CITY OF MOBILE, ALABAMA
FLOOD PLAIN MANAGEMENT PLAN

1984

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FLOOD PLAIN MANAGEMENT PROGRAM

INTRODUCTION

Mobile is located at the mouth of Mobile River at the head of Mobile Bay. The Mobile River drains 64 per cent of the land area of the State of Alabama as well as portions of Georgia, Mississippi and Tennessee. The City's harbor has access to the Gulf of Mexico and world wide deep water ports. Completion of the Tennessee-Tombigbee Waterway will provide navigational access to the nations interior and accelerate economic development in Mobile and the upstream region.

Mobile presently has an area of 142 square miles, approximately 850 miles of paved streets, many large shopping centers and numerous large undeveloped areas.

The eastern part of the City lies in the Mobile River flood plain, and its flat topography causes two separate types of drainage problems. In the lower flat section, water ponds, is hard to drain and is subject to the effects of tidal action. In the western section where the topography is hilly, storm water travels at a high velocity and causes considerable erosion problems.

To compound that problem the City of Mobile experiences more rainfall than any other City its size in the United States. Information obtained from the U. S. Weather Bureau indicates that Mobile receives more than 64 inches of rainfall each year. This figure may be misleading, however, because the U. S. Weather Bureau rain gauge is located at the Mobile Municipal Airport which is located outside the Mobile City limits.

In 1980 the City of Mobile installed eight recording rain gauges in various locations within the City to assist in developing better rainfall information for the City.

These rain gauges are now being monitored by the City Engineering Department and as time goes by it is hoped that a rainfall pattern can be established for the City that will enable the Engineering Department to better plan for future drainage improvements.

CITY OF MOBILE
MASTER DRAINAGE MANAGEMENT OBJECTIVES

The following Flood Plain Management Program establishes criteria to control in the best interest of the City of Mobile and its' citizens all development in the City of Mobile with respect to the effect the development will have on the drainage system of the City and the 100 year flood plain in particular.

This program will stress control for the long term protection of the flood plain and the impact development will have on the environment.

The short term objectives shall consist of setting priorities for improvements to benefit large groups of citizens, access to emergency facilities and both structural and non-structural approaches to solving the City's drainage problems.

No dates for short term improvements shall be designated since this timetable will vary according to the financial capability of the City to carry out this program. The governing body of the City of Mobile will use this priority list as a guide for selecting projects to be constructed when funds become available.

This program has made no attempt to address the many individual problems that exist within the City since it is the existing policy of the City to correct these problems as quickly as possible by the use of Public Works forces or small contracts when funds allow these improvements.

SHORT RANGE DRAINAGE IMPROVEMENT GOALS

Although the following list of projects are included as short range improvement goals, the costs involved are of such magnitude that it would be impossible to accomplish all of these projects in a short range planning period such as five years. This list contains many projects that we consider to be of major importance to the improvement of drainage in the City and is set up as a guide for the governing body of the City of Mobile to select from when monies become available for construction.

Should other projects develop in the future that become of major importance they will be added to this list.

(1) Three Mile Creek Improvements - Corps of Engineers and City of Mobile Joint Project.

(2) Eslava Creek Improvements - Ralston Road to Pinehill Drive - Corps of Engineers and City of Mobile Joint Project.

(3) Eslava Creek Improvements - Holcombe Avenue to McVay Drive - City of Mobile Project.

(4) Completion of Woodcock Creek, Phase I Improvements.

(5) Completion of Boltons Branch Drainage Improvements.

(6) Extension of Moores Creek Drainage to Halls Mill Road.

(7) Repairs to Moores Creek - Highway 90 to Aldebaran Way.

(8) Repairs to Montlimar Creek - Highway 90 to Halls Mill Road.

(9) Big Stickney Drainage Improvements.

(10) Springhill Avenue Improvements at Wingfield Drive.

(11) Dauphin Street Drainage Improvements West of Sage Avenue near Lowes Hardware.

(12) Sage Avenue Drainage Improvements from Heather Street to Eslava Creek.

(13) Spring Creek Drainage Improvements.

(14) Replacement of Overlook Road Bridge.

(15) Replacement of Halls Mill Road Bridge at Spring Creek.

(16) Replacement of Demetropolis Road Bridge at Spring Creek.

(17) Morningside Drive Drainage System.

(18) Azalea Road, Highway 90 and Spring Valley Drive Drainage.

(19) McVay Drive and Highway 90 Drainage Improvements.

(20) Three Mile Creek at Greenway Subdivision Drainage.

(21) Tributary to Three Mile Creek at Victor Road.

(22) Twelve Mile Creek Tributary at Scout Hut.

(23) Texas Street Area Drainage Improvements.

(24) Stoneway, Craft Highway Improvements.

(25) Ravine Woods Drainage Improvements.

(26) Second Phase Magnolia Road Drainage.

(27) Automatic flood gates at Municipal Park dams.

(28) North end West Toulminville Drainage at Prichard City Limits.

(29) Cooperate with the University of South Alabama in the development of retention ponds and recreational lakes on campus.

LONG RANGE DRAINAGE IMPROVEMENTS

(1) Carlysle Subdivision and Forest Ridge Road Drainage.

(2) Virginia Street Drainage

(3) Hallett Street Pumping Station.

(4) Downtown Streets Drainage Improvements.

(5) Phase II Woodcock Creek Drainage.

(6) Crestivew Subdivision to I-10 Drainage Outfall.

(7) Completion of Toulmin Springs Branch Drainage.

(8) Little Stickney Drainage Improvements.

EVALUATION OF THE PROGRAM

It is the objective of this plan to continually update and evaluate the progress being made in controlling the Master Drainage Management Program.

As new methods and new construction products are brought to the attention of the Stormwater Drainage Management Officer they will be evaluated and permitted when it is felt they will work to the betterment of the plan.

As problems not previously addressed are brought to the attention of the Stormwater Drainage Management Officer they will be discussed and if necessary incorporated in the plan. These revisions shall be made on an annual basis.

ANNUAL PUBLIC HEARINGS TO KEEP THE PUBLIC INFORMED

At least once each year the City of Mobile shall provide for a public hearing to keep the public informed on progress being made with the City's Flood Control, Drainage, Erosion and Sedimentation Management objectives.

The City shall inform the public of the steps taken to enforce the plan over the past year, improvements made in the drainage system during the past year and to the best of our ability, proposals of what is planned for the coming year.

The public shall be given an opportunity to ask questions about the program and to express their viewpoint on how they feel the program is working and make suggestions for consideration on methods to improve the program.

These hearings shall be held annually in the council chamber of the City of Mobile Municipal Building and shall be scheduled at night for the benefit of the public.

INVENTORY OF MAJOR AND SECONDARY DRAINS

Although it would be desirable, the cost to obtain a field inventory of the location, size and elevation of all of the City of Mobile's underground storm drainage system would be prohibitive in view of the fact that with the exception of some of the drainage in the old downtown section of the City we have records of the major and secondary storm drain system in the other parts of town.

We have prepared maps which we keep on file in the City Engineers Office showing all of the major drains within the City and on individual maps of the subdivisions submitted for approval we have records of the secondary drains that feed these major drains.

With this information available we are able to develop the following Master Drainage Management Plan with utmost confidence that with proper enforcement and good cooperation from the developers this plan will give the required protection to the citizens of this City.

STORMWATER DRAINAGE MANAGEMENT OFFICER

The City Engineer of the City of Mobile has been designated by the Board of Commissioners of the City of Mobile to serve in the position of Stormwater Drainage Management Officer.

It shall be the duty of the Stormwater Drainage Management Officer to see that the Master Drainage Management Plan is administered and enforced in a manner consistent with the requirements and intent of the plan.

The Stormwater Drainage Management Officer shall interpret the plan and administer it to the best of his ability. He shall not have the authority to waive any requirements of the plan.

Sole authority for waiving the requirements of the plan shall rest with the Board of Commissioners of the City of Mobile and only then when it would cause an extreme hardship on the developer to follow the plan and when the waiver would not cause a flooding problem to any property downstream or upstream of the development.

FLOOD CONTROL DIVISION

Following the May 1981 flood the City of Mobile formed a new division of Public Works designated as the Flood Control Division.

This section consists of twelve men and the necessary equipment to monitor the condition of the major unimproved drains in the City and on a regular schedule clean and remove any debris that would tend to block the drainage and cause flooding problems.

In addition to this crew, the City has also an ongoing program to spray the major drains with approved chemicals to assist in controlling the growth of weeds on the ditch banks.

The Flood Control Division has become a permanent division of the Public Works Department and will be continued in force at its present level of strength until conditions develop that require the size of this organization to be increased.

INSPECTION OF FLOOD CONTROL STRUCTURES

In addition to the inspections performed by the Inspection Services Department and the City Engineering Department prior to approval of a Certificate of Occupancy of a building and the acceptance of the streets and drainage of a subdivision development, the City Engineering Department requires a certification by the registered professional engineer representing the developer that the development was built according to the approved plan.

It shall be the legal responsibility of the owner to see that the approved drainage system continues to operate as designed.

The system will be checked at appropriate times by the City Engineering Department to see that it continues to operate as designed. If the system is not operating correctly due to lack of proper maintenance or from being tampered with, the owner will be notified in writing that he has 10 days from date of notification to put the system back in working order.

If the system is not corrected to its original approved condition within the 10 day notification period, the owner will be issued a citation and fined One Hundred Dollars ($100.00) per occurence. Each day following the citation that the system remains out of compliance shall be considered a seperate occurence.

EXPOSED WATER AND SEWER LINES

The City of Mobile has been engaged in an active program to remove or have removed all known water and sewer lines that have become exposed as a result of the way they were installed or by deepening of the creek bed from the lowering of the grade by erosion.

Many of these locations have been corrected and others will be taken care of in the upcoming Three Mile Creek Project and the Eslava Creek Project now under study by the U. S. Corp of Engineers.

No further approvals for elevated water and sewer crossings will be issued or allowed.

No other utility will be permitted to install their facility in creek crossings in a manner that could cause potential flooding.

ACCESS TO EMERGENCY FACILITIES

The Three Mile Creek Project scheduled for construction by the U. S. Corp of Engineers in 1985 requires the City of Mobile to replace four bridges across Three Mile Creek and the State of Alabama will replace one existing bridge on U. S. Highway 45 at Three Mile Creek.

The replacement of these bridges will improve access to two of the major emergency facilities within the City.

The short range program to correct street flooding on several main thoroughfares within the City will also improve access to these and other facilities.

New emergency facilities built or now under construction in the western section of the City have good access and will be able to be reached in the event that problems arise to hamper access to other facilities prior to the necessary corrective measures being completed.

ENERGY DISSIPATION MEASURES

All developments requiring storm drainage to be released in a natural or man-made channel are required to take appropriate measures to reduce the flow velocity to a level that will not cause erosion at the point of release in the channel.

There are many approved methods of accomplishing energy dissipation such as drop structures, gabions, rip rap, sand bags with the appropriate cement content and others.

The City Engineering Department will examine any proposal using new ideas and state-of-the-art methods of reducing velocity and controlling erosion and if convinced that the proposal will accomplish the purpose for which it is intended without increasing the burden of maintenance on the Public Works Department will approve the plan.

LAND DISTURBING ACTIVITY PERMITS

A permit for land disturbing activity shall be required for any land change including but not limited to clearing, grading, transportation and filling of land, or other construction activities which would disturb the natural vegetation or the existing contours of the land which may result in soil erosion from wind or water and the movements of sediments into public or private storm drainage facilities.

No permit shall be required for such minor activities as home gardens, construction or maintenance of electric, television or telephone lines, construction or maintenance of underground utility lines in an existing hard surfaced street, alley or sidewalk provided the activity is confined to the hard surfaced area, construction or maintenance of individual underground utility connections, individual home landscaping, minor repairs, maintenance work, preparation for single family residences separately built where the residence, including driveways and other improvements, does not exceed 4,000 square feet, unless in conjunction with multiple construction in subdivision development, individual non-commercial tracts of land less than seven thousand five hundred (7,500) square feet. Persons engaged in agricultural operations requiring the tilling of soil shall not be required to secure a separate permit for each seasonal tilling activity; emergency work to protect life, limb or property or emergency repairs.

CITY OF MOBILE, ALABAMA
ENGINEERING DEPARTMENT

APPLICATION FOR
LAND DISTURBING ACTIVITY
PERMIT

Applications Fee Received By

Instructions: An application for a permit must include the Applicant's Site Grading and Drainage Plan to include an Erosion Control Plan along with sufficient engineer calculations to verify stormwater discharge(s). The plans must be factual and complete and submitted in duplicate to the City of Mobile, Alabama, Engineering Department after payment of an appropriate fee to the Land Use and Code Administration Department (LUCA).

Pursuant to the requirements of the City of Mobile Ordinance and its Flood Plain Management Plan the undersigned hereby applies for a permit as indicated hereon for the activity represented by the attached plans.

Applicant's Name	Telephone Number
Authorized Representative	Telephone Number
Street Address	Site Location/Legal Description
City State Zip Code	Address assigned by Engineer
Signature Date	City Engineer

Approval of Land Disturbance Permit is NOT authority to initiate construction. Applicant is responsible to obtain necessary approvals and insure compliance with applicable Zoning, Subdivision, Tree and Traffic Ordinance or Regulations.

LUCA Representative

Refer to construction plans on file in City Engineer's Office and in Land Use and Code Administration prepared for compliance with Ordinance 65-052 and accompanying standards. It is required that a licensed Professional Engineer certify to Land Use and Code Administration Department that this project has been completed in compliance with plans approved by the City Engineer prior to receiving a Certificate of Occupancy.

FEE STRUCTURE FOR LAND DISTURBING ACTIVITY PERMITS

The fee for the examination, inspection, checking and approval of site plans for the purpose of issuing a land disturbing activity permit shall be as follows:

Commercial building sites:

Parking lots under 10,000 S.F.	$100.00
Parking lots 10,000 S.F. - 50,000 S.F.	200.00
Parking lots over 50,000 S.F.	300.00

Subdivisions - with paving and underground drainage:

Two lot subdivisions	50.00
Three to five lots	100.00
Six to Twenty five lots	200.00
Over twenty five lots	300.00

P.U.D.'s and multi-family developments:

One to twenty five units	200.00
Over twenty five units	400.00
Land clearing only	50.00

No plans shall be considered for approval unless the application for a land disturbing activity permit is attached.

Each application shall be checked on a first in - first out basis. No application will be held by the City Engineering Department for more than 30 days unless it has to be resubmitted for changes.

POLICY GOVERNING CERTIFICATION FOR COMPLIANCE WITH APPROVED PLANS

Each project or development requiring a land disturbing activity permit shall have the site plan for grading, paving, and drainage designed by a registered professional engineer in the State of Alabama and licensed to do business in the City of Mobile, Alabama.

The developer shall retain the services of a registered professional engineer for the site work design and a sufficient amount of inspection time to allow the developer's engineer to submit to the Storm Water Drainage Management Officer a certification that the project was built according to the approved plans, provided, that if there are any significant changes in the final construction of the project from what was shown on the previously approved plans, new drawings and calculations must be submitted to the City Engineer for his approval. In the event that the changes from the original plan are of such significance that the conditions under which the plan was approved no longer can be met, then appropriate corrective measures must be taken to bring the project into compliance.

Any development plans that require Planning approval shall be approved for concept only by the City Engineer prior to receiving the approval of Planning Commission.

The City Engineer shall not recommend the project be accepted by the City of Mobile as complete nor shall the Director of Inspection Services issue a certificate of occupancy for any building until the City Engineering Department has received the certification of compliance from the developer's engineer and forwarded a copy to the Director of Inspection Services.

DRAINAGE AND DETENTION

In 1972 the City of Mobile initiated a major drainage program to upgrade and improve the many major drains within the City.

To set up this program it was first necessary to divide the City into three major water shed acres. These were established as the Three Mile Creek, Mobile River and Dog River Drainage Basins. Each of these major areas consist of many individual drainage areas. It is the primary outfall system in each of these drainage areas plus the major creeks that make up the major drainage system of the City of Mobile. In addition to the major drains, the City has many thousand feet of secondary drains that are the responsibility of the City. Many other small drains exist in the back yards of existing subdivisions that were left for the convenience of the property owner and are not the responsibility of the City of Mobile.

Setting up the criteria of the major drainage program was accomplished after numerous meetings with members of the City Engineering Department and various consulting engineers.

Considering the topography, the annual rainfall data and the economic ability of the City, it was decided that a rainfall criteria using a 3.2 inch per hour rainfall would be the best for the City . This very closely equaled the ten year rainfall curve for this section of the State and compared very favorably with the ten year rainfall design selected by many cities across the country.

It should be noted that even though the ten year rainfall criteria was the same as selected by many other cities, the rainfall curve that designates the ten year rainfall in Mobile shows more hourly rainfall than any other City this size, therefore, a system to handle a ten year rainfall in Mobile is considerably larger than many other cities using the ten year rainfall criteria.

PURPOSE

The purpose of this program is to allow for the orderly growth of the City and the development of properties in accordance with the guidelines set forth by the City of Mobile Planning Commission in such a manner as to protect the property of adjacent citizens from flooding as a result of development. For this reason, the Planning Commission will coordinate it implementation of this plan with adjacent communities in order to develop as effectively as possible a unified regional approach to the flooding problems in and around the City of Mobile.

It is also the purpose of this program to set acceptable standards for the control of sedimentation and erosion and the provision of retention/detention when required.

POLICY FOR ADEQUATE DRAINAGE REQUIREMENTS

1. Policy

In order to protect the citizens of this area and to reduce the probability of flooding as well as to control the environment by the reduction of erosion and sedimentation, measures for adequate drainage of surface waters shall be taken and provided in connection with all land development activities.

Adequate drainage of surface waters means the effective conveyance of storm and other surface waters through and from the development site and the discharge of such waters into a natural water course or drainage facility of sufficient capacity, without adverse impact upon the land over which the waters are conveyed or upon the water course or facility into which such waters are discharged.

The provisions of the necessary easements to accomplish the above including sufficient easement to allow for future development and enlargement of drainage facilities shall be required.

2. Minimum Requirements

The following are the minimum functional requirements for adequate drainage:

(a) The drainage system must have the hydraulic characteristics to accomodate the maximum expected flow for surface waters for a given watershed, or portion thereof, for the duration and intensity of rainfall as shown on the 3.2 inch per hour rainfall curve for the City of Mobile.

(b) Determination of the size and capacity of the drainage system shall be based on the planned development and zoning as shown on the City of Mobile Planning Commission proposed land use maps or the existing development, whichever is the greater, within the watershed or sub-drainage area within the watershed.

(c) The drainage system shall be designed:

(1) To honor natural drainage divides.

(2) To account for both on-site and off-site surface waters.

(3) To convey such waters to a natural watercourse, or an existing storm drainage facility and

(4) To discharge the surface waters into a natural watercourse at the natural elevation, or into an existing storm drain facility of adequate capacity.

(d) The drainage system shall be designed such that properties over which the surface waters are conveyed, from the development site to discharge point(s), are not adversely affected.

(e) Concentrated surface waters shall not be discharged on adjoining property, unless an easement expressly authorizing such discharge has been granted by the owner of the affected land or unless the discharge is into a natural watercourse, or other appropriate discharge point.

(f) The owner of a development may continue to discharge storm water which has not been concentrated into a lower lying property if:

(1) The developed peak discharge rate does not exceed the pre-development peak discharge rate.

(2) The increase in volume caused by the development will not have an adverse impact on the lower lying property; and

(3) There is no existing drainage problem on the downstream property.

If these discharge conditions are not met, and the discharge may aggravate an existing drainage problem or cause a drainage problem, the developer must provide a drainage system satisfactory to the Storm-water Drainage Management Officer of the City of Mobile, to preclude

an adverse impact upon the adjacent property.

(g) Drainage structures, including retention ponds, shall be constructed in such a manner that they can be maintained at reasonable cost. To facilitate design, construction, and maintenance, all drainage facilities, as far as practical, shall meet and conform to the City of Mobile and Alabama State Highway Standards.

(h) If the outfall is into a natural watercourse, the ten year peak flow from the development within the watershed, must be at a flow rate and velocity which the watercourse can handle without erosion or over-bank flooding. Alternately, if the developer chooses, the downstream watercourse may be modified so that it can handle the ten year post-development flow, provided, however, that if the developer chooses to install a storm drain system, the system shall be designed in accordance with the City of Mobile drainage criteria for such systems.

(i) If off-site downstream construction and easements are necessary to obtain an adequate outfall, no plans will be approved until such storm drainage easement(s), extending to the nearest natural and well-defined, adequate, stabilized watercourse, or adequate man-made drainage channel or pipe, has been obtained and recorded. If the downstream owner or owners refuse to give or to sell such easement(s), the developer may request condemnation of the easement(s) by the City at the developer's expense, if a public need can be established.

(j) Storm sewers should be discharged into the area least likely to erode. Generally it is better to discharge at the flood plain limit into an adequate existing watercourse channel leading to the main stream bed rather than disturb the flood plain by extending the storm sewer. If an adequate watercourse channel doesn't exist, the only alternative is to discharge into the main stream bed. In either case, energy dissipation devices are required.

(k) All drainageways, including overland relief pathways, must be separated from buildings. Where storm drains in a public easement are adjacent to or run between buildings the pipe must be gasket joint or equal. Mortar joint pipe will not be permitted.

(l) Consideration must be given in the preparation of the plans to prevent adverse impacts on adjacent property due to higher rates of volumes and flow than the design criteria. Particular attention must be given during construction to protect adjacent properties from damage due to surface flow, erosion or sedimentation.

3. Submission of Narrative Description

In addition to plats, plans, and other documents that shall be required, a description of the outfall of the storm drainage system and of non-concentrated discharge(s) of surface waters from the development site shall be submitted as part of the relevant subdivision construction plan or site plan. This additional submission shall include a narrative, computations, and sketches describing the major elements (pipe, channel, natural watercourse stream, etc.) of the outfall drainage system(s), including discharges of non-concentrated surface waters from the development site, divided into reaches. This downstream review shall note the existing surrounding topography, soil types, embankments, vegetation, structures, abutting properties, etc., which may be impacted by drainage and shall conclude with a written opinion, signed and sealed by the designer as to the adequacy of the downstream system(s) for the critical storm return period.

Where erosion is an issue, the critical storm return period referenced in the preceding paragraph would normally be the two-year storm. Where an existing facility is at issue (such as storm sewer system, highway culvert, etc.), the critical storm return period would be that storm return frequency which begins to exceed the capacity of the existing

facility up through the normal design standard for that type of facility (such as 10 year for storm sewer, 50 year for primary highway culvert, etc.). Where house flooding is involved, the critical storm return period would normally be the storm that begins to flood the structure up through the 100 year flooding event. Similarly, where a primary highway culvert is involved, the critical storm return period would normally be the storm which begins to exceed the capacity of the culvert up through the 50 year event.

Where open streams are involved, the designer must check the stream adequacy to receive the two-year run-off without causing erosion or the ten year storm run-off without causing over-bank flooding.

The downstream extent of this review shall be:

(a) To the point at which an adequate channel* is found; or

(b) to the point at which the total drainage area is at least 100 times greater than the area of the development site in question; or

(c) to the limit of the nearest 100 year current FEMA Flood Insurance Rate Map flood plain, whichever occurs first.

The Stormwater Drainage Management Officer shall have the right to require further downstream analysis, where the submitted narrative and all related plats and plans are insufficient to show the true impact of the development on surrounding and other lower lying properties.

No narrative description will normally be required when the storm sewer discharge is into a pipe or other drainage system meeting current design standards and the peak rates of non-concentrated flows onto adjoining properties are not increased by the development.

*An adequate channel shall be defined as a natural or man-made channel or pipe which is capable of conveying the run-off from a 10 year storm without overtopping its banks or eroding after development of the site in

question, or without causing the flooding of structures from the 100 year storm event.

RETENTION/DETENTION

It is the intent of this program to encourage the use of various methods of on-site detention of stormwaters in the interest of minimizing the effects of increased stormwater run-off resulting from development of land within the City and adjacent areas that discharge stormwater into the City drainage system(s).

Further, it is also the intent of this program to encourage a regional approach in the implementation of storm water detention, rather than numerous small, marginally effective individual on-site ponds. Some methods of detention are discussed later in this article, however, we encourage the designer to seek new approaches for consideration.

Temporary on-site detention of stormwater is desirable in many cases to alleviate existing downstream drainage problems and to prevent the development of new ones. Detention is mandatory where the existing downstream drainage system is clearly inadequate and its expansion or improvement is either financially prohibitive or aesthetically unacceptable. However, there may be some occasions where detention will cause increased peak flows to occur on the major streams or outfalls. The City reserves the right to prohibit stormwater detention where it is not in the best interest of the City.

The release rate from any detention site shall not be greater than the run-off rate prior to the development of the site for the 10 year storm. Adequate overflow drainage must be provided to accomodate the excessive flows from storms greater than the design storm. In no event shall the pond be built in such a manner as to cause flooding of downstream properties in cases of over-topping of the detention pond.

Storage may be accomplished by utilizing roof tops of buildings properly designed to accomodate the additional live loading involved.

Detention ponds or storage basins may be constructed in parks (with the approval of the Parks and Recreation Director), parking lots or by the use of underground storage to provide temporary on-site storage. Care must be taken that the ponds do not become nuisances or health hazards. The design engineer should strive to design detention facilities which require minimal maintenance. The maintenance responsibility will be clearly stated on the plans. Where a property owners association is responsible for the maintenance of the detention pond such an agreement must be recorded prior to the final acceptance of the development plans. Any such statements of maintenance responsibilities must specify the types of maintenance activities which will be used in conjunction with detention ponds or storage basins and must include a statement of the frequency and anticipated expense of such maintenance activities.

Where off-site run-off is allowed to pass through the pond area, adequate provision for low flow drainage may be required.

Where soil conditions are such that stormwater run-off would be readily absorbed by the ground a porous material such as gravel may be used as an alternative to a non porous paving material to lessen the amount of stormwater run-off when approved by the Board of Commissioners of the City. Design engineers are encouraged to investigate and propose experimental uses of new or existing products and methods where such use may appear appropriate.

At the present time all detention facilities are to be maintained by the developer or in the case of subdivisions by the property owners association. The property owners association agreement must be approved and recorded prior to final acceptance of the subdivision.

Although this policy is set out to prevent the post-development peak flow from exceeding the pre-development peak flow this does not improve the condition when the outfall system is overloaded. By utilizing additional storage it might be possible to reduce the pre-development

peak flow to the point where an inadequate outfall is acceptable. When used in this manner it may reduce the responsibility of being required to make improvements to the outfall system.

When the existing outfall system does not meet the required 10 year design capacity it may be necessary to reduce the pre-development peak flow by as much as 25 per cent to avoid making improvements in the outfall system.

Whenever stormwater management facilities, such as detention ponds, are planned in areas within 300 feet of a residence or active recreation areas, special design attention shall be given to the safety aspects of the facility including such factors as mild bottom slopes along the outer edge of the pond extending into the pond to where the depth exceeds two feet, flat lateral and longitudinal slopes where concrete low flow channels are used, properly designed outlet structures to prevent human entrance.

POLICY ON OFF-SITE DRAINAGE IMPROVEMENTS

In the interest of the health, safety and welfare of all, when the appropriate land use has been determined for any area to be developed, the City reserves the right to require the developer to show that off-site downstream drainage can be accomodated (considering the planned development of the contributing watershed) without damage to existing facilities or properties before such development is approved for construction.

In some instances, the developer will have a choice to either contribute his proportionate share toward the correction of off-site outfall deficiencies or install on-site storm water drainage detention to minimize the downstream impacts. However, the City reserves the right to require pro-rata share contributions in areas where downstream pro-rata share improvements have been installed and/or storm water detention is not in the best interests of the overall drainage system.

Where the developer chooses to either construct or provide the funds for the construction of more than his proportionate share of the downstream off-site drainage improvements so that he may proceed with the improvement of his land without damaging the properties of others, the City will endeavor to collect, on a pro-rata basis, any excess funds expended beyond his proportionate share of the cost of such improvements from other properties within the watershed served by such drainage improvements when such properties are developed within a period of ten years from the date that the drainage improvements are financed or constructed and to turn these funds without interest over to the initial developer or his assigns.

POLICY ON PROPORTIONATE COST

OFF-SITE DRAINAGE IMRPOVEMENTS

Development within a watershed involving a change of land use therein is normally associated with an increase in impervious areas resulting in a greater quantity as well as a more rapid and frequent concentration of stormwater run-off. The construction of storm drainage improvements is required along waterways as shed development progresses to alleviate flood damage and arrest deterioration of existing drainageways. The extent and character of such improvements shall be designed to provide for the adequate correction of deficiencies. Improvements will extend downstream to a point where damages to existing properties ascribable to the additional run-off will be minimized. The purpose and intent is to require a subdivider or developer of land to pay his pro-rata of the cost of providing reasonable and necessary drainage facilities located outside the property limits of the land owned or controlled by the subdivider or developer, but necessitated or required, at least in part, by the construction or improvement of his subdivision or development.

When directed to do so by the City Commission, the Stormwater Drainage Management Officer or his designee shall study and compute the total estimated cost of ultimate drainage facilities required to serve a drainage-shed when and if such drainage-shed is fully developed in accordance with the adopted comprehensive plan for the shed or the current zoning of the land, whichever is higher.

The computation of estimated cost shall include the cost of an engineering study of the watershed, the total cost of storm drainage construction, the engineering cost of such construction, easement and flood plain acquisition cost where necessary plus a factor of twenty five percent (25%) to be added to cover the cost of contingencies and inflation until such time as the project is constructed by the City.

The above study with its attendant cost figures shall be updated to reflect actual estimated costs plus contingencies and inflation for each development that is to become a part of this program.

When a general drainage improvement program has been established a pro-rata share of the total cost of the program shall be determined as follows:

(1) The estimated increased volume and velocity of storm water run-off for the drainage-shed shall be computed in a fully developed state in accordance with the adopted comprehensive plan or the current zoning of the land, whichever is higher.

(2) The increased volume and velocity of storm water run-off caused by the development under consideration shall be computed.

(3) The ratio of the volume and velocity of storm water run-off caused by the development under consideration to the estimated total increased volume and velocity of storm water run-off for the developed drainage shed, expressed as a percentage, shall be applied to the total cost of the drainage improvement program for the drainage shed. The resultant figure shall be the pro-rata share for the development under consideration.

The payment of the pro-rata share of the development under consideration shall be due prior to the approval of the plans for the development.

Payments shall be deposited in an interest bearing account by the Director of Finance of the City of Mobile. Interest shall accrue to the benefit of the City of Mobile.

Payments received shall be expended only for the construction of the

drainage facility for which the payment was calculated.

When storm water retention/detention facilities are incorporated in the drainage design for a development plan to reduce the increase in storm water runoff and thereby reduce or eliminate the pro-rata share cost, an agreement must be made with the City to insure that the construction of such facilities will be in accordance with approved plans and specifications, and that the facility will be adequately maintained. This agreement will be executed and recorded before the development plan is approved.

POLICY ON WHAT IS ALLOWED IN FLOOD PLAINS

It is recognized by the Board of Commissioners that certain activities must be permitted in the 100 year flood plain so long as the permitted activity does not alter the flood carrying capacity of the altered or relocated portion of the natural channel of the flood plain.

In order to allow limited development in the flood plain some improvements may be needed in the flood plain, streams and/or drainage-ways in such a manner that the increased run-off from changes or improvements within the watershed be accomodated without raising the level of the flood plain or stream levels.

In the development of subdivison lots located in or adjacent to a flood plain each lot must contain sufficient area of land above the 100 year flood plain to reasonably allow a residence to be constructed thereon, taking into account all required setbacks. No clearing or grading may be done in the flood plain without the approval of the Stormwater Drainage Management Officer.

The lowest floor elevation shall be a minimum of one foot above the 100 year flood plain or a minimum of one foot above known high water when the flood plain has not been designated.

In order to develop within the 100 year flood plain the applicant must have a registered professional engineer provide factual data that any proposed structure will not raise the water surface elevation of the 100 year flood plain, that the first floor elevation is at least one foot above the water surface elevation of the 100 year flood plain.

The applicant must specify the 100 year flood plain water surface elevation and the limits of the 100 year flood plain on the plan.

Non-residential structures or parts therof may be constructed below the regulatory flood elevation provided that these structures are designed to withstand inundation to an elevation at least equal to the 100 year flood elevation. The submitting engineer or architect shall specify this elevation and certify that the structure has been flood-proofed and that the flood-proofing complies with F.E.M.A. requirements.

Filling will be allowed in the flood plain only when it is possible to compensate for the fill with an equal amount of excavation or it can be shown by proper engineering data that it does not interfere with flow of surface drainage or raise the elevation of the flood plain and provided that the conveyance capacity of the flood plain is conserved.

WARNING AND DISCLAIMER OF LIABILITY

The degree of flood protection required by this program is considered reasonable for regulatory purposes. Larger floods may occur on rare occasions or flood heights may be increased by man-made or natural causes, such as pipe openings, box culvert openings or bridge openings being restricted by debris. This program does not imply that areas outside of the flood plain areas, or land uses permitted within such areas, will be free from the possibility of flooding or flood damages. Additionally, the granting of a permit or approval of a site, subdivision of land development plan in an identified flood plain or flood hazard area shall not constitute a representation, guaranty or warranty of any kind by any official or employee of the City of Mobile of the practicability or safety of the proposed use, and shall create no liability upon the Cityof Mobile, its officials or employees.

RULES
OF
CITY OF MOBILE, ALABAMA
DEPARTMENT OF
FLOOD PLAIN MANAGEMENT, CONSTRUCTION AND
ENGINEERING SERVICES
FOR EROSION AND SEDIMENTATION CONTROL AND
STORM WATER RUN-OFF CONTROL

It is the intent of the Board of Commissioners of the City of Mobile that these standards be used in conjunction with the City of Mobile Ordinance 65-045, being an ordinance to supplement Ordinance 65-122 (The Flood Plain Land Use Ordinance) to provide comprehensive jurisdictionwide land management specifically to implement Ordinance 65-122 Article IV A(5) and including site control, soil and sediment control and applicable storm water retention/detention.

"These standards shall not be considered as a rigid requirement where variation will achieve a better technical and/or economical solution. Indeed it is encouraged that consulting engineers continuously seek new and better solutions."

CITY OF MOBILE, ALABAMA

Gary A. Greenough - Commissioner
Robert B. Doyle - Commissioner
Lambert C. Mims - Commissioner

Rick Stout
City Attorney

Thomas K. Peavy
City Engineer

Rules
of
City of Mobile, Alabama
Department of
Flood Plain Management, Construction and
Engineering Services
For Erosion and Sedimentation Control and
Storm Water Run-off Control

Plans Required.

(a) The Plan for the land-disturbing activity shall consider the interrelationship of the soil types, geological characteristics, hydrological characteristics, topography, watershed, vegetation, proposed permanent structures including roadways, constructed waterways, sediment control and storm water management facilities, local ordinances and State laws.

(b) The Plan shall consist of narratives, maps and drawings, activity schedules, and other supportive data as necessary to present a complete understanding of the proposed land-disturbing activity.

(1) A brief description of the following shall be provided:

a. Locations, size and zoning classification of the land to be disturbed;
b. Size and type of existing and proposed structures, paved areas and vegetative areas;
c. Existing and anticipated erosion and sediment control problems;
d. Proposed sediment control program;
e. Storm water management program, if proposed, including the effect on the downstream facilities;
f. Major topographic features, streams, existing soil types and vegetation;
g. Maintenance programs for the sediment control facilities and vegetative practices; and
h. Site preparation including clearing, grubbing and disposition of debris.

(2) Maps, drawings, or sketches of the following shall be provided:

a. Vicinity and location of the land to be disturbed;
b. Boundaries of the land and of any easements across such land;
c. Existing and proposed finished grades (topography);
d. Cross sections of existing and proposed finished grades (cuts and fills);
e. Existing and proposed water courses and drainage characteristics;
f. Existing and proposed vegetative covers;
g. Existing soil types and locations, and soil type classification of imported fill; and
h. Existing and proposed structures and paved areas.

(3) Activity schedules shall show the anticipated starting and completion dates for all land-disturbing activities including, but not limited to:

a. Clearing and grubbing operations;
b. Excavation and rough grading;
c. Finished grading;
d. Construction of temporary and permanent sediment control measures;
e. Disposition of temporary sediment control measures;
f. Consruction of storm water management facilities;
g. Building construction; and
h. Final stabilization.

(4) Supportive data used in design of storm water run-off control shall include calculations and references to applicable charts, graphs, maps, standards and specifications and other resource data.

A. Basic Principles.

The erosion which is to be controlled is caused by rainfall and run-off water. The energy of raindrops displaces soil particles on incompletely protected areas, and water running over this land toward downstream channels moves these soil particles generally in proportion to the water's velocity and volume. As the volume and velocity increase, additional particles are picked up from the channels, large and small, and added to the sediment load. Deposition occurs as the water slows down in dispersion or behind barriers such as causeways and dams.

The foregoing provides the basic principles for reduction of soil loss and sediment deposition:

a. Minimize the area and duration of soil exposure.
b. Protect the soil with mulch or vegetative cover.
c. Slow down the velocity of run-off with planned engineering works.
d. Reduce the volume of run-off on denuded areas by planned diversions.
e. Prepare the drainageways to handle the concentrated and increased run-off resulting from paved areas.
f. Trap the sediment in temporary or permanent basins.
g. Maintain the work done; inspect it frequently.

To enlarge on the principles above, consider the following:

(a-1) Minimize the area of soil exposed. The smaller the area exposed the less chance there is for costly soil loss. Soil exposure can be reduced by minimizing grading through adapting the development to the natural terrain and by limiting grading to areas of workable size.

(a-2) Reduce the duration of soil exposure. The less time the land is exposed during this vulnerable period the less chance there is of serious erosion.

(b) Protect the soil with mulch or vegetative cover. Both a-1 and a-2 above can be served by covering denuded areas quickly with mulches of straw, hay or fibers, by sodding or by planting with temporary or permanent vegetation. All areas not being actively worked should be covered, and this requires detailed scheduling for grading, utilities installation and building construction. Mulch or grass will absorb the impact energy of raindrops, slow the flow and permit more rainfall to soak in. Street areas can be protected by getting the base down early.

(c) Slow down the velocity of run-off with planned engineering works. Water velocity provides energy for soil transportation. Velocities of 6-8 feet per second will cause erosion even on a cohesive soil with good vegetation. Interceptors and diversions with grades of 0.5 to 2% will reduce velocities to the point where erosion is minimized and deposition will occur on-site rather than off-site.

(d) Reduce the volume of run-off on denuded areas with planned diversions. A diversion at the top of a slope will reduce the volume of flow across the slope to that which actually falls on the slope. The energy of an ever-increasing stream running unimpeded for several hundred feet down a 10% slope will carve great gullies in a single storm. Designed interceptors which divert the flow to protected areas can reduce the volume of flow across unprotected areas and minimize this gullying. Temporary storage produces the same benefits.

(e) Prepare the drainageways to handle the concentrated and increased run-off. Paving, rip-rap, sodding or protection by seeding and anchoring with jute or other fibers permit waterways to carry the increased peak volumes and velocities without contributing to the erosion protential. The waterway must obviously be protected in advance of the increase in run-off.

(f) Trap the sediment in temporary or permanent basins. Stopping the flow for even short periods of time will cause some deposition to occur. A sediment basin is the most positive remedy against downstream siltation, but it is the last chance when all else fails. Sediment basins are expensive to build and difficult to clean out. Where used, advance plans must be made for their periodic cleanout and for disposal of the removed sediments. Recognize that only 70 - 75% trap efficiency is reasonably attainable with mechanical measures.

(g) Maintain the work done; inspect it frequently. Diversion berms which are breached for construction and not repaired do no good when the storm hits; the extra costs are wasted. Likewise, sediments traps which are full of silt have done their work and no longer function. Gullies starting on seeded slopes may be checked easily if quick action is taken for repair. All measures should be inspected at the close of each work day and after every rain storm.

The above prinicples apply universally, but some soils are much more erodible than others. It pays to know what type you are dealing with and to plan accordingly.

B. Requirements for Erosion and Sediment Control Plans.

1. The Plan

(a) The plan shall consist of two parts:

A narrative report describing the project and giving the purposes, schedule or phasing of major construction activities, schedule of application of conservation practices, engineering assumptions and calculations for the control measures; this narrative is to be included in the construction plans so that it is readily available to the job superintendent and the inspector.

A map or maps of the same scale, depicting the topography of the area, the limits for clearing and grading, other proposed alterations of the area, and the location of the control measures and facilities.

(b) The plan shall spell out the methods, techniques and procedures to be followed to control accelerated erosion and sedimentation.

(c) The plan shall:

Clearly identify the type, magnitude and location of both existing and anticipated erosion and sedimentation.

Define the areas to be affected by clearing and grading.

Show the areas to be mulched and the areas to be established with temporary or permanent vegetation.

Account for the staging of major land disturbing activities and include the timing and sequence of installing the conservation practices and facilities.

Show the location of erosion and sediment control practices, such as sediment basins, diversions, waterways, storm drains, dikes, terraces and similar structures when such practices are needed.

*Show the location and design basis for storm water management facilities, including retention/detention structures if proposed.

Provide details on topography, drainage and existing vegetation.

Be an integral part of the site plan, subdivision plan, or grading plan required.

*If stormwater detention storage is included, owner must provide City with a plan for the maintenance of the detention facility. Said plan shall set forth the maintenance requirements of the facility and the party responsible for performing the maintenance, other than the City of Mobile, and shall include an estimate of the anticipated costs of such maintenance.

(d) The conservation practices needed to control accelerated erosion and sedimentation vary widely from site to site. Such factors as degree of slope, nature and types of soil, drainage characteristics, proximity to property boundaries and watercourses, acreage disturbed, amount of cut and fill, as well as other factors have a direct bearing on what combination of conservation practices will result in an adequate erosion and sediment control plan.

(e) Recognizing the wide variations from one site to another the following are required.

2. In the narrative:

Brief description of the overall project.

Date project is to begin and expected date final stabilization will be completed.

Predominant soil types.

Brief description of accelerated erosion control program.

Brief description of sediment control program.

The phasing or staging of land-disturbing activities, including removal and stockpiling of topsoil.

Brief description of storm water management program.

Maintenance program, including frequency of inspection, resodding or reseeding of vegetated areas, repair or reconstruction of damaged structural measures, method and frequency of cleanout, disposal of waste materials, and disposition of control measures after they have served their purpose.

3. On the Plan or Map

The location of the project relative to streets, subdivisions, major streams, or other identifiable landmarks.

Acreage of the project.

Contours at an interval and scale that will adequately describe the area.

Limits of clearing and grading.

Limits of the flood plain.

Critical environmental areas located within or in proximity of the project areas, such as stream, lakes, ponds, wetland areas.

Nature and extent of existing vegetation.

Location and types of facilities to be installed.

Dimensional details of facilities.

4. Supporting Data

*Design considerations and calculations showing pre-development run-off, post-development run-off, and retention/detention facilities.

Brief analysis of problems posed by storm run-off on downstream areas.

For areas less than 200 acres of tributary area the Standard Rational Method for pre-development run-off will be acceptable.

The Standard Rational Method and the Modified Rational Method of calculating release rate and required storage after development are typical examples of approved methods. Complex drainage basins may require more sophisticated techniques for calculating **run-off and required storage than the above described methods.

Included for convenience are the following:

(1) Rational Method
(2) Modified Rational Method
(3) Pre-Development Nomograph
(4) Values for rainfall - intensity duration 3.2 inch/hour (10 year - 60 minute duration) curve
(5) Map showing 10 year - 60 minute rainfall curves
(6) Rational Formula Run-off Coefficients
(7) Typical installation for restricting flow from a developed site

*If stormwater detention storage is included, owner must provide City with a plan for the maintenance of the detention facility. Said plan shall set forth the maintenance requirements of the facility and the party responsible for performing the maintenance, other than the City of Mobile, and shall include an estimate of the anticipated costs of such maintenance.
**Such techniques shall be undertaken only by a professional engineer licensed in the State of Alabama who shall certify that the technical methods used reflect currently accepted engineering concepts.

THE RATIONAL METHOD

I. The Rational Method or modification thereof, shall be used to calculate peak flows due to rainfall in drainage areas of less than 200 acres.

II. Underlying Assumptions:
   a. The rainfall intensity is uniform over the entire watershed during the entire storm duration,
   b. The maximum run-off rate occurs when the rainfall lasts as long or longer than the time of concentration,
   c. The time of concentration is the time required for the run-off from the most remote part of the watershed to reach the point under design.

III. Rational Formula:
   $Q=CiA$
   where Q is peak discharge, cfs
   C is a run-off coefficient, dimensionless
   i is rainfall intensity, in/hr
   A is drainage area, acres

IV. Description of Variables:
   a. C Run-off coefficient: Percentage of rainfall within a certain drainage area which appears as run-off. Is a function of surface type, slope, intensity, and, to lesser extents, other factors.
   b. i Rainfall intensity: Intensity of rain occurring at time of concentration. Function of storm frequency, location, and time of concentration. Severe, less frequent storms are more intense.
   c. A Area: Drainage area, i.e. area which contributes run-off flows to point under consideration. Also called watershed, drainage basin, catchment area.

The Rational Method should be modified to allow for Antecedent Moisture Precipitation Conditions for use with major storms. The Rational Formula is modified as follows to allow for frequency factor C_f:

$$Q=CiA\ C_f$$

Recommended Antecedent Moisture Factors for the Rational Formula:

Recurrence Interval (years)	C_f
2 to 10	1.0
25	1.1
50	1.2
100	1.25

Definitions:

Time of concentration: The required time for run-off to become established and flow from the most remote (in time) part of the drainage area to the point under consideration (concentration point).

Modified Rational Method Analysis

The term Modified Rational Method Analysis refers to a procedure for manipulating the basic Rational Method techniques to reflect the fact that storms with durations greater than the normal time of concentration for a basin will result in a larger volume of run-off even though the peak discharge is reduced. This greater volume of run-off produced by longer duration storms must be analyzed to determine the correct sizing for detention facilities. This procedure should be limited to tributary basins less than 200 acres.

Figure 9. Modified Rational Method Hydrographs presents a family of curves for a theoretical basin. These hydrographs are developed by using the basic Rational Method assumptions of constant rainfall intensity (i) time of Concentration (T_c) from the most distant point, timewise, and the coefficient of run-off (C). The typical Rational Formula hydrograph with the peak discharge coinciding with the time of concentration for the basin (T_c), is first calculated using the normal formula Q=CiA. Following this, a family of hydrographs representing storms of greater duration are developed. The peak run-off rate for each hydrograph is equal to CiA where (i) is the rainfall intensity for the storm duration in question. The rising limb and falling limb of the hydrograph are, in each case, equal to (T_c) for the basin. The basic assumption of this method is that the area under the assumed trapazoidal hydrograph equals the volume of run-off from the theoretical rainfall. The area under the hydrograph is also equal to the peak discharge rate for that particular rainfall times the duration of the rainfall.

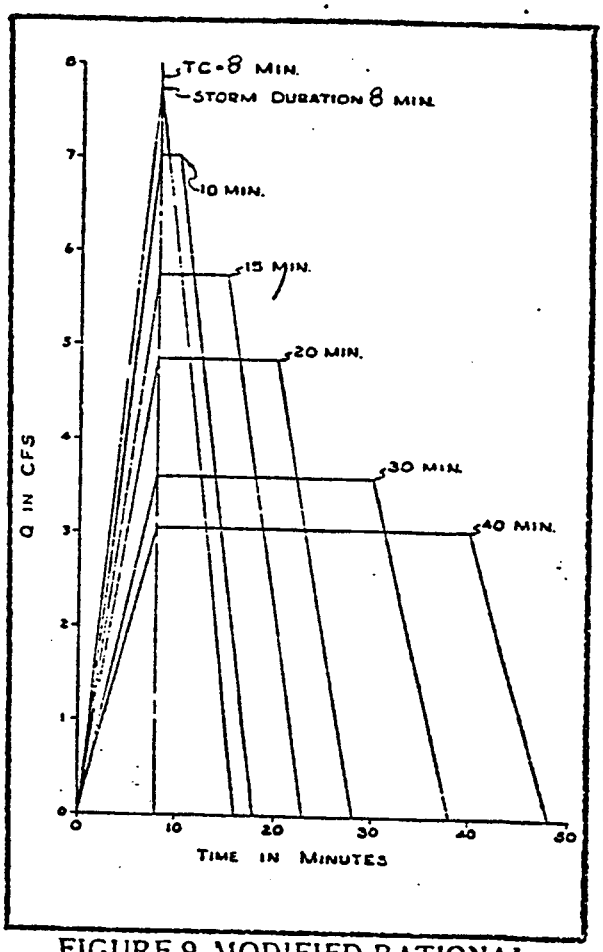


FIGURE 9 MODIFIED RATIONAL METHOD HYDROGRAPHS

The following example represents the calculation method for a typical two-acre basin.

Example No.1
Given
Area: A=2.0 acres
Type of development: commercial parking lot, fully paved, C=0.9
Design rainfall frequency: five-year
Rainfall time-intensity-frequency curves: as indicated in Figure 10, Rainfall time-intensity-frequency chart
Time of Concentration: T_c=8 minutes
Required:
Develop family of curves representing Modified Rational Method hydrographs for the 8, 10,15,20,30 and 40 minute rainfall durations.

Rainfall Duration (minutes)	Rainfall Intensity (in/hr)	Rainfall Run-off Rate(cfs)
8	4.3	7.74
10	3.9	7.02
15	3.2	5.76
20	2.7	4.86
30	2.0	3.60
40	1.7	3.06

Answer: The resulting storm hydrographs are depicted in Figure 9.

It is recommended that a coefficient be added to the Rational Method to account for antecedent precipitation conditions for major storms with recurrence intervals greater than 25 years. Table 13, Recommended Antecedent Precipitation Factors, presents a set of recommended coefficients. Under these conditions, the Rational Formula becomes $Q=CC_aiA$. Although this approach does not totally reconcile the difficulties in representing volume of run-off by the Rational Method, it does attempt to predict more realistic hydrograph volumes characteristic of the higher frequency storms.

TABLE 13
Recommended Antecedent Precipitation Factors for the Rational Formula

Recurrence Interval (years)	C_a
2 to 10	1.0
25	1.1
50	1.2
100	1.25

The next step in determining the necessary storage volume for the detention facility is to (1) set a release rate and determine the volume of storage necessary to accomplish this release rate or (2) determine the amount of stormwater storage volume available on the site and then determine the minimum release rate required so as to not exceed the storage volume. The first possibility, that of determining necessary storage volume when a pre-determined release rate is selected. will be dealt with first.

To determine the storage volume required, a reservoir routing procedure should be accomplished on each of the hydrographs, with the critical storm duration and required volume being determined. The importance of the particular project should govern the type of routing utilized. For small areas requiring repetitive calculations, such as in bays of a parking lot, an assumed release curve is normally satisfactory. When good Engineering practice dictates a need, standard reservoir routing procedures will be used

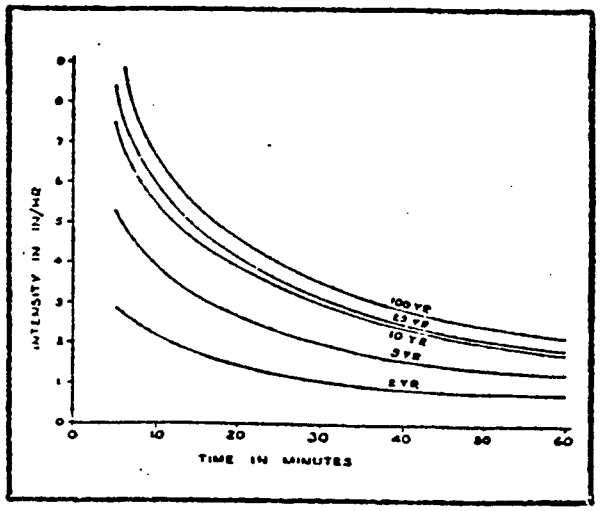


FIGURE 10 RAINFALL TIME-INTENSITY-FREQUENCY CHART

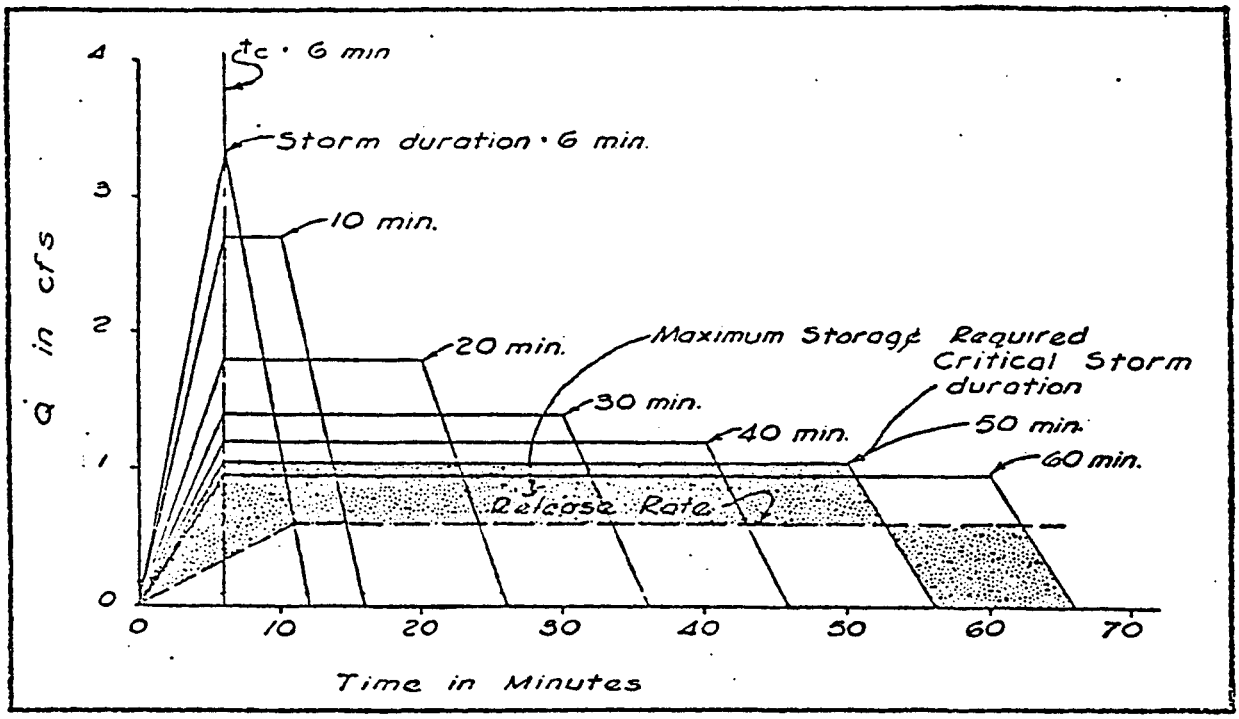


FIGURE 11 TYPICAL EXAMPLE OF ON-SITE DETENTION RATIONAL METHOD ANALYSIS

The assumed release curve approximates a formal reservoir routing in much the same way the Rational Method Hydrograph approximates a true storm hydrograph. The curve allows for the low release rate at the beginning of a storm and an increasing release rate as the storage volume increases. In normal flood routing, the maximum release rate will always occur at the point where the outflow hydrograph crosses the receding limb of the inflow hydrograph. For this reason, the design release rate is forced to coincide with that point on the falling limb of the hydrograph resulting from the storm of duration equal to the time of concentration for the basin. The release rate is held constant past this point. The critical storage volume is then found by determining the area between the inflow and release hydrographs. Example No. 2 continues the calculations initiated in Example No. 1 to determine the required storage volume.

Example No. 2

Given:

Drainage basin and other hydrologic information presented in Example No. 1

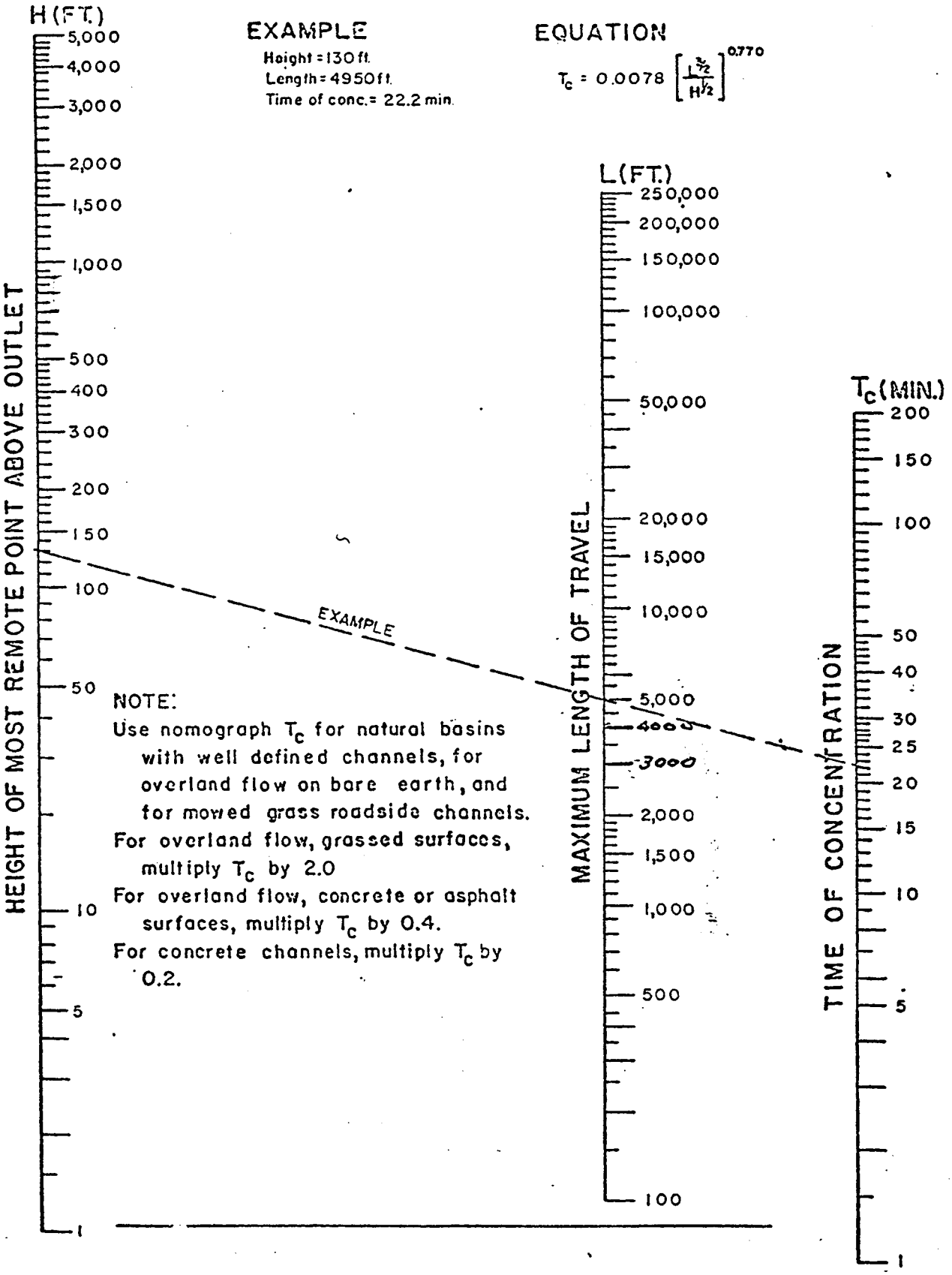
Allowable release rate: Q = 2.5 cfs

Required:

Determine the critical storage volume

Storm Duration (Minutes)	Storm Runoff Volume (cu.ft.)	Release Flow Volume (cu.ft.)	Required Storage Volume (cu. ft.)
8	3715	1200	2515
10	4212	1500	2712
15	5184	2250	2934
20	5832	3000	2832
30	6480	4500	1980
40	7344	6000	1344

The critical storage volume is then 2,934 cubic feet occurring for a 15-minute rainfall duration, or time of concentration.

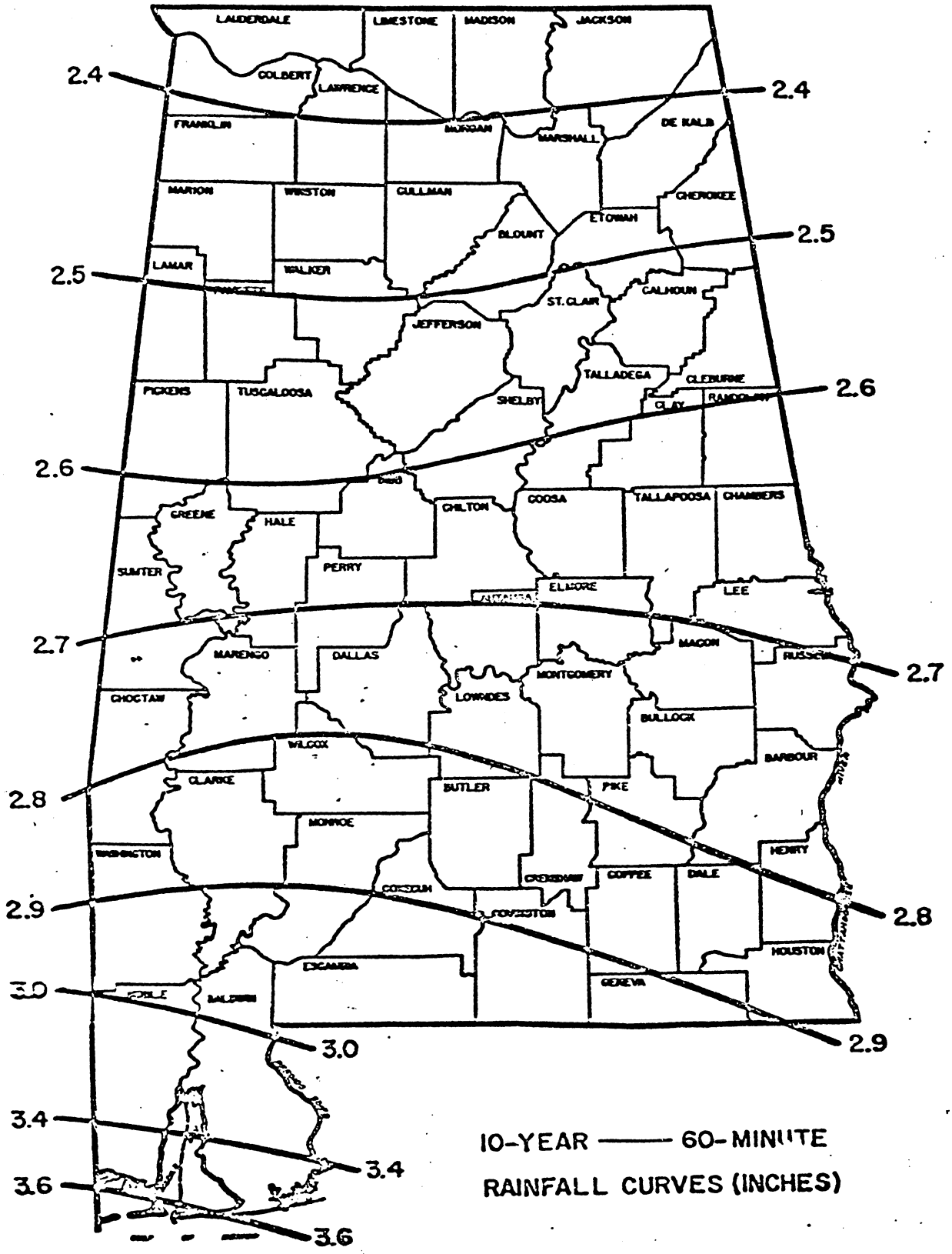


EQUATION: BY Z.P. KIRPICH
BASED ON DATA BY C.E. RANSER

TO BE USED IN DETERMINING TIME OF CONCENTRATION IN PRE-DEVELOPMENT CALCULATIONS ONLY

VALUES FOR RAINFALL - INTENSITY DURATION CURVE NO. 3.2

5. 8.75	27. 4.99	49. 3.65
6. 8.42	28. 4.90	50. 3.61
7. 8.13	29. 4.82	51. 3.57
8. 7.86	30. 4.75	52. 3.53
9. 7.61	31. 4.67	53. 3.49
10. 7.38	32. 4.60	54. 3.45
11. 7.15	33. 4.53	55. 3.41
12. 6.95	34. 4.46	56. 3.37
13. 6.75	35. 4.40	57. 3.34
14. 6.57	36. 4.34	58. 3.31
15. 6.40	37. 4.28	59. 3.28
16. 6.24	38. 4.22	60. 3.25
17. 6.09	39. 4.16	
18. 5.95	40. 4.10	
19. 5.82	41. 4.05	
20. 5.70	42. 4.00	
21. 5.58	43. 3.95	
22. 5.47	44. 3.90	
23. 5.37	45. 3.85	
24. 5.27	46. 3.80	
25. 5.17	47. 3.75	
26. 5.08	48. 3.70	

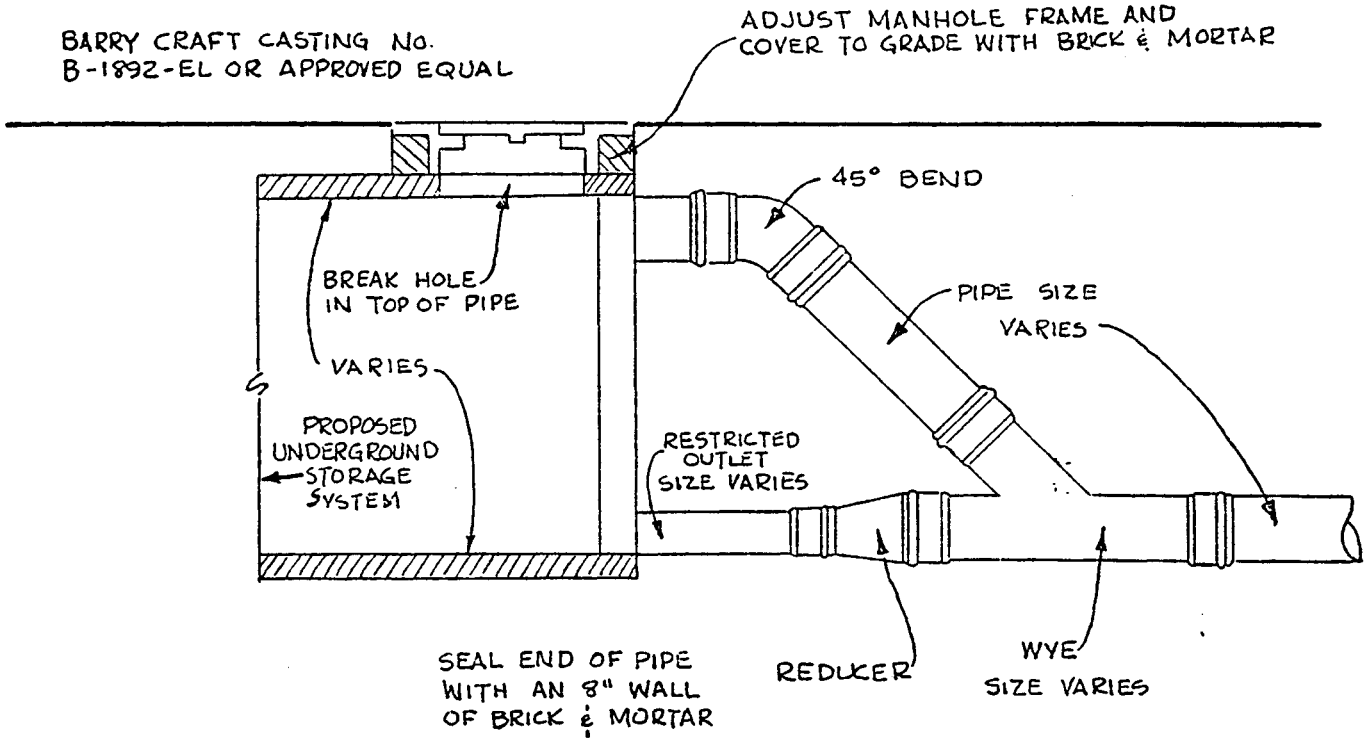

LAUDERDALE
LIMESTONE
MADISON
JACKSON
COLBERT
LAWRENCE
MORGAN
MARSHALL
DE KALB
FRANKLIN
MARION
WINSTON
CULLMAN
CHEROKEE
ETOWAH
BLOUNT
LAMAR
WALKER
ST. CLAIR
CALHOUN
JEFFERSON
TALLADEGA
CLEBURNE
PICKENS
TUSCALOOSA
SHELBY
CLAY
GREENE
HALE
CHILTON
COOSA
TALLAPOOSA
CHAMBERS
SUMTER
PERRY
ELMORE
LEE
MARENGO
DALLAS
MACON
MONTGOMERY
CHOCTAW
LOWNDES
BULLOCK
WILCOX
BARBOUR
CLARKE
BUTLER
PIKE
MONROE
HENRY
COFFEE
DALE
ESCAMBIA
HOUSTON
GENEVA
2.4
2.5
2.6
2.7
2.8
2.9
3.0
3.4
3.6
10-YEAR —— 60-MINUTE
RAINFALL CURVES (INCHES)

RATIONAL FORMULA RUNOFF COEFFICIENTS

Description of Area		Coefficient "C"
Cultivated, flat	0-5% slopes	0.20
Cultivated, rolling	5-10% slopes	0.60
Cultivated, hilly	10-30% slopes	0.72
Pasture, rolling	5-10% slopes	0.36
Pasture, hilly	10-30% slopes	0.42
Timber, rolling	5-10% slopes	0.18
Timber, hilly	10-30% slopes	0.21
Barren, steep	30% slopes or greater	0.90
Barren, rolling	10-30% slopes	0.80
Upland farms	0-10% slopes	0.30
All watertight roof surfaces		0.75 - 0.95
Asphalt pavements		0.80 - 0.95
Concrete pavements		0.70 - 0.90
Gravel or Macadam pavements		0.35 - 0.70
Impervious Soils (heavy)*		0.40 - 0.65
Impervious Soils with turf*		0.30 - 0.55
Slightly pervious soils*		0.15 - 0.40
Slightly pervious soils with turf*		0.10 - 0.30
Moderately pervious soils*		0.05 - 0.20
Moderately pervious soils with turf*		0.00 - 0.10
Densely built up area where streets, walks and yards are paved and the remaining area is practically all roof area as in downtown districts		0.75
Areas adjacent to downtown district where streets and alleys are paved and yards small.		0.70
Densely built up residential district where streets are paved and houses are close together.		0.65
Ordinary residential areas.		0.55 - 0.65
Areas having small yards and medium density of population.		0.45 - 0.55
Sparcely built up areas or those having large yards.		0.35 - 0.45
Suburbs having gardens and large lawns and with paved streets.		0.30
Parks, golf course, etc., covered with sod and having no pavement.		0.20

*For slopes from 1 to 2 percent

The selection of the above coefficients should be made with consideration of future development.



TYPICAL INSTALLATION FOR RESTRICTING FLOW FROM A DEVELOPED SITE

C. Erosion - Sedimentation Control Review Sequence and Check List.

1. Subdivision Plans and Profiles, Site Plans and Grading Plans.

(a) See that an identifiable erosion and sediment control plan is included for each subdivision plan, site plan or grading plan. This may be a separate sheet or included with the drainage or grading plan; in either case, the title block must show it contains the Erosion and Sediment Control Plan. The plan must include a written summary of the means to be used and the sequence of construction and erosion-sediment control measures (narrative).

(b) Identify major soil types in the area and determine their physical limitations for the intended use.

(c) Check that standard conservation notes, applicable to the site, appear with the erosion-sediment plan, as follows:

(1) No disturbed area will be denuded for more than _____ calendar days unless otherwise authorized by the City Engineer or his agent. (Number of days to be determined by reviewer, normally 60 to 90 days.)

(2) All erosion and sediment control measures are to be placed prior to or as the first step in grading.

(3) All storm and sanitary sewer lines not in streets are to be mulched and seeded within 15 days after backfill. No more than 500 feet are to be open at any one time.

(4) Electric power, telephone and gas supply trenches are to be compacted, seeded and mulched within 15 days after backfill.

(5) All temporary earth berms diversions and sediment dams are to be mulched and seeded for temporary vegetative cover within 10 days after grading. Straw or hay mulch is required. The same applies to all soil stock-piles.

(6) During construction all storm sewer inlets will be protected by sediment traps, maintained and modified as required by construction progress.

(7) Any disturbed area not covered by item #1 above and not paved, sodded or built upon by 1 November, or disturbed after that date, is to be seeded within 15 days with oats, abruzzi rye, or equivalent and mulched with hay or straw mulch at the rate of two tons per acre. (Modify as applicable depending on proposed time of construction. For Sanitary Sewer outfalls, the following standard notes should appear:

LAND CONSERVATION NOTES - SANITARY SEWERS

1. No disturbed area to be denuded for more than _____ days.

2. Temporary diversions, seeded and mulched or staked straw bale diversions and other control measures as necessary are to be placed as indicated on the drawings prior to or as the first step in excavation.

3. Where consistent with job safety requirements, all excavated material is to be placed on the uphill side of trenches. No material is to be placed in streambeds. Any stockpiled material which will remain in place longer than 30 days is to be seeded for temporary vegetation and mulched with straw mulch. Where spoil is placed on downhill side of trench it is to be back-sloped to drain toward trench. When necessary to dewater the trench, the pump discharge hose must outlet in a stabilized area or a sediment basin.

4. Where stream crossings are required for equipment, temporary culverts will be provided.

5. No more than 500 feet of trench are to be open at any one time.

6. All disturbed areas are to be seeded and mulched within 15 days after backfill of the applicable trench section. Speed is the essential land conservation element for linear projects.

(a) Examine the existing and proposed drainage patterns; review the drainage area and ten year storm run-off quantities - where does and will the run-off go?

(b) Locate and check the acreage to be disturbed.

(c) Examine the exit swales and slopes to:

(1) Off-site properties
(2) Park Lands
(3) Major streams and lakes or ponds

Who is going to catch the sediment if controls are not provided?

(d) Spot woodlands and other areas to remain undisturbed.

(e) Identify possible problem areas.

(f) Examine lengths and grades of long slopes, existing and proposed:

(1) Classify soils as to degree of erodibility.

(2) Check velocities of sheet, swale, or pipe discharge velocities on slopes, or unprotected soil surfaces.

(3) Check use of diversions and seeding and mulching when slope exceeds 4:1 and length exceeds 20 feet see that adequate outlets are provided for diversions.

(4) Look for interceptor ditch at top of cut slopes, for berm (dike) at base of fill slopes and see that outlets with storage are provided.

(g) Review storm and sanitary sewer routes. Look for sediment traps around all structures and for work-area control. Visualize the construction sequence.

(h) Check locations for and suitability of:

(1) Temporary diversion berms, ditches and terraces.

(2) Permanent berms, ditches and terraces.

(3) Temporary seeding and mulching - highly erodible areas and long slopes.

(4) Sediment barriers - straw bales and gravel weirs.

(5) Minor sediment dams - areas 2-3 acres.

(6) Major sediment basins - drainage area over 3 acres (to be designed structures).

(i) Check sequence of construction operations and areas to be opened up simultaneously.

(j) Review instructions to contractor for clarity.

(k) Reivew proposed construction timing for suitability of planting and mulching provisions. Check the time span for establishment of permanent cover.

(l) Check adequacy of diversions to handle the design storm run-off without excessive velocities or over-topping. Check dimensions of all storage areas and outlets. There should be adequate storage for each acre draining to each outlet, and the basin dimensions should be shown.

(m) Insure proper maintenance (including cleanout) instructions to contractor and developer. Daily inspection should be required.

(n) Remember that maximum erosion occurs during construction; the period immediately following stripping and stockpiling of topsoil is critical. Look at the probable drainage flow before and during that period -- while the grading is being done and the storm drainage ditches are being dug.

STANDARD AND SPECIFICATIONS
FOR
TEMPORARY CONSTRUCTION ENTRANCE

Definition

A stone, gravel, or reef shell stabilized pad located at any point where traffic will be entering of leaving a construction site to or from a public right-of-way, street, alley, sidewalk, or parking area.

Purpose

To reduce or eliminate the transport of mud from the construction area onto public rights-of-way by motor vehicles or by run-off.

Conditions Where Practice Applies

This practice is applied at appropriate points of construction ingress and egress.

Design Criteria

Aggregate -------- Stone, gravel or reef shell

Pad thickness --- 6 inch thickness

Pad width ------- not less than full width of all points of vehicular ingress or egress.

Pad length ------ not less than 50 feet.

Washing --------- wheels must be cleaned to remove mud prior to entrance onto public rights-of-way. When washing is required, it shall be done on an area stabilized with crushed stone which drains into an approved sediment trap or sediment basin.

Location -------- entrance shall be located or protected so as to prevent sediment from leaving the site.

Maintenance

The entrance shall be maintained in a condition which will prevent tracking or flow of mud onto public rights-of-way. This may require periodic top dressing with two inches of aggregate, as conditions demand, and repair and/or cleanout of any structures used to trap sediment. All materials spilled, dropped, washed, or tracked from vehicle or site onto roadway or into storm drain must be removed immediately.

STANDARD AND SPECIFICATIONS
FOR
TEMPORARY DIVERSION DIKE

Definition

A ridge of compacted soil with a general life expectancy of one year or less constructed immediately above cut or fill slopes.

Purpose

To intercept storm run-off from small higher areas and to divert it away from exposed slopes to a stabilized outlet.

Conditions Where Practice Applies

At the top or toe of newly constructed slopes to prevent excessive erosion until permanent storm drainage features are installed and the slopes are stabilized.

Design Criteria

A design is not required. The following criteria will be used:

Drainage areas----not more than 5 acres

Top width---------2 foot minimum

Height (compacted fill)---18 inch minimum (height measured from the natural ground at the upslope toe to the top of the dike).

Side slopes-------2:1 or flatter.

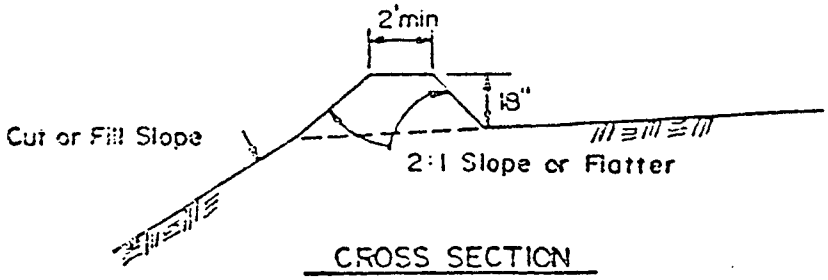
Grade-------------dependent upon topography, but must have positive drainage to the outlet; where slope of channel behind dike is less than 2%, stabilization may not be required; where the slope is 2% or greater, stabilization shall be required.

See Standard Drawing T.D.D.-1 for details.

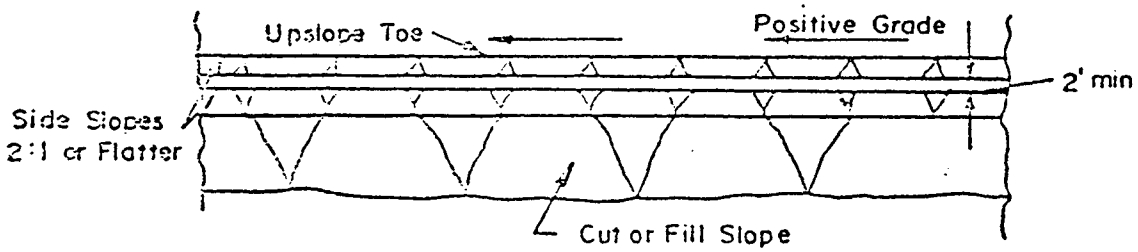
Outlet

Diverted run-off must outlet directly onto an undisturbed stabilized ares, a level spreader, or into a grade stabilization structure.

TEMPORARY
DIVERSION DIKE
(Not To Scale)



CROSS SECTION



PLAN VIEW

	TEMPORARY DIVERSION DIKE	STANDARD DRAWING
		T.D.D.-1

STANDARD AND SPECIFICATIONS
FOR
TEMPORARY PERIMETER DIKE

Definition

A ridge of compacted soil, with a life expectancy of one year or less, constructed along the perimeter of the disturbed area.

Purpose

To divert sediment-laden storm run-off to on-site trapping facilities.

Conditions Where Practice Applies

At the perimeter of the site or disturbed area to direct sediment-laden water to a trapping facility. This dike will remain in place until the site is permanently stabilized.

Design Criteria

A design is not required. The following standards will be used:

Drainage areas----not more than 5 acres.

Top width---------2 foot minimum

Height (compacted fill)---18 inch minimum unless otherwise noted on the plans. (Height measured from the natural ground at the upslope toe to top of the dike).

Side slopes-------2:1 or flatter.

Grade-------------dependent upon topography, but must have positive drainage to the outlet; where slope of channel behind dike is less than 2%, stabilization may not be required, where 2% or more stabilization will be required.

See Standard Drawing T.P.D.-1 for details

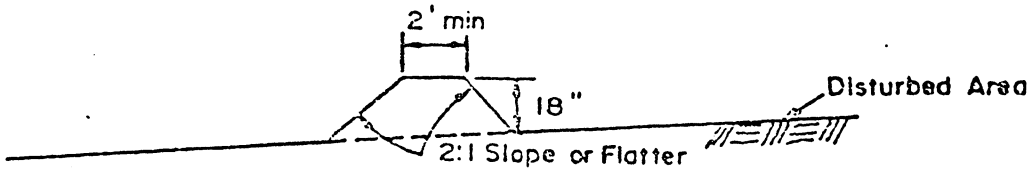
Outlet

Diverted run-off must be discharged directly into a sediment trapping facility such as a sediment basin, sediment trap, or gravel outlet structure.

(The perimeter dike may function as an elongated sediment dam. The capacity behind the dike must be checked to assure good trap efficiency).

TEMPORARY

PERIMETER DIKE
(not to scale)



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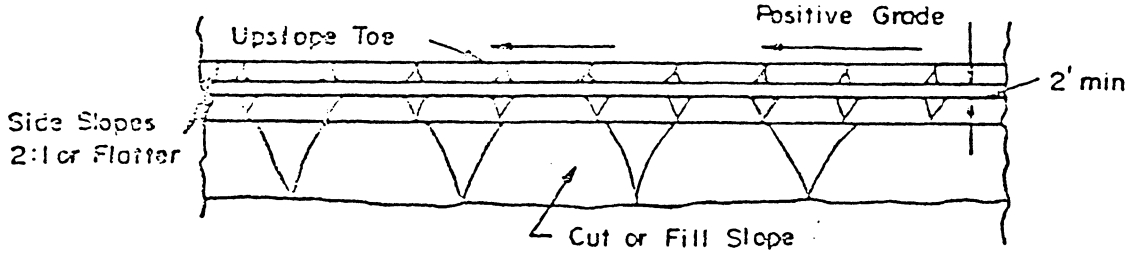


PLAN VIEW

	TEMPORARY PERIMETER DIKE	STANDARD DRAWING
		T.P.D.- 1

STANDARD AND SPECIFICATION
FOR
TEMPORARY STRAW (OR HAY) BALE BARRIER

Definition

A barrier installed across, or at the toe of, a slope to intercept and detain sediment.

Purpose

To intercept and detain small amounts of sediment from unprotected areas of less than one acre.

Conditions Where Practice Applies

Where it is feasible.

Contributing area is approximately one acre, or less.

There is no concentration of water in a channel above the barrier.

Erosion would normally occur in form of sheet erosion.

Length of slope above the barrier is less than 100 feet.

Straw bales must not be used on high sediment producing areas, above "high risk" areas, where water concentrates, or where there would be a possibility of a washout. Greatest application is for single family separately built residential construction.

Design Criteria

No design required. Bales must be securely tied.

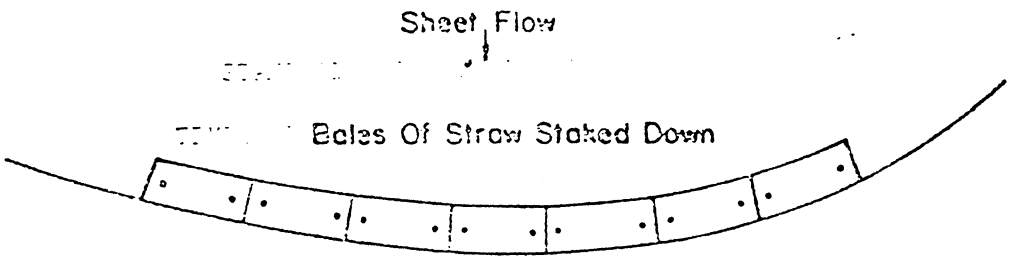
See Standard Drawing T.S.B.-1 for details.

CONSTRUCTION SPECIFICATIONS

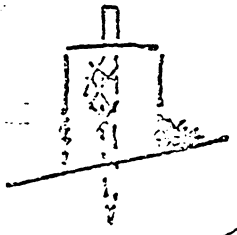
1. Bales will be placed in a single row, lengthwise, on the contour and embedded in the soil to a depth of 3 inches.

2. Bales must be securely anchored in place by stakes or re-bars driven through the bales or by other acceptable means to prevent displacement.

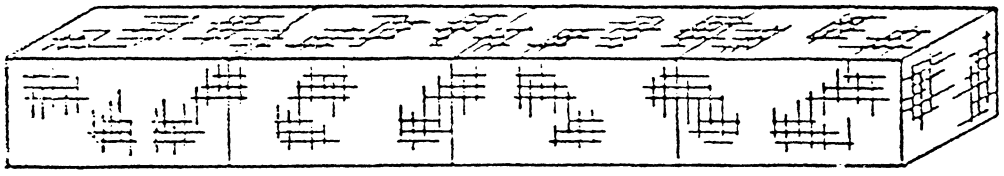
3. Inspection must be frequent and repair or replacement must be made promptly as needed.



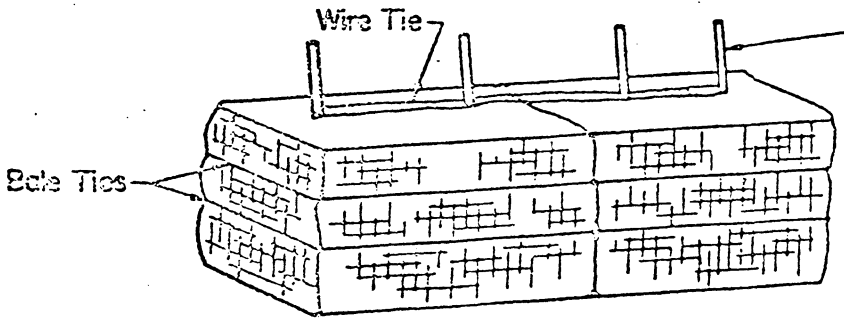
Single Row Of Bales Of Straw
To Be Placed Prior To The
Start Of Rough Grading



PLAN VIEW



FRONT VIEW



Securely Bound Bales
Required For Durability

ANCHORING BALES

	TEMPORARY STRAW BALE SEDIMENT BARRIER	STANDARD DRAWING
		T.S.B.-1

STANDARD AND SPECIFICATIONS
FOR
TEMPORARY SEDIMENT TRAP

Definition

An impounding area formed by excavation or barrier to trap sediment being transported by storm run-off from a disturbed area of very limited size.

Purpose

To prevent sediment from leaving the site, or from entering natural or constructed drainageways or storm drainage systems, prior to permanent stabilization of the disturbed area.

Conditions Where Practice Applies

Where construction schedules or other considerations preclude erosion control treatment on sediment-producing areas not exceeding one acre in extent. Traps are usually excavated or installed at or around storm drain inlets, in drainageways, or at points of discharge of sediment-laden storm run-off.

Design Criteria

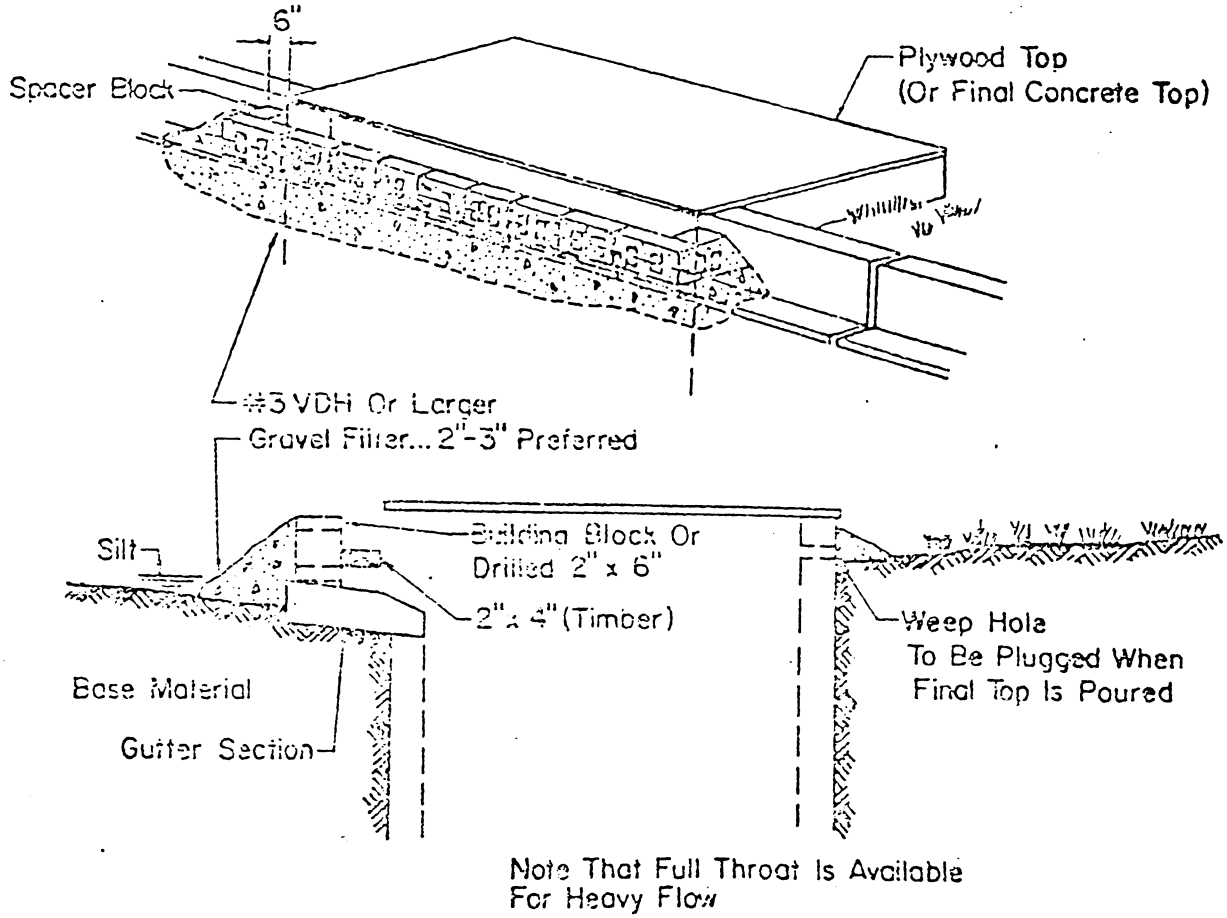
The trap shall be sized to provide a minimum storage capacity of 67 cubic yards per acre of contributing drainage area. It should be dimensioned to fit the site conditions and located so as to not interfere with construction operations and to facilitate periodic cleanout. Traps shall be not less than one foot nor more than two foot deep measured from the invert of the outlet. The minimum length of flow through the trap shall be 10 feet. Side slopes shall not be steeper than 1:1. Sediment traps must be self-draining unless they are otherwise protected in an approved fashion so as not to present a safety hazard. See Standard Drawings T.S.T.-1, T.S.T.-2 or T.S.T.-3 for three acceptable details of sediment traps at storm drain inlets.

CONSTRUCTION SPECIFICATIONS

1. Sediment traps may be constructed on natural ground surface, on an excavated surface, or on machine compacted fill provided they have a non-erodible outlet.

2. They must be checked at the end of each working day and repaired or cleaned as necessary to insure that they will operate as intended.

Building Block Laid 6" From Throat Web Horizontal



Note That Full Throat Is Available For Heavy Flow

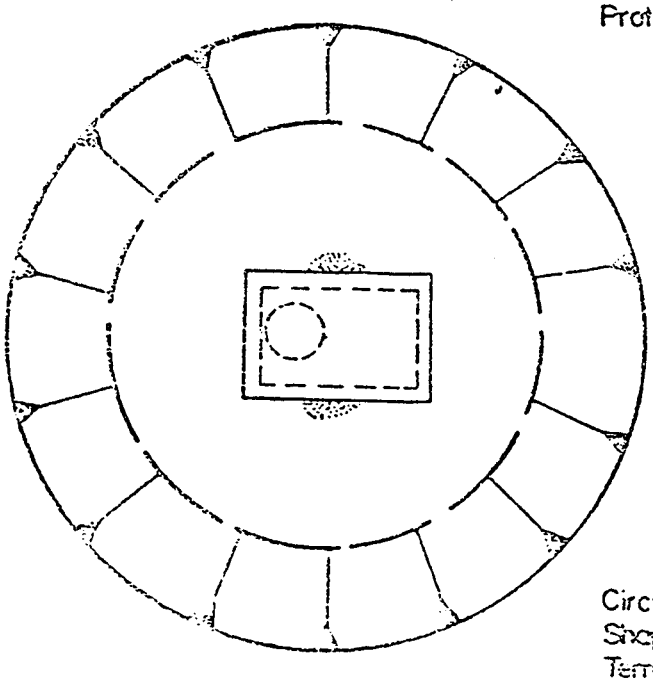
Expanded Metal Or Hardware Cloth In Front Of Block Prevents Gravel From Washing Into Structure

2" x 4" Behind Block And Across Throat Helps Keep Block In Place. Place In Outer Hole Of Spacer Block.

(USE DURING STREET CONSTRUCTION)

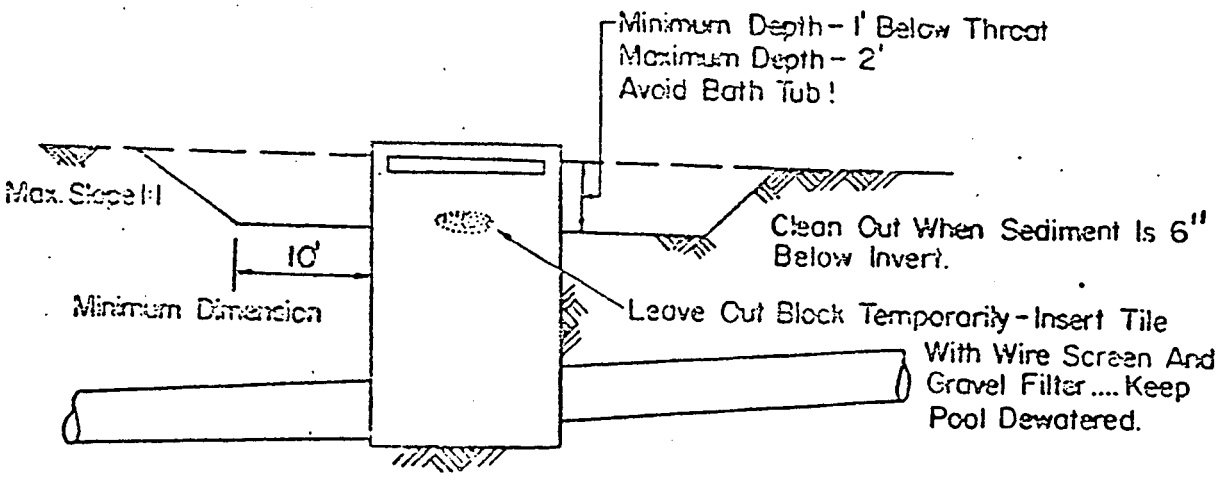
	TEMPORARY SEDIMENT TRAP AT CURB INLET	STANDARD DRAWING
		T.S.T. - 1

Sediment Out Of The Storm Drainage System! Use Half-Circle Behind Curb Inlets During Street Construction. Modify Protection As Construction Progresses.



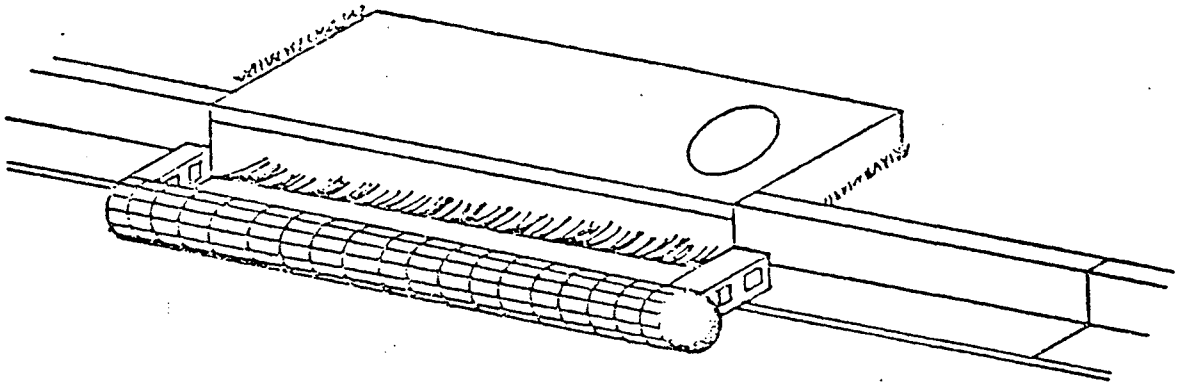
PLAN

Circular Shape Is Not Essential - Vary Shape To Fit Drainage Area And Terrain. Observe To Check Trap Efficiency And Modify As Necessary To Insure Satisfactory Trapping Of Sediment.



SECTION

	TEMPORARY SEDIMENT TRAP AT STORM DRAIN INLET	STANDARD DRAWING T.S.T. - 2



Soccer Block, Roll Of 12 1/2 Gauge Welded Fence, 2" x 2" Mesh, 8" – 10" Diameter Filled With 3" Stone.

Easily Made And Placed
Easy To Clean
Can Be Moved And Re-Used

Prevents Storm Sewer From Becoming Clogged With Silt During Construction

Prevents Silt From Getting In Stream

MINI-GABIONS FOR INLET PROTECTION
(USE DURING STREET CONSTRUCTION)

	TEMPORARY SEDIMENT TRAP AT CURB INLET	STANDARD DRAWING
		T.S.T. – 3

STANDARD AND SPECIFICATIONS
FOR
STORM DRAIN OUTLET PROTECTION

Definition

Paved and/or rip-rap channel sections, placed below storm drain outlets.

Purpose

To reduce velocity of flow before entering receiving channels below storm drain outlets.

Conditions Where Practice Applies

To all storm drain outlets, road culverts, paved channel outlets, etc., discharging into natural or constructed channels. Analysis and/or treatment will extend from the end of the conduit, channel or structure to the point of entry into an existing stream or publicly maintained drainage system.

Design Criteria

Show plan view, profile, and cross section of receiving channel to existing publicly maintained system or natural stream channel. Indicate the actual velocity for the following: (1) outlet (pipe or structure), (2) rip-rap or paved channel section, and (3) each channel reach and/or to point of entry into existing system or natural stream. Show on plan the proposed method of stabilizing the channel consistent with computed velocities.

Length----Minimum total length of rip-rap and/or paved section below outlet equals 6 times the diameter of the pipe or 6 times the depth of flow in the outlet channel.

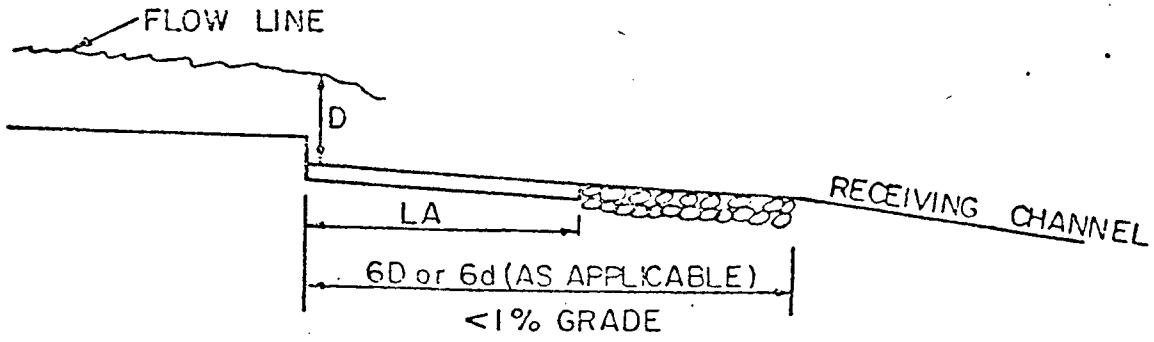
Grade-----Less than 1%.

Rip-rap---Rip-rap shall be sized according to standard and specifications for rip-rap. Where size or rip-rap is impractical, a concrete apron may be used with length according to Table 1, and rip-rap the remainder of the length specified above.

TABLE 1

APRON LENGTHS (IN FEET)

ACTUAL OUTLET VELOCITY F.P.S.	d - INCHES													
	15	18	21	24	27	30	33	36	42	48	54	60	66	72
6	3	3	3	3	3	4	4	4	4	4	5	5	5	5
8	3	4	4	4	4	5	5	5	6	6	6	7	7	7
10	4	5	5	5	6	6	6	6	7	7	8	8	9	9
12	5	5	6	6	7	7	7	8	8	9	10	10	11	11
14	6	6	7	7	8	8	9	9	10	10	11	12	12	13
16	7	7	8	8	9	9	10	10	11	12	13	13	14	15
18	8	8	9	10	10	11	11	12	13	13	14	15	16	16
20	8	9	10	11	11	12	12	13	14	15	16	17	18	18
22	9	10	11	12	12	13	14	14	15	16	17	18	19	20
24	10	11	12	13	13	14	15	16	17	18	19	20	21	22
26	11	12	13	14	15	15	16	17	18	19	21	22	23	24
28	12	13	14	15	16	17	17	18	20	21	22	23	25	26
30	13	14	15	16	17	18	19	19	21	22	24	25	26	27



The preceding specifications and plans are typical solutions to erosion and sedimentation problems. Other solutions may be in new marketed products such as Hold-Gro, a degradable soil cover, or Enkamat, an open plastic mat that decreases soil movement until growth of grass.

The Alabama State Highway Department Specifications in the following sections also list acceptable erosion and sedimentation methods:

Section 107.21 Prevention of Soil Erosion
- 650 Topsoil
- 651 Ground Preparation & Fertilizer for Erosion Control
- 652 Seeding
- 654 Solid Sodding
- 656 Mulching
- 657 Grassing Mulch
- 658 Hydro Seeding & Mulching
- 659 Erosion Control Netting
- *665 Temporary Erosion Control

*The maximum 17.5 acre exposed erodible material will not apply. Construction scheduling should be set up to keep exposed areas to minimum size and minimum time and must be approved by the City Engineer.