

CHAPTER 15
DESIGN AND CONSTRUCTION STANDARDS

ARTICLE I – IN GENERAL

15-1 PURPOSE.

These Engineering Design Standards are intended to provide a reasonable and proper basis for the design and construction of subdivision and other project site Improvements, including sanitary sewer, water main, storm water management paving and grading.

The Charter Township of Lyon Standard Details and Specifications shall be considered a part of the Design Standards.

15-2 GENERAL

1. All plans submitted shall bear the seal of the Registered Professional Engineer responsible for the design.
2. Signed contracts for all improvements shall be submitted to the Township Engineer prior to start of construction.
3. A two year Maintenance Bond shall be furnished to the Township before any development is approved and accepted. The term of the bond shall begin on or after the date of acceptance of the work by the Township. The amount of the bond shall be equal to 50% of the construction cost for water main, sanitary sewer, storm sewer, and paving.
4. All public improvements must be staked under the supervision of a Registered Land Surveyor according to the latest approved plans. All plans used by the contractor for construction must be stamped "For Construction" by the Township. Cut sheets must be prepared for all construction work by the engineer or surveyor responsible for the staking.
5. Record drawings of sanitary sewer, storm sewer, water main, retention basin, paving and grading shall be provided to the Township and to such county agencies as required prior to acceptance of the improvements by the Township (**See Article IX Record Drawings**).
6. Financial Guarantee shall be provided in accordance with the Zoning Ordinance of the Charter Township of Lyon.

7. Insurance

The proprietor shall cause its contractors to furnish to the Charter Township of Lyon evidence of public liability and property damage insurance coverage with a responsible insurance company which meets the approval of the Township in such amounts as will be adequate to protect the public, the Charter Township of Lyon, individual members of the Township Board, Township Employees and Agents for the Township and all parties of interest, and shall not be less than the limits set forth herein:

<u>Type of Insurance</u>	<u>Limits</u>
(a) Social Security	As required by laws of Michigan
(b) Workman's Compensation & Employers Liability	As required by laws of Michigan
(c) Bodily Injury (including death)	\$1,000,000.00
(d) Property Damage	\$500,000.00
(e) Owner's and Contractor's	Protective Same as (c) and (d)
(f) Motor Vehicle (including owned hired and non-owned vehicles)	Same as (c) and (d)

Policies shall be presented to the Charter Township of Lyon for examination as to their validity and any undesirable exclusions deemed improper by legal opinion rendered to the Township regarding same. Underground construction, where applicable, shall be specified in the coverage. Certificates of coverage signed by the insurance carriers shall include a guarantee that 30 days written notice shall be given by the insurance carrier to the Charter Township of Lyon prior to cancellation of, or any change in, the respective policies. In the event that insurance is canceled, operations shall cease prior to the cancellation date and shall not resume until evidence is provided that the proper insurance is again in effect.

Additional named insured under (e) above shall include the Charter Township of Lyon, its Township Board and individual members thereof, the Engineer and members of its staff, Township employees and agents for the Township.

8. Permits-Jurisdiction-Notification

The proprietor shall obtain, or cause his contractor(s) to obtain all permits, post all required bonds, and pay all required fees for each and all permitting agencies departments having jurisdiction over the land and rights-of-way involved in the project. Proper notification shall be given to each governmental agency and utility company prior to beginning of construction. The Charter Township of Lyon shall require a minimum 48-hour notice prior to commencement of any construction.

9. Pre-construction Meeting

A pre-construction meeting will be held when ALL permits, bonds and insurance are submitted to the Township Engineer and all required escrow deposits are submitted to the Lyon Township Building Department.

10. Certificate of Completion

The record drawings furnished by the design Engineer shall contain a statement certifying that all surface grades, roads and structures are in substantial conformance with the approved engineering plans. This statement shall be signed by a Registered Professional Engineer prior to acceptance of the improvements by the Township.

11. Plans in Electronic Form

Upon final approval of the engineering plans the proprietor's engineer shall provide the Township with an electronic copy (AutoCAD, Microstation, or shapefile) of the proposed plans. This is required so that the proposed improvements can be added to the Township's GIS database.

12. Required Easements

A developer shall provide the Township with the necessary easements to allow maintenance of any water mains, sanitary sewers or storm drains that are to be located on developed property and maintained by the Township. The form of such easements shall be subject to the approval of the Township. Sufficient evidence of title shall be provided by the grantor along with the easement in the form of a policy of title insurance, acceptable to the Township, to show that the grantor of the easement is the owner of the property. All parties having a legal interest in the property shall execute and grant the easement. Easements shall be of a minimum twenty-foot width, unless a more narrow width is approved by the Township engineer. The engineer may approve a narrower width

upon a determination that strict adherence to the twenty-foot standard will result in undue hardship to the developer, and that all necessary maintenance functions can be adequately and efficiently performed within a more narrow easement. All necessary off-site easements shall be executed and submitted to the Township engineer for review and approval prior to approval of the final site plan or subdivision engineering drawings. All necessary on-site easements shall be executed and submitted to the Township engineer for review and approval prior to issuance of building permits for site condominium projects and prior to issuance of a temporary certificate of occupancy for all other developments.

ARTICLE II – SUBMITTAL, REVIEW, APPROVAL & CONSTRUCTION PROCEDURES

15-5 GENERAL

All improvements to vacant land, expansions and/or modifications to existing developed parcels, and improvements or extensions to water main systems, sanitary sewers, storm water management systems, mass grading, other grading as described in Article VI and paving require the review and approval of detailed engineering design plans prior to the issuance of Township permits and construction commencement.

The plan review and approval process consists of two (2) separate review submittals. The first review is of the SITE PLAN and the second review is the ENGINEERING PLAN review.

This standard establishes the basic submittal, review and permit processing procedures in the Township.

15-6 SUBMITTALS FOR REVIEW OF SITE PLANS & PRELIMINARY PLATS

See **Article 5.00 (SITE PLAN REVIEW)** of the Lyon Township Zoning Ordinance for site plan/preliminary plat submittal information.

1. Depending on the scope of work, the following engineering related items are to be incorporated in the plans or submitted as applicable to the project:
 - a. Calculations for volume, outlet restrictor size, sediment loading, percolation rates, etc. for detention or retention storm water management systems.

- b. Drainage district maps showing the various areas contributing to the points of inlet and total area drained (including off-site contributions).
 - c. Other information/calculations pertinent to the project.
2. The Township Engineer will review the plans for conformance to Article 5.00 of the Lyon Township Zoning Ordinance and provide a letter of recommendation to the Township Planning Department.

15-7 SUBMITTALS FOR ENGINEERING/CONSTRUCTION PLANS

All applicable materials shall be submitted to the Township Building Department for distribution. **See Article VIII (PLAN REQUIREMENTS)** of these standards for the detailed information required on each drawing sheet.

1. The following items are common for all projects being submitted for engineering review:
 - a. Three sets (3) of ENGINEERING PLANS with applicable Township Standard Detail Sheets and project specific details. Plans shall be signed and sealed by a Professional Engineer registered in the State of Michigan.
 - b. The projects tree survey information shall also be provided. The developer's engineer shall be responsible for coordinating tree removal plans with construction plans. Grading limits shall be shown on the tree removal plan.
 - c. Easements for off-site work must be submitted prior to construction. Appropriate notes shall be provided.
 - d. Two (2) copies of the Sanitary Sewer Basis of Design (gravity or low pressure sewer).
 - e. The calculations for volume, outlet restrictor size, sediment loading, percolation rates, etc. for detention/ retention/infiltration storm water management systems.
 - f. Drainage district maps showing the various areas contributing to the points of inlet and total area drained (including off-site contributions).
 - g. Soil boring logs and geotechnical report.

- h. Detailed storm sewer/open drain calculations.
- i. All wetlands are to be delineated by a wetland specialist. The Township will verify all of the wetland delineations. If there is a question or a discrepancy between the Township and the applicant on the status of a wetland, a determination will be required to be made by the Michigan Department of Natural Resources and Environment.
- j. A cost estimate for the site construction signed and sealed by a professional engineer.
- k. Any other information/calculations pertinent to the project.

15-8 OTHER AGENCY REVIEWS

- 1. With the exception of public water main and sanitary sewer plans, the applicant or his designee shall be responsible for submitting plans to any public utility and any state or county agency whose facilities or rights-of-way may be affected by or has jurisdiction over the proposed construction.
- 2. Applicant is responsible to submit the changes requested by any state or county agency back to the Township for approval.

15-9 FINAL APPROVALS

- 1. If the Township Engineer finds that the revised plans and related material conform to the standards of the Township, he/she will stamp the plans "Recommend Approval" and return one (1) set to the Township Building Department, one (1) set to the applicant, and retain one set. An approval letter will be prepared by the Township Engineer that lists all fees, permits, insurance and bonds that will be required for the project.
- 2. If minor corrections are still required, at the discretion of the Township Engineer, the plans may be stamped "Recommend Approval As Noted". Plans so stamped will be required to be revised prior to the Pre-Construction meeting. An approval letter will be prepared by the Township Engineer that lists all fees, permits, insurance and bonds that will be required for the project.
- 3. Applicant must submit copies of the documentation from other agencies (as applicable to the project) to the Township Engineer indicating that the plans have received their approval for work

within, and/or modifications to, their facilities prior to the Township Engineer granting any engineering construction plan approval.

15-10 PERMITS/CONSTRUCTION

1. A preconstruction meeting will not be scheduled until all of the required items listed in the engineering approval letter are received by the Township Engineer.
2. When engineering construction plans have been approved, the applicant may apply for a building permit from the Township Building Department. The number of permits and any other building issues will be at the discretion of the Building official. Prior to the start of construction, the applicant must secure all necessary permits from other agencies as applicable to the project and attend a pre-construction meeting.
3. For projects where the water main will become part of the public system, the Township Engineer shall notify the applicant for additional copies of the plans, including current standard detail sheets, signed and sealed by a Michigan Registered Professional Engineer for processing and eventual issuance of a MDEQ construction permit for water main systems. No construction may commence on the public water system until this permit is issued.
4. For projects where the sanitary sewer will become part of the public system, the Township Engineer shall notify the applicant for additional copies of the plans, including current standard detail sheets and a completed Part 41 permit application, signed and sealed by a Michigan Registered Professional Engineer for processing and eventual issuance of a MDEQ construction permit for sanitary sewer systems. No construction may commence on the public sanitary sewer system until this permit is issued.
5. All other permits and payment of associated fees required to perform the work shall be the responsibility of the applicant and/or his designee. No construction may commence until permits, as applicable to the project, are secured from the appropriate agencies. Such permits include, but are not limited to, the following:
 - a. Road Commission for Oakland County permit for work within the county road right-of-way, including discharges from storm water management systems to county road drainage facilities.
 - b. Oakland County Water Resources Commissioner water main permit.

- c. MDEQ permit for public water mains.
- d. Road Commission for Oakland County permit for approach work in the County right-of-way.
- e. Road Commission for Oakland County permit for utility, curb and sidewalk work within the County right-of-way.
- f. Oakland County Water Resources Commissioner permit for storm water discharge and/or taps to county controlled drainage facilities.
- g. Oakland County Water Resources Commissioner permit for connection(s) to existing public water mains
- h. MDEQ Part 41 Permit for public sanitary sewers.
- i. N.P.D.E.S. permit for storm water discharge for areas disturbed greater than five (5) acres.
- j. MDEQ permit for all work and/or storm water discharges to a regulated wetland or floodplain.
- k. Oakland County Water Resources Commissioner permit for soil erosion and sedimentation control.

6. OTHER REQUIREMENTS

- a. Temporary construction easements from adjacent property owners and/or permanent easements for off-site facilities shall be obtained by the applicant. Documents shall be in a form acceptable to the Township Attorney. Copies shall be submitted to the Township Engineer prior to construction plans being approved.
- b. A Maintenance and Guarantee Bond shall be submitted for all of the public improvements (i.e. storm, sanitary, water main and private road paving).
- c. Insurance (see Article 1 - GENERAL).**
- d. Engineering inspection escrow deposit to the Lyon Township Building Department.

7. ACCEPTANCE OF IMPROVEMENTS

- a. Final acceptance requirements for project improvements are outlined in each individual section of the standards.
- b. Building permits can be issued prior (at the discretion of the Building Official) to final acceptance of site improvements if a monetary bond covering the cost of installing the remaining improvements is provided to the Township.
- c. Certificates of Occupancy will not be issued for any residential or commercial developments until all project improvements have been accepted (per requirements).

15-11 to 15-14 RESERVED.

ARTICLE III – WATER MAIN

15-15 GENERAL

This standard establishes the minimum requirements for the design of water main in the Township.

15-16 DESIGN CONSIDERATIONS

A. GENERAL

1. Water mains shall be looped whenever possible.
2. 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 Township for future extensions.
3. All water mains shall be installed with a minimum cover of 5-1/2 feet below finish grade. Whenever water mains must dip to pass under a sewer or other obstruction, the sections that are deeper, shall be kept to a minimum length by the use of vertical 11-1/4 degree bends properly anchored.
4. A 5-1/2 foot minimum horizontal clearance at all open drain crossings are required between the bottom of the drain and the top of the water main.

5. Where water main is constructed in pavement areas or within a one-on-one influence of pavement, compaction of backfill to 95% maximum density is required and shall be tested by an independent laboratory.
6. Where the water main crosses another utility, provide Class II backfill material in twelve (12) inch compacted lifts to the top of the higher utility.
7. All water mains shall be Class 54, cement lined ductile iron pipe. High Density Polyethylene Pipe SDR 11 may be used under certain circumstances and upon approval by Township Engineer.
8. All water mains shall be designed for 150 p.s.i. minimum working pressure.
9. Concrete thrust blocks or other approved restraint systems shall be provided at all bends, tees, hydrant shoes, at plugs and caps and at any crosses where necessary to prevent lateral movement of the pipe. Thrust blocks shall bear against undisturbed earth and shall have sufficient bearing area to develop the full resultant axial thrust of the pipe at test pressure.
10. No house or hydrant leads shall be made to a transmission main 16" or larger without approval of the Township Engineer.
11. The current Lyon Township Standard Details must be included with the plan set.
12. All water mains twelve (12) inches and larger must be profiled.
13. The minimum separation (barrel to barrel) of water main to sewers shall be ten (10) feet horizontal and eighteen (18) inches vertical.
14. Water mains shall be designed using two-45 degree bends rather than 90 degree bends when possible.
15. All water mains must end with a hydrant or blow-off, and gate valve.

B. DESIGN FLOWS

The Design Engineer shall arrange a meeting with the Township Engineer and the Fire Chief to discuss specific fire protection needs.

1. Single Family Residential- Water mains shall have the ability to provide a fire demand of at least 1,200 gallons per minute. Design calculations shall be furnished upon request to the Engineer.
2. Multiple Family and Institutional- Water mains shall have the ability to provide a fire demand of at least 2,000 gallons per minute in multiple family, institutional, and school areas. Design calculations shall be furnished upon request to the Engineer.
3. Commercial & Industrial- Water mains shall have the ability to provide a fire demand of at least 3,000 gallons per minute in commercial, industrial, office and shopping center developments. Design calculations shall be furnished upon request to the Township Engineer.

C. MINIMUM SIZE

1. Single Family Residential-Water mains within new single family residential developments shall be eight (8) inches in diameter minimum or larger as design dictates.
2. Major Roads- Water mains within major roads shall be minimum 12 inches in diameter. Larger mains will be required as indicated on the Township's Water main Master Plan.
3. Commercial & Industrial- Within commercial, office, industrial and multiple family residential developments, 12 inches in diameter water main is considered to be the minimum, except in a looped system of 1,500' or less where 8 inches in diameter mains may be permitted.

D. LOCATION OF WATER MAINS

1. In Street Right-of-Way

Water mains shall generally be located on opposite sides of streets from sanitary and storm sewers. Water mains shall be located seven (7) feet inside the public right-of-way line in existing subdivisions and other establishments.

2. In Easements

All water main, fire hydrants, valves, service valve boxes and other appurtenances shall be located in a 20-foot wide easement, centered on the water main. The easement shall extend ten (10) feet beyond a hydrant. Such easement shall be dedicated to the

Township, with restriction against use or occupation of easements by the property owners and/or by other utilities in any manner which would restrict water main maintenance or repair operations.

A written description and drawing of the easement shall be prepared by the Design Engineer and be presented to the Township for examination before recording.

- a. Easements for possible extensions shall be provided to the property lines at locations designated by the Township Engineer.
- b. Water mains shall preferably be constructed outside of paved parking areas, streets, drives, and rear-yards.
- c. Within unplatted projects, water mains shall be installed parallel to the property lines or building lines.

E. GATE VALVES

1. General

- a. When connecting to an existing water main, a tapping sleeve, gate valve and well will be required unless connection to the existing water main can be made without interrupting service. Only mechanical joint tapping sleeves shall be used.
- b. All valves 2" and greater, except hydrant shut-off valve, shall be installed in a gate well (not in a box).

2. Location

- a. In single family residential areas, valves shall be arranged so that no single water main failure will require more than 1,000 feet of water main, not more than 26 homes and not more than two (2) hydrants to be out of service.
- b. In multiple housing, commercial and industrial areas, valves shall be so arranged that no single water main failure will require more than 800 feet of water main or more than one (1) hydrant to be out of service.
- c. Valves shall be so arranged such that any section can be isolated by closing not more than four (4) valves.

- d. Valves shall generally be located at street intersections, and such that the gate well structure will clear sidewalks, five (5) feet from the intersecting street right-of-way line.
- e. On all water mains to be extended in the future, install a 10-foot stub with gate valve and plug for future connection.
- f. Gate valves are not permitted in pavement area.
- g. At high points in water mains where air can accumulate, provisions shall be made to remove the air by means of air relief valves.

F. HYDRANTS

1. General

- a. Spacing of hydrants around multiple family, institutional, commercial and industrial areas shall be considered as individual cases and the design engineer is encouraged to arrange a meeting with the Township Engineer and Fire Chief to review specific fire protection requirements. The Fire Chief shall have final approval for number and arrangement of hydrants.
- b. Hydrant nozzles shall face the road.
- c. Hydrant leads shall be six (6) inch diameter minimum with a maximum length of 20 feet. Hydrant leads longer than 20 feet must be eight (8) inch diameter and have an eight (8) inch gate valve and well installed at the tee.
- d. Hydrants shall be plumb and set to grade before final acceptance.
- e. No service leads are allowed to extend from a 6" hydrant lead.

2. Location

- a. In single family residential areas, hydrants shall be generally located ten (10) feet off the street right-of-way line, and spaced along the water main so that all dwelling units are within 300 feet of a hydrant.

- b. In multiple family, institutional, commercial, and industrial areas, hydrants shall be arranged so that all exterior parts of a building are within 250 feet of a hydrant.
- c. In single family residential areas, hydrants shall be located at the center of the lot or at lot lines.
- d. When near a street intersection, hydrants shall be located 15 feet from the intersecting street right-of way.
- e. Hydrants shall be located at least 25 feet from any exterior wall of a masonry building and at least 50 feet from any exterior wall of frame or equivalent construction including brick and stone veneer.
- f. Hydrants located in parking areas shall be protected with a six (6) inches (minimum) concrete curb or standard guard posts.
- g. All dead end water mains shall end with a hydrant blow-off, gate valve and minimum ten (10) feet of stub and plug for future extensions. A temporary blow-off in lieu of a hydrant will be considered based on hydrant spacing and future extension of the water main.

G. SERVICE LEADS

- a. Service leads shall be type "K" copper or HDPE pipe with a minimum of 1" in diameter. Service leads shall be sized according to the volume and pressure requirements of the development structure.
- b. Service leads must be a separate/individual connection to the water main. Domestic service and fire service lines to the buildings must have separate taps, separate shut-off valves, and separate services.
- c. All leads for irrigation purposes must tap and branch from the existing domestic lead. A tap to the fire service lead is not acceptable.
- d. All services shall include a corporation valve at the main and a curb stop valve and box inside the right-of-way or easement.

- e. No house leads shall be made to a transmission main 16" in diameter or larger without approval from the Township Engineer.
- f. All water service connections two (2) inches and smaller shall be made by the Oakland County Water Resources Commissioner (OCWRC).
- g. All water taps greater than two (2) inches require a gate valve and well (i.e. no valve boxes).
- h. A separate fire service tap is required for buildings with fire protection. Domestic service can not come off a fire line.
- i. A "detecto" meter is required on all fire service lines.
- j. A cross connection control plumbing detail (riser diagram) must be provided to the OCWRC for review.

H. PRESSURE REDUCING VALVES

- 1. In systems where two or more pressure districts are to be interconnected, the plans shall include a pressure reducing valve near the point of connection to the higher pressure district to balance pressures across the new water system. The PRV shall conform to the Township's Standards for such facilities.
- 2. A line gate valve shall be installed both upstream and downstream of each pressure reducing valve to permit isolation of the pressure reducing valve for maintenance and repair. A bypass line that is equivalent in pipe size to the water main and an additional bypass gate valve and well shall be provided.

15-17 FINAL ACCEPTANCE

- A. No water main taps shall be made to existing water main lines until pressure testing and bacteria testing is approved and accepted by the OCWRC and Lyon Township.
- B. Water main pressure testing, bacteria testing, and final taps shall be scheduled through the OCWRC by the Township Engineer.
- C. Water mains shall be flushed and cleaned, and followed by chlorination and bacteria testing. Water main sterilization shall be in accordance with all local, state and federal regulations.

- D. A set of approved Record Drawings, an approved Bill of Sale, and a copy of any recorded easements required for construction, shall be submitted to the Township prior to final acceptance of the water main.

15-18 to 15-19 RESERVED.

ARTICLE IV - SANITARY SEWER

15-20 GENERAL

This standard establishes the minimum requirements for the design of sanitary sewer systems in the Township.

Sanitary Sewers are also subject to the Charter Township of Lyon Water and Sewage Ordinance.

Prior to starting any sanitary sewer design, the design engineer is encouraged to make use of maps and information available at the Township offices. It shall be the responsibility of the design engineer to verify utility locations provided by the Township or any other parties.

15-21 DESIGN CONSIDERATIONS

A. GENERAL

1. No connection receiving storm water, surface water, **water softener backwash discharge**, or ground water shall be made to sanitary sewers.
2. A minimum vertical clearance of 18 inches shall be provided at all crossings with other utilities. A minimum horizontal separation of 10 feet shall be provided between the sanitary sewer and any water main or storm sewer.
3. Sanitary sewers shall be located so as to provide unrestricted access for maintenance and inspection purposes.
4. Sewer pipe and appurtenances shall conform to the current standards of the Charter Township of Lyon.
5. A grease interceptor will be required for all food service operations. No connections for domestic waste will be allowed to the interceptor.

6. The current Lyon Township Standard Details must be included with the plan set.
7. Where required, the proprietor must demonstrate that any wastewater resulting from commercial or industrial processes are similar in quality to domestic wastewater as stated in the Township Utility Ordinance.
8. Types of piping:

Gravity Sewer – PVC SDR 26, truss pipe; A2000
Low Pressure Sewer – HDPE SDR 9, HDPE SDR 11, Ductile Iron Pipe CL 54 interior lined and coated.
Gravity Sewer Leads – PVC SDR 23.5

B. LOCATION OF GRAVITY, FORCE MAIN AND LOW PRESSURE SANITARY SEWERS

1. In Street Right-of-Way

Sanitary sewers for existing subdivisions and other establishments shall generally be located on opposite sides of streets from water mains, seven (7) feet inside the public right-of-way line.

Sanitary sewers shall be located a minimum of ten (10) feet horizontally away from water mains.

2. In Easements

All sanitary sewers shall be located within a minimum 20-foot wide, or 1:1 depth of the sewer easement (whichever is greater), centered upon the sewer. Such easement shall be dedicated to the Township, with restrictions against use or occupation of easements, by the property owners and/or by other utilities, in any manner that would restrict sewer maintenance or repair operations.

A written description and drawing of the easement shall be prepared by the Design Engineer and be presented to the Township for examination before recording.

- a. Easements for possible extensions shall be provided to the property lines at locations designated by the Township Engineer.

- b. Sewers shall preferably be constructed outside of paved parking areas, streets, drives and rear-yard areas.
- c. Within unplatted projects, sewers shall be installed parallel to the property lines, or building lines, with clearance distances to accommodate the full width of the proposed easement or the distance necessary to accommodate a slope of one horizontal to one vertical from invert of sewer to ground surface, whichever is greater.

C. SEWER CAPACITY

1. Tributary Area

Sanitary sewers shall be designed to serve all natural tributary areas with due consideration given to topography, the Township Sanitary Sewer Master Plan, established zoning, and the adopted Township Master Land Use Plan. Sanitary sewers serving a tributary area beyond the project limits shall extend to the boundary of the project site to provide for future extension.

2. Population

For design purposes, population shall be based on a minimum of 2.8 persons per detached single-family home site. Population figures for all other dwelling units and buildings shall be based upon the current "Schedule of Unit Assignment Factors" as published by the Oakland County Water Resources Commissioner (OCWRC) and as accepted by the Township Board of Trustees. The adopted unit factors shall be used to convert the different occupancy types to equivalent single-family units.

Submission for review shall include a tabulation of occupancy (usage) types and the conversion of these into terms of equivalent single-family units. The tributary area, in acres, may be used to calculate dwelling units based on density allowed in the Zoning Ordinance.

3. Sewage Quantities for Pipe Design

For service areas with design populations of 500 or less, sewer design capacity shall be 400 gallons per capita per day.

For service areas with design populations greater than 500 but less than 28,400, sewer design capacity per capita shall be based on the following formula:

$$Q = 100 \frac{18 + (P)^{1/2}}{4 + (P)^{1/2}}$$

Q = Design capacity in gallons per capita per day

P = Design population expressed in thousands

For service areas with design populations exceeding 28,400, sewer design capacity shall be 250 gallons per capita per day.

D. MINIMUM PIPE SIZE

1. Minimum pipe size for gravity sanitary sewers shall be eight (8) inches in diameter.
2. Minimum pipe size for low pressure sanitary sewers shall be 2 inches in diameter.

E. HYDRAULICS

1. Calculations

For gravity sanitary sewer, Manning's Formula, with $n = 0.013$, shall be used for hydraulic calculations.

For low pressure sanitary sewer and force main trunk sewers, the Hazen-Williams formula with $C = 120$, shall be used for hydraulic calculations.

2. Minimum and Maximum Velocities

Minimum design velocity for gravity and low pressure sanitary sewers shall be two (2) feet per second, and maximum design velocity shall be ten (10) feet per second, with pipe flowing full. The slope of the sewer between the last two manholes at the upper end of any gravity lateral shall be increased above the minimum permissible pipe slope, wherever possible, to obtain cleansing velocity.

3. Allowable Pipe Slopes For Gravity Sewers

<u>PIPE DIAMETER (INCHES)</u>	<u>MINIMUM SLOPE (FEET PER 100 FEET)</u>
8	0.40
10	0.28
12	0.22
14	0.17
15	0.15
16	0.14
18	0.12
21	0.10
24	0.080
27	0.067
30	0.058
36	0.046

4. Allowances for Changes in Pipe Size in Gravity Sewers

Maximum flow velocity for pipe flowing full shall be maintained by matching the 0.80 of the diameter depth above invert for pipe size increases.

5. Allowances for Direction Change in Gravity Sewers

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.

F. BASIS OF DESIGN-LOW PRESSURE SANITARY SEWER

1. Low pressure sanitary sewer systems consisting of individual grinder pump stations at each building site, connecting to a common pressurized sewer to convey domestic waste to an acceptable outlet will be considered for use in the Township.
2. The use of a low pressure sanitary sewer system in any development within the Township will require preliminary approval by the Township. A request for approval shall be submitted to the Township, together with a preliminary plan of the proposed development which delineates the extent of the proposed pressure sewer system, including future extension. The preliminary plan shall include existing ground contours at two feet intervals,

proposed grades over the site, and the outlet for the pressure sewer system.

3. Upon securing the Township's preliminary approval for use of a low pressure sanitary sewer system and prior to commencing with final construction plans and specifications for the system, the project's Design Engineer shall submit for review and approval a basis of design for the low pressure sewer system. The basis of design shall include as a minimum but not necessarily limited to the following:

Layout of development and pressure sewer system, including future extension, indicating:

1. Proposed grades over the site.
2. Sewer pipe sizes and lengths.
3. Sewer line numbering system for each branch of sewer by pipe size.
4. Elevation along centerline of sewer approximately 100 foot intervals, and with maximum centerline of pipe denoted.
5. Elevation at each individual grinder pump station.
6. Location and elevation (or hydraulic grade line) at connection of pressure sewer to source of outlet.

Tabular system analysis which is similar to and provides the system data as required on the following exhibit sheet "Low pressure Sewer System Pipe Schedule and Branch Analysis". (Reference: Low Pressure Sewer Systems Using Environment One Grinder Pumps, February, 1995).

Tabular system analysis shall be provided for the initial and ultimate service areas along with an initial and ultimate exhibit showing the branches corresponding to the tabular analysis. The tabular system analysis shall be divided into branches with an increasing number of "pumps on" (1,2,3...)

4. Submissions for review shall include a tabulation of occupancy (usage) types and the conversion of these into terms of equivalent single-family units. The tributary area, in acres, may be used to calculate dwelling units based on density allowed in the Zoning Ordinance. The adopted "Schedule of Unit Assignment Factors" shall be used to convert the different occupancy types to equivalent single-family units.
5. Property owners will be required to use the approved Township Contractor to connect to the low pressure sewer, grinder pump

installation, and the installation of the sewer lead. Connections to the low pressure sewer shall be initiated through the Township Building Department.

6. Property owners will also be required to use the approved Township grinder pumps when connecting to the low pressure sewer. The approved grinder pump will be determined by the Township Engineer after an on-site inspection.

G. DEPTH OF SEWERS

1. No sanitary sewer shall have less than four (4) feet of cover.
2. In general, gravity sanitary sewers shall have a minimum depth of ten (10) feet from top of curb (or centerline if uncurbed) to the invert of sewer. The sewer shall have sufficient depth to serve a standard depth basement by gravity.

H. SPECIAL BACKFILL REQUIREMENTS

Granular material meeting the requirements for MDOT Granular Material, Class II, shall be required for full depth backfill of trenches, above a horizontal line one (1) foot above the pipe, under existing or planned road surfaces, pavements, curbs, driveways, parking areas and sidewalks, and where the trench edge is within three feet of the edge of existing or planned pavements. Backfill shall be compacted to a minimum of 90% maximum dry density from above the pipe to 18 inches below grade. Compaction shall be 95% of maximum dry density for top 18 inches of trench. The Compaction results will be determined by a Modified Proctor Test, ASTM Designation D-1557. House lead trenches shall have compacted granular backfill within the entire street right-of-way where sidewalks are required. Compacted granular backfill shall be provided between all utility crossings.

I. HOUSE LEADS

1. Unless otherwise approved, construction of house leads from a gravity sanitary sewer to the easement and/or property line, for each fronting parcel in which the sewer is designed to serve, shall be included with the construction of the sanitary sewer.
2. Where construction of house leads to the property line is not required concurrently with gravity sanitary sewer construction, a wye branch with riser, and water-tight stopper or plug, shall be installed for every lot or building site which the sewer is designed to serve.

3. Minimum size for house leads shall be six (6) inches in diameter.
4. Minimum slope for house leads shall be 1/8 inches per foot (1.00%).

J. MANHOLES - GRAVITY SEWER

1. Location

Manholes shall be constructed at every change in sewer grade, alignment and pipe size, and at the end of each sewer line. Generally maximum distance between manholes shall be as follows:

<u>Diameter of Sewer</u>	<u>Maximum Manhole Spacing</u>
8" - 21"	400'
24" - 30"	450'
36" - 42"	500'

2. Monitoring manholes are required for all non-residential connections to the sanitary sewer system.

3. Drop Connections

Internal drop connections are required at new manholes where the outlet pipe is 18 inches or more below the inlet pipe. Inverts shall be matched at the flow line whenever possible if 18 inches or less.

A minimum five (5) foot diameter manhole is required for any drop connection.

Generally, drop connections are discouraged and will be considered only if other alternatives are not acceptable.

4. The most downstream manhole in a gravity sewer system shall have a two (2) foot sump for infiltration testing when required. This sump shall be filled in prior to final acceptance of the system.
5. Where future connections to a manhole are anticipated, stubs or blind drop connections, with watertight bulkheads, shall be provided. Stubs shall be five (5) foot minimum in length.

- K. AIR RELEASE VALVES (ARV), INTERMEDIATE FLUSHING CONNECTIONS (IFC), BRANCHED FLUSHING CONNECTIONS (BFC) AND TERMINAL FLUSHING CONNECTIONS (TFC), LOW PRESSURE AND FORCE MAIN SEWER
1. Air Release Valves shall be located at all high points in low pressure and force main sewers.
 2. Intermediate Flushing Connections in low pressure and force main sewers shall be located so as not to allow more than 1000 feet between structures. Intermediate flushing connections may also be required at significant low points.
 3. Branched Flushing Connections shall be located at places where the low pressure sewer branches off.
 4. Terminal Flushing Connections shall be located at the ends of the low pressure and force main sewer system.

L. GRINDER PUMPS

1. Grinder pumps are installed and maintained by Lyon Township. A permit for installation shall be obtained through the Lyon Township Building Department.

2. Location

Grinder pumps shall be located five feet away from any permanent structure including buildings, decks and sheds.

Grinder pumps shall be located in the side yard of new residential and non-residential buildings, except for walk-out residential buildings.

Grinder pumps for new residential and non-residential properties shall have a maximum of one 4' extension.

15-22 FINAL ACCEPTANCE

- A. No connections shall be made to the existing sanitary sewer system until final pressure testing has been accepted by Township Sanitary Sewer System Operator or the successor operator of the sanitary sewer system and the Township Engineer.

- B. All sewers shall be pressure tested, videotaped and mandrel tested prior to final acceptance. All tests shall be witnessed by Township Sanitary Sewer System Operator and the Township Engineer.
- C. A set of approved Record Drawings, an approved Bill of Sale, and a copy of all recorded easements shall be submitted to the Township prior to final acceptance of the sanitary sewer.

15-23 to 15-24 RESERVED.

ARTICLE V – STORM WATER MANAGEMENT

15-25 GENERAL

The management of increased storm water which results from the development of vacant land or expansions to existing facilities will be considered as a critical component of all development plans which are submitted to Lyon Township for approval. The intent of this standard is to provide guidelines for the sound management of increased storm water run-off and to provide sufficient flexibility for design professionals to develop innovative solutions that protect the resources of Lyon Township while meeting the objectives of water quality preservation and flood control.

The use of natural drainage features, shallow swales and landscape areas shall be incorporated into the drainage planning for a site whenever possible. The objective is to achieve a functional and aesthetically pleasing development that minimizes the use of extensive enclosed storm drains and large obtrusive storm water detention or retention basins while providing for the proper management of storm water runoff.

Development plans must present a unified design that, as a minimum, provides the following protections:

1. The design must show that the development will not cause any impact to downstream properties or upstream properties. Both the rate of storm water discharge, and the volume of storm water discharge must be considered.
2. The development plan shall be fitted to the topography and soil to create the least erosion potential and to effectively accommodate the increased runoff caused by changed soil and surface conditions during and after development.

3. The design must demonstrate the use of “Best Management Practices” for minimizing erosion and controlling sedimentation and other pollutants through all phases of construction.
4. The design must demonstrate that proposed buildings or other permanent structures, on and adjacent to, a proposed development are and will remain safe from flooding.

15-26 SOIL EROSION AND SEDIMENTATION CONTROL

Under the Natural Resources & Environmental Protection Act (Act 451), Part 91, the developer shall submit an erosion control plan to the Oakland County Water Resources Commission (OCWRC) - Soil Erosion Control Division. The Soil Erosion and Sedimentation Control Permit must be issued by the OCWRC prior to any earth moving operations. The methods used for soil erosion control must be in accordance with the Oakland County Erosion Control Manual.

An approved National Pollution Discharge Elimination System (NPDES) permit where applicable, will be required prior to the commencement of any earthmoving operations.

A. DESIGN CONSIDERATIONS

To provide effective erosion and sedimentation control, practical combinations of the following technical principles shall be applied to the erosion control aspects of the plan:

1. Under Natural Resources & Environmental Protection Act 451, Part 91, the developer shall submit an erosion control plan to the OCWRC for permit issuance. An approved soil erosion permit from OCWRC, as well as the National Pollution Discharge Elimination System (NPDES) permit where applicable, shall be required prior to the commencement of any earthmoving operations.
2. The permittee shall be responsible for maintaining temporary erosion control devices during all phases of construction.
3. The smallest practical area of land shall be exposed at one time during development.
4. When land is exposed during development, the exposure shall be kept to the shortest possible period of time.
5. Temporary vegetation and/or mulching shall be used to protect critical areas exposed during development.

6. Temporary sedimentation basins (debris basins or silt traps) shall be installed and maintained to remove sediment from runoff waters from land undergoing development.
7. Mud mats shall be installed at construction access points to provide a buffer area where vehicles can deposit mud and sediment prior to leaving the site, to control erosion from surface runoff and to help control dust.
 - a. Sediment basins for construction purposes shall be separated from permanent storm water detention or retention basins.
 - b. Basins shall be designed in accordance with the current OCWRC standards for sedimentation basin design.
 - c. Construction runoff shall be directed to the basin in a controlled manner through mass grading techniques, diversion berms/swales, enclosed storm sewers or any combination thereof that would limit runoff velocities and provide for the least potential for erosion of the site.
8. Areas set aside on the site for equipment storage, laydown, fuel, lubricants, chemical compounds and material stockpiles shall be contained in such a manner as to prevent any leakage or spillage from contaminating the surrounding soils and groundwater, and from entering any storm water management system or existing surface waters.
9. Filters shall be provided at catch basins and culvert inlet points to prevent sedimentation of storm sewers for both new and existing systems.
10. Adequate dust control shall be maintained at all times. Surface streets adjacent to the site will be cleaned of any deposits on a daily basis.
11. The permanent vegetation and structures shall be installed as soon as practical in the development.
12. Whenever feasible, natural vegetation shall be retained and protected.
13. Riprap shall be required at all pipe entrances to detention or retention basins. The minimum width of the riprap shall be twice the outside diameter of the pipe. The riprap shall extend from the bottom of the basin to the top of the pipe. Two types of materials may be use: 1.

fieldstone or broken concrete of a minimum of eight (8) inches, mortared to form a monolithic slab with a minimum thickness of four (4) inches; 2.gabions installed per the manufacturer's specifications.

15-27 STORM WATER MANAGEMENT BASINS AND PRETREATMENT SYSTEMS

On-site storm water detention or retention is necessary for all developments in the Township (including private roads) whenever runoff is increased. Waiver of this requirement may be considered by the Planning Commission upon submittal of a request for waiver, and report stating the reasons why detention or retention should not be necessary. Such report shall include maps, charts, and calculations prepared by a Professional Engineer registered in the State of Michigan. The report and the request shall be subject to review and recommendation by the Township Engineer.

Generally speaking, detention basins temporarily store storm runoff for a period of time in which the runoff is released through a positive outlet, at a controlled rate. Retention basins do not have a positive outlet, so that the stored runoff will either percolate or evaporate.

Infiltration (recharge) systems that store and release run-off through permeable soils to the groundwater may be allowed under specific circumstances and with the review and approval of the Township Engineer.

In cases where the requirements for detention/retention basins have been waived, storm water pretreatment (in the form of permanent debris and sedimentation control systems) will be required.

Any site outletting stormwater directly to a County Drain will need to meet the design requirements of the Oakland County Water Resources Commissioner. Pretreatment of the stormwater is also required and shall meet the required design standards of the OCWRC.

Any site outletting stormwater directly to a wetland area will require an MDEQ permit. Pretreatment of the stormwater is also required and shall meet the required design standards of the MDEQ.

15-28 Design Considerations

A. Detention Basins

1. Detention basins may only be used when the design shows that there is an adequate outlet for the storm water, and where the increased volume of storm water will not damage downstream property owners. Construction drawings must

include sufficient off-site information to demonstrate the existence of an adequate outlet.

2. Water originating from off-site is not required to be detained in the detention basin. Storm water originating from off-site should be diverted around the detention basin whenever practical, and where the diversion will not increase the erosion of soils and will not decrease the time of concentration to the most downstream point of the site.
3. Detention basins shall be designed so that the resulting storm water discharge from the developed site does not exceed the agricultural rate of discharge from the site. The Township has defined an agricultural rate of storm water run-off as 0.10 cubic feet per second per acre; or the capacity of the existing storm drainage facilities downstream of the detention basin outlet, whichever is less.
4. The volume of detention provided must be equal to or in excess of that calculated by the Oakland County Drain Commissioner's "Simplified Detention Basin Design Procedure" for a 100-year frequency storm.
5. The maximum water level shall be controlled by gravity outlets. The use of pumps for dewatering is not allowed.
6. Detention basin volumes shall not include volumes below the invert of outlet pipe (s). Provide an additional 2' of volume below the outlet pipe invert to be used for sediment storage.
7. Detention basins shall be provided with an overflow spillway or manhole set at the high water levels capable of passing a 100-year frequency storm. The overflow spillway shall be located so not to cause potential damage to adjacent properties. All overflow spillways shall be protected from erosion by surfacing with concrete, asphalt, or rip-rap. The edges of the surface shall have headers of the same or similar materials to prevent undercutting by the storm water overflow.
8. One foot of freeboard shall be provided above the high water elevation.
9. Side slopes for detention basins shall not be steeper than

one (1) vertical to five (5) horizontal to a minimum depth of 6 feet.

10. Detention basins will not be permitted within a floodplain.
11. An access path for maintenance shall be provided to the detention basin control structure.
12. Underground Detention will be considered on a case-by-case basis with the following conditions:
 - a. Provisions must be made in the design for the collection and removal of sediment and debris accumulated in the system. All applicable health and safety requirements shall also be incorporated in the design of systems that require access by inspection or maintenance personnel.
 - b. Detailed shop drawings are required for underground detention systems, including pertinent engineering calculations and soils information.
14. Detention in wetland areas will be considered with the following conditions:
 - a. If in a regulated wetland, an MDEQ permit is required.
 - b. A permanent pretreatment system for the removal of sediment is required prior to outletting to the wetland.
 - c. Calculations indicating what the water elevation will rise to during the design storm event will be required. The design must show that properties adjacent to the wetland area will not be negatively impacted by the increase in storm water runoff. Consideration must be given to future developments in the immediate area that could also use the wetland for storm water management purposes.

B. Retention Basins

1. If a gravity outlet cannot be provided, then the storm water holding facility shall be designed as a retention basin with a volume equal to or in excess of the volume of storm water run-off from two consecutive 100-year frequency storms. The storm water storage volume shall be calculated by:

Volume = 16,500 x 2 x total tributary acres x run-off coefficient.

2. Off-site tributary areas: Retention basins must be sized for storm water that originates off-site and which cannot be bypassed around the proposed retention basin to a site where the storm water originally flowed to. In such cases, the retention basin must be sized using the following design parameters:

Tributary acres: On-site area plus the off-site area

C Factor: Weighted C factor of the entire tributary area that considers the existing off-site conditions, and the proposed on-site conditions.

3. Retention basin volumes shall not include volumes below the existing groundwater table, permanent water elevation or invert of outlet pipe(s).
4. One foot of freeboard shall be provided above the high water elevation.
5. Side slopes for retention basins shall not be steeper than one (1) vertical to five (5) horizontal to a minimum depth of 6'
6. Retention basins will not be permitted within a floodplain.
7. Retention of storm water in parking lots is strictly prohibited.
8. The retention basin design shall demonstrate that the soils are capable of providing necessary infiltration. A soils report will be required.
9. An access path for maintenance shall be provided around the entire retention basin.

C. Infiltration (Recharge) Systems

1. An infiltration system will be considered if the design engineer can demonstrate that all of the following conditions exist:

- a. An adequate positive outlet is not available or it is not possible to construct an off-site drainage system to convey basin discharge to the nearest outlet, and the installation of a retention basin is not feasible or practical.
 - b. The natural underlying soils are well-drained (hydrologic groups A or B) and the ground water is suitable for percolation.
 - c. The underlying soils and ground water table have the ability to move water away from the site for the area and volume being drained.
 - d. Permanent pretreatment system upstream of inlet point to prevent any material from potentially clogging the infiltration medium (both surface and subsurface).
 - e. An overflow for a 100 year storm must be provided.
 - f. Infiltration system can be easily accessed for maintenance and replacement if necessary. The use of perforated storm pipe under pavements is discouraged.
 - g. There must be a method for determining a failure in the infiltration system. The system cannot be designed such that a failure in the infiltration system results in short circuit to the emergency overflow without on-site ponding.
2. The following information shall be supplied and/or incorporated in the design of infiltration systems:
- a. Soil boring logs/sieve analysis/geotechnical report indicating type and properties of both surface and subsurface soils, suitability of surface soils for infiltration, capability of subsurface soils to conduct seepage to the underlying groundwater table, and flow from the system under mounding conditions at the maximum infiltration rate. Conditions of less than 6 inches/hr. percolation rate will not be allowed.
 - b. Computed percolation rate and infiltration/exfiltration calculations.

- c. Drainage area map, including any off-site contributing areas and emergency overflow route in the event of system failure.
- d. Construction methods to prevent compacting the surface soils which may reduce the infiltration capacity of the soils.

D. Permanent Pretreatment Systems

- 1. Permanent pretreatment systems when called for on the plans, shall be sized for a “first flush” depth of 0.5 inches of runoff from the entire drainage basin area of the project. Permanent systems are required when discharging to an existing lake, drain, stream, waterway or wetland.
- 2. Pretreatment can be in the form of open basins or engineered treatment systems.
 - a. Open basins shall be designed with minimum side slopes of one (1) vertical to five (5) horizontal, one (1) foot of freeboard above design storm water elevation, emergency sodded overflow, and outlet control devices.
 - b. Design calculations, plans and shop drawings for engineered treatment systems shall be certified by a Professional Engineer licensed in the State of Michigan.
 - c. Horizontal velocities through the system shall be minimized to prevent turbid flows and allow particles to settle in the pretreatment system.
- 3. Permanent pretreatment facilities will not be allowed within a floodplain.

15-29 STORM SEWERS AND OPEN DRAINS

The following details and specifications shall be required for developments utilizing storm sewers and/or open drains to convey runoff from the site. All such storm drainage systems must outlet to either a detention basin, retention basin, infiltration system, or pretreatment facility as outlined in Section 15-28 of this Standard prior to discharging to any natural or man-made water course, wetland, drain or other body of water.

This standard establishes the minimum requirements for the design of storm drainage systems in the Township.

Design Considerations

A. STORM SEWER CAPACITY

1. Sufficient capacity shall be provided in the storm sewer system to allow existing runoff from upstream drainage to "pass through" the proposed storm sewer system.
 - a. When a storm sewer is designed to provide capacity for upstream areas, the hydraulic gradient shall remain in the pipe. For storm sewer designed to take on-site drainage only, the hydraulic gradient must be no higher than one (1) foot below storm structure rim elevations.
 - b. 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.
 - c. If the heights of the hydraulic gradient exceed two (2) feet above the top of pipe, rubber joints shall be used.

B. HYDRAULICS AND HYDROLOGY

1. Storm drainage systems shall be designed for a minimum of a ten-year storm. To determine the storm water runoff, the rational method shall be used ($Q=CIA$)

where Q = peak rate of runoff in cubic feet per second

A = area in acres

C = runoff coefficient for drainage area

I = average rainfall intensity in inches per hour for a given time of concentration

2. The formula for rainfall intensity (I) shall be determined by using the formula $I = 175/(T+25)$, where T is the time of concentration in minutes. For residential areas, T shall usually be 20 minutes; for commercial and office areas, T shall be 15 minutes or less.
3. Run-off coefficients shall be determined for each individual drainage area. Drainage area coefficient determination shall generally be based on the following:

<u>SURFACE</u>	<u>C</u>
Agricultural/Grass	0.15 - 0.20
Pavement/Buildings	0.80 - 0.90
Residential	0.25 - 0.35
Multiple Housing	0.55
Commercial/Industrial	0.75

The above run-off coefficients are minimum. Actual site design may require an increase in run-off coefficient. A weighted run-off coefficient can be used (provide calculations). Coefficients proposed for a project are subject to approval by the Township Engineer.

4. An overland flood route for a 100 year storm frequency shall be provided and shown on the plans. A minimum freeboard of six inches shall be provided from any building's exterior finished grade (brick ledge) to the 100 year flood elevation.
5. In Manning's formula, $n = 0.013$, shall be used for hydraulic calculations.
6. Minimum design velocity shall be 2.5 feet per second and maximum design velocity shall be 10 feet per second, with the pipe flowing full.
7. Allowable pipe slopes:

<u>Pipe Diameter (in)</u>	<u>Minimum Slope (ft/100 ft)</u>
12	0.32
15	0.24
18	0.18
21	0.14
24	0.12
27	0.10
30	0.09
36	0.08
42	0.06
48	0.05
54	0.04
60	0.04

8. For changes in pipe size, the maximum flow velocity for full pipe flow shall be maintained by continuity of the 0.80 diameter depth above invert.
9. For changes in direction, a drop of 0.10 feet in the downstream sewer invert shall be provided for direction changes of 30 degrees or greater to compensate for velocity head loss of the incoming flow.
10. All catch basin and inlet leads shall be laid on a minimum slope of 1%.
11. Wherever differences in manhole pipe invert elevations exceed two (2) feet, a two (2) foot sump shall be provided to prevent channel erosion.

C. SEWER PIPE

1. Size

Storm Sewer:

- a. The minimum pipe size for storm sewers, catch basin leads and inlet leads shall be 12 inches in diameter.
- b. Rear yard under drain system with no inlets: 8" perforated plastic pipe.

2. Location

- a. Storm sewer shall have a minimum of four (4) feet of cover unless an alternative is approved by the Township Engineer.
- b. Storm sewers shall generally be located on the opposite sides of streets from water mains. Storm sewers shall be located ten feet from the right-of-way line in the public right-of-way.
- c. A minimum ten feet horizontal separation is required between storm sewer and water mains.

3. Special Backfill Requirements:
 - a. Granular material meeting the requirements for MDOT Granular Material, Class II, compacted to 95% maximum density, shall be required for full depth backfill of trenches under existing or proposed road surfaces, pavements, curbs, driveways, parking areas, and sidewalks, and where the storm sewer is within a one-on-one influence of the edge of existing or proposed pavements. Compaction testing shall be performed by an independent laboratory.
 - b. Storm sewer leads shall have compacted granular backfill within the entire street right-of-way where sidewalks are required. Compacted granular backfill shall be provided between all utility crossings.

D. MANHOLES

1. Location
 - a. Manholes shall be located at:
 - Points where the sewer changes direction
 - Points where the size of the sewer changes
 - Points where the slope of the sewer changes
 - The junction of sewer lines
 - Street intersections or other points where catch basins or inlets are to be connected
 - The end of the sewer line
 - b. Maximum distance between manholes shall be as follows:

<u>Diameter of Sewer</u>	<u>Maximum Manhole Spacing</u>
8" - 15"	350'
18" - 30"	400'
36" - 48"	500'
54" - 60"	550'
66" - 72"	650'
78" & Larger	1000'

E. CATCH BASINS, INLETS, AND END-SECTIONS

1. Size

- a. Inlets and rear-yard catch basins up to four (4) feet deep from invert to top of casting may be (two) 2 feet in diameter.
- b. Inlets and rear-yard catch basins more than four (4) feet deep from the inlet to top of casting and all other catch basins shall be four (4) feet in diameter.

2. Location

- a. Catch Basins shall be located: at:
 - At the radius return of street intersections. A maximum distance of 150 feet is allowed when drainage is required to go around a corner between a high point and a corner catch basin.
 - At maximum intervals of 500 feet along a continuous slope.
 - At all low points in streets, swales and ditches, where applicable.
 - At a location to provide a maximum of 800 feet of drainage from two directions.
- b. Standard rear yard basins shall be provided at all low points in easements. All catch basins shall be located within four (4) feet of lot corners. 12-foot side yard easements to the street shall be included at all rear yard basins.
- c. All catch basins and inlets located at low points in poor draining soils shall have a minimum of two ten (10)-foot runs of six (6) inches perforated pipe with pea gravel bedding and backfill. Other trench collecting underdrains may be required, as required by the Township Engineer.
- d. Catch basin leads may tap directly into sewers 48 inches in diameter and larger.

- e. End-sections or headwalls shall be placed at all culverts and pipe inlets or outlets.
- f. A prefabricated bar screen shall be used on all storm sewer openings 18 inches in diameter and larger. The bar screens shall be constructed according to an approved separate enlarged detail in the drawings and shall be designed to be sturdy, permanent easily maintained, non-clogging and shall have clear openings of no more than six (6) inches. Bar screens shall not be required on driveway culverts.

F. UNDERDRAIN/SUMP PUMP SYSTEMS

1. Where the proposed ground surface slope is less than 2% (two percent), supplementary drainage shall be provided by an underdrainage system.
2. Locate the underdrain/sump pump systems in a six (6) foot drainage easement along the rear or side lot lines at three (3) feet from the property line. Where abutting off-site property, it shall be located six (6) feet from the property line in a twelve- foot easement.
3. Place underdrain at a minimum grade of 0.30%.
4. Trench for underdrain shall have adequate depth to provide gravity flow of sump pump and softener discharge lines to underdrain, and shall have a minimum depth of three (3) feet from the property line.
5. Install two (2) foot diameter inlets at 400 foot maximum intervals along the underdrain and located three (3) feet from side lot lines.
6. Install a two (2) inch P.V.C. capped tee at each lot for the sump pump.
7. Show the underdrain system with sump pump on the storm sewer plan, with a dimension to the nearest lot line for each sump pump tee.
8. The sump pump collector system may be combined with the underdrain system, as noted above.

9. Minimum pipe material shall be eight (8) inch PVC constructed with a minimum of 3.0 feet of cover and 0.30 percent slope.
10. Eight (8) inch lines must not be used for the collection of surface runoff and therefore structures on these size lines must have solid covers.

G. OPEN DRAIN REQUIREMENTS

1. Open drains shall have slope protection (rip-rap) at bends with radius of 500 feet or less and other points as designated by the Township Engineer.
2. The drain bottom and slopes, to the hydraulic gradient line, shall be sodded. The remainder of the drain shall be seeded. The Township will not approve the work until all turf is established.
3. Specific drain cross-section and velocity control measures will be approved by the Township Engineer on an individual basis.

15-30 EASEMENTS

1. Provide a minimum 12 foot wide easement for access for maintenance and/or inspection of storm water management facilities.
2. Easements for storm sewers and open ditches shall be centered upon the sewer or ditch.
3. An easement shall be provided for the pretreatment system to allow access for maintenance and/or inspection.
4. When drainage is required to flow across an adjacent lot, a 12-foot wide storm water easement, centered on the drain, must be provided. This easement shall be dedicated to the Homeowners Association or Township with restriction against use or occupation of easements by the property owners and/or by other utilities in any manner that would restrict storm system maintenance or repair operations.
5. A written description and drawing of the easement shall be prepared by the Design Engineer and be presented to the Township for examination before recording.

6. Easements for possible extensions shall be provided to the property lines at locations designated by the Township Engineer.
7. The easement must be large enough to accommodate a slope of 1 horizontal to 1 vertical from the sewer invert to the edge of easement.
8. The horizontal alignment of sewers that are not proposed to generally follow street, drive, or parking area pavements, shall parallel property lines or building lines.

15-31 MAINTENANCE

1. In Subdivisions, Condominiums and private roads the developer and/or owners must provide for continued maintenance of storm water management basins and permanent pretreatment facilities, through acceptance of ownership and maintenance responsibility by a home owners or a condominium association. The developer shall be responsible for the maintenance of detention/retention basins until at least ninety-five percent (95%) of all homes have been constructed and sold. The subdivision covenants or condominium bylaws shall incorporate a procedure to finance this maintenance. The developer or owner(s) shall post a cash bond with the Township, in the amount to be determined by the Township Engineer until the association can assume the maintenance responsibility.
2. Commercial, Industrial and Office Sites: The proprietor shall maintain the storm water management basins and permanent pretreatment facilities in proper working order at all times.

15-32 FINAL ACCEPTANCE

1. All sewer systems shall be subject to a Final Township Inspection prior to acceptance of the system by the Township Engineer.
2. A set of approved Record Drawings and a copy of any recorded easements that were required for construction are required for final acceptance of the storm sewer.
3. The entire detention/retention basin must be vegetated and turf established prior to acceptance by the Township. For detention basins designed as a dry basin, the bottom and sides up to the high water elevation shall be vegetated with a dense turf of water tolerant grass. The remainder of the side slopes and top of bank can be seeded or sodded.

15-33 to 15-34 RESERVED.

ARTICLE VI – GRADING

15-35 GENERAL

For all new subdivisions, site plans, private roads and within existing lots or parcels, and other development proposals within the Township, a grading plan shall be submitted for review and approval.

This standard establishes the minimum requirements for the design of grading and surface drainage in the Township.

15-36 DESIGN CONSIDERATIONS

1. The grading plan shall be designed to insure that if a failure occurs in any storm drainage system, storm waters will drain to an approved outlet in overland swales without flooding buildings or adjacent properties.
2. Positive drainage of all yard areas is required for all residential developments. In special cases involving extreme vertical relief and wooded areas, isolated undrained potholes will be considered. These undrained areas must be provided with an easement for surface drainage and retention which will encompass the storm water storage level for two 100 year frequency storms plus one (1) foot of freeboard.
3. Generally, residential lot drainage shall be split at the building; drainage from the front of the building shall drain to the road and drainage from the rear of the building shall drain to the rear lot line. Rear to front surface drainage shall be avoided and will only be permitted under extreme topographic conditions. If rear to front drainage is permitted, only the drainage from the rear of the specific lot is allowed.
4. Side yard swales shall be a minimum of 0.5 feet below the building brick ledge grade of the building and located a minimum of ten (10) feet away from the building.
5. Rear to front lot drainage shall have protective drainage swales around the building. The high point of the swale shall generally be located a minimum distance of 15 feet off the rear of the building and generally one (1) foot (0.5 foot minimum) below the building brick ledge grade.
6. Rear-yards shall be drained with swales and shallow ditches unless topographic features prevent surface drainage.

7. Meet existing ground at the property boundaries. Construct an intercepting swale to prevent drainage onto adjacent property or lots.
8. All building footing drains and sump pumps shall discharge into enclosed storm systems if available. When footing drains or sump pumps are discharged onto the ground surface, the point of discharge shall generally be in the rear directed away from side lot lines and road right-of-way.
9. In residential development with poor draining soils or high groundwater table, an enclosed drainage system for footing drains/sump pumps discharge is required. (See Underdrain/Sump Pump Collection Systems – Section 5.0 F).
10. No rear yard drainage system shall be constructed until rear yard grading is completed and approved.

A. SLOPE REQUIREMENTS

1. Protective perimeter slope: A minimum slope of 5% is required for areas within 10 feet of building perimeter.
2. Minimum ground slope for any portion of the site shall be two (2) %. A one (1) % minimum will be considered for occasional use.
3. Drainage swales along side and rear property lines, and the protective swale around buildings shall generally have a two (2) % slope. A one (1)% minimum will be considered for occasional use. Rear yard swales shorter than 300 feet may have a minimum slope of 0.8%.
4. Maximum ground slope for any graded portion of the site shall be 25% (one (1) vertical to four (4) horizontal). A maximum slope of 33% (one (1) vertical to three (3) horizontal) will be considered for occasional use and for side slopes of landscape berms. Retaining walls will be required where these slopes cannot be met.
5. Retaining wall structural calculations will be required for any retaining wall greater than 2.5 feet.

B. PLOT PLAN REQUIREMENTS

1. Prior to issuance of a building permit the permit holder shall submit a plot plan drawing to the Building Department for review and approval. All grades shown on the plot plan shall be in accordance with the approved subdivision grading plans. All plot plans shall be in accordance with an accurate boundary line survey and include the following information:
 - a. Date of plan or revision, north arrow, drawing scale, property address, sidwell number, and legal description of property.
 - b. Provide site benchmark on USGS datum.
 - c. All existing and proposed water courses, swales and ditches.
 - d. Elevations at each lot corner and grade change points.
 - e. Finish grade and finish floor elevations for first floor, garage and basement. Provide finish grade elevation of adjacent houses. Please indicate if the adjacent lot is vacant.
 - f. All overland drainage routes must be maintained. The lowest house grades are to be a minimum of one foot higher than the highest overland flow route elevation.
 - g. Location of all the new construction on the site and distances from lot lines.
 - h. Ensure architectural plan elevation and footprint match plot plan.
 - i. All proposed and existing utility structures, with as-built rim elevation and finish grade elevations for hydrants.
 - j. Sidewalks and driveways (with elevations). Please indicate driveway slopes, they shall be less than 10%, preferred slopes for driveways are 2-8%. All sidewalks and driveways shall be ADA compliant. Driveway locations shall match the approved plans. Show 5-foot wide concrete sidewalk along right-of-way with proposed grading as appropriate for development.
 - k. All setback and easement locations.
 - l. Wetland boundaries, water surface and floodplain elevations.

- m. Show and label all easements.
 - n. Sanitary sewer lead location shall be shown at the as-built location with invert elevation. Provide proposed grade of the sanitary lead.
 - o. Provide sump lead location. Sump leads shall have a minimum cover of 2 feet at the building and a minimum of 3 cover in all other locations. The sump lead must connect above all trunk line pipes at structures.
2. Prior to backfill inspection as-built brick grade elevations must be submitted for review and approval by the Building Official.
 3. Prior to issuance of a Certificate of Occupancy a Final Grade Certificate must be submitted and approved by the Building Official indicating that all lot grading has been done and accomplished in accordance with the approved plot plan (within an allowable tolerance of plus or minus 0.25 feet). A temporary Certificate of Occupancy may be issued by the Building Official upon the posting by the permit holder or his authorized agent, of a cash bond in the sum of one thousand dollars (\$1,000), said bond to be released upon satisfactory completion of grading and the submission and approval of a grading certificate as hereinbefore provided.

15-37 GRADING PERMIT

- A. It shall be unlawful to change the grade of land so as to affect the drainage or change the drainage pattern of any land or part thereof, without first obtaining a grading permit from the Lyon Township Building Department.
- B. Where an applicant has received a site plan approval, subdivision grading plan approval, or soil mining and filling license, in accordance with the applicable ordinances, the applicant shall not be required to submit a separate grading plan.
- C. Most activities that fall under the Lyon Township Grading Permit will also require an Oakland County Water Resources Commissioner Soil Erosion Control permit.

15-38 to 15-39 RESERVED.

ARTICLE VII- PAVING

15-40 GENERAL

This standard establishes the minimum requirements for paving in the Township.

15-41 NON-PUBLIC STREETS & PARKING LOTS

The design of non-public streets and parking lots shall conform to the Lyon Township Private Road Ordinance (for roads) and the following standards:

1. Parking lots shall be of the size and configuration as required by the Lyon Township Zoning Ordinance.
2. The minimum grade on any roadway, except parking areas, shall be 0.5% for concrete pavement. Minimum slope on asphalt surfaces is 1%. The maximum grade allowed on any surface type is 6.0%. In parking areas the minimum grade allowed on any surface is 1%.
3. The intersection radii in residential developments shall be a minimum 25 feet.
4. The intersection radii in industrial developments shall be minimum 35 feet. Radii for commercial developments will be evaluated on a case-to-case basis.
5. The minimum length of vertical curves shall be 100 feet for grade changes greater than 2%.
6. The minimum radius in horizontal alignment is 250 feet. When reverse curves are used provide a minimum 100 feet tangent.
7. Approaches to any sites from roads under the jurisdiction of the Road Commission for Oakland County (R.C.O.C.) or the Michigan Department of Transportation (M.D.O.T.) shall be designed according to their criteria. Approval of these improvements by the above agencies must be obtained and furnished to the Township Engineer prior to Township approval of the paving. Passing lanes and acceleration/deceleration lanes are required by the Township on connections to all paved roads under R.C.O.C. or M.D.O.T. standards.
8. All paved areas shall be designed to meet current Americans with Disabilities Act (ADA) requirements.

15-42 MATERIAL REQUIREMENTS

1. All paving material for non-public streets, sidewalks and bike paths shall conform to the requirements of the Road Commission for Oakland County and the M.D.O.T. Standards and Specifications, current edition.
2. Parking lot pavement material shall be as follows:

Concrete pavement: 6" non-reinforced concrete over 6" compacted subgrade.

Asphalt pavement: A minimum of 3" MDOT 1100 mixture over 6" MDOT 21AA gravel or 8" of MDOT 22A gravel. Base material shall be placed over 6" of compacted subgrade to 95% modified proctor.

15-43 PUBLIC STREETS

All streets within public right-of-way shall be designed according to the criteria and specifications of the R.C.O.C. or M.D.O.T.

15-44 SIDEWALKS AND BICYCLE PATHWAYS

This standard establishes the minimum requirements for pathways, sidewalks and sidewalk repair in the Township.

A. Design Requirements

Where pathways are proposed or required, they shall be indicated on the site plan. Proposed grades shall be indicated at the lot lines.

1. The pathway shall be ten (10) feet wide and located one (1) foot inside the existing or proposed right-of-way line of public street.
1. Pathway material shall be 3" MDOT 1100 mixture on 4" of MDOT 22A gravel. Where the pathway crosses driveways, the material shall be 6" concrete.
2. The existing subgrade shall be compacted to 95% modified proctor and must have a soil sterilant applied prior to placing base material.
4. All pathways should be in compliance with current AASHTO geometric standards.

5. Pathways shall be designed to meet current ADA requirements.

Where sidewalks are proposed, they shall be indicated on the site plan. Proposed grades shall be indicated at the lot lines.

1. The sidewalk shall be five (5) feet wide and located one (1) foot inside the existing or proposed right-of-way line of public street.
2. Sidewalks shall extend through all driveways without steps.
3. Concrete sidewalks shall be four (4) inches thick, except at driveways where they shall be six (6) inches thick. Concrete for sidewalks shall have a 28 day compressive strength of at least 3,000 pounds per square inch.
4. Sidewalks shall have a transverse slope of 1/4" per foot. The maximum longitudinal slope shall be 5%.
5. All sidewalks shall be designed to meet current ADA requirements.

15-45 FINAL ACCEPTANCE

- A. All public road systems shall be subjected to a Final Inspection by the Road Commission for Oakland County prior to acceptance of the system by the Township or issuance of a certificate of occupancy.
- B. A set of approved record drawings, together with copies of all material certifications, density testing reports, concrete cylinder test reports and any recorded easement shall be submitted to the Township prior to final acceptance.

15-46 TO 15-49 RESERVED.

ARTICLE VIII - PLAN REQUIREMENTS

15-50 GENERAL

This standard establishes the minimum requirements for engineering plans for submittal to the Township.

- A. Prior to starting any design, the design engineer is encouraged to make use of maps and information available at the Township and County

offices. It shall be the responsibility of the design engineer to verify utility locations provided by the Township, Oakland County or other agencies.

- B. A statement indicating that the design engineer has reviewed the Charter Township of Lyon Engineering Design Standards and other applicable ordinances and that the prepared work is in conformance with the standards and ordinances. All exceptions must be indicated. This can be submitted as a separate letter.

15-51 PLANS AND SPECIFICATIONS

The plans and specifications shall be prepared under the supervision of a Civil Engineer registered in the State of Michigan and the plans shall have imprinted thereon the seal and original signature of that engineer.

Plans shall consist of a title sheet, plan and profile, project specific notes and details, and standard detail sheets. Sheet size shall be 24" x 36", minimum scale of 1" = 50' horizontal and 1" = 5' vertical for plan and profile sheets (an overall development and/or utility layout plan may be at 1" = 100'). Details specific to the project shall be drawn at scale.

All plan sheets shall have a north arrow and all elevations shall be on U.S.G.S. (NAVD 88 or NGVD 29) datum.

Existing topography and proposed ground contours at a minimum of 2 foot intervals extending 100 feet past the boundary of the site. All existing ground elevations shall be shown to tenths of a foot.

A. TITLE SHEET

A title sheet, or the first sheet of a set of plans, shall show the following:

1. Project Title.
2. Name, address and phone number of proprietor.
3. Name, address and phone number of designing engineer.
4. The seal and signature of engineer responsible for the project.
5. Location map drawn to an appropriate graphic scale, generally not greater than 1" = 100' nor smaller than 1" = 2000', with North indicator, showing location of project area with respect to the surrounding area.

6. Reference bench marks, established at intervals not greater than 1,200 feet and on U.S.G.S. Datum, convenient to the proposed construction. Each benchmark shall be noted with number, location, description and established elevation. A minimum two bench marks shall be provided. The Township Engineer can provide a list of available benchmarks.
7. Name of the Township.
8. Legal description of the property.
9. Legend.
10. Plan completion date.
11. Dates of submittals and revisions.
12. Sheet Index.
13. Quantity List of Public Improvements.

B. EXISTING CONDITIONS / TOPOGRAPHIC SURVEY PLAN

ALTA plan or Certified Surveyor's Plan of the existing features and easements.

1. At a minimum, plan sheets shall include:
 - a. Existing site conditions, including but not limited to: ditches, culverts, utilities, sidewalks, utility poles, easements, building footprint and finish grade, finish grade of adjacent buildings, wetlands and woodlands, and floodplains.
 - b. Topographic elevations to a minimum of 100' beyond the property line.

C. GENERAL IMPROVEMENT PLAN

If a development can not be shown on one 24"x36" sheet at 1"=50' scale, then provide an overall plan that shows the proposed phasing, overall utilities and layout of the entire development.

The general improvement plan can also include general notes that are applicable to all drawings.

D. SOIL EROSION AND SEDIMENTATION CONTROL PLANS

1. Can be incorporated with Drainage Area plan sheet or other appropriate construction plan.
2. At a minimum, plan sheets shall include:
 - a. Location, types and details of perimeter and on-site sediment and erosion control methods.
 - b. An erosion control and construction sequence schedule.
 - c. Location and details of mud mats.
 - d. Location, dimensions, surface material and thickness, method of containment, and restoration of construction staging and equipment and material storage areas.
 - e. Construction sediment basins (when indicated on the plans or required due to site conditions):
 - i. Location of basin.
 - ii. Calculations for the size of the basin and amount of sediment loading.
 - iii. Method and/or location of conveying site runoff to the basin and erosion control measures along drainage route.
 - iv. Location, cross-section, and details of access route to basin for periodic dredging and maintenance.
 - v. Maintenance schedule for removing accumulated sediment. Note indicating method and location of disposal of sediment basin soils.
 - vi. Location and detail of basin outlet filter.
 - vii. Location and elevation of sodded emergency spillway.
 - viii. Location and detail of temporary security fencing.
 - ix. Cross-section of basin side slopes, top of bank/basin bottom elevations, inlet/outlet elevations, and water surface elevation/depth of storage.

- x. Plan or description for the removal of the temporary basin and restoration of the affected area once permanent control devices and stabilization are in place.
3. The following Erosion Control Standard Notes” shall be placed on the soil erosion and sediment control plans:
- a. All erosion and sedimentation control work shall conform to the current standards and specifications of the Oakland County Water Resources Commissioner (OCWRC) and the Charter Township of Lyon.
 - b. Daily inspections shall be made by the Contractor for effectiveness of erosion and sedimentation control measures. Any necessary repairs shall be performed without delay.
 - c. Erosion and any sedimentation from work on this site shall be contained within the work area and not allowed to collect on any off-site areas or in waterways. Waterways include both natural and man-made open ditches, streams, storm drains, lakes, ponds and wetlands.
 - d. The Contractor shall apply temporary erosion and sedimentation control measures as directed on these plans and where otherwise required by the work. The Contractor shall remove temporary measures as soon as permanent stabilization of slopes, ditches, and other changes have been accomplished.
 - e. Soil erosion control practices will be established in early stages of construction by the Contractor. Sediment Control Practices will be applied as a perimeter defense against any transporting of dirt off the work area.
 - f. The Contractor shall preserve off-site natural vegetation as much as possible.
 - g. Protect all existing trees, including their branches and roots, from damage due to this work unless specifically identified for removal.

- h. Stabilization of all disturbed areas shall be established using the appropriate vegetation within 5 days of completion of final grading.
- i. The Contractor shall sweep the existing streets surrounding the project site as needed.
- j. The Contractor shall be responsible for dust control and shall provide all equipment and material to keep dust in check at all times. The Contractor shall respond immediately to any and all complaints.
- k. The Contractor shall be responsible for obtaining the NPDES permit and ensuring compliance with all applicable permit regulations, including but not limited to, inspection, restoration and record keeping requirements. Reports from the Certified Storm Water Operator shall be made available to the Township.

E. GRADING PLANS

- 1. Scale of sheets shall be 1" = 50'.
- 2. As a minimum, plan sheets shall include:
 - a. Centerline of street stationing with centerline or top-of-curb elevations at 50-foot intervals.
 - b. Existing and proposed ground elevations shall be provided at all lot corners along the boundaries of the development and 50 foot intervals along all site boundary lines.
 - c. Street names, street widths, subdivision names, lot numbers and dimensions, and permanent parcel numbers and dimensions for all unplatted parcels for the site and adjacent properties.
 - d. Floodplain contour line, where applicable.
 - e. Wetland limits, where applicable and the name of the consultant that flagged the wetland limits.
 - f. All proposed and existing storm drainage facilities, storm sewers, manholes, catch basins and inlets including rim and end section finish grades, and all

existing and proposed utility structures (i.e., sanitary manholes, hydrants, etc.) with rim or finished grade elevations and invert elevations to one hundredths of a foot.

- g. All easements.
- h. Proposed top of curb or shoulder elevation opposite each front lot corner to hundredths of a foot.
- i. Finish grades are to be placed in rectangular boxes drawn to dimensions comparable to a typical house to be built in the development. A box shall be placed on each proposed lot according to the front yard setback. Indicate walkouts (w/o) on rectangle box.
- j. Proposed ground elevation at each lot corner (front and rear), and side lot elevations between houses to tenths of a foot.
- k. Provide sidewalk elevations at all lot corners to one hundredths of a foot. Minimum slope across walk shall be $\frac{1}{4}$ inch per foot.
- l. Provide elevations for pavement, sidewalks, parking islands and other locations as required by the Township Engineer.
- m. When swales for lot drainage are called for on the plan, swale elevations at the high point adjacent to the house, the back of the house, and the front of the house shall be provided. General flow direction of swales shall be shown with arrows.
- n. Drainage flow arrows shall be provided to indicate the direction of surface water drainage over the development.
- o. The 100-year overland flow route shall be shown.
- p. In residential developments each grading plan sheet shall contain a note indicating the location of footing drain/sump pump discharge.
- q. Indicate rear yard catch basins where required. The proposed rim shall be shown to the nearest hundredths of a foot.

Catch basins are required to be placed at a lot corner and the catch basin elevation shall be the only proposed elevation shown at that corner.

- r. Written description of proposed land use.
- s. Zoning classification of petitioner's parcel and all abutting parcels.
- t. Total acreage and net acreage (minus right-of-way).

F. PAVING PLANS

1. The plan portion of the sheet shall include, at a minimum:
 - a. Street names, street and easement widths, subdivision names, lot numbers and frontage dimensions, for all unplatted parcels.
 - b. Location of existing and proposed utilities crossing or within proposed right-of-way.
 - c. Existing easements on the site.
 - d. Existing adjacent streets.
 - e. Type of paving.
 - f. Radii of all curves.
 - g. Construction notes.
 - h. A tabulated list of quantities appearing on that sheet.
 - i. Sidewalks and approaches.
 - j. Proposed public street approaches with alignment and dimensions.
 - k. A striping and traffic control plan for the parking lot that indicates proposed loading areas.
2. The profile portion of the sheet, when applicable, shall appear below the companion plan portion, generally projected vertically, and shall show at least the following:

- a. Existing and proposed centerline.
 - b. Proposed top of curb.
 - c. Proposed storm sewer and or ditch.
 - d. Existing storm sewer facilities.
 - e. Stationing were applicable.
3. Cross-sections shall be provided with the following information:
- a. Paving type, thickness and specification.
 - b. Base type, thickness and specification.
 - c. Pavement width, crown and cross-slope.
 - d. Curb section (where applicable).
 - e. Subgrade treatment.

G. PLAN AND PROFILE SHEETS (SANITARY, WATER MAIN & STORM)

1. Each plan and profile sheet shall include a tabulated list of quantities appearing on that sheet.
2. Structures shall be identified by numbers assigned consecutively and increasing in direction opposite to direction of flow in each sewer.
3. The plan portion of sheet shall include, at minimum:
 - a. All existing or planned surface or underground improvements in streets or easements in which sewer construction is proposed, and in adjacent areas if pertinent to design and construction.
 - b. Street names, street and easement widths, subdivision names, lot numbers, lot dimensions, and parcel numbers and frontage dimensions for all unplatted parcels.
 - c. Location, length, size and direction of flow of each section of proposed sewer between manholes.

- d. Natural or man-made features such as drainage courses, county drains, lakes, wetlands and floodplains.
 - e. Locations of all manholes, ARV's, IFC's, BFC's, TFC's and other sewer appurtenances and special structures with ties to property lines.
 - f. Existing pipe inverts involved in the project.
 - g. House leads, wye branches or tee inlets, to be constructed with the proposed sewer, with locations at easement and/or property lines.
 - h. Limits of special backfill requirements.
 - i. A note stating that the Contractor shall adjust existing manhole covers, as required.
4. The profile portion of sheet shall appear below companion plan portion, generally projected vertically, and shall show at least the following:
- a. Size, length, slope, type and class of pipe, and bedding for each section of proposed sewer between structures.
 - b. Limits of special backfill requirements.
 - c. Profile, over centerline of proposed sewer, of existing and proposed finished ground and pavement surfaces.
 - d. Location of existing and proposed utilities crossing the line of the sewer or otherwise affecting sewer construction, with a note of caution.
 - e. Location of all proposed structures, with structure number, invert elevation/direction of all connecting pipes, top of casting elevation, and structure type.
 - f. Location of all house leads and wye branches to be constructed with the proposed sewer.
 - g. Length of risers.
 - h. Invert elevation at property line or easement line for house leads to be included with sewer construction.

- i. A note stating that the Contractor shall verify the location and elevation of all existing utilities prior to construction.
- j. In the profile view, all crossings of utilities must be shown. When a water main crosses a sanitary sewer, the top of pipe elevation of the water main shall be indicated. Minimum vertical clearance between utilities shall be 18 inches. Compacted sand backfill is required between utilities.

H. STORM WATER MANAGEMENT BASINS AND PRETREATMENT SYSTEMS

- 1. Storm water management basins and/or pretreatment systems can be placed on the storm drainage plan and profile sheets or on a separate plan sheet.
 - a. Design calculations for detention/retention basin volumes required and provided, sediment loading calculations, basin outlet restriction, and a plan of the drainage area tributary to the basin shall accompany construction plans submitted for review.
 - b. For all open detention/retention basins, indicate the top-of-bank, high water and bottom of pond elevations, and side slopes. Provide location, elevation and details of basin outlet restriction and emergency overflow spillway or manhole for detention basins.
 - c. For enclosed detention basins, provide high water and bottom of system elevations, cross-section or profile of system; location, elevation and details of outlet restrictor, and method of providing for emergency overflows.
 - d. For infiltration (recharge) systems, provide soil boring logs and soils analysis, volume requirements, percolation rate, infiltration/exfiltration design calculations, cross-section or profile of system, and method for handling emergency overflows caused by rainfall in excess of the design storm event or failure of the infiltration/exfiltration medium. Soil boring for retention basins also to show ground water level, and soil types.
 - e. For open basin pretreatment systems, provide storage volume calculations, top of bank, high water and basin

bottom elevations, side slopes, location of emergency overflow, and details of outlet control.

I. DETAIL SHEETS

1. The Sanitary Sewer, Water Main, and Storm Sewer Standard Detail sheets as adopted by Lyon Township and the Soil Erosion Control Detail sheets from the OCWRC shall be considered as a part of these design standards and shall be included as part of the construction plans. A copy of these details may be obtained from the Township's website.
2. Additional required details for the project construction can be provided on the appropriate plans sheet or on a separate detail sheet.
3. Scales for special details shall be selected to clearly portray intended construction and component or equipment arrangement. Scales used shall be clearly identified.

15-52 TO 15-54 RESERVED.

ARTICLE IX - RECORD DRAWINGS

15-55 GENERAL

This standard establishes the minimum requirements for record drawings in the Township.

Record drawings of water main, sanitary sewer, storm sewer, detention and retention basins, drainage ditches and swales shall be submitted for review and approval prior to acceptance of the improvements by the Township.

15-56 PLAN REQUIREMENTS

Record drawing information shall be provided on the original approved construction drawings and shall contain, but not necessarily be limited to, the following items:

1. General Items
 - a. 3 sets of record drawings plans shall be submitted directly to the Township Engineer for review.

- b. All record drawings shall contain a statement by an engineer or land surveyor, registered in the State of Michigan certifying that “the record drawings conform to the approved construction drawings”. The statement shall bear an original signature and seal of the engineer or land surveyor.
- c. All record drawing elevations shall be based on U.S.G.S. (NAVD 88 or NGVD 29) Datum.
- d. All record drawing information shall be clearly marked as such by adding an “AB” or “RD” after the updated information.
- e. Record drawing locations shall be shown on the plans to an accuracy of one (1) foot horizontal and 0.1 foot vertical.
- f. All location changes of 10 feet or more horizontally and .5 feet vertically shall be redrawn on the plan and the original location shall be crossed out (X-ed) on the plan.
- g. Once the record drawings are approved, 5 final sets of plans shall be submitted to the Township Engineer for distribution as required.
- h. An electronic copy (AutoCAD, Microstation, or shapefile) of the final plans shall be submitted to the Township Engineer so that the Township GIS utility database can be updated.

2. Water mains

- a. Location of all water mains with respect to property line, back of curb or edge of pavement.
- b. Rim elevation of gate wells.
- c. Fire hydrant bury line/arrow elevations.
- d. Top of pipe elevation at gate wells.
- e. A minimum of three witnessed dimensions (and a northing and easting coordinate) to each bend, hydrant, valve, gate well, meter pit, pressure reducing valve, water main stub, etc.
- f. A minimum of three witnessed dimensions (or a northing and easting coordinate) to each connection to an existing water main or restrained joint, and at each connection point for transition from ductile iron pipe (D.I.P.) to high-density polyethylene (HDPE).
- g. The distance between the hydrant and water main.

- h. Accurately locate all utilities (storm, sanitary, water main etc.) where the recommended separation horizontally or vertically is less than that required ten (10) feet horizontal and 18" vertical.
- i. The Liber and Page number for any easement obtained for water main as well as any existing easement involved in the project shall be noted.
- j. Length and location (witnessed to three (3) points) of any casing pipe.
- k. Materials installed:
 - (1) Size, length, type, class, joint and manufacturer of pipe.
 - (2) Size, brand and manufacturer of valves and hydrants.
 - (3) A total record drawing quantity list.

3. Sanitary and Storm Sewer

- a. Location of all sewers with respect to property line, back of curb or edge of pavement.
- b. Rim elevation of all structures.
- c. Pipe invert elevations at all structures, end-sections or headwalls.
- d. Percent grade of all pipe runs.
- e. A minimum of three witnessed dimensions (and a northing and easting coordinate) to each structure.
- f. A minimum of three witnessed dimensions to all force main bends.
- g. Length of pipe from center to center of manholes, and length of stubs out of manholes.
- h. Length and location (witnessed to three (3) points) of any casing pipe.
- i. Materials installed:
 - (1) Size, type, class, joint and manufacturer of pipe.

- (2) For pressure sewers, a diagram of all appurtenances in each valve structure shall be drawn with flow arrow.
 - (3) A total record drawing quantity list.
 - j. The Liber and Page number for each easement obtained for the construction of sewer as well as any existing easement involved in the project shall be noted.
 - k. House lead locations:
 - (1) Information shall be obtained from inspection records and transferred to the plans.
 - (2) Location of wye measured from downstream manhole.
 - (3) Length of lead.
 - (4) Length of any risers, if placed.
 - (5) Location of end of lead measured from downstream manhole.
- 4. Detention/Retention/Infiltration Basins
 - a. Width and length of top and bottom of basin.
 - b. Elevations at sufficient intervals to verify basin side slopes and capacity.
 - c. Location, width and elevations of basin overflow facility.
 - d. Invert elevation of inlet and outlet pipes.
 - e. Basin outlet restriction size.
 - f. Calculations of the basin volume between the high water elevation and the invert of the outlet pipe for a detention basin, and the bottom of the basin for a retention basin (based on as-built elevations).
- 5. Drainage Ditches and Swales
 - a. Location of centerline of all ditches and swales with respect to property lines.

- b. Elevations of top and bottom at lot corners.
- c. Elevations at top and bottom along all road frontages.
- d. As-built cross section of any ditch or swale.
- e. Elevations at all high and low points and 50' along the centerline of any ditch or swale.