



# HELP 4.0

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Parkhill Smith and Cooper, Inc.



# HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP)

```
C:\WINDOWS\system32\cmd.exe
Hydrologic Evaluation of Landfill Performance

HELPHelp

Version 3.07  1 November 1997

Developed by
Environmental Laboratory
USAE Waterways Experiment Station
Vicksburg, Mississippi 39180-6199

for
USEPA Risk Reduction Engineering Laboratory
Cincinnati, Ohio 45268

Press any key to continue...
```

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# HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP)

- Developed to help hazardous landfill designers and regulators evaluate to evaluate hydrologic performance for proposed landfill
- To assist in comparisons of alternative closure cap and bottom liner designs using water balance calculations and stability evaluations
- Primary purpose is the comparison of design alternatives as judged by the water balance for the climate of the particular site



# HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP)

- Quasi dimensional hydrologic numeric model
- Water balance analysis of landfills
- Water movement across, into, through and out of landfills



# HELP MODEL

- Developed by USEPA
- Developed in 1982 by Paul Schroeder (U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi)
- Version 1 – 1984
- Version 2 - 1988
- **Version 3 – 1994 : Current version of HELP**



# HELP MODEL

- Applicable to open, partially closed, and fully closed landfills
- Process description:
  - Optional Synthetic Weather Generator (WGEN) by USDA
  - Runoff modelling based on USDA Soil Conservation Service (SCS) curve number method
  - Potential evapotranspiration is modeled by a modified Penman method
  - Evapotranspiration is modeled in the manner developed by Ritchie
  - Plant transpiration Ritchie
  - Vertical drainage Darcy's law



# HELP

- ❑ Geographical area / climate
- ❑ Groundwater intrusion
- ❑ Season of year, Growing Season
- ❑ Use of covers: daily, intermediate and final
- ❑ Operational impacts
- ❑ Waste composition



# HELP

- ❑ Modelling for:
  - ❑ Active cells
  - ❑ Intermediate Cover
  - ❑ Final Cover/ Alternative Cover
  
- ❑ Modelling for:
  - ❑ Without Recirculation
  - ❑ With Recirculation





# HELP MODEL INPUT PARAMETERS

```
C:\WINDOWS\system32\cmd.exe
```

```
HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE <HELP> UER. 3.07
```

```
MAIN MENU
```

```
1. Enter/Edit Weather Data
```

```
2. Enter/Edit Soil and Design Data
```

```
3. Execute Simulation
```

```
4. View Results
```

```
5. Print Results
```

```
6. Display Guidance
```

```
7. Quit
```

```
F1=Info  F2=Help  F3=Keys  <↑↓ then enter or number>=Select
```



# HELP MODEL INPUT PARAMETERS

- Evapotranspiration Data
  - Evaporative Zone Depth:
    - Maximum depth from which water may be removed by evapotranspiration
    - Cannot exceed the top of the topmost liner
    - Clay: 12” to 60”
    - Silt: 8 to 18”
    - Sand: 4 to 8”
    - Gravel: Few inches
    - Less for surface without vegetation and more for with vegetation



# HELP MODEL INPUT PARAMETERS

- Evapotranspiration Data
  - Maximum Leaf Area Index
    - (Leaf area of actively transpiring vegetation) : (area of land on which the vegetation is growing)
      - Bare Ground: 0
      - Poor Strand of Grass: 1
      - Fair Strand of Grass: 2
      - Good Strand of Grass: 3.5
      - Excellent Strand of Grass: 5



# HELP MODEL INPUT PARAMETERS

- Evapotranspiration Data
  - Growing Season Start Day:
    - Day of year when the normal mean daily temperature rises above 50-55F.
  - Growing Season End Day:
    - Day of year when the normal mean daily temperature falls below 50-55
- Normal Average annual wind speed
- Normal Average quarterly relative humidity
  - Data available from NOAA climatological data summary



# HELP MODEL INPUT PARAMETERS

```
C:\WINDOWS\system32\cmd.exe
WEATHER DATA - EVAPOTRANSPIRATION DATA

Units: 1      1 - CUSTOMARY
          2 - METRIC

Nearby City : Denton
State       : TX
Latitude    = _____

Evaporative zone depth = IN
Maximum leaf area index =
Growing season start day =
Growing season end day =

Average wind speed = MPH

First quarter relative humidity = %
Second quarter relative humidity = %
Third quarter relative humidity = %
Fourth quarter relative humidity = %

F5 = City Selection for Default Evapotranspiration Data
F1=Info  F2=Help  F3=Keys  F9=Quit  F10=End  PgUp=Cycle  PgDn=Proceed
```



# HELP MODEL INPUT PARAMETERS

- Weather Data:
  - Evapotranspiration Data
  - Precipitation
  - Temperature
  - Solar Radiation



# HELP MODEL INPUT PARAMETERS

```
C:\WINDOWS\system32\cmd.exe
WEATHER DATA - FILE EDITING

PRECIPITATION      C:\HELP\
TEMPERATURE        C:\HELP\
SOLAR RADIATION   C:\HELP\
EVAPOTRANSPIRATION C:\HELP\

-----DIRECTORY-----
--FILE--

Enter names for files that you wish to edit, or PgDn to create new data.

F4 = List Files on Specified Directory
F1=Info  F2=Help  F3=Keys  F9=Quit  F10=End  PgUp=Return  PgDn=Proceed
```



# HELP MODEL INPUT PARAMETERS

C:\WINDOWS\system32\cmd.exe

**WEATHER DATA - PRECIPITATION, TEMPERATURE AND SOLAR RADIATION**

PRECIPITATION (IN)	TEMPERATURE (°F)	SOLAR RADIATION (Langleys)
<b>Default</b> Synthetic	Synthetic	Synthetic
<b>User</b> Create/Edit NOAA Tape Climatedata ASCII HELP 2 Canadian	<b>User</b> Create/Edit NOAA Tape Climatedata ASCII HELP 2 Canadian	<b>User</b> Create/edit NOAA Tape Climatedata ASCII HELP 2 Canadian

F1=Info F2=Help F3=Keys F9=Quit F10=End PgUp=Cycle PgDn=Proceed

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# HELP MODEL INPUT PARAMETERS

C:\WINDOWS\system32\cmd.exe

**SYNTHETIC TEMPERATURE DATA**

City: DALLAS State: TEXAS  
Number of Years for Synthetic Data Generation   
Use Default Normal Mean Monthly Temperatures YES NO

Normal Mean Monthly Temperature (<math>^{\circ}\text{F}</math>)

	USER	DEFAULT
1.	January	44.0
2.	February	48.5
3.	March	56.1
4.	April	65.9
5.	May	73.7
6.	June	82.0
7.	July	86.3
8.	August	85.5
9.	September	78.6
10.	October	67.9
11.	November	55.6
12.	December	47.8

F1=Info F2=Help F9=Quit F10=Generate Data Esc=Cancel



# HELP MODEL INPUT PARAMETERS

```
C:\WINDOWS\system32\cmd.exe
SYNTHETIC SOLAR RADIATION DATA

City: DALLAS           State: TEXAS
Number of Years for Synthetic Data Generation  5
Station Latitude = 32.85   Degrees   <Negative for southern
                                   hemisphere>

F1=Info   F2=Help   F9=Quit   F10=Generate Data   Esc=Cancel
```



# HELP MODEL INPUT PARAMETERS

- Soil & Design Data
  - Landfill General Information
  - Layer Data
  - Geomembrane Characteristics
  - Drainage Characteristics
  - Site Characteristics



# HELP MODEL INPUT PARAMETERS

```
C:\WINDOWS\system32\cmd.exe
SOIL AND DESIGN DATA - LANDFILL GENERAL INFORMATION

Project Title
Test_

Landfill area = 1 ACRES
Percent of area where runoff is possible = 100 %
Do you want to specify initial moisture storage? <Y/N> N
<If No, the program will initialize moisture
contents to approximately steady-state.>

F1=Info F2=Help F3=Keys F9=Quit F10=End PgUp=Cycle PgDn=Proceed
```



# HELP MODEL INPUT PARAMETERS

C:\WINDOWS\system32\cmd.exe

	LAYER TYPE	LAYER THICKNESS (IN)	SOIL TEXTURE NO.	TOTAL POROSITY (UOL/UOL)	FIELD CAPACITY (UOL/UOL)	WILTING POINT (UOL/UOL)	INITIAL MOISTURE (UOL/UOL)
1	1	36		.38	.229	.058	
2	1	2400		.52	.294	.14	
3	1	12		.38	.229	.058	
4	2	.235		.85	.01	.005	
5	4	.06	35				
6	3	840		.25	.22	.055	
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Alt A=Add Above    Alt B=Add Below    Alt C=Copy    Alt D=Delete    Alt M=Move  
 F1=Info    F2=Help    F3=Keys    F6/F7=Default/User Soils    F9=Quit    F10=End    PgUp PgDn



# HELP MODEL INPUT PARAMETERS

C:\WINDOWS\system32\cmd.exe

LAYER TYPE	SAT. HYD. CONDUCTIVITY (CM/SEC)	DRAINAGE LENGTH (FT)	DRAIN SLOPE (%)	LEACHATE RECIRC. (%)	RECIRC. TO LAYER (#)	SUBSURFACE INFLOW (IN/YR)
1	.0000001					
2	.0002					
3	.000001					
4	1.4	100	2			
5	.00000000000002					
6	.000000002					
7						
8						
9						
0						
1						
2						
3						
4						
5						
6						
7						
8						
9						
0						

Alt A=Add Above    Alt B=Add Below    Alt C=Copy    Alt D=Delete    Alt M=Move  
 F1=Info    F2=Help    F3=Keys    F6/F7=Default/User Soils    F9=Quit    F10=End    PgUp PgDn



# HELP MODEL INPUT PARAMETERS

C:\WINDOWS\system32\cmd.exe

LAYER TYPE	GEOMEMBRANE PINHOLE DENSITY <#/ACRE>	GEOMEMBRANE INSTAL. DEFECTS <#/ACRE>	GEOMEMBRANE PLACEMENT QUALITY	GEOTEXTILE TRANSMISSIVITY <CM <sup>2</sup> /SEC>
1				
2				
3				
4				
5		1	4	3
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Alt A=Add Above    Alt B=Add Below    Alt C=Copy    Alt D=Delete    Alt M=Move  
 F1=Info    F2=Help    F3=Keys    F6/F7=Default/User Soils    F9=Quit    F10=End    PgUp PgDn



# HELP MODEL INPUT PARAMETERS

C:\WINDOWS\system32\cmd.exe

**SOIL AND DESIGN DATA - RUNOFF CURVE NUMBER INFORMATION**

Select Method For Computing Runoff Curve Number

- **User Specified Curve Number**
- Modified User's Curve Number
- HELP Model Computed Curve Number

USER SPECIFIED CN	MODIFIED USER'S CN	HELP MODEL CN
SCS AMCII CN= 87.5	SCS AMCII CN= 87.5 Slope= % Slope Length= FT	Slope= % Slope Length= FT Soil Texture= Vegetation=

Program will use a runoff curve number of 87.5

Cursor ↑ and press Enter to select method for computing runoff curve number  
F1=Info F2=Help F3=Keys F9=Quit F10=End PgUp=Cycle PgDn=Proceed





# HELP MODEL INPUT PARAMETERS

C:\WINDOWS\system32\cmd.exe

**SOIL AND DESIGN DATA - RUNOFF CURVE NUMBER INFORMATION**

Select Method For Computing Runoff Curve Number

- **User Specified Curve Number**
- Modified User's Curve Number
- HELP Model Computed Curve Number

USER SPECIFIED CN	MODIFIED USER'S CN	HELP MODEL CN
SCS AMCII CN= 87.5	SCS AMCII CN= 87.5 Slope= % Slope Length= FT	Slope= % Slope Length= FT Soil Texture= Vegetation=

Program will use a runoff curve number of 87.5

Cursor ↑ and press Enter to select method for computing runoff curve number  
F1=Info F2=Help F3=Keys F9=Quit F10=End PgUp=Cycle PgDn=Proceed



# CHALLENGES WITH HELP 3.07

## Operational

- DOS executable program
- Does not run in a Windows or iOS environment
- 16-bit program will not natively work with 64-bit systems (i.e., most Windows 7 and more recent systems)
- DOS emulator to install the HELP model
  - Windows virtual PC
  - DOSBox



# CHALLENGES WITH HELP 3.07

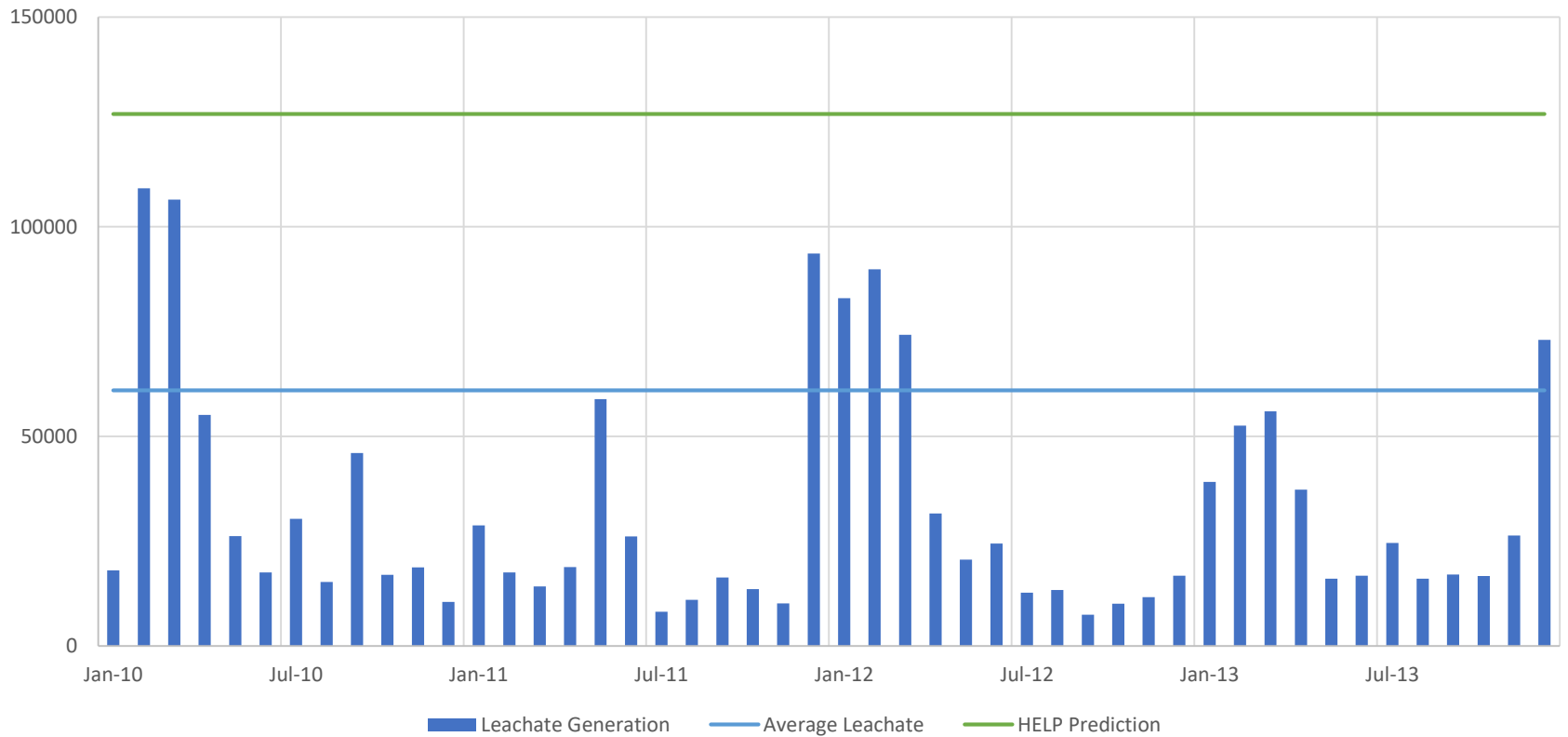
## Analytical

- Default Weather Data only available for USA
- Default Weather Data limits to past 50 years of weather
- Considers vertical percolation through waste
- Overpredicts Leachate Generation



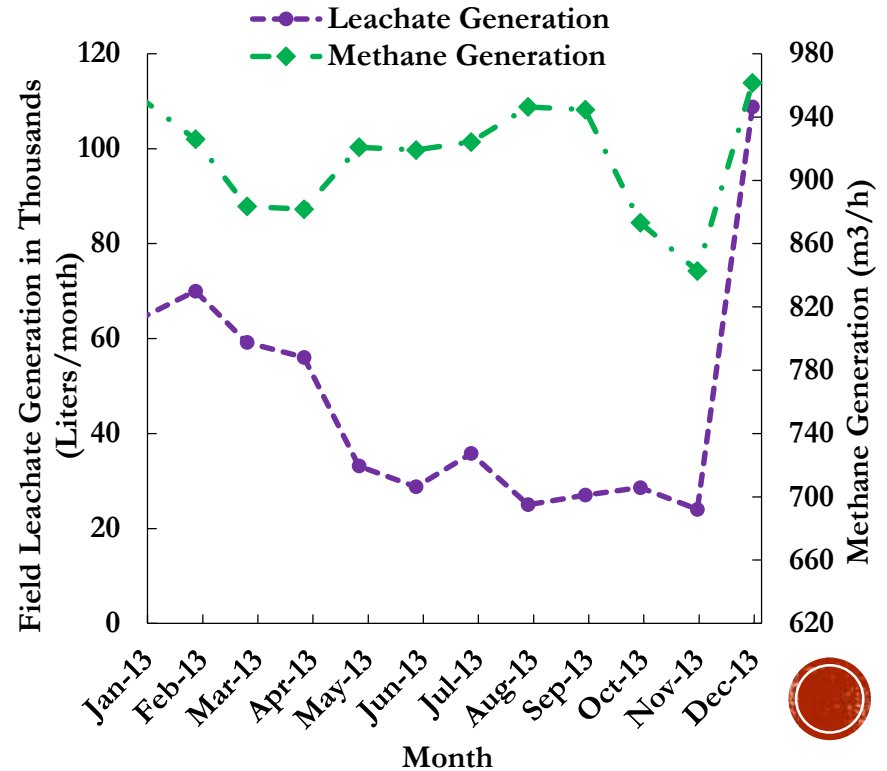
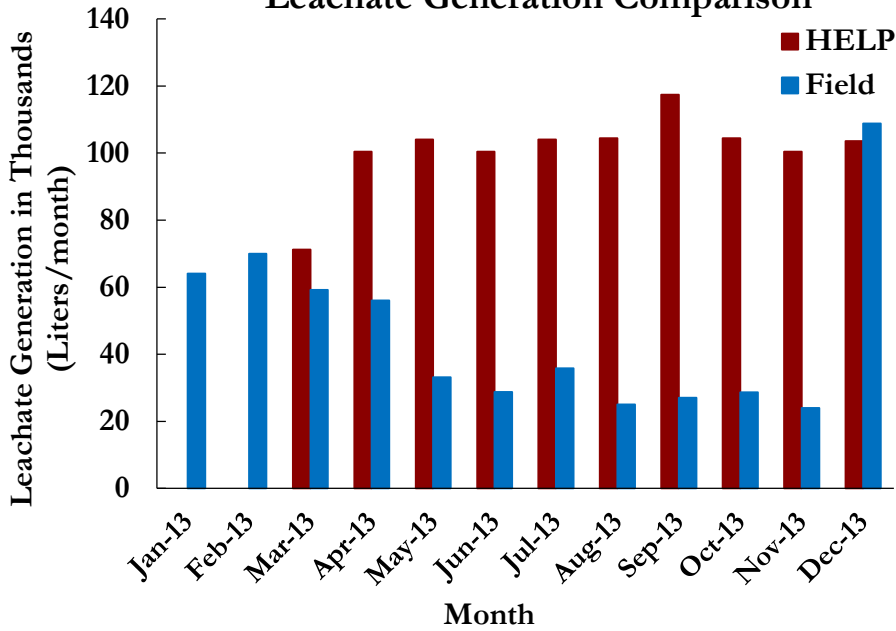
# CHALLENGES WITH HELP 3.07

Leachate Generation vs Prediction



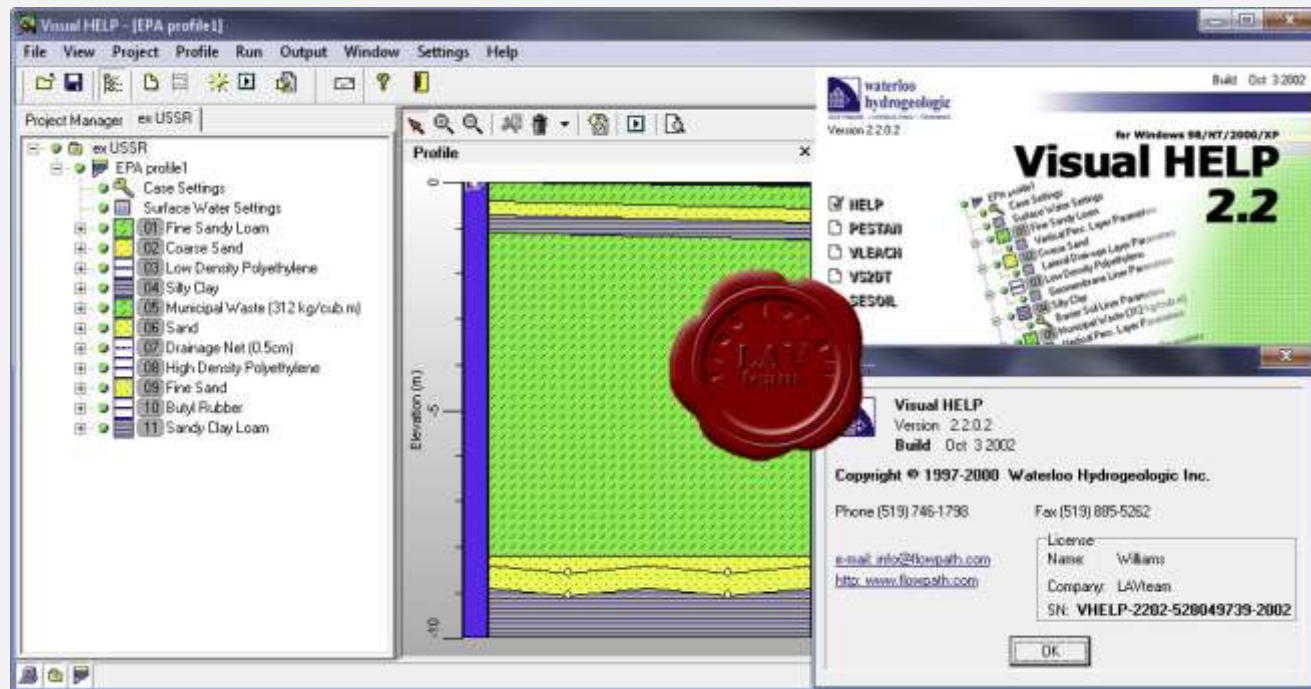
# CHALLENGES WITH HELP 3.07

Leachate Generation Comparison



# VISUAL HELP MODEL

- Commercial versions:
  - Visual HELP – based on the HELP version 3.07, offers a Microsoft Windows GUI to view and edit soil profiles and to generate weather data.



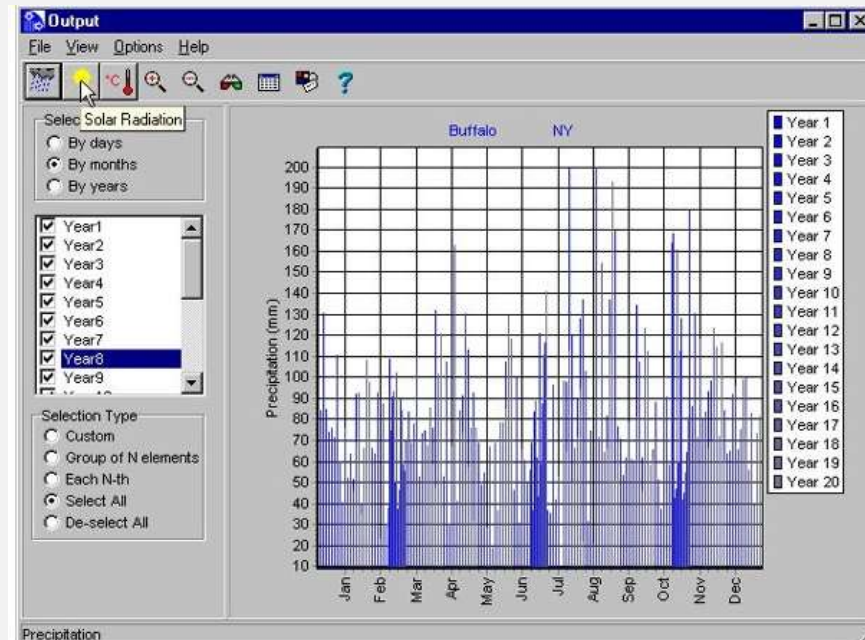
# VISUAL HELP MODEL

- Commercial versions
- Developed by Waterloo Hydrologic Software
- Based on EPA's HELP 3.07
- Windows based



# VISUAL HELP MODEL

- Advantages
  - Graphically create landfill profiles of the landfill
  - Built in International Weather Generator (GIS Based)
  - Generate reports
  - Analyze model results using daily, monthly and yearly plots
  - Built in landfill material database for 42 materials





# VISUAL HELP MODEL

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  - Graphically create landfill profiles of the landfill
  - Built in International Weather Generator (GIS Based)
  - Generate reports
  - Analyze model results using daily, monthly and yearly plots
  - Built in landfill material database for 42 materials
  
- Disadvantages
  - Cost
  - US Weather Data
  - Validation
  - Accuracy



# HELP 3.95D MODEL

- [HELP 3.95 D](#) – by Dr. Klaus Berger at the [University of Hamburg](#); offers a [Microsoft Windows](#) UI and includes the model HELP 3.07 and the enhanced model HELP 3.95 D.



# HELP 3.95D MODEL

- Advantages
  - Windows user interface
  - Executable in Windows 7 and 8 (32-bit and 64-bit; except maybe for the starter editions) and Windows 10
  - Online help and User Guide in English and in German
  - Additional daily weather data and Evapotranspiration can be synthetically generated for selected locations in Germany
  - US and German soil textures
  - The model HELP 3.95 D outputs daily, monthly and yearly results as tables in separate text (ASCII) files
- Disadvantages
  - Cost
  - Accuracy
  - Limited to US and German data



# HELP 4.0 MODEL

## HELP Model

Hydrologic Evaluation of Landfill Performance Model

Import v3.07

Reset All

Evaluate

Run HELP Mode

---

### General Information

Edit

Reset

Title

Address

Latitude  (degrees)

---

Years of Simulation  Landfill Area (acres)

Units  % Subject to Runoff  %

### Weather

Data Type	Import New Data	Import Status	Years of Data	Edit
Precipitation	<input style="width: 40px;" type="text" value="Import"/>	<span style="color: green;">✔</span>	30	<input style="width: 40px;" type="text" value="Edit"/>
Temperature	<input style="width: 40px;" type="text" value="Import"/>	<span style="color: green;">✔</span>	30	<input style="width: 40px;" type="text" value="Edit"/>
Solar Radiation	<input style="width: 40px;" type="text" value="Import"/>	<span style="color: green;">✔</span>	30	<input style="width: 40px;" type="text" value="Edit"/>
Landfill Parameters <small>[wind speed and humidity]</small>	<input style="width: 40px;" type="text" value="Import"/>	<span style="color: green;">✔</span>	---	<input style="width: 40px;" type="text" value="Edit"/>

### Runoff Curve Number

Edit Data

HELP will use the curve number:  Data entered? ✖

### Soil & Design

Add/Insert New Layers

Reset

1	Layer to be specified	<span style="font-size: 0.7em;">↻</span> <span style="font-size: 0.7em;">↕</span> <span style="font-size: 0.7em;">↑</span>
2	Layer to be specified	<span style="font-size: 0.7em;">↻</span> <span style="font-size: 0.7em;">↕</span> <span style="font-size: 0.7em;">↑</span>

Dashboard

About

Main Menu

+

# HELP 4.0 MODEL

**General Information**    Edit    Reset

Title: Landfill

Address: Main St

NASHVILLE    TN

Latitude: 36.12 (degrees)

Years of Simulation: 4    Landfill Area (acres): 12

Units: U.S. standard    % Subject to Runoff: 100 %

**Weather**

Data Type	Import New Data	Import Status	Years of Data	
Precipitation	Import	✓	30	Edit
Temperature	Import	✓	30	Edit
Solar Radiation	Import	✓	30	Edit
Landfill Parameters	Import	✓	--	Edit

[wind speed and humidity]

**Runoff Curve Number**

HELP will use the curve number: 82.2    Data entered? ✗

**Soil & Design**    Add/Insert New Layers    Reset

1	Layer to be specified	✎	↕
2	Layer to be specified	✎	↕
3	Layer to be specified	✎	↕
4	Layer to be specified	✎	↕
5		✎	↕
6		✎	↕

**Soil & Design**    Layer No. 1

Layer category: Waste     Standard HELP layer  
 Previously saved custom layer  
 New custom layer

Layer description: Municipal Solid Waste (MSW) (900 pcy)

Layer type: Municipal Solid Waste (MSW) (900 pcy)  
 MSW with Channeling  
 High-Density Electric Plant Coal Fly Ash  
 High-Density Electric Plant Coal Bottom Ash  
 High-Density MSW Fly Ash  
 High-Density Copper Slag

Layer thickness: [input field]

Total porosity (vol/vol)	[input field]	Drainage slope (%)	[input field]
Field capacity (vol/vol)	0.292	Leachate recirculation (%)	[input field]
Willing point (vol/vol)	0.077	Recirculation to layer	[input field]
Initial moisture (vol/vol)	[input field]	Subsurface inflow (in/y)	[input field]
Saturated hydraulic conductivity (cm/s)	1.00E-03		

Cancel    Reset    Submit



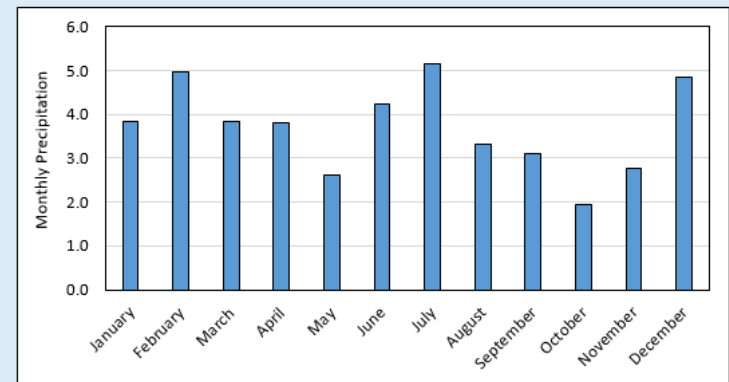
# HELP 4.0 MODEL

## Precipitation Data for NASHVILLE, TENNESSEE

[Return to Main Dashboard](#)

Year	Daily Rainfall (inches)										Row
1	0	0	0	0	0	0.2	0	0	0	0	1
1	0.17	0.02	0	0	0	0	0.01	0	0	0.5	2
1	0.52	0.19	0.54	0	0	0	0	0.12	0	0	3
1	0.02	0	0	0.22	0	0	0	0	0.1	0.39	4
1	0.2	0.26	0.44	0	0.02	0	0.18	0.11	1.15	0.04	5
1	0.5	0	0.62	0	0.02	0	0	0.57	0.07	0	6
1	0.86	0	0.2	0	0	0	0.35	0	0	0.06	7
1	0	0.02	0	0	0	0	0.52	0.99	0.05	0	8
1	0	0	0	0	0	0	0	0	0	0	9
1	0.36	0	0	0.14	0	0.02	0	0	0.01	0	10
1	0	0	0	0.39	0.12	0	0	0.39	0.03	0.11	11
1	0.55	0	0	0	0	0	0.05	0	0	0	12
1	0	0	0	0	0	0	0	0	0	0.96	13
1	0.12	0	0	0	0	0	0	0	0.06	0	14
1	0.36	0.22	0	0	0.74	0.19	0.05	0.71	0	0	15
1	0	0	0	0.22	1.08	0	0	0	0	0	16
1	0	0.63	0	0	0.31	0.57	0.2	0.37	0.4	0	17
1	0	0	0.46	0	0	0	0	0.02	0.09	0	18
1	0.18	0	0.13	0	0	0	0	0.23	0.09	0.2	19
1	0.05	0.58	0	0.18	0	0.02	0.24	0	0.08	0	20
1	0.04	0	0	0.01	0.1	0.06	0.02	0.04	0	0.17	21
1	0.39	1	0.29	0	0	0.16	0.27	0.09	0	0	22
1	0.08	0.47	0	0	0	0	0	0	0	0	23
1	0	1.8	0	0	0	0	0	1.22	0	0	24
1	0	0	0	0	0	0	0	0	0	0.13	25
1	0.14	0	0	0	0	0	0	0	0	0.45	26
1	0.04	0	0	2.57	0	0	0	0	0.18	1.19	27
1	0	0	0	0	0	0.69	0.6	0	0.49	0.05	28
1	0	0	0	0	0.12	0	0	0.01	0	0	29
1	0	0	0	0.68	0	0	0	0	0	0	30
1	0	0	0	0	0	0	0	0	0	0.34	31
1	0	0	0	0	0	0	0.62	0	0	0	32

Monthly Rainfall	Average
	(in)
January	3.85
February	4.96
March	3.83
April	3.81
May	2.63
June	4.23
July	5.16
August	3.31
September	3.09
October	1.94
November	2.76
December	4.86
Average Annual	52.2



# HELP 4.0 MODEL

- Advantages
  - Windows user interface
  - Executable in Windows 7 and 8 (32-bit and 64-bit; except maybe for the starter editions) and Windows 10
  - Weather Data can be directly imported from NOAA
- Disadvantages
  - Validation
  - Accuracy
  - US Weather Data



# HELP 4.0 BETA MODEL SUBSCRIPTION

Max Krause

[krause.max@epa.gov](mailto:krause.max@epa.gov)

Thabet Tolaymat

[tolaymat.thabet@epa.gov](mailto:tolaymat.thabet@epa.gov)

<https://www.epa.gov/land-research/hydrologic-evaluation-landfill-performance-help-model>

