WiscLEACH© 2.0 Tutorial

Department of Civil and Environmental Engineering
Jackson State University

October 15, 2011

Software Website: http://wiscleach.engr.wisc.edu

WiscLEACH© 2.0

- A web-based computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications.
  - The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater (Li et al. 2006, 2011)
  - The application was designed to be computationally efficient and can be used without experience in numerical modeling.
- WiscLEACH is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
  - Contact Information for Q & A: Dr. Lin Li (lin.li@jsums.edu), Department of Civil and Environmental Engineering, Jackson State University, Jackson, MS 39217-0168, US
  - Acknowledgement: Financial support for the development of WiscLEACH software was provided by the Recycled Materials Resource Center and Wisconsin Department of Natural Resources Waste Reduction and Recycling Demonstration Grant and Alliant Energy.
-

Homepage of Web-based WiscLEACH© 2.0

Home | Roadway Stabilization | Embankment/Structural Fill Applications | User Manual

A computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications. The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater. The application was designed to be computationally efficient and can be used without experience in numerical modeling. © 2011. Developed by Dr. Lin Li at Jackson State University.

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P. O. Box 17068
Jackson, MS 39217-0168, US

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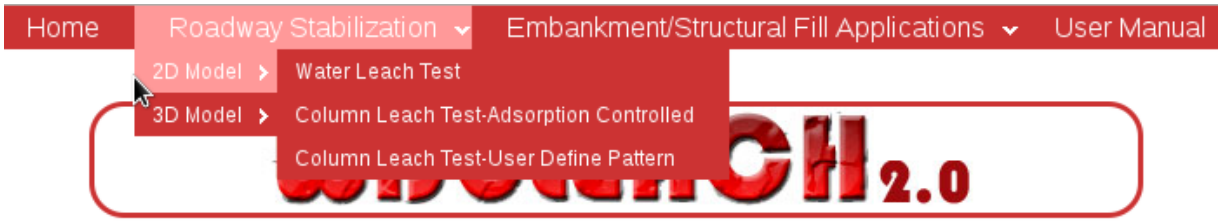
Structure of Web-based WiscLEACH© 2.0

- There are nine modules for simulation scenarios:
  - Roadway stabilization
    - 2D Model
      - Water leach test
      - Column leach test – adsorption control
      - Column leach test – User defined pattern
    - 3D Model
      - Water leach test
      - Column leach test – adsorption control
      - Column leach test – User defined pattern
  - Embankment/Structural Fill Application
    - 3D Model
      - Water leach test
      - Column leach test – adsorption control
      - Column leach test – User defined pattern

Module #1: Roadway Stabilization (2D model) - Water Leach Test

- **Select the menu/Roadway Stabilization/2D Model/Water Leach Test**



A computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications. The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater. The application was designed to be computationally efficient and can be used without experience in numerical modeling. © 2011. Developed by Dr. Lin Li at Jackson State University.

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Initial Webpage After Launching Module #1

Enter input data

File Edit View History Bookmarks Tools Help

2D Water Leach Test

143.132.96.67/~wischleach/2dwlt.html

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2D Water Leach Test

WisLEACH 2.0

Enter Site Parameters:

Point of Compliance	20.0	(m)
Pavement Width	10.4	(m)
Shoulder Width	1.5	(m)
Depth to Groundwater	6.0	(m)
Depth to Top of Stabilized Layer	0.10	(m)
Depth to Bottom of Stabilized Layer	0.459	(m)
Infiltration Rate	0.365	(m/yr)
Maximum Simulation Time	200.0	(yr)

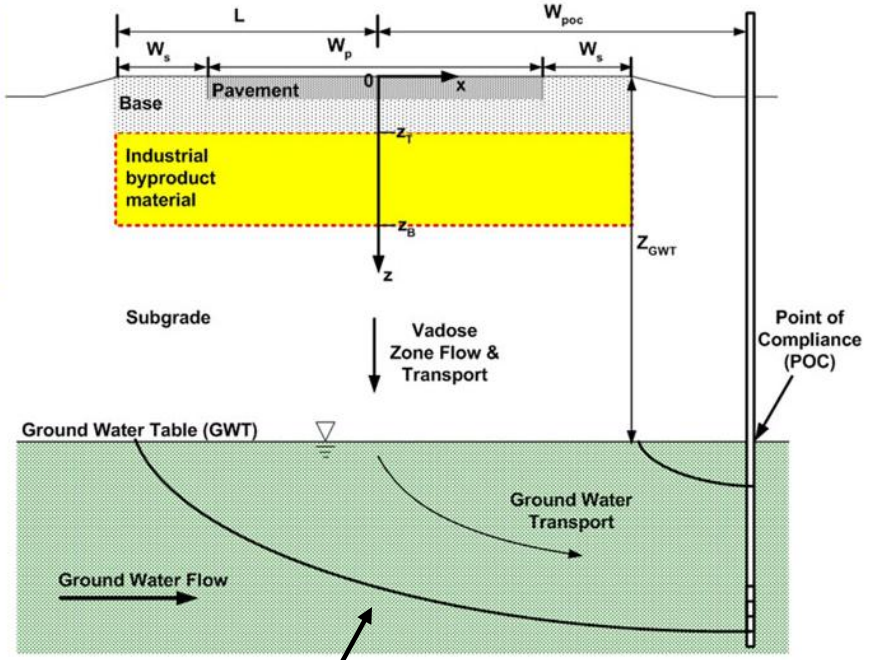
Enter Hydraulic Properties above Groundwater Table:

	Pavement	Base	Stabilized Layer	Subgrade
Hydraulic Conductivity (m/yr)	1.0	3650	0.042	0.31
Porosity	0.33	0.33	0.33	0.33

Enter Contaminant Properties:

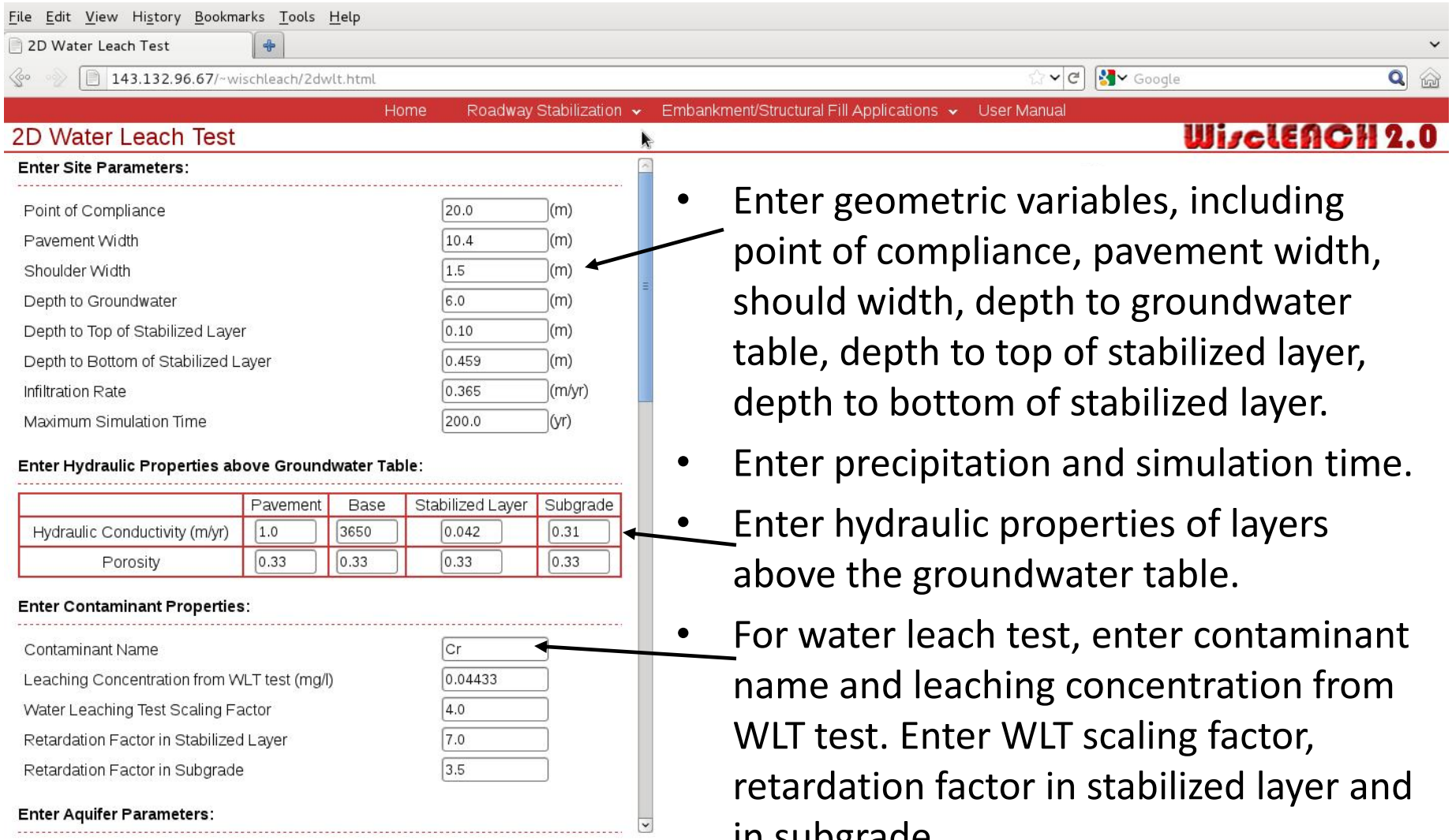
Contaminant Name	Cr
Leaching Concentration from WLT test (mg/l)	0.04433
Water Leaching Test Scaling Factor	4.0
Retardation Factor in Stabilized Layer	7.0
Retardation Factor in Subgrade	3.5

Enter Aquifer Parameters:



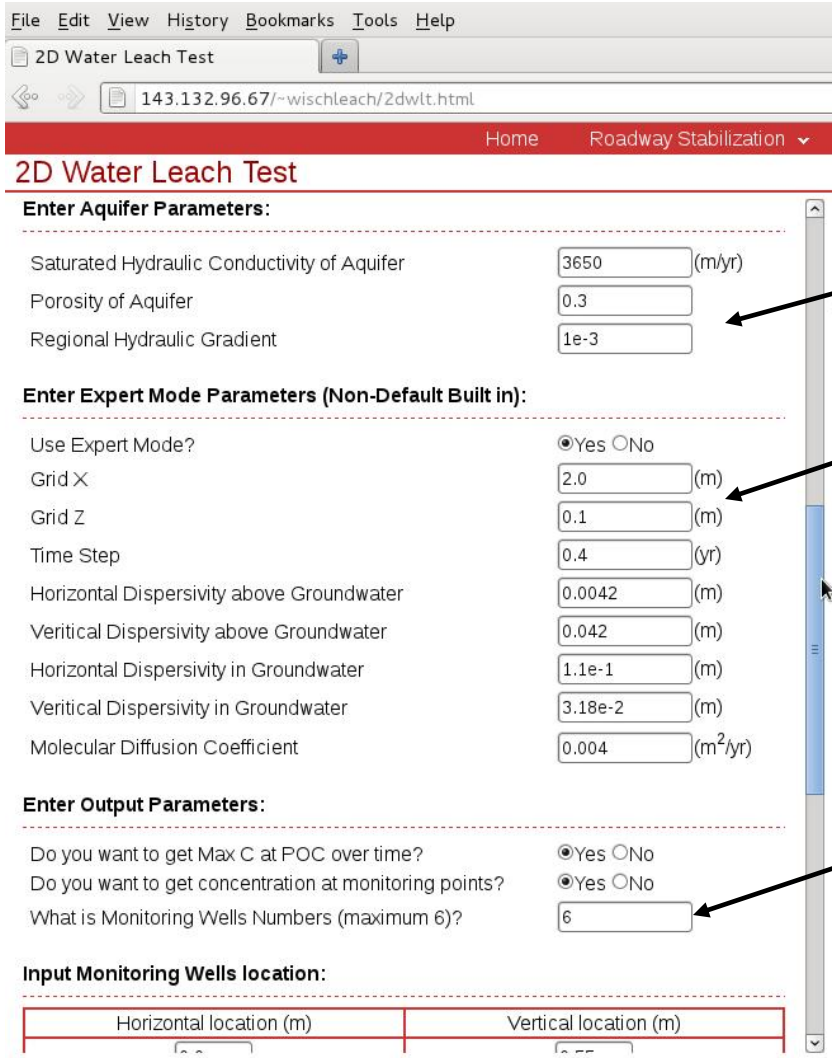
Conceptual model in Module #1

Data Input Windows for Module #1



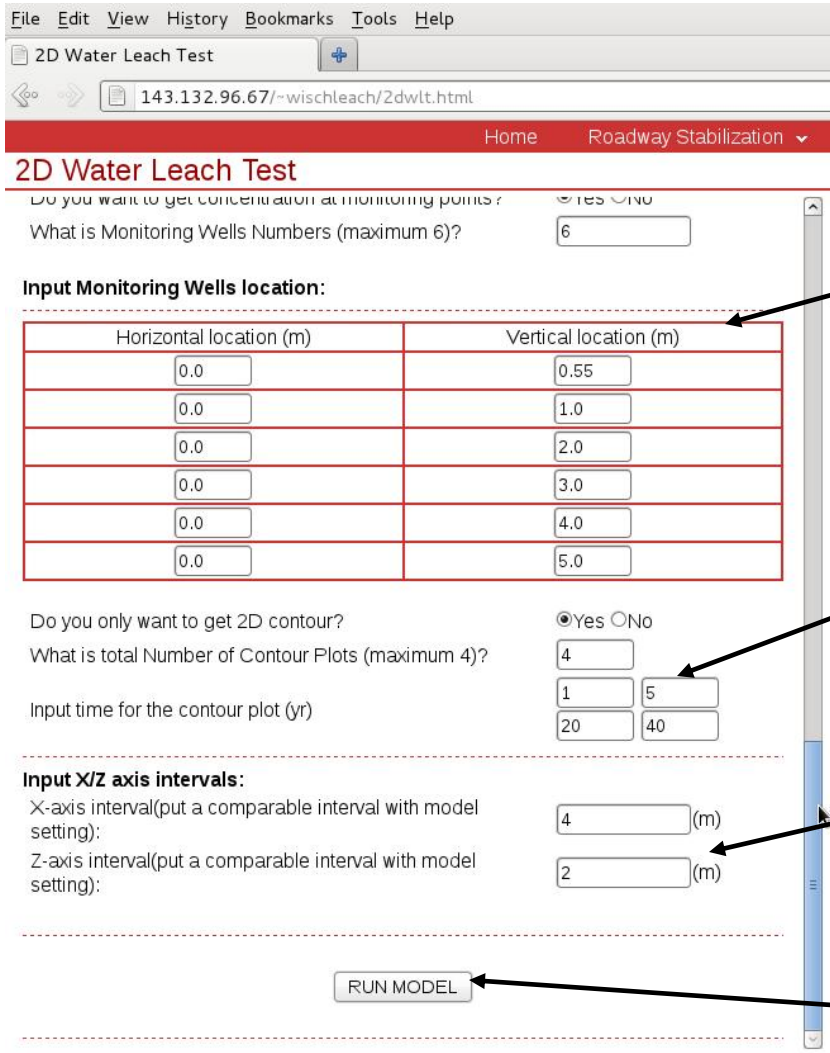
- Enter geometric variables, including point of compliance, pavement width, should width, depth to groundwater table, depth to top of stabilized layer, depth to bottom of stabilized layer.
- Enter precipitation and simulation time.
- Enter hydraulic properties of layers above the groundwater table.
- For water leach test, enter contaminant name and leaching concentration from WLT test. Enter WLT scaling factor, retardation factor in stabilized layer and in subgrade.

Data Input Windows for Module #1 (Cont')



- Enter aquifer properties.
- Additional options for Expert Model Parameters: grid size, time step, dispersivity and diffusion coefficient.
- Select output at the Point of Compliance.
- Select concentrations are to be reported at monitoring well locations. Enter coordinates of these locations. The coordinates are defined based on the coordinate system shown in conceptual model.

Data Input Windows for Module #1 (Cont')



- Enter coordinates of monitoring well locations (maximum locations = 6).
- Select if 2D contour graphs are desired, and enter times when contours are to be output. (maximum contour = 4) Note: contouring can require considerable processing time.
- Enter the axis intervals for the contour graph axis.
- **Click it to run the WiscLEACH model**

Webpage to Running WiscLEACH Module #1

WiscLEACH is running in the web browser. The results are calculated.

File Edit View History Bookmarks Tools Help

Connecting...

143.132.96.67/~wischleach/2dwlt.html

Google

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2D Water Leach Test

WiscLEACH 2.0

Enter Site Parameters:

Point of Compliance	20.0	(m)
Pavement Width	10.4	(m)
Shoulder Width	1.5	(m)
Depth to Groundwater	6.0	(m)
Depth to Top of Stabilized Layer	0.10	(m)
Depth to Bottom of Stabilized Layer	0.459	(m)
Infiltration Rate	0.365	(m/yr)
Maximum Simulation Time	200.0	(yr)

Enter Hydraulic Properties above Groundwater Table:

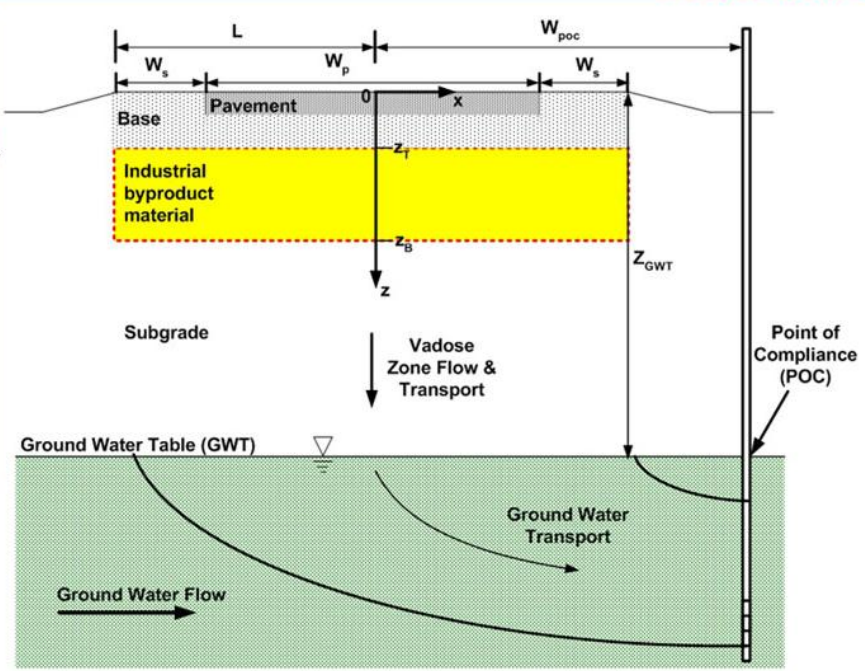
	Pavement	Stabilized Layer	Subgrade	
Hydraulic Conductivity (m/yr)	1.0	1.0	0.042	0.31
Porosity	0.33	0.33	0.33	0.33

Enter Contaminant Properties:

Contaminant Name	Cr
Leaching Concentration from WLT test (mg/l)	0.04433
Water Leaching Test Scaling Factor	4.0
Retardation Factor in Stabilized Layer	7.0
Retardation Factor in Subgrade	3.5

Enter Aquifer Parameters:

Transferring data from 143.132.96.67...



Webpage to Visualize Model Output for Module #1

File Edit View History Bookmarks Tools Help

2D Water Leach Test

143.132.96.67/~wischleach/2dwlt.html

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2D Water Leach Test

WisLEACH 2.0

Input Monitoring Wells location:

Horizontal location (m)	Vertical location (m)
0.0	0.55
0.0	1.0
0.0	2.0
0.0	3.0
0.0	4.0
0.0	5.0

Do you only want to get 2D contour? ◉Yes ○No

What is total Number of Contour Plots (maximum 4)? 4

Input time for the contour plot (yr): 1 5 20 40

Input X/Z axis intervals:

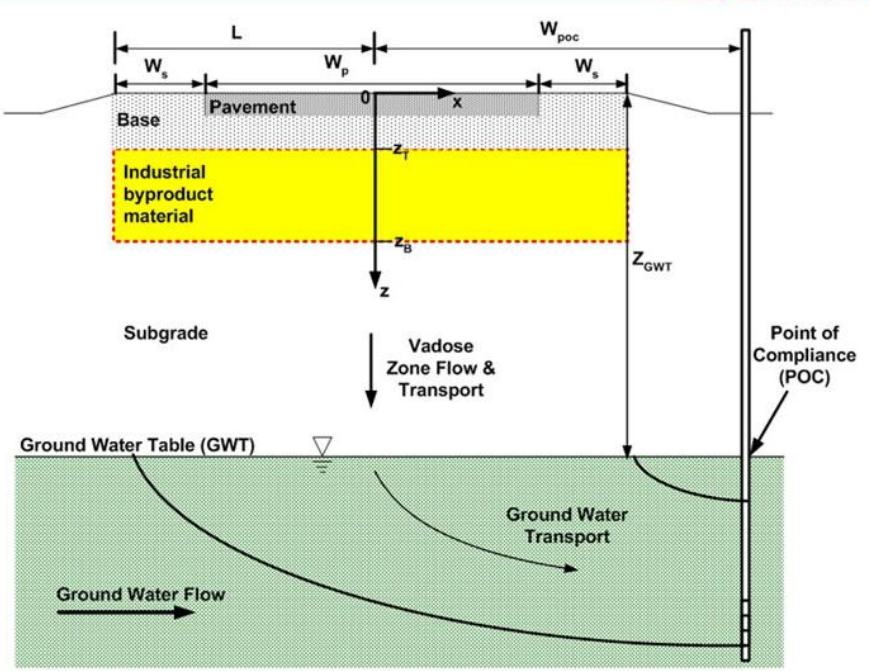
X-axis interval(put a comparable interval with model setting): 4 (m)

Z-axis interval(put a comparable interval with model setting): 2 (m)

RUN MODEL

Visualize Model Output:

Choose 1 graph to display GO



After simulation, the results are allowed to graphically output.

Webpage to Visualize Model Output for Module #1

File Edit View History Bookmarks Tools Help

2D Water Leach Test

143.132.96.67/~wischleach/2dwlt.html

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2D Water Leach Test

WiscLEACH 2.0

Input Monitoring Wells location:

Horizontal location (m)	Vertical location (m)
0.0	0.55
0.0	1.0
0.0	2.0
0.0	3.0
0.0	4.0
0.0	5.0

Do you only want to get 2D contour? ◉Yes ○No

What is total Number of Contour Plots (maximum 4)? 4

Input time for the contour plot (yr): 1 5 20 40

Input X/Z axis intervals:

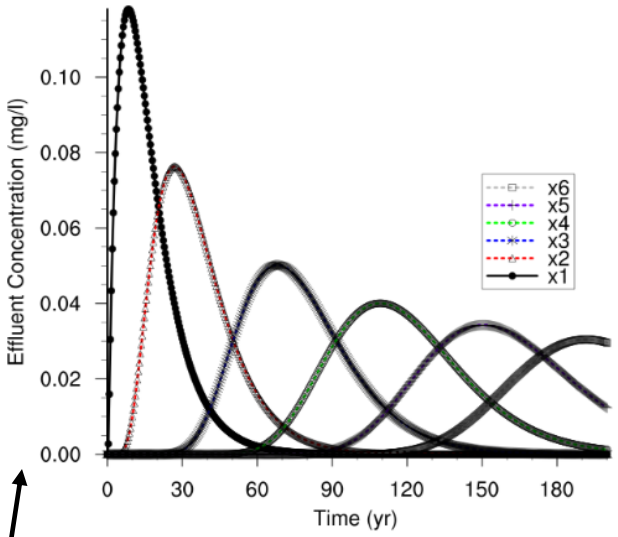
X-axis interval(put a comparable interval with model setting): 4 (m)

Z-axis interval(put a comparable interval with model setting): 2 (m)

RUN MODEL

Visualize Model Output:

OBS GO



After simulation, the concentrations at the monitoring locations are allowed to graphically output. The graphic can be saved as separated file.

Webpage to Visualize Model Output for Module #1

File Edit View History Bookmarks Tools Help

2D Water Leach Test

143.132.96.67/~wischleach/2dwlt.html

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2D Water Leach Test

WisLEACH 2.0

Input Monitoring Wells location:

Horizontal location (m)	Vertical location (m)
0.0	0.55
0.0	1.0
0.0	2.0
0.0	3.0
0.0	4.0
0.0	5.0

Do you only want to get 2D contour? ◉Yes ○No

What is total Number of Contour Plots (maximum 4)? 4

Input time for the contour plot (yr): 1 5 20 40

Input X/Z axis intervals:

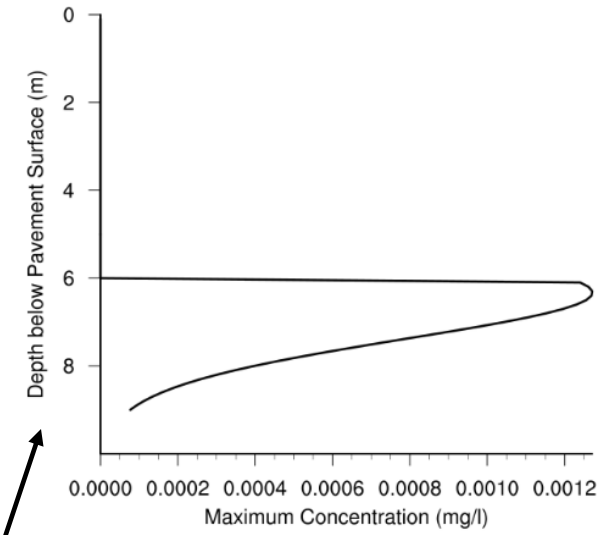
X-axis interval(put a comparable interval with model setting): 4 (m)

Z-axis interval(put a comparable interval with model setting): 2 (m)

RUN MODEL

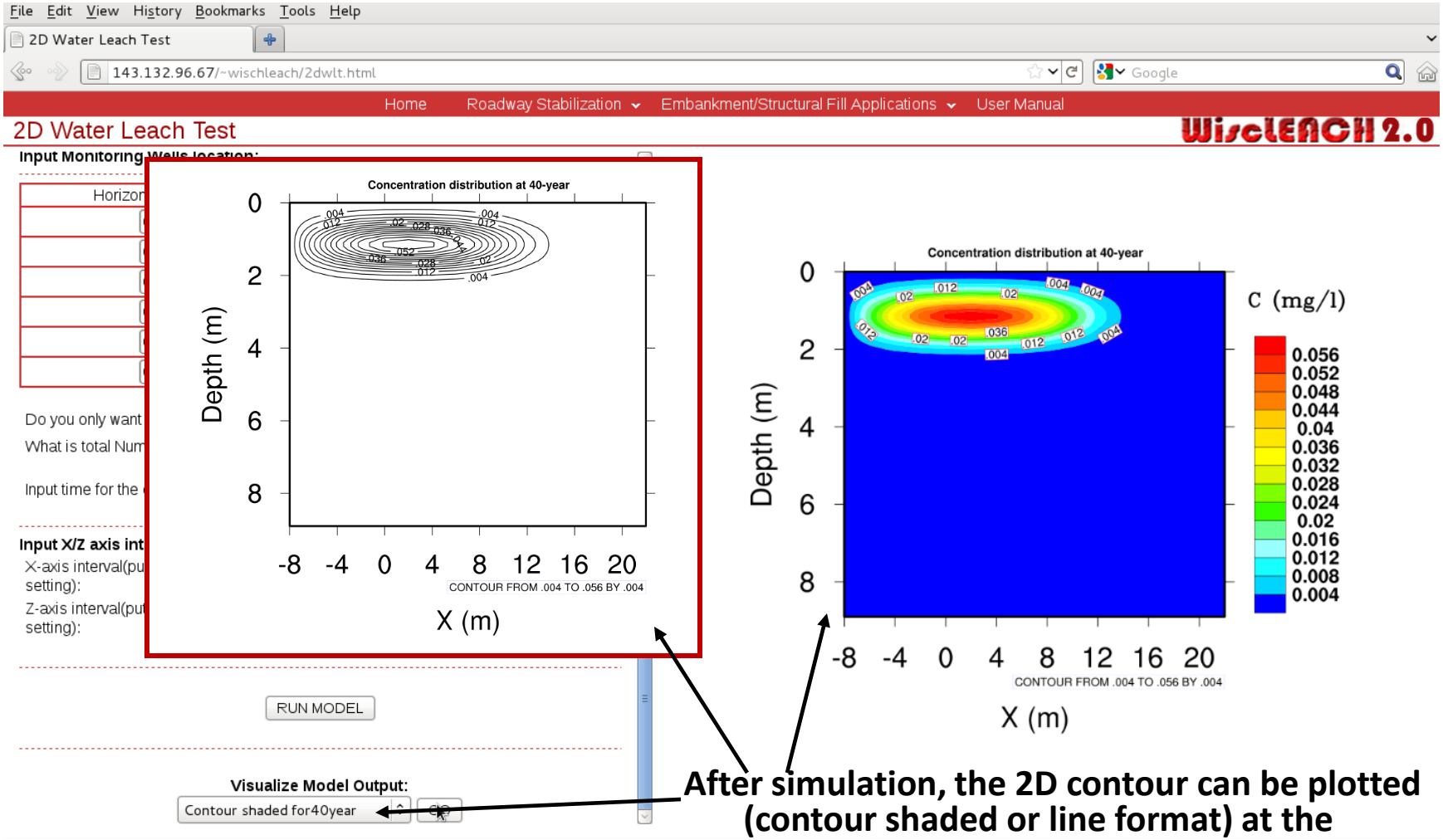
Visualize Model Output:

max Conc GO



After simulation, the maximum concentrations at the POC during the maximum simulation time are plotted. The figure can be saved as separated file.

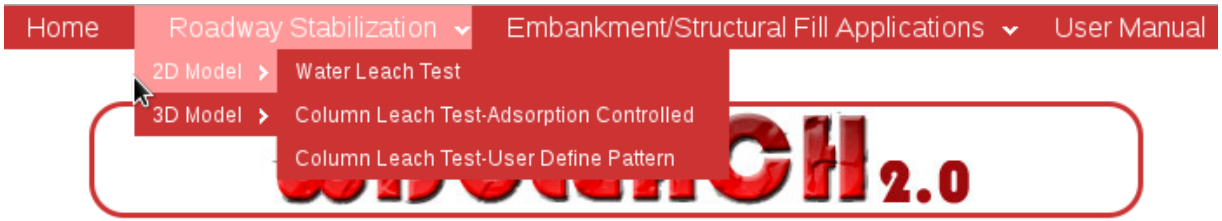
Webpage to Visualize Model Output for Module #1



After simulation, the 2D contour can be plotted (contour shaded or line format) at the specified time. The graphic can be saved as separated file.

Module #2: Roadway Stabilization (2D model) - Column Leach Test – Adsorption Controlled

- **Select the menu/Roadway Stabilization/2D Model/Column Leach Test – Adsorption Controlled**



A computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications. The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater. The application was designed to be computationally efficient and can be used without experience in numerical modeling. © 2011. Developed by Dr. Lin Li at Jackson State University.

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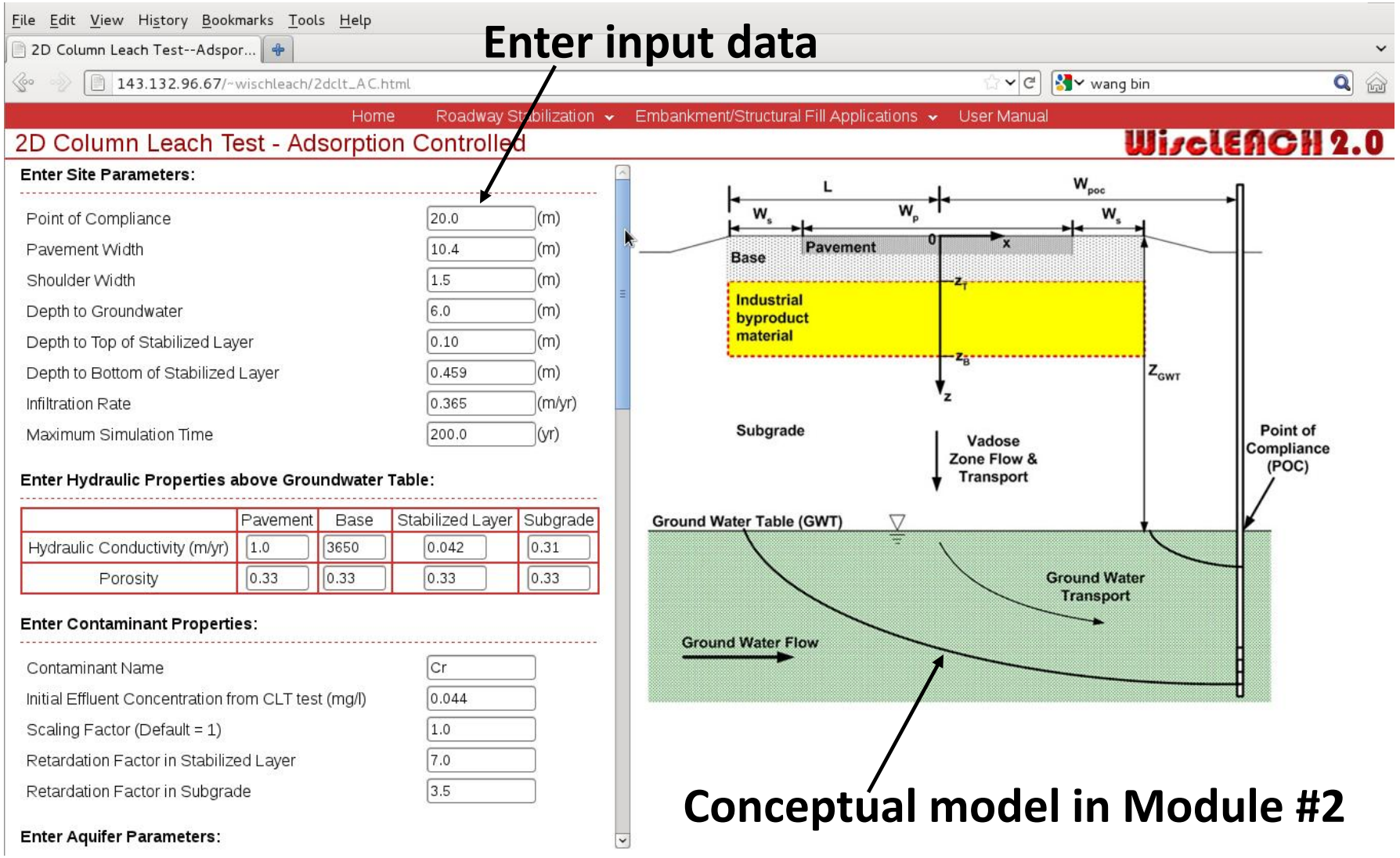
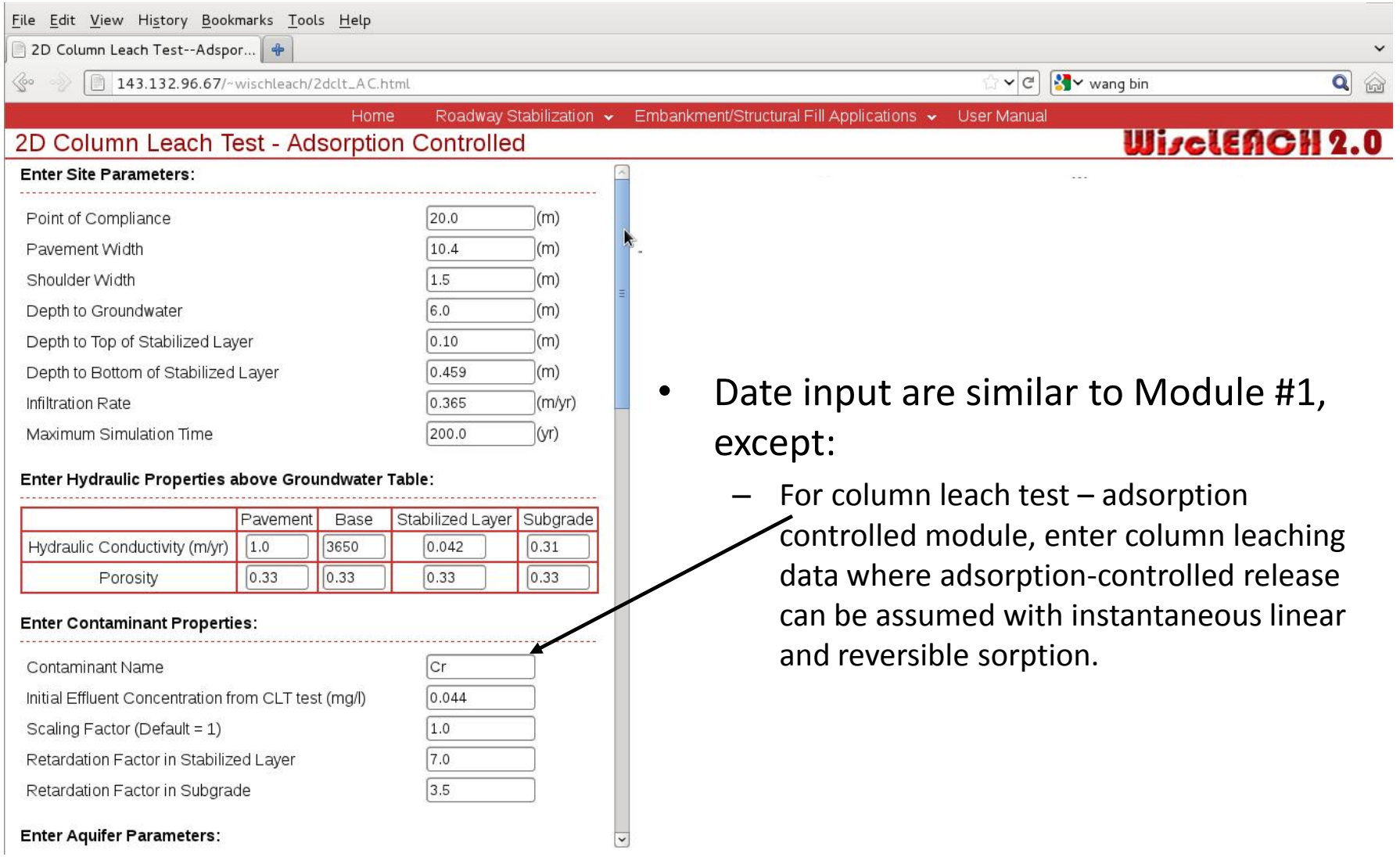
Initial Webpage After Launching Module #2



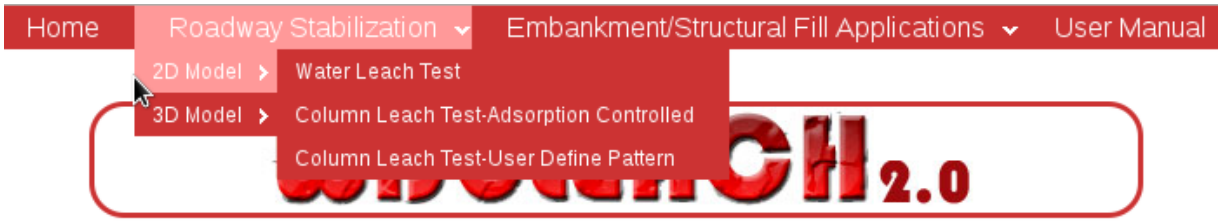
Data Input Windows for Module #2



- Date input are similar to Module #1, except:
  - For column leach test – adsorption controlled module, enter column leaching data where adsorption-controlled release can be assumed with instantaneous linear and reversible sorption.

Module #3: Roadway Stabilization (2D model) - Column Leach Test – User Defined Pattern

- **Select the menu/Roadway Stabilization/2D Model/Column Leach Test – User Defined Pattern**



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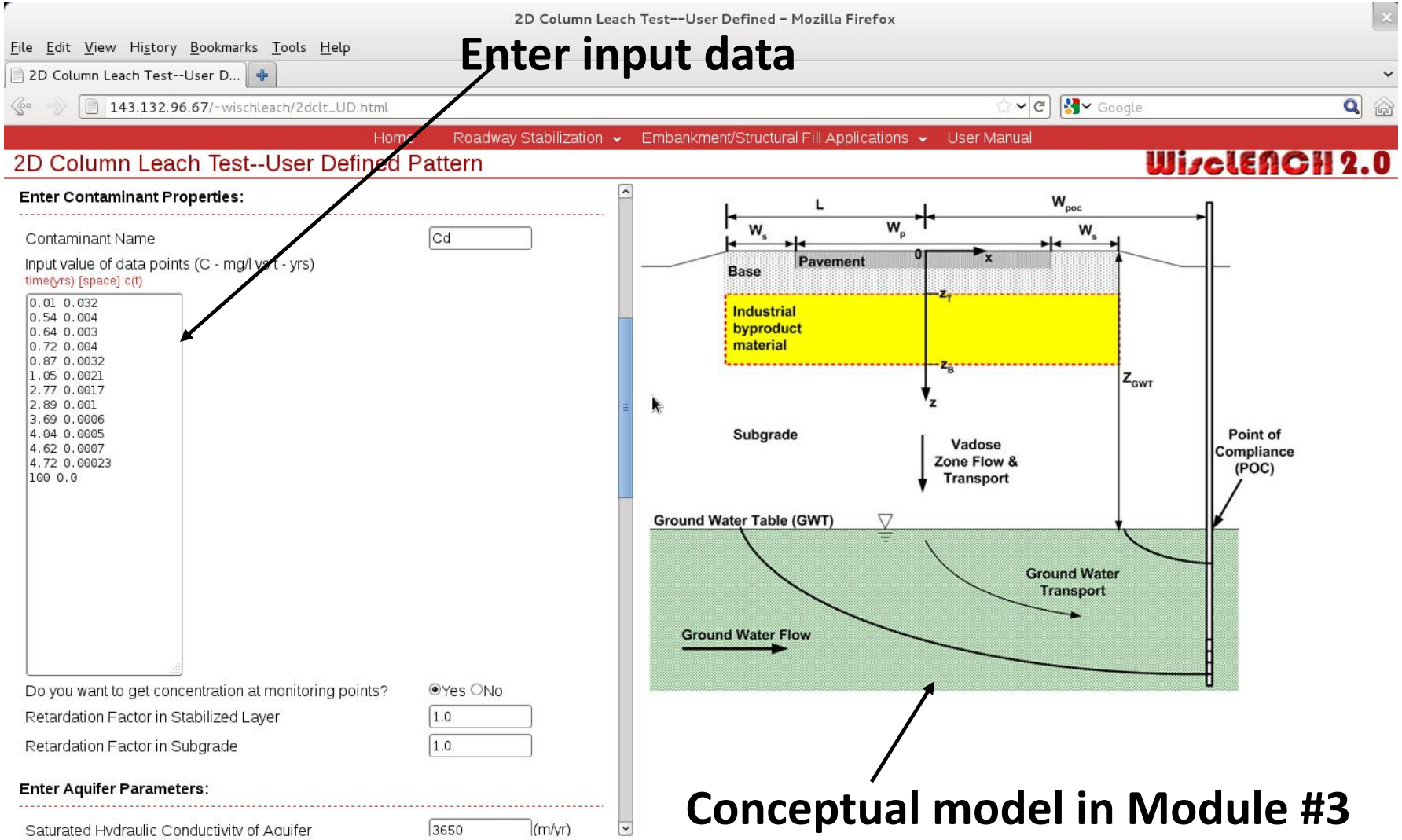
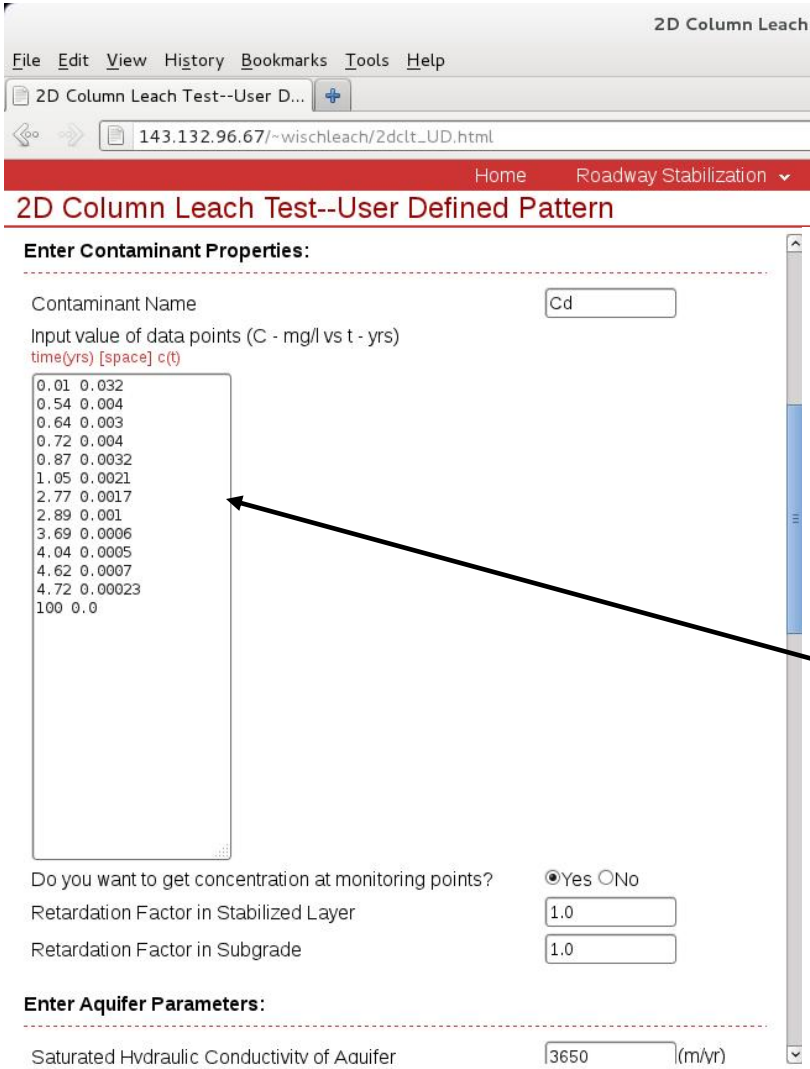
Initial Webpage After Launching Module #3



Enter input data

Conceptual model in Module #3

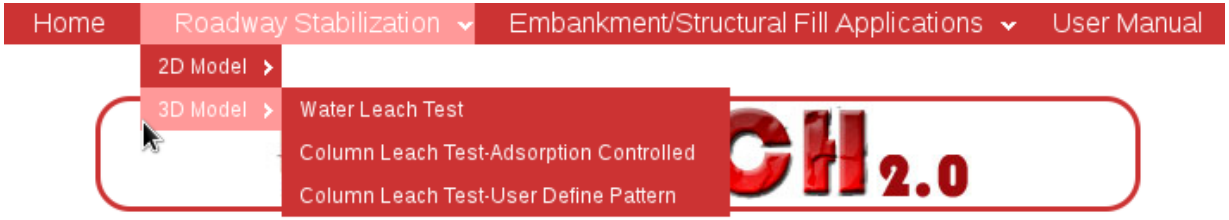
Data Input Windows for Module #3



- Date input are similar to Module #1, except:
  - For column leach test – user defined pattern module, enter leachate concentrations at various time.

Module #4: Roadway Stabilization (3D model) - Water Leach Test

- **Select the menu/Roadway Stabilization/3D Model/Water Leach Test**



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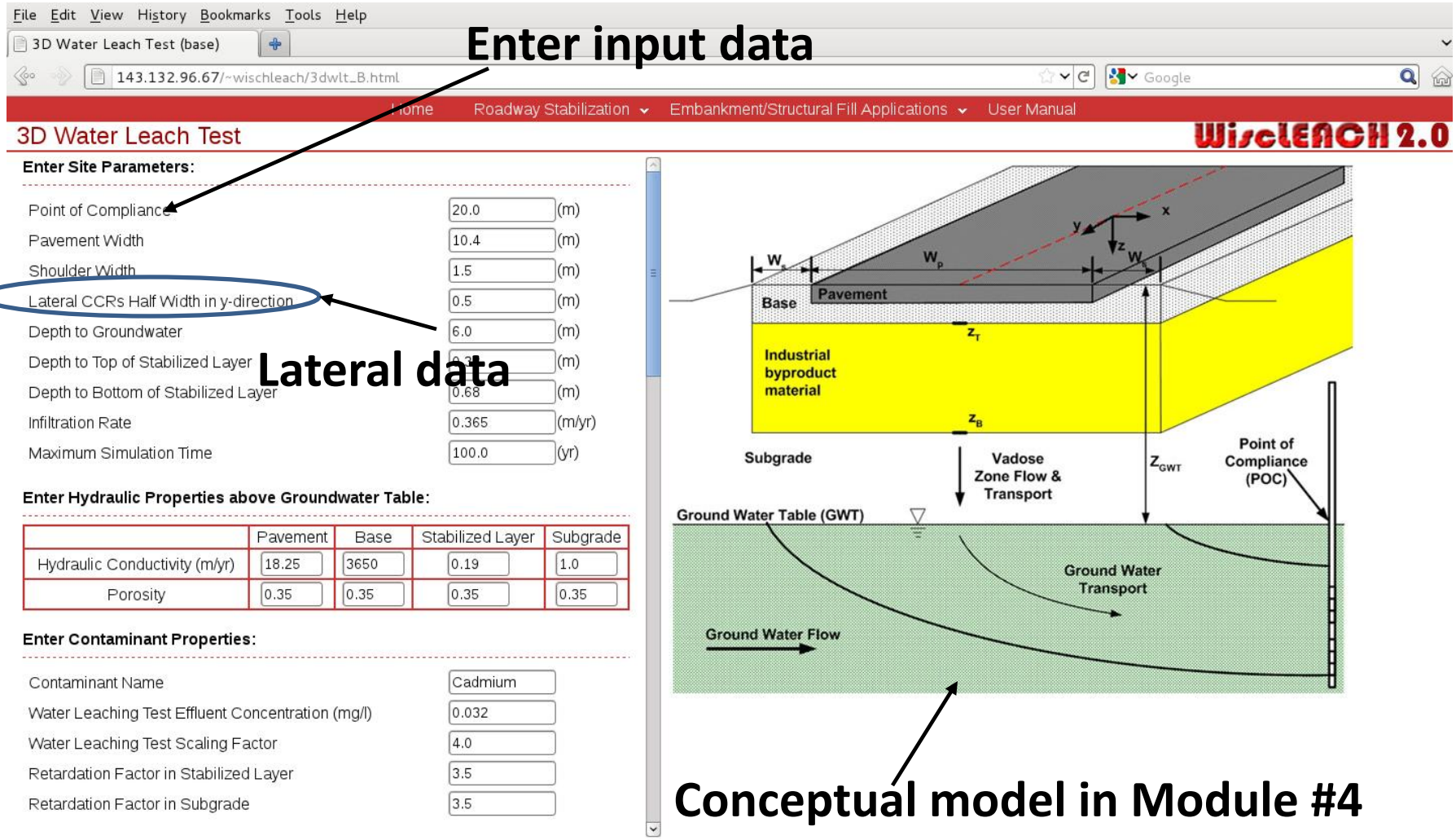
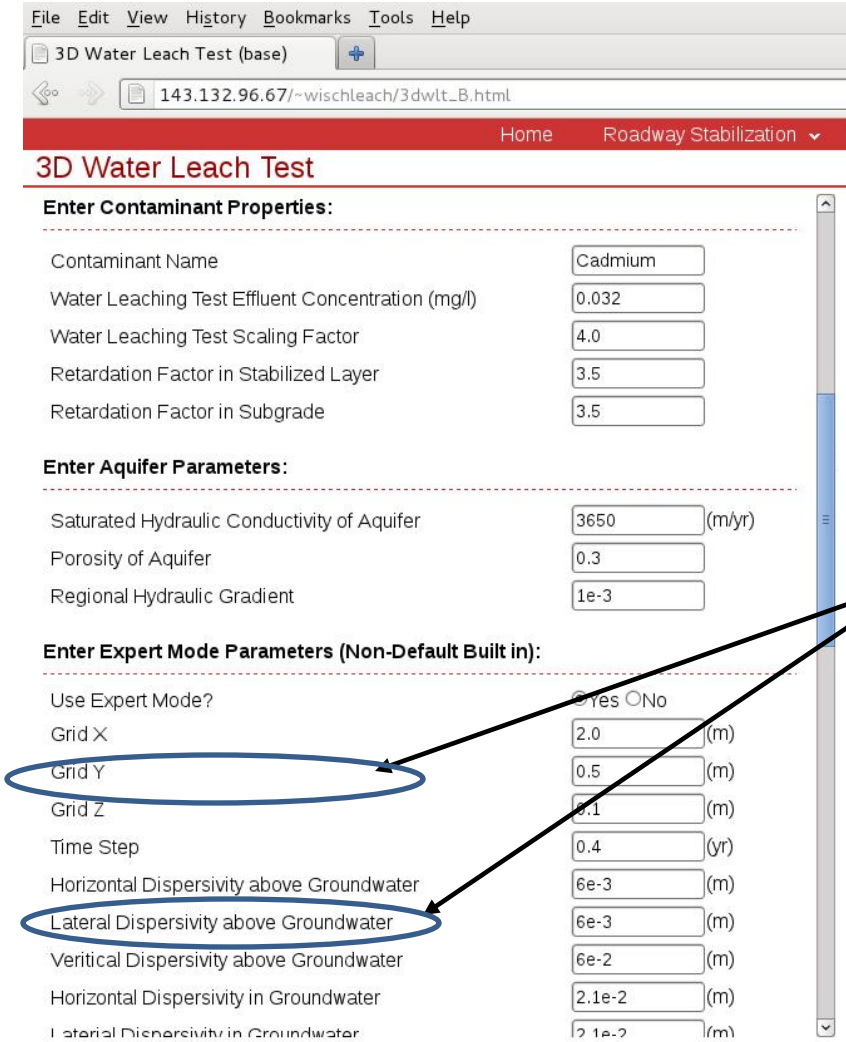
Initial Webpage After Launching Module #4

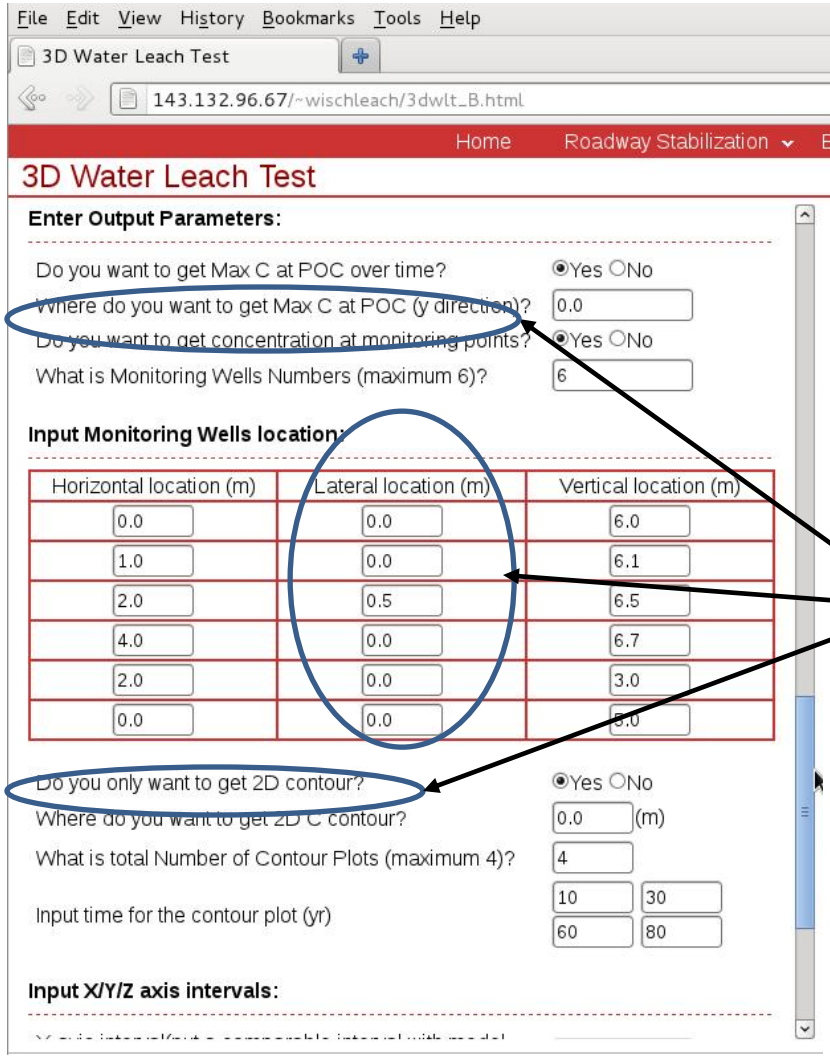


Data Input Windows for Module #4 (Cont')



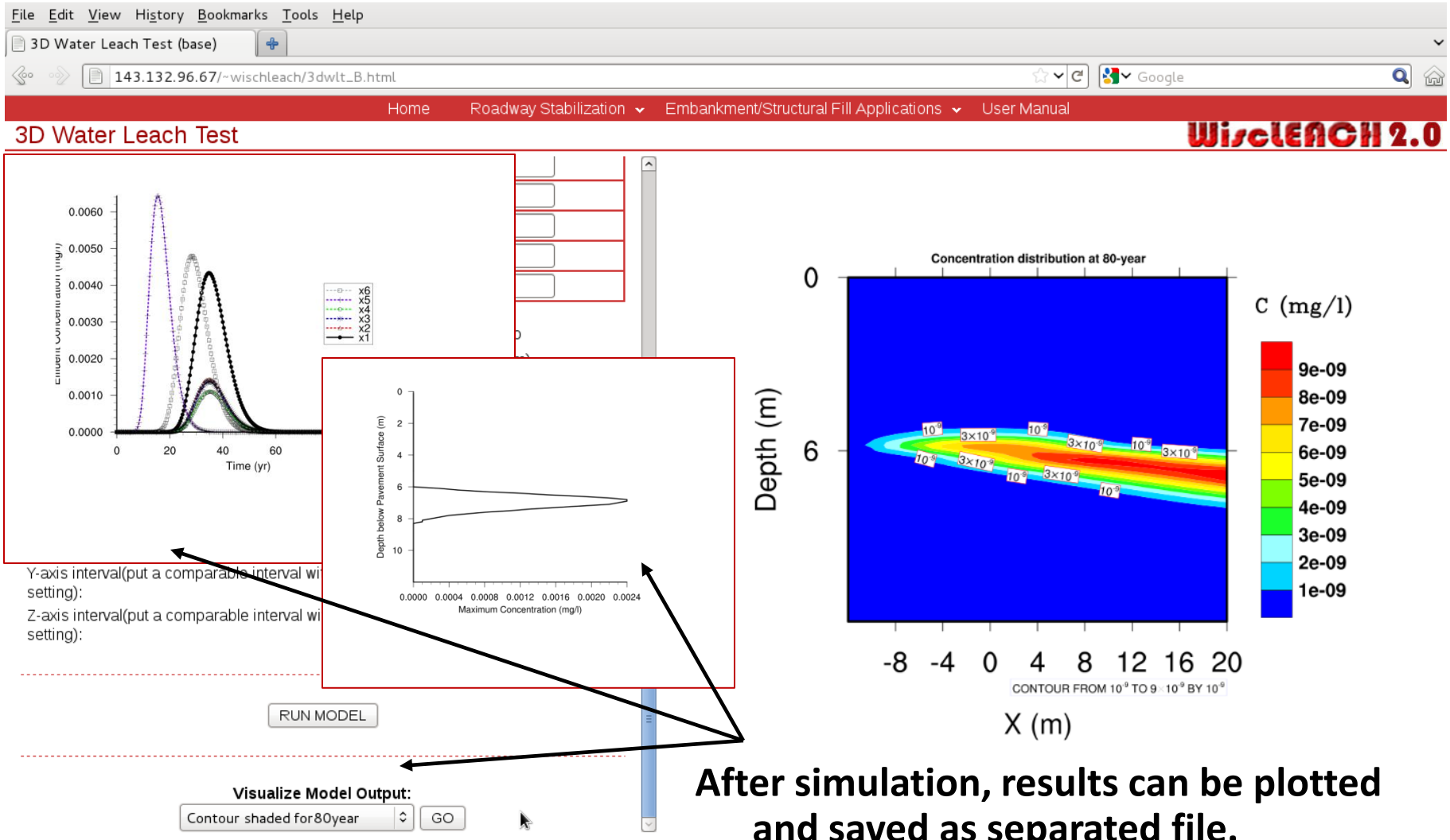
- Date input are similar to Module #1, except
  - Enter lateral grid space.
  - Enter lateral dispersivity.

Data Input Windows for Module #4 (Cont')



- Date input are similar to Module #1, except:
  - Enter lateral location for POC
  - Enter lateral location for MW locations
  - Enter lateral location for contours

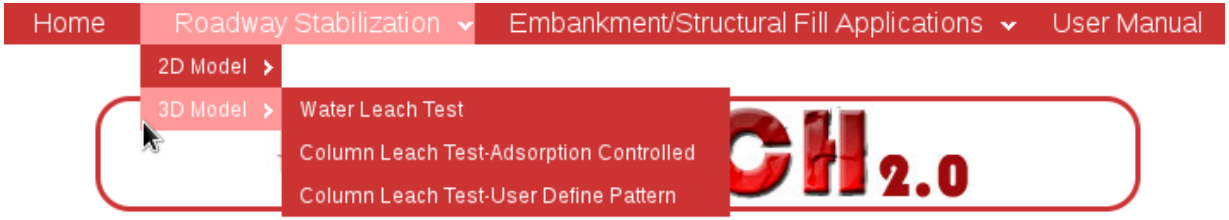
Webpage to Visualize Model Output for Module #4



After simulation, results can be plotted and saved as separated file.

Module #5: Roadway Stabilization (3D model) - Column Leach Test – Adsorption Controlled

- **Select the menu/Roadway Stabilization/3D Model/Column Leach Test – Adsorption Controlled**



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Initial Webpage After Launching Module #5

Enter input data

File Edit View History Bookmarks Tools Help

3D Column Leach Test--absorp...

143.132.96.67/~wischleach/3dclt_AC_B.html

Google

Home | Roadway Stabilization | Embankment/Structural Fill Applications | User Manual

3D Column Leach Test - Adsorption Controlled

WisLEACH 2.0

Enter Site Parameters:

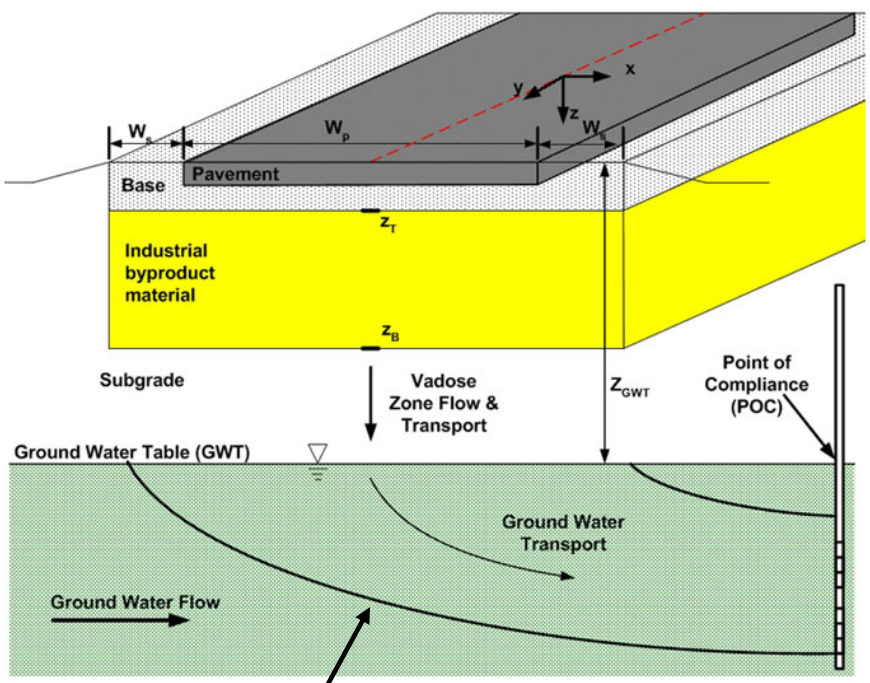
Point of Compliance	20.0	(m)
Pavement Width	10.4	(m)
Shoulder Width	1.5	(m)
Lateral CCRs Half Width in y-direction	0.5	(m)
Depth to Groundwater	6.0	(m)
Depth to Top of Stabilized Layer	0.38	(m)
Depth to Bottom of Stabilized Layer	0.68	(m)
Infiltration Rate	0.365	(m/yr)
Maximum Simulation Time	100.0	(yr)

Enter Hydraulic Properties above Groundwater Table:

	Pavement	Base	Stabilized Layer	Subgrade
Hydraulic Conductivity (m/yr)	18.25	3650	0.19	1.0
Porosity	0.35	0.35	0.35	0.35

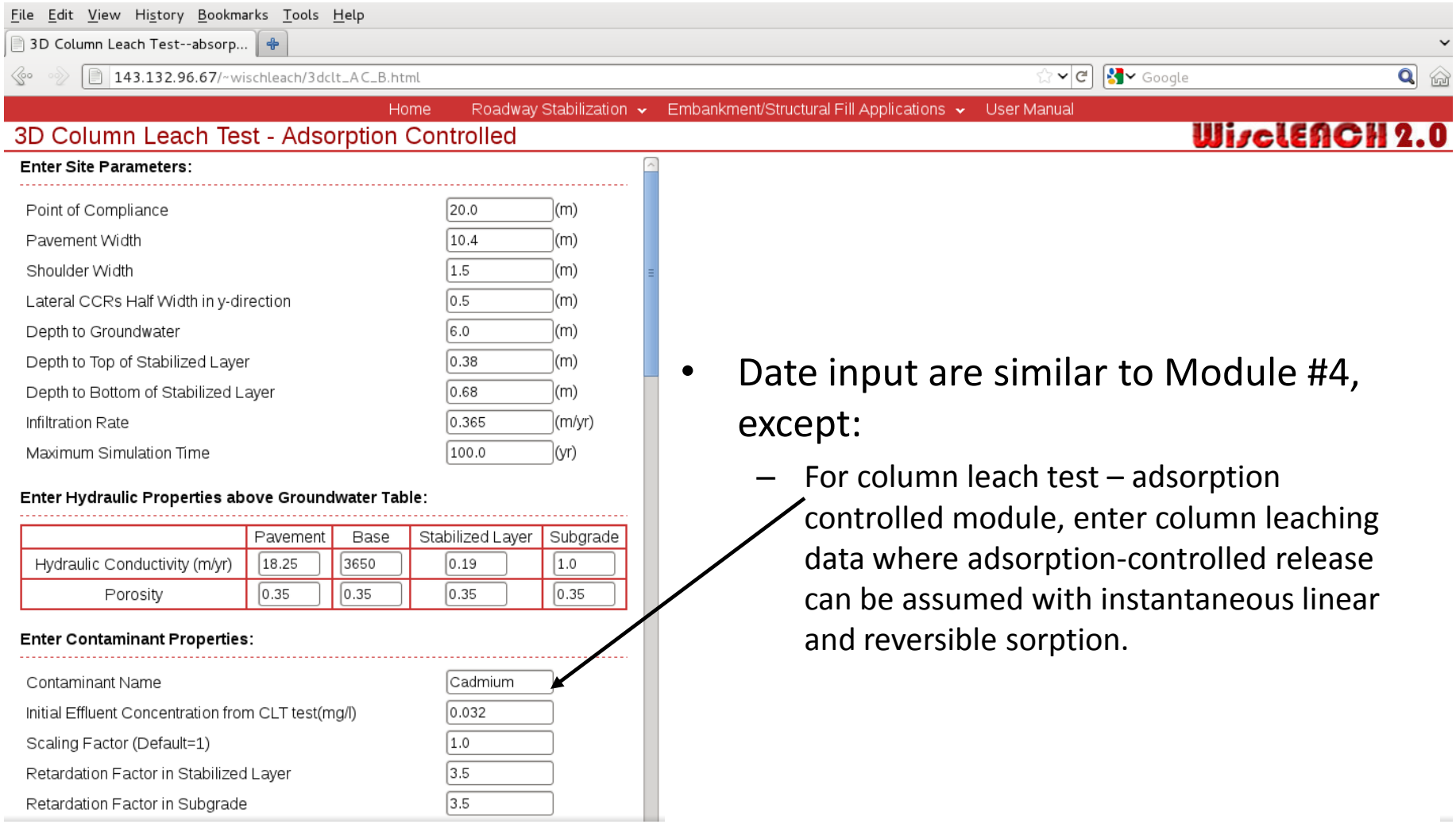
Enter Contaminant Properties:

Contaminant Name	Cadmium
Initial Effluent Concentration from CLT test(mg/l)	0.032
Scaling Factor (Default=1)	1.0
Retardation Factor in Stabilized Layer	3.5
Retardation Factor in Subgrade	3.5



Conceptual model in Module #5

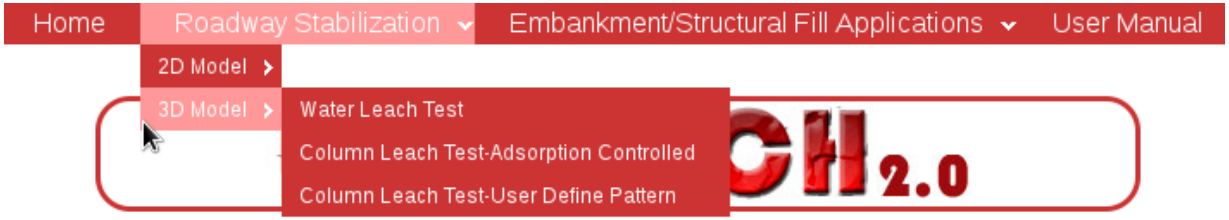
Data Input Windows for Module #5



- Date input are similar to Module #4, except:
  - For column leach test – adsorption controlled module, enter column leaching data where adsorption-controlled release can be assumed with instantaneous linear and reversible sorption.

Module #6: Roadway Stabilization (3D model) - Column Leach Test – User Defined Pattern

- **Select the menu/Roadway Stabilization/3D Model/Column Leach Test – User Defined Pattern**



A computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications. The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater. The application was designed to be computationally efficient and can be used without experience in numerical modeling. © 2011. Developed by Dr. Lin Li at Jackson State University.

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Contact Information for Q & A:
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Jackson, MS 39217-0168, US

Acknowledgement: Financial support for the development of WiscLeach software was provided by the Recycled Materials Resource Center and Wisconsin Department of Natural Resources Waste Reduction and Recycling Demonstration Grant and Alliant Energy.

Initial Webpage After Launching Module #6

Enter input data

File Edit View History Bookmarks Tools Help

3D Column Leach Test--user D...

143.132.96.67/~wischleach/3dclt_UD_B.html

Google

Home | Roadway Stabilization | Embankment/Structural Fill Applications | User Manual

3D Column Leach Test--User Defined Pattern

WiscLEACH 2.0

Enter Site Parameters:

Point of Compliance	12.7	(m)
Pavement Width	10.4	(m)
Shoulder Width	1.5	(m)
Lateral CCRs Half Width in y-direction	0.5	(m)
Depth to Groundwater	5.0	(m)
Depth to Top of Stabilized Layer	0.38	(m)
Depth to Bottom of Stabilized Layer	0.68	(m)
Infiltration Rate	0.042	(m/yr)
Maximum Simulation Time	100.0	(yr)

Enter Hydraulic Properties above Groundwater Table:

	Pavement	Base	Stabilized Layer	Subgrade
Hydraulic Conductivity (m/yr)	1.0	3650	0.3135	0.90
Porosity	0.33	0.33	0.33	0.33

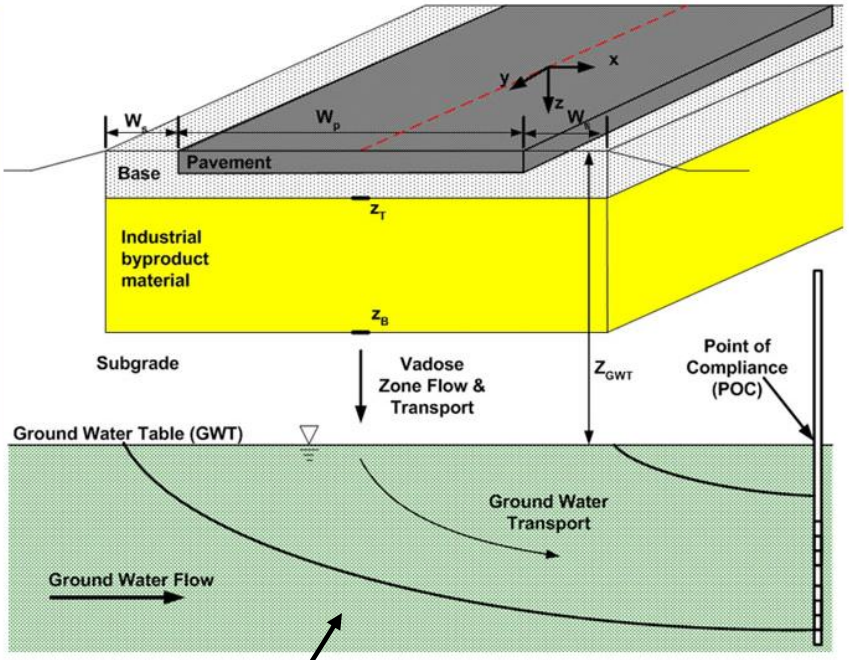
Enter Contaminant Properties:

Contaminant Name: Cd

Input value of data points (C - mg/l vs t - yrs)

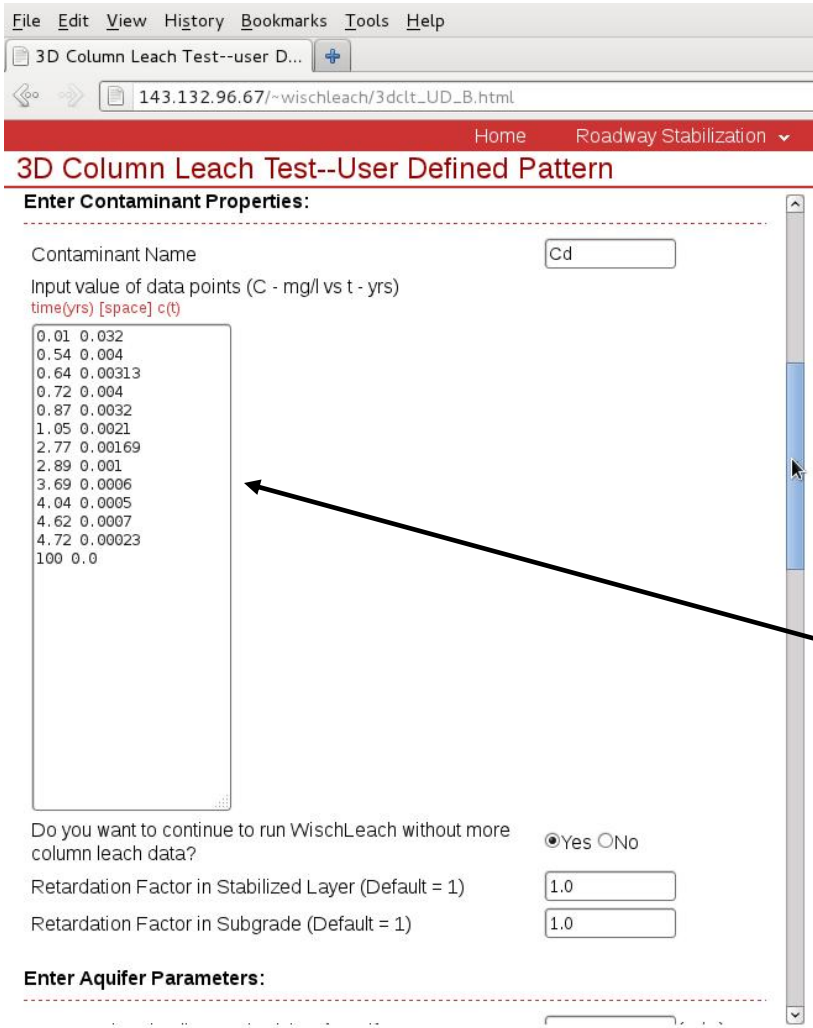
time(yrs) [space] c(t)

```
0.01 0.032
0.54 0.004
0.64 0.00313
0.72 0.004
0.87 0.0032
1.05 0.0021
```



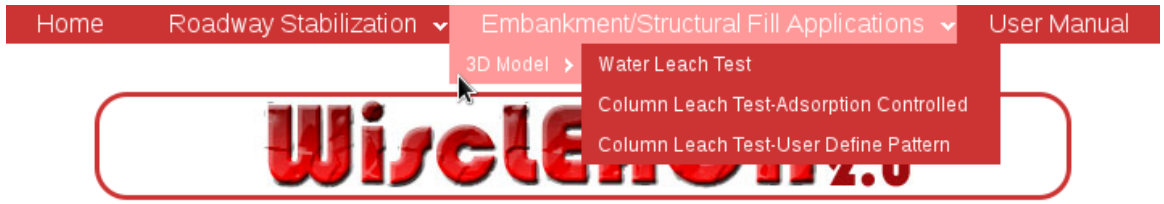
Conceptual model in Module #6

Data Input Windows for Module #6



- Date input are similar to Module #4, except:
  - For column leach test – user defined pattern module, enter leachate concentrations at various time.

Module #7: Embankment/Structural Fill Applications (3D model) - Water Leach Test



A computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications. The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater. The application was designed to be computationally efficient and can be used without experience in numerical modeling. © 2011. Developed by Dr. Lin Li at Jackson State University.

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- **Select the menu/Embankment/Structural Fill Applications/3D Model/Water Leach Test**

Initial Webpage After Launching Module #7

File Edit View History Bookmarks Tools Help

Water Leach Test for Embankm...

143.132.96.67/~wischleach/3dwlt_E.html

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Water Leach Test for Embankment/Structural Fill Applications

WisLEACH 2.0

Enter input data

Enter Site Parameters:

Point of Compliance	30.0	(m)
Pavement Width	6.0	(m)
Shoulder Width	4.0	(m)
Lateral Byproduct Half Width in y-direction	0.5	(m)
Depth to Groundwater	10.0	(m)
Depth to Top of Byproduct Layer	1.0	(m)
Depth to Bottom of Byproduct	4.0	(m)
Depth to Ground Surface	5.0	(m)
Embankment Side Slope H:V	3.00	(m)
Infiltration Rate	0.19	(m/yr)
Maximum Simulation Time	300.0	(yr)

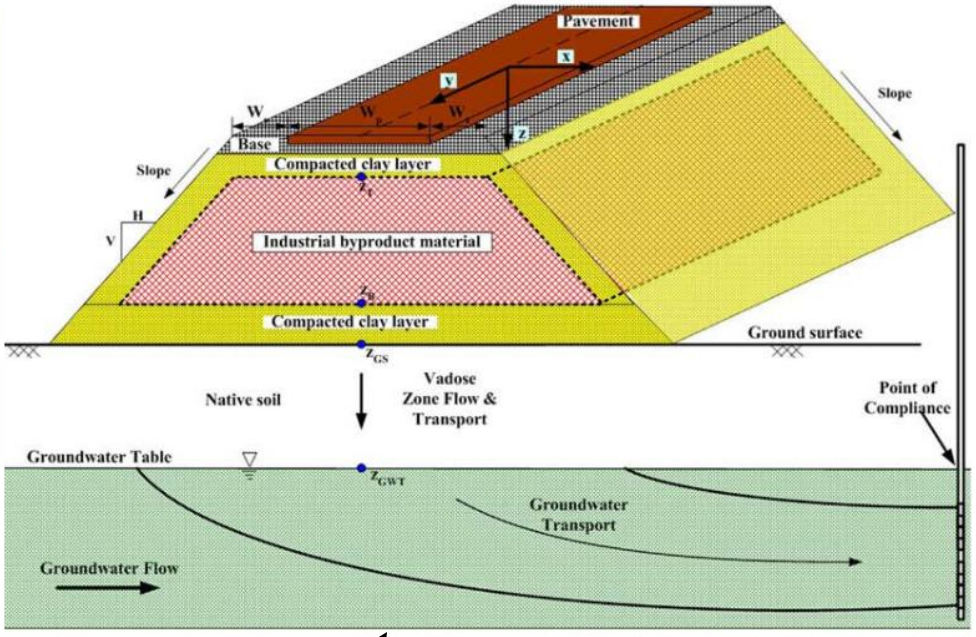
Embankment data

Enter Hydraulic Properties above Groundwater Table:

	Pavement	Base	Compact Clay Layer	Byproduct Layer	Subgrade
Hydraulic Conductivity (m/yr)	18.25	3650	0.042	1.0	3.56
Porosity	0.33	0.33	0.33	0.33	0.33

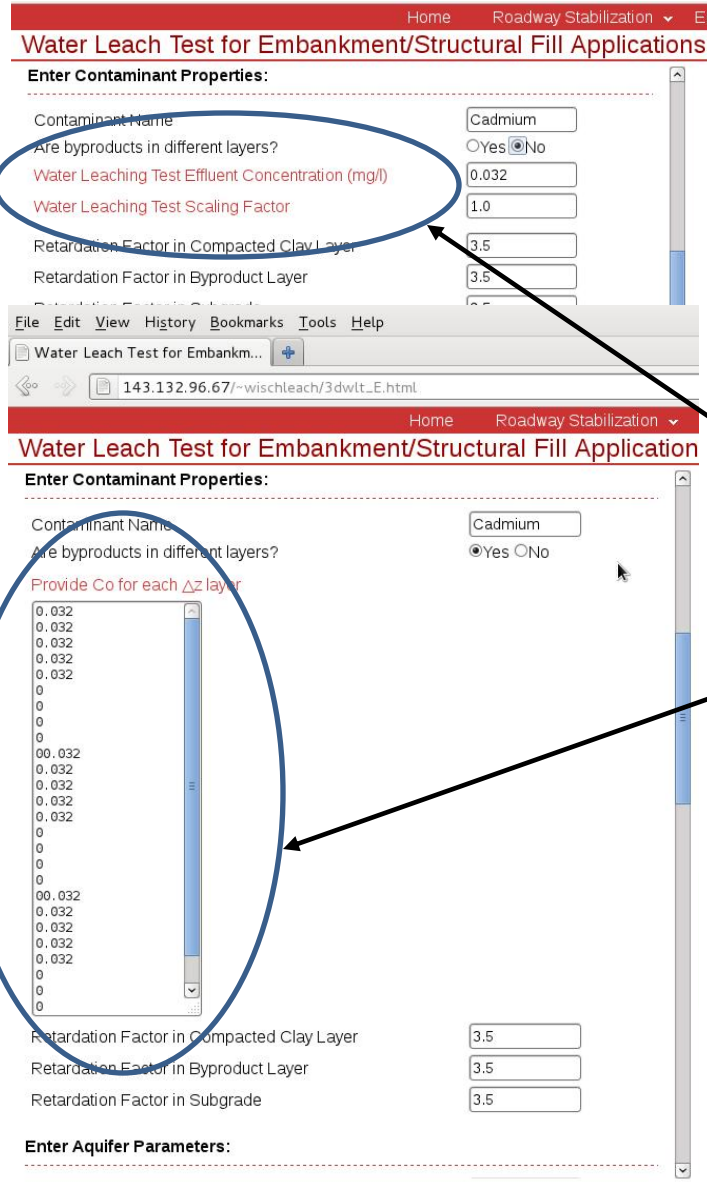
Enter Contaminant Properties:

Contaminant Name	Cadmium
Are byproducts in different layers?	○Yes ○No



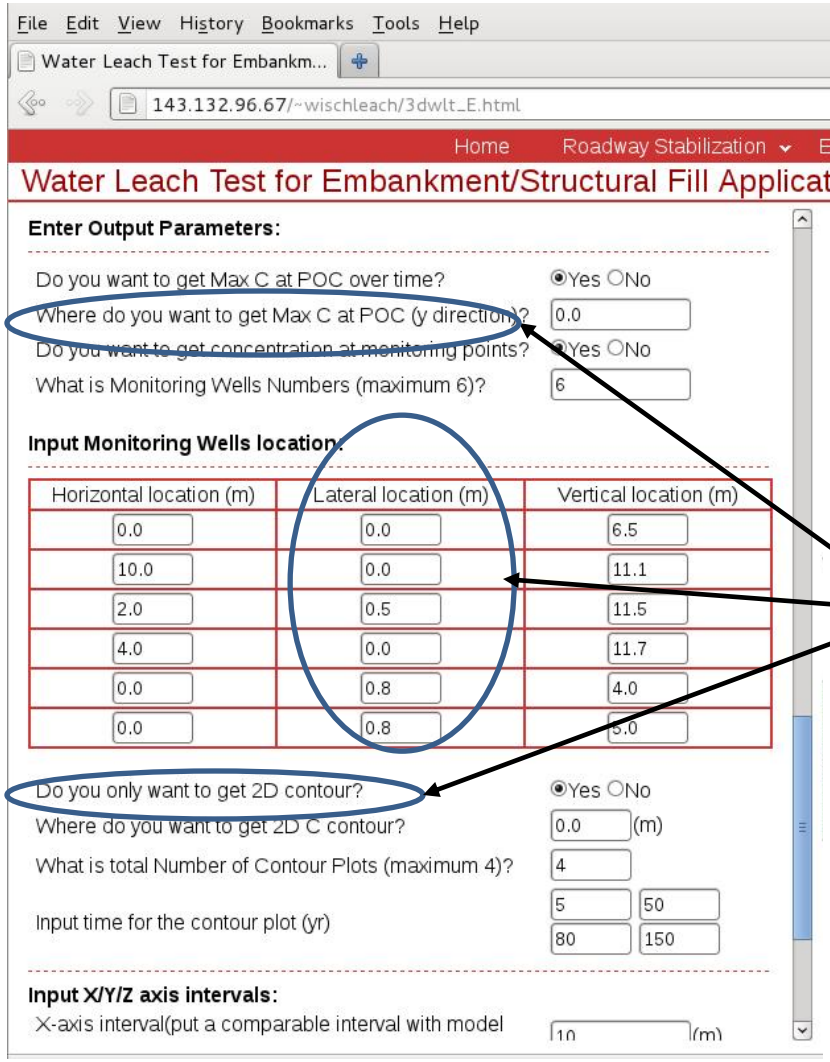
Conceptual model in Module #7

Data Input Windows for Module #7 (Cont')



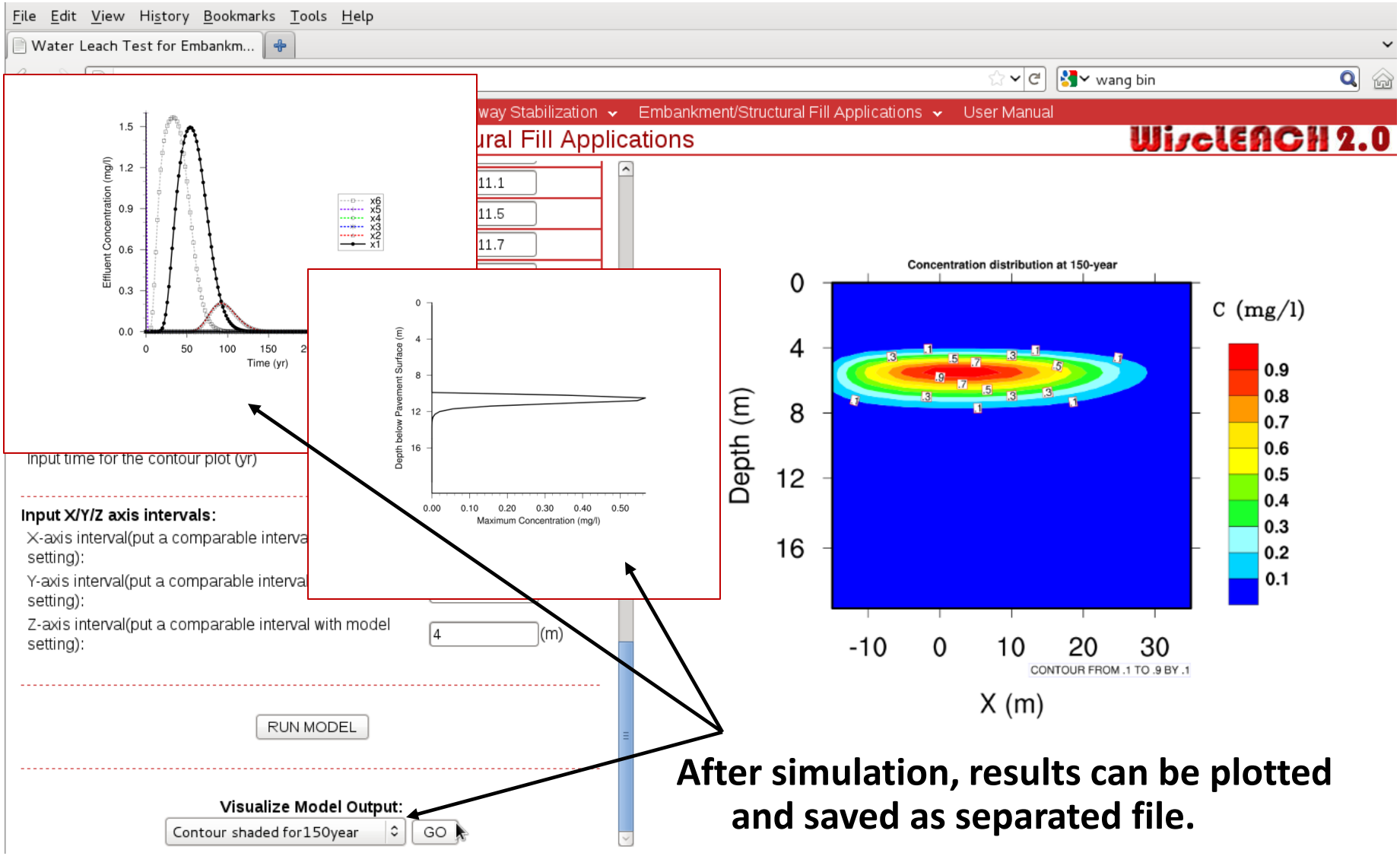
- Date input are similar to Module #4, except
  - Select the byproducts in different layer. If "No", the byproducts is in one layer. Enter the WLT concentration and scaling factor.
  - If "Yes", the byproducts are in different layers. Enter WLT concentration in each Δz layer.

Data Input Windows for Module #7 (Cont')



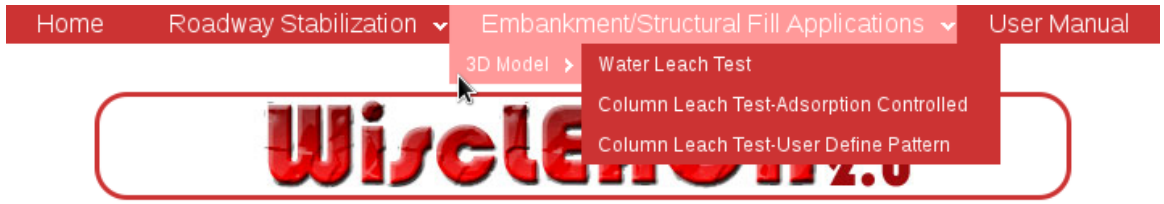
- Date input are similar to Module #4, except:
  - Enter lateral location for POC
  - Enter lateral location for MW locations
  - Enter lateral location for contours

Webpage to Visualize Model Output for Module #7



After simulation, results can be plotted and saved as separated file.

Module #8: Embankment/Structural Fill Applications (3D model) - Adsorption Controlled



A computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications. The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater. The application was designed to be computationally efficient and can be used without experience in numerical modeling. © 2011. Developed by Dr. Lin Li at Jackson State University.

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- **Select the menu/Embankment/Structural Fill Applications/3D Model/Adsorption Controlled**

Initial Webpage After Launching Module #8

File Edit View History Bookmarks Tools Help

Column Leach Test--absorption...

143.132.96.67/~wischleach/3dclt_AC_E.html

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Column Leach Test - Adsorption Controlled for Embankment/Structural Fill Applications

WiscLEACH 2.0

Enter input data

Enter Site Parameters:

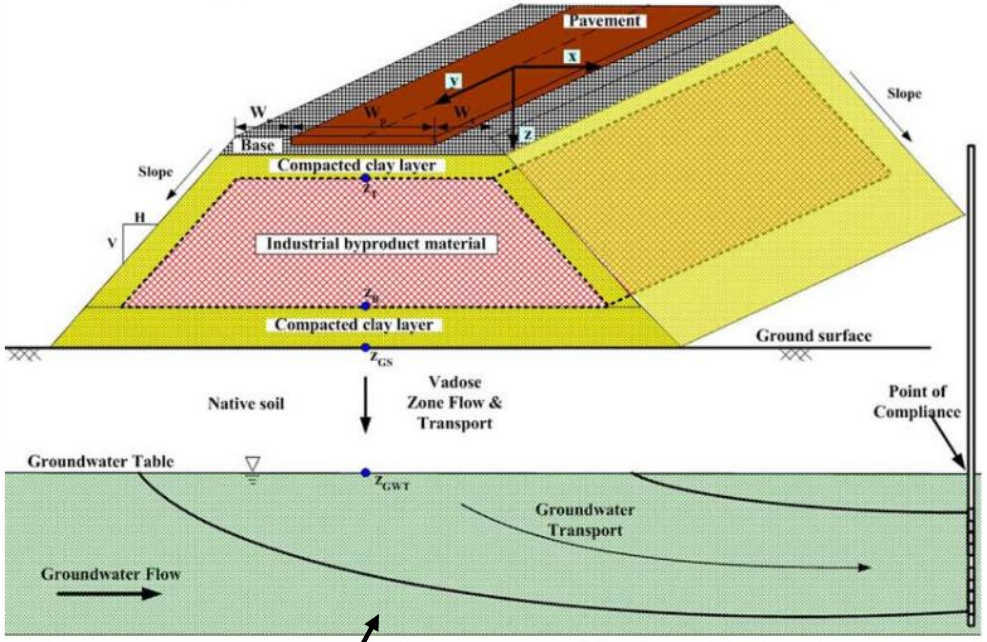
Point of Compliance	30.0	(m)
Pavement Width	6.0	(m)
Shoulder Width	4.0	(m)
Lateral Byproduct Half Width in y-direction	0.5	(m)
Depth to Groundwater	10.0	(m)
Depth to Top of Byproduct Layer	1.0	(m)
Depth to Bottom of Byproduct	4.0	(m)
Depth to Ground Surface	5.0	(m)
Embankment Side Slope H:V	3.00	(m)
Infiltration Rate	0.19	(m/yr)
Maximum Simulation Time	300.0	(yr)

Enter Hydraulic Properties above Groundwater Table:

	Pavement	Base	Compact Clay Layer	Byproduct Layer	Subgrade
Hydraulic Conductivity (m/yr)	18.25	3650	0.042	1.0	3.56
Porosity	0.33	0.33	0.33	0.33	0.33

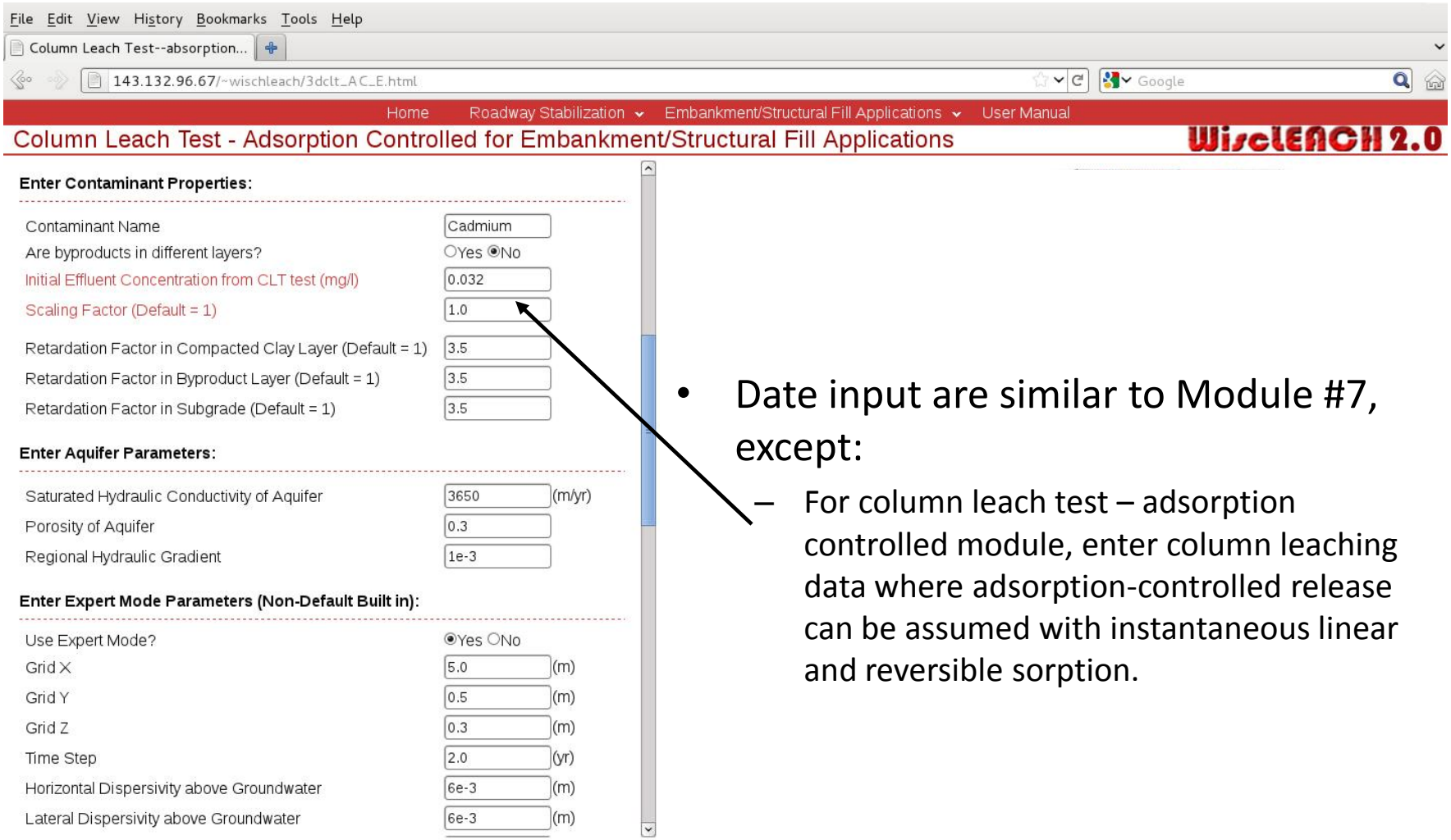
Enter Contaminant Properties:

Contaminant Name	Cadmium
Are byproducts in different layers?	○Yes ◉No
Initial Effluent Concentration from CLT test (mg/l)	0.032



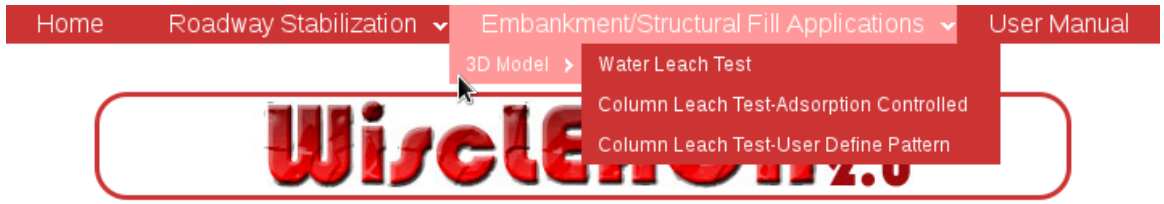
Conceptual model in Module #8

Data Input Windows for Module #8



- Date input are similar to Module #7, except:
  - For column leach test – adsorption controlled module, enter column leaching data where adsorption-controlled release can be assumed with instantaneous linear and reversible sorption.

Module #9: Embankment/Structural Fill Applications (3D model) - User Defined Pattern



A computing tool to evaluate groundwater impacts from beneficial use of industrial byproducts in roadway stabilization and embankment/structural fill applications. The tool is based on three analytical solutions to the advection-dispersion-reaction equation that describe transport in the vadose zone and groundwater. The application was designed to be computationally efficient and can be used without experience in numerical modeling. © 2011. Developed by Dr. Lin Li at Jackson State University.

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- **Select the menu/Embankment/Structural Fill Applications/3D Model/User Defined Pattern**

Initial Webpage After Launching Module #9

Enter input data

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Column Leach Test--User Defin...

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Column Leach Test--User Defined for Embankment/Structural Fill Applications

WiscLEACH 2.0

Enter Site Parameters:

Point of Compliance	25.0	(m)
Pavement Width	6.0	(m)
Shoulder Width	4.0	(m)
Lateral Byproduct Half Width in y-direction	0.5	(m)
Depth to Groundwater	10.0	(m)
Depth to Top of Byproduct Layer	1.0	(m)
Depth to Bottom of Byproduct	4.0	(m)
Depth to Ground Surface	5.0	(m)
Embankment Side Slope H:V	3.00	(m)
Infiltration Rate	0.19	(m/yr)
Maximum Simulation Time	100.0	(yr)

Enter Hydraulic Properties above Groundwater Table:

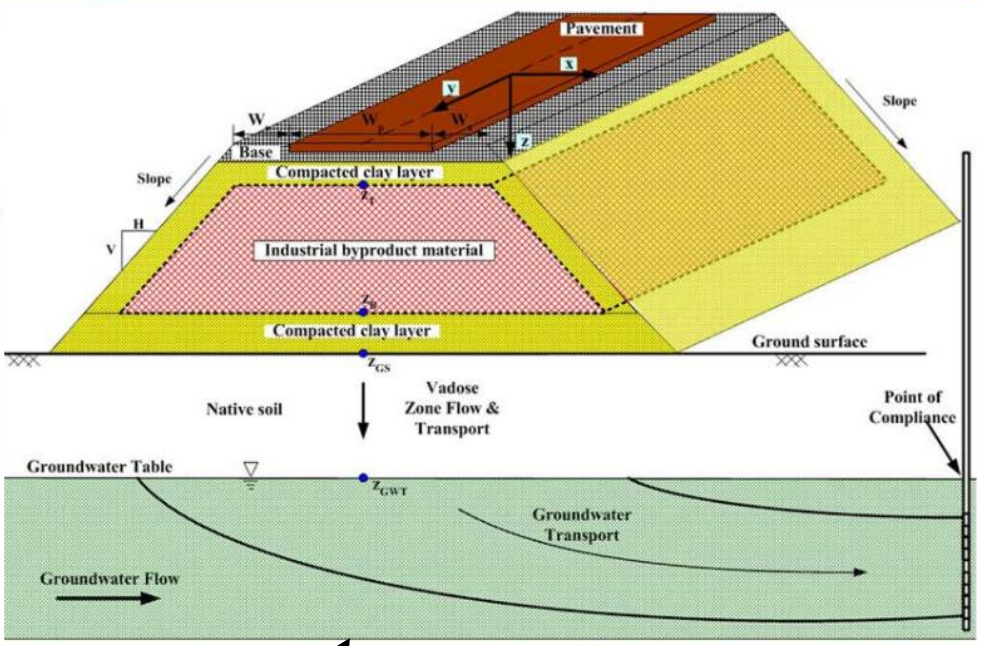
	Pavement	Base	Compact Clay Layer	Byproduct Layer	Subgrade
Hydraulic Conductivity (m/yr)	18.25	3650	0.2	1.0	3.56
Porosity	0.33	0.33	0.33	0.33	0.33

Enter Contaminant Properties:

Contaminant Name: Cd

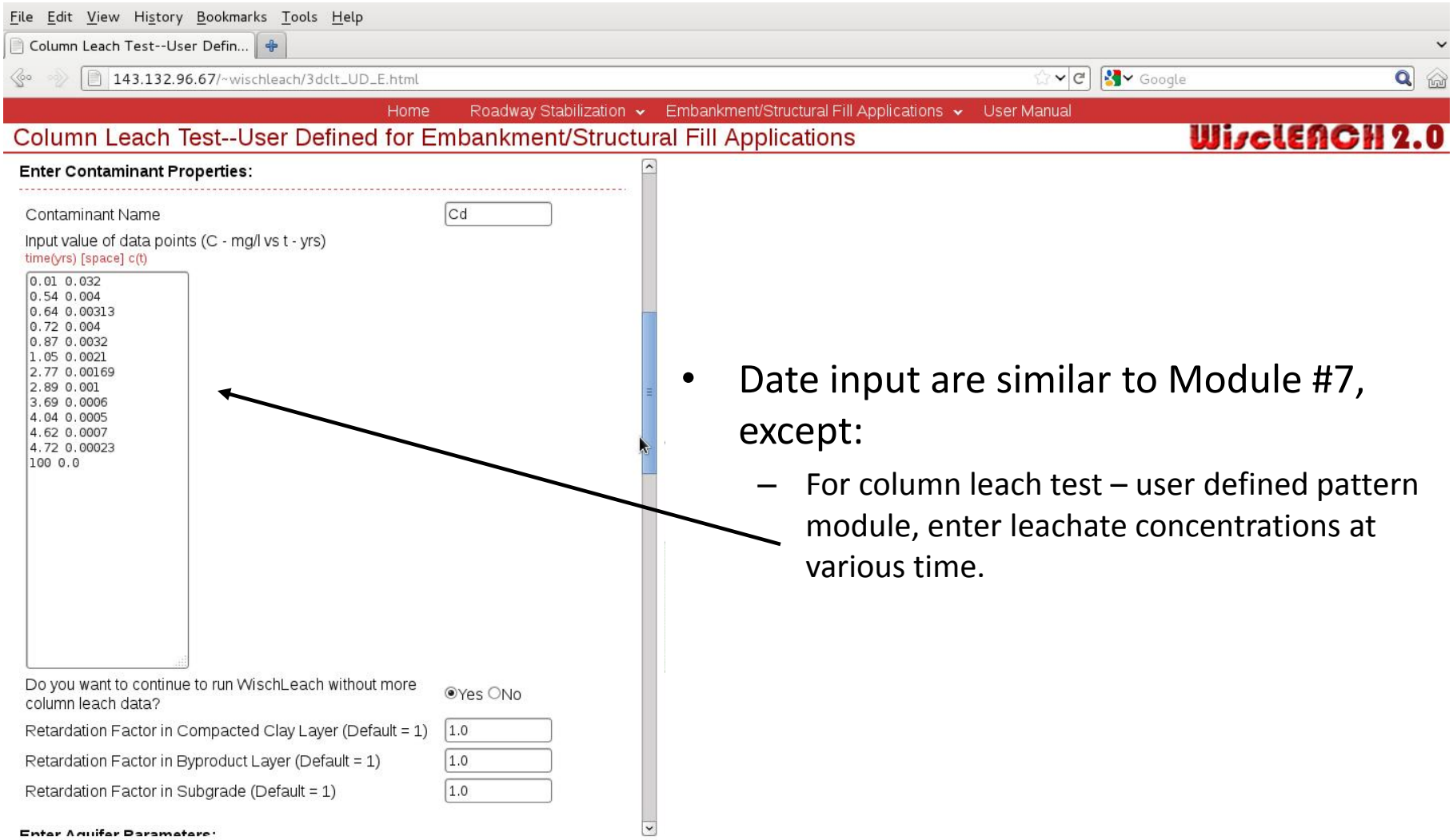
Input value of data points (C - mg/l vs t - yrs)

time(yrs) [space] c(t)



Conceptual model in Module #9

Data Input Windows for Module #9



- Date input are similar to Module #7, except:
  - For column leach test – user defined pattern module, enter leachate concentrations at various time.

Software Developers

- The algorithms used in WiscLEACH© 2.0 were developed by Dr. Lin Li of Jackson State University.
- The web-based WiscLEACH © 2.0 were developed by Dr. Lin Li, Dr. Duanjun Lu, and Ms. Cindy Mei Wu of Jackson State University.

Publications on WiscLEACH ©

- **Li, L.**, B. Peng, F. Santos, Y. Li, and F. Amini, 2011, Groundwater Impacts from Leaching of Coal Combustion Products in Roadways Embankment Constructions, *Journal of ASTM International*, 8(8): 1-12.
- Cetin, B., Aydilek, A. and **L. Li**, 2011, Experimental and Numerical Analysis of Metal Leaching from Fly Ash Amended Highway Bases, *Resources, Conservation & Recycling,* In Print.
- Cetin, B., Aydilek, A. and **L. Li**, 2011, Leaching of Chromium Metal from High Carbon Fly Ash Stabilized Highway Base Layers, *Geo-Frontiers 2011,* 1066-1074, ASCE.
- **Li, L.,** J. Li, and N. Kebede, 2010, Using WiscLEACH to Estimate Groundwater Impacts from Fly Ash Stabilized Layers in Roadways, *GeoFlorida 2010: Advances in Analysis, Modeling & Design,* D. Fratta, A. Puppala, B. Muhunthan (Eds), 199: 99-108, ASCE.
- **Li, L.,** C.H. Benson, T. B. Edil, and B. Hatipoglu, 2006, Groundwater Impact from Coal Ash in Highways, *Waste and Resource Management,* 159(4): 151-162.
- **Li, L.,** C.H. Benson, T. B. Edil, and B. Hatipoglu, 2006, WiscLEACH: A Model for Predicting Ground Water Impacts from Fly-Ash Stabilized Layers in Roadways, *Geotechnical Engineering in the Information Technology Age*, DeGroot, D.J., DeJong, J.T., Frost, D.J., Baise, L.G. (Eds), 187(58): 1-8, ASCE.