Vermont Agency of Transportation

CADD Drafting Standards Manual

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SECTION 7-1 - DRAFTING STANDARDS

1. INTRODUCTION

The primary function of the CADD Drafting Standards Manual is to:

1. Provide requirements and guidance on CADD Drafting methods and to supplement the VAOT CADD Standards Manual, expanding on the established drafting standards in SECTION 7.

2. Assure uniformity of practice for projects designed by or for the Agency. This manual focuses mainly on **detail drafting, annotation standards and dimensioning standards**.

The primary purpose of this manual is to provide guidance for drafting standards. In the past drafting was an established discipline where standards were learned and practiced through mentorship. The method of drafting has changed and the discipline has adapted to using computer aided drawing applications. The standards and practice of drawing has lost much of its discipline and organization due to automation. Using the standards and guidance in this manual will provide necessary discipline and organization required to draft quality plans and details. Drawings created on a computer often lack the "skill" and or "art" of drafting as explained below. Drafting excellence is a skill developed over years of experience. Computer applications aid in drafting but do not replace the need for skilled draftspersons.

A **draughtsman** or **draftsman** (the former more often in the UK, the latter more often in the US), also known as a **draughts person** or **draftsperson** is a person skilled in drawing, either:
- drawing for artistic purposes, or
- Technical drawing for practical purposes such as architecture or engineering. Many modern draftspersons use computer aided design (CAD) software to produce drawings.

A **draftsperson**, spelt same way in both British and American English, is also an individual who drafts (i.e. draws up) documents, especially for official purposes.
A draftsperson is an artist skilled in technical drawing. The 'skill' is to draw complex instructions precisely and accurately. The 'art' is to arrange that information in a clear organized, eye pleasing manner. Combine these two factors and you have accurate drawings that are easy to read and interpret.

Drafting includes any task that utilizes graphics to convey instructions to another person. Commonly this is associated with the making of plans for structures or mechanical devices before they are built. Disciplines of drafting include: Architectural, Civil, Structural, Plumbing, Cartography, Electrical, Thermodynamics (and HVAC), Mechanical, Hydraulics, Telecommunications, Materials and Aerodynamics.

CAD, or computer aided drafting, is the modern, principle tool, used by drafters to create drawings or plans. AutoCAD, MicroStation, Archicad, VectorWorks, Allplan are some popular CAD software packages out of many.

(Wikipedia.org/wiki/Technical_drawing)

1.1.   DRAFTING (Technical Drawing)

Drafting is both a skill and an art. Engineering plans convey instruction to contractors, fabricators and other construction engineering professionals. These plans must be accurate and clear as to the intended design. Skilled drafting makes plans easier to understand, easier to check, easier to edit, reduces misinterpretation and generally reassures that the engineering is sound. A good clean, clear organized set of plans implies attention to detail for both the drawing and the engineering behind them as well. Conversely when a set of plans is messy and unorganized one could call into question the entire design and engineering due to a lack of attention to detail. The plans should be considered the engineering design phase end product.

Know your audience. Each set of drafted plans contains sheets and details for different purposes. In order to properly draft plans and details for construction the drafter must understand the process and know the requirements. Extensive checking and verification of plan drawings is part of our quality control process, but each drafter is responsible for verifying to the best of their ability the accuracy and completeness of each drawing worked on.

The drafting process is an integral part of the design process, especially now with the aid of computer drafting applications. Computer Aided Drafting and Design (CADD) applications CADD now enables drafters to accurately draw to scale and verify many of the dimensions and clearances as well as measure drafted portions of a design. The draft person now with the aid of computers is more integrated into the design. The line between drafter and engineer is blurred. Many Engineers are also excellent draftspersons and as a whole in the industry, Engineers are expected to draw and draft parts of if not entire designs in some cases.

The modern engineer designs and draws plans and details. Computers enable the design and drawing to happen simultaneously. Most design applications generate drawings (graphics) and details as the design is progressed, assuming applications are used to their full extent. There remains skills and art involved in putting the drawings into plans and details (drafting them) for construction.

1.2.   DISTRIBUTION

This manual, in its entirety, may be freely distributed for the purpose of providing a consistent guide for CADD requirements of the Vermont Agency of Transportation. The manual, Standard CADD files and other support files can be downloaded from the VAOT CADD website at the following address.

<div align="center">

http://www.aot.state.vt.us/caddhelp

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SECTION 7-2 – DRAFTING OVERVIEW

2. INTRODUCTION

There are many different types of drawings and Drafting styles. The main style of drafting used by Civil engineers (specifically Roadway and Bridge) is primarily referred to as the Architectural or Structural drafting style. There are some differences depending on the type of drawing be done. Topographical Drawings such as site or road layout plans use a combination of cartographic and structural drafting styles. This is because those are the two main features on such plan drawings. For the most part annotations and dimensions are a structural style drafting entity while much of the mapping type features are drawn using cartographic style symbology.

2.1. Drafting Styles

What exactly is the Structural drafting style? What is a drafting style period? A drafting style is the basic principle for standardizing. It is all the rules that define the look and functionality of the specific style. The drafting style is the starting point for drafting standards. Now with computers, drafting standards can be expanded to include all aspect of the drawing with regard to CADD applications. Drafting standards are commonly grouped into a category of CADD Standards.

The structural drafting style was established to standardize drawings and is mainly emphasized in Structural and Architectural specific disciplines. This style has been established to best annotate and dimension objects of relatively large size with intricate details involved. This allows the flexibility to annotate all aspects of a design from the larger plans and assemblies to the smallest details while keeping one overall standard style that governs the appearance and adds consistency to Technical Drawings.

There are many hybrid drafting styles. As mentioned earlier drafting is somewhat of an art. The standard establishes rules and guidance but judgment must be applied to insure accurate overall design intent. When applied properly, drafting style induces consistent accurate plans that are readily interpreted by Engineering and Construction personnel. Standard terminology and symbology play an important role in drafting.

2.2. Structural Drafting

The Vermont Agency of Transportation, Project Development Engineering essentially employs the Structural Drafting Style as do most transportation type engineering organizations doing similar work. We also use a cartographic style annotation when needed on survey and or topographical features. The basic principals for "Structural Drafting Style" are defined in the VAOT CADD Standards and Procedure manual Chapter 7.

2.2.1. List of Basic Rules

- Dimensions and Annotation are generally shown with in CASE CAPITAL letters

- Dimension Lines are never broken and take precedence over annotation leaders and dimension extension lines.

- Extension lines extend to the object and are general offset back (½) the standard text height for clarity.

- Extension lines may be broken around dimension lines and leader lines as well as other drawn obstacles. This practice can greatly increase readability and clarity on complex details with lots of dimensions and notes.

- Leader lines are drawn from the object with an arrow (generally) to the annotation text. Leader lines can be broken around dimension lines as needed for clarity in complex details.

- Annotation text notes are drawn in CAPITALS and are generally left justified. Annotation should be lined up whenever possible and placed above, below or to the side of details with adequate white space to separate object lines from annotation.

- Dimension values are always placed above the dimension line and generally centered over the dimension line, but they can be nudged for clarity.

- When Dimension text does not fit between the extension lines the text can be moved to the side, but the dimension line must always connect the extension lines. Never leave an open space between the extension lines across the actual dimensioned length.

- Dimensions are read from the bottom or the right hand side of the sheet. Never rotate text upside-down when reading from the bottom or the right hand side of the sheet.

- Dimension lines for VAOT use an arrow head for the terminator. There is "VAOT Standard Dimension Styles" setup in MicroStation workspace.

- Leader lines also use the arrow head for the terminator.

- Stacked dimensions are spaced (3) times the text height apart. This is a VAOT standard.

- Dimensions are generally pulled away from the object in order to create white space separation between the object and the dimension.

- Dimensions should be a minimum of (6) times the text heights away from the object being dimensioned, for standard situations.

- For details the dimension lines and extension lines are drawn with a thin line weight (wt=0) and the Dimension text is drawn slightly heavier (wt=1). On plan sheet leaders and dimensions are sometimes "heavy-ed" up for clarity.

This list is not all inclusive and some are specific to VAOT CADD Standards. There are more rules and guidance in the **VAOT CADD Standards and Procedure Manual (Section 7)**. These rules are intended to be followed and used on all detail type sheets and in plan sheets where dimensions and annotation is used. The concept of drafting, according to set rules is always subject to engineering judgment. No one set of rules can cover all possible situations but this one covers typical VAOT drafting situations. It is still the drafter's responsibility to place annotation and dimensions in unobstructed spaces in the plans and details. One good guideline is to always avoid overlapping text on text. If something is important enough to show it should be clearly legible.

2.3. Definitions

Plan: The term "Plan" or "Plan View" generally refers to a drawing of a relatively large sized object or area as it is seen from directly above looking down. Plan drawings can refer to anything from topographic layout areas to a plan view of a specific object such as a building, bridge or other structure. The term "Plan View Detail" is sometime used to indicate a similar situation i.e. looking from above down at an object or area but generally refers to a smaller subsection of a larger Plan view.

Elevation: Generally refers to a drawing of a relatively large object or area as seen from the side looking directly horizontally at the object. Elevation views are generally drawn in reference to ground and ground lines are generally shown. Elevation views often show above and below ground structures much like a section, with a vertical cutting plan.

Section: Section or Cross Sections in drafting refers to projected views of an object or area along a specified cut plan. These views are commonly used to show internal features with more clarity than may be available using regular projections or hidden lines. Section markers are normally shown in Plan, Elevation, Details or other Section drawings to identify the location that a specific section view represents.

Detail: Detail is a general term used for describing an enlarged drawing of an object or area to more clearly show smaller features. Details can take different forms. There are Plan Details, Elevation Details, Section Details, and there are even Detail Details. Each of these basically refers to a larger scale drawing that is typically shown in conjunction with smaller scale Plans, Elevation or Section. Details are seldom produced in isolation: a set of details shows information needed to understand the construction in three dimensions.

Object Line: An object line is a line drawn to represent a physical object. It is not a text or dimension element.

Standard Abbreviations

Abbreviation/symbol	Definition	Description
APPROX	Approximately	
CL or ₡	Center line	Center line of a feature
CHAM	Chamfer	
CRS	Cold rolled steel	
D or Ø or DIA	Diameter	D or Ø Commonly used in Dimensions or Size annotations, DIA is commonly used as an Acronym in text notes.
HRS	Hot rolled steel	
MAX	Maximum	
MIN	Minimum	
NOM	Nominal	
R	Radius	Radius of an arc or circle
STD	Standard	
STL	Steel	
THRU	Through	Usually applied to a hole dimension to signify that the hole extends through to the wall thickness.
TYP	Typical	Other features share the same characteristic
LLH	Long Leg Horzontal	Standard acronym for Structural Steel Angle orientation.
LLV	Long Leg Vertical	Standard acronym for Structural Steel Angle orientation.
ROW	Right of Way	
m	Meter	Unit of Measure (SI)
mm	Milimeter	Unit of Measure (SI)
rad	Radian	Unit of Measure (SI) (Angular)
FT or '	Foot	Unit of Measure (Imperial)
USFT	U.S. Foot	Unit of Measure(Imperial)
IN or "	Inch	Unit of Measure (Imperial)
DEG or °	Degree	Unit of Measure (Imperial) (Angular)
© or (C)	Copy Right	
&	And	Use to abbreviate the word "and"
W/	With	Abbreviate "WITH" in a note or dimension
EL	Elevation	Abbreviate Elevation
o/c	On Center	o/c Call out On Center Spacing

## 2.4.   Drafting Example (Section)

RAILING SECTION
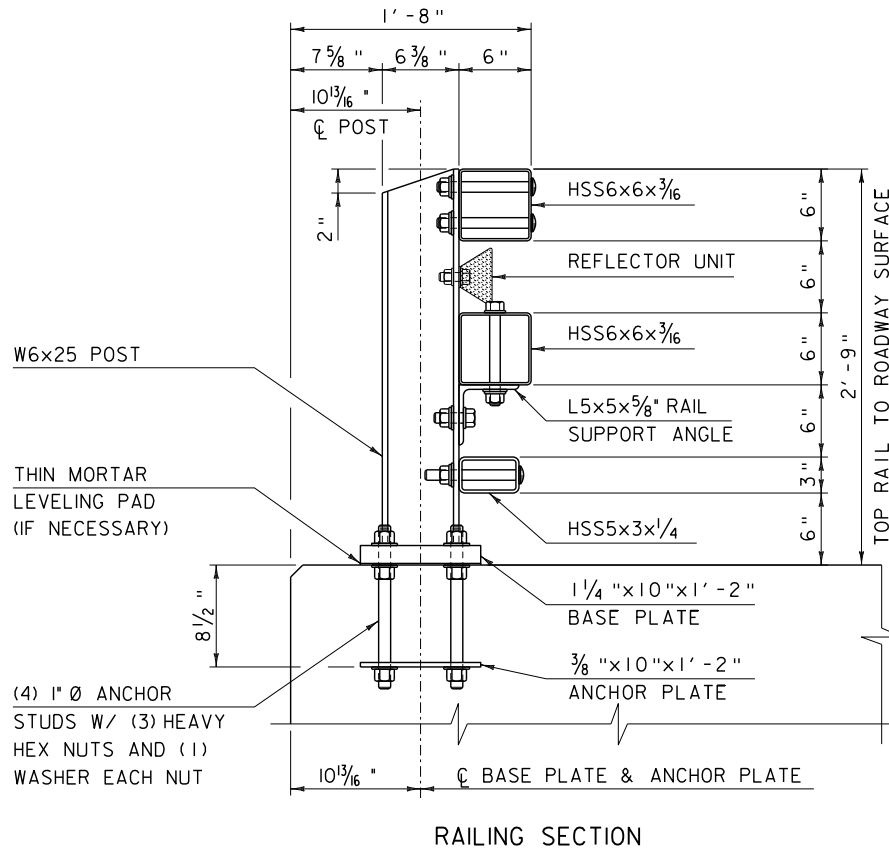
This example uses the rules shown in the previous section. Note that VAOT generally uses a leader line that extends under the first line of text in a callout note. This is a VAOT convention carried over from past practice not necessarily a standard Structural or Architectural Style convention.

The above example uses the standard dimension annotation placement method. That is the Dimension Text is above the dimension line and read from the bottom or right hand side of the page.   Dimension lines are generally placed at least 6x the text height from the object lines and stacked dimensions are spaced 3x the text height. As shown, there are situations that allow for adjusting the spacing for clarity. The 2" dimension for the post top bevel is closer than the basic rule allowance of 6x the text height, but moving it further out would appear awkward and the dimension fits nicely between the object and the extension lines of the post center line dimension.

The annotation of standard steel shapes should, as a rule, match the nomenclature shown in the AISC steel hand book (***W12x26***, ***HSS6x6x¼***, ***L4x4x¼*** etc). Plate steel should always be called out with the thickness of the plate first; this is the only real physical variable the length and with of the plate is a cut dimension. Nomenclature rules also hold for dimension lumber such as a ***2x4*** or ***4x4***. No units are specified for standard dimension lumber. Labeling a structural member as 2"x4" or 6"x6" indicates non standard dimension lumber or rough cut lumber of the specified size.

2.5.   Drafting Example (Plan & Elevation)
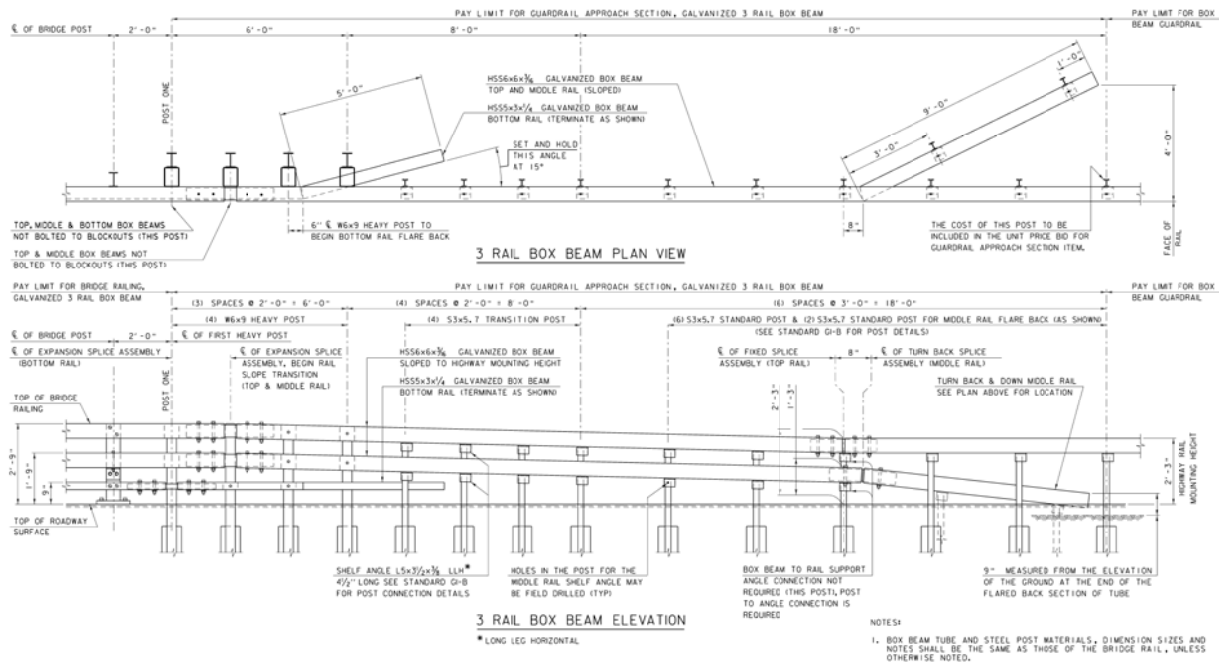
This example demonstrates some basic drafting standards as applied to plan and elevation views. The annotation notes are generally left justified and notes are aligned whenever possible. This creates clear lines to read down and helps separate text from objects while maintaining white space for clarity. It should be noted that white space on plans and details is very important. Drawings with scattered notes, lines and details will clutter the drawing. Organized white space creates order and separates notes, details and other features on the sheet. This is not to say you should limit the notes it means you can actually fit more annotation and details on the drawing while retaining order and clarity.

Drafting judgment or as it is sometimes referred to as drafting license can be seen in the use of curved and offset extension lines. This method is used sparingly to help pull extension lines off object lines for clarity. This method can be viewed on the post annotation above where (2) box beam rail transitions to (1) box beam rail.

The plan view as shown above would normally have a north arrow indicating "Vermont State Plane Grid North" or "Magnetic North" direction relative to the view. This particular plan is a generic Bridge Rail Transition Plan so the north arrow is omitted.

The above drawing can be viewed in large format PDF or Design File format on the Vermont Agency of Transportation, Standards Download web page. The S364 series standard drawings for (3) Rail Box Beam are located at the below web page.

http://www.aot.state.vt.us/Caddhelp/DownLoad/Standards/Standards.htm

2.6.   Drafting Examples (Details)
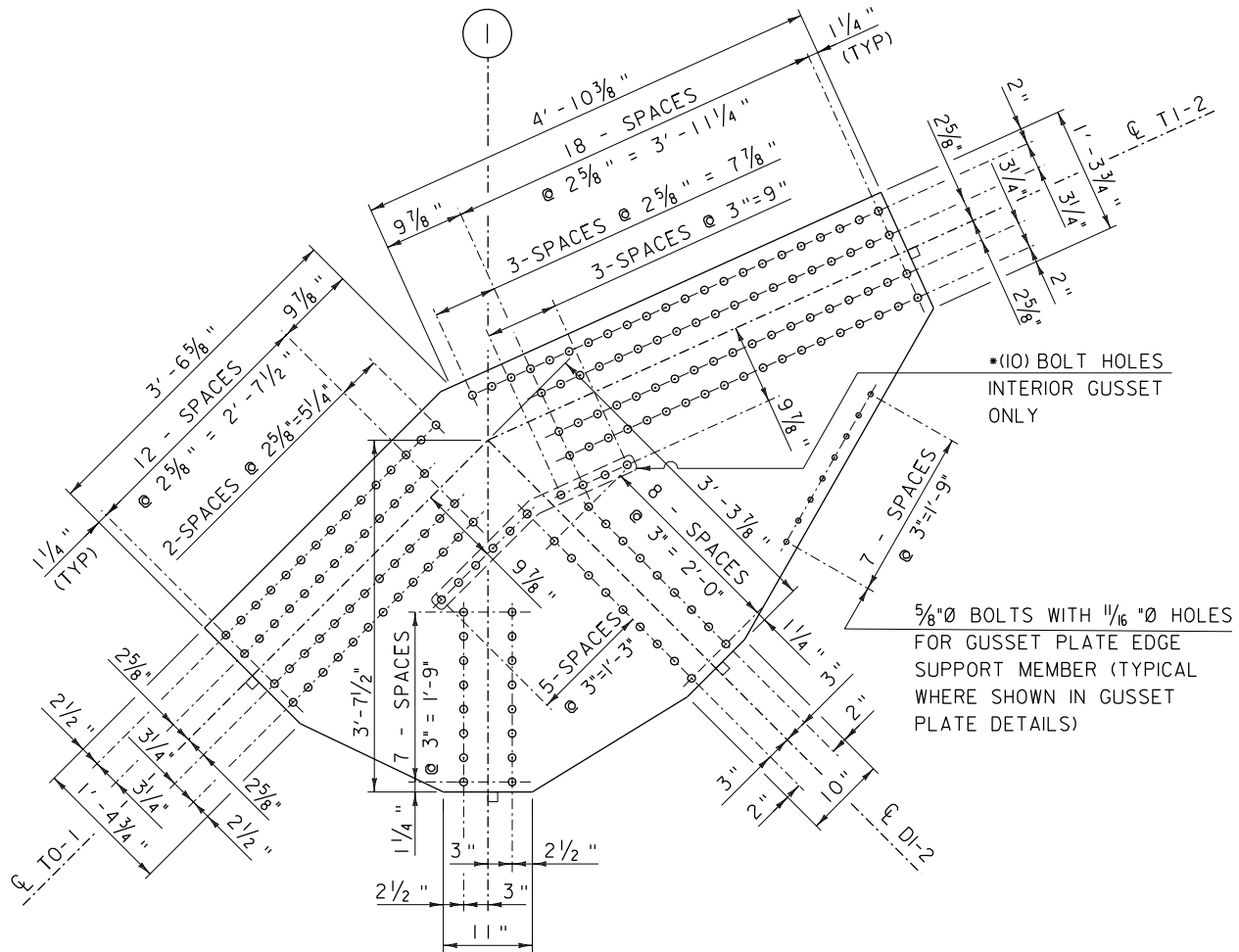

GUSSET PLATE DETAIL G1 TOP

SCALE 1" = 1'-0"

Shown here is a typical although somewhat crowded detail of a Truss Gusset Plate. The basic principles of drafting as defined in the VAOT CADD Standards and Procedure Manual and supplemented in this manual have been followed.   This example points out typical situations and possible solutions in crowded drawings.   Note the use of centerline symbology when dimensioning to the center of an object holes in this case. Also note the use of spacing between dimension lines as well as the breaking of lesser priority lines to increase clarity and avoid overwriting and crossing symbology.   This method of breaking out lesser priority lines (never dimension or object lines) can be omitted on simpler details; but it is good practice and can be used generously to retain consistency.

Notice in the above detail no dimension line is ever broken. Also notice that no object line is ever broken or partially removed. It is poor practice to break out object lines to facilitate annotation. The exception to this is the proper use of breaklines, which will be discussed later in this manual.

2.7.   Drafting Examples (Truss Elevation)

The GUSSET PLATE DETAIL shown previously is not a standalone detail. It must be read in conjunction with other sheets and drawings in the set. For example truss member centerlines with the standard Grid Bubble identification are shown to identify the member. These labels locate the Gusset Plate within the overall truss assembly. The fabricator must look at the Truss Elevation drawing to find the truss member sizes and the layout. The member layout angles are dimensioned on the elevation using horizontal and vertical dimensions to locate the truss working points, in this example the member centerline intersection points. These are the measurements required to build the Gusset Plate. The draftsperson or designer would not supply the measured angle dimension in angular format because it would actually be a calculated value with rounding error. The fabricator should use the dimensions provided to calculate the angles. This will eliminate any rounding error that may be introduced. The fabrication of this truss should be based on the dimensions provided.   It is the draftsperson's responsibility to provide all required dimensions. Care should be taken not to provide measured values that are not actual design parameters.

TRUSS FRAMING ELEVATION
SCALE ⅛ " = 1'-0"
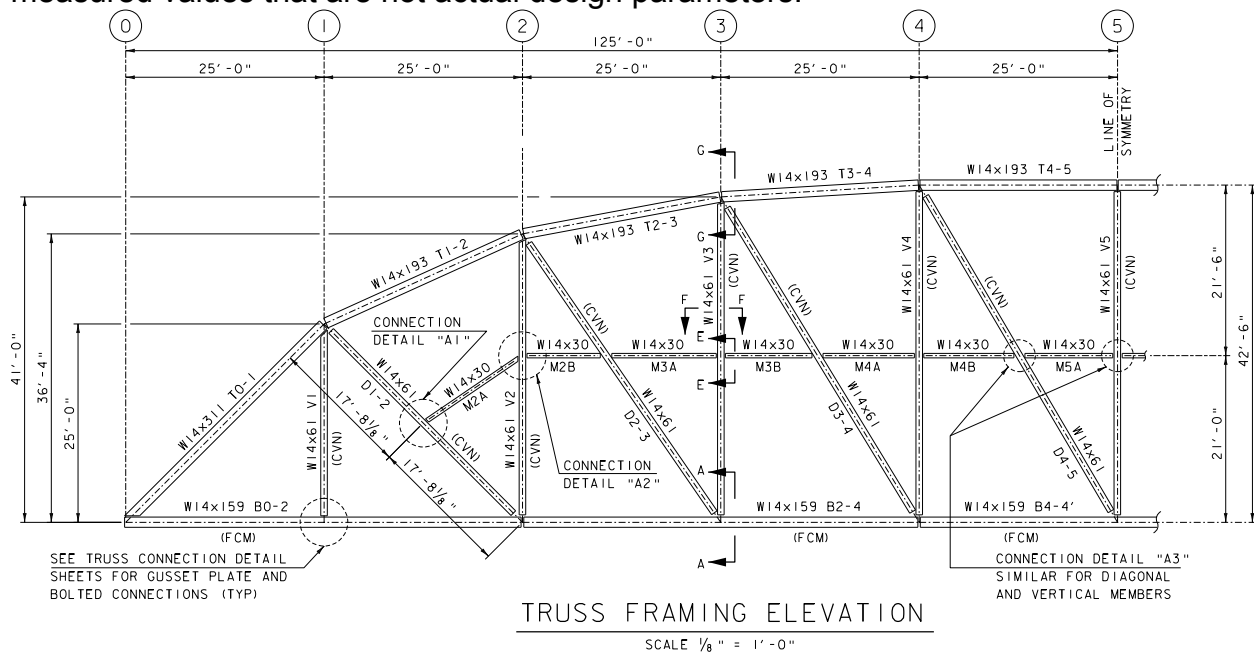
2.8.   Design Parameters vs. Measurements

An example of measured values that are not design parameters is the truss member angles. As seen in the image to the right the angle between T1-2 & DI-2 measures 69.4 DEG or does it? The measured angle would not match the design angle because the design angle is a triangle as dimensioned in the Truss Framing Elevation. If the steel fabricator used a measured angle to layout the truss because it was provided, then error would be introduced into the framing layout.   The steel fabricators are actually responsible for tolerances for fit so design parameters should be provided not measured parameters. There may be instances where measured values are required, if so be sure the appropriate significant digits are provide. This is a simplified example and the actual error introduced may be insignificant (depending on the angle's values precision) but the concept of providing design parameters vs. measured dimensions is hopefully clearer.
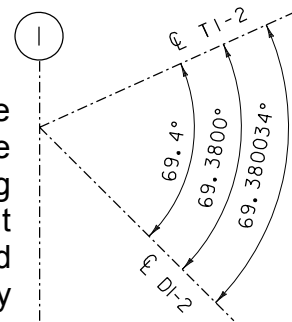
SECTION 7-3 – Structural Detailing

3. INTRODUCTION

This section will cover basic examples for drawing a Bridge Abutment Plan, Elevation, Section and Details. There are different types of bride abutments. The VAOT Structures Design Manual should be referenced for any specific bridge type or abutment type engineering requirements. These examples are only for the purpose of Drafting and Detailing methods as well as Drafting Standards explanation. Methods for calling out reinforcing steel can very, these examples uses an extensive bar detailing method. These examples call out and detail each bar by bar mark and the calculated quantity of bars required. There are more general reinforcing steel detailing methods employed by VAOT, but this is a standardized method.

3.1. Abutment Plan (Curved Wing Walls)

ABUTMENT #1 PLAN VIEW
SCALE ¼" = 1'-0"
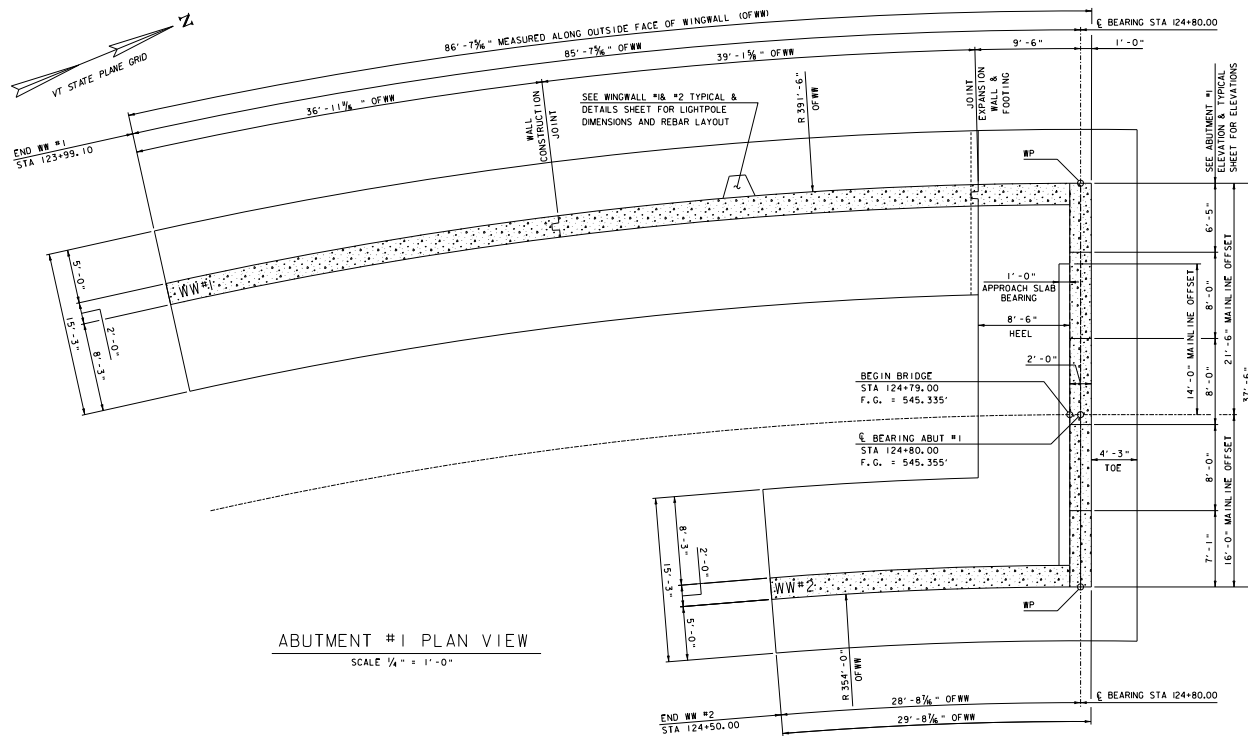
This is a plan view of an abutment with curved wing walls that parallel the roadway centerline geometry. General practice calls for a North Arrow on plan views as shown in the top left corner of the example above. This example demonstrates Agency Standard Drafting practices and demonstrates drafting techniques. Each project will have project specific challenges but the basic rules can and should be applied.

The notes and dimensions are pulled away from the object lines. The dimension lines parallel the object being dimensioned. Dimension lines are never broken. Stacked dimensions are spaced accordingly. Also note that in the drafting examples the text and dimension arrow sizes are consistent regardless of scale (more on this subject later).

3.2. Abutment Plan (Common)
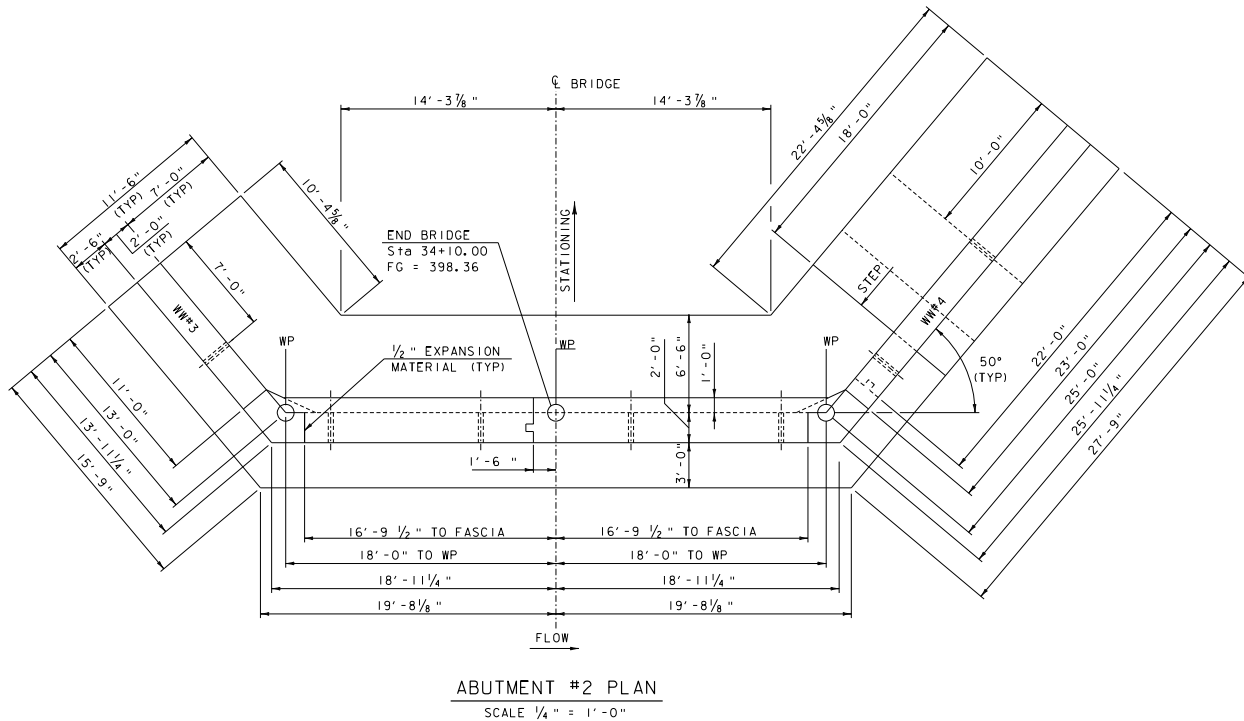
This is a typical abutment with angled wing walls. Wing Walls are labeled, working points are labeled, river flow direction is labeled and stationing is also labeled. This example follows the Agency Standard Drafting guidelines with a few exceptions. Notice that on WW#3 the wall width is close to the object line. In the actual plan sheet there were space limitations. The basic rule of dimensions being (6) times the text height from and object line is violated here for space reasons (not apparent in the image). On WW#4 the 10'-0" dimension for the footing step is placed on the object. This is acceptable assuming there is space and the dimension is clear.

It is standard practice to dimension the location of working points on the bridge abutment in accordance with the VAOT Structures Design Manual.

The Plan title and scale are generally noted below the drawing. In this example the plan is the "ABUTMENT #2 PLAN" and will be plotted to scale at ¼" = 1'-0". The actual drawing is drawn full scale 1:1 then a border is fit around the drawing and plotted at 1:48 or ¼" scale.

☯ The scale of the example details in this manual varies to fit on the manual pages. Full size plans are generally drawn full size and plotted to scale. Where possible the details were inserted at ½ the scale noted on the details.

3.3.   Abutment Elevation
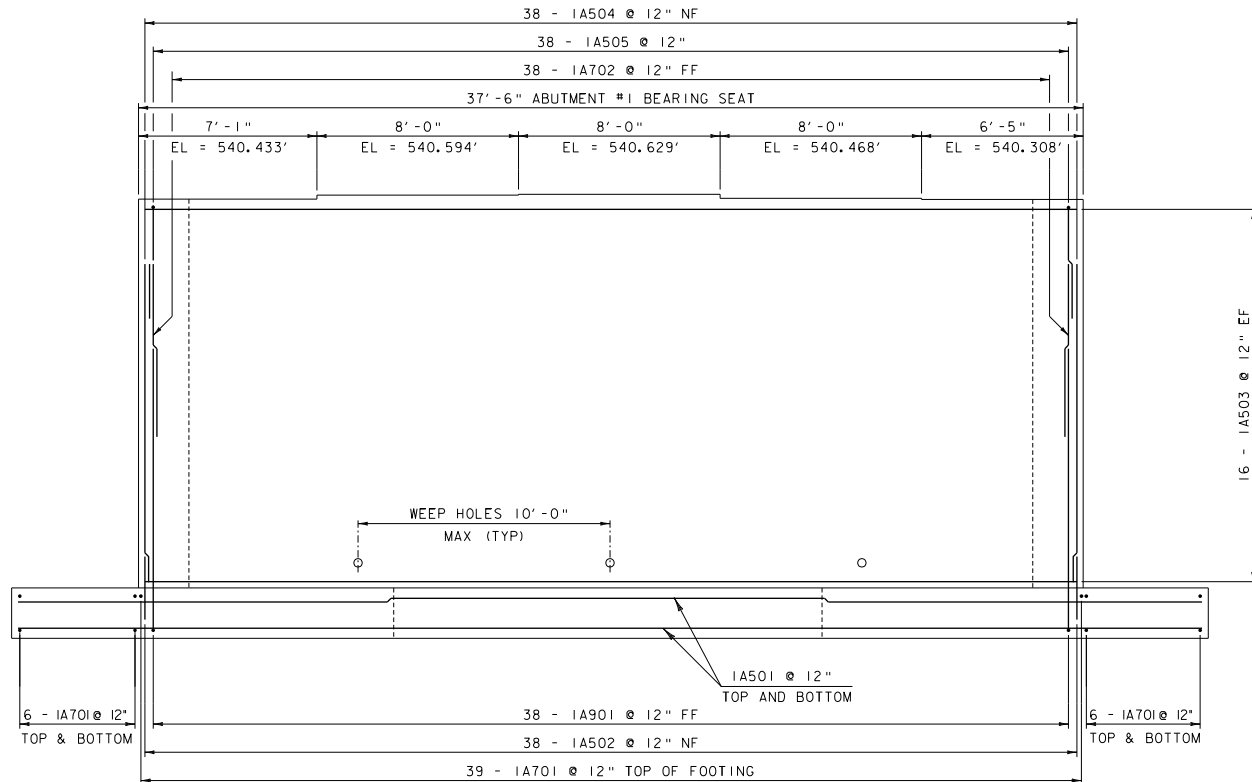
ABUTMENT #1 ELEVATION
SCALE 3/8" = 1'-0"

This is a typical abutment elevation looking at the stem of the bridge. Here reinforcing steel bar numbers are called out in the standard dimension line and extension line format. This process involves adding standard dimensions the modifying the dimension text. There is no need to drop the dimension.

Near Face (NF), Far Face (FF): suffixes are used to indicate the bars being noted. The NF and FF terms are specific to the view referring to the Far Face in reference to the drawing. The FF is the face represented in this drawing that would be the back side of the abutment. The NF is the face shown in the drawing on the front side of the abutment. The NF or FF terms are not generally applicable in section views where the reinforcing steel is drawn on the face where it is located. In some cases the term EF is used and refers to each face. This is used when the rebar being called out is the same on the FF and the NF so we can use the term Each Face (EF). The EF, FF and NF are applicable in plan and elevation views not usually in cross section.

In the example the bar noted at the bottom of the drawing as "39 – 1A701 @ 12" TOP OF FOOTING" is a standard rebar callout. The top of Footing note is to clarify the location of the bar but is optional if the extension lines clearly show the location. The "1A" indicates that this is a bar for Abutment #1; the "701" indicates that this is a #7 size bar, and that it is the first #7 bar for Abutment #1, the bar spacing is 12" on center.

3.4.   Abutment Wing Wall Elevation
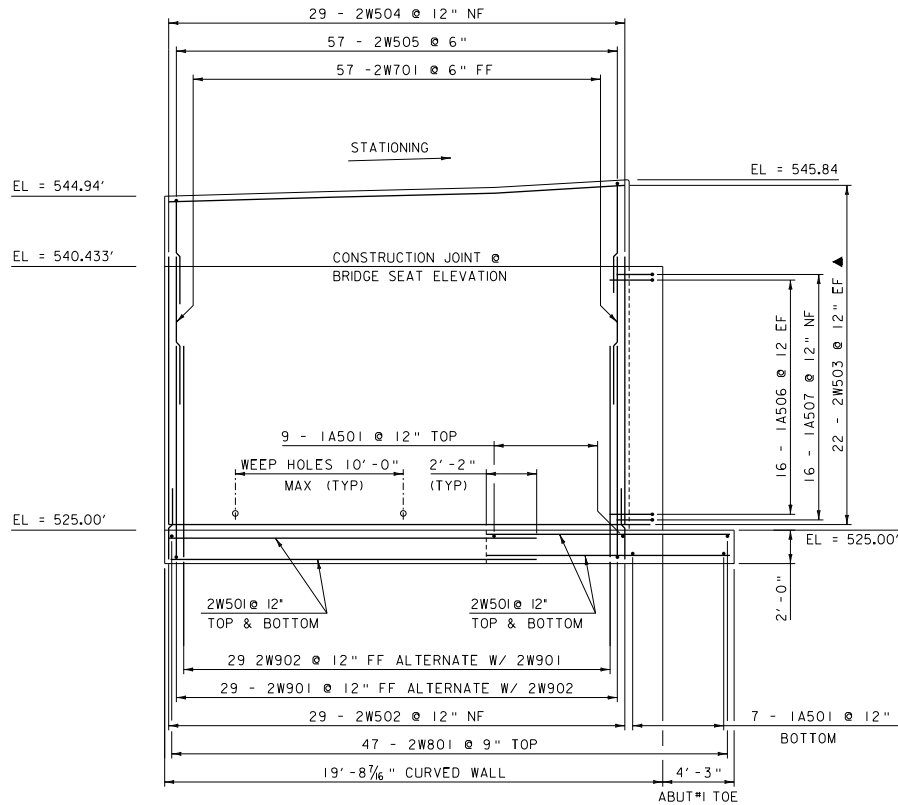

WINGWALL # 2 ELEVATION (CURVED)
SCALE ¼" = 1'-0"

1. TOP OF WW#1 ELEVATION FOLLOWS THE LEFT SHOULDER FINISH GRADE ELEVATION +7".
   THE WALL ELEVATION IS 10⅜" ABOVE ROAD CENTER LINE ELEVATION, EXCEPT FOR THE
   10'-0" TRANSITION FROM 10" CURB ON THE BRIDGE TO 7" CURB IN THE TYPICAL SECTION.
   SEE STATION OFFSET REPORT ON THE WINGWALL TYPICALS SHEET.

This is another example of a typical Wing Wall elevation. Notice the EF and FF usage as well as one EF where the bars being called out are located on the face of the abutment being shown as well as the face behind or into the paper. The term Each Face will also require the quantity shown in the callout to be multiplied by (2). In the example above there are (16) 1A506 bars at 12" on center each face and there are two faces the far and near face, so there are (32) 1A506 bars required.

The Wing Wall footing reinforcing 2W801 is a VAOT standard naming convention for reinforcing steel. The "2W" indicates that this is a bar on WW#2, the "8" actual indicates the bars size, the "01" represents the bar number in this case it is the first #8 size bar on WW#2. Generally the bars are numbered from the bottom up in the order they might be placed. The "TOP" in this case is optional and is intended to clarify the bars being pointed to by the extension lines.

The drawing is labeled "WING WALL #2 ELEVATION (CURVED)". The explanation added to the title "CURVED" tells the persons reading the drawing that the scale of the drawing is affected by the curve of the wall being drawn. It is also typical to add notes below the drawing title for information that pertains directly to the drawing. In this example the top of the wall elevations are located by following the finish grade + 10.375" and there is a station offset report located on the drawing to aide in setting the top of wall elevation.

### 3.5. Abutment Typical Section
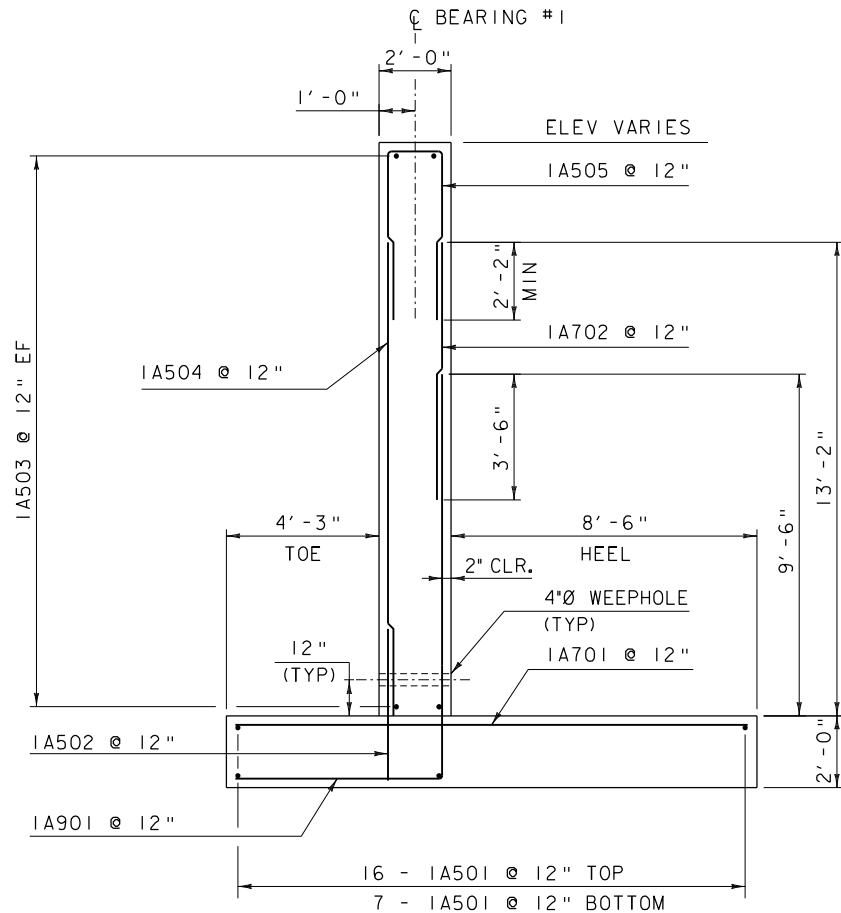
ABUTMENT #1 TYPICAL

SCALE ⅜" = 1'-0"

This example is of a typical Abutment Cross Section. Many sections are labeled as sections but in VAOT Bridge plans typical sections are drawn for the Abutment and Wing Walls and are generally simple labeled as typical. This is a carryover from roadway cross section typical sections that are generally referred to as "Typical Sections". Technically, the title of this drawing should be "ABUTMENT #1 TYPICAL SECTION" but it is "ABUTMENT #1 TYPICAL" for short in many cases.

Reinforcing Bars are shown as well as bar lap locations. Bar lap locations are labeled and the actual lap distance is dimensioned. VAOT has tools available for aiding in drawing reinforcing steel bars in cross section and the lap symbology. This will be covered later in the training examples.

The standard symbology for Diameter in dimensions and callouts is Ø as shown in WEEPHOLE note. MicroStation automatically adds the Ø symbology when using the dimension diameter tools and adds the R for radius when using the dimension radius tools. Typically in longer text such as listed notes the acronym DIA or full word Diameter is used. When using acronyms such as DIA or TYP no period should be used.

3.6. Bridge Detail
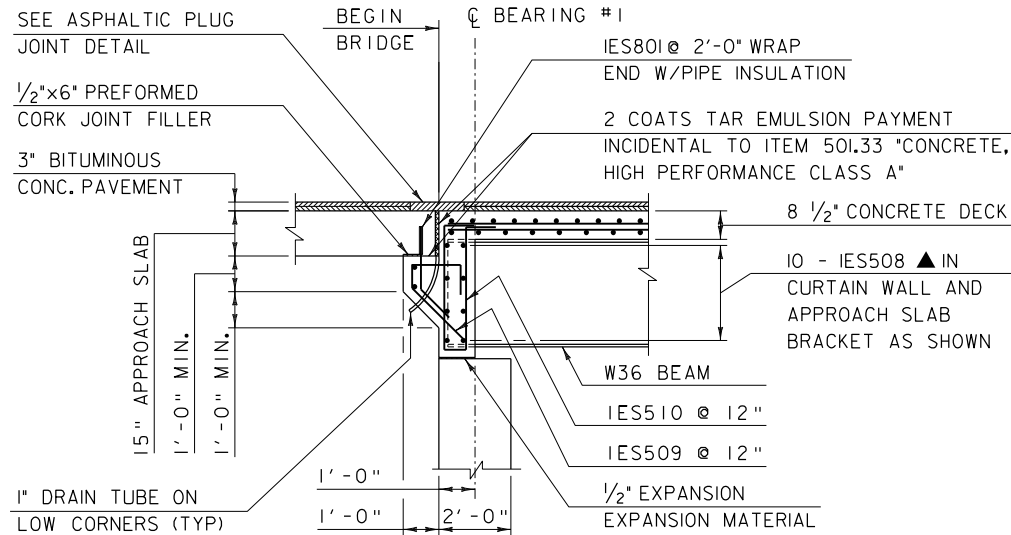
ABUTMENT #1 END DETAIL

SCALE 3/8" = 1'-0"

This is a typical drawing for a Bridge End Detail.   Standard drafting guidance is applied to this detail with some drafting judgment applied to best fit the required notes.

This example uses dimension leaders attached to dimension lines. This method is used when the dimension line is not long enough to fit the required text and there is no space on the sides of the dimension.   Dimension leaders follow the same spacing and placement guidelines as dimension lines. They can be rotated to fit when needed

The standard annotation leaders in this detail are also well organized. The annotation notes themselves are aligned where possible and left justified as well as spaced clear of other notes or elements in the detail. The leaders and notes guide the reader into the details on relatively parallel lines. This process reduces the cluttered, disorganized look of details and in general makes a detail easier to read. The more notes and annotations a detail has the more important it is to place the notes and dimensions in an organized, planned out manner.

Computer Aided Drafting in general has led to sloppy drafting practices over the years. In the old days detailers, drafters, and designers were forced to plan out and organize drawings before actually putting "ink" to paper.   Mistakes were costly and time consuming, often resulting in redrawing. Skilled drafters learned quickly how to draw in an organized well thought out manner. Now we can place graphics with little regard to proper placement because the idea is that a graphic can be moved if for some reason it is in conflict with another graphic. But in the process we must not abandon well drawn standardized and organized drafting.

If proper drafting is utilized and incorporated into drafting standards, Computer Aided Drafting applications (such as MicroStation) can optimize drawing productivity. This leads us to training on CAD Applications and Drafting tools.   Well trained drafters produce better standardized drawings that can be used and reused. No Engineer or Technician should want to inherit or reuse sloppy drawings, nor should they need to.

SECTION 7-4 – CADD Drafting Tools

4. INTRODUCTION

This section will cover actual computer application tools used for generating drawings and then annotating and dimensioning the drawing using Agency Standards as defined in the VAOT CADD STANDARDS AND PROCEDURE manual and this Drafting Standards Manual. The general goal of this section is to guide users through available tools for Drafting and demonstrate use of the tools. When used properly drawing and drafting productivity can be increased while actually generating standardized, well organized drawings.

Standard Dimension Styles and Text Styles have been setup in the VAOT MicroStation workspace. The Styles are used in conjunction with predefined drawings annotation scale settings to automatically adjust annotation and dimension text and symbology to the Agency Standards. The rules that will be applied in this section work in conjunction with the Standard Styles defined in MicroStation. There are drafting irregularities that the Drafter must recognize and account where appropriate, the software cannot do every aspect of the drafting standards automatically. If the automatic drafting methods are functional and do not interfere with or otherwise detract from the intent of the drawing then they can and should be utilized. There are some irregular font issues with spacing and possible other application process issues that we accept to facilitate computer automation. However if there are issues that detract from the drawing's intent we should and will fix the issue by the most efficient method available.

This section of the manual will use MicroStation Drawing and Drafting tools focusing mainly on Dimensioning and Annotation drafting.

4.1. MicroStation

The Vermont Agency of Transportation uses MicroStation for Drafting Roads, Bridge Structures as well as other Transportation Related engineering features. MicroStation is a fully functional Graphical interface specifically designed to Generate Engineering Plans and Details of all scales and complexity. MicroStation is the dominate CADD application utilized in the Government Transportation Engineering Industry. More on MicroStation can be fond at the Bentley Systems web site.

MicroStation usage is supplemented by several other vertical applications that run on top of the platform application MicroStation. Bentley InRoads is the primary vertical CADD application used for Civil Engineering specific design by the Agency and is also the dominate application in Civil Engineering (Roadway and Rail) design used by Government Transportation Agencies.

4.2. Drawing Productivity

The base for using the Dimension and Annotation tools is to apply them to a drawing of an object or area. All objects drawn should be drawn at Full Size 1:1 scale whenever possible. This is true for plan drawings as well as sections and details. MicroStation has unlimited capability to draw measure and layout drawings to scale. Some details are drawn not to scale for clarity or simply because the actual size is not known or not

relevant to the drawing. However the majority of Engineering Drawings and Details are drawn to scale and then plotted to the specified scale.

The basic drawing tools include the ability to generate Lines, Circles, Arcs, Shapes and Line Strings in a variety of symbolic attributes that include Color, Linestyle, Lineweight and of course an assigned Level. We will briefly cover the process for using these basic drawing tools. Extensive training on using MicroStation drawing tools can be found in the MicroStation Help or in the [Agency MicroStation Training Manuals](). The activation key can be obtained from Agency CADD management personnel.

There are basic element placement tools and are advanced placement tools used for quickly and accurately drawing. Both the basic and advanced tools have functionality to increase productivity. These productivity tips and Techniques will be covered. Taking advantage of the productivity functionality in MicroStation makes the job easier and less redundant, often eliminating multiple clicks and repetitive typing. The Advanced and basic placement tools used to increase periodicity that will be covered are listed below.

- Setting Element Attributes Tips
- AccuDraw
- AccuSnap
- Shortcuts Menus

4.2.1. Basic Drawing Tools

- Line: The most basic Drawing tool. The line tool buttons are located on the drawing Task/Tool bar or the drawing Task Pane Shown here. Click on the desired tool or type the associated number and the command is activated. Follow the command prompts and draw. (More on accurate placement later.)
- Circle: Shown to the right is also a basic command used to place circular type elements. Click on the tool and follow the command prompts.
- Arc: Arcs are found in the same Drawing Task/Tool box as the Circle tool.
- Shapes: Tools are also found on the main menus and are relatively easy to use.
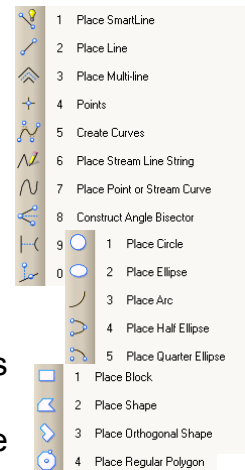
4.2.2. Manipulate Tools

After drawing an object or part of an object it is inevitable that the object will need to be modified or manipulated. There are many different manipulate tools. Too many to actually cover but the most often used ones are the move, copy, and stretch commands. Also the copy parallel is commonly used to generate a parallel line at a specified distance.
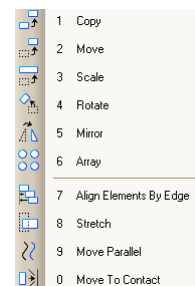
The modify commands can be accessed on the main task/tool bar or the Classic Main tool bar. There are again many tools for actually drawing and manipulating elements; this was only an introduction. Before annotating or dimensioning a drawing the Draftsperson should have a strong ability to graphically draw a design.

4.2.3. Drawing Skills

Engineering Drawing skills are not the main topic of this manual, but the topic is worth mentioning. This skill is leaned by most of us in College or trade schools. The ability to mentally visualize objects or areas and then reproduce this in an organized symbolic drawing is an essential part of Drafting. The symbolic drawing follows basic rules for linestyles such as solid lines represent visible edges, dashed line usually represent hidden edges, proposed objects are generally drawn with a heavier line weight etc. Engineering is not only the ability to mathematically, logistically, and physically conceptualize a project but also generate Engineering Plan Drawings that clearly instruct Fabricators and Contractors how to actually build the project. Traditionally drafting has been a specialized skill applied by Engineering Technicians trained in generating Engineering Construction Plans from engineered data sources. These sources can vary from survey data field measurements to mathematical design computations and sketches.

With the use of CADD, Engineers and Technical personnel are now integrating design into the plan generation. Computer aided design software often generates drawings or requires drawn models to complete computations. Engineering Design software and Drafting software are merging and working to automate fabrication and construction documentation processes.

The skills to draw then clearly annotate and dimension proposed plans for construction remains an important part of Engineering. Organizing annotation and dimensioning is critical to the readability of drawings. Standardization in drafting also means consistency in the way dimensions and annotation are handled. Standardized drawing consistency makes the drawing easier to read, easier to check, resulting in fewer errors. Less errors in the "Plans" means time and money saved during construction.

4.3. Dimensioning Tools

This section will cover in some depth using MicroStation Dimensioning tools. There are Agency Dimensioning Standards that are configured in the VAOT CADD workspace as Dimension Styles to help automate standard practices. MicroStation Dimension Styles are setup and available on every workstation within the Agency and provided on the CADD web for consultants. The dimStyles, as they are refer to, define Dimension Line, Extension Line and Dimension text placement, orientation, level, color and pretty much every aspect of a dimension. The draftsperson controls what objects are being dimensioned and is able to guide the location of the dimensions. Dimensioning should in no way be considered automatic; there is required input and guidance to actually place the dimensions in an organized standardized manner.

Almost every aspect of dimensioning placement can be measured relative to the standard text height. The Agency standard text height for normal proposed text including dimension text is 0.14" on the full size plotted plan sheet. This means, the scale a drawing will be plotted at should be determined and defined prior to dimensioning or annotating a drawing. MicroStation does have the ability to regenerate dimension and annotation size according to a defined scale but this functionality does not generally reorganize the dimensions or annotation to properly fit or maintain relative spacing. In short, automatic scale propagation functionality in MicroStation generally makes a mess of the dimension and annotation placement. Skilled draftspersons have

been determining the intended scale of drawings for decades. This does take some planning and skill but it is not overly difficult. Generally the object or area is drawn either partially or fully. This will help to define the size or extent of the drawing. Then a drawing border is scaled around the drawing to determine the appropriate scale the drawing will be plotted at. It is not uncommon to have one drawing sheet with details at different scales but the sheet itself is plotted at one specified scale and details that are different scales are factored accordingly through referencing. This multi scale detail in sheets subject will be covered in more depth later.

☹ *Dropping Dimensions should be avoided when ever possible! This makes editing the drawing later much more difficult! Users should learn how to use dimension tools without disabling the intelligence built into the drawing by dropping Elements!*

4.3.1. Plot Scales & Text Size Table

Standard plot scales and text sizes are defined in the "**VAOT CADD STANDARDS AND PROCEDURE MANUAL**". The table below will aid in determining plot scale and text size as well as aid in dimension line placement. Since most aspects of annotation and dimensioning is relative to the scale and text size, the table serves as a quick reference and can be referred to rather than memorizing or calculating scale factors or proper spacing. In the table the ***140 column*** values represent text height for the plot scale shown on the left side. Since in dimensioning the stacked spacing of dimension lines is 3 times the text height the ***x3 column*** serves as a quick reference for this spacing. The L120, L175 and L200 column headers represent text sizes other than the standard L140 or 0.14" text size.

Scale	Scale	Ratio X	L120	x3	L140	x3	L175	x3	L200	x3
1	Full Size 1=1	1	0.12	0.36	0.14	0.42	0.18	0.53	0.20	0.60
10	1"=10'	120	1.20	3.60	1.40	4.20	1.75	5.25	2.00	6.00
20	1"=20'	240	2.40	7.20	2.80	8.40	3.50	10.50	4.00	12.00
25	1"=25'	300	3.00	9.00	3.50	10.50	4.38	13.13	5.00	15.00
30	1"=30'	360	3.60	10.80	4.20	12.60	5.25	15.75	6.00	18.00
40	1"=40'	480	4.80	14.40	5.60	16.80	7.00	21.00	8.00	24.00
50	1"=50'	600	6.00	18.00	7.00	21.00	8.75	26.25	10.00	30.00
60	1"=60'	720	7.20	21.60	8.40	25.20	10.50	31.50	12.00	36.00
80	1"=80'	960	9.60	28.80	11.20	33.60	14.00	42.00	16.00	48.00
100	1"=100'	1200	12.00	36.00	14.00	42.00	17.50	52.50	20.00	60.00
150	1"=150'	1800	18.00	54.00	21.00	63.00	26.25	78.75	30.00	90.00
0.3333	3"=1'-0"	4	0.04	0.12	0.05	0.14	0.06	0.18	0.07	0.20
0.6667	1 ½"=1'-0"	8	0.08	0.24	0.09	0.28	0.12	0.35	0.13	0.40
1.0000	1" = 1'-0"	12	0.12	0.36	0.14	0.42	0.18	0.53	0.20	0.60
1.3333	3/4"=1'-0"	16	0.16	0.48	0.19	0.56	0.23	0.70	0.27	0.80
2.0000	1/2"=1'-0"	24	0.24	0.72	0.28	0.84	0.35	1.05	0.40	1.20
2.6667	3/8"=1'-0"	32	0.32	0.96	0.37	1.12	0.47	1.40	0.53	1.60
4.0000	1/4"=1'-0"	48	0.48	1.44	0.56	1.68	0.70	2.10	0.80	2.40
8.0000	1/8"=1'-0"	96	0.96	2.88	1.12	3.36	1.40	4.20	1.60	4.80
16.0000	1/16"=1'-0"	192	1.92	5.76	2.24	6.72	2.80	8.40	3.20	9.60

4.3.2. Linear Dimension

Linear dimension is the most common dimension used in Civil / Structural drafting. The MicroStation tool is located in the Dimension Task bar shown right as (2). The function of this tool is to select two point locations and have MicroStation annotate the dimension value. Shown left is the Linear Dimension dialog; the Top pull down selector indicates the dimension style. In this dialog "English (ft-in)" is the active style. This is the Basic VAOT Standard dimensioning style and will serve as the base dimension style for all standard dimensions. This style sets a plethora of settings for the dimension placement options. The button to the right of the style pull down is the dimension style button where all the settings can be viewed. The next button over is the dimension style reset button. If the Dimension style is modified in any way, it can be reset to the standard using this button.
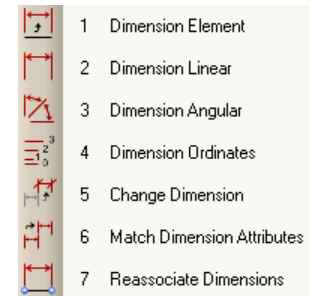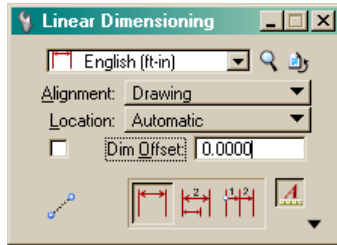
The Alignment pull down allows the placement orientation to be adjusted to follow the drawing rotation or one of the other choices shown here. Drawing or True are the most commonly used but the others are required in some circumstances. The user can read more about each setting in the MicroStation Training manual or the help.
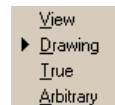
The Location pull down allow the draftsperson to automatically or manually position the dimension text location along the dimension line. The setting is toggled back and forth as needed during the drafting process. The Dim Offset: option is off but can be set to automatically place the dimension line at a specified distance from the object. The offset distance can be set during placement allowing the user to place the dimension in the most appropriate location; so generally, this option is not necessary.

The final toggle we need to look at is the Annotation Scale Lock. This is the ▲ button on the right corner shown pushed down and "ON" in the Linear Dimension dialog above. This option is what adjusts the text and dimension properties according to the intended plot scale. There is _no need to modify the dimension setting_ when switching from say ¼"=1'-0" scale to 1"=20'-0" scale. This is done by simply changing the annotation scale setting of the drawing model.
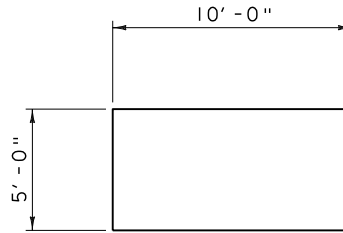
One way to set and view the drawing annotation scale is to use the Drawing Scale tool bar. This can be activated from the MicroStation Main menu > Setting > Drawing Scale. The tool may show additional settings. They can be toggled off by right clicking over the tool box and un-checking the tools not required. The Drawing units and Annotation scale are the ones we will most often need.
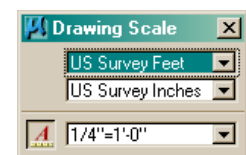
4.3.2.1.   Linear Dimension (Example)

The dimensions shown in this example use the settings as discussed.   Both the dimensions and the annotations on this "BOX PLAN" follow VAOT Standards. Note that there is no need for a graphical scale bar on details or cross section only topographical

THIS 10'-0"×5'-0" BOX IS ANNOTATED USING THE ENGLISH DIMENSION STYLE WITH AN ANNOTATION SCALE SET TO $\frac{1}{4}$"=1'-0" (1:48) THE TEXT HEIGHT IS 0.14"×48 THE DIMENSION LINE OFFSET FROM THE BOX IS 0.14"×48×6 AND THE ACCUDRAW OFFSET TOOL WAS USED TO SET THE OFFSET.

BOX PLAN

SCALE $\frac{1}{4}$"=1'-0"

layout plans require a graphical scale bar. The graphical scale bar is a cartographical drafting standard and should not be applied to Structural detail drawings. It takes up valuable space and serves no functional value. In Structural Detailing the drawings should never be measured for the purpose of fabrication or construction. If a measurement or dimension is required for construction purpose it should be provided in the detail. The scale of the drawing is provided mainly for engineering purposes and all Engineering personnel should have an Engineering Scales readily available to check drawing dimensions (Typical Engineering Scale shown below).

4.3.3. Stacked Linear Dimension

The linear Dimension topics discussed in the previous section all apply to generating stacked dimensions. Stacked dimensioning is the term used when multiple dimensions apply to one side or area of a drawing. Stacked dimensioning applies as the details get more complex requiring multiple dimensions in close proximity. The distance between dimension lines is the stack distance. The VAOT standard stack distance is 3x Text Height or 0.42" on the full size plotted plans. The table provided previously has the x3 value for standard plot scales.

There are stack dimension tools in MicroStation; generally they do not function well with multiple linear and stacking at the same time, so it is generally simpler to use linear dimension tools and apply the stacking as a standard offset distance using AccuDraw or some other precision input function of MicroStation. But the AccuDraw offset function is likely the most productive method.

Stacking Dimensions starts to introduce more complexity into the dimensioning process. The more complex a drawing is the more important it is to develop skill in placing and organizing dimensions and annotation. With more dimensions and annotation, conflicts between dimensions and annotation start to be introduced. As the draftsperson gains experience in drafting, methods for cleaning up and creating professional looking details will develop. The conflict resolution for overlapping dimension lines, extension lines and leaders can be ignored in simple drawings without much issue. Very complex details with lots of intricate parts will be very messy without some method to clarify the tangled mesh of crossing lines. It is suggested that the draftsperson simple adapt conflict resolution methods and use them extensively. Often a simple drawing turns into a complex drawing quickly as a project develops.

4.3.3.1.   Stacked Linear Dimension (Example)

The dimensions shown in this example use the settings as discussed and follow the VAOT CADD Standards.   The Dimension Style "English (ft-in)" was used to generate the dimensions and the annotation scale was set to 1:48 scale.

STACKED EXAMPLE
SCALE ¼"=1'-0"

The process for laying out stacked dimensions is simple. Start with the smaller dimensions. In this case, the locations of the holes in the box are dimensioned.   Then work up to the next larger section, the overall Box length, and the length of the extended portion. Next the overall dimension is placed above the first two rows of dimensions. The Extension lines that locate the holes were then toggled off and replaced with Centerline symbology.
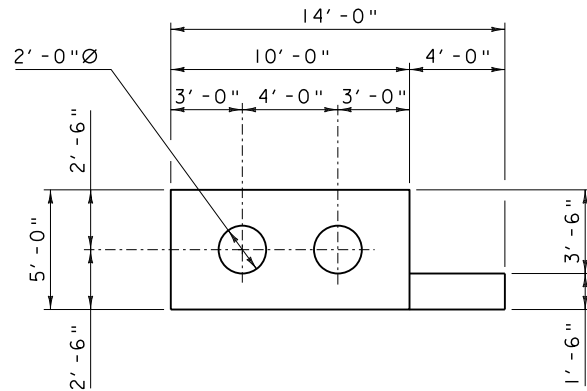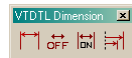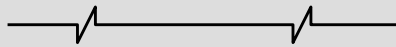
The width dimensions were placed in a similar manner.   The box extension was dimensioned on the side nearest the extension for clarity, but the overall width of 5'-0" need not be repeated.   Generally speaking, if similar objects or features are not dimensioned, it can be assumed that they are typical and have the same dimension and/or property. If the dimension is different it must be labeled each time.

The 2'-0" Diameter holes were labeled using the MicroStation Dimension Style standard settings. Note that there are two holes and only one is labeled. It can be assumed that each one is the same diameter due to proximity and layout it is obvious without further explanation that both holes are the same diameter. There is no need to repetitively note TYPICAL or (TYP) on details.   Similar objects can be assumed to have the same dimensions in size and placement unless specifically noted otherwise. However it is not incorrect to label or annotate such similar objects if space permits.

The conflict resolutions applied in the example are basic ones. The extension lines of several dimensions were toggled off. This can be done with the MicroStation key-in *change dimension extension toggle* or the VT Detailing tool box has a tool that applies this by selecting the far right tool, then selecting the extension line. The extension line was then replaced with an ordinary line element, and partial delete was used to wipe away a portion of the line to clean up the crossing dimension element. This process did not require the dimension to be dropped and the extension line can at any time be toggled back on. Never partially delete actual object lines to clear a path for a dimension or extension line.

☹ *Breaking or partially deleting an object line to make space for any annotation, dimension line or extension is typically not a good practice and should be avoided when ever possible! When an object line is broken a "breakline symbology" should be utilized. Breaklines can be partially deleted to avoid conflicts with dimensions and annotation. Breaklines can be seen in many of the details shown in this document.*

Breakline Symbology =

4.3.4. Crowding Dimensions

The term crowding seems to imply that there is not enough space. This is exactly the condition a draftsperson is often faced with. How do draftspersons compress four, five, six or more dimensions in a space that seems too small for one dimension? Well the answer is not to abandon all rules and standards, drop all the dimensions and just let disorder rule the drawing. No, this is where true skill comes into practice. Anyone can dimension and annotate a simple drawing.

Developing a set of rules and standards for complex drawing and drafting is as much an art as it is technical ability. These types of details will require the draftsperson to a have a good eye for detail and be able to visualize how annotation and dimensions should appear prior to placing them. Then they need to have the technical ability to make the drafting software (i.e. MicroStation) generate what needs to be done in the most efficient manner. This is actually true for most drawings done in the Engineering world. The good news is MicroStation is forgiving and dimensions and annotations can be moved and reworked. But who wants to do that?

The other key component in complex detailing is patience and persistence. It can be a slow tedious process. Changing the details is always a possibility. A good drafter will or should investigate and check possible issues with the project design as the details are being drawn. Finding issues early makes changes less costly. Changes made at the end phases of a project's design often affect many drawings. Issues found early on in the design process will inevitable have less of an effect on already completed or started drawings.

To the right is an example where the dimensions are pulled out and off the dimension line and annotated with a dimension leader line. The leader leads the reader to the dimension line. Dimension call outs follow the stacked dimension line spacing rules but are no longer associative. They have been dropped.

No matter how complicated the detail is or how crowded it may be. It is the draftsperson's responsibility to make it look as simple, clean and organized as possible. The best way to achieve this is to follow standard practices consistently through the individual details, then through the project as a whole and to every detail and project worked on. Once a draftsperson develops good drafting skills, they should keep and practice them. Bad habits in drafting are hard to unlearn and the details drafted using bad habits are less valuable for reuse on later projects.
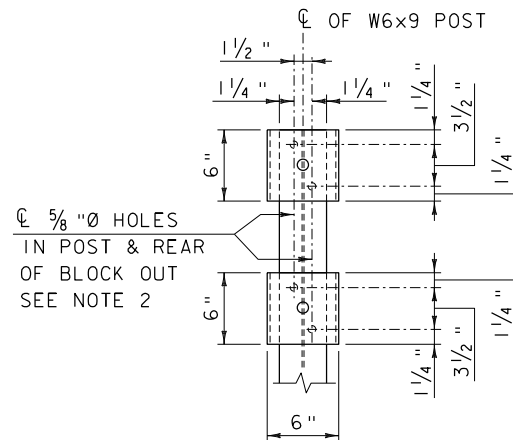
4.3.4.1. Crowding Dimensions (Example)


GUSSET PLATE DETAIL G4 TOP

SCALE 1" = 1'-0"
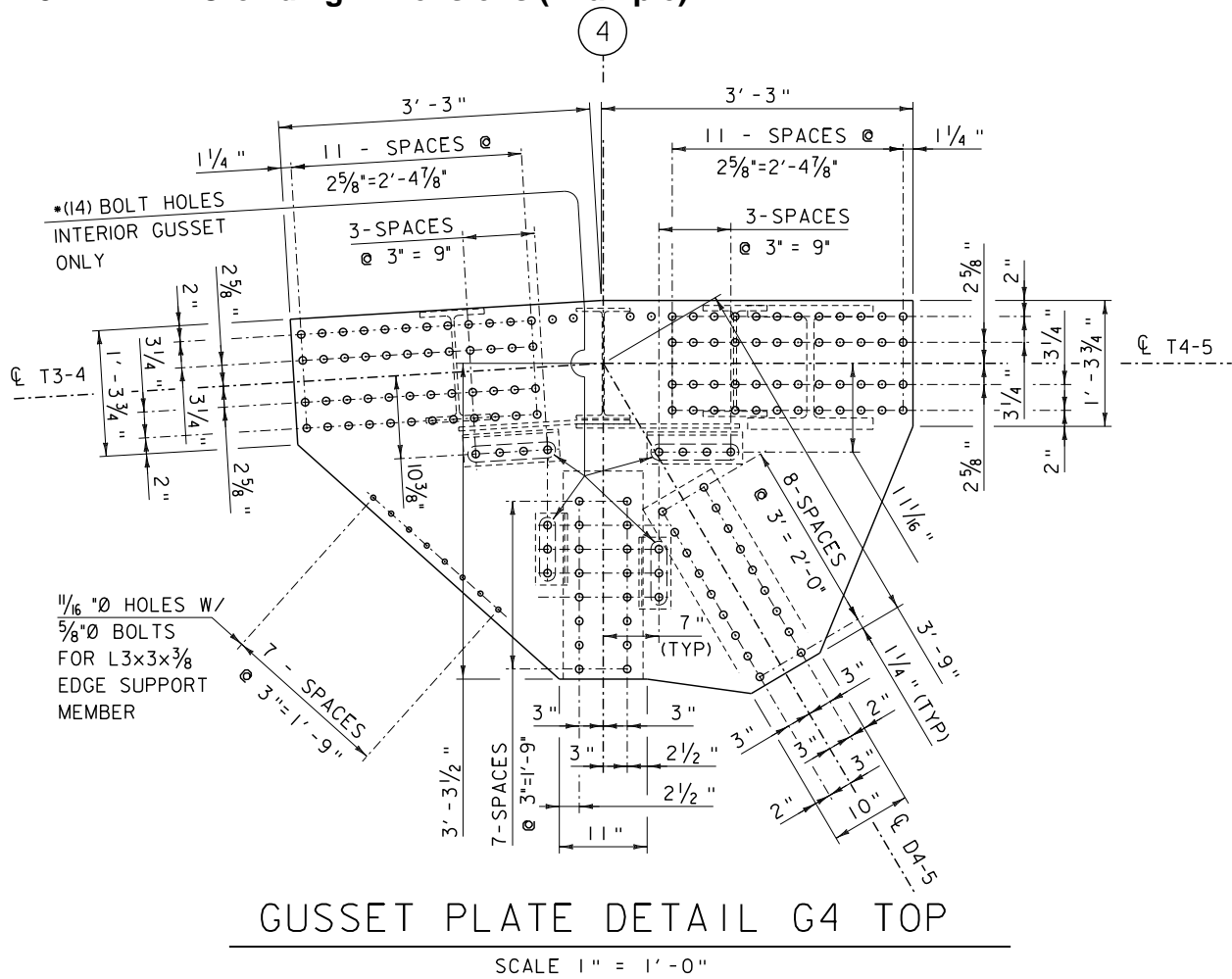
This example basically demonstrates how crowded details might be dimensioned while still applying the Agency CADD Standard Drafting style. Moving the dimension value outside the extension lines while maintaining the dimension line between the extension lines is a basic standard. In some instances the dimension arrows have been reversed because the dimension value space is not large enough for both arrows or sometimes not even large enough for one arrow. In all of the cases above, the dimensions were not dropped; the dimension style was simply modified to reverse the arrow heads. Two linear dimensions side by side with reversed arrow heads produces the appearance of one arrow head reversed and the other not reversed.

In the drawing above some dimensions seem to have non-dimension values. This is done by simply double clicking on the dimension and adding the required prefix or suffix. In some cases the auto dimension string ✳ is replaced with simple text but the dimension is still associated and the ✳ value can be added back at any time.

On some occasions in crowded drawings the dimension must be dropped to force a clear annotation of the drawing. This is true when dimension space is simply too small and the arrow does not fit properly. Leader lines are sometimes added to call out the dimension with standard annotation.

4.3.4.2.   Angular Dimensions (Example)
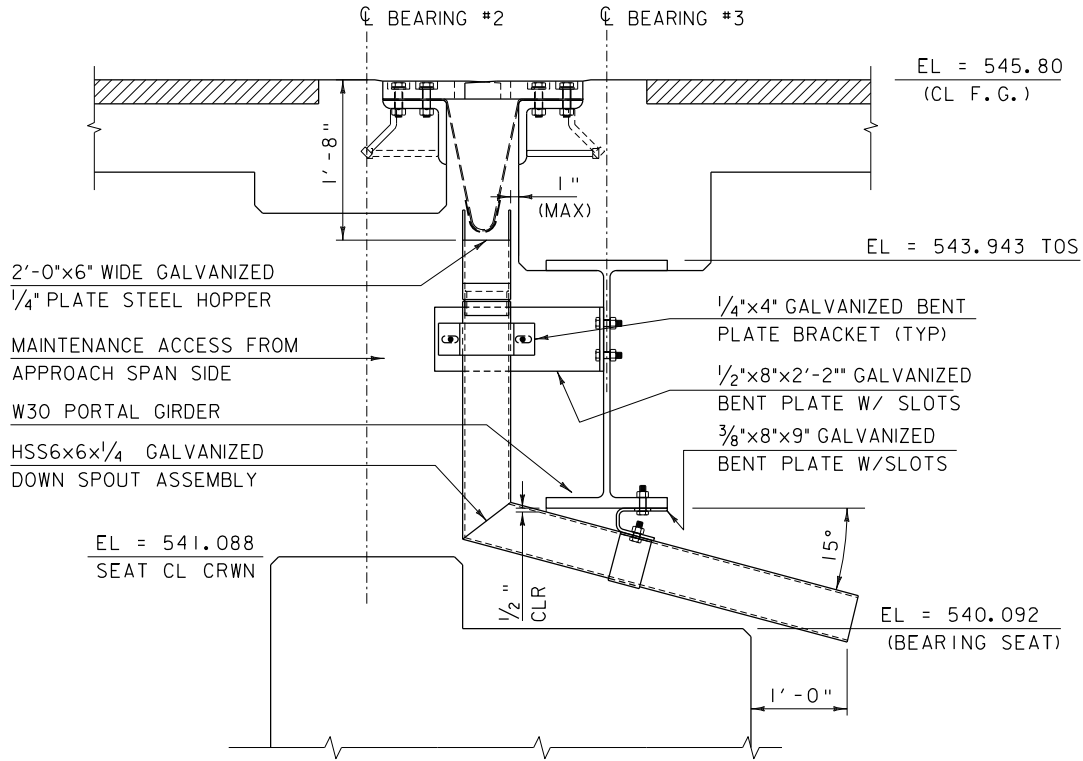
HOPPER TYPICAL SECTION

SCALE 1" = 1'-0"

This is example is showing standard dimensioning. The downspout has an angle dimensioned at 15 Degrees. This is the angle as designed for the downspout. The standard rules still apply the dimension line in this case an arc is shown across the measured area. The dimension text 15° is sown as read from the right hand side of the sheet. The number of decimal places shown in the accuracy of the angle will vary. Show as many digits as needed to insure the proper angle is constructed.   In this example the angle is set to 15 DEG by design so no decimal places are required. Example below shows bridge layout with angle accuracy to 4 decimal places where required.
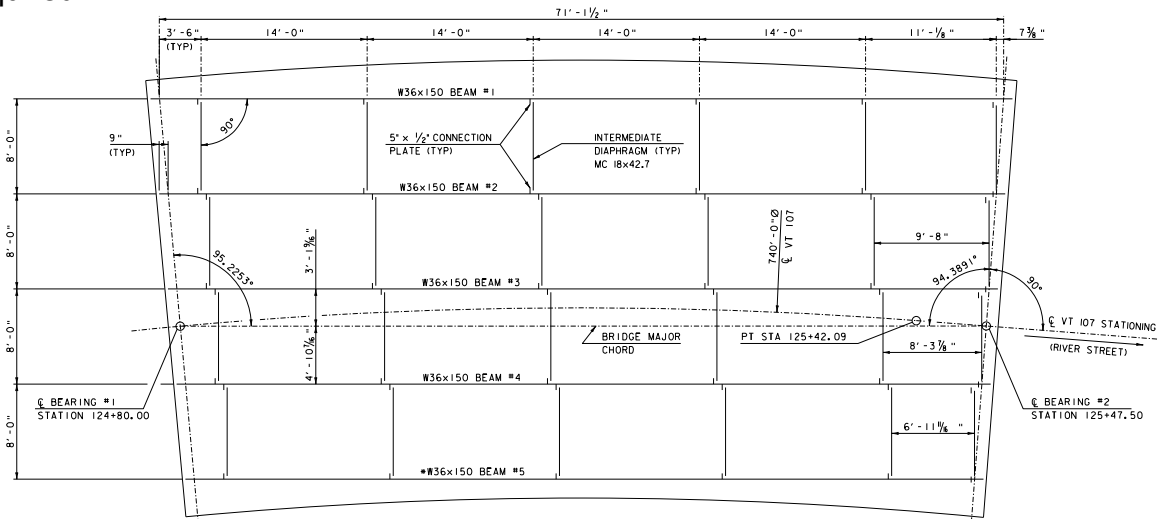
APPROACH FRAMING PLAN

SCALE 1/4" = 1'-0"

4.4. Annotation tools

Annotation tools and dimension tools in MicroStation are integrated. Dimension tools use the annotation functionality to place dimension text and adjust the text height according the defined annotation scale. Basically Dimensioning is a form of annotation. The integration works both ways; when an annotation with a leader is required, the tool is found with MicroStation annotation tools. As shown in the "Text Classic" tool box above or in the "Text Task" pane to the left. They both do the same thing. The "Place Note" tool adds a leader line and gives the user the option to place text on the end of the leader.

The Vermont Agency of Transportation has a tradition of placing the leader line under the first line of text in an annotation callout note. This practice is not automatically handled by MicroStation. The typical process for placing callout notes to the Standard requires a two step procedure.

1. Place the note or sets of notes in the required positions on or around the drawing. Generally callout notes are placed in groups so the notes should be left justified and lined up whenever possible. The generic place text tool can be used to accomplish this. Placing the notes separate from the leaders is not an issue because common practice would be to place all or most of the callout notes required then move on to placing leaders.

2. Once the notes are placed, use the "Place Note" tools to place the leader. There is a Dimension Style setup for placing standard detail callout annotation leaders. This dimStyles is named "LeaderArrow"; it is basically the same as the "English" style but the ability to manually manipulate the location of multiple line segments when placing the leader has been toggled on. This will allow the user to place as many actual vertices as needed in the leader line; but one vertex, as shown, is the preferred method. Previous examples in this manual have shown multiple vertex leader lines. The text in the annotation callout will often be multi line text. The text style "English" spaces text accordingly, as shown above, to allow for the leader line to be placed clearly through and under the first line in the note.
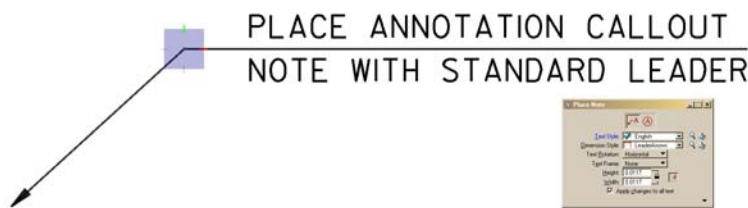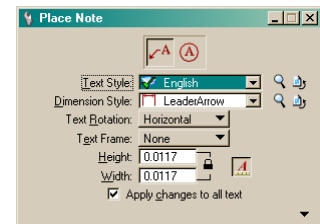
The "English" text style and "English" dimension style work together. When using the English dimension style the English Text style, should be activated. This actually will happen automatically when the styles are updated from the library.

☹ It should be noted that mixing of fonts on drawings should be avoided. VAOT Standard font and font size are defined in the Standards and should be used exclusively in plan and detail drawings. The exception is **inside** title block corner card or Title Sheets, different fonts and font sizes are used to emphasize the project information.

4.4.1. Annotation Leader Line (Example)

A Leader Line annotation example is shown with notes on both the left and right side of the detail; both sides are left justified text. The leader line minimum spacing as shown on the right side is the same as the minimum dimension line spacing. When it comes to leader line spacing, the notes should be spaced out for the best fit; often they are spaced more than the minimum. Leader lines lead the reader into the object being noted in an organized, sorted manner from top to bottom. Crossing leader lines should be avoided. Properly ordering notes in the order the objects are drawn will increase the readability of the drawing. Here we also see a section B-B called out; this is an example of a section of a section. Since there is no indication of the sheet to find B-B, we can assume it is on the same sheet near SECTION A-A. If not, the location should be noted.
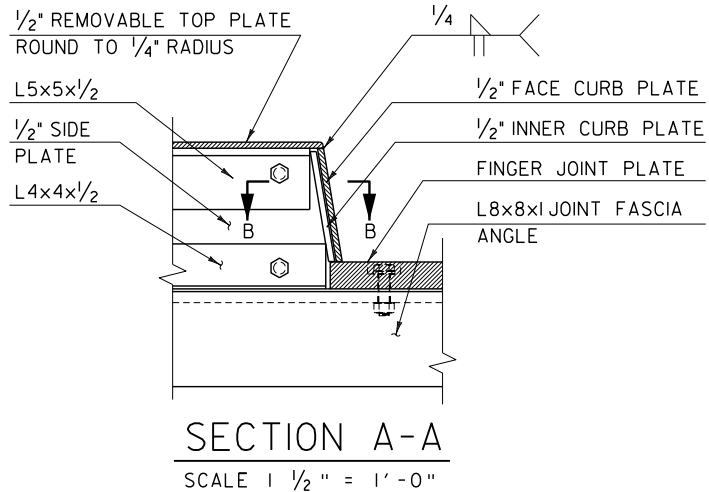
## 4.4.2. Welding Symbology Annotation

The weld symbol in SECTION A-A is shown correctly. In the example the fillet weld symbol shown on the top of the weld Reference Line indicates that the weld is on the (other) side of the leader arrow. The square weld symbols || on the bottom of the reference line indicates the weld type to be made on the arrow side of the joint.

Welding symbology is standardized and specific. The draftsperson should take specific care to properly symbolize welding on the drawing.
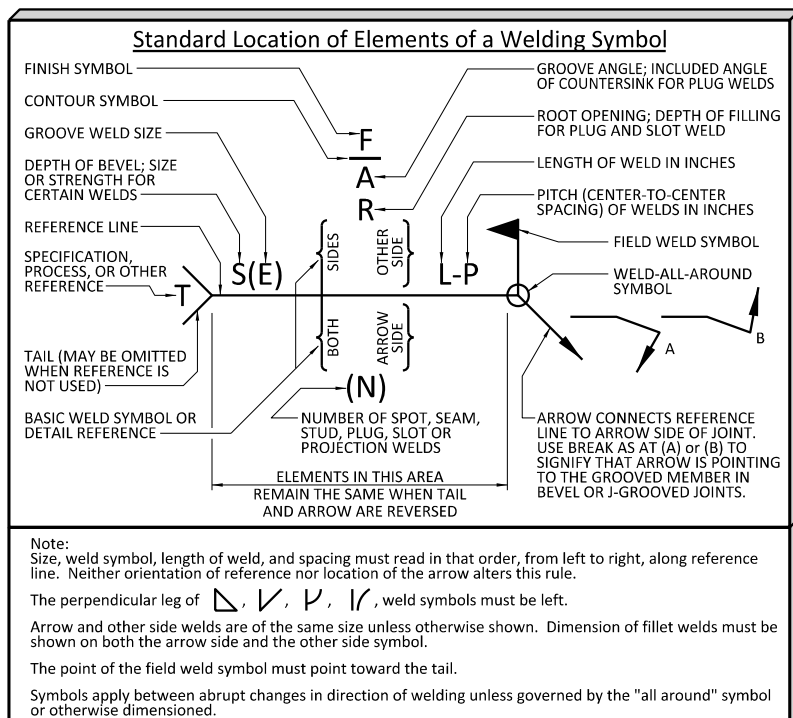
The weld symbol is placed on the welding symbol reference line to indicate the type of weld being specified. Weld symbols can be found in the AISC Steel Design Book. The welding symbol key, shown to the right, is found in the AISC Steel hand book and in American Welding Society (AWS) documents.

4.4.3. Typical Deck Annotation Example

APPROACH SPAN DECK TYPICAL
SCALE ½" = 1'-0"
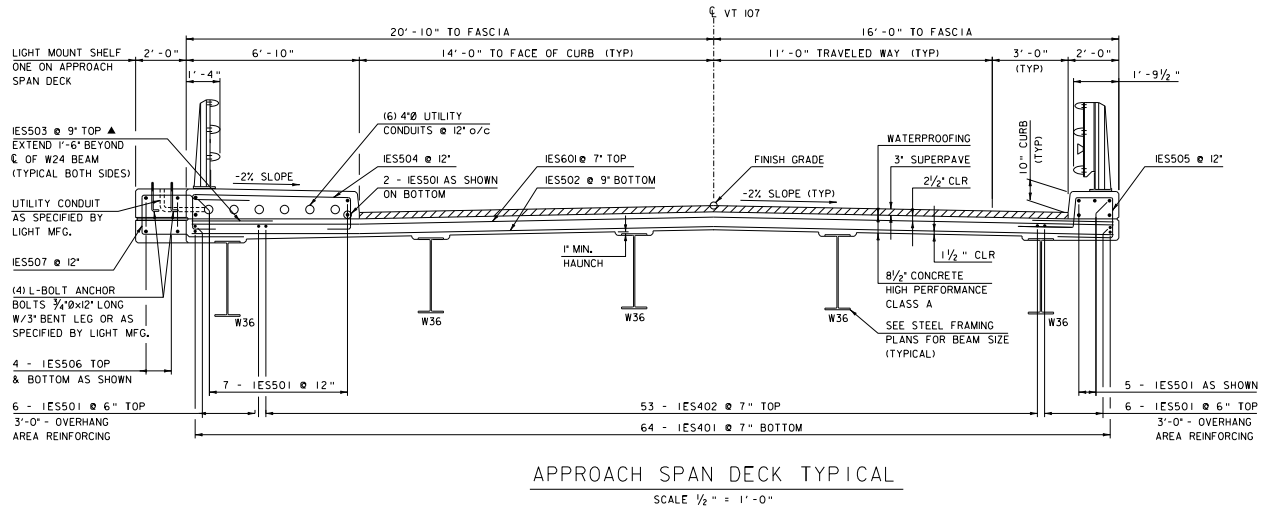
Typical bridge deck Section. Text is left justified and lined up when possible. Each drawing attempts to represent the components and annotate the design parameters needed for construction in as neat and clear a manner as possible. The W36 beams on the deck are specifically labeled simply as W36; no beam weight is specified because this is called out on the Framing Plan. Redundant noting of structural members increases the probability that it will be incorrect; especially if the size changes during the design. Label structural members once in the proper location, then abbreviate the size elsewhere. The fabricator cannot fabricate the W36 beams without looking at the framing plan.

4.5. Tool Tips

MicroStation has many different methods for getting the job done. In general, MicroStation attempts to retain workflows and processes used in legacy software versions. Each new version adds new and advanced methods. This is a great function of MicroStation, but each user is able to ignore learning new and better tools if they so choose. Some of the most improved areas of MicroStation are listed below and will be discussed. Each of the functions of MicroStation listed below has the ability to increase drafting productivity and aid standardization.

4.5.1. Change Properties Tool

This VAOT customized tool will modify the Level, Color, Linestyle and Lineweight of selected elements to the active settings. This differs from the Change Attributes tools because there is no dialog and no toggles to select what attributes will be modified. It is a quick tool to change selected elements to the active settings.

To set an existing element attribute to the active attributes, MicroStation has a short cut. Hover over the element > hold down the Alt key and data point, the active setting will change to match the element under the cursor. Use this in conjunction with the *Change Properties tool,* and there is a quick method for changing one set of elements to match another element's properties.

The match element setting is accomplished by holding down the Alt Key and data pointing on an element. The match settings works by selecting an element or selection set then right clicking and selecting the Change Element tools on the right click short cut menu. This option will only be visible when an element is selected. The tools can also be found on the VAOT Levels tool bar.
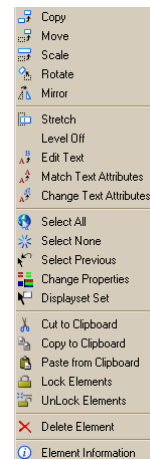
We have just demonstrated the right click menu. This option should be used often. The menu will change depending on the elements types selected or not selected.

4.5.2. AccuDraw

AccuDraw serves many functions in the modern MicroStation environment. If AccuDraw is not being utilized, the user is at a significantly diminished productivity level. MicroStation help and training manuals cover Full AccuDraw usage. The O or Set Origin is extremely useful in placing dimension lines at specified spacing as well just in every day drawing. There is no really good way to demonstrate on paper AccuDraw's ability, but in Agency training sessions, we can demonstrate better. The above image uses the origin offset command "O" with an X offset of 1.68 for dimension line spacing. A data point sets the origin location then type an O on the keyboard. As the name suggests, AccuDraw conveniently delivers accuracy and precision tools to the draftsperson. There are more than 20 standard AccuDraw shortcut commands defined by default.
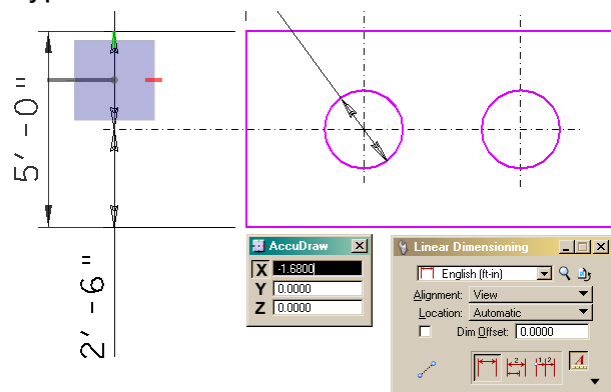
4.5.3. AccuSnap

AccuSnap not only makes drawing to specified key points more accurate, it releases the uses from the endless tentative clicks required in previous versions of MicroStation. Snapping is the ability to connect or snap to specified pints such as end points, center points, tangent or perpendicular points or almost any other possible geometric point in a drawing.   There is also the ability to allow MicroStation to toggle through multiple combinations of Snap points through defined Milti-snap modes.

In the screen shot here, a dimension is being placed from center to center of the circles. The snap mode is toggled to Center and when the MicroStation cursor is near the circle graphics, it automatically snaps to the center point as indicated by the yellow X and the circle with a blue dot symbol. Each snap mode has a different symbology to accompany the yellow X marks the spot indicator. In MicroStation V8i; holding down the Shift key and tentative snap will present the AccuSnap shortcut menu; there is also an AccuSnap tool bar and an AccuSnap selection button down at the bottom of the MicroStation application near the Lock icon.
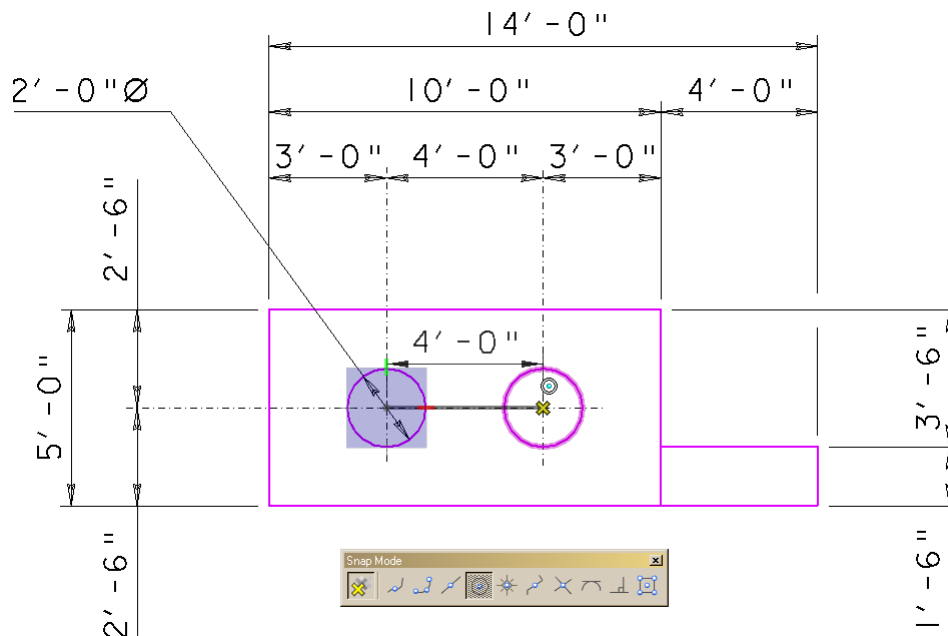

4.5.4. Shortcuts Menus

A quick way to access commands is to use the new right click shortcuts menus. MicroStation has always had right click shortcut menus but they have been greatly expanded. The menu is now Context Sensitive; it knows what elements are under the cursor and the menu changes accordingly. For example, if text is under the cursor, text editing tools are available; if dimensions are under the cursor; then, Dimension tools are available.   In particular, dimension modification tools are avaliable because there are existing dimensions under the cursor.
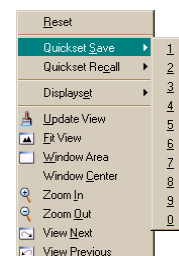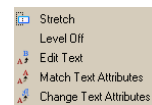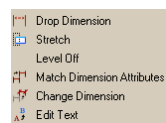
The user will get different menus for different keyboard combinations. Hold down the Shift key and right click presents the view manipulation and Quickset tools.

4.5.5. Annotation Scale

This tool set has already been referred to but we can expand on it here. Annotation Scale, by definition, is the Scale that the drawing will be plotted. We draw our drawings at 1:1 scale, and then adjust the annotation according to the intended plot scale. The standard text height is 0.14" on the full size plotted sheet. So if the drawing or details is to be plotted at ¼"=1'-0" then the text must be drawn at a height of 0.14"x48 or 6.72" so that on the plotted sheet the text measures 0.14". This topic is covered extensively in the VAOT CADD Standards and Procedure Manual.
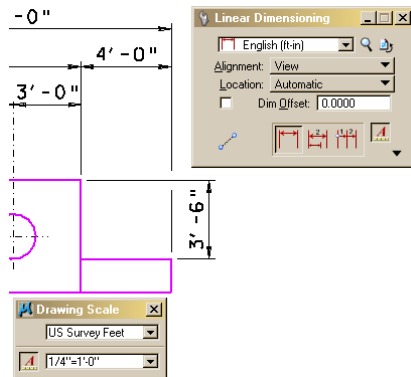
The Annotation Scale setting in MicroStation sets the multiplication factor for the text and dimension annotations. The annotation scale setting is a MicroStation lock that can be toggled ON or OFF as needed. Not using Annotation Scale automation inevitable lowers user productivity when detailing and dimensioning. It may seem easier not use it because it seems complicated; but it is very simple to use.

Shown to the right is annotation placed according to ¼"=1'-0" scale factor using the English DimStyle with no modifications. Note that the A toggle button is pushed in or ON. Changing the annotation scale factor to 1"-20' also changes the size of the Dimension Annotations as shown. The 3'-6" was placed using ¼" scale as shown above; the 5'-0" dimensions were place at 3/8" then ½" then ¾" scale. The text and dimension arrows get scaled accordingly with no change to the Dimension or Annotation standard settings as defined in the "English" dimension and Text Style.
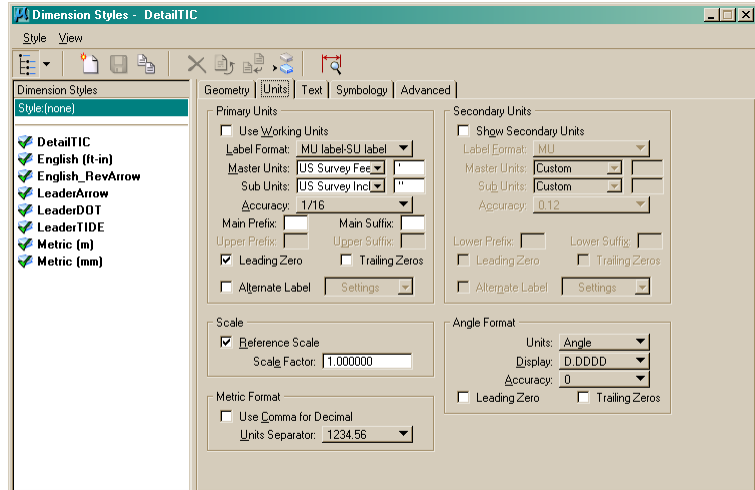
The Annotation scale of elements can be changed. The key-in "*ANNOTATIONSCALE CHANGE 48*" will change selected dimensions and annotations to the ¼'=1'-0" scale assuming they were not dropped. *If nothing is selected, all annotation objects in the drawing will be changed to the current or specified scale value!*
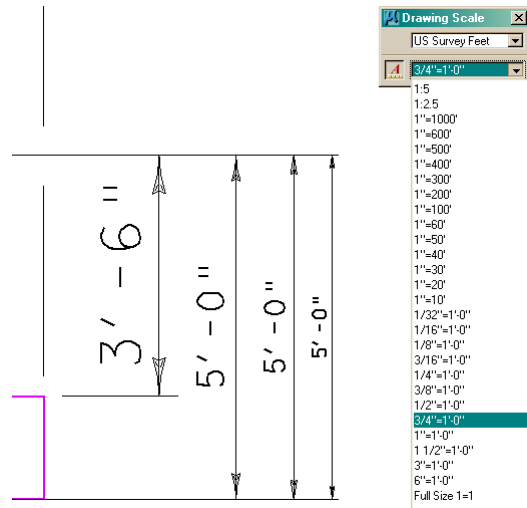
Dimensions can be moved using the standard MicroStation ⬈ modify element tool. This will slide the dimension value along the dimension line, even outside the extension lines when needed, if the text is selected. If the dimension line is selected it can be moved in or out as needed and the extension lines will follow.

4.5.6. Dimension Style

This subject was covered in the Dimensioning Section. This section will briefly show the dimension styles available and explain their use. The dialog shown to the right is the Dimension Style dialog box. Here all the Styles defined in the Agency Standard Library are shown. As the Style is used, it becomes part of the Design file it is being used in. If the dimension style is changed, it will show a Δ symbol next to the style indicating it has been modified. This is not uncommon; minor changes do take place for placement or accuracy of the dimension, but they can always be synchronized back to the library when ever needed. The users should, as a rule, never need to save changes made to the standard Styles shown here. Change and them use them, but do not save them. If a saved one is needed make a copy and save the copy. It will be saved in the current Design file. Changing and saving a style that originated from the library will work but it may be easily overwritten by clicking "Update from Library" button.

4.5.7. Text Style

This subject has been covered somewhat but this dialog shows the Text Styles defined in the Agency Standard Library. The English style and L140 are essentially the same but "English" matches up with the Dimension Style definition. Each "L" number represents text size in Mills or 1/1000 of an inch per the Leroy Text standard. These styles can be used in metric drawings as they will be converted by MicroStation to meter values. Text styles, once used are saved in the current design file. The Check mark indicates it is a used style. The L280 in this example was used for the details title text. It is not usually necessary to change the text styles, but if required, a copy should be made. These text styles have been set up according the Agency Standards for Engineering Plan set drawings. There are drawings such as Hearing Rolls and other non typical drawings that may require modified or different Text.