

The System Approach to Designing a Low Velocity Circulating System

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Prelude

“Science and the public have separated so much that many people in the public consider science just another option”- Alan Alda.

This document pertains to circulating water, particularly to swimming pools. It provide a viable global energy plan that has a multitude of energy efficient savings. It is based on lowering the hydraulic resistance within three designated modules of an integrated system.

The science begins with defining parameter values related to the hydraulic resistance and defining energy standards that applies to components, electrical consumption and configurations. An energy efficiency quotient can be applied to all new and old pools.

Swimming pools waste too much electricity, too much chlorine, too much time cleaning and take too long to complete one turnover. Pressure gauges read too high, water whirlpools through skimmers, returns are too small and too little, while many components are placed in series.

Existing laws do not reflect new goals, standards, procedures, nor education, for developing a sustainable energy efficient plan. The industry is component oriented with many innovated products but none addresses energy efficiency as a totally integrated sustainable system where the components serve the system.

The world of low velocity circulating systems presents many discoveries of new products in the realm of energy efficiency. When the hydraulic resistance is lowered, the design of circulating systems takes on a new physical and functional form. A host of new products present themselves as well as the methods to make them.

Four products are described here in.

*“Providing a viable global energy plan for swimming pools” - **Manny Garcia***

Describing a Swimming Pool Circulating System

The system contained herein has been separated into three modules. The components are very familiar to many. The primary pump and motor, pipes, skimmers, filters, heaters, hydro jets, cleaners, chlorinators, sheer descents, etc.

MODULE 1 is called the Acquisition Module. It acquires a bountiful, low velocity, safe supply of swimming pool water by way of skimmers having large diameter ports (3" and 4" in diameter). The Blue Whale Skimmer™ has been designed as the keystone of energy efficiency for the circulating system. 75 GPM at a velocity of 3.1 feet per second is a nominal value. No more traumatic suctions. Suction entrapment does not exist.

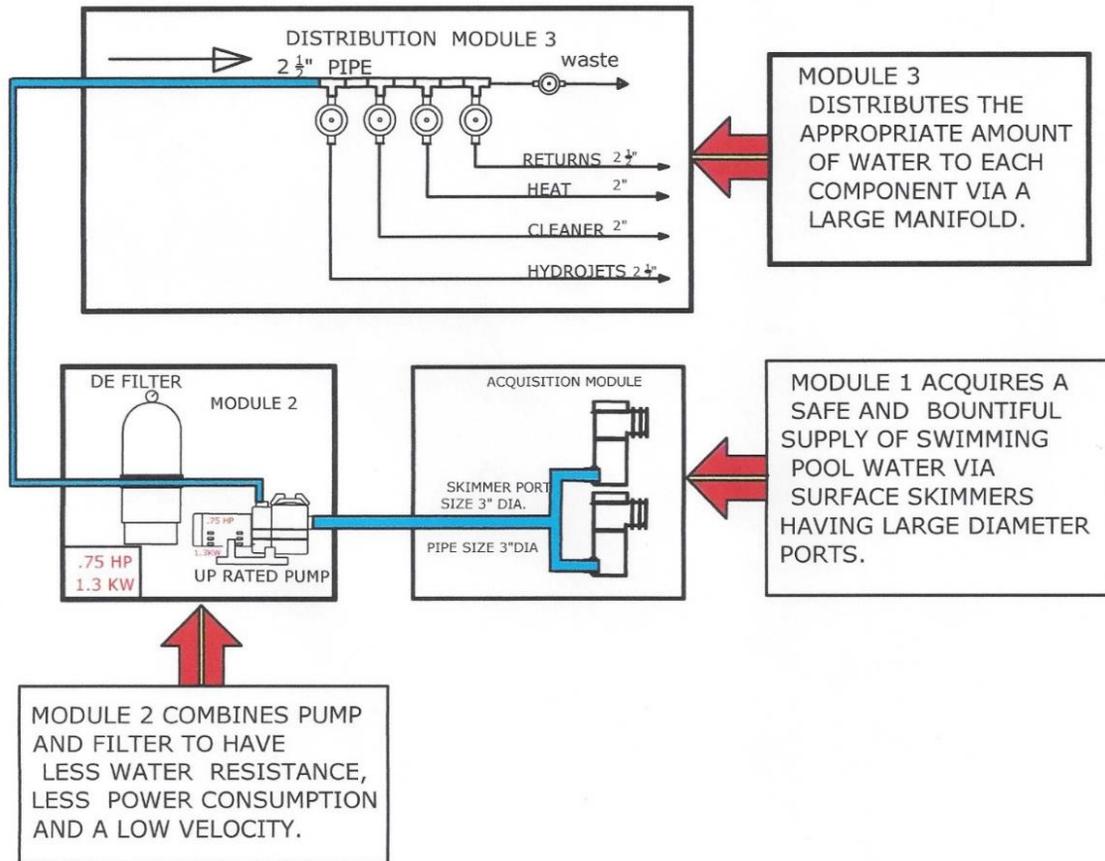
KEY ELEMENT - LOW HYDRAULIC RESISTANCE

MODULE 2 is called the Pump and Filter Module. This section also contributes to the flow rate, velocity, turnover rate, horse power and filter capacity. This module utilizes single speed pumps. Single speed pumps are predictable, steady, inexpensive, and easy to make accurate sustainable measurements. "Small Pumps Do What Big Pumps Did". Baskets and filter grids last longer and backwash cycle is increased.

KEY ELEMENT – SUSTAINABLE DATA

MODULE 3 is called the Distribution Module. It is a large diameter manifold that delivers the appropriate gallons per minute to each component.

KEY ELEMENT – PARALLEL DISTRIBUTION



Parameters That Measure the Efficiency of a Swimming Pool.

The water flowing through a PVC pipe is directly proportional to its diameter. If the diameter of a pipe gets larger, then the hydraulic resistance decreases and allows the flow rate to increase.

The numeric value of the velocity defines the efficiency of the circulation system.

Determining the Velocity:

Velocity is equal to the flow rate (Q) divided by the surface area (A) of the pipe.

$$V = Q/A \quad \text{The Velocity (V) is given in feet per second (ft/sec)}$$

The flow rate (Q) is given in cubic feet per second (ft³/sec)

The surface area (A) is given in square feet (ft²)

Normally, flow rates are described in gallons per minute, but since velocity is described in feet per second, a conversion of gallons per minute to cubic feet per second is needed. (See chart to the right).

Nominal Pipe Size	Inside Diameter	Area
1 ½"	1.61"	.0141 ft ²
2"	2.067"	.0233 ft ²
2 ½"	2.469"	.033 ft ²
3"	3.068"	.051 ft ²
4"	4.026"	.088 ft ²

GPM	cu. ft. per sec
1	.00223ft ³ /sec
40	.089 ft ³ /sec
50	.111 ft ³ /sec
60	.134 ft ³ /sec
70	.156 ft ³ /sec
80	.178 ft ³ /sec
90	.200 ft ³ /sec
100	.223 ft ³ /sec
110	.245 ft ³ /sec
120	.267 ft ³ /sec
130	.290 ft ³ /sec
140	.312 ft ³ /sec

The above chart expresses the surface area of 5 pipe sizes

For example: 80 gallons = .178 ft³/sec = (Q)

The surface area of a three inch pipe = .051 ft² = (A)

$$V = Q/A \quad V = \frac{.178 \text{ ft}^3/\text{sec}}{.051 \text{ ft}^2} = 3.49 \text{ ft/sec}$$

Determining The Velocity using chart below.

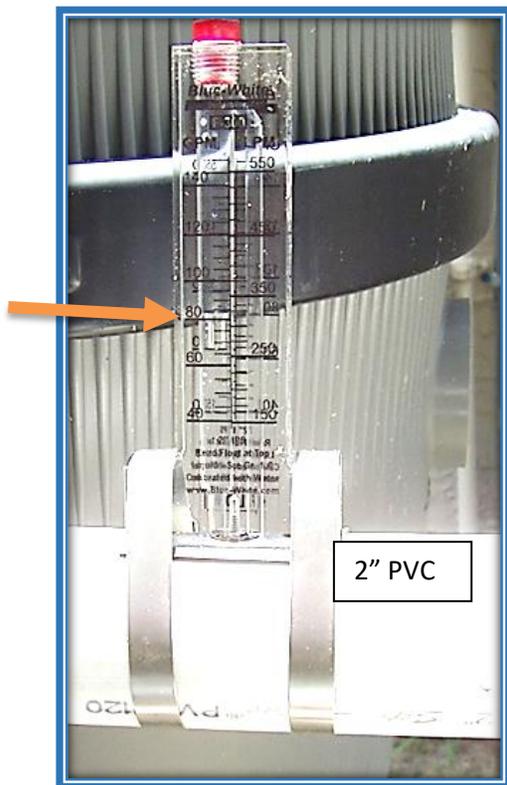
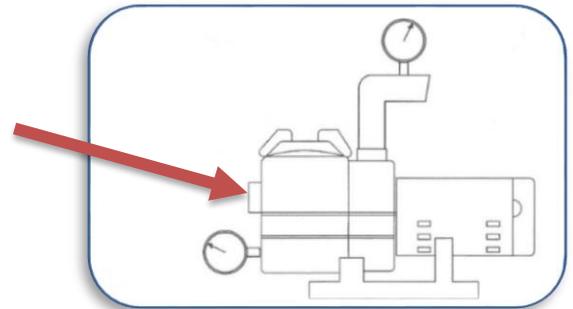
1½" PVC PIPE	2" PVC PIPE	2 ½" PVC PIPE	3" PVC PIPE
area = .014 sq ft	area = .023 sq ft	area = .033 sq ft	area = .051 sq ft
GPM ft ³ /sec VEL.			
25 0.056 3.98	40 0.089 3.9	50 0.11 3.4	70 0.156 3.1
30 0.067 4.78	45 0.100 4.4	60 0.13 4.1	80 0.178 3.5
35 0.078 5.58	50 0.112 4.8	65 0.14 4.4	85 0.190 3.7
40 0.089 6.37	55 0.123 5.3	70 0.16 4.7	90 0.201 3.9
45 0.100 7.17	60 0.134 5.8	75 0.17 5.1	95 0.212 4.2
	65 0.145 6.3	80 0.18 5.4	100 0.223 4.4
	70 0.156 6.8	85 0.19 5.7	110 0.245 4.8
	75 0.167 7.3	90 0.20 6.1	120 0.268 5.2
	80 0.178 7.8	95 0.21 6.4	125 0.279 5.5
		100 0.22 6.8	130 0.290 5.7
		105 0.23 7.1	140 0.312 6.1

How to Find Out If Your Pool Is an Efficient One

1. The filter gauge should read less than 12 psi.
2. Looking into the skimmer basket should reveal no vortex.
3. Remove basket and CAUTIOUSLY put your hand into skimmer with thick gloves. Notice the danger.
4. Does the surface look like the Dead Sea?

5. Use procedure below to verify a numeric value.

Install a flow meter to the suction side pipe connected to the pump.
 The red arrow points to the suction side of the pump.
 Insure that the flow meter is compatible to the size of the pipe.



Start the pump and visually record the gallons per minute in the window of the flow meter.

The orange arrow points to 80 gallons per minute located on a two inch pipe.

On the pink chart to the right:

2" PVC PIPE		
area = .023 sq ft		
GPM	ft ³ /sec	VEL
40	0.089	3.9
45	0.100	4.4
50	0.112	4.8
55	0.123	5.3
60	0.134	5.8
65	0.145	6.3
70	0.156	6.8
75	0.167	7.3
80	0.178	7.8

80 gallons per minute indicates a velocity of 7.8 feet per second.

The conclusion is that this system could use a bigger suction pipe. The velocity is too high. If the suction pipe is changed to a 2 1/2" pipe then velocity will change favorably (lower) and probably be in the range of 5.4 feet per second.

The change in the flow rate will be noticeably greater which will provide an option to use a smaller pump or add more components to the system. The turnover rate and the running time can also be decreased.

2 1/2" PVC PIPE		
area = .033 sq ft		
GPM	ft ³ /sec	VEL
50	0.11	3.4
60	0.13	4.1
65	0.14	4.4
70	0.16	4.7
75	0.17	5.1
80	0.18	5.4
85	0.19	5.7
90	0.20	6.1
95	0.21	6.4
100	0.22	6.8
105	0.23	7.1

Sustainable Systems Requirement Standards

Endorsement by swimming pool institutes, government departments, utilities companies, component manufactures, incentive programs and universities that the playing field of sustainability must be that
ONE HORSE POWER = 746 WATTS.

Other standards derived to reflect energy efficiency are:

1. GALLONS PER MINUTE PER KILOWATT HOUR
2. VELOCITIES OF LESS THAN 4 FEET PER SECOND
3. SINGLE SPEED PUMPS
4. Drawing configuration of nominal systems
5. Annotations of power consumption for all products consuming electricity.

TRUISMS

A belief of 9 axioms is based on good science towards the goal of energy efficiency.

1. Most of the debris (85%) resides within the top 4" of the pool surface.
(Wind particles, organic, non-organic, rain, bird droppings, animal hair, dirt, poop, etc., etc.)
2. Swimming pool circulating systems are used to remove suspended particles that have fallen from the sky and into the pool.
3. The removal capability of the circulating system must far exceed the input deluge of debris.
4. The circulating system traps particles, into a dark filter area, to achieve clarity, sanitation, chemical circulation and deliver a sufficient amount of water to the various components.
5. Increasing in the flow rates will:
 - Diminish bacterial colonization
 - Achieve quicker clarity and sanitation
 - Lower the Chlorine demand.
6. The hydraulic resistance of a water flowing system is fundamental to energy efficiency.
7. The hydraulic energy efficiency is determined by the measurements of the following parameters:
 - Flow rate in cubic feet per second
 - Velocity in feet per second
 - Turnover rate in hours and minutes
 - Pipe diameters in square feet
8. The circulating system is described as containing a single speed pump, a filter, skimmers, pipes, returns, and water features.
9. An efficiency quotient is established by determining the values of the following parameters:
 - Flow rate in cubic feet per second
 - Velocity in feet per second (under 5 feet per second)
 - Turnover rate in hours and minutes (between 3 and 4 hours)
 - Pipe diameters in square feet (2.5", 3" and 4" pipe)
 - Power consumed in kilowatt hours
 - Gallons per minute per kilowatts hours

The World of Low Velocity Circulation Systems

The world of low velocity swimming pool circulating systems presents many discoveries of new products in the realm of energy efficiency. When the hydraulic resistance is lowered, the design of circulating systems takes on a new physical and functional form. A host of new products present themselves as well as the methods to make them. All low velocity circulating systems will indicate gauges in the vicinity of 9 psi. Less filters will crack or leak, baskets and diatomaceous filters will last longer.

Benefits

Smaller pumps will do more than pumps twice its size.

Cleaner pumps are eliminated.

Electric bill will be lower.

Turnover rate will fall in the vicinity of 3 hours.

Chlorine demand will diminish.

Distribution manifold will enhance multiple functions.

Availability of a Gravity Feed System for residential pools.

A multitude of water feature enhancements like water falls and low impact swimmers.

It is sustainable, and predictable as to consumption and easy to record energy usage.

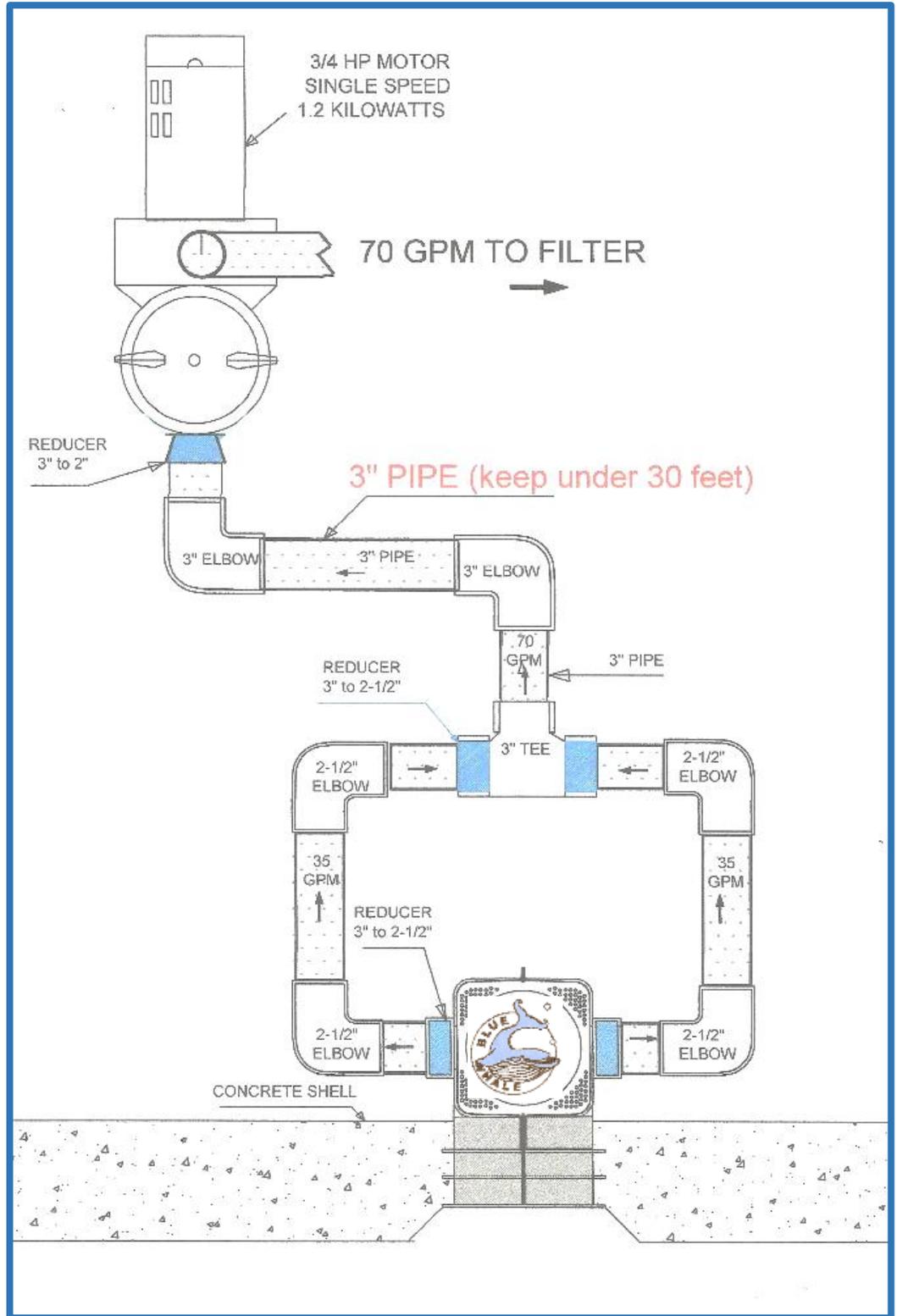
Emergence of new products and procedures.

Each circulating system uses less electricity, achieves clarity and sanitation quicker with less bacteria and less chlorine demand. The designs are simpler, cost less, and performs better than systems with twice the horse power. Suction entrapment is nonexistent.

Four New Designs as a Results of a Low Velocity Philosophy.

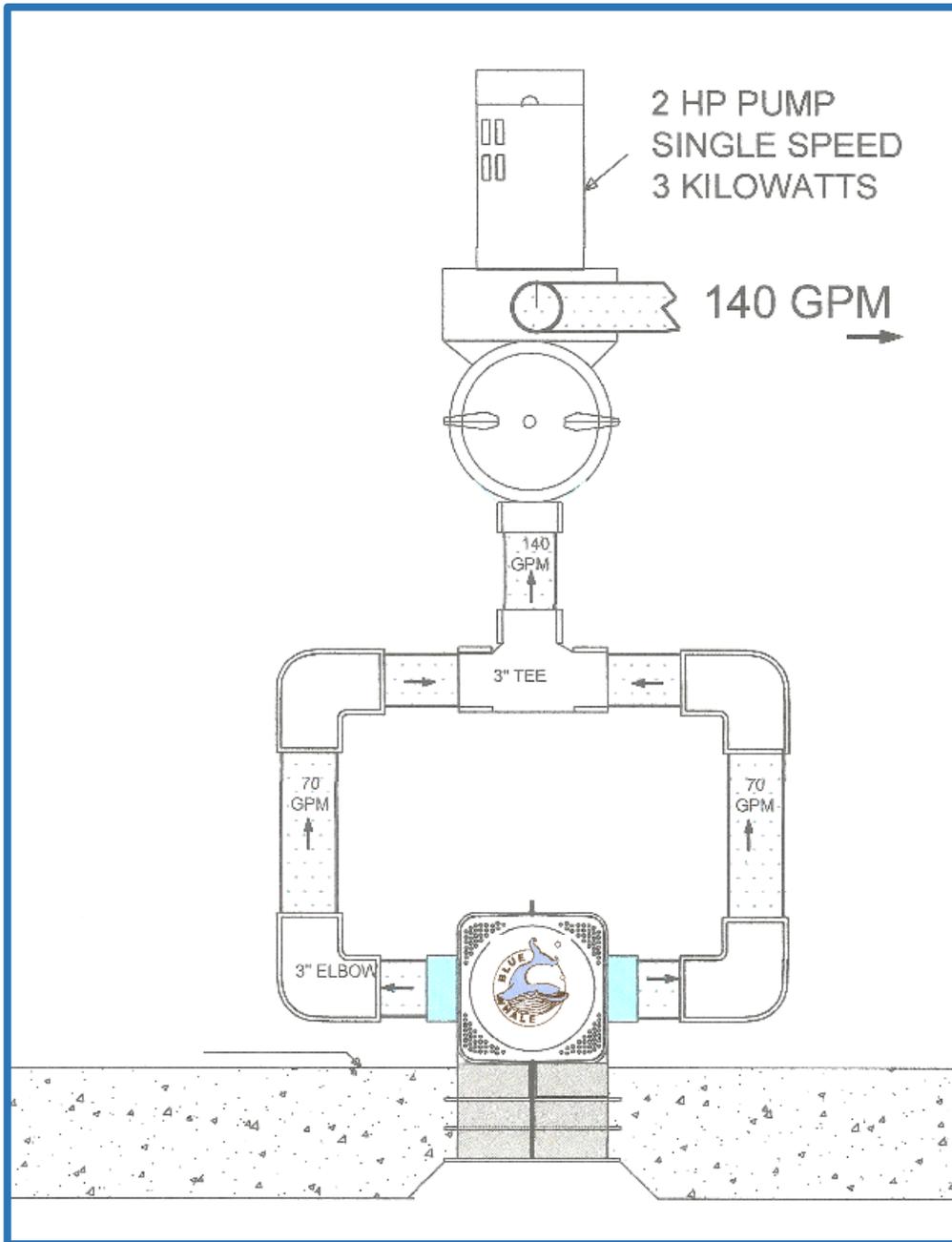
1. THE FIRST ENERGY EFFICIENT LOW VELOCITY ACQUISITION SUBSYSTEM.

The velocity at each port is less than 2 feet/sec. When connected as shown to a pump (1.2 kw.) it will supply 70 GPM. A greater flow than any system with twice its horsepower. This configuration is the keystone of all energy efficient circulating systems.



The Water Mover

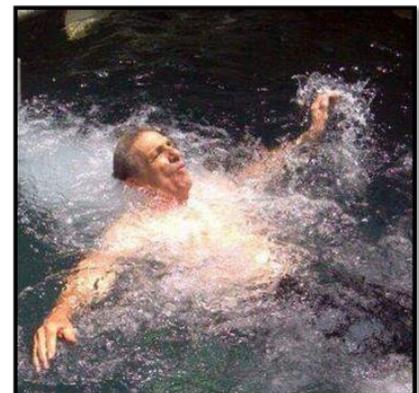




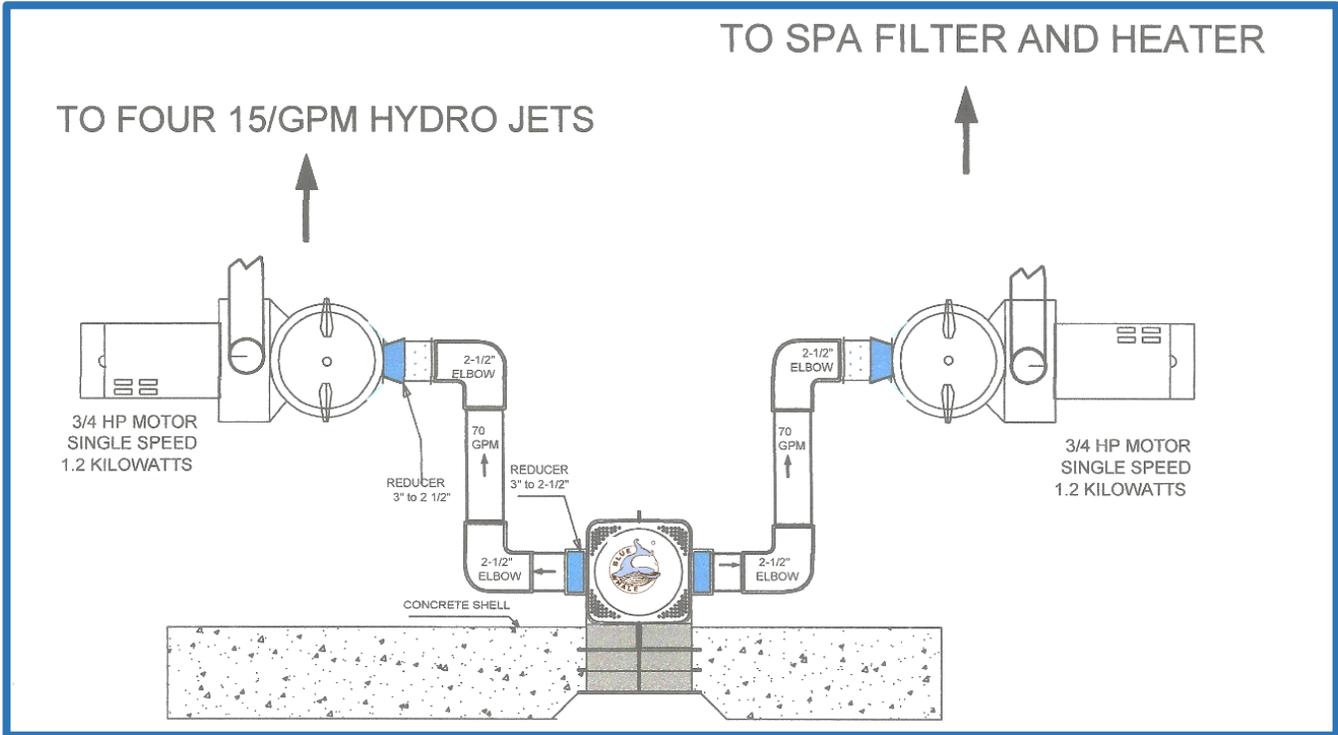
2. A SAFE LOW IMPACT SWIMMER AND A MASSIVE WATER MOVER.

This configuration is designed for water features like waterfalls, shear descents, and low impact in place swimming. It is a safe massive water mover.

One single speed pump 2 HP (2.8 kW) will produce 140 GPM.

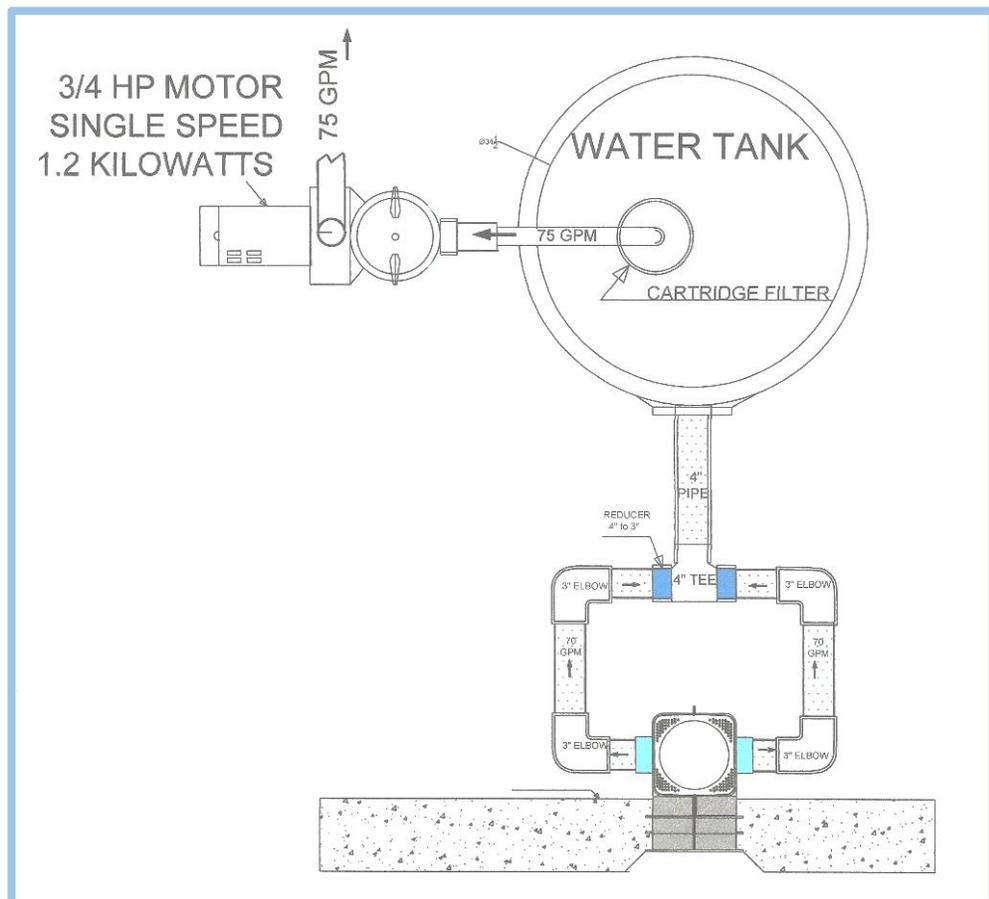


3. A Spa Configuration Using One Large Capacity Skimmer with Two Functions.



4. A COMPLETE GRAVITY FEED SYSTEM

Gravity feed systems have been in existence for many years and today commercial pools use this system frequently. For reasons unknown, these systems have not gained too much popularity in the residential swimming pool market place until the discovery of the Blue Whale Skimmer™, with its 3” and 4” side ports.



BENEFITS

No Suction Entrapment

Simple Design (Cost Saving)

Major Components Are Recycled

Multiple Use of “Off the Shelf” Components

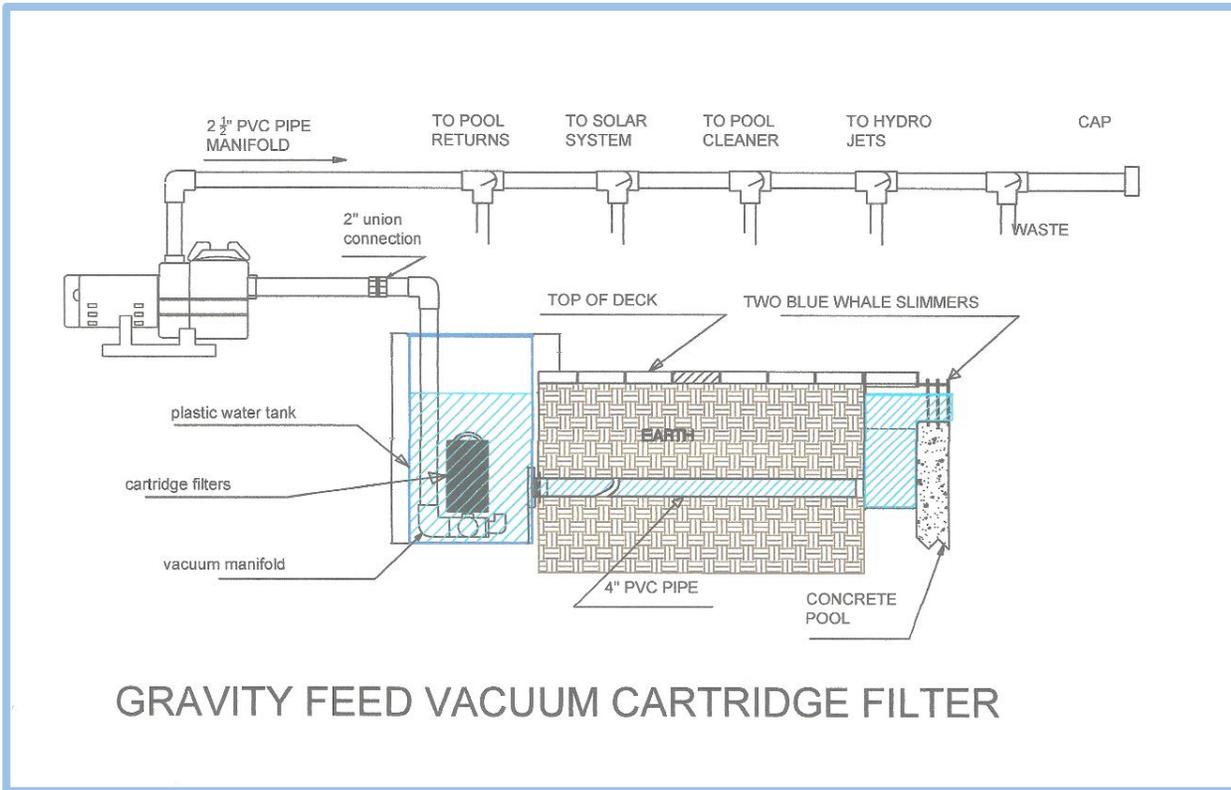
One System Fits Many

Lowest Frictional Loss

Largest Flow Rate, Shortest Turnover

The Blue Whale Skimmer™ as applied to a Gravity Feed System saves even more energy and increases flow rates. By its very nature, water is virtually transferred free from the skimmers to the retention tank.

A Distribution Manifold is (Module 3) shown at the top of the diagram.

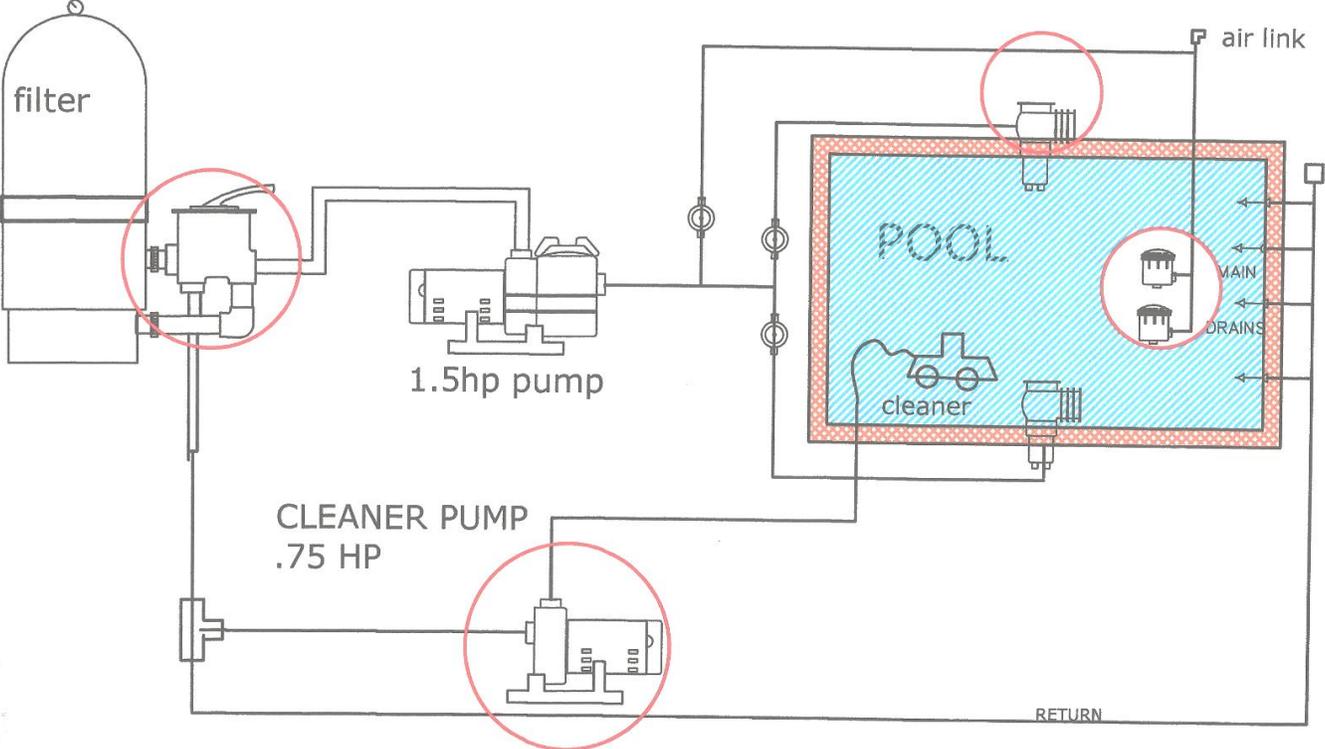


Suction Entrapment



The picture of a preteen, invited to swim in a neighbor's pool and spa. Unaware of the danger, she decided to lie down on the bottom of the spa. She came too close to the main drain and was pulled in by the tremendous flow of water. The picture shows an exact duplicate of the main drain lid, which is approximately 8 inches in diameter. No one really knows how long it took her to free herself from this entrapment, but she did, and we all are grateful for that.

A CONVENTIONAL SYSTEM



A LOW VELOCITY SYSTEM

