TRICK OR "TREAT": WHY TREATMENT BMP PERFORMANCE IS IRRELEVANT FOR INDUSTRIAL STORMWATER AND WHAT WE CAN DO TO MAKE CLEAN WATER THAT MATTERS.

"trick or treat?" The "trick" is a (usually idle) threat to perform mischief on the homeowners or their property if no treat is given.(Wikipedia)

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ABSTRACT

The basic premise of this report is that the structural treatment BMPs that are found across the country on BMP menus and approval lists, generally serve no value to industrial sites in terms of reaching permitted effluent limits. Typical treatment BMPs offer black box style of treatment and operation which does not give the designer and operator the flexibility they need to control the unit processes at work. Two stormwater treatment train designs are described that have removed dissolved metals successfully, and provided attractive cost and risk factors site owners. We promote the separation of the design paradigms - the BMP based one that works for general land development, and a unit process and treatment train methodology decoupled from the BMP device market.

INTRODUCTION

In 1990, the US promulgated Clean Water Act Amendments which are ultimately the framework for current stormwater regulation. A regular land development feature that sprouted from those rules was the many thousands of manufactured water quality structures, or treatment control BMPs (treatment BMPs) that state removal efficiencies of 80% of pollutants. The removal efficiencies have invariably used total settleable solids (TSS) as a surrogate of total pollutants and therefore target a certain particle size, or assume a particle size distribution (PSD). Both the local jurisdictions and the EPA who approved the approaches were content with accepting stated BMP removals, since water monitoring programs are inherently complicated and expensive for both owner and regulator. For industrial NPDES permittees, though, it's a different story; they must sample the effluent, and they face exorbitant risk with exceeding permit limits; so it is a very different environment for the industrial water quality practitioner.

As of 1999, EPA's Phase II required communities to implement stormwater management plans with "six minimum control measures"[1]. Of which, treatment BMPs are a subset of one of the measures. The Phase II architecture laid the framework for communities to continue developing with BMP-based stated efficiencies, but also foresaw the evolution to low impact development BMPs. But little has evolved since the first implementations of industrial stormwater permitting, except that the discharge limits have tended to shrink to background levels.

[1] The Six Minimum Control Measures contain types of BMPS, such as 1 Public Education, 2 Public Involvement, 3 Illicit Discharge Detection & Elimination, 4 Construction, 5 Post-construction (Development), 6 Pollution Prevention/Good Housekeeping (Municipal).

INDUSTRIAL STORMWATER REGULATION

As part of the 1990 federal rules, ten categories of industrial activity were regulated under 40 CFR 122.26(b), and subsequent revisions applied to the industrial activities in municipalities of less than 100,000 under 40 CFR 122.26(e)(1)(ii). Facilities within the ten categories are classified using either their Standard Industrial Classification (SIC) or narrative descriptions. The EPA has defined industrial activity to include manufacturing, processing or raw material storage areas. Generally, these definitions do not include wholesale, retail, service or other commercial facilities.

The EPA regulates industrial facilities with the Multi-sector General Permit (MSGP), which is used for the general industrial permit for a number of states. To receive a permit a facility must develop a stormwater pollution prevention plan (SWPPP), employ a combination of operational, structural and treatment BMPs, and then monitor and evaluate the performance of treatment BMPs by comparing effluent results against benchmark goals. The MSGP applies directly to facilities in only 5 states[2]. In the other 45 states, EPA has delegated responsibility to the state regulators. Most states use the MSGP as a framework for the state specific permit, however there is a wide variance in regulatory requirements from state to state.

The MSGP was re-issued in 2008 with significant reduction for benchmarks for the ubiquitous metals, copper and zinc, often found as dissolved ions or complexes. The 2008 benchmarks for the metals zinc and copper are hardness based resulting in levels as low at 0.0038 mg/L and 0.04mg /L for copper and zinc respectively[3]. These levels are challenging targets for advanced wastewater treatment systems and not remotely achievable using basic ‘suspended solids’ removal BMPs.

TREATMENT BMPS AT INDUSTRIAL FACILITIES

Often due to the overlapping regulation of stormwater and spill containment control and countermeasure (SPCC) rules, many industrial facilities installed basic oil water separators as both stormwater pre-treatment and spill containment volume for oil. Oil water separators general design criteria was described by American Petroleum Institute (API) Technical Bulletin # 421. Much of the criteria for design of oil water separators is based on physical geometry (i.e. number of baffles, flow separation, etc) and no performance specification. Subsequently as water quality professionals evaluated performance against benchmark criteria, they often found the performance of oil water separators to be inadequate. In parallel to these adaptive management techniques at industrial sites, post-construction best management practices were being tested for qualification programs in the commercial market place, including the Washington Department of Ecology, New Jersey Center for Advanced Technology and Environmental Technology Verification (ETV).

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[2] USEPA, NPDES Industrial MSGP, September, 2008.
[3] USEPA, NPDES Industrial MSGP, September, 2008, updated May 2009

Industrial sites began seeing installations of treatment BMPs in part since there were performance claims available being widely accepted by NPDES authorities. These treatment BMPs typically included hydrodynamic devices, extended detention, wet vaults, and filtration systems. The problem with this scenario, is that the practice of designing treatment BMPs based on stated TSS removal performance, does not approach the level of detail needed to design adequate treatment for an industrial site. In other words, treatment BMP's stated performance is practically irrelevant to industrial stormwater designing. Here is an example that applies to typical treatment BMPs that utilize the unit treatment process of settling. The basis for performance claims is typically the removal of a select PSD in a controlled environment. The odds that the stated performance will match the results at an industrial site, with respect to either the TSS characterization or the discharge limits are low[4]. So even where a settling process may be an absolute prerequisite for an industrial site's treatment train, a typical treatment BMP device is likely to be a bad match for that process - because of particle size discrepancy and O&M mismatches. BMP devices are generally designed for poor access and to be operated automatically and cleaned once a year - a one size fits all approach not suited to industrial sites.

A SIMPLE MISMATCH

The above differences in need between industrial treatment BMPs and typical treatment BMPs has become muddled in the design and regulatory sectors over the last decade. In general, treatment BMPs are not well suited to industrial facilities for several reasons. First, industrial stormwater tends to have higher concentrations of pollutants than commercial facilities[5],[6] – Second, many jurisdiction's approvals of treatment BMPs while based on actual performance data, the approved TSS or PSD factors do not reflect the pollutants or the treatment. Third, given that is assumed, their design and O&M do not favor inspection and monitoring procedures and do not adapt well to an industrial site's SWPPP process. Even when a treatment BMP alternative can meet an industrial sites unit process requirements, typically that treatment BMP is so oversized to make other custom designs more feasible.

Fundamentally the post-construction runoff BMP industry led regulators, designers and suppliers to approach treatment as a single 'black box'. The 'black box' approach meant that the proposed design had been tested and approved which provided a certain level of confidence of performance. This approach violates the most basic tenants of environmental and process engineering in that one must select a design criteria and select unit operations or processes that will achieve the performance design criteria. Selecting a generic performance criteria without a site specific design criteria is simply a bad idea.

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[4] Based on these designers experiences with monitored industrial sites.

[5] Minton, Gary, *Stormwater Treatment,* Resource Planning Associates, Seattle, WA, 2002

[6] Herrera Environmental Consultants, "Evaluation of Washington's Industrial Stormwater General Permit", Washington Department of Ecology, November 2006.,

AN ENVIRONMENTAL ENGINEER'S PERSPECTIVE

It is generally accepted and becoming more so on purely economic terms, that the best way to manage industrial stormwater is through the use of source control BMPs. Nevertheless most sites cannot practicably implement enough source controls to forgo installing treatment systems. As stated above the environmental engineer selects a design criteria that includes site specific influent and effluent requirements, maintenance and cost.

When considering treatment alternatives and the site stormwater characterization for industrial stormwater, the stew of oil, dirt (TSS) and metals, represents an extreme challenge where strict effluent limits are in play. Common pollutant sources include hydraulic oil from equipment and rolling stock; tire and brake dust from vehicles; vehicle washing, fueling, maintenance and repair; and galvanized roof runoff.

With a site specific characterization, the designer should be led to a treatment train of unit processes as the most efficient solution. For example, assuming a dissolved metals removal scenario, options include adsorption, precipitation and/or filtration. Working back upstream to the TSS and oil, these contaminants clog adsorptive filters. In this case we must select a robust treatment train to protect the final process, normally an expensive investment. Hence, in our experience a successful approach for industrial treatment train is to remove oil, TSS and then dissolved metals.

CASE STUDIES

Metal Recycling Facility

To those that much is given, much is expected. John F Kennedy

In our eco-conscious age, recycling is an important facet of environmentalism, however for many, recycling ends at the curb. Recycling businesses are innovating the sorting and material handling processes, but it is an inherently low margin and large space activity. In particular metals recycling facilities are tasked with recycling some challenging items such as cars, refrigerators, turnings or borings, etc.

The facilities are often of significant size have many exposed materials which can be dirty, oily and are by their nature made of metals. This results in stormwater which contains elevated concentrations of oil, suspended solids and metals.

The first facility we consider is located in the pacific northwest, along the Duwamish waterway in urban Seattle (Figure 1). The facility is comprised of approximately 2.5 acres, and began operations there in 2008. The facility's owners being lifelong residents of Seattle had a strong commitment to environmental quality and especially to the Duwamish waterway, known for historic impairment. As they prepared to begin operations at the new facility on the Duwamish, they engaged environmental engineers to design upgrades to the site to meet stormwater requirements. The facility recycles metal, automobiles, white goods (refrigerators / washers) and general bulk ferrous and non-ferrous scrap. Their sister operation has been connected for many years to the sanitary sewer system, so it was adequately served by a basic oil water separator.

While this was a new facility and there was limited stormwater quality data, experience at other metal recycling facilities has shown to expect significant concerns with water quality as illustrated in Table 1.

Table 1: Typical Metal Recycling Facility Stormwater Quality

	Influent Design Basis	
Parameter	Mean (mg/L)	Maximum (mg/L)
Total Zinc	0.88	6.41
Total Copper	0.91	5.95
Total Lead	0.17	2.83
Total Iron	1.61	32.4
Total Suspended Solids	160	500
Turbidity	66.7	320
pH	6.8	n/a
Oil and Grease	22.0	73.4

Source: Aquarius Environmental Internal Data – 4 Metal Recycling Facilities

Based on years of experience with similar influent and effluent conditions a treatment train was designed, focused first on free floating oils, next suspended solids and then dissolved metals. The selected treatment train as shown in Figure 2 included trapped catchbasins(1)to remove gross sediment and trash, conventional coalescing oil water separator (2) to remove oils, followed by a lift station(3) to a surge / settling tank(4) to remove finely suspended solids, followed by an enhanced sandfilter that employs sand, zeolites and carbon media to remove particulate and dissolved metals.

As part of permit requirements the facility regularly samples only the effluent, however several influent samples were shown to be consistent with the assumed design basis. A photograph of an inlet and outlet sample pair from a recycling facility is shown in Figure 3. A summary of the average effluent data is shown in Table 2.

Table 2 – Average Stormwater Treatment Train Effluent Data

	Effluent
Parameter	Mean (mg/L)
Total Zinc	0.063
Total Copper	0.029
Total Lead	<0.005
Turbidity	8.5
pH	6.8
Oil and Grease	<5

Source: Aquarius Environmental Internal Data

After nearly two years of operation, the facility routinely meets benchmarks and was successful such that a ‘copy’ of this treatment train was ordered and installed by a similar facility also in the pacific northwest. The cost per acre of the treatment train as installed is approximately $50,000. This is roughly 2 times higher than one may expect to treat a commercial site with a BMP-based with no effluent monitoring requirements.

Galvanizing Facility

There are those in the environmental community who state “There is no such thing as pollution, only resources in the wrong place at the wrong time”. Robert Hoehn

Another case study is a hot dip galvanizing facility located in the Pacific Northwest,on approximately 7 impervious acres. The bulk of the facility's stormwater is conveyed to a detention pond and discharged. While the bulk of material processing occurs indoors, and many source control BMPs are in place, the facility had difficulty reducing zinc concentrations below benchmark targets.

An alternatives analysis was conducted which evaluated industrial stormwater treatment solutions such as enhanced sandfilters and precipitation (electrical coagulation) both being ruled out because zinc concentrations were so elevated (as much as 10X other industrial facilities) . Un-conventional options such as ion exchange were also evaluated. These options had high operations and maintenance costs that made them unattractive.

Subsequent discussions with the equipment supplier for an onsite process wastewater acid recovery system, led to piloting of a combination of reverse osmosis and nanofiltration to remove and concentrate zinc from the stormwater and return it as a process additive. This system would appear at the extreme of the unconventional until recently. The reality of the costs and effectiveness of conventional practices is opening the door to creative designing on many fronts. This system recycles ‘pollutant’ metals into the process baths, reduces raw water consumption, minimizes the discharge of overall flows, and dissolved metals, and reduces environmental risk to the maximum extent. The environmental stewardship benefits are not quantified, but purely on economic terms, the system costs less than the alternatives which solely removed the dissolved metals.

FIGURES

Figure 1. Metal Recycling Facility – Aerial View

Figure 2 – Metal Recycling Facility Treatment Train

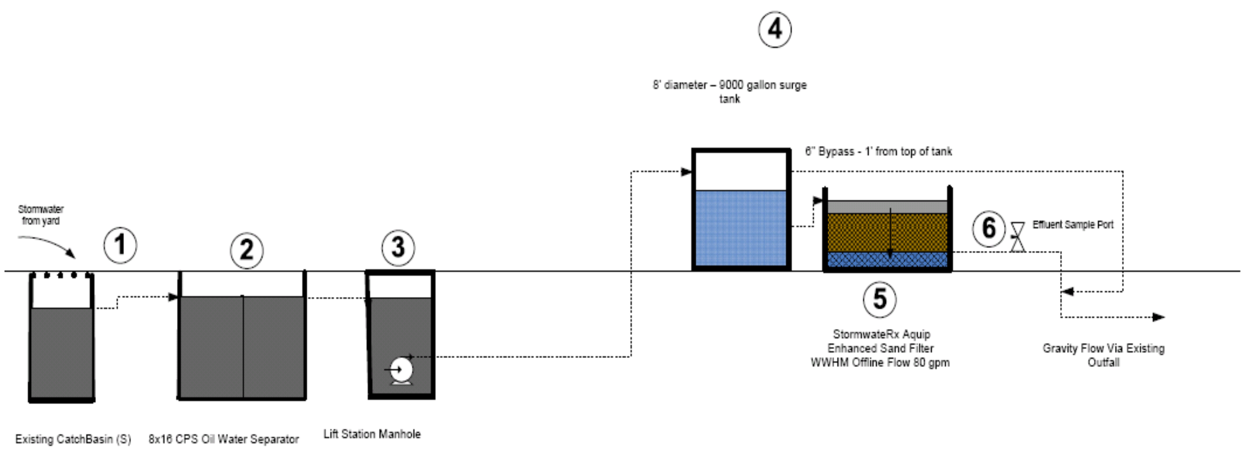

Figure 3 – Representative Inlet(R) and Effluent (L) Pair

SUMMARY

When challenged with an industrial site close the BMP manual and offer the owner and public the trick and the treat. Meet the effluent limits and reduce relative costs and environmental risks. There's good potential to provide both stakeholders added value such as water recycling or many other synergies to explore.

ABOUT AQUARIUS ENVIRONMENTAL,LLC

Aquarius Environmental is an engineering and consulting firm specializing in water related design, treatment, and compliance. We bring innovative solutions to a variety of complex problems while maintaining a high level of personal service with integrity and efficiency.