



PUMPTEST, a template for water-bore pump test data reduction using LOTUS 1-2-3.

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Abstract

A template has been developed within LOTUS 1-2-3 to present the results of a water-bore pump test. Various details concerning the bore are requested, along with observation times and depth to the water table. The drawdown is calculated and a graph of log time versus drawdown is produced. The template can accept either imperial or metric units of depth.

INTRODUCTION

To facilitate the analysis of water-bore pump tests, a LOTUS 1-2-3 spreadsheet template has been developed to process the field observations. The template has been automated for ease of use and allows field data to be processed quickly. Additional functions such as regression analysis available within LOTUS 1-2-3 enhance the ability to determine aquifer properties.

The template has been automated by incorporating macros which control certain processes, such as moving between the pumping stage and recovery stage data input screens, saving graphs, files etc. A listing of the macros is provided in Appendix A.

The formulae used within the template are listed in Appendix B.

LOADING THE TEMPLATE

The template is accessed by starting LOTUS 1-2-3 (8 columns×20 rows) from the menu system on either of the Engineering Geology and Groundwater Branch's micro-computers. The initial 1-2-3 access menu is displayed, and the cursor will highlight 1-2-3 at the top of the screen. Press the ENTER key to load the spreadsheet program. The template must then be loaded into the spreadsheet program by pressing the sequence of keystrokes listed below:

/FR

After typing these characters, the second line from the top of the screen will display:

Name of file to retrieve: A:*.WK1?

or something similar. A series of filenames may be listed below this line. These should be disregarded. Press the key labelled ESC situated at the top left hand side of the keyboard until the second line reads:

Name of file to retrieve:

then type:

C:\PUMPTEST\PUMPTEST

When this command is issued by pressing the ENTER key, the template will be loaded into memory.

INITIALIZING THE TEMPLATE

Initially the template is controlled by a 'macro' and it is necessary to follow the instructions given. Read the instructions on the first screen (fig. 1) and when ready press the ENTER key. Read the instructions on the second screen (fig. 2) and when ready press the ENTER key. Type the site identification (upper or lower case, or a mixture of cases, can be used). The keystrokes typed are echoed to the second top line of the screen. When the ENTER key is pressed, the site identification will be placed into the cell and a request will then be made to enter M or I for (M)etric or (I)mperial units of depth. Respond accordingly (either upper or lower case can be used; there is no need to press the enter key here). The template will advance to the relevant cell where the standing water level prior to commencement of the pump test is entered. Type the value(s) required and press the ENTER key after the value(s). The template then advances to the pumping stage.

At this point, the macro terminates and the user regains full control over the cursor. The instructions on the initial screens may be reviewed, if desired, by using the cursor keys (left, right, up, down arrow keys and PgUp or PgDn keys).

The template will have several columns with the entry ERR. This is because some values are missing from the formula in that cell. These do not affect the operation of the template or the production of the graph.

From this point onwards, data is placed in a cell by typing a value (which will be displayed on the second line at the top of the screen). To place this value into a cell, press one of the arrow keys. The value may also be placed in a cell by pressing the ENTER key, but the cursor will remain in that cell. It is then necessary to use an arrow key to move to the next cell into which data will be entered.

If a cell is blank, it is assumed to contain the value 0 (zero). It is not necessary to enter zero values into the template.

Cells into which data should not be entered are protected against data entry. If you attempt to place data into these cells, an audible tone is issued and an ERROR message is displayed at the top right hand side of the screen. To clear the error, simply press the ENTER key and move to the correct column in the template.

PUMPING STAGE

Enter the date on which the pump test was performed under the relevant headings (DD—day, MM—month and YY—year). A word of caution for pump tests which extend over several days. The first and last observations should occur within the same month (otherwise errors arise during calculation of elapsed time). If this is not the case, adjust the starting date accordingly. If the pump test duration still exceeds the number of days in the month specified, full results will not be obtained and the data should be reduced and plotted by hand. In Tasmania, pump test duration rarely exceeds several days, so this should not be a problem.

The time at which pumping commenced is entered into cells B47–D47 beneath the relevant headings (HH—hours, MM—minutes and SS—seconds). A 24-hour clock is used so that 3 pm is entered as 15.

The pump rate can be entered if desired. For imperial units, the rate is entered into cell J47 (in gph) and converted to metric units later to be displayed in cell K47. With metric units, the pump rate is entered in litres/minute directly into cell K47.

The times at which observations were made are entered beneath the headings in:

- column A DD—days elapsed since pumping started
- column B HH—time of day in hours (REMEMBER 24 HOUR CLOCK)
- column C MM—time of day in minutes
- column D SS—time of day in seconds

The depth to the water table at the time of an observation is entered on the corresponding row, viz:—

Imperial units feet are entered in column H and inches in column I. The metric equivalent will later be calculated and displayed in column J

Metric units are entered directly into column J

Rows 51 to 100 are available for the pumping stage observations.

Figure 3 shows part of the template's pumping stage.

The ALT and R keys can be pressed together to move to the recovery stage data input screen. The ALT and P keys can be pressed together to move back to the pumping stage data input screen. These macros can be used at any time to move between the pumping and recovery stage data input screen areas.

RECOVERY STAGE

The time at which pumping ceased is entered into cells B106–D106 beneath the relevant headings (as for the time at which pumping started during the pumping stage). The number of days elapsed since pumping started to when pumping ceased is entered into cell A106.

The times at which observations were made are entered beneath the relevant headings (as for the pumping stage).

The depth to the water table at the time of an observation is entered on the corresponding row (again as for the pumping stage).

Rows 110–160 are available for the recovery stage observations.

Figure 4 shows part of the template's recovery stage.

CALCULATIONS

When all data have been entered, the F9 function key (located on the uppermost row of keys on the keyboard) is pressed to force the spreadsheet to calculate the following:

Pumping stage

- column E minutes pumped (or elapsed time in minutes)
- column J depth to the water table in metres (if imperial units used during input)
- column K drawdown in metres
- column L log of elapsed time (i.e. log of minutes pumped)
- column N square root of elapsed time

Recovery stage

- column E recovery time (i.e. minutes elapsed since pumping ceased)
- column F elapsed time (i.e. minutes elapsed since pumping started)
- column G ratio elapsed time : recovery time
- column J depth to the water table in metres (if imperial units used during input)
- column L log of the ratio elapsed time : recovery time
- column M drawdown in metres

The spreadsheet can be forced to calculate at any time by pressing the F9 function key. A reminder: "CALC" will appear near the bottom of the screen when calculations are pending. The formulae used in the calculations are listed in Appendix B.

GRAPH

The template has had a default graph defined with it and this may be viewed after completing data entry and forcing the calculation of the spreadsheet. To view the graph press the F10 function key. To return to the template press any key. The graph settings, titles etc can be altered by the user as required. To save the graph, press the ALT and G keys together. The second top line of the screen will display:

Enter graph file name: C:\PUMPTEST\

Type in the name of the file to which the graph will be saved. This should commence with an alphabetic character and may include numeric characters. File names should not exceed 8 characters in length and the file name PUMPTEST should not be used. The file will be saved to the hard disk in directory PUMPTEST.

SAVING THE SPREADSHEET

The data you have entered can be saved to the disk by pressing the ALT and S keys together. The second top line of the screen will display:

Enter save file name: C:\PUMPTEST\

Type in the name of the file to which the template data is to be saved. This should commence with an alphabetic character and may include numeric characters. File names should not exceed 8 characters in length and the file name PUMPTEST should not be used. The file will be saved to the hard disk in directory PUMPTEST.

LEAVING THE TEMPLATE

To quit the template, press the ALT and Q keys together. The initial LOTUS 1-2-3 screen will be displayed. To return to the menu system press the E key.

only a portion of the spreadsheet was extracted, the default graph settings are incorrect. To correct this, the ranges of the graph in the saved file should be altered to:

setting	new range
X	L14..L123
A	K14..K63
B	M14..M123

COMMENTS

When the spreadsheet is saved, only a portion of the template is extracted and saved to the new file name. The default graph is also saved during this process but because

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PUMP TEST TEMPLATE

Read these instructions before executing any keystrokes.

Enter the details for location then press enter. You will then be prompted for metric or imperial depth units. Enter the standing water level value(s) pressing the enter key after each entry. The metric equivalent for imperial units will later be calculated automatically.

Enter the date that the test commenced [cells B45 - D45] and the time that the pumping started [cell B47 - D47].

The pump rate in l/m can be entered [cell K47], or for imperial units enter the pump rate in gph [cell J47] and the metric equivalent will later be calculated and displayed [cell K47].

For the pumping stage, enter the observation times in columns A - D. If the pump test extends over several days, the days elapsed since pumping started are entered in column A.

<press ENTER key>

Figure 1. Initial screen instructions for use of template PUMPTEST.

The depth to the water table is entered [column J] for metric units, or for imperial units, enter the feet [column H] and inches [column I] and the metric equivalent will later be displayed [column J].

Enter the data for the recovery stage by first entering the time at which pumping ceased [cells A106 - D106].

The observation times and depth to the water table are entered as for the pumping stage in the appropriate columns.

When data entry is complete, press the F9 key to calculate the results.

A default graph has been defined and this may be viewed by pressing the F10 key. You may wish to enhance the graph as you see fit.

Finally save your data with a name other than "PUMPTEST.WK1".

<press ENTER key>

LOCATION:

	(m)	(ft)	(in)
STANDING WATER LEVEL:	0.00	0	0

Figure 2. Second screen of instructions for use of the template PUMPTEST.

PUMPING STAGE						
DD MM YY						
DATE PUMPING STARTED						
HH MM SS	PUMPING STARTED	PUMP RATE	gph	l/m		
			0	0.00		
TIME	MINUTES	DEPTH	DEPTH	DRAWDOWN	LOG TIME	ROOT TIME
DD HH MM SS	PUMPED	(ft)(in)	(m)	(m)		
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR
	ERR		0.00	0.00	ERR	ERR

Figure 3. Pumping stage data input screen before data has been entered. When the spreadsheet is calculated, the entries are replaced by calculated values.

RECOVERY STAGE							
DD HH MM SS							
PUMPING CEASED							
TIME	MINUTES	ELAPSED	RATIO	DEPTH	DEPTH	LOG	DRAWDOWN
DD HH MM SS	RECOVERY	TIME		(ft)(in)	(m)	RATIO	(m)
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00
	ERR	ERR	ERR		0.00	ERR	0.00

Figure 4. Recovery stage data input screen before data has been entered. When the spreadsheet is calculated, the ERR entries are replaced by calculated values.

APPENDIX A

The template PUMPTEST contains a start-up macro which guides the user through the initial screen displays and site identification process.

```

\O    /wgdd{esc}C:\PUMPTEST\~q           :set default directory
      {home}{down 19}{right 9}         :move to end of first screen
      {?}~                               :wait for ENTER key
      {GOTO}A21~{down 16}{right 9}      :move to end of second screen
      {?}~                               :wait for ENTER key
      {goto}F38~ {getlabel "",f38}~     :get location details
      {GOTO}O21~                         :move to cell O21 and print comment below in cell
Choose (M)etric or (I)mperial depth units{down}
{get units} ~                           :get units of measurement
{if units="M"}{branch metric}           :M key for metric
{if units="m"}{branch metric}          :m key also for metric
{goto}a21~{down 19}{right 7}           :imperial units so move to area for data input
{getnumber "enter 0 for zero : ",h40}~ :get feet value
{right}                                 :move right
{getnumber "enter 0 for zero : ",i40}~ :get inches value
{goto}a41~{down 4}{right}{quit}       :move to pumping stage area and return control to user

UNITS i                                 :variable UNITS

METRIC {goto}a21~{down 19}{right 5}    :metric units so move to right area for data input
      {getnumber "enter 0 for zero : ",f40}~ :get metres value
      {goto 4}{right}{quit}           :move to pumping stage area and return control to user

ALT G saves the graph to disk, file name must be provided by user and must not be PUMPTEST
\G    {esc 8} /gs{esc}{?}~q           :save graph

ALT S saves the spreadsheet to disk, file name must be provided by user and must not be PUMPTEST
\S    {esc 8}/wgpd                     :disable global protection
      /fxv{esc}{?}~a38..n160~        :save file, extract as values
      /wgpe                             :enable global protection

ALT Q quits from the template.
\Q    {esc 8} /qy                       :quit from LOTUS 1-2-3

ALT P moves to the pumping stage area of the template.
\P    {goto}a41~                       :move to pumping stage

ALT R moves to the recovery stage area of the template.
\R    {goto}a101~                      :move to recovery stage

```

APPENDIX B

The following is a listing of various formula used in the template. A section of the template is hidden from the user. In this section the times that have been entered are replicated and converted into columns of data which conform to LOTUS 1-2-3's date and time number parameters. For completeness, a portion of this section of the spreadsheet is included below.

In the pumping stage:

- K47: (F2) U (J47*4.546)/60
- E51: (F2) PR (Q51*1440)+(R51*60)+S51+T51
- J51: (F2) U (H51+(I51/12))*0.3048
- K51: (F2) PR +\$F\$40-J51
- L51: (F4) PR @LOG(E51)
- N51: PR [W10] @SQRT(E51)

- Cell K47 converts pump output in gallons per hour to litres per minute.
- Column E calculates the elapsed time in minutes since pumping started.
- Column J calculates the depth to the water table in metres (if imperial units of depth used during data input).
- Column K calculates the drawdown (in metres).
- Column L calculates the log of the elapsed time.
- Column N calculates the square root of the elapsed time.

	P	Q	R	S	T
45	STARTING DATE NUMBER				
46	ERR				
47					
48					
49	DATE	DAYS	HOURS	MINUTES	SECONDS
50	NUMBER	ELAPSED	ELAPSED	ELAPSED	ELAPSED
51	ERR	ERR	ERR	ERR	ERR

The section of the template hidden from the user in the pumping stage.

- P46: PR @DATE(\$D\$45,\$C\$45,\$B\$45)+@TIME(\$B\$47,\$C\$47,\$D\$47)
- P51: PR @DATE(\$D\$45,\$C\$45,\$B\$45+A51)+@TIME(B51,C51,D51)
- Q51: PR @DAY(P51-\$P\$46)
- R51: PR @HOUR(P51-\$P\$46)
- S51: PR @MINUTE(P51-\$P\$46)
- T51: PR @SECOND(P51-\$P\$46)/60

- Cell P46 calculates the date and time number at which pumping commenced.
- Column P calculates the date and time number at an observation point.
- Column Q calculates the days elapsed since pumping commenced.
- Column R calculates the hours elapsed since pumping commenced.
- Column S calculates the minutes elapsed since pumping commenced.
- Column T calculates the seconds elapsed as a fraction of a minute since pumping commenced.

In the recovery stage:

- E110: (F2) PR +F110-\$P\$107
- F110: (F2) PR (Q110*1440)+(R110*60)+S110+T110
- G110: (F2) PR +F110/E110
- J110: (F2) U (H110+(I110/12))*0.3048
- L110: (F4) PR @LOG(G110)
- M110: (F2) PR +\$F\$40-J110

- Column E calculates the recovery time in minutes since pumping ceased.
- Column F calculates the elapsed time in minutes since pumping commenced.
- Column G calculates the ratio elapsed time : recovery time.
- Column J calculates the depth to the water table in metres (if imperial units of depth are used during data input).
- Column L calculates the log of the ratio elapsed time : recovery time.
- Column M calculates the drawdown in metres.

	P	Q	R	S	T
105	RECOVERY COMMENCED DATE NUMBER				
106	ERR	ERR	ERR	ERR	ERR
107	ERR				
108	DATE	DAYS	HOURS	MINUTES	SECONDS
109	NUMBER	ELAPSED	ELAPSED	ELAPSED	ELAPSED
110	ERR	ERR	ERR	ERR	ERR

The section of the template hidden from the user in the recovery stage

```

P106: PR@DATE($D$45,$C$45,$B$45+A106)+@TIME($B$106,$C$106,$D$106)
Q106: PR @DAY(P106-$P$46)
R106: PR @HOUR(P106-$P$46)
S106: PR @MINUTE(P106-$P$46)
T106: PR @SECOND(P106-$P$46)/60
P107: PR (Q106*1440)+(R106*60)+S106+T106
P110: PR@DATE($D$45,$C$45,$B$45+A110)+@TIME(B110,C110,D110)
Q110: PR @DAY(P110-$P$46)
R110: PR @HOUR(P110-$P$46)
S110: PR @MINUTE(P110-$P$46)
T110: PR @SECOND(P110-$P$46)/60

```

- Cell P106 calculates the date and time number at which pumping ceased.
- Cell Q106 calculates days elapsed when pumping ceased.
- Cell R106 calculates hours elapsed when pumping ceased.
- Cell S106 calculates the minutes elapsed when pumping ceased.
- Cell T106 calculates the seconds elapsed as a fraction of a minute when pumping ceased.
- Cell P107 calculates minutes elapsed when pumping ceased.
- Column P calculates date and time number since pumping ceased.
- Column Q calculates days elapsed since pumping ceased.
- Column R calculates hours elapsed since pumping ceased.
- Column S calculates minutes elapsed since pumping ceased.
- Column T calculates seconds elapsed as a fraction of a minute since pumping ceased.