WATER QUALITY SAMPLING RESULTS FOR DILLON'S CREEK MARINA HULL WASH WASTEWATER TREATMENT SYSTEM EVALUATION

Site Location:
Dillon's Creek Marina
240 Lake Ave
Island Heights, NJ 08732

Sponsored by:
I Boat New Jersey Program
New Jersey Department of Transportation

Prepared By:
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1.0 Introduction

During the fall of 2007, Najarian Associates (NA) was retained by Dillon's Creek Marina to conduct water quality sampling services intended to evaluate the performance of a hull wash wastewater treatment system installed by Water Maze. This system employs electro-coagulation process to remove the hull wash water contaminants. The project is being funded by the I-Boat New Jersey Program. A Water Maze EC1-300A treatment system was provided by the manufacturer and installed at the Dillon's Creek Marina site in December 2007. The first sampling event was conducted on December 10 and 11, 2007, when five (5) rounds of samples were collected from various locations within the treatment system to analyze the influent, effluent, and recycled wastewater characteristics. Based on the results of the laboratory analysis, a number of recommendations were made to improve the treatment system performance so that the treated effluent meets the local sanitary discharge requirements. The evaluation study was deferred until the next season in 2008.

In 2008, Dillon's Creek Marian received an offer from Oil Trap to evaluate the performance of Oil Trap's Electro Pulse treatment system. This second system was installed at the site toward the end of 2008 boat wash season. Both treatment systems' performances were evaluated through new rounds of sampling during the 2008 boat-wash season. This report contains the performance evaluation sampling results for the above-referenced treatment systems.

2.0 Water Maze Treatment System

Water Maze installed an EC1-300A treatment system through its local representative Aqua Tech. The treatment system contains a primary settlement tank that receives pressure-wash waste water from the wash pad sump pit (sampling location #1/sump). Influent pH is monitored in the primary settlement tank and a neutralizing chemical is added to maintain a near-neutral range of pH. Effluent (sampling location #2/WM1) from the primary settlement tank is pumped through an electro-coagulation (EC) unit into a three-chamber self-contained secondary settlement and/or final effluent tank. To enhance the coagulation process, a fixed preset dose of liquid polymer coagulant is injected into the process water as it passes through the EC unit. Effluent from the EC unit is passed through two static mixer units to enhance the mixing of polymer with the process water and then discharged into the first chamber of the secondary settlement tank. Discharge into the secondary settlement tank occurs through a funnel-shaped outlet to encourage the separation of flocculated solids from the process water. Effluent of the initial secondary settlement chamber overflows to the second settlement chamber. Effluent (sampling location #3/WM2) from the second settlement chamber overflows into the third chamber which is the final effluent tank. The final effluent is ready to be recycled with make-up freshwater (sampling location #4) or directly discharged into the final effluent receiving system such as sanitary sewer.

The self-contained treatment system EC1-300A includes several transfer pumps in order to convey the process water stream through the treatment system. Two dosing pumps are utilized to inject polymer coagulant and pH-adjustment solution into the process stream. As the treatment of hull-wash wastewater continues, dense solids are deposited at the bottom of the tanks and lighter/oxidized floatable solids are accumulated at the surface in the first secondary settlement chamber. The treatment system is programmed to purge the top and bottom solids at a regular interval into a solids separation/dewatering unit.

2.1 Treatment System Performance Sampling Activities: EC1-300A

Five rounds of hull wash wastewater were collected during the 2007 boat wash season. Five to six samples were collected during each sampling round from various locations of the treatment train in order to evaluate the system performance at different stages of treatment process. Based on field observations during the sampling event on December 10 and 11, 2007, the treatment system installation appeared to be incomplete due to the absence of solids purging components and dewatering operation. Dillon's Creek Marina and the local treatment system installer were made aware of the fact that the accumulated solids must be removed and/or purged from the system in order to improve the treatment efficiency. Furthermore, Najarian Associates recommended to install a Totalizer to measure the volume of freshwater (make-up water) which was added to the treated effluent to compensate the evaporation and/or line losses from the power wash recycling system.

Aqua Tech upgraded the treatment system by installing an additional primary settlement tank in series, and an in-line discharge filter to polish the final effluent. The final effluent was directly discharged without recycling and/or mixing with the make-up freshwater. On December 17, 2007, one round of samples was collected after the system upgrade and prior to the permanent cessation of the treatment system operation for the 2007 boat-wash season. The sampling plan was slightly modified during this sampling event when effluent from the third chamber (sampling location #5/WM3) was collected as pre-filtered effluent and the final discharge effluent (after the in-line filter unit, sampling location #6/WM4) was collected as filtered effluent. Sampling location #2 also was changed to sample the effluent of the second primary settlement tank.

Based on the results of laboratory analysis of five (5) rounds of influent and effluent samples collected during the 2007 boat-wash season, the primary contaminants of concerns (COCs) identified at Dillon's Creek Marina hull-wash wastewater were copper, lead and zinc. The first four rounds of samples indicated a very poor performance of the treatment system. It failed to achieve any reasonable treatment goals required for sanitary discharge. The last round of sampling results conducted after the system upgrade indicated an improved total copper removal rate. However, this improvement should be tempered by the fact that the pre-treatment concentration of total copper at the sump-pit influent sample was very low in this case. In order to monitor the solids characteristics, a sludge sample was collected from the purged solids accumulated at the surface of the first secondary settlement tank.

Based on the sampling results, it was recommended that the various components of the installed treatment system be upgraded and/or redesigned in order to achieve the target treatment goals. Water Maze further upgraded the installed treatment system in 2008 through the incorporation of automatic solid purging system and various adjustments within the treatment train. Also, a larger, multi-chamber water quality sump was installed at the Marina to enhance the overall treatment efficiency. During the 2008 boat wash season, additional five rounds of samples were collected from various locations along the treatment train for laboratory analysis.

3.0 Oil Trap Treatment System

Toward the end of 2008 wash season, Oil Trap Environmental Inc. installed an Electro-Pulse treatment system, EP5-SD, at the Dillon's Creek Marina to evaluate its performance. Similar to the Water Maze EC1-300A treatment system, the Oil Trap EP5-SD treatment system utilizes electro-coagulation process to separate the contaminants from the waste stream. Wash water is pumped into the primary sump tank where pH and conductivity are monitored and adjusted though automatic chemical injection pumps. The primary effluent wash water (sampling location OT1) is then pumped through the Electro-Cells where heavy metals can oxidize and paint, oil & grease, and marine debris can coagulate. Micro-bubbles are formed within the Electro-Cells as low voltage electrical current comes in contact with the water. The micro-bubbles help separate the oxidized heavy metals and coagulated contaminates. The Electro-Cell effluent water (sampling location OT2) flows into a separator tank where the coagulated contaminants float at the surface and are skimmed off into a sludge dewatering bag. The clean water is transferred from the separator tank by gravity into the effluent holding tank. Finally, the clean water is to be discharged (sampling location OT3) into a sanitary sewer (if permitted) or recycled after proper sanitation.

3.1 Treatment System Performance Sampling Activities: EP5-SD

Five rounds of samples were collected during the 2008 wash season. The following performance evaluation samples were collected during each sampling round:

Sump: Influent hull-wash wastewater from the wash-pad sump pit
OT1: Effluent from the primary Oil Trap sump tank
OT2: Effluent from the electro-coagulation unit
OT3: Final effluent from the discharge tank

In order to monitor the solids characteristics, a sludge sample was collected from the purged solids dewatering tank.

4.0 Results and Discussions

Based on all the sampling results collected during 2007 and 2008 wash seasons, copper, lead, and zinc appear to be the contaminants of concern exceeding the sanitary discharge limits required to be met by the Ocean County Utility Authority. Concentrations of metals in the untreated wastewater collected from the wash pad sump varied from 1.18 to 58.8 mg/l copper, 0.05 to 6.09 mg/l lead, and 0.35 to 24.2 mg/l of zinc. Concentrations of metals in the treated wastewater collected from the final discharge outlet of the Water Maze system varied from 0.76 to 15.10 mg/l copper, 0.01 to 0.80 mg/l lead, and 0.50 to 7.55 mg/l of zinc. Concentrations of metals in the treated wastewater collected from the final discharge outlet of the Oil Trap system varied from 1.05 to 8.16 mg/l copper, 0.01 to 0.04 mg/l lead, and 0.20 to 8.16 mg/l of zinc.

Concentration of Total Suspended Solids (TSS) in the untreated wastewater varied from 48 to 940 mg/l. The final effluent TSS concentration varied from 10 to 128 mg/l for the Water Maze system and 28 to 54 mg/l for the Oil Trap system. As determined through the laboratory test, TCLP copper concentration was 32.6 mg/l for the sludge sample collected from the Water Maze system and 44.5 mg/l for the Oil Trap system.

Concentrations of copper, zinc, and lead in the influent and effluent samples are shown in Figures 3 through 8. As shown in the figures, the influent concentrations of metals are significantly less in the 2008 samples which may be attributed to the installation of dual chamber water quality sump. In general, the effluent concentrations of copper and zinc exceed the sanitary sewer discharge limits required by the Ocean County Utility Authority. Furthermore, significant proportion of dissolved metals was detected in the effluent samples. The laboratory analytical reports are included in Appendices I and II.

Although, neither of the treatment systems achieved the local sanitary sewer discharge requirements, EP5-SD by Oil Trap consistently outperformed the Water Maze EC1-300A. Furthermore, Oil Trap Electro-Pulse system is relatively simpler to operate and it requires smaller floor space to install. Both the manufacturers were contacted to provide the explanation for high effluent concentrations of metals. Also, the manufacturers were requested to provide an upgrade of the treatment systems which would meet the local sanitary discharge requirements.

Water Maze failed to provide any technical details for the requested information. Oil Trap's response can be summarized as follows:

1. Chemical Feed Tubing: The factory-installed chemical feeding tubes were misplaced in wrong containers, causing additions of brine solution when the system control was requiring pH adjustment chemicals (aluminum sulfate). As the system required brine solution to adjust the conductivity, aluminum sulfate was added causing a drop in pH, which reduced the efficiency of heavy metal oxidation process. Oil Trap will introduce color coding to eliminate the chances of similar mistakes in the future installations.

2. Metal Complexing Agents: The gel version of the MaryKate On & Off hull wash product #3532 – which was used for water scale and barnacle removal at Dillon's Creek Marina -- contains a common metal complexing

agent Amine. The Amine agents are often used as gel thickeners or water conditioners to tie-up water hardness such as calcium and silica. It also complexes with heavy metals, holding them in solution and not allowing for easy removal. This problem can be overcome if the boatyards utilize non-amine based chemicals such as MaryKate de-scaling product #2032.

5.0 Conclusion and Recommendation

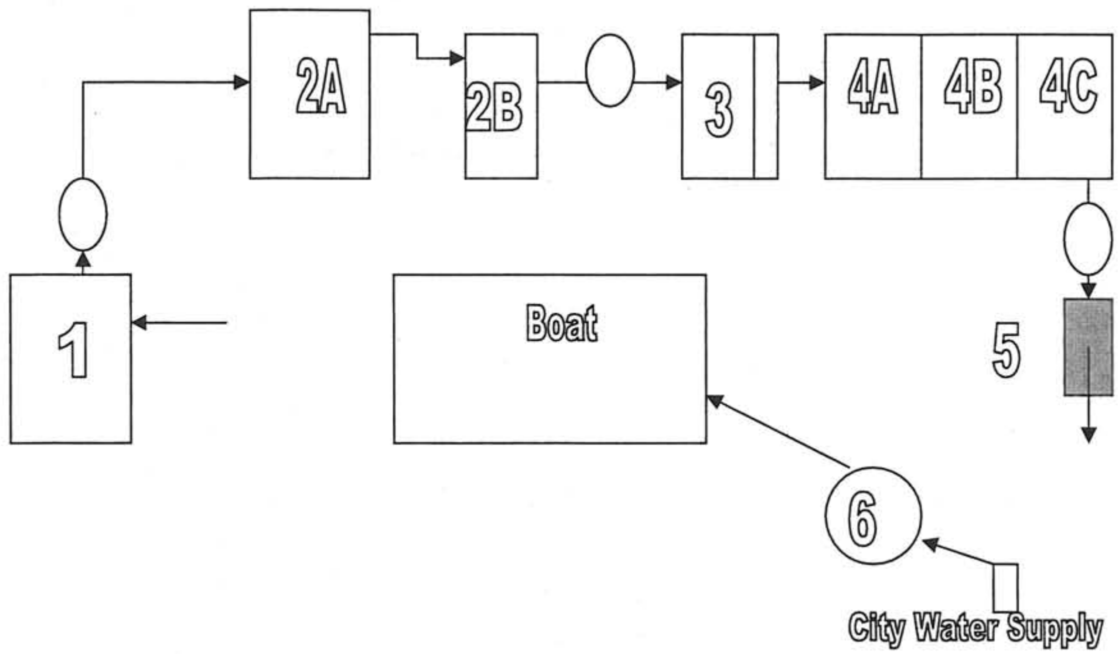
Hull-wash wastewater contains elevated levels of metals, Biological Oxygen Demand (BOD), and Total Suspended Solids (TSS) which will require pre-treatment to discharge into the local sanitary sewer. Dissolved as well as particulate Copper, Zinc, and Lead are the three most predominate metal contaminants depending of its use in bottom-paints and corrosion protective anodes. Based on the effectiveness and the level of operation & maintenance requirements, electro-coagulation process is one of the best suited treatment technologies to meet the pre-treatment target goals for discharge into the sanitary sewer.

Two fully automated treatment systems based on electro-coagulation process were tested at the Dillon's Creek Marina. EC1-300A was installed by Water Maze and EP5-SD was installed by Oil Trap Environmental. None of the treatment systems met the target pre-treatment goals for discharge into the local sanitary sewer. Apparent failure to meet the treatment goals can be attributed to the inadequate system design, faulty installation, poor maintenance, and use of non-compatible de-scaling chemicals containing metal complexing agent such as Amines.

Overall, EP5-SD by Oil Trap Environmental Inc. consistently outperformed the Water Maze EC1-300 treatment system. Furthermore, Oil Trap Electro-Pulse system is relatively simpler to operate and it requires smaller floor space to install. The operational control system appears to be more user friendly for the Oil Trap system. Furthermore, Oil Trap system provides superior sludge handling system which is extremely important for a Marina owner who may not have skilled system operator.

The treatment system efficiency can be increased through the improved design, installation, and operation to meet the sanitary sewer discharge requirements. We recommend further samplings during the 2009 boat-wash season to verify the effectiveness of the technology operated in a typical Marina along the New Jersey waterline, provided the installed treatment system addresses the issues regarding its design, installation, and operation as discussed above.

As an interim measure, an ion-exchange filter bed can be installed by the manufacturer at the downstream end of the treatment train to pass the final effluent prior to discharging into the sanitary sewer. The ion-exchange bed should be designed with sufficient capacity and detention time so that the effluent meets the sanitary sewer discharge limits.



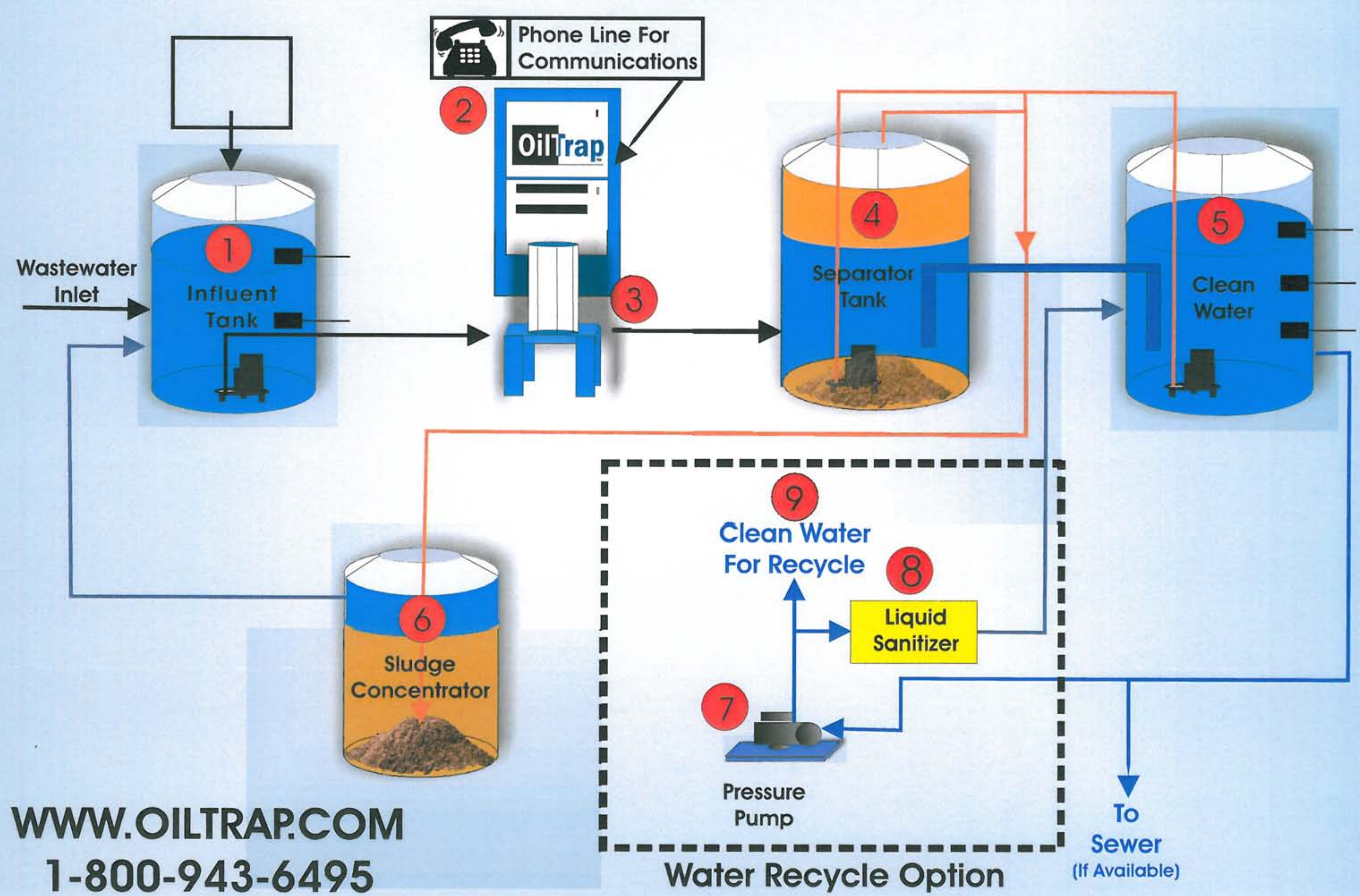
COMPONENTS:

1.	**SUMP**
2A.	**U/S PRIMARY TANK**
2B.	**D/S PRIMARY TANK**
3.	**ELECTRO-COAGULATOR**
4A – 4C	**SOLIDS SEPERATION / SECONDARY SETLLING TANKS**
5.	**EFFLUENT FILTER**
6.	**FRESH WATER SUPPLY**

Figure 1. Water Maze Electro-Coagulation Treatment System Flow Diagram / Sampling Locations.

ectrocoagulation Water Treatment
nufactured By OilTrap Environmental Inc.

Figure 2 Oil Trap EP5-SD Electro-Pulse Treatment System Flow Diagram



WWW.OILTRAP.COM
1-800-943-6495

Figure 3. Influent and Effluent Concentrations of Copper

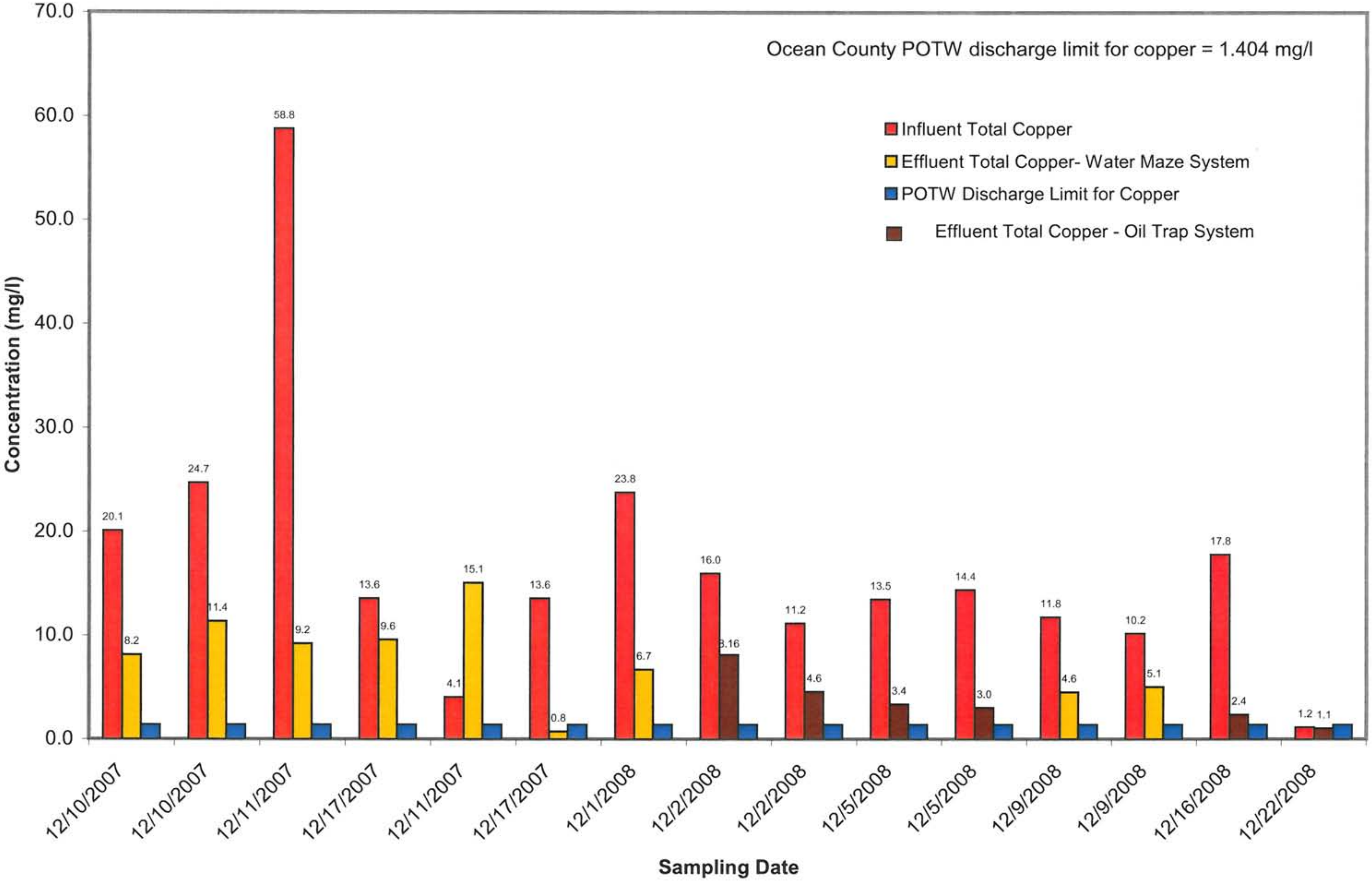
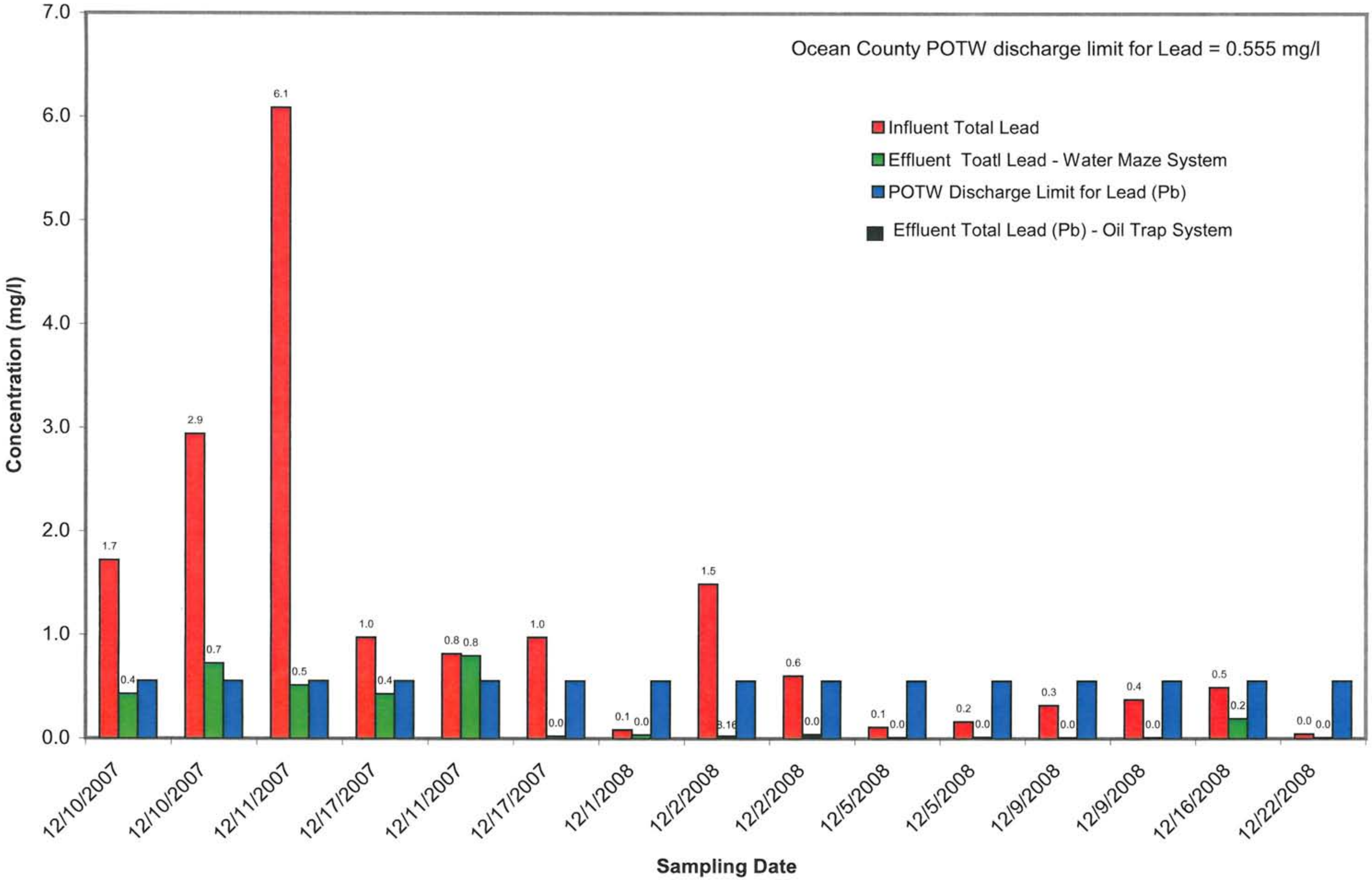
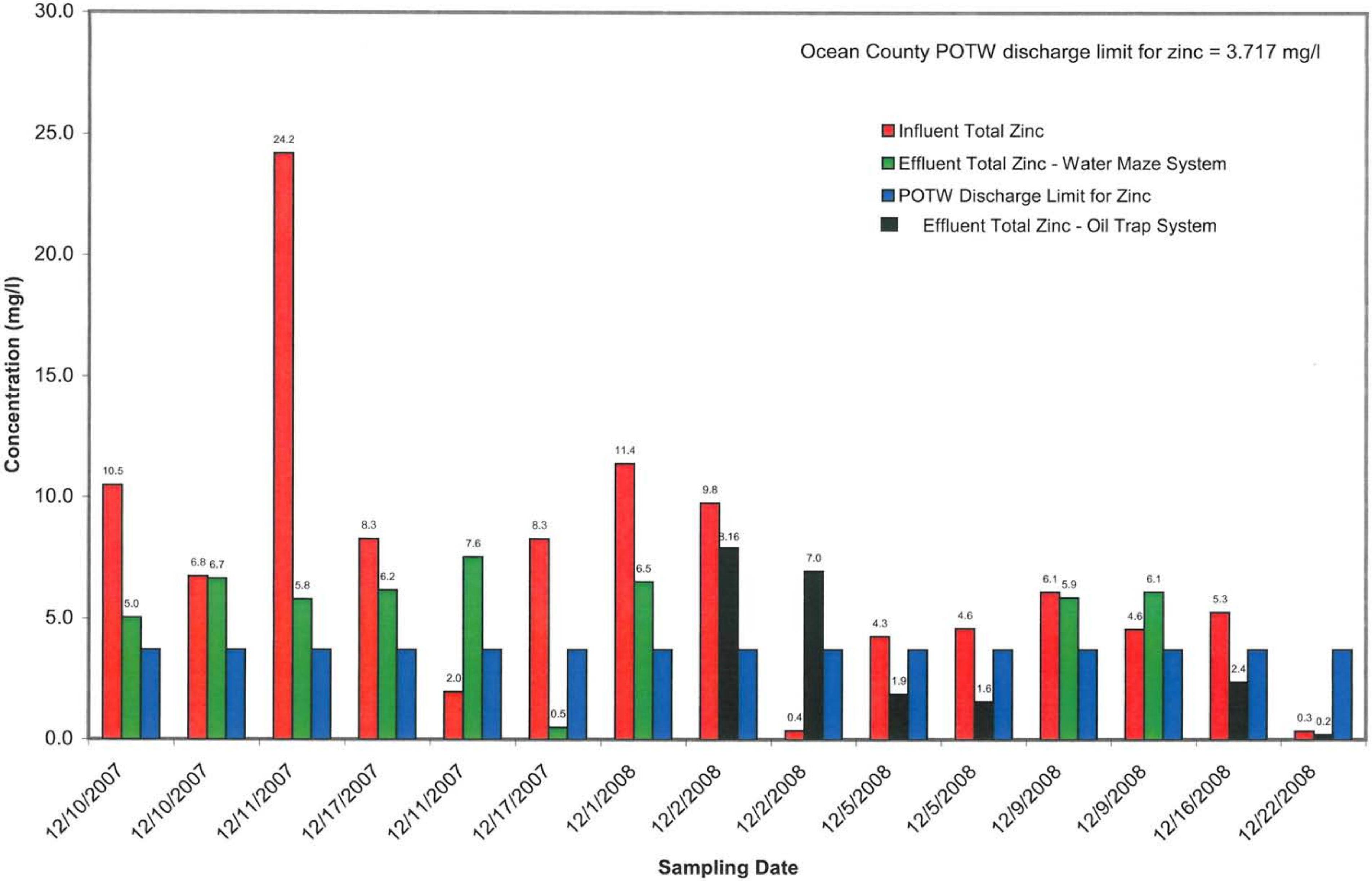


Figure 4. Influent and Effluent Concentrations of Lead



Hull Wash Wastewater Treatment Evaluation, I-Boat NJ
Dillon's Creek Marina

Figure 5. Influent and Effluent Concentrations of Zinc



Hull Wash Wastewater Treatment Evaluation, I-Boat NJ
Dillon's Creek Marina

Figure 6. Percent of Metal Contaminants Removed

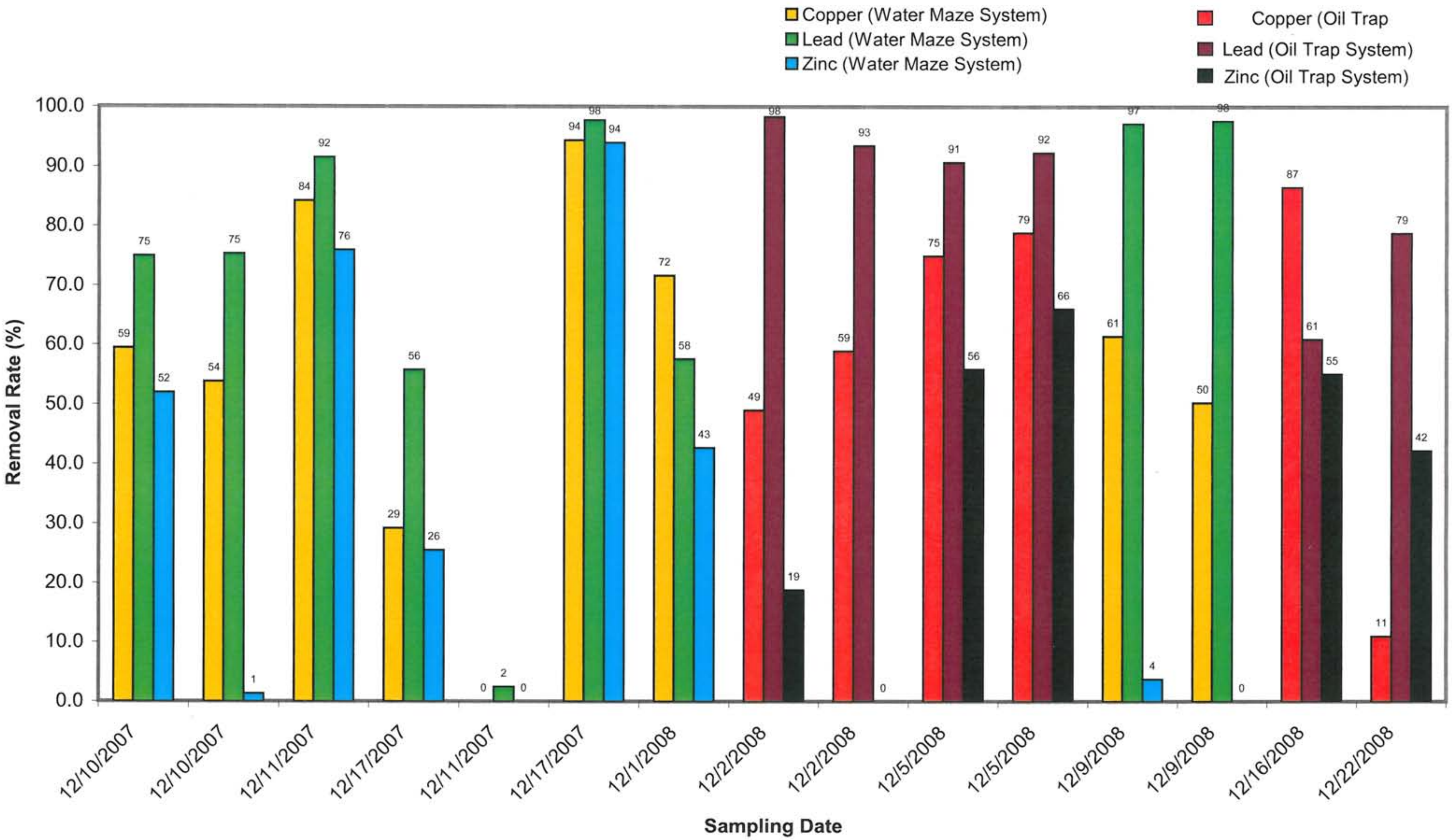


Figure 7. Average Influent and Effluent Concentration

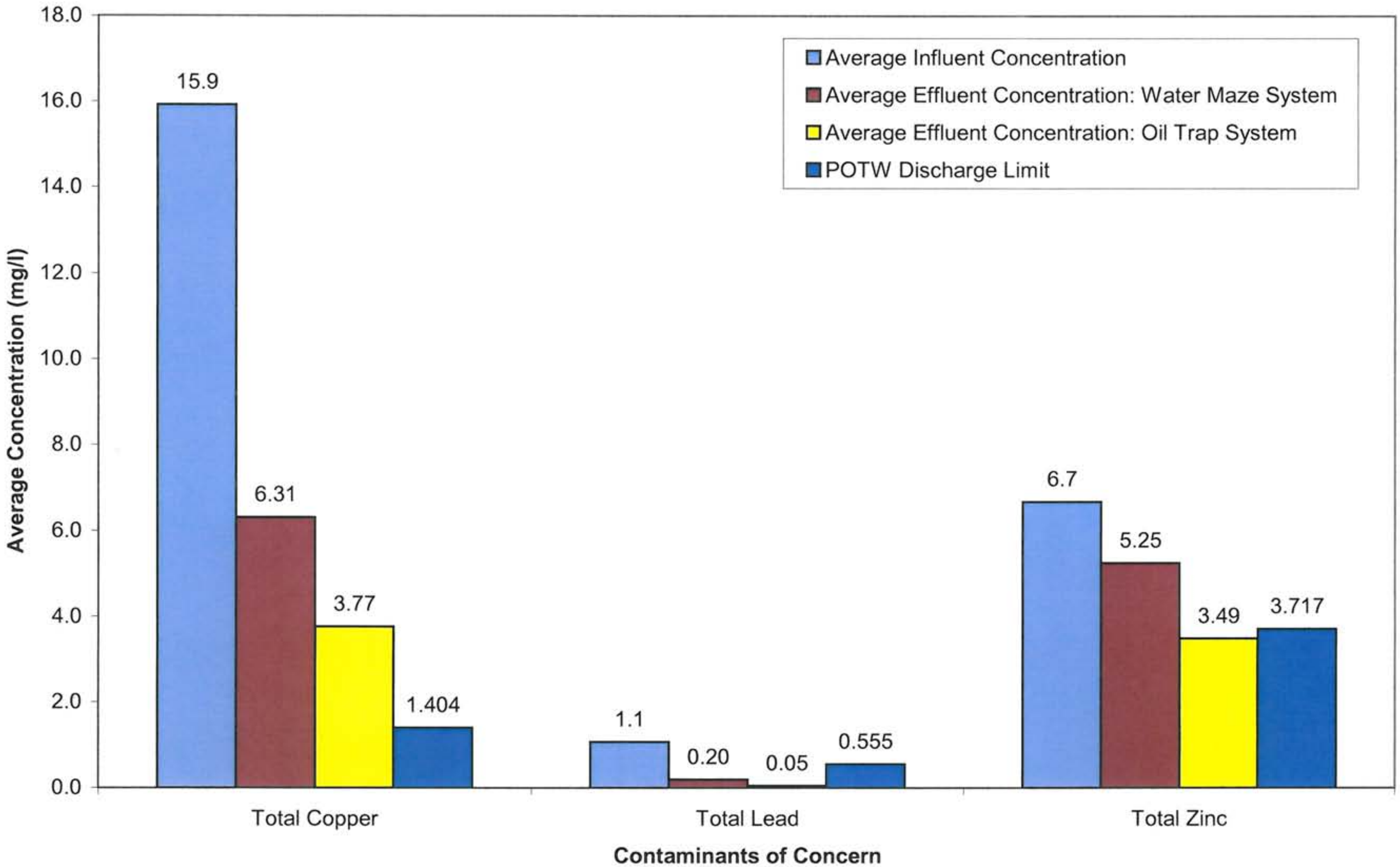


Figure 8. Average Percent Removal of Metals