Evolving Equipment Washing Technology and What's in That Water

The environmental and technological aspects of cleaning golf course maintenance equipment.

BY A. MARTIN PETROVIC, PH.D.

Golf courses should evaluate their equipment wash areas to ensure that these important parts of maintenance facilities are not impacting the environment. The latest technology involves using a recycling system that treats the wash water.

The technology of cleaning turfgrass equipment has been an ever-evolving science and art. There are several basic types of systems used today, including a simple hose on bare soil, some type of wash pad with or without collection of the wash water, and state-of-the-art recycling wash stations. The simplest systems often involve using a hose to wash off the clippings and any other debris from equipment and allowing the wash water to percolate into the ground. Concrete or asphalt wash pads are commonly used; sometimes they are covered for use during rainy weather, and they have some outlet for the wash water. Some users of this type have a screen to collect clippings so as not to clog the water discharge. The latest technology involves using enclosed structures with recycling systems that treat the wash water. Some of the systems collect clippings and employ biological and chemical treatment of the wash water, using technology that has been used for car washing. Golf course superintendents also have used compressed air to initially clean the clippings off mowers to reduce the amount of maintenance required for the grass-filtering system.

Which types of equipment washing systems are golf courses using? Are there laws regulating which type of system a golf course must use? What is in the wash water, and should there be a concern about where it is going? Cornell University was funded by the New York State Department of Environmental Conservation (NYSDEC) with USEPA Region II Peconic Estuary Program funding to answer these questions for the Peconic Estuary region of eastern Long Island, N.Y. The results provide insight into the topic and may be useful to other regions of the country.

REGULATIONS ON TURF EQUIPMENT WASHING AND WASTEWATER DISCHARGE

To answer the question about whether there are laws pertaining to turf equipment washwater systems and what happens to the discharge, we conducted a survey of several governmental agencies at the federal (USEPA), state

Table 1

Summary of current laws pertaining to turf equipment washing and discharge of wash wastewater.

Agency	Requirement for Washing Systems	Requirements for Wastewater Discharge Handling
USEPA	None at present	If the wastewater were to be discharged into a storm water runoff system* in small urbanized areas (population of 100,000 or more), then USEPA Storm Water Phase II rules (permitting and reporting requirements) may apply.
NYSDEC	None at present	If pesticides, oils/grease, and/or fertilizers were being discharged into a storm water runoff system, then this type of practice could be considered a point source of pollution and would require a storm water discharge permit. Discharge of wash wastewater with low concentrations of pesticides, oils/grease, and/or fertilizers onto the ground would not require a permit.
Suffolk County	None at present	None at present.
Local Towns	None at present	None at present, but issues of equipment wastewater disposal would be reviewed on proposed new golf courses during site plan review.

*Storm water runoff systems include surface water that enters draining ditches, storm sewers, streams, or other connected surface water bodies like wetlands, ponds, lakes, and estuaries.

(NYSDEC), and county (Suffolk) levels, and several local towns in the region (Riverhead, Southold, and Southampton). A summary of the information obtained is found in Table 1. In general, there are no local, county, state, or federal requirements for turf equipment wash pads or systems on golf courses or other turf operations at present, and none are being contemplated for eastern Long Island. None of the golf courses surveyed on the east end of Long Island had a permit required by USEPA or NYSDEC for its turf equipment washing wastewater discharge, even though it is possible that such permits may be needed as outlined in Table 1. It is advisable to check your state, county, and local towns for laws pertaining to turf equipment washing system requirements and rules relating to washwater discharge.

WHAT SYSTEMS ARE GOLF COURSES USING?

To determine the range of types and locations of commercially available wash pad technology used on eastern Long Island (and the northeastern U.S.), information was gathered from golf course superintendents on the east end of Long Island, wash pad equipment suppliers, and others as to the scope and nature of systems used. The information obtained included the type of washing equipment, where and how rinseate was handled, where and how clippings that were collected during washing were handled, the time required to wash equipment, and the costs associated with the system and/or maintenance of the system.

It was found that most of the 20 east-end Long Island golf courses that responded to the survey (out of 35 sent) use a low-tech equipment washing and wastewater disposal system. Seventy-five percent of the survey respondents reported washing equipment on an uncovered concrete or asphalt pad, and only 5 percent used a recycling type system. Only two did not discharge the wash wastewater onto the ground, to a dry well, grassy swale, or ditch. One course recycled and reused the wash water, while the other had the water held in a tank that was periodically pumped and removed from the golf course.

EQUIPMENT WASHING RECYCLING SYSTEM OPTIONS

We found six wash pads specifically designed for golf courses and turf settings. They are the Washmaster 36 by RGF Environmental Group, the Mi-T-M Biological Waste Water Treatment System, ESD Waste2Water Inc., Watermaze bioremediation system and carbon filter system, Wastech System, and the Carbtrol System. These systems take into consideration the large volume of clippings and associated pesticides generated during the wash cycle.

The Washmaster 36 (unit is 90 sq. ft., http://www.rgf.com/recycle_systems.cfm) is engineered for removal of herbicides, insecticides, and fungicides in addition to oils, solids, and grass. It is equipped with an auto-back flush system for the media, and polishing filters that help reduce maintenance. It is also equipped with an advanced catalytic oxidation system for organics. An aerobic digester reduces high BOD (biological oxygen demand) loading associated with golf and turf applications. The system uses a high-volume wash station for equipment washing. The process flow rate is 25 gpm, and the system capacity is 1,500 gallons. Filtered water delivery is 25 gpm at 50 psi. There is a single skid-mounted, scaled-down model for smaller operations (Washmaster 18 with a smaller footprint of 5 ft. × 10 ft. × 7 ft.). The Washmaster 36 costs about $30,000, and the Washmaster 18 about $20,000. Each unit requires a wash pad and/or a building for containment.

The Mi-T-M (http://www.mitm.com/, similar to the one sold by Great Lakes Cleaning Systems Inc., http://www.waterquip.com/wwbw.htm) is also designed for removal of herbicides, insecticides, and fungicides, in addition to oils, solids, and grass. This system can

be used to either recycle or discharge the wash wastewater. It needs a sump pit but does not require a specific type of wash pad. The process flow range is from 0 to 20 gpm, and it has a capacity of 890 gallons for the discharge system and 0 to 35 gpm and up to 2,244 gallons for the recycle system. Recycled water is ready for washing at 45 gpm on up to three hoses. The small unit costs about $9,000 as a discharge type and $15,000 as a recycling type. The largest system, a recycling type, costs about $30,000. Each requires a wash pad and/or a building to contain the unit.

The Carbtrol system (http://www.carbtrol.com) can provide 20-30 gpm of recycled wash water on a continuous basis. The Carbtrol system has the ability to handle wash water from a heavy equipment washday. This system also has up to 4 discharge hoses for multiple washing. Minimum space requirement for the treatment system is 10 ft. × 20 ft. for the small unit and 15 ft. × 25 ft. for the large unit. Operational costs involve chemical (peroxide) and carbon for water treatment at about $1,200 plus disposal cost of the spent carbon. Treated water storage capacity is 500 to 1,000 gallons. The larger system costs about $35,000 plus the cost of the pad and building. The smaller version is about $25,000.

The system from ESD Waste to Water Inc. (model 5000 GC-4, http://www.waste2water.com/) is a fixed-film wastewater recycle system. This system uses aerobic microbes for the breakdown of pollutants. Daily throughput for this system is 6,050 gallons, and it has 4 wash hoses at 14.6 gpm each. The system requires weekly additions of microbes ranging at about $20 to $40 per week. The footprint for the system is 16 ft. × 5 ft. × 5 ft. Smaller systems are available for a 9-hole course or low-maintenance operations. The cost for the equipment is about $35,000.

Landa (http://www.landa.com/pages/mainpage.asp) is the supplier for two types of systems from Watermaze, a bioremediation system for golf courses and a carbon filter system. The bioremediation system has a recycler and a sewer discharge model. Both models can treat wastewater at 50 gpm, but the recycler has a capacity of 1,500 gpd and the discharger 2,000 gpd. The carbon-based systems have a flow rate of 1-30 gpm, they are designed for small equipment, but they do not have holding tanks for recycled water. The bioremediation system costs between $20,000 and $30,000, depending on size. The carbon-based systems cost between $25,000 and $30,000.

There are other closed washpad systems on a much smaller scale that are not designed to remove or treat pesticides. Many are car-wash types that will discharge water to a common outlet. Examples of these types are: Wastech System (http://www.wastechengineering.com/products/rinse-water-recycle-systems.html) that removes emulsified oils, heavy metals, and contaminants by

Table 2

Types of turfgrass equipment washing systems and discharge of wastewater for 20 east end Long Island golf courses.

Golf Course Number	No. of Holes	Type	Type of Wash Area	Wastewater	Clippings
1	18	Public	Uncovered concrete pad	Drains to grassy swale	
2	9	Public	Uncovered concrete pad		
3	18	Public	Uncovered asphalt pad	Drains to dry well, discharged into ground	Composted
4	18	Private	Uncovered asphalt pad	Drains out to a lawn area	
5	9	Public	Uncovered concrete pad	Drains to a wooded area	
6	18	Private	Uncovered concrete pad	Drains to a ditch	Spread on roughs
7	18	Public	Covered concrete pad	Drains to a tank	
8	18	Semi-Private	Uncovered concrete pad		
9	18	Private	Uncovered concrete pad	Drains to a trough	
10	27	Private	Washes on course at quick couplers	Flows on the ground	Composted
11	18	Public	Uncovered asphalt pads	Drywell on one pad, grassy swale on the other	Spread on course
12	18	Private	Uncovered asphalt and concrete pad	Drains to a drywell, discharges into the ground	Composted
13	18	Private	Uncovered soil pad	Runs into the woods	
14	18	Private	Uncovered asphalt pad	Drains into a grassy swale	Composted
15	9	Private	Gravel driveway	Flows onto the ground	
16	18	Public	Uncovered concrete pad	Drains to ditch and grass area	
17	9	Public	Uncovered concrete pad	Drains to drywell, discharges into the ground	
18	18	Private	Uncovered concrete pad	Drains to two drywells, pumped out periodically	Spread on driving range
19	18	Private	Recycling system*	Water is collected, filtered, and reused	Spread on roughs
20	18	Private	Uncovered asphalt pad	Drains to ditch	

*Cost of equipment is about $35,000 plus the cost of the building, used 3 hours per day.

Table 3

The concentration of nitrate, ammonium, total phosphorus, and pesticides that were detected in equipment wash wastewater for three eastern Long Island golf courses.

GOLF COURSE I	Water Collection Site	Ammonium-N	Nitrate-N	Total Phosphorus
		mg/L		
	Hose	< 0.1	< 0.1	0.2
	Wash Pad	0.2	< 0.1	3.6
	Wash Pad	0.2	< 0.1	1.1
	Holding Tank	7.5	< 0.1	5.9
	Holding Tank	4.9	< 0.1	6.5
		Pesticides	**Concentration (ug/L)**	
	Hose	None detected		
	Wash Pad	Iprodione	85	
	Holding Pad	Chloropyrifos	2.1	
		Deltamethrin	2.3	
		Fenarimol	6.5	
		Iprodione	1,200	
		Propiconazole-a	4	
		Propiconazole-b	5.6	
		Vinclozolin	41	
GOLF COURSE II	**Water Collection Site**	**Ammonium-N**	**Nitrate-N**	**Total Phosphorus**
		mg/L		
	Hose	< 0.1	< 0.1	< 0.05
	Mower	0.6	< 0.1	13.0
	Mower	0.5	< 0.1	9.3
	Pipe	2.5	< 0.1	5.4
	Pipe	2.3	< 0.1	8.0
		Pesticides	**Concentration (ug/L)**	
	Hose	None detected		
	Mower	Chlorothalonil	5.2	
		Propiconazole-a	2.2	
		Propiconazole-b	4.0	
		Vinclozolin	2.5	
	Pipe	Chlorothalonil	4.5 & 6.1	
		Iprodione	12 & 14	
		Propiconazole-a	2.6 & 2.7	
		Propiconazole-b	4.3 & 4.4	
GOLF COURSE II	**Water Collection Site**	**Ammonium-N**	**Nitrate-N**	**Total Phosphorus**
		mg/L		
	Hose	< 0.1	2.5	< 0.05
	Mower	0.2	4.5	7.7
	Mower	0.6	4.3	1.9
	Wash Pad	2.7	0.5	2.8
	Holding Tank	13.0	< 0.1	8.1
		Pesticides	**Concentration (ug/L)**	
	Hose	None detected		
	Mower	Chlorothalonil	38	
		Deltamethrin	1.1	
		Propiconazole-a	110	
		Propiconazole-b	190	
		Vinclozolin	110	
	Wash Pad	Chloropyrifos	2.7	
		Deltamethrin	1.6	
		PCNB	0.5	
		Propiconazole-a	12	
		Propiconazole-b	18	
		Trinexapac-ethyl	0.5	
		Vinclozolin	1200	
	Holding Pad	Butylate	5.8 & 7.2	
		Chloropyrifos	35 & 44	
		Lambda-Cyhalothrin	nd & 2.6	
		Deltamethrin	71 & 83	
		Iprodione	10 & 13	
		PCNB	2.0 & 2.2	
		Propiconazole-a	32 & 55	
		Propiconazole-b	45 & 79	
		Trinexapac-ethyl	72 & 79	
		Vinclozolin	460 & 510	

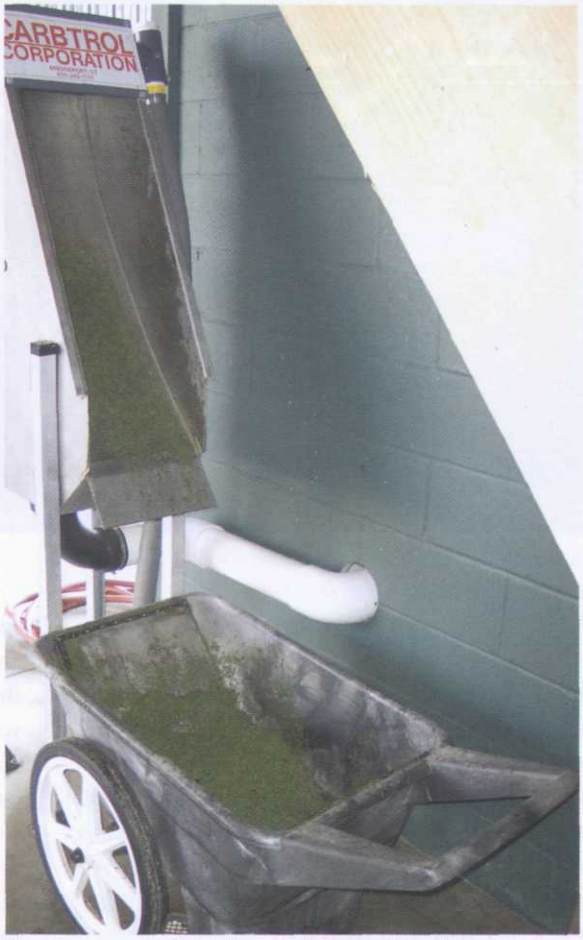
The hose sample was taken from the end of the hose. The mower sample was collected by placing the sample bottle under the mower as it was being washed. The wash pad sample was collected as the rinseate came off the pad. The holding tank sample was collected using a bucket that was dipped into the tank.

flocculation and forming a sludge system from Hydro Engineering Inc. (http://www.hydroblaster.com/).

EQUIPMENT WASH WASTEWATER QUALITY

The effectiveness of the range of equipment washing systems used on eastern Long Island golf courses on filtering potential toxicants (fertilizer nutrients and pesticides) was determined by collecting discharge water samples from three golf courses. Sampling was done on September 23, 2004. At each golf course the water used for washing was sampled. On two golf courses a sample of water was collected coming off a mower being washed. Water also was collected coming directly off the wash pad (all three golf courses) and at the collecting tank before discharge into the ground (on two golf courses). Duplicate samples were collected at some locations. Pesticides were collected in 1L glass bottles, 250ml plastic bottles for ammonium, and 120ml plastic bottles for total phosphorus and nitrate. The water was analyzed for nutrients (nitrate-nitrogen, ammonium-nitrogen, and total phosphorus) and for 28 turfgrass pesticides (chloroneb, chlorothalonil, chlorpyrifos, cyfluthrin, DCPA, deltamethrin, diazinon, dithiopyr, ethofumesate, ethoprop, etridiazole, fenamiphos, fenarimol, fenoxaprop-ethyl, flurprimidol, flutolanil, iprodione, isofenphos, myclobutanil, pendimethalin, pentachloronitrobenzene, propiconazole isomer a and b, trichlorfon, trifluralin, trinexapac-ethyl, vinclozolin, and lambda-cyhalothrin) by GC/MS method EHL S150 used by Environmental Health Laboratory, South Bend, Indiana.

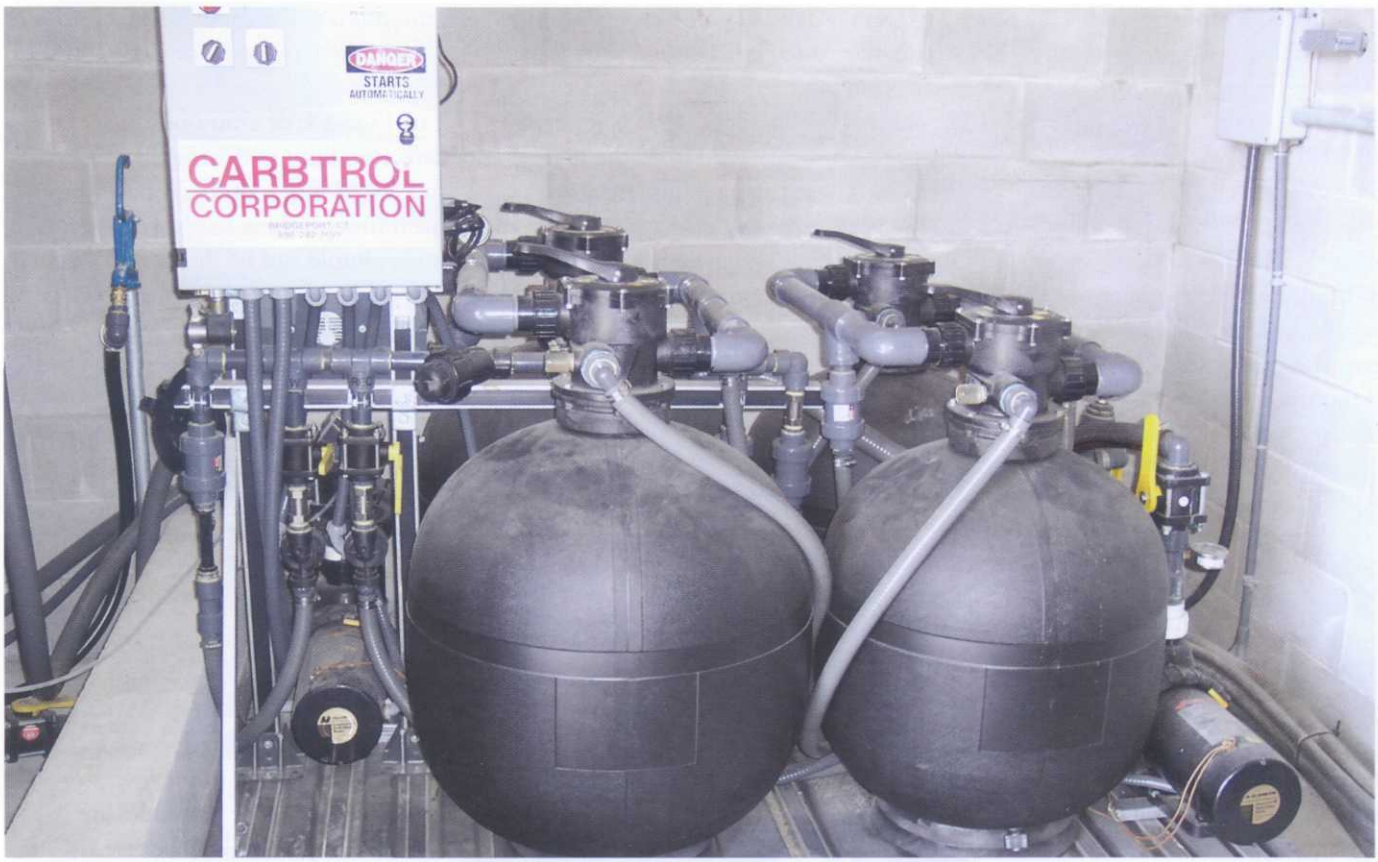
Table 3 contains the testing results of water collected at each of the three golf courses. Golf Course I had a covered concrete pad that did not collect clippings and drained to a holding tank that discharged into the ground. Golf Course II had an uncovered asphalt pad that drained into a ditch. Golf Course III had an uncovered concrete pad that screened out clippings and drained to a holding tank that is periodically pumped and removed from the golf course. These three equipment wash systems covered the range of wash water discharge systems found on golf courses on the east end of Long Island.



Clippings screened and deposited in a cart for disposal.

This study is considered somewhat preliminary since only three golf courses were sampled just one time. Therefore, caution should be taken from this in interpreting data on how much of an impact turfgrass equipment washing has on the environment. Nevertheless, there were some interesting findings. The water used to wash equipment at all three golf courses did not have any pesticides or ammonium detected, but in one case there was a small concentration of total phosphorus and nitrate. For nutrients (ammonium, nitrate, and total phosphorus), the concentrations in the water being discharged onto (Golf Course II) or in the ground (Golf Course I) were low, ranging from 2 to 13 mg/L of ammonium, below detection limit (<0.1 mg/L) of nitrate, and 6 to 8 mg/L of total phosphorus. Even though these levels are low, wash water should not be discharged directly into surface waters or a deep well. The USEPA sets a limit of 0.1 mg/L of total phosphorus in storm water as a level that could lead to nuisance plant growth. The concentration of fertilizer nutrients coming directly off the mowers was small, < 1 mg/L of ammonium, < 5 mg/L of nitrate, and < 14 mg/L of total phosphorus. Golf Courses I and III have holding tanks and have elevated ammonium and total phosphorus levels in the holding tank compared to what is coming off the wash pad or the mowers.

The results for pesticides are interesting. For Golf Course II, three pesticides detected were found coming off the mower as well as leaving the wash pad in the drainpipe. Chlorothalonil had been applied to greens 15 and 24 days before the sample was taken and to tees and collars 6 days before the sample was taken. Iprodione had been applied to fairways 16 days before sampling and to greens 24 days before sampling. Propiconazole was applied to greens 9 days before the sample was collected, and vinclozolin had not been applied in one month. The pesticide application equipment is not washed at the equipment wash pad. In contrast, Golf Course III had been washing the pesticide application equipment on the wash pad when the samples were taken, and the four pesticides that were detected coming off the mower were applied two days before the samples were taken. When pesticide application equipment is washed where other maintenance equipment is being washed, high concentrations of at least one pesticide were found coming off the wash pad



Biological processing of washwater.

and in the holding tank. This was also true for Golf Course I, which washed its pesticide application equipment and had a high level of iprodione in the holding tank. It also is interesting to note that for Golf Course I, small amounts of some pesticides (chlorpyrifos, propiconazole, and vinclozolin) were detected in the holding tank but had not been used on the golf course since before 2001.

The limited results of this study do suggest that equipment wash water can contain low levels of nutrients and pesticides. However, if pesticide application equipment is washed with these systems, the wastewater could be very high in pesticides. Therefore, pesticide application equipment should not be cleaned using the same wash pad unless a recycling system that removes pesticides is used. For equipment wash water, it is advisable to either recycle it, have it put through some type of treatment system to remove pesticides (carbon or biological), or allow it to be filtered in a grassy swale (not close to sensitive environmental areas) that can filter out the contaminates. The equipment wash water should not be discharged into any surface water body (pond, stream, lake, or reservoir) or into a deep well that could contaminate groundwater.

CONCLUSIONS

Currently there are no local, county, state, or federal requirements for turf equipment wash pad or systems on golf courses on eastern Long Island or other turf operations, and none are being contemplated as long as the wash wastewater is not discharged into storm water systems or deep well groundwater. The east end Long Island golf courses used low-tech equipment washing and wastewater disposal, with 75% of the survey respondents washing equipment on an uncovered concrete or asphalt pad, and only 5% using a recycling type system. We found there are six washpad-recycling systems specifically designed for golf courses and turf settings. The limited results of this study suggest that equipment wash wastewater can contain low levels of nutrients and pesticides. However, if pesticide application equipment is washed with these systems, the wastewater could be very high in pesticides that were applied recently. Therefore, pesticide application equipment should not be cleaned using the same wash pad unless a recycling system that removes pesticides is used. For equipment wash wastewater, it is advisable to either recycle it, have it put through some type of treatment system to remove pesticides (carbon or biological) or allow it to be filtered in a grassy swale (not close to sensitive environmental areas) that can filter out the contaminates.

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