

**“The Flowsheet
Processor”**

1_D VERTICAL WIZARD MANUAL

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CONTENTS

1.	INTRODUCTION	3
2.	DRAWING THE FLOWSHEET	3
2.1	Drawing the flowsheet on paper	3
2.2	Using the LIMN Draw function	4
2.3	Cloning a flowsheet.....	6
3.	RUNNING THE 1_D VERTICAL WIZARD	8
4.	POPULATING THE WORKSHEETS.....	12
4.1	The Configuration Sheet	12
4.2	The Stream Data(Input) Sheet.....	13
4.3	The Stream Summary Sheet	13
4.4	The Unit_Ball Mill sheet	14
4.5	The Unit_Cylone sheet.....	14
4.6	The Unit_Screen sheet	15
4.7	The DataBlocks sheet.....	15
5.	RUNNING THE LIMN SOLVER 	16
6.	USING THE LIMN SCENARIOS SHEET	17
7.	CHANGING STREAMS IN THE FLOWSHEET.....	18
8.	ADDING A UNIT OPERATION.....	21
	APPENDIX A: 1_D VERTICAL WIZARD WORKED EXAMPLE	25
	APPENDIX B: MODIFIED STREAM EXAMPLE	26
	APPENDIX C: ADDITIONAL UNIT WORKED EXAMPLE	27

1. INTRODUCTION

The best way to get to know the LIMN simulation tool is to complete a worked example. The following pages detail the worked example. It is strongly recommended that one complete the worked example, as it will benefit a first time user.

2. DRAWING THE FLOWSHEET

It is recommended that one draws the flowsheet by hand on paper before using the LIMN draw function. This will save the user having to redraw the flowsheet to get the spacing correct.

2.1 Drawing the flowsheet on paper

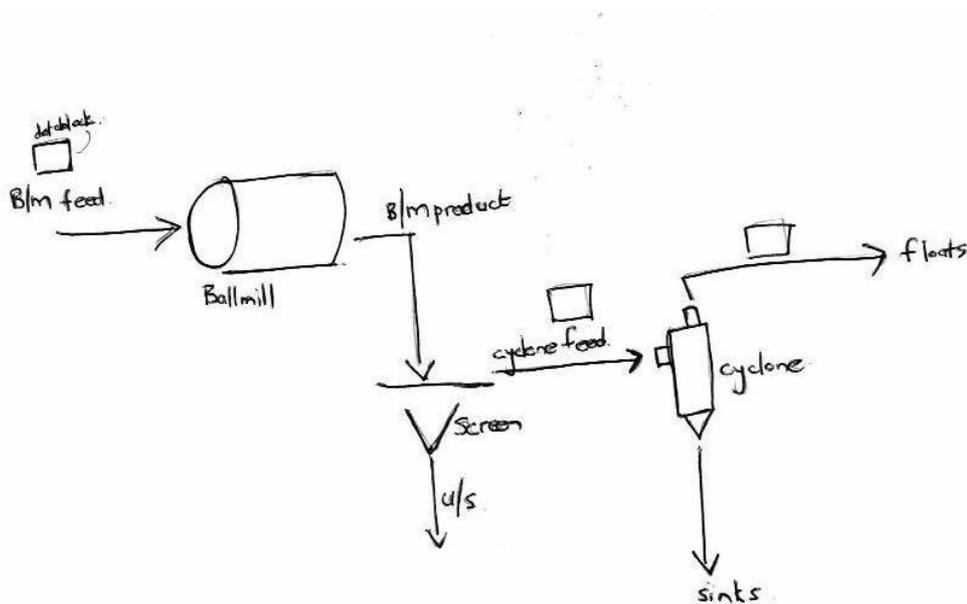


Figure 1: Drawn flowsheet

Make sure that the flowsheet, unit operations and spacing is correct before drawing the flowsheet using LIMN. Much time can be saved by making corrections before drawing the flowsheet using LIMN.

2.2 Using the LIMN Draw function

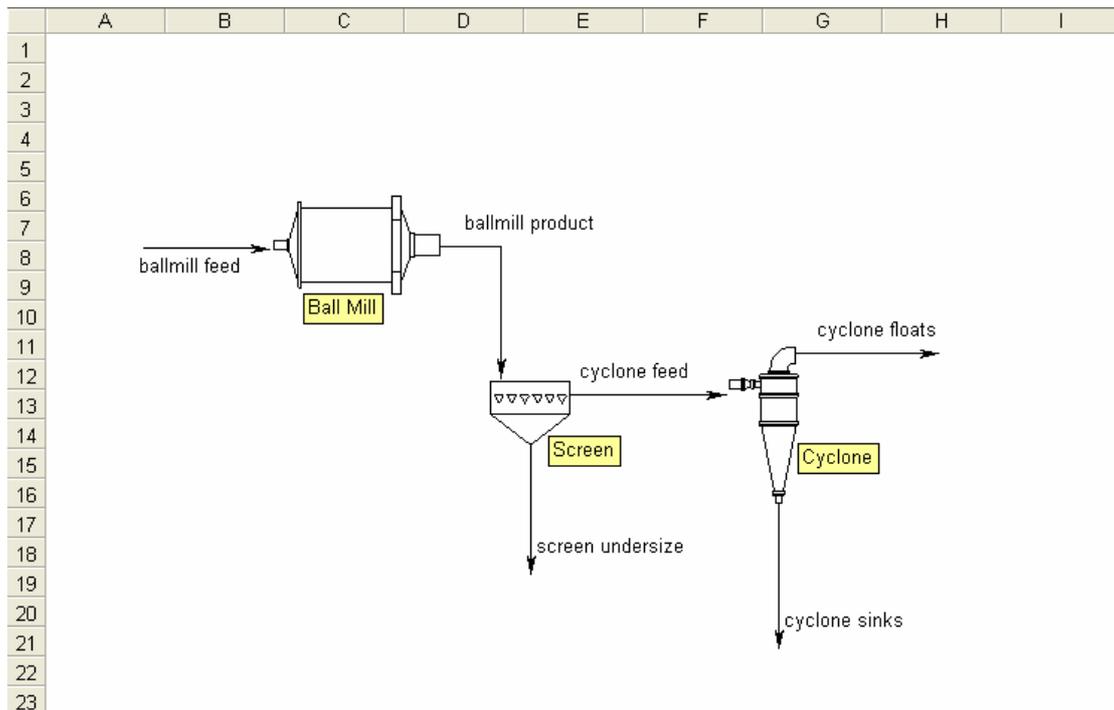


Figure 2: LIMN drawn flowsheet

- 2.2.1 Click on the LIMN draw button. 
- 2.2.2 Add each of the three icons by clicking on the New Icon button. 
- 2.2.3 The icons can be found by searching through the Icons lists, see figure 3 below.

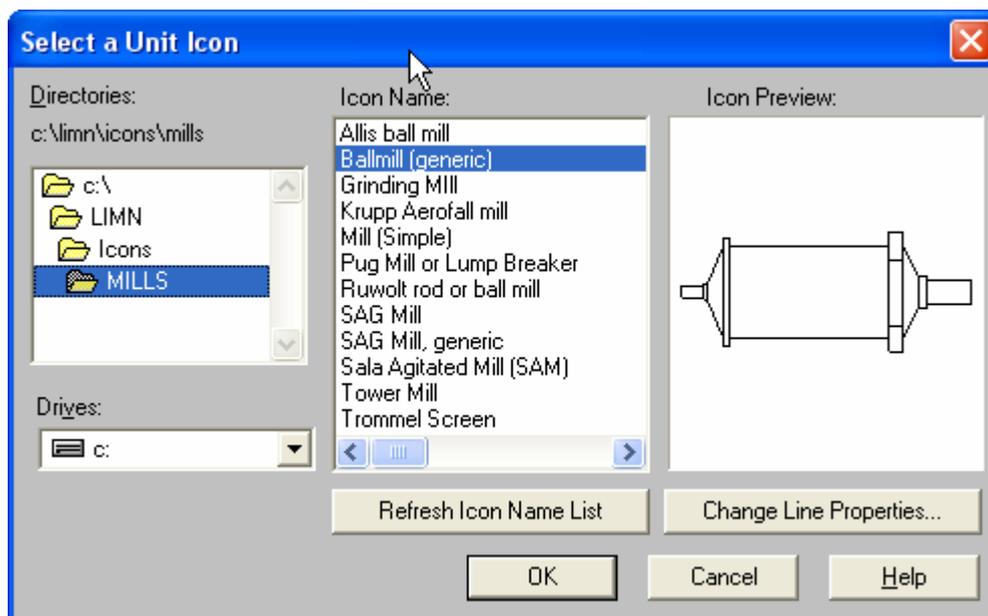


Figure 3: Icon list

- 2.2.4 Be careful when connecting the streams to the unit operations. Make sure that the arrow of the stream changes to the connection arrow before connecting, check the LIMN demo.
- 2.2.5 Label the unit operations by clicking on the unit and then entering the unit operation name in the Select Limn Object textbox. The unit operation names are: Ball Mill; Screen; Cyclone.

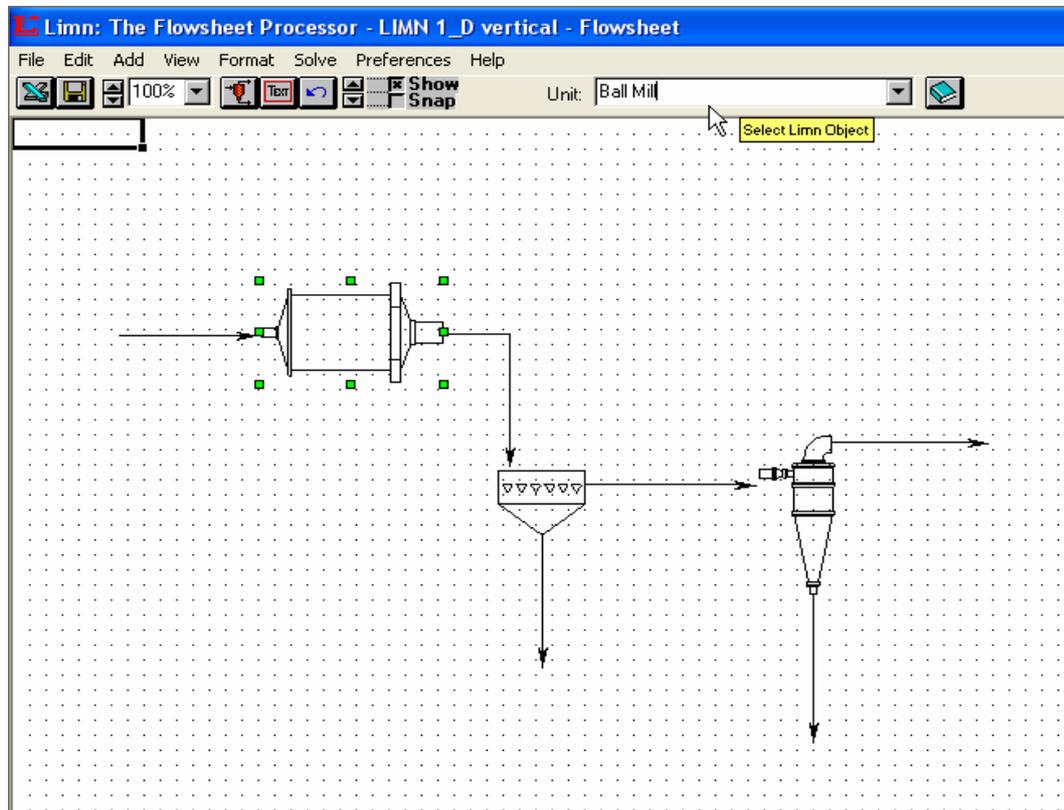


Figure 4: Naming Units

Note: When naming the unit operations and the streams one can switch from item to item by using the TAB key.

- 2.2.6 Label the streams by clicking on the stream and then entering the stream name in the Select Limn Object textbox. The stream names are: ballmill feed; ballmill product; screen undersize; cyclone feed; cyclone floats; cyclone sinks.
- 2.2.7 To display the labels of the unit operations and streams on the flowsheet click on the Add menu and then select Label All. Make sure that attach labels dialogue boxes are ticked. Position the labels as required.

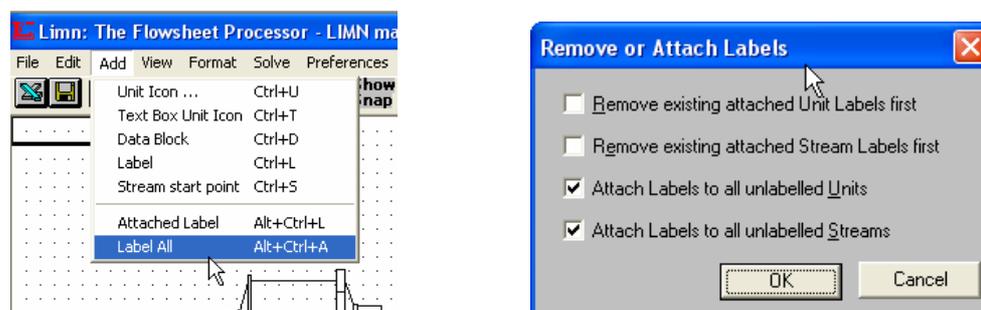


Figure 5: Adding Labels

2.3 Cloning a flowsheet

During the Data Wizard manual example the flowsheet in figure 6 was created. This flowsheet can be cloned and used for the 1D_Verical wizard example.

2.3.1 Open the Excel workbook file that was saved for the Data Wizard example.

2.3.2 Click on the flowsheet for the Data Wizard example.

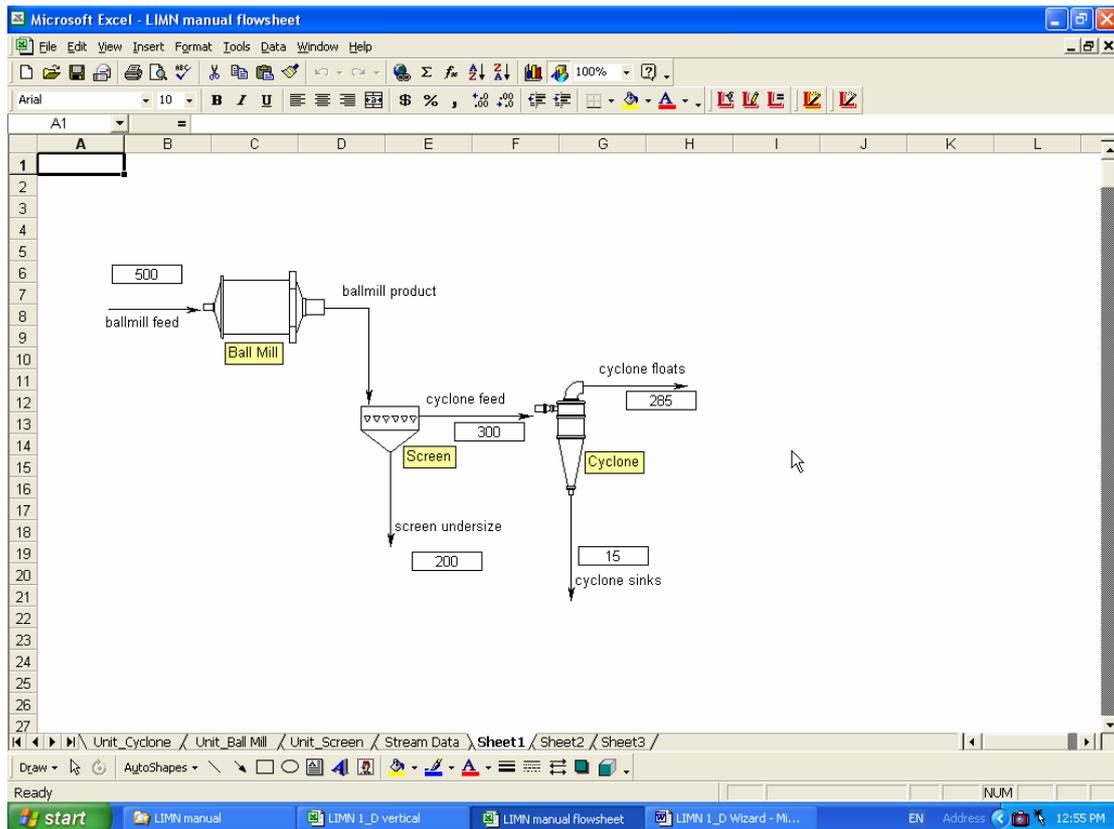


Figure 6: Data Wizard flowsheet

2.3.3 Click on the LIMN: Wizards Icon. 

2.3.4 Click on the Other Useful LIMN Related Functions... button.

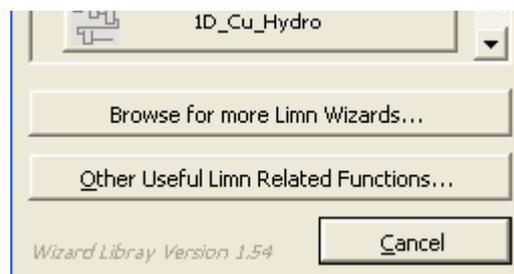


Figure 7: LIMN: Wizards

2.3.5 Click on the create a clone button.

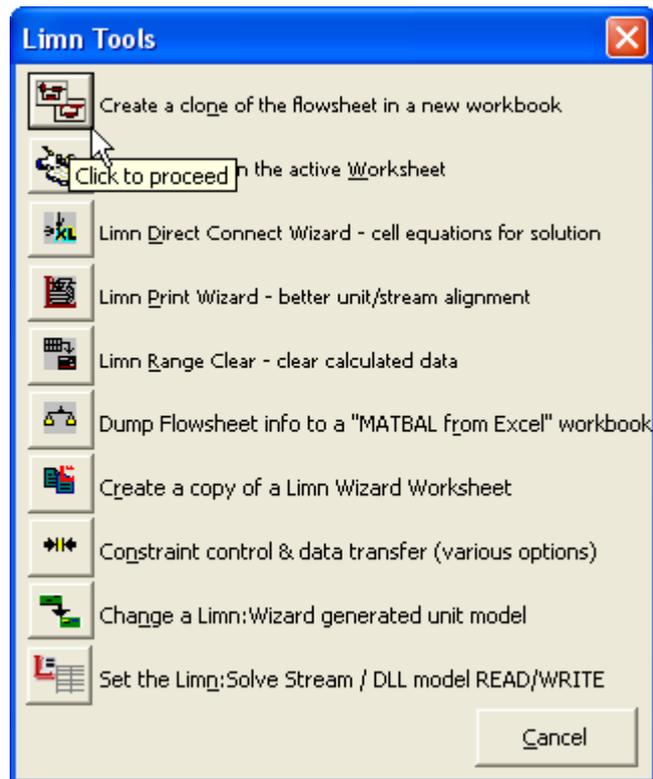


Figure 8: Other Useful Functions Menu

2.3.6 Click on the LIMN Draw button once the flowsheet has been cloned to a new workbook. 

2.3.7 Save the workbook.

3. RUNNING THE 1_D VERTICAL WIZARD

- 3.1 Click on the Limn: Wizards icon. 
- 3.2 Click on the 1D_Vertical button.

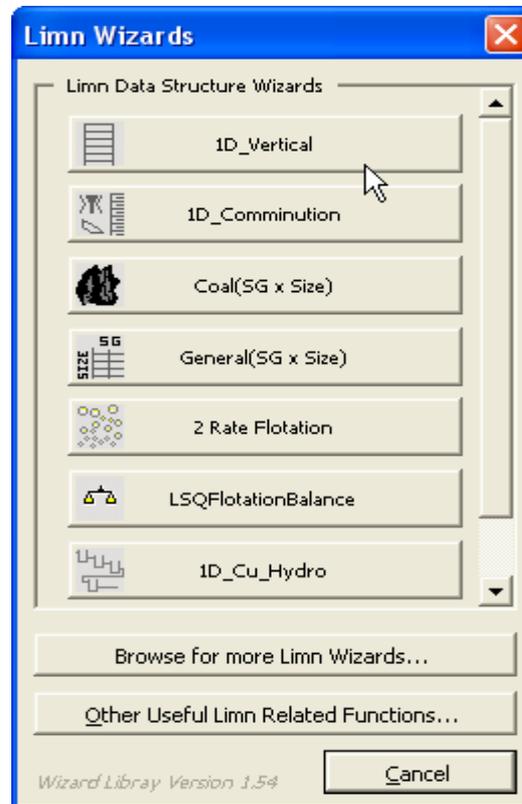


Figure 9: LIMN Wizards Menu

- 3.3 The wizard should begin with Step 1 of 6. Click the Next button.

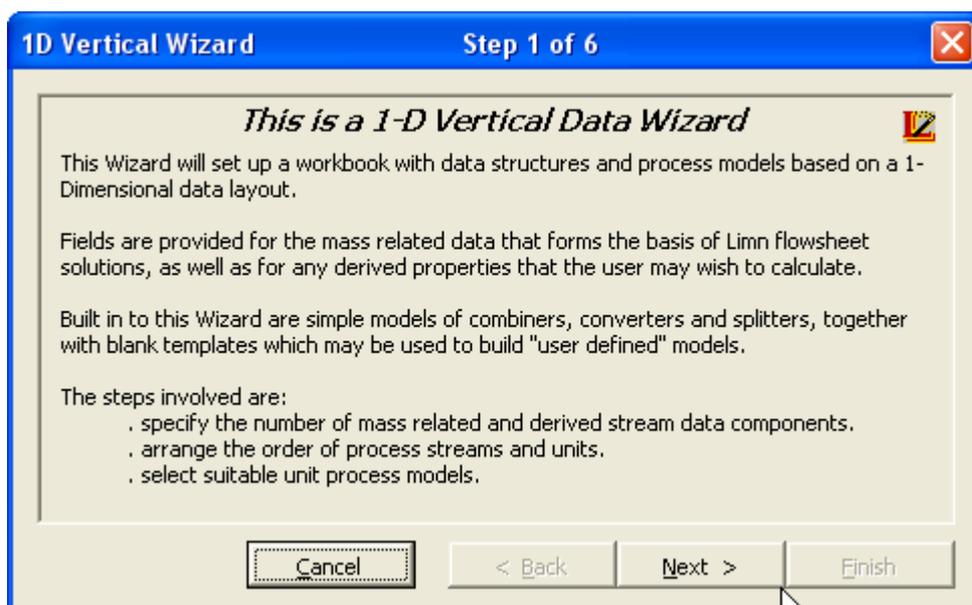


Figure 10: 1_D Vertical Step 1

- 3.4 Change the number of mass components to 5 and the number of derived components to 1. Click Next.

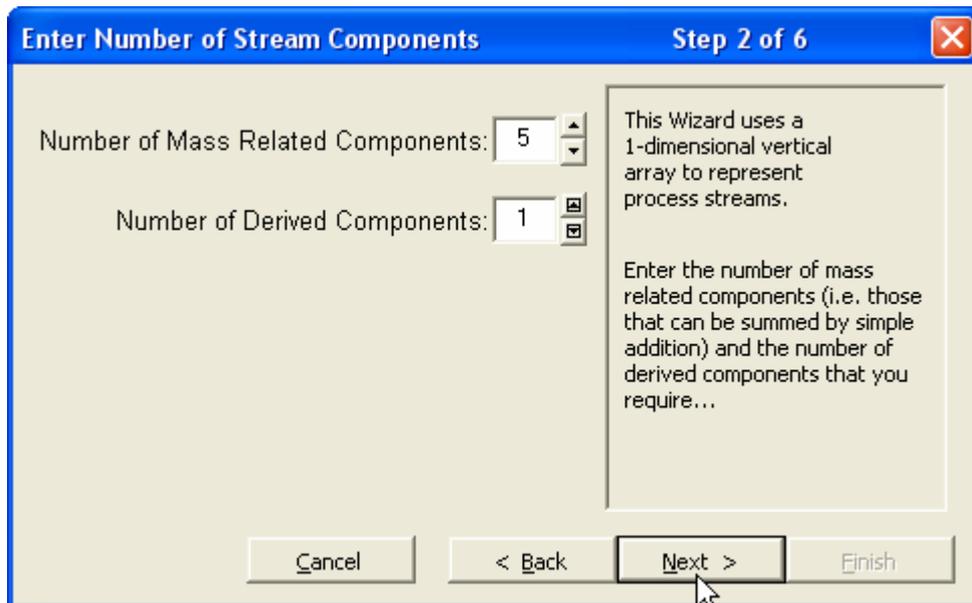


Figure 11: 1_D Vertical Step 2

- 3.5 Check that the stream names are correct. Click Next.

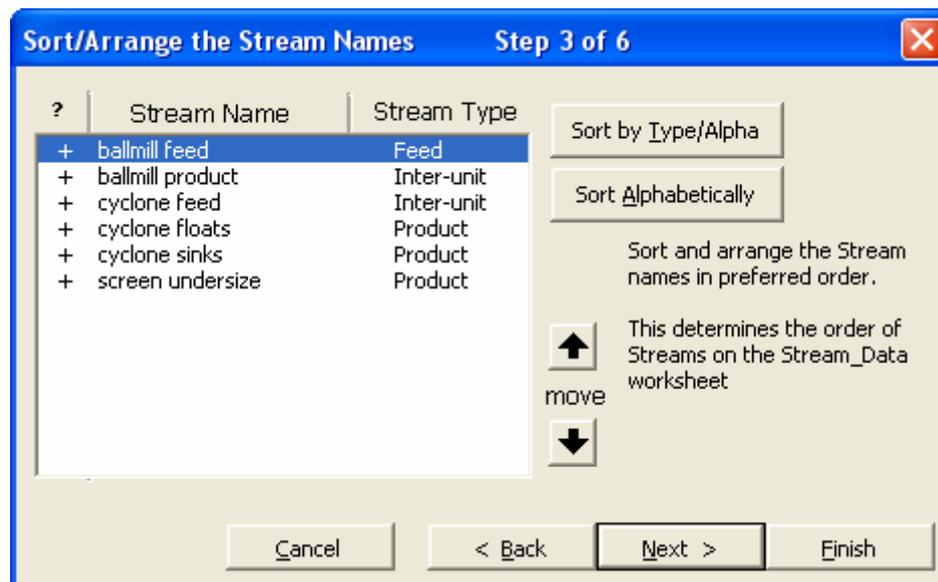


Figure 12: 1_D Vertical Step 3

- 3.6 One can change the order of the streams by selecting the stream name then clicking on the arrow above or below the word move.

3.7 Check that the unit operations are correct. Click Next.

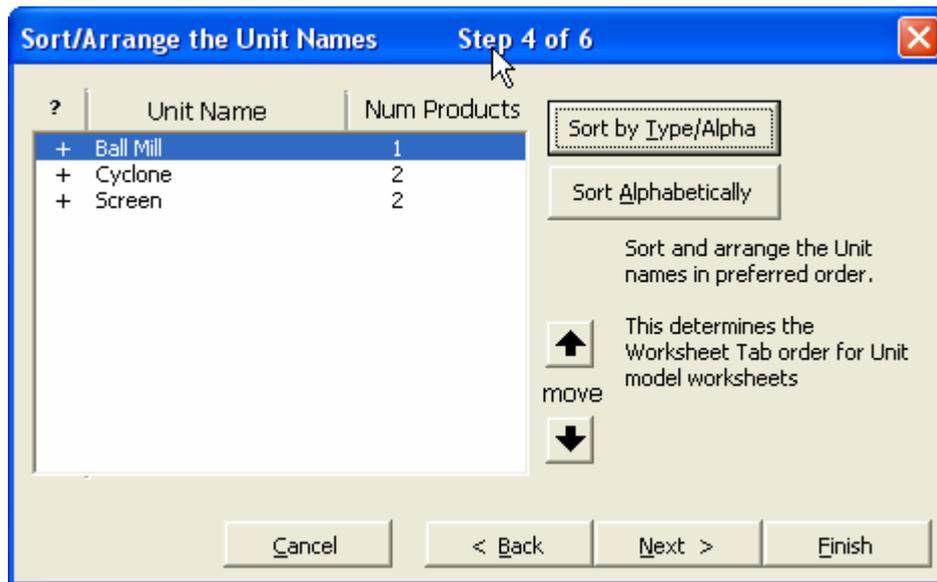


Figure 13: 1_D Vertical Step 4

3.8 Select the different models for the unit operations. Click on the unit name then select the model from the drop down list on the right hand side. Make sure that the same models are selected for the different units as those in figure 14 below.

Ball Mill: 1Product FixedProduct
 Cyclone: 2Product ComponentSplitter
 Screen: 2Product ComponentSplitter

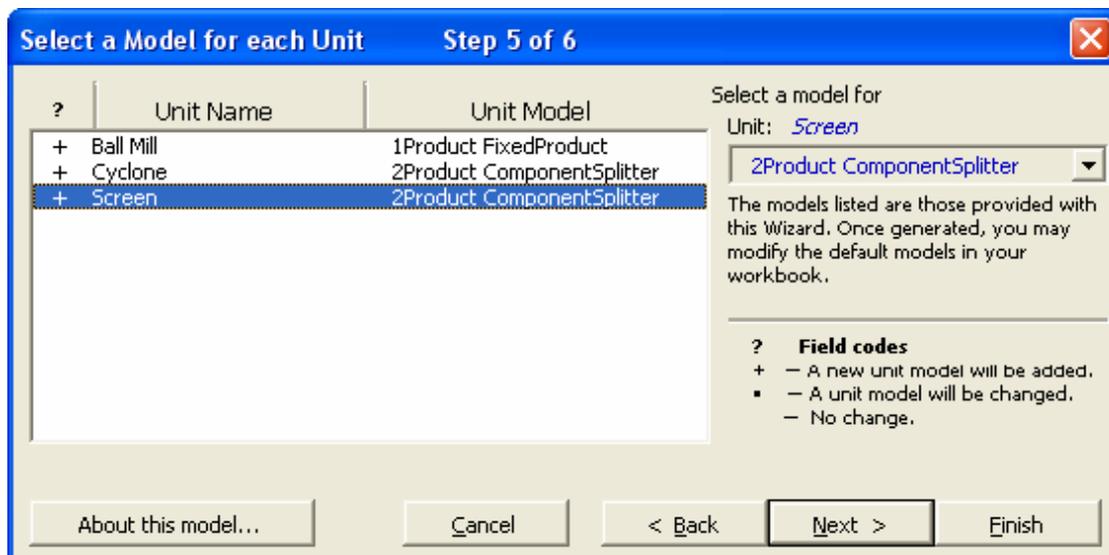


Figure 14:1_D Vertical Step 5

3.9 Click Next.

3.10 Click Finish.

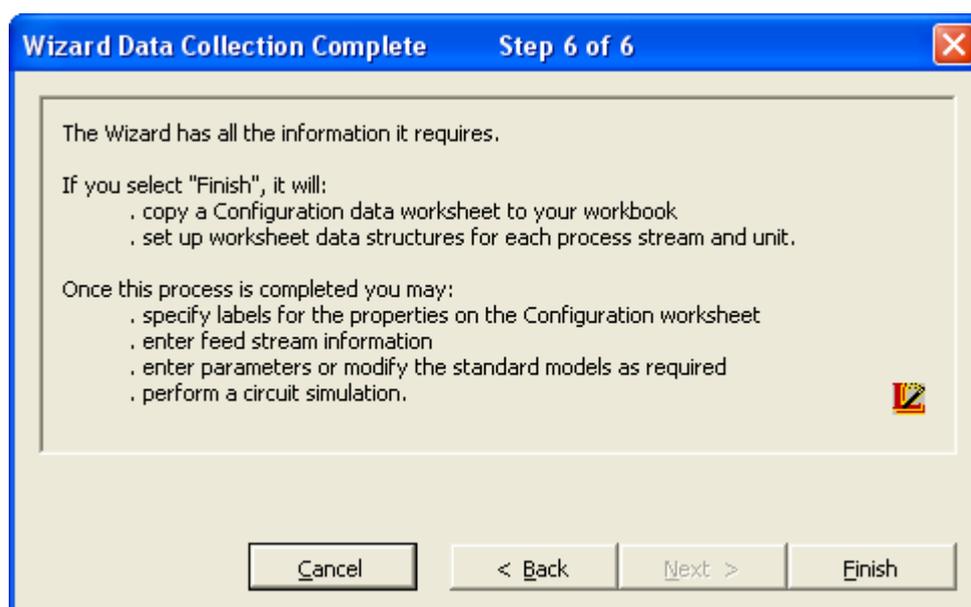


Figure 15: 1_D Vertical Step 6

3.11 Once the sheets have been constructed and the wizard is complete, save the workbook.

4. POPULATING THE WORKSHEETS

Now that the worksheets have been set up for the different units, one needs to specify the simulation inputs.

4.1 The Configuration Sheet

Configuration Data Created with Wizard: 1D_Generic Located at: C:\LIMN\Wizards\Wizard_1_ID_Vertical.xls

Property Definition

Simulation Components	
20 mm	
15 mm	
10 mm	
5 mm	
0 mm	

Derived Components	
Total	

Default Data Heading Layout for Streams and Units

20 mm	
15 mm	
10 mm	
5 mm	
0 mm	
Total	

Figure 16: Configuration Sheet

Note: The blue shaded cells are cells that require an input. The grey shaded cells do not require an input as LIMN has assigned formulas to these cells.

- 4.1.1 Enter the 5 size fractions: 20 mm; 15 mm; 10 mm; 5 mm; 0 mm.
- 4.1.2 Enter Total as a Derived Component and we shall use the sum function on the required sheets.

4.2 The Stream Data(Input) Sheet

Feed Stream Data Input

	ballmill feed
20 mm	200.00
15 mm	125.00
10 mm	100.00
5 mm	50.00
0 mm	25.00
Total	500.00

	% PSD
20 mm	40.00
15 mm	25.00
10 mm	20.00
5 mm	10.00
0 mm	5.00
Total	500.00

Figure 17: Stream Data (Input) Sheet

- 4.2.1 LIMN requires the t/h of material in each size interval to calculate the mass balance through the flowsheet. Therefore one needs to input the % PSD per size interval and the total t/h of the feed stream.
- 4.2.2 The easiest is to copy the ballmill feed table and paste it close by. Enter in the % PSD as in figure 17.
- 4.2.3 Enter the 500 in the Total cell below the % PSD table.
- 4.2.4 In the ballmill feed column, multiply the % PSD in each size interval by the total feed (500) to give the t/h in each size interval.
- 4.2.5 Total the ballmill feed column using the Sum function.

4.3 The Stream Summary Sheet

E4 = {='Stream_Data(Input)!Limnballmill_feedRange}

	ballmill feed	ballmill product	cyclone feed	cyclone floats	cyclone sinks	screen undersize
20 mm	200.00					
15 mm	125.00					
10 mm	100.00					
5 mm	50.00					
0 mm	25.00					
Total	500.00	0.00	0.00	0.00	0.00	0.00

Figure 18: Stream Summary Sheet

- 4.3.1 The light blue shaded cells have been assigned formula by LIMN, see the formula assigned to cell E4 in figure 18 above.
- 4.3.2 Total each of the stream columns using the sum function.

4.4 The Unit_Ball Mill sheet

Model for Unit: Ball Mill

Model Parameters	
	Required % Product Component
20 mm	5.00
15 mm	10.00
10 mm	15.00
5 mm	20.00
0 mm	50.00

	Feed	ballmill
20 mm	200.00	25.00
15 mm	125.00	50.00
10 mm	100.00	75.00
5 mm	50.00	100.00
0 mm	25.00	250.00

Figure 19: Unit_Ball Mill sheet

- 4.4.1 Enter the required PSD of the ball mill product as in figure 19 above. When LIMN Solve runs the Feed stream will be multiplied by the required product PSD.

4.5 The Unit_Cyclone sheet

Model for Unit: Cyclone

Partition Fractions	
	Split to cyclone floats
20 mm	0.95
15 mm	0.95
10 mm	0.95
5 mm	0.95
0 mm	0.35

	Feed	cyclone floats	cyclone sinks
20 mm	25.00	23.75	1.25
15 mm	50.00	47.50	2.50
10 mm	75.00	71.25	3.75
5 mm	100.00	95.00	5.00
0 mm	50.00	47.50	2.50

Figure 20: Unit_Cyclone Sheet

- 4.5.1 Enter the split of cyclone feed to cyclone floats in the model column. Partition fractions must be entered as whole numbers and not percentages (i.e. $0 < x < 1$).

4.6 The Unit_Screen sheet

Model for Unit: Screen

Partition Fractions	
	Split to cyclone feed
20 mm	1.00
15 mm	1.00
10 mm	1.00
5 mm	1.00
0 mm	0.20

	Feed		cyclone feed	screen undersize
20 mm			0.00	0.00
15 mm			0.00	0.00
10 mm			0.00	0.00
5 mm			0.00	0.00
0 mm			0.00	0.00

Figure 21: Unit_Screen Sheet

- 4.6.1 Enter the required split for the Feed stream to the cyclone feed (screen oversize). When LIMN Solve is run the Feed stream will be split into the oversize and the undersize.

4.7 The DataBlocks sheet

Top Cell Index	7	1	Number of cell rows to display	1
Bottom Cell Index	1	1	Number of cell columns to display	1

	Row	Column
Legend / Drop down location	1	7

Add data blocks to flowsheet (below stream labels)

Add data blocks to flowsheet, (adjacent to stream segment 1)

Remove data blocks from flowsheet

Stream	Index	
ballmill feed	0	5
		2
ballmill product	1	5
		2
cyclone feed	2	3
		2
cyclone floats	3	2
		2
cyclone sinks	4	

Figure 22: DataBlocks Sheet

- 4.7.1 To add one Datablock displaying the total t/h for each stream on the flowsheet, change cell F2 to 1 and cell F3 to 1.
- 4.7.2 Click on the add data blocks adjacent to stream segment button.
- 4.7.3 Click on the Flowsheet sheet, click on LIMN draw and place the data blocks.

5. RUNNING THE LIMN SOLVER

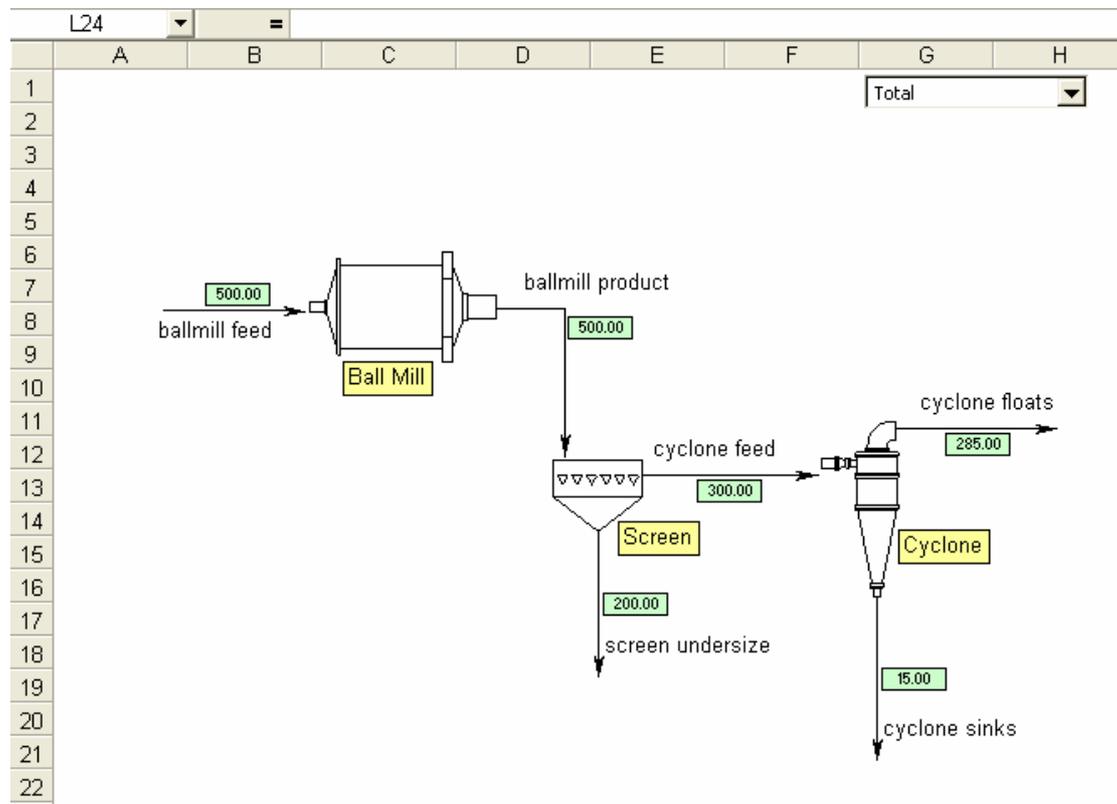


Figure 23: Flowsheet after solving

- 5.1 Click on the Flowsheet sheet in the Excel workbook.
- 5.2 Click on the Limn: Solve button. 
- 5.3 Check that the mass balance is the same as figure 23 above.
- 5.4 Save the workbook.

6. USING THE LIMN SCENARIOS SHEET

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2		Run the Scenarios											
3													
4				Variables				Results					
5		Cell Address		1,000.00			1,000.00	1,000.00	400.00	600.00	570.00	30.00	
6		Cell Description		Ball Mill feed			ballmill feed	ballmill product	screen undersize	cyclone feed	cyclone floats	cyclone sinks	
7				100.00			100.00	100.00	40.00	60.00	57.00	3.00	
8				200.00			200.00	200.00	80.00	120.00	114.00	6.00	
9				300.00			300.00	300.00	120.00	180.00	171.00	9.00	
10				400.00			400.00	400.00	160.00	240.00	228.00	12.00	
11				500.00			500.00	500.00	200.00	300.00	285.00	15.00	
12				600.00			600.00	600.00	240.00	360.00	342.00	18.00	
13				700.00			700.00	700.00	280.00	420.00	399.00	21.00	
14				800.00			800.00	800.00	320.00	480.00	456.00	24.00	
15				900.00			900.00	900.00	360.00	540.00	513.00	27.00	
16				1,000.00			1,000.00	1,000.00	400.00	600.00	570.00	30.00	
17													
18													
19													
20													
21													

Figure 24: LIMN Scenarios Sheet

- 6.1 Click on the Scenarios sheet.
- 6.2 Column D and Column E are for the variables that are to be changed for each scenario. Column G and higher are for the data that one wants to capture for each scenario.
- 6.3 Type in Ball Mill feed in cell D6.
- 6.4 In cell D5, type the "=" sign then select the cell I10 on the Stream Data(Input) sheet.
- 6.5 Type in the stream names from cell G6 to cell L6.
- 6.6 In cell G5, type the "=" sign the select cell E10 on the Stream Data sheet. Do the same for each of the remaining streams from cell H5 to cell L5.
- 6.7 Enter the values for the ballmill feed stream for each scenario: 100; 200; 300; 400; 500; 600; 700; 800; 900; 1000.
- 6.8 Click on the Run Scenarios button.
- 6.9 Save the workbook.
- 6.10 Check that the results are the same as figure 24 above.

7. CHANGING STREAMS IN THE FLOWSHEET

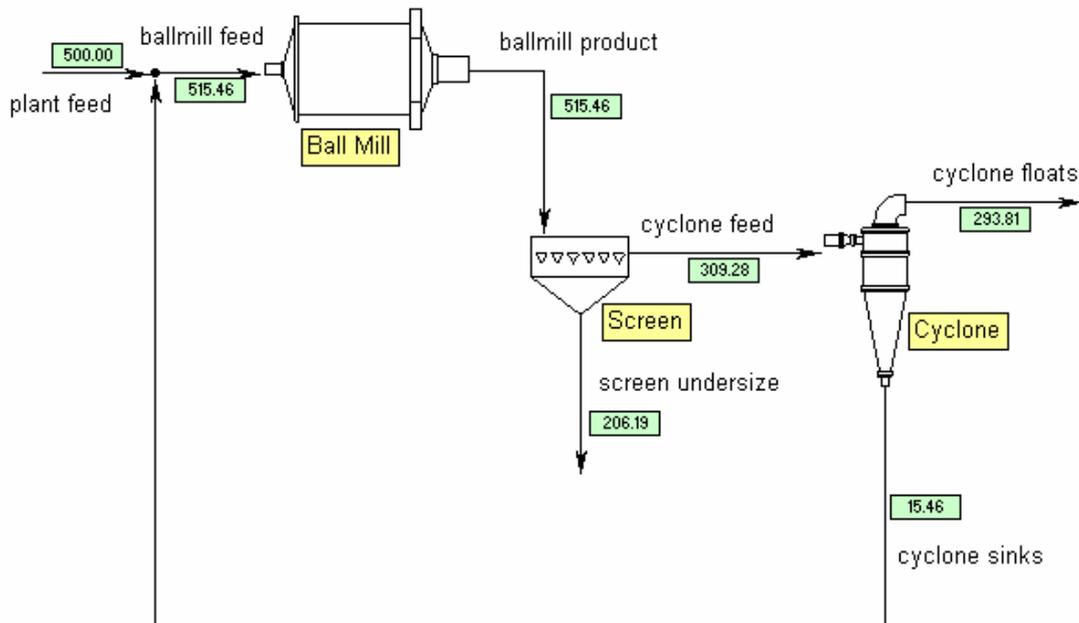


Figure 25: Modified stream flowsheet

- 7.1 Open the workbook for the 1_D Vertical Wizard example.
- 7.2 Click on the flowsheet in the workbook. Click on the Limn Draw button. 
- 7.3 Click on the cyclone sinks stream and join the stream to the ballmill feed stream as in figure 25 above.
- 7.4 Rename the streams to plant feed and ballmill feed as per figure 25 above.
- 7.5 Save the workbook with a different name.
- 7.6 Click on the Limn: Wizards button. 
- 7.7 Select the 1_D Vertical Wizard, as per Section 3: Running the 1_D Wizard above.

7.8 One will notice that each of the steps from 1 to 6 of the wizard are the same as figures 10 – 15, except for Step 3 of 6 in figure 26 below.

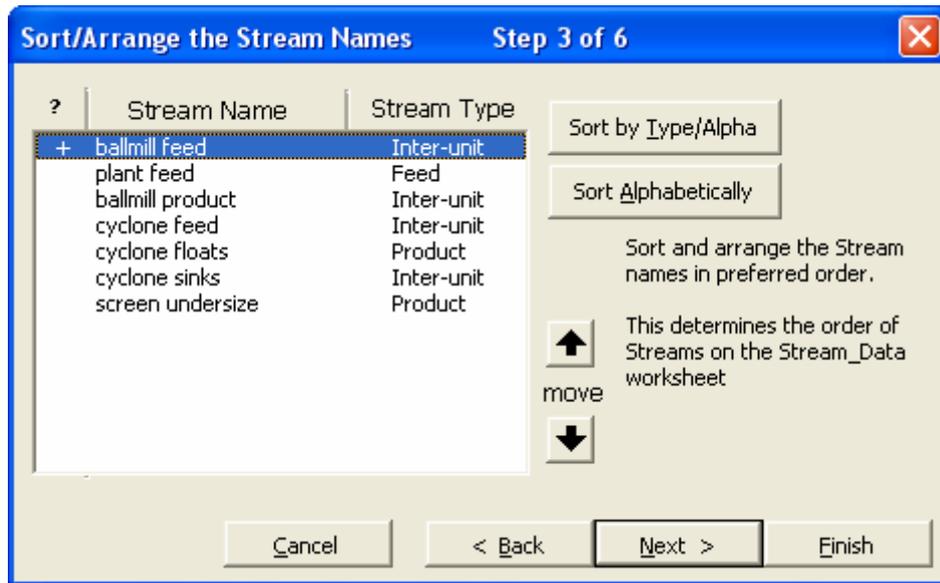


Figure 26: Step 3 of 6

7.9 The Wizard has picked up the additional stream, ballmill feed, and has assigned a + sign to the stream.

7.10 Change the order of the stream names so that plant feed is before ballmill feed. Click on the stream plant feed then click on the up arrow above the word move.

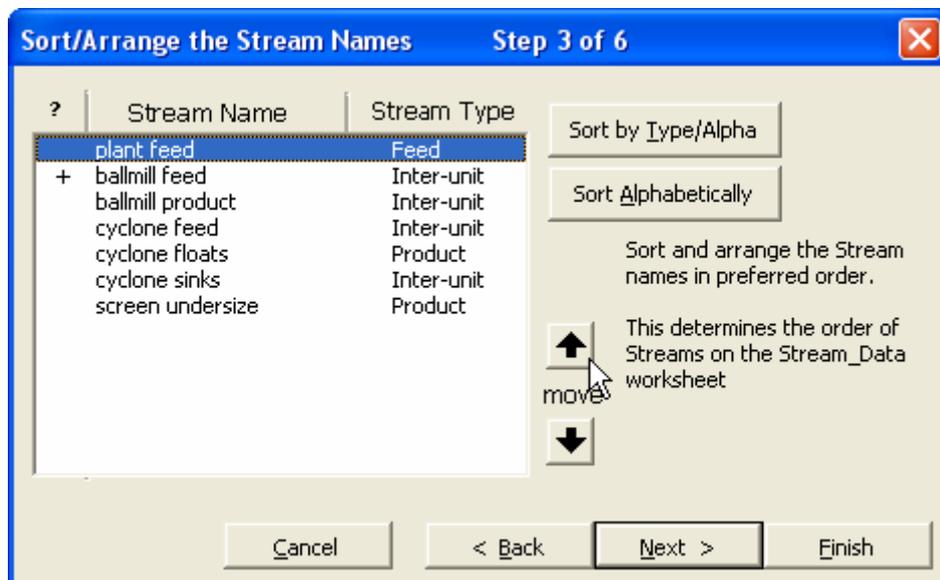


Figure 27: New stream name order

7.11 Complete the wizard and save the workbook.

7.12 Click on the Stream_Data sheet. One will notice that a column has been created for the ballmill feed stream.

7.13 Click on Limn: Solve. 

7.14 Copy the Sum function in the Total row to the ballmill feed column. Check that the values for the different streams are the same as figure 28 below.

	A	B	C	E	F	G	H	I	J	K
1	Stream Summary									
2										
3			plant feed	ballmill feed	ballmill product	cyclone feed	cyclone floats	cyclone sinks	screen undersize	
4	20 mm	200.00	201.29	25.77	25.77	24.48	1.29	-		
5	15 mm	125.00	127.58	51.55	51.55	48.97	2.58	-		
6	10 mm	100.00	103.87	77.32	77.32	73.45	3.87	-		
7	5 mm	50.00	55.15	103.09	103.09	97.94	5.15	-		
8	0 mm	25.00	27.58	257.73	51.55	48.97	2.58	206.19		
9	-									
10	Total	500.00	515.46	515.46	309.28	293.81	15.46	206.19		
11										

Figure 28: Solved Stream_Data sheet

7.14 Save the workbook.

8. ADDING A UNIT OPERATION

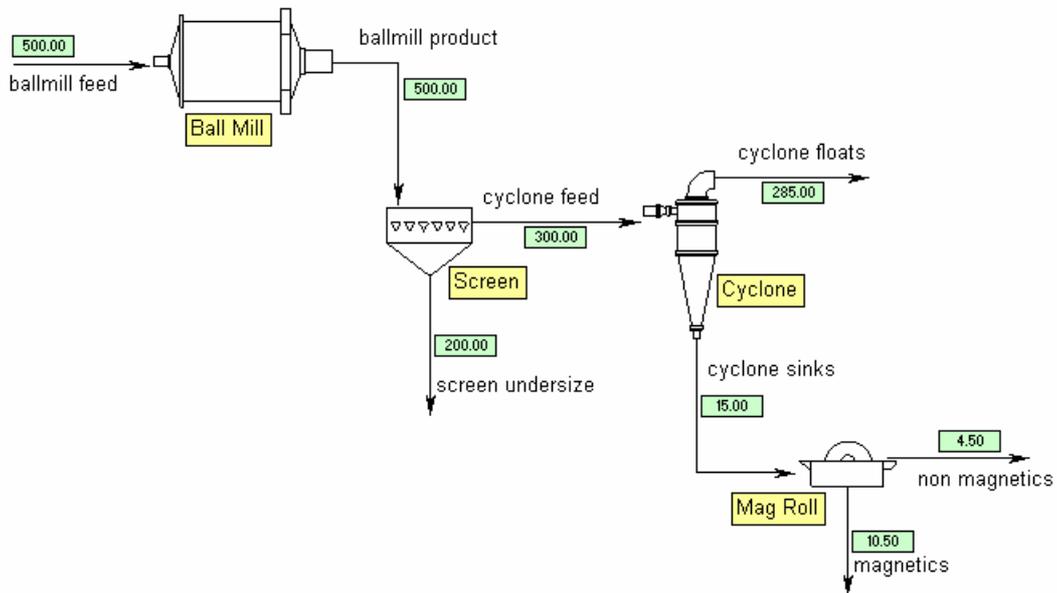


Figure 29: Additional unit worked example

- 8.1 Open the workbook for the 1_D Vertical Wizard worked example (without the recycle of cyclone sinks to the ballmill feed).
- 8.2 Click on the flowsheet. Click on Limn: Draw. 
- 8.3 Click on the New Icon button. 
- 8.4 Select the Magnetic Separator – Single Drum from the WETMAGS icon list, see figure 29 below.

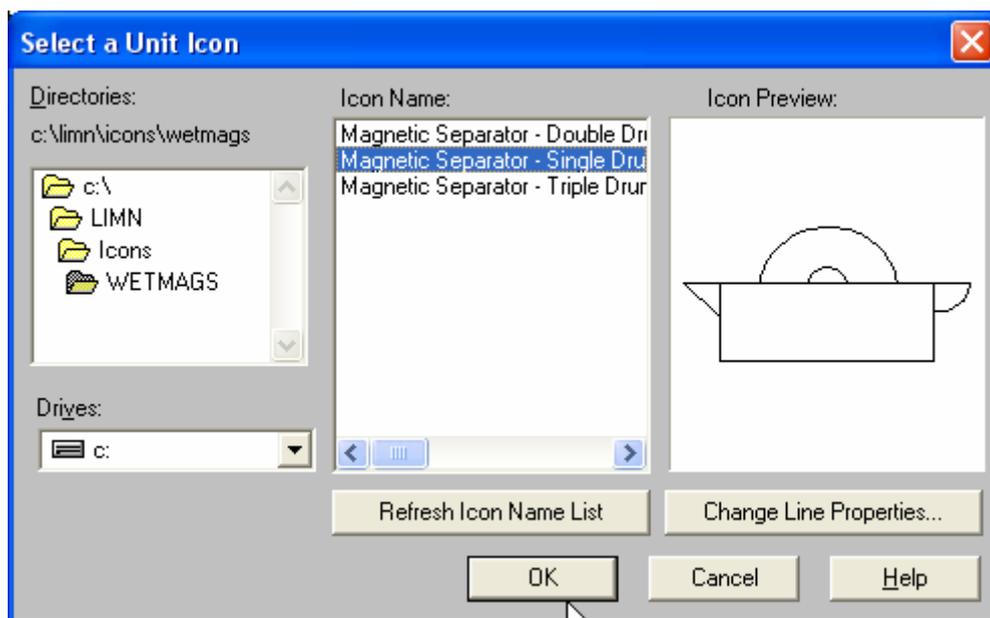


Figure 30: Wetmags Icon List

- 8.5 Rename the unit to Mag Roll. Label the product streams non magnetics and magnetics. Add the labels to the unit and streams, see figure 30 below.

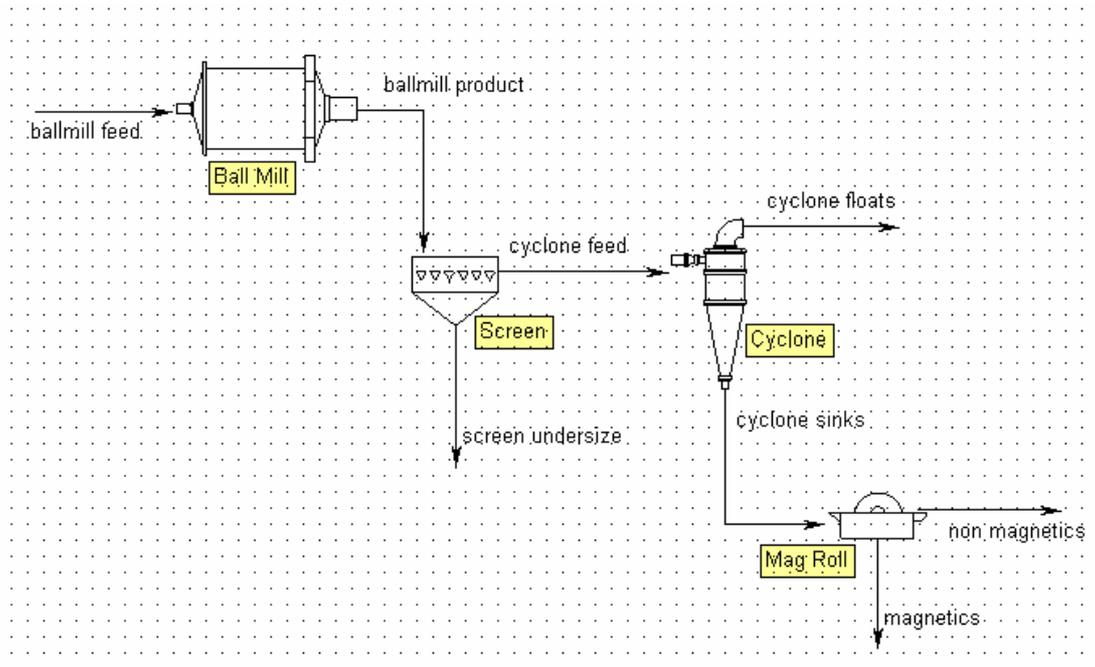


Figure 31: Additional unit flowsheet

- 8.6 Save the workbook with a different name.
- 8.7 Click on the Limn: Wizards button. 
- 8.8 Run the wizard as in section 3: Running the 1_D Wizard.
- 8.9 During Step 3 of 6 one will notice that the magnetics and non magnetics streams have been added to the list.

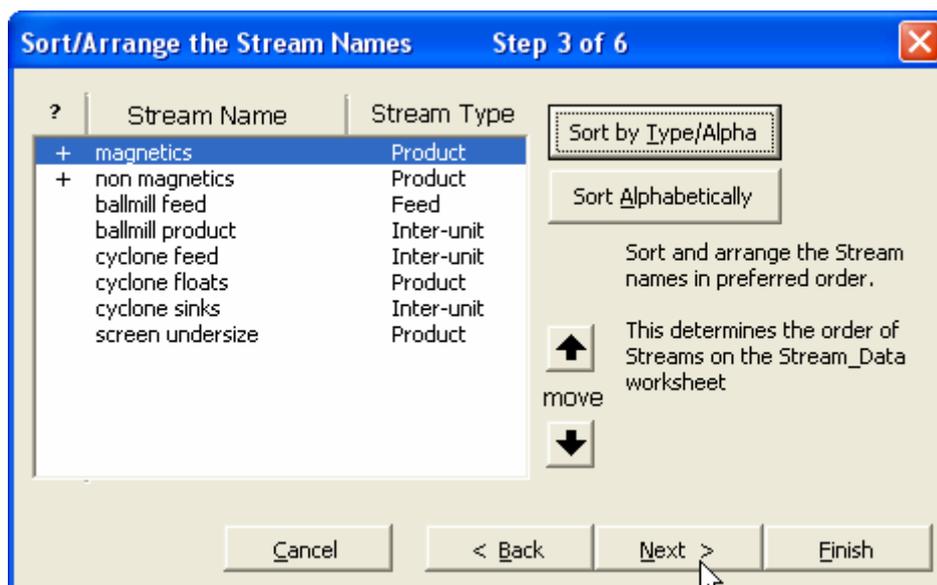


Figure 32: Step 3 of 6

8.10 During Step 4 of 6 one will notice that the Mag Roll unit has been added to the list.

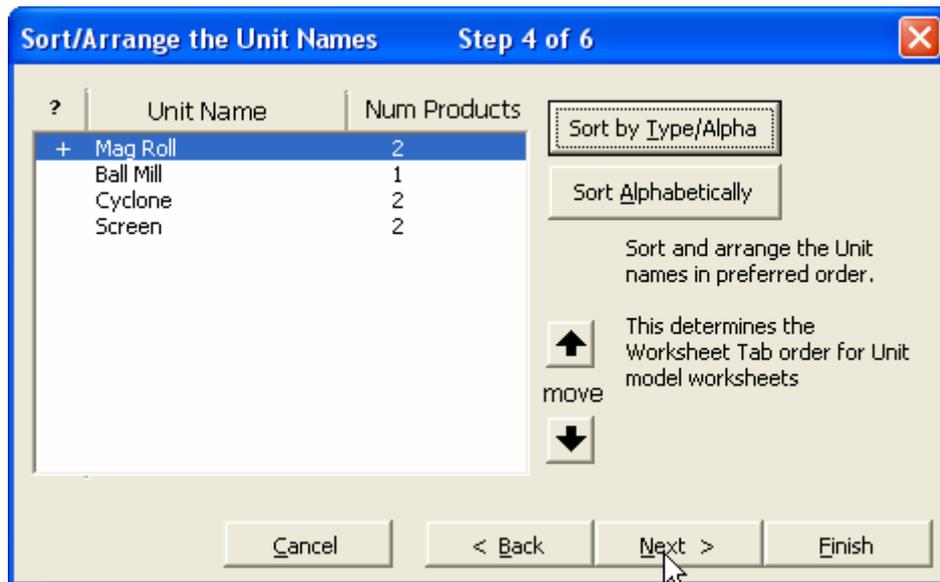


Figure 33: Step 4 of 6

8.11 Select the 2Product ComponentSplitter model for the Mag Roll.

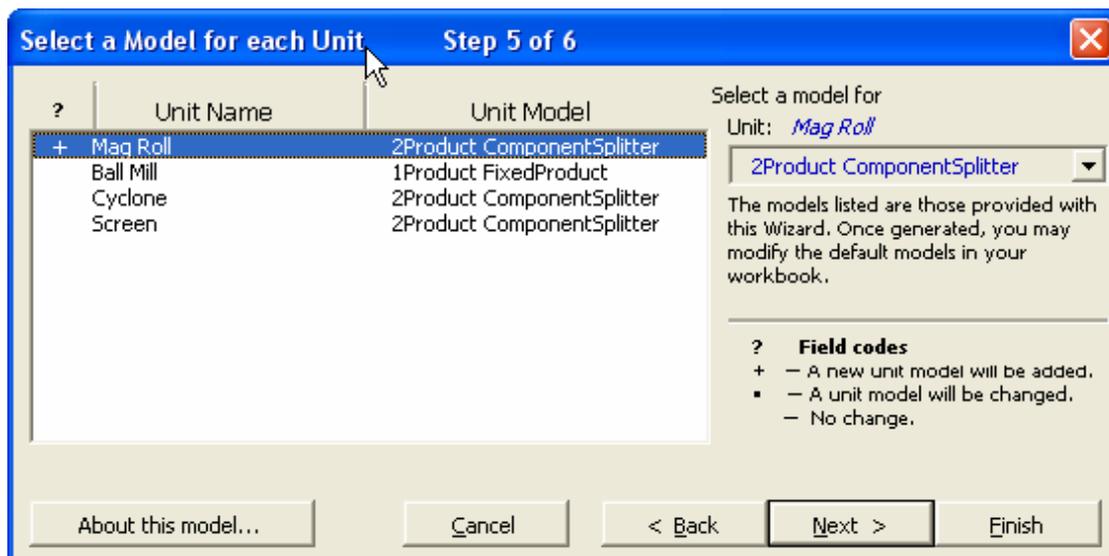


Figure 34: Step 5 of 6

8.12 Complete running the wizard and save the workbook.

8.13 Click on the Unit_Mag Roll sheet and enter the partition numbers for the split of feed to non magnetics.

	A	B	C	D	E	F
1	Model for Unit: Mag Roll					
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13		Feed			non magnetics	magnetics
14	20 mm	1.25			0.375	0.875
15	15 mm	2.50			0.75	1.75
16	10 mm	3.75			1.125	2.625
17	5 mm	5.00			1.50	3.50
18	0 mm	2.50			0.75	1.75
19						
20						

Partition Fractions	
	Split to non magnetics
20 mm	0.30
15 mm	0.30
10 mm	0.30
5 mm	0.30
0 mm	0.30

Figure 35: Unit_Mag Roll sheet

8.14 Click on the Stream_Data sheet.

8.15 Click on the Limn: Solve button. 

8.16 Check that the values on the Stream_Data sheet are the same as figure 35 below.

	A	B	C	E	F	G	H	I	J	K	L	M									
1	Stream Summary																				
2																					
3														magneti es	non magneti es	ballmill feed	ballmill product	cyclone feed	cyclone floats	cyclone sinks	screen undersi ze
4													20 mm	0.875	0.375	200.00	25.00	25.00	23.75	1.25	0.00
5													15 mm	1.75	0.75	125.00	50.00	50.00	47.50	2.50	0.00
6													10 mm	2.625	1.125	100.00	75.00	75.00	71.25	3.75	0.00
7													5 mm	3.50	1.50	50.00	100.00	100.00	95.00	5.00	0.00
8													0 mm	1.75	0.75	25.00	250.00	50.00	47.50	2.50	200.00
9																					
10													Total	10.50	4.50	500.00	500.00	300.00	285.00	15.00	200.00
11																					
12																					

Figure 36: Stream_Data Sheet

8.17 Save the workbook.

APPENDIX A: 1_D VERTICAL WIZARD WORKED EXAMPLE

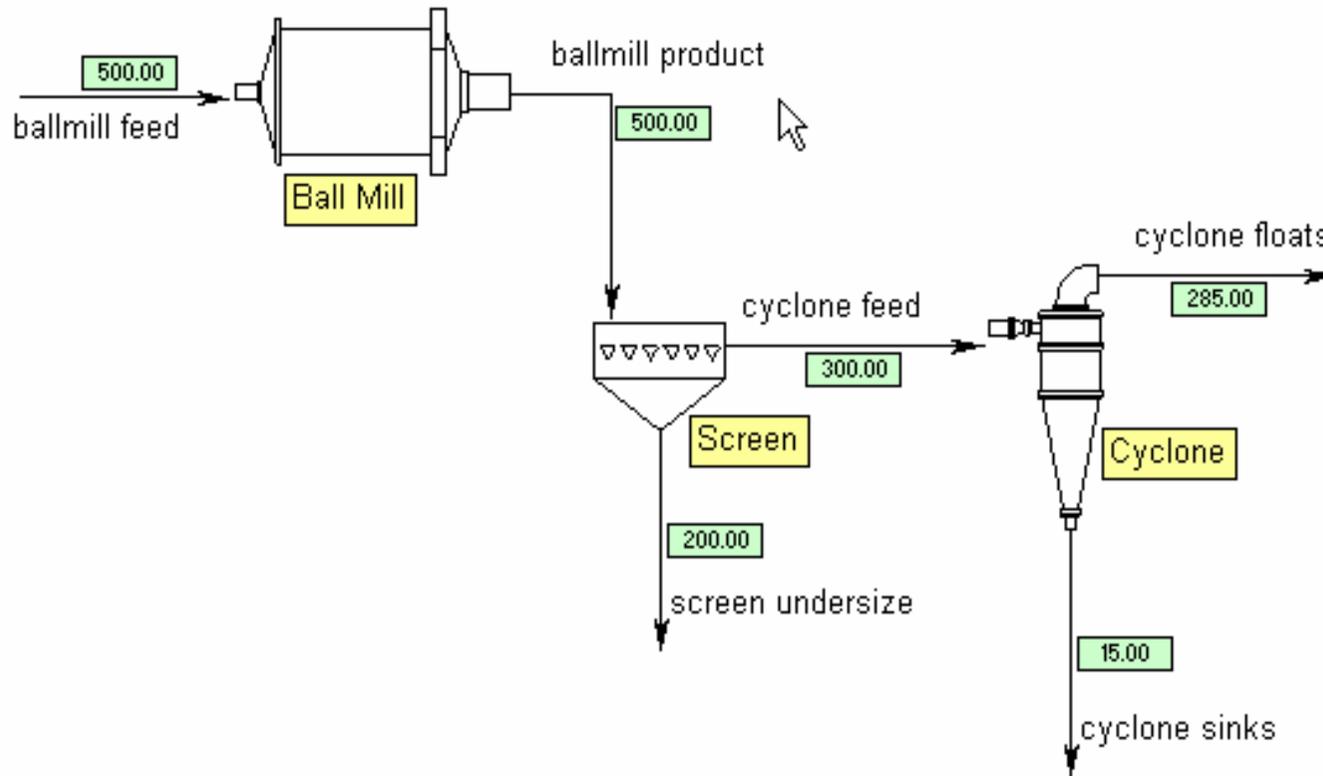


Figure 37: 1_D Vertical worked example

APPENDIX B: MODIFIED STREAM EXAMPLE

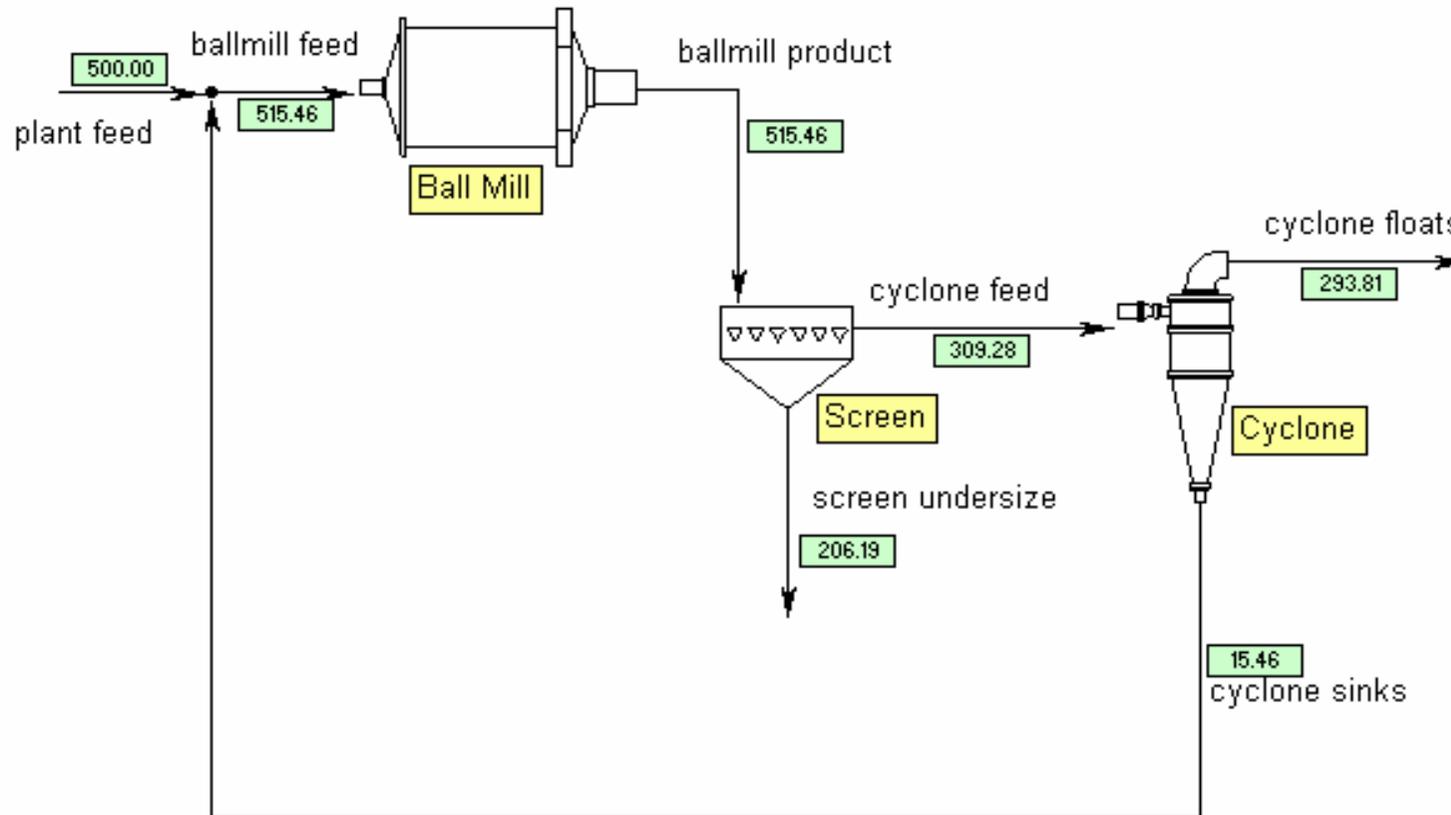


Figure 38: Modified stream worked example

APPENDIX C: ADDITIONAL UNIT WORKED EXAMPLE

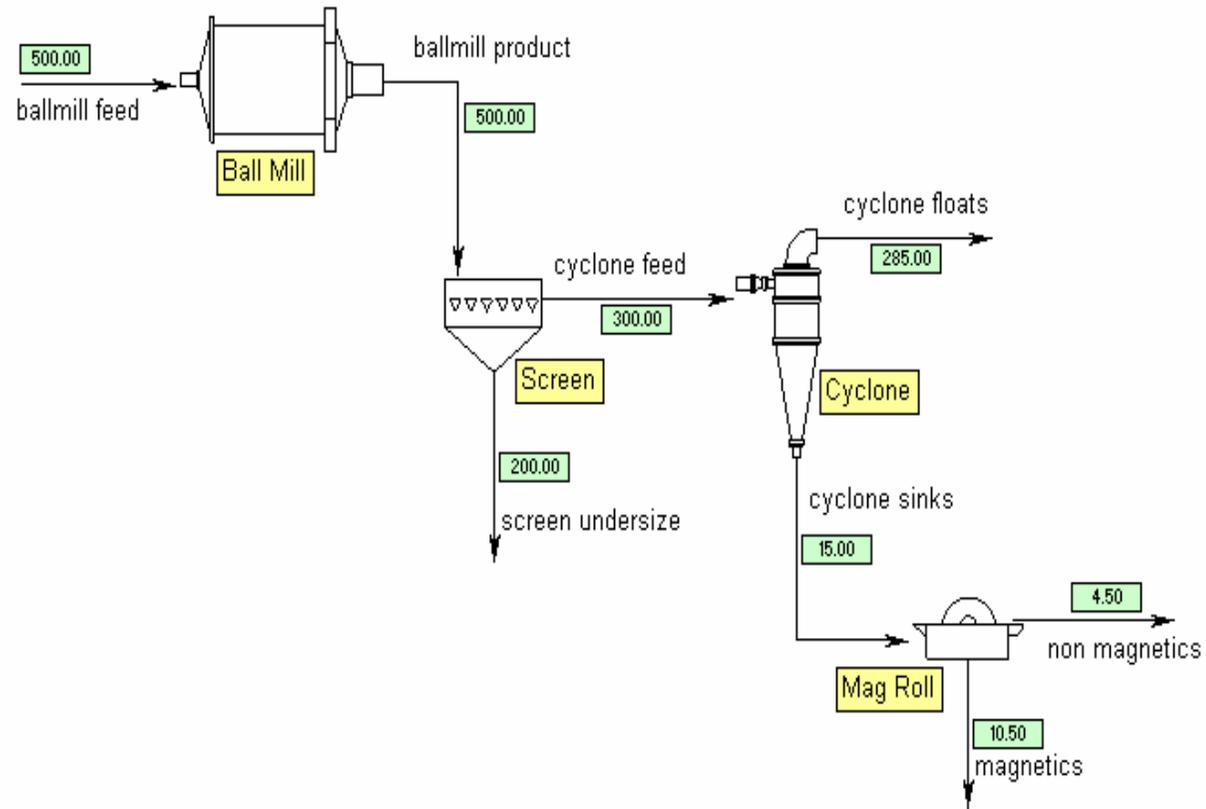


Figure 39: Additional unit worked example