SECTION IV

STORM WATER DRAINAGE SYSTEMS AND APPURTENANCES

A. GENERAL

No residential, commercial or industrial subdivision or development shall be approved unless it is served by storm water drainage and detention/retention facilities designed in accordance with this Section.

All storm sewers which are installed in the public rights-of-way or in public drainage and utility easements serving a central drainage system concept, shall be deemed to be dedicated to the Village of Northbrook upon acceptance of the subdivision.

Every subdivision shall have storm sewers separate and independent of the sanitary sewer system and with an adequate outlet or connection to all existing storm systems. The outfall of said storm sewer system shall be designed to prevent, through proper erosion controls, the transportation of eroded soil and floating matter to downstream points of discharge whether they be to rivers, creeks, lakes, detention/retention ponds or municipal or privately owned storm sewer systems.

Storm sewers and appurtenances shall be adequately sized to accept and convey storm waters from rainfall events of ten (10) year storms. Storm sewer systems shall be installed in accordance with the "Standard Specifications for Road and Bridge Construction", published by IDOT, and "The Standard Specifications for Water and Sewer Main Construction in Illinois", latest edition. Storm sewers emptying into a river or stream shall be designed using the ten-year frequency tailwater.

B. SERVICE AREAS

All storm sewers, streams, channels, ponds and basins shall be designed to accommodate all areas which naturally flow to the area of the development and also any additional areas which are planned to contribute to the drainage area as identified by the Village Engineer. If extending the ultimate service area beyond the natural drainage area limits served by the proposed development results in additional construction costs within the development, a written agreement may be made with the Village for the recapture by the owner or developer of the additional cost when future system extensions are made. By-pass flows are to be designed based on 100-year frequency storm.

C. PUBLIC EASEMENTS AND UTILITIES (See Section II - Water Distribution System and Appurtenances - page II-3)

D. SYSTEM EXTENSION/CONNECTIONS

The location of proposed extensions and connections to the existing storm sewer system shall be reviewed and is subject to the approval of the Village Engineer.

E. BOUNDARY FLOW WAYS

Where the storm sewer system is being designed for connection to a development and the tributary drainage area extends more than one hundred (100) feet beyond the boundary of the development, surface flow ways shall be constructed along the upstream boundary of the development in such a fashion as to intercept and safely convey and by-pass all storm water runoff from the upstream watershed. The by-pass flows must not increase upstream flood stage or increase downstream flood stage or velocity.

F. DESIGN

1. Storm Sewer, Stream Improvement and Open Channel Hydraulics

(a) Storm sewers, stream improvements and open channels shall be designed to provide adequate design flow capacity using Manning's formula:

$$Q = (A)\frac{1.486}{n}(R)^{2/3}(S)^{1/2}$$

Q = Flow
A = Cross-sectional area
R = Wetted perimeter
S = Slope

(b) Roughness coefficients ("n") shall be as follows:

(i) Concrete pipe - 0.013
(ii) Open channels, concrete or asphalt lining - 0.013
(iii) Open channels, sodded - 0.020
(iv) Improved stream - 0.025
(v) Natural stream - 0.050

(c) Minimum cleansing velocities shall be maintained and design mean velocity shall not exceed the following:

(i) Storm sewers - ten (10) feet per second
(ii) Open channels, concrete or asphalt lining - fifteen (15) feet per second.
(iii) Open channels, sodded - ten (10) feet per second.

(d) Storm sewer, including manholes, shall be constructed so that infiltration will not exceed four hundred (400) gallons per inch diameter of sewer per mile per twenty-four (24) hour day at any time for any section of the system.

Storm Sewer Pipe Diameter (in inches)	Maximum Manhole Interval Spacing (in feet)
10 - 24	350
27 - 36	400
42 - 54	500
60 or larger	600

Where flows and other conditions dictate, special reinforced concrete manholes or junction chambers shall be designed and constructed by the developer.

(e) Inlet grate capacities shall meet or exceed design flows. Double inlets shall be installed where flows warrant. Ponding on streets shall not exceed 1 foot in depth for a 100-year storm and be confined to the public right-of-way. Ponding

(f) in front yards is not allowed unless specifically approved by the Village Board and the ponding area is reserved by easement.

2. Sewer Size

Storm sewers serving inlets shall not be less than ten (10) inches in diameter.

Storm sewer house service lines shall not be less than four (4) inches in diameter.

Storm sewers of different inside diameters shall join only at structures. The invert elevations shall be adjusted to maintain a uniform energy gradient by matching the 0.8 depth points of the different diameters.

The end of storm sewer service leads shall be marked with a 4" x 4" x 10" hardwood stake.

3. Storm Sewer Depth/Size

Storm sewers shall be constructed with a minimum depth of cover of two (2) feet so as to prevent freezing and sized to provide an outfall for all storm water from a 10 year rainfall event within the ultimate service area, both existing and ultimate service area.

4. Storm Sewer Manholes

Manholes shall be located as follows:

- At the termination of all sewers which do not terminate at a catch basin, flared end section, headwall, clean out or inlet.
- At changes in direction, horizontal or vertical.
- At changes in pipe shape or size.
- At junctions with other storm sewers.

5. Storm Sewer Pipe

Storm sewer pipe class shall be determined based upon the manufacturer's standards, trench depth, width and backfill/cradle type.

Storm sewer pipe bedding shall be to the spring line of CA-11 crushed aggregate except when located in easements in which case no bedding shall be used and joints shall be C-443. Approved trench backfill shall be used under and within all pavements, curbs and sidewalks 1 to 1 slope from surface to trench bottom.

Storm sewer pipe concrete cradle, arch, or fill encasement shall be constructed whenever dictated by trench or embankment conditions.

6. Storm Sewer Pipe Alignment/Size

Storm sewer shall be laid using a laser beam and be straight in both horizontal and vertical planes between manholes, unless otherwise approved by the Village Engineer. Adequate separation from wells/water mains and water services shall be provided in accordance with state law.

All open channels and storm sewers must be sized by the Rational Method of runoff determination for service areas up to 50 acres on the basis of a ten (10) year storm event and shall be sized to adequately carry all tributary areas. The size calculations shall take into account the receiving sewer or channel capacity. Inlet time shall be assumed not to be greater than fifteen (15) minutes.

$$Q = C\,i\,A$$

Where:
- Q = Runoff flow, cubic feet per second (CFS)
- C = Runoff coefficient, characteristic of tributary drainage area in dimensionless units (C)
- A = Tributary drainage area, (acres)
- i = Average rainfall intensity, (inches per hour) using Village routing table, page D-29

Rainfall intensity:

The average rainfall intensity used for design shall be selected from Rainfall Intensity - Duration curve data as published in the Illinois State Water Survey Bulletin No. 70, Chicago area Sectional Zone 2 (NE).

(1) Underground storm sewer water conduit sizes shall be determined using a minimum of a ten (10) year storm.

(2) Surface streams and open channels shall be designed using a twenty-five-- (25) year storm event, contained within stream or channel banks, including at any culverts.

(3) Overland flow and overbank flow shall be designed for a one-hundred (100) year storm event, such that the storm flow can be conveyed to a storm water basin or downstream system without endangering structures or roadways. The overland flow way shall be clearly identified on the design drawings.

Runoff Coefficient:

(1) The runoff coefficient C is the ratio of runoff to rainfall and shall be assumed as follows:

(a) all impervious areas (paved or hard surfaced areas, including gravel, decks, patios, pools, ponds of all types and buildings), C shall equal 0.95 (water surface C = 1.0).

(b) all pervious areas such as lawn areas (all areas not classified as impervious), C shall equal 0.50.

(2) The runoff coefficient used in design shall be the weighted average for the proposed tributary watershed.

(3) Within a development, the runoff coefficient shall be computed assuming ultimate development and a minimum future impervious area of fifty (50) percent of the design area. Where ultimate development plans are not available at the time of the design of the storm sewer system, a runoff coefficient will be selected by the Village Engineer, based on the zoning classification, knowledge of the specific development and the previous experience of the Village with similar developments. The area within the watershed, but outside the development, shall be computed for existing conditions if future development will be under Village control.

7. Drainage Computations

The drainage area, in acres, used for design shall be the entire watershed service area tributary to the point in the drainage system under design. It shall include any tributary service area that may be outside the development.

Two copies of the design computations prepared by a registered/licensed professional engineer for the following facilities together with one drawing defining each drainage area shall be submitted to the Village Engineer for review.

(a) On site ditches, swales and storm sewers:

Storm sewers shall be designed to flow full with a minimum velocity of three (3) feet per second and a maximum velocity of ten (10) feet per second.

Minimum grade for a grass bottom ditch shall be 1.0 percent. For lesser ditch grade, the engineer shall submit design for paved invert or underdrain system as directed by the Village Engineer.

(b) Street drainage design:

Surface drainage inlets shall be provided so that surface water is not carried across any street intersection, parking lot or depressed drives. Surface runoff shall not extend a distance of more than four hundred (400) feet along the surface of the ground. Inlets shall discharge into storm sewers and shall not discharge into side lot or rear lot drainage ditches. Inlets/catch basins shall be provided at all low points. Rear yard inlets and catch basins having a minimum diameter of four (4) feet shall be provided where necessary to comply with these Standards. Overland flow maximum depth allowed at centerline of roadway is 1.0 foot based on a 100-year storm event.

(c) Vacant lot drainage design:

Positive drainage and soil erosion control shall be established for each lot whether or not it is intended for immediate construction of a building.

(d) Parking lot drainage design:

Overland flow within and from parking lots shall be shown by arrows on design drawings. Inlets and catch basins shall be provided so that flow from said lots is not carried across any public sidewalk line or across or around any major intersection. The maximum depth for storm water detention provided in parking lots shall be limited to one (1) foot.

The minimum longitudinal slopes shall be 0.5% and the maximum shall be 5% in the paved area of the parking lot. The inlets/catch basins, where up to one (1) foot of water is ponded, shall be located in driving aisles wherever possible.

Restrictors shall be of the trapped pipe kind and shall be securely cemented and mortared in place. The minimum restrictor size shall be 2 1/2-inch diameter, unless approved by the Village Engineer to be smaller to restrict the 2-year and less design storms.

An additional 1 1/2" storage depth of parking lot detention must be provided initially to allow for future parking lot resurfacing.

(e) Building drainage:

The point of discharge of sump pumps shall be shown on the Development Plan for each building served having a basement or crawl space. Storm sewer service lines from that point shall be provided to the storm sewer system.

Buildings shall be positioned on lots and the lots graded to drain away from the building to the lot line swales or ditches, which shall merge as quickly as possible and then discharge into a storm sewer. The route of flow of storm water away from each building into swales, ditches and storm sewers, to where it leaves the site, shall be shown on the engineering plans.

(f) Sediment control basins:

Temporary sediment control basins shall be constructed and adequately sized. Retention ponds shall be overexcavated (10%) to accommodate future sediment. For aquatic life purposes, ponds shall maintain minimum ten (10) foot depths.

G. DESIGN FLOW

Design flow used in sizing storm sewers and flow ways shall be the sum of the runoff determined as described above plus the release rate from any existing storm water holding facilities tributary to the point under consideration.

H. CONVEYANCE

1. Swales

All swales shall have a minimum width of eighteen (18) inches, must be sodded and limited to a maximum water depth of twelve (12) inches. Maximum side slopes of swales shall not be steeper than three- (3) horizontal to one (1) vertical with a minimum longitudinal slope of 1%.

Underdrains may be required by the Village Engineer.

2. Open Channels

(a) Open channels in nonresidential areas may be provided at the option of the Village Engineer in lieu of enclosed storm sewer pipe when the channel will be draining large areas.

(b) All open channels located within a development or located on public property or easements adjacent to the development and other open channels within one hundred fifty (150) feet of the development shall be improved as follows:

(1) Maximum side slopes shall be three (3) horizontal to one (1) vertical with a minimum one (1) foot bottom width.

(2) A four (4) inch minimum diameter underdrain with filter cloth and washed stone, paved invert, or other flow line protection measures may be required in channels with minimal slopes.

(3) The sides shall be stabilized with approved vegetation or structural measures, as approved by the Village Engineer.

(4) An easement for drainage, access and public utilities shall be provided along the open channel with a width adequate to include the area covered by the limits of a one hundred- (100) year storm event.

(c) Open channels of trapezoidal design may, at the option of the Village Engineer, be provided in lieu of enclosed storm sewer pipe in hardship cases provided a minimum ten (10) foot access easement adjacent to the open channel for maintenance is provided.

(1) The channel will serve as the outlet for the enclosed storm sewers from a large drainage area.

(2) No major open channel shall be permitted within thirty (30) feet of a habitable residential structure. Said channel must be designed to where the 100 year frequency high water level will be at least two (2) feet below the finished first floor or lowest building opening.

(3) The Village Engineer may require that the channel be concrete lined to reduce maintenance costs and retain conveyance capacity.

Where an existing river/creek traverses a proposed development, the river/creek and/or culverts shall be cleaned and the channel reshaped by excavating a trapezoidal channel. The cross-section shall be determined by Manning's Formula for a minimum one hundred- (100) year storm event. All State and Federal permits, as required, must be obtained by the developer.

3. Driveway Culverts

In areas where there is no storm sewer system, the Village Engineer may permit an open channel storm water drainage system with sodded swales and adequately sized driveway culverts. The minimum allowable culvert size shall be twelve (12) inch diameter with eight (8) inch minimum depth of cover, and of sufficient length to afford acceptable driveway side slopes with culvert flared end sections or poured in place concrete headwalls. Reinforced concrete pipe with a minimum of 4 inch crushed aggregate (CA-11) bedding is required. The culvert pipes must be adequately sized for the anticipated 25-year storm frequency storm water flows and at a location and elevation approved by the Village Engineer.

I. STORM SEWER CONNECTIONS

Storm water runoff shall enter the underground storm sewer system only through inlets, catch basins, headwalls and flared end sections after passing over the surface of the ground or through storm sewer service line connections designed to receive flow from a single building. Storm sewer service lines must be designed, sized and positioned to receive the storm water runoff from roofs, parking lots, driveways, areaways, window wells, footing drains and sump pumps. All storm water sump pumps for new construction, including additions, shall be connected to an underground storm sewer system where such system is available.

If either a storm sewer service line connection or connection to the storm sewer system is contemplated as a part of a development and is intended to receive other than pumped flow, the inlet time assumed in determining the time of concentration used in the design of the storm sewer system shall be reduced to five (5) minutes maximum.

J. STORM WATER DETENTION/RETENTION REQUIREMENTS

1. General

It is recognized that the receiving streams within the Village do not have the capacity to receive and convey the increased storm water runoff resulting from rapid urbanization occurring in many areas. These receiving streams are subject to frequent flooding which results in a growing rate of property damage.

2. Release Rate

The release rate of storm water for design frequencies of 10 year and 100 year storms from all developments requiring detention shall not exceed the storm water runoff from the area in its natural undeveloped state or shall not be greater than 0.15 cfs per acre. Where determined to be practical by the Village Engineer, the release rate of storm water

for design frequencies for storms of 2 year and less shall not be greater than 0.04 cfs per acre.

The release rate and required detention/volume shall be limited to the carrying capacity of downstream natural channels and downstream storm sewer capacity.

Such release rate shall also be limited to a rate that will, in the opinion of the Village Engineer, not cause overland flooding of existing homes nor exceed the capacity of the downstream receiving sewer system or regional outfall when runoff from other sources is considered. For this purpose the capacity of downstream sewers shall be taken to mean the capacity when flowing full with no surcharge. When considering downstream sewers, runoff from upstream watersheds shall be based on the Design Storm Event. When considering downstream natural or other surface water courses, surface drainage runoff shall be based on a minimum 100-Year Storm Event.

3. Bypass and Underdrain System

Drainage systems shall have adequate capacity to bypass through the development the flow from all upstream areas for a storm of design frequency assuming that the land is in a fully developed state under present zoning or zoning proposed under a comprehensive plan. The maximum bypass flow rate shall be computed utilizing a composite runoff coefficient of not less than 0.70 in an urban area. An allowance will be made for upstream detention when such upstream detention and release rates have previously been approved by the Village Engineer and that evidence of its construction and satisfactory operation can be shown.

Storm water detention basins designed to drain dry shall be sodded and constructed with an underground piping or concrete invert low flow system between the inlet and outlet.

A minimum bottom slope of two (2) percent is required, with an underdrain piping system and a subsurface filter cloth provided for all detention pond bottoms. Underdrains in ditches shall be laid in the flow line. Cleanouts shall be provided at the upstream end of all subsurface drains. Those drain pipes shall be of perforated PVC, minimum size four (4) inch diameter, with a filter cloth and a minimum six (6) inch thick washed gravel on all sides.

4. Service Area

The tributary area for storm water holding facilities shall be submitted to the Village Engineer.

5. Design Standards

The retention/detention storage to be provided shall be calculated on the basis for the 100-year storm rainfall as published by the Illinois State Water Survey - Bulletin No. 70 for this area. The required detention storage volume must be a minimum of 115% of the calculated amount necessary to handle the runoff of a standard 100 year rainfall, for any and all duration's, from the fully developed drainage area tributary to the reservoir, less that volume discharged during the same duration at the approved natural state release rate. The volume of retention/detention facilities shall be designed to exceed the

minimum standards of the MWRDGC's "Manual of Procedures for the Administration of Sewer Permit Ordinances", latest edition.

In order to prevent soil erosion and to reduce weed problems, detention basins must be landscaped including the establishment of a ground cover over all unpaved areas through sodding or other approved means which result in a quality of ground cover comparable to that obtained through sodding. Public detention facilities shall be usable as active recreational areas during dry weather conditions. Detention facilities must be designed so that the cross slope is at least two (2) percent. The entire bottom of the facility shall be provided with an underdrain (minimum four (4) inch diameter perforated drain tile) covered on all sides with a minimum of six (6) inches of washed stone. The underdrain shall be installed to drain the basin's bottom "dry" below grade during periods of low flow and shall connect to a storm sewer outfall pipe. Public detention facilities shall be designed with side slopes not steeper than four- (4) horizontal to one (1) vertical, preferably at a five (5) to one (1) slope. In certain situations, the Village Engineer may approve a stone retaining wall. Walls over 2.5 feet high will require protective fencing at the top. In no circumstances will it be allowed that walls of any kind be constructed on all sides of the detention facility. At least one side of the detention facility shall have a side slope of not steeper than 4 (horizontal) to 1 (vertical).

Retention ponds shall have a maximum two (2) foot horizontal to one (1) foot vertical side slope (2:1) from a point two (2) feet above normal water level, down to a point two (2) feet below normal water level. This 2:1 sloped area shall be covered with a layer of stone rip-rap, with a minimum diameter of four (4) inches or other approved shoreline erosion protection. The area between the top of the 2:1 slope and the high water level must be protected by sodding in order to prevent soil erosion. At the toe of the 2:1 slope, an eight- (8) foot wide safety ledge shall be provided. Beyond the safety ledge, the pond bottom shall slope at two- (2) horizontal to one (1) vertical (2:1) down to the pond bottom elevation. A minimum of 25% of the pond bottom elevation shall be ten (10) feet below normal water level to protect aquatic life from winterkill. Points of inflow to the pond shall be accessible to construction equipment for dredging as necessary. If retention facilities are designated for recreational purposes, appropriate consideration shall be reflected in the design for maintenance of fish life, boating and safety. If required by the Village Engineer, all retention ponds shall be provided with shoreline access ramps, submerged safety ledges and aeration equipment acceptable to the Village Engineer.

Roof detention and "under-building" storage is prohibited.

The basis for design for flood storage and/or sustaining water level, including geotechnical data, shall be submitted with the engineering plans together with a topographic drawing indicating the high water elevation and relief overflow path.

<u>Design formula for storm water holding reservoirs:</u>

Required storage for storm water holding reservoirs shall include the volume computed in accordance with the MWRDGC's Design Manual and the design formula and the resultant storage multiplied by 115%. Rainfall intensities shall be from Technical Bulletin No. 70 Zone 2 (NE) and subsequent updates issued by Illinois State Water Survey or latest available data for the Chicago area.

Alternate methods of storm water basin design such as TR55 may be utilized by the design engineer provided it meets or exceeds the requirements of MWRDGC and the Village.

Streets or homes built adjoining retention/detention facilities in flood prone areas shall meet the requirements of current Village, MWRDGC, FEMA and IDOT flood plain regulations.

In the event that the Village elects that pond ownership shall remain with the developer or property owner's association, the responsibility for the expense of maintenance and operation shall be determined in a written agreement with a copy being retained in the office of the Village Engineer and/or as noted on the Subdivision Plans. It must be submitted prior to approval of project plans. In such cases, easements shall be provided for the inspection of the facility and for emergency maintenance by the Village Public Works Department at the developer's expense in case of failure by the developer or his successor to properly maintain the facility. Such agreements and easements are to be included as part of the final plan submittal and Plat of Subdivision and properly recorded against the title of the property.

The detention/retention facility shall be located in the front or corner side yards of a lot(s) wherever practical based on topography and outfall location. When the Village Engineer determines that it is impractical to locate the facility in the front or corner side yard, the facility can be located in the rear of the lot, provided that the necessary access easements are provided and a covenant or other appropriate legal document is executed and recorded to ensure that the facility remains visible from the public right-of-way for inspection purposes.

A stormwater treatment structure, type and size to be approved by the Village Engineer, must be provided for all underground detention systems on all properties that are 0.5 acre, or larger in size.

All private underground detention systems must be inspected and cleaned a minimum of once a year by a licensed contractor retained by the property owner with a copy of the Inspection Report, which will include a closed circuit television CD, provided to the Public Works Department for verification. Any identified maintenance work must be immediately completed by the owner.

6. Compensatory Storage

In addition to storm water volume storage provided as described above, additional compensatory storage shall be provided for the "Historical Storm of Record". Current maps, identified as the Floodway and Flood Insurance Rate Map, are available for inspection in the office of the Village Engineer. Areas identified as "Floodplains" and "Floodways" are delineated on this map. The watershed tributary to a proposed reservoir must lie within 90% of the floodplain so delineated, and the finished grade within the floodplain shall be altered as part of a development in such a manner as to not reduce the storage volume available or increase the velocity or high water level for storm water that would otherwise be available if the topography were to remain in its natural state. Compensatory storage equal to 110% of the volume lost shall be included in the required

storage capacity of the reservoir. Compensatory storage volume shall be provided below the flood crest elevation of the floodplain for the "Historical Storm of Record."

7. Small Developments

Where the area of a development is less than 1 acre, the Village Engineer may, at his option, exempt the developer from the storm water holding reservoir requirements if immediate downstream flooding conditions will not be significantly impacted. Such option shall require a cash payment of $1.60/SF for all new impervious areas, with the collected monies deposited in the impervious surface fees revenue account in the Annual Budget.

8. Reservoir Outlet

The reservoir outfall system shall include the outfall structure itself and the outfall sewer conveyance system proposed for construction. The facility is to be maintained and operated by gravity wherever feasible in the opinion of the Village Engineer. Pumping will not be allowed in residential areas and in commercial/industrial areas only where necessary and where adequate maintenance staff by the owner is available. When pumping is required, a low maintenance, energy efficient pumping station with backup power provisions meeting the detailed requirements of the Village Engineer shall be provided. The outfall sewer shall meet all the applicable requirements for storm sewers and appurtenances (previously described) in these Standards.

The maximum allowable release rate shall be limited to the amount determined as previously described. In the case of pumping facilities, the control shall be the capacity of the pumps. In the case of gravity flow, the control may be either a mechanical device, limiting the flow to the design capacity regardless of upstream or downstream hydraulic conditions, or a hydraulic control with a variable release rate with a maximum no greater than the maximum allowable release rate described above.

The maximum capacity of a outlet structure shall be its capacity with water in the reservoir at the design high water level and the water in the downstream receiving sewer at the crown of the sewer or, in the case of a surface receiving channel, with the water level at the hydraulic gradient under design storm conditions. An approved overflow point(s) shall be designated at 0.1 feet above design high water. Other edges of the detention area shall be 0.5 feet minimum above design high water to direct any overflow to the designated overflow.

9. Secondary Benefits

The design of storm water holding facilities for low annual maintenance costs and to provide secondary aesthetic, recreational and other benefits is encouraged. Approval of the details of design for such secondary benefits is required as necessary to protect public health and safety and adjacent property values.

10. Storm Water Pumping Facilities and Force Mains

If necessary, for commercial or industrial properties, pumping facilities shall be designed in accordance with good engineering practice and the detailed requirements of the Village Engineer. Standby power and maintenance staff shall be required.

11. Control Facilities

When required by the Village Engineer for those pumping facilities where satisfactory performance is considered particularly critical, telemetering control and report back capability to the Village Public Works Department will be required.

12. High Water Level

Design high water level for storage in a reservoir shall be set at such an elevation that, for 115% of the 100 year storm, all flood water from the upstream watershed shall be confined within the underground storm sewer system and surface flow-ways, if any, leading to the reservoir. Drainage easements shall be provided.

13. Guard Rails and Fencing

All sharp or vertical breaks in grade at inlet and outlet structures shall be protected with guard rails or fencing. When, in the opinion of the Village Engineer, such local areas cannot be adequately protected or where other hazardous conditions may exist, or when side slopes generally exceed one (1) vertical to three (3) horizontal, the entire reservoir shall be fenced with a locking gate.

14. Willow Trees

All existing willow trees within seventy-five feet (75') of any proposed stormwater facility and inlet/discharge pipe(s) shall be removed. If any applicable willow trees are not located on the property to be developed, the developer will use its best efforts to obtain approval from the appropriate property owner(s) for their removal. If the removed willow tree is the only tree within 1,000 square feet, then one new tree (minimum 3' diameter) must be planted on the property in which the willow tree was removed from.

K. MATERIAL SPECIFICATIONS

All storm sewer system elements shall conform to the following specifications:

1. Sewer Pipe

(a) Sump pump services (4") and small storm sewer lines (6" to 10") – PVC SDR 26 sewer pipe ASTM D-3034 or Ductile Iron Class 52 pipe.

(b) Reinforced concrete pipe (12 inch diameter and larger), circular reinforcement, minimum Class III, ASTM C76.

(c) Reinforced concrete arch culvert pipe - double line reinforcement, minimum Class III, ASTM C506.

(d) Reinforced concrete elliptical culvert pipe - minimum Class HE-III or VE-III, ASTM C507.

(e) PVC underdrain pipe (4 and 6 inch diameter) - ASTM D2729, SDR26.

2. Sewer Pipe Joints

(a) PVC pipe - ASTM D3212, push-on type, except underdrain pipe, which shall have solvent, welded joints.

(b) Reinforced concrete pipe - ASTM C443 ("O" ring), or mastic joint sealer.

(c) Reinforced concrete arch or elliptical pipe - ASTM C877.

3. Casing Pipes

Steel pipe - ASTM A120, 3/8 inch minimum wall thickness with 1/2 inch bond weld, bituminous coated.

4. Manholes and Catch Basins

(a) Precast circular reinforced concrete structures - ASTM C478 and ASTM C443.

(b) Size:

- For sewers 18 inches in diameter or less, manholes shall have a 48-inch inside diameter.

- For sewers 21 to 36 inch in diameter, manholes shall have a 60" inside diameter.

- For sewers greater than 36 inches in diameter, manholes shall have an offset riser pipe of 48 inch inside diameter.

- Inlets shall have 24 inch inside diameter and a maximum depth of four (4) feet.

(c) Adjustment:

- No more than three (3) precast concrete adjusting rings with a twelve (12) inch maximum height adjustment shall be allowed.

(d) Pipe and frame seals:

- All pipe connection openings shall be precast with mastic watertight pipe to manhole seals. External flexible watertight sleeves may also be used from the manhole cone to the manhole frame.

(e) Bottom sections:

- All bottom sections shall be precast concrete including bases and poured concrete invert flowlines.

- Catch basins shall have a minimum diameter of 48 inches and sumps of 30 inches.

5. Castings

(a) Manhole frame and cover - Neenah No. R-1712 embossed "STORM SEWER", or Neenah R-1772-C in grass areas.

(b) Manhole steps - Neenah No. R-1981-I or approved plastic.

(c) Six (6) inch curb and gutter inlets – East Jordan 7220 catch basin curb inlet, heavy duty with M1 grate and T1 back.

(d) Four- (4) inch curb and gutter inlets - Neenah No. R-2015 or Neenah No. R-3501-D2A.

(e) Yard inlets - Neenah No. R-4340-B.

(f) Parking lot inlets - Neenah No. R-2502.

(g) Neenah "Vane" type open grates shall be utilized in gutter sections roadway troughs to improve the hydraulic capacity where dictated by flow calculations (Neenah R-3588-L or R-3501-TR).

(h) All grates shall be bicycle-safe, as applicable.

6. Crushed Granular Bedding

Crushed aggregate - CA-7, CA-11, or approved equal.

7. Headwalls/Flared End Sections

Storm pipes discharging to rivers or streams shall terminate at a reinforced concrete headwall with wing walls or with a precast concrete flared end section and rip-rap, as permitted by the Village Engineer, IDOT (Division of Water Resources) and/or U.S. Army Corp. of Engineers.

Approved grating and/or screens with locking devices shall be installed on all end sections and headwalls unless waived by the Village Engineer.

8. Loadings

The depth to which a particular type or class of pipe may be used shall be selected to provide protection against structural failure when subject to all future dead loads, live loads and impact. For design purposes, live load plus impact shall be assumed to be in

no case less than that resulting from a surcharge at the ground surface of 250 pounds per square foot.

In computing trench loading, the Marston formula or table based on the Marston formula shall be used with proper consideration for pipe material, class, trench width and depth.

9. Remedial Residential Work

In existing residential areas where remedial drainage work is being performed, other types of plastic pipe and drainage structures such as those supplied by Advanced Drainage Systems (ADS) and Nyloplast Engineered Surface Drainage Products may be used with written approval from the Village Engineer.

10. Underground Detention Systems

Pre-cast, or cast-in-place, reinforced concrete only.

L. CONSTRUCTION REQUIREMENTS

Construction requirements for the installation of storm sewers are identical to sanitary sewer construction.

Construction requirements for drainage swales, retention/detention facilities and open channels shall be in accordance with IDOT and MWRDGC Standard Specifications and these Standards.

The contractor is responsible for the construction techniques, procedures and compliance with O.S.H.A. standards to insure a safe and proper installation.

1. Storm Sewer Appurtenances

All appurtenances shall be constructed of precast units or be poured in place.

If castings must be adjusted to meet the finished grade line, all adjustments are to be made with precast concrete rings. All adjusting rings must be sealed to the casting, as well as to the cone section of the structure with mastic and mortar. The maximum height of adjusting rings shall be twelve (12) inches.

All headwalls and spillways must be poured in place concrete or precast and shall be designed in accordance with the State Standard Specifications.

2. Channels

Channels and paved inverts shall be made to conform accurately to the proposed profile and shall be brought together smoothly with well-rounded junctions, satisfactory to the Village Engineer.

3. Backfilling

The space between the sides of the excavation and the outer surfaces of the storm sewer manholes shall be backfilled with selected granular backfill if the manhole is in a

pavement or if the nearest point of the excavation for the manhole falls within two (2) feet of the pavement edge.

If the structure falls beyond these limits, other backfilling materials may be used, provided they meet with the approval of the Village Engineer.

4. Cleaning

All newly constructed manholes, inlets and catch basins shall be cleaned of any accumulation of silt, debris or foreign matter of any kind and shall be free from such accumulations at the time of final inspection.

5. Placing Castings

All castings shall be placed with mastic and mortar beds. The mortar shall be mixed in proportions of one (1) part cement to three- (3) parts sand by volume, based on dry materials. Castings shall be set accurately to the finished elevation so that no subsequent adjustment will be necessary.

M. RESTORATION, INSPECTION AND TESTING

1. Restoration of Surface and Paved Streets

Restoration for storm sewer installation shall be the same as for sanitary sewers.

2. Inspections and Tests

All storm sewers shall be properly cleaned, flushed and rodded, if necessary, prior to acceptance by the Village. If sanitary wastes or unusual debris are found in the storm drainage system, or if required by the Village Engineer for special circumstances, the section of storm sewer suspected shall be T.V. tested in order to locate the point(s) of cross connection and corrected by the developer prior to retesting and approval of/by the Village Engineer.

(a) Cleaning:

All sewers and appurtenances shall be cleaned prior to inspection and testing.

(b) Visual Inspection:

(1) All storm sewers and appurtenances shall be visually inspected by representatives of the developer during and following construction prior to the request for Village Engineering inspection.

(2) Sewers designed to be straight between manholes will be tested for straightness by flashing a light with a mirror from manhole to manhole, lamping or by other suitable means.

(c) Record Drawings:

Prior to acceptance of the storm sewer and drainage systems, Record Drawings of the system must be delivered to the Village Engineer. The Record Drawings shall indicate all structure locations, the size, length, slope, and material of all sewer lines, and shall be certified as to accuracy by an Illinois Registered/Licensed Professional Engineer or registered/licensed surveyor.