# Instructions for the groundwater Well Interference Assessment tool

# Key notes

1. This document is intended to be a user's guide for Environment Canterbury's well interference web application. It is not meant to be a full training and background document on how to conduct a well interference assessment.
2. We assume that you are familiar with groundwater models and aquifer test theories.
3. The well interference assessment application calculates **potential** water level drawdown effects from proposed groundwater abstractions on neighbouring wells.
4. It also calculates potential existing cumulative drawdown effects for each neighbouring well based on its neighbours (existing effect without the proposed new abstraction).
5. The user can apply one of four different groundwater models based on hydrogeological knowledge and (assumed) aquifer parameters that preferably should be based on aquifer tests analysis in the area – also available on Environment Canterbury's web site.
6. All models use the assumption of linear superposition of pumping effects of multiple wells
7. The application uses an adaptation of the VBA source code for the drawdown calculations as written by Dr Bruce Hunt of the University of Canterbury.
8. The application should only be used as a 'screening tool' where by using 'conservative' aquifer parameters and assumptions the likelihood of interference of the proposed abstraction can be considered as minor. If the analysis results show that interference is a potential issue then it might be necessary to conduct an aquifer test in the immediate area to establish and use more accurate but possibly less conservative aquifer parameters. At the same time a test would give an opportunity to measure actual drawdown effects.
9. Results from the application should be thoroughly verified. Environment Canterbury cannot accept responsibility for application, data or user errors.

# Before using the well interference web application

What you need to know before you start:

1. The **location of the proposed abstraction** in NZTM coordinates to the nearest 10m or the Environment Canterbury's well number. If the location of the existing well is inaccurate then you will have to correct this first as the assessment is only valid for that particular location. If the well is drilled at a later date and at a different location it will invalidate the well interference assessment and with that the consent applied for

NOTE: More than one abstraction well can be handled with the application. You therefore have the option to divide the proposed volume of water between the proposed wells. However separate assessments might have to be run to investigate if taking the full proposed volume from one well (if possible) could affect neighbouring wells beyond the permitted levels.

2. The proposed **volume** and flow rate that the abstraction is for. The application uses a 7 day and a 150 day flow rate. The 7 day is the maximum flow rate (L/s) allowed under the **daily consented volume divided by the 'return period'**. The 150 day flow rate is calculated from the annual consented volume taken over 150 days at 60% of this rate. The 150 day should not be larger than the 7 day volume. The application uses a 7 day and a 150 day period of pumping at those 2 rates and takes the larger drawdown of the two as the calculated drawdown effect
3. The justification for the used groundwater model and aquifer parameters.

The application will:

1. Select all wells and consented flow rates from Environment Canterbury Consents and Wells database, based on a 2km radius from the proposed new location or well. The information can be downloaded as a 'PRN' file (CSV format) and edited and re-used in the web application allowing you to run scenarios with e.g. modified locations, extra (virtual) wells or different flow rates. This downloadable PRN file is still compatible with the old unsupported VB6 program.
2. Calculate with the (re-uploaded) PRN file:
    a. drawdowns on the neighbouring wells from the proposed new abstraction using the groundwater model with aquifer parameters you have provided
    b. drawdowns in neighbouring wells experienced from all abstractions in a 2 km (standard) radius from the neighbouring well. Therefore the total area covered by the PRN is double the radius set under step 2.
3. Use the calculated minimum water level **'CalcMin'** established by Environment Canterbury for most wells in the Canterbury Plains to help calculate the available drawdown for each well (see appendix 1 (pdf 950 kB). The CalcMin level is provided as a best estimate only; it helps avoid inconsistencies between assessments. In some cases the CalcMin can be debatable as it relies on various assumptions and accuracy of local ground level heights. Additional information can be used to improve the CalcMin at the time of analysis if available.

**The CalcMin** is the groundwater level that is exceeded 80% of the time in the month May. A water level data series of 10 years is needed before the 80% level can be estimated. For wells without sufficient groundwater level observations the CalcMins are **spatially interpolated** from wells that do have CalcMins based on long term water level data. Another assumption is that the **ground level** between wells is relatively straight which only applies to some extent within the Canterbury Plains area. Therefor interpolated CalcMins are only provided for this area. Some newer wells might not have a CalcMin assigned yet. The application will interpolate when possible and mark that with a comment.

Using the Web Application has 8 steps:

1. enter the proposed abstraction well(s) or location(s)
2. define parameters for the required data selection
3. generate or upload a data input file (PRN file) for analysis
4. optional data check
5. provide the model run parameters
6. select the model type and aquifer parameters
7. run the analysis
8. interpret the results

# Using the application

## Step 1 Enter the Location

There are three ways to enter one or more new abstractions into the web form:

1. enter an Environment Canterbury Well number in field 1 then click on “add to list”
2. enter (multiple) wells against a consent/application number, enter the groundwater take consent/application number in the box in field 1 and then click on “add to list”
3. If a well does not exist in Wells Database or is not a valid well number, the user can enter a “virtual well”. An Easting, Northing and well depth is required for a virtual well, along with the proposed Q7 and Q150 flow rate. If no rate is given then a nominal rate will be used.

This web application links directly to Environment Canterbury's databases so can only accept valid consent numbers and well numbers. Please contact Customer Services if you suspect errors.

If a mistake is made or the user wants to perform a new assessment, pressing the “Reset Form” button will remove the wells from the list and reset to the default parameter values.

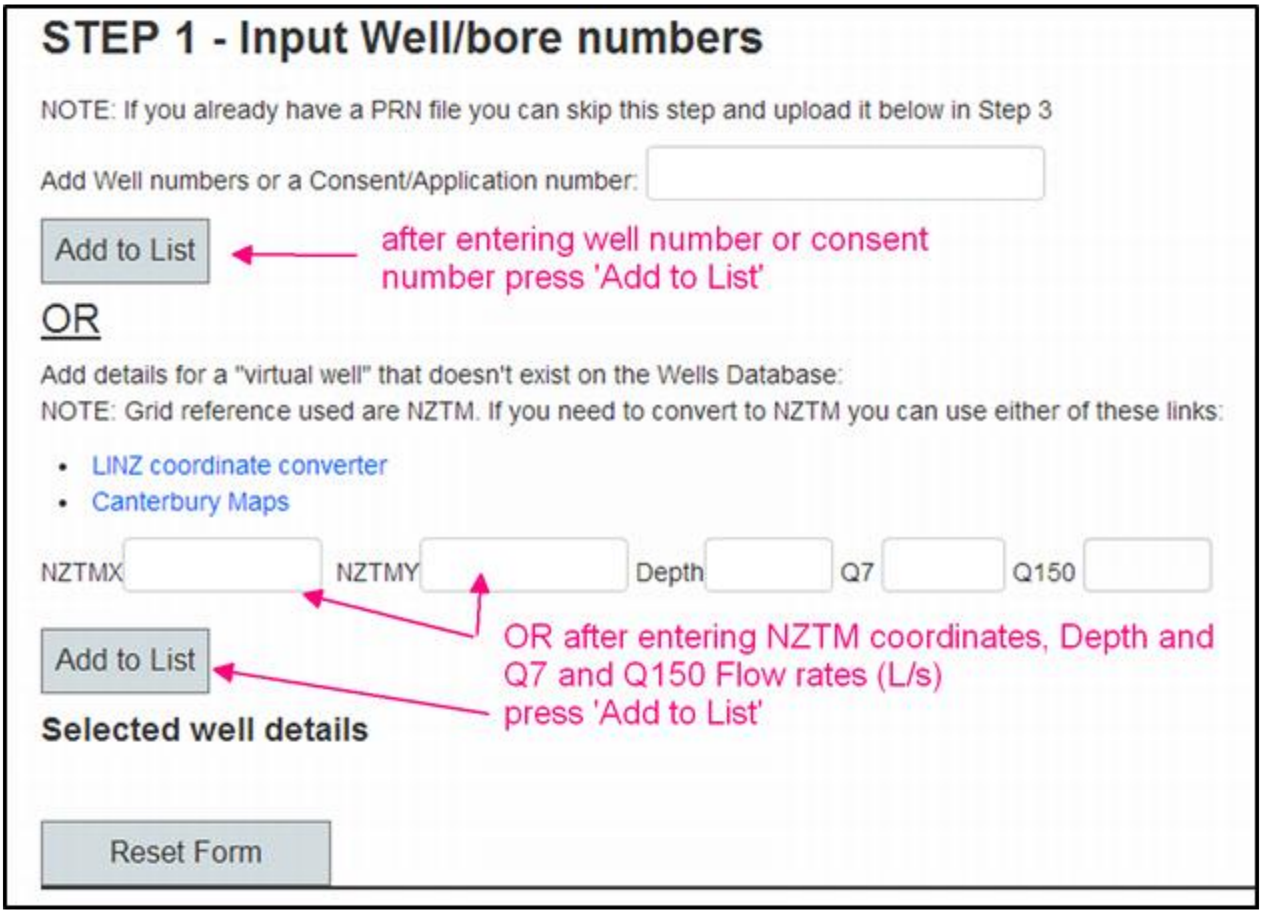


Figure 1 Step 1 - Add Wells for proposed abstraction location(s)

**Step 1 b editing well details in the selected abstraction locations:**

When assessing a “virtual well” or proposed well, it is possible to edit the details of the well before generating the PRN file by clicking on “edit” next to the well to be altered (this will not change the data in Environment Canterbury's databases). This is the place to input the Q7 and Q150 values to the virtual well. Press UPDATE when you have entered the depth and Q7/Q150. If you are entering a “Virtual Well” or assessing a well with missing data, it is possible to edit all other information before you run the actual assessment in Step 5. See step 4 for how to edit/add these values.

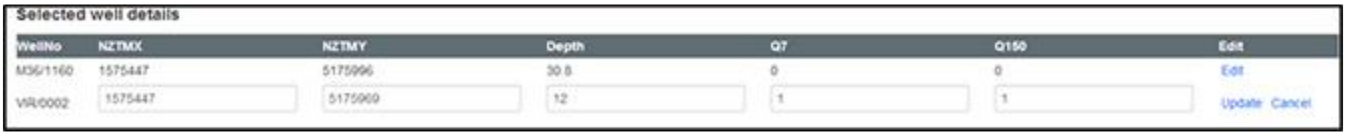


Figure 2 Edit details of selected locations

## Step 2 Default Application Settings for generating a PRN file

The search radius, minimum drawdown and nominal flow rate should be left as default. You can change them if you (for example) want to run the model for a larger area, or if you want to include every individual drawdown in the total cumulative drawdown of all abstractions (rather than to ignore drawdowns less than 0.1m). A flow rate of 0.12 L/s is the permitted 10 $m^3$/day for domestic and stock water (this might vary per location and size of property). Increasing the maximum search radius will exponentially increase the number of wells in the assessment. You cannot increase the area of interest with the existing PRN file as the set of wells is limited to the search radius initially set there when you created the PRN file. You will have to create a different (larger) PRN file.

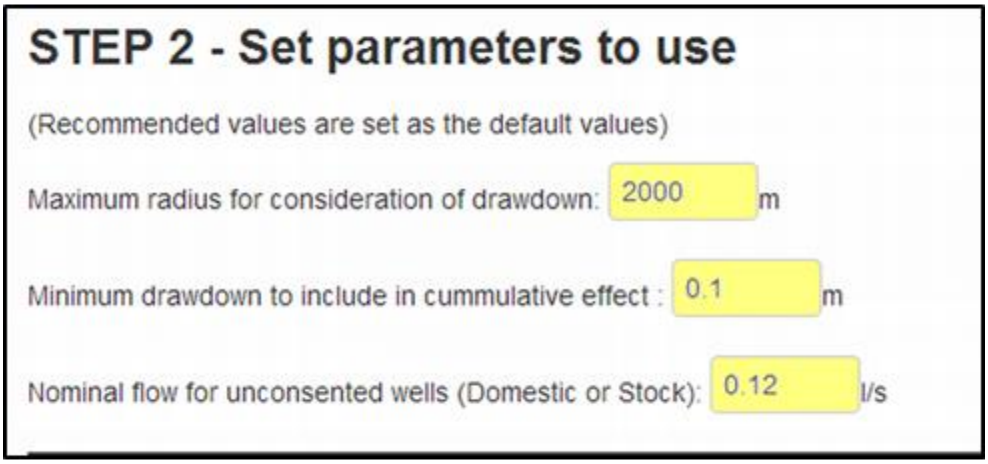


Figure 3 Default Parameters for extracting surrounding well locations and default flow

## Step 3 Generating the PRN file OR Uploading a PRN file

In this step you create an input file with all information of surrounding wells that will be used by the model. Press the “Generate PRN File” button to start the process which may take up to a couple of minutes.

A pop-up screen will appear asking where the file should be saved on the user's computer. The file can be relocated and renamed as desired but **do not** change the extension of the file (“.prn”).

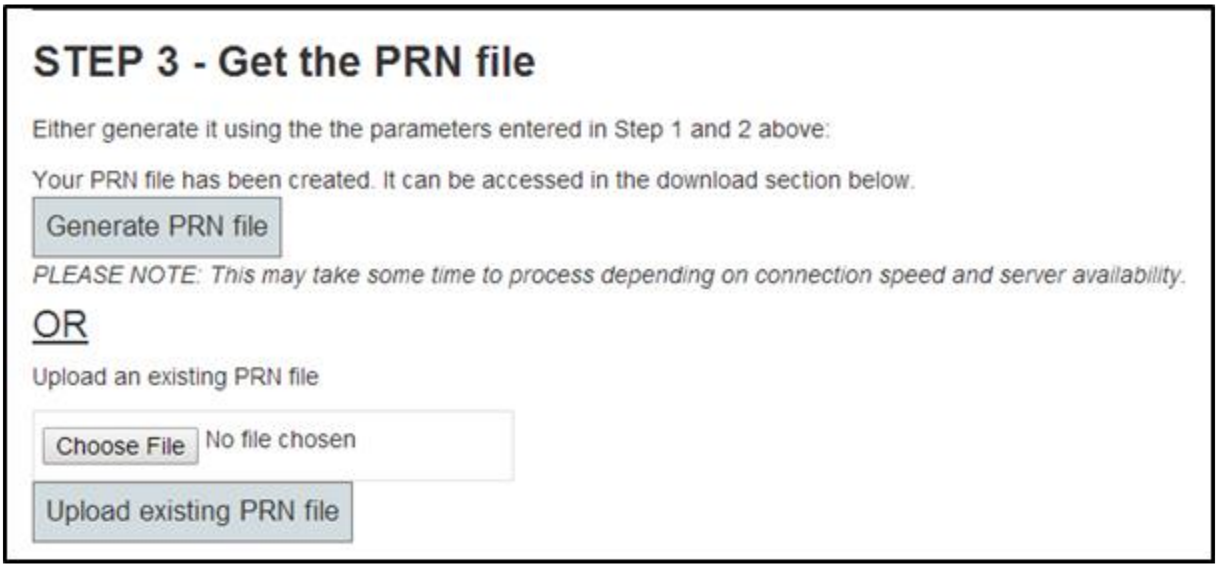


Figure 4 “Step 3” form before generating the PRN data

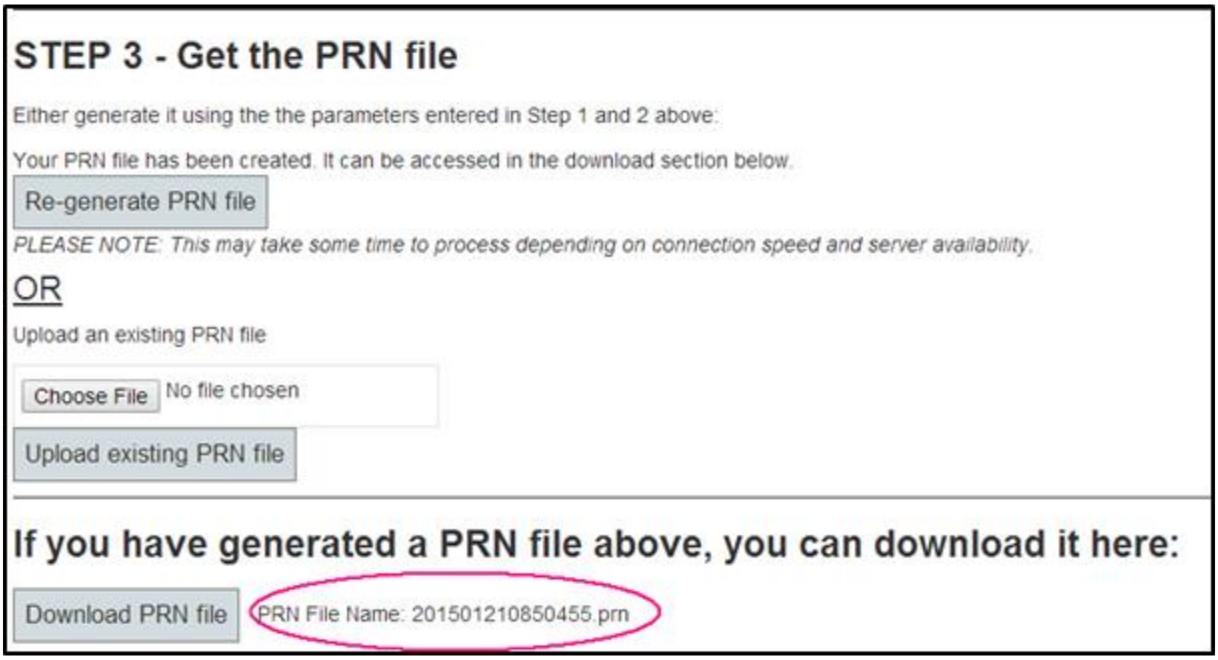


Figure 5 After the PRN data has been generated red circle for the PRN filename appears

At this stage you can download the PRN file (press Download PRN file) to your computer but **you don’t have to**. The browser will show when the download is completed. You can then inspect the CSV file in Notepad or MSexcel or any other ‘plain’ editor program. You can also make changes to the data with these programs where necessary, e.g. complete some of the additional information for virtual wells, change the number of wells in your selection, add more virtual wells, or update locations/screens /CalcMins of wells in the file.

It is critical that you do not alter the layout of file, only change the data in the ‘columns’. If you use MSexcel make sure that you save the PRN back as a CSV file (Commas Separated Values) and that you haven’t inadvertently changed the date formats. You won’t have these problems with Notepad or Notepad++ but reading the file ‘manually’ is a bit harder. The first line in the PRN files contains the columns headers (see appendix 2 (pdf 950 kB)).

If you want to use this edited data in the application then re-upload the modified PRN file. Press the "Choose file" button and browse to the location on your computer of the altered PRN file.

## Step 4 Data Checks

For the user convenience two graphs are displayed. The first one is a simple count of how many wells have a certain depth (well depth) grouped in classes of a meter around the proposed well. The second graph, screen distribution, is how many screens are recorded for all the wells in the PRN file at a 1 m interval classes. For example, if a well has a screen between 10 and 20 m this screen is counted at each 1 m class between 10-11 m and so on till 19-20 m class. This can help visualise where the aquifers might be.

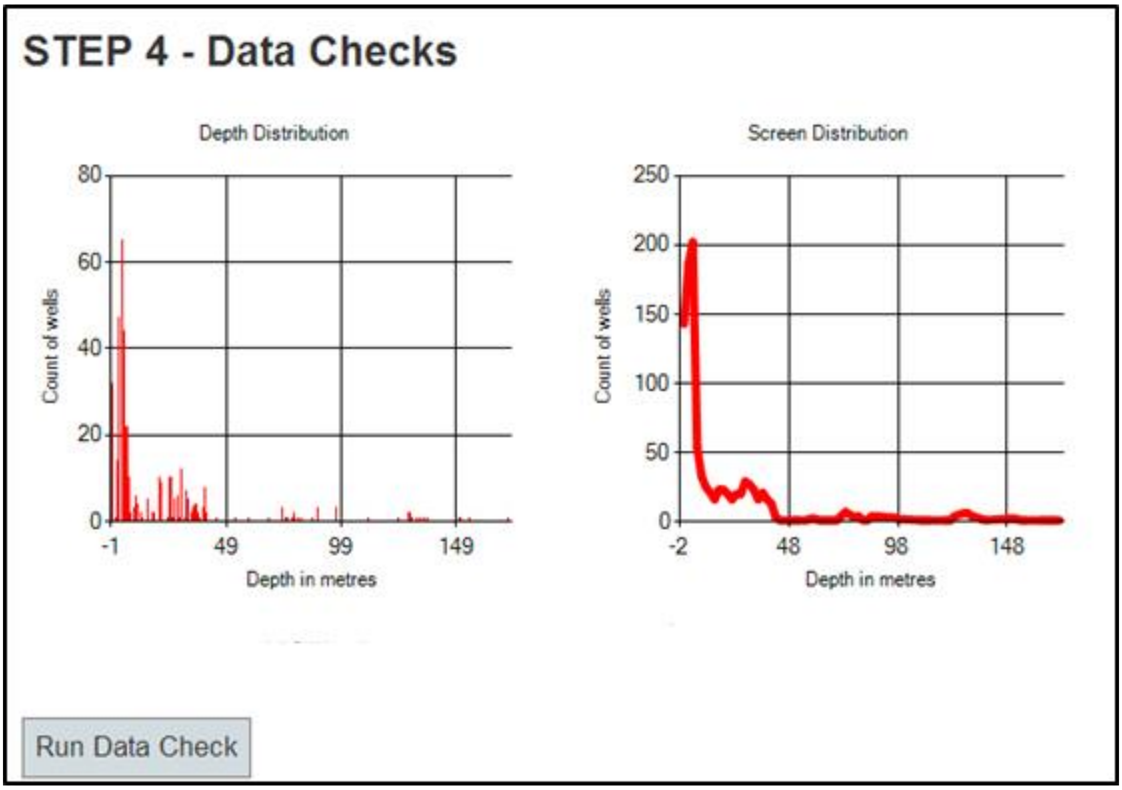



Figure 6 Step 4 after pressing the 'Run Data Check'

## Step 5 Analysis Parameters for well interference assessment

The application uses a few default parameters, mostly based on assumptions, to make up for a lack of detailed actual information for wells like screen lengths and pump length. If you have more detailed information you can add/edit that in your PRN file and include a comment in the final assessment. As in Step 2, it is best to run with the default settings specified in theSchedule 12 of the LWRP. The difference with step 2 parameters is that the settings there are used to create a PRN file and that the settings in step 5 are used in the well interference assessment model 'run'.

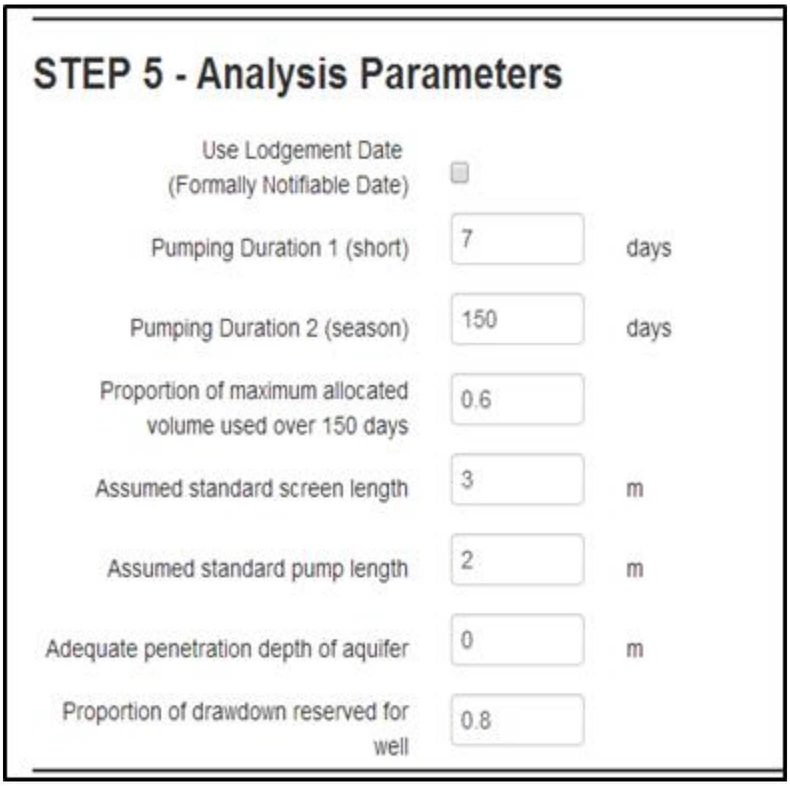


Figure 7 Model run parameters

If the 'Lodgement Date' checkbox at the top is selected then all wells will have their notification date or lodgement date taken into account. All wells with a **later** notifiable date in their application than the target well will not be 'pumping' in the model run as the RMA uses a **first-in-first-served** principle. This option is handy for example when you run several assessments for several applications in the same area that could be based on the same PRN file with different centre wells selected each time. The Notified dates are editable in the PRN file e.g. for virtual points. Please look at the figure in the appendix 1 (pdf 950 kB) to better understand the parameters used.

## Step 6 Selection of the groundwater model and parameters

Selection of the model type and parameters is probably the most difficult part of the process as you will have to justify the choices and understand the differences is the model options. Again, we assume that you are familiar with the models and limitations of models.

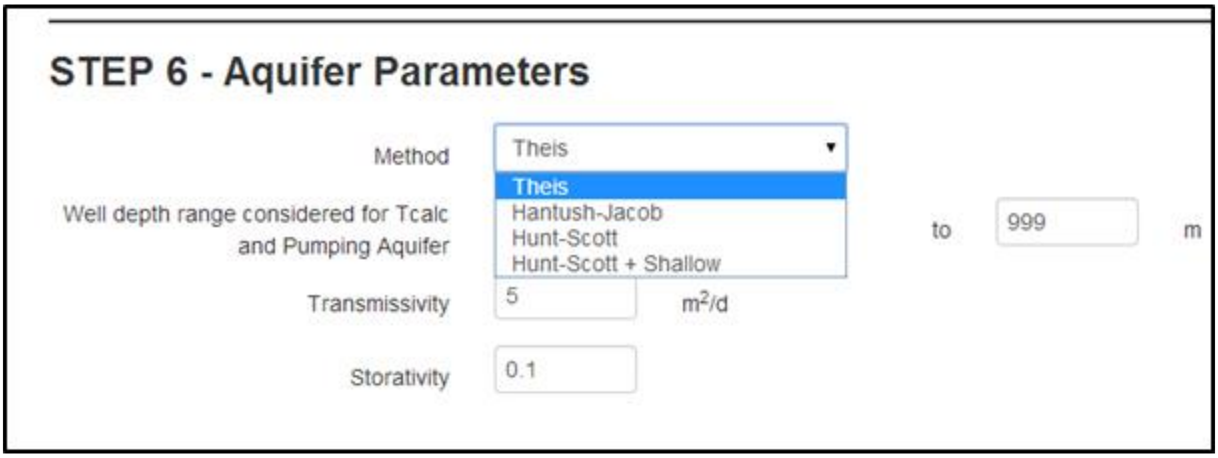
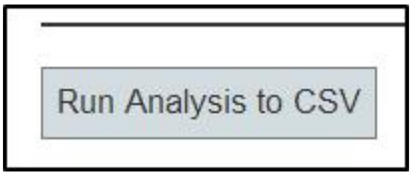


Figure 8 Model and aquifer parameter selections

The simplest model is the Theis model, requiring only a Transmissivity and a storativity value. The Hantush-Jacob requires an additional parameter of the Leakage Factor or K'/B'. This parameter field only appears in the form after you have selected this model. The Hunt-Scott and Hunt-Scott + Shallow each require an extra parameter of Specific Yield of the overlying layer and the Transmissivity of the overlying layer. For the last two models it is important that you specify a depth in the Well Depth Range box. This value will be used to split up the wells in two layers; above the top of the pumped aquifer for shallow, and the rest between the top and the bottom (default 999m). Any wells with their top of screens below this last level will be ignored.

### Step 7 Press 'Run Analysis to CSV' button.




The file will download to your PC, store it and open it with MSexcel for easy sorting. We recommend sorting the file in MSexcel on **Column N** in descending order below the last centre well so the wells are in order of drawdown experienced by the new proposed abstraction.

### Step 8 Interpretation of the results

The column descriptions are shown in appendix 3. Column "<well> DD_OK" shows the outcome of the test. Some comments to indicate special cases are noted by the program in the PRN file (Appendix 3 (pdf 950 kB)) or while running the model in two 'comments' columns in the output file. They can be helpful for the interpretation of the results.

You probably want to examine the 'problem' cases and whether they can be eliminated, for example:

- affected well not deep enough
- screen set higher than usual

- The calculated minimum water level is not appropriate for the aquifer, or location, or is simply wrong. You can set the “adequate penetration depth of aquifer” on the form to a depth that will then be used in the assessment for shallower wells. In some cases, well interference effects can be excluded on the basis of aquitards between wells with different depths, but you have to show with bore logs or aquifer test that show that that is likely
- For shallow aquifers and wells, the default screen and pump length are not appropriate. Knowledge of likely pump settings (surface pumps) for these type of wells might lead to setting different pump and screen lengths, but again needs to be justified
- Well that are not used (anymore): well is not used for water abstraction, well users have indicated that they have no problems with the new abstraction, or maybe it could be the same consent holder for different consented wells, etc.

If none of the affected wells can be excluded for the above reasons, well interference effects might have to be considered as a possibility. If the aquifer parameters cannot be derived from any of the involved wells, we recommend that an aquifer test is conducted to better determine the aquifer parameters and possibly measure the interference effects directly. In cases where the proposed wells aren’t drilled yet, potential interference problems can be avoided by shifting the proposed location to where the interference is below the set limits. Other mitigation options can include changing screen depth, e.g. when shallow wells would be affected the proposed take can be shifted to a deeper aquifer to avoid affecting the shallow wells.

# Literature and sources


- Canterbury Natural Resources Regional Plan Chapter 5 Water Quantity Prepared under the Resource Management Act 1991 Operative 11 June 2011
- Kruseman, G.P., and De Ridder, N.A.,1990, Analysis and evaluation of pumping test data
- Dr Bruce Hunt, the University of Canterbury