

DISCHARGE MEASUREMENT FIELD DATA AND CALCULATION (DMFDC) 2.0

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1.0 Introduction to DMFDC

The Discharge Measurement Field Data and Calculation (DMFDC) Excel program calculates and displays stream flow data in a user friendly, Windows based environment. Users can enter stream flow data and see the results instantly. Many features have been included in the DMFDC program to give the user more flexibility than has been available in the past. For example, there is an entry in DMFDC pages to input the equations for meters. This prevents users from having to alter the equations contained in the many cells every time a different meter is used.

The DMFDC program is composed of two types of worksheets. The first type of worksheet is called “Std.xls”, the second worksheet type is called “Multi.xls”. The only difference between the two types of worksheets is their size. “Std.xls” worksheets are designed for measurement sessions that consist of only single vertical measurements like “point six” and “point five” measurements. Therefore there are 25 rows for stream flow data to be entered in the “Std.xls” worksheet. The “Multi.xls” worksheet is designed to handle “two” and “three” point measurements. To handle the extra rows required for these measurements “Multi.xls” worksheets have 62 rows available for stream data to be entered. Beyond the number of rows for data entries, the two worksheets are exactly the same in every respect.

Each of the worksheets is broken up into two sections. The first part of a worksheet is called “Section 1: Site Information”, the second part of a worksheet is labeled as “Section 2: Data Entry”. Each section describes a different aspect of a measurement session.

Section 1 contains data that describes many conditions and variables of the measurement session. Examples of items that are entered into the Section 1 are station name, temperatures and meter equations. Section 2 accepts actual stream flow data input from the user. Items like rotor revolutions and water depth are entered into Section 2 by the user. As data is entered into Section 2, results such as velocities and discharges are displayed in real time. Each row in Section 2 represents a single measurement, although two and three point measurements occupy two and three rows respectively.

2.0 Entering Data into a DMFDC worksheet

2.1 Section 1: Site Information

As previously noted, the “Section 1: Site Information” portion of the worksheet contains all the environmental data for the stream, as well as other variables.

The following entries are made in Section 1:

- Station Operating Agency/Firm, Station Number and Station Name
- Date
- Metered by
- Location and Time of Metering
- Weather and Air and Water Temperatures
- Gauge Heights and Corrections
- Pen Corrections
- Meter Type, Number and Fan Number (meters with interchangeable impellers)
- Method of Suspension¹
- Meter Equation²
- Remarks

Although most of the input into Section 1 is for descriptive purposes only, (ie. temperatures and station names) there are several cells that display calculations. For example, when start and end values for the pen correction and inside gauge are entered, the mean of each will be displayed. When the start and end outside gauge heights are entered, the resulting mean height will be added to any gauge correction to produce a corrected gauge height. In addition, once Section 2 has been filled with stream data, the “Total Discharge”, “Total Area” and “Average Velocity” entries in Section 1 will be automatically updated.

Section 1 also requires input that determines how data is calculated in Section 2. For example, specifying the Method of Suspension is a critical entry in Section 1. The method of suspension entered by the user will appear in the “Method of Suspension” title to confirm the correct setting. The method of suspension directly affects the Depth of Observation. If the Cable and Weight suspension method is active, the depth of observation will be measured from the water surface to the stream bed. When the Standard or Bridge Rod method of suspension is selected, the depth of observation will be

¹ Valid data must be entered to receive accurate output.

² Valid data must be entered to receive accurate output

measured from the stream bed to the surface of the water, finally if the Top Setting Rod method is employed, no depth of observation will be calculated.

To choose a method of suspension, enter a value in the “Method of Suspension” portion of Section 1 that describes the desired method. The three methods and their respective values are displayed below.

Table 1: Methods of Suspension

<i>Value for Method of Suspension</i>	<i>Method of Suspension</i>
1	Top Setting Rod
2	Standard of Bridge Rod
3	Cable and Weight

Entering an equation for the meter type is another important input found in Section 1. The equation for a meter is entered in the “Meter Type” portion of Section 1. A meter can have a single range or a multiple range. To enter an equation for a single range meter, enter the slope and intercept into the appropriate headings of the box labeled "Single Range Meter Equation". To enter an equation for a multiple range meter, enter the slopes and intercepts into the appropriate headings of the box labeled "Multiple Range Meter Equation". If the equation for the multiple range meter only has two lines instead of three, simply enter the equation into the first two lines of the "Multiple Range Meter Equation" box.

Certain meter equations contain intercepts that are subtracted from the rest of the equation. In contrast, intercepts are always added to the equations in the “Meter Type” box. To subtract an intercept from an equation, simply enter the intercept as a negative number. For example, if the equation was: $V = 0.251 X n - 0.004$, enter 0.251 for the slope and -0.004 for the intercept. If the maximum revs/seconds for an equation is unknown, choose a value that will be higher than the highest possible value (i.e. 99).

Ideally, users should ensure that only one meter range has equation(s) entered into it. If both meter range boxes have valid equations entered, the single range meter equation will be used and the multiple range meter equations will be ignored. To confirm which meter range is activated; refer to the "Meter Type" heading above the two meter range boxes. This heading indicates which meter type is selected based on the equations entered. Initially, it will display “No Meter Range Selected”. After a valid equation(s) is entered into one of the meter ranges this heading will describe the range selected. It is critical that one of the meter ranges are activated before entering data into a "Section 2". If a range is not selected, the output of the "Sheet" will be completely invalid.

2.2 Section 2: Data Entry

Section 2 of the worksheet contains all the actual stream data of the measurement session. Values such as water depth, method and revolutions of fan are entered here. "Section 2" also displays the results of such input, such as calculated velocities and areas.

There are two main sections in "Section 2". The first section is the "Observations" section which covers the first seven columns from the left. The second section is the "Computations" section which covers the remaining six columns.

The Columns in the "Observations" section:

- Method
- Distance From Initial Point
- Depth
- Depth of Observation*
- Revs
- Time
- Cos of Flow

The Columns in the "Computations" section:

- Velocity: at Point*
- Velocity: Mean in Vertical*
- Width*
- Area*
- Discharge*

* indicates that no user input is permitted in column.

User input is only allowed in six of the seven columns in the "Observations" section and no input is permitted in the "Computations" section.

The "Method" column, or left most column, is used for inputting the method of measurement used for each corresponding row. There are many methods available for taking measurements. Each method is described below

- 2 A Two Point measurements. Two vertical measurements are taken at depths of 0.2 and 0.8. The depths of observations are calculated either from the water surface down if the cable and weight suspension method is chosen, or from the stream bed up if the standard or bridge rod suspension method is selected. The two point method requires two rows to complete. In the first row of the method, (the row with the 2 in the method column), enter values for "Distance From Initial Point", "Depth", "Revs", "Time". This row represents the first of two vertical measurements. The

second measurement should be entered in next row and only requires that the "Revs" and "Time" be entered, even the "Method" column should remain blank in the second row. The user may enter values into the "Cos of Flow" column for both vertical measurements, but these are optional entries. If no entries exist in the "Cos of Flow" columns, it is assumed that no cosine corrections are required. *See Note 1.*

- 3 A Three Point measurements. The depths of observations are calculated either from the water surface down if the cable and weight suspension method is chosen, or from the stream bed up if the standard or bridge rod suspension method is selected. The three point method requires three rows to complete. For the first row of the method, (the row with the 3 in the method column), enter values for "Distance From Initial Point", "Depth", "Revs", "Time". This row represents the first of three vertical measurements. The second measurement should be entered in next row and only requires that the "Revs" and "Time" be entered, the "Method" column for this row should remain blank. The third measurement should be entered immediately after the row containing the second measurement and only requires that the "Revs" and "Time" be entered, the "Method" column for this row should remain blank. The user may enter a value into the "Cos of Flow" column for all three vertical measurements, but these are optional entries. If no entries exist in the "Cos of Flow" column, it is assumed that no cosine corrections are required. *See Note 1.*

- 6 A Point Six measurement. Represents a single measurement taken at a relative depth of 0.6. The depth of observation is calculated either from the water surface down if the cable and weight suspension method is chosen, or from the stream bed up if the standard or bridge rod suspension method is selected. Values should be entered for "Distance From Initial Point", "Depth", "Revs", "Time". The user may enter a value into the "Cos of Flow" column, but this is an optional entry. If no entries exist in the "Cos of Flow" column, it is assumed that no cosine correction is required. *See Note 1.*

- 5 A Point Five measurement. A single measurement taken at a relative depth of 0.5. Values should be entered for "Distance From Initial Point", "Depth", "Revs", "Time". The user may enter a value into the "Cos of Flow" column, but this is an optional entry. If no entries exist in the "Cos of Flow" column, it is assumed that no cosine correction is required. The depth is the same regardless which suspension method is employed. *See Note 1.*

Note 1: The angle of flow through a cross section is applied to the velocity of each panel affected. The cosine value of any flow that deviates from right-angles to the cross section is entered in the "Cos of Flow" column, e.g. an angle of about 15° would have an entry of 0.96 which is applied to the velocity at the point. Thus, if it is observed that angles of flow change at differing depths, these angular coefficients

may be entered in each row of a 2 or 3 point measurement. Angular flow entries may also be made in conditions of reverse flow.

Note 2: Reverse flow entry may be accomplished by entering a negative value in the revolutions column, i.e. -75.

- B** The Beginning of the measurement. It is used at the very beginning as well as directly after an S occurs. Enter values in the "Distance from Initial Point" and "Depth" columns.
- E** Estimated Velocity. This is used to estimate the velocity in locations where the fan is too close to the edge to get a proper measurement. It can be used after a B or before an S or a T and at least one adjacent measurement method should be 2, 3, 6, or 5. Enter values in the "Distance from Initial Point", "Depth" and "Cos of Flow" columns. The new estimated velocity is calculated by multiplying the value in the "Cos of Flow" column with the velocity that is adjacent to the estimate. The (mean in the vertical) value in the adjacent vertical is used for the comparison, i.e. an estimated 66% flow of the adjacent vertical is entered as 0.66 in the "Cos of Flow" column.
- S** Temporary Stop. For example, if an obstacle was sticking out of the water in the middle of a measurement, making a velocity check impossible, enter S at it's edge. The next row's method must be a B located at the obstructions far edge. Enter values in the "Distance from Initial Point" and "Depth" columns.
- T** Terminates measurement session. It is the absolute last measurement. Enter values in the "Distance from Initial Point" and "Depth" columns. A T should always be the very last row's method.

The second column, "Distance From Initial Point", represents the distance from where the measurements started to the current measurement position. The user inputs the distances from shore along this column for each measurement. This value always gets larger as the measurement goes across the creek. The distance is measured in meters.

The third column, "Depth", represents the depth of the water for the current measurement. The depth shouldn't be negative. A negative depth will cause problems with some of the calculations. The user inputs this value which is measured in meters.

The fourth column, "Depth of Observation", is NOT for user input. This column displays the depth of measurement, which indicates the depth at which the velocities are measured. In the case of standard or bridge rod, this number reflects the depth from the surface, in the case of cable and weight this number reflects the depth from the bottom, and in the case of top setting rod, there is no "Depth of Observation" value calculated.

The fifth column, "Revs.", is where the user enters the number of full revolutions the fan completes in the time specified.

The sixth column, "Time", is where the user enters the time for each vertical measurement. The measurement is timed in seconds.

The seventh column, "Cos of Flow", indicates the Cosine of the flow angle. This value corrects the velocity based on any differences between the angle of the waters flow vs. the angle that the fan is being held at. This value is optional. If it is entered, it is multiplied to the raw velocity to produce a corrected velocity representing more accurately the effects of the flow angle on velocity measured by the meter.

The remaining columns are found in the "Computation" section. They are not for user input. They are strictly calculations based on the data that the user input in the "Observations" section of the Sheet.