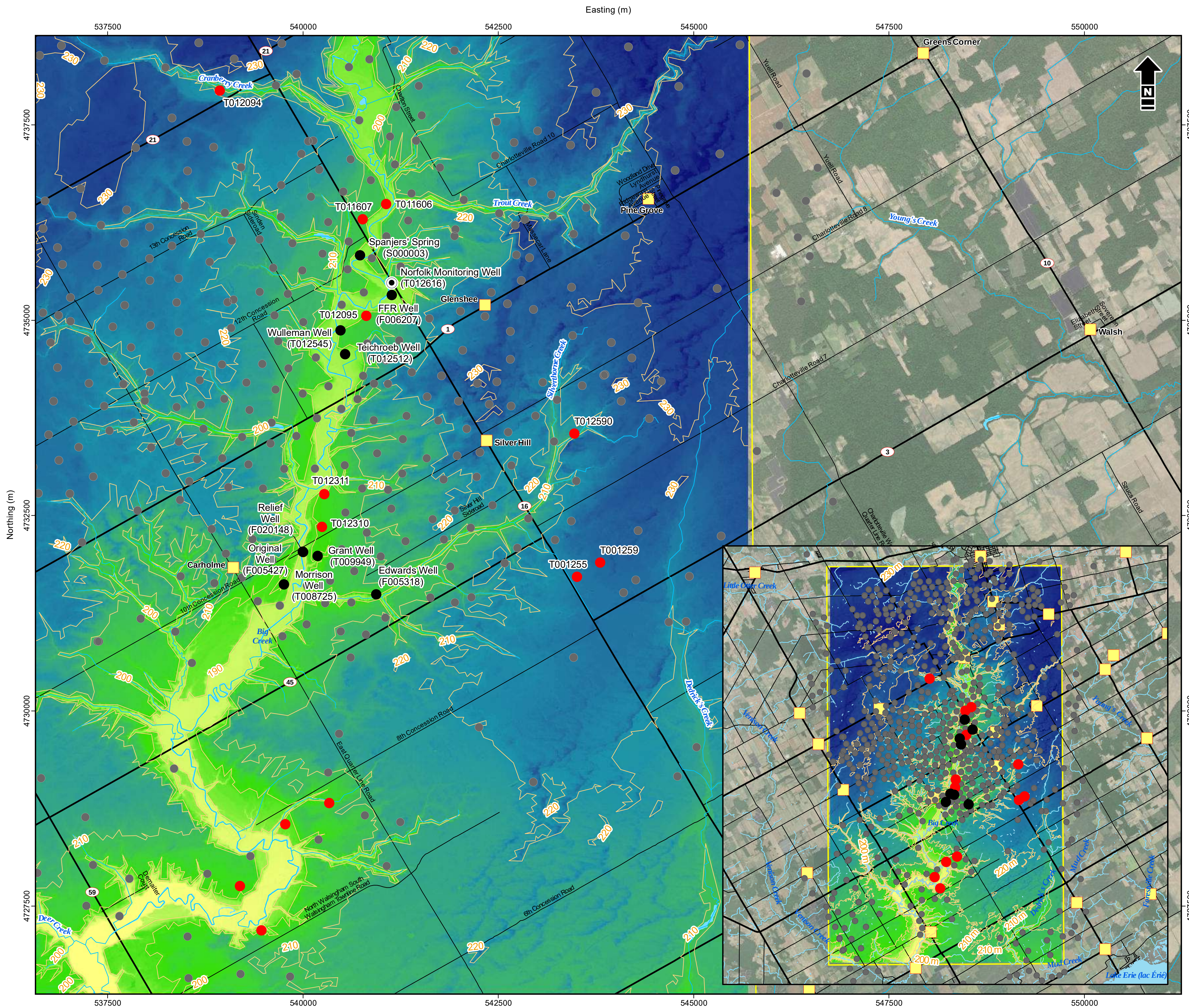
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

History of Flowing Wells in Big Creek Valley

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 2



Study Area
Water Body
Watercourse
Topographic Contours (masl)
Highway
Road
Community
Known Flowing OGSR Well
Recently Plugged OGSR Well
Other OGSR Well
Monitoring Well

MNRF Digital Elevation Model Ground Surface Topography (masl)
248
179

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:50,000 Kilometers
0.5 0 0.5 1
NAD 1983 UTM Zone 17N

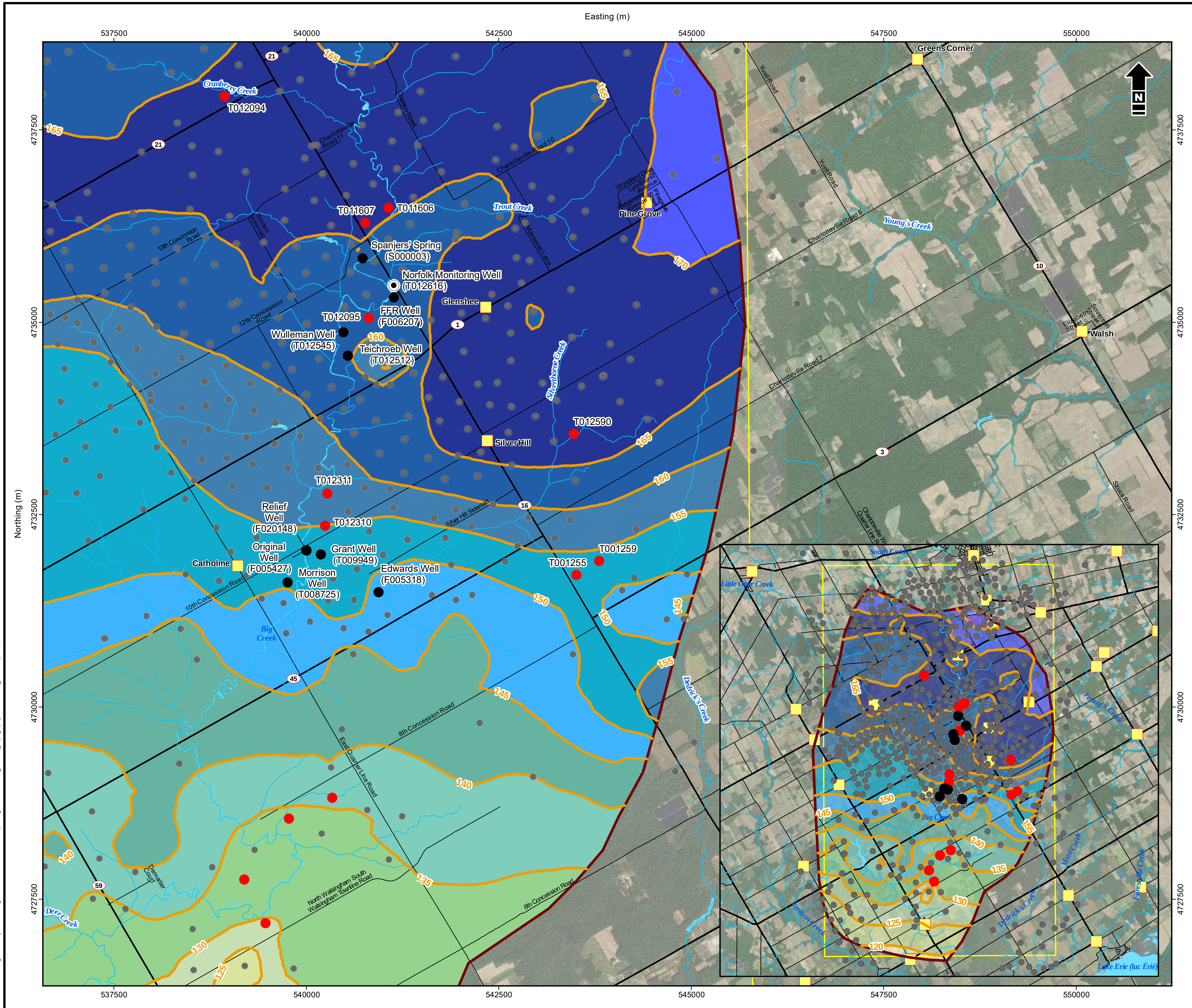
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Ground Surface Elevation

Date: September 2021	Project: 31976	Submitter: J. Melchin	Reviewer: L. Boutin

Figure 3



Study Area
FEFLOW Model Domain
Water Body
Watercourse
Highway
Road
Simulated Bedrock Topography Contours (masl)
Community
Known Flowing OGSR Well
Recently Plugged OGSR Well
Other OGSR Well
Monitoring Well

Simulated Bedrock Topography (masl)
120
125
130
135
140
145
150
155
160
165
170

Note:
Simulated bedrock topography represents top of simulated overburden/bedrock contact zone (Layer 7) from groundwater flow model

1:50,000 Kilometers
0.5 0 0.5 1
NAD 1983 UTM Zone 17N

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

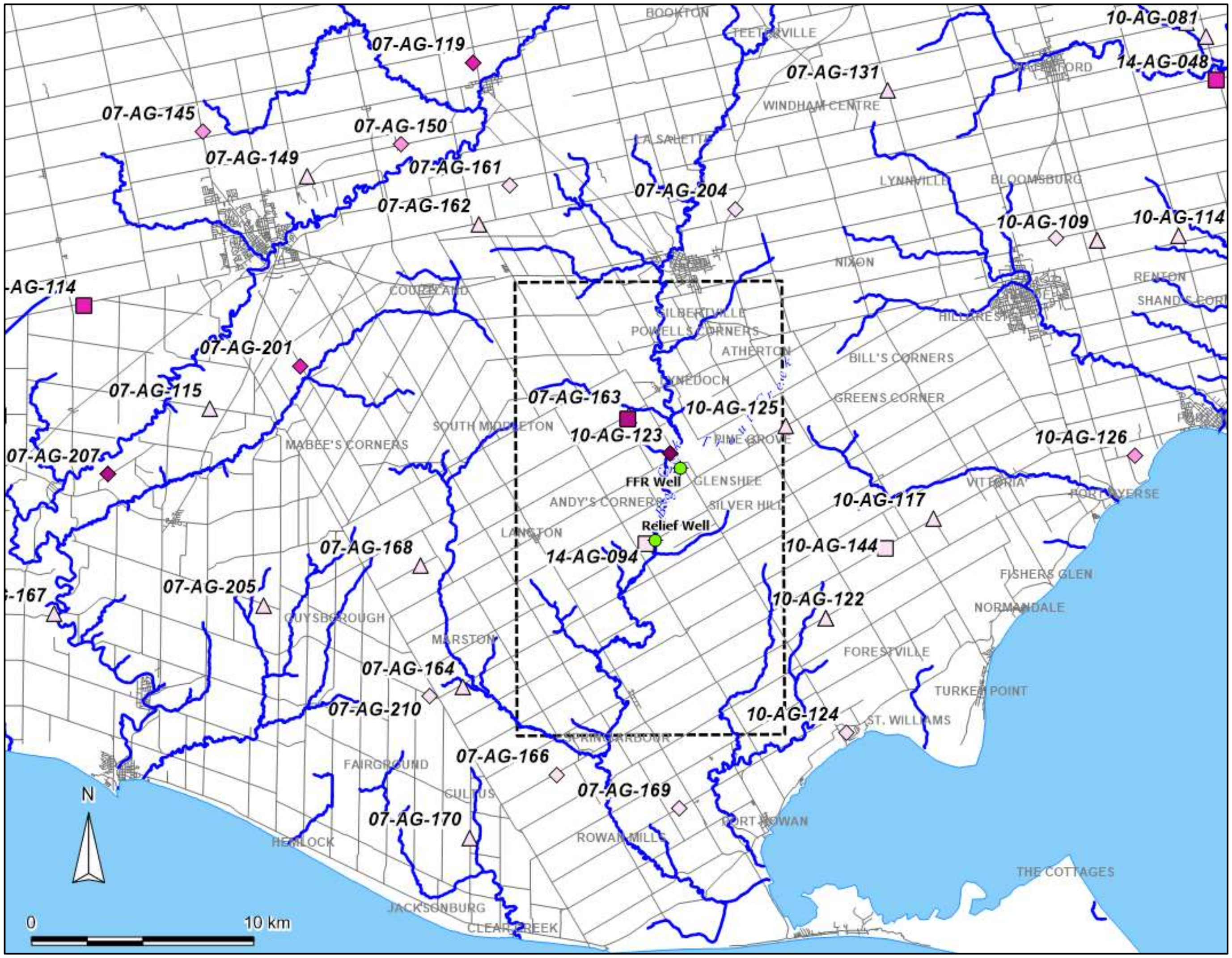
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Simulated Bedrock Topography

Date:	Project:	Submitter:	Reviewer:
September 2021	31976	J. Melchin	L. Boutin

Figure
4



FFR Well and Relief Well

OGS (2015) Sample Type

Overburden Well

Bedrock Interface Well

Bedrock Well

Hydrogen Sulfide (mg/L)

<0.5

0.5...2

2...5

5...10

10...20

>20

Road

Drainage

Study Area

Hydrogen Sulfide:

No guideline;

1 to 2 mg/L tastes bad

Ontario Geological Survey (OGS). 2015. Ambient Groundwater Geochemistry Data for Southern Ontario, 20017-2014; Miscellaneous Release-Data 283-Revised

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

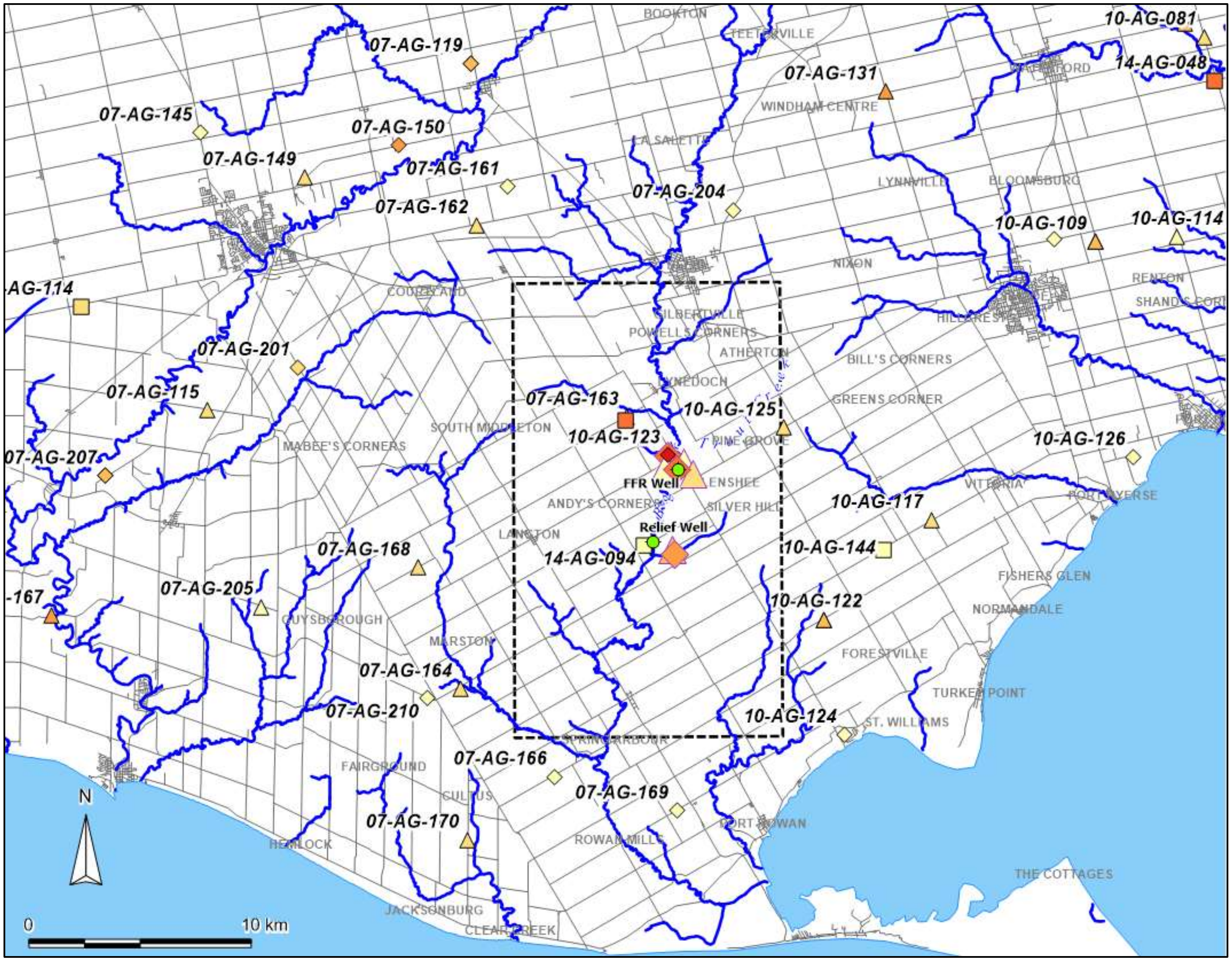
Norfolk County

Norfolk Gas Well Management Project

Hydrogen Sulfide Concentration Distribution in the Study Area

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 5a



FFR Well and Relief Well
U of W Sample
OGS (2015) Sample

Sample Type

Overburden Well
Bedrock Interface Well
Bedrock Well

Sulfate (mg/L)

<25
25...50
50...100
100...250
250...500
500...750
750...1000
>1000
Road
Drainage
Study Area

Sulfate:
Aesthetic Objective (AO): 250 mg/L

Ontario Geological Survey (OGS). 2015. Ambient Groundwater Geochemistry Data for Southern Ontario, 20017-2014; Miscellaneous Release-Data 283-Revised

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Hydrogen Sulfate Concentration Distribution in the Study Area

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 5b

Study Area
Water Body
Watercourse
Groundwater Flow Direction
Potentiometric Surface Contour (m asl)
Highway
Road
Known Flowing OGSR Well
Recently Plugged OGSR Well
Other OGSR Well
Monitoring Well
Water Well Information System Record

180 185 190 195 200 205 210 215 220 225 230 235

Potentiometric Surface (masl)

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:50,000 Kilometers
0.5 0 0.5 1
NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

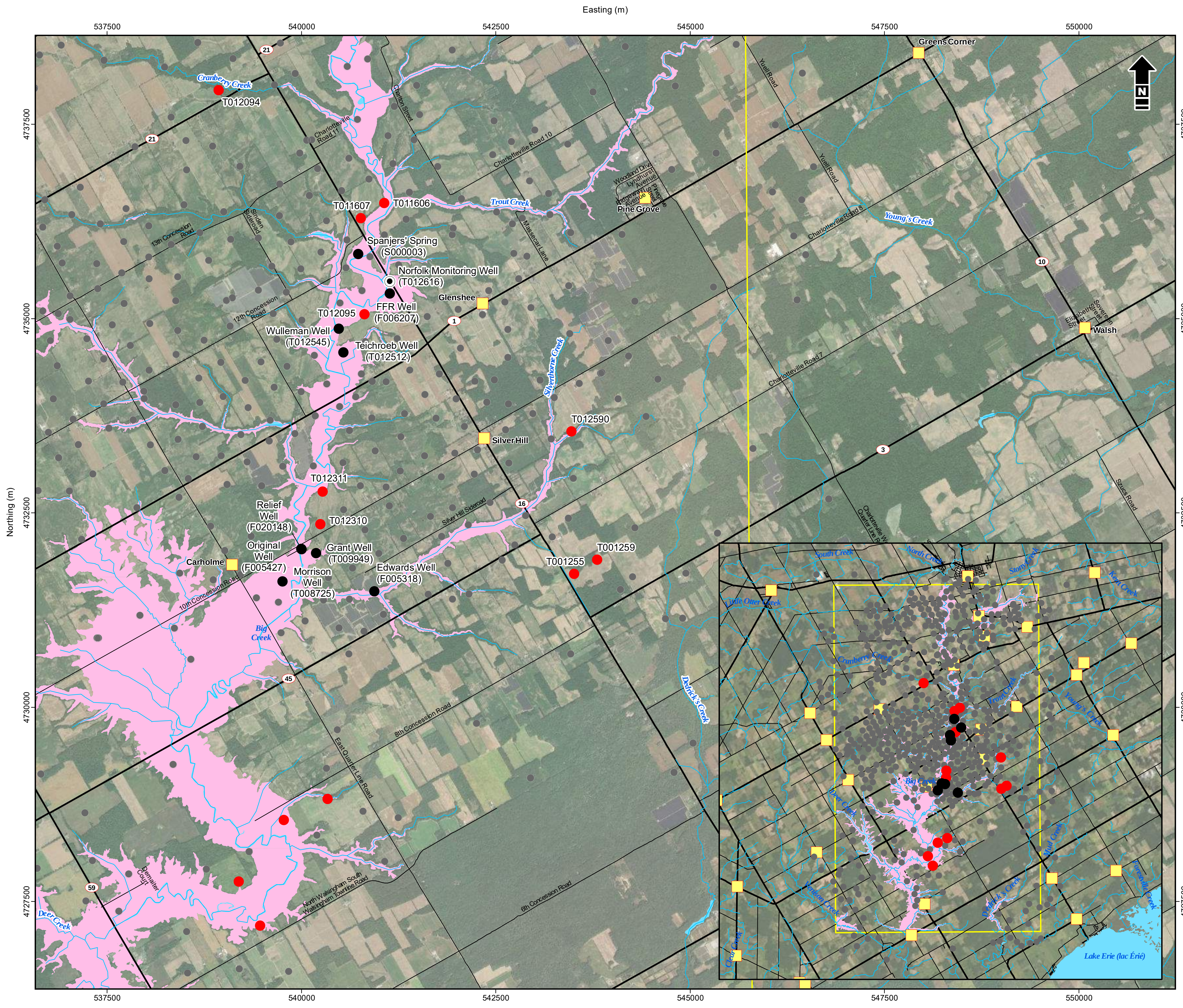
Norfolk County
Norfolk Gas Well Management Project

Interpreted Upper Bedrock Potentiometric Surface

Date: September 2021	Project: 31976	Submitter: J. Melchin	Reviewer: L. Boutin

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure 6



- Study Area
- Interpreted Artesian Zone
- Water Body
- Watercourse
- Highway
- Road
- Community
- Known Flowing OGSR Well
- Recently Plugged OGSR Well
- Other OGSR Well
- Monitoring Well

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:50,000 Kilometers
0.5 0 0.5 1
NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

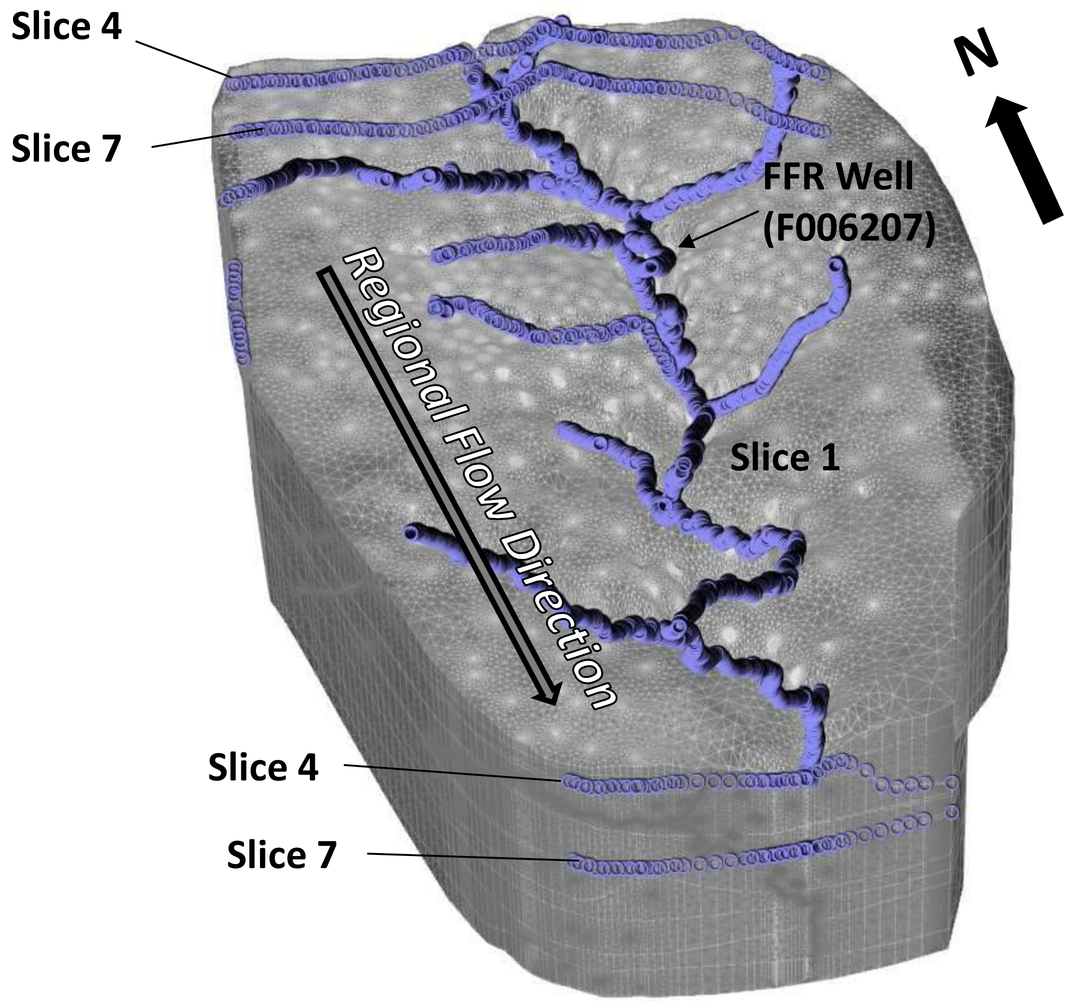
Norfolk County
Norfolk Gas Well Management Project

Bedrock Groundwater Level Above Ground Surface - Interpreted Artesian Zone

Date:	Project:	Submitter:	Reviewer:
September 2021	31976	J. Melchin	L. Boutin

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure 7



Constant Head Boundary Condition

Model Mesh

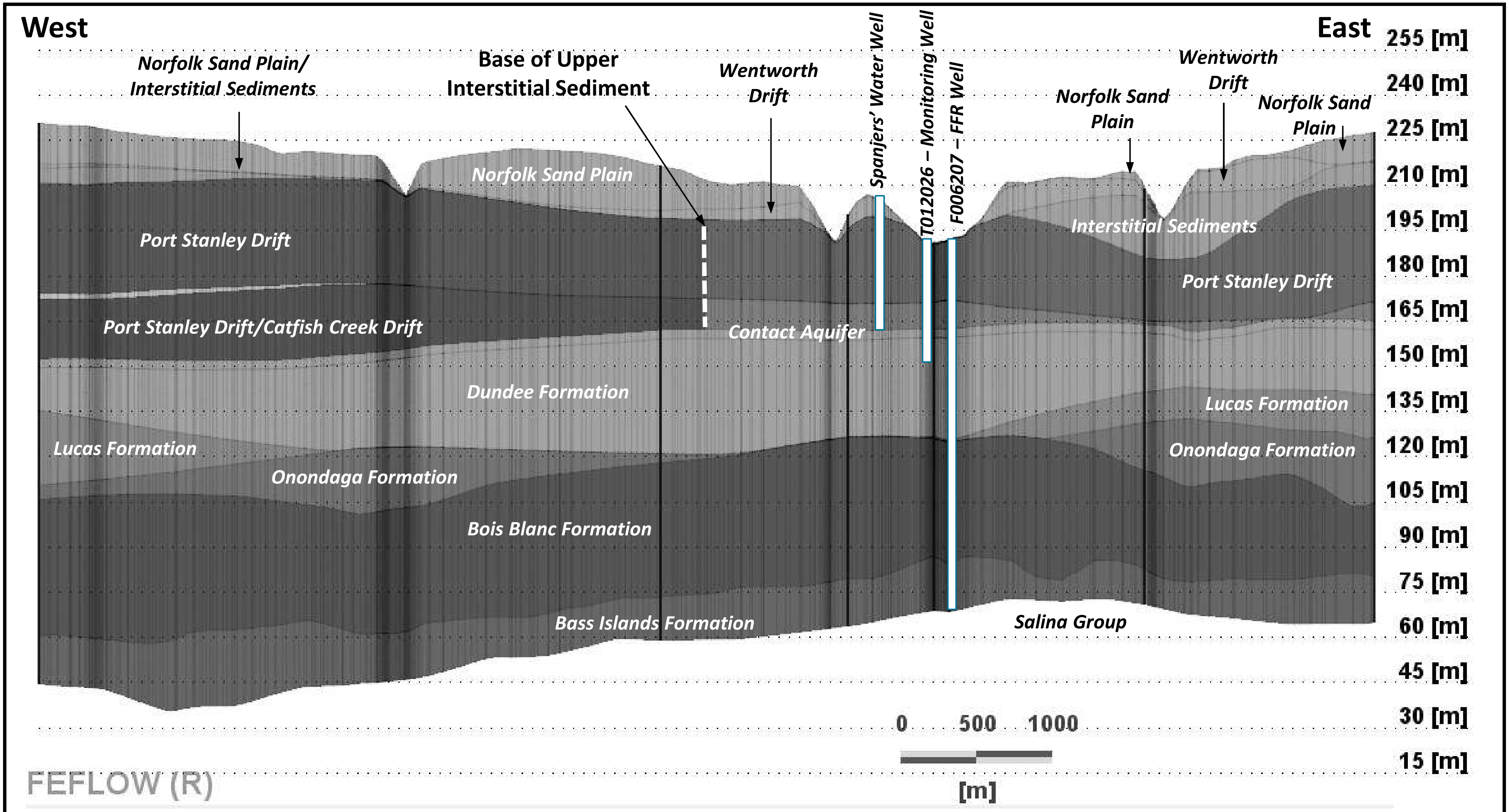
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Model Domain and Constant Head Boundary Conditions

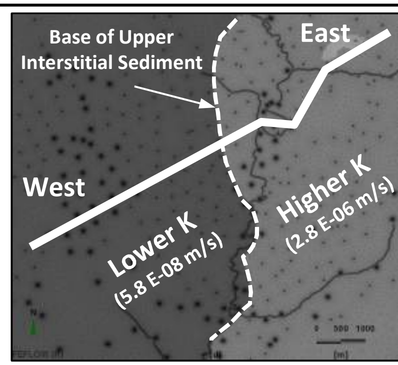
Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 8



Conductivity: K_xx
- Patches -
[m/s]

1.0E-03
1.0E-04
1.0E-05
1.0E-06
1.0E-07
1.0E-08



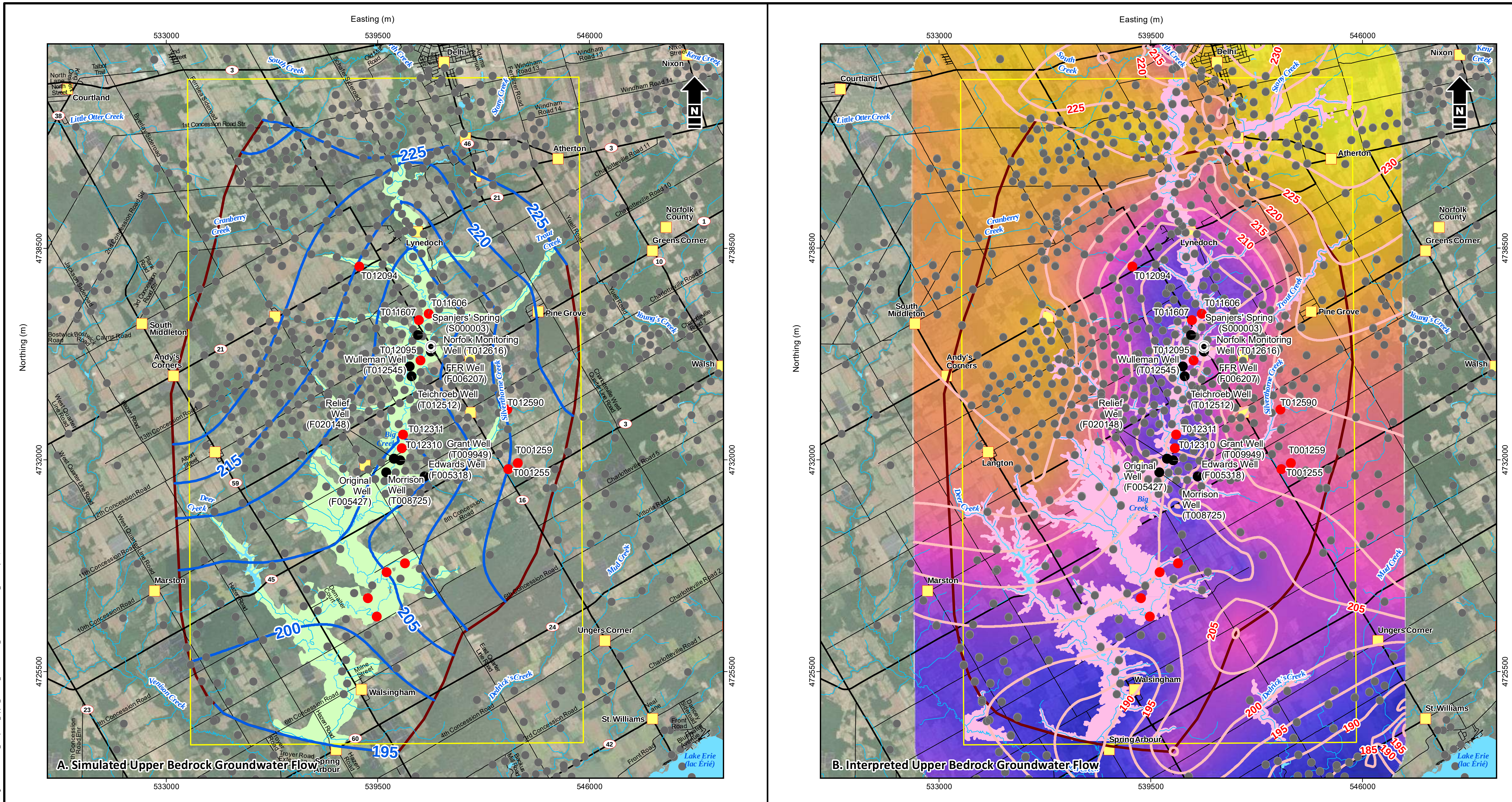
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Numerical Model Representation of the Overburden and Bedrock

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure
9



- Study Area
- FEFLOW Model Domain
- Interpreted Artesian Zone
- Simulated Artesian Zone Pre 1966
- Water Body
- Watercourse
- Simulated Hydraulic Head Contours (masl)
- Interpreted Hydraulic Head Contours (masl)
- Highway
- Road
- Community
- Known Flowing OGSR Well
- Recently Plugged OGSR Well
- Other OGSR Well
- Monitoring Well

180 185 190 195 200 205 210 215 220 225 230 235

Interpreted Potentiometric Surface (masl)

1:115,000 Kilometers

1 0 1 2

NAD 1983 UTM Zone 17N

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

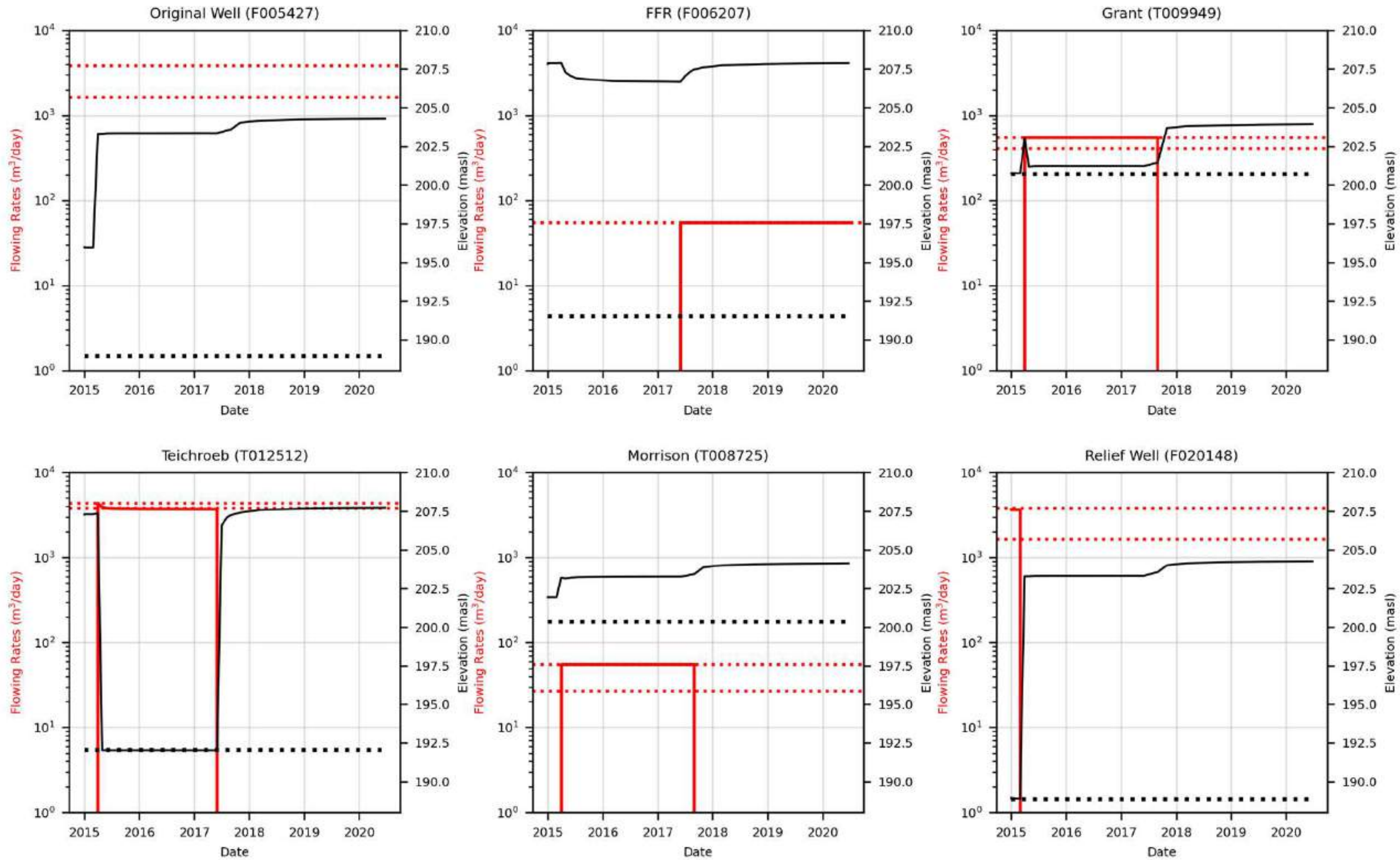
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Simulated vs. Interpreted Upper Bedrock Potentiometric Surface

Date:	Project:	Submitter:	Reviewer:
September 2021	31976	J. Melchin	L. Boutin

Figure 10



- Simulated Flowing Rates
- Min. and Max. Estimated Flowing Rates
- Simulated Water Levels
- Ground Surface Elevation

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

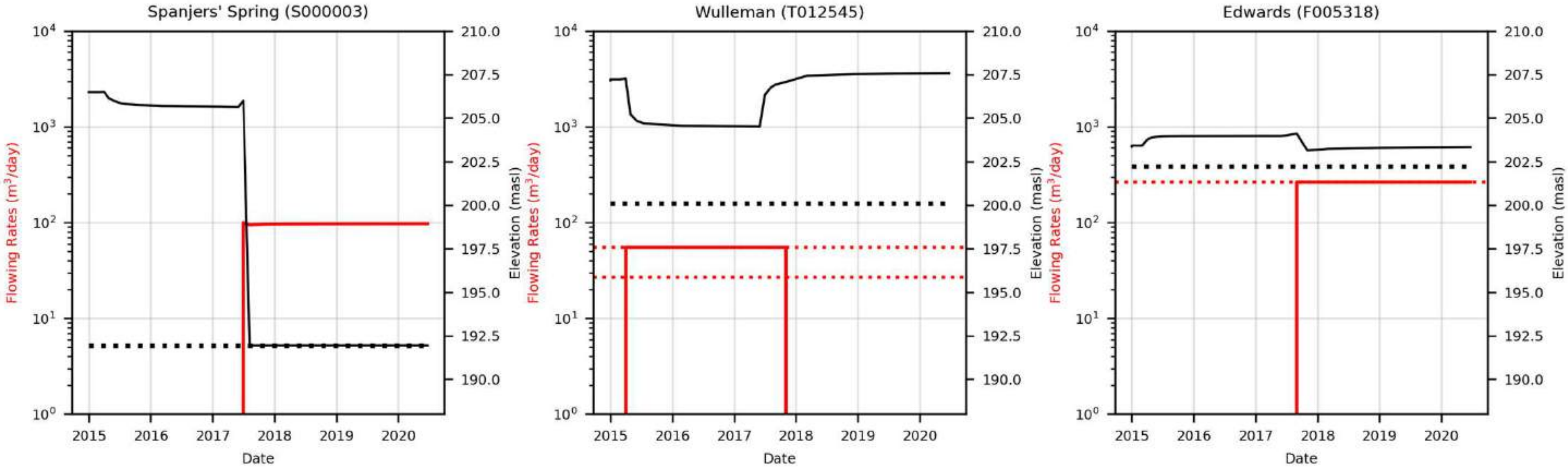
Norfolk County
Norfolk Gas Well Management Project

Transient Simulation – Historical Flowing Events

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

Figure **11a**



- Simulated Flowing Rates
- Min. and Max. Estimated Flowing Rates
- Simulated Water Levels
- Ground Surface Elevation

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

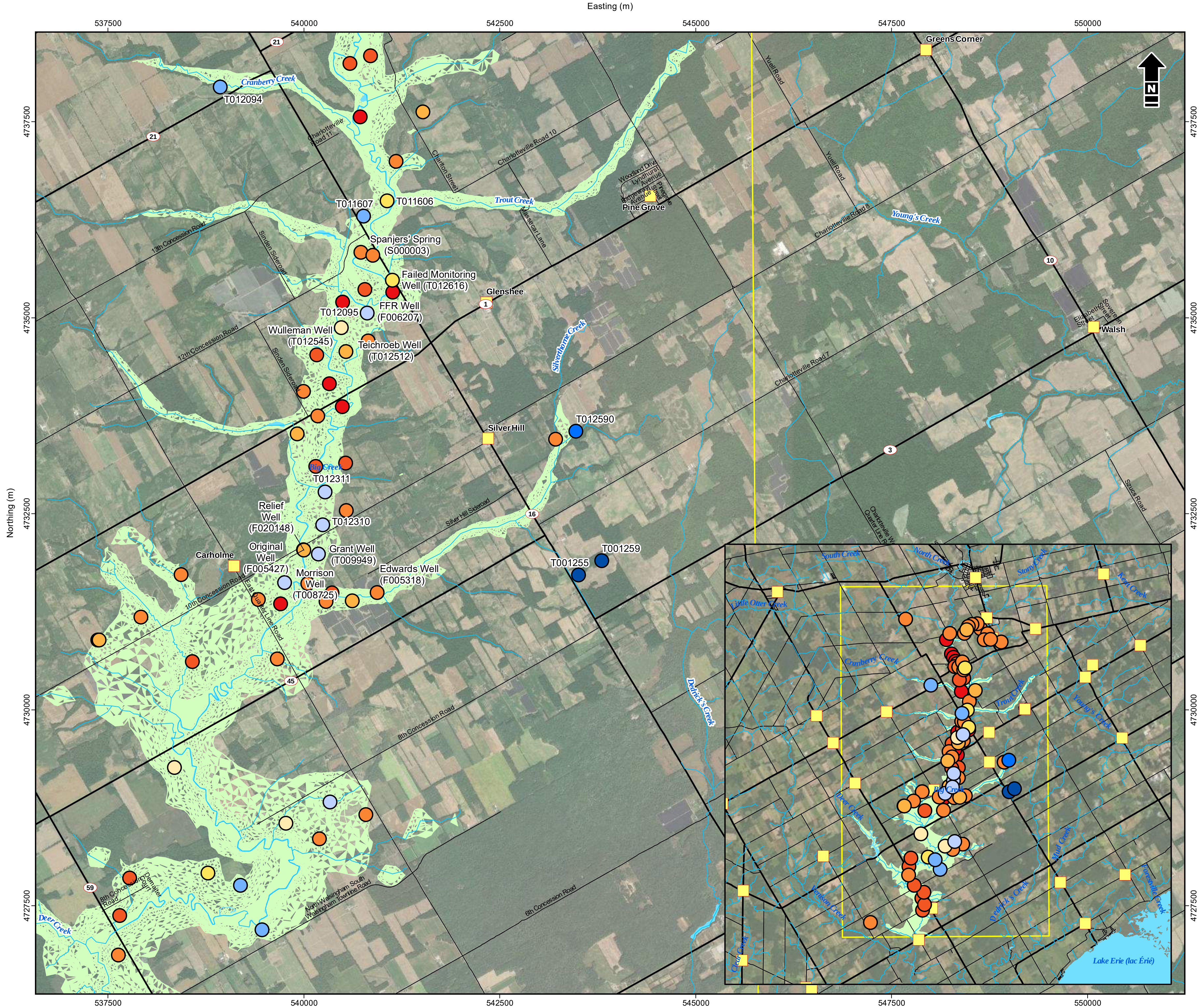
Norfolk County

Norfolk Gas Well Management Project

Transient Simulation – Historical Flowing Events

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 11b



Study Area
Simulated Artesian Zone Pre 1966
Water Body
Watercourse
Highway
Road
Community

Relative Risk

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0

Note:
Value of 1 = Highest Risk
Value of 0 = Lowest Risk

1:50,000 Kilometers
0 0.5 1 1.5
NAD 1983 UTM Zone 17N

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

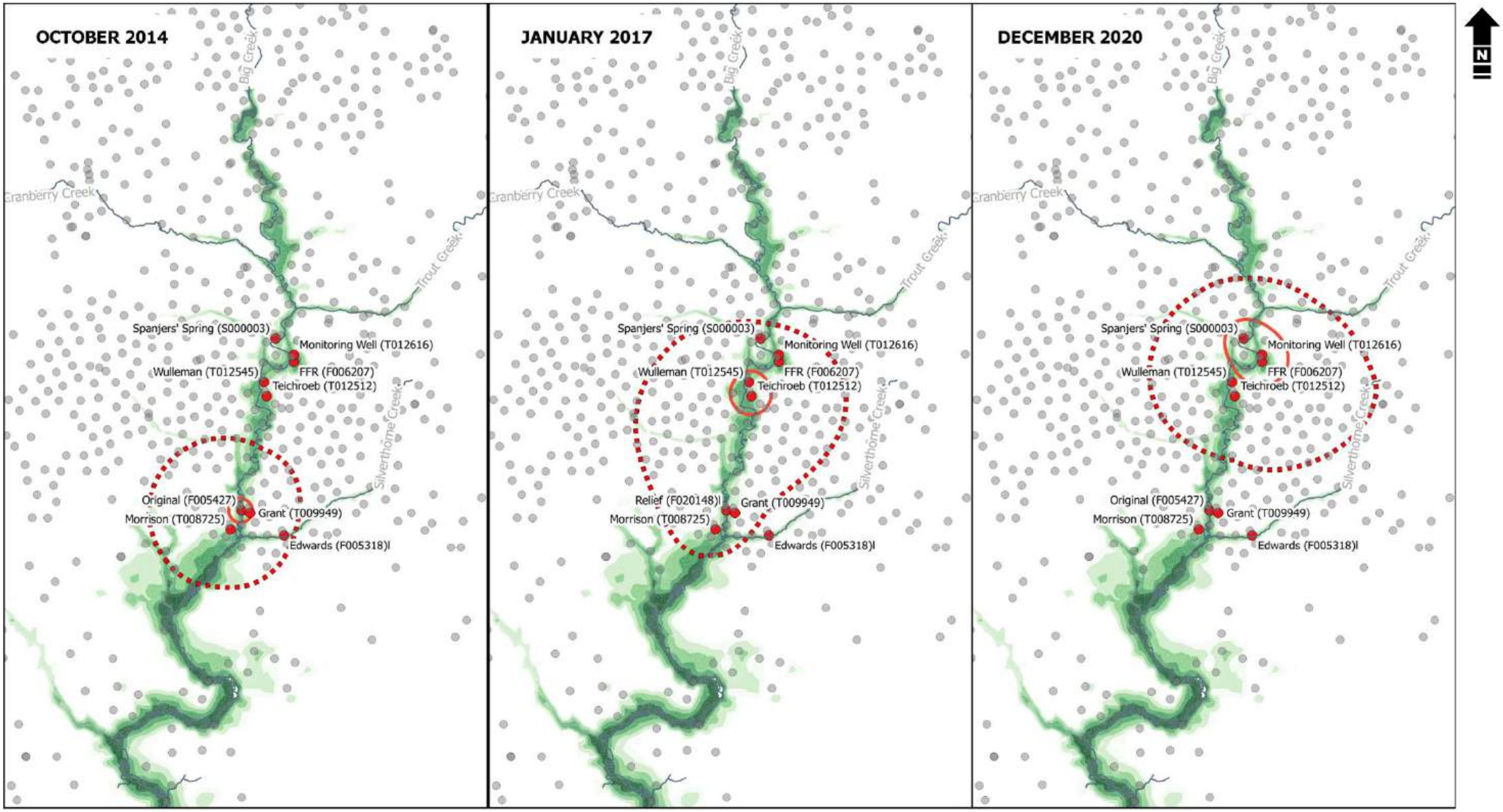
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

OGSR and WWIS Wells Relative Flowing Risk

Date:	Project:	Submitter:	Reviewer:
September 2021	31976	J. Melchin	L. Boutin

Figure 12b



Legend

- Surface Water Features
- OGSR Wells
- Known OGSR Flowing Wells

Simulated Change in Water Level (m)

- 1
- 3

Simulated Artesian Zone (m)

- 0.0 - 0.0
- 0.0 - 4.0
- 4.0 - 10.0
- 10.0 - 16.0
- 16.0 - 22.0

1000 0 1000 2000 m

Notes: No constraints on flowing rates. Estimated upper range radius of influence.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

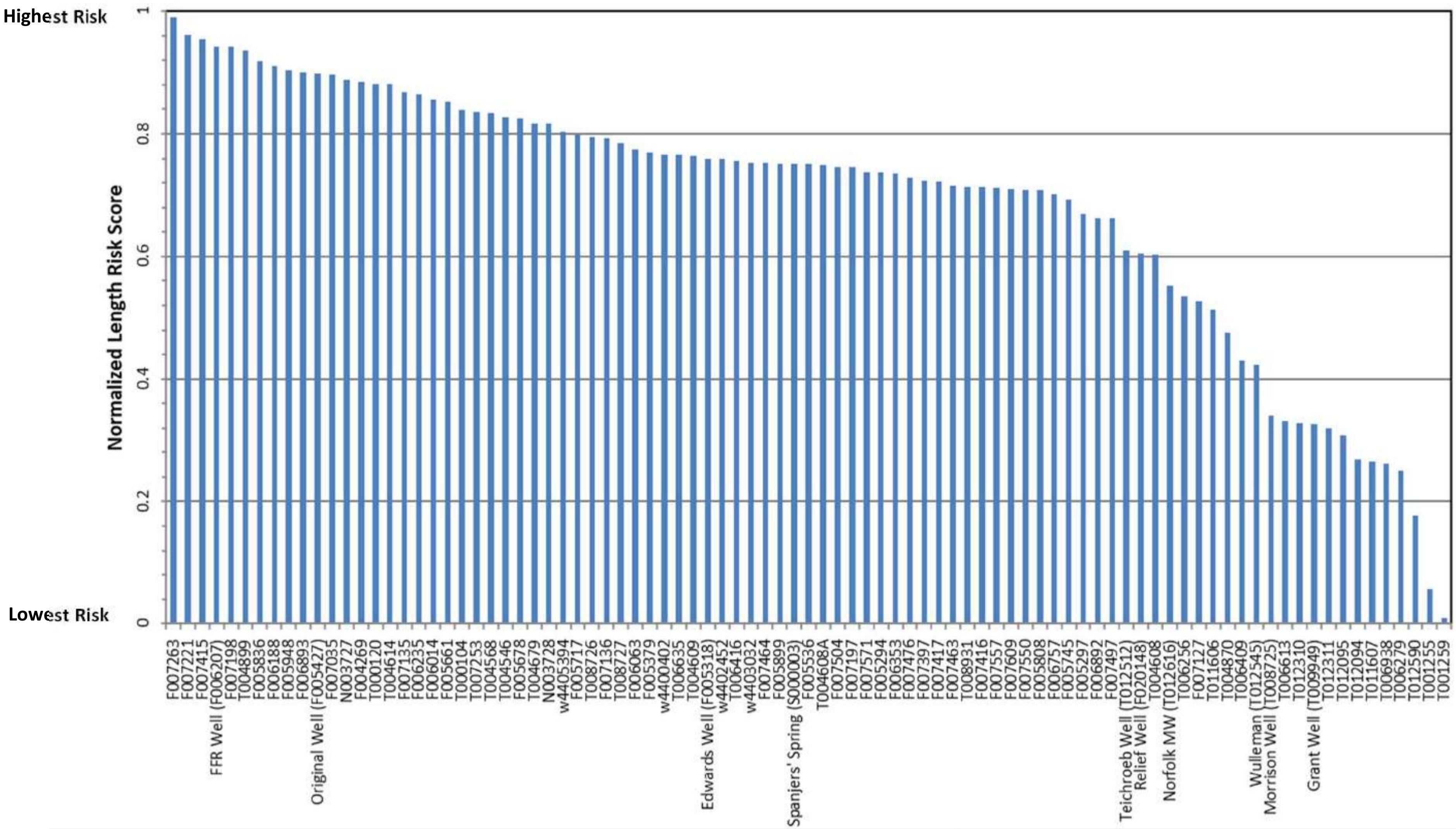
Norfolk County
Norfolk Gas Well Management Project

Simulated Radius of Influence of Historical Plugging Activities

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 12

f:\drafting department\software\powerpoint\figure eia - letter landscape.potm



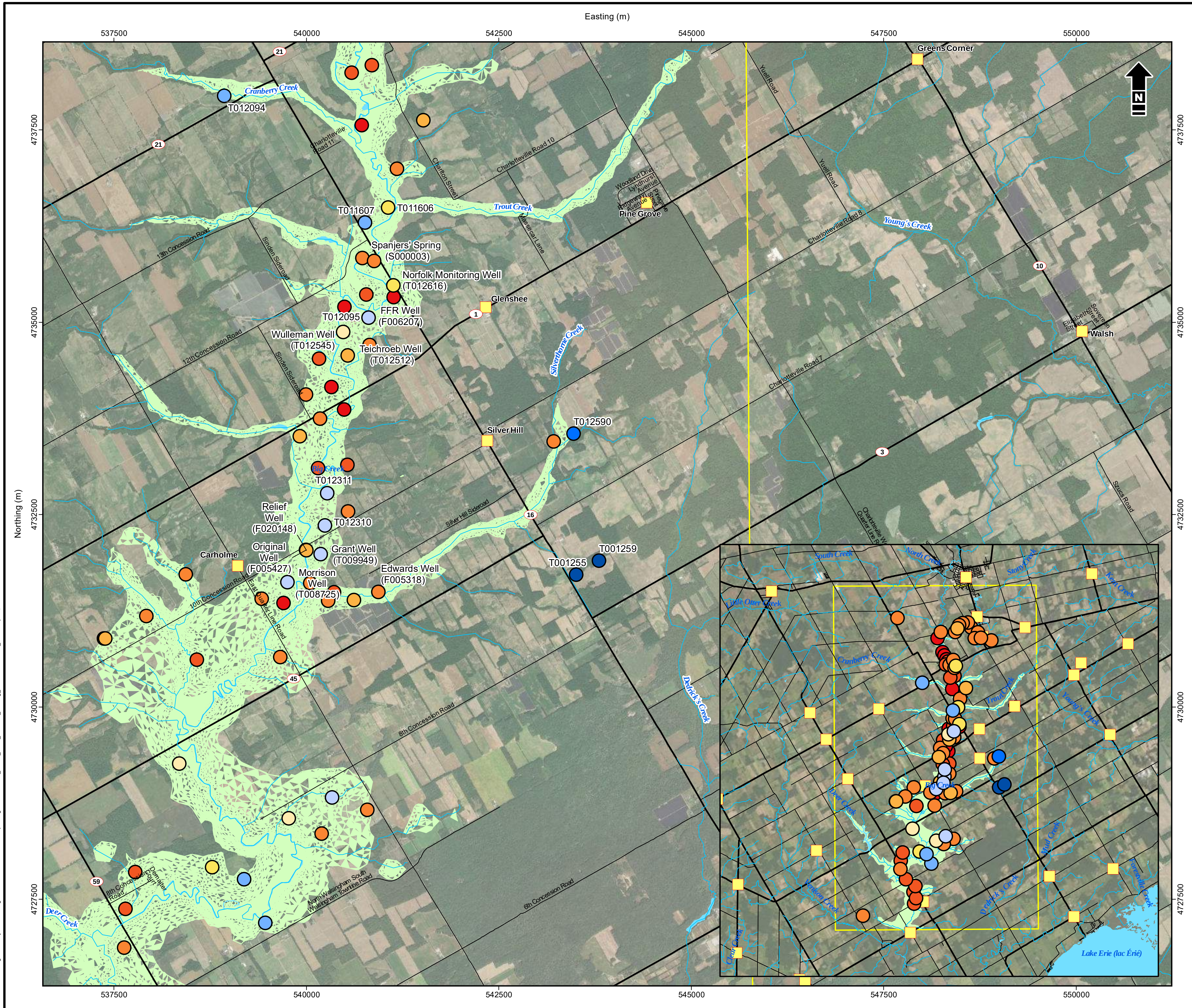
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

OGSR and WWIS Wells - Relative Flowing Risk

Date:	Project:	Technical:	Reviewer:	Drawn:
August 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 13a



Study Area
Simulated Artesian Zone Pre 1966
Water Body
Watercourse
Highway
Road
Community

Relative Risk

- 0.0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1.0

Note:
Value of 1 = Highest Risk
Value of 0 = Lowest Risk

1:50,000 Kilometers
0 0.5 1 1.5
NAD 1983 UTM Zone 17N

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Norfolk County
Norfolk Gas Well Management Project

OGSR and WWIS Wells Relative Flowing Risk

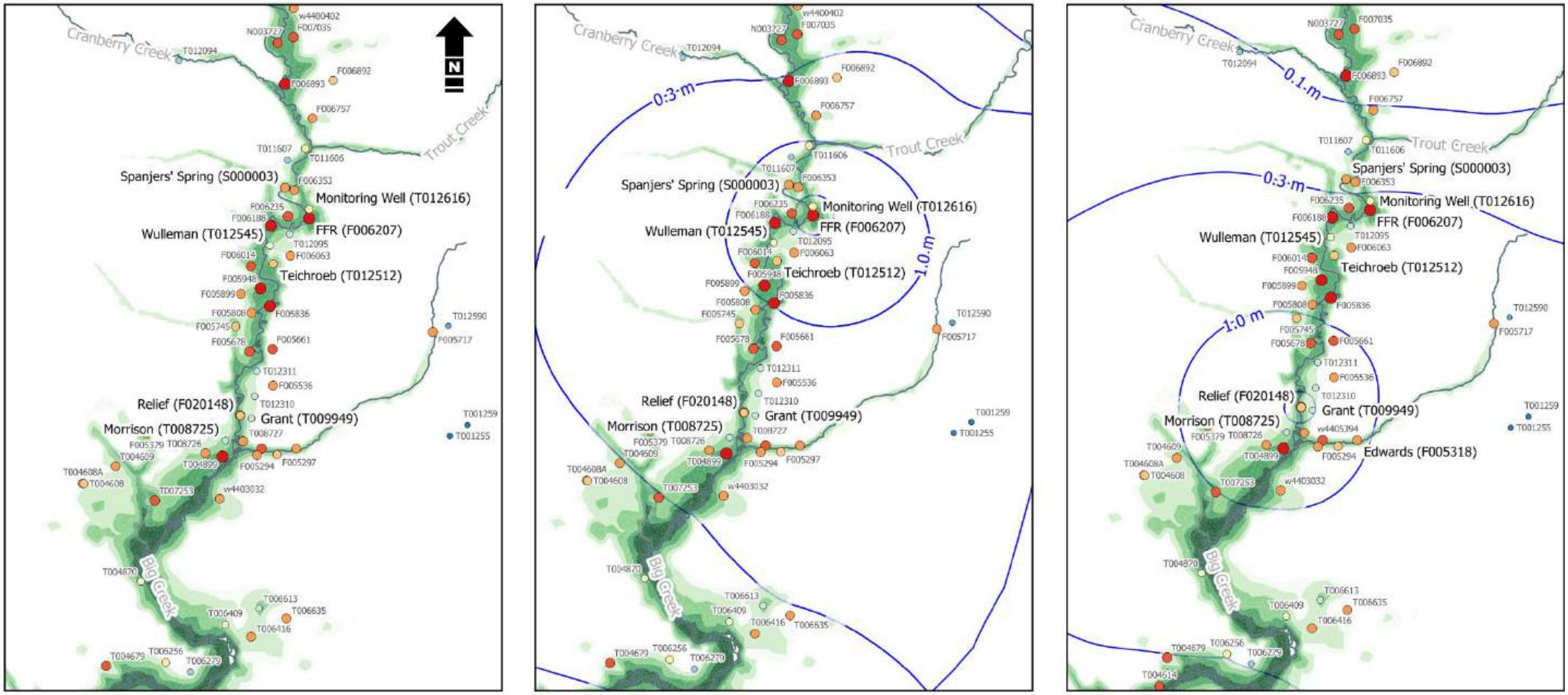
Date:	Project:	Submitter:	Reviewer:
September 2021	31976	J. Melchin	L. Boutin

Figure 13b

Option 1 & 2:
Plugging FFR or Capture & Treat

Option 3:
Relief Well Near FFR (F006207)

Option 4:
Relief Well Near Original (F005427)



Legend

Surface Water Features
Simulated Change in Water Level (m)

Simulated Artesian Zone (m)
- 0.0 - 0.0
- 0.0 - 4.0
- 4.0 - 10.0
- 10.0 - 16.0
- 16.0 - 22.0

Relative Risk (Highest = 1.0)
- 0.01 - 0.10
- 0.10 - 0.20
- 0.20 - 0.30
- 0.30 - 0.40
- 0.40 - 0.50
- 0.50 - 0.60
- 0.60 - 0.70
- 0.70 - 0.80
- 0.80 - 0.90
- 0.90 - 0.99

1,000 0 1,000 2,000 m

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

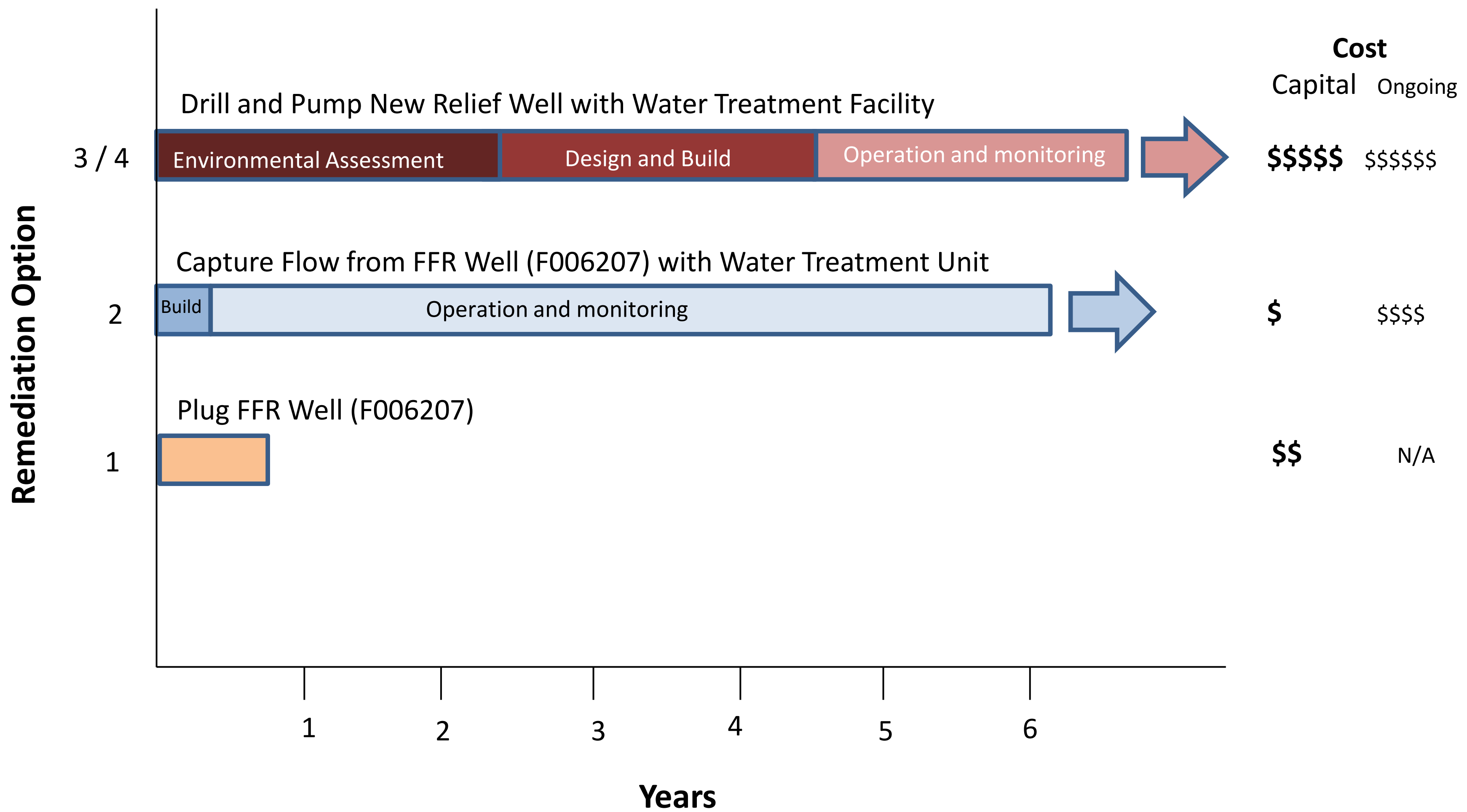
Norfolk County
Norfolk Gas Well Management Project

Remediation Options – Predicted Impacts on Water Levels

Date:	Project:	Technical:	Reviewer:	Drawn:
December 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 14

H:\31976_NorfolkGasWellManagement\Report\Figures\PPT_Figures.pptx / H:\31976_NorfolkGasWellManagement\GIS\Manifold\QGIS_Project_31976.qgs



Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Remediation Options – Time and Cost

Date:	Project:	Technical:	Reviewer:	Drawn:
December 2021	31976	J. Melchin	LC. Boutin	J. Melchin

Figure 15

APPENDIX A
Numerical Model Calibration

APPENDIX A

NUMERICAL MODEL CALIBRATION

1 MODELLING APPROACH AND SOFTWARE SELECTION

This work assumes that a representative elementary volume (Bear 1972) of the porous medium exists and can represent the effective hydraulic behavior of the medium. Groundwater flow within the model domain was interpreted to be normal gravity-driven flow that can be represented by the fluid continuity equation:

$$\frac{\partial}{\partial x}\left(K_x \frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y \frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z \frac{\partial h}{\partial z}\right) = S_s \frac{\partial h}{\partial t}$$

where:

x, y, z = Cartesian coordinates (L)

h = hydraulic head (L)

S_s = specific storage (L^{-1})

K = hydraulic conductivity (L/t)

t = time

The above equation is derived based on the assumption that the principal directions of the hydraulic conductivity tensor are uniform throughout the model domain and that the Cartesian coordinate system is chosen such that its axes (x, y, z) coincide with the easting, northing, and elevation. The principal directions of the hydraulic conductivity tensor were parallel to the Cartesian coordinate system. The major assumptions within the continuity equation and in its application are that groundwater flow follows Darcy's Law and the fluid throughout the model domain has a constant density. Furthermore, in solving the fluid continuity equation, it is assumed that the hydraulic properties of saturated units (K and S_s) are independent of hydraulic head.

2 CALIBRATION TARGETS

Steady-state hydraulic heads calibration targets representing pre-2015 conditions are provided in Table A1 attached to the end of this appendix. This includes observations from the Otterville model, as well as those from the Water Well Information System (WWIS). Table A1 also summarizes the simulated hydraulic heads and the misfit (i.e., residual = simulated - observed hydraulic head) between simulated and observed. Table A2 (also attached to the end of this appendix) summarizes the additional hydraulic head data that was used as a qualitative check on model simulated hydraulic head against ground surface elevation. This allowed an assessment of the presence of artesian conditions at known flowing wells and identification of potential wells in the Oil, Gas and Salt Resources (OGSR) Library under artesian conditions.

Scatter plots for the simulated versus measured hydraulic heads are presented on Figure A1 for upper bedrock observations in the WWIS (upper chart) and for Quaternary overburden observations from the previous Otterville model. The scatter plots illustrate the goodness-of-fit for hydraulic head targets, with model-simulated heads plotted on the vertical axis and observed heads plotted on the horizontal axis. The 1:1 line corresponds to simulated head being equal to observed head, and the objective of the calibration effort is to have the points as close as possible to this line. The difference between the observed and calibrated points may be due to factors such as model error, assumptions in the conceptual model, or may also be due to errors associated with the field-observed data. Given the lack of continuous monitoring of water levels and uncertainty in representativeness of reported measurements from well records, it is assumed that the margin of error is relatively high, and therefore, the match between simulated and observed is considered good. While it is noted that below 210 m above sea level the misfit seems to be slightly higher, with simulated heads tending to be higher, generally, the numerical model can reproduce the measured information for both datasets.

A map showing the calibration residuals spatially is illustrated on Figure A2 attached at the end of this appendix. The symbols are sized by the magnitude of the residual (i.e., larger circles = smaller misfit between observed and simulated hydraulic heads and vice versa). The symbols are different colors depending on whether the residual is positive (i.e., simulated head greater than observed head) or negative (i.e., simulated head lower than observed head) and different shapes depending on whether the observations are from the Otterville model or the WWIS. The spatial distribution of the misfit suggests that the numerical model is generally simulating hydraulic heads higher than observed within the Big Creek valley center, although the simulated heads at the 2019 Norfolk County monitoring well is reasonably well reproduced (i.e., misfit less than 2 m).

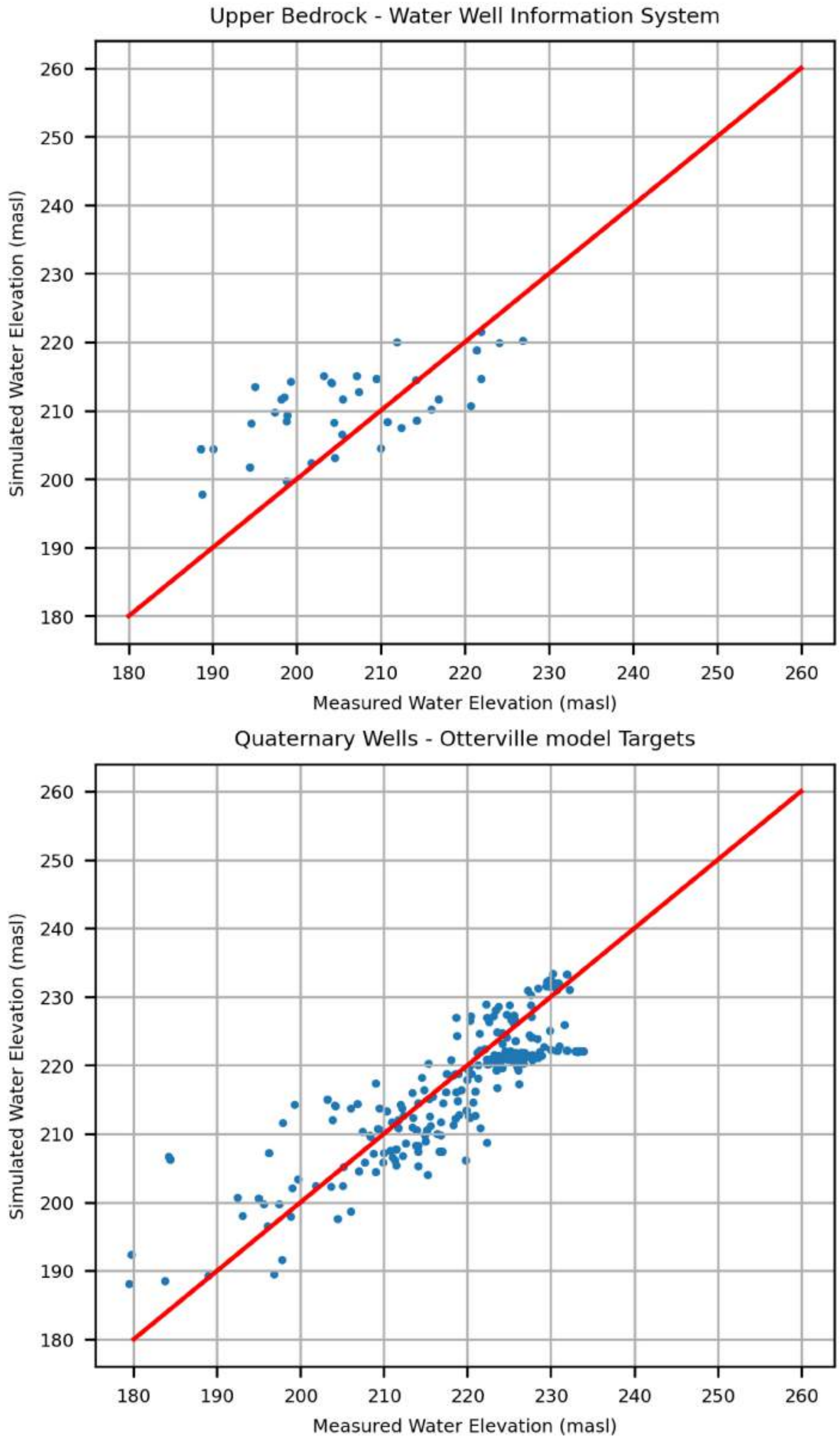


FIGURE A1 Scatter Plots - Simulated vs Measured Water Elevation

3 CALIBRATED PARAMETERS

A summary of calibrated parameters is provided in Table A3.

TABLE A3 Calibrated Hydraulic Parameters

Hydrogeological Unit	Parameter Zone	Preferred/Initial Horizontal Hydraulic Conductivity (m/s)	Calibrated Horizontal Hydraulic Conductivity (m/s)	Calibrated Vertical Hydraulic Conductivity (m/s)	Specific Storage (1/m)
Norfolk Sand Plain	2200	9.8E-05	1.1E-04	4.6E-07	1.0E-04
Norfolk Sand Plain	3200	1.4E-05	1.1E-04	1.0E-06	1.0E-04
Norfolk Sand Plain	3300	3.0E-06	3.9E-06	6.6E-07	1.0E-04
Norfolk Sand Plain	3400	3.0E-06	4.4E-06	8.9E-07	1.0E-04
Norfolk Sand Plain	5200	1.4E-05	2.9E-05	3.3E-06	1.0E-04
Norfolk Sand Plain/Upper Interstitial Sediments	4200	1.9E-04	5.8E-05	6.4E-07	1.0E-04
Upper Interstitial Sediments	4230	9.2E-04	6.7E-04	8.8E-05	1.0E-04
Port Stanley Drift - Higher T	401	3.0E-07	4.3E-07	1.2E-07	1.0E-04
Port Stanley Drift - Lower T	402	1.0E-08	1.0E-07	1.0E-07	1.0E-04
Lower Interstitial Sediments	6200	4.0E-06	4.0E-05	1.2E-05	1.0E-04
Lower Interstitial Sediments	6300	2.1E-05	1.5E-05	1.8E-06	1.0E-04
Lower Interstitial Sediments	6310	8.8E-04	9.0E-04	1.1E-04	1.0E-04
Port Stanley Drift - Higher T	601	3.0E-07	2.8E-06	1.8E-06	1.0E-04
Port Stanley Drift - Lower T	602	1.0E-08	5.8E-08	9.1E-09	1.0E-04
Contact Aquifer	700	5.0E-05	2.0E-05	2.6E-06	1.0E-04
Dundee Formation	801	2.0E-05	1.2E-04	2.1E-05	1.0E-04
Lucas Formation	901	2.0E-05	7.4E-06	7.7E-07	1.0E-04
Onondaga Formation	1001	1.0E-06	1.1E-06	1.3E-07	1.0E-04
Bois Blanc Formation	1101	5.0E-07	7.3E-08	1.2E-08	1.0E-04
Bass Islands Formation	1201	5.0E-07	3.2E-07	3.8E-08	1.0E-04

4 WATER BALANCE

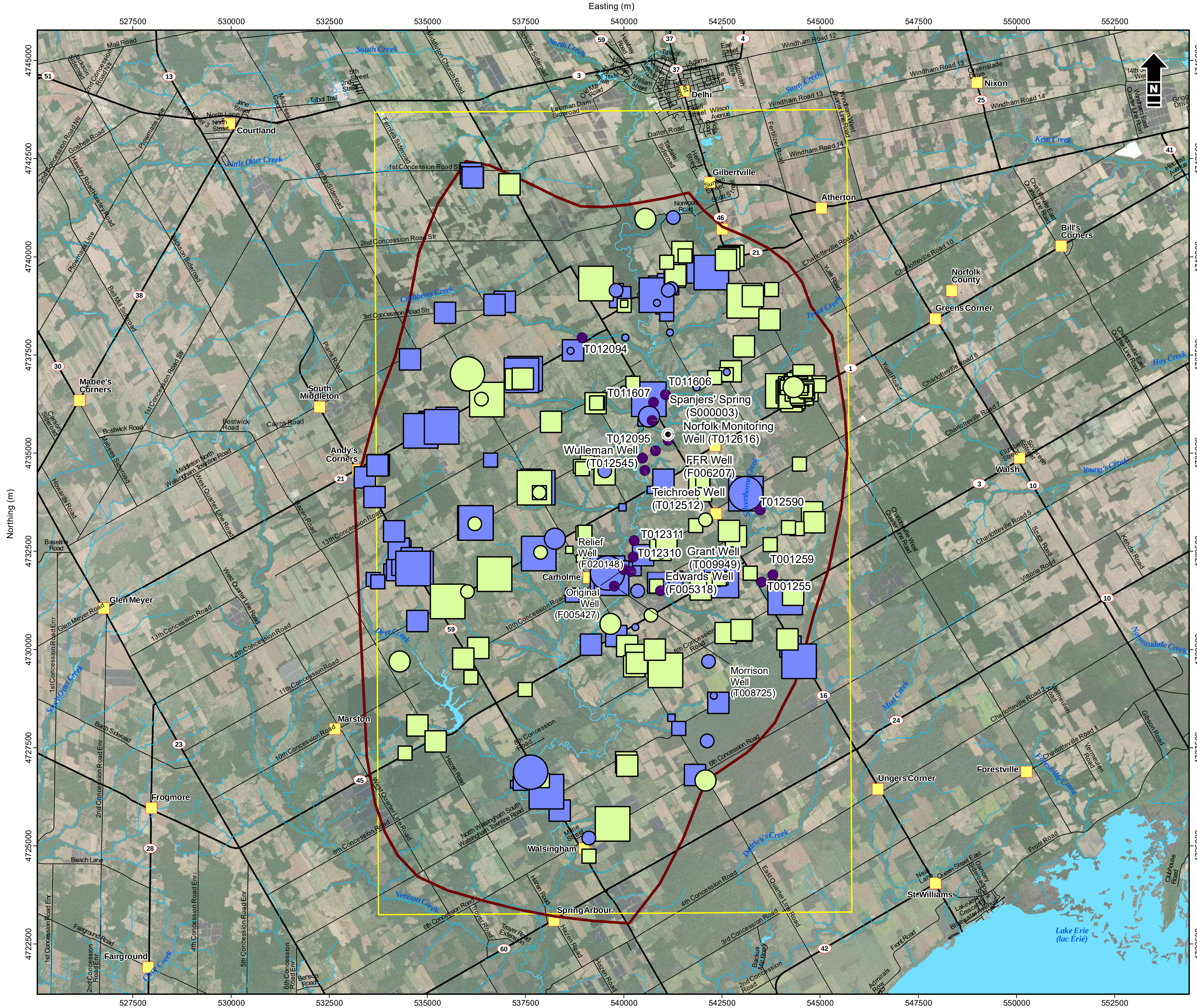
A summary of the water balance from the steady-state model is summarized in Table A4.

TABLE A4 Water Balance Pre-development

Component of Numerical Model	Input (m^3/day)	Output (m^3/day)	Net (m^3/day)
Specified Heads	18,530	-182,280	-163,750
Sources/Sinks	163,750	0	163,750
		Imbalance	**0**

5 REFERENCES

Bear J. 1972. *Dynamics of Fluids in Porous Media*. American Elsevier, New York. 1972.



Study Area
FEFLOW Model Domain
Water Body
Watercourse
Highway
Road
Community
Key OGSR Wells
Monitoring Well

Calibration Group

Otterville Model Targets
Water Well Information System Targets

Residual (Simulated - Observed Hydraulic Head) (m)

< - 10
-10 - -5
-5 - -1
-1 - 0
0 - 1
1 - 5
5 - 10
>10

Reference: Contains information licensed under the Open Government Licence – Ontario. GDM midstream data provided by IHS© 2021 used under license. Data obtained from GeoBase® used under license. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

1:100,000 Kilometers
0.5 0 0.5 1
NAD 1983 UTM Zone 17N

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Norfolk County
Norfolk Gas Well Management Project

Spatial Residuals Map

Date:	Project:	Submitter:	Reviewer:
September 2021	31976	J. Melchin	L. Boutin

Figure
A2

TABLE A1 Calibration Targets

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
obs1	534744.0	4728072.0	210.30	elevation (masl)	Otterville Model Targets	211.03	206.52	-4.51
obs2	543004.0	4730502.0	217.07	elevation (masl)	Otterville Model Targets	220.93	216.18	-4.75
obs3	536514.0	4736362.0	221.23	elevation (masl)	Otterville Model Targets	227.71	227.05	-0.66
obs4	544414.0	4736462.0	225.89	elevation (masl)	Otterville Model Targets	227.63	221.39	-6.23
obs5	534614.0	4732142.0	224.93	elevation (masl)	Otterville Model Targets	225.63	226.71	1.08
obs6	544594.0	4736632.0	230.21	elevation (masl)	Otterville Model Targets	232.97	222.02	-10.96
obs7	544574.0	4736692.0	225.58	elevation (masl)	Otterville Model Targets	226.35	221.83	-4.52
obs8	534274.0	4732562.0	222.28	elevation (masl)	Otterville Model Targets	225.02	228.82	3.80
obs9	535364.0	4735672.0	223.49	elevation (masl)	Otterville Model Targets	230.75	231.02	0.26
obs10	544624.0	4736502.0	224.68	elevation (masl)	Otterville Model Targets	228.61	222.00	-6.61
obs11	534634.0	4732062.0	220.69	elevation (masl)	Otterville Model Targets	225.69	226.36	0.68
obs12	544244.0	4730072.0	215.57	elevation (masl)	Otterville Model Targets	217.48	218.76	1.28
obs13	536164.0	4733072.0	219.60	elevation (masl)	Otterville Model Targets	221.48	224.63	3.15
obs14	540064.0	4727132.0	201.51	elevation (masl)	Otterville Model Targets	203.67	202.30	-1.37
obs15	540094.0	4727042.0	203.55	elevation (masl)	Otterville Model Targets	205.08	202.43	-2.64
obs16	542414.0	4728642.0	207.96	elevation (masl)	Otterville Model Targets	213.34	215.94	2.60
obs17	544314.0	4731392.0	217.99	elevation (masl)	Otterville Model Targets	220.35	218.90	-1.44
obs18	542604.0	4739922.0	220.86	elevation (masl)	Otterville Model Targets	228.38	223.87	-4.51
obs19	543734.0	4732672.0	220.94	elevation (masl)	Otterville Model Targets	223.57	216.70	-6.86
obs20	544794.0	4733492.0	224.12	elevation (masl)	Otterville Model Targets	225.21	221.29	-3.92
obs21	534434.0	4727362.0	208.26	elevation (masl)	Otterville Model Targets	211.23	206.13	-5.10
obs22	534564.0	4737392.0	229.36	elevation (masl)	Otterville Model Targets	230.03	232.32	2.29
obs23	539514.0	4734462.0	211.64	elevation (masl)	Otterville Model Targets	215.09	210.54	-4.55
obs24	537724.0	4734122.0	212.42	elevation (masl)	Otterville Model Targets	215.41	215.11	-0.30
obs25	534294.0	4732352.0	220.80	elevation (masl)	Otterville Model Targets	223.37	228.03	4.66
obs26	534834.0	4735572.0	226.77	elevation (masl)	Otterville Model Targets	231.00	231.77	0.77
obs27	538944.0	4734602.0	217.17	elevation (masl)	Otterville Model Targets	220.27	212.33	-7.94
obs28	536114.0	4742122.0	228.52	elevation (masl)	Otterville Model Targets	230.25	233.35	3.09
obs29	534154.0	4733012.0	221.34	elevation (masl)	Otterville Model Targets	227.58	230.31	2.73
obs30	536149.0	4742022.0	225.62	elevation (masl)	Otterville Model Targets	231.93	233.31	1.38
obs31	536164.0	4742022.0	225.57	elevation (masl)	Otterville Model Targets	231.90	233.29	1.39
obs32	539014.0	4732987.0	210.95	elevation (masl)	Otterville Model Targets	214.07	205.28	-8.79
obs33	534589.0	4732012.0	221.69	elevation (masl)	Otterville Model Targets	222.62	226.29	3.67
obs34	544439.0	4736402.0	223.76	elevation (masl)	Otterville Model Targets	228.33	221.46	-6.86
obs35	534714.0	4732192.0	219.80	elevation (masl)	Otterville Model Targets	225.26	226.64	1.38
obs36	544650.0	4736685.0	229.24	elevation (masl)	Otterville Model Targets	230.83	222.15	-8.68
obs37	544503.0	4736484.0	225.29	elevation (masl)	Otterville Model Targets	226.90	221.67	-5.23
obs38	534374.0	4732662.0	218.17	elevation (masl)	Otterville Model Targets	222.26	228.87	6.61
obs39	544666.0	4736682.0	227.05	elevation (masl)	Otterville Model Targets	230.66	222.13	-8.53

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
obs40	534314.0	4732512.0	223.17	elevation (masl)	Otterville Model Targets	223.70	228.58	4.87
obs41	544557.0	4736501.0	226.28	elevation (masl)	Otterville Model Targets	226.57	221.85	-4.73
obs42	544537.0	4736496.0	226.26	elevation (masl)	Otterville Model Targets	226.84	221.79	-5.05
obs43	544691.0	4736560.0	228.35	elevation (masl)	Otterville Model Targets	229.94	222.24	-7.70
obs44	544641.0	4736582.0	229.64	elevation (masl)	Otterville Model Targets	231.88	222.14	-9.74
obs45	544599.0	4736565.0	230.28	elevation (masl)	Otterville Model Targets	233.79	222.04	-11.75
obs46	544574.0	4736626.0	231.06	elevation (masl)	Otterville Model Targets	233.19	221.98	-11.21
obs47	544596.0	4736640.0	231.71	elevation (masl)	Otterville Model Targets	233.93	222.06	-11.87
obs48	544598.0	4736653.0	230.15	elevation (masl)	Otterville Model Targets	233.26	222.02	-11.24
obs49	544416.0	4736451.0	226.83	elevation (masl)	Otterville Model Targets	228.89	221.43	-7.46
obs50	544573.0	4736553.0	225.24	elevation (masl)	Otterville Model Targets	225.73	221.85	-3.88
obs51	534600.0	4732323.0	221.78	elevation (masl)	Otterville Model Targets	225.55	227.31	1.76
obs52	544364.0	4736570.0	225.24	elevation (masl)	Otterville Model Targets	228.44	221.13	-7.31
obs53	544342.0	4736554.0	224.90	elevation (masl)	Otterville Model Targets	226.62	221.04	-5.59
obs54	544472.0	4736479.0	226.07	elevation (masl)	Otterville Model Targets	224.90	221.59	-3.31
obs55	544197.0	4733105.0	224.26	elevation (masl)	Otterville Model Targets	226.11	219.26	-6.84
obs56	543221.0	4731948.0	214.73	elevation (masl)	Otterville Model Targets	220.69	214.56	-6.14
obs57	544674.0	4736644.0	229.61	elevation (masl)	Otterville Model Targets	231.93	222.21	-9.72
obs58	544433.0	4736451.0	226.34	elevation (masl)	Otterville Model Targets	226.69	221.47	-5.22
obs59	544418.0	4733079.0	222.61	elevation (masl)	Otterville Model Targets	225.95	219.91	-6.04
obs60	544619.0	4736636.0	230.13	elevation (masl)	Otterville Model Targets	233.38	222.08	-11.29
obs61	544116.0	4731324.0	217.99	elevation (masl)	Otterville Model Targets	218.31	218.55	0.24
obs62	544351.0	4736411.0	223.58	elevation (masl)	Otterville Model Targets	225.55	221.13	-4.42
obs63	538614.0	4732542.0	211.78	elevation (masl)	Otterville Model Targets	219.81	206.19	-13.62
obs64	544376.0	4736480.0	224.31	elevation (masl)	Otterville Model Targets	226.23	221.20	-5.03
obs65	544434.0	4736602.0	224.75	elevation (masl)	Otterville Model Targets	227.71	221.37	-6.34
obs66	534074.0	4732002.0	219.63	elevation (masl)	Otterville Model Targets	220.40	227.21	6.80
obs67	537094.0	4741842.0	227.17	elevation (masl)	Otterville Model Targets	232.24	231.00	-1.24
obs68	539074.0	4734762.0	214.41	elevation (masl)	Otterville Model Targets	218.56	212.28	-6.28
obs69	538894.0	4734662.0	217.64	elevation (masl)	Otterville Model Targets	220.15	212.59	-7.56
obs70	544594.0	4736702.0	223.26	elevation (masl)	Otterville Model Targets	225.50	221.82	-3.68
obs71	539714.0	4725562.0	196.99	elevation (masl)	Otterville Model Targets	198.82	197.88	-0.93
obs72	539114.0	4724742.0	193.42	elevation (masl)	Otterville Model Targets	197.75	191.58	-6.18
obs73	544494.0	4736802.0	222.40	elevation (masl)	Otterville Model Targets	223.75	221.43	-2.32
obs74	544434.0	4736782.0	222.92	elevation (masl)	Otterville Model Targets	224.63	221.21	-3.43
obs75	539334.0	4736282.0	212.74	elevation (masl)	Otterville Model Targets	216.67	207.41	-9.26
obs76	540934.0	4739122.0	205.40	elevation (masl)	Otterville Model Targets	212.18	213.68	1.50
obs77	543714.0	4738402.0	225.05	elevation (masl)	Otterville Model Targets	225.76	223.60	-2.17
obs78	535214.0	4735662.0	224.55	elevation (masl)	Otterville Model Targets	228.45	231.30	2.85
obs79	544514.0	4736822.0	222.74	elevation (masl)	Otterville Model Targets	224.60	221.50	-3.10

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
obs80	535114.0	4735782.0	223.71	elevation (masl)	Otterville Model Targets	229.99	231.51	1.52
obs81	535074.0	4735762.0	223.74	elevation (masl)	Otterville Model Targets	229.52	231.55	2.03
obs82	535054.0	4735802.0	224.29	elevation (masl)	Otterville Model Targets	229.40	231.61	2.21
obs83	544454.0	4736782.0	222.54	elevation (masl)	Otterville Model Targets	224.06	221.29	-2.77
obs84	534714.0	4732062.0	221.54	elevation (masl)	Otterville Model Targets	225.45	226.23	0.78
obs85	535214.0	4727662.0	203.85	elevation (masl)	Otterville Model Targets	208.97	204.42	-4.55
obs86	544174.0	4730262.0	217.19	elevation (masl)	Otterville Model Targets	220.45	218.73	-1.72
obs87	538154.0	4735802.0	218.19	elevation (masl)	Otterville Model Targets	219.26	216.43	-2.83
obs88	544174.0	4736422.0	224.55	elevation (masl)	Otterville Model Targets	225.77	220.37	-5.40
obs89	536614.0	4734822.0	215.29	elevation (masl)	Otterville Model Targets	218.69	224.29	5.60
obs90	537434.0	4736902.0	221.85	elevation (masl)	Otterville Model Targets	225.10	222.12	-2.99
obs91	535494.0	4735902.0	224.42	elevation (masl)	Otterville Model Targets	227.19	230.96	3.77
obs92	536234.0	4733222.0	219.71	elevation (masl)	Otterville Model Targets	224.12	224.67	0.55
obs93	536214.0	4733222.0	219.96	elevation (masl)	Otterville Model Targets	224.15	224.78	0.62
obs94	540834.0	4739022.0	203.46	elevation (masl)	Otterville Model Targets	210.92	211.67	0.75
obs95	544854.0	4733242.0	226.82	elevation (masl)	Otterville Model Targets	225.90	221.20	-4.70
obs96	542594.0	4730422.0	215.44	elevation (masl)	Otterville Model Targets	218.78	214.84	-3.94
obs97	539314.0	4736282.0	212.28	elevation (masl)	Otterville Model Targets	216.95	207.46	-9.49
obs98	544974.0	4736722.0	228.05	elevation (masl)	Otterville Model Targets	231.03	222.79	-8.25
obs99	533414.0	4734382.0	225.25	elevation (masl)	Otterville Model Targets	229.51	232.27	2.76
obs100	537494.0	4728982.0	211.09	elevation (masl)	Otterville Model Targets	214.10	207.42	-6.68
obs101	544494.0	4736722.0	224.23	elevation (masl)	Otterville Model Targets	227.06	221.52	-5.55
obs102	544474.0	4734722.0	224.21	elevation (masl)	Otterville Model Targets	226.82	221.82	-5.00
obs103	543064.0	4737722.0	219.70	elevation (masl)	Otterville Model Targets	224.19	219.64	-4.54
obs104	533763.0	4734700.0	226.12	elevation (masl)	Otterville Model Targets	229.83	232.05	2.23
obs105	533731.0	4734691.0	226.20	elevation (masl)	Otterville Model Targets	230.56	232.06	1.50
obs106	544977.0	4736788.0	225.56	elevation (masl)	Otterville Model Targets	229.19	222.74	-6.45
obs107	534366.0	4732158.0	218.59	elevation (masl)	Otterville Model Targets	223.12	227.16	4.03
obs108	541820.0	4726807.0	208.12	elevation (masl)	Otterville Model Targets	209.28	210.70	1.42
obs109	544444.0	4736382.0	223.11	elevation (masl)	Otterville Model Targets	227.76	221.49	-6.28
obs110	544354.0	4736352.0	222.62	elevation (masl)	Otterville Model Targets	227.00	221.18	-5.83
obs111	535454.0	4731172.0	213.43	elevation (masl)	Otterville Model Targets	215.33	220.23	4.90
obs112	541564.0	4740022.0	217.52	elevation (masl)	Otterville Model Targets	226.01	219.61	-6.40
obs113	538884.0	4732322.0	204.50	elevation (masl)	Otterville Model Targets	215.23	203.96	-11.27
obs114	540234.0	4736782.0	204.44	elevation (masl)	Otterville Model Targets	212.22	206.78	-5.44
obs115	544214.0	4736487.0	222.74	elevation (masl)	Otterville Model Targets	223.56	220.47	-3.09
obs116	544264.0	4736472.0	222.89	elevation (masl)	Otterville Model Targets	225.39	220.72	-4.67
obs117	544244.0	4736462.0	222.69	elevation (masl)	Otterville Model Targets	225.97	220.64	-5.34
obs118	540789.0	4729997.0	209.79	elevation (masl)	Otterville Model Targets	212.57	208.64	-3.93
obs119	544204.0	4736432.0	221.16	elevation (masl)	Otterville Model Targets	223.50	220.47	-3.04

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
obs120	540764.0	4738922.0	202.71	elevation (masl)	Otterville Model Targets	207.42	210.27	2.85
obs121	542064.0	4733947.0	215.63	elevation (masl)	Otterville Model Targets	220.92	212.64	-8.28
obs122	544514.0	4736772.0	222.24	elevation (masl)	Otterville Model Targets	226.78	221.52	-5.26
obs123	544364.0	4736682.0	222.03	elevation (masl)	Otterville Model Targets	225.06	220.98	-4.08
obs124	544339.0	4736672.0	222.15	elevation (masl)	Otterville Model Targets	224.68	220.87	-3.80
obs125	544414.0	4736622.0	222.40	elevation (masl)	Otterville Model Targets	224.27	221.23	-3.05
obs126	544214.0	4736372.0	222.41	elevation (masl)	Otterville Model Targets	223.59	220.59	-3.00
obs127	541064.0	4729472.0	205.79	elevation (masl)	Otterville Model Targets	211.69	210.90	-0.79
obs128	539289.0	4736272.0	202.16	elevation (masl)	Otterville Model Targets	208.71	207.12	-1.59
obs129	544289.0	4736422.0	222.42	elevation (masl)	Otterville Model Targets	226.00	220.87	-5.14
obs130	544289.0	4736497.0	223.55	elevation (masl)	Otterville Model Targets	227.76	220.82	-6.94
obs131	543765.0	4739168.0	227.93	elevation (masl)	Otterville Model Targets	231.62	225.96	-5.66
obs132	544320.0	4736354.0	221.80	elevation (masl)	Otterville Model Targets	223.76	221.04	-2.73
obs133	541963.0	4731535.0	204.87	elevation (masl)	Otterville Model Targets	211.44	207.75	-3.69
obs134	544130.0	4736314.0	223.46	elevation (masl)	Otterville Model Targets	226.74	220.25	-6.49
obs135	544275.0	4736322.0	222.77	elevation (masl)	Otterville Model Targets	225.38	220.89	-4.49
obs136	544242.0	4736375.0	222.88	elevation (masl)	Otterville Model Targets	223.78	220.72	-3.06
obs137	542857.0	4732884.0	209.68	elevation (masl)	Otterville Model Targets	213.87	210.54	-3.33
obs138	544546.0	4736541.0	223.04	elevation (masl)	Otterville Model Targets	226.16	221.74	-4.43
obs139	542680.0	4733020.0	212.53	elevation (masl)	Otterville Model Targets	215.54	211.13	-4.40
obs140	544354.0	4736722.0	221.40	elevation (masl)	Otterville Model Targets	222.64	220.89	-1.76
obs141	544354.0	4736722.0	221.40	elevation (masl)	Otterville Model Targets	222.34	220.89	-1.45
obs142	540014.0	4738802.0	218.38	elevation (masl)	Otterville Model Targets	222.37	208.70	-13.67
obs143	542614.0	4737002.0	215.55	elevation (masl)	Otterville Model Targets	219.87	213.44	-6.43
obs144	544214.0	4736682.0	222.08	elevation (masl)	Otterville Model Targets	222.32	220.23	-2.08
obs145	537934.0	4726662.0	191.36	elevation (masl)	Otterville Model Targets	196.80	189.44	-7.35
obs146	544154.0	4736542.0	222.24	elevation (masl)	Otterville Model Targets	222.42	220.10	-2.32
obs147	542434.0	4731802.0	211.36	elevation (masl)	Otterville Model Targets	216.76	209.80	-6.96
obs148	541014.0	4734322.0	206.66	elevation (masl)	Otterville Model Targets	208.40	209.58	1.18
obs149	539854.0	4739082.0	213.98	elevation (masl)	Otterville Model Targets	221.53	210.83	-10.70
obs150	544254.0	4736402.0	223.32	elevation (masl)	Otterville Model Targets	225.18	220.75	-4.43
obs151	537394.0	4736982.0	216.39	elevation (masl)	Otterville Model Targets	222.05	222.42	0.37
obs152	537494.0	4737022.0	215.42	elevation (masl)	Otterville Model Targets	221.16	221.84	0.68
obs153	537254.0	4736882.0	218.17	elevation (masl)	Otterville Model Targets	224.20	223.13	-1.07
obs154	536714.0	4731922.0	210.80	elevation (masl)	Otterville Model Targets	218.88	218.72	-0.16
obs155	542294.0	4731782.0	211.62	elevation (masl)	Otterville Model Targets	214.95	208.97	-5.98
obs156	542314.0	4736922.0	211.98	elevation (masl)	Otterville Model Targets	218.30	211.31	-6.99
obs157	541094.0	4739862.0	222.89	elevation (masl)	Otterville Model Targets	226.21	217.21	-9.00
obs158	541094.0	4739862.0	222.89	elevation (masl)	Otterville Model Targets	226.21	217.21	-9.00
obs159	544294.0	4736662.0	222.74	elevation (masl)	Otterville Model Targets	223.80	220.68	-3.12

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
obs160	544254.0	4736582.0	221.48	elevation (masl)	Otterville Model Targets	225.50	220.55	-4.95
obs161	544234.0	4736542.0	220.89	elevation (masl)	Otterville Model Targets	223.87	220.49	-3.38
obs162	536974.0	4738852.0	221.04	elevation (masl)	Otterville Model Targets	224.68	227.45	2.77
obs163	544164.0	4736372.0	223.60	elevation (masl)	Otterville Model Targets	225.67	220.36	-5.31
obs164	541494.0	4740122.0	213.12	elevation (masl)	Otterville Model Targets	223.42	219.27	-4.16
obs165	540264.0	4729572.0	188.84	elevation (masl)	Otterville Model Targets	210.73	207.50	-3.24
obs166	540094.0	4730092.0	200.52	elevation (masl)	Otterville Model Targets	207.69	205.83	-1.86
obs167	535454.0	4738572.0	224.37	elevation (masl)	Otterville Model Targets	229.79	232.46	2.67
obs168	533744.0	4731722.0	217.48	elevation (masl)	Otterville Model Targets	220.29	226.55	6.26
obs169	540834.0	4731612.0	198.25	elevation (masl)	Otterville Model Targets	206.04	198.68	-7.36
obs170	539814.0	4730342.0	192.66	elevation (masl)	Otterville Model Targets	199.66	203.35	3.69
obs171	544464.0	4729702.0	212.19	elevation (masl)	Otterville Model Targets	218.58	218.78	0.20
obs172	541314.0	4739532.0	219.41	elevation (masl)	Otterville Model Targets	221.23	218.08	-3.15
obs173	541304.0	4739492.0	215.92	elevation (masl)	Otterville Model Targets	219.92	217.91	-2.01
obs174	540264.0	4732052.0	188.54	elevation (masl)	Otterville Model Targets	193.01	198.04	5.03
obs175	539164.0	4730122.0	191.98	elevation (masl)	Otterville Model Targets	195.60	199.77	4.18
obs176	535914.0	4729772.0	198.25	elevation (masl)	Otterville Model Targets	213.37	210.95	-2.42
obs177	541339.0	4731822.0	188.50	elevation (masl)	Otterville Model Targets	194.94	200.61	5.67
obs178	544264.0	4736542.0	219.51	elevation (masl)	Otterville Model Targets	223.62	220.62	-3.00
obs179	544294.0	4736572.0	220.25	elevation (masl)	Otterville Model Targets	223.54	220.74	-2.80
obs180	538964.0	4732972.0	202.81	elevation (masl)	Otterville Model Targets	211.43	205.40	-6.03
obs181	536114.0	4729297.0	197.33	elevation (masl)	Otterville Model Targets	214.05	208.33	-5.71
obs182	540639.0	4736372.0	200.05	elevation (masl)	Otterville Model Targets	205.14	205.18	0.04
obs183	541089.0	4732747.0	206.27	elevation (masl)	Otterville Model Targets	209.84	205.83	-4.01
obs184	539914.0	4738972.0	204.53	elevation (masl)	Otterville Model Targets	208.30	209.79	1.49
obs185	542013.0	4734215.0	210.10	elevation (masl)	Otterville Model Targets	218.98	212.81	-6.17
obs186	534749.0	4730726.0	212.95	elevation (masl)	Otterville Model Targets	214.48	218.19	3.71
obs187	542678.0	4740002.0	218.57	elevation (masl)	Otterville Model Targets	227.58	224.07	-3.51
obs188	542694.0	4739962.0	217.29	elevation (masl)	Otterville Model Targets	227.75	224.13	-3.62
obs189	538694.0	4731388.0	187.83	elevation (masl)	Otterville Model Targets	192.40	200.72	8.32
obs190	540878.0	4731701.0	196.06	elevation (masl)	Otterville Model Targets	197.43	199.70	2.27
obs191	537838.0	4732449.0	202.06	elevation (masl)	Otterville Model Targets	211.68	212.07	0.39
obs192	534674.0	4730632.0	206.81	elevation (masl)	Otterville Model Targets	208.96	217.32	8.36
obs193	541404.0	4727989.0	202.92	elevation (masl)	Otterville Model Targets	203.78	212.00	8.23
obs194	542485.0	4731756.0	208.37	elevation (masl)	Otterville Model Targets	209.80	210.37	0.57
obs195	544431.0	4736565.0	218.60	elevation (masl)	Otterville Model Targets	225.49	221.29	-4.20
obs196	541925.0	4734274.0	207.84	elevation (masl)	Otterville Model Targets	215.47	212.56	-2.91
obs197	544681.0	4736597.0	221.13	elevation (masl)	Otterville Model Targets	224.51	222.08	-2.43
obs198	533624.0	4731783.0	215.92	elevation (masl)	Otterville Model Targets	218.66	226.98	8.32
obs199	544434.0	4736782.0	216.83	elevation (masl)	Otterville Model Targets	223.11	221.14	-1.97

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
obs200	540993.9	4738722.0	203.27	elevation (masl)	Otterville Model Targets	206.04	213.71	7.66
obs201	540014.0	4738762.0	204.53	elevation (masl)	Otterville Model Targets	213.79	208.27	-5.53
obs202	541094.0	4738542.0	202.36	elevation (masl)	Otterville Model Targets	206.76	214.37	7.62
obs203	538034.0	4726382.0	184.39	elevation (masl)	Otterville Model Targets	188.93	189.25	0.32
obs204	540934.0	4732542.0	202.28	elevation (masl)	Otterville Model Targets	206.94	204.57	-2.37
obs205	544054.0	4736582.0	219.48	elevation (masl)	Otterville Model Targets	220.08	219.39	-0.69
obs206	544154.0	4736582.0	219.66	elevation (masl)	Otterville Model Targets	221.26	220.02	-1.25
obs207	539294.0	4739322.0	214.39	elevation (masl)	Otterville Model Targets	215.81	215.39	-0.42
obs208	541214.0	4728262.0	193.34	elevation (masl)	Otterville Model Targets	197.89	211.57	13.68
obs209	543014.0	4730482.0	210.94	elevation (masl)	Otterville Model Targets	217.45	216.11	-1.35
obs210	543014.0	4730482.0	209.11	elevation (masl)	Otterville Model Targets	218.67	216.08	-2.59
obs211	538374.0	4725902.0	174.29	elevation (masl)	Otterville Model Targets	183.70	188.51	4.80
obs212	540914.0	4739242.0	205.03	elevation (masl)	Otterville Model Targets	211.98	214.27	2.29
obs213	544534.0	4736842.0	220.47	elevation (masl)	Otterville Model Targets	223.21	221.54	-1.67
obs214	534234.0	4732022.0	217.91	elevation (masl)	Otterville Model Targets	222.32	226.94	4.62
obs215	540314.0	4729862.0	205.79	elevation (masl)	Otterville Model Targets	209.91	207.24	-2.67
obs216	536294.0	4730042.0	197.95	elevation (masl)	Otterville Model Targets	213.45	212.34	-1.12
obs217	544574.0	4736982.0	222.95	elevation (masl)	Otterville Model Targets	225.16	221.62	-3.54
obs218	541134.0	4739302.0	210.05	elevation (masl)	Otterville Model Targets	214.81	216.40	1.58
obs219	543254.0	4738962.0	222.29	elevation (masl)	Otterville Model Targets	223.51	224.80	1.28
obs220	540334.0	4729662.0	203.00	elevation (masl)	Otterville Model Targets	211.48	207.70	-3.79
obs221	539734.0	4732002.0	201.56	elevation (masl)	Otterville Model Targets	204.42	197.65	-6.77
obs222	542474.0	4731822.0	208.98	elevation (masl)	Otterville Model Targets	216.33	209.96	-6.37
obs223	536714.0	4738782.0	219.80	elevation (masl)	Otterville Model Targets	227.63	228.77	1.14
obs224	542794.0	4740022.0	215.16	elevation (masl)	Otterville Model Targets	227.45	224.41	-3.04
obs225	544454.0	4736762.0	220.30	elevation (masl)	Otterville Model Targets	223.19	221.28	-1.92
obs226	543074.0	4738882.0	220.31	elevation (masl)	Otterville Model Targets	224.72	224.11	-0.61
obs227	533654.0	4733882.0	213.86	elevation (masl)	Otterville Model Targets	230.93	231.95	1.02
obs228	539694.0	4731822.0	187.95	elevation (masl)	Otterville Model Targets	196.01	196.50	0.49
obs229	542234.0	4739602.0	211.92	elevation (masl)	Otterville Model Targets	221.42	222.16	0.74
obs230	543294.0	4739002.0	224.93	elevation (masl)	Otterville Model Targets	229.84	225.02	-4.82
obs231	541874.0	4739602.0	214.97	elevation (masl)	Otterville Model Targets	218.03	220.74	2.71
obs232	542734.0	4737082.0	213.69	elevation (masl)	Otterville Model Targets	217.07	214.50	-2.56
obs233	538714.0	4737622.0	203.45	elevation (masl)	Otterville Model Targets	210.29	213.27	2.98
obs234	540494.0	4732402.0	194.55	elevation (masl)	Otterville Model Targets	199.02	202.06	3.04
obs235	544194.0	4736582.0	220.50	elevation (masl)	Otterville Model Targets	222.65	220.24	-2.42
obs236	544214.0	4736622.0	220.53	elevation (masl)	Otterville Model Targets	223.37	220.29	-3.08
obs237	541831.0	4733160.0	203.31	elevation (masl)	Otterville Model Targets	214.86	209.82	-5.03
obs238	537364.0	4726592.0	172.29	elevation (masl)	Otterville Model Targets	179.39	188.07	8.68
obs239	537214.0	4726572.0	164.59	elevation (masl)	Otterville Model Targets	179.67	192.33	12.66

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
obs240	537654.0	4734322.0	209.44	elevation (masl)	Otterville Model Targets	209.41	213.71	4.30
obs241	537814.0	4734122.0	203.59	elevation (masl)	Otterville Model Targets	212.34	212.63	0.28
obs242	535514.0	4731222.0	194.96	elevation (masl)	Otterville Model Targets	220.33	219.95	-0.38
obs243	540689.0	4734059.0	187.87	elevation (masl)	Otterville Model Targets	196.17	207.19	11.02
obs244	543114.0	4733972.0	172.42	elevation (masl)	Otterville Model Targets	214.11	214.44	0.33
obs245	539974.0	4733622.0	156.43	elevation (masl)	Otterville Model Targets	184.37	206.21	21.84
obs246	539594.0	4731942.0	152.73	elevation (masl)	Otterville Model Targets	201.77	202.42	0.65
obs247	537854.0	4733992.0	148.38	elevation (masl)	Otterville Model Targets	216.81	211.69	-5.12
obs248	540454.0	4735782.0	151.98	elevation (masl)	Otterville Model Targets	184.17	206.66	22.49
obs249	539814.0	4739142.0	160.45	elevation (masl)	Otterville Model Targets	204.18	214.03	9.85
obs250	539814.0	4739182.0	159.60	elevation (masl)	Otterville Model Targets	204.06	214.15	10.09
obs251	538654.0	4737602.0	167.10	elevation (masl)	Otterville Model Targets	203.18	215.04	11.86
obs252	542634.0	4737062.0	162.36	elevation (masl)	Otterville Model Targets	199.25	214.23	14.98
w4404645	538653.9	4737602.0	7	model slice number	Water Well Information System Targets	203.21	215.04	11.83
w4404679	534299.8	4729694.0	7	model slice number	Water Well Information System Targets	212.44	207.50	-4.94
w4402452	537633.8	4726872.0	7	model slice number	Water Well Information System Targets	198.79	199.68	0.89
w4401038	536028.8	4731472.0	7	model slice number	Water Well Information System Targets	220.66	210.70	-9.96
w4401041	537888.8	4732472.0	7	model slice number	Water Well Information System Targets	214.26	208.61	-5.65
w4404099	538253.8	4732822.0	7	model slice number	Water Well Information System Targets	204.42	208.24	3.82
w4401077	536213.8	4733202.0	7	model slice number	Water Well Information System Targets	221.95	214.66	-7.29
w4402495	537853.8	4733992.0	7	model slice number	Water Well Information System Targets	216.83	211.69	-5.14
w4401144	536378.9	4736372.0	7	model slice number	Water Well Information System Targets	226.87	220.25	-6.62
w4408502	536029.0	4737019.0	7	model slice number	Water Well Information System Targets	221.95	221.51	-0.44
w7141029	542091.0	4726666.0	7	model slice number	Water Well Information System Targets	210.77	208.34	-2.43
w7141025	542135.0	4727673.0	7	model slice number	Water Well Information System Targets	205.45	211.67	6.22
w7248356	540552.0	4740962.0	7	model slice number	Water Well Information System Targets	221.41	218.78	-2.63
w7199430	541139.0	4739145.0	7	model slice number	Water Well Information System Targets	209.44	214.62	5.18
w7276709	541186.0	4738070.0	7	model slice number	Water Well Information System Targets	198.15	211.62	13.47
w7328054	542085.0	4733303.0	7	model slice number	Water Well Information System Targets	216.02	210.19	-5.83
w4400979	542163.9	4729697.0	7	model slice number	Water Well Information System Targets	207.35	212.71	5.36
w4400977	542303.9	4728822.0	7	model slice number	Water Well Information System Targets	195.01	213.53	18.52
w4401250	539113.8	4725197.0	7	model slice number	Water Well Information System Targets	188.75	197.75	9.00
w4404520	539593.8	4731942.0	7	model slice number	Water Well Information System Targets	201.73	202.42	0.69
w4403032	539663.8	4730647.0	7	model slice number	Water Well Information System Targets	204.50	203.15	-1.35
w4401002	540703.9	4730872.0	7	model slice number	Water Well Information System Targets	209.97	204.51	-5.46
w4405394	540361.8	4731490.0	7	model slice number	Water Well Information System Targets	194.42	201.68	7.26
w4406394	540302.1	4730566.0	7	model slice number	Water Well Information System Targets	188.57	204.35	15.78
w4401042	539523.9	4734547.0	7	model slice number	Water Well Information System Targets	198.77	208.50	9.73
w4401003	540953.9	4732397.0	7	model slice number	Water Well Information System Targets	190.09	204.37	14.28
w4403105	543113.9	4733972.0	7	model slice number	Water Well Information System Targets	214.13	214.43	0.30

Observation Name	Easting	Northing	Z	Z Type	Calibration Group	Observed Hydraulic Head (masl)	Simulated Hydraulic Head (masl)	Residual (Simulated - Observed Hydraulic Head) (m)
w7047368	540653.0	4735924.0	7	model slice number	Water Well Information System Targets	205.40	206.51	1.11
w4406310	544329.2	4736678.0	7	model slice number	Water Well Information System Targets	224.10	219.84	-4.26
w4400962	541263.9	4740997.0	7	model slice number	Water Well Information System Targets	211.90	220.03	8.13
w4400372	541863.9	4736672.0	7	model slice number	Water Well Information System Targets	198.85	209.36	10.51
w4404637	542633.9	4737062.0	7	model slice number	Water Well Information System Targets	199.25	214.23	14.98
w4404073	539813.9	4739142.0	7	model slice number	Water Well Information System Targets	204.12	214.03	9.91
w4404074	539813.9	4739182.0	7	model slice number	Water Well Information System Targets	204.08	214.14	10.06
w4401081	540008.9	4736622.0	7	model slice number	Water Well Information System Targets	194.54	208.14	13.60
w4405085	540051.9	4737940.0	7	model slice number	Water Well Information System Targets	197.35	209.75	12.40
w4400402	540853.9	4738822.0	7	model slice number	Water Well Information System Targets	198.47	212.02	13.55
w4404745	541213.9	4739182.0	7	model slice number	Water Well Information System Targets	207.11	215.10	7.99

TABLE A2 Data for Qualitative Calibration Verification

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
Grant Well (T009949)	540187.6	4731986.1	153.21	elevation (masl)	Heads at Flowing Wells	200.71	200.76	0.05
Relief Well (F020148)	539999.3	4732035.6	153.92	elevation (masl)	Heads at Flowing Wells	188.87	188.96	0.09
Original Well (F005427)	539995.8	4732040.1	153.94	elevation (masl)	Heads at Flowing Wells	188.95	195.98	7.03
Morrison Well (T008725)	539757.2	4731619.2	151.37	elevation (masl)	Heads at Flowing Wells	200.36	201.94	1.58
Edwards Well (F005318)	540938.1	4731493.5	149.06	elevation (masl)	Heads at Flowing Wells	202.20	203.36	1.16
Wulleman Well (T012545)	540479.4	4734871.6	160.94	elevation (masl)	Heads at Flowing Wells	200.09	207.17	7.08
Teichroeb Well (T012512)	540536.9	4734565.8	160.28	elevation (masl)	Heads at Flowing Wells	192.05	207.29	15.24
FFR Well (F006207)	541133.6	4735325.8	162.41	elevation (masl)	Heads at Flowing Wells	191.52	207.82	16.30
Norfolk Monitoring Well (T012616)	*541132.7*	*4735476.7*	*162.84*	*elevation (masl)*	*Heads at Flowing Wells*	*209.50 (water level)*	*207.65*	*-1.85*
Norfolk Monitoring Well (T012616)	541132.7	4735476.7	162.84	elevation (masl)	Heads at Flowing Wells	194.66	207.65	12.99
Spanjers' Spring (S000003)	540728.3	4735835.5	164.26	elevation (masl)	Heads at Flowing Wells	191.93	206.48	14.55
F004269	538451.2	4724801.0	7	model slice number	Oil, Gas and Salt Resources Library	184.33	196.51	12.18
F004546	534038.8	4726943.3	7	model slice number	Oil, Gas and Salt Resources Library	211.86	201.75	-10.11
F004945	537024.8	4735293.3	7	model slice number	Oil, Gas and Salt Resources Library	225.21	216.98	-8.23
F005081	534172.3	4728927.4	7	model slice number	Oil, Gas and Salt Resources Library	218.48	205.18	-13.30
F005214	539738.3	4730955.9	7	model slice number	Oil, Gas and Salt Resources Library	204.28	202.60	-1.68
F005218	540807.0	4730977.6	7	model slice number	Oil, Gas and Salt Resources Library	212.36	204.48	-7.88
F005226	540483.8	4731018.9	7	model slice number	Oil, Gas and Salt Resources Library	210.79	203.35	-7.44
F005246	540046.7	4731108.9	7	model slice number	Oil, Gas and Salt Resources Library	204.49	202.32	-2.17
F005259	541053.6	4731195.0	7	model slice number	Oil, Gas and Salt Resources Library	211.29	204.66	-6.63
F005294	540283.9	4731378.6	7	model slice number	Oil, Gas and Salt Resources Library	201.94	201.80	-0.14
F005297	540618.1	4731386.7	7	model slice number	Oil, Gas and Salt Resources Library	203.16	202.54	-0.62
F005304	542157.2	4731454.6	7	model slice number	Oil, Gas and Salt Resources Library	216.74	209.45	-7.29
F005310	541631.9	4731451.4	7	model slice number	Oil, Gas and Salt Resources Library	211.13	206.68	-4.45
F005347	535752.4	4731736.2	7	model slice number	Oil, Gas and Salt Resources Library	224.07	211.95	-12.12
F005359	538865.8	4731635.8	7	model slice number	Oil, Gas and Salt Resources Library	209.40	204.64	-4.76
F005367	539215.6	4731705.6	7	model slice number	Oil, Gas and Salt Resources Library	206.18	203.67	-2.51
F005379	538435.5	4731722.8	7	model slice number	Oil, Gas and Salt Resources Library	204.81	205.91	1.10
F005397	541884.2	4731850.8	7	model slice number	Oil, Gas and Salt Resources Library	210.36	207.37	-2.99
F005412	542582.0	4731892.1	7	model slice number	Oil, Gas and Salt Resources Library	220.63	210.78	-9.85
F005426	540994.4	4731978.1	7	model slice number	Oil, Gas and Salt Resources Library	210.91	203.62	-7.29
F005428	539607.7	4731923.8	7	model slice number	Oil, Gas and Salt Resources Library	207.52	202.34	-5.18
F005447	540659.0	4731788.0	7	model slice number	Oil, Gas and Salt Resources Library	207.00	202.30	-4.70
F005453	539016.0	4732012.9	7	model slice number	Oil, Gas and Salt Resources Library	210.81	204.59	-6.22
F005463	542744.5	4732087.4	7	model slice number	Oil, Gas and Salt Resources Library	217.96	211.31	-6.65
F005464	535941.5	4732098.1	7	model slice number	Oil, Gas and Salt Resources Library	224.95	212.52	-12.43
F005471	541804.8	4732195.8	7	model slice number	Oil, Gas and Salt Resources Library	217.79	207.05	-10.74
F005476	541313.8	4732171.3	7	model slice number	Oil, Gas and Salt Resources Library	210.68	205.11	-5.57
F005477	537171.2	4732157.0	7	model slice number	Oil, Gas and Salt Resources Library	217.65	209.81	-7.84
F005481	539351.4	4732199.9	7	model slice number	Oil, Gas and Salt Resources Library	208.96	203.77	-5.19

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F005482	535508.7	4732253.1	7	model slice number	Oil, Gas and Salt Resources Library	227.94	214.24	-13.70
F005487	540819.8	4732279.4	7	model slice number	Oil, Gas and Salt Resources Library	210.37	203.64	-6.73
F005505	542149.5	4732346.0	7	model slice number	Oil, Gas and Salt Resources Library	209.87	208.63	-1.24
F005514	535875.9	4732461.7	7	model slice number	Oil, Gas and Salt Resources Library	226.67	213.71	-12.96
F005528	542885.4	4732464.6	7	model slice number	Oil, Gas and Salt Resources Library	213.67	211.76	-1.91
F005530	535297.9	4732563.6	7	model slice number	Oil, Gas and Salt Resources Library	228.89	215.87	-13.02
F005536	540544.1	4732538.3	7	model slice number	Oil, Gas and Salt Resources Library	205.02	203.49	-1.53
F005537	537885.2	4732565.0	7	model slice number	Oil, Gas and Salt Resources Library	213.87	208.79	-5.08
F005538	534229.3	4732434.2	7	model slice number	Oil, Gas and Salt Resources Library	226.44	218.49	-7.95
F005545	541129.4	4732589.7	7	model slice number	Oil, Gas and Salt Resources Library	211.44	205.45	-5.99
F005546	538830.0	4732329.6	7	model slice number	Oil, Gas and Salt Resources Library	217.93	205.65	-12.28
F005550	542425.1	4732631.5	7	model slice number	Oil, Gas and Salt Resources Library	218.33	210.11	-8.22
F005564	536613.1	4732783.3	7	model slice number	Oil, Gas and Salt Resources Library	222.23	212.47	-9.76
F005569	535683.2	4732806.2	7	model slice number	Oil, Gas and Salt Resources Library	230.84	215.28	-15.56
F005581	537017.8	4732782.4	7	model slice number	Oil, Gas and Salt Resources Library	220.26	211.41	-8.85
F005584	540757.3	4732846.6	7	model slice number	Oil, Gas and Salt Resources Library	206.60	204.96	-1.64
F005585	539486.4	4732848.5	7	model slice number	Oil, Gas and Salt Resources Library	214.49	205.00	-9.49
F005592	539045.3	4732864.5	7	model slice number	Oil, Gas and Salt Resources Library	220.49	206.12	-14.37
F005599	541089.3	4732833.1	7	model slice number	Oil, Gas and Salt Resources Library	208.84	205.95	-2.89
F005600	536038.0	4732771.0	7	model slice number	Oil, Gas and Salt Resources Library	226.99	214.07	-12.92
F005607	535246.1	4732911.9	7	model slice number	Oil, Gas and Salt Resources Library	227.80	217.08	-10.72
F005614	541800.1	4732960.8	7	model slice number	Oil, Gas and Salt Resources Library	218.19	208.58	-9.61
F005615	538544.7	4732941.9	7	model slice number	Oil, Gas and Salt Resources Library	219.06	207.65	-11.41
F005624	542225.1	4732997.3	7	model slice number	Oil, Gas and Salt Resources Library	222.27	210.06	-12.21
F005625	537314.4	4733003.0	7	model slice number	Oil, Gas and Salt Resources Library	223.75	211.10	-12.65
F005633	538244.0	4733045.1	7	model slice number	Oil, Gas and Salt Resources Library	220.17	208.70	-11.47
F005641	541272.2	4733040.9	7	model slice number	Oil, Gas and Salt Resources Library	209.80	207.05	-2.75
F005643	539757.8	4733099.9	7	model slice number	Oil, Gas and Salt Resources Library	215.10	205.18	-9.92
F005644	536545.4	4733122.2	7	model slice number	Oil, Gas and Salt Resources Library	224.43	213.46	-10.97
F005645	536154.4	4733120.2	7	model slice number	Oil, Gas and Salt Resources Library	226.05	214.63	-11.42
F005655	542667.5	4733141.9	7	model slice number	Oil, Gas and Salt Resources Library	219.46	211.77	-7.69
F005661	540535.0	4733144.5	7	model slice number	Oil, Gas and Salt Resources Library	196.26	205.08	8.82
F005668	536874.6	4733207.3	7	model slice number	Oil, Gas and Salt Resources Library	224.23	212.73	-11.50
F005677	541584.8	4733234.0	7	model slice number	Oil, Gas and Salt Resources Library	211.87	208.48	-3.39
F005678	540151.1	4733102.2	7	model slice number	Oil, Gas and Salt Resources Library	195.72	204.78	9.06
F005679	538645.4	4733223.1	7	model slice number	Oil, Gas and Salt Resources Library	218.33	207.95	-10.38
F005695	541975.6	4733267.2	7	model slice number	Oil, Gas and Salt Resources Library	224.92	209.78	-15.14
F005696	540950.2	4733298.1	7	model slice number	Oil, Gas and Salt Resources Library	212.14	206.62	-5.52
F005697	538965.9	4733234.2	7	model slice number	Oil, Gas and Salt Resources Library	216.86	207.14	-9.72
F005700	535012.2	4733317.9	7	model slice number	Oil, Gas and Salt Resources Library	229.66	219.02	-10.64
F005707	537128.3	4733378.3	7	model slice number	Oil, Gas and Salt Resources Library	222.09	212.41	-9.68
F005717	543213.5	4733447.6	7	model slice number	Oil, Gas and Salt Resources Library	209.26	214.06	4.80

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F005725	539585.4	4733422.8	7	model slice number	Oil, Gas and Salt Resources Library	215.18	206.28	-8.90
F005726	538055.8	4733374.1	7	model slice number	Oil, Gas and Salt Resources Library	219.44	209.86	-9.58
F005738	541278.7	4733479.0	7	model slice number	Oil, Gas and Salt Resources Library	212.66	207.99	-4.67
F005739	536501.2	4733748.2	7	model slice number	Oil, Gas and Salt Resources Library	224.46	215.17	-9.29
F005745	539914.5	4733517.2	7	model slice number	Oil, Gas and Salt Resources Library	204.10	206.04	1.94
F005747	535370.3	4733523.3	7	model slice number	Oil, Gas and Salt Resources Library	231.58	218.37	-13.21
F005754	542623.9	4733567.3	7	model slice number	Oil, Gas and Salt Resources Library	222.68	212.32	-10.36
F005755	540913.0	4734189.3	7	model slice number	Oil, Gas and Salt Resources Library	213.51	207.87	-5.64
F005756	536743.3	4733533.6	7	model slice number	Oil, Gas and Salt Resources Library	224.05	213.88	-10.17
F005757	534824.6	4733557.5	7	model slice number	Oil, Gas and Salt Resources Library	228.58	220.20	-8.38
F005761	540619.0	4733558.3	7	model slice number	Oil, Gas and Salt Resources Library	208.43	206.18	-2.25
F005762	539221.3	4733504.0	7	model slice number	Oil, Gas and Salt Resources Library	211.23	207.15	-4.08
F005767	542096.3	4733610.4	7	model slice number	Oil, Gas and Salt Resources Library	221.05	210.75	-10.30
F005768	537522.7	4733590.2	7	model slice number	Oil, Gas and Salt Resources Library	220.60	211.78	-8.82
F005786	537838.1	4733693.7	7	model slice number	Oil, Gas and Salt Resources Library	220.22	211.11	-9.11
F005796	540906.7	4733720.4	7	model slice number	Oil, Gas and Salt Resources Library	212.40	207.25	-5.15
F005797	539599.8	4733691.2	7	model slice number	Oil, Gas and Salt Resources Library	208.62	206.86	-1.76
F005798	537062.9	4733701.8	7	model slice number	Oil, Gas and Salt Resources Library	219.21	213.34	-5.87
F005799	533992.0	4733670.6	7	model slice number	Oil, Gas and Salt Resources Library	230.87	222.60	-8.27
F005806	542977.3	4733776.2	7	model slice number	Oil, Gas and Salt Resources Library	221.84	213.75	-8.09
F005807	541734.2	4733716.1	7	model slice number	Oil, Gas and Salt Resources Library	218.33	209.80	-8.53
F005808	540176.9	4733747.0	7	model slice number	Oil, Gas and Salt Resources Library	202.71	206.25	3.54
F005809	534432.8	4733716.0	7	model slice number	Oil, Gas and Salt Resources Library	229.69	221.72	-7.97
F005815	541326.9	4733775.4	7	model slice number	Oil, Gas and Salt Resources Library	213.94	208.63	-5.31
F005836	540489.9	4733863.0	7	model slice number	Oil, Gas and Salt Resources Library	190.32	206.26	15.94
F005843	539314.8	4733850.0	7	model slice number	Oil, Gas and Salt Resources Library	215.45	207.71	-7.74
F005851	544074.0	4733965.1	7	model slice number	Oil, Gas and Salt Resources Library	227.41	217.45	-9.96
F005852	542662.8	4733903.8	7	model slice number	Oil, Gas and Salt Resources Library	224.86	212.88	-11.98
F005853	538691.5	4733920.5	7	model slice number	Oil, Gas and Salt Resources Library	217.05	209.27	-7.78
F005854	538382.6	4733891.0	7	model slice number	Oil, Gas and Salt Resources Library	217.85	210.01	-7.84
F005861	543251.5	4733981.9	7	model slice number	Oil, Gas and Salt Resources Library	219.20	214.90	-4.30
F005862	541991.8	4733964.5	7	model slice number	Oil, Gas and Salt Resources Library	225.70	210.87	-14.83
F005863	537455.1	4733904.4	7	model slice number	Oil, Gas and Salt Resources Library	221.25	212.67	-8.58
F005872	534702.4	4733893.2	7	model slice number	Oil, Gas and Salt Resources Library	229.88	221.28	-8.60
F005876	541586.9	4734020.6	7	model slice number	Oil, Gas and Salt Resources Library	223.94	209.70	-14.24
F005877	538991.2	4733996.2	7	model slice number	Oil, Gas and Salt Resources Library	216.00	208.70	-7.30
F005878	536806.9	4733965.7	7	model slice number	Oil, Gas and Salt Resources Library	224.23	214.77	-9.46
F005887	536320.2	4734021.8	7	model slice number	Oil, Gas and Salt Resources Library	226.08	216.50	-9.58
F005888	535697.2	4734043.2	7	model slice number	Oil, Gas and Salt Resources Library	229.58	218.64	-10.94
F005899	539997.8	4734060.6	7	model slice number	Oil, Gas and Salt Resources Library	203.70	207.04	3.34
F005900	537974.7	4734061.5	7	model slice number	Oil, Gas and Salt Resources Library	219.56	211.49	-8.07
F005901	534431.2	4734036.8	7	model slice number	Oil, Gas and Salt Resources Library	229.59	222.44	-7.15

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F005911	540700.5	4733993.8	7	model slice number	Oil, Gas and Salt Resources Library	209.26	207.01	-2.25
F005912	539649.7	4734114.1	7	model slice number	Oil, Gas and Salt Resources Library	211.65	207.61	-4.04
F005913	535115.0	4734108.1	7	model slice number	Oil, Gas and Salt Resources Library	229.36	220.53	-8.83
F005914	533765.2	4734030.4	7	model slice number	Oil, Gas and Salt Resources Library	232.58	223.52	-9.06
F005930	541090.4	4734187.3	7	model slice number	Oil, Gas and Salt Resources Library	221.30	208.38	-12.92
F005937	543072.3	4734208.6	7	model slice number	Oil, Gas and Salt Resources Library	221.00	214.52	-6.48
F005938	542483.6	4734211.2	7	model slice number	Oil, Gas and Salt Resources Library	229.24	212.58	-16.66
F005940	539278.7	4734201.5	7	model slice number	Oil, Gas and Salt Resources Library	217.26	208.46	-8.80
F005941	537701.3	4734180.3	7	model slice number	Oil, Gas and Salt Resources Library	221.27	212.57	-8.70
F005947	543867.3	4734303.1	7	model slice number	Oil, Gas and Salt Resources Library	225.20	217.17	-8.03
F005948	540326.8	4734155.1	7	model slice number	Oil, Gas and Salt Resources Library	191.78	206.88	15.10
F005949	538680.7	4734232.0	7	model slice number	Oil, Gas and Salt Resources Library	220.76	209.92	-10.84
F005950	537260.3	4734196.4	7	model slice number	Oil, Gas and Salt Resources Library	222.84	213.93	-8.91
F005954	541773.9	4734290.1	7	model slice number	Oil, Gas and Salt Resources Library	226.20	210.45	-15.75
F005955	536466.3	4734334.1	7	model slice number	Oil, Gas and Salt Resources Library	224.58	216.80	-7.78
F005956	536859.2	4734394.8	7	model slice number	Oil, Gas and Salt Resources Library	224.23	215.66	-8.57
F005964	541394.1	4734334.1	7	model slice number	Oil, Gas and Salt Resources Library	221.06	209.35	-11.71
F005965	540769.3	4734287.2	7	model slice number	Oil, Gas and Salt Resources Library	209.63	207.57	-2.06
F005966	535986.7	4734328.5	7	model slice number	Oil, Gas and Salt Resources Library	230.33	218.37	-11.96
F005967	535466.3	4734313.5	7	model slice number	Oil, Gas and Salt Resources Library	229.62	219.94	-9.68
F005968	534525.8	4734210.0	7	model slice number	Oil, Gas and Salt Resources Library	230.86	222.50	-8.36
F005977	538041.4	4734336.4	7	model slice number	Oil, Gas and Salt Resources Library	220.27	211.89	-8.38
F005984	534872.9	4734344.4	7	model slice number	Oil, Gas and Salt Resources Library	229.79	221.65	-8.14
F005989	539814.0	4734386.5	7	model slice number	Oil, Gas and Salt Resources Library	210.15	207.78	-2.37
F005990	539481.9	4734440.1	7	model slice number	Oil, Gas and Salt Resources Library	217.41	208.43	-8.98
F005995	538963.7	4734437.2	7	model slice number	Oil, Gas and Salt Resources Library	221.07	209.59	-11.48
F006006	542656.8	4734499.1	7	model slice number	Oil, Gas and Salt Resources Library	228.01	213.29	-14.72
F006007	537456.5	4734478.2	7	model slice number	Oil, Gas and Salt Resources Library	221.14	213.98	-7.16
F006013	541063.6	4734486.4	7	model slice number	Oil, Gas and Salt Resources Library	216.75	208.46	-8.29
F006014	540165.5	4734524.3	7	model slice number	Oil, Gas and Salt Resources Library	193.38	207.40	14.02
F006025	542046.9	4734618.8	7	model slice number	Oil, Gas and Salt Resources Library	225.68	211.35	-14.33
F006027	538385.8	4734535.7	7	model slice number	Oil, Gas and Salt Resources Library	222.13	211.31	-10.82
F006028	535744.7	4734533.9	7	model slice number	Oil, Gas and Salt Resources Library	230.38	219.55	-10.83
F006037	536073.6	4734655.9	7	model slice number	Oil, Gas and Salt Resources Library	231.36	218.77	-12.59
F006038	535192.2	4734574.2	7	model slice number	Oil, Gas and Salt Resources Library	231.07	221.18	-9.89
F006053	536768.8	4734715.1	7	model slice number	Oil, Gas and Salt Resources Library	223.18	216.67	-6.51
F006054	534658.0	4734593.1	7	model slice number	Oil, Gas and Salt Resources Library	231.25	222.60	-8.65
F006063	540823.6	4734700.9	7	model slice number	Oil, Gas and Salt Resources Library	205.31	207.84	2.53
F006064	539684.8	4734731.2	7	model slice number	Oil, Gas and Salt Resources Library	211.82	208.39	-3.43
F006065	538746.2	4734719.7	7	model slice number	Oil, Gas and Salt Resources Library	221.92	210.64	-11.28
F006069	541232.5	4734740.3	7	model slice number	Oil, Gas and Salt Resources Library	212.62	208.89	-3.73
F006079	537977.5	4733972.1	7	model slice number	Oil, Gas and Salt Resources Library	217.50	211.29	-6.21

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F006087	542656.9	4734860.0	7	model slice number	Oil, Gas and Salt Resources Library	227.35	213.34	-14.01
F006088	537239.2	4734739.2	7	model slice number	Oil, Gas and Salt Resources Library	221.54	215.22	-6.32
F006089	536411.3	4734836.6	7	model slice number	Oil, Gas and Salt Resources Library	225.55	218.06	-7.49
F006097	535577.4	4734807.6	7	model slice number	Oil, Gas and Salt Resources Library	230.60	220.49	-10.11
F006106	538406.8	4734847.4	7	model slice number	Oil, Gas and Salt Resources Library	221.40	211.84	-9.56
F006114	537567.7	4734916.8	7	model slice number	Oil, Gas and Salt Resources Library	222.32	214.56	-7.76
F006120	540003.8	4734976.8	7	model slice number	Oil, Gas and Salt Resources Library	210.73	207.92	-2.81
F006121	539083.8	4734900.6	7	model slice number	Oil, Gas and Salt Resources Library	218.88	209.99	-8.89
F006122	534513.1	4734934.8	7	model slice number	Oil, Gas and Salt Resources Library	233.62	223.15	-10.47
F006127	542330.7	4735049.3	7	model slice number	Oil, Gas and Salt Resources Library	225.07	212.16	-12.91
F006128	538049.5	4734934.9	7	model slice number	Oil, Gas and Salt Resources Library	222.72	213.09	-9.63
F006129	537801.0	4734652.8	7	model slice number	Oil, Gas and Salt Resources Library	222.33	213.29	-9.04
F006131	534456.2	4734940.7	7	model slice number	Oil, Gas and Salt Resources Library	234.09	223.25	-10.84
F006136	541619.5	4735023.3	7	model slice number	Oil, Gas and Salt Resources Library	220.44	209.89	-10.55
F006137	535926.6	4734957.4	7	model slice number	Oil, Gas and Salt Resources Library	231.30	219.74	-11.56
F006151	539637.4	4735061.0	7	model slice number	Oil, Gas and Salt Resources Library	211.73	208.76	-2.97
F006158	542952.9	4735139.5	7	model slice number	Oil, Gas and Salt Resources Library	228.59	214.43	-14.16
F006159	542016.6	4735118.3	7	model slice number	Oil, Gas and Salt Resources Library	222.95	211.08	-11.87
F006160	536873.8	4735064.2	7	model slice number	Oil, Gas and Salt Resources Library	224.16	217.03	-7.13
F006173	542616.1	4735211.4	7	model slice number	Oil, Gas and Salt Resources Library	229.49	213.10	-16.39
F006174	536671.3	4735097.1	7	model slice number	Oil, Gas and Salt Resources Library	223.83	217.73	-6.10
F006175	536280.4	4735104.3	7	model slice number	Oil, Gas and Salt Resources Library	227.49	218.93	-8.56
F006176	535357.5	4735133.4	7	model slice number	Oil, Gas and Salt Resources Library	231.92	221.47	-10.45
F006183	537718.5	4735195.3	7	model slice number	Oil, Gas and Salt Resources Library	223.66	214.62	-9.04
F006188	540498.0	4735198.7	7	model slice number	Oil, Gas and Salt Resources Library	191.04	206.91	15.87
F006189	537046.5	4736336.0	7	model slice number	Oil, Gas and Salt Resources Library	223.67	218.48	-5.19
F006194	539034.2	4735233.4	7	model slice number	Oil, Gas and Salt Resources Library	221.89	210.53	-11.36
F006195	538384.2	4735229.8	7	model slice number	Oil, Gas and Salt Resources Library	222.03	212.55	-9.48
F006208	535754.5	4735274.3	7	model slice number	Oil, Gas and Salt Resources Library	230.95	220.64	-10.31
F006209	534166.2	4735226.1	7	model slice number	Oil, Gas and Salt Resources Library	234.81	223.71	-11.10
F006221	539113.5	4735264.7	7	model slice number	Oil, Gas and Salt Resources Library	220.38	210.33	-10.05
F006235	540778.9	4735357.6	7	model slice number	Oil, Gas and Salt Resources Library	196.37	206.91	10.54
F006236	539806.3	4735339.6	7	model slice number	Oil, Gas and Salt Resources Library	211.63	208.44	-3.19
F006268	539444.8	4735362.2	7	model slice number	Oil, Gas and Salt Resources Library	216.96	209.44	-7.52
F006270	536140.3	4735381.2	7	model slice number	Oil, Gas and Salt Resources Library	229.17	219.75	-9.42
F006278	538041.8	4735511.7	7	model slice number	Oil, Gas and Salt Resources Library	223.10	214.13	-8.97
F006284	542796.0	4735511.7	7	model slice number	Oil, Gas and Salt Resources Library	229.41	213.66	-15.75
F006304	538409.8	4735538.4	7	model slice number	Oil, Gas and Salt Resources Library	222.94	212.95	-9.99
F006318	537689.1	4735589.9	7	model slice number	Oil, Gas and Salt Resources Library	224.14	215.41	-8.73
F006319	535562.0	4735584.8	7	model slice number	Oil, Gas and Salt Resources Library	232.76	221.42	-11.34
F006325	539990.9	4735636.8	7	model slice number	Oil, Gas and Salt Resources Library	211.74	207.85	-3.89
F006332	541249.6	4735690.5	7	model slice number	Oil, Gas and Salt Resources Library	211.27	207.84	-3.43

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F006333	540570.3	4735649.5	7	model slice number	Oil, Gas and Salt Resources Library	207.13	206.51	-0.62
F006334	539620.3	4735671.7	7	model slice number	Oil, Gas and Salt Resources Library	215.14	209.01	-6.13
F006335	535982.1	4735642.5	7	model slice number	Oil, Gas and Salt Resources Library	230.09	220.48	-9.61
F006344	536436.5	4735660.3	7	model slice number	Oil, Gas and Salt Resources Library	230.82	219.30	-11.52
F006353	540883.1	4735793.2	7	model slice number	Oil, Gas and Salt Resources Library	204.17	206.66	2.49
F006354	538806.3	4735747.3	7	model slice number	Oil, Gas and Salt Resources Library	221.35	211.87	-9.48
F006355	537365.7	4735708.5	7	model slice number	Oil, Gas and Salt Resources Library	225.71	216.62	-9.09
F006362	536922.6	4735715.4	7	model slice number	Oil, Gas and Salt Resources Library	225.89	217.98	-7.91
F006372	542732.6	4735838.3	7	model slice number	Oil, Gas and Salt Resources Library	224.08	213.08	-11.00
F006373	538037.9	4735789.3	7	model slice number	Oil, Gas and Salt Resources Library	223.94	214.58	-9.36
F006374	534965.6	4735782.3	7	model slice number	Oil, Gas and Salt Resources Library	233.06	222.74	-10.32
F006387	540248.7	4735854.2	7	model slice number	Oil, Gas and Salt Resources Library	211.95	207.07	-4.88
F006395	536860.0	4735930.9	7	model slice number	Oil, Gas and Salt Resources Library	227.63	218.47	-9.16
F006408	540586.4	4736010.5	7	model slice number	Oil, Gas and Salt Resources Library	206.95	206.57	-0.38
F006409	538325.7	4735951.3	7	model slice number	Oil, Gas and Salt Resources Library	222.45	213.84	-8.61
F006410	536323.6	4735962.0	7	model slice number	Oil, Gas and Salt Resources Library	232.02	219.97	-12.05
F006422	541940.4	4736077.2	7	model slice number	Oil, Gas and Salt Resources Library	213.13	209.45	-3.68
F006423	539863.9	4735984.7	7	model slice number	Oil, Gas and Salt Resources Library	214.95	208.14	-6.81
F006424	539447.7	4736037.8	7	model slice number	Oil, Gas and Salt Resources Library	218.10	209.73	-8.37
F006425	537714.2	4735991.1	7	model slice number	Oil, Gas and Salt Resources Library	224.92	215.96	-8.96
F006437	541067.8	4736075.0	7	model slice number	Oil, Gas and Salt Resources Library	208.82	206.90	-1.92
F006438	539091.1	4736020.3	7	model slice number	Oil, Gas and Salt Resources Library	221.72	211.10	-10.62
F006439	535807.7	4735962.4	7	model slice number	Oil, Gas and Salt Resources Library	229.60	221.19	-8.41
F006449	543462.7	4736105.1	7	model slice number	Oil, Gas and Salt Resources Library	224.42	216.62	-7.80
F006458	538692.9	4736104.5	7	model slice number	Oil, Gas and Salt Resources Library	217.42	212.72	-4.70
F006466	542714.4	4736217.6	7	model slice number	Oil, Gas and Salt Resources Library	230.25	212.61	-17.64
F006492	537415.2	4736217.7	7	model slice number	Oil, Gas and Salt Resources Library	222.30	217.24	-5.06
F006493	536674.7	4736176.7	7	model slice number	Oil, Gas and Salt Resources Library	229.24	219.30	-9.94
F006506	540321.4	4736255.7	7	model slice number	Oil, Gas and Salt Resources Library	211.77	207.09	-4.68
F006507	538038.0	4736193.4	7	model slice number	Oil, Gas and Salt Resources Library	224.13	215.19	-8.94
F006517	542841.2	4736292.5	7	model slice number	Oil, Gas and Salt Resources Library	232.95	213.19	-19.76
F006518	541348.3	4736277.2	7	model slice number	Oil, Gas and Salt Resources Library	211.13	207.29	-3.84
F006519	536185.8	4736242.0	7	model slice number	Oil, Gas and Salt Resources Library	227.46	220.58	-6.88
F006525	543197.6	4736337.9	7	model slice number	Oil, Gas and Salt Resources Library	219.06	215.05	-4.01
F006538	542513.5	4736370.6	7	model slice number	Oil, Gas and Salt Resources Library	212.51	211.67	-0.84
F006539	539718.8	4736326.2	7	model slice number	Oil, Gas and Salt Resources Library	216.92	208.79	-8.13
F006540	535606.2	4736260.6	7	model slice number	Oil, Gas and Salt Resources Library	230.96	221.83	-9.13
F006572	537743.7	4736413.8	7	model slice number	Oil, Gas and Salt Resources Library	225.03	216.48	-8.55
F006614	538491.0	4736464.2	7	model slice number	Oil, Gas and Salt Resources Library	220.64	213.96	-6.68
F006623	536700.1	4736528.5	7	model slice number	Oil, Gas and Salt Resources Library	225.57	219.63	-5.94
F006630	543180.1	4736606.1	7	model slice number	Oil, Gas and Salt Resources Library	225.89	215.21	-10.68
F006631	540101.3	4736584.5	7	model slice number	Oil, Gas and Salt Resources Library	216.09	207.85	-8.24

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F006643	541389.4	4736626.0	7	model slice number	Oil, Gas and Salt Resources Library	210.80	207.37	-3.43
F006654	540516.8	4736645.5	7	model slice number	Oil, Gas and Salt Resources Library	212.55	206.99	-5.56
F006659	537153.7	4736688.3	7	model slice number	Oil, Gas and Salt Resources Library	229.45	218.61	-10.84
F006688	539721.0	4736730.3	7	model slice number	Oil, Gas and Salt Resources Library	220.33	209.29	-11.04
F006699	540870.3	4736795.6	7	model slice number	Oil, Gas and Salt Resources Library	208.97	206.69	-2.28
F006709	536160.2	4736787.9	7	model slice number	Oil, Gas and Salt Resources Library	227.30	221.10	-6.20
F006740	540208.3	4736930.6	7	model slice number	Oil, Gas and Salt Resources Library	218.41	207.70	-10.71
F006741	538524.8	4736911.7	7	model slice number	Oil, Gas and Salt Resources Library	225.32	214.50	-10.82
F006749	541753.2	4736955.2	7	model slice number	Oil, Gas and Salt Resources Library	212.27	209.96	-2.31
F006757	541178.2	4736991.8	7	model slice number	Oil, Gas and Salt Resources Library	203.88	207.60	3.72
F006758	539208.5	4736958.7	7	model slice number	Oil, Gas and Salt Resources Library	220.44	211.92	-8.52
F006773	540609.7	4737062.5	7	model slice number	Oil, Gas and Salt Resources Library	217.09	206.85	-10.24
F006811	538859.4	4737215.9	7	model slice number	Oil, Gas and Salt Resources Library	224.85	213.72	-11.13
F006812	537859.7	4737210.3	7	model slice number	Oil, Gas and Salt Resources Library	228.46	217.14	-11.32
F006822	541449.0	4737298.8	7	model slice number	Oil, Gas and Salt Resources Library	210.92	210.00	-0.92
F006829	541112.4	4737355.4	7	model slice number	Oil, Gas and Salt Resources Library	209.18	208.61	-0.57
F006830	540067.6	4737293.7	7	model slice number	Oil, Gas and Salt Resources Library	221.07	208.35	-12.72
F006831	538513.6	4737291.1	7	model slice number	Oil, Gas and Salt Resources Library	226.91	215.09	-11.82
F006837	540133.5	4737300.3	7	model slice number	Oil, Gas and Salt Resources Library	220.90	208.06	-12.84
F006840	539002.7	4736374.6	7	model slice number	Oil, Gas and Salt Resources Library	216.97	211.85	-5.12
F006868	534527.6	4737479.7	7	model slice number	Oil, Gas and Salt Resources Library	233.25	223.42	-9.83
F006892	541519.7	4737623.1	7	model slice number	Oil, Gas and Salt Resources Library	211.88	211.63	-0.25
F006893	540720.4	4737562.8	7	model slice number	Oil, Gas and Salt Resources Library	193.87	207.28	13.41
F006903	538325.6	4737592.3	7	model slice number	Oil, Gas and Salt Resources Library	227.44	216.14	-11.30
F006919	541196.5	4737732.2	7	model slice number	Oil, Gas and Salt Resources Library	211.34	210.48	-0.86
F006946	535879.1	4737542.1	7	model slice number	Oil, Gas and Salt Resources Library	229.97	222.05	-7.92
F006952	535813.6	4737902.7	7	model slice number	Oil, Gas and Salt Resources Library	230.87	222.30	-8.57
F006966	541483.4	4737999.2	7	model slice number	Oil, Gas and Salt Resources Library	216.42	212.82	-3.60
F006967	539654.6	4738003.9	7	model slice number	Oil, Gas and Salt Resources Library	216.48	211.85	-4.63
F006968	536565.2	4737968.3	7	model slice number	Oil, Gas and Salt Resources Library	230.30	221.14	-9.16
F007001	539919.5	4738153.5	7	model slice number	Oil, Gas and Salt Resources Library	223.81	211.01	-12.80
F007002	536225.7	4738157.8	7	model slice number	Oil, Gas and Salt Resources Library	230.68	221.84	-8.84
F007035	540852.1	4738341.0	7	model slice number	Oil, Gas and Salt Resources Library	197.51	210.63	13.12
F007036	537458.3	4738321.7	7	model slice number	Oil, Gas and Salt Resources Library	223.26	219.53	-3.73
F007043	536142.6	4738407.2	7	model slice number	Oil, Gas and Salt Resources Library	231.73	222.11	-9.62
F007049	539121.1	4738343.3	7	model slice number	Oil, Gas and Salt Resources Library	231.15	214.65	-16.50
F007050	536631.1	4738391.3	7	model slice number	Oil, Gas and Salt Resources Library	229.34	221.34	-8.00
F007061	541941.8	4738455.5	7	model slice number	Oil, Gas and Salt Resources Library	219.48	216.17	-3.31
F007080	536909.8	4738516.1	7	model slice number	Oil, Gas and Salt Resources Library	231.35	220.94	-10.41
F007086	538667.9	4738550.5	7	model slice number	Oil, Gas and Salt Resources Library	233.11	216.52	-16.59
F007092	536318.5	4738654.9	7	model slice number	Oil, Gas and Salt Resources Library	230.47	222.04	-8.43
F007117	539236.6	4738800.4	7	model slice number	Oil, Gas and Salt Resources Library	233.49	215.20	-18.29

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F007118	536951.4	4738806.3	7	model slice number	Oil, Gas and Salt Resources Library	225.55	221.15	-4.40
F007119	535836.3	4738775.8	7	model slice number	Oil, Gas and Salt Resources Library	234.12	222.74	-11.38
F007125	541678.0	4738879.5	7	model slice number	Oil, Gas and Salt Resources Library	224.41	216.35	-8.06
F007127	540919.0	4738939.8	7	model slice number	Oil, Gas and Salt Resources Library	213.48	212.80	-0.68
F007132	540126.2	4738944.4	7	model slice number	Oil, Gas and Salt Resources Library	225.85	212.21	-13.64
F007135	540465.5	4739190.0	7	model slice number	Oil, Gas and Salt Resources Library	201.26	212.28	11.02
F007136	540566.6	4738993.2	7	model slice number	Oil, Gas and Salt Resources Library	199.85	211.43	11.58
F007159	537415.5	4739105.0	7	model slice number	Oil, Gas and Salt Resources Library	231.73	220.62	-11.11
F007162	543252.6	4739163.8	7	model slice number	Oil, Gas and Salt Resources Library	230.03	222.63	-7.40
F007164	536216.3	4739089.3	7	model slice number	Oil, Gas and Salt Resources Library	229.92	222.55	-7.37
F007167	539486.5	4739193.6	7	model slice number	Oil, Gas and Salt Resources Library	234.51	215.27	-19.24
F007173	536633.7	4739181.0	7	model slice number	Oil, Gas and Salt Resources Library	228.15	222.07	-6.08
F007197	540771.5	4739299.8	7	model slice number	Oil, Gas and Salt Resources Library	214.07	213.50	-0.57
F007198	540357.9	4739334.4	7	model slice number	Oil, Gas and Salt Resources Library	196.89	213.14	16.25
F007199	537932.1	4739339.1	7	model slice number	Oil, Gas and Salt Resources Library	230.61	219.86	-10.75
F007200	536588.3	4739424.4	7	model slice number	Oil, Gas and Salt Resources Library	233.40	222.41	-10.99
F007205	536969.1	4739327.7	7	model slice number	Oil, Gas and Salt Resources Library	229.48	221.73	-7.75
F007218	536305.0	4739484.6	7	model slice number	Oil, Gas and Salt Resources Library	234.45	222.83	-11.62
F007221	540245.3	4739558.9	7	model slice number	Oil, Gas and Salt Resources Library	196.64	214.12	17.48
F007229	539722.9	4739562.1	7	model slice number	Oil, Gas and Salt Resources Library	233.18	215.45	-17.73
F007236	539768.1	4739596.3	7	model slice number	Oil, Gas and Salt Resources Library	233.28	215.40	-17.88
F007247	538312.1	4739612.7	7	model slice number	Oil, Gas and Salt Resources Library	231.51	219.51	-12.00
F007248	536608.8	4739588.0	7	model slice number	Oil, Gas and Salt Resources Library	233.94	222.57	-11.37
F007255	535764.2	4739540.4	7	model slice number	Oil, Gas and Salt Resources Library	237.14	223.43	-13.71
F007263	540123.7	4739755.6	7	model slice number	Oil, Gas and Salt Resources Library	195.56	214.88	19.32
F007264	537226.1	4739693.1	7	model slice number	Oil, Gas and Salt Resources Library	232.54	221.80	-10.74
F007284	538979.1	4739742.9	7	model slice number	Oil, Gas and Salt Resources Library	233.38	218.11	-15.27
F007288	542478.2	4739883.9	7	model slice number	Oil, Gas and Salt Resources Library	228.88	221.73	-7.15
F007289	540732.0	4739833.2	7	model slice number	Oil, Gas and Salt Resources Library	221.80	215.37	-6.43
F007293	537729.4	4739850.1	7	model slice number	Oil, Gas and Salt Resources Library	231.59	221.19	-10.40
F007305	541698.6	4739980.9	7	model slice number	Oil, Gas and Salt Resources Library	228.81	219.08	-9.73
F007306	538107.6	4740037.2	7	model slice number	Oil, Gas and Salt Resources Library	232.21	220.87	-11.34
F007310	541244.0	4740046.0	7	model slice number	Oil, Gas and Salt Resources Library	226.82	217.53	-9.29
F007311	536926.6	4740058.6	7	model slice number	Oil, Gas and Salt Resources Library	238.38	222.77	-15.61
F007312	536626.2	4739316.6	7	model slice number	Oil, Gas and Salt Resources Library	229.72	222.24	-7.48
F007324	539608.5	4740104.3	7	model slice number	Oil, Gas and Salt Resources Library	230.50	217.19	-13.31
F007325	535634.2	4740079.5	7	model slice number	Oil, Gas and Salt Resources Library	241.70	224.02	-17.68
F007335	542290.0	4740194.3	7	model slice number	Oil, Gas and Salt Resources Library	226.96	221.70	-5.26
F007365	542632.8	4740230.3	7	model slice number	Oil, Gas and Salt Resources Library	228.32	222.88	-5.44
F007366	540239.1	4740231.3	7	model slice number	Oil, Gas and Salt Resources Library	232.58	215.85	-16.73
F007367	537495.5	4740259.1	7	model slice number	Oil, Gas and Salt Resources Library	236.30	222.28	-14.02
F007381	537145.4	4740334.3	7	model slice number	Oil, Gas and Salt Resources Library	239.34	222.88	-16.46

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F007386	541773.2	4740404.0	7	model slice number	Oil, Gas and Salt Resources Library	227.31	220.24	-7.07
F007397	543042.4	4740451.9	7	model slice number	Oil, Gas and Salt Resources Library	228.60	224.25	-4.35
F007398	541080.4	4740433.7	7	model slice number	Oil, Gas and Salt Resources Library	227.38	217.85	-9.53
F007399	540616.7	4740501.9	7	model slice number	Oil, Gas and Salt Resources Library	228.65	216.80	-11.85
F007400	538321.1	4740448.7	7	model slice number	Oil, Gas and Salt Resources Library	232.92	221.53	-11.39
F007401	536331.8	4740447.2	7	model slice number	Oil, Gas and Salt Resources Library	238.64	223.91	-14.73
F007408	535536.8	4740470.8	7	model slice number	Oil, Gas and Salt Resources Library	235.44	224.39	-11.05
F007415	539846.4	4740580.7	7	model slice number	Oil, Gas and Salt Resources Library	201.18	218.25	17.07
F007416	542419.2	4740617.7	7	model slice number	Oil, Gas and Salt Resources Library	230.10	223.12	-6.98
F007417	542051.4	4740593.8	7	model slice number	Oil, Gas and Salt Resources Library	226.31	221.68	-4.63
F007418	540359.6	4740481.0	7	model slice number	Oil, Gas and Salt Resources Library	230.55	216.51	-14.04
F007420	535257.0	4740565.0	7	model slice number	Oil, Gas and Salt Resources Library	234.23	224.52	-9.71
F007421	541347.3	4740620.4	7	model slice number	Oil, Gas and Salt Resources Library	226.09	219.20	-6.89
F007422	535892.7	4740599.1	7	model slice number	Oil, Gas and Salt Resources Library	238.02	224.36	-13.66
F007442	537715.1	4740793.9	7	model slice number	Oil, Gas and Salt Resources Library	237.84	223.05	-14.79
F007448	539531.7	4740822.6	7	model slice number	Oil, Gas and Salt Resources Library	234.29	220.69	-13.60
F007449	535368.7	4740768.4	7	model slice number	Oil, Gas and Salt Resources Library	234.65	224.64	-10.01
F007457	536182.0	4740859.7	7	model slice number	Oil, Gas and Salt Resources Library	237.90	224.46	-13.44
F007463	540891.1	4740950.8	7	model slice number	Oil, Gas and Salt Resources Library	225.34	219.10	-6.24
F007464	540032.7	4740964.3	7	model slice number	Oil, Gas and Salt Resources Library	219.55	219.76	0.21
F007476	542249.1	4740943.6	7	model slice number	Oil, Gas and Salt Resources Library	226.60	223.28	-3.32
F007485	540427.5	4741025.2	7	model slice number	Oil, Gas and Salt Resources Library	234.84	219.18	-15.66
F007495	536822.0	4740921.7	7	model slice number	Oil, Gas and Salt Resources Library	235.91	224.12	-11.79
F007497	541017.0	4741173.7	7	model slice number	Oil, Gas and Salt Resources Library	226.95	220.47	-6.48
F007498	537493.1	4741125.8	7	model slice number	Oil, Gas and Salt Resources Library	239.57	223.90	-15.67
F007499	535494.7	4741161.5	7	model slice number	Oil, Gas and Salt Resources Library	234.50	224.86	-9.64
F007504	541834.1	4741234.1	7	model slice number	Oil, Gas and Salt Resources Library	223.19	222.65	-0.54
F007507	537045.3	4741216.0	7	model slice number	Oil, Gas and Salt Resources Library	234.27	224.36	-9.91
F007508	535207.8	4741168.5	7	model slice number	Oil, Gas and Salt Resources Library	234.42	224.84	-9.58
F007520	536700.0	4741238.8	7	model slice number	Oil, Gas and Salt Resources Library	235.51	224.57	-10.94
F007521	536316.3	4741233.7	7	model slice number	Oil, Gas and Salt Resources Library	237.90	224.73	-13.17
F007526	537839.4	4741319.0	7	model slice number	Oil, Gas and Salt Resources Library	236.94	224.08	-12.86
F007544	537348.4	4741415.0	7	model slice number	Oil, Gas and Salt Resources Library	234.60	224.44	-10.16
F007546	536208.5	4741427.4	7	model slice number	Oil, Gas and Salt Resources Library	235.21	224.89	-10.32
F007550	541122.6	4741362.5	7	model slice number	Oil, Gas and Salt Resources Library	230.75	221.79	-8.96
F007551	538111.3	4741422.3	7	model slice number	Oil, Gas and Salt Resources Library	233.00	224.26	-8.74
F007557	541326.2	4741487.1	7	model slice number	Oil, Gas and Salt Resources Library	229.89	222.67	-7.22
F007566	536669.1	4741494.7	7	model slice number	Oil, Gas and Salt Resources Library	235.42	224.79	-10.63
F007571	541650.7	4741513.7	7	model slice number	Oil, Gas and Salt Resources Library	224.98	223.12	-1.86
F007584	536938.7	4741607.1	7	model slice number	Oil, Gas and Salt Resources Library	235.31	224.77	-10.54
F007609	537464.5	4741782.7	7	model slice number	Oil, Gas and Salt Resources Library	233.02	224.78	-8.24
F007619	536197.4	4741822.2	7	model slice number	Oil, Gas and Salt Resources Library	234.51	225.05	-9.46

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
F007631	535792.9	4741875.6	7	model slice number	Oil, Gas and Salt Resources Library	234.10	225.10	-9.00
F007644	537041.3	4741959.3	7	model slice number	Oil, Gas and Salt Resources Library	233.81	224.93	-8.88
F007693	536011.7	4742154.4	7	model slice number	Oil, Gas and Salt Resources Library	233.01	225.11	-7.90
F007716	536388.3	4742215.0	7	model slice number	Oil, Gas and Salt Resources Library	234.15	225.07	-9.08
F013555	536268.8	4738164.2	7	model slice number	Oil, Gas and Salt Resources Library	230.23	221.77	-8.46
F013644	541951.2	4736163.6	7	model slice number	Oil, Gas and Salt Resources Library	213.18	209.35	-3.83
N002829	536560.7	4737956.0	7	model slice number	Oil, Gas and Salt Resources Library	230.32	221.14	-9.18
N003727	540589.2	4738243.8	7	model slice number	Oil, Gas and Salt Resources Library	196.42	208.96	12.54
N003728	540332.4	4739028.9	7	model slice number	Oil, Gas and Salt Resources Library	200.96	211.34	10.38
S000003	540728.3	4735835.5	7	model slice number	Oil, Gas and Salt Resources Library	191.93	206.48	14.55
T000104	538560.9	4725140.9	7	model slice number	Oil, Gas and Salt Resources Library	188.36	197.10	8.74
T000105	542410.6	4735358.2	7	model slice number	Oil, Gas and Salt Resources Library	224.92	212.24	-12.68
T000111	534740.3	4728603.2	7	model slice number	Oil, Gas and Salt Resources Library	217.70	204.10	-13.60
T000120	538404.1	4725504.1	7	model slice number	Oil, Gas and Salt Resources Library	185.61	197.61	12.00
T000137	544762.1	4736916.5	7	model slice number	Oil, Gas and Salt Resources Library	233.94	220.93	-13.01
T000676	543437.9	4735421.7	7	model slice number	Oil, Gas and Salt Resources Library	228.19	216.51	-11.68
T000677	543625.5	4736442.2	7	model slice number	Oil, Gas and Salt Resources Library	222.85	217.35	-5.50
T000678	544208.8	4734516.9	7	model slice number	Oil, Gas and Salt Resources Library	228.82	218.50	-10.32
T000680	544946.4	4731720.9	7	model slice number	Oil, Gas and Salt Resources Library	225.03	217.60	-7.43
T001028	543948.8	4734713.9	7	model slice number	Oil, Gas and Salt Resources Library	228.29	217.90	-10.39
T001255	543508.0	4731717.5	7	model slice number	Oil, Gas and Salt Resources Library	223.52	214.56	-8.96
T001259	543802.2	4731900.9	7	model slice number	Oil, Gas and Salt Resources Library	226.30	215.30	-11.00
T001269	544102.3	4731513.3	7	model slice number	Oil, Gas and Salt Resources Library	225.09	216.08	-9.01
T002505	542701.0	4737278.7	7	model slice number	Oil, Gas and Salt Resources Library	224.32	215.24	-9.08
T002531	545303.4	4735407.4	7	model slice number	Oil, Gas and Salt Resources Library	232.54	221.29	-11.25
T002545	543002.3	4737425.5	7	model slice number	Oil, Gas and Salt Resources Library	225.98	216.79	-9.19
T002833	545335.3	4737128.9	7	model slice number	Oil, Gas and Salt Resources Library	234.48	221.72	-12.76
T002940	535979.8	4726475.0	7	model slice number	Oil, Gas and Salt Resources Library	206.41	199.72	-6.69
T003299	543753.5	4737914.6	7	model slice number	Oil, Gas and Salt Resources Library	233.26	220.38	-12.88
T003300	544811.6	4737992.3	7	model slice number	Oil, Gas and Salt Resources Library	229.43	222.69	-6.74
T003371	543295.9	4738778.5	7	model slice number	Oil, Gas and Salt Resources Library	228.85	221.68	-7.17
T004143	539977.7	4737129.7	7	model slice number	Oil, Gas and Salt Resources Library	220.83	208.64	-12.19
T004146	540608.6	4730686.5	7	model slice number	Oil, Gas and Salt Resources Library	212.84	204.83	-8.01
T004152	538425.5	4732700.6	7	model slice number	Oil, Gas and Salt Resources Library	216.69	207.51	-9.18
T004153	544259.2	4731674.4	7	model slice number	Oil, Gas and Salt Resources Library	225.40	216.42	-8.98
T004182	537313.3	4728027.8	7	model slice number	Oil, Gas and Salt Resources Library	206.62	202.03	-4.59
T004199	541946.1	4731388.5	7	model slice number	Oil, Gas and Salt Resources Library	217.60	208.50	-9.10
T004208	543462.7	4730685.3	7	model slice number	Oil, Gas and Salt Resources Library	224.07	215.12	-8.95
T004211	539198.8	4726634.4	7	model slice number	Oil, Gas and Salt Resources Library	203.44	200.32	-3.12
T004223	540083.1	4725599.9	7	model slice number	Oil, Gas and Salt Resources Library	205.18	200.15	-5.03
T004461	544288.7	4735225.0	7	model slice number	Oil, Gas and Salt Resources Library	230.38	219.44	-10.94
T004525	537228.1	4727507.3	7	model slice number	Oil, Gas and Salt Resources Library	203.48	200.83	-2.65

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
T004527	536648.4	4729137.5	7	model slice number	Oil, Gas and Salt Resources Library	215.40	205.03	-10.37
T004546	537960.7	4726266.9	7	model slice number	Oil, Gas and Salt Resources Library	191.08	198.73	7.65
T004553	537212.9	4728640.8	7	model slice number	Oil, Gas and Salt Resources Library	213.38	203.64	-9.74
T004558	536367.8	4725856.6	7	model slice number	Oil, Gas and Salt Resources Library	204.59	198.60	-5.99
T004568	538522.8	4725853.3	7	model slice number	Oil, Gas and Salt Resources Library	190.05	198.26	8.21
T004587	534919.9	4724581.8	7	model slice number	Oil, Gas and Salt Resources Library	204.82	196.58	-8.24
T004588	534665.1	4727594.2	7	model slice number	Oil, Gas and Salt Resources Library	213.77	202.52	-11.25
T004590	535104.0	4725514.3	7	model slice number	Oil, Gas and Salt Resources Library	206.72	198.52	-8.20
T004592	535924.3	4730329.9	7	model slice number	Oil, Gas and Salt Resources Library	218.39	208.31	-10.08
T004601	536389.6	4730770.9	7	model slice number	Oil, Gas and Salt Resources Library	217.19	208.65	-8.54
T004608	537387.3	4730887.3	7	model slice number	Oil, Gas and Salt Resources Library	208.23	207.34	-0.89
T004608A	537372.1	4730889.8	7	model slice number	Oil, Gas and Salt Resources Library	208.32	207.37	-0.95
T004609	537920.9	4731179.6	7	model slice number	Oil, Gas and Salt Resources Library	205.67	206.57	0.90
T004614	537652.0	4727375.4	7	model slice number	Oil, Gas and Salt Resources Library	188.69	200.49	11.80
T004679	537779.8	4727851.7	7	model slice number	Oil, Gas and Salt Resources Library	194.74	201.45	6.71
T004870	538351.4	4729260.8	7	model slice number	Oil, Gas and Salt Resources Library	194.56	203.94	9.38
T004872	539835.7	4726599.2	7	model slice number	Oil, Gas and Salt Resources Library	207.79	201.67	-6.12
T004874	535294.9	4726477.7	7	model slice number	Oil, Gas and Salt Resources Library	209.61	200.16	-9.45
T004874A	535301.7	4726465.4	7	model slice number	Oil, Gas and Salt Resources Library	209.53	200.13	-9.40
T004877	536600.2	4727924.9	7	model slice number	Oil, Gas and Salt Resources Library	212.01	202.09	-9.92
T004899	539705.7	4731351.0	7	model slice number	Oil, Gas and Salt Resources Library	188.16	202.31	14.15
T005535	542461.7	4737106.0	7	model slice number	Oil, Gas and Salt Resources Library	218.38	213.67	-4.71
T005540	544126.4	4736084.6	7	model slice number	Oil, Gas and Salt Resources Library	226.85	219.14	-7.72
T005558	542479.0	4737545.7	7	model slice number	Oil, Gas and Salt Resources Library	220.43	215.26	-5.17
T005905	543452.7	4734803.3	7	model slice number	Oil, Gas and Salt Resources Library	225.61	216.19	-9.42
T006118	544683.3	4731137.3	7	model slice number	Oil, Gas and Salt Resources Library	222.70	216.81	-5.89
T006140	544901.6	4731141.8	7	model slice number	Oil, Gas and Salt Resources Library	222.14	216.96	-5.18
T006245	542933.4	4736770.7	7	model slice number	Oil, Gas and Salt Resources Library	225.86	214.51	-11.35
T006256	538777.5	4727915.2	7	model slice number	Oil, Gas and Salt Resources Library	201.85	201.69	-0.16
T006279	539190.6	4727757.5	7	model slice number	Oil, Gas and Salt Resources Library	202.44	201.91	-0.53
T006348	543427.6	4737245.0	7	model slice number	Oil, Gas and Salt Resources Library	228.51	217.75	-10.76
T006356	539326.3	4728141.3	7	model slice number	Oil, Gas and Salt Resources Library	204.10	202.54	-1.56
T006409	539770.3	4728550.1	7	model slice number	Oil, Gas and Salt Resources Library	198.46	204.61	6.15
T006416	540201.4	4728352.7	7	model slice number	Oil, Gas and Salt Resources Library	205.84	206.19	0.35
T006440	542058.0	4736539.3	7	model slice number	Oil, Gas and Salt Resources Library	213.96	209.83	-4.13
T006562	534616.5	4738334.6	7	model slice number	Oil, Gas and Salt Resources Library	232.25	223.47	-8.78
T006610	543433.5	4732430.9	7	model slice number	Oil, Gas and Salt Resources Library	223.31	213.98	-9.33
T006611	543228.1	4732189.0	7	model slice number	Oil, Gas and Salt Resources Library	222.97	213.25	-9.72
T006613	540335.5	4728823.5	7	model slice number	Oil, Gas and Salt Resources Library	204.66	207.47	2.81
T006635	540790.8	4728660.6	7	model slice number	Oil, Gas and Salt Resources Library	208.05	209.41	1.36
T006736	544289.2	4732306.9	7	model slice number	Oil, Gas and Salt Resources Library	227.46	216.69	-10.77
T006843	544586.1	4734221.3	7	model slice number	Oil, Gas and Salt Resources Library	229.53	219.10	-10.43

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
T006938	539467.5	4727192.7	7	model slice number	Oil, Gas and Salt Resources Library	201.71	201.70	-0.01
T006961	540321.6	4729210.3	7	model slice number	Oil, Gas and Salt Resources Library	210.82	207.27	-3.55
T006982	542901.0	4735799.3	7	model slice number	Oil, Gas and Salt Resources Library	227.58	213.91	-13.67
T006985	540464.2	4729707.8	7	model slice number	Oil, Gas and Salt Resources Library	216.09	207.03	-9.06
T006991	544165.4	4738500.2	7	model slice number	Oil, Gas and Salt Resources Library	239.03	222.73	-16.30
T007050	544434.6	4733742.2	7	model slice number	Oil, Gas and Salt Resources Library	227.33	218.20	-9.13
T007066	541244.3	4728577.3	7	model slice number	Oil, Gas and Salt Resources Library	215.53	210.66	-4.87
T007107	541072.5	4728011.7	7	model slice number	Oil, Gas and Salt Resources Library	212.57	209.08	-3.49
T007137	538535.8	4726577.6	7	model slice number	Oil, Gas and Salt Resources Library	201.22	199.45	-1.77
T007167	543850.0	4734297.8	7	model slice number	Oil, Gas and Salt Resources Library	225.43	217.11	-8.32
T007208	538522.6	4727111.8	7	model slice number	Oil, Gas and Salt Resources Library	201.85	200.24	-1.61
T007253	538579.8	4730612.1	7	model slice number	Oil, Gas and Salt Resources Library	196.97	204.62	7.65
T007320	538366.9	4731014.4	7	model slice number	Oil, Gas and Salt Resources Library	208.46	205.36	-3.10
T007717	543498.5	4732943.5	7	model slice number	Oil, Gas and Salt Resources Library	219.66	214.45	-5.21
T008470	542945.9	4729088.9	7	model slice number	Oil, Gas and Salt Resources Library	223.29	214.81	-8.48
T008726	539419.6	4731404.5	7	model slice number	Oil, Gas and Salt Resources Library	199.78	203.01	3.23
T008727	540052.9	4731608.6	7	model slice number	Oil, Gas and Salt Resources Library	199.74	201.37	1.63
T008931	535409.2	4724103.1	7	model slice number	Oil, Gas and Salt Resources Library	202.38	195.67	-6.71
T008932	534228.0	4725941.8	7	model slice number	Oil, Gas and Salt Resources Library	208.51	199.85	-8.66
T009058	541658.6	4732456.0	7	model slice number	Oil, Gas and Salt Resources Library	216.33	206.96	-9.37
T009857	536268.3	4728743.7	7	model slice number	Oil, Gas and Salt Resources Library	215.14	204.31	-10.83
T009860	534573.4	4725141.5	7	model slice number	Oil, Gas and Salt Resources Library	206.45	198.00	-8.45
T009861	535132.0	4727183.2	7	model slice number	Oil, Gas and Salt Resources Library	208.75	201.58	-7.17
T009864	534975.0	4725828.3	7	model slice number	Oil, Gas and Salt Resources Library	207.49	199.14	-8.35
T009888	535688.7	4729968.4	7	model slice number	Oil, Gas and Salt Resources Library	217.30	207.73	-9.57
T009944	537381.1	4735384.7	7	model slice number	Oil, Gas and Salt Resources Library	224.57	216.03	-8.54
T009945	538715.0	4739059.8	7	model slice number	Oil, Gas and Salt Resources Library	233.61	217.34	-16.27
T009946	538412.3	4733443.9	7	model slice number	Oil, Gas and Salt Resources Library	220.75	209.02	-11.73
T009947	538727.4	4733609.2	7	model slice number	Oil, Gas and Salt Resources Library	213.57	208.53	-5.04
T009948	540346.3	4731666.7	7	model slice number	Oil, Gas and Salt Resources Library	205.69	201.40	-4.29
T009950	539300.6	4733152.8	7	model slice number	Oil, Gas and Salt Resources Library	215.80	206.18	-9.62
T010020	535349.0	4730675.0	7	model slice number	Oil, Gas and Salt Resources Library	219.62	209.84	-9.78
T010032	542253.6	4729789.8	7	model slice number	Oil, Gas and Salt Resources Library	220.23	212.84	-7.39
T010058	534094.1	4725202.6	7	model slice number	Oil, Gas and Salt Resources Library	207.56	198.52	-9.04
T010106	542266.0	4733308.5	7	model slice number	Oil, Gas and Salt Resources Library	224.76	210.77	-13.99
T010119	541945.2	4732562.9	7	model slice number	Oil, Gas and Salt Resources Library	220.36	208.21	-12.15
T010134	533940.0	4726643.5	7	model slice number	Oil, Gas and Salt Resources Library	210.54	201.31	-9.23
T011105	535679.4	4725197.6	7	model slice number	Oil, Gas and Salt Resources Library	207.70	197.84	-9.86
T011453	534785.2	4728639.5	7	model slice number	Oil, Gas and Salt Resources Library	217.20	204.14	-13.06
T011455	534762.0	4729266.5	7	model slice number	Oil, Gas and Salt Resources Library	216.22	206.10	-10.12
T011528	534480.4	4730410.1	7	model slice number	Oil, Gas and Salt Resources Library	221.02	210.10	-10.92
T011534	535409.0	4731743.1	7	model slice number	Oil, Gas and Salt Resources Library	225.33	212.84	-12.49

Observation Name	Easting	Northing	Z	Z Type	Data Group	Ground Surface Elevation (masl)	Simulated Hydraulic Head (masl)	Head Above Ground Surface (Simulated Head - Ground Surface Elevation) (m)
T011604	542231.2	4734194.2	7	model slice number	Oil, Gas and Salt Resources Library	231.84	211.78	-20.06
T011605	542382.4	4733925.0	7	model slice number	Oil, Gas and Salt Resources Library	226.10	212.02	-14.08
T011606	541061.4	4736489.1	7	model slice number	Oil, Gas and Salt Resources Library	195.98	206.63	10.65
T011607	540762.0	4736296.2	7	model slice number	Oil, Gas and Salt Resources Library	207.61	206.60	-1.01
T011613	540497.8	4732068.0	7	model slice number	Oil, Gas and Salt Resources Library	206.96	202.08	-4.88
T012078	539729.8	4738544.4	7	model slice number	Oil, Gas and Salt Resources Library	226.89	212.81	-14.08
T012094	538935.7	4737943.1	7	model slice number	Oil, Gas and Salt Resources Library	214.80	214.57	-0.23
T012095	540809.2	4735058.2	7	model slice number	Oil, Gas and Salt Resources Library	205.89	207.45	1.56
T012141	543575.1	4734163.9	7	model slice number	Oil, Gas and Salt Resources Library	224.60	216.11	-8.49
T012310	540240.3	4732357.5	7	model slice number	Oil, Gas and Salt Resources Library	201.17	202.09	0.92
T012311	540271.7	4732778.2	7	model slice number	Oil, Gas and Salt Resources Library	202.32	203.51	1.19
T012588	537024.2	4734984.8	7	model slice number	Oil, Gas and Salt Resources Library	223.90	216.40	-7.50
T012589	537921.4	4738793.1	7	model slice number	Oil, Gas and Salt Resources Library	232.31	219.01	-13.30
T012590	543473.8	4733552.6	7	model slice number	Oil, Gas and Salt Resources Library	218.70	215.10	-3.60
T012597	538240.3	4738233.4	7	model slice number	Oil, Gas and Salt Resources Library	222.75	217.29	-5.46