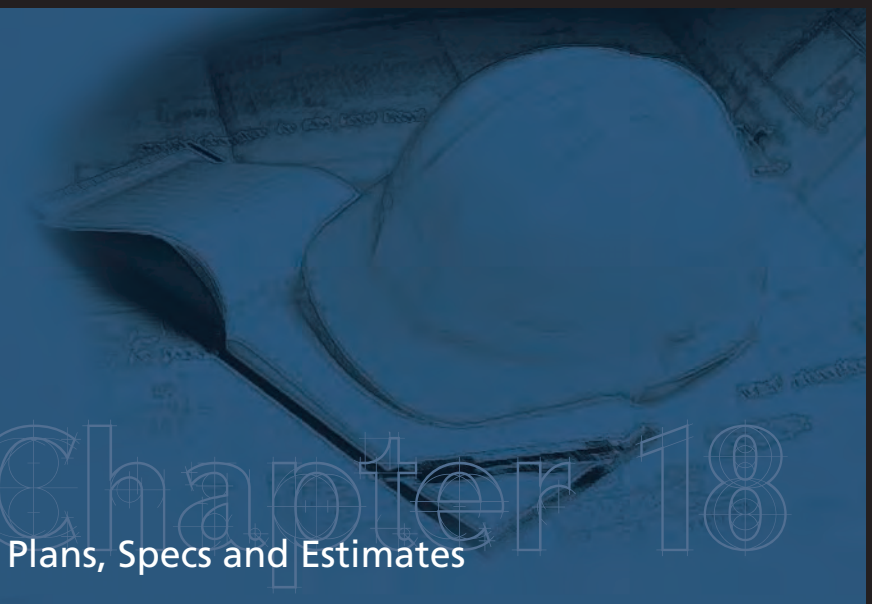
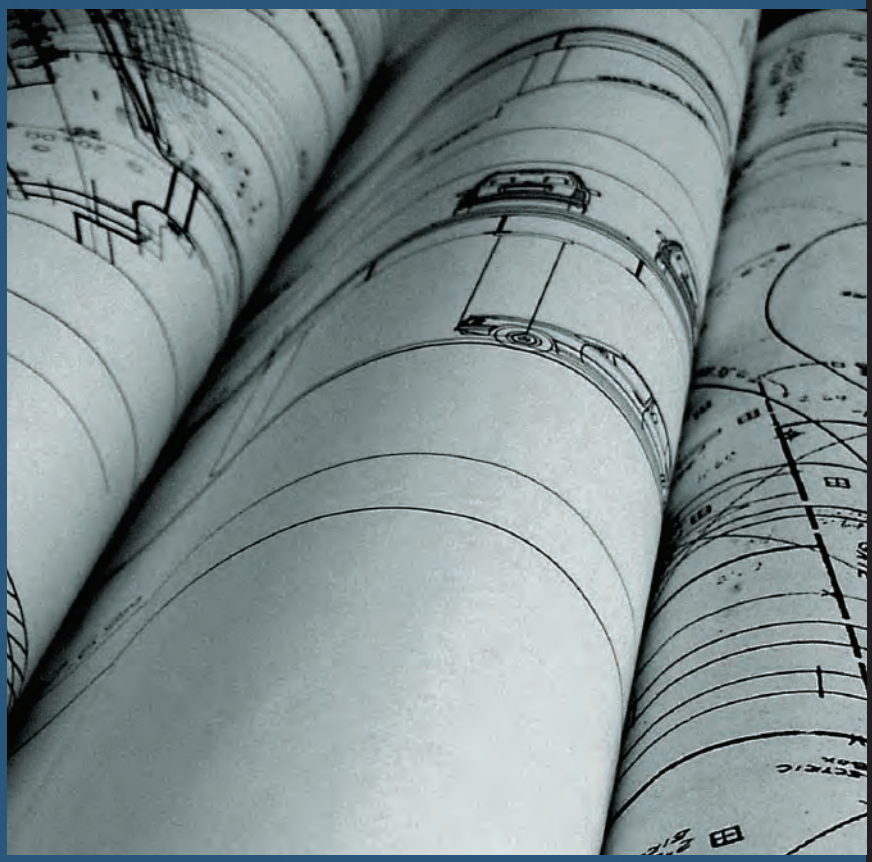


Chapter 18

Plans, Specs and Estimates



Chapter 18

Plans, Specifications, and Cost Estimates

18.1 Introduction

Plans are the documentation prepared to convey physical information so that designers, reviewers, and the public can understand both the existing conditions and the project. Plans also allow a contractor to construct the project and define the right-of-way available or to be acquired. This chapter describes the procedures for different types of plans associated with MassHighway projects.

Specifications define the materials and methods to be used by the contractor when constructing a project and are discussed. Standard specifications are used for most MassHighway projects; however, supplemental specifications are often prepared to alter the basic requirements for specific projects. This chapter describes the procedure for developing supplemental specifications, describes their format and content, and provides guidance on specific language to be used or avoided.

Estimates are prepared for project budgeting and to evaluate responses to project advertisements. Estimating procedures for MassHighway projects are also discussed.

18.2 Construction Plans

18.2.1 Base Plans

Base plans show all man-made and natural features located within the proposed project limits. Examples of such details as they would be shown on a plan are indicated in Exhibit 18-1. Base plans also show state, county, city, and town layouts, city/town lines, property lines, owners' names, deed references, land court case numbers and land court certificate number.

In addition to the plan symbols in Exhibit 18-1, base plans also use numerous abbreviations to convey information. Exhibit 18-2 lists some of the most commonly used abbreviations. Exhibit 18-3 shows an example base plan with symbols and abbreviations.

18.2.1.1 Survey Data

The MassHighway Survey Manual provides the Department's criteria and procedures for highway location and survey work, including the requirements for aerial photography, photogrammetry, and geodetic surveys. Surveys are collected with computerized "Total Station and Data Collector" survey equipment. The designer will be furnished digital base plan information for use in CADD systems. The designer should consult with the MassHighway Survey Section for more information.

Field Notes (Survey Books)

After the field survey is completed, the surveyor will compute and plot the alignment data, details, bench level notes, and cross-section notes. The surveyor will adjust all baseline data, traverses, and levels by the Department method and to the allowable limits of closure. The surveyor can use the method of weighted least squares, the compass rule, or the transit rule. However, the method of weighted least squares is the preferred method. All field notes should be checked. Any discrepancies which cannot be readily adjusted should be checked in the field. All survey books must have a plan number, date plotted, and the initials of the plotter. The initials are noted on a stamp on each page in the survey book.

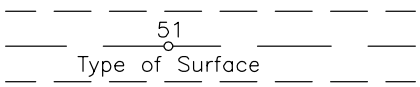
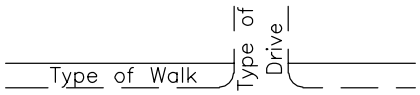
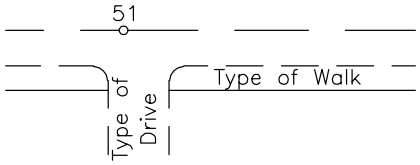
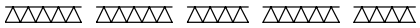
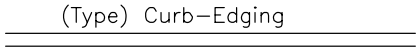
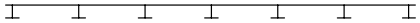
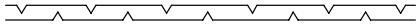
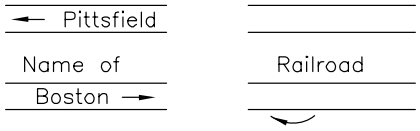
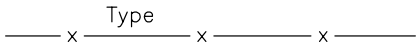
Aerial Surveys

The photogrammetric aerial surveys are required to be supplemented by field surveys. Field surveys supply critical elevations, utility details, surface types, property lines, etc., which are plotted on the photogrammetrics.

Cross-section Field Data

The surveyor should check the bench mark datum and transcription used in running a circuit of levels against the originally established references. Exhibit 18-4 illustrates a datum table. A field bench mark should be checked arithmetically. If it is correct, a red ink check mark should be made in the field book. All corrections should be noted with red ink directly above the original.

Exhibit 18-1
Plan Symbols

Roadway edges dash ¼" long	
Cement concrete walks and drives, solid line	
Walks and drives (bituminous concrete, gravel, dirt, etc.) Dash line ⅛" long	
Paved gutter	
Curbing, edging double solid line	
Wood guard rail steel beam guard, wood or steel posts	
Guard rail, steel posts	
Balanced stone wall	
Retaining wall	
Double faced wall	
Pointed wall	
Railroad or s-ree- railway -racks	
- nce	

Note: All symbols noted apply to existing details. They are similarly shown on base plans and construction tracings in black ink, unless otherwise noted.

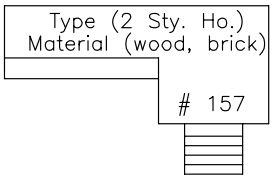
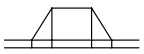
Source: MassHighway

Exhibit 18-1
Plan Symbols (continued)

Woods or Brush	Woods
Hedge	
Wetland	
Rock/ Ledge	
Utility pole: telephone, power	. o- pole & Type o -ili-
Guy pole	Guy (2' diame- r)
Light pole	(2' diame- r)
Trolley pole	(2' diame- r)
Trees	Diame- r & Type (- ale)
Proper- line, pencil i- approx.	Mark Approx: l- -pproxima-
S-a- boundary line	ame o -a
Coun- mmissioner's line (layou- i- r - n layou- line railroad sideline	ame o -a- . Comm., Ci- Town, or R.R. Layou- a-
City, town, or county boundary line	Name o- Town, Ci- r Coun- a- Name o- Town, Ci- r Coun- a-
State hwy. layout line: on mylar roll on construction plan	a- -l- ra-ion e- (Da -a- Highway Layou-
Stone bound	(2' Square) Type o- a- rial
Mass. highway bound	HB quare) Type o- a- rial
County bound	Co. Bd (2' Square) Type o- a- rial
Town or ci- bound	Town or City Bd. quare) Type of Material
Mass. -riangula-ion s-a-ion	Number (Each Leg 2')

Source: MassHighway

Exhibit 18-1
Plan Symbols
(continued)

Buildings, houses, etc.	
Drainage pipe	Size & Type of Material
Concrete box culvert	Width, Height Conc. Box Culvert
Underground Utilities	Name of Utility (Tel. & Tel. etc.)
Catch basin & curb inlet	CBCI (2' Each Side)
Manhole (Label type, i.e. sewer, drainage, etc.)	MH (2' Diameter)
Water gate	WG (1' Diameter)
Hydrant	Hyd. (2' Diameter)
Gas gate	GG (1' Diameter)
Catch basin	CB (2' Each Side)
Deep Sump Catch basin	DSCB (2' Each Side)
Leaching Basin	LB (2' Each Side)
Drop inlet	DI (Rectangle 4' x 2')
Concrete headwall (end) for culverts	Conc. Hdr 1' x Actual Length
Stone headwall (end) for culverts	Stone Hdr.
Wheelchair ramp	

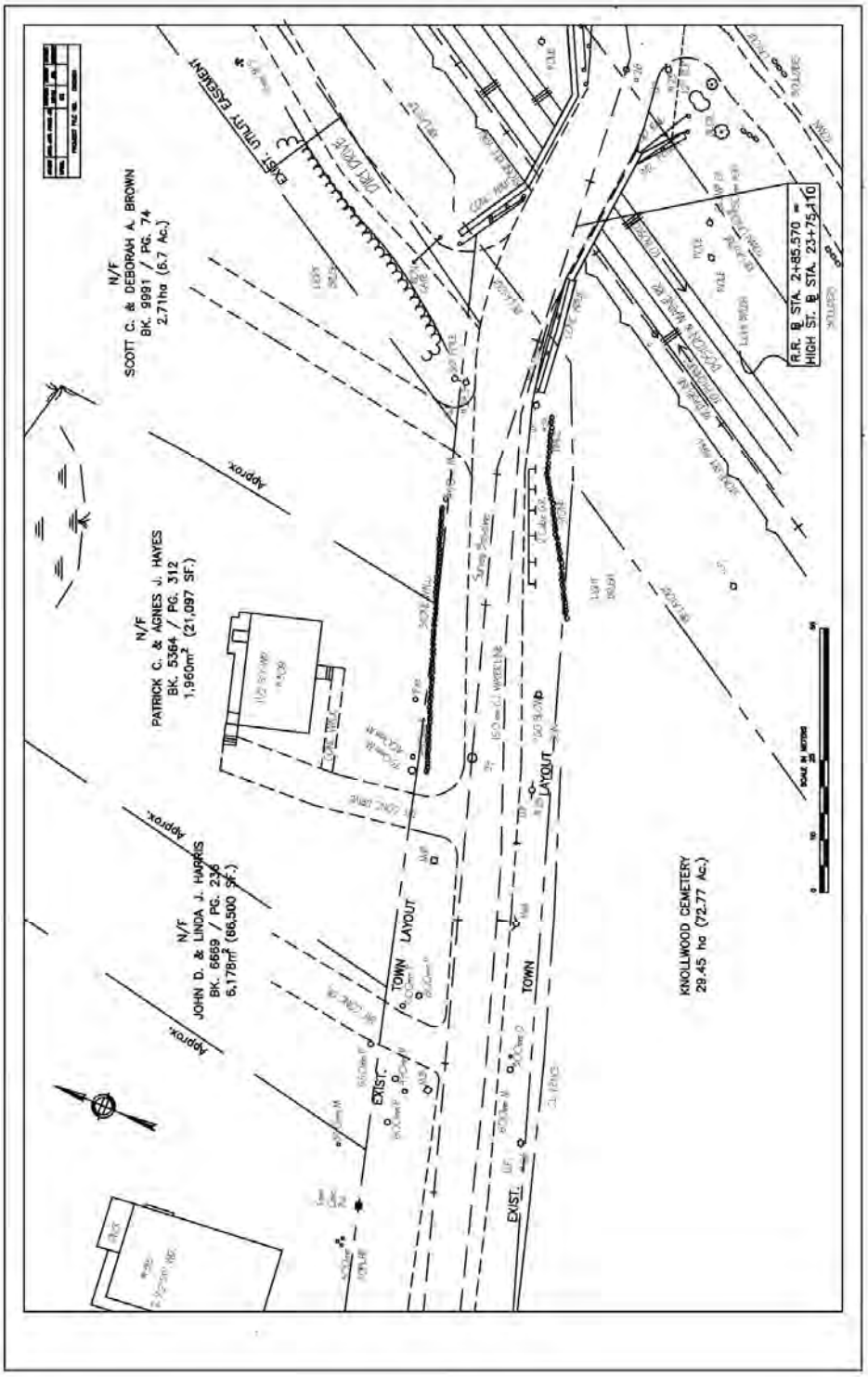
Source: MassHighway

Exhibit 18-2
Abbreviations

AADT	Annual Average Daily Traffic
ABAN	Abandon
A.C.	Asphaltic Concrete
ACCM PIPE	Asphalt Coated Corrugated Metal Pipe
APPR	Approach
BD.	Bound
BIT CONC	Bituminous Concrete
℄	Baseline
BLDG	Building
BMA	Bituminous Macadam
BM	Bench Mark
BO	By Others
BR.	Bridge
CB	Catch Basin
CBCI	Catch Basin With Curb Inlet
CC	Cement Concrete
CCM	Cement Concrete Masonry
CEM	Cement
CI	Curb Inlet
CIP	Cast Iron Pipe
CI.	Class (Concrete, Excavation, etc.)
℄	Center Line
℄ CONST.	Ceneterline of Construction
CMP	Corrugated Metal Pipe
CSP	Corrugated Steel Pipe
CO.	County
CO. BD.	County Bound
CONC	Concrete
CONST	Construct(ion)
CR GR	Crown Grade
CULV	Culvert
CM	Cubic Meter
D	Delta Angle (Central Angle o- Horiz. Curve)
Δ	Directional Percentage of DHV (Ti-le Shee-
DA	Drainage Area
DHV	Design Hourly Volume
DI	Drop Inlet
DIP	Ductile Iron Pipe
DR	Drive
E	External
EB	East Bound
ELEV (OR EL)	Elevation
EMB	Embankment
ENT	Entrance
EXC	Excavation
EXIST (OR EX.)	Existing
FAS	Federal–Aid Secondary
FL (OR ℉)	Flow Line
FLDSTN	Fieldstone
GAR	Garage
GD	Ground
GG	Gas Gate
CI	Gutter Inlet
GIP	Galvanized Iron Pipe
GRAV	Gravel
GRAN	Granite
GRD	Guard
HDW	Headwall
HI	Height of Instrument
HMA	Ho- ix Asphal-
HO	House
HOR	Horizontal
HYD	Hydrant
IT	Intersection of Slopes or Pro-ile Grade Lines
JCT	Junction
L	Length of Curve
LB	Leaching Basin
LP	Light Pole
LT	Left
MB	Mail Box
MED	Median
MH	Manhole
MHB	Massachusetts Highway Bound
NB	North Bound
NIC	Not In Contract
PVM'T	Pavement
PC	Point of Curvature
PCC	Point of Compound Curvature
PI	Point of Intersection
ℙ (OR PROP. LINE)	Property Line
POC	Point On Curve
POT	Point On Tangent
PRC	Point of Reverse Curvature
PROJ	Project
PROP	Proposed
PT	Point of Tangency
PVI	Point of Vertifcal Intersection
PVC	Point of Vertical Curvature
PVT	Point of Vertical Tangency
PWW	Paved Waterway
R	Radius of Curvature
PC	Reinforced Concrete
RD	Road
RDWY	Roadway
REM	Remove
RET	Retain
RET WALL	Retaining Wall
ROW	Right–of–Way
RR	Railroad
RT	Right
R/W	Right–of–Way
SB	Stone Bound
S.BD.	South Bound
SD	Subdrain
SEC	Section
SECTS	Sections (End sec-ions - r pipes)
SH	Sheet
SHLD	Shoulder
SK	Skew
SMH	Sewer Manhole
SM	Square Meter
ST	Street
STA	Station
SSD	Stopping Sight Distance
SURF	Surfacing or Surface
SW	Sidewalk
T	Tangent Distance of Curve/ Truck Percentage
TAN	Tangent
TEMP	Temporary
TP	Turning Point
TR	Top of Rail
TR SIG	Traffic Signal
TSC	Traffic Signal Conduit
V	Speed (usually Design Speed)
VAR	Variable
VC	Vertical Curve
VCP	Vitrified Clay Pipe
VERT	Vertical
WR	Wheelchair Ramp
WB	West Bound
WD	Wood
WG	Water Gate
WIP	Wrought Iron Pipe
WM	Water Meter/Water Main
X–SECT	Cross Section

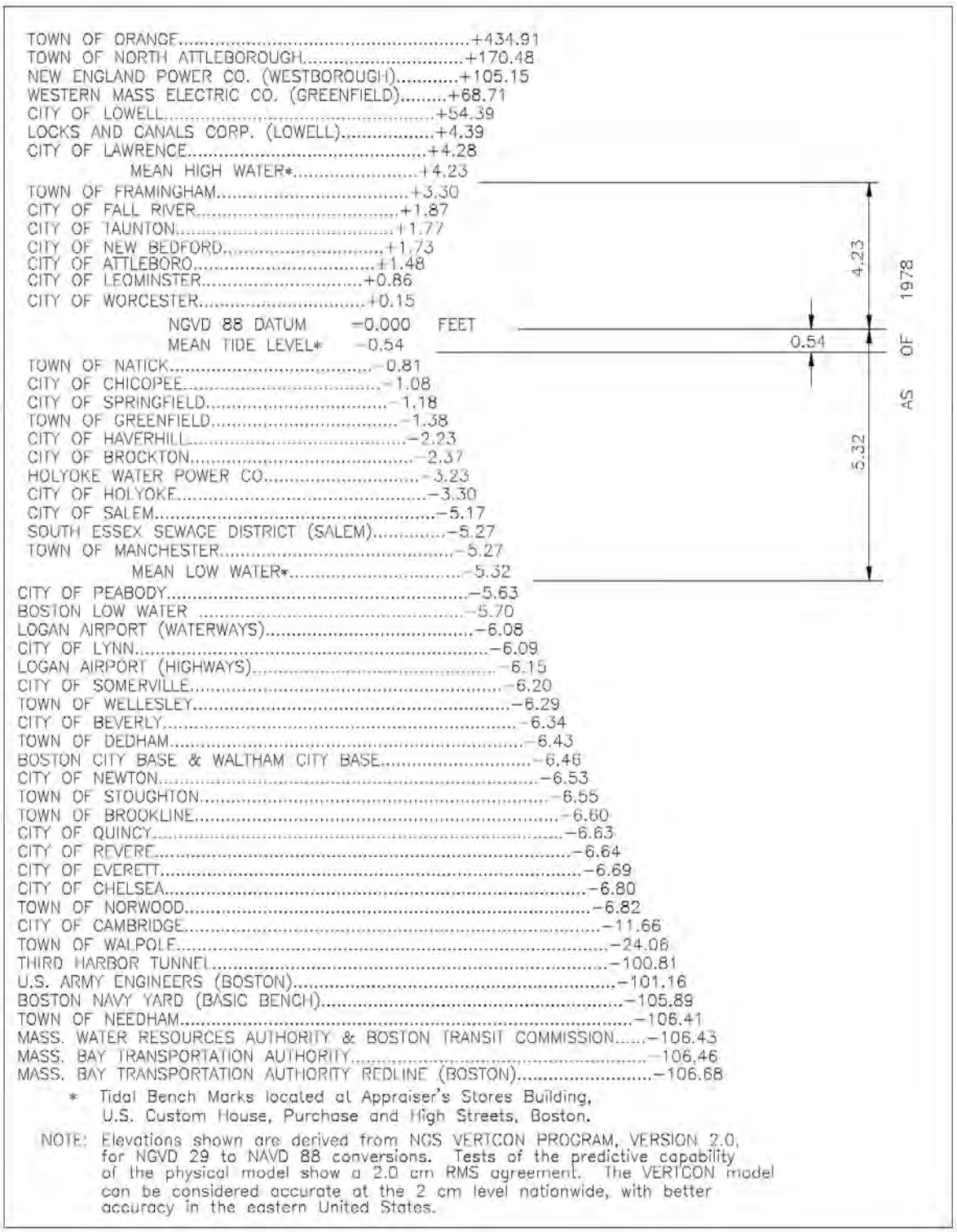
Source: MassHighway

Exhibit 18-3
Base Plan



Source: MassHighway

Exhibit 18-4
Relation of Datum Planes



Source: MassHighway

These instructions also apply to the survey cross-section data:

- The number of significant figures in the final computation will be determined by the degree of precision used in taking the rod readings.
- Check and underline the height of instrument (H.I.) in green ink. When an H.I. is adjusted, show the correction in green ink.
- Computed elevations should be shown directly under the rod readings with red ink.
- Green ink is used for checking and correcting office computations. A green check mark should be placed at the extreme right end of each line of elevations to indicate that they have been checked and corrected, if needed.
- The engineer's name and the date of calculations should be recorded at the end of each set of notes.

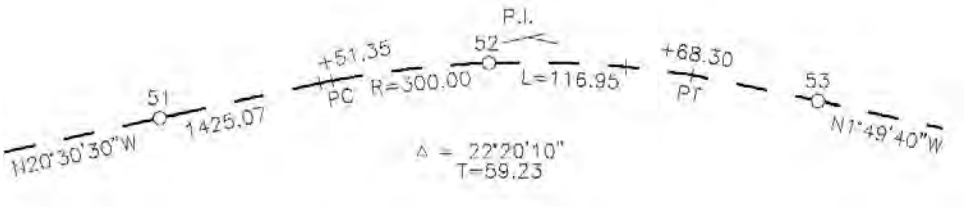
18.2.1.2 Plotting Base Plan

Base plans will be plotted on paper for review purposes. The following criteria will apply in plotting the base plan:

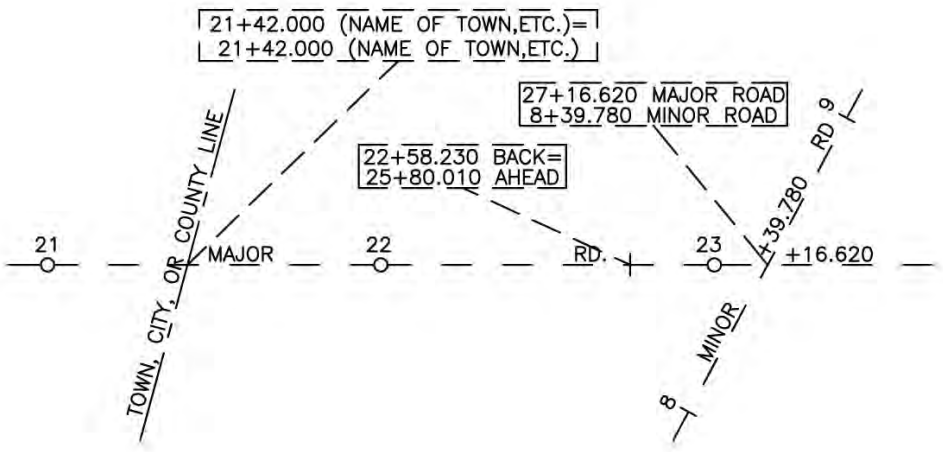
- Plans require a title.
- The baseline shall be stationed at 100 foot intervals (100 feet = 1 station) and can break where necessary, but there should be an overlap of 100 feet.
- Match lines should be plotted to indicate overlap sections.
- Plans should extend at least 100 feet beyond the anticipated beginning and end of the project, unless there is an intersection, major structure, or railroad crossing within 300 feet.
- All baselines and center lines are plotted by coordinates on the North American Datum 83 System as follows:

Scale	Size of Coordinate Squares
1″ = 20′	250′
1″ = 40′	500′
1″ = 100′	1250′

- Indicate coordinate points by intersecting 1-1/2 inch lines. Describe these by noting the coordinate values at each point.
- The baseline or center line is drawn as a dashed line, with the dashes about 1/2-inch long (see below). The 100-foot stations are indicated by small circles of 5/40-inch diameter, and the stations are noted above each circle with numerals 5/40-inch (L120) high with 4/40-inch ticks at 50-foot intervals. Points of curvature and tangency and angle points are marked with a short line intersecting the baseline at a right angle. The stations above the baseline or center line and the description of points (P.C., P.T.) below the baseline are 5/40-inch high. Bearings, length of tangents, curve number, and length and radii of curve are shown below the line. The remaining curve data (i.e., delta angle, length of curve tangent) are shown in a curve table or on the concave side of the curve if the curve data will not interfere with other plan details.



- An equation may occur where baselines intersect or at a change in station (see diagram below). This is usually offset from the point to which it refers and is enclosed by a rectangle to the point. If the plan detail requires the equation to be removed from the point, the equation may be placed on the intersection lines.



- Arrange the lettering so it can be read without turning the plan from its normal position (i.e., from bottom to top and from left to right).

18.2.1.3 Plotting Base Profiles

Basic profiles may be plotted on paper for review purposes. The following criteria apply:

- Scales of 1" = 20' horizontally and 1" = 4' vertically may be used.
- Scales of 1" = 40' horizontally and 1" = 8' vertically are usually used.
- The stations at the beginning and end of each profile will coincide with those of the corresponding plan. Stations to be at 100-foot intervals.
- The plan and profile may be shown on the same sheet.
- The horizontal profile scale shall be the same as the horizontal base plan scale when shown on the same sheet.
- The base elevation should be in multiples of 5 feet.
- A minus base value is indicated as "Base = Minus 10" and a zero base is shown "Base Zero."
- Bench marks with datum noted are described on the profile approximately above the corresponding station on the profile.
- Equations are noted below the datum line.
- Broken profiles are permissible, when the ground rises or falls rapidly, to keep the profile within the limits of the sheet. They should be overlapped 100 feet horizontally.

- Punchings in wetland areas are shown as a dashed line at the proper elevations and are designated "Approx. Hard Bottom."
- Culverts which cross the baseline are shown in section on the profile. The field book usually provides the elevation of the flow line (invert), elevation of the end (header), width and height of a square or rectangular box culvert, and diameter of a pipe. The dimensions describing the square and rectangular structures are the width of opening first and height of opening second.
- The clearance to the lowest wire of a high tension line will be shown on the profile. Plot the elevation of the lowest wire at the proper station location, and show this point as a heavy black ink dot. The number of wires, voltage, and clearance from the ground to the lowest wire will be indicated. The location of these wires is highlighted by a finger indicator next to it.
- Water levels are shown as a thin dashed line, and the elevation and date of measurement are noted.
- Sills of major structures are plotted at their respective elevations. A dimension facing the baselines is determined by projecting the extremities of the structure at right angles or radial to the baseline stations.
- Side streets should be shown on base profiles.

18.2.1.4 Cross-sections

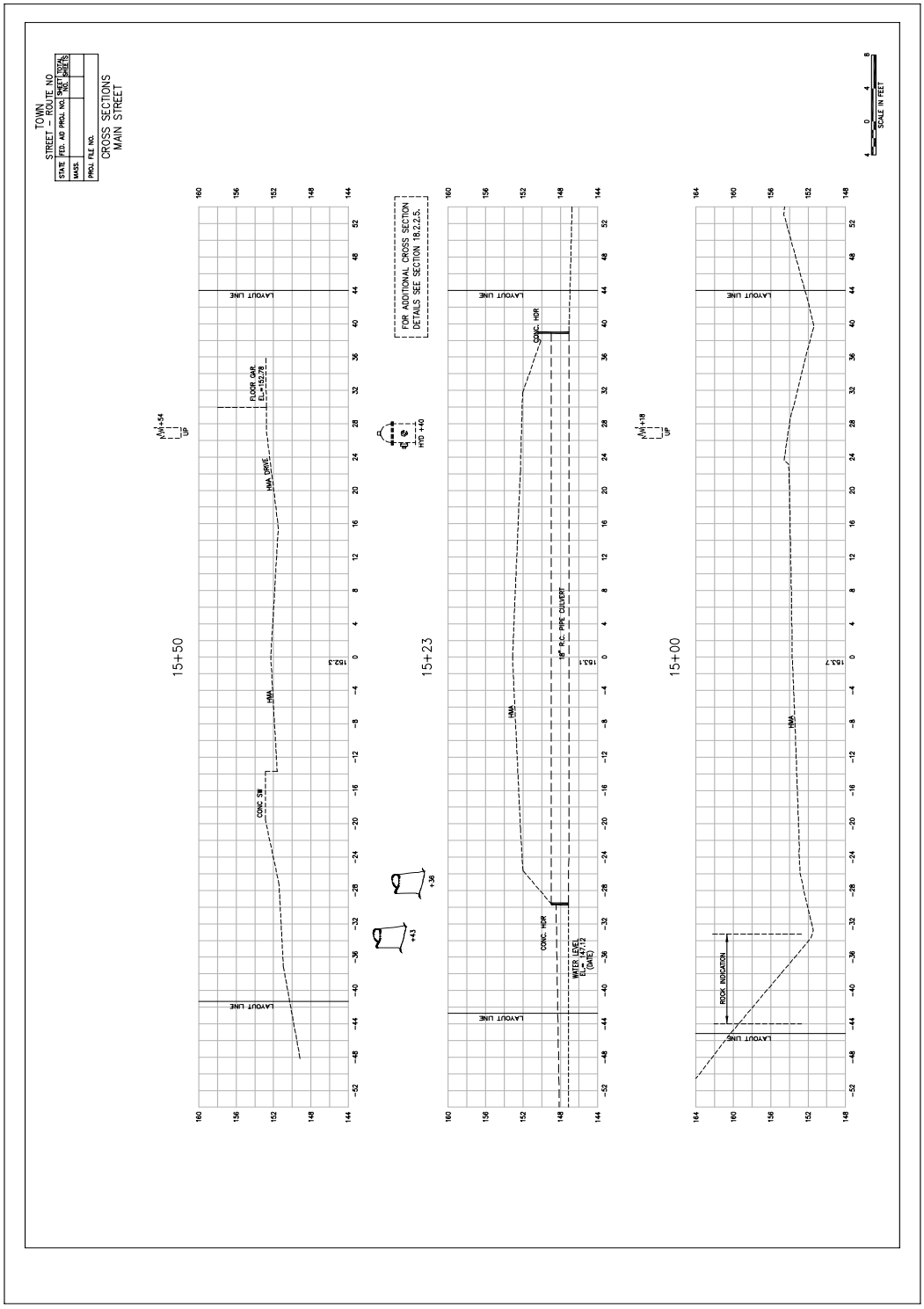
The sample sheet in Exhibit 18-5 shows the method of plotting existing ground sections and title block. Symbols for cross-sections are illustrated in Exhibit 18-6. The data for plotting sections is either obtained from field books, survey data collectors (digital terrain modules) or by interpolating from photogrammetric maps and contour plans. These last two methods are described in Section 18.2.1.1.

The following criteria apply for plotting cross-sections:

- The usual scale for cross-sections is 1″ = 4′ horizontally and vertically. However, on multilane divided highways, a scale of 1″ = 8′ is more practical. The selection of the proper scale depends on the width of the cross-section.
- Cross-sections shall be plotted at 50-foot intervals and at critical points, such as superelevation transition points, intersecting streets, driveways, etc..

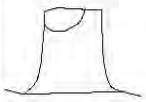
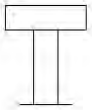
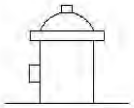
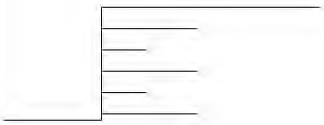
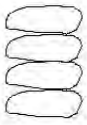
- Cross-sections are normally plotted along the length of the cross-section sheet. The stations of cross-sections increase from the bottom to the top of the sheet. The cross-sections of very narrow roads may be plotted across the width of the sheet.
- Existing ground line should be plotted as a thin dashed line.
- Sufficient space between cross-sections should be provided so that the proposed highway template can be drawn without overlapping the adjoining section. To determine spacing, refer to the tentative grade line furnished by the designer. Additional space allowances may be needed if punchings or soundings are shown.

Exhibit 18-5
Sample Existing Ground Cross-sections



Source: MassHighway

Exhibit 18-6
Symbols for Detailing Sections

Tree (8" and over)	 Diameter & Type Station Offset
Pole	 Type of Utility Pole, Number Station
Mail box	 Mail Box Station
Well — cesspool	
Hydrant	 Hydrant Station
Sill of structure (when plotted)	Sill of (Type of Structure) EL. = _____ HO#
Sill of structure (when beyond limits of sheet)	Offset = _____ Sill of (Type of Structure) EL. = _____ HO#
Retaining wall	
Balanced wall	
Punching	Approx. Hard Bottom

Source: MassHighway

- A complete cross-section must be shown on one sheet for estimating and continuity. This practice should be followed even if space is wasted.
- Equations of stations are shown whether or not a cross-section is drawn at that point.
- Profiles of intersecting streets, drives, roads, etc., are plotted in the sequence of the base or center line stationing. The reference baseline for intersecting streets, drives, walks, and steps may be offset from the regular cross-section to allow more room for plotting the profiles. When streets, drives, and roads are indicated by stations along their profile, only the main baseline station is shown rather than an equation.
- Often, the width of the cross-section extends beyond the limits of the sheet. Extensions may be indicated by noting the next offset and elevation near the margin slightly above the cross-section.
- Plus and minus cross-sections are plotted as one section. The plus and minus are indicated on the cross-section lines. "Minus" always indicates the section back and "Plus" the section ahead.
- The cross-section limit should not be extended beyond the border of the sheet, and the data in the title box must be provided.

The following features should be shown on the preliminary cross-sections:

- Edges of roads, drives, walks, steps, wetlands, lawns, etc., should be plotted.
- Walls should be plotted.
- Hydrants, poles, and mailboxes are plotted by station and offset.
- All trees 8 inches and over should be plotted. The diameter and type of tree, station and offset should be noted on the side of the tree away from the baseline or center line.
- Punchings are shown as a dashed line and labeled "Approx. Hard Bottom."
- Indicate elevation, station, and description of wells, cesspools and septic systems, and provide a description and elevation for sills of buildings. Plot sill elevation and offset to proper dimension, scaling offset from the plan when not shown in notes. Sills which fall between cross-sections are shown by a vertical line at the correct distance from the baseline. The elevations are printed away from the baseline.

- Culverts are shown as long dashed lines. (Dimensions in a field survey book indicate width first and height second.)
- Water elevations are shown as a dashed line. The elevation and date recorded are noted.
- The limit of rock excavation are indicated as shown in Exhibit 18-5 and labeled "Rock Indication". To avoid interference with the proposed roadway cross-section, the notation will appear either above or below the section, depending upon the type of earthwork involved.
- Lines of bridge seats or tops of openings are shown as long dashed lines.
- Rails are shown as a "T" with the horizontal line representing the elevation of top of rail. Indicate the elevation of the top of rail nearest the baseline for rails which run parallel to the main baseline. The elevation is printed vertically.
- Descriptions (type of surface, etc.) are shown on the bottom and top cross-sections only if the description applies to all cross-sections on the sheet (see Exhibit 18-5).
- A Federal-aid block including a project file number must be shown.

18.2.2 Final Plans

18.2.2.1 Drafting Standards for Construction Plans and Cross-sections

The plans shall include all drawings and data necessary for proper construction of the proposed project. The plans will be plotted on the standard size translucent mylar (4 mil) matted on at least one side. Minimum height of all lettering is 1/8 inch. The density of screened mylars may be approved on a project-by-project basis. Exhibit 18-7 provides an example of the Standard Drawing Sheet.

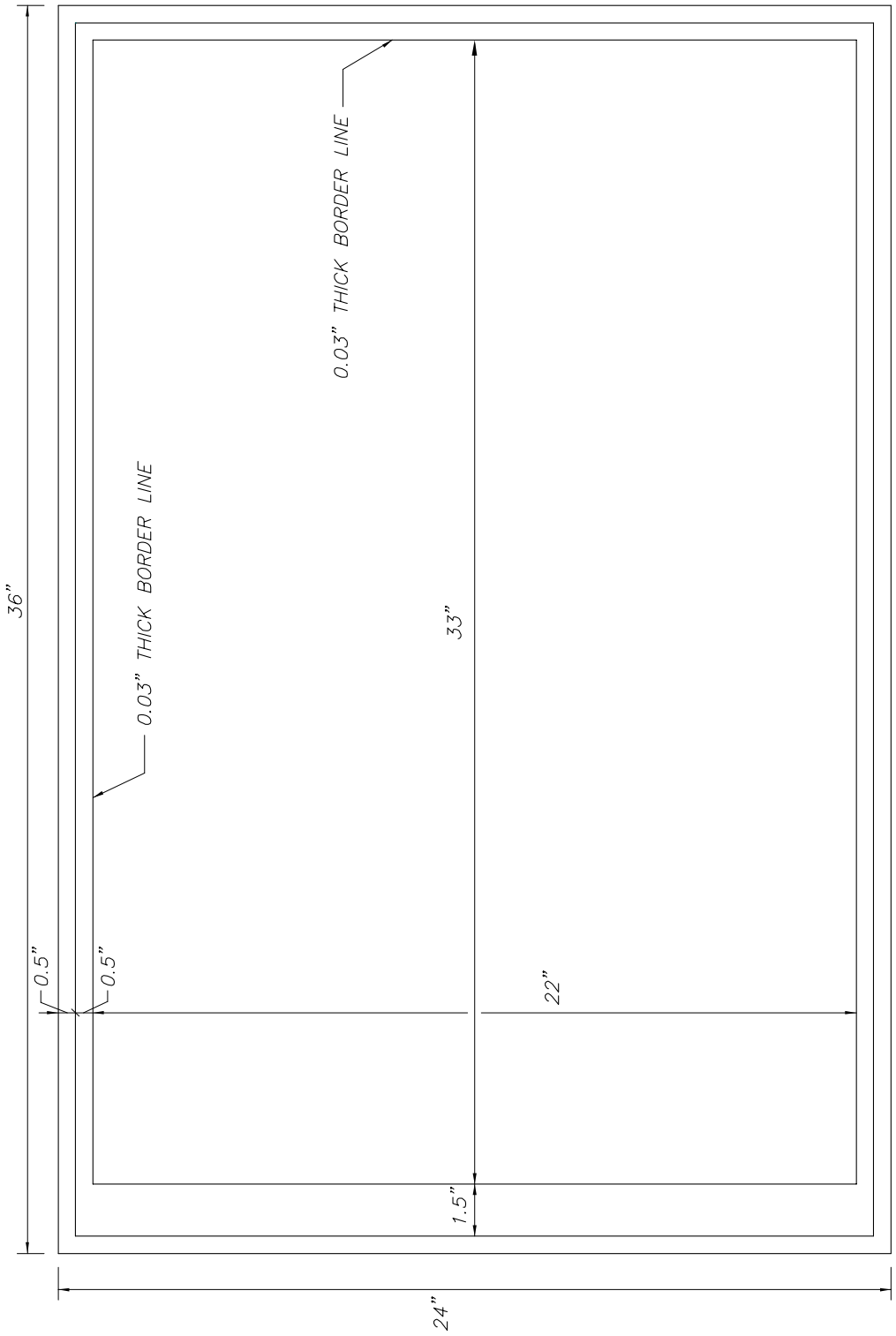
These drafting procedures will ensure archival original quality drawings. It is absolutely necessary to produce drawings with uniform density of line work.

The lettering line thickness shall not be less than .017 inch.

18.2.2.2 Construction Plans

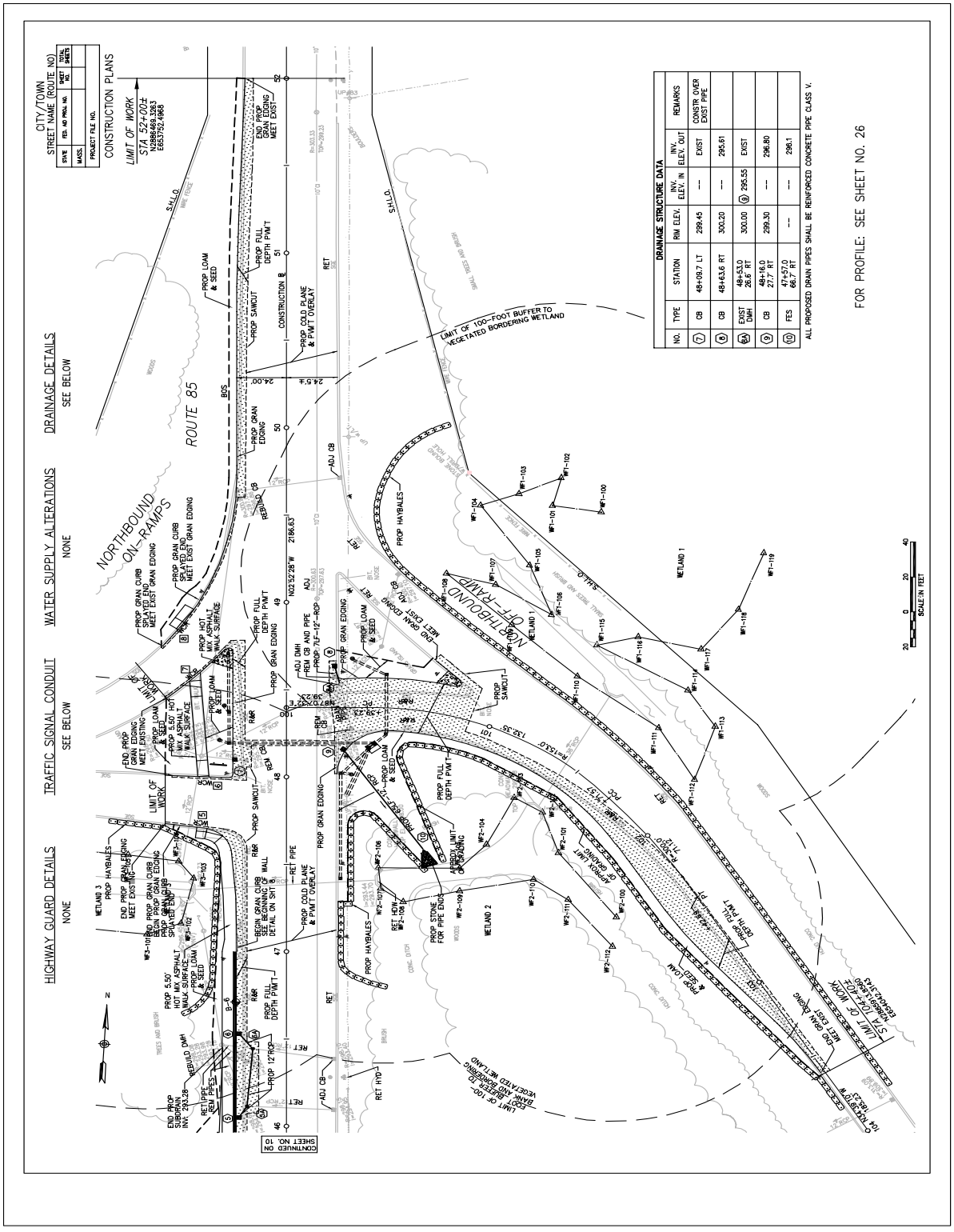
Exhibit 18-8 provides an example of a plan view. Exhibit 18-9 illustrates the necessary data for construction plans. Design symbols are illustrated in Exhibit 18-10.

Exhibit 18-7
Sample of Standard Drawing Sheet



Source: MassHighway

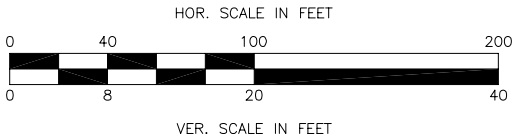
Exhibit 18-8
Sample Construction Plan



Source: MassHighway

Exhibit 18-9
Data for Construction Plans

STANDARD BARSCALE



FEDERAL AID BLOCK

STATE	FED.PROJ. AID NO.	SHEET NO.	TOTAL SHEETS
MASS.			
PROJ. FILE NO.			

(ACTUAL SIZE)

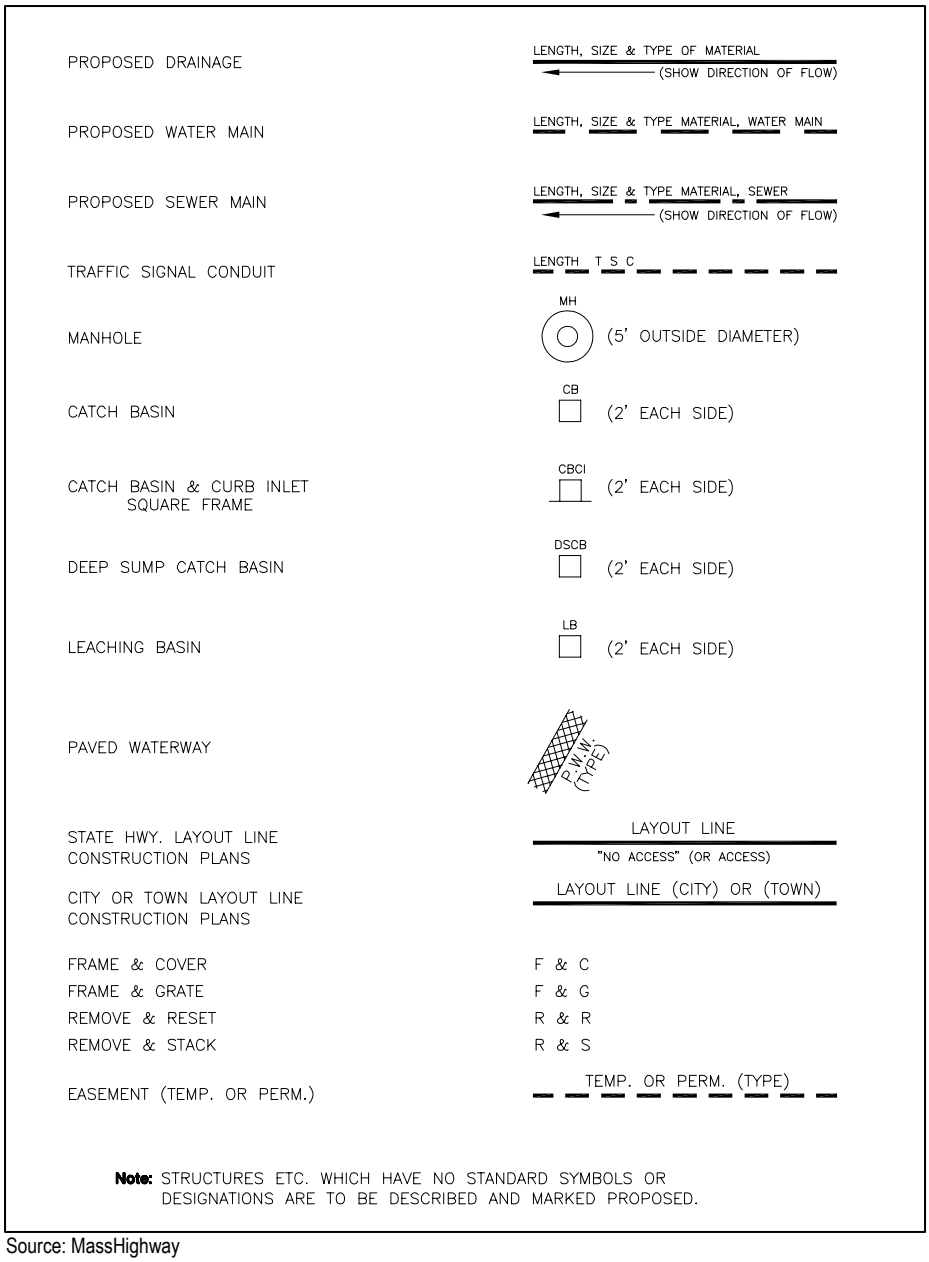
STANDARD NORTH ARROWS

TRUE NORTH OR MASS. CO-ORD SYSTEM

MAGNETIC NORTH OR ASSUMED

Source: MassHighway

Exhibit 18-10
Symbol for Proposed Design



Source: MassHighway

When preparing construction plans, the following apply:

- Existing detail information should be screened for clarity.
- Construction plans are normally drawn at a scale of 1" = 20'. Plans at a scale of 1" = 40' may be approved on a project to project basis.

- The corresponding profile is placed below the plan. If there is too much detail, the profile should be placed on a separate sheet.
- For 40-scale plans, each succeeding plan is overlapped 100 feet and the plan information will extend a minimum of 150 feet beyond the beginning and end of the project. When 20 scale plans are used, the overlap may be reduced to 50 feet. Match lines should be plotted to indicate overlap sections.
- P.I.s of curve tangents are not shown on final plans.
- The proposed center line and record baseline are shown, stationed at 100-foot intervals.
- If there is a portion of a curve or tangent at either end of a plan more than 100 feet in length, indicate the curve data or bearing and distance.
- Show the State Highway, City, Town, or County layout as shown in Exhibit 18-1. Do not show the radii, ties, etc., of layout lines. Show the beginning and end of the state highway layout, alterations of the layout, and the year recorded.
- When the plan and profile are on the same sheet, the town, city, county, and state names are shown only on the plan portion. If on separate sheets, this data must be shown on each sheet.
- Show a north arrow on all plan sheets. The direction of the north arrow can be determined from the coordinates.
- The stations and coordinates for the beginning and end of project are shown where appropriate.
- Plans showing at-grade intersections should be drawn in a manner that provides the greatest amount of continuity and the least amount of repetition.
- Bar scales will be shown on all construction plans.
- Construction plans which show only the roadway drawings must have profile sheet number references in the lower right edge of the sheet (inside the border). When the continuity of streets or ramps is broken, a sheet number reference should be noted at the breaks.
- Denote the beginning and end of the project and the limit of work. Indicate the project number, associated stations, and coordinates. The beginning of a project is the southerly or westerly end; the end of a project is the northerly or easterly extremity, regardless of the direction of the line stationing and center line.

- Proposed state highway location lines are drawn as solid lines labeled "Proposed State Highway Location Line." Town, city, or county locations are drawn as solid lines labeled " Proposed Location Line (town, city, or county)."
- Easement lines are drawn as long dash lines and labeled drainage, slope, or construction easement, as appropriate. Designate whether the easement line is temporary or permanent.
- Names of property owners are noted in the proper locations.

The following criteria apply to the presentation of the technical content in construction plans:

- **Sight Distance –** Horizontal sight distances shall be noted on the plans in the vicinity of the horizontal curve or in the curve table.
- **Roadway Widths –** All proposed roadway edges will be heavy solid lines. The widths are indicated at the beginning and end of each sheet and at all other points where a change in width occurs. The offset from the center line at all of these points should be shown. All curved edges that are not concentric with the center line of construction should have the radius and any other data noted. All points of curvature and the tangency at the edge should be noted with ties to the center line.
- **Center Line –** A construction center line will be used as the baseline for proposed projects. The proposed center line shall be stationed and labeled with appropriate geometric data. Coordinates in NAD 83 shall be shown at the project limits along with ties to known reference points as appropriate to establish this new line in the field. It is critical that the Record Baseline is also shown within the plan set. The Record Baseline is a historical reference and is necessary to establish reference in the field. It is also the reference used for all Right of Way work.
- **Drives, Sidewalks, Walks –** Proposed edges of drives, sidewalks and walks to houses are drawn as heavy solid lines. The radii of drive curb returns are noted; other curve data is not necessary unless there is a wheelchair ramp (see below). The type of structure should be noted with the abbreviation "PROP" (proposed) before the description. The minimum width of sidewalks and walkways is necessary. Slopes and cross slopes of sidewalks and pedestrian paths should be detailed.

- **Wheel Chair Ramps –** Wheel chair ramps must be drawn as heavy solid lines. A separate sheet listing critical dimensions including ramp length, design slope, curb transition lengths, gutter slopes and level landings must be shown.
- **Edging, Curbing, Berms –** The types of edging, curbing, and berms are shown without indicating lengths. Extremities of each type will be defined by arrows or similar notations. The abbreviation "PROP" (proposed) will appear before the description.
- **Drainage –** The words "DRAINAGE DETAILS" with location reference such as "SEE BELOW" or "SEE PAGE NO. ___" will be placed on the upper part of the sheet near the border. The above is noted whether or not drainage is required in the area shown on the sheet. Where there is no proposed drainage required, the word "NONE" is substituted for the location reference. The proposed drainage details, such as pipe, catch basins, manholes, detention basins, drainage swales, etc., are shown directly on the roadway plan with heavy solid lines so the proposed detail will be easily distinguished from the existing. Where there is a considerable amount of detail on the plan that may obscure the proposed drainage, a separate plan showing the proposed drainage details is recommended. Any water supply alterations and other underground utility data should also be shown on the separate plan.

The length, size, direction of flow, and type of material will be noted at each pipe. Special drainage structures must be noted; the abbreviation "PROP" is not necessary before the description. The stations of the drainage structures are also noted. Details of all special drainage structures will be shown on a separate sheet. The type of material used for culvert ends will be noted at each end. To indicate which pipes or structures of the existing drainage system will be incorporated in the new system, the proper notations will be made, such as "RET" (retain),"ADJ " (adjust),"R&R" (remove & reset), "ABAN" (abandon), "REM" (remove), etc.

- **Ditches –** Ditches that are not part of the normal section are shown by two heavy broken lines. Note the appropriate payment item. The distance between the lines represents the width of the bottom of the ditch to scale. The abbreviation "PROP" is part of the description.

- **Paved Waterways –** The type is identified and the abbreviation "PROP PWW." is required. Paved waterways are drawn as heavy lines and cross-hatched with its description shown.
- **Sub-Drains** – These are shown as heavy solid lines with their length and diameter of pipe; for example: " 300’ – 8” SUBDRAIN." The abbreviation "PROP" is required. When a grade line is broken, the designer should indicate the direction of flow.
- **Relocation of Streams** – The relocation of brooks, rivers, or other waterways is shown as a solid line. The lines defining the new location will be designated by crosshatching. Plans should indicate whether this change is temporary or permanent.
- **Water Supply** – The words "WATER SUPPLY ALTERATIONS," with a location reference such as "SEE BELOW" will be placed on the upper part of the sheet near the border. This is only noted when water supply changes are required in the area shown on the sheet. Plans should also note what type of water supply is within the area, including boundaries of Zone A, Zone 1, and Zone 2. Where the proposed water supply system may be obscured by existing detail, a separate plan is recommended. This should be combined with the proposed drainage details as discussed previously under the “Drainage” bullet. Heavy, solid lines designate any proposed water pipe. The length, size, type of material, direction of flow, and bends must be noted. Other details include hydrants, gates, etc. The abbreviation "PROP" is required before the description. The description will include any special materials such as insulation, etc.
- **Traffic Signal Conduit** – The words "TRAFFIC SIGNAL CONDUIT," with a location reference such as "SEE BELOW," will be placed on the upper part of the sheet near the border. This is only noted when a traffic signal conduit is required in the area shown on the sheet. The conduit is indicated with a short, heavy, dashed line (about 1/4 -inch long). Complex traffic signal installations should be shown on a separate plan.
- **Utility Relocation** - The proposed relocation of utilities such as utility poles, underground utility conduit, gas lines, etc., are shown directly on the roadway plan with heavy solid lines so the proposed detail will be easily distinguished from the existing facilities. Where there is a considerable amount of information on the plan that may obscure the proposed utility, a separate plan showing the proposed utility information is recommended. The symbols for the utilities

are shown in Exhibit 18-1. The overhead wire is indicated with a long dashed line with "OHW" noted on each length. Underground conduit is shown as two parallel short dashed lines with the type of conduit marked on each span. All utility structures (both existing and proposed) must be noted. The abbreviation "PROP" is necessary before the description. Proposed work that is not performed by the MHD Contractor, but which is performed within the project limits either by or for a utility company, shall be clearly labeled "(type of work) BY OTHERS." To indicate the utilities in the existing utility system that will be incorporated into the new system, but not relocated, the proper notations must be made, such as "RET" (retain), "ADJ" (adjust), "ABAN" (abandon), "REM" (remove), etc.,

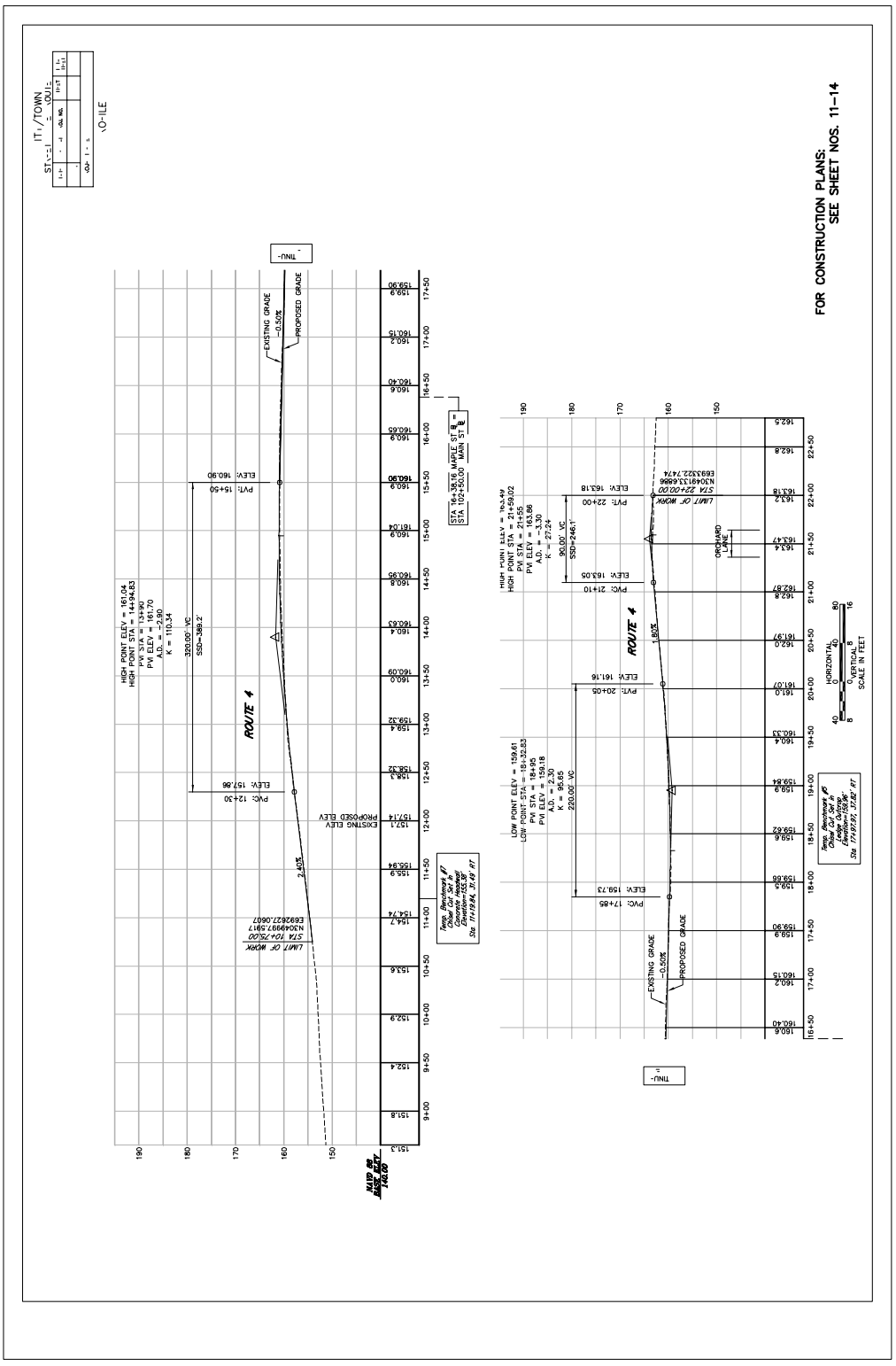
- **Demolition –** Buildings that will be demolished are designated with cross-hatching and marked "STRUCTURE NO. ___." (Insert number shown on the demolition report or detail sheet).
- **Bridges –** The outlines of all bridges will be shown on the construction plans. The bridge number will be placed as close to the bridge as possible.
- **Special Sloped Paving –** The area where special sloped paving is placed, such as on the slopes at open-end span bridges, should be indicated as "SPECIAL SLOPED PAVING."
- **Highway Guard –** The words "HIGHWAY GUARD DETAILS" with locations references such as "SEE BELOW" or the type and station of guardrail will be tabulated in the upper part of the sheet near the border. The above is noted whether or not highway guard is required in the area shown on the sheet. Where there is no proposed highway guard required, the word "NONE" is substituted for the location referenced. If the proposed highway guard does not obscure the detail than it can be drawn on the plan.
- **Slopes –** Tops and bottoms of slopes are shown as dashed lines and marked "TOS (Prop. Top of Slope)" or "BOS (Prop. Bottom of Slope)."
- **Fences –** Proposed fences are not indicated on the construction plans. However, they must be listed on the "Detail Sheets."
- **Work by Others –** Work that is not performed by the MassHighway contractor but which is performed within the project limits either by or for a utility company or for other construction work, shall be clearly labeled " (type of work) BY OTHERS."

18.2.2.3 Construction Profiles

Exhibit 18-11 provides an example of a construction profile on the sheet. The following criteria shall apply:

- The method of presenting the data on the profile sheet is similar to that used on base plans. The base elevation (datum) need only be shown once to the left of the profile, unless the profile is broken.
- When the profile is shown on the same sheet as the plan view, the length of the profile should be the same length in stations as the baseline of the plan, to the extent possible. When the profile is on a separate sheet, the length shown must be the same as the length of the corresponding plan in stations. An overlap of 100 feet is required for each profile.
- Horizontal and vertical bar scales will be shown on construction profiles.
- The proposed profile lines are drawn as heavy solid lines.
- The proposed elevations are labeled to the right of the respective upright as shown in Exhibit 18-11. The proposed elevation labels are darker than the existing elevation labels, which are to the left of their respective uprights.

Exhibit 18-11
Sample Roadway Profile



Source: MassHighway

- The rates of grade, points of curvature and tangency, and vertical curve data (length of curve, K value, PVI station and elevation, etc.) must be labeled as shown in Exhibit 18-11.
- The proposed outline of each bridge and its bridge number is traced from the profile shown on the first sheet of the bridge plans.
- The calculated lengths of vertical curve sight distances are labeled and described as "(distance in feet) SSD."
- Sheets that show only profiles will have their corresponding plan sheet number placed on the lower right edge of the sheet inside the border.
- The beginning and end of the project will be shown and the project number, stations, and coordinates indicated.
- Profiles should extend a minimum of 50 feet beyond the beginning and end of the project.

18.2.2.4 Grading and Tie Plans

Grading plans and tie plans (Exhibit 18-12) are required for all ramp and major at-grade intersections. They are also required on projects where roadway widening and resurfacing results in horizontal realignment (crown line shift) of the roadway. Grading and tie plans may also be required to locate wheelchair ramps and drainage ditches. These criteria apply:

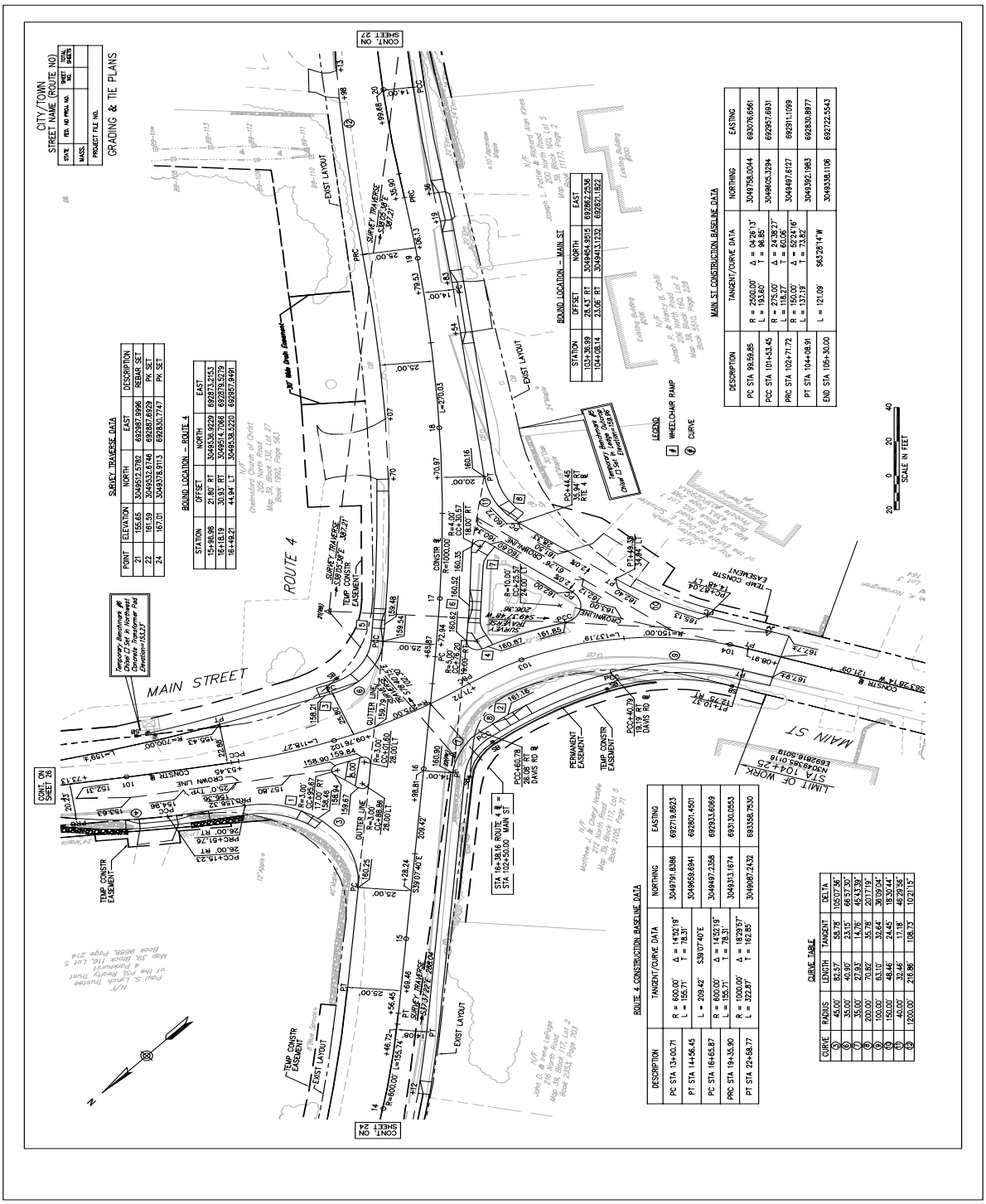
- The elevation will be computed along each roadway edge at 50-foot intervals and at other intermediate points where required. The edge profiles for the grading plan are normally plotted to a scale of 1” = 40’ horizontally and 1” = 8’ vertically.
- Ties will be computed and shown on the plans (at P.C., P.T., etc.) to properly locate the roadway edge in the field.
- Contour plans may be required for special grading areas (drainage, landscaping, aesthetics, etc.).

18.2.2.5 Construction Cross-sections

Exhibit 18-13 provides an example of the construction cross-section. The following criteria apply:

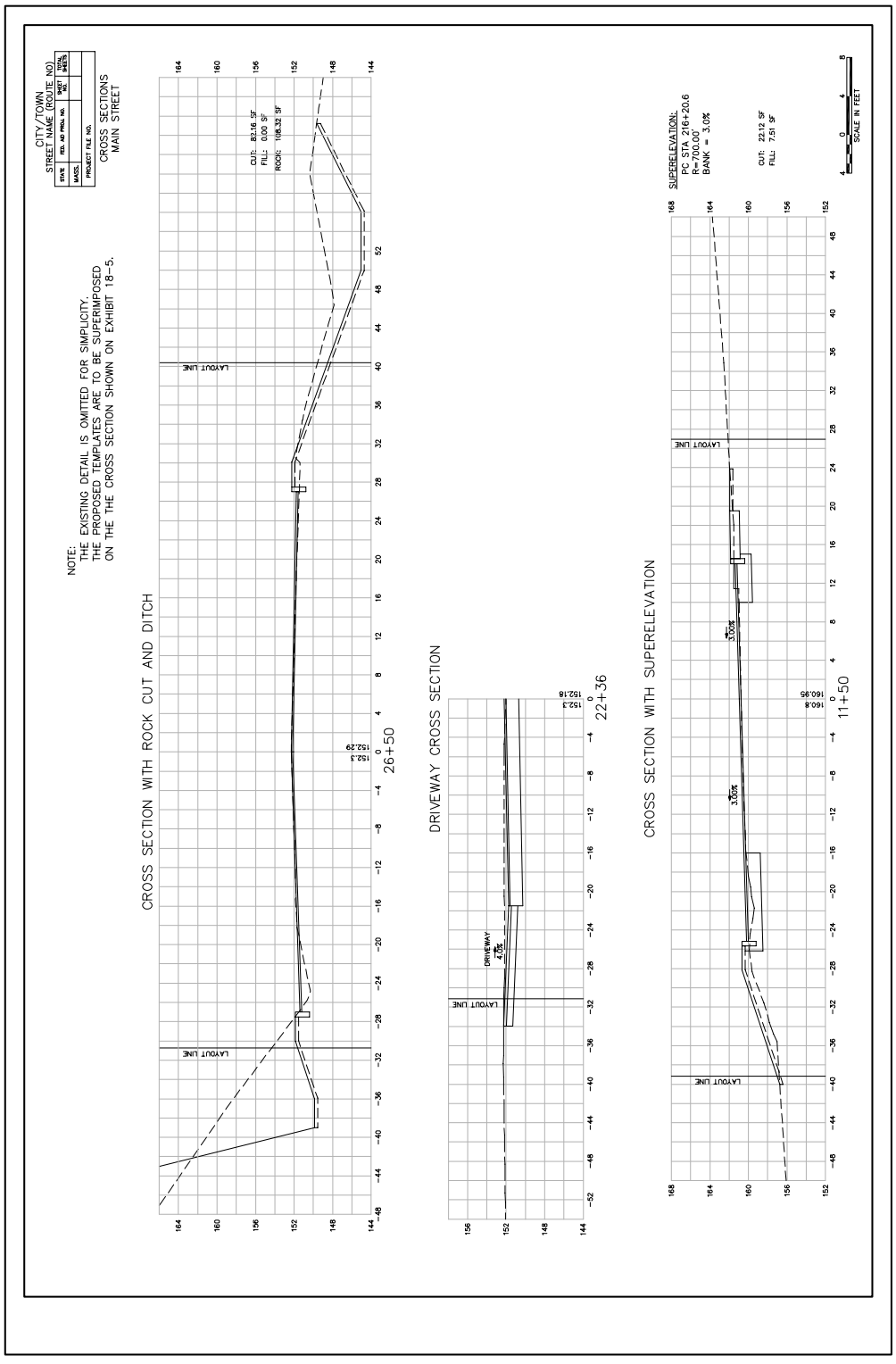
The proposed roadway cross-sections are on the cross-section sheets described in Section 18.2.1.4. The proposed roadway cross-sections are to be plotted as a thick, dark lines.

Exhibit 18-12
Sample Grading & Tie Plan



Source: MassHighway

Exhibit 18-13
Sample Finished Ground Cross-section



Source: MassHighway

- The proposed profile elevation shall be noted on each roadway cross-section. On a banked curve or a curve transition, the theoretical profile elevation is noted on the left side of the profile grade line, and the actual elevation is noted on the right side of the profile grade line (with "actual" noted in parentheses). Show actual edge elevations for banked curves and curve transitions.
- Rate of bank and the P.C. or P.S. and P.T. stations of the horizontal curve in areas where normal cross slopes do not apply must be shown on each sheet that has any portion of the curve or transition of the curve on it. The above data is placed at a convenient location near the right-hand border of the sheet.
- The cross-section must show the limits of muck excavation, if any, as determined by the standard MassHighway methods.
- The depth of existing topsoil to be excavated and stacked will be indicated with a dashed line and marked "TOPSOIL STRIPPING." This information is generally obtained from the boring logs or test pits.
- Show details of rock excavation and special borrow in embankment areas.
- The type of surface or subbase of the proposed roadway will not be indicated.
- Proposed layout lines will be shown on each cross-section where the layout falls within the sheet limits. Proposed layout lines are drawn as solid lines parallel to the proposed centerline of the cross-section and are labeled “PROP LAYOUT LINE” (Town, City, County or state).
- PTH (Planimeter to Here) lines will be indicated where required. The limits of bridge excavation and gravel backfill should always be indicated for estimating purposes.
- Show all ditches within the limits of cross-section sheets. Indicate the type of excavation for estimating purposes.
- Record cut and fill (square feet) for each section to the right of the particular proposed roadway cross-section so that the areas measured will be clearly defined.
- A legend of terms (abbreviations) should be included on the first sheet.

18.2.2.6 Assembly of Construction Plans

A complete set of construction plans shall include:

1. Title Sheet

A title sheet is required for all projects (See Exhibit 18-14). The title sheet will show:

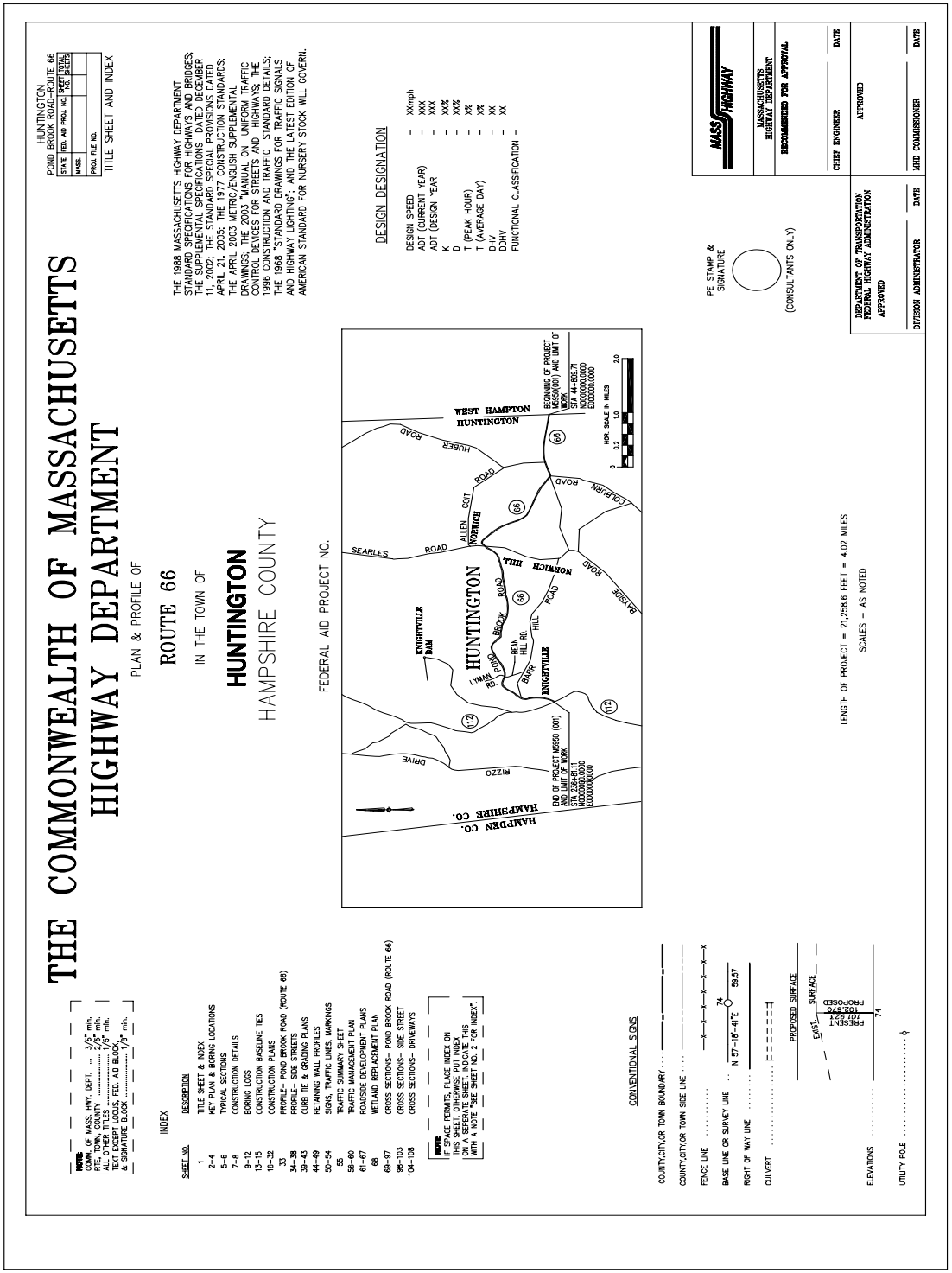
- A locus plan reproduced from a topographic map without contours, or similar map or plan. The scale must be large enough to identify project location. The locus map should not be a photograph, color map, or shaded map and should be suitable for producing a clear photocopy. The locus plan will show:
  - Stations of beginning and end of project and limits of work;
  - Coordinates of beginning and end of project expressed to the nearest 0.0001 foot;
  - Federal-aid project number and an adjacent Federal-aid project number, if any;
  - Route numbers of all roads in the vicinity of the project; and
  - Bridge numbers and stations of the bridges.
- Conventional signs on lower left corner of sheet.
- The project length of roadway, expressed to the nearest 0.01 foot and 0.001 mile. This is the length of roadway measured along the center line of construction considering all equations. The length of divided highways will be the average length of each roadway.
- In the lower right corner of the sheet, blocks for the signature of the MassHighway Chief Engineer and MassHighway Commissioner; in the extreme lower right corner, a block for the signature of the FHWA Division Administrator; above the FHWA block, the P.E. seal and signature for the design consultant as well as the name of firm if applicable.
- Federal-aid Block in the upper right corner with project file number (See Exhibit 18-14).
- Directly below the Federal-aid Block, place the following note:

  "The (latest year) Massachusetts Highway Department Specifications, as amended, the (latest year) Construction Standards, as amended, and the (latest year) "Manual on Uniform Traffic Control Devices for Streets and Highways," and the (latest year) Standard Drawings for

Signs and Supports, and the (latest year) Edition of the American Standard Nursery Stock will govern."

- Listing of the Design Designation Data including all traffic data and Functional Classification of roadway(s).
- Plan submissions should show design stage (25, 75, or 100 percent) and include the submittal date. The date is not required on the final stamped mylar.

Exhibit 18-14
Sample of Title Sheet for Construction Plans



Source: MassHighway

Exhibit 18-14 (continued)
Sample of Title Sheet for Construction Plans

	MASS HIGHWAY
	MASSACHUSETTS HIGHWAY DEPARTMENT
	RECOMMENDED FOR APPROVAL _____ _____ CHIEF ENGINEER Date
DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION APPROVED _____ _____ DIVISION ADMINISTRATOR Date	APPROVED _____ _____ MHD COMMISSIONER Date

Source: MassHighway

2. Index Sheet (optional separate sheet)

An index is required for all projects. Exhibit 18-15 provides an example.

3. Key Plan

A key plan is required for all projects, as illustrated in Exhibit 18-16.

4. Boring Logs

Boring Logs are required for all projects, as illustrated in Exhibit 18-17. Boring logs may be provided in the specifications, as necessary.

Exhibit 18-15
Sample of Index Plan

TOWN
STATE ROUTE
INDEX

IND

SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	INDEX
3	KEY PLAN AND BORING LOCATION
4	BORING LOGS
5–8	TYPICAL SECTION
9–50	PLANS ROUTE I–99
51–56	PLANS SUSAN AVE.
57–61	PLANS WILLIAMS ST.
62–103	PROFILES ROUTE I–99
104–109	PROFILES SUSAN AVE.
110–116	PROFILES WILLIAMS ST.
117–118	PROFILES S.W. RAMP AT WILLIAMS ST.
119–120	GRADING AND TIE PLAN S.W. RAMP AT WILLIAMS ST.
121–123	PROFILES N.E. RAMP AT WILLIAMS ST.
124–126	GRADING AND TIE PLAN N.E. RAMP AT WILLIAMS ST.
127	DRAINAGE DETAILS (NOT SHOWN ELSEWHERE)
128	WATER SUPPLY DETAILS
129	SIGN PLANS AND DETAILS
130	TRAFIC LINES AND MARKINGS
131	LIGHTING DETAILS
132–136	BRIDGE NO. D–5–43, ROUTE I–99 OVER SUSAN AVE.
137–140	BRIDGE NO. D–5–43, ROUTE I–99 UNDER WILLIAMS ST.
141–201	CROSS SECTIONS ROUTE I–99
202–220	CROSS SECTIONS SUSAN AVE.
221–239	CROSS SECTIONS WILLIAMS ST.
240–249	CROSS SECTIONS S.W. RAMP AT WILLIAMS ST.
250–261	CROSS SECTIONS N.E. RAMP AT WILLIAMS ST.

MINOR ROADS

SUSAN AVE.

PLANS	SHEET NO. 51–56, 72
PROFILES	SHEET NO. 104–109

WILLIAMS ST

PLANS	SHEET NO. 57–61, 83
PROFILES	SHEET NO. 110–116

RAMPS

S.W. RAMPS AT WILLIAMS ST.

PLANS	SHEET NO. 16–18, 58
PROFILES	SHEET NO. 117–118

N.E. RAMPS AT WILLIAMS ST.

PLANS	SHEET NO. 16–19, 60
PROFILES	SHEET NO. 110–116

TEMPORARY ROADS AND DETOURS

SUSAN AVE.

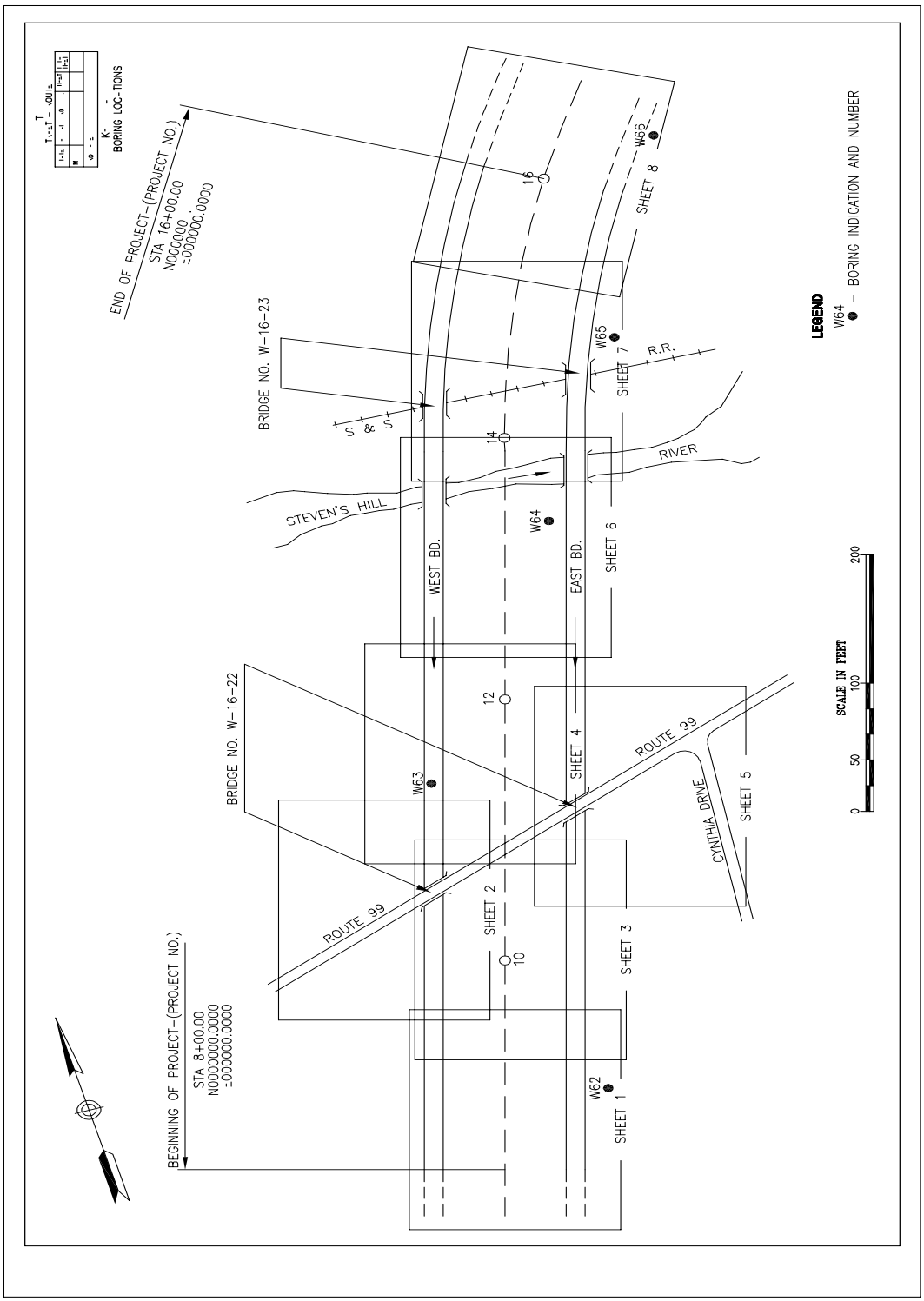
PLANS	SHEET NO. 22–23, 53
PROFILES	SHEET NO. 71

WILLIAMS ST

PLANS	SHEET NO. 48, 60
PROFILES	SHEET NO. 97

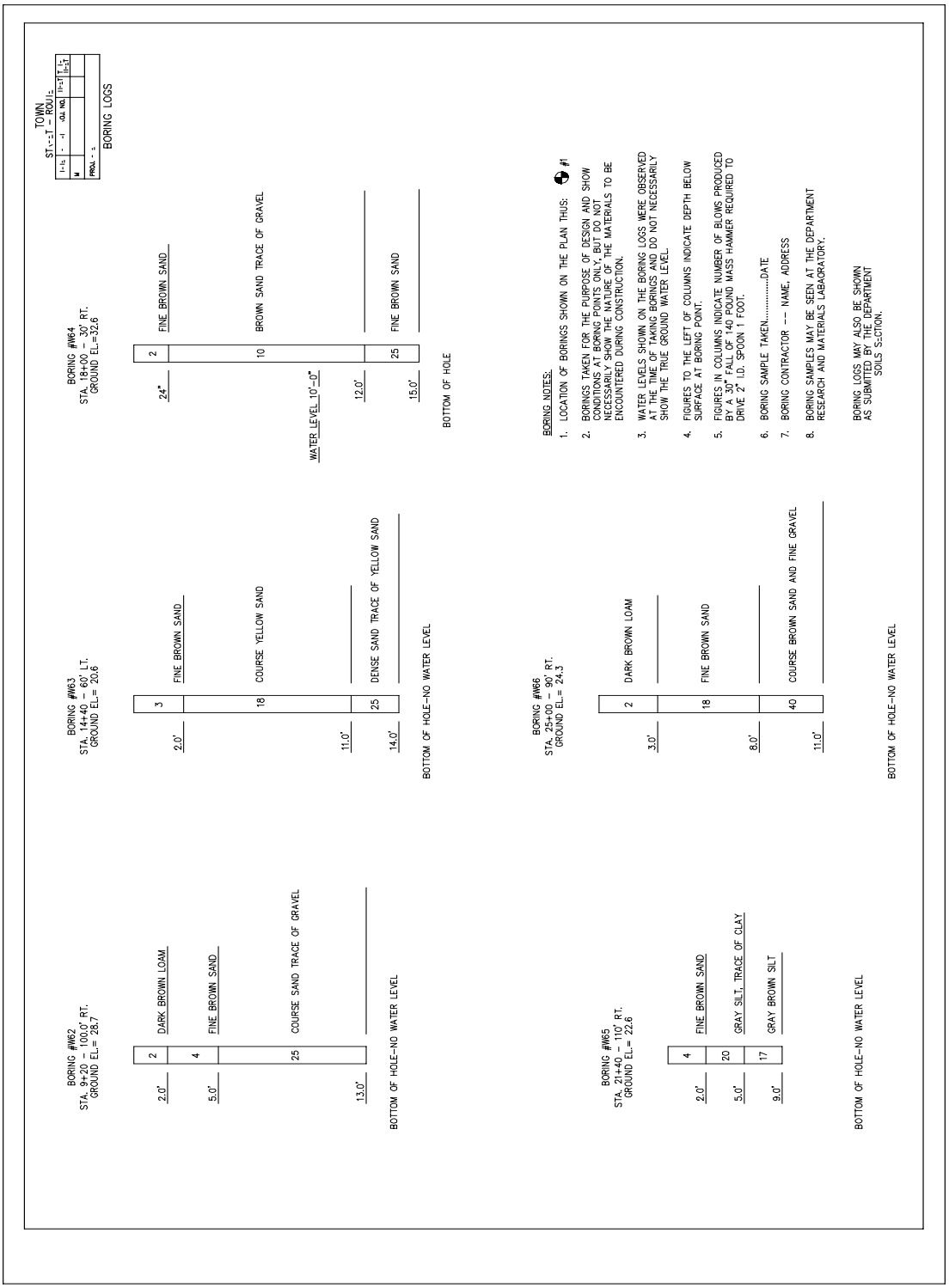
Source: MassHighway

Exhibit 18-16
Sample Key Plan and Boring Location Plan



Source: MassHighway

Exhibit 18-17
Sample Boring Logs Plan



Source: MassHighway

Exhibit 18-18
NOTES - PAVEMENT FOR (Name or Rte. No.)

Traveled Way and Shoulders	
Surface Course	2" HMA Surface Course -Type B
Intermediate Course	2" HMA Intermediate Course – Type A
Base Course	4" HMA Base Course -Type A.
Subbase	4" Dense Graded Crushed Stone over 8" Gravel.

All roads, ramps, etc., are similarly described on the typical section sheets. The thickness of the layers are only for illustration; they vary for each project, and must be approved by the Pavement Design Engineer. In addition, note other pertinent data such as the application of special borrow.
Source: MassHighway

5. Typical Sections

Show typical sections as illustrated in Exhibit 18-19, for all roads and ramps, indicating the following on the typical section sheets:

- Descriptions of pavement and shoulder structures (see Exhibit 18-19);
- Method of banking; and
- Special types of curbing, edging, berms, structures and details which have not been approved as standards.

Plans and profiles may appear on the same sheet when marked with a star below.

6. Construction Plans (Exhibit 18-8)

- Plans of Main Road*
- Plans of Side Roads*

7. Profiles (Exhibit 18-11)

- Profiles of Main Road*
- Profiles of Side Roads*
- Ramp Profiles*

8. Grading and Tie Plans (Exhibit 18-12)

9. Drainage Details and/or Water Supply Details

10. Sign Plans and Details

11. Traffic Signal Plans

- Pavement Markings

12. Traffic Management Plans

13. Utility Plans and Details

14. Landscaping Plans and Details

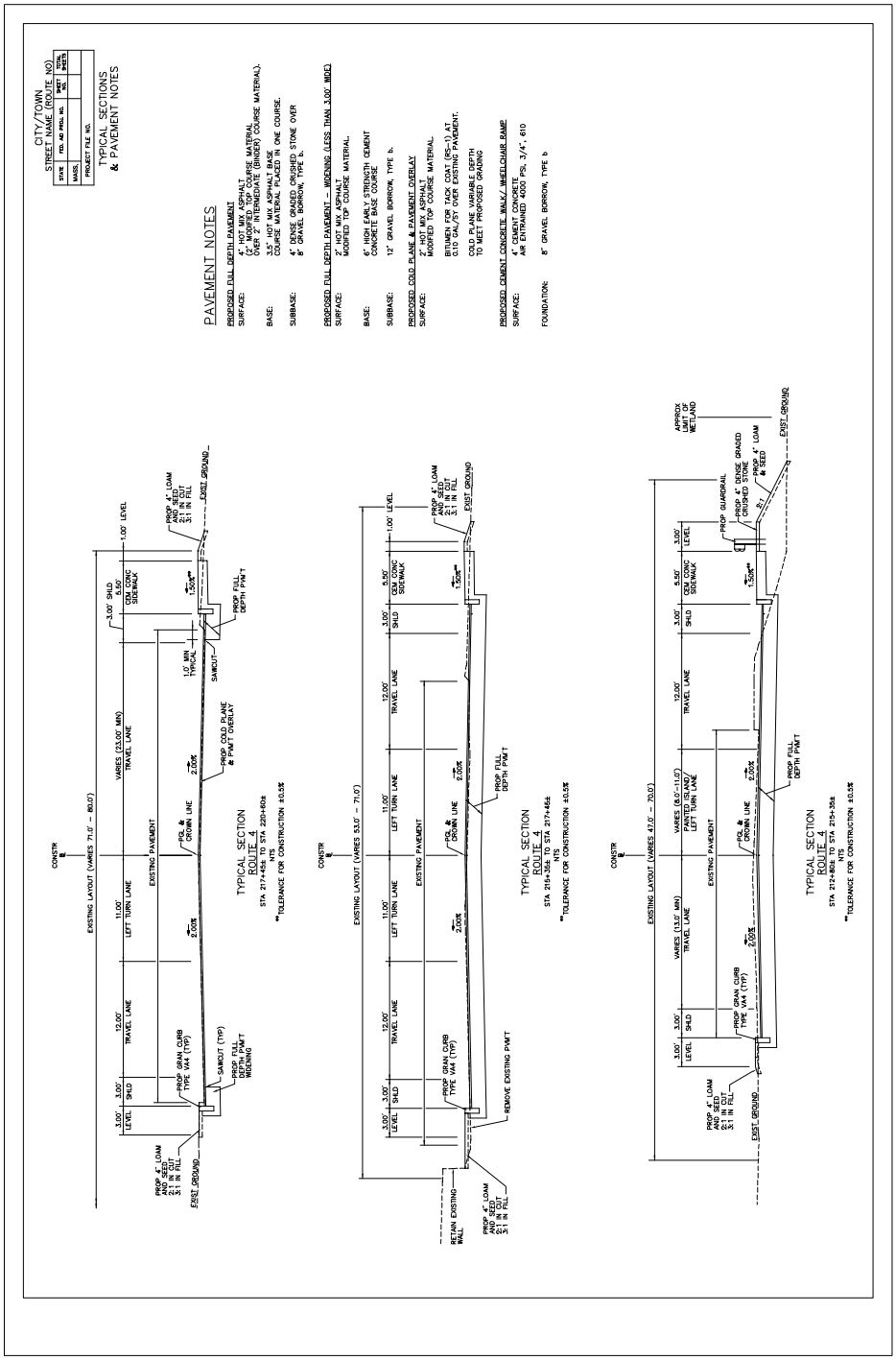
15. Special Details

- Construction Details
- Pedestrian Amenities (Wheelchair Ramp) Details (Exhibit 18-20)

16. Bridge Plans

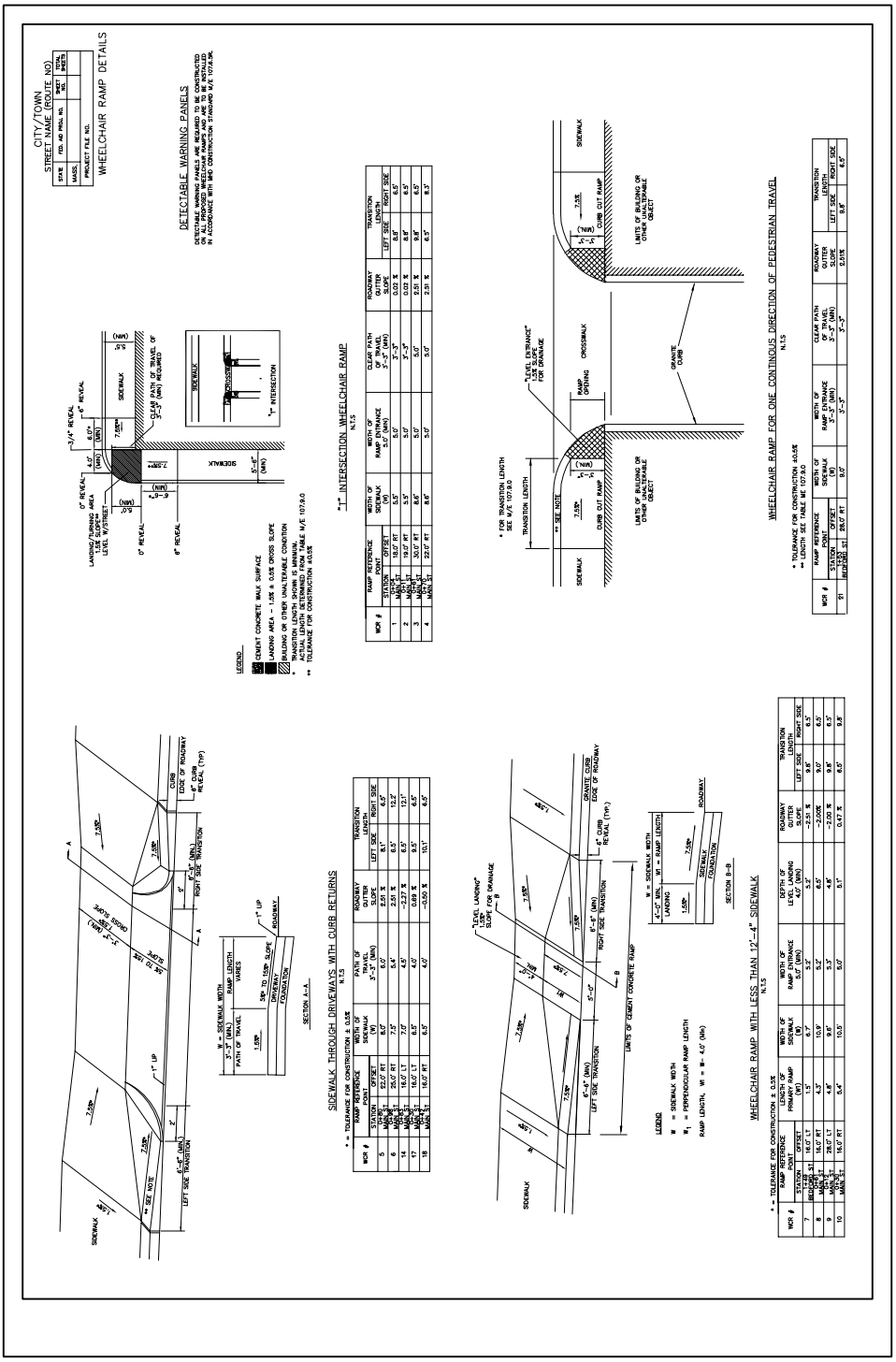
17. Cross-sections (Exhibit 18-5 & Exhibit 18-13)

Exhibit 18-19
Sample Typical Sections



Source: MassHighway

Exhibit 18-20
Sample Wheelchair Ramp Details



Source: MassHighway

18.3 Decree Plans

MassHighway is required to make decree plans when existing railroad crossings are abolished or altered in conjunction with highway work. MassHighway has jurisdiction for abolitions on all public highways within the state for any alterations on state highways or direct continuations of state highways.

When a new state highway layout crosses a railroad where no crossing previously existed, a decree plan is not required - the layout plans will be sufficient.

A crossing is considered to be altered when:

- an existing bridge has major structural changes to strengthen or improve it;
- an existing highway layout at a grade crossing is widened; or
- the grade crossing is resurfaced or repaired outside the state highway layout (changes to grade crossings within the existing state highway layout are not considered alterations).

Decree plans for alterations must show layouts, takings, major construction and design detail, bridge plans and plans of existing conditions. The plan should extend about 600 feet on either side of the crossing. Decree plans are not a part of the construction plans but a separate set of plans.

The following data must be shown on decree plans:

- **Existing Conditions** — All existing detail and proposed edges.
- **Proposed Surface** — The type of surface on pavements, walks, drives, etc. should be identified as "Proposed (kind) Pavement."

18.4 Layout Plans

Layout plans, descriptions, and orders of taking are required to establish highway right of way for all projects which involve land takings. The proposed layouts may result in changes to existing state highway layouts or to existing county, city, or town layouts, or may revise existing limited access provisions.

All proposed layouts must be accurately computed. A complete set of original calculations and a check set of calculations must be submitted. Where a project is in more than one municipality, separate layouts are required. Railroad baselines should be tied to the state highway layout.

The procedure and methods outlined below provide a guide for the preparation of layout plans:

- On the Right-of-Way Plans, the designer will furnish the tentative location of the layout line.
- The tentative location is then definitely set and the computations of curves, lengths, bearings, etc., are made. The computed layout data is then shown on the Layout Plans along with the Massachusetts State Plane Coordinates to all angle points, points of curvature, and points of beginning and ending. Deeds, existing state, county, city, and town layouts, survey ties into the Massachusetts State Plane Coordinate system, and other sources of information may be needed to complete the above. If the Massachusetts State Plane Coordinate system is not readily available, MassHighway should be contacted for further instructions.
- Layout plans will show proposed layout (location) lines, approximate property lines, corner markers, names of property owners, access and non-access (if limited access highway) points, and the locations of bounds. The plans will indicate existing surface details, such as trees, poles, structures, manholes, curbing, walls, fences, streams, existing streets, etc. All of the above details are shown in black. The proposed details are not shown.
- The bearings and distances, or radii and lengths of all proposed layout lines are shown in English units, including Massachusetts State Plane Coordinates to all angle points, points of curvature, and the points of beginning and ending. When a record baseline exists in the area of proposed layout or alteration, it shall be shown on the plan to facilitate in determining locus. (Ties to this baseline are not to be used.)

Data on the layout plans are to be drawn as described below:

- Layout plans are normally drawn to a scale of either 1” = 20’ or 1” = 40’.
- Where a record baseline exists and is shown, points of curvature, points of tangency and the applicable description "Main Baseline"

or "Auxiliary Baseline" will be shown along each baseline. The 100-foot stations are indicated by small circles with a 5/40-inch diameter. The stations are noted above each circle. Tick marks are shown at 50-foot intervals between the circles. All bearings, distances, and radii are marked below the line.

- The proposed state highway layout line is a heavy, solid line, with bearing, radius, and length indicated along the outside of the line. Access provisions are shown inside the layout line.
- The old state highway layout line, where superseded by a revised state highway layout line, is a broken line.
- The state highway layout line is a thin solid line.
- The proposed town or city layout line is a solid line. The bearings, radii, and lengths, are indicated along the outside of the line.
- The old town or city layout line is a broken line. The date that the existing layout line was made is noted along the line.
- Property lines are shown as broken lines.
- Each parcel of land to be taken must have its parcel number, owner's name, area and length of each course ± distances noted. Registered land must show the parcel number, exact name of owner, the words "Registered Land," Land Court case number, Land Court certificate number, book and page number, the area, and the length of each course. Supplementary plans and traverses must be submitted to the Land Court to conform to Land Court Regulations for the land taken and land remaining. Easement locations taken in connection with the layout will be outlined in black, dashed ink lines marked "Line of Easement."
- Existing state highway layout lines shall be identified with the proper notation, as follows: Layout Lines of December 20, 1995 State Highway Layout/Alteration (L.O. No. 5678).

In accordance with MassHighway practice, parcels are numbered in a manner that will indicate permanent or temporary takings and the nature of the rights taken. Locations where rights of access to or egress from existing ways are taken, but no land taking is involved, will be designated by parcel numbers AT-1, AT-2, etc.

The written instrument for the Layout and Order of Taking will be prepared according to MassHighway practice. Four typewritten copies, double-spaced and carefully checked against the layout tracings, must

be submitted. Separate plans and written instruments for advance taking and/or additional easements may be required.

All submissions of tracings to the Department shall be comprised of the original tracings and full-size wash mylar reproductions. Electrostatic mylar plots are unacceptable. The reproductions, to be acceptable to the registers of deeds, must meet the most recent Plan Regulations approved by the State Attorney General.

Among the requirements for recording are the following:

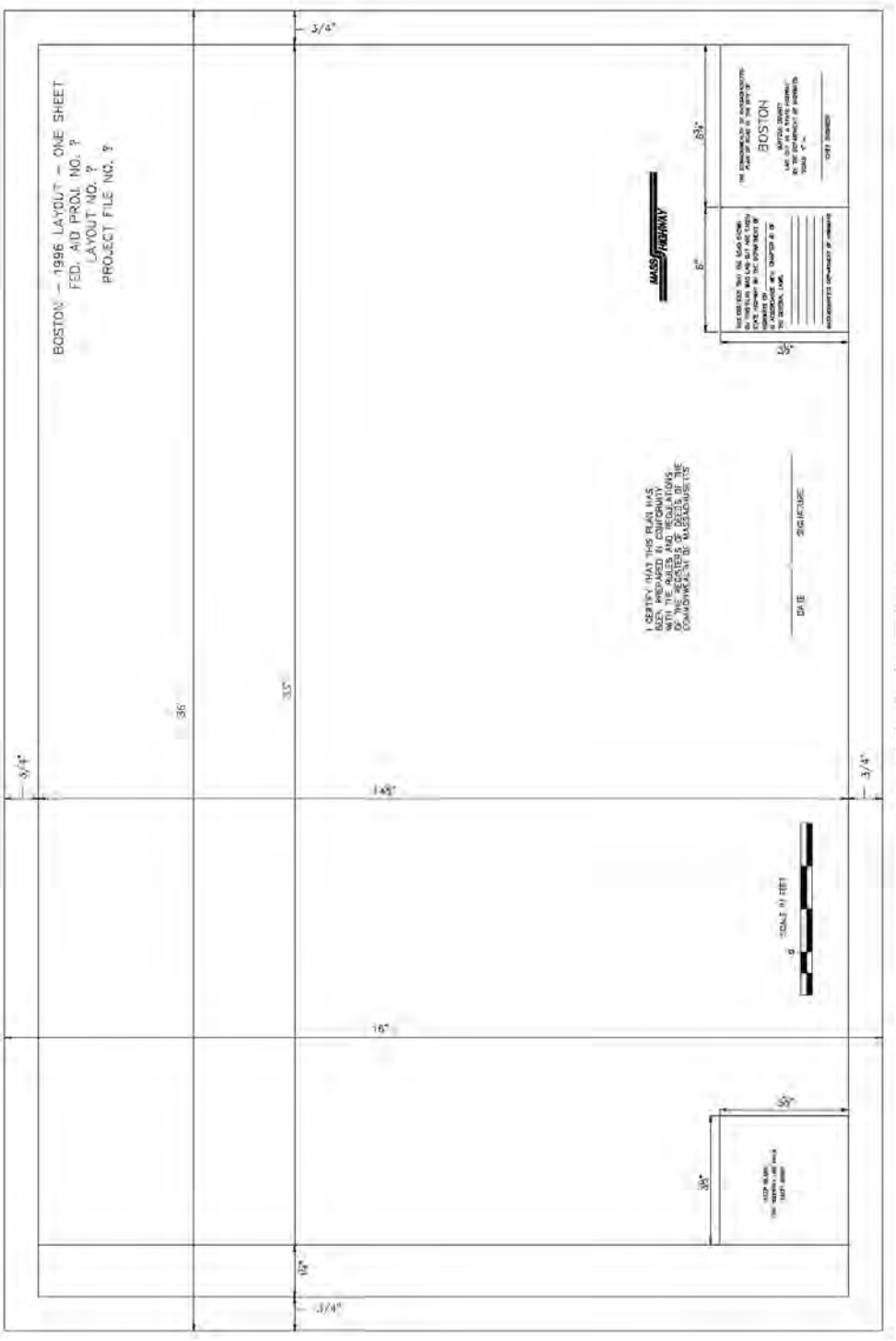
- Plans must be on mylar wash-off matted on at least one side, having a thickness of .4 mil. The matte surface and ink must be on the front of the mylar sheet.
- Ink must be opaque and of archive quality. It is imperative that the ink used on mylar plans be specifically designed for mylar applications to prevent its chipping off.
- The minimum letter height permitted on plans is 1/8-inch for hand-lettering and 1/10-inch when a machine or template is used.

In addition, the Federal Aid Project No. shall be shown on the upper right-hand corner of the first sheet; the Layout No. shall be shown in the upper right-hand corner of each sheet; and on Limited Access projects the notation "Limited data, parcel nomenclature and existing detail" shall be on one side only on both the original and the reproduction. Also, a key plan is needed for all layouts and alterations where sheets do not follow each other in successive numerical order. No reproductions are needed for key plans.

All layout tracings, supplementary plans and traverse computations for the Land Court will be stamped with the seal of a Massachusetts Registered Land Surveyor. All layout plans will show on the title sheets the words "Plans Prepared By," followed by the name and address of the person or organization responsible. Samples of the supplementary plans and traverses for registered land, general type of layout descriptions, and order of taking may be obtained from the Layout Engineer.

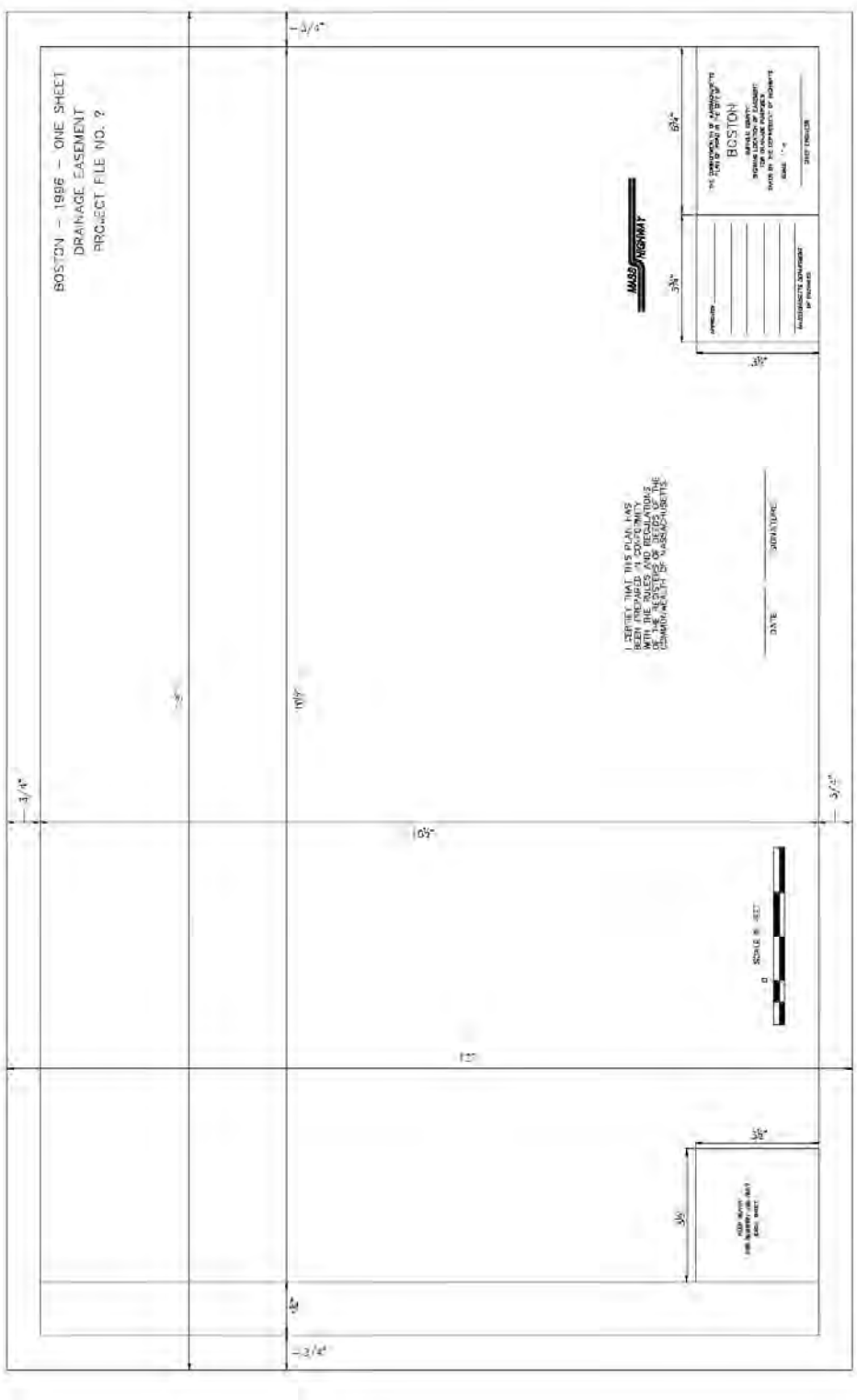
Titles of plans and necessary notes for signature by the MassHighway Commissioners are shown in Exhibit 18-22. Exhibit 18-21 provide sizes of standard tracings. Exhibit 18-23 provides symbols for layout tracings. Exhibit 18-24 provides abbreviations for Layout Plans. Both of these tables also apply to right-of-way plans.

Exhibit 18-21
Sizes of Standard Tracings



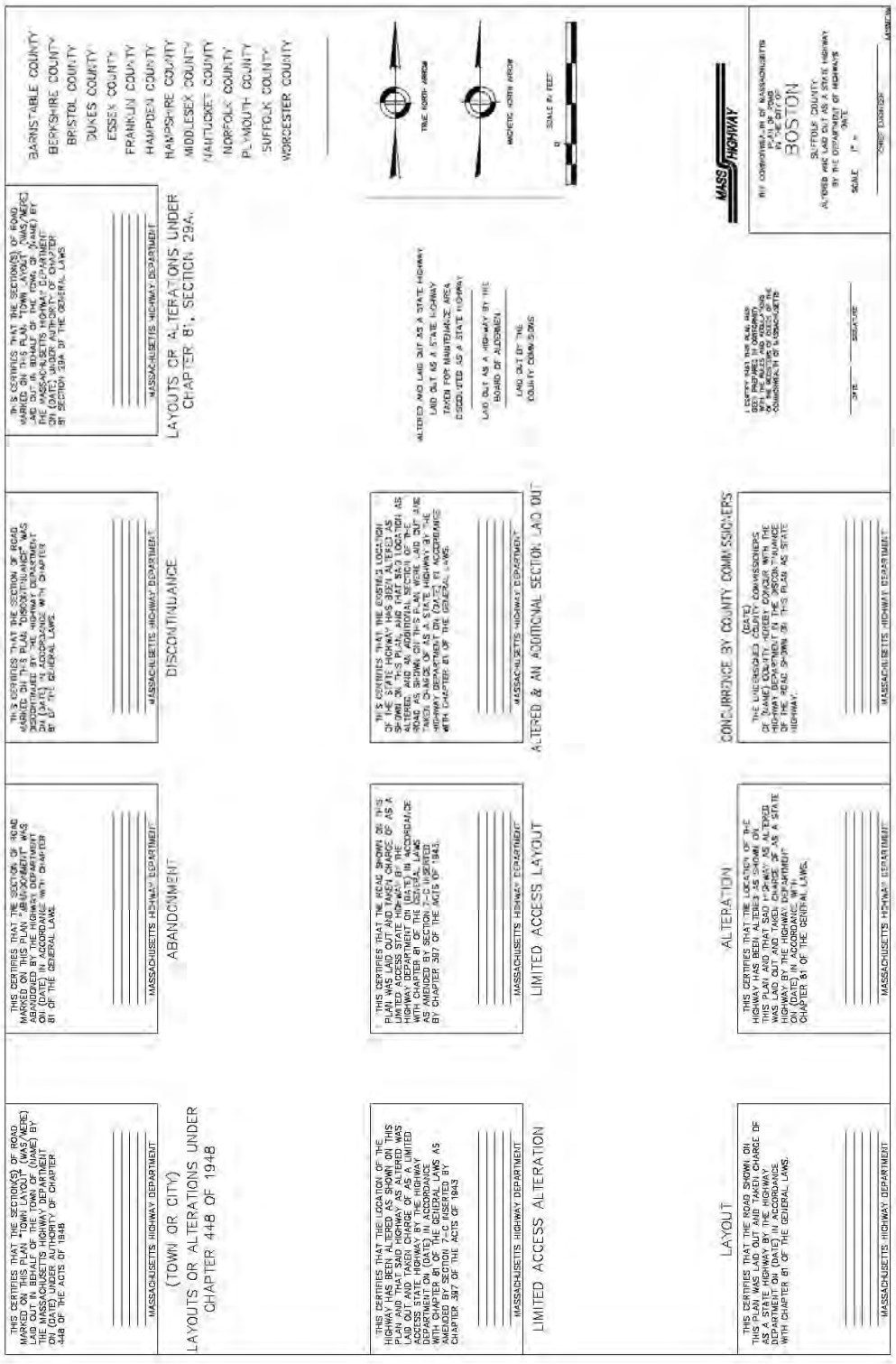
Source: MassHighway

Exhibit 18-21 (continued)
Sizes of Standard Tracings



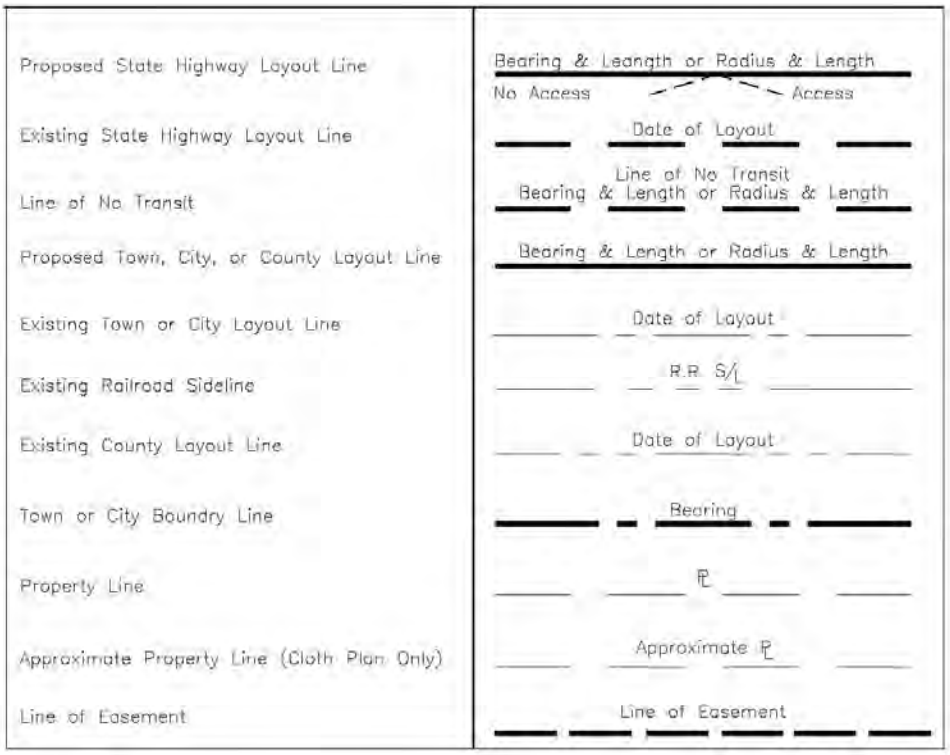
Source: MassHighway

Exhibit 18-22
Data for Layout Plan and Title Sheet



Source: MassHighway

Exhibit 18-23
Symbols for Layout Tracings



Source: MassHighway

18.5 Right of Way Plans

These procedures for the preparation of "Right of Way" (ROW) plans are consistent with the Federal Aid Policy Guide (FAPG). Since these instructions are general, the designer must discuss the content requirements for each project with the MassHighway Right of Way Bureau.

The "Right of Way" plans are not a substitute or replacement for the Department layout plans described in this manual; both are required.

Preliminary ROW plans shall be prepared and submitted along with the 25 Percent Construction Design submittal. Preliminary ROW plans shall be available for the Public Hearing.

If the Designer determines that no ROW acquisitions, and no new layouts or alterations are required to advertise and construct their project, a letter stating so must accompany the 25 Percent design submittal. If MassHighway concurs, the designer will show and identify

all ROW and property lines on the construction plans, identify the abutting owners, and a set of ROW plans will not be required. If, as the design progresses, ROW acquisition does become necessary, the designer will prepare and submit a set of Preliminary ROW plans in accordance with the following guidelines.

18.5.1 General

Preliminary and Final ROW plans will be prepared by the designer as specified and as noted in the Federal Aid Policy Guide (FAPG).

Preliminary and Final ROW plans will include all pertinent data affecting the cost of ROW such as structures, land service or access roads, improvements, landscaping, drainage, and fences.

The linestyles used shall conform to the requirements given for Layout plans. Abbreviations used in Layout and ROW plans are shown in Exhibit 18-23.

The electronic drafting standards, and object naming requirements, used on the "Right of Way" plans shall conform to the requirements for Constructions drawings and Layout plans.

The Preliminary Right-of-Way plans are used by MassHighway Right-of-Way agents to communicate with property owners, title examiners, and appraisers. The Preliminary Right-of-Way plans must be prepared to be clearly understood by non-engineers.

The size, form and arrangement of Preliminary and Final ROW plans will conform to the general requirements of highway plans. They will contain sufficient dimensional and angular data to permit easy identification of all fee parcels and easement areas that are required by the highway project. The following symbols and/or identification information shown on the construction plans will also be shown on ROW plans:

- Right of Way Federal-aid project number.
- Scales to be used.
- A north arrow for each Property and Location plan sheet, and for each insert plan included on any sheet.
- Access symbols or any other symbols which may be used.
- A revision block on the Title Sheet which will show identify any changes, and the date of revision.

Exhibit 18-24
Abbreviations for Layout and Right-of-Way Plans

Abbreviations for Fee Takings

1	Taken in fee in behalf of the Commonwealth	D-1-F	Drainage Taking in Fee
1-C	Taken in fee in behalf of the City	C-1-F	Channel Taking in Fee
1-T	Taken in fee in behalf of the Town	UR-1	Uneconomic Remainder
1-U	Taken in fee (ordinarily conveyed to utility)	VP-1	Vehicular Parking
1-RR	Taken in fee in behalf of the Railroad	CVP-1	Commuter Vehicular Parking
1-X	Excess Land	FRL-1	Functional Replacement Land
M-1	Maintenance Area	RL-1	Replacement Land

Abbreviations for Easement Takings

AT-1	Access Taking	R-B-S-1	Road, Bridge and Slope
B-1	Bridge	RD-1	Temporary easement for removal or demolition of certain structures
BA-1	Bridge Abutment	RR-1	Railroad Bypass
C-1	Channel	R-RR-1	Road and Railroad Bypass
CD-1	Channel Drainage	RS-1	Slope in connection with Right-of-Way
CL	Construction Limitation	RT-1	Temporary easement for removal or demolition of certain structures
D-1	Drainage	S-1	Slope
DS-1	Drainage and Slope	SRE-1	Temporary Sign Removal
E-1	Highway Easement (Portion of Right-of-Way)	SS-1	Sanitary Sewer
E-RR-1	Easement on behalf of Railroad	SW-1	Sidewalk
FB-1	Footbridge	SW-S-1	Sidewalk and Slope
FS-1	Flight of Steps	TB-1	Tie Back
GD-1	Gravel Dike	TE-1	Temporary Easement for various purposes
GR-1	Guard Rail	TR-1	Temporary Road
GU-1	General Utility	U-1	Utility Easement (ordinarily conveyed to a utility company)
HS-1	Highway Sign	W-1	Wall
HL-1	Highway Light	WM-1	Watermain
PL-1	Power Line	WMD-1	Watermain and Drainage
R-1	Right-of -way taken in behalf of owner of land whose rights of access thereto and egress therefrom would otherwise be inoperative due to limited access provisions	WQM-1	Water Quality Monitoring Station
R-B-1	Road and Bridge	WS-1	Wall and Slope

Abbreviations for Disposition of State Property

LL	Land Lease (Portion of State Highway)	LS	Land Sale (Portion of State Highway)
LR	Land Lease (Not part of State Highway)	SR	Land Sale (Not part of State Highway)
LU	Land Use (Portion of State Highway)	LA	Land Acquired by Department (usually be deed)

* Notes for Easement Takings:
1 Temporary easements are preceded by letter "T". (For example, TD-1, TWM-1, etc.)
2. Easement in behalf of Town, City, Railroad or the M.D.C. are followed by letters: "T", "C", "RR", "MDC" (For example, D-1-T, D-1-C, D-1-RR, D-1-MDC, etc.)
3. EG-1. This symbol is used to delineate an area comprising a portion of State Property in which an easement is to be granted.
4. The symbols listed and described above may be preceded by a number prefix. (For example, 1-1, 1-D-1, 2-1, 2-D-1, etc.)
5. The symbols A, B, C, etc. designate "Spot Takings in Fee." The symbols B-11-1, B-11-2, etc. designate "Block Takings in Fee."

Source: MassHighway

18.5.2 Preliminary Right-of-Way Plans

A set of Preliminary ROW plans will be prepared to produce legible reproductions. Each sheet will be labeled in the upper right hand corner as "Preliminary Right of Way," with sheet type identified (for example "Location Plan," "Typical Section," etc,) and if more than one of a sheet type, sequential and total of sheets (for example, "Sheet 1 of 2").

ROW plans will remain "Preliminary" until a submission of "Final" ROW plans is requested by the Right of Way Bureau, or project close out, which ever is sooner.

ROW acquisition information will be posted on the Preliminary ROW Parcel Summary by the designer when the designer obtains the information.

18.5.3 Final Right-of-Way Plans

After the ROW Bureau requests submission of the Final ROW plans, the designer will change "Preliminary" to "Final" on all sheets, update the revision box, and produce and submit a set of Mylars.

18.5.4 Format of Right-of-Way Plans

The set of ROW plans shall include the following:

Title Sheet and Index — The Title Sheet will include the same information as the title sheet prepared for highway construction drawings. Information noted on the construction plan title sheet which is not germane to the ROW plan should be removed.

The following information will be noted on the Title Sheet of the ROW plan:

- The ROW Federal-aid project number;
- Project file number;
- An index;
- The termini baseline stations of the project on the Locus plan, and the length of project below the Locus plan;
- An indication of a Preliminary or Final ROW plan; and
- A revision block.

Typical Cross-sections — Typical cross-sections shall be provided to facilitate the understanding of the impacts to properties affected by the proposed work. Detail sections shall be provided as determined to be needed by the designer, or requested by the ROW Bureau.

Critical Profiles — Profiles shall be provided to illustrate the difference between existing and proposed conditions, where necessary.

Parcel Summary Sheet — A parcel summary, in MassHighway format, will show the following information:

- All parcel numbers (the format of parcel numbers is as follows: a Department supplied prefix number which is project specific, followed by the easement abbreviation from Exhibit 18-24 if not a fee parcel, then the sequential numerical designation);
- Sheet numbers of where the parcel is shown on the Location plan and the Property Plan sheets;
- The name of the owner of record as it appears on the deed;
- A reference to the book and page where the title is recorded in the appropriate registry of deeds and/or probate court;
- The area of the parcel, noting whether the parcel is in fee, or as a permanent or temporary easement;
- The areas of all portions of an affected property which remain after the takings;
- The area of each property before the taking (this is preferably the Deed area, less desirable is the Assessors area, last resort is a calculated area); and
- A remarks column giving the purpose of TE's, acquisition information when available, or other pertinent information regarding the property or acquisition.

On some projects it may be possible to place the parcel summary box on the Property or Location plan.

Location Plan — All properties impacted by a fee taking or permanent easement shall have their entire perimeter shown and dimensioned. If this cannot be done on the Property Plan, a location plan will be prepared. The location plan map will be to a scale practical to show the

property in its entirety without match lines, and that will produce legible reproductions.

Location Plans will show the dimensioned outline of all properties affected by fee or permanent takings, the owner's name, total property area, the parcel linework, the parcel identification number with a leader to the parcel, and enough auxiliary information to orientate the user (such as street name, baselines, identified L.O. lines, etc.) Parcel dimensions, parcel areas, base mapping and or proposed design features are not shown on Location Plans. On some projects it may be possible to place the location plan of a property(s) as a detail on the Property Plan.

Property Plan Sheets — Property Plan(s) will be prepared at an appropriate scale to clearly illustrate the takings, and impacts to, affected properties. This is typically 20 scale in highly developed areas, and 40 scale in rural areas. The hierarchy of linework and text is as follows: ROW information (property lines, L.O. lines, street lines, parcel dimensions and identification text, etc.) is darkest, the proposed work is lighter, and the existing conditions base mapping is lightest. All layers must be legible and reproducible.

The following information will be shown on the Property Plan sheets:

- Existing ROW limits identified as State, County, City or Town, with year if known. Existing S.H.L.O.s shall also be identified by number. Both the existing and proposed baselines, with stations. Do not show distances, bearings, radii or curve length. All property lines, identified with a "PL" symbol, or "Z" symbol if common ownership.
- All parcels. All sides of the parcel will be dimensioned +/-, with tic marks at all changes in direction of the parcel boundary. The parcel will be identified by the parcel identification text in this format: parcel identification number, owner's name, then approximate area. If the parcel identification text cannot be practically fit within the boundaries of the parcel, a leader ending with a dot inside the parcel will be used to locate the parcel.
- Proposed L.O. lines, identified as such, and with the MassHighway supplied L.O. number, when applicable. Do not identify proposed layouts by year.

- All existing improvements included within any taking, such as structures, driveways, landscaping, and fences, etc. The disposition of all improvements within temporary easements will be identified.
- The proposed tops and bottoms of slopes will be shown, and identified.
- All new construction features, such as pavements, sidewalks, signals and foundations, erosion control measures, structures, and drainage. It must be clearly shown and identified what proposed work necessitates the acquisitions.
- All work to be performed to mitigate land damage.
- All dimensions are to be shown in the English system. Bar scales shall be provided.
- Names of the property owners of all properties affected by takings. Known abutter names of properties not affected by takings shall be identified as "N/F."
- All streets shown will be identified by name and Route number, and as public or private. Waterways, and other named features will be identified.
- Project limits.

18.6 Specifications

Construction specifications for highway improvement projects are prepared by utilizing the current edition of the Massachusetts Highway Department Standard Specifications for Highways and Bridges as the base specification for the project, and the Department's supplements to the standard.

The goal of the designer is to use the standard items specified in the Standard Specification to the greatest extent practicable, therefore avoiding the need to supplement the construction documents with unique items that are currently not standard. In certain instances, however, projects contain proposed features that are not specified in the Standard Specifications, thereby requiring the use of the supplemental specifications or development of Special Provisions.

Supplemental specifications are prepared to alter or supplement the base specification requirements provided in the Standard Specifications for Highways and Bridges (hereinafter called the

Standard Specifications). As stated above, new specifications are prepared for special work involving materials or construction requirements not covered by the Department standard or supplementary specifications.

18.6.1 Procedure

The Standard Specifications for Highways and Bridges (hereinafter called the Standard Specifications) are usually based on a unit price format. Each major item of work is defined and paid for separately at the unit price bid for the work. Payment for most items of work is based on the measured quantity of work actually constructed, while some are paid on a lump sum price basis.

The first task in preparing project specifications is to determine the unit price items needed to totally pay for all the project construction. The MassHighway Standard Item List is used for this purpose. New items are established for special work not included on the list.

The next step is to determine if the proposed work requires a supplemental or new specification by:

- Carefully review the work as defined on the drawings and read the Standard Specifications for the work included in the particular unit price item under consideration. If some part of the required work, such as a material or performance requirement, construction method or payment provision is not adequately covered, then additional supplemental specifications, called Special Provisions, must be written for this part of the work.
- If a Special Provision for the item does not exist, then a new complete Special Provision must be written.
- When a Special Provision covers the same work under several unit price items, it is not repeated but made applicable to all by including all the item titles in the title of the Special Provision.

18.6.2 Format and Content

Special Provisions are written to contain the following information in the following order:

Reference. The first sentence references the Special Provision to the applicable section of the Standard Specification and thereby ties both

standard and Special Provisions together into a single complete specification. The first sentence should read:

> "The work under this (these) items shall conform to the relevant provisions of Section (no. or nos.) of the Standard Specifications and the following:"

This sentence is omitted only in the new specifications that are not supplemental to any section of the Standard Specifications.

Content. The body of the specification contains the material, quality, performance and method instructions. It should not duplicate any requirements already adequately covered in the Standard Specifications.

The first sentence should read "The work shall include ..." followed by a brief overview of the particular construction to be specified.

Material and material quality specifications are described next by generic name or manufacturer title. Generic material quality is defined by standard ASTM, AASHTO, or other specifications references. When specifying materials by manufacturer, include three choices whenever possible, and end with "or approved equivalent."

Material and material quality requirements are followed by requirements for construction performance, equipment and methods, such as:

> "place, grade and compact the gravel base..."
> "the concrete base shall be thoroughly cleaned..."
> "... shall be conducted by workmen thoroughly experienced..."

This part of the specification should be written in concise language in start-to-finish order. For example, requirements for preparatory work are written first, followed by principal construction, followed by finishing requirements.

***Measurement and Payment*.** These clauses are the last part of the specification and should not be inserted fully or partially within the body of the Special Provision. If desired to call attention to separate or no separate payment for a particular task within the body of Special Provision, say so, but put detailed description in measurement and payment clause.

The Standard Specifications describe separately how a particular item of work will be measured for payment and how the measured quantity will be paid for. Special Provisions must use this same format.

Measurement clauses are written:

> "(Item title words in lower case) will be measured for payment by the (measurement unit) (follow with the definition of where the measurement will be taken, e.g., from end post to ..., on the pavement surface..., etc., when applicable), complete in place. Measurements are assumed to be taken in a horizontal plane or vertical plane unless otherwise noted in the measurement clause. The difference can be significant when the work is on a slope and the measurement is linear or an area, such as for pipe, seeding, etc."

Lump sum items do not require a measurement clause.

Payment clauses are written:

> "(Item title words in lower case) will be paid for at the Contract unit price per (measurement unit), which price shall include all labor, materials, equipment and incidental costs required to complete the work."

The payment clause can be written to cover more than one unit price item with the same measurement unit with the words "at the respective Contract unit prices per (measurement unit)."

Do not expand the "all labor, materials,..." clause with additional words such as "transporting," cutting," "storage," "cleaning," etc. since these can all be considered covered by the words labor, materials, equipment or incidental costs, or clarified by inclusion in the "no separate payment" sentence.

When payment for a particular part of the work is to be paid for under another item, add the standard sentence: "(work description)... will be paid for separately under (Item title), (Item number)."

When the cost of a particular part of the work is to be included in the unit price bid and therefore no separate payment is to be made, but

there could be some question of payment since the same or similar work is included in the other items, then include the standard sentence:

> *"No separate payment will be made for (work or material description), but all costs in connection therewith shall be included in the Contract unit price bid. (If the Special Provision is for more than one item, include item title and number reference here.)"*

This sentence can also be used to call attention to some special or unusual part of the work whose cost is to be included in the unit price.

18.6.3 Coordination With the Drawings

Terminology – The labels used on the drawings must be consistent with the payment item titles, material names and specification titles used in the technical applications.

For example:

- The plans should not label fill or backfill as structural fill, or gravel, while the specification and payment item is for gravel borrow or processed gravel.

Reference to information on the drawings – The term, "as shown on the drawings," is frequently found in specifications. The term appears to be most often included out of force of habit, usually in the sentence, "as shown on the drawings and as directed by the Engineer."

This term is needed since the drawings are as much a part of the contract documents as the specifications and the contractor is responsible for finding the information and does not have to be repeatedly told to do so. The term should be reserved for some unusual type of work where:

- The specifications and the drawings need to be studied together to achieve a full understanding of what is required.
- The contractor is given a choice of options in the specifications and the drawings illustrate only one of the choices.

Also, when the term is used, there must be something shown on the drawings. Too often the term is included, but there's actually nothing

on the drawings and the term therefore is not only unnecessary, but erroneous.

Duplication of notes – Notes shown on the drawings should not replace or duplicate information that is already in, or should be in, the specifications.

Notes should not include:

- Material requirements, such as concrete strength, reinforcing steel strength,
- AASHTO references.
- Performance requirements.
- Measurement and payment statements.

18.6.4 Language

Specifications are precise legal requirements which effect how a Contractor will perform the work and how he will determine his costs and bid prices. The language, therefore, must be clear and specific to avoid questions on the intent, requirements and basis of payment. Specification language must be clearly worded, consistent, specific, and complete. The key to good specification language is to use:

- Only those words that are necessary.
- Words whose meaning can be determined by a quality or quantity criteria.
- Words that are technically correct and not jargon.

Unnecessary words are empty words – words with no meaning that only make the specification harder to read and understand. Empty words to be avoided include:

- in order to
- So as to
- To the fact that
- In such a manner as to

Words and phrases must also be technically and legally correct and with only one meaning:

NO	YES
are to be, may, must, should	shall
his, hers, him, he, she	contractor, agency (not a person)
directed by the Engineer	required by the Engineer
insure (means insurance)	ensure
manner that will not cause	prevent
necessary (subject to dispute)	required
borne, absorbed, covered	paid

Words and phrases that have no criteria to define or enforce their meaning should not be used. These include:

- satisfactory, adequate, neatly, suitably, properly
- workmanlike, workmanship
- highest quality, best practices
- to the satisfaction of
- excessive stress
- a manner acceptable to
- pleasing, well tailored, etc., appearance
- firmly, securely, necessary

Strive to use those words which are most specific, yet are general enough to cover all conditions.

USED	BETTER
"Excavate and dispose of"	"Remove and dispose of," or "Excavate, remove and dispose of"
"… fire alarm apparatus"	"… fire alarm system equipment"
"… operations on the water mains …"	"… alterations of the existing water system …"
"damaged by the Contractor due to neglect …"	"… damaged by the Contractor's operations …"
"… of the applicable item aforementioned in these Special Provisions"	"of Item (No.) …"

Words used to describe materials and technical terms must not be jargon and must agree with the words and terms used on the plans and in the payment items. These include:

YES	NO
Excavate, trench	Dig, bulldoze
Pipe	Main, line
Bituminous concrete, hot mix asphalt	Blacktop
Open graded friction course	Popcorn mix
Grading	Blading, dozing
Gate Valve	Gate
Conduit (single electrical pipe)	Duct
Duct (many electrical pipes in the group)	Conduit
Cold plane	Mill
Course (bituminous concrete)	Layer
Reinforcing bars (steel)	Rebar
Masonry work, brick work, etc.	Masonry, brick
Through bolts	Thrubolts

In addition to the use of correct words, phrases and sentences must be worded clearly and correctly. Some frequently used phrases to be avoided include:

- "as directed by the Engineer" – The engineer does not "direct" the contractor's work, but provides the contractor with requirements. The contractor has the legal responsibility to determine the means and methods needed to accomplish the requirements and to "direct" the workmen implementing the means and methods.
- "The Contractor shall be responsible for" – The contractor is responsible for all the contract requirements, thus it is not necessary to state it. This statement is only needed when the task may normally be accomplished by others, but paid for elsewhere, and similar circumstances. Permits are an example.
- "to the satisfaction of the Engineer" – An undeterminable requirement.
- "or equal" use "or equivalent" instead since no product can truly be equal to another.

- Quotation marks for dimension units should not be used since they can be easily incorrectly typed or lost in printing. The words foot, inch, etc. should always be used and fully spelled out.

18.7 Estimates

All projects require a final estimate of the quantity and unit bid price for each construction item. The following apply:

- The method of payment and units of measurement must conform to the latest editions of the *Standard Specifications for Highways and Bridges* and the *Standard Nomenclature and Designation of Items*.
- Any item of work not covered in the Standard Specifications must be submitted to the Specifications Engineer as a special provision.
- Earth quantities are calculated by computer or by planimetering the cross sections.
- At the 25% and 75% stages, project cost estimates are prepared using up-to-date information.

18.7.1 Types of Project Estimates

Federal-Aid Projects

Separate estimates are required for Federal-Aid projects.

- **Non-Participating Estimate** - This is required for items which will be paid for with other than state and federal funds:
  - Non-Participating State only; i.e., cleaning pipes and drainage structures.
  - Non-Participating Municipal; i.e., "gas lanterns," "ashfield stone" paved sidewalks.
- **Federal-Aid Roadway Estimate** - This is required for roadway construction items, exclusive of bridge items.
- **Federal-Aid Bridge Estimate** - This is required for each bridge and for walls which are assigned a structure number by the Bridge Section.
- **Contract Estimate** - This is an estimate for the project showing the total project cost, including total contract items, construction

engineering, contingencies, force accounts, non-participating costs, and a summary of project costs which include the requested federal funds.

Exhibit 18-25 provides the shrinkage and swell percentages for excavation and embankment quantities. Exhibit 18-26 provides the weights and measures used for estimating.

Exhibit 18-25
Shrinkage and Swell Criteria

Item	Factor in Percent to Be Applied
Estimate of earth excavation available for embankment: Earth excavation quantity (excluding rock and unsuitable materials) measured and/or computed	-5% (Shrinkage)
Estimate of embankment required: Embankment quantity measured and/or computed	+15% (Swell)
Estimate of rock excavation available for embankment: Rock excavating quantity measured and/or computed	+37.5% (Swell)
Estimate of muck excavation: Muck excavating quantity measured and/or computed	0%
Estimate of gravel borrow required: Borrow quantity measured and/or computed	+25% (Swell)
Estimate of Loam Required: Loam quantity measured and/or computed	+25% (Swell)
Estimate of topsoil required: Topsoil quantity measured and/or computed	+25% (Swell)

Note: These percentages are for estimating purposes only.
Source: MassHighway

The Shrinkage factor accounts for loss of material during handling and stockpiling. The Swell factor accounts for the increased volume of earth due to through excavation. Stockpiled or hauled materials assume a larger volume area than in their natural state. After swelled (loose) material has been placed as fill, it is compacted to a 95% density. Therefore when calculating the quantities required for special borrow, gravel borrow and loam borrow material, the volumes are increased per the above percentages.

Exhibit 18-26
Weights and Measurements for Estimating Purposes

Material	Use	Weight – Ton Per Square Yard	Remarks
Bituminous Concrete	For surface, binder or base	0.056	Per 1 inch of depth
Bitumen	Dust layer	—	Estimate 0.2 gallons per square yard of surface area
	Prime coat	—	Estimate 0.05 gallon per square yard of surface area
Crushed Stone	For top course or base course	0.05	Per 1 inch of depth
	Dense packed mass	0.062	Per 1 inch of depth
Pea Stone	For driveways	0.05	Per 1 inch of depth, to be included in the item: "Crushed stone for wearing surface," use when a small quantity is required.
	For driveways	—	3,300 pounds per cubic yard, use when a large quantity is required. Item designation is "peastone for driveways"
Stone Dust	Walks, drives, etc.	—	Estimate 2,700 pounds per cubic yard
Water	Dust layer	—	Estimate 1.0 gallon per square yard of surface area

Source: MassHighway

Quantity Detail Sheets are part of the contract documents and are required to advertise a project. The amounts match those in the Contract Estimate, but without the estimated costs. Exhibit 18-27 provides examples of Quantity Detail Sheets.

Non Federal-Aid Projects

Only one contract estimate is required for non Federal-Aid projects. This estimate is similar to the final Contract Estimate for Federal-Aid projects.

Utility Force Accounts

On many highway projects, utility adjustments or relocations will be necessary. The costs of labor and materials may be reimbursable by the State on a force account basis. A separate estimate should be prepared for any force account work for a highway project. The utility company usually prepares this estimate.

Exhibit 18-27
Sample Quantity Detail Sheet

ORDER NO._____

THE COMMONWEALTH OF MASSACHUSETTS
MASSACHUSETTS HIGHWAY DEPARTMENT
TEN PARK PLAZA - BOSTON, MA

—PRELIMINARY ESTIMATE OF QUANTITIES — DETAIL SHEET—

CITY/TOWN: (CITY / TOWN) YEAR: 2006
STA. 10+75 to 22+00 ROAD: MAIN STREET
CLASS: _____
Type of Project: Transportation Improvement Project DATE: JAN 12, 2006

Unclassified Excavation	3,700	Cu. Yards	Gravel for Sidewalks	289	Cu. Yards
Class "B" Trench Excavation	20	Cu. Yards	Gravel for Driveways	185	Cu. Yards
Subbase Borrow	383	Cu. Yards	Embankment +15%	374	Cu. Yards

PROPOSED FULL-DEPTH PAVEMENT (WIDENING) **AREA = 1,211 SY**

SURFACE:	4 INCHES HOT MIX ASPHALT [2 INCHES MODIFIED TOP COURSE MATERIAL OVER 2 INCHES INTERMEDIATE (BINDER) COURSE MATERIAL].
BASE:	3.5 INCHES HOT MIX ASPHALT BASE COURSE
SUBBASE:	4 INCHES DENSE GRADED CRUSHED STONE OVER 8 INCHES GRAVEL BORROW

PROPOSED COLD PLANE & PAVEMENT OVERLAY **AREA = 3,749 SY**

SURFACE:	2 INCHES HOT MIX ASPHALT MODIFIED TOP COURSE MATERIAL.
LEVELING COURSE:	VARIABLE DEPTH HOT MIX ASPHALT TOP COURSE MATERIAL
TACK COAT:	BITUMEN FOR TACK COAT (RS-1) AT 0.10 GALLONS/SQUARE YARD OVER EXISTING OR COLD-PLANED SURFACE.
COLD PLANE:	COLD PLANE VARIABLE DEPTH TO MEET PROPOSED GRADING

Plan No.'s _____ Estimated by _____
Profile No.'s _____ Reviewed by _____
Calculation Book No.'s _____ Submitted by _____

Source: MassHighway

Exhibit 18-27 (Continued)
Sample Quantity Detail Sheet

PROJECT FILE NO. 000000

—PRELIMINARY ESTIMATE OF QUANTITIES— DETAIL SHEET—

TOWN-CITY NAME MAIN STREET YEAR 2006

DATE- JAN 12, 2006

ALL ITEMS NOT COMPLETELY DESCRIBED AND LOCATED ON THE PLANS ARE TO BE DETAILED AS SHOWN BELOW:

ITEM 102. SELECTIVE CLEARING AND THINNING

MAIN STREET
Sta. 10+40 to Sta. 14+00 LT
Sta. 14+70 to Sta. 16+70 RT
Sta. 19+00 to Sta. 19+80 LT

MAPLE STREET
Sta. 213+00 to Sta. 215+70 RT

ITEM 103. TREE REMOVED – DIAMETER UNDER 24 INCHES

MAIN STREET
Sta. 19+02 – 25' RT
Sta. 19+56 – 28' RT
Sta. 19+77 – 29' RT
Sta. 19+96 – 28' RT

MAPLE STREET
Sta. 215+85 – 31' RT
Sta. 216+78 – 20' RT
Sta. 216+85 – 21' RT
Sta. 216+88 – 33' RT
And as directed

ITEM 104. TREE REMOVED – DIAMETER 24 INCHES AND OVER

At various locations as directed.

ITEM 123. MUCK EXCAVATION

MAPLE STREET
Sta. 213+56 to Sta. 214+34

For removal of the top 12 inches of topsoil in wetland impact areas as shown on the plans and as directed.

ITEM 141. CLASS A TRENCH EXCAVATION

For excavation at the proposed stone masonry walls, cement concrete headwall and as directed.

Source: MassHighway

Municipal utilities are those operated by a municipality such as fire alarm systems, water, sewer, or electric power and light systems. Private utilities refer to utilities such as Telephone, Cable and Electric.

The following criteria apply in determining the eligibility for State reimbursement for utility force account work:

- MassHighway will replace in-kind or adjust all municipally owned utilities on state highways which are disturbed by construction. If any 'betterments' are to be made to a utility, the municipality must pay for the additional cost. MassHighway will also reimburse the municipality for the required relocation of municipally owned monuments, flagpoles, etc.
- Private companies may be reimbursed for adjustments made to facilities only when they occupy the way by legal title or easement. A company incurs the cost of making the adjustments at its own expense when the facilities are within a public way by permit, license, or sufferance. The only exception is on the Interstate Highway System where the Department will reimburse for all adjustments.
- MassHighway will pay a railroad under a force account agreement for any work done by the railroad as a result of highway construction. Special provisions submitted by the Railroad will become part of the proposal to bidders.

The designer is responsible for the preparation of utility plans for the Utilities Section which in turn will distribute them to each municipality or utility company. The plan must show all utility changes required by the highway construction. The MassHighway Utility and Railroad Engineer will request the municipality or utility company to submit its force account plans, estimates, and special provisions for reimbursable items. The utility owner must also include special insurance requirements in the special provisions. The MassHighway Utility and Railroad Engineer will prepare all agreements with the utility owner covering costs, scope of work, etc. The MassHighway utility policy is fully discussed in the "*Utility Accommodation Policy*." Note: Special reimbursement to utilities for bridge reconstruction work may apply.

18.7.2 Procedures for Submitting Estimates

The cost estimate cover sheets are prepared on standard MassHighway forms. See the MassHighway Web site at www.mass.gov\mhd for these forms. The Engineer shall submit an electronic version of the

Construction Cost Estimate Spreadsheet to the MassHighway Project Manager in a format acceptable to the Department. Estimates for bridges, non-participating items, or work paid by a municipality directly to the contractor appear on the cover sheets and all contract items appear on the electronic estimate sheets.

18.7.3 Office Calculation Book

The Office Calculation Book (OCB) is to contain all calculations together with locations of the contract quantities as listed in the Proposal. Prior to binding, the OCB pages are to be numbered and two additional sets copied for submission with the PS&E (Copies are to be used in construction). The OCB (original) is to be assembled with a cardboard cover and back, and labeled with an assigned OCB number for the specified project issued by the Plans and Records Section.

The format of the office calculation book should meet these criteria:

- Place index in the beginning.
- Illustrate by stations calculated surface areas, including sketches of street approaches and driveways.
- Quantities should be entered in the calculation book in the order in which they are estimated; i.e., chronologically. (See Exhibit 18-28)
- Quantities must be initialed and dated by the estimator and checked, initialed and dated by the checker.
- Include an earthwork summary with the earthwork calculations. (See Exhibits 18-29 and 18-30.)
- All work is to be neat, legible, and suitable for reproduction.
- Do not make erasures; strike out with a single line.
- Provide a one inch border around each page.
- Handwritten entries are acceptable.
- Enter all project calculations in the office calculation book.

See the MassHighway Web site at www.mass.gov\mhd for samples and excerpts illustrating the recommended format for the preparation of the office calculation book.

Exhibit 18-28

Sample Item Quantity Sheet

151 GRAVEL BORROW CY

Drainage Trenches in Full Depth Pavement:

Drainage Trenches: (3+D)ft width x 18" high x length of pipe(ft)

Str		Str	Pipe Dia. (ft)	Pipe Length	Area (sf)	Volume (cf)	Volume (cy)
3A	to	1A	1.00	38.00	6.00	228.00	8.44
3	to	3A	1.00	208.00	6.00	1248.00	46.22
5	to	6	1.00	34.00	6.00	204.00	7.56
7	to	8	1.00	13.00	6.00	78.00	2.89
11	to	10	1.00	14.00	6.00	84.00	3.11
12	to	13	1.00	61.00	6.00	366.00	13.56
13	to	13A	1.00	44.00	6.00	264.00	9.78
19	to	16	1.00	229.00	6.00	1374.00	50.89
19A	to	19	1.00	13.00	6.00	78.00	2.89
23	to	19	1.00	69.00	6.00	414.00	15.33
17	to	18	1.00	32.00	6.00	192.00	7.11
25	to	26	1.00	4.00	6.00	24.00	0.89
							168.67

Stone Wall Sta 103+65.64 Maple St to Sta. 15+25.00 Main St

Panel	Average Height (ft)	Area (sf)	Length (ft)	Volume (cf)	Volume (cy)
1	5.65	16.30	24.00	391.20	14.49
2	6.28	17.56	24.00	421.44	15.61
3	6.00	17.00	24.00	408.00	15.11
4	5.88	16.76	24.00	402.24	14.90
5	6.00	17.00	24.00	408.00	15.11
6	6.00	17.00	24.00	408.00	15.11
7	6.00	17.00	24.00	408.00	15.11
8	6.00	17.00	13.50	229.50	8.50
					113.94

Gravel bedding under Stone Masonry Wall - Dry

3ft (wide) x 1ft (deep) x 180ft (length) x 1cy/27cf = **20.00**

SUBTOTAL:	302.61
PLUS 25% SWELL:	75.65
	378.26

ITEM 151.01 SAY 400 CY

Estimated by: Intials and date
Checked by: Intials and date

Source: MassHighway

Exhibit 18-28 (Continued)
Sample Item Quantity Sheet

ITEM 220.5 **DRAINAGE STRUCTURE REMODELED** **EACH**

MAIN STREET

	Structure No.	Station	Offset		Type	Quantity
*	--	11+21.2	17.2'	RT	CB	1
*	1	11+66.0	15.4'	LT	GI	1
*	3A	11+55.0	7.5'	RT	DMH	1
*	3	13+65.0	15.3'	RT	CB	1
*	7	17+26.4	31.1'	RT	CB	1
*	8	17+42.1	39.4'	RT	CB	1
*	10	18+32.4	25.0'	LT	CB	1
*	11	18+50.0	25.0'	LT	CB	1
*	12	18+92.5	14.0'	RT	CB	1
*	13	19+60.9	5.5'	RT	DMH	1
*	--	21+22.2	15.2'	RT	CB	1
*	--	21+64.4	32.8'	RT	CB	1

MAPLE STREET

	Structure No.	Station	Offset		Type	Quantity
	24	218+56.2	25.0'	LT	CB	1
	15	214+01.6	11.4'	LT	CB	1
*	16	214+00.0	8.7'	LT	DMH	1
*	19	216+30.0	16.6'	LT	DMH	1
						16

ITEM 220.5 SAY 16 EACH

* To raise structures (lowered for reclamation) to binder course

Estimated by: Intials and date
Checked by: Intials and date

Source: MassHighway

Exhibit 18-28 (Continued)
Sample Item Quantity Sheet

ITEM 460 **HOT MIX ASPHALT** **TON**

FROM SURFACE AREA CALCULATIONS:	Quantity
FULL DEPTH PAVEMENT: 1211 SY 1211 SY x 4" x 0.056 TON/ SY*IN =	271.3 TON
FULL DEPTH LESS THAN 3.0 ft: 340 SY 340 SY x 2" x 0.056 TON/ SY*IN =	38.1 TON
FULL DEPTH RECLAMATION: 6453 SY 6453 SY x 4" x 0.056 TON/ SY*IN =	1445.5 TON
COLD PLANE & PVM'T OVERLAY: 3750 SY 3750 SY x 2" x 0.056 TON/ SY*IN =	420.0 TON
From Cross Sections Leveling Volume: 114 CY 114 CY x 2.02 TON/CY =	230.3 TON
	2405.1 TON

ITEM 460 SAY 2,500 TON

Estimated by: Intials and date
Checked by: Initials and date

Source: MassHighway

Exhibit 18-29
Sample Earthworks Quantity Sheet

EARTHWORK QUANTITY SHEET

MAIN STREET

Station	Length (ft)		Cut Area (sf)	Avg Cut Area (sf)	Cut Vol (cy)		Fill Area (sf)	Avg Fill Area (sf)	Fill Vol (cy)
10+50			0.00				0.00		
11+00	50		2.90	1.45	2.69		2.02	1.01	1.87
11+50	50		3.70	3.30	6.11		2.31	2.17	4.01
12+00	50		2.71	3.21	5.94		1.15	1.73	3.20
12+50	50		15.47	9.09	16.83		0.00	0.58	1.06
13+00	50		24.98	20.23	37.45		2.61	1.31	2.42
13+50	50		16.03	20.51	37.97		8.86	5.74	10.62
14+00	50		16.14	16.09	29.79		10.42	9.64	17.85
14+50	50		25.06	20.60	38.15		14.19	12.31	22.79
15+00	50		28.68	26.87	49.76		1.05	7.62	14.11
15+50	50		27.84	28.26	52.33		3.25	2.15	3.98
16+00	50		38.83	33.34	61.73		0.00	1.63	3.01
16+50	50		16.61	27.72	51.33		15.86	7.93	14.69
17+00	50		10.68	13.65	25.27		3.43	9.65	17.86
17+50	50		4.32	7.50	13.89		1.46	2.45	4.53
18+00	50		7.52	5.92	10.96		2.11	1.79	3.31
18+50	50		24.35	15.94	29.51		1.78	1.95	3.60
19+00	50		24.95	24.65	45.65		1.29	1.54	2.84
19+50	50		20.95	22.95	42.50		3.08	2.19	4.05
20+00	50		19.24	20.10	37.21		0.00	1.54	2.85
20+50	50		13.36	16.30	30.19		0.22	0.11	0.20
21+00	50		9.14	11.25	20.83		1.35	0.79	1.45
21+50	50		0.00	4.57	8.46		0.00	0.68	1.25
22+00	50		0.00	0.00	0.00		0.00	0.00	0.00
				TOTAL:	**654.56**			TOTAL:	**141.56**

Estimated by: Initials & date
Checked by: Initials & date

Source: MassHighway

Exhibit 18-30
Sample Earthworks Summary Quantity Sheet

SUMMARY QUANTITY SHEET

FROM EARTHWORKS SHEETS:

EXCAVATION			EMBANKMENT		
Main Street:	655.00	CY	Main Street:	142.00	CY
Boston Road	482.00		Boston Road	49.00	
	1137.00	CY		191.00	CY

EXCAVATION			EMBANKMENT		
Earthworks:	1137.00	CY	Earthworks:	191.00	CY
HMA Driveways:	208.91				
Cement Driveways:	27.77				
Class A Trench:	71.15				
Estimated Excavation:	1444.83	CY	Estimated Embankment:	191.00	CY
DEDUCT 2.5% (Boulders):	- 36.12				
DEDUCT 5% (Unsuitable):	- 72.24				
DEDUCT 5% (Shrinkage):	- 72.24		PLUS 15% (Swell):	28.65	
Available for Embankment:	1264.23	CY	TOTAL Embankment Required:	219.65	CY
			Available from Embankment:	-1264.23	
			WASTE:	**-1044.59**	**CY**

Estimated by: Initials & date
Checked by: Initials & date

Source: MassHighway