Dual Media Filtration System for Reducing Pollutants in Storm Water Runoff

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Outline

- Background
- Dual Media Treatment Technology Demonstration
- Technology Transition

Background

- The Navy is required to self-monitor their storm water discharges, identify and install best management practices (**BMPs**) appropriate to their facilities.
- The EPA is establishing guidelines for total maximum daily loadings (**TMDL**) for impaired water bodies. This will result in stricter discharge limits being placed on Navy storm water discharges.
- Navy industrial activities and other DoD components will be forced to implement storm water treatment systems in order to comply with stricter permit requirements.

Background

Navy industrial sites have limited real estate and limited resources.

The ideal storm water treatment system concept should:

1. Have a low capital cost
2. Be easy to install
3. Require little land area
4. Be inexpensive to maintain
5. Enable sites to comply with permit requirements

Storm Water Treatment Technology Demonstration

Project Approach

- Identify Navy industrial site storm water runoff permit requirements.
- Analyze storm water runoff characteristics.
- Evaluate commercially available structural BMP treatment technologies.
- Demonstrate new storm water treatment technology to address Navy industrial site specific requirements.
- Transition technology.

Navy Site Specific Storm Water Permit Requirements

The Naval Regional Recycling Center (**NRRC**) was selected because they must comply with an order from the California Regional Water Quality Control Board (**CRWQCB**) that requires them to:

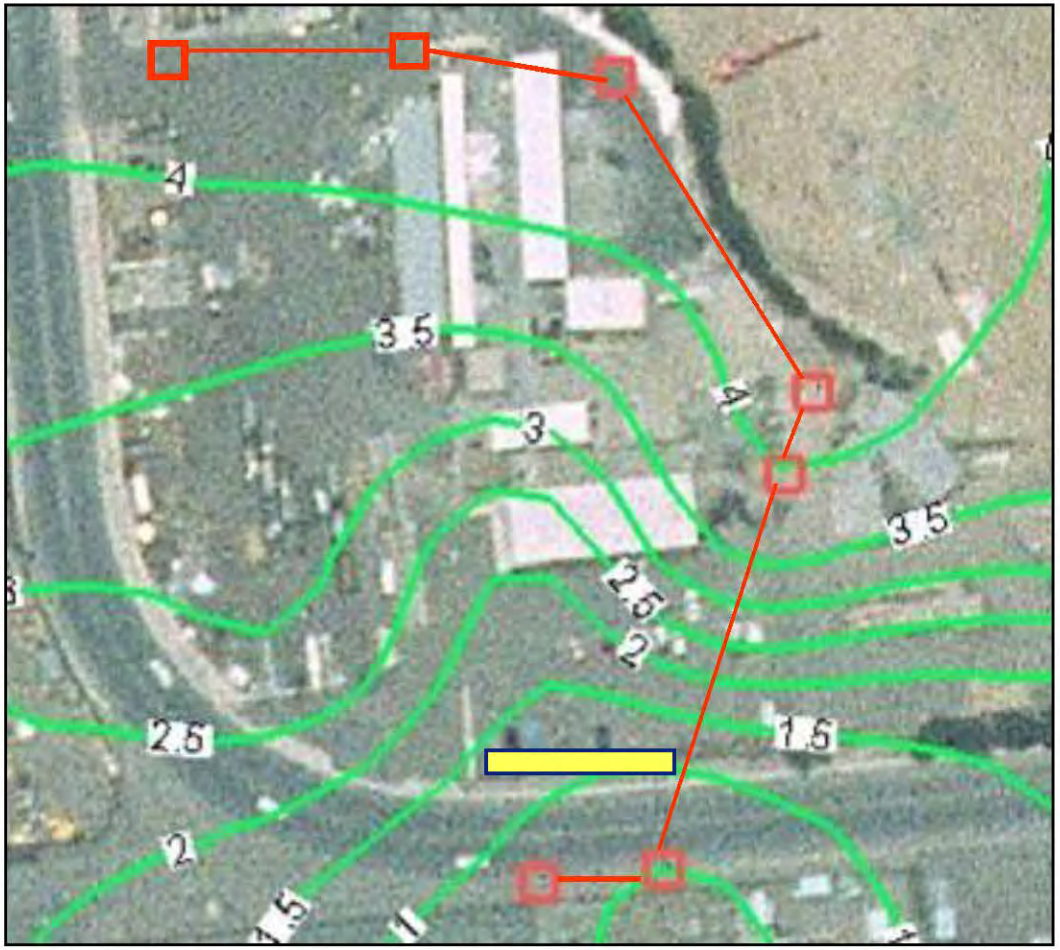
(1) pass a 96-hour acute toxicity test,

(2) reduce copper discharges to less than 63 ppb, and

(3) reduce zinc discharges to less the 117 ppb.

In the past, NRRC discharges significantly exceeded the metals discharge limits and failed the toxicity tests.

Naval Regional Recycling Center (NRRC) San Diego



Location of demonstration

Storm drain system

Location of Test Site

Previous Method of Handling Storm Water Runoff at NRRC

Characterize Storm Water Runoff

Simulated Rain Event at NRCC

Storm Water Runoff from Simulated Rainfall Event

Metals	Runoff Level (µg/L)	Hydrant Level (µg/L)	Permit Limit (µg/L)
Antimony	138	7	
Arsenic	18	ND	168
Beryllium	ND	ND	
Cadmium	136	ND	15.9
Chromium	102	ND	
Copper	3,350	5	64
Lead	1,200	5	82
Mercury	ND	ND	2.4
Nickel	245	ND	1417
Selenium	14	6	238
Silver	4	ND	32
Thallium	ND	ND	
Zinc	6,860	169	117
Aluminum	19,900	9	750

Evaluate Available Structural Best Management Practices

- Compliance with the CRWQCB order will require a significant investment by the Navy.
- Commercial off the shelf (**COTS**) technologies are expensive. (> $57K per acre of drainage area)
- COTS technologies have not reliably passed toxicity test.

Evaluate Available Structural Best Management Practices

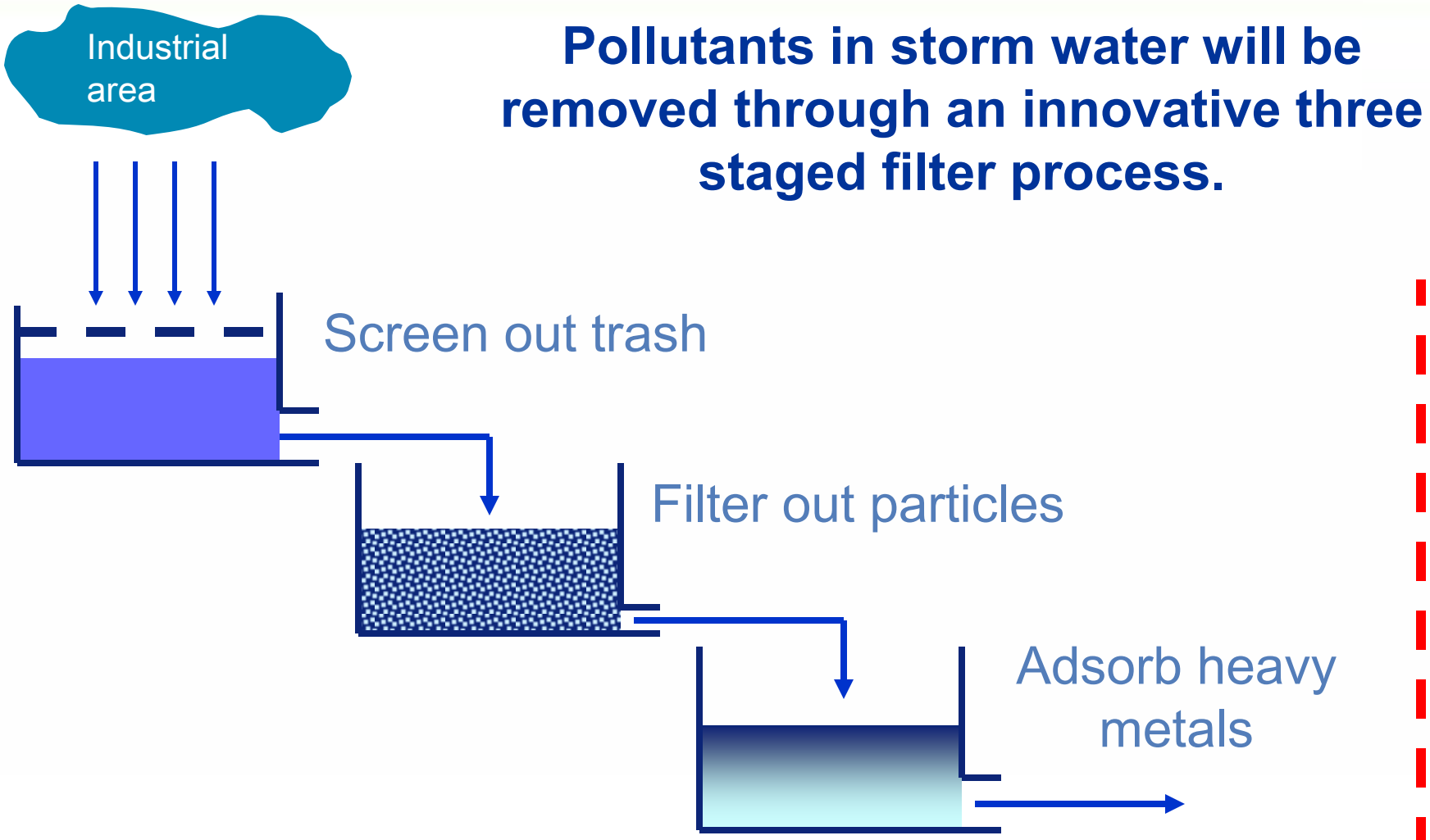
Large scale StormWater Management, Inc. Installation

This 165 cartridge SMI installation at NASSCO costs $530K

Storm Water Treatment Technology Demonstration

NFESC developed and tested a storm water runoff treatment system that meets the stated Navy industrial site requirements. The system is similar to a sand filter. However, instead of using sand as the filter medium, heavy metals from storm water are removed by flowing the runoff through a bed of special filter-adsorption materials.

Storm Water Treatment System Overview



Adsorption Media Tested

Organic Materials	Active Minerals	Inert Minerals	Proprietary Materials	Others
Loose peat moss	A-400 activated alumina	Perlite	Forager sponge cubes	Iron chips and filings
Hardwood chips	FS-50 activated alumina	Washed plaster's sand	Dynaphore granules	Sodium alginate beads
Bone char	DD-2 activated alumina	Washed concrete sand	Ancor M-20/80 zero valence iron	geotextile
Anthracite	Chabasite	Washed well-packing gravel	Stormwater Management Metal Rx	
Sulphonated peat moss	Manganese green sand		Environmental H20, LLC White Karbon	
	Ilmanite			
	Glauconite			

Treatment Media Test Stands

Test Column Setup

Dual Chamber Test Device

Tanks hold runoff water from NRRC; cylinders contain filter/adsorption media

Media Selection

The performing media selected are: activated alumina with surface coating of iron oxide and bone char. Both are readily available and inexpensive.

- **Bone char** is used to adsorb heavy metals, fluorides, and iron .
- **Activated alumina** is commonly used to remove arsenic and fluoride.

1/20th Scale Model Test Setup

Scale model installed at NRRC

1/20th Scale Model Treatment Test Results

Metal	Influent mg/L	Effluent, mg/L	Permit Limit, mg/L	Detection Limit, mg/L
Aluminum	.330 - .860	ND - 0.100	.750	0.04
Cadmium	ND - .012	ND	.0159	.008
Chromium	ND - .018	ND	.020	.008
Copper	1.90 – 4.70	ND – 0.021	.064	.006
Iron	3.00 – 8.20	ND – 0.170	1.0	.008
Lead	0.150 - .360	ND	.082	.014
Zinc	.680 – 1.70	ND – 0.041	.117	0.01

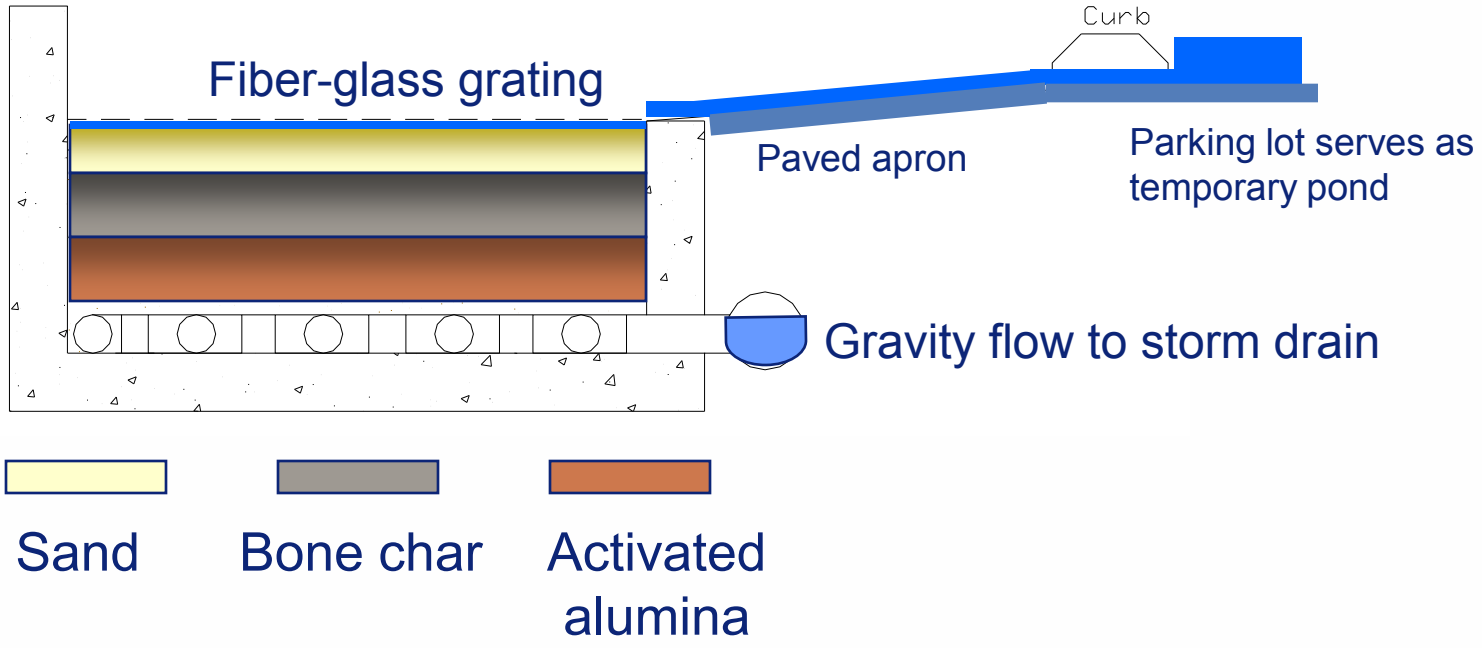
Test Method EPA 200.7

Below practical detection limit - ND

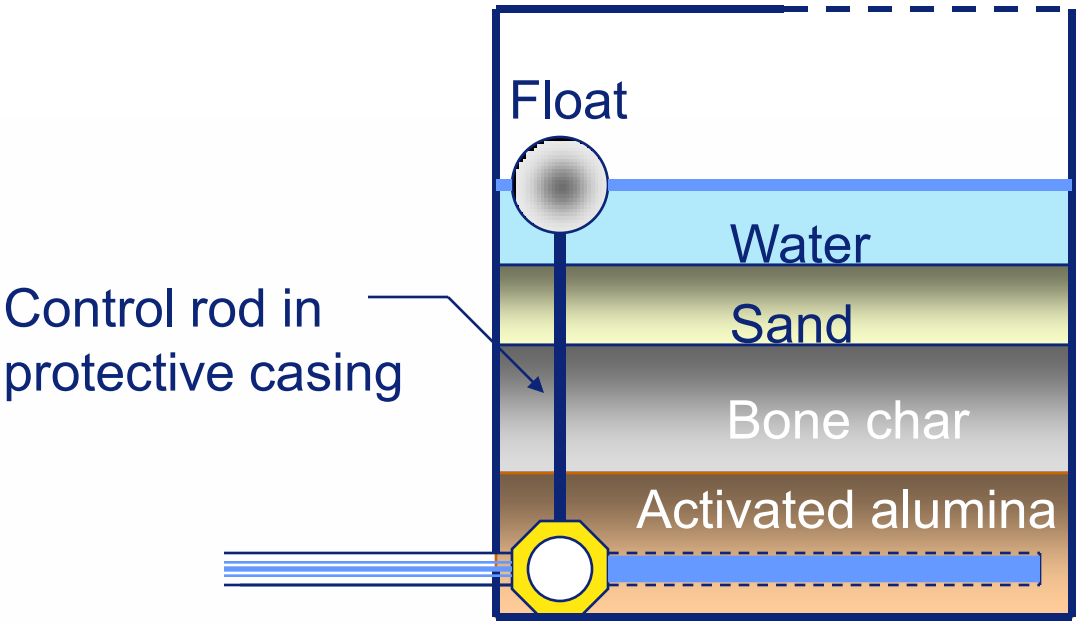
Basic Design Overview

Porous pavement curb acts as coarse filter

Pre-cast concrete vault



Cell Water Level Control

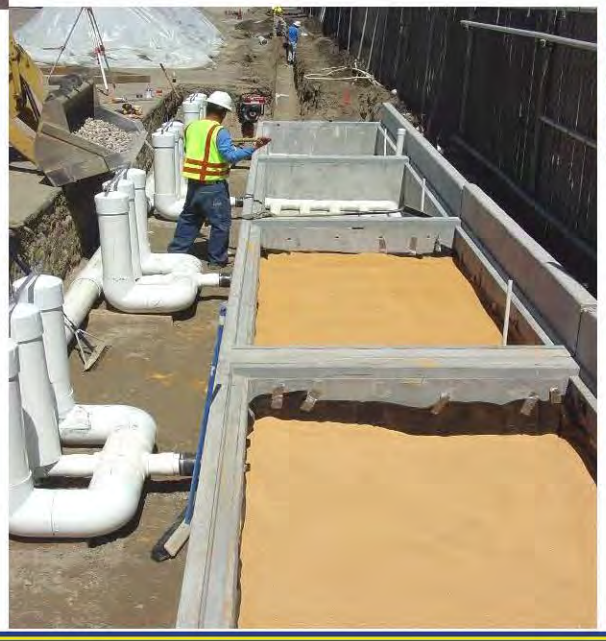


Direct lift gate valve

Mechanical Level Control Valve

Containment Cell Installation

Drain Manifold Installation



Backfilling and Pouring Concrete

Sampler and Instrumentation Shed

- Samples are taken from influent and effluent.
- Takes first flush and composite samples.

Completed System

- Installation completed 4/22/2005.

Results

Date	Total Rainfall (inches)	First Flush Intensity (in/hr)	Survival 100% Concentration (%)	First Flush Influent/Effluent Cu (µg/L)	Cu % Removal	First Flush Influent/Effluent Zn (µg/L)	Zn % Removal
3/28/06	0.35	0.17	95	1170 339	71	1480 343	77
4/14/06	0.16	0.07	85	550 201	63	981 711	28
4/23/06	0.11	0.08	60 [3]	351 228	35	1270 913	28
5/22/06	0.60	0.4	90	987 397	60	2620 1140	57
10/16/06 [1]	0.40	0.06	45 [4]	1070 401	63	4810 1330	72
1/29/07	0.85	0.11	85	488 85	83	1960 277	86
2/18/07 [2]	0.9	0.06	100	307 63	79	1170 180	85
2/22/07	0.2	0.19	100	143 29	80	572 102	82
2/27/07	0.24	0.07	97	356 34	91	1870 167	91
3/22/07	0.06	0.25	100	335 81	76	928 222	76
4/20/07	0.53	0.18	100	342 88	74	1260 251	80

Results

	Influent / Effluent, Average Event Mean Concentration (µg/L) [1]						
Date	**Al**	**Cd**	**Cu**	**Fe**	**Pb**	**Ni**	**Zn**
2/18/2007	893 / 141	10 / 1	150 / 24	1229 / 219	43 / 5	11 / 2	561 / 74
2/22/2007	651 / 92	7 / 1	116 / 20	826 / 106	28 / 2	9 / 3	515 / 71
2/27/2007	952 / 220	13 / 2	181 / 29	1242 / 285	51 / 5	14 / 3	865 / 129
3/22/2007	3180 / 265	11 / 3	335 / 81	5350 / 524	66 / 9	29 / 8	928 / 122
4/20/2007	739 / 142	7 / 1	210 / 45	1084 / 208	38 / 5	15/ 3	738 / 113
Last 5 Storm Events Efficiency Ratio	1283 / 172 (87)	10 / 2 (83)	198 / 40 (80)	1946 / 268 (86)	45 / 5 (88)	16 / 4 (75)	721 / 122 (83)

1. ER in parenthesis.

Other Applications

Other Applications

Potential Sites

- **Industrial areas**
  - Recycling Centers
  - DRMOs
  - Drydocks & Boatyards
  - Maintenance Facilities
  - Storage yards
  - Facilities with copper gutters, galvanized roofs & fences.

Benefits

1. Enable sites to comply with permit requirements.
2. Treatment system has a low capital cost. ($20,000 per acre of watershed)
3. Virtually no operational/maintenance costs.
4. Requires little land area.
5. Installation similar to other commercially available systems.

Technology Transfer

- Technology is patented and will be commercially licensed.
- The NAVFAC-ESC Technology Integration Team is actively identifying potential user of this technology.
- NAVFAC-ESC has published project results.

Publications

Publications:

•R.E. Kirts, M.E. Foreman, and G.D. Anguiano, *Removal of Toxic Metals from Storm water Runoff at Naval Installations*, NAVFAC Technical Report TR-2256-ENV, November, 2004.

• G.D. Anguiano, and M.E. Foreman, *Low Impact Technologies to Reduce Pollution from Storm Water Runoff*, NAVFAC Technical Report TR-2300-ENV, September, 2008.

•R. E. Kirts, et. al., *METHOD AND MATERIALS TO REDUCE POLLUTION CAUSED BY COPPER, ZINC, AND OTHER METALS IN WASTE WATER , Patent application,* November, 2004,

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