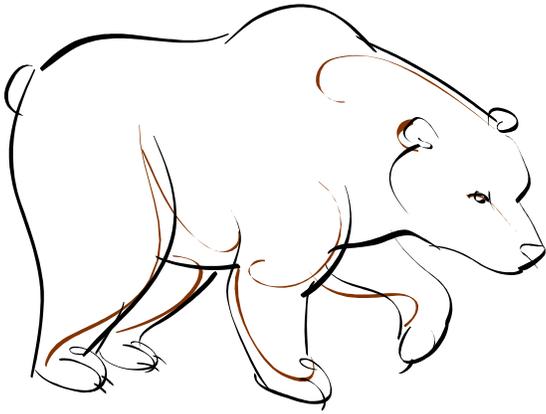


**VILLAGE OF MUKWONAGO  
SPECIFICATIONS**



**1/31/2018**

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# VILLAGE OF MUKWONAGO

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## ***Definition of Terms***

**AASHTO:** Guide for the Development of Bicycle Facilities by the American Association of State Highway and Transportation Officials.

**ASTM:** American Society for Testing and Materials.

**As-Built Drawings:** Design plans reviewed in the field and revised to show actual construction dimensions and quantities. The plan shall specify the location of all improvements where installed and include a description of the item including the type, make, materials used and any unusual characteristics.

**Building or Structure:** Anything constructed or erected, the use of which requires more or less permanent location on ground, or attached to something having permanent location on the ground. This does not include public utility fixtures and appurtenances.

**Storm Water Technical Standards, Models and Best Management Practices (BMP's):**

<http://dnr.wi.gov/topic/stormwater/standards/index.html>

**Contract Documents:** Includes the notice to bidders, instructions to bidders, bid proposal, affidavit of organization and authority, listing of subcontractors, bid bond, contract, performance bond, detailed specifications, general specifications, standard specifications, state specifications, construction plans, special provisions, wage rates, agency permits addenda, and notice to proceed. Also included are any contract change orders and agreements that are required to complete construction in an acceptable manner, including any authorized extensions, all of which constitute one instrument.

**Contractor:** An individual, company, firm, or other party or organization who contracts to construct all or a portion of a project.

**Design Engineer:** A qualified professional engineer registered in the State of Wisconsin responsible for the design and preparation of contract documents.

**Developer:** Any person, firm, corporation, agent partnership, or entity that seeks to improve land in accordance with the Village's development regulations.

**Development:** A man-made change to improved or unimproved real estate.

**DNR:** Wisconsin Department of Natural Resources.

**Easement:** The area of land set aside or over or through which a liberty, privilege or advantage in land, distinct from ownership of the land, is granted to the public or some particular person or part of the public.

**Erosion Control:** Any method or means of controlling sediment carried in runoff from a construction site, as specified in the technical standards: [http://dnr.wi.gov/topic/stormwater/standards/const\\_standards.html](http://dnr.wi.gov/topic/stormwater/standards/const_standards.html).

**"Or Equal":** An item determined by the Village Engineer or Utility Director to be functionally equal to an item named and sufficiently similar so that no change in related work will be required. To qualify as an

equal the product must be of equal materials, quality, durability, appearance, and design. The product must perform as well as the specified product and have a proven history of performance.

**Inspector:** An individual or firm appointed or employed by the Village as the authorized representative of the Village assigned to provide more detailed observation of construction and to serve as a liaison between the Contractor and the Village. The inspector shall have no responsibility to the Contractor or Developer. The inspector will not supervise, direct, control or have authority over or be responsible for the Contractor's means, methods, techniques, sequences, or procedures of construction or safety precautions and programs incident thereto or for failure of Contractor to comply with any laws or regulations. Inspector will not be responsible for Contractor's failure to perform the work. Inspector will not be responsible for the acts or omissions of the Contractor or any Subcontractor, supplier or other individual or entity performing the work.

**Owner:** Any government, firm, association, partnership, private corporation, public or quasi-public corporation, or a combination of any of them, or other legal entity having sufficient proprietary interest in the land to be subdivided to commence and maintain proceedings to subdivide.

**Parcel:** A lot or tract of land.

**Plans:** The approved plans, profiles, typical cross sections, working drawings, supplemental drawings, or exact reproductions that show the location, character, dimensions, and details of the work to be done.

**Punch List:** A list of deficiencies requiring corrective action before final payment or acceptance of the project.

**Right-of-Way (ROW):** A public way dedicated to the public for its intended use.

**Road or Roadway:** The paved and shoulder areas or paved and curbed areas within the street ROW.

**Standard Specifications (SWS):** Refers to the Standard Specifications for Sewer and Water Construction in Wisconsin, current edition and its revisions.

**State Specifications:** Refers to the Standard Specifications for Highway and Structure Construction, State of Wisconsin, Department of Transportation, current edition and its supplements.

**Sub divider:** Any person, firm, corporation, agent partnership, or other entity that divides or proposes to divide, by plat or certified survey, or re-plat land in any manner.

**Substitute:** An item of material or equipment proposed by the Contractor that does not meet the requirements of an "or equal" but is functionally equivalent to that named and is an acceptable substitute therefor.

**Utility:** Refers to the Village of Mukwonago Water/Sewer Utility.

**Village:** Village of Mukwonago

**Wisconsin Administrative Code:** The rules of administrative agencies having rule-making authority in Wisconsin, published in loose-leaf, continual revision system, as directed by Section 35.93 and Chapter 227 of the Wisconsin Statutes.

## CONSTRUCTION SPECIFICATIONS/REQUIREMENTS

The Village and/or Village Engineer requires plan and profile drawings for all utility structures.

### **Village Construction Goal**

The purpose of this document is to provide a guide for persons associated with the establishment of new developments, rehab/maintenance projects, and Village projects located in the Village of Mukwonago. This document applies to prospective developers, design engineers, material suppliers, and construction contractors.

The Village also strives in effectively and efficiently developing and completing projects at the lowest long-term cost. To ensure this, the Village created a Developer Checklist and a Village Contact List. Please refer to the Appendix A.

### **GENERAL**

#### ***Specifications***

The "Standard Specifications for Sewer and Water Construction in Wisconsin", (SWS) Current Edition, with all addenda, will govern all utility work performed with the Village and hereinafter will be referred to as the "Standard Specifications" or "SWS". Reference to "State Specifications" shall be the "Standard Specifications for Highway and Structure Construction of State of Wisconsin, Department of Transportation".

#### ***Substitute Materials***

If the Contractor wishes to submit an alternate material as an "equal" to the material specified, he shall first submit a detailed description of such to the Village for its review and approval/disapproval. An "or equal" will meet the definition listed above. In the event the Contractor wishes to substitute a material for a named material or equipment. The Contractor must identify all changes, costs, additional time and operational changes in writing prior to evaluation by the Village Engineer or Utility Director. The Contractor shall provide necessary data, and information requested by the Village Engineer or Utility Director. The Contractor shall bear all costs of evaluation by the Village Engineer and Utility Director. The Contractor will bear all costs of providing all required and requested data in support of the proposed substitute. The Contractor shall not install any alternate materials prior to receiving approval for their use. Only those materials listed in these Requirements or approved as "Or Equals" or substitutes may be used.

#### ***Work Schedule/Noise Abatement***

1. The Contractor shall submit a detailed work schedule to the Village prior to the preconstruction conference.
2. Construction shall be Monday through Saturday, 7:00 am to 9:00 pm. There shall be no work on Sundays or holidays.
3. Any other work schedules besides before mentioned, would need approval from the Village Board.
4. Each item of motorized construction equipment shall be equipped with a muffler constructed according to the equipment manufacturer's specifications or a system of equivalent noise reducing capability. Mufflers and exhaust systems shall be maintained in good operating condition, free from leaks and holes.

### **Project Completion and Acceptance**

1. Following project completion, the design engineer, developer, or contractor shall initiate the acceptance of those public improvements by notifying the Village/Utility. The notification must be made in writing.
2. The Village/Utility will conduct a final inspection, prepare a punch list of the deficiencies, and send it to the design engineer, developer, or contractor.
3. After receiving a punch list, the noted deficiencies shall be remedied to meet the Village/Utility's requirements. If the deficiencies are not resolved within three months, the list will become null and void and a new list will be prepared.
4. Costs for inspection and re-inspections will be incurred by Developer.
5. When the items have been corrected, the Village/Utility will move to accept the project. The date the Village Board accepts the project is the date the one-year warranty will begin.

### **EASEMENT AND CONSTRUCTION LICENSE AGREEMENTS**

The Developer shall obtain the necessary easements and construction license agreements for construction of the work. The Contractor shall comply with all the conditions of these easements. Unless written permission is obtained from the off-site Property Owners, all work, materials, and equipment shall be confined to the project limits. Contractor shall obtain and provide the Village with copies of a letter from each easement grantor indicating that all work has been successfully completed and no work remains to be performed. Said letter must be received prior to release of fund in the Letter of Credit.

### **PERMITS**

The Developer has or will obtain the necessary permits/approvals needed for construction of the work. Copies of these documents are or will be made available to the Village and the Contractor to review and become familiar with in order that he may comply with their special provisions. The Contractor shall obtain all permits not provided by the Developer and will pay all charges, and fees required. Contractor will also give notice as required in SWS 1.2.8.

#### ***Highway Permits***

1. Construction within the right-of-ways of State, County, and Town Highways shall be governed by the applicable permits and the appropriate sections of the Specifications.
2. The Contractor shall familiarize him/herself with all requirements of said permits and general requirements of these agencies.

#### ***Soil Boring Permit***

1. The Contractor is responsible to contact all utilities, as well as Digger's Hotline, before performing soil boring work.
2. Contractors shall obtain permission from the Village or Property Owners prior to performing subsurface investigations. Street opening or highway permits may be required for taking soil borings within streets or highway departments other than the Village's.
3. Soil borings shall not be taken within pavement or shoulder areas without the Village's permission. All boring holes shall be completely filled after the work has been completed.

### **PRECONSTRUCTION CONFERENCE**

Village will schedule and conduct a preconstruction conference at a time and location selected by the Village. The conference shall be attended by authorized representatives of the Contractor and Village.

**SAFETY**

1. Contractor shall follow all necessary State and Federal safety regulations at all times.
2. Contractor shall have an established safety program, practices, procedures, and protection of persons or property. These shall be followed throughout the construction period.
3. Village personnel will follow the Contractor's safety program.

**PROTECTION OF WORK**

1. Openings and surface obstructions: Protect with barricades, signs, or other devices.
2. Street barricades, signs and other devices: Erect and maintain for public safety and convenience. Follow applicable Laws and Regulations. Generally, mark hazards within Work limits and on detours around Work with well-painted, well-maintained barricades, reflectors, electric lights, flashers, and warning and directional signs in quantity and size to protect life and property.
3. Locate and use safeguards to meet changing work conditions.
  - a. Streets closed to through traffic: Place barricades at adjacent intersections as well as at obstruction location. Attach detour signs to barricades at adjacent intersections.
  - b. Streets totally closed: At Engineer's request, install snow fence across full width of streets or alleys.
  - c. At end of each day, install snow fence around any open excavation.

**DAMAGED PROPERTY**

1. All damaged private and public property, such as trees, fences, culverts, utility poles, etc. and including existing streets and underground utilities, caused by construction of a project shall be restored to the condition existing prior to construction at the Contractor's expense unless otherwise specified by the Village.

**WARRANTY**

The Contractor and/or Developer shall leave the entire system for which he is responsible in good working order and shall at his expense repair, rebuild, remodel, and make good and acceptable all defective labor, and materials, that may develop within one year after completion and final acceptance of the work by resolution of the Village Board. The one year period will begin when final acceptance has been given in writing. But in no case will it be before the Village Board adopts a resolution accepting the work. Warranty provisions shall not bar any claims against Contractor or subcontractors for negligence.

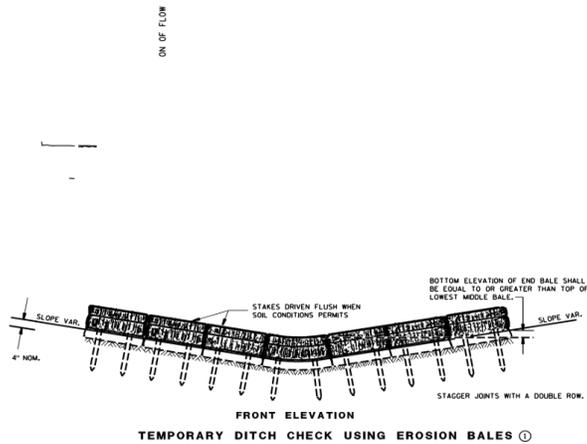
**EROSION CONTROL**

1. The Contractor shall obtain a permit from the Village prior to beginning any work and shall take all measures necessary to minimize erosion, water pollution and siltation caused by construction of this project. Erosion control measures shall be in accordance with the State of "Wisconsin Technical Standards [http://dnr.wi.gov/topic/stormwater/standards/const\\_standards.html](http://dnr.wi.gov/topic/stormwater/standards/const_standards.html) and SWS 107.20, and shall include, but not be limited to: prompt removal of excavated material, proper storage of backfill and bedding materials, construction of erosion control measures such as temporary silt traps, silt fences, and erosion control bales, prompt cleanup of material tracked onto adjacent streets and timely restoration of damaged surface areas.
2. The Contractor shall maintain silt fences, hay bales, silt traps, and other construction site erosion and sediment control devices which are installed by him or others, at all times to prevent sediment from entering any surface water, existing ditches or storm sewers. If maintenance of the existing measures is needed due to the occurrence of sedimentation from this project, the Contractor will be responsible for this maintenance work.

3. The Contractor shall remove all erosion control measures installed by him after notification is given by the Village. If sedimentation and/or erosion does occur, the Contractor must promptly remove said sediment material and must repair erosion damage or such property damage caused by said sedimentation and/or erosion.
4. A sweeper shall be available and utilized on the jobsite at all times.

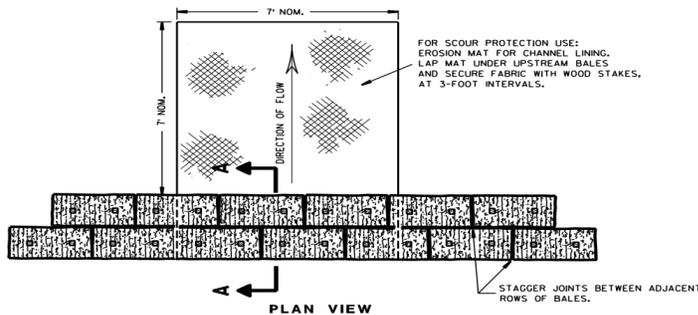
**Erosion Mat**

1. The Contractor shall place erosion mat over all seeded and sodded areas where shown on the Drawings.
2. Erosion mat material shall be either jute fabric or wood fiber blanket.
3. Secure the mat with staples placed at three foot centers except place at ten inch centers at end or junction slots in accordance with Subsection 628.2.3. of the "State Specifications".

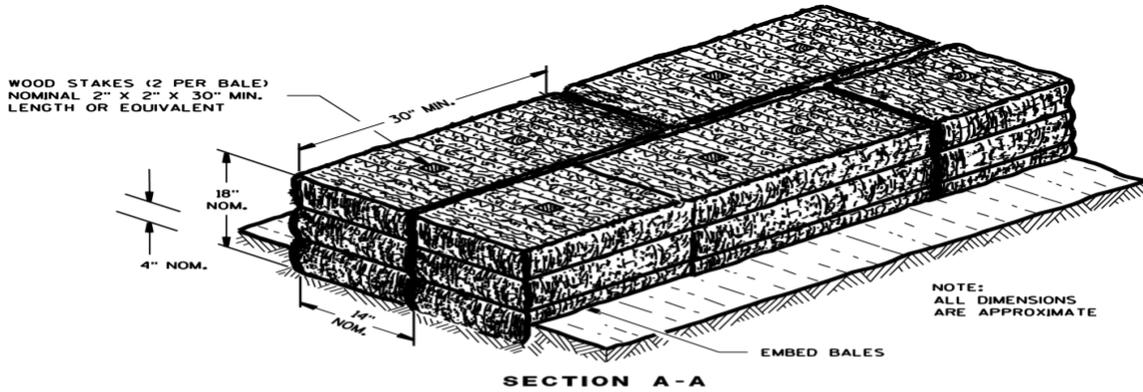


**Erosion Bales**

1. The Contractor shall place erosion bales of straw, hay or other suitable baled material to form checks or dikes to control erosion, at locations shown on the Drawings. Placement of erosion bales, including excavation of upstream sumps, shall be accordance with Subsection 628.3.3. of the "State Specifications".



BOTTO



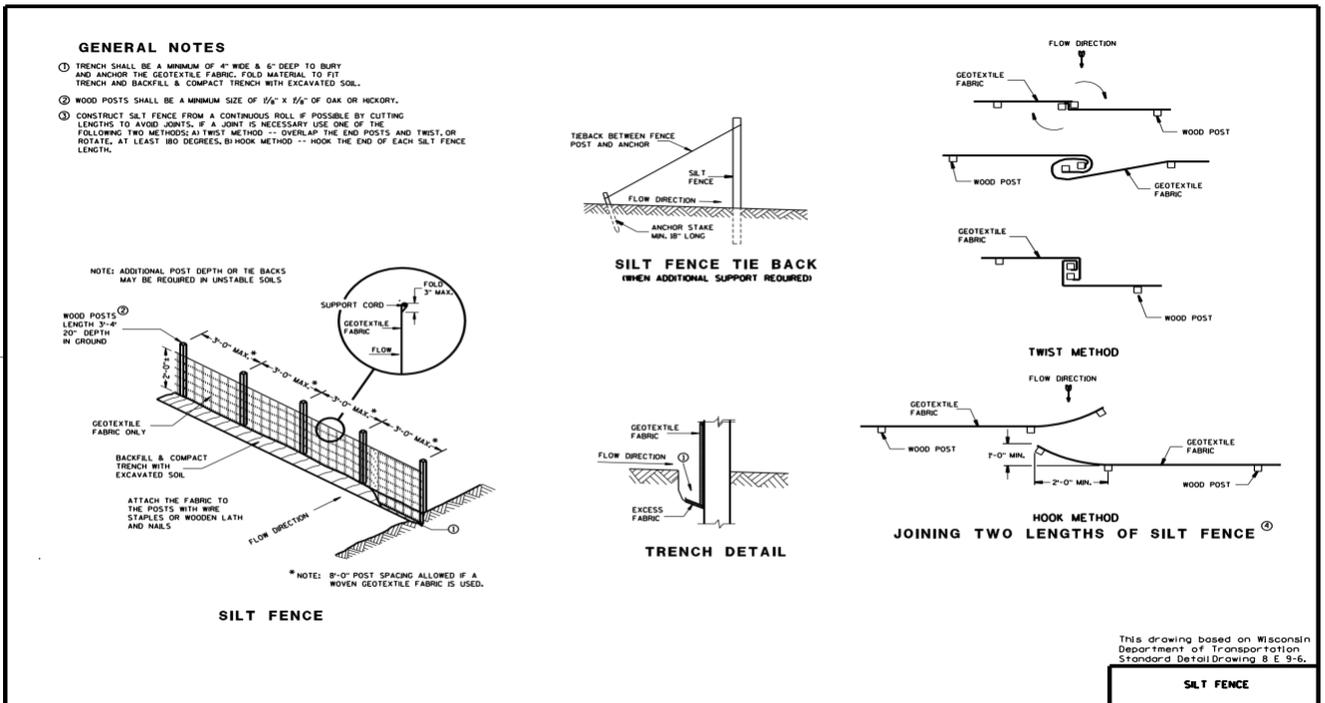
①

**Silt**

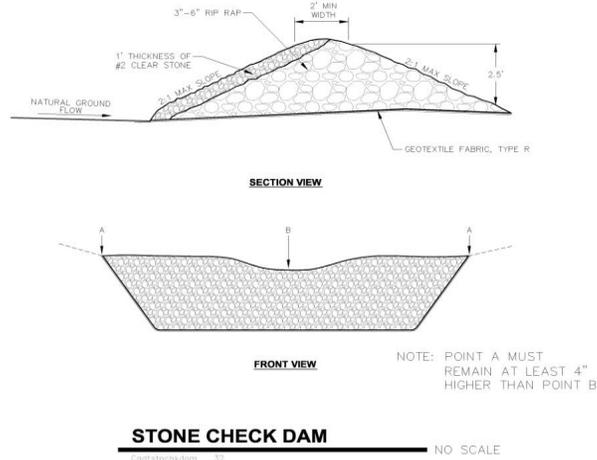
**Fence**

1. The Contractor shall place silt fence at the locations shown on the Drawings. Silt fence installed shall be toed in to a 6 inch minimum depth.

**Temporary Erosion Barriers**

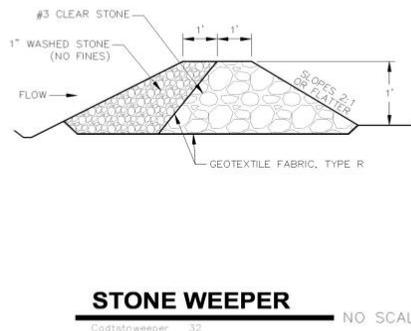


1. The Contractor shall construct temporary earthen dikes to prevent surface runoff from flowing over areas as shown on the Drawings. The earthen dikes shall be removed after slopes and ditches have been stabilized and turf developed to the extent that future erosion is unlikely. The dike area shall be reshaped and restored by seeding in accordance with Landscaping Restoration section of this document.



**Temporary Sedimentation Basins**

1. The Contractor shall construct temporary sedimentation basin(s) at location(s) shown on the Drawings.

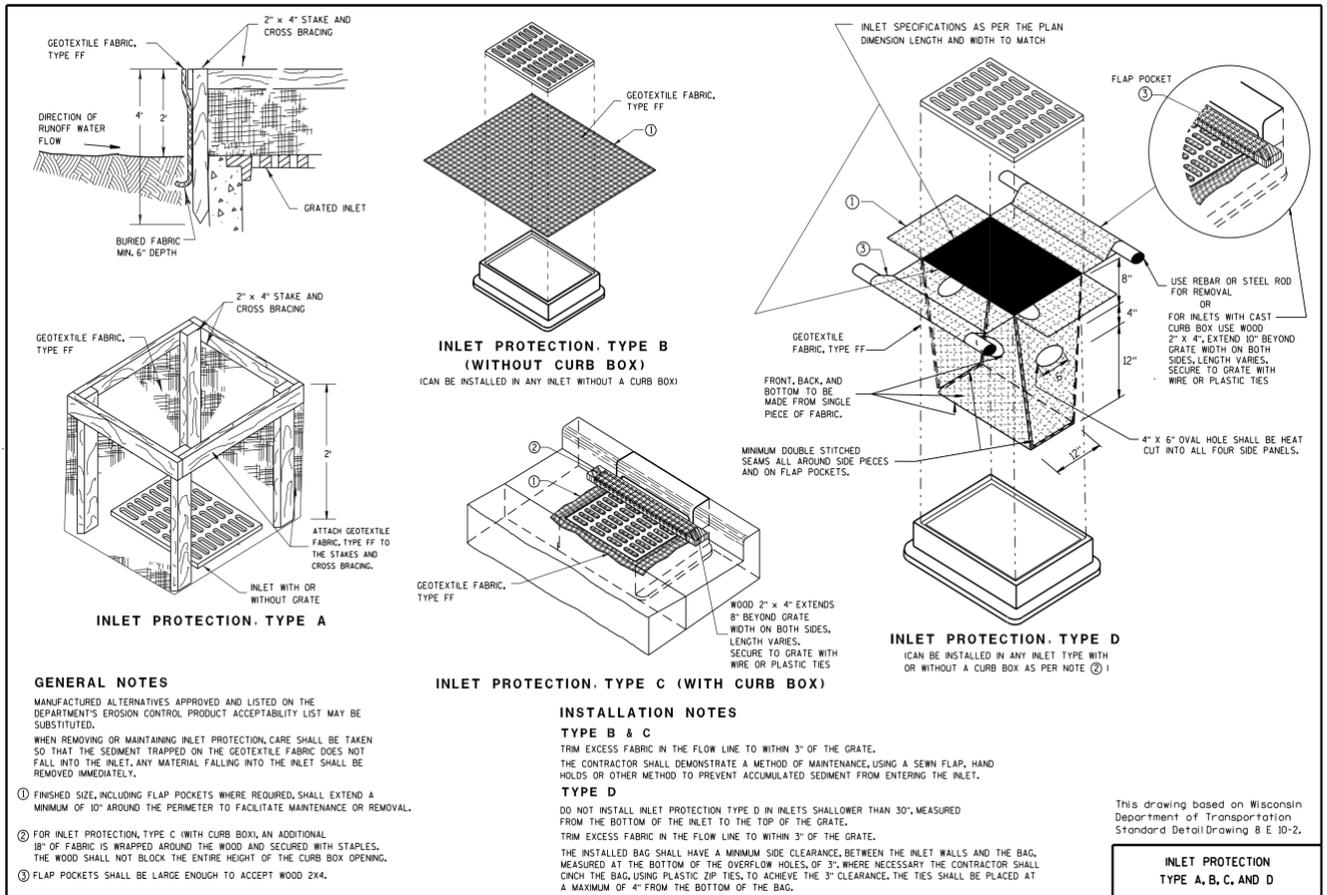


The basin(s) shall be filled in and banks removed after slopes and ditches have been stabilized and turf developed to the extent that future erosion is unlikely. The basin area shall be reshaped and restored by seeding in accordance with Landscaping Restoration section of this document.

**REMOVAL OF WATER**

**General**

1. During construction, provide and maintain adequate means and equipment to promptly remove and dispose of all water encountered during excavating and trenching. Under normal excavating and pipe laying conditions, maintain the groundwater table at least one foot below the bottom of the trench.
2. Under no circumstances shall water be allowed to rise above any trench bottom until the affected work has been completed, including backfilling.
3. The removal of water shall be accomplished in a manner which will not undermine structures and utilities or cause damage to the work. Water shall be disposed of so as not to interfere with other work.
4. Where dewatering wells are installed to accomplish the removal of water, the wells shall be drilled and sealed in accord with the applicable regulations of the Wisconsin Department of Natural Resources (DNR).
5. Permits are required to remove trench water and groundwater. (DNR)



**Ground Water Control**

1. To accomplish the construction, Contractor shall provide and maintain a groundwater control system as is necessary and mandatory for the performance of the work. The type of groundwater control system used shall be selected and designed by the Contractor and may include well points, deep wells, grouting, or a combination thereof.

2. Contractor shall maintain groundwater levels such that any excavation, trench or other construction will be performed in the dry and until backfilling is completed.
3. The dewatering system shall be designed and operated so as to prevent removal of existing soils. Open excavations shall be dewatered from outside their structural limits and from a point below the bottom of the excavation.
4. All water shall be removed in a manner which will not cause damage to existing structures and property, both on and off the site. The repair and restoration of any such damage shall be the responsibility of the Contractor.
5. Throughout the dewatering period, Contractor shall carefully monitor and record the operation and performance of the groundwater control system. Provide the means necessary to facilitate the monitoring and allow Village access to the information recorded.
6. Contractor shall be responsible for the continuous operation and maintenance of the groundwater control system at all times.
7. Upon completion of the work, all materials and equipment shall be removed from the site. Wells must be abandoned in accordance with DNR regulations.
8. Contractor must obtain all permits for removal of ground water.

***Disposal of Water and Sedimentation Control***

1. Contractor shall dispose of all water by methods which will prevent erosion of earth and control of discharge and deposition of sediment and complies with the Erosion Control section of these Requirements.
2. All groundwater removed from the site shall be conveyed through pipes to the point of discharge. The conveying water in open ditches or trenches will not be allowed.
3. Provide and maintain the temporary facilities necessary to control the discharge of sediment resulting from the removal of water and groundwater. The methods and facilities necessary to prevent erosion and control sedimentation shall be selected in accordance with Section 107.20 of the "State Specifications" and applicable permits. Contractor shall take all necessary precautions to prevent silting of existing drainage systems including any storm sewers, ditches, and natural waterways, and to prevent flooding damage to property.
4. The means of water disposal and the methods of erosion and sedimentation control shall be acceptable to the Village and shall comply with pollution control laws and regulations. Village's approval of means and methods shall not relieve Contractor of his responsibilities to comply with the requirements of any authority having jurisdiction over the work.
5. Permission to use any storm sewers, ditches, or other existing drainage facilities for the disposal of water shall be obtained by the Contractor from the authority having jurisdiction. However, Contractor shall not utilize such facilities in any manner which will obstruct their normal function or cause flooding or damage. Upon completion of the work, Contractor shall leave such facilities as clean as originally found. Contractor shall make repairs resulting from damage at his own expense.
6. Temporary facilities provided for the disposal of water and erosion and sedimentation control shall be maintained until no longer needed. At such time, remove all temporary structures and equipment from the premises, restore area and proceed with remaining work.

## **WATER MAIN CONSTRUCTION**

All components in the water main design and construction shall be lead free.

All components shall be American made.

Follow SWS Part IV and DR 501, 505, 506, 510, 530, 540, 550, and except that bedding and cover material shall be crushed stone chips.

### ***Pipe***

1. All 6 through 12 inch PVC pipe for water main shall be AWWA C900, Class 150 PVC pressure pipe, DR 18 or less.
2. All 14 through 36 inch PVC pipe for water main shall be AWWA C905 CIOD pressure pipe, 235 PSI, DR 18 or less.
3. All PVC pipe shall have integral elastomeric bell and spigot joints.
4. Standard or compact mechanical joint cast iron fittings shall be used.
5. All water main will have detector wire attached to pipe.

### ***Pipe-Waterway Crossings***

1. Polyethylene pipe may be used for waterway crossings with no taps when approved by the Village.
2. Water main fittings shall conform to SWS 8.22.0.
3. Buried joints shall be mechanically fastened, while joints in structures shall be flanged.
4. Full body fittings shall have a pressure rating of 250 PSI, and compact fittings shall have a rating of 350 PSI.
5. Ductile iron fittings shall have a Class 52 wall thickness with a bituminous exterior coating per ANSI/AWWA C110/A21.10.
6. Interior of fittings shall be cement lined and bituminous coated per ANSI/AWWA C104/A21.4.
7. Use standard stainless steel bolts for fastening.
8. Remove beveled pipe end at connections to mechanical joint or flanged fittings.
9. Buttress concrete shall be Class F, SWS 8.35.3, ready-mixed.

### ***Tapping Sleeve***

1. Use tapping sleeves with gate valves 24-inches and under. Use Smith Blair 662 or Ford Fast-Tap with stainless steel bolts and a carbon steel flange.

### ***Valves***

#### ***Resilient-Seated Gate Valves***

1. Follow AWWA C-509 and SWS 8.27.0. All valves less than 16 inches shall be Mueller or Waterous resilient seat gate valves. Valves shall have non-rising stems, O-ring stem seals, epoxy coating per ANSI/AWWA C550, stainless steel bolts, mechanical joint ends, turn counterclockwise to open, and a 2" square operating nut.

#### ***Butterfly Valves***

1. Follow AWWA C-504 and SWS 8.28.0. All valves 16 inch or larger shall be butterfly valves manufactured by M&H (450), Pratt (Groundhog HP250), Clow (2810-F5365). Valves shall have non-rising stems, epoxy coating, stainless steel bolts, mechanical joint ends, turn counterclockwise to open, and a 2" square operating nut.

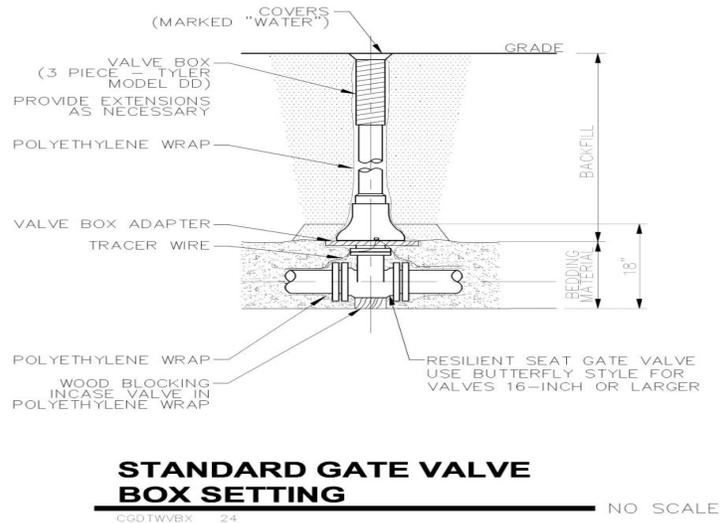
**Air Release Assemblies**

1. Need verification from DNR, to allow below-grade vent(s) for our location(s).
2. For assemblies placed in valve boxes, follow SWS 4.12.0
3. For assemblies placed in valve vaults, follow SWS 4.11.0, except provide HS20 load-rated flat top slab.

**Valve Boxes**

1. Follow SWS 8.29.0. Valve boxes shall be Tyler, Model 6860S, Model DD, with a cover marked "WATER".
2. Extension sections shall be furnished if valve is greater than 8 feet in depth.
3. All water valves and valve box (s) shall be polywrapped.
4. Valve boxes shall be furnished for the depth of trench shown on the Drawings with the cover placed at the proposed grade or to the elevation shown on the Drawings. Water valve boxes shall be set  $\frac{1}{2}$ " to  $\frac{3}{4}$ " below asphaltic binder course grade upon initial installation.
5. Valve stem extender shall be furnished if valve depth is greater than 8 feet. Extend to 4 feet (plus or minus 3 inches) below finish grade. Stem extender shall be stainless steel or epoxy coated iron. Stem extenders 6 feet or longer shall be a solid shaft. Stem shall have a spacer ring at 3 inches below operating nut and be furnished with stainless steel pins and bolts.
6. All valve boxes shall be installed using a valve box adaptor. Adaptors shall be those manufactured by Adaptors, Inc. or equal.
7. At the time of asphaltic surface course placement, the valve boxes shall be turned up to  $\frac{1}{2}$ " to  $\frac{3}{4}$ " below the surface course elevation. If the valves cannot be turned up a, Rite Hite or riser rings will be allowed to make the adjustment.

- Valve boxes shall not be asphalt ramped.



### Hydrants

#### Standard Hydrant

- Mueller Centurion A-423.
- Shall be new, manufactured within 24 months of construction and stored properly.
- Shall have a mechanical joint connection, turn left to open, and have a 6 foot 6 inch trench depth.
- Shall be break-flange type, 5 ½ inch main valve opening, shall have 2 National Standard 2 ½ inch hose nozzles.
- Shall have 5 inch Storz pumper nozzle.
- Public** hydrants shall be painted factory red.
- Private** hydrant shall be painted factory yellow.
- All hydrants shall have hydrant markers. Markers shall be spring mounted 5 foot reinforced fiberglass shafts with alternating red and white reflectorized coloring.

#### Barrel Extensions

- Shall be used where necessary to set the hydrant to the required elevation.
- Only one (1) hydrant extension per hydrant.
- Shall be compatible with hydrant barrel and stem extensions.
- The distance from finish grade to the centerline of the lowest nozzle shall be from 18 to 21 inches.

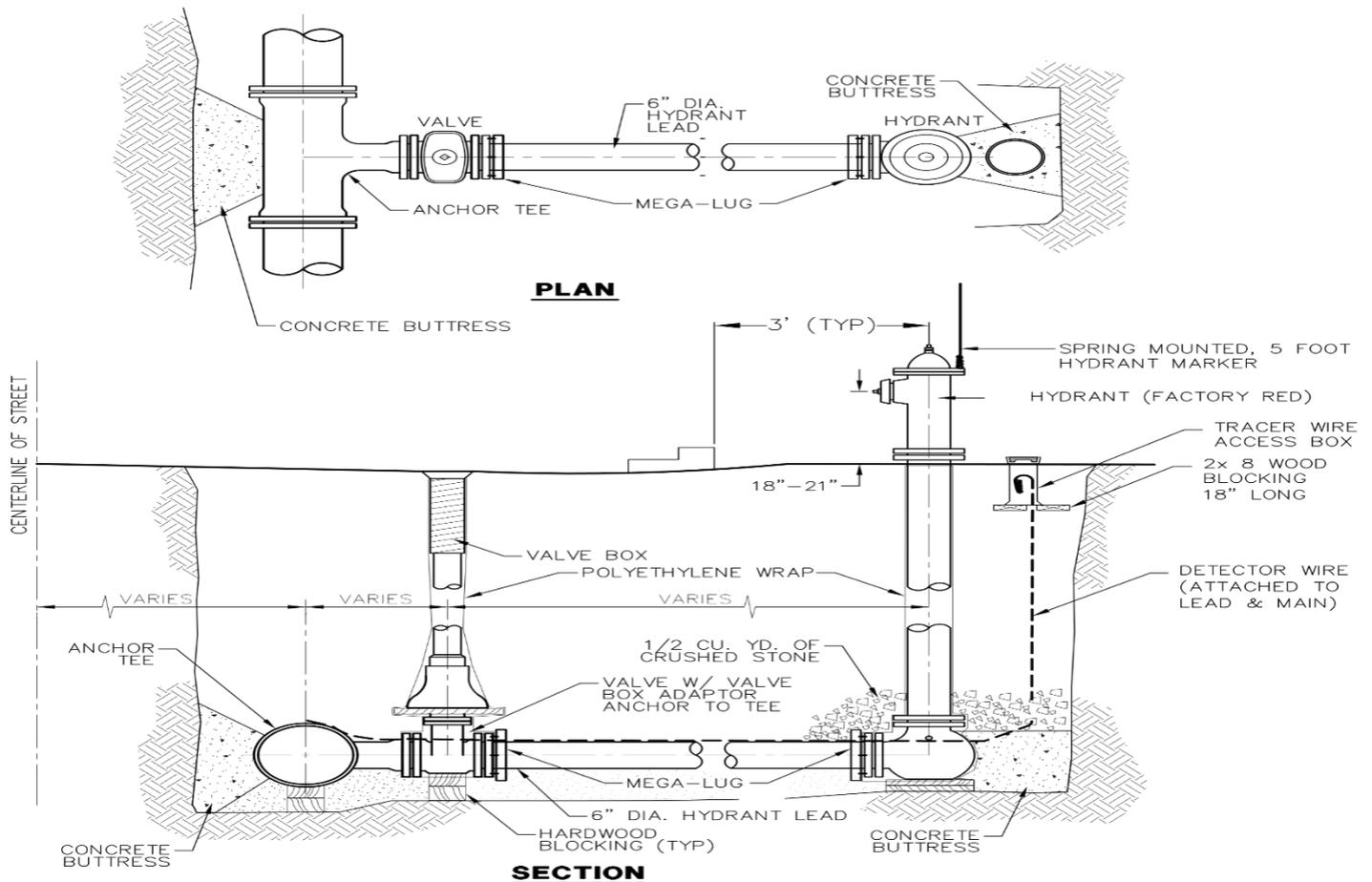
#### Hydrant Leads and Anchoring Tee

- Leads shall be six (6) inch PVC AWWA C900 Pressure Class 150.

2. Hydrant leads shall use two (2) Mega-lugs. One on the hydrant and one on the hydrant valve.
3. Mega-lugs shall be of the type corresponding to the pipe, ABAA Iron, Inc.
4. Provide Clow F1217 or Tyler C-153 anchoring tee which shall be secured to the hydrant.
5. At least one (1) continuous length of pipe shall be used between hydrant and valve. If length between valve and hydrant is greater than 20 feet, all joints shall be restrained in manner approved by the Village of Mukwonago Utilities Department.
6. All barrels shall be polyethylene wrapped with tape.

### ***Hydrant Placement***

1. Shall be located a minimum distance away from buildings of 1.5 times the height of nearest building wall.
2. Shall be located 350 feet apart (residential districts) and 300 feet apart in (commercial, industrial and multi-family districts) or other approved distances by the Utility.
3. Shall be located a minimum horizontal distance of 10 feet from all driveway approaches and street lights, utility poles, and pedestals.
4. If hydrant shoe is below water table, provide hydrant with plugged weep holes.
5. Hydrants shall be supported upon a precast concrete or hardwood block.
6. Each hydrant shall be braced against the far end of the trench by a poured concrete buttress. Do not block/cover weep hole.
7. Where a hydrant is set in soil that allows drainage, drainage shall be provided at the bases of the hydrant by placing crushed stone from the bottom of the trench to at least six (6) inches above waste opening in the hydrant and to a distance of one (1) foot around the base elbow.
8. Where a hydrant is set in clay, rock, or other impervious soil, a drainage pit two (2) feet in diameter and three (3) feet deep shall be excavated below each hydrant base and filled with compacted crushed stone. Stone shall be placed under and around the elbow and concrete base to a level of six (6) inches above the waste opening. No drainage system shall be connected to a sanitary sewer.



NOTE :  
REFER TO FILE NO. 38 OF THE "STANDARD SPECIFICATIONS  
FOR SEWER AND WATER CONSTRUCTION IN WISCONSIN" FOR  
FURTHER INFORMATION

HYDRANT LEADS SHALL BE RESTRAINED

### **HYDRANT SETTING DETAIL**

CGDTHYD 24

NO SCALE

#### **Hydrant Assembly Cost**

1. The cost of hydrant assemblies shall include the cost of furnishing and installing hydrant, barrel extension, gate valve, valve box, fittings, restraint, six (6) inch lead, storz nozzle, and lowering of hydrant, if required.

#### **Water Services**

1. All services two (2) inch or smaller shall be DR9 HDPE (CTS) with a minimum inside diameter of 1 ¼ inch.
2. Corporation stops, use Mueller B-25008 or Ford FB1001, shall withstand a 150 PSI pressure test.
3. Curb valves, use Mueller H15155 or Ford B44-M, shall withstand a 150 PSI pressure test.
4. Compression fittings with stainless steel stiffeners shall be used for corporation stops and curb valves.
5. For 2 ½ inch and larger services, follow SWS Part IV and V. Provide tee connection with anchor valve mega lugged to it. Provide plug and buttress.
6. Use Teflon tape or Teflon paste on threaded joints.

**Curb Boxes**

1. Shall be Tyler 101F with four (4) foot heavy-duty rod with guide ring and stainless steel bolts
2. Shall be screw-on style.
3. Use valve stem extenders.
4. Shall be placed on the right of way line in lawn area, not in an existing or proposed driveway approach.
5. All curb stops, laterals, and hydrants shall be a minimum of 10 feet from the approach.

**Installation and Placement**

1. No water service shall be laid through any trench having cinders, rubbish, rock, or any other material which may cause injury to or disintegration of the service pipe, unless adequate means of protection are provided by sand filling or such other insulation as may be approved by the Village.
2. Service pipes passing through curb or retaining walls shall be adequately safeguarded by provision of channel space or pipe casing, not less than twice the diameter of the service connection. The space between the service pipe and channel or pipe casing, shall be filled and lightly caulked with oakum, mastic cement, or other resilient material, and made impervious to moisture.
3. Pressure test water main sections before installing services two (2) inch and smaller, following SWS 4.15.0
4. All water services shall be wet tapped under normal operating system pressure. Use double-strap PVC tapping saddle for service lines two (2) inch and smaller. Use Ford FS202 or 303, or Smith-Blair 377 or 372.
5. All services shall be installed a minimum of ten (10) feet from existing or future driveway locations.
6. All new services shall extend ten (10) feet beyond right of way line.
7. All water services are to be centered on the lot as close as practical (within five (5) feet of center).
8. All services shall be staked prior to construction.
9. Provide a two (2) by six (6) inch hardwood marker at end of service from invert of service to two (2) feet above finished grade.
10. All unused water services shall have the corporation stop turned off and the service (and all appurtenances) removed to the corporation stop.
11. Test services following SWS 5.5.18.

**Cover Depth**

1. The minimum depth of cover between finish grad and the top of the water main pipe shall be 6 feet.
2. No water main shall be installed with more than 8 feet of cover below finish grade.

**Bedding and Cover Material**

1. No water service or water main shall be laid through any trench having cinders, rubbish, rock, or any other material which may cause injury or disintegration of the pipe.
2. Water main bedding and cover material shall be crushed stone or sand. Water valve bonnets shall be set in stone on wood blocking.
3. If a wet trench condition exists, the water main bedding and cover material shall be supported by 3" of crushed limestone chips or crushed limestone screenings, conforming to Chapter 8.43.0, Tables 32 and 33 of the "SWS" and placed as shown on File No. 36 of the "Standard Specifications".

**Testing**

1. Hydrostatic testing shall be performed as specified in Chapter 4.15.0 of the "SWS" .....A Village Representative must be present at all times during the testing process.

2. In a new development the contractor has the option to test the entire new water main, including corporation valves, as one continuous test section or in segments including corps per his discretion.
3. In a rehabilitation project, the contractor has the option to test the entire new water main, including corporation valves, as one continuous test section or in segments including corps per his discretion.
4. The contractor shall furnish all labor, equipment and material to complete all testing.

***Disinfection***

1. Water main shall be disinfected in accordance with SWS 4.3.12 and SWS 4.16.0.
2. Contractor shall furnish and bond chlorine tablets to the inside spigot end top of each pipe as it is installed in the ground.
3. All piping installed outside of the water main segments shall be disinfected by swabbing with a five (5)% hypochlorite solution and thoroughly flushed. The entire interior surfaces of all pipes and fittings shall be thoroughly swabbed.
4. Contractor shall use extreme care to insure the cleanliness of all water main materials used
5. All cost of sterilization work, including re-chlorination if necessary, flushing, sampling and processing of bacteriological samples shall be paid for by the Developer or Contractor.

***Safe Samples***

1. A safe sample must be obtained from each of the segments hydrostatically tested.
2. Samples shall also be taken from connection to intersecting mains to check effectiveness of the disinfection procedure.
3. Samples must be proven safe by a Wisconsin DNR-certified independent laboratory.
4. Village of Mukwonago Utility shall receive a copy of the bacteriological test before water main will be placed in service.
5. If a test is proving unsatisfactory, the water main shall be sterilized by the Contractor by such methods as he deems necessary and samples taken until acceptable results are obtained.

***Flushing/Filling Water Main***

1. Water for testing and flushing of mains will be made available by the Mukwonago Utility subject to its requirements and charges.
2. Contractor shall notify the Utility of flushing/filling schedule, and obtain a meter to be used.
3. All flushing/filling of new mains shall be completed by Contractor.

***Water Discharge***

1. Provisions shall be made to convey water used for flushing or testing to a suitable discharge point without causing damage or erosion to properties.
2. Water wasted from pipeline, well, and/or tower that may reach bodies of surface water may not contain any substances in concentrations that adversely affect the water as determined by NR 105 and NR 106.
3. For chlorine, no total residual chlorine may be measured in water being discharged to surface water.
4. Water with residual chlorine may be discharged to the sanitary sewer with prior approval of the Utilities Director.
5. If chlorinated water is contained by a dike or berm and allowed to seep into the ground, or discharged to an area at a rate where it will seep into the ground prior to reaching a surface water, then no chlorine neutralization is required.

**SANITARY SEWER CONSTRUCTION**

Prior to construction, the Contractor shall provide and install a bulkhead and/or plug at the point of connection to the existing sewer. The plug shall conform to the requirements of SWS 3.2.25. This plug shall remain in place until final acceptance by the Village.

All components shall be American made.

**Connections to Existing Sewers and/or Manholes**

1. Contractor shall make the connection to existing sewers, force mains, and/or manholes as shown on the Drawings, in conformance with SWS 3.2.27. The Contractor shall verify alignment and grade of existing sewers in existing manholes and replace and/or restore bench as necessary.
2. Drain line connections to existing manholes shall be made in accordance with SWS 3.5.7. Field tapped holes for connecting sewer pipe to manholes shall be made by coring the manhole except that connections to brick or block manholes may be made by punching out the opening. Flexible pipe connections shall be made with flexible watertight connectors, Kor-N-Seal, Link-Seal or equal. All clamps, bolts, etc. of pipe to manhole seals shall be stainless steel. If Link-Seal connectors are used, the bolt heads shall be placed on the inside of manholes.

**Design**

1. Where site conditions allow, all sewer lines shall be designed with a slope ten (10) percent greater than the minimum slope allowed per the Wisconsin Administrative Code.
2. A minimum drop shall be required in all manholes if practicable. Follow the Wisconsin Administrative Code for manholes at bends.
- 3.

MH I.D.	DROP (Feet)
42"	0.1
48"	0.1
60"	0.1
72"	0.13
84"	0.15
96"	0.17

**Well Protection**

1. Sanitary sewer pipe material within 25 to 50 feet of private wells, as shown on the Drawings, shall be polyvinyl chloride (PVC) pressure pipe. The pressure pipe shall extend from manhole to manhole. No changes in material will be allowed mid-span.
2. Sanitary sewer lateral pipe material within 8 to 25 feet of private wells shall be plastic sewer pipe conforming to the requirements for polyvinyl chloride (PVC) pressure pipe.

**Sanitary Sewer Televising**

1. All newly installed sanitary sewers shall be televised prior to acceptance. Following SWS 7.1.2 and 02955, perform televising after manhole benches are installed, surfacing has been restored, and the pipe has been successfully tested. Prior to televising, clean water shall be flushed through lines to prove there are no possible sags in line.
2. The Contractor shall ensure that all lines are flushed and clean prior to video recording.

3. Video records which show debris in lines will not be accepted. In the event a sewer span is not accepted, cleaning and re-video may be required.
4. The cost of cleaning and video recording shall be paid for by the Developer or his Contractor.
5. In a new development, the sewer plug and/or bulkhead as defined in (first paragraph) shall remain in place throughout the cleaning and video recording process and until final acceptance of the project.
6. In a rehabilitation project, the sewer plug and/or bulkhead as defined in (first paragraph)
  - a. Shall remain in place throughout the cleaning and video recording process and until final acceptance of the project or approval of the Village.
  - b. Or, Contractor may bypass pumps during the day but flumes to flow to the sewer overnight.
6. Televising shall only be performed by The Expeditors, Inc., 400 N. Summit Drive, Oconomowoc, WI 53066. (800) 657-0879.

### **Sanitary Sewer Pipe**

Sanitary sewer pipe material shall be polyvinyl chloride (PVC), reinforced concrete, ductile iron, prestressed concrete pressure pipe or HDPE pipe for drilling or other if approved, as shown on the drawings, and conforming to the following:

1. Polyvinyl chloride (PVC) sewer pipe, 4 inch through 15 inch diameter, meeting the requirements of ASTM D-3034, SDR-35, with integral bell type flexible elastomeric joints meeting the requirements of ASTM D-3212. Sampling, test reports, and markings per SWS 8.3.0 and 8.10.0.
2. Polyvinyl chloride (PVC) large diameter solid wall sewer pipe, 18 inch through 27 inch diameter, meeting the requirements of ASTM F-679, Type T-1, with a minimum pipe stiffness of 46 psi and having integral bell type flexible elastomeric joints meeting the requirements of ASTM D-3212. Lateral pipe material shall conform to the requirements of line 1.
3. Polyvinyl chloride (PVC) pressure pipe, 4 inch through 12 inch diameter, meeting the requirements of AWWA C900 SDR18 or less.
4. Polyvinyl chloride (PVC) pressure pipe 14 inch through 20 inch diameter, meeting the requirements of AWWA C905 SDR18 or less.
5. Fittings for PVC and ductile iron pipe shall follow SWS 8.22.0 and: Shall be ductile iron Class 52 wall thickness with interior and exterior bituminous coating per ANSI/AWWA C110/A21.10. Fittings for buried applications shall be mechanical joint type and fittings within structures shall be flanged type. Full body fittings shall have a pressure rating of 250 psi, compact fittings shall have a pressure rating of 350 psi.
6. Reinforced concrete sanitary sewer pipe (RCP) 12 inches and larger, meeting the requirements of ASTM C-76, wall thickness C, with R-4 rubber gasket joints conforming to ASTM C-361.
7. Ductile iron pipe meeting the requirements of AWWA Standard C-151 (ANSI 21.51), Class 52 equal to Tyton gasket joint pipe, cement mortar lined with internal and external bituminous coating and furnished with push-on rubber gasket joints.
8. Ductile iron pipe shall be wrapped with polyethylene wrap meeting the requirements of AWWA Standard C-105 (ANSI A21.5) and SWS 8.21.0 using Class C (black) polyethylene material and shall be installed as specified in SWS 4.4.4.
9. Sanitary sewer lateral and riser pipe material shall be the same as selected for the main sanitary sewer, and the riser pipe. Lateral pipe material shall be 6 inch PVC. Follow SWS 5.3.10 and SWS 5.3.11, SDR 35 pipe. Install test tee with plugs and connect to main with tees or wyes.

### **Laterals**

1. Building sewer lateral connections to the main sewer shall be made with wyes. All laterals shall be a minimum of 6 inch. The ends of laterals shall be plugged in accordance with SWS 3.2.25(a). Laterals

shall be normally installed at a slope of  $\frac{1}{4}$  (2%) inch per foot and not less than  $\frac{1}{8}$  (1%) inch per foot from the sewer main to the lot line.

2. Laterals shall be placed a minimum of 10 feet from an existing or proposed driveway location.
3. The Contractor shall furnish and install a marker stake over the end of each lateral installed. The marker shall be a minimum 2"x6"x12' hardwood plank. The stake shall extend a minimum of 3 feet above finish grade and to bottom of service.
4. Risers for sewers shall be constructed as required by SWS 3.2.26 and SWS Drawing File No. 10A and 10E as determined by the sewer main and lateral material.
5. For new construction, no laterals may be connected at or within 5 feet of a manhole.
6. For relays, when possible, laterals should be relayed and tied directly into sewer main, not manholes. A trough shall be constructed with material consistent with the size of the lateral, and be constructed within the bench where laterals come into manholes.
7. Laterals in manholes shall be subject to requirements of visible beam lamping to identify uniformity of bore and must be air tested. Provide test tee at end of lateral.
8. All sanitary laterals shall have a maximum depth of 13 feet at the property line, while still providing basement drainage.
9. All unused laterals shall be eliminated by cured-in place liner and/or capped, and grouted solid at the mainline sewer. At the discretion of which procedure to be used shall be designated by Village Designee.

### ***Bedding and Cover Material***

1. Sanitary sewer bedding and cover material shall conform to the appropriate sections of the "Standard Specifications", SWS 8.43.0 and as specified and/or modified below:
  - a. PVC pipe-SWS 3.2.6(b) and 3.2.6(i). Use Class "B" bedding conforming to the Standard Specifications.
  - b. Reinforced concrete, ductile iron, pre-stressed concrete and non-reinforced concrete pipe Class "C" Bedding conforming to SWS 3.2.6(a) and SWS Drawing File No.3  
Class "B" Bedding conforming to SWS 3.2.6(b) and SWS Drawing File No.4  
Class "A" Bedding conforming to SWS 3.2.6(c) and SWS Drawing File No. 5 (concrete cradle) of SWS 3.2.6(d) and SWS Drawing File No.6 (concrete cap). Unless specified otherwise on the Drawings, Class "C" Bedding may be used.

### ***Deflection Testing***

1. Polyvinyl chloride (PVC) sewer pipe shall be deflection tested with an approved go-no-go acceptance testing device. The test shall not be conducted until after all backfill has been placed and consolidated and after riser pipes and sewer laterals have been installed before binder course. The entire length of sewer pipe shall be tested
2. PVC pipe shall be deflection tested in accordance with SWS 3.2.6(i)4.
3. Go-no-go mandrels shall conform to the requirements of SWS Drawing File No.30.

### ***Leakage Testing***

1. Sanitary sewers shall be tested for leakage using the low pressure air test. The length of laterals included in the test section shall be included in determining the test time.

### ***Insulation***

1. Sewer lines shall be insulated where noted on the Drawings and wherever the depth of cover is less than five (5) feet. Insulation shall be in accordance with Wisconsin Administrative Code 82.30(11)(c)3.

2. SWS 8.50.0 and SWS 8.43.7 for graded aggregate insulation.

### ***Sanitary Sewer Manholes***

#### ***Manhole Construction***

1. Sanitary manholes shall be constructed in accordance with SWS 3.5.0, 8.39.0, and SWS Drawing File No. 12, 12A, 13, and 15, and these requirements for waterproof manholes.
2. Manholes shall be precast 48 inch inside diameter with eccentric cones.
  - a. A minimum of 6 inches to a maximum of 15 inches of adjusting rings shall be furnished for each manhole.
  - b. Final manhole rim grades shall be adjusted within  $\frac{1}{2}$  to  $\frac{3}{4}$  inch below the existing and/or proposed pavement grades after the curb and gutter is completed. Manholes shall be initially set  $\frac{1}{2}$  to  $\frac{3}{4}$  inch below binder pavement grade. Neenah R-1979 series adjusting rings shall be used when adjusting manhole rims from binder grade to surface pavement grade.
3. Plastic manhole steps shall be provided in accordance with SWS 3.5.4(g). Do not locate steps over pipe penetrating manhole wall. Follow SWS Drawing File No. 13.

#### ***Manhole Frames and Covers***

1. Machined manhole frames and covers shall be Neenah R-1710, T-Sealed lids 1090-5255, with Type "B" self-sealing lids, concealed pick hole and no vent holes. Manhole frames shall be centered on the top of the cone, and not sealed to Pro-Ring riser rings.

#### ***Manhole Frame Seal***

1. Manholes shall be constructed and furnished with waterproof frames, lids, and seals. Combination internal/external (Adaptor, Inc. or Cretex External X-85) rubber seals shall be installed in all manholes. These seals shall be installed at the manhole frame-chimney interface and shall be extruded or molded from high-grade rubber compound conforming to the applicable requirements of ASTM C923. Seals shall cover the entire chimney section.
2. Bands for sealing the sleeve against the manhole shall be fabricated of stainless steel conforming to ASTM W240, Type 304. Screws, bolts, and nuts used on the band shall be stainless steel conforming to ASTM F593 and F594, Type 304.
3. All materials shall be installed per the manufacturer's instructions and tested per SWS 3.5.4(1)(a).
4. For frames subject to inundation, install anchored manhole frame and cover following SWS Drawing File No.32.
5. External joint wrap shall be provided on all manhole joints. (Caddilloc, Inc., Esky-Wrap, or Mac Wrap)

#### ***Frame/Chimney Joints***

1. The manhole chimney rings, only CRETEX Pro-ring shall be allowed for adjustment rings and be installed per manufacturer's specifications, and shall not be bonded to the frame.
2. The interior and exterior dimensions of the top of the cone section and adjusting rings shall be equal and these surfaces shall be constructed flush with each other.

#### ***Manhole Riser Joints***

1. Follow SWS 3.2.26. Joints for precast manhole riser sections shall be made with rubber "O"-ring gaskets or two continuous rings of butyl rubber sealant (EZ-Stik or Kent-Seal in rope form) or equal. The butyl sealant shall be 1 inch diameter equivalent or as recommended by the manhole manufacturer. External joint wrap shall be provided on all manhole joints.

**Manhole Lifting Holes**

1. All lifting holes in precast manhole sections shall be plugged using cement mortar and rubber plugs supplied by the manhole supplier. Rubber plugs shall be placed from the exterior of the manhole.

**Manhole Pipe Connections**

1. Connections of pipes to manholes shall be made in accordance with SWS 3.5.7. All field-tapped holes for connecting sewer pipe to manholes shall be made by coring.
2. Flexible pipe connections shall be made with flexible watertight connectors, Kor-N-Seal, Link Seal or Equal. All clamps, bolts, etc. of pipe to manhole seals shall be stainless steel. If Link Seal connectors are used, the bolt heads shall be placed on the inside of the manholes.
3. Mortar annular space between all pipes and man hole cores.

**Drop Manholes**

1. Drop manholes shall be constructed in accordance with SWS 3.5.8(d), and SWS Drawing File No.19 or 20.

**Sewer Stubs**

1. Sewer stubs shall be plugged in accordance with SWS 3.2.25.(a).

**Manhole Marker Posts**

1. The Contractor shall furnish and place fiberglass marker posts to mark manholes located within easements. See LOCATION AIDS section of this document for further detail (Pages 32-36)

**Control (Sampling/Gauging) Manholes**

1. Required for all industrial buildings and select commercial/other developments at the direction/location of the Village.
2. Follow SWS 3.5.8(e) for gauging manholes, SWS 3.5.8(f) for sampling manholes and SWS File No. 23.

**Sanitary Sewer Testing: SWS Part III**

1. Test manholes following SWS 3.5.4(1) a.
2. Before testing, repair or replace piping, valves, fittings, structures, or other parts of the system which have visible defects or leakage even if leakage or pressure loss may be below allowable limits.
3. Air Test: SWS 3.7.3.
4. Go-No-Go test: SWS 3.2.6(i)4.
5. Manhole correction period tests: Water test all seals. Follow SWS 3.5.4(f)1.a.
6. Water exfiltration test: SWS 3.7.4.
7. Infiltration test: SWS 3.7.5.

**SANITARY PRESSURE SEWER**

1. All sanitary force main pipes shall be polyethylene, ductile iron, or PVC.
  - a. Polyethylene pipe shall be Class 160m SDR 11 HDPE in accordance with ASTM D2239.
  - b. Ductile iron pipe shall conform to AWWA C-151, thickness Class 52 with cement lining. Use Tyton gasketed joint pipe and Contractor shall install two bronze serrated wedges at each joint. Follow SWS 8.18.0.

- c. For PVC pipe 6 through 12 inch diameter, use AWWA C-900, Class 150 pressure pipe with DR18 or less. For PVC pipe of 14 through 36 inch diameter, use AWWA C-905, CIOD pressure pipe rated 235 psi with DR18 or less. Pipe shall have integral elastomeric bell and spigot joints. Follow SWS 8.20.0.
2. All ductile iron pipe shall be polyethylene wrapped.
3. Shall be marked with fiberglass marker posts at change of direction or every 400 feet.

***Fittings for ductile iron and PVC pipe shall conform to SWS 8.22.0.***

1. Buried joints shall be mechanical or push-on, while joints in structures shall be flanged. Full body fittings shall have a pressure rating of 250 psi and compact fittings shall be 350 psi.
2. Ductile iron fittings shall have Class 52 wall thickness with bituminous interior and exterior coating per ANSI/AWWA C110/A21.4. Coating can be polythane of 0.04 inch nominal thickness, or Protecto 401 ceramic epoxy of 0.04 inch nominal thickness. Buried fittings shall be fastened using Cor-Blue tee bolts, while exposed fittings shall use stainless steel fasteners. Shall follow SWS 4.4.4. polyethylene wrapped.

***Fittings for polyethylene pipe shall conform to ASTM D3261.***

1. Molded fittings shall have the same pressure class as the pipe, while fabricated fittings should be one class higher than the pipe.
2. Fittings shall be butt-fused or flanged. Exposed fittings shall have a molded flange adaptor with ductile iron or stainless steel backup ring. Buried fittings shall be molded mechanical restrained joint adaptor with stainless steel stiffener and ductile iron or stainless steel backup ring with Cor-Blue, or stainless steel hardware.
3. Shall be polyethylene wrapped.
4. In accordance with ASTM 2513D, use threaded transition fittings when going from stainless steel to HDPE, or HDPE same as sanitary pressure sewer material.

***Sanitary pressure levels shall be of the same material as the pressure sewer.***

1. Curb valves must withstand a 150 psi test. Acceptable valves include Mueller H-10287 and Ford B11-M.
2. Curb boxes shall be screw-on style with plain lid or "SEWER" written on it. Acceptable boxes include Mueller H-10-300-99002 and Ford EM2-65-57R.
3. Use Teflon tape on threaded joints. Use valve stem extensions (also known as stationary or shut-off rod) if necessary.
4. Shall be polyethylene wrapped.

***Air Release Assembly***

1. Valve box shall conform to SWS 4.12.0 using valve stem extenders and a lid marked with "SEWER".
2. Drain stop shall have female iron pipe (FIP) inlet and a flared copper outlet. Acceptable products include Ford B210-333, or Muller equivalent.
3. Shall be polyethylene wrapped.

**FORCE MAIN CONSTRUCTION**

***General Requirements***

1. Contractor shall follow SWS 3.2.6(n)1.

**Polyethylene Wrap**

1. Following SWS 4.4.4, polyethylene wrap shall be provided on all ductile iron or cast iron force main, laterals and fittings. Polyethylene wrap shall be taped tightly at all ends.
2. Polyethylene wrap shall meet the requirements of AWWA Standard C-105 (ANSI A21.5) using Class C (black) polyethylene material with a nominal 0.008 inch thickness and shall be installed as specified in SWS 4.4.4.

**Bedding Material**

1. Follow SWS 3.2.6(b) Class B, or SWS 3.2.6(a) Class C.
2. Force main bedding and cover material shall be crushed stone chips conforming to SWS 8.43.0.
3. The trench section shall conform with Subsection SWS 4.3.3 and SWS Drawing File No. 36, as amended:
  - a. Bedding and cover material shall be placed in a minimum of three separate lifts to ensure adequate compaction of these materials, with one lift of bedding material ending at or near the spring line of the pipe. The Contractor shall take care to completely work bedding material under the haunch of the pipe to provide adequate side support.

**Water Main Crossings**

1. Center one full length of force main on water mains wherever the force main crosses over or under a water main so that both force main joints will be as far from the water main as possible.

**High Points in Force Main**

1. The Contractor shall install force main at the grades shown on the Drawings with no high points constructed in the main except as indicated on the Drawings. If a high point which could trap air cannot be prevented, then an air release assembly shall be constructed at that point.

**Joint Restraint**

1. Concrete Blocking (Buttresses)
  - a. All bends, tees, caps, and plugs shall be buttressed to provide thrust blocking in accordance with SWS 4.3.13 and SWS Drawing File No. 44, 44A, 45, and 46.
2. Restraining Vertical Bends and Offsets
  - a. Changes in the grade of the force main made by vertical bends or offsets shall be restrained by strapping in accordance with SWS Drawing File No. 47, or as provided below.
    - i. The Contractor has the option of using retainer glands in the place of tie rods to restrain mechanical joint fittings where bends or offsets are used to make changes in the grade of the main.

**Insulation**

1. Force mains shall be insulated where noted on the Drawings and wherever the depth of cover is less than six (6) feet. Insulation shall be accordance with SWS 4.17.2, SWS 8.50.0, and SWS Drawing File No.48.

**Polyethylene**

1. Butt-fuse joints following ASTM D2657 and manufacturer's recommendations.
2. Connect to flanged pipe with molded flange adaptor with ductile iron backup ring.
3. Install following ASTM D2321, SWS, and manufacturer's recommendations.
4. Provide embedment material from 6 inches below pipe to 12 inches above top of pipe and compact to 85 percent Standard Proctor density (AASHTO T-99)

5. Protect cut ends and bell fittings with factory-supplied, field applied touchup coating.

### **Materials**

1. Force main pipe material shall be AWWA C900, Class 150, PVC pressure pipe, DR18 or less, for 6 through 12 inch diameter; For 14 through 36 inch diameter force main, refer to AWWA C-905, with CIOD pressure pipe rated 235 psi with DR18 or less. Refer to SWS 8.20.0 and 8.51.2 for PVC also. Ductile iron, SWS 8.18.0, AWWA thickness, Class 52 or Polyethylene, SWS 8.51.3 PPI PE3408, Type III, Class C, Category 5, Grade P34 with Cell Classification 345434C, DIPS, DR9.
2. Ductile iron pipe shall be cement mortar lined with internal and external bituminous coating, meeting the requirements of SWS 8.18.0 and AWWA Standard C-151 (ANSI A21.51). The contractor shall furnish and install 2 bronze serrated wedges in each joint of force main.
3. ASTM D-2241 with Plastics Pipe Institute hydrostatic design stress of 200 psi and SDR of 26 or less.

### **Fittings and Joints**

1. Force main fittings shall be ductile iron cement mortar lined with internal and external bituminous coating and meet the requirements of AWWA Standard C-110 (ANSI 21.10). Also follow SWS 8.22.0. Fittings shall be supplied with mechanical joints with lead tipped rubber gaskets. Pressure Class 250. Ductile iron fittings shall have a Class 52 wall thickness with bituminous exterior coating per ANSI/AWWA C110/A21.10. Use Cor-Blue tee bolts on buried fittings and stainless steel bolts on exposed fittings.
2. Ductile iron fittings meeting the requirements of AWWA Standard C-153 for "compact fittings" may be used. Compact fittings shall be U.S. Pipe "Trim Tyte" ductile iron mechanical joint fittings or equal. Minimum pressure class 350.
3. Polyethylene fittings shall be ASTM D3261 and butt fused or flanged. Molded fittings shall match the pipe pressure class. Fabricated fitting shall be one pressure class higher than the pipe class. Exposed fittings shall have a molded flange adaptor with ductile iron or stainless steel backup ring and stainless steel bolts. Buried fittings shall have a molded mechanical restrained joint adaptor with stainless steel internal stiffener and ductile iron or stainless steel backup ring with Cor-Ten hardware.
4. Interior coating for ductile iron pipe and fittings shall be cement-lining and bituminous-coating following ANSI/AWWA C104/A21.4. Otherwise, polythane with a 0.04 inch nominal thickness, or ceramic epoxy (Protecto 401) with a 0.04 inch nominal thickness can be used.
5. Restrained joints shall have strapping following SWS 4.9.0. Joints may be restrained by EBAA Iron Mega lug or Star Pipe Products Allgrip 3600.
6. External joint wrap shall be used for use in greater than ten feet ground water. Use manufacturers Caddilloc, Inc., Esky-Wrap, or Mac Wrap.
7. Anchored manhole frame and cover shall be used for all frames subject to inundation.

### **Valves and Valve Boxes**

1. Eccentric Plug Valves
  - a. Eccentric plug valves shall be furnished for buried or submerged service with mechanical joint ends, cast iron body, corrosion resistant bearings, nickel or stainless steel seat, resilient faced plug for drip-tight shutoff, 2" square operating nut opening to the left (counterclockwise) with a by-directional worm gear actuator operating against a shut-off pressure of from 0 to 75 psi and rated at 175 psi working pressure.
  - b. Eccentric plug valves shall be DeZurik Series 100 or Val-Matic Cam-Centric (no equal substitution permitted)
2. Valve Boxes

- a. Follow SWS 8.29.0. Valve boxes shall be three-piece cast iron valve boxes consisting of base, screw type center (5 ¼ inch shaft diameter) and top section with cover marked "SEWER". Extension sections shall be furnished as required. Valve boxes shall be furnished for the depth of trench shown on the Drawings with the cover placed at the existing grade or to the elevation shown on the Drawings. Air release vents shall be installed in accordance with SWS Drawing File 42 or File 43 as applicable (separate box).
- b. Valve boxes shall be Tyler 6860S, Model DD, with a cover marked "Sewer".
- c. Rotary gear type actuator for valves 8 inches and larger.
- d. Valve stem extender shall be securely attached to valve operator and extended to 2 feet (plus or minus 3 inches) below finished grade. Provide a solid shaft for 6 foot and longer extenders. Extender shall be epoxy coated iron with stainless steel pins or bolts. A spacer ring shall be located 3 inches below operating nut.

### ***Air Release Assembly***

1. In a valve box, follow SWS 4.12.0, except include the following: valve stem extenders, plain or "SEWER" lid, female iron pipe inlet and flared copper outlet (Ford B21-333), or Mueller equivalent.
2. In valve vault, follow SWS 4.11.0, except provide HS20 load-rated flat top slab.

### ***Sewage Air Valves and Air Valve Manholes***

1. Sewage air release valves shall be APCO, Golden-Anderson or equal.
2. Valves shall be constructed of cast iron body and cover, stainless steel float and linkage and resilient seat. Valves shall be furnished with protective hoods.
3. Valves shall be furnished rated for a working pressure of 0 to 75 psi.

### ***Back-flushing Accessories***

1. Back-flushing accessories consisting of a 4 inch inlet shutoff plug valve or inlet isolation valve(s) on combination air valves, bronze rubber seated blow off valve(s), bronze rubber seated clear water inlet valve(s) with quick disconnect coupling, quick disconnect coupling to insert in air release valve orifice outlet and 5 feet minimum of rubber hose with quick disconnect couplings on each end shall be furnished by the valve manufacturer and assembled to all sewage air valves.

### ***Air Valve Coating System***

1. All interior and exterior surfaces of sewage air valves shall be sandblasted and coated to protect them from corrosion. The coating system shall consist of 10% solid epoxy, non-solvent bearing, non-leaching, Keyset #740 or equal, applied in 2 coats each 7/10 mil minimum thickness.

### ***Air Valve Manholes***

1. Air valve manholes shall be constructed in accordance with the general requirements of Section Sanitary Sewer Manholes of these Requirements for Sanitary Manholes. Make sure they are the same make, model, rings, etc.

### ***Warning Label***

1. Weather proof durable warning labels, 4 inch by 6 inch size, printed in red, shall be permanently attached to the inside surface of manhole slabs in line with manhole steps.
2. The labels shall read:
  - a. "Warning: Hazardous gases may be present which could cause severe injury or death. No smoking. Enter only with proper ventilation, life line attached and standby personnel present".

- b. Permit required—Confined Space Entry Only.

***Frame and chimney sealants in accordance with SWS 8.42.0.***

1. External rubber sleeve chimney sealants shall be in accordance with ASTM C-923. Acceptable products include: Internal/External Adaptor Seal by Adaptor, Inc. and CreteX external manhole chimney seal.

***Air Valve Warranty***

1. The sewage air valve manufacturer shall provide a two (2) year warranty from the date that the work is accepted by the Village guaranteeing that all materials and equipment are free from defects in design, materials and workmanship. The manufacturer shall, upon proper notification, repair or replace any equipment proven defective during the warranty period.

***Hydrostatic Testing***

1. Force mains shall be hydrostatically tested in accordance with SWS 4.15.0.
2. For the pressure test, follow SWS 4.15.2, except test at pipe pressure rating or 150 psi, whichever is less.
3. The leakage test shall be run at 150% of the design operation pressure, but not less than 50 psi, measured at the point of the highest elevation of the section of force main being tested. The final leakage test shall be run for three (3) continuous hours. The formula for computing maximum allowable leakage is shown in SWS 4.15.3.
4. The Village or their Representative shall be present at all times during testing.
5. The Contractor shall furnish all labor, equipment, and material to complete all testing.
6. The cost of all force main testing shall be paid for by the Developer or his Contractor.

***Water for Testing***

1. Water for testing may be purchased from the Utilities Department. The Contractor shall notify and coordinate his operations with the Utilities Director.

**LIFT STATIONS**

***Equipment Testing, Start-up and Instructions.***

1. The Contractor shall test all equipment, including air valves and plug valves, after it is installed and prior to lift station start-up to ensure that it is functioning and in proper working order.
2. The Contractor shall have personnel available should they be needed to adjust or repair force main equipment during start-up of the lift station, by others
3. After the equipment has been installed, inspected, and approved the manufacturer's representative shall instruct the Villages operating personnel as to the proper procedures for operating and maintaining the equipment.

***Operation/Maintenance Manuals and Instructions***

1. Prior to substantial completion, the Contractor shall provide the Village with four (4) operation and maintenance manuals covering each item of equipment, including air valves and plug valves, furnished or installed under the contract.
2. Manuals shall be delivered to the Village for approval prior to 75% of job completion.
3. Data shall be folded to 8 ½"x11" size and placed into hard cover binders. Material shall be grouped according to specifications sections and filed behind individual filing tab pages on which the following

is to be typed: Item, Manufacturer, Contractor's Order Number, Supplier's Order Number, and Manufacturer's Order Number.

4. The correct model number shall be designated where the literature covers more than one model.
5. For items, assembled by the Contractor, the Contractor shall write and provide duplicate operation and maintenance instructions.
6. Operation and maintenance manuals shall include the following information:
  - a. Supplier and manufacturer's name, address, telephone number, and local representative's name, address, and telephone number. Sources of service and parts and a list of local repair services, supply houses and potential sources for the types of repairs and equipment parts.
  - b. Warranties and bonds shall be included in manual.
  - c. Catalog literature complete with performance data and ratings.
  - d. Specify equipment function, normal operating and limiting conditions.
  - e. Assembly, installation for start-up, shutdown, routine and normal operation.
  - f. Detailed service information including schedule of recommended maintenance.
  - g. Troubleshooting, common operating problems, problems that might occur in unit/process. List probable causes and discuss control/prevention.
  - h. Detailed safety section covering the operation and maintenance of unit. Contractor shall supply a complete list of equipment service numbers, model numbers, electrical requirements, manufacturer's names, etc.
  - i. Complete an accurate set of as-built drawings including dimensions, schematics of hydraulics, wiring and piping.
  - j. Emergency operating instructions indicating range and flexibility during emergencies.

## **STORM SEWER**

### ***Storm Sewer Televising***

1. All newly installed storm sewers shall be televised prior to acceptance.
2. Shall follow SWS 7.1.2 and 02955, perform televising after manhole benches are installed, surfacing has been restored and the pipe has successfully tested.
3. Televising shall only be performed by the Expeditors, Inc. 400 N. Summit Drive, Oconomowoc, WI 53066. (800) 657-0879.
4. The Contractor shall ensure that all lines are flushed and clean prior to video recording. Use self-propelled crawler camera as opposed to jetter-propelled camera.
5. Video records which show debris in lines will not be accepted. In the event a sewer span is not accepted, cleaning and re-video may be required.
6. The cost of cleaning and video recording shall be paid for by the Developer or his Contractor.
7. The sewer plug and/or bulkhead shall remain in place throughout the cleaning and video recording process and until final acceptance of the project.

### ***Bedding and Cover Material***

1. Storm sewer bedding and cover material shall conform to the appropriate sections of the SWS, SWS 8.43.2 and as noted below. Unless otherwise specified on the Drawings, Class "C" Bedding shall be used.
2. Class "C" Bedding-SWS Drawing File No.3 and SWS 3.2.6(a)
3. Culvert construction follow SWS 3.2.6.

**Ditch Filling and Grading**

1. The Contractor shall fill in ditches where indicated on the Drawings, grade the ditches to drain storm sewer inlets in accordance with the grades shown and form new ditch sections per typical details and cross-sections.
2. Prior to grading and filling in ditches, the Contractor shall strip and stockpile all topsoil for future use in restoring disturbed construction areas. All fill areas shall be covered with a minimum of 4 inches of topsoil. If sufficient quantities of salvaged topsoil are not available for covering fill areas, the Contractor shall furnish additional topsoil.
3. Ditch drainage, in accordance with SWS 1.7.10, must be provided at all times.

**Storm Sewer Materials****Pipe**

1. Storm sewer pipe material shall be reinforced concrete sewer pipe as shown on the drawings conforming to the following;
  - a. Reinforced concrete sewer pipe (RCP) shall meet the requirements of ASTM C-76 and SWS 8.6.0. Joints shall be cement mortared type joints, as per SWS 3.2.16 or rubber gasket joints as per SWS 3.2.11.
  - b. All pipe inlet and outlet end sections greater than 18 inches shall have hinged, locked trash racks. Trash racks will be vertical on inlets and horizontal on outlets. Bar spacing is 6 inches.
  - c. Provide Master Lock with Number 2436 keys.

**Storm Sewer Manholes**

1. Storm sewer manholes shall be constructed in accordance with SWS 3.5.0, 8.39.0 and SWS Drawing File No. 12, 13, 15, and 16, and these Requirements. Pipe to manhole connections shall be mortared.
2. For storm sewer 42 inch and greater, manholes shall be 48" precast manhole tees with eccentric cones. All other manholes shall be 48 inch or larger inside diameter. When manhole tees are used, Contractor shall supply 2 foot and 4 foot bell and spigot lengths of pipe to allow required positioning of manholes. Miter pipe may be used for bends immediately upstream and downstream of Tee Manholes for bends shown at Manholes unless noted on the Drawings.
3. Flat top slabs with offset openings may be used for shallow manholes where there is not sufficient depth to install cones or on deeper manholes with the approval of the Village.
4. A minimum of 6 inches to a maximum of 15 inches of adjusting rings shall be furnished for each manhole.
5. Manhole depths shown on the Drawings are approximate only. Final manhole rim grades shall be adjusted within  $\frac{1}{2}$  to  $\frac{3}{4}$  inch below the existing and proposed pavement grades after the curb and gutter is completed.
6. Manholes shall be initially set to  $\frac{1}{2}$ - $\frac{3}{4}$  inch below binder pavement grade. Neenah R-1979 series adjusting rings shall be used when adjusting manhole rims from binder grade to within  $\frac{1}{2}$  to  $\frac{3}{4}$  inch below surface pavement grade, per SWS 8.39.11. Wood shims are not permitted.
7. Plastic manhole steps shall be provided in accordance with SWS 3.5.4(g).
8. Manholes less than 4 feet deep do not require steps.

**Manhole Frames and Covers**

1. Manhole frames and covers shall be Neenah R-1710. Where height restrictions apply, Neenah R-1580 frames and covers shall be used.
2. Beehive grate manhole covers shall be Neenah R-2560-D3 or equal.
3. Manhole frames shall be centered on the top of the cone section.

**Manhole Joints**

1. The manhole chimney rings, only CRETEX Pro-ring shall be allowed for adjustment rings and be installed per manufacturer's specifications and shall not be bonded to the frame.
2. Joints for precast manhole riser sections shall be made with rubber "O"-ring gaskets or two continuous rings of butyl rubber sealant (Ex-Stik or Kent Seal in rope form) or equal. The butyl sealant shall be 1 inch diameter equivalent or as recommended by the manhole manufacturer.
3. The interior and exterior dimensions of the top of the cone section and adjusting rings shall be equal and these surfaces shall be constructed flush with each other.

**Sewer Stubs**

1. Sewer stubs shall be bulk headed in accordance with SWS 3.2.25(a).

**Storm Water Catch Basins**

1. Catch basins shall be constructed in accordance with SWS 3.6.0 for precast using WisDOT SDD 8C7, 2x2.5 FT structure with 1 FT sump and the following:
  - a. Catch basins, with the exception of catch basins at sumps, shall be precast concrete and shall be installed to match surface pavement grade. At sump locations, dual catch basins shall be installed with a 10 foot separation and a summit between inlets. Pitch sump lines to catch basin or manhole and bed and cover PVC following SWS 3.2.6.i. Catch basins at sump locations shall be initially installed to match binder pavement grade, leaving out a five (5) foot section of curb on each side of the basin and the entire curb between the inlets. In place of the curb, a temporary asphalt flume shall be constructed to direct runoff into the catch basins. Prior to completion of the surface course, the catch basin shall be adjusted to match surface grade, the flume shall be removed, and the granular backfill shall be compacted in six (8) inch lifts or thoroughly flushed, as specified. Slurry may be used in place of compacted or flushed fill. Then new concrete curb and gutter shall be installed adjacent to the existing curb. Inlet and catch basin mortar shall comply with State Specifications 519.2.3. Concrete block used shall follow State Specifications 519.2.2 (salt-resistant pink block).
  - b. The depths of catch basins shown on the Drawings are measured from the invert of the lead to the flow line of the grate. Catch basin grates shall be placed to match the gutter grade or at the elevation indicated on the Drawings. Catch basin frame and cover shall be Neenah R3228-BC with Type C grates.
  - c. The Utility Contractor shall construct catch basin chimneys using CRETEX Pro-ring adjustment rings per manufacturer's specifications to a height just below the base casting elevation. The Paving Contractor will set the casting as part of their curb and gutter installation. Chimney adjustments made with anything other than CRETEX Pro-rings shall not be allowed.
  - d. Catch basins greater than four (4) feet in depth, shall be provided with plastic steps in accordance with SWS 3.5.4(g).
  - e. The Contractor shall install geotextile fabric under all lids of storm manholes, to prevent siltation of the storm sewer system during construction. The fabric shall be placed as storm sewer is constructed and removed upon completion of the project as directed by the Village. The Contractor shall remove sediment from this fabric after each rainfall.

- f. The Contractor shall provide and install Ultratech ultra drain guard curb-inlet style (or equal) in all catch basins at the time of construction. The Contractor shall remove sediment from drain guard after each rainfall.
- g. The storm sewer outlets shall be lined with geotextile fabric and covered with medium rip-rap. (6"-12" limestone) 18" deep. See State Specifications Sections 520 through 525 for apron end walls using same material as pipe. Geotextile fabric shall follow State Specifications 645.2, Type R.
- h. Storm sewer catch basin and outlet end sections follow culvert sections.
- i. Storm sewer catch basins shall be located a minimum distance of 8 feet from hydrants.
- j. Storm sewer catch basins shall be located at lot lines, to the maximum extent practicable.

### ***Culvert Materials***

#### ***Under existing or Future Village Streets***

1. Reinforced concrete sewer pipe (RCP) shall meet the requirements of ASTM C76 and SWS 8.6.0. Joints shall be cement mortar following SWS 3.2.16 or rubber gasket joints as per SWS 3.2.11. ASTM C-443 for joints.
2. Reinforced concrete horizontal elliptical pipe (RCHEP), follow ASTM C-507 and SWS 8.6.0.

#### ***Outside Village Street***

1. Reinforced concrete sewer pipe (RCP) shall meet the requirements of ASTM C76 and SWS 8.6.0. Joints shall be cement mortar following SWS 3.2.16 or rubber gasket joints as per SWS 3.2.11. ASTM C-443 for joints.
2. Reinforced concrete horizontal elliptical pipe (RCHEP), follow ASTM C-507 and SWS 8.6.0.
3. Corrugated steel culvert pipe, follow SWS Chapter 8.14.0. Minimum WisDOT gauge.
4. Corrugated aluminum culvert pipe, follow SWS 8.15.0.
5. All culverts shall have inlet and outlet section of the same material of the culvert.
6. All end sections shall be provided with bar grates or trash racks.
7. All end sections greater than 18 inches in diameter shall have locked, hinged trash racks. See detail on Drawings.
8. Sump lines and sump line cleanouts, follow SWS 8.10.0. Use PVC SDR35 sumps and Neenah R1977 cleanout frost sleeves.

### **LOCATION AIDS**

1. Contractor shall provide and install warning tape 18 inches above pipe.
2. Contractor shall provide and attach detector wire with tape at a maximum of 6 inches directly above.
3. Warning tape and detector wire shall be provided for the following:
  - a. Force Mains
  - b. Water mains and services
  - c. Sanitary sewers and laterals
  - d. Pressure sewers and laterals
  - e. Storm sewer and laterals
4. Contractor shall demonstrate continuity of detector wires to the Mukwonago Utilities.
5. Provide a temporary above-ground wire between adjacent marker posts, and location boxes. Connect ohm meter in a series loop with detector wire and above ground wire. Circuit resistance shall not exceed 5 ohms. Demonstration shall occur prior to placement of base course in paved areas and restoration in lawn areas.

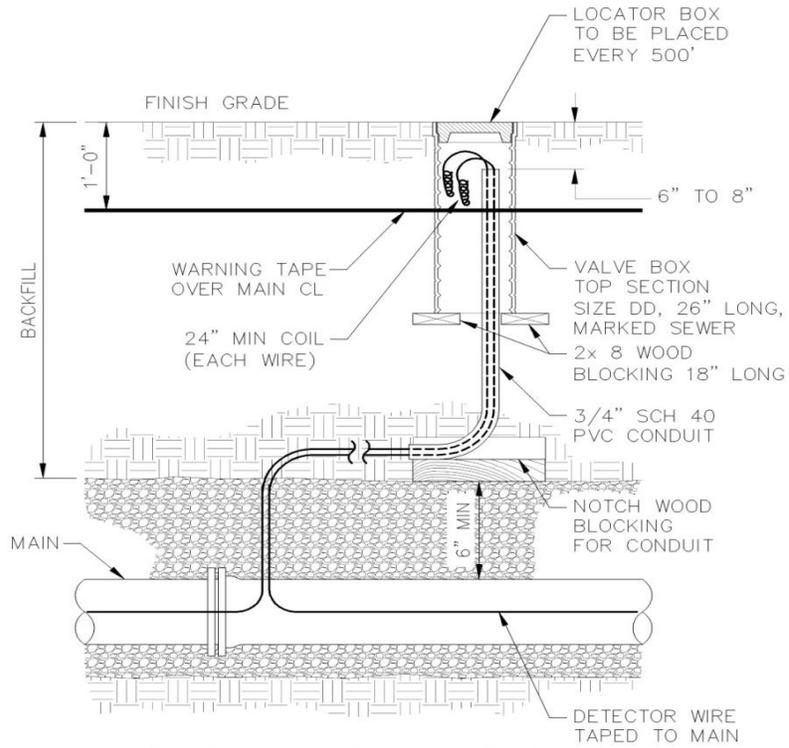
6. Do not splice between marker posts and location boxes without Village's approval except at laterals and services. Follow SWS 4.3.14.
7. Provide and install one-pound anode a minimum of 1 foot to the side of termination of main or service/lateral where detector wire end is buried.
8. Location of water, sanitary sewer, force main, and storm sewer in utility easements shall be marked at all change of direction and every 400 feet with fiberglass marker posts.

**Warning Tape**

1. Use TERRA TAPE EXTRA STRENGTH 540, by Reed Industries, Inc or Shieldtec by Empire Level Manufacturing Corporation.
2. Tape width 3 inches.
3. Contractor shall follow State Statutes 182.0157 and ANSI Standards 253.1.
4. Tape color and verbiage:
  - a. Water: Blue. "CAUTION: WATER LINE BELOW".
  - b. Sanitary: Green.
    - i. Gravity: "CAUTION-SANITARY LINE BURIED BELOW".
    - ii. Pressure sewer or force main: "CAUTION-BURIED PRESSURE SEWAGE FORCE MAIN".
  - c. Storm: Brown. "CAUTION-BURIED STORM LINE DRAIN".
  - d. Non-potable Water: Purple.

**Detector Wire**

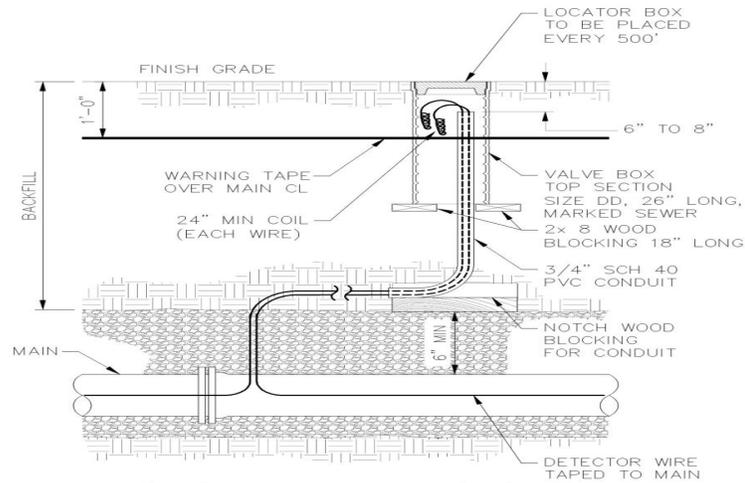
1. Contractor shall follow SWS 4.3.14 for detector wire.
2. For open cut construction, Contractor shall provide and install direct-burial-rated insulated AWG #10 copper conductor wire.
3. For trenchless installation, Contractor shall provide and install aircraft cable, nylon-coated stainless-steel, 3/8 inch diameter wire.
4. Splices shall follow SWS Drawing File No.24B.
5. Connections can be made with gel caps. Copperhead Drycon or comparable approved by Village Engineer and Utility Director shall be used.



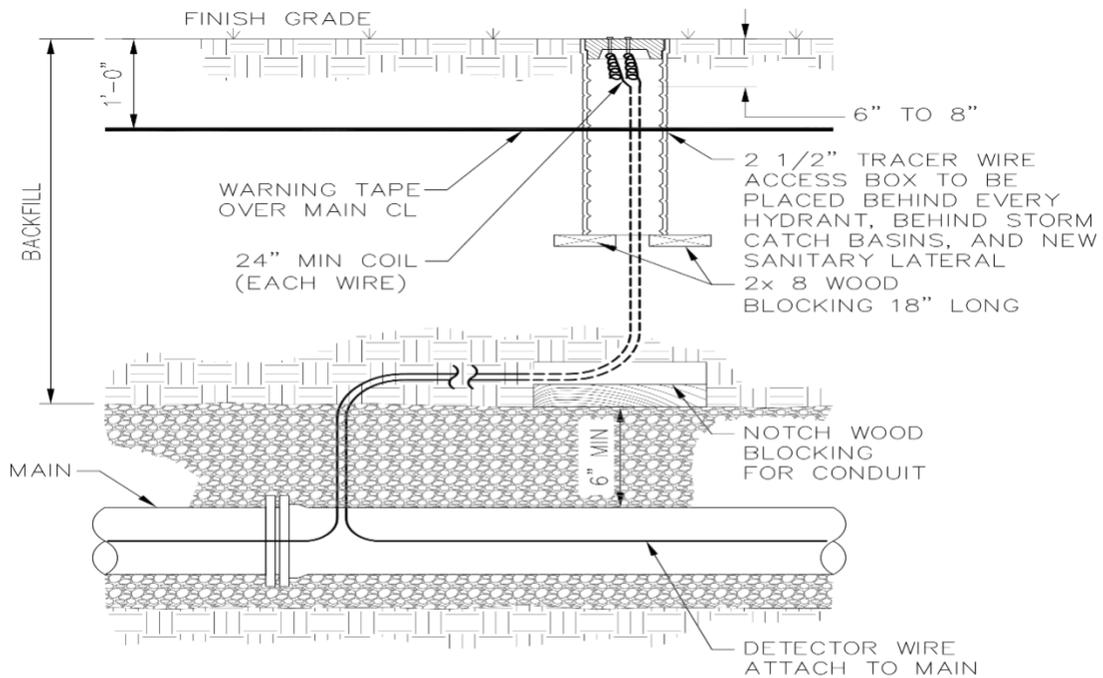
**FORCE MAIN DETECTOR WIRE & LOCATION BOX**

02500LOCF 16

NO SCALE



**FORCE MAIN DETECTOR WIRE & LOCATION BOX** NO SCALE  
02500LOCF 16



**DETECTOR WIRE & LOCATION BOX (ON TERRACE)** NO SCALE  
02500LOCT 16

**Location Boxes and Marker Posts**

1. Contractor shall provide and install water system location boxes behind each hydrant. The location box shall not exceed the bottom flange of hydrant.
2. Contractor shall provide and install water system location boxes at each curb stop and at a maximum spacing of 500 feet.
3. Contractor shall provide and install location boxes at the right of way line for all laterals.
4. Contractor shall provide and install force main and pressure sewer marker posts and location boxes at 500 foot maximum spacing and at all changes in horizontal alignment. Marker posts are not required in paved areas.
5. Contractor shall provide and install location boxes where a sewer lateral and water lateral are installed in a common trench, terminate sewer and water detector wire in a common location box at curb box.
6. Sanitary sewer and storm sewer location boxes shall be top section valve box, size DD, 26 inch length, with cover marked "SEWER" and hardwood blocking.
7. Water, sanitary sewer and storm sewer lateral location boxes shall be tracer wire access box (Valvco, Inc.) with cover marked "SEWER" for sewer and "WATER" for water. Include hardwood blocking.
8. Sanitary sewer and storm sewer marker posts shall be "Rib Bak" U-channeled by Marion Steel Company, Marion, Ohio. Marker posts shall have hot-dipped galvanized finish and weigh 3 pounds per foot.

**BACKFILLING-EXISTING**

1. The Contractor shall dispose of surplus excavated material as directed by the Developer or his Engineer.
2. Existing roads that are cut open shall have slurry backfill.
3. Where called for on the Drawings or where required by permit, slurry backfill conforming to SWS 8.43.8 and the following mix shall be used:
  - a. 1350 lbs. Sand
  - b. 775 lbs. #1 Stone
  - c. 1150 lbs. #2 Stone
  - d. 25 gals. (0-0.5 gal.) Water per C.Y.
4. No additional water will be allowed. The above weights are damp weights. This material shall be thoroughly mixed just prior to installation.

**BACKFILLING-NEW DEVELOPMENT**

1. The Contractor shall dispose of surplus excavated material as directed by the Developer or his Engineer.
2. All granular backfill shall be compacted in six (6) inch lifts or thoroughly flushed, as specified under SWS 2.6.14, Flooding, of the Standard Specification. Water for flooding will be furnished by the Village at the Contractor's expense. The Contractor shall contact the Utilities Department to make arrangements for water meter. Mechanically compact trench backfill following SWS 2.6.14(b), except Contractor shall furnish and pay for compaction testing services.

**Excavated Material Backfill**

1. Excavated material, in accordance with SWS 8.43.5, may be used to backfill trenches except through future and existing paved or graveled surfaces, such as driveways, parking areas, shoulders, curb and gutter, sidewalks; and in future streets, or within 5 feet of such surface shall be backfilled with granular material.

**Granular Backfill**

1. Granular backfill, in accordance with Table 37 of SWS 8.43.4, shall be used to backfill trenches as stated above
2. Granular backfill placed within state highway right-of-ways shall conform to Section 209 of the "State Specifications".

**Slurry Backfill**

1. Where called for on the Drawings or where required by permit, slurry backfill conforming to SWS 8.43.8 and the following mix shall be used:
  - a. 1350 lbs. Sand
  - b. 775 lbs. #1 Stone
  - c. 1150 lbs. #2 Stone
  - d. 25 gals. (0-0.5 gal.) Water per C.Y.
2. No additional water will be allowed. The above weights are damp weights. This material shall be thoroughly mixed just prior to installation.

**SURFACE PLACEMENT****General Placement**

1. No street construction or surface restoration work may begin until the alignment and grade of Village utilities has been accepted by the Village
2. The provisions of SWS 2.6.11 and SWS 2.7.2 are modified as follows:
  - a. The Contractor shall replace or restore to its original condition, unless specified otherwise, any sidewalk, driveway, curb, gutter, shoulder, pavement, culvert, drain tile, lawn, ditch, fence, sign, mailbox, or other property damaged by him during his work operations at his own cost. SWS 2.7.3.
  - b. Restoration of pavements damaged by normal truck hauling operations; i.e., hauling within approved weight and speed limits and exercising reasonable care while starting, stopping, or turning vehicles, will not be the responsibility of the Contractor. This provision does not apply to pavement damaged during loading or unloading operations.

**Pavement Protection**

1. The Contractor shall take all precautions necessary to protect road pavements, including shoulders, from being damaged. Sheathing and bracing or the use of a portable trench box, if required, shall be in accordance with SWS 2.3.0 and SWS 2.3.6.
2. Backfill or excavated material spilled or tracked onto pavements or shoulders shall be removed at the completion of each working day or more often if needed as directed by the Village. Any such materials interfering with traffic shall immediately be swept off with power brooming equipment.

**Pavement Replacement**

1. Damaged shoulder, road pavement and driveway areas shall be replace "in kind" with the following exceptions:
  - a. Road Shoulder
    - i. A minimum of 8 inches of crushed aggregate base course shall be placed over road shoulder areas.
  - b. Road Pavements

- i. A minimum of 8 inches of crushed aggregate base course, 2.5 inches of binder course and 1.5 inches of asphaltic concrete pavement (hot mix) shall be placed over trenches within paved areas of local streets. All pavement joints including the curb flange on the final lift of asphalt shall be sealed with CRAFCO Pavement joint adhesive (34524) per manufactures specifications.
  - ii. A minimum of 10 inches of crushed aggregate base course, 3 inches of binder course and 1.5 inches of asphaltic concrete pavement (hot mix) shall be placed over trenches within paved areas of collector streets. All pavement joints including the curb flange on the final lift of asphalt shall be sealed with CRAFCO Pavement joint adhesive (34524) per manufactures specifications.
- c. Driveways and Parking Areas
  - i. A minimum of 6 inches of crushed aggregate base course shall be placed over existing gravel driveways and parking areas, in addition to a minimum of 2 inches of asphaltic concrete pavement (hot mix, surface course) over existing paved drives and parking areas.

### ***Utilities***

1. The Contractor shall contact all utility companies prior to the commencement of construction and shall arrange to have those existing utilities located and staked or marked in the field that are in the construction area.

### ***Street Lights***

1. Street lights shall be We Energies Night Aura, with black coach light fixtures on black fiberglass poles. These costs are typically listed on the We Energies work order as Option B. Additionally, if the Developer would desire to use standards and fixtures that are more costly than the black coach light on black fiberglass pole, the Village may approve that type of lights on a case by case basis. If approved, the Developer would be responsible for all capital costs as above and additionally would be required to pay the incremental monthly charge over that charged for standard street lighting for a period of 10 years.
2. Street lights shall illuminate all fire hydrants and be located no less than 10 feet and no more than 20 feet from the hydrant.
3. Street lights shall illuminate all intersections. At a minimum, there shall be one (1) street light at each intersection, with additional street lights at major intersections.
4. Additional street lights may be required by the Village to illuminate other locations, such as mid-block pedestrian crossing.
5. Additional street lights may be required by the Village based on land use and street type.

### ***Temporary Surfacing***

1. All trenches in asphaltic shoulders, driveways and pavements shall be temporarily surfaced with crushed aggregate base course equal in thickness to the total thickness of gravel base course and asphaltic surfacing.

### ***Saw-cutting Pavements***

1. All concrete and asphalt pavements, curbs, shoulders, and driveways shall be saw-cut to full depth prior to being shattered and removed. Where concrete pavements are covered with asphalt overlay, both the asphalt and concrete shall be saw-cut. Pavements shall be saw-cut in a neat straight line to

produce a clean joint for pavement restoration. If the saw-cut edge is damaged during construction, the Contractor shall saw-cut the pavement again immediately prior to paving.

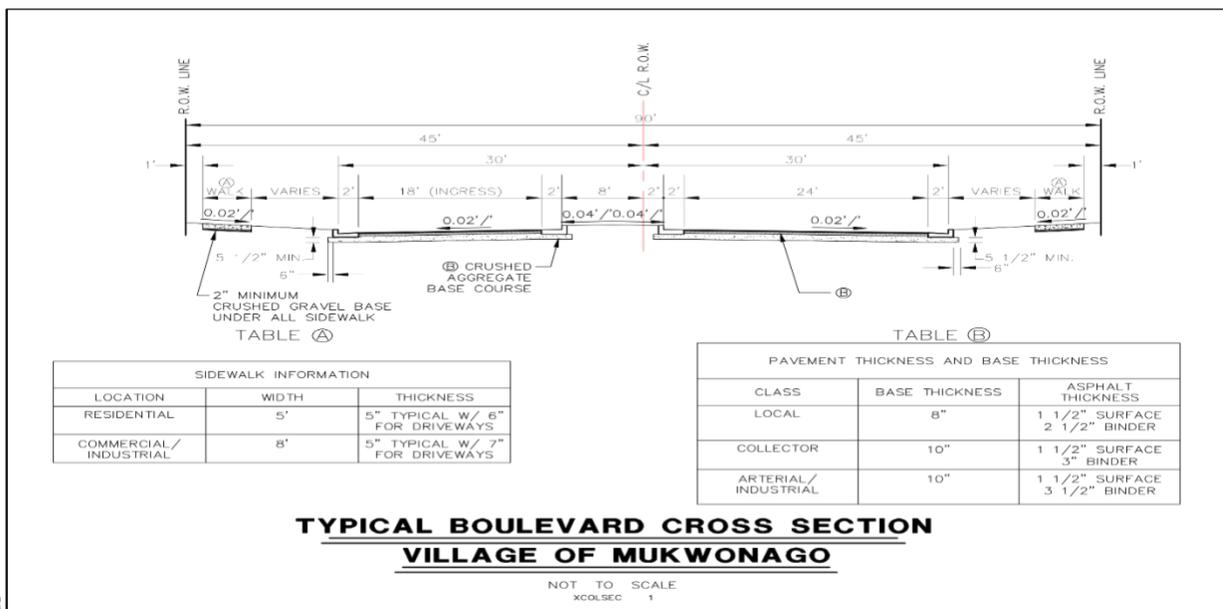
**STREET DESIGN**

1. All street design shall conform with the requirements of the Municipal Code, A Policy on the Geometric Design of Highways and Streets, current edition, published by the American Association of State Highway and Transportation Officials, Manual on Uniform Traffic Control Devices for Streets and Highways, current edition, published by the Federal Highway Administration, and the Standard Specifications for Highway and Structure Construction 2003 Edition, published by Wisconsin Department of Transportation, and these Development Requirements.
2. All street designs, including construction plans, pavement marking layouts and signage plans must be approved by the Village prior to construction. Speed limit signs shall be installed at all development entrances. Where applicable, street signs shall be installed on top of stop signs.
3. Follow State Specifications 643 for traffic control. Follow State Specifications 637 for the placement of signs and State Specifications 638 for the relocation of signs. Guardrail construction shall be governed by State Specifications 614. Retaining walls shall conform to State Specifications 504.3 and asphalt curb shall follow State Specifications 465.3.2. Rumble strips shall be constructed following State Specifications 465.3.3.

**Width**

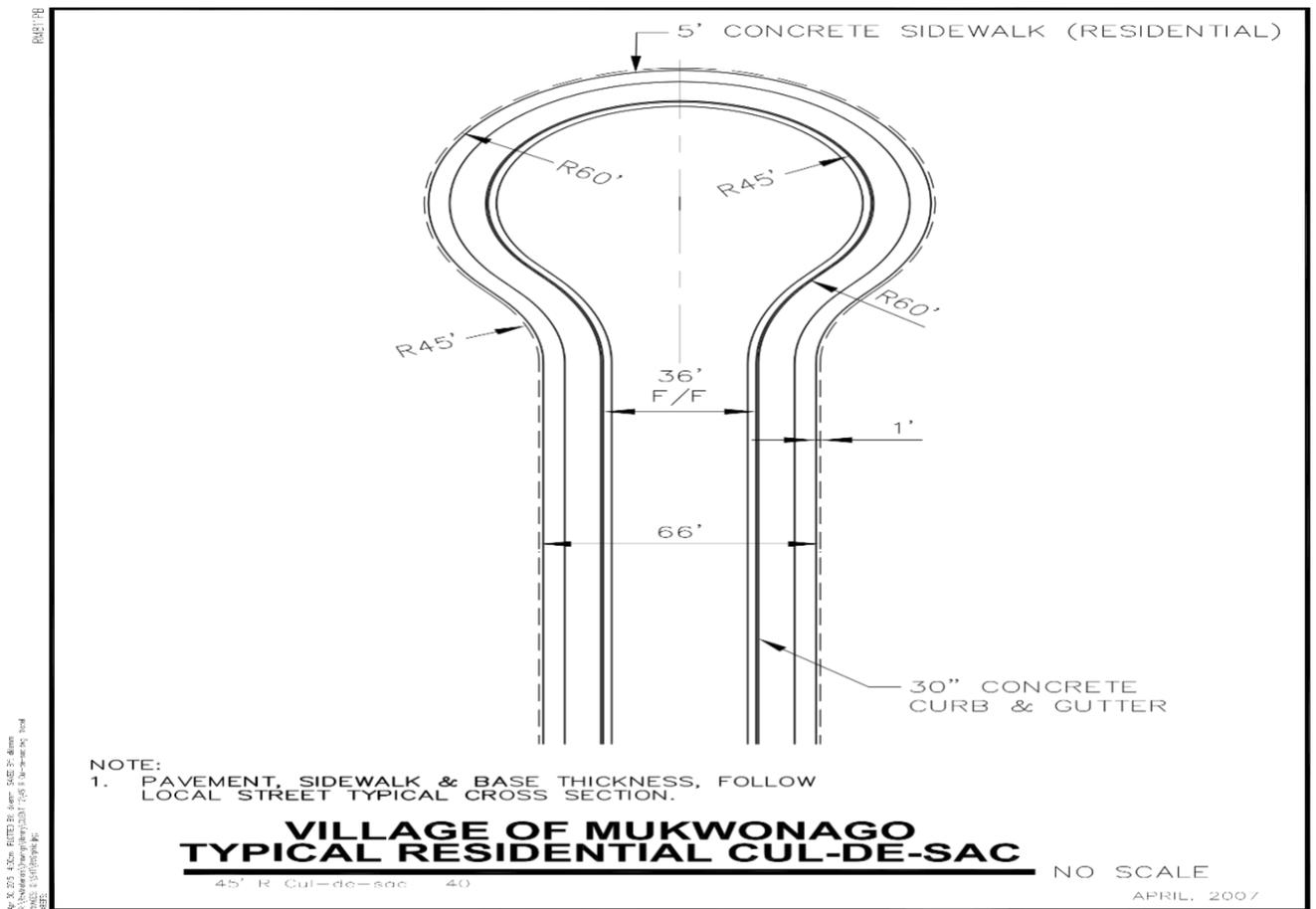
1. The right of way width of all streets shall not be less than the width shown in the master plan or if no width is specified, they shall be not less than the width specified as follows:

Street Type	Right of way width
Arterial	120 feet
Collector	80 feet
Local Street	66 feet
Frontage Street	30 feet
Private Road	30 feet
Boulevard	90 feet



P. No. 2015-132m, V. 07/15/15, P. 18mm, S. 02/15/15  
 P. No. 2015-132m, V. 07/15/15, P. 18mm, S. 02/15/15  
 8/22/15





### Grades

1. The grade of arterial and collector streets shall not exceed 6 percent, and the grade of all other streets shall not exceed 10 percent, unless necessitated by exceptional topography and approved by the plan commission. The minimum grade of all streets shall be no less than one half of one percent, and such minimums shall not be permitted for long sustained distances.

### Horizontal Curves

1. A minimum sight distance with clear visibility, measured along the centerline, shall be provided of at least 300 feet on arterial streets, 200 feet for collector streets, and 100 feet on local streets. All streets shall accommodate the WB-50 design vehicle. The WB-62 design vehicle shall be accommodated as directed by the Village.



**STREET CONSTRUCTION**

1. State Specifications 204 shall govern the removal of miscellaneous structures such as curb and gutter, asphaltic concrete pavement, sidewalk, guardrail, manholes, inlets, tanks, wells, and buildings.
2. The streets shall be constructed according to the profiles and Typical Sections as shown on the plans. The roadways shall be graded and compacted to bring the subgrade of the roads and parkways to the proposed grades as shown on the plans.
3. Follow State Specifications 305 using 3/4 inch crushed limestone or crushed gravel. For reclaimed asphaltic pavement, follow State Specifications 305.2.2.2. Compaction of the subgrade and the base course shall be in accordance with the "State Specifications" but shall never be less than 95% of the maximum density of the material being compacted using the Modified Proctor test.
4. All manholes, valve boxes, etc. shall be set 1/2" to 3/4" inches below asphaltic binder course grade. The Road Contractor shall coordinate all utility adjustments with the Utility Contractor. Neenah R-1979 series adjusting rings shall be used when adjusting manhole rims from binder grade to finish surface pavement grade. All utility structures, including manhole rims, shall be adjusted within 1/2 inch to 3/4 inch below finish grade prior to placement of surface course.
5. All utilities such as valve boxes shall be mechanically adjusted to finished grade upon installation of the bituminous concrete surface course pavement. The Road Contractor shall coordinate all utility adjustments with the Utility Contractor.
6. The bituminous concrete pavement shall be installed in stages. In regards to the complete construction of a new street, the bituminous concrete surface course shall not be installed for a minimum of a year after the initial construction of the street. Final surface course shall be placed when one of the following conditions exist:
  - a. 80% of subdivision is developed.
  - b. Maximum of three (3) years since initial construction of the street.
  - c. The second and final lift of asphalt shall not be installed less than one (1) year after the binder course of asphalt has been installed.
7. Concrete pavement design and placement shall be in accordance with State Specifications 415 and 501. Hand consolidated concrete shall have a slump of 1 to 3 inches, while vibratory consolidated concrete shall have a slump of 1 to 2 1/2 inches. Concrete shall achieve a minimum compressive strength of 4000 pounds per square inch at 28 days. Calcium chloride is not permitted to prevent freezing of the concrete. Concrete set retarder, water reducer, and air entrainment are specified by State Specifications 501.2.3.2, 501.2.3.3, and 501.2.2 respectively. State Specifications 505 specifies steel reinforcement of concrete.
8. All asphaltic pavements shall follow State Specifications 460.2.7 and the following:

<b>Street Classification</b>	<b>Binder</b>	<b>Surface</b>
Residential, Parking Lots and Driveways	3 LT 58-28 S	5 LT 58-28 S
Collector Streets	3 LT 58-28 S	5 LT 58-28 S
Arterial and Industrial Streets	3 HT 58-28 S	5 HT 58-28 S

9. Contractor shall arrange and conduct the following tests to demonstrate compliance with these development requirements. Make plant adjustments as necessary to meet these requirements.
  - Test materials at plant daily.
  - Maintain air voids between 2.7 percent and 5.3 percent, and follow State Specifications including additional special provisions 460.2.1 issued under ASP-6.
  - Void in mineral aggregate (VMA) follow State Specifications Table 460-1.

10. Density testing shall be one test for every location and one test per 250 tons. Use Nuclear Method, use maximum specific gravity running average of four from mix design. The Village will determine locations of testing. Follow State Specifications 460.3.3 Maximum Density Method, except minimum density shall not be less than:
  - a. 91.5 percent for binder courses. 93% if over existing pavement.
  - b. 93 percent for surface courses Village will request locations.
11. For all streets constructed of asphaltic pavement, the asphalt shall be a minimum of 4 inches thick, with 2.5 inches of binder course and 1.5 inches of surface course. For all driveways constructed of asphaltic pavement, the asphalt shall be a minimum of 3.75 inches thick, with 2.25 inches of binder course and 1.5 inches of surface course.
12. Maintain material within specified tolerances. If test is out of tolerance, increase testing frequency until material is within specification. Submit test reports to Village at end of project. Follow State Specifications 460.2.8.2.2.
13. Following State Specifications 455.3, apply tack coat at 0.1 gallons per square yard between each layer of asphaltic concrete and allow to cure before paving. The binder course shall be delivered at a minimum temperature of 225 degrees Fahrenheit and the surface course shall be delivered at a minimum temperature of 250 degrees Fahrenheit. The asphaltic concrete shall be placed at temperatures between 235 and 330 degrees Fahrenheit. The subgrade temperature shall be above 32 degrees Fahrenheit and the air temperature shall conform to State Specifications 450.3.2.1.
14. All pavement joints, including centerline and curb flange lines, on the final lift of asphalt shall be sealed with CRAFCO Pavement joint adhesive (34524) per manufactures specifications.
15. The required pavement markings and signage shall be installed by the Road Contractor in accordance with the publications listed under Section 1 of these Development Requirements. For all pavement markings, follow State Specifications 646. Pavement surface temperatures for painted, hot thermoplastic, and epoxy pavement markings shall be above 35 degrees Fahrenheit, above 60 degrees Fahrenheit, and above 50 degrees Fahrenheit respectively. For temporary pavement markings, follow State Specifications 649 and Drawings.

### ***Undercutting Subgrade***

1. The Village may order that the subgrade of the roadway be undercut due to unsuitable soil conditions. Where directed by the Village, the Contractor shall undercut these areas to a stable base and backfill with compacted backfill material approved by the Village. This work may include the placement of geotextile fabric equal to Mirafi 600X.

### ***Subgrade/Gravel Checks***

1. Contractor shall contact the Village upon completion of the grading of the subgrade of the roads and again upon completion of the gravel base course for review and approval.
2. Contractor shall provide the equipment and perform a roll test of the subgrade and the gravel base course as directed by the Village. Allow Engineer to inspect prepared base course and to witness proof roll test by a fully loaded dump truck. Reconstruct where deflection is greater than 1/2 inch. All tests shall be in the presence of and directed by the Village.

## **CURB & GUTTER AND SIDEWALK CONSTRUCTION**

1. All work shall be constructed in accordance with Section 601 and Section 602 of the "State Specifications" and with the typical sections. Curb ramps shall be installed at all intersections in accordance with the detail as shown on the plans.
2. The subgrade shall be prepared by excavating to the line, grade and cross section as established by the Development Requirements. Soft and unsuitable material shall be removed to a stable base and replaced with compacted backfill material approved by the Village. The subgrade shall be thoroughly and uniformly compacted and moistened immediately before the concrete is placed. On embankments, the subgrade shall extend at least one foot beyond each edge of the sidewalk.



**Expansion Joint Filler**

1. Type I shall consist of a bituminous (asphalt or tar) mastic composition, formed and encased between two layers of bituminous impregnated felt.

**Finishing**

1. After the concrete has been placed and struck off to the required elevations, the surface shall be worked by means of long handled wood or metal floats with a circular motion until a thin uniform mortar surface is obtained. The surface shall then be troweled smooth with a metal hand trowel. Immediately after the water glaze or sheen has disappeared, the surface shall again be troweled smooth with a metal hand trowel operated with a circular motion.
2. All sidewalk edges shall be finished with an edging tool having a radius of 1/2 inch. All dummy joints shall be finished with a jointer having radii of 1/2 inch and minimum depth equal to one third of the sidewalk depth.
3. Before final finishing, the surface shall be checked with a ten foot straight edge and any areas departing more than one eighth inch from the testing edge shall be corrected by adding or removing concrete while the concrete in the walk is still elastic.
4. The final surface finish shall be obtained by brushing lightly with a damp whitewash brush or with a floor brush having soft bristles. Any marring of the finished concrete surface before it has set will be cause for rejection and replacement of the concrete at the Contractor's expense.
5. The contractor shall not apply a stamp indicating any of the following:
  - a. Contractor name.
  - b. Date.

**Joints**

1. Dummy joints for the sidewalks shall be constructed at right angles to the edge of the walk and spaced at a distance equal to the width of the sidewalk with spacing of no less than 3 feet and no more than 6 feet, unless otherwise directed. These joints shall be 1/4 inch in width and have a minimum depth equal to one third of the depth of the sidewalk.
2. Dummy joints for curb and gutter shall be constructed at right angles to the edge of the curb at a distance of every 10 feet.
3. For pavement sawing, follow State Specifications 690 with a cut depth of 1/3 of the pavement thickness with a minimum of 3-inches deep.
4. Expansion Joints shall be one-half-inch expansion joint material (Type I) installed to the full depth of the concrete in a neat workmanlike manner with its upper edge slightly below the finished surface at the following locations:
  - a. The end of all curb & gutter radii;
  - b. 5 feet from all catch basins;
  - c. Where walk adjoins a curb;
  - d. Where walk abuts a building, wall, driveway, flag pole or other fixed object;
  - e. At intervals not to exceed 150 feet;
  - f. Where curb ramp adjoins sidewalk.

**Curing and Protection**

1. Follow State Specifications 415.3.12. All freshly placed concrete shall be protected from rapid drops in temperature and loss of moisture and from subsequent construction operations. No concrete shall be allowed to freeze. An approved liquid membrane-forming curing compound shall be applied to all finished concrete surfaces as soon as possible after placement, but in no case more than one hour after concrete placement. Curing compound shall have white pigmentation having AASHTO Designation M148 and be applied in two coats in perpendicular directions to each other (cross pattern). Each coat should be applied at the recommended application rate. Extreme care shall be taken so as not to injure the surface of the concrete during the process of applying curing compound. Curing compound shall be applied thick

enough that the concrete is white, not grey and sprayed on to the top and all exposed sides at the time of placement. Failure to comply with this requirement shall be deemed sufficient cause for rejection of the work.

2. Concrete work shall be closed to pedestrian traffic for a period of twenty-four hours and to vehicular traffic until the design compressive strength for the concrete is achieved by lab test samples and with the Engineer's approval. The Contractor shall provide and maintain sufficient barricades and watchmen as necessary to effectively protect the work and close the concrete work to traffic.

### **Concrete Testing**

1. Follow State Specifications 501. Perform slump test. Measure air entrainment by following State Specifications 501 and AASHTO T152. Allow Engineer to observe all field-testing. The Contractor shall be responsible for supplying, obtaining and testing of concrete cylinders at the discretion of the Village. One set (3 cylinders per set) of test cylinders shall be taken for every 1500 feet or 250 cubic yards of concrete curb placed with a minimum of two sets of test cylinders per day. Test results shall be submitted to the Village and shall include one cylinder tested for 7 day strength and two cylinders tested for 28 day strength per set. The minimum 28 day compressive strength is 4,000 psi. Follow AASHTO T22 and T23. Contractor may make additional cylinders as necessary to determine compressive strength for opening pavement to traffic.
2. The Village may take test cylinders at their discretion. Concrete failing to obtain the required 28 day strength shall be rejected as unacceptable material. Areas in which this material was placed shall be removed and replaced with concrete of specified quality and thickness at the Contractor's expense. The Contractor may have an independent testing laboratory cut cores from a questionable area at his expense. In this case, acceptance of the compressive strength shall be based on the compressive strength of the cores.

### **Hot Weather Work**

1. Comply with the requirements of ACI 305-77R. During hot weather, that is when the air temperature is above 80 degrees F., special precautions shall be taken, during mixing, transporting, handling and placement, and finishing of all concrete work. Concrete work shall be carefully scheduled and maintained to minimize the elapsed time between mixing and placement.
2. During handling and placement, special efforts shall be directed toward the prevention of excessive loss of moisture from the concrete, loss of slump, flash setting, and the development of cold joints. Subgrades and abutting finished concrete work shall be sprinkled or wetted just prior to placement to prevent suction of water from fresh concrete. All new work shall be carefully protected against excessively rapid drying.
3. The published recommended practices of the ACI and PCA shall be adhered to as they apply to the work. A set-retarding admixture may be used when approved by the Village.

### **Cold Weather Work**

1. Comply with the provisions of ACI 306R. Unless the air temperature is at least 40 degrees F. and rising, heat concrete materials at the time of mixing. Handle and protect the mix so that the temperature of the concrete when placed is not less than 55 degrees F. Written authorization from the Village must be obtained for concrete placement when the air temperature is below 40 degrees F. Do not place concrete in temperatures below 35 degrees Fahrenheit.
2. The use of salts or other chemical additives (i.e., calcium chloride) which prevent the concrete from freezing will not be permitted, except in extreme conditions as determined by the Village.
3. All reinforcement, forms, fillers, soils and other surfaces with which the concrete may come in contact shall be free of frost, snow and ice. All concrete must be protected from frost for a minimum of seven days.
4. Following State Specifications 415.5.14, cover completed work in cold weather. When the projected overnight temperature is 32 degrees F. or below, double polyethylene wrap must be placed over concrete. When the projected overnight temperature is 25 degrees F. or below, hay must be placed over concrete in addition to the double polywrap.

**Sidewalks**

1. The sidewalks shall be installed in accordance with the typical Section shown on the plans, except as where noted on the plans.

**Stormwater Inlets**

1. Inlet castings shall be set by the Paving Contractor as part of their curb and gutter placement operations. Any needed height adjustments shall be made by the Paving Contractor using precast concrete chimney rings with mortar joints. Adjustments made with any materials other than precast concrete adjusting rings will not be accepted and will be cause for rejection. Contractor must provide temporary asphaltic curb and flume a minimum of 5 feet on each side of inlets in sumps. Remove temporary asphaltic curb and flume before placing asphaltic surface course and replace with concrete curb and gutter. After curb and gutter operations have been completed, the Utility Contractor shall return to tuck-point and back plaster the interior of all catch basins. No wood shims are allowed for the adjustment of frames. All adjustments shall be made with precast adjusting rings.

**Curb Cutting**

1. Curb cutting shall be allowed for driveway construction. Approved contractors are Interstate Sawing Company (800-572-9626) and National Kurb Kut (630-759-0303). Others may be approved on a case by case basis by the Village prior to the start of work.

**Material Delivery Tickets**

1. Contractor shall supply all material delivery tickets to the Village on a daily basis, or as otherwise directed by the Village. These material delivery tickets include asphalt, concrete and base course.

**MULTI-USE TRAIL STANDARDS****Purpose**

The Village of Mukwonago Comprehensive Plan (Designing Mukwonago) requires the installation and connection of multi-use trails within and throughout the community. Where the trails are required and constructed with new development, these standards are provided for consistency of design and construction within and between developments, for the protection and safety of path users, for the mitigation of conflicts between path users and neighboring private property owners and for reduction of long term maintenance costs of the trails.

**General Rules**

1. Developer and/or sub divider shall be responsible for the cost of design and installation, with all appurtenances, for trails required.
2. These standards will apply in most situations. When special circumstances exist, such as constructing a trail within a right-of-way adjacent to a public street, exceptions can be granted by the Village Engineer and Village Planner. If exceptions are granted, then any deviation to the design pursuant to these standards shall conform with safety guidelines found in the "Guide for the Development of Bicycle Facilities by the American Association of State Highway and Transportation Officials" (AASHTO)
3. In the absence of the Village Engineer and/or Village Planner, a Committee of the Building Inspector, Police Chief and Fire Chief shall determine compliance with these standards.

**Location Criteria**

1. Multi-use trails should be located in accordance with recommendations contained in the Village Comprehensive Plan and should be provided to connect residential areas to each other; to park and

pool and park and ride transit stations; to commercial, industrial and other major activity centers; and to recreational areas.

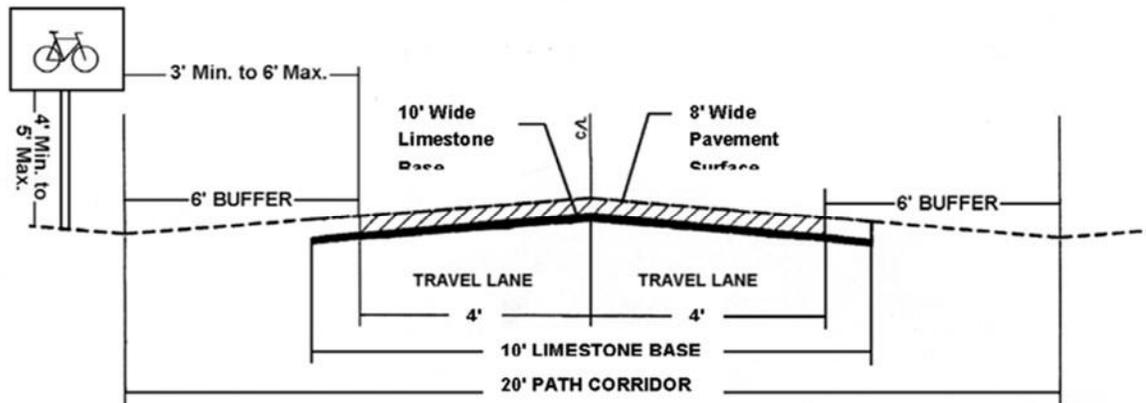
2. Proposed new trails should be located so as to connect to existing trails in adjacent residential, commercial, and industrial areas and in major parks and parkways so as to form an integrated system.
3. Trails generally should not be located immediately adjacent to roadways, except as directed by the Comprehensive Plan.
4. Trails that are located adjacent to roadways shall be located as far from the roadway as reasonably practicable.

### **Design**

Whenever feasible, the multi-use trail design shall be part of the development design and/or layout so the trail and trail corridor shall conform to AASHTO Guidelines and the following Village of Mukwonago standards:

1. The trail corridor shall be at least 20 feet wide as illustrated in Figure 1.
2. The trail corridor shall accommodate a path width of a 10 foot base and an 8 foot paved surface as illustrated in Figure 1.
3. The trail shall provide for two-way traffic.
4. When the trail corridor is straight (non-curved), the alignment shall accommodate a cross section of 2% grade from the high side to the direction of desired drainage.
5. When the trail corridor is curved, the alignment shall accommodate:
  - a. A superelevation of 3%.
  - b. A minimum radii of curvature in accordance to AASHTO guidelines.
  - c. To transition the superelevation of the curve to a straight route or reversing curves, a 25 foot tangent transition distance shall be required.
6. Where conditions such as limited sight distances make it desirable to clearly separate the two directions of travel, a double yellow line shall be used to indicate no passing and no traveling to the left of the center line. A yellow centerline shall be used 100 feet from the intersection of the path with the public right-of-way street pavement. On the trail, permanent marking shall be installed with the installation of the paving.
7. The trail corridor shall accommodate a maximum lineal grade of no less the 0.5% and no more than 5%, or per the table in the AASHTO Guidelines, subject to the approval of the Village Engineer.
8. The trail corridor shall accommodate a slope on each path side, of between 2 to 4% grade slope away from the path, and of at least 6 feet in width. However, on the side accepting the path drainage, a swale shall be allowed 3 inches deep over a 2 foot width.
9. If site conditions prevent the opportunity to accommodate a 2 to 4% slope away from the trail to a distance of 6 feet from the path's edge of pavement, then the Village Engineer may grant a waiver to #8. To grant a waiver, the following conditions must exist:
  - a. Extreme site conditions that prevent conformance with #8, and the waiver shall only apply to the section of path where the extreme site conditions exist.
  - b. The maximum slope allowed, from the edge of trail base, shall be 3 to 1.
  - c. Only in severe topographical cases shall the gradual slope be waived on both sides of the trail. In those cases, accommodations shall be made to drain the trail along the lineal length of path, and not to the edge of cross section.
  - d. Where down slope exists immediately adjacent to the trail, a decorative safety rail shall be installed between slope and trail, with rail design approved by Village Engineer and Village Planner.
10. Trail pavement shall accommodate a minimum of 6 foot horizontal distance from trees, poles, wall, fences or other lateral obstruction, except where a waiver is granted by the Village Board when the obstruction is unavoidable due to a pre-existing condition or the obstruction is necessary for the safety of trail users, such as a bridge.

11. Trail pavement shall accommodate a minimum of 10 foot vertical clearance from any overhead wires, tree branches, low structural members of underpasses, or other horizontal obstructions.
12. Crossing of streams or wetlands shall be avoided if at all possible. If unavoidable in certain conditions, a trail corridor shall be selected that minimizes disturbance to the natural feature, such as crossing the stream or wetland at the narrowest point.
13. Developer/Sub divider shall be responsible for obtaining any permits required by Wisconsin Department of Natural Resources (WDNR), or any other government agency, for the crossing of streams and/or wetlands.
14. At no time shall any creek, stream, or man-made or natural flow of drainage be allowed to sheet drain across the trail's surface. In those cases, the design shall include a bridge or piping of the drainage below the crushed limestone base of the trail, so to not obstruct or interfere with proper use of the trail.
  - a. Bridge water openings and culverts or piping shall be designed to pass the 10 year recurrence interval flood flow of the stream, watercourse, or drainage way concerned without raising the upstream or downstream hydraulic grade line by more than 0.001 foot and without overstepping the bicycle way.
  - b. In the case of a required WDNR permit, design and sizing of flow beneath the trail shall be according to the approval of the WDNR.
  - c. In the case the WDNR is not needed, design and sizing of flow beneath the trail shall be according to the approval of the Village Engineer.
15. If a bridge is required to cross a drainage flow, then the following shall apply:
  - a. Developer/Sub divider shall obtain all necessary permits.
  - b. Design shall be as approved by WDNR, other government agency, or Village Engineer.
  - c. Bridge shall have a usable width of at least 8 feet.
  - d. Design precautions shall be taken at bridge approaches, such as aesthetic barriers or fencing, to prevent inadvertent bicycling off of the trail. For purposes of these standards, aesthetic means nicely designed fitting into the natural landscape.
  - e. Developer/Sub divider shall be responsible for cost of bridge design, materials, and installation.
16. The trail edge of pavement shall be located as far as practicable or a minimum of 2 feet from any property line in private ownership. If it is determined a fence is necessary to separate the trail from neighboring property, the fence design shall be aesthetically pleasing and approved by the Village.
17. The trail shall intersect a sidewalk and street pavement at a right angle or radial to sidewalk or street pavement.
18. All trails shall connect to a subdivision sidewalk or to street pavement to allow a continuous trail circuit.
19. When a trail is designed to connect to a street pavement and will extend across the street pavement, either with current construction or in the future, the trail shall cross the street at a right angle or radial to the street centerline.
20. Any trail intersection with street curb and gutter shall employ the design of a ramp from path to street level. The width of ramp and path taper to ramp, and other standards, shall meet the requirements of the American With Disabilities Act (ADA) and Wisconsin State Statutes 66.0909 and all pertinent federal and state laws, and shall be subject to the approval of Village Engineer and Village Planner. Design could differ from location to location due to conditions at the location, anticipated amount of bike traffic, site distances, etc.
21. Where trails and sidewalks intersect, the concrete sidewalks shall extend through the intersection with the trails, with the asphalt trail continuing between the sidewalk and the edge of the street curb and gutter or pavement.
22. The Village Engineer, Village Planner, Police Chief and/or Fire Chief may require the design and installation of a bollard or gate system at trail entrances from streets. The bollard or gate system would prevent motor vehicle access to the path, while retaining an opening to allow free flow of bicycles or pedestrians. A lock system would allow emergency vehicle access to the path.



### **Construction**

1. Construction standards shall be utilized conjointly with the design standards. Generally, construction shall adhere to the standards of Village Specifications. Where the standards are not specific to a trail, the following shall apply:
2. Remove all top soil and remove subgrade to depth of at least 8 inches below adjacent match grade.
3. If the trail necessitates a grade higher than existing grade to facilitate proper slopes away from path, then remove top soil of entire width to be disturbed (complying with permit requirements of protection of any natural site feature), and raise path base with clean clay and/or other suitable material.
4. Compact subgrade, with proper sloping as designed.
5. Install and compact 6 inches of 3/4 inch crushed limestone traffic bond, to a 10 foot width as illustrated in Figure 1.
6. Install 2 inch surface course Bituminous Concrete (State Gradation #3), leaving one foot of crushed limestone visible on each side.]
7. Complete side slopes in accordance with design standards and fill 2 to 4 inches top soil over exposed crushed limestone to edge of surface course.
8. Where trail intersects with street and trail is planned to continue across the street, paint onto street pavement a crosswalk according to the Manual of Uniform Traffic Control Devices (MUTCD) standards.
9. Install street warning signs indicating a trail street crossing according to the Manual of Uniform Traffic Control Devices (MUTCD) standards. All trail street signs within common space of a subdivision shall be maintained and replaced when necessary by the Homeowners Association.
10. Install trail signage (stop signs) at intersections with sidewalks/streets according to the Manual of Uniform Traffic Control Devices (MUTCD) standards.

### **Landscaping**

Landscaping along the trail shall conform to the following standards:

1. Top soil shall be placed over the crushed limestone that extends beyond the pavement, at 2 to 4 inch depth.
2. Top soil shall be placed over the required side slope, at 2 to 4 inch depth.
3. On the side slope, a durable grass mixture or a low growing ground cover, such as crown vetch, shall be planted, subject to the approval of the Village Engineer.
4. Maintain a minimum 6 foot clear space from the edge of any deciduous or coniferous trees or bushes at maturity and the edge of the pavement.
5. Any preserved existing trees within the trail corridor shall be trimmed to maintain a 10 foot vertical clearance from trail surface to any tree branch or limb.

**Maintenance**

The Homeowners Association shall be responsible for all lawn mowing, tree pruning, and all other landscape maintenance along the trail and trail corridor, for the trails within common open space controlled by the Homeowners Association.

**LANDSCAPING AND RESTORATION****Clearing and Grubbing**

1. Amend SWS 2.1.3 and SWS 2.2.15 to read:
  - a. "The Contractor shall cut down and remove all trees, stumps, bushes, shrubs, and brush interfering with construction of utilities as shown on the Drawings and/or as directed by the Village".
2. The Contractor's attention is directed to SWS 2.1.3, requiring the Contractor to neatly cut and treat with a tree wound dressing all tree limbs and roots one inch or greater in diameter.

**Waterway Restoration**

1. Care shall be taken during construction to minimize erosion into waterways. Temporary erosion control measures including bales or silt fences shall be used to prevent sediment-laden runoff from entering waterways.

**Grass Seeding**

1. The Contractor shall place four (4) inches minimum of topsoil or salvaged topsoil in all existing grass and terrace areas and as shown on the Drawings.
2. Seed mixture shall be as per the "Standard Specifications". The fertilizer shall be 10-10-10 or 12-7-7 and shall be applied in strict accord with the manufacturer's instructions.
3. Fertilizing shall be done according to Section 629 of the "State Specifications" using Type A fertilizer.

**Sodding**

1. The Contractor shall place sod over all damaged grass, lawn, and terrace areas shown on the Drawings. Sodding shall comply with Section 631 of the "State Specifications".
2. The Contractor shall submit a certificate to the Village before installation, detailing the sod grass composition and place of origin.
3. Sod shall be cut in uniform strips approximately 18 inches x 72 inches, be  $\frac{3}{4}$  inch thick or more and have grass 2 inches tall.
4. Areas to be sodded shall be covered with 4 inches minimum of topsoil or salvaged topsoil and fertilized in accordance with the above Grass Seeding Section.
5. All sodded areas shall be kept thoroughly moist by watering or sprinkling until grass is fully matured.

**Tree Planting/Installation**

A comprehensive plan and the rules pertaining to the Village of Mukwonago Urban Forestry Management Plan can be found in Ordinance Number 885, Section 34, Article III of the Village of Mukwonago Municipal Code.

**General****New Installation****Tree Planting Standards**

1. Condition: All plant material shall be healthy nursery stock.

2. Diameter of Tree Trunk: All trees planted along public streets must be of sufficient size to absorb the abuse and conditions common to street trees. Unless otherwise permitted by the Village Forester, the minimum size will be 6 feet high and 2 inches in diameter for residents and 2 ½ inches in diameter for Developers. The diameter size of the tree is established by measuring 4 feet above its base.
3. Location: Generally, all street trees shall be planted midway between the sidewalk and curb, following all guidelines listed below.
  - a. Twenty-five (25) feet from an intersection of two streets measure on the property line.
  - b. Twenty (20) feet from a signal or power pole.
  - c. Ten (10) feet from a driveway approach.
  - d. Ten (10) feet from a fire hydrant.
  - e. Ten (10) feet from gas, water valves and sewer lateral.
4. Parkway Width: No trees will be planted where the grassy terrace between the sidewalk and curb is less than 5 feet wide.
5. Planting Depth: The planting depth is determined by root collar. All new plantings should be placed so that the root collar is even with the soil surface or 1 to 2 inches above the surface.
6. Spacing: Depending on growth characteristics of species, trees will be planted thirty-five (35) to fifty (50) feet apart unless otherwise approved by the Village Forester and UFC.
7. Transplanted Trees: When planting bare root trees, care must be taken to prevent unnecessary injury to roots. All damaged roots should be pruned.
8. Tree selection:
  - i. Select the right tree for the right place:
    - a. Carefully review all aspects of the site.
    - b. Closely review the soils ability of moisture to drain through the soil.
    - c. How much physical space is available above ground and below ground?
    - d. Don't plant a tree that will grow to a height of more than thirty (30) feet under power lines.
    - e. Consider environmental factors such as exposure to the sun and road salt.
    - f. Choose a tree species which matches, or is adaptable, to the growing conditions you have found during the site analysis.
  - ii. Select a healthy tree from a reputable nursery.
    - a. Avoid plants that have damaged twigs, branches, roots or trunk.

### ***Tree Planting Procedures***

To plant the trees properly:

1. Prepare the site by digging a hole at least three times the diameter, and at least the depth of the root ball, or the full extent of the root system of bare root trees. Leave a pedestal in the center of the hole to rest the root system on. This should provide trees with enough worked earth for its root system to be established. All banks of the hole shall be loosened by shovel and trees should be planted at their original soil level at the root collar.
2. Find the root collar and plant the tree even or 1 to 2 inches high. It is recommended to remove burlap and/or wire prior to planting.
3. Use good quality soil as backfill. Discard any rocks and debris from the soil before backfilling.
4. Water the soil with a garden hose. Do not pack the soil down manually; water will do this naturally. Fill in voids with more-soil after watering. New trees shall be watered as part of the planting process the day they are planted and then regularly for the first two years after planting, utilizing techniques such as hose, water spikes, watering bags, etc. The goal is to ensure that newly planted trees receive the equivalent of 1 inch of rainfall per week.

5. Create a 2-4" deep mulch bed using wood chips. The mulch should not touch the trunk directly to prevent mold and bacteria from forming. Apply heavier at edges to create a "saucer" effect. All newly planted trees shall be wood chip mulched and protected with at minimum 12 inch plastic boots.
6. Staking: If you must stake, use a wide belt-like material when supporting the tree to avoid injuring the bark, Trees need to move in the wind, so allow some "play" in the support system to allow the trunk to sway without being uprooted.
7. Prune any broken, dead or dying limbs without damaging the branch collar at the time of planting. Routine pruning should be started one year after planting. Do not use pruning paint or wound dressing on the pruning cuts.
8. Wait until one year after planting to fertilize.
9. Additional Care. Pruning, mulching and fertilizing should be provided as needed.

### ***Maintenance and care of newly planted trees.***

1. Fertilizing. Fertilization of planted trees in the first year is not recommended. Typically a tree can be fertilized once it has become established, usually 2 or 3 years after planting. Only healthy established trees are to be fertilized. Fertilizing an established tree when growth is slow and vigor is low, which is indicated by off color leaves or needles and by abnormal loss of foliage, will place the stressed tree even deeper into stress. Stressed trees should be watered and otherwise left undisturbed until they recover. Fertilizer should be applied in the early spring before leaves appear. A general purpose fertilizer containing nitrogen and potash is recommended.
2. Mulching. A layer of wood chip mulch around the base of the tree will help conserve the soil moisture and help protect the tree and reduce competition from grass for nutrients. The mulch should not be piled around the trunk as the heat generated may damage the bark. The mulch should be approximately 4" thick at the perimeter, creating a "saucer" effect towards the trunk. Newly planted trees shall be wood chip mulched and protected with at minimum 8 inch plastic boots.
3. Tree Pruning. No pruning should occur at the time of planting, Pruning at this time will reduce the amount of stored energy that the tree contains and could cause added stress to the tree. During the 2<sup>nd</sup> year a pruning schedule can begin.
4. Tree Staking. When staking, use wide bands of nylon strap or inner-tubes to support the tree. Make sure that the tree has a small amount of room to move.
5. Watering. Newly planted trees require 1" (10 gallons) of water per week during the growing season to maintain health. The property owner shall provide adequate moisture to trees. The Village should use local media to promote watering during dry periods. New trees shall be watered as part of the planting process the day they are planted and then regularly for the first two years after planting, utilizing techniques such as hose, water spikes, watering bags, etc. The goal is to ensure that newly planted trees receive the equivalent of 1 inch of rainfall per week.

### ***Acceptable Village Trees***

1. The Village of Mukwonago Street Tree List is a list of acceptable trees to be planted within the Village.
2. The Developer/Contractor shall verify that he/she has the current Village of Mukwonago Street Tree List.
3. If the Developer/Contractor wishes to deviate from the current tree list, he must get written consent from the Village Forrester.

### ***Village of Mukwonago Street Tree List***

1. The selection of street trees for the terrace area is based upon the trees ability to withstand urban conditions such as salt tolerance, drought, soil conditions, and insect and disease resistance.
2. The terrace area is located between the street curb and the sidewalk.
3. Please note that Ash trees are **not** allowed to be planted due to emerald ash borer.

## Large Trees 8 foot Terraces or Wider

Scientific Name	Species	Cultivar	Size H X W
Acer × freemanii	Freeman Maple	<u>Armstrong</u>	45 x 15
		<u>Indian Summer</u>	45 x 40
		<u>Jeffersred (Autumn Blaze®)</u>	50 x 40
		<u>Marmo</u>	55 x 45
<b>Acer miyabei</b>	Miyabe Maple	<u>State Street®</u>	40 x 25
<b>Acer platanoides</b>	Norway Maple	<u>Columnare</u>	40 x 15
		<u>Deborah</u>	50 x 40
		<u>McGill No. 42 (Emerald Queen®)</u>	50 x 40
		<u>Princeton Gold</u>	40 x 30
<b>Celtis occidentalis</b>	Common Hackberry	<u>Chicagoland</u>	55 x 40
<b>Ginkgo biloba</b>	Ginkgo	<u>Autumn Gold</u>	45 x 35
<b>Gleditsia triacanthos</b>	Thornless Honeylocust,	<u>PNI 2835 (Shademaster®):</u>	45 x 35
		<u>Skycole (Skyline®):</u>	45 x 35
<b>Gymnocladus dioica</b>	Kentucky Coffeetree,	<u>Espresso</u>	50 x 35
<b>Quercus bicolor</b>	Swamp White Oak		55 x 55
<b>Quercus robur</b>	English Oak		50 x 50

<b>Tilia americana</b>	American Linden	<u>Boulevard</u>	50 x25
		<u>Mcksentry (American Sentry)</u>	45 x 30
		<u>DTR 123 (Legend®)</u>	40 X 30
<b>Tilia cordata</b>	Littleleaf Linden	<u>Chancole</u>	40 X 20
		<u>PNI 6025 (Greenspire®)</u>	40 X 30
<b>Tilia tomentosa</b>	Silver Linden	<u>Wandell (Sterling®)</u>	45 X 35
<b>Ulmus hybrids</b>	Hybrid Elms (DED Resistant)	<u>Frontier</u>	35 X 25
		<u>Homestead</u>	55 X 35
		<u>Regal</u>	55 X 30

### Small Trees For Terraces 5 and Wider or Under Wires

<b>Acer tataricum</b>	Tartarian Maple		18 x 18
<b>Amelanchier x grandiflora</b>	Serviceberry	Autumn Brilliance	30 x 25
	Cockspur Hawthorn Thornless		
<b>Crataegus crus-galli var. inermis</b>		<u>Cruzam (Crusader®)</u>	15 X 15
<b>Maackia amurensis</b>	Amur Maackia	<u>Starburst</u>	20 X 15
<b>Prunus 'Accolade'</b>	Accolade Cherry		25 X 25
<b>Pyrus calleryana</b>	Callery Pear	<u>Autumn Blaze</u>	30 X 25
		<u>Capital</u>	30 X 12
		<u>Cleveland Select</u>	30 X 15
<b>Syringa pekinensis</b>	Peking Lilac	<u>Morton (China Snow®)</u>	25 X 20
<b>Syringa reticulata</b>	Japanese Lilac Tree	<u>Ivory Silk</u>	20 X 15
		<u>Summer Snow</u>	20 X 15

## Appendix A

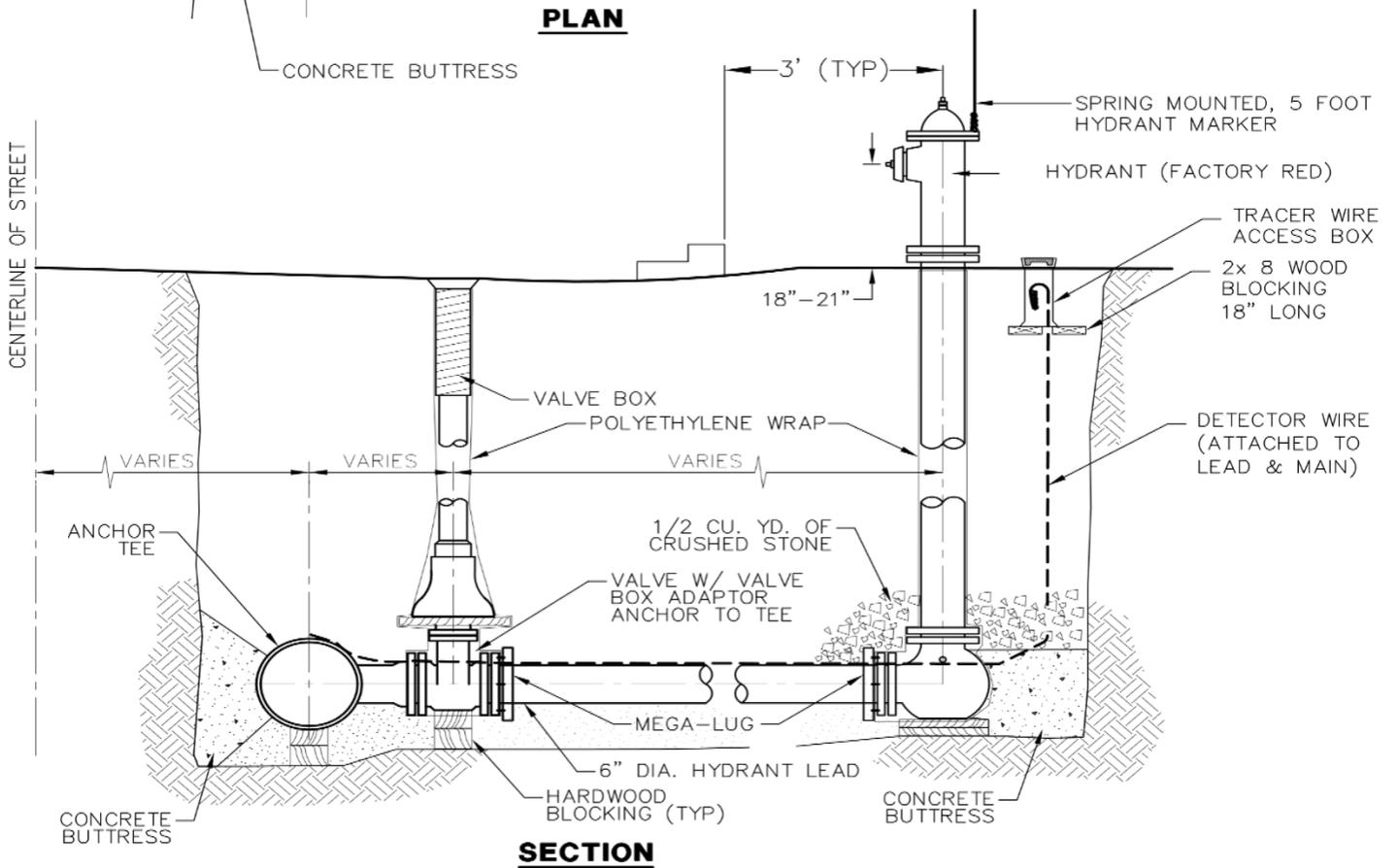
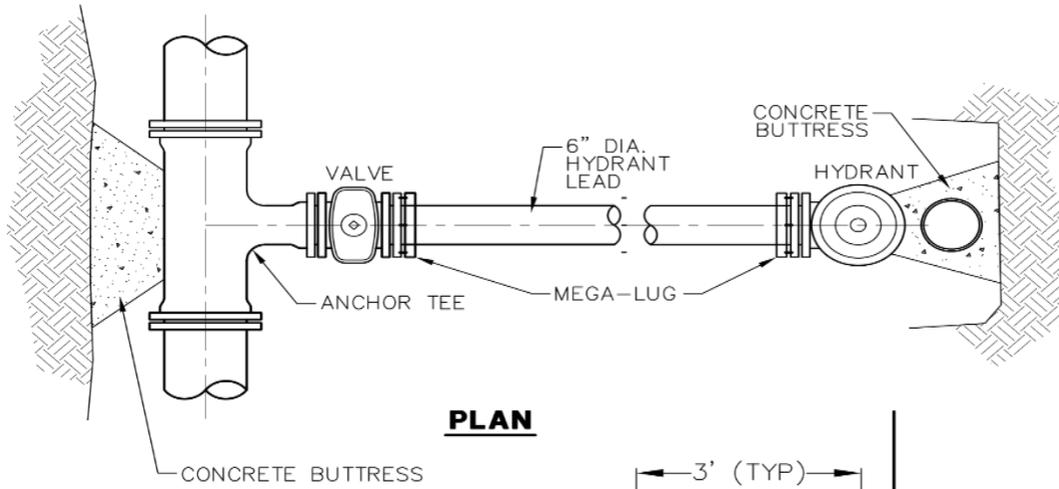
### Village Contact Information

Village Department Heads					
Department	Name	Office #	Fax #	Cell #	E-mail
Administrator	John Weidl	262-363-6420	262-363-6425		jweidl@villageofmukwonago.com
Clerk-Treasurer	Steven Braatz, Jr	262-363-6420	262-363-6425		sbraatzjr@villageofmukwonago.com
Fire	Jeff Stein	262-363-6426	262-363-6454		chiefstien@mukwonagofire.org
Police	Kevin Schmidt	262-363-6435	262-363-6438		kschmidt@mkpd.org
Water/Sewer	Dave Brown	262-363-6416	262-363-0552	414-550-2509	dbrown@villageofmukwonago.com
DPW	Ron Bittner	262-363-6447	262-363-7197		rbittner@villageofmukwongo.com
Inspections/Zoning	Bob Harley	262-363-6419	262-363-6425		bharley@villageofmukwonago.com
Library	Angela Zimmerman	262-363-6411	262-363-6912		azimmerman@mukcom.lib.wi.us

Contracted Village Personnel					
Department	Name	Office #	Fax #	Cell #	E-mail
Engineer	Rebecca Alonge	262-953-3046	262-542-5631		ralonge@ruekert-mielke.com
Planner	Bruce Kaniewski	414-339-4105			bkaniewski@bkplanning.com
Attorney	Mark Blum	549-8181	549-8191		mglum@hmlawfirm.com
Disposal	John's Disposal	888-473-4701	262-473-4914		www.johnsdisposal.com
Diggers Hotline		800-242-8511			
Humane Officer	HAWS	542-8851	542-8853		
Newspaper	Mukwonago Chief	368-2966	368-2967		mukpubs@jcpgroup.com

### Developer Checklist



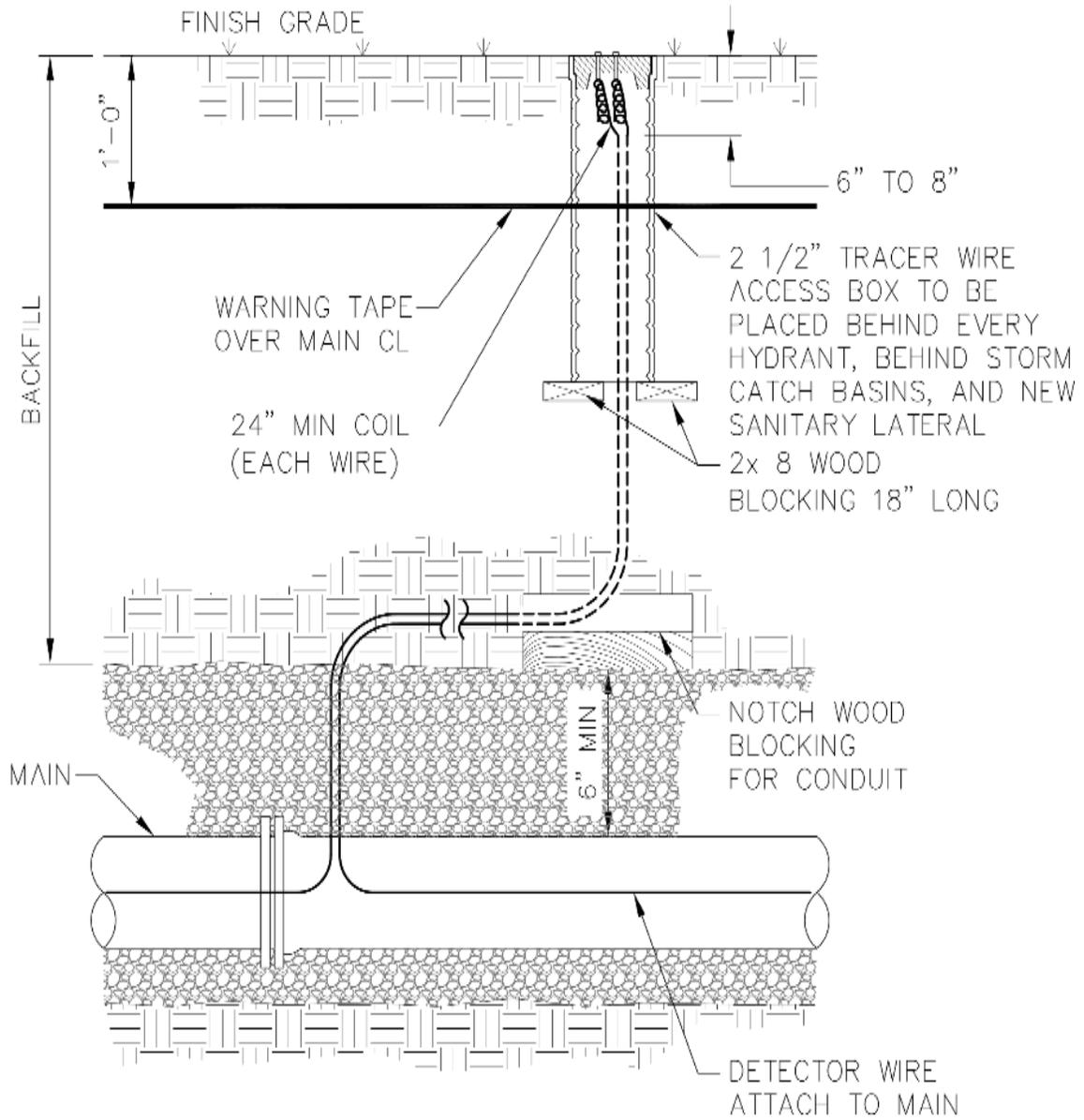


NOTE :  
 REFER TO FILE NO. 38 OF THE "STANDARD SPECIFICATIONS  
 FOR SEWER AND WATER CONSTRUCTION IN WISCONSIN" FOR  
 FURTHER INFORMATION

HYDRANT LEADS SHALL BE RESTRAINED

**HYDRANT SETTING DETAIL**

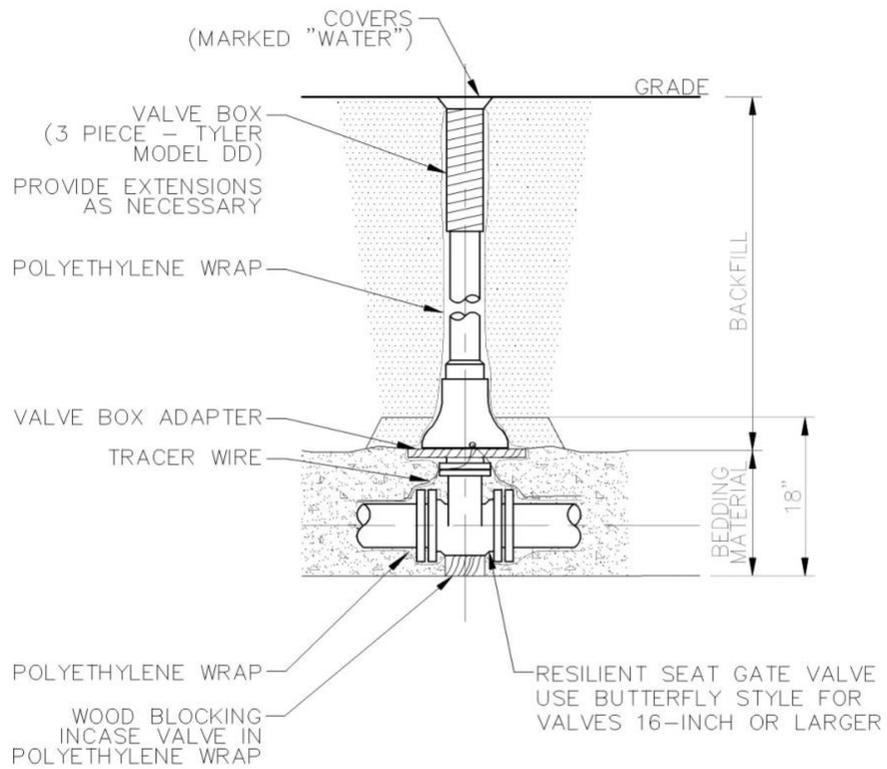
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## **DETECTOR WIRE & LOCATION BOX (ON TERRACE)**

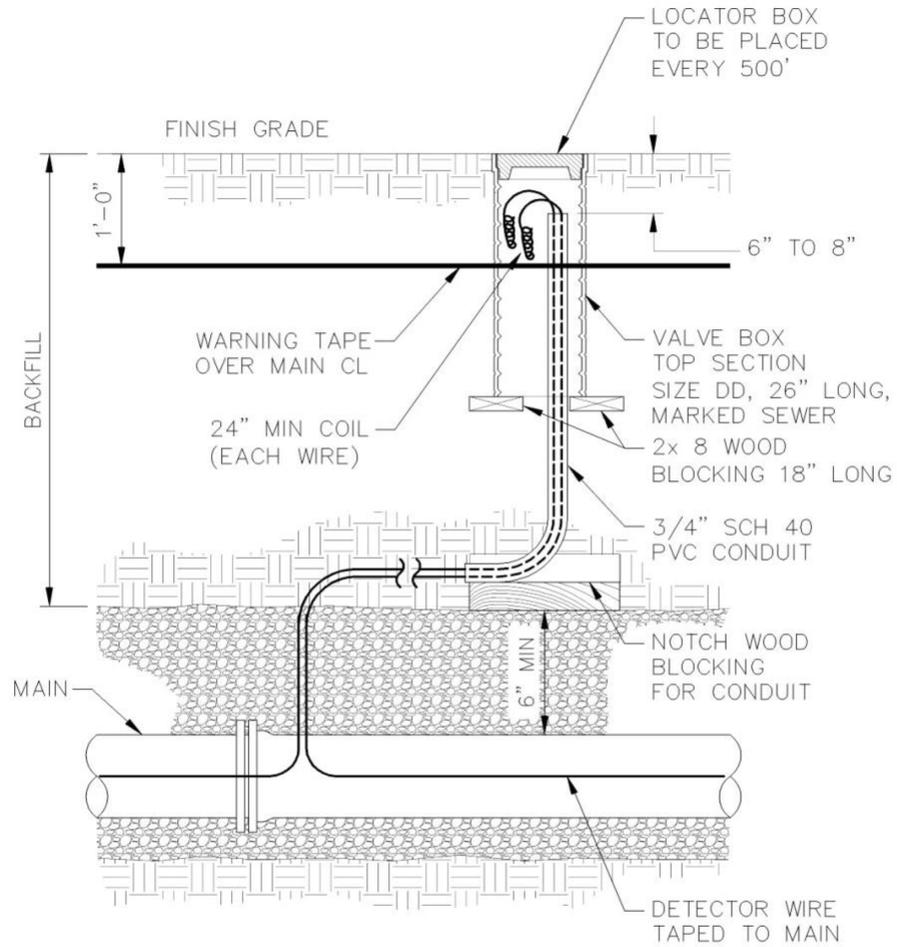
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## STANDARD GATE VALVE BOX SETTING

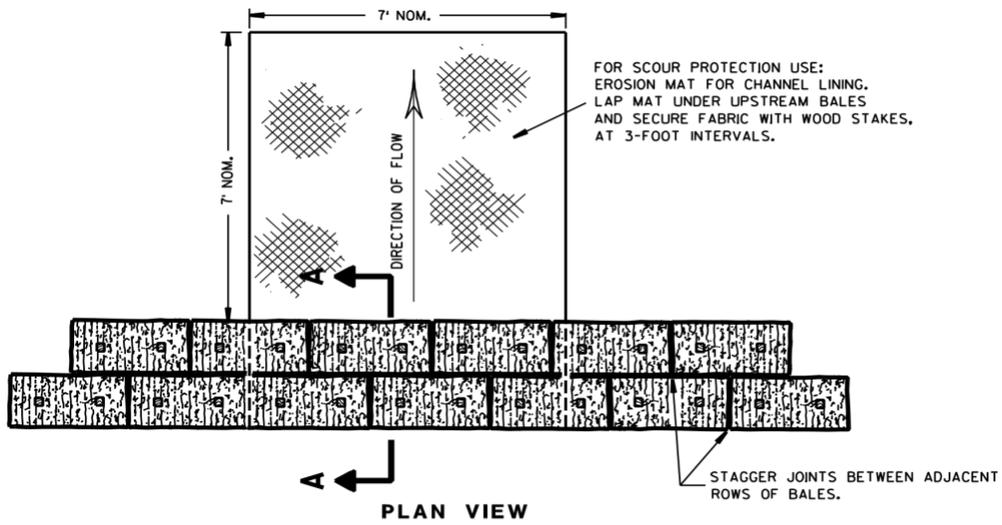
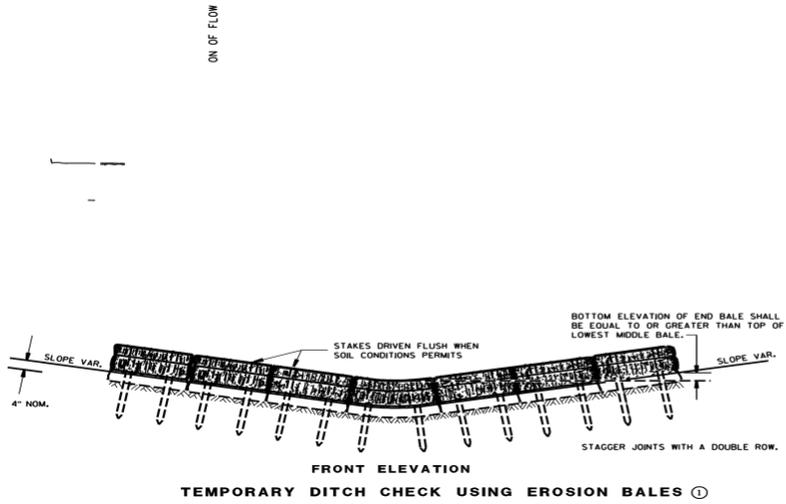
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**FORCE MAIN DETECTOR  
WIRE & LOCATION BOX**

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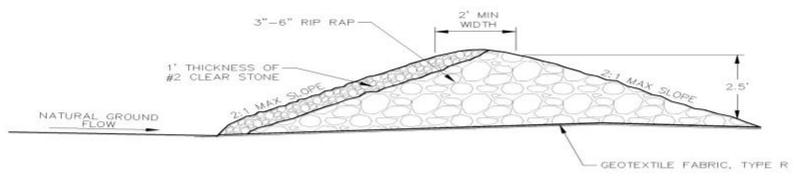




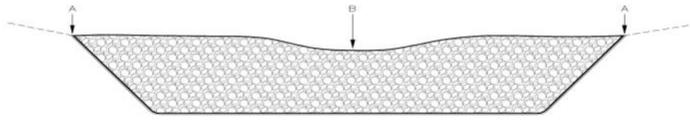
BOTTO

W.





**SECTION VIEW**



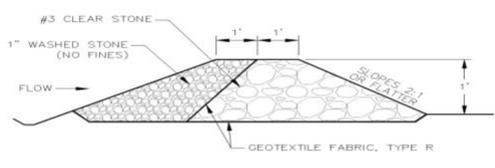
**FRONT VIEW**

NOTE: POINT A MUST REMAIN AT LEAST 4" HIGHER THAN POINT B

**STONE CHECK DAM**

cgdtstnchkdam 32

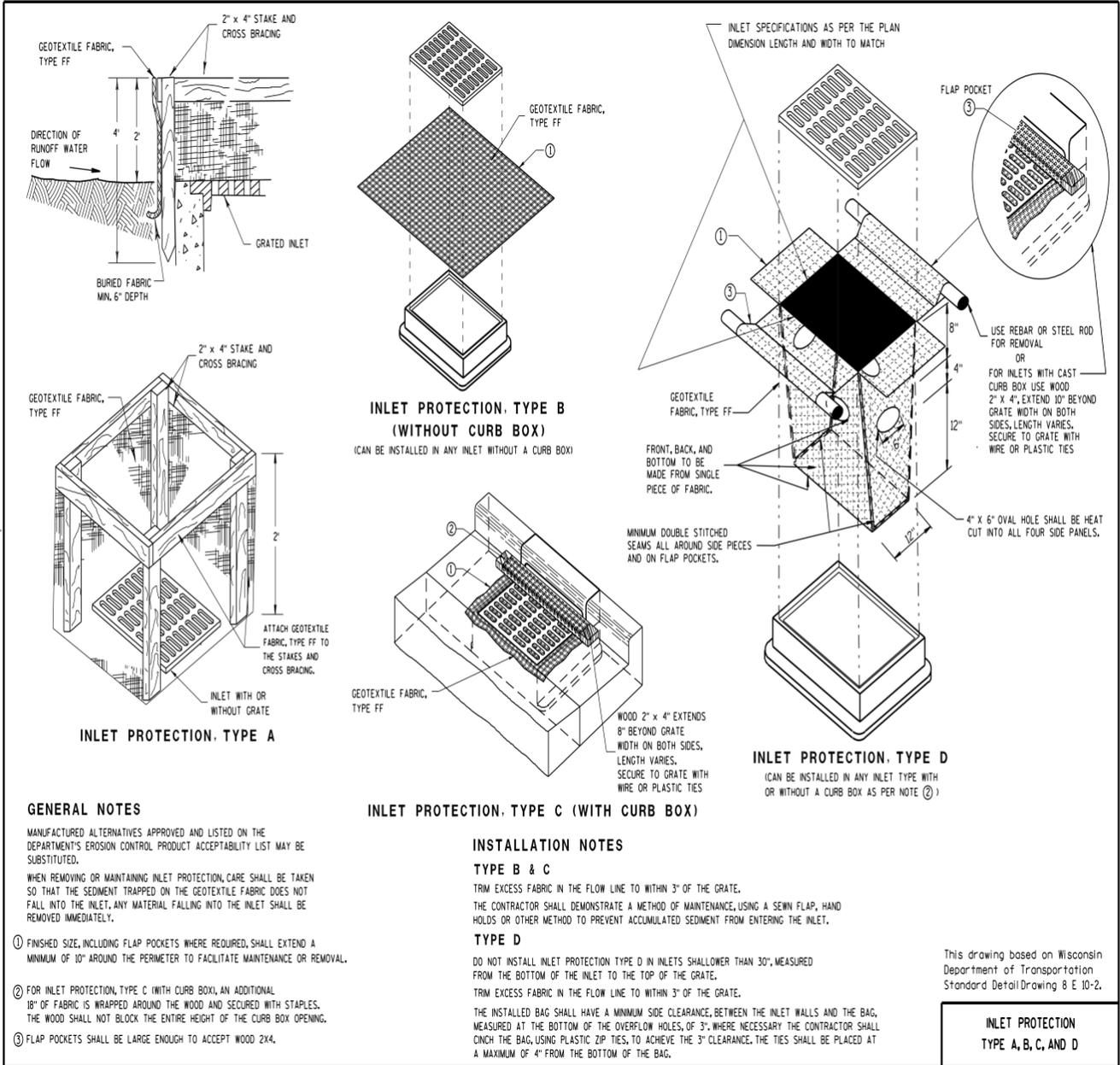
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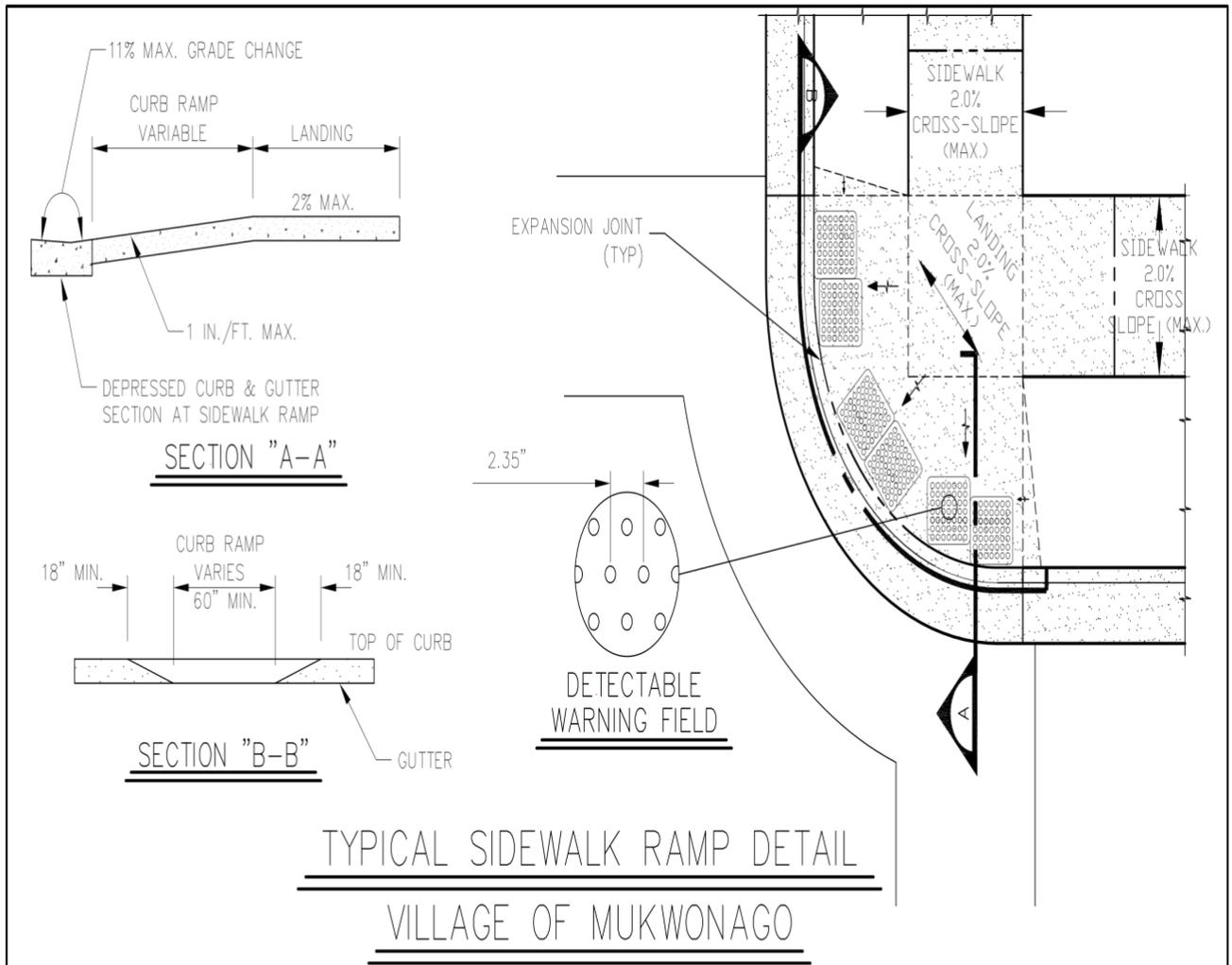


**STONE WEEPER**

cgdtstnwepwr 32

NO SCALE





TYPICAL SIDEWALK RAMP DETAIL  
VILLAGE OF MUKWONAGO

NOT TO SCALE  
swrampA

GENERAL NOTES

DETAILS OF CONSTRUCTION, MATERIALS AND WORKMANSHIP NOT SHOWN ON THIS DRAWING SHALL CONFORM TO THE PERTINENT REQUIREMENTS OF THE STANDARD SPECIFICATIONS AND THE APPLICABLE SPECIAL PROVISIONS.

RAMPS SHALL BE BUILT AT 12:1 OR FLATTER. WHEN NECESSARY, THE SIDEWALK ELEVATION MAY BE LOWERED TO MEET THE HIGH POINT ON THE RAMP. RAMP OPENING VARIES DEPENDENT ON CURB RADIUS AND RIGHT OF WAY WIDTH. NUMBER OF DETECTABLE WARNING FIELDS VARIES BASED UPON RAMP OPENING. WARNING FIELDS TO BE PLACED ALONG RAMP OPENING SPACING NOT MORE THAN 12-INCHES OR LESS THAN 4-INCHES BETWEEN WARNING FIELDS. CURB RAMP OPENING SHALL BE STAKED IN THE FIELD PRIOR TO CURB AND GUTTER CONSTRUCTION.

BACK OF CURB RUNNING SLOPE MUST MATCH RAMP RUNNING SLOPE.

CONTRACTOR SHALL PROVIDE POSITIVE DRAINAGE ACROSS CURB AND GUTTER SECTION.

SURFACE TEXTURE SHALL BE OBTAINED BY USING THE DETECTABLE WARNING PLATES BY NEENAH FOUNDRY FOLLOWING THE MANUFACTURERS RECOMMENDATIONS AND FOLLOWING WISCONSIN DEPARTMENT OF TRANSPORTATION STANDARD DETAIL S.D.D. 8D5-9B AND SECTION 602.0505.S OF THE 2003 STANDARD SPECIFICATIONS AND 2004 SUPPLEMENTAL SPECIFICATIONS.

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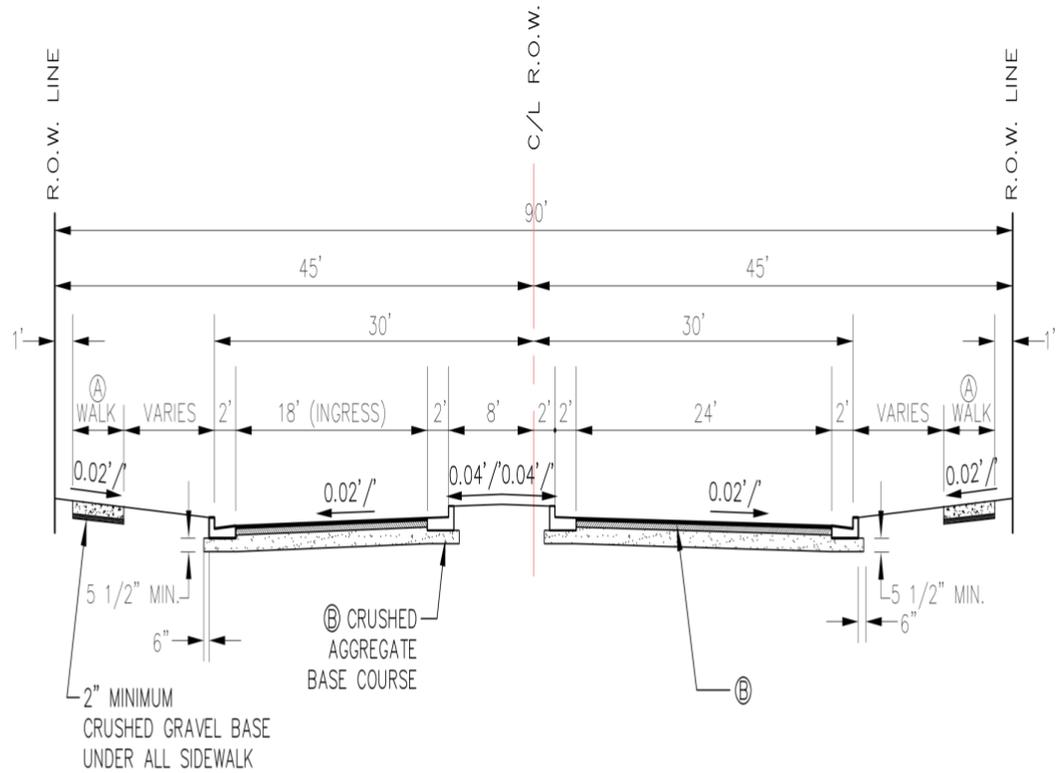


TABLE A

SIDEWALK INFORMATION		
LOCATION	WIDTH	THICKNESS
RESIDENTIAL	5'	5" TYPICAL W/ 6" FOR DRIVEWAYS
COMMERCIAL/ INDUSTRIAL	8'	5" TYPICAL W/ 7" FOR DRIVEWAYS

TABLE B

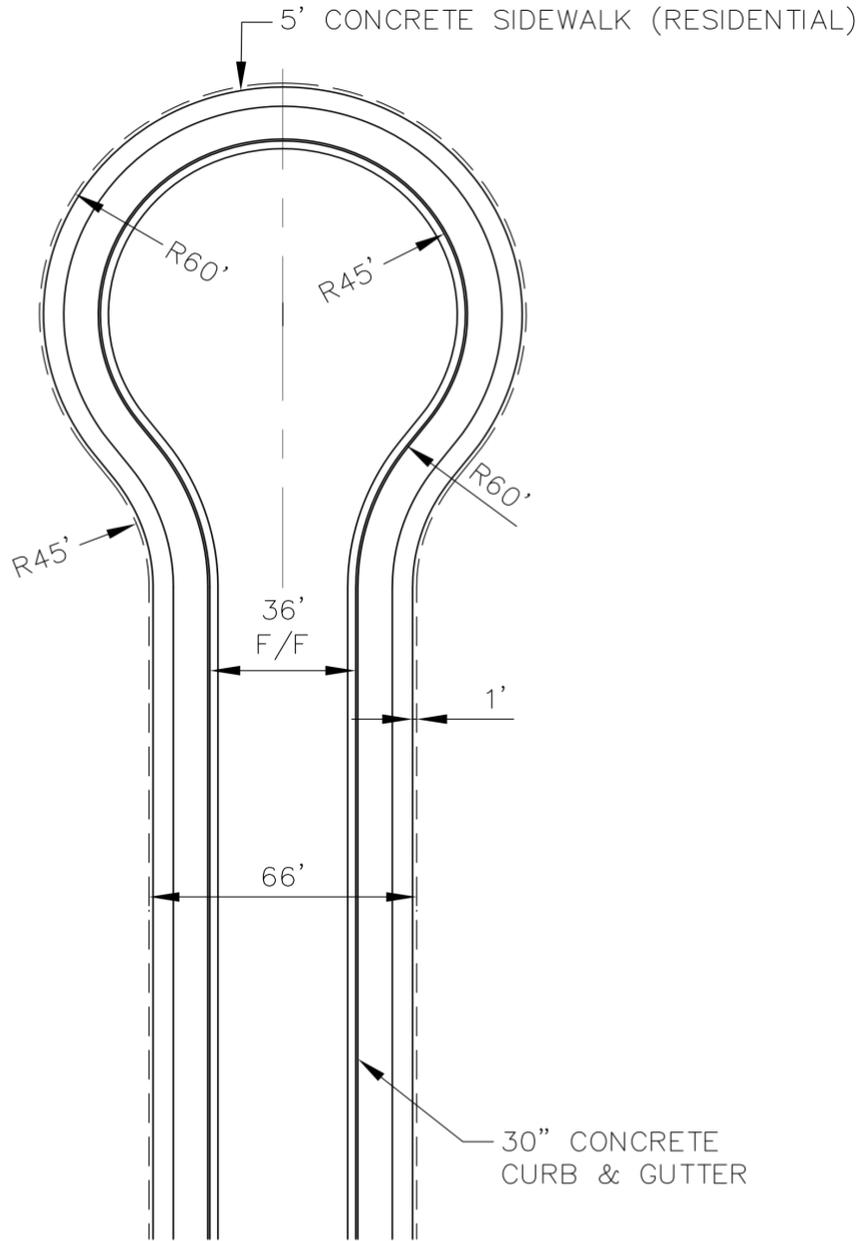
PAVEMENT THICKNESS AND BASE THICKNESS		
CLASS	BASE THICKNESS	ASPHALT THICKNESS
LOCAL	8"	1 1/2" SURFACE 2 1/2" BINDER
COLLECTOR	10"	1 1/2" SURFACE 3" BINDER
ARTERIAL/ INDUSTRIAL	10"	1 1/2" SURFACE 3 1/2" BINDER

## TYPICAL BOULEVARD CROSS SECTION VILLAGE OF MUKWONAGO

NOT TO SCALE  
XC0LSEC 1

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RM811PB



NOTE:

- 1. PAVEMENT, SIDEWALK & BASE THICKNESS, FOLLOW LOCAL STREET TYPICAL CROSS SECTION.

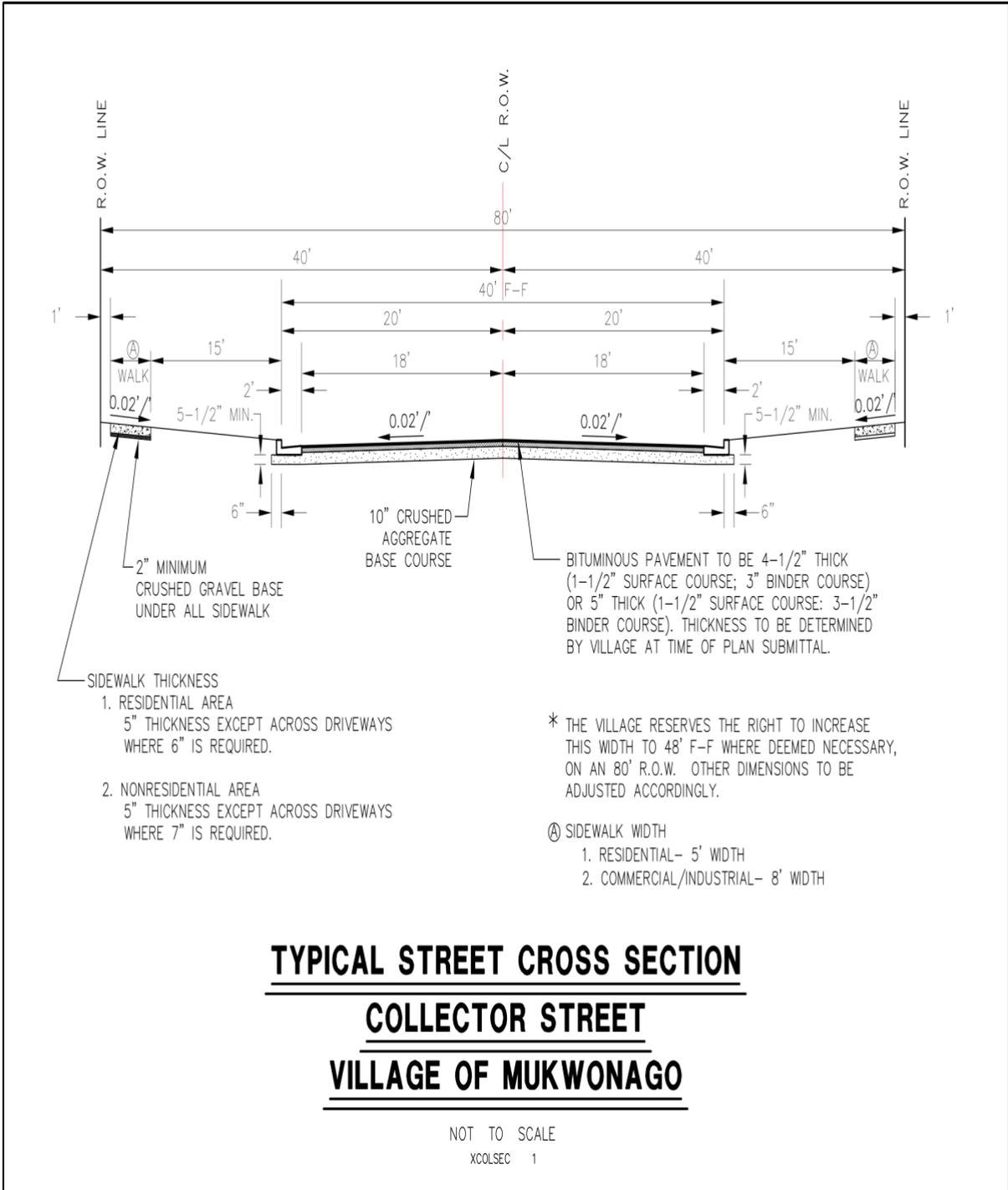
**VILLAGE OF MUKWONAGO  
TYPICAL RESIDENTIAL CUL-DE-SAC**

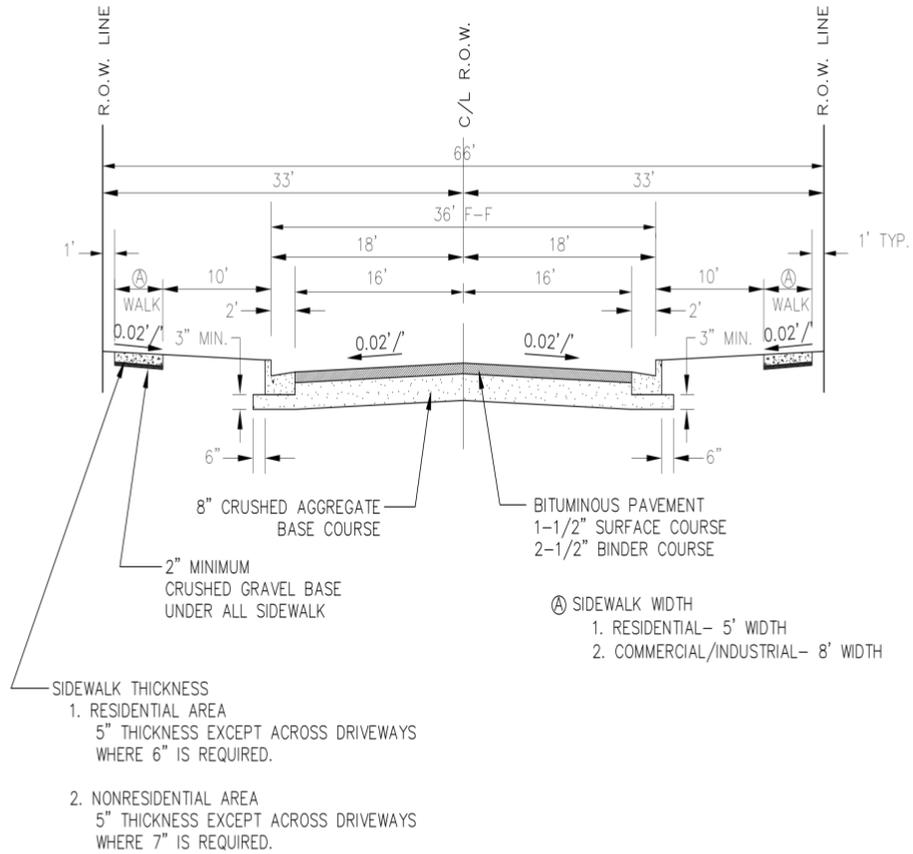
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NO SCALE

APRIL, 2007

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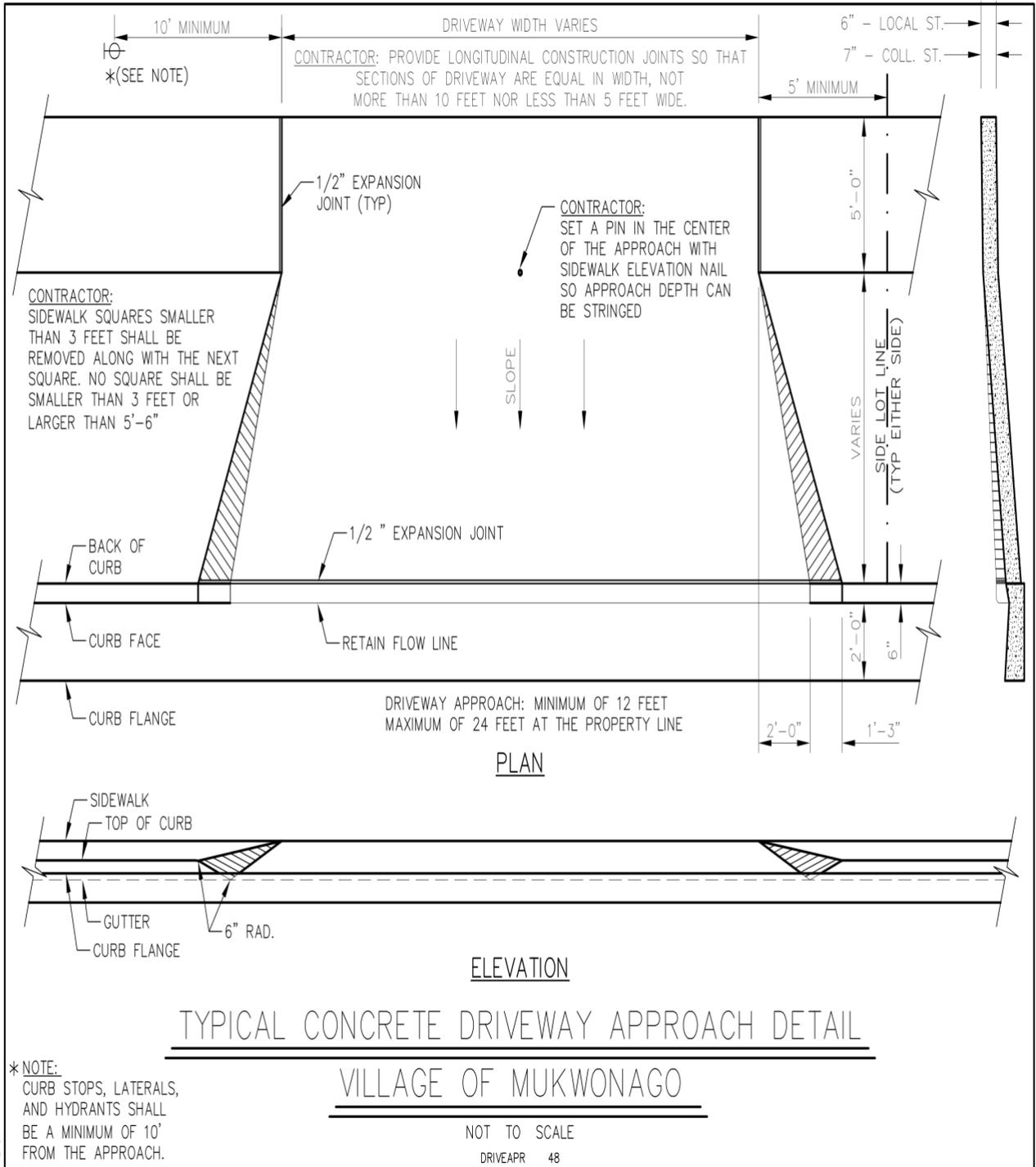


- SIDEWALK THICKNESS**
1. RESIDENTIAL AREA  
5" THICKNESS EXCEPT ACROSS DRIVEWAYS WHERE 6" IS REQUIRED.
  2. NONRESIDENTIAL AREA  
5" THICKNESS EXCEPT ACROSS DRIVEWAYS WHERE 7" IS REQUIRED.

**TYPICAL STREET CROSS SECTION**  
**LOCAL STREET**  
**VILLAGE OF MUKWONAGO**

NOT TO SCALE  
 XCOLSEC 1

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 KREFFS



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