

Results of a Retail Gasoline Outlet And Commercial Parking Lot Storm Water Runoff Study

**This study was funded by the Western States
Petroleum Association (WSPA) and the
American Petroleum Institute**

API PUBLICATION 1669
DECEMBER 1994

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005



Results of a Retail Gasoline Outlet And Commercial Parking Lot Storm Water Runoff Study

Manufacturing, Distribution and Marketing Department

API PUBLICATION 1669
DECEMBER 1994

**American
Petroleum
Institute**



Documents
Document Sharing Hub

SPECIAL NOTES

1. API PUBLICATIONS NECESSARILY ADDRESS PROBLEMS OF A GENERAL NATURE. WITH RESPECT TO PARTICULAR CIRCUMSTANCES, LOCAL, STATE, AND FEDERAL LAWS AND REGULATIONS SHOULD BE REVIEWED.
2. API IS NOT UNDERTAKING TO MEET THE DUTIES OF EMPLOYERS, MANUFACTURERS, OR SUPPLIERS TO WARN AND PROPERLY TRAIN AND EQUIP THEIR EMPLOYEES, AND OTHERS EXPOSED, CONCERNING HEALTH AND SAFETY RISKS AND PRECAUTIONS, NOR UNDERTAKING THEIR OBLIGATIONS UNDER LOCAL, STATE, OR FEDERAL LAWS.
3. INFORMATION CONCERNING SAFETY AND HEALTH RISKS AND PROPER PRECAUTIONS WITH RESPECT TO PARTICULAR MATERIALS AND CONDITIONS SHOULD BE OBTAINED FROM THE EMPLOYER, THE MANUFACTURER OR SUPPLIER OF THAT MATERIAL, OR THE MATERIAL SAFETY DATA SHEET.
4. NOTHING CONTAINED IN ANY API PUBLICATION IS TO BE CONSTRUED AS GRANTING ANY RIGHT, BY IMPLICATION OR OTHERWISE, FOR THE MANUFACTURE, SALE, OR USE OF ANY METHOD, APPARATUS, OR PRODUCT COVERED BY LETTERS PATENT. NEITHER SHOULD ANYTHING CONTAINED IN THE PUBLICATION BE CONSTRUED AS INSURING ANYONE AGAINST LIABILITY FOR INFRINGEMENT OF LETTERS PATENT.
5. GENERALLY, API STANDARDS ARE REVIEWED AND REVISED, REAFFIRMED, OR WITHDRAWN AT LEAST EVERY FIVE YEARS. SOMETIMES A ONE-TIME EXTENSION OF UP TO TWO YEARS WILL BE ADDED TO THIS REVIEW CYCLE. THIS PUBLICATION WILL NO LONGER BE IN EFFECT FIVE YEARS AFTER ITS PUBLICATION DATE AS AN OPERATIVE API STANDARD OR, WHERE AN EXTENSION HAS BEEN GRANTED, UPON REPUBLICATION. STATUS OF THE PUBLICATION CAN BE ASCERTAINED FROM THE API AUTHORIZING DEPARTMENT [TELEPHONE (202) 682-8000]. A CATALOG OF API PUBLICATIONS AND MATERIALS IS PUBLISHED ANNUALLY AND UPDATED QUARTERLY BY API, 1220 L STREET, N.W., WASHINGTON, D.C. 20005.

FOREWORD

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any federal, state, or municipal regulation with which this publication may conflict.

Suggested revisions are invited and should be submitted to the director of the Manufacturing, Distribution and Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY	ii
1.0 INTRODUCTION	1
1.1 Objective	1
1.2 Background	1
1.3 Other Studies	3
1.3.1 Sacramento County's Action Plan Demonstration Project	3
1.3.2 National Urban Runoff Program	4
2.0 WSPA/API PART I AND PART II STORM WATER RUNOFF STUDIES	5
2.1 Literature Search	5
2.2 Selection of RGOs and Test Sites	6
2.3 Selection of Parking Lots and Test Sites	7
2.4 Testing Methodology	7
2.5 Sampling Procedures	9
2.6 Analytical Testing	9
2.7 Quality Assurance and Quality Control	9
3.0 RESULTS AND DISCUSSION	10
3.1 Analytical Results	10
3.2 Data Comparisons	11
3.2.1 Comparison of Results from RGO Pump Islands and Driveways	12
3.2.2 Comparison of Results from RGOs, Parking Lots, and NURP	12
4.0 CONCLUSIONS	13
5.0 REFERENCES	14

EXECUTIVE SUMMARY

This report presents the results of a two-part study of constituents present in simulated storm water runoff from six retail gasoline outlets (RGOs) and four commercial parking lots. The objective of the study is to characterize storm water runoff from RGOs and to compare the results with runoff from commercial parking lots and published urban "background" values. The study was funded by the Western States Petroleum Association (WSPA) and the American Petroleum Institute (API).

The study demonstrates that for the constituents analyzed, median event mean concentrations (EMCs) in storm water runoff from normally operated and maintained RGOs are no higher than those in runoff from commercial parking lots. Additionally, median EMCs of total suspended solids, copper, lead, and zinc in runoff from RGOs and parking lots are no higher than background levels present in urban runoff as established by the National Urban Runoff Program. Furthermore, there are no significant differences in median EMCs in runoff from RGO pump islands and driveways for the constituents analyzed. These results indicate that fueling activities at normally operated and maintained RGOs do not contribute additional significant concentrations of measured constituents in storm water runoff.

In 1987, Section 402(p) was added to the Clean Water Act to establish a framework for addressing storm water discharges under the National Pollutant Discharge Elimination System (NPDES) program. Storm water discharges from commercial facilities, such as RGOs and parking lots, are not included under the initial regulations. However, regulations are to be promulgated that are expected to increase the number and types of dischargers required to obtain NPDES permit coverage for storm water discharges. EPA, in a report to Congress (EPA, 1993), identified several business categories that are not currently regulated by NPDES permits. Automotive service facilities, including RGOs, are included on EPA's list of potential Phase II permittees.

RESULTS OF A RETAIL GASOLINE OUTLET AND COMMERCIAL PARKING LOT STORM WATER RUNOFF STUDY

1.0 INTRODUCTION

This report presents the results of a two-part study of simulated storm water runoff from six retail gasoline outlets (RGOs) and four commercial parking lots. Part I was conducted by Hart Crowser, Inc. (Hart Crowser) and characterized simulated storm water runoff from five RGOs. Part II was conducted by Geomatrix Consultants, Inc. (Geomatrix) and characterized simulated storm water runoff from four commercial parking lots and one RGO. The study was funded by the Western States Petroleum Association (WSPA) and the American Petroleum Institute (API).

1.1 Objective

The objective of this study is to characterize storm water runoff from RGOs and to compare the results with runoff from commercial parking lots and published urban "background" values.

1.2 Background

In 1972, the Federal Water Pollution Control Act (also known as the Clean Water Act or CWA) was amended to provide that any discharge of pollutants from a point source to Waters of the United States is effectively prohibited unless it is in compliance with a National Pollutant Discharge Elimination System (NPDES) permit.

As more significant sources of water pollution were brought under control, the impact of pollutants in storm water became more noticeable. Water quality studies conducted in the 1970s and 1980s identified urban runoff as a source of pollution. In response to these studies, the 1987 amendments to the Water Quality Act added Section 402(p). This section established a comprehensive two-phased approach for the U.S. Environmental Protection Agency (EPA) to follow in addressing storm

water discharges. Five types of storm water discharges are covered under the Phase I program. Dischargers within these five categories, listed below, were required to obtain permit coverage before October 1, 1992:

- A) A discharge for which a permit has been issued prior to February 4, 1987;
- B) A discharge associated with industrial activities;
- C) A discharge from a municipal separate storm sewer system serving a population of 250,000 or more;
- D) A discharge from a municipal separate storm sewer system serving a population of 100,000 or more, but less than 250,000; or
- E) A storm water discharge determined by the EPA Administrator or the State to contribute to a violation of a water quality standard or to be a significant contributor of pollutants to the waters of the United States.

Discharges from commercial facilities, such as RGOs and parking lots, are not included under the Phase I regulations. However, Phase II regulations to be promulgated are expected to increase the numbers and types of dischargers that are required to obtain NPDES permit coverage for storm water discharges. EPA, in a draft Phase II report to Congress (EPA, 1993), identified several business categories that are not currently regulated by NPDES permits. Automotive service facilities, including RGOs, are included on EPA's list of potential Phase II permittees. It should be noted that, according to the EPA draft Phase II report, the list of potential permittees was created using limited reliable data on storm water problems associated with Phase II sources nationwide. In order to provide data regarding storm water runoff from potential Phase II facilities, WSPA and API commissioned this study.

1.3 Other Studies

This study utilized the results from a recently published RGO runoff study titled *Action Plan Demonstration Project, Demonstration of Gasoline Fueling Station Best Management Practices, Phase I Report* (September, 1993), prepared by Uribe & Associates and Larry Walker Associates for the County of Sacramento, Water Resources Division. Another storm water runoff study used for the WSPA/API study described herein is the *Final Report of the Nationwide Urban Runoff Program* (December 30, 1983) prepared by the Water Planning Division of EPA. These storm water studies are described in the following sections.

1.3.1 Sacramento County's Action Plan Demonstration Project

Sacramento County's Action Plan Demonstration Project characterized storm water runoff from RGOs and identified potential best management practices (BMPs) to reduce storm water runoff pollution. EPA provided funding of the study by a grant through the San Francisco Estuary Project and the Sacramento County Water Resources Division. The report presents the analytical results of samples collected from storm water runoff from three RGOs in Sacramento County.

The Sacramento County project selected high-volume (over 200,000 gallons per month), self-service RGOs with convenience markets and without automobile repair service bays for the study. The selected RGOs are located less than 2 miles apart.

Within each RGO, a single representative sampling point was selected where station runoff leaves the property and includes drainage from the fueling and auxiliary services areas. Uribe collected samples during six storm events during the 1992/93 wet season. For five of the storms, the sample collection procedure consisted of placing a 1 liter sampling bottle into a below-grade concrete sump. A portion of the storm water discharge flowed over the lip of the sump directly into a sampling bottle. Samples were collected in this manner for each 0.05 inch increment of measured rainfall. The samples were composited immediately into a 5-liter borosilicate bottle until the 5-liter bottle was filled. The one exception to this sample collection method occurred during the first storm event, when only grab samples were collected.

The initial analytical program for the collected samples included analyses for oil and grease, total suspended solids, metals (13 EPA priority pollutant metals plus aluminum and iron), polycyclic aromatic hydrocarbons (PAHs), and petroleum hydrocarbons. However, some of the metals, petroleum hydrocarbons, and PAHs were consistently not detected in samples collected from the first three storm events. On the basis of these results, the following parameters were selected for the final three sampling events:

- oil and grease
- total suspended solids
- heavy metals (cadmium, chromium, copper, lead, and zinc)

Pertinent results of Sacramento County's Action Plan Demonstration Project are discussed in Sections 3 and 4 of this report.

1.3.2 National Urban Runoff Program

The National Urban Runoff Program (NURP) was conducted from 1978 through 1983 with funding and guidance provided by EPA. NURP characterized the chemicals present in discharges from separate storm sewers that drain residential, commercial, and light industrial areas. NURP included 28 projects across the nation, conducted separately at the local level, but centrally reviewed, coordinated, and guided. The overall objective of the program was to collect information from a national perspective that could be used to characterize urban runoff, assess the impact of non-point source urban runoff on the quality of the receiving waters, and assist decision makers in developing control measures to limit its impact. The results of NURP provide insight on what can be considered background levels for urban runoff.

The resultant NURP data represent a cross section of regional climates, land use types, and ground surface conditions. The sites sampled during NURP included 81 sites that were unaffected by hydraulic devices, such as detention basins, that would modify runoff. A total of more than 2300 separate storm events were sampled from these sites during the project. Samples collected from these sites were tested for the following standard pollutants:

- total suspended solids
- biochemical oxygen demand
- chemical oxygen demand
- total phosphorus
- soluble phosphorus
- total Kjeldahl nitrogen
- nitrite and nitrate as N
- heavy metals (copper, lead, and zinc)

Pertinent results of NURP are discussed in Sections 3 and 4 of this report.

2.0 WSPA/API PART I AND PART II STORM WATER RUNOFF STUDIES

This section describes both parts of the WSPA/API runoff study. Part I, conducted by Hart Crowser, characterized simulated storm water runoff from five RGOs. Part II, conducted by Geomatrix, characterized simulated storm water runoff from four commercial parking lots and one RGO.

2.1 Literature Search

As part of this WSPA/API study, Hart Crowser conducted a literature search to assess whether analytical results from prior RGO runoff studies were available for this study. The search was conducted using the Dialog Information Database and included a search of the following databases:

NTIS (National Technical Information Service)
 COMPENDEX (Engineering Information Inc.)
 APILIT (American Petroleum Institute)
 Pollution Abstracts/Cambridge Scientific Abstracts
 Water Resources Abstracts
 WATERNET (American Water Works Association)
 CA SEARCH (Chemical Abstracts)

The database search did not disclose prior RGO storm water runoff studies.

2.2 Selection of RGOs and Test Sites

In selecting the RGOs to be used for the study, the following characteristics were evaluated for a number of potential RGO sites:

- monthly throughput
- site location
- anticipated level of use by commercial vehicles
- age and general appearance
- types of ancillary services provided including on-site vehicle service, car washes, or convenience stores
- on-site drainage patterns and adjacent property usage.

On the basis of this evaluation, six RGOs, all located in Southern California, were selected for the study. The six RGOs provide a representative cross section of typical RGOs in Southern California. Site characteristics for each RGO are summarized in Table 1. Each of the selected RGOs was considered "normally operated and maintained". For the purposes of this study, "normally operated and maintained" signifies that the RGOs utilize Best Management Practices (BMPs) to minimize the buildup of potential storm water contaminants on exposed areas. These BMPs include regular sweeping of exposed areas, regular site inspections, and standardized spill response procedures.

Hart Crowser and Geomatrix conducted the simulated rainfall application and sample collection at a pump island and driveway approach area within each RGO. These areas were selected to provide results that are representative of discharge from the entire RGO. A summary of pavement types and conditions of each test site location is presented in Table 2.

A simulated gasoline spill was performed at RGO 5 to provide data regarding the effectiveness of standardized spill response procedures. One quart of regular unleaded gasoline from a pump nozzle was discharged onto the pump island pavement. Absorbent material was applied to the spill after one

minute. The absorbent material was then swept up after it appeared to have absorbed the spilled liquid, and the simulated runoff test was conducted.

2.3 Selection of Parking Lots and Test Sites

Commercial parking lots for the second part of the study were evaluated using the following criteria:

- site use
- relative parking duration
- traffic and parking volume
- pavement type, condition, and visual appearance
- cleaning methods and frequency
- on-site drainage patterns.

On the basis of this evaluation, Geomatrix and WSPA selected four commercial parking lots, all located in Southern California, for the study. The selected parking lots were associated with a grocery store, bank, office complex, and restaurant.

Simulated rainfall was applied and samples were collected at two locations at each of the four parking lots for a total of eight test sites. The test locations included one high-use and one moderate-use parking area. The high-use area was generally closer to the commercial facility entrance, and was occupied more frequently than the moderate-use area. Each of the parking lots used scheduled sweeping as a good housekeeping BMP. Parking lot test locations, conditions, and BMPs are summarized in Table 3.

2.4 Testing Methodology

To minimize test variability caused by differing rainfall intensities and durations, both parts of the WSPA/API runoff study used a simulated rainfall method to induce runoff from the study sites. The water-dispensing system and sampling procedures were identical for both the RGO and commercial

parking lot sites. The water-dispensing system was designed to apply water uniformly over the test area and create sheet flow.

During the test, potable water was distributed uniformly over an approximate 400-square-foot area using a network of perforated 1-inch-diameter, schedule 80 polyvinyl chloride (PVC) pipes elevated approximately 4 feet above the pavement surface. A schematic of the simulated rainfall system is shown on Figure 1.

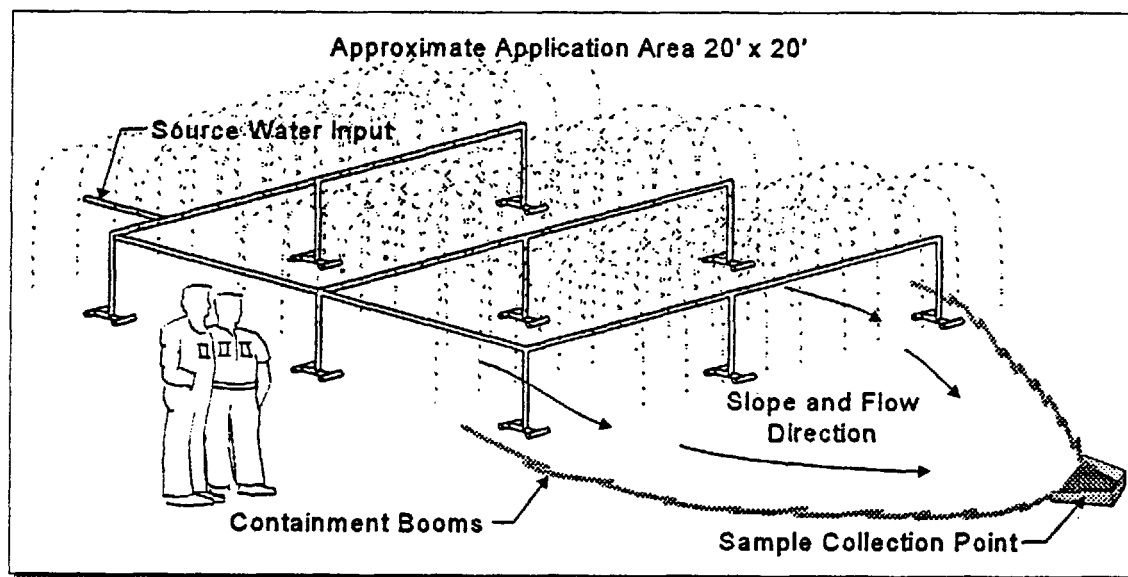


Figure 1. Schematic of Simulated Rainfall System

The water was applied at a rate of approximately 2.0 gallons per minute (gpm) for the duration of the 45-minute test. This rate represents a rainfall rate of approximately 0.008 inch per minute or 0.12 inch every 15 minutes over the test application area.

The runoff from the simulated rainfall application was channeled by gravity and sand-filled polyethylene tubing containment berms to a collection point. The runoff was diverted into a stainless steel collection trough and was pumped into a poly-lined 55-gallon steel drum.

2.5 Sampling Procedures

Sampling procedures for both Part I and II studies follow the sampling protocol established by SW-846, "Test Methods for Evaluating Solid Waste" (including surface and groundwater).

The following samples were collected at each test site.

- A discrete grab sample from the collection trough every 15 minutes during the 45 minute test
- One composite sample from the runoff pumped into the 55-gallon drum.

In addition to these samples, a background sample of the on-site water supply was collected at the point of discharge from the simulated rainfall application apparatus, and a duplicate oil and grease sample was collected at each test site. Samples were obtained using cleaned sampling equipment and were placed into laboratory-supplied and certified "clean" sampling containers. Collected samples were labeled, placed on ice in a cooler, and maintained under proper chain-of-custody procedures. A trip blank sample was included in each of the sample coolers used for this study.

2.6 Analytical Testing

GTEL Environmental Laboratories, a state-certified analytical laboratory located in Torrance, California analyzed samples from RGOs 1 through 5. Del Mar Analytical, a state-certified laboratory located in Irvine, California analyzed samples from RGO 6 and all four parking lots.

Laboratory analyses were conducted in accordance with appropriate EPA methods. The constituents, analytical test methods, and detection limits used for the WSPA/API study are listed in Table 4.

2.7 Quality Assurance and Quality Control

Both parts of the WSPA/API study described herein developed and implemented field and laboratory quality assurance/quality control (QA/QC) procedures. Field QA/QC includes following strict sampling protocols as specified in the project work plans and standard operating procedures. These

procedures include an evaluation of cross-contamination through the analysis of trip blanks. Laboratory QA/QC addressed the following:

- Accuracy (analysis of matrix spike recoveries on each batch of samples and regular analysis of certified samples)
- Precision (analysis of matrix spike duplicates)
- Contamination (analysis of method and filter blanks)
- Holding Time (specified holding times associated with each chemical method)
- Certified Methods of Analysis (EPA or State certified methods of analysis) .

3.0 RESULTS AND DISCUSSION

The following sections present the results of the WSPA/API simulated runoff study and provide summaries of analytical data from Sacramento County's Action Plan Demonstration Project and NURP. Also presented are data plots that provide comparisons between the pump islands and driveway RGO results and between RGOs, parking lots, and NURP.

3.1 Analytical Results

The analytical results of simulated runoff samples collected from RGOs as part of this study are summarized in Tables 5a and 5b. These tables present the results of both the Part I study conducted by Hart Crowser (RGOs 1 through 5) and the Part II study conducted by Geomatrix (RGO 6). Tables 6a and 6b summarize the results of laboratory analyses of simulated runoff samples from commercial parking lots. Tables 7 and 8, respectively, summarize the results from Sacramento County's Action Plan Demonstration Project and median concentrations reported in NURP.

3.2 Data Comparisons

This report compares analytical data from the WSPA/API RGOs and parking lots, the Action Plan Demonstration Project, and NURP using a series of box plots, Figures 3 through 24. Box plots are a simple and useful method of data comparison because they effectively describe the characteristics of single groups of data and reveal differences between groups. The components of a typical box plot are presented on Figure 2. Shown on this figure are the 25th and 75th percentiles of the data, which form the

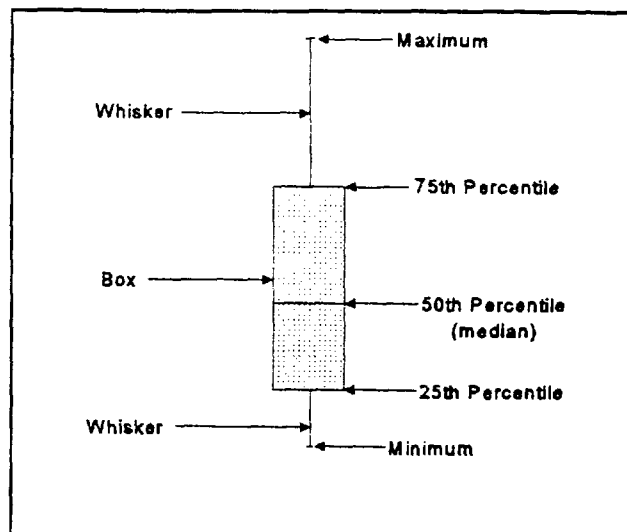


Figure 2. Components of a Typical Box Plot

top and bottom of the box. Therefore, by definition, 25 percent of the data have a value equal to or less than the bottom line of the box, and 75 percent have a value equal to or less than the top of the box. The middle horizontal line within the box is the median, or 50th percentile (one-half of the data values are equal to or less than the median, and one-half are equal to or greater). Lines (called whiskers) extend vertically from the top and bottom of each box to the maximum and minimum data values.

In many cases, the boxes shown on Figures 3 through 24 are collapsed into a single horizontal line without a whisker extending to the minimum value. The principal reason for the shape of these plots is the presence of a large number of non-detect values in the data set. When this occurs, a single horizontal line is drawn at the detection limit, and the whisker and box segments below the reporting limit are masked.

Although Hart Crowser and Geomatrix collected and analyzed both discrete and composite samples for this study, only the composite results are used for comparison purposes in this report. Composite results are normally considered more meaningful than individual discrete results when evaluating pollutant loading in storm water discharges. It should be noted that the composite sampling