City of Rochester Hills

Engineering Design Standards

Adopted September 23, 2019

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

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CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 1

General Requirements and Submittals

The items found in this Chapter contain the general requirements for the submittal of Engineering Construction Plans to the City of Rochester Hills for review, comment and approval. In addition, specific requirements pertaining to Water Mains, Sanitary Sewers, Storm Water Management, Paving and Grading follow this Chapter and apply as stated within their respective context.

Land Improvement Permit (LIP) Application

1. A properly completed Land Improvement Permit (LIP) Application shall be submitted to the Engineering Division. The application form is available at the Engineering Division. The required materials listed on the form must be submitted along with the application.

Submittal

1. Three sets of complete engineering construction plans, bearing the seal of a Professional Engineer, licensed to practice in the State of Michigan, shall be submitted to the Engineering Division for review. Each plan sheet shall contain the project name, the project owner, the City File Number (assigned by the City of Rochester Hills), and the section number.

2. A Certified Boundary Survey of the site, prepared and sealed by a Professional Surveyor, licensed to practice in the State of Michigan, or a copy of the complete plat, shall be submitted along with the Engineering Construction Plans.

3. Plans shall be submitted on twenty-four inches (24") x thirty-six inches (36") white plan sheets having black print, and shall be neatly and accurately prepared.

4. All engineering construction plans shall contain the latest version of the applicable City of Rochester Hills' Standard Detail Sheets.

5. The cover sheet shall include a map showing the location of the proposed project, a symbol legend, a sheet index, a quantities table, and a permit schedule.

6. Existing information, topography, utilities, etc., shall be shown in gray or lighter line weight, while proposed improvements shall be shown in dark and heavy black lines. The legend shall clearly refer to all line symbols used.

7. For projects having more than one sheet of plans, a general plan having a scale of one inch (1") equal to one-hundred feet (100') shall be provided showing the overall project, and indicating the size and general location of all improvements shown in the detailed plans. Street names, street and easement widths, lot lines, lot dimensions, lot numbers, and ownership shall be shown on all plans.

8. Utilities shall be located in accordance with City Standards. Easement boundary lines shall be no closer than ten feet (10') from the utility. Utilities shall typically be centered within easements and parallel to lot lines. Generally, utilities shall be constructed in the road right-of-way or in easements adjacent to the road right-of-way, and shall not be located under existing or proposed pavement, including pathways and sidewalks. Side yard easements should be avoided if possible.

9. Grading plans are required for all developments. Refer to *Grading and Rear Yard Drainage*, for specific requirements.

10. Engineering plans having a scale of no greater than one inch (1") equals fifty feet (50') horizontal and one inch (1") equals five feet (5') vertical (for profiles) shall be provided. Sanitary sewer and water main shall be shown on the same sheet. Plan and profile views are required on all gravity sewers. The profile should be shown below the plan view on the same sheet.

11. Storm sewer and pavement shall be shown on the same sheets. Plan and profile views are required for all storm sewers. A plan view with centerline stationing shown is required on all paving plans. Show the top-of-curb line on profile.

12. In the profile view, all crossings of utilities must be shown. When a water main crosses above a sewer, an invert elevation for the water main shall be shown. The minimum vertical clearance between utilities shall be eighteen inches (18"). Class II sand backfill compacted to at least ninety-five percent (95%) of maximum unit weight is required between utilities.

13. Profiles of sewers shall indicate the size, material type, and class of pipe, rim elevations of all structures, the length of pipe between structures, the slope of the pipe, numbering of structures, locations of service leads, and casting and cover type. Bedding shall be shown if it differs from the typical trench detail. The profile shall indicate the existing and proposed ground elevations above the route of the sewer. The inverts of all sewers, both existing and proposed, shall be given at manholes. The location of areas requiring compacted sand backfill shall be indicated on the profile.

14. Vertical controls shall be in accordance with the U.S.G.S. Datum, and horizontal controls shall be in accordance with State Planar Coordinates. A minimum of two project benchmarks for the vertical controls shall be indicated on each sheet. Two permanent benchmarks shall be included on the alignment and control sheet.

15. Any areas that are considered to be "wetlands" as defined by the City of Rochester Hills or the Michigan Department of Environmental Quality (MDEQ) shall be shown on the plans. Improvements will not be permitted in wetlands unless the MDEQ and the City issue a permit or a letter of "No Authority" for such activity. Refer to Wetland and Watercourse Determination Section (Section 126, Article IV, Division II) in the City Code of Ordinances.

16. Finished exterior elevations shall be shown at the corners of all buildings and for all utility structures. Lowest floor elevation, including basement, shall be shown on the plans.

17. The City encourages the incorporation of cross access agreements and may require them.

18. Plans for landscaping or tree planting required by either City Ordinance or City Standards, relating to such items as greenbelts, street islands, detention basins, or landscape and open space areas, shall conform to the City Standards and shall be submitted to the Department of Planning and Economic Development for review and approval prior to final site approval. The approved landscape plans shall also be attached to the construction plans.

19. All new grass areas that are required in the public right-of-way, by any City Ordinance or City Standard, and all existing grass areas that are disturbed by construction, shall be established or restored in conformance with the City's Standard Specifications.

20. Street names shall be approved by the City. The Department of Public Services charges a fee to the Developer for the installation of permanent street signs. All permanent street name and traffic control signs shall be installed by the City, and the cost of these signs shall be paid by the Developer.

21. The Developer's consulting engineer shall forward plans for approval to any public utility (gas, electric etc.) and to any Federal, State or County agency whose facilities or rights-of-way may be affected by the proposed construction. Permits for such construction, if required, shall be the responsibility of the Developer. The City shall approve all plans for public utilities.

22. After the plans are approved by the City and prior to any construction, six (6) complete sets of residential projects and seven (7) complete sets for commercial/industrial projects for field construction shall be submitted to the Engineering Division. The plans shall be sealed and signed on the cover sheet by the Licensed Engineer responsible for their preparation. The plans shall be rubber-stamped instead of embossed. All updated revisions from outside agencies shall be included on the plans. The City will stamp the construction plans approved and disperse as follows:

    Residential Development Project
    Three - City of Rochester Hills
    Two - Owner
    One - Engineer

    Commercial/Industrial Development Project
    Three - City of Rochester Hills DPS
    One - City of Rochester Hills Building Department
    Two - Owner
    One - Engineer

    These approved plans shall be the only plans used during construction.

23. Construction Plans shall include the following sheets (when applicable) and the order shall be maintained as indicated:

    Cover Sheet
    Overall Plan, General Notes & Legal Descriptions
    Existing Conditions
    Demolition Plans
    Construction Staging Plans
    Overall Grading Plans
    Detailed Grading, Soil Erosion Control Plans & Tree Protection Fencing Plans
    Sanitary Sewer & Water Main Plan & Profile Plans (including basis of design)
    Road & Storm Sewer Plan & Profile
    Drainage Area Map
    Traffic Staging/Signing/Paving
    Soil Boring Data Sheets
    Applicable Detail Sheets
    Landscape Plans & Details
    Natural Features Plan

    Revisions shall be identified if submitted after construction approval.

24. For all developments, a complete set of as-built plans including, but not limited to, sanitary sewers, storm sewers, water mains, detention basins, streets, roads, sidewalks, safety paths, grading, basis of designs, drainage maps and calculations, shall be provided by the Developer. The as-built set format shall be provided to the City as a PDF (Portable Document Format) version.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 2

Water Distribution System

A. Plans and Specifications – Submittal Procedure

1. The plans and specifications shall be submitted in accordance with *Chapter 1, General Requirements and Submittals.*

2. The Applicant may proceed with water main permitting once the City has conducted an initial review of the entire construction plan submittal and all revisions pertaining to the water main have been completed. The Applicant shall supply nine (9) sets of plans to the City for distribution to the Great Lakes Water Authority (GLWA) for approval, and forwarding to the Michigan Department of Environment, Great Lakes & Energy (EGLE) for approval and an EGLE construction permit. After, a copy of the approved permit will be provided to the applicant.

B. Plans and Specifications – Design Considerations; General

1. All water systems shall be designed conforming to the current edition of the "Recommended Standards for Water Works", published by Health Education Services, also known as the "Ten State Standards".

2. Plans shall consist of a cover sheet showing a plan view of the complete job, (split plan and profile sheets are required for water main sixteen inches (16") and greater), and the City's standard detail sheets.

3. Reference *Chapter 1, General Requirements and Submittal* for specific requirements pertaining to the presentation of plans.

4. The cover sheet shall contain a total quantity listing of the proposed water main improvements, indicating the lengths of pipe, type of pipe, and their respective sizes.

5. Provide continuous stationing. Identify all existing and proposed tees, valves, bends, hydrants, etc.

C. Benchmarks and Elevations

1. All elevations shall be on U.S.G.S. Datum.

2. Reference benchmarks, established at intervals not greater than 1,200 feet and convenient to the proposed construction, shall be noted on the plan and profile sheets, with identification, location, description and established elevation listed.

3. Street names and widths, subdivision names, lot numbers, addresses, legend, list of quantities, and other pertinent information (including proposed finish grade elevations at hydrants and gate wells) shall be shown on the plans.

D. Soil Conditions

1. Exploratory borings shall be provided by the developer, if requested by the City. Boring logs shall be indicated on the plans, if required.

2. Water main design, relative to pipe bedding and location, shall reflect the proper selection of materials and construction method compatible with the field conditions. Areas which show unsatisfactory ground material for pipe bearing, or possible chemical deterioration due to soils, shall be avoided or the pipe shall be suitably installed on adequately designed bedding and/or enclosed in protective wrap or coating.

3. Sand or other approved porous material shall be required for the full depth of trenches under all driveways and parking areas (private or commercial), streets, alleys, pathways and sidewalks.

E. Location and Layout

1. The distribution system in all developments requiring more than 600 feet of water main shall have a minimum of two (2) connections to a source of supply, and shall be a "looped" system on separate mains, if possible. If the looped system comes off the same water main, an isolation valve between the connection points is required.

2. Generally, water mains shall be installed in a public street right-of-way or in easements exclusively reserved for such use on the opposite side of the street from sanitary sewers. All easements shall be a minimum of twenty feet (20') wide and shall be dedicated to the City of Rochester Hills.

3. Water main shall be installed parallel to the property lines, or building lines, with clearance distances to allow for a twenty-foot (20') wide easement centered on the water main.

4. Preferably, water main should be constructed outside of paved parking areas, streets, and drives.

5. In new developments water mains shall be installed from boundary to boundary in abutting roads and interior streets, and at other locations as may be deemed necessary by the City, for future extensions.

6. All water mains shall be installed with a minimum cover of six feet (6') below finish grade. When water mains must dip to pass under a storm sewer or sanitary sewer, the sections, which are deeper than normal shall be kept to a minimum length by the use of vertical 45 degree (45°) - 11¼ degree (11¼°) bends properly anchored with thrust blocks and restrained joints, as approved by the City Engineer.

7. Open Drain Crossings:
   At all open drain crossings, a separate enlarged scale view is required. A minimum of four-foot (4') clearance or as required by the Michigan Department of Environment, Great Lakes & Energy between the bottom of the drain and the top of the water main is required.

8. Connections to Existing Main:
   When connecting to an existing water main, a tapping sleeve, valve and well are required. Same size taps are **not** allowed. In this case, a cut-in-tee with an in-line gate valve and well is required. A full body sleeve is required for all taps made to ductile iron, cast iron, or PVC water main, or as directed by the City Engineer.

9. Finish Grades:
   The plans shall indicate the finish grades of all hydrants and gate well rims.

10. Horizontal Clearance:
    All water mains shall be located so as to provide a minimum of ten feet (10') horizontal clearance between the nearest edge of the water main and the nearest edge of any sanitary or storm sewer.

11. Vertical Clearance:
    A minimum vertical clearance of eighteen inches (18") shall be maintained between the bottom of any water main and the top of any sanitary sewer, or any other utility, crossing under the water main. Vertical clearance of less than eighteen inches (18") or crossing of a sewer over a water main will require the encasement of the sewer or for special measures to be taken to prevent contamination of the water supply. Details must be submitted with the plans for review and approval by the City Engineer. Class II sand compacted to ninety-five percent (95%) maximum density shall be used at all utility crossings in twelve inch (12") compacted lifts, to the top of the highest utility.

12. Tunneling:
    Where conditions require tunneling or boring, consult the City Engineer for specific requirements. These conditions may include road crossings or conflicts with trees, shrubs, structures, or other utilities. Where water mains cross an improved road of any type, the pipe shall be installed by tunneling or boring and be placed in a steel casing pipe, or as directed by the City Engineer.

13. Profiles:
    Profile view is required for sixteen inch (16") and larger water mains, and for other smaller sizes when determined necessary by the City Engineer. Water mains shall be kept on one side of the street for the entire length of the street. Water mains shall <u>not</u> be located under pavement.

F. <u>Easements</u>

1. Easements for possible extensions or looped connections shall be extended to the property line, at locations designated by the City Engineer.

2. The easement descriptions shall include the hydrant leads and shall extend a minimum of ten feet (10') beyond the hydrant on any lead. The easement documents shall contain a

provision prohibiting the construction of, or locating of, any above ground structures within the limits of such easements.

G. Pipe Sizes

1. Eight-inch (8") diameter mains are the minimum size to be installed in single-family residential areas.

2. Twelve-inch (12") mains are considered to be the minimum size in commercial, office, industrial, and multiple family residential areas, except in a looped system of 1,500 feet or less where eight-inch (8") mains may be permitted, if approved by the City Engineer.

3. All single-hydrant lead longer than seventy-five feet (75') must be a minimum of eight inches (8") in diameter.

4. Water mains are to be looped whenever possible.

5. Ninety degree (90º) bends are not permitted.

H. Pipe Materials and Connections

1. Water mains sixteen inches (16") in diameter or less shall be cement-lined, ductile iron pipe Class 54. An alternate of zinc coated ductile iron Class 52 pipe will be considered and is subject to approval by the City Engineer on a case-by-case basis.

2. Water mains larger than sixteen inches (16") in diameter may be either ductile iron, or concrete lined cylinder pipe, conforming to AWWA C301, as determined by the City Engineer.

3. All ductile iron pipe shall be encased with a loose polyethylene wrap in tube or sheet form of 8 mils minimum thickness per the requirements of ANSI / ASTM standard specification D1248 and AWWA C105.

4. Crosses shall not be allowed, unless specifically approved by the City Engineer.

I. Valves – Location

1. A valve shall be provided at every connection to existing mains, unless otherwise approved by the City Engineer.

2. In general, valves on cross connecting mains shall be arranged so that no single line failure will require more than 800 feet of main to be out of service. Valves shall be so arranged that any section can be isolated by closing not more than four (4) valves.

3. A valve shall be provided on every dead-end line where required for future extension, at a location approved by the City Engineer.

4. Valves shall generally be located far enough back from the intersection of street rights-of-way lines for the gate well structure to clear crosswalks.

5. Sufficient valves shall be placed such that not more than twenty-four (24) homes, thirty (30) multiple family units, or two (2) hydrants shall be out of service within such section of water main, which can be isolated.

6. Where possible, gate valves shall be located at street intersections seven feet (7') from the intersecting street right-of-way line. All dead-end mains must include a valve at the tee. Valves should not be located under roadway pavement, pathways, sidewalks, or driveway approaches whenever possible.

J. Valves – Materials

1. Resilient Wedge or Resilient Seated type gate valves (East Jordan or U.S. Pipe) are required.

2. Valves shall be 'Left Hand Open' type.

K. Pressure Reducing Valves (PRV's)

1. In systems where two (2) or more pressure districts are to be connected for a "looped" supply, the plans shall include a PRV near the point of connection to the higher pressure district, to balance pressure across the new water system

2. A line gate valve shall be installed both upstream and downstream of each PRV to permit isolation of the PRV for maintenance or repair. If an alternative service ("looped" supply) to the water system is not available to permit repair on the PRV without a complete shutdown of the system, then a bypass line of equivalent size pipe as the water main and an additional bypass gate valve and well shall be provided.

L. Gate Wells

1. All valves shall be constructed within a gate well, as specified in the Standard Details for water mains.

2. A valve-in-box shall not be constructed unless specifically authorized by the City Engineer.

M. Fire Hydrants

1. In general, residential dwellings shall not be more than 250 feet from a fire hydrant, as measured along the street right-of-way line.

2. The Rochester Hills Fire Department will also review and approve the total number and location of fire hydrants for proposed developments based on building construction type and available pressure in the water system. For information regarding the number of hydrants and spacing, see part R.2., in this section.

3. A hydrant shall be installed at the end of every dead-end main. Temporary blow-offs may be allowed at the end of dead-end mains when future extension is imminent, as approved by the City Engineer.

4. In general, hydrants shall be located in the road right-of-way nine feet (9') from the right-of-way line, but not closer than six feet (6') to the back of curb. The location of hydrants with respect to the right-of-way line shall be indicated on the plans. Hydrant valves shall face the road, and hydrants shall be plumb and set to grade prior to final acceptance.

5. Hydrants, not located within a public road right-of-way, shall be located a minimum of five feet (5') from the edge of pavement or protected by bollards per City Detail Sheets.

6. A six-inch (6") gate valve with a three (3) piece cast iron valve box, and five and a quarter inch (5¼") diameter screw shaft, shall be placed forty-two inches (42") from the centerline of the valve to the centerline of the hydrant, at each hydrant.

7. Hydrants shall be as specified on the City Detail Sheets.

N. Pipe Restraints

1. Restraining glands shall be installed at all bends, dead ends, tees, and hydrants. Installation of thrust blocks is not permitted unless it is placed to supplement or provide redundancy to a restrained joint.

2. Vertical bends that exceed eleven and a quarter degrees (11¼^{o}) shall be restrained with rods.

O. Services

1. Service lines are to be shown to all buildings, or each unit in a multi-tenant buildings, other than single-family detached dwellings.

2. Service lines shall be installed using K soft copper or 200 p.s.i. SDR-9 poly pipe. Tracer wire shall be required for any water service built on private property.

3. A valve-in-box for each service line shall be provided and located at five feet (5') from the edge of non-residential buildings.

4. The basis of design for size shall be considered using a flow rate of twenty (20) gpm per residential dwelling unit. The basis of size other than for residential use shall be determined by the developer's Engineer and submitted for approval by the City prior to submittal of final plans.

P. Fire Protection Lines

1. Fire protection lines, where applicable, are to be shown to all buildings.

2. A valve-in-box for each fire protection line shall be provided and located at five feet (5') from the edge of the building.

3. The domestic supply lead shall tee off from the fire protection line, prior to the valve-in-box. The valve-in-box shall be located five feet (5') from the building. A separate domestic supply lead is also acceptable.

Q. Design Geometry

1. Piping Arrangement:
   Any water main in excess of 1,600 feet in length between interconnections may be required by the City Engineer to be oversized. On dead ends where there is no possibility of a future extension a main may not exceed 600 feet in length. Where a dead end exceeds 600 feet in length, the developer will be required to extend the main to provide a loop or oversize the main, as directed by the Engineer. Dead-end mains shall not connect to a looping main of smaller size without City Engineer approval. Hydrants shall be installed at the end of all dead-end water mains.

2. Design Pressures:
   Pipe shall be sized to carry maximum day flow plus fire flow with minimum pressures at any hydrant of twenty (20) psi.

R. Fire flow design criteria:

1. The number of hydrants and spacing is determined by the currently adopted Fire Prevention Code (2006 International Fire Code). See tables B105.1 and C105.1 below.
   Water flow requirements may be increased or decreased based on individual circumstances. Please contact the City of Rochester Hills Fire Prevention Bureau, 248.656.4717, if further information is needed.

2. Design calculations, including hydrant flow tests and/or a simulated hydraulic analysis, shall be furnished upon request of the City Engineer to confirm that pressure is available.

TABLE B105.1

MINIMUM REQUIRED FIRE-FLOW FOR BUILDINGS

FIRE-FLOW CALCULATION AREA (square feet)					FIRE-FLOW (gallons per minute)
Type IA IB	Type IIA and IIIA	Type IV and V-A	Type IIB and IIIB	Type V-B	
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000
		115,801-125,500	83,701-90,600	51,501-55,700	6,250
		125,501-135,500	90,601-97,900	55,701-60,200	6,500
		135,501-145,800	97,901-106,800	60,201-64,800	6,750
		145,801-156,700	106,801-113,200	64,801-69,600	7,000
		156,701-167,900	113,201-121,300	69,601-74,600	7,250
		167,901-179,400	121,301-129,600	74,601-79,800	7,500
		179,401-191,400	129,601-138,300	79,801-85,100	7,750
		191,401-Greater	138,301-Greater	85,101-Greater	8,000

Revised 3/27/2008

TABLE C105.1			
NUMBER AND DISTRIBUTION OF FIRE HYDRANTS			
FIRE-FLOW REQUIREMENT (gpm)	**MINIMUM NUMBER OF HYDRANTS**	**AVERAGE SPACING BETWEEN HYDRANTS (feet)**	**MAXIMUM DISTANCE FROM ANY POINT ON STREET OR ROAD FRONTAGE TO A HYDRANT**
1,750 or less	1	500	250
2,000-2,250	2	450	225
2,500	3	450	225
3,000	3	400	225
3,500-4,000	4	350	210
4,500-5,000	5	300	180
5,500	6	300	180
6,000	6	250	150
6,500-7,000	7	250	150
7,500 or more	8 or more	200	120

Revised 3/27/2008

S. Acceptance of Utilities

1. Preliminary Acceptance

   a. The installed mains must pass all required pressure tests and bacteriological tests as required by current City Standards, prior to the final connections.

   b. Prior to acceptance, water mains shall be flushed in accordance with City Standards. This consists of flowing all hydrants installed with the project.

   c. All structures must be clean and free of construction debris.

   d. The Engineer shall make first submittal of record drawings, which must include rim elevations, pipe size, and tie downs to all water main appurtenances.

2. Final Acceptance

   a. Approved as-built drawings shall be submitted to the City prior to final acceptance of the water main. The as-built set format shall be provided to the City as a PDF (Portable Document Format) version.

   b. Final Acceptance is based on a two (2) year maintenance inspection.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 3

Sanitary Sewer System

A. Plans and Specifications - Submittal Procedure

1. The plans and specifications shall be submitted in accordance with *Chapter 1, General Requirements and Submittals.*

B. Plans and Specifications – Design Considerations; General

1. All sanitary sewer designs shall be developed conforming to the current edition of "Recommended Standards for Wastewater Facilities", Published by Health Education Services, also known as the "Ten State Standards".

2. Prior to starting any sanitary sewer design, the applicant is encouraged to make use of maps and information available at the City offices. It shall be the responsibility of the applicant to field check and verify utility locations provided by the City.

3. Reference *Chapter 1, General Requirements and Submittals* for specific requirements pertaining to the presentation of plans.

4. An overall utility layout sheet shall include the following:

   a. Basis of Design for the service area, and any future service area that may be ultimately served by the proposed sewer. Include interceptor sewer sub-district.

   b. Overall layout of the sewer system with manhole numbers, pipe sizes and direction-of-flow arrows. Existing and proposed sewers shall be shown with different symbols and line types. Direction-of-flow arrows will only be required on larger projects with multiple sewer runs.

C. Plan and Profile Sheets

1. The Plan portion of the sheet shall include, at a minimum, the following:

   a. Existing topography and all existing or planned surface or underground improvements in streets or easements in which sewer construction is proposed, or in contiguous areas if pertinent to design and construction.

   b. Street names, street and easement widths, and all other street and easement survey information, including subdivision names, lot numbers and lot dimensions, and existing addresses.

   c. Location, length, and size of each section of the proposed sewer between manholes.

d. Locations of all manholes and other sewer appurtenances and special structures.

e. Sanitary sewer leads are to be constructed or installed concurrently with sewer construction, with locations two feet (2') beyond easement and/or property lines. Sanitary sewer leads shall be extended to the far side of any proposed franchise utility easements.

2. The profile portion of the sheet shall appear below the companion plan portion, generally projected vertically, and shall show at a minimum the following:

a. Size, slope, type and class of pipe, and controlling invert elevations for each section of proposed sewer between manholes.

b. Limits of special backfill requirements.

i. Locations and limits of Class II sand backfill, where required.

ii. Class of bedding material.

iii. Backfill requirements will be in accordance with MDOT Standard Details.

c. Location of existing or proposed utilities crossing the line of the sewer or otherwise affecting sewer construction.

d. Location, by station, of every proposed manhole, with manhole number, invert elevation of all inlet or outlet pipes, top of casting elevation, and manhole type.

e. Length of run between manholes (400 feet maximum).

f. Location, by station from downstream manhole, of all sanitary sewer leads, to be constructed or installed concurrently with the proposed sewer construction.

g. Existing and proposed ground elevation above the route of the sewer.

h. Provide a minimum depth from top of curb (or road centerline if uncurbed) to the top of any sanitary sewer of ten feet (10') at local control points, or a minimum of ten feet (10') at locations where the sewer grade is parallel to the road grade. Under any design the sewer shall be deep enough to reasonably serve, by gravity, a standard depth basement.

i. Required risers, with control elevations.

j. Invert elevation at property line for sanitary sewer leads to be included with sewer construction.

k. Manholes shall be identified by numbers assigned consecutively and increasing in direction opposite to direction of flow in each sewer.

l. All elevations shall be on U.S.G.S. Datum.

m. Reference benchmarks, established at intervals not greater than 1,200 feet and convenient to the proposed construction, shall be noted on the Plan and Profile Sheets, with identification, location, description and established elevation listed.

n. Each Plan and Profile Sheet shall include a tabulated list of quantities of construction pay items appearing on those sheets, with a total quantity list on the coversheet.

D. Location of Sanitary Sewers

1. Sanitary sewers shall generally be located on opposite sides of streets from water mains, eight feet (8') from the back of the curb on the southerly and westerly side of the street.

2. Generally, sanitary sewers shall be installed in a public street right-of-way or in easements exclusively reserved for such use.

3. Easements for sanitary sewers shall have a minimum width of twenty feet (20'), centered upon the sewer. Such easements shall be deeded or dedicated to the City of Rochester Hills, with restrictions against use or occupation of easements, by the property owners and/or by other utilities, in any manner which would restrict sewer maintenance or repair operations.

4. Easements for possible extensions shall be provided to the property lines at locations designated by the City Engineer.

5. Sewers shall preferably be constructed outside of paved parking areas, streets, and drives.

6. Sewers shall be installed parallel to the property lines or building lines, with clearance distances to accommodate the full width of the proposed easement.

7. Sanitary sewers shall maintain ten feet (10') of horizontal separation from all parallel utilities.

8. Sanitary sewer crossings of other utilities shall have a minimum vertical clearance of eighteen inches (18"), with the sanitary sewer placed below the other utility.

E. Bedding

1. Sewer pipe shall be placed on Class "B" bedding or better, as indicated on the sewer detail sheet.

F. Drop Connections

1. Drop connections are required at manholes where the invert of the outlet pipe is eighteen inches (18") or more below the invert of the inlet pipe.

2. Internal drop connections are required to be constructed in accordance with the conditions stated on the Rochester Hills standard sanitary sewer detail sheet.

G. Tunneling and Boring

1. Where conditions require tunneling or boring, consult the City Engineer for specific requirements. Where sanitary sewers or sanitary sewer leads cross improved roads of any type, the pipe shall normally be installed by tunneling or boring, located within a steel casing pipe.

H. Extensions and Future Connections

1. Where the sanitary sewer must be extended from off-site, sanitary sewer leads extending two feet (2') beyond the property line of all adjacent property, on both sides of the right-of-way, the entire length of the off-site sanitary sewer installation, shall be provided.

I. Minimum Pipe Size

1. Minimum pipe size for sanitary sewers shall be eight inches (8") nominal internal diameter.

2. Minimum pipe size for sanitary leads shall be six inches (6") nominal internal diameter.

J. Sanitary Sewer Materials

1. The following materials may be used for public sanitary sewer construction. Approved pipe materials must conform to standards adopted by the Office of the Oakland County Drain Commissioner:

   a. For sewers eight inches (8") to fifteen inches (15"):

      i. PVC truss pipe, ASTM D-2680, with gasket joints, ASTM D-3212.

      ii. Other types of pipe as approved by the City Engineer.

   b. For six inch (6") sewer leads:

      i. Six inch (6") leads shall be PVC SDR 23.5 or PVC Sch 40, both solid walled. Gasketed or solvent-weld joints are acceptable. Pipe shall have a minimum pipe stiffness of 150 p.s.i., and a minimum deflection of fifteen percent (15%) at failure. The sewer lead material shall be compatible with sewer main material.

   c. For Sewers greater than fifteen inches (15"):

      i. Reinforced Concrete Pipe (RCP) shall conform to the current ASTM D C76, wall B. Joints shall be synthetic rubber and meet or exceed the requirements established by ASTM C361.

K. Backfill

1. Trench backfill shall be MDOT approved Class II sand under all proposed and existing paved areas, roads, streets, drives, pathways and sidewalks, or within the one-on-one (1-on-1) influence of the road. Sand shall be compacted to ninety-five percent (95%) maximum density.

L. Manhole Locations

1. Manholes shall be constructed at every change in sewer grade, alignment and pipe size, and at the end of each sewer line. Maximum distance between manholes shall not exceed 400 feet.

2. Manholes shall be constructed of precast reinforced concrete sections.

3. Where future connections to a manhole are anticipated, stubs with watertight bulkheads, shall be provided.

4. Monitoring manholes shall be required for connections associated with non-domestic uses, or as required by the City Engineer.

5. Consideration shall be given to installation of grease/oil separators during design where applicable.

M. Allowable Pipe Slopes

Pipe Diameter (inches)	Minimum Slope (feet per 100 feet)	Maximum Slope (feet per 100 feet)
8	0.40	8.36
10	0.28	6.22
12	0.22	4.88
15	0.15	3.62
18	0.12	2.84
21	0.10	2.32
24	0.080	1.94
27	0.067	1.66
30	0.058	1.44
36	0.046	1.14

N. Hydraulic Calculations

1. Calculations

   a. Gravity sanitary sewers, Manning's Formula, with n = 0.013 is required for concrete sewer pipes. A Manning roughness coefficient of n = 0.010 should be used for plastic sewer pipe.

   b. Low-pressure sewer systems and force mains, the Hazen-Williams formula with C=120 shall be used.

2. Minimum and Maximum Velocities

   Minimum design velocities for gravity and low-pressure sanitary sewers shall be two feet (2') per second, and a maximum design velocity shall be ten feet (10') per second, with

pipe flowing full. The slope of the sewer between the last two manholes at the upper end of any gravity sewer lateral shall be increased above one percent (1%) to obtain cleansing velocity.

O. Allowances for Changes in Pipe Size

1. Maximum flow velocity for full pipe flow shall be maintained by continuity of the 0.80 diameter depth above invert for pipe size increases and also with intersecting sewer grade raised to compensate for head loss due to direction change.

P. Sanitary Sewer Leads

1. Unless otherwise approved by the City Engineer, construction of sanitary sewer leads from the public sewer to a point two feet (2') beyond the easement and/or property line, for each fronting parcel, which the sewer is designed to serve, shall be included with the construction of each sanitary sewer.

2. Where construction of sanitary sewer leads to the property line is not required concurrently with sanitary sewer construction, a wye branch with riser, if required, and with water-tight stopper or plug with type of joint used for the sewer pipe, shall be installed for every lot or building site which the sewer is designed to serve.

3. Where depth of sewer from top of pipe to finished surface exceeds ten feet (10'), risers shall be installed from wyes to an elevation ten feet (10') below finished surface. Additional riser height will be required when the observed ground water level during construction is above ten feet (10') with a minimum of four feet (4') of cover.

4. Minimum size for sanitary sewer leads shall be six-inch (6") nominal internal diameter. Each building structure shall have a separate individual sanitary service lead connected to a public sanitary sewer.

5. Minimum slope for building sewers shall be one-percent (1%).

6. Sanitary sewer leads shall not be connected directly into manholes unless approved by the City Engineer.

Q. Sewer Capacity Design

1. Tributary Area

a. Sanitary sewers shall be designed to serve all natural tributary areas, with due consideration given to topography, the master sanitary sewer plan, established zoning, and the adopted City Master Land Use Plan.

2. Population

a. For design purposes, population shall be based on 2.44 persons per detached single-family home site (or equivalent single family unit), and 1.46 persons for each multiple-family dwelling unit (1,200 S.F. or less).

b. Submissions for review shall include a tabulation of occupancy (usage) types and the conversion of these into terms of equivalent single-family units. The area of the site, in acres, may be used to calculate dwelling units based on density allowed in the Zoning Ordinance. The most current unit assignment factors as published by the Office of the Oakland County Water Resources Commissioner (OCWRC) shall be used to convert the different usage types to equivalent single-family units.

3. Design Criteria

a. To determine the daily average flow (gal /day), a factor of one hundred (100) gal per capita per day as specified in the Recommended Standards for Wastewater Facilities (known as the Ten State Standards) as determined by the GLUMRB shall be utilized.

b. To determine the peak flow (gal per day), the peaking factor (PF) will be calculated by using the following formula as specified in the Recommended Standards for Wastewater Facilities.

$$PF = \frac{18 + (P)^{1/2}}{4 + (P)^{1/2}}$$, P, design population expressed in thousands

c. The peaking factor shall not be less than 2.5 or exceed 4.0.

R. Acceptance of Utilities

1. Preliminary Acceptance

a. Prior to acceptance, all sanitary sewers shall be flushed and cleaned in accordance with City Standards.

b. Air Test or Infiltration Test shall be completed in accordance with the current Standards of the Office of the Oakland County Water Resources Commissioner.

c. Televising: Prior to acceptance of new sanitary systems, a televised inspection of every section of the sewer shall be conducted from manhole to manhole. A videotape of this inspection shall be submitted to the City Engineer for review and approval prior to acceptance. The sewer shall be flooded prior televising.

d. As-built drawings require rim~~s~~ elevations, invert~~s~~ elevations, pipe size**s**, and slopes.

2. Final Acceptance

a. As-built drawings shall be submitted to the City prior to final acceptance of the sanitary sewer. The as-built set format shall be provided to the City as a PDF (Portable Document Format) version**.**

b. Final Acceptance is based on a two-year maintenance inspection. This shall include a televised inspection, at the city's expense, of every section of the sanitary sewer from manhole (MH) to manhole (MH). This shall be witnessed by the City inspector, and a copy of the videotape must be given to the City Engineer prior to final acceptance. If a problem is found, the City reserves the ability to use the maintenance bond or project

escrow account balance to have the developer pay for the expense of a second televising.

S. Permit Acquisition

1. Nine (9) sets of plans need to be submitted to the City, along with a completed MDEQ Part 41 permit application for request of issuance of sanitary sewer construction permit.

2. An OCWRC sanitary sewer tap permit is required unless the sanitary sewer is private or a service lead.

T. Private Sewers

1. Private owners are permitted only if one (1) legal owner is connected to the system. If parcel development is possible, private systems will not be permitted.

2. Private sanitary sewer materials and construction to be in accordance with all of the above standards.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 4

Stormwater Management

A. Purpose

In order to protect the health, safety, and general welfare of the residents of the City of Rochester Hills, comply with Rochester Hills' MS4 general permit No. MIG619000, as well as to protect, sustain, and enhance the surface and ground water resources of the City of Rochester Hills, drainage and stormwater management practices shall be utilized as directed herein to achieve the following objectives:

1. Accommodate site development and redevelopment in a manner that protects public safety and is to the extent practicable consistent with (or re-establishes) the natural hydrologic characteristics of each watershed and sustains ground water recharge, stream baseflows, stable stream channel (geomorphology) conditions, the carrying capacity of streams and their floodplains, ground water and surface water quality, and aquatic living resources and their habitats.

2. Protect water quality by removing and/or treating pollutants prior to discharge to ground and surface waters throughout the City of Rochester Hills, and to protect, restore, and maintain the chemical, physical, and biological quality of ground and surface waters.

3. Reduce flooding impacts and prevent a significant increase in surface runoff rates and volumes, predevelopment to post-development, which could worsen flooding downstream in the watershed, enlarge floodplains, erode stream banks and create other flood-related health-welfare-property losses; in general, to preserve and restore the natural flood-carrying capacity of streams and their floodplains.

4. Ensure effective long-term operation and maintenance of all permanent stormwater management facilities.

B. Applicability

The following construction projects shall be regulated by these standards:

1. Land development, including but not limited to plats, single family detached site condos, commercial developments, industrial developments, and all other developments that are subject to site plan review and approval.

2. Redevelopment of existing improved land

    a. Redevelopment projects that change or alter the existing developed surface of one acre or more; or

b. Redevelopment that disturbs less that an acre but increases the impervious surface area by 10% or greater; flood protection and channel protection standards need to be met, at a minimum, for the increased impervious surface area.

c. Redevelopment of less than one acre, but disturbs greater than 50 % of the site and involves a site plan approval and use change;

d. Redevelopment that involves removal and/or installation of site storm sewer and/or detention system.

e. Redevelopment projects that change or alter the existing developed surface of less than one acre where the downstream conditions show evidence of negative impacts from excessive stormwater discharge rate. This in particular applies to existing developed sites that have no flood protection and/or channel protection controls.

f. If the proposed site use does not meet the above five types of redevelopment but is of a Heavy Traffic and Pollutant Load or Moderate Traffic and Pollutant Load as defined in Subsection 4.3.2 B2 "Catch Basin and Inlets," then the post development water quality standards apply.

Exception:

i. If the redevelopment is part of a larger development with a private regional stormwater system that includes detention and there is no net increase in impervious surface with the redevelopment.

ii. An alternate method acceptable to the City Engineer is proposed that will address post development water quality and the channel and flood protection objectives of the City of Rochester Hills.

C. Stormwater Management Plan

For all activities regulated by these Standards in accordance with the above sub-section, B. Applicability, the Applicant shall submit a stormwater management plan and report prepared by a Professional Engineer licensed in the State of Michigan, which shall contain, but not be limited to, the following:

1. Suitable maps and drawings showing all existing natural and constructed drainage facilities affecting the subject property.

2. Hydrologic (watershed) and water feature boundaries, including all areas flowing to the proposed project, existing streams (including first order and intermittent streams), springs, lakes, ponds, or other bodies of water within the project area.

3. Sufficient topographical information with elevations to verify the location of all ridges, streams, etc. (two-foot contour intervals within the project's boundaries and for proposed offsite improvements.

4. Notes pertaining to and locations of existing standing water, areas of heavy seepage, springs, wetlands, streams, and hydrologically sensitive areas.

5. A drainage area map showing all sub-watershed areas, runoff coefficients, acreage of drainage area, general type of soils with hydrologic soil group (HSG) noted, estimated permeability in inches per hour, location and results of all soil tests and borings, and proposed stormwater management system in plan view shall be included with the plans.

6. 100-year flood elevations for any Special Flood Hazard Areas on or within one hundred feet (100') of the property.

7. Description of current and proposed ground cover and land use. The total area and runoff coefficient for each drainage area noted.

8. A plan of the proposed stormwater drainage system attributable to the activity proposed, including runoff calculations, stormwater management practices to be applied both during and after development, and the expected project time schedule.

9. The design computations for all proposed stormwater drainage systems, including storm-drain pipes, inlets, runoff control measures and culverts, drainage channels, and other features, facilities, and stormwater management practices

10. A grading plan, as required under *Chapter 5* of the City of Rochester Hills Engineering Design Standards; including all areas of disturbance, of the subject activity. The total area of disturbance shall be noted in square feet and acres.

11. A plan of the erosion and sedimentation procedures to be utilized as required under *Chapter 11* of the City of Rochester Hills Engineering Design Standards and/or as required by the Oakland County Water Resources Commission (OCWRC).

12. A route delineation of all concentrated flow (that is, flow other than overland sheet flow).

13. The effect of the project (in terms of runoff volumes and peak flows) on adjacent properties and on any other stormwater collection system that may receive runoff from the project site and specifics of how erosion and flooding impacts to adjacent properties will be avoided or otherwise mitigated.

14. An operation and maintenance plan consistent with the requirements of Section E of this chapter. Such a plan should clearly explain how the proposed facilities operate and the functions they serve.

15. The name of the development, the name and address of the property owner and Applicant, and the name and address of the individual or firm preparing the plan.

16. A north arrow, submission date, scale and revision dates as applicable shall be included on each page of all plans submitted.

17. Construction details sufficient to completely express the intended stormwater design components consistent with these standards.

D. Stormwater Management Design Standards

1. Design Goals, Principles and Standards

   a. The post development peak discharge rate shall not exceed 0.2 cfs/acre for the 25-year storm event.

   b. The bankfull storm event or the 1-year 24-hour storm event shall be attenuated for at least 24 hours (i.e. the stormwater will be released over a minimum of 24 hours) as described in chapter pages 4-6 to 4-7 for Channel Protection (Bankfull).

2. Stormwater Runoff Calculation Methods

   For parcels of land with an area of 120 acres or less, the Rational Formula (Q=CIA) shall be calculated as I = 175 / (T+25), for a 10-year frequency, one hour intensity storm, in which T is the time of concentration in minutes and I is the intensity in inches per hour. The initial T is generally 20 minutes for residential areas and 15 minutes for high runoff areas, such as commercial and office space. All composite runoff coefficients shall be based on the values shown in the table below. The slopes listed for the semi-pervious surfaces are the proposed finished slope of the tributary area.

Type of Surface	**Runoff Coefficient (c)**		
Water Surfaces	1.00		
Roofs	0.95		
Asphalt or concrete pavements	0.95		
Gravel, brick, or macadam surfaces	0.85		
Green Roofs (< 4 in)*	0.50		
Green Roofs (4 – 8 in)*	0.30		
Green Roofs (9 –20 in)*	0.20		
Green Roofs (> 20 in)*	0.10		
Porous asphalt or concrete pavements**	0.10		
Paving stones (a.k.a. unit pavers)**	0.10 – 0.70 (as specified by manufacturer)		
Grass Pavers (a.k.a. turf blocks)**	0.15 – 0.55		
Semi-pervious; lawns, parks, playgrounds	Slope <4%	Slope 4%-8%	Slope >8%
Hydrologic Soil Group A	0.15	0.20	0.25
Hydrologic Soil Group B	0.25	0.30	0.35
Hydrologic Soil Group C	0.30	0.35	0.40
Hydrologic Soil Group D	0.45	0.50	0.55

* Referenced from The State of Minnesota Sustainable Building Guidelines – Version 2.0, Worksheet S-1

** Referenced from the Massachusetts Low Impact Development Toolkit, Fact Sheet #6.

More precise methodologies for predicting runoff such as runoff hydrographs are widely available, and may be required by the City of Rochester Hills Engineering Division for sizing the drainage systems on large sites and/or smaller sites that are deemed potentially problematic. –Use of an alternate method can be proposed for review and approval by the City Engineer.

3. Stormwater Management Practices-Sizing Criteria

The following sizing criteria shall be followed at all sites required to meet the standards of Section B - Applicability.

a. Stormwater Recharge and Infiltration

Impervious and disturbed surfaces from development alter the natural hydrologic cycle by discharging stormwater directly to streams, rather than allowing it to infiltrate through the soils and into groundwater as it did before development. This increases flooding and reduces the base flow to streams that is needed in the summer months when there is little precipitation. The increased runoff from impervious surfaces also increases stream temperatures, since pavement and other impervious surfaces absorb substantial amounts of heat in the summer due to their dark coloring and lack of shade, which is transferred to runoff passing over the surface. The result is runoff that is dramatically warmer than natural groundwater inflow would have been under a natural hydrologic cycle. The purpose of this criterion is to maintain existing recharge rates to preserve existing groundwater levels and stream base flows.

i. All storms up to one half inch (½") must be captured and infiltrated on-site. The volume of water to be infiltrated shall be calculated using the following equation:

Re_v =1,815 (A)(C),
Where:
Re_v = recharge volume (ft^3)
C = weighted runoff coefficient
A = site area in acres
1,815 = 0.5 inch (½") rainfall x 3,630 to convert ac-in to cf.

ii. The maximum depth of an infiltration system shall be one and a half feet (1½') unless the infiltration rate is greater than one half inches (½") per hour, in such case, the system may be deeper and must be capable of infiltrating the recharge volume within a 48-hour period.

iii. Recharge should not be concentrated to one area. It should be distributed to multiple areas throughout the site.

iv. Site design should implement runoff reduction techniques such as those described in Appendix A.

Exception to Subsection D.3.a Stormwater Recharge and Infiltration:
Stormwater Recharge and Infiltration standards must be met except where it has been demonstrated, to the satisfaction of the City Engineer, that use of recharge and infiltration is not suitable for the site due to the soil conditions, ground water

conditions or risk of negative environmental impact, provided that an alternate method acceptable to the City Engineer is proposed that will address the recharge /stormwater volume reduction objectives of the City of Rochester Hills.

b. Post Development Water Quality

Development also impacts the water quality of streams, ponds, lakes and wetlands. As impervious area increases, the volume and velocities of stormwater increase, often resulting in erosion of soils. Pollutant deposits on the land surface also increase as the intensity of land use increases. These materials are then washed off by rain and runoff, increasing the pollutant load to receiving waters. Thus, it is important that stormwater management practices (SMP) are used to handle water quantity as well as treat water quality. The water quality volume should include the first flush of storms, as this is where the majority of pollutants are collected and discharged.

i. The water quality volume required to be treated shall be calculated as:

WQv =1,815 (A)(C),
Where:
WQv = water quality volume (ft3)
C = weighted runoff coefficient
A = site area in acres
1,815 = one half inch (½") rainfall x 3,630 to convert ac-in to cf.

ii. The post development water quality stormwater management practice (SMP) shall meet the minimum performance criteria of Section 4.1. A short list of acceptable structural and nonstructural water quality SMPs are listed below (Acceptable SMP Options, Pages 15-16). This is not an all-inclusive list, the design engineer is encouraged to select other structural and/or non-structural SMPs that are best suited for their site and meet the water quality requirement.

As a basis for design, the following assumptions may be made:

Multiple Drainage Districts: When a project contains or is divided by multiple drainage districts, the WQv volume shall be addressed for each drainage district.

Offsite Drainage Areas: The WQv shall be based on the runoff coefficient of the proposed site. Offsite existing impervious areas may be excluded from the calculation of the water quality volume requirements.

c. Channel Protection (Bankfull)

Many storm water management practices focus on controlling peak flow rates for larger storms, including the 10-year, 25-year, 50-year, and 100-year storms. This does not address the increased duration at which those high flows occur because of the increased volume of water from development compared to pre-development. For example, although the peak flows are kept the same, there is a much greater volume of water leaving the site under developed conditions and the streams have higher flows for longer durations than they did under predevelopment conditions. In addition, because the impervious development has limited recharge, base flow during non-storm

event times is lower. The purpose of this criterion is to limit the total amount of time that a receiving stream exceeds an erosion-causing threshold, based on pre-developed conditions.

i. The volume and storage provided for controlling the bank full flood will be equal to or in excess of the runoff from a 1-year, 24-hour storm, which can be determined by:

Cpv =6,788(A)(C),
Where:
Cpv = channel protection volume (ft3)
C = weighted runoff coefficient
A = site area in acres
6,788 = 1.87 inch rainfall x 3,630 to convert ac-in to cf.

ii. The release rate from the bank full storage volume will be such that this volume will be stored not less than 24 nor more than 48 hours.

d. Flooding Protection (Overbank)

The goal of this criterion is to prevent flood damage to conveyance systems and infrastructure and reduce minor flooding caused by overbank floods. Overbank floods are defined as floods, which exceed the bankfull capacity of the channel and spill over to the floodplain where they can damage property and structures. The key management objective is to protect downstream structures (houses, businesses, culverts, bridge abutments, etc.) from increased flows and velocities from upstream development

i. The over bank flood protection volume shall be calculated to detain the volume of runoff from the entire site, resulting from a 25-year frequency storm.

ii. The allowable release rate from the over bank flood protection volume shall be 0.2 cfs per acre, but in no case shall exceed the capacity of the receiving stream or body of water. In the event that the receiving stream cannot properly convey the 0.2 cfs per acre design discharge, the discharge shall be limited to the existing capacity of the receiving stream. Hydraulic calculations shall be submitted showing the existing capacity of the receiving stream for review.

iii. In general, the Oakland County, "A Simple Method of Detention Basin Design" method by Glen Yrjanainen shall be used.

e. Extreme Flooding Protection

The site shall provide a safe overflow for the 100-year storm event.

f. Pretreatment

To prevent premature failure, the design of stormwater management practices (SMPs) shall include a pre-treatment device or method that will trap sand and sediments to avoid clogging the treatment mechanism. Infiltration of stormwater from the SMP into underlying soils and eventually groundwater aquifers is an important beneficial

component of the device. Pre-treatment basins must be designed and located to be easily inspected and accessible to facilitate maintenance.

i. The pretreatment device shall be sized to accommodate a one-year storm event. The "Detention Time" method of design from the OCWRC Erosion Control Manual should be used to calculate the volume of storage.

g. Acceptable Storm Water Management Practices (SMP) Options

Rochester Hills encourages the design of storm water management systems that meet or exceed the site storm water storage requirements and also incorporate elements to improve aesthetic value, sustainability, and creativity. Detention basins with or without permanent water storage are preferred. Underground detention systems can be proposed for consideration but must identify a means of operating the underground facility to ensure that the required storage volume can be maintained. Above or underground storage basins that rely upon pumps for dewatering are least desirable and must be shown to be the only reasonable means of use for the development. Retention basins and infiltration trenches (items that do not have an outlet and rely on the underlying soil infiltration) can be proposed and must have sufficient soil borings information to demonstrate the level of ground permeability for dewatering the stored storm water.

4. Stormwater Conveyance System (Open Channel, Drainage Way, and Storm Sewers)

a. General

i. Applicants are encouraged to design conveyance systems that encourage infiltration and improve water quality wherever possible.

ii. Wherever conveyance channels are necessary, drainage shall be maintained by an open channel with landscaped banks designed to carry the 10-year frequency rainfall event. All open channels shall be designed with one foot (1') of freeboard above the design water surface elevation of the design runoff condition.

iii. Flood relief channels shall be provided and designed to convey the runoff from the 100-year frequency rainfall event, such that positive discharge of this runoff to an adequate receiving stream or conveyance system occurs without harmful affects.

iv. Where drainage swales are used in lieu of or in addition to storm sewers, they shall be designed to carry the required runoff without erosion and in a manner not detrimental to the properties they cross. Drainage swales shall be provide a minimum of two percent (2%) but shall not exceed a grade of nine percent (9%). Drainage swales used strictly for conveyance are not the same as Open Vegetated Channels. Design standards for Open Vegetated Channels are provided in the following section.

v. Use of grassed swales or open vegetated swales in lieu of curbing to convey, infiltrate and/or treat stormwater runoff from roadways is encouraged.

b. Open Vegetated Channels

i. Open Vegetated Channels are conveyance systems that are engineered to also perform as water quality and infiltration practices. Such systems can be used for the conveyance, retention, infiltration and filtration of stormwater runoff.

ii. Open Vegetated Channels primarily serve a water quality function (WQv), they also have the potential to augment infiltration. Examples of such systems include, but are not limited to: dry swales, wets swales, and grass channels.

iii. Open Vegetated Channels shall be designed to meet the following minimum standards:

The channel shall be designed to safely convey the ten-year frequency storm event with a freeboard of at least twelve inches (12”). Freeboard is the difference between the elevation of the design flow in the channel and the top elevation of the channel.

The peak velocity of the runoff from the ten–year storm shall be non-erosive for the soil and ground cover provided in the channel.

The longitudinal slope shall be no greater than four percent (4%) to qualify for water quality treatment.

Channels shall be trapezoidal in cross section.

Channels shall be designed with moderate side slopes of 1V:4H. Flatter side slopes may be necessary under certain circumstances.

The maximum allowable ponding time in the channel shall be less than 48 hours.

Channels (for example, dry swales) may require an underdrain in order to function and dewater.

Channels shall be designed to temporarily store the WQv within the system for a maximum period of forty-eight (48) hours and a minimum period of one (1) hour.

Landscape specifications shall address the grass species, wetland plantings (if applicable), soil amendment and hydric conditions present along the channel.

Accumulated sediment within the channel bottom shall be removed when twenty-five (25%) of the original WQv volume has been exceeded.

Check dams along the channel length may be warranted.
The bottom of dry swales shall be situated at least two feet (2’) above the seasonal high water table.

A minimum vertical clearance of five feet (5') is required between open swale/ditch inverts and underground utilities unless special provisions are employed.

c. Natural Streams and Channels

i. Natural streams and channels are to be preserved. Natural swales and channels should be preserved, whenever possible.

ii. If channel modification must occur, the physical characteristics of the modified channel will duplicate the existing channel in length, cross-section, slope, sinuosity, and carry capacity.

d. Storm Sewers

i. Sizing/Hydraulics

Storm sewer systems shall be designed for a 10-year frequency rainfall event.

Storm sewer design velocities, capacities, and friction losses shall be based on Manning's equation.

$$Q = \frac{1.49\ AR^{2/3}S^{1/2}}{n}$$

Manning's coefficient for concrete pipe shall be n = 0.013. Minimum design velocity shall be two and a half feet (2½') per second, and maximum velocity shall be ten feet per second (10 fps) , with pipe flowing full.

Submerged systems are not allowed. Submerged systems are storm sewers that are entirely or in part below the outlet surface elevations and do not dewater.

Surcharging under design conditions is permitted provided the surcharged hydraulic grade line (HGL) is maintained at or lower than one foot (1') below the rim elevations of all upstream structures.

The hydraulic grade line must be calculated for the entire system. The hydraulic grade will be assumed to start at the elevation 0.80 x pipe diameter of the outlet pipe or the high water level (HWL), which ever is higher.

Minimum and maximum design slopes, for concrete pipe, shall be as follows:

Pipe Diameter (inches)	Minimum Slope (feet per 100 feet) > 2.5 fps	Maximum Slope (feet per 100 feet) < 10 fps
12	0.32	4.88
15	0.24	3.60
18	0.20	2.84
21	0.16	2.32
24	0.14	1.92
27	0.12	1.64
30	0.10	1.44
36	0.08	1.12
42	0.06	0.92
48	0.05	0.76
54	0.04	0.64
60	0.04	0.56

ii. Location

In-line catch basins on storm lines greater than eighteen-inches (18") are prohibited.

Storm sewers shall generally be located on the same sides of streets as water mains, and generally within the street right-of-way, 7 ½ feet from Northerly and Easterly street right-of-way lines.

Easements for sewers not located within a street R.O.W. shall have a minimum width of twenty feet (20'), centered upon the sewer. Such easements shall be reserved with restrictions against use or occupation by other utilities, in any manner, which would restrict sewer maintenance or repair operations.

For subdivisions, storm sewers shall be located in the public road right-of-way or in easements adjacent to the public road right-of-way. Storm sewers shall not be located in rear yards except to pick up rear yard drainage or in unusual circumstances or for sump pump discharge lines.

The horizontal alignment of sewers which are not proposed to generally follow street, drive, or parking area pavements, shall parallel property lines or building lines, with clearance distances sufficient to accommodate the full width of the proposed easement.

Horizontal clearance between storm pipes and sanitary sewer and water lines shall be a minimum of ten feet (10').

Horizontal separation from buildings shall be a minimum of ten feet (10') or distance, which will allow a 1:1 slope to the base of the foundation, whichever is greater.

All storm sewers located beneath pavement or a traveled portion of a roadway shall have a minimum of three and a half feet (3½') of cover.

Vertical separation distances between storm sewers and other buried storm sewers and other buried utility lines should be at least eighteen inches (18").

e. Catch Basin and Inlets

Catch Basin outlet pipes located in pavement areas will incorporate a floatable trap device that captures floatable debris and oils, provides for pipe maintenance access, stainless steel hardware, oil and gas resistant gaskets, and is designed to prevent siphoning according to the following:

i. In "Heavy Traffic and Pollutant Load" areas a floatable trap outlet in every catch basin is required. This includes, but is not limited to, gas stations, convenience stores, fast foot restaurants, vehicle repair facilities, stores with "drive through" service (i.e. banks, drug stores, dry cleaners, coffee shops), loading docks, distribution facilities, hospitals, school bus loading areas, maintenance facilities, light industrial sites, "dumpster areas", parking and roadway areas of shopping centers close to the stores, etc. The exception will be where a catch basin cannot be maintained. An oil-absorbing boom may also be required in structures that receive heavy hydrocarbon loading.

ii. In "Moderate Traffic and Pollutant Load" areas, floatable trap outlets will be located in catch basins so as surface water passes through no more than one (1) catch basin that does not have a floatable trap. This includes, but is not limited to, office buildings, multi-residential complexes, schools (other than bus areas), most shopping mall parking areas, mixed retail commercial facilities, municipal/government buildings, athletic/entertainment/recreational facilities, non-fast food restaurants, special event/remote parking areas, etc. The downstream structures (prior to discharge) are most critical, and oil-absorbing booms may be useful if heavier hydrocarbon loading is expected.

iii. In "Low Traffic and Pollutant Loading" areas, floatable trap outlets will be located so that surface water passes through no more than two (2) catch basins that do not have a floatable trap. This includes, but is not limited to, grassy or vegetated areas, single family residences, parks, parking for offices within residences, flow excess from permeable paving areas, etc.

NOTE: A large site may have different areas, just like it may have different runoff coefficients. For instance, a shopping mall may have a heavy traffic roadway and loading/unloading areas as well as a remote parking area. Therefore, apply the appropriate placement criteria to each area of the site to arrive at the total number of floatable trap equipped catch basins for the project.

Minimum sump depth is two-feet (2') for catch basins that do not require a floatable trap outlet.

Minimum sump depths for catch basins equipped with floatable trap outlets is thirty-six inches (36").

Surface water flows shall not exceed the intake capacity of the structure casting.

At all low points in gutters, and in swales and ditches, where applicable.

At the upstream curb return, if more than two hundred feet (200') downstream of a high point in the gutter.

At maximum intervals of six hundred feet (600') along a continuous slope.

Such that there is a maximum pavement length per structure as follows:

- 300 lineal feet for a catch basin or inlet at a low point; and
- Vane grates shall be provided on relief basins when the longitudinal slope of road is four percent (4%) or greater.

Such that, where low point exists in the gutter line, no more than two relief basins shall be used in either direction in advance of the low point, (i.e., 4 relief basins would be possible). When a total of two or more relief basins are used in such a system, a double catch basin will be placed at the low point.

At tee intersections, catch basins may only be installed at the property line extended, on the leg of the tee.

Drainage structures shall not be located in line with sidewalks.

Typically, depending on surface types, no more than one (1) acre of area should be tributary to one standard catch basin. Catch basins may be doubled in order to provide for additional capacity.

f. Manholes

i. Depending on pipe size, Manholes should be located at:

All changes in alignment

Points where the size of the sewer changes

Points where the grade of sewer changes

The junction of sewer lines

Street intersections or other points where catch basins or inlets are to be connected.

ii. Manhole spacing for storm sewers shall be as follows:

Diameter of Sewer	Maximum Manhole Spacing
12” – 18”	400 ft.
21” – 30”	450 ft.
36” & 42”	500 ft.
48”	550 ft.
54”& 60”	600 ft.
66” & larger	650 ft.

Where future connections to a manhole are anticipated, stubs with watertight bulkheads shall be provided.

g. Materials

i. Covers for Manholes, Catch Basins and Inlets

Manhole frame and cover shall be EJIW 1040, Type A cover, or equivalent.

Manhole and catch basin covers shall include “Dump no waste! Drains to Waterways” or approved similar message.

Catch basin and inlet frame and cover shall be as follows:

- EJIW 7045, or equal, for use with barrier curb and gutter, and with concrete pavement with integral curb.
- EJIW 7065, or equal, for use with mountable curb and gutter, and with concrete pavement with mountable integral curb.
- EJIW 7085, or equal, for use with B-2 or rolled curb.
- EJIW Type O Beehive Grate, or equal, for use on open ditch structures and catch basins located in swales in easements outside the public street right-of-way.
- Vane grates, EJIW 7010 with type M6 vane grate and T1 back, shall be provided when the longitudinal slope of road is four percent (4%) or greater.

ii. Pipe/Structure Type

Minimum pipe size for sewers, catch basin leads and inlet leads shall be twelve inches (12”) nominal internal diameter.

Reinforced Concrete Sewer Pipe shall conform to the requirements of ASTM Designation: C76. Joints shall conform to the requirements of ASTM Designation. C443 Joints and Circular Concrete Sewer and Culvert Pipe,

Using Rubber Gaskets. All catch basin leads and inlet leads shall be ASTM C76-Class IV pipe.

Roof and sump leads shall be Schedule 40 PVC or SDR 23.5.

Eccentric cones shall be provided on all structures, regardless of the material used (precast reinforced concrete, manhole block, or brick), to provide a true vertical face for placement of manhole steps. Manhole steps shall be steel, encased with polypropylene plastic, equivalent to M.A. Industries, Inc. PS1 or PS1-B, as appropriate. A minimum of four inch (4") and a maximum of twelve inch (12") HDPE or concrete grade rings shall be placed on the cone section of all precast concrete, and concrete block, structures.

h. Miscellaneous

i. Bar Grates

A pre-fabricated bar screen should be designed to be self-cleaning so as to minimize plugging with debris and be installed on all storm sewers eighteen inch (18") in diameter and larger. Except when dealing with an open channel to enclosed system (i.e. cross culvert), where it is a straight pass through transition, in such case, the city engineer shall determine if bar grates are necessary.

ii. Special Drainage Structures

Preliminary plans for special structures and appurtenances required for storm sewer systems shall be submitted to the City Engineer for review and comment, prior to their inclusion in the construction drawings.

iii. Pumps

Stormwater management systems incorporating pumps shall not be permitted. Variances of this requirement will be considered only as a measure of last resort, subsequent to demonstration that no alternative system designs are feasible. Where pumps are absolutely necessary, an alternate method of draining shall be provided.

iv. Taps

Connections must be made at manholes, except when the receiving storm sewer pipe is twenty-seven inch (27") or larger.

v. Roof Leads and Sump Lines

Sump pump discharge lines are required to be connected to an approved drainage system.

Residential roof leads are not permitted to discharge to the sanitary sewer or storm sewer system.

i. Plan Criteria

i. Plan and Profile General

All storm sewers shall be shown in Plan and Profile, with the profile generally shown below the plan view. All structures and end-sections shall be sequentially labeled in both plan and profile views.

Scale of plan portion of sheet shall be no smaller than one inch (1") = fifty feet (50'), with scale of profile portion of sheet one inch (1") = fifty feet (50') horizontal and one inch (1") = five feet (5') vertical.

All elevations shall be on U.S.G.S. datum.

ii. Plan View

Existing topography and all existing and planned surface and underground improvements in streets and easements in which sewer construction is proposed, and in contiguous areas if pertinent to design and construction.

Street names, street and easement widths, all other street and easement survey information, subdivision names, lot numbers and frontage dimensions, and permanent parcel numbers and frontage dimensions for all unplatted parcels.

Location, length, size, material type, and direction of flow of each section of proposed sewer between manholes.

Locations of all manholes and other sewer appurtenances and special structures, with proposed rim elevations for all inlets and catch basins.

Reference benchmarks, established at intervals not greater than 1,200 feet and convenient to the proposed construction, with identification, location, description and established elevation listed. Generally, at least two benchmarks shall be noted on each sheet.

A tabulated list of quantities of construction pay items appearing on that sheet.

iii. Profile View

Profile portion of sheet shall appear below companion plan portion, generally projected vertically, and shall show at least the following:

- Size, slope, type and class of pipe, and controlling invert elevations for each section of proposed sewer between manholes.
- Limits of special backfill requirements.
- Profile, over centerline of proposed sewer, of existing and proposed finished ground and pavement surfaces.

- Profile of hydraulic grade line staring at the elevation of 0.80 x pipe diameter of the outlet pipe or the HWL of the pond, whichever is greater.

- Location of existing and proposed utilities crossing the line of the sewer or otherwise affecting sewer construction.

- Location, by station, of every proposed manhole, with manhole number, invert elevation of all inlet and outlet pipes, and top of casting elevation.

- Show end section footing detail.

Manholes shall be identified by numbers assigned consecutively, and increasing in magnitude in the direction opposite to the direction of flow.

All catch basin and inlet leads shall be laid on slope no flatter than one percent (1%).

Types of covers and grates for structures shall be shown.

5. Stormwater Ponds/Basins

a. General

i. Wet ponds are preferred to extended dry basins.

ii. Stormwater Ponds/Basins shall be located on common-owned property in multi-ownership developments such as subdivisions and site condominiums, and not on private lots or condominium units.

iii. Stormwater Ponds/Basins shall discharge to a natural watercourse, established drainage system, or drainage area where a dedicated easement exists for the purpose of drainage. In no case shall a pond/basin or system discharge onto adjacent property without an easement or the property owner's permission.

iv. Sediment Forebay

- A sediment forebay should be used to isolate gross sediments as they enter the storm water storage facility and to simplify sediment removal. The sediment forebay should consist of a separate cell formed by an earthen berm.

- The sediment forebay shall be sized to contain the water quality volume and be a minimum of three feet (3') deep.

- Exit velocities from the forebay shall not be erosive.

- Direct maintenance access shall be provided to the forebay.

v. In-line detention ponds/basins are not permissible. Except in the event there is no practicable alternative or it is demonstrated that the use of an inline basin is an enhancement to the environment, it may be considered for approval by the City Engineer.

vi. Interior side slopes of dry basins should not exceed 1:6 (V:H), unless unfeasible, steeper slopes are permissible under the following conditions: Side slopes steeper than 1:6 (V:H) require a safety bench starting at the design surface water elevation (25 year), sloping inward at a maximum of 6% slope, and at a minimum width of 5'. The side slope, below the downward slope end of the safety bench, shall not be steeper than 1:3 (V:H). Chain link fence may be substituted for the safety bench. For the purpose of providing safety protection and maintenance access the minimum standard for fences is 6 feet high vinyl clad chain link with a locking access gate, 8 feet wide. Alternate types of fencing or safety protection accepted by the Planning Commission may be permitted, for aesthetic purposes, subject to approval by the Engineering Division.

vii. Stormwater management systems incorporating pumps shall not be permitted. Variances of this requirement will be considered only as a measure of last resort, subsequent to demonstration that no alternative system designs are feasible. Where pumps are absolutely necessary, an alternate method of draining shall be provided.

viii. A minimum one-foot (1') freeboard is required above the 25-year stormwater elevation on all stormwater ponds/basins.

ix. All ponds/basins must be designed with a 100-year storm overflow to control flooding. The overflow shall discharge to an existing drainage system. If a weir overflow is used sufficient erosion protection must be incorporated into the design. Calculations for the overflow design must accompany the plans.

x. The principal spillway will be sized to pass the maximum design flow tributary to the pond/basin.

xi. Vegetative Plantings Associated with Stormwater Ponds/Basins.

Ponds/basins and wetland designs will be accompanied by a landscaping plan that incorporates native plants and indicates how aquatic and terrestrial areas will be vegetated, stabilized, and maintained.

Whenever possible, native wetland plants should be encouraged in the pond/basin design, either along the aquatic bench, fringe wetlands, safety shelf and side slopes or within shallow areas of the pools

A permanent buffer strip of natural vegetation extending at least twenty-five feet (25') in width beyond the freeboard elevation will be maintained or restored around the perimeter of all stormwater ponds/basins. No lawn care chemicals shall be applied to the buffer area.

xii. Easements and Access

For all new residential development, the property in which the pond/basin is located upon must be contained in an easement reserved or dedicated for detention purposes only.

A minimum twenty-foot (20') wide maintenance access easement shall be provided.

At a minimum, a twelve-foot (12') wide gravel access drive shall be located within the above easement for maintenance purposes.

b. Pond/Basin Inlet/Outlet Design

i. Velocity dissipation measures will be incorporated into pond/basin designs to minimize erosion at inlets and outlets, and to minimize the resuspension of pollutants.

ii. To the extent feasible, the distance between inlet and outlets will be maximized. The length and depth of the flow path across ponds/basins shall be maximized by:

Increasing the length to width ratio of the entire design.

Increasing the dry weather flow path with the system to attain maximum sinuosity.

Inlets and outlets should be offset at opposite longitudinal ends of the basin.

iii. Storage shall be required for all site runoff. Detention is not required for flows originating offsite that flow through the site. The restrictor size, designed for onsite runoff storage, shall not be upsized to pass through offsite flows.

iv. The use of dual outlets, risers, V-notched weirs or other designs that assure an appropriate detention time for all storm events is required.

v. The outlet will be protected from clogging. Methods, such as a weir, or incorporating self cleaning trash racks, or using proprietary flow control devices (i.e. Hydro-Brakes and Reg-U-Flow) or other innovative designs shall be used. A reverse slope submerged orifice with trash rack or a hooded, broad crested weir is recommended options. If a reverse-slope pipe is used, an adjustable valve may be necessary to regulate flows and the invert of the pipe drawing from the pool should be at least eighteen inches (18") from the bottom to prevent sediment discharge.

vi. Where a pipe outlet or orifice plate is to be used to control discharge, it will have a minimum diameter of four inches (4"). If this minimum orifice size permits release rates greater than 0.2 cfs/acre, an alternative outlet design that incorporates self-cleaning flow resrictors will be required. Examples include perforated risers, proprietary flow control devices, and "V" notch orifice plates

that provide the required release rate. Calculations verifying this rate will be required for approval.

vii. The hydraulic grade (H.G.) of the receiving waterway must be investigated to assure it is not higher than the pond/basin outlet H.G. If the H.G. of the receiving waterway is higher, the design engineer shall provide a method to allow a positive outflow at the required discharge rate.

viii. OCWRC SO-2 (Riser) detail and design standards shall be adhered to.

ix. The riser shall be placed near or within the embankment to provide for ready maintenance access.

x. Orifices used to maintain a permanent pool level shall withdraw at least one foot (1') below the surface of the water.

xi. Where feasible, a drain for completely de-watering wet ponds should be installed for maintenance purposes.

xii. All outlets will be designed to be easily accessible for heavy equipment required for maintenance purposes.

xiii. Anti-seep collars shall be installed on any piping passing through the sides or bottom of the pond/basin to prevent leakage throughout the embankment.

xiv. Storm sewers serving as an outlet for stormwater ponds/basins shall be designed in accordance with the standard requirements for other storm sewers in the design.

c. Wet Ponds

i. Facility Sizing

The volume of permanent pool shall equal or greater than twice the water quality volume.

ii. Pond Configuration

The wet basin shall be configured as a two-stage facility with a sediment forebay and a main pool.

The outlet should be located at the opposite and farthest end of the pond from the inlet.

The minimum length to width ratio shall be 3:1 where feasible. If it is not feasible to construct a pond with such dimensions, baffles or islands should be used to achieve the flow path length.

iii. Depth

The depth of the pond should be variable, with the average depth between three (3) and six (6) feet.

The deep section of the pool should have a minimum depth of three feet (3'). This prevents resuspension of sediments by wind turbulence.

The maximum depth of the permanent pool shall be ten feet (10'). Ponds deeper than this depth may be subject to stratification and promote anoxic conditions at the pond bottom, releasing sediment-bound pollutants into the water column.

iv. Pond Side Slopes/Benches

Interior side slopes of wet ponds should not exceed 1:6 (V:H), unless unfeasible, steeper slopes are permissible under the following conditions: Side slopes steeper than 1:6 (V:H) require two safety benches. One should start at the design surface water elevation (25 year). The other should extend from the wet pool elevation and slope inward to a maximum depth of 18 inches (also considered an aquatic bench). Both benches should be a maximum of 6 % slope and a minimum width of five-feet (5'). The aquatic bench should be landscaped with appropriate native plantings. Slopes below the safety/aquatic benches shall not be steeper than 1:3 (V:H). Chain link fence may be substituted for the safety bench located above the design surface elevation, which eliminates the need for the aquatic bench. Fences shall be a minimum of 6 feet (6') high vinyl clad chain link with a locking access gate, 8 feet (8') wide. Alternate types of fencing may be permitted, for aesthetic purposes, subject to approval by the Engineering Division.

d. Extended Detention Basins

i. A two-stage design is required, with separate outlet controls to detain both the first flush volume and larger rain events.

Lower Stage: The lower stage should contain a shallow, permanent pool designed to store and treat the water quality volume. This pool should be managed as a shallow marsh or wetland and average six to twelve inches (6"-12") in depth. A sediment basin upstream for the lower stage must also be incorporated into the design.

Upper Stage: The upper stage should be sized for the 25-year storm event, as defined by the Oakland County Water Resources Commissioner (OCWRC), and should be graded to remain dry except during large storms.

• A low flow channel, constructed of natural permeable material (no cunettes permitted), stabilized against erosion, will be provided through the dry portion of the pond. This channel should have a minimum grade of one half percent (0.5%) and the remainder of the pond should drain toward this channel at a grade of at least one percent (1%). The low flow channel should end at the lip of the lower stage, where riprap or gabion baffles should be placed to prevent scour and resuspension of pollution particles.

6. Underground Detention Facilities

a. General

Underground detention is a less preferred method of meeting the City's stormwater storage requirements, however, if the developer determines that underground detention is the development's best alternative, the following design considerations will need to be addressed:

b. Design Considerations

i. Applicability

These standards are appropriate for all underground pipe or vault detention, whether intended to detain flood and/or channel protection volume, or temporarily store a portion of the water quality volume. Pipes or vaults may be located below vehicular or non-vehicular areas, and must be a minimum of ten feet (10') horizontally from other utilities. Underground detention is generally not acceptable in single-family residential or multi-unit condominium developments. Approval by the City Engineer may be granted on an individual case basis in coordination with the Planning Department.

ii. Design Storm

The facility must be sized to provide storage for the channel protection volume, flood protection volume, and/or recharge volume, with safe conveyance of larger flows through the facility. In addition, the hydraulic grade (H.G.) of the receiving water way must be investigated to assure it is not higher than the pond/basin outlet H.G. If the H.G. of the receiving waterway is higher, the design engineer shall provide a method to allow a positive outflow at the required discharge rate.

One (1) foot of freeboard is required.

iii. Groundwater

In general, underground storage should not be located in areas of shallow groundwater. In situations, where groundwater is encountered, additional design requirements may be necessary.

iv. Geotechnical Analysis

Soil borings must be performed in the location of the proposed detention facility in order to determine presence and location of fill materials, soil type, or groundwater. Borings must extend to a minimum of two feet (2') below a facility.

v. Pretreatment

Stormwater must be pretreated prior to entering the underground system.

The pretreatment BMP must be located so as to provide ease maintenance accessibility.

vi. Inspection accessibility

An adequate number of inspection manholes need to be provided to inspect all of the cells in the system.

c. Specifications and Details

i. Outlet Structure

The outlet structure shall be composed of concrete, and may be cast in place or precast. Precast structures must be monolithic, including the control weir. Structures must be designed for HS20 loading at a minimum. Direct access to both side of the control structure is required.

ii. Overflow Weir Sizing Criteria

The overflow weir in the control structure must be designed to safely pass larger flows through the facility.

iii. Low Flow Outlet Orifice

The low flow orifice may be no smaller than four inches (4") in diameter and must be protected by a trash rack. Expanded metal or perforated half-round CMP should be used. All trash racks must be removable. The surface area of the trash rack perforations must exceed the low flow orifice area by a ratio of at least 5:1. For orifice sizes.

iv. Storage Pipe

All storage pipes must be circular, and must be a minimum of forty-eight inches (48") in diameter. Metal, HDPE, or concrete may be used. Crossover connections must be provided between storage pipes, and these must be a minimum of forty-eight inches (48") in diameter, also. Pipes may not be closer together than one half (½) the inside pipe diameter or three feet (3'); whichever is greater. Minimum cover must be per the manufacture's specifications, based on the design load and considering flotation where required. PH and resistivity test may be required if metal pipe is proposed, on a case-by-case basis, wherever soil acidity is a concern.

v. Metal Pipe

Metal storage pipe must be aluminized, Type 2, and must be designed for the appropriate loading (pipes may not be less than 14-gauge). Pipe ends must be matched and numbered by the manufacturer. Coupling bands must be per the City of Rochester Hills Engineering Construction Specifications, Materials – Storm Drain Pipe.

vi. Concrete Pipe

Concrete pipe must meet ASTM C76. Joints must meet ASTM C443.Only circular pipe may be used.

vii. HDPE Pipe

High Density Polyethylene pipe is acceptable for use in underground storage facilities. Concrete manholes must be used at all HDPE pipe connections. Pipe installation must comply with ASTM D2321.

viii. Concrete Vaults

Concrete vaults may be used for underground detention, with design approved by the Engineering Division on a case by case basis.

ix. Pipe Bedding

Must be per the bedding details on the storm system detail sheets or the manufactures specification/details, whichever is greater.

x. Access

All facility access manholes must be thirty-six inch (36") diameter. Manhole steps shall be provided. Concrete manholes must be used for access to HDPE pipes. Manhole access is required at least in corners of the system and where necessary to allow proper jetting operations and entry for maintenance.

7. Manufactured Treatment Devices (MTD)

a. General Performance and Design Specifications

i. If a manufactured treatment device (MTD) is proposed to help achieve better stormwater quality, it must be capable of treating the peak stormwater quality flow rate, which is, the one year, one half inch (0.5") rain event which occurs within 15 minutes using the rational method. Use a 15-minute time of concentration for commercial sites and a 20-minute time of concentration for residential sites.

ii. The MTD must remove eighty percent (80%) or more of OK 110 (110 um sized particles) based on test results indicated on the third party testing selection guide, provided in Section 4.3.5 (Plan Submittals, B).

iii. Rain events larger than the 1 year, 15 minute rain event shall bypass without causing any resuspension of trapped sediments and without causing re-entrainment of floatable contaminants.

iv. All MTDs should be configured as off-line units unless a detailed hydraulic analysis is provided. The analysis must demonstrate the up- and downstream pipes will have capacity and surcharging created by high rainfall storms will not result in loss of previously captured material.

v. The treatment system must prevent oil and floatable contaminants from entering downstream piping during routine maintenance and during rain events. The use of a floatable trap should be used to meet this requirement.

vi. Direct vehicular access must allow complete and unrestricted access to the entire bottom of the chamber from the top.

vii. The private manufactured treatment device (MTD) should be located outside the City right-of-way.

viii. There can be no points of constriction in the system to cause plugging or flooding.

ix. System must be built to withstand HS-20 loads.

b. Maintenance Guidelines

i. The treatment system shall be maintained according to the manufacturer's recommendations. An Operations and Maintenance Manual (O&M manual) must be provided for review specific to the model. See notes below for information to include in the O&M manual.

The following notes/maintenance items should be included in an Operations and Maintenance Manual (O&M manual):

The maximum sediment depth should be clearly specified.

Graphical and written description of sediment measuring procedure. This should include the use of a dipstick tube equipped w/ a ball valve. (e.g. sludge judge).

Oil removal procedure during routine cleanout.

The O&M manual should specify if entry into the manufactured treatment device (MTD) should be considered an OSHA confined space and guidelines followed.

The inspection frequency should be according to the manufacturer recommendation and approved by the Engineering Division. In no case should it be less than six (6) months.

Off-line configurations must include inspection and maintenance of connecting manhole and diversion weir.

Detail drawing of proposed MTD should be included.

Note in manual to clean unit immediately if there is a hydrocarbon spill (e.g. gasoline or oil).

A note should be provided indicating disposal of all sediment must be in accordance with all federal, state and local requirements.

c. Plan Submittals

i. Calculations associated with the sizing and selection of the appropriate model for the selected type of treatment system shall be included in all plan submissions.

8. Construction Specifications

a. Storm Drain Pipe Materials

i. General

The purpose of this specification is to establish provisions for substitution of the storm drain pipe and joint that has been specified on the Plans. Substitutions may be approved by the Owner, provided the flow capability and pipe (external load supporting) strength is equal to or exceeds that of the pipe specified on the Plans.

Alternate type of storm sewer pipe is allowable under the following conditions:

- The development is non residential
- Location of the storm sewer is on private property.
- The alternate pipe must meet or exceed the performance requirements of this section.
- The City Engineer reserves the right to accept or reject the use of alternate pipe proposes in non-residential developments.
- Aluminized CSP will be permitted after an on site soil analysis indicates pH ranges of 5.0-9.0 and resistivity of 1500 ohm-cm and greater.

ii. Video Inspection

As a means of insuring proper installation of the storm sewer pipe, at the discretion of the City Engineer, the contractor shall video inspect, according to the city of Rochester Hills video inspection standards, up to 100% of the storm sewer pipe 12" and larger in diameter. If video inspection is required by the City Engineer the contractor shall provide 24 hours notice to the City of Rochester Hills prior to video inspection, so a representative may be present. Rochester Hills will be provided with a digital copy of the video inspection and log in accordance with the City of Rochester Hills video inspection standards.

Projects that the City Engineer may impose these requirements are:

- All public projects or projects being constructed on public property.
- Any project involving a development, subdivision, site condominium, condominium, or association.

- Any project the will result in more then one owner responsible for the operation and maintenance of the complete storm drainage system.

iii. Plastic Pipe Testing

All pipe shall be certified by the manufacturer to meet applicable ASTM specification requirements. Certification forms, together with a report of the test results, shall be provided the inspector with pipe deliveries and copies shall be forwarded to the Engineer or Owner.

Certification forms shall include project name, location, contractor and test lot number. Lot sizes shall be acceptable to the Engineer.

All pipefittings shall be suitably marked to provide manufacturer's name, lot or production number. ASTM Designation, PVC, nominal diameter, and SDR number, where applicable. Fittings, however, need not contain lot or production number. Pipe shall have a "home" mark. Truss Pipe with an absence of filler material at the ends greater than one-fourth (1/4") inch deep shall be subject to rejection or acceptable repair.

The completed installation shall at no point have out-of-round pipe deflections greater than 5%. Deflectometer or go/non-go gauging tests may be required prior to acceptance of pipelines, at the discretion of engineer. No more than 50% of installed lines will be mandrel tested unless deflection tests results are unsatisfactory.

b. Products

v. Reinforced Concrete Pipe

Shall be in accordance with ASTM C76 standards. Modified groove tongue joint with approved rubber gasket (current ASTM C443, except as such Specifications relate to infiltration limitations).

Lubricant, as supplied by the pipe manufacturer, shall be used on the groove and on the tongue in making up joints. The joints shall be coupled in accordance with the pipe manufacturer's requirements.

b. Reinforced Concrete Elliptical Culvert Storm Drain

Shall be in accordance with ASTM Designation C-507-79, Class HE-1 through HE-IV or VE-II through VE-VI.

Tongue and groove bituminous (DeWitt #10) joint with inside cement pointing.

c. Corrugated Steel Pipe

All corrugated steel pipe for storm sewers shall be Aluminized Type 2 formed with an external spiral rib. Hydraulic capacity must be equivalent to concrete pipe (N=0.013) for storm sewer calculations.

- For underground detention systems, pipe materials must be Aluminized Type 2, and may be either $2^2/_3$" x ½" corrugation, or 3" x 1" corrugation with gauge as specified by design engineer.

All corrugated steel pipe shall be joined together with a watertight circumferentially corrugated steel-coupling band furnished with two (2) rubber gaskets or bell and spigot end. Gasket shall be manufactured from an elastomeric material and shall meet the requirements of MTM 723.04, (MDOT): Where field jointing of non re-rolled end pipe is required. A 12" wide flat gasket with a minimum 12" wide flat or dimple band will be required. All pipe entering a concrete or block manhole shall be sealed with a minimum 12" wide external gasket. Additionally, all joints in storm sewers and underground detention systems will be wrapped with an 18" wide non woven (4 oz. min.) geotextile.
In underground detention systems, a 12" wide flat gasket with a flat band may be used as an alternate to rubber gasket system.

Gauge thickness shall be as specified on the plans, but in no case be less than the following:

18"-30" = 16ga; 36"-48" = 14 ga; 54"-60" = 12ga; 66"-78" = 10ga.

All pipe connections to the side wall of main-line corrugated steel pipe shall be of the diameter specified on the plans, and shall consist of similar steel pipe that connects or taps into the main-line pipe wall using a pre-fabricated steel saddle plate or factory welded connection.

c. Polyvinyl Chloride (PVC) Pipe

i. (4") to (36")

Material shall be PVC Composite (Contech Truss) Pipe - ASTM D-2680 or PVC Solid Plastic Pipe - ASTM D-3034, SDR 35 or PVC (Contech A2000) Pipe - ASTM F949. Pipe to be made of PVC compound having a minimum cell classification of 12454.

Gaskets for PVC pipe and fittings shall be of the elastomeric type. Gasket joints shall be installed in accordance with procedures specified by the pipe manufacturer. Joints shall meet the requirements of MTM 723.04 (MDOT). Care should be taken to insure all joints being pushed to the full home position and held tightly in home position during any grade or line adjustments.

Haunching, bedding, and backfill materials for pipe (4"-36") shall be as shown on the detail sheet.

d. High Density Polyethylene (HDPE) pipe

i. (8" – 48")

HDPE – ASTM F-2306; AASHTO M-294.

Joints to be bell and spigot with gaskets to be elastomeric type. Joint performance to meet the requirements of MTM 723.04 (MDOT).

Haunching, Bedding, and backfill materials for HDPE (8"- 48") shall be as shown on the detail sheet and must consist of class I (crushed stone) meeting MDOT 21a,22a, or 6a gradation.

e. Manhole, Catch Basin and Inlet Block and Brick

Brick shall be made of clay or shale, and shall be whole, thoroughly and evenly burned, of close and uniform texture, free from cracks and warps, with true even faces and uniform in shape and size. Brick shall show a minimum average compressive strength of 2,000 pounds per square inch and an average absorption of water in twenty-four (24) hours of not more than 25% of the dry weight.

Concrete brick shall conform to the requirements for concrete building brick of ASTM C-55-75, Grade N-1.

Concrete block for manholes, catch basins, and inlets shall conform to ASTM C139-73 with the following exceptions:

The blocks shall be solid curved blocks with the inside and outside surfaces curved to the required radii. The blocks shall have tongue and groove or other approved type of joint at the ends so that the units interlock to form a strong, rigid structure. Curved blocks shall have the inside and outside surfaces parallel.

The nominal dimensions of the block shall be 18 inches maximum for length, 8 inches maximum for depth (height), and 6 inches minimum for width (thickness). The length shall be measured along the chord on the convex face of the block. The tolerances of ASTM C 129-73 shall apply. Where the specified wall thickness on the standard plans is 12 inches, a multiple block wall of two 6-inch wide blocks is permitted. All blocks in one structure shall be of the same height dimension. The blocks shall be designed for length so that only full length or half-length blocks are required to lay the circular wall of any one course.

Blocks intended for use in the cones or tops of manholes or other structures shall have such shape as may be required to form the structure as shown on the plans with inside and outside joints not to exceed 1/4 inch in thickness.

The mortar shall be composed of one (1) part of a combination of Portland Cement and hydrated lime and three (3) parts of fine aggregate, by volume. The combination of cement and lime shall consist of 90% of Portland Cement and 10% of hydrated lime, by volume. In lieu of the above combination of cement and lime, a standard brick mortar cement may be used if approved by the Engineer.

All Manhole, Catch Basin, or Inlet Structure Steps shall be M.A. Industries, Inc., Numbers PS-1-B or PS-2-PFS or approved equal.

f. Precast Manholes

All precast manhole sections and bases shall be 4000 lbs per square inch concrete as determined by core test or cylinders.

Unless otherwise noted on the drawings or in the Supplemental Specifications, precast reinforced concrete manhole sections shall meet the requirements of current ASTM C-478.

Precast manhole tees for forty-eight inch (48") and larger storm drains shall be the same class pipe as that specified on the plans, but shall be a minimum ASTM C-76-79 Class IV. The manhole riser shall meet the requirements of current ASTM C-478.

g. Storm Drain Stubs

Four inch (4") to ten inch (10") diameter stubs shall be PVC Composite (Contech Truss) Pipe or PVC Solid Plastic Pipe as specified under Section 8, Construction Specifications, Item c, or approved alternate. Stubs twelve inches (12") and larger shall be ASTM C76 Class IV Reinforced Concrete Pipe or as otherwise noted. Maximum pipe length of stubs shall be eight feet (8').

E. Operation and Maintenance Responsibilities

1. General Responsibilities

a. The Owner/Developer of a property is responsible for the proper installation and initial function of the stormwater management system in accordance with the approved Stormwater Management Plan. All temporary soil erosion and sedimentation control measures shall be removed or converted to their permanent configuration in accordance with an approved erosion control plan. It is required that the Oakland County Water Resources Commissioner (OCWRC) determine and approve when sufficient stabilization has occurred on a site in order to convert to the permanent stormwater management facilities.

b. The Owner/Developer is responsible for the proper operation and maintenance of the stormwater management system during and after construction. An Operation and Maintenance Plan consistent with the requirements of Section E shall be prepared for review and approval by the engineering division. The operation and maintenance plan will become an exhibit to the operation and maintenance agreement. See Section 3 and 4 for further detail.

c. Approval and Transfer of Stormwater Operation and Maintenance (O&M) Responsibilities.

i. The City of Rochester Hills requires that the stormwater management system is operated and maintained by the individual property owners or an owners/homeowners association or similar entity, or an organization capable of carrying out maintenance responsibilities. However, the Developer is responsible for O & M until:

Evidence of final approval by OCWRC is received indicating the site has been sufficiently stabilized to convert to the permanent stormwater management system.

The stormwater management system is cleaned and free of sediment, as well as defects and/or damage corrected.

Evidence that the stormwater management system has been transferred to an association or relevant owner, as well as approval of the transfer by the City of Rochester Hills.

2. Ownership and Maintenance

All stormwater management systems identified within an approved Stormwater Management Plan shall be owned and maintained by one of the following entities:

a. Individual On Property Stormwater Management Systems

i. Where individual on-property stormwater management systems are proposed, the land development plan shall contain a note designating the entity responsible for operation and maintenance of the on-property system consistent with an approved Operation and Maintenance Plan.

b. Owners, Homeowners or Condominium Association Ownership

Where an association is created to own and manage the stormwater management system, the subdivision and/or land development plan shall contain a note designating the entity responsible for construction and/or maintenance of the stormwater management system consistent with an approved Operation and Maintenance Plan.

3. Operation and Maintenance Plan

An Operation and Maintenance Plan shall be prepared to identify the ownership, operation and maintenance responsibilities and as-built conditions for all stormwater management systems. At a minimum, the operation and maintenance plan shall include the following:

a. Any obligations concerning perpetuation and/or maintenance of natural drainage or infiltration facilities, and other facilities identified within the Stormwater Management Plan. Ownership of and responsibility for operation and maintenance of stormwater management systems, including names and contact information, shall be required.

b. A description of the permanent stormwater management practices on the site, explaining how each practice is intended to function and operate over time. All drainage and access easements shall be depicted and any site restrictions to be recorded against the property shall be identified on the plan. All such easements and restrictions shall be perfected to run with the land and be binding upon the landowner and any successors in interest.

c. A description of the actions, budget and schedule for operating and maintaining the stormwater management system. This description should be written in a clear manner, consistent with the knowledge and understanding of the intended user.

d. A general description of operation and maintenance activities and responsibilities for systems held in common or on-property, including but not limited to: lawn care, vegetation maintenance, clean out of accumulated debris and sediment (including from grates, trash racks, inlets, etc.), liability insurance, maintenance and repair of stormwater management systems, landscaping and planting, payment of taxes and construction of any kind associated with the use, benefit and enjoyment of the facilities by the owners. In particular, a description of routine facility operation and day-to-day management requirements (as needed) and a description of routine maintenance actions and schedules necessary to ensure proper operation of stormwater management systems shall be submitted.

e. Assurances that no action will be taken by any property owner to disrupt or in any way impair the effectiveness of any stormwater management system, setting forth in deed restrictions the ability of the City of Rochester Hills to take corrective measures if it is determined, at any time, that stipulated permanent stormwater management systems have been eliminated, altered, or improperly maintained.

f. Parties responsible for the long term operation and maintenance of stormwater management systems shall make records of the installation and of all maintenance and repairs, and shall retain the records for at least ten (10) years. These records shall be submitted to the City of Rochester Hills as established by the Operation and Maintenance Plan or if otherwise required by the City of Rochester Hills.

4. Operation and Maintenance Agreement

a. The owner of any land upon which permanent stormwater management systems and/or BMPs will be placed, constructed or implemented, as described in an approved Stormwater Management Plan and the Operations and Maintenance Plan, shall provide the City of Rochester Hills a Stormwater System Operations and Maintenance Agreement that includes:

The Operations and Maintenance Plan, or a summary thereof,

Legal Description of the development property and,

Map of the development with the Stormwater System depicting components and access and/or drainage Easements.

In cases where the predevelopment offsite drainage is dependent on draining through the development, the agreement shall provide for that right of flow.

b. The Operation and Maintenance Agreement shall be submitted to the City Engineering Division, executed and in recordable form, acceptable to the City for acceptance and recording.

c. Other items or conditions may be included in the Operation and Maintenance Agreement where determined necessary to guarantee the satisfactory operation and maintenance of all permanent stormwater systems and BMPs. The agreement shall be subject to the review and approval of the City of Rochester Hills.

APPENDIX A

Non-Structural Stormwater Management Practices AlternativeApproach for Managing Stormwater Runoff

Stormwater Discussion

Land development can dramatically alter the hydrologic cycle of a site, and ultimately, an entire watershed. Prior to development, native vegetation can either directly intercept precipitation or draw that portion that has infiltrated into the ground and return it to the atmosphere through evapotranspiration. Development can remove this beneficial vegetation and replace it with lawn or impervious cover, reducing the site's evapotranspiration and infiltration rates. Clearing and grading a site can remove depressions that store rainfall. Construction activities may also compact the soil and diminish its infiltration ability, resulting in increased volumes and rates of stormwater runoff from the site. Impervious areas that are connected to each other through gutters, channels, and storm sewers can transport runoff more quickly than natural areas. This shortening of the transport or travel time quickens the rainfall-runoff response of the drainage area, causing flow in downstream waterways to peak faster and higher than natural conditions. These increases can create new and aggravate existing downstream flooding and erosion problems and increase the quantity of sediment in the channel. Filtration of runoff and removal of pollutants by surface and channel vegetation is eliminated by storm sewers that discharge runoff directly into a stream. Increases in impervious area can also decrease opportunities for infiltration, which, in turn, reduce stream base flow and groundwater recharge. Reduced base flows and increased peak flows produce greater fluctuations between normal and storm flow rates, which can increase channel erosion. Reduced base flows can also negatively impact the hydrology of adjacent wetlands and the health of biological communities that depend on base flows. Finally erosion and sedimentation can destroy habitat from which some species cannot adapt.

In addition to increases in runoff peaks, volumes, and loss of groundwater recharge, land development often results in the accumulation of pollutants on the land surface that runoff can mobilize and transport to streams. New impervious surfaces and cleared areas created by development can accumulate a variety of pollutants from the atmosphere, fertilizers, animal wastes, and leakage and wear from vehicles. Pollutants can include metals, suspended solids, hydrocarbons, pathogens, and nutrients.

In addition to increased pollutant loading, land development can adversely affect water quality and stream biota in more subtle ways. For example, stormwater falling on impervious surfaces or stored in detention or retention basins can become heated and raise the temperature of the downstream waterway, adversely affecting cold water fish species such as trout. Development can remove trees along stream banks that normally provide shading, stabilization, and leaf litter that falls into streams and becomes food for the aquatic community.

Alternative Approach

The recommended alternative approach is to promote practices that will minimize post-development runoff rates and volumes, which will minimize needs for artificial conveyance and storage facilities. To simulate pre-development hydrologic conditions, forced infiltration is often

necessary to offset the loss of infiltration by creation of impervious surfaces. The ability of the ground to infiltrate depends upon the soil types and its conditions.
Preserving natural hydrologic conditions requires careful alternative site design considerations. Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. A well-designed site will contain a mix of all those features. The following describes various techniques to achieve the alternative approach:

Preserving Natural Drainage Features. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. However, this objective is often not accomplished in land development. In fact, commonly held drainage philosophy encourages just the opposite pattern -- streets and adjacent storm sewers typically are located in the natural headwater valleys and swales, thereby replacing natural drainage functions with a completely impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Developments designed to fit site topography also minimizes the amount of grading on site.

Protecting Natural Depression Storage Areas. Depressional storage areas have no surface outlet, or drain very slowly following a storm event. They can be commonly seen as ponded areas in farm fields during the wet season or after large runoff events. Traditional development practices eliminate these depressions by filling or draining, thereby obliterating their ability to reduce surface runoff volumes and trap pollutants. The volume and release-rate characteristics of depressions should be protected in the design of the development site. The depressions can be protected by simply avoiding the depression or by incorporating its storage as additional capacity in required detention facilities.

Avoiding introduction of impervious areas. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints, sidewalks, driveways and other features producing impervious surfaces should be evaluated to minimiz***e*** impacts on runoff.

Reducing the Hydraulic Connectivity of Impervious Surfaces. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as storm sewer). Two basic ways to reduce hydraulic connectivity are routing of roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff, and should help reduce concentration of runoff to a single point in the development.

Routing Roof Runoff Over Lawns. Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connections of downspouts to storm sewers or parking lots. The practice also discourages sloping driveways and parking lots to the street. By routing roof drains and crowning the driveway to run off to the lawn, the lawn is essentially used as a filter strip.

Reducing the Use of Storm Sewers. By reducing use of storm sewers for draining streets, parking lots, and back yards, the potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a “reasonable” time. The practice requires educating local citizens and public works officials, who expect runoff to disappear shortly after a rainfall event.

Reducing Street Widths. Street widths can be reduced by either eliminating on-street parking or by reducing roadway widths. Municipal planners and traffic designers should encourage narrower neighborhood streets, which ultimately could lower maintenance.

Limiting Sidewalks to One Side of the Street. A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines. Where appropriate, backyard trails should be constructed using pervious materials.

Using Permeable Paving Materials. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads.

Reducing Building Setbacks. Reducing building setbacks reduces driveway and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

Constructing Cluster Developments. Cluster developments can also reduce the amount of impervious area for a given number of lots. The biggest savings is in street length, which also will reduce costs of the development. Cluster development clusters the construction activity onto less-sensitive areas without substantially affecting the gross density of development.

In summary, a careful consideration of the existing topography and implementation of a combination of the above mentioned techniques may avoid construction of costly stormwater control measures. Other benefits include reduced potential of downstream flooding, water quality degradation of receiving streams/water bodies and enhancement of aesthetics and reduction of development costs. Beneficial results include more stable base flows in receiving streams, improved groundwater recharge, reduced flood flows, reduced pollutant loads, and reduced costs for conveyance and storage.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 5

Grading

A. Requirements for Master Grading Plans

A Master Grading Plan is required for all developments. Master grading plans shall accompany the set of engineering construction plans and shall include the following:

1. Benchmark locations, descriptions and elevations (USGS) to be used for the development.

2. The minimum scale for grading plans is one-inch (1") = fifty feet (50').

3. The grades of existing adjacent houses, buildings, drainage structures, and streets shall be shown. The actual surveyed grades of existing adjacent ground and yards shall be shown as necessary to clearly define off-site drainage patterns for one hundred feet (100') from the property line. The drainage pattern of all adjacent existing land shall be indicated. All off-site drainage flowing onto the site shall be clearly labeled and identified.

4. Meet existing ground at the property boundaries. Construct an intercepting swale to prevent drainage from development improvements onto adjacent property.

5. Grading plans shall correspond with proposed landscape, tree protection and soil erosion requirements. Any revisions in the grading plan may require Planning and Economic Development Department approval if it directly or indirectly affects the approved landscape or tree protection plans.

6. The grading plan shall be designed to ensure that if a failure occurs in the storm system, water will drain away in overland swales without flooding structures.

7. Show proposed building finish floor grade and top of curb grade at the center of each lot to tenths of a foot. Also include grades at the mid-point of the building, at each lot corner, and at the midpoints on lot lines. Place house grades on the plan view of the typical building(s) to be built in the development. Front yard setbacks shall be drawn to scale.

8. The finish grade shall be compatible with the grades of surrounding buildings and yards.

9. Show grade changes at proposed sidewalks and at driveway crossings.

10. Rear yard storm drainage is required in all residential developments where adjacent lots drain to the rear. Twenty-foot (20') easements shall be established for the required storm drains.

11. Indicate rear yard catch basins. Show the proposed rim elevation to hundredths of a foot. Catch basins are required to be at a lot corner and the catch basin rim grade shall be the only grade shown at that corner.

12. Indicate perforated plastic rear yard underdrains and tees for sump pumps where they are called for in the storm sewer plans. Use different symbols for plastic underdrains and concrete storm sewer on the plans.

13. All existing and proposed earth grades are to be in tenths (10ths) of a foot.

14. Rear yard swales shall be, in general, no longer than 400 feet before being intercepted by a catch basin, and shall have a minimum grade of one percent (1%).

15. Rear yard storm drain piping shall be concrete, at twelve inches (12") minimum diameter.

16. Show the proposed side yard swale elevation between all buildings. This elevation must be a minimum of one-half feet (0.5') below the lower adjacent building grade. The side yard swale must have a minimum slope of one percent (1%) to the front and rear.

17. Where topography prevents rear yard drainage from being practical, rear to front or rear to side drainage may be allowed. The following swale elevations must be shown:

    a. The high point of the swale(s), located generally behind the building, a minimum of fifteen feet (15') from the building, and one foot (1') below the building brick ledge grade.

    b. The side swale elevation located even with the front and back of the building.

18. The general direction of flow of the rear yard drainage and all swales must be indicated with arrows. Swales need not be otherwise labeled. Arrows need not be drawn for front yards with standard building to street drainage.

19. Additional grades shall be shown under Special Conditions as required.

20. The lot number, address or Tax ID (Sidwell) shall be shown for each lot.

21. All easements, drawn to scale and properly labeled, shall be shown, including natural feature setbacks.

22. Master grading plan must include a note stating that the site must be balanced and certified by a licensed professional surveyor within one foot (1') of finished grade prior to underground utility installation.

23. Existing moderate steep slopes, very steep slopes or bluff slopes as defined by Rochester Hills City zoning ordinance Section 138, Chapter 2, shall be shown on the plans along with any association setback lines.

B. Requirements for Individual Grading Plans

The following general grading requirements shall be applied in the design of the individual site grading plans (plot plan or single lots):

1. Drainage shall be adequately discharged off-site, to either the street or a dedicated storm drain.

2. No upstream drainage shall be restricted.

3. The developed portion of the site in general shall drain without standing water, unless specifically designed for retention and/or detention.

4. Elevations representing the brick ledge, finished grade, and the first floor grade shall be indicated. Basement and lowest opening grades shall be shown.

5. Lots with rear-to-front drainage shall have swales shown around each building or structure. Elevations of swales shall be called out at high points and low points.

6. No berms shall be placed over any water main, sanitary sewer, or storm drain, or within the designated easements for such facilities.

7. Grading plans shall be prepared by a licensed professional engineer or surveyor, signed and sealed, and shall conform with the following minimum requirements, with the final sufficiency of such plan to be determined by the Department of Public Services:

    a. A scale of not less than one inch (1") equals fifty feet (50'). Scales of one-inch (1") equals twenty feet (20') are preferred.

    b. Date, north arrow, and scale must be called out.

    c. The dimensions of all property lines, showing the relationship of the subject property to abutting properties.

    d. All required zoning setbacks shown and property labeled.

    e. All existing and proposed ground grades in tenths (10ths) of a foot.

    f. General direction of the rear yard drainage and swales indicated with arrows.

    g. Additional grades shown under special conditions as required by the Department of Public Services.

    h. The location of all utility leads (water, sanitary, sump pump).

8. Proposed driveways shall be shown with grades called out at the house and at the street. Driveway slopes shall be shown in percent (%). The minimum allowable slope is two percent (2%) with maximum allowable slopes of eight percent (8%) along roads with posted speed limits of 40 MPH or greater and ten percent (10%) along roads with a posted speed limit of 35 MPH or less. Note: driveway slopes shall not exceed two percent (2%)

through the portion of the driveway that is to be utilized for existing and/or proposed pedestrian facilities, i.e., pathways and sidewalks, in order to meet American with Disabilities Act (ADA) requirements.

9. All public and private easements, drawn to scale and properly labeled, shall be shown, including natural features setbacks.

10. Existing moderate steep slopes, very steep slopes or bluff slopes as defined by Rochester Hills City zoning ordinance Section 138, Chapter 2, shall be shown on the plans along with any association setback lines.

C. Retaining Walls

1. Retaining walls should be used when adequate grading cannot be accomplished.

2. Retaining walls exceeding forty-two inches (42") in height should include protective fencing on top.

3. Retaining walls exceeding forty-eight inches (48") in height shall be designed by a licensed professional engineer. Design calculations shall be submitted with the construction plans.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 6

Roads

A. Plans & Specifications – Submittal Procedure

1. The plans and specifications shall be prepared in accordance with Chapter 1, *General Requirements and Submittals*.

2. Paving designs, including soil borings (minimum of five feet (5') deep) may be required with particular paving submittals.

B. Requirements for New Public Roadways

1. Paving width and thickness shall conform to the following requirements for public roadways:

   a. Concrete roads shall be eight inches (8") 3,500 psi concrete over four inches (4") 21AA aggregate base course materials (crushed limestone or crushed concrete). Alternate recycled asphalt product (RAP) base course materials may be considered upon approval of the City Engineer. Alternate RAP materials must meet equivalent structural strength of 21AA aggregate (crushed limestone or concrete).

      Extend four inches (4") of base course material to one foot (1') beyond edge drain. All industrial subs shall be constructed with concrete to meet all weather conditions.

   b. Asphalt roads shall be nine inches (9") deep strength asphalt over six inches (6") of 21AA aggregate base course materials (crushed limestone or crushed concrete). Alternate recycled asphalt product (RAP) base course materials may be considered upon approval of the City Engineer. Alternate RAP materials must meet equivalent structural strength of 21AA aggregate (crushed limestone or concrete). The nine inches (9") shall consist of two inches (2") of HMA 5E3 (wearing), two and-one half inches (2-1/2") HMA 4E3 (leveling), four and one-half inches (4-1/2") HMA 3E3 (base course). Extend six inches (6") base course material to one foot (1') beyond edge drain. Asphalt binder shall be PG 64-22.

   c. Asphalt road sections for projects that follow the special assessment district (SAD) paving program will be in accordance with the design standards for that policy. Furthermore, reconstruction of City local roads may be rebuilt with a section less than the requirements identified in items a. or b. above if approved by the City Engineer.

2. Other alternative paving and drainage designs may be submitted to the Department of Public Services for consideration, following review and recommendation by the City's Engineer, in limited areas where such alternative paving and drainage designs would be more consistent with the character and construction of existing paving and drainage

facilities in the area. Such alternative paving and drainage facilities shall only be acceptable in those instances where the City finds that the proposed design will provide an acceptable level of serviceability, ease of maintenance, and facility life, consistent with public paving and drainage facilities in similar areas, elsewhere in the City.

3. The minimum radius of cul-de-sacs is as follows:

    a. With island, the minimum outside radius of a cul-de-sac from back-of-curb (b/c) shall be fifty-seven feet (57'). The inside radius shall be thirty feet (30') (b/c). All right-of-way radii shall be seventy-three feet (73') minimum.

    b. Without island, the minimum outside radius of a cul-de-sac (b/c) shall be forty-seven feet (47'). All right-of-way shall be sixty-three feet (63') minimum.

4. Pavement widths for residential streets shall be twenty-seven feet (27') (b/c to b/c). Pavement widths for streets in an industrial subdivision shall be thirty-six feet (36') (b/c to b/c). Streets that are developed as part of a flex business overlay district per zoning ordinance section 138.8.302 – Street Design will be given consideration to deviate from the above road width standards as agreed upon by the Department of Public Services Engineering Division and Planning and Economic Development department.

5. A boulevard section may be allowed in an enlarged right-of-way. Pavement widths shall be at least twenty-four feet (24') (b/c to b/c) for all boulevard streets within residential subdivisions. The minimum island width shall be sixteen feet (16'). Within industrial subdivisions the pavement sections should be increased to twenty-seven feet (27') (b/c to b/c). The nose of the median shall be offset at least eight feet (8') from the edge of pavement of the intersecting street.

6. The minimum longitudinal pavement slope shall be one percent (1%), and a maximum of six percent (6%) for major roads, and eight percent (8%) for local roads. A grade in excess of the standard will not be allowed. Vertical curves are necessary when a change in grade of one percent (1%) or more occurs. The minimum length of vertical curve shall be one hundred feet (100'). Cross slope shall be at two and one-half percent (2.5%).

    The pavement profile view must include:

    a. Elevations at top of curb, or at centerline if not curbed.
    b. Existing ground elevations at the center of the right-of-way, and at other locations as required for review.
    c. Station and elevations of all high points, low points, grade-breaks, curb returns intersecting property lines, and necessary information at vertical curves.
    d. Top of curb (or centerline) elevations at each station. Grade in vertical curves must be indicated at twenty-five foot (25') intervals.
    e. The station and top of casting grade of all pavement catch basins and inlets.

7. The pavement radius at all intersections of all roads shall be a minimum twenty-five feet (25'). Allow for a minimum of one-half foot (0.5') drop in elevation around the curb return for twenty-five foot (25') radius. For larger radii, a proportionately greater amount of fall must be provided.

8. The Michigan Department of Transportation and/or Road Commission for Oakland County design requirements shall be met for intersecting roads under their jurisdictions. Passing lanes, center left-turn lanes, acceleration, and deceleration lanes shall conform to the requirements as outlined under *Chapter 8, Widening Lanes*.

9. All horizontal curves shall be consecutively numbered and indicated in the plan view. Curve data shall be given for the respective curve on the same sheet as it occurs.

10. Finish grade of all structures shall be indicated in the plan view.

11. All pavement in residential areas shall have thirty-inch (30") mountable concrete curb and gutter with a three-inch (3") curb height. All island curbs and street intersections shall have MDOT B-2 modified curbing with a five and one-half inch (5.5") curb height. In either case, the face of gutter depth shall be nine inches (9") thick. Curb height through driveway locations shall be reduced to one-inch or less.

12. City major roads shall have B-2 modified curbing. A five-foot (5') transition area is required where the curb changes from MDOT B-2 modified to four-inch (4") mountable curb and gutter. Curb height through driveway locations shall be reduced to one-inch or less.

13. A detail of all intersections and cul-de-sacs must be provided. The detail shall show jointing and detailed grades. Maximum scale of the detail shall be one inch equals thirty feet (1" = 30'). On intersections where jointing is shown on the pavement Standard Detail sheet and where grades are completely determined by additional notes on the plans, separate details need not be shown.

14. At the end of a street that may be extended in the future, indicate a one-foot (1') end header, barricade and signs (end of roadway object marker ("OM4-3") and a "Road Ends" sign ("W-14-2-a").

15. Edge drains shall be placed one foot (1') offset from the back of curb and placed with three and a half feet (3.5') of cover (from top of curb) for the full length of all curb. Edge drains in open ditched sections where the ditch slope is less than one percent (1%) will require a solid wall perforated in a fabric/sock pipe under the ditch. Edge drain, six inches (6") in diameter, perforated or slotted, shall be constructed in the back of curb line for the full length of curb, backfilled with either 2NS sand or pea stone. Perforated pipe shall be Smooth-Wall PVC Plastic Edge Drain with 3/16 inch to 3/8-inch perforations. Slotted pipe shall be A-2000 (Contech or equivalent approved by the City Engineer) sewer pipe, with slotted perforations. The pipe shall be installed with the protective geotextile sock wrap. Roadway rehabilitation or reconstruction projects may consider the use of flexible piping for common sump pump collection lines.

16. Temporary access roads shall be sixteen feet (16') wide minimum. Construction plans shall identify a method to prevent site development vehicles and equipment from tracking mud and/or dirt onto roadways.

17. Streetlights – The City may require street lighting at street intersections or other locations to serve purposes of safety and/or security. When required, the intensity and type of illumination, location and types of poles, bases, etc. shall be coordinated with the existing and future street lighting within that area and conform to the latest version of the American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide.

18. The owner/developer shall provide and properly maintain until accepted by the City all traffic and pavement markings, which the City may determine necessary, for the proper operation of the roadway/driveway/curb cut. Only those traffic signs and pavement markings specified by the City (or jurisdictional authority) may be used within the road right-of-way. All signs and pavement markings shall conform to the current Michigan Manual of Uniform Traffic Control Devices (MMUTCD).

19. All plans are to clearly identify public or private dedication.

20. Private roads are to be designed to City Public Road Standards.

21. Shared driveways can be proposed to the Planning and Economic Development Department and the Department of Public Services. The applicant must demonstrate that the incorporation of any shared driveways provides a measurable benefit and better aligns with the development intent and surrounding environmental characteristics. Ingress/egress agreements for the shared operation, maintenance and future replacement are required.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 7

Widening Lanes

A. Plans and Specifications – Submittal Procedure

1. A Traffic Impact Study (TIS) or a Traffic Impact Assessment (TIA) may be required by the City prior to site plan approval, and shall conform to the MDOT Geometric Design Guidance document sections 1.2.4 and 1.2.5 dated September 2017. https://mdotjboss.state.mi.us/TSSD/getSubCategoryDocuments.htm?prjNumber=1403850&category=Geometrics&subCategory=Correspondence/Guidelines&subCategoryIndex=subcat0Geometrics&categoryPrjNumbers=1403850,140385

   The requirement for a TIS may be waived/modified by the City's Engineering Division provided that documentation is submitted considering and verifying the following factors:

   a. Roadway improvements are scheduled, which are expected to mitigate any impacts associated with the proposed project.
   b. The existing level of service along the roadway is not expected to drop below C due to the proposed project.
   c. The existing level of service is not expected to be significantly impacted by the proposed project due to specific conditions at this location.
   d. A similar traffic study was previously performed for the site and is still considered applicable.

2. Widening Lane Improvement Plans and Specifications must be submitted to and approved by the Department of Public Services prior to receiving approval for construction in accordance with *Chapter 1, General Requirements and Submittals,* and must illustrate the following:

   a. All improvements required by the appropriate road agency maintaining jurisdiction of the particular road section, i.e. Road Commission for Oakland County (RCOC), Michigan Department of Transportation (MDOT), or the City of Rochester Hills.
   b. Proposed treatment of drive/street entrances and exits to and from public roads, which comply with typical RCOC, MDOT and City details.
   c. Existing and proposed public right-of-way throughout the extension of proposed improvements, if any.

B. Plans and Specifications – Design Criteria

1. Any development that will contribute traffic flow on existing RCOC, MDOT, or City roads may be required to construct widening lane improvements based on RCOC, MDOT, and City guidelines. City guidelines shall typically conform to the RCOC requirements.

However, City requirements may exceed those of RCOC and MDOT based upon projected or forecasted traffic volumes.

2. The widening lane improvements of existing roads at the intersections of new streets and driveways may include, but are not limited to:

   a. Right-turn acceleration and deceleration lanes.
   b. Center left-turn lanes.
   c. Left-turn passing lanes.
   d. Ultimate road re-alignment.
   e. Storm drainage.
   f. Road base drainage upgrades.
   g. Traffic signage and/or pavement markings.
   h. All other items necessary to facilitate the construction of the required pavement section.

   Note: Center left-turn lanes are strongly encouraged over left-turn passing lanes as determined by the City.

3. Additionally, off-site road improvements may be required, if warranted by traffic studies and/or RCOC, MDOT, or City guidelines, to provide the necessary capacity and safety requirements.

4. The proposed widening improvements shall match existing pavement type, concrete or hot mix asphalt (HMA), and pavement thickness; unless approved otherwise by City Engineer or other applicable road agency.

5. Geometric configurations shall be in accordance with applicable road agency guidelines for widening lane improvements, including MDOT's *Access Management Guidebook.*

6. A review of fixed object clear zones may be required to verify that appropriate clearances are maintained from objects such as trees, utility poles, hydrants, etc. When such objects are within the appropriate clear zones they shall be required to be removed/relocated, unless otherwise approved by the City Engineer or other applicable road agency.

B. Proposed Improvements within Limited Rights-of-Way

1. When sufficient public right-of-way does not exist for the construction of required widening lanes, the owner or builder shall dedicate the necessary right-of-way to the road agency owning the roadway to facilitate the construction, at the developer's cost, of the proposed improvement.

2. When the required improvements extend beyond the ownership of the subject site(s) and public right-of-way is insufficient, the owner shall obtain the necessary off-site easements/right-of-way. If the owner has exhausted all avenues for obtaining the easements/right-of-way, then the owner shall deposit the cost of providing these widening lane improvements with the City's Treasury Department. The cost of the required improvements shall be subject to review and approval by the City. These funds will be used at a later date when the right-of-way becomes available to place the required widening lanes.

3. As an alternative, these funds may be used at a later date as a contribution toward a larger project. If deemed appropriate by the City, a recordable agreement to be in favor of a future special assessment project for road improvements may be substituted for the cash deposit.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 8
Driveway Approaches and Drainage Ditches

A. Plans and Specifications – Submittal Procedure

1. The plans and specifications shall be prepared in accordance with *Chapter 1, General Requirements and Submittals*.

B. Requirements for Residential Driveway Approaches

1. Pavement cross-sections shall conform to the following requirements:

   a. Concrete driveway approaches shall be six inches (6") 3,500 psi concrete over four inches (4") 21AA aggregate base course materials (crushed limestone or crushed concrete). Alternate recycled asphalt product (RAP) base course materials may be considered upon approval of the City Engineer. Alternate RAP materials must meet equivalent structural strength of 21AA aggregate (crushed limestone or concrete).

   b. Asphalt driveway approaches shall be six inches (6") hot mix asphalt (HMA) over four inches (4") 21AA aggregate base course materials (crushed limestone or crushed concrete). Alternate recycled asphalt product (RAP) base course materials may be considered upon approval of the City Engineer. Alternate RAP materials must meet equivalent structural strength of 21AA aggregate (crushed limestone or concrete). The cross-section shall consist of two inches (2") HMA 13A wearing course over four inches (4") HMA 3C leveling course (two (2) two inch (2") lifts.

2. Driveway approach dimensions shall conform to the following requirements:

Garage Size	Approach Width At ROW	Local/Collector Approach Width at Street	Flare Width	Major Street Approach Width at Street	**Radius**
1 Car	12 Ft	18 Ft	3 Ft	32 Ft	10 Ft
	13 Ft	19 Ft	3 Ft	33 Ft	10 Ft
	14 Ft	20 Ft	3 Ft	34 Ft	10 Ft
	15 Ft	21 Ft	3 Ft	35 Ft	10 Ft
2 or More Cars	16 Ft	22 Ft	3 Ft	36 Ft	5 Ft to 10 Ft
	18 Ft	24 Ft	3 Ft	36 Ft	5 Ft to 10 Ft
	20 Ft	25 Ft	2.5 Ft	36 Ft	5 Ft to 10 Ft
	22 Ft	25 Ft	1.5 Ft	36 Ft	5 Ft to 10 Ft
	24 Ft	25 Ft	0.5 Ft	36 Ft	5 Ft to 10 Ft
	25 Ft	25 Ft	0.0 Ft	36 Ft	5 Ft to 10 Ft

3. Circular Driveways

    a. The property shall have a minimum of eighty feet (80') of road frontage.

    b. The minimum spacing between driveway approaches shall be forty-five feet (45') from centerline to centerline.

    c. Entering driveway approach angle from street shall be ninety degrees (90º).

4. Proposed driveways shall be shown with grades called out at the house and at the street. Driveway slopes shall be shown in percent (%). The minimum allowable slope is two percent (2%) with maximum allowable slopes of eight percent (8%) along roads with posted speed limits of 40 MPH or greater and ten percent (10%) along roads with a posted speed limit of 35 MPH or less. Note: driveway slopes shall not exceed two percent (2%) through the portion of the driveway that is to be utilized for existing and/or proposed pedestrian facilities, i.e., pathways and sidewalks, in order to meet American with Disabilities Act (ADA) requirements.

5. Additional requirements shall be in accordance with the City Standard Details.

C. Requirements for Commercial Driveway Approaches

1. Pavement cross-sections shall conform to the following requirements:

    a. Concrete driveway approaches shall be eight inches (8") 3,500 psi concrete over four inches (4") 21AA aggregate base course materials (crushed limestone or crushed concrete). Alternate recycled asphalt product (RAP) base course materials may be considered upon approval of the City Engineer. Alternate RAP materials must meet equivalent structural strength of 21AA aggregate (crushed limestone or concrete).

    b. Asphalt driveway approaches shall be nine inches (9") hot mix asphalt (HMA) over six inches (6") 21AA aggregate base course materials (crushed limestone or crushed concrete). Alternate recycled asphalt product (RAP) base course materials may be considered upon approval of the City Engineer. Alternate RAP materials must meet equivalent structural strength of 21AA aggregate (crushed limestone or concrete). The cross-section shall consist of two inches (2") HMA 13A wearing course over two inches (2") HMA 3C leveling course over five inches (5") HMA base course two (2) two and a half inch (2-1/2") lifts.

2. Driveway locations and geometrics shall at a minimum meet the Road Commission for Oakland County (RCOC) *Permit Rules, Specifications & Guidelines,* Michigan Department of Transportation (MDOT) *Administrative Rules Regulating Driveways Banners & Parades,* and MDOT *Access Management Guidebook*. City requirements may exceed those of RCOC and MDOT.

3. Driveway grades shall not exceed six percent (6%) within the right-of-way. Note: driveway slopes shall not exceed two percent (2%) through the portion of the driveway that is to be utilized for existing and/or proposed pedestrian facilities, i.e., pathways and sidewalks, in order to meet American with Disabilities Act (ADA) requirements.

4. Curb heights must be reduced to 1-inch or less height through a driveway opening.

5. Additional requirements shall be in accordance with the City Standard Details.

D. Drive Culverts and Drainage Ditches

1. Drive culverts shall meet the following requirements:

    a. Minimum of twelve inches (12”) in diameter.

    b. Material shall be sixteen (16) Gauge Galvanized Corrugated Metal Pipe (CMP).

    c. A minimum of one foot (1’) of cover must be provided between top of culvert pipe and top of driveway pavement.

    d. The culvert shall extend a minimum of three feet (3’) beyond driveway width on each side and shall meet the minimum side slopes of 1 on 2 for local streets, and 1 on 3 for major roads.

2. Ditches shall meet the following requirements:

    a. The maximum ditch depth shall be two and a half feet (2.5’) from bottom of centerline of ditch to top of road pavement.

    b. The desired maximum roadside ditch slope shall be 1 on 4.

    c. The desired maximum property side ditch slope shall be 1 on 3.

3. The minimum depth required for ditch enclosures is two and a half feet (2.5’) from the top of road pavement to bottom of ditch centerline.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 9

Sidewalks

A. Plans and Specifications – Submittal Procedure

1. Plans and Specifications for Sidewalks may be submitted either as part of a site development package, or as a separate entity for a specific location in accordance with *Chapter 1, General Requirements and Submittals*.

B. Plans and Specifications – Design Criteria

1. Sidewalks shall, in general, be located completely within the right-of-way, and be located one foot (1') from the edge of the City's Master Plan right-of-way.

2. Sidewalks shall generally conform to the grade of the existing topography. Transverse slopes shall not exceed two percent (2%), and longitudinal slopes shall not exceed eight percent (8%) for mainline sidewalks, with five to seven percent (5% - 7%) being the recommended range. Sidewalk ramps shall not exceed five percent (5%) longitudinal slope or two percent (2%) cross-slope.

3. Mastic expansion joints shall be provided wherever the sidewalk abuts existing pavement.

4. Sidewalks shall have smooth transitions and gentle curves. Sharp edges or abrupt changes in alignment are not allowed.

5. Plans for sidewalks shall include existing contours at a minimum of two-foot (2') intervals. Proposed grades along the centerline of the sidewalk shall be at twenty-five foot (25') intervals.

6. In general, sidewalks shall be at a higher elevation than the street, and slope transversely toward the street at a minimum half percent (0.5%) and a maximum slope of two percent (2%).

7. Where sidewalks meet driveways, they shall run continuously through the driveways. The slope of the driveways shall be designed to meet the sidewalk.

8. At street intersections sidewalk ramps shall be used to meet the existing street grade. If existing curb is involved, the curb shall be removed and the sidewalk ramped to meet the pavement. Curb cuts shall not be used. All sidewalk ramps shall conform to the latest MDOT sidewalk ramp and detectable warning detail R28 Series, and the latest American with Disabilities Act (ADA) requirements.

9. All existing trees, public utilities, utility poles, signs, guy wires, hydrants, driveways and any aboveground structures in the right-of-way shall be accurately shown.

10. All underground utilities in the right-of-way shall be shown.

11. The distance from the edge of the sidewalk to the back of curb or edge of the road shall clearly be called out on the plans. Sidewalks shall not be placed any closer than ten feet (10'), unless otherwise approved by the City Engineer.

12. A minimum three-foot (3') lateral clearance should be maintained on either side of the sidewalk to fixed objects such as utility poles, trees, hydrants, etc.

13. A minimum eight-foot (8') vertical clearance should be maintained above the surface of the sidewalk to fixed objects such as utility poles, trees, signs, etc.

14. Public sidewalk construction within Rochester Hills typically consists of 5-foot square panels by and intended for public use. Maintenance of sidewalks located in right-of-way or easement per City ordinance is the responsibility of the adjacent property owner.

C. Materials

1. Sidewalks shall be four inches (4") thick, air-entrained concrete, at 3,500 psi compressive strength. Sidewalk thickness shall be increased to six inches (6") through driveways and at ramps.

2. Sidewalk base shall be six inches (6") of MDOT Granular Material Class II Sand, compacted to ninety-five percent (95%) maximum density.

3. Two-foot (2') wide shoulders shall be sloped away from the sidewalk at a maximum of two percent (2%).

4. ADA detectable warning plates shall be color contrasted and consist of pre-formed plastic/fiberglass materials. Pre-formed plastic detectable warning plates shall be brick red in color. Stamped concrete is not acceptable.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 10

Pathways

A. Plans and Specifications – Submittal Procedure

1. Pathway Plans and Specifications must be submitted to and approved by the Department of Public Services prior to receiving approval for construction in accordance with Chapter 1, *General Agreements, and Submittals*.

2. If the pathway is proposed as part of a general development or site improvement, then the details of the pathway and its location can be incorporated into the overall site plan.

3. If the proposed pathway is within the right-of-way of another agency or entity having jurisdiction over such right-of-way, then the applicant will be responsible for acquiring any necessary permits after first having the plans approved by the City, for permit processing.

B. Plans and Specifications – Design Criteria

1. Plans shall show the entire proposed pathway in plan view, and shall be presented at a scale to clearly identify grades and spot elevations at twenty-five foot (25') intervals along the pathway.

2. Pathways shall, in general, be located completely within the right-of-way, and be located one foot (1') from the edge of the City's Master Plan right-of-way.

3. Pathways shall be eight feet (8') wide. In some instances where constraints exist (e.g. within historic districts, steep adjacent grading, limited room due to utility poles and/or trees), the pathway width may be reduced down to a minimum width of six feet (6') if approved by the City Engineer. Pathway widths for new construction or proposed for overlay that are adjacent to existing gravel driveways shall be constructed at a 10-foot width (10') thru the driveway limit. A 10-foot (10') mill shall be performed at each existing asphalt driveway for a pathway overlay project in accordance with the typical details attached to the end of this section.

4. The distance from the edge of the pathway to the back of curb or edge of the road shall clearly be called out on the plans. Pathways shall not be placed any closer than ten feet (10'), unless otherwise approved by the City Engineer.

5. In general, longitudinal slopes of proposed paths shall not exceed eight percent (8%), and shall follow the natural contour of the land. Transverse slopes shall be a minimum of one percent (1%) and not exceed two percent (2%).

Pathway ramps shall not exceed five percent (5%) longitudinal slope, with two percent (2%) maximum transverse slope. A minimum eight-foot (8') by five-foot (5') level landing area shall be constructed adjacent to the pathway ramp. The slope shall not exceed two percent (2%) in any direction within the level landing area.

At street intersections, concrete pathway ramps shall be used to meet the existing street grade. If existing curb is involved, the curb shall be removed and the pathway ramped to meet the pavement. Curb cuts shall not be used. All pathway ramps shall conform to the latest MDOT sidewalk ramp and detectable warning detail R28 series, and the latest American with Disabilities Act (ADA) requirements.

6. Pathways shall freely drain and not pond water. Appropriately sized culverts shall be used where crossing streams or ditches. Calculations for sizing such culverts shall be submitted along with the plans for approval. In general, pathways shall drain toward the roadway.

7. Crossings of wetland areas or other special~~,~~ natural features, as determined by the City, may require special structures such as wooden pedestrian bridges. Such designs will need to comply with City typical designs in regard to railings, construction, and cross section. The traveled width shall be a minimum of ten foot (10') wide, and designed to accommodate a four (4) ton vehicle loading. The proposed structure will be reviewed by the City Engineer on a case-by-case basis.

8. Detailed construction drawings of such structures shall be submitted to the City Department of Public Services for review and approval prior to construction.

9. Existing and proposed land contours shall be clearly shown and labeled on the plans at two-foot (2') intervals.

10. Any other grades, slopes, or details, where requested by the City Engineer, shall be clearly shown on the plans.

11. All existing trees, public utilities, utility poles, signs, guy wires, hydrants, driveways and any aboveground structures in the right-of-way shall be accurately shown.

C. Crossings

1. At all street intersections, pathways shall be ramped to meet the street at grade. Horizontal curb cuts shall not be allowed unless approved by the City Engineer. Curbs shall be cleanly sawcut, removed, and replaced with a dropped curb section to meet the existing grade, and comply with MDOT Ramp Detail R-28 Series.

2. At all driveway crossings, pathways shall go through the drive. Existing drives shall be cleanly sawcut and the pathway shall continue through the drive uninterrupted. In general, the transverse slope of the pathway shall not exceed two percent (2%).

D. General

1. All construction of pathways shall conform to the City of Rochester Hills' Construction Standards and approved details.

2. A three-foot (3') shoulder shall be graded to smoothly drain away from the pathway. Shoulders shall be seeded or sodded.

3. Minimum ten-foot (10') vertical clearance from the base of the pathway to any object shall be maintained, unless otherwise approved by the City.

4. Minimum three-foot (3') horizontal clearance from the edge of the pathway to any object shall be maintained, unless otherwise approved by the City.

5. Where the adjacent cross slope exceeds the acceptable 1:3 slope, a safety fence or railing shall be constructed when required by the City Engineer. The fence or railing shall be designed and constructed as approved by the City Engineer.

6. Alignment of pathway shall be designed to avoid existing and proposed utility structures being located in the pathway. If this cannot be avoided, alignment should be established to minimize the encroachment or locate the structure(s) along the center of the pathway.

7. Significant grade changes may require the use of retaining walls to construct the pathway. Keystone walls or equivalent (full block) may be used. Block color shall be as approved by the City. Timber retaining walls are not acceptable.

8. All rights-of-way areas shall be fully restored to original or better condition, and be properly graded after pathway construction.

9. All tree roots shall be cut and removed within the influence of the pathway.

10. During pathway construction, signs shall be placed in accordance with the latest edition of the Michigan Manual of Uniform Traffic Control Devices, providing notification that the pathway is closed. Pedestrians shall not be detoured into the roadway.

E. Materials and Forms

1. Pathways shall be four inches (4") thick, hot mixed asphalt (HMA) comprised of one and a half inches (1.5") of HMA 5E03 (PG 58-22) over two and a half inches (2.5") of HMA 4E03 (PG 58-22). Pathways shall consist of an additional two inches (2") of HMA 4E03 through existing and proposed drives and pathway ramps abutting proposed commercial drives. Pathway ramps located at public and private streets and signalized drives shall be constructed in concrete with ADA detectable warning plates. Concrete pathway ramps shall be six inches (6") thick, air-entrained concrete, at 3,500 psi compressive strength.

2. The aggregate base shall be four inches (4") MDOT 21AA materials (crushed limestone or crushed concrete). Alternate recycled asphalt product (RAP) base course materials may be considered upon approval of the City Engineer. Alternate RAP materials must meet equivalent structural strength of 21AA aggregate (crushed limestone or concrete), compacted to ninety-seven percent (97%) maximum density, placed on base treated with a soil sterilant. The base shall have all existing topsoil removed as well as be firm and compact. The base shall at a minimum be extended to one-half foot (0.5') wider then the proposed pathway on each side.

3. Pathways shall have smooth, curved transitions, minimum ninety-foot (90') centerline radius. Sharp angles or abrupt changes in direction are prohibited unless the only feasible option.

4. The width of the pathway shall be constant and uniform throughout its entire length, including curves and transitions.

5. In general, pathways shall be placed to parallel the right-of-way line. Curving the pathway to avoid trees and landscaping is encouraged, but in general the pathway should follow a straight line if at all possible.

6. ADA detectable warning plates shall be color contrasted and consist of pre-formed materials, either steel or plastic/fiberglass. Pre-formed plastic detectable warning plates shall be brick red in color. Stamped concrete is not acceptable.

CITY OF ROCHESTER HILLS

ENGINEERING DESIGN STANDARDS

CHAPTER 11

Soil Erosion and Sedimentation Control (SESC) Plan

A. Submittal Procedure

1. Soil Erosion and Sedimentation Control Plans must be incorporated into any plans submitted along with a Land Improvement Permit Application. A soil erosion control permit, administered through the Oakland County Water Resources Commissioner's Office, is required.

B. Plan Requirements

1. The Soil Erosion and Sedimentation Control (SESC) plans shall contain the following data on twenty-four inch by thirty-six inch (24" x 36") sheets, using the USGS Vertical Datum.

    a. Public and private roads in the area and all adjacent properties, the extent of site grading, all to at least one hundred (100') outside site boundaries.

    b. All lakes or streams within five hundred feet (500') of site boundaries shall be shown.

    c. Topographic plan, scale one inch equals fifty feet (1"=50'), to one-hundred feet (100') beyond site boundaries showing:

        i. Existing ground elevations, with either two-foot (2') contour intervals or spot elevations on a fifty-foot (50') grid.

            ii. Existing structures and significant features including trees six inches (6") in diameter or larger, existing ground cover, extent, and condition.

        iii. Existing drainage and soil information.

    d. Site Grading and Development Plans as required under other Chapters of City of Rochester Hills Design Standards for all proposed utilities on the site.

    e. The SESC plan shall include the following:

        i. Description and location of the limits for all proposed earth changes.

        ii. Description and location of all soil erosion measures (e.g. silt fence, inlet filters, straw bales, etc).

        iii. Show all trees to be preserved and describe and show the location of all associated tree protection fencing.

iv. The timing and sequence of all proposed earth changes.

v. Information as to how excavated material will be handled and stored to prevent erosion.

vi. Information on trench backfill restoration including schedule of placement.

vii. Information concerning the existing drainage system, including a provision for maintenance.

C. Principles of Erosion and Sediment Control

1. Plan the development to fit the topography, soils, waterways, and natural vegetation at a site with the least necessary earth disturbance or change.

2. Expose the smallest practical area of land for the shortest practical time through staging the work and early application of temporary or permanent erosion control measures.

3. Apply soil erosion control measures as a first line of defense against on-site damage, to prevent sediment from being produced. These measures included special grading methods, run-off control structures, temporary and permanent vegetation.

4. Apply sedimentation control measures as a perimeter protection to prevent off-site damage. These measures include, but are not limited to, diversion ditches, sediment traps, vegetative filters, and sediment basins.

5. Dust control measures shall be maintained at all times.

6. Apply follow-up and periodic maintenance for continued effectiveness of control measures.

D. Design Standards

1. Riprap is required at all locations where storm water velocities may be erosive to soils. Riprap shall be placed at all storm water inlets and outlets and basin outlets. Riprap shall be a nominal four inches (4”) to six inches (6”) minimum diameter and be clean of any foreign material.

2. Newly constructed storm water facilities shall be constructed to control flow velocities to limit erosion.

3. The plans shall, based on the nature of the proposed development, contain a time schedule for the installation of permanent soil erosion control measures.

4. As a basis of design, the standards set in the Oakland County *Soil Erosion Control Manual* shall be used.

E. Notes

The following notes shall appear on the plans:

1. All erosion and sediment control work shall conform to standards and specifications of the Oakland County Water Resources Commissioner.

2. All temporary and permanent (post construction) SESC measures shall conform to the City of Rochester Hills current MS4 permit. Any conflict between these standards and the MS4 permit, the permit's conditions shall take precedence.

3. Daily inspections shall be made by the Contractor for effectiveness of erosion and sedimentation control measures, and any necessary repairs shall be performed without delay.

4. Any sedimentation from work on this site shall be contained on the site and not allowed to collect on any off-site areas or in waterways.

5. Contractor shall apply temporary erosion and sedimentation control measures when required and as directed on these plans. Temporary measures shall be removed as soon as permanent stabilization of slopes, ditches, and other earth changes have been accomplished per Oakland County Water Resources Commissioner's standards. This would include temporary sedimentation ponds and temporary SO2 filters.

6. Staging the work will be done by the Contractor as directed in these plans and as required to ensure progressive stabilization of disturbed earth.

7. Soil erosion control practices shall be established in the early stages of construction by the Contractor. Sediment control practices will be applied as a perimeter defense against any transporting of silt off the site.

8. Failure to comply with approved soil erosion and sedimentation measures may result in work stoppage by appropriate authority.

9. Exceptions to timing of control measures' installation will only be permitted where trees and stumps need to be removed to install SESC measures.

10. Contractor is to provide the City with permit renewals, violation corrections, and/or releases.