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USGS Urban Stormwater Investigations in the  
Dallas-Fort Worth, Texas Metroplex

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**ABSTRACT**

Stormwater runoff in urban and industrialized areas carries a considerable amount of pollutants to nearby lakes and streams. In an effort to control this source of pollution, the U.S. Environmental Protection Agency has issued stormwater regulations to control these discharges. Municipalities with a population of 100,000 or more must undertake a process to obtain permits to control the quality of their storm runoff. The Dallas-Fort Worth metroplex includes seven cities that must meet these regulations and obtain permits. The U.S. Geological Survey is assisting the North Texas Council of Governments and its associated cities in meeting the water science requirements of the National Pollution Discharge Elimination System permitting process.

**INTRODUCTION**

Historically, the Environmental Protection Agency's (EPA) National Pollution Discharge Elimination System (NPDES) has focused on the discharge of industrial process waste-water treatment plants. Between 1978 and 1983, the EPA funded the National Urban Runoff Program (NURP) to measure pollutants in urban stormwater runoff. Results of these NURP studies indicated that stormwater runoff in urban and industrial areas carries a considerable amount of pollutants to nearby lakes and streams. In an effort to control this source of pollution, the EPA issued stormwater regulations in November 1990, which apply to both municipal and industrial stormwater discharges. These regulations define who must apply for and obtain a NPDES permit for stormwater discharges.

Section 402(p) of the Water Quality Act of 1987, (EPA, 1990), requires that municipalities with a population of 100,000 or greater obtain permits to control the quality of their storm runoff. A two-part permit application is required for municipal storm-sewer systems. The objective of Part 1 of the permitting

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process is to assess the existing stormwater quality management program and to formulate a strategy for characterizing discharges from the stormwater system. Part 1 requirements include mapping all outfalls that discharge to U.S. waters and collecting flow samples for analysis during periods of dry weather flow.

The objective of Part 2 of the permitting process is to develop a comprehensive stormwater quality management program. Requirements include collecting samples at representative outfalls during representative storm events, analyzing samples for over 140 priority pollutants, estimating annual stormwater pollutant loadings from all gaged outfalls, and developing a comprehensive stormwater management program.

**SCOPE OF STUDY**

The Dallas-Fort Worth metroplex is a growing urban center in north central Texas with an estimated 1990 population of 4.1 million containing seven cities with populations of at least 100,000 encompassing a combined area of over 1000 square miles.

The U.S. Geological Survey (USGS), through a cooperative agreement with the North Central Texas Council of Governments (NCTCOG), is assisting the cities in meeting the water science requirements for the regulations outlined in Section 402(p) of the Water Quality Act of 1987. The operation of a 30-station regional network will be used to collect data from 210 stormwater events providing information to characterize stormwater quality for the entire metroplex. This study will be implemented in three phases: a) Dallas and Fort Worth by November, 1992, b) Arlington, Garland and Irving by May, 1993, and c) Plano and Mesquite by August 1993.

The specific steps for this project are:

- 1) Select the 30 sites (for the seven cities) to be representative of residential, commercial, and industrial land use.
- 2) Install a wet-weather monitoring network and collect quantitative data to characterize stormwater quality at each site.
- 3) Estimate the region-wide storm-event mean concentrations and annual pollutant loads of the cumulative discharges to designated receiving waters.
- 4) Assist in the design of a monitoring program for the life of the permit to achieve representative data collection.
- 5) Evaluate selected deterministic stormwater quality models with the collected data for use in stormwater management planning.

Figure 1. shows the location of gaging stations for the first phase of the study.

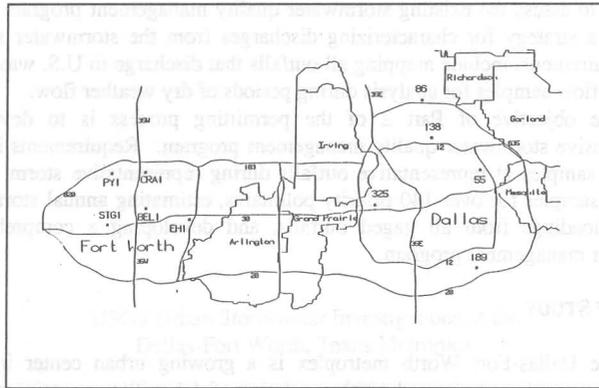


Figure 1. Location of First-phase Gaging Stations

#### Site Selection Criteria

The NCTCOG, along with its participating member cities, with assistance from the USGS, and approval of the EPA, will select 30 sites within the Dallas-Fort Worth metroplex for stormwater data collection. Selection criteria for these sites will be based on catchment characteristics, hydraulic factors, accessibility and safety factors. Each site will be representative of a residential, commercial or industrial predominant land use, ranging in drainage area from 10 to 500 acres, for the respective city.

The outfall must meet several preliminary hydraulic criteria: Storm-sewer pipe diameter will be 3 to 6 feet, uniform and stable pipe conditions (straight and uniform slope) for a distance of at least 6 pipe diameters upstream from the flow measurement device, lack of backwater effects from receiving waters, no evidence of surcharging or submergence over the normal range of precipitation, adequate distance from tributaries to allow for complete mixing, and no dry weather flow or illicit upstream connection (as determined by dry-weather screening).

Accessibility and safety factors for each site are also a consideration for selection. These include adequate access to outfall or manhole for instrumentation and personnel and a safe location with regard to dangerous flow conditions, sewer gases, and heavy traffic. Lighting at the site should be adequate, and evidence of crime and vandalism also will be considered.

#### Station Design and Instrumentation

The field study for stormwater quality sampling will be designed to collect accurate hydrologic information to quantify discharges and to collect flow-weighted composite samples for the duration of the storm.

A stage-discharge relationship will be developed at each site for the determination of flow. Flumes for circular pipes, Kilpatrick and others, 1985, and in some cases, weirs for non-circular pipes and open channels will be used to measure flow.

The samples will be collected using an automatic water-quality sampler connected to a controller and data recorder. Samples will be collected at variable time intervals corresponding to a measured volume of water flowing past the sampling station. The volumes are user-specified and will be chosen based on site-specific factors including basin size and impervious area. Because a minimum amount of water is required for lab analysis, the sample volume must be programmed to collect enough sub-samples for the smallest rainfall event.

In addition, grab samples will be collected at sites during an event. Grab samples will be analyzed for pH, temperature, cyanide, residual chlorine, phenols, volatile organic compounds, oil and grease, fecal coliform and fecal streptococcus. Figure 2 shows the instrumentation and type of shelter used in this study.

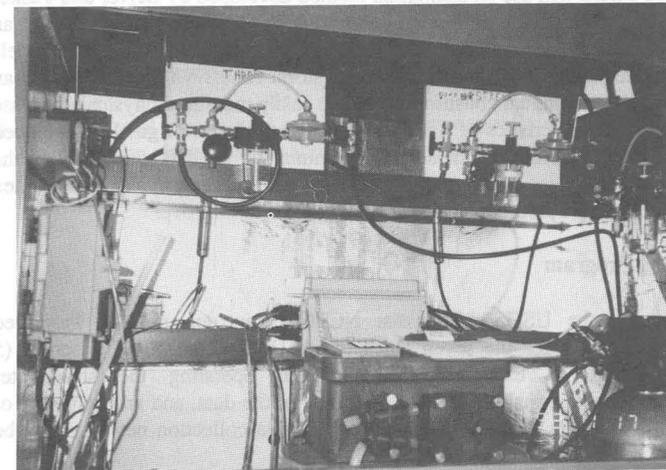


Figure 2. Instrumentation Shelter

The equipment for a typical site includes:

- automatic water quality sampler, modified for organic sampling
- controller/datalogger
- telephone modem
- 2 or 3 pressure transducers for stage measurement
- Palmer-Bowlus flume (circular pipes) OR  
V-notch weir (for square pipes and open channels)
- raingage, tipping bucket
- solar panel and ancillary equipment
- telephone (wired or cellular)
- alert system
- 12 volt DC battery with solar panel or AC power
- shelter

#### Regression Analysis of Stormwater Quality Data

In addition to providing lab analyses of over 140 different constituents for sampled storm events, the cities must provide an estimate to the EPA of the total annual pollutant loads and the storm event-mean concentrations of Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, and several other pollutants.

The USGS will use an estimation method developed by Driver and Tasker (1990). In this method, regression models were developed based on urban stormwater quality data collected for NURP in the early 1980's. These models relate variables such as storm-runoff loads, storm-runoff volumes, event-mean concentrations, and annual constituent loads to easily measured physical, land use and climactic characteristics of a region. This method was originally developed to predict these variables at sites where minimal or no data exist. With the inclusion of stormwater quality data collected at the Dallas-Fort Worth metroplex NPDES sites, model prediction accuracy is expected to improve.

#### Monitoring Program

Finally, the USGS will assist NCTCOG in designing a watershed monitoring program for the seven cities for the life of the NPDES permit (5 years). Based on experience gained from operating the stormwater characterization sites, analysis and interpretation of the data, and an evaluation of long-term monitoring needs, adjustments to the data collection network may be made.

To assist in determining long-term monitoring needs and to assess a framework for stormwater management planning, USGS will calibrate various deterministic watershed models at one or more monitored urban watersheds.

#### SUMMARY AND FUTURE DIRECTION

The North Central Texas Council of Governments, in cooperation with the U.S. Geological Survey, will assist its member cities in meeting the new EPA requirements for stormwater management. Data collected and analyzed by the USGS will be used to characterize the quality of stormwater in the Dallas-Fort Worth metroplex. An overall assessment of pollutant loadings from each city will be derived. As part of stormwater management planning, each city may investigate best management practices for implementing water pollution controls. These controls may be used, in accordance with EPA regulations, to the maximum extent practicable and will be in effect for the life of the NPDES permit. It is expected that the NCTCOG/USGS investigative program will be of substantial value to future stormwater management planning in the Dallas-Fort Worth, Texas, metroplex.

#### SELECTED REFERENCES

- Driver, N.E. and Tasker, G.D., 1990, Techniques for estimation of storm-runoff loads, volumes, and selected constituent concentrations in urban watersheds in the United States: U.S. Geological Survey Water Supply Paper 2363, 44p.
- Kilpatrick, F.A., Kaehrle, W.R., Jack Hardee, E.H. Cardes, and M.N. Landers, 1985, Development and testing of highway storm-sewer flow measurement and recording system: U. S. Geological Survey Water Resources Investigations Report 85-4111, 98p.
- U.S. Environmental Protection Agency, 1990, National pollutant discharge elimination system permit application regulations for storm-water discharges; final rule: U.S. Federal Register, Vol. 55, No.222, pp 47989-48091.