Devan stormVAULT tanks

Nom Vol (m3)	Nom Vol (L)	Working Vol (L)	Length Overall (m)	Weight (kg)
1.0	1000	1283	1.47	113
1.5	1500	1672	1.91	137
2.0	2000	2039	2.25	160
2.5	2500	2552	2.73	192
3.0	3000	3065	3.20	224
3.5	3500	3578	3.68	256
4.0	4000	4091	4.15	288
4.5	4500	4523	4.55	314
5.0	5000	5063	5.05	348
5.5	5500	5549	5.50	378
6.0	6000	6035	5.95	409
6.5	6500	6548	6.43	441
7.0	7000	7061	6.90	473
7.5	7500	7547	7.35	503
8.0	8000	8087	7.85	537
8.5	8500	8573	8.30	567
9.0	9000	9059	8.75	597
9.5	9500	9545	9.20	627
10.0	10000	10031	9.65	658
10.5	10500	10517	10.10	688
11.0	11000	11003	10.55	718
11.5	11500	11543	11.05	752
12.0	12000	12083	11.55	786
12.5	12500	12515	11.95	813

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Introduction

1.1 Purpose of the Toolbox:

The Tank Engineering Toolbox is an Excel spreadsheet designed to assist engineers and specifiers in various aspects of tank design and analysis. It includes functions for looking up Devan stormVAULT tank sizes, calculating detention and retention volume splits, calculating ground anchor requirements for mitigating tank buoyancy under various backfill and groundwater conditions, analysing tank storage volume in 100mm high sections, calculating detention volume orifice diameters, looking up tank set out distances from building structures and retaining walls, and matching tanks of user enterable diameters to stormVAULT tanks for specific requirements.

1.2 System Requirements

The spreadsheet was created using Microsoft (MS) Excel so recommend you use MS Excel (Version 2010 or later) with a Windows or MacOS operating system.

1.3 Installation

No installation is required. Simply download and open the Excel spreadsheet.

1.4 Functionality (available from Main Menu)

- Tank Sizes, Dimensions and Buoyancy
- Tank Sections and detention volume orifice calculation
- Tank Set out lookup
- Tank Matching (Match a user specified diameter tank to a 1.2m diameter stormVAULT)

1.5 Data Entry Cells

All data entry cells are highlighted in green. Do not attempt to enter data in other cells.

1.6 Results Cells

Calculated results are shown in cells that are highlighted in blue. Do not attempt to enter data in these cells.

1.7 Limitations

All tank sizes, dimensions and calculation results are specific to the Devan stormVAULT range of tanks. Consequently, calculation results for buoyancy mitigation, water storage by height, detention orifices, tank set out, and tank matching cannot be applied to any other tanks.

stormVAULT Tank Sizes, Dimensions and Buoyancy

2.1 Accessing Tank Sizes, Dimensions and Buoyancy:

Open the spreadsheet and navigate to the "Sizes & Dimensions" tab or go to the Main Menu tab and select the “Tank Sizes, Dimensions and Buoyancy” option.

2.2 Selecting Tank size and entering data for calculations

2.2.1 Selecting tank size and obtaining retention/detention volume splits

Using the drop-down list in cell B7 select the nominal tank volume required. You can enter a retention height in cell G7 if desired.

Once the tank volume is selected, basic information about the tank is displayed in cells B7 through M7. For a retention height greater than zero entered in cell G7 a Retention Volume will be displayed in cell I7 and a Detention Volume in cell J7.

Note: A retention height can be calculated by running a Goal Seek What-If Analysis and inputting a required Retention Volume for cell I7 (To value) and selecting cell G7 as the target cell (By changing cell). To do this

- click on “Data” in the Excel main menu ribbon
- click on What-If-Analysis
- click on Goal Seek
- when the Goal Seek dialogue box appears
- select cell I7 for the “Set cell”
- enter the retention volume you want in “To value”
- select G7 in “By changing cell”
- click OK
- The spreadsheet will calculate the retention height and display it in cell G7
- Click OK on the dialogue box when done

To configure the display to meet your requirements use the drop-down box in cell I4 to select the label for columns G, H and I. Options are:

- Dead
- Detention
- Retention

The selected option will appear in cells G4, H4 and I4.

To further configure the display to meet your requirements use the drop-down box in cell J4 to select the label for column J. Options are:

- Detention
- Retention
- Void

The selected option will appear in cells J4.

2.2.2 Finished Ground and Water Table levels:

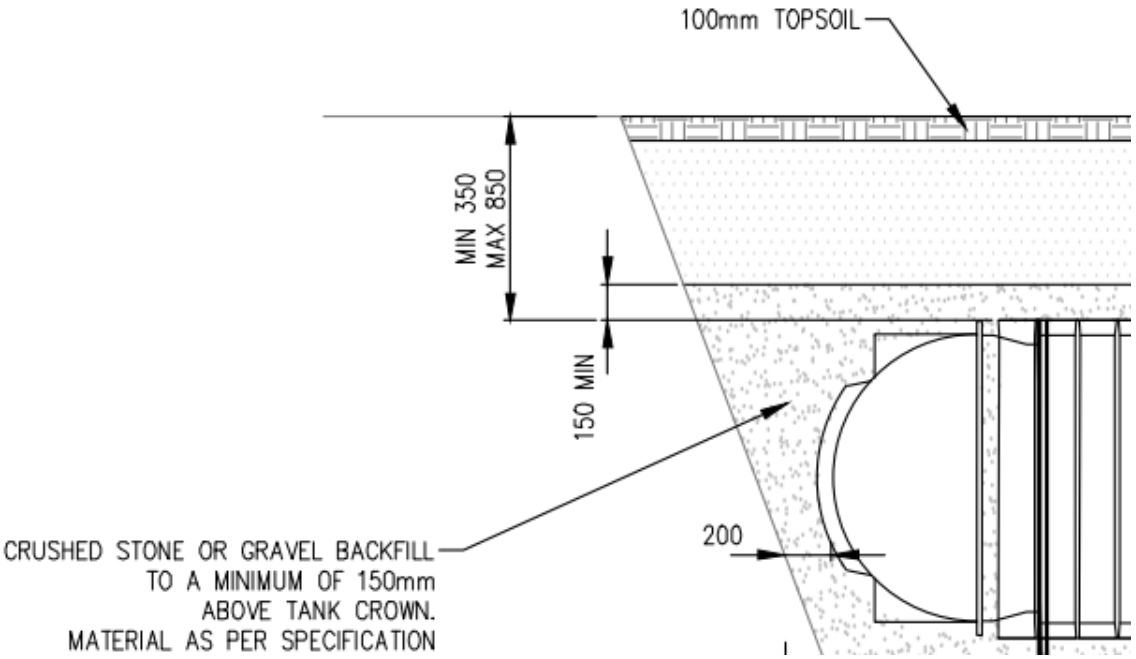
Enter the finished ground level (FGL) in cell D9 and the maximum water table level in cell D10 for the location where the tank is to be installed. The levels can be entered in absolute or relative values as the calculator just wants to know the difference. This will be calculated and displayed in cell D11.

Note: The water table level must be lower than or equal to the finished ground level. If not you will ger an error message saying: **ERROR: Water Table must be lower than FGL!**

Example: If the FGL is at RL 5.6m and the maximum water table level is at RL 4.6m then you could enter 5.6 in cell D9 and 4.6 in cell D10. Alternatively, you could enter 0 in cell D9 and -1 in cell D10. Either way the depth of the water table below FGL will be displayed as "1" in cell D11.

2.2.3 Fill layer depths, dry density, porosity and submerged density:

Up to 4 different fill layers with different densities can be entered. Layer 1 is the topmost layer and Layer 4 is the lowermost layer. Layer 4 is assumed to commence at the base of the tank and extend a minimum of 150mm above the top of the tank in accordance with the Devan stormVAULT tank installation details. (You are entering only the layer height above the top of the tank.)



If a layer height of 0 is entered for Layers 1, 2 or 3, then the layer is ignored in the calculations. Always use Layer 1 for the finish layer. In cell E13 you can select from the following options:

- Concrete Residential
- Concrete Commercial
- Other

Select one of the Concrete options when you are working with the Devan Residential or Commercial driveway details. In all other cases select Other. When you select one of the Concrete options the spreadsheet will prompt you to enter the minimum concrete thickness for the selected option in cell D13, density in cell H13 and porosity in cell I13.

Once all layer heights have been entered the total depth of cover is calculated and displayed in cell D17. The total depth of cover must be between 0.35m (350mm) and 0.85m (850mm) to comply with the Devan installation details. The spreadsheet will still operate correctly if

the minimum depth of cover (0.35m) is not achieved, however the installation will not be trafficable (refer to Devan installation details).

Enter dry densities for fill layers in cells H13 through H16 along with porosity values in cells I13 through I16. Porosity is a value between 0 to 1 determined by (Void Volume/Total Volume). Porosity of 0 (zero) indicates no voids in the fill material. Porosity of 1 means there is no hard fill and no layer!

Porosity example: Suppose we have a 1 cubic metre container and fill it with hardfill. When it's full of hardfill we start adding water and find we can get 300 Litres (0.3 m^3) of water into the container. Porosity is then 0.3/1.0 = 0.3.

Submerged density: From the example above suppose we have hardfill with a dry density of 1600 $kgm^{-3}$and a porosity of 0.3. As shown above 0.3m^3 of water will saturate the hardfill. For a cubic metre that means the hardfill is displacing 0.7m^3 of water. Applying Archimedes principle to the hardfill we have

Submerged density = fill dry density – displaced water density
Submerged density = 1600 – 700 = 900 kgm^{-3}
Submerged density = 1600 – (1000 – 300) kgm^{-3}
Submerged density = 1600 – 1000 x (1 – 0.3) kgm^{-3}
Submerged density = fill dry density – water density x (1 – porosity) kgm^{-3}

Notes:
Submerged densities are calculated from entered dry densities and porosity values.
Density of water is assumed to be 1000 kgm^{-3}.
Loading contributions for the entire residential or commercial driveway concrete slab are calculated as per the Devan installation details. The result is included in the Load from fill results displayed in cells G21 through J21 and cells L21 through O21.

2.2.4 NZS 1170 Load reduction and uplift increase factors:

Enter the load reduction factor required in cell D19
Enter the uplift increase factor required in cell D20
The cross product of the factors is displayed in cell D21
The entered factors will be used when calculating ground anchor requirements which are displayed in the "Factored" results cells of I26, J26, N26 and O26

2.2.5 Ground anchor calculation results:

Once you have:
- Selected the tank you want to work with
- Entered Finished Ground Level and Water Table heights
- Entered Fill heights, dry densities and porosities
- Load reduction and uplift force factors

Then, un-factored and factored ground anchor requirements are displayed for both dry densities and submerged densities.
Cells G26, H26, I26, and J26 show ground anchor requirements using dry densities
Cells G27, H27, I27, and J27 show ground anchor spacing using dry densities
Cells L26, M26, N26, and O26 show ground anchor requirements using submerged densities
Cells L27, M27, N27, and O27 show ground anchor spacing using submerged densities

Note: Various values, in Kilograms (kg) and kiloNewtons (kN) from the relevant calculations are displayed in cells G19 through J24 and L19 through O24.

2.2.6 Ground anchor calculation error messages:

Error messages regarding the ground anchor calculations will appear in red text in the cell block F30:O33.

Dry density error messages start in column F:
INSUFFICIENT SPACING FOR ANCHORS (UN-FACTORED)
INSUFFICIENT SPACING FOR ANCHORS (FACTORED)
ANCHOR BREAKING LOAD EXCEEDED (UN-FACTORED)
ANCHOR BREAKING LOAD EXCEEDED (FACTORED)

Submerged density error messages start in column K:
INSUFFICIENT SPACING FOR ANCHORS (UN-FACTORED)
INSUFFICIENT SPACING FOR ANCHORS (FACTORED)
ANCHOR BREAKING LOAD EXCEEDED (UN-FACTORED)
ANCHOR BREAKING LOAD EXCEEDED (FACTORED)

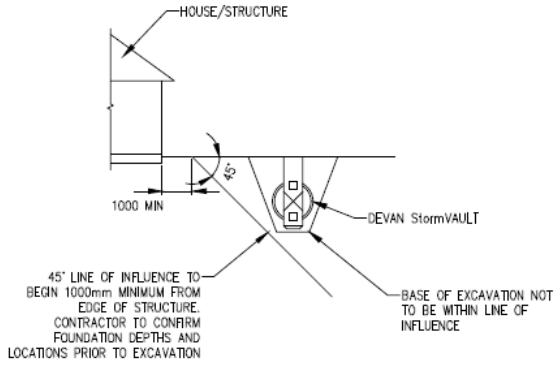
The solution for these error messages is to add more depth of cover or increase fill densities above the tank, or both.

2.2.7 Manual ground anchor entry:

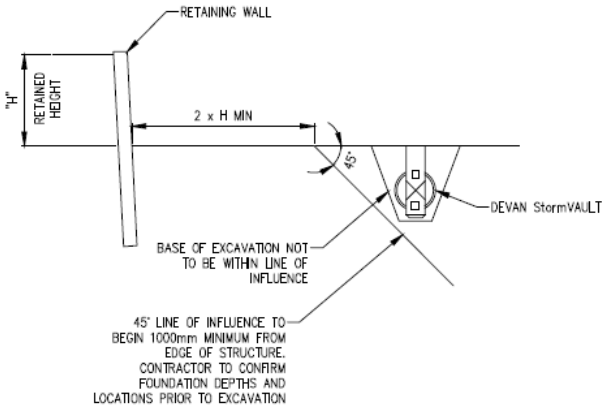
If for some reason you are not satisfied with the results of the ground anchor calculation you can manually enter the number of ground anchors you want (minimum 2) in cells G28 through J28 for dry densities and cells L28 through O28 for submerged densities. The spacing between the anchors will be displayed in cells G29 through J29 for dry densities and cells L29 through O29 for submerged densities. If the message "**SPACING ERROR**" appears instead of a spacing distance, then there are too many ground anchors to fit along the length of the tank.

2.2.8 Tank set out distance from building structure and timber pole retaining wall:

The set out distances are calculated in accordance with the Devan installation details. The relevant drawings are shown below.



TANK POSITION NEAR STRUCTURE



TANK POSITION NEAR RETAINING WALL

Set out distances change with depth of cover and this is automatically calculated as layer heights are entered.
Enter the retaining wall height in cells D25 or D30 depending on whether you want the set out for the silt trap end of the tank or the non-silt trap end.

Notes:
1: There is a slight variation between the silt trap end of the stormVAULT tank and the non-silt trap end as the base of the silt trap is 300mm lower than the tank base.
2: Calculated set outs are for a vertical walled trench, not a sloping walled trench.
3: For sloping walled trenches set outs are a minimum of 1m for building structures and for retaining walls it is the minimum of 1m or 2 x H (retained height), then the 45 degree line of influence.
4: See section 6 for a tank set out lookup table.

stormVAULT Tank Sections (water storage by 100mm sections plus user entered height) and Detention Volume Orifice Calculation

3.1 Accessing Tank Sections and detention volume orifice calculation

Open the spreadsheet and navigate to the "Sections & Orifice" tab or go to the Main Menu tab and select the “Tank Sections and Orifice Calculation” option.

3.2 Selecting Tank Size and entering a retention height

Using the drop-down list in cell B7 select the nominal tank volume required. You can enter a retention height in cell G7 if desired. For a retention height greater than zero entered in cell G7 a Retention Volume will be displayed in cell I7 and a Detention Volume in cell J7.

Once the tank volume is selected, information about the tank in 100mm sections is displayed in cells G12 through J24. Water is displayed in column I for the heights displayed in columns G and H.

Note: A retention height can be calculated by running a Goal Seek What-If Analysis and inputting a required Retention Volume for cell I7 (To value) and selecting cell G7 as the target cell (By changing cell). To do this

- click on “Data” in the Excel main menu ribbon
- click on What-If-Analysis
- click on Goal Seek
- when the Goal Seek dialogue box appears
- select cell I7 for the “Set cell”
- enter the retention volume you want in “To value”
- select G7 in “By changing cell”
- click OK
- The spreadsheet will calculate the retention height and display it in cell G7
- Click OK on the dialogue box when done

To configure the display to meet your requirements use the drop-down box in cell I4 to select the label for columns G, H and I. Options are:

- Dead
- Detention
- Retention

The selected option will appear in cells G4, H4 and I4.

To further configure the display to meet your requirements use the drop-down box in cell J4 to select the label for column J. Options are:

- Detention
- Retention
- Void

The selected option will appear in cell J4.

3.3 Detention Volume orifice calculation

Using the volume appearing in cell J7 the spreadsheet calculates the minimum orifice diameter required to drain the tank in the detention release time entered in cell I29 and subject to the Local Authority minimum orifice diameter entered in cell I34. The result is shown in cell I35. For comparison the calculated orifice diameter is shown in cell I33.

stormVAULT Tank Set out lookup

4.1 Accessing Set out lookup table

Open the spreadsheet and navigate to the "Tank set out lookup" tab or go to the Main Menu tab and select the “Tank set out lookup” option.

4.2 Using the Set out lookup table

Find the overall depth of cover for the tank in the table and the set out for either end of the tank will be found on the same line of the table. If the depth of cover is not shown exactly in the table then you can interpolate using table values or go to the Sizes & Dimensions spreadsheet and make the calculation there. Refer to section 2.2.8 above.

Tank Matching (Match a user specified diameter tank to a 1.2m diameter stormVAULT)

This spreadsheet will help you match a different brand tank to a Devan 1.2m diameter stormVAULT tank. The diameter of the other tank must be less than or equal to 1.2m. The calculation assumes that the levels required on site won't change, so the "equivalent" stormVAULT tank will have a dead or retention volume.

5.1 Accessing Tank Matching

Open the spreadsheet and navigate to the "Tank Matching" tab or go to the Main Menu tab and select the "Tank Matching" option.

5.2 Inputting Tank Parameters:

If the volume and diameter are known then:

Enter the volume in cubic metres in cell C3 and the diameter in metres in cell C6. The dead or retention volume height will be displayed in cell G16.
The equivalent tank options are displayed in cells B19 through G42 and highlighted with a light green background. The tanks highlighted with a red background are not big enough.
Dead or retention volumes are shown in column F.
Available volumes are shown in column G.

If the length and diameter are known then:

Enter the tank length in metres in cell J3 and the diameter in metres in cell J6. The dead or retention volume height will be displayed in cell N16.
The equivalent tank options are displayed in cells I19 through N42 and highlighted with a light green background. The tanks highlighted with a red/pink background are not big enough.
Dead or retention volumes are shown in column M.
Available volumes are shown in column N.

5.3 Analysing Matched Tanks:

Review the list of possible equivalent tanks. Select the smallest tank that will meet requirements from those options with a light green background.

Toolbox version and support

6.1 Current Toolbox: Version 1.0

Updates to the Toolbox will be emailed to you when available but please check with Devan Plastics if you want to confirm you have the current version – see section 6.2 for contact details.

6.2 Contacting Support:

For any technical issues or questions, please contact

Richard Ruddell at Devan Plastics

email: richard.ruddell@devan.co.nz

mobile: 021 748 081