Engineering Design Standards

Adopted May 14, 2013

(Intentionally Blank)

Table of Contents

These Engineering Design Standards are intended to provide a reasonable basis for design of public and private improvements in the City of Wixom. They are not intended as a substitute for sound engineering judgment. The Standards may not apply to all conditions, and alternate solutions shall be permitted as approved by the pertinent City departments.

SECTION 1 GENERAL

1.1 Complete improvement plans bearing the seal of a licensed Professional Engineer, Surveyor or Architect licensed to practice in the State of Michigan shall be submitted prior to review and approval of any portion thereof.

1.2 Plans submitted shall be on 24" x 36" white prints having black lines, and shall be neatly and accurately prepared. Judgment should be exercised in the design, layout, and the presentation of proposed improvements.

1.3 For projects or subdivisions having more than one sheet of plans, a general plan having a scale of 1" = 100' shall be provided showing the overall project and indicating the size and general location of all improvements shown in the detailed plans.

1.4 Street names, street and easement widths, lot lines, lot dimensions, lot numbers and ownership shall be shown on all plans.

1.5 Elevations shall be on U.S.G.S. Datum. Two (2) permanent bench marks for the work shall be indicated on the plans.

1.6 Any areas that are considered to be "wetlands" as defined by the Michigan Department of Environmental Quality (MDEQ) shall be indicated on the plans. No improvements will be allowed in wetlands unless the MDEQ or City issues a permit, or a letter of "No Authority", for such improvements.

1.7 Finished grade shall be indicated for all structures.

1.8 The developer or their engineer shall be responsible for forwarding plans for approval to any private utility company (gas, electric, phone, cable, etc.) and any Federal, State or County (Water Resource Commission, Road Commission, etc.) agency whose facilities, easements or rights-of-way may be affected by the proposed construction.

1.9 It shall be the developer's engineer and contractor's responsibility to verify the existence and location of all existing underground utilities.

1.10 All engineering construction plans shall contain the latest version of the applicable City of Wixom Standard Detail Sheets.

1.11 The plans shall include the developers name(s), address, phone number, fax number and email address.

1.12 An Engineer's Opinion of Construction Cost must be supplied with the Construction Plan submittal. This estimate will be used by the City to establish review and inspection fees for the improvements in accordance with the City Ordinance(s).

1.13 All utility trenches under the 45 degree zone of influence line of existing or proposed pavements, bike paths, sidewalks or drive approaches shall be backfilled with Michigan Department of Transportation (MDOT) Class II sand, compacted to at least 95% of maximum unit weight.

1.14 Utility crossings of paved roadways will be required to be bored. Open cutting of paved roadways will not be permitted.

1.15 An itemized quantity list will be required for all proposed utility improvements (water main, sanitary sewer, storm sewer and paving).

1.16 All required street name and traffic control devices shall be installed by the developer. Signs shall meet the requirements of the Michigan Manual on Uniform Traffic Control Devices (MMUTCD) and reflectivity standards of the DPW.

1.17 The developer shall submit to the City five (5) sets of complete construction plans for review. All plan submittals must go directly to the City. Plans cannot be delivered directly to the City's Engineer. After the plans receive approval, they will be distributed as follows; one (1) set to the City, one (1) set to the developer/owner, one (1) set to the design engineer and two (2) sets to the City Engineer.

1.18 Alternatives to the Engineering Design Standards may be submitted to the City for consideration. They will be reviewed by the City's Engineer and recommendation will be made to the City. Such alternatives shall only be acceptable in those instances where the City finds that the proposed design(s) will provide an acceptable level of serviceability, ease of maintenance and are consistent with sound engineering practices.

1.19 A general overview of the plan review process is described below:

1.19.1 Site Plan Review

The City's consultants will review of the site plan including: water supply, wastewater disposal, storm water management, site grading, pavement improvements and right-of-way improvements. Review comments will be issued to the City Planning Commission for discussion at Planning Commission meetings. Once the site plan has been accepted by the Planning Commission, the Applicant will be required to submit engineering drawings and an itemized cost estimate of the proposed improvements so

that an escrow account may be established for plan reviews and construction observation. The amount of the escrow account will be determined by the City.

1.18.2 Construction Plan Review

The City's Engineer will review the construction plans for conformance to City Engineering Design Standards. The will strive to complete a typical review in five business days. More complex reviews may take as long as 10 business day or more. Once the plans are in an acceptable form, the plans will be issued as approved construction plans. The Applicant will be responsible to apply for all required County and State permits including: soil erosion, water supply, wastewater disposal, right-of-way, wetlands, etc. Public water main and sanitary sewer improvements will require the submittal of plans and permit applications to the City for review and approval, prior to them being forwarded to the governing agency by the City's Engineer.

1.18.3 Pre-Construction Meeting

Once the approved engineering plans have been issued, a pre-construction meeting with the Applicant (or their representative) and their related contractors, is required prior to the start of any site work. This meeting will verify that all relevant permits have been applied for, that the proper insurance/bonds are provided and to schedule construction observation.

1.18.4 Site Construction and Observation

Observation by the City and/or its consultant(s) will be as described below. The City will assign observation responsibilities at the preconstruction meeting.

- Roadways (public and private) - Spot observation on the subgrade and aggregate base. Full time observation curb & gutter and pavement placement.
- Parking Lots (public and private) - Spot observation on the subgrade, aggregate base, curb& gutter and pavement placement.
- Safety Paths - Spot observation on the subgrade and sand base. Full time observation on concrete placement
- Sidewalks - Spot observation.

- Storm Sewer - Full time observation on public facilities, spot observation on private facilities.
- Detention/Retention Facilities - Spot observation on grading.
- Water Main (public and private) - Full time observation on all facilities with spot observation on 2" diameter and smaller service leads and full time observation on service leads larger than 2" diameter.
- Sanitary Sewer - Full time observation with spot observation on private facilities.
- Retaining Walls - Spot observation on all structures over 30" in height.

Additional construction observations may be required, on a case by case basis, at the discretion of the City.

The developer will be required to provide backfill density testing for all public utility construction and work within the public road right-of-way.

1.18.5 Bond Inspection and Final Inspections

Once the proposed improvements have been completed, the Applicant may request that the City have their Engineer perform a site inspection to establish bond amounts to complete the remaining site improvements for final acceptance by the City.

1.18.6 Record Drawing Plan Review

Record drawings, describing the location and elevations of the proposed site improvements are required to be submitted for review and approval. See Section 8 of the City's Engineering Design Standards for the requirement of the Record Drawings submittal. The applicant will also be required to submit all public utility easements, detention basin maintenance agreement, off-site easements, etc. for review. Once approved, original copies of the applicable documents shall be submitted to the City for recording at the Oakland County Register of Deeds.

SECTION 2 WATER MAIN

2.1 General

2.1.1 If the proposed improvements include the construction of public water main, the developer shall submit sufficient sets of water main only plans, with a completed MDEQ permit application. This information will be forwarded by the City's Engineer to the MDEQ for permitting.

2.1.2 All water system improvements shall be design in accordance with the current edition of "Recommended Standards for Water Works" (a/k/a Ten State Standards).

2.1.3 Water mains in new developments 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.

2.1.4 Water mains must be placed within a minimum 12 foot wide easement. The required easement width may be increased depending on the proposed pipe depth, soil conditions or adjacent facilities/utilities.

2.2 Design Requirements

2.2.1 Eight (8) inch minimum diameter mains will be installed in single family residential areas.

2.2.2 Twelve (12) inch 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 (8) inch mains may be permitted.

2.2.3 Water mains are to be looped whenever possible.

2.2.4 Hydrant leads longer than 75 feet must be eight (8) inch diameter.

2.2.5 No service leads are allowed to extend from a six (6) inch hydrant lead.

2.2.6 Profile view is required for 16 inch and larger water mains, and for other smaller sizes when determined necessary by the City

2.2.7 Water mains shall be kept on one side of the street for the entire length of the street. Water mains shall not be located under pavement or under cul-de-sacs.

2.2.8 Gate valves shall be spaced at a maximum of 800 foot intervals on distribution lines. They shall be spaced such that not more than four (4) valves need to be turned off to isolate any section of the water main.

2.2.9 Sufficient valves shall be placed such that not more than 30 single family homes, 30 multiple family units or two (2) hydrants shall be out of service within a section of isolated water main.

2.2.10 Dead-end mains must end with a hydrant and a gate valve and well.

2.2.11 Gate valves should not be located under roadway pavement, bike paths, sidewalks or driveway approaches when possible.

2.2.12 Eight (8) inch and larger valves are required to be installed in a gate well, except for fire suppression line which can be place in a box.

2.2.13 In single family residential areas, hydrants shall be spaced along the water main a maximum of 600 feet. In no case shall a house be more than 350 feet from a hydrant. Commercial, industrial and multiple family spacing shall be a maximum of 400 feet.

2.2.14 Along major roadways and in areas other than single family residential, hydrant spacing shall be a maximum of 350 feet.

2.2.15 In commercial and industrial areas, the exterior of buildings shall be no further than 250 feet from a hydrant, measured along shortest feasible exterior route for laying hose. Hydrants shall be no closer than 2 times the height of the tallest part of the structure. There shall be a fire hydrant located within 150 feet of any building fire department connection.

2.2.16 Where possible, hydrants shall be located at the lot corners, but no closer than eight (8) feet from any driveway or driveway approach.

2.2.17 Hydrants located in parking areas shall be protected with a six (6) inch concrete curb or standard guard posts.

2.2.18 When connecting to an existing water main, a tapping sleeve, gate valve and well will be required unless connection to the existing main can be made without interrupting service on the main.

2.2.19 The plans shall indicate the finish grades of all hydrants and gate well rims.

2.2.20 Water mains shall be located so as to provide a minimum of 10 feet horizontal

clearance between the nearest edge of the water main and the nearest edge of any sanitary or storm sewer.

2.2.21 A minimum vertical clearance of 18 inches shall be maintained between the top or bottom of any water main and the top or bottom of any sewer or utility. Vertical clearance of less than 18 inches will require concrete encasement of the sewer and/or utility.

2.2.22 Restrained joints shall be used at all bends, tees, hydrant shoes, plugs and caps where necessary to prevent lateral movement of the water main. Thrust blocks will not be allowed.

2.3 Materials

2.3.1 All water main 20 inch in diameter and smaller shall be Ductile Iron pipe, Class 54. Two (2) brass wedges shall be used per joint.

2.3.2 All water main valves shall be left hand open, resilient seated (American Flow Control series 2500 or approved equal) and conform to AWWA C509 Standards.

2.3.3 Hydrants shall be either Waterous Pacer or Muller Centurion, and shall have a Storz nozzle.

2.3.4 Restrained joints shall be Mega-Lug or Field-Lok gaskets.

2.3.5 Water service leads shall be a minimum one (1) inch diameter. Water service leads 1" up to 2" diameter shall be K copper or SDR 9 HDPE meeting AWWA C-901, ASTM D2737. All HDPE pipe shall be installed with a minimum 12 gauge copper tracer wire (colored black or white) the entire length with the ends being accessible for lead location. Water service leads larger than 2" diameter shall be HDPE or ductile iron.

2.4 Installation

2.4.1 All water main shall be installed with a minimum cover of six (6) feet below finish grade. When water mains must dip to pass under another utility, the sections which are deeper than normal shall be kept to a minimum length by the use of vertical bends, properly restrained.

2.4.2 The contractor will fill, disinfect and pressure test all new water main construction under the supervision of the City's Engineer.

2.4.3 Before any water main will be accepted, it must pass a pressure test complying with the current specifications and procedures of the City.

2.4.4 Fire hydrants must be brush coated with Glamortex 501 enamel, Color 314 Vermillion fire hydrant red paint or approved equal prior to final acceptance by the City. The Storz nozzle shall not be painted.

2.4.5 Gate well covers shall be East Jordan Iron Works No. 1040 or approved equal with the text "City of Wixom Water" embossed on the surface.

SECTION 3 SANITARY SEWER

3.1 General

3.1.1 If the proposed improvements include the construction of public sanitary sewer, the developer shall submit sufficient sets of sanitary sewer only plans, with a completed Part 41 MDEQ permit application. This information will be forwarded by the City's Engineer to the MDEQ for permitting.

3.1.2 All sanitary sewer improvements shall be design in accordance with the current edition of "Recommended Standards for Wastewater Facilities" (a/k/a Ten State Standards).

3.1.3 A grease interceptor will be required for all food service operations. No connections for domestic waste will be allowed to the interceptor.

3.1.4 Downspouts, weep tile, footing drains, sump pump discharges, or any conduit, that carries storm or ground water shall not be allowed to discharge into a sanitary sewer.

3.1.5 Sanitary sewers must be placed in standard minimum 20 foot easements. The easement width may be increased depending on the proposed sewer depth, soil conditions or adjacent facilities.

3.1.6 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 the utility information provided by the City.

3.2 Design Requirements

3.2.1 At all connections to the City 's Sanitary System or extension thereto, in the first manhole upstream from the connection, provide a water-tight bulkhead with a 1" diameter pipe through the bulkhead for measuring infiltration immediately upstream. Also a one foot sump at the base of the manhole shall be provided.

3.2.2 The minimum allowable size of a public sanitary sewer is eight (8) inch diameter.

3.2.3 The following table of minimum slopes for sanitary sewers shall be adhered to:

SIZE (INCH)	STANDARD GRADE (%)	MIMIMUM GRADE (%)	MAXIMUM GRADE (%)
8	0.80	0.40	8.0
10	0.60	0.30	6.2
12	0.40	0.22	6.0
15	0.24	0.16	3.6
18	0.18	0.12	2.8
21	0.14	0.1	2.2

3.2.4 The last upstream run of sewer must be at a grade of 1.00% or greater.

3.2.5 The minimum slope for building leads is 1.00%.

3.2.6 A monitoring manhole is required on the sanitary lead for all non-residential connections to the sanitary sewer system. The monitoring manhole can only have one (1) lead running through it. It must be located on a straight run of lead and can not be a manhole on the public sewer main.

3.2.7 Each building structure shall have a separate individual sanitary service lead connected to a public sanitary sewer.

3.2.8 Sanitary sewer manholes shall not exceed the spacing listed below:

DIAMETER OF SEWER (INCHES)	MAXIMUM MANHOLE SPACING (FEET)
8 & 10	400
12	450
15	500
18 and larger	600

3.2.9 Generally, sanitary sewers will not be approved in a rear lot easement.

3.2.10 The following information shall be indicated on the sanitary sewer profile:

a. Length of run between manholes
b. Type, class, size and slope of pipe and leads
c. Class of bedding
d. Rim elevation of all manholes
e. Existing and proposed ground elevation line above the route of the sewer
f. A logical numbering system for manholes shall be included
g. Invert elevations of all sewer at manholes
h. Location and limits of sand backfill (where required)
i. Location and elevations of crossings with other utilities

3.2.11 Provide a minimum depth from top of curb (or road centerline if uncurbed) to the top of any sanitary sewer of nine (9) feet 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.

3.2.12 Sanitary sewer shall be placed on the opposite side of the street from the water main, and shall have a horizontal separation of at least 10 feet from any water main or service.

3.2.13 External drop connections are required at manholes where the invert of the outlet pipe is 18 inches or more below the invert of the inlet pipe. Internal drop connections will not be allowed.

3.2.14 Where the applicant must extend the sanitary sewer from off-site, the applicant shall extend sanitary sewer leads to 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.

3.2.15 In new subdivisions, all service leads shall be sand backfilled and extended a minimum of 10 feet past the property line or to the easement line.

3.2.16 The plan and profile view of the proposed sanitary sewer shall generally be shown on the same sheet.

3.2.17 Maximum flow velocity for pipe flowing full shall be maintained by matching the 8/10ths point of the diameter depth above invert for pipe size increases.

3.2.18 Provide a drop of 0.10 feet in the downstream sewer invert for a direction change of 30 degrees or greater to compensate for velocity head loss of the incoming flow.

3.3 Materials

3.3.1 Service leads installed with the lateral sewer mainline shall be a minimum of six (6) inch diameter and shall be Schedule 40 PVC or SDR 23.5.

3.3.2 New sanitary sewer manholes must be water-tight and shall be pre-cast sections with modified grooved tongue joints with rubber gaskets, conforming to ASTM C-478. Also, a geomembrain with elastomer seal around the casting and cone shall be provided for all new manholes as noted on the City's standard detail sheet.

3.3.3 Main line sewer shall be: PVC Truss pipe, PVC solid wall SDR 26, or RCP C-76 Class IV or V, or approved equal.

3.4 Installation

3.4.1 No sanitary sewer installation, or portion thereof, shall have infiltration exceeding the MDEQ requirements as contained in their permit.

3.4.2 The end of each a service lead shall be marked by setting a two (2) inch square, eight (8) foot long, wooden stake vertically above the end of the lead.

3.4.3 Each end of service lead shall have an airtight stopper of compatible joint material and shall be adequately braced to withstand exfiltration and/or air test pressure.

3.4.4 When existing manholes are to be tapped, a hole of the appropriate diameter shall be core drilled through the wall of the manhole. A watertight fitting shall be used to connect the pipe into the manhole.

3.4.5 All sewers shall be subjected to infiltration, air or exfiltration tests, or a combination thereof, in accordance with the following requirements, prior to acceptance of the system by the City, and prior to removal of the bulkhead.

a. All sewers over 24 inch diameter shall be subjected to infiltration tests. All sewers of 24 inch diameter or smaller, where ground water level above the top of sewer is over seven (7) feet, shall be subjected to an infiltration test.
b. All sewers of 24 inch diameter or less, where the ground water level above the top of the sewer is seven (7) or less, shall be subjected to air tests or exfiltration tests.

3.4.6 A minimum of 30 days after installation, and prior to the acceptance of new

mainline sanitary sewer systems, a televised inspection of each section of the mainline shall be conducted from manhole to manhole. A DVD and log of this inspection shall be submitted to the City, for review by the City's Engineer, to document the current condition of the sanitary system at the time of the utility acceptance. The DVD and log shall be consistent with the Standards of the City of Wixom.

SECTION 4 STORM SEWER

4.1 Design Requirements

4.1.1 In no event will maximum design rate or volume of discharge exceed the maximum capacity of the downstream land, channel, pipe or watercourse to accommodate the flow. It is the applicant's obligation to meet this standard. Should a storm water system, as built, fail to comply, it is the applicant's responsibility to redesign, reconstruct, or make modifications at his/her expense to storm water management facilities. Such modifications or additional facilities will be subject to the City's review and approval.

4.1.2 Storm drainage systems shall be designed for a ten year intensity rainfall. The Rational Method for arriving at storm sewer runoff shall be used. An "N" value of 0.013 shall be used for concrete pipe.

4.1.3 The formula for a 10 year rainfall intensity shall be equivalent to I = 175/(T+25) in which T is the time of concentration in minutes, and I is the intensity of inches per hour.

4.1.4 The initial T is generally 20 minutes for residential areas and 15 minutes for high runoff areas.

4.1.5 The design engineer shall use the following minimum values for "C", the runoff coefficient, in the "Rational Formula" of computing storm water flows (Q = CIA).

SURFACE TYPE	C FACTOR
Single Family Residential	0.35
Multi Family	0.55
Commercial	0.70
Industrial	0.70
Agricultural	0.20

Other values of the runoff coefficient may be used or required at the discretion of the City's Engineer for such areas as parks, open-spaces or unusual sites.

4.1.6 Sufficient capacity shall be provided in the storm sewer system to take fully developed upstream drainage into the system. When a storm sewer is designed to provide capacity for upstream areas, the hydraulic gradient shall remain in the pipe.

4.1.7 Storm sewer design calculations, including a drainage area map shall be submitted with the construction plans. The storm district map shall show all on-site and off-site drainage districts. The district limits must be over laid on a proposed grading plan for the site.

4.1.8 All public storm sewers must be located in a public right-of-way or an easement. The minimum storm sewer easement shall be 12 feet. The easement size will vary as required for maintenance and access. Any storm sewer that accepts runoff from abutting property or public right-of-way must be placed in a minimum 12 foot wide storm sewer easement.

4.1.9 If a storm sewer is designed to take on-site drainage only, the hydraulic gradient must be no higher than one (1) foot below ground. When the hydraulic gradient is above the top of the sewer pipe, the design elevation of the hydraulic gradient shall be indicated on the profile at each manhole.

4.1.10 Storm water detention is necessary for all developments in the City. See Section 5, Detention/Retention Facilities, for details.

4.1.11 Manholes shall be located as follows:

a. All changes in alignment
b. Points where the size of the sewer changes
c. Points where the grade of the sewer changes
d. The junction of sewer lines
e. Street intersections or other points where catch basins or inlets are to be connected.

4.1.12 Manhole spacing for storm sewers shall be as follows:

DIAMETER OF SEWER (INCHES)	MAXIMUM MANHOLE SPACING (FEET)
12 - 18	400
21 - 30	450
36 - 42	500
48	550
54 - 60	600
66 & larger	650

4.1.13 The minimum diameter of a public storm sewer is 12 inches. Ten (10) inch diameter pipe will be allowed for sewer lines that pick up footing drain or roof conductor drainage. No open covers will be permitted for a 10 inch diameter storm sewer.

4.1.14 Connection must be made at manholes, blind taps are not allowed.

4.1.15 End sections are required for all storm sewers.

4.1.16 The following information shall be indicated on the storm sewer profile:

a. Length of run between structures
b. Type, class, size and slope of pipe and leads
c. Rim elevations of all structures
d. Existing & proposed ground elevations above the route of the sewer
e. A logical numbering system for structures shall be included
f. Invert elevations of all sewers at structures
g. Locations and limits of sand backfill (where required)
h. Locations and elevations of crossing with other utilities

4.1.17 The following table of minimum slopes for storm sewers shall be adhered to:

SIZE (INCHES)	MIMIMUN GRADE (PERCENT)
12	0.32
15	0.24
18	0.18
21	0.14
24	0.12
27	0.10
30	0.09
36	0.07
42	0.06
48	0.05

4.1.18 The minimum velocity may not be less than 2.5 feet per second in a pipe flowing full. The maximum velocity in storm sewers shall be ten (10) feet per second. The contents of a larger pipe will never be discharged into a smaller line even though the slope may be steeper for the smaller line. This principle does not apply, however, to a restricted opening or discharge.

4.1.19 Where possible provide a minimum of three (3) feet of cover from the top of curb (or road centerline) to the top of any storm sewer.

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

4.1.21 At all pavement catch basins and inlets, 40 lineal feet (20 feet in each direction) of six (6) inch perforated edge drain with sock shall be constructed at the back of curb line, backfilled with pea gravel.

4.1.22 No more than 1.0 acre of area shall be tributary to one standard catch basin. Catch basins may be placed side by side in order to provide for additional capacity.

4.1.23 Where lateral storm sewers are proposed, all new homes must be constructed with sump pumps which discharge to an underground pipe connected to an underground public rear yard drain, or an approved alternate storm drain. The sump pump discharge lead shall be a minimum of four (4) inch diameter and shall be constructed to each lot in a new subdivision from the rear yard under drain. The lead shall be constructed at a minimum 1.0% grade.

4.1.24 The minimum grade for swales shall be 1.00%.

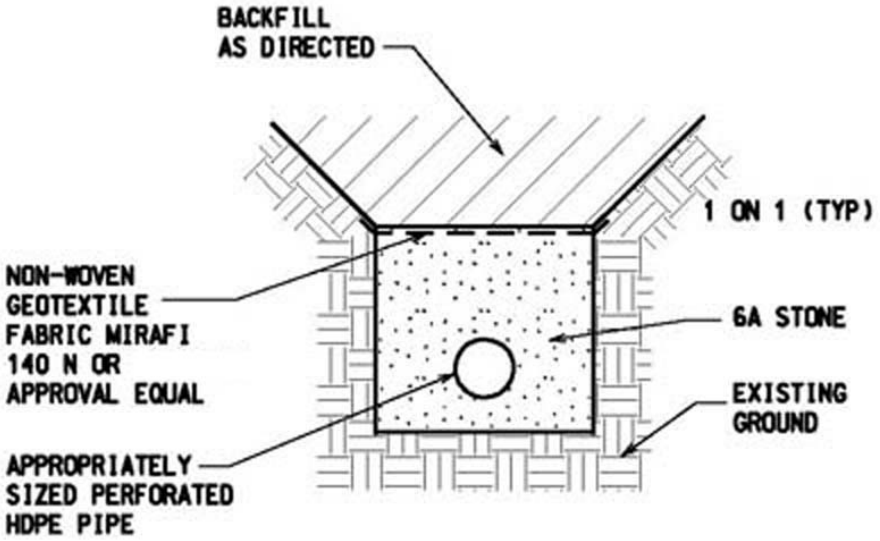
4.1.25 The City encourages the use of Best Management Practices (BMPs) in the design of the storm water collection system. These shall include, but are not limited to: rain gardens, bioswales, green roofs, oil/water separators, porous pavements, etc. Design calculation for the BMPs shall be submitted for review with the construction plans. The use of BMPs will be reviewed and approved on a site by site basis by the City's Engineer.

4.1.26 The City reserves the right to require additional storm water management procedures for a site based on its intended usage and impact on storm water runoff.

4.2 Materials

4.2.1 Allowable pipe material for storm sewers shall be:

a. C-76 reinforced concrete pipe conforming to Classes III, IV or V.
b. Perforated high density polyethylene with smooth interior and annular exterior corrugation meeting requirements of ASTM F2306. Bedding and backfill shall be as shown in the following detail:



4.2.2 Joints for storm sewer shall be tongue and groove premium joints with rubber gaskets.

4.2.3 All lead material shall be schedule 40 PVC or SDR 23.5.

4.2.4 A pre-fabricated bar screen shall be installed on all storm sewers 18 inch in diameter and larger.

SECTION 5 DETENTION / RETENTION FACILITIES

5.1 Design Requirements

5.1.1 A storm water detention is required for all developments in the City. The City encourages Best Management Practices (BMPs) of detention facilities.

5.1.2 Detention basins shall be designed to detain improved storm water over the developed areas on site. The applicant is not required to detain water from off site areas in the drainage district.

5.1.3 Detention basins shall be designed to store a volume of storm water equivalent to the following depth of water over the entire site.

Single family (detached)	1.65 inches
Multiple	1.85 inches
Commercial and Industrial	2.00 inches

Discharge must be limited to 0.2 cfs per acre when the detention basin is holding the required run-off.

Retention basins (basins with no outlet) must be sized to meet current Oakland County Water Resource Commissioners standards. Documentation must be submitted by a licensed Professional Engineer in the State of Michigan specializing in soils that the ground in the area or the basin will "perk."

5.1.4 All open detention basins must be fenced if the side slopes exceed 1 vertical to 6 horizontal. This may be waived by the City when the design is an integral part of the landscaping and the location and depth does not present a potential hazard. The maximum earthen side slope shall be 1 vertical to 3 horizontal. All residential subdivisions detention basins shall be unfenced with a 5 foot minimum flat shoulder around the perimeter of the basin.

5.1.5 Fences shall be a minimum of six (6) feet high vinyl clad chain link with a locking access gate, eight (8) feet wide. Alternate types of fencing may be permitted, for aesthetic purposes, subject to approval by the City.

5.1.6 An agreement for operation and maintenance of all detention systems must be completed by the owner and submitted to the City prior to final acceptance of the project by the City. Standard agreement forms are available at the City.

5.1.7 The entire detention basin must be seeded or sodded, except below the water

line for detention basins designed to have a permanent body of water. A native plant buffer of ten (10) feet or more is encouraged along the embankments. The City will not approve the basin until turf is established.

5.1.8 Concrete rip-rap is required at all pipe entrances and exits to the basin. The minimum width of the rip-rap shall be twice the outside diameter of the pipe. The rip-rap shall extend from bottom of basin to the top of the slope.

5.1.9 A minimum of 12 inches of freeboard must be maintained in all detention and retention facilities.

5.1.10 The overland overflow must be designed as to not flood adjacent properties, and the back-water elevation must be no higher than one (1) foot below the lowest ground elevation of the developed area.

5.1.11 Detention basins that drain into an open drain must have the outlet pipe invert above the normal water level of the drain.

5.1.12 A sediment forebay, or equivalent structure, designed to capture the runoff from a 1 year storm is required for all sites. The forebay should be a separate cell from the main detention basin and designed such that it will dewater within 48 hours. The volume of detention within the forebay, above any proposed permanent pool of water, can be considered when calculating total detention volume required for a site.

5.1.13 A manufactured storm water treatment system may be used in lieu of a sediment forebay.

SECTION 6 GRADING

6.1 General

6.1.1 A grading plan is required for all developments. Rear yard storm drainage systems are required for all residential projects.

6.1.2 The grading of the proposed development shall not create drainage problems, or make existing drainage problems worse, on adjacent property. If necessary, storm drains shall be extended to the adjacent property to alleviate drainage problems.

6.2 Design Requirements

6.2.1 First floor and basement (where applicable) elevations for each proposed structure or building shall be shown on the plans. It is the design engineer's responsibility to verify the existing ground water elevations when setting the basement elevations.

6.2.2 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 on a grid pattern a minimum of 100 feet from the property line. The drainage pattern of all adjacent existing land shall be indicated.

6.2.3 The grading plan shall be designed to insure that if a failure or overflow occurs within the storm system, water will drain away in overland swales without impacting houses or other structures.

6.2.4 Finish grade shall be compatible with the grades of surrounding existing houses, yards and with the existing ground at the proposed house.

6.2.5 All existing and proposed ground grades are to be in tenths of a foot.

6.2.6 Rear yard swales shall be no longer than 450 feet before being intercepted by a catch basin and shall have a minimum grade of 1.00%.

6.2.7 The proposed side yard swale elevation shall be shown between all houses. This elevation must be a minimum of 0.5 feet below the lower adjacent house grade. The side yard swale must have a minimum slope of 1.00% to the front and rear.

6.2.8 General direction of flow of the rear yard drainage and swales must be indicated with arrows.

6.2.9 The maximum allowable grade shall be 1 vertical to 4 horizontal.

6.2.10 The maximum driveway slope for non-single family sites is 8.0%. All driveway approaches shall not exceed 1.50% for a minimum distance of 25 feet from the edge of the roadway. The slope of the driveway shall be labeled on the plans.

6.2.11 All proposed retaining wall designs will require review by the City's Building Department and/or the City's Engineer on an individual basis.

SECTION 7 PAVING

7.1 General

7.1.1 Alternative pavement cross-section designs may be submitted to the City for consideration. They will be reviewed by the City's Engineer and recommendation will be made to the City. Such alternative paving designs 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 are consistent with other paving in similar areas elsewhere in the City.

7.1.2 For roads under the jurisdiction of MDOT or RCOC all improvements shall be designed to meet their requirements.

7.1.3 Acceleration, deceleration and passing lanes are required at all road entrances that front on paved major roads.

7.1.4 All ramp, sidewalk and safety path work within the public right-of-way shall conform to the current American with Disabilities Act (ADA). This shall include upgrades to existing ramps, sidewalks and safety paths within the influence of the proposed new development.

7.2 Design Requirements

7.2.1 The minimum outside paved radius of a residential cul-de-sac (back of curb) shall be 47 feet, and the right-of-way radii shall be 60 feet minimum. Islands are allowed in residential cul-de-sacs. The back of curb inside radius shall be 20 feet. The home owners association is responsible of maintenance of the island.

7.2.2 For industrial developments, the minimum paved radii shall be 75 feet, and the right-of-way radii shall be 90 feet. Islands within cul-de-sacs are not allowed in commercial/industrial applications.

7.2.3 A boulevard island may be allowed in an enlarged right-of-way. Roadway pavement widths shall be at least 24 feet for all boulevard streets (back of curb to back of curb). The minimum island width shall be 10 feet and maximum 16 feet. The nose of the boulevard island shall be set back at least 12 feet from the edge of pavement of the intersecting street.

7.2.4 Vertical curves are necessary when a change in grade of 1.5% or more occurs. The minimum length of vertical curve shall be 100 feet.

7.2.5 The minimum pavement vertical grade for roadways shall be 0.50% when concrete curb and gutter is utilized, and 1.0% with open ditch. The maximum allowable grade on any major roadway is 6.0%, or 8.0% for local roads.

7.2.6 The maximum cross slope on a cul-de-sac is 3.0%.

7.2.7 All proposed roadways shall be profiled. The pavement profile view shall include:

a. Elevations at each station for the top of curb or at centerline if not curbed.
b. Existing ground elevations at the center of the right-of-way and 30 feet either side of the centerline.
c. Station and elevations of all high points, low points, grade-breaks and necessary information at vertical curves. Grades for vertical curves must be indicated at 25 foot intervals.
d. The station and top of curb grade of all pavement catch basins & inlets.

7.2.8 The pavement radius at all intersections of all roads shall be a minimum 25 feet. Industrial developments will require a minimum radius of 35 feet.

7.2.9 The proposed roadway cross-section (public or private) shall be the following:

ZONING	ROADWAY WIDTH (BC / BC)	AGGREGATE BASE	SURFACES
Single Family	36' – collector 27' – local	8"-21AA	3-1/2" HMA*
Multi-Family	36' – collector 27' – local	8"-21AA	3-1/2" HMA*
Office/Commercial/ Industrial	36'	8"-21AA	8" non-reinforced concrete
Major Roads	varies	8"-21AA on 12" Class II	7" HMA* or 8" non-reinforced concrete

** - Geogrid required on all HMA pavement sections*

7.2.10 All pavements in residential areas shall have four (4) inch mountable concrete curb and gutter. All island curbs shall have six (6) inch concrete roll curb and gutter. A five (5) foot transition area is required where the curb changes from six (6) inch roll to four (4) inch mountable.

7.2.11 Major roads shall have six (6) inch minimum concrete roll curb and gutter.

7.3 Materials

7.3.1 The subgrade aggregate material for paved public (and private) roads shall be 21AA limestone. Aggregate shall be placed on Tensar TX130S geogrid or City approved equal.

7.3.2 Allowable HMA mix for roadway surfaces shall be: MDOT 13A, 4C, 3C and 2C, or approved equal.

7.3.3 Allowable parking lot HMA surfaces shall be: MDOT 1300, or approved equal.

7.3.4 Alternate mix designs and/or application methods may be submitted to the City of consideration.

7.4 Installation

7.4.1 The installation of roadways within the City shall require inspection by the City's Engineer at the following stages:

a. After the sub grade has been rough cut to the plan elevation
b. After the placement of the aggregate base
c. Full-time during the placement of the HMA pavement

7.4.2 The developer or his engineer/contractor shall be responsible to provide an independent testing firm to certify that the sub-base, aggregate base and HMA products meet compaction/density requirements.

SECTION 8 RECORD DRAWINGS

8.1 General

8.1.1 Two (2) sets of record drawings (a/k/a as-builts) shall be submitted to the City by the design engineers for review. The record drawings shall contain the following information:

a. Plans shall be provided in both mylar and electronic format. The minimum scale shall be one (1) inch equals 50 feet. All as-built plans shall bear the seal of a registered professional engineer or professional surveyor licensed to practice within the State of Michigan.
b. All as-built lengths and elevations must be labeled as "As-Built." Locations shall be shown on the plans with an accuracy of ± one (1) foot.

8.2 Requirements

8.2.1 The following individual system requirements must also be submitted:

a. Water System
   1) Locate gate valves, wells, hydrants and all water system appurtenances from the nearest property corner (using an X-Y coordinate system).
   2) Itemized as-built quantities list, which indicates the size, type, brand name and lengths of water main used. Hydrants, gate valves, blow-off valves and appurtenances must also be listed showing their type, brand name, and quantity.

b. Sanitary System
   1) Indicate the length of sewer, invert elevation, rim elevation, percentage of grade, manhole location from the nearest property corner (using an X-Y coordinate system), sewer material and joints used.
   2) Itemized as-built quantities list, which indicates the size, type, brand name and lengths of pipe used.

c. Storm System
   1) Indicate length of sewer, invert elevation, rim elevation, percentage of grade, manhole location from the nearest property corner (using an X-Y coordinate system), sewer material and joints used.
   2) As-built storm system plans are required to be accompanied by a letter (8.5" x 11") signed and sealed by the design engineer stating that the detention/retention basin is properly sized according to the

approved construction plans, and that the outlets are properly located and sized.

3) Itemized as-built quantities list, which indicates the size, type, brand name and lengths of pipe used.

CITY OF WIXOM

AS-BUILTS REQUIREMENTS CHECKLIST

SANITARY, STORM & WATER MAIN In Plan & Profile, Show:	Completed	Outstanding	N/A
All invert and rim elevations to USGS Datum			
Actual laying length between structures			
Type of pipe used			
Actual slope of pipe			
Size of pipe			
Tie all structures to property corners using an X-Y coordinate system			
Lead information (distance from downstream manhole, tie down end, invert elevation, etc.)			

DETENTION PONDS	Completed	Outstanding	N/A
Letter required by the design engineer stating that the pond is properly sized according to approved plans, and the outlets are properly located and sized			

ROADS / PARKING LOTS	Completed	Outstanding	N/A
Roadway centerline spot elevations			
Edge of road tied to ROW/easement			
Curbing and parking lot spot elevations			
Spot elevations on parking lot structures			

MISCELLANEOUS	Completed	Outstanding	N/A
Plans noted as record drawings & dated in title block			
Record drawings sealed			

Additional information may be required at the discretion of the City.