JMS ENGINEERING

Existing Storm Drainage System & Master Plan Aumsville, Oregon

July, 1990 #108-7

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& Master Plan
Aumsville, Oregon

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Master Drainage Plan
Aumsville, Oregon

I. BACKGROUND

Prior to this report, no detailed mapping of existing storm drainage facilities had been completed, nor had the existing system been studied to determine current and future storm drainage needs within the system.

The object of this report is two-fold: first, inventory the existing drainage system to determine locations, line sizes and quantities of lines and fixtures in existence, second, analyze the abilities of the existing system to handle current and future flows.

From these findings, recommendations will be made as to what storm drainage improvements will likely be required within the next five years.

II. EXISTING CONDITIONS

An inventory of the Aumsville storm drainage system was made and the following was found:

16,620 lf or 3.15 miles of 4"-36" diameter of storm drain pipe

80 Catch basins

16 Manholes and Junction Boxes

Overall, the existing storm drainage system as shown on Map I is adequate to serve the developed areas of the City. Undeveloped areas can be served with connections to the existing system, or designed with new outlets to existing natural drainage ways.

III. SPECIFIC PROBLEM AREAS

Areas where existing drainage problems need to be resolved are as follows:

a. Cleveland St.-between 3rd and 5th St.: Standing water was a problem in this area. However, a new drainage system was installed in this area in June, 1990, and this problem has been corrected.

b. 5th and Washington: Standing water at this intersection is also a problem, particularly after a heavy rainstorm. The outfall from this section of storm drain enters Mill Creek Ditch, the water-level of which is controlled by a dam structure just downstream from the outfall. The dam operating level must be lowered during the winter months if this area is to be drained properly. The City should contact the owner/operator of the dam to see if dam level could be lowered during the winter months. Estimated Cost: $0.00

c. Catch Basins: There are 10 catch basins that should be replaced and or raised:

Micheal Way and 4th: Replace catch basin	$400.00
Darla Ct. and 4th: Replace catch basin	$400.00
Donna Ct. and 4th: Replace 3 catch basins	$1200.00
Dianne Ct. and 4th: Replace 2 catch basins	$800.00
Shamrock and 5th: Raise 3 catch basins	$450.00

Total cost for the above work is $3250.00 or $810.00/yr over a 4 year period.

d. Cleaning of Storm Drainge System: Nearly every catch basin is filled with debris that reduces the flow capacity of the system. In some cases, the debris covers the entire pipe. At present, a maintenance program is non-existent, with cleaning work being done only on an as-needed basis or in emergencies.

It is recommended a 4 year program be developed so that at the end of a 4 year cycle, the entire storm drain system is cleaned. It would be an on-going maintenance cycle. Approximately 4000 feet could be cleaned each year as well as 24 catch basins and manholes. Estimated cost for this work: $5800.00/yr

e. Yearly Budget: With the catch basin replacement program @ $810.00/yr, and cleaning work @ $5800.00/yr, it is recommended that $7500.00/yr be budgeted for storm drainage maintenance.

f. Street Sweeping: An important element to be considered is more frequent street sweeping. Much of the debris in the catch basins can be attributed to come from the street surface. It costs $300-$400 to sweep all the streets in the city; it costs $125.00/hr to clean the storm drain pipe. It would seem more frequent street sweeping would be cost effective.

IV. STORM DRAINAGE MANAGEMENT APPROACHES

Approach 1: Make drainage facilities large enough to handle projected peak 25 year storm water run-off and allow unrestricted water run-off.

Some existing facilities are already adequate to handle projected peak flows without restriction. In other areas, adequate drainage facility run-off capacity can be provided at reasonable cost. This approach is most appropriate where downstream impacts are minimized and development costs are reasonable. This is the traditional approach to storm water management.

Approach 2: Restrict peak storm water flows to reasonable levels by utilizing community storm water retention facilities.

Typically this approach involves building or utilizing storm water retention facilities which are sized so that peak flows are maintained within the capacity of the existing storm drainage facilities.

Approach 3: Restrict run-off by requiring individual on-site retention basins.

Problem with this approach is that administration and enforcement is often difficult and overall costs are sometimes high in comparison with other alternatives. This approach is mostly for industrial developments.

Approach 4: Divert all excess flows into facilities having excess capacity.

This approach is most appropriate where the diversions can be made relatively inexpensively and where diversion will result in few negative downstream impacts.

V. CALCULATING STORM WATER FLOWS

The standard method for calculating the storm water run-off is shown in Attachment #1 of this report and should be used for future additions to the storm drainage system in Aumsville, particularly those additions of 0.5 acres or greater. The City Engineer should review all run-off calculations submitted with proposed development plans to check that the storm drainage system is adequate.

Appendix 1

STANDARD PROCEDURE FOR CALCULATING STORM WATER FLOWS

Methodology

a) The technique used for calculating the peak rate of runoff is based on Chapter 2 of the Engineering Field Manual published by the U.S. Department of Agriculture - Soils Conservation Service.

b) Calculation Procedures.

i) Compute a weighted curve nubmer (CN) for the drainage area

a) Determine size of total drainage area
b) Use Table 1 and soil type "C" to determine the CN for each land use
c) Multiply the percent each land use is of the total drainage area by their respective curve numbers
d) Sum the total product calculated above to determine the weighted curve number.

ii) Determine Slope Factor

Use Map 3 to determine the average slope factor for the total drainage area.

iii) Determine Peak Discharge

Using the total drainage area, slope factor and rainfall depth, enter the proper ES-1029 curves and read the peak discharge. The actual peak runoff to be based on an arithmetric interpolation between curves or the higher curve at the option of the developer.

iv) Determine Final Peak Discharge

Using the runoff coefficients in Table 1 to determine the percent impervious to adjust the discharge to urbanized conditions. Enter Figure 1 to get the peaking factor and multiply it by the discharge determined in "iii)" above to get the final peak discharge.

v) Determine Volume of Runoff

Use Table 2 and the average curve number computed in "i)" above. Multiply by the total drainage area to determine total volume of runoff.

TABLE 1

RUNOFF CURVE NUMBERS (CN) FOR VARIOUS LAND USES

LAND USE DESCRIPTION	RUNOFF COEFFICIENT "C"	RUNOFF CURVE NO.
Open Spaces, Lawns, Parks, Pasture, etc. (Grass cover on 75% or more of the area)		
Soil B	0.18	76
Soil C	0.18	86
Soil D	0.18	90
Commercial and Business Areas	0.75	97-98*
Industrial Districts	0.80	95-98*
Residential:		
Average Lot Size		
6,000 S.F. lot or less (high density)	0.62	94-97*
10,000 S.F. lot (medium density)	0.37	88-95
14,000 S.F. lot (medium density)	0.30	86-94
20,000 S.F. lot (low density)	0.25	85-94
1 acre (low density)	0.20	84-93
Paved Parking Lots	0.85	99
Streets and Roads:		
Paved w/ Curbs and Storm Sewers	0.90	99
Freeway Right-Of-Way	0.75	97

Soil Conservation Service, Tech. Release No. 55

*Range in curve numbers is based on various soil classifications.

TABLE 2

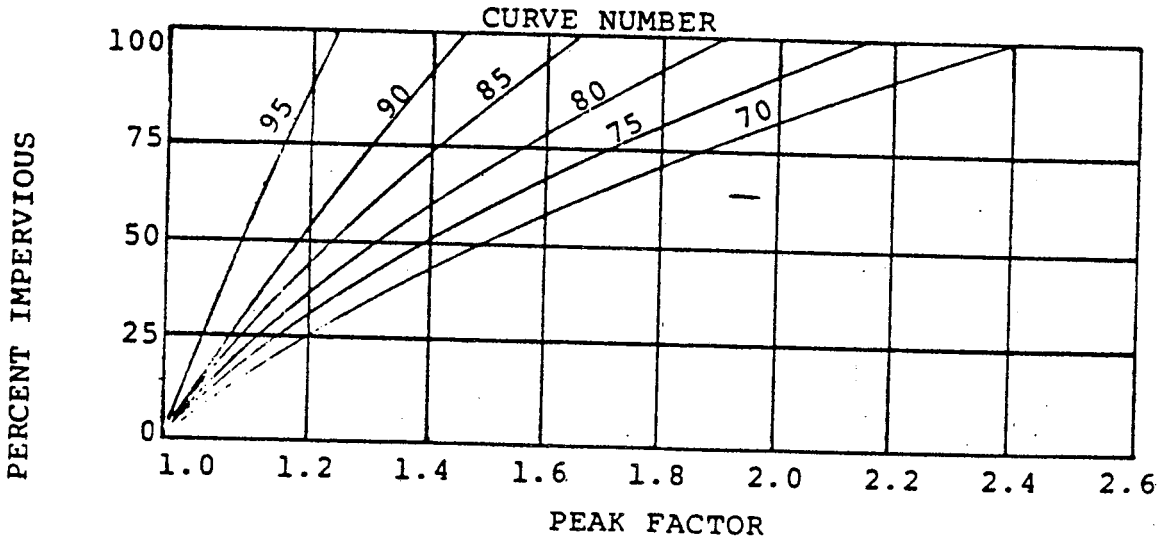
RUNOFF DEPTH IN INCHES

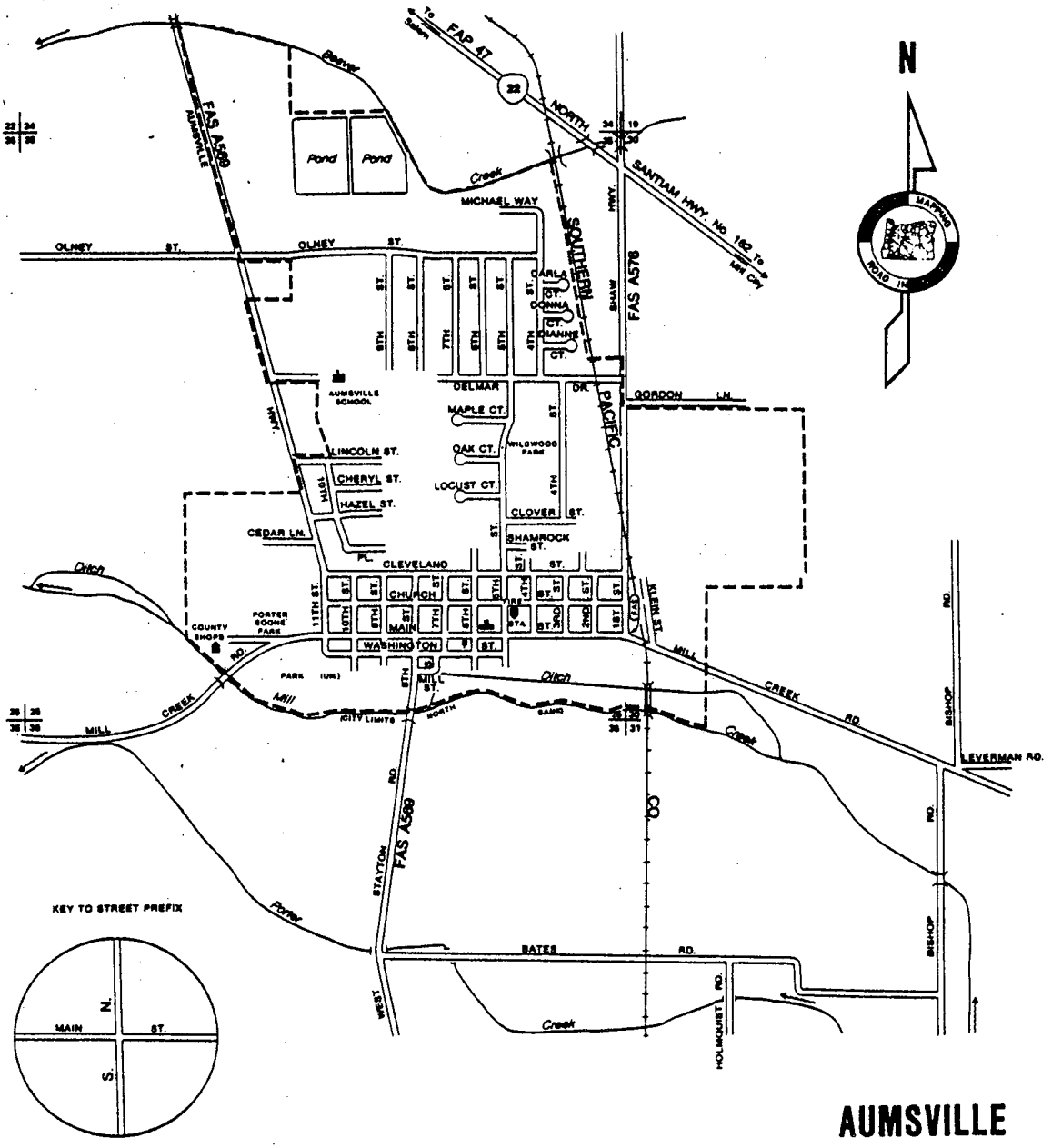
Flood Recurrence Interval	Curve Number (CN) 1/						
	60	65	70	75	80	85	90
5 year (3")	0.33	0.51	0.72	0.96	1.25	1.50	1.98
25 year (4")	0.76	1.03	1.33	1.67	2.04	2.46	2.92

1/ To obtain runoff depths for CN's and other rainfall amounts not shown in this table, use an arithmetic interpolation.

FIGURE 1

URBANIZATION PEAK FACTOR CURVE BASED ON IMPERVIOUS AREA





AUMSVILLE

MARION COUNTY, OREGON

Population 1,455

Slope Factor= Flat, 0-4% over entire area within city limits

Map 3

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT

CURVE NUMBER - 60

24 HOUR RAINFALL FROM US WB TP-40
(Revised)

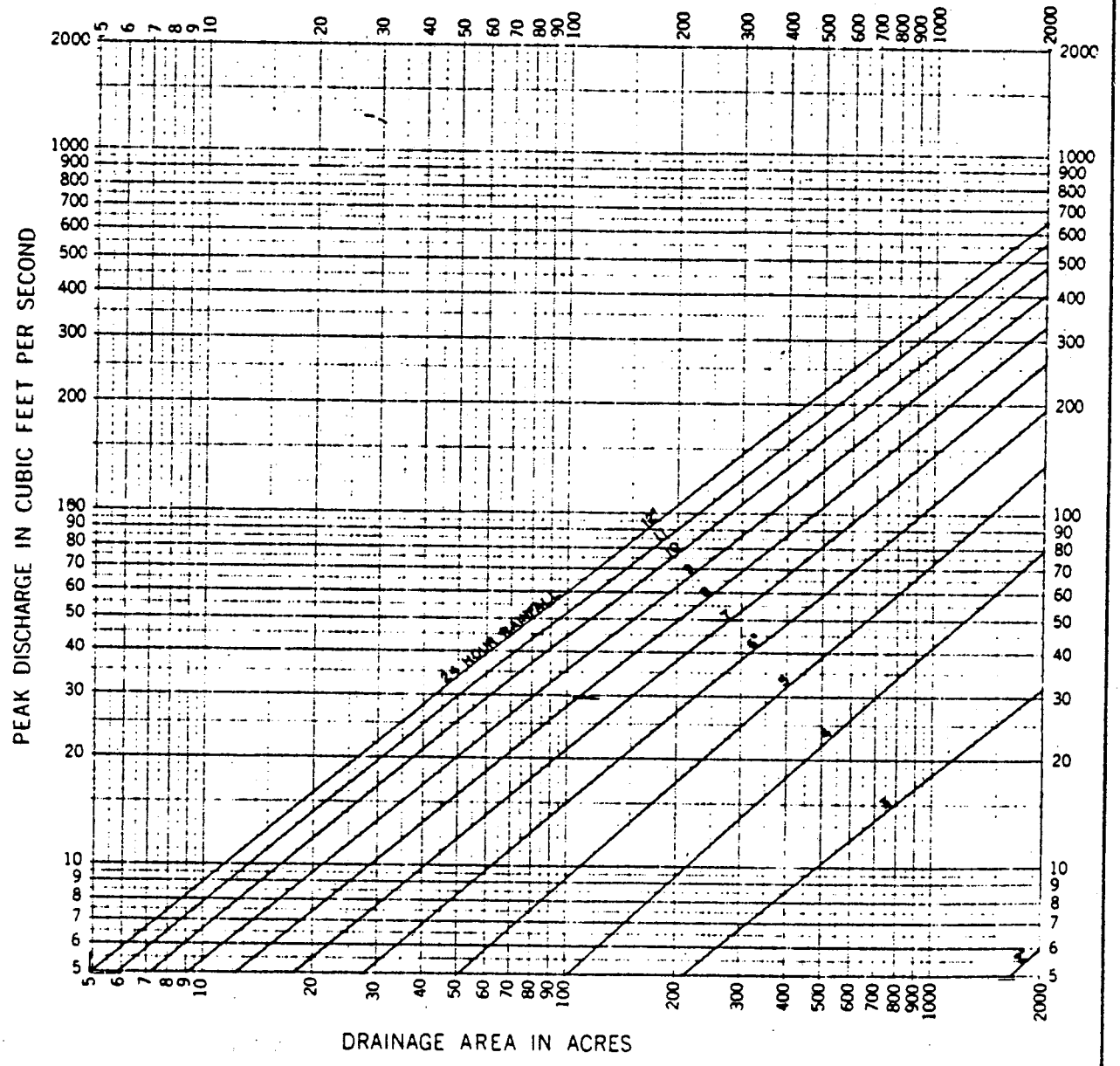


Exhibit 2-12

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT

CURVE NUMBER - 65

24 HOUR RAINFALL FROM US WB TP-40
(Revised)

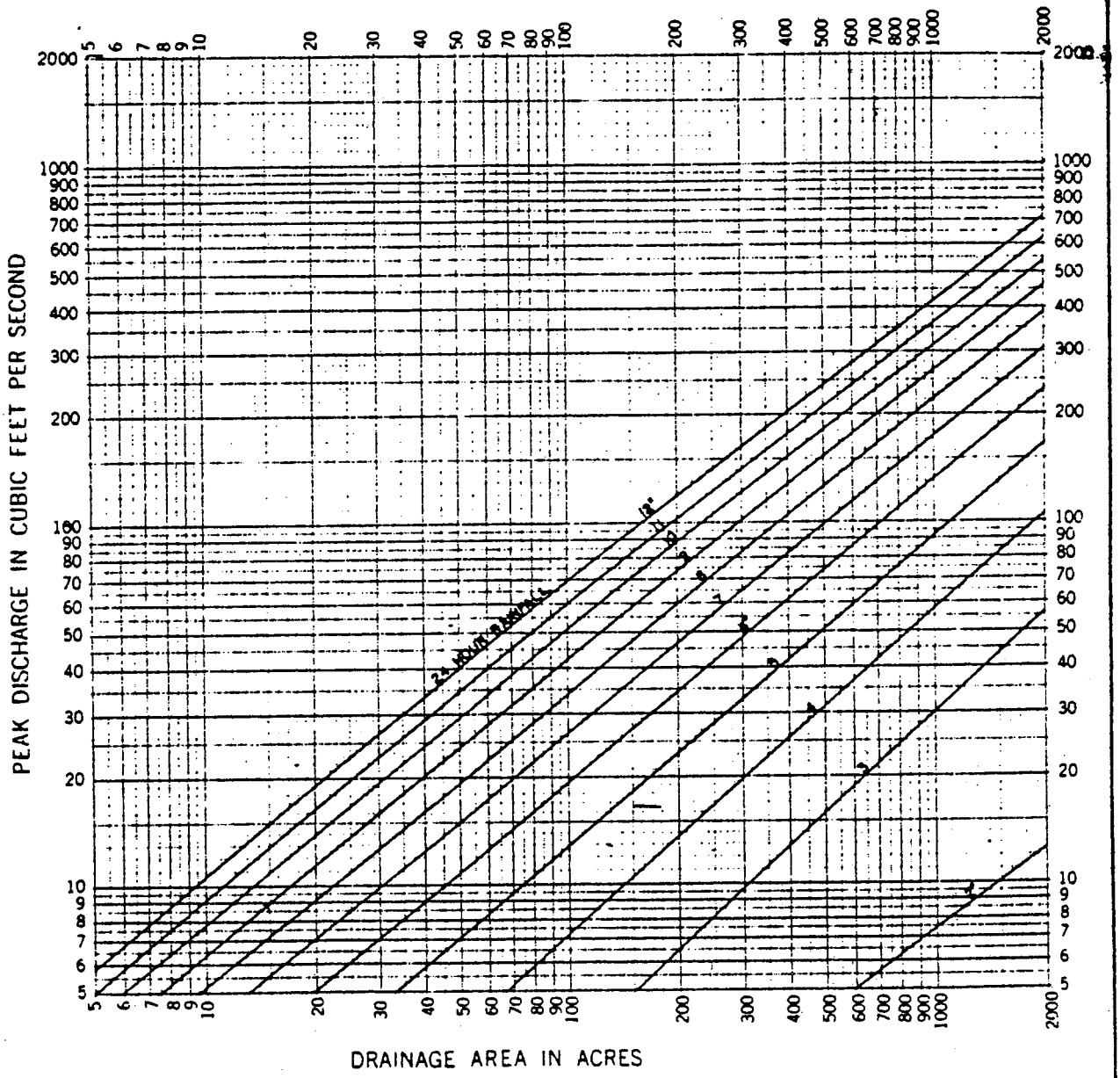


Exhibit 2 - 12

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT

CURVE NUMBER - 70

24 HOUR RAINFALL FROM US WB TP-

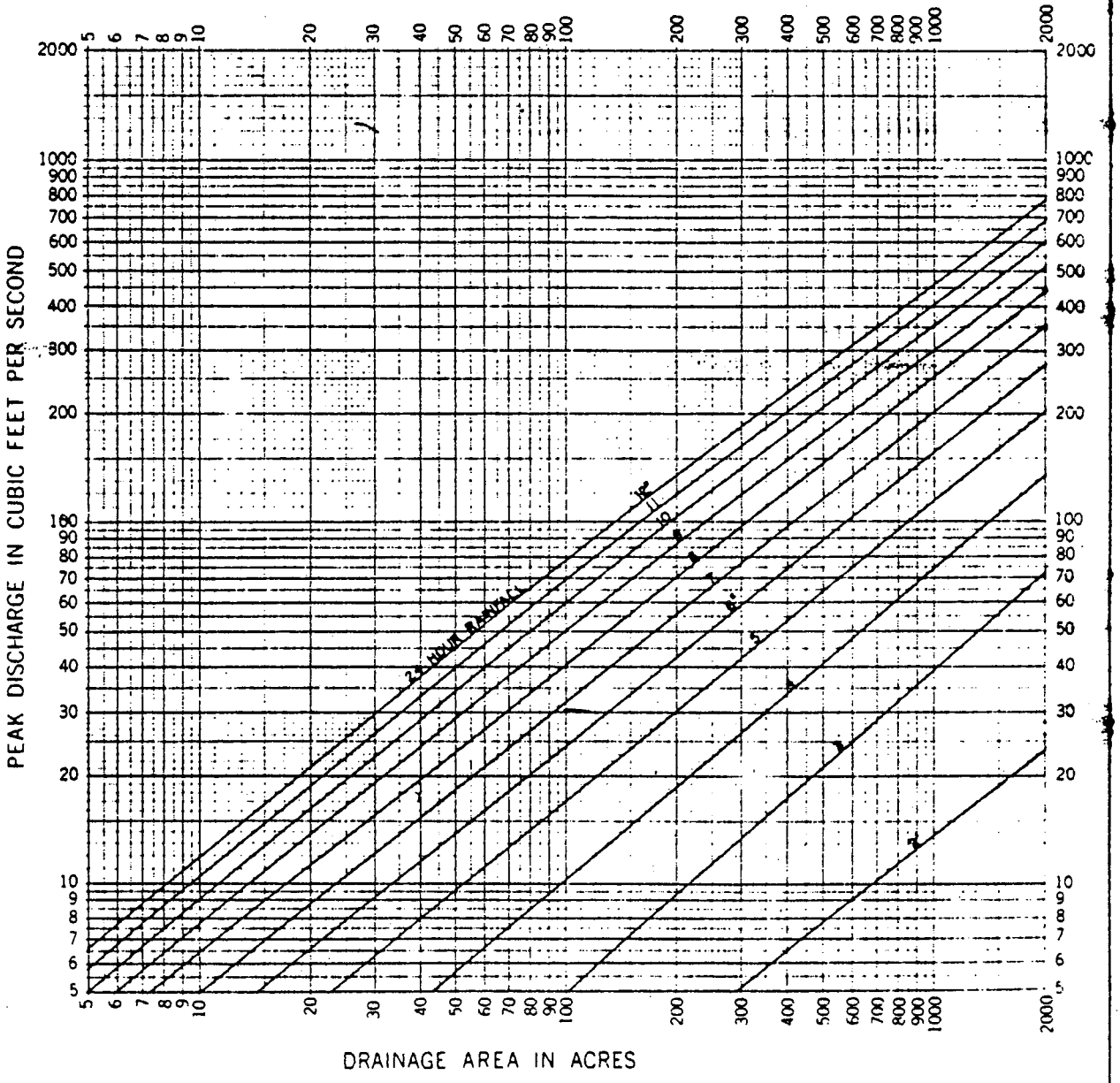


Exhibit 2 - 12

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT

CURVE NUMBER - 75

24 HOUR RAINFALL FROM US WB TP-40
(Revised)

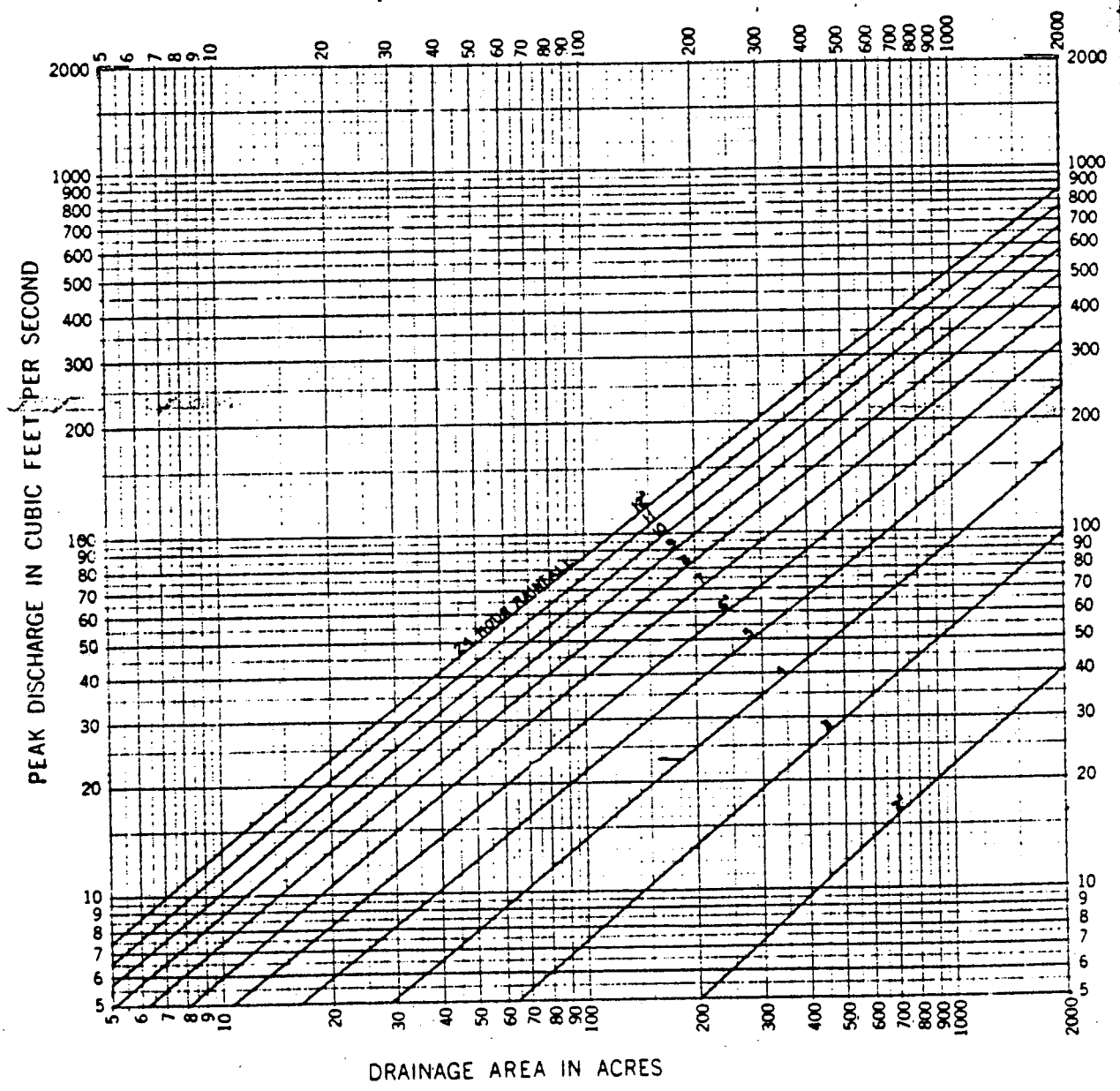


Exhibit 2 - 12

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT

CURVE NUMBER - 80

24 HOUR RAINFALL FROM US WB TP-40
(Revised)

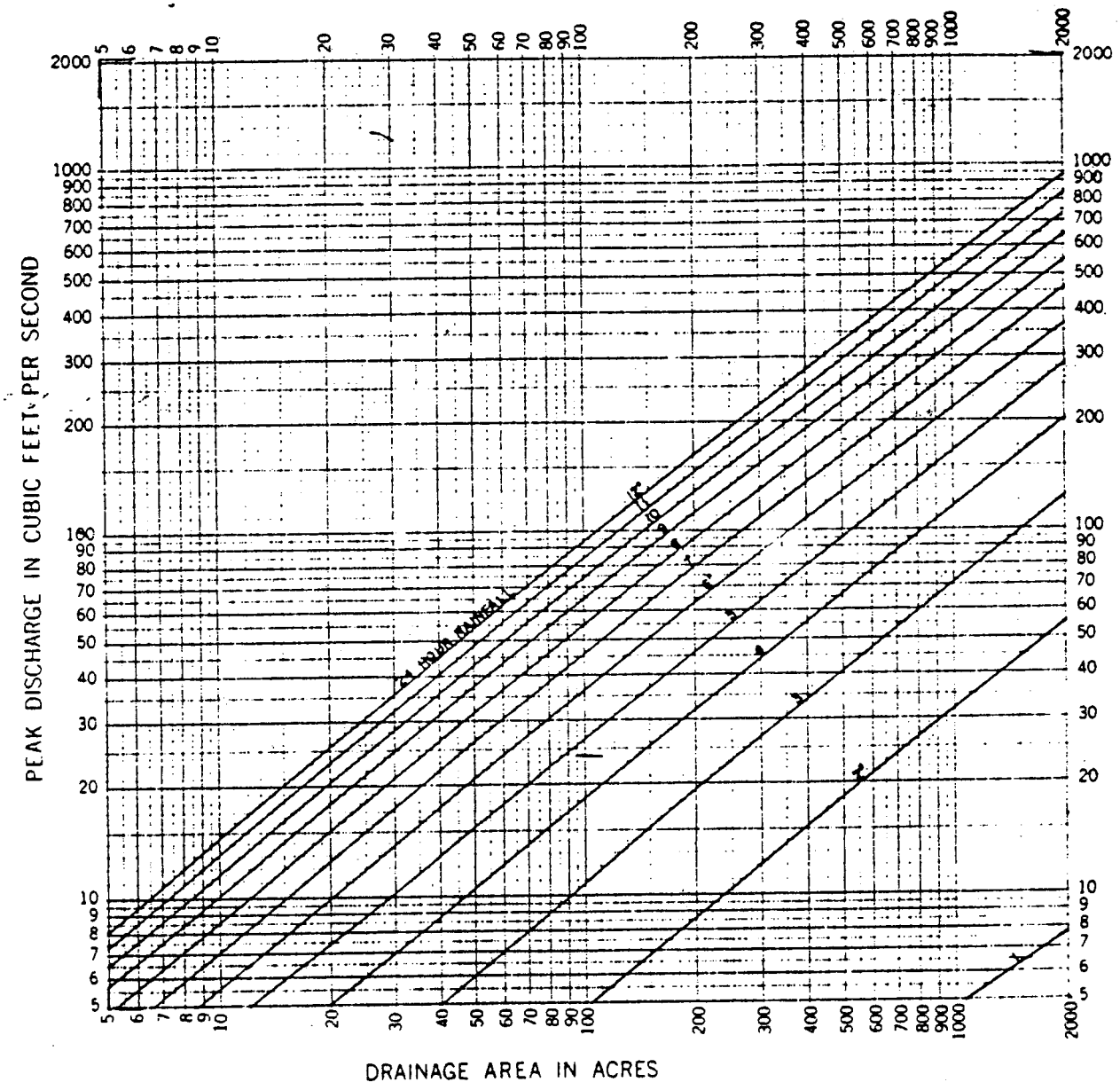


Exhibit 2 - 12

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT
CURVE NUMBER - 85

24 HOUR RAINFALL FROM US WB TP-40
(Revised)

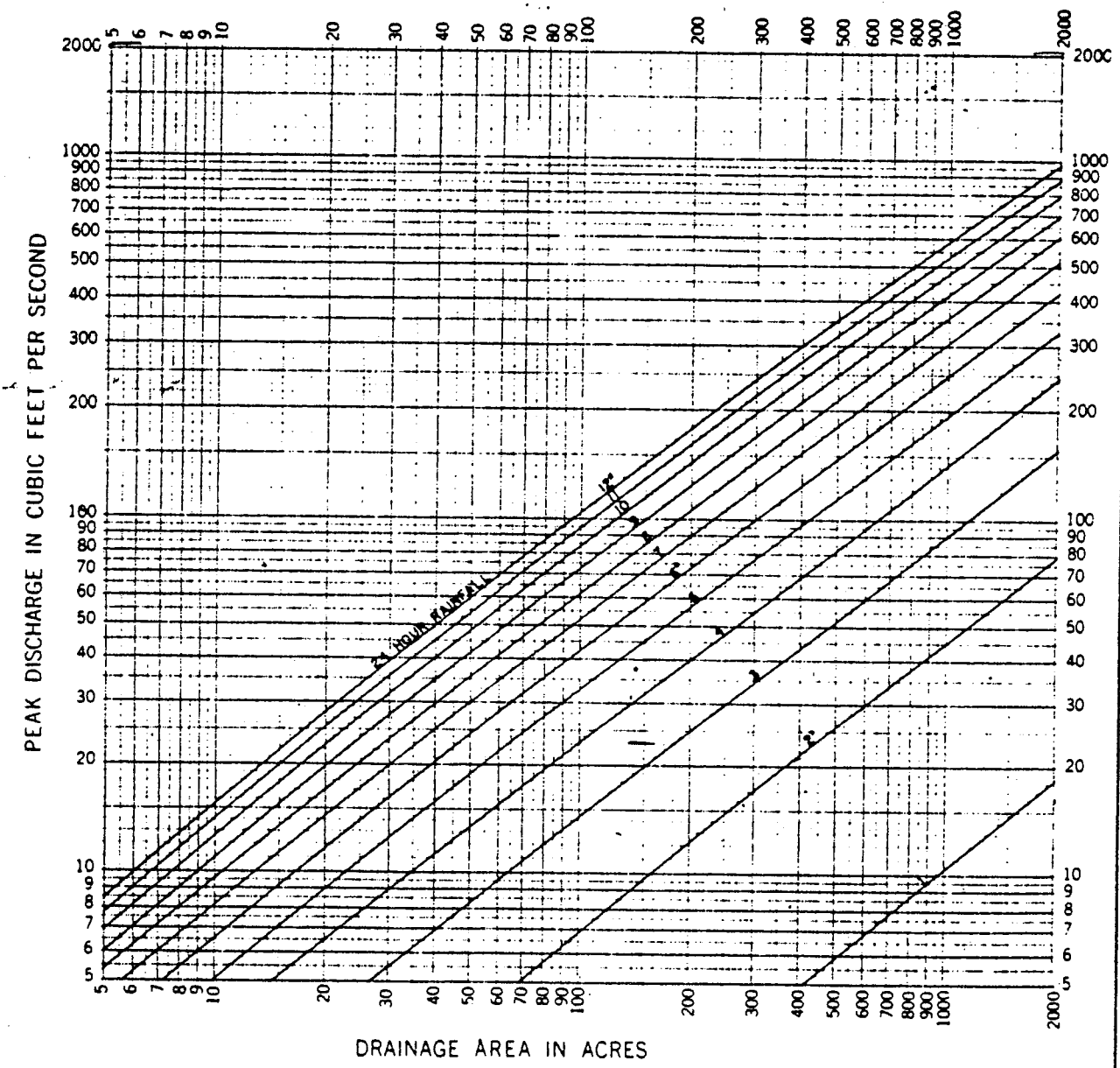


Exhibit 2 - 12

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT
CURVE NUMBER - '90

24 HOUR RAINFALL FROM US WB TP-40
(Revised)

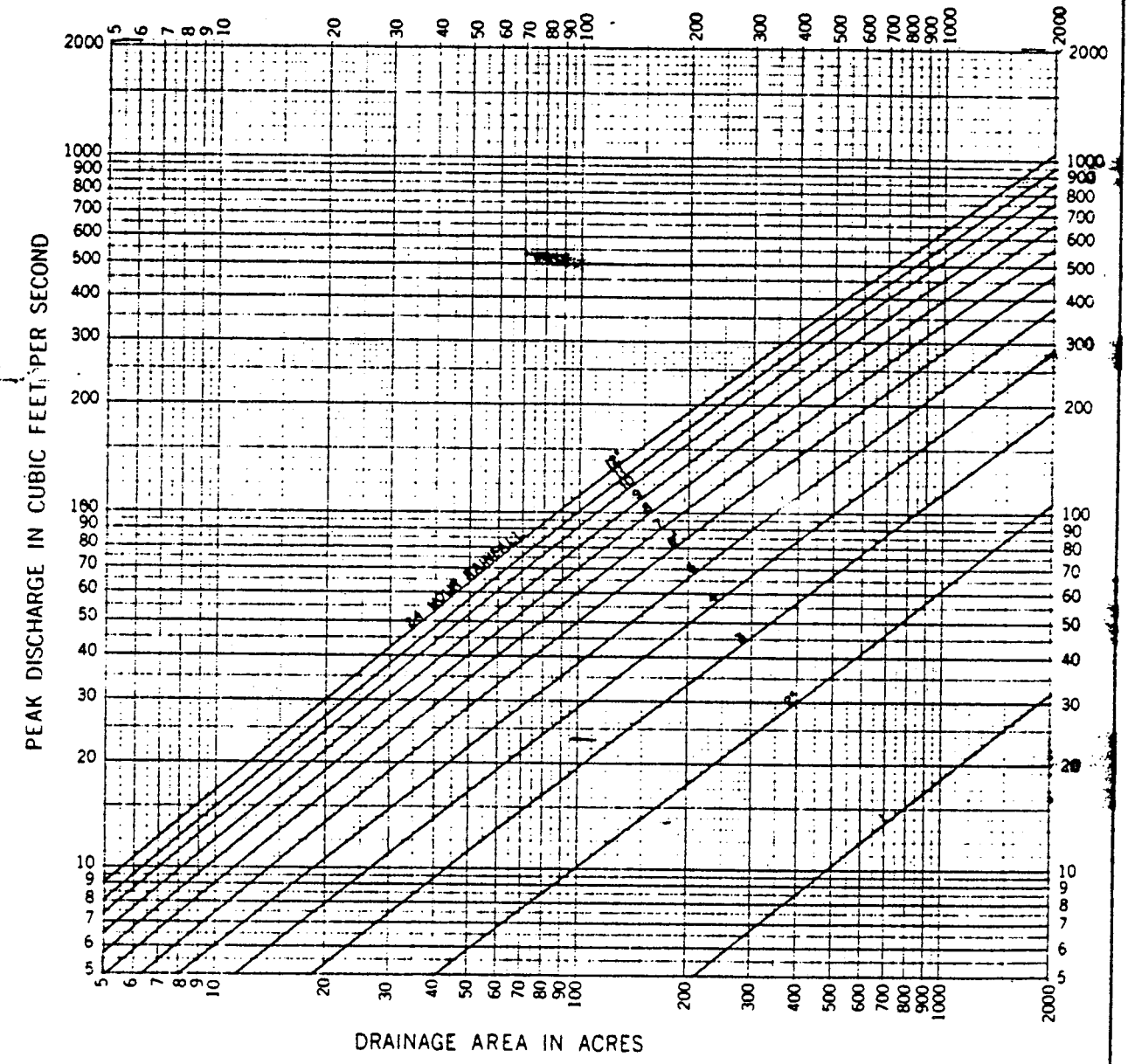


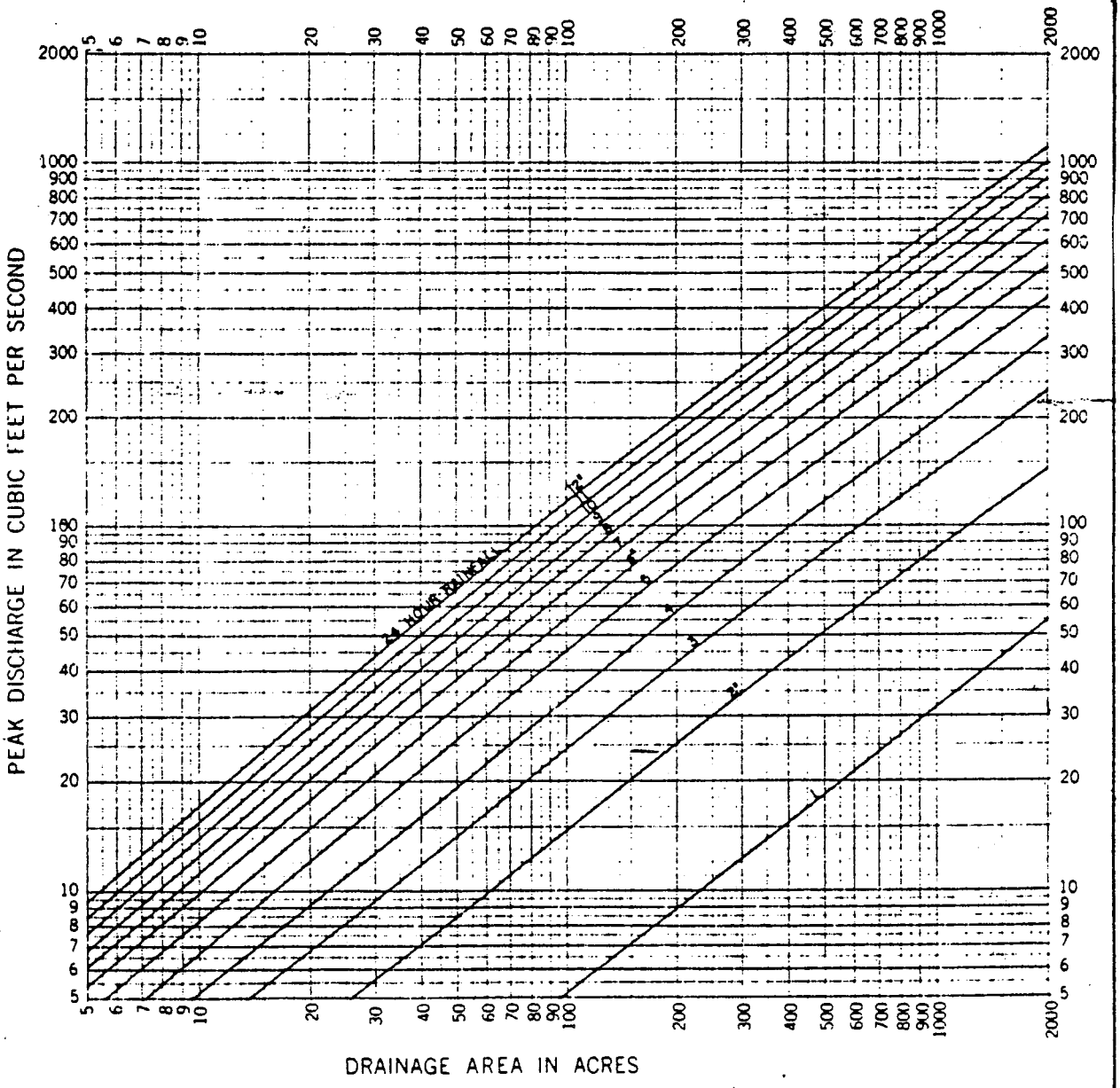
Exhibit 2 - 12

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS
TYPE I A STORM DISTRIBUTION

SLOPES - FLAT

CURVE NUMBER - 95

24 HOUR RAINFALL FROM US WB TP-40 (Revised)



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Proposed Construction Standards

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301 Trench Excavation, Bedding and Backfill

301.1.00 Description

This work consists of trench excavation, trench foundation, pipe bedding, pipe zone material, trench backfill, embankment and surface removal, and replacement.

301.1.01 Trench Excavation

Trench excavation is defined as the removal of all material encountered in the trench to the depths as shown or as directed. Trench excavation shall be classified as either common or rock excavation.

301.1.01A Common Excavation

Common excavation is defined as the removal of all material which is not classified as rock excavation.

301.1.01B Rock Excavation

Rock excavation is defined as boulders exceeding 1/2 cubic yard in size, or solid ledge rock, which in the opinion of the engineer requires, for its removal, drilling and blasting, wedging, sledging, barring, or breaking up with power-operated tools.

No soft or disintegrated rock; hard-pan or cemented gravel that can be removed with a hand pick or power operated excavator or shovel; no loose, shaken, or previously blasted rock or broken stone in rock fillings or elsewhere; and no rock outside of the minimum limits of measurement allowed, which may fall into the excavation, will be measured or allowed.

301.1.02 Trench Foundation

Trench foundation is defined as the bottom of the trench on which the pipe bedding is to lay and which provides support for the pipe.

301.1.03 Pipe Bedding

Pipe bedding is defined as the furnishing, placing and compacting of specified materials on the trench foundation so as to uniformly support the barrel of the pipe to the springline. The total bedding depth shall be a minimum of 6 inches below the outside bell of the pipe.

301.1.04 Pipe Zone

The pipe zone is defined as the furnishing, placing and compacting of specified materials for the full width of the trench from the top of the bedding to a point 12 inches above the top outside surface of the barrel of the pipe.

301.1.05 Trench Backfill

Trench backfill is defined as the furnishing, placing, and compacting of material in the trench between the top of the pipe zone material and the bottom of the pavement base rock, ground surface, or surface material.

301.1.06 Embankment

Embankment is defined as furnishing, placing, and compacting of the embankment material to the depth and configuration specified.

301.1.07 Surface Removal and Replacement

Surface removal and replacement is defined as the removal and/or replacement of surface material such as topsoil, sod, pavement, sidewalks, gravel, etc., which requires special consideration in order to accomplish.

301.2.00 Materials

Materials may be native or imported as specified. Materials proposed for use in the work shall not be used without the approval of the engineer.

301.2.01 Trench Foundation

The trench foundation shall be undisturbed native material. Where ground water or other unstable conditions exist and the native material cannot support the pipe, additional excavation may be required. The trench shall be stabilized with pipe bedding material.

301.2.02 Pipe Bedding

Pipe bedding material shall be crushed rock with a maximum size of 3/4 inch, well graded from coarse to fine. Clean beach, pit run, or reject crusher sand, or other materials may be approved as a substitute for gravel in trenches that have no groundwater in the pipe zone.

301.2.03 Pipe Zone

The pipe zone material shall consist of bedding material as described in subsection 301.2.02.

301.2.04 Trench Backfill

301.2.04A Class A Backfill

Class A backfill shall be native or common material which, in the opinion of the engineer, meets the characteristics required for the specific surface loading or other criteria of the backfill zone.

301.2.04B Class B Backfill

Class B backfill shall be granular material consisting of gravel or crushed rock meeting the requirements of Section 207. Designated size shall be 3/4"-0.

301.2.04C Class C Backfill

Class C backfill shall be clean sand with no particle size larger than 1/4 inch.

301.2.04D Class D Backfill

Pit run or bar run material well graded from coarse to fine. The maximum dimension shall be 3 inches.

301.2.05 Embankment

Embankment materials shall be as shown on the plan.

301.2.06 Embankment Geotextile Fabric

Embankment geotextile fabric shall be composed of a polymeric yarn or fiber oriented into a stable network which retains its relative structure during handling, placement, and design service life. Fabric may be rejected by the engineer if dimensional stability or resistance of the fabric to ambient temperatures, acid, and alkaline conditions and microorganisms/insects does not appear to be satisfactory for the intended purpose. The fabric shall be free of any chemical treatment or coating which might significantly reduce permeability. The selvage of fabric shall be such that the outer fibers are prevented from pulling away from the fabric. Embankment and foundation geotextile fabrics shall conform to the following requirements.

Geotextile Fabric Property	Test Method	
Grab tensile strength, lbs.	ASTM D 1682 Modified	180 mins.
Burst strength (diaphragm method), psi.	ASTM D 3786 Modified	290 mins.
AOS (Apparent Opening Size), ... U.S. Std. sieve	OSHD TM 815	50
Water permeability, cm./sec.	ASTM D 4491	0.04 mins.
Ultraviolet stability, percent strength retained	ASTM D 4355	70 mins.

301.2.07 Surface Removal and Replacement

301.2.07A Topsoil

Topsoil shall be friable, fertile, natural surface loam consisting of sands, silts, clays and organic matter in combination and free of noxious weeds, roots, refuse, sticks, lumps, and substances toxic to plant growth.

301.2.07B Other Material

All other materials to be used in this section shall be in accordance with their respective standard specifications. Special material shall be as designated in the contract documents.

301.3.00 Construction

301.3.01 Trench Excavation

301.3.01A General

All trench excavation and backfill shall conform to the requirements of regulatory agencies having jurisdiction over the work or within the work site.

301.3.01B Clearing the Right of Way

Where clearing of the right of way is necessary, it shall be completed prior to the start of the trenching.

The contractor shall observe all federal and state laws relating to fire permits and local regulations relating to burning materials. Under no conditions shall excavated materials be permitted to cover brush prior to clearing and disposal of the brush.

301.3.01C Open Trench Limit

The length of open trench shall be kept to a minimum. The engineer shall be the sole judge of the amount of trench allowed open based upon work conditions of the area. In normal cases, the open trench length shall not exceed 100 feet. Related construction such as pavement, road gravel, concrete restoration, etc., shall be completed within 800 feet of the open trench limit.

301.3.01D Trench Width

Trench width at the ground surface shall be kept to the minimum necessary to install the pipe in a safe manner but not less than 24 inches. In all cases, trenches must be of sufficient width to allow for shoring and permit proper joining of the pipe and backfilling of material along the sides of the pipe. The minimum trench width in the pipe zone must provide a clear working space of 6 inches outside the maximum outside diameter of the pipe. Excavation for manholes and other structures shall be wide enough to provide a minimum of 12 inches between the structure surface and the sides of the excavation.

The the top of the trench shall be confined to rights of way or easements. Special written agreements to extend the width may be made with the affected property owners, provided the agreements are first approved by the engineer.

301.3.01E Trench Grade

The contractor shall excavate the trench to the lines and grades shown or as established by the engineer, with proper allowance for pipe thickness, pipe bedding and foundation stabilization. The foundation upon which the bedding is to be placed shall be firm, undisturbed, and true to grade. If the trench is excavated below grade without authorization, the contractor shall restore to grade with material of the type specified for pipe bedding at no expense to the owner. The material shall be placed over the full width of the trench, in compacted layers not exceeding 6 inches.

301.3.01F Disposal of Excess Material

Excavated material shall be placed at locations and in such a manner that it does not create a hazard to pedestrian or vehicular traffic, or interfere with the function of existing drainage facilities.

The contractor shall make arrangements for and dispose of all excess material not required elsewhere on the project at no cost to the owner.

301.3.01G Trench Protection

The contractor shall provide the materials, labor and equipment necessary to protect trenches at all times. The trench protection shall provide safe working conditions in the trench and protect the work, existing property, utilities, pavement, etc. The method of protection shall be according to the contractor's design. The contractor may elect to use a combination of shoring, overbreak, tunneling, boring, sliding trench shields, or other methods of accomplishing the work provided the method meets with the approval of all applicable local, state, and federal safety codes.

Damages resulting from improper shoring, improper removal of shoring or from failure to shore shall be the sole responsibility of the contractor.

301.3.01H Existing Abandoned Facilities

The contractor shall remove and dispose of existing abandoned sewer pipe, structures, and other facilities as necessary to construct the sewer. The cost of such removal will be considered incidental to the item trench excavation and backfill.

301.3.02 Rock Excavation

Where ledge rock or boulders and large stones meeting the definition of rock as described in subsection 301.1.01 are encountered during trench excavation, the rock shall be removed to provide a minimum of 6 inches of clearance to each side of and below all pipe and appurtenances. The contractor will be required to excavate and remove the overburden and expose the rock to allow the engineer to profile or cross section the rock for measurement of pay quantity. The measurement shall be completed prior to removal of the rock.

The use of explosives shall comply with the requirements of Section 107. The contractor shall provide all tools and devices required for loading and using explosives, blasting caps, and accessories. When blasting rock in trenches, cover the area to be shot with blasting mats or other protective material to prevent the scattering of rock fragments outside of the excavation.

The contractor shall assume all liability and responsibility connected with or accruing from blasting or the use of explosives or dangerous material.

301.3.03 Dewatering

The contractor shall promptly remove and dispose of all water entering the trench during the time the trench is being prepared for the pipe laying, during the laying of the pipe and until the backfill at the pipe zone has been completed. The contractor shall dispose of the water in a suitable manner without damage to adjacent property.

Groundwater shall be controlled to prevent softening of the bottom of excavations or formation of "quick" conditions or "boils." Dewatering systems shall be designed and operated so as to prevent removal of the natural soils and so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property.

301.3.04 Trench Foundation

When, in the judgment of the engineer, the existing material in the bottom of the trench is unsuitable for supporting the pipe, the contractor shall excavate below grade, as directed. The excavated material shall be replaced with foundation material meeting the requirements of subsection 301.2.01. If unsuitable foundation material is removed in the same operation and manner as trench excavation, the removal will be measured and paid for as trench excavation. Otherwise, the removal will be paid as trench foundation.

301.3.05 Pipe Bedding

The contractor shall spread the bedding smoothly to proper grade so that the pipe is uniformly supported along the barrel and shall excavate bell holes at each joint to permit proper assembly and inspection of the joint. Bedding under the pipe shall provide a firm, unyielding support along the entire pipe length. The contractor shall place subsequent lifts of not more than 1 foot in thickness up to the springline of the pipe, bringing lifts up together on both sides of the pipe. The material under the pipe haunches shall be thoroughly compacted.

301.3.06 Pipe Zone

Pipe zone material shall be carefully placed around the pipe and thoroughly compacted in 6-inch layers to provide complete support of the pipe and to prevent deflection or damage. The contractor shall prevent pipe from movement either horizontally or vertically during placement and compaction of pipe zone material.

301.3.07 Trench Backfill

The engineer may sample excavated material to determine the suitability of the Class A material for use as backfill. If the material is found to be suitable, the contractor may elect to use the material in place of the specified backfill. The contractor shall take reasonable precautions to prevent excavated material from becoming saturated beyond the critical moisture limits and replace any saturated Class A material with Class B, C, or D material, as specified, at no additional expense to the owner.

The contractor shall backfill the trench above the pipe zone in successive lifts. Backfill shall not be allowed to free-fall into the trench until at least 3 feet of cover is provided over the top of the pipe. The method of compaction shall be modified as necessary to protect the pipe.

The contractor shall compact each lift to a minimum of 95 percent of the maximum density as determined by AASHTO T 99, Method D. If the specified compaction is not obtained, the contractor may be required to use a modified compaction procedure and/or reduce the thickness of lifts. If approved materials meeting the specifications cannot be compacted to the required density regardless of compactive effort or method, the engineer may reduce the required density or direct that alternate materials be used. In no case shall excavation and pipe laying operations proceed until the contractor is able to compact the backfill to the satisfaction of the engineer.

When the backfilling is complete, the contractor shall finish the surface area as specified. In paved or graveled areas the contractor shall maintain the surface of the trench backfill level with the existing grade with 3/4"-0 crushed aggregate material, or asphalt concrete, if directed, until final pavement replacement is completed and accepted by the owner.

301.3.08 Structural Embankments

The contractor shall construct embankment to support the pipeline in accordance with the details shown on the plans. The contractor shall spread excess excavated trench material suitable for embankment, or approved imported material when directed, in maximum 1-foot lifts for the full width of the embankment cross section and compact to a minimum of 95 percent of maximum density for the full depth of the fill as determined by AASHTO T 99.

The contractor shall moisten or dry layers of fill as required to obtain the compaction specified and compact the embankment to final cross section before the trench excavation for the pipe is made.

301.3.09 Compaction

If the compaction specified for trench backfill or embankment is not obtained, the contractor will be required to use a modified compaction procedure. If approved materials meeting the specifications cannot be compacted to the required density regardless of compactive effort or method, the engineer may reduce the required density or direct that alternate materials be used. In no case shall embankment or backfill operations proceed until the contractor is able to compact the backfill material to the satisfaction of the engineer.

301.3.10 Embankment Geotextile Fabrics

Fabric shall be protected against damage and deterioration until incorporated into the work. The fabric shall be dry at the time of installation. Fabric will be rejected if, at the time of installation, it has defects, deterioration, or damage, as determined by the engineer.

The minimum overlap of fabric panels shall be 2 feet.

301.3.11 Surface Removal and Replacement

301.3.11A Topsoil

Where trenches cross lawns, garden areas, pastures, cultivated fields, or other areas on which reasonable topsoil conditions exist, the contractor shall remove the topsoil to the specified depth and place the material in a stockpile. The contractor shall not mix the topsoil with other excavated material. After the trench has been backfilled, the topsoil shall be replaced.

In lieu of stockpiling the topsoil, approved imported topsoil may be substituted, to a depth specified or approved, at no expense to the owner.

The contractor shall maintain the finished grade of the topsoil level with the area adjacent to the trench until final acceptance by the engineer and shall repair damage to adjacent topsoil caused by work operations. The contractor shall remove all rock, gravel, clay, and any other foreign materials from the surface, regrade, and add topsoil as required.

301.3.11B Pavement, Curb and Sidewalk

Cuts in bituminous pavement, portland cement concrete pavement, curbs, and sidewalks, regardless of thickness, shall be made with a pavement saw. The width of the opening shall be the minimum necessary for the excavation and shall follow lines parallel to the pipe.

Replacement of pavement, curb and sidewalk shall be as specified in Division 2.

301.4.00 Measurement and Payment

301.4.01 Trench Excavation and Backfill

301.4.01A Lineal Foot Basis

Trench excavation and backfill will be measured and paid for on a lineal foot basis, to the nearest foot. Measurement will be along the pipe from center to center of manholes, catch basins, or other structures, or to the end of the pipe where no structures exist, with no deduction for structures or fittings.

301.4.01B Lineal Foot Basis (Depth Method)

Trench excavation shall be measured and paid for on a lineal foot basis, to the nearest foot, for the length of trench in each of the depth ranges listed in the bid schedule.

The depth will be measured from the original ground or paved surface to the invert of the pipe. Depth will be measured at intervals of 25 feet along the centerline of the trench beginning at the center of the downstream manhole. The average depth between measuring points will be the depth used for computing payment for each section of the trench.

The length of trench shall be measured in accordance with subsection 301.4.01A.

301.4.01C Cubic Yard Basis

Trench excavation and backfill shall be measured and paid for on a cubic yard basis, to the nearest 0.1 yard Measurement shall be to the nearest 0.01 foot and computed on the following basis.

Length. The length will be the horizontal distance measured along the centerline of the trench. Measurement shall be continuous through manhole or structure locations unless the bid schedule carries separate items of excavation applicable to the manholes or structures.

Width. The width will be the diameter of the bell of the pipe plus 12 inches, with a minimum of 24 inches.

Depth. The depth will be the vertical distance from the original ground or paved surface to the invert of the pipe. The depth will be measured at intervals of 25 feet, or as directed by the engineer, along the centerline of the trench and the average depth between points will be used for the volume computations.

301.4.02 Rock Excavation

Rock excavation will be measured and paid for on a cubic yard basis to the nearest 0.1 cubic yard. Measurement will be of the actual dimensions rock removed within the following limits:

The length will be the horizontal distance measured along the centerline of the trench. The measurement will exclude manholes and other structures, which will be measured separately. The width and depth will be measured in accordance with subsection 301.4.01C.

Rock excavation quantities for manholes and other structures shall be computed from the actual rock excavated to a depth 6 inches below the bottom of the structure and an area within a line parallel with and 1 foot outside of the actual dimensions of the manhole or structure.

301.4.03 Trench Protection

Shoring, mobile trench shields, overbreak, and other trench protection measures will be considered incidental work.

301.4.04 Trench Foundation

Payment for this item shall include removal of unsuitable material and replacement as necessary to provide for a stable foundation for the pipe.

301.4.04A Ton Basis

Trench foundation will measured and paid for on a ton basis, to the nearest 0.01 ton. The pay quantity will be based on weigh tickets from scales meeting the requirements of Section 109. Weigh tickets shall be presented to the engineer for his signature on the day the material is delivered.

301.4.04B Cubic Yard Basis

Trench foundation shall be measured and paid for on a cubic yard basis, to the nearest 0.1 yard. Measurement shall be to the nearest 0.01 foot and computed on the following basis.

Depth shall be the actual depth of trench foundation placed as specified. Length and width shall be measured in accordance with the provisions of subsection 301.4.01C

301.4.04C Extra Work Basis

When not listed in the bid schedule, trench foundation will be paid for as extra work.

301.4.05 Pipe Bedding

Pipe bedding will be considered incidental work.

301.4.06 Pipe Zone Backfill

When suitable material exists at the trench side, as determined by the engineer, pipe zone backfill shall be considered incidental work. When Class B, C, or D backfill is required and approved by the engineer, measurement and payment will be as follows.

301.4.06A Ton Basis

Pipe zone backfill will be measured and paid for in accordance with the provisions of subsection 301.4.04A.

301.4.06B Cubic Yard Basis

Trench foundation shall be measured and paid for on a cubic yard basis, to the nearest 0.1 yard. Measurement shall be to the nearest 0.01 foot and computed on the following basis.

Depth shall be the actual depth of trench foundation placed as specified. Length and width shall be measured in accordance with the provisions of subsection 301.4.01C. The volume of material displaced by pipe and structures will be deducted from the calculated backfill volume to determine the final pay quantity.

301.4.07 Embankment

Embankment materials will be measured in place and paid for on a cubic yard basis, to the nearest 0.1 yard. Trench excavation, bedding, and backfill placed in the completed embankment will be measured and paid for at the unit prices listed in the bid schedule.

301.4.08 Embankment Geotextile Fabric

Embankment geotextile fabric will be measured and paid for on a square yard basis, to the nearest 0.1 yard, for the surface area covered in accordance with the plans or as required by the engineer. No separate measurement will be made for construction of laps, seams, joints, or patches, unless the engineer orders more than the specified lap, in which case the added lap width will be included in the measurement.

301.4.09 Imported Topsoil

Imported topsoil will be measured and paid for on ton basis, to the nearest 0.01 ton. Measurement will be based on weigh tickets from scales meeting the requirements of Section 109.

301.4.10 Incidental Basis

When not listed in the bid schedule, trench excavation, dewatering, geotextile fabric, pipe zone material, backfill material, imported topsoil, maintenance of backfilled trenches, and other anticipated items will be considered incidental work.

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305 Storm Drain Pipe and Fittings

305.1.00 Description

This work consists of the construction of surface and subsurface drainage facilities.

305.2.00 Materials

305.2.01 Galvanized Corrugated Steel Pipe and Fittings

Galvanized corrugated steel pipe and fittings shall conform to the requirements of AASHTO M 36 or M 167.

The surfaces of corrugated steel pipe shall be completely coated with bituminous material conforming to AASHTO M 190, with a minimum thickness of 0.05 inch at the crest of the corrugations.

305.2.02 Corrugated Aluminum Alloy Pipe and Fittings

Corrugated aluminum alloy pipe and fittings shall conform to the requirements of AASHTO M 196, M 197, M 211, and M 219.

305.2.03 Nonreinforced Concrete Pipe and Fittings

Nonreinforced concrete pipe and fittings shall conform to the requirements of ASTM C 14.

305.2.04 Reinforced Concrete Pipe and Fittings

Reinforced concrete pipe and fittings shall conform to the requirements of ASTM C 76 or ASTM C 655.

305.2.05 PVC Pipe and Fittings

PVC pipe and fittings shall conform to the requirements of ASTM D 3034 or F794 and have a minimum wall stiffness of 46 psi or an SDR of 35.

305.2.06 Polyethylene Pipe and Fittings

Polyethylene pipe and fittings shall be made of polyethylene compounds which conform with the physical requirements of Type III, Category 3, 4, or 5, P23, P33, P34, Class C, with the applicable requirements defined in ASTM D 1248.

305.2.07 Galvanized Corrugated Steel Pipe Arches and Fittings

Galvanized corrugated steel pipe arches and fittings shall conform to the requirements of AASHTO M 36 and AASHTO M 136.

305.2.08 Corrugated Aluminum Alloy Pipe Arches and Fittings

Corrugated aluminum alloy pipe arches and fittings shall conform to the requirements of AASHTO M 196 and AASHTO M 197.

305.2.09 Galvanized Corrugated Steel Structural Plate Arches

Galvanized corrugated structural steel plate pipe, arches and pipe arches shall conform to the requirements of AASHTO M 167, except there shall be no limitation to the weight of a single plate. After galvanizing and corrugating, the base metal for structural plate shall also conform to the following mechanical requirements:

Tensile Strength	45,000 psi min.
Yield Point	33,000 psi min.
Elongation in 2 inches	20% min.

Tension test specimens shall be prepared and tested in accordance with ASTM A 446, except specimens shall be cut from the flat test portion of the roll with the specimen length parallel to the corrugation.

305.2.10 Aluminum Structural Plate Arches

Aluminum structural plate arches shall conform to the requirements of AASHTO M 219.

305.2.11 Perforated Galvanized Corrugated Steel Pipe and Fittings

Perforated galvanized corrugated steel pipe and fittings shall conform to the requirements of AASHTO M 36 or AASHTO M 197.

305.2.12 Perforated Corrugated Aluminum Alloy Pipe and Fittings

Perforated corrugated aluminum alloy pipe and fittings shall conform to the requirements of AASHTO M 197.

305.2.13 Perforated Concrete Pipe and Fittings

Perforated concrete pipe and fittings shall conform to the requirements of ASTM C 444.

305.3.00 Construction

305.3.01 Installation

Pipe laying shall begin at the downstream end of the pipe line. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid pipe and outside circumferential laps of flexible pipe shall be placed facing upstream. Flexible pipe shall be placed with longitudinal laps or seams at the sides. The lower segment of the pipe shall be in contact with the shaped bedding throughout the full length of the pipe.

Paved invert or partially lined pipe shall be laid so that the longitudinal centerline of the paved segment coincides with the flow line. Elliptical and elliptically reinforced pipe shall be placed with the major axis within 5 degrees of vertical.

All field joints made in the joining of sections of pipe to form culverts and sewers, and to connect to structures and special sections, shall be closely fitted, tight, and shall provide a smooth and uniform interior surface. The joints shall secure and hold adjoining sections to each other and shall fasten securely to adjoining structures and special sections.

Perforated pipe shall be placed with the perforations facing down. The pipe shall be inspected prior to lowering into the trench and cleaned of any material that may plug the perforations of the pipe. Pipe sections shall be securely fastened together with couplings, fittings or bands as specified by the manufacturer for the type of pipe used. Upgrade ends of all subsurface drain pipe shall be capped with approved plugs.

305.3.02 Filter Material

The contractor shall place a minimum of 4 inches of filter material under perforated pipe. The material shall be brought to grade prior to placing the pipe. The filter material shall provide a firm unyielding support along the entire pipe length.

305.3.03 Drainage Geotextile Fabrics

Fabric shall be protected against damage and deterioration until incorporated into the work. The fabric shall be dry at the time of installation. Fabric will be rejected if, at the time of installation, it has defects, deterioration, or damage, as determined by the engineer.

The minimum overlap of fabric shall be 2 feet.

305.3.04 Cast-in-Place Storm Sewer Pipe

Cast-in-place pipe shall conform to the special provisions.

305.3.05 Television Inspection

Television inspection shall conform with the requirements of Section 303. Only the acceptance inspection will be required.

305.3.06 Deflection Testing

Flexible pipe shall be deflection tested in accordance with the requirements of Section 303.

305.3.07 Repairs

The contractor shall locate and repair any sections failing to pass the required tests and inspections and shall then repeat the specified tests and inspections on those sections at no expense to the owner.

305.4.00 Measurement and Payment

305.4.01 Storm Drain Pipe

Storm drain pipe will be measured and paid for on a lineal foot basis, to the nearest foot, for each size and type listed in the bid schedule. Measurement will be along the pipe from center to center of manholes, catch basins, or other structures, or to the end of the pipe where no structures exist, with no deduction for structures or fittings.

305.4.02 Underdrains

Perforated drain pipe will be measured and paid for on a lineal foot basis, to the nearest foot, for each size and type listed in the bid schedule.

305.4.03 Filter Material

Filter material will be considered incidental to the construction of underdrains.

305.4.04 End Sections

End sections will be paid for at the unit price for each size and type listed in the bid schedule.

305.4.05 Tee and Wye Fittings

Tee and wye fittings will be paid for at the contract unit price for each size and type listed in the bid schedule. Payment for tee and wye fittings will be in addition to payment for pipe.

305.4.06 Drainage Geotextile Fabrics

305.4.06A Square Yard Basis

Geotextile fabrics will be measured and paid for on a square yard basis, to the nearest 0.1 yard, for the surface area covered in accordance with the plans or as required by the engineer. No separate measurement will be made for construction of laps, seams, joints, or patches, unless the engineer orders more than the specified lap, in which case the added lap width will be included in the measurement.

305.4.06B Lineal Foot Basis

Geotextile fabric used in trench applications will be measured and paid for on a lineal foot basis, to the nearest foot, for the length of trench the fabric is used in. No separate measurement will be made for construction of laps, seams, joints, or patches, unless the engineer orders more than the specified lap, in which case the added lap width will be included in the measurement.

305.4.07 Television Inspection

TV inspection will be measured and paid for in conformance with Section 303.

305.4.08 Deflection Testing

Deflection testing of flexible pipe shall be considered incidental work.

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307 Catch Basins and Inlets

307.1.00 Description

This work consists of the construction of catch basins and inlets.

307.2.00 Materials

307.2.01 Concrete

Concrete shall conform to the requirements of Section 212 and shall be Class 3000-1 1/2.

307.2.02 Forms

Forms shall conform to the requirements of Section 306.

307.2.03 Metal Reinforcement

Metal reinforcement shall conform to the requirements of Section 306.

307.2.04 Mortar

Mortar shall conform to the requirements of Section 306.

307.2.05 Cast Iron Frames and Grates

Cast iron frames and grates shall conform to the requirements of Section 306.

307.2.06 Welded Frames and Grates

Welded frames and grates shall be fabricated of steel conforming to ASTM A 7, A 36, or A 373 in accordance with the details shown.

307.2.07 Precast Concrete Units

Precast units shall conform to the requirements of ASTM C 478.

307.3.00 Construction

307.3.01 Excavation and Backfill

Excavation and backfill shall conform to the requirements of Section 301.

307.3.02 Cast-in-Place Catch Basins and Inlets

Forms shall be tight and well braced. The corners shall be chamfered. All water and debris shall be removed.

Immediately after placement, the concrete shall be consolidated with an approved vibrator. Vibration time shall be limited to that necessary to produce satisfactory consolidation without causing segregation. The top surface shall be screeded and exposed surfaces trowelled to a smooth finish free from marks or irregularities. Exposed edges shall be radiused with a steel edging tool. After forms are removed, the contractor shall patch any defects in the concrete with approved mortar mix.

Immediately after removal of forms and final finishing, the concrete shall be treated with an approved curing compound.

307.3.03 Precast Concrete Units

Precast catch basins and inlets shall be installed at the specified line and grade.

307.4.00 Measurement and Payment

Catch basins and inlets will be paid for at unit price for each type and size listed in the bid schedule.