

TRAFFIC SIGNAL STRUCTURES DESIGN GUIDELINES

CS: Statewide

MICHIGAN TRAFFIC SIGNAL 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 statements 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.

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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

Where national standards or specifications (e.g., AASHTO, MUTCD) are referenced herein, the designer shall utilize the current edition, including all interim revisions, as formally adopted by the Federal Highway Administration (FHWA) in 23 CFR 625 (Design Standards for Highways) at the time of project scoping, unless otherwise directed by MDOT.

- 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**
- L. Public Right-of-Way Accessibility Guidelines (PROWAG)**

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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
ADA	Americans with Disabilities Act
AISC	American Institute for Steel Construction
FHWA	Federal Highway Administration
LRFD	Load and Resistance Factor Design
MiOSHA	Michigan Occupational Safety and Health Administration
MDOT.....	Michigan Department of Transportation
MMUTCD	Michigan Manual on Uniform Traffic Control Devices
POCH	Point of Contact Height
ROW	Right-of-Way
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

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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.

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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

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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**.

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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.

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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.

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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

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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;

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- 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**.

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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.

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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 residences. 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.

MICHIGAN TRAFFIC SIGNAL STRUCTURES DESIGN GUIDELINES

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 outlined in the **Public Right-of-Way Accessibility Guidelines (PROWAG)**.

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)**.

MICHIGAN TRAFFIC SIGNAL STRUCTURES DESIGN GUIDELINES

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

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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

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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 traffic 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.

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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.

MICHIGAN TRAFFIC SIGNAL STRUCTURES DESIGN GUIDELINES

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

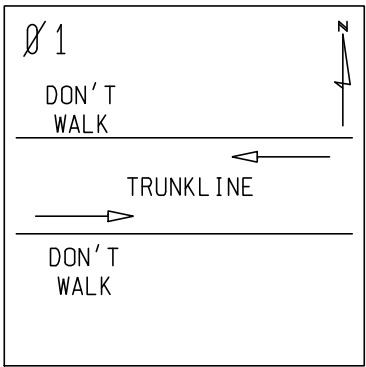
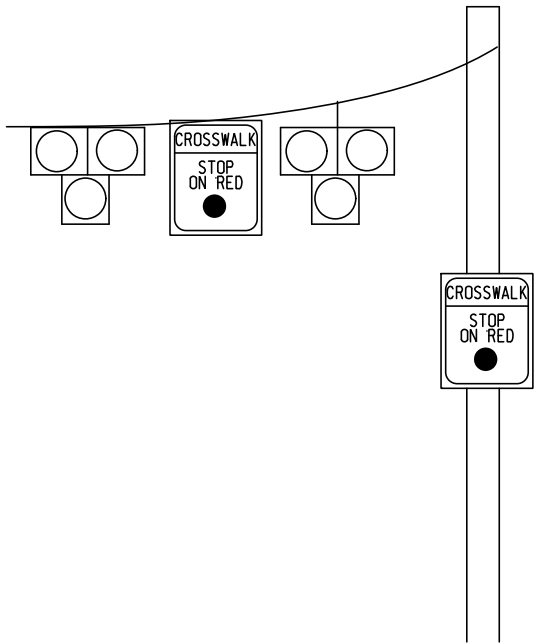
The structural details provided in all special details mentioned in this guidance must be included. If a designer must deviate from the proposed guidance, contact the **MDOT Ancillary Structures Program** to verify the proposed design. Also contact the **MDOT Traffic Signals Unit** and **Structural Fabrication 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.

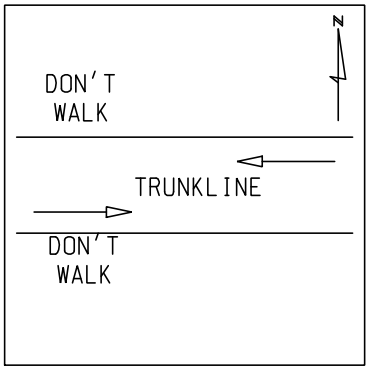
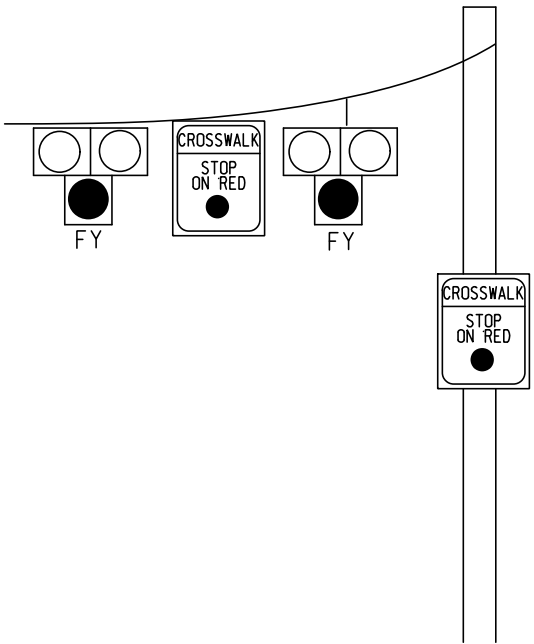
**MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES**

Appendix A – HAWK Signal Sample Plan

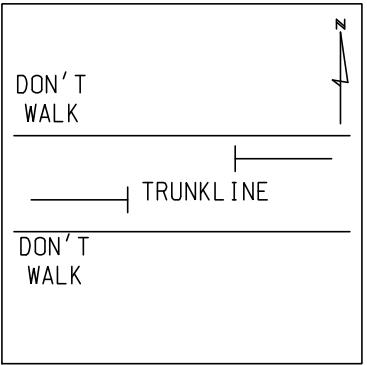
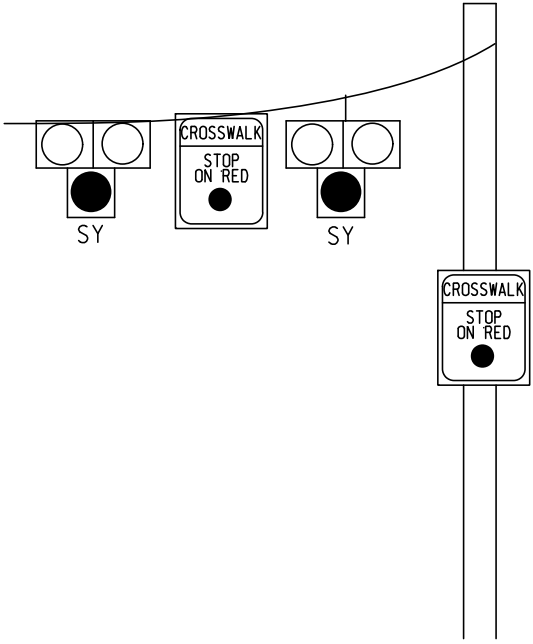
SIG-DESIGN-030



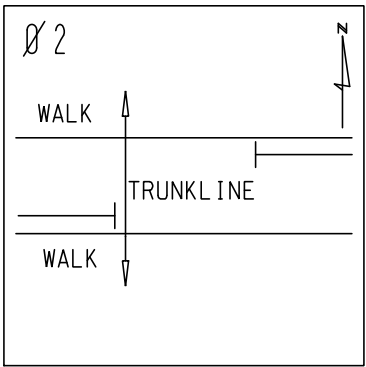
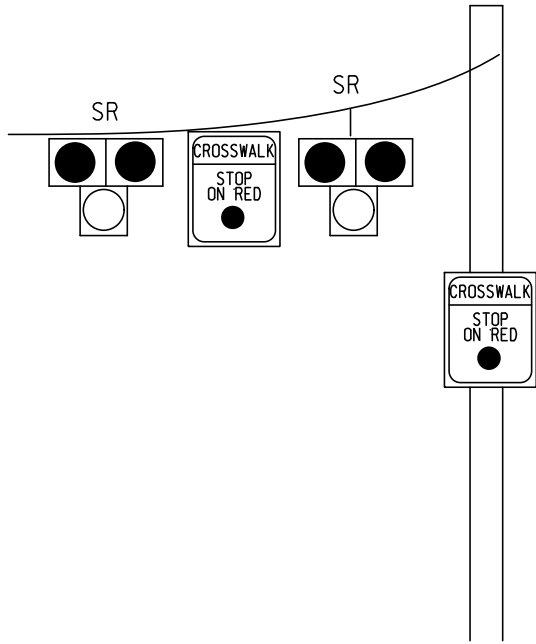
DARK DISPLAY
FOR TRUNKLINE



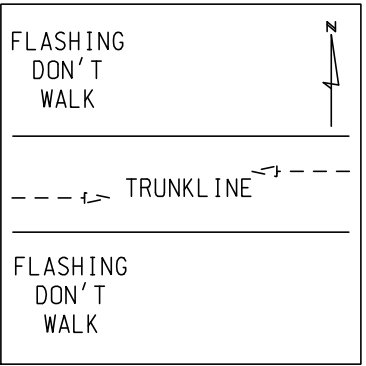
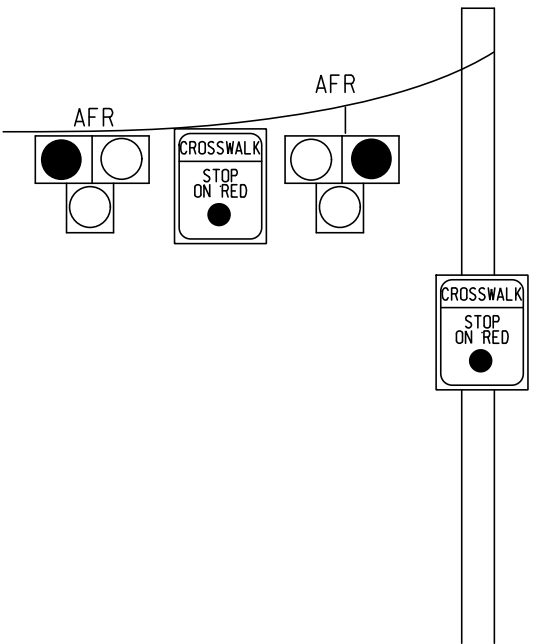
PB ACTUATION
FLASHING YELLOW
FOR TRUNKLINE



SOLID YELLOW
FOR TRUNKLINE

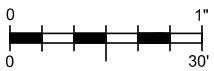


SOLID RED
FOR TRUNKLINE



ALTERNATING
FLASHING RED
FOR TRUNKLINE

AS-LET PLAN REVISIONS							
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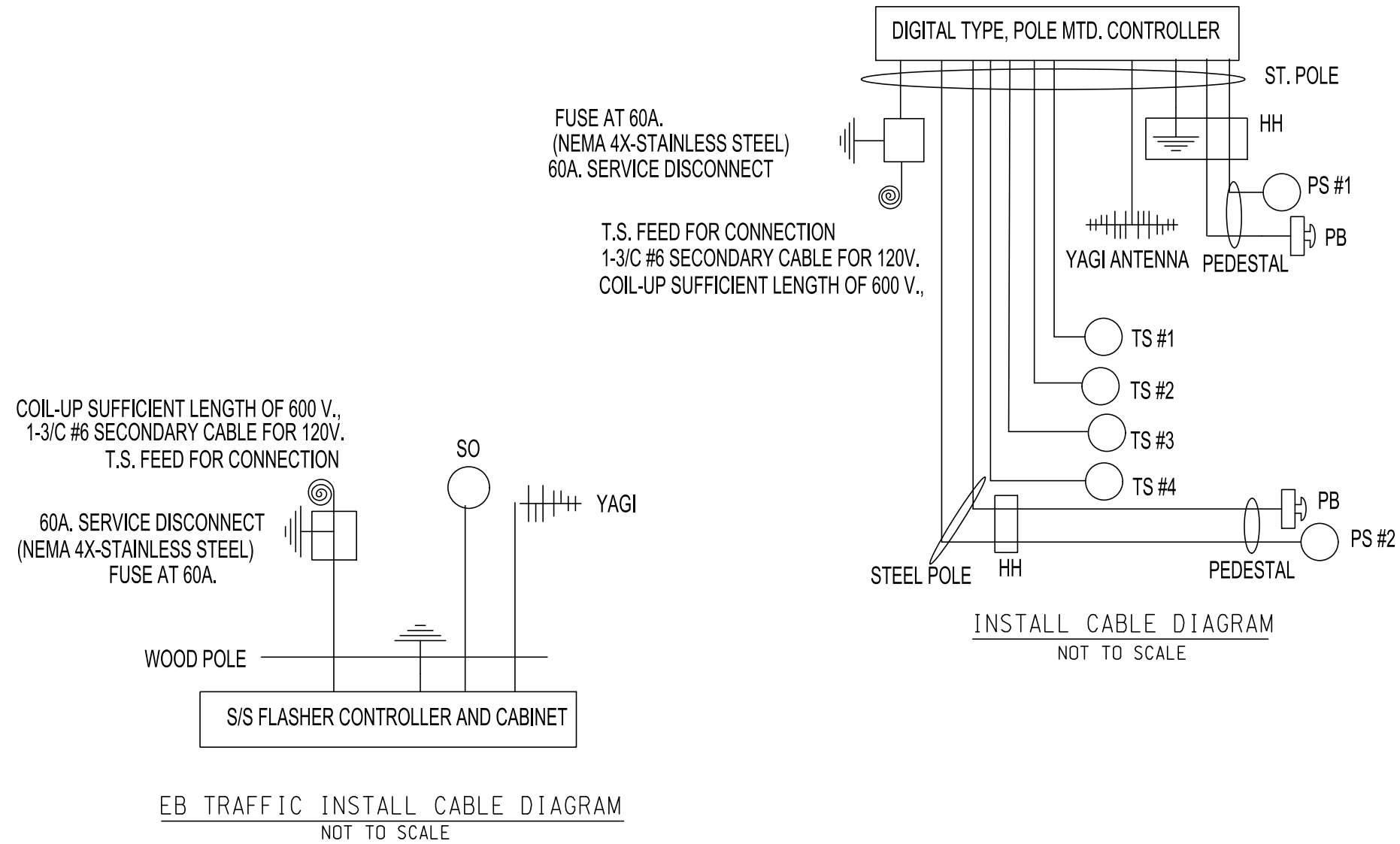
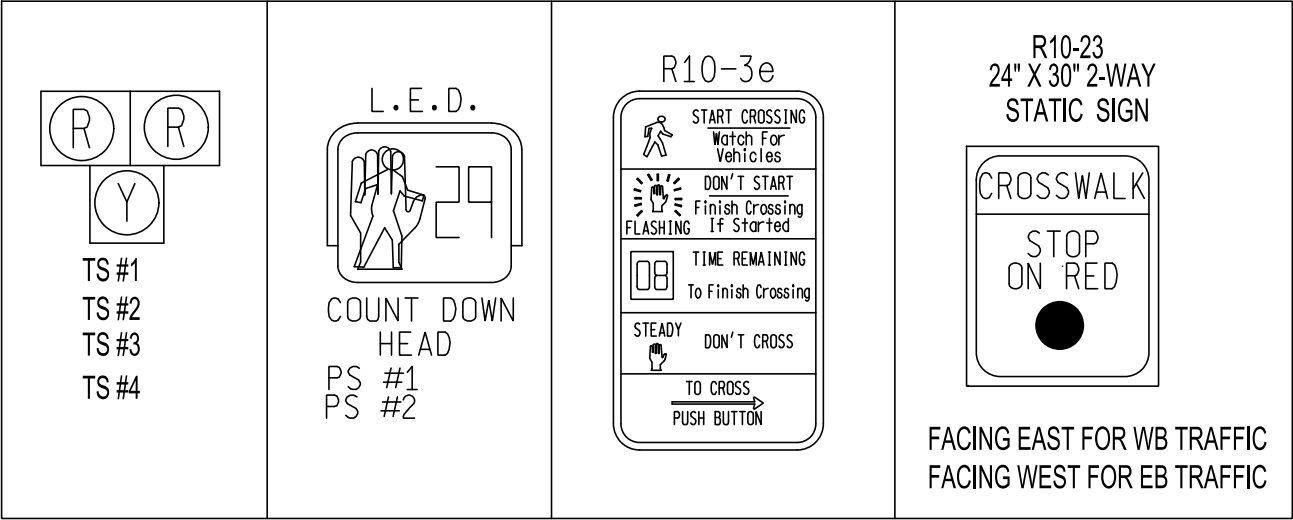
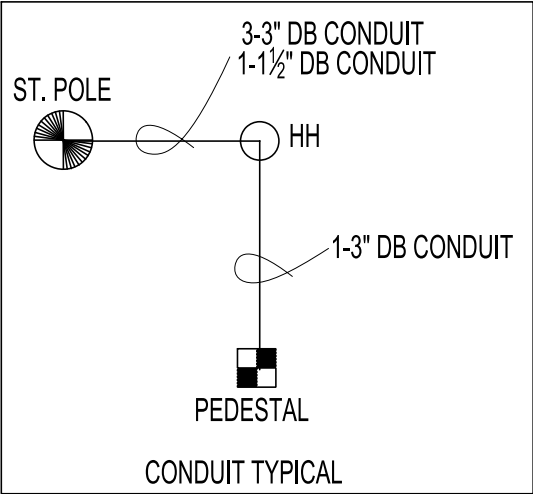
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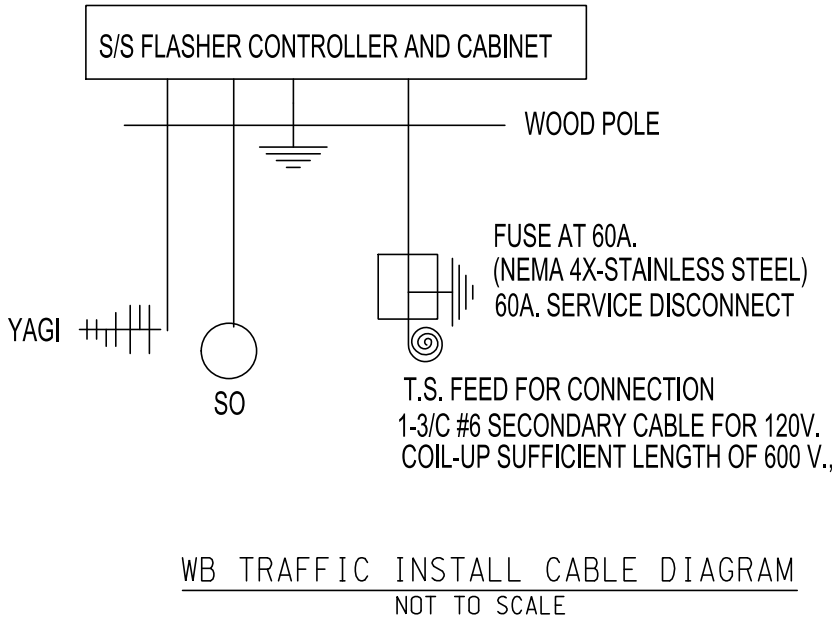
CS:
JN:

TRAFFIC SIGNAL INSTALL SHEET

HAWK Signal Sample Plan		DRAWING	SHEET
Sig-Design-030-F			2 of 3



- 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.



AS-LET PLAN REVISIONS								TRAFFIC SIGNAL INSTALL SHEET			
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION	HAWK Signal Sample Plan			
								Sig-Design-030-F			

	DESIGNED BY: YOUR NAME HERE	DATE:	CS:
	PLAN: 12345-01-001	DESIGN UNIT: TRAFFIC SIGNALS	JN:
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0	30'

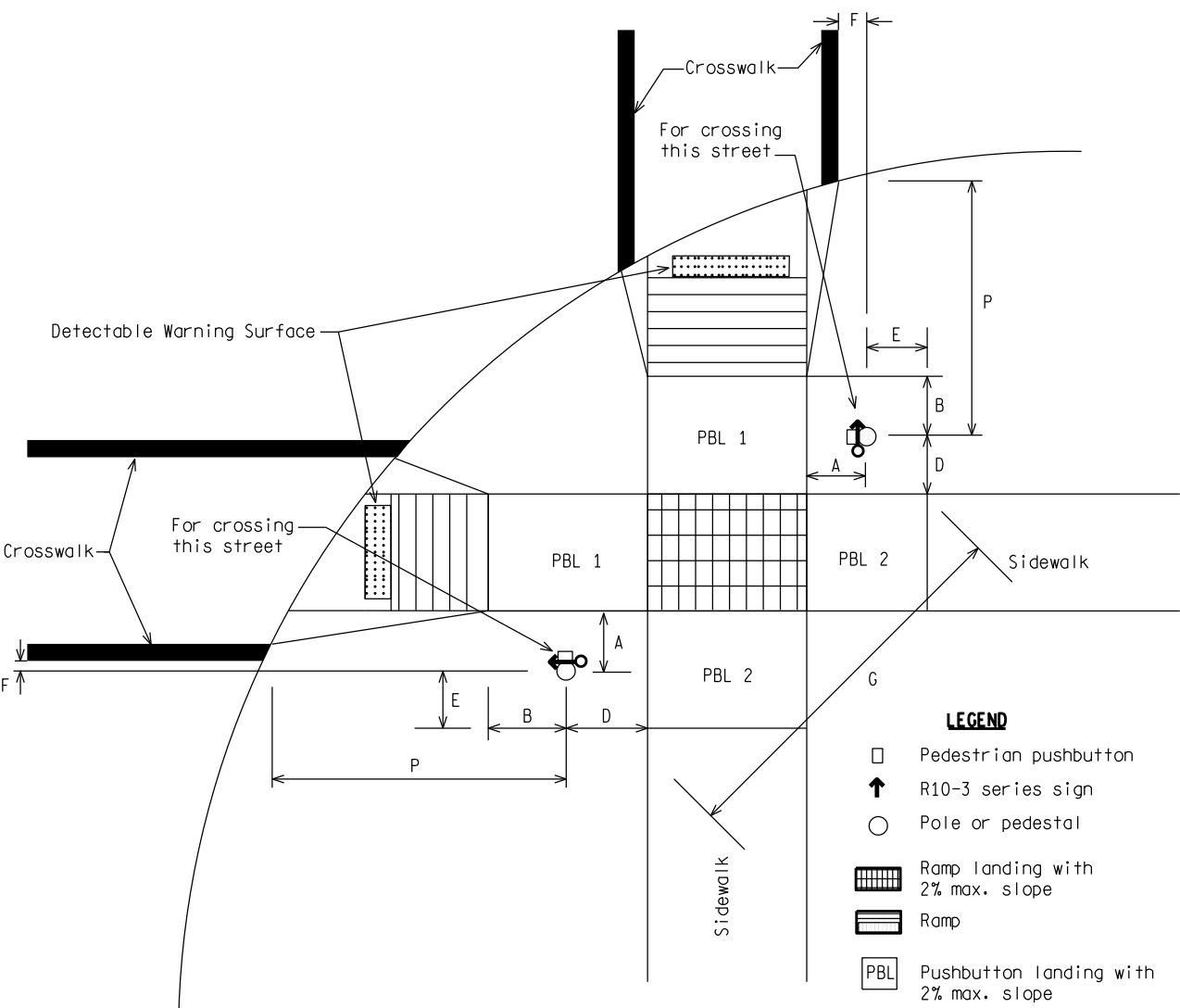
DRAWING	SHEET
	3 of 3

**MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES**

Appendix B – Pushbutton Design

SIG-DESIGN-120

RECOMMENDED PUSHBUTTON LOCATIONS



PLAN VIEW OF TYPICAL QUADRANT

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.

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

 Michigan Department of Transportation TRAFFIC SIGNAL DESIGN	DESCRIPTION	DATE	PUSHBUTTON DESIGN	
	INITIAL POST TO WEB	02/15/11		
	REVISED	02/21/12		
	REVISED	11/18/14		
			SIG-DESIGN-120-A	
DRAWN BY:			SHEET 1 of 2	
CHECKED BY:				

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 – 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 ≤ N ₆₀ < 10	42	19.0	48	17.5	48	19.5	48	20.5	As Shown on Plans
	Med Sand	-	10 ≤ N ₆₀ < 20	42	16.5	48	15.5	48	17.0	48	18.0	
	High Sand	-	N ₆₀ ≥ 20	42	15.5	48	15.0	48	16.0	48	17.0	
	Low Clay	500 ≤ S _u < 1000	-	42	26.0	48	23.5	48	26.0	48	28.0	
	Med Clay	1000 ≤ S _u < 2000	-	42	18.5	48	17.5	48	19.0	48	20.0	
	High Clay	S _u ≥ 2000	-	42	14.5	48	14.0	48	15.0	48	16.0	
101 to 120	Low Sand	-	5 ≤ N ₆₀ < 10	42	19.0	48	18.0	48	19.5	48	20.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	42	17.0	48	16.0	48	17.5	48	18.0	
	High Sand	-	N ₆₀ ≥ 20	42	16.0	48	15.0	48	16.0	48	17.0	
	Low Clay	500 ≤ S _u < 1000	-	42	26.5	48	24.0	48	26.5	48	29.0	
	Med Clay	1000 ≤ S _u < 2000	-	42	19.0	48	18.0	48	19.5	48	20.5	
	High Clay	S _u ≥ 2000	-	42	15.0	48	14.0	48	15.5	48	16.0	
121 to 150	Low Sand	-	5 ≤ N ₆₀ < 10	42	19.5	48	18.0	48	20.5	48	21.0	
	Med Sand	-	10 ≤ N ₆₀ < 20	42	17.5	48	16.0	48	17.5	48	18.5	
	High Sand	-	N ₆₀ ≥ 20	42	16.0	48	15.0	48	16.5	48	17.5	
	Low Clay	500 ≤ S _u < 1000	-	42	27.5	48	24.5	48	27.5	48	29.5	
	Med Clay	1000 ≤ S _u < 2000	-	42	19.0	48	18.0	48	20.0	48	21.0	
	High Clay	S _u ≥ 2000	-	42	15.0	48	14.5	48	15.5	48	16.5	
151 to 176	Low Sand	-	5 ≤ N ₆₀ < 10	42	-	48	-	48	20.0	48	21.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	42	-	48	-	48	17.5	48	18.5	
	High Sand	-	N ₆₀ ≥ 20	42	-	48	-	48	16.5	48	17.5	
	Low Clay	500 ≤ S _u < 1000	-	42	-	48	-	48	28.0	48	30.5	
	Med Clay	1000 ≤ S _u < 2000	-	42	-	48	-	48	20.0	48	21.0	
	High Clay	S _u ≥ 2000	-	42	-	48	-	48	15.5	48	16.5	
177 to 200	Low Sand	-	5 ≤ N ₆₀ < 10	42	-	48	-	48	20.5	48	21.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	42	-	48	-	48	18.0	48	19.0	
	High Sand	-	N ₆₀ ≥ 20	42	-	48	-	48	16.5	48	17.5	
	Low Clay	500 ≤ S _u < 1000	-	42	-	48	-	48	28.0	48	30.5	
	Med Clay	1000 ≤ S _u < 2000	-	42	-	48	-	48	20.0	48	21.0	
	High Clay	S _u ≥ 2000	-	42	-	48	-	48	16.0	48	16.5	

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

* N₆₀ = 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 $N_{60} < 5 \text{ bpf}$ or $S_u < 500 \text{ psf}$
- 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.

FINAL ROW PLAN REVISIONS								SUBMITTAL DATE:		 Michigan Department of Transportation	NO SCALE		DATE: 07/27/23	CS:STATEWIDE	TRAFFIC SIGNAL STRAIN POLE		DRAWING	SHEET
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION		DESIGN UNIT:SIGNALS			JN:STATEWIDE	FOUNDATION DESIGN TABLE			SECT		
									FILE: sig-design-153-A			TSC:STATEWIDE	SIG-DESIGN-153-A			2 of 4		

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 ≤ N ₆₀ < 10	48	15.5	48	16.0	As Shown on Plans
	Med Sand	-	10 ≤ N ₆₀ < 20	48	13.5	48	14.0	
	High Sand	-	N ₆₀ ≥ 20	48	13.0	48	13.5	
	Low Clay	500 ≤ S _u < 1000	-	48	19.5	48	20.5	
	Med Clay	1000 ≤ S _u < 2000	-	48	15.0	48	16.0	
	High Clay	S _u ≥ 2000	-	48	12.5	48	12.5	
101 to 120	Low Sand	-	5 ≤ N ₆₀ < 10	48	16.0	48	16.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	14.5	48	14.5	
	High Sand	-	N ₆₀ ≥ 20	48	13.5	48	14.0	
	Low Clay	500 ≤ S _u < 1000	-	48	21.0	48	21.5	
	Med Clay	1000 ≤ S _u < 2000	-	48	16.0	48	16.5	
	High Clay	S _u ≥ 2000	-	48	12.5	48	13.5	
121 to 150	Low Sand	-	5 ≤ N ₆₀ < 10	48	16.5	48	17.0	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	14.5	48	15.0	
	High Sand	-	N ₆₀ ≥ 20	48	13.5	48	14.0	
	Low Clay	500 ≤ S _u < 1000	-	48	21.0	48	22.0	
	Med Clay	1000 ≤ S _u < 2000	-	48	16.5	48	17.0	
	High Clay	S _u ≥ 2000	-	48	13.0	48	13.5	
151 to 176	Low Sand	-	5 ≤ N ₆₀ < 10	48	17.5	48	18.0	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	15.5	48	16.0	
	High Sand	-	N ₆₀ ≥ 20	48	14.5	48	15.0	
	Low Clay	500 ≤ S _u < 1000	-	48	23.0	48	24.0	
	Med Clay	1000 ≤ S _u < 2000	-	48	17.5	48	18.0	
	High Clay	S _u ≥ 2000	-	48	14.0	48	14.5	
177 to 200	Low Sand	-	5 ≤ N ₆₀ < 10	48	18.0	48	18.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	16.0	48	16.5	
	High Sand	-	N ₆₀ ≥ 20	48	15.0	48	15.5	
	Low Clay	500 ≤ S _u < 1000	-	48	23.5	48	24.5	
	Med Clay	1000 ≤ S _u < 2000	-	48	18.0	48	18.5	
	High Clay	S _u ≥ 2000	-	48	14.0	48	14.5	

* S_u = Undrained Shear Strength in Cohesive Soil (psf)
* N₆₀ = 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 N₆₀ < 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 N₆₀ 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 ≤ N ₆₀ < 10	48	20.0	48	21.5	As Shown on Plans
	Med Sand	-	10 ≤ N ₆₀ < 20	48	17.5	48	18.5	
	High Sand	-	N ₆₀ ≥ 20	48	16.5	48	17.5	
	Low Clay	500 ≤ S _u < 1000	-	48	27.5	48	30.0	
	Med Clay	1000 ≤ S _u < 2000	-	48	20.0	48	21.0	
	High Clay	S _u ≥ 2000	-	48	15.5	48	16.5	
101 to 120	Low Sand	-	5 ≤ N ₆₀ < 10	48	20.5	48	21.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	18.0	48	19.0	
	High Sand	-	N ₆₀ ≥ 20	48	16.5	48	17.5	
	Low Clay	500 ≤ S _u < 1000	-	48	28.0	48	30.5	
	Med Clay	1000 ≤ S _u < 2000	-	48	20.0	48	21.0	
	High Clay	S _u ≥ 2000	-	48	16.0	48	16.5	
121 to 150	Low Sand	-	5 ≤ N ₆₀ < 10	48	21.0	48	22.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	18.5	48	19.5	
	High Sand	-	N ₆₀ ≥ 20	48	17.5	48	18.0	
	Low Clay	500 ≤ S _u < 1000	-	48	30.0	48	33.5	
	Med Clay	1000 ≤ S _u < 2000	-	48	21.0	48	22.0	
	High Clay	S _u ≥ 2000	-	48	16.5	48	17.0	
151 to 176	Low Sand	-	5 ≤ N ₆₀ < 10	48	21.5	48	23.0	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	19.0	48	20.0	
	High Sand	-	N ₆₀ ≥ 20	48	17.5	48	18.5	
	Low Clay	500 ≤ S _u < 1000	-	48	31.5	48	37.5	
	Med Clay	1000 ≤ S _u < 2000	-	48	21.5	48	22.5	
	High Clay	S _u ≥ 2000	-	48	16.5	48	17.5	
177 to 200	Low Sand	-	5 ≤ N ₆₀ < 10	48	22.0	48	23.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	48	19.0	48	20.0	
	High Sand	-	N ₆₀ ≥ 20	48	18.0	48	18.5	
	Low Clay	500 ≤ S _u < 1000	-	48	32.0	48	38.0	
	Med Clay	1000 ≤ S _u < 2000	-	48	21.5	48	23.5	
	High Clay	S _u ≥ 2000	-	48	16.5	48	17.5	

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

* N₆₀ = 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 N₆₀ < 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 N₆₀ 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 Condltion		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)
*N₆₀ = 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 N₆₀ < 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 N₆₀ 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.

**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 ≤ N ₆₀ < 10	42	15.0	16.5	As Shown on Plans
	Med Sand	-	10 ≤ N ₆₀ < 20	42	13.0	14.0	
	High Sand	-	N ₆₀ ≥ 20	42	12.5	12.5	
	Low Clay	500 ≤ S _u < 1000	-	42	16.5	19.5	
	Med Clay	1000 ≤ S _u < 2000	-	42	14.0	15.5	
	High Clay	S _u ≥ 2000	-	42	11.5	12.5	
Double Arm	Low Sand	-	5 ≤ N ₆₀ < 10	42	18.0	22.5	
	Med Sand	-	10 ≤ N ₆₀ < 20	42	14.5	18.5	
	High Sand	-	N ₆₀ ≥ 20	42	14.0	15.0	
	Low Clay	500 ≤ S _u < 1000	-	42	19.5	29.5	
	Med Clay	1000 ≤ S _u < 2000	-	42	15.5	18.5	
	High Clay	S _u ≥ 2000	-	42	12.5	15.0	

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

*N₆₀ = 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 N₆₀ < 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 N₆₀ 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


Michigan Department of Transportation

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


Michigan Department of Transportation

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



FINAL ROW PLAN REVISIONS				SUBMITTAL DATE:					NO SCALE			DATE:	DESIGN UNIT:	TSC:	CS:	JN:			DRAWING	SHEET
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION													
												FILE:								SECT 1

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.

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:									NO SCALE	DRAWN BY:	DATE:	CS:	PLAN GUIDELINES	DRAWING	SHEET
NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION								
										CHK'D BY:	DESIGN UNIT:	JN:			SECT 2
										FILE:	TSC:				

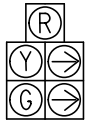
1-WAY 12"x27"
NON-ILLUMINATED CASE SIGN



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)



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

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



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



COUNT DOWN
HEAD

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



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



STEWART AVE.
(SPEED LIMIT=35 MPH)

- ① REMOVE H.H.
⑩ ⑭ REMOVE 30 FT. STEEL STRAIN POLE
⑤ REMOVE GLOBAL POSITIONING MODULE
① REMOVE H.H.
③ REMOVE BASE MOUNT CONTROLLER
& CABINET (NEMA 6, 16 L.S. BAY)
④ REMOVE CONTROLLER FDN

- REMOVE SPAN WIRE
REMOVE SEC. CABLE ⑨

- REMOVE WOOD POLE ⑮

- REMOVE SPAN WIRE
REMOVE SEC. CABLE ⑨

- REMOVE 30 FT. STEEL STRAIN POLE ⑩ ⑭
REMOVE PUSH BUTTON & SIGN FOR
CROSSING DORT HWY ⑧

- REMOVE H.H. ①

- REMOVE SPAN WIRE
REMOVE SEC. CABLE ⑨

- ⑥ REMOVE PEDESTAL & FDN
⑦ REMOVE PUSHBUTTON & SIGN
FOR CROSSING DORT HWY
⑧ SALV FLINT RIVER TRAIL SIGN

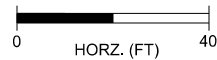
- ① REMOVE H.H.

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



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, Pedestrian, Bracket Arm Mtd, Rem	1 Ea
⑫	TS, Pedestrian, Pedestal Mtd, Rem	1 Ea
⑬	TS, Span Wire Mtd, Rem	10 Ea
⑭	Fdn, Rem	2 Ea
⑮	Wood Pole, Rem	1 Ea

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

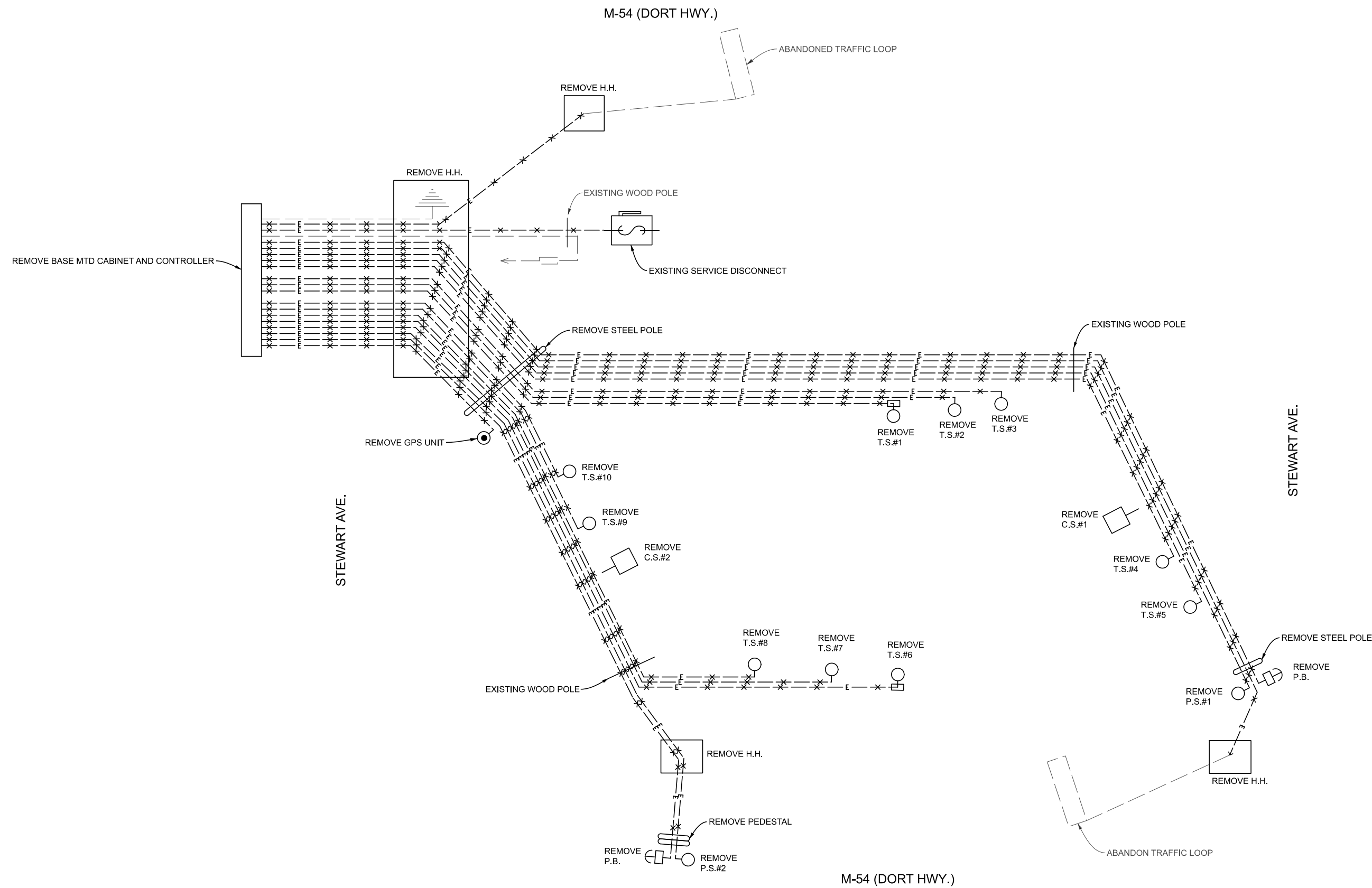


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DATE:
DESIGN UNIT:
TSC:

CS: 25132
JN: 210054A

SIGNALS	
OPENINGS:	37
CYCLIC WATTS:	404
STEADY WATTS:	210
PLAN:	25072-01-017
REMOVAL	
M-54 (DORT HWY.) AT STEWART AVE	
CITY OF FLINT	
DRAWING SHEET	
I-475 PSIGN 001	SECT 1



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



NO SCALE

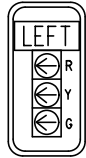
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DESIGN UNIT:
TSC: I

CS: 25132
JN: 210054A

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

DRAWING SHEET
I-475 PSIGN 002
SECT 1



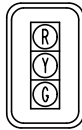
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SOUTH (T.S.#1)



FACING
WEST (T.S.#5)



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

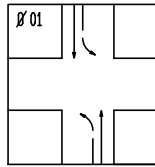


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SOUTH (T.S.#2, #3)

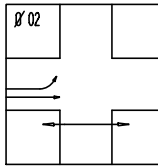
SPEED
LIMIT
50

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

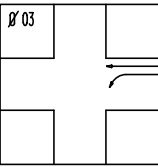
PHASING DIAGRAMS



M-54 (DORT HWY)



EB STEWART AVE



WB STEWART AVE



2-WAY 24"x30"
ILLUMINATED CASE SIGN



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



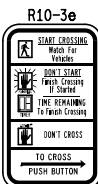
FACING
EAST (C.S.#1, #2)

L.E.D.



COUNT DOWN
HEAD

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



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

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

(2) 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
(19) 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

INSTALL SPAN WIRE (6)

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

INSTALL SPAN WIRE (6)

RADAR STOPBAR DETECTION
50' X 15'

CAUTION -
CRITICAL UTILITY

SPEED
LIMIT
35

STEWART AVE.
(SPEED LIMIT=35 MPH)

EX 100' ROW

HAZARDOUS OR
FLAMMABLE MATERIAL

RADAR STOPBAR DETECTION
50' X 15'

INSTALL SPAN WIRE (6)

(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
(1) (1) INSTALL (2) POLYMER CONC HH
(22) INSTALL LIGHTNING PROTECTION

CAUTION -
CRITICAL UTILITY

INSTALL SPAN WIRE (6)

ABANDONED TRAFFIC LOOP

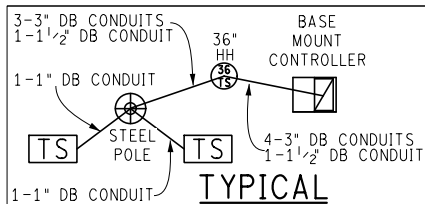
(12) INSTALL 30 FT. STEEL STRAIN POLE
(14) INSTALL STRAIN POLE FDN (36" DIA., 12') (SB-22)
(15) INSTALL CASING (8.5')
N: 567100.87, E: 13309267.78

(19) INSTALL RADAR STOPBAR DETECTION SENSOR
(1) (1) INSTALL (2) POLYMER CONC HH
(22) INSTALL LIGHTNING PROTECTION

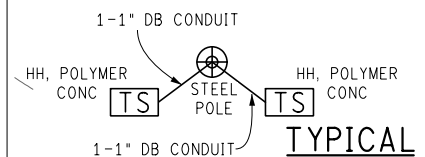
CONTACT: THE REGION TRAFFIC ENGINEER TRAVIS
PHILLIPS (989) 233-7363 FOR LAYOUT OF
TRAFFIC LOOPS, GIVE 5 WORKING DAYS NOTICE.

NOTE

1. CONTRACTOR TO COORDINATE WITH UTILITIES FOR EXISTING
CONNECTIONS



TYPICAL



TYPICAL

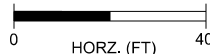
SPEED
LIMIT
50

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

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
(1)	Conduit, DB, 1, 1 1/2 inch	15 Ft
(2)	Conduit, DB, 1, 3 inch	20 Ft
(3)	Conduit, DB, 3, 3 inch	15 Ft
(4)	Conduit, DB, 4, 3 inch	5 Ft
(5)	Conduit, DB, 1, 1 inch	20 Ft
(6)	DB Cable, in Conduit, 600V, 1/C#6	55 Ft
(7)	Cable, Equipment Grounding Wire, 1/C#6	55 Ft

FINAL ROW PLAN REVISIONS SUBMITTAL DATE:

NO.	DATE	AUTH	DESCRIPTION	NO.	DATE	AUTH	DESCRIPTION



FILE: 210054_I475_North_Signal_PR01.dgn

DATE: I

DESIGN UNIT:

TSC: I

CS: 25132

JN: 210054A

CONSTRUCTION

M-54 (DORT HWY.) AT STEWART AVE

CITY OF FLINT

SIGNALS

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

DRAWING SHEET

I-475 PSIGN 003

SECT 1

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.

INSTALL T.S. CONTROLLER

M-54 (DORT HWY.)

INSTALL H.H.

EXISTING WOOD POLE

INSTALL SERVICE DISCONNECT

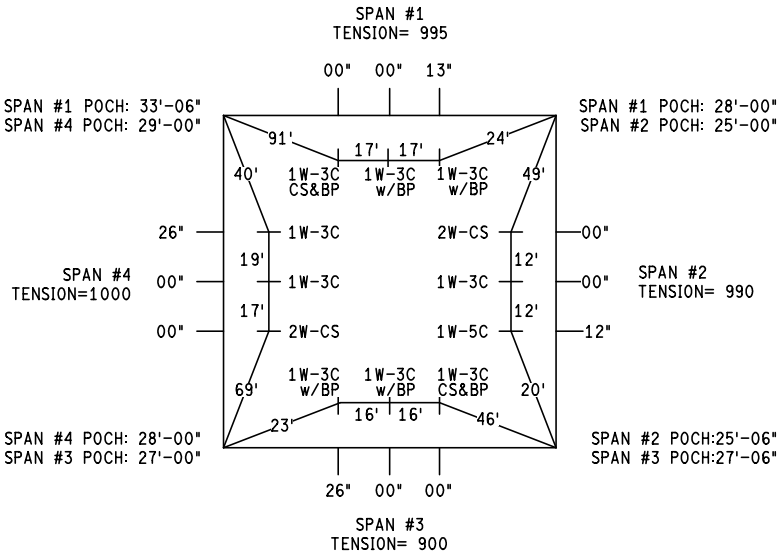
EXISTING INTERCONNECT CABLE TO I-475 N.B.
RAMPS & STEWART AVE. SEE SIGNAL SERVICE
REMOVAL SHEET FOR REMOVAL.

INSTALL STEEL POLE

INSTALL STEEL POLE

STEWART AVE.

BOX SPAN CALCULATIONS
NOT TO SCALE



INSTALL STEEL POLE

INSTALL T.S.#8

INSTALL T.S.#7

INSTALL T.S.#6

INSTALL P.S.#2

INSTALL P.B.

INSTALL C.S.#1

INSTALL T.S.#4

INSTALL T.S.#5

INSTALL STEEL POLE

INSTALL P.B.

INSTALL P.S.#1

M-54 (DORT HWY.)

CABLING INSTALL DIAGRAM

NOT TO SCALE



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



NO SCALE

FILE: 210054_I475_North_Signal_WPR01.dgn

DATE:

DESIGN UNIT:

TSC: I

CS: 25132

JN: 210054A

CONSTRUCTION

M-54 (DORT HWY.) AT STEWART AVE

CITY OF FLINT

DRAWING SHEET

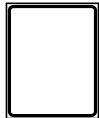
I-475 PSIGN 004

SECT 1

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



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



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

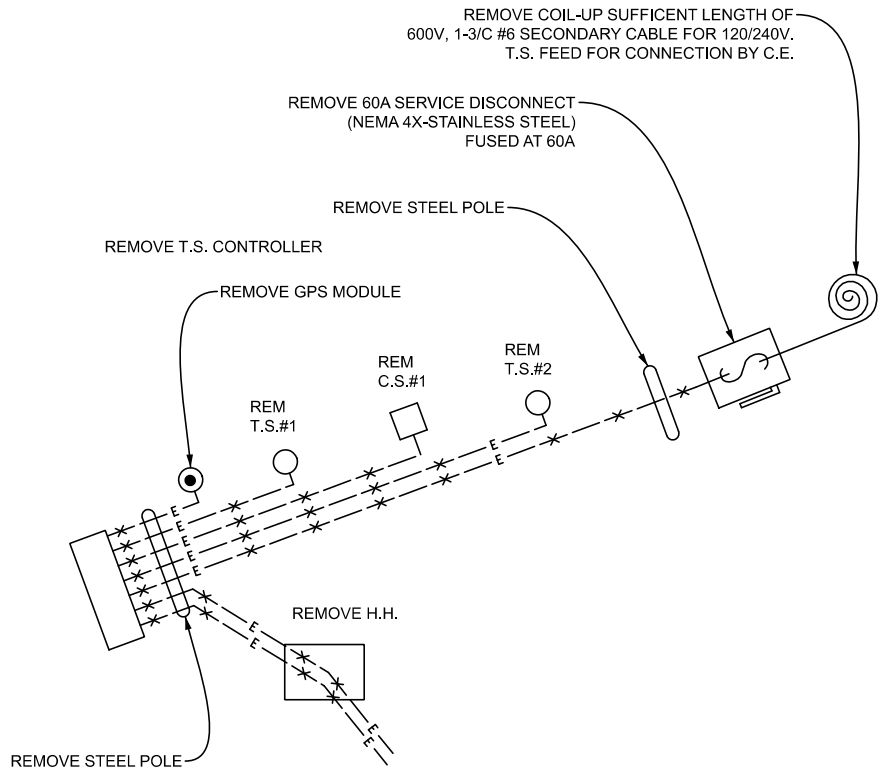


2-WAY
3 HEAD TRAFFIC SIGNAL
FACING
SOUTHEAST (T.S.#1, #2)
NORTHWEST (T.S.#1, #2)

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

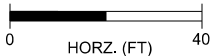
FOR ELECTRICAL SERVICE INSPECTION CONTACT
THE MICHIGAN DEPARTMENT OF LICENSING AND
REGULATORY AFFAIRS AT 810-247-9558
COST TO CONTRACTOR WILL BE INCIDENTAL.

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

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



FILE: 210054_I475_North_Signal_REM02.dgn

DATE: 1
DESIGN UNIT:

CS: 25132
JN: 210054A

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



I-475 NB SERVICE DR

SIGNALS	
OPENINGS:	16
CYCLIC WATTS:	1800
STEADY WATTS:	275
PLAN:	25132-01-037
REMOVAL	
M-54 (DORT HWY.) AT I-475 NB SERVICE DR	
CITY OF FLINT	
DRAWING	SHEET
I-475 PSIGN 005	SECT 1

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)

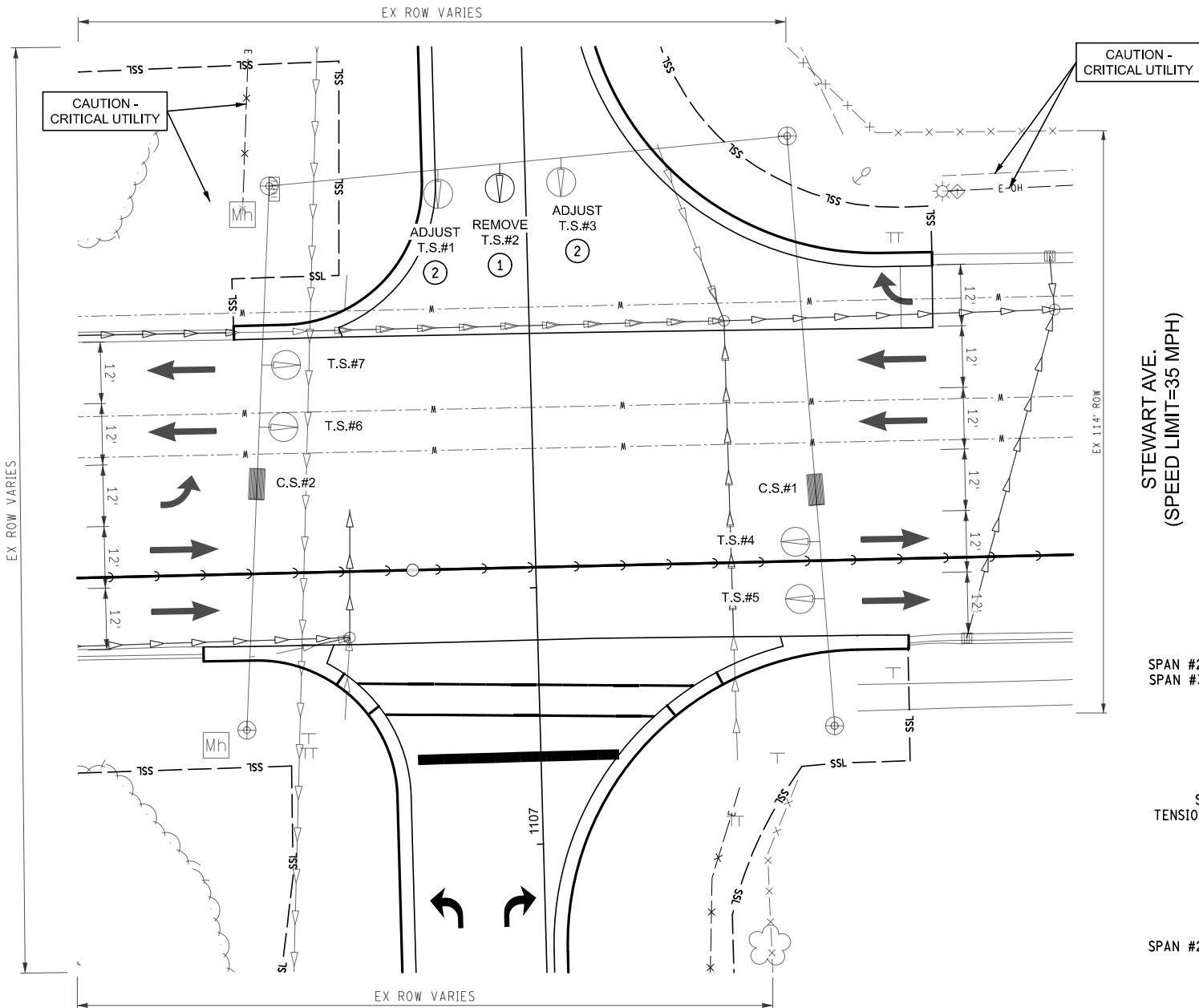
ONE WAY
←

ONE WAY
→

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

SPEED
LIMIT
35

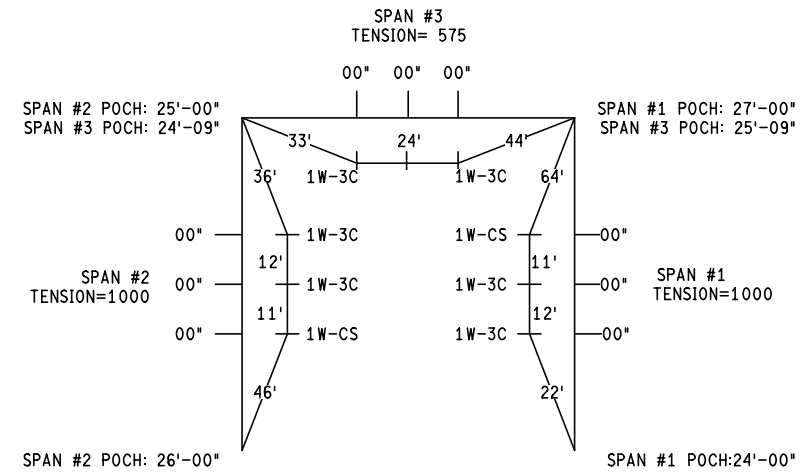
I-475 NB ENTRANCE RAMP
(SPEED LIMIT=35 MPH)



STEWART AVE.
(SPEED LIMIT=35 MPH)

SPEED
LIMIT
35

BOX SPAN CALCULATIONS
NOT TO SCALE

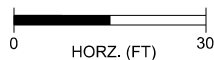


LIST OF MATERIAL		
NO.	ITEM	QUANTITIES
①	TS, Span Wire Mtd, Rem	1 Ea
②	TS Head, Adj	2 Ea

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

SPEED
LIMIT
35

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



FILE: 210054_I475_North_Signal_REM03.dgn

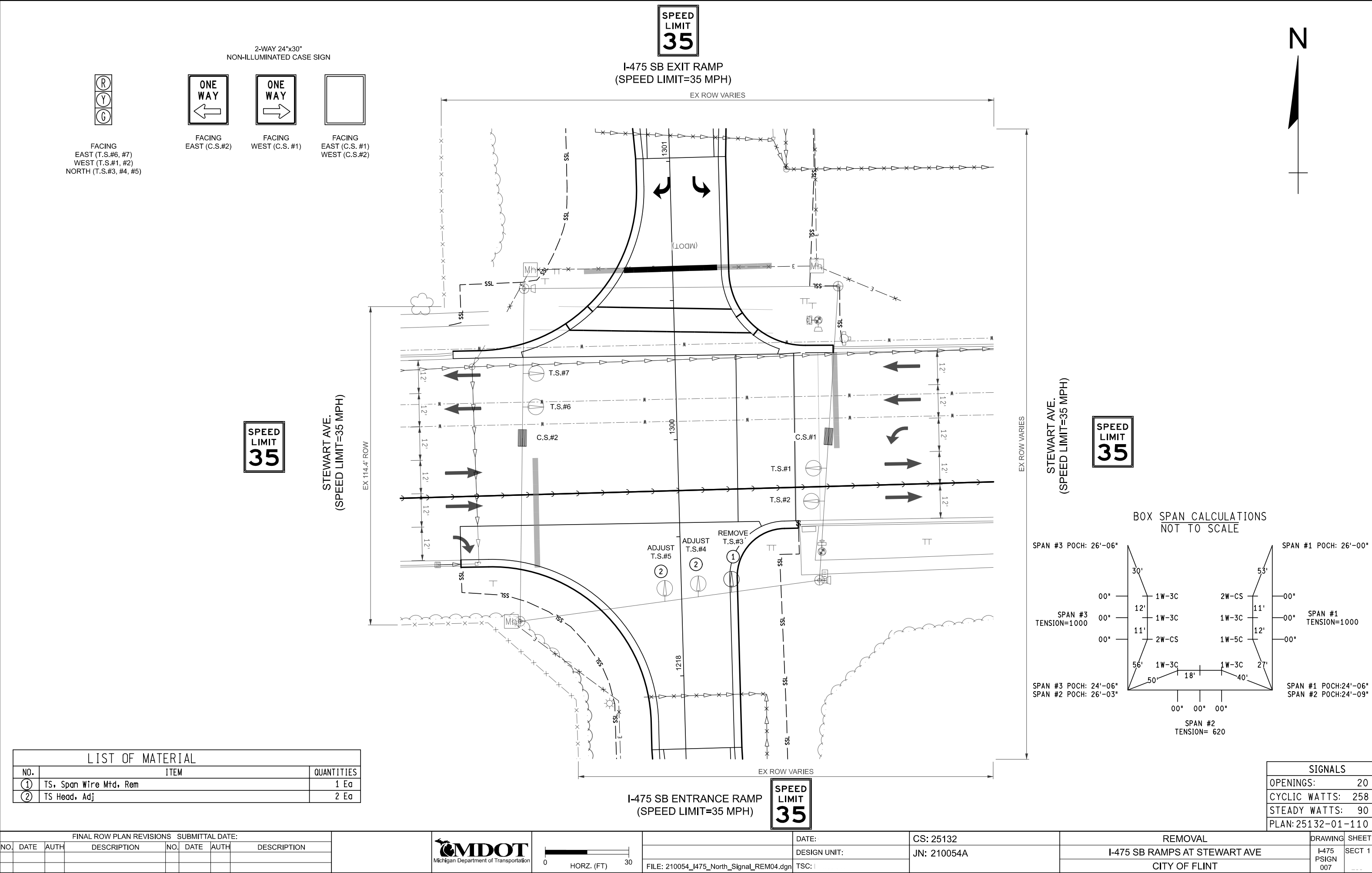
DATE:
DESIGN UNIT:

CS: 25132
JN: 210054A

REMOVAL
I-475 NB RAMPs AT STEWART AVE
CITY OF FLINT

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

DRAWING SHEET
I-475 PSIGN 006
SECT 1



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 GROUND SURFACE ELEVATION: 713.3 FT NORTHING: 562909 EASTING: 13307962				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 GROUND SURFACE ELEVATION: 725.4 FT NORTHING: 562999 EASTING: 13307860				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 GROUND SURFACE ELEVATION: 721.8 FT NORTHING: 562965 EASTING: 13307739				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 GROUND SURFACE ELEVATION: 713.0 FT NORTHING: 562948 EASTING: 13308014				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 GROUND SURFACE ELEVATION: 715.7 FT NORTHING: 563274 EASTING: 13308010				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 GROUND SURFACE ELEVATION: 745.9 FT NORTHING: 563252 EASTING: 13307909					
713.3 6 FIELD ENGINEER REPORTED 5 INCHES OF SANDY TOPSOIL, BLACK 712.9 6 FILL - FIELD ENGINEER REPORTED 6 INCHES OF BROWN SAND 712.4 5 FILL - MEDIUM DENSE POORLY GRADED FINE SAND WITH SILT, TRACE CLAY, TRACE GRAVEL, DARK BROWN AND BLACK, MOIST (SP-SM) 710.8 2 709.8 1 707.3 3 VERY LOOSE TO LOOSE CLAYEY FINE SAND WITH SILT, BROWN WITH POCKETS OF BLACK, MOIST (SC) (POSSIBLE FILL) 704.8 2 699.8 10 699.3 12 694.8 13 693.3 24 VERY DENSE POORLY GRADED FINE SAND WITH SILT, TRACE GRAVEL, GRAY, WET (SP-SM) 689.8 15 684.8 30 EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, WET (SM) 679.8 5 678.3 82 EXTREMELY DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, GRAY, WET (SP) E.O.B. 35 FEET PP MC 4.5+ 11.3 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				725.4 6 11 INCHES OF ASPHALTIC CEMENT CONCRETE 724.5 4 FILL - FIELD ENGINEER REPORTED 7 INCHES OF SAND AND GRAVEL 724.4 5 723.9 3 FILL - VERY STIFF SANDY LEAN CLAY, TRACE GRAVEL, DARK BROWN WITH POCKETS OF BLACK (CL) 721.9 3 721.4 3 FILL - LOOSE POORLY GRADED FINE TO MEDIUM SAND, TRACE SILT, BLACK, MOIST (SP) (POSSIBLE FOUNDRY SAND) 720.4 3 719.4 3 716.9 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 4 710.4 4 VERY STIFF LEAN CLAY, FEW SAND, TRACE GRAVEL, BROWN (CL) 706.9 8 701.9 22 FIELD ENGINEER REPORTED SANDY SILT LAYER FROM 23.5 TO 24.5 FT. 700.4 31 696.9 43 EXTREMELY DENSE TO VERY DENSE POORLY GRADED FINE SAND WITH SILT, FEW GRAVEL, TRACE CLAY, GRAY, MOIST TO WET (SP-SM) 693.4 37 691.9 44 E.O.B. 33.5 FEET (BORING TERMINATED DUE TO AUGER REFUSAL) PP MC 3.25 11.5 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				721.8 5 FIELD ENGINEER REPORTED 4 INCHES OF SANDY TOPSOIL, BLACK 721.5 5 FILL - FIELD ENGINEER REPORTED 8 INCHES OF BROWN SANDY CLAY 720.8 14 718.3 10 FILL - MEDIUM DENSE TO LOOSE POORLY GRADED FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP) 715.8 4 714.8 2 713.3 3 FILL - MEDIUM DENSE CLAYEY FINE SAND, TRACE GRAVEL, OCCASIONAL SANDY CLAY SEAMS, BROWN AND DARK BROWN, MOIST (SC) 712.3 6 712.1 15 708.3 25 703.3 50 698.3 45 VERY DENSE TO EXTREMELY DENSE CLAYEY FINE SAND/SANDY LEAN CLAY, TRACE GRAVEL, GRAY (SC)(CL) 693.3 45 NOTE: SPLIT SPOON REFUSAL AT 19 FT. DUE TO POSSIBLE COBBLES 688.3 46 EXTREMELY DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, OCCASIONAL CLAY POCKETS, GRAY, WET (SP) 686.8 50 NOTE: DRILLER REPORTED POSSIBLE COBBLES AT 31.5 FT. AND 33 FT. E.O.B. 35 FEET PP MC 4.5 16.8 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				713.0 POORLY GRADED SAND WITH SILT, TRACE GRAVEL (SP-SM) 712.5 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				715.7 6 FIELD ENGINEER REPORTED 3 INCHES OF SANDY TOPSOIL, BLACK 715.5 6 FILL - FIELD ENGINEER REPORTED 9 INCHES OF BROWN SANDY CLAY 714.7 4 712.2 5 FILL - LOOSE SILTY FINE SAND, TRACE GRAVEL, RED-BROWN, MOIST (SM) 711.7 6 710.7 5 FILL - VERY STIFF SANDY LEAN CLAY, TRACE GRAVEL, RED-BROWN (CL) 709.7 8 707.2 18 707.2 32 HARD LEAN CLAY, FEW SAND, TRACE GRAVEL, OCCASIONAL FINE SAND PARTINGS BELOW 8.5 FT., BROWN (CL) 702.2 42 702.2 49 697.2 15 697.2 26 692.2 50 687.2 46 687.2 30 EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, WET (SM) 682.2 31 682.2 51 EXTREMELY DENSE POORLY GRADED FINE SAND WITH SILT, TRACE GRAVEL, GRAY, WET (SP-SM) 680.7 E.O.B. 35 FEET PP MC 3.5 18.4 4.5+ 15.8 4.5+ 11.4 4.5+ 10.5 4.5+ 10.1 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				745.9 3 6.5 INCHES OF PORTLAND CEMENT CONCRETE 745.4 3 744.9 5 742.4 5 FILL - MEDIUM DENSE POORLY GRADED FINE TO MEDIUM SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP) 742.1 6 739.9 3 737.4 3 FILL - VERY STIFF TO HARD LEAN CLAY WITH SAND, TRACE GRAVEL, GRAY-BROWN TO MOTTLED BROWN AND GRAY (CL) 732.4 6 730.9 727.4 6 725.9 722.4 10 HARD LEAN CLAY WITH SAND, TRACE GRAVEL, FREQUENT SILT PARTINGS, OCCASIONAL CLAYEY FINE SAND SEAMS, GRAY-BROWN (CL) (POSSIBLE FILL) 717.4 16 (CONT.) PP MC 4.5+ 13.1 3 11.8 4.5+ 10.9 4.5+ 18.3 4.5+ 11.1 4.5+ 10.1 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					
0 1st 6 in 0 2nd 6 in 0 3rd 6 in 0 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:						MDOT Michigan Department of Transportation NO SCALE		FILE: 210054_I475_North_Soil Borings.dgn		DATE: DESIGN UNIT: TSC:		CS: 25132 JN: 210054A		LOG OF BORINGS		DRAWING		SHEET	
NO.		DATE		AUTH		DESCRIPTION		I-475 RECONSTRUCTION		I-475 BORING 001										SECT 1					
								LOG OF BORINGS																	

TEST HOLE NO. CB-D-02 (CONT.)				TEST HOLE NO. CB-D-03				TEST HOLE NO. CB-D-HA				TEST HOLE NO. CB-E-01				TEST HOLE NO. CB-E-02				TEST HOLE NO. CB-E-02 (CONT.)																			
				LOCATION: SB I475 WEST R.O.W PHYSICAL REFERENCE: 24 FEET EAST OF JAMES P. COLE BOULEVARD PHYSICAL OFFSET: 215 FEET NORTH OF LEITH STREET				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				LOCATION: NB I475 EAST R.O.W PHYSICAL REFERENCE: 26 FEET WEST OF W. BOULEVARD DRIVE PHYSICAL OFFSET: 445 FEET NORTH OF LEITH STREET				LOCATION: NB I475 LEFT SHOULDER PHYSICAL REFERENCE: 4 FEET WEST OF NB I475 E.O.M LEFT PHYSICAL OFFSET: 468 FEET NORTH OF LEITH STREET																							
				BORING DATE: 3/29/21 GROUND SURFACE ELEVATION: 720.7 FT				NORTHING: 563265 EASTING: 13307774				BORING DATE: 4/27/21 GROUND SURFACE ELEVATION: 711.0 FT				NORTHING: 563319 EASTING: 13308081								BORING DATE: 3/30/21 GROUND SURFACE ELEVATION: 716.1 FT				NORTHING: 563499 EASTING: 13308075				BORING DATE: 4/19/21 GROUND SURFACE ELEVATION: 743.1 FT				NORTHING: 563511 EASTING: 13307965			
712.4 9 46 23 707.4 11 18 21 702.4 21 45 31 697.4 16 44 44 695.9 16 44 44 PP MC 4.5+ 10.1 HARD LEAN CLAY WITH SAND, TRACE GRAVEL, BROWN (CL) 4.5+ 16.3 VERY DENSE SILTY FINE SAND, TRACE GRAVEL, GRAY, MOIST (SM) 4.5+ 9.9 E.O.B. 50 FEET				720.7 7 18 720.2 7 18 719.7 7 18 717.2 5 8 18 717.0 5 8 18 716.7 5 8 18 714.7 9 13 12 712.2 4 3 5 711.7 4 3 5 710.7 4 3 5 707.2 13 20 25 705.7 13 20 25 702.2 21 30 42 697.2 20 54 692.2 28 50 691.2 28 50 PP MC 1 19.2 FIELD ENGINEER REPORTED 6 INCHES OF SANDY TOPSOIL, BLACK 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) NOTE: SPT TERMINATED DUE TO CONCRETE DEBRIS 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) FILL - HARD LEAN CLAY, FEW SAND, TRACE GRAVEL, TRACE COAL PIECES, BROWN (CL) HARD LEAN CLAY, TRACE SAND, TRACE GRAVEL, BROWN (CL) VERY DENSE TO EXTREMELY DENSE CLAYEY FINE SAND/SANDY LEAN CLAY, TRACE GRAVEL, GRAY (SC)(CL) EXTREMELY DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, OCCASIONAL CLAY POCKETS, GRAY, WET (SP) E.O.B. 29.5 FEET (BORING TERMINATED DUE TO SPLIT SPOON REFUSAL)				711.0 5 8 5 710.5 5 8 5 SANDY LEAN CLAY E.O.B. 0.5 FEET				716.1 5 8 5 715.6 5 8 5 715.1 5 8 5 712.6 5 9 14 712.1 5 9 14 710.1 10 16 17 708.1 25 32 36 707.6 25 32 36 702.6 36 50 50 697.6 28 46 25 696.1 28 46 25 692.6 40 50 50 687.6 34 54 50 682.6 34 54 50 681.1 34 54 50 PP MC 4.5+ 15.7 FIELD ENGINEER REPORTED 6 INCHES OF SANDY TOPSOIL, BLACK 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) HARD LEAN CLAY, FEW SAND, TRACE ROOTS, TRACE GRAVEL, OCCASIONAL SILT POCKETS, BROWN WITH SEAMS OF GRAY (CL) 1 19.3 STIFF LEAN CLAY, TRACE SAND, TRACE GRAVEL, OCCASIONAL FINE SAND LAYERS, BROWN WITH SEAMS OF GRAY (CL) EXTREMELY DENSE SILTY FINE SAND WITH GRAVEL, TRACE CLAY, GRAY, MOIST (SM) 4.5+ 8.3 HARD SANDY LEAN CLAY, TRACE GRAVEL, GRAY (CL) EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, MOIST TO WET (SM) EXTREMELY DENSE SILTY FINE SAND, TRACE CLAY, TRACE GRAVEL, GRAY, MOIST TO WET (SM) E.O.B. 35 FEET				743.1 2 4 6 742.5 2 4 6 742.1 2 4 6 739.6 5 7 6 737.1 5 5 9 736.1 5 5 9 734.6 4 9 11 729.6 4 11 13 724.6 7 8 11 719.6 5 7 8 714.6 3 6 10 PP MC 4.5+ 12.4 7 INCHES OF PORTLAND CEMENT CONCRETE FILL - MEDIUM DENSE POORLY GRADED FINE SAND, TRACE SILT, TRACE GRAVEL, BROWN, MOIST (SP) 4.5+ 16.4 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) 4.5+ 10.1 HARD LEAN CLAY WITH SAND, TRACE GRAVEL, OCCASIONAL FINE SAND PARTINGS, GRAY (CL) 4.5+ 7.6 EXTREMELY DENSE SILTY FINE SAND, TRACE GRAVEL, GRAY, MOIST (SM) E.O.B. 49.9 FEET (BORING TERMINATED DUE TO SPLIT SPOON REFUSAL)				709.6 22 25 17 704.6 7 19 17 699.6 16 26 36 694.6 42 56 50 693.2 42 56 50 PP MC 4.5+ 13.5 DENSE POORLY GRADED FINE SAND WITH SILT, TRACE GRAVEL, BROWN, MOIST (SP-SM) 4.5+ 7.6 EXTREMELY DENSE SILTY FINE SAND, TRACE GRAVEL, GRAY, MOIST (SM) 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				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				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				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				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 1st 6 in 0 2nd 6 in 0 3rd 6 in 0 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:				MDOT Michigan Department of Transportation NO SCALE				FILE: 210054_I475_North_Soil Borings.dgn				DATE: DESIGN UNIT: TSC:				CS: 25132 JN: 210054A				LOG OF BORINGS				DRAWING		SHEET									
NO.				DATE																				AUTH				DESCRIPTION				I-475 RECONSTRUCTION				I-475 BORING 002		SECT 1	
																																LOG OF BORINGS							

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

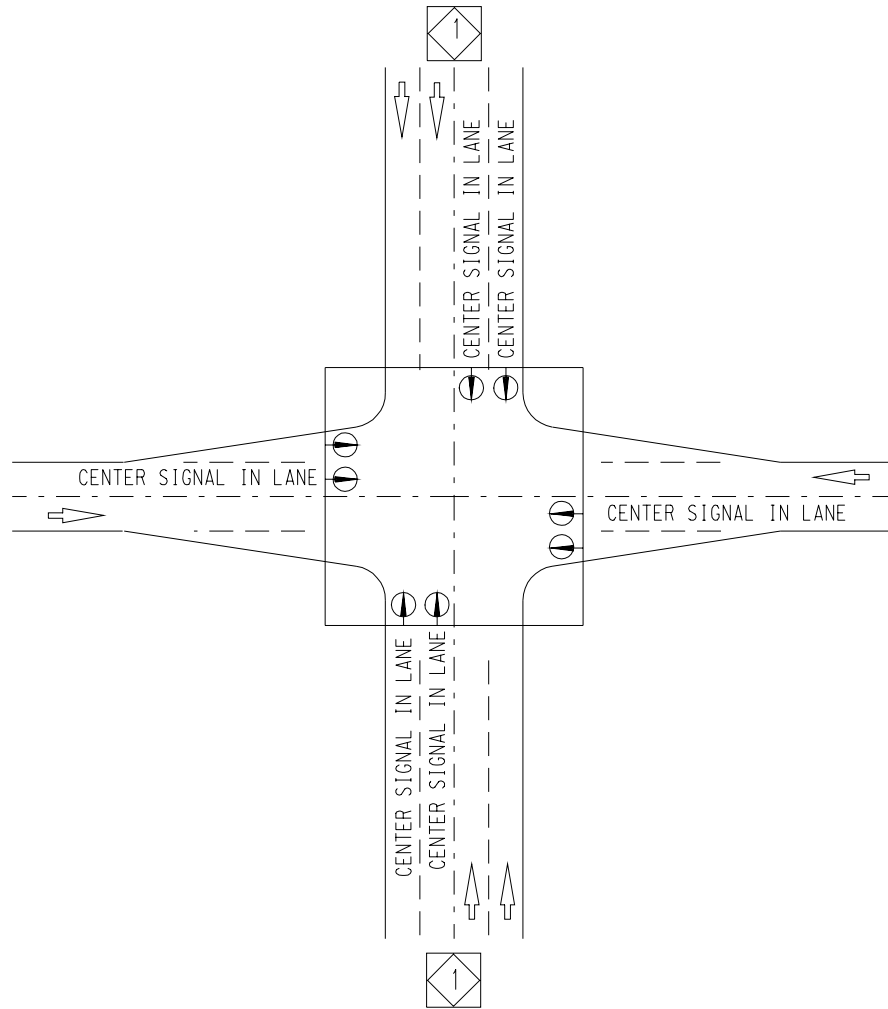
- 1. Soil borings must be located with station-offsets and/or stat plane northing and easting coordinates. Preferably both are shown.
- 2. Soil borings should be taken at each traffic signal structure location.
- 3. Show soil boring locations on the traffic signal plan views.

ADD MDOT SPECIAL DETAILS
AS REQUIRED

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

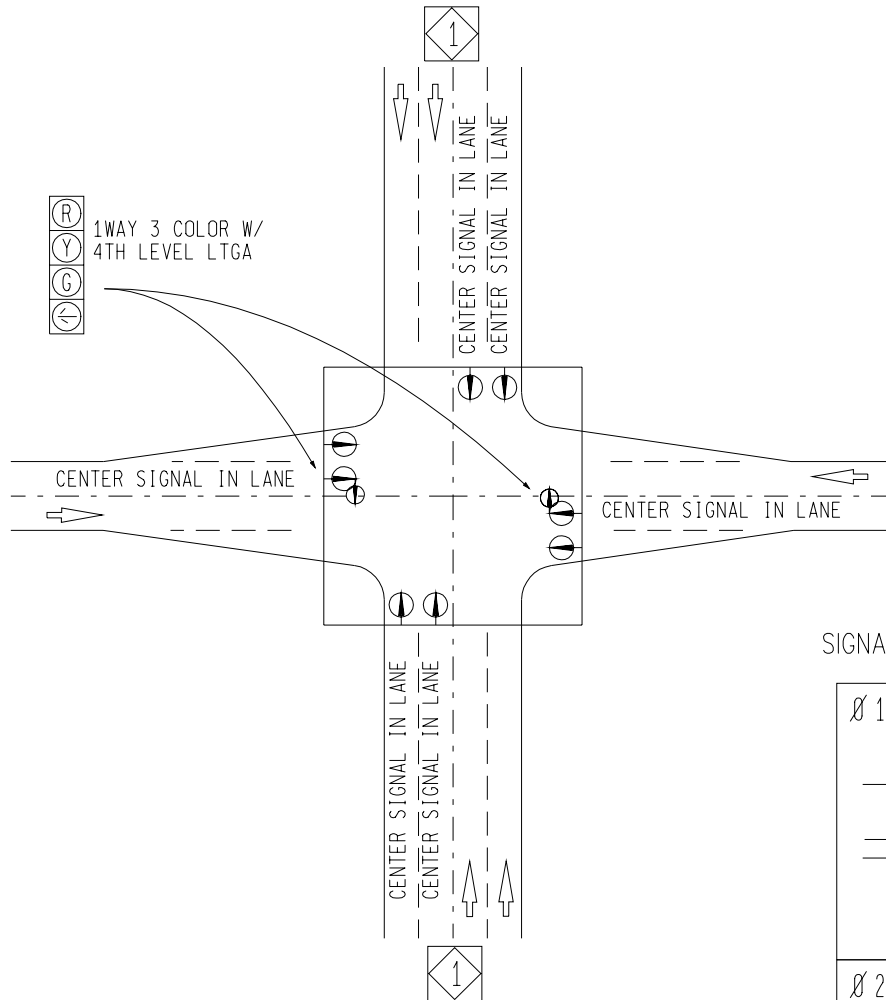
**MICHIGAN TRAFFIC SIGNAL STRUCTURES
DESIGN GUIDELINES**

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

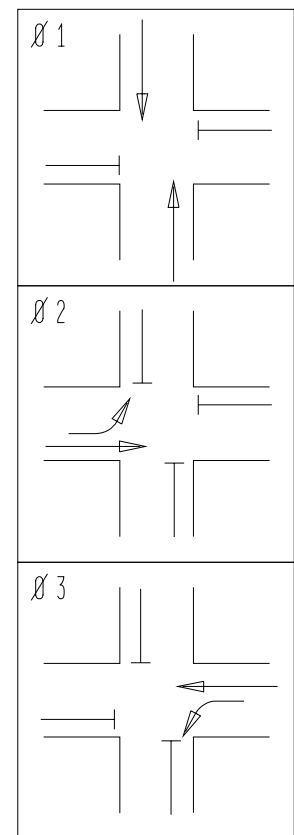


NOTES:

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

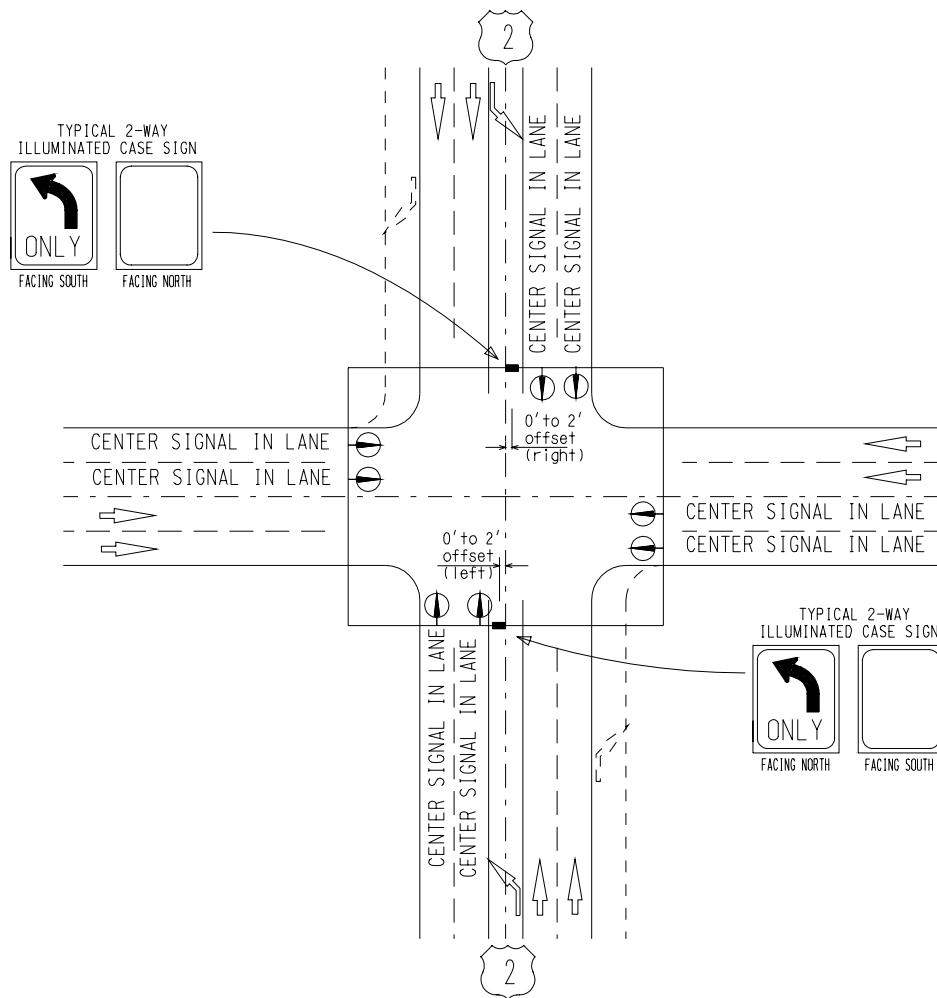


SIGNAL PHASING DIAGRAM



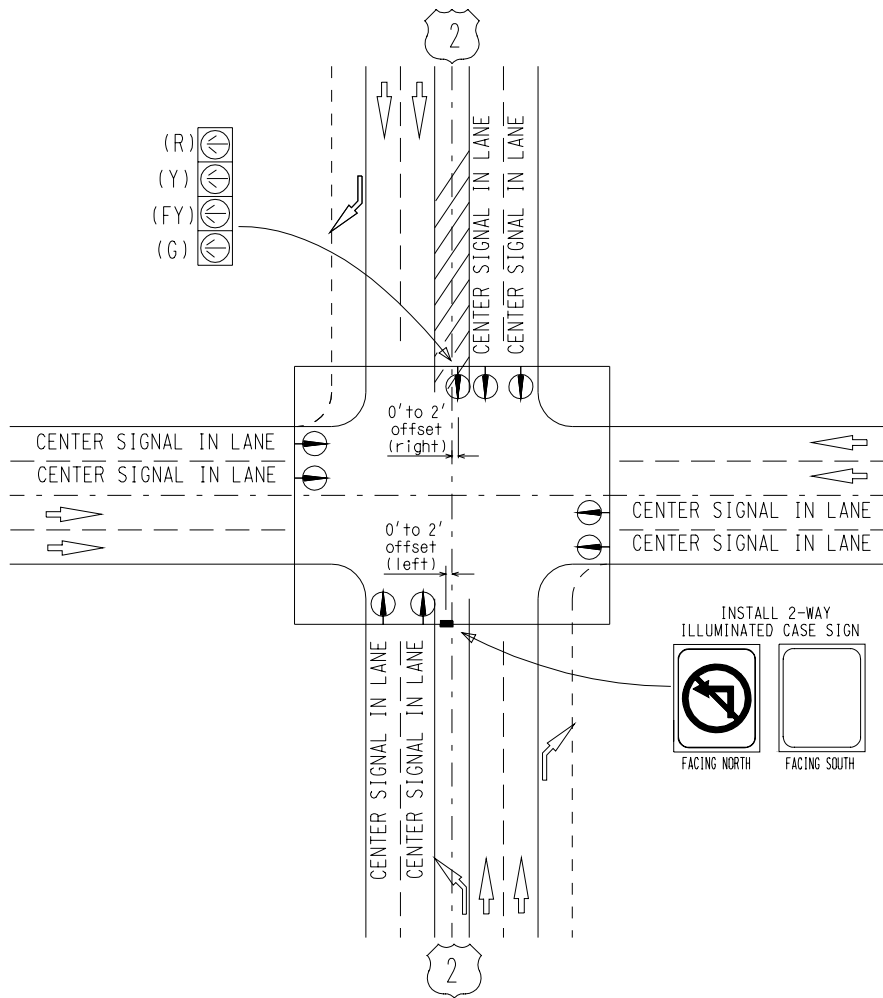
NOTES:

- 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.

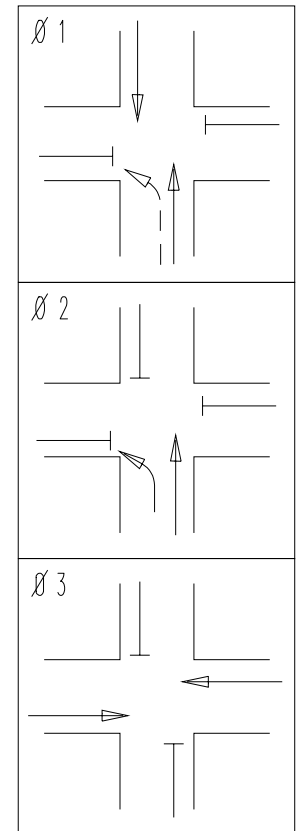


NOTES:

- 1 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
- 2 in THE ABSENCE OF A STOP BAR, THE CURB RADIUS 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 CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.



SIGNAL PHASING DIAGRAM

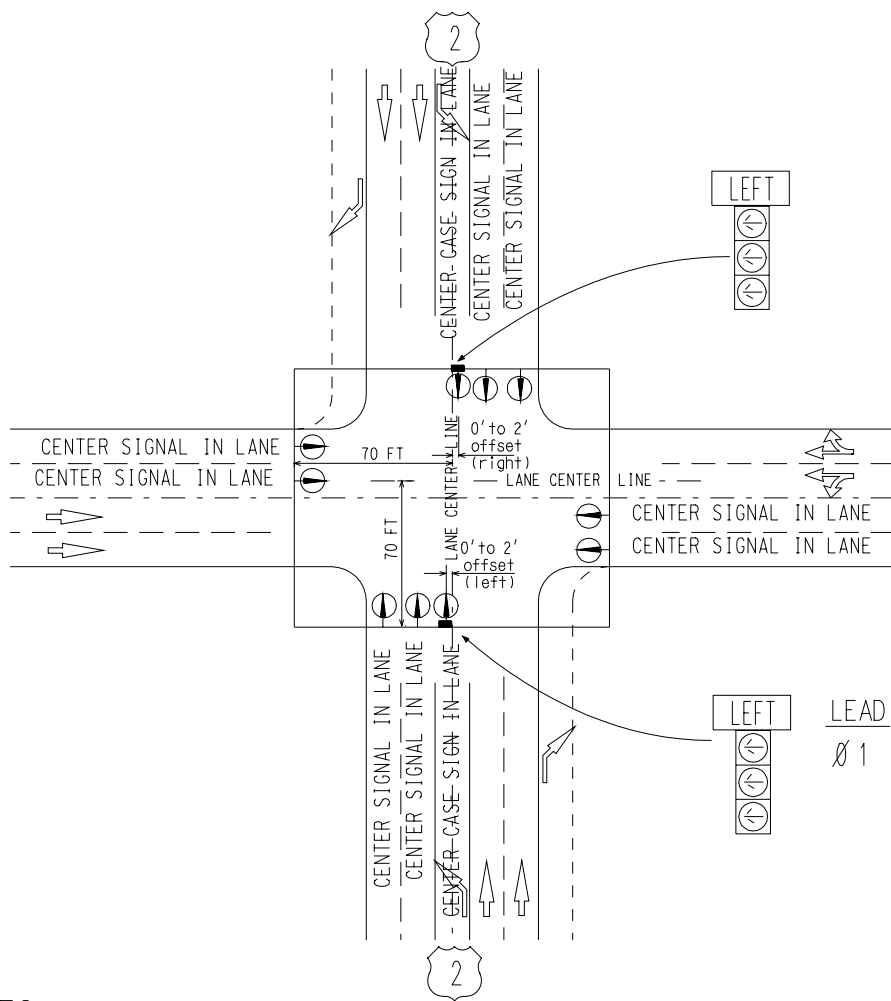


NOTES:

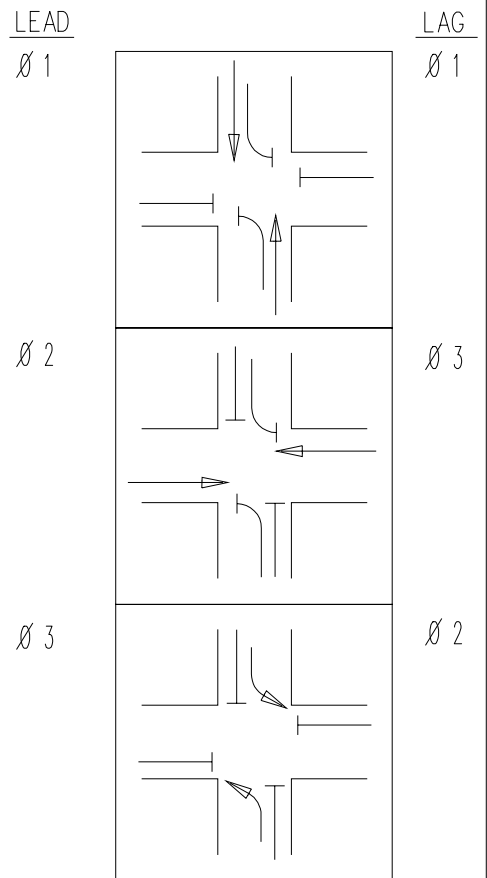
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- 2 in THE ABSENCE OF A STOP BAR, THE CURB RADIUS SPRING POINT SHOULD BE USED.
- 3 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
- 4 THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED OUT SO DRIVERS ONLY READ THE THE CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
- 5 USE PERMISSIVE FLASHING YELLOW LEFT TURN.

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
SINGLE LAGGING LEFT TURN PHASE
ON TRUNKLINE



SIGNAL PHASING DIAGRAM



NOTES:

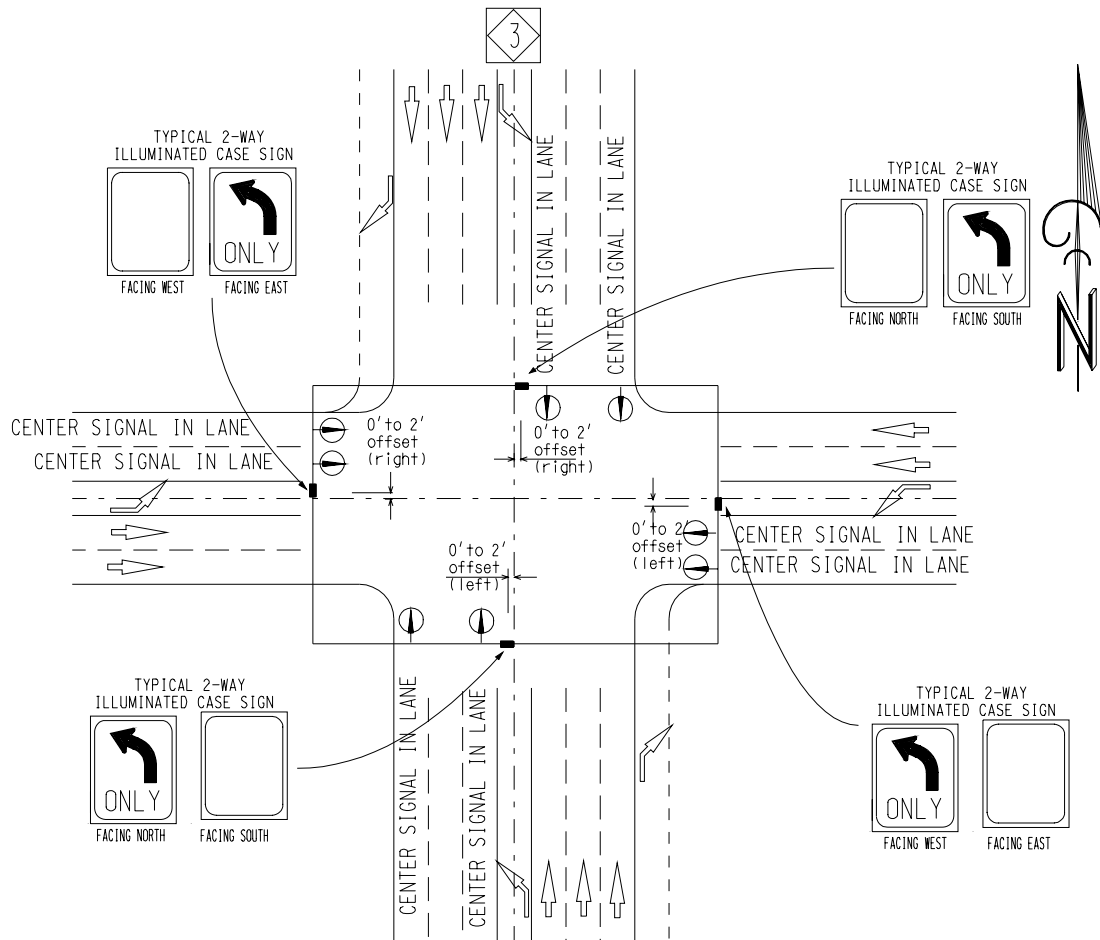
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- 2 in THE ABSENCE OF A STOP BAR, THE CURB RADIUS SPRING POINT SHOULD BE USED.
- 3 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
- 4 THE APPROACH LEGEND OF THE NEAR SIDE CASE SIGN SHOULD BE BLANKED 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.



SHEET 5 OF 26

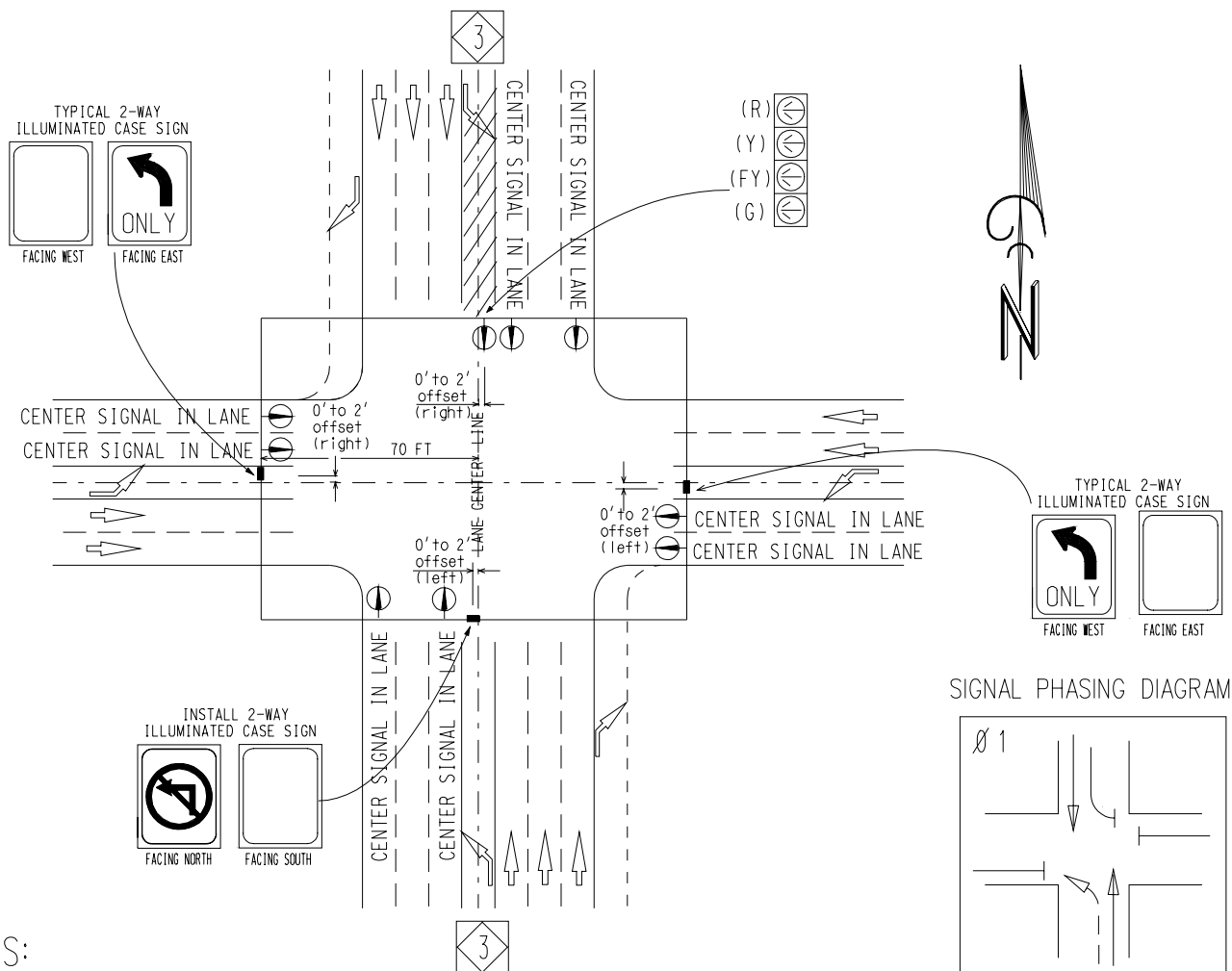
HEAD PLACEMENT DIAGRAM

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



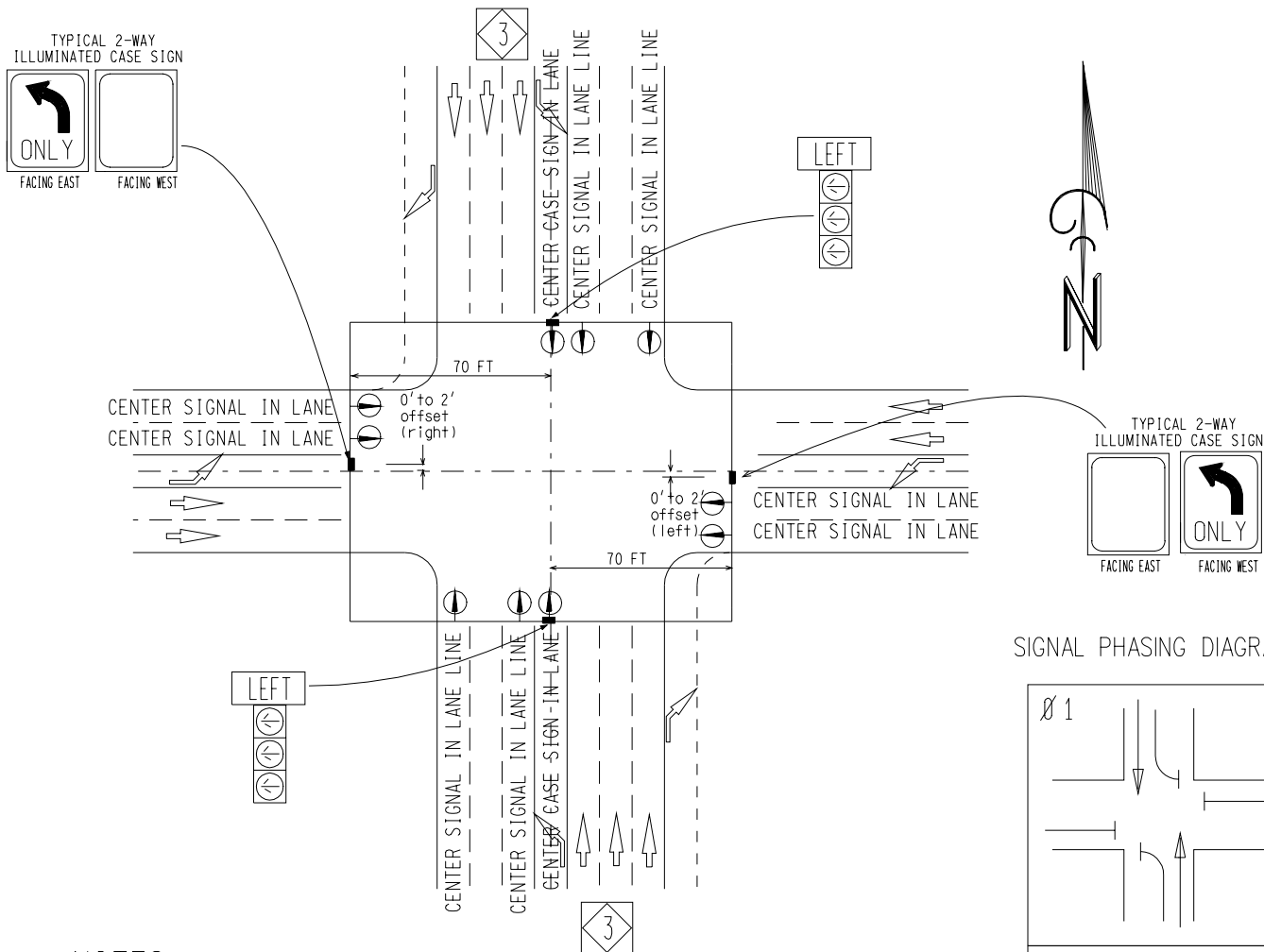
NOTES:

- 1 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
- 2 IN THE ABSENCE OF A STOP BAR, THE CURB RADIUS 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 CASE SIGN LEGEND ON THE FAR SIDE OF THE INTERSECTION.
- 5 PEDESTRIAN SIGNALS OPTIONAL.



NOTES:

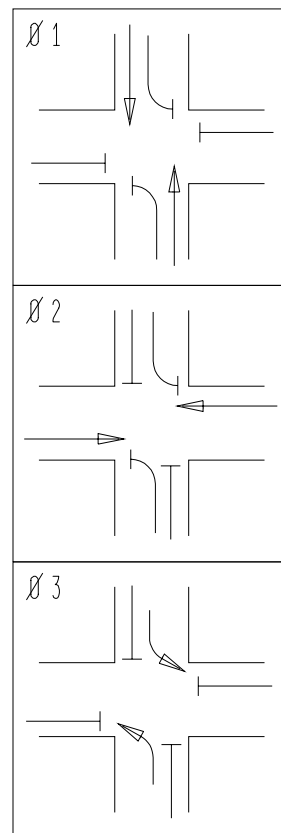
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- 2 IN THE ABSENCE OF A STOP BAR, THE CURB RADIUS SPRING POINT SHOULD BE USED.
- 3 MAINTAIN 8 FEET (MIN) - 12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
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- 5 PEDESTRIAN 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.



NOTES:

- 1 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
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- 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.

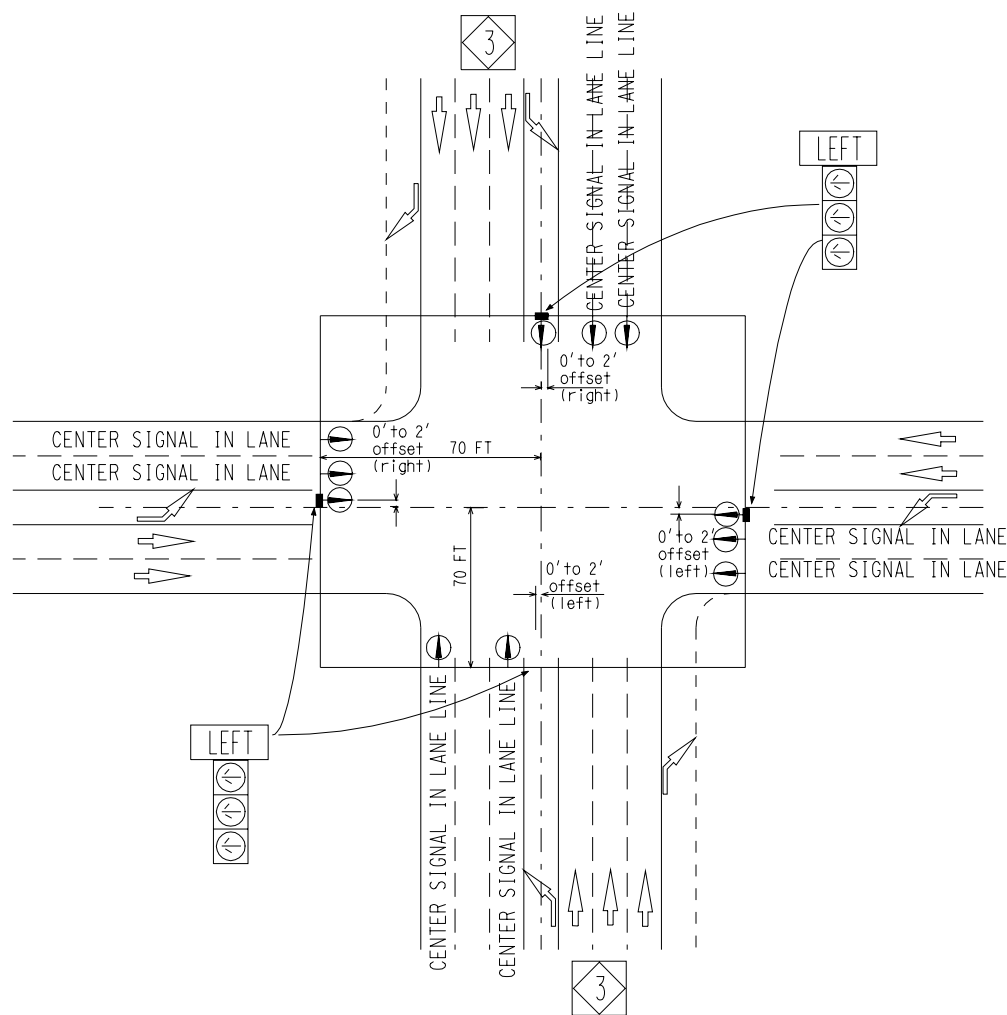
SIGNAL PHASING DIAGRAM



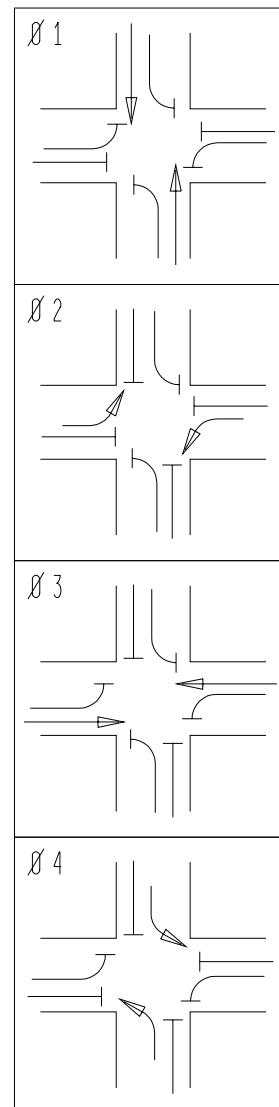
SHEET 8 OF 26

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
DUAL LEADING LEFT TURN PHASING
ON TRUNKLINE



SIGNAL PHASING DIAGRAM



NOTES:

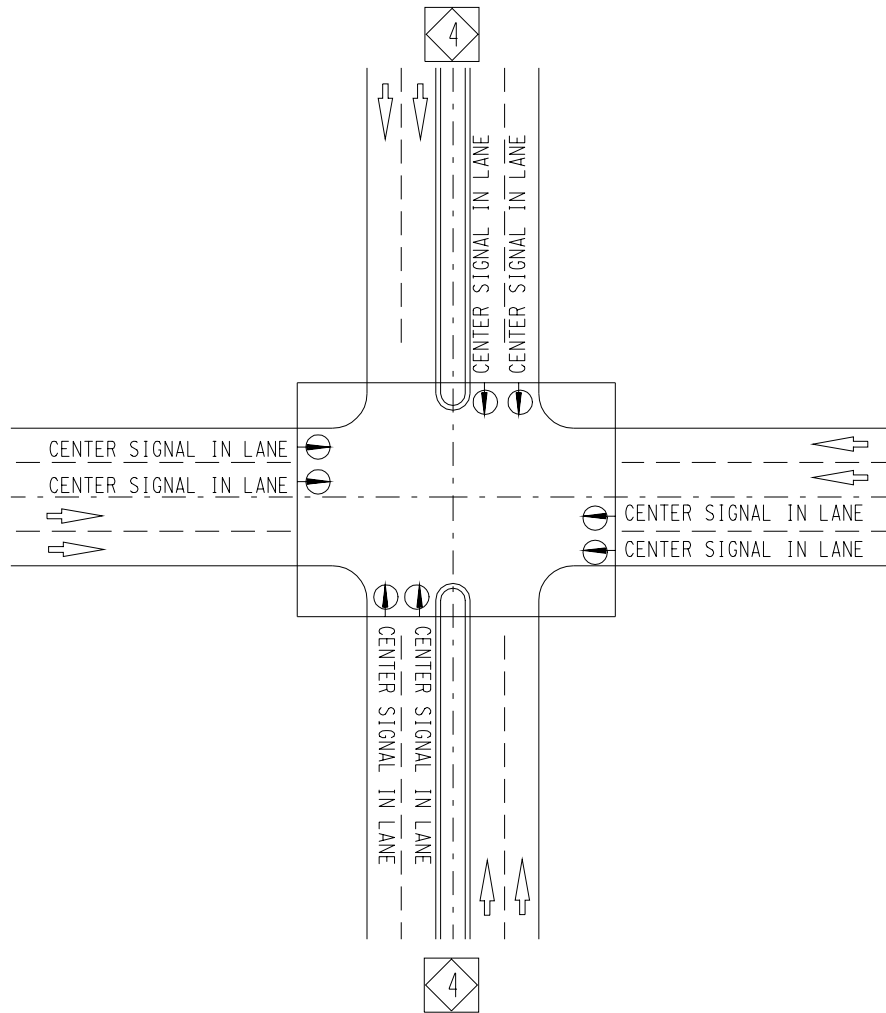
- 1 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
- 2 in THE ABSENCE OF A STOP BAR, THE CURB RADI SPRING POINT SHOULD BE USED.
- 3 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
- 4 PEDESTRIAN SIGNALS SHOULD BE CONSIDERED WHERE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



SHEET 9 OF 26

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

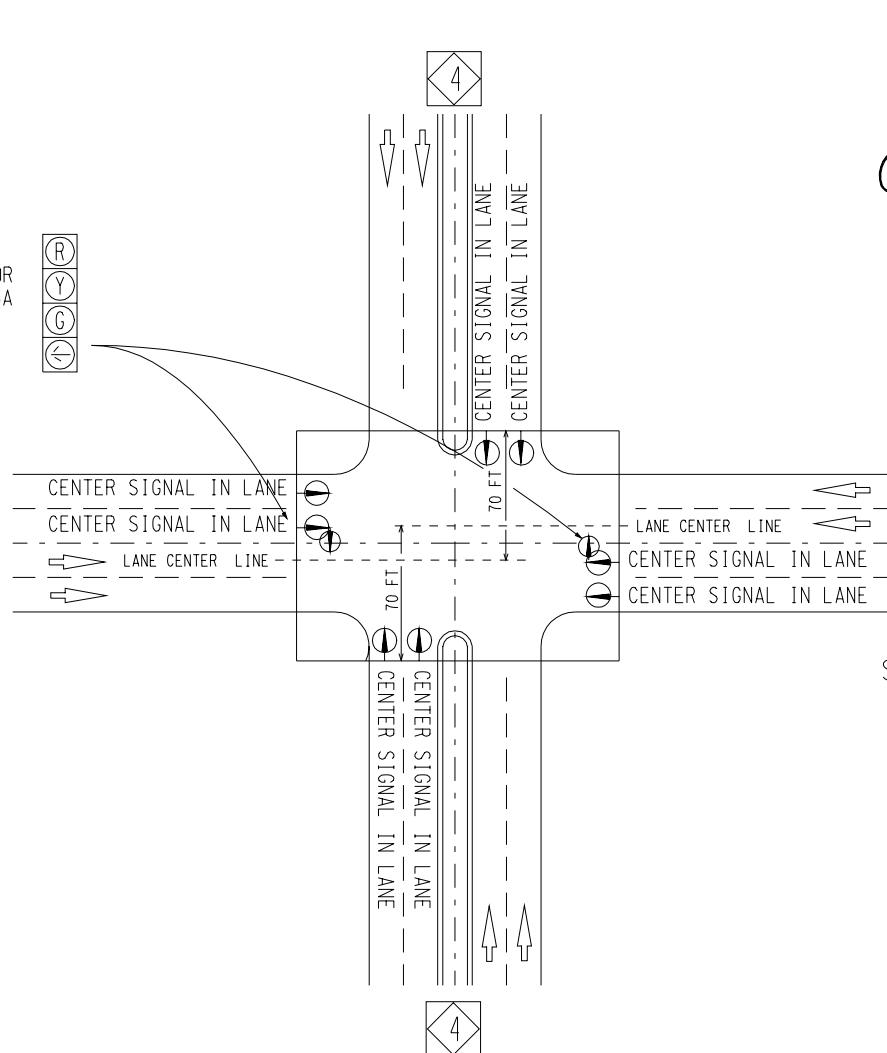


SHEET 10 OF 26

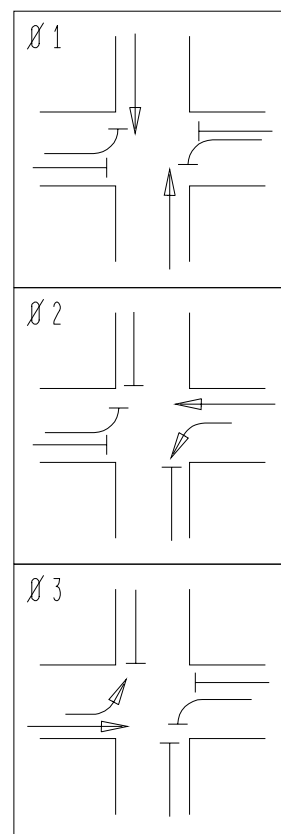
HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

1WAY 3 COLOR
W/4TH LEVEL LTGA



SIGNAL PHASING DIAGRAM



NOTES:

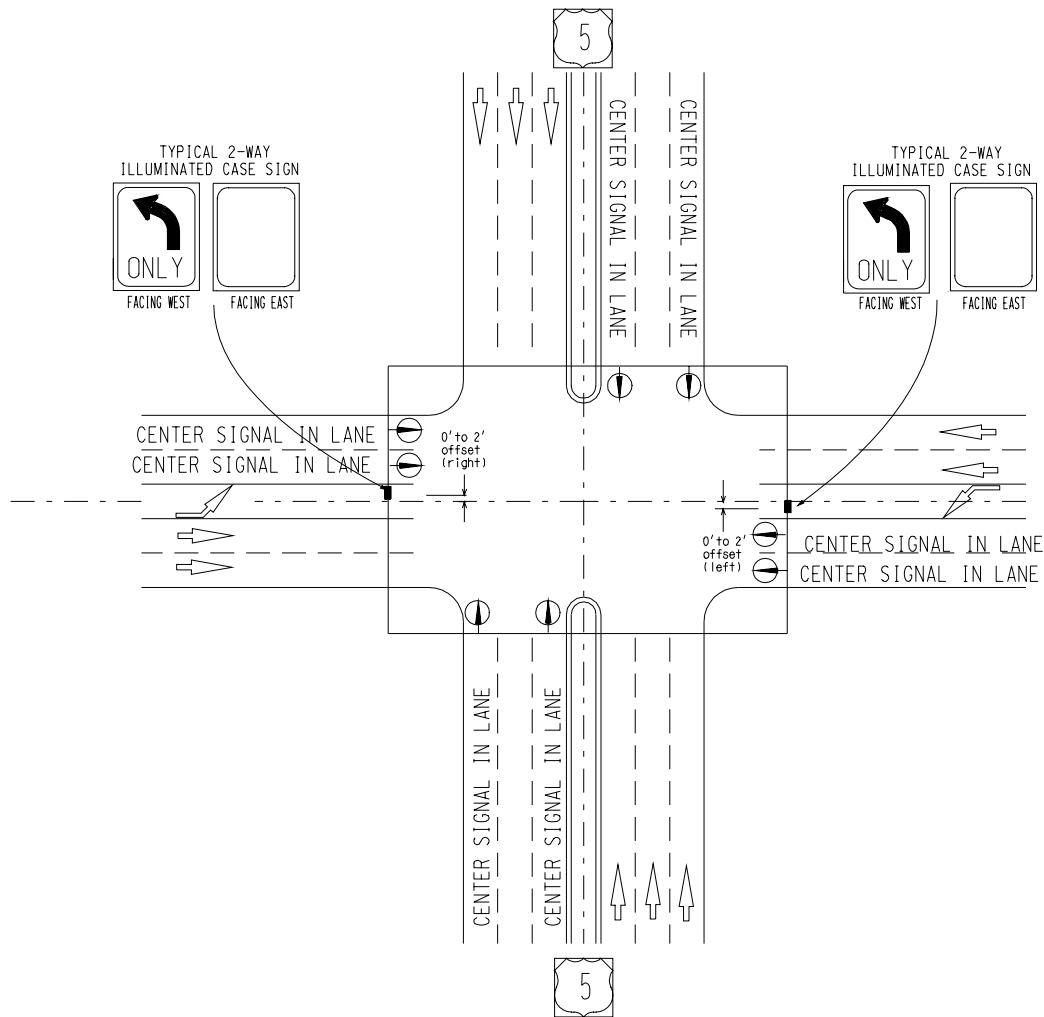
- 1 MEDIAN WIDTH LESS THAN 30'.
- 2 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
- 3 in THE ABSENCE OF A STOP BAR, THE CURB RADI SPRING POINT SHOULD BE USED.
- 4 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
- 5 UTILIZE A 4TH 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.



SHEET 11 OF 26

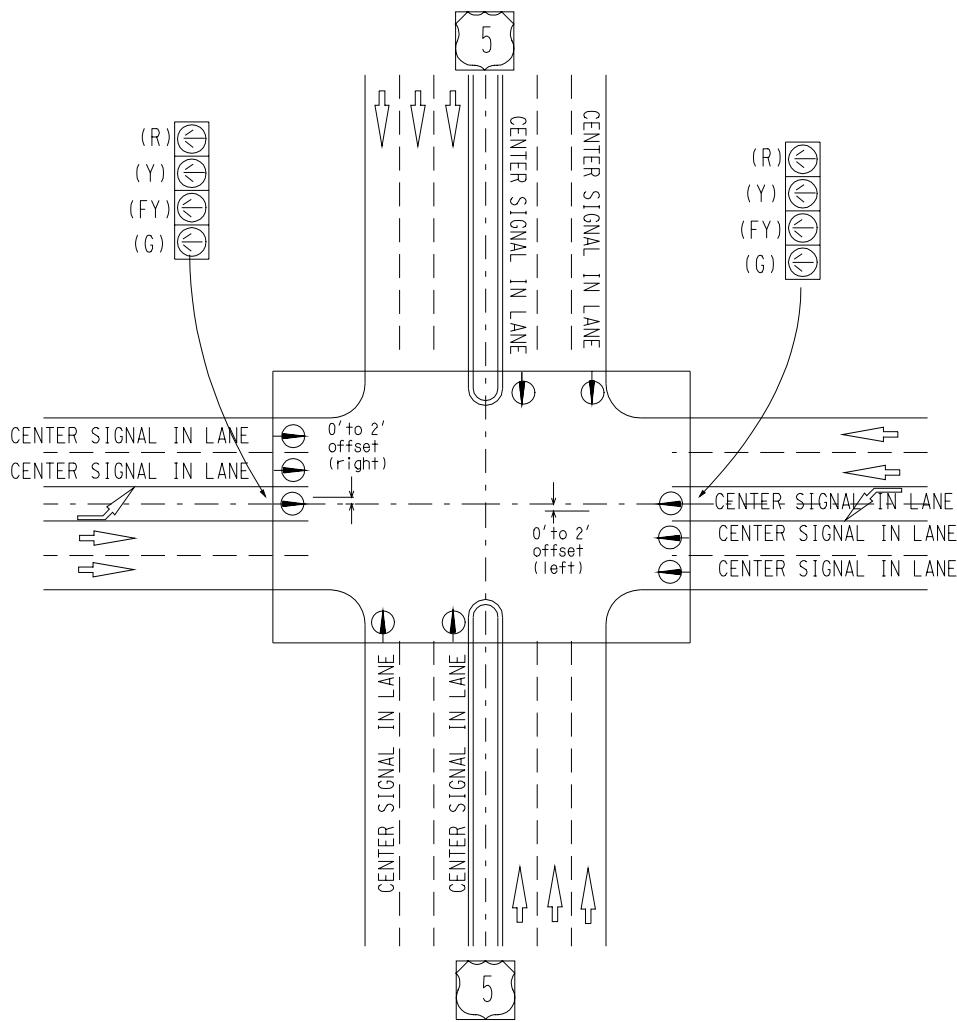
HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION
SPLIT PHASE

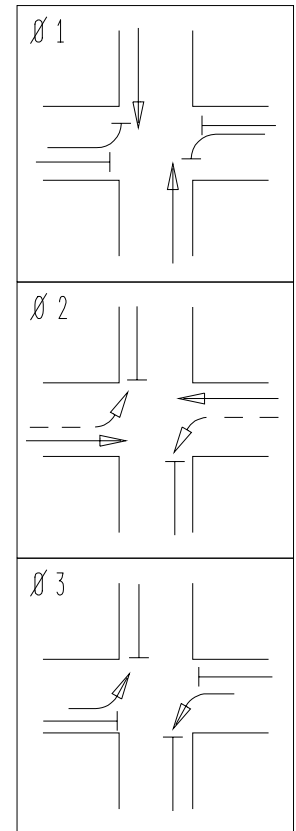


NOTES:

- 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.



SIGNAL PHASING DIAGRAM



NOTES:

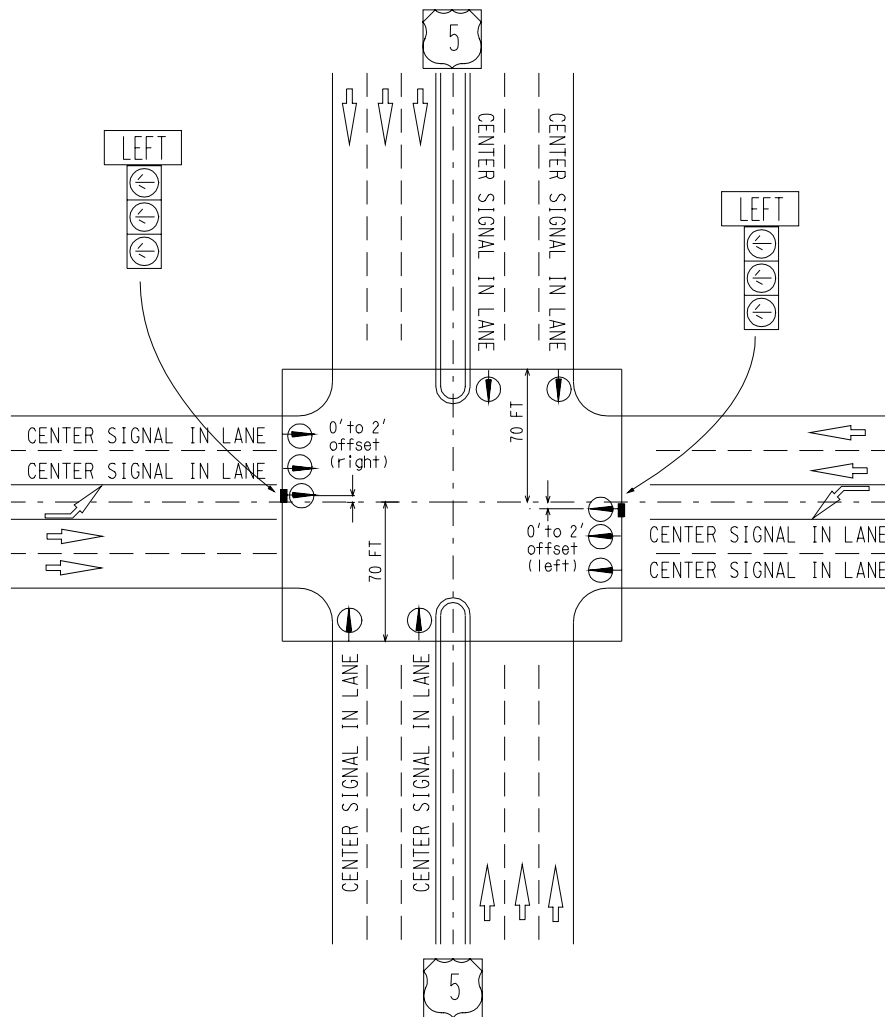
- 1 MEDIAN WIDTH LESS THAN 30'.
- 2 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
- 3 in THE ABSENCE OF A STOP BAR, THE CURB RADII SPRING POINT SHOULD BE USED.
- 4 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
- 5 THE APPROACH 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.



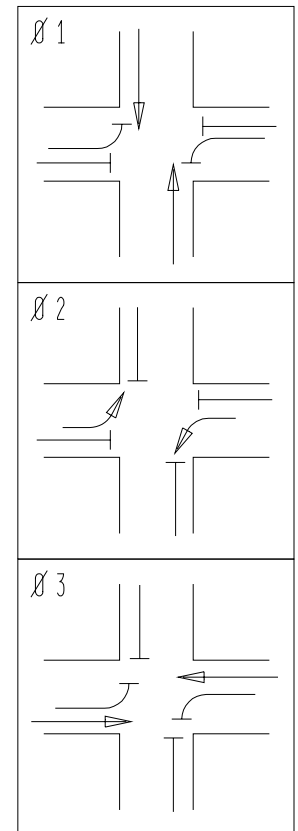
SHEET 13 OF 26

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
DUAL LAGGING LEFT TURN PHASE
ON X-RD

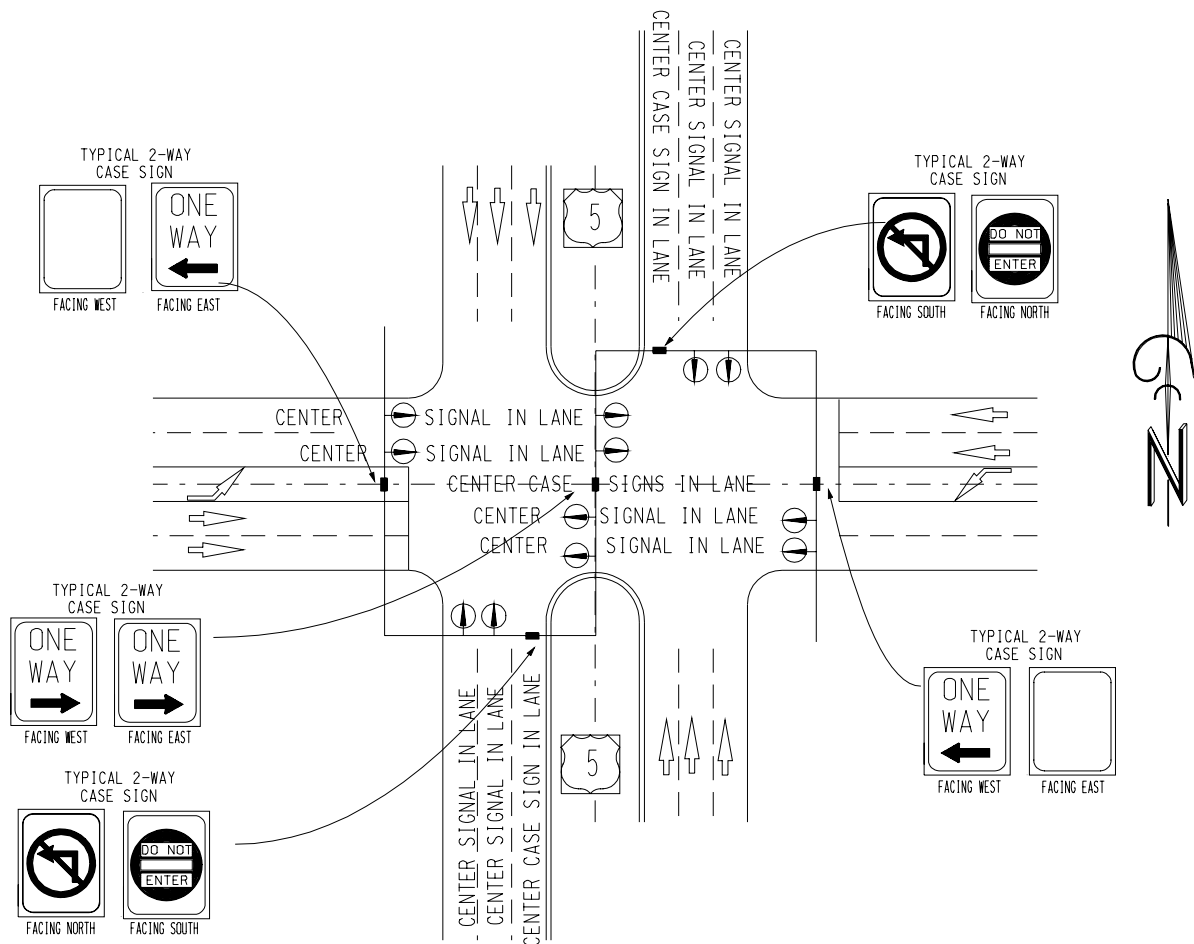


SIGNAL PHASING DIAGRAM



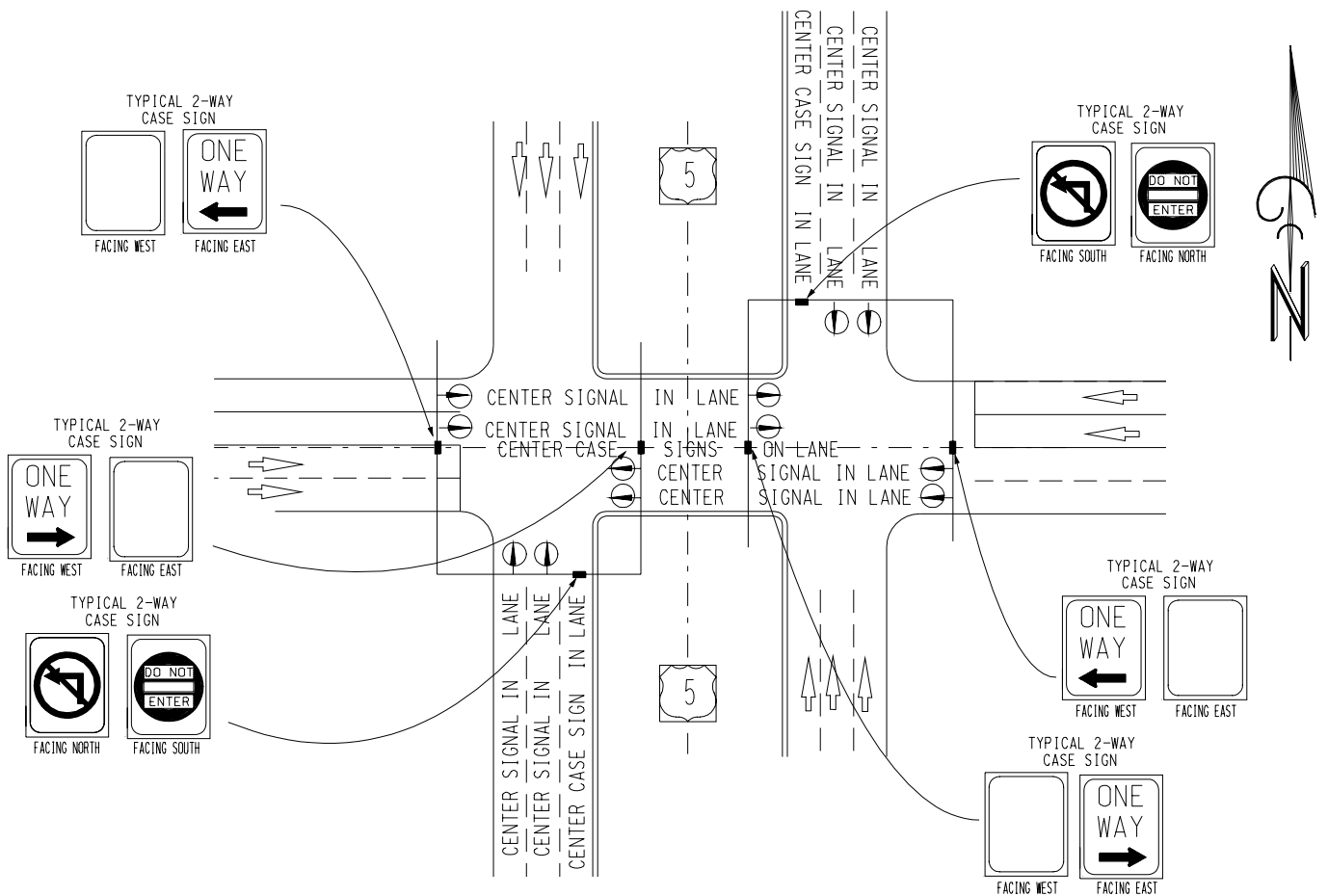
NOTES:

- 1 MEDIAN WIDTH LESS THAN 30'.
- 2 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.



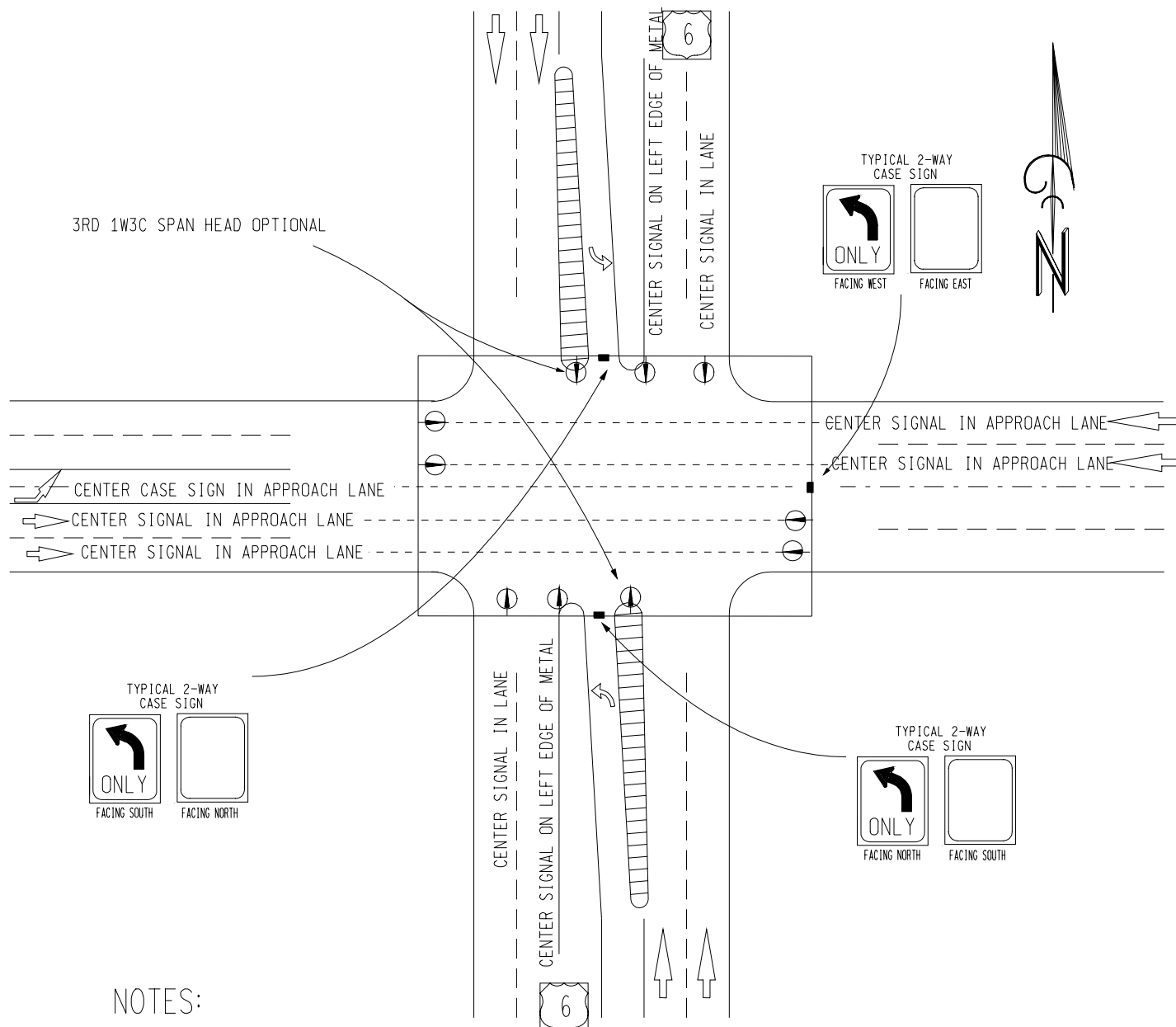
NOTES:

- 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 RADIUS 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 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 CROSSEOVERS. THE MAIN PROBLEM IS THE INTERLOCKING OF LEFT TURN MOVEMENTS.
- 7 TO REDUCE THE NUMBER OF CONDUCTOR CABLES CROSSING 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.



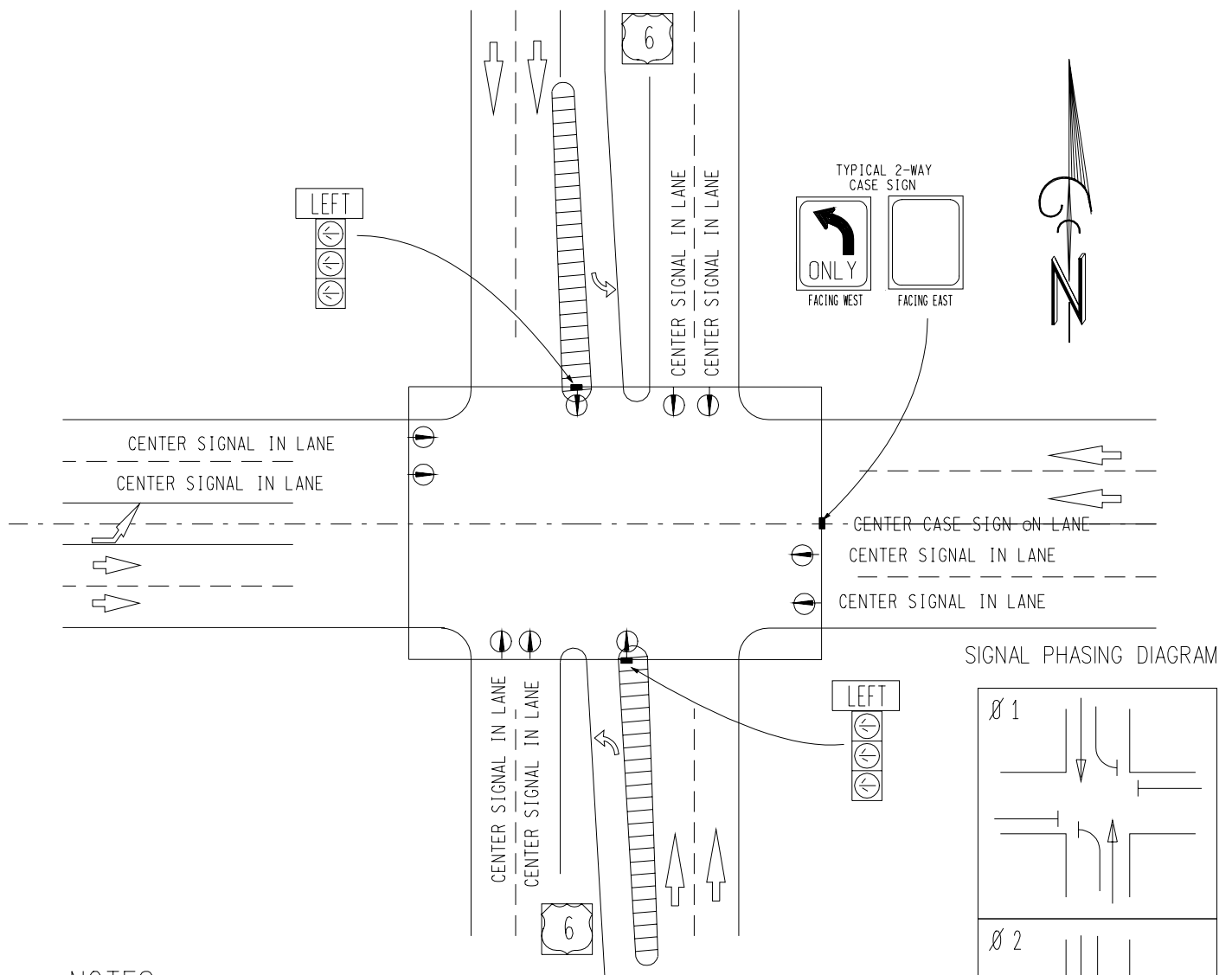
NOTES:

- 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 RADI 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 TO REDUCE THE NUMBER OF CONDUCTOR CABLES CROSSING A SPAN, CONSIDERATION SHOULD BE GIVEN TO PLACING THE CONTROLLER IN THE MEDIAN.
- 10 TO REDUCE THE NUMBER OF OVERHEAD CONDUCTORS CABLES CROSSING THE SPAN TO 10 OR LESS.
- 11



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 RADIUS 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 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.

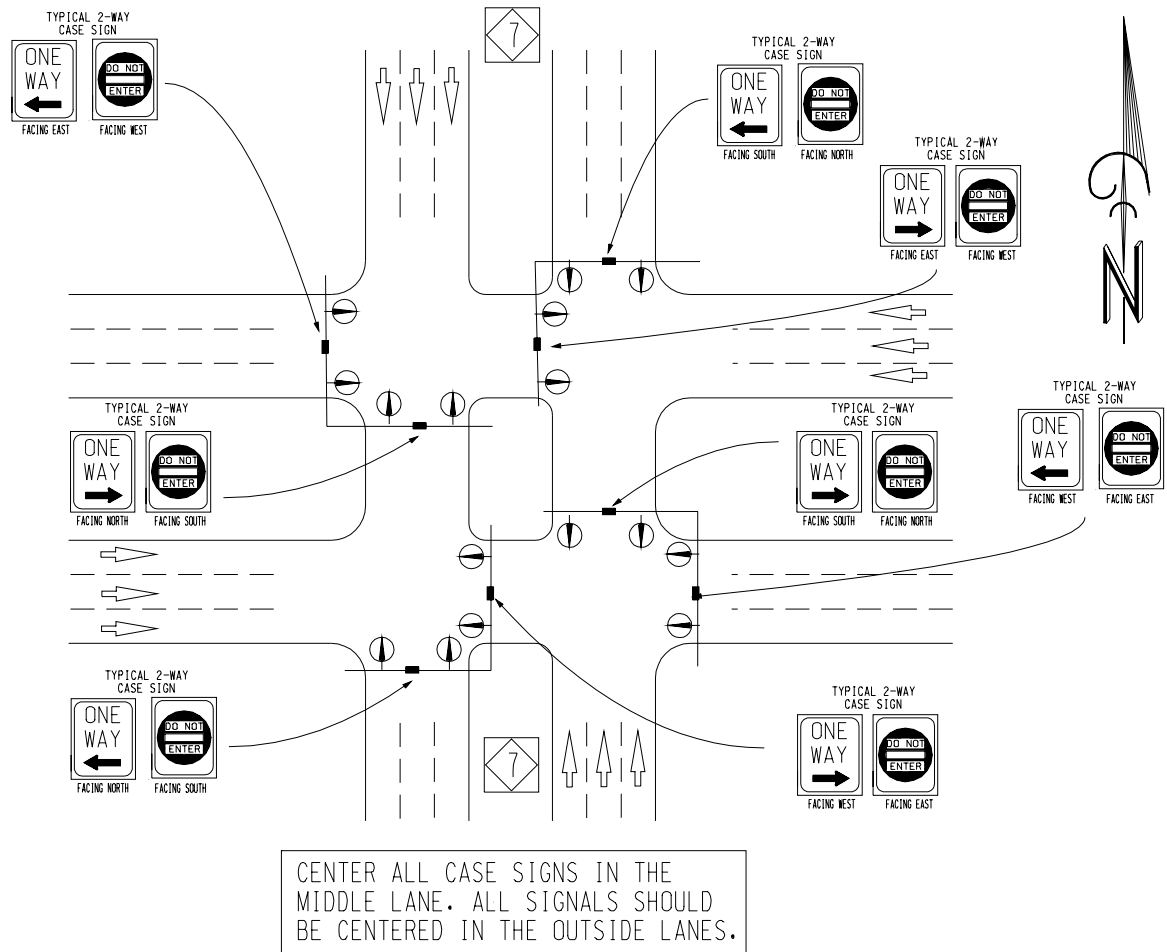


NOTES:

- 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 RADIUS 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 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.

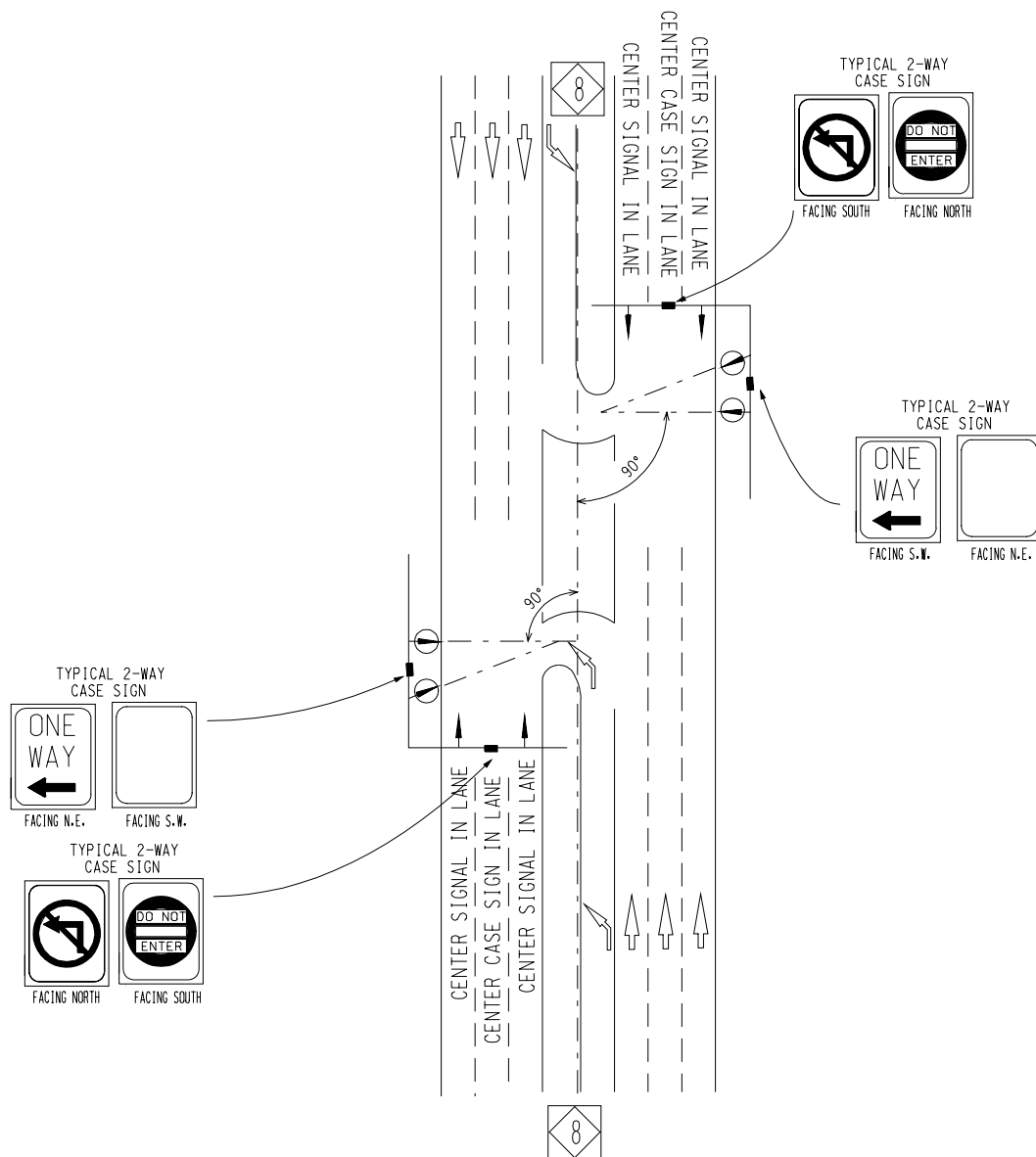
HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
DUAL LEADING LEFT-TURN PHASE
(SAME FOR LAGGING LEFT-TURN)



NOTES:

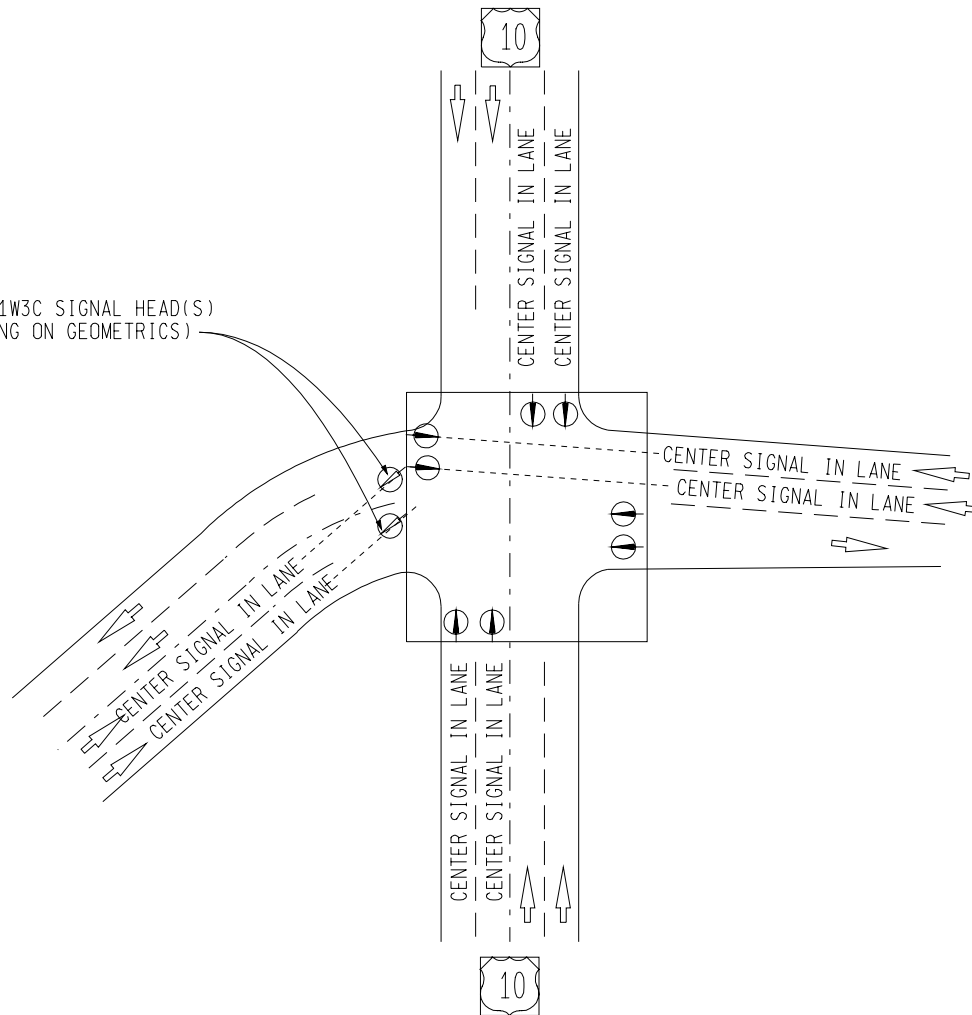
- 1 MEDIAN WIDTH IS 30' OR MORE, AND THE DISTANCE FROM THE X-ROAD STOP BAR TO THE MEDIAN SIGNAL IS GREATER THAN 150 FEET.
- 2 DESIGN AS FOUR SEPARATE INTERSECTIONS
- 3 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
- 4 in THE ABSENCE OF A STOP BAR, THE CURB RADIUS SPRING POINT 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 CROSSING A SPAN, CONSIDERATION SHOULD BE GIVEN TO PLACING THE CONTROLLER IN THE MEDIAN.
- 9 A BASE MOUNTED CABINET MAY BE REQUIRED



NOTES:

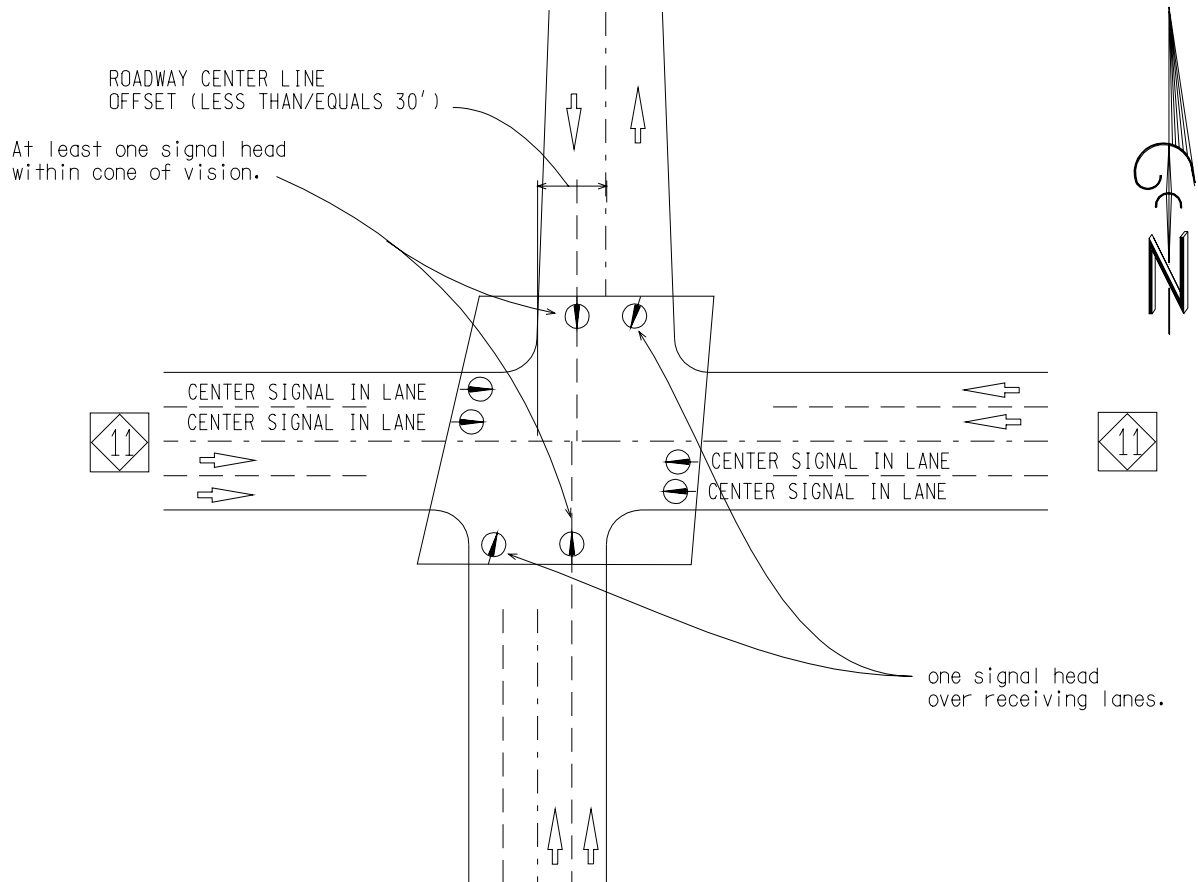
- 1 TREAT EACH CROSS OVER AS A SEPARATE INTERSECTION
- 2 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.

OPTIONAL 1W3C SIGNAL HEAD(S)
(DEPENDING ON GEOMETRICS)



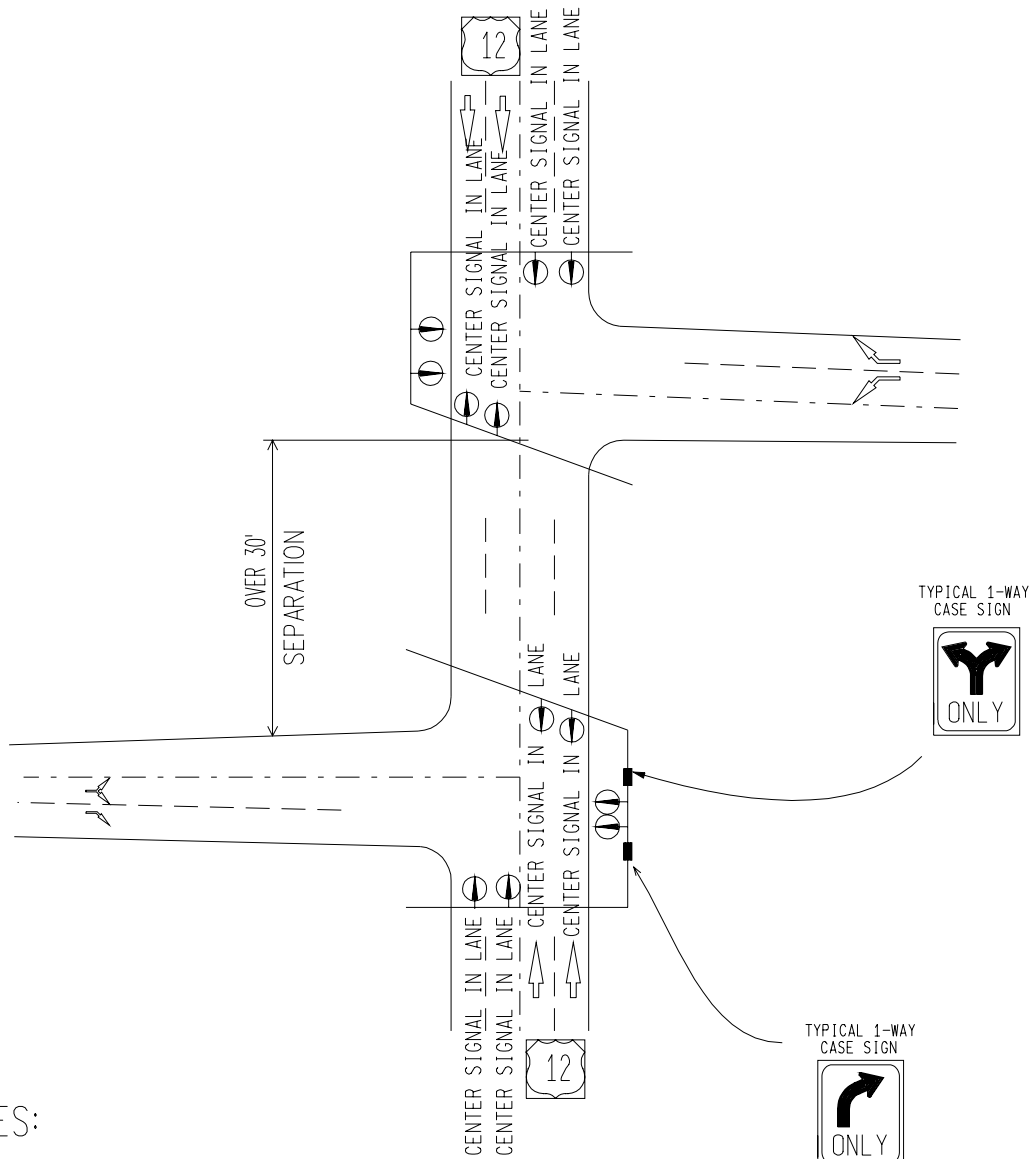
NOTES:

- 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.



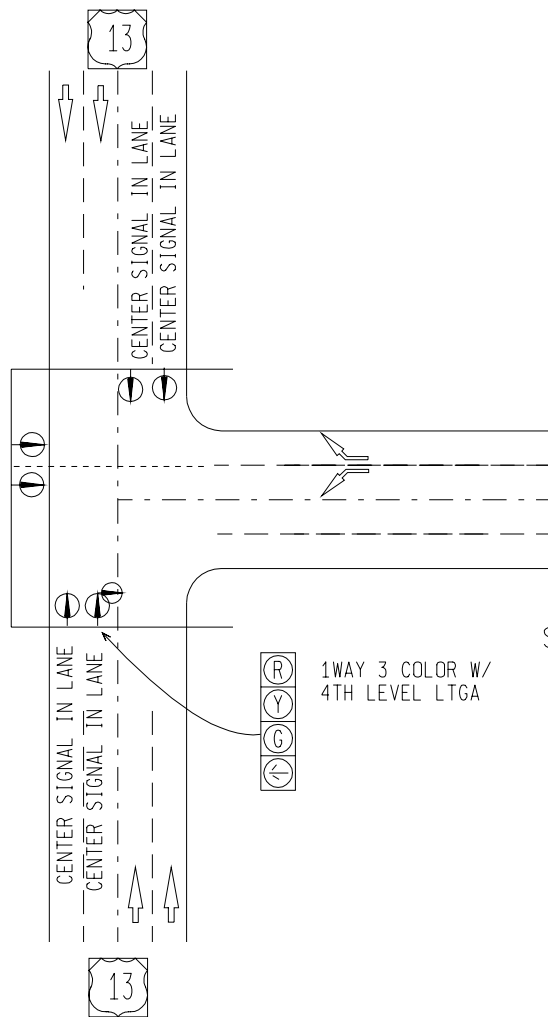
NOTES:

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

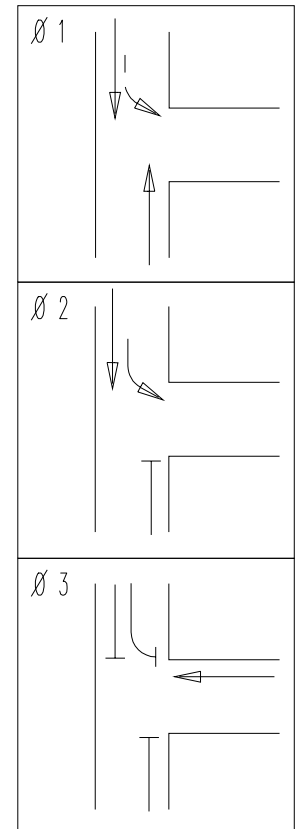


NOTES:

- 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 RADIUS 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



SIGNAL PHASING DIAGRAM



NOTES:

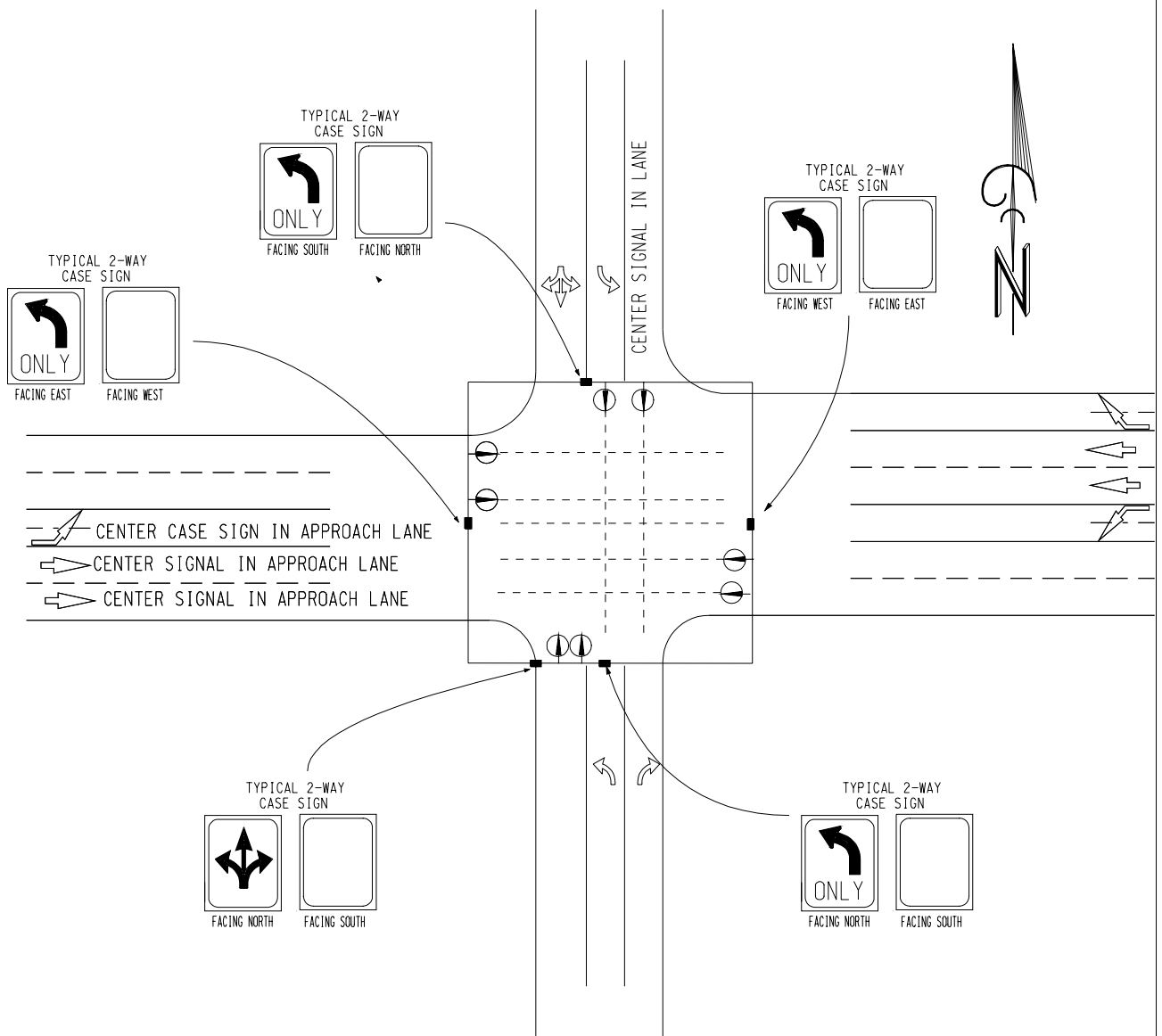
- 1 THE DISTANCE BETWEEN THE STOP BAR AND SIGNAL SHALL NOT EXCEED 150 FEET.
- 2 IN THE ABSENCE OF A STOP BAR, THE CURB RADIUS SPRING POINT SHOULD BE USED.
- 3 MAINTAIN 8 FEET (MIN) -12 FEET (DESIRED) BETWEEN SIGNAL HEADS, SIGNS, AND OTHER SPAN EQUIPMENT.
- 4 PEDESTRIAN SIGNALS REQUIRED UNLESS OTHERWISE DIRECTED.
- 5 UTILIZE A 4TH LEVEL LTGA FOR THE SOUTH PROTECTED LEFT MOVEMENTS.



SHEET 25 OF 26

HEAD PLACEMENT DIAGRAM

3 PHASE OPERATION WITH
SINGLE LAGGING LEFT-TURN PHASE
ON TRUNKLINE

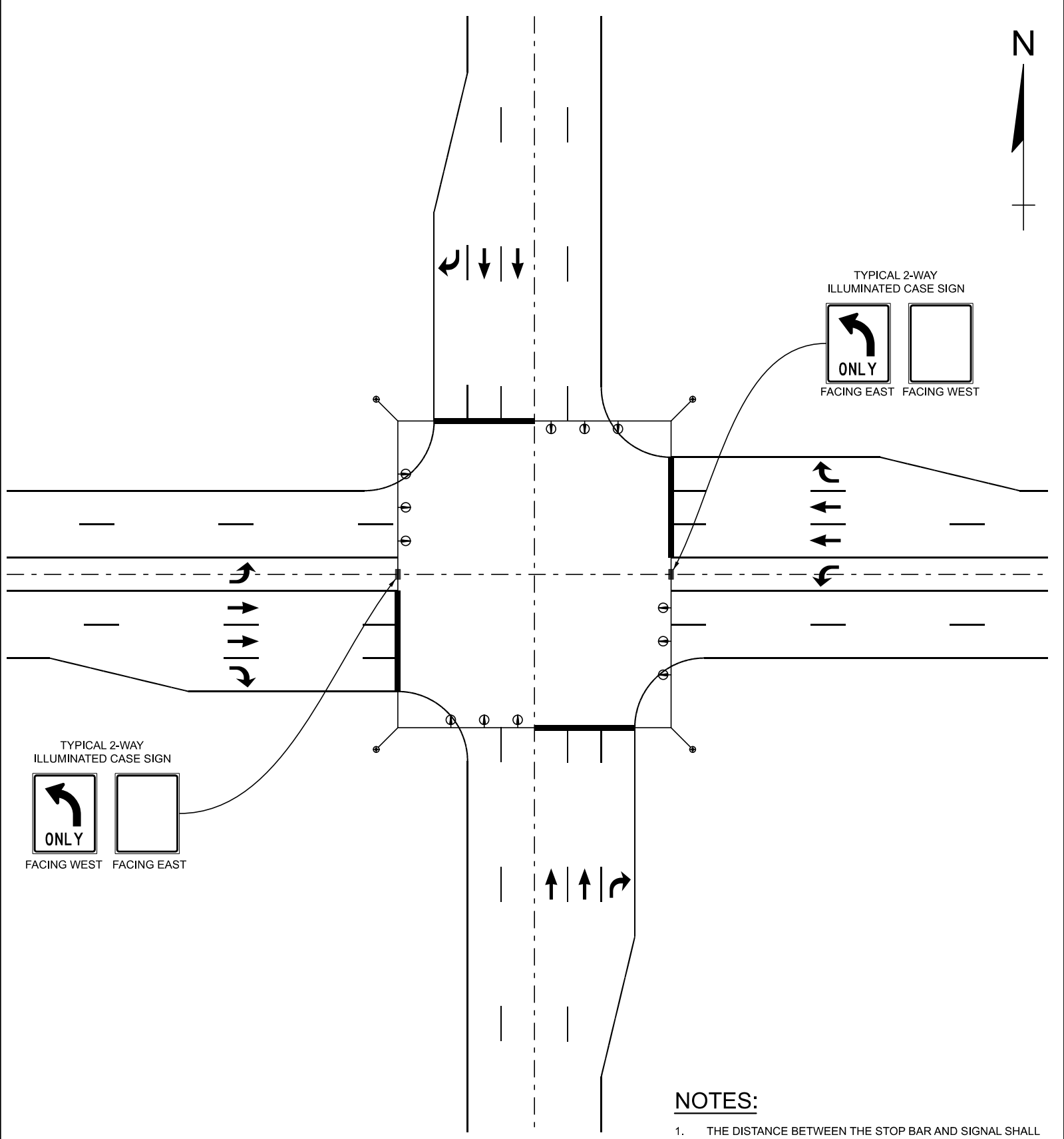


NOTES:

- 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 RADIUS 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 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.

**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.

 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	



TYPICAL 2-WAY
ILLUMINATED CASE SIGN



FACING WEST FACING EAST

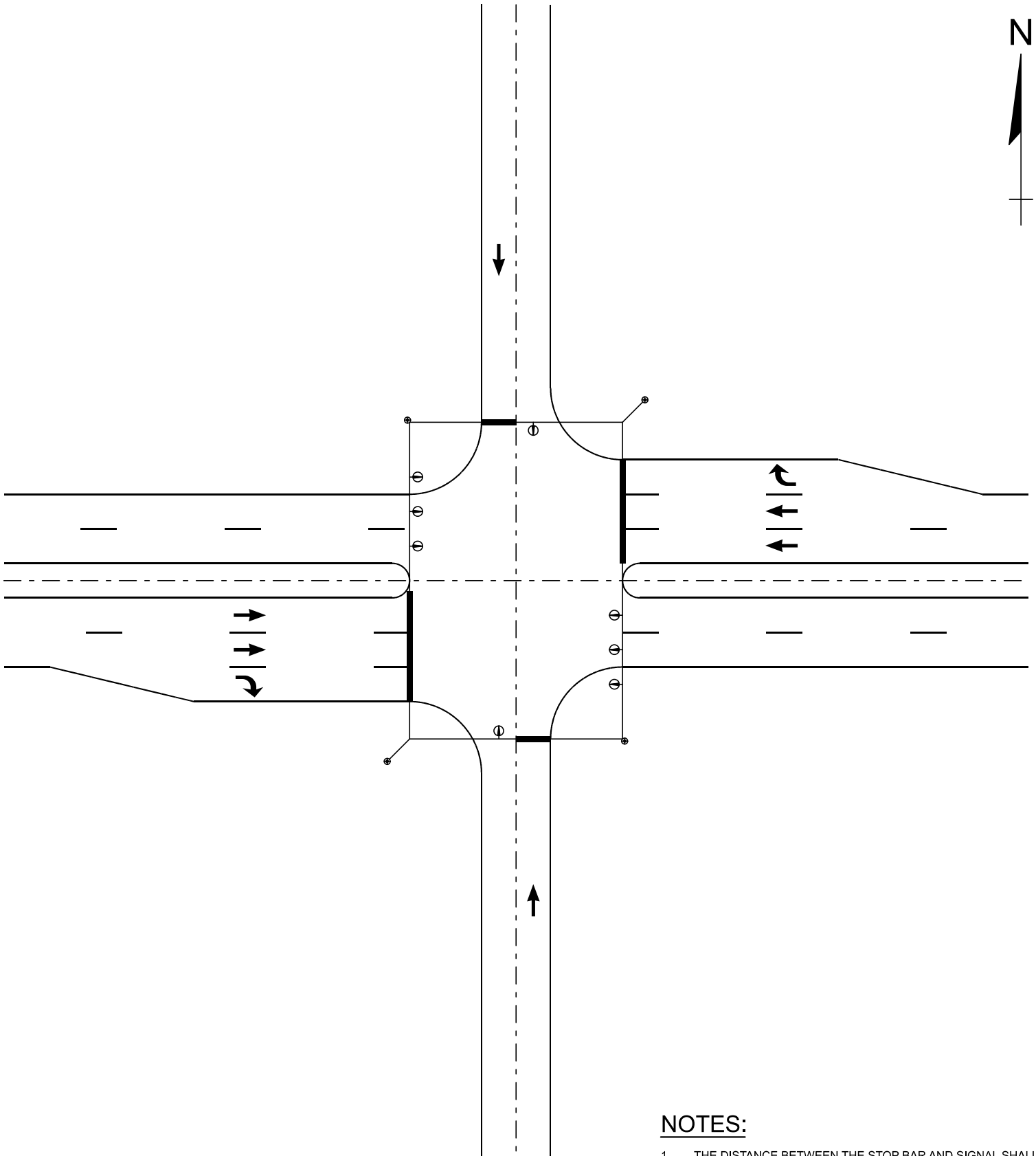
TYPICAL 2-WAY
ILLUMINATED CASE SIGN



FACING EAST FACING WEST

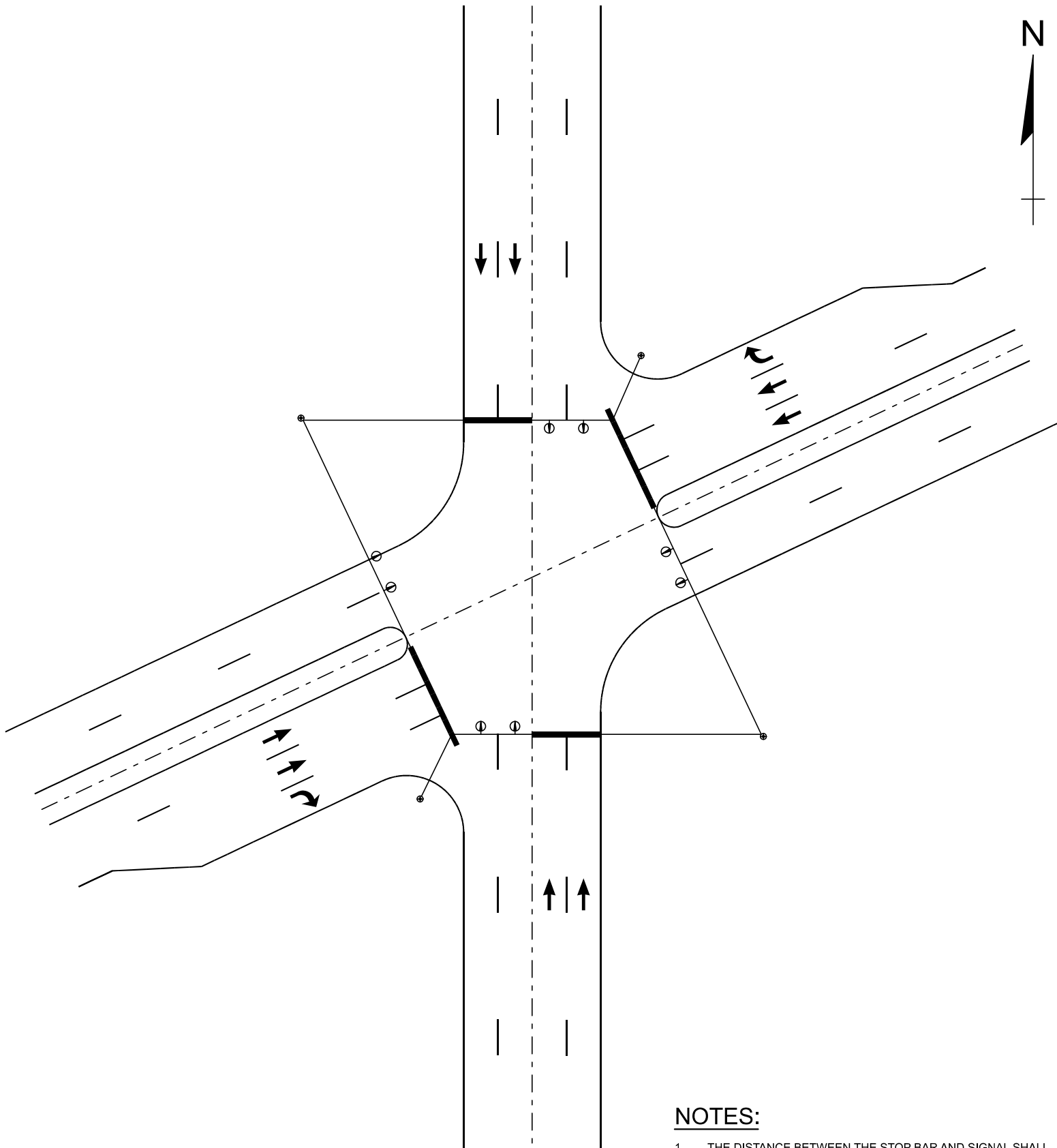
NOTES:

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.



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.



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.



NO SCALE

DESIGN UNIT: SIGNALS

TSC: STATEWIDE

DATE:

CS: STATEWIDE

BOX SPAN WITH 2 TIE-OFFS

DRAWING SHEET

JN: STATEWIDE

BOX SPAN TYPICALS.dgn

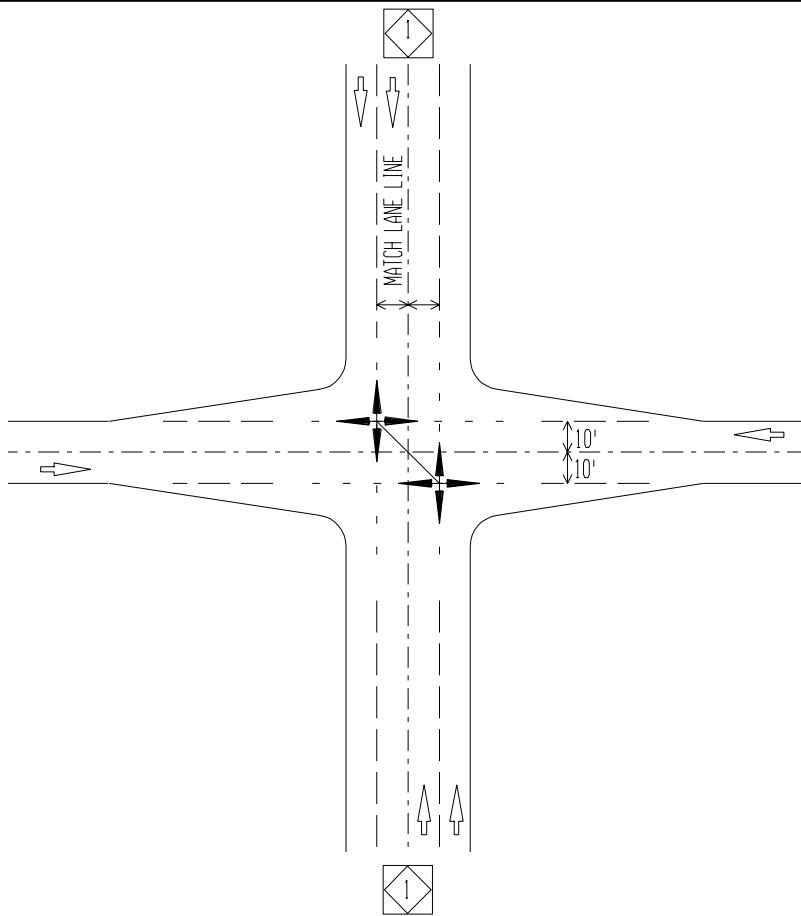
SECT

4 OF 4

FILE:

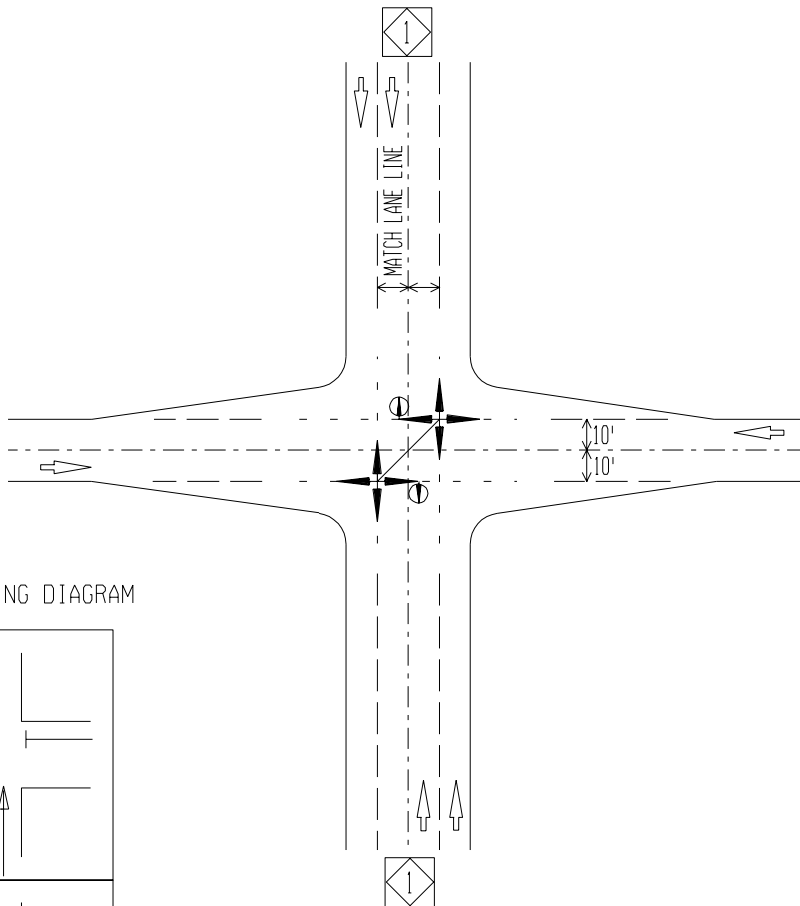
MICHIGAN TRAFFIC SIGNAL STRUCTURES DESIGN GUIDELINES

Appendix I – Traffic Signal Head Placement Diagrams (Diagonal Span)

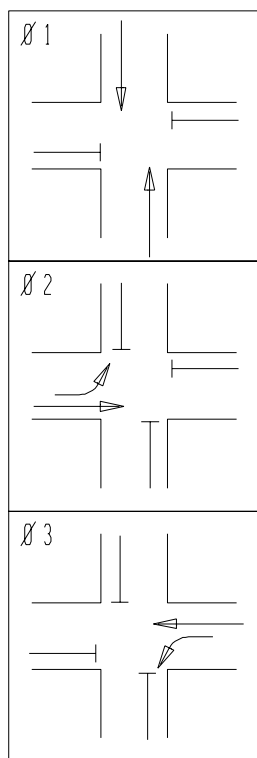


NOTES:

- 1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE
- 2 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE

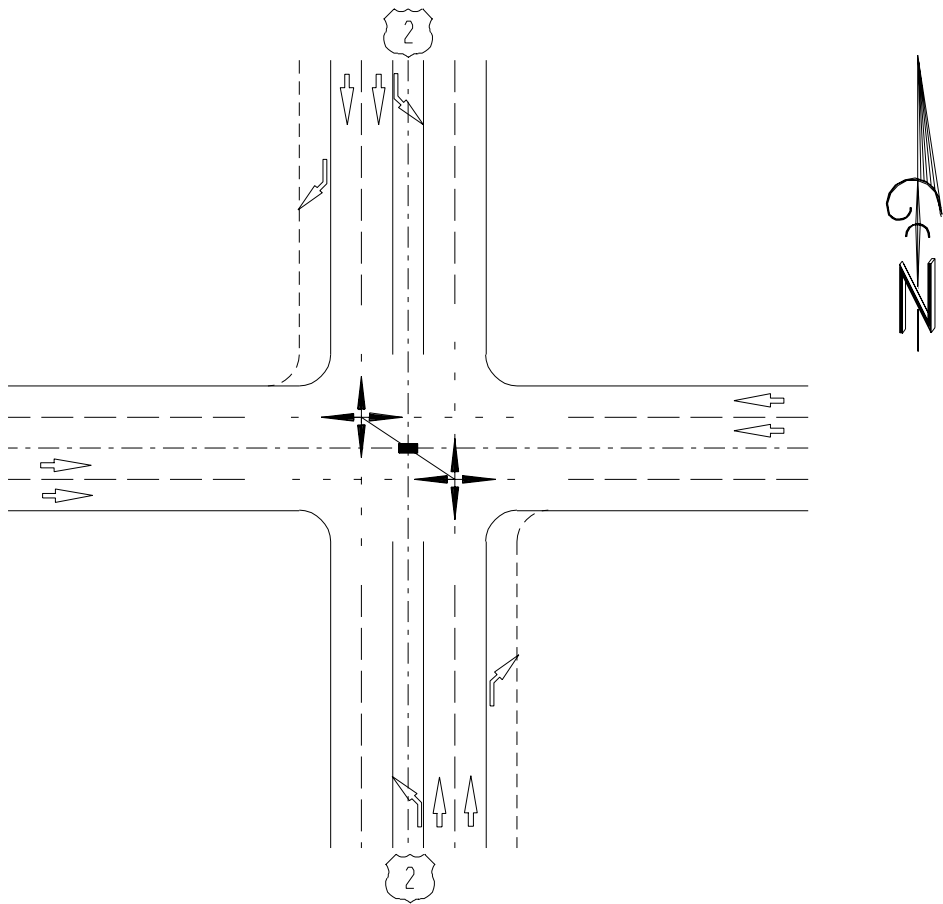


SIGNAL PHASING DIAGRAM



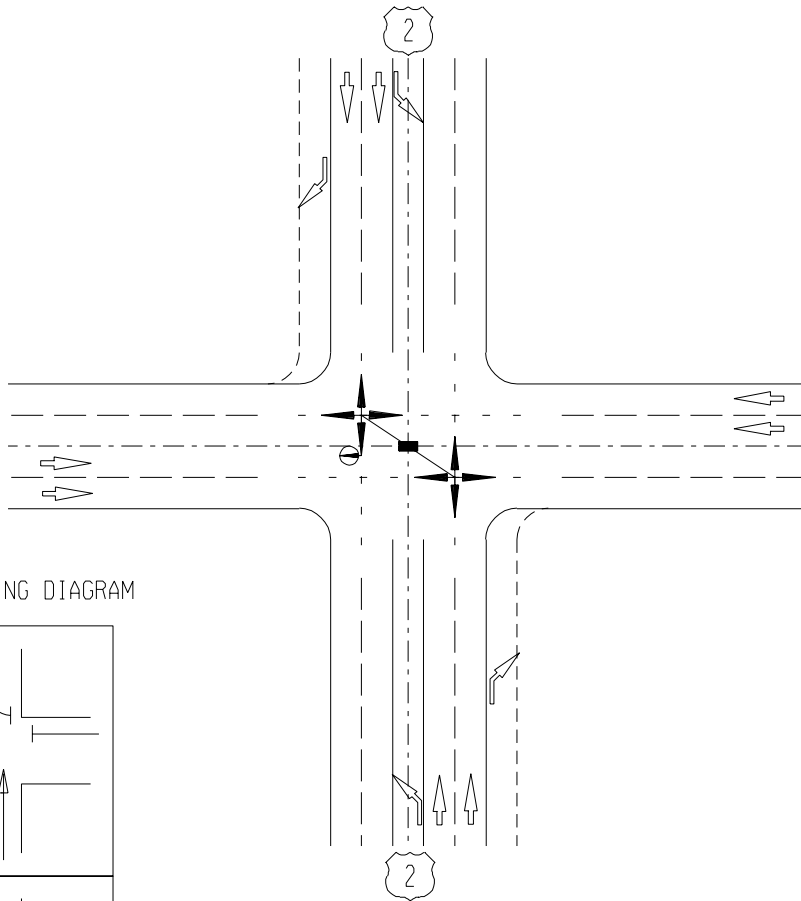
NOTES:

- 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 GREEN ARROWS (L.T.G.A.)
- 4 PEDESTRIAN SIGNALS REQUIRED

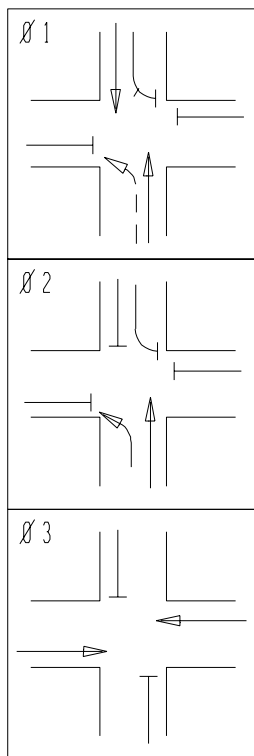


NOTES:

- 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

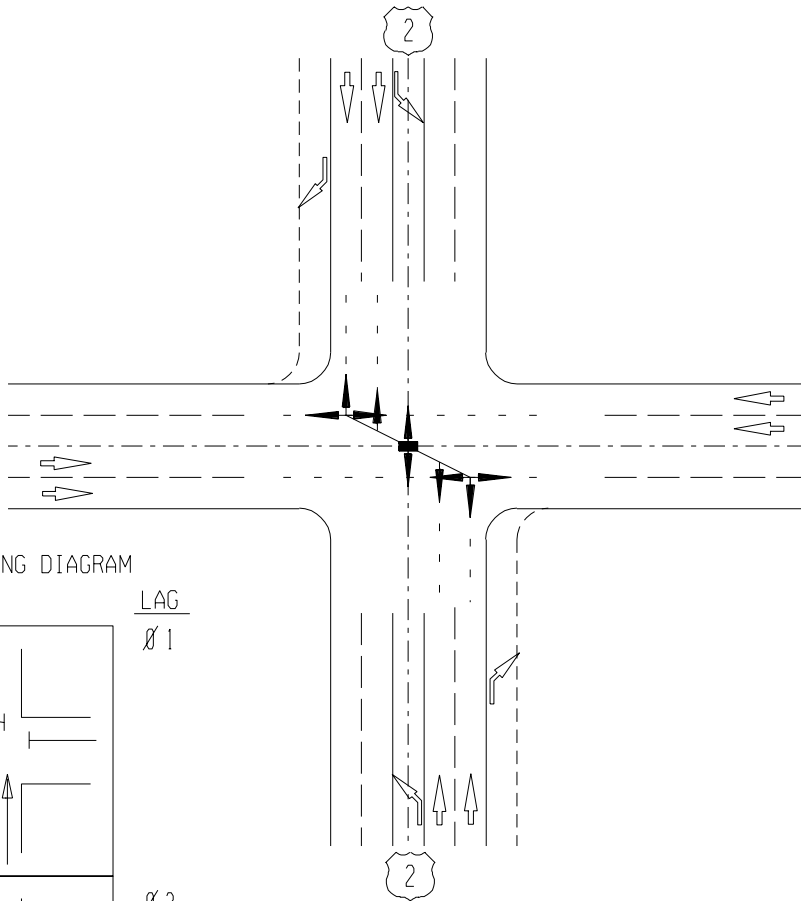


SIGNAL PHASING DIAGRAM



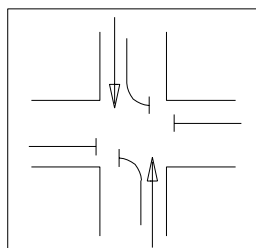
NOTES:

- 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



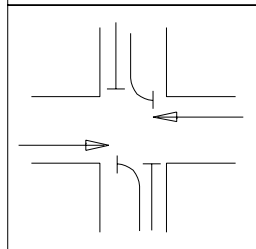
SIGNAL PHASING DIAGRAM

LEAD
Ø 1



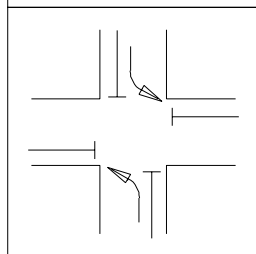
LAG
Ø 1

Ø 2



Ø 3

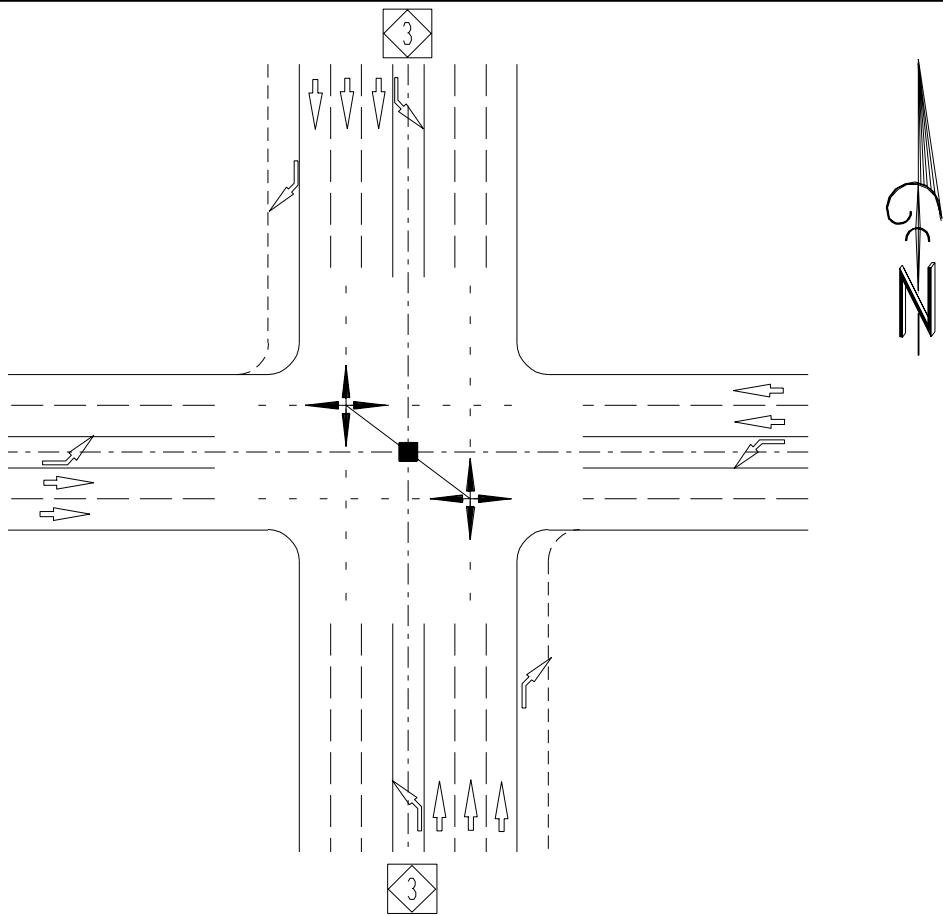
Ø 3



Ø 2

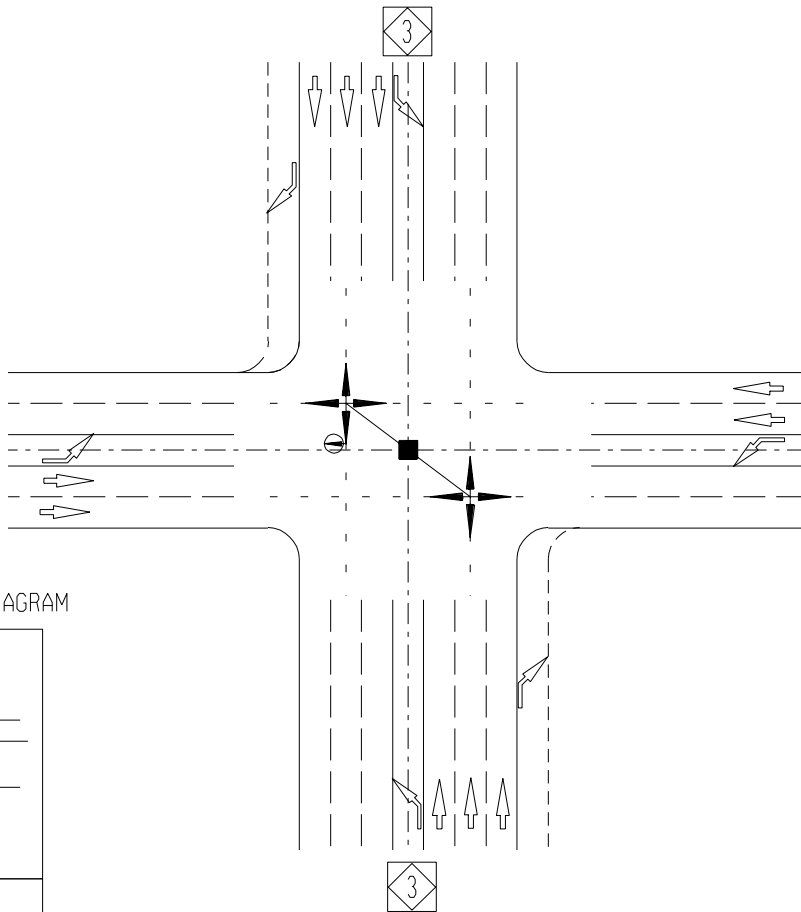
NOTES:

- 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 THE LEFT-TURN SIGNAL
- 4 WITH TWO THRU LANES - SPLIT EACH LANE
- 5 WITH TWO THRU LANES & RIGHT LANE - ADJUST 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 PERMISSIVE (i.e. FLASHING RED LEFT-TURN SIGNAL)

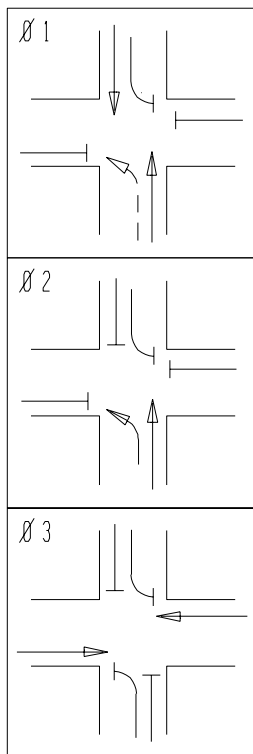


NOTES:

- 1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE
- 2 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE
- 3 USE 4-WAY CASE SIGN
- 4 CONSIDER LOW LEVEL SIGNALS ON X-RD FOR HEAVY LEFT TURN MOVEMENTS

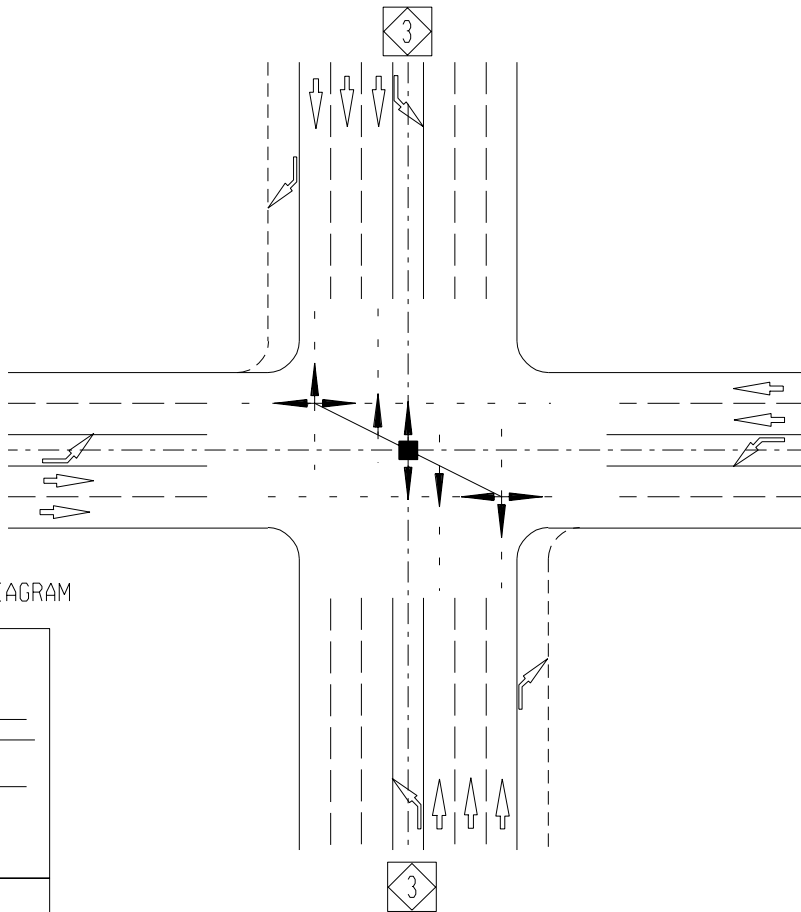


SIGNAL PHASING DIAGRAM

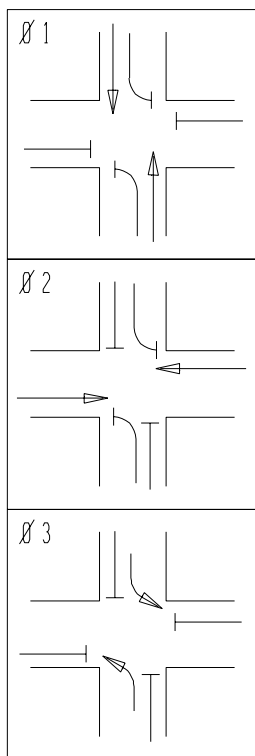


NOTES:

- 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 F OR HEAVY LEFT TURNS MOVEMENTS

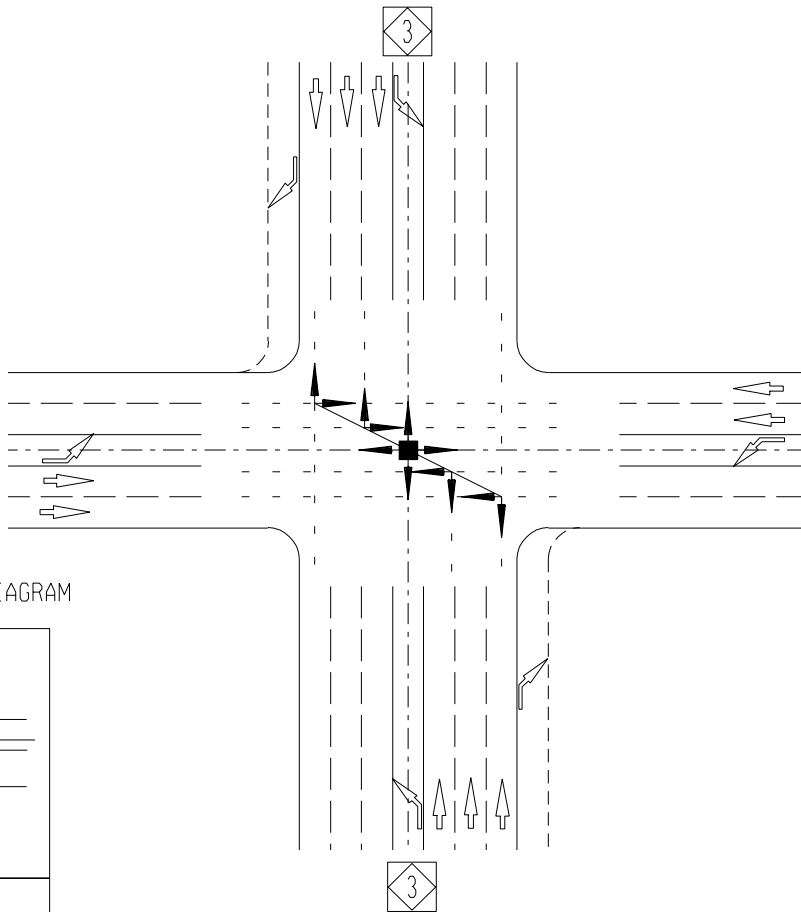


SIGNAL PHASING DIAGRAM

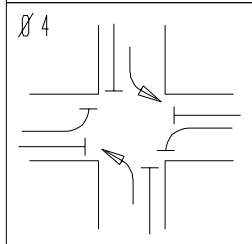
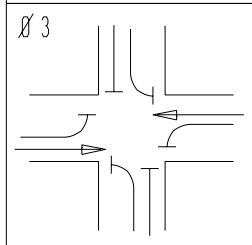
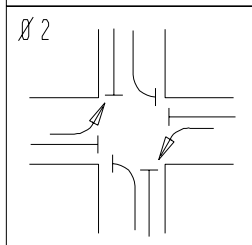
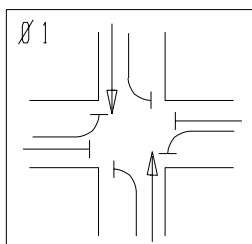


NOTES:

- 1 DRAW HEAD PLACEMENT BOX-SPLIT LANES FOR EACH TRUNKLINE APPROACH
- 2 USE EXCLUSIVE LEFT - TURN SIGNAL HEADS WITH CASE SIGNS
- 3 PLACE TWO THRU SIGNALS TO THE RIGHT OF THE LEFT TURN SIGNAL
- 4 WITH THREE LANES: SPLIT CURB LANE FOR RIGHT SIGNAL AND ADJUST LEFT SIGNAL BETWEEN CENTER OF LEFT THRU LANE AND LANE LINE
- 5 WITH THREE LANES & RIGHT LANES: SAME PLACEMENT BUT RIGHT SIGNAL CAN BE ADJUSTED TOWARD RIGHT TURN LANE IF DESIRABLE
- 6 PEDESTRIAN SIGNALS REQUIRED UNLESS OTHERWISE DIRECTED
- 7 CONSIDER LOW LEVEL SIGNALS ON X-ROAD FOR HEAVY LEFT TURN MOVEMENTS

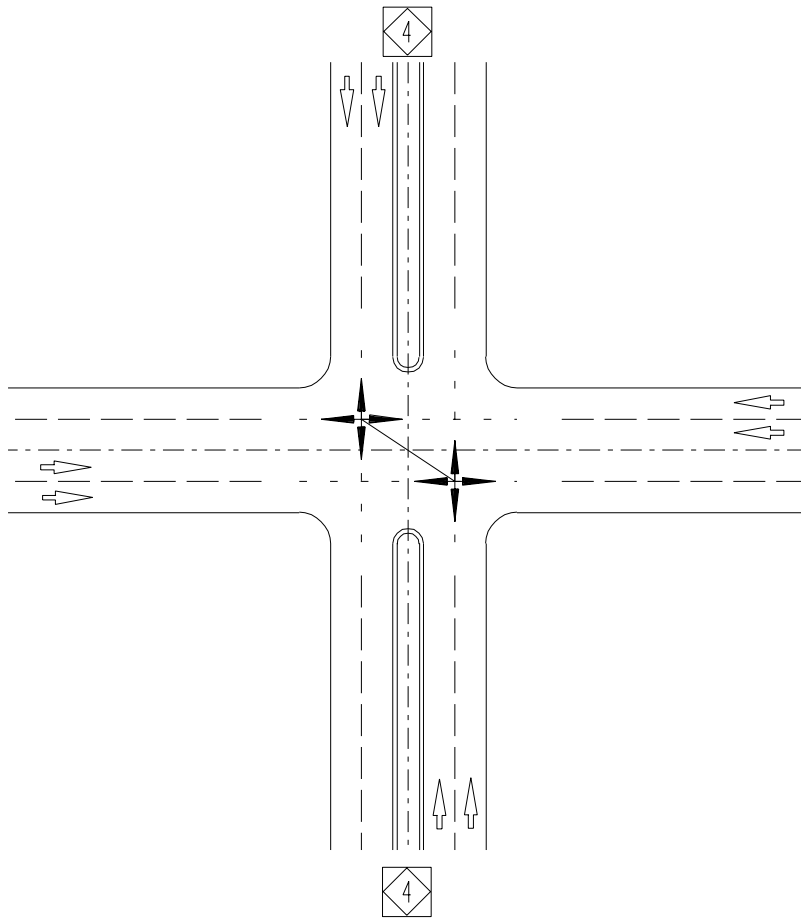


SIGNAL PHASING DIAGRAM



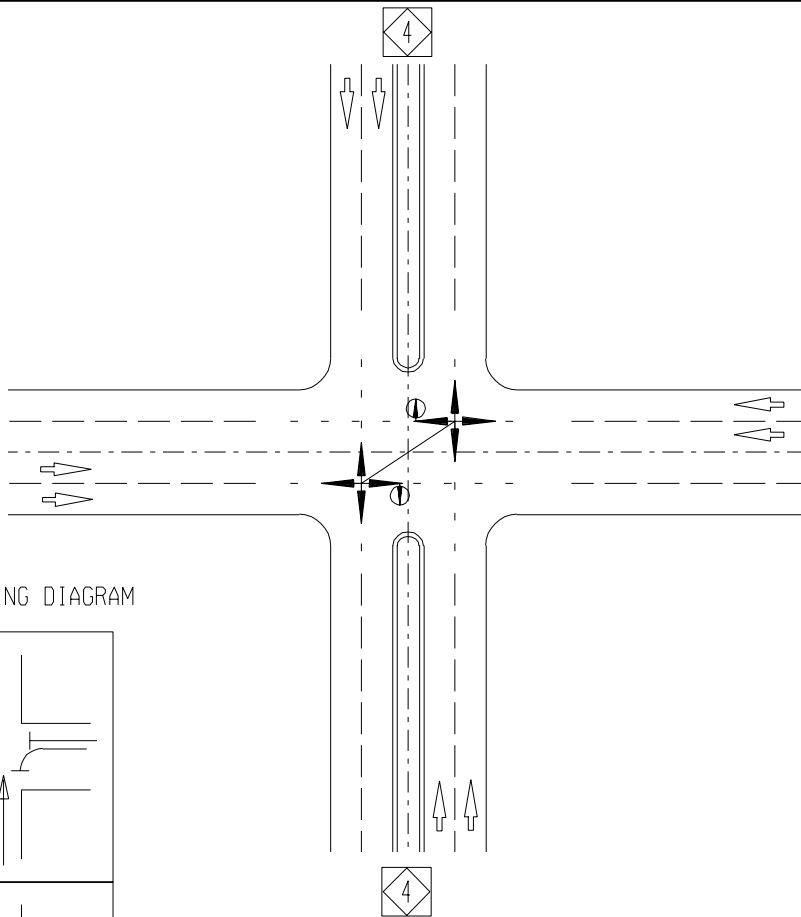
NOTES:

- 1 DRAW HEAD PLACEMENT BOX- SPLIT THRU LANEAGE ON EACH APPROACH
- 2 USE EXCLUSIVE 4-WAY LEFT TURN SIGNALS 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 FOR RIGHT SIGNAL AND ADJUST LEFT SIGNAL BETWEEN CENTER OF LEFT THRU LANE AND LANE LINE
- 6 PEDESTRIAN SIGNALS REQUIRED
- 7 LOW LEVELS NOT REQUIRED FOR SUPPLEMENTAL HEADS FOR LEFT TURNS

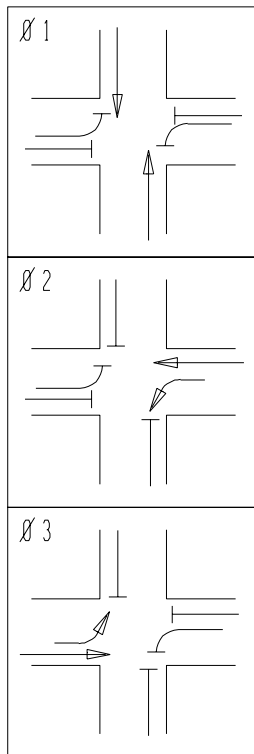


NOTES:

- 1 MEDIAN WIDTH LESS THAN 30'
- 2 DRAW HEAD PLACEMENT BOX-SPLIT THRU L ANEAGE
- 3 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE

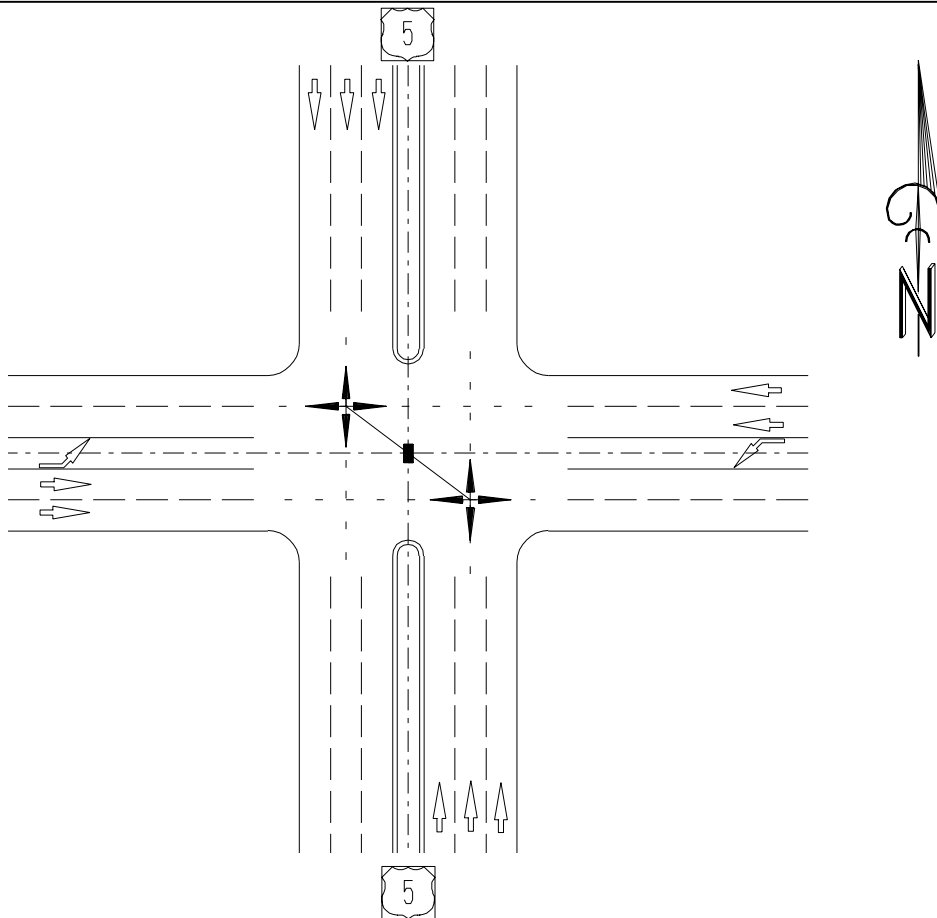


SIGNAL PHASING DIAGRAM



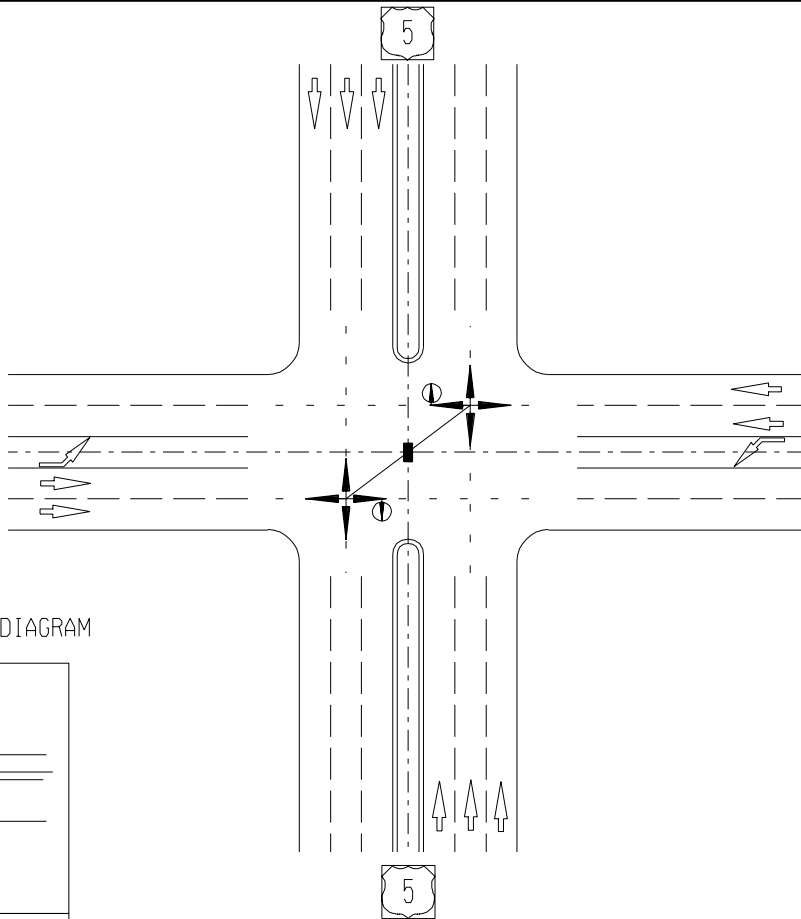
NOTES:

- 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

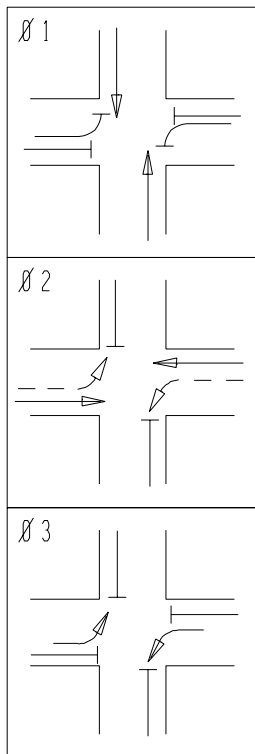


NOTES:

- 1 MEDIAN WIDTH LESS THAN 30'
- 2 DRAW HEAD PLACEMENT BOX-SPLIT THRU L ANEAGE
- 3 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE
- 4 USE 2-WAY CASE ON X-RD WHEN LEFT TURNS ARE ALLOWED OR PROHIBITED

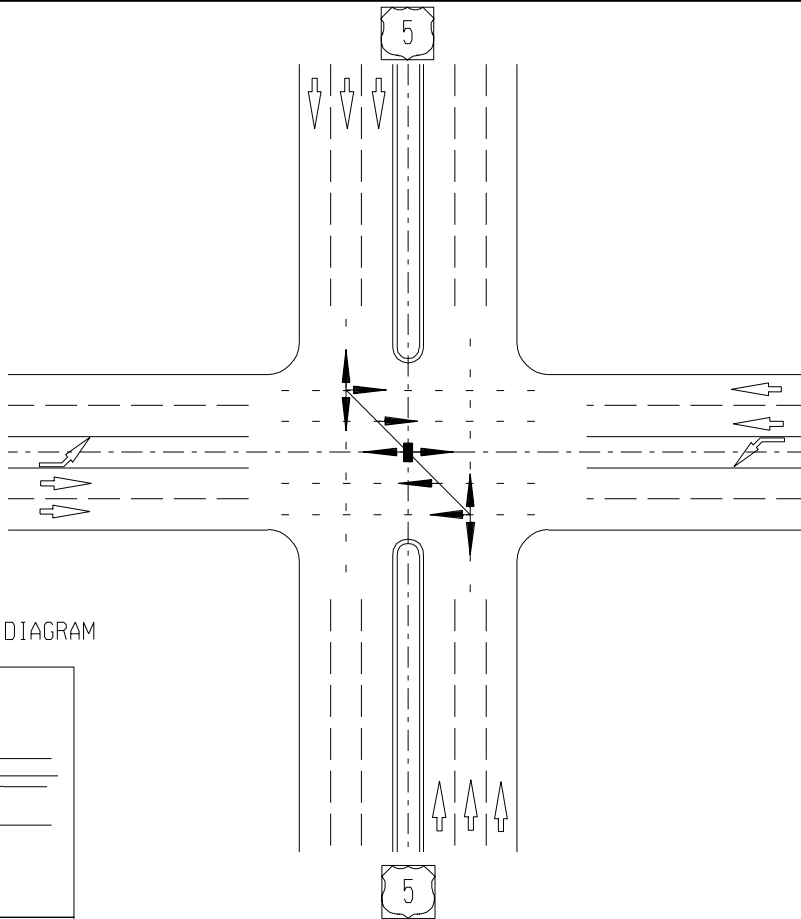


SIGNAL PHASING DIAGRAM

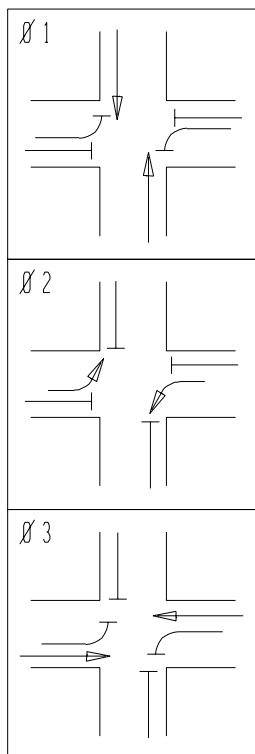


NOTES:

- 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

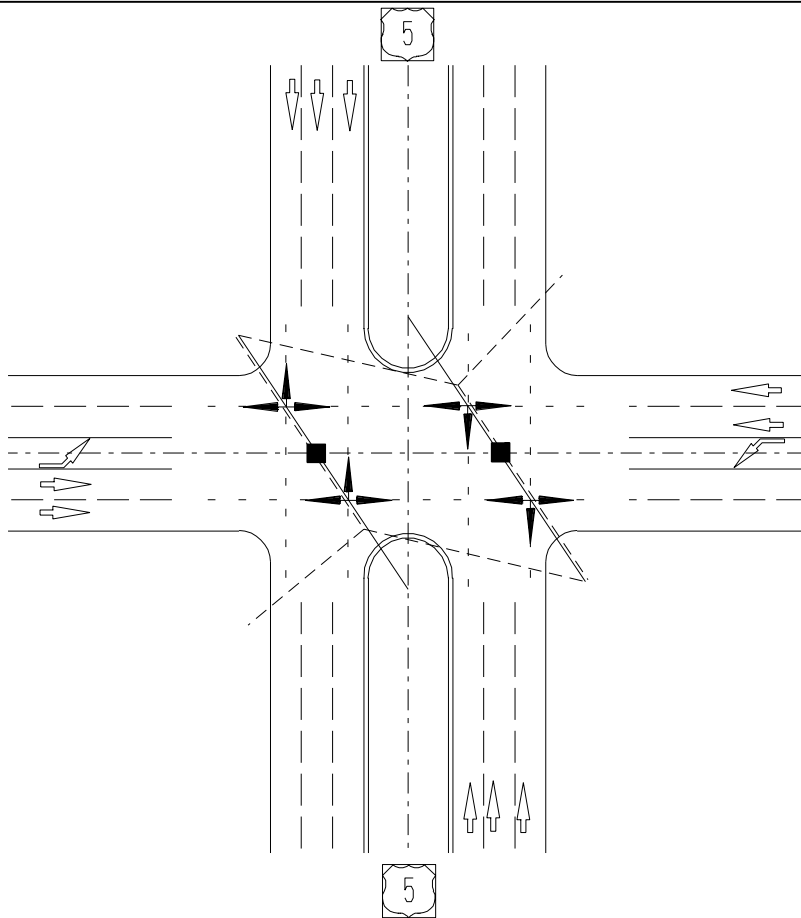


SIGNAL PHASING DIAGRAM



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

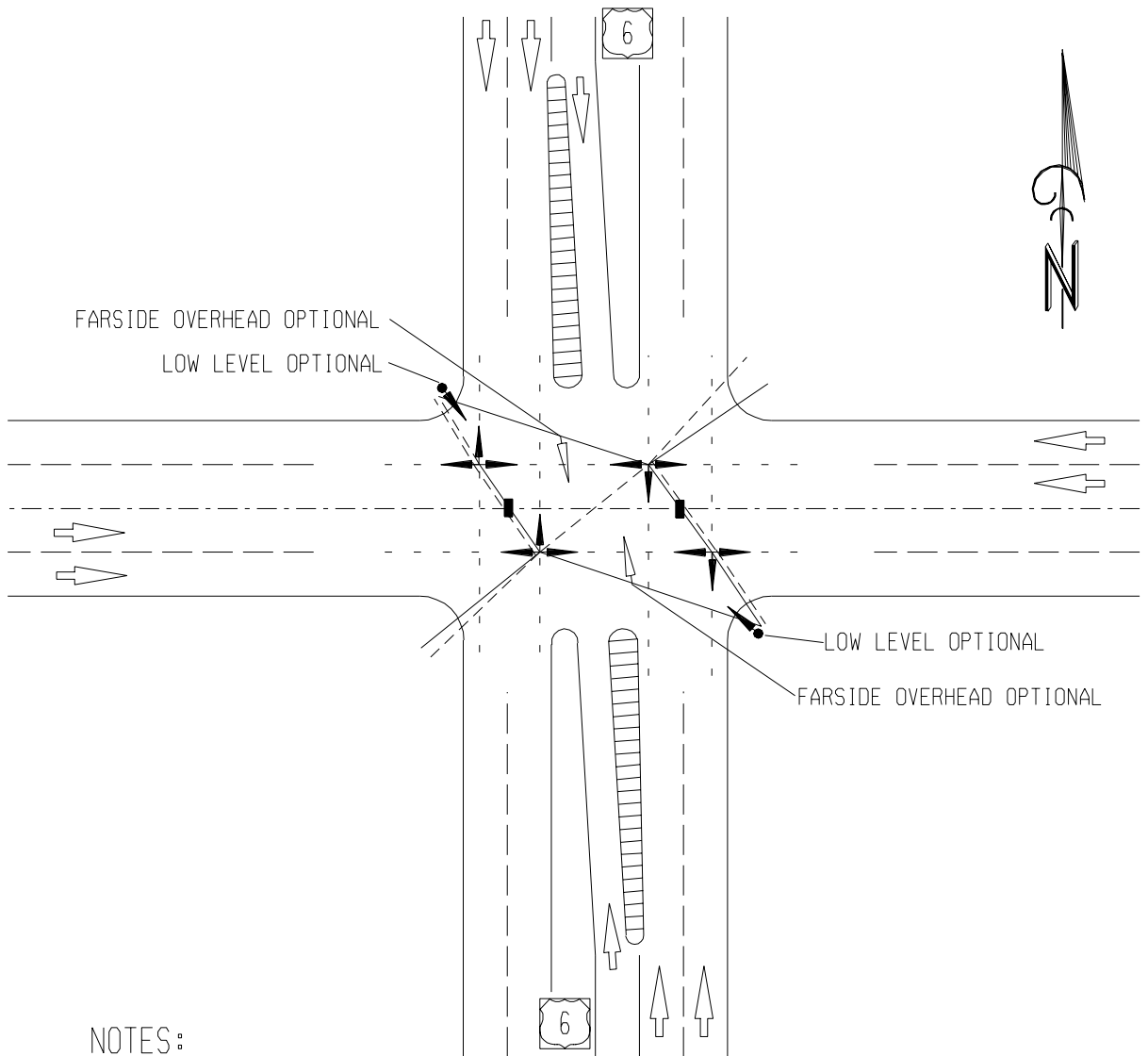


NOTES:

- 1 MEDIAN WIDTH 30' OR MORE
- 2 DESIGN AS TWO SEPARATE INTERSECTIONS
- 3 DRAW HEAD PLACEMENT BOX-SPLIT THRU APPROACH LANES ON TRUNKLINE; SPLIT LANEAGE ON X-RD
- 4 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE AT BOTH INTERSECTIONS
- 5 USE 4-WAY CASE SIGN AT BOTH INTERSECTIONS
- 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 SOLID LINE SPAN ARRANGEMENT SHOWS TWO THRU SPANS
- 8 DASHED LINE SPAN ARRANGEMENTS SHOWS TWO 3-WAY TIE-OFF COMBINATIONS
- 9 PEDESTRIAN SIGNALS OR A BACKSIDE HEAD SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT AND THE OVERHEAD SIGNAL INDICATIONS ARE NOT READILY VISIBLE.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

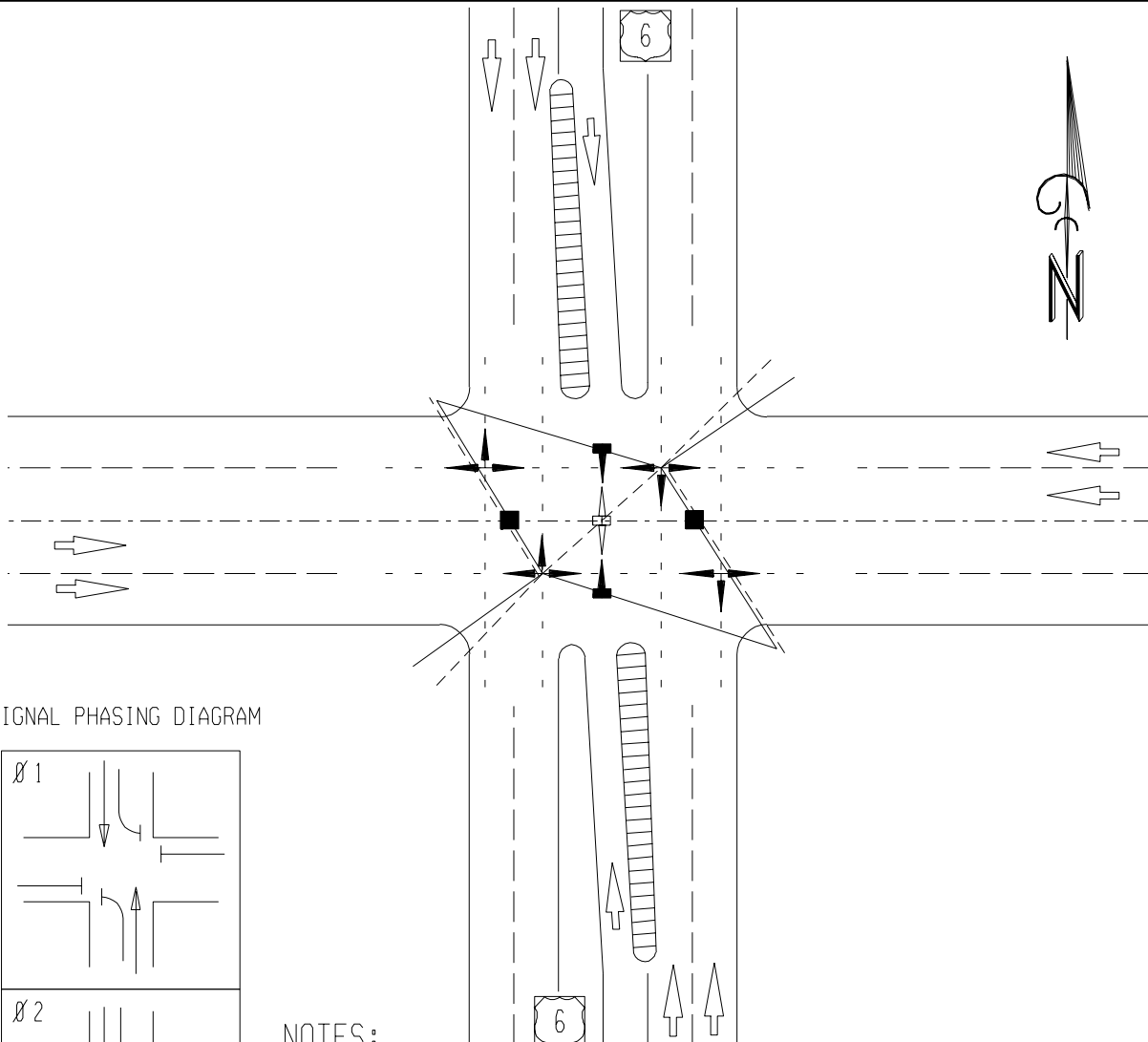


NOTES:

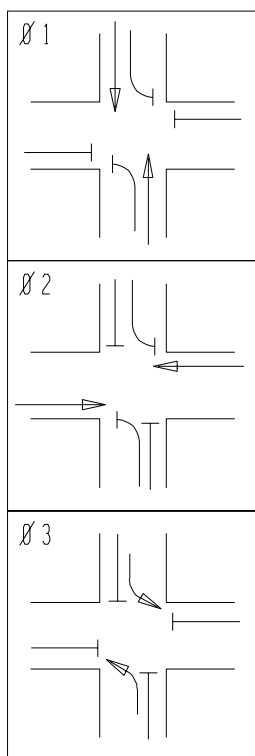
- 1 EXCLUSIVE LEFT - TURN SLOTS
- 2 DESIGN AS TWO SEPARATE INTERSECTIONS
- 3 DRAW HEAD PLACEMENT BOX: SPLIT THRU APPROACH
LANEAGE ON TRUNKLINE - SPLIT LANEAGE ON X-RD
- 4 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE AND BOTH INTERSECTIONS
- 5 USE 2-WAY CASE SIGN FACING X-RD
- 6 LOW LEVEL OR FARSIDE OVERHEAD SIGNALS ARE OPTIONAL
- 7 SOLID LINE SPAN ARRANGEMENT SHOWS TWO 3-WAY TIE-OFF SPAN COMBINATIONS
- 8 DASHED LINE SPAN ARRANGEMENT SHOWS 4-WAY TIE-OFF (SADDLE SPAN)
- 9 PEDESTRIAN SIGNALS OR A BACKSIDE HEAD SHOULD BE CONSIDERED WHERE
PEDESTRIAN ACTIVITY IS EVIDENT AND THE OVERHEAD SIGNAL INDICATIONS ARE
NOT READILY VISIBLE.

HEAD PLACEMENT DIAGRAM

2 PHASE OPERATION

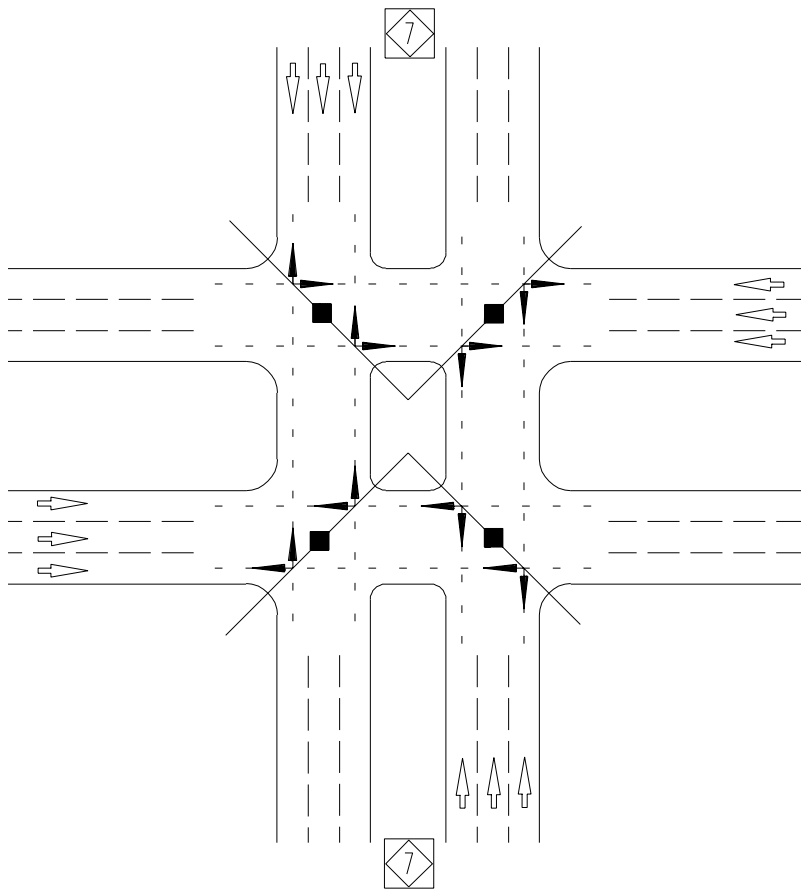


SIGNAL PHASING DIAGRAM



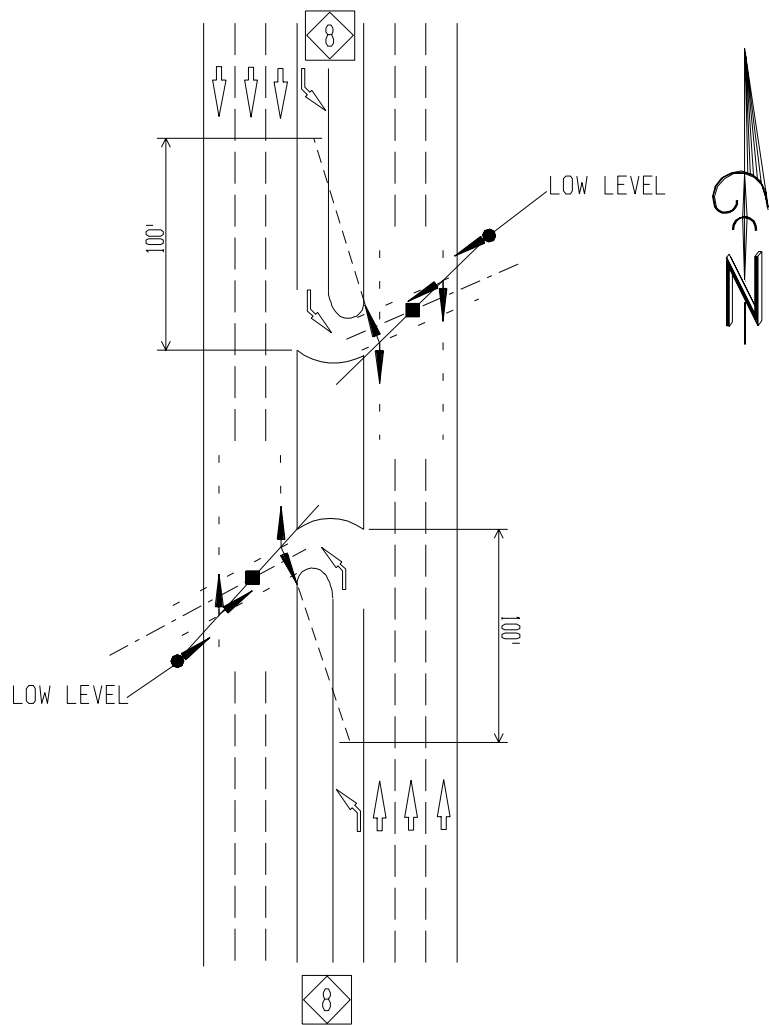
NOTES:

- 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 TRUNKLINE AT BOTH INTERSECTIONS
- 5 USE TWO 1-WAY EXCLUSIVE LEFT TURN SIGNALS WITH CASE SIGNS ON THE
3-WAY TIE-OFF SPAN COMBINATION-SOLID LINE SPAN ARRANGEMENT
- 6 USE ONE 2-WAY EXCLUSIVE LEFT TURN SIGNAL 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 ROADWAY
- 8 PEDESTRIAN SIGNALS REQUIRED



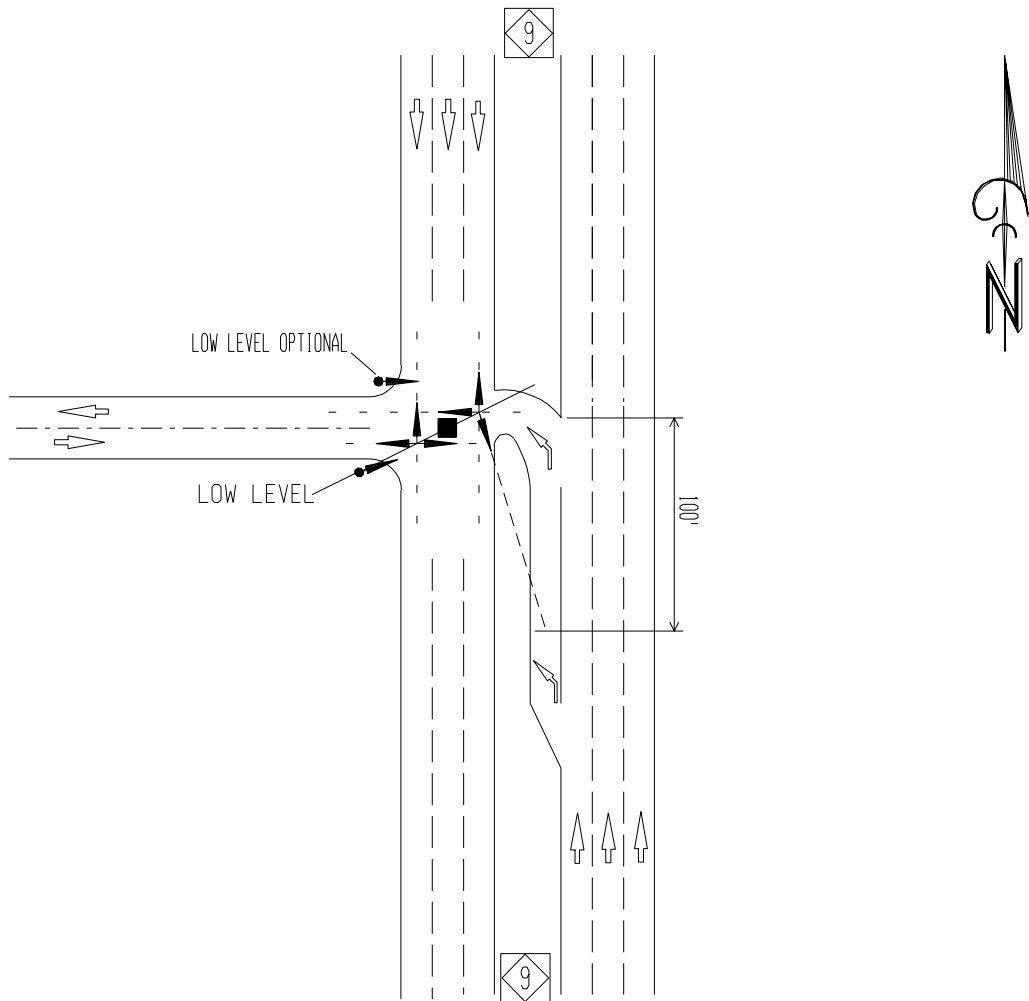
NOTES:

- 1 DESIGN AS FOUR SEPARATE INTERSECTIONS
- 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 BOTH ROADWAYS
- 4 USE 4-WAY CASE SIGNS AT ALL INTERSECTIONS
- 5 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.
- 6 PEDESTRIAN SIGNALS OR A BACKSIDE HEAD SHOULD BE CONSIDERED WHERE PEDESTRIAN ACTIVITY IS EVIDENT AND THE OVERHEAD SIGNAL INDICATIONS ARE NOT READILY VISIBLE.



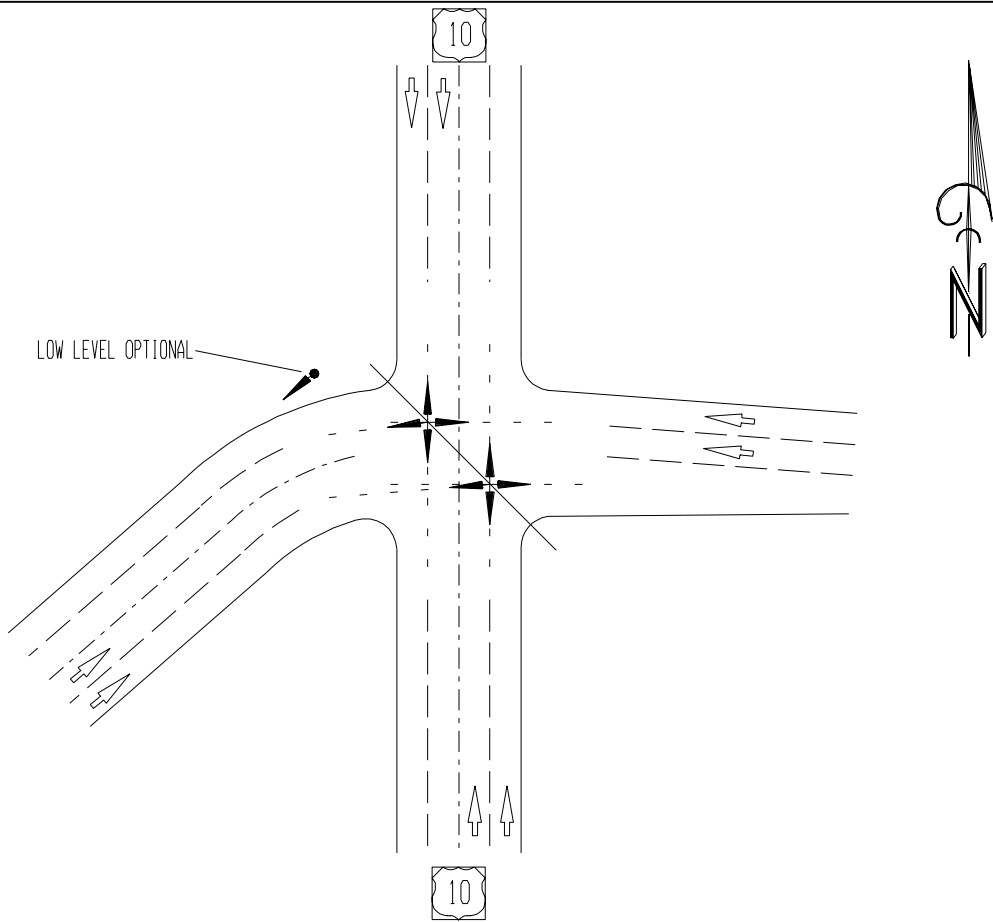
NOTES:

- 1 TREAT EACH CROSSOVER AS SEPARATE INTERSECTION
- 2 DRAW HEAD PLACEMENT BOX - SPILT THRU LANEAGE ON TRUNKLINE
- 3 USE NEAR RIGHT - FAR LEFT FOR CROSSOVER
- 4 SIGNAL SEPARATION FOR CROSSOVER HEADS SHOULD BE 10' AND 10'
- 5 AIM RIGHT SIGNAL INDICATION FOR CROSSOVER TO MIDDLE OF LEFT-TURN LANE AT A SPOT 100' FEET FROM CROSSOVER RADIUS POINT
- 6 ADD FAR SIDE LOW LEVEL SIGNAL TO INSURE TWO INDICATIONS ARE FACING CROSSOVER
- 7 USE ONE 4-WAY CASE SIGN



NOTES:

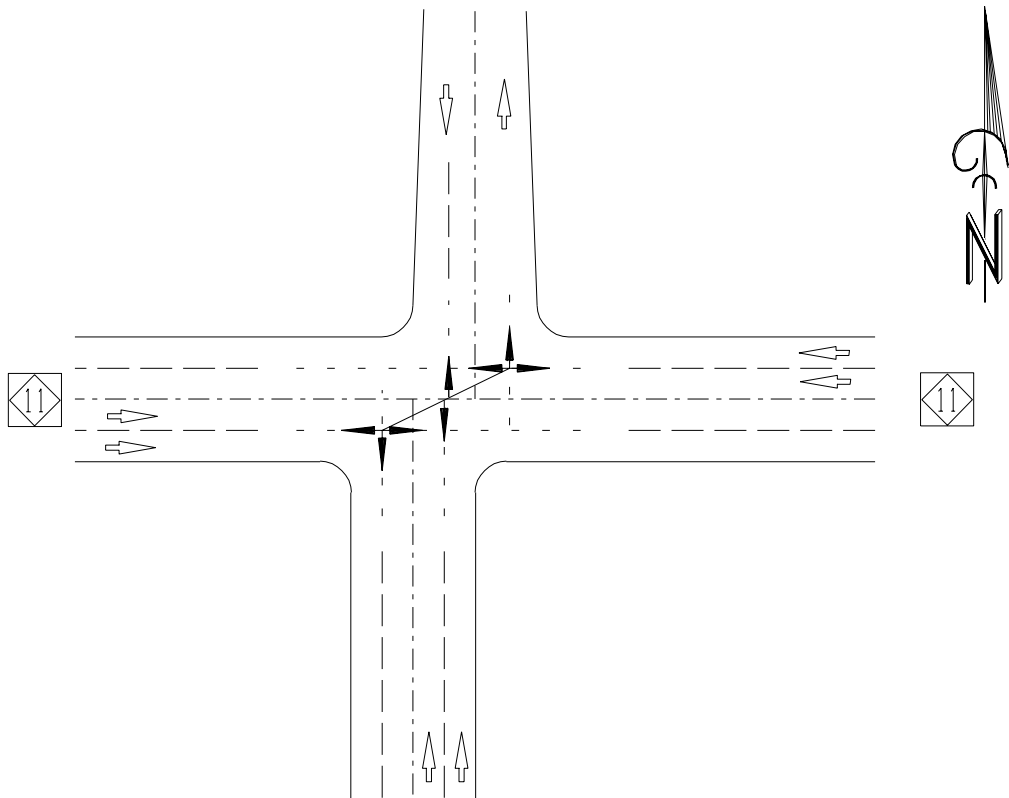
- 1 DRAW HEAD PLACEMENT BOX - SPLIT LANE AGE ON TRUNKLINE AND ON X-RD
- 2 USE NEAR RIGHT - FAR LEFT FOR CROSSOVER
- 3 SIGNAL SEPARATION FOR CROSSOVER HEADS SHOULD BE 10' AND 10'
- 4 AIM RIGHT SIGNAL INDICATION FOR CROSSOVER TO MIDDLE OF LEFT-TURN LANE AT A SPOT 100' FROM CROSSOVER RADIUS POINT
- 5 ADD FARSIDE LOW LEVEL SIGNAL TO INSURE TWO INDICATIONS ARE FACING CROSSOVER
- 6 FARSIDE LOW LEVEL INDICATION ON RIGHT SIDE IS OPTIONAL FOR THRU MOVEMENT FROM CROSSOVER
- 7 USE ONE 4-WAY CASE SIGN



LOW LEVEL OPTIONAL

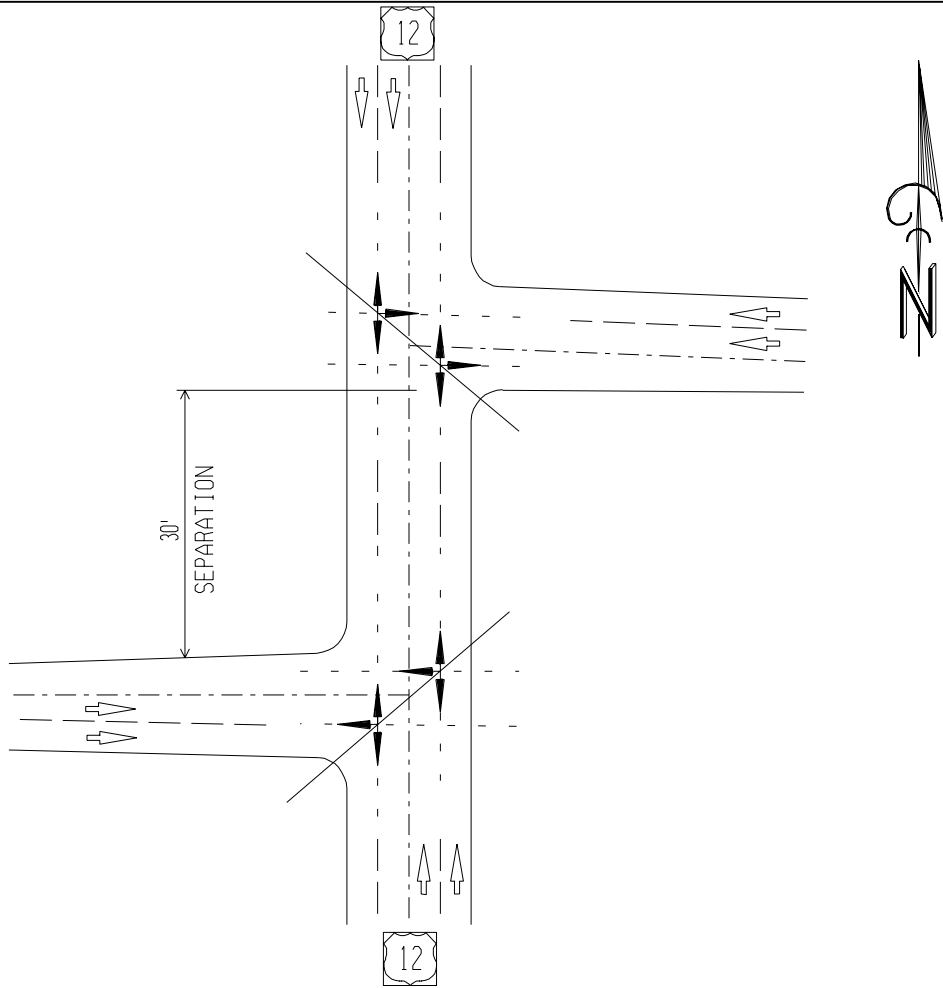
NOTES:

- 1 DRAW HEAD PLACEMENT BOX - SPLIT THRU LANEAGE FOR EACH ROADWAY
- 2 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE
- 3 ADDITIONAL ADVANCE LOW LEVEL INDICATION ON CROSSROAD IS OPTIONAL
DEPENDENT ON GEOMETRICS



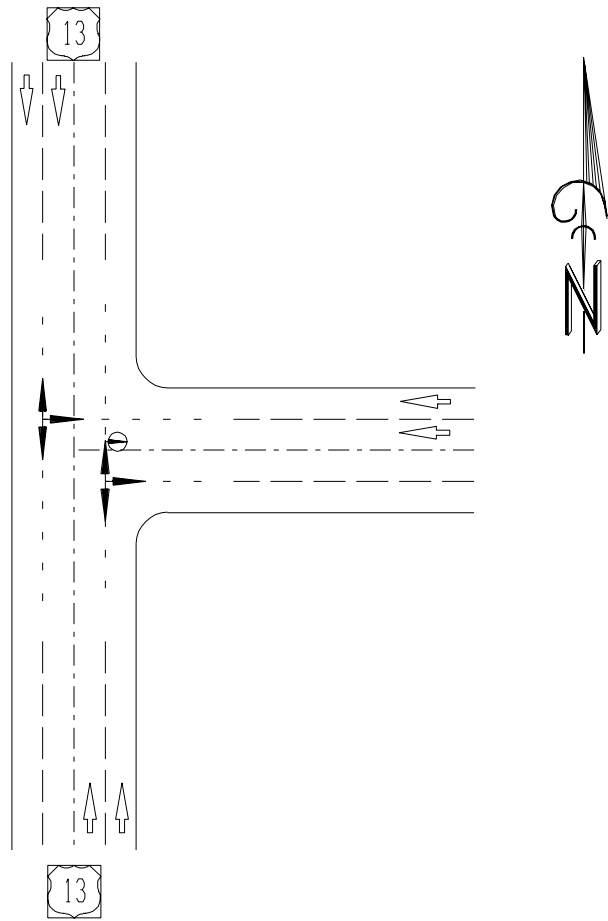
NOTES:

- 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

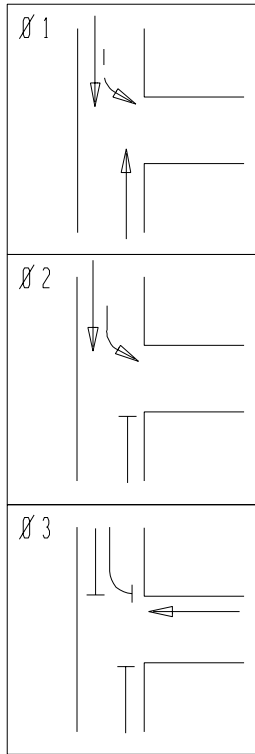


NOTES:

- 1 DESIGN AS TWO SEPARATE INTERSECTIONS (IF SEPARATION IS 30' OR MORE)
- 2 DESIGN AS ONE INTERSECTION (IF SEPARATION IS LESS THAN 30')
- 3 DRAW HEAD PLACEMENT BOX - SPLIT THRU ON TRUNKLINE AND ON EACH SIDE STREET T
- 4 USE NEAR RIGHT - FAR LEFT ON TRUNKLINE
- 5 NOTE: NEAR RIGHT - FAR LEFT CAN BE USED ON SIDE STREET TO ACCOMMODATE HEAVY TURNING MOVEMENTS.
- 6 USE INSIDE SIGNAL INDICATIONS FOR WIDELY SPACED OFFSET



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