LUCAS COUNTY ENGINEERS OFFICE

STORM DRAINAGE DESIGN CRITERIA

<u>Drainage</u>
The design of storm sewer systems will be based upon the "Rational Method" using the equation Q=CiA and the "Manning Formula" (A is less than 100acres). Areas greater than 100 acres use State of Ohio Bulletin Number 43 and compare with Bulletin Number 45 Floods in Ohio or Soil Conservation Service Technical Release #55, 2nd edition.

A.   The rainfall intensity, "I", will be taken from the appropriate curve for the Toledo, Ohio, area as published in Technical Paper No. 25, of the U.S. Weather Bureau. "Rainfall Intensity-Duration-Frequency Curves for Selected Station in the United States, Alaska, Hawaiian Islands and Puerto Rico" Government Printing Office, 1955.

B.   A minimum of t=20 minutes may be used as the time of concentration to the first pick-up point in the system, in residential areas. In areas other than residential, time of concentration shall be determined by the use of overland flow charts.

C.   The runoff coefficients for rational method shall be used as shown on page 6. When a soil has two hydrologic groups the sandier soil grouping can be used for determining the proposed runoff coefficient.   Example: B/D Hydrologic group proposed residential subdivision with average 1/3 acre lot size "C"=0.32.

D.   Storm sewers shall be designed to flow just full for the 5 year intensity-duration-frequency curve. The minimum velocity at just full shall be 2 feet per second. Minimum pavement gutter elevations shall be at or above the hydraulic grade line for a 10 year frequency storm. Use the 10 year intensity-duration-frequency curve for determining this hydraulic grade line.

E.   Catch basin type and spacing shall be designed using the 2 year intensity-duration-frequency curve. The maximum allowable width of the sheet gutter flow from the face of the curb shall be limited to 8 feet into the driving lane. Curb inlets will usually be required at all intersections and cul de sacs to provide for more positive drainage.

F.   An overall drainage area layout showing the limits of the contributing runoff area, broken down into areas contributing to each drainage pick-up point, shall be submitted prior to the development of final paving and drainage plans. Drainage design within the development shall be adequate to handle the entire contributing watershed area, and its existing, proposed and probable future development, and not the area under submission only. When the design makes use of an existing storm sewer or open ditch, cross sections and profiles shall be submitted which show the existing conditions at least 500 feet downstream from the plat

being considered. The outletting stream for the development may need to be improved before development begins. An approved plan and County inspection is required when cleaning any ditch required for plat approval. If future plat extensions will utilize the same drainage system, the overall drainage plan shall be submitted with the first plat paving plans. When the drainage system includes the construction of an outlet pipe or ditch outside of the limits of current plat or development parcel, a drainage easement shall be secured and recorded for the outlet.

G.   Complete drainage calculations shall be submitted for pipe size determinations, 10 year hydraulic gradient checks and catch basin type and spacing designs. All culverts will be designed for a 10 year frequency storm with a hydraulic gradient check for a 25 year storm. The County has data for many ditches with 10 year hydraulic grade lines already determined. Drainage calculations shall be neatly prepared, organized, and submitted in a report format for review by the County drainage engineer. The report shall include the designer and/or reviewer name(s) and the seal, signature, and date of the professional engineer responsible for the calculations in accordance with Section 4733.14 of the *Ohio Revised Code*.

H.   Storm sewers and culverts shall be designed to conform to the requirements of Item 603 of the current State of Ohio, Department of Transportation Construction and Material Specifications. Pipe under pavement shall be Type "A" or "B" Conduit. Pipe not under pavement shall be Type "C" Conduit. The designer may indicate a particular kind of pipe by inserting the specification item number after the designation of the type of conduit. Pipe permitted are:

Item 603, Conduit, As Per Plan
Where Type B or C Conduit of less than or equal to 18" diameter is specified the contractor may use any of the following conduit materials:

Concrete Conduit:
    *ODOT 706.02 with 706.11 joints
The bedding for Type C Conduit may consist of a natural foundation with recesses shaped to receive the bell and spigot pipe. Scarify and loosen the middle one third of the trench.

Polyvinyl Chloride (PVC) Conduit:
    *ODOT 707.42
    *ODOT 707.43
    *ODOT 707.45 (For 15" and under diameter)
    *ASTM F679 (For 18" diameter)
PVC Conduit will only be permitted at those locations where a minimum cover from the top of the pipe to the bottom of the subgrade is 12 inches, however, for no installation shall the distance from the top of the pipe to the surface of pavement, or finish grade for conduit not under the pavement, be less than 18 inches. The bedding shall extend to a height of 12 inches above the top of the polyvinyl chloride conduit.

Polyethylene Conduit:
*ODOT 707.33 with in-line bell couplings and o-ring rubber
gaskets meeting ASTM F477 only.

Polyethylene conduit will only be permitted at those locations where a minimum cover from the finish grade to the top of the pipe is 18 inches or greater. The bedding shall extend to a height of 12 inches above the top of the polyethylene conduit.

Where 21" or 24" diameter is specified for either Type B conduit not under the mainline pavement including shoulder and berm, or Type C conduit. The contractor may use any of the following conduit material:

Concrete Conduit
*ODOT 706.02 with 706.11 joints

The bedding for Type C conduit may consist of a natural foundation with recesses shaped to receive the bell and spigot pipe. Scarify and loosen the middle one third of the trench.

Polyvinyl Chloride (PVC) Conduit:
*ODOT 707.42
*ODOT 707.43
*ASTM F679

PVC Conduit will only be permitted at those locations where a minimum cover from the finish grade to the top of the pipe is 18 inches or greater. The bedding shall extend to a height of 12 inches above the top of the PVC conduit.

Polyethylene Conduit:
*ODOT 707.33 with in-line bell couplings and o-ring rubber
gaskets meeting ASTM F477 only.

Polyethylene conduit will only be permitted at those locations where a minimum cover from the finish grade to the top of the pipe is 18 inches or greater. The bedding shall extend to a height of 12 inches above the top of the polyethylene conduit.

For 21" & 24" Type B Conduit under mainline pavement including shoulder and berm, and for 27" Conduit and over the Contractor shall use:

Concrete Conduit:
*ODOT 706.02 with 706.11 joints

The bedding for Type C conduit may consist of a natural foundation with recesses shaped to receive the bell and spigot pipe. Scarify and loosen the middle one third of the trench.

It is the designers responsibility to determine which conduit meets as per plan bidding conditions, and which conduit is closed to a specific conduit type. The plan's subsummaries and general summaries shall reflect this. Corrugated metal pipe will be permitted only when being used as a restriction in a detention facility. The design manning roughness coefficient for corrugated pipe shall be $n=0.024$. All other pipe shall have a roughness coefficient of $n=0.013$.

Type "A" and "B" Conduit shall have a minimum cover of 9" from the top outside crown to the bottom of the finished subgrade for concrete pipe and 12" minimum cover for polyvinyl chloride and polyethylene conduit. Type "C" Conduit with less than 18" of cover shall be reinforced concrete. Pipe shall be minimum 12" diameter beyond the first structure which picks up surface water.

I.   Mainline storm sewers should not be placed in rear yards. 12" crossovers should have a 1% grade for better cleanout purposes.

J.   Grading plans will be required showing the proposed elevations at the right of way line, building lines and back lot lines. In areas where the site grading plan calls for the conveyance of surface storm water along or across rear property lines, a catch basin shall be provided to limit the length draining to the basin to a maximum of the lesser of 3 lots or 300 feet in any one direction. For the sump condition with back to back lots, a maximum of 12 lots may drain to one catch basin. A desirable grade of 0.5% and an absolute minimum grade of 0.3% shall be provided for rear lot swales.

K.   Rock channel protection will be required at all sewer and culvert outlets.

L.   Storm sewer taps shall be provided for all lots unless basements and crawl spaces are prohibited by plat recitation. Taps shall be outletted to the main storm sewer system for the development and may not be outletted directly to open ditches or rear yard drainage. Storm sewer taps shall be a minimum of 6" diameter and shall be carried to the right of way line or on to the lot. If more than one lot is served by a single line, the line shall be sized assuming each lot is contributing 50 gal./min (0.11 c.f.s.). The minimum velocity for full flow shall be 2 ft./sec. In structures storm sewer taps shall be placed at least 6 inches above main line sewers and into structures whenever possible.

M.   Any storm sewers connecting into State of Ohio drainage systems or crossing state highways must be approved by the Ohio Department of Transportation.

N.   For manhole and catch basin locations, use the center of the structure.

O.   Cross sections shall show all cross overs, catch basins, manholes, and rear yard drainage swales.

P.   Detention facilities will be required by the County and the allowable flow out will be limited to the existing 5 year intensity storm for existing conditions of the proposed site or available capacity of the outlet. The detention facility shall store the proposed flow from a 25 year intensity storm. Existing conditions may limit the allowable out flow of the proposed site. For example, a proposed development may drain 20 acres to a ditch or conduit that receives a

total drainage area of 100 acres. The existing ditch or conduit may have the capacity to carry 20 c.f.s. and it was determined that the existing conditions for the 20 acres to be developed carried 20 c.f.s. In this situation, the proposed site would be prorated over the entire drainage area and would be allowed one fifth of the outlet capacity (4 c.f.s.) since the site has one fifth of the overall drainage area. The storage area for the detention pond should be above the 10 year storm of the outletting stream. The outlet conduit for the detention area must be set above normal water elevation of the receiving stream, ditch, or conduit. Detention (dry) ponds will be maintained by owners and County will put residential, commercial and industrial subdivision detention (dry) ponds under a petition to be maintained by County as a backup only. When determining meter size for detention ponds Q flow and not Q avg. shall be used for determining peak discharge. Detention ponds should be set up near outlet on separate lot and not in rear yards. See sample storm water detention calculations sheets 7, 8, and 9. When the drainage system includes the construction of an outlet pipe or ditch outside of the limits of current plat or development parcel, a drainage easement shall be issued and recorded for the outlet.

Q.   The side slopes shall have a maximum slope of 2.5:1 or flatter for residential areas. Steeper slopes may be approved, but may require fencing or other safety measures. Dry ponds should be graded for complete drainage (0.50% minimum internal slope) shall be of sufficient strength to support a tractor mower, or other equipment required for maintenance. Wet ponds shall include a bench and safety ledge. Where ground conditions are favorable, the use of permeable pavement surfaces as a lining material should be considered to encourage percolation of stored runoff water into the ground. All slopes shall have erosion control with an approved turf reinforcement mat and/or mulch system.

R.   Maximum spacing between access structures (catch basins or manholes) shall be 350 feet for pipe sizes of 36" and under and 500 feet for sizes over 36".

S.   All catch basins and manholes shall be constructed without sumps or traps, except where two main runs intersect then a sump would be required. Also a sump is required at the last manhole prior to the outlet.

T.   Access to main line storm sewers shall be provided through the use of manholes located to keep the sewer a sufficient distance behind the edge of pavement or curb line. Catch basins are not to be located on the main line storm sewer, on curbed or urban pavement typicals, but is allowed on rural typicals.

U.   Rear yard catch basins shall be constructed and rear yard swales graded at the time the development's storm drainage and pavement is constructed. Swales shall be seeded, mulched and fertilized. Silt fences shall be placed around all rear yard catch basins.

V.   Subdivisions which are involved with an open ditch may be required to enclose the ditch if the enclosure would involve a 48 inch conduit or smaller size. Larger open ditches may require that side slopes of ditch banks be stabilized with dumped rock or by some other means. Ditch easements will be required for ditches from top of bank plus 20 ft. on one continuous side. Multiple conduit culvert systems will not be allowed and enclosures must be single structures. See FEMA section Y.

W.   Drive entrances that disturb County, State, or Township Right of Way may require drive tiles, and a permit.

X.   Storm sewer easements shall be a minimum of 20 feet for all storm sewers and a minimum 15 feet for drainage easements involving swales.

Y.   Requirements for NPDES permits shall be followed when a permit is required.

Z.   FEMA regulations shall be strictly followed for all developments. Impacts on floodway and floodway fringe shall be addressed. Filling in floodplain requires a permit from Lucas County Building Regulations. Flood boundaries shall be shown on plans along with 100 year storm elevations. All necessary CLOMRs, LOMRs, or LOMAs shall be secured from FEMA before construction of buildings can commence. FEMA studied streams and ditches require that new structures do not raise 100 year storm elevation unless public notification is performed and all parties affected by change are contacted and are agreeable to the raise in the 100 year storm elevation.

AA.   Mainline storm sewers in Township or County right-of-way shall not be placed with flowlines below normal water of any ponds.

BB.   Outletting storm sewers shall be placed a minimum of 6" above existing ditch bottoms unless outlet ditch has been cleaned within the previous two years then outlet storm sewer shall be placed 1 foot above ditch bottom, for ditches that are normally dry year round. For ditches that have water in them most of the year the storm sewer outlet shall be placed above the normal water elevation.

CC.   Wetlands that could be affected by the development shall be shown on plans by a qualified professional. No dredging, filling, clearing or altering of wetlands is allowed until the proper Army Corp of Engineers and/or Ohio EPA permit are secured.

DD.   Riparian setbacks that are required by County Flood Drainage Regulations or by Township Resolutions shall be shown and incorporated into the overall drainage design.

EE.   Any ditch enclosure or ditch work may require Army Corp of Engineers permit or Ohio EPA permit. When doing any work in a ditch, stream, creek or river, contact Army Corp of Engineers and Ohio EPA for any applicable permits.

FF.   Cross sections of ditches, creeks or rivers where fill is being placed in a floodplain will be required and must show effects of any flooding caused by additional fill in floodplain for 5, 10, 25 and 100 year storms.

GG.   Discharge from enclosure shall be as follows
     a. All outlets will be designed so that velocities will be appropriate to, and will not damage, receiving waterways.

     b. Outlet protection using riprap or other approved materials will be provided as necessary to prevent erosion.

c. The soils above and around the outlet will be compacted and stabilized to prevent piping around structure. Riprap extending 3 feet above the ordinary high water mark is recommended for all outlets and should be keyed in 18" below outlet grade line.

d. When the outlet empties into a detention/retention facility, channel or other watercourse, and the difference in elevation between the outfall storm sewer flow line to the receiving detention/retention facility, channel or other watercourse is greater than 3 feet then a drop manhole will be required to dissipate energy. If the outletting storm sewer velocity is 4ft./s flowing full or less, then another approved method of stabilization may be considered.

HH. An agreement for maintenance of detention ponds, retention ponds, water quality structures or any other Best Management Practice (BMP) will be required for all site plans and subdivisions that are not already placed under maintenance through the County petition process. A sample of agreement required is shown on page 8 of Storm Drainage Design Criteria.

TOLEDO STORMWATER CREDIT
BEST MANAGEMENT PRACTICE (BMP)
<u>MAINTENANCE AGREEMENT</u>

<u>APPLICANT:</u>

Name: _____

Address: _____

City: _____ State: _____ Zip: _____

Phone: (____) _____ Fax: _____

Email: _____

<u>PROJECT INFORMATION:</u>

Name of Project: _____

Location: _____

_____

_____

Type of BMP: _____

<u>CERTIFICATION:</u>

I certify that the above information is true and correct to the best of my knowledge and belief. I agree to maintain the above stated BMP to the prescribed criteria according to the Lucas County Engineers. I, hereby, release the County and Township from any maintenance responsibility whatsoever on the above identified BMP located on my property. I agree to provide corrected information should there be any change in the information provided herein. I agree to allow the County or Township to inspect BMP to assure proper working order.

_____   _____
Name   Title

_____   _____
Signature   Date

RUNOFF COEFFICIENTS FOR RATIONAL METHOD

LAND USE DESCRIPTION	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Cultivated Land: without conservation treatment	.32	.50	.66	.74
: with conservation treatment	.17	.30	.43	.50
Pasture or Range Land: poor condition	.26	.45	.61	.69
good condition	.05	.16	.36	.47
Meadow: good condition	.50	.13	.30	.43
Wood or Forest Land: thin stand, poor cover, no mulch	.05	.23	.41	.54
good cover	.05	.10	.29	.41
Open Spaces, lawns, parks, golf courses, cemeteries, etc.				
good condition: grass cover on 75% or more of the area	.05	.16	.36	.47
fair condition: grass cover on 50% to 75% of the area	.05	.28	.45	.57
Commercial and Business Areas (85% impervious)	.69	.77	.83	.86
Industrial Districts (72% impervious)	.50	.66	.74	.80
Residential:				

Average Lot Size	Average % Impervious	A	B	C	D
⅛ acre or less	65	.41	.59	.72	.77
¼ acre	38	.16	.37	.54	.64
⅓ acre	30	.12	.32	.50	.61
½ acre	25	.09	.29	.47	.59
1 acre	20	.06	.26	.45	.57
2 acres		.05	.23	.41	.50

LAND USE DESCRIPTION	A	B	C	D
Pavement Parking lots, roofs, driveways, etc.	.96	.96	.96	.96

The coefficients are applicable for storm of five to ten year return frequencies.

For recurrence intervals longer than ten years, the indicated runoff coefficients should be increased, assuming that nearly all of the rainfall will become runoff and should be accommodated by and increased runoff coefficient.

Source: *Medina County Stormwater Management and Sediment Control Rules and Regulations, Dec. 1998, Page 53*

A.   Gross Area   =   _____ S.F.

B.   Pavement Area   =   _____ S.F.

C.   Building Area   =   _____ S.F.

D.   Total Impervious _____ S.F. = _____ S.F. x 0.90 = _____

E.   Net Pervious Area   S.F. x 0.15 = _____

F.   Wt. C. = C_w = $\dfrac{C\,A_I}{A_T}$ =   _____ $C \times A_I$ +

G.   Allowable Q into exist system (see Design Considerations "Sect. IV-N")
                                   (April, 1977)

$$Q_{allow} = CiA = 0.15 \times 3.2 \times AT/43560 = 0.15 \times 3.2 \times \overline{43560} =$$

(Note: $i_5 = 3.2$"/hr. (5 year 20 min.)

H.   Detention Volume Required

	I_{25} In/hr	C_wA (A=Acres)	Q_{in} Q_{25}	$Q_{out}=$ Q_{allow}	$Q_{in} - Q_{out}$	$(Q_{in}-Q_{out}) \times t_c \times 60$ ft^3	Design Detention Volume
20	4.40						
30	3.60						
40	3.00						
50	2.60						
60	2.30						
70	2.10						
80	1.90						
90	1.70						
00	1.60						
10	1.50						
20	1.40						
30	1.30						
40	1.20						
50	1.15						
60	1.10						
70	1.05						
80	1.00						

If peak storage volume is not reached within the 3 hour time period in the above table, continue this procedure until peak storage volume is reached. Rainfall Intensity Chart, dated 4/17/61, is available from this Office upon request.

I.   Determination of Design Detention Volume

Area	End Area of Section	Length	Volume (ft^3)

O.   Detention Design Meter Line Check (Culvert Analysis)

$$H = \frac{V^2}{2g} \left(1 + K_e + \frac{29n^2L}{R\ 4/3}\right)$$

$$2gH = V^2 \left(1 + K_e + \frac{29n^2L}{R\ 4/3}\right)$$

$$V^2 = \frac{2\ gH}{\left(1 + K_e + \frac{29n^2L}{R\ 4/3}\right)}$$

DATA:

1.   Length of meter line =   ft.

2.   Slope of meter line =   %

3.   Size of meter line =   in.

4.   Pipe type & "N"
        (CMP – n = 0.024 =
        all others n = .013)

5.   Entrance Coeff (K$_e$) =   0.5

6.   Assumed Max. Head =   ft.

7   Hydr. Radius (R) =   ft.
                (R 4/3) =

Assumed Head (H)	H x 2g	$1+K_e+\dfrac{29n^2L}{R^{4/3}}$	V^2	V	Area of Pipe (A)	Flow Q.	Q av. = $\sum$ Q./number
0.5'							
1.0'							
1.5'							
2.0'							
2.5'							
3.0'							

STORM WATER DETENTION

EXAMPLE PROBLEM

Determine Weighted "C"

Gross Area	=	578,000 ft^2
Pavement Area	=	325,000 ft^2
Building Area	=	45,000 ft^2
Lawn Area	=	208,000 ft^2