Boat Pressure Washing

Handling Marina Wastewater Discharge

Resource Guide
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CLEAN MARINA

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Pressure washing of boat bottoms to remove marine organisms produces contaminated wastewater. Particles from antifouling paints contain heavy metals in concentrations that are harmful to the marine environment.

Wastewater that drains to surface waters is considered an illegal discharge under the Federal Clean Water Act. Even small amounts of untreated pressure washing wastewaters can adversely impact water quality and accumulate in bottom sediments. Toxic residues from antifouling bottom paints can result in future problems and expenses for marina operators when faced with dredging contaminated sediments and their disposal.

Clean Marina programs are designed to eliminate the runoff of contaminated water to the surface water. Marinas should also not direct pressure-washing wastewater runoff over land to a permeable surface as it may contaminate groundwater and soil. This potential violation of EPA regulations may result in fines and require a future costly clean-up of the contaminated soil.

Contaminants in Pressure-washing Wastewater

Pressure-washing wastewater includes dirt, algae, barnacles, salts, and paint particles. The paint particles are the source of heavy metals. About 90% of the heavy metals; copper, lead, tin, zinc, and arsenic are solid particles that are not dissolved. Typical untreated pressure-washing wastewater samples contain copper levels in the 50 to 190 mg/l range, while typical municipal sewer standards limit copper concentrations to the 2.4 to 8 mg/l range. The allowed copper concentration in USA waterways is only 0.006 mg/l which makes even treated wash water discharges virtually impossible.

The suspended contaminants are small particles less than 50 microns (0.0004 inch) that show in the turbidity (or cloudiness) of the pressure-washing wastewater sample. These solids resist rapid settling and can plug cartridge or bag filters in a few minutes. Oil is usually not present in pressure-washing wastewater unless spilled or released from bilge water. The organic material in pressure-washing wastewater decays rapidly and under warm conditions bacterial growth and odors can be expected.

Waste Water Options for Marine Bottom Cleaning

There are several options for dealing with the waste water generated by pressure washers during boat bottom cleaning. Each of the options, with pros and cons, are shown in the following chart:

Options	Pros	Cons
Cease the activity and discharge	• May be the easiest and most cost-effective option for some marinas • No permits required • No equipment required	• Loss of the revenue earned from boat washing • Possible loss of customers to competitors • Future fines for customers illegally washing boats
Haul wash water offsite to a treatment facility	• Revenue from boat wash • Suitable for low waste water generation • Sewer access not required • No discharge permits required • Licensed certified operators not required • No equipment costs	• Requires wash pad to collect wash water • High disposal costs ($4 per gal) • Need holding tank permit in compliance with state regulations (may include double wall around the tank). • Must schedule licensed wastewater disposal pickups
Discharge treated wash water to Sanitary Sewer	• Revenue from boat wash • Suitable for large or small discharge volumes • Low odor problems • Lower haul off cost (only need for residual hazardous materials)	• Requires wash pad to collect wash water • May require a holding tank if water is not treated and immediately discharged. • Monthly sewerage fees • Must have sewer access • High initial capital costs • Requires a discharge permit from the local sewer authority • Pre-treatment required before disposal. • May require regular discharge monitoring reports • May require licensed certified operators • May require a coastal building permit if the water treatment unit is not portable equipment
Evaporation system for wastewater	• Revenue from boat wash • Zero discharge • Suitable for only small waste water quantities • No discharge permits required • Licensed certified operators not required • Sewer access not required • Low operating cost for solar evaporator	• Requires wash pad to collect wash water • Requires large holding tank because evaporation is a very slow process • Need holding tank permit in compliance with state regulations (may include a berm or double wall around the tank). • High initial capital cost • High energy costs (16 cents/gal) for gas evaporator -or-

Evaporation system for wastewater (continued)		• Very large solar evaporator required. (capacity averages 20 gallons in a year per square foot of evaporator with mean range 48 to 88 F) • High Maintenance • System downtime • Water quality problems • Odor and bacteria growth • Potential air pollution risk for VOC's released • Potential fines if caught dumping tank because of insufficient capacity • Licensed hauler will have to periodically remove residual wastewater solids • May require a coastal building permit if the water treatment unit is not portable equipment
Closed Loop Recycling of wastewater for reuse as wash water	• Revenue from boat wash • Zero discharge • Suitable for large waste water quantities • No holding tank permits are required because process water is not classified as waste water • No discharge permits required • Licensed certified operators not required • Sewer access not required • Water conservation • Appeals to environmentally responsible customers	• Requires wash pad to collect wash water • High initial capital cost • Operating cost (chemicals, labor, filters, etc.) • High Maintenance • System downtime • Water quality problems • Odor and bacteria growth • Pressure washer degradation (unless <20 micron filtration) • Must add make up water for evaporation losses • A licensed hauler will have to periodically remove residual wastewater solids • May require a coastal building permit if the water treatment unit is not portable equipment

Recycling is the best option for handling Pressure Washer Wastewater

It's easy to reach the same conclusion as the NJ advisory committee - installing a closed loop water recycling system is the most cost efficient and best option for most marina facilities. It is not a surprising choice since most industrial applications have been recycling manufacturing fluids for years, adding make up fluid for loses due to evaporation, and usually only changing fluids annually. The cost of disposal by truck or sewer, with permits, fluid treatment, and water are just too high not to recycle.

Pressure Washing Recycling Capacity Requirements

Most pressure washers use about 3.5 gpm at pressures around 2,500 PSI. Assume that it takes about 15 minutes to wash a 20 foot boat and about 1 minute for each additional foot of boat length. The pressure washer water usage for a typical boat is shown this chart

Boat Length	Time Used	Water Used
20 ft	15 min	53 gal
25 ft	20 min	70 gal
30 ft	25 min	88 gal
35 ft	30 min	105 gal
40 ft	35 min	123 gal

If a marina washes 200 boats averaging 30 feet, by the end of the season they can expect to use 17,600 gallons of water. Marinas can expect about 10 to 15% of the water used to be lost to evaporation, so make-up water will need to be added to keep the tank at the desired level. Surface water evaporates at approximately 1.5 gallons per square foot per month during a mild November (Temp 52ºF). For a 1,500 square foot pad, the loss of about 2,250 gallons due to evaporation during the month (unless it rains), will leave about 15,350 gallons of waste water to treat.

Treatment Options for Recycling Waste Water

There are several treatment options for the waste water generated by pressure washers. All of these options will require an impervious wash pad to collect the waste water for processing. The treatment options are discussed in the following chart:

Settling Tank	Particles aided by gravity, settle to the bottom of a liquid and form sediment. It may take 10 to 12 hours for heavy metals to settle if at a low flow. Bacteria and odor can be a problem. Since, some of contaminated particles will be stirred up in the tank when pressure washing resumes, the water cannot safely be re-used by a pressure washer. Labor costs are high to remove the sediment from the tank.
Electro-coagulation	As wastewater travels through a series of cells, an electrical current is applied to anode and cathode that allow certain compounds to approach a more stable state and produce a solid form that is removed by precipitation or filtration. This process can remove emulsified oils, solids, and heavy metals. A large tank is generally required to allow processing time. Training and maintenance is complex for operation of these units. The units also frequently require proprietary expensive replacement components and repairs.
Chemical Treatment	Various chemicals are used that can include pH adjustment to neutralize wastewater and flocculants to improve settling. A large tank is generally required to allow processing time. Skimming, shoveling, or filtration is still required to remove solids from solution. Chemicals can be cost prohibitive and require properly trained operators. Labor costs are high to remove sediment.
Biological Treatment	Biological treatment utilizes designer microbes that feed on organic materials and nutrients and oils. These bacteria require "dwell time" to work effectively so large storage tanks are required. If the water is too cold the bacteria go dormant, and they die if water is too hot. The normal chlorine present in city water kills these custom microbes. These treatments require a constant source of organic matter, costly bacteria at over $100+ each month, and properly trained operators.

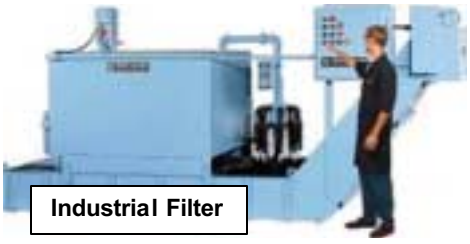
Ozone Treatment	These systems use Ozone to kill bacteria and help clarify water. They do not remove solids or heavy metals. A large tank is generally required to allow settling time. These systems often use very expensive UV tubes that typically burn out each year. Labor costs are high to remove the sediment.
Media Filtration	Filters mechanically separate solids from a waste stream. There are many types of filters available that include: (1) paper type media in the form of cartridges, paper, and bags, (2) activated carbon, (3) ultra-filtration membranes, and (4) sand and diatomaceous earth filters. Replacement media is often expensive and clogs quickly. Oil will destroy most replaceable media. Bacteria and odor can be a problem. System maintenance may require back flushing to reduce back pressure. Disposal problems are created with used filter media and the several hundred gallons of dirty back flush water.
Cyclonic Separators	Cyclonic separators use cones to separate solids from water. Older technology large cone units were usually not capable of filtration below 50 microns, but more advanced smaller cones can filter particulates as small as 5 microns with 98% efficiency. There is no filter media to purchase and install. A cyclonic cone aerates water to stop anaerobic bacterial growth. Solids are discharged to a separate waste container for easy disposal. Maintenance costs are low. Continuous filtration uses smaller tanks.

Evaluation of Water Treatment Systems

Waste water recycling systems are best evaluated on the quality of the water before and after the filtering process. The system's efficiency, costs, size, and durability are all important factors. Looking at the manufacturer's past track record can also help avoid companies that may go out of business. They may already be operating under a new name because their last "magical mystery box" didn't quite work out. Question whether this company might still be around in a few years. Do they sell other products to keep them in business after the limited numbers of marinas have purchased a filter to satisfy the EPA mandate?

Encyclon™ - Cyclonic Filtration is the Cost Effective Recycling Solution

Encyclon offers the best filtration for the lowest cost. These units are manufactured in Kenosha, Wisconsin, USA. Since 1974 we have built hundreds of filtrations systems for demanding industrial applications. Our industrial customers include some of the world's largest corporations who have the resources to regularly test fluid samples and reject filtration systems that do not perform to advertised standards. When an aircraft engine builder makes a bad filter choice, a defective part that causes an engine failure can result in disaster. A damaged pressure washer seems almost trivial by comparison.



Industrial Filter

We manufacture over 60 types of filtration systems with capacities up to 560-gpm and tanks as large as 3,000 gallons. Our industrial systems remove thousands of pounds of abrasive grit and steel particles from water based coolants each day, so removing a few pounds of paint chips with copper is relatively easy stuff. Some of our other water recycling applications include: semi-truck washing, stone cutting, paint booth water-falls, potato washing, in addition to marina pressure washing.

All of our systems operate on the simplest, most efficient means of separating foreign particles from liquids – centrifugal force generated in a cyclonic chamber. The same high efficiency cyclonic cones are used in all of our systems, so replacement parts are readily available.

High Efficiency Cyclonic Cones are the key to removing particulate contaminates down to 5-microns or 0.00019 inches. The filtered particle size is smaller that a human hair split (21) times. Encyclon cyclonic cones generate a centrifugal force at 7,500 times gravity so the heavier copper items found in marina waste water are filtered at the most efficient rate. The Encyclon cone has a 98% efficiency rating on the first pass, however since the water passes through the filter multiple times, the 98% efficiency is effectively multiplied endlessly. After several passes through the cyclonic system, the water may be clean enough to be discharged to most sanitary sewer systems, but since a discharge permit, testing, and monitoring is usually required, most marinas find it easier to re-use the filtered water for boat washing.

There is no "magical mystery box" used inside of Encyclon filtration systems. The cyclonic cones are in plan view. The #65 cone is capable of 5-micron filtration. It is made from nylon with ceramic wear resistant parts and is 18-inches in length. This #65 cone filters at a rate of 20-gpm, which is over five times the amount of water used by a typical 3.5 gpm pressure washer.

Dirty water enters the side of the cone with an input pressure of 35 PSI and clean water exits the top of the cone with an output pressure of less than 10 PSI. The dirty particles are continuously discharged in a 0.3 gpm spray from the 0.25 inch diameter orifice at the bottom of the cone that also injects air back into the cone. If you would like to learn more about what happens inside our cyclonic cone, see the appendix "How a cyclone works".

Smaller cyclones are more efficient. Often when I mention cyclones to a new customer they tell me how great their Dyson vacuum cleaner works. They understand efficiency as the *Dyson Root Cyclone*™ uses as many as (14) very small cyclonic chambers in their product. As a cyclone becomes more efficient, both the length and capacity are reduced. Our smaller 3-micron #28 cone measures about half the length of our #65 cone with only 25% the capacity. We use a single #65 cone for our standard marina waste water filter systems because our standard 5-micron filtration is already more efficient than the 50-micron filtration obtained when using new filter paper, cartridges and bags media.

Low efficiency (LE) cyclones cause problems. Unfortunately potential customers have also complained about problems when using some of our competitor's cyclonic systems. I find that low efficiency (LE) cyclones are usually the problem. LE cyclones are commonly used in process applications like separating corn kernels. These big LE cyclones may also be great for filtering sand from a water main supply line, but they can

only remove a small percentage of the smaller contaminates that can destroy the pump seals found in a marina pressure washer. You can avoid these inefficient filtration systems because the LE cyclonic cone is easy to recognize. Look for a cyclonic cone that is typically longer than 40- inches. You can often find other types of additional media filtration that actually filter out the small stuff in many of LE cyclonic systems. LE cyclonic chambers often use complicated dump valves that require electrical controls for the discharge of effluent. Their low cyclonic pressures do not work well with an open discharge that is required for the helpful air injection feature. LE cyclones do not need a ceramic discharge nozzle because they develop a much lower centrifugal force and particle velocity that leaves many of the smaller contaminates unfiltered.

Encyclon frequently get calls asking how to fix a competitor's broken cyclonic unit. These big cones can have big rust problems. Their LE cyclonic cones are usually made from steel that is prone to internal corrosion and almost impossible to repair. Often the company that supplied the LE cyclonic system is no longer in business. With a little plumbing work and a few Encyclon #65 high-efficiency cones, we can usually fix our competitor's broken filter. These satisfied "repair" customers usually purchase their next new system from Encyclon.

Encyclon filtration controls bacterial problems because the recycled water is continuously aerated during filtration to keep anaerobic bacteria under control. Living organisms need oxygen to maintain the metabolic processes that produce energy for growth and reproduction. The dissolved oxygen in waste water determines whether the biological changes are brought by aerobic or by anaerobic organisms. Aerobic bacteria use free oxygen for oxidation of organic and inorganic matter and produce innocuous end products. Anaerobic oxidation however, causes the reduction of certain inorganic salts such as sulfates that cause bad odors. Aerobic organisms are highly desirable to keep anaerobic organisms in check. Since both types of organisms are present in waste water, unless aerobic bacteria receive proper amount of oxygen, the anaerobic bacteria will take over and cause a bad odor.

Many of our competitor's filtrations systems just kill all the bacteria using expensive chlorine, biocides or ozone generators. A few use chemicals to change the water pH to a level that is not only harmful to bacteria, but can be harmful to gel-coat and operators.

Encyclon units are simple to service with low maintenance as most models have just one moving part–the cyclone pump. Not much can go wrong with Encyclon filtration unless one of the following problems occurs: (1) low input water pressure, (2) high output water pressure, or (3) clogged discharge orifice. It's not rocket science, but a cyclonic system must be designed properly to prevent problems. The design criteria include; a working pump, a constant supply of water usually requiring a tank, a discharge pipe for clean water with bypass capabilities and no restrictions, and a strainer basket to catch the larger stuff before it can clog the discharge orifice. The dirty discharged particulates are directed to a small collection container that has an overflow for excess water to be reprocessed.

Eventually the discharge orifice will wear from the abrasion of the dirty particles being discharged. Encyclon uses an easy to change low cost ceramic tip for the cone discharge orifice. Industrial users typically change these tips each year after filtering thousands of pounds of abrasive and steel particles. These tips can be expected to last much longer for marina applications. The $65 cost of a ceramic tip is a bargain when compared to cost and labor for frequently changing our competitor's filter paper, bags, or cartridges. Since there is no filter media used in Encyclon systems, there is no media that adds to the waste disposal problem. Debris from an Encyclon system is discharged into a small wheeled container. Smaller wastes equal lower disposal costs.

Encyclon standard marina filtration units use a modular design. Our building block design lets you customize the Encyclon cyclonic filtration system for your wash pad. Our standard self-prime (SP) unit has a very small foot print of only 24 x 32 inches that will meet the needs of most marinas. We can build a larger system for whatever tank size and filtration capacity you may require. If you need us to provide tanks with your system, we can add them. If you need more capacity than our standard 20-gpm flow rate, we can use multiple cones. If your customers discharge bilge water on your pad, we build several types of oil skimmers that can be added to your system. We have even added magnetic separators, bags, and refrigeration units for some of our industrial customers. Our standard SP system includes casters, but we can skid mount it, or put the whole system on a trailer.

Encyclon self prime systems are easy to install. Each unit is completely assembled and tested before shipping. You connect the water feed and return lines from your wash pad sump to our system. Next plug the supplied cord set into a standard marine dockside 110V electrical receptacle. Turn the switch on and clean water flows to your pressure washer and tanks. Since our standard unit is designed to be portable equipment, it requires no permanent structure or coastal building permit.

Selecting the Best Filtration System

- **Choose Value -** Encyclon offers a system that is less than half the cost of our competitors. You could spend ten times as much for some of our competitor's systems and still not reach our 5-micron filtration level.
- **Plan Ahead -** Encyclon has been building filters for over 35 years. Don't purchase a "magical mystery box" from one of our competitors and expect to find their proprietary parts in a few years after they are out of business.
- **Think Quality -** Don't expect a filter that looks like it was made from swimming pool components in someone's garage to hold up as well as the Encyclon industrial strength unit.

- **Be Aware -** Factor in the high cost for consumables such as filter paper, bags, cartridges, tubes, microbes, and chemicals.
- **Work Smart -** Select a system that can simultaneously operate while washing boats. Systems that require quiet time, frequent recharging, or backwashes, reduce boat pressure washing capacity and revenue.
- **Lower Costs** – The revenue generated from pressure washing boats can easily pay for the system cost by adding an environmental charge for pressure washing.
- **Save Water -** Recycling can save thousands of gallons of water in a year.
- **Be Green -** Waste water recycling appeals to environmentally responsible customers and helps keep our water-ways clean.
- **Increase Profits -** As other marinas may eliminate the service of hull washing, your marina can gain new customers and sell other value added services.
- **Stay Legal -** Avoid permits, reports, and costly non-compliance penalties.
- **Act Promptly -** There is a limited amount of time to purchase the system before the EPA deadlines. Delivery times will increase as demand increases.

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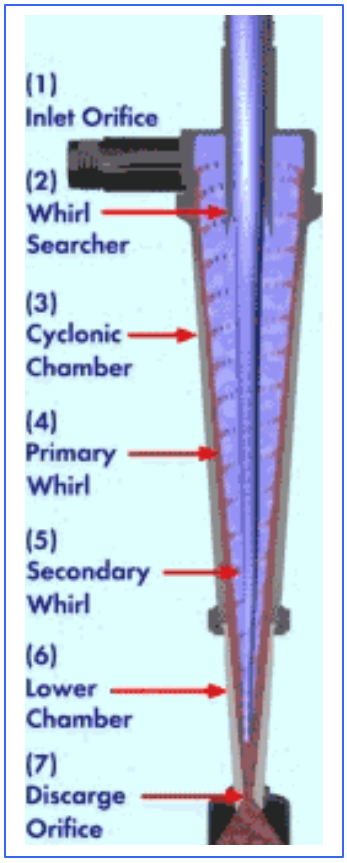
Appendix – **How a Cyclone Works**

Dirty liquid enters the cyclone at the inlet orifice (1) of the cyclonic chamber (3). The shape and tangential location of the orifice develop a downward, spiraling flow of the liquid. This is called the primary whirl (4) which follows the chamber walls downward, developing centrifugal force of up to 7500 times that of gravity.

This same force spins out the solid particles to 5 microns, or .00019" diameter from the liquid. The solid particles (often referred to as swarf) strike the wall and slide down to the discharge orifice (7).



A throttling effect in the lower cyclonic chamber (6) reverses the descent of the liquid but not the rotation. This forms the secondary whirl (5), a rising, spiraling flow of cleaned liquid that passes up through the primary whirl to the whirl searcher (2).

The diameter of the whirl searcher is smaller than the secondary whirl, and the whirl searcher accepts only the center of the upward, secondary whirl flow.

The outside portion of the secondary whirl (containing impurities missed by the primary whirl) is diverted back to the primary whirl for further cleansing. This double cleansing action is significant to the efficiency of the Encyclon Cyclonic Filtration Systems.

Liquid that passes through the whirl searcher is then piped out to the clean coolant storage tank or can be directly used with 5 micron filtration with 98% efficiency.