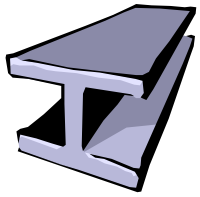
Flat Out Consulting Engineers Pty Ltd



Proposal for

Converting Winery into a Orange juice/Brewery

Prepared by

Team X07

Anthony Maggary, Mario Pace,
Phillip Snell, Mark Santoro,
Anthony Young.

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PROPOSAL 1

The Orange Juice Factory

To convert the existing winery to an Orange Juice Factory the following tanks have to be removed 1.5Ø x 2m, 2 x 1.8Ø x 2m and 3Ø x 2m. That's leaving a Water tank (3Ø x 2m), OJ Concentrate (3Ø x 3.5m on a 2m stand) and the Orange Juice (3.6dia x 2m). The un -used tanks may be sold or kept as a backup.

For the water to mix with the OJ concentrate at a ratio of 2:1 the following number of pipes have to be used. (See appendix A)

Water	→	OJ 1 pipe
OJ concentrate	→	OJ 4 pipes
OJ	→	Bottling plant 6 pipes

(Note: all pipes are to be the same size)

Below is a table of pipe sizes and their relative flow rates for the Orange Juice Factory. Any pipe size between 60mm and 150mm will be sufficient but all pipes must be the same diameter. (See appendix B)

Pipe Dia (mm)	Orange Juice Production Litres/Sec	Total Refurbish Price $	Min Bottle Plant Input Flow Rate Q=litres/sec	Max Bottle Plant Input Flow Rate Q=litres/sec
60	2.471	$ 2,071.09	1	100
75	6.034	$ 2,211.46	1	100
85	9.954	$ 2,445.40	1	100
95	15.532	$ 2,492.18	1	100
105	23.179	$ 2,585.76	1	100
130	54.464	$ 2,679.34	1	100
150	96.539	$ 2,772.91	1	100
200	305.110	$ 3,240.79	1	100

Pipe diameter to large (flow rate to fast do not use)

PROPOSAL 2

The Boutique Brewery

The brewery is designed so the volume is fully utilized on the brew tank leaving. A 50mm space at the top of the tank is for froth due to turbulent mixing.

Malt/Hops Syrup Tank:

Placed close to the edge to reduce pipe length requirements and reducing friction. It has a high viscosity. As 8% of the batch only 1.38m liquid is required from the 2m high x 1.8Ø tank

Water Tanks:

Water is 88% of the receipt these tanks are fully utilized and placed further away due to low viscosity.

Glucose Tank:

Also placed at the edge for hygiene and pipe considerations. Glucose is 4% of the receipt and equates to 900 mm of liquid from a 2m h x 1.5 dia

Brew Tank:

Balance tubes are used to maintain and even level and increased surface area for faster velocity.

All piping is straight (only laminar flow)

Costing

$14m^3$ Water tank to brew tank pipe work
95mmØ x7.52 long x 3 off =$136.17

$24m^3$ Water tank to brew tank pipe work
105mmØ x 7.52 long x 1 off = $151.52

Glucose tank to brew tank
200mmØ x 1.2 long x 2 off = $81.60

Malt/Hops Syrup
200 mmØ x 0.8 long x 3 off = $81.60

Beer to bottling machine
200mmØ x 3.5 long x 1 off = $119.00

Cost of filler pipe work to batch tanks
200mmØ x 27m long x 1 off = $918.00

Total Cost = $1618.97

Factors considered during design process.

Capacity of tanks -

For both the Orange Juice design and the brewery the capacity of the tanks determines their individual usefulness. The team settled on the use of the four largest tanks for the orange juice plant and the six largest tanks for the brewery. Refer drawings.

Position of tanks -

The criteria for the orange juice plant required a 2m free space around each tank; the design was therefore restricted to the three largest tanks in order to accommodate this.

The brewery design could not achieve the 2m limitations and so a 600 mm free area was selected in accordance with AS1657 for plant design (walkways).

The position of the tanks was governed by the need for maximum useful head and the viscosity of the relevant fluids for fluid transfer rates sufficient to meet the design cri teria.

Flow rates -

The design required a series of preselected flow rates:

Bottling plant 1 - 100 litres per second

Main brewing tanks to be filled in less than 30 mins

The flow rates are varied by the pipe diameter, fluid viscosity and the head pressure of the pipe, which is in turn governed by the height the tank is filled to.

The tank height is critical to ensure laminar flow remains within the delivery pipes.

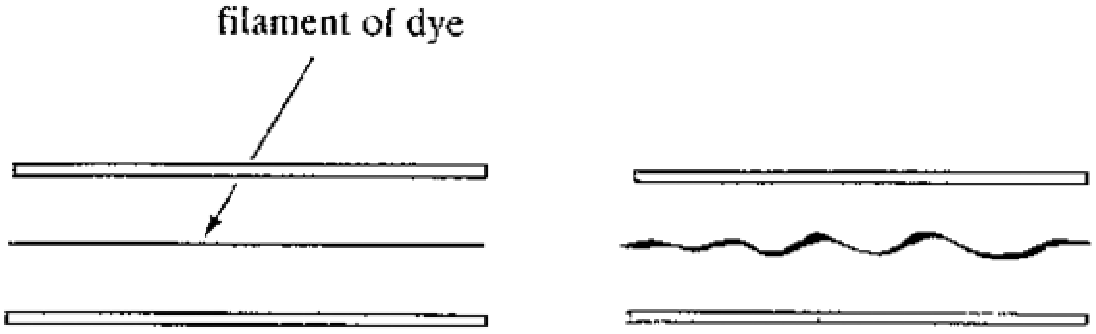
As the height increase so does the pressure and subsequent velocity. This can be seen as a direct result of the barometer equation, which relates the Height of a column of liquid to the pressure at the bottom and therefore the pressure at the inlet of the delivery pipe. The flow rate through the pipe is then predicted by Poiseuille's equation, w hich relates the diameter of the pipe, inlet and outlet pressure, the density of the fluid and the length of the pipe.

Also Bernoulli's equation:

(*p + qv2/2 + qgy = constant)*

Where p is the pressure, q is the density, v the velocity and y the height in a gravitational field of strength g, all measured at the same point.

Shows us that the total energy i.e. the sum of pressure, potential and kinetic energies per unit volume is constant at any point. E.g.. If we change pipe diameter mid run from say 100 mm to 60 mm while the velocity will go up the pressure will decrease.



Laminar (viscous) **Transitional**

Turbulent

At a specific velocity characterised by a Reynolds number of greater than 2000 the flow may become turbulent. Turbulent flow will decrease the flow rate and increase the ab sorption of heat through the pipe walls. In order

for the design to ensure the flow rates remain laminar, a calculation of the Reynolds number for the maximum flow rate experienced in each pipe has been worked out.

$$\mathrm{Re} = \frac{\rho u d}{\mu}$$

Where p = density, u = mean velocity, d = diameter and $ų$ = viscosity

Laminar flow: Re < 2000

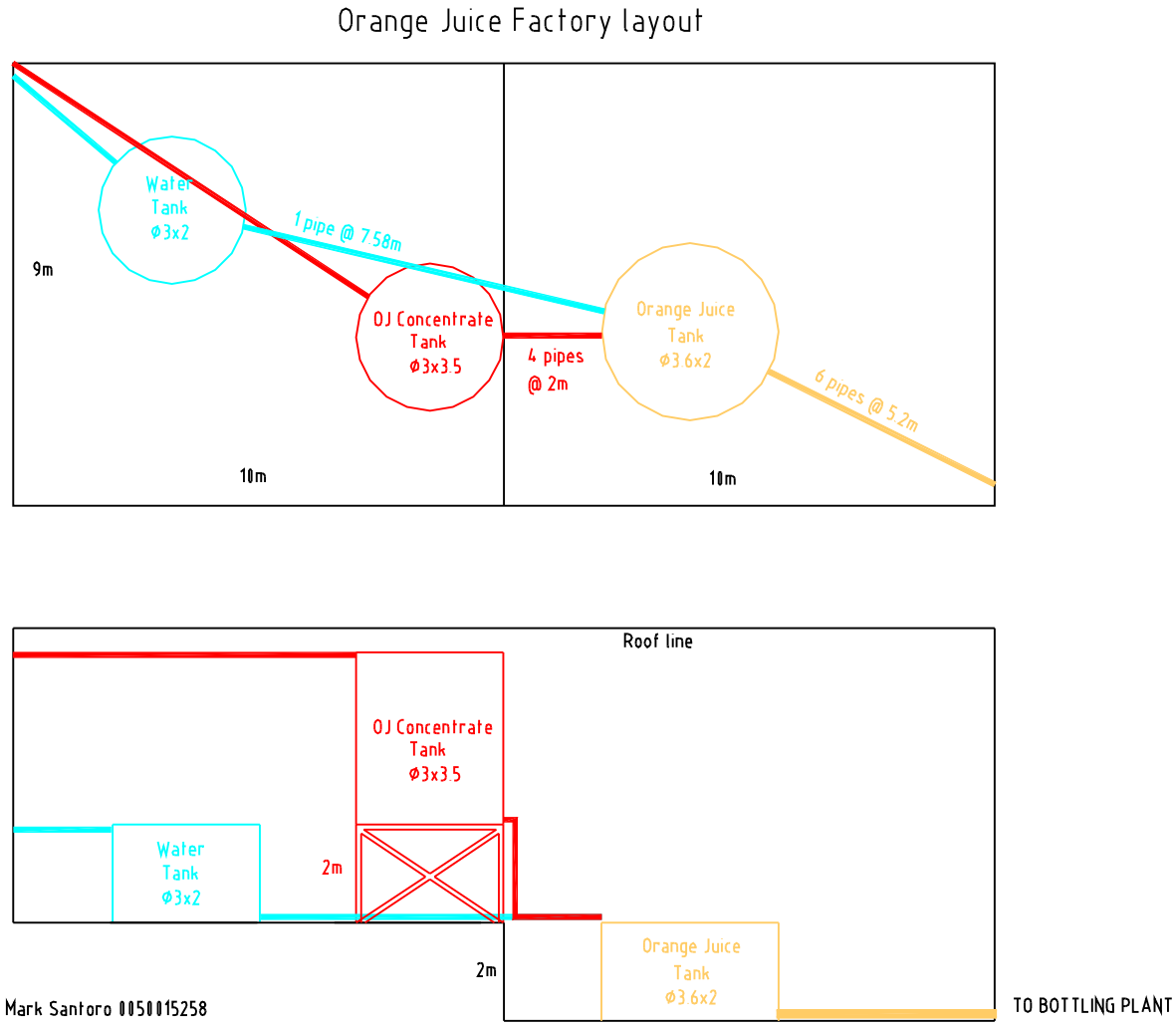
Transitional flow: 2000 < Re < 4000

Turbulent flow: Re > 4000

Cost of construction-

In order to keep the cost of construction down, the use of stands was minimised and instead larger sized pipes were used in the br ewery design.

Appendix A Orange Juice Tank Layout



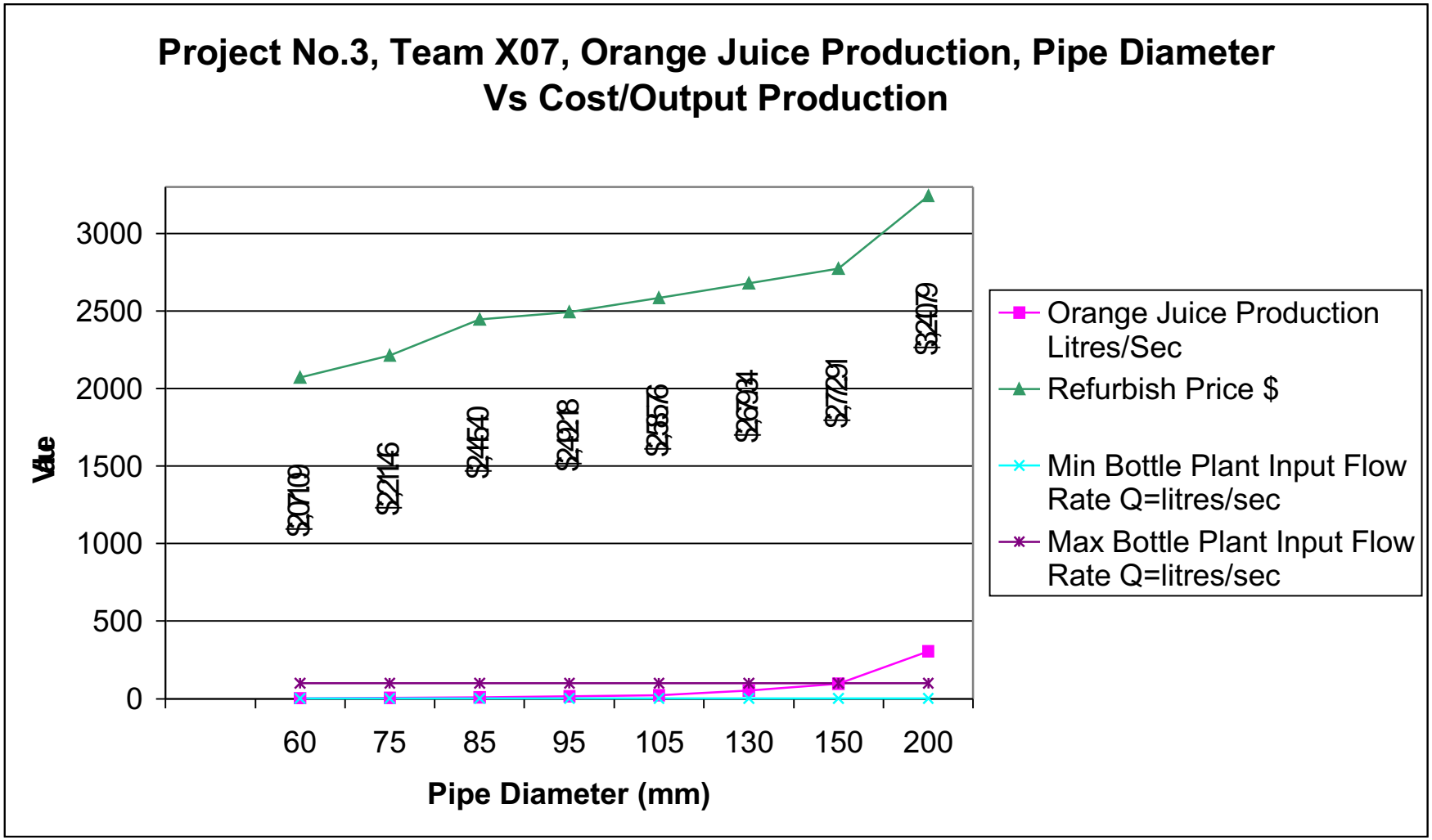
Appendix B

Orange Juice Production

Tank Dia (m)	Tank Liquid Surface Height h full assumed (m)	Tank Surface Area (m^2)	Tank Volume (m^3)	Gravity (m/s^2)	Density (kg/m^3)	Fluid Pressure at base of tank (Pa)	Pipe Dia (mm)	Pipe Area (mm2)	Viscosity η Pa.s or N.s/m2	Pipe Length (m)	No Pipes Req'd	Total Length of Pipe	Pipe cost per metre	Pipe Cost per sq.mm	Stand ($1650) & Pipe Cost $	Flow Rate Q=Litres/ Sec
OJ Concentrate								Note: This tank on 2 m higher side of shed								
3.0	5.5	7.07	24.74	9.81	1200	64746	**60**	2827	0.05	**2.0**	4	8	$ 9.00	$ 0.00318	**$ 1,722.00**	0.824
3.0	5.5	7.07	24.74	9.81	1200	64746	**75**	4418	0.05	**2.0**	4	8	$ 12.00	$ 0.00272	**$ 1,746.00**	2.011
3.0	5.5	7.07	24.74	9.81	1200	64746	**85**	5675	0.05	**2.0**	4	8	$ 17.00	$ 0.00300	**$ 1,786.00**	3.318
3.0	5.5	7.07	24.74	9.81	1200	64746	**95**	7088	0.05	**2.0**	4	8	$ 18.00	$ 0.00254	**$ 1,794.00**	5.177
3.0	5.5	7.07	24.74	9.81	1200	64746	**105**	8659	0.05	**2.0**	4	8	$ 20.00	$ 0.00231	**$ 1,810.00**	7.726
3.0	5.5	7.07	24.74	9.81	1200	64746	**130**	13273	0.05	**2.0**	4	8	$ 22.00	$ 0.00166	**$ 1,826.00**	18.155
3.0	5.5	7.07	24.74	9.81	1200	64746	**150**	17671	0.05	**2.0**	4	8	$ 24.00	$ 0.00136	**$ 1,842.00**	32.179
3.0	5.5	7.07	24.74	9.81	1200	64746	**200**	31416	0.05	**2.0**	4	8	$ 34.00	$ 0.00108	**$ 1,922.00**	101.703
Water @ 20																
3.0	4.0	7.07	14.14	9.81	1000	39240	**60**	2827	0.001	**7.576**	1	7.576	$ 9.00	$ 0.00318	**$ 68.18**	1.648
3.0	4.0	7.07	14.14	9.81	1000	39240	**75**	4418	0.001	**7.576**	1	7.576	$ 12.00	$ 0.00272	**$ 90.91**	4.022
3.0	4.0	7.07	14.14	9.81	1000	39240	**85**	5675	0.001	**7.576**	1	7.576	$ 17.00	$ 0.00300	**$ 128.79**	6.636
3.0	4.0	7.07	14.14	9.81	1000	39240	**95**	7088	0.001	**7.576**	1	7.576	$ 18.00	$ 0.00254	**$ 136.37**	10.354
3.0	4.0	7.07	14.14	9.81	1000	39240	**105**	8659	0.001	**7.576**	1	7.576	$ 20.00	$ 0.00231	**$ 151.52**	15.452
3.0	4.0	7.07	14.14	9.81	1000	39240	**130**	13273	0.001	**7.576**	1	7.576	$ 22.00	$ 0.00166	**$ 166.67**	36.308
3.0	4.0	7.07	14.14	9.81	1000	39240	**150**	17671	0.001	**7.576**	1	7.576	$ 24.00	$ 0.00136	**$ 181.82**	64.357
3.0	4.0	7.07	14.14	9.81	1000	39240	**200**	31416	0.001	**7.576**	1	7.576	$ 34.00	$ 0.00108	**$ 257.58**	203.399
Orange Juice																
3.6	2.0	10.18	20.36	9.81	1030	20209	**60**	2827	0.003	**5.202**	6	31.212	$ 9.00	$ 0.00318	**$ 280.91**	2.471
3.6	2.0	10.18	20.36	9.81	1030	20209	**75**	4418	0.003	**5.202**	6	31.212	$ 12.00	$ 0.00272	**$ 374.54**	6.034
3.6	2.0	10.18	20.36	9.81	1030	20209	**85**	5675	0.003	**5.202**	6	31.212	$ 17.00	$ 0.00300	**$ 530.60**	9.954
3.6	2.0	10.18	20.36	9.81	1030	20209	**95**	7088	0.003	**5.202**	6	31.212	$ 18.00	$ 0.00254	**$ 561.82**	15.532
3.6	2.0	10.18	20.36	9.81	1030	20209	**105**	8659	0.003	**5.202**	6	31.212	$ 20.00	$ 0.00231	**$ 624.24**	23.179
3.6	2.0	10.18	20.36	9.81	1030	20209	**130**	13273	0.003	**5.202**	6	31.212	$ 22.00	$ 0.00166	**$ 686.66**	54.464
3.6	2.0	10.18	20.36	9.81	1030	20209	**150**	17671	0.003	**5.202**	6	31.212	$ 24.00	$ 0.00136	**$ 749.09**	96.539
3.6	2.0	10.18	20.36	9.81	1030	20209	**200**	31416	0.003	**5.202**	6	31.212	$ 34.00	$ 0.00108	**$ 1,061.21**	305.110

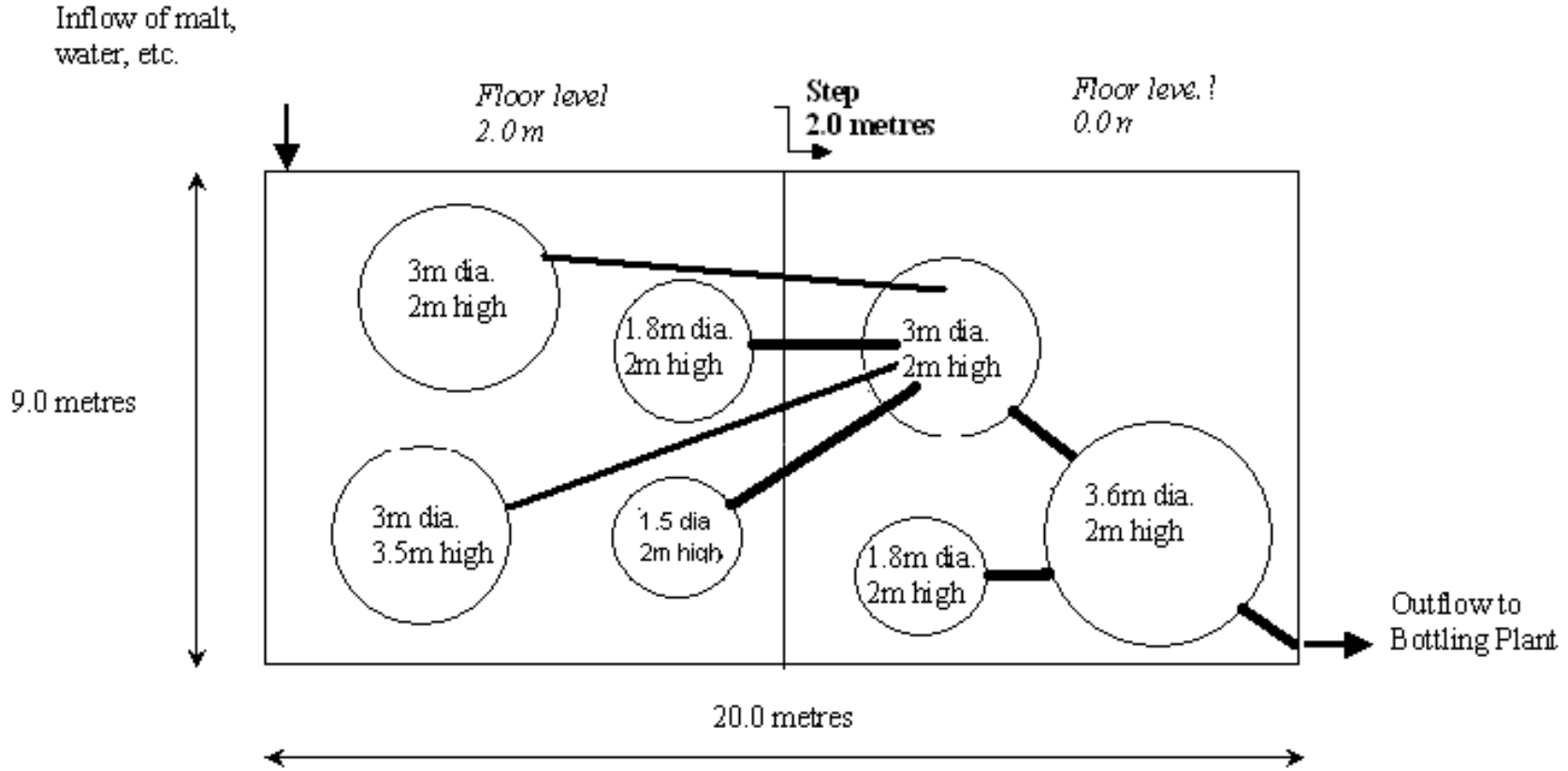
Pipe diameter to large (flow rate to fast do not us

Appendix C


Project No.3, Team X07, Orange Juice Production, Pipe Diameter Vs Cost/Output Production
3000
2500
2000
1500
1000
500
0
60
75
85
95
105
130
150
200
Pipe Diameter (mm)
Orange Juice Production Litres/Sec
Refurbish Price $
Min Bottle Plant Input Flow Rate Q=litres/sec
Max Bottle Plant Input Flow Rate Q=litres/sec

Appendix D

The Brewery Layout



I believe this format forfills the requirements of the brewery, the top tank 3m x 3.5m will only be filled to a 2.2m high mark giving 15.5 and 14.1cu/m, 29 cu/m of water requires 1.5 cu/m of glucose and 2.9 cu/m of hops, allowing a brewing tank is 39 cu/m, 3 cu/m will be used for froth, 36 cu/m of brew.
Piping =

Appendix E

Appendix E cont

Appendix E cont

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