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MEETING NOTES

ISSUED FOR USE

MEETING TO DISCUSS PINE POINT GROUNDWATER QUALITY MODELING PPT PRESENTATION

MEETING TIME:	0800-1000 PDT	**DATE:**	October 12, 2012
LOCATION:	Teleconference	**EBA FILE:**	V15101007.004
ATTENDEES:	Anne Wilson – Environment Canada Nathan Richea– Aboriginal Affairs and Northern Development Canada Mark Wiseman – Avalon Rare Metals Inc. Colin Fyfe – EBA, A Tetra Tech Company Rick Hoos– EBA, A Tetra Tech Company		

The October 12, 2012, telecom meeting was held to discuss the results of the groundwater quality modeling conducted by EBA on the proposed Hydrometallurgical plant effluent, which will initially be directed to the historical L-37 mine pit for deposition of tailings solids, followed by the transfer of excess water to the former N-42 pit for exfiltration of the water into the Presqu'ile aquifer.

Approximately one week prior to the meeting, a copy of the presentation had been provided to all participants, but we understand that there were transmission issues and both Environment Canada (EC) and Aboriginal Affairs and Northern Development (AANDC) could not access the presentation until immediately prior to the meeting. A complete copy of the presentation is provided as Attachment 1 to these meeting notes.

Following a brief round of introductions, Mr. Colin Fyfe (Senior Hydrogeologist with EBA), led the group through the power point presentation. Questions were encouraged throughout the presentation.

A brief summary of the presentation, taken from the power point presentation follows:

The basic scope of the groundwater modeling work was to:

- Run an accepted 3D numerical contaminant transport model in conjunction with an existing 3D groundwater flow model.
- Existing groundwater flow model from the DAR was used as the basis of the study but inputs included representations of the planned water management practices for the site (change to new water source pit, revised concentrations, etc.).
- Develop a conservative estimate of the concentrations of magnesium and sulphate reporting to Great Slave Lake.

Magnesium and sulphate were selected for modeling as these were the only parameters remaining in the process effluent that were anticipated to be present in concentrations that were significantly higher than typical background values present in the groundwater of the Pine Point area.

The groundwater flow portion of the model was simulated using MODFLOW-2000. MODFLOW is an industry standard software package originally developed by the US Geological Survey. This model had been calibrated to observed conditions at the Pine Point site and was used for groundwater flow predictions made in the DAR. The contaminant transport simulation was modeled using MT3DMS v.5.2. MT3DMS is an industry standard "bolt on" module developed for use with MODFLOW.

The modeled scenario included:

- Extraction of water from J-44 at a rate of 95 m^3/hr for 20 years.
- Infiltration of water at N-42 at a rate of 76 m^3/hr for 20 years.
- After 20 years, infiltration at N-42 stopped; model run continued to 100 years and past the peak concentrations reaching Great Slave Lake.
- Initial magnesium concentration of 800 mg/L at N-42.
- Initial sulphate concentration of 4,500 mg/L at N-42.
- Model inputs are based on the most recent data provided by Avalon (i.e. concentrations and volumes).

There was some discussion on the current projected effluent quality and Avalon (M. Wiseman) agreed to provide a copy of the most recent effluent quality data generated for the Hydrometallurgical plant effluent to EC and AANDC.

AANDC had a question regarding the conflicting responses to AANDC's IRs that it raised at the technical session. It was clarified in (IR #21.5) that the general flow direction of groundwater had been based on 20 years of record from the site and information was presented in the DAR. EC requested current groundwater quality data for the Pine Point area. EBA provided all of the available groundwater quality reports during the course of the telecom. These reports have previously been provided to the MVEIRB and are on the MVEIRB project registry.

The modeling required several assumptions to be made due to a lack of site specific information. These assumptions included:

- Application of conservative boundary conditions, shown to be conservative by sensitivity analysis.
- Transport simulation conservative; no retardation considered. The transport model included no sorption, no precipitation and no chemical reactions. Thus the predicted transport model concentration reductions were representative entirely of dilution, without any other possible natural underground physico/chemical retardation or mitigation being considered.
- Due to the conservative assumptions employed the results presented represent an unlikely, worst case scenario.

Based on the modeling that was undertaken, the following are the main highlights as summarized in the presentation for each of magnesium and sulphate:

Magnesium

- Magnesium (attributable to the effluent) reaches Great Slave Lake at a concentration of 8 mg/L (C/Co = 1%) above background after a period of approximately 40 years.
- Magnesium concentration (attributable to the effluent) increases to 80 mg/L (C/Co = 10%) above background after a period of approximately 70 years. This occurs over a relatively short portion of Great Slave Lake.
- By year 80 the concentration of magnesium has decreased to 8 mg/L and remains at this level for the remainder of the simulation.
- Background concentrations of magnesium in the Presqu'ile aquifer vary from 15.7 to 96.5 mg/L (s=20.47 mg/L).
- The simulation indicates that for all but a 10 year period the magnesium concentration reporting to Great Slave Lake is considered to be indistinguishable from the natural variation within the Presqu'ile aquifer.
- Given the highly conservative assumptions applied to the model, it is considered unlikely that a detectable variation in magnesium levels reporting to Great Slave Lake will be observed.

Sulphate

- The simulation indicates that sulphate reaches Great Slave Lake at a concentration of 45 mg/L (C/Co = 1%) after a period of approximately 40 years.
- Sulphate concentration increases to 450 mg/L (C/Co = 10%) after a period of approximately 70 years over a relatively short portion of the receiving waters.
- By year 80 the concentration has decreased to 45 mg/L and remains at this level for the remainder of the simulation.
- Background concentrations of sulphate in the Presqu'ile aquifer vary from 9.9 to 1270 mg/L (s=288.46 mg/L).
- For all but a 10 year period the sulphate concentration reporting to Great Slave Lake is considered to be indistinguishable from the natural variation within the Presqu'ile aquifer.
- It is considered unlikely that a detectable variation in sulphate levels outside the natural range present within the Presqu'ile aquifer, will be observed reporting to Great Slave Lake.

AANDC asked if the modeled isopleths for the simulation for both magnesium and sulphate could be increased in later years of the model run. EBA indicated that this could be done but would require additional modeling work.

EC questioned whether these results would be representative of other parameters such as chloride, which are considerably more soluble than magnesium or sulphate and less likely to be precipitated out in the aquifer. Avalon initially indicated that the anticipated concentration of chloride in the effluent is near background concentrations. EBA indicated that the assumptions in the model, which were based entirely

on dilution/dispersion of effluent parameters in the groundwater, with no consideration of possible natural physico/chemical retardation or mitigation, were in effect being modeled to be acting in a similar manner to chloride.

General discussion occurred regarding installation of additional groundwater monitoring wells outside the assumed or modeled flow path to confirm model predictions during operations. As well, discussions occurred on the potential time required for groundwater to move downgradient from N-42 and what would be considered the Near-Field area. There was some discussion on the adaptive management strategy and options that would be considered if the measured concentrations differed from the modeled predictions during operations. Further, AANDC asked if there was some way to quantify the level of conservatism presumed in the modeled results; however, upon discussion of the modeling and the decision making process used to select inputs to the model, it was agreed that there was a fairly high degree of conservatism in the results.

Other general discussion and questions included:

- Could the infiltrated water float on top of the groundwater; similar to a hydrocarbon influx? EBA responded that the effluent will have a different (higher) density relative to the groundwater density, so will more likely sink within the groundwater layer.
- The question was raised whether cation exchange and precipitation would be expected to occur; this is possible and not included in the model, thus making the model very conservative. pH of groundwater is neutral to basic, so would be unlikely to have Fe soluble.
- Discussion of sampling locations and nearfield monitoring followed; EBA stated monitoring would start in the nearfield, and based on the results would influence the design of further monitoring farther downfield. EBA indicated that it would be useful to continue to monitor baseline (background) followed by nearfield plume definition first EBA felt that the nearfield distance would be close; 50-100 m would be appropriate.
- The aquifer variability was noted – because of this a reasonably long baseline program is warranted. The aquifer is very conductive, has poor quality water, and is connected to surface – given these factors, enough work must be done to understand seasonal variability.
- EC concurred with the last slide, stressing the need to monitor and refine the model with real-world data.

Following further general discussion on the overall results and recommendations included in the presentation, both EC and AANDC were satisfied with the information provided and the meeting ended.

EBA is producing a technical memo that details the assumptions and presents the results, for submission to AANDC, EC and the MVEIRB.

Avalon Rare Metals Inc.

Pine Point Groundwater Modeling

October 12th, 2012

creating & delivering | BETTER SOLUTIONS

Scope

- Run contaminant transport model with existing groundwater flow model.
- Existing groundwater flow model amended to be representative of the planned water management practices for the site.
- Develop a conservative estimate of the concentrations of Magnesium and Sulphate reporting to Great Slave Lake.
- Report the results.

Methodology

- An existing groundwater flow model for the Pine Point area was used as a basis for this study. This model had been calibrated to observed conditions at the Pine Point site and was used for groundwater flow predictions made in the DAR.
- The groundwater flow portion of the model was simulated using MODFLOW-2000. MODFLOW is an industry standard software package originally developed by the US Geological Survey.
- The contaminant transport simulation was modeled using MT3DMS v.5.2. MT3DMS is an industry standard “bolt on” module developed for use with MODFLOW.

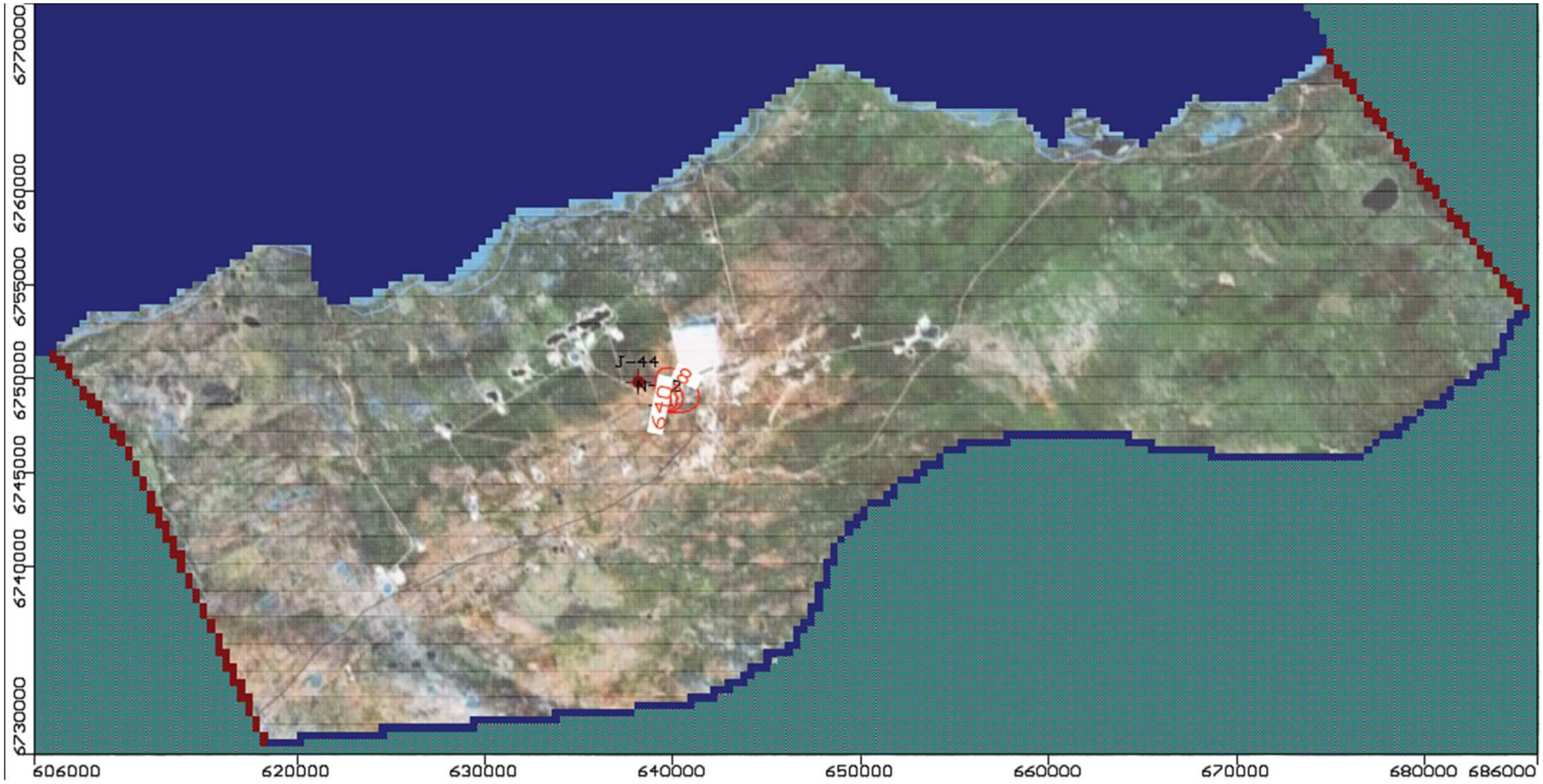
Modeled Scenario

- Extraction of water from J-44 at a rate of 95 m^3/hr for 20 years.
- Infiltration of water at N-42 at a rate of 76 m^3/hr for 20 years.
- After 20 years, infiltration at N-42 stopped; model run continued to 100 years and past the peak concentrations reaching Great Slave Lake.
- Initial Mg concentration of 800 mg/L at N-42.
- Initial Sulphate concentration of 4500 mg/L at N-42.
- Model inputs are based on the most recent data provided by Avalon.

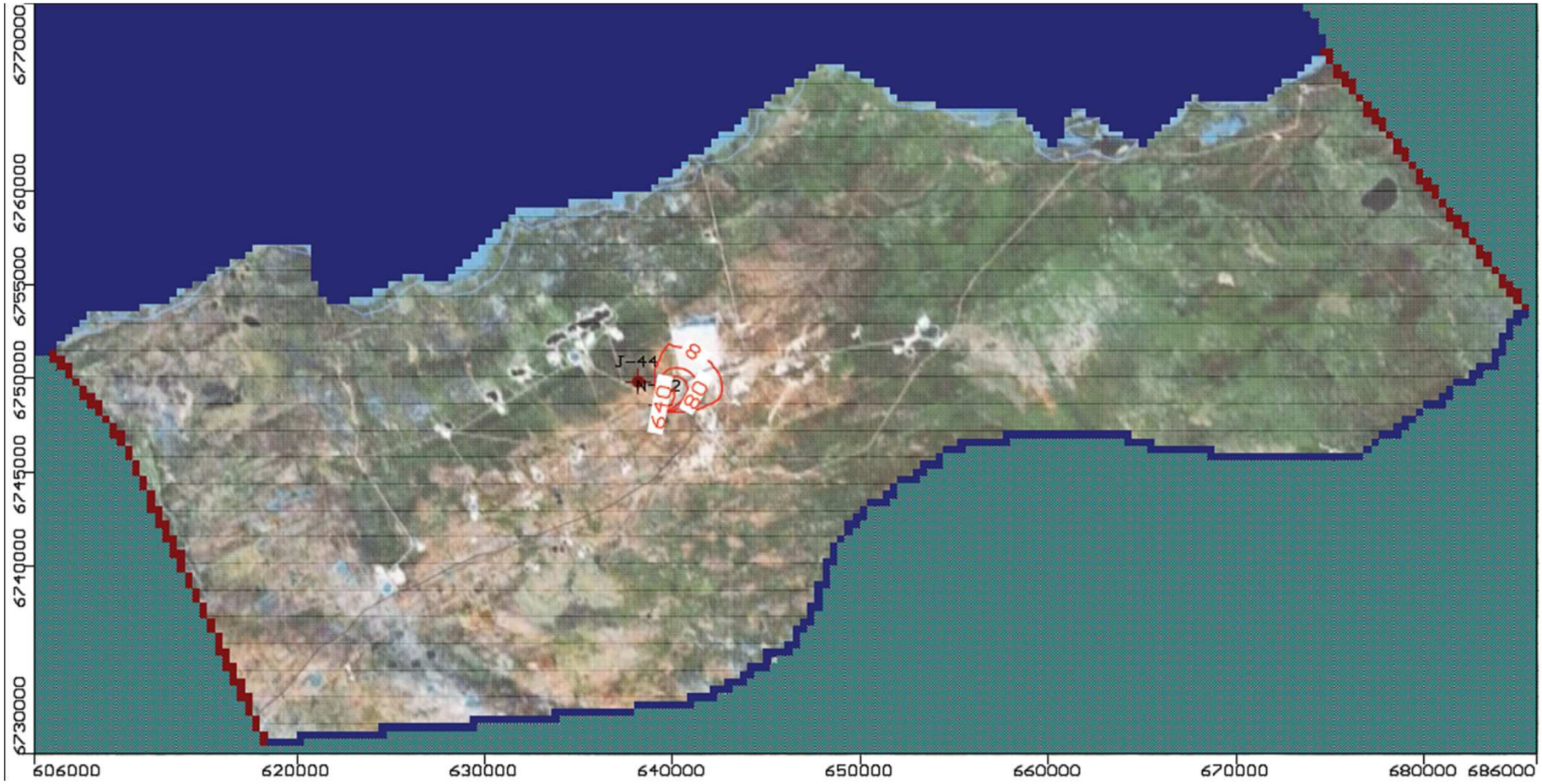
Modeling Assumptions

- Modeling required several assumptions to be made due to a lack of site specific information. In all cases assumptions used were conservative.
- Application of conservative boundary conditions, shown to be conservative by sensitivity analysis.
- Transport simulation conservative; no retardation considered. The transport model included no sorption, no precipitation and no chemical reactions. Transport model concentration reductions is purely dilution.
- Due to conservative assumptions results presented here represent an unlikely, worst case scenario.

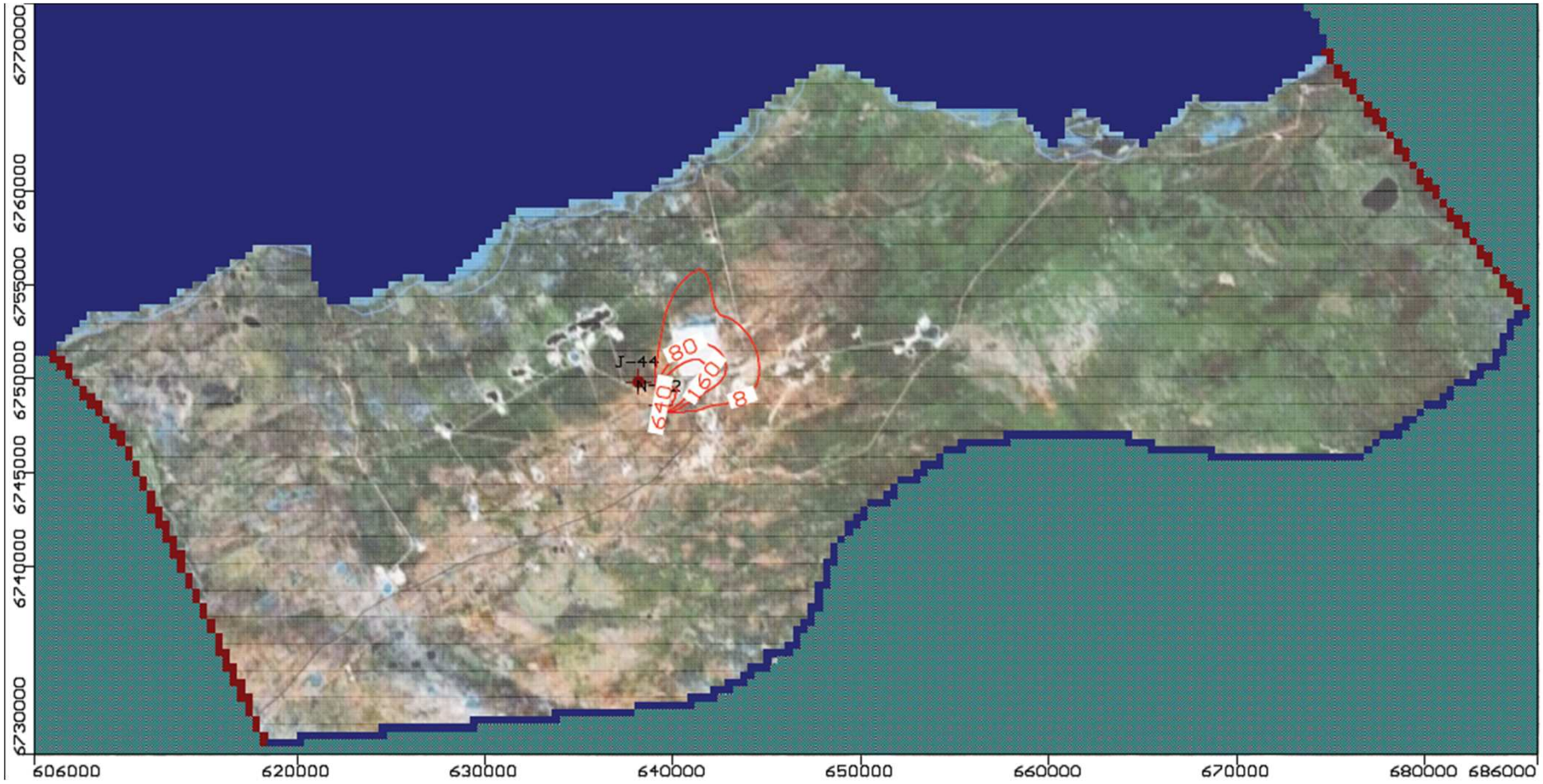
Magnesium Results – Year 5



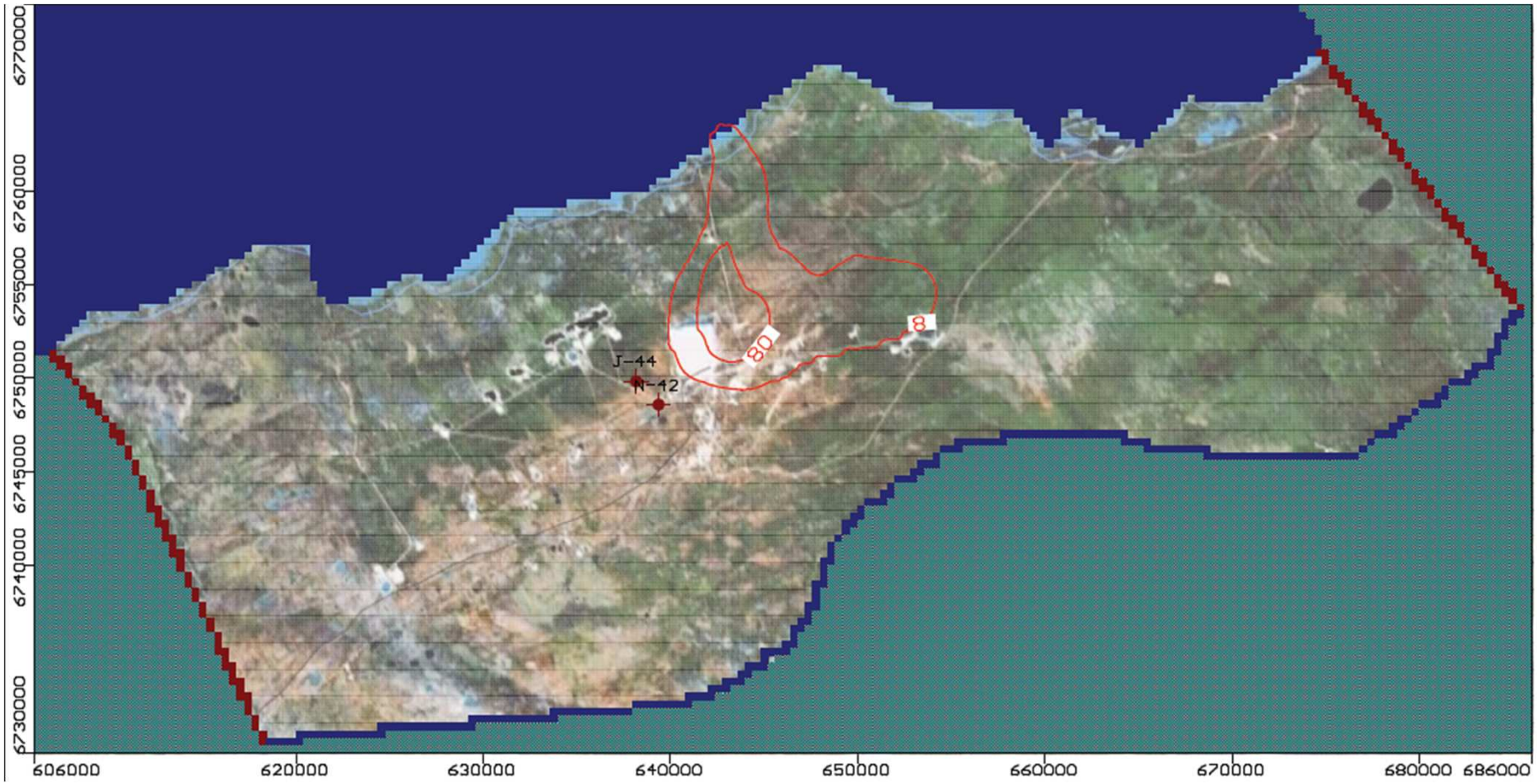
Magnesium Results – Year 10



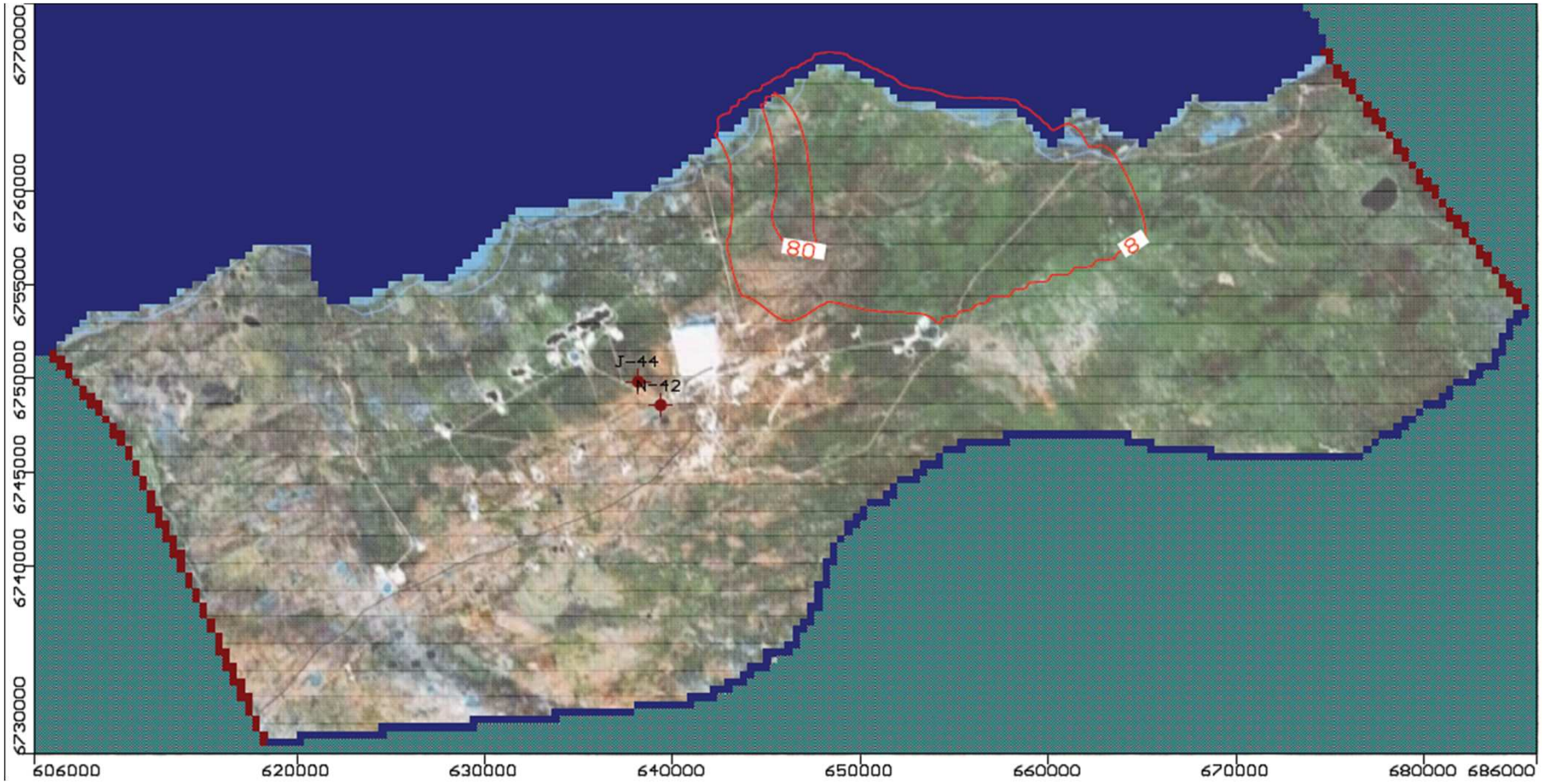
Magnesium Results – Year 20



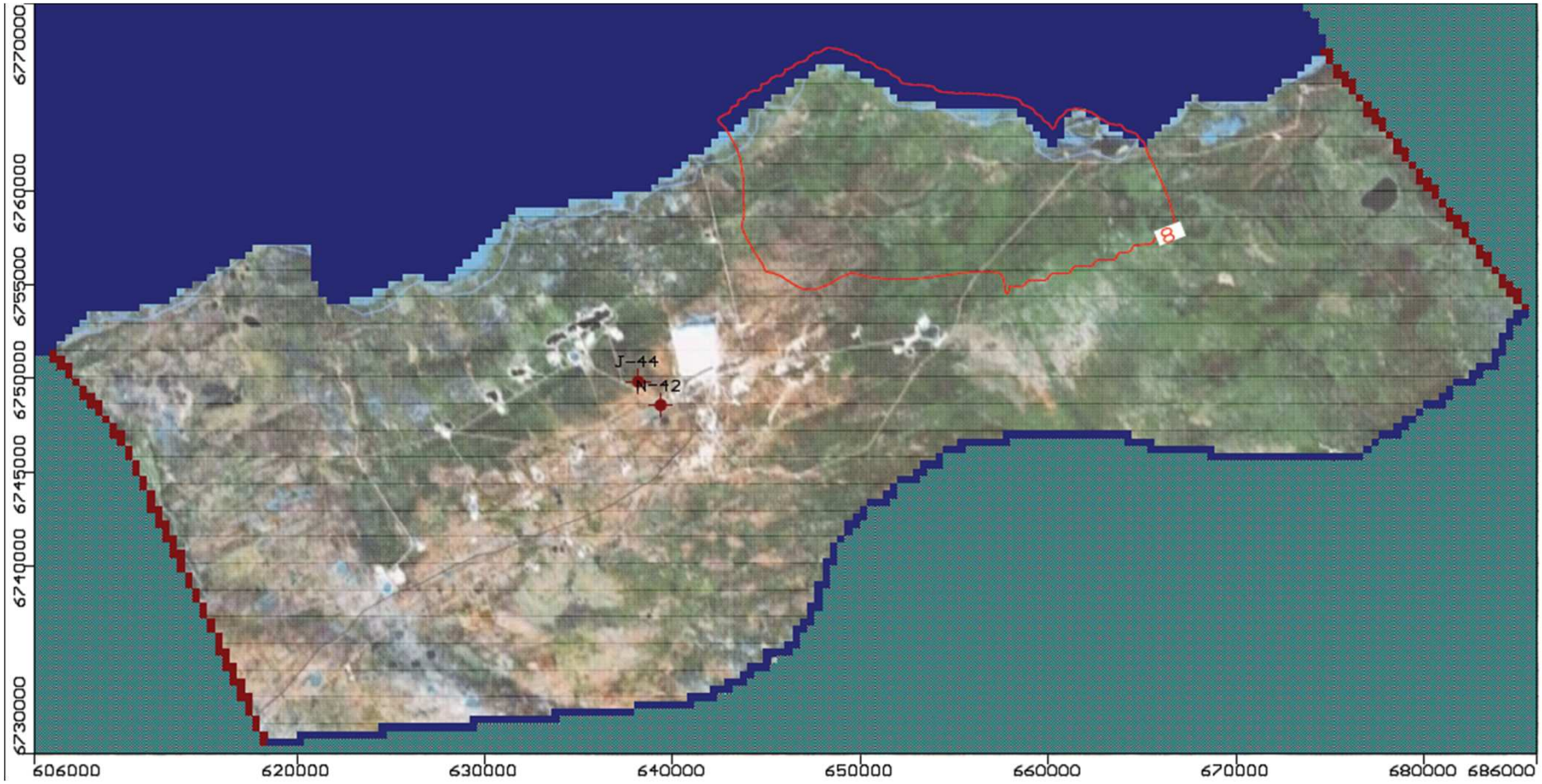
Magnesium Results – Year 40



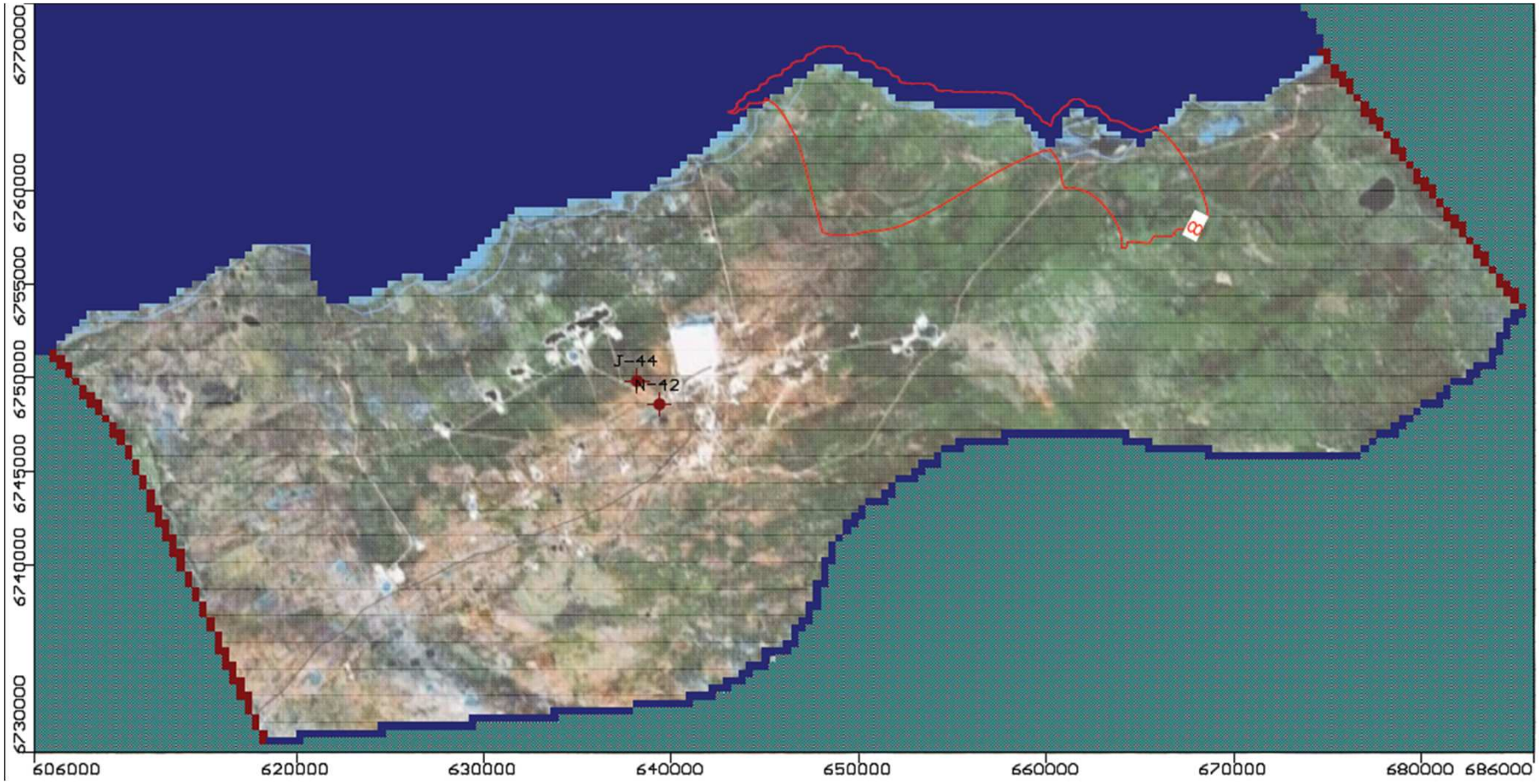
Magnesium Results – Year 70



Magnesium Results – Year 80



Magnesium Results – Year 100



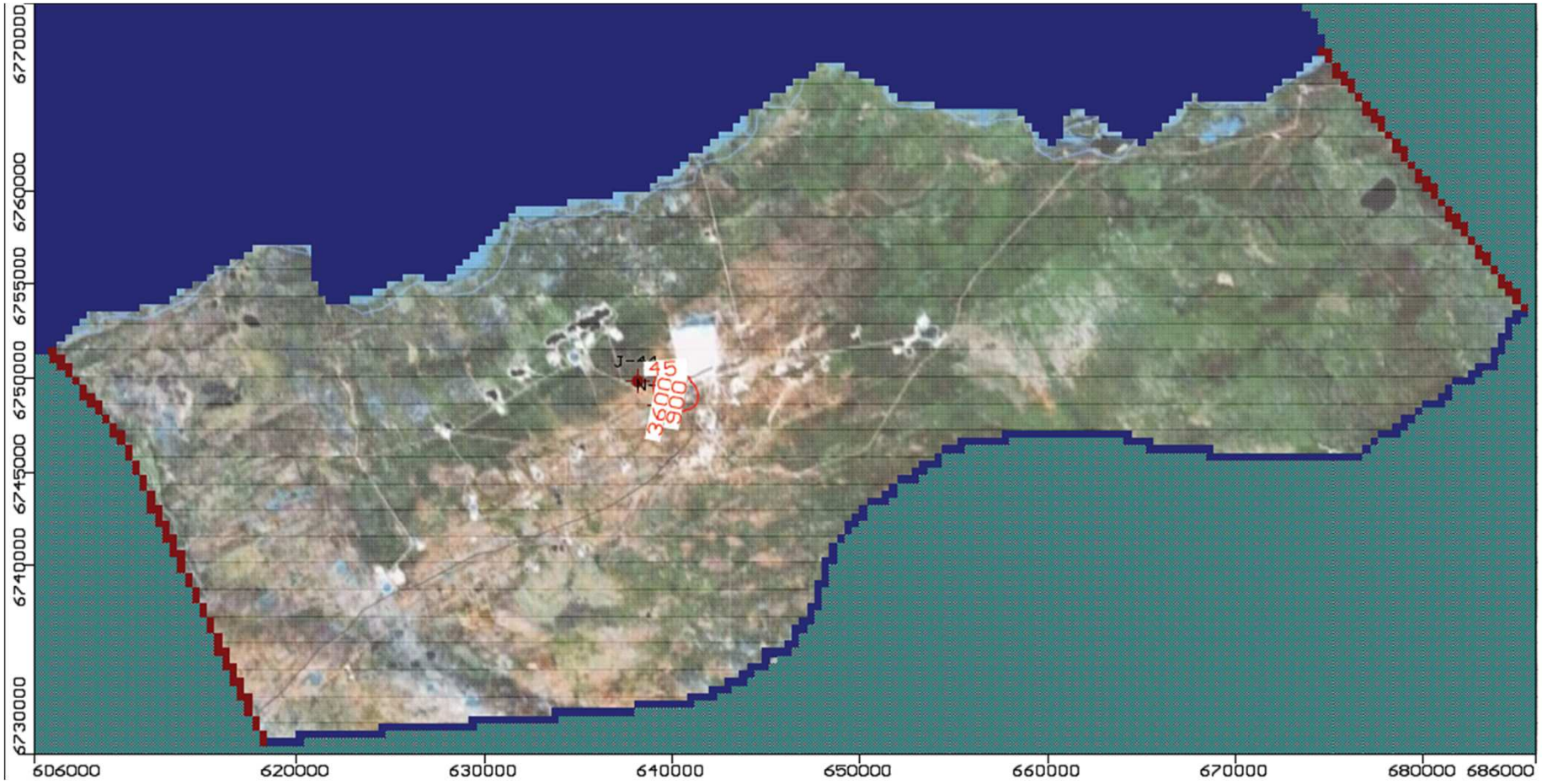
Summary of Magnesium Results

- Magnesium reaches Great Slave Lake at a concentration of 8 mg/L (C/Co = 1%) above background after a period of approximately 40 years.
- Magnesium concentration increases to 80 mg/L (C/Co = 10%) above background after a period of approximately 70 years. This occurs over a relatively short portion of Great Slave Lake.
- By year 80 the concentration has decreased to 8 mg/L and remains at this level for the remainder of the simulation.

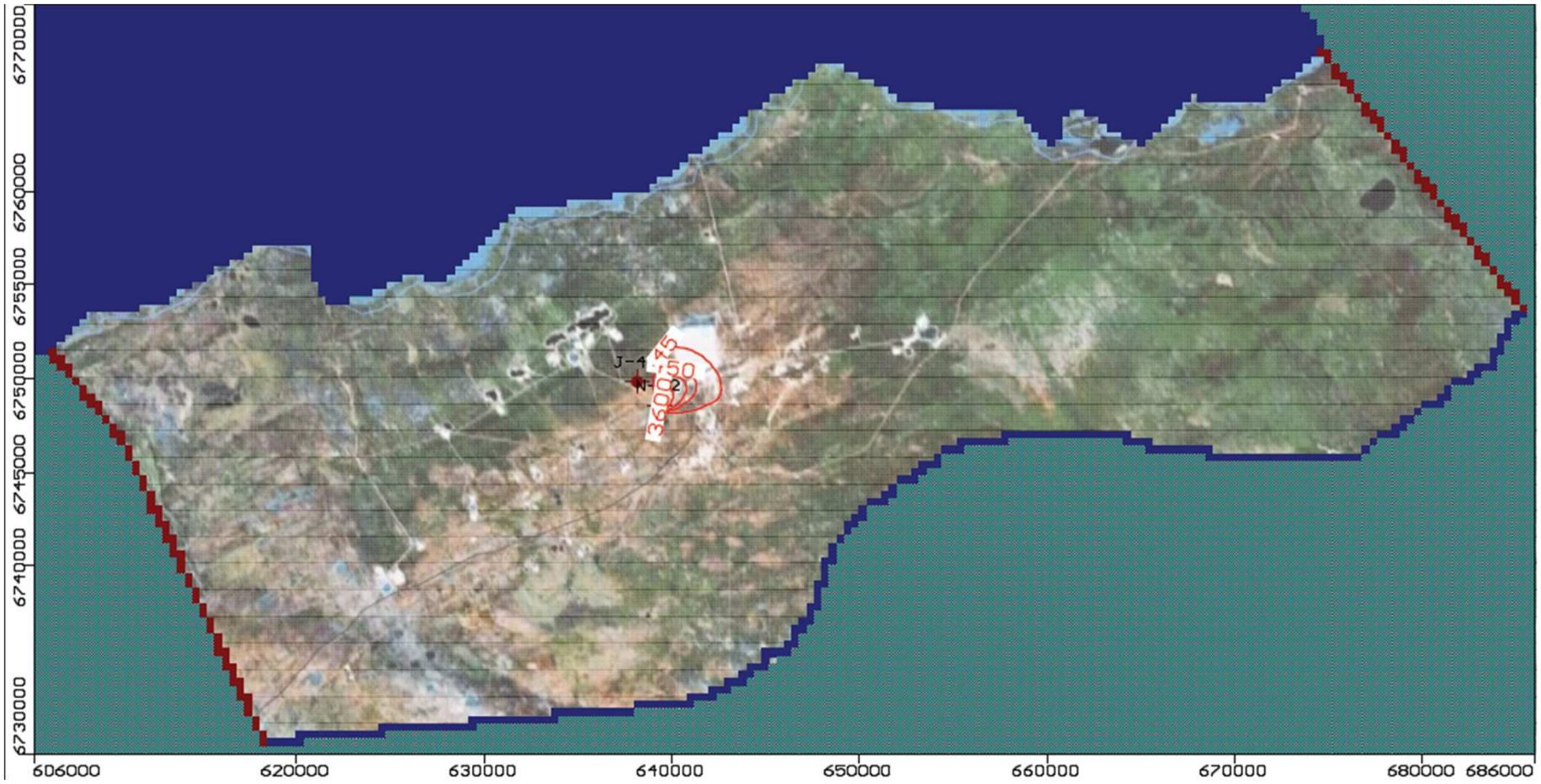
Summary of Magnesium Results

- Background concentrations of dissolved Magnesium in the Presqu'ile aquifer vary from 15.7 to 96.5 mg/L (s=20.47 mg/L).
- The simulation indicates that for all but a 10 year period the Magnesium concentration reporting to Great Slave Lake is considered to be indistinguishable from the natural variation within the Presqu'ile aquifer.
- Given the highly conservative assumptions applied to the model, it is considered unlikely that a detectable variation in Magnesium levels reporting to Great Slave Lake will be observed.

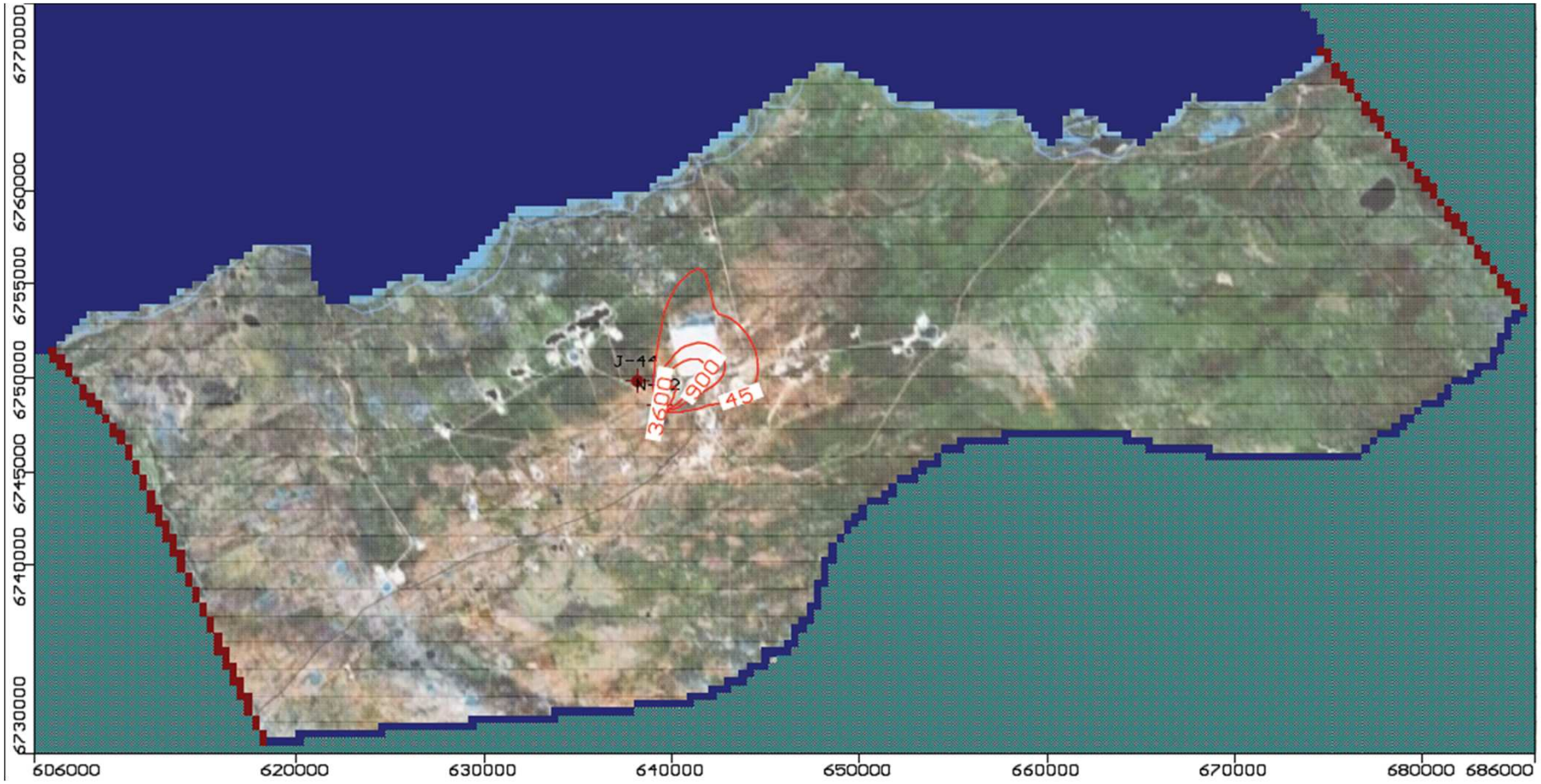
Sulphate Results – Year 5



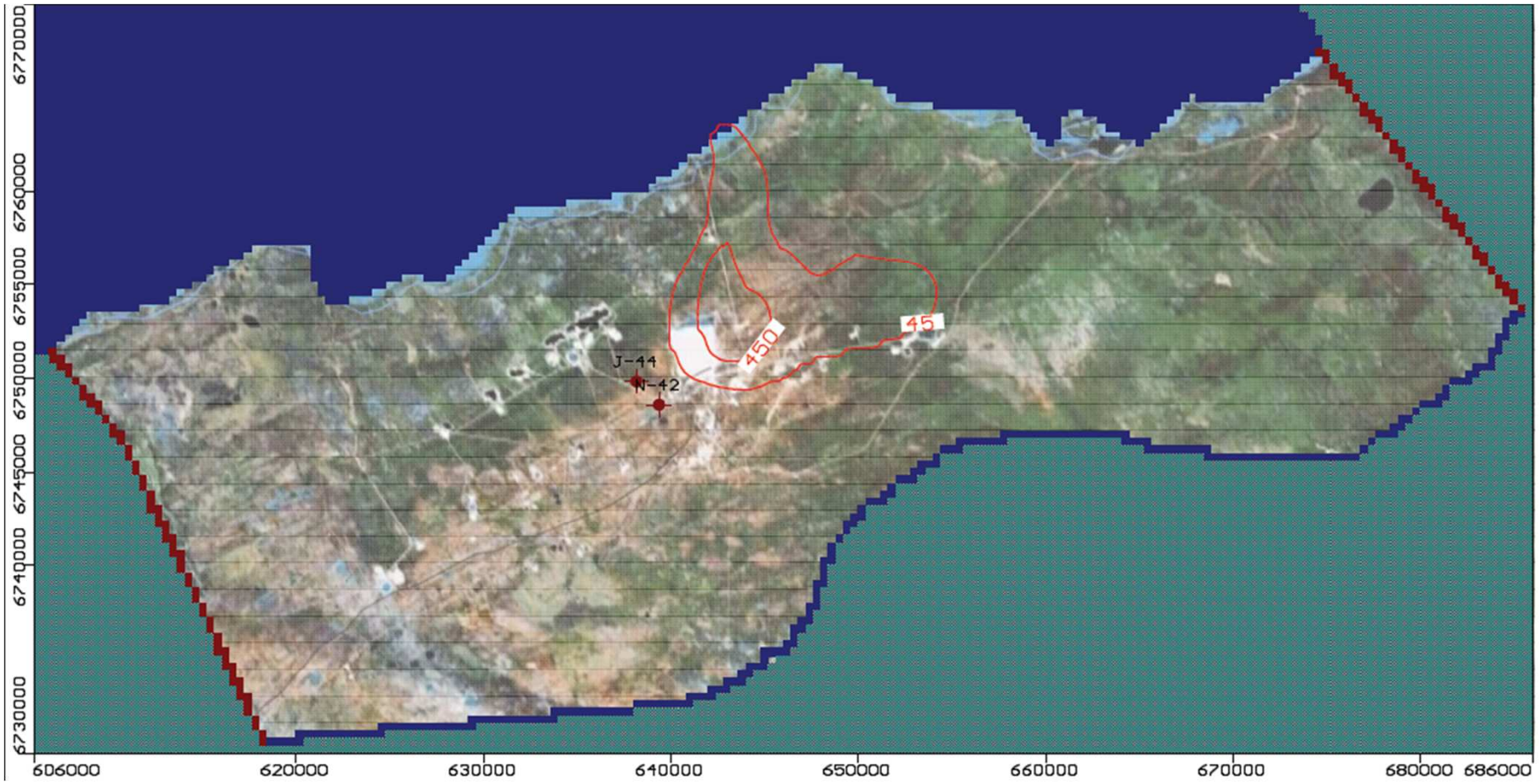
Sulphate Results – Year 10



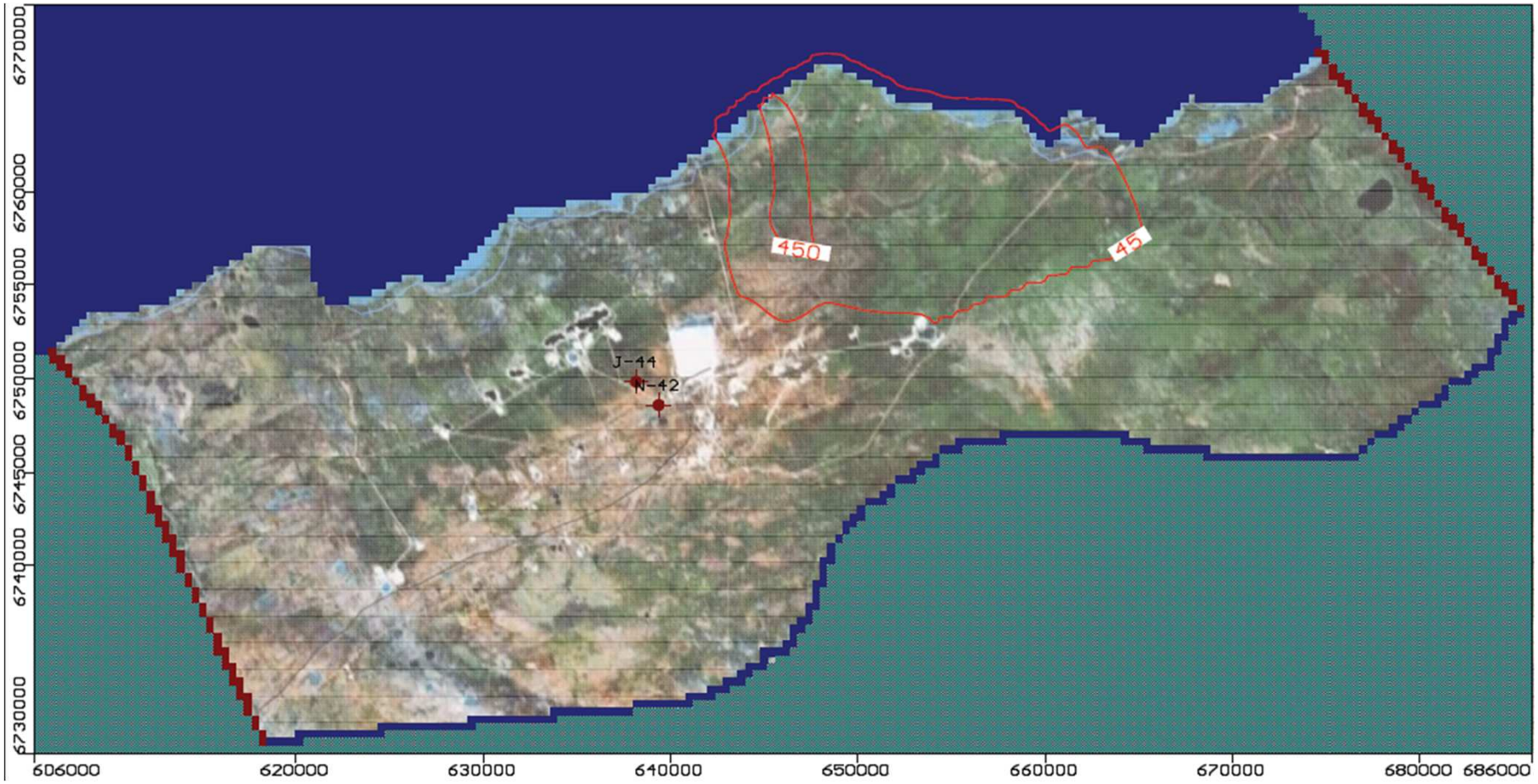
Sulphate Results – Year 20



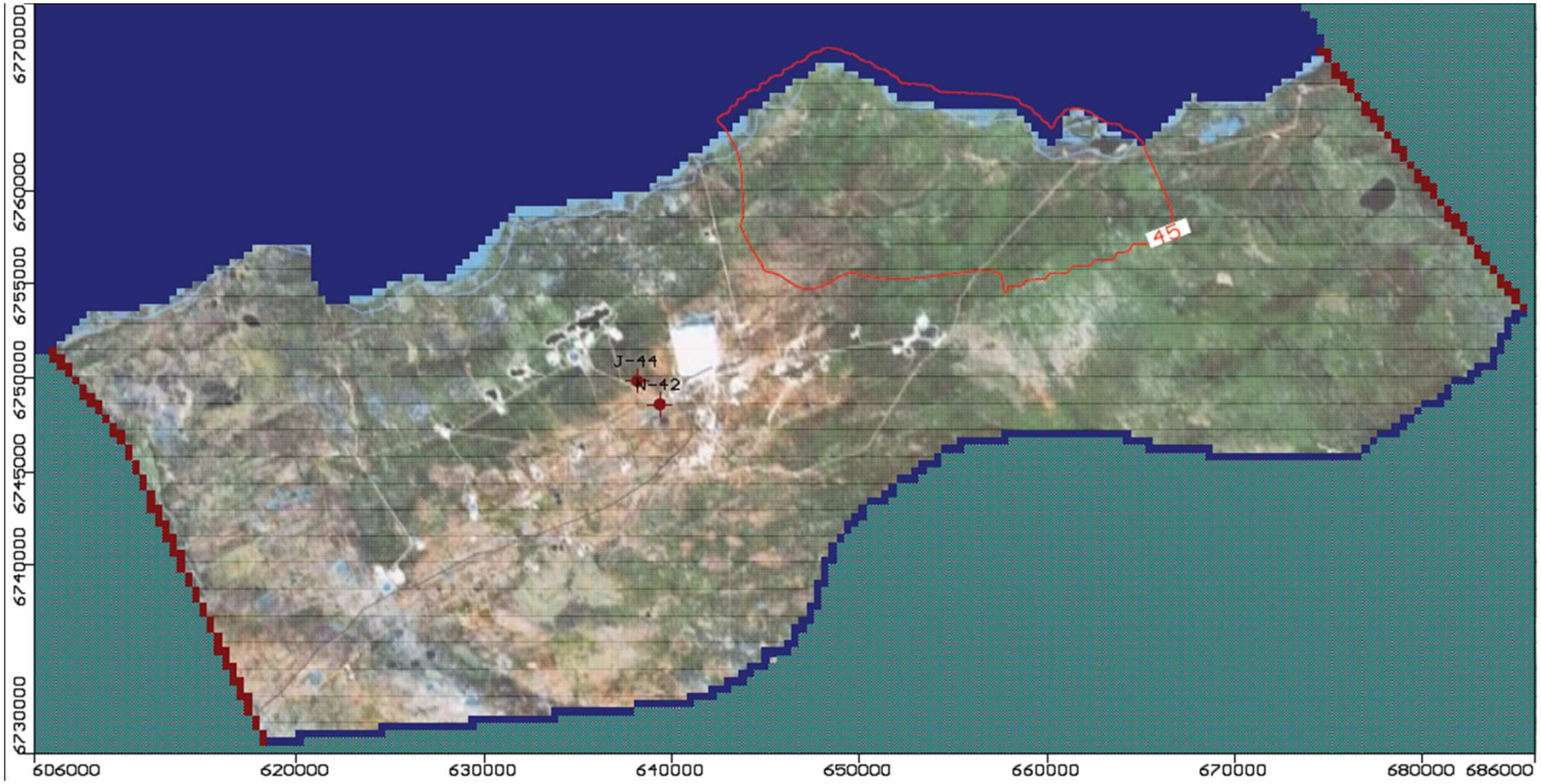
Sulphate Results – Year 40



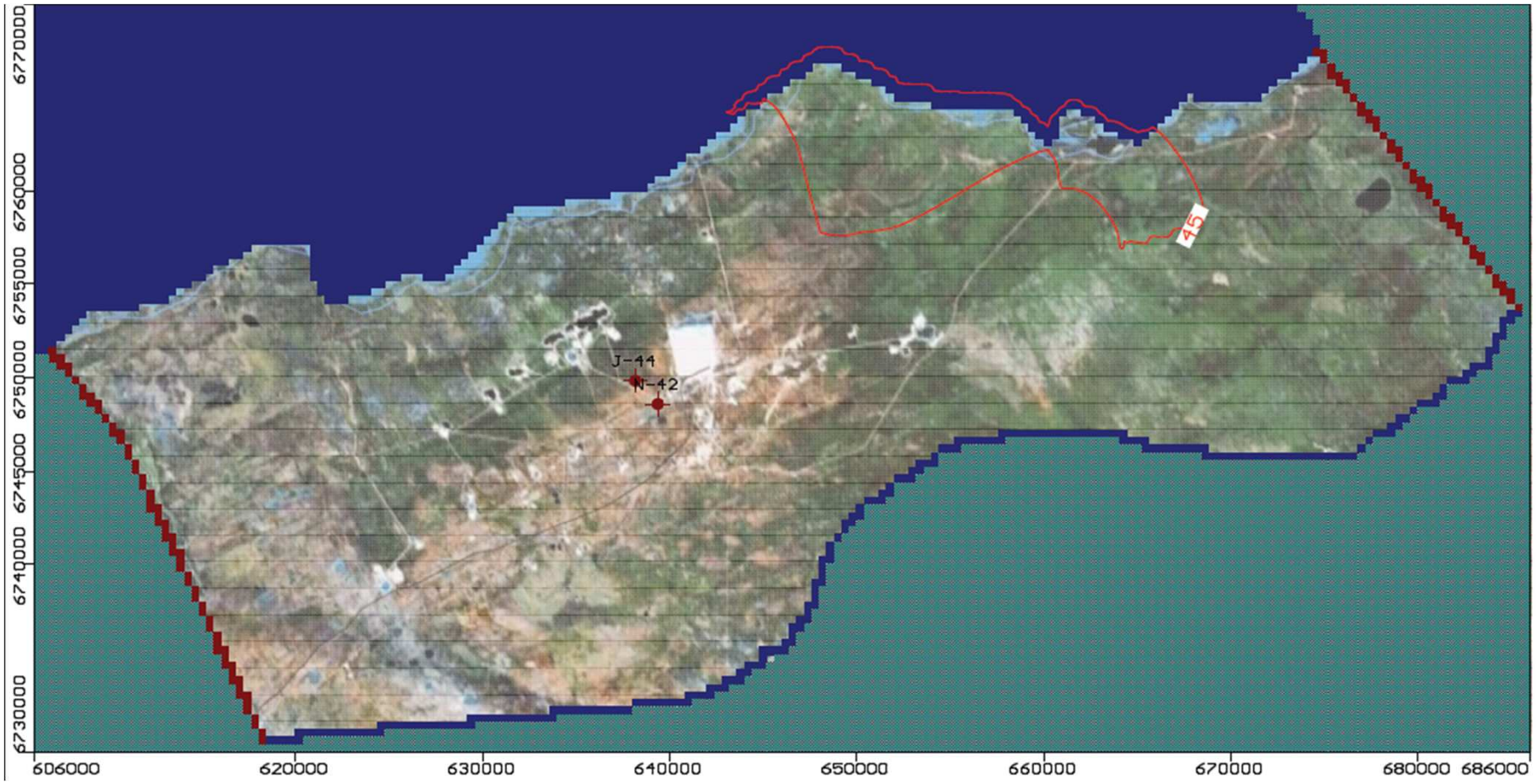
Sulphate Results – Year 70



Sulphate Results – Year 80



Sulphate Results – Year 100



Summary of Sulphate Results

- The simulation indicates that Sulphate reaches Great Slave Lake at a concentration of 45 mg/L (C/Co = 1%) after a period of approximately 40 years.
- Sulphate concentration increases to 450 mg/L (C/Co = 10%) after a period of approximately 70 years over a relatively short portion of the receiving waters.
- By year 80 the concentration has decreased to 45 mg/L and remains at this level for the remainder of the simulation.

Summary of Sulphate Results

- Background concentrations of Sulphate in the Presqu'ile aquifer vary from 9.9 to 1270 mg/L (s=288.46 mg/L).
- For all but a 10 year period the Sulphate concentration reporting to Great Slave Lake is considered to be indistinguishable from the natural variation within the Presqu'ile aquifer.
- It is considered unlikely that a detectable variation in Sulphate levels, outwith the natural range within the Presqu'ile aquifer, will be observed reporting to Great Slave Lake.

Conclusions

- It will not be possible to determine variations from the background Magnesium concentrations reporting to Great Slave Lake, for most of the modeling period, given the natural variation observed in the Presqu'ile aquifer.
- Variations in Sulphate concentrations reporting to Great Slave Lake will be within the naturally observed variation in the Presqu'ile aquifer for most of the modeling period.
- The model predicts that both Magnesium and Sulphate concentrations would increase to 10% of the initial concentration of the discharge for a relatively brief period, over a limited extent of Great Slave Lake.
- Given the very conservative assumptions applied to the modeling effort it is our opinion that statistically significant increases in Magnesium and Sulphate concentrations reporting to Great Slave Lake are unlikely to be observed.

Recommendations

- Installation of additional monitoring wells along the projected migration path prior to the commencement of operations.
- Groundwater quality monitoring at the new installations.
- Comparison of measured groundwater quality with modeling predictions.
- Reassessment of model predictions based on observed groundwater quality. Apply adaptive management measures if required.