MICHIGAN ANCILLARY STRUCTURES DESIGN GUIDE

MICHIGAN ANCILLARY STRUCTURES
DESIGN GUIDELINES

Design Guidance Preamble

The proceeding design guidance serves as an aid to administrative, engineering, and technical staff. Engineering practice requires that professionals use a combination of technical skills and judgment in decision making. Engineering judgment is necessary to allow decisions to account for unique site-specific conditions and considerations to provide high quality products, within budget, and to protect the public health, safety, and welfare. This manual provides the general operational guidelines; however, it is understood that adaptation, adjustments, and deviations are sometimes necessary. Innovation is a key foundational element to advance the state of engineering practice and develop more effective and efficient engineering solutions and materials. As such, it is essential that our engineering manuals provide a vehicle to promote, pilot, or implement technologies or practices that provide efficiencies and quality products, while maintaining the safety, health, and welfare of the public. It is expected when making significant or impactful deviations from the technical information from these guidance materials, that reasonable consultations with experts, technical committees, and/or policy setting bodies occur prior to actions within the timeframes allowed. It is also expected that these consultations will eliminate any potential conflicts of interest, perceived or otherwise. MDOT Leadership is committed to a culture of innovation to optimize engineering solutions.

The National Society of Professional Engineers Code of Ethics for Engineering is founded on six fundamental canons. Those canons are provided below.

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health, and welfare of the public.
2. Perform Services only in areas of their competence.
3. Issue public statement only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, reasonably, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

NOISE BARRIER WALL DESIGN GUIDELINES

CS: Statewide

MICHIGAN NOISE BARRIER WALL
DESIGN GUIDELINES

INDEX

2.01

INTRODUCTION

This guidance text addresses procedures involved in the design and plan preparation of noise barrier walls on the interstate/freeway, arterial, collector, and local road system governed by the Michigan Department of Transportation (MDOT).

A major portion of this text is devoted to design items to be investigated for every project. However, other sections provide details on constructability, plan preparation, and involvement of other agencies affected by the noise barrier wall projects. In general, the Noise Barrier Wall Design Guidance is intended to be a single source reference for the MDOT Design Engineers and consultants assigned the responsibility of producing noise barrier wall plans.

The design of noise barrier walls in Michigan is based on the **MDOT Standard Specifications for Construction** and **AASHTO LRFD Bridge Design Specifications**. However, it is understood that sometimes adaptations and deviations may be necessary as these publications can be vague or leave decisions up to the judgement of the Engineer.

As procedures and guidelines change, the Noise Barrier Wall Design Guidance will be continually updated to keep the text as current as possible. These updates will describe the revision, explain the reason, serve as commentary, and assign the date of its implementation.

2.01.01

References

A. Noise Analysis and Abatement Handbook, MDOT

B. MDOT Standard Specifications for Construction

C. AASHTO LRFD Bridge Design Specifications

D. PCI Design Handbook

E. Drainage Manual, MDOT (Chapter 4)

F. Road Design Manual, MDOT

G. Geotechnical Manual, MDOT

H. Bridge Design Manual, MDOT

I. Special Provision for Structural Precast Concrete Noise Barrier Wall

2.01.02

Abbreviations and Definition of Terms

When the following abbreviations are used in the guidance text, they have the meanings listed below.

AASHTO .....American Association of State Highway and Transportation Officials

FHWA .....Federal Highway Administration

LRFD .....Load and Resistance Factor Design

MASH .....Manual for Assessing Safety Hardware

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MDOT..... Michigan Department of Transportation

ROW..... Right-of-Way

4D Rule – The FHWA provides the 4D rule, which states that the overlap or termination distance of a barrier wall should equal 4 times the wall gap or the distance between the back of the wall and the last noise-sensitive receiver.

Active Earth Pressure - Lateral pressure resulting from the retention of the earth by a structure or component that is tending to move away from the soil mass.

Appurtenances - Barriers, signs, and miscellaneous structures used alongside noise barrier walls.

Bolster - A concrete spacer between the top of shaft and bottom of panel.

Clear Zone - The unobstructed, traversable roadside area provided beyond the edge of the through traveled way that allows a driver to stop safely or regain control of a vehicle that has left the roadway.

Deflection - The degree to which a part of a structural element is displaced (typically under a load).

Front side (of Wall) – The side of wall facing the noise source (e.g., a roadway)

Back side (of Wall) – The side of wall facing opposite of the noise source (e.g., a private residence)

Ground Mounted - Supported directly on shallow or deep foundations extending into the soil (not mounted on a bridge, retaining wall or other type of structure).

Noise Barrier Wall - A wall constructed along a roadway to reduce the noise level in areas behind the wall. May also be referred to as “Noise Wall” or “Sound Wall.”

Noise Sensitive Receptor – A discrete or representative location impacted by traffic noise.

Post and Panel Noise Barrier Wall - A type of noise barrier wall construction consisting of vertical posts supported on a structure or on foundations with panels spanning horizontally between adjacent posts.

Right-of-Way (ROW) - The entire area reserved for the construction, operation, and maintenance of the roadway and the improvement of the roadside such as landscaping, sidewalks, pathways, or transit stops. ROW will either be free access or limited access. Limited access ROW is when the inherent right of access to a public highway by the abutting owner or occupant is acquired along with the title to the ROW.

Roadside - Portion of the right-of-way outside of the footprint of the roadway.

2.02

NOISE BARRIER WALL SITE PLANNING

Site planning of noise barrier walls must follow and account for specifications outlined in the **MDOT Road Design and Bridge Design Manuals.** Coordinate site planning with the project's noise analyst.

In scenarios where proper sizing, spacing, or placement of the wall do not satisfy the site's noise analysis, consider incorporating sound absorptive material. Design using sound absorptive material must be project specific and additional material loads must be accounted for.

2.02.01

Wall Types

Various wall types and alternatives exist throughout Michigan. The proceeding sections provide brief information on these wall types and those that are preferred for ground mounted applications. Note that Appendix B - Guidelines for Noise Barrier Wall Plan Preparation only applies to the ground mounted precast concrete post and panel wall type. For information on wall types specific to bridge mounted applications, see the **Bridge Design Manual Section 7.02.30**. Design of other wall types must be separate and site-specific.

While various density materials are suitable for use as noise barriers, a minimum density of about 4 pounds per square foot is required to adequately prevent sound transmission through the material.

A. Preferred Wall Types

Earth berms and ground mounted precast concrete post and panels are the preferred ground mounted noise barrier wall options in Michigan. These are briefly discussed as follows:

1. Earth Berm - If sufficient ROW exists to place an earth berm, consider its implementation into the project to minimize or eliminate the need for a structural wall and improve aesthetics.

The Engineer must follow noise analysis procedures laid out in the **Noise Analysis and Abatement Handbook** to confirm that placement of a berm will provide sufficient noise abatement in addition to or in place of a noise barrier wall.

In instances where a standalone earth berm provides sufficient noise abatement, it is preferred that the side slopes grade down towards the roadway at a slope of 3(H):1(V) to facilitate maintenance.

When earth berms are used in conjunction with a noise barrier wall, construct them with a 2' bench sloping at 5% away from the wall. This helps to prevent sloughing and helps inspectors traverse along the alignment of the wall. Additionally, side slopes grading down from the bench are preferred to have a slope of 3(H):1(V) to facilitate access and maintenance. The noise barrier wall requires site specific design in instances where a slope steeper than 3(H):1(V) is provided.

2. Ground Mounted Precast Concrete Post and Panel - Ground mounted precast concrete post and panels with drilled shafts serve as the primary option for newly constructed noise barrier walls in the state of Michigan. The standard design of these elements is using conventional reinforcement and based on a 20'-0" center-to-center post spacing and a wall height of 20'-0" measured from the top of the post to the top of the shaft.

B. Alternative Wall Types

Consider alternative wall types in scenarios when their design and implementation is beneficial to a project. Alternatives are deemed acceptable upon approval by the Engineer and governing authority. The following list presents primary alternatives to consider:

1. Galvanized Steel Posts

2. Cast-In-Place Wall Elements

3. Prestressed Wall Elements

4. Alternate Wall Materials (e.g., Acrylic Noise Barrier Walls)

5. Spread footings in place of drilled shafts

C. Historic Wall Types

Historically, Michigan has implemented some additional noise barrier wall types. However, new construction using these requires site specific design and approval from the governing authority. These are briefly discussed as follows:

1. Brick – Were proven to be a popular noise barrier wall material, especially in an urban setting. Typically consisted of concrete base walls with 4” thick clay brick wall laid on top, utilizing brick pilasters on the residence side for rigidity and strength. If the wall was placed back from the highway, the concrete base wall was typically omitted, and the wall would be constructed entirely of brick (though brick also requires a footing). These walls were found to be more expensive than concrete walls in initial costs and maintenance. Often requiring frequent aesthetic fixes such as replacement of bricks that have fallen off. Form liners for concrete can now provide the same aesthetic look with a reduced level of maintenance. A range of colors were available for these walls.

2. Metal - Metal noise barrier walls were an outgrowth of metal building construction. Their principal advantage was that they could be painted to almost any desired color, e.g., brown, if earth tones are desired. Their alignment could be easily jogged or could be built through or near trees that needed to be saved. For visual effects, their heights could be easily varied. They required more maintenance than concrete walls but were less expensive initially as they did not require full-length footings. Different color selections and textures were available.

3. Wood – Some of the earliest noise barrier walls were built of wood. Initially, there were visual problems because of the blotchy effect of the creosote preservative, and warpage of the boards created cracks that allowed the sound to go through the wall. More modern techniques called for water-borne and Penta preservatives, and panels were constructed of 2" x 6" lumber with double walled treated plywood. These panels could be 2' x 10', or 2' x 12'. Advantages of wood were that it was comparatively light, allowing its use for noise barrier walls on top of bridge railings, and it did not require full length footings.

4. Stab-in concrete panels - As the term implies, stab-in noise barrier walls were composed of precast concrete panels that had stability by virtue of having about one-third of their length embedded in the ground, thus eliminating the need for supporting H-beam columns. The panels were usually heavier than the simple panels used for precast concrete post and panels, preceding, and had tongue and grooved edges that allowed sealing of the joints. They required no foundation, and the height of the panels could be staggered. However, the required depth of embedment was not compatible with a concentration of underground utilities.

5. Concrete block - Concrete block was a rather economical alternate to other forms of concrete noise barrier walls. Blocks could be made rough on one side and smooth on the other or could be alternated to achieve a pattern. It was essential that water be kept out of the core holes, otherwise it would freeze and break off the block faces. One wall was constructed with a concrete block bottom and a wood wall higher up. Concrete block walls required full length footings. A wide range of colors and textures were available.

2.02.02

Aesthetics

Designers must coordinate aesthetic treatments with MDOT's Roadside Development Design Unit. If applicable, follow corridor-specific aesthetic design guides.

Beyond this, consider the following general guidelines for aesthetic features:

1. Seek public input on color of coating and texture of form liners if a corridor-specific aesthetic is not already in place.

2. When color coating is desired, it is recommended that one-color systems be used, when possible, to ease future color matching and painting over graffiti.

3. Form flat or nearly flat surfaces for the tops of panels and posts. Consider a slight slope on the top of the post and top panel to encourage water runoff.

4. When form liners are used, liners must be stopped a minimum of 6" short of the top wall panel to create a coped look. The maximum depth of form liners must be limited to 2" to avoid unnecessary cost and weight of non-structural concrete.

2.02.03

Right-of-Way Coordination

Place noise barrier walls within the ROW wherever possible. Coordinate with MDOT Region Real Estate staff early in the project schedule to determine real estate needs and impacts to the project schedule. Any temporary work outside the ROW requires a legal agreement such as a Consent or Temporary Construction Easement. The Real Estate Services Section of the Development Services Division or Region Real Estate will determine just compensation for the agreement which is offered to the property owner. Permanent ROW acquisition may also need to be considered. Review Chapter 16 of the **MDOT Real Estate Procedure Manual** for more details on ROW considerations during design.

2.02.04

Drainage

Noise barrier walls must be accounted for in the project drainage design. Noise barrier walls act as a dam which can lead to water pooling at the wall, backing up into adjacent properties and leading to wall maintenance issues. Drainage design must follow the requirements and procedures in the **MDOT Drainage Design Manual**. Drainage features must implement soil erosion measures per the **Road Design Manual**. The following drainage features may be implemented to convey water through or away from the wall.

A. Ditching

Longitudinal ditching may be implemented along either side of the noise barrier wall. For ease of maintenance, side slopes of ditches are preferred to be graded at 3(H):1(V). The bottom width of ditches may vary with the longitudinal profile of the site.

In instances where the site's topography conveys water away from the wall, longitudinal ditching may not be required.

B. Drainage Structures

Drainage structures may be installed along the alignment of the wall when flooding is a concern. Location and size of these structures must be determined by the Engineer.

C. Raising Bottom Panels

Raising bottom panels creates a gap between the final grade noise barrier wall which allows water to flow through the wall. This option requires coordination with the noise analyst to ensure the wall provides proper noise abatement. Consider the long-term maintenance of the gap required for it to continue functioning as a drainage path.

2.02.05

Appurtenances

A. Fire Hose Access

Provide fire hose access openings based on project specific needs. Coordinate with the local fire department during the design process. Details for the openings must be shown on the plans. Water lines must be coordinated with other project features.

B. Signs

Attachment of signage to noise barrier walls is heavily discouraged. If necessary, the design of noise barrier walls must account for all relevant loads from the signage. Signage must be located as to not interfere with the construction, inspection, or maintenance of the wall.

C. Fencing

Often when noise barrier walls are placed, existing private property or ROW fencing is within the vicinity of the wall. Consider the presence of fencing and potential tie-ins to the wall during design.

2.02.06

Construction Access

Assume a minimum of 10’-0” on each side of the centerline of the noise barrier wall for construction related activities. Any temporary work outside the ROW requires a legal agreement such as a Consent or Temporary Construction Easement. The Real Estate Services Section of the Development Services Division or Region Real Estate will determine just compensation for the agreement which is offered to the property owner. Clearly show temporary access limits on the design plans. For further details on ROW coordination, see **Section 2.02.03**.

Consider how the contractor will access the wall alignment from the roadway. Steep existing slopes may require constructing benches or haul roads.

2.02.07

Inspection and Maintenance Access

Access for inspection and maintenance of the front side of the wall must be provided. Access to the back side of the wall is also preferred. In instances where backside access is being considered, coordination with MDOT Region Real Estate staff must take place.

See **Section 2.02.03** for additional information regarding ROW.

A. Wall Gaps and Required Termination Lengths

Location and width of wall gaps must be coordinated with the noise analyst. When determining the length of termination or overlap, follow the FHWA’s 4D Rule.

2.02.08

Vegetation Trimming, Removal, and Placement

Coordinate with MDOT Roadside Development Design Unit and the Region Resource Specialists to determine landscape needs of trees and other sensitive vegetation early in the project development. Before doing so, establish tree removal counts. Coordination must take place no later than the preliminary plan review meeting.

Provide trimming of vegetation only in instances where its presence interferes with construction access. Remove vegetation that contacts the permanent wall.

Avoid removal as much as possible. However, the removal plan must consider construction access to the wall alignment and the space along the horizontal alignment required to build the wall (see **Section 2.02.05**).

When placement of trees or vegetation is desired, place them so that their branches and roots will stay clear of the wall once fully mature and will not impede maintenance and inspection access to the wall. Because of this, small ornamental trees and columnar shape trees are preferred.

2.03

NOISE BARRIER WALL LAYOUT

2.03.01

Horizontal Alignment

The horizontal alignment of the wall must follow what has been prescribed by the site's noise analysis. If the alignment requires attachment to an existing structure, the feasibility of this placement must be discussed with the MDOT Bureau of Bridges and Structures. Special permission must be obtained for any deviations.

For safety reasons, it is preferred that the horizontal alignment does not result in blunt edges. Consider this regardless of the wall's placement in relation to the roadway clear zone.

A. Post Spacing and Panel Alignment Deviation

Place posts at a standard center to center spacing of 20'-0".

Place panels so that their centerline does not deviate more than 6-degrees from the centerline of the post. This deviation results in a minimum allowable radius of approximately 95' for the horizontal wall alignment.

Larger deviation angles may be used when permitted by the Engineer and governing agency. If larger angles are to be used, keep deviations in 45 and 90-degree increments to assist with fabrication and construction.

B. Adjustments for Roadways/Driveways

Consider intersecting roadways and driveways during the design phase. When these obstructions interfere with the 4D Rule, the designer must coordinate with the noise analyst on the adjustment of wall termination locations.

C. Adjustments for Underground Obstructions

Underground obstructions such as drainage structures or utilities must be considered during the design phase. Adjust post spacing to clear the obstruction. It is preferred to minimize the number of panels with non-typical post spacings for ease of fabrication.

Add notes to design plans to emphasize the contractor's responsibility to locate utilities and provide the preferred clearances of the utility owner prior to construction.

2.03.02

Clear Zone

Locate noise barrier walls outside of the upper bound clear zone distance specified in the **Road Design Manual** when feasible. The preferred location is 3'-0" from the right-of-way line. Locating the wall this distance from the ROW limits the space behind the wall requiring maintenance. Additionally, the 3'-0" offset provides room for the following features used on typical projects:

1. Drilled shaft foundations.

2. Drainage structures along the back side of the wall if needed.

3. Grading and erosion control measures behind the wall.

When none of these conditions are present, the back of the wall may be placed as close to the ROW line as the geometry of the foundation will allow.

In instances where site topography or noise abatement requires installation within the clear zone, one of the following protection methods must be met:

4. If the noise barrier wall is to be placed greater than 12' from the travel way, guardrail

protection is recommended for the protection of the motorist as appropriate per Chapter 7 of the **Road Design Manual**.

5. If the noise barrier wall is to be placed 12’ or closer to the travel way, concrete barrier (per Standard Plan R-54-Series) is recommended for protection of the motorist. While placement of the noise barrier wall 12’ or closer to the traveled way is an option, it is not desirable. When installing concrete barrier, the noise barrier wall face must be a minimum of 3’-3” from the top of the traffic face of the barrier. In addition, a 4” sidewalk section with subbase and foundation drainage must be provided between the barrier and the noise barrier wall. Place the top of the sidewalk section at the same elevation as the top of the concrete barrier, sloping away from the noise barrier wall.

Noise barrier walls located ≤4’ from the traffic face of the barrier must be designed for vehicle impact per **AASHTO LRFD Bridge Design Specifications**.

For details regarding roadside safety barriers, see the **Road Design Manual**.

Consider roadway snow removal storage in regard to noise barrier wall placement and barriers.

Coordinate with MDOT on the future changes in the clear zone for highway expansion before finalizing the walls placement.

2.03.03

Vertical Alignment

The top of wall must meet or exceed the acoustic profile obtained from procedures outlined in the **Noise Analysis and Abatement Handbook**.

Concrete panels are typically detailed as either 2’ or 4’ tall. Therefore, the height of the wall must be kept to 2’ increments.

Minimize steps in the top of the wall. More infrequent but larger steps are preferred to many smaller steps. Do not step the beginning or end of the wall’s layout.

Embed the bottom of the panels a minimum of 6”. Cast-in-place concrete bolsters are used at each shaft to step panels if necessary. Bolsters do not need to be standardized for a given project. Set bolster heights as needed to minimize the overall wall area and to meet the provisions noted above.

2.04

STRUCTURAL DESIGN

2.04.01

Foundation Types

Review historic structure borings before new borings are obtained. If poor soils are shown, the Engineer must coordinate with the noise analyst during the Base Plan phase to ensure the design stays within the cost threshold specified in the **Noise Analysis and Abatement Handbook**.

New soil borings must be obtained along the proposed alignment of the noise barrier wall consistent with the requirements in the **Geotechnical Manual**.

A. Drilled Shafts

Drilled shafts serve as the standard foundation type for noise barrier walls. See Appendix A – Drilled Shaft Tables for standard drilled shaft designs and for drilled shaft design assumptions. Confirm with the project geotechnical engineer whether casing is recommended. Standard designs are provided in Appendix A for typical posts, not for corner posts or posts where the panel deviation is greater than that shown on the details in Appendix B – Guidelines for Noise Barrier Wall Plan Preparation. Those posts require a site-specific design.

B. Spread Footings

Spread footings may be considered as an alternative to drilled shafts when the following conditions exist:

1. Competent bearing stratum, as defined by the geotechnical engineer, exists within 5 feet of the ground surface along the wall alignment and foundations will not bear on or within undocumented fills. Competent bearing stratum identified in soil borings must be verified as representative through hand auger borings during construction and other construction testing.

2. Total estimated settlement is less than 1” for the design life of the structure.

3. Differential settlement is estimated to be less than 0.75” between consecutive posts for the design life of the structure.

4. No existing underground utilities or historically abandoned underground utilities are located within the foundation footprint, or within 5 feet laterally in all directions beyond the limits of the foundation excavation.

5. Support excavations to protect existing pavement or other features from damage such as undermining, excessive settlement, or lateral deflection.

Use of spread footings must be approved by MDOT Geotechnical Services Section during the Preliminary Plan phase.

2.04.02

Design Specifications

Noise barrier walls in Michigan must be designed according to the current edition of the **AASHTO LRFD Bridge Design Specifications.**

2.04.03

Loadings

Noise barrier walls must be designed for the loadings and load combinations required by the **AASHTO LRFD Bridge Design Specifications** and the **PCI Design Handbook** for handling, hauling, and lifting. The posts, panels, and foundations must be designed for a load case where the entire height of the wall from top of foundation upwards is subject to wind load and a case where the soil on one side of the wall is 2’-0” higher than the other side.

For handling, hauling, and lifting checks, assume the component to be supported at the locations of lifting devices and apply an equivalent static load multiplier of 1.5 to the component weight in Service and Strength Cases in addition to the load factors to account for dynamic effects.

Avoid designing ground mounted noise barrier walls for vehicle impact. Locate them outside of the clear zone or protected if located inside the clear zone. If design for vehicular impact is absolutely necessary, walls must be designed for the specific needs of the project. Follow the **AASHTO LRFD Bridge Design Specifications** for vehicle impact design

A. Sound Absorptive Material

When sound absorptive material is used, its weight must be accounted for in the design of wall components.

2.04.04

Handling, Hauling, & Lifting

Include plan notes requiring concrete panels to be shipped, stored, and handled in the upright position. This prevents excess cracking in the panels. Show lifting devices in the panels and posts near the ¼ points.

2.04.05

Deflection Limits

Analyze deflection using the service load combinations per the **AASHTO LRFD Bridge Design Specifications**. The following limits for ground mounted walls must be checked:

The top of post deflection, including the translation and rotation of the foundation, must be less than H/100, where H is measured from the top of the foundation to the top of the wall.

The maximum horizontal deflection of any panel with respect to the posts must be less than L/240, where L is measured as the clear distance of the panel between posts. The calculated panel deflection need not include deflection of the posts or the foundation.

The horizontal deflection at the top of the foundation must be less than 1”.

2.04.06

Structural Details

Recommended details are shown in the Noise Barrier Wall Sample Plans provided in Appendix B.

A. Foundation Anchorages

The preferred foundation anchorage detail is to embed the posts into the foundation a minimum of 6’-0”. Additional transverse shear reinforcement must be provided in the embedment zone.

Post-to-foundation connections using anchor bolts are prohibited.

B. Bolsters

Design bolsters following the detail shown in Appendix B – Guidelines for Noise Barrier Wall Plan Preparation.

2.05

PLAN PREPARATION

2.05.01

Naming Noise Barrier Walls

Noise barrier wall plans must use the naming convention "NW-XXXXXX" where NW-XXXXXX is the ID of the noise barrier wall. Designers must contact the MDOT Ancillary Structures Program after the Base Plan Review Meeting to confirm the name of all noise barrier walls on the project.

Additionally, each noise barrier wall for a given project must be assigned their own funding category. Confirm funding categories with MDOT during the Base Plan Review Meeting.

2.05.02

Preliminary Plan Composition

Use the following list and ordering of sheets for the Preliminary Plan stage of noise barrier wall projects. This list assumes no major work aside from the wall is included in the project:

A. Title Sheet

B. Project Information Sheet

C. Legend Sheet

D. Note Sheet

E. Survey Information

F. Noise Barrier Wall Plan and Profile*

*Use Appendix B – Guidelines for Noise Barrier Wall Plan Preparation as a reference for these sheets.

At the Preliminary Plan stage the noise barrier wall plan and profile sheet must convey the wall alignment, wall profile, and proposed wall type at a minimum. If multiple wall types are used, call out in the wall profile view with lengths of each type shown.

2.05.03

Final Plan Composition

Use the following list and ordering of sheets for the final plan stage of noise barrier wall projects. This list assumes no major work aside from the wall is included in the project:

A. Title Sheet

B. Project Information Sheet

C. Legend Sheet

D. Note Sheet

E. Miscellaneous Quantities

F. Typical Cross Sections

G. Miscellaneous Details

H. Survey Information

I. Alignment

J. Noise Barrier Wall Plan and Profile*

K. Noise Barrier Wall Details*

L. Maintenance of Traffic

M. Soil Boring Data*

*Use Appendix B – Guidelines for Noise Barrier Wall Plan Preparation as a reference for these sheets.

See the **Road Design Manual** and **Bridge Design Manual** for guidance on all other sheets.

2.05.04

Structural Details

Use the structural details provided in Appendix B – Guidelines for Noise Barrier Wall Plan Preparation as a template when preparing noise barrier wall plans. These details may be modified to fit the project specific needs. The design of these details must be analyzed if modifications will impact the structural capacity.

Apply the details to instances where concrete post and panel walls supported on drilled shafts are proposed. Details are shown for a 20ft maximum post spacing and 20ft maximum wall height (measured from top of shaft to top of highest panel). When post spacing or wall height exceed these limits, site specific design is required.

Provide conventionally reinforced section details. Use epoxy coated reinforcing steel above ground. Reinforcing steel below ground may be left uncoated.

If alternative details are proposed, it is preferred that mild reinforced sections be used. However, prestressed sections may be utilized upon approval from the Engineer.

MDOT requires a 75-year service life for noise barrier walls.

APPENDIX A – DRILLED SHAFT TABLES

The following assumptions were made for lateral and axial analyses:

1. Loads at the top of foundation were calculated per the loading criteria provided in Section 1.04.03 of the Noise Barrier Wall Design Guidelines.
2. Service loads were utilized for evaluating settlement and lateral deflection.
    a. Maximum tolerable foundation settlement of 1 inch.
    Maximum tolerable lateral deflection of 1 inch at top of foundation.
3. To evaluate minimum required foundation depth to resist axial loads, 100 percent of factored axial side resistance plus 30 percent of the factored axial end bearing resistance was utilized, and the foundations were assumed to have permanent casing or temporary casing-left in place.
4. An additional factor of 0.75 was applied to the nominal axial side resistance to account for permanent casing or temporary casing-left in place.
5. Resistance factors for axial evaluation:
    a. 0.45 for clay and 0.55 for sand for frictional resistance to axial compressive load
    b. 0.40 for clay and 0.50 for sand and for end bearing resistance to compressive load
6. The foundations were modeled as uncased concrete for lateral loading.
7. Drilled shaft diameter will be 42 inches. A maximum stickup of 3 inches above ground line was assumed. Foundation lengths were measured from top of drilled shaft, and not from ground line.
8. Analysis assumed vertical reinforcement consisting of 11 #9 bars (approximately one percent of drilled shaft volume).
    a. Reinforcing bars were assumed to have yield strength of 60 ksi and an elastic modulus of 29,000 ksi.
9. The 28-day compressive strength (f'c) of the drilled shaft concrete was assumed to be 3,000 psi.
10. The P-y curves used for the lateral analysis will be the default P-y curves provided in the LPile software.
    a. 1,000 cycles of loading were assumed.
11. Ground surface was modelled as both flat (horizontal) and inclined at 18.43 degrees (3H:1V).
12. Groundwater was assumed at a depth of 3 feet below ground surface.
13. Soil resistance in the upper 3.5 feet of the profile has been modeled as disturbed soil consisting of low strength sand for all cases in accordance with LRFD design updates developed for the 2023 traffic signal foundation standards. The soil properties applied in the upper 3.5 feet are summarized below in Table 1:

Table 1 - Summary of Disturbed Soil Parameters

Depth Range (feet)	Lpile P-y curve	Effective Unit Weight (pcf)	Effective Friction Angle (Degrees)	Horizontal Modulus of Subgrade Reaction (pci)
0.25 to 3.25	Sand (Reese)	100.0	28	5
3.25 to 3.75	Sand (Reese)	38.0	28	5

14. Soil categories below a depth of 3.5 feet are consistent with the current designs such as the Strain Pole Foundation Chart, SIG-DESIGN-153-A (dated 02/15/11), and as noted below in Table 2. These soil properties were applied to soil below a depth of 3.5 feet. Effective unit weights are used below the groundwater depth.

Table 2 - Soil Property Summary for Soils below 3.5 feet

Soil Category	Soil Condition		Total Unit Weight[C] (pcf)	Effective Friction Angle (Degrees)	Horizontal Modulus of Subgrade Reaction[D], k (pci)	Modeled Undrained Shear Strength (psf)	Strain at 50% Stress	Lpile P-Y Curve Utilized
	S_u[A] (psf)	N_{60}[B] (bpf)						
Low Sand	NA[E]	$5 \leq N_{60} < 10$	105	28	20	NA[E]	NA[E]	Sand (Reese)
Medium Sand	NA[E]	$10 \leq N_{60} < 20$	114	30	60	NA[E]	NA[E]	Sand (Reese)
High Sand	NA[E]	$N_{60} \geq 20$	120	32	75	NA[E]	NA[E]	Sand (Reese)
Low Clay	$500 \leq S_u < 1000$	NA[E]	120	NA[E]	NA[E]	500	0.01	Soft Clay
Medium Clay	$1000 \leq S_u < 2000$	NA[E]	125	NA[E]	NA[E]	1000	0.007	Stiff Clay without Free Water
High Clay	$S_u \geq 2000$	NA[E]	130	NA[E]	NA[E]	2000	0.006	Stiff Clay without Free Water

Footnotes:
A) S_u = Undrained Shear Strength in Cohesive Soils (psf)
B) N_{60} = Standard Penetration Resistance (blows/foot determined in accordance with ASTM D1586), corrected to 60 % hammer efficiency utilizing the hammer's calibration energy
C) Effective unit weight will be used below groundwater elevation
D) Assumes soil is below groundwater elevation
E) NA = Not Applicable

MICHIGAN NOISE BARRIER WALL
DESIGN GUIDELINES

Additional Analysis Notes:

1. Axial capacity analysis was performed for the lower bound undrained shear strength for each cohesive soil category and the lower bound N60 value for each granular soil category.
2. Per AASHTO 10.8.3.5.2b-4 for each cohesionless soil category, an m coefficient of 0.6 was assumed. Analysis was completed with and without the resistance factor for casing reduction.
3. Lateral analyses were performed based on foundation lengths determined by the axial analysis results.

MICHIGAN NOISE BARRIER WALL
DESIGN GUIDELINES

Granular Soil Foundation Depth Table					
Post Spacing = 20ft		Shaft Diameter (in)	Soil Type	Soil Condition N60 (bpf)	Foundation Depth (ft)
Wall Height (ft)	10	42	Low Sand	5 ≤ N60 < 10	24.5
		42	Medium Sand	10 ≤ N60 < 20	18.0
		42	High Sand	N60 ≥ 20	13.0
	12	42	Low Sand	5 ≤ N60 < 10	27.5
		42	Medium Sand	10 ≤ N60 < 20	21.0
		42	High Sand	N60 ≥ 20	15.0
	14	42	Low Sand	5 ≤ N60 < 10	30.5
		42	Medium Sand	10 ≤ N60 < 20	23.0
		42	High Sand	N60 ≥ 20	17.0
	16	42	Low Sand	5 ≤ N60 < 10	34.0
		42	Medium Sand	10 ≤ N60 < 20	25.0
		42	High Sand	N60 ≥ 20	18.5
	18	42	Low Sand	5 ≤ N60 < 10	37.0
		42	Medium Sand	10 ≤ N60 < 20	27.5
		42	High Sand	N60 ≥ 20	20.5
	20	42	Low Sand	5 ≤ N60 < 10	*Site Specific
		42	Medium Sand	10 ≤ N60 < 20	30.0
		42	High Sand	N60 ≥ 20	22.0

Notes:

* Site Specific Design is required for scenarios where soil type or stratigraphy differs from standard soil categories shown or foundation depth exceeds 40ft based assumptions provided in Appendix A - Drilled Shaft Tables of the Noise Barrier Wall Design Guidance

Shaft diameters shown assume permanent casing or temporary casing-left in place is included.

The table above is based on ground slopes from level 3(H):1(V). Ground slopes steeper than 3(H):1(V) will require site specific design.

Foundation depth shown in table assumed to extend below top of shaft.

MICHIGAN NOISE BARRIER WALL
DESIGN GUIDELINES

Cohesive Soil Foundation Depth Table					
Post Spacing = 20ft		Shaft Diameter (in)	Soil Type	Soil Condition: Su (psf)	Foundation Depth (ft)
Wall Height (ft)	10	42	Low Clay	500 ≤ Su < 1000	*Site Specific
		42	Medium Clay	1000 ≤ Su < 2000	21.5
		42	High Clay	Su ≥ 2000	11.5
	12	42	Low Clay	500 ≤ Su < 1000	*Site Specific
		42	Medium Clay	1000 ≤ Su < 2000	25.5
		42	High Clay	Su ≥ 2000	13.0
	14	42	Low Clay	500 ≤ Su < 1000	*Site Specific
		42	Medium Clay	1000 ≤ Su < 2000	29.5
		42	High Clay	Su ≥ 2000	15.0
	16	42	Low Clay	500 ≤ Su < 1000	*Site Specific
		42	Medium Clay	1000 ≤ Su < 2000	33.5
		42	High Clay	Su ≥ 2000	17.0
	18	42	Low Clay	500 ≤ Su < 1000	*Site Specific
		42	Medium Clay	1000 ≤ Su < 2000	37.5
		42	High Clay	Su ≥ 2000	19.0
	20	42	Low Clay	500 ≤ Su < 1000	*Site Specific
		42	Medium Clay	1000 ≤ Su < 2000	*Site Specific
		42	High Clay	Su ≥ 2000	21.0

Notes:

* Site Specific Design is required for scenarios where soil type or stratigraphy differs from standard soil categories shown or foundation depth exceeds 40ft based assumptions provided in Appendix A - Drilled Shaft Tables of the Noise Barrier Wall Design Guidance

Shaft diameters shown assume permanent casing or temporary casing-left in place is included.

The table above is based on ground slopes from level 3(H):1(V). Ground slopes steeper than 3(H):1(V) will require site specific design.

Foundation depth shown in table assumed to extend below top of shaft.

Top 5 feet of soil profile neglected for axial side resistance for clay soils per AASHTO section 10.8.3.5.1b

APPENDIX B – GUIDELINES FOR NOISE BARRIER WALL PLAN PREPARATION

GUIDELINES FOR NOISE BARRIER WALL PLAN PREPARATION

MDOT
Michigan Department of Transportation

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation	NO SCALE		DATE:	CS:		DRAWING	SHEET
			DESIGN UNIT:	JN:			SECT 1
		FILE:	TSC:				

PURPOSE AND APPLICATION

This set of sample plans is intended for use as a guideline for preparing a set of noise barrier wall construction plans for the Michigan Department of Transportation. The examples of various sheets illustrate preferred techniques to ensure the uniformity, quality, and continuity of plans.

The Noise Barrier Wall Details sheets (NW DET 001 through 007) show preferred structural details. CAD files for these drawings should be downloaded from the following link and must be reviewed and adjusted as needed for individual projects. This includes but is not limited to, the aesthetic and drainage details for which the details shown are only placeholders and must be updated and/or expanded to fully show all required information for each noise barrier wall in a project.
<need link to MDOT website>

Other sheets are examples of various plan sheets, based on the most commonly occurring situations. However, it is recognized that some projects will have unusual circumstances that may allow for some variations from the preferred techniques contained herein.

This set is not to be considered or used as a single, coordinated plan, but as a collection of individual sheet types. In many cases, copies of actual plan sheets have been used to develop the sheets contained herein. Since modifications have been made to those sheets to develop an appropriate sample, they are not to be considered an official record of the plans from which they were taken.

Where the information shown on the sample plan sheets is in conflict with the design standards or practices of Michigan Department of Transportation as contained in its standard Specifications for Construction special provisions, design manuals or design standards, the standards and practices supersede any sample plan sheet information.

Boxed numbers refer to the plan guidelines located on the plan Guidelines Sheet at the beginning of each section.

See MDOT Guidelines for Bridge Plan Preparation for general plan preparation guidelines not specific to noise barrier walls such as guidelines for sheet layout, text, dimensions, plan notes, etc.

See MDOT Guidelines for Plan Preparation for guidelines related to sheets not specific to noise barrier walls such as survey, alignment, and typical section sheets.

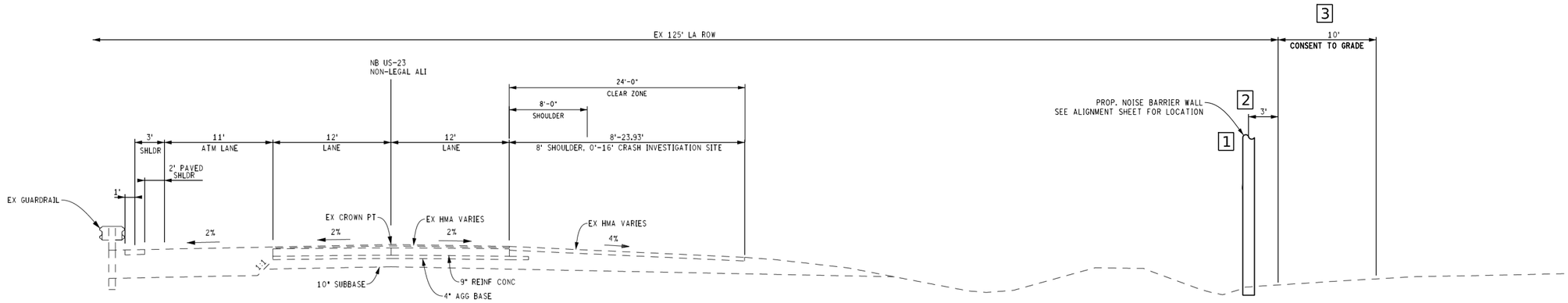
Errors and omissions can be reported to MDOT-Ancillary@Michigan.gov.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS:	NOISE BARRIER WALL PLAN GUIDELINES	DRAWING SHEET
CHK'D BY:	DESIGN UNIT:	JN:		SECT 1
FILE:	TSC:			



PROP NORMAL SECTION

SECTION APPLIES TO:
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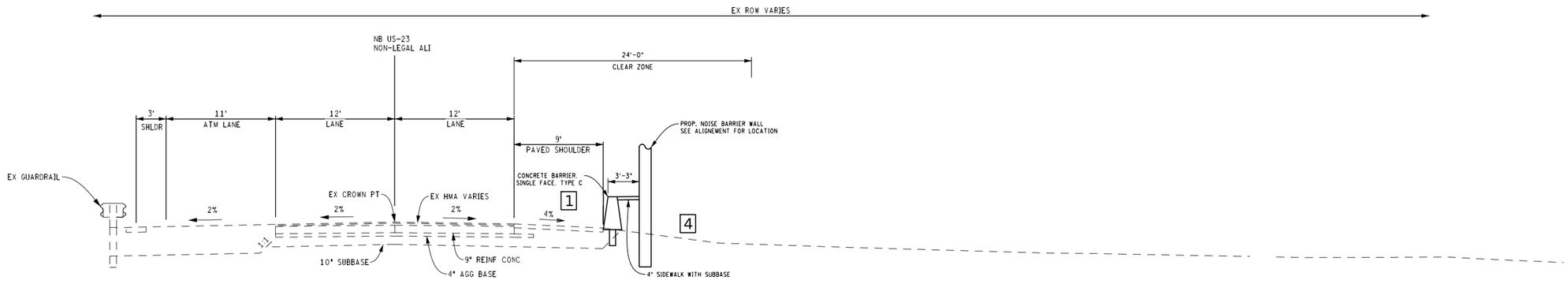
SW01 OF 47013 NON-LEGAL ALI STA 5012+67.11 TO STA 5016+23.00



PROP NORMAL SECTION

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NB US-23 NON-LEGAL ALI STA 723+14.33 TO STA 729+75.09
SW01 OF 47013 NON-LEGAL ALI STA 5020+21.54 TO STA 5027+00.00

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS:	TYPICAL CROSS SECTIONS
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	
FILE: 130028_W01_PRTYP002.dgn	TSC:		

DRAWING	SHEET
PRTYP 001	SECT 1

TYPICAL SECTIONS

1. Place noise barrier walls outside of the clear zone. When this is not feasible provide protection as described in Section 1.03.02.

2. The preferred location of the wall centerline is 3'-0" from the existing right-of-way line. This allows for installation of drilled shaft foundations, drainage structures, or grading and erosion control measures behind the wall. When none of these conditions are present, the wall may be placed as close to the right-of-way line as the foundation installation will allow.

3. Design plans should assume a minimum of 10'-0" on each side of the CL of the noise barrier wall is required for construction related activities.

4. Slopes no steeper than 3H:1V are preferred to facilitate access and maintenance.

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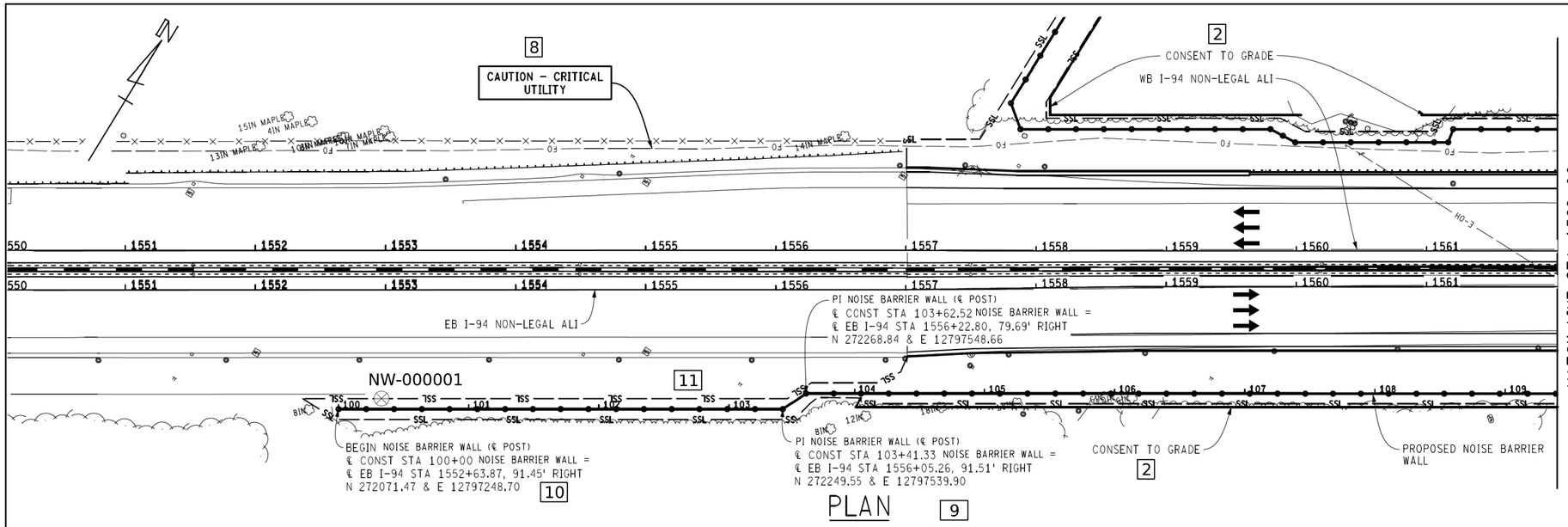
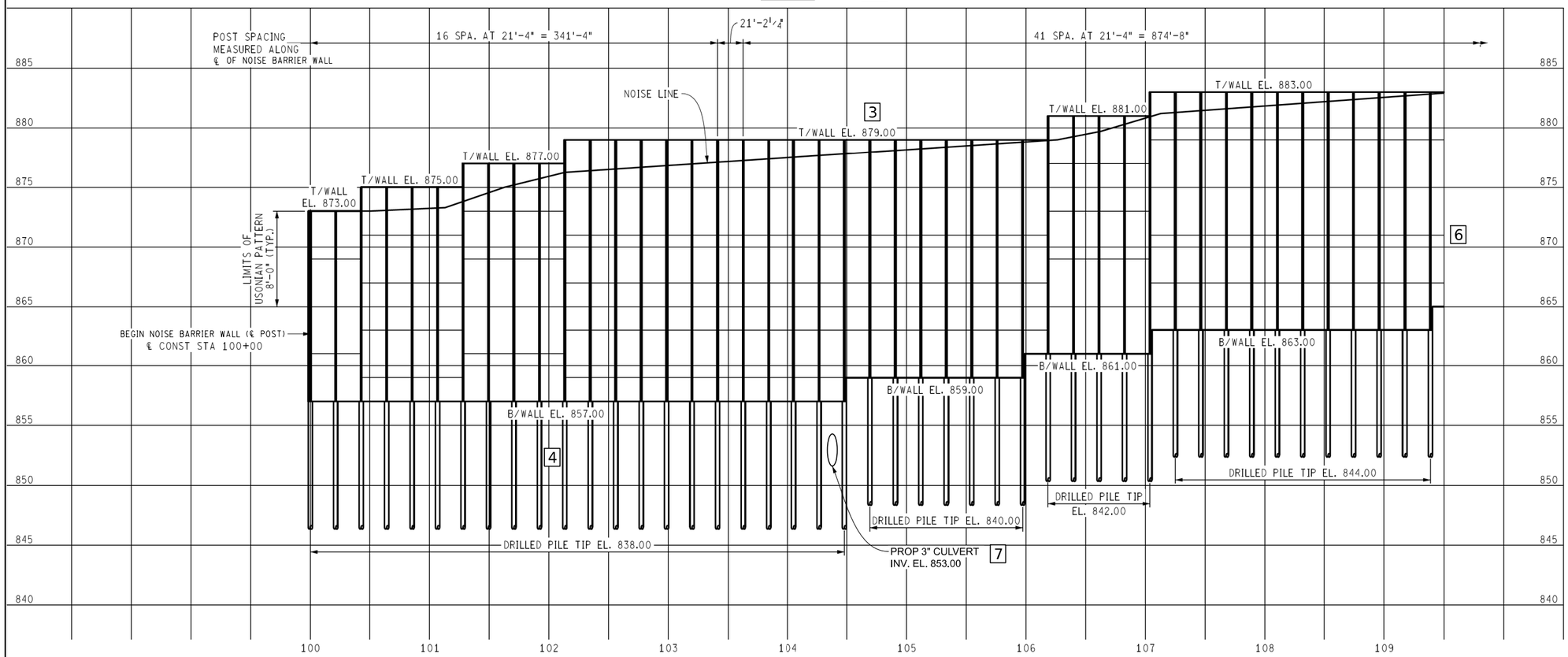
NO SCALE

DRAWING BY:	DATE:	CS:	NOISE BARRIER WALL PLAN GUIDELINES	DRAWING	SHEET
CHK'D BY:	DESIGN UNIT:	JN:			SECT 1
FILE:	TSC:				



PLAN 9



PROFILE

(USONIAN PATTERN NOT SHOWN FOR CLARITY)

MISCELLANEOUS QUANTITIES

CAT 0001 AMOUNT	CAT 0006 AMOUNT	UNIT	Item
-	1	LSUM	Structures, Rem Portions (NW-000001 of 39002)
-	1	LSUM	Drilled Shaft Equipment, Furnished (NW-000001 of 39002)
-	7800	Cyd	Backfill, Structure, CIP
-	7800	Cyd	Excavation, Fdn
-	554	Ft	Underdrain, Fdn, 4 inch
40	-	Ft	Underdrain Outlet, 4 inch
2	-	Ea	Underdrain Outlet Ending, 4 inch
8585	-	Ft	Fence, Temp
-	2144	Cyd	Substructure Conc, High Performance
-	126	Sft	Wall Drain
-	466	Syd	Texturing Conc
-	168686	Sft	Noise Barrier Wall, Precast Conc, Erect
-	168686	Sft	Noise Barrier Wall, Precast Conc, Furn
-	270	Sft	Joint Waterproofing
-	1	LSUM	Conc Surface Coating, Warranty (NW-000001 of 39002)
-	7410	Ft	Drilled Shaft, 42 inch
-	7410	Ft	Temp Casing-Left in Place
-	1	LSUM	Monitoring Structure (NW-000001 of 39002)
-	62,325	Lb	Reinforcement, Steel
-	2	Cyd	Conc, Grade 3500

NOTES:

THE WORK COVERED BY THESE PLANS INCLUDES REMOVAL OF THE EXISTING NOISE WALLS AND CONSTRUCTION OF THE PROPOSED NOISE WALLS AND DRILLED SHAFTS. ALL OTHER WORK IS INCLUDED IN THE ROAD PLANS THAT ARE PART OF THIS CONTRACT.

THE DESIGN OF THIS NOISE BARRIER IS BASED ON CURRENT AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS WIND EXPOSURE C AND 115 MILE PER HOUR WIND LOADING.

PRIOR TO WORKING DRAWING DEVELOPMENT, THE CONTRACTOR SHALL LOCATE ALL ACTIVE UNDERGROUND UTILITIES PRIOR TO STARTING WORK AND SHOP DRAWING DEVELOPMENT AND SHALL CONDUCT HIS OPERATIONS IN SUCH A MANNER AS TO ENSURE THAT THOSE UTILITIES NOT REQUIRING RELOCATION WILL NOT BE DISTURBED. ADJUST POST SPACING IF NECESSARY TO AVOID CONFLICTS WITH UTILITIES. PAYMENT FOR ADJUSTING POST SPACING IS INCLUDED IN THE PAY ITEM "NOISE BARRIER WALL, PRECAST CONC, FURN".

FIELD MEASURE LOCATIONS OF EXISTING NOISE WALL FOUNDATIONS PRIOR TO SHOP DRAWING CREATION TO CONFIRM THAT THERE ARE NO CONFLICTS WITH PROPOSED DRILLED SHAFTS. ADJUST NOISE WALL POST SPACING PRIOR TO WORKING DRAWING SUBMITTAL, AS APPROVED BY THE ENGINEER, TO AVOID ANY CONFLICTS THAT ARE IDENTIFIED (INCLUDED IN THE PAY ITEM "NOISE BARRIER WALL, PRECAST CONC, FURN").

PLACE TEMPORARY FENCE ALONG THE RIGHT-OF-WAY OR CONSENT-TO-GRADE, WHICHEVER IS CLOSEST TO RESIDENTIAL PROPERTY, AND AS DIRECTED BY THE ENGINEER TO SECURE THE PERIMETER OF THE PROJECT.

REMOVAL OF THE EXISTING NOISE WALLS INCLUDES REMOVAL OF THE EXISTING NOISE WALL PANELS, CUTTING OFF AND REMOVING STEEL/CONCRETE POSTS AND PORTIONS OF THE CONCRETE FOUNDATIONS. DO NOT REMOVE ENTIRE CONCRETE FOUNDATIONS UNLESS OTHERWISE APPROVED BY THE ENGINEER. REMOVE EXISTING POSTS AND FOUNDATIONS TO 6 INCHES BELOW THE BOTTOM OF PROPOSED NOISE WALL PANELS. REMOVALS ARE INCLUDED IN THE PAY ITEMS "STRUCTURES, REM PORTIONS (NOISE WALLS)"

ALL LABOR, EQUIPMENT AND MATERIALS REQUIRED TO RESOLVE CONFLICTS BETWEEN THE EXISTING NOISE WALLS AND THE PROPOSED NOISE WALLS WILL NOT BE PAID FOR SEPARATELY BUT INCLUDED IN THE PAY ITEM "STRUCTURES, REM PORTIONS (NOISE WALLS)".

SEE ROAD PLANS FOR SOIL EROSION AND SEDIMENTATION CONTROLS.

SEE ROAD PLANS FOR VERTICAL EXPLORATORY INVESTIGATION.

13

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

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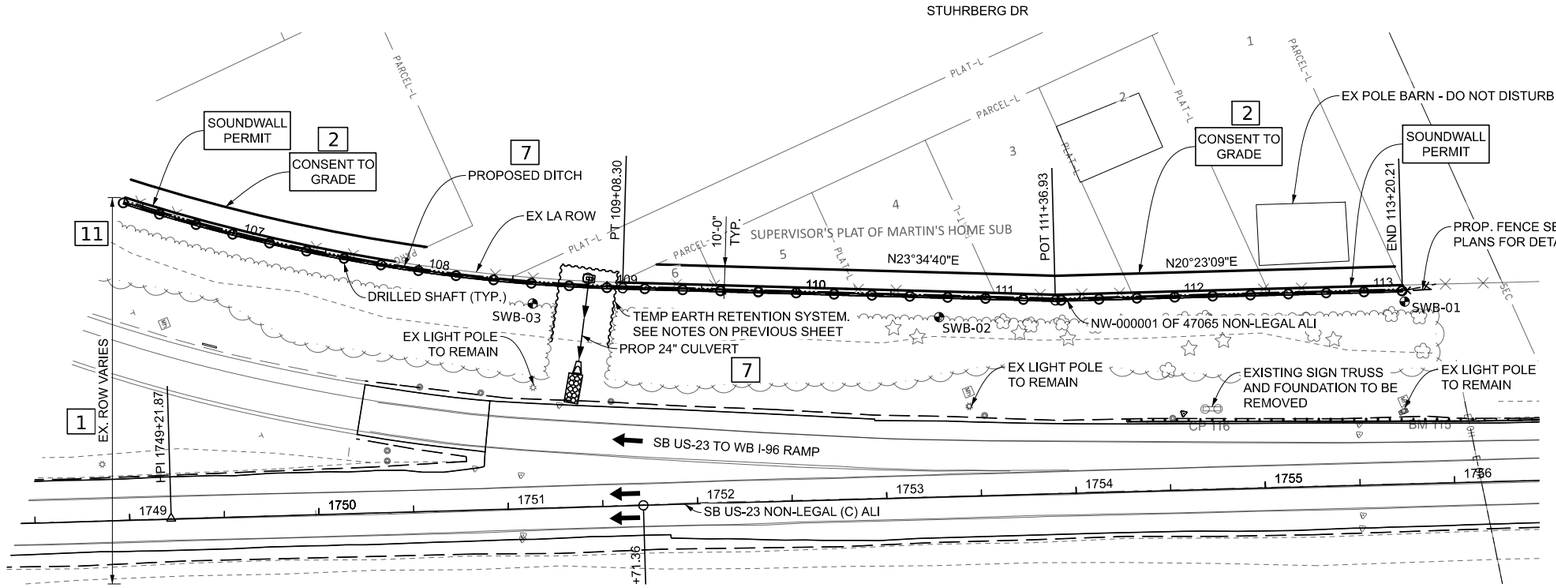
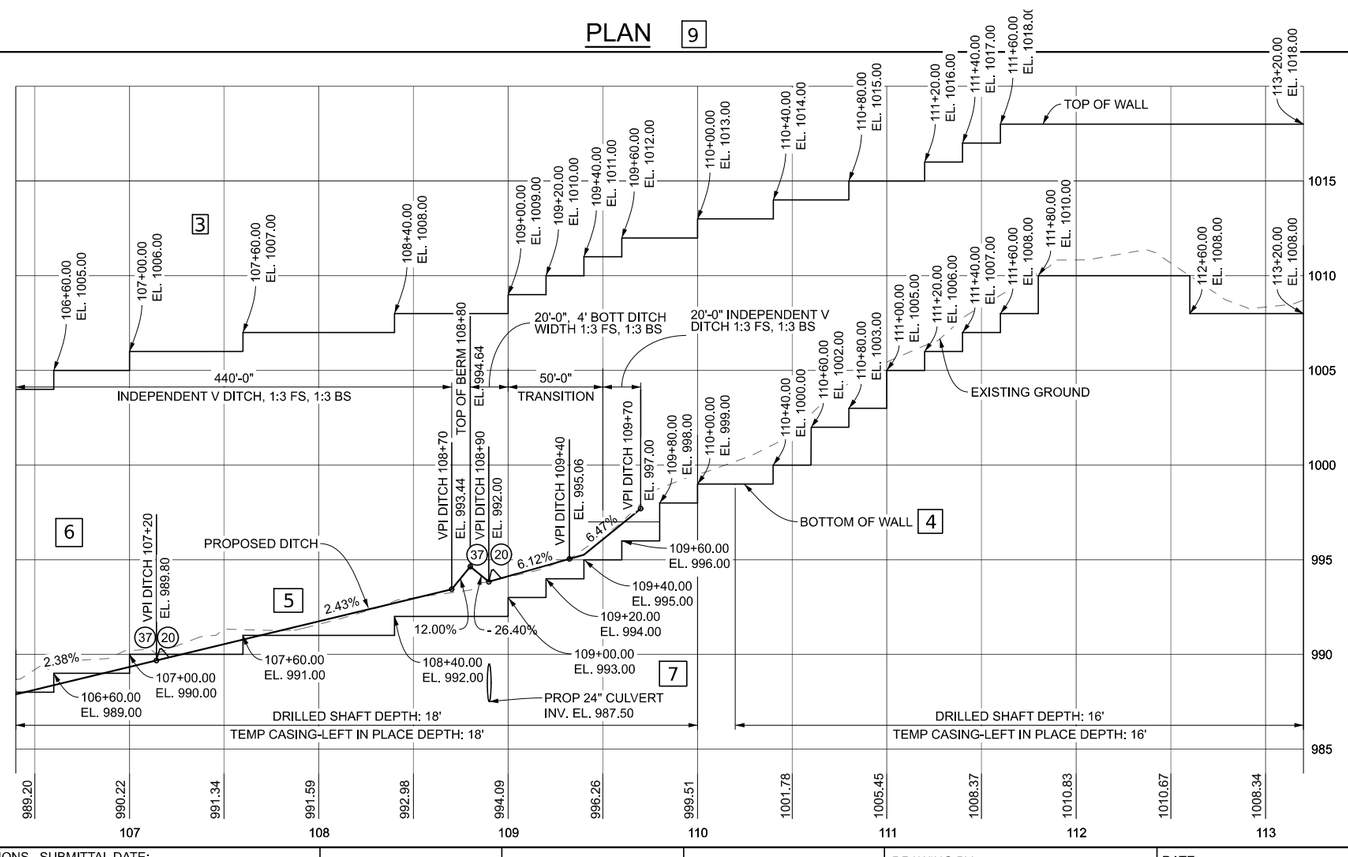
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-000001 OF 39002 12
FILE: SW_39022_layout_001.dgn	TSC:		IN KALAMAZOO COUNTY

DRAWING	SHEET
NW PLAN 001	SECT 1



PLAN 9



MISCELLANEOUS QUANTITIES

NW-000001 OF 47065
JN 210068A
CAT 0024

30,750	Lb	Reinforcement, Steel
5	Cyd	Conc, Grade 3500
9080	Sft	Noise Barrier Wall, Precast Conc, Furn
9080	Sft	Noise Barrier Wall, Precast Conc, Erect
64	Syd	Substructure Horizontal Surface Sealer (NW-000001 of 47065)
580	Ft	Drilled Shaft, 42 inch
580	Ft	Temp Casing-Left in Place
9	Cyd	Embankment, CIP
15000	Dlr	Obstruction Rem

14

SOIL EROSION & SEDIMENTATION CONTROL QUANTITIES

NW-000001 OF 47065
JN 210068A
CAT 0001

22	Ft	Erosion Control, Check Dam, Stone (37)
2	Ea	Erosion Control, Sediment Trap (20)

13

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS: 47065	NOISE BARRIER WALL PLAN AND PROFILE	DRAWING	SHEET
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-000001 OF 47065 12	NW PLAN 001	SECT 1
FILE: SW01_47065_plan and profile_002.dgn	TSC:		STA 106+40 TO STA 113+20		

NOISE BARRIER WALL PLAN AND PROFILE

1. Label ROW according to the MDOT Guidelines for Plan Preparation.

2. Show consent to grade lines if applicable. Assume a minimum of 10'-0" on each side of the centerline of the noise barrier wall is required for construction related activities.

3. Top of wall elevations and stationing shall be provided at every wall step. Steps should be provided as infrequently as possible and in large increments when used. The top of wall must exceed the acoustical profile from the noise analysis.

4. Bottom of wall elevations and stationing shall be provided at every wall step. Provide steps as necessary to keep the wall height to 2ft increments and maintain 6" minimum embedment of the bottom panel below proposed ground.

5. The profile of drainage mitigation measures shall be provided on the wall profile. Each change in grade must be labeled.

6. Fire hose access openings, access points, and any other appurtenances attached to the wall or running through the wall must be shown and dimensioned on the wall plans.

7. Utilities, drainage features, and any known underground obstructions shall be labeled and shown on the wall plan and profile along with any known elevation information.

8. Show all existing utilities. Label in accordance with the MDOT Guideline for Plan Preparations.

9. The plan view should show a topographic survey of the area within 150' beyond the ends of the noise barrier wall and 100' outside each face of the proposed wall. Show the following:
a. Alignments of noise barrier wall(s) and roads with stationing
b. Wall alignment points
c. Curbs and pavement edges
d. Bodies of water and wetland boundaries
e. ROW and Consent to Grade lines
f. Existing and proposed features
g. Existing and proposed utilities including sewers and drainage structures and utility poles
h. Traffic flow arrows
i. Temporary sheeting or access roads required for construction
j. Soil boring locations

10. Stations for the beginning, end, and changes in alignment of the wall should be provided.

11. Outlines of drilled shafts should be provided on the plan view.

12. See Section 1.05.01 of the design guidelines for noise barrier wall naming system.

13. Include noise barrier wall plans in Section 1 along with the road plans.

14. SESC quantities shown on this plan sheet are for a unique circumstance. SESC quantities should be placed on road sheets.

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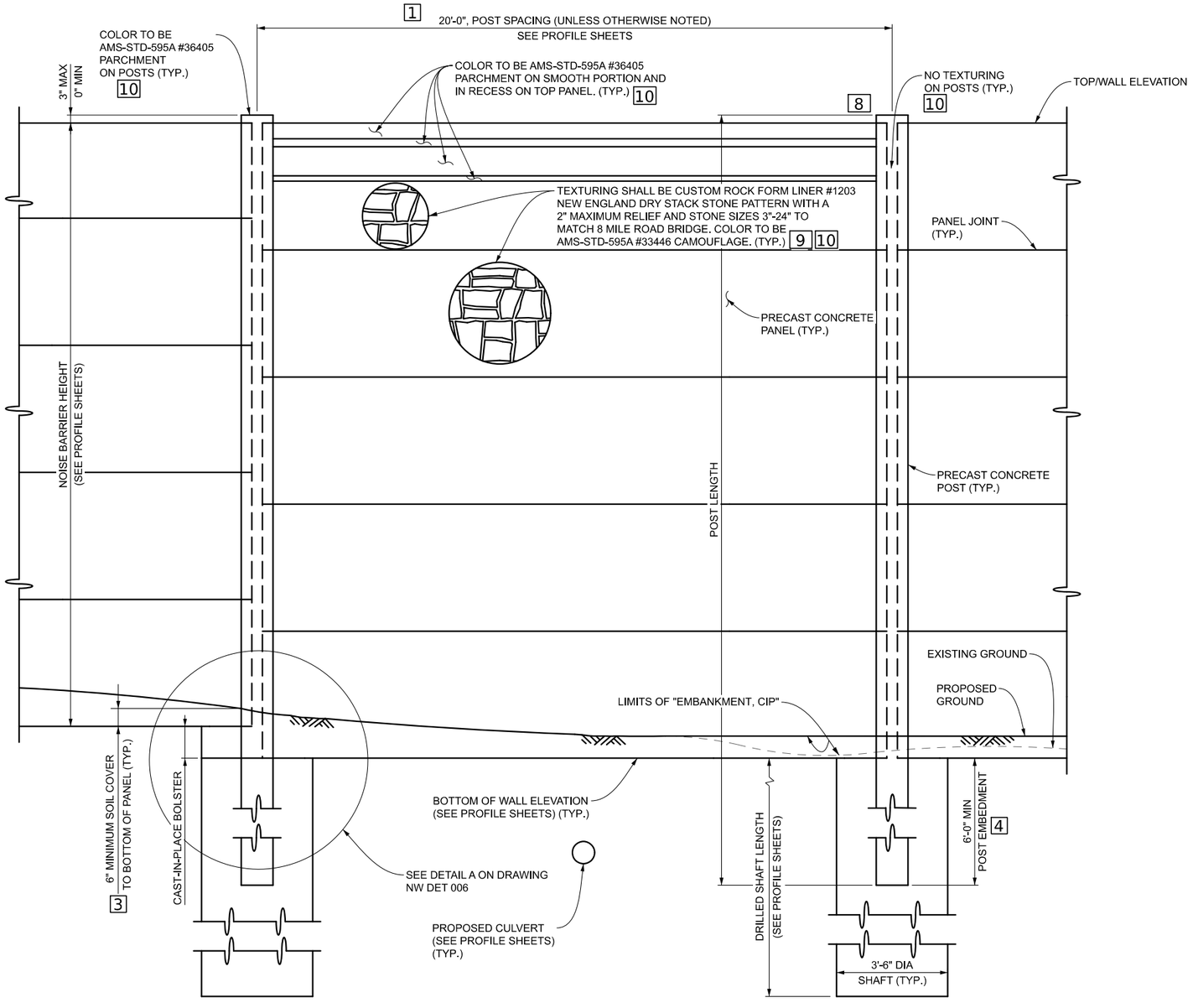
MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS:	NOISE BARRIER WALL PLAN GUIDELINES	DRAWING	SHEET
CHK'D BY:	DESIGN UNIT:	JN:			SECT 1
FILE:	TSC:				



ELEVATION

NOTES:

ES DENOTES EACH SIDE.

THE DESIGN OF THIS NOISE BARRIER WALL IS BASED ON AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 9TH EDITION FOR WIND EXPOSURE CATEGORY C AND A 3-SECOND GUST WIND SPEED OF 115 MPH.

THE NOISE BARRIER WALL IS DESIGNED TO RETAIN A DIFFERENCE IN SOIL ELEVATION EQUAL TO 24 INCHES OF EARTH ON EITHER SIDE OF THE WALL. HOWEVER, THE RETAINED FILL DIFFERENCE AT THE END OF CONSTRUCTION SHOULD BE LIMITED TO 18 INCHES TO PROVIDE AN ALLOWANCE FOR FUTURE GRADE CHANGES.

USE CONCRETE WITH A COMPRESSIVE STRENTH AT 28 DAYS OF 5000 PSI FOR POST AND PANELS.

USE GRADE 3500 CONCRETE FOR BOLSTERS.

APPLY LOW TEMPERATURE PROTECTION OF CONCRETE ACCORDING TO SECTION 706.03.J OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION. LOW TEMPERATURE PROTECTION OF CONCRETE IS INCLUDED IN RELATED ITEMS OF WORK.

REINFORCING STEEL IN PRECAST CONCRETE NOISE WALL PANELS AND POSTS, CAST IN PLACE BOLSTERS, AND CAST IN PLACE DRILLED SHAFTS WILL NOT BE PAID SEPARATELY, BUT IS INCLUDED IN THE RELATED ITEMS OF WORK.

ELASTOMERIC BEARINGS WILL NOT BE PAID FOR SEPARATELY, BUT ARE INCLUDED IN THE PAY ITEMS "NOISE BARRIER WALL, PRECAST CONC, FURN" AND "NOISE BARRIER WALL, PRECAST CONC, ERECT".

PAYMENT FOR CAST IN PLACE BOLSTERS IS INCLUDED IN THE PAY ITEM "DRILLED SHAFT, 42 INCH".

LOCATE ALL ACTIVE UNDERGROUND UTILITIES PRIOR TO STARTING WORK AND SHOP DRAWING DEVELOPMENT. CONDUCT OPERATIONS IN SUCH A MANNER AS TO ENSURE THAT THOSE UTILITIES NOT REQUIRING RELOCATION WILL NOT BE DISTURBED. ADJUST POST SPACING IF NECESSARY AND AS APPROVED BY THE ENGINEER TO AVOID CONFLICTS WITH UTILITIES. PAYMENT FOR ADJUSTING POST SPACING IS INCLUDED IN THE PAYMENT FOR PRECAST NOISE BARRIER WALL SYSTEM.

THE POST MAY PROJECT A MAXIMUM OF 3 INCHES ABOVE THE TOP PANEL. USE A CONSTANT PROJECTION FOR THE ENTIRE WALL.

CENTER ALL POSTS ON THE WALL ALIGNMENT CENTERLINE. AT CHANGES IN WALL ALIGNMENT, PANEL CENTERLINES MAY NOT NECESSARILY COINCIDE WITH WALL ALIGNMENT CENTERLINE.

SET POSTS PLUMB AND WITHIN TOLERANCES SPECIFIED IN THE CONTRACT DOCUMENTS. SET PANELS HORIZONTAL AND WITHIN THE TOLERANCES SPECIFIED IN THE CONTRACT.

CONFIGURE RIGGING SO THAT SLING ANGLES ARE NO LESS THAN 45 DEGREES TO THE HORIZONTAL.

THE DRILLED SHAFT DIAMETER SHOWN IS THE MINIMUM DIAMETER. DETERMINE IF LARGER DIAMETER DRILLED SHAFTS ARE NECESSARY FOR POST FIT UP TOLERANCE. ADJUST STEEL REINFORCEMENT TO THE SATISFACTION OF THE ENGINEER. PAYMENT FOR ADJUSTING SHAFT DIAMETER AND STEEL REINFORCEMENT IS INCLUDED IN THE PAY ITEM "DRILLED SHAFT, 42 INCH".

CONSTRUCT DRILLED SHAFTS SO THAT THE TOP OF SHAFT IS WITHIN ONE INCH OF THE POSITION SHOWN ON THE PLANS.

PROVIDE FULL LENGTH TEMPORARY CASING - LEFT IN PLACE TO PREVENT CAVING DURING SHAFT EXCAVATION.

DO NOT USE VIBRATORY EQUIPMENT FOR DRILLED SHAFT AND CASING CONSTRUCTION.

10 PROVIDE TEXTURING ON BOTH SIDES OF NOISE BARRIER WALL PANELS. SEE THE PRECAST NOISE BARRIER WALL SPECIAL PROVISION FOR TEXTURING PATTERNS. PAYMENT FOR AESTHETIC TEXTURING AND FORMLINERS IS INCLUDED IN THE PAY ITEM "NOISE BARRIER WALL, PRECAST CONC, FURN".

12

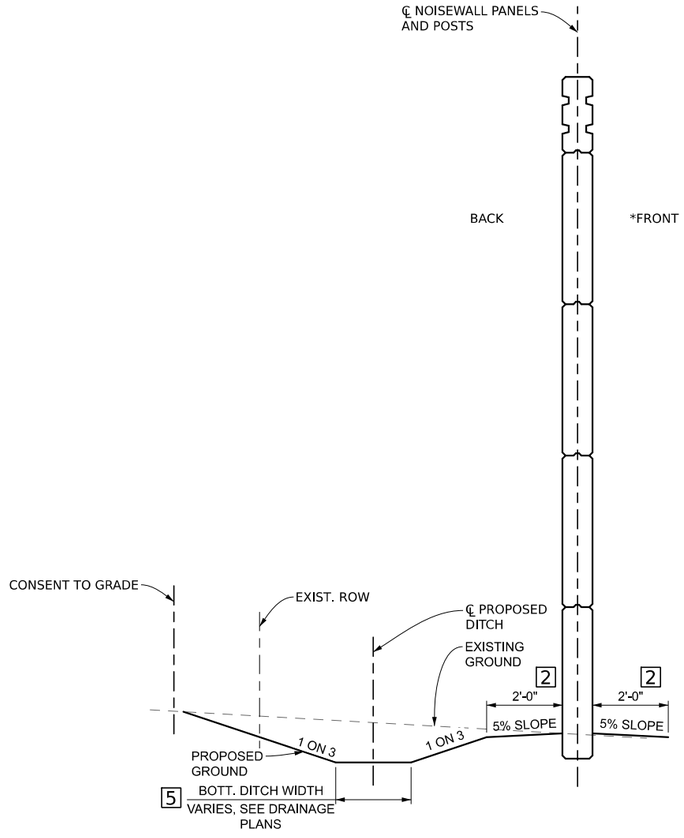
FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

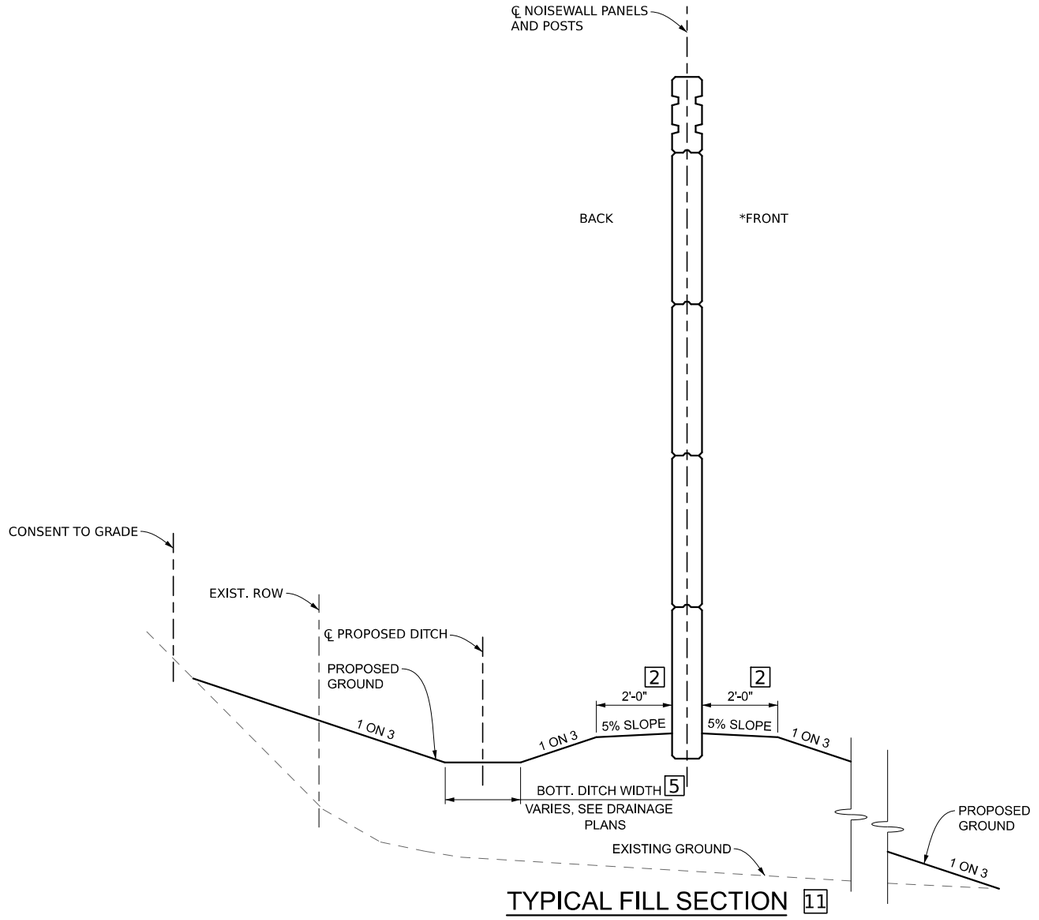
DRAWING BY:	DATE:	CS: YYYYY	NOISE BARRIER WALL DETAILS
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-XXXXXX OF YYYYY
FILE: NW_DET001_2024-08-22.dgn	TSC:		

DRAWING	SHEET
NW DET 001	SECT 1



TYPICAL CUT SECTION 11

APPLIES STA. XXX+XX.XX TO XXX+XX.XX
*THE FRONT SIDE OF THE WALL FACES THE ROADWAY



TYPICAL FILL SECTION 11

APPLIES STA. XXX+XX.XX TO XXX+XX.XX
*THE FRONT SIDE OF THE WALL FACES THE ROADWAY

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

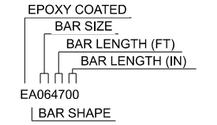
MDOT Michigan Department of Transportation

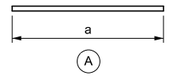
NO SCALE

DRAWING BY:	DATE:	CS: YYYYY	NOISE BARRIER WALL DETAILS
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-XXXXXX OF YYYYY
FILE: NW_DET002_2024-08-22.dgn	TSC:		

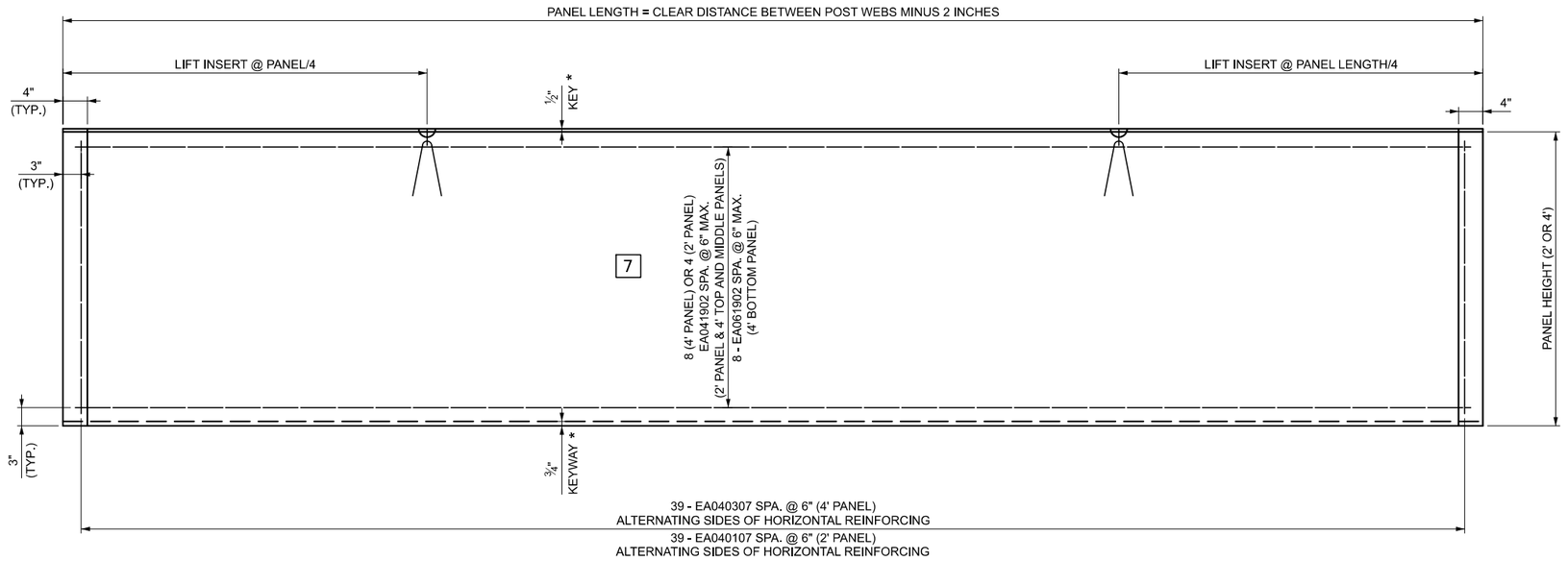
DRAWING	SHEET
NW DET 002	SECT 1

MEMBER	BAR	DIMENSIONS			
		a	b	c	d
4' TOP & MIDDLE PANELS	EA040307	3'-7"			
	EA041902	19'-2"			
4' BOTTOM PANEL	EA040307	3'-7"			
	EA061902	19'-2"			
2' TOP PANEL	EA040107	1'-7"			
	EA041902	19'-2"			



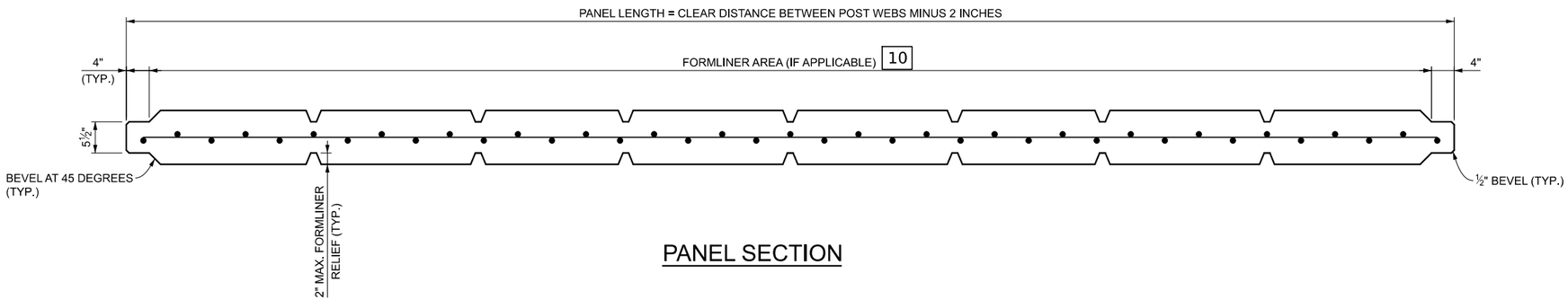


BAR LEGEND



PANEL ELEVATION

*EXCEPT AS NOTED ON SECTION THRU PANEL DETAILS



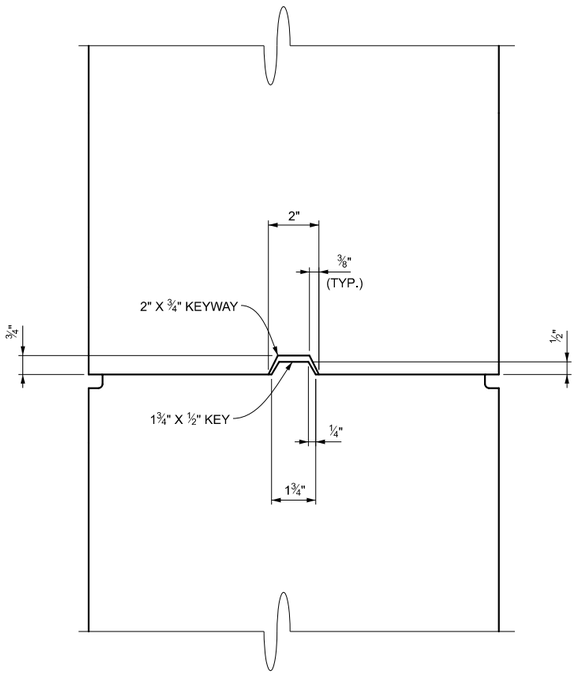
PANEL SECTION

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

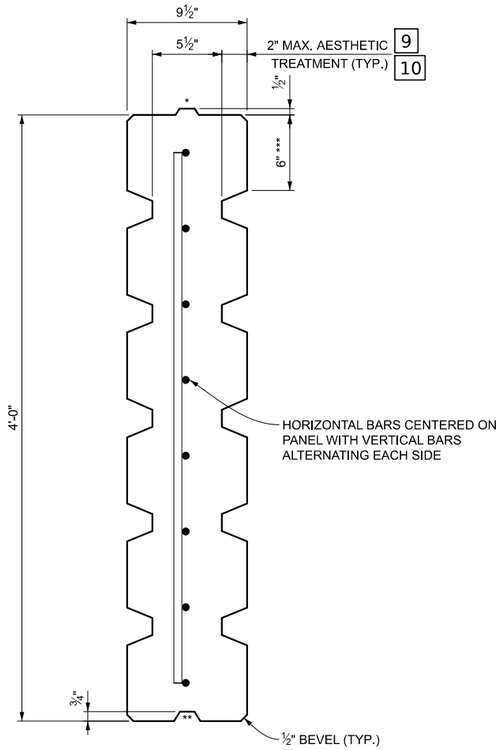
MDOT Michigan Department of Transportation

NO SCALE

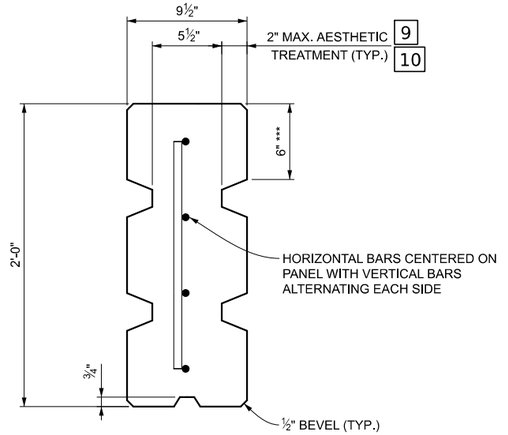
DRAWING BY:	DATE:	CS: YYYYY	NOISE BARRIER WALL DETAILS	DRAWING / SHEET
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-XXXXXX OF YYYYY	NW DET 003 / SECT 1
FILE: NW_DET003_2024-08-22.dgn	TSC:			



PANEL JOINT DETAIL



SECTION THRU 4"-0" PANEL



SECTION THRU 2"-0" PANEL

USE FOR TOP PANEL ONLY

*OMIT KEY FOR THE TOP ROW OF PANELS
**OMIT KEYWAY FOR THE BOTTOM ROW OF PANELS
***LEAVE FORM LINER 6" MIN. SHORT OF THE TOP ROW OF PANELS

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
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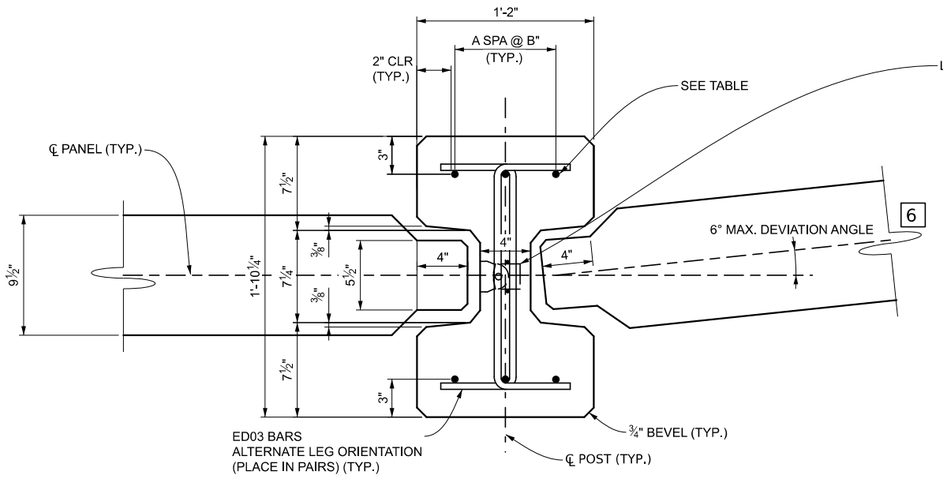
MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS: YYYYY	NOISE BARRIER WALL DETAILS	DRAWING / SHEET
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-XXXXXX OF YYYYY	NW DET 004 / SECT 1
FILE: NW_DET004_2024-08-22.dgn	TSC:			

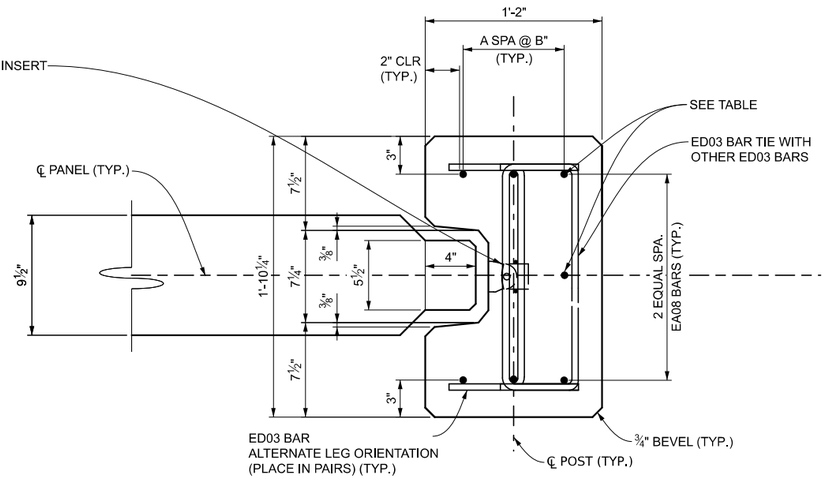
MEMBER	BAR	DIMENSIONS			
		a	b	c	d
POSTS	ED030206	6"	1'-6"	6"	
	EA06/EA07	*			

* POST LENGTH MINUS 4"



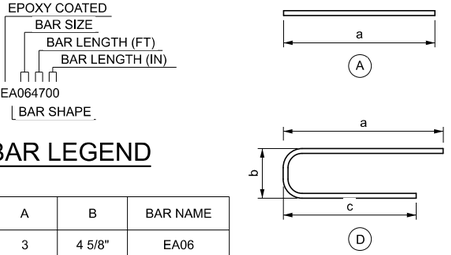
TYPICAL POST SECTION DETAIL

(PANEL AESTHETIC TREATMENT NOT SHOWN)



END POST SECTION DETAIL

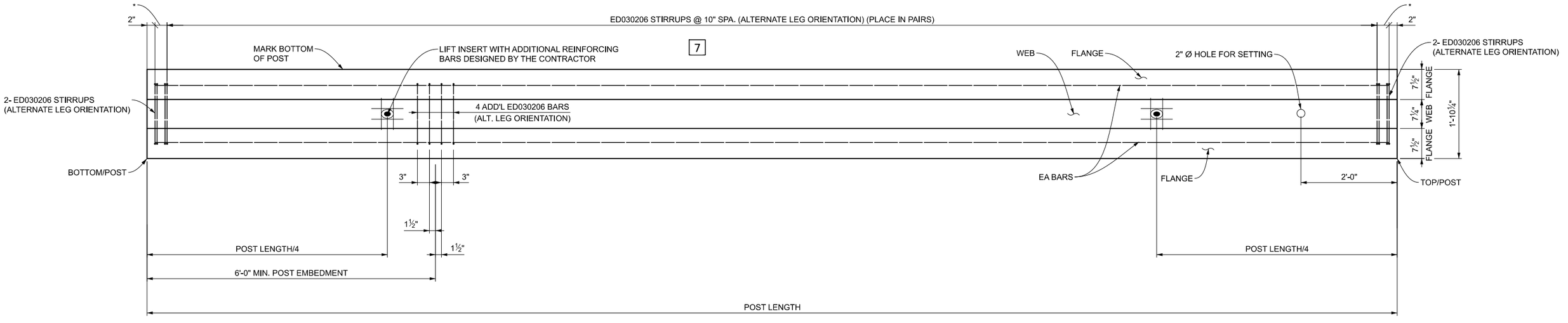
(PANEL AESTHETIC TREATMENT NOT SHOWN)



BAR LEGEND

WALL HEIGHT (FT)	A	B	BAR NAME
10	3	4 5/8"	EA06
12	3	4 5/8"	EA06
14	3	4 5/8"	EA06
16	4	3 1/8"	EA06
18	4	3"	EA07
20	4	3"	EA07

POST BAR TABLE



PRECAST CONCRETE POST ELEVATION

(LAYING HORIZONTAL)

* ADJUST SPACING TO FIT ED03 BARS

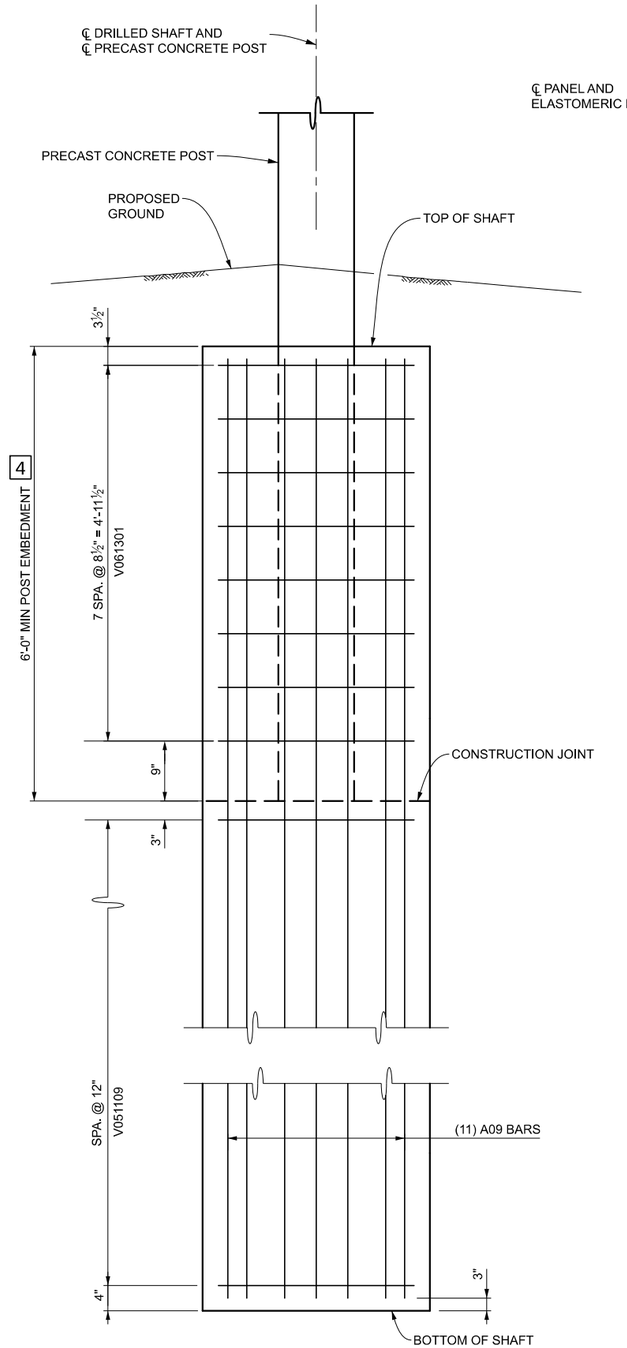
FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

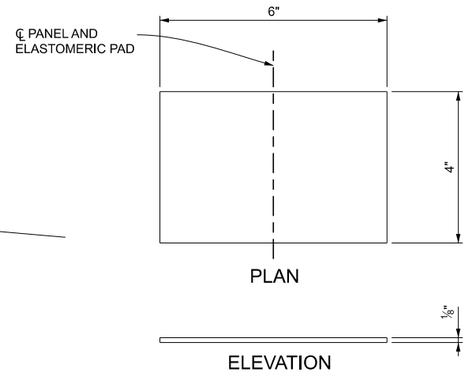
NO SCALE

DRAWING BY:		DATE:	CS: YYYYY	NOISE BARRIER WALL DETAILS
CHK'D BY:	CORR BY:	DESIGN UNIT:	JN:	NW-XXXXXX OF YYYYY
FILE: NW_DET005_2024-08-22.dgn		TSC:		

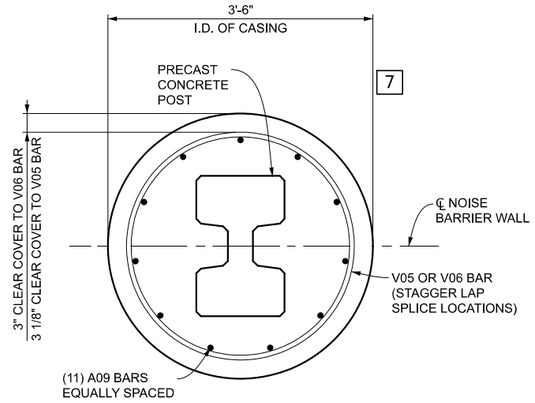
DRAWING	SHEET
NW DET 005	SECT 1



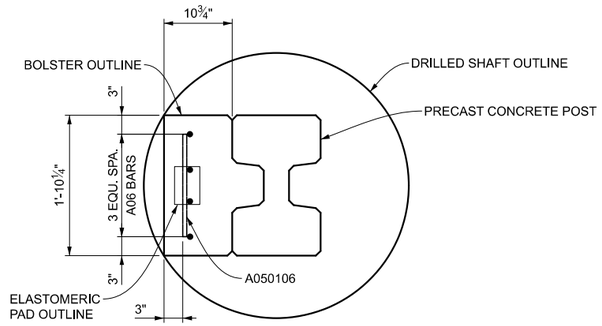
TYPICAL DRILLED SHAFT ELEVATION



ELASTOMERIC PAD DETAILS

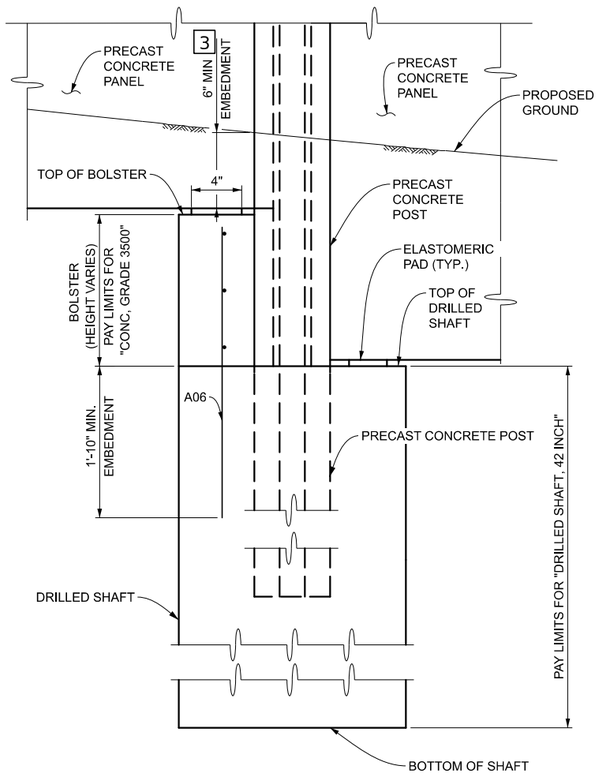


TYPICAL SECTION THRU DRILLED SHAFT



TOP VIEW

(DRILLED SHAFT REINFORCEMENT NOT SHOWN)



DETAIL A

13

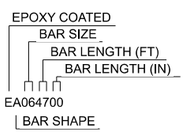
STEEL REINFORCEMENT									
	BAR	DIMENSIONS						NO. REQ'D	TOTAL WEIGHT
		a	b	c	d	e	f		
DRILLED SHAFTS	A091306	13'-6"						11	505
	A091506	15'-6"						11	580
	V051109	9'-5"	2'-4"	1'-5¼"				17	208
	V061301	9'-6"	3'-7"	1'-5¼"				8	157
							SUBTOTAL:		1450
BOLSTERS	A05106	1'-6"						8	13
	A060301	3'-1"						4	19
	A060401	4'-1"						4	25
							SUBTOTAL:		57
							TOTAL:		1507

13

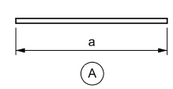
SHAFT LENGTH	VERTICAL BAR
14'-0"	A091306
16'-0"	A091506

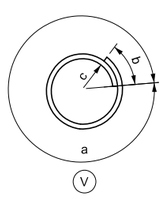
13

BOLSTER HEIGHT RANGE	VERTICAL BAR
0" < HEIGHT < 1'-6"	A060301
1'-6" ≤ HEIGHT < 2'-6"	A060401



BAR LEGEND





12

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

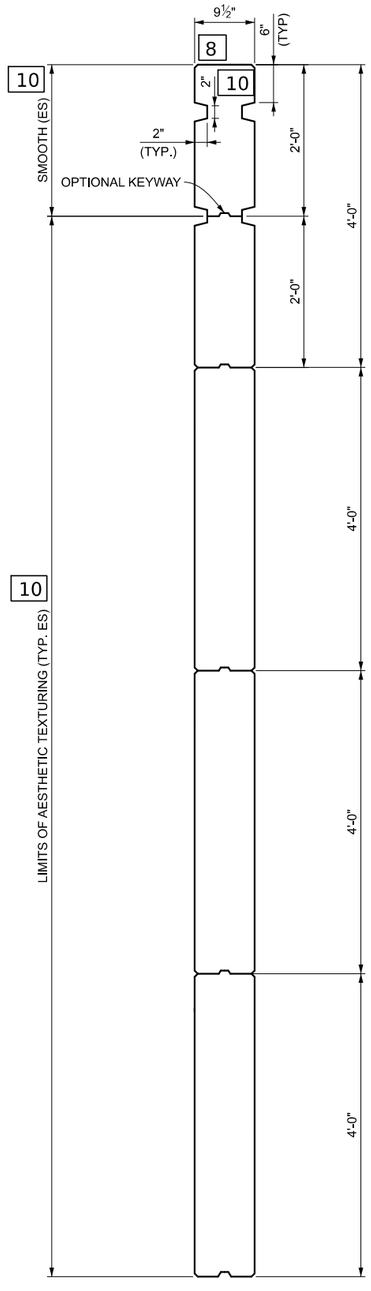
NO SCALE

DRAWING BY:		DATE:	CS: YYYYY
CHK'D BY:	CORR BY:	DESIGN UNIT:	JN:
FILE: NW_DET006_2024-08-22.dgn		TSC:	

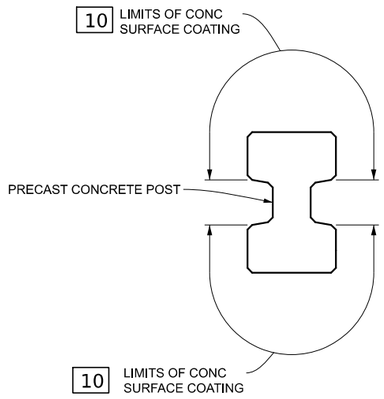
NOISE BARRIER WALL DETAILS

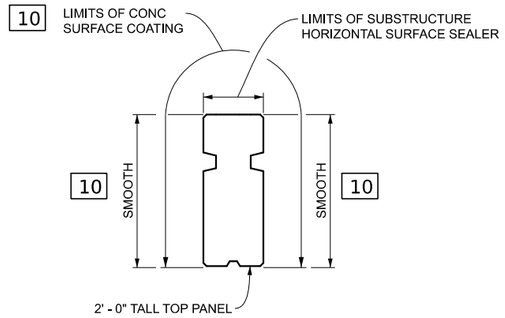
NW-XXXXXX OF YYYYY

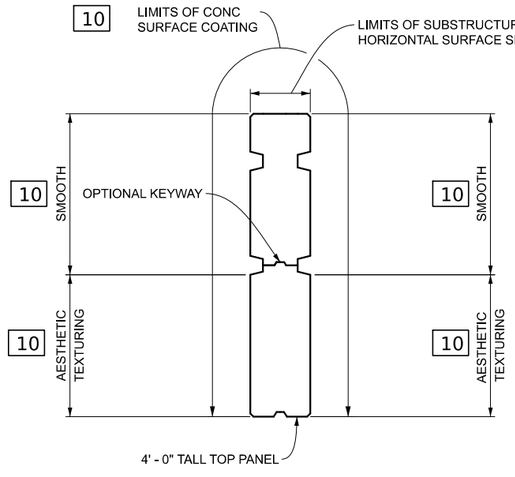
DRAWING	SHEET
NW DET 006	SECT 1

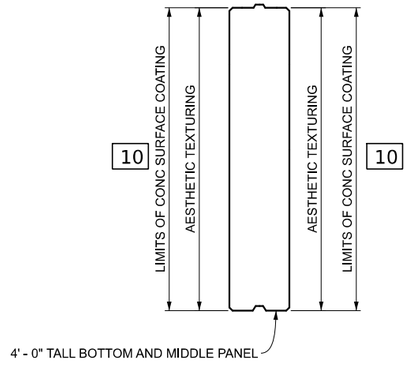


TYPICAL SECTION THROUGH PANELS 10









10

NOTES:

APPLY CONCRETE SURFACE COATING TO ALL EXPOSED PORTIONS OF POSTS INCLUDING TOP OF POSTS AND ALL EXPOSED PORTIONS OF PANELS.

APPLY SUBSTRUCTURE HORIZONTAL SURFACE SEALER TO THE TOP OF ALL POSTS AND THE TOP OF ALL PANELS. DO NOT ALLOW HORIZONTAL SURFACE SEALER TO DRIP OR RUN ONTO VERTICAL SURFACE OF POSTS OR PANELS.

APPLY SUBSTRUCTURE HORIZONTAL SURFACE SEALER BEFORE CONCRETE SURFACE COATING.

12

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS: YYYYY	NOISE BARRIER WALL DETAILS
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-XXXXXX OF YYYYY
FILE: NW_DET007_2024-08-22.dgn	TSC:		

DRAWING	SHEET
NW DET 007	SECT 1

TEST HOLE NO. SWB-01

LOCATION: US-23 SB/I-96 WB RAMP EMBANKMENT

PHYSICAL REFERENCE: 1640 FT. NORTH OF I-96 WB
PHYSICAL OFFSET: 80 FT. WEST OF RAMP FROM US-23 SB TO I-96 WB RT EOM

STATION: 1758+46.88 (NB US-23)
STATION OFFSET: 604.02 FEET WEST

BORING DATE: 12/17/21 NORTHING: 376009
GROUND SURFACE ELEVATION: 1008.8 FT EASTING: 13288416

1008.8		APPROXIMATELY 7 INCHES OF SANDY BROWN TOPSOIL.
1008.2	2 1 2	
1007.8		FILL • VERY LOOSE TO LOOSE POORLY GRADED FINE SAND WITH SILT, TRACE ROOTS, TRACE GRAVEL, BROWN, MOIST (SP-SM)
1005.3	2 2 3	
1002.8	16 24 28	FILL • VERY DENSE SILTY FINE SAND WITH CLAY, WITH GRAVEL, BROWN, MOIST (SM)
1000.3	39 29 27	
998.8		MEDIUM DENSE TO LOOSE POORLY GRADED FINE SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)
995.3	5 8 9	
990.3	2 2 3	MEDIUM DENSE POORLY GRADED FINE TO COARSE SAND WITH GRAVEL, TRACE SILT, BROWN, MOIST (SP)
985.3	7 12 11	
980.3		MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)
979.8	8 11 15	
975.3	11 15 21	DENSE POORLY GRADED FINE SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)
973.8		END OF TEST HOLE AT 35 FT.

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: R. CALKINS (SOMAT)
- CHECKED BY: J. ABADIR/J. SCHMITZER (SOMAT)
- DRILL RIG: CME 55 ATV (RIG 3799935; ER=83.0%)
- METHOD: 2 1/4 INCH HSA
- COORDINATES AND GROUND SURFACE ELEVATION FROM PROJECT SURVEYOR

TEST HOLE NO. SWB-02

LOCATION: US-23 SB/I-96 WB RAMP EMBANKMENT

PHYSICAL REFERENCE: 1410 FT. NORTH OF I-96 WB
PHYSICAL OFFSET: 73 FT. WEST OF RAMP FROM US-23 SB TO I-96 WB RT EOM

STATION: 1756+23.37 (NB US-23)
STATION OFFSET: 706.66 FEET WEST

BORING DATE: 12/17/21 NORTHING: 375778
GROUND SURFACE ELEVATION: 1004.8 FT EASTING: 13288332

1004.8		APPROXIMATELY 8 INCHES OF SANDY BROWN TOPSOIL.
1004.1	2 2 2	
1003.8		FILL • VERY LOOSE CLAYEY FINE SAND, TRACE GRAVEL, OCCASIONAL TOPSOIL LAYERS WITH ROOTS, BROWN, MOIST (SC)
1001.8		
1001.3	2 2 2	FILL • VERY LOOSE SILTY FINE SAND, TRACE CLAY, TRACE ROOTS, TRACE GRAVEL, BROWN, MOIST (SM)
998.8	6 8 13	
996.3	7 9 11	MEDIUM DENSE TO VERY DENSE POORLY GRADED FINE SAND, FEW GRAVEL, TRACE SILT, OCCASIONAL FINE TO MEDIUM SAND LAYERS, BROWN, MOIST (SP)
991.3	9 14 20	
986.3	10 18 20	
981.3	17 24 29	
976.3	16 25 24	DENSE TO VERY DENSE POORLY GRADED FINE SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)
971.3	19 29 30	
969.8		END OF TEST HOLE AT 35 FT.

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: R. CALKINS (SOMAT)
- CHECKED BY: J. ABADIR/J. SCHMITZER (SOMAT)
- DRILL RIG: CME 55 ATV (RIG 3799935; ER=83.0%)
- METHOD: 2 1/4 INCH HSA
- COORDINATES AND GROUND SURFACE ELEVATION FROM PROJECT SURVEYOR

TEST HOLE NO. SWB-03

LOCATION: US-23 SB/I-96 WB RAMP EMBANKMENT

PHYSICAL REFERENCE: 1690 FT. NORTH OF I-96 WB
PHYSICAL OFFSET: 70 FT. WEST OF RAMP FROM US-23 SB TO I-96 WB RT EOM

STATION: 1754+34.54 (NB US-23)
STATION OFFSET: 809.1 FEET WEST

BORING DATE: 12/16/21 NORTHING: 375582
GROUND SURFACE ELEVATION: 992.5 FT EASTING: 13288245

992.5		APPROXIMATELY 6 INCHES OF BROWN SANDY TOPSOIL.
992.0	2 1 2	
991.5		FILL • VERY LOOSE SILTY FINE SAND, TRACE ROOTS, TRACE CLAY, TRACE GRAVEL, RED-BROWN, MOIST (SM)
989.5		
989.0	3 7 12	FILL • MEDIUM DENSE TO LOOSE CLAYEY FINE TO MEDIUM SAND WITH GRAVEL, TRACE SILT, TRACE ROOTS, BROWN, MOIST (SC)
986.5	4 3 5	
984.0	9	DENSE POORLY GRADED FINE TO COARSE SAND WITH GRAVEL, TRACE SILT, BROWN, MOIST (SP)
983.5	15 18	
979.0	6 11 15	MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)
974.0	12 23 30	VERY DENSE POORLY GRADED FINE TO COARSE SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)
969.0	9 17 20	
964.0	16 22 22	DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)
959.0	12 17 17	
957.5		END OF TEST HOLE AT 35 FT.

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: S. SWAMINATHAN (SOMAT)
- CHECKED BY: J. ABADIR/J. SCHMITZER (SOMAT)
- DRILL RIG: CME 55 ATV (RIG 3799935; ER=83.0%)
- METHOD: 2 1/4 INCH HSA
- COORDINATES AND GROUND SURFACE ELEVATION FROM PROJECT SURVEYOR

TEST HOLE NO. SWB-04

LOCATION: US-23 SB/I-96 WB RAMP EMBANKMENT

PHYSICAL REFERENCE: 1390 FT. NORTH OF I-96 WB
PHYSICAL OFFSET: 70 FT. WEST OF RAMP FROM US-23 SB TO I-96 WB RT EOM

STATION: 1752+06.38 (NB US-23)
STATION OFFSET: 1010.62 FEET WEST

BORING DATE: 12/16/21 NORTHING: 375338
GROUND SURFACE ELEVATION: 985.3 FT EASTING: 13288063

985.3			PP MC
985.0		APPROXIMATELY 4 INCHES OF BROWN SANDY TOPSOIL.	
984.3	2 4 4		
981.8	3 3 12	FILL • LOOSE TO MEDIUM DENSE SILTY FINE SAND WITH CLAY, TRACE ROOTS, TRACE GRAVEL, RED-BROWN, MOIST (SM)	
979.3	3 7 2		
976.8	4 4 6	LOOSE TO MEDIUM DENSE POORLY GRADED FINE SAND WITH SILT, TRACE ROOTS, TRACE GRAVEL, BROWN, MOIST (SP-SM)	
971.8	8 11 13	MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP) (POSSIBLE BOULDER BETWEEN 18.5-20.5 FT.)	
966.8	11 36 50		
961.8	7 13 16	MEDIUM DENSE POORLY GRADED FINE TO MEDIUM SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)	
956.8	9 15 19	DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)	
951.8	6 9 8	VERY STIFF SANDY LEAN CLAY, TRACE GRAVEL, BROWN (CL)	3.0 11.5
950.3		END OF TEST HOLE AT 35 FT.	

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: S. SWAMINATHAN (SOMAT)
- CHECKED BY: J. ABADIR/J. SCHMITZER (SOMAT)
- DRILL RIG: CME 55 ATV (RIG 3799935; ER=83.0%)
- METHOD: 2 1/4 INCH HSA
- COORDINATES AND GROUND SURFACE ELEVATION FROM PROJECT SURVEYOR

TEST HOLE NO. SWB-05

LOCATION: US-23 SB/I-96 WB RAMP EMBANKMENT

PHYSICAL REFERENCE: 1130 FT. NORTH OF I-96 WB
PHYSICAL OFFSET: 65 FT. WEST OF RAMP FROM US-23 SB TO I-96 WB RT EOM

STATION: 1750+36.85 (NB US-23)
STATION OFFSET: 1281.8 FEET WEST

BORING DATE: 12/15/21 NORTHING: 375147
GROUND SURFACE ELEVATION: 979.6 FT EASTING: 13287806

979.6		APPROXIMATELY 7 INCHES OF BROWN SANDY TOPSOIL.	PP
979.0	2 2 2		
978.6		FILL • VERY LOOSE TO LOOSE SILTY FINE SAND, TRACE ROOTS, TRACE CLAY, TRACE GRAVEL, RED-BROWN, MOIST (SM)	
976.1	2 3 2		
973.6	5 5 6		
971.1	5 8 12	MEDIUM DENSE POORLY GRADED FINE TO MEDIUM SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)	
966.1	10 12 11		
961.1	8 12 12	MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)	
956.1	3 4 10	MEDIUM DENSE SILTY CLAYEY FINE SAND, TRACE GRAVEL, OCCASIONAL SANDY LEAN CLAY LAYERS, BROWN, MOIST (SC-SM)	<>
951.1	8 12 13	MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, BROWN, MOIST (SP)	
946.1	12 20 20	DENSE POORLY GRADED FINE TO MEDIUM SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)	
944.6		END OF TEST HOLE AT 35 FT.	

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: S. PANETTA (SOMAT)
- CHECKED BY: J. ABADIR/J. SCHMITZER (SOMAT)
- DRILL RIG: CME 55 ATV (RIG 3799935; ER=83.0%)
- METHOD: 2 1/4 INCH HSA
- COORDINATES AND GROUND SURFACE ELEVATION FROM PROJECT SURVEYOR

TEST HOLE NO. SWB-06

LOCATION: US-23 SB/I-96 WB RAMP EMBANKMENT

PHYSICAL REFERENCE: 930 FT. NORTH OF I-96 WB
PHYSICAL OFFSET: 63 FT. WEST OF RAMP FROM US-23 SB TO I-96 WB RT EOM

STATION: 1749+28.64 (NB US-23)
STATION OFFSET: 1490.34 FEET WEST

BORING DATE: 12/15/21 NORTHING: 375022
GROUND SURFACE ELEVATION: 975.3 FT EASTING: 13287607

975.3		APPROXIMATELY 6 INCHES OF BROWN SANDY TOPSOIL.
974.8	2 2 3	
974.3		FILL • LOOSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, RED-BROWN, MOIST (SM)
972.3		
971.8	4 8 10	FILL • MEDIUM DENSE POORLY GRADED FINE TO MEDIUM SAND WITH SILT, FEW GRAVEL, TRACE ROOTS, BROWN, MOIST (SP-SM)
969.3	5 7 8	
966.8	6 8 10	MEDIUM DENSE POORLY GRADED FINE TO MEDIUM SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)
961.8	9 10 7	MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)
960.3		
956.8	5 13 21	DENSE POORLY GRADED FINE TO COARSE SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)
951.8	13 18 18	
946.8	15 21 20	DENSE POORLY GRADED FINE SAND WITH SILT, TRACE GRAVEL, BROWN, MOIST (SP-SM)
941.8	18 22 22	DENSE POORLY GRADED FINE TO COARSE SAND, FEW GRAVEL, TRACE SILT, BROWN, MOIST (SP)
940.3		END OF TEST HOLE AT 35 FT.

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: S. PANETTA (SOMAT)
- CHECKED BY: J. ABADIR/J. SCHMITZER (SOMAT)
- DRILL RIG: CME 55 ATV (RIG 3799935; ER=83.0%)
- METHOD: 2 1/4 INCH HSA
- COORDINATES AND GROUND SURFACE ELEVATION FROM PROJECT SURVEYOR

0 / 0 / 0 — 1st 6 in, 2nd 6 in, 3rd 6 in, 4th 6 in

50/4"

NUMBERS IN CIRCLES DENOTE NUMBER OF BLOWS REQUIRED TO DRIVE A 2" O.D., X 1.5" I.D., SPLIT SPOON SAMPLER 3 OR 4 SUCCESSIVE 6" INCREMENTS USING A 140 LB AUTOMATIC HAMMER FALLING 30".

WHERE THE SAMPLER IS DRIVEN DISTANCES LESS THAN 6" PER INCREMENT, THE DISTANCE IS SHOWN IN THE CIRCLE WITH THE NUMBER OF BLOWS IN THE FORM OF A FRACTION.

PP = POCKET PENETROMETER, UNCONFINED COMPRESSIVE STRENGTH • TONS/SQ.FT (TSF)
UCS = LAB DETERMINED UNCONFINED COMPRESSIVE STRENGTH • TONS/SQ.FT (TSF)
TV = TORVANE SHEAR TEST, SHEAR STRENGTH • TONS/SQ.FT (TSF)
MC = MOISTURE CONTENT • (%)
DD = DRY DENSITY • LBS/CU.FT (PCF)
DCP = DYNAMIC CONE PENETRATION • (MM/BLOW)

R = ROCK CORE RECOVERY (%)
RQD = ROCK QUALITY DESIGNATION (%)
<> = DISTURBED SAMPLE

CONSISTENCY WAS DETERMINED BY INSPECTION OF SAMPLES AND SUBSTANTIATED BY SOILS RESISTANCE TO DRILLING TOOLS. UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP SYMBOL DETERMINED PER (ASTM) VISUAL-MANUAL PROCEDURES.

THE DCP INDEX IS REPORTED AT DEPTHS EXHIBITING DISTINCT CHANGES IN SLOPE ON A PLOT OF CUMULATIVE PENETRATION VS. NUMBER OF BLOWS. EACH DCP INDEX REPRESENTS THE AVERAGE PENETRATION PER BLOW FOR THE SOIL BELOW THAT POINT. "ETD" = END TEST DEPTH.

GROUNDWATER LEVELS REPRESENT THE CONDITIONS AT THE TIME THE MEASUREMENTS WERE OBTAINED AND SHOULD BE EXPECTED TO FLUCTUATE THROUGHOUT THE YEAR. GROUNDWATER LEVELS MAY ALSO BE INFLUENCED BY RESIDUAL BORING WATER.

THE SOIL BORING LOGS REPRESENT POINT INFORMATION. PRESENTATION OF THIS INFORMATION IN NO WAY IMPLIES THAT SUBSURFACE CONDITIONS ARE THE SAME AT LOCATIONS OTHER THAN THE EXACT LOCATION OF THE BORING.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS: 39002	SOIL BORING DATA	DRAWING	SHEET
CHK'D BY: CORR BY:	DESIGN UNIT:	JN:	NW-000001 OF 39002	NW BORING 001	SECT 1
FILE: R03_R04_39022_BORING_002.dgn	TSC:				

NOISE BARRIER WALL DETAILS

1. Use 20' post spacing wherever possible. Spacing may be adjusted to avoid utility conflicts or underground obstructions. It is desirable to minimize the number of different post spacings within a project.

2. Earth berms should be constructed with a 2’ bench sloping at 5% away from the wall.

3. Bottom panels shall be buried a minimum of 6" and designed to retain 2'-0" of soil.

4. Posts should be embedded a minimum of 6'-0" into foundations. Details with base plates and anchor bolts are prohibited.

5. Adjust details to show drainage features in the vicinity of the noise barrier walls. The proposed ditch shown is only a placeholder.

6. Panels should be laid out so that their centerline does not deviate more than 6-degrees from the centerline of post.

7. All reinforcement provided in elements above ground shall be epoxy coated. Reinforcement provided in buried wall elements may be left uncoated.

8. Flat or nearly flat surfaces should be formed for the top of post and top panels.

9. Form liners are to be applied to panels only, specified lining must be consistent throughout project. Liners should be stopped 6" minimum short of the top edge of panels. Liner treatments shall be limited to a maximum depth of 2" per side of panel and left 4" short of each end of the panel.

10. Adjust all aesthetic details shown on all sheets to meet project aesthetic requirements (these sheets only show placeholder details). Provide additional sheets if necessary to show all aesthetic details needed to fabricate the posts and panels.

11. Expand and adjust these sections as necessary to show the required grading, ROW, consent to grade, and other notable features adjacent to the noise barrier wall.

12. CAD files for these drawings should be downloaded from this link and adjusted as needed: xxxxxx

13. Provide tables for drilled shaft and bolster reinforcement. When projects require multiple shaft and/or bolster heights, provide tables to specify which bars are needed for a given shaft length or bolster height range.

SOIL BORING DATA

1. Soil borings must be located with station-offsets and/or state plane northing and easting coordinates. Preferably both are shown.

Show soil boring locations on the noise barrier wall plan and profile sheets.

If there is any soil shear data it shall be shown on this sheet.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

DRAWING BY:	DATE:	CS:	NOISE BARRIER WALL PLAN GUIDELINES	DRAWING SHEET
CHK'D BY:	DESIGN UNIT:	JN:		SECT 1
FILE:	TSC:			

OVERHEAD SIGN STRUCTURES DESIGN GUIDELINES

CS: Statewide

MICHIGAN OVERHEAD SIGN STRUCTURES
DESIGN GUIDELINES

INDEX

3.01

INTRODUCTION

This guidance text addresses procedures involved in the design and plan preparation of overhead sign structures on the interstate/freeway, arterial, collector, and local road system governed by the Michigan Department of Transportation (MDOT). It includes cantilever and truss supported signs and bridge-mounted signs.

A major portion of this text is devoted to structure type design and placement considerations. Other sections provide guidance on foundation types and fabrication process. In general, the Overhead Sign Structures Design Guidelines is intended to be a single source reference for the MDOT Design Engineers and consultants responsible for incorporating overhead sign structures on highway design projects.

The design of overhead sign structures in Michigan is based on the **MDOT Standard Specifications for Construction** and **AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (AASHTO LRFDLTS)**. However, it is understood that sometimes adaptations and deviations may be necessary as these publications can be vague or leave decisions up to the judgement of the Engineer.

As procedures and guidelines change, the Overhead Sign Structures Design Guidelines will be continually updated to keep the text as current as possible. These updates will describe the revision, explain the reason, serve as commentary, and assign the date of its implementation.

3.01.01

References

A. Standard Specifications for Construction (SSC), MDOT

B. Sign Support Standard Plans and Special Details, MDOT

C. AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (AASHTO LRFDLTS)

D. Michigan Manual on Uniform Traffic Control Devices (MMUTCD)

E. Guidelines for Signing on State Trunkline Highways, MDOT

F. Road Design Manual, MDOT

G. Geotechnical Manual, MDOT

H. Bridge Design Manual, MDOT

I. Traffic Sign Design, Placement, and Application Guidelines, MDOT

J. Real Estate Procedure Manual, MDOT

3.01.02

Abbreviations and Definition of Terms

When the following abbreviations are used in the guidance text, they have the meanings listed below.

AASHTO.....American Association of State Highway and Transportation Officials

BOBS.....Bureau of Bridges and Structures (MDOT)

DMS.....Dynamic Message Sign

MICHIGAN OVERHEAD SIGN STRUCTURES
DESIGN GUIDELINES

FHWA..... Federal Highway Administration

LRFD..... Load and Resistance Factor Design

MASH..... Manual for Assessing Safety Hardware

MDOT..... Michigan Department of Transportation

MMUTCD…… ..... Michigan Manual on Uniform Traffic Devices

PPDM..... Preconstruction Process Documentation Manual

ROW..... Right-of-Way

Appurtenances - A miscellaneous device or attachment mounted to a structure that can include signs, antennas, and other devices.

Cantilever - A cantilever structure consists of a rigid structural element extending above the roadway supported only at one end.

Clear Zone - The unobstructed, traversable roadside area provided beyond the edge of the through traveled way that allows a driver to stop safely or regain control of a vehicle that has left the roadway.

Deflection - The degree to which a part of a structural element is displaced (typically under a load).

Ground Mounted - Supported directly on foundations extending into the soil (not mounted on a bridge, retaining wall or other type of structure).

Right-of-Way (ROW) - The entire area reserved for the construction, operation, and maintenance of the roadway and the improvement of the roadside such as landscaping, sidewalks, pathways, or transit stops. ROW will either be free access or limited access. Limited access ROW is when the inherent right of access to a public highway by the abutting owner or occupant is acquired along with the title to the ROW.

Roadside - Portion of the right-of-way outside of the footprint of the roadway.

Truss - A truss structure consists of a rigid structural element spanning across the roadway with supporting columns at both ends.

Bridge-Mounted – Supported by brackets directly mounted to the sides of grade separated highway bridges over the underpass roadway.

3.02

OVERHEAD SIGN STRUCTURE SITE PLANNING

Site planning of overhead sign structures must follow and account for specifications outlined in the **MDOT Road Design Manual, MMUTCD, MDOT Guidelines for Signing on State Trunkline Highways,** and the **MDOT Traffic Sign Design, Placement, and Application Guidelines.**

Specifications for the design and construction of structural supports for signs have been standardized by **AASHTO.** Bridges in sufficient condition often serve as the support structure for overhead signs. In some cases, they may be the only practical location that will provide adequate sight distance. Use bridge structures as sign supports to eliminate the need for additional sign supports and foundations along the roadside. The designer must conduct a field review with the **MDOT Signing Unit** and the **Region Bridge Engineer** to evaluate the selection and use of bridge-mounted signing. Refer to **Section 3.04.02** for details regarding bridge-mounted signs.

Determine if roadside signs will serve traffic needs before considering the use of overhead signs. Clear zone guidelines must be considered when evaluating the need for overhead signing. Factors justifying the installation of overhead signs are given in **Section 3.02.03**.

3.02.01

Project Scoping and Survey

Understanding the project scope is critical for the Engineer to establish what deliverables (e.g., permits, easement acquisition, design exceptions, etc.) are required. To ensure consistency across projects, the Engineer must follow the scoping process provided by the **MDOT PPDM Task Series 2100 – EPE Scoping Analysis through Series 2800 – Contamination Investigation**.

Proper survey, specifically those related to the structures and roadway, is critical to ensure a project can provide what has been scoped. The Engineer must review **MDOT PPDM Task Series 3100 – Scope Verification through Series 3600 – Utilities/Railroad** before survey takes place so that consistent and thorough survey can be prescribed.

3.02.02

Overhead Sign Use Cases

Use overhead sign structures to support guide signs on freeways and expressways depending on traffic control needs, the size of sign required, roadway location, and many other considerations. Refer to the **MMUTCD** for a list of conditions that require an overhead sign.

The principal applications for overhead sign structures are on multilane heavily traveled highways. Place signs directly over the travel lanes to which they apply to assist in increasing communications with the driver. Use overhead signs on freeways, at locations where some degree of lane use control is desirable, and at locations where space is not available on the roadside. Before placing a W-series post-mounted sign in an overhead position, consider the upstream configuration of signing and a ground mounted placement. If ground mounting of the W-series cannot be done at an upstream location, please contact the **MDOT Signing Unit**.

A. General Use Cases:

1. Where the message is applicable to a particular lane(s) over which the sign is placed and where lane use can be made significantly more effective.

2. Where traffic or roadway conditions are such that an overhead mounting is necessary for adequate visibility (e.g., vertical or horizontal curvature, closely spaced interchanges, three or more through lanes in one direction etc.).

3. At, or just in advance of, a divergence from a heavily traveled roadway (e.g., at a ramp exit where the roadway becomes wider, and a sign on the right side is usually not in the line of sight for the driver).

4. Where there is no space for signs at the side of the roadway (e.g., where narrow right-of-way does not provide adequate width for a sign installation).

5. Where ground-mounted placement would create an undue roadside hazard.

6. Where, because of hazardous conditions, particularly effective guidance is needed for the unfamiliar driver.

3.02.03

Overhead Sign Considerations and Requirements

The following sections describe situations to consider overhead signs and cases where their use is required. Subsequent sections outline which types of overhead signs to use.

A. Considerations

The operational requirements of our present highway system are such that overhead signs will have value at many locations. The factors justifying the erection of overhead sign displays are not definable in specific numerical terms, but the following conditions may be considered:

1. Exit only lanes

2. Left exit ramps

3. Traffic volume at or near capacity

4. Complex interchange design (double exits)

5. Three or more lanes in each direction

6. Restricted sight distance (ramp deceleration lanes located over crest vertical curves)

7. Closely spaced interchanges

8. Multi-lane exits

9. Large percentage of trucks

10. Street lighting background

11. High speed traffic

12. Consistency of sign message location through a series of interchanges

13. Insufficient space for ground mounted signs

14. Junction of an Interstate route with another freeway (lane assignments)

15. Deficient Bridges (see **MDOT Highway Bridge Safety website**) for bridge-mounted signs.

B. Requirements

Other than what is a standard in the **MMUTCD**, the existence of any one or more of the factors does not automatically justify the use of overhead signs. Some of the factors listed above can be made less critical by close coordination between design and operation.

Overhead signing is required per the **MMUTCD** for the following situations/sign types:

1. Overhead Arrow per Lane or Diagrammatic Guide Signs at Major Interchanges

2. Pull Through Signs

3. Interchange Lane Drops

4. Interchange Sequence Signs in the Median

5. Freeway to Freeway – 1 Mile Advance and at theoretical gore

6. Cloverleaf – At theoretical gore for first exit ramp and Advance Guide sign for second ramp

If a Region/TSC Traffic and Safety Representative desires to pursue overhead signing for a specific location(s), conduct a joint field investigation with **MDOT Signing Unit** and Region/TSC personnel to determine final signing requirements.

3.02.04

Design Considerations

If it has been determined that an overhead sign installation is required, then criteria for overhead sign structure selection may include cost, sign layout, roadway characteristics, site-specific factors, and more.

Most bridge-mounted sign connections are significantly lower in cost than standalone overhead sign structures. Design and placement of a truss or cantilever in front of a bridge structure is least desirable but are options based on deficient bridge conditions.

The size and number of guide signs are the principal factors that determine the type of overhead sign structures to choose from. The following is a list of common structures for consideration based on in-depth field review and location availability:

A. Truss

Used for more than one sign per location. Use **Type E** (**Type C and D** are for maintenance use only, not permitted in new projects).

B. Bridge-Mounted

Used if there is a suitable structure available in approximate location for sign replacement. See **Section 3.04.02** for information on bridge-mounted sign structures.

C. Cantilever

Used when previous alternatives are cost prohibitive (trusses) or are not applicable. Use **Type E**, (**Type J** for special conditions, ex. poor soil conditions, if multiple signs needed, but truss is not possible, or other adverse conditions).

3.02.05

Aesthetics

In order to limit confusion for roadway users, signage is specifically designed for simplicity and uniformity, as outlined in the **MMUTCD** and the **MDOT Guidelines for Signing on State Trunkline Highways**. No coatings or painting of sign structures, except for hot dip galvanizing, are allowed. Refer to **MDOT Standard Specifications of Construction** to determine allowed sign support material and **MDOT Sign Support Standard Plans and Special Details** to determine the appropriate sign structure design.

3.02.06

Appurtenances

A. Signs

Refer to the current **MDOT Sign Support Standard Plan SIGN-700-Series** for connection details.

B. Dynamic Message Signs

Consider the attachment of small dynamic message signs to overhead sign structures for specific purposes such as flex lane assignments. Typically, the standard **Truss, Type E** trusses are used for this purpose. The designer must consult with the **MDOT Signing Unit** to determine the appropriate support for these signs. Minor sign attachment modifications and additional electrical requirements will be necessary. Refer to Chapter 6 of these guidelines for information regarding design of dynamic message sign structures.

C. Others

Although not common practice, several additional appurtenances may be added to sign structures such as cameras, sensors, and radios. Any appurtenances not shown on the **MDOT Standard Plans** and **MDOT Special Details** have not been accounted for in design. The designer must submit structural calculations sealed by a Professional Engineer who is licensed in the State of Michigan addressing the extra weight and effective projected area of the appurtenances.

3.03

OVERHEAD SIGN STRUCTURE PLACEMENT

3.03.01

Placement

The placement and clearance of sign structures must follow what is outlined in the **MMUTCD**. If the placement requires attachment to an existing structure, the feasibility of this placement must be discussed with the **MDOT Ancillary Structures Program**, the **MDOT Signing Unit**, and **MDOT BOBS** if attaching to a bridge. Special permission must be obtained for any deviations.

3.03.02

Clear Zone

It is desirable to place structures outside of the clear zone if possible, however this is typically not feasible for overhead sign structures. Install protective measures such as barrier or guardrail when placing overhead sign structures within the clear zone. Refer to Chapter 7 of the **MDOT Road Design Manual** for current clear zone criteria and more information regarding barrier and guardrail placement.

Coordinate with MDOT on the future changes in the clear zone for highway expansion before finalizing sign structure placement.

3.03.03

Utility Coordination

Compile existing utility information as part of the base plan phase. Avoid utility impacts when possible. If signing work will impact site utilities, additional coordination with utility owners will be needed.

Include notes in the design plans to emphasize the contractor's responsibility to locate utilities and provide the preferred clearances of the utility owner prior to construction.

3.03.04

Right-of-Way Coordination

Place overhead sign structures within the ROW wherever possible. Coordinate with **MDOT Region Real Estate** staff early in the project schedule to determine real estate needs and impacts to the project schedule. Any temporary work outside the ROW requires a legal agreement such as a Consent or Temporary Construction Easement. The **Real Estate Services Section** of the **Development Services Division** or **Region Real Estate** will determine just compensation for the agreement which is offered to the property owner. Permanent ROW acquisition may also need to be considered. Review Chapter 16 of the **MDOT Real Estate Procedure Manual** for more details on ROW considerations during design.

3.04

STRUCTURAL DESIGN

Early in the design process, determine if any deviation from the **MDOT Standard Plans** and **MDOT Special Details** may be necessary. The current cantilever and truss support structures are designed in accordance with **AASHTO LRFDLTS** for infinite fatigue life and any modifications must meet these requirements. Any modifications must be approved by the **MDOT Signing Unit** and **MDOT Ancillary Structures Program**. This includes any new structures as well as any modifications to existing structures.

3.04.01

Foundation Types

Review historic structure borings before new borings are obtained. New soil borings must be obtained in accordance with the requirements in the **MDOT Geotechnical Manual.**

A. Drilled Shafts

Drilled shafts serve as the standard foundation type for overhead sign structures. Standard designs are provided in the **MDOT Standard Plans** and **MDOT Special Details.**

B. Spread Footings

Spread footings may be used when utility conflicts exist or when other site considerations may dictate. The designer must coordinate with the **MDOT Signing Unit.**

3.04.02

Bridge-Mounted Sign Structures

A field review is required for all bridge-mounted signs and the designer must coordinate with the **MDOT Signing Unit**, the **MDOT Region Bridge Engineer**, and **MDOT BOBS**.

Use bridge-mounted signs if there is a suitable structure available in approximate location for sign replacement. The primary selection factor is the beam type and material. The following bridge beams call for specific bridge sign connection types for upgrades (see **Appendix A – MDOT Bridge Sign Connection Cheat Sheet**).

A. Beams- Steel

1. **SIGN-800-Series** (Type B)
2. **SIGN-820-Series** (Types F & G)
3. **SIGN-830-Series** (Types H, I & J)

B. Beams- Concrete

1. **SIGN-800-Series** (Types A1 & A2)
2. **SIGN-810-Series** (Types C, D, &E)
3. **SIGN-850-Series** (Types K, L & M)
4. **SIGN-870-Series** (Types O, P & Q)
5. **SIGN-880-Series** (Types R, S & T)
6. **SIGN-890-Series** (Types U, V & W)

The principal design application for the bridge sign connections listed above is to replace the existing supports to accommodate larger signs, based on the new sign sizes. Newly built bridges with beams greater than 36 inches are excellent structures for considering new-style bridge sign connections.

Existing steel beam bridges with bridge sign connections must be carefully inspected for maintenance replacement. Ideally, the beam has been determined sufficient to receive a new set of bolt holes to replace the existing bridge sign connection. In some cases, a new set of bolt holes is not desirable per MDOT policy specifically for railroad and pedestrian structures. Replace the existing bridge sign connections on these structures utilizing existing bolt holes.

The following bridge sign connections are for Maintenance purposes only:

C. 4-Bolt Pattern

1. **SIGN-821-Series** (Types C & D)
2. **SIGN-831-Series** (Types E & F)

D. 6-Bolt Pattern

1. **SIGN-898-Series** (Types C & D)
2. **SIGN-899-Series** (Types E & F)

Existing Concrete beam bridges with bridge sign connections must be carefully inspected. Non-standard concrete bridge sign connections must be replaced with the current design standards, which utilizes concrete railings and fascia in good condition. Where a concrete bridge is being considered for a bridge sign connection, the concrete surface must be free of defects, deformation, missing chunks or other undesirable characteristics. In some circumstances, the existing bridge sign connection may be retained. The use of existing concrete holes is not permitted.

E. Re-Use of Steel Bridge Beam Connections

Where there is a need to reuse the bolt holes from a bridge mounted sign in a steel bridge girder, use the **AASHTO LRFDLTS** compliant standards, **SIGN-820-Series** and **SIGN-830-Series** in select cases with some modifications. The modifications have been published as **SIGN-825-Series** and **SIGN-835-Series**

The designer must first verify that the capacity of the existing beam is sufficient to support the new sign. Consult with the **MDOT Signing Unit**, the **MDOT Ancillary Structures Program**, and **MDOT BOBS** in these cases. Where applicable, use the following standards to reuse bridge girder bolt holes with **AASHTO LRFDLTS** compliant standards.

1. For reuse of bolt holes from **SIGN-820-Series**, use **SIGN-825-Series**.
2. For reuse of bolt holes from **SIGN-830-Series**, use **SIGN-835-Series**.

3.04.03

Salvaging Existing Sign Structures and Foundations

Evaluate overhead sign supports and foundations for salvaging and re-use if certain conditions are met. Typically, this involves evaluation of existing condition, age, structure type, foundation type, specific details, and more.

Due to cost, reuse **Truss, Type E**, and **Cantilever, Type J**, structures whenever possible. If no re-use is possible, evaluate salvaging for maintenance purposes.

Strongly consider the reuse of foundations when part of a road project.

The Engineer must coordinate salvaging and reuse of any overhead sign structure or foundation with the **MDOT Signing Unit** and **MDOT Ancillary Structures Program**.

3.04.04

Overhead Sign Structures Mounted to Other Structures

A unique design is required when mounting overhead signs to retaining walls, noise barriers, or bridges. Consult with the **MDOT Signing Unit**, the **MDOT Ancillary Structures Program**, and **MDOT BOBS** in these cases. In addition, when truss foundations are mounted to walls, barriers, and bridges, consideration must be given to the potential differential movement of the two foundations. Mounting a truss with foundations attached to two separate bridges is not permitted.

3.05

FABRICATION

3.05.01

Shop Drawing Review Process

MDOT's Shop Drawing Review Process must be followed when the Engineer receives shop drawings from a fabricator. This ensures that responsibilities have been properly coordinated and consistency is provided between all parties performing the reviews.

3.05.02

Fabrication Schedule

The fabrication of overhead sign structures is completed off-site at numerous facilities. Acquisition of materials and fabrication may take six months or more from award to on-site delivery. Consult with the **MDOT Signing Unit** and the **MDOT Structural Fabrication Unit** for questions regarding schedules and progress clauses.

MICHIGAN OVERHEAD SIGN STRUCTURES
DESIGN GUIDELINES

APPENDIX A – MDOT BRIDGE SIGN CONNECTION CHEAT SHEET

	Pay Item	Description	Standard	Width	Height	Angle	# of Columns	Comments	Connection Surface
	8100020	Bridge Sign Connection, Bolt Replacement							
Concrete Surface	8100031	Bridge Sign Connection, Conc, Type A1	800	6 - 12	0 - 2.5	0 - 40	n/a		Deck Fascia
	8100032	Bridge Sign Connection, Conc, Type A2	800	6 - 12	0 - 2.5	0 - 40	n/a		T-Beams or Conc Barriers
	8100033	Bridge Sign Connection, Conc, Type C	810	0 - 22	0 - 20	0 - 40	2 Columns		Prestressed Conc I-beam
	8100034	Bridge Sign Connection, Conc, Type D	810	0 - 40	0 - 20	0 - 40	3 Columns		Prestressed Conc I-beam
	8100035	Bridge Sign Connection, Conc, Type E	810	0 - 40	0 - 20	0 - 40	4 Columns		Prestressed Conc I-beam
	8100037	Bridge Sign Connection, Conc, Type K	850	0 - 22	0 - 20	0 - 40	2 Columns	Area<190	Conc T-beam
	8100038	Bridge Sign Connection, Conc, Type L	850	0 - 40	0 - 20	0 - 40	3 Columns	Area<300	Conc T-beam
	8100039	Bridge Sign Connection, Conc, Type M	850	0 - 40	0 - 20	0 - 40	4 Columns	Area<370	Conc T-beam
	8100040	Bridge Sign Connection, Conc, Type O	870	0 - 22	0 - 10	0 - 40	2 Columns	Area<200	Prestressed I-beam
	8100041	Bridge Sign Connection, Conc, Type P	870	0 - 40	0 - 10	0 - 40	3 Columns	Area<300	Prestressed I-beam
	8100042	Bridge Sign Connection, Conc, Type Q	870	0 - 40	0 - 10	0 - 40	4 Columns	Area<380	Prestressed I-beam
	8100043	Bridge Sign Connection, Conc, Type R	880	0 - 22	0 - 10	0 - 40	2 Columns	Area<200	Side by Side Box Beam
	8100044	Bridge Sign Connection, Conc, Type S	880	0 - 40	0 - 10	0 - 40	3 Columns	Area<340	Side by Side Box Beam
	8100045	Bridge Sign Connection, Conc, Type T	880	0 - 40	0 - 10	0 - 40	4 Columns	Area<380	Side by Side Box Beam
	8100046	Bridge Sign Connection, Conc, Type U	890	0 - 22	0 - 10	0 - 40	2 Columns	Area<200	Spread Box Beam
	8100047	Bridge Sign Connection, Conc, Type V	890	0 - 40	0 - 10	0 - 40	3 Columns	Area<300	Spread Box Beam
	8100048	Bridge Sign Connection, Conc, Type W	890	0 - 40	0 - 10	0 - 40	4 Columns	Area<380	Spread Box Beam
Steel Surface	8100061	Bridge Sign Connection, Steel, Type B	800	6 - 12	0 - 2.5	0	n/a		
	8100062	Bridge Sign Connection, Steel, Type C (old type)	821	0 - 22	0 - 20	0	2 Columns	4 bolts on top	
	8100063	Bridge Sign Connection, Steel, Type D (old type)	821	0 - 40	0 - 20	0	3 Columns	4 bolts on top	
	8100062	Bridge Sign Connection, Steel, Type C (old type)	898	0 - 22	0 - 20	0	2 Columns	6 bolts on top	
	8100063	Bridge Sign Connection, Steel, Type D (old type)	898	0 - 40	0 - 20	0	3 Columns	6 bolts on top	
	8100064	Bridge Sign Connection, Steel, Type E (old type)	831	0 - 22	0 - 20	5 - 40	2 Columns	4 bolts on top	
	8100065	Bridge Sign Connection, Steel, Type F (old type)	831	0 - 40	0 - 20	5 - 40	3 Columns	4 bolts on top	
	8100064	Bridge Sign Connection, Steel, Type E (old type)	899	0 - 22	0 - 20	5 - 40	2 Columns	6 bolts on top	
	8100065	Bridge Sign Connection, Steel, Type F (old type)	899	0 - 40	0 - 20	5 - 40	3 Columns	6 bolts on top	
	12SPB10(H)	Bridge Sign Connection, Steel, Modified, Type F	820	0 - 22	0 - 20	0 - 40	2 Columns	New Type F	Web less than 36"
	8100326	Bridge Sign Connection, Steel, Type G	820	0 - 40	0 - 20	0 - 40	3 Columns		Web less than 36"
	8100327	Bridge Sign Connection, Steel, Type H	830	0 - 22	0 - 20	0 - 40	2 Columns		Web greater than 36"
	8100328	Bridge Sign Connection, Steel, Type I	830	0 - 40	0 - 20	0 - 40	3 Columns		Web greater than 36"
	8100329	Bridge Sign Connection, Steel, Type J	830	0 - 40	0 - 20	0 - 40	4 Columns		Web greater than 36"
Removals	8100015	Bridge Sign Connection, Type A, Rem					n/a		
	8100016	Bridge Sign Connection, Type B, Rem					n/a		Steel Web Connection
	8100017	Bridge Sign Connection, Type C, Rem				0	2 Columns		
	8100018	Bridge Sign Connection, Type D, Rem				0	3 Columns		
	8100019	Bridge Sign Connection, Type E, Rem				5 - 40	2 Columns		
	8100020	Bridge Sign Connection, Type F, Rem				5 - 40	3 Columns		
							4 Columns	Pay for with 2 Type C or Type E Removals	

TRAFFIC SIGNAL STRUCTURES DESIGN GUIDELINES

CS: Statewide

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

INDEX

4.05 PLAN PREPARATION

4.01

INTRODUCTION

This guidance text addresses procedures involved in the design and plan preparation of traffic signal structures including steel strain poles, mast arm poles, and wood poles on the interstate/freeway, arterial, collector, and local road system governed by the Michigan Department of Transportation (MDOT).

A major portion of this text is devoted to design items to be investigated for every project. However, other sections provide details on plan preparation and involvement of other agencies affected by the traffic signal projects. In general, the Traffic Signal Structures Design Guidance is intended to be a single source reference for the MDOT design engineers and consultants assigned the responsibility of producing steel strain pole, mast arm pole, and wood pole plans.

The design of traffic signal structures in Michigan is based on the **MDOT Standard Specifications for Construction (MDOT SSC)** and the **AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (AASHTO LRFDLTS)**. However, it is understood that sometimes adaptations and deviations may be necessary as these publications can be vague or leave decisions up to the judgement of the Engineer. This guidance text does not focus on traffic signal head selection or traffic design. For traffic head selection and design, reference the **Michigan Manual on Uniform Traffic Control Devices (MMUTCD)**.

As procedures and guidelines change, the Traffic Signal Structures Design Guidance will be continually updated to keep the text as current as possible. These updates will describe the revision, explain the reason, serve as commentary, and assign the date of its implementation.

4.01.01

References

A. Michigan Manual on Uniform Traffic Control Devices (MMUTCD)

B. Standard Specifications for Construction (SSC), MDOT

C. Frequently Used Special Provisions (FUSPs), MDOT

D. AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LRFDLTS)

E. AASHTO LRFD Bridge Design Specifications (LRFDBDS)

F. Geotechnical Manual, MDOT

G. Preconstruction Process Documentation Manual (PPDM), MDOT

H. Michigan Ancillary Structures Inspection Manual (MiASIM), MDOT

I. Real Estate Procedure Manual, MDOT

J. Road Design Manual, MDOT

K. Traffic and Safety Standards and Special Details, MDOT

4.01.02

Abbreviations and Definition of Terms

When the following abbreviations are used in the guidance text, they have the meanings listed below.

AASHTO .....American Association of State Highway and Transportation Officials

AISC .....American Institute for Steel Construction

MICHIGAN TRAFFIC SIGNAL STRUCTURES
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FHWA ..... Federal Highway Administration

LRFD ..... Load and Resistance Factor Design

MiOSHA ..... Michigan Occupational Safety and Health Administration

MDOT..... Michigan Department of Transportation

MRI ..... Mean Recurrence Interval

POCH ..... Point of Contact Height

ROW ..... Right-of-Way

ROWPRO ..... Right-of-Way Parcel Overlay

SUE ..... Subsurface Utilities Engineering

Appurtenance – A miscellaneous device or attachment mounted to a structure that can include signs, antennas, and other devices.

Camera – A device that captures images or videos that can be mounted to a pole.

Clear Zone – The unobstructed, traversable roadside area provided beyond the edge of the through traveled way that allows a driver to stop safely or regain control of a vehicle that has left the roadway.

Deflection – The degree to which a part of a structural element is displaced (typically under a load).

Design Life – The period of time assumed in design that the structure will perform its intended function without need for major rehabilitation or replacement.

Drilled Shaft – A foundation type, constructed by placing concrete in a drilled hole with steel reinforcement.

Engineer – Person responsible for the design of the structure or review of design-related field submittals such as erection plans, or both.

Guy wire (Anchor wire) – A tensioned cable designed to reduce the effects of creep and add stability to free-standing structures.

Luminaire – A complete lighting unit consisting of a lamp or lamps together with the parts designed to provide the light, to position and protect the lamps, and to connect the lamps to an electric power supply.

Mast Arm – A steel arm attached to a mast arm pole, commonly used as a horizontal support for traffic signals and signs.

Mast Arm Pole – A cantilever structure used to hold signs, signals heads, or luminaires in an approximately horizontal position.

Right-of-Way (ROW) - The entire area reserved for the construction, operation, and maintenance of the roadway and the improvement of the roadside such as landscaping, sidewalks, pathways, or transit stops. ROW will either be free access or limited access. Limited access ROW is when the inherent right of access to a public highway by the abutting owner or occupant is acquired along with the title to the ROW.

Roadside - Portion of the right-of-way outside of the footprint of the roadway.

Sensor – A device that detects and measures changes in traffic or the environment that can be mounted to a pole.

Sign – A device conveying a specific message by means of words or symbols, erected for the purpose of regulating, warning, or guiding traffic.

Span Wire – A steel cable or strand extended between two poles, commonly used as a horizontal support for traffic signals and signs.

Traffic Signal – An electrically operated device that directs traffic to stop or proceed.

Strain Pole – A cantilever pole that utilizes anchor bolts to transfer load from the pole to a concrete foundation and often supports span wires carrying traffic signals, lighting, and other appurtenances.

Wood Pole – A pole made of wood that often supports span wires carrying traffic signals, lighting, utilities, or other appurtenances.

4.01.03

Available Design Tools

When designing an intersection, verify that existing applicable standards can be utilized for the given project. Each standard and its listed design requirements must be investigated accordingly. The design tools presented below were developed to assist designers with this process and can be found on **MDOT's Traffic and Safety Standards and Special Details website**.

A. Steel Strain Pole Tools

The requirements for standard steel strain pole design are outlined in **SIG-020, SIG-021, SIG-022,** and **SIG-023-Series** with additional guides on foundation design presented in **SIG-DESIGN-153** and **SIG-DESIGN-154-Series**. The tools for strain pole design verification are discussed below:

1. Signal Design Calculator Spreadsheet – Often referred to as the Span Calculation Program, this tool assists with facilitating a faster, more reliable signal span design procedure. Use this iterative tool to verify a given intersection's proposed design, including POCH's, stem lengths, and other design criteria presented in **SIG-020** and **SIG-022-Series**.

2. Strain Pole Foundation Worksheet – This tool provides the required drilled shaft diameter and foundation depth based on the given pole dimensions and soil type. Both the signal designer and the geotechnical designer should enter information into the tool. The criteria each foundation is evaluated against is based on **SIG-DESIGN-153-Series**.

3. Strain Pole Scoping Tool –Utilize this tool to evaluate whether existing strain poles can be retained for modernization projects like adding backplates and tethering. This tool investigates whether the proposed loading falls within the existing poles' loading envelopes.

B. Mast Arm Pole Tools

The requirements for standard mast arm pole design are outlined in **SIG-030, SIG-031, SIG-032, SIG-033,** and **SIG-040-Series** with an additional guide on foundation design presented in **SIG-DESIGN-284-Series**. The tool(s) for mast arm pole design verification are discussed below:

1. Mast Arm Design Worksheet – Use this tool to verify that the proposed configuration of signals, signs, and any other items attached to the mast arm falls within the envelope presented in MDOT special details **SIG-030, SIG-031, SIG-032, SIG-033,** and **SIG-040-Series** and to confirm that a site-specific design is not required. This must be completed for each mast arm on the project. Notify the **MDOT Ancillary Structures Program** and the **MDOT Geotechnical Services Unit** if a site-specific design is required.

4.02

TRAFFIC SIGNAL STRUCTURES SITE PLANNING

Site planning of traffic signal structures must follow and account for specifications outlined in the **MDOT Road Design Manual** and **MMUTCD.** Coordinate site planning with the **MDOT Traffic Signals Unit**.

4.02.01

Project Scoping and Survey

Understanding the project scope is critical for the Engineer to establish what deliverables (e.g., permits, easement acquisition, design exceptions, etc.) are required. To ensure consistency across projects, the Engineer must follow the scoping process provided by the **MDOT PPDM Task Series 2100 – EPE Scoping Analysis through Series 2800 – Contamination Investigation**.

Proper survey, specifically those related to ROW, utilities, sidewalks (if present), existing structures, and the existing intersection geometry, is critical to ensure a project can provide what has been scoped. The Engineer must review **MDOT PPDM Task Series 3100 – Scope Verification through Series 3300 – Base Plan Preparation** before survey takes place to prescribe a consistent and thorough survey.

4.02.02

Traffic Signal Structure Types and Selection

Various pole types and alternatives exist throughout Michigan for traffic signal structures. The design life of MDOT traffic signal mast arms and steel strain pole structures in accordance with **AASHTO LRFDLTS**, standard plans, and special details is assumed to be 50 years. The following sections provide brief information on these pole types and those that are preferred. It is best practice when designing an intersection to utilize one pole type throughout. For example, do not mix strain poles with mast arm poles.

A. Preferred and Required Pole Types

The preferred pole design in Michigan is the 6-anchor bolt steel strain pole, but mast arm poles are often used as well. Bridge-mounted poles are not common but may be used under certain circumstances. These are briefly discussed as follows:

1. 6-Anchor Bolt Steel Strain Poles – The standard 6-anchor bolt steel strain poles were designed utilizing the **AASHTO LRFDLTS** and serve as the primary option for traffic signal intersection poles. Both round and 12-sided poles are allowed with selection typically driven by the fabricator. Pole height must account for span wire sag, signal head height, required vertical clearance above roadway, a minimum of 10 feet clearance between the pole and primary and secondary overhead lines and required POCH for span wire and attachments. See **Section 4.02.06.C** for more on Vertical Clearance. The standard design of these poles is reflected in the most current traffic signal special details including **SIG-020** through **SIG-023-Series**.

Some intersections, like those in urban areas with limited right-of-way or utility conflicts, can restrict pole size and foundation size. **SIG-022** and **SIG-023-Series** were developed based on the 2020 6-anchor bolt steel strain pole design. They provide a 30-foot pole with a 36-inch drilled shaft foundation and a span length limited to 150 feet. Reference special detail **SIG-022-Series** for pole design criteria.

2. Mast Arm Poles – Mast arms provide a more rigid mounting option for traffic signals than span wire. They can be utilized as an alternative to steel strain poles to reduce the number of poles in an intersection, if longer spans are required, or to improve intersection aesthetics. In general, standard mast arm pole configurations are typically more expensive than steel strain poles but in some intersection configurations, like those utilizing double-arm

mast arms, they can be lower cost due to the reduced quantity of foundations required. Perform a cost comparison between steel strain poles and mast arm poles to verify cost efficiency. If a local agency prefers mast arms over strain poles for aesthetic reasons, they are responsible for the difference if mast arms cost more, Cost sharing agreements with the local agency are worked out in the Engineer's Estimate.

Mast arm pole design is broken up by fatigue categories as defined within **AASHTO LRFDLTS**.

Category I mast arm poles are the preferred mast arm pole type. They are typically used in intersections where the impact of a structural failure is higher, such as intersections with higher speeds or larger traffic volumes. **AASHTO LRFDLTS** recommends that all structures without effective mitigation devices on roadways with a speed limit in excess of 35 mph and average daily traffic (ADT) exceeding 10,000 or average daily truck traffic (ADTT) exceeding 1,000 be classified as Category I structures. ADT and ADTT are for one direction regardless of the number of lanes. Structures located in an area that is known to have wind conditions that are conducive to vibration must also be classified as Category I. Because Category I mast arm poles are designed for infinite fatigue life, they typically require larger pole diameters but do not require biennial inspection.

Classify structures as Category III if they are located on roads with speed limits of 35 mph or less. Structures that are located such that a failure will not affect traffic may be classified as Category III.

Category II mast arm poles fall between category I and category III with regards to application. Classify all structures not explicitly meeting the Category I or Category III criteria as Category II. Category II mast arm poles, comparable to category III poles, require local agencies to sign an inspection agreement.

Category III mast arm poles are typically utilized at intersections where the impact of structural failure is much lower, such as intersections with reduced speeds or minimal traffic volumes. Local agencies must sign biennial inspection agreement if category III mast arm poles are selected.

Mast arm pole categories are indicative of the anticipated fatigue loading on the structure and thus can alter the structure's configuration including pole length, arm length, and arm configuration (single arm versus double arm). Arm configuration selection is based primarily on intersection requirements. In general, double arm mast arm poles tend to require deeper foundation depths but can reduce the number of foundations required.

The standard design of these poles is reflected in the most current traffic signal special details **SIG-030, SIG-031, SIG-032, SIG-033** and **SIG-040-Series**.

Utilize the **Mast Arm Design Worksheet** to verify that the proposed configuration of signals, signs, and any other items attached to the structure falls within the envelope presented in the MDOT special details to confirm that a site-specific design is not required. It can be found on **MDOT's Traffic and Safety Standards and Special Details website** under the "Traffic Signals" section. If a site-specific design is required, notify **MDOT's Ancillary Structures Program** and **Geotechnical Services Unit**.

3. Wood Poles – Wood poles are not the preferred option but can be used as a lower cost or temporary alternative if steel strain poles and mast arm poles are not feasible. Wood poles often require more real estate for guy wires and thus limited ROW, or utility conflicts can often restrict their use. If project funding is limited and ROW is available, they may be utilized. Standard wood pole types and lengths are outlined in the **MDOT Standard Specifications for Construction**.

4. Bridge-Mounted Poles – Bridge-mounted steel strain poles can be used for projects where signalization is required on a bridge. In general, bridge-mounted poles will experience increased wind loading due to their higher elevation. Reference the **AASHTO LRFDLTS** for additional information regarding bridge-mounted pole design.

B. Historic Pole Types

Historically, Michigan has implemented additional pole types. However, new construction using these while retaining the original foundation requires site specific design and approval from the **MDOT Traffic Signals Unit.** These are briefly discussed as follows:

1. 4-Anchor Bolt Steel Strain Poles – Similar to the 6-anchor bolt steel strain poles, these had three differing pole heights at 30 feet, 36 feet, and 40 feet with both a round pole and 12-sided pole option. The foundation was comparable to that of the 6-anchor bolt design, prior to the LRFD revision in 2023, with a 42-inch outer diameter steel casing at a minimum 11'-6" depth. These are no longer designed as their anchor bolt configuration is non-redundant. Historically, these were chosen over wood poles because they required less ROW as guy wires were not required and chosen over embedded steel poles because they were more durable and had higher capacity.

2. Embedded Steel Poles – Embedded steel poles are no longer permitted and are not permitted in new construction. MDOT is removing these when found in the field and replacing them with steel strain poles. Embedded steel poles are difficult to inspect because the part of the pole experiencing the highest stress is below the surface.

C. Other Considerations

Additional considerations when choosing which pole type to utilize are discussed below:

1. Guy wire – Guy wire is most commonly used on wood poles to provide additional structural support and counteract the effects of creep. These typically require additional ROW and may impact adjacent sidewalk. Installing guy wires on strain poles is not recommended or customary practice as they do not add significant strength capacity. Common practice is to guy wood poles per span attached as outlined in **MDOT's Standard Specifications for Construction,** however, the guy wire anchorage must be adequately spaced to ensure capacity of the soil to resist tear out. Additional guy wire guidance can be found on special detail **SIG-050-Series**.

2. Temporary Traffic Signals – Temporary traffic signals can be utilized on projects to assist with maintaining traffic during construction. Reference **MDOT's Typical Temporary Traffic Signal Plan** guidance and the **MMUTCD** for more information on temporary traffic signals.

4.02.03

Aesthetics

Designers must coordinate aesthetic elements with any local stakeholders. If applicable, follow corridor-specific aesthetic design guides.

Beyond this, consider the following general guidelines for aesthetic features:

1. Place poles so as not to impede the travelling public.

2. Design and locate poles so as not to distract users or obstruct the view of the roadway or other important roadway structures.

3. Placement of poles and cabinets must not significantly impede or block access to nearby businesses and residential entrances or visibility of advertising signage. This most often happens in urban settings but should be considered at all intersections.

4. If luminaire arms are mounted to the steel strain pole or wood pole, consider the impact to surrounding environment.

5. Consider poles which serve multiple functions such as lighting, traffic control, and power to reduce the number of individual poles along the roadway.

6. Local agencies are responsible for any aesthetic-related costs outside of galvanizing. On occasion, local agencies may require certain coloring or coating characteristics of their poles. All costs associated with this preference must be covered by the local agency.

7. As noted earlier in this guidance, mast arms can be chosen over steel strain poles to improve intersection aesthetics.

8. Decorative bases may be utilized to cover anchor bolt configurations as requested by the local agency.

4.02.04

Right-of-Way Coordination

Place signal structures within the ROW wherever possible. Coordinate with **MDOT Region Real Estate** staff early in the project schedule to determine real estate needs and impacts to the project schedule. Any temporary work outside the ROW requires a legal agreement such as a Consent or Temporary Construction Easement. The **Real Estate Services Section** of the **Development Services Division** or **Region Real Estate** will determine just compensation for the agreement which is offered to the property owner. Permanent ROW acquisition may also need to be considered. Review Chapter 16 of the **MDOT Real Estate Procedure Manual** for more details on ROW considerations during design.

If right-of-way is limited, the Engineer may consider using the pole design outlined in **SIG-023-Series** but will need to verify the design criteria shown in **SIG-022-Series** is met. Refer to **Section 4.02.02.C.1**.

If a pole is proposed to be placed within 3 ft of the ROW line, consider including consents to grade.

4.02.05

Span Types and Mast Arm Configurations

A. Preferred and Required Span Types

The most common span types utilized in Michigan are box spans and diagonal spans. Box spans are the preferred span type.

Utilize the **Signal Design Calculator Spreadsheet**, hosted on **MDOT's Traffic and Safety Standards and Special Details website** to verify span configuration design. Instructions on how to use this tool can be found in the instructions tab of the spreadsheet.

Refer to special detail **SIG-020-Series** for calculating span length of poles with two span wires attached. If more than two span wires are attached, a site-specific design will be required, and the designer must coordinate with **MDOT's Traffic Signals Unit**.

1. Box Span – Box span configurations place traffic signal heads on the far side of each approach to an intersection, with at least one signal head for each approach lane as required by the MMUTCD. Box spans allow drivers to see signal heads with a less obtrusive visual angle (cone of vision). It also assists in reducing red light running because drivers are more reluctant to "run the red" when they can see the red indication as they traverse the intersection. This design is also safer for maintenance operations. Sample plans with traffic signal head placement for box span configurations can be found in **Appendix G**.

2. Suspended Box Spans –Suspended box span configurations place traffic signal heads similarly to a box span, however, these spans utilize tie-offs at each pole location to meet traffic signal head placement requirements. Refer to **Appendix H** for suspended box plans.

3. Diagonal Spans – Diagonal spans are often referred to as “traditional signal design” as this was customary practice historically in Michigan. Diagonal spans locate two traffic signals in the middle of the intersection. They are suspended on span wire secured to two poles placed opposite of each other in the intersection. Evaluate diagonal spans for additional low-level signals depending on the sight distance from the vehicle to the overhead signal. Sample plans with traffic signal head placement for diagonal span configurations can be found in **Appendix I**. These are not the preferred span alternative. The process for using a diagonal span is to first demonstrate that box span, strain pole and mast arm checks have been exhausted. If a non-box span is required for an intersection, coordinate with **MDOT’s Traffic Signals Unit.** A design exception form and approval of the Region TSMO Engineer will be required.

B. Mast Arm Configurations

Mast arm configurations are typically either single arm or double arm. Single arm mast arm poles have a single mast arm extending from the upright, whereas double arm mast arms have two extending from the upright. In some intersection configurations, double arm mast arms are used to reduce the total number of poles required thus resulting in a lower overall cost. Investigate the cost comparison between steel strain poles and mast arm poles if applicable.

Mast arm length is often dictated by signal head placement in relation to the travel lanes and the pole placement. Standard mast arm lengths can reach up to 60 feet, but configurations requiring arm lengths exceeding 30 feet typically splice two arms together, referred to as the inbound and outbound arms. As mast arm length increases, the arm will experience increased oscillation due wind loading. The MDOT special details **SIG-030** through **SIG-033-Series** highlight the arm length limits for mast arm structures.

4.02.06

Traffic Signals

A. Signal Types

Traffic signals are the primary attachment discussed in this guidance. They can include typical signal heads with and without backplates, case signs, pedestrian signals, and more. Traffic signal names indicate both their directionality and coloration. The directionality of signal heads is becoming less imperative as box spans are becoming customary practice, reducing the need for multi-way traffic signal heads. Reference Chapter 4 of the **MMUTCD** for more information regarding signal types.

B. Placement

Traffic signal placement is based upon the traffic lane design outlined in the **MMUTCD**. They can be suspended on span wire, mounted to mast arms, pole-mounted, pedestal-mounted, wall-mounted, or bridge-mounted. Pedestal-mounted, wall-mounted, and bridge-mounted traffic signals are not discussed in these design guidelines. Pole-mounted traffic signals are not explicitly discussed in this guidance; however, they are included in the loading assumptions identified in special details **SIG-020** and **SIG-022-Series** for steel strain poles and **SIG-030-Series** for mast arm poles. Reference **MDOT’s Traffic and Safety Standards and Special Details** for more information.

This guidance serves to provide information regarding traffic signal structure design; reference the **MMUTCD** for guidance on traffic signal placement and design.

For intersections utilizing a Pedestrian Hybrid Beacon, or HAWK Signal design, utilize **SIG-DESIGN-030 (Appendix A)** included in these design guidelines.

C. Vertical Clearance Considerations

The bottom of traffic signal heads supported by untethered and top-tethered spans or mast

arms must provide 17 feet of vertical clearance at a minimum from the crown of roadway to the lowest point of the signal configuration, as shown in special details **SIG-010, SIG-031, SIG-032,** and **SIG-033-Series**. The bottom of traffic signal heads supported by bottom-tethered spans must provide 18 feet of vertical clearance to account for the bottom-tethered system.

Standard steel strain pole heights and maximum span length are provided in special details **SIG-020** and **SIG-022-Series**. As span lengths increase and the required POCH increases, pole height will also increase.

Mast arm pole heights vary based on their fatigue category level. Typical pole heights for Category I and Category II poles are 23 feet and 29 feet. However, category III poles range in height between 21 feet and 40 feet.

Wood pole heights vary based on their required POCH and available depth for embedment. Standard pole heights for wood poles range from 35 feet to 60 feet typically.

Design all poles to meet the offset distance requirements detailed in the National Electrical Safety Code. The top of all traffic signal structures must be evaluated for its 3D clearance distance from overhead utilities. A minimum 10-foot radial offset from the pole to any primary, secondary, or neutral power lines is required by MiOSHA. See **Section 4.03.03** for more information regarding utility coordination.

D. Temporary and Portable Traffic Signals

A temporary traffic signal is generally installed using methods that minimize the costs of installation, relocation, and/or removal. Typical temporary traffic signals are used for specific purposes such as one-lane, two-way facilities in temporary work zones, for a haul-road intersection, or for access to a site that will have a permanent access point developed at another location in the near future. Portable traffic signals are temporary traffic signals.

A temporary traffic signal must meet the physical display and operational requirements of a conventional traffic signal. Factors related to the design and application of a temporary traffic signal include:

Use other TTC devices to supplement temporary traffic control signals, including warning and regulatory signs, pavement markings, and channelizing devices.

1. Safety and road user needs;

2. Work staging and operations;

3. The feasibility of using other Temporary Traffic Control (TTC) strategies (for example, flaggers, providing space for two lanes,

or detouring road users, including bicyclists and pedestrians);

4. Sight distance restrictions;

5. Human factors considerations (for example, lack of driver familiarity with temporary traffic control signals);

6. Road user volumes including roadway and intersection capacity;

7. Affected side streets and driveways;

8. Vehicle speeds;

9. The placement of other TTC devices

10. Parking;

11. Turning restrictions;

12. Pedestrians;

13. The nature of adjacent land uses (such as residential or commercial);

14. Legal authority;

15. Signal phasing and timing requirements;

16. Full-time or part-time operation;

17. Actuated, fixed-time, or manual operation;

18. Power failures or other emergencies;

19. Inspection and maintenance needs;

20. Need for detailed placement, timing, and operation records; and

21. Operation by contractors or by others.

4.02.07

Appurtenances

A. Mounting Bracket Arms

Mounting bracket arms typically hold sensors, cameras, and other appurtenances. Loading on these is typically limited the longer the bracket arm length is. Wood poles typically require a different mounting bracket from steel poles. Consider distances from bracket arm to primary electric or neutral wires during design. Refer to special detail **SIG-060-Series** and **MDOT's Standard Specifications for Construction** for mounting bracket arm requirements and limits for both steel and wooden poles.

B. Luminaire Arms

When luminaires are installed on traffic signal structures, their design must be integrated with the pole. When mounted to steel strain poles, wood poles, or mast arm poles, consider impacts to the surrounding environment. Luminaire arms may be selected for intersections where the intersection traffic signals do not provide adequate illumination for travelers or as requested by local agencies. Depending on the location, the local agency may be required to cover the cost of all operating and maintenance expenses. Coordinate with local agencies to determine if a luminaire is desired. Reference MDOT standard plan **R-130-Series** for luminaire sizing and placement recommendations.

C. Conduits

Conduits can be run through steel strain poles or mast arm poles to provide power to mounted equipment. In some cases, like wood poles, conduit is banded along the outside of the pole and is often not aesthetically desirable. Conduits are also required for grounding and lightning protection on poles. Give consideration to how conduit is run through or along the poles. The designer must verify all conduit is in accordance with the **MDOT Standard Specifications for Construction**.

D. Others

Many additional appurtenances can be added to steel strain poles, mast arm poles, and wood poles including, but not limited to, sensors, cameras, antennas, and pole-mounted cabinets. These must all be considered during design. Manufacturers often prefer steel poles over wood poles for sensors, like cameras, which require limited pole movement. Additionally, provide documentation that coordination has been performed with adjacent property owners regarding cabinet placement and other appurtenance placement relative to commercial signs and entrances to businesses or residences.

Signing is another common attachment to traffic signal structures. Typically, non-illuminated street name signs are utilized unless illuminated street name signs are requested or preferred by local agencies. Coordinate any signage required at intersections with **MDOT's Traffic Signing Unit**.

4.02.08

Construction Access

Consider including consents to grade any time a pole is proposed to be placed within 3 feet of the ROW line. Clearly show temporary access limits on the design plans. For further details on ROW coordination, see **Section 04.02.04**.

If the presence of vegetation interferes with construction access, it must be trimmed. Overhead utility lines can often impact pole installation and must be considered during design. Consider both lifting and setting the pole when defining construction stages. A 10-foot clearance to overhead utility lines is required throughout the entire installation process per MiOSHA's standards for construction safety and health and may impact pole sizing.

4.02.09

Inspection and Maintenance Access

Access for safe inspection and maintenance of the poles must be provided. All steel strain poles and mast arm poles must have handholes for the purposes of routine maintenance and inspection. Do not place on steep slopes, in drainage lines, and any lowering devices must be easily accessible. **MDOT's Ancillary Structures Program** manages the inspection of these assets as outlined in the **Michigan Ancillary Structures Inspection Manual (MiASIM)**.

4.02.10

Guardrail

When poles are placed in close proximity to the roadway, protective barriers such as guardrail or concrete barriers may be required. Reference Chapter 7 of the **MDOT Road Design Manual** for more information regarding guardrail placement.

4.03

TRAFFIC SIGNAL STRUCTURES PLACEMENT

4.03.01

Horizontal Placement

The horizontal placement of traffic signal structures relies primarily on the phasing required in an intersection as outlined in the **MMUTCD** and other requirements outlined in **MDOT's Road Design Manual**.

A. Pole Placement

Pole placement is based primarily on the intersection's traffic design per requirements outlined in the **MMUTCD**. Perform traffic studies prior to designing the intersection to verify signal and pole placement.

B. Nearby Business and Residence Considerations

Placement of poles and their facilities (including cabinets, signage, and other appurtenances) must consider access to and advertising of nearby businesses and residencies. Coordinate with both parties if an impact is likely.

C. Pedestrian Travel Considerations

Consider pedestrian travel when aligning traffic signal structures and minimize impacts. Refer to **Section 4.03.05** for more information regarding pedestrian accommodations.

4.03.02

Clear Zone

If possible, place traffic signal structures outside of the upper bound roadway clear zone distance specified in the **MDOT Road Design Manual**.

Historically, intersections with curbing had smaller clear zones and therefore most poles were not considered to be in the clear zone. However, it was discovered that curbs do not provide substantial redirection or containment and therefore this consideration has been removed.

In instances where site restrictions require installation within the clear zone, exercise engineering judgement to determine the feasibility of installing a protection method. Consider whether existing conditions, such as historical crash data, warrant the use of a barrier. For traffic signal structures, guardrail is typically a lower cost option compared to concrete barrier. However, in intersections with higher crash rates, the cost of maintaining guardrail may exceed the cost of installing concrete barrier.

For details regarding roadside safety barriers, see the **MDOT Road Design Manual**.

Consider roadway snow removal in regard to traffic signal structure placement and barriers.

4.03.03

Utility Coordination

Make every effort to determine existing utility locations during the design phase including design miss digs with surveyed pickup. Consider **SUE** to verify impacts when other techniques have not fully determined potential impacts. In congested areas and when non-metallic utilities are present, consider additional investigatory measures such as Exploratory Investigation.

Compile existing utility information as part of the base plan development phase. Avoid utility impacts when possible. If traffic signal work will impact site utilities, additional coordination with utility owners will be needed. Coordinate with MDOT's local utilities and permitting engineer if impacts are anticipated.

Place traffic signal structures to avoid underground and aboveground obstructions.

Include in the design plans language emphasizing the contractor's responsibility to perform utility conflict assessment and provide adequate clearance of facilities identified by the facility owner prior to construction.

4.03.04

Roadway

Minimum sight distance for signal visibility must follow those guidelines outlined in the **MMUTCD**. In general, place traffic signal structures in a manner that provides adequate distance between the asset and the traversable roadway.

4.03.05

Pedestrian Accommodations

A. Sidewalk and Sidewalk Ramps

Reference the **MDOT Road Design Manual** for circumstances where new signal installation may warrant a sidewalk ramp upgrade. When designing a new intersection or upgrading an existing intersection, avoid impact to sidewalks and ramps if possible. Traffic signal structures are often installed in close proximity to sidewalks and therefore impacts may be unavoidable. It is best practice to place poles and their facilities adjacent to sidewalks, as opposed to in the direct path of travelers.

Intersections utilizing wood poles require guy wire that can often cross the path of sidewalks and other pedestrian pathways. In general, 10 feet of clearance above sidewalk must be maintained for travelers. If the guy wire is anticipated to cross this boundary, utilize guy struts. Guy struts push out the guy wire to increase vertical clearance. Refer to special detail **SIG-050-Series** for guidance on guy strut placement. Designers must ensure the proposed intersection design complies with all ADA requirements.

B. Pedestrian Pushbuttons

Pedestrian pushbuttons can be mounted directly to traffic signal poles or to their own pedestals. In general, pedestrian pushbuttons often interact with traffic signal structures and can influence pole placement. Minimize sidewalk congestion by placing pedestrian pushbuttons on signal poles, if applicable. Reference the **MMUTCD** for guidance regarding pushbutton placement and **SIG-DESIGN-120 (Appendix B)**.

4.04

STRUCTURAL DESIGN

Typically, a site-specific structural design is not required if the Engineer uses the existing traffic signal standards and special details. Verify the design meets all criteria outlined in the above standards and special details. If the design falls outside of the applicable standard requirements, a site-specific design will be required and **MDOT's Ancillary Structures Program** and **MDOT's Geotechnical Services Unit** must be contacted. The following sections provide guidance on several areas related to structural design, but the Engineer must develop a comprehensive site-specific design.

4.04.01

Foundation Types

Review historic structure borings before new borings are obtained. If poor soils are shown, the Engineer must coordinate with **MDOT's Geotechnical Services Unit**. All preliminary foundation investigations and new soil boring obtainment per foundation location must follow requirements outlined in the **MDOT Geotechnical Manual**. In general, designers may not utilize an existing foundation for new poles as a new foundation will be required to comply with current standards.

A. Drilled Shafts

Drilled shafts serve as the standard foundation type for traffic signal structures. MDOT has provided a **Traffic Signal Strain Pole Foundation Design Worksheet** located on the **MDOT Traffic and Safety Standards and Special Details website** under the Traffic Signals section. This tool is based on **SIG-DESIGN-153 (Appendix C)** which provides foundation design tables for steel strain poles utilizing the updated LRFD design presented in special details **SIG-020** and **SIG-021-Series**. It allows designers to input strain pole characteristics and soil types, returning the required foundation sizing.

The steel strain pole foundation design tables are split up based on whether a pole has a tie-off span and whether a pole's span is tethered. Tie-off spans impact how the total maximum span length is calculated for a given pole and can often result in deeper foundations being required. Similarly, tethered spans will typically require deeper foundation depths than untethered spans due to the increased loading effect caused by tethering the signals. **SIG-DESIGN-153 (Appendix C)** was initially designed with bottom-tethered intersections. **SIG-DESIGN-154 (Appendix D)** can be utilized for steel strain poles designed with special details **SIG-022** and **SIG-023-Series**.

Similarly, **SIG-DESIGN-284 (Appendix E)** provides a foundation table for mast arm pole design broken up by mast arm configuration (single arm versus double arm) and length. The more loading experienced by the pole, the deeper the foundation depth will need to be therefore, double arm configurations typically require deeper foundations than single arm configurations. Similarly, mast arm poles with longer arm lengths will typically require deeper foundations.

Soil type and condition impact the foundation depth for both steel strain poles and mast arm poles. Review the **SIG-DESIGN-153, SIG-DESIGN-154,** and **SIG-DESIGN-284-Series** guidance documents to verify all foundation design criteria is met. If the foundation design criteria is not met, contact the **MDOT Geotechnical Services Unit** as a site-specific design will be required. Drilled shafts can be cased or uncased. Casing installation must follow all procedures outlined in **MDOT's Standard Specifications for Construction**.

Consult with a geotechnical engineer to determine the necessity of temporary supports for assets. Determine the allowable proximity of the drilled shaft to other utilities and structures.

Evaluate the installation and removal of temporary support in coordination with **MDOT's Geotechnical Services Unit** based on the project soil types, groundwater

conditions anticipated during construction, and proximity to existing structures or utilities. Consider temporary support especially for soft cohesive soils and granular soils where the groundwater table is above the bottom of drilled shaft elevation, or where structures or utilities exist within 5 times the drilled shaft diameter.

Do not place drilled shaft foundations in close proximity to each other as this will reduce the capacity of the surrounding soil. Center-to-center spacing within 5 times the drilled shaft diameter requires evaluation of group effects for the corresponding soil type per recommendations in **AASHTO LRFBDS**.

4.04.02

Design Specifications and Special Provisions

Traffic signal structures in Michigan must be designed according to the current edition of the **AASHTO LRFDLTS.** Also reference the most up to date traffic signal standards and special details referenced on **MDOT's Traffic and Safety Standards and Special Details website**.

4.04.03

Loading

Design traffic signal structures for the loading and load combinations required by the **AASHTO LRFDLTS**. The primary load cases for traffic signal poles are wind loading and dead load. Because traffic signal structures do not have walkways or service platforms, live load is not considered. Span wires must consider loading induced by signs, traffic signals, appurtenances, and supporting wires. Reference special details **SIG-020-Series** for loading parameters for steel strain poles and **SIG-030-Series** for loading parameters for mast arm poles.

If a site-specific design is required, traffic signal structures must be designed for the loadings and load combinations required by the **AASHTO LRFDLTS**. Design the poles and foundations for the load cases presented in special details **SIG-020, SIG-022,** and **SIG-030-Series** where pole-mounted and arm- or wire-mounted devices and signals are considered.

4.04.04

Strain Pole Span Types

Span types can impact how traffic signal structures are loaded. Span wire must meet strength requirements as identified in the **MDOT Standard Specifications for Construction** as modified by the **Frequently Used Special Provisions**.

A. Box Span

The current special details for steel strain poles are designed for poles at each corner of a box span with two span wires extending from the pole.

B. Suspended Box Span

The introduction of tie-offs can impact loading and have been accounted for in the typical design represented in special details **SIG-020** and **SIG-022-Series**.

C. Diagonal Span

Diagonal spans are occasionally used for intersections where low loading is required, like intersections with overhead flashers, or if box span types are not feasible. If a non-box span is required for an intersection, coordinate with **MDOT's Traffic Signals Unit.**

D. Other Span Types

1. Z-Span. Z-span configurations are most often utilized at offset intersections or on applicable divided roadways where the median clear zone requirements can be met. When weight requirements for intersections utilizing wood poles (and a steel strain pole for vehicle detection) control, this span type is utilized. Z-spans can reduce span length, however, when

used on divided roadways, they can limit pedestrian view of traffic signals and increase likelihood of the pole being struck by vehicles at the median.

2. U-Span. U-span configurations are utilized at T-intersections. They have similar advantages to box span configurations, with one less span wire. The total span length for each pole will be calculated similarly to a box span, however, the poles with only one span connected will utilize the length of the given span since an additional span is not considered for determining the maximum span length.

3. Unique configurations. Other configurations may be utilized if required at an intersection. If this is the case, the span configuration must meet all requirements outlined in the **MMUTCD** and coordination with **MDOT's Traffic Signals Unit** will be required.

E. Preferred Span Types

Box spans are the preferred span type where applicable. If box spans are not feasible, see discussion above for additional span types and **Section 4.02.05** for additional discussion regarding span type selection.

4.04.05

Modernization

Check existing structure inspection reports to verify modernization efforts are allowable. Please contact the **MDOT Ancillary Structures Program** for inspection information.

A. Backplates and Tethering

Backplates are most often used where speed limits are 45 mph or greater and on signals facing east or west where the sun can often interfere with visibility. They have been proven to significantly reduce crashes. Where backplates are present, signals can additionally be tethered. Bottom-tethered is the preferred approach as it minimizes traffic signal movement caused by wind. Adding signals with backplates and tethering is a common method for modernizing existing intersections and preferred for new intersection construction, however it does add wind area and loading to the spans. Account for this increase in demand in design. Utilize the **Strain Pole Scoping Tool** during the scoping phase to evaluate whether existing strain poles can be retained for modernization projects.

4.04.06

Signals and Appurtenances

Traffic Signal heads are the primary load impact that drive strain pole design and can significantly affect the demand placed on the pole. Larger, heavier, back plated signals have the highest impact. Account for raffic signal mounting height and signal visibility for in accordance with the **MMUTCD**. All signals and appurtenances must meet requirements set forth in the **MDOT Standard Specifications for Construction**.

A. Signal Types

Often, traffic signals primarily include traffic heads and case signs. Traffic heads can face one-way (1W), two-way (2W) or more and can include up to five (doghouse) or more colorations. Box span configurations typically do not require multi-way traffic signals whereas diagonal spans, z-spans, and other spans may require multi-way signal heads. Therefore, the primary method of increasing the total generalized load experienced by a steel strain pole or wood pole is by increasing either the amount of traffic signals placed on the span wire, or increasing the coloration count on each signal.

Case signs typically provide travelers with additional information regarding lane directions and more. They can be illuminated or non-illuminated and are often paired with traffic signals. Consider all attachments when calculating anticipated load effects on traffic signal structures.

B. Signage

Coordinate any signage required at intersections with **MDOT's Traffic Signing Unit**. If signage is added to the traffic signal structure, account for both loading and wind area in design.

C. Pole-Mounted Cabinets

Intersection cabinets can be pole-mounted and if done, their load impacts must be included in design. Special details **SIG-020, SIG-022**, and **SIG-030-Series** include pole-mounted cabinets in their loading assumptions.

D. Mounting Appurtenances

When appurtenances are mounted to traffic signal structures, account for their weight and wind areas in the design of traffic signal structures. Refer to special detail **SIG-060-Series** for typical mounting details utilizing truss brackets on traffic signal structures and **R-130-Series** for luminaire mounting details.

4.04.07

Deflection Limits

Analyze deflection using the service load combinations per the **AASHTO LRFDLTS.** The following limits must be checked:

1. The horizontal deflection limit at the top of steel strain poles per **SIG-020** and **SIG-022-Series**.

2. The vertical deflection under galloping and truck gust-induced loading limit for mast arms per **SIG-030-Series**.

3. The span wire sag is typically a minimum of 5%. Tension the span wire per **AASHTO LRFDLTS**.

Per the **MDOT Standard Specifications for Construction** wood pole guy wire is typically added per span attachment to reduce the impacts of creep and pole deflection.

4.04.08

Structural Details

Include all relevant special details and standards in the contract plans if standard designs are utilized. If a site-specific design is required, full structural details must be included.

4.05

PLAN PREPARATION

4.05.01

Preliminary Plan Composition

Use the following list and ordering of sheets for the Preliminary Plan stage of traffic signal structures projects. Traffic signal projects often overlap with roadwork or other rehabilitation and reconstruction projects. This list assumes no major work aside from the traffic signal structures is included in the project:

A. Title Sheet

B. Project Information Sheet(s)

C. Legend Sheet(s)

D. Note Sheet(s)

E. Survey Information Sheet(s)

F. Signals Sheet(s)*

G. Special Details Sheet(s)

*Use **Appendix F** – Guidelines for Traffic Signal Structures Plan Preparation as a reference for these sheets and MDOT's Online CAD Standards for guidance on setting up the CAD workspace.

At the Preliminary Plan stage, the traffic signal structure plan sheets must convey the pole alignment and proposed pole type at a minimum. If multiple pole types are used, they must be called out in the intersection plan view with locations of each type shown. Verify all traffic signal warrants and phasing are valid with **MDOT's Traffic Signals Unit**.

4.05.02

Final Plan Composition

Use the following list and ordering of sheets for the final plan stage of traffic signal structure projects. This list assumes no major work aside from the poles is included in the project:

A. Title Sheet

B. Project Information Sheet(s)

C. Legend Sheet(s)

D. Note Sheet(s)

E. Miscellaneous Quantities Sheet(s)

F. Miscellaneous Detail Sheet(s)

G. Survey Information Sheet(s)

H. Signals Sheet(s)*

I. Log of Borings Sheet(s)*

J. Special Details Sheet(s)

*Use **Appendix F** – Guidelines for Traffic Signal Structures Plan Preparation as a reference for these sheets.

See the **Road Design Manual** for guidance on all other sheets.

4.05.03

Structural Details

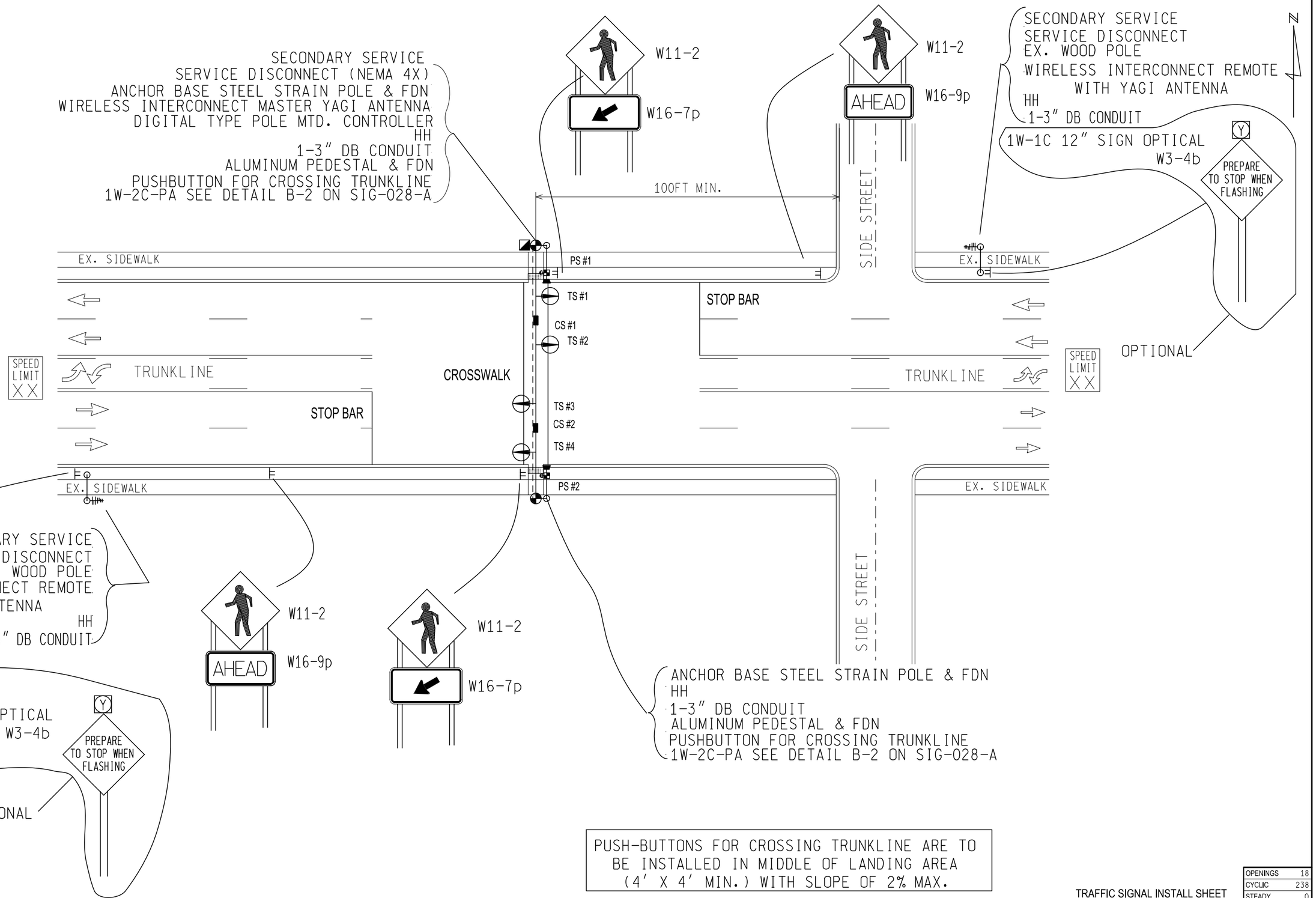
The structural details provided in all special details mentioned in this guidance must be included. If a designer must deviate from the proposed guidance, contact the **MDOT Ancillary Structures Program** to verify the proposed design. Also contact the **MDOT Traffic Signals Unit** and **Structural Fabrication Unit** for approval. The design of these details must be analyzed if modifications will impact the structural capacity.

Include the details where strain poles and mast arm poles supported on drilled shafts or embedded wood poles are proposed.

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

Appendix A – HAWK Signal Sample Plan

SIG-DESIGN-030



PUSH-BUTTONS FOR CROSSING TRUNKLINE ARE TO BE INSTALLED IN MIDDLE OF LANDING AREA (4′ X 4′ MIN.) WITH SLOPE OF 2% MAX.

TRAFFIC SIGNAL INSTALL SHEET

OPENINGS	18
CYCLIC	238
STEADY	0

AS-LET PLAN REVISIONS

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 1" 0 30'

DESIGNED BY: YOUR NAME HERE	DATE:	CS:	HAWK Signal Sample Plan	DRAWING / SHEET
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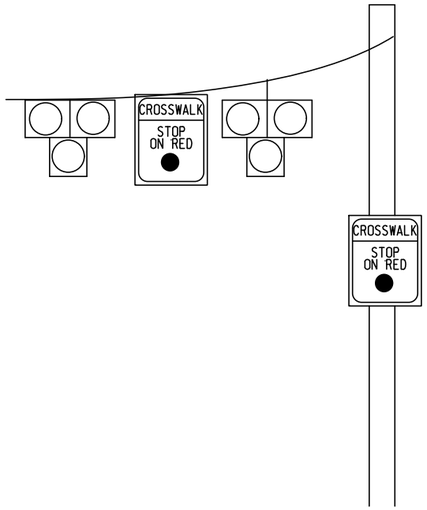
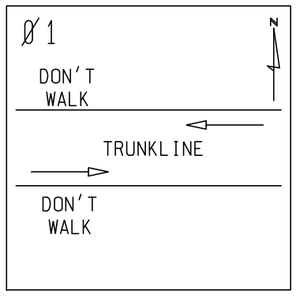
FILE: 1234501001e-pr010210ct.dgn	TSC:		Sig-Design-030-F	

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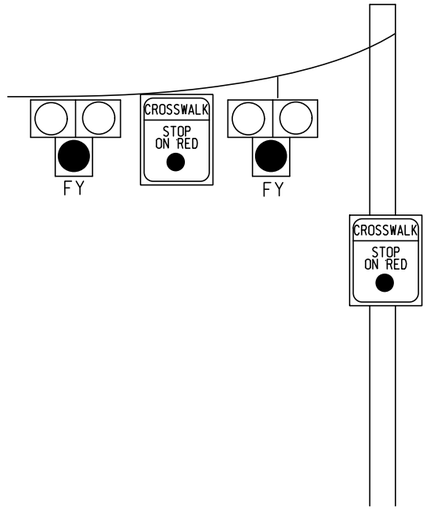
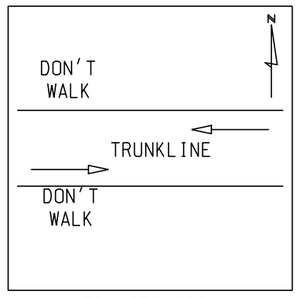
DARK DISPLAY
FOR TRUNKLINE

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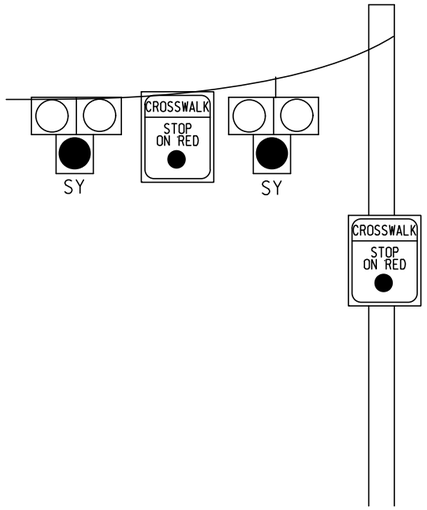

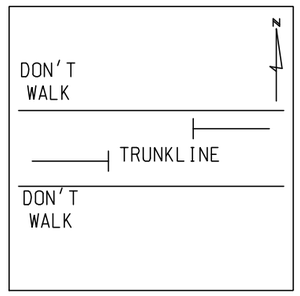
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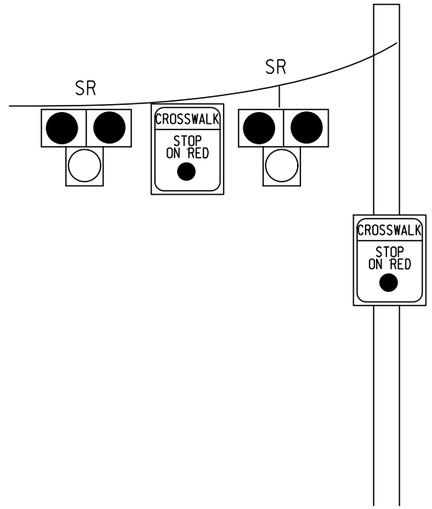

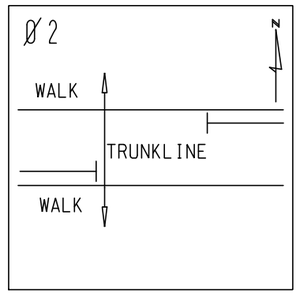
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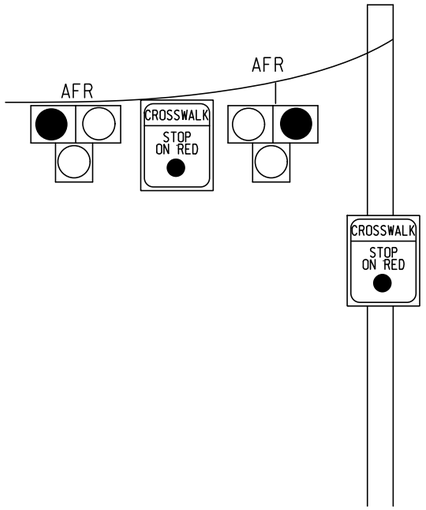

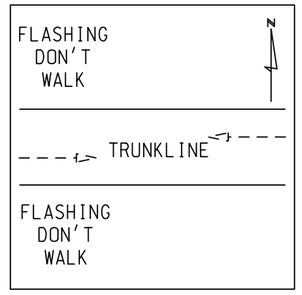
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TRAFFIC SIGNAL INSTALL SHEET

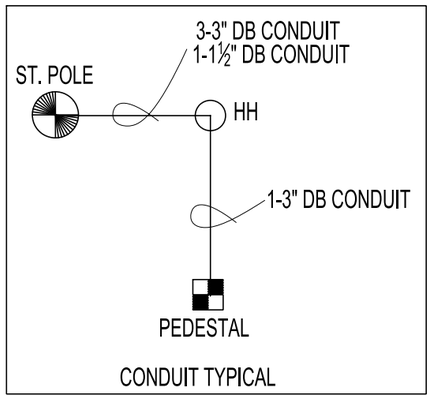
AS-LET PLAN REVISIONS							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

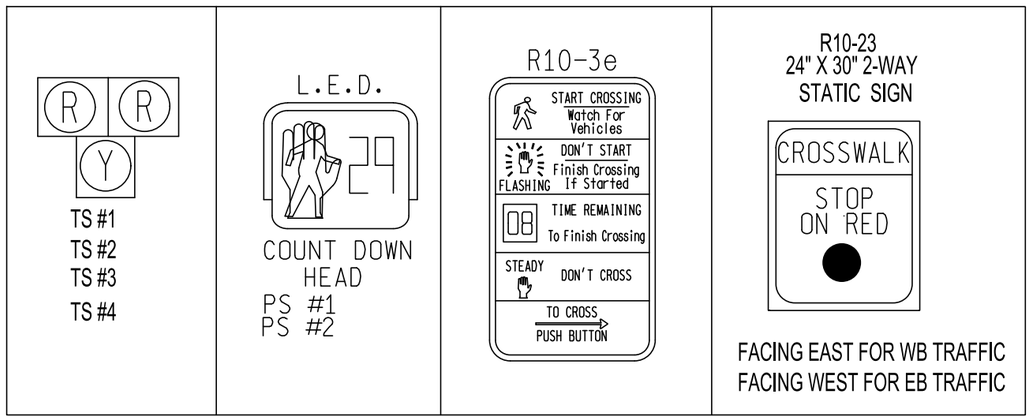
0 1" 0 30'

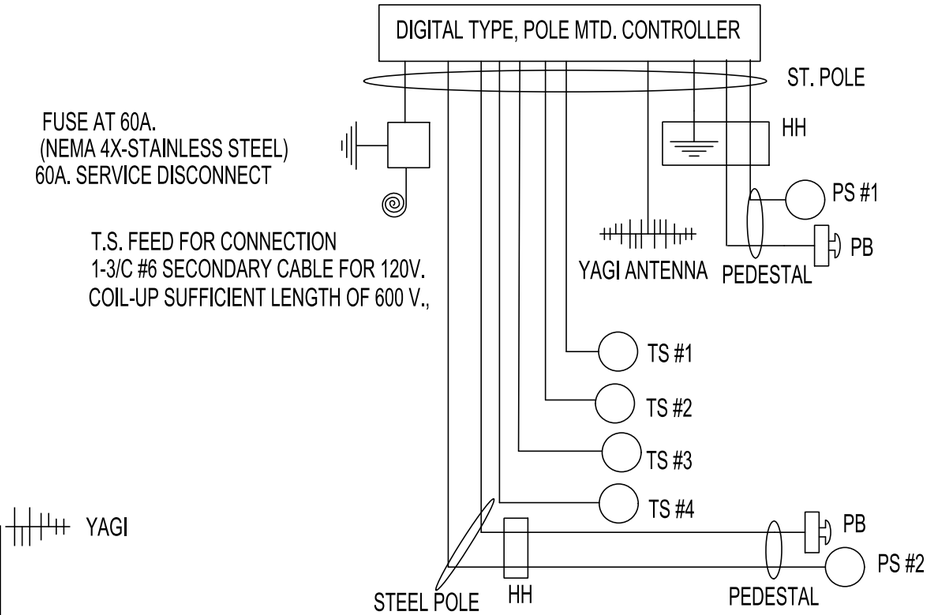
DESIGNED BY: YOUR NAME HERE	DATE:	CS:	HAWK Signal Sample Plan
PLAN: 12345-01-001	DESIGN UNIT: TRAFFIC SIGNALS	JN:	
FILE: 1234501001e-pr010210ct.dgn	TSC:		Sig-Design-030-F

DRAWING | SHEET



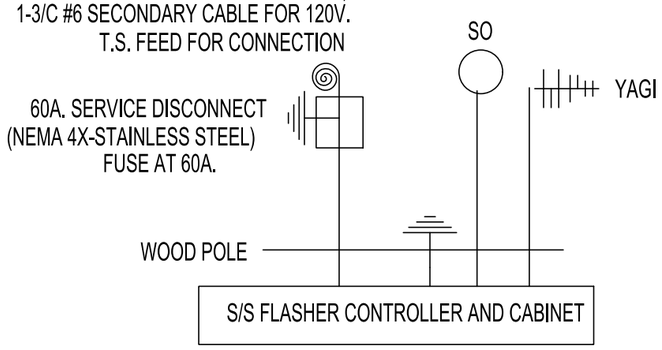
CONDUIT TYPICAL



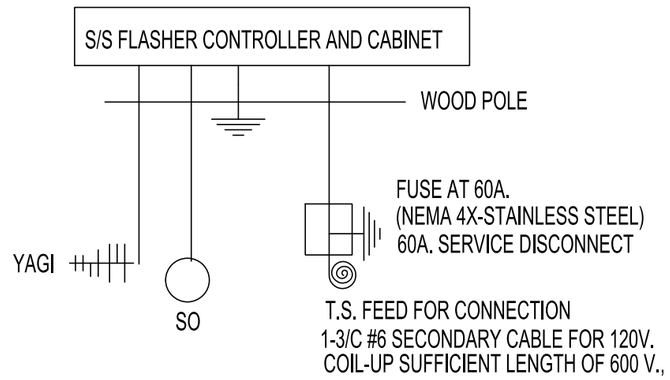


INSTALL CABLE DIAGRAM
NOT TO SCALE

NOTE: CABLES TO BE USED UNLESS SPECIFIED OTHERWISE
1. TRAFFIC SIGNAL CABLES ARE 5/C#16 PJ.
2. PEDESTRIAN SIGNAL CABLES ARE 7/C#16 PJ.
3. PUSHBUTTON CABLES ARE 2/C#16 SHIELDED PJ.
4. YAGI ANTENNA CABLES ARE LMR 400 OR APPROVED EQUAL.



EB TRAFFIC INSTALL CABLE DIAGRAM
NOT TO SCALE



WB TRAFFIC INSTALL CABLE DIAGRAM
NOT TO SCALE

TRAFFIC SIGNAL INSTALL SHEET

AS-LET PLAN REVISIONS							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 1" 0 30'

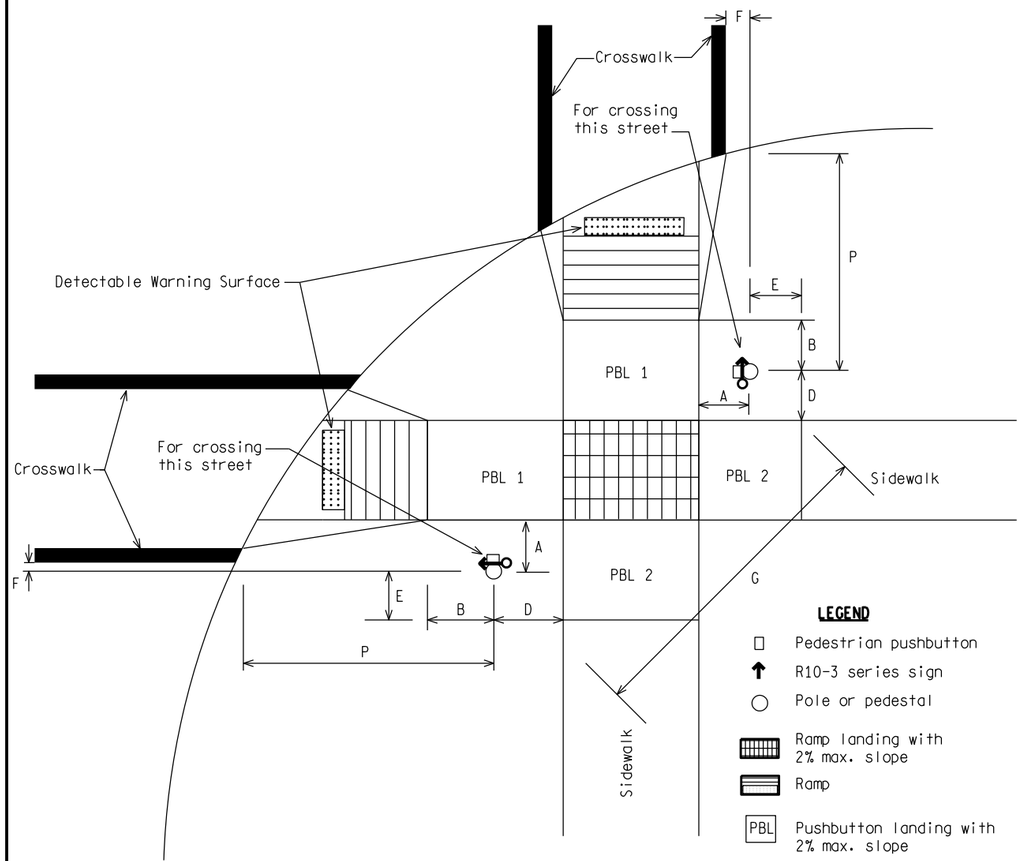
DESIGNED BY: YOUR NAME HERE	DATE:	CS:	HAWK Signal Sample Plan	DRAWING / SHEET
PLAN: 12345-01-001	DESIGN UNIT: TRAFFIC SIGNALS	JN:		
FILE: 1234501001e-pr010210ct.dgn	TSC:		Sig-Design-030-F	3 of 3

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

Appendix B – Pushbutton Design

SIG-DESIGN-120

RECOMMENDED PUSHBUTTON LOCATIONS



PLAN VIEW OF TYPICAL QUADRANT

File: PW:Reference Documents/Traffic Reference/Signals/Design Guides/Final/SIG-DESIGN-120-A.dgn

	DESCRIPTION	DATE
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	REVISED	02/21/12
	REVISED	11/18/14
TRAFFIC SIGNAL DESIGN		
DRAWN BY:		
CHECKED BY:		

PUSHBUTTON DESIGN

SIG-DESIGN-120-A

SHEET 1 of 2

NOTES:

PBL1 is the preferred location for the pushbutton landing.
If PBL1 is chosen, then:
A = 2′ maximum
B = D = 2′ minimum

If PBL2 is chosen, then:
D = 2′ maximum (1′ maximum is preferred)
A = E = 2′ minimum
E = 2′ minimum

P = 6′ maximum preferred distance from pushbutton to back of curb
If P exceeds 6′, then the required pedestrian walk time must be evaluated and increased if necessary.

F = 5′ maximum preferred distance from crosswalk to pushbutton.
If F exceeds 5′, then the required pedestrian walk time must be evaluated and increased if necessary.

G = 10′ minimum required separation of audible pushbuttons on the same quadrant.
G = 10′ minimum preferred separation of non-audible pushbuttons on the same quadrant.

NOT TO SCALE

MICHIGAN DEPARTMENT OF TRANSPORTATION TRAFFIC & SAFETY	DESIGN GUIDE		SIG-DESIGN-120-A	SHEET 2 of 2
File:PW:RD/TR/Signals/Design Guides/Final/SIG-DESIGN-120-A.dgn Rev. 11/18/14		PLAN DATE		

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

Appendix C – Traffic Signal Strain Pole Foundation Design Table

SIG-DESIGN-153

Strain Pole Foundation Chart – Untethered Spans – Poles Not Connected to Tie-Off Spans[A]

Span Length (ft)	Soil Type	Soil Condition		30 ft Pole Length				36 ft Pole Length		40 ft Pole Length		Casing Length
		S_u *	N_{60} *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	
≤ 100	Low Sand	-	$5 \le N_{60} < 10$	42	13.5	48	13.0	48	14.0	48	14.5	As Shown on Plans
	Med Sand	-	$10 \le N_{60} < 20$	42	12.0	48	11.5	48	12.5	48	12.5	
	High Sand	-	$N_{60} \ge 20$	42	11.5	48	11.0	48	11.5	48	12.0	
	Low Clay	$500 \le S_u < 1000$	-	42	16.5	48	16.5	48	17.5	48	18.0	
	Med Clay	$1000 \le S_u < 2000$	-	42	13.0	48	13.0	48	13.5	48	14.0	
	High Clay	$S_u \ge 2000$	-	42	10.5	48	10.5	48	11.0	48	11.5	
101 to 120	Low Sand	-	$5 \le N_{60} < 10$	42	14.0	48	14.0	48	14.5	48	15.0	
	Med Sand	-	$10 \le N_{60} < 20$	42	12.5	48	12.0	48	12.5	48	13.0	
	High Sand	-	$N_{60} \ge 20$	42	12.0	48	11.5	48	12.0	48	12.5	
	Low Clay	$500 \le S_u < 1000$	-	42	17.5	48	17.0	48	18.0	48	19.0	
	Med Clay	$1000 \le S_u < 2000$	-	42	13.5	48	13.0	48	14.0	48	14.5	
	High Clay	$S_u \ge 2000$	-	42	11.0	48	11.0	48	11.5	48	12.0	
121 to 150	Low Sand	-	$5 \le N_{60} < 10$	42	14.0	48	14.0	48	14.5	48	15.0	
	Med Sand	-	$10 \le N_{60} < 20$	42	12.5	48	12.0	48	13.0	48	13.5	
	High Sand	-	$N_{60} \ge 20$	42	12.0	48	11.5	48	12.5	48	12.5	
	Low Clay	$500 \le S_u < 1000$	-	42	18.0	48	17.5	48	18.5	48	19.5	
	Med Clay	$1000 \le S_u < 2000$	-	42	14.0	48	13.5	48	14.5	48	15.0	
	High Clay	$S_u \ge 2000$	-	42	11.5	48	11.0	48	11.5	48	12.0	
151 to 176	Low Sand	-	$5 \le N_{60} < 10$	42	-	48	-	48	15.5	48	16.0	
	Med Sand	-	$10 \le N_{60} < 20$	42	-	48	-	48	13.5	48	14.0	
	High Sand	-	$N_{60} \ge 20$	42	-	48	-	48	13.0	48	13.5	
	Low Clay	$500 \le S_u < 1000$	-	42	-	48	-	48	20.0	48	20.5	
	Med Clay	$1000 \le S_u < 2000$	-	42	-	48	-	48	15.5	48	16.0	
	High Clay	$S_u \ge 2000$	-	42	-	48	-	48	12.5	48	13.0	
177 to 200	Low Sand	-	$5 \le N_{60} < 10$	42	-	48	-	48	15.5	48	16.0	
	Med Sand	-	$10 \le N_{60} < 20$	42	-	48	-	48	14.0	48	14.5	
	High Sand	-	$N_{60} \ge 20$	42	-	48	-	48	13.0	48	13.5	
	Low Clay	$500 \le S_u < 1000$	-	42	-	48	-	48	20.0	48	21.0	
	Med Clay	$1000 \le S_u < 2000$	-	42	-	48	-	48	15.5	48	16.0	
	High Clay	$S_u \ge 2000$	-	42	-	48	-	48	12.5	48	13.0	

* S_u = Undrained Shear Strength in Cohesive Soil (psf)

* N_{60} = Standard Penetration Resistance (Blows/Foot according to ASTM D-1586) Corrected to 60 % Hammer Efficiency Utilizing the Hammer's Calibrated Energy

* Foundation length measured from the top of the shaft, and assumes maximum 0.25 feet (3 inches) of stickup

NOTE: A Detailed Site Specific Design is Required for the Following Conditions

1) If $N_{60} < 5$ bpf or $S_u < 500$ psf
2) If span lengths are greater than 200 feet
3) If ground water is less than 3 feet below the ground surface.
4) If a rock socket is required for the drilled shaft, if N_{60} values greater than 50 blows per foot dominate the lower half of the drilled shaft length, or if drilling refusal or split-spoon refusal is encountered above design bottom of foundation elevation.

OTHER NOTES:

A. This chart is for use with untethered spans not connected to tie-offs with signals that do not have backplates. See SIG-020 for details.
The upper 5 feet of soil modeled as disturbed soil assuming ground is disturbed to locate utilities.
Drilled shaft head deflection less than or equal to 1 inch.

Strain Pole Foundation Chart – Tethered Spans – Poles Not Connected to Tie-Off Spans[A]

Span Length (ft)	Soil Type	Soil Condition		30 ft Pole Length				36 ft Pole Length		40 ft Pole Length		Casing Length
		S_u *	N_{60} *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	
≤ 100	Low Sand	-	$5 \le N_{60} < 10$	42	19.0	48	17.5	48	19.5	48	20.5	As Shown on Plans
	Med Sand	-	$10 \le N_{60} < 20$	42	16.5	48	15.5	48	17.0	48	18.0	
	High Sand	-	$N_{60} \ge 20$	42	15.5	48	15.0	48	16.0	48	17.0	
	Low Clay	$500 \le S_u < 1000$	-	42	26.0	48	23.5	48	26.0	48	28.0	
	Med Clay	$1000 \le S_u < 2000$	-	42	18.5	48	17.5	48	19.0	48	20.0	
	High Clay	$S_u \ge 2000$	-	42	14.5	48	14.0	48	15.0	48	16.0	
101 to 120	Low Sand	-	$5 \le N_{60} < 10$	42	19.0	48	18.0	48	19.5	48	20.5	
	Med Sand	-	$10 \le N_{60} < 20$	42	17.0	48	16.0	48	17.5	48	18.0	
	High Sand	-	$N_{60} \ge 20$	42	16.0	48	15.0	48	16.0	48	17.0	
	Low Clay	$500 \le S_u < 1000$	-	42	26.5	48	24.0	48	26.5	48	29.0	
	Med Clay	$1000 \le S_u < 2000$	-	42	19.0	48	18.0	48	19.5	48	20.5	
	High Clay	$S_u \ge 2000$	-	42	15.0	48	14.0	48	15.5	48	16.0	
121 to 150	Low Sand	-	$5 \le N_{60} < 10$	42	19.5	48	18.0	48	20.5	48	21.0	
	Med Sand	-	$10 \le N_{60} < 20$	42	17.5	48	16.0	48	17.5	48	18.5	
	High Sand	-	$N_{60} \ge 20$	42	16.0	48	15.0	48	16.5	48	17.5	
	Low Clay	$500 \le S_u < 1000$	-	42	27.5	48	24.5	48	27.5	48	29.5	
	Med Clay	$1000 \le S_u < 2000$	-	42	19.0	48	18.0	48	20.0	48	21.0	
	High Clay	$S_u \ge 2000$	-	42	15.0	48	14.5	48	15.5	48	16.5	
151 to 176	Low Sand	-	$5 \le N_{60} < 10$	42	-	48	-	48	20.0	48	21.5	
	Med Sand	-	$10 \le N_{60} < 20$	42	-	48	-	48	17.5	48	18.5	
	High Sand	-	$N_{60} \ge 20$	42	-	48	-	48	16.5	48	17.5	
	Low Clay	$500 \le S_u < 1000$	-	42	-	48	-	48	28.0	48	30.5	
	Med Clay	$1000 \le S_u < 2000$	-	42	-	48	-	48	20.0	48	21.0	
	High Clay	$S_u \ge 2000$	-	42	-	48	-	48	15.5	48	16.5	
177 to 200	Low Sand	-	$5 \le N_{60} < 10$	42	-	48	-	48	20.5	48	21.5	
	Med Sand	-	$10 \le N_{60} < 20$	42	-	48	-	48	18.0	48	19.0	
	High Sand	-	$N_{60} \ge 20$	42	-	48	-	48	16.5	48	17.5	
	Low Clay	$500 \le S_u < 1000$	-	42	-	48	-	48	28.0	48	30.5	
	Med Clay	$1000 \le S_u < 2000$	-	42	-	48	-	48	20.0	48	21.0	
	High Clay	$S_u \ge 2000$	-	42	-	48	-	48	16.0	48	16.5	

*S_u = Undrained Shear Strength in Cohesive Soil (psf)

* N_{60} = Standard Penetration Resistance (Blows/Foot according to ASTM D-1586) Corrected to 60 % Hammer Efficiency Utilizing the Hammer's Calibrated Energy

*Foundation length from the top of the shaft, and assumes maximum 0.25 feet (3 inches) of stickup

NOTE: A Detailed Site Specific Design is Required for the Following Conditions

1) If $N_{60} < 5$ bpf or $S_u < 500$ psf
2) If span lengths are greater than 200 feet
3) If ground water is less than 3 feet below the ground surface.
4) If a rock socket is required for the drilled shaft, if N_{60} values greater than 50 blows per foot dominate the lower half of the drilled shaft length, or if drilling refusal or split-spoon refusal is encountered above design bottom of foundation elevation.

OTHER NOTES:

A. This chart is for use with tethered spans not connected to tie-offs with signals that have backplates. See SIG-020 for details.
The upper 5 feet of soil modeled as disturbed soil assuming ground is disturbed to locate utilities.
Drilled shaft head deflection less than or equal to 1 inch.

Strain Pole Foundation Chart - Untethered Spans - Poles Connected to Tie-Off Spans[A]

Span Length (ft)	Soil Type	Soil Condition		36 ft Pole Length		40 ft Pole Length		Casing Length
		S_u *	N_{60} *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	
≤ 100	Low Sand	-	$5 \le N_{60} < 10$	48	15.5	48	16.0	As Shown on Plans
	Med Sand	-	$10 \le N_{60} < 20$	48	13.5	48	14.0	
	High Sand	-	$N_{60} \ge 20$	48	13.0	48	13.5	
	Low Clay	$500 \le S_u < 1000$	-	48	19.5	48	20.5	
	Med Clay	$1000 \le S_u < 2000$	-	48	15.0	48	16.0	
	High Clay	$S_u \ge 2000$	-	48	12.5	48	12.5	
101 to 120	Low Sand	-	$5 \le N_{60} < 10$	48	16.0	48	16.5	
	Med Sand	-	$10 \le N_{60} < 20$	48	14.5	48	14.5	
	High Sand	-	$N_{60} \ge 20$	48	13.5	48	14.0	
	Low Clay	$500 \le S_u < 1000$	-	48	21.0	48	21.5	
	Med Clay	$1000 \le S_u < 2000$	-	48	16.0	48	16.5	
	High Clay	$S_u \ge 2000$	-	48	12.5	48	13.5	
121 to 150	Low Sand	-	$5 \le N_{60} < 10$	48	16.5	48	17.0	
	Med Sand	-	$10 \le N_{60} < 20$	48	14.5	48	15.0	
	High Sand	-	$N_{60} \ge 20$	48	13.5	48	14.0	
	Low Clay	$500 \le S_u < 1000$	-	48	21.0	48	22.0	
	Med Clay	$1000 \le S_u < 2000$	-	48	16.5	48	17.0	
	High Clay	$S_u \ge 2000$	-	48	13.0	48	13.5	
151 to 176	Low Sand	-	$5 \le N_{60} < 10$	48	17.5	48	18.0	
	Med Sand	-	$10 \le N_{60} < 20$	48	15.5	48	16.0	
	High Sand	-	$N_{60} \ge 20$	48	14.5	48	15.0	
	Low Clay	$500 \le S_u < 1000$	-	48	23.0	48	24.0	
	Med Clay	$1000 \le S_u < 2000$	-	48	17.5	48	18.0	
	High Clay	$S_u \ge 2000$	-	48	14.0	48	14.5	
177 to 200	Low Sand	-	$5 \le N_{60} < 10$	48	18.0	48	18.5	
	Med Sand	-	$10 \le N_{60} < 20$	48	16.0	48	16.5	
	High Sand	-	$N_{60} \ge 20$	48	15.0	48	15.5	
	Low Clay	$500 \le S_u < 1000$	-	48	23.5	48	24.5	
	Med Clay	$1000 \le S_u < 2000$	-	48	18.0	48	18.5	
	High Clay	$S_u \ge 2000$	-	48	14.0	48	14.5	

* S_u = Undrained Shear Strength in Cohesive Soil (psf)
* N_{60} = Standard Penetration Resistance (Blows/Foot according to ASTM D-1586) Corrected to 60 % Hammer Efficiency Utilizing the Hammer's Calibrated Energy
* Foundation length measured from the top of the shaft, and assumes maximum 0.25 feet (3 inches) of stickup

NOTE: A Detailed Site Specific Design is Required for the Following Conditions

1) If $N_{60} < 5$ bpf or $S_u < 500$ psf
2) If span lengths are greater than 200 feet
3) If ground water is less than 3 feet below the ground surface.
4) If a rock socket is required for the drilled shaft, if N_{60} values greater than 50 blows per foot dominate the lower half of the drilled shaft length, or if drilling refusal or split-spoon refusal is encountered above design bottom of foundation elevation.

OTHER NOTES:

A. This chart is for use with untethered spans connected to tie-offs with signals that do not have backplates. See SIG-020 for details.
See SIG-020 for definition of span length when tie-offs are used.
The upper 5 feet of soil modeled as disturbed soil assuming ground is disturbed to locate utilities.
Drilled shaft head deflection less than or equal to 1 inch.

Strain Pole Foundation Chart - Tethered Spans - Poles Connected to Tie-Off Spans [A]

Span Length (ft)	Soil Type	Soil Condition		36 ft Pole Length		40 ft Pole Length		Casing Length
		S_u *	N_{60} *	Diameter (in)	Foundation Depth (ft) *	Diameter (in)	Foundation Depth (ft) *	
≤ 100	Low Sand	-	$5 \le N_{60} < 10$	48	20.0	48	21.5	As Shown on Plans
	Med Sand	-	$10 \le N_{60} < 20$	48	17.5	48	18.5	
	High Sand	-	$N_{60} \ge 20$	48	16.5	48	17.5	
	Low Clay	$500 \le S_u < 1000$	-	48	27.5	48	30.0	
	Med Clay	$1000 \le S_u < 2000$	-	48	20.0	48	21.0	
	High Clay	$S_u \ge 2000$	-	48	15.5	48	16.5	
101 to 120	Low Sand	-	$5 \le N_{60} < 10$	48	20.5	48	21.5	
	Med Sand	-	$10 \le N_{60} < 20$	48	18.0	48	19.0	
	High Sand	-	$N_{60} \ge 20$	48	16.5	48	17.5	
	Low Clay	$500 \le S_u < 1000$	-	48	28.0	48	30.5	
	Med Clay	$1000 \le S_u < 2000$	-	48	20.0	48	21.0	
	High Clay	$S_u \ge 2000$	-	48	16.0	48	16.5	
121 to 150	Low Sand	-	$5 \le N_{60} < 10$	48	21.0	48	22.5	
	Med Sand	-	$10 \le N_{60} < 20$	48	18.5	48	19.5	
	High Sand	-	$N_{60} \ge 20$	48	17.5	48	18.0	
	Low Clay	$500 \le S_u < 1000$	-	48	30.0	48	33.5	
	Med Clay	$1000 \le S_u < 2000$	-	48	21.0	48	22.0	
	High Clay	$S_u \ge 2000$	-	48	16.5	48	17.0	
151 to 176	Low Sand	-	$5 \le N_{60} < 10$	48	21.5	48	23.0	
	Med Sand	-	$10 \le N_{60} < 20$	48	19.0	48	20.0	
	High Sand	-	$N_{60} \ge 20$	48	17.5	48	18.5	
	Low Clay	$500 \le S_u < 1000$	-	48	31.5	48	37.5	
	Med Clay	$1000 \le S_u < 2000$	-	48	21.5	48	22.5	
	High Clay	$S_u \ge 2000$	-	48	16.5	48	17.5	
177 to 200	Low Sand	-	$5 \le N_{60} < 10$	48	22.0	48	23.5	
	Med Sand	-	$10 \le N_{60} < 20$	48	19.0	48	20.0	
	High Sand	-	$N_{60} \ge 20$	48	18.0	48	18.5	
	Low Clay	$500 \le S_u < 1000$	-	48	32.0	48	38.0	
	Med Clay	$1000 \le S_u < 2000$	-	48	21.5	48	23.5	
	High Clay	$S_u \ge 2000$	-	48	16.5	48	17.5	

*S_u = Undrained Shear Strength in Cohesive Soil (psf)

* N_{60} = Standard Penetration Resistance (Blows/Foot according to ASTM D-1586) Corrected to 60 % Hammer Efficiency Utilizing the Hammer's Calibrated Energy

*Foundation length from the top of the shaft, and assumes maximum 0.25 feet (3 inches) of stickup

NOTE: A Detailed Site Specific Design is Required for the Following Conditions

1) If N_{60} < 5 bpf or S_u < 500 psf
2) If span lengths are greater than 200 feet
3) If ground water is less than 3 feet below the ground surface.
4) If a rock socket is required for the drilled shaft, if N_{60} values greater than 50 blows per foot dominate the lower half of the drilled shaft length, or if drilling refusal or split-spoon refusal is encountered above design bottom of foundation elevation.

OTHER NOTES:

A. This chart is for use with tethered spans connected to tie-offs with signals that have backplates. See SIG-020 for details.
See SIG-020 for definition of span length when tie-offs are used.
The upper 5 feet of soil modeled as disturbed soil assuming ground is disturbed to locate utilities.
Drilled shaft head deflection less than or equal to 1 inch.

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

Appendix D – Traffic Signal Strain Pole 36” Dia. Foundation Design Table

SIG-DESIGN-154

Strain Pole Foundation Chart - Tethered and Untethered Spans

Span Length (ft)	Soil Type	Soil Condition		30 ft Pole Length		Casing Length
		S_u *	N_{60} *	Diameter (in)	Foundation Depth (ft) *	
≤ 100	Low Sand	-	5≤ N_{60} < 10	36	14.0	As Shown on Plans
	Med Sand	-	10≤ N_{60} < 20	36	13.0	
	High Sand	-	N_{60} ≥ 20	36	12.5	
	Low Clay	500 ≤ S_u < 1000	-	36	18.0	
	Med Clay	1000 ≤ S_u < 2000	-	36	14.0	
	High Clay	S_u ≥2000	-	36	11.5	
101 to 120	Low Sand	-	5≤ N_{60} < 10	36	14.0	
	Med Sand	-	10≤ N_{60} < 20	36	13.0	
	High Sand	-	N_{60} ≥ 20	36	12.5	
	Low Clay	500 ≤ S_u < 1000	-	36	18.0	
	Med Clay	1000 ≤ S_u < 2000	-	36	14.0	
	High Clay	S_u ≥2000	-	36	11.5	
121 to 150	Low Sand	-	5≤ N_{60} < 10	36	14.0	
	Med Sand	-	10≤ N_{60} < 20	36	13.0	
	High Sand	-	N_{60} ≥ 20	36	12.5	
	Low Clay	500 ≤ S_u < 1000	-	36	18.0	
	Med Clay	1000 ≤ S_u < 2000	-	36	14.0	
	High Clay	S_u ≥ 2000	-	36	11.5	

*S_u = Undrained Shear Strength in Cohesive Soil (psf)
*N_{60} = Standard Penetration Resistance (Blows/Foot according to ASTM D-1586) Corrected to 60% Hammer Efficiency Utilizing the Hammer's Calibrated Energy
*Foundation length measured from the top of the shaft, and assumes 0.25 feet (3 inches) of stickup

NOTE: A Detailed Site Specific Design Is Required for any of the Following Conditions

1) If N_{60} < 5 or S_u <500 psf
2) If span lengths are greater than 150 feet
3) If groundwater is less than 3 feet below the finished ground surface
4) If a rock socket is required for the drilled shaft, if N_{60} values greater than 50 blows per foot dominate the lower half of the drilled shaft length, or if drilling refusal or split-spoon refusal is encountered above design bottom foundation elevation.

OTHER NOTES:

This chart is for use with tethered and untethered spans. See SIG-022 for details.
The upper 3.5 feet of soil modeled as soil assuming ground is disturbed to locate utilities.
Drilled shaft head lateral deflection less than or equal to 1 inch.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

	DATE: 05/17/24	CS:STATEWIDE	TRAFFIC SIGNAL STRAIN POLE - 36" DIA FOUNDATION	DRAWING / SHEET
	DESIGN UNIT:SIGNALS	JN:STATEWIDE	FOUNDATION DESIGN TABLE	SECT
FILE: sig-design-154-A	TSC:STATEWIDE		SIG-DESIGN-154-A	1 of 1

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

Appendix E – Traffic Signal Mast Arm Pole Foundation Design Table

SIG-DESIGN-284

Mast Arm Foundation Chart[A]

Mast Arm Type	Soil Type	Soil Condition		Diameter (in)	Foundation Length (ft) *		Casing Depth
		S_u *	N_{60} *		Arm Length 20 to 50 Feet	Arm Length > 50 to 60 feet	
Single Arm	Low Sand	-	$5 \le N_{60} < 10$	42	15.0	16.5	As Shown on Plans
	Med Sand	-	$10 \le N_{60} < 20$	42	13.0	14.0	
	High Sand	-	$N_{60} \ge 20$	42	12.5	12.5	
	Low Clay	$500 \le S_u < 1000$	-	42	16.5	19.5	
	Med Clay	$1000 \le S_u < 2000$	-	42	14.0	15.5	
	High Clay	$S_u \ge 2000$	-	42	11.5	12.5	
Double Arm	Low Sand	-	$5 \le N_{60} < 10$	42	18.0	22.5	
	Med Sand	-	$10 \le N_{60} < 20$	42	14.5	18.5	
	High Sand	-	$N_{60} \ge 20$	42	14.0	15.0	
	Low Clay	$500 \le S_u < 1000$	-	42	19.5	29.5	
	Med Clay	$1000 \le S_u < 2000$	-	42	15.5	18.5	
	High Clay	$S_u \ge 2000$	-	42	12.5	15.0	

*S_u = Undrained Shear Strength in Cohesive Soil (psf)

*N_{60} = Standard Penetration Resistance (Blows/Foot according to ASTM D-1586) corrected to 60% Hammer Efficiency utilizing the Hammer's Calibrated Energy

*Foundation length measured from the top of the shaft, and assumes maximum 0.25 feet (3 inches) of stickup

Note: A Detailed Site Specific Design is Required for any of the Following Conditions

1) If $N_{60} < 5$ bfp or $S_u < 500$ psf
2) If mast arm lengths are greater than 60 feet
3) If groundwater is less than 3 feet below the finished ground surface
4) If a rock socket is required for the drilled shaft, if N_{60} values greater than 50 blows per foot dominate the lower half of the drilled shaft length, or if drilling refusal or split-spoon refusal is encountered above design bottom of foundation elevation.

OTHER NOTES:

A. This chart is for use with Mast Arms. See SIG-030, SIG-031, SIG-032, and SIG-033 for details.

The upper 3.5 feet of soil modeled as low strength granular soil assuming ground is disturbed to locate utilities.

Drilled shaft head lateral deflection less than or equal to 1 inch.

APPROVED BY: _____
DIRECTOR, BUREAU OF FIELD SERVICES

APPROVED BY: _____
DIRECTOR, BUREAU OF DEVELOPMENT

MDOT Michigan Department of Transportation

DEPARTMENT DIRECTOR
BRADLEY C. WIEFERICH, PE

STANDARD PLAN FOR
TRAFFIC SIGNAL MAST ARM POLE
FOUNDATION DESIGN TABLE

(SPECIAL DETAIL) FHWA APPROVAL	05/17/24 PLAN DATE	SIG-DESIGN-284-B	SHEET 1 OF 1

MDOT Michigan Department of Transportation

DEPARTMENT DIRECTOR
BRADLEY C. WIEFERICH, PE

STANDARD PLAN FOR

(SPECIAL DETAIL) FHWA APPROVAL	00/00/00 PLAN DATE		SHEET OF

SECT

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

Appendix F – Guidelines for Traffic Signal Structures Plan Preparation

GUIDELINES FOR TRAFFIC SIGNAL STRUCTURES PLAN PREPARATION

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FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

	DATE:	CS:		DRAWING	SHEET
	DESIGN UNIT:	JN:			SECT 1
FILE:	TSC:				

PURPOSE AND APPLICATION

This set of sample plans is intended for use as a guideline for preparing a set of traffic signal structure construction plans for the Michigan Department of Transportation. The examples of various sheets illustrate preferred techniques to ensure the uniformity, quality, and continuity of plans.

Other sheets are examples of various plan sheets, based on the most commonly occurring situations. However, it is recognized that some projects will have unusual circumstances that may allow for some variations from the preferred techniques contained herein.

This set is not to be considered or used as a single, coordinated plan, but as a collection of individual sheet types. In many cases, copies of actual plan sheets have been used to develop the sheets contained herein. Since modifications have been made to those sheets to develop an appropriate sample, they are not to be considered an official record of the plans from which they were taken.

Where the information shown on the sample plan sheets is in conflict with the design standards or practices of Michigan Department of Transportation as contained in its Standard Specifications for Construction special provisions, design manuals or design standards, the standards and practices supersede any sample plan sheet information.

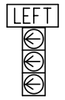
Boxed numbers refer to the plan guidelines located on the plan Guidelines Sheet at the beginning of each section.

See MDOT Guidelines for Bridge Plan Preparation for general plan preparation guidelines not specific to culverts such as guidelines for sheet layout, text, dimensions, plan notes, etc.

See MDOT Guidelines for Plan Preparation for guidelines related to sheets not specific to traffic signal structures such as survey, alignment, and typical section sheets.

Errors and omissions can be reported to MDOT-Ancillary@Michigan.gov.

1-WAY 12"x27"
NON-ILLUMINATED CASE SIGN



FACING
NORTH (T.S. #6)
SOUTH (T.S. #1)

FACING
EAST (T.S. #9, #10)
WEST (T.S.#4)
NORTH (T.S. #7, #8)
SOUTH (T.S. #2, #3)

FACING
WEST (T.S. #5)

EXISTING 2-WAY 24"x30"
NON-ILLUMINATED CASE SIGN

FACING
EAST (C.S.#1, #2)
WEST (C.S. #1, #2)

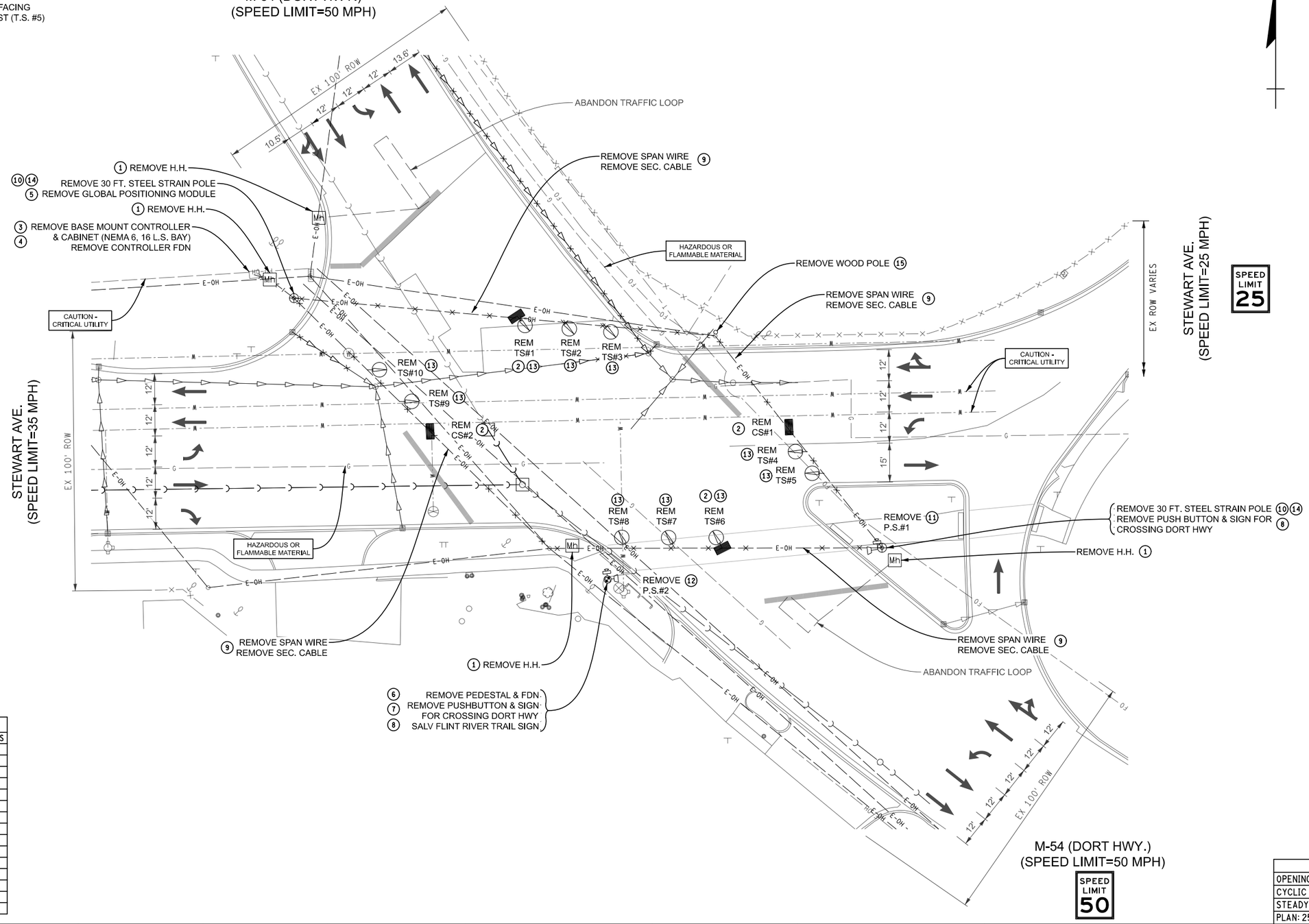
L.E.D.

COUNT DOWN
HEAD

FACING
WEST (P.S.#1)
EAST (P.S.#2)

R10-3e

FACING
WEST (P.S.#1)
EAST (P.S.#2)



LIST OF MATERIAL		
NO.	ITEM	QUANTITIES
(1)	Hh, Rem	4 Ea
(2)	Case Sign, Rem	4 Ea
(3)	Controller and Cabinet, Rem	1 Ea
(4)	Controller Fdn, Rem	1 Ea
(5)	Global Positioning System Module, Rem	1 Ea
(6)	Pedestal Fdn, Rem	1 Ea
(7)	Pedestal, Rem	1 Ea
(8)	Pushbutton, Rem	2 Ea
(9)	Span Wire, Rem	4 Ea
(10)	Steel Pole, Rem	2 Ea
(11)	TS, Pedestrain, Bracket Arm Mtd, Rem	1 Ea
(12)	TS, Pedestrain, Pedestal Mtd, Rem	1 Ea
(13)	TS, Span Wire Mtd, Rem	10 Ea
(14)	Fdn, Rem	2 Ea
(15)	Wood Pole, Rem	1 Ea

SIGNALS	
OPENINGS:	37
CYCLIC WATTS:	404
STEADY WATTS:	210
PLAN: 25072-01-017	

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 40

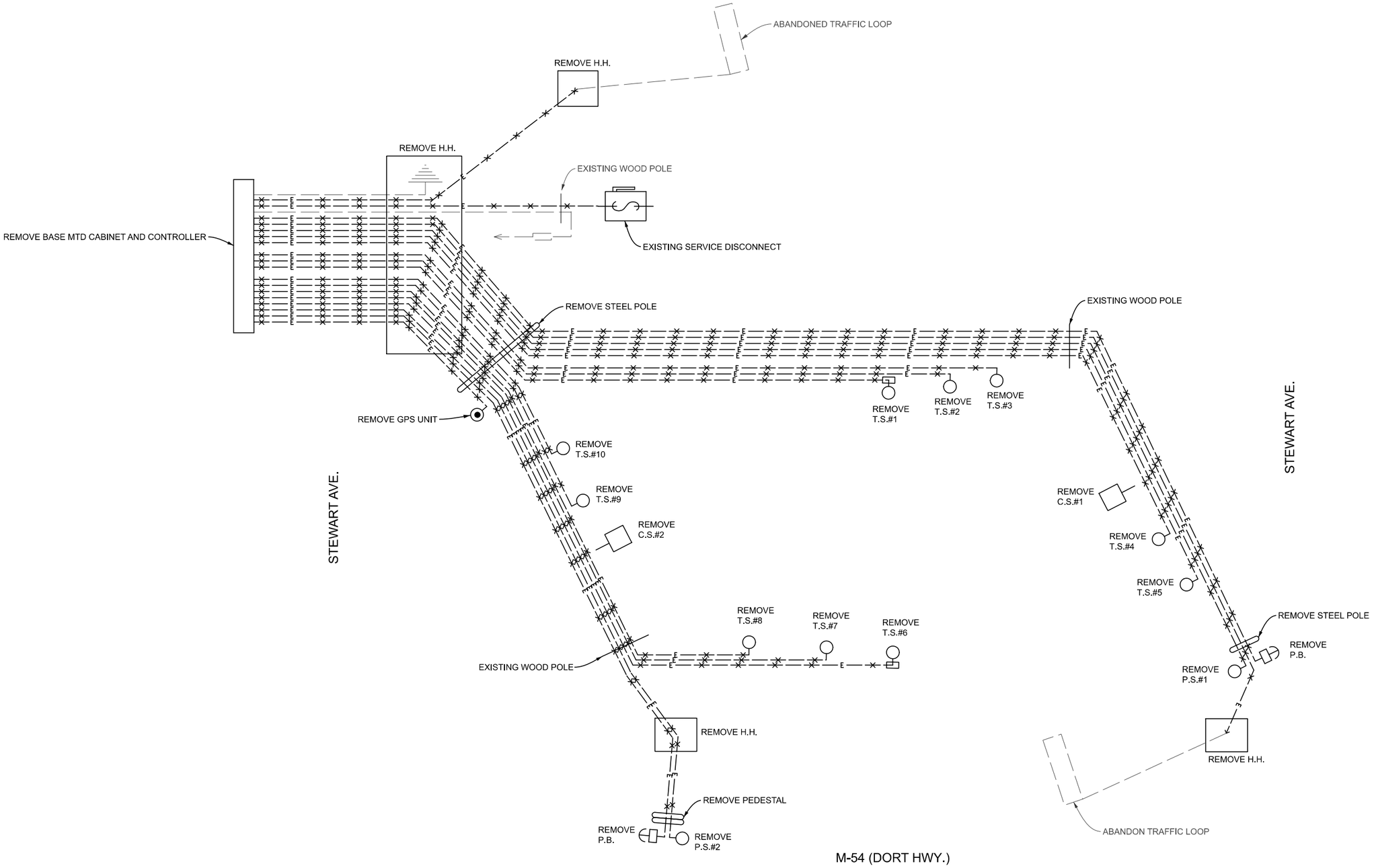
FILE: 210054_I475_North_Signal_REM01.dgn

DATE: 08/22/23
DESIGN UNIT:VINCKE
TSC: DAVISON

CS: 25132
JN: 210054A

REMOVAL
M-54 (DORT HWY.) AT STEWART AVE
CITY OF FLINT

DRAWING	SHEET
I-475 PSIGN 001	SECT 1 253



REMOVAL CABLING DIAGRAM

NOT TO SCALE

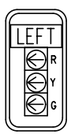
SIGNALS	
OPENINGS:	37
CYCLIC WATTS:	404
STEADY WATTS:	210
PLAN: 25072-01-017	

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

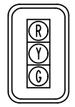
	DATE: 08/22/23	CS: 25132	REMOVAL	DRAWING / SHEET
	DESIGN UNIT:VINCKE	JN: 210054A	M-54 (DORT HWY.) AT STEWART AVE	I-475 PSIGN 002 / SECT 1 254
FILE: 210054_I475_North_Signal_WRM01.dgn	TSC: DAVISON		CITY OF FLINT	



FACING
NORTH (T.S.#6)
SOUTH (T.S.#1)

FACING
WEST (T.S.#5)

FACING
EAST (T.S.#9, #10)
WEST (T.S.#4)



FACING
NORTH (T.S.#7, #8)
SOUTH (T.S.#2, #3)

2-WAY 24"x30"
ILLUMINATED CASE SIGN

FACING
WEST (C.S.#1, #2)

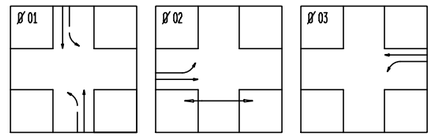
FACING
EAST (C.S.#1, #2)

COUNT DOWN
HEAD

FACING
EAST (P.S.#2)
WEST (P.S.#1)

FACING
EAST (P.S.#2)
WEST (P.S.#1)

PHASING DIAGRAMS



M-54 (DORT HWT) EB STEWART AVE WB STEWART AVE

SPEED LIMIT 50

M-54 (DORT HWY.)
(SPEED LIMIT=50 MPH)

SPEED LIMIT 35

STEWART AVE.
(SPEED LIMIT=35 MPH)

SPEED LIMIT 25

STEWART AVE.
(SPEED LIMIT=25 MPH)

SPEED LIMIT 50

M-54 (DORT HWY.)
(SPEED LIMIT=50 MPH)

CONDUIT, DB, 1, 3 INCH
DB CABLE, IN CONDUIT, 600V, 1/#6
CABLE, EQUIPMENT GROUNDING WIRE, 1/#6

(21) INSTALL HH, ROUND, 3 FOOT DIA
N: 567187.62, E: 13309047.68

CAUTION - CRITICAL UTILITY

(4) (7) (20) INSTALL BASE MOUNT CONTROLLER & CABINET (NEMA 6, 16 L.S. BAY)
(16) INSTALL CELLULAR MODEM
(18) INSTALL RADAR STOPBAR DETECTION SYSTEM

(13) INSTALL 36 FT. STEEL STRAIN POLE
(14) INSTALL STRAIN POLE FDN (42" DIA., 14') (SB-01)
(15) INSTALL CASING (10.5')
N: 567179.27, E: 13309056.43
(19) INSTALL RADAR STOPBAR DETECTION SENSOR
(1) (1) INSTALL (2) POLYMER CONC HH
(22) INSTALL LIGHTNING PROTECTION

RADAR STOPBAR DETECTION
50' X 15'

ABANDONED TRAFFIC LOOP

EXISTING 55'/4 C.E. WOOD POLE
EXISTING 120V SERVICE
EXISTING SERVICE DISCONNECT (NEMA 4X)

HAZARDOUS OR FLAMMABLE MATERIAL

(6) INSTALL SPAN WIRE

(12) INSTALL 30 FT. STEEL STRAIN POLE
(14) INSTALL STRAIN POLE FDN (36" DIA., 13') (SB-02)
(15) INSTALL CASING (9.5')
N: 567170.46, E: 13309205.41
(19) INSTALL RADAR STOPBAR DECTION SENSOR
(1) (1) INSTALL (2) POLYMER CONC HH
(22) INSTALL LIGHTNING PROTECTION

INSTALL T.S.#1 (2) (10) (17)
INSTALL T.S.#2 (8) (17)
INSTALL T.S.#3 (8) (17)
INSTALL T.S.#4 (8)
INSTALL T.S.#5 (9)
INSTALL T.S.#6 (2) (10) (17)
INSTALL T.S.#7 (8) (17)
INSTALL T.S.#8 (8) (17)
INSTALL T.S.#9 (8)
INSTALL T.S.#10 (8)

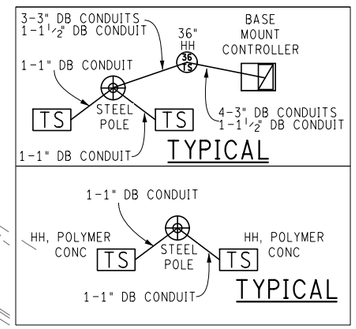
INSTALL C.S.#1 (3)
INSTALL C.S.#2 (3)

INSTALL P.S.#1 (11)
INSTALL P.S.#2 (11)

EX 100' ROW
EX ROW VARIES
E-OH
F.O.

(12) INSTALL 30 FT. STEEL STRAIN POLE
(14) INSTALL STRAIN POLE FDN (36" DIA., 13') (SB-05)
(15) INSTALL CASING (9.5')
N: 567086.58, E: 13309167.58
(5) (11) INSTALL PUSHBUTTON & SIGN
(19) INSTALL RADAR STOPBAR DETECTION SENSOR
(1) (1) INSTALL (2) POLYMER CONC HH
(22) INSTALL LIGHTNING PROTECTION

(12) INSTALL 30 FT. STEEL STRAIN POLE
(14) INSTALL STRAIN POLE FDN (36" DIA., 12') (SB-22)
(15) INSTALL CASING (8.5')
N: 567100.87, E: 13309267.78
(5) (11) INSTALL PUSHBUTTON & SIGN
(19) INSTALL RADAR STOPBAR DETECTION SENSOR
(1) (1) INSTALL (2) POLYMER CONC HH
(22) INSTALL LIGHTNING PROTECTION



LIST OF MATERIAL		
NO.	ITEM	QUANTITIES
(1)	Hh, Polymer Conc	8 Ea
(2)	Case Sign (LED), One Way, 12 inch by 27 inch	2 Ea
(3)	Case Sign (LED), Two Way, 24 inch by 30 inch	2 Ea
(4)	Controller Fdn, Base Mtd	1 Ea
(5)	Pushbutton and Sign	2 Ea
(6)	Span Wire	4 Ea
(7)	Cabinet, NEMA Type	1 Ea
(8)	TS, One Way Span Wire Mtd (LED)	7 Ea
(9)	TS, One Way Span Wire Mtd, Five Sect (LED)	1 Ea
(10)	TS, One Way Span Wire Mtd, LTGA (LED)	2 Ea
(11)	TS, Pedestrian, One Way Bracket Arm Mtd (LED) Countdown	2 Ea
(12)	Strain Pole, Steel, 6 Bolt, 30 foot	3 Ea
(13)	Strain Pole, Steel, 6 Bolt, 36 foot	1 Ea
(14)	Strain Pole Fdn, 6 Bolt	52 Ft
(15)	Casing	38 Ft
(16)	Cellular Modem, TS, 4th G	1 Ea
(17)	Backplate, TS	6 Ea
(18)	Radar Vehicle Presence Stop-Bar Detector System	1 Ea
(19)	Radar Vehicle Presence Stop-Bar Detector Sensor	4 Ea
(20)	Controller, NEMA, ATC Type, Modified	1 Ea
(21)	Hh, Round, 3 foot dia	1 Ea
(22)	Lightning Protection, Pole	4 Ea
◯	Conduit, DB, 1, 1 1/2 inch	15 Ft
◯	Conduit, DB, 1, 3 inch	20 Ft
◯	Conduit, DB, 3, 3 inch	15 Ft
◯	Conduit, DB, 4, 3 inch	5 Ft
◯	Conduit, DB, 1, 1 inch	20 Ft
◯	DB Cable, in Conduit, 600V, 1/C#6	55 Ft
◯	Cable, Equipment Grounding Wire, 1/C#6	55 Ft

CONTACT: THE REGION TRAFFIC ENGINEER TRAVIS PHILLIPS (989) 233-7363 FOR LAYOUT OF TRAFFIC LOOPS, GIVE 5 WORKING DAYS NOTICE.

NOTE

1. CONTRACTOR TO COORDINATE WITH UTILITIES FOR EXISTING CONNECTIONS

SIGNALS	
OPENINGS:	37
CYCLIC WATTS:	404
STEADY WATTS:	210
PLAN: 25072-01-017	

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

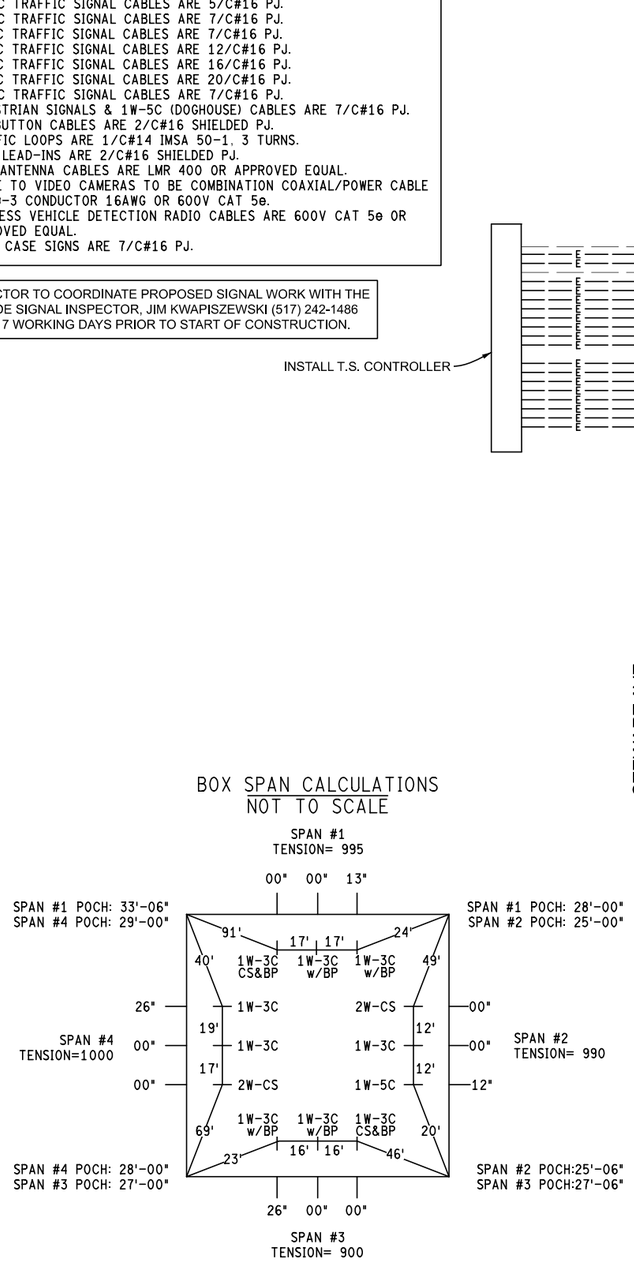
0 HORZ. (FT) 40

	DATE: 08/22/23	CS: 25132	CONSTRUCTION	DRAWING SHEET
	DESIGN UNIT:VINCKE	JN: 210054A	M-54 (DORT HWY.) AT STEWART AVE	I-475 PSIGN 003 SECT 1 255
FILE: 210054_I475_North_Signal_PR01.dgn	TSC: DAVISON		CITY OF FLINT	

CABLES TO BE USED UNLESS SPECIFIED OTHERWISE

1. 1W-3C TRAFFIC SIGNAL CABLES ARE 5/C#16 PJ.
2. 1W-4C TRAFFIC SIGNAL CABLES ARE 7/C#16 PJ.
3. 2W-3C TRAFFIC SIGNAL CABLES ARE 7/C#16 PJ.
4. 3W-3C TRAFFIC SIGNAL CABLES ARE 12/C#16 PJ.
5. 4W-3C TRAFFIC SIGNAL CABLES ARE 16/C#16 PJ.
6. 4W-4C TRAFFIC SIGNAL CABLES ARE 20/C#16 PJ.
7. 4W-1C TRAFFIC SIGNAL CABLES ARE 7/C#16 PJ.
8. PEDESTRIAN SIGNALS & 1W-5C (DOGHOUSE) CABLES ARE 7/C#16 PJ.
9. PUSHBUTTON CABLES ARE 2/C#16 SHIELDED PJ.
10. TRAFFIC LOOPS ARE 1/C#14 IMSA 50-1, 3 TURNS.
11. LOOP LEAD-INS ARE 2/C#16 SHIELDED PJ.
12. YAGI ANTENNA CABLES ARE LMR 400 OR APPROVED EQUAL.
13. CABLE TO VIDEO CAMERAS TO BE COMBINATION COAXIAL/POWER CABLE RG 59-3 CONDUCTOR 16AWG OR 600V CAT 5e.
14. WIRELESS VEHICLE DETECTION RADIO CABLES ARE 600V CAT 5e OR APPROVED EQUAL.
15. L.E.D. CASE SIGNS ARE 7/C#16 PJ.

CONTRACTOR TO COORDINATE PROPOSED SIGNAL WORK WITH THE STATEWIDE SIGNAL INSPECTOR, JIM KWAPISZEWSKI (517) 242-1486 AT LEAST 7 WORKING DAYS PRIOR TO START OF CONSTRUCTION.



CABLING INSTALL DIAGRAM

NOT TO SCALE

N

SIGNALS	
OPENINGS:	37
CYCLIC WATTS:	404
STEADY WATTS:	210
PLAN: 25072-01-017	

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

DATE: 08/22/23
DESIGN UNIT:VINCKE
FILE: 210054_I475_North_Signal_WPR01.dgn
TSC: DAVISON

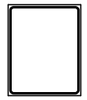
CS: 25132
JN: 210054A

CONSTRUCTION
M-54 (DORT HWY.) AT STEWART AVE
CITY OF FLINT

DRAWING	SHEET
I-475 PSIGN 004	SECT 1 256

4-WAY 24"X30"
ILLUMINATED CASE SIGN

FACING
NORTH (C.S.#1)
SOUTHEAST (C.S.#1)



FACING
NORTHWEST (C.S.#1)
SOUTH (C.S.#1)

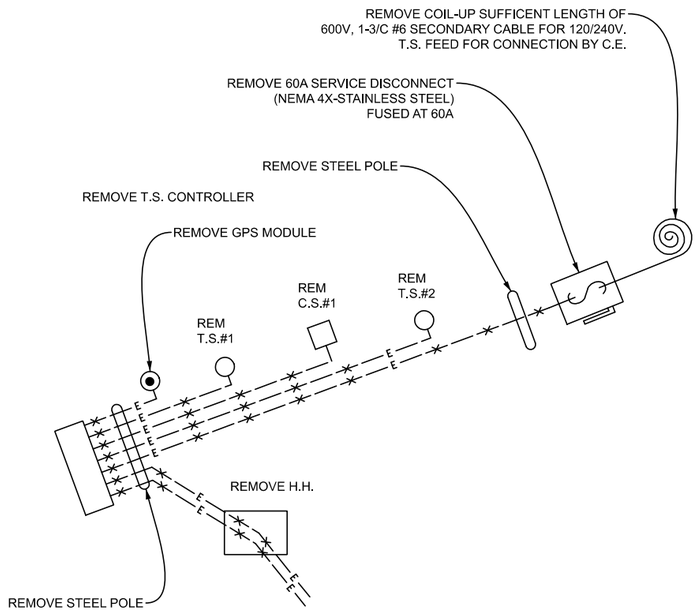
2-WAY
3 HEAD TRAFFIC SIGNAL

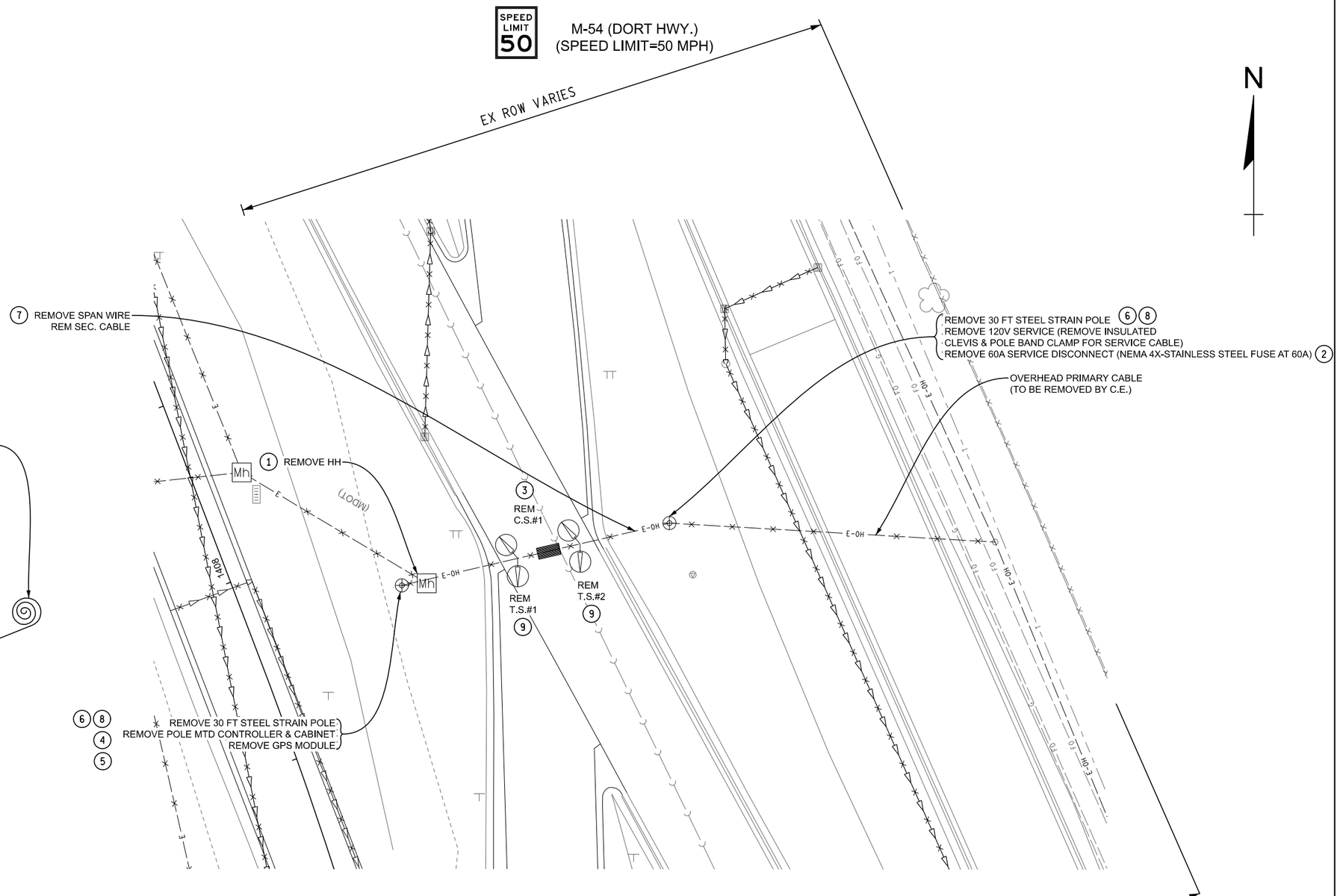
FACING
SOUTHEAST (T.S.#1, #2)
NORTHWEST (T.S.#1, #2)

CONTACT: TRACEY MAHAR OF CONSUMERS ENERGY AT 517-204-9018 FOR ELECTRICAL SERVICE CONNECTION. NO CHARGES

FOR ELECTRICAL SERVICE INSPECTION CONTACT THE MICHIGAN DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS AT 810-247-9558
COST TO CONTRACTOR WILL BE INCIDENTAL.

SEE SIGNAL SERVICE REMOVAL SHEET FOR REMOVAL OF SEC. & INTERCONNECT CABLES.





LIST OF MATERIAL

NO.	ITEM	QUANTITIES
1	Hh, Rem	1 Ea
2	Serv Disconnect, Rem	1 Ea
3	Case Sign, Rem	1 Ea
4	Controller and Cabinet, Rem	1 Ea
5	Global Positioning System Module, Rem	1 Ea
6	Fdn, Rem	2 Ea
7	Span Wire, Rem	1 Ea
8	Steel Pole, Rem	2 Ea
9	TS, Span Wire Mtd, Rem	2 Ea

SIGNALS	
OPENINGS:	16
CYCLIC WATTS:	1800
STEADY WATTS:	275
PLAN:	25132-01-037

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 40

FILE: 210054_I475_North_Signal_REM02.dgn

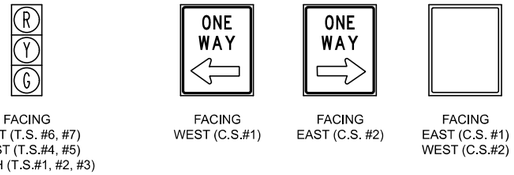
DATE: 08/22/23
DESIGN UNIT:VINCKE
TSC: DAVISON

CS: 25132
JN: 210054A

REMOVAL
M-54 (DORT HWY.) AT I-475 NB SERVICE DR
CITY OF FLINT

DRAWING	SHEET
I-475 PSIGN 005	SECT 1 257

2-WAY 24"x30"
NON-ILLUMINATED CASE SIGN



FACING
EAST (T.S. #6, #7)
WEST (T.S.#4, #5)
SOUTH (T.S.#1, #2, #3)

FACING
WEST (C.S.#1)

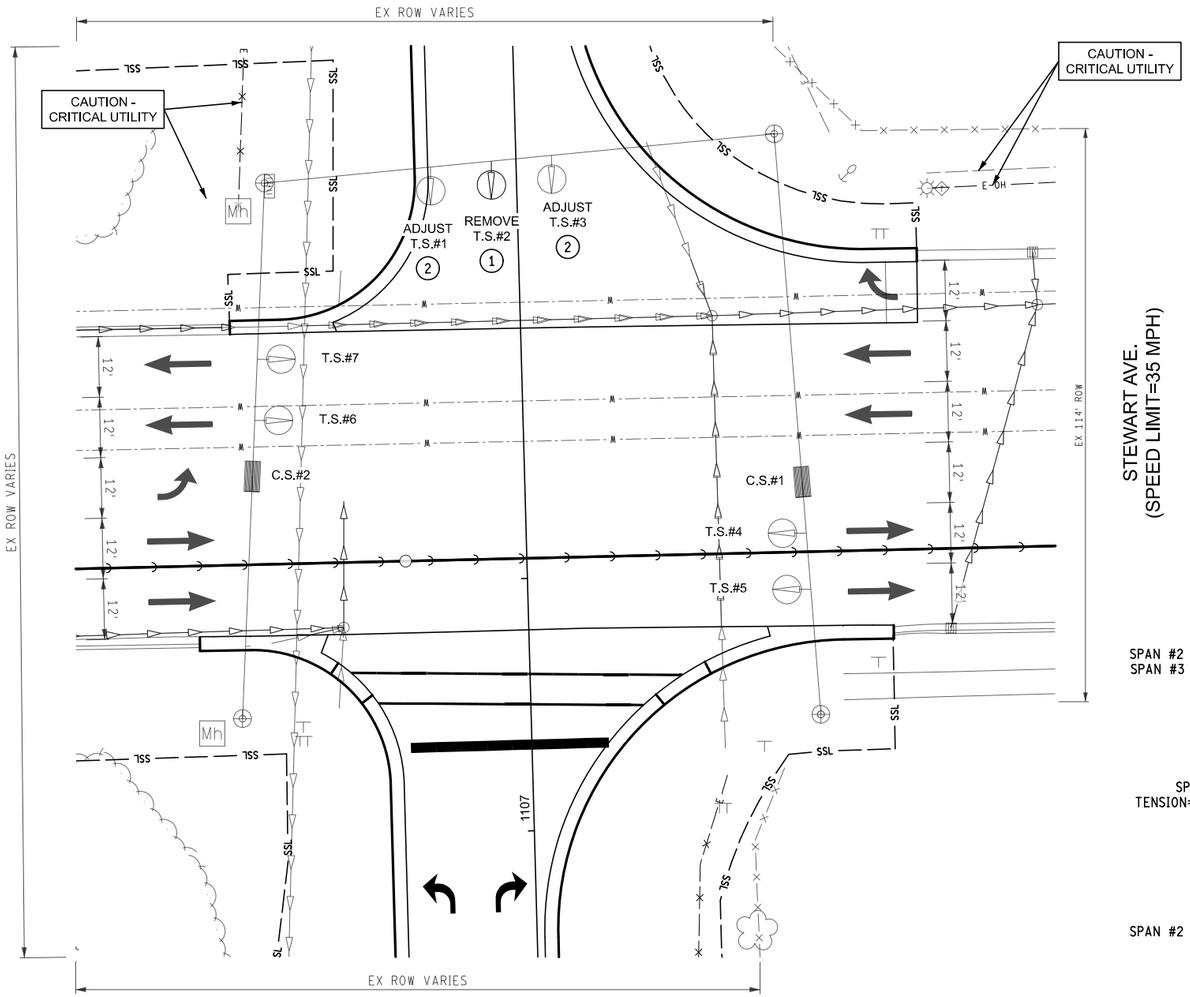
FACING
EAST (C.S. #2)

FACING
EAST (C.S. #1)
WEST (C.S.#2)

SPEED LIMIT 35

STEWART AVE.
(SPEED LIMIT=35 MPH)

I-475 NB ENTRANCE RAMP
(SPEED LIMIT=35 MPH)



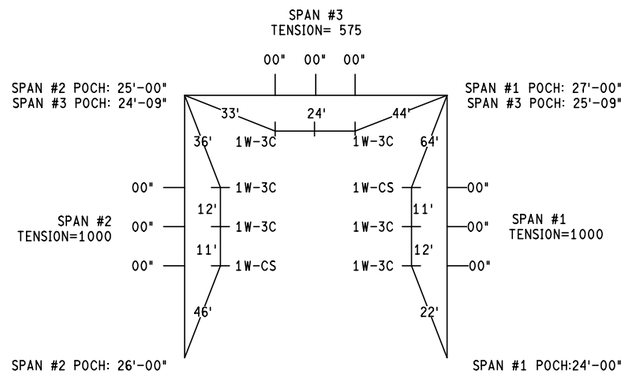
I-475 NB EXIT RAMP
(SPEED LIMIT=35 MPH)

SPEED LIMIT 35

STEWART AVE.
(SPEED LIMIT=35 MPH)

SPEED LIMIT 35

BOX SPAN CALCULATIONS
NOT TO SCALE



LIST OF MATERIAL		
NO.	ITEM	QUANTITIES
(1)	TS, Span Wire Mtd, Rem	1 Ea
(2)	TS Head, Adj	2 Ea

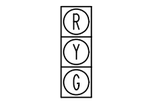
SIGNALS	
OPENINGS:	20
CYCLIC WATTS:	258
STEADY WATTS:	90
PLAN: 25132-01-010	

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 30

	DATE: 08/22/23	CS: 25132	REMOVAL	DRAWING	SHEET
	DESIGN UNIT:VINCKE	JN: 210054A	I-475 NB RAMPS AT STEWART AVE	I-475 PSIGN 006	SECT 1
FILE: 210054_I475_North_Signal_REM03.dgn	TSC: DAVISON		CITY OF FLINT		258



FACING
EAST (T.S.#6, #7)
WEST (T.S.#1, #2)
NORTH (T.S.#3, #4, #5)

2-WAY 24"x30"
NON-ILLUMINATED CASE SIGN

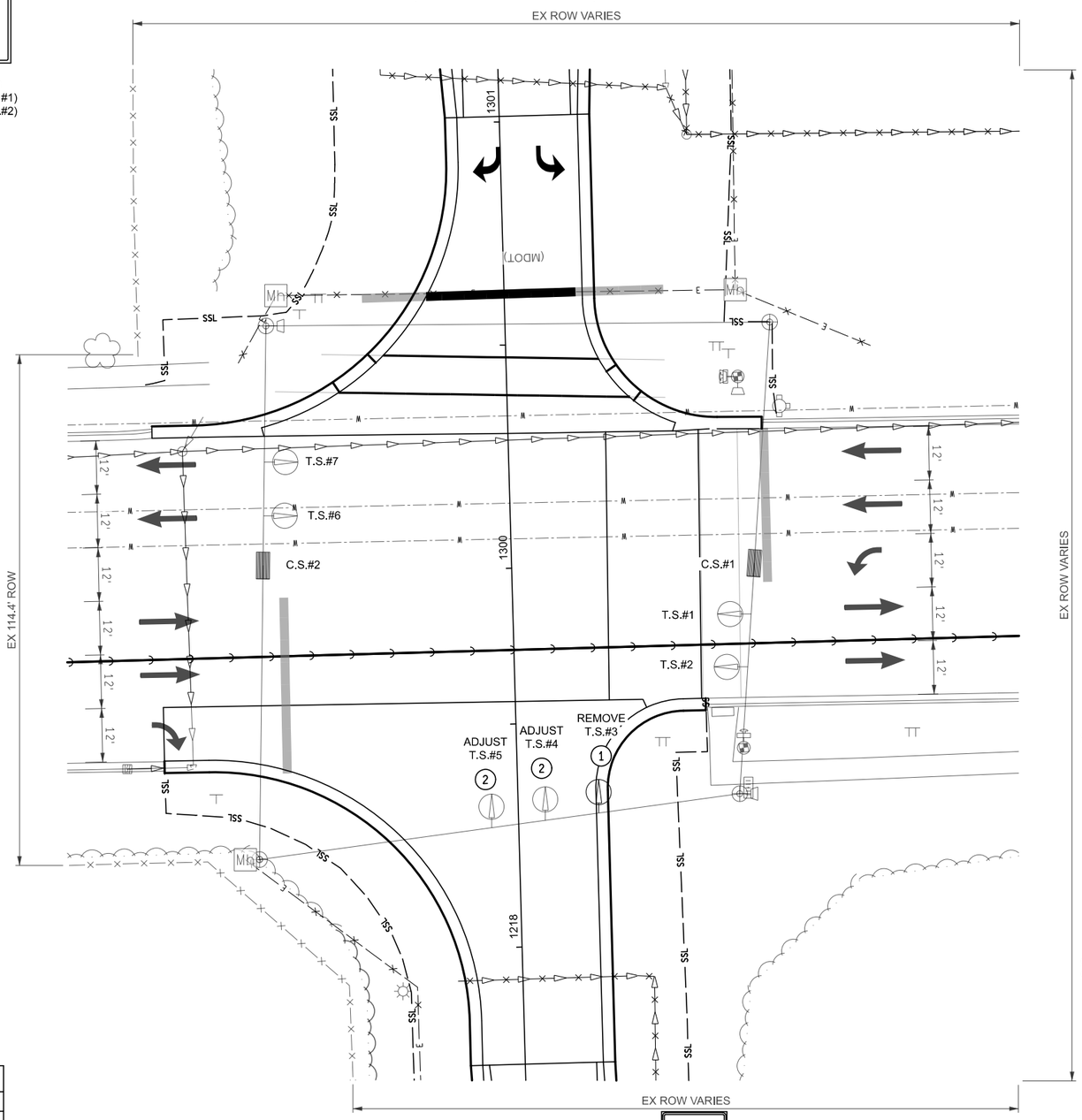
FACING
EAST (C.S.#2)

FACING
WEST (C.S. #1)

FACING
EAST (C.S. #1)
WEST (C.S.#2)

STEWART AVE.
(SPEED LIMIT=35 MPH)

I-475 SB EXIT RAMP
(SPEED LIMIT=35 MPH)

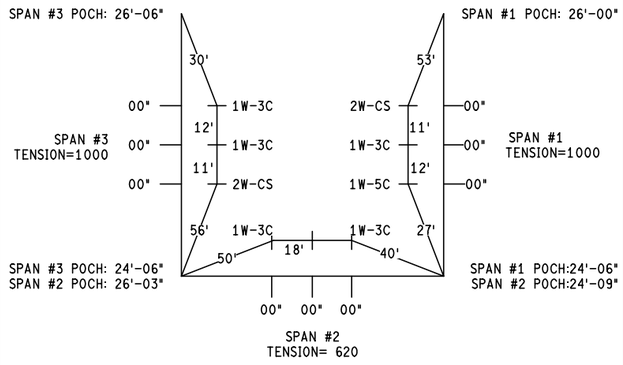


I-475 SB ENTRANCE RAMP
(SPEED LIMIT=35 MPH)

STEWART AVE.
(SPEED LIMIT=35 MPH)

N

BOX SPAN CALCULATIONS
NOT TO SCALE



LIST OF MATERIAL		
NO.	ITEM	QUANTITIES
(1)	TS, Span Wire Mtd, Rem	1 Ea
(2)	TS Head, Adj	2 Ea

SIGNALS	
OPENINGS:	20
CYCLIC WATTS:	258
STEADY WATTS:	90
PLAN: 25132-01-110	

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 30

	DATE: 08/22/23	CS: 25132	REMOVAL	DRAWING	SHEET
	DESIGN UNIT:VINCKE	JN: 210054A	I-475 SB RAMPS AT STEWART AVE	I-475 PSIGN 007	SECT 1 259
FILE: 210054_I475_North_Signal_REM04.dgn	TSC: DAVISON		CITY OF FLINT		

TEST HOLE NO. CB-C-01

LOCATION: NB I-475 EAST R.O.W

PHYSICAL REFERENCE: 12 FEET WEST OF W. BOULEVARD DRIVE
PHYSICAL OFFSET: 98 FEET SOUTH OF LEITH STREET

BORING DATE: 3/31/21 NORTHING: 562909
GROUND SURFACE ELEVATION: 713.3 FT EASTING: 13307962

			PP	MC
713.3				
712.9	6 5 6	FIELD ENGINEER REPORTED 5 INCHES OF SANDY TOPSOIL, BLACK FILL - FIELD ENGINEER REPORTED 6 INCHES OF BROWN SAND		
712.4 712.3		FILL - MEDIUM DENSE POORLY GRADED FINE SAND WITH SILT, TRACE CLAY, TRACE GRAVEL, DARK BROWN AND BLACK, MOIST (SP-SM)		
710.8				
709.8	2 1 2			
		VERY LOOSE TO LOOSE CLAYEY FINE SAND WITH SILT, BROWN WITH POCKETS OF BLACK, MOIST (SC) (POSSIBLE FILL)		
707.3	3 2 4			
704.8	2 3 9			
		MEDIUM DENSE SILTY SAND, TRACE CLAY, BROWN, MOIST TO WET (SM)		
699.8	10 12 15		4.5+	11.3
699.3				
		HARD LEAN CLAY WITH SAND, TRACE GRAVEL, GRAY (CL)		
694.8	13 24 36			
		VERY DENSE POORLY GRADED FINE SAND WITH SILT, TRACE GRAVEL, GRAY, WET (SP-SM)		
693.3				
689.8	15 50			
		EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, WET (SM) NOTE: DRILLER REPORTED POSSIBLE COBBLES BETWEEN 21 AND 22 FT.		
684.8	30 49 50			
679.8	5 38 82			
		EXTREMELY DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, GRAY, WET (SP)		
678.3		E.O.B. 35 FEET		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: 13.5 FEET
- GROUNDWATER LEVEL UPON COMPLETION: N/A
- LOGGED BY: S. SWAMINATHAN; CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 55 ATV (HAMMER ID 286595); EFFICIENCY = 90.8%; METHOD: 2 1/4 INCH HSA
- HOLE COLLAPSED AT 10 FT. AFTER PULLING OUT AUGERS

TEST HOLE NO. CB-C-02

LOCATION: LIETH STREET EB RIGHT LANE

PHYSICAL REFERENCE: 151 FEET EAST OF JAMES P. COLE BOULEVARD
PHYSICAL OFFSET: 50 FEET NORTH OF SOUTH BRIDGE ABUTMENT

BORING DATE: 4/6/21 NORTHING: 562999
GROUND SURFACE ELEVATION: 725.4 FT EASTING: 13307860

			PP	MC
725.4				
724.5	6 4 5	11 INCHES OF ASPHALTIC CEMENT CONCRETE FILL - FIELD ENGINEER REPORTED 7 INCHES OF SAND AND GRAVEL	3.25	11.5
724.4 723.9				
		FILL - VERY STIFF SANDY LEAN CLAY, TRACE GRAVEL, DARK BROWN WITH POCKETS OF BLACK (CL)		
721.9	3 3 3			
721.4		FILL - LOOSE POORLY GRADED FINE TO MEDIUM SAND, TRACE SILT, BLACK, MOIST (SP) (POSSIBLE FOUNDRY SAND)		
720.4				
719.4	3 3 2			
716.9	3 4 3	FILL - LOOSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, OCCASIONAL SANDY CLAY SEAMS AND GRAY FINE SAND POCKETS, OCCASIONAL DARK BROWN SILTY FINE SAND LAYERS ABOVE 7.5 FT., BROWN, MOIST (SP)		
711.9	4 4 4		2.75	17.4
		VERY STIFF LEAN CLAY, FEW SAND, TRACE GRAVEL, BROWN (CL)		
710.4				
706.9	8 14 20		4.5+	15.5
		HARD LEAN CLAY, FEW SAND, TRACE GRAVEL, FREQUENT SILT PARTINGS BELOW 24.5 FT., GRAY (CL)		
701.9	22 25 31	FIELD ENGINEER REPORTED SANDY SILT LAYER FROM 23.5 TO 24.5 FT.	4.5+	10.7
700.4				
696.9	31 43 46	EXTREMELY DENSE TO VERY DENSE POORLY GRADED FINE SAND WITH SILT, FEW GRAVEL, TRACE CLAY, GRAY, MOIST TO WET (SP-SM)		
693.4	37 34 44			
691.9		E.O.B. 33.5 FEET (BORING TERMINATED DUE TO AUGER REFUSAL)		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: 30 FEET
- GROUNDWATER LEVEL UPON COMPLETION: 30 FEET
- LOGGED BY: P. CODY; CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 45 SKID (HAMMER ID 246024); EFFICIENCY = 88.3%; METHOD: 2 1/4 INCH HSA
- PAVEMENT WAS DRILLED THROUGH WITH AUGERS

TEST HOLE NO. CB-C-03

LOCATION: SB I-475 WEST R.O.W

PHYSICAL REFERENCE: 36 FEET EAST OF JAMES P. COLE BOULEVARD
PHYSICAL OFFSET: 26 FEET SOUTH OF LEITH STREET

BORING DATE: 3/30/21 NORTHING: 562965
GROUND SURFACE ELEVATION: 721.8 FT EASTING: 13307739

			PP	MC
721.8				
721.5	5 10 14	FIELD ENGINEER REPORTED 4 INCHES OF SANDY TOPSOIL, BLACK FILL - FIELD ENGINEER REPORTED 8 INCHES OF BROWN SANDY CLAY		
720.8				
718.3	10 8 7	FILL - MEDIUM DENSE TO LOOSE POORLY GRADED FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)		
715.8	4 2 5			
714.8				
713.3	3 6 15	FILL - MEDIUM DENSE CLAYEY FINE SAND, TRACE GRAVEL, OCCASIONAL SANDY CLAY SEAMS, BROWN AND DARK BROWN, MOIST (SC)		
712.3 712.1			4.5	16.8
		HARD LEAN CLAY, FEW SAND, TRACE GRAVEL, BROWN (CL)		
708.3	25 25 35			
703.3	50			
		VERY DENSE TO EXTREMELY DENSE CLAYEY FINE SAND/SANDY LEAN CLAY, TRACE GRAVEL, GRAY (SC)/(CL) NOTE: SPLIT SPOON REFUSAL AT 19 FT. DUE TO POSSIBLE COBBLES		
698.3	45 50			
693.3	45 56 50	EXTREMELY DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, OCCASIONAL CLAY POCKETS, GRAY, WET (SP) NOTE: DRILLER REPORTED POSSIBLE COBBLES AT 31.5 FT. AND 33 FT.		
688.3	46 58 50			
686.8		E.O.B. 35 FEET		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: 29 FEET
- GROUNDWATER LEVEL UPON COMPLETION: 22.5 FEET
- LOGGED BY: S. SWAMINATHAN; CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 55 ATV (HAMMER ID 286595); EFFICIENCY = 90.8%; METHOD: 2 1/4 INCH HSA
- HOLE COLLAPSED AT 12 FT. AFTER PULLING OUT AUGERS

TEST HOLE NO. CB-C-HA

LOCATION: W. BOULEVARD DRIVE FLINT RIVER CULVERT OUTLET

PHYSICAL REFERENCE: 13 FEET EAST OF W. BOULEVARD DRIVE
PHYSICAL OFFSET: 60 FEET SOUTH OF LEITH STREET

BORING DATE: 4/27/21 NORTHING: 562948
GROUND SURFACE ELEVATION: 713.0 FT EASTING: 13308014

713.0		
712.5		POORLY GRADED SAND WITH SILT, TRACE GRAVEL (SP-SM)
		E.O.B. 0.5 FEET

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: N/A
- GROUNDWATER LEVEL UPON COMPLETION: N/A
- LOGGED BY: P. CODY (SOMAT)
- CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: HAND AUGER PROBE; METHOD: 3 1/4 INCH BUCKET AUGER
- SAMPLE COLLECTED FROM CULVERT OUTLET INTO FLINT RIVER

TEST HOLE NO. CB-D-01

LOCATION: NB I-475 EAST R.O.W

PHYSICAL REFERENCE: 5 FEET WEST OF W. BOULEVARD DRIVE
PHYSICAL OFFSET: 255 FEET NORTH OF LEITH STREET

BORING DATE: 3/30/21 NORTHING: 563274
GROUND SURFACE ELEVATION: 715.7 FT EASTING: 13308010

			PP	MC
715.7				
715.5	6 3 4	FIELD ENGINEER REPORTED 3 INCHES OF SANDY TOPSOIL, BLACK FILL - FIELD ENGINEER REPORTED 9 INCHES OF BROWN SANDY CLAY		
714.7				
		FILL - LOOSE SILTY FINE SAND, TRACE GRAVEL, RED-BROWN, MOIST (SM)		
712.2	5 6 5		3.5	18.4
711.7		FILL - VERY STIFF SANDY LEAN CLAY, TRACE GRAVEL, RED-BROWN (CL)		
710.7				
709.7	5 8 16		4.5+	15.8
707.2	18 32 32	HARD LEAN CLAY, FEW SAND, TRACE GRAVEL, OCCASIONAL FINE SAND PARTINGS BELOW 8.5 FT., BROWN (CL)	4.5+	11.4
702.2	42 49 50			
		EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, OCCASIONAL SAND SILT SEAMS, GRAY, MOIST TO WET (SM)		
697.2	15 17 26		4.5+	10.5
		HARD LEAN CLAY, FEW SAND, TRACE GRAVEL, GRAY (CL) NOTE: DRILLER REPORTED HARD DRILLING FROM 18.5 TO 23.5 FT.		
692.2	50			
		EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, WET (SM) NOTE: DRILLER REPORTED HARD DRILLING FROM 28.5-33.5 FT.		
687.2	46 38 50			
682.2	31 42 51			
		EXTREMELY DENSE POORLY GRADED FINE SAND WITH SILT, TRACE GRAVEL, GRAY, WET (SP-SM)		
680.7		E.O.B. 35 FEET		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: 15 FEET
- GROUNDWATER LEVEL UPON COMPLETION: 15 FEET
- LOGGED BY: S. SWAMINATHAN; CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 55 ATV (HAMMER ID 286595); EFFICIENCY = 90.8%; METHOD: 2 1/4 INCH HSA
- HOLE COLLAPSED AT 23.5 FEET AFTER PULLING OUT AUGERS

TEST HOLE NO. CB-D-02

LOCATION: NB I-475 LEFT SHOULDER

PHYSICAL REFERENCE: 3 FEET WEST OF NB I-475 E.O.M LEFT
PHYSICAL OFFSET: 198 FEET NORTH OF LEITH STREET

BORING DATE: 4/19/21 NORTHING: 563252
GROUND SURFACE ELEVATION: 745.9 FT EASTING: 13307909

			PP	MC
745.9				
745.4	3 6 5	6.5 INCHES OF PORTLAND CEMENT CONCRETE		
744.9				
		FILL - MEDIUM DENSE POORLY GRADED FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)		
742.4	5 6 7		4.5+	13.1
742.1				
739.9	3 5 8		3	11.8
737.4	3 6 5		4.5+	10.9
		FILL - VERY STIFF TO HARD LEAN CLAY WITH SAND, TRACE GRAVEL, GRAY-BROWN TO MOTTLED BROWN AND GRAY (CL)		
732.4	6 9 20		4.5+	18.3
730.9				
		HARD LEAN CLAY WITH SAND, TRACE GRAVEL, OCCASIONAL BROWN FINE SAND LAYERS, BROWN/GRAY/BLACK (CL) (POSSIBLE FILL)		
727.4	6 12 13		4.5+	11.1
725.9				
722.4	10 13 11	HARD LEAN CLAY WITH SAND, TRACE GRAVEL, FREQUENT SILT PARTINGS, OCCASIONAL CLAYEY FINE SAND SEAMS, GRAY-BROWN (CL) (POSSIBLE FILL)	4.5+	10.1
717.4	16 31 47			
		VERY DENSE POORLY GRADED FINE TO MEDIUM SAND WITH SILT, TRACE GRAVEL, BROWN, MOIST (SP-SM)		
		(CONT.)		

1st 6 in
2nd 6 in
3rd 6 in
4th 6 in

NUMBERS IN CIRCLES DENOTE NUMBER OF BLOWS REQUIRED TO DRIVE A 2" O.D. X 1.5" I.D. SPLIT SPOON SAMPLER 3 OR 4 SUCCESSIVE 6" INCREMENTS USING A 140 LB HAMMER FALLING 30".

PP = POCKET PENETROMETER, UNCONFINED COMPRESSIVE STRENGTH - TONS/SQ.FT (TSF)
UCS = LAB DETERMINED UNCONFINED COMPRESSIVE STRENGTH - TONS/SQ.FT (TSF)
TV = TORVANE SHEAR TEST, SHEAR STRENGTH - TONS/SQ.FT (TSF)
MC = MOISTURE CONTENT - (%)
DD = DRY DENSITY - LBS/CU.FT (PCF)

CONSISTENCY DETERMINED BY INSPECTION OF SAMPLES AND BY SOIL RESISTANCE TO PENETRATION BY JET ROD AND CASING OR AUGER. UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP SYMBOL DETERMINED PER (ASTM) VISUAL-MANUAL PROCEDURES.

COORDINATES AND GROUND SURFACE ELEVATIONS FROM SURVEY (ROWE)

GROUNDWATER LEVELS REFRESENT THE CONDITIONS AT THE TIME THE MEASUREMENTS WERE OBTAINED AND SHOULD BE EXPECTED TO FLUCTUATE THROUGHOUT THE YEAR. GROUNDWATER LEVELS MAY ALSO BE INFLUENCED BY RESIDUAL BORING WATER.

THE BORING LOGS REPRESENT POINT INFORMATION. PRESENTATION OF THIS INFORMATION IN NO WAY IMPLIES THAT THE SUBSURFACE CONDITIONS ARE THE SAME AT LOCATIONS OTHER THAN THE EXACT LOCATION OF THE BORING.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

FILE: 210054_I475_North_Soil Borings.dgn

DATE: 08/22/23
DESIGN UNIT:VINCKE
TSC: DAVISON

CS: 25132
JN: 210054A

LOG OF BORINGS
I-475 RECONSTRUCTION
LOG OF BORINGS

DRAWING: I-475 BORING 001
SHEET: SECT 1 254

TEST HOLE NO. CB-D-02 (CONT.)

		PP	MC
712.4	9 16 23	4.5+	10.1
707.4	11 18 21 HARD LEAN CLAY WITH SAND, TRACE GRAVEL, BROWN (CL)	4.5+	16.3
702.4	21 45 31 VERY DENSE SILTY FINE SAND, TRACE GRAVEL, GRAY, MOIST (SM)		
697.4	16 24 44	4.5+	9.9
695.9	HARD LEAN CLAY WITH SAND, TRACE GRAVEL, GRAY (CL) E.O.B. 50 FEET		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: P. CODY (SOMAT)
- CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 55 (HAMMER ID 404135); EFFICIENCY = 87.1%; METHOD: 2 1/4 INCH HSA

TEST HOLE NO. CB-D-03

LOCATION: SB I-475 WEST R.O.W

PHYSICAL REFERENCE: 24 FEET EAST OF JAMES P. COLE BOULEVARD
PHYSICAL OFFSET: 215 FEET NORTH OF LEITH STREET

BORING DATE: 3/29/21 NORTHING: 563265
GROUND SURFACE ELEVATION: 720.7 FT EASTING: 13307774

		PP	MC
720.7			
720.2	FIELD ENGINEER REPORTED 6 INCHES OF SANDY TOPSOIL, BLACK		
719.7	7 18 FILL - FIELD ENGINEER REPORTED 6 INCHES OF BROWN SANDY CLAY		<>
	FILL - STIFF SANDY LEAN CLAY, FREQUENT CLAYEY SAND SEAMS AND LAYERS, TRACE GRAVEL, TRACE ROOTS AND BRICK DEBRIS ABOVE 2.5 FT., DARK BROWN (CL)		
717.2	5 8 18 NOTE: SPT TERMINATED DUE TO CONCRETE DEBRIS	1	19.2
717.0			
716.7			
714.7	9 13 12 FILL - MEDIUM DENSE FINE SAND, OCCASIONAL DARK GRAY SANDY CLAY LAYERS WITH TRACE ROOTS AND GRAVEL ABOVE 5 FT., BLACK, MOIST (SP) (POSSIBLE FOUNDRY SAND)		
712.2	4 3 5	4.5	17.4
711.7	FILL - HARD LEAN CLAY, FEW SAND, TRACE GRAVEL, TRACE COAL PIECES, BROWN (CL)		
710.7			
	HARD LEAN CLAY, TRACE SAND, TRACE GRAVEL, BROWN (CL)		
707.2	13 20 25	4.5	16.7
705.7			
702.2	21 30 42		8.6
	VERY DENSE TO EXTREMELY DENSE CLAYEY FINE SAND/SANDY LEAN CLAY, TRACE GRAVEL, GRAY (SC)/(CL)		
697.2	20 54		11.7
692.2	28 50 50 EXTREMELY DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, OCCASIONAL CLAY POCKETS, GRAY, WET (SP)		
691.2	E.O.B. 29.5 FEET (BORING TERMINATED DUE TO SPLIT SPOON REFUSAL)		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: 19 FEET
- GROUNDWATER LEVEL UPON COMPLETION: 7 FEET
- LOGGED BY: S. SWAMINATHAN (SOMAT)
- CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 55 ATV (HAMMER ID 286595); EFFICIENCY = 90.8%; METHOD: 2 1/4 INCH HSA
- HOLE COLLAPSED AT 25 FT. AFTER PULLING OUT AUGERS

TEST HOLE NO. CB-D-HA

LOCATION: W. BOULEVARD DRIVE FLINT RIVER CULVERT OUTLET

PHYSICAL REFERENCE: 17 FEET EAST OF W. BOULEVARD DRIVE
PHYSICAL OFFSET: 261 FEET NORTH OF LEITH STREET

BORING DATE: 4/27/21 NORTHING: 563319
GROUND SURFACE ELEVATION: 711.0 FT EASTING: 13308081

711.0	
710.5	SANDY LEAN CLAY E.O.B. 0.5 FEET

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: N/A
- GROUNDWATER LEVEL UPON COMPLETION: N/A
- LOGGED BY: P. CODY (SOMAT)
- CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: HAND AUGER PROBE: METHOD: 3 1/4 INCH BUCKET AUGER
- SAMPLE COLLECTED FROM CULVERT OUTLET INTO FLINT RIVER

TEST HOLE NO. CB-E-01

LOCATION: NB I-475 EAST R.O.W

PHYSICAL REFERENCE: 26 FEET WEST OF W. BOULEVARD DRIVE
PHYSICAL OFFSET: 445 FEET NORTH OF LEITH STREET

BORING DATE: 3/30/21 NORTHING: 563499
GROUND SURFACE ELEVATION: 716.1 FT EASTING: 13308075

		PP	MC
716.1			
715.6	FIELD ENGINEER REPORTED 6 INCHES OF SANDY TOPSOIL, BLACK		
715.1	5 6 5 FILL - FIELD ENGINEER REPORTED 6 INCHES OF BROWN SANDY CLAY		
	FILL - MEDIUM DENSE SILTY FINE SAND, TRACE ROOTS, TRACE GRAVEL, OCCASIONAL SILT POCKETS, BROWN WITH SEAMS OF GRAY (SM)		
712.6	5 9 14	4.5+	15.7
712.1			
710.1	10 16 17 HARD LEAN CLAY, FEW SAND, TRACE ROOTS, TRACE GRAVEL, OCCASIONAL SILT POCKETS, BROWN WITH SEAMS OF GRAY (CL)	4.5+	13.2
708.1			
707.6	25 32 36	1	19.3
	STIFF LEAN CLAY, TRACE SAND, TRACE GRAVEL, OCCASIONAL FINE SAND LAYERS, BROWN WITH SEAMS OF GRAY (CL)		
702.6	36 50 50		
	EXTREMELY DENSE SILTY FINE SAND WITH GRAVEL, TRACE CLAY, GRAY, MOIST (SM)		
697.6	28 25 25	4.5+	8.3
	HARD SANDY LEAN CLAY, TRACE GRAVEL, GRAY (CL)		
696.1			
692.6	40 50 50 EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, MOIST TO WET (SM)		
687.6	34 54 50		
682.6	34 54 50 EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, MOIST TO WET (SM)		
681.1	E.O.B. 35 FEET		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: 34 FEET
- GROUNDWATER LEVEL UPON COMPLETION: 32.5 FEET
- LOGGED BY: S. SWAMINATHAN; CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 55 ATV (HAMMER ID 286595); EFFICIENCY = 90.8%; METHOD: 2 1/4 INCH HSA
- HOLE COLLAPSED AT 6 FT. AFTER PULLING OUT AUGERS

TEST HOLE NO. CB-E-02

LOCATION: NB I-475 LEFT SHOULDER

PHYSICAL REFERENCE: 4 FEET WEST OF NB I-475 E.O.M LEFT
PHYSICAL OFFSET: 468 FEET NORTH OF LEITH STREET

BORING DATE: 4/19/21 NORTHING: 563511
GROUND SURFACE ELEVATION: 743.1 FT EASTING: 13307965

		PP	MC
743.1			
742.5	7 INCHES OF PORTLAND CEMENT CONCRETE		
742.1	2 4 6 FILL - MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP)		
739.6	5 7 6	4.5+	12.4
737.1	5 5 9		16.4
736.1		4.5+	
734.6	4 9 11 FILL - HARD TO VERY STIFF LEAN CLAY WITH SAND, TRACE GRAVEL, OCCASIONAL VERY STIFF CLAY LAYERS, OCCASIONAL FINE SAND PARTINGS AND SILT PARTINGS, MOTTLED BROWN AND GRAY TO GRAY-BROWN (CL)	4.5+	10.1
729.6	4 11 13	4.5+	10.4
724.6	7 8 11	3.75	11.5
719.6	5 7 8	4.5+	9.4
	FILL - HARD TO VERY STIFF LEAN CLAY WITH SAND, TRACE GRAVEL, OCCASIONAL VERY STIFF CLAY LAYERS, OCCASIONAL FINE SAND PARTINGS AND SILT PARTINGS, MOTTLED BROWN AND GRAY TO GRAY-BROWN (CL)		
714.6	3 6 10	<>	13.6
	(CONT.)		

TEST HOLE NO. CB-E-02 (CONTINUED)

		PP	MC
709.6	22 22 17		
	DENSE POORLY GRADED FINE SAND WITH SILT, TRACE GRAVEL, BROWN, MOIST (SP-SM)		
704.6	7 13 17	4.5+	13.5
699.6	16 26 36 HARD LEAN CLAY WITH SAND, TRACE GRAVEL, OCCASIONAL FINE SAND PARTINGS, GRAY (CL)	4.5+	7.6
694.6	42 50 50 EXTREMELY DENSE SILTY FINE SAND, TRACE GRAVEL, GRAY, MOIST (SM)		
693.2	E.O.B. 49.9 FEET (BORING TERMINATED DUE TO SPLIT SPOON REFUSAL)		

NOTES:
- GROUNDWATER LEVEL DURING DRILLING: NONE
- GROUNDWATER LEVEL UPON COMPLETION: NONE
- LOGGED BY: P. CODY (SOMAT)
- CHECKED BY: R. GONDLE/J. ABABIR (SOMAT)
- DRILL RIG: CME 55 (HAMMER ID 404135); EFFICIENCY = 87.1%; METHOD: 2 1/4 INCH HSA

(0 0 0) 1st 6 in, 2nd 6 in, 3rd 6 in, 4th 6 in

NUMBERS IN CIRCLES DENOTE NUMBER OF BLOWS REQUIRED TO DRIVE A 2" O.D. X 1.5" I.D. SPLIT SPOON SAMPLER 3 OR 4 SUCCESSIVE 6" INCREMENTS USING A 140 LB HAMMER FALLING 30".

PP = POCKET PENETROMETER, UNCONFINED COMPRESSIVE STRENGTH - TONS/SQ.FT (TSF)
UCS = LAB DETERMINED UNCONFINED COMPRESSIVE STRENGTH - TONS/SQ.FT (TSF)
TV = TORVANE SHEAR TEST, SHEAR STRENGTH - TONS/SQ.FT (TSF)
MC = MOISTURE CONTENT - (%)
DD = DRY DENSITY - LBS/CU.FT (PCF)

CONSISTENCY DETERMINED BY INSPECTION OF SAMPLES AND BY SOIL RESISTANCE TO PENETRATION BY JET ROD AND CASING OR AUGER. UNIFIED SOIL CLASSIFICATION SYSTEM (USCS) GROUP SYMBOL DETERMINED PER (ASTM) VISUAL-MANUAL PROCEDURES.

COORDINATES AND GROUND SURFACE ELEVATIONS FROM SURVEY (ROWE)

GROUNDWATER LEVELS REPRESENT THE CONDITIONS AT THE TIME THE MEASUREMENTS WERE OBTAINED AND SHOULD BE EXPECTED TO FLUCTUATE THROUGHOUT THE YEAR. GROUNDWATER LEVELS MAY ALSO BE INFLUENCED BY RESIDUAL BORING WATER.

THE BORING LOGS REPRESENT POINT INFORMATION. PRESENTATION OF THIS INFORMATION IN NO WAY IMPLIES THAT THE SUBSURFACE CONDITIONS ARE THE SAME AT LOCATIONS OTHER THAN THE EXACT LOCATION OF THE BORING.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

FILE: 210054_I475_North_Soil Borings.dgn

DATE: 08/22/23
DESIGN UNIT:VINCKE
TSC: DAVISON

CS: 25132
JN: 210054A

LOG OF BORINGS
I-475 RECONSTRUCTION
LOG OF BORINGS

DRAWING: I-475 BORING 002
SHEET: SECT 1 255

TRAFFIC SIGNAL REMOVAL AND CONSTRUCTION

1. Label ROW according to the MDOT Guidelines for Plan Preparation.

2. Show consent to grade lines if applicable. Permanent fixtures that require maintenance should be placed within existing right-of-way.

3. Utilities, drainage features, and any known underground obstructions should be labeled and shown on the traffic signal structure construction sheet along with any known elevation information.

4. Show all existing utilities. Label in accordance with the MDOT Guidelines for Plan Preparation.

5. Situation plan should show a topographic survey of the area within 150' beyond the traffic intersection and. For information regarding what should be shown on the situation plan, refer to MDOT Guidelines for Plan Preparation.

6. Removal and construction sheets should show all signal, signing, and other appurtenance facing included in the intersection design.

7. Removal and construction sheets should include dimensioning of signal and signage placement along span, in addition to span tension for each span included in the intersection. Each pole should be labelled with applicable POCH for each span.

8. Outlines of drilled shafts should be provided on removal and construction sheets.

SOIL BORING DATA

1. Soil borings must be located with station-offsets and/or stat plane northing and easting coordinates. Preferably both are shown.

2. Soil borings should be taken at each traffic signal structure location.

3. Show soil boring locations on the traffic signal plan views.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

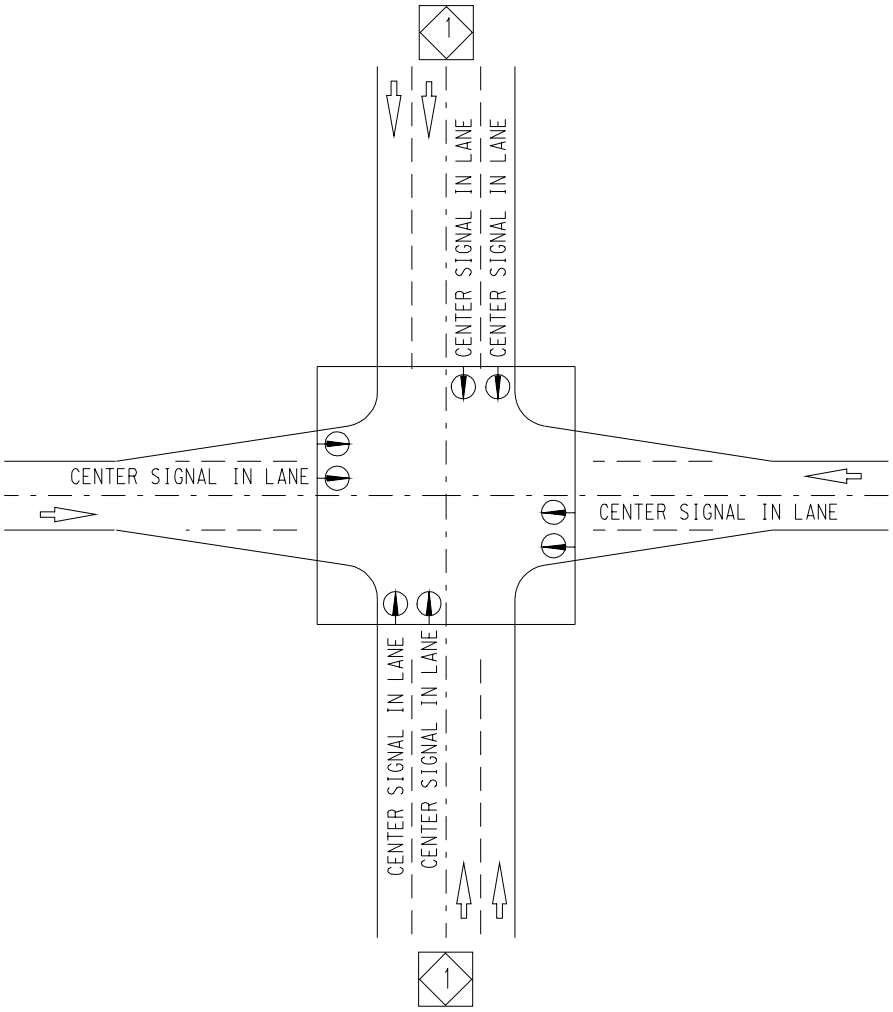
DRAWN BY:	DATE:	CS:	PLAN GUIDELINES	DRAWING SHEET
CHK'D BY:	DESIGN UNIT:	JN:		SECT 2
FILE:	TSC:			

ADD MDOT SPECIAL DETAILS AS REQUIRED

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:															
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION		MDOT Michigan Department of Transportation	NO SCALE		DATE:	CS:	PLAN GUIDELINES	DRAWING	SHEET
												DESIGN UNIT:	JN:			SECT 2
											FILE:	TSC:				

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

Appendix G – Traffic Signal Head Placement Diagrams (Box Span)



NOTES:

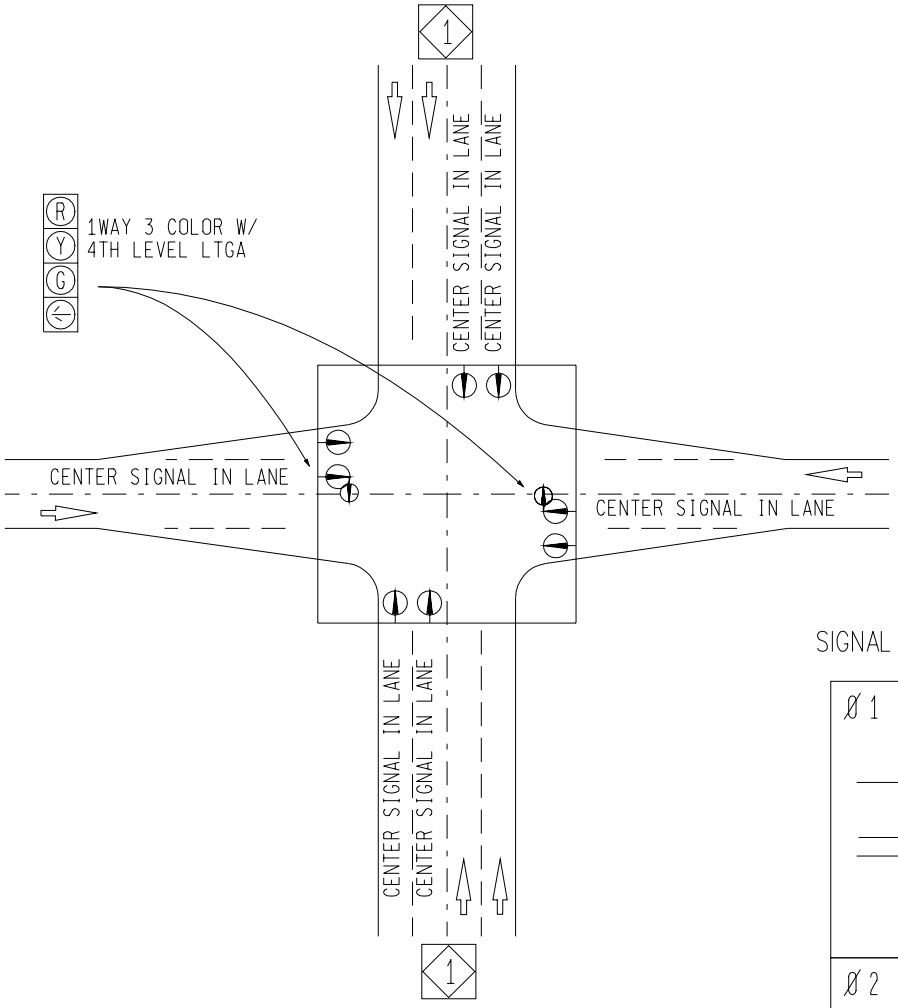
1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

MDOT Michigan Department of Transportation

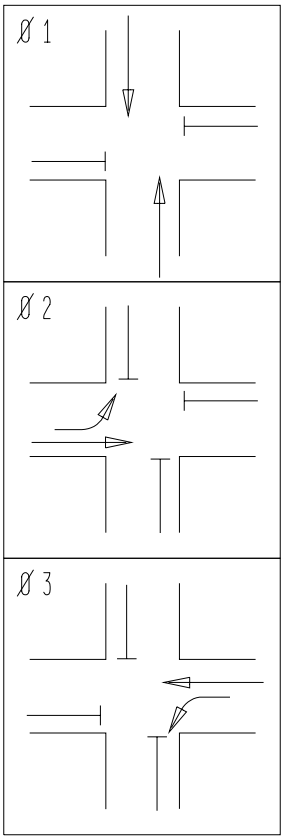
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM



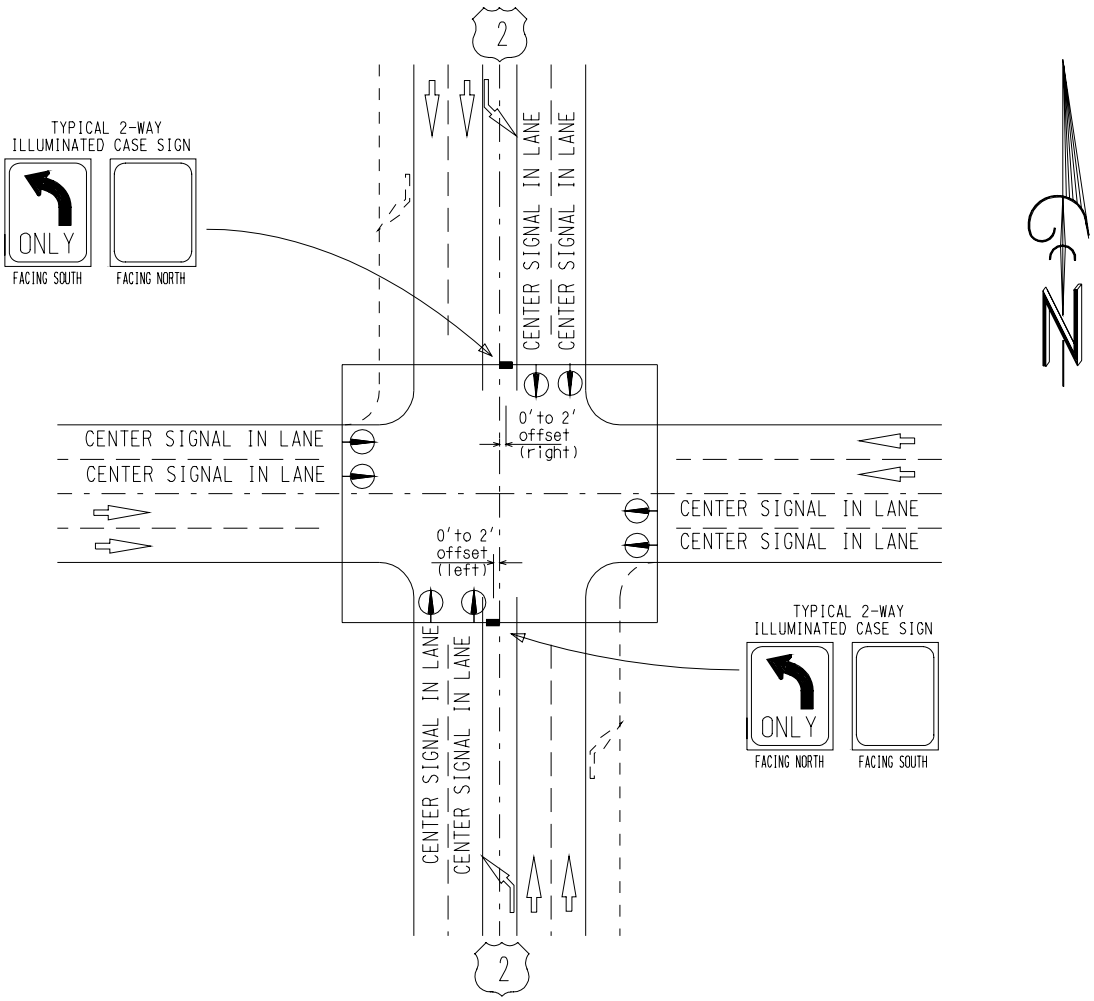
NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. UTILIZE A 4TH LEVEL LTGA FOR THE EAST & WEST PROTECTED LEFT MOVEMENTS.

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION
SPLIT PHASE

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



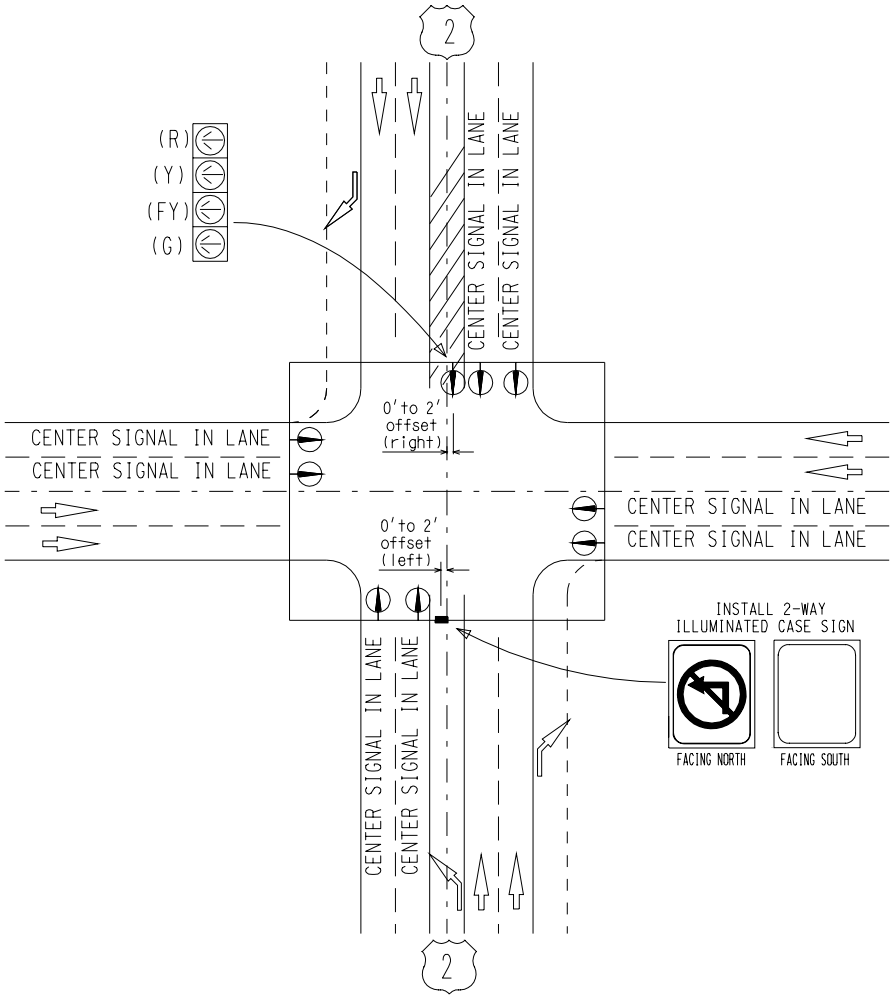
NOTES:

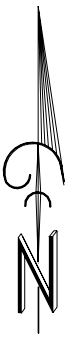
1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.

HEAD PLACEMENT DIAGRAM

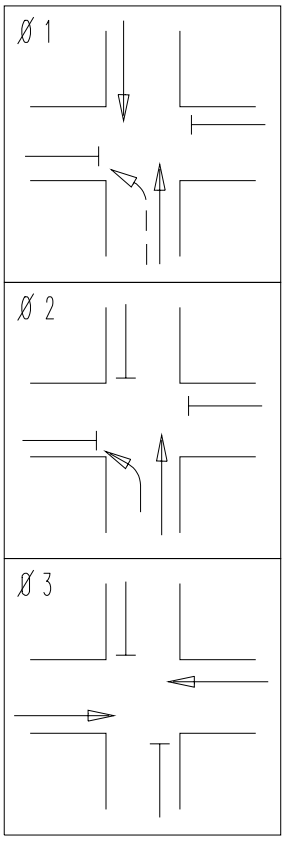
2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009





SIGNAL PHASING DIAGRAM



NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
5. USE PERMISSIVE FLASHING YELLOW LEFT TURN.

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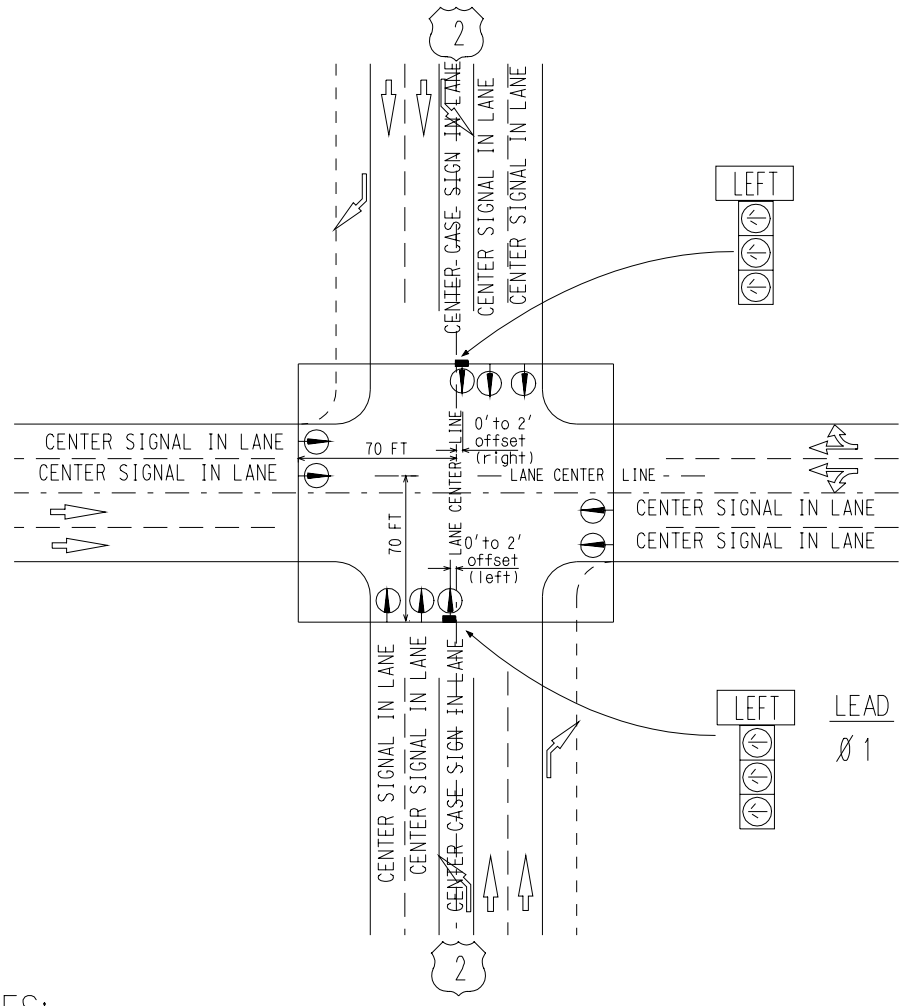
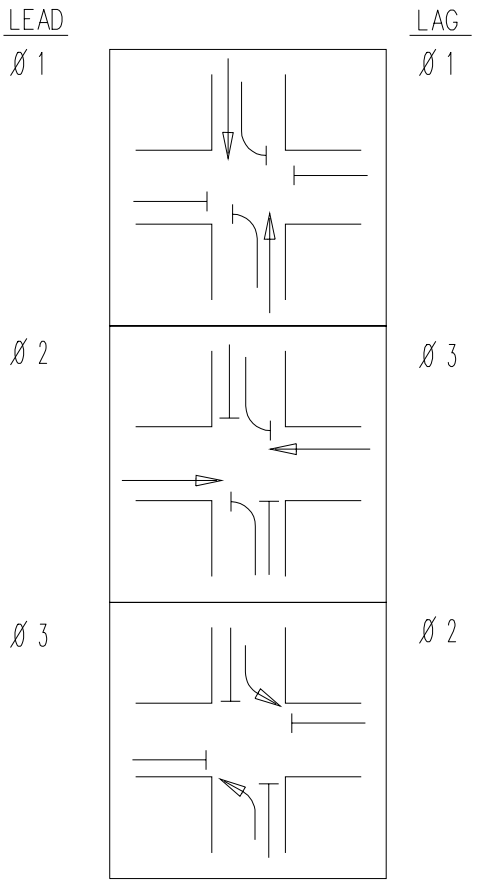
HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH SINGLE LAGGING LEFT TURN PHASE ON TRUNKLINE

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM

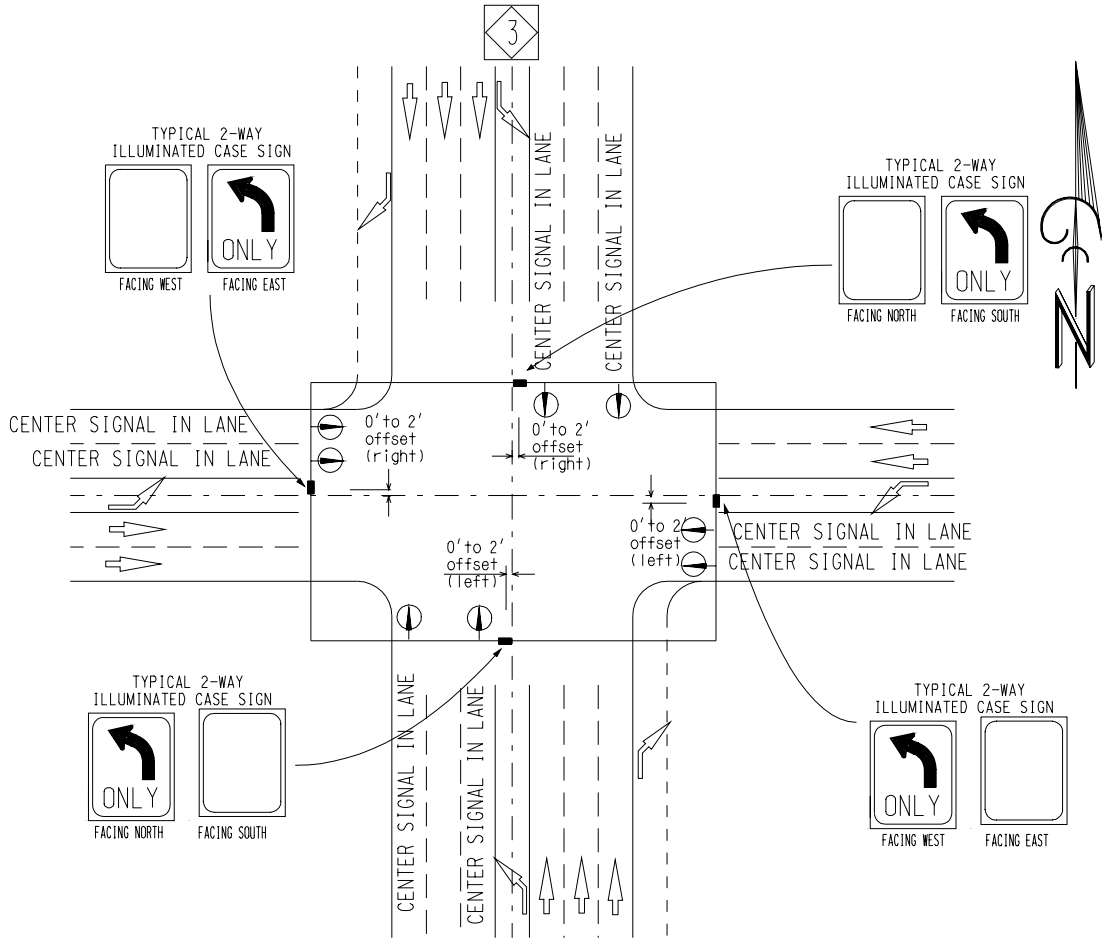


NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
5. LEAD LEFT-TURN SHALL NOT BE PERMISSIVE.
6. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
7. THE MAXIMUM DESIRED DISTANCE FROM THE CENTER OF THE LANE TURNING LEFT, TO THE CROSSROAD THROUGH SIGNAL (LOCATED ON THE SPAN, LEFT OF THE LANE TURNING LEFT) SHOULD NOT EXCEED 70 FEET. ADDITIONAL SIGNS AND ENGINEERING JUDGMENT MAY BE REQUIRED FOR DISTANCES IN EXCESS OF 70 FEET; OR AT SKEWED INTERSECTIONS.

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH DUAL LEAD OR LAG LEFT TURN PHASE ON TRUNKLINE



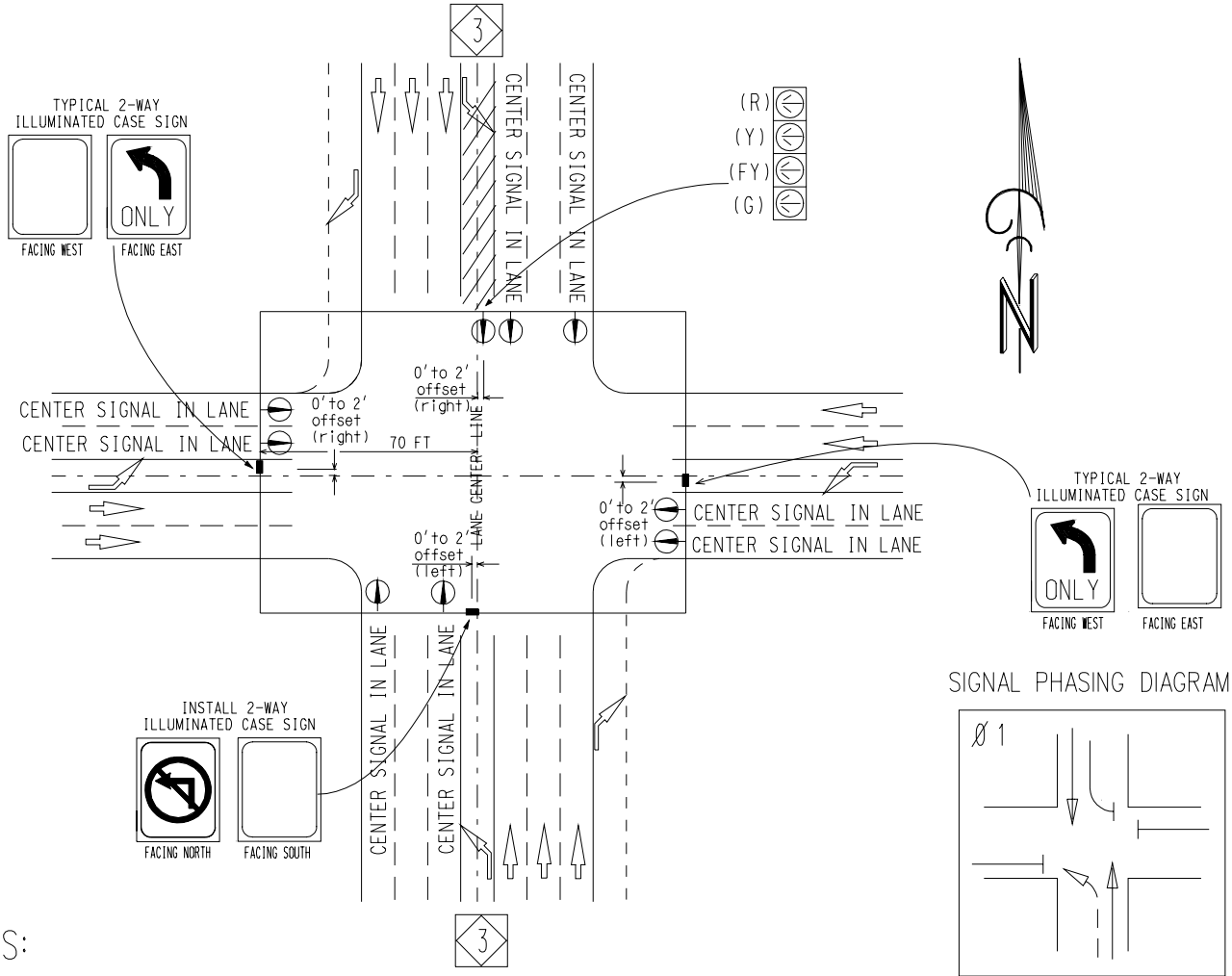
NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
5. PEDESTRIAN SIGNALS OPTIONAL.

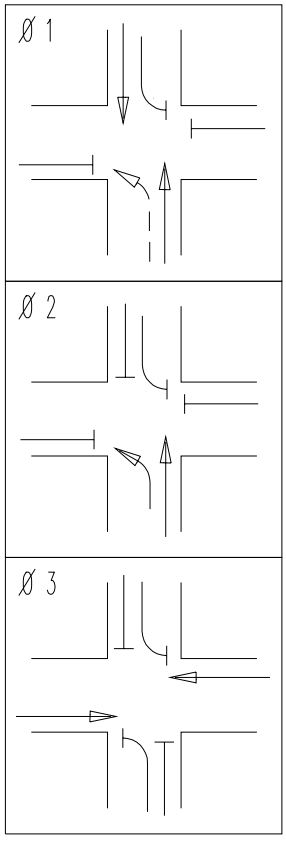
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM



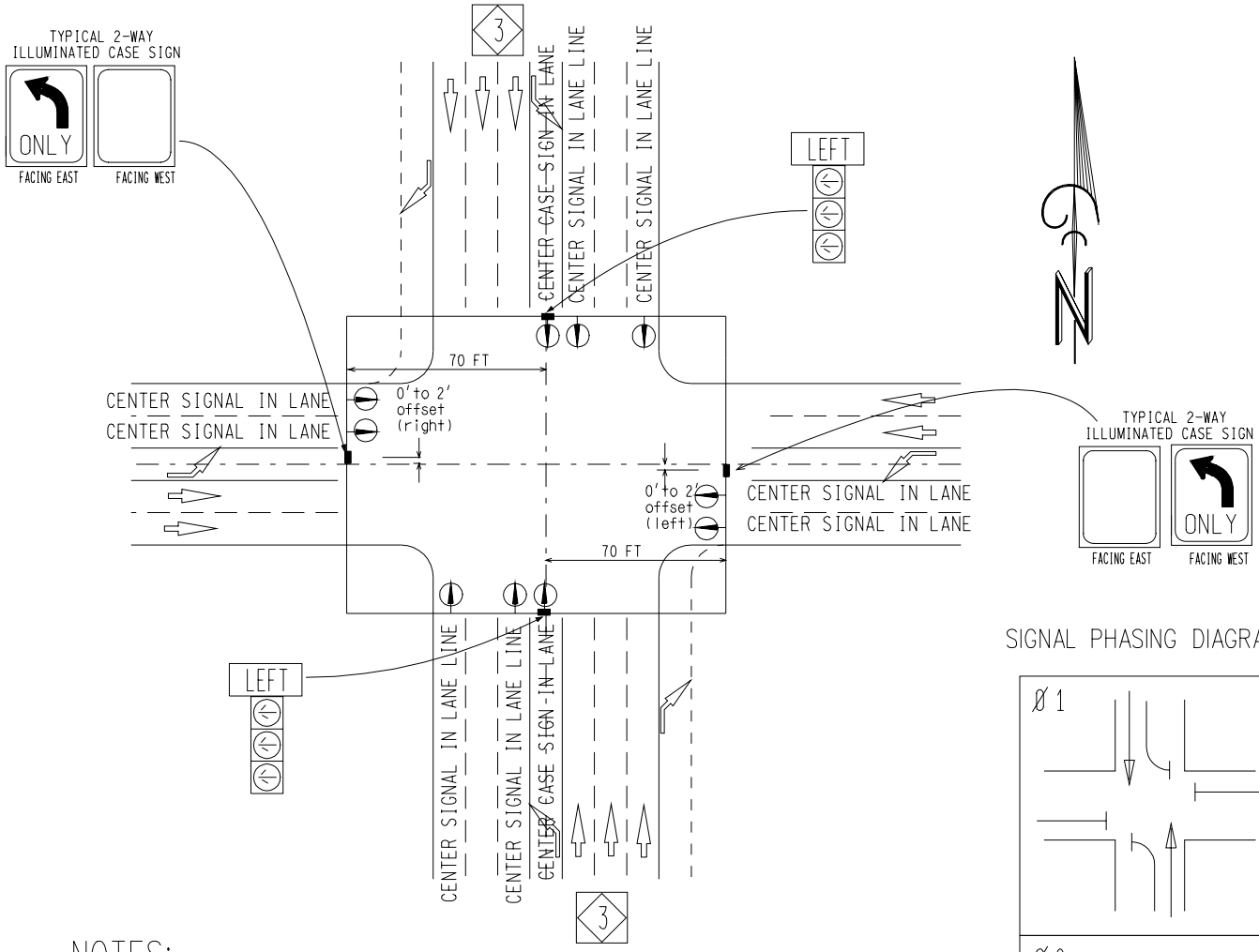
NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
5. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
6. THE MAXIMUM DESIRED DISTANCE FROM THE CENTER OF THE LANE TURNING LEFT, TO THE CROSSROAD THROUGH SIGNAL (LOCATED ON THE SPAN, LEFT OF THE LANE TURNING LEFT) SHOULD NOT EXCEED 70 FEET. ADDITIONAL SIGNS AND ENGINEERING JUDGMENT MAY BE REQUIRED FOR DISTANCES IN EXCESS OF 70 FEET; OR AT SKEWED INTERSECTIONS.

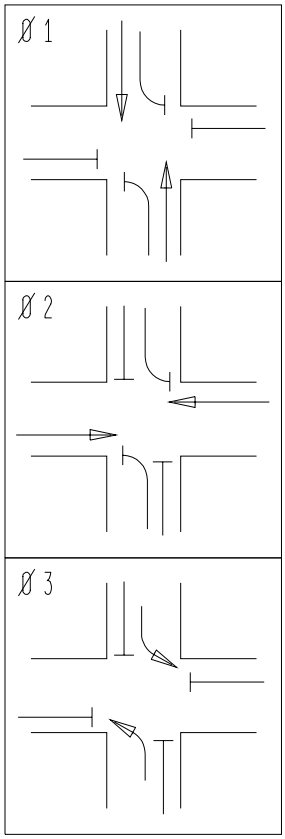
HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH SINGLE LAGGING LEFT TURN PHASE ON TRUNKLINE

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM

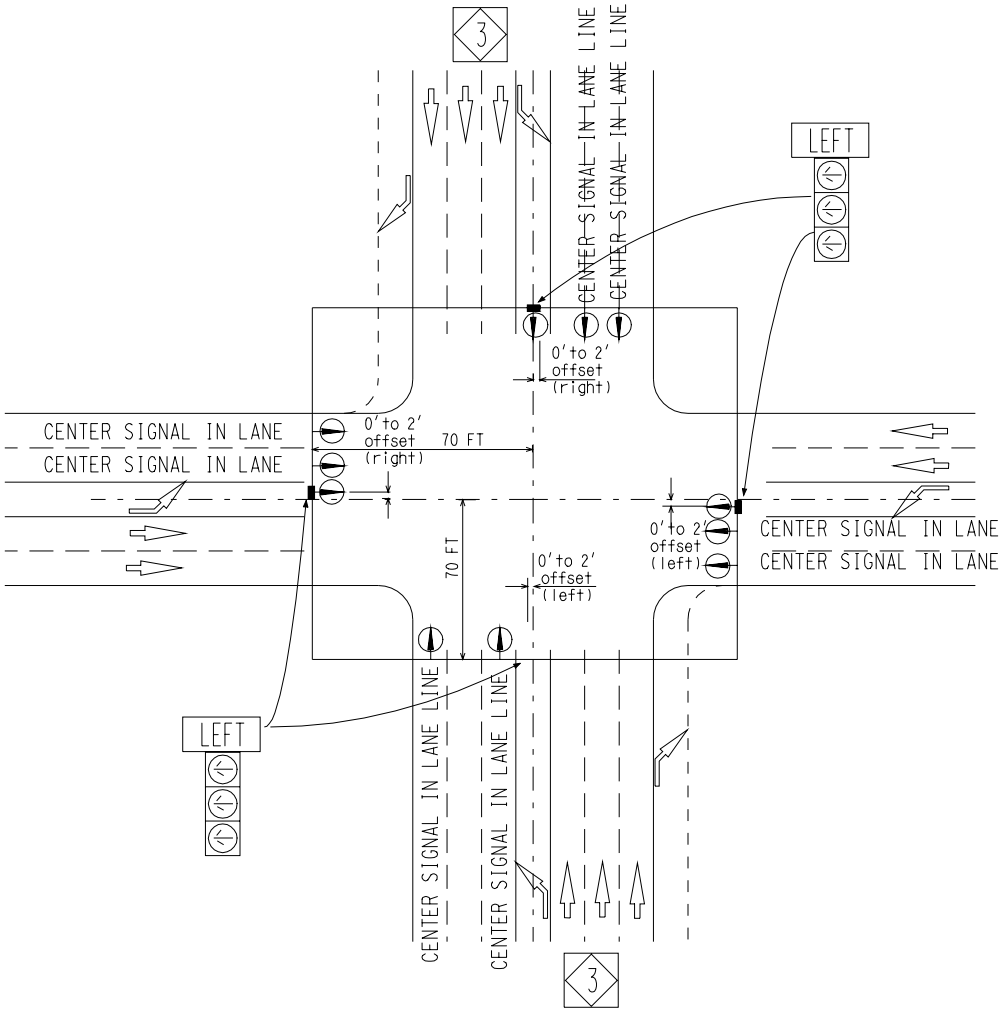


NOTES:

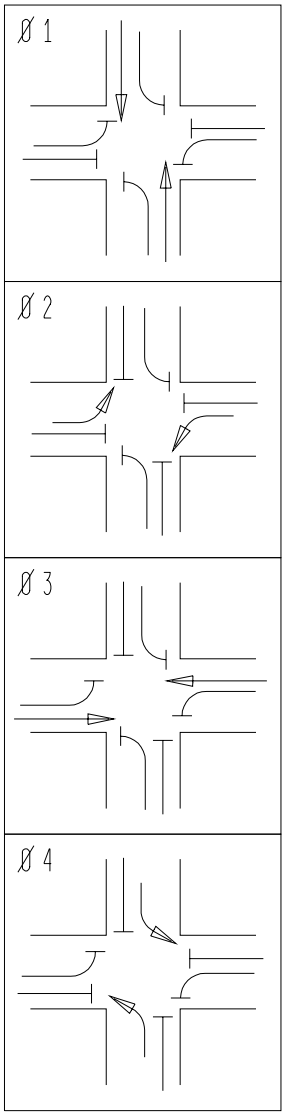
1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
5. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
6. THE MAXIMUM DESIRED DISTANCE FROM THE CENTER OF THE LANE TURNING LEFT, TO THE CROSSROAD THROUGH SIGNAL (LOCATED ON THE SPAN, LEFT OF THE LANE TURNING LEFT) SHOULD NOT EXCEED 70 FEET. ADDITIONAL SIGNS AND ENGINEERING JUDGMENT MAY BE REQUIRED FOR DISTANCES IN EXCESS OF 70 FEET; OR AT SKEWED INTERSECTIONS.

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
DUAL LEADING LEFT TURN PHASING
ON TRUNKLINE



SIGNAL PHASING DIAGRAM



NOTES:

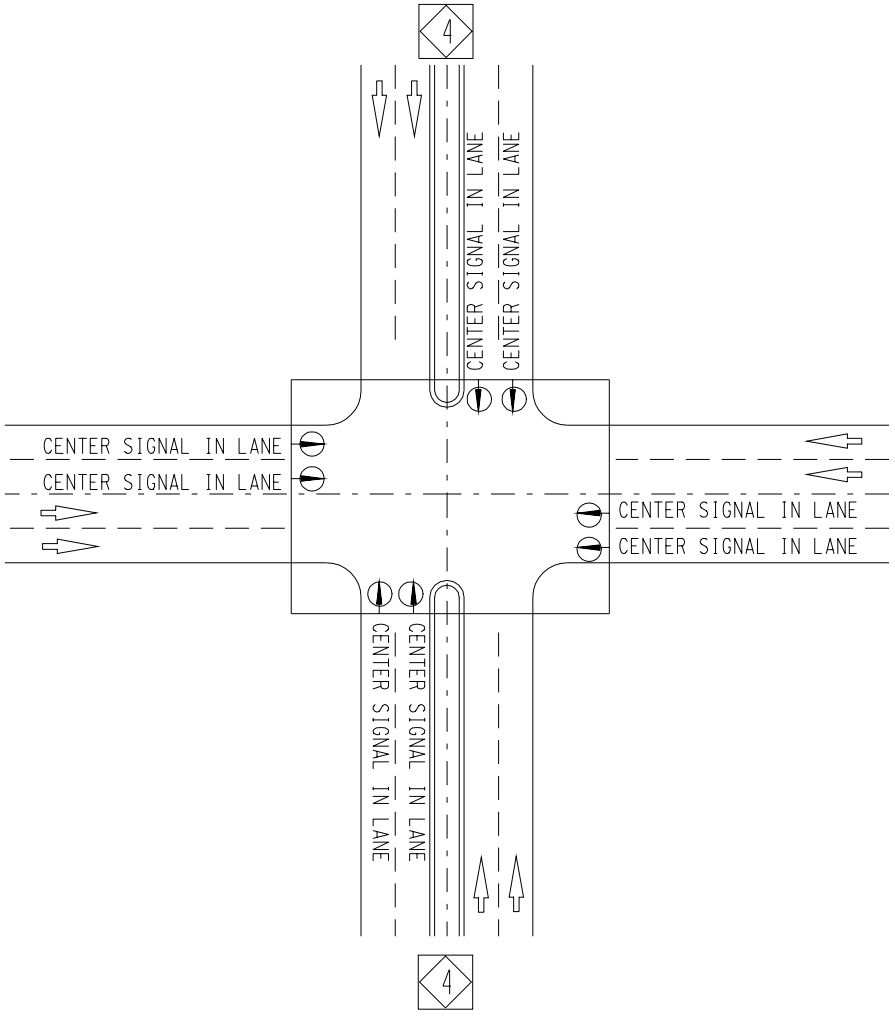
1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
5. THE MAXIMUM DESIRED DISTANCE FROM THE CENTER OF THE LANE TURNING LEFT, TO THE CROSSROAD THROUGH SIGNAL (LOCATED ON THE SPAN, LEFT OF THE LANE TURNING LEFT) SHOULD NOT EXCEED 70 FEET. ADDITIONAL SIGNS AND ENGINEERING JUDGMENT MAY BE REQUIRED FOR DISTANCES IN EXCESS OF 70 FEET; OR AT SKEWED INTERSECTIONS.

MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

4 PHASE OPERATION WITH LEADING LEFT TURNS FOR BOTH ROADS (SAME OPERATION AS 8 PHASE)

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



NOTES:

1 MEDIAN WIDTH LESS THAN 30'.

2 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.

3 in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.

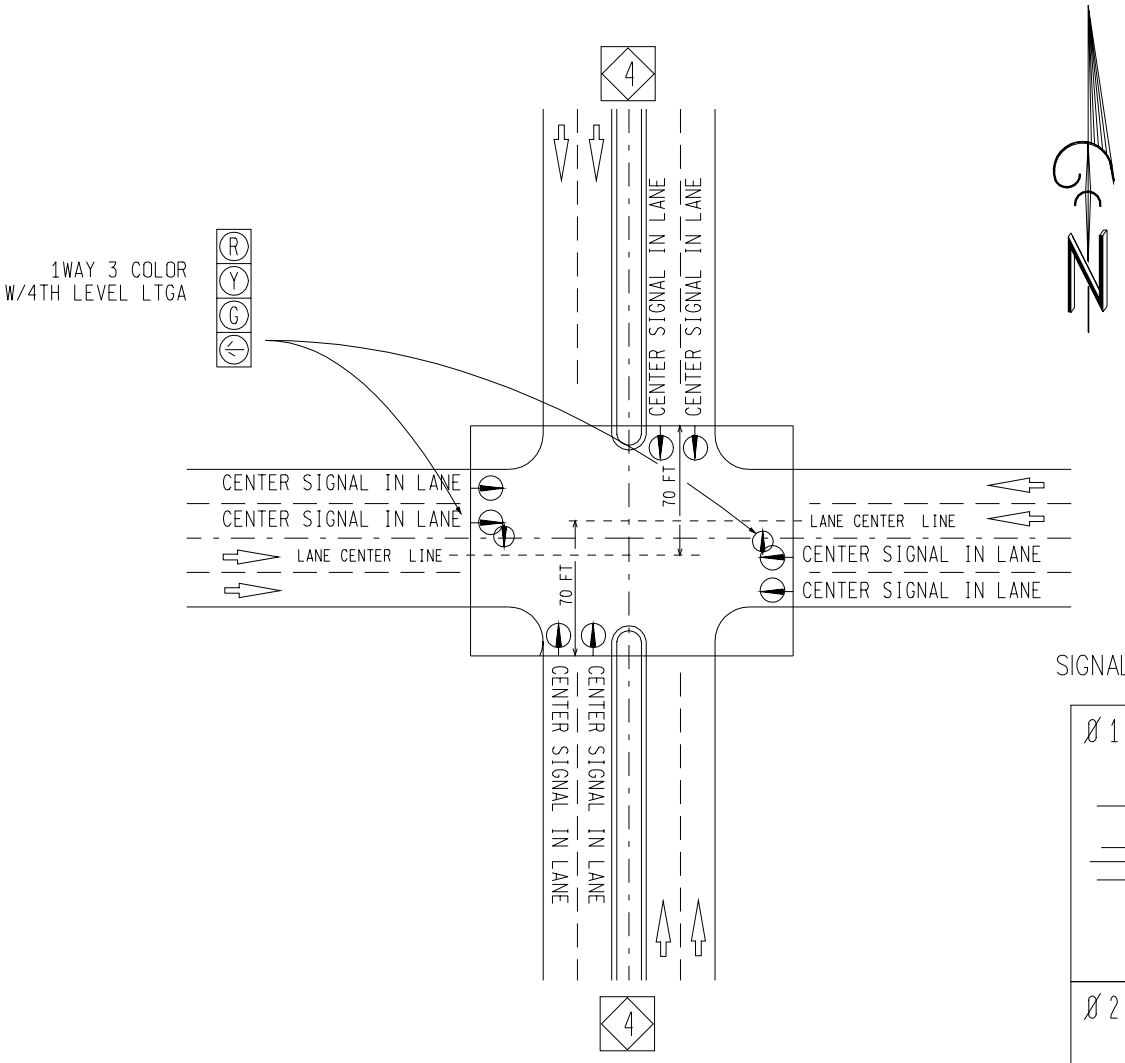
4 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

MDOT Michigan Department of Transportation

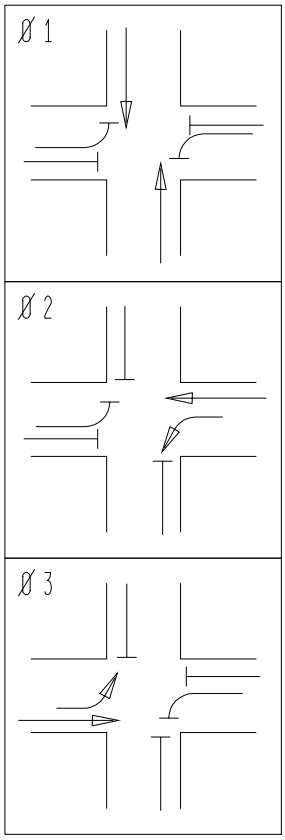
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM

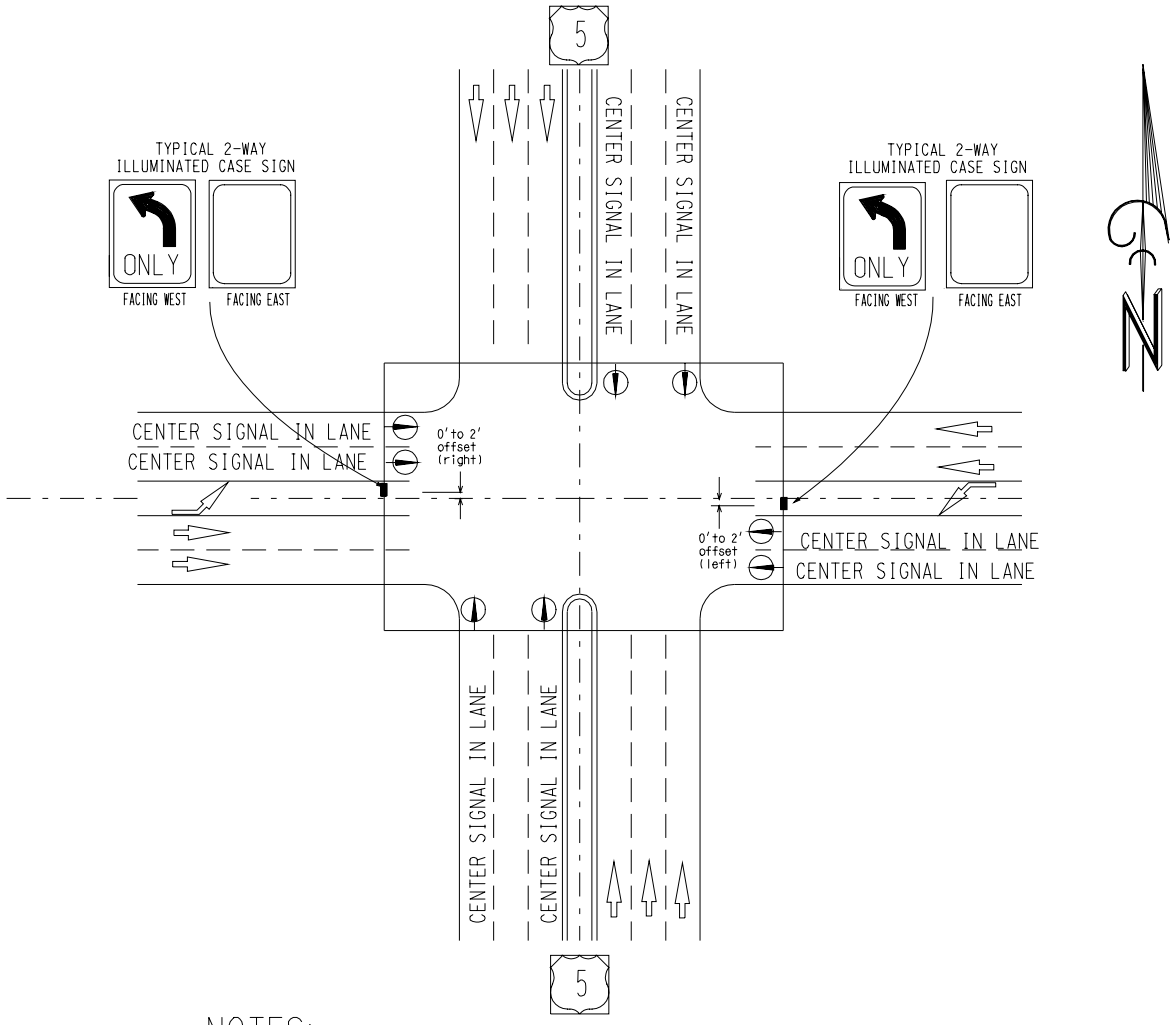


NOTES:

1. MEDIAN WIDTH LESS THAN 30'.
2. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
3. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
4. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
5. UTILIZE A 4TH LEVEL LTGA FOR THE EAST & WEST PROTECTED LEFT MOVEMENTS.
6. THE MAXIMUM DESIRED DISTANCE FROM THE CENTER OF THE LANE TURNING LEFT, TO THE CROSSROAD THROUGH SIGNAL (LOCATED ON THE SPAN, LEFT OF THE LANE TURNING LEFT) SHOULD NOT EXCEED 70 FEET. ADDITIONAL SIGNS AND ENGINEERING JUDGMENT MAY BE REQUIRED FOR DISTANCES IN EXCESS OF 70 FEET; OR AT SKEWED INTERSECTIONS.

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION SPLIT PHASE



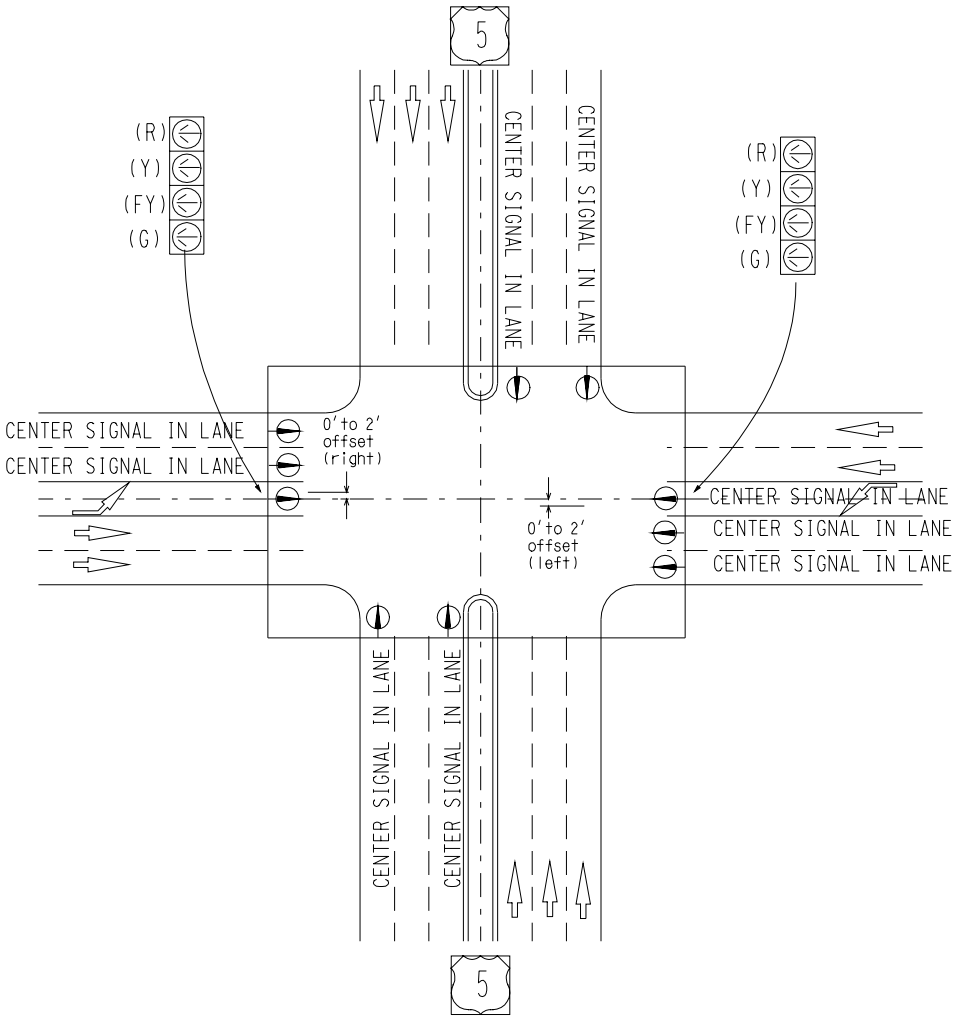
NOTES:

1. MEDIAN WIDTH LESS THAN 30'.
2. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
3. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
4. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
5. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.

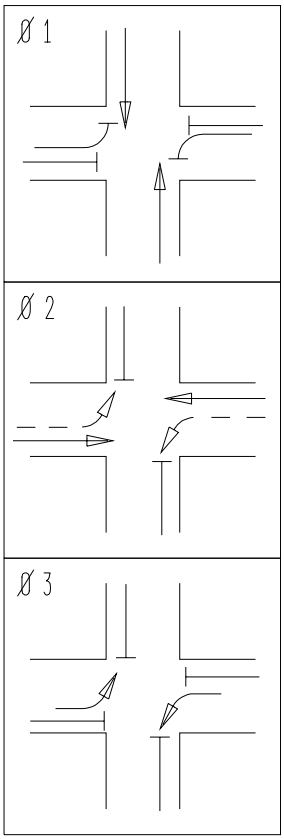
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM



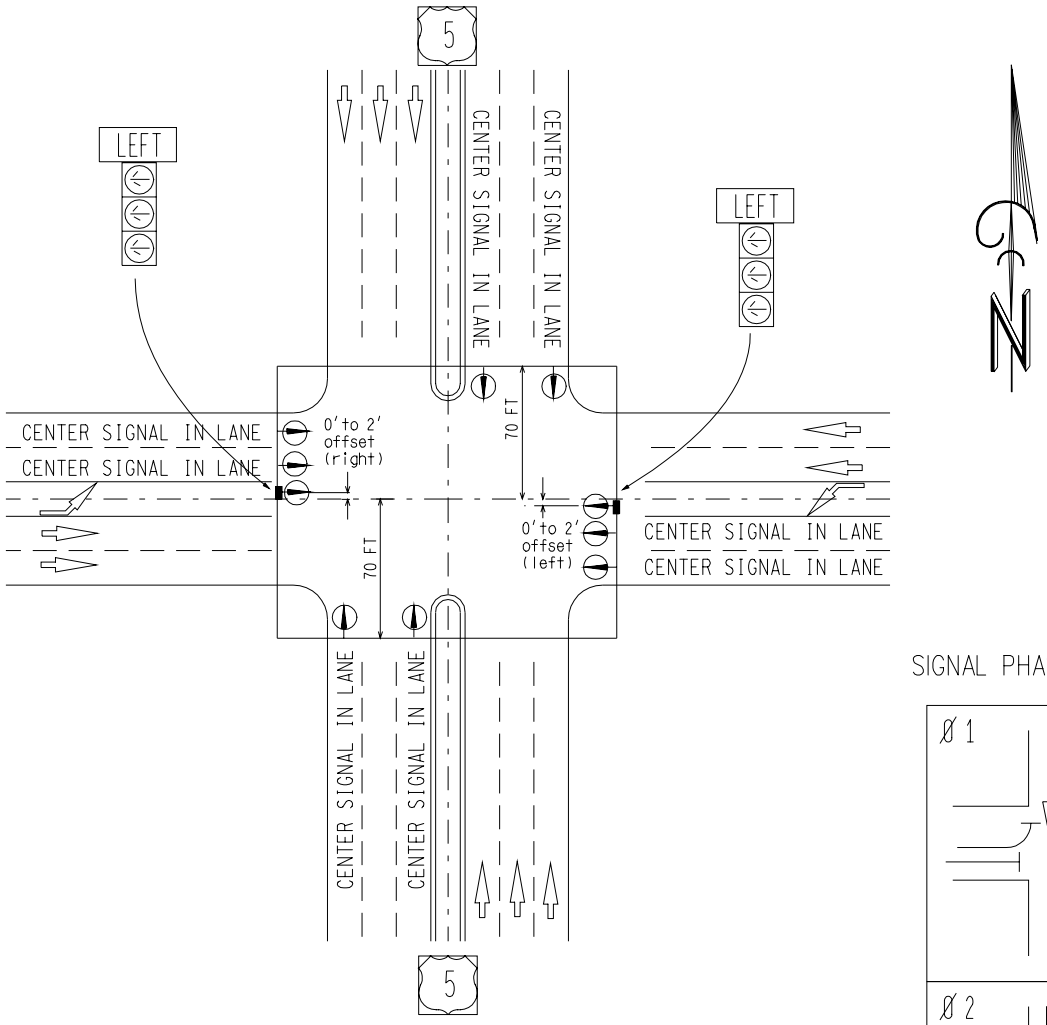
NOTES:

1. MEDIAN WIDTH LESS THAN 30'.
2. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
3. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
4. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
5. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
6. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
7. USE PERMISSIVE FLASHING YELLOW LEFT TURN.

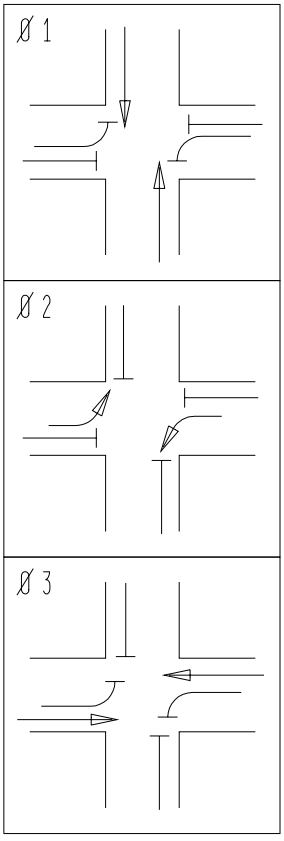
HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH DUAL LAGGING LEFT TURN PHASE ON X-RD

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM



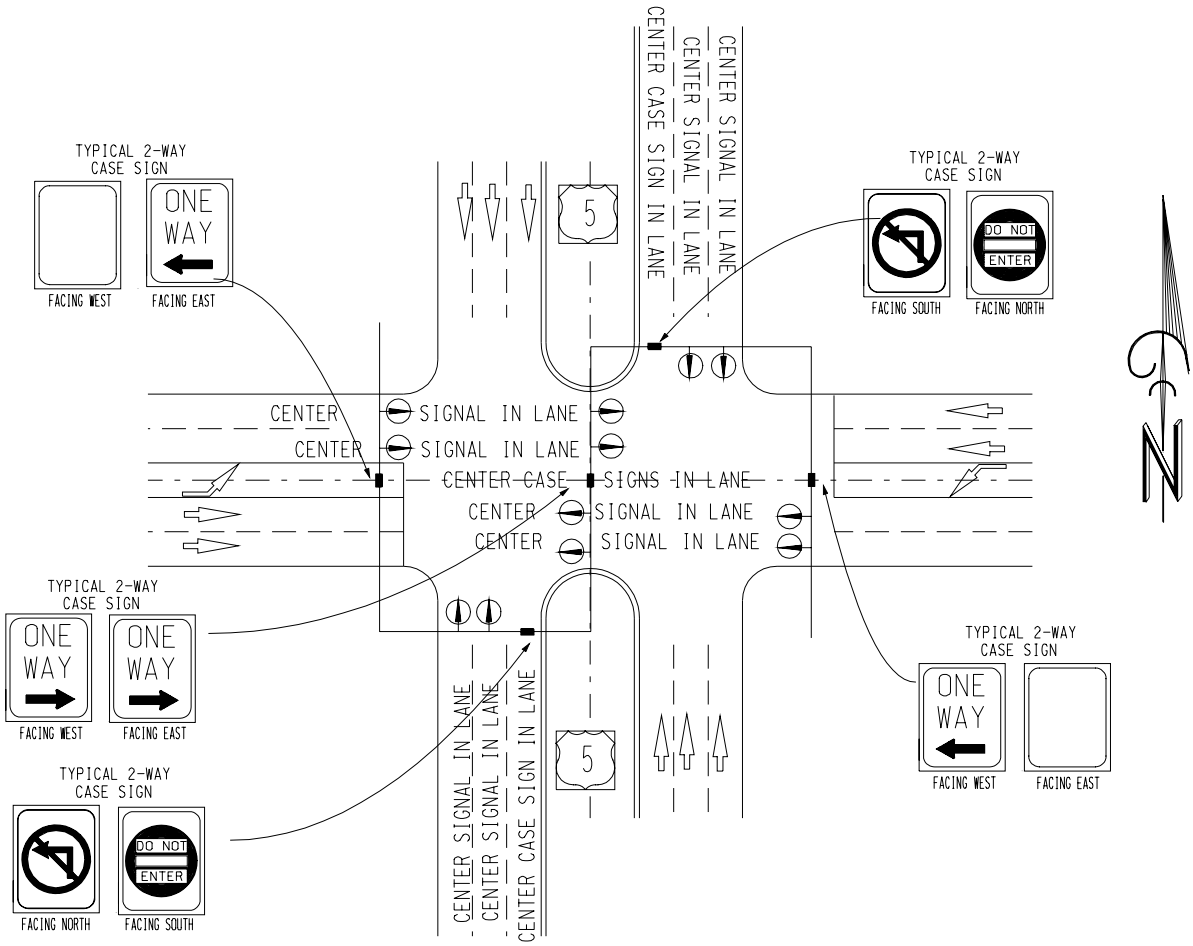
NOTES:

1. MEDIAN WIDTH LESS THAN 30'.
2. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
3. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
4. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
5. LEAD LEFT-TURN SHALL NOT BE PERMISSIVE.
6. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
7. THE MAXIMUM DESIRED DISTANCE FROM THE CENTER OF THE LANE TURNING LEFT, TO THE CROSSROAD THROUGH SIGNAL (LOCATED ON THE SPAN, LEFT OF THE LANE TURNING LEFT) SHOULD NOT EXCEED 70 FEET. ADDITIONAL SIGNS AND ENGINEERING JUDGMENT MAY BE REQUIRED FOR DISTANCES IN EXCESS OF 70 FEET; OR AT SKEWED INTERSECTIONS.

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH DUAL LEADING LEFT TURN PHASE FOR X-RD

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



NOTES:

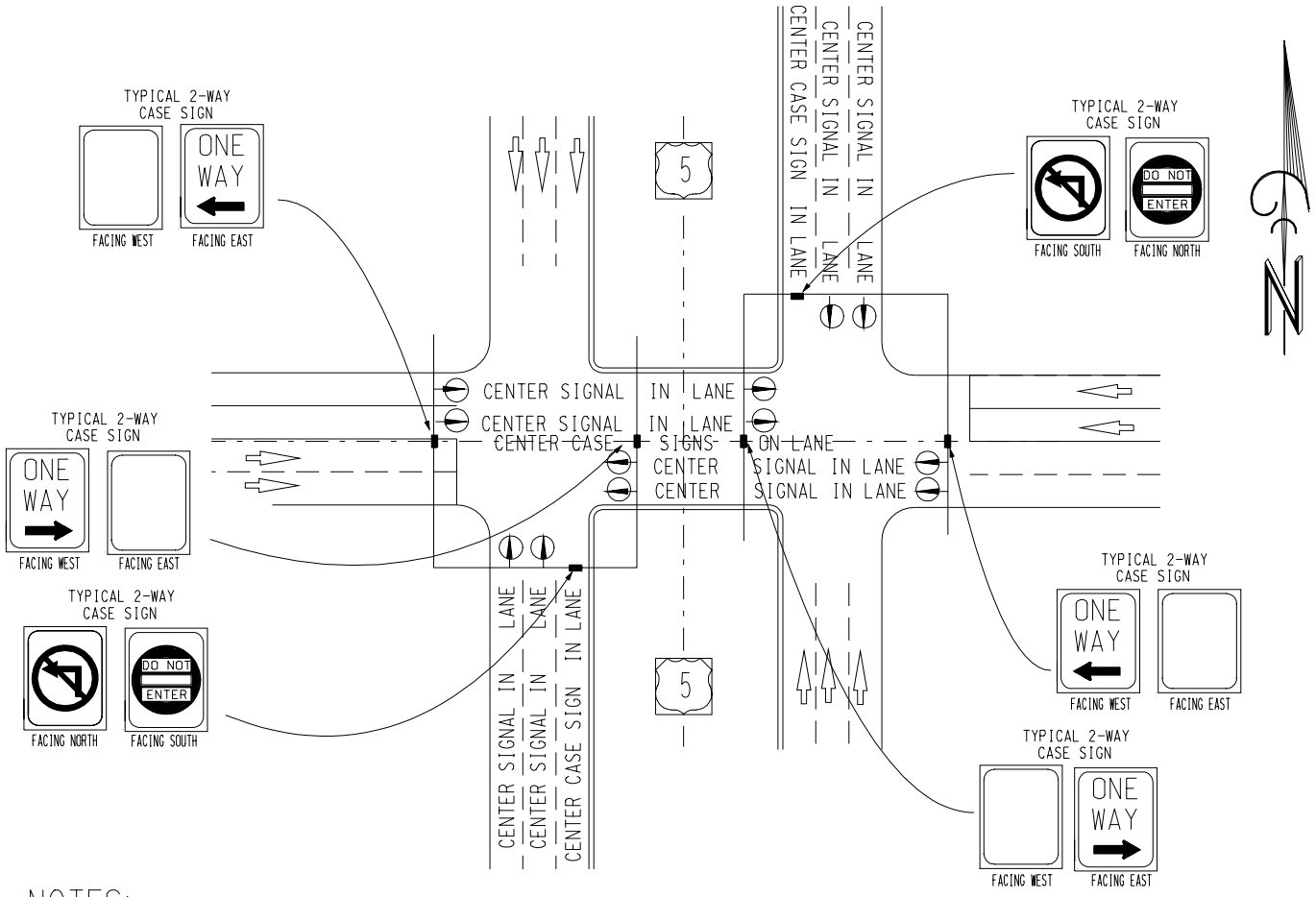
1. MEDIAN WIDTH IS 30' OR MORE, AND THE DISTANCE FROM THE X-ROAD STOP BAR TO THE MEDIAN SIGNAL IS LESS THAN OR EQUAL TO 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
5. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
6. WHILE PHASING IS POSSIBLE FOR EITHER ROADWAY, USUALLY LEFT TURNS ARE PROHIBITED AT THE INTERSECTION PROPER AND REDIRECTED THROUGH MEDIAN CROSSOVERS. THE MAIN PROBLEM IS THE INTERLOCKING OF LEFT TURN MOVEMENTS.
7. TO REDUCE THE NUMBER OF CONDUCTOR CABLES CROSSSING A SPAN, CONSIDERATION SHOULD BE GIVEN TO PLACING THE CONTROLLER IN THE MEDIAN.
8. A DIRECTIONAL BORE CONDUIT MAY BE REQUIRED TO REDUCE THE NUMBER OF OVERHEAD CONDUCTORS CABLES CROSSING THE SPAN TO 10 OR LESS.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN

06/23/2009

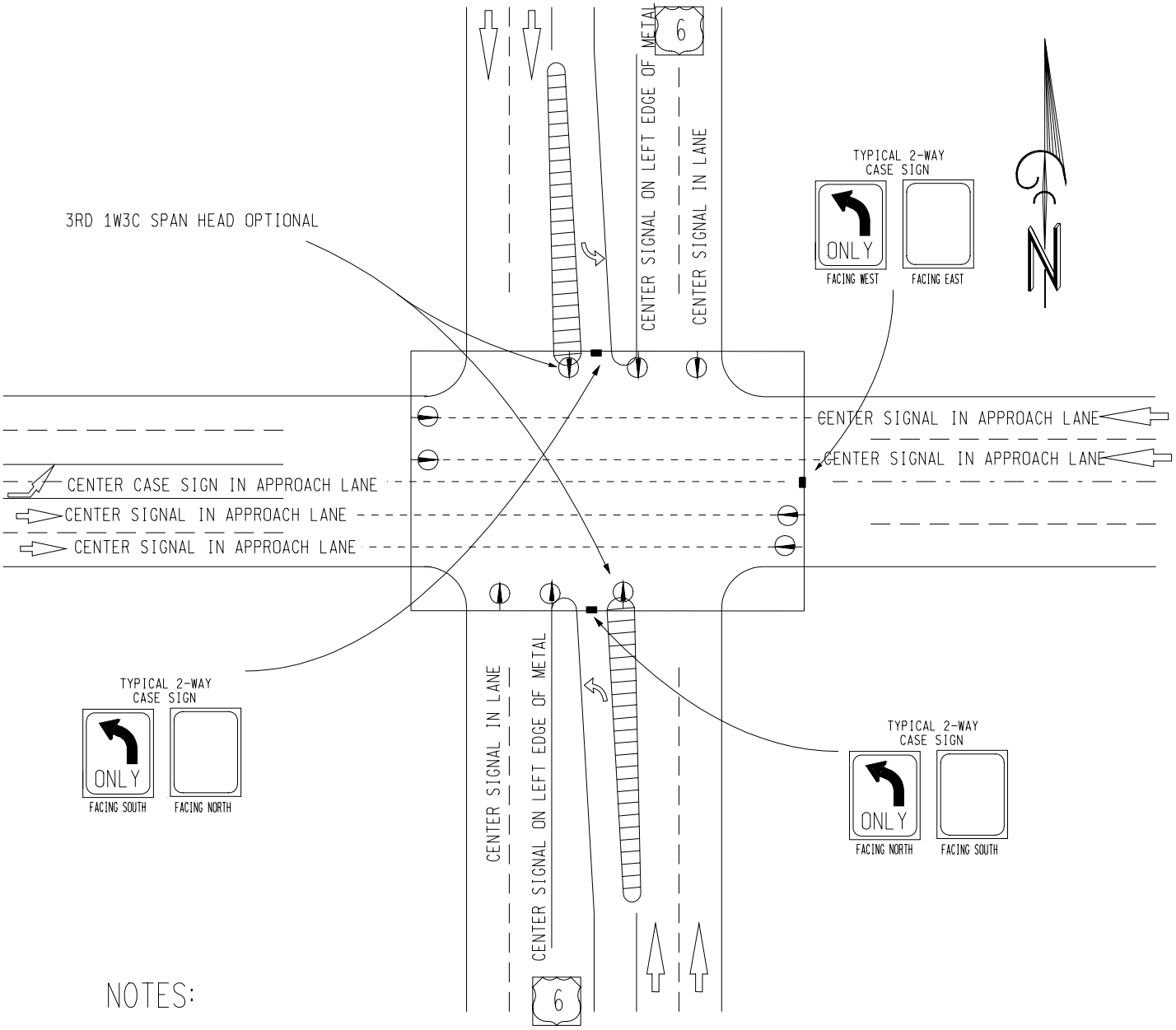


NOTES:

1. MEDIAN WIDTH IS 30' OR MORE, AND THE DISTANCE FROM THE X-ROAD STOP BAR TO THE CENTER LINE OF THE MEDIAN IS GREATER THAN 150 FEET
2. DESIGN AS TWO SEPARATE INTERSECTIONS.
3. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
4. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
5. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
6. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
7. WHILE PHASING IS POSSIBLE FOR EITHER ROADWAY, USUALLY LEFT TURNS ARE PROHIBITED AT THE INTERSECTION PROPER AND REDIRECTED THROUGH MEDIAN CROSSOVERS. THE MAIN PROBLEM IS THE INTERLOCKING OF LEFT TURN MOVEMENTS.
8. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
9. A BASE MOUNTED CABINET MAY BE REQUIRED
10. TO REDUCE THE NUMBER OF CONDUCTOR CABLES CROSSSING A SPAN, CONSIDERATION SHOULD BE GIVEN TO PLACING THE CONTROLLER IN THE MEDIAN.
11. A DIRECTIONAL BORE CONDUIT MAY BE REQUIRED TO REDUCE THE NUMBER OF OVERHEAD CONDUCTORS CABLES CROSSING THE SPAN TO 10 OR LESS.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

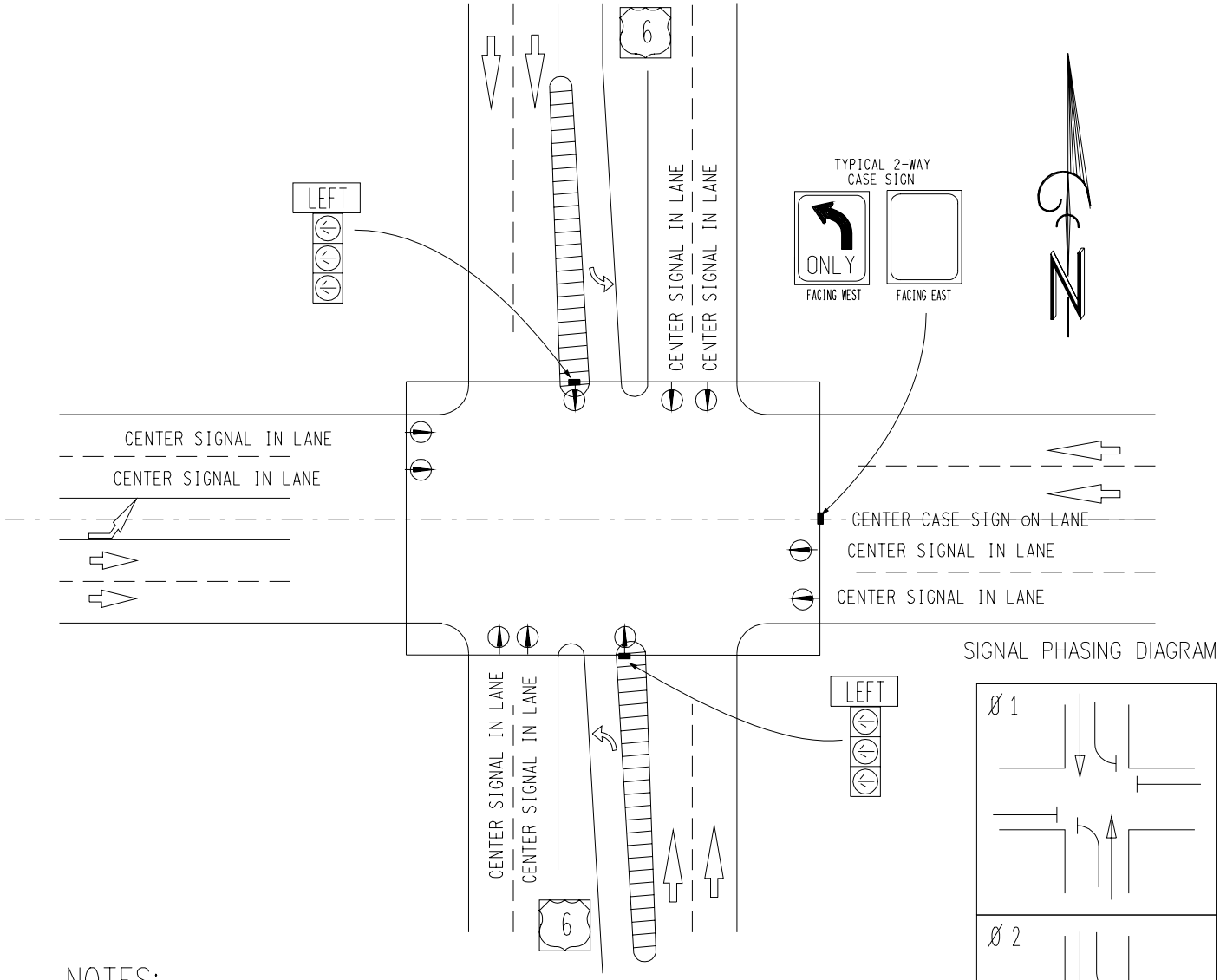


NOTES:

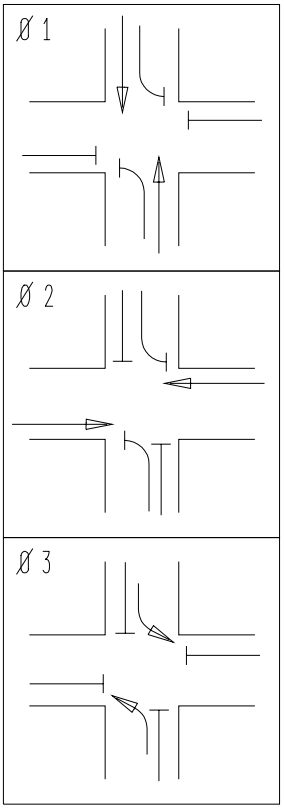
1. EXCLUSIVE LEFT TURN SLOTS
2. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
3. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
4. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
5. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION (IF THERE ARE CASE SIGNS).
6. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
7. TO MEET THE REQUIREMENTS FOR CONE OF VISION A 3RD 1W3C SPAN HEAD OR LOW LEVEL MAY BE REQUIRED.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



SIGNAL PHASING DIAGRAM



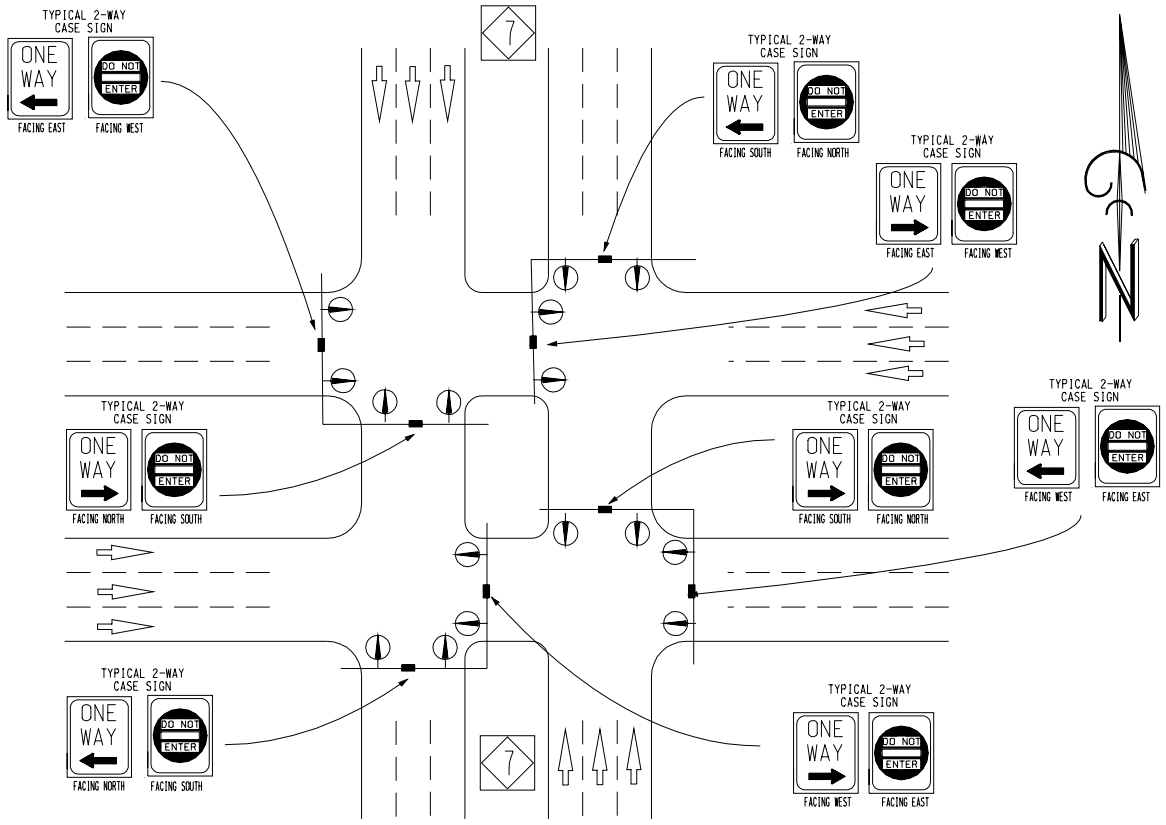
NOTES:

1. EXCLUSIVE LEFT TURN SLOTS
2. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
3. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
4. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
5. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION (IF THERE ARE CASE SIGNS).
6. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.

MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH DUAL LEADING LEFT-TURN PHASE (SAME FOR LAGGING LEFT-TURN)



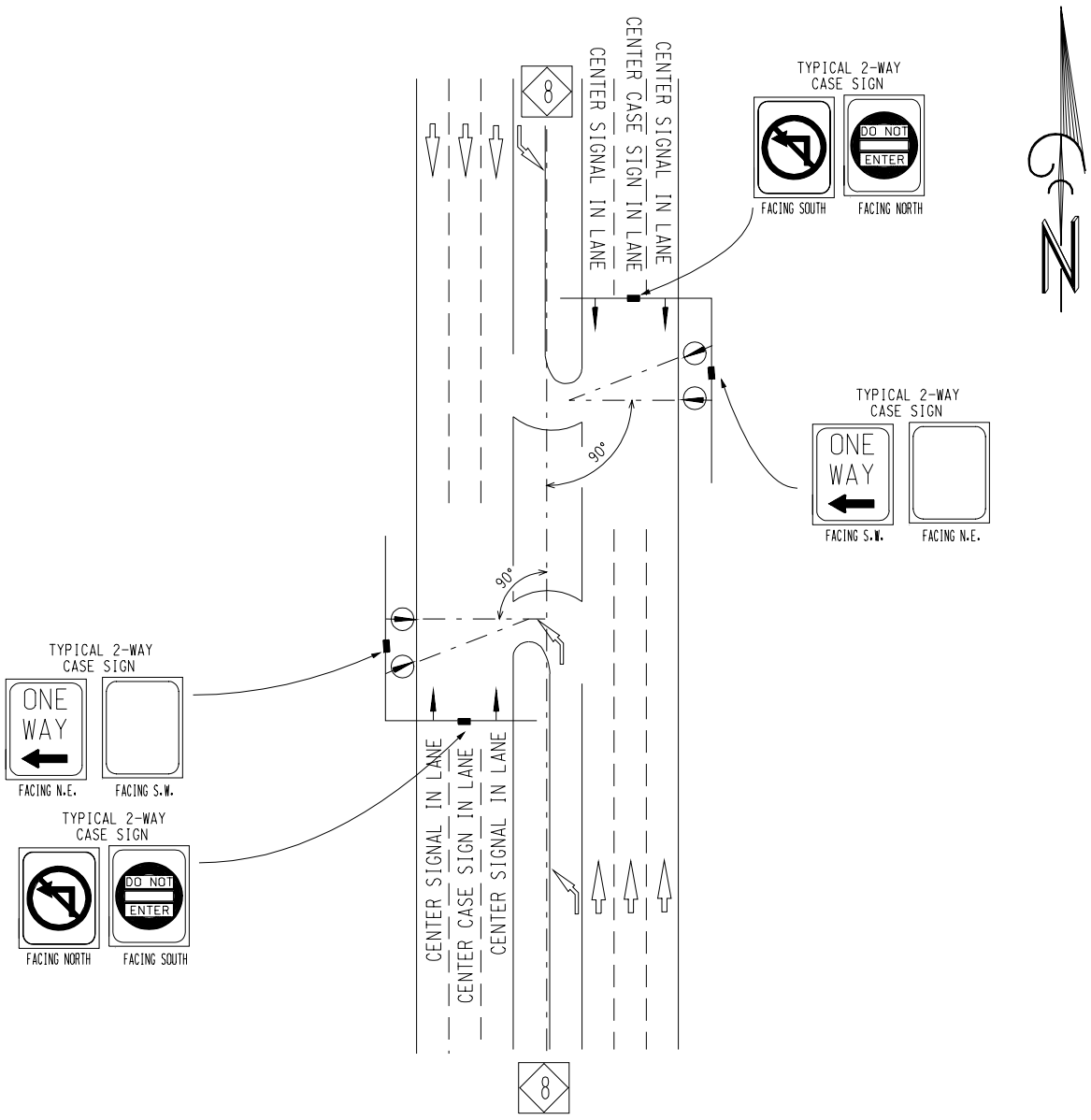
CENTER ALL CASE SIGNS IN THE MIDDLE LANE. ALL SIGNALS SHOULD BE CENTERED IN THE OUTSIDE LANES.

NOTES:

1. MEDIAN WIDTH IS 30' OR MORE, AND THE DISTANCE FROM THE X-ROAD STOP BAR TO THE MEDIAN SIGNAL IS GREATER THAN 150 FEET.
2. DESIGN AS FOUR SEPARATE INTERSECTIONS
3. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
4. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
5. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
6. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.
7. WHILE PHASING IS POSSIBLE FOR EITHER ROADWAY, USUALLY LEFT TURNS ARE PROHIBITED AT THE INTERSECTION PROPER AND REDIRECTED THROUGH MEDIAN CROSSOVERS. THE MAIN PROBLEM IS THE INTERLOCKING OF LEFT TURN MOVEMENTS.
8. TO REDUCE THE NUMBER OF CONDUCTOR CABLES CROSSSING A SPAN, CONSIDERATION SHOULD BE GIVEN TO PLACING THE CONTROLLER IN THE MEDIAN.
9. A BASE MOUNTED CABINET MAY BE REQUIRED

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



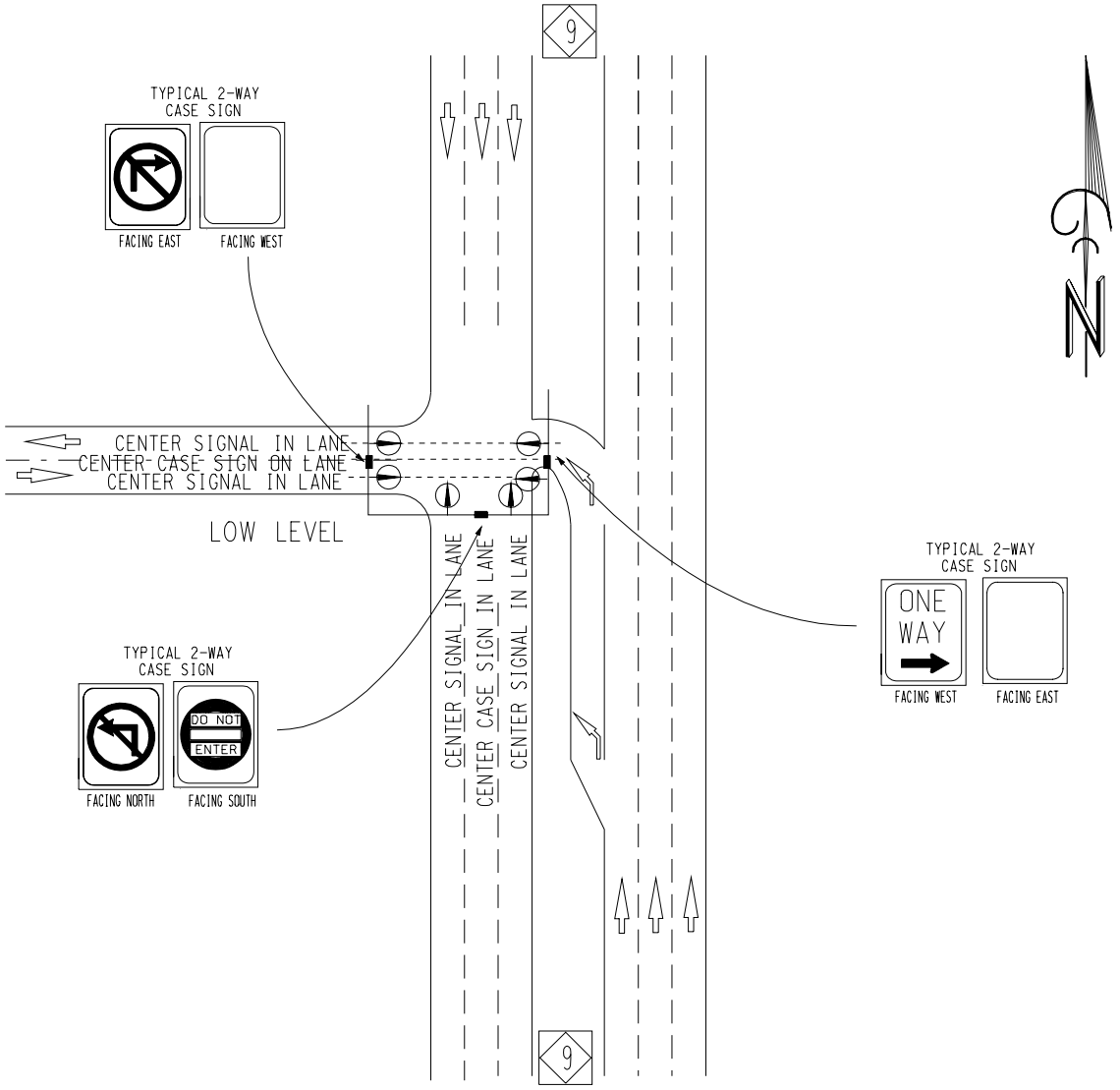
NOTES:

1. TREAT EACH CROSS OVER AS A SEPARATE INTERSECTION
2. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



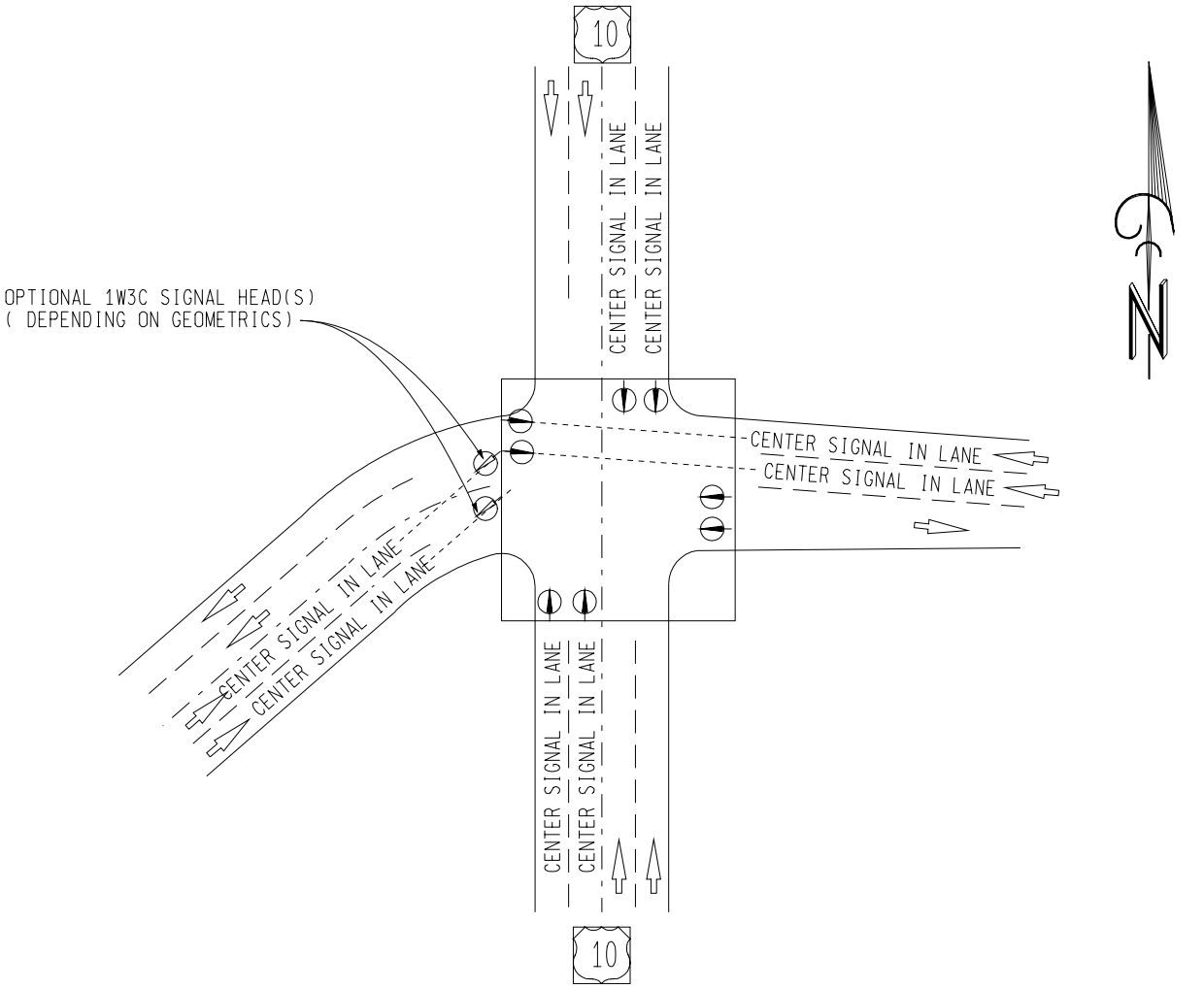
NOTES:

1 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



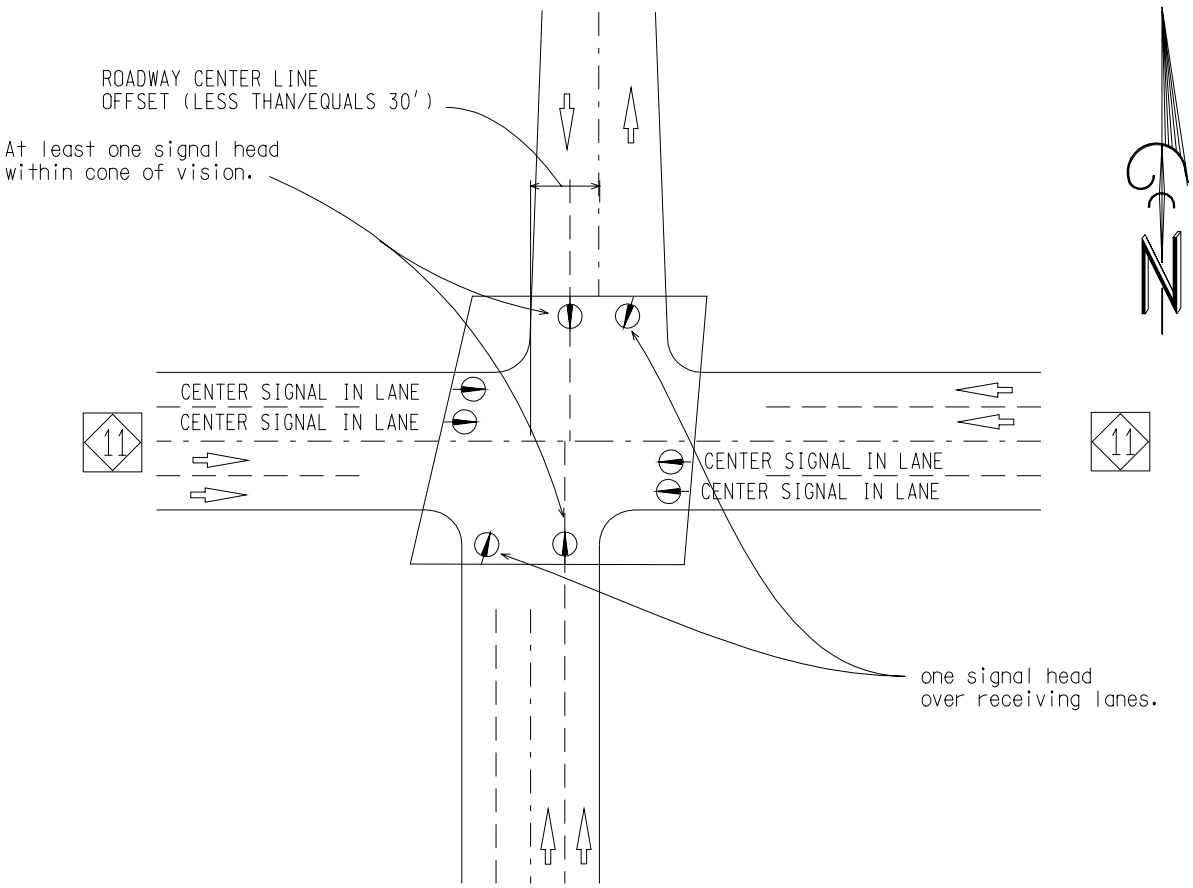
NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
3. TO MEET THE REQUIREMENTS FOR CONE OF VISION - 1W3C SPAN HEADS OR LOW LEVEL MAY BE REQUIRED.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



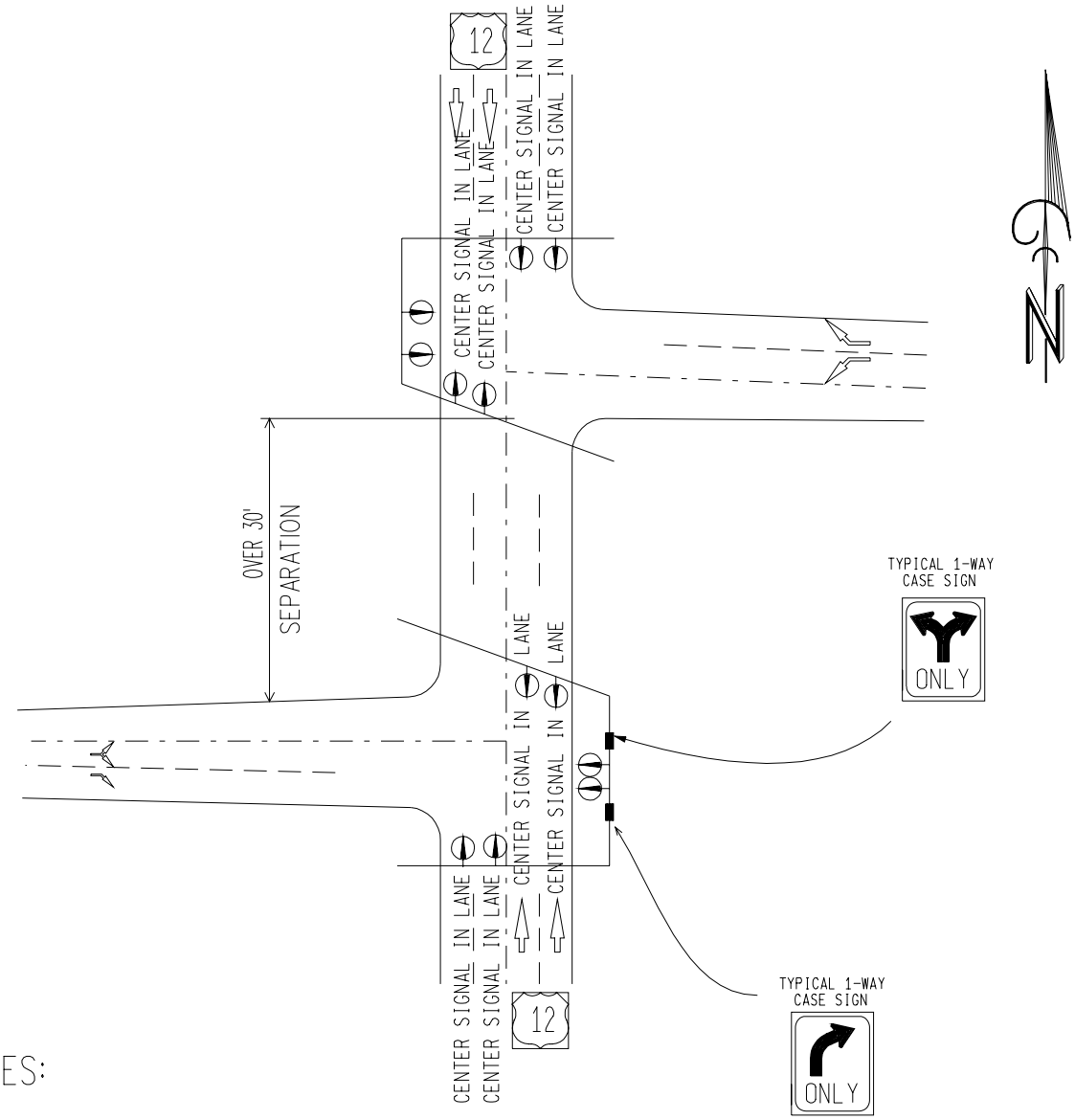
NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



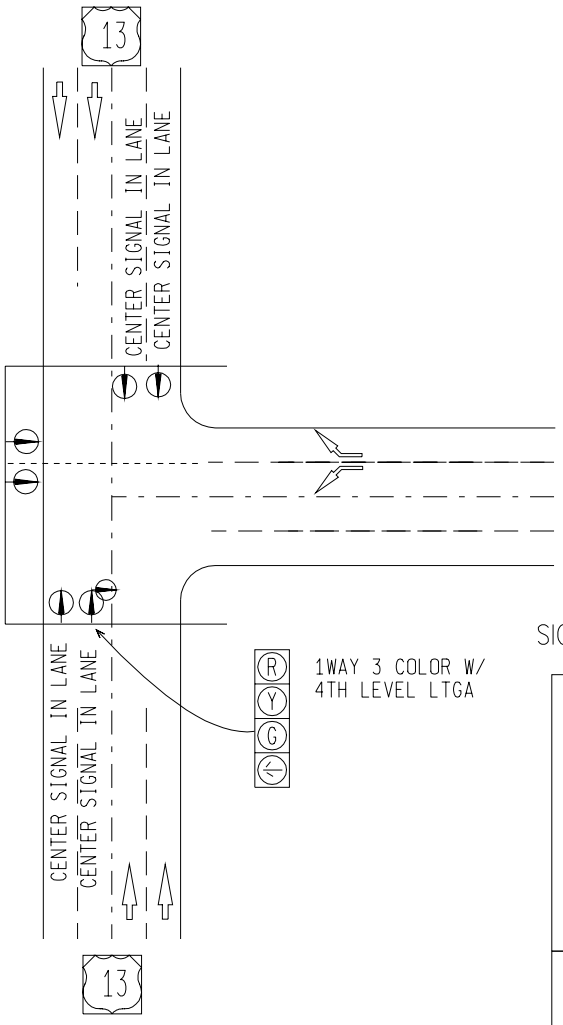
NOTES:

1. DESIGN AS TWO SEPARATE INTERSECTIONS (IF SEPARATION IS 30 ' OR MORE)
2. DESIGN AS ONE INTERSECTION (IF SEPARATION IS LESS THAN 30').
3. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
4. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
5. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
6. No case sign is necessary unless one of the approach lanes is a combination lane

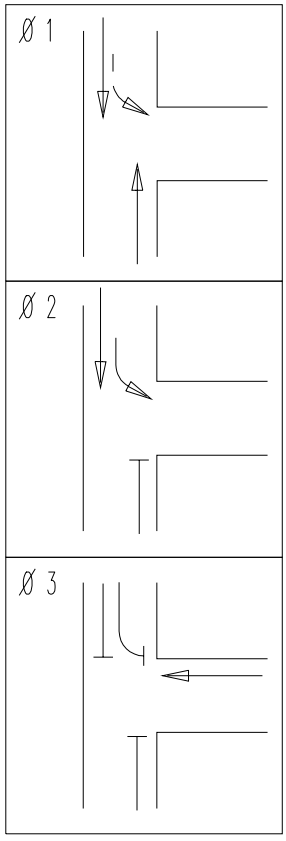
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009



SIGNAL PHASING DIAGRAM



NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
4. PEDESTRIAN SIGNALS REQUIRED UNLESS OTHERWISE DIRECTED.
5. UTILIZE A 4TH LEVEL LTGA FOR THE SOUTH PROTECTED LEFT MOVEMENTS.

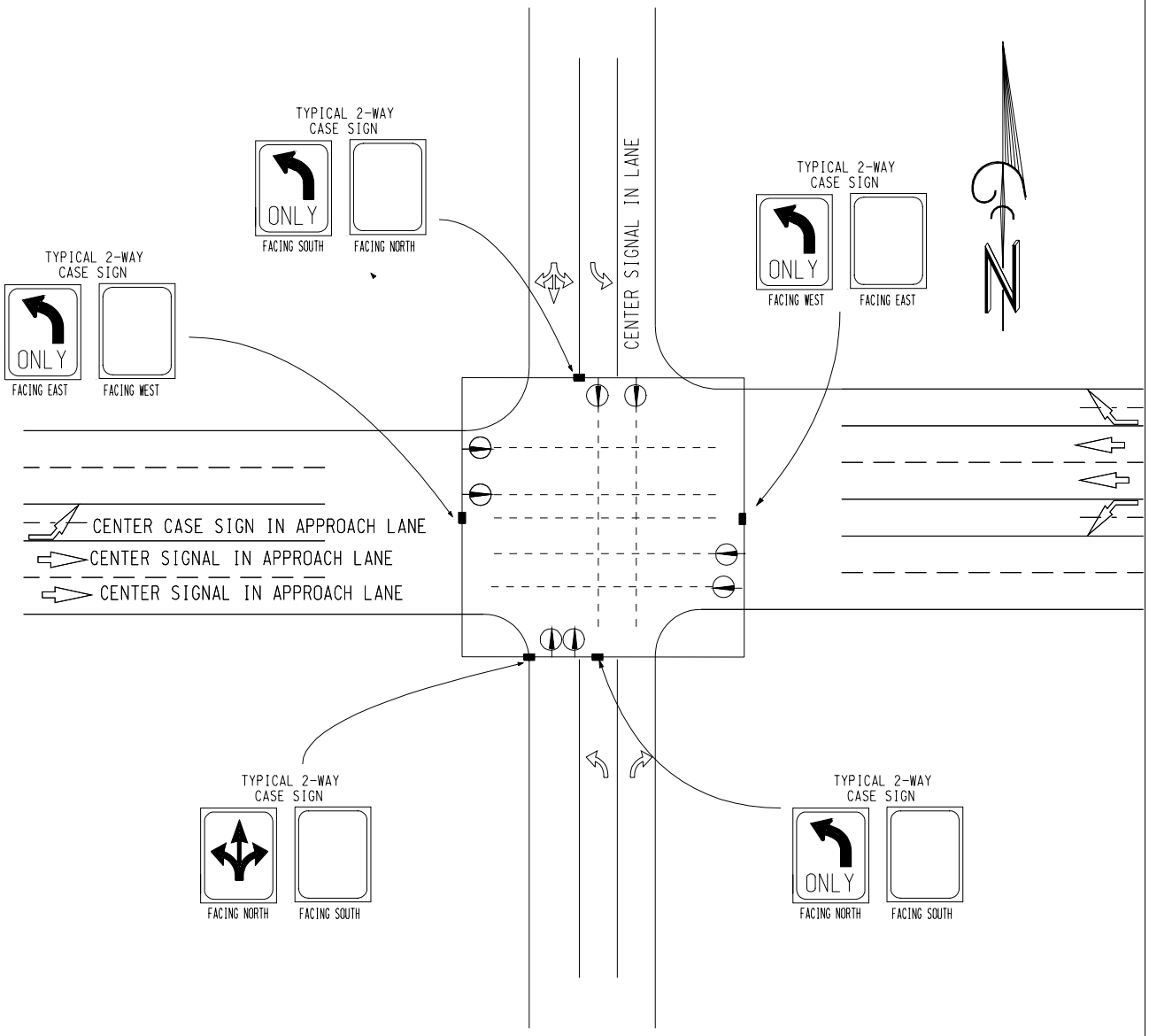
MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH SINGLE LAGGING LEFT-TURN PHASE ON TRUNKLINE

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN

06/23/2009



NOTES:

1. EXCLUSIVE LEFT TURN SLOTS
2. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
3. in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
4. MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
5. THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION (IF THERE ARE CASE SIGNS).
6. PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT.

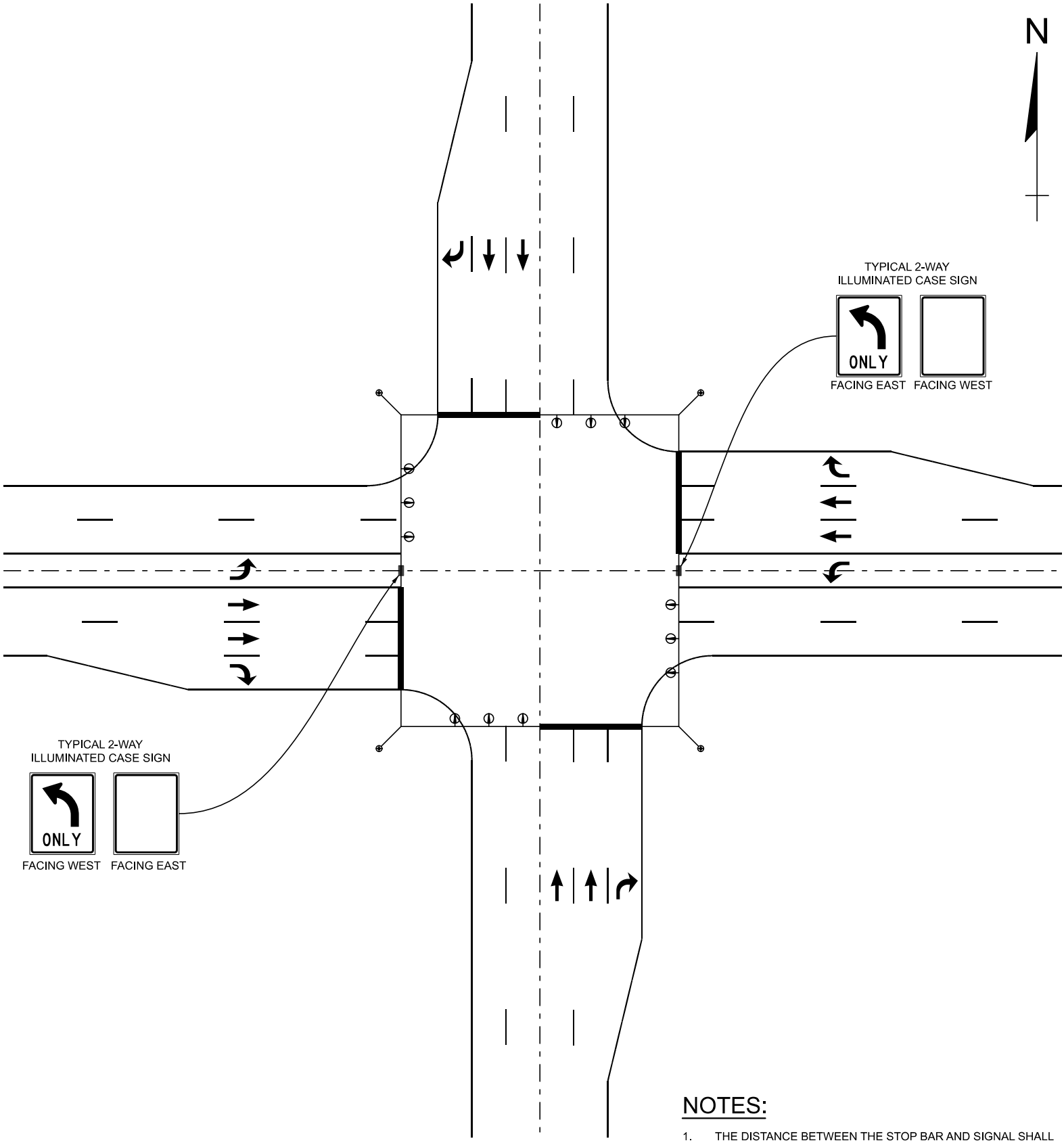
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

pwname:\MDOTProjectWise\Documents\Reference Documents\Traffic and Safety\Standards\Develop\Signal Stds D\BOX SPAN TYPICALS.DGN 06/23/2009

MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES

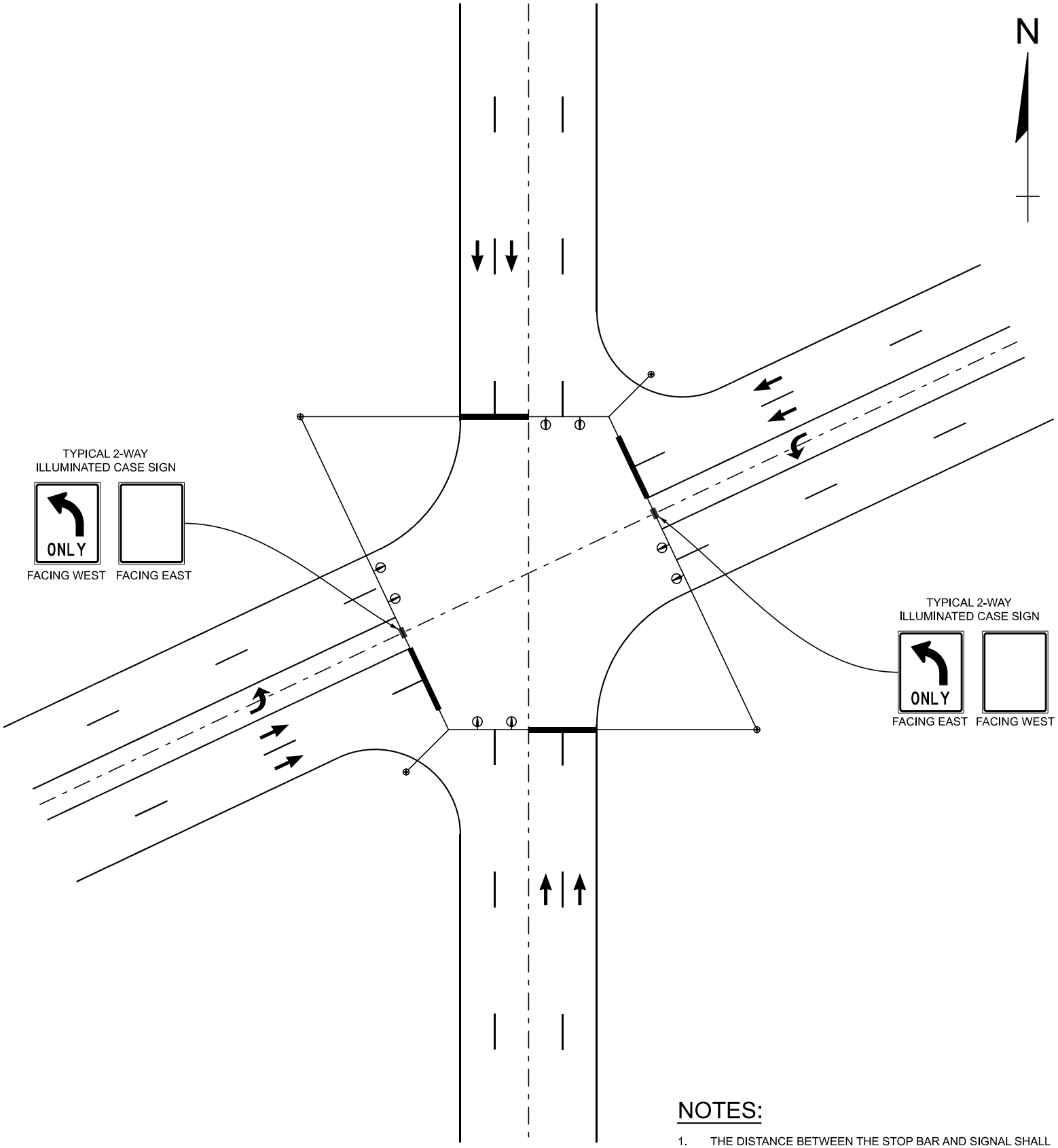
Appendix H – Traffic Signal Head Placement Diagrams (Suspended Box Span)



NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. IN THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) - 12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

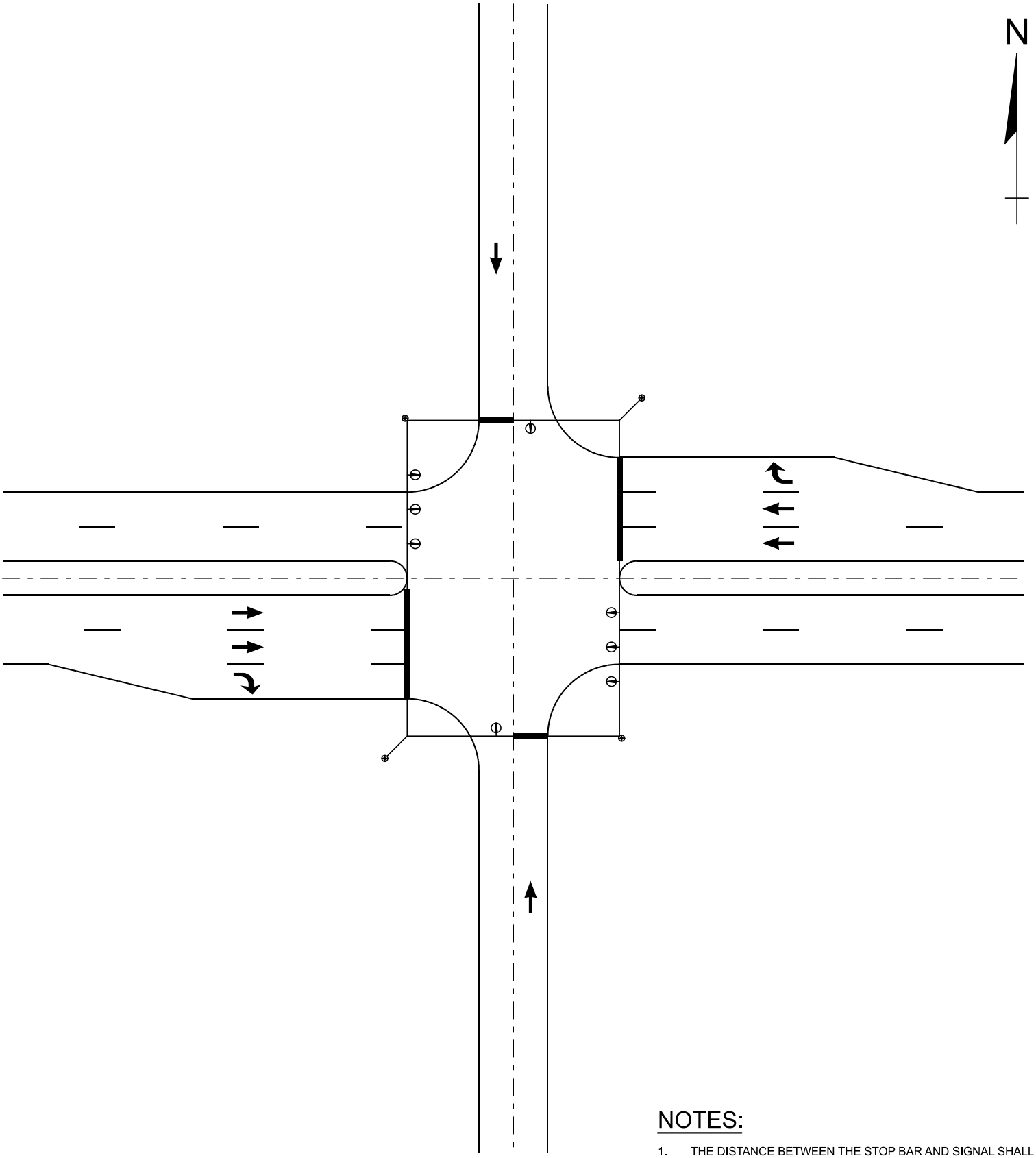
MDOT Michigan Department of Transportation	NO SCALE	DESIGN UNIT: SIGNALS	TSC: STATEWIDE	DATE:	
		CS: STATEWIDE	SUSPENDED BOX SPAN CONFIGURATION	DRAWING	SHEET
		JN: STATEWIDE			SECT
FILE:			BOX SPAN TYPICALS.dgn		1 OF 4



NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. IN THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) - 12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

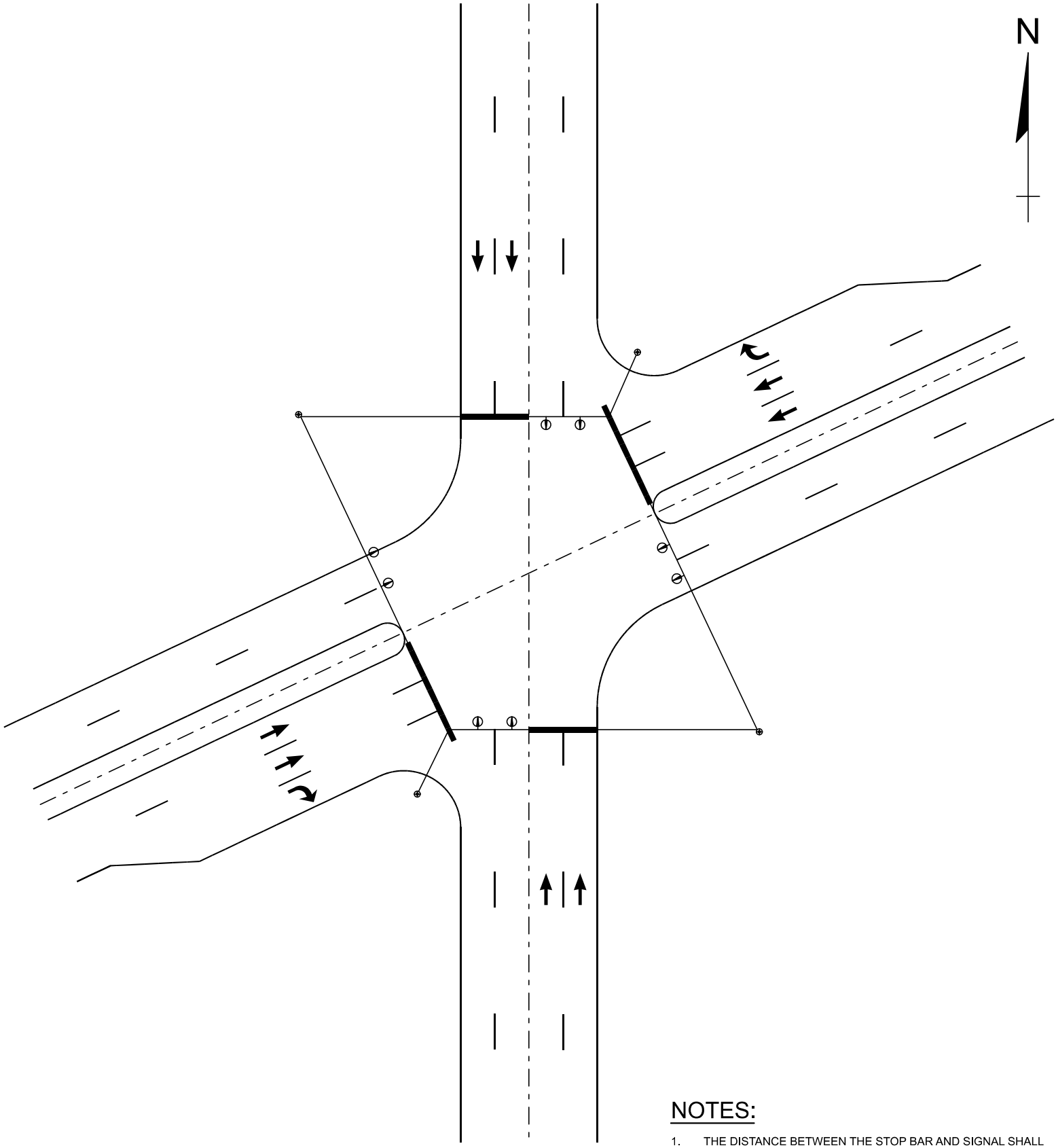
MDOT Michigan Department of Transportation	NO SCALE	DESIGN UNIT: SIGNALS	TSC: STATEWIDE	DATE:	
		CS: STATEWIDE	BOX SPAN WITH 2 TIE-OFFS	DRAWING	SHEET
		JN: STATEWIDE			SECT
FILE:			BOX SPAN TYPICALS.dgn		2 OF 4



NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. IN THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) - 12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

MDOT Michigan Department of Transportation	NO SCALE	DESIGN UNIT: SIGNALS	TSC: STATEWIDE	DATE:	
		CS: STATEWIDE	BOX SPAN WITH 2 TIE-OFFS	DRAWING	SHEET
		JN: STATEWIDE			SECT
FILE:			BOX SPAN TYPICALS.dgn		3 OF 4

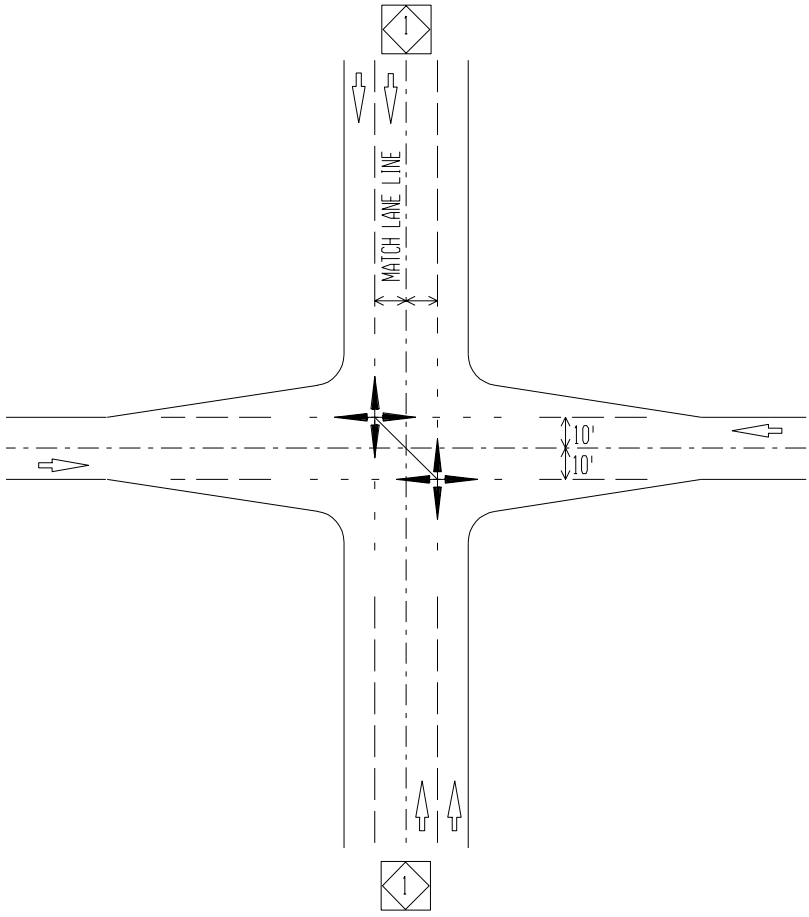


NOTES:

1. THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
2. IN THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
3. MAINTAIN 8 FEET (MIN) - 12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

MDOT Michigan Department of Transportation	NO SCALE	DESIGN UNIT: SIGNALS	TSC: STATEWIDE	DATE:	
		CS: STATEWIDE	BOX SPAN WITH 2 TIE-OFFS	DRAWING	SHEET
		JN: STATEWIDE			SECT
FILE:			BOX SPAN TYPICALS.dgn		4 OF 4

Appendix I – Traffic Signal Head Placement Diagrams (Diagonal Span)



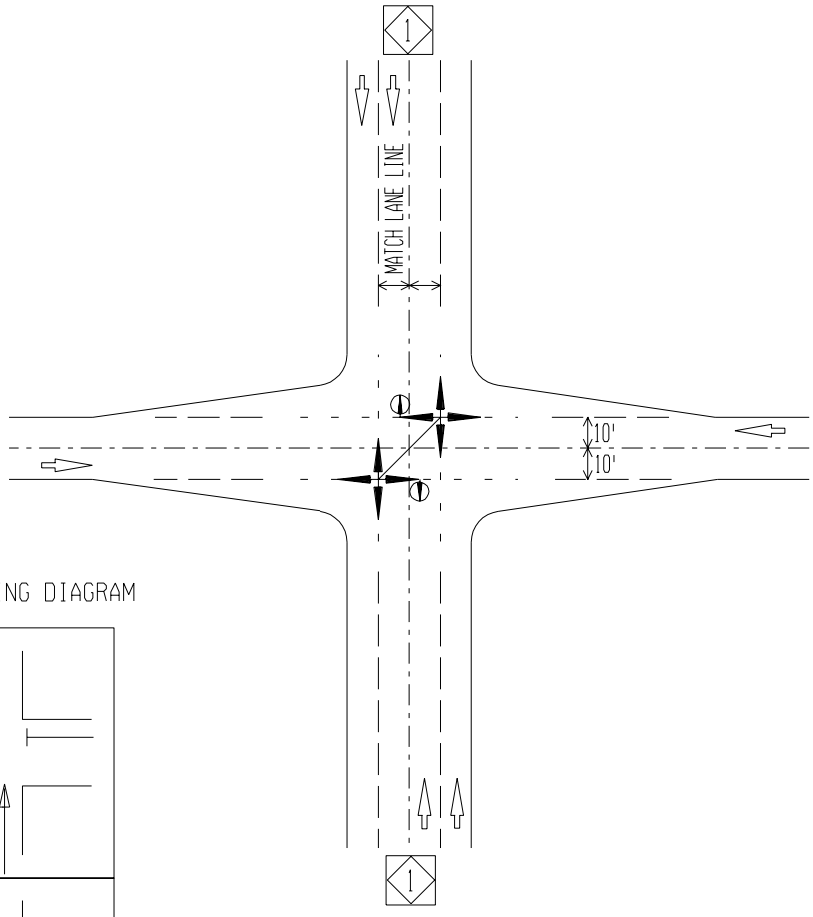
NOTES:

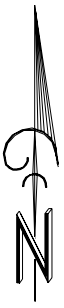
1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE

2 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE

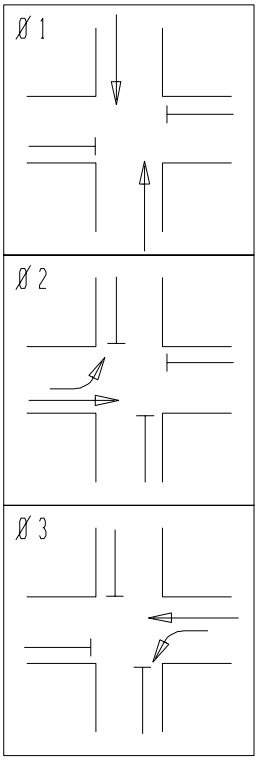
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION





SIGNAL PHASING DIAGRAM



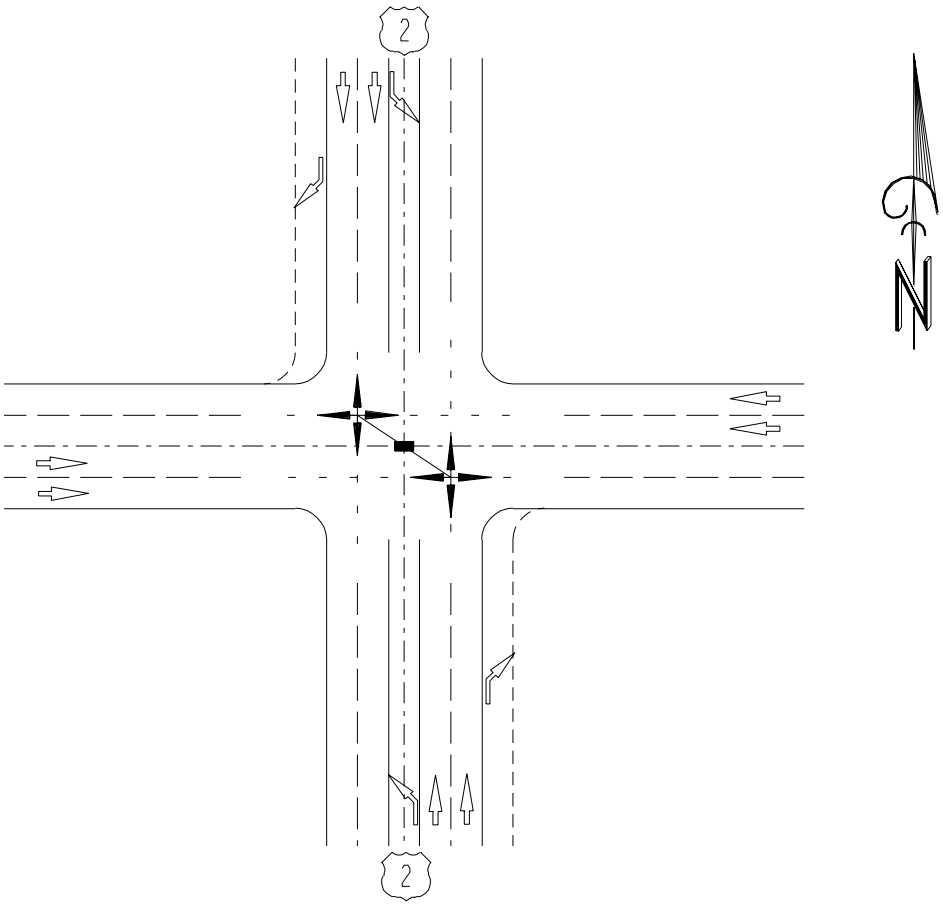
NOTES:

1. DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE
2. USE NEAR RIGHT - FAR LEFT FOR PHASED DIRECTION
3. USE FAR SIDE 4th LEVEL LEFT TURN GRE EN ARROWS (L.T.G.A.)
4. PEDESTRIAN SIGNALS REQUIRED

MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION
SPLIT PHASE

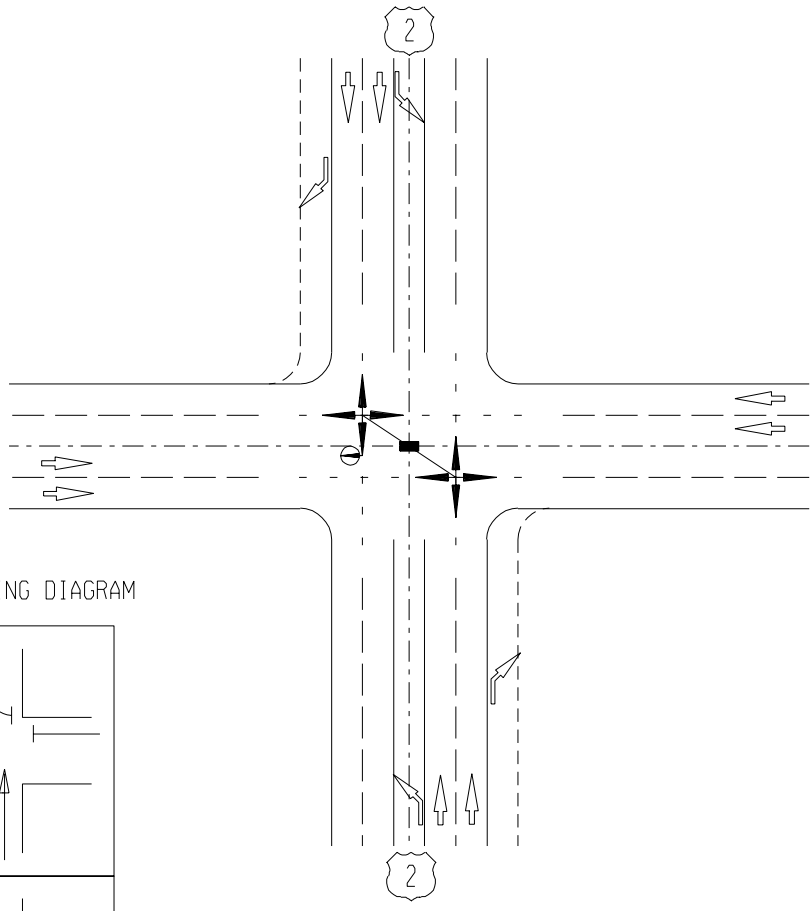


NOTES:

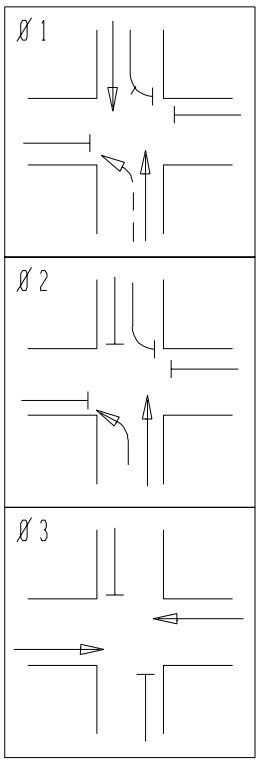
1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE
2 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE
3 USE 2-WAY CASE SIGN
4 CONSIDER LOW LEVEL SIGNALS ON X-RD F OR HEAVY LEFT TURN MOVEMENT

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



SIGNAL PHASING DIAGRAM

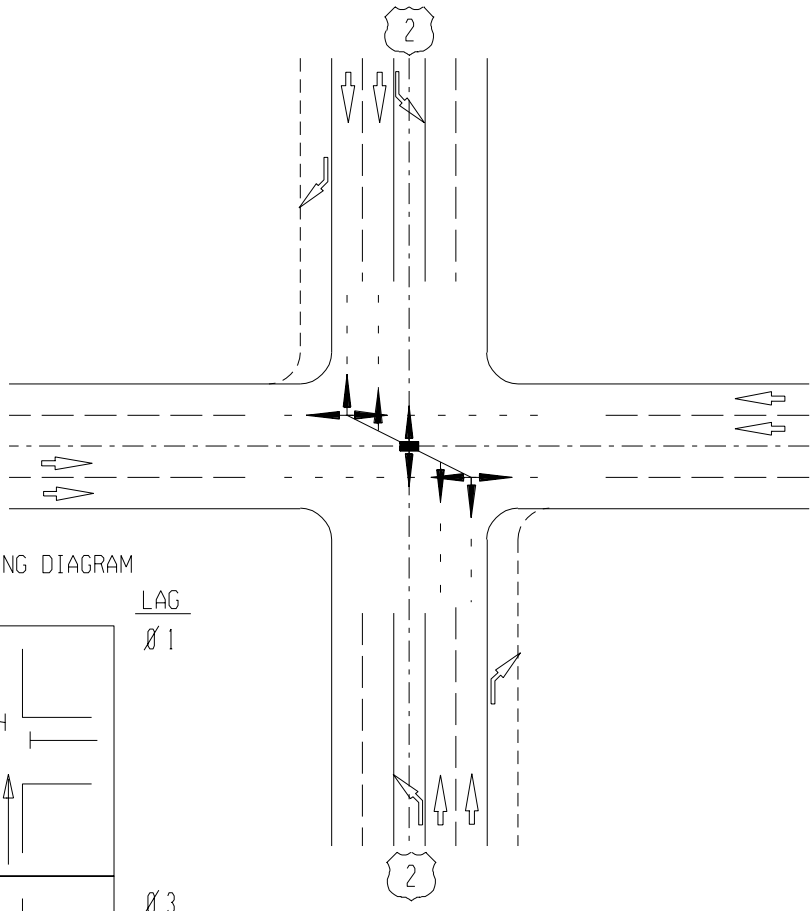


NOTES:

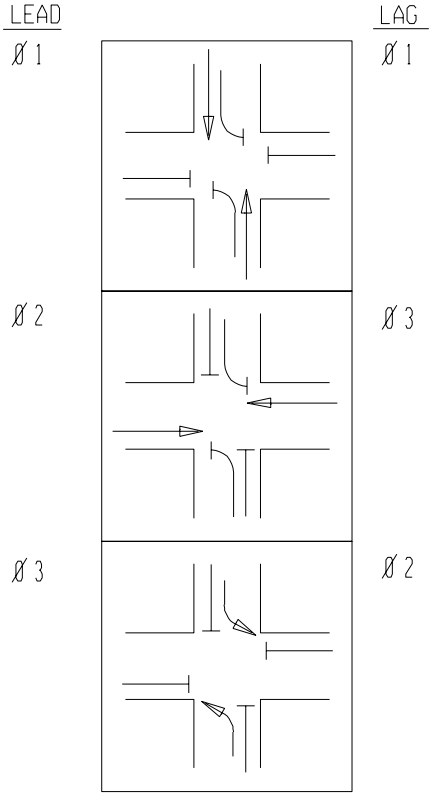
1. DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE
2. USE NEAR RIGHT - FAR LEFT ON TRUNKLINE
3. USE 4TH LEVEL LEFT TURN GREEN ARROW (L.T.G.A.)
4. USE 2 - WAY CASE SIGN
5. OPPOSING LEFT-TURN MOVEMENT MUST BE PROHIBITED
6. PEDESTRIAN SIGNALS OPTIONAL

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH SINGLE LAGGING LEFT TURN PHASE ON TRUNKLINE



SIGNAL PHASING DIAGRAM



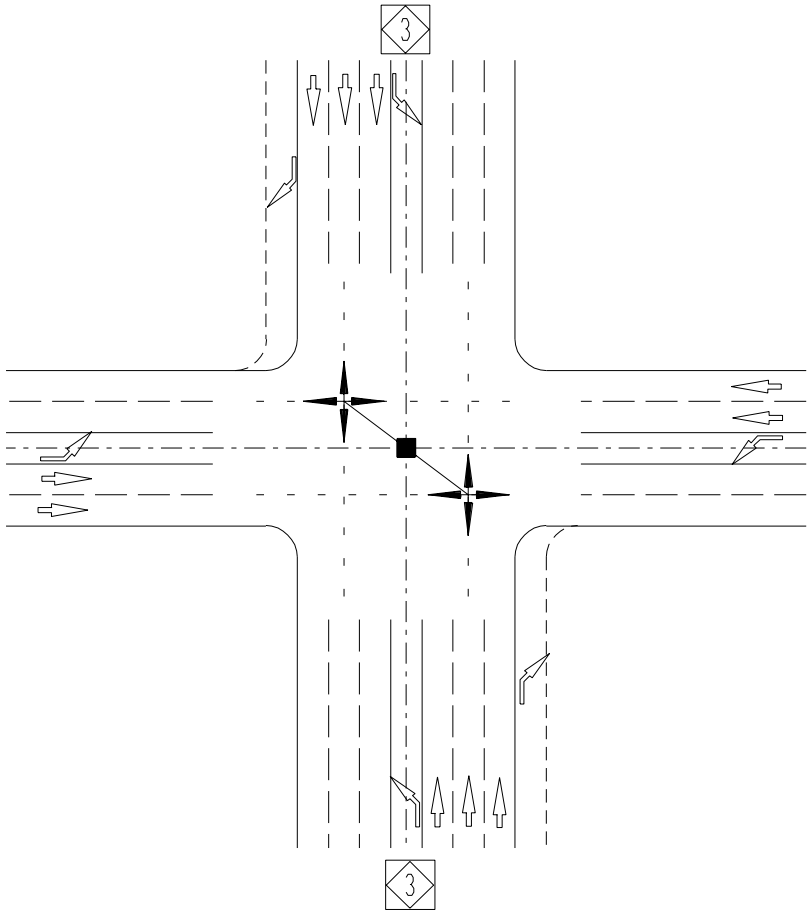
NOTES:

1. DRAW HEAD PLACEMENT BOX - SPLIT LANE S FOR EACH APPROACH
2. USE EXCULUSIVE LEFT-TURN SIGNAL HEAD S WITH CASE SIGNS
3. PLACE TWO THRU SIGNALS TO RIGHT OF T HE LEFT-TURN SIGNAL
4. WITH TWO THRU LANES - SPLIT EACH LANE
5. WITH TWO THRU LANES & RIGHT LANE = A DJUST LEFT SIGNAL TOWARD RIGHT LANE LINE AND RI GHT SIGNAL TOWARD RIGHT TURN LANE. THIS IS TO P ROVIDE FOR A WIDER HEAD SEPARATION & IMPROVE VISI BILITY FOR ALL LANES
6. PEDESTRIAN SIGNALS REQUIRED UNLESS O THERWISE DIRECTED
7. LEAD LEFT-TURN PHASE SHALL NOT BE PE RMISSIVE (i.e. FLASHING RED LEFT-TURN SIGNAL)

MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH DUAL LEAD OR LAG LEFT TURN PHASE ON TRUNKLINE

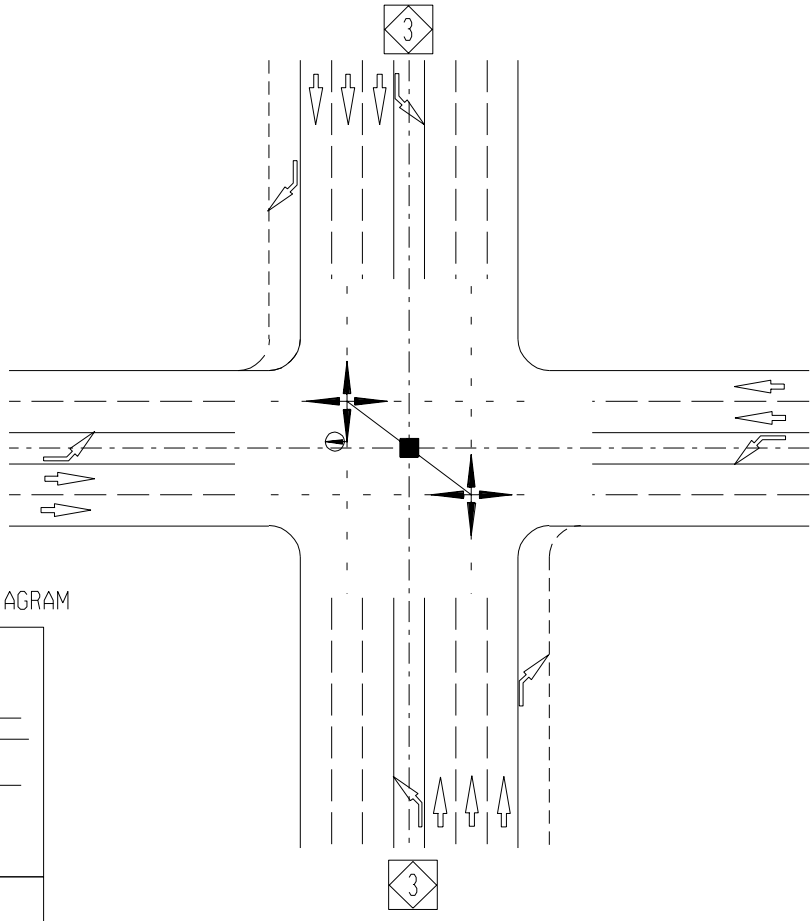


NOTES:

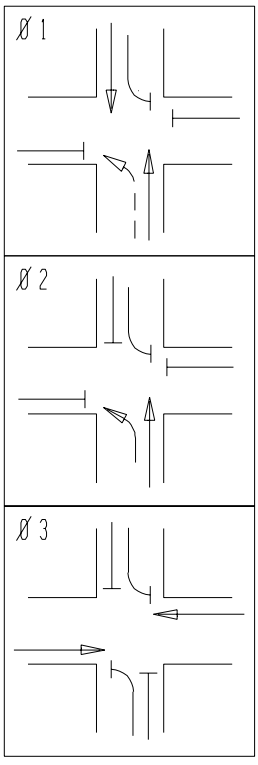
1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE
2 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE
3 USE 4-WAY CASE SIGN
4 CONSIDER LOW LEVEL SIGNALS ON X-RD F OR HEAVY LEFT TURN MOVEMENTS

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



SIGNAL PHASING DIAGRAM

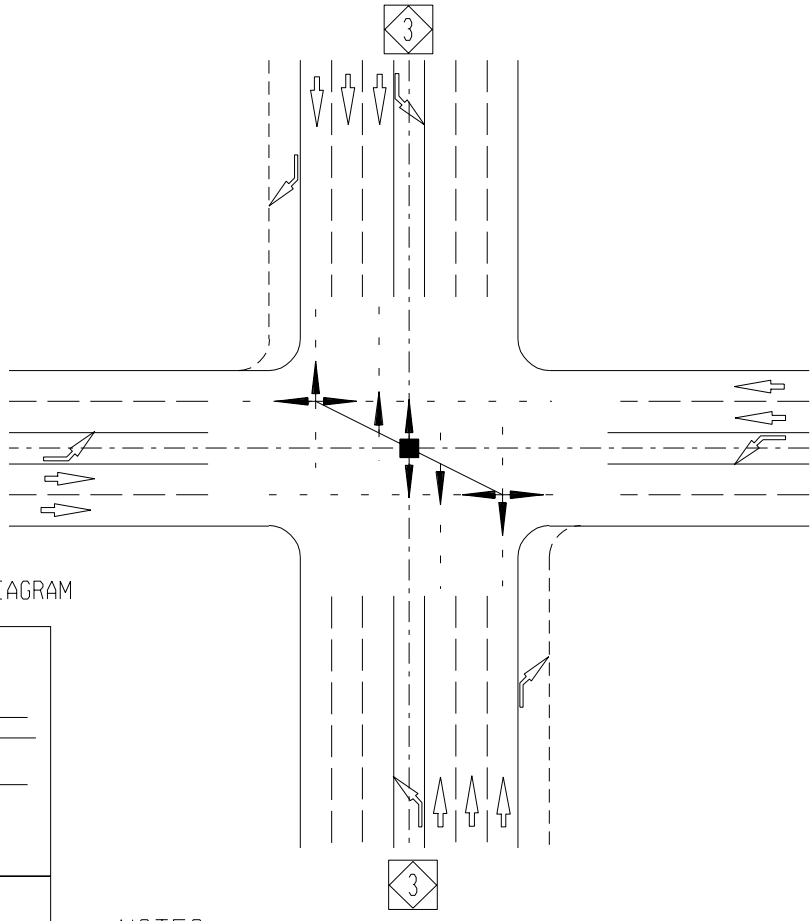


NOTES:

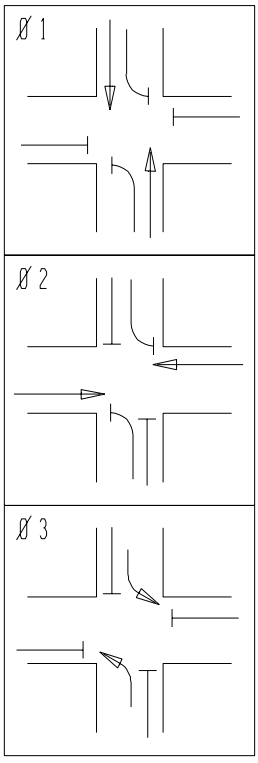
1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE - BOTH APPROACHES
2 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE
3 USE 4TH LEVEL LEFT TURN GREEN ARROW (L.T.G.A.)
4 USE 4-WAY CASE SIGN
5 OPPOSING LEFT TURN MOVEMENT MUST BE PROHIBITED
6 PEDESTRIAN SIGNALS OPTIONAL
7 CONSIDER LOW LEVEL SIGNALS ON X-RD FOR HEAVY LEFT TURNS MOVEMENTS

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH SINGLE LAGGING LEFT TURN PHASE ON TRUNKLINE



SIGNAL PHASING DIAGRAM

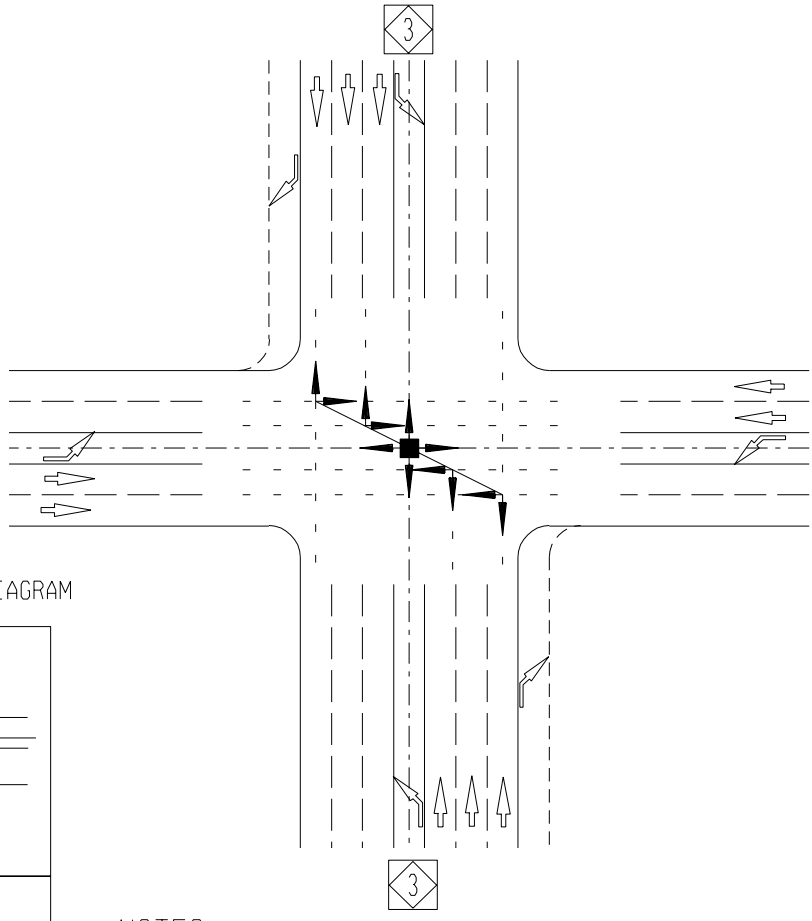


NOTES:

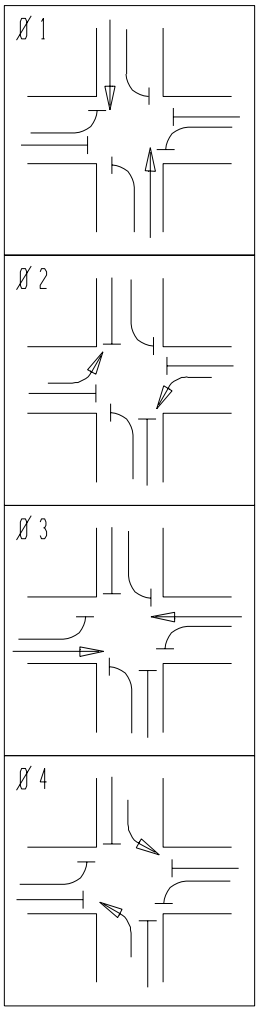
1. DRAW HEAD PLACEMENT BOX-SPLIT LANES FOR EACH TRUNKLINE APPROACH
2. USE EXCLUSIVE LEFT - TURN SIGNAL HEA DS WITH CASE SIGNS
3. PLACE TWO THRU SIGNALS TO THE RIGHT OF THE LEFT TURN SIGNAL
4. WITH THREE LANES: SPLIT CURB LANE FO R RIGHT SIGNAL AND ADJUST LEFT SIGNAL BETWEEN CENTER OF LEFT T HRU LANE AND LANE LINE
5. WITH THREE LANES & RIGHT LANES: SAME PLACEMENT BUT RIGHT SIGNAL CAN BE ADUSTED TOWARD RIGHT TURN LAN E IF DESIRABLE
6. PEDESTRIAN SIGNALS REQUIRED UNLESS O HERWISE DIRECTED
7. CONSIDER LOW LEVEL SIGNALS ON X-RD F OR HEAVY LEFT TURN MOVEMENTS

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH DUAL LEADING LEFT TURN PHASING ON TRUNKLINE



SIGNAL PHASING DIAGRAM



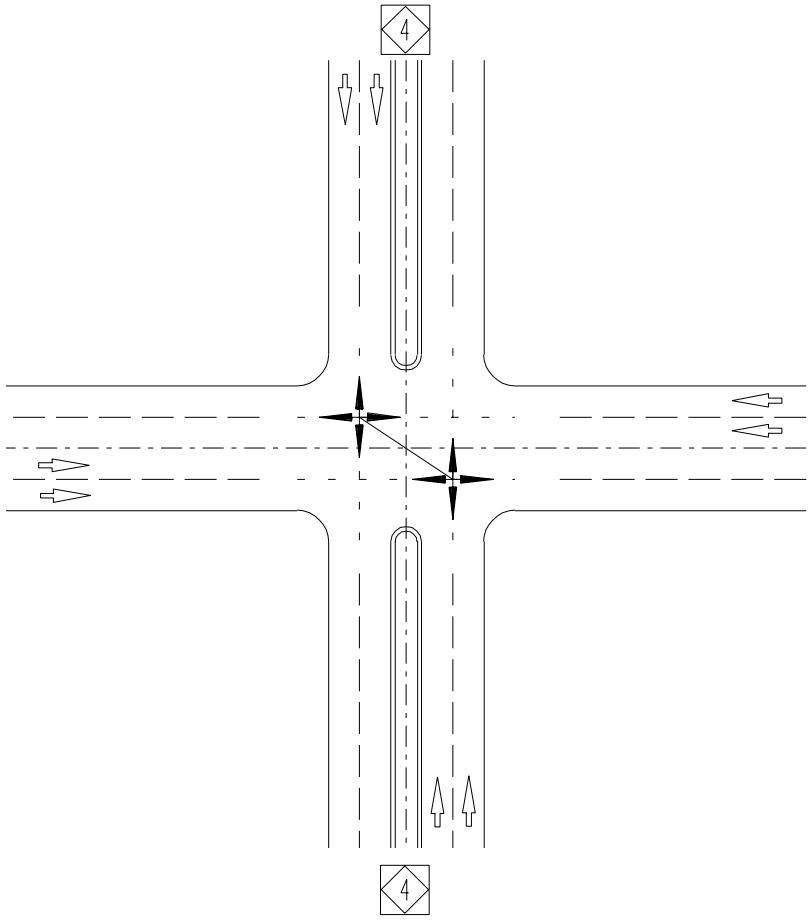
NOTES:

1. DRAW HEAD PLACEMENT BOX- SPLIT THRU LANEAGE ON EACH APPROACH
2. USE EXCLUSIVE 4-WAY LEFT TURN SIGNAL S WITH CASE SIGNS
3. PLACE TWO THRU SIGNALS TO THE RIGHT OF THE LEFT TURN SIGNAL
4. WITH THREE LANES: SPLIT THRU LANEAGE
5. WITH THREE LANES: SPLIT CURB LANE FO R RIGHT SIGNAL AND ADJUST LEFT SIGNAL BETWEEN CENTER OF LEFT T HRU LANE AND LANE LINE
6. PEDESTRIAN SIGNALS REQUIRED
7. LOW LEVELS NOT REQUIRED FOR SUPPLEME NTAL HEADS FOR LEFT TURNS

MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

4 PHASE OPERATION WITH
LEADING LEFT TURNS FOR BOTH ROADS
(SAME OPERATION AS 8 PHASE)



NOTES:

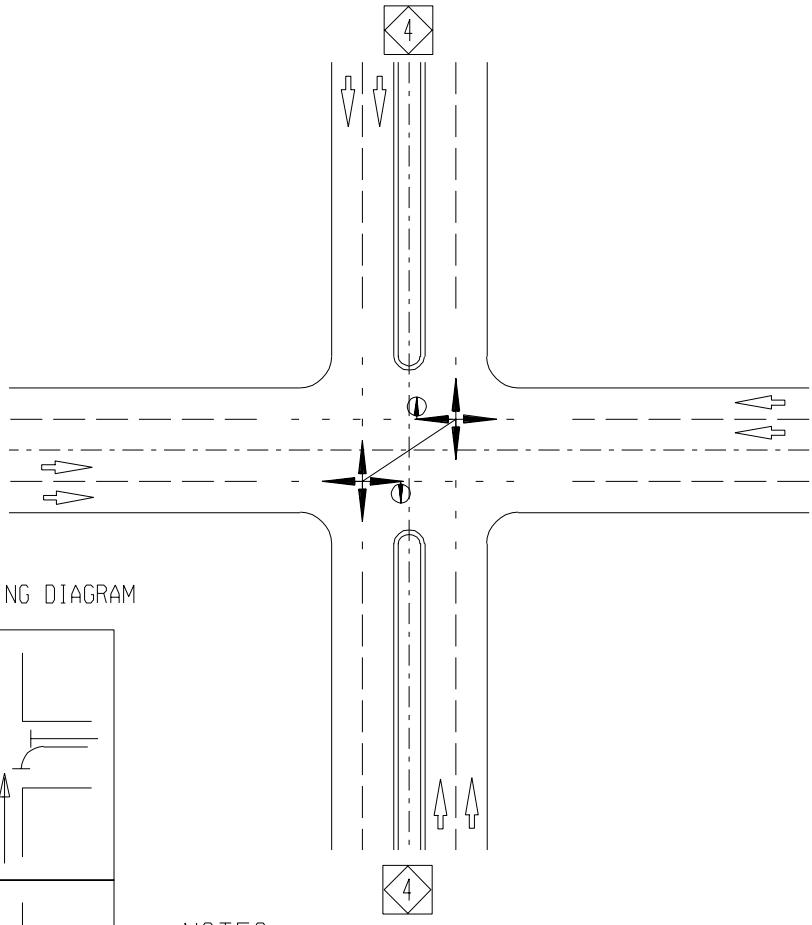
1 MEDIAN WIDTH LESS THAN 30'

2 DRAW HEAD PLACEMENT BOX-SPLIT THRU L ANEAGE

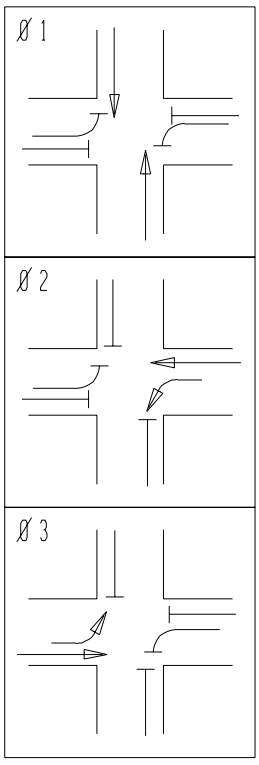
3 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



SIGNAL PHASING DIAGRAM

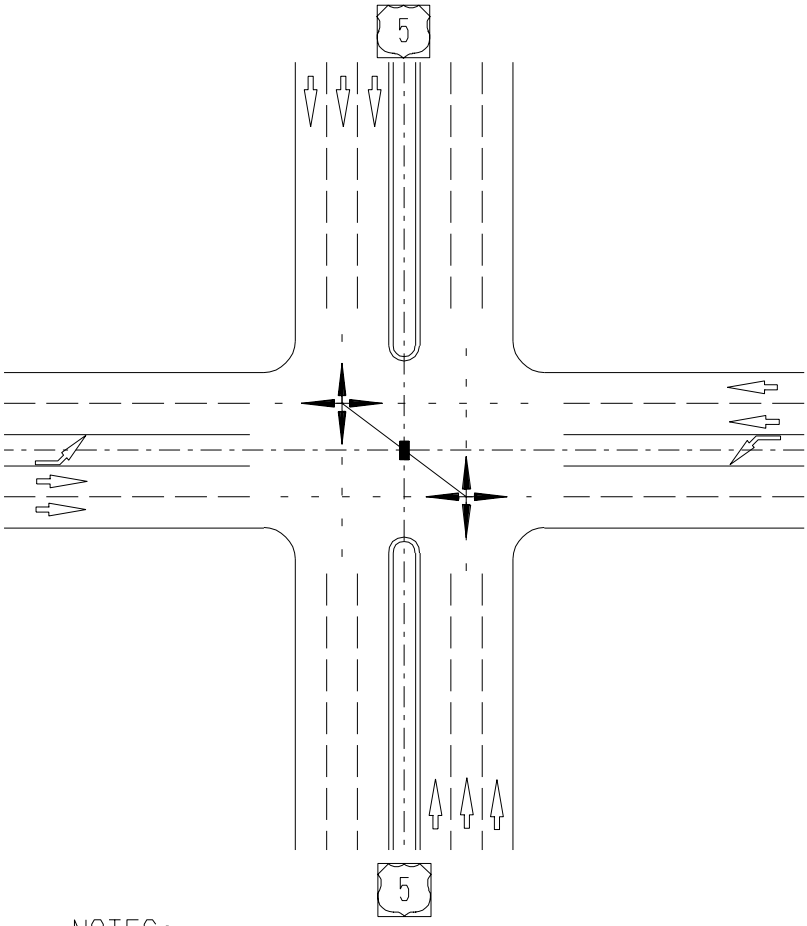


NOTES:

1. MEDIAN WIDTH LESS THAN 30'
2. DRAW HEAD PLACEMENT BOX-SPLIT THRU L ANEAGE
3. USE NEAR RIGHT FAR LEFT FOR PHASE DI RECTION
4. USE 4th LEVEL LEFT TURN GREEN ARROWS (L.T.G.A.'S)
5. PEDESTRIAN SIGNALS REQUIRED

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION
SPLIT PHASE

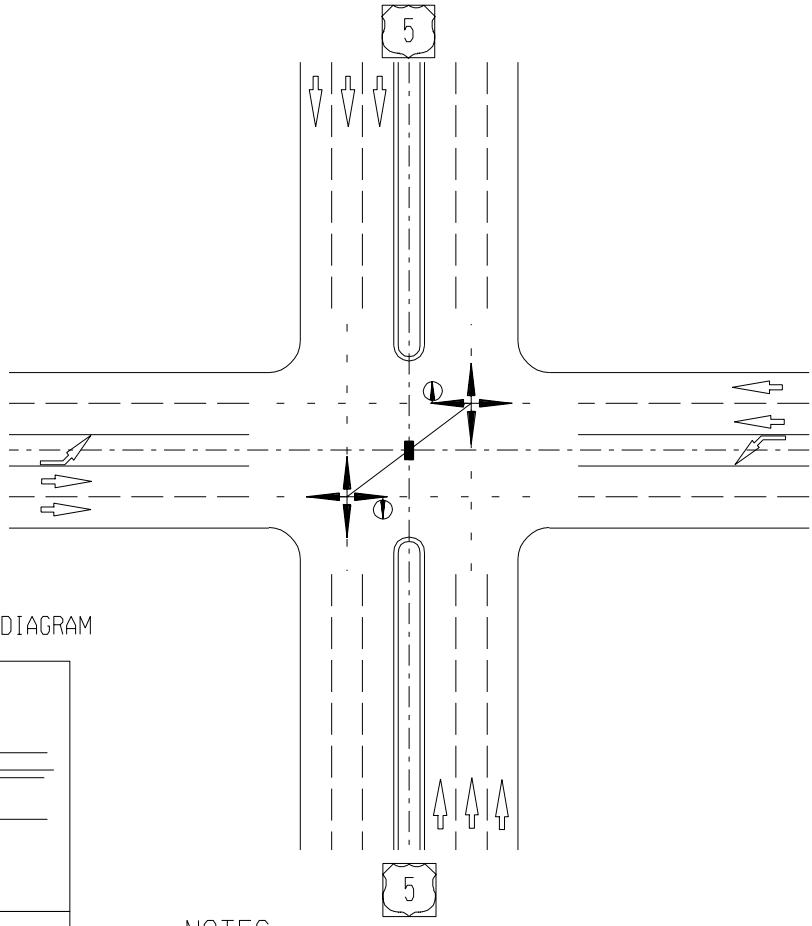


NOTES:

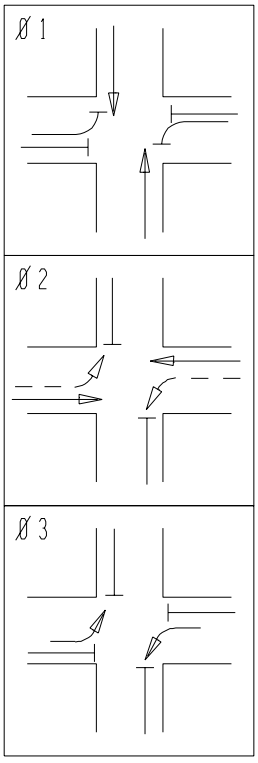
1 MEDIAN WIDTH LESS THAN 30'
2 DRAW HEAD PLACEMENT BOX-SPLIT THRU L ANEAGE
3 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE
4 USE 2-WAY CASE ON X-RD WHEN LEFT TUR NS ARE ALLOWED OR PROHIBITED

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



SIGNAL PHASING DIAGRAM

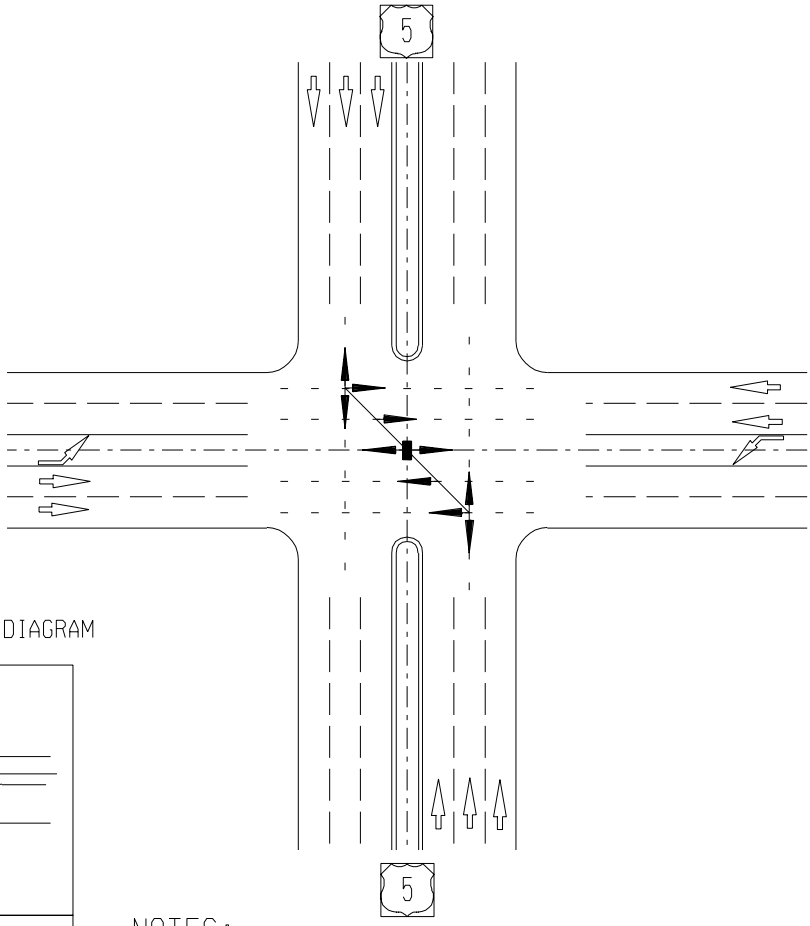


NOTES:

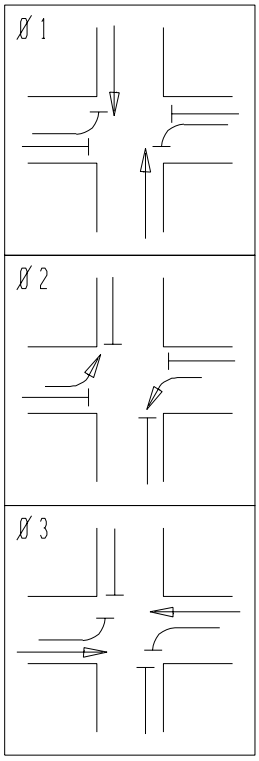
1 MEDIAN WIDTH LESS THAN 30'
2 DRAW HEAD PLACEMENT BOX-SPLIT THRU L ANEAGE
3 USE NEAR RIGHT - FAR LEFT FOR PHASE DIRECTION
4 USE 4th LEVEL LEFT TURN GREEN ARROWS (L.T.G.A'S)
5 USE 2-WAY CASE SIGN FOR X-RD
6 PEDESTRIAN SIGNALS OPTIONAL

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
DUAL LAGGING LEFT TURN PHASE
ON X-RD



SIGNAL PHASING DIAGRAM



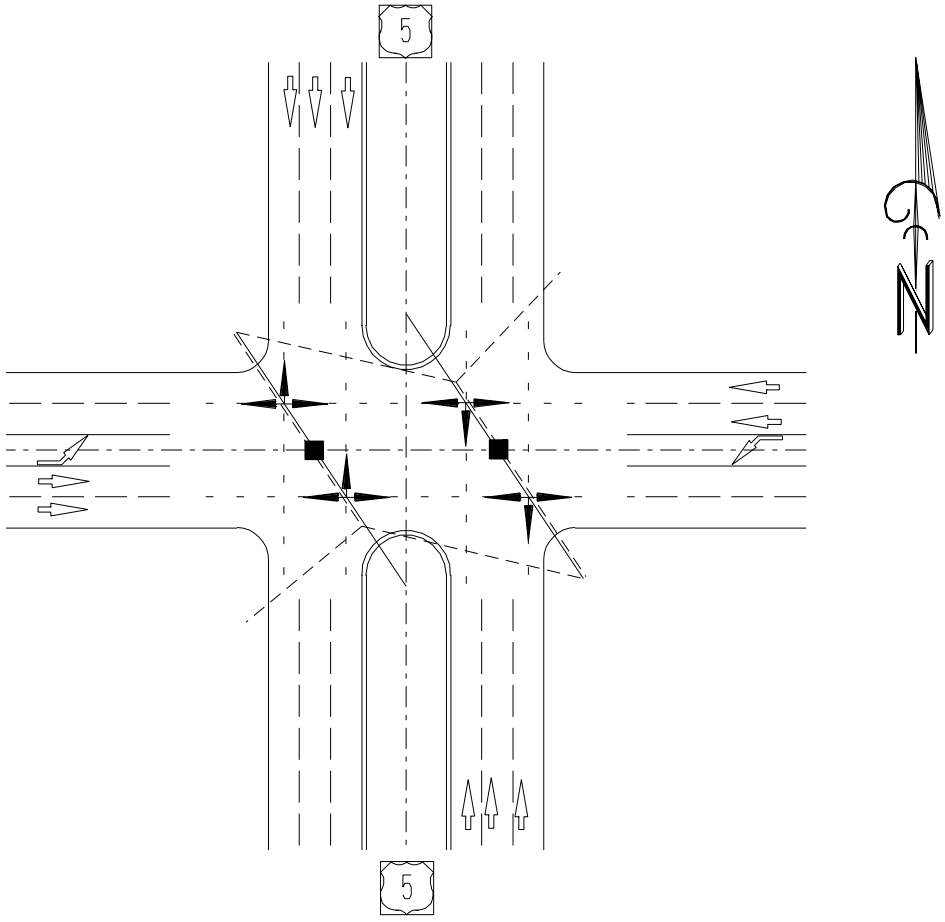
NOTES:

1 MEDIAN WIDTH LESS THAN 30'
2 DRAW HEAD PLACEMENT BOX-SPLIT THRU L ANEAGE ON TRUNKLINE AND SPLIT LANES FOR X-RD A PPROACHES
3 USE EXCLUSIVE LEFT TURN SIGNAL ON X- RD WITH CASE SIGNS
4 PLACE TWO THRU SIGNALS TO THE RIGHT OF THE LEFT TURN SIGNAL ON X-RD
5 PEDESTRIAN SIGNALS REQUIRED UNLESS O THERWISE DIRECTED

MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
DUAL LEADING LEFT TURN PHASE
FOR X-RD

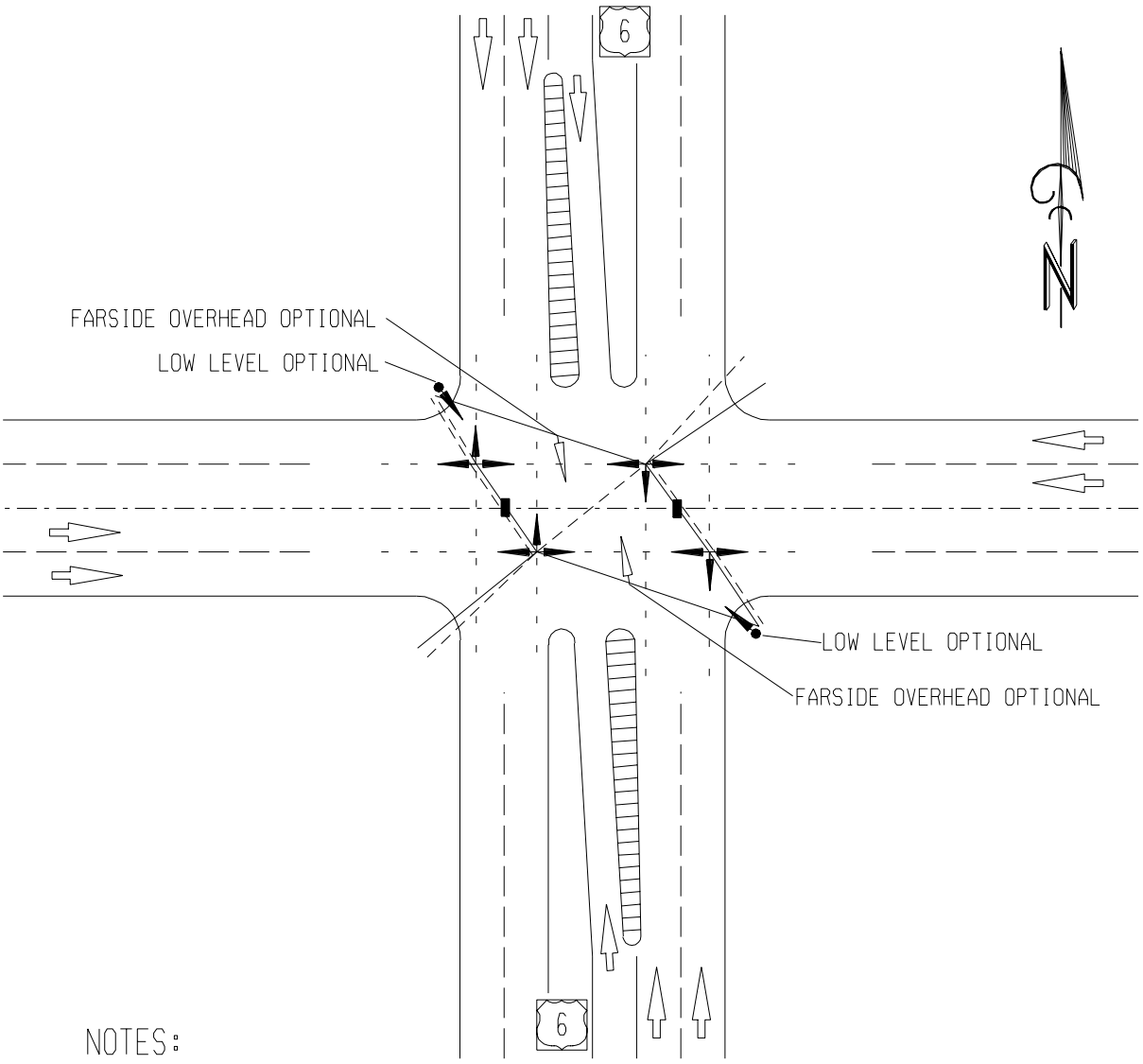


NOTES:

1 MEDIAN WIDTH 30' OR MORE
2 DESIGN AS TWO SEPARATE INTERSECTIONS
3 DRAW HEAD PLACEMENT BOX-SPLIT THRU A PPROACH LANES ON TRUNKLINE; SPLIT LANEAGE ON X-RD
4 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE AT BOTH INTERSECTIONS
5 USE 4-WAY CASE SIGN AT BOTH INTERSEC TIONS
6 WHILE PHASING IS POSSIBLE FOR EITHER ROADWAY - USUALLY LEFT TURN S ARE PROHIBTED AT THE INTERSECTION PR OPER AND REDIRECTED THROUGH MEDIAN CROSSOVERS. THE MAIN PROBLEM IS THE INTERLOCKING OF LEFT-TURN MO VEMENTS.
7 SOLID LINE SPAN ARRANGEMENT SHOWS TW O THRU SPANS
8 DASHED LINE SPAN ARRANGEMENTS SHOWS TWO 3-WAY TIE-OFF COMBINATIONS
9 PEDESTRIAN SIGNALS OR A BACKSIDE HEA D SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT AND T HE OVERHEAD SIGNAL INDICATIONS ARE NOT READILY VISIBLE.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

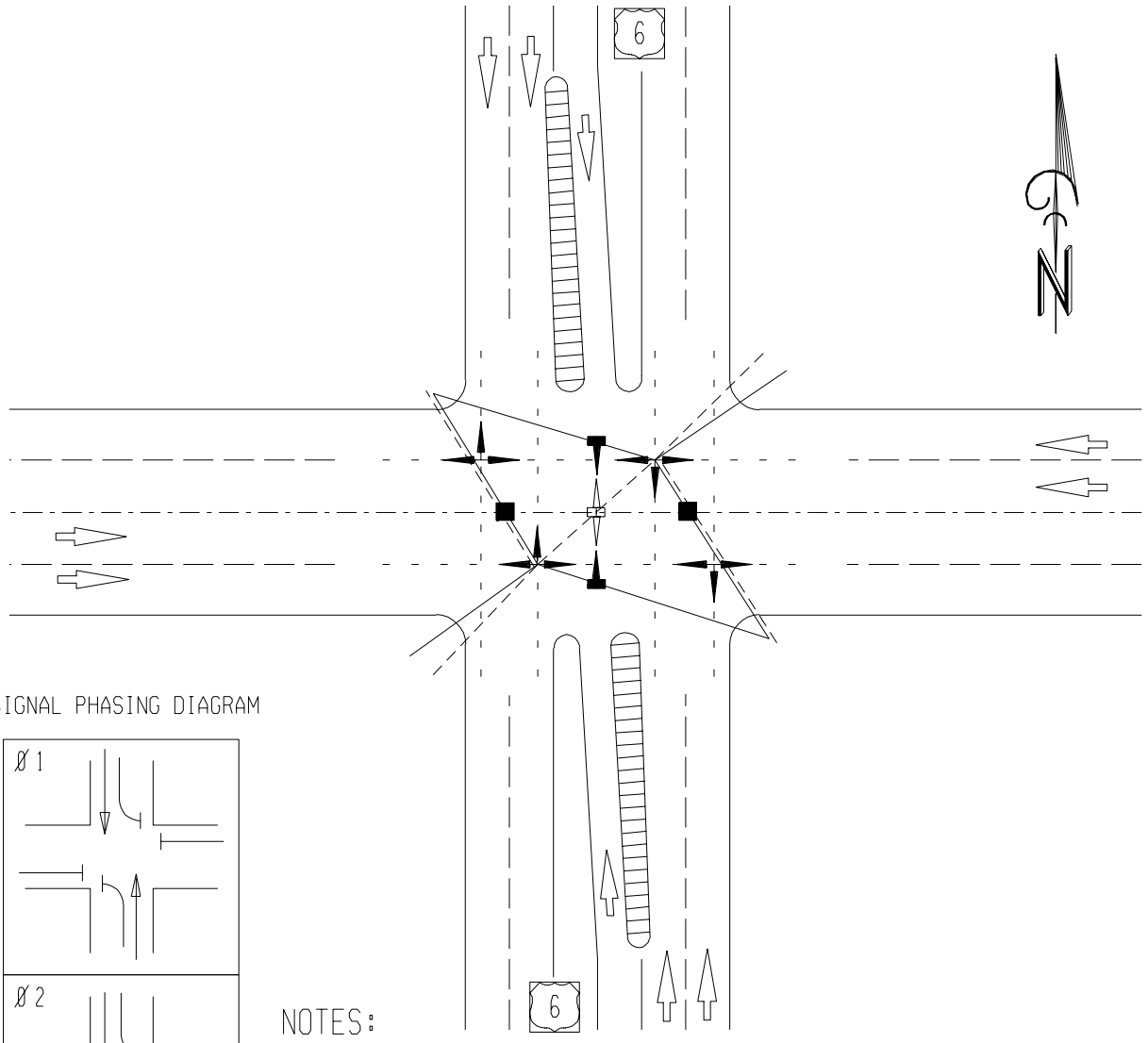


NOTES:

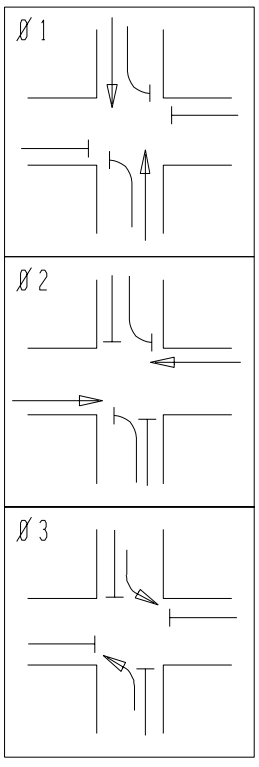
1 EXCULSIVE LEFT - TURN SLOTS
2 DESIGN AS TWO SEPARATE INTERSECTIONS
3 DRAW HEAD PLACEMENT BOX: SPLIT THRU APPROACH
LANEAGE ON TRUNKLINE - SPLIT LANEAGE ON X-RD
4 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE AND BOTH INTERSECTIONS
5 USE 2-WAY CASE SIGN FACING X-RD
6 LOW LEVEL OR FARSIDE OVERHEAD SIGNAL S ARE OPTIONAL
7 SOLID LINE SPAN ARRANGEMENT SHOWS TW O 3-WAY TIE-OFF SPAN COMBINA TIONS
8 DASHED LINE SPAN ARRANGEMENT SHOWS 4 -WAY TIE-OFF (SADDLE SPAN)
9 PEDESTRIAN SIGNALS OR A BACKSIDE HEA D SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT AND T HE OVERHEAD SIGNAL INDICATIONS ARE NOT READILY VISIBLE.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



SIGNAL PHASING DIAGRAM



NOTES:

1 EXCLUSIVE LEFT - TURN SLOTS
2 DESIGN AS TWO SEPARATE INTERSECTIONS
3 DRAW HEAD PLACEMENT BOX: SPLIT THRU APPROACH LANEAGE ON TRUNKLINE- SPLIT LANEAGE ON X-RD
4 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE AT BOTH INTERSECTIONS
5 USE TWO 1-WAY EXCLUSIVE LEFT TURN SI GNALS WITH CASE SIGNS ON THE 3-WAY TIE-OFF SPAN COMBINATION-SOLID LINE SPAN ARRANGEMENT
6 USE ONE 2-WAY EXLUSIVE LEFT TURN SIG NAL ON THE 4-WAY TIE OFF (SADDLE SPAN) WITH CASE SIGNS - DASH ED LINE SPAN ARRANGEMENT
7 USE TWO 4-WAY CASE SIGNS OVER THRU R OADWAY
8 PEDESTRIAN SIGNALS REQUIRED

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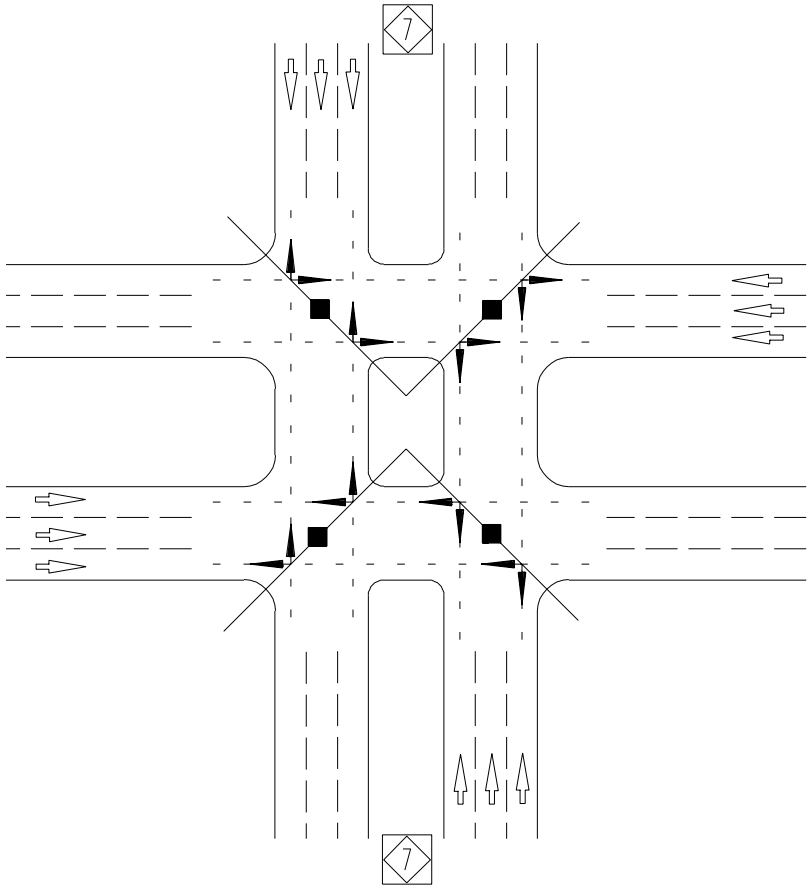
HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
DUAL LEADING LEFT-TURN PHASE
(SAME FOR LAGGING LEFT-TURN)



NOTES:

1 DESIGN AS FOUR SEPARATE INTERSECTION S

2 DRAW HEAD PLACEMENT BOX: SPLIT THRU APPROACH LANEAGE ON BOTH ROADWAYS

3 USE NEAR RIGHT - FAR LEFT FOR FIRST INTERSECTION ON APPROACH LEG FOR BOT H ROADWAYS

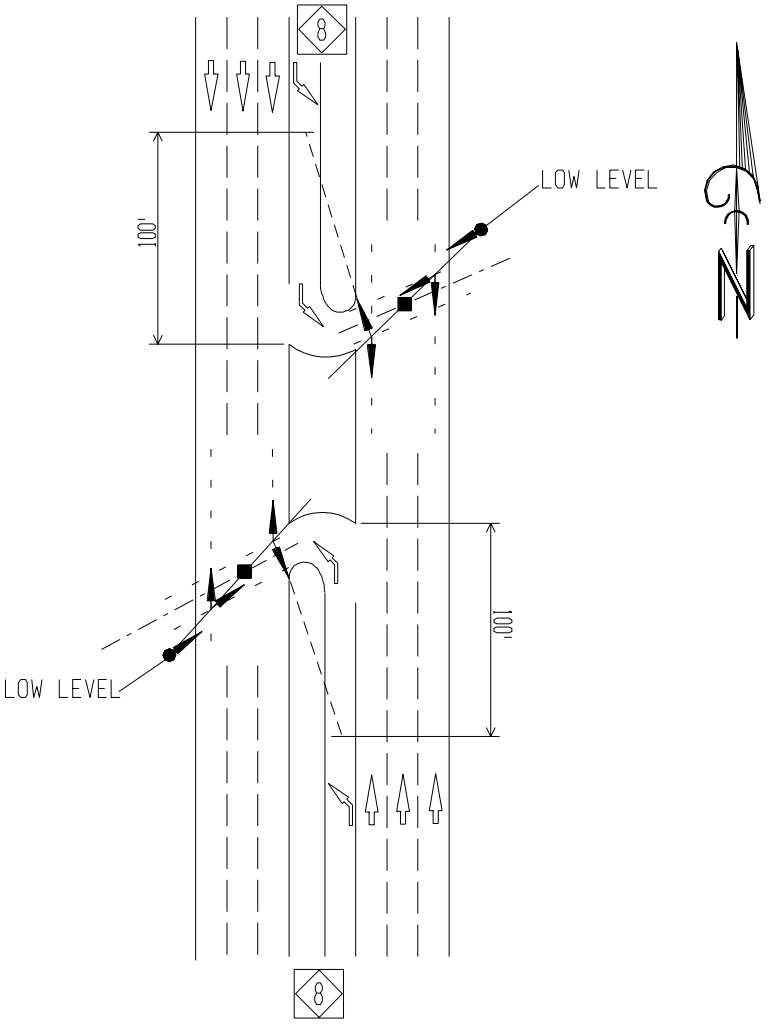
4 USE 4-WAY CASE SIGNS AT ALL INTERSEC TIONS

5 WHILE PHASING IS POSSIBLE FOR EITHER ROADWAY, USUALLY LEFT- TURNS ARE PROHIBITED AT THE INTERSECTION PROPE R AND REDIRECTED THROUGH MEDIAN CROSSOVERS. THE MAIN PROBLEM IS THE INTERLOCKING OF LEFT-TURN MOVEMENTS.

6 PEDESTRIAN SIGNALS OR A BACKSIDE HEA D SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT AND T HE OVERHEAD SIGNAL INDICATIO NS ARE NOT READILY VISIBLE.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

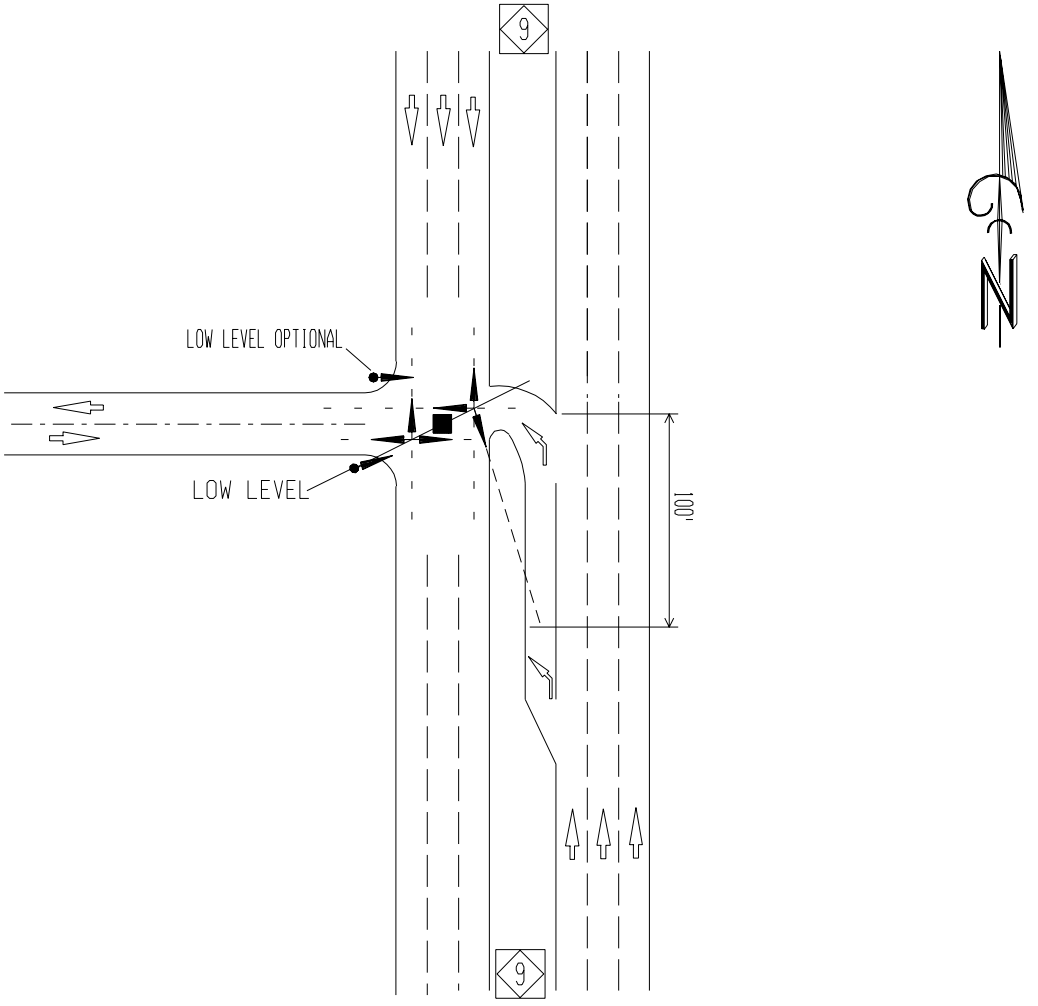


NOTES:

1 TREAT EACH CROSSOVER AS SEPARATE INT ERSECTION
2 DRAW HEAD PLACEMENT BOX - SPILT THRU LANEAGE ON TRUNKLINE
3 USE NEAR RIGHT - FAR LEFT FOR CROSSO VER
4 SIGNAL SEPARATION FOR CROSSOVER HEAD S SHOULD BE 10' AND 10'
5 AIM RIGHT SIGNAL INDICATION FOR CROS SOVER TO MIDDLE OF LEFT-TURN LANE AT A SPOT 100' FEET FROM CROSSOVER RADI I POINT
6 ADD FARSIDE LOW LEVEL SIGNAL TO INSU RE TWO INDICATIONS ARE FACING CROSSO VER
7 USE ONE 4-WAY CASE SIGN

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

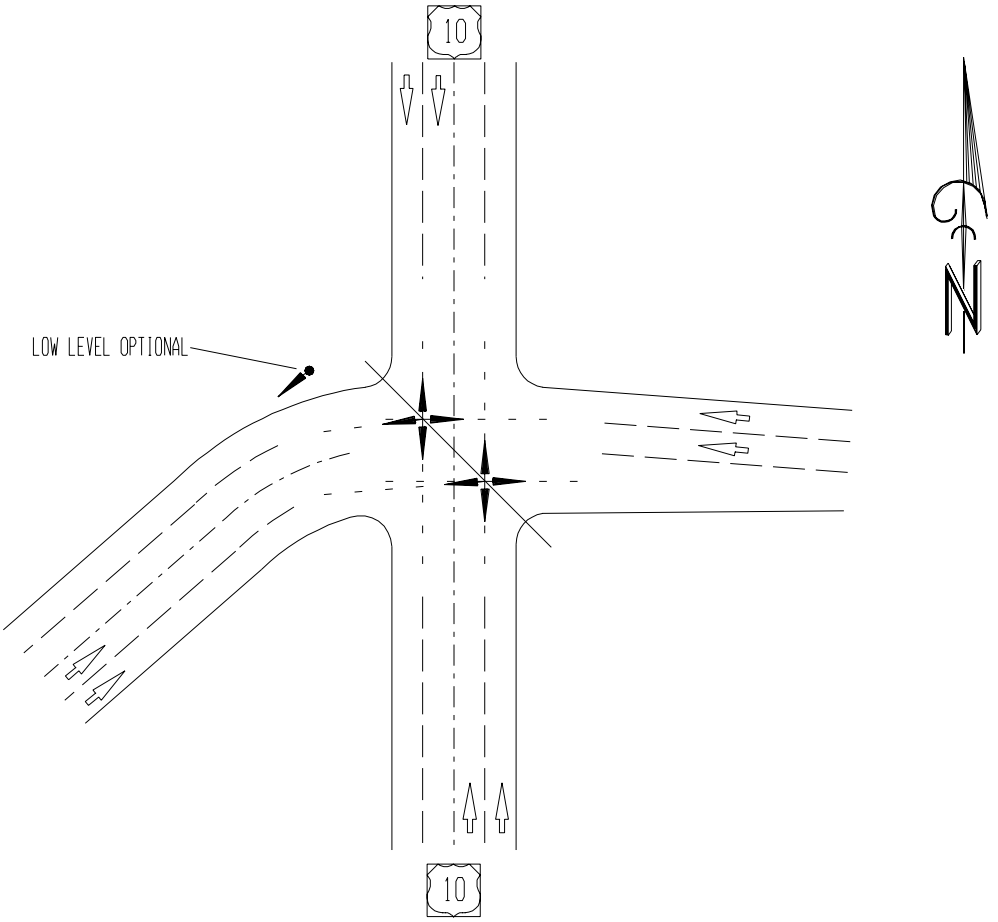


NOTES:

1 DRAW HEAD PLACEMENT BOX - SPLIT LANE AGE ON TRUNKLINE AND ON X-RD
2 USE NEAR RIGHT - FAR LEFT FOR CROSSO VER
3 SIGNAL SEPARATION FOR CROSSOVER HEAD S SHOULD BE 10' AND 10'
4 AIM RIGHT SIGNAL INDICATION FOR CROS SOVER TO MIDDLE OF LEFT-TURN LANE AT A SPOT 100' FROM CROSSOVER RADII POI NT
5 ADD FARSIDE LOW LEVEL SIGNAL TO INSU RE TWO INDICATIONS ARE FACING CROSSO VER
6 FARSIDE LOW LEVEL INDICATION ON RIGH T SIDE IS OPTIONAL FOR THRU MOVEMENT FROM CROSSOVER
7 USE ONE 4-WAY CASE SIGN

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

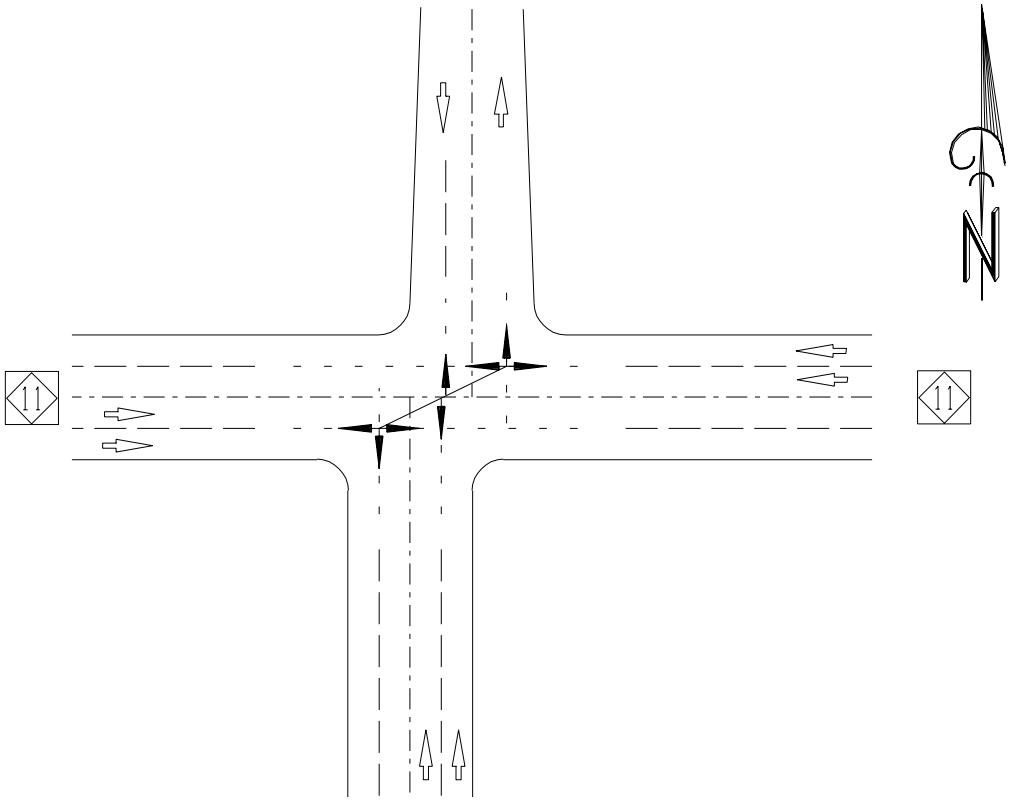


NOTES:

1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE FOR EACH ROADWAY
2 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE
3 ADDITIONAL ADVANCE LOW LEVEL INDICAT ION ON CROSSROAD IS OPTIONAL DEPENDENT ON GEOMETRICS

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



NOTES:

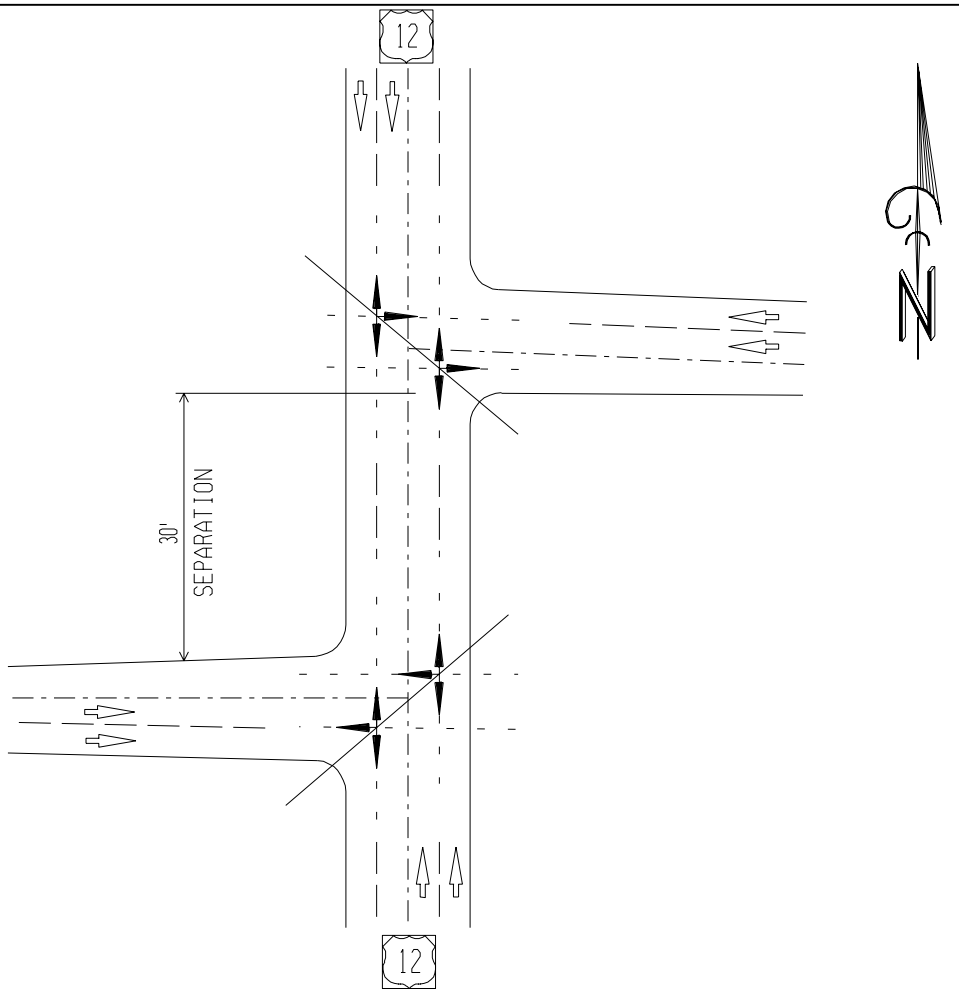
1 TREAT CLOSELY SPACED OFFSET AS ONE I NTERSECTION

2 DRAW HEAD PLACEMENT BOX:
- SPLIT THRU LANEAGE TRUNKLINE
- SPLIT LANEAGE ON EACH SIDE STREET (OFFSET) APPROACH

3 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

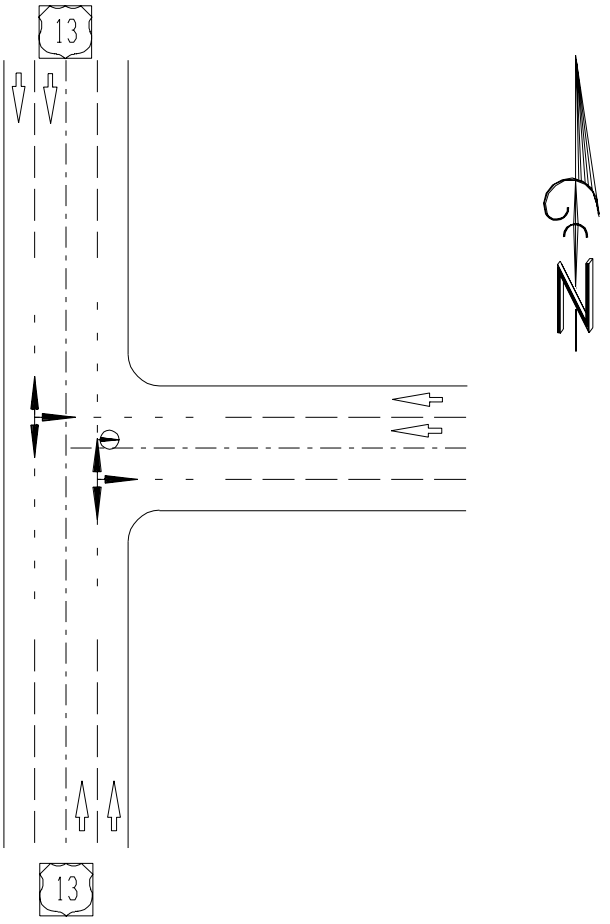


NOTES:

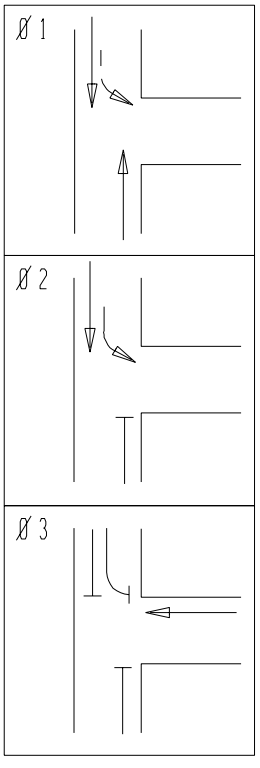
1 DESIGN AS TWO SEPARATE INTERSECTIONS (IF SEPARATION IS 30' OR MORE)
2 DESIGN AS ONE INTERSECTION (IF SEPAR ATION IS LESS THAN 30')
3 DRAW HEAD PLACEMENT BOX - SPLIT THRU ON TRUNKLINE AND ON EACH SIDE STREE T
4 USE NEAR RIGHT - FAR LEFT ON TRUNKLI NE
5 NOTE: NEAR RIGHT - FAR LEFT CAN BE U SED ON SIDE STREET TO ACCOMMODATE HEAVY TURNING MOVEMENTS.
6 USE INSIDE SIGNAL INDICATIONS FOR WI DELY SPACED OFFSET

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION



SIGNAL PHASING DIAGRAM



NOTES:

1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE ON BOTH TRUNKLINE AND CROSSROAD

2 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE

3 USE 4th LEVEL LEFT TURN GREEN ARROW(L.T.G.A.'S)

4 PEDESTRIAN SIGNALS REQUIRED UNLESS OTHERWISE DIRECTED

MDOT Michigan Department of Transportation

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH SINGLE LAGGING LEFT-TURN PHASE ON TRUNKLINE

ITS STRUCTURES DESIGN GUIDELINES

CS: Statewide

MICHIGAN ITS STRUCTURES
DESIGN GUIDELINES

INDEX

6.01

INTRODUCTION

This guidance text addresses procedures involved in the design and plan preparation of intelligent transportation systems (ITS) structures including spun concrete poles, dynamic message sign (DMS) structures, environmental sensor station (ESS) towers, and communications towers on interstate/freeway, arterial, collector, and local road systems governed by the Michigan Department of Transportation (MDOT).

A major portion of this text is devoted to design items to be investigated for every project. However, other sections provide details on plan preparation and involvement of other agencies affected by the ITS projects. In general, the ITS Structures Design Guidelines is intended to be a single source reference for the MDOT design engineers and consultants assigned the responsibility of producing spun concrete pole, DMS structure, ESS Tower, or communications tower plans.

The design of ITS structures in Michigan is based on the **MDOT Standard Specifications for Construction (MDOT SSC)** and the **AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (AASHTO LRFDLTS)**. However, it is understood that sometimes adaptations and deviations may be necessary as these publications can be vague or leave decisions up to the judgement of the Engineer. This guidance text does not focus on ITS device selection or design. For ITS device selection and design, reference the **MDOT ITS Project Guidelines**.

As procedures and guidelines change, the ITS Structures Design Guidelines will be continually updated to keep the text as current as possible. These updates will describe the revision, explain the reason, serve as commentary, and assign the date of its implementation.

6.01.01

References

A. ITS Project Guidelines, MDOT

B. Standard Specifications for Construction (SSC), MDOT

C. Frequently Used Special Provisions (FUSPs), MDOT

D. AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LRFDLTS)

E. AASHTO LRFD Bridge Design Specifications (LRFDBDS)

F. Geotechnical Manual, MDOT

G. Preconstruction Process Documentation Manual (PPDM), MDOT

H. Michigan Ancillary Structures Inspection Manual (MiASIM), MDOT

I. Road Design Manual, MDOT

J. Real Estate Procedure Manual, MDOT

K. Scoping Manual, MDOT

L. ITS Standards and Special Details, MDOT

6.01.02

Abbreviations and Definition of Terms

When the following abbreviations are used in the guidance text, they have the meanings listed below.

AASHTO.....American Association of State Highway and Transportation Officials

FAA .....Federal Aviation Administration

MICHIGAN ITS STRUCTURES
DESIGN GUIDELINES

ITS	Intelligent Transportation Systems
LRFD	Load and Resistance Factor Design
MiOSHA	Michigan Occupational Safety and Health Administration
MDOT	Michigan Department of Transportation
ROW	Right-of-Way

Appurtenance – A miscellaneous device or attachment mounted to a structure that can include signs, antennae, and other devices.

Camera – A device that captures images or videos that can be mounted to a pole.

Clear Zone – The unobstructed, traversable roadside area provided beyond the edge of the through traveled way that allows a driver to stop safely or regain control of a vehicle that has left the roadway.

Communications Tower – A lattice tower structure that supports ITS infrastructure and communication antennae.

Drilled Shaft – A foundation type, constructed by placing concrete in a drilled hole with steel reinforcement.

Dynamic Message Sign (DMS) – Programmable electronic signs that are located along highways and provide real-time information to drivers.

Engineer – Person responsible for the design of the structure or review of design-related field submittals such as erection plans, or both.

Environmental Sensor Station (ESS) – a location along the roadway to host multiple sensors to detect various conditions, such as atmospheric, ground, hydraulic, and other environmental factors.

Gantry – A cantilever or truss overhead sign structure that is used to support a small dynamic message sign, typically for lane control purposes.

Light Pole – A steel or aluminum light standard shaft on a frangible or non-frangible base mounted to a concrete foundation with anchor bolts that often supports a light standard arm.

Right-of-Way (ROW) – The entire area reserved for the construction, operation, and maintenance of the roadway and the improvement of the roadside such as landscaping, sidewalks, pathways, or transit stops. ROW will either be free access or limited access. Limited access ROW is when the inherent right of access to a public highway by the abutting owner or occupant is acquired along with the title to the ROW.

Roadside – Portion of the ROW outside of the footprint of the roadway.

Sensor – A device that detects and measures changes in traffic or the environment that can be mounted to a structure.

Spun Concrete Pole – A high mast prestressed precast concrete pole used to support ITS infrastructure such as cameras and radar detectors.

Strain Pole – A cantilever pole that utilizes anchor bolts to transfer load from the pole to a concrete foundation and often supports span wires carrying traffic signals, lighting, and other appurtenances.

Walkway – Horizontal steel structures with grating and supporting frame that provide walkable access to the DMS and supporting structure.

6.02

ITS STRUCTURES SITE PLANNING

Site planning of ITS structures must follow and account for specifications outlined in the **MDOT Road Design Manual** and **MDOT ITS Project Guidelines.** Coordinate site planning with **MDOT's ITS Program Office**.

6.02.01

Project Scoping and Survey

Understanding the project scope is critical for the Engineer to establish what deliverables (e.g., permits, easement acquisition, design exceptions, etc.) are required. To ensure consistency across projects, the Engineer must follow the scoping process provided by the **MDOT PPDM Task Series 2100 – EPE Scoping Analysis** through **Series 2800 – Contamination Investigation** and review the tasks outlined in **Section 5.1 – Special Tasks for Intelligent Transportation Systems**. Furthermore, the Engineer must adhere to the scoping guidelines in the **MDOT Scoping Manual** and review **Section 3.7 – Intelligent Transportation Systems**.

Proper survey, specifically those related to ROW, utilities, sidewalks (if present), existing structures, and existing roadway geometry, is critical to ensure a project can provide what has been scoped. The Engineer must review **MDOT PPDM Task Series 3100 – Scope Verification** through **Series 3300 – Base Plan Preparation** before survey takes place so that consistent and thorough survey can be prescribed.

6.02.02

ITS Structure Types and Selection

Various structure types exist throughout Michigan for ITS applications. The following sections provide brief information on these structure types and their purpose.

A. DMS Structures

DMS support structures consist of a single vertical support with horizontal arms supporting electronic signs and access walkways. Additional arms may be mounted to the DMS structure to support various ITS devices. DMS support structures are galvanized steel structures mounted on a concrete foundation with anchor bolts. The DMS structure can be left-handed, right-handed, or double-sided to ensure proper viewing from the traveling public.

B. Spun Concrete Poles

Spun concrete poles are high mast prestressed precast concrete poles embedded in a concrete foundation and typically reach 85 feet in height. Spun concrete poles are often required to mount closed-circuit television (CCTV) cameras at the desired viewing angle and may support other ITS devices.

C. ESS Towers

An ESS Tower is a single vertical support of built-up steel or aluminum members supported on a concrete foundation with anchor bolts. Some towers are a combination of steel and aluminum members. They are three or four leg lattice structures and jointed to allow the structure to be lowered for maintenance. They support a variety of sensor attachments.

D. Others

Additional structures utilized for ITS infrastructure are discussed below:

1. Strain Pole – ITS devices are often mounted on strain poles at intersections. Refer to **Chapter 4** for details on steel strain pole structures.

2. Gantry – The gantry is an overhead sign support structure that can have lane control signs (LCS) and small DMS mounted to it. Gantries are most often used for lane control purposes.

The design of overhead cantilever and truss sign support structures are discussed in **Chapter 3**.

3. Light Poles – ITS devices may be mounted on light standard shafts mounted on a concrete foundation with anchor bolts. Refer to **Chapter 5** for more details regarding light poles.

4. Communications Towers – Communications towers support ITS infrastructure and communication antennae. The tower structure consists of three main vertical supports, each mounted on a separate concrete foundation, that combine into a single vertical lattice member at higher elevations.

6.02.03

Right-of-Way Coordination

Place ITS structures within the ROW wherever possible. Coordinate with **MDOT Region Real Estate** staff early in the project schedule to determine real estate needs and impacts to the project schedule. Any temporary work outside the ROW requires a legal agreement such as a Consent or Temporary Construction Easement. The **Real Estate Services Section** of the **Development Services Division** or **Region Real Estate** will determine just compensation for the agreement which is offered to the property owner. Permanent ROW acquisition may also need to be considered. Review Chapter 16 of the **MDOT Real Estate Procedure Manual** for more details on ROW considerations during design.

6.02.04

Appurtenances

Multiple ITS devices and other appurtenances can be added to ITS structures including, but not limited to, cameras, sensors, antennae, lightning protection, and ITS cabinets. A multitude of devices may be mounted to a single ITS structure. Consider all of these during design.
DMS structures have specially designed mounting arms to hold multiple ITS device additions to the main structure, as shown in special detail **ITS-034-Series**.

A. Cameras

Cameras are a common attachment to various types of ITS structures. The structure type used to support the camera is chosen depending on the intended use of the device and the available infrastructure in the area.

B. Sensors

Integral to the ITS network are sensors that collect various information on traffic and environmental factors. Many types of ITS sensors may be desired at a point along the roadway. The type of sensor will determine which ITS structures are available to support the necessary device.

C. ITS Cabinets

ITS cabinets may be pole-mounted or ground-mounted depending on the type of structure. Mount ITS cabinets to spun concrete poles and steel strain poles as shown in special detail **ITS-063-Series**. For DMS structures and ESS towers, the ITS cabinet is ground mounted as shown in special detail **ITS-062-Series**.

6.02.05

Construction Access

Show temporary access limits clearly on the design plans for work outside of the ROW. For further details on ROW coordination, see **Section 06.02.03**.

Trim vegetation if it interferes with construction access. Consider overhead utility lines that may impact ITS structure installation. Consider both lifting and setting the structure when defining construction stages. A 10-foot clearance is required throughout the entire installation process per MiOSHA's standards for construction safety and health and may impact pole sizing.

Review the FAA pre-screening tool for Obstruction Evaluation/Airport Airspace Analysis to determine if the proposed construction or alteration requires notice to the FAA.

6.02.06

Inspection and Maintenance Access

Provide access for safe inspection and maintenance of the ITS structures. Do not place on steep slopes or in drainage ditches, and any lowering devices or walkways must be easily accessible. Ensure that vehicles have access to the site and a safe pull-off location is available. Consider whether an access drive or culvert should be constructed to traverse an existing ditch and allow for maintenance vehicles to reach the structure. **MDOT's Ancillary Structures Program** manages the inspection of these assets as outlined in the **MiASIM**.

6.03

ITS STRUCTURE PLACEMENT

Refer to Chapter 3 of the **MDOT ITS Project Guidelines** for considerations regarding the placement of ITS infrastructure and project location coordination.

6.04

STRUCTURAL DESIGN

Typically, a site-specific design is not required if the Engineer uses the existing special details from **MDOT's ITS Special Details website**. Verify the design of ITS structures meet all criteria outlined in the existing ITS special details presented in **ITS-030, ITS-031, ITS-032, ITS-033**, **ITS-052, ITS-053,** and **ITS-054-Series.** Any modifications to existing special details require review and approval from **MDOT's ITS Program Office**.

6.04.01

Foundations

The Engineer must use foundation details **ITS-032-Series** for DMS Sign Supports, **ITS-033-Series** for Spun Concrete Poles, and **ITS-053-Series** for ESS Towers. If the foundation design falls outside of these special details, refer to the following guidance. Review historic structure borings before new borings are obtained. If poor soils are shown, the Engineer must coordinate with **MDOT's Geotechnical Services Unit.** Follow requirements outlined in the **MDOT Geotechnical Manual** for all preliminary foundation investigations and new soil borings obtained**.** The designer must verify that no underground geotechnical anomalies are present in conflict with the ancillary structure foundation.

Drilled shafts serve as the standard foundation type for DMS structures and ESS towers. Follow all procedures outlined in Section 718 of **MDOT's Standard Specifications for Construction** for casing installation for drilled shaft foundations.

6.04.02

Design Specifications and Special Provisions

Design ITS structures according to the current edition of the **AASHTO LRFDLTS.** Reference the most up to date standards and special details on **MDOT's ITS Special Details website** and **FUSPs**.

6.04.03

DMS Structures

ITS special details **ITS-030-Series** and **ITS-031-Series** for left-hand and right-hand sign placement, respectively, provide detailed design of DMS Support Structures. DMS structures use a drilled shaft foundation as outlined in special detail **ITS-032-Series**. The designer will need to determine an appropriate depth of the foundation depending on the soil borings. The height of the DMS vertical shaft is dependent on the vertical clearance of the sign.

6.04.04

Spun Concrete Poles

Typical spun concrete poles are designed to reach a height of 85 feet above ground and support several ITS attachments, including a CCTV camera and an ITS cabinet. Special Detail **ITS-033-Series** details the design of spun concrete pole structures. Spun concrete poles are embedded in a concrete foundation.

6.04.05

ESS Towers

Design ESS Towers according to ITS special detail **ITS-052-Series**. The drilled shaft foundation and conduit installation details are provided in special detail **ITS-053-Series.** All device attachments to the tower must be per the manufacturer specifications.

6.04.06

Other

The design of other ITS support structures such as cantilever or truss supports, strain poles, and light poles is covered in Chapters 3, 4, and 5, respectively.

6.05

PLAN PREPARATION

6.05.01

Preliminary Plan Composition

Use the following list and ordering of sheets for the Preliminary Plan stage of ITS projects. ITS projects often overlap with roadwork or other rehabilitation and reconstruction projects. This list assumes no major work aside from the ITS infrastructure is included in the project:

A. Title Sheet

B. Project Information Sheet(s)

C. Legend Sheet(s)

D. Vicinity Sheet(s)

E. Note Sheet(s)

F. Survey Information Sheet(s)

G. ITS Sheet(s)*

H. Special Details Sheet(s)

*Use **Appendix A** – Guidelines for ITS Support Structures Plan Preparation as a reference for these sheets and MDOT's Online CAD Standards for guidance on setting up the CAD workspace.

At the Preliminary Plan stage, the ITS sheets must convey the location and communication path of the ITS infrastructure at a minimum. If multiple ITS structures are used, they must be called out in the plan view with locations of each type shown.

6.05.02

Final Plan Composition

Use the following list and ordering of sheets for the final plan stage of ITS projects.

This list assumes no major work aside from ITS infrastructure is included in the project:

A. Title Sheet

B. Project Information Sheet(s)

C. Legend Sheet(s)

D. Vicinity Sheet(s)

E. Note Sheet(s)

F. Miscellaneous Quantities Sheet(s)

G. Survey Information Sheet(s)

H. Construction Sheet(s)

I. ITS Cross Section(s)*

J. Communication Plan Sheet(s)

K. ITS Detail Sheet(s)*

L. Log of Borings Sheet(s)

M. Special Details Sheet(s)

*Use **Appendix A** – Guidelines for ITS Support Structures Plan Preparation as a reference for these sheets. See the **MDOT Road Design Manual** for guidance on all other sheets.

6.05.03

Structural Details

The structural details provided in all special details mentioned in this guidance must be included. If a designer must deviate from the proposed guidance, they must contact the **MDOT Ancillary Structures Program** to verify the proposed design. The **MDOT ITS Program Office** and **Structural Fabrication Unit** must also be contacted for approval. The design of these details must be analyzed if modifications will impact the structural capacity.

MICHIGAN ITS STRUCTURES
DESIGN GUIDELINES

Appendix A – Guidelines for ITS Structures Plan Preparation

GUIDELINES FOR ITS STRUCTURES
PLAN PREPARATION

Michigan Department of Transportation

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation	NO SCALE	FILE:	DATE: DESIGN UNIT: TSC:	CS: JN:	DRAWING SHEET SECT 1

SURVEY

GENERAL

- ALIGNMENT POINT MONUMENT
- MONUMENT BOX

CONTROL

- CP CONTROL POINT
- BM BENCHMARK
- REFERENCE – GPS
- REFERENCE – NGS
- REFERENCE – USGS

BOUNDARY

- CITY LIMIT (MAP)
- CITY LIMIT
- PARCEL-L — PARCEL – LEGAL
- PARCEL-NL — PARCEL – NONLEGAL
- PLAT-L — PLAT – LEGAL
- PLAT-NL — PLAT – NONLEGAL
- ROW – FREEACCESS
- ROW – LIMACCESS
- SEC — SECTION LINE
- TOWNSHIP LINE (MAP)
- CONCRETE MONUMENT
- PCS PARCEL CORNER – CAPPED IRON
- PARCEL CORNER – IRON PIN
- PARCEL CORNER – IRON PIPE
- PARCEL CORNER – NO ID
- PLAT CORNER
- ROW ROW MONUMENT
- SECTION CORNER – CENTER
- SECTION CORNER – MEANDER
- SECTION CORNER – QUARTER
- SECTION CORNER – QUARTER-HALF
- SECTION CORNER – SECTION
- SECTION CORNER – SECTION-HALF
- SECTION CORNER – SIXTEENTH
- SECTION CORNER – WITNESS

MONUMENT PRESERVATION

- PRESERVE — PRESERVE MONUMENT
- PROTECT — PROTECT MONUMENT

GENERAL LABELING

GENERAL

- LEFT TURN ARROW
- TRAFFIC FLOW ARROW

REMOVAL

- A — ABANDON
- B — BULKHEAD
- C — CLEARING
- R — REMOVE
- SALV — SALVAGE
- S — SAVE

CONSTRUCTION

- ADJ — ADJUST
- ADJ-B — ADJUST – STRUC COVER W/ TYPE
- ADJ-B/O — ADJUST – BY OTHER

REMOVAL AND CONSTRUCTION

- REL-1 — RELOCATE – W/ CASE NUMBER
- REL-B/O — RELOCATE – BY OTHER

CONSTRUCTION LIMITS

- SSL — — — SSL — SLOPE STAKE LINE

BORINGS

- BH# — BORING
- TH# — TEST HOLE

STRUCTURES

- BEAM UNDERCLEARANCE
- REFERENCE POINT
- S01 OF 12345 — STRUCTURE NO. + CONTROL SEC. LABEL

VEGETATION

- BRUSH LINE
- HEDGE LINE
- TREE LINE – CANOPY OR TRUNK
- SHRUB
- TREE – CONIFER
- TREE – DECID
- TREE – STUMP

ENVIRONMENTAL

- 26 — EROSION CONTROL – SILT FENCE
- WETLAND – LEGAL
- WETLAND – NONLEGAL
- CONTAMINATION – MONITORING WELL
- 12 — EROSION CONTROL – NUMBER
- EROSION CONTROL – RIPRAP
- W.T. 12' — WATER TABLE – PLAN NOTE
- WETLAND – SPOT EL
- POTENTIALLY CONTAMINATED SITE

ROADSIDE / SITE

- ANTENNA
- BIG ROCK
- FLAG POLE
- PICNIC STOVE
- PICNIC TABLE
- SATELLITE DISH

NOTE:

EXISTING ITEMS ARE REPRESENTED BY THIN LINE WEIGHTS.
PROPOSED ITEMS ARE REPRESENTED BY HEAVIER LINE WEIGHTS.

RAILROAD

- TRACK
- CROSSING – GATE
- RR CROSSING – SIGNAL BOX
- CROSSING – SIGNAL FLASHING
- CROSSING – SYMBOL

SIGNS

- POST – DOUBLE
- POST – SINGLE
- C STRUCTURE – CANTILEVER
- T STRUCTURE – TRUSS
- SS SUSPENDED

MAINTAINING TRAFFIC

- TYPE III BARRICADE
- CHANNELIZING DEVICE – CONE
- CHANNELIZING DEVICE – DRUM

BARRIERS

- CABLE BARRIER – NOT TO SCALE
- CABLE BARRIER – TRUE SCALE
- CONCRETE BARRIER – DOUBLE FACE
- CONCRETE BARRIER – SINGLE FACE
- FENCE
- GUARDRAIL – NOT TO SCALE
- GUARDRAIL – TRUE SCALE
- NOISE BARRIER
- FENCE POST
- 123 — GUARDRAIL RUN NUMBER
- IMPACT ATTENUATOR
- POST – MAILBOX
- POST – NO ID

SURFACING

REMOVAL

- CONCRETE RUBBLIZING OR HMA CRUSH & SHAPE
- HMA COLDMILLING
- HMA SURFACE REMOVAL AND / OR PAVEMENT REMOVAL

PROPOSED

- AGGREGATE APPROACH
- BRIDGE APPROACH
- HMA APPROACH
- MISCELLANEOUS CONCRETE

SIDEWALK

- SIDEWALK – REMOVAL
- SIDEWALK – CONCRETE RAMP
- SIDEWALK – DETECT. WARNING SURF.
- SIDEWALK – LANDING
- SWR-1 — SIDEWALK – RAMP LABEL

TYPICAL SECTION

- CONCRETE – PROPOSED
- HMA – EXISTING AND PROPOSED

CURB & GUTTER

- CURB & GUTTER REMOVAL

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

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UTILITIES

COMBINED SEWER

- COMBINED SEWER
- COMBINED SEWER - TO BE ABANDONED
- COMBINED SEWER - OUT OF SERVICE
- COMBINED SEWER - TO BE REMOVED

COMMUNICATION

- C
- C-OH — CABLE - OVERHEAD
- C — CABLE - OUT OF SERVICE
- CABLE - MARKER
- CABLE - PEDESTAL
- FO — FIBER OPTIC
- FO — FIBER OPTIC - OUT OF SERVICE
- FIBER OPTIC - MARKER
- T
- T-OH — PHONE - OVERHEAD
- T — PHONE - OUT OF SERVICE
- PHONE - BOX
- PHONE - MANHOLE
- PHONE - PEDESTAL
- PHONE - POLE

FUEL / PETROLEUM

- OIL — OIL PIPELINE
- OIL — OIL PIPELINE - OUT OF SERVICE
- GAS - FILLER PIPE
- GAS - PUMP
- GAS - UNDERGROUND TANK
- OIL WELL
- PETROLEUM PIPELINE - MARKER
- P — PROPANE TANK

NATURAL GAS

- G — GAS LINE
- G — GAS LINE - OUT OF SERVICE
- MARKER
- VALVE
- WELL

SANITARY SEWER

- SEWER
- SEWER - TO BE ABANDONED
- SEWER - OUT OF SERVICE
- SEWER - TO BE REMOVED
- S — MANHOLE W/ COVER

WATER

- W — WATER MAIN
- W — WATER MAIN - TO BE ABANDONED
- W — WATER MAIN - OUT OF SERVICE
- W — WATER MAIN - TO BE REMOVED
- FIRE HYDRANT
- FIRE HYDRANT (ALT)
- IRRIGATION - CONTROL VALVE
- IRRIGATION - SPRINKLER HEAD
- SERVICE - METER
- SERVICE - SHUT OFF VALVE
- GATE VALVE + BOX
- W — GATE WELL (SP?)
- WATER WELL

UNIDENTIFIED EXISTING UTILITIES

- MARKER
- MANHOLE COVER
- PEDESTAL
- POLE
- SEWER CLEANOUT
- STRUCTURE BOTTOM
- UTILITY BOX

DRAINAGE

CULVERT

- CULVERT - EX
- CULVERT - PR
- END SECTION OPENING - EX
- END SECTION - PR
- OUTLET HEADWALL - PR
- PIPE / BOX CULVERT HEADWALL - PR

STORM SEWER

- SEWER - EX
- SEWER - PR
- CB — CATCH BASIN W/ COVER
- MANHOLE W/ COVER
- MANHOLE BASE W/ RISER AND COVER
- MANHOLE TEE W/ RISER AND COVER
- 12 — DRAINAGE STRUCTURE NUMBER

UNDERDRAIN

- UNDERDRAIN - PR

SURFACE DRAINAGE

- DITCH CENTERLINE
- WATERS EDGE

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MDOT Michigan Department of Transportation

NO SCALE

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ITS

PROPOSED	EXISTING	
		ITS CABINET
		FIBER OPTIC SPLICE PEDESTAL
		JUNCTION BOX
ITS	ITS	HANDHOLE, ROUND, 3 FOOT DIA.
E	E	HANDHOLE, ROUND
ITS	ITS	HANDHOLE, TYPE D
		SURVEILLANCE SYSTEM
		SURVEILLANCE SYSTEM, TOWER MOUNT
		MICROWAVE VEHICLE DETECTION SYSTEM
		DYNAMIC MESSAGE SIGN
		WIRELESS VEHICLE DETECTION SENSOR
SPP	SPP	RADIO RECEIVER FOR WIRELESS VEHICLE DETECTION
		VEHICLE DETECTOR
		SPUN CONCRETE POLE
		STEEL STRAIN POLE
		WOOD POLE
		MICROWAVE VEHICLE DETECTION SYSTEM ZONE COVERAGE
		OMNI ANTENNA
		YAGI ANTENNA
		WIRELESS LINK/REPEATER
M	M	POWER SERVICE METER
F	F	ELECTRICAL SERVICE DISCONNECT
		ELECTRICAL TRANSFORMER
		COMMUNICATIONS TOWER
		DYNAMIC PANEL SIGN
LCS	LCS	LANE CONTROL SIGN
		ESS SITE

E — PROPOSED CONDUIT (ELECTRICAL)

ITS — PROPOSED CONDUIT (COMMUNICATIONS)

E — EXISTING CONDUIT

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)

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MDOT Michigan Department of Transportation

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CS: 84923
JN: 106329A

ITS LEGEND SHEET

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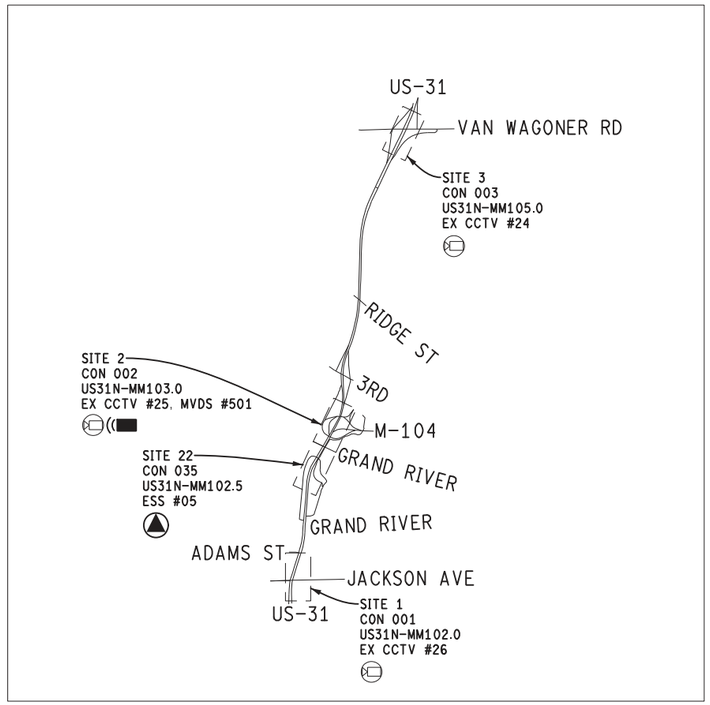
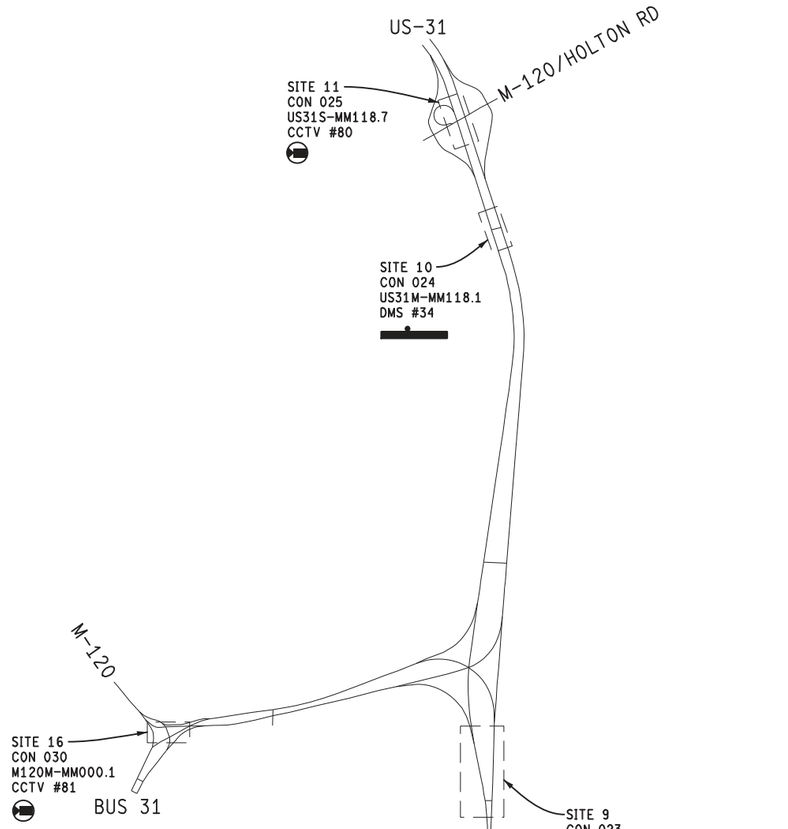
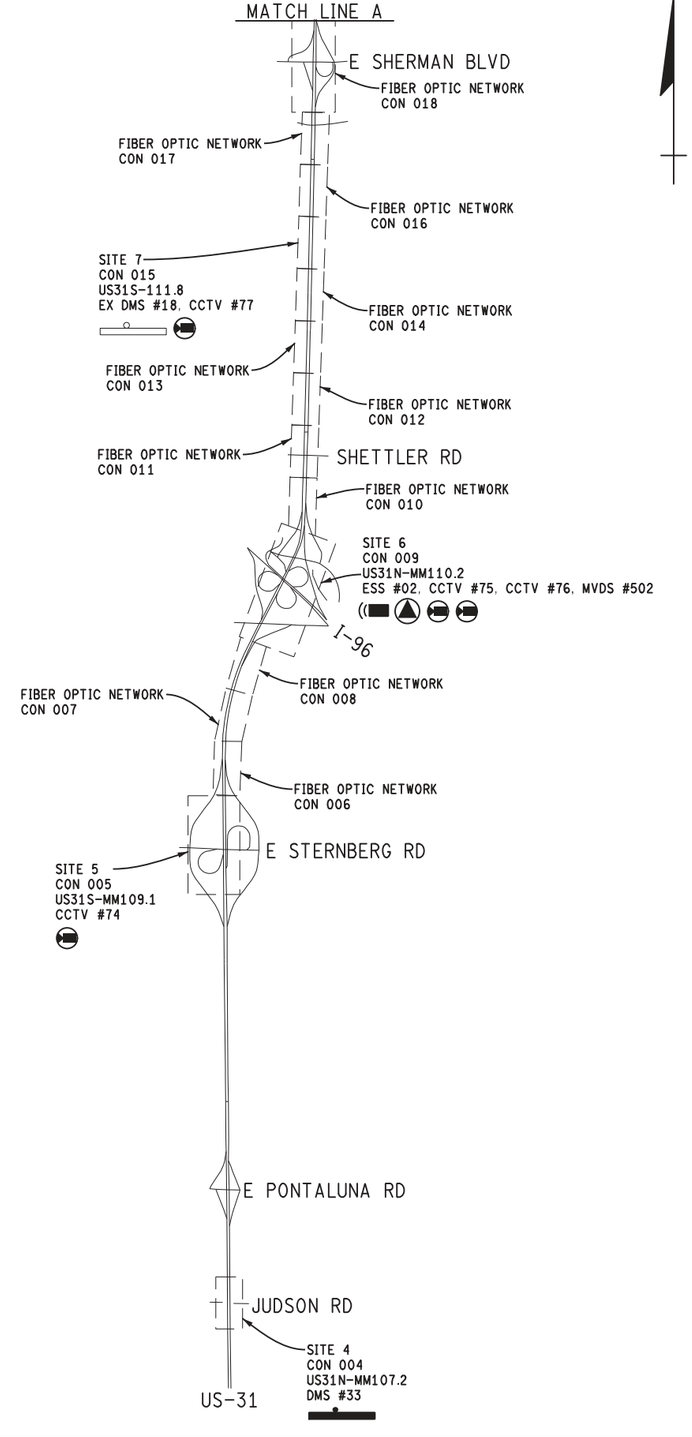
SHEET: SECT 1 7







N

LEGEND

EXISTING MVDS	EXISTING SURVEILLANCE SYSTEM	EXISTING DMS	EXISTING ESS
PROPOSED MVDS	PROPOSED SURVEILLANCE SYSTEM	PROPOSED DMS	PROPOSED ESS
	SHEET LIMITS		

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)

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VICINITY SHEET
US-31

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GENERAL NOTES

UTILITIES

MISS DIG/UNDERGROUND UTILITY NOTIFICATION
For the protection of underground utilities and in conformance with Public Act 174 of 2013, the Contractor shall contact MISS DIG System, Inc. by phone at 811 or 800-482-7171 or via the web at either elocate.missdig.org for single address or rte.missdig.org, a minimum of 3 business days prior to excavating, excluding weekends and holidays.

MDOT's roadway lighting system, Intelligent Transportation Systems (ITS) and other miscellaneous electrical systems are not a part of Miss Dig. Contractors shall contact the following at least 5 business days in advance for staking requests. Note these are not emergency contacts for damage to utilities.

Grand Region:
MDOT Roadway Lighting, Traffic Signals, or other electrical systems staking should be Emailed on MDOT Form 5300B (http://mdotcf.state.mi.us/public/webforms/public/5300B.pdf) to:
MDOT-Electrical-Staking@michigan.gov

Muskegon TSC: 231-767-9038 Ext. 310

Grand Haven Roadway Lighting:
Grand Haven Board of Power and Light: 231-646-6250 or Email to nwinsemius@ghblp.org

Kent, Ottawa and Muskegon Counties:
MDOT ITS systems including traffic cameras, changeable message signs, detection equipment, other sensors and related communication cables and equipment in, over, or along the roadway. ITS staking requests per the Special Provision for Protect ITS Infrastructure should be e-mailed on MDOT Form 5300 to:
MDOT-ITS-Staking-Grand@michigan.gov

Telephone inquiries can be made at 616-451-3091.

OUT OF SERVICE UTILITIES
If plan information indicates an existing underground utility is or will be out of service within the limits of this contract, the Contractor is cautioned to treat such a line as if it were still in service and notify "Miss Dig" when working in the area of the out of service facility.

EXISTING WATER MAINS AND SEWERS
The Contractor shall be responsible for any damage to properly identified existing water mains and/or existing sewers during the construction of this project.

ROW / REAL ESTATE

LAWN SPRINKLER SYSTEMS AND LANDSCAPING
Owners of existing lawn sprinkler systems and/or landscaping shall be notified (in writing with a copy sent to the Engineer) by the Contractor two weeks in advance of any work to be done that will affect those systems and/or landscaping. If the property owner fails to relocate the lawn sprinkler system prior to the Contractor beginning work, and if the Contractor cuts the system during the construction, the Contractor shall cap the system pipe and witness the location of the cap with a wooden stake for the property owner's use. The Contractor shall place the salvaged sprinkler heads on the property owner's property. If the property owner fails to relocate the landscaping prior to the Contractor beginning work, the Contractor shall carefully salvage the landscaping items and stockpile them on the property owner's property for the property owner. Any other modification to the lawn sprinkler systems and/or landscaping is the responsibility of the owner and is not part of this contract. This work is included in other items of the project.

OLD PLANS

OLD ROAD PLANS
The following old road plans were referred to in the design of this project.
106327A, 100377A, 89731A

In addition, other old road plans that predate this project may be available. These plans may be reviewed in the Transportation Service Center (TSC) during normal working hours.

EARTHWORK

EARTHWORK
Earthwork quantities are computed based upon limited survey information. These quantities are for bidding purposes only and will be adjusted by the Engineer based upon actual field measurements.

SOIL EROSION MEASURES
Appropriate soil erosion and sedimentation control measures shall be in place prior to earth-disturbing activities. Place silt fencing to protect ditches and waterways during construction of conduit, handholes, and foundations as directed by the Engineer. Place turf establishment items as soon as possible on potential erodable slopes as directed by the Engineer. Critical ditch grades shall be protected with either sod or seed/mulch or mulch blanket as directed by the Engineer.

PAVEMENT

SOIL BORINGS AND/OR PAVEMENT CORES
The soil boring logs and/or pavement cores represent point information. No inference should be made that subsurface or pavement conditions are the same at other locations.

GUARDRAIL

GUARDRAIL AT BRIDGE APPROACH
Guardrail shall be extended parallel to the existing bridge railing until past the bridge approach curb & gutter before flaring to shoulder.

GUARDRAIL CONNECTIONS TO EXISTING GUARDRAIL
Connections of proposed guardrail to existing guardrail shall be field drilled. Any additional cost for this work shall be included in the pay item of the proposed guardrail.

GUARDRAIL POST HOLES
Posts placed within 3' of existing culverts shall be in drilled holes and shall not be driven.

TURF ESTABLISHMENT

SEED MIXTURE
The symbol for the permanent turf seed mixture on this project is symbol TDS.

REST AREA AND/OR LANDSCAPING

Existing vegetation shall not be damaged during construction operations, per the 2012 Standard Specifications for Construction.

Heavy equipment will not be allowed to work outside the slope stake lines in the wooded portion of the site. All equipment to be used must be approved by the engineer prior to beginning work.

Storage of equipment and materials will be restricted to areas designated by the Engineer. No equipment is permitted within the drip line of existing trees to remain.

Branches of all trees to be saved shall not be removed, or damaged by construction equipment. If removal of lower branches is necessary, contact Roadside Development or the Region Resource Specialist for proper methods.

Do not trench within the drip line of existing trees to remain unless specifically approved by the Engineer.

Contractor shall promptly restore any property damage at no expense to MDOT.

All raw fill or cut slopes will be covered with slope restoration according to the special provision and time limitations specified in section 816.03 of the 2012 Standard Specifications for Construction.

All excavated material will become the property of the contactor. Any excavated material not used on the project will be removed from the site and disposed of in accordance with section 205.03.P. of the 2012 Standard Specification for Construction and any applicable state and/or local ordinances.

Protect existing sidewalks from damage.

SIGNALS

PREVIOUS GENERAL NOTES
Some notes previously included in "General Notes" are now located within the Frequently Used Special Provision titled "Traffic Signal Work - Construction Methods".

MAINTAINING AGENCY CONTACT INFORMATION
- MDOT: Statewide Signal Shop (517-322-3360)

NOTIFICATIONS TO MAINTAINING AGENCIES
Contact MDOT (and any other maintaining agency) seven working days prior to start of construction and seven working days prior to signal activation.

PROJECT SPECIFIC NOTES

GENERAL

1. Splices in conductors will not be allowed at any location in the power system, unless otherwise noted.

2. The Contractor shall be responsible for returning all areas which are disturbed as a result of construction and installation of elements in this contract to their original state within 15 days of completion of work in that area, or as directed by the Engineer. The restoration of such areas will be paid for with the slope restoration contract items. The area of slope restoration shall be limited to four (4) feet parallel to each side of direct burial conduit and a 625 square foot area of excavation for each ITS handhole or device foundation. Any disturbance outside of these areas shall be restored at the Contractors' expense. No damage to ditches shall occur. Any ditches requiring restoration will be paid for with the Ditch Cleanout contract item, as directed by the Engineer.

3. At no time during the construction of this project will the Contractor be permitted to impact any Enhanced Mile Marker sign. Any sign damaged as a result of the Contractor's operations shall be replaced at the Contractor's expense, including surveying and staking the sign location.

4. The Contractor must field verify all device locations. The northing and easting coordinates provided will be used to determine approximate device location. Offsets given from edge of traveled lane, control points, and other existing features must be used to determine the exact location of the device. These offsets are to the centerline of the device/pole, unless noted otherwise. All device locations are subject to approval by the Engineer.

CONDUIT AND HANDHOLE INSTALLATION

1. 14AWG THHN solid copper wire shall be placed continuously in all underground conduit runs with fiber optic cable as a tracer wire. The tracer wire shall not be connected to any other electrical components and shall not have green insulation. All materials and labor associated with furnishing and installing the copper wire are considered included in the pay item "Tracer Wire".

2. Conduit sizes are shown as minimums. The Contractor may at his option and expense, use a larger size conduit than specified provided the larger size is continuous for the entire length of the run from outlet to outlet. Reducing couplings are not permitted. Changes in the conduit location and size on the project plans shall be documented by the Contractor and submitted to the project Engineer for approval prior to installation.

3. All direct buried conduits shall be Schedule 80 or equivalent.

4. Trenched conduits shall be separated by the use of a commercially available conduit spacer or approved equivalent for runs with three (3) or more conduits in the same trench.

5. Where expansion fittings are used on steel conduit, provide a bonding jumper of #6 AWG flexible wire or bond bushing.

6. Conduit expansion joints shall be installed on all new conduits that are crossing expansion joints on bridge structures and where conduit transitions from underground to above ground. They will not be paid for separately, but shall be included in the cost of the conduit.

7. After the installation of all cables and wire in conduit, conduit openings shall be plugged at both ends with a conduit sealant approved by the Engineer. No expanding foam sealant shall be used.

8. The phone number for the West Michigan Transportation Operations Center, (616) 451-8329, shall be printed on all above ground fiber optic markers.

TRENCHING

1. All trenching must be done in accordance with section 819 of the 2012 Standard Specifications for Construction. Trenches shall not be left open overnight (unless approved by the Engineer) and shall be backfilled to the satisfaction of the Engineer. If a trench must be left open overnight a minimum of 6 inches of backfill material shall be used as a protective cover to eliminate contraction of the conduit system. No additional payment shall be made for trenches left open overnight. The backfill material shall be removed by the Contractor upon the request of the Engineer if final inspection has not been made.

3. If trench widths less than 1 foot are proposed by the Contractor, approved compaction methods shall be used during backfill to prevent latent trench failures. The Contractor shall use grout or lean fill as approved by the Engineer in lieu of earth backfill.

BACKFILLING AND SURFACE RESTORATION

1. All surplus excavated material shall be removed and properly disposed within 48 hours by the Contractor outside of the right-of-way. After each excavation is complete the Contractor shall notify the Engineer for inspection and under no circumstances shall any underground materials or equipment be covered with fill without proper approval.

UNDERGROUND UTILITIES

1. If any parts of the freeway lighting system, traffic signal systems, ITS network, or other miscellaneous electrical systems are damaged during

construction, the Contractor shall contact the designated MDOT project representative immediately. The Contractor shall be responsible for all repairs including any expenses. The freeway lighting system, traffic signal systems, ITS network, or other miscellaneous electrical systems are to remain unless otherwise noted on the plans.

2. The plans show the best available underground facilities information as provided by the utility companies. Before beginning excavation, the Contractor shall field verify location and depth of existing underground utility systems. The Department will not be responsible for damage to any underground facilities caused by the Contractor.

3. Work required to locate existing underground facilities will only be paid for separately to install direct burial conduit, the cost for this work is included in the pay item “Exploratory Investigation, Vertical”. Work required to locate existing underground facilities will not be paid for separately to install directionally bored conduit, the cost for this work will be included in contract unit prices for directionally bored conduit.

4. Except as noted on the plans, direct burial conduit shall cross above existing underground utilities and directionally bored conduit shall cross below existing utilities.

5. Conduit runs shown on the project plans shall be changed to avoid underground obstructions as directed by the Engineer. The maximum bend of a conduit shall be 45 degrees, with the exception of pre-formed vertical sweeps, and the radius shall not be less than twelve times the inside diameter.

6. All underdrain outlets, outlet endings, culverts less than or equal to 24 inches in diameter, and fencing conflicting with the proposed design shall be removed and replaced by the Contractor as approved by the Engineer.

7. Minimum clearances must be maintained according to the Conduit Installation Details sheet.

8. Damage to underdrain outlets shall be repaired by the Contractor and this work is quantified on the miscellaneous quantities sheet.

TREES AND VEGETATION

1. Do not trench within the drip line of existing trees to remain unless specifically approved by the Engineer. No machinery, vehicles, equipment, stock pile of materials or aggregate of any kind shall be either stored or staged with the drip line of the any tree that will not be removed as part of the project. All remaining trees are to be protected from all equipment and activities as part of this project.

2. All proposed handhole locations and conduit routes that will require the removal of trees or clearing of brush shall be approved by the Engineer prior to the commencing of work. Trees with a diameter of 6 inches or greater, as specified in section 202.04A of the 2012 Standard Specifications for Construction, will not be removed.

JACKSON AVE

SECTION 21
T08N, R16W
CITY OF GRAND HAVEN

EX ROW VARIES

N

NB US-31 SB US-31

EX ROW VARIES

US31N-MM102.0

EX STEEL POLE
-EX CCTV
-EX WIRELESS LINK
-EX POLE-MTD CABINET
-EX ETHERNET SWITCH
-UNLICENSED RADIO, REM AND SALV
-WIRELESS LINK, 5 GHZ, SU
(FACING NORTH – SEE NOTE 1 & 2)
-CABINET EQUIPMENT CONFIGURATION

EX ROW VARIES

NB US-31 SB US-31

NOTES:
1. SEE MSDET DETAIL 020 AND 021 FOR MOUNTING WIRELESS LINK TO EXISTING POLE. APPROXIMATE ANTENNA AZIMUTH TO US31N-MM103.0 – 14.67° TN.
2. CONNECT NEW WIRELESS LINK CABLE TO EXISTING ETHERNET SWITCH.

SECTION 21
T08N, R16W
CITY OF GRAND HAVEN

EX ROW VARIES

JACKSON AVE

QUANTITIES – THIS SHEET

1 Ea	Unlicensed Radio, Rem and Salv
1 Ea	Wireless Link, 5 GHz, SU
1 Ea	Cabinet Equipment Configuration

SITE 1

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 80

	DATE:11/10/2016	CS: 70014	CONSTRUCTION SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US-31	US-31 CON 001	SECT 1 33
FILE:106329_01_US31@Jackson.dgn	TSC: MUSKEGON		US31N-MM102.0		

SECTION 16
T08N, R16W
CITY OF FERRYSBURG

N

NB US-31 SB US-31

EX LA ROW VARIES

B02 OF 70014

R01 OF 70016

EX LA ROW VARIES

NB US-31 SB US-31

US31N-MM103.0

EX CONC POLE
-EX CCTV
-EX POLE-MTD CABINET
-EX ETHERNET SWITCH
-UNLICENSED RADIO, REM AND SALV
-WIRELESS LINK, 5 GHZ, SU (FACING EAST - SEE NOTE 1 & 4)
-WIRELESS LINK, 5 GHZ, AP (FACING SOUTH - SEE NOTE 2 & 4)
-WIRELESS LINK, 5 GHZ, AP (FACING NORTH - SEE NOTE 3 & 4)
-MICROWAVE VEHICLE DETECTION SYSTEM
-CABINET EQUIPMENT CONFIGURATION

FO AT&T/GRAND HAVEN SCHOOLS FO

FO FO

FO FO

FO AT&T

CAUTION - CRITICAL UTILITY

NOTES:
1. SEE MSDET DETAIL 020 AND 021 FOR MOUNTING WIRELESS LINK TO EXISTING POLE. APPROXIMATE ANTENNA AZIMUTH TO I96W-MM007.7 - 79.30° TN.
2. SEE MSDET DETAIL 020 AND 021 FOR MOUNTING WIRELESS LINK TO EXISTING POLE. APPROXIMATE ANTENNA AZIMUTH TO US31N-MM102.0 - 194.67° TN.
3. SEE MSDET DETAIL 020 AND 021 FOR MOUNTING WIRELESS LINK TO EXISTING POLE. APPROXIMATE ANTENNA AZIMUTH TO US31N-MM105.0 - 12.05° TN.
4. CONNECT NEW WIRELESS LINK CABLES TO EXISTING ETHERNET SWITCH.

SECTION 16
T08N, R16W
CITY OF FERRYSBURG

EB M-104

WB M-104

PINE ST

QUANTITIES - THIS SHEET

1	Ea	Unlicensed Radio, Rem and Salv
1	Ea	Wireless Link, 5 GHz, SU
2	Ea	Wireless Link, 5 GHz, AP
1	Ea	Cabinet Equipment Configuration
1	Ea	Microwave Vehicle Detection System

SITE 2

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 80

FILE:106329_02_US31@M104.dgn

DATE:11/10/2016
DESIGN UNIT: PEPLINSKI
TSC: MUSKEGON

CS: 70016
JN: 106329A

CONSTRUCTION SHEET
US-31
US31N-MM103.0

DRAWING	SHEET
US-31 CON 002	SECT 1 34

VAN WAGONER RD

SECTION 09
T08N, R16W
CITY OF FERRYSBURG

SECTION 09
T08N, R16W
SPRING LAKE TWP

N

SPRING LAKE TWP

CITY OF FERRYSBURG

NB US-31 SB US-31

EX LA ROW VARIES

S03 OF 70016

US31N-MM105.0

ITS

EX STEEL POLE
-EX CCTV
-EX POLE-MTD CABINET
-EX ETHERNET SWITCH
-UNLICENSED RADIO, REM AND SALV
-WIRELESS LINK, 5 GHZ, SU
(FACING SOUTH - SEE NOTE 1 & 2)
-CABINET EQUIPMENT CONFIGURATION

EX LA ROW VARIES

NB US-31 SB US-31

NOTES:
1. SEE MSDET DETAIL 020 AND 021 FOR MOUNTING WIRELESS LINK TO EXISTING POLE. APPROXIMATE ANTENNA AZIMUTH TO US31N-MM103.0 - 192.05° TN.
2. CONNECT NEW WIRELESS LINK CABLES TO EXISTING ETHERNET SWITCH.

SECTION 09
T08N, R16W
CITY OF FERRYSBURG

SECTION 09
T08N, R16W
SPRING LAKE TWP

VAN WAGONER RD

QUANTITIES - THIS SHEET

1	Ea	Unlicensed Radio, Rem and Salv
1	Ea	Wireless Link, 5 GHz, SU
1	Ea	Cabinet Equipment Configuration

SITE 3

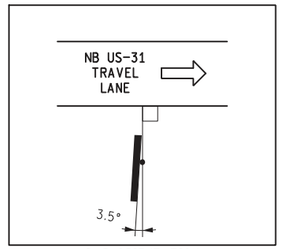
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 80

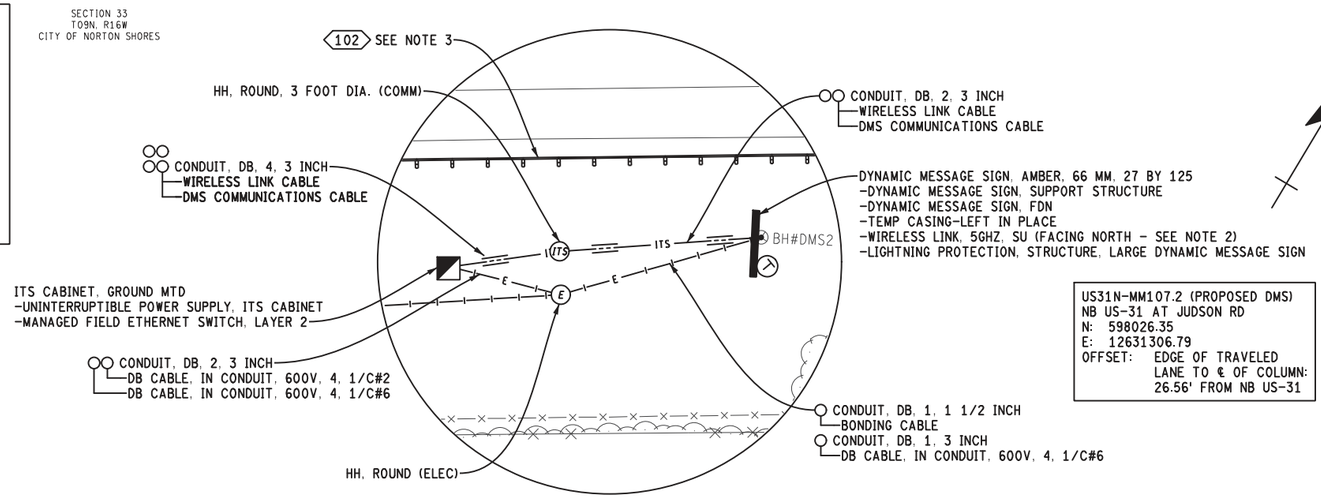
	DATE:11/10/2016	CS: 70016	CONSTRUCTION SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US-31	US-31 CON 003	SECT 1 35
FILE:106329_03_US31@VanWagoner.dgn	TSC: MUSKEGON		US31N-MM105.0		

JUDSON RD



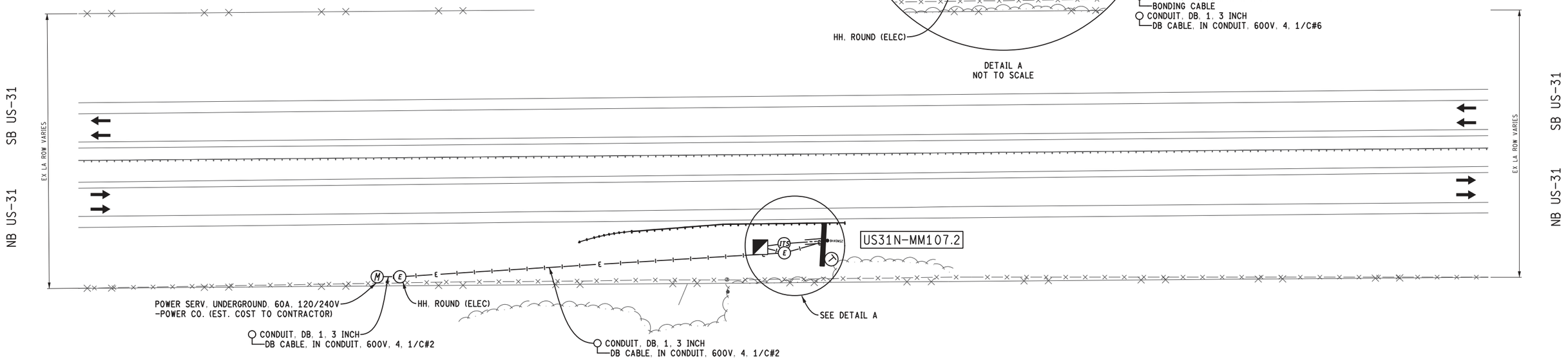
DMS ORIENTATION

SECTION 33
T09N, R16W
CITY OF NORTON SHORES



DETAIL A
NOT TO SCALE

US31N-MM107.2 (PROPOSED DMS)
NB US-31 AT JUDSON RD
N: 598026.35
E: 12631306.79
OFFSET: EDGE OF TRAVELED LANE TO ℄ OF COLUMN: 26.56' FROM NB US-31



CONTRACTOR TO PROVIDE NEW POWER SERVICE.
CONTACT MATT O'BRIEN AT CONSUMERS ENERGY (231.332.2693) FOR COORDINATION OF INSTALLATION OF PROPOSED ELECTRIC SERVICE. CONTRACTOR SHALL CONTACT CONSUMERS ENERGY TO COORDINATE THE ELECTRIC SERVICE CONNECTION AS SOON AS THE CONTRACT IS AWARDED. REFERENCE THIS SHEET AND SPECIAL PROVISION FOR GROUNDING, BONDING, LIGHTNING PROTECTION AND SURGE PROTECTION FOR INTELLIGENT TRANSPORTATION SYSTEM EQUIPMENT FOR ELECTRICAL WIRE COUNTS, SIZES, GROUNDING AND BONDING REQUIREMENTS. CONTRACTOR TO COORDINATE ALL FINAL LOCATIONS OF ELECTRICAL SERVICE EQUIPMENT AND REQUIRED DATES WITH THE POWER COMPANY AND THE ENGINEER. WORK PERFORMED BY CONSUMERS ENERGY FOR THIS CONTRACT TO BE PAID FOR AS 'POWER CO. (EST. COST TO CONTRACTOR)'.

REFERENCE THE FOLLOWING INFORMATION:
CONSUMERS ENERGY WORK ORDER NO: 1031429411
SERVICE ADDRESS: 1410 JUDSON RD, NORTON SHORES, MI 49456

CONTACT RICK FREEMAN, MICHIGAN DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS (517.241.9319), TO COORDINATE INSPECTION OF NEW ELECTRIC SERVICE.

CONTACT TOM RICHER (616.451.2604) TO COORDINATE UTILITY BILLING.
MDOT GRAND REGION OFFICE: 1420 FRONT AVE, GRAND RAPIDS, MI 49504

NOTES:
1. ELECTRICAL BONDING CABLE IS INCLUDED IN "ITS GROUNDING, BONDING, AND SURGE PROTECTION" PAY ITEM AND WILL NOT BE PAID FOR SEPARATELY. SEE "ITS SITE GROUNDING AND BONDING" MSDET 004-006.
2. APPROXIMATE ANTENNA AZIMUTH TO US31S-MM109.1 - 356.89° TN
3. SEE "GUARDRAIL DETAIL SHEET" MSDET 031 FOR INSTALLATION DETAILS

JUDSON RD

SECTION 33
T09N, R16W
CITY OF NORTON SHORES

GUARDRAIL RUN 102 QUANTITIES - THIS SHEET

162.5	Ft	Guardrail, Type T
1	Ea	Guardrail Approach Terminal, Type 1T
1	Ea	Guardrail Departing Terminal, Type T
4	Ea	Guardrail Reflector
13	Cyd	Excavation, Earth
160	Cyd	Embankment, CIP, Special
44	Cyd	Shoulder, Cl II, LM

QUANTITIES - THIS SHEET

675	Syd	Slope Restoration, Type A
375	Ft	Conduit, DB, 1, 3 inch
40	Ft	Conduit, DB, 1, 1 1/2 inch
60	Ft	Conduit, DB, 2, 3 inch
20	Ft	Conduit, DB, 4, 3 inch
395	Ft	DB Cable, in Conduit, 600V, 4, 1/C#2
105	Ft	DB Cable, in Conduit, 600V, 4, 1/C#6
2	Ea	Hh, Round
1	Ea	Hh, Round, 3 foot Dia.
1	Ea	Uninterruptible Power Supply, ITS Cabinet
1	Ea	ITS Cabinet, Ground Mtd
1	Ea	Managed Field Ethernet Switch, Layer 2
1	Ea	Dynamic Message Sign, Amber, 66 mm, 27 by 125
1	Ea	Dynamic Message Sign, Support Structure
24	Ft	Dynamic Message Sign, Fdn
24	Ft	Temp Casing-Left in Place
1	Ea	Lightning Protection, Structure, Large Dynamic Message Sign
1	Ea	Wireless Link, 5GHz, SU
1	Ea	Power Serv, Underground, 60A, 120/240V
228	Dlr	Power Co. (Est. Cost to Contractor)

SITE 4

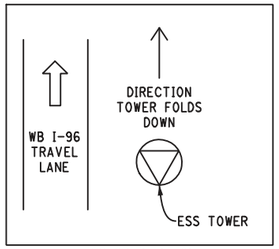
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

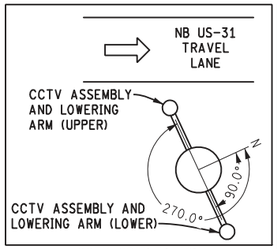
0 HORZ. (FT) 80

	DATE:11/10/2016	CS: 61074	CONSTRUCTION SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US-31	US-31 CON 004	SECT 1 36
FILE:106329_04_US31_DMS2.dgn	TSC: MUSKEGON		US31N-MM107.2		

E HILE RD



ESS ORIENTATION



CCTV ORIENTATION

CONTRACTOR TO PROVIDE NEW POWER SERVICE.
CONTACT MATT O'BRIEN AT CONSUMERS ENERGY (231.332.2693)
FOR COORDINATION OF INSTALLATION OF PROPOSED ELECTRIC SERVICE.
CONTRACTOR SHALL CONTACT CONSUMERS ENERGY TO COORDINATE THE ELECTRIC SERVICE CONNECTION AS SOON AS THE CONTRACT IS AWARDED.
REFERENCE THIS SHEET AND SPECIAL PROVISION FOR GROUNDING, BONDING, LIGHTNING PROTECTION AND SURGE PROTECTION FOR INTELLIGENT TRANSPORTATION SYSTEM EQUIPMENT FOR ELECTRICAL WIRE COUNTS, SIZES, GROUNDING AND BONDING REQUIREMENTS. CONTRACTOR TO COORDINATE ALL FINAL LOCATIONS OF ELECTRICAL SERVICE EQUIPMENT AND REQUIRED DATES WITH THE POWER COMPANY AND THE ENGINEER. WORK PERFORMED BY CONSUMERS ENERGY FOR THIS CONTRACT TO BE PAID FOR AS 'POWER CO. (EST. COST TO CONTRACTOR)'.

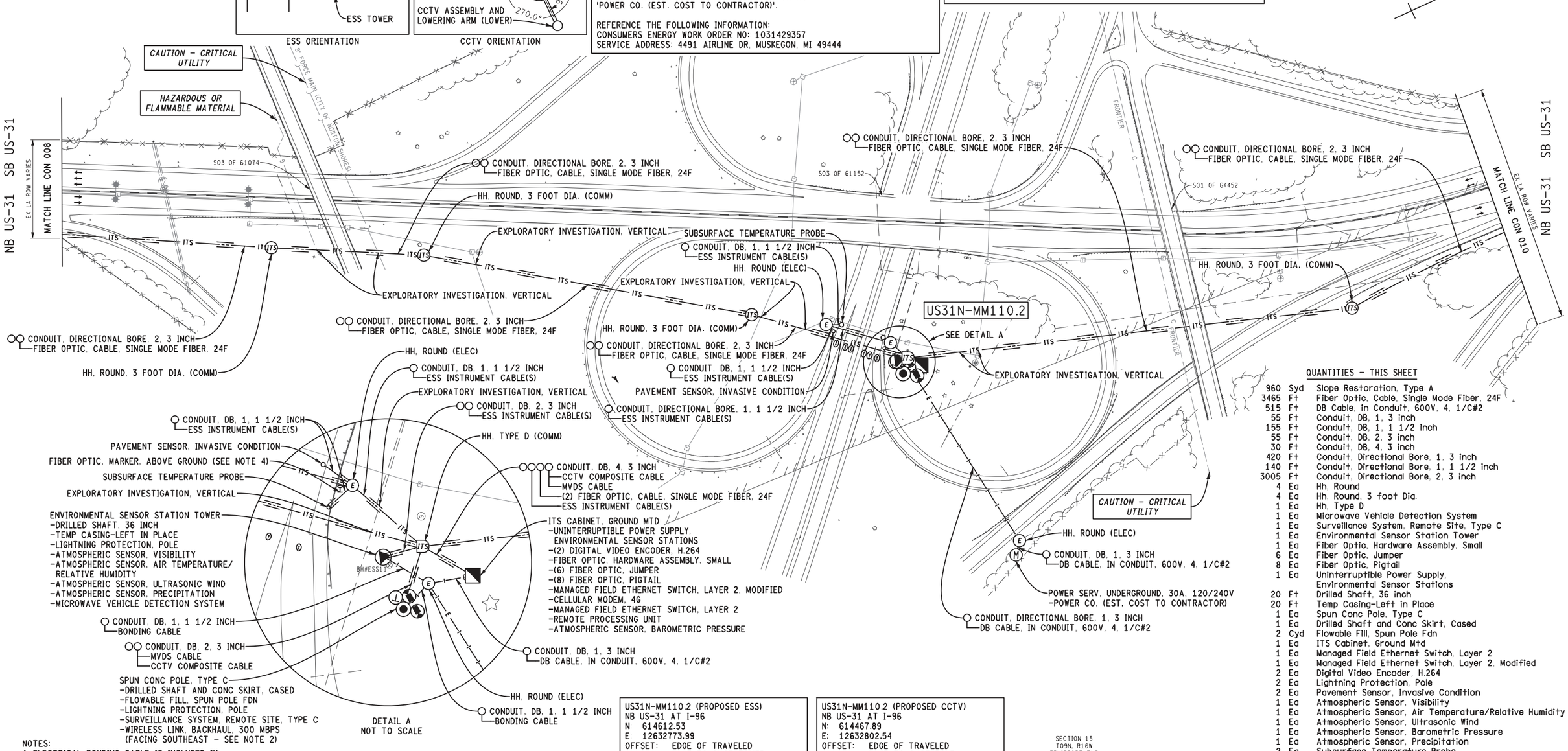
REFERENCE THE FOLLOWING INFORMATION:
CONSUMERS ENERGY WORK ORDER NO: 1031429357
SERVICE ADDRESS: 4491 AIRLINE DR, MUSKEGON, MI 49444

SB US-31 BR NB US-31 BR AIRLINE HWY

CONTACT RICK FREEMAN, MICHIGAN DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS (517.241.9319), TO COORDINATE INSPECTION OF NEW ELECTRIC SERVICE.

CONTACT TOM RICHER (616.451.2604) TO COORDINATE UTILITY BILLING. MDOT GRAND REGION OFFICE: 1420 FRONT AVE, GRAND RAPIDS, MI 49504

SECTION 16
T09N, R16W
CITY OF NORTON SHORES



DETAIL A
NOT TO SCALE

US31N-MM110.2 (PROPOSED ESS)
NB US-31 AT I-96
N: 614612.53
E: 12632773.99
OFFSET: EDGE OF TRAVELED LANE TO ℄ OF TOWER: 35.76' FROM WB I-96 ON RAMP

US31N-MM110.2 (PROPOSED CCTV)
NB US-31 AT I-96
N: 614467.89
E: 12632802.54
OFFSET: EDGE OF TRAVELED LANE TO ℄ OF POLE: 45.44' FROM WB I-96 ON RAMP

SECTION 15
T09N, R16W
FRUITPORT TWP

NOTES:
1. ELECTRICAL BONDING CABLE IS INCLUDED IN "ITS GROUNDING, BONDING, AND SURGE PROTECTION" PAY ITEM AND WILL NOT BE PAID FOR SEPARATELY. SEE "ITS SITE GROUNDING AND BONDING" MSDET 004-006.
2. APPROXIMATE ANTENNA AZIMUTH TO 68TH AVE AND LINCOLN ST – 133.28° TN
3. "ESS INSTRUMENT CABLE(S)" WHERE NOTED ON THE PLANS REPRESENTS ALL CABLES REQUIRED FOR THE INSTRUMENTS SHOWN TO BE INSTALLED AT THAT PARTICULAR ESS TOWER SITE. INSTRUMENTS WILL VARY PER SITE.
4. PLACE MARKER TO SHOW LOCATION OF CONDUITS AT GUARDRAIL.

E HILE RD EB I-96 WB I-96 AIRLINE HWY

QUANTITIES – THIS SHEET

960	Syd	Slope Restoration, Type A
3465	Ft	Fiber Optic, Cable, Single Mode Fiber, 24F
515	Ft	DB Cable, In Conduit, 600V, 4, 1/C#2
55	Ft	Conduit, DB, 1, 3 Inch
155	Ft	Conduit, DB, 1, 1 1/2 Inch
55	Ft	Conduit, DB, 2, 3 Inch
30	Ft	Conduit, DB, 4, 3 Inch
420	Ft	Conduit, Directional Bore, 1, 3 Inch
140	Ft	Conduit, Directional Bore, 1, 1 1/2 Inch
3005	Ft	Conduit, Directional Bore, 2, 3 Inch
4	Ea	Hh, Round
4	Ea	Hh, Round, 3 Foot Dia.
1	Ea	Hh, Type D
1	Ea	Microwave Vehicle Detection System
1	Ea	Surveillance System, Remote Site, Type C
1	Ea	Environmental Sensor Station Tower
1	Ea	Fiber Optic, Hardware Assembly, Small
6	Ea	Fiber Optic, Jumper
8	Ea	Fiber Optic, Pigtail
1	Ea	Uninterruptible Power Supply, Environmental Sensor Stations
20	Ft	Drilled Shaft, 36 Inch
20	Ft	Temp Casing-Left in Place
1	Ea	Spun Conc Pole, Type C
1	Ea	Drilled Shaft and Conc Skirt, Cased
2	Cyd	Flowable Fill, Spun Pole Fdn
1	Ea	ITS Cabinet, Ground Mtd
1	Ea	Managed Field Ethernet Switch, Layer 2
1	Ea	Managed Field Ethernet Switch, Layer 2, Modified
2	Ea	Digital Video Encoder, H.264
2	Ea	Lightning Protection, Pole
2	Ea	Pavement Sensor, Invasive Condition
1	Ea	Atmospheric Sensor, Visibility
1	Ea	Atmospheric Sensor, Air Temperature/Relative Humidity
1	Ea	Atmospheric Sensor, Ultrasonic Wind
1	Ea	Atmospheric Sensor, Barometric Pressure
1	Ea	Atmospheric Sensor, Precipitation
2	Ea	Subsurface Temperature Probe
1	Ea	Remote Processing Unit
1	Ea	Cellular Modem, 4G
1	Ea	Power Serv, Underground, 30A, 120/240V
1974	Dlr	Power Co. (Est. Cost to Contractor)
1	Ea	Wireless Link, Backhaul, 300 Mbps
40	Ft	Exploratory Investigation, Vertical
1	Ea	Fiber Optic, Marker, Above Ground

SITE 6–FIBER OPTIC NETWORK

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 200

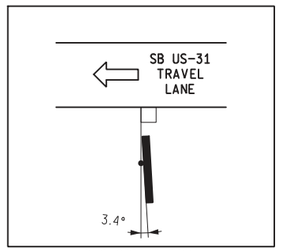
	DATE: 11/10/2016	CS: 61074, 61072	CONSTRUCTION SHEET	DRAWING / SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US-31	US-31 CON 009 / SECT 1
FILE: 106329_09_US31_CCTV4_EES11.dgn	TSC: MUSKEGON		US31N-MM110.2	41

CONTRACTOR TO PROVIDE NEW POWER SERVICE.
CONTACT NICHOLAS PAGE AT CONSUMERS ENERGY (231.332.2640) FOR COORDINATION OF INSTALLATION OF PROPOSED ELECTRIC SERVICE. CONTRACTOR SHALL CONTACT CONSUMERS ENERGY TO COORDINATE THE ELECTRIC SERVICE CONNECTION AS SOON AS THE CONTRACT IS AWARDED. REFERENCE THIS SHEET AND SPECIAL PROVISION FOR GROUNDING, BONDING, LIGHTNING PROTECTION AND SURGE PROTECTION FOR INTELLIGENT TRANSPORTATION SYSTEM EQUIPMENT FOR ELECTRICAL WIRE COUNTS, SIZES, GROUNDING AND BONDING REQUIREMENTS. CONTRACTOR TO COORDINATE ALL FINAL LOCATIONS OF ELECTRICAL SERVICE EQUIPMENT AND REQUIRED DATES WITH THE POWER COMPANY AND THE ENGINEER. WORK PERFORMED BY CONSUMERS ENERGY FOR THIS CONTRACT TO BE PAID FOR AS 'POWER CO. (EST. COST TO CONTRACTOR)'.

REFERENCE THE FOLLOWING INFORMATION:
CONSUMERS ENERGY WORK ORDER NO: 1031427499
SERVICE ADDRESS: 1640 BECKER RD, MUSKEGON, MI 49445

CONTACT RICK FREEMAN, MICHIGAN DEPARTMENT OF LICENSING AND REGULATORY AFFAIRS (517.241.9319), TO COORDINATE INSPECTION OF NEW ELECTRIC SERVICE.

CONTACT TOM RICHER (616.451.2604) TO COORDINATE UTILITY BILLING.
MDOT GRAND REGION OFFICE: 1420 FRONT AVE, GRAND RAPIDS, MI 49504



DMS ORIENTATION

SECTION 04
T10N, R16W
MUSKEGON TWP

US31M-MM118.1 (PROPOSED DMS)
NB US-31 AT M-120
N: 655637.28
E: 12634004.81
OFFSET: EDGE OF TRAVELED LANE TO ℄ OF COLUMN: 29.14' FROM SB US-31

DYNAMIC MESSAGE SIGN, AMBER, 66 MM, 27 BY 125
-DYNAMIC MESSAGE SIGN, SUPPORT STRUCTURE
-DYNAMIC MESSAGE SIGN, FDN
-TEMP CASING-LEFT IN PLACE-LEFT IN PLACE
-LIGHTNING PROTECTION, STRUCTURE, LARGE DYNAMIC MESSAGE SIGN
-WIRELESS LINK, 5GHZ, SU (FACING NORTH - SEE NOTE 2 & 3)

103 SEE NOTE 4

CONDUIT, DB, 2, 3 INCH
-WIRELESS LINK CABLE
-DMS COMMUNICATIONS CABLE

HH, ROUND, 3 FOOT DIA. (COMM)

CONDUIT, DB, 4, 3 INCH
-WIRELESS LINK CABLE
-DMS COMMUNICATIONS CABLE

ITS CABINET, GROUND MTD
-UNINTERRUPTIBLE POWER SUPPLY, ITS CABINET
-MANAGED FIELD ETHERNET SWITCH, LAYER 2

CONDUIT, DB, 2, 3 INCH
-DB CABLE, IN CONDUIT, 600V, 4, 1/C#2
-DB CABLE, IN CONDUIT, 600V, 4, 1/C#6

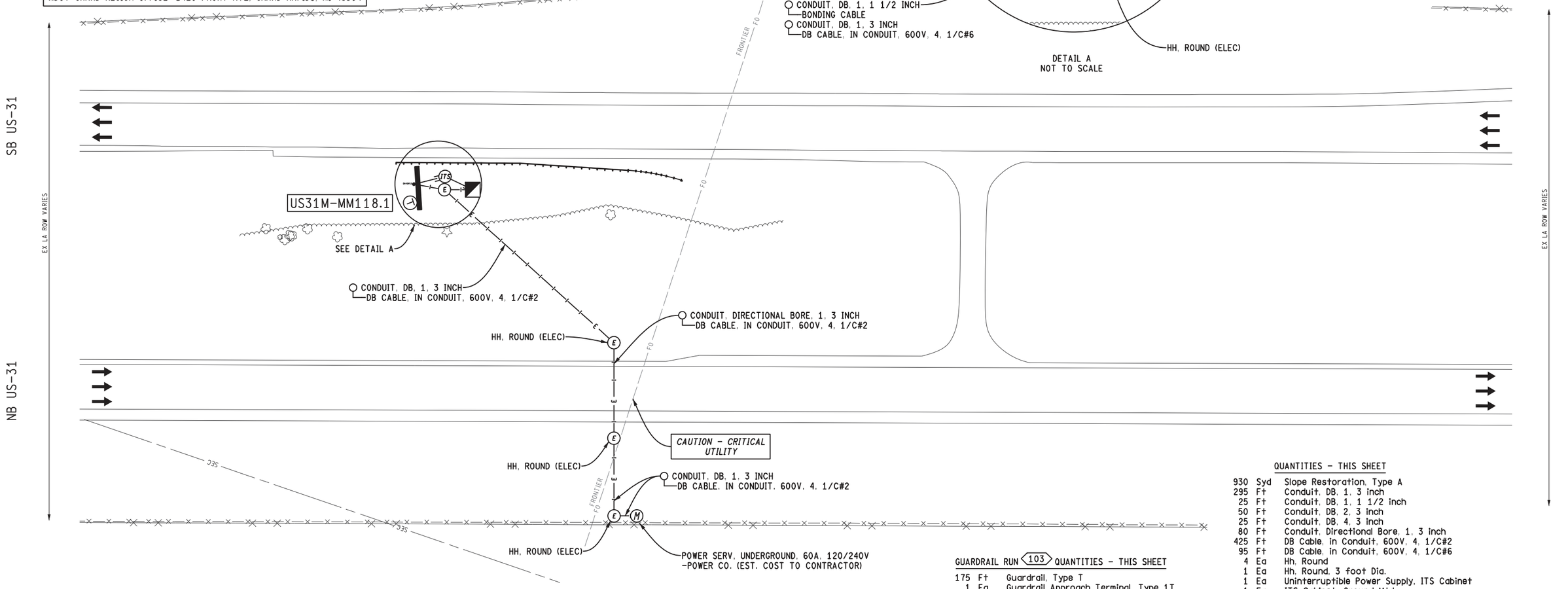
CONDUIT, DB, 1, 1 1/2 INCH
-BONDING CABLE

CONDUIT, DB, 1, 3 INCH
-DB CABLE, IN CONDUIT, 600V, 4, 1/C#6

HH, ROUND (ELEC)

BH#DMS3

DETAIL A
NOT TO SCALE



NOTES:
1. ELECTRICAL BONDING CABLE IS INCLUDED IN "ITS GROUNDING, BONDING, AND SURGE PROTECTION" PAY ITEM AND WILL NOT BE PAID FOR SEPARATELY. SEE "ITS SITE GROUNDING AND BONDING" MSDET 004-006.
2. SEE ITS DETAIL 023 FOR MOUNTING WIRELESS LINK TO DMS.
3. APPROXIMATE ANTENNA AZIMUTH TO US31M-MM118.7 = 338.40° TN
4. SEE "GUARDRAIL DETAIL SHEET" MSCDET 030 FOR INSTALLATION DETAILS.

SECTION 04
T10N, R16W
MUSKEGON TWP

GUARDRAIL RUN 103 QUANTITIES - THIS SHEET

175	Ft	Guardrail, Type T
1	Ea	Guardrail Approach Terminal, Type 1T
1	Ea	Guardrail Departing Terminal, Type T
4	Ea	Guardrail Reflector
19	Cyd	Excavation, Earth
73	Cyd	Embankment, CIP, Special
48	Cyd	Shoulder, Cl II, LM

QUANTITIES - THIS SHEET

930	Syd	Slope Restoration, Type A
295	Ft	Conduit, DB, 1, 3 inch
25	Ft	Conduit, DB, 1, 1 1/2 inch
50	Ft	Conduit, DB, 2, 3 inch
25	Ft	Conduit, DB, 4, 3 inch
80	Ft	Conduit, Directional Bore, 1, 3 inch
425	Ft	DB Cable, in Conduit, 600V, 4, 1/C#2
95	Ft	DB Cable, in Conduit, 600V, 4, 1/C#6
4	Ea	Hh, Round
1	Ea	Hh, Round, 3 foot Dia.
1	Ea	Uninterruptible Power Supply, ITS Cabinet
1	Ea	ITS Cabinet, Ground Mtd
1	Ea	Managed Field Ethernet Switch, Layer 2
1	Ea	Dynamic Message Sign, Amber, 66 mm, 27 by 125
1	Ea	Dynamic Message Sign, Support Structure
25	Ft	Dynamic Message Sign, Fdn
25	Ft	Temp Casing-Left in Place-Left in Place
1	Ea	Lightning Protection, Structure, Large Dynamic Message Sign
1	Ea	Wireless Link, 5GHz, SU
1	Ea	Power Serv, Underground, 60A, 120/240V
802	Dlr	Power Co. (Est. Cost to Contractor)

SITE 10

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 80

FILE:106329_24_US31_DMS3.dgn

DATE:11/10/2016
DESIGN UNIT: PEPLINSKI
TSC: MUSKEGON

CS: 61075
JN: 106329A

CONSTRUCTION SHEET
US-31
US31M-MM118.1

DRAWING	SHEET
US-31 CON 024	SECT 1 56

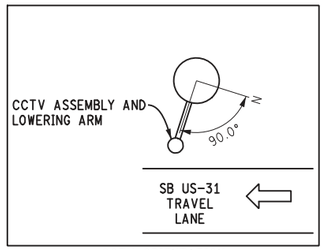
M-120/HOLTON RD

CONTRACTOR TO PROVIDE NEW POWER SERVICE.
CONTACT NICHOLAS PAGE AT CONSUMERS ENERGY (231.332.2640)
FOR COORDINATION OF INSTALLATION OF PROPOSED ELECTRIC SERVICE.
CONTRACTOR SHALL CONTACT CONSUMERS ENERGY TO COORDINATE THE
ELECTRIC SERVICE CONNECTION AS SOON AS THE CONTRACT IS AWARDED.
REFERENCE THIS SHEET AND SPECIAL PROVISION FOR GROUNDING, BONDING,
LIGHTNING PROTECTION AND SURGE PROTECTION FOR INTELLIGENT
TRANSPORTATION SYSTEM EQUIPMENT FOR ELECTRICAL WIRE COUNTS, SIZES,
GROUNDING AND BONDING REQUIREMENTS. CONTRACTOR TO COORDINATE ALL
FINAL LOCATIONS OF ELECTRICAL SERVICE EQUIPMENT AND REQUIRED DATES
WITH THE POWER COMPANY AND THE ENGINEER. WORK PERFORMED BY CONSUMERS
ENERGY FOR THIS CONTRACT TO BE PAID FOR AS
'POWER CO. (EST. COST TO CONTRACTOR)'.

REFERENCE THE FOLLOWING INFORMATION:
CONSUMERS ENERGY WORK ORDER NO: 1031427589
SERVICE ADDRESS: 2100 HOLTON RD, MUSKEGON, MI 49445

CONTACT RICK FREEMAN, MICHIGAN DEPARTMENT OF
LICENSING AND REGULATORY AFFAIRS (517.241.9319),
TO COORDINATE INSPECTION OF NEW ELECTRIC SERVICE.

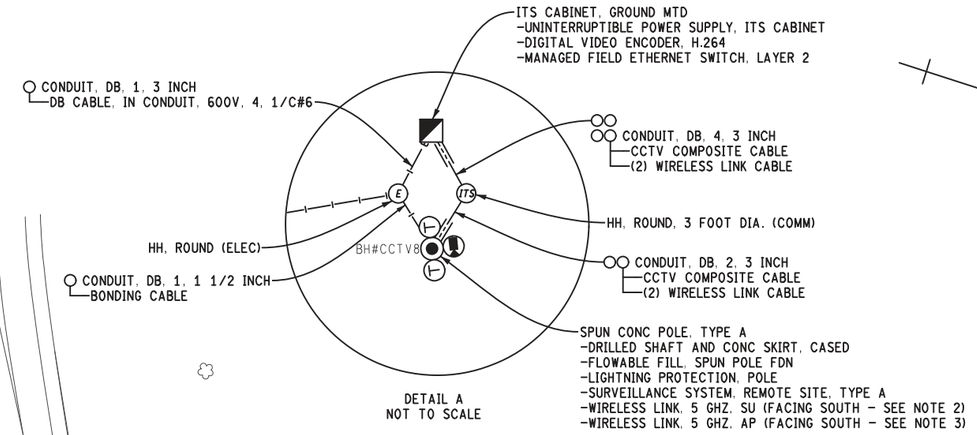
CONTACT TOM RICHER (616.451.2604) TO COORDINATE UTILITY BILLING.
MDOT GRAND REGION OFFICE: 1420 FRONT AVE, GRAND RAPIDS, MI 49504



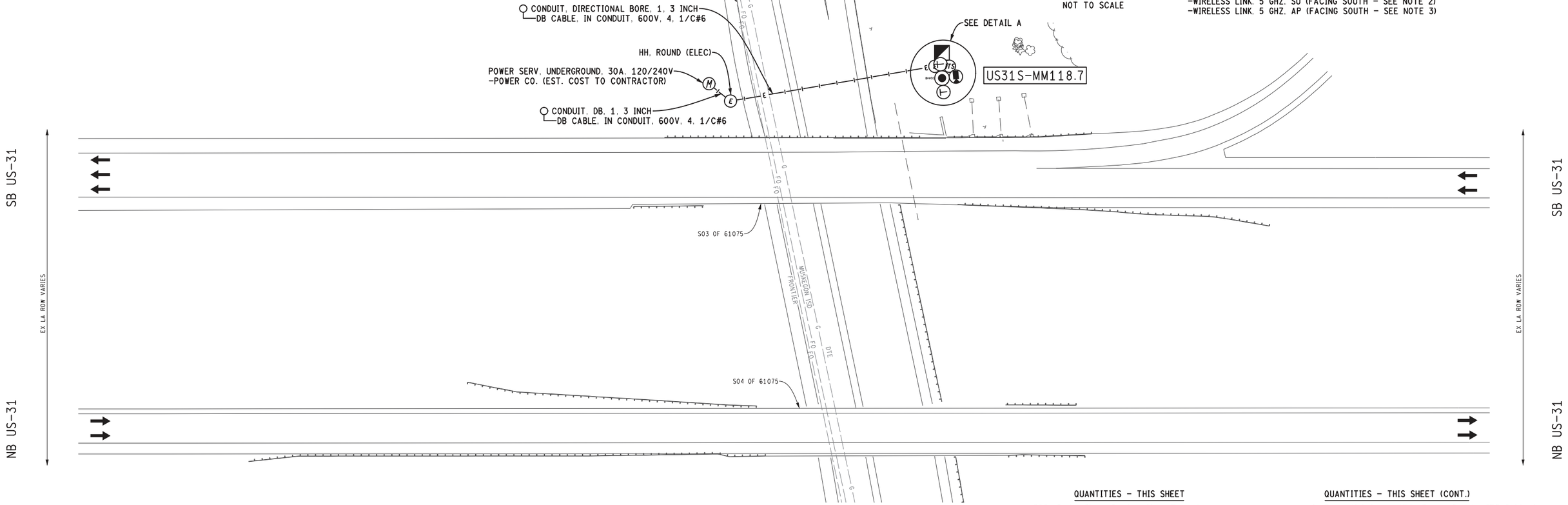
CCTV ORIENTATION

SECTION 04
T1ON, R16W
MUSKEGON TWP

US31S-MM118.7 (PROPOSED CCTV)
SB US-31 AT HOLTON RD
N: 658664.83
E: 12632895.56
OFFSET: EDGE OF TRAVELED
LANE TO ℄ OF POLE:
59.79' FROM SB US-31 ON RAMP



DETAIL A
NOT TO SCALE



NOTES:
1. ELECTRICAL BONDING CABLE IS INCLUDED IN
"ITS GROUNDING, BONDING, AND SURGE PROTECTION"
PAY ITEM AND WILL NOT BE PAID FOR SEPARATELY.
SEE "ITS SITE GROUNDING AND BONDING" MSDET 004-006.
2. APPROXIMATE ANTENNA AZIMUTH TO US31S-MM118.1 = 158.04° TN
3. APPROXIMATE ANTENNA AZIMUTH TO US31N-MM113.7 = 177.66° TN

SECTION 04
T1ON, R16W
MUSKEGON TWP

M-120/HOLTON RD

QUANTITIES - THIS SHEET

500	Syd	Slope Restoration, Type A
35	Ft	Conduit, DB, 1, 3 inch
15	Ft	Conduit, DB, 1, 1 1/2 inch
15	Ft	Conduit, DB, 2, 3 inch
15	Ft	Conduit, DB, 4, 3 inch
170	Ft	Conduit, Directional Bore, 1, 3 inch
245	Ft	DB Cable, In Conduit, 600V, 4, 1/C#6
2	Ea	Hh, Round
1	Ea	Hh, Round, 3 foot Dia.
1	Ea	Surveillance System, Remote Site, Type A

QUANTITIES - THIS SHEET (CONT.)

1	Ea	Uninterruptible Power Supply, ITS Cabinet
1	Ea	Spun Conc Pole, Type A
1	Ea	Drilled Shaft and Conc Skirt, Cased
2	Cyd	Flowable Fill, Spun Pole Fdn
1	Ea	ITS Cabinet, Ground Mtd
1	Ea	Managed Field Ethernet Switch, Layer 2
1	Ea	Digital Video Encoder, H.264
1	Ea	Lightning Protection, Pole
1	Ea	Wireless Link, 5 GHz, SU
1	Ea	Wireless Link, 5 GHz, AP
1	Ea	Power Serv, Underground, 30A, 120/240V
130	Dlr	Power Co. (Est. Cost to Contractor)

SITE 11

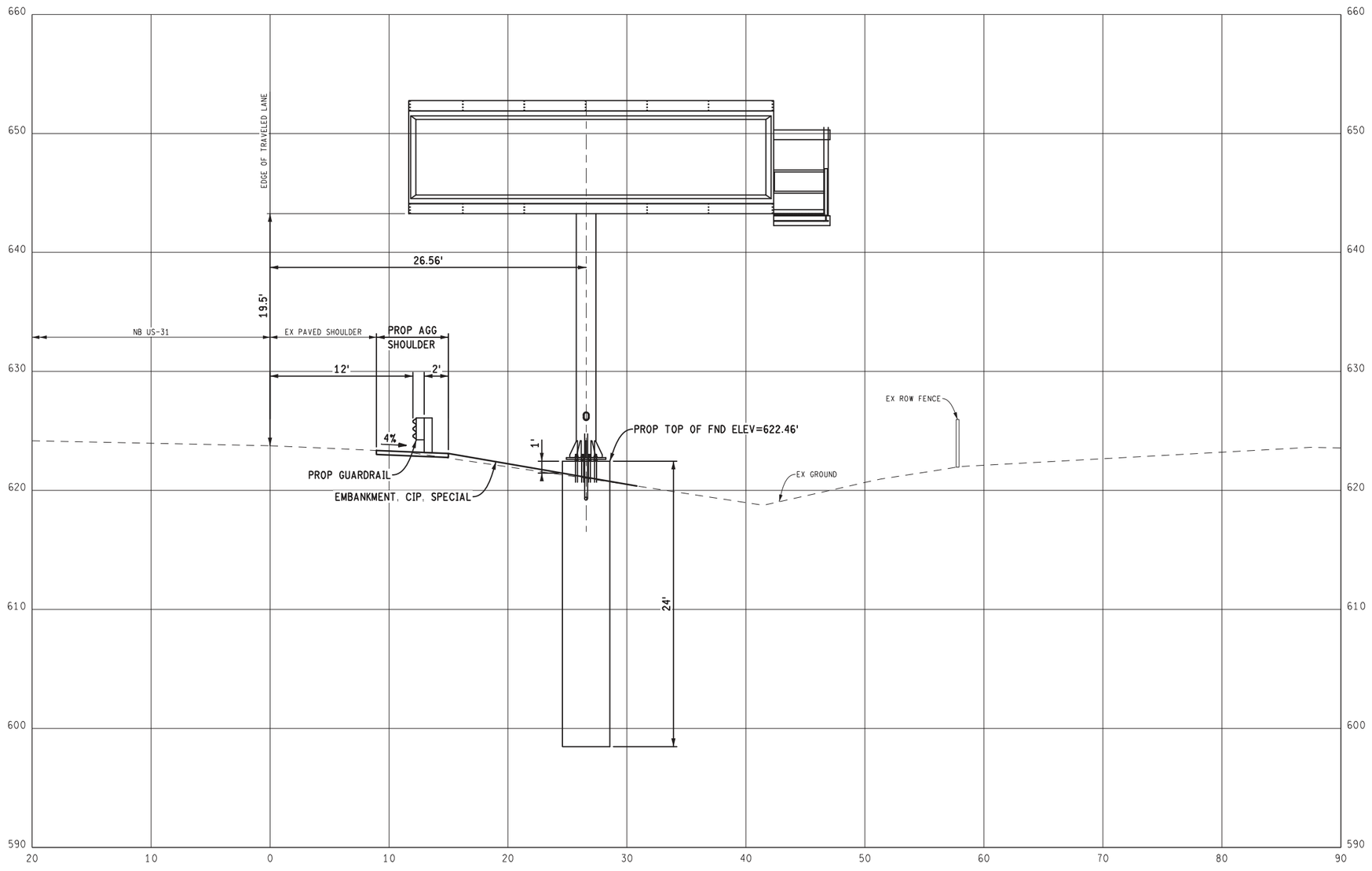
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 80

	DATE:11/10/2016	CS: 61075	CONSTRUCTION SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US-31	US-31 CON 025	SECT 1 57
FILE:106329_25_US31_CCTV8.dgn	TSC: MUSKEGON		US31S-MM118.7		

CROSS SECTION FACING NORTH



US31N-MM107.2

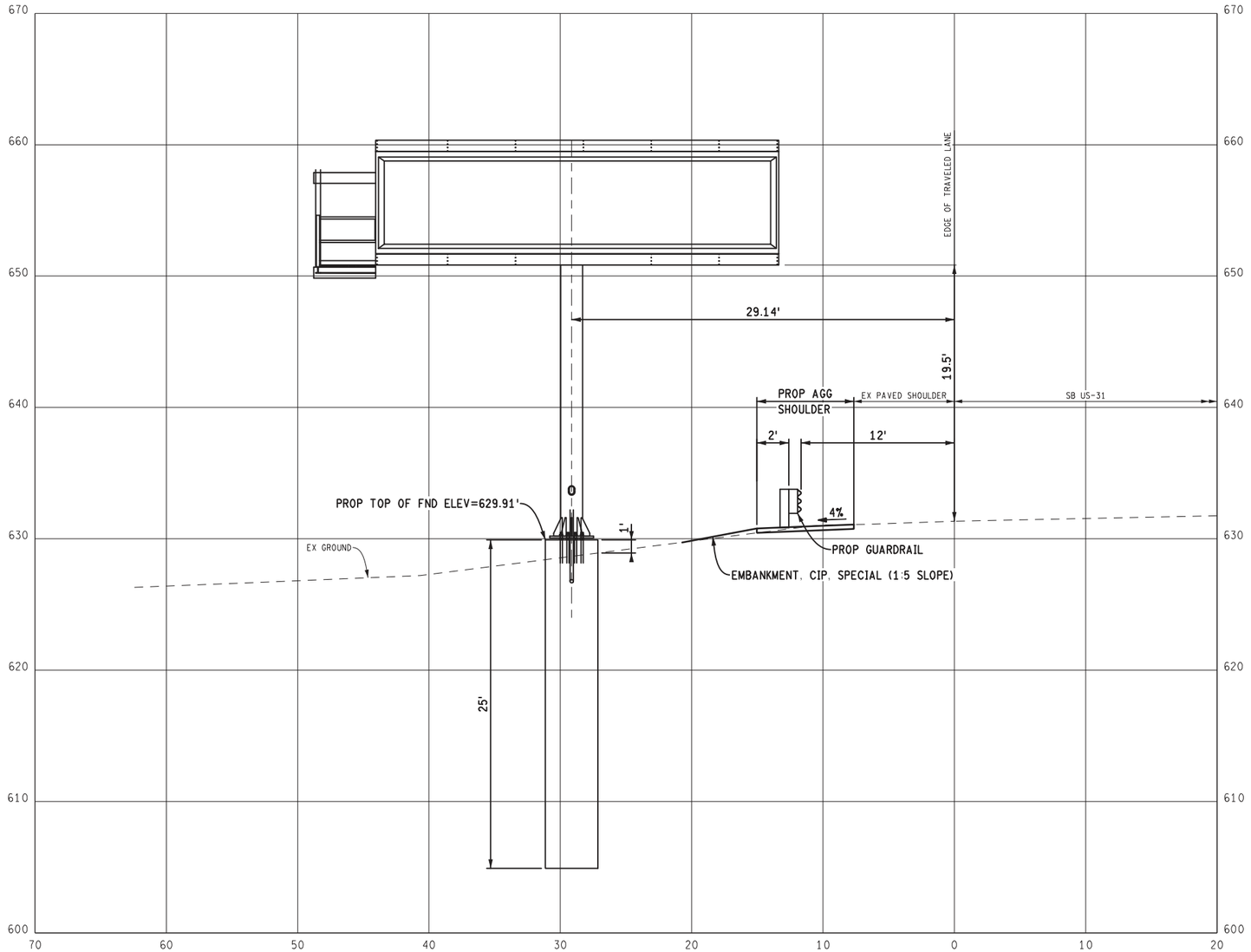
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

VERT. (FT) 0 10
HORZ. (FT) 0 10

	DATE:11/10/2016	CS: 61074	CROSS SECTION SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US-31	US-31 XS 002	SECT 1 72
FILE:106329_XS2_DMS2.dgn	TSC: MUSKEGON		US31N-MM107.2		

CROSS SECTION FACING SOUTH



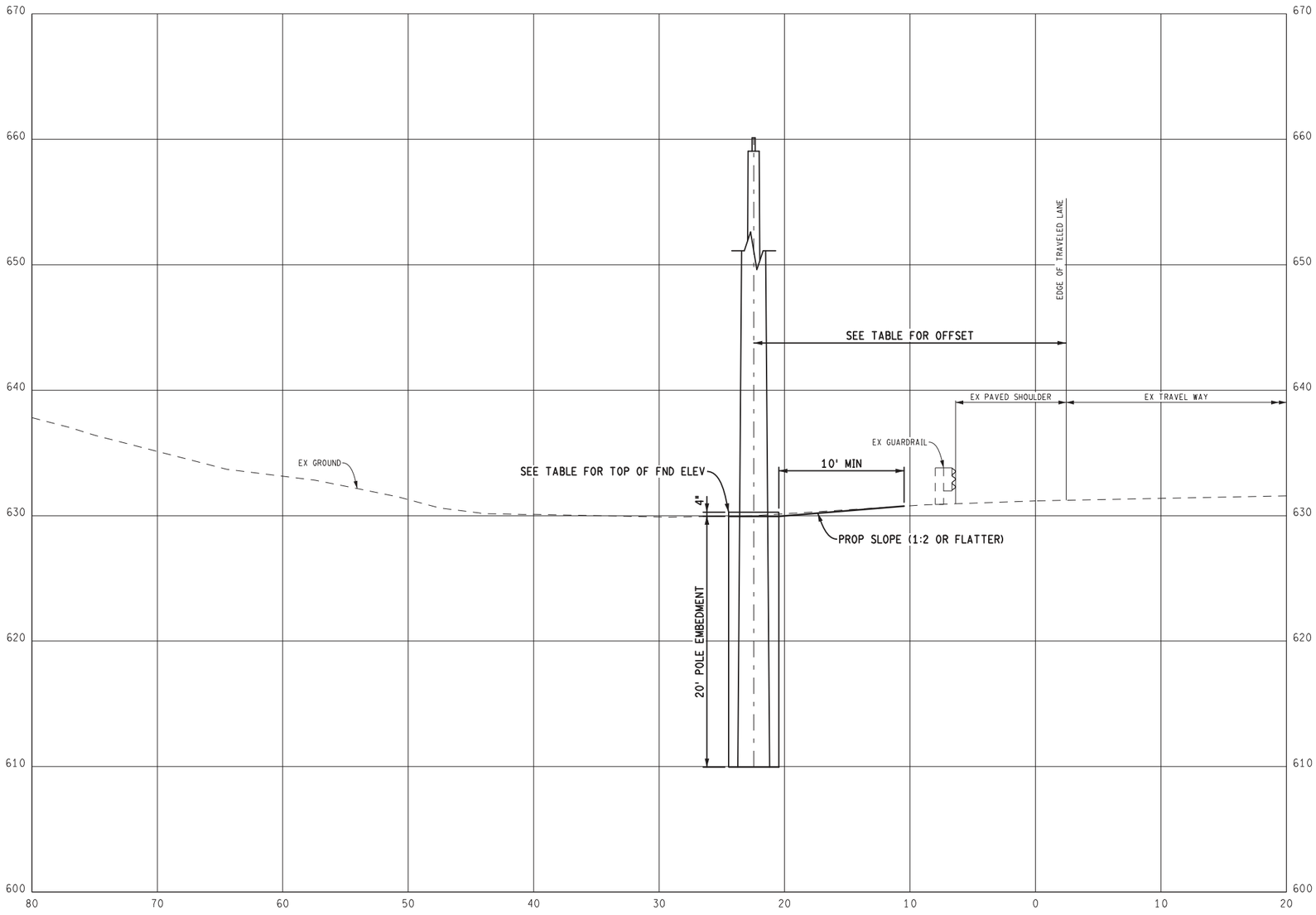
US31M-MM118.1

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

VERT. (FT) 0 10
HORZ. (FT) 0 10

	DATE: 11/10/2016	CS: 61075	CROSS SECTION SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US-31	US-31 XS 003	SECT 1 73
FILE: 106329_XS3_DMS3.dgn	TSC: MUSKEGON		US31M-MM118.1		



SITE NAME	TOP OF FND ELEV	OFFSET
US31N-MM110.2	614.93'	45.44' FROM WB I-96 ON RAMP
US31M-MM113.7	657.82'	19.28' FROM NB US-31
US31M-MM115.8	626.06'	81.61' FROM NB US-31
US31S-MM118.7	643.17'	59.79' FROM SB US-31 ON RAMP
I96W-MM005.1	630.32'	22.47' FROM WB I-96
I96W-MM007.7	621.40'	53.35' FROM WB I-96
I96E-MM010.1	626.06'	82.79' FROM EB I-96
M120M-MM000.1	586.80'	86.00' FROM SB BUS US-31

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

VERT. (FT) 0 10

HORZ. (FT) 0 10

FILE:106329_XS4_CCTV_Typ.dgn

DATE:11/10/2016

DESIGN UNIT: PEPLINSKI

TSC: MUSKEGON

CS: 84923

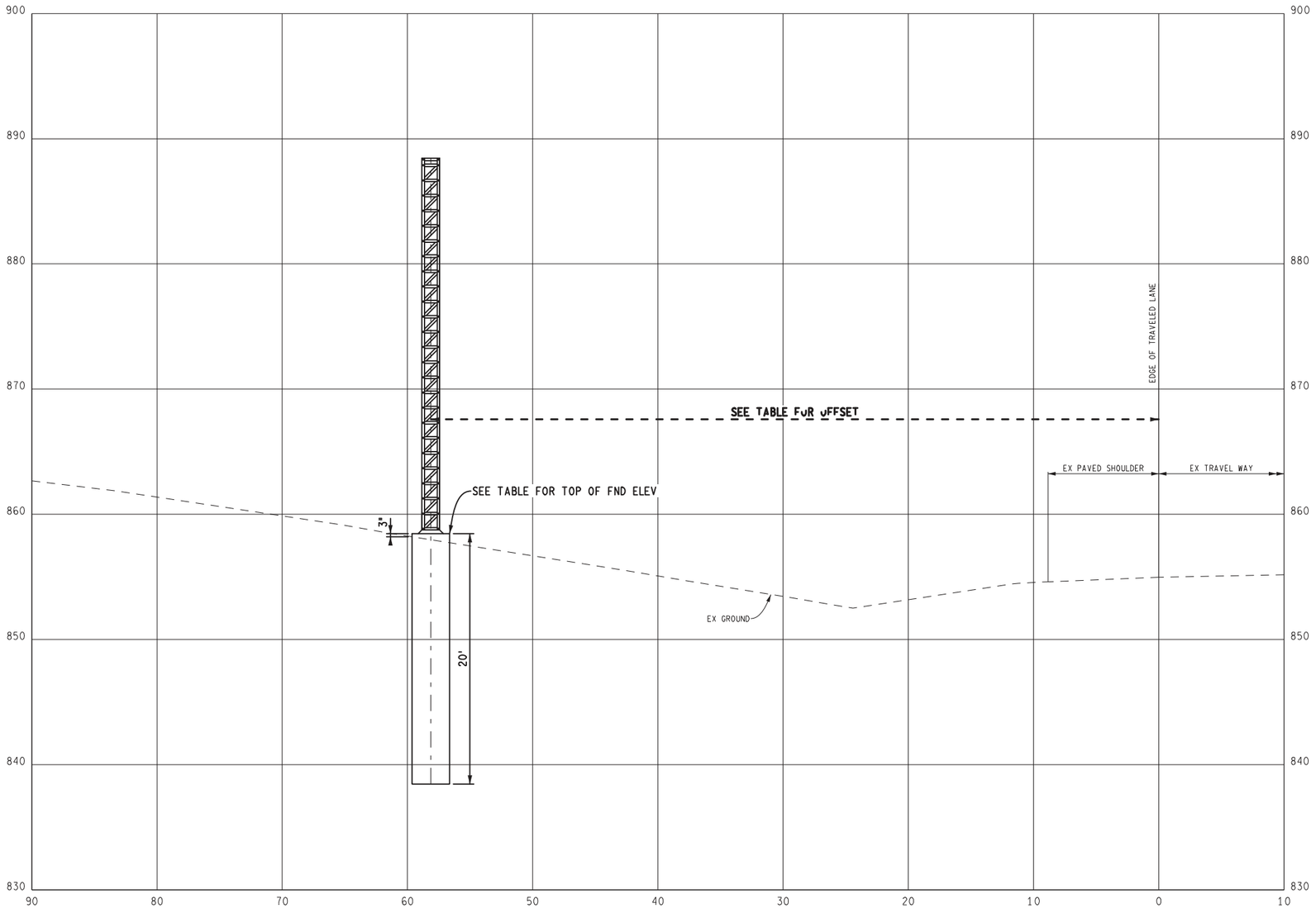
JN: 106329A

CROSS SECTION SHEET

TYPICAL SPUN CONC POLE

DRAWING: XS 004

SHEET: SECT 1 74



SITE NAME	TOP OF FND ELEV	DEPTH	OFFSET
US31N-MM102.5	599.01'	20.0'	21.44' FROM NB US-31
US31N-MM110.2	613.00'	20.0'	31.73' FROM WB I-96 ON RAMP
US31N-MM115.8	619.12'	20.0'	40.14' FROM NB US-31
US31N-MM128.7	650.78'	20.0'	33.90' FROM NB US-31 OFF RAMP

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 VERT. (FT) 10
0 HORZ. (FT) 10

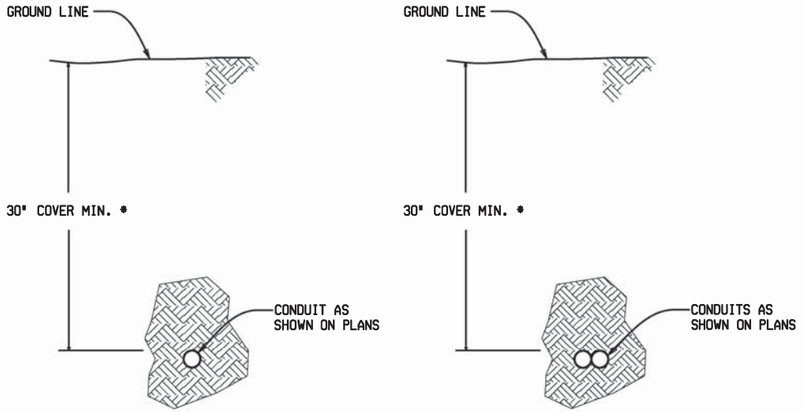
FILE:106329_XS5_EES_Typ.dgn

DATE:11/10/2016
DESIGN UNIT: PEPLINSKI
TSC: MUSKEGON

CS: 84923
JN: 106329A

CROSS SECTION SHEET
TYPICAL ESS TOWER

DRAWING: XS 005
SHEET: SECT 1 75



DIRECTIONAL BORE, 1

DIRECTIONAL BORE, 2

DIRECTIONAL DRILLED AND JACK-BORED CONDUIT INSTALLATION

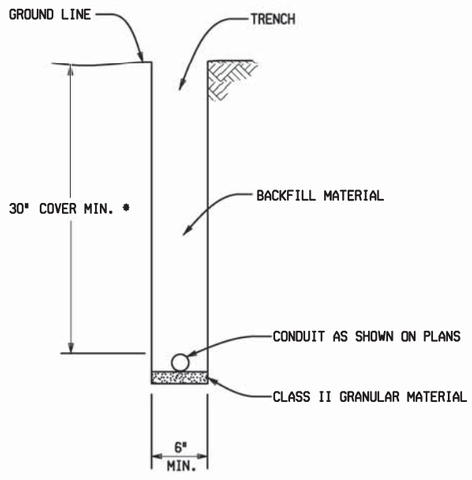
* 30" COVER IS THE MINIMUM. IN ADDITION, MINIMUM CLEARANCES MUST BE MAINTAINEO ACCORDING TO THE MINIMUM CONDUIT CLEARANCE TABLE.

H	BEHIND GUARDRAIL POSTS	60"
H	FOUNDATIONS	36"
H	OUTSIDE EDGE OF PAVED SHOULDER	60"
H	BACK OF CURB	24"
H	CONCRETE BARRIERS	36"
H	RETAINING WALLS	36"
H	PARALLEL UTILITY RUNS*	24"
H	CENTERLINE OF DITCH	36"
V	BELOW ROAD AND SHOULDER SURFACE	72"
V	OVER/UNDER CULVERTS	12"
V	UTILITY CROSSINGS	24"
V	BOTTOM OF CONCRETE STRUCTURE	120"
V	BELOW STREAM OR CREEK	120"
V	BELOW SURFACE GRADE AT GUARDRAIL POSTS	84"

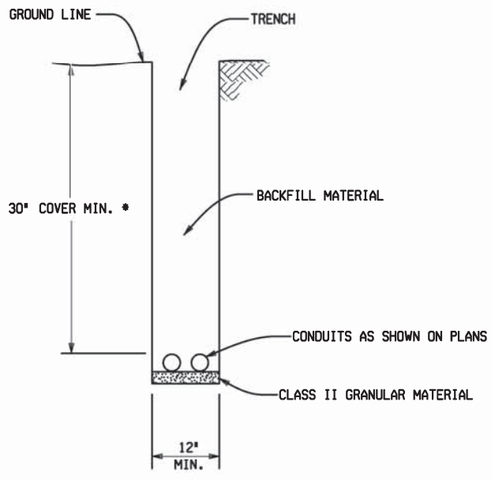
H= HORIZONTAL CLEARANCE TO NEAREST EDGE OF CONDUIT.
V= VERTICAL CLEARANCE TO NEAREST EDGE OF CONDUIT
*VERTICAL CLEARANCE OF 2' WILL BE ALLOWED IN PLACE OF HORIZONTAL CLERANCE

MINIMUM CONDUIT CLEARANCES

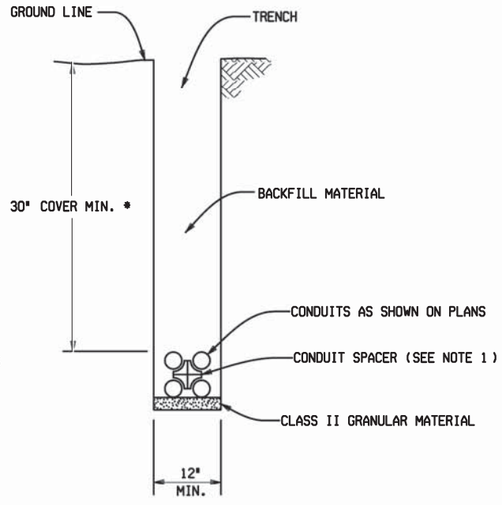
ALL CONDUIT INSTALLATION TO FOLLOW THESE MINIMUMS UNLESS OTHERWISE NOTED IN THE PLANS



SINGLE CONDUIT



TWO CONDUITS



FOUR CONDUITS

TRENCHED OR PLOWED-IN CONDUIT INSTALLATION

* 30" COVER IS THE MINIMUM. IN ADDITION, MINIMUM CLEARANCES MUST BE MAINTAINED ACCORDING TO THE MINIMUM CONDUIT CLEARANCE TABLE.

NOTES:

1. MORE THAN TWO CONDUITS INSTALLED IN THE SAME TRENCH SHALL BE SEPARATED USING CONDUIT SPACERS. THE SPACERS SHALL BE USED TO MAINTAIN 2" OF VERTICAL AND HORIZONTAL SEPARATION BETWEEN CONDUITS.
2. CONDUIT INSTALLATION LOCATION AND METHOD ARE SUBJECT TO ENGINEER APPROVAL PRIOR TO BEGINNING WORK.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

	DATE:11/10/2016	CS:84923	ITS DETAIL SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	CONDUIT DETAIL	MSDET 001	SECT 1 105
FILE:106329_Conduit_Detail.dgn	TSC: MUSKEGON				

The following items shall be labeling accordingly as they apply throughout the project.

Device Type	Device Type Abbreviation	Device Label Required
Air Conditioning	AC	
CCTV	CCTV	X
Cable Modem	CAMODM	X
Cellular Modem	CEMODM	X
Cabinet Monitor	CM	X
Controller, DMS	CNTR-DMS	X
Controller, Traffic Signal	CNTR-TS	X
Controller, Truck Parking Sign	CNTR-TP	X
Controller, Dynamic Trailblazing Panel	CNTR-DTP	X
Controller, Lane Control System	CNTR-LCS	X
Dehydrator	DHYD	X
Digital Video Encoder	DVE	X
Environmental Sensor, Air	ESAR	X
Environmental Sensor, Barometric Pressure	ESBP	X
Environmental Sensor, Precipitation	ESP	X
Environmental Sensor, Control Unit	ESS	X
Environmental Sensor, Sub-Surface	ESSS	
Environmental Sensor, Various	ESVR	X
Environmental Sensor, Visibility	ESVS	X
Environmental Sensor, Wind	ESWD	X
Ethernet Switch	ESW	X
Fiber Splice Enc.	FBRSP	X
Fiber Distribution Unit	FDU	X
Firewall	FW	X
I/O Module	IO	X
Media Converter	MEDIA	X
MVDS	MVDS	X
Power Supply, AC	PSAC	X
Power Supply, DC	PSDC	X
Radio	RADIO	X
Relay	RLY	X
Remote Processor Unit	RPU	X
Surge Suppression, AC	SGAC	X
Surge Suppression, CAT5	SGC5	X
Surge Suppression, Coax	SGCX	X
Surge Suppression, DC	SGDC	X
Surge Suppression, Serial	SGSR	X
UPS SNMP	SNMP	
Solar Panel	SOLAR	
Safety Switch	SSW	X
Switch	SWITCH	X
Terminal Server	TERM	X
Transformer	TRANS	
Lane Control Sign	LCS	X
Dynamic Trailblazing Sign	DTS	X
Truck Parking Sign	TPS	X
Travel Time Sign	TTS	X
Uninterruptible Power Supply	UPS	X
Variable Speed Sign	VSS	X
Radio - Wireless Interconnect Master	WIM	X
Radio - Wireless Interconnect Remote	WIR	X

Device Labeling

Label all devices in the ITS cabinet as shown in the table to the left. Include both the IP Address (for IP devices) and the site naming convention described below. Use ½" P-Touch label (vinyl) with black printing on white label, and a minimum font size of 5 point. Use the "ITS Common Name", excluding the cross street name, from the Asset Management Data Entry Form. Device #'s are only included for device with a device # greater than one (1).

1. ITS Field Devices Label: ITS Field Equipment ID to be the "ITS Common Name" from the Asset Management Data Entry Form.

   Examples:
   I94E-MM123.4-DVE2
   The second DVE at a site on EB I-94 at Mile Marker 123.4

   M10S-MM005.4-EWS
   The first Ethernet Switch on SB M-10 at Mile Marker 5.4

For sub-devices of a main device, power supply for MVDS, label as described below:

2. Sub Device for ITS Field Device Label: (ITS Sub-device) – (ITS Device)
   Examples:
   TERM-MVDS
   The Terminal Server 1 for MVDS1.

   PSDC2-CCTV
   The second DC power supply in the cabinet powering CCTV1.

ITS Cabinet Labeling

Label all ITS cabinets including splice cabinets per the MDOT Special Provision for "Basic Methods and Materials for Intelligent Transportation Systems Work". Use the "Site Common Name" from the Asset Management Data Entry Form

1. ITS Field Cabinet Label:
   Example:
   I94M-MM123.4
   The ITS Cabinet for a site at Mile Marker 123.4 in the median on I-94.

2. Splice Cabinet Label
   Example:
   I94E-MM123.4SP
   The Splice Cabinet for a site at Mile Marker 123.4 on eastbound I-94. The notation shall be used for pump stations and cabinets for the State of Michigan drop locations.

Cable Labeling

1. All cables starting and ending inside of the cabinet shall be labeled on both ends with an identical label. Use 1" for Cat5 cables or 1½" for fiber cable, self-laminating label (polyester or vinyl), and a minimum font size of 5 point. Labeling of other Cables inside of the ITS Cabinet shall follow the labeling scheme below.

   (Device From) – (Device To) — (Cable Type)
   Example:
   TERM-MVDS-TWP
   Twisted Pair cable from MVDS 1 to Terminal Server 1.

   Example:
   TERM3-MVDS2-TWP
   Twisted Pair cable from MVDS 2 to Terminal Server 3.

Cable Type	Cable Type Abbreviation
COMPOSITE CABLE	CC
TWISTED PAIR	TWP
SERIAL	RS-485 RS-422
COAXIAL	COAX
MULTIMODE FIBER	MMFO
SINGLEMODE FIBER	SMFO
POWER CABLE	AC-120/240V DC – xxV

2. Labeling of Ethernet (Cat5E) Cables in Cabinets

   Example:
   (Device From)- (Device To)-(Port #)
   UPS-ESW-04
   Cat5E cable from UPS 1 to Ethernet Switch 1, Port 4.

   (Device From)-(Sub-Device to)-(Device To)-(Port #)
   PSDC2-RADIO-ESW-06
   Cat5E cable from DC Power Supply 2 to Ethernet Switch 1, through Port 6, powering Radio 1.

Labeling Details for Fiber Deployments:

Fiber Device Description	Tape Size	# of Lines	Label Type	Example	Note
Patch Panel *	½"	1 Line	P Touch	FDU-PPA	Patch Panel A in Fiber Hardware Assembly 01
Patch Cord/Jumper** *	1½"	1 Line	Self-Laminating	FDU-A02-ESW-09-RX	Jumper cord from Patch Panel A, FDU 1, connector 02 to Ethernet Switch 01, Port 09, Receive (RX) fiber port.
Duplex Patch Cord/Jumper **	1½"	1 Line	Self-Laminating	FDU-C01/C02-ESW-10	Jumper from Patch Panel C1, connectors 01 and 02, to Ethernet Switch , Port 10.
Fiber Pigtail	1"	1 Line	Self-Laminating	BL-BL- W	Pigtail cable from the blue tube, blue fiber in the Fiber Optic Distribution Cable going west to cabinet 194E-MM122.4.
Fiber Distribution Cable	1½"	2 Lines	Self-Laminating	I94E-MM1234-I94E-MM1224-FODC-24	Fiber Optic Distribution cable 01 on I-94 between Cabinet I94E-MM123.4 and I94E-MM122.4, with 24 strands.
Fiber Trunk (Backbone) Cable	1½"	2 Lines	Self-Laminating	I94E-MM1234-I94E-MM1224-FOTC-60	Fiber Optic Trunk cable 01 on I-94 between Cabinet I94E-MM123.4 and I94E-MM122.4, with 60 strands.
Fiber Partner Agency Cable	1½"	2 Lines	Self-Laminating	I94E-MM1234-I94E-MM1224-FOPC-24	Fiber Optic Partner Agency cable 01 on I-94 between Cabinet I94E-MM123.4 and I94E-MM122.4, with 24 strands.

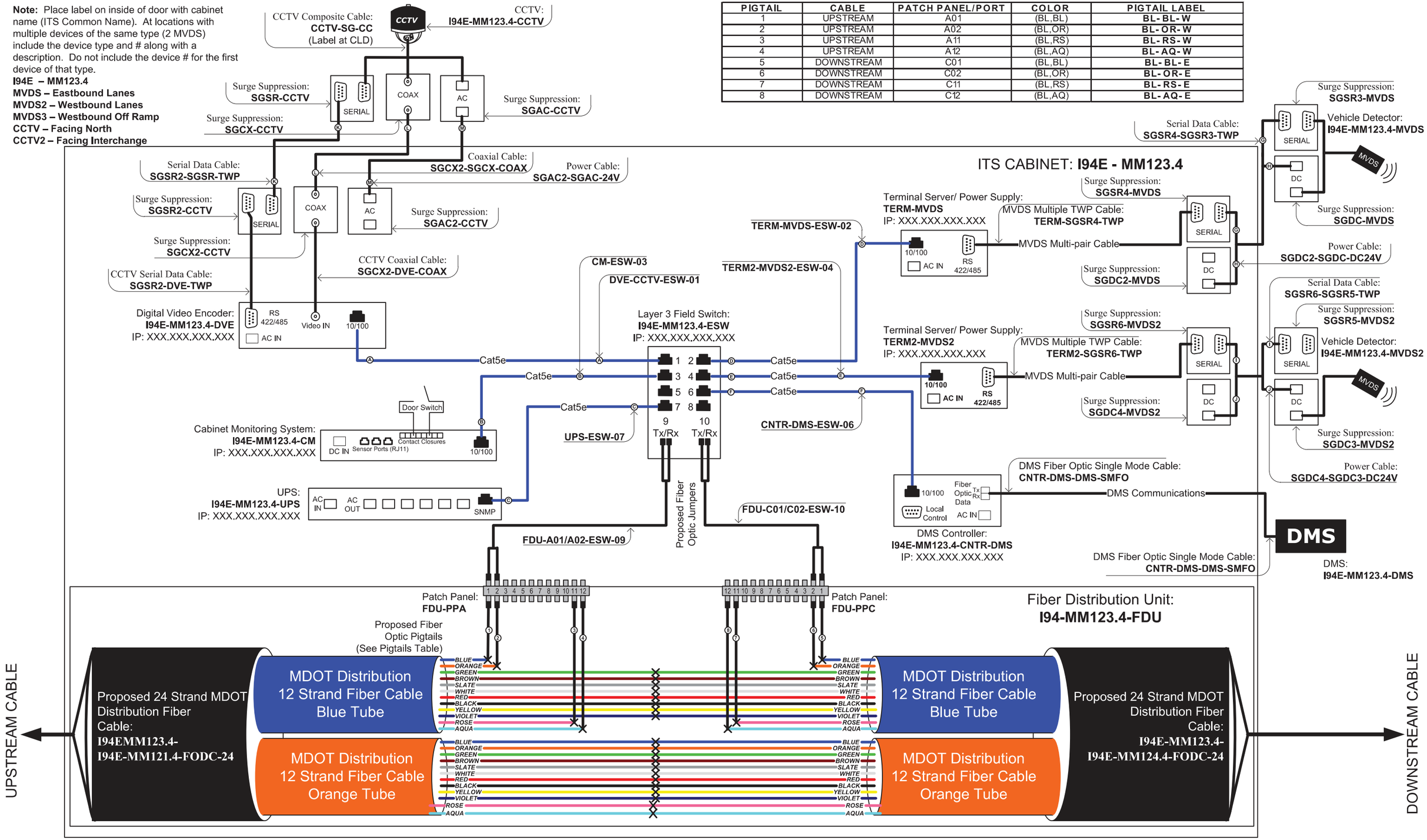
* Individual modules on the patch panel should be labeled and tied to key that references each port to a fiber strand.
** Note all jumpers shall be labeled on both ends with identical labels for easy tracking.

AS-LET PLAN REVISIONS								FOR INFORMATION ONLY	MDOT Michigan Department of Transportation	NO SCALE						
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION					DATE: 11/10/2016	CS: 84923	ITS Cabinet Labeling Scheme	DRAWING	SHEET
											PRINT DATE: 06/03/2016	DESIGN UNIT: PEPLINSKI	JN: 106329a		MSDET 002	SECT 1 106
											FILE: ITS Cabinet Labeling.pdf	TSC: MUSKEGON		1 of 2		

Note: Place label on inside of door with cabinet name (ITS Common Name). At locations with multiple devices of the same type (2 MVDS) include the device type and # along with a description. Do not include the device # for the first device of that type.

I94E – MM123.4
MVDS – Eastbound Lanes
MVDS2 – Westbound Lanes
MVDS3 – Westbound Off Ramp
CCTV – Facing North
CCTV2 – Facing Interchange

PIGTAIL	CABLE	PATCH PANEL/PORT	COLOR	PIGTAIL LABEL
1	UPSTREAM	A01	(BL,BL)	BL- BL- W
2	UPSTREAM	A02	(BL,OR)	BL- OR- W
3	UPSTREAM	A11	(BL,RS)	BL- RS- W
4	UPSTREAM	A12	(BL,AQ)	BL- AQ- W
5	DOWNSTREAM	C01	(BL,BL)	BL- BL- E
6	DOWNSTREAM	C02	(BL,OR)	BL- OR- E
7	DOWNSTREAM	C11	(BL,RS)	BL- RS- E
8	DOWNSTREAM	C12	(BL,AQ)	BL- AQ- E



AS-LET PLAN REVISIONS							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

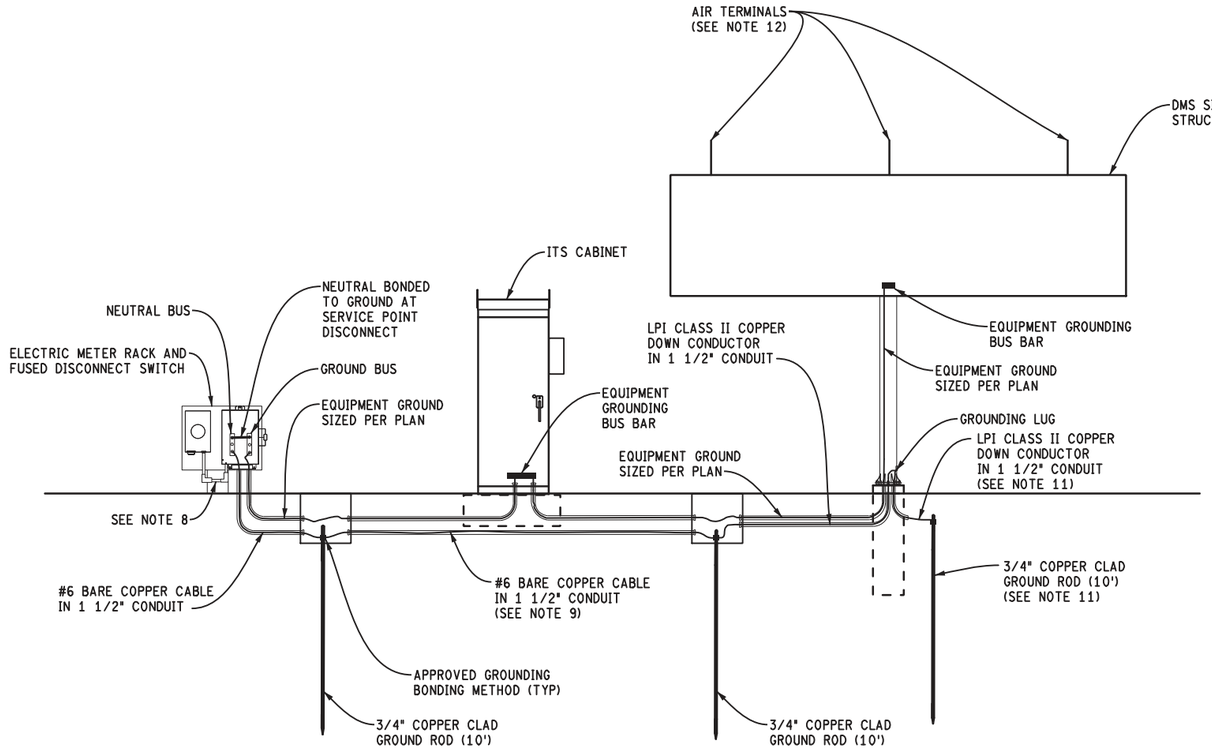
PRINT DATE: 5/18/2016
FILE: ITS Cabinet Labeling 2.pdf

DATE: 11/10/2016
DESIGN UNIT: PEPLINSKI
TSC: MUSKEGON

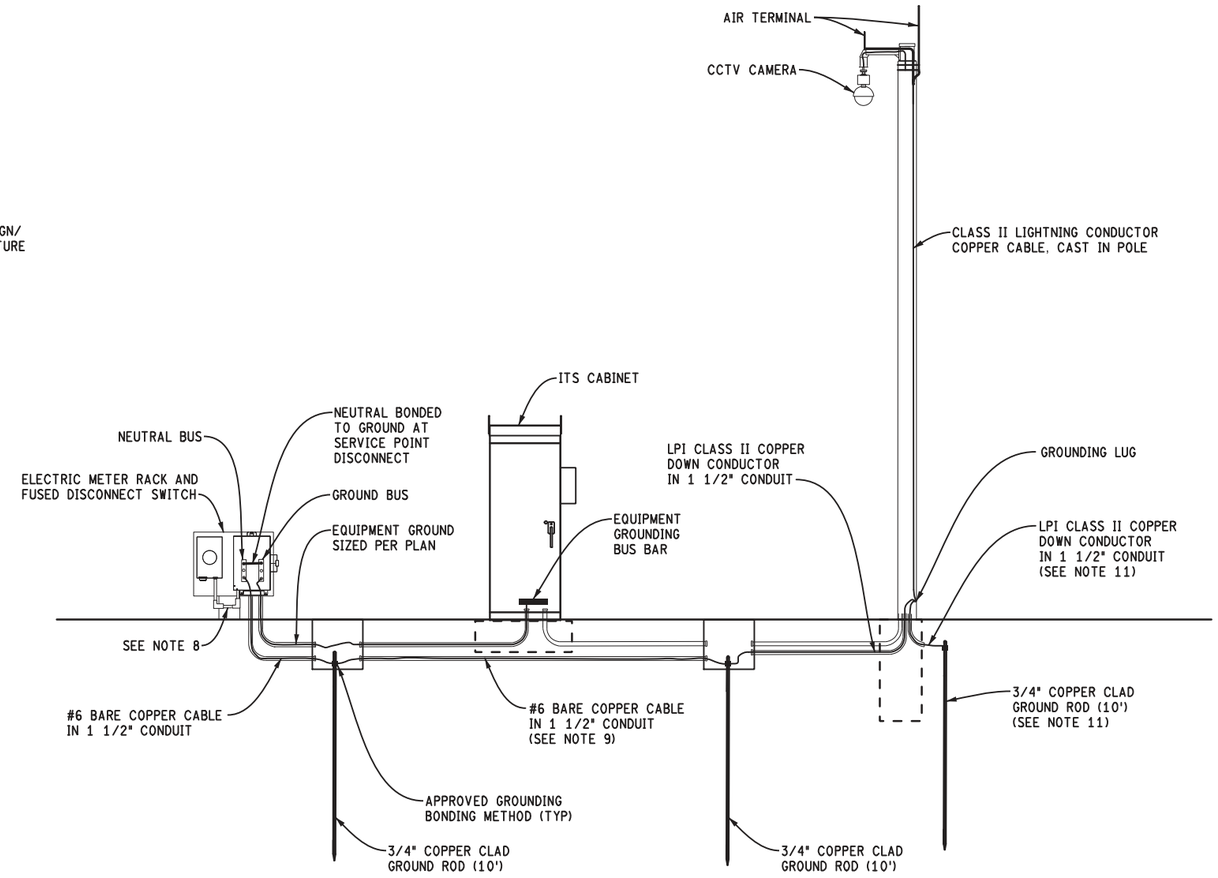
CS: 84923
JN: 106329A

ITS Cabinet Labeling Scheme
Example for I94E-MM123.4 on EB I-94
2 of 2

DRAWING: MSDET 003
SHEET: SECT 1 107



ITS (DMS) SITE GROUNDING



ITS (CCTV CAMERA) SITE GROUNDING

NOTES:

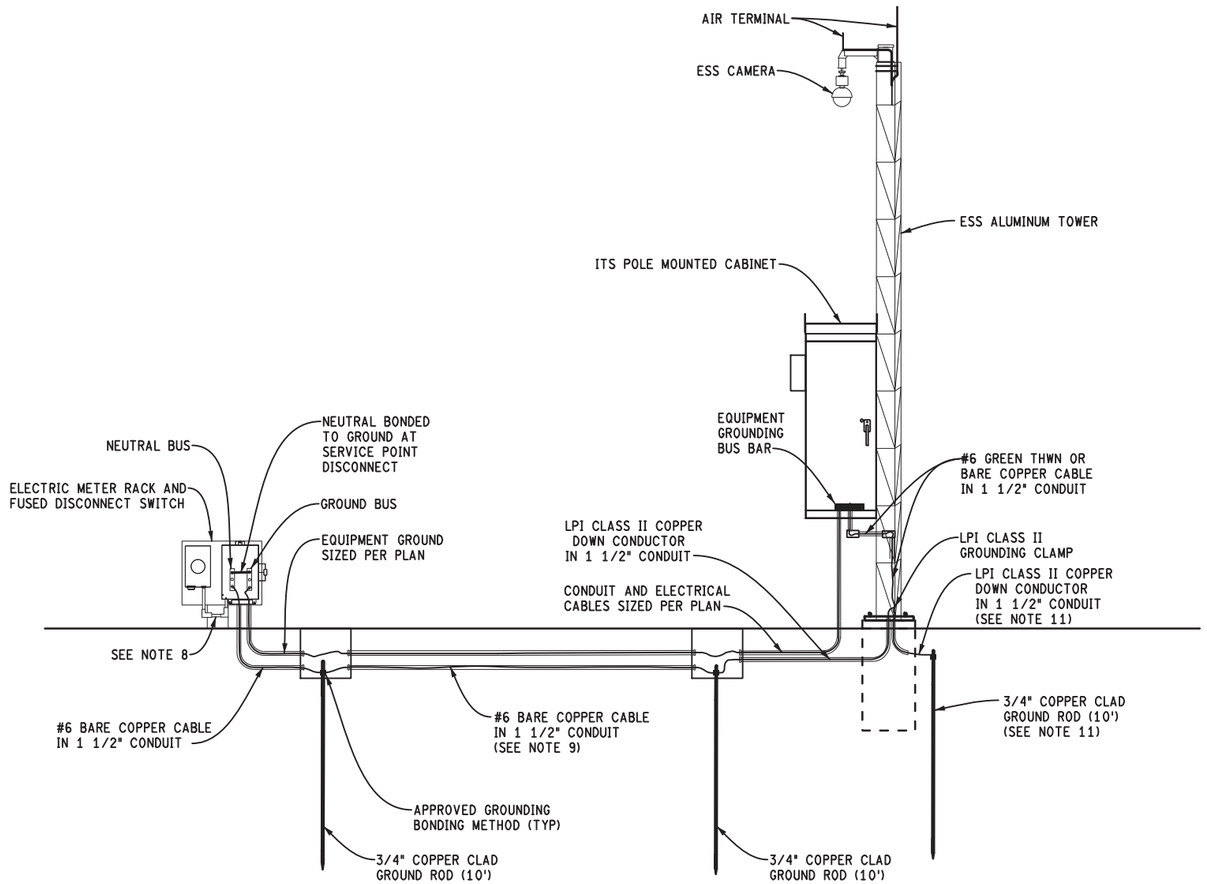
1. FENCES AND OTHER METALLIC STRUCTURES WITH PATHS TO GROUND SHALL BE CONNECTED TO THE GROUNDING CONDUCTOR IF THEY ARE LOCATED WITHIN 25' OF THE GROUNDING ELECTRODE SYSTEM OR ANY OBJECT GROUNDED TO THE GROUNDING ELECTRODE SYSTEM. GROUNDING ELECTRODE SYSTEM CONNECTIONS TO FENCING SHALL BE MADE USING HEAVY DUTY TINNED LISTED PIPE CLAMPS DESIGNED FOR GROUNDING, STAINLESS STEEL HARDWARE, AND #2 TINNED COPPER CABLE.
2. GROUND ROD ELECTRODES NOT INSIDE A HANDHOLE SHALL BE BURIED TO A MINIMUM DEPTH OF 12 INCHES BELOW FINISHED GRADE. GROUND ROD ELECTRODES AT HANDHOLES SHALL BE INSTALLED INSIDE AT THE BASE OF THE HANDHOLE, KEEPING THE CONNECTION TO GROUND WIRE VISIBLE.
3. ALL EQUIPMENT GROUNDS SHALL BE PROPERLY CONNECTED TO A CHASSIS: ALL PAINT AND OTHER COATINGS, INCLUDING GALVANIZATION, SHALL BE REMOVED PRIOR TO TERMINATION OF A GROUND. AFTER THE GROUND IS TERMINATED A NON-OXIDIZING COATING SHALL BE PAINTED OVER THE EXPOSED METAL SURFACES.
4. ALL GROUNDING DIAGRAMS ARE SCHEMATIC ONLY. DIAGRAM SHOWS MAIN BONDING JUMPERS, GROUNDING ELECTRODE CONDUCTORS, AND COMMON BONDING OF GROUNDING SYSTEMS. DIAGRAM DOES NOT SHOW THE GROUNDED CONDUCTOR (NEUTRAL) THAT IS ROUTED IN CONDUIT WITH POWER CONDUCTORS.
5. AT LEAST AN 8 INCH MINIMUM BENDING RADIUS SHALL BE MAINTAINED ON ALL LIGHTNING PROTECTION DOWN CONDUCTORS. THE ANGLE OF ANY BEND SHALL NOT BE MORE THAN 90 DEGREES.
6. LIGHTNING PROTECTION DOWN CONDUCTORS SHALL ALWAYS ROUTE AS STRAIGHT AS POSSIBLE.
7. WHENEVER POSSIBLE, LIGHTNING PROTECTION GROUND ROD ELECTRODES SHALL BE INSTALLED NO CLOSER THAN 2' FROM CONCRETE FOUNDATIONS.
8. RIGID GALVANIZED STEEL (RGS) CONDUIT MUST BE BONDED PER NEC AND LOCAL UTILITY REQUIREMENTS. USE OF BONDING BUSHINGS IS PREFERRED.
9. #6 COPPER BONDING CABLE AND 1 1/2" CONDUIT REQUIRED IF STRUCTURE OR POLE IS WITHIN 100 FEET OF THE METER RACK.
10. ALL BONDING CABLES MUST BE INSTALLED IN 1 1/2" SCHEDULE 80 PVC CONDUIT.
11. INSTALL ADDITIONAL GROUND ROD ELECTRODES AND LPI CLASS II COPPER DOWN CONDUCTOR AS NECESSARY TO MEET MINIMUM RESISTANCE REQUIREMENTS IN THE SPECIAL PROVISION FOR GROUNDING AND BONDING.
12. SEE DMS STRUCTURE DETAIL FOR CONNECTION OF AIR TERMINALS TO DMS HOUSING.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

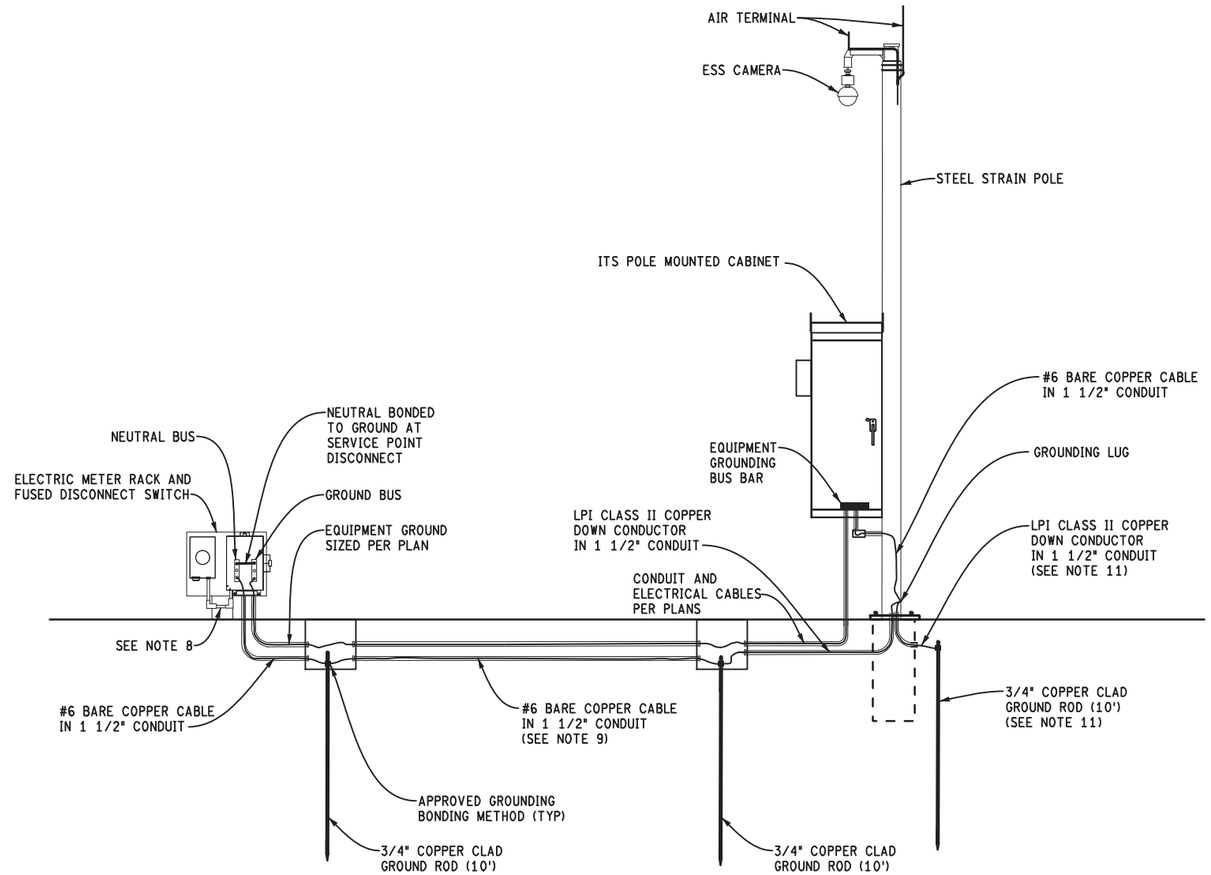
MDOT Michigan Department of Transportation

NO SCALE

	DATE: 11/10/2016	CS: 84923	ITS SITE GROUNDING AND BONDING	DRAWING / SHEET
PRINT DATE: 12/21/2015	DESIGN UNIT: PEPLINSKI	JN: 106329A		MSDET 004 / 108
FILE: Grounding and Bonding1.dgn	TSC: MUSKEGON		SHEET 1 OF 3	



ITS/ESS SITE GROUNDING TOWER MOUNTED CABINET



ITS/ESS SITE GROUNDING POLE MOUNTED CABINET

NOTES:

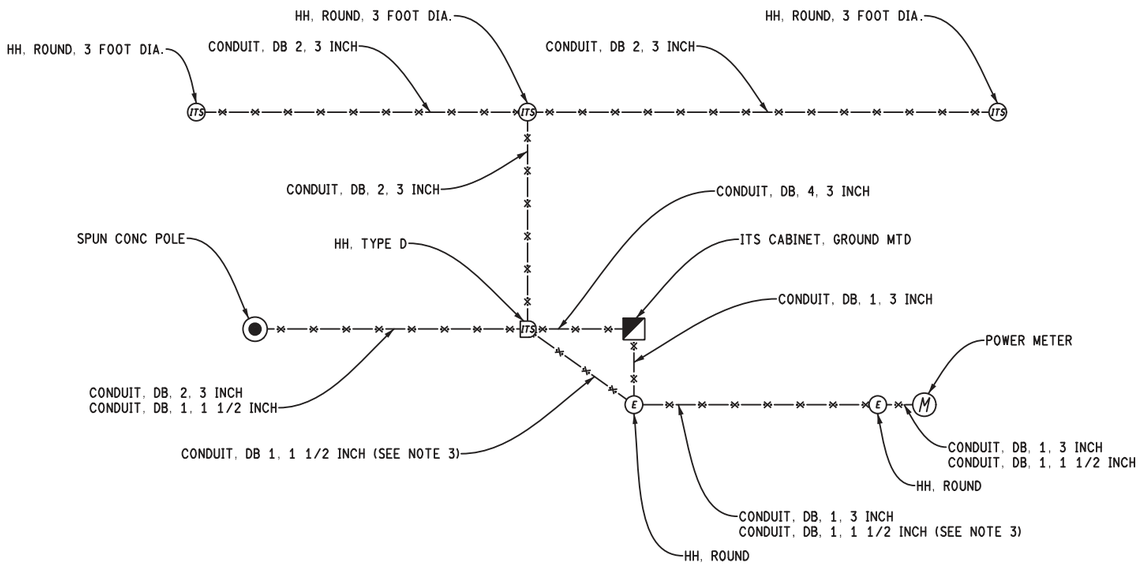
1. FENCES AND OTHER METALLIC STRUCTURES WITH PATHS TO GROUND SHALL BE CONNECTED TO THE GROUNDING CONDUCTOR IF THEY ARE LOCATED WITHIN 25' OF THE GROUNDING ELECTRODE SYSTEM OR ANY OBJECT GROUNDED TO THE GROUNDING ELECTRODE SYSTEM. GROUNDING ELECTRODE SYSTEM CONNECTIONS TO FENCING SHALL BE MADE USING HEAVY DUTY TINNED LISTED PIPE CLAMPS DESIGNED FOR GROUNDING, STAINLESS STEEL HARDWARE, AND #2 TINNED COPPER CABLE.
2. GROUND ROD ELECTRODES NOT INSIDE A HANDHOLE SHALL BE BURIED TO A MINIMUM DEPTH OF 12 INCHES BELOW FINISHED GRADE. GROUND ROD ELECTRODES AT HANDHOLES SHALL BE INSTALLED INSIDE AT THE BASE OF THE HANDHOLE, KEEPING THE CONNECTION TO GROUND WIRE VISIBLE.
3. ALL EQUIPMENT GROUNDS SHALL BE PROPERLY CONNECTED TO A CHASSIS: ALL PAINT AND OTHER COATINGS, INCLUDING GALVANIZATION, SHALL BE REMOVED PRIOR TO TERMINATION OF A GROUND. AFTER THE GROUND IS TERMINATED A NON-OXIDIZING COATING SHALL BE PAINTED OVER THE EXPOSED METAL SURFACES.
4. ALL GROUNDING DIAGRAMS ARE SCHEMATIC ONLY. DIAGRAM SHOWS MAIN BONDING JUMPERS, GROUNDING ELECTRODE CONDUCTORS, AND COMMON BONDING OF GROUNDING SYSTEMS. DIAGRAM DOES NOT SHOW THE GROUNDED CONDUCTOR (NEUTRAL) THAT IS ROUTED IN CONDUIT WITH POWER CONDUCTORS.
5. AT LEAST AN 8 INCH MINIMUM BENDING RADIUS SHALL BE MAINTAINED ON ALL LIGHTNING PROTECTION DOWN CONDUCTORS. THE ANGLE OF ANY BEND SHALL NOT BE MORE THAN 90 DEGREES.
6. LIGHTNING PROTECTION DOWN CONDUCTORS SHALL ALWAYS ROUTE AS STRAIGHT AS POSSIBLE.
7. WHENEVER POSSIBLE, LIGHTNING PROTECTION GROUND ROD ELECTRODES SHALL BE INSTALLED NO CLOSER THAN 2' FROM CONCRETE FOUNDATIONS.
8. RIGID GALVANIZED STEEL (RGS) CONDUIT MUST BE BONDED PER NEC AND LOCAL UTILITY REQUIREMENTS. USE OF BONDING BUSHINGS IS PREFERRED.
9. #6 COPPER BONDING CABLE AND 1 1/2" CONDUIT REQUIRED IF STRUCTURE OR POLE IS WITHIN 100 FEET OF THE METER RACK.
10. ALL BONDING CABLES MUST BE INSTALLED IN 1 1/2" SCHEDULE 80 PVC CONDUIT.
11. INSTALL ADDITIONAL GROUND ROD ELECTRODES AND LPI CLASS II COPPER DOWN CONDUCTOR AS NECESSARY TO MEET MINIMUM RESISTANCE REQUIREMENTS IN THE SPECIAL PROVISION FOR GROUNDING AND BONDING.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

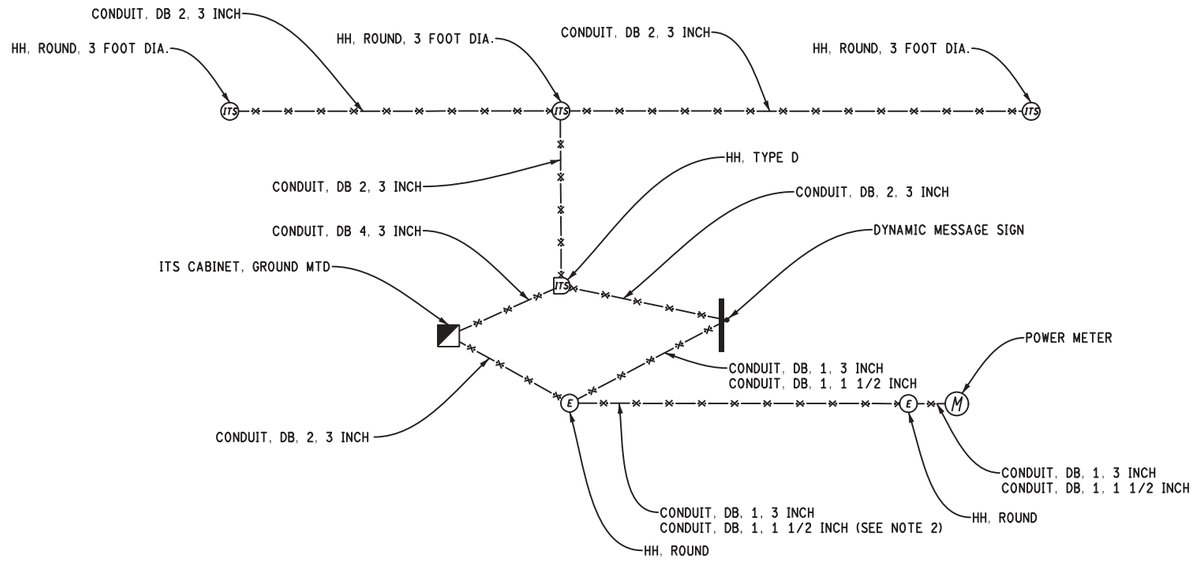
MDOT Michigan Department of Transportation

NO SCALE

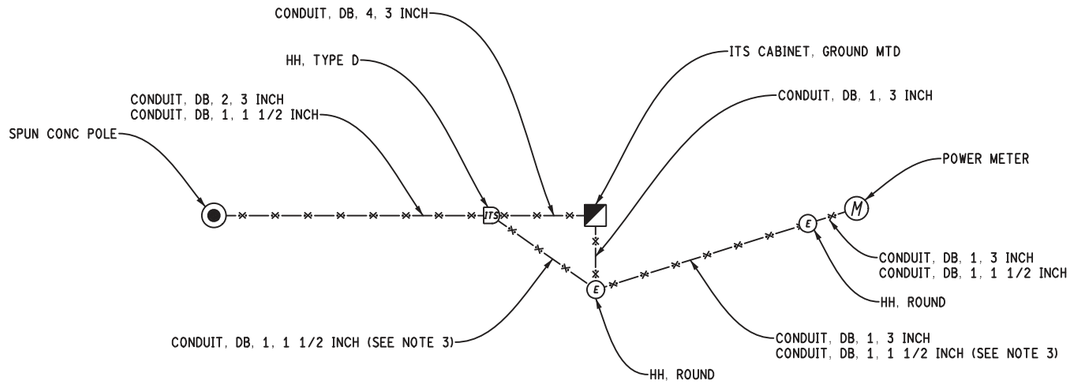
	DATE: 11/10/2016	CS: 84923	ITS SITE GROUNDING AND BONDING	DRAWING	SHEET
PRINT DATE: 12/21/2015	DESIGN UNIT: PEPLINSKI	JN: 106329A		MSDET 005	109
FILE: Grounding and Bonding1.dgn	TSC: MUSKEGON		SHEET 2 OF 3		



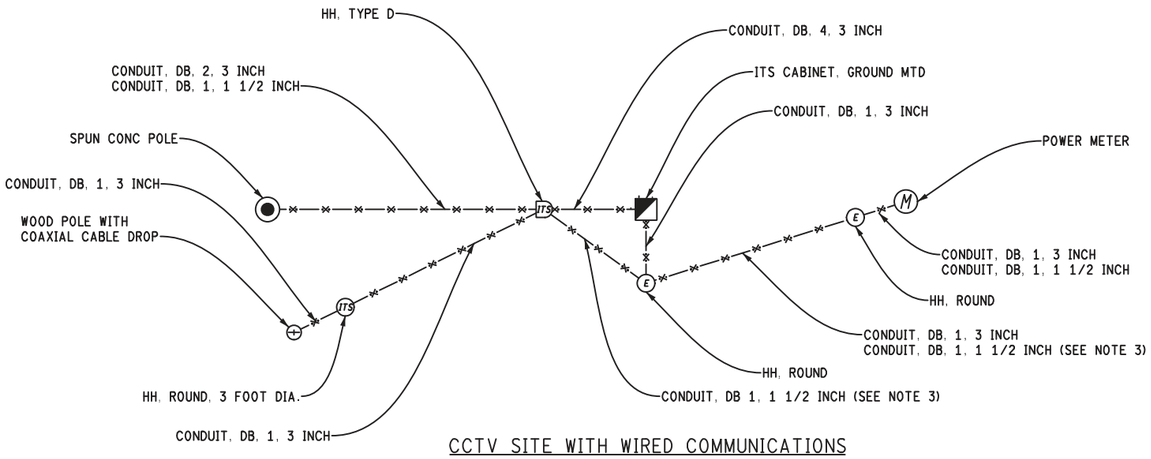
CCTV SITE WITH FIBER NETWORK



DMS SITE WITH FIBER NETWORK



CCTV SITE WITH WIRELESS COMMUNICATIONS



CCTV SITE WITH WIRED COMMUNICATIONS

NOTES
1. $1\frac{1}{2}$ INCH CONDUIT TO BE USED FOR BONDING CABLE.
2. INSTALL $1\frac{1}{2}$ INCH CONDUIT FOR BONDING CABLE IF DMS STRUCTURE IS WITHIN 100 FEET OF THE POWER METER RACK.
3. INSTALL $1\frac{1}{2}$ INCH CONDUIT FOR BONDING CABLE IF SPUN CONCRETE POLE IS WITHIN 100 FEET OF THE POWER METER RACK.

TYPICAL ITS SITE CONDUIT LAYOUTS FOR BONDING CABLE

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

PRINT DATE: 12/21/2015
FILE: Grounding and Bonding2.dgn

DATE: 11/10/2016
DESIGN UNIT: PEPLINSKI
TSC: MUSKEGON

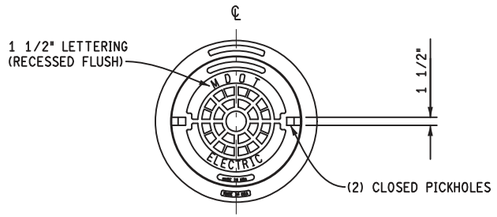
CS: 84923
JN: 106329A

ITS SITE GROUNDING AND BONDING

SHEET 3 OF 3

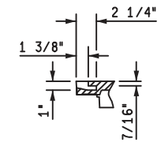
DRAWING: MSDET 006

SHEET: SECT 1 110



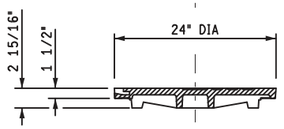
ITS ELECTRIC (ELEC) HANDHOLE COVER

NOT TO SCALE



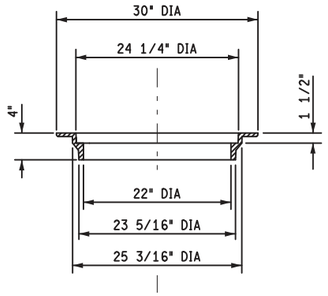
COVER PICKHOLE SECTION

NOT TO SCALE



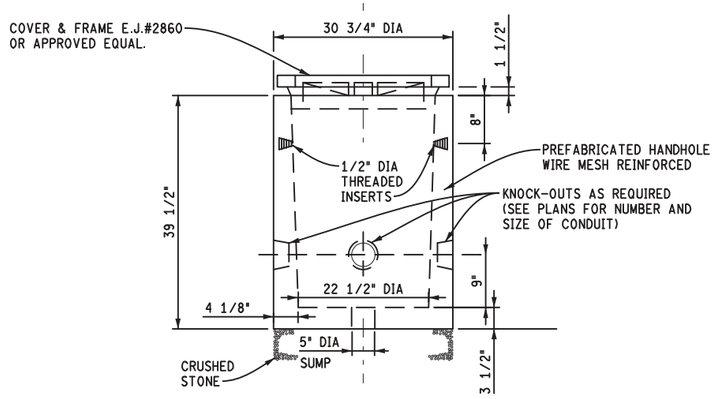
COVER SECTION

NOT TO SCALE



FRAME SECTION

NOT TO SCALE



SIDE VIEW OF ROUND HANDHOLE

NOT TO SCALE

NOTES:

1. PROVIDE HANDHOLE AND COVER MEETING THE REQUIREMENTS OF AASHTO HS 20 FOR WHEEL LOADING.
2. CURRENT COVER AND FRAME FOR ROUND HANDHOLES ARE EAST JORDAN IRON WORKS PART NO. 2860 (COVER) AND 1120 (FRAME) OR APPROVED EQUAL. A.S.T.M. CLASS 30 GRAY IRON, HEAVY DUTY. APPROX. WT. 250 LB.
3. REFER TO CONSTRUCTION SHEETS FOR TYPE (COMM OR ELEC) OF COVER FOR EACH HANDHOLE.

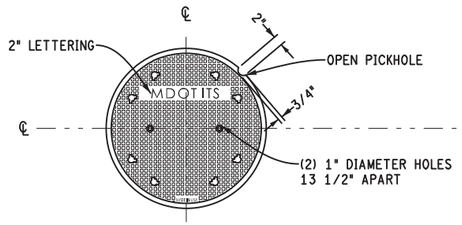
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

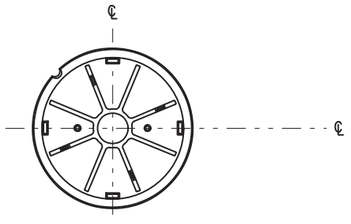
	DATE: 11/10/2016	CS: 84923	HANDHOLE, ROUND (ELECTRIC)
PRINT DATE: 6/13/2014	DESIGN UNIT: PEPLINSKI	JN: 106329A	
FILE: Handhole, Round.dgn	TSC: MUSKEGON		SHEET 1 OF 1

DRAWING	SHEET
MSDET 007	SECT 1 111



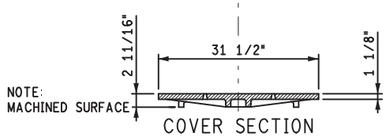
TOP VIEW OF COVER

NOT TO SCALE



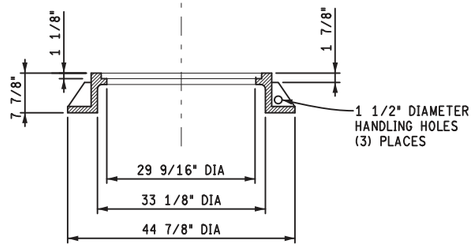
BOTTOM VIEW OF COVER

NOT TO SCALE



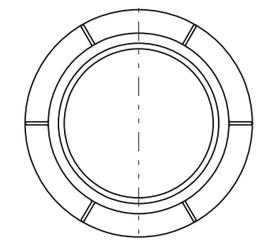
COVER SECTION

NOT TO SCALE



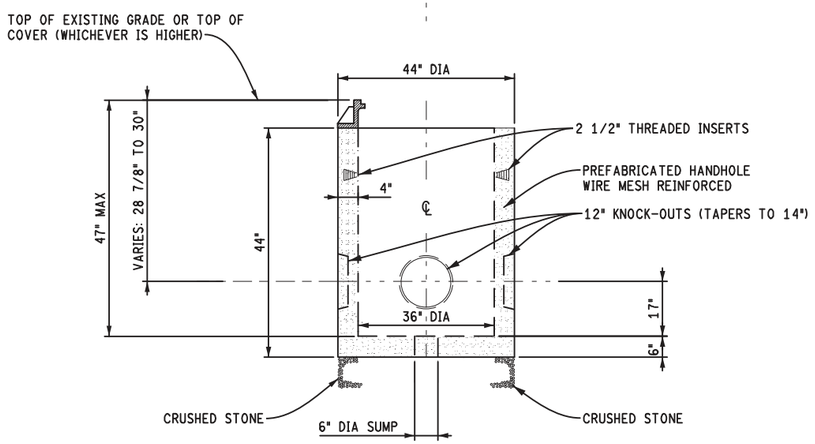
FRAME SECTION

NOT TO SCALE



TOP VIEW OF FRAME

NOT TO SCALE



36" DIAMETER ROUND HANDHOLE SECTION

NOT TO SCALE

NOTES:

1. PROVIDE HANDHOLE AND COVER MEETING THE REQUIREMENTS OF AASHTO HS 25 FOR WHEEL LOADING.

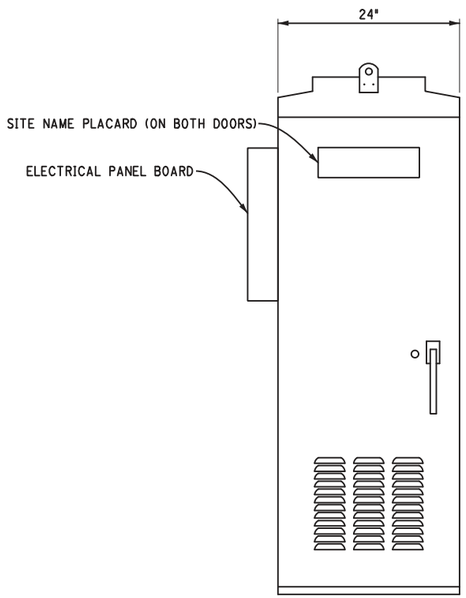
2. CURRENT COVER AND FRAME FOR 36" ROUND HANDHOLES ARE EAST JORDAN IRON WORKS PART NO. 1220 OR APPROVED EQUAL, A.S.T.M. CLASS 30 GRAY IRON, HEAVY DUTY, APPROX. WT. 685#.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

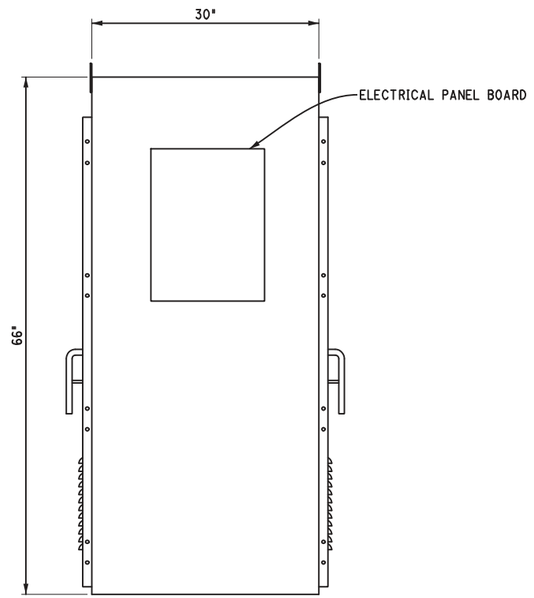
MDOT Michigan Department of Transportation

NO SCALE

	DATE: 11/10/2016	CS: 84923	HANDHOLE, ROUND, 3 FOOT DIA.	DRAWING / SHEET
PRINT DATE: 6/13/2014	DESIGN UNIT: PEPLINSKI	JN: 106329A		MSDET 008 / SECT 1
FILE: Handhole, Round, 3 foot dia.dgn	TSC: MUSKEGON		SHEET 1 OF 1	112

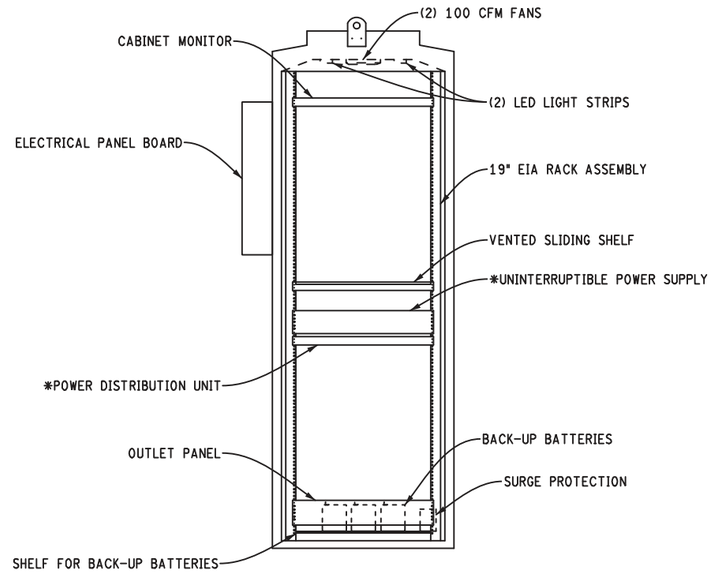


ELEVATION (FRONT)



ELEVATION (SIDE)

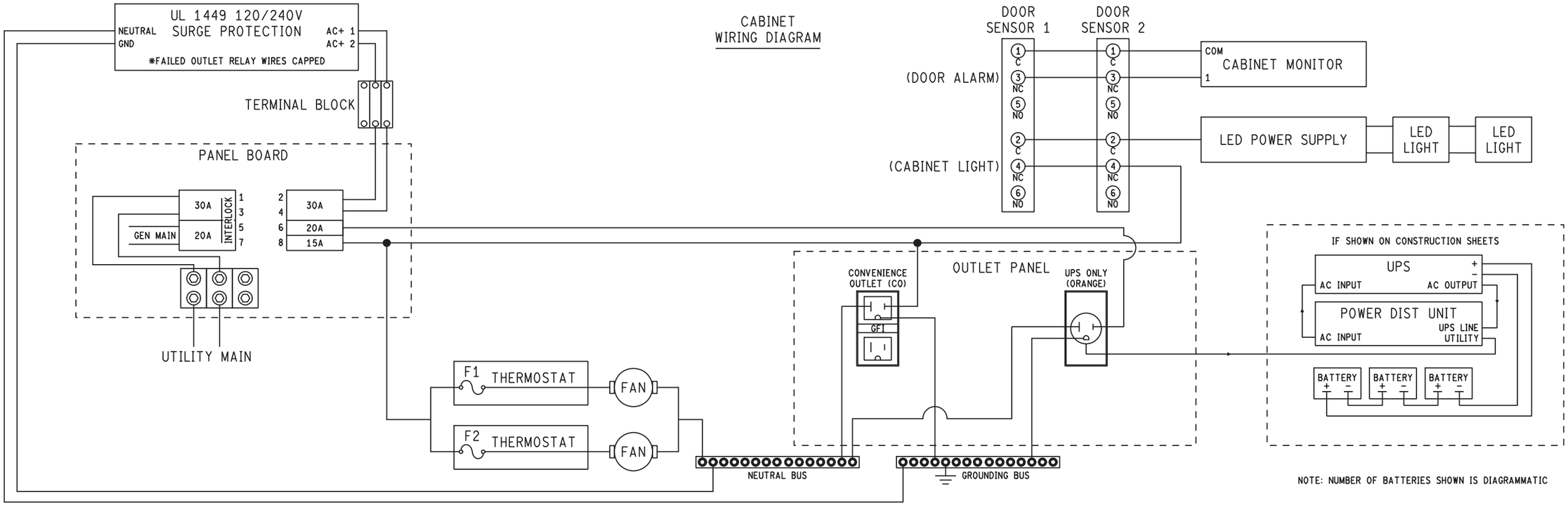
NOTE: REQUIRED SUNSHIELD NOT SHOWN FOR CLARITY.



CABINET EQUIPMENT CONFIGURATION (FRONT)

*IF SHOWN ON CONSTRUCTION SHEETS

CABINET WIRING DIAGRAM



NOTE: NUMBER OF BATTERIES SHOWN IS DIAGRAMMATIC

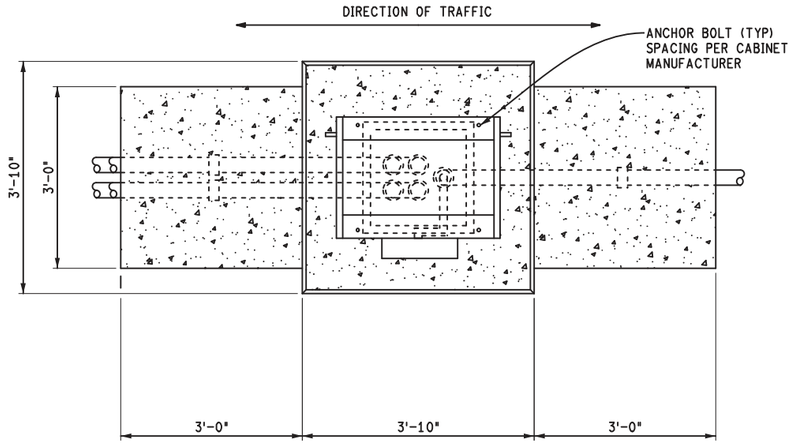
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

PRINT DATE: 6/13/2014	DATE: 11/10/2016	CS: 84923	ITS CABINET, GROUND-MOUNTED
FILE: ITS Cabinet, Ground-Mounted 1.dgn	DESIGN UNIT: PEPLINSKI	JN: 106329A	SHEET 1 OF 2
	TSC: MUSKEGON		

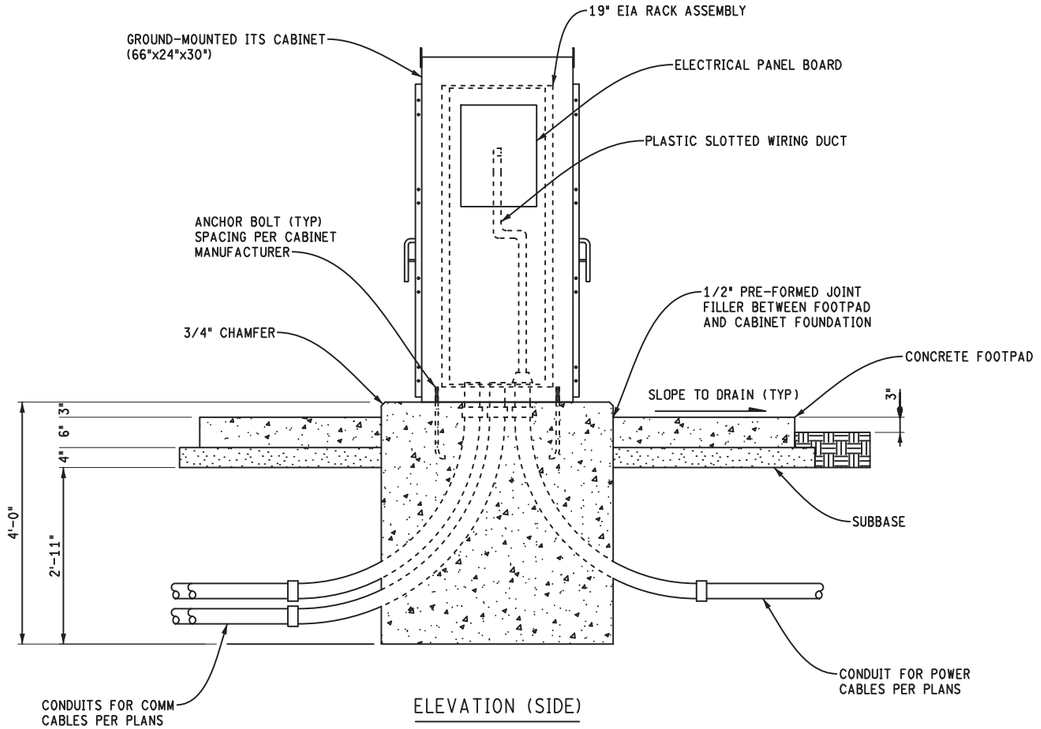
DRAWING	SHEET
MSDET 009	SECT 1 113



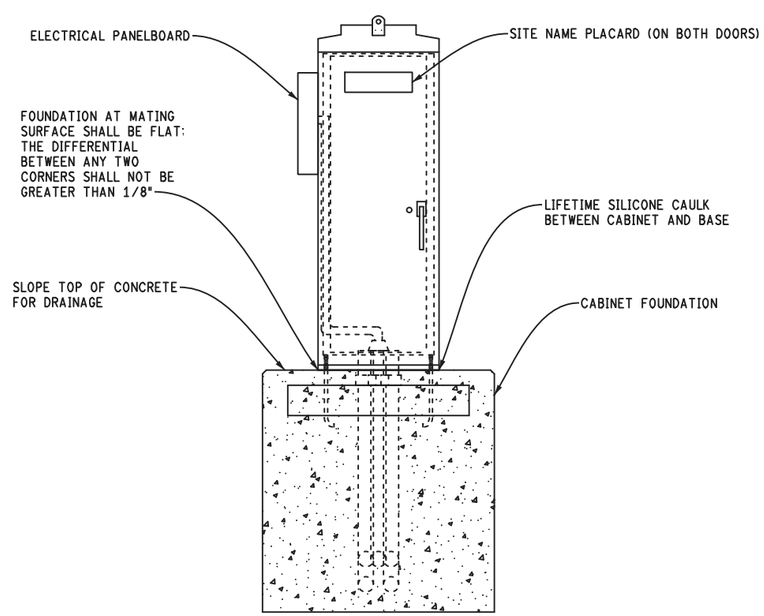
PLAN VIEW

NOTES:

1. ADJUST THE ELEVATIONS OF CONCRETE FOOTPADS TO MEET THE SITE CONDITIONS.
2. COMPACT THE SOIL BENEATH THE CONCRETE FOOTPAD AND AGGREGATE IN PLACE WITH A PLATE COMPACTOR OR OTHER COMPACTION METHOD APPROVED BY THE ENGINEER. PRIOR TO PLACING THE AGGREGATE.
3. CONSTRUCT FOUNDATION PER 2012 STANDARD SPECIFICATIONS FOR CONSTRUCTION, SECTION 820.03 (D).
4. INSTALL THE NUMBER, SIZE, AND TYPE OF CONDUIT(S) FOR COMMUNICATIONS AND POWER AS SHOWN IN THE PLANS. DETERMINE THE APPROACH/ENTRY ANGLE TO FOUNDATION BASED ON SITE CONDITIONS. THE NUMBER AND LOCATION OF CONDUIT SWEEPS SHOWN IN THIS THIS DRAWING ARE DIAGRAMMATIC.



ELEVATION (SIDE)



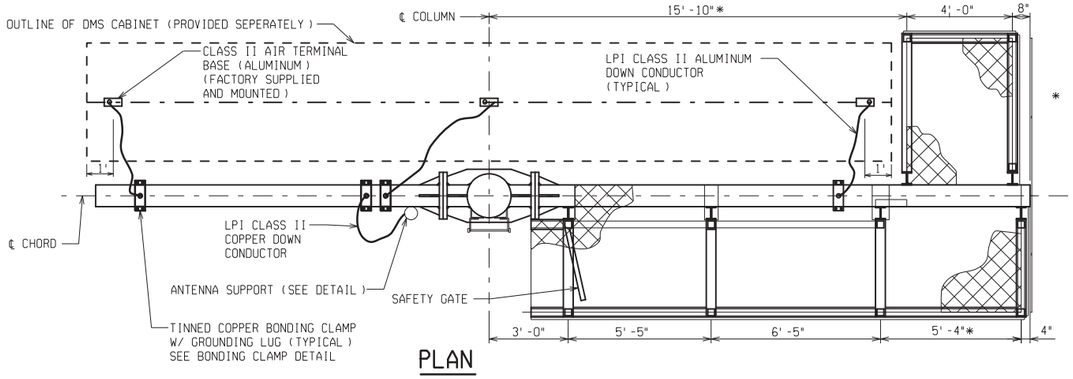
ELEVATION (FRONT)

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

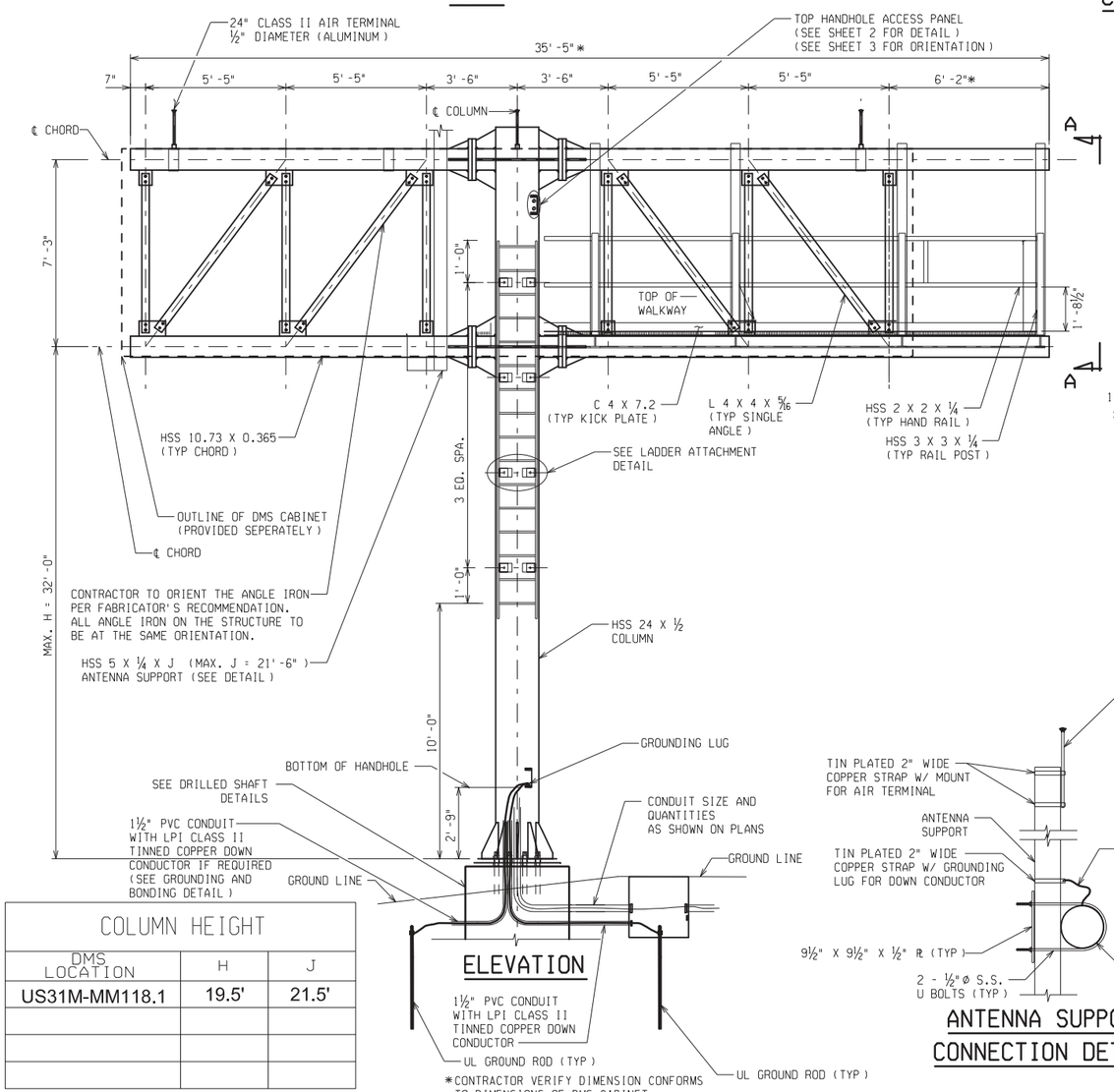
MDOT Michigan Department of Transportation

NO SCALE

	DATE: 11/10/2016	CS: 84923	ITS CABINET, GROUND-MOUNTED	DRAWING / SHEET
PRINT DATE: 6/13/2014	DESIGN UNIT: PEPLINSKI	JN: 106329A		MSDET 010 / SECT 1
FILE: ITS Cabinet, Ground-Mounted 2.dgn	TSC: MUSKEGON		SHEET 2 OF 2	114

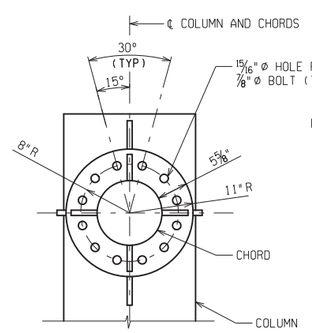


PLAN

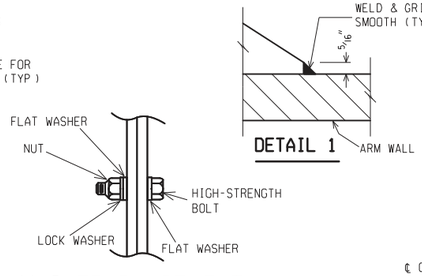


ELEVATION

COLUMN HEIGHT		
DMS LOCATION	H	J
US31M-MM118.1	19.5'	21.5'

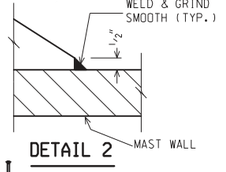


CHORD FLANGE PLATE DETAIL

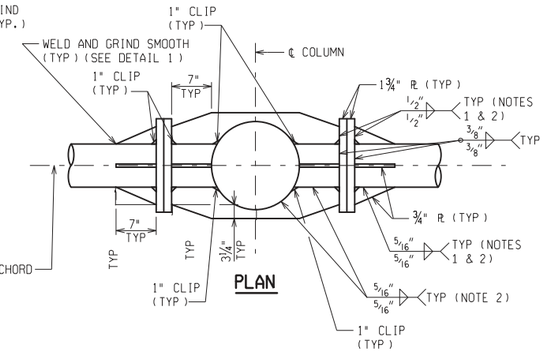


WASHER PLACEMENT

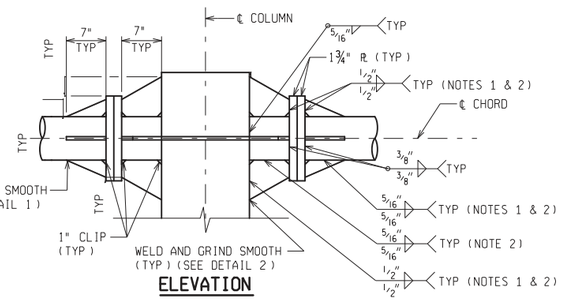
DETAIL 1



DETAIL 2



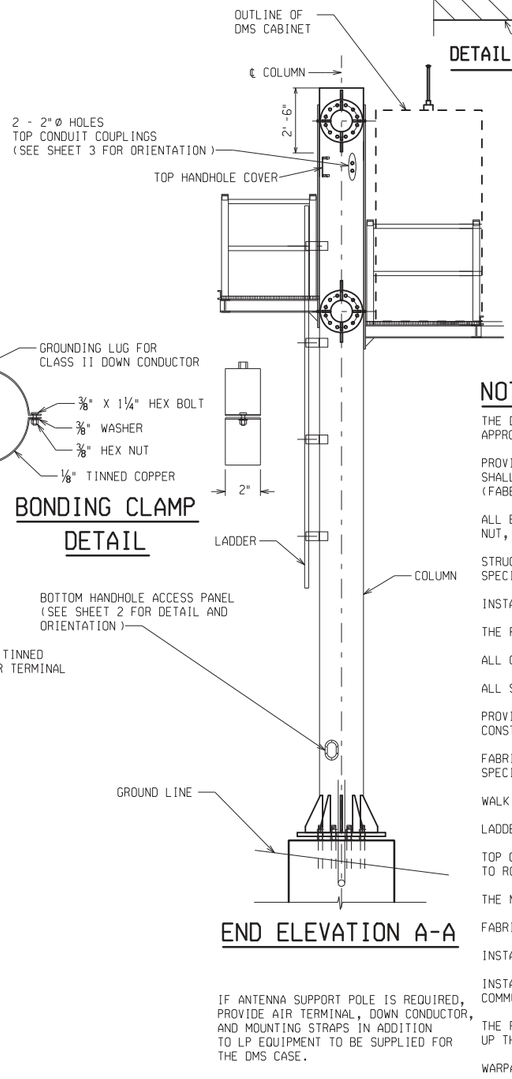
PLAN



ELEVATION

* NOTE 1: WRAP WELD AROUND OUTSIDE EDGE. NOTE 2: STOP WELD ¼" SHORT OF 1" CORNER CLIP.

CHORD CONNECTION DETAILS



BONDING CLAMP DETAIL

END ELEVATION A-A

ANTENNA SUPPORT CONNECTION DETAIL

IF ANTENNA SUPPORT POLE IS REQUIRED, PROVIDE AIR TERMINAL, DOWN CONDUCTOR, AND MOUNTING STRAPS IN ADDITION TO LP EQUIPMENT TO BE SUPPLIED FOR THE DMS CASE.

NOTES:

THE DESIGN OF THE CONNECTION OF THE DMS CABINET MOUNTING POSTS TO TRUSS CHORDS SHALL BE SUBMITTED FOR APPROVAL.

PROVIDE GALVANIZED STEEL, SELF-CLOSING SAFETY GATE, MOUNTED TO HANDRAIL PER MFR DIRECTION. STEEL SHALL BE ASTM A36 MATERIAL GALVANIZED PER ASTM A123. ADJUST STOP BOLTS TO ASSURE PROPER CLOSING. (FABENCO. INC MODEL A71-27 OR EQUAL)

ALL BOLTS SHALL BE ⅞ INCH DIAMETER A325 GALVANIZED WITH 3/16INCH THICK WASHER AND ⅞ INCH DIAMETER NUT, UNLESS NOTED OTHERWISE.

STRUCTURAL STEEL, BOLTS, WELDING, AND GALVANIZING SHALL BE ACCORDING TO THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MDOT SPECIAL PROVISION 03SP707(A).

INSTALL VENT HOLES AS REQUIRED FOR GALVANIZING.

THE PIPE MATERIAL SHALL MEET THE REQUIREMENTS OF API 5L, GRADE X52.

ALL OTHER STRUCTURAL STEEL SHALL BE ASTM A-36, UNLESS OTHERWISE NOTED.

ALL STEEL, INCLUDING BAR GRATING, SHALL BE HOT DIP GALVANIZED PER ASTM 123 OR 153, AS APPLICABLE.

PROVIDE ANCHOR BOLTS IN ACCORDANCE WITH SECTIONS 908.14 A & B OF THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

FABRICATION AND ERECTION SHALL BE ACCORDING TO SECTIONS 707 AND 810.03 OF THE CURRENT MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

WALK PLATFORM SHALL NOT BE LIFTED BY HANDRAILS OR POSTS. TRUSS SHALL NOT BE LIFTED BY WEB MEMBERS.

LADDER SHALL BE EQUIPPED WITH A SAFETY RAIL SYSTEM APPROVED BY THE ENGINEER.

TOP OF THE ANTENNA SUPPORT SHALL BE SEALED WITH A TENON. CONTRACTOR TO VERIFY WITH ENGINEER METHOD TO ROUTE WIRE TO THE INTERIOR OF THE ANTENNA SUPPORT SUCH THAT A WATER TIGHT SEAL IS MAINTAINED.

THE MAXIMUM PERMISSIBLE SIGN AREA IS 285 SQFT.

FABRICATOR MUST BE AISC SIMPLE BRIDGE (SBR) OR AISC BRIDGE & HIGHWAY METAL COMPONENT CERTIFIED.

INSTALL RODENT SCREEN BETWEEN THE BASE PLATE AND TOP OF FOUNDATION.

INSTALL A FLEXIBLE CONDUIT IN THE DMS SUPPORT STRUCTURE CENTER COLUMN TO SEPARATE POWER AND COMMUNICATIONS CABLING.

THE FLANGES SHALL BE WELDED TO ASSURE OBTAINING FULL CONTACT IN THE RELAXED POSTION PRIOR TO SNUGGING UP THE FLANGE BOLTS. THE FLANGE BOLTS SHALL NOT BE TORQUED IN AN ATTEMPT TO CLOSE.

WARPAGE IN THE BASE PLATE SHALL NOT EXCEED 1/16" PER FOOT.

AS-LET PLAN REVISIONS							
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JN: 106329A

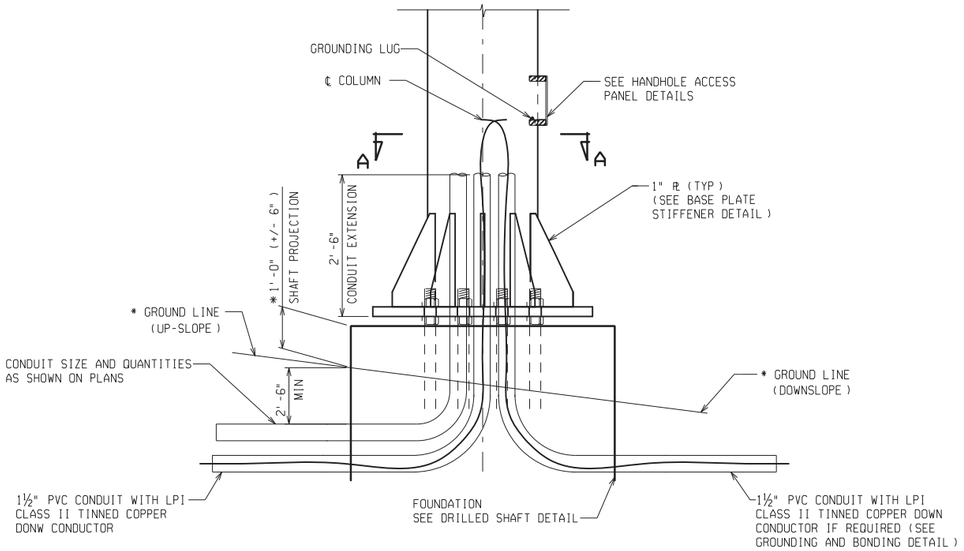
DMS SIGN SUPPORT

LEFT SIDE ENTRANCE

SHEET 1 OF 4

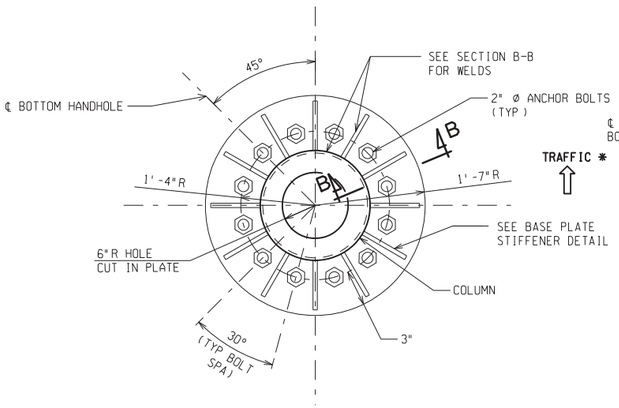
DRAWING: MSDET 011

SHEET: SECT 1 115



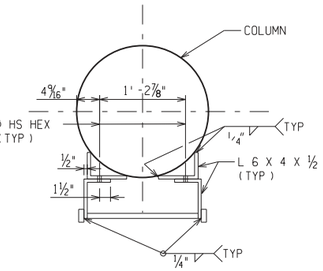
BASE PLATE ELEVATION

* THE SLOPE OF THE GROUND LINE AND MIN. SHAFT PROJECTION ARE FOR THE TYPE A DRILLED SHAFT. REFER TO SHEET 4 FOR DETAILS ON THE TYPE B DRILLED SHAFT.

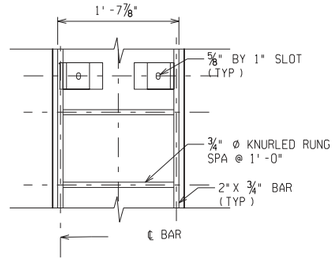


SECTION A-A

* POSITION BASE PLATE AND ANCHOR BOLTS SO THAT THE SIGN FACE IS ROTATED TOWARD TRAFFIC AT THE ANGLE SPECIFIED IN THE PLANS.

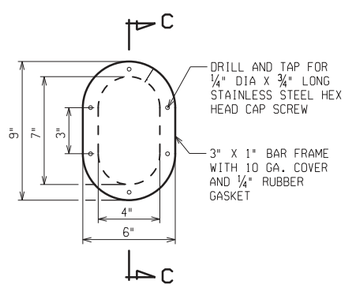


PLAN

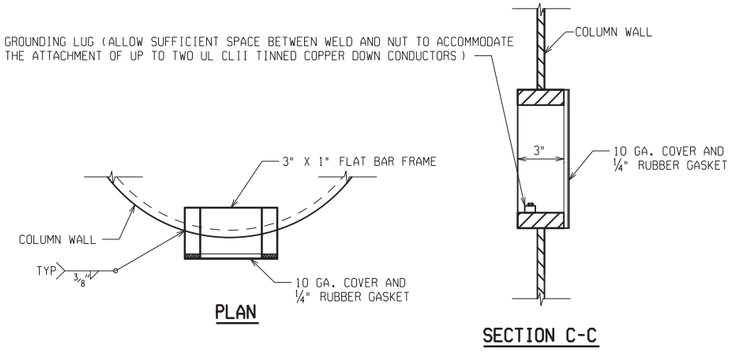


ELEVATION

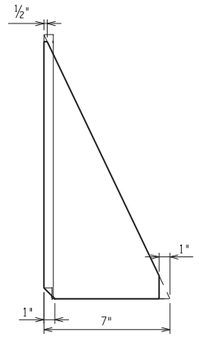
LADDER ATTACHMENT DETAILS



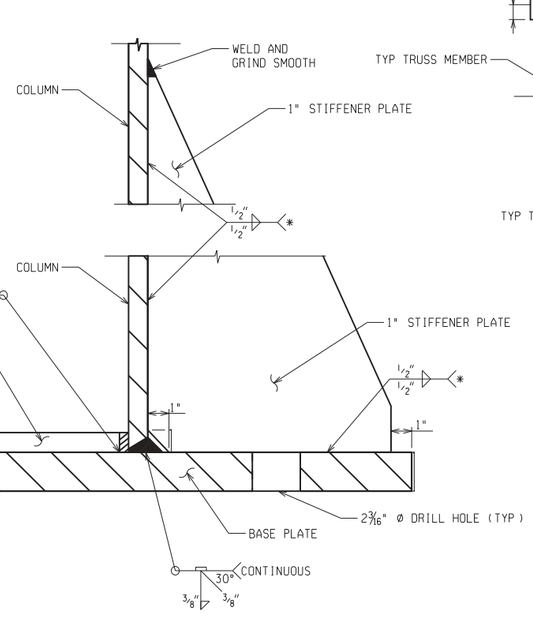
ELEVATION



HANDHOLE DETAILS

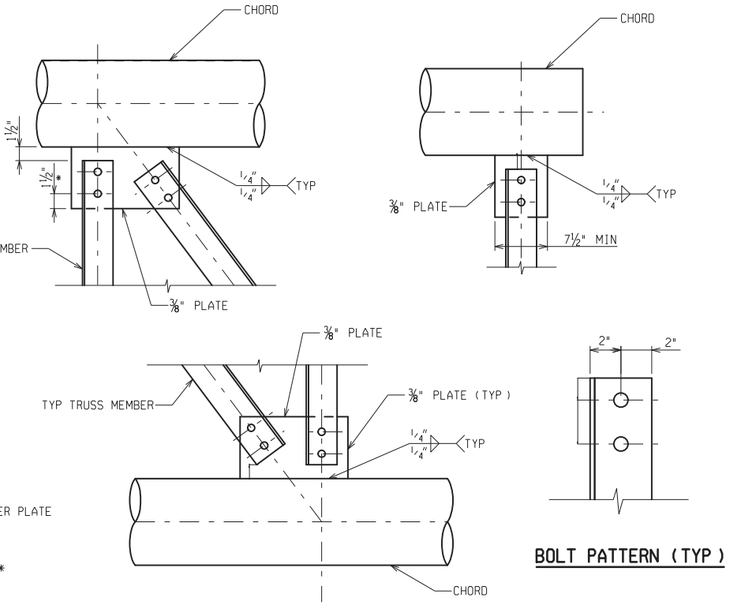


BASE PLATE STIFFENER



SECTION B-B

* WRAP WELD AROUND OUTSIDE EDGE. STOP WELD ¼" FROM CORNER CLIP



BOLT PATTERN (TYP)

GUSSET PLATE CONNECTIONS

* TYPICAL MINIMUM EDGE DISTANCE

GROUNDING LUG (ALLOW SUFFICIENT SPACE BETWEEN WELD AND NUT TO ACCOMMODATE THE ATTACHMENT OF UP TO TWO UL CLII TINNED COPPER DOWN CONDUCTORS)

BONDING CLAMP INSTALLATION

1. REMOVE GALVANIZING FROM SURFACE OF CHORD WHERE BONDING WILL TAKE PLACE.
2. AFTER GALVANIZING IS REMOVED APPLY CONDUCTIVE GREASE COMPOUND TO SURFACE.
3. ATTACH BONDING CLAMP TO THE CHORD, REMOVE EXCESS COMPOUND.
4. AFTER BONDING CLAMP HAS BEEN SECURED, APPLY COLD GALVANIZING PAINT. (SPRAY PAINT SHALL NOT BE ALLOWED)

AS-LET PLAN REVISIONS							
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1							
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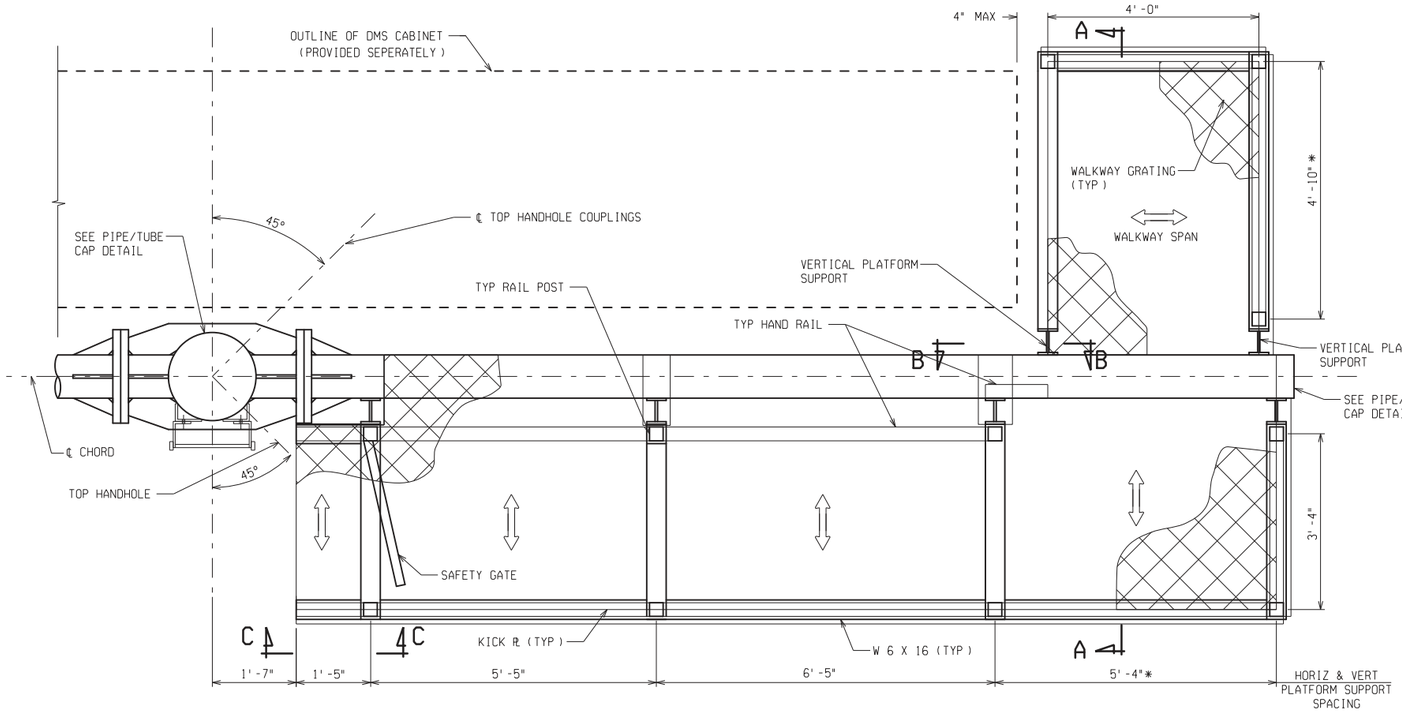
DMS SIGN SUPPORT

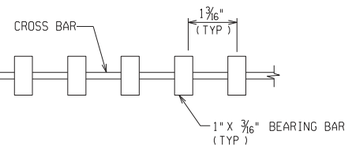
LEFT SIDE ENTRANCE

SHEET 2 OF 4

DRAWING	SHEET
MSDET 012	SECT 1 116

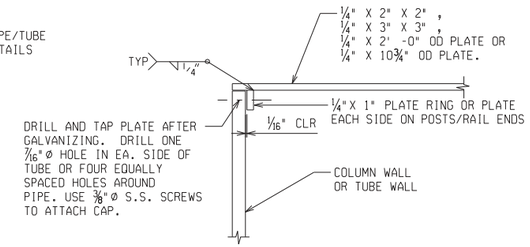


PLATFORM PLAN

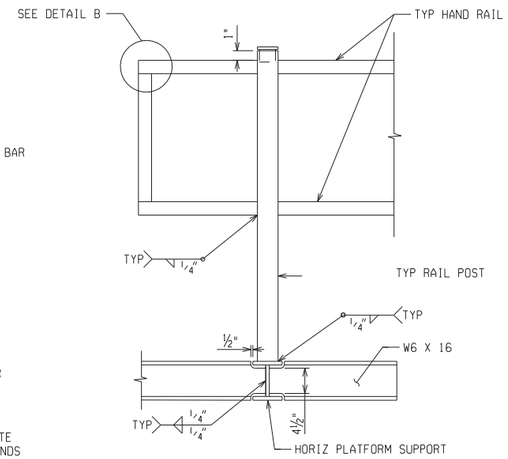


WALKWAY GRATING

ATTACH GRATING TO W6 X 16 MEMBER WITH GALVANIZED FASTENERS APPROVED BY ENGINEER, 2 MIN PER W6 X 16 MEMBER PER GRATING PIECE.

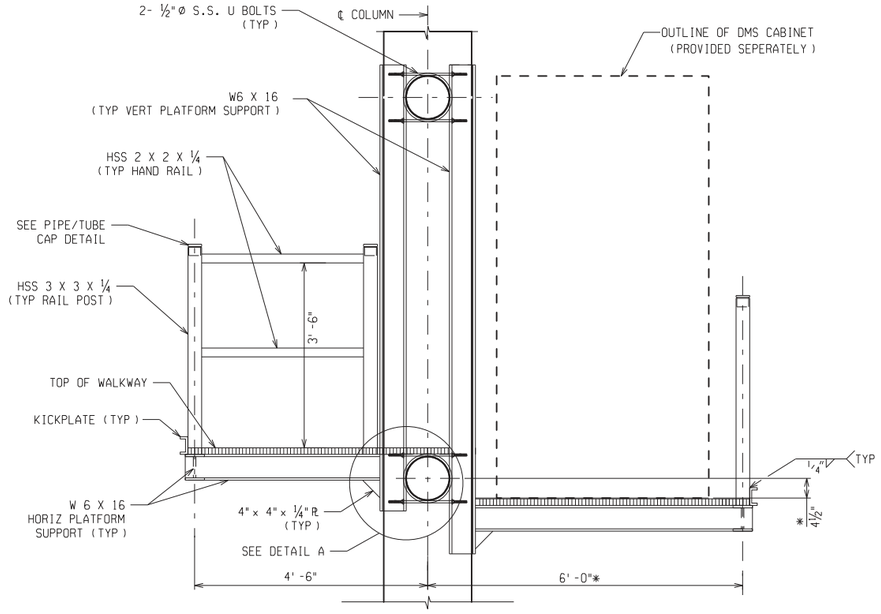


PIPE/TUBE CAP DETAIL



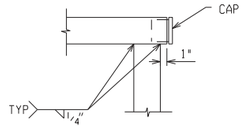
SECTION C-C

(GRATING AND KICK PLATE NOT SHOWN FOR CLARITY.)

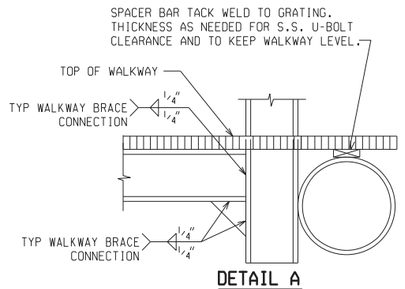


SECTION A-A

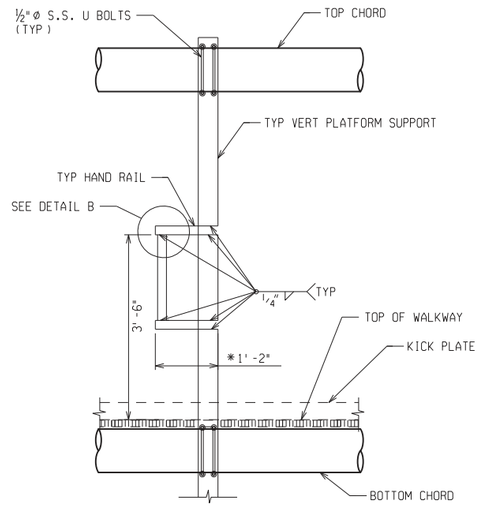
(NON PLATFORM MEMBERS SHOWN DASHED)
* CONTRACTOR VERIFY DIMENSIONS CONFORM TO DIMENSIONS OF DMS CABINET.



DETAIL B



DETAIL A



SECTION B-B

* CONTRACTOR VERIFY DIMENSION CONFORMS TO DIMENSIONS OF DMS CABINET.

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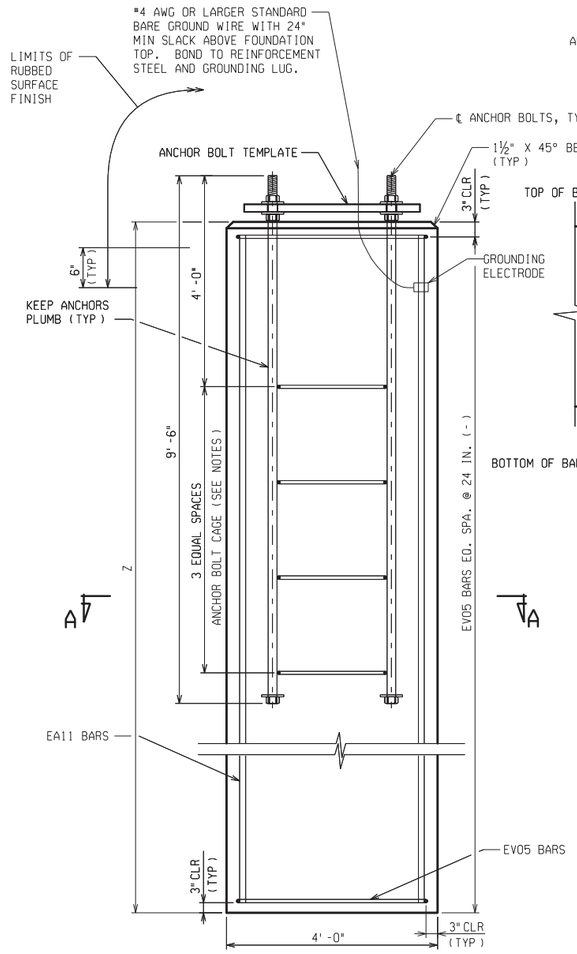
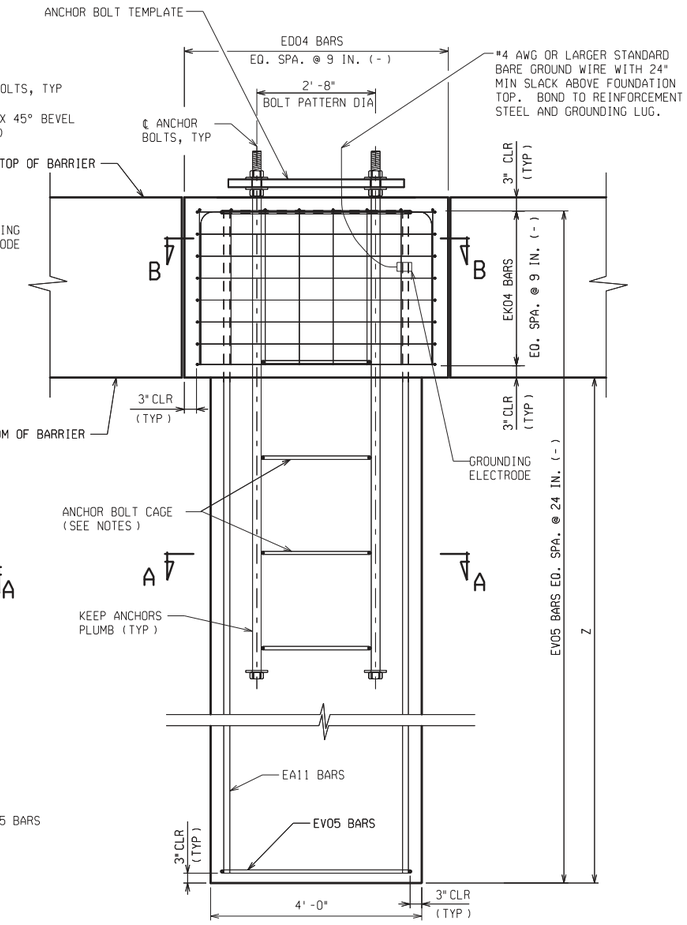
DMS SIGN SUPPORT
LEFT SIDE ENTRANCE
SHEET 3 OF 4

DRAWING	SHEET
MSDET 013	SECT 1 117



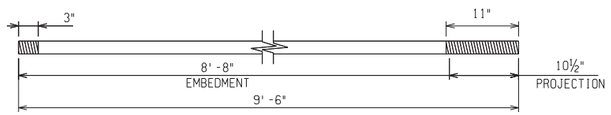
TYPE A DRILLED SHAFT



TYPE B DRILLED SHAFT

REINFORCEMENT TYPE AND LOCATION FOR CIRCULAR PORTION OF DRILLED SHAFT SAME AS TYPE A.

ANCHOR BOLT & CAGE SIZE AND LOCATION SAME AS TYPE A



ANCHOR BOLT DETAIL

USE GALVANIZED ANCHOR BOLTS

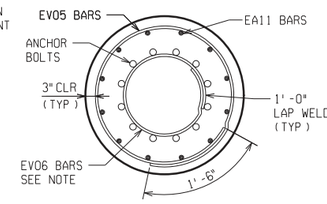
MISCELLANEOUS QUANTITIES

(FOR INFORMATION ONLY)

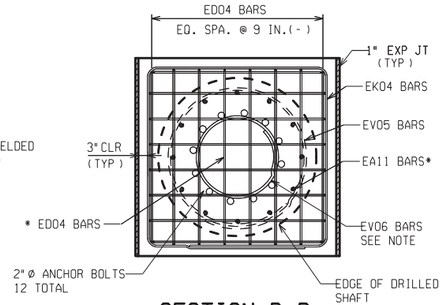
* STEEL WEIGHT = 16,398 Lbs
CONDUIT, 1 INCH = 8.5 Ft
CONDUIT, 3 INCH = 10.5 Ft
CONDUIT, 1½ INCH = 10.0 Ft
** SUBSTRUCTURE CONCRETE = 0.50 CY/Ft
STEEL REINFORCEMENT, EPOXY COATED = 76 Lb/Ft
SAFETY GATE = 1 Ea.

* STEEL WEIGHT INCLUDES COLUMN, CHORDS, DIAGONALS, VERTICALS, GUSSET PLATES, BASE PLATES, HORIZONTAL PLATFORM SUPPORTS, VERTICAL PLATFORM SUPPORTS, STIFFENER PLATES, U BOLTS, ANCHOR BOLTS, BOLTS FOR ALL OTHER CONNECTIONS, LADDER RUNGS, LADDER BARS, AND KICK PLATE.
COLUMN HEIGHT IS BASED ON A 32 FT DIMENSION FROM THE TOP OF THE BASE PLATE TO THE CENTER OF THE BOTTOM CHORD.

** STEEL REINFORCEMENT WEIGHT IS IN TERMS OF LBS/FT OF DRILLED SHAFT LENGTH. THIS DOES NOT INCLUDE THE REINFORCING BARS FOR THE MEDIAN BARRIER.



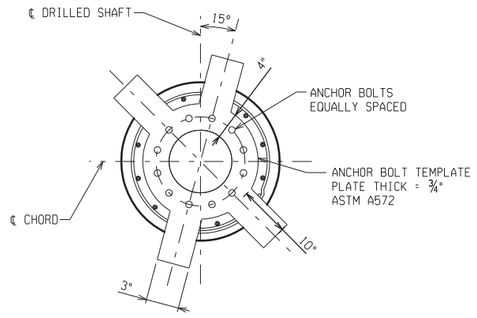
SECTION A-A



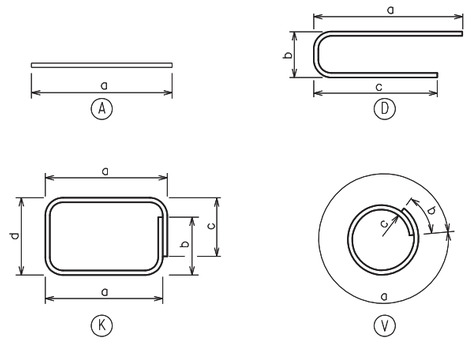
SECTION B-B

* CONTRACTOR TO VERIFY ED04 BARS DO NOT CONFLICT WITH ANCHOR BOLTS.

DRILLED SHAFT LENGTH	
DMS LOCATION	Z
US31M-MM118.1	25'



ANCHOR BOLT TEMPLATE LAYOUT PLAN



REINFORCEMENT DETAILS

NOTES:

ALL MATERIALS AND CONSTRUCTION SHALL CONFORM TO THE REQUIREMENTS OF THE MDOT STANDARD SPECIFICATIONS AND THE SPECIAL PROVISION FOR DYNAMIC MESSAGE SIGN, LARGE, SUPPORT STRUCTURE; DYNAMIC MESSAGE SIGN, LARGE, FOUNDATION.

TOP OF DRILLED SHAFT FOUNDATION SHALL BE 1'-0" (+/- 6") ABOVE FINISHED GRADE. THE FINISHED GRADE FOR THE PURPOSES OF ROADSIDE SIGNS INSTALLED ON SLOPES IS THE UPSLOPE SIDE OF THE DRILLED SHAFT.

DRILLED SHAFT FOUNDATION SHALL RECEIVE RUBBED SURFACE FINISH FROM TOP OF FOUNDATION TO 6" BELOW GRADE.

SUBSURFACE AND GROUNDWATER INFORMATION WILL BE OBTAINED FROM THE BORING LOG INFORMATION.

ANCHOR BOLT CAGE SHALL BE SHOP FABRICATED FROM #6 CIRCLE BARS OR ¾" SQUARE STOCK, OR EQUAL, WELDED TO INSIDE OF ANCHOR BOLTS TO HOLD ALIGNMENT.

REINFORCEMENT BARS FOR FOUNDATION SHALL BE GRADE 60, WITHOUT EXOXY COATING, DEFORMED BARS AS SPECIFIED IN SECTION 905.03 OF THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

ANCHOR BOLTS ARE TO BE VERTICAL AND POSITIONED AS SHOWN IN PLAN.

TEMPLATE PLATES AND ANCHOR BOLT CAGE SHALL BE SHOP FABRICATED AND ASSEMBLED PRIOR TO BEING APPROVED BY MDOT FOR SHIPPING.

DIAMETER OF BOLT HOLES IN TEMPLATES SHALL BE 1/16" LAGER THAN ANCHOR BOLT DIAMETERS.

INSTALLATION SHALL BE ACCORDING TO SUBSECTION 810.03 OF THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

TEMPLATES THAT HOLD ANCHOR BOLTS SHALL BE WELL SUPPORTED, HORIZONTALLY LEVEL AND FIRMLY ANCHORED IN PLACE FOR A MINIMUM OF 24 HOURS AFTER THE CONCRETE PLACEMENT IS COMPLETED.

DUE CARE SHALL BE TAKEN DURING THE CONCRETE PLACEMENT TO AVOID DISPLACING THE ANCHOR BOLTS.

NO HAMMERING ON THE ANCHOR BOLTS OR TEMPLATES WILL BE ALLOWED. NO CHISELING OR DAMAGING OF GALVANIZED FINISH WILL BE PERMITTED.

AFTER TOP TEMPLATE IS REMOVED, THREAD NUTS ON TO THE BOLT FLUSH WITH THE BOLT END TO PROTECT THREADS UNTIL SIGN SUPPORT IS ERECTED.

GROUNDING OF STRUCTURE INCLUDES ELECTRICALLY BONDING THE FOUNDATION REINFORCING STEEL TO THE ANCHOR BOLTS.

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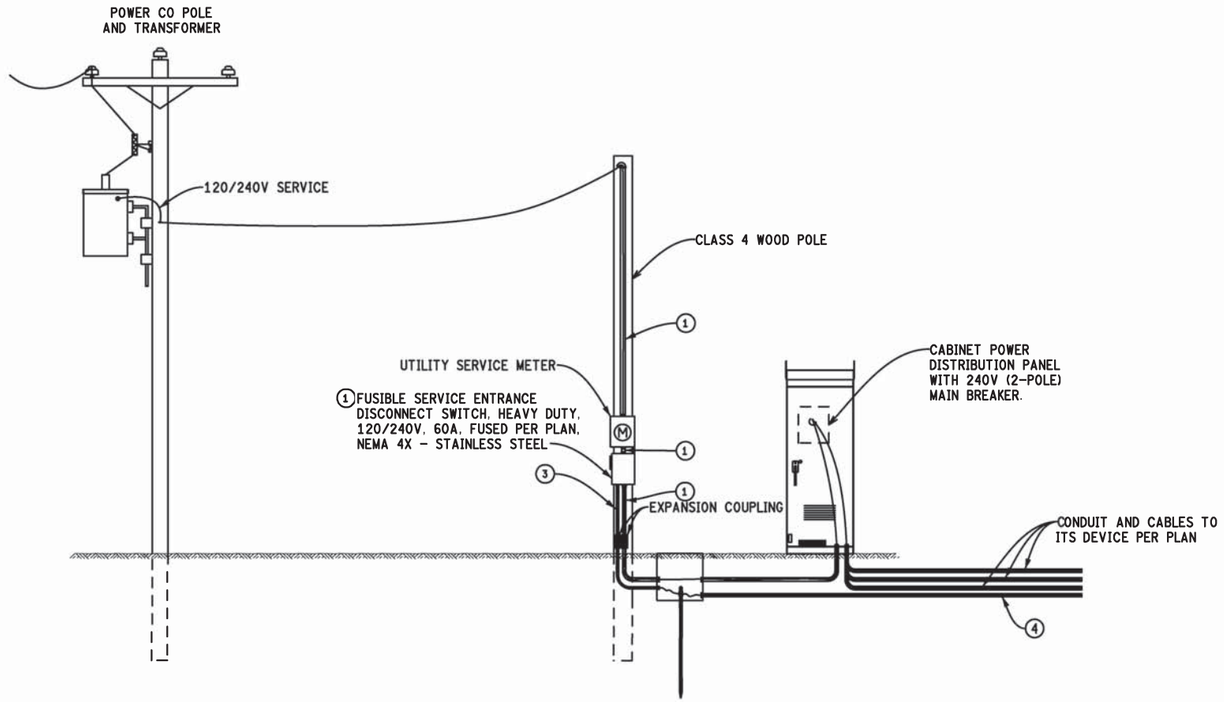
DMS SIGN SUPPORT
SHEET 4 OF 4

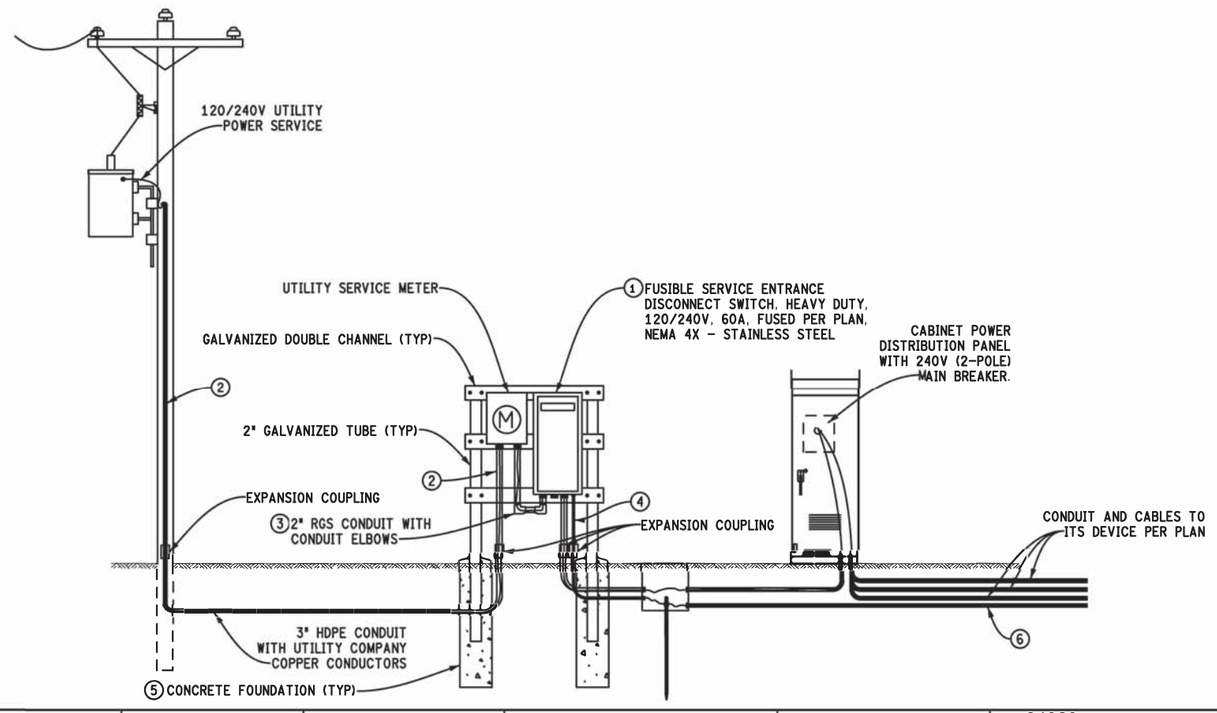
DRAWING	SHEET
MSDET 014	SECT 1 118



DETAIL 1

POWER SERVICE, OVERHEAD
3 WIRE PLUS GROUND, 1 PHASE, PER PLAN

1. RIGID GALVANIZED STEEL (RGS) ATTACHED AS RISER ON POLE. PROPER BONDING OF METALLIC CONDUIT IS REQUIRED UTILIZING BUSHINGS OR OTHER APPROVED METHOD BY LARA AND THE LOCAL UTILITY.
2. NEMA 4X SERVICE ENTRANCE RATED DISCONNECT ENCLOSURE. FUSE SIZES AND SERVICE RATING PER PAY ITEM AND SPECIAL PROVISION FOR POWER SERVICE. PROVIDE ONE PADLOCK FOR EACH ENCLOSURE. PADLOCK SHALL BE IN ACCORDANCE WITH THE SPECIAL PROVISIONS. PROVIDE AND ATTACH LABEL WITH SITE ADDRESS TO OUTSIDE OF ENCLOSURE.
3. 1-1/C #6 XHHW-2 GROUNDING ELECTRODE CONDUCTOR IN CONDUIT TO DISCONNECT SWITCH GROUND BUS. GROUND BUS BONDED TO NEUTRAL BUS.
4. SEE "ITS GROUNDING AND BONDING" DETAIL.



DETAIL 2

POWER SERVICE, UNDERGROUND
3 WIRE PLUS GROUND, 1 PHASE, PER PLAN

1. NEMA 4X SERVICE ENTRANCE RATED DISCONNECT ENCLOSURE. FUSE SIZES PER PAY ITEM AND SPECIAL PROVISION FOR POWER SERVICE. PROVIDE ONE PADLOCK FOR EACH ENCLOSURE. PADLOCK SHALL BE IN ACCORDANCE WITH THE SPECIAL PROVISIONS. PROVIDE AND ATTACH LABEL WITH SITE ADDRESS TO OUTSIDE OF ENCLOSURE.
2. RIGID GALVANIZED STEEL (RGS) ATTACHED TO EQUIPMENT STAND OR AS RISER ON POLE. PROPER BONDING OF METALLIC CONDUIT IS REQUIRED UTILIZING BUSHINGS OR OTHER APPROVED METHOD BY LARA AND THE LOCAL UTILITY.
3. THREADED HUB TYPE CONDUIT COUPLING BETWEEN ENCLOSURES SIZED TO ACCOMODATE CONDUCTORS.
4. 1-1/C #6 XHHW-2 GROUNDING ELECTRODE CONDUCTOR IN CONDUIT TO DISCONNECT SWITCH GROUND BUS. GROUND BUS BONDED TO NEUTRAL BUS.
5. (2) 12" DIA. X 44" CONCRETE FOUNDATIONS. SLOPE TOP OF FOUNDATION AWAY FROM GALVANIZED TUBE FOR DRAINAGE. ONE SOLID CONCRETE FOUNDATION MAY BE USED AS AN ALTERNATE DESIGN WITH APPROVAL FROM THE ENGINEER.
6. SEE "ITS GROUNDING AND BONDING" DETAIL.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

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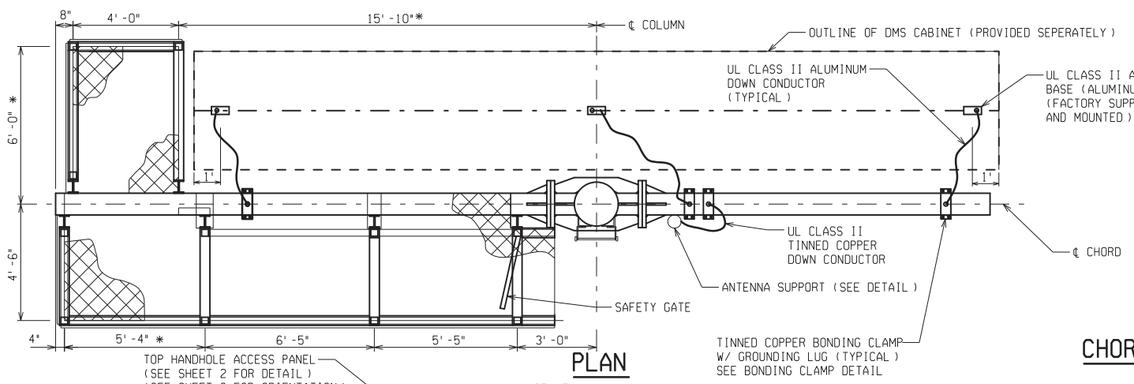
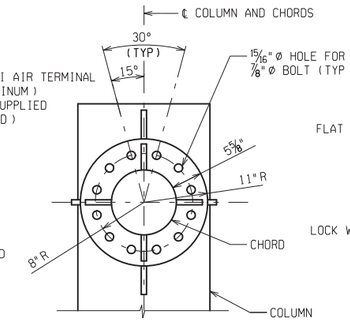
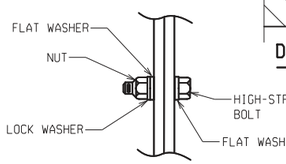
	DATE: 11/10/2016	CS: 84923	POWER SERVICE	DRAWING	SHEET
PRINT FILE: 12/21/2015	DESIGN UNIT: PEPLINSKI	JN: 106329A		MSDET 015	SECT 1 119
FILE: Power Service.dgn	TSC: MUSKEGON		SHEET 1 OF 1		



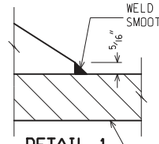
PLAN



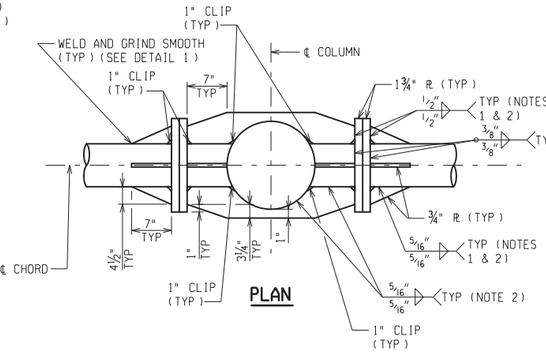
CHORD FLANGE PLATE DETAIL



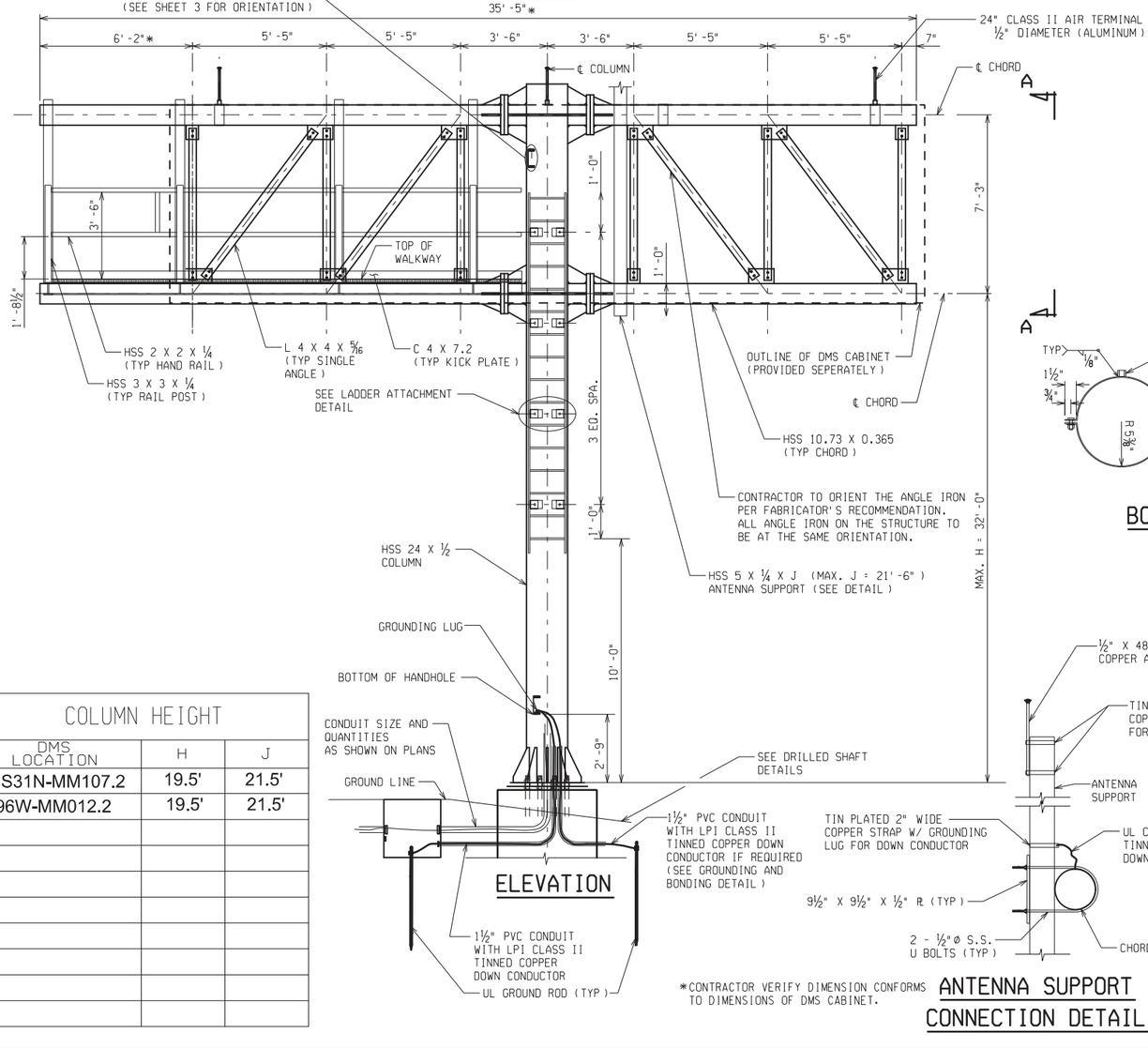
WASHER PLACEMENT



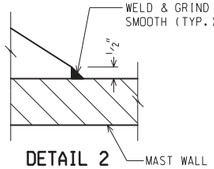
DETAIL 1



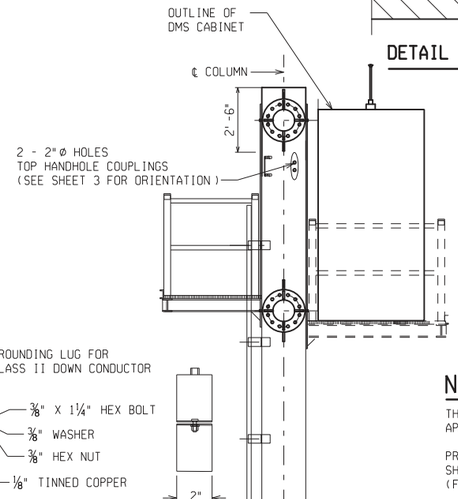
PLAN



ELEVATION

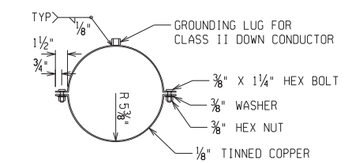


DETAIL 2



END ELEVATION A-A

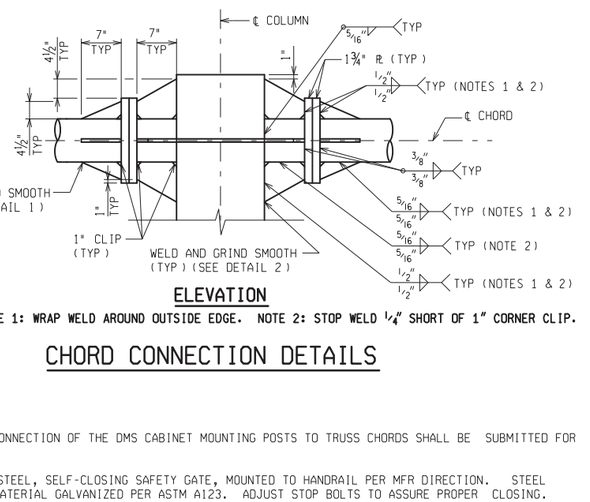
IF ANTENNA SUPPORT POLE IS REQUIRED, PROVIDE AIR TERMINAL, DOWN CONDUCTOR, AND MOUNTING STRAPS IN ADDITION TO LP EQUIPMENT TO BE SUPPLIED FOR THE DMS CASE.



BONDING CLAMP DETAIL

*CONTRACTOR VERIFY DIMENSION CONFORMS TO DIMENSIONS OF DMS CABINET.

ANTENNA SUPPORT CONNECTION DETAIL



ELEVATION

*NOTE 1: WRAP WELD AROUND OUTSIDE EDGE. NOTE 2: STOP WELD ¼" SHORT OF 1" CORNER CLIP.

CHORD CONNECTION DETAILS

COLUMN HEIGHT		
DMS LOCATION	H	J
US31N-MM107.2	19.5'	21.5'
I96W-MM012.2	19.5'	21.5'

NOTES:

THE DESIGN OF THE CONNECTION OF THE DMS CABINET MOUNTING POSTS TO TRUSS CHORDS SHALL BE SUBMITTED FOR APPROVAL.

PROVIDE GALVANIZED STEEL, SELF-CLOSING SAFETY GATE, MOUNTED TO HANDRAIL PER MFR DIRECTION. STEEL SHALL BE ASTM A36 MATERIAL GALVANIZED PER ASTM A123. ADJUST STOP BOLTS TO ASSURE PROPER CLOSING. (FABENCO. INC MODEL A71-27 OR EQUAL)

ALL BOLTS SHALL BE ⅞ INCH DIAMETER A325 GALVANIZED WITH 3⁄16INCH THICK WASHER AND ⅞ INCH DIAMETER NUT, UNLESS NOTED OTHERWISE.

STRUCTURAL STEEL, BOLTS, WELDING, AND GALVANIZING SHALL BE ACCORDING TO THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION AND MDOT SPECIAL PROVISION 03SP707(A).

INSTALL VENT HOLES AS REQUIRED FOR GALVANIZING.

THE PIPE MATERIAL SHALL MEET THE REQUIREMENTS OF API 5L, GRADE X52.

ALL OTHER STRUCTURAL STEEL SHALL BE ASTM A-36, UNLESS OTHERWISE NOTED.

ALL STEEL, INCLUDING BAR GRATING, SHALL BE HOT DIP GALVANIZED PER ASTM 123 OR 153, AS APPLICABLE.

PROVIDE ANCHOR BOLTS IN ACCORDANCE WITH SECTIONS 908.14 A & B OF THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

FABRICATION AND ERECTION SHALL BE ACCORDING TO SECTIONS 707 AND 810.03 OF THE CURRENT MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

WALK PLATFORM SHALL NOT BE LIFTED BY HANDRAILS OR POSTS. TRUSS SHALL NOT BE LIFTED BY WEB MEMBERS.

LADDER SHALL BE EQUIPPED WITH A SAFETY RAIL SYSTEM APPROVED BY THE ENGINEER.

TOP OF THE ANTENNA SUPPORT SHALL BE SEALED WITH A TENON. CONTRACTOR TO VERIFY WITH ENGINEER METHOD TO ROUTE WIRE TO THE INTERIOR OF THE ANTENNA SUPPORT SUCH THAT A WATER TIGHT SEAL IS MAINTAINED.

THE MAXIMUM PERMISSIBLE SIGN AREA IS 285 SQFT.

FABRICATOR MUST BE AISC SIMPLE BRIDGE (SBR) OR AISC BRIDGE & HIGHWAY METAL COMPONENT CERTIFIED.

INSTALL RODENT SCREEN BETWEEN THE BASE PLATE AND TOP OF FOUNDATION.

INSTALL A FLEXIBLE CONDUIT IN THE DMS SUPPORT STRUCTURE CENTER COLUMN TO SEPARATE POWER AND COMMUNICATIONS CABLING.

THE FLANGES SHALL BE WELDED TO ASSURE OBTAINING FULL CONTACT IN THE RELAXED POSTION PRIOR TO SNUGGING UP THE FLANGE BOLTS. THE FLANGE BOLTS SHALL NOT BE TORQUED IN AN ATTEMPT TO CLOSE.

WARPAGE IN THE BASE PLATE SHALL NOT EXCEED 1⁄16" PER FOOT.

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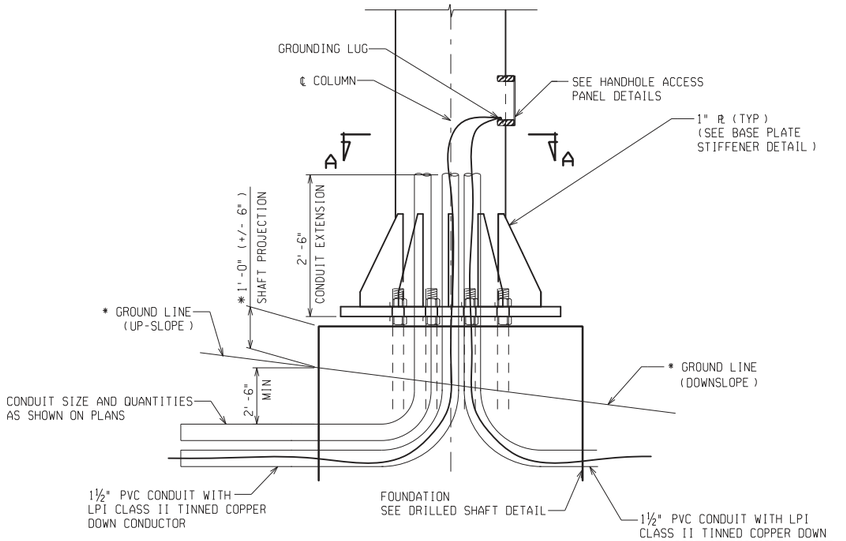
DMS SIGN SUPPORT

RIGHT SIDE ENTRANCE

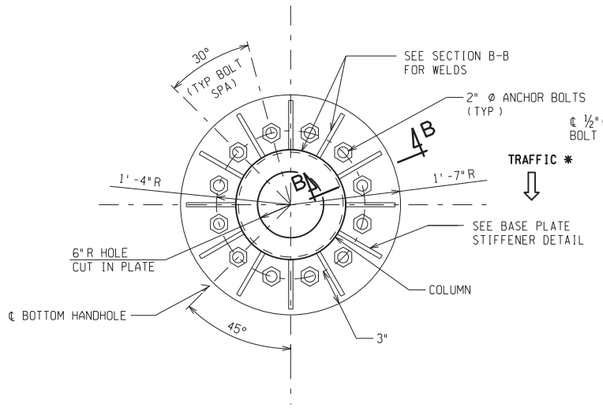
SHEET 1 OF 4

DRAWING	SHEET
MSDET 016	SECT 1 120



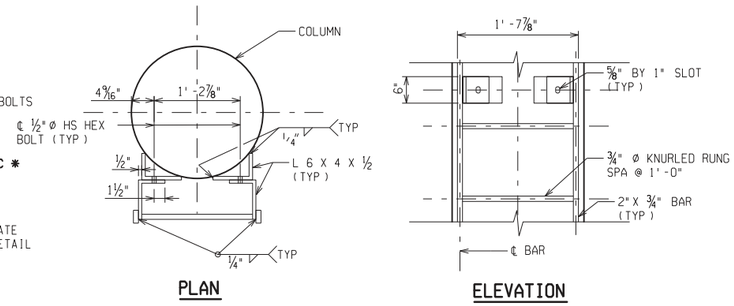
BASE PLATE ELEVATION

* THE SLOPE OF THE GROUND LINE AND MIN. SHAFT PROJECTION ARE FOR THE TYPE A DRILLED SHAFT. REFER TO SHEET 4 FOR DETAILS ON THE TYPE B DRILLED SHAFT.

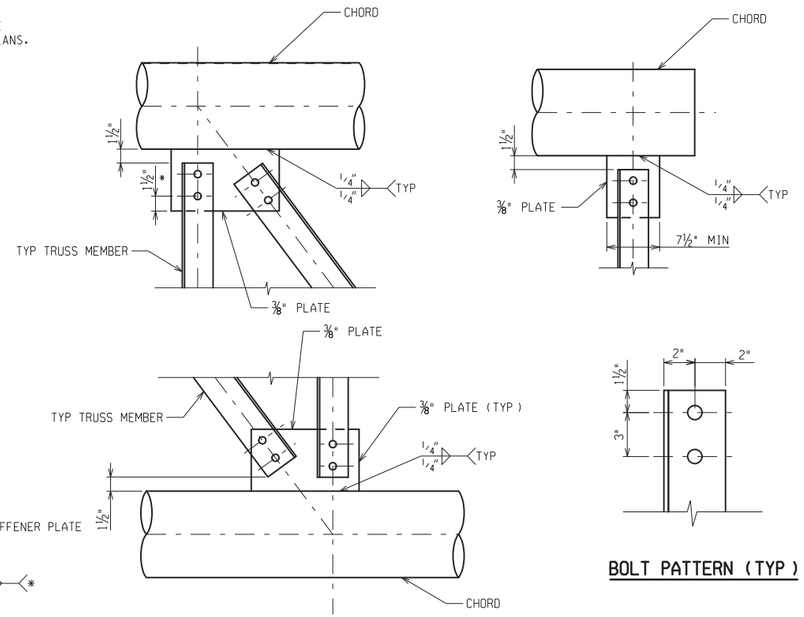


SECTION A-A

* POSITION BASE PLATE AND ANCHOR BOLTS SO THAT THE SIGN FACE IS ROTATED TOWARD TRAFFIC AT THE ANGLE SPECIFIED IN THE PLANS.



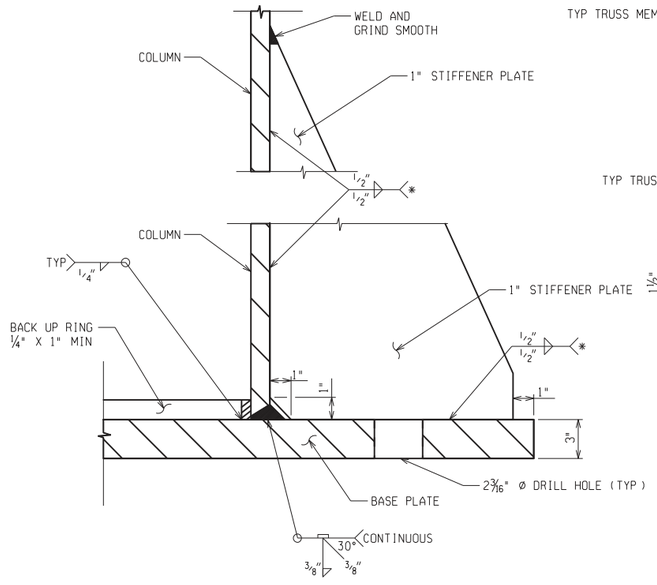
LADDER ATTACHMENT DETAILS



GUSSET PLATE CONNECTIONS

* TYPICAL MINIMUM EDGE DISTANCE

BOLT PATTERN (TYP)

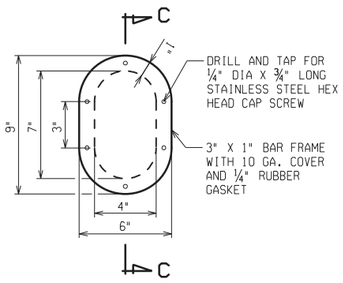


SECTION B-B

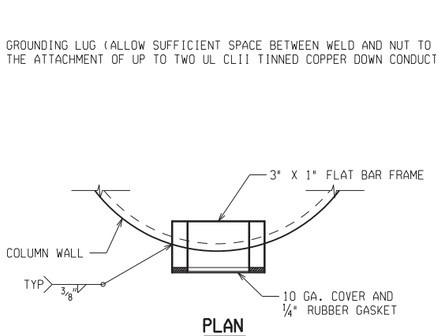
* WRAP WELD AROUND OUTSIDE EDGE. STOP WELD ¼" FROM CORNER CLIP

BONDING CLAMP INSTALLATION

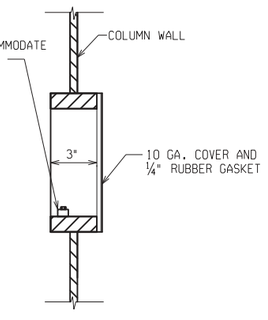
1. REMOVE GALVANIZING FROM SURFACE OF CHORD WHERE BONDING WILL TAKE PLACE.
2. AFTER GALVANIZING IS REMOVED APPLY CONDUCTIVE GREASE COMPOUND TO SURFACE.
3. ATTACH BONDING CLAMP TO CHORD, REMOVE EXCESS COMPOUND.
4. AFTER BONDING CLAMP HAS BEEN SECURED, APPLY COLD GALVANIZING PAINT. (SPRAY PAINT SHALL NOT BE ALLOWED)



ELEVATION

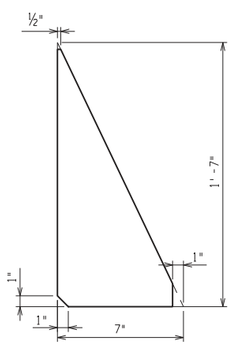


PLAN



SECTION C-C

HANDHOLE DETAILS



BASE PLATE STIFFENER

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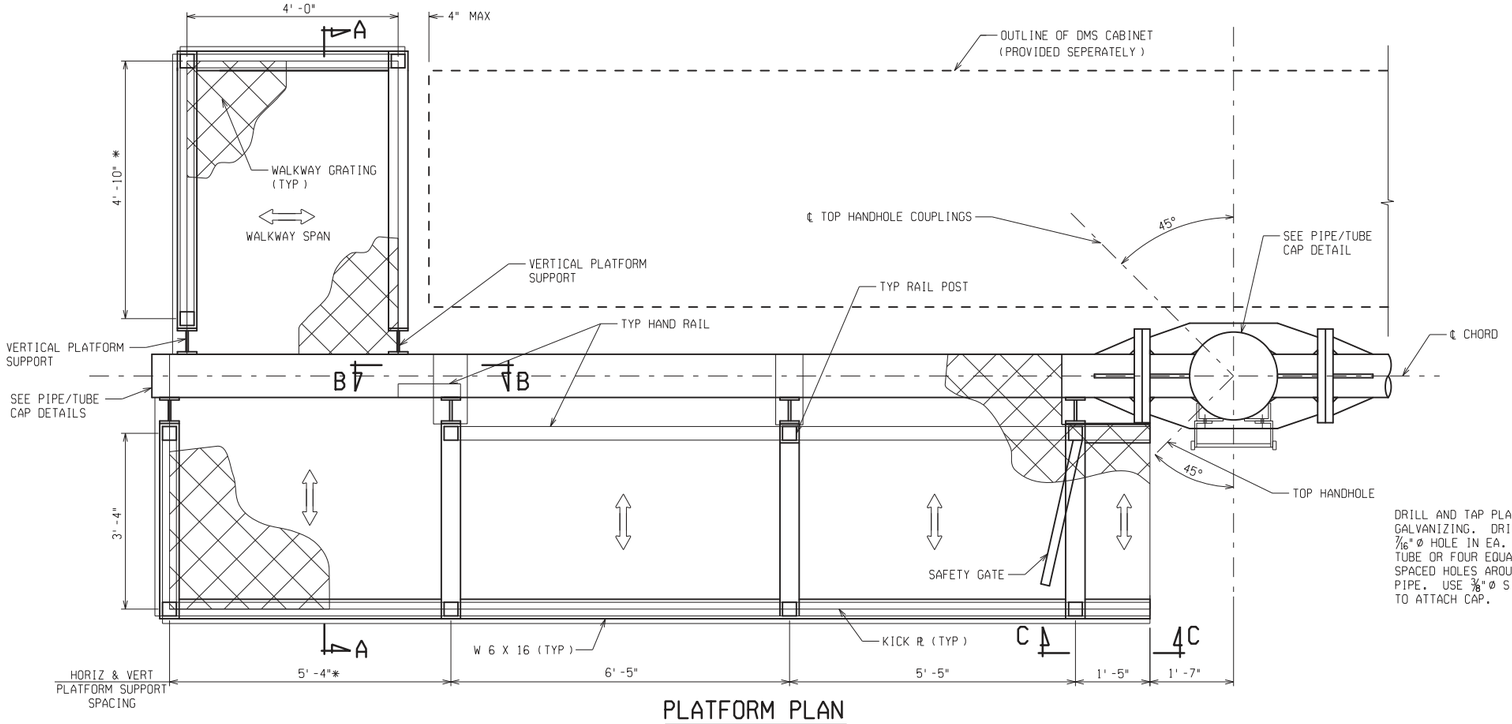
DMS SIGN SUPPORT

RIGHT SIDE ENTRANCE

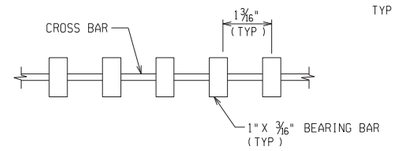
SHEET 2 OF 4

DRAWING: MSDET 017

SHEET: SECT 1 121

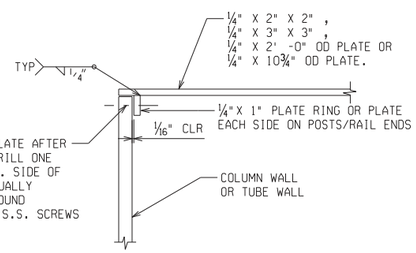


PLATFORM PLAN

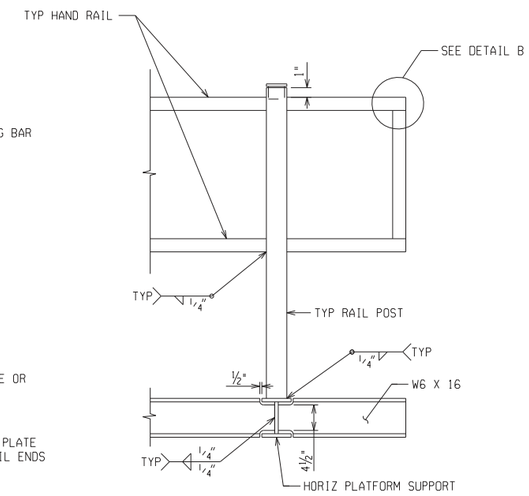


WALKWAY GRATING

ATTACH GRATING TO W6 X 16 MEMBER WITH GALVANIZED FASTENERS APPROVED BY ENGINEER, 2 MIN PER W6 X 16 MEMBER PER GRATING PIECE.

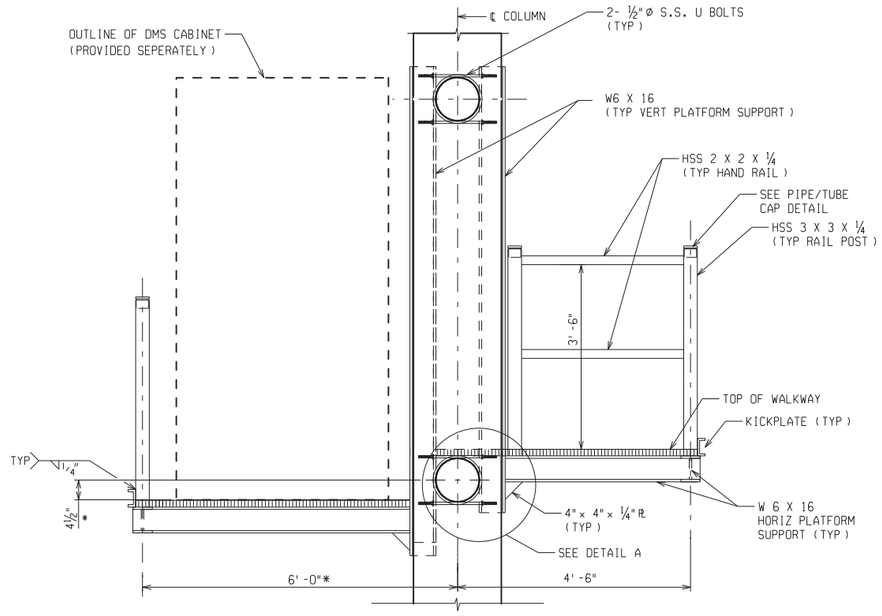


PIPE/TUBE CAP DETAIL



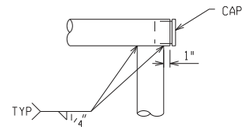
SECTION C-C

(GRATING AND KICK PLATE NOT SHOWN FOR CLARITY.)

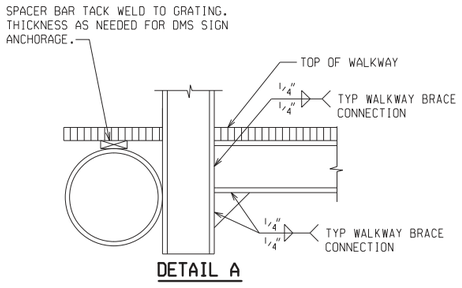


SECTION A-A

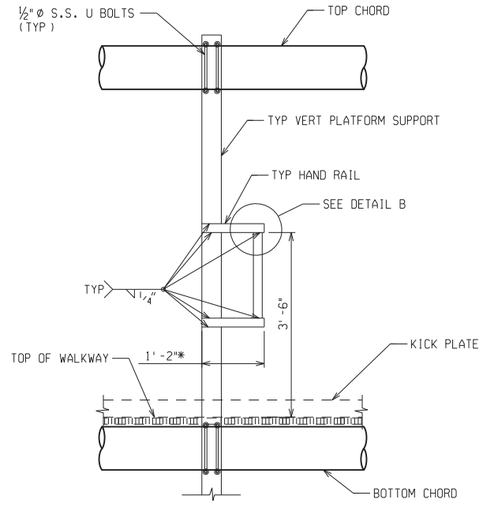
(NON PLATFORM MEMBERS SHOWN DASHED)
* CONTRACTOR VERIFY DIMENSIONS CONFORM TO DIMENSIONS OF DMS CABINET.



DETAIL B



DETAIL A



SECTION B-B

* CONTRACTOR VERIFY DIMENSION CONFORMS TO DIMENSIONS OF DMS CABINET.

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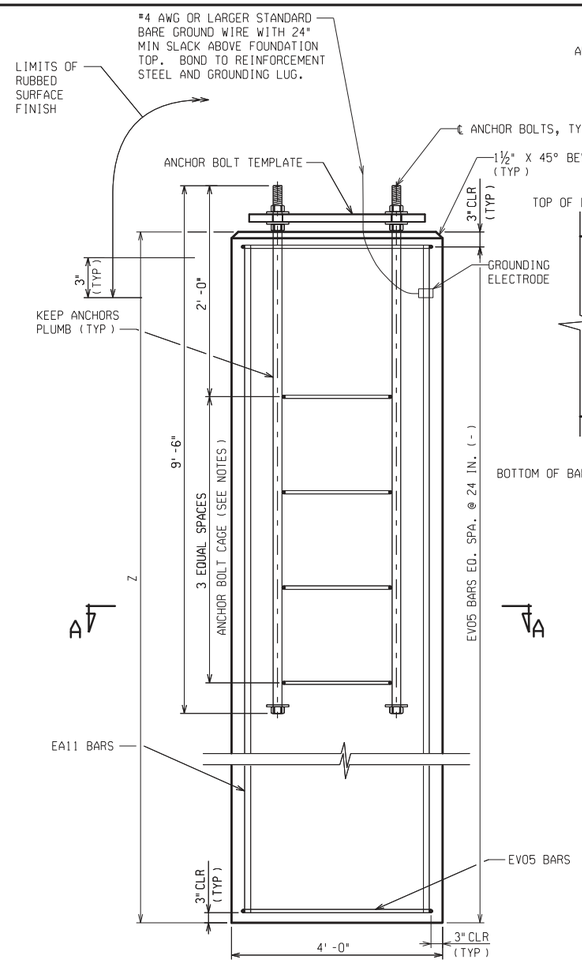
DMS SIGN SUPPORT

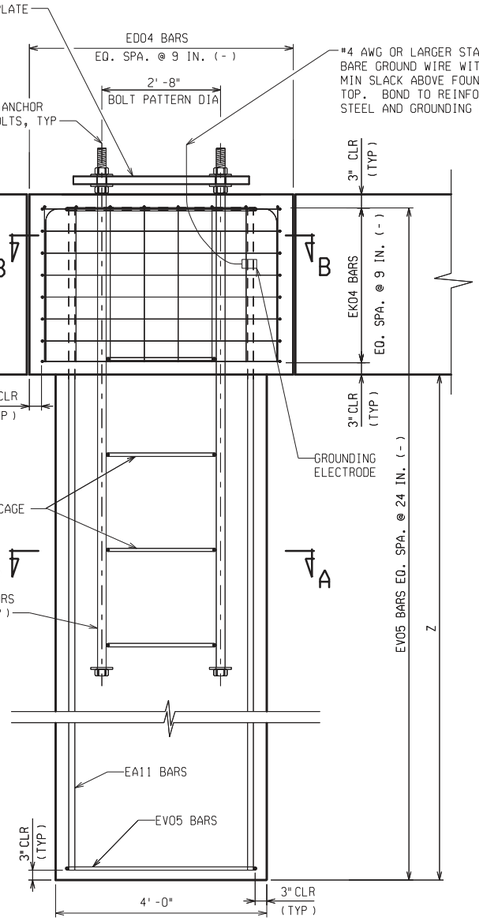
RIGHT SIDE ENTRANCE

SHEET 3 OF 4

DRAWING	SHEET
MSDET 018	SECT 1 122



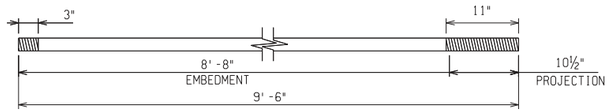
TYPE A DRILLED SHAFT



TYPE B DRILLED SHAFT

REINFORCEMENT TYPE AND LOCATION FOR CIRCULAR PORTION OF DRILLED SHAFT SAME AS TYPE A.

ANCHOR BOLT & CAGE SIZE AND LOCATION SAME AS TYPE A



ANCHOR BOLT DETAIL

USE GALVANIZED ANCHOR BOLTS

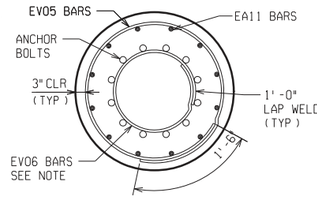
MISCELLANEOUS QUANTITIES

(FOR INFORMATION ONLY)

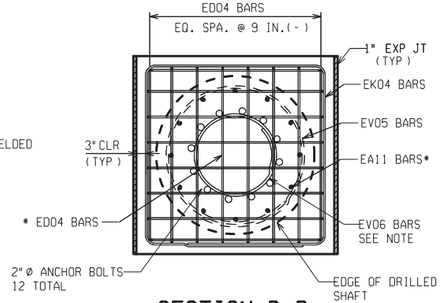
* STEEL WEIGHT = 16,398 Lbs
CONDUIT, 1 INCH = 8.5 Ft
CONDUIT, 3 INCH = 10.5 Ft
CONDUIT, 1½ INCH = 10.0 Ft
** SUBSTRUCTURE CONCRETE = 0.50 CY/Ft
STEEL REINFORCEMENT, EPOXY COATED = 76 Lb/Ft
SAFETY GATE = 1 Ea.

* STEEL WEIGHT INCLUDES COLUMN, CHORDS, DIAGONALS, VERTICALS, GUSSET PLATES, BASE PLATES, HORIZONTAL PLATFORM SUPPORTS, VERTICAL PLATFORM SUPPORTS, STIFFENER PLATES, U BOLTS, ANCHOR BOLTS, BOLTS FOR ALL OTHER CONNECTIONS, LADDER RUNGS, LADDER BARS, AND KICK PLATE.
COLUMN HEIGHT IS BASED ON A 32 FT DIMENSION FROM THE TOP OF THE BASE PLATE TO THE CENTER OF THE BOTTOM CHORD.

** STEEL REINFORCEMENT WEIGHT IS IN TERMS OF LBS/FT OF DRILLED SHAFT LENGTH. THIS DOES NOT INCLUDE THE REINFORCING BARS FOR THE MEDIAN BARRIER.

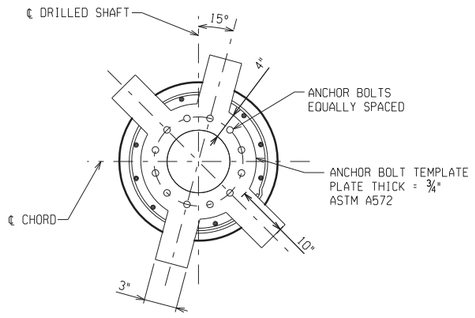


SECTION A-A

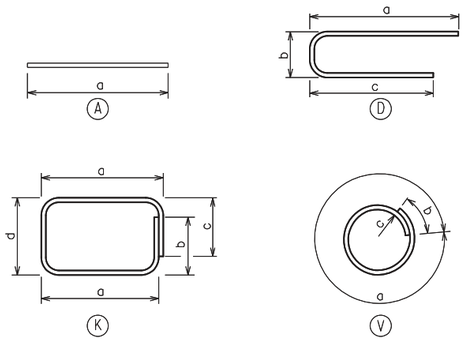


SECTION B-B

* CONTRACTOR TO VERIFY ED04 BARS DO NOT CONFLICT WITH ANCHOR BOLTS.



ANCHOR BOLT TEMPLATE LAYOUT PLAN



REINFORCEMENT DETAILS

DRILLED SHAFT LENGTH	
DMS LOCATION	Z
US31N-MM107.2	24'
I96W-MM012.2	25'

NOTES:

ALL MATERIALS AND CONSTRUCTION SHALL CONFORM TO THE REQUIREMENTS OF THE MDOT STANDARD SPECIFICATIONS AND THE SPECIAL PROVISION FOR DYNAMIC MESSAGE SIGN, LARGE, SUPPORT STRUCTURE; DYNAMIC MESSAGE SIGN, LARGE, FOUNDATION.

TOP OF DRILLED SHAFT FOUNDATION SHALL BE 1'-0" (+/- 6") ABOVE FINISHED GRADE. THE FINISHED GRADE FOR THE PURPOSES OF ROADSIDE SIGNS INSTALLED ON SLOPES IS THE UPSLOPE SIDE OF THE DRILLED SHAFT.

DRILLED SHAFT FOUNDATION SHALL RECEIVE RUBBED SURFACE FINISH FROM TOP OF FOUNDATION TO 6" BELOW GRADE.

SUBSURFACE AND GROUNDWATER INFORMATION WILL BE OBTAINED FROM THE BORING LOG INFORMATION.

ANCHOR BOLT CAGE SHALL BE SHOP FABRICATED FROM #6 CIRCLE BARS OR ¾" SQUARE STOCK, OR EQUAL, WELDED TO INSIDE OF ANCHOR BOLTS TO HOLD ALIGNMENT.

REINFORCEMENT BARS FOR FOUNDATION SHALL BE GRADE 60, WITHOUT EPOXY COATING, DEFORMED BARS AS SPECIFIED IN SECTION 905.03 OF THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

ANCHOR BOLTS ARE TO BE VERTICAL AND POSITIONED AS SHOWN IN PLAN.

TEMPLATE PLATES AND ANCHOR BOLT CAGE SHALL BE SHOP FABRICATED AND ASSEMBLED PRIOR TO BEING APPROVED BY MDOT FOR SHIPPING.

DIAMETER OF BOLT HOLES IN TEMPLATES SHALL BE 1/16" LARGER THAN ANCHOR BOLT DIAMETERS.

INSTALLATION SHALL BE ACCORDING TO SUBSECTION 810.03 OF THE MDOT STANDARD SPECIFICATIONS FOR CONSTRUCTION.

TEMPLATES THAT HOLD ANCHOR BOLTS SHALL BE WELL SUPPORTED, HORIZONTALLY LEVEL AND FIRMLY ANCHORED IN PLACE FOR A MINIMUM OF 24 HOURS AFTER THE CONCRETE PLACEMENT IS COMPLETED.

DUE CARE SHALL BE TAKEN DURING THE CONCRETE PLACEMENT TO AVOID DISPLACING THE ANCHOR BOLTS.

NO HAMMERING ON THE ANCHOR BOLTS OR TEMPLATES WILL BE ALLOWED. NO CHISELING OR DAMAGING OF GALVANIZED FINISH WILL BE PERMITTED.

AFTER TOP TEMPLATE IS REMOVED, THREAD NUTS ON TO THE BOLT FLUSH WITH THE BOLT END TO PROTECT THREADS UNTIL SIGN SUPPORT IS ERECTED.

GROUNDING OF STRUCTURE INCLUDES ELECTRICALLY BONDING THE FOUNDATION REINFORCING STEEL TO THE ANCHOR BOLTS.

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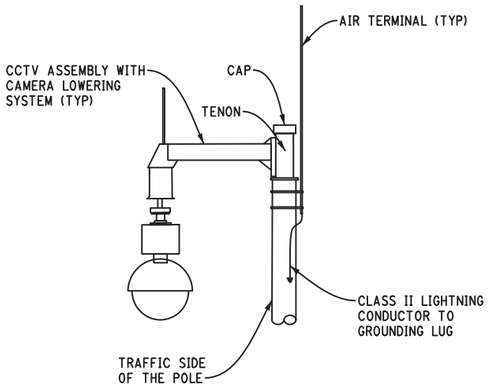
DMS SIGN SUPPORT

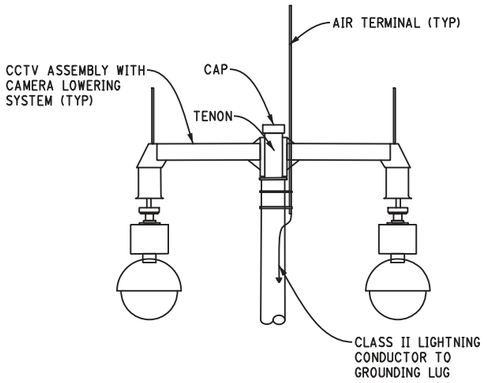
SHEET 4 OF 4

DRAWING: MSDET 019

SHEET: SECT 1 123

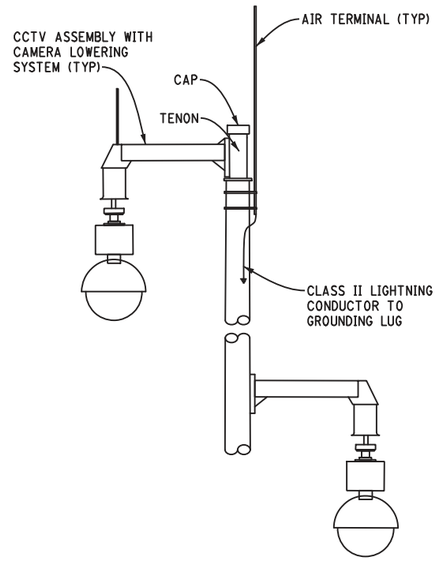


SURVEILLANCE SYSTEM, TYPE A



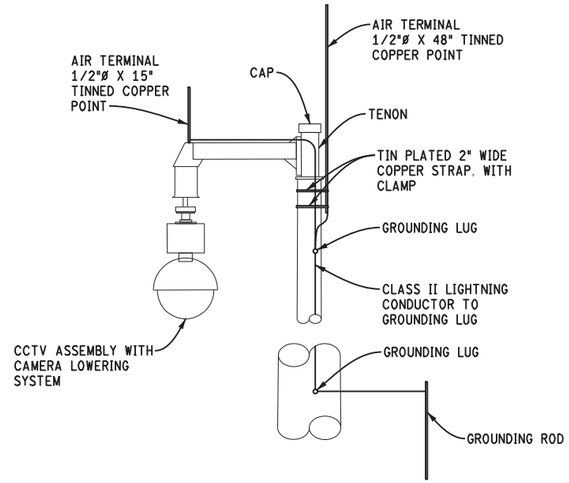
SURVEILLANCE SYSTEM, TYPE B

ORIENT CCTV POLE AS CALLED FOR ON PLANS.



SURVEILLANCE SYSTEM, TYPE C

ORIENT CCTV POLE AS CALLED FOR ON PLANS.



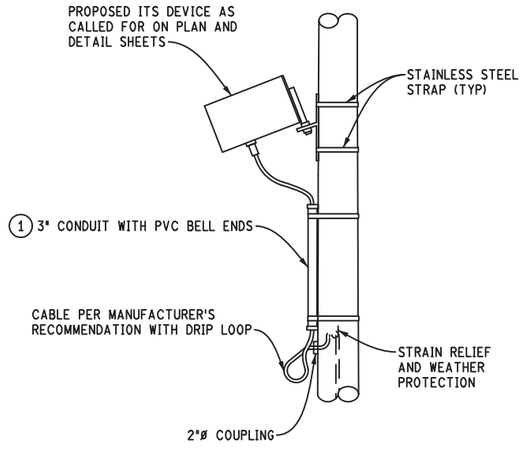
LIGHTNING PROTECTION

SURVEILLANCE SYSTEM, TYPE A SHOWN, TYPES B AND C SIMILAR.

GROUNDING LUGS ARE TO BE CAST INTO THE POLE.

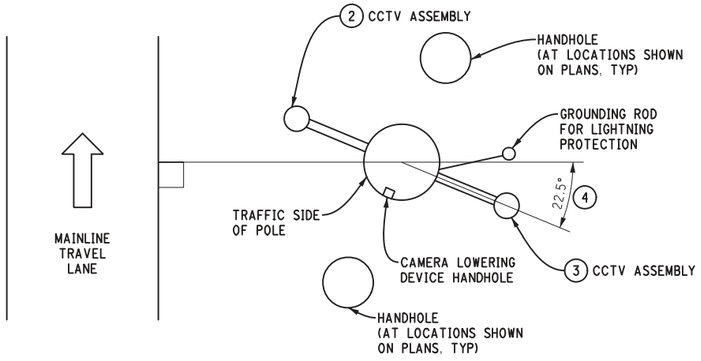
USE A LPI CLASS II CONDUCTOR TO CONNECT THE TOP GROUNDING LUG TO THE GROUNDING LUG AT THE BASE OF THE POLE.

AIR TERMINALS SHALL EXTEND A MINIMUM OF 10 INCHES ABOVE THE POLE.



ACCESSORY POLE-MOUNT DETAIL

(1) CONDUIT REQUIRED IF DISTANCE FROM PROPOSED ITS DEVICE TO 2"ø COUPLING IS 3 FEET OR GREATER.



ORIENTATION DIAGRAM

(2) SEE PLANS FOR ORIENTATION ON POLE.

(3) ORIENT CCTV POLE AS CALLED FOR ON PLANS FOR SPUN CONC POLE, TYPE B AND TYPE C.

(4) ROTATE CCTV ASSEMBLY 22.5° TOWARDS THE NEREST CROSS ROAD AS CALLED FOR ON THE PLANS.

NOTES:

1. ALL CONDUITS AND DUCTS SHALL BE SEALED WITH A RUBBER FITTING OR A WEATHER HEAD.

2. ALL MOUNTING HARDWARE SHALL BE STAINLESS STEEL.

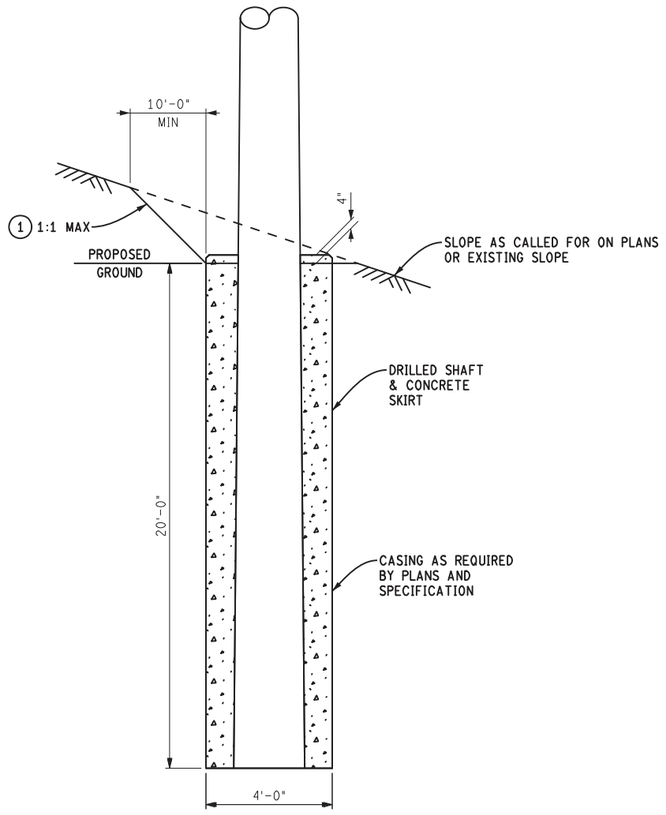
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

	DATE: 11/10/2016	CS: 84923	SURVEILLANCE SYSTEMS
PRINT DATE: 8/14/2014	DESIGN UNIT: PEPLINSKI	JN: 106329A	
FILE: Surveillance Systems.dgn	TSC: MUSKEGON		SHEET 1 OF 1

DRAWING	SHEET
MSDET 020	SECT 1 124

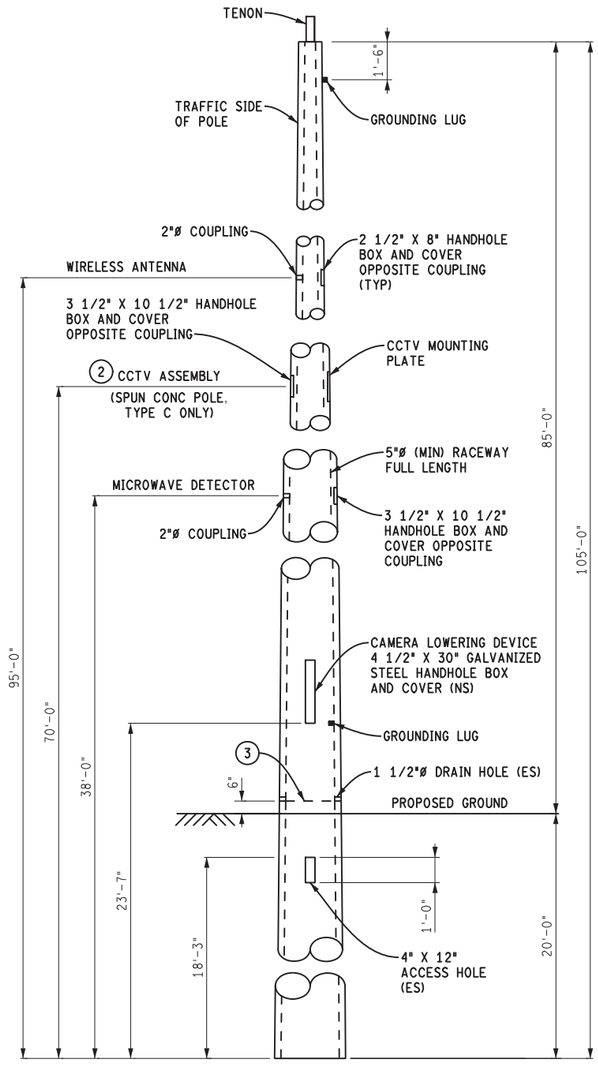


FOUNDATION DETAIL

(FILL OR CUT SLOPE)

CONDUIT AND FLOWABLE FILL NOT SHOWN FOR CLARITY.

(1) VERIFY THAT 1:1 MAX SLOPE MEETS CLEAR ZONE REQUIREMENTS OR PROVIDE PROTECTION.



FOUNDATION DETAIL

ES DENOTES EACH SIDE.

FS DENOTES FAR SIDE.

NS DENOTES NEAR SIDE.

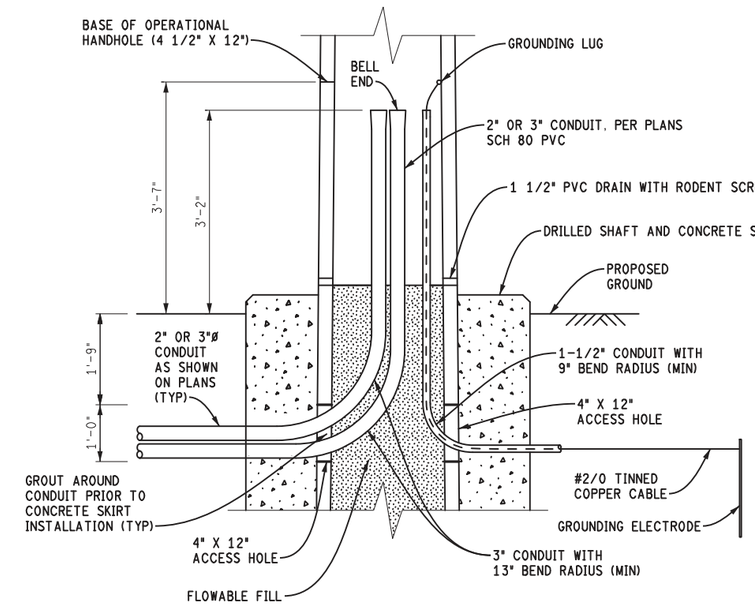
CAPS SHALL BE PROVIDED FOR ALL COUPLINGS.

CCTV CAMERA ASSEMBLY, WIRELESS ANTENNA, MICROWAVE DETECTOR AND LIGHTNING CONDUCTOR ARE NOT SHOWN FOR CLARITY.

GROUNDING LUGS ARE FOR LIGHTNING PROTECTION. THE CONDUCTOR SHALL BE CAST INSIDE THE POLE.

(2) IF CALLED FOR ON PLANS. OMIT CCTV MOUNTING PLATE AND HANDHOLE IF NOT CALLED FOR ON PLANS. SEE PLANS FOR ORIENTATION ON POLE.

(3) FILL THE INTERIOR VOID WITH NON-STRUCTURAL FLOWABLE FILL FROM THE BUTT OF THE POLE TO THE ELEVATION SHOWN. SEE CONDUIT DETAIL.



CONDUIT DETAIL

CONDUIT SWEEPS TO BE FIELD INSTALLED PRIOR TO POLE ERECTION. INSTALL A SWEEP TO EACH COUPLING THAT WILL HAVE CONDUIT ATTACHED AS SHOWN ON PLANS.

SEE STANDARD PLAN R-80 SERIES FOR RODENT SCREEN DETAILS. SCREENS SHALL BE PERMANENTLY ATTACHED TO THE POLES.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

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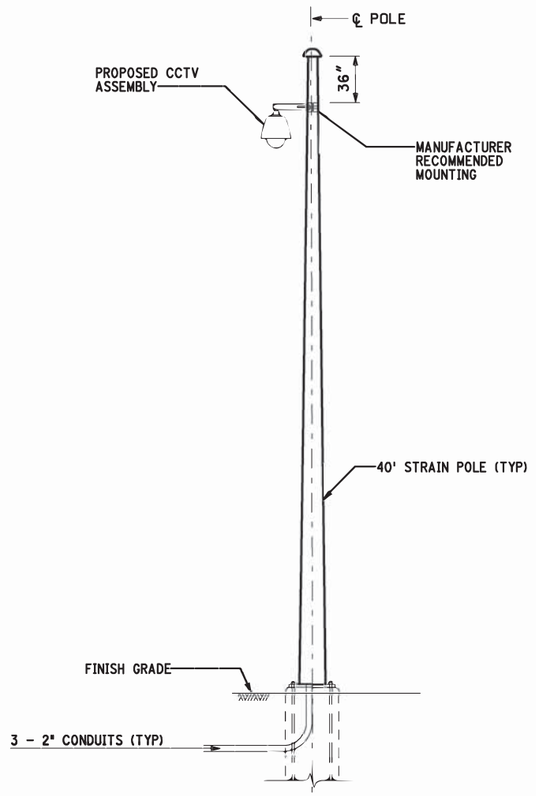
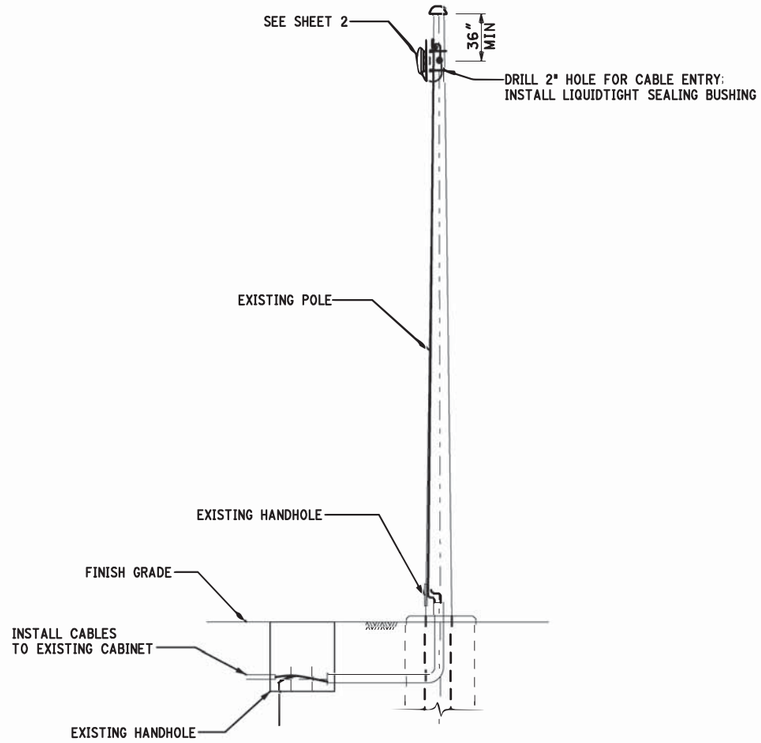
NO SCALE

	DATE: 11/10/2016	CS: 84923	SPUN CONCRETE POLE
PRINT DATE: 6/13/2014	DESIGN UNIT: PEPLINSKI	JN: 106329A	
FILE: Spun Concrete Pole.dgn	TSC: MUSKEGON		SHEET 1 OF 1

DRAWING	SHEET
MSDET 021	SECT 1 125



EQUIPMENT ON PROPOSED STEEL STRAIN POLE



CABLE ROUTING THROUGH EXISTING STRAIN POLE

NOTES:

1. ALL EQIUPMENT SHOWN ON POLES IS FOR DETAILING PURPOSES ONLY. SEE PLAN SHEET FOR ALL PAY ITEMS TO BE INSTALLED ON POLES.
2. CONTACT ENGINEER IF EXISTING GROUNDING LUG IS NOT WELDED TO STEEL POLE.
3. SEE SPECIAL PROVISION FOR REQUIRED SURGE SUPPRESSION DETAILS.
4. ALL WIRES ENTERING CONDUIT, LB'S AND SERVICE CAPS SHALL HAVE AN ESTABLISHED DRIP LOOP TO PREVENT WATER FROM ENTERING THE CONDUIT.
5. ANY LB OPENINGS THAT ARE NOT ATTACHED TO CONDUIT SHALL BE WEATHERPROOFED USING A SILICONE SEAL.
6. PLANS ARE DIAGRAMMATIC AND INDICATE THE GENERAL ARRANGEMENT OF EQUIPMENT AND WORK INCLUDED IN THESE DOCUMENTS. FINAL PLACEMENT AND ARRANGEMENT ARE THE RESPONSIBILITY OF THE CONTRACTOR. IT IS THE CONTRACTOR'S RESPONSIBILITY TO FIELD VERIFY WITH MDOT AND THE PROJECT ENGINEER FINAL EQUIPMENT PLACEMENT PRIOR TO INSTALLATION.
7. THE CONTRACTOR SHALL MAINTAIN EXISTING SYSTEMS DURING CONSTRUCTION. IT IS THE CONTRACTOR'S RESPONSIBILITY TO REPAIR/REPLACE EXISTING SYSTEMS THAT ARE DAMAGED DURING INSTALLATION

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

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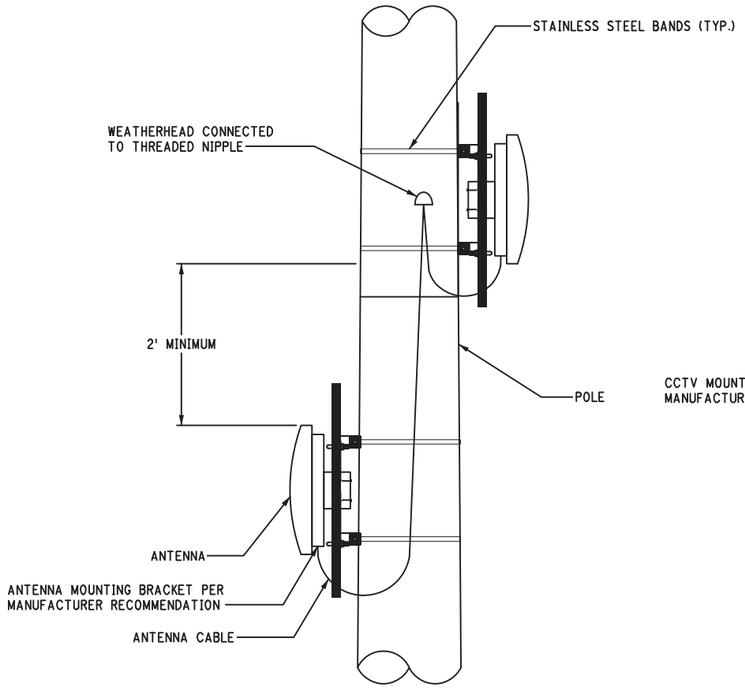
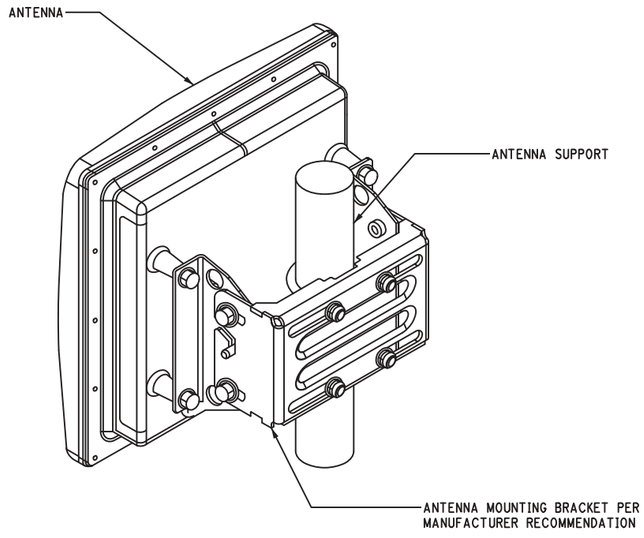
NO SCALE

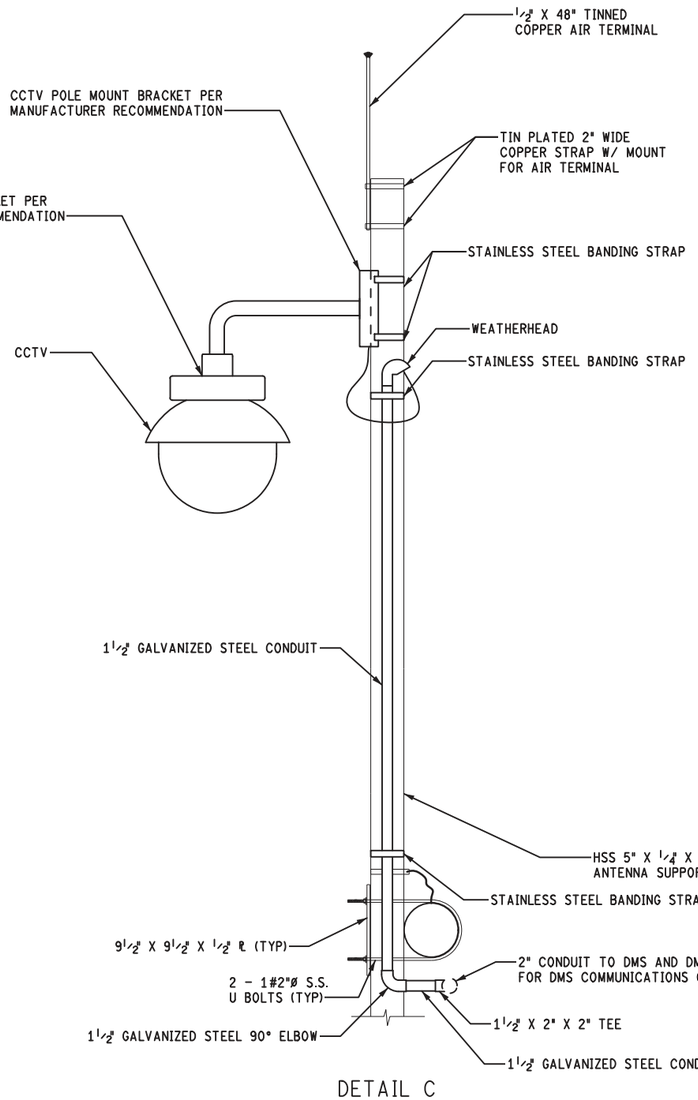
	DATE: 11/10/2016	CS: 84923	ITS DETAIL SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	MOUNTING DETAIL	MSDET 022	SECT 1 126
FILE: 106329_ITS_Mount_Detail1.dgn	TSC: MUSKEGON		SHEET 1 OF 2		



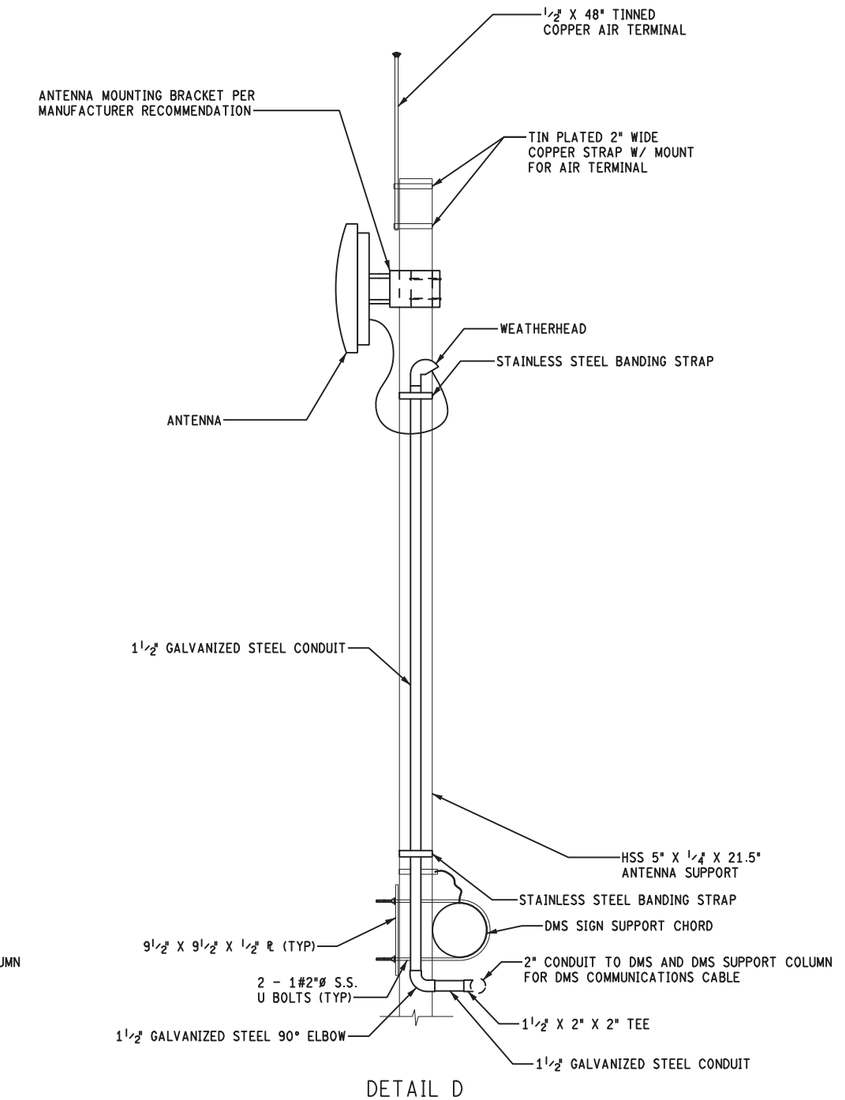
DETAIL A
ANTENNA MOUNTING ON STEEL POLE



DETAIL B
ANTENNA MOUNTING BRACKET



DETAIL C
CCTV MOUNTING ON DMS ANTENNA SUPPORT
(SEE NOTES 1 AND 2)



DETAIL D
ANTENNA MOUNTING ON DMS ANTENNA SUPPORT
(SEE NOTES 1 AND 2)

NOTES:
1. MOUNT CCTV AND MVDS AS CLOSE TO TOP OF DMS ANTENNA SUPPORT AS POSSIBLE WHILE MAINTAINING RELEVANT LOCAL AND NATIONAL CODES.
2. SEE "DMS SIGN SUPPORT" DETAIL ON MSDET 016 FOR ADDITIONAL REQUIREMENTS.

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NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

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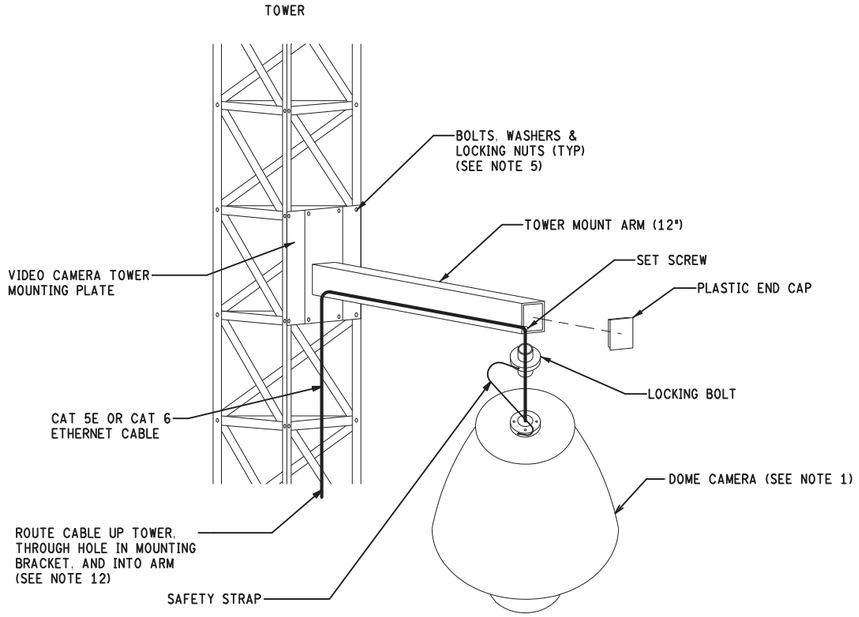
NO SCALE

DATE: 11/10/2016
DESIGN UNIT: PEPLINSKI
FILE: 106329_ITS_Mount_Detail2.dgn
TSC: MUSKEGON

CS: 84923
JN: 106329A

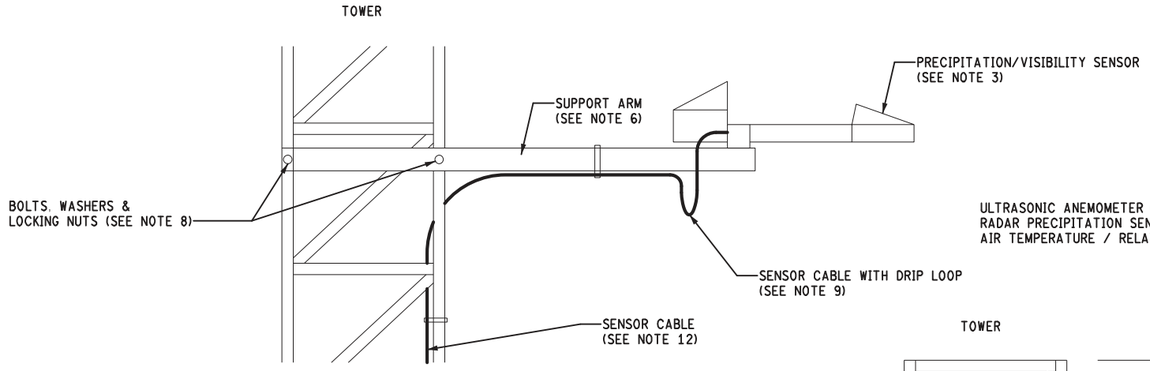
ITS DETAIL SHEET
MOUNTING DETAIL
SHEET 2 OF 2

DRAWING: MSDET 023
SHEET: SECT 1, 127



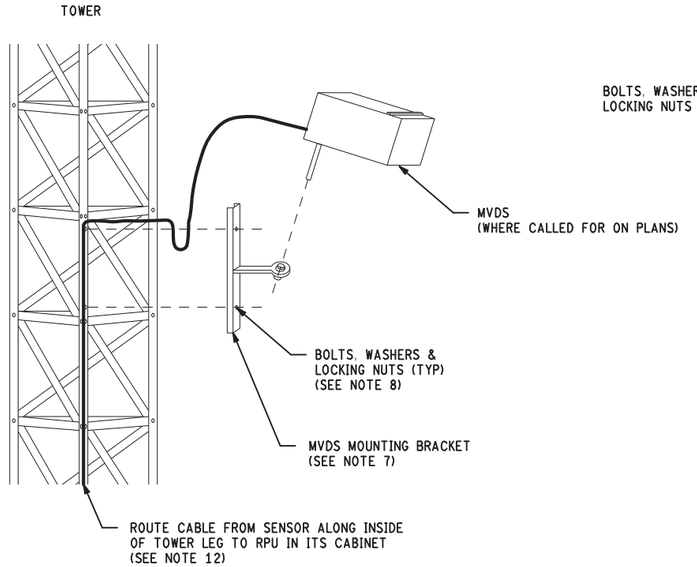
VIDEO CAMERA MOUNTING DETAIL ON TOWER

SCALE: NTS



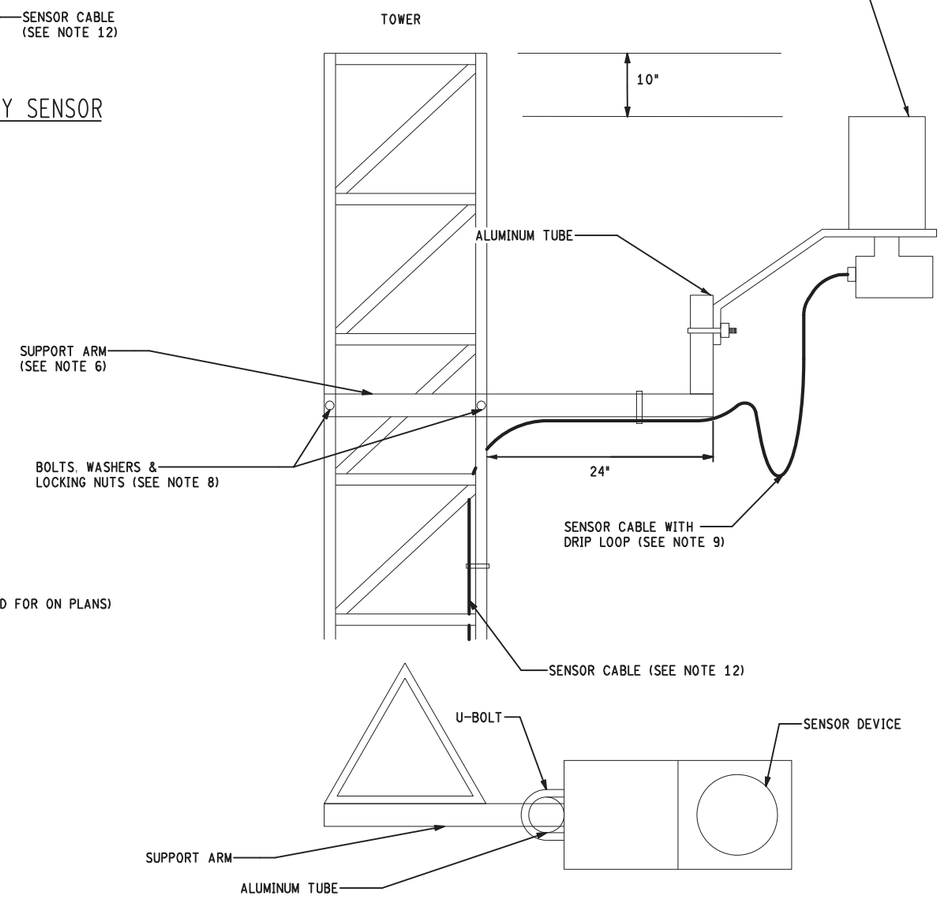
PRECIPITATION/VISIBILITY SENSOR ON TOWER

SCALE: NTS



TYPICAL MICROWAVE VEHICLE DETECTION SYSTEM (MVDS) MOUNTING DETAIL

SCALE: NTS



SENSORS DETAIL ON TOWER

SCALE: NTS

NOTES:

1. DOME CAMERA AND MOUNTING EQUIPMENT SHALL BE PAID FOR UNDER THE INTERNET PROTOCOL SURVEILLANCE SYSTEM, ENVIRONMENTAL SENSOR STATION PAY ITEM.
2. AIR TEMPERATURE/RELATIVE HUMIDITY SENSOR AND MOUNTING EQUIPMENT SHALL BE PAID FOR UNDER THE ATMOSPHERIC SENSOR, AIR TEMPERATURE/RELATIVE HUMIDITY PAY ITEM
3. PRECIPITATION/VISIBILITY SENSOR AND MOUNTING EQUIPMENT SHALL BE PAID FOR UNDER THE ATMOSPHERIC SENSOR, PRECIPITATION/VISIBILITY PAY ITEM.
4. ATTACHMENTS OF ALL DEVICES TO TOWER SHALL BE PER MANUFACTURER SPECIFICATIONS.
5. ALL HARDWARE SHALL BE STAINLESS STEEL.
6. SUPPORT ARM SHALL BE ANGLE ALUMINUM.
7. MOUNTING PLATE SHALL BE SIZED ACCORDINGLY FOR FLUSH INSTALL ON TOWER FACE.
8. ALL EQUIPMENT SHALL BE MOUNTED TO THE STRUCTURE WITH THE USE OF PRE-DRILLED HOLES ON THE TOWER. IT IS THE CONTRACTOR'S RESPONSIBLITY TO DETERMINE THE EXACT SIZE AND PLACEMENT OF THE HOLES ON THE TOWER. UNUSED HOLES SHALL BE FILLED USING APPROPRIATELY SIZED NUTS AND BOLTS.
9. EACH TOWER-MOUNTED SENSOR CABLE SHALL HAVE QUICK DISCONNECTS AT THE TOP AND BOTTOM OF THE TOWER.
10. ALL TIE WRAPS SHALL BE INSTALLED TO ENSURE THE CABLES ARE SECURELY TIED TO THE TOWER. TIE WRAPS SHALL BE WEATHER RESISTANT.
11. EQUIPMENT SHOWN ABOVE IS FOR DIAGRAMMATIC PURPOSES ONLY AND ARE NOT OF SPECIFIC PRODUCTS. CONTRACTOR SHALL PROCURE EQUIPMENT BASED ON THE SPECIFICATIONS IN THE PROPOSAL.
12. PROVIDE CABLE STRAIN RELIEF AS NESSARY TO PREVENT THE CABLE FROM BEING DAMAGED.
13. ULTRASONIC ANEMOMETER AND MOUNTING EQUIPMENT SHALL BE PAID FOR UNDER THE ATMOSPHERIC SENSOR, ULTRASONIC WIND PAY ITEM.
14. RADAR PRECIPITATION SENSOR AND MOUNTING EQUIPMENT SHALL BE PAID FOR UNDER THE ATMOSPHERIC SENSOR, RADAR PRECIPITATION PAY ITEM.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

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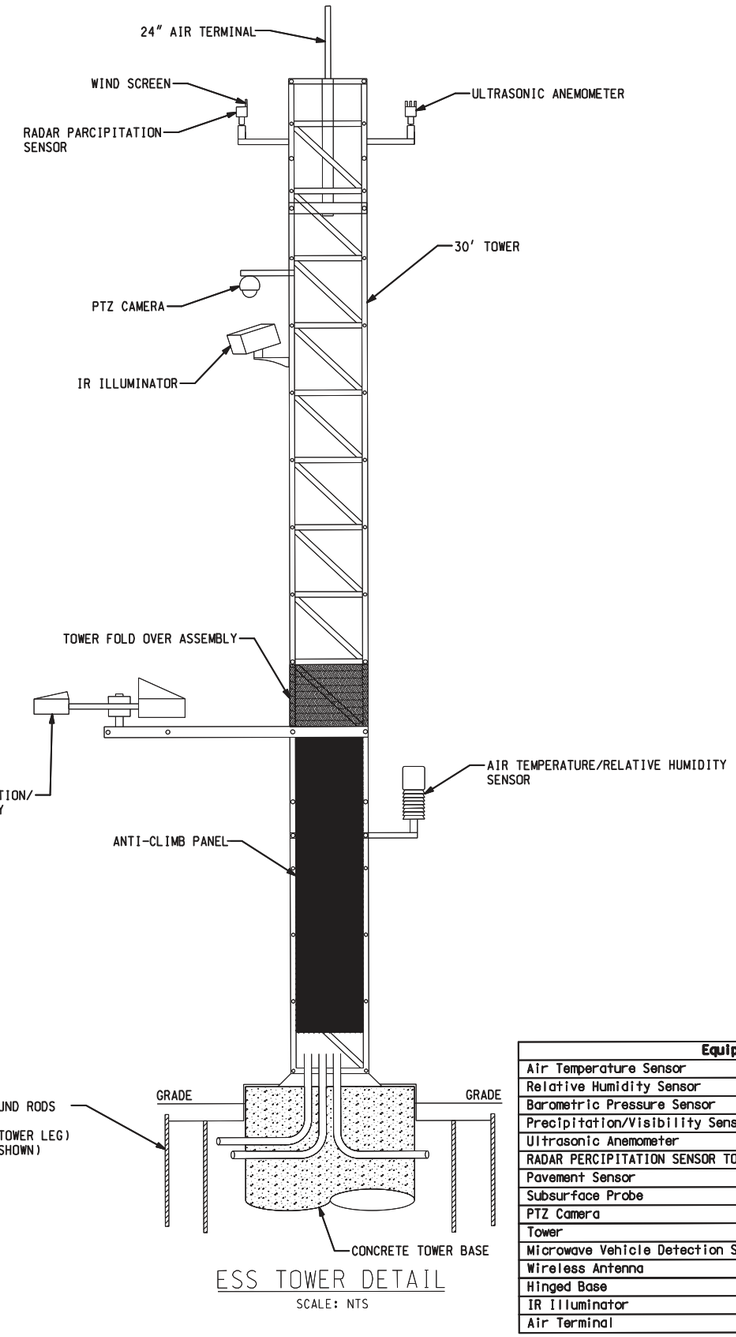
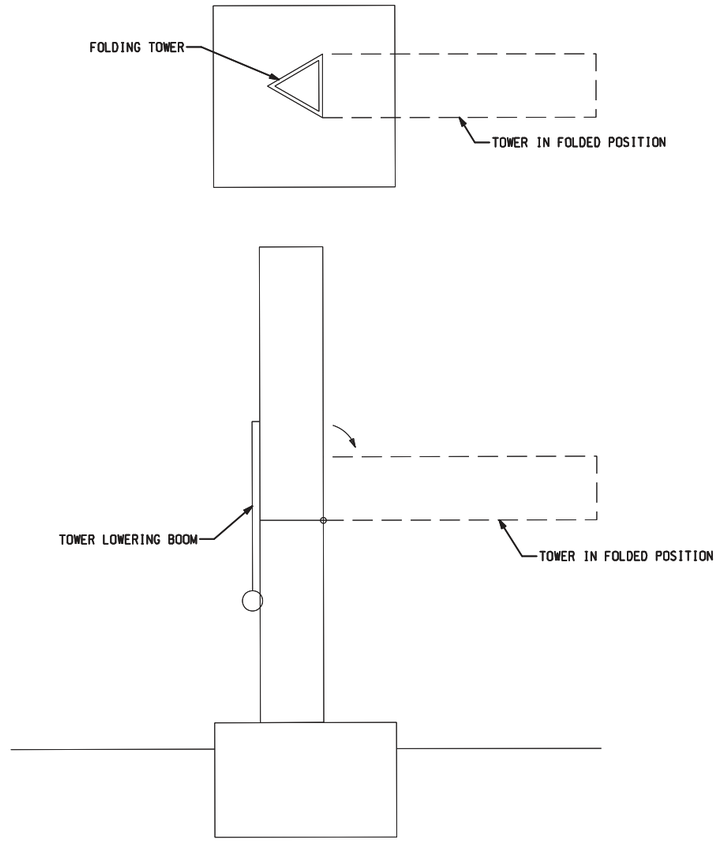
PRINT DATE: 9/28/2016	DATE: 11/10/2016	CS: 84923	ESS SENSOR DETAIL
FILE: ESS Sensor Detail 1.dgn	DESIGN UNIT: PEPLINSKI	JN: 106329A	SHEET 1 OF 1
	TSC: MUSKEGON		

DRAWING	SHEET
MSDET 024	SECT 1 128



ESS TOWER DETAIL

SCALE: NTS



TYPICAL TOWER FOLDING DETAIL

SCALE: NTS

Equipment	Recommended Mounting	Horiz Offset from Twr	Weight
Air Temperature Sensor	Tower, at approx 8' height	approx 12"	2 lb
Relative Humidity Sensor	Tower, at approx 8' height		incl
Barometric Pressure Sensor	In RPU cabinet	0 (inside RPU cabinet)	1 lb
Precipitation/Visibility Sensor and Visibility Sensor	Tower, at approx 8'7" height	approx 12"	34 lb
Ultrasonic Anemometer	Tower, 10" BELOW TOP OF TOWER	2'	2 lb
RADAR PERCIPITATION SENSOR TOWER	Tower, 10" BELOW TOP OF TOWER	2'	2 lb
Pavement Sensor	Flush with Pavement Surface	inset in ground	n/a
Subsurface Probe	In vertical array, below pavement	inset in ground	n/a
PTZ Camera	Tower, near top	approx 12"	10 lb
Tower			300 lb
Microwave Vehicle Detection System High Resolution (MVDS)	Tower, at 20' to 30' height (site specific)	0 (bolts directly to tower)	5 lb
Wireless Antenna	Tower, Near Top		5 lb
Hinged Base	Tower, Underneath		3 lb
IR Illuminator	Below Camera		3-4 lb
Air Terminal	TOP OF TOWER		

NOTES:

1. ITEMS NOT SHOWN:
   CONCRETE SERVICE PAD: IN-GROUND POWER,
   COMMUNICATION, SENSOR CABLES AND BAROMETRIC PRESSURE SENSOR.
2. IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL PTZ CAMERA TO PROVIDE BEST VIEWING ANGLE OF BOTH DIRECTIONS OF TRAFFIC AND SENSORS ON ROADWAY. FINAL PLACEMENT SHALL BE APPROVED BY THE ENGINEER.
3. LIGHTNING ROD MUST BE MOUNTED TO PROTECT ESS EQUIPMENT.
4. IR ILLUMINATOR SHALL BE ALIGNED TO PROVIDE BEST VIEW OF ROADWAY AND PAVEMENT SENSORS. FINAL PLACEMENT SHALL BE APPROVED BY THE ENGINEER.
5. ATTACHMENTS OF ALL DEVICES TO TOWER SHALL BE PER MANUFACTURER SPECIFICATIONS.
6. ALL HARDWARE SHALL BE STAINLESS STEEL.
7. ALL EQUIPMENT SHALL BE MOUNTED TO THE STRUCTURE WITH THE USE OF PRE-DRILLED HOLES ON THE TOWER. IT IS THE CONTRACTOR'S RESPONSIBLITY TO DETERMINE THE EXACT SIZE AND PLACEMENT OF THE HOLES ON THE TOWER. UNUSED HOLES SHALL BE FILLED USING APPROPRIATELY SIZED NUTS AND BOLTS.
8. EQUIPMENT SHOWN ABOVE IS FOR DIAGRAMMATIC PURPOSES AND ARE NOT OF SPECIFIC PRODUCTS. CONTRACTOR SHALL PROCURE EQUIPMENT BASED ON THE SPECIFICATIONS OF THE PROPOSAL.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

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PRINT DATE: 09/28/2016

FILE: ESS Tower Detail.dgn

DATE: 11/10/2016

DESIGN UNIT: PEPLINSKI

TSC: MUSKEGON

CS: 84923

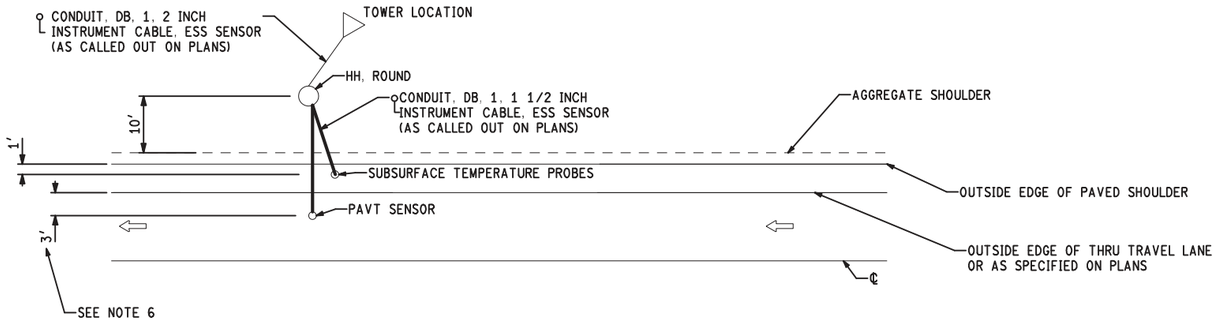
JN: 106329A

ESS TOWER DETAIL

SHEET 1 OF 1

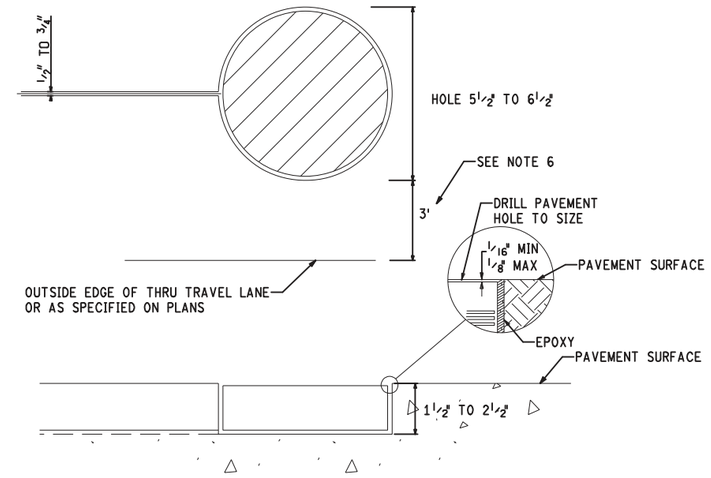
DRAWING: MSDET 025

SHEET: SECT 1 129



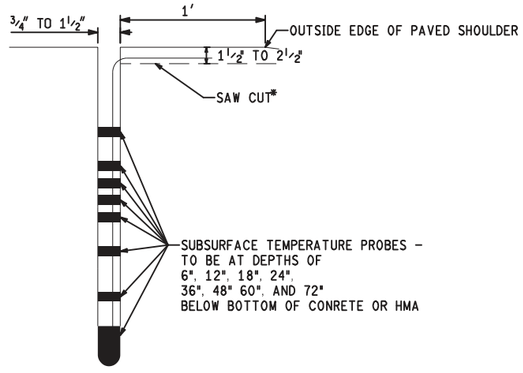
TYPICAL ROAD SENSORS DETAIL

SCALE: NTS



TYPICAL PAVEMENT SENSOR, INVASIVE CONDITION

SCALE: NTS



TYPICAL SUBSURFACE TEMPERATURE PROBE

SCALE: NTS

NOTES:

1. SENSOR CABLES SHALL RUN FROM REMOTE PROCESSING UNIT (RPU) CABINET TO SENSOR WITHOUT SPLICES. HH, ROUND TO BE USED AS PULL BOXES FOR EASY INSTALLATION AND MAINTENANCE.
2. PAVEMENT CUT TO BE NORMAL SAW BLADE SIZE TO HOLD SENSOR CABLE. PAVEMENT CUT SHALL BE FILLED WITH APPROPRIATE FLEXIBLE SEALANT AS RECOMMENDED BY MANUFACTURER (3M DBR-6 OR APPROVED EQUAL). PAVEMENT CUT AND SEALANT SHALL BE PAID FOR UNDER THE SITE, RWIS, BASIC ESS PAY ITEM
3. ALL ESS SENSORS, EQUIPMENT AND INSTRUMENT CABLE, ESS SENSOR SHALL BE PAID FOR UNDER THE PAVEMENT SENSOR, INVASIVE CONDITION AND SUBSURFACE TEMPERATURE PROBE.
4. THE CONDITIONS OF THE MATERIALS UNDERNEATH THE ROADWAY SURFACE ARE UNKNOWN AND ANY COSTS INCURRED WHILE INSTALLING EQUIPMENT IN ROADWAY SHALL BE PAID FOR UNDER THE PAVEMENT SENSOR, INVASIVE CONDITION OR SUBSURFACE TEMPERATURE PROBE.
5. SUBSURFACE PROBE SHALL BE PLACED 1' FROM THE OUTSIDE EDGE OF SHOULDER. FINAL PLACEMENT SHALL BE APPROVED BY THE ENGINEER.
5. INVASIVE PAVEMENT SENSOR MUST BE A MINIMUM OF THREE FEET FROM EDGE OF TRAVEL LANE, OR AS RECOMMENDED BY THE MANUFACTURER.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)

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FILE: Road Sensor Detail.dgn

DATE: 11/10/2016
DESIGN UNIT: PEPLINSKI
TSC: MUSKEGON

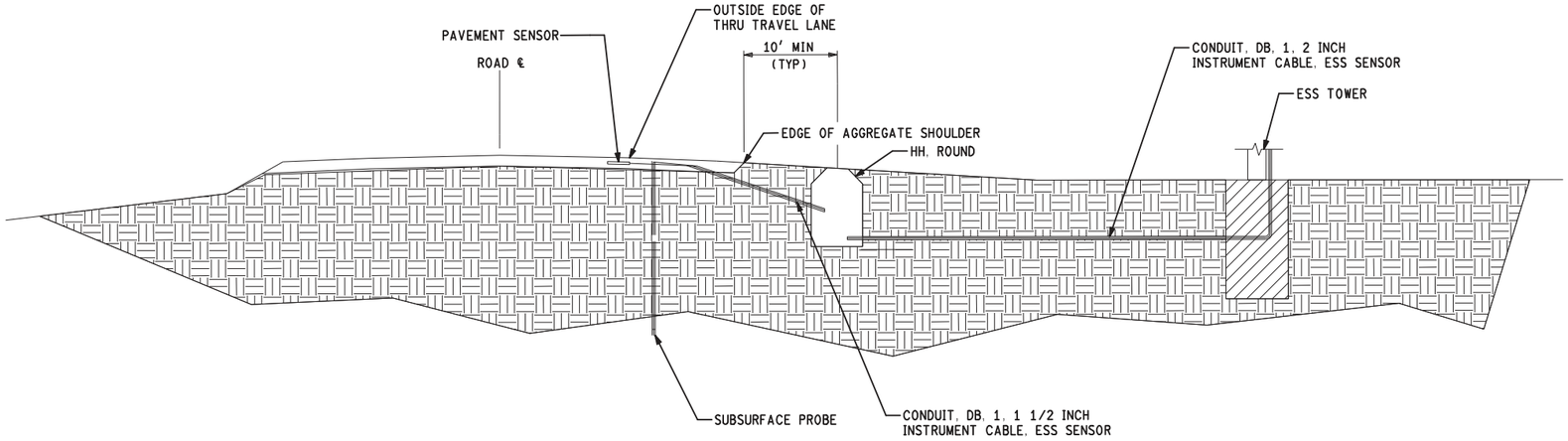
CS: 84923
JN: 106329A

ROAD SENSOR DETAIL

SHEET 1 OF 1

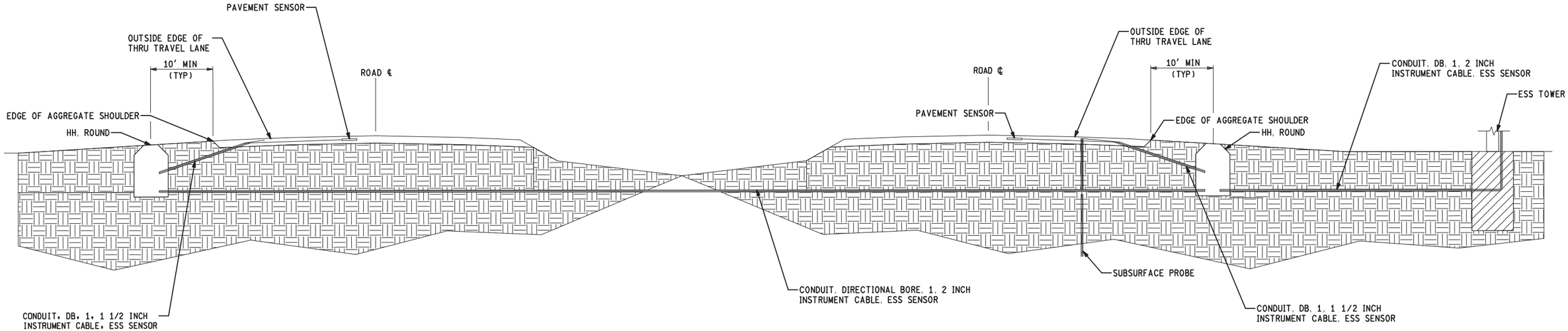
DRAWING: MSDET 026

SHEET: SECT 1 130



TYPICAL 2 LANE 2 WAY ESS ROADWAY DETAIL

SCALE: NTS



TYPICAL ESS ROADWAY DETAIL FOR FREEWAY

SCALE: NTS

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

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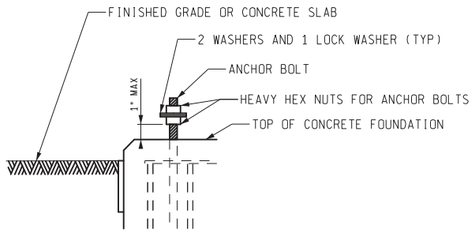
CS: 84923
JN: 106329A

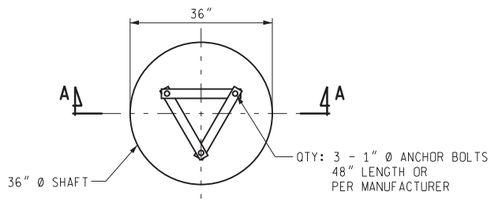
ESS TYPICAL DETAIL
SHEET 1 OF 1

DRAWING: MSDET 027
SHEET: SECT 1 131



ANCHOR BOLT DETAIL
PARTIAL ELEVATION

CONDUITS NOT SHOWN IN THIS VIEW FOR CLARITY.



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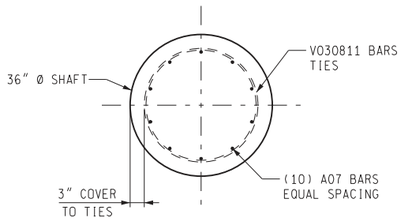
PLAN VIEW



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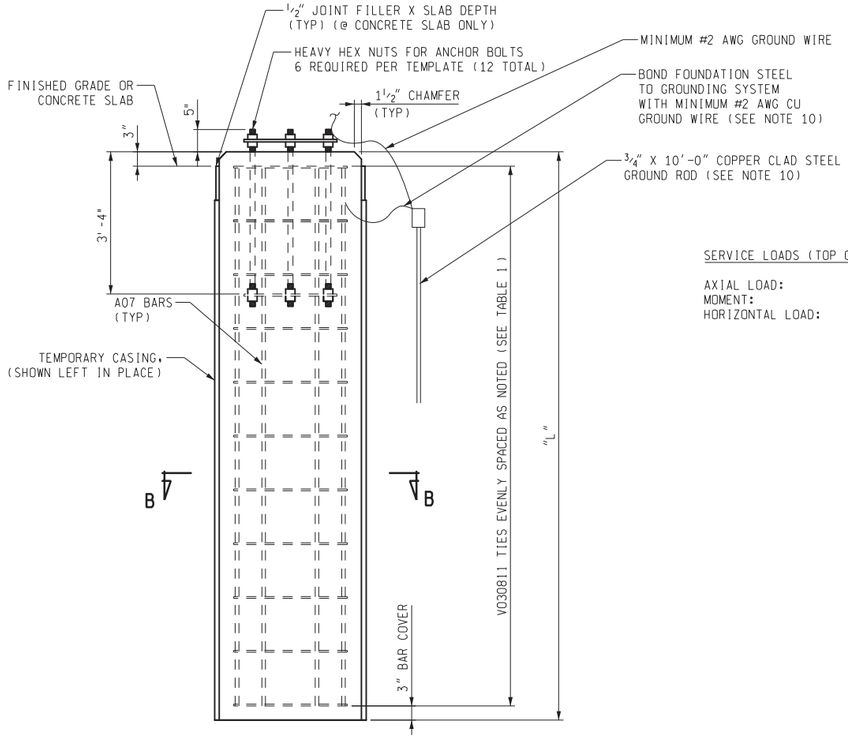
SECTION B-B



ESS DRILLED SHAFT
SECTION A-A

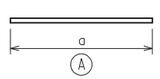
CONDUIT NOT SHOWN FOR CLARITY

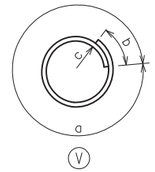
SERVICE LOADS (TOP OF FOUNDATION):

AXIAL LOAD:	0.78 KIPS
MOMENT:	20.3 KIP-FT
HORIZONTAL LOAD:	1.08 KIPS

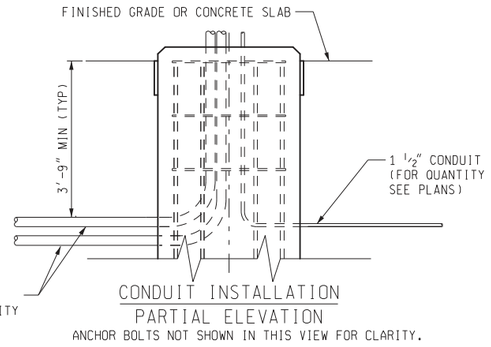
BAR SIZE
BAR LENGTH (FT)
BAR LENGTH (IN)
A064700
BAR SHAPE

BAR LEGEND



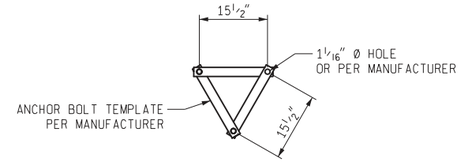


DRILLED SHAFT LENGTH	
EES LOCATION	L
US31N-MM110.2	20'
US31N-MM115.8	20'
I96W-MM018.5	20'
US31N-MM128.7	20'
US31N-MM102.5	20'
I196E-MM061.8	20'



CONDUIT INSTALLATION
PARTIAL ELEVATION

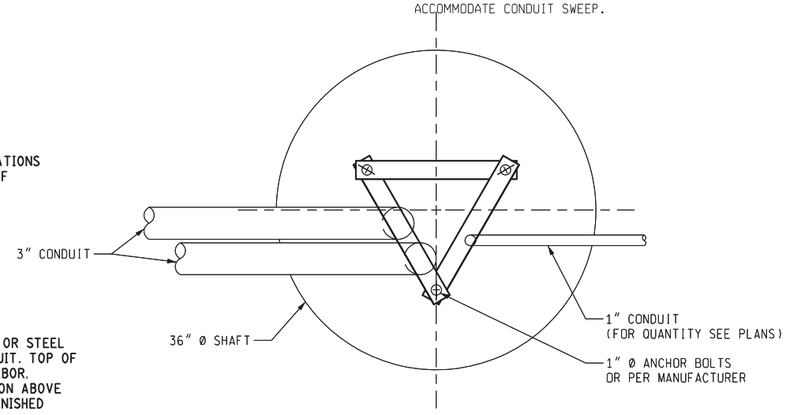
ANCHOR BOLTS NOT SHOWN IN THIS VIEW FOR CLARITY.



ANCHOR BOLT TEMPLATE DETAIL
PLAN VIEW (2 REQ'D PER FOUNDATION)

NOTE: ALL DIMENSIONS TYPICAL

V03 BAR SPACING MAY BE ADJUSTED IN FIELD TO ACCOMMODATE CONDUIT SWEEP.



CONDUIT INSTALLATION PLAN

REINFORCEMENT STEEL NOT SHOWN FOR CLARITY

NOTES:

1. ALL MATERIALS & CONSTRUCTION SHALL CONFORM TO THE REQUIREMENTS OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION.
2. CONTRACTOR MUST TAKE APPROPRIATE PRECAUTIONS TO PREVENT DAMAGING EXISTING STRUCTURES AND UTILITIES. ANY DAMAGE TO EXISITNG STRUCTURES OR UTILITIES MUST BE REPAIRED AT THE CONTRACTOR'S EXPENSE TO THE SATISFACTION OF THE ENGINEER, INCLUDING ENGINEERING ANALYSUS AND REDESIGN, AND WITHOUT ANY EXTENSION OF THE COMPLETION DATES FOR THE PROJECT.
3. ALL DISTURBED AREAS SHALL BE RESTORED IN ACCORDANCE WITH THE SPECIAL PROVISION FOR, "Slope Restoration, TYPE A". CONTRACTOR IS TO MINIMIZE THE AREAS OF DISTURBANCE AS MUCH AS IT IS PRACTICAL.
4. CONCRETE MUST BE PROTECTED FROM FLOWING WATER AND DAMAGE FROM MECHANICAL EQUIPMENT AND NEARBY CONSTRUCTION VIBRATIONS. VIBRATIONS FROM CONSTRUCTION OPERATIONS (VIBRATORY CASING INSTALLATIONS, CONCRETE DEMOLITION, ETC.) WILL NOT BE PERMITTED WITHIN A RADIUS OF 25 FEET UNTIL THE CONCRETE HAS ATTAINED 75 PERCENT OF ITS SPECIFIED MINIMUM STRENGTH.
5. CONCRETE MUST BE PROTECTED FROM STRENGTH REDUCTION CAUSED BY HEAT, FROST OR FREEZING ACTIONS PER SECTION 706.03 OF THE STANDARD SPECIFICATIONS.
6. FINAL CONDUIT LOCATIONS AND HARDWARE INSTALLATION CONFIGURATION PLANS, INCLUDING WIRING CIRCUIT SCHEMATICS, TO BE SUBMITTED IN CONTRACTOR'S DRILLED SHAFT INSTALLATION PLANS FOR APPROVAL BY THE ENIGNEER.
7. CONDUIT MUST BE AS SPECIFIED IN SECTION 819 OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION.
8. SEE PLANS FOR TOP OF SHAFT ELEVATION. IN ORDER FOR CONDUIT TO ENTER FOUNDATION, CONTRACTOR MAY CUT HOLES IN THE STEEL CASING OR STEEL CASING MAY STOP AT THE CONDUIT ENTRANCE TO FOUNDATION. CUT HOLES MUST BE LOCATED, CUT AND FINISHED SO AS NOT TO DAMAGE CONDUIT. TOP OF FOUNDATION MUST BE FORMED SEPARATELY IF THE STEEL CASING STOPS AT THE CONDUIT ENTRANCE TO THE FOUNDATION. THE COST OF ALL LABOR, MATERIALS, AND EQUIPMENT NECESSARY TO CUT HOLES IN THE STEEL CASING OR FORM, POUR, FINISH AND CURE THE PORTION OF THE FOUNDATION ABOVE THE CASING SHALL BE INCLUDED IN THE BID ITEM "Drilled Shaft, 30 inch". AT CONTRACTOR'S OPTION, THE CASING MAY STOP 1'-0" BELOW FINISHED GRADE ELEVATIONS.
9. COBBLES, BOULDERS OR RIPRAP MUST NOT BE CLASSIFIED AS OBSTRUCTIONS.
10. ALL GROUNDING WORK INCLUDING MATERIALS AND LABOR SHALL BE PAID FOR IN ACCORDANCE WITH THE SPECIAL PROVISION FOR "GROUNDING, BONDING, LIGHTNING PROTECTION AND SURGE PROTECTION FOR ITS EQUIPMENT".

REINFORCEMENT BAR & ANCHOR BOLT NOTES:

1. REINFORCEMENT BARS FOR FOUNDATION SHALL BE GRADE 60 DEFORMED BARS AS SPECIFIED IN SECTION 905.03 OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION.
2. CONTRACTOR SHALL VERIFY ANCHOR BOLT PATTERN PRIOR TO FABRICATION OF ANCHOR BOLTS AND TEMPLATES.
3. ANCHOR BOLTS ARE TO BE VERTICAL & POSITIONED AS SHOWN IN PLAN.
4. TEMPLATE PLATES & ANCHOR BOLT CAGE SHALL BE SHOP FABRICATED, ASSEMBLED, AND APPROVED BY MDOT PRIOR TO SHIPPING.
5. DIAMETER OF BOLT HOLES IN TEMPLATES SHALL BE 1/16" LARGER THAN ANCHOR BOLT DIAMETER.
6. INSTALL AND TIGHTEN BOLTS/NUTS ACCORDING TO SUBSECTION 810.03N OF THE STANDARD SPECIFICATIONS FOR CONSTRUCTION, EXCEPT ADDITIONAL ONE-THIRD TURN AFTER SNUG CONDITION IS NOT REQUIRED.
7. THE TEMPLATES SHALL BE WELL SUPPORTED, HORIZONTALLY LEVEL & FIRMLY ANCHORED IN PLACE FOR A MINIMUM OF 24 HOURS AFTER THE CONCRETE PLACEMENT IS COMPLETED.
8. DUE CARE SHALL BE TAKEN DURING THE CONCRETE PLACEMENT TO AVOID DISPLACING THE ANCHOR BOLTS.
9. NO HAMMERING ON OR CUTTING OF THE ANCHOR BOLTS OR TEMPLATES WILL BE ALLOWED. NO CHISELING OR DAMAGING OF GALVANIZED FINISH WILL BE PERMITTED.
10. AFTER TOP TEMPLATE IS REMOVED, THREAD NUTS ON TO THE BOLT FLUSH WITH THE BOLT END TO PROTECT THREADS UNTIL FRAME IS ERECTED.

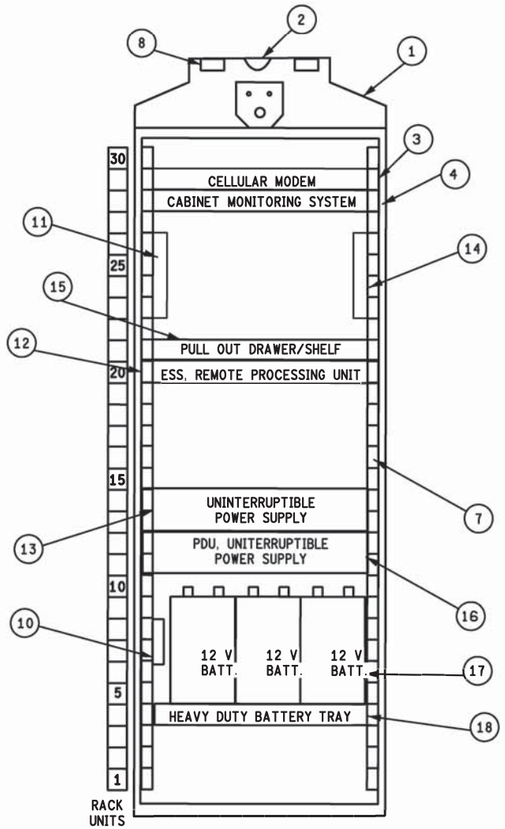
FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

	DATE: 11/10/2016	CS: 84923	TOWER FOUNDATION DETAIL	DRAWING / SHEET
PRINT DATE: 11/1/2016	DESIGN UNIT: PEPLINSKI	JN: 106329A		MSDET 028 / SECT 1 132
FILE: Tower Foundation Detail.dgn	TSC: MUSKEGON		SHEET 1 OF 1	

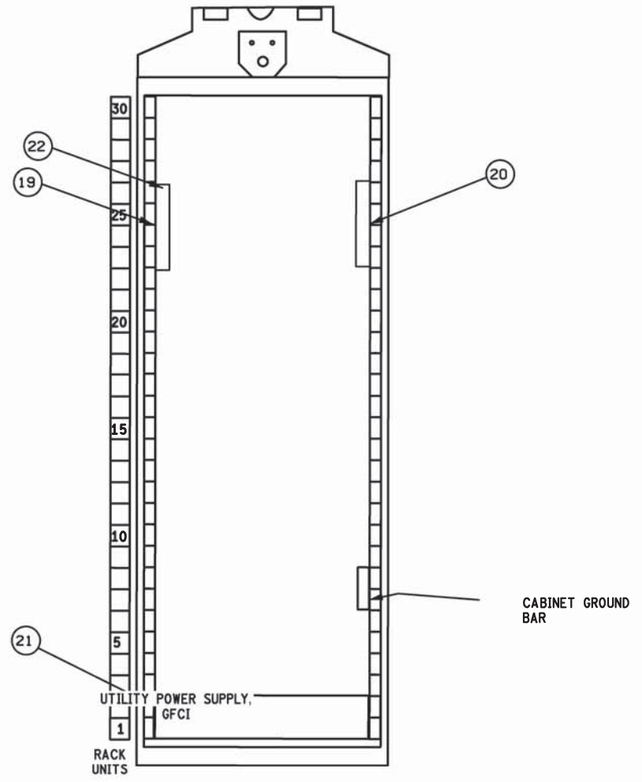
BILL OF MATERIALS		
ITEM NO.	DESCRIPTION	QUANTITY
1	CABINET MODEL	1
2	CABINET FAN KIT	1
3	CELLULAR MODEM, 4G	1
4	CABINET MONITORING SYSTEM	1
5	CABINET R-4 INSULATION KIT	1
6	CABINET SUN SHIELD KIT	1
7	CABINET 19" RACK FRAME	1
8	CABINET LED LIGHTING KIT	1
9	CABINET ANCHOR BOLT KIT	1
10	CABINET GROUND BUS BAR KIT	1
11	MANAGED FIELD ETHERNET SWITCH, LAYER 3 SPECIAL	1
12	ESS, REMOTE PROCESSING UNIT	1
13	650 WATTS UPS	1
14	DIGITAL VIDEO ENCODER, H.264	1
15	PULLOUT DRAWER SHELF	1
16	POWER DISTRIBUTION UNIT, UPS	1
17	12 VOLT BATTERY	3
18	19" HEAVY DUTY BATTERY TRAY	1
19	MICROWAVE VEHICLE DETECTION SYSTEM	1
20	MANAGED FIELD ETHERNET SWITCH, LAYER 2	1
21	UTILITY POWER SUPPLY, GFCI	1
22	COMMUNICATION SURGE PROTECTION FOR MVDS	1



COMMUNICATIONS
CABINET RACK LAYOUT
FRONT VIEW

NOTES:

1. BILL OF MATERIALS ITEMS 11, 14, 19, 20 AND 22 ARE DIN RAIL MOUNTED.



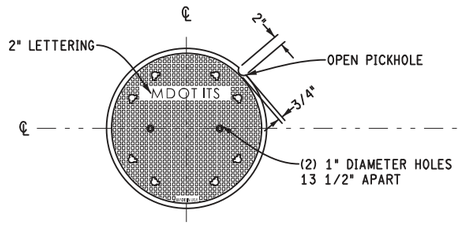
COMMUNICATIONS
CABINET RACK LAYOUT
REAR VIEW

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

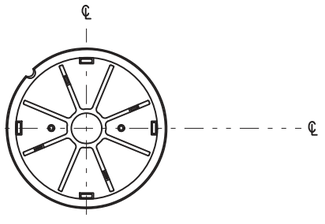
NO SCALE

	DATE: 11/10/2016	CS: 84923	COMBINED ITS/ESS CABINET	DRAWING	SHEET
PRINT DATE: 01/26/2016	DESIGN UNIT: PEPLINSKI	JN: 106329A		MSDET 029	SECT 1 133
FILE: ITS-ESS Combined Cabinet.dgn	TSC: MUSKEGON		SHEET 1 OF 1		



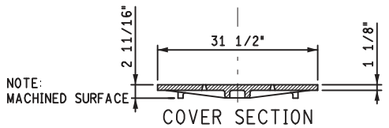
TOP VIEW OF COVER

NOT TO SCALE



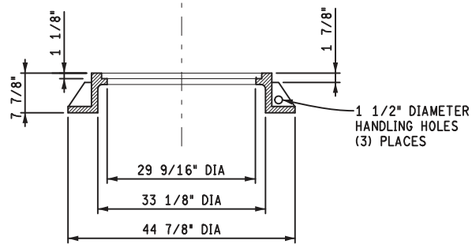
BOTTOM VIEW OF COVER

NOT TO SCALE



COVER SECTION

NOT TO SCALE



FRAME SECTION

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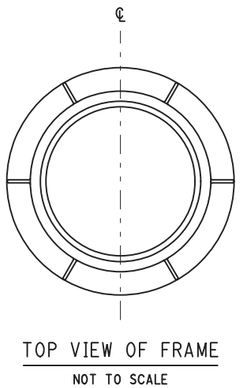
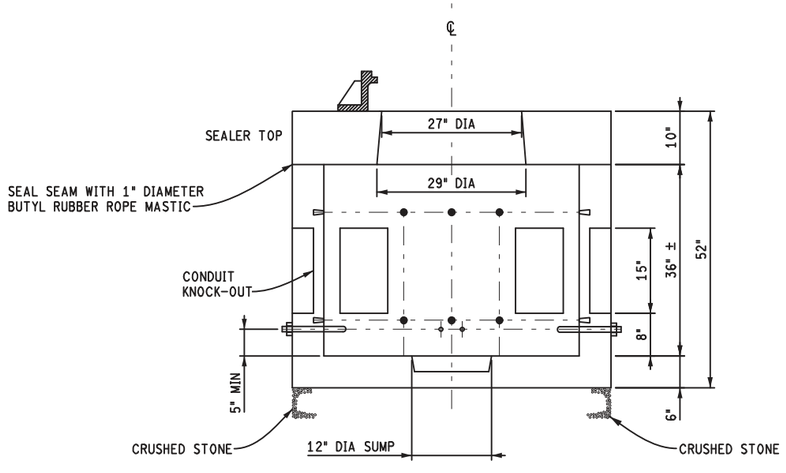


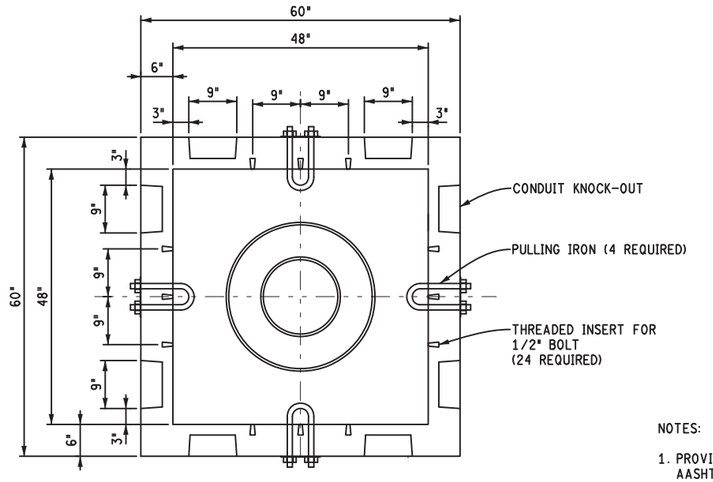
TOP VIEW OF FRAME

NOT TO SCALE



SIDE VIEW OF TYPE D HANDHOLE

NOT TO SCALE



TOP VIEW OF TYPE D HANDHOLE

NOT TO SCALE

NOTES:

1. PROVIDE HANDHOLE AND COVER MEETING THE REQUIREMENTS OF AASHTO HS 25 FOR WHEEL LOADING.
2. CURRENT COVER AND FRAME FOR TYPE D HANDHOLES ARE EAST JORDAN IRON WORKS PART NO. 1220 OR APPROVED EQUAL, A.S.T.M. CLASS 30 GRAY IRON, HEAVY DUTY, APPROX. WT. 685#.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

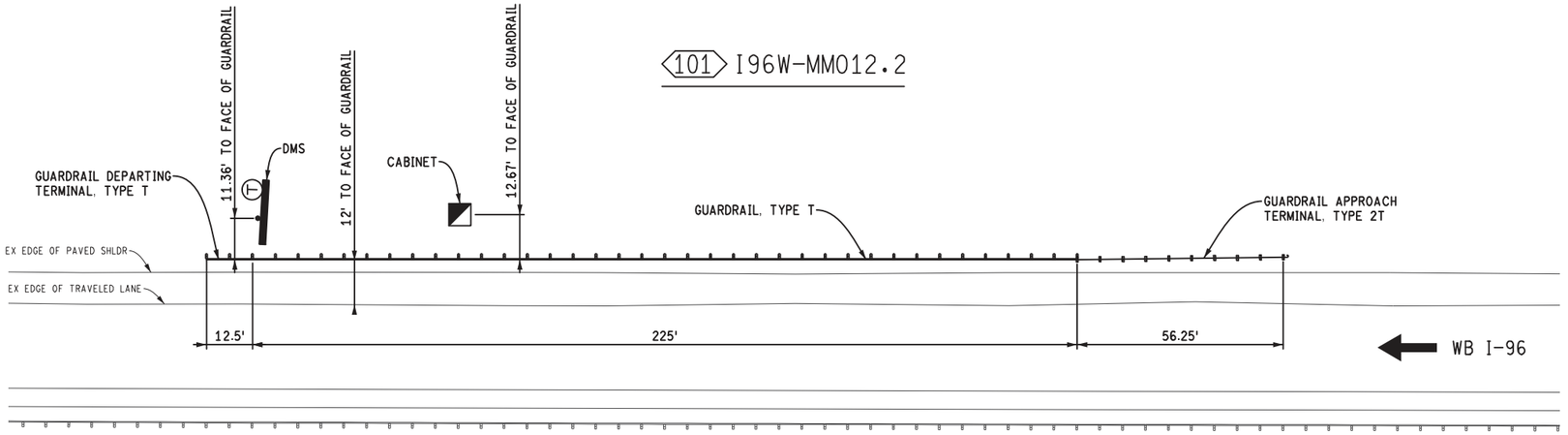
MDOT Michigan Department of Transportation

NO SCALE

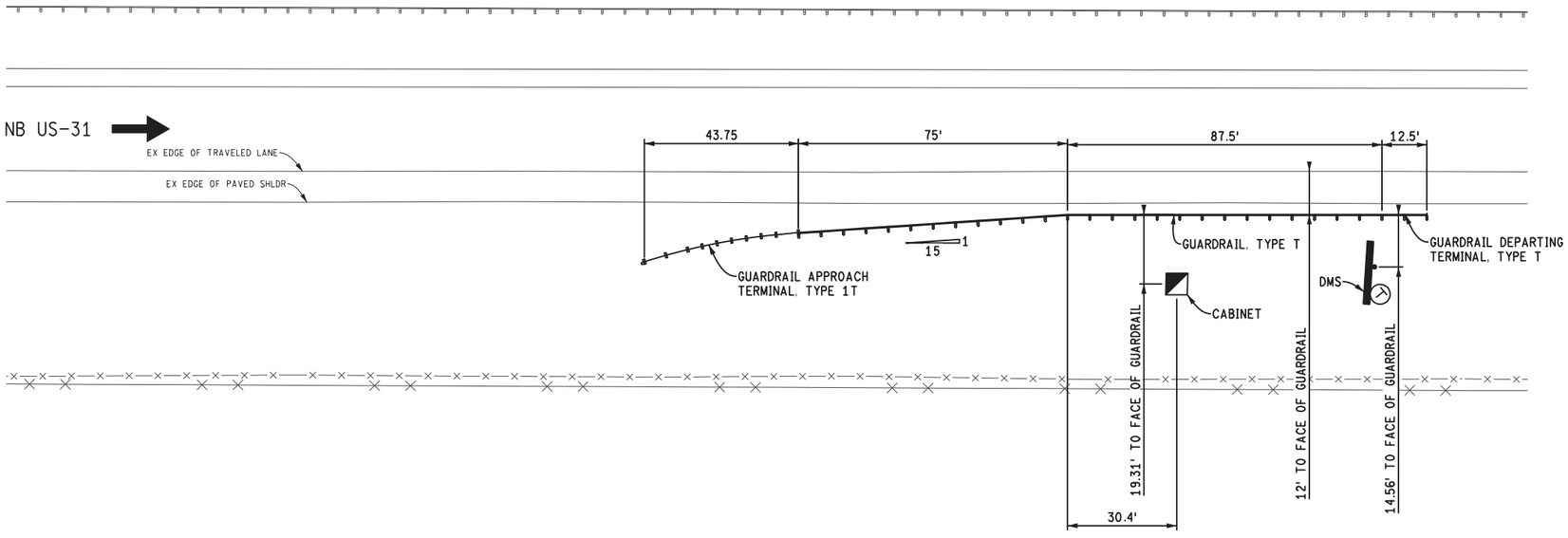
PRINT DATE: 6/13/2014	DATE: 11/10/2016	CS: 84923	HANDHOLE, TYPE D
FILE: Handhole, Type D.dgn	DESIGN UNIT: PEPLINSKI	JN: 106329A	SHEET 1 OF 1
	TSC: MUSKEGON		

DRAWING	SHEET
MSDET 030	SECT 1 134

101 I96W-MM012.2



102 US31N-MM107.2



FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

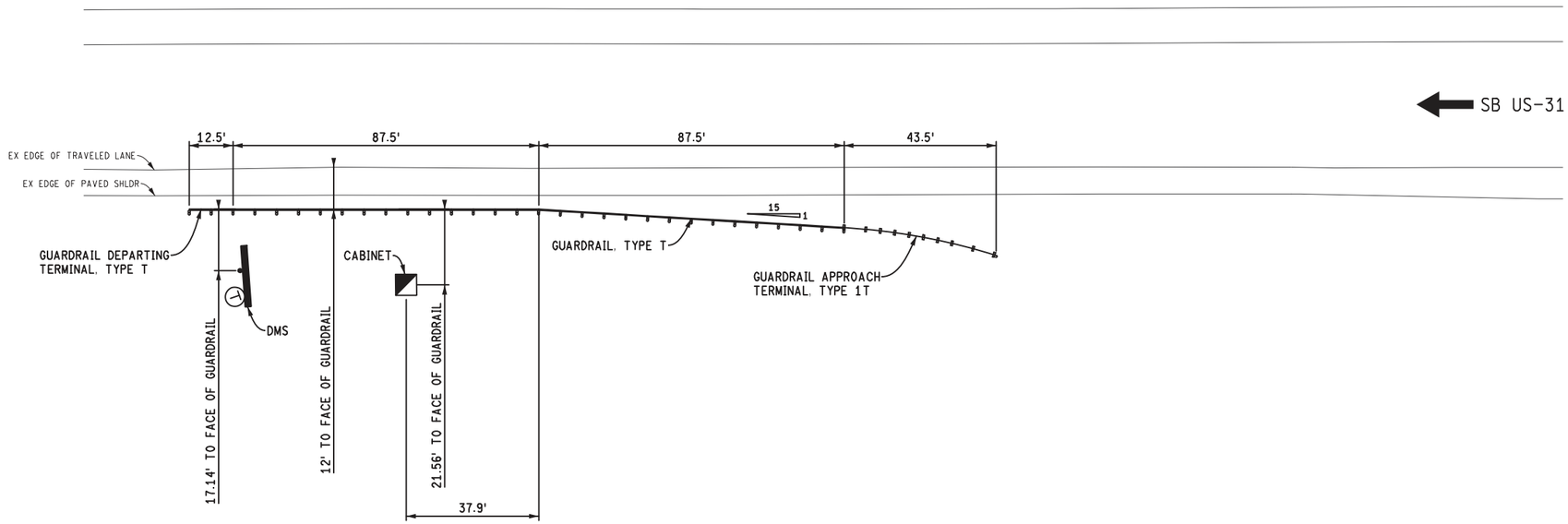
MDOT Michigan Department of Transportation

0 HORZ. (FT) 40

	DATE: 11/10/2016	CS: 84923	GUARDRAIL DETAIL SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	I96W-MM012.2 & US31N-MM107.2
FILE: 106329_Guardrail_Detail_1.dgn	TSC: MUSKEGON		

DRAWING	SHEET
MSDET 031	SECT 1 135

103 US31M-MM118.1

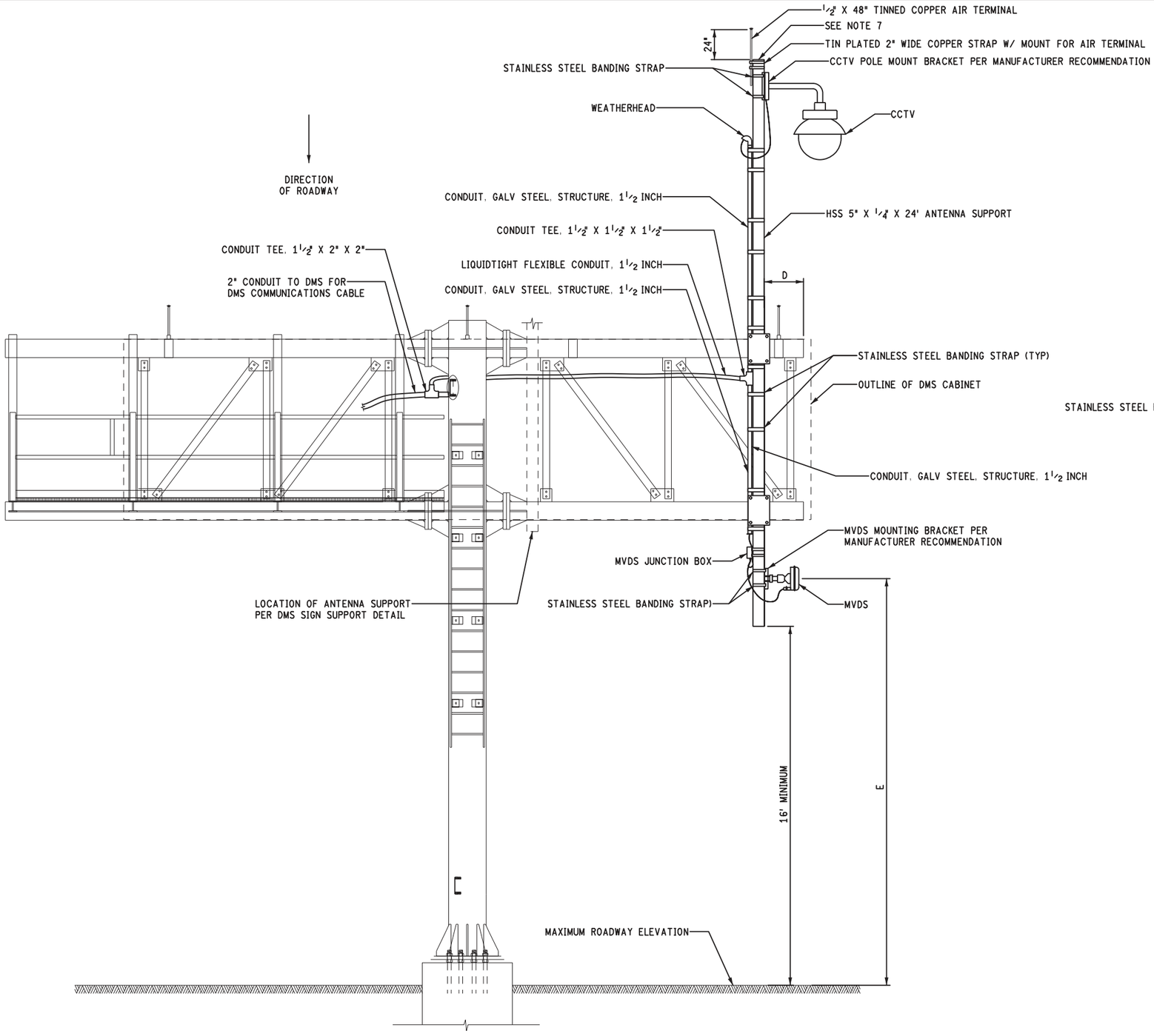


FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

0 HORZ. (FT) 40

	DATE: 11/10/2016	CS: 84923	GUARDRAIL DETAIL SHEET	DRAWING	SHEET
	DESIGN UNIT: PEPLINSKI	JN: 106329A	US31M-MM118.1	MSDET 032	SECT 1 136
FILE: 106329_Guardrail_Detail_2.dgn	TSC: MUSKEGON				



ELEVATION
DMS STRUCTURE REAR VIEW

NOTES:
1. MOUNT CCTV AS CLOSE TO TOP OF DMS ANTENNA SUPPORT AS POSSIBLE WHILE MAINTAINING RELEVANT LOCAL AND NATIONAL CODES.
2. SEE "DMS SIGN SUPPORT" DETAIL FOR ADDITIONAL REQUIREMENTS.
3. IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL CAMERA TO PROVIDE BEST VIEWING ANGLE OF BOTH DIRECTIONS OF TRAFFIC. FINAL PLACEMENT SHALL BE INCLUDED IN THE PRE-CONSTRUCTION SITE SURVEY AND APPROVED BY THE ENGINEER.
4. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE FINAL MOUNTING HEIGHT "E" OF MVDS TO PROVIDE OPTIMAL MVDS PERFORMANCE. FINAL PLACEMENT SHALL BE INCLUDED IN THE PRE-CONSTRUCTION SITE SURVEY AND APPROVED BY THE ENGINEER.
5. IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL ANTENNA SUPPORT AT AN OFFSET "D" FROM THE EDGE OF DMS SUPPORT CHORD TO PROVIDE OPTIMAL MVDS PERFORMANCE. FINAL MVDS PLACEMENT MAY BE BELOW BOTTOM DMS SUPPORT CHORD OR ABOVE TOP DMS SUPPORT CHORD. FINAL PLACEMENT SHALL BE INCLUDED IN THE PRE-CONSTRUCTION SITE SURVEY AND APPROVED BY THE ENGINEER.
6. SECURE ALL CONDUIT, CONDUIT TEES, AND CABLES IN ACCORDANCE WITH NEC AND RELEVANT LOCAL AND NATIONAL CODES.
7. ANTENNA SUPPORT SHALL NOT EXTEND BEYOND 13 FEET ABOVE THE TOP OF THE TOP DMS SIGN SUPPORT CHORD.

FINAL ROW PLAN REVISIONS (SUBMITTAL DATE:)							
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION

MDOT Michigan Department of Transportation

NO SCALE

	DATE: 1/10/2016	CS: 84923	ITS DETAIL SHEET	DRAWING	SHEET
PRINT DATE: 1/6/2017	DESIGN UNIT: PEPLINSKI	JN: 106329A	MOUNT CCTV AND MVDS ON DMS ANTENNA SUPPORT	MSDET 033	SECT 137
FILE: CCTV MVDS ANTENNA MOUNT.dgn	TSC: MUSKEGON				