Appendix I

Simple Model Description and Output Data

Table I-1
Descirption of changes to hydraulic conductivity zones for "simple" groundwater flow model

Unit	Description of change/simplification
Quaternary Sediments	Hydraulic conductivity of Quaternary sediments adjusted based on average sand percentage within each zone. Minimum and maximum horizontal hydraulic conductivity of the quaternary sediments were set as free parameters. For the vertical hydraulic conductivity of the quaternary sediments an anisotropy ratio of 0.01 was assumed. For zones where till and outwash are distinguished as a separate units, the horizontal and vertical hydraulic conductivity of the outwash were based on the pumping test conducted as part of this study and fixed at 88.4 m/day and 30.6 m/day respectively. The hydraulic conductivity of the till was fixed at 4.6 x 10^{-2} (assumed value, based on assumption that falling head permeameter tests are 3 orders of magnitude low (Anderson and Woessner, 1992).
St. Peter Sandstone	Horizontal hydraulic conductivity of all zones fixed at 0.3 m/day (geometric mean from specific capacity tests conducted on-site). Vertical Hydraulic Conductivity of all zones fixed at 3.0 x 10^{-3} m/day (Assumed an anisotropy ratio of 0.01).
Prairie du Chien Group	All horizontal hydraulic conductivity zones tied together and set as a free parameter during model calibration. Vertical hydraulic conductivity of all zones fixed at 3.8 x 10^{-2} m/day based on value calculated from pumping test at Rosemount wells 7, 8, & 9.
Jordan Sandstone	Horizontal hydraulic conductivity set at values based on pumping tests. For zones without an associated pumping test, horizontal hydraulic conductivity set at value of a neighboring zone. Vertical hydraulic conductivity set using an assumed anisotropy ratio of 0.1.
St. Lawrence Formation	Horizontal hydraulic conductivity for all zones set at 4.3 m/day (Runkel et al., 2003). Vertical hydraulic conductivity for all zones set at 3.0 x 10^{-6} m/day (Runkel et al., 2003).
Franconia Formation	Horizontal hydraulic conductivity for all zones set at 9.8 m/day (Runkel et al., 2003). Vertical hydraulic conductivity for all zones set at 0.98 m/day (assumed anisotropy ratio of 0.1).
Ironton and Galesville Sandstones	Horizontal hydraulic conductivity for all zones set at 3.3 m/day (Runkel et al., 2003). Vertical hydraulic conductivity for all zones set at 3.3 x 10^{-1} m/day (assumed anisotropy ratio of 0.1)
Eau Claire Formation	Horizontal hydraulic conductivity of all zones set at 0.03 m/day (Runkel et al., 2003). Vertical hydraulic conductivity for all zones set at 3.0x 10^{-4} m/day (Runkel et al., 2003)
Mt. Simon Sandstone	Horizontal hydraulic conductivity of all zones set at 12 m/day (Runkel et al., 2003). Vertical hydraulic conductivity for all zones set at 1.2 m/day (assumed anisotropy ratio of 0.1)

Table I-2
Optimized Model Hydraulic Conductivity Values
Simple Model

Zone	Horizontal K (m/day)	Vertical K (m/day)	Zone	Horizontal K (m/day)	Vertical K (m/day)	Zone	Horizontal K (m/day)	Vertical K (m/day)
1	4.60E-02	2.30E-02	**239**	1.87E+00	3.83E-02	**402**	4.30E+00	3.00E-06
15	8.84E+01	3.06E+01	**240**	1.87E+00	3.83E-02	**417**	4.30E+00	3.00E-06
16	4.56E-01	4.56E-03	**241**	1.87E+00	3.83E-02	**420**	4.30E+00	3.00E-06
20	7.57E-01	7.57E-03	**244**	1.87E+00	3.83E-02	**424**	4.30E+00	3.00E-06
21	4.12E-01	4.12E-03	**245**	1.87E+00	3.83E-02	**425**	4.30E+00	3.00E-06
23	5.04E-01	5.04E-03	**247**	1.87E+00	3.83E-02	**426**	4.30E+00	3.00E-06
25	8.84E+01	3.06E+01	**248**	1.87E+00	3.83E-02	**427**	4.30E+00	3.00E-06
26	8.84E+01	3.06E+01	**251**	1.87E+00	3.83E-02	**429**	4.30E+00	3.00E-06
29	8.84E+01	3.06E+01	**252**	1.87E+00	3.83E-02	**431**	4.30E+00	3.00E-06
30	3.20E-01	3.20E-03	**253**	1.87E+00	3.83E-02	**432**	4.30E+00	3.00E-06
34	5.04E-01	5.04E-03	**254**	1.87E+00	3.83E-02	**433**	4.30E+00	3.00E-06
35	7.19E-01	7.19E-03	**255**	1.87E+00	3.83E-02	**434**	4.30E+00	3.00E-06
45	1.19E+00	1.19E-02	**256**	1.87E+00	3.83E-02	**435**	4.30E+00	3.00E-06
49	1.39E+00	1.39E-02	**257**	1.87E+00	3.83E-02	**437**	4.30E+00	3.00E-06
53	1.62E+00	1.62E-02	**258**	1.87E+00	3.83E-02	**500**	9.80E+00	9.80E-01
56	1.46E+00	1.46E-02	**259**	1.87E+00	3.83E-02	**501**	9.80E+00	9.80E-01
74	5.87E-01	5.87E-03	**260**	1.87E+00	3.83E-02	**502**	9.80E+00	9.80E-01
77	3.04E-01	3.04E-03	**261**	1.87E+00	3.83E-02	**504**	9.80E+00	9.80E-01
81	8.84E+01	3.06E+01	**268**	1.87E+00	3.83E-02	**505**	9.80E+00	9.80E-01
82	7.19E-01	7.19E-03	**270**	1.87E+00	3.83E-02	**512**	9.80E+00	9.80E-01
83	5.58E-01	5.58E-03	**273**	1.87E+00	3.83E-02	**513**	9.80E+00	9.80E-01
101	3.00E-01	3.00E-03	**274**	1.87E+00	3.83E-02	**535**	9.80E+00	9.80E-01
104	3.00E-01	3.00E-03	**307**	4.85E+01	4.85E+00	**538**	9.80E+00	9.80E-01
108	3.00E-01	3.00E-03	**309**	1.65E+01	1.65E+00	**601**	3.30E+00	3.30E-01
109	3.00E-01	3.00E-03	**320**	2.30E+01	2.30E+00	**603**	3.30E+00	3.30E-01
110	3.00E-01	3.00E-03	**321**	2.30E+01	2.30E+00	**618**	3.30E+00	3.30E-01
111	3.00E-01	3.00E-03	**322**	2.30E+01	2.30E+00	**620**	3.30E+00	3.30E-01
112	3.00E-01	3.00E-03	**325**	4.06E+01	4.06E+00	**622**	3.30E+00	3.30E-01
113	3.00E-01	3.00E-03	**330**	8.59E+00	8.59E-01	**701**	3.00E-02	3.00E-04
114	3.00E-01	3.00E-03	**332**	8.59E+00	8.59E-01	**711**	3.00E-02	3.00E-04
115	3.00E-01	3.00E-03	**334**	8.89E+00	8.89E-01	**716**	3.00E-02	3.00E-04
133	3.00E-01	3.00E-03	**335**	8.59E+00	8.59E-01	**723**	3.00E-02	3.00E-04
134	3.00E-01	3.00E-03	**339**	4.85E+01	4.85E+00	**724**	3.00E-02	3.00E-04
137	3.00E-01	3.00E-03	**340**	4.85E+01	4.85E+00	**733**	3.00E-02	3.00E-04
138	3.00E-01	3.00E-03	**342**	2.30E+01	2.30E+00	**734**	3.00E-02	3.00E-04
139	3.00E-01	3.00E-03	**343**	9.30E+00	9.30E-01	**735**	3.00E-02	3.00E-04
140	3.00E-01	3.00E-03	**344**	1.65E+01	1.65E+00	**812**	1.20E+01	1.20E+00
141	3.00E-01	3.00E-03	**345**	7.59E+01	7.59E+00	**818**	1.20E+01	1.20E+00
142	3.00E-01	3.00E-03	**346**	9.40E+00	9.40E-01	**819**	1.20E+01	1.20E+00
143	3.00E-01	3.00E-03	**347**	9.40E+00	9.40E-01	**823**	1.20E+01	1.20E+00
144	3.00E-01	3.00E-03	**352**	8.59E+00	8.59E-01	**824**	1.20E+01	1.20E+00
201	1.87E+00	3.83E-02	**358**	1.65E+01	1.65E+00	**825**	1.20E+01	1.20E+00
206	1.87E+00	3.83E-02	**359**	9.40E+00	9.40E-01	**827**	1.20E+01	1.20E+00
225	1.87E+00	3.83E-02	**360**	9.40E+00	9.40E-01			
238	1.87E+00	3.83E-02	**401**	4.30E+00	3.00E-06			

Table I-3
Simple Model
Baseflow Calibration Targets

Baseflow Reach Number	Reach Description	Estimated Baseflow	Model Simulated Net Baseflow
		cfs	cfs
1012[2]	Minnesota and Mississippi Rivers: USGS Fort Snelling and Model edge to USGS St. Paul	14.4	9.1
1013[2]	Mississippi River: USGS St. Paul to model edge	439.7	54.3
1025[2]	Minnesota River: Edge of model to USGS Fort Snelling	0.5	6.6
1081[2]	Vermillion River: VR809 to SC804	8.9	-0.3
1082[2]	Vermillion River: South Creek and SC804 to CHP1	8.7	4.9
1083[1]	Vermillion River: Middle Creek, CHP1, and CHP2 to BSC2	7.99 - 15.22	9.9
1084[1]	Vermillion River: BSC2 to USGS Empire	17.5 - 22.7	14.6
1085[2]	Vermillion River: USGS Empire to VR803	4.7	15.4
1087[1]	Vermillion River: North Creek Beginning to CHP2	1.3 - 4.3	-1.3

[1] Baseflow estimates from EOR (2007)
[2] Estimates based off those established for the Metro Model 2 (Metropolitan Council, 2008)

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Figure I-1
Observed vs. Computed Hydraulic Head Values
Simple Model
Measurements taken as part of this study

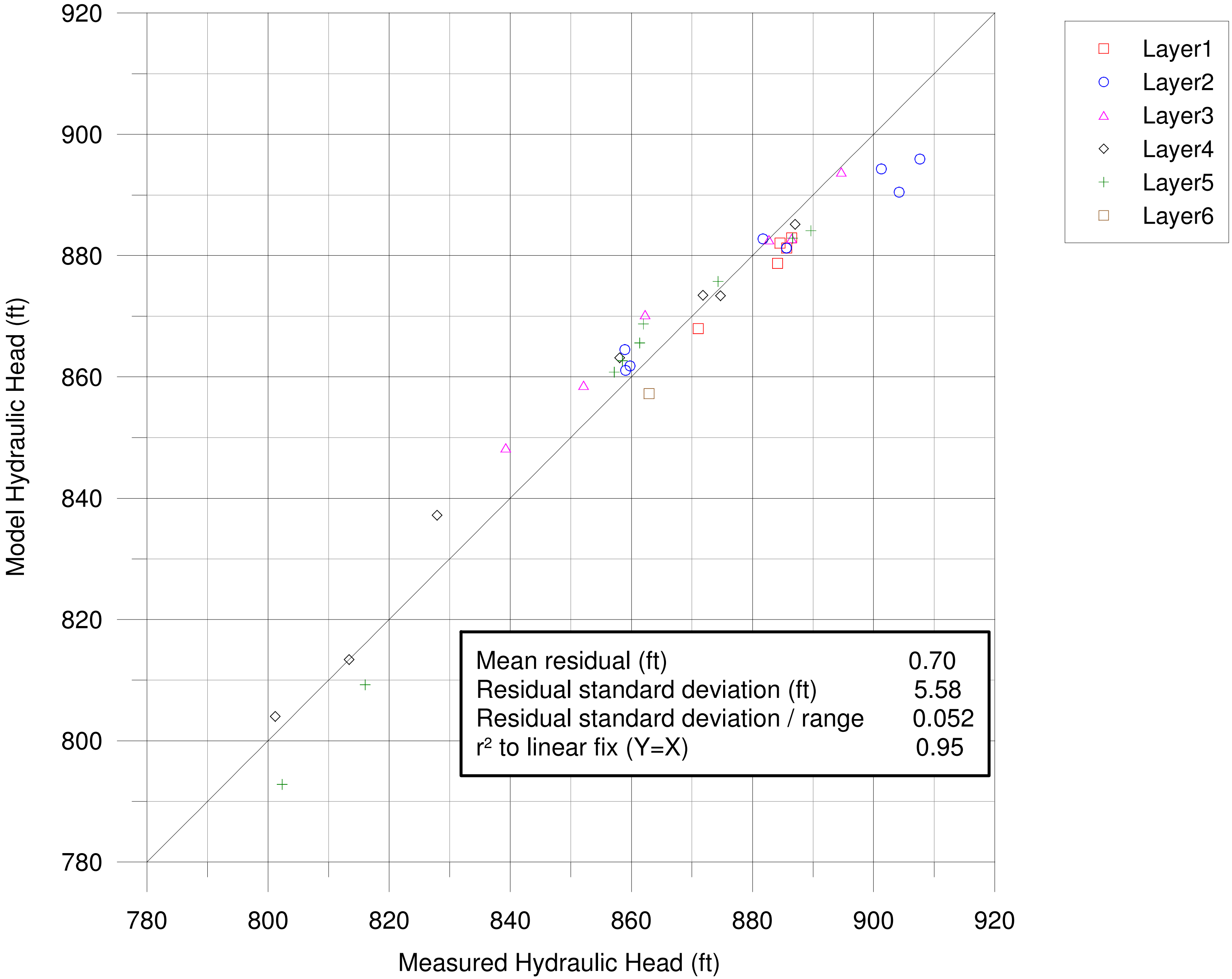
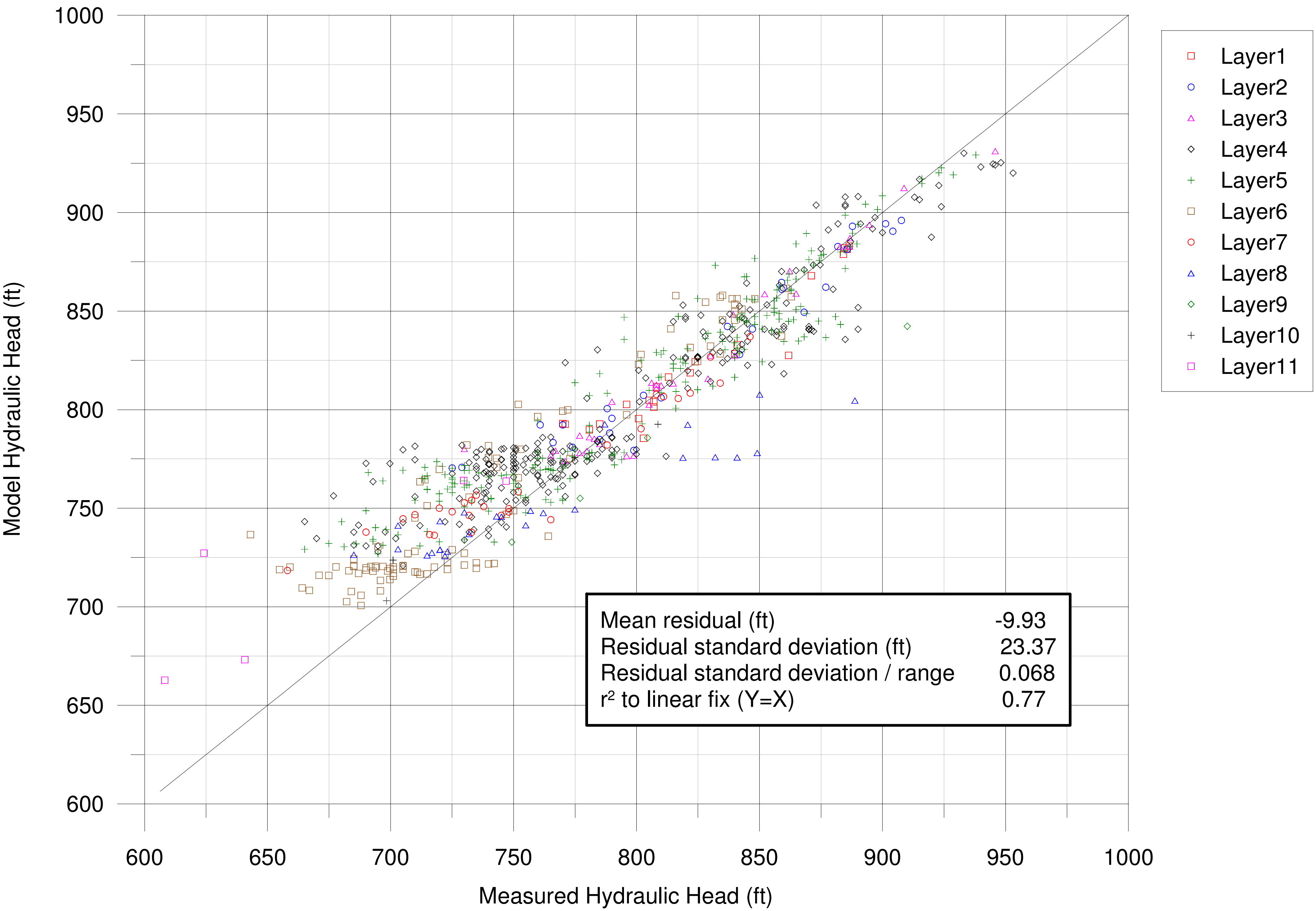


Figure I-2
Observed vs Computed Hydraulic Head Values
Simple Model



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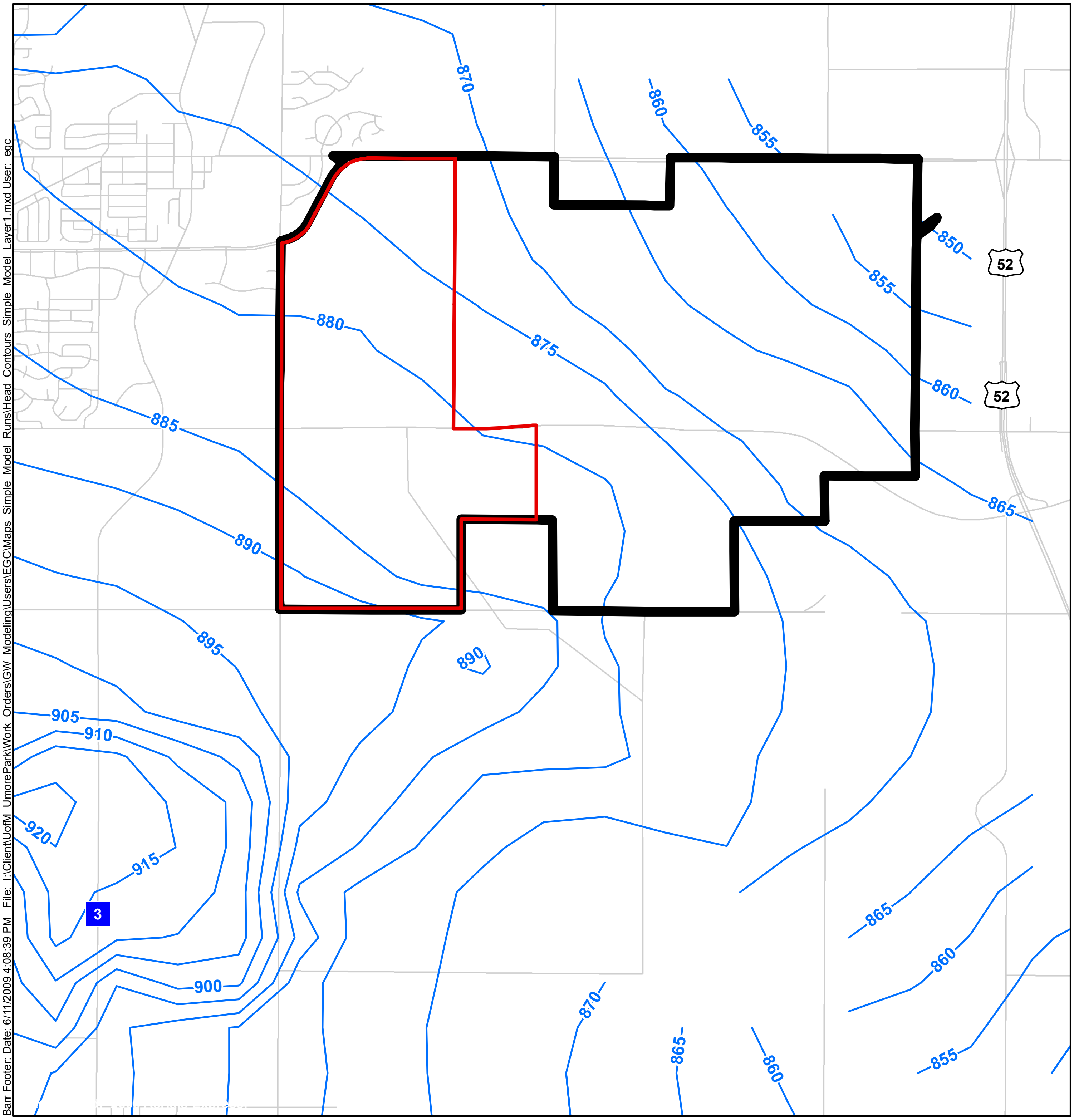


UMore Mining Area (UMA)

UMore Park Boundary

Head Contour (Contour Interval = 5 ft)

N

Feet
4,000 0 4,000

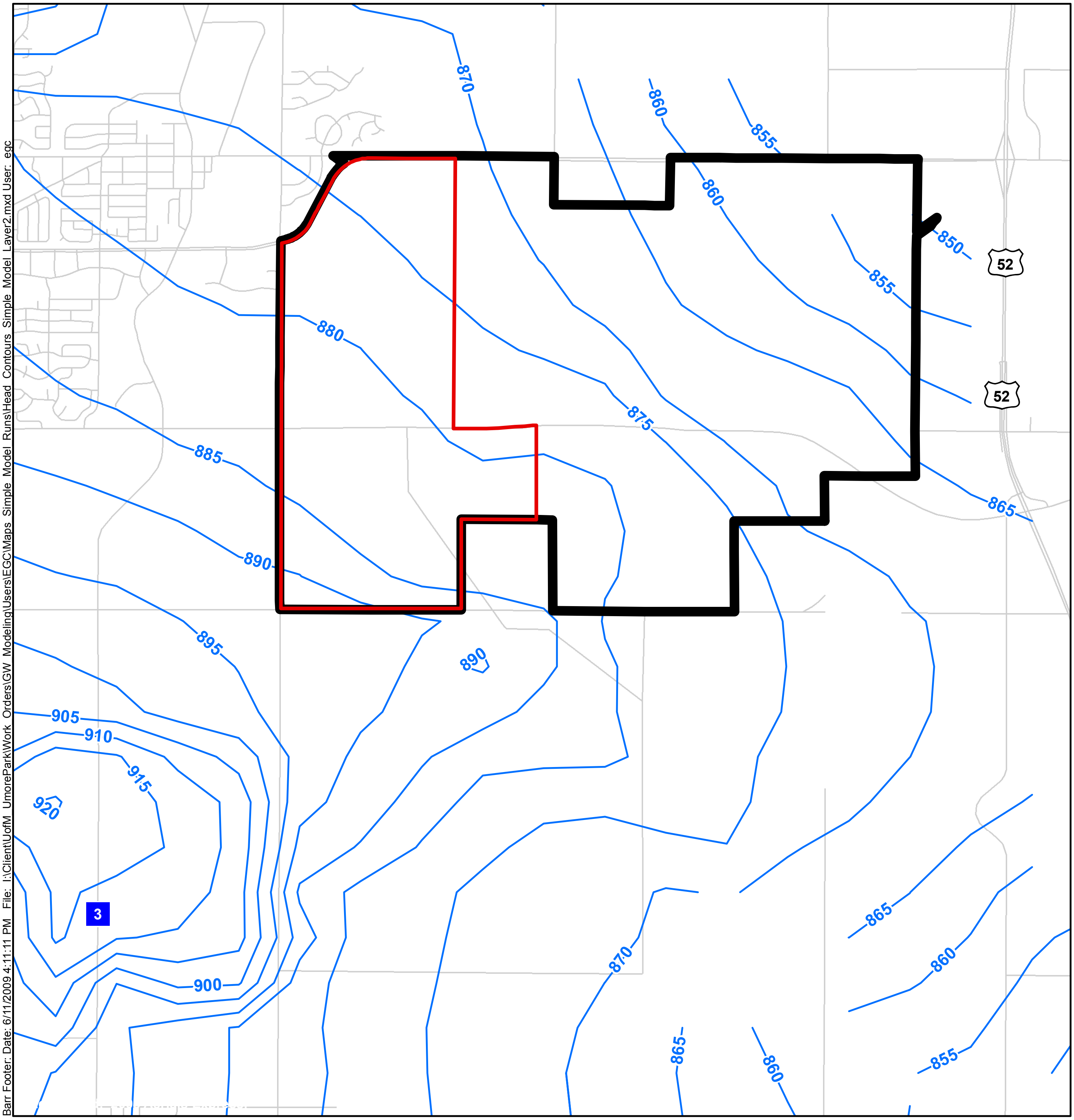
FIGURE I-3
SIMPLE MODEL SIMULATED
GROUNDWATER CONTOURS
MODEL LAYER 1
QUATERNARY

Groundwater Assessment Report
UMore Mining Area
Dakota County, MN

BARR

Source: MnDOT, MN dnr, Barr, SEH.

UMP005449



UMore Mining Area (UMA)

UMore Park Boundary

Head Contour (Contour Interval = 5 ft)

N

Feet

4,000 0 4,000

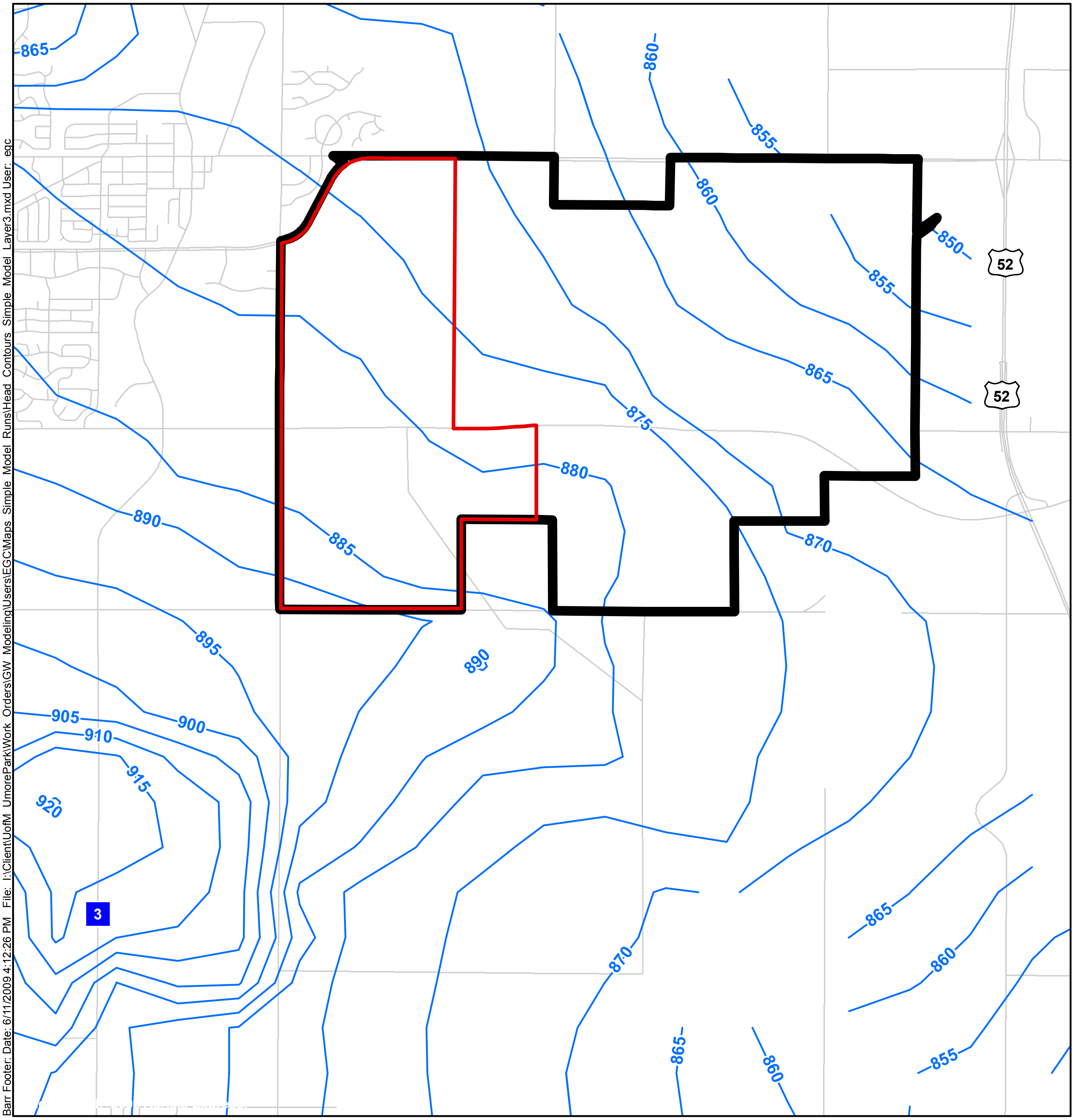
FIGURE I-4
SIMPLE MODEL SIMULATED
GROUNDWATER CONTOURS
MODEL LAYER 2
QUATERNARY

Groundwater Assessment Report
UMore Mining Area
Dakota County, MN

BARR

Source: MnDOT, MN dnr, Barr, SEH.

UMP005450



UMore Mining Area (UMA)

UMore Park Boundary

Head Contour (Contour Interval = 5 ft)

N

Feet

4,000 0 4,000

FIGURE I-5
SIMPLE MODEL SIMULATED
GROUNDWATER CONTOURS
MODEL LAYER 3
QUATERNARY

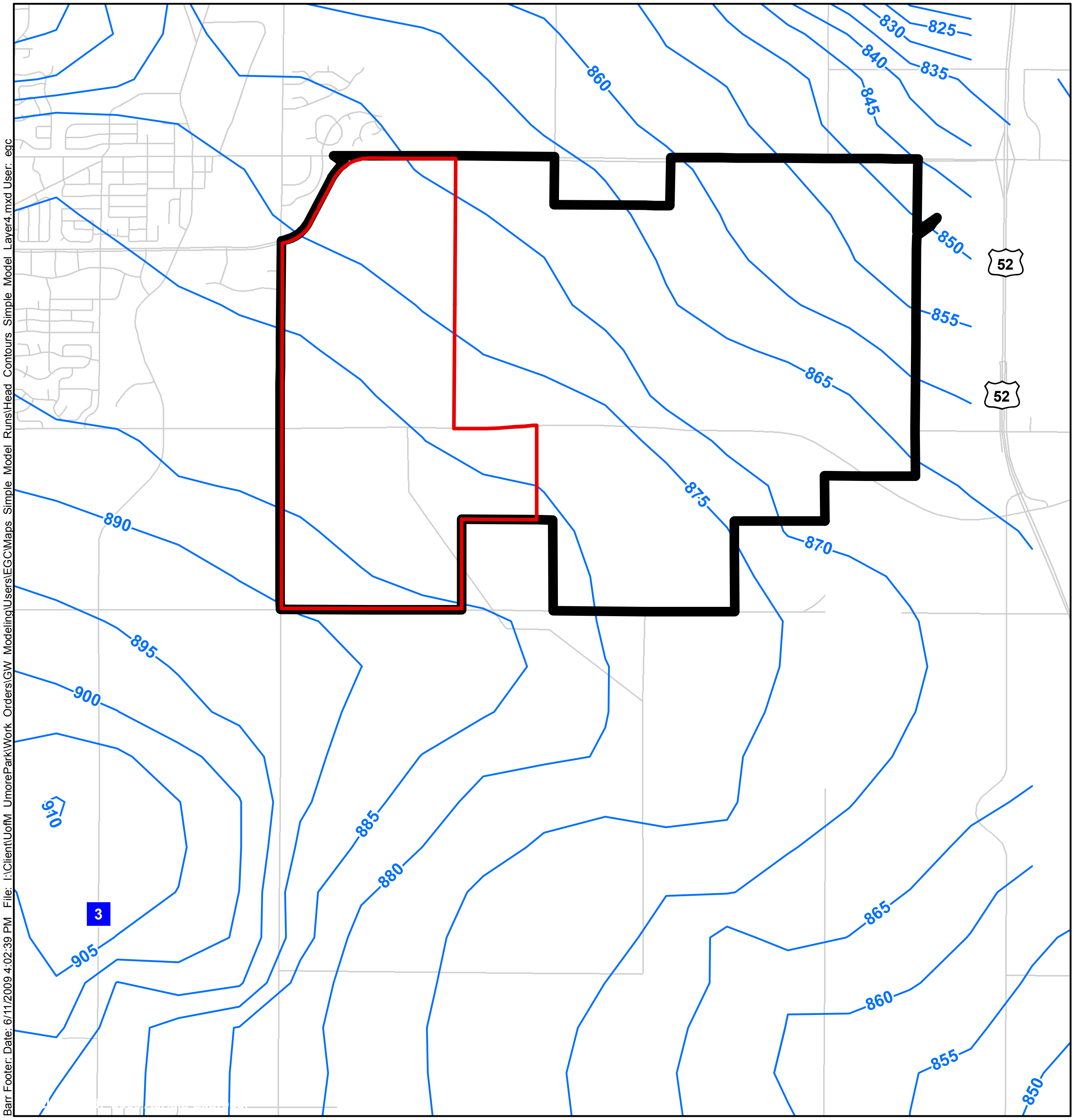
Groundwater Assessment Report
UMore Mining Area
Dakota County, MN

BARR

UMP005451

Source: MnDOT, MN dnr, Barr, SEH.

Barr Footer: Date: 6/11/2009 4:12:26 PM File: I:\Client\UofM UmorePark\Work Orders\GW Modeling\Users\EGC\Maps Simple Model Runs\Head Contours Simple Model Layer3.mxd User: egc



UMore Mining Area (UMA)

UMore Park Boundary

Head Contour (Contour Interval = 5 ft)

N

Feet

4,000 0 4,000

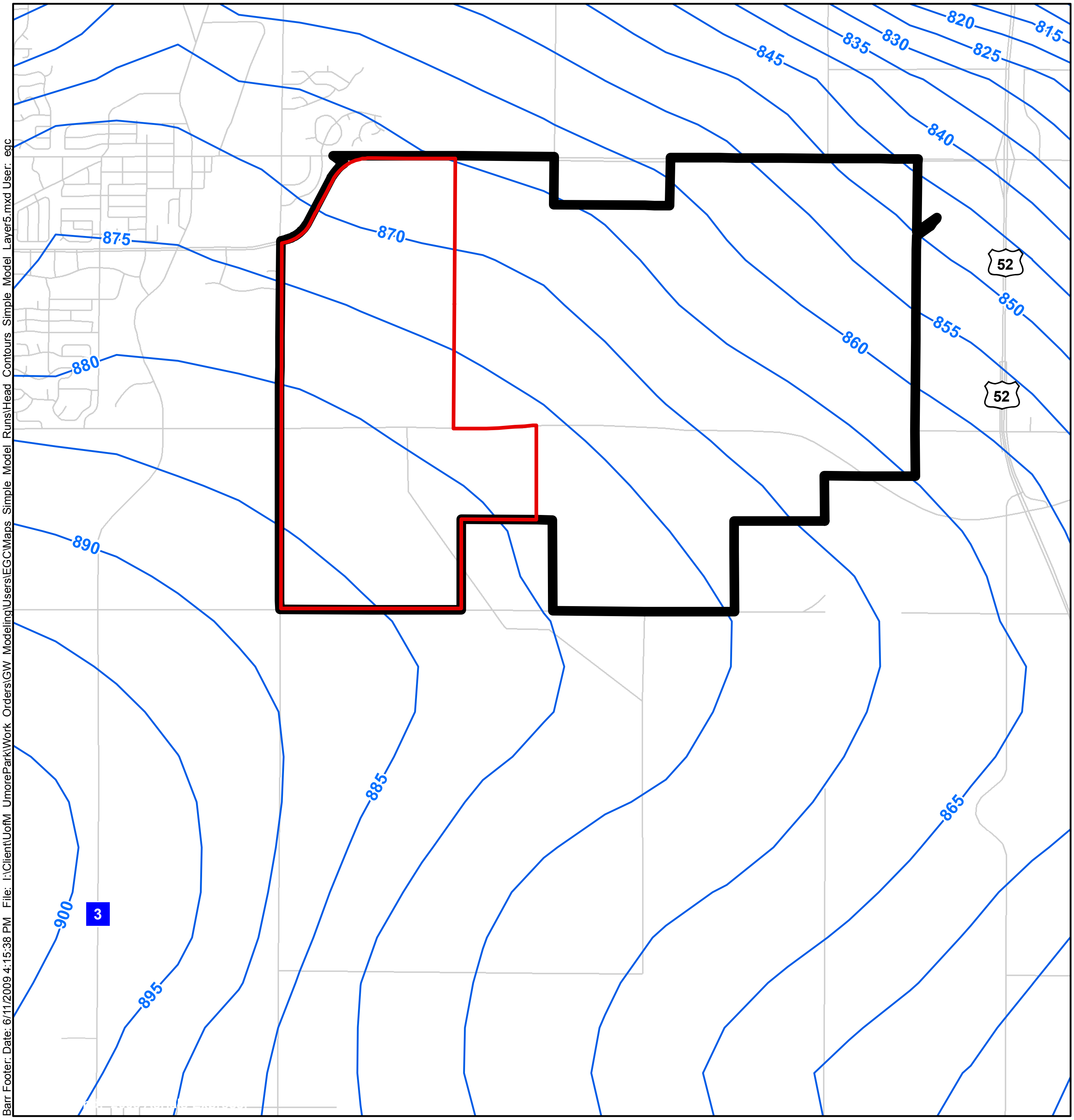
FIGURE I-6
SIMPLE MODEL SIMULATED
GROUNDWATER CONTOURS
MODEL LAYER 4
QUATERNARY & ST. PETER
SANDSTONE (WHERE PRESENT)

Groundwater Assessment Report
UMore Mining Area
Dakota County, MN

BARR

Source: MnDOT, MN dnr, Barr, SEH.

UMP005452



UMore Mining Area (UMA)

UMore Park Boundary

Head Contour (Contour Interval = 5 ft)

FIGURE I-7
SIMPLE MODEL SIMULATED
GROUNDWATER CONTOURS
MODEL LAYER 5
PRAIRIE DU CHIEN GROUP

Groundwater Assessment Report
UMore Mining Area
Dakota County, MN

N

Feet
4,000 0 4,000

Source: MnDOT, MN dnr, Barr, SEH.

BARR

UMP005453