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Quarles & Brady

Preliminary Results of Groundwater Modeling

C.D. Besadny Arsenic Site
Kewaunee, Wisconsin

STS Consultants Ltd.
Consulting Engineers



November 11, 1996

Mr. James R. Reyburn
Wisconsin Department of Natural Resources
1125 North Military Avenue
P.O. Box 10448
Green Bay, Wisconsin 54307-0448

Re: Preliminary Results of Groundwater Modeling for the C.D. Besadny Arsenic Site,
Kewaunee, Wisconsin -- STS Project No. 20716XA

Dear Jim,

Enclosed are the preliminary results of groundwater modeling. We will also be providing you with preliminary surface water modeling results shortly. We would appreciate it if you would circulate this information for review and comment. Following your review, we would like to arrange a meeting to discuss this information.

If you have any questions or comments regarding this project, please contact me at 406-3210. We appreciate your assistance with this project.

Sincerely,

STS CONSULTANTS LTD.

A handwritten signature in black ink, appearing to read "Michael T. Berger".

Michael T. Berger, R.M., CHMM
Microbiologist

A handwritten signature in black ink, appearing to read "Mark A. Bergeon".

Mark A. Bergeon, P.G.
Associate

MTB/dke.wd

Enclosures:

GeoTrans, Inc., Preliminary Modeling Results

Copy to: Mr. Thomas P. McElligott
Quarles & Brady
411 East Wisconsin Avenue
Milwaukee, Wisconsin 53202-4497

(C416A010)

STS Consultants Ltd.
Consulting Engineers

1035 Kepler Drive
Green Bay, Wisconsin 54311-8320
414.468.1978/Fax 414.468.3312

October 10, 1996

Mr. Michael T. Berger
STS Consultants Ltd.
1035 Kepler Drive
Green Bay, Wisconsin 54311

Dear Mike:

Enclosed are preliminary results from the Kewaunee Marsh arsenic transport modeling work. Figures 1 through 3 are potentiometric surface maps for the site based on State water level measurements. Figure 4 is the best fit of measured sediment/water arsenic concentrations to the Freundlich and Langmuir isotherms.

Figures 5 through 12 show the results of the BIO1D model simulations. Figures 5 and 6 show the flow paths used in the BIO1D model simulations. The flow paths are based on flow lines from the potentiometric surface map for May 1996. Figure 6 shows the combined STS and State groundwater arsenic concentration data and the one-dimensional grids used to extrapolate initial concentration data for the start of the model simulations.

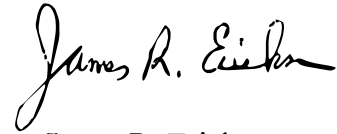
Figure 7 shows the initial concentration data used in the model simulations for the Central Flow Path. Figure 8 shows the arsenic concentration distribution from the upgradient end of the Central Flow Path to the Kewaunee River after 8000 years. Figure 9 shows the concentration breakthrough at the Kewaunee River as a function of time. The maximum concentration discharge to the river is about 300 mg/L after about 2700 years.

Figures 10 through 12 show the transport results for the Northern Flow Path. Figure 10 is the initial starting concentration data for the model simulations. Figure 11 shows the distribution of arsenic concentration in the groundwater after 3000 years and Figure 12 shows the concentration breakthrough at the river as a function of time.

All model simulation were run with the Langmuir isotherm, which is the more conservative of the two isotherms. We plan to perform a sensitivity analysis of the model for both the Freundlich and Langmuir isotherms to demonstrate that the results are not significantly impacted by the choice of isotherms.

I would like to discuss future model runs that STS and State would like to see performed for the Kewaunee Marsh site. Please call me after you have had a chance to review these results.

Sincerely,



James R. Erickson
Principal Hydrogeologist
Boulder Office Manager

Enclosures

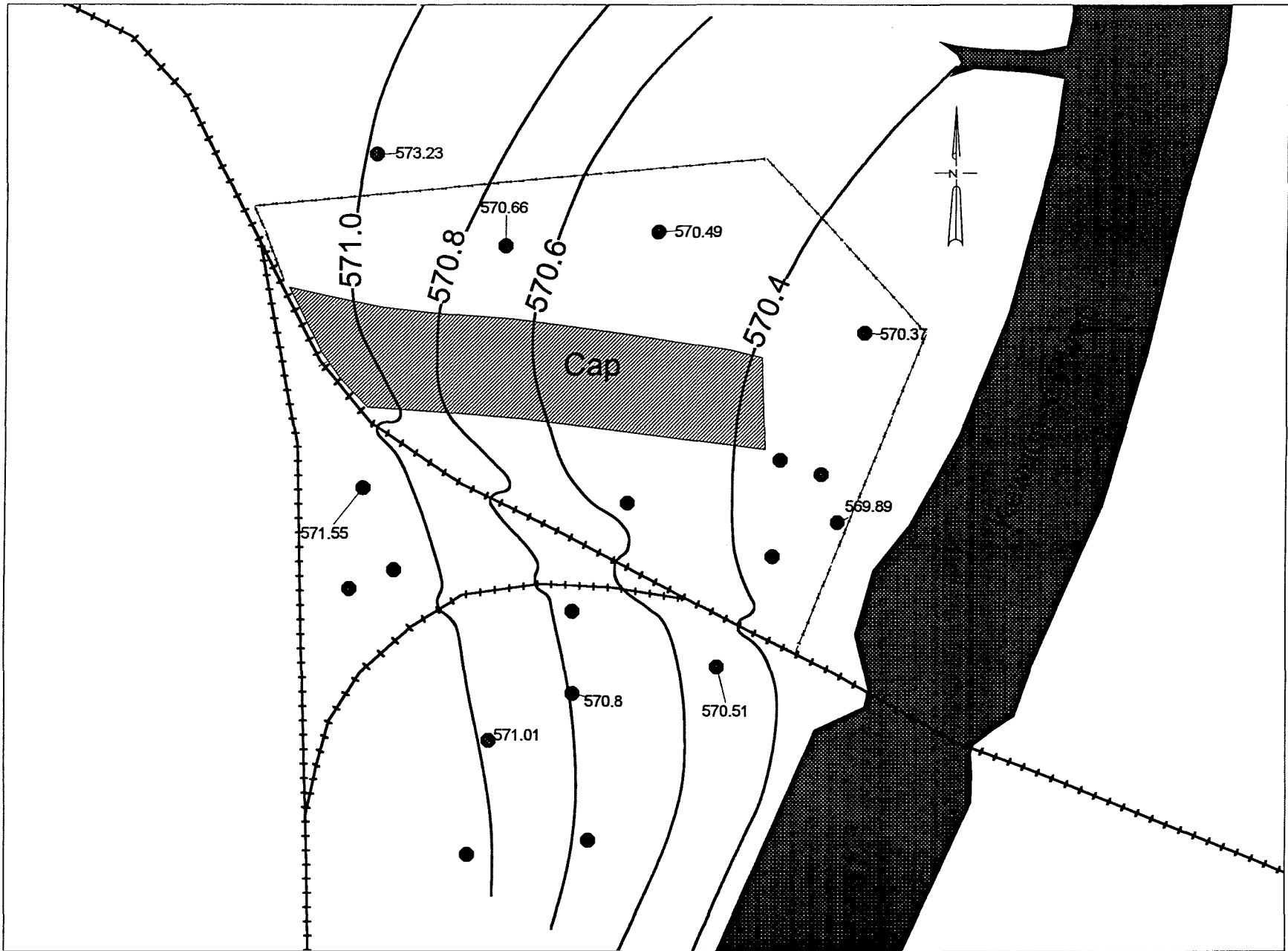


Figure 1. Potentiometric surface based on State water-level measurements at the Kewaunee marsh for May 1996.

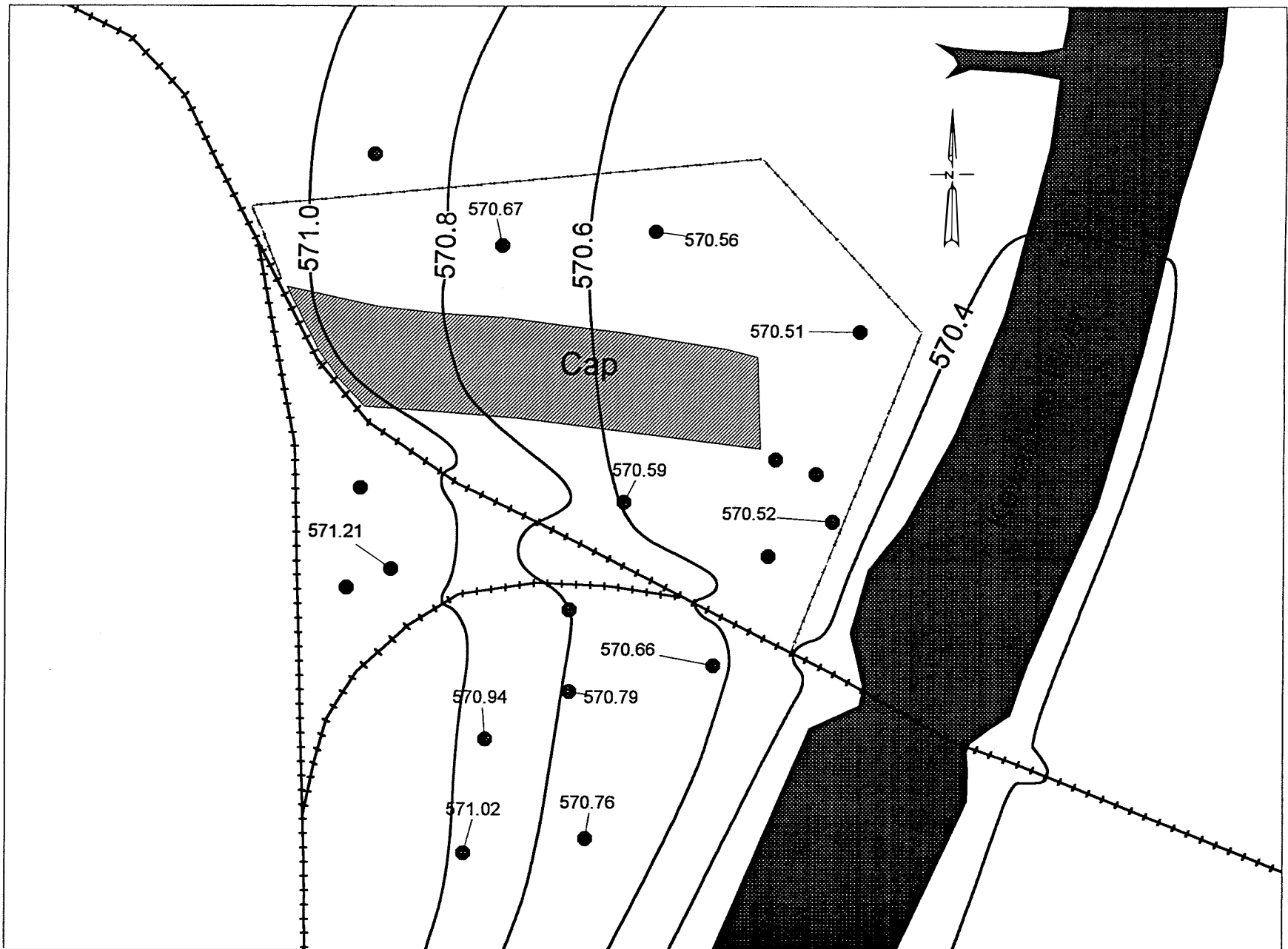


Figure 2. Potentiometric surface based on State water-level measurements at the Kewaunee marsh for August 1996.

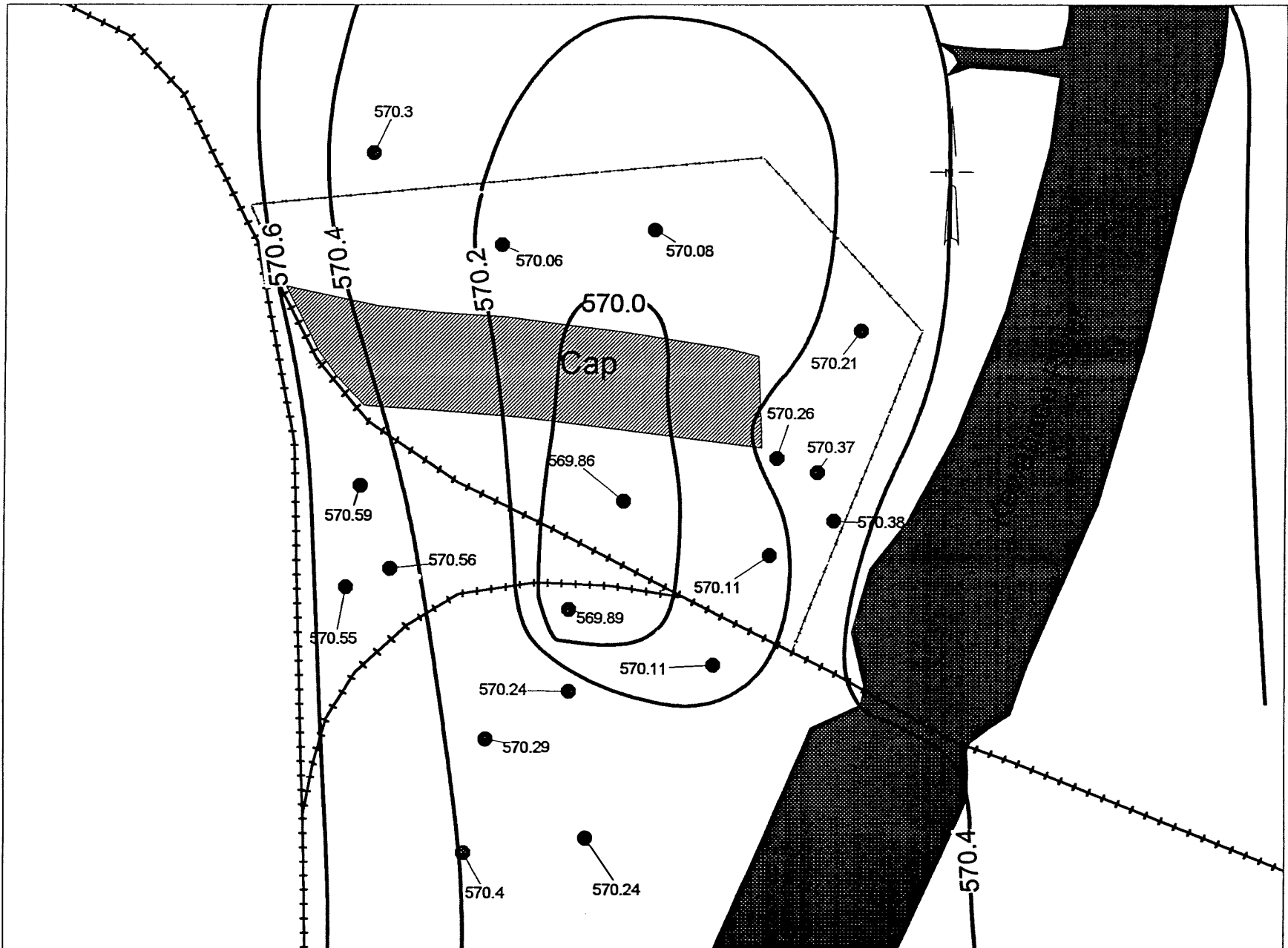
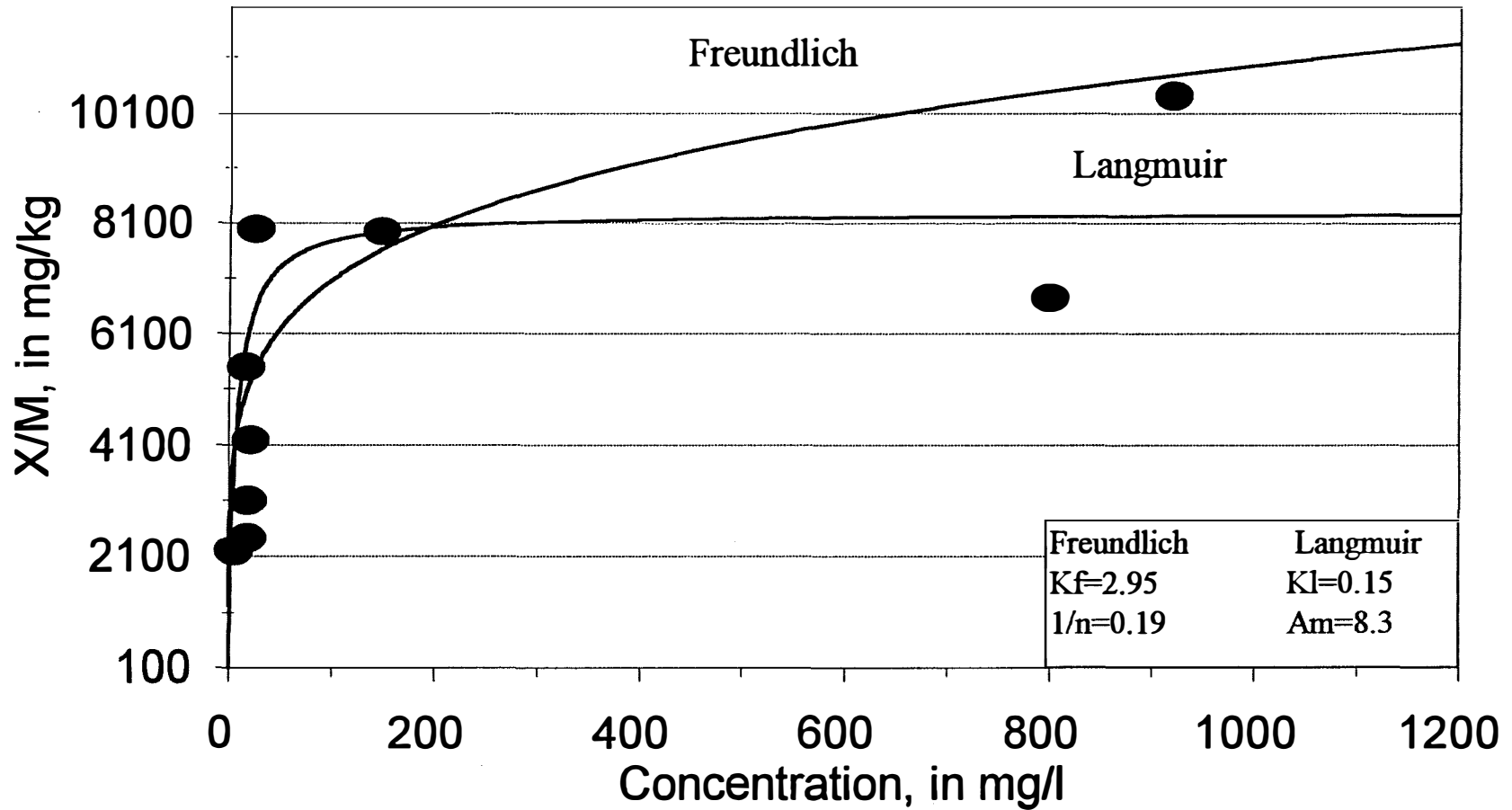


Figure 3. Potentiometric surface based on State water-level measurements at the Kewaunee marsh for September 1996.

Figure 4. Measured arsenic concentration data for sediments and water versus the Langmuir and Freundlich calculated data.



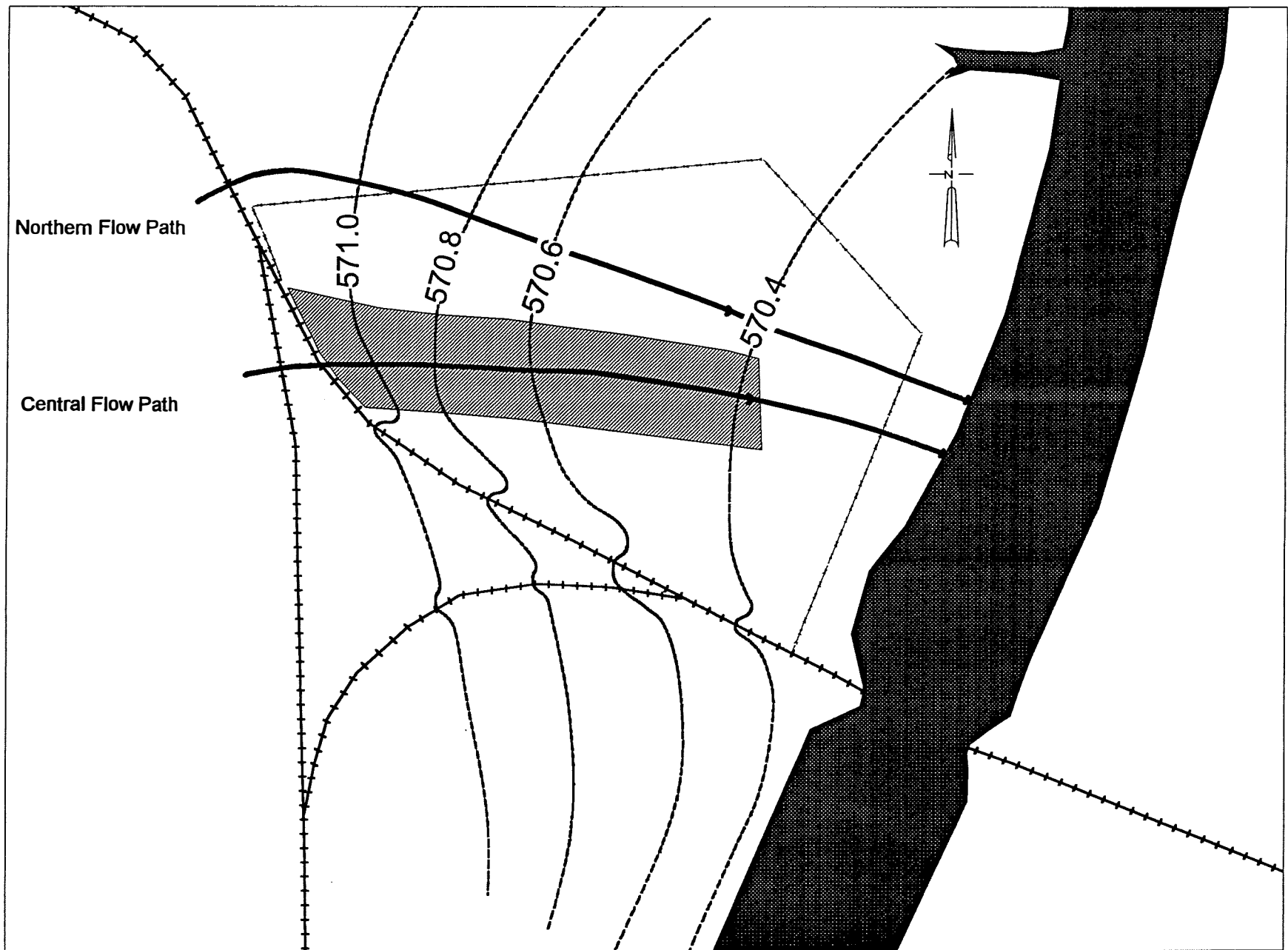


Figure 5. BIO1D flow paths for arsenic transport simulations .

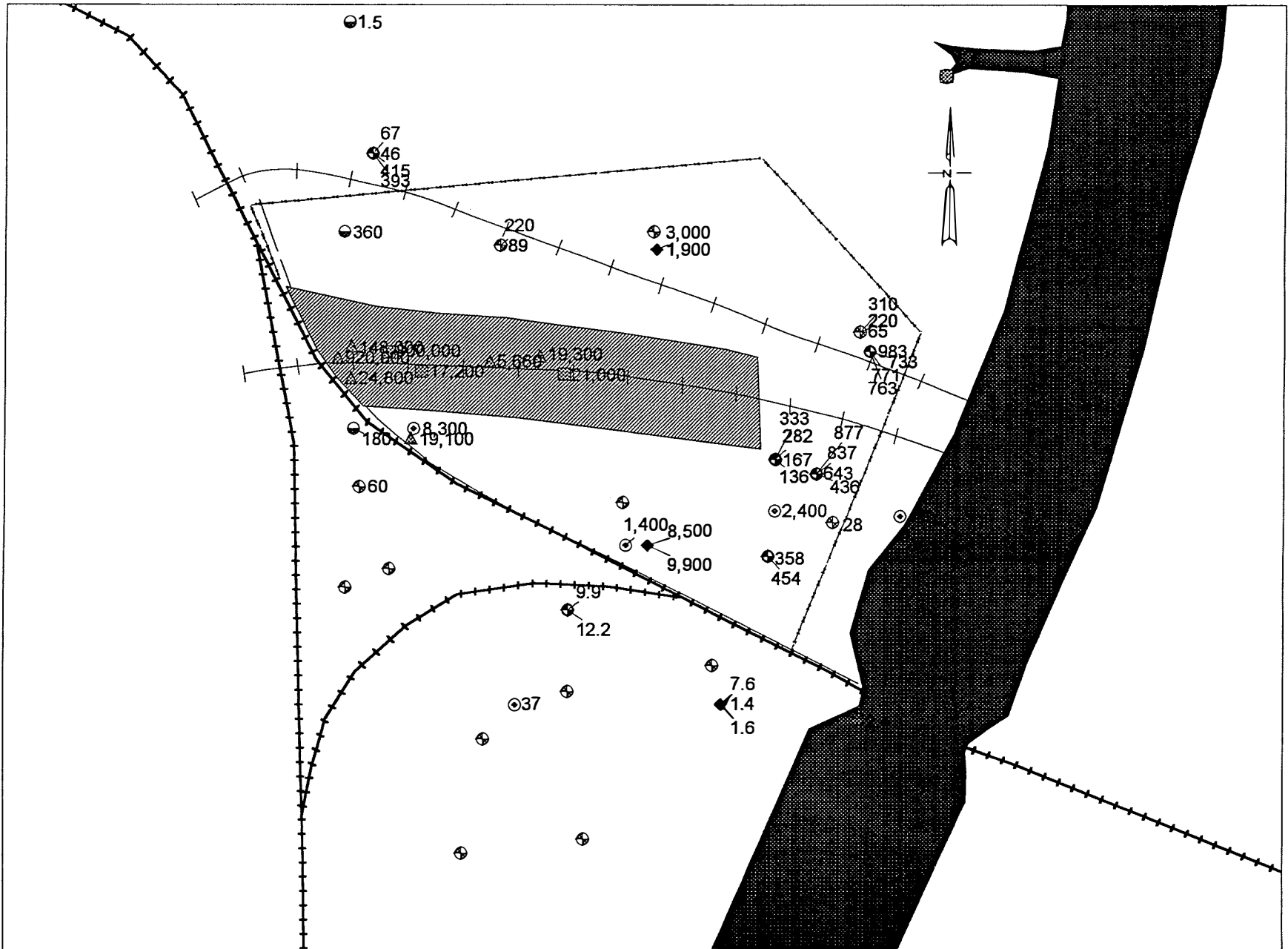


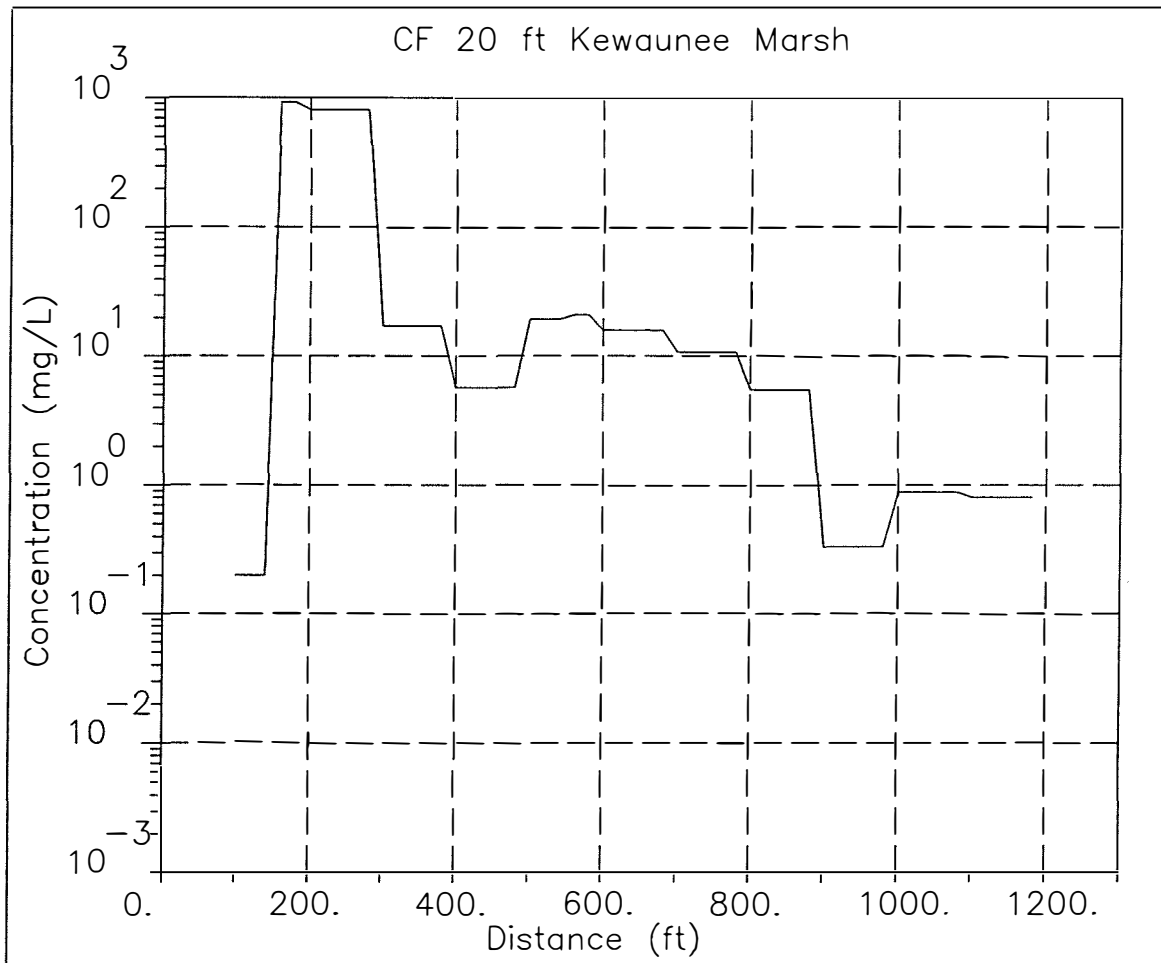
Figure 6. BIO1D flow paths and grid spacings for initial starting groundwater arsenic concentrations.

TIME (yr)

 0.00

Description	V	D	Ae	An	Li	Fr	La
Arsenic	<input type="checkbox"/>	<input type="checkbox"/>					<input type="checkbox"/>

BIO1D
 Version 1.2
 GeoTrans, Inc.



CUMULATIVE MASS BALANCE

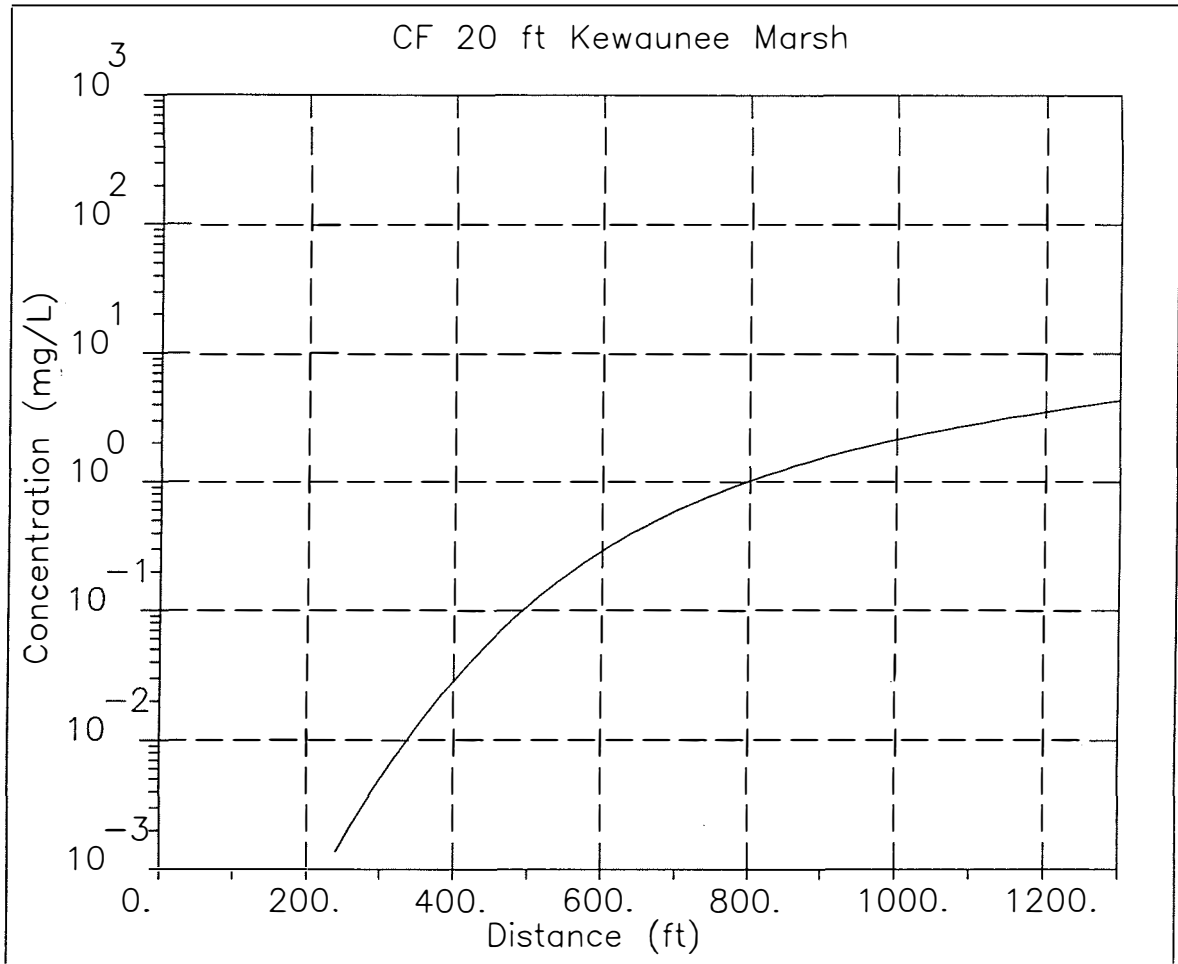
As	
in	out

Figure 7. Initial arsenic concentrations in groundwater at the start of the model simulations for the Central Flow Path.

TIME (yr)
 8000.34

Description	V	D	Ae	An	Li	Fr	La
Arsenic	□	□					□

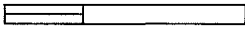
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CUMULATIVE MASS BALANCE

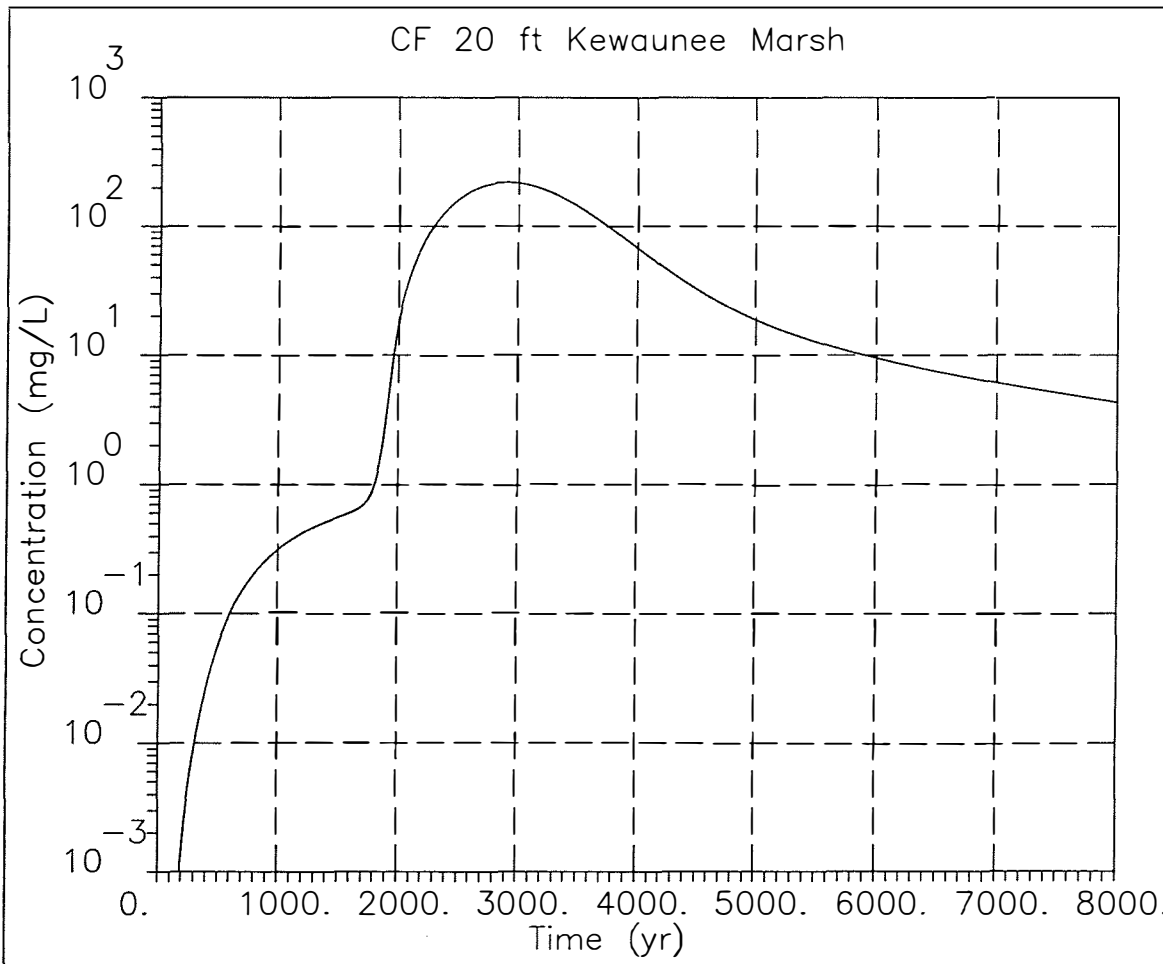
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DES			
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Figure 8. Groundwater arsenic concentrations as a function of distance for the Central Flow Path.

DISTANCE(ft)

 1300.00

Description	V	D	Ae	An	Li	Fr	La
Arsenic	—	□	□				□

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 GeoTrans, Inc.



CUMULATIVE MASS BALANCE

As in DIS	As out DIS	CON	CON

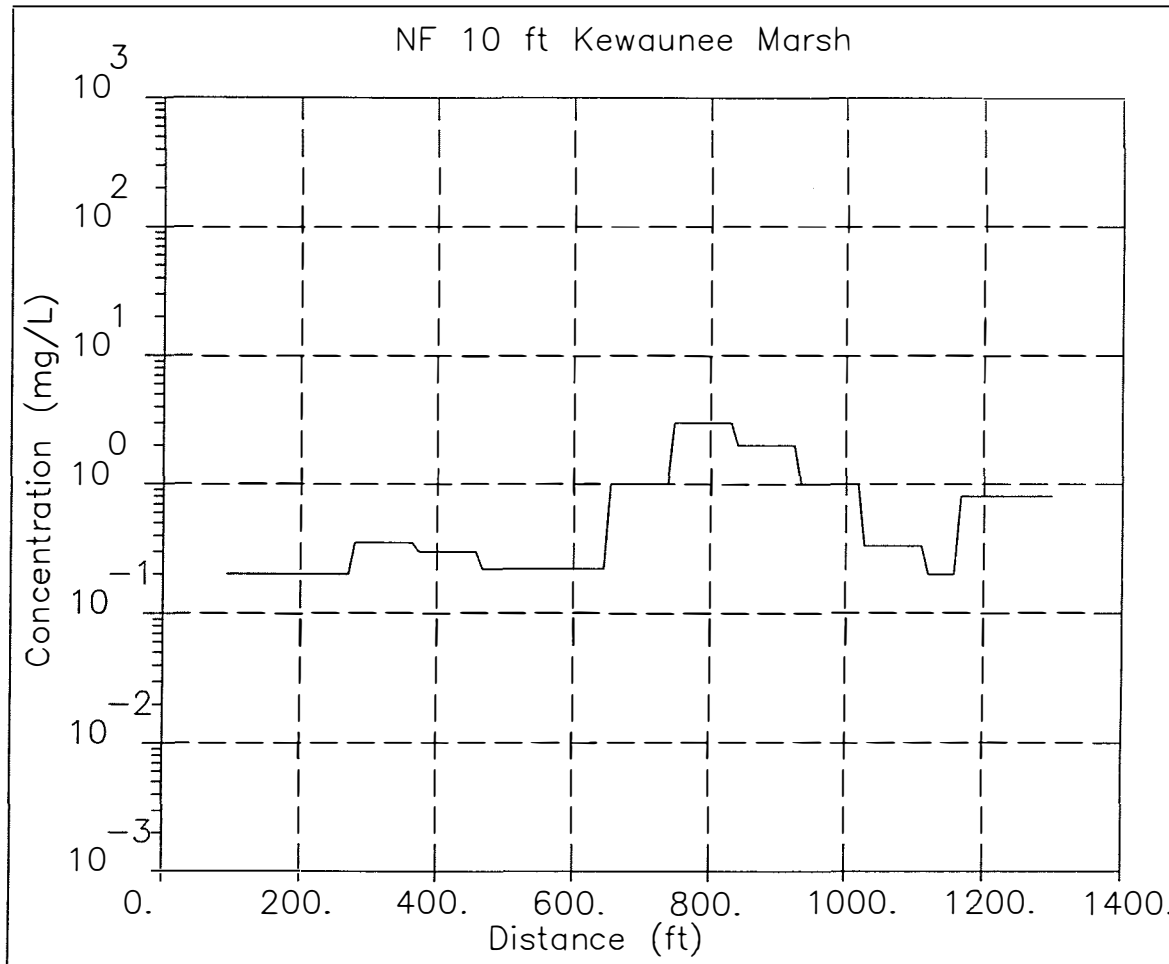
Figure 9. Groundwater arsenic concentrations discharging to river as a function of time for the Central Flow Path.

TIME (yr)

 0.00

Description	V	D	Ae	An	Li	Fr	La
Arsenic	<input type="checkbox"/>	<input type="checkbox"/>					<input type="checkbox"/>

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CUMULATIVE
 MASS BALANCE

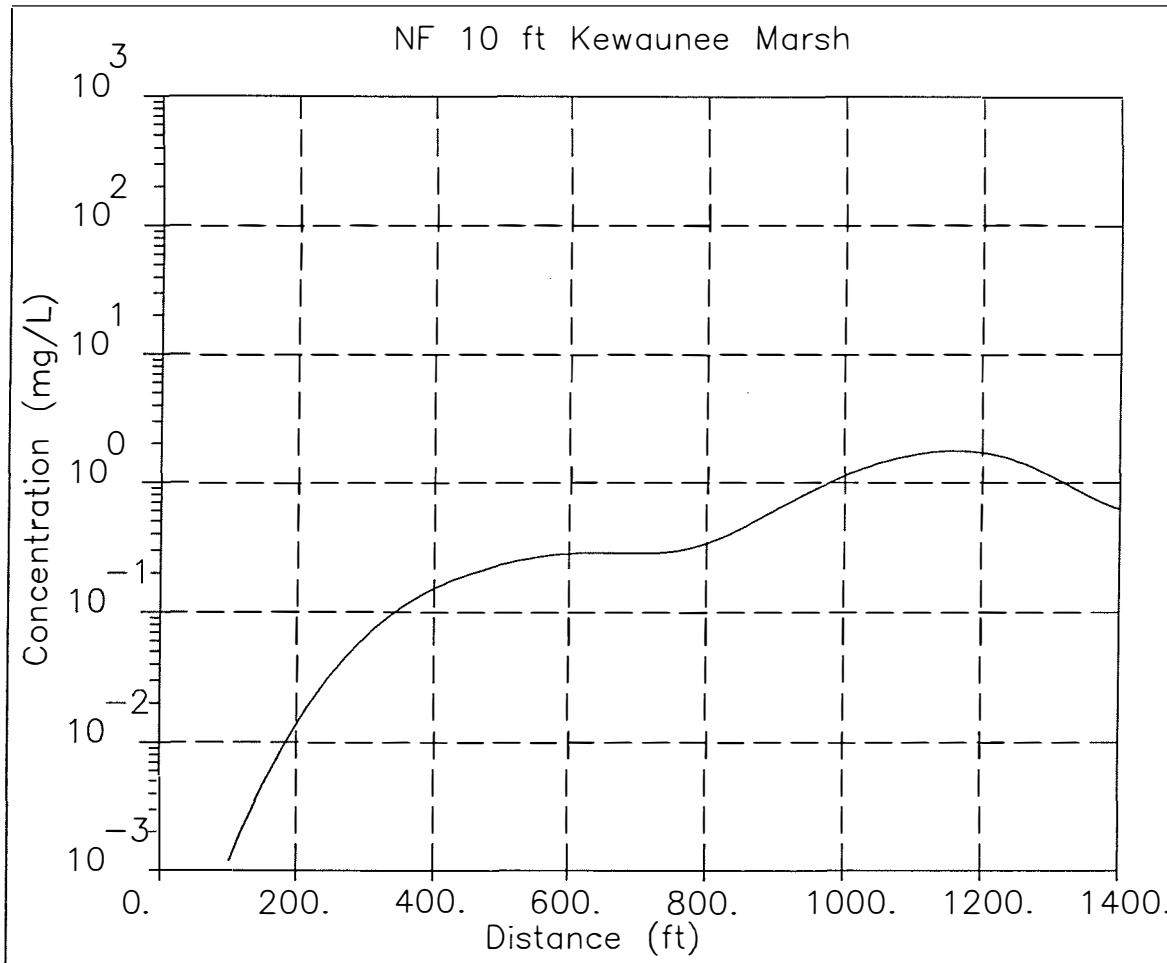
As	
in	out

Figure 10. Initial arsenic concentrations in groundwater at the start of the model simulations for the Northern Flow Path.

TIME (yr)
 3000.10

Description	V	D	Ae	An	Li	Fr	La
Arsenic	□	□					□

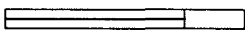
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CUMULATIVE MASS BALANCE

As	
in	out
DES	ADS
STO	

Figure 11. Groundwater arsenic concentrations as a function of distance between the marsh and river for the Northern Flow Path.

DISTANCE(ft)

 1500.00

Description	V	D	Ae	An	Li	Fr	La
Arsenic	—	□	□				□

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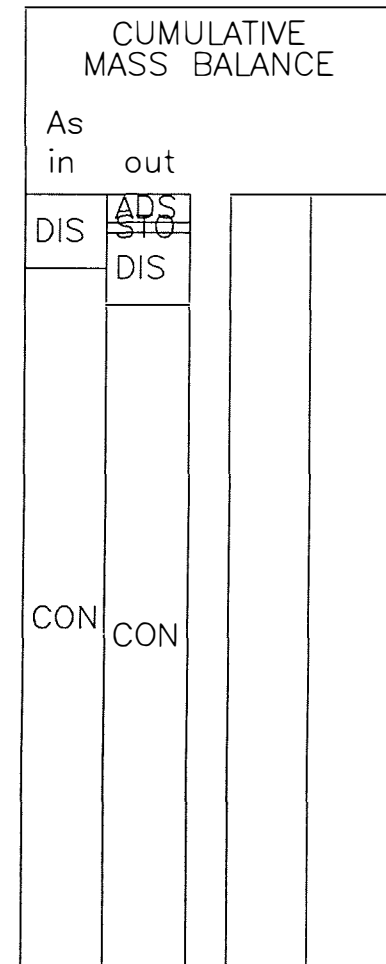
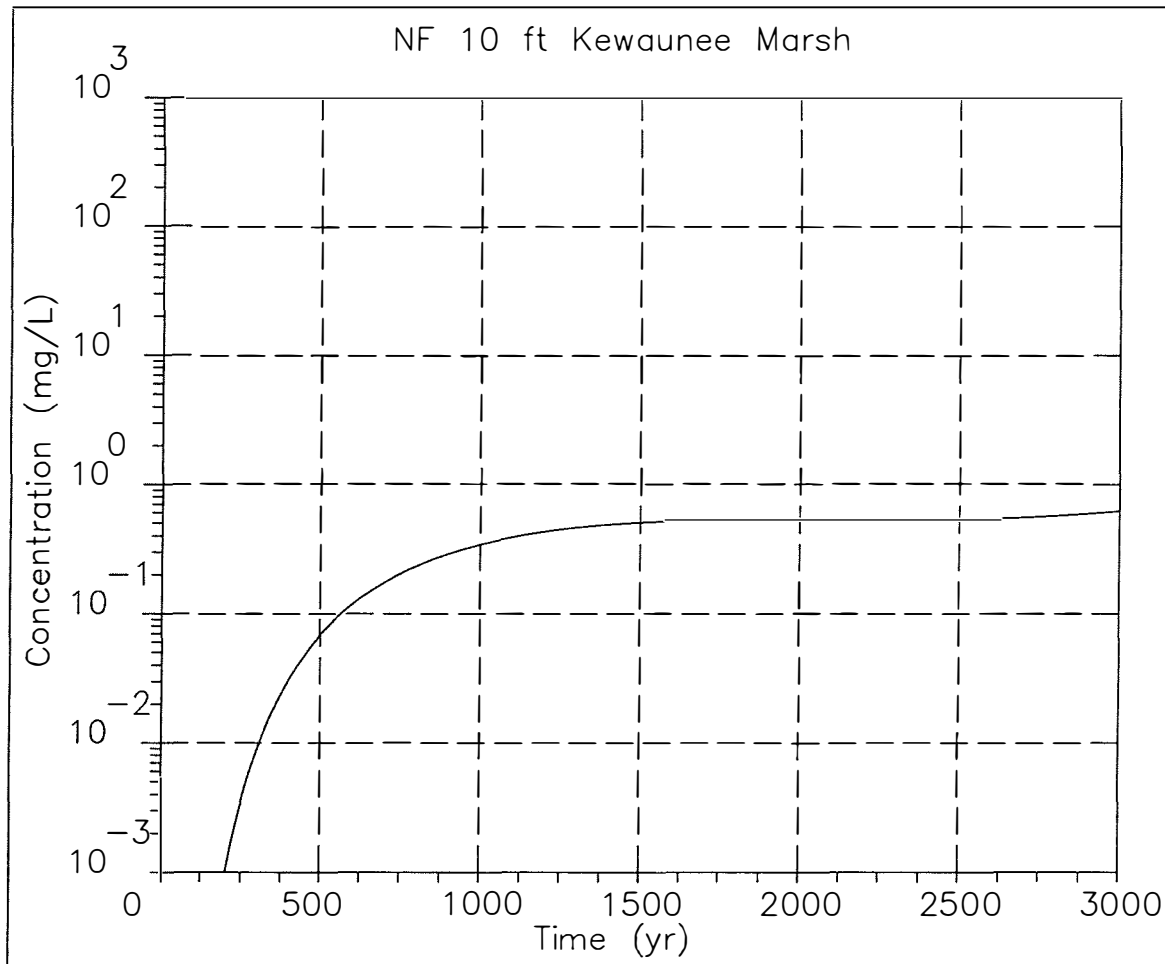


Figure 12. Groundwater arsenic concentrations discharging to the river as a function of time for the Northern Flow Path.