

Chapter 8

QUANTITY COMPUTATION

INTRODUCTION

The intent of this chapter is to provide guidelines for computing quantities for contract items needed to construct a highway project. These guidelines will help standardize the *Quantity Workbook* that contains all the project quantity calculations for the Contract Administrator's information during construction.

The Designer should reference the Special Attentions, Special Provisions, Special Details, Supplemental Specifications, *Standard Specifications for Road and Bridge Construction* (Spec. Book) (7), Standard Plans and the Item Description Master File (Appendix 13-2) for various application rates, constants, appropriate item numbers, item nomenclature and the intent of the work to be performed under that item.

Computation and estimation of quantities are not just "number crunching". The items and quantities shown on the PS&E Estimate must be the result of sound engineering judgment. Calculate each item for the contract in the *Quantity Workbook* on a form similar to the Highway Design Calculation Sheet (see Appendix 8-1). The calculations in the *Quantity Workbook* should be initialed by the person calculating the quantity and verified and initialed by a checker within the design team. Both individuals are responsible for the accuracy of the quantity. Keep the calculations simple, organized, clear, and neat as possible. It is helpful to write down formulas, define variables and always include the units. This will avoid confusion, minimize errors in calculation, and make calculations easier to understand for the checker.

A good example of when these principles are important is the calculation of final pay quantities. Certain item quantities shown in the estimate will be the quantity paid for during construction and are considered final pay quantities. There will not be any measuring or checking of calculations for final pay quantities in the field by Construction Field Personnel. With no measuring or checking of calculations for these quantities, there will not be any adjustment in the field to these quantities. Therefore, it is important that the quantity shown in the estimate be as accurate as possible. Those items which are designated as having a final pay quantity are noted with an (F) at the end of the item description in the *Item Description Master File*.

Another situation when good engineering judgment should be used is earthwork calculations along an alignment with sharp curvature. Cut and Fill quantities computed from the cross sectional information may not be accurate. Distances between stations along the construction baseline are significantly shorter at the toe of slope on the inside of the curve, and longer at toe of slope on the outside of the curve. If the volume of cut is primarily on one side of the baseline and fill primarily on the other, the quantities for cut and fill along this alignment will be inaccurate. Cut and Fill quantities for these situations should be adjusted for the sharp curvature. Consult your supervisor for direction.

It is important not to round individual quantity calculations since the quantities are rounded when sub-totals are derived. The procedure to round quantities is explained in Chapter 13 of this manual.

Generally, calculate a quantity to one more significant digit than is stated in the Method of Measurement for that item in the *Standard Specifications*. For example, Item 417 - Cold Planing of Bituminous Surfaces states that this item will be measured by the square meter (m^2); therefore, calculate individual areas of Cold Planing to the nearest 0.1 m^2 .

Perform individual quantity calculations to the following level of precision:

<u>Item No./Description</u>	<u>Method of Measurement</u>	<u>Calculate to</u>
Item 201.1 - Clearing & Grubbing	0.01 ha	0.001 ha
Item 202.41 - Removal of Existing Pipe	0.1 m*	0.1 m
Item 202.6 - Curb Removal for Storage	0.1 m*	0.1 m
Item 202.7 - Removal of Guardrail	0.1 m*	0.1 m
Section 203 - Excavation & Embankment	1 m^3	0.1 m^3
Section 206 - Structure Excavation	1 m^3	0.1 m^3
Section 207 - Channel Excavation	1 m^3	0.1 m^3
Section 209 - Granular Backfill	1 m^3	0.1 m^3
Section 300 - Base Courses	1 m^3	0.1 m^3
Section 306 - Reclaimed Stabilized Base	1 m^2	0.1 m^2
Section 403 - Hot Bituminous Pavement	0.1 t	0.01 t
Section 417 - Cold Planing of Bituminous Surfaces	1 m^2	0.1 m^2
Section 508 - Structural Fill	1 m^3	0.1 m^3
Section 520 - Portland Cement Concrete	1 m^3	0.1 m^3
Section 544 - Reinforcing Steel	1 kg*	1 kg
Section 570 - Stone Masonry	0.1 m^3	0.01 m^3
Section 572 - Stone Wall	0.5 m*	0.5 m
Section 583 - Riprap	0.1 m^3 *	0.1 m^3
Section 585 - Stone Fill	1 m^3	0.1 m^3
Section 593 - Geotextile	1 m^2	0.1 m^2
Section 603 - Culverts and Storm Drains	0.1 m	0.01 m
Section 604 - CB's, DI's, and MH's	0.1 Units	0.01 Units
Section 605 - Underdrains	0.1 m	0.01 m

<u>Item No./Description</u>	<u>Method of Measurement</u>	<u>Calculate to</u>
Section 606 - Guardrail	0.1 m	0.01 m
Barrier	1 m	0.1 m
Section 607 - Fences	0.1 m*	0.1 m
Section 608 - Sidewalks	0.1 m ²	0.01 m ²
Section 609 - Curbs	0.1 m	0.01 m
Section 614 - Electrical Conduit	0.1 m	0.01 m
Section 615 - Traffic Signs	0.01 m ² *	0.01 m ²
Section 628 - Sawed Pavements	1 m	0.1 m
Section 632 - Pavement Markings (Line)	1 m	0.1 m
(Symbol)	0.01 m ² *	0.01 m ²
Section 641 - Loam	0.1 m ³	0.01 m ³
Section 642 - Limestone	0.01 t	0.001 t
Section 643 - Fertilizer (t)	0.01 t	0.001 t
(kg)	1 kg*	1 kg
Section 644 - Seed	1 kg*	1 kg
Section 645 - Erosion Control (Matting)	1 m ²	0.1 m ²
Mulch	0.01 ha	0.001 ha
Silt Fence	0.1 m*	0.1 m
Section 646 - Turf Establishment (ha)	0.01 ha	0.001 ha
(m ²)	1 m ²	0.1 m ²
Section 647 - Humus	1 m ³	0.1 m ³
Section 648 - Sod	1 m ²	0.1 m ²

Any item that is measured by the number of units will be measured to the whole number.

NOTE: * This item does not follow the general guideline.

The following general information is useful when calculating certain quantities:

Conversions for Digitizing Metric Plans and Cross Sections in English Units (in²)

$$\begin{aligned}
 1:500 \text{ plan:} & \quad N \text{ in}^2 \times 161.29 \text{ m}^2/\text{in}^2 = P \text{ m}^2 \\
 1:250 \text{ plan:} & \quad N \text{ in}^2 \times 40.32 \text{ m}^2/\text{in}^2 = P \text{ m}^2 \\
 1:100 \text{ x-sect:} & \quad N \text{ in}^2 \times 6.45 \text{ m}^2/\text{in}^2 = P \text{ m}^2 \\
 1:50 \text{ x-sect:} & \quad N \text{ in}^2 \times 1.61 \text{ m}^2/\text{in}^2 = P \text{ m}^2 \\
 & \quad N = \text{number of in}^2; P = \text{number of m}^2
 \end{aligned}$$

This information is included to help those who use an instrument known as a *Digitizer* or the *Electronic Planimeter* to measure scaled areas. This instrument is usually calibrated to measure areas in square inches (in²) at a scale of 1:1. Confusion can be avoided if the area is measured using CAD/D. Most software will have commands that allow measured areas to be produced as if they were measured "in the field".

Another important issue is the Slope Correction Factor. Some work, e.g., drainage, landscaping, erosion control, etc., is often performed on a steep slope. Typically, these quantities are calculated by measuring the lengths (and widths to compute an area if needed) or measuring the areas from the plans. This can be done, but realize that the measurements will be made in the horizontal plane and must be corrected for the slope angle. For example, an area measured in the horizontal plane is actually 29% smaller than the same area measured on a 1:1 slope. The standard Slope Correction Factors are as follows:

4:1 (1.03)	3:1 (1.05)	2:1 (1.12)	1.5:1 (1.20)
1.25:1 (1.28)	1:1 (1.41)		

Quantities summarized within the Quantity Workbook should be referenced to the pertinent page(s) on which the quantity was calculated. For example, Item 209.1 - Granular Backfill would look like this:

Retaining Wall	Page 18	8.1 m ³
Drainage:		
Note 6	Page 37	4.5 m ³
Note 13	page 46	<u>11.7 m³</u>
	Total =	24.3 m ³

DIVISION 200 - EARTHWORK

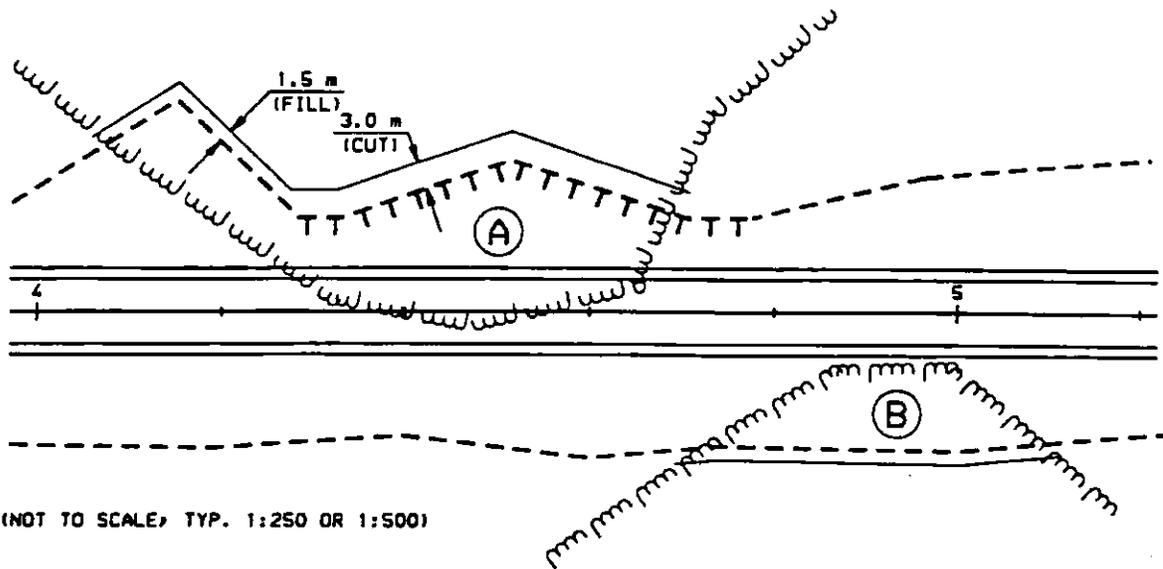
SECTION 201 - CLEARING AND GRUBBING

Item 201.1 - Clearing & Grubbing

Trees 700 mm or under in circumference will be classified as brush, and as such, their clearing will be considered subsidiary, see spec. 201.4.2.2. Additional clearing may be required for sight distance at intersections or along the inside of horizontal curves.

Planimeter/digitize the area to the nearest 0.01 square inch (or measure the area to the nearest 0.01 ha if CAD/D will allow). Assign a letter designation to each measured area as shown in Figure 8-1. Estimate a 1 meter wide clearing strip for fence lines by a station to station reference and compute to the nearest 0.01 ha. Do not assign a letter designation to fence line clearing areas. Remember that a R.O.W. slope easement may be required to clear and grub along a fence line since it is common practice to place the fence along the R.O.W. line. Show a column on the Fencing Summary and pay under Item 201.6 - Clearing for Fence Lines.

FIGURE 8-1



Location

- (A) Sta. 4+15.0, Lt. to 4+73.0, Lt. $3.20 \text{ in}^2 \times 161.29 \frac{\text{m}^2}{\text{in}^2} \times \frac{1 \text{ ha}}{10\,000 \text{ m}^2} = 0.052 \text{ ha}$
- (B) Sta. 4+75.0, Rt. to 5+05.0, Rt. $1.30 \text{ in}^2 \times 161.29 \frac{\text{m}^2}{\text{in}^2} \times \frac{1 \text{ ha}}{10\,000 \text{ m}^2} = 0.021 \text{ ha}$
- Total = 0.073 ha

A contract item total smaller than 0.10 ha can be considered subsidiary, so no item for Clearing and Grubbing would be included in the contract. If subsidiary, the area designations are still shown in the Clearing and Grubbing Summary box on the summary.

The calculation for each designated area should be identifiable and summarized separately. There are other areas that may require clearing and grubbing. A few of these are:

- Mitigation Areas
- Sight distance easements
- Detours
- Erosion Control areas (Swales, Sedimentation Basins)
- Special Access drives
- Right-of-Way agreements

SECTION 202 - REMOVAL OF STRUCTURES & OBSTRUCTIONS

Item 201.21, .2, .4 - Removing Trees & Stumps

Tabulate trees and stumps to be removed as shown on the cross sections, within the limits of the roadbed and less than 1 meter below subgrade. (Check against the Plan Preparation Record Plan.)

Location	201.21 Small	201.22 Large	201.4 Stumps
16+37, 5.0 m Rt.	1	-	-
16+39, 1.0 m Lt.	-	1	-
17+04, 3.0 m Lt.	-	-	1
19+97, 7.0 m Rt. (triple)	2	1	-
Total	3	2	1

Item 202.1, .2 - Demolishing Buildings

There are definite cases for the use of each of these items. Item 202.1xx is used when the building may be removed prior to a date specified in the contract by others (not the Contractor). Item 202.2xx is used if the building is removed by the Contractor as part of the project. For example:

Parcel No.	Station	Structure	Item No.	Unit
8	30+21, Rt.	Garage & House	202.101	1
13	33+20, Lt.	Barn	202.102	1
21	34+10, Rt.	Shed	202.201	1

The table shown above is an example of a typical summary for this item. The first two structures are on the same parcel and will be removed as one unit, thus, they are paid under the same item. Refer to Volume II of for the sample layout of the summary sheet. On urban projects, include the street address if available.

Item 202.4, 202.5 - Removal of Pipes, Catch Basins, Drop Inlets and Manholes

Removal of pipes and other drainage structures is paid under *Standard Specifications* Section 202 if the Contractor is required to perform the removal as a separate operation. If the pipe or drainage structure is removed as the result of excavation for another structure, removal is considered subsidiary. See the Section 603 & 604 computations for additional information.

Item 202.51 - Removal of Granite Curb Inlets (GCI)

Tabulate by station and offset. If CB's and DI's are being removed, the granite curb inlet removal is subsidiary to the removal of the structure (See Spec. 202.4.3). Otherwise, pay under Item 202.51. This item will be listed in the curbing summary.

Item 202.6 - Curb Removal for Storage

There is a distinction between *Reset Curb*, *Curb Removal for Storage*, and *New Curb*. It is important that the Designer understands what will happen to a particular run of existing curb as a result of the project. The Designer should always try to reuse existing curbing if it is

found to be in good condition. Curbing is considered as surplus when it is stockpiled and not reused on the project. Vertical and slope curb should be tabulated separately for informational purposes. For more information, see the Section 609 computations. For example:

Location	Curb to be Removed	
	Slope	Vertical
1+10.0 to 1+45.0, Rt.	-	35.0 m
1+10.1 to 1+70.2, Lt.	60.1 m	-
1+70.3 to 2+20.6, Lt.	-	50.3 m
	60.1 m	85.3 m

Total = 145.4 m

Item 202.7 - Removal of Guardrail

The removal of guardrail will be paid under Item 202.7 only when the existing guardrail is being eliminated and not replaced, i.e., when slopes are flattened or hazards are removed. When new guardrail replaces existing, removal of the existing is subsidiary to the construction of the new guardrail.

Be careful how the removal of an anchor unit is paid for. FHWA will not fund the removal of obsolete guardrail terminal units, e.g., cable guardrail anchors, terminal units type F, etc. The anchor rod on a cable guardrail anchor unit is usually cut 300 mm below ground, allowing the terminal unit to be left in place. If the anchor is removed, the removal is included in the payment for Item 203.1 - Common Excavation.

Check with the District Maintenance Engineer to inquire if any of the guardrail materials are to be salvaged, e.g., rail, cable, anchor units, posts or hardware. Salvaged materials are noted on the summary sheets and in the Prosecution of Work. Locate the guardrail removed by a station to station reference. For example:

Location	Subsidiary Removal of Guardrail (Replaced)	Item 202.7 Removal of Guardrail (Eliminated)
10+00.5 to 12+13.8, Rt.	-	213.8 m (w/ 2 Melts)
13+20.4 to 16+13.0, Lt.	292.6 m (w/ 2 Melts)	-
30+00.3 to 32+20.7, Rt.	174.8 m (w/ 2 Melts)	45.6 m
Total	467.4 m	258.9 m

SECTION 203 - EXCAVATION AND EMBANKMENT

Excavation and Embankment commonly are "big ticket" items on a highway project. The payment quantity for these items is derived by performing calculations on an Earthwork Summary Sheet. This document, which is included in the plans as the Earthwork Summary, will be discussed later in this section.

Start your calculations for the Earthwork Summary by first determining the amount of material to be excavated (known as "Cut"). The common method for determining this is an Average End Area calculation. This method involves determining the size of the end area on

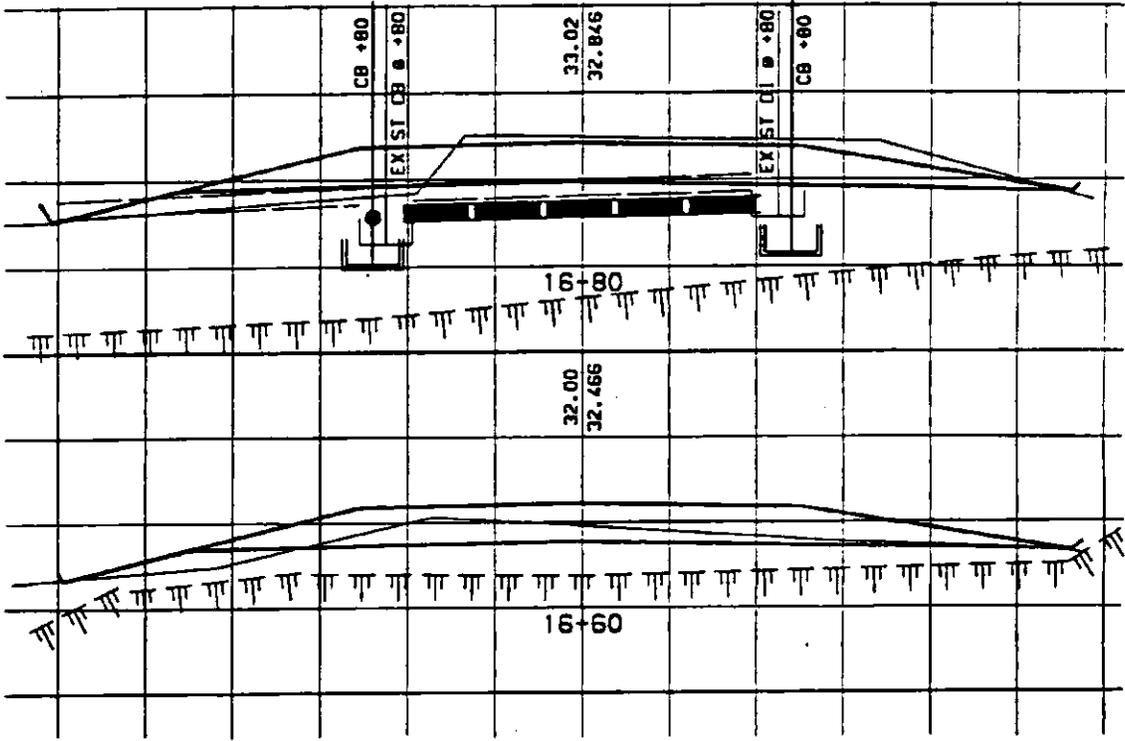
successive cross sections and multiplying the length between the sections by the average of the end areas.

Figure 8-2 shows a roadway cross section sheet (NOTE: the minor grid is removed to help visualize the information). Notice that each section requires removal of existing material to construct the base course, i.e., that area from the existing ground down to the subgrade (see the diagram preceding the *Standard Specifications* Section 100). These areas are entered on the Earthwork Quantities Sheet under the heading "Excavation" (Figure 8-3). They will be used to calculate the amount of Cut between each station.

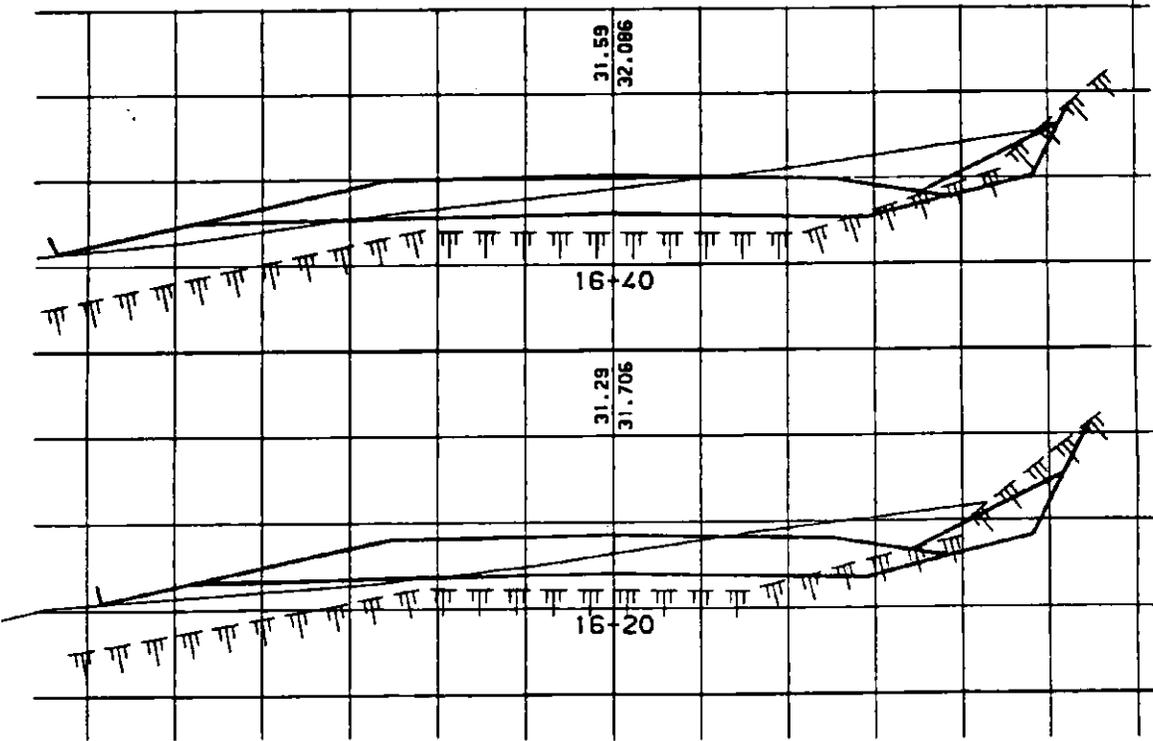
There are two ways that the Earthwork Quantities Sheet can be compiled. The first method involves making measurements using a planimeter. Make this entry on the Earthwork Quantities sheet in the column labeled in^2 under the heading "Excavation".

To compute the volume of material between the sections, multiply the appropriate "K" factor from Table 8-1 by the sum of the areas in in^2 . The "K" factor accounts for the average of the end areas. "K" factors for distances not shown on the chart can be interpolated from the "K" factors the distances falls between (e.g., the "K" factor for 13.56 meters can be interpolated from the "K" factors for 13 meters and 14 meters, which is "K" = 43.741).

FIGURE 8-2



(NOT TO SCALE, TYP. 1:50 OR 1:100)



The second method is the use of computer software. Programs or commands can identify volumes for earthwork quantities. However, it is important to note how the calculation was performed so that it can be reviewed. The size of the end areas at each cross section involved in the computation must be shown on the Earthwork Quantities Sheet. This area could be shown as in^2 or m^2 (NOTE: If you decide to make entries in m^2 note this under the headings Excavation & Embankment on the Earthwork Quantities Sheet).

Show the total amount of excavation to be performed within the limits of each cross section sheet on the line labeled "Common Excavation". This is where the Engineer will look to verify payment to the Contractor for the earthwork completed at various stages of the construction phase.

Once all the excavation from the cross sections has been computed, compute the amount of material needed to construct any embankments needed along the roadway (known as "Fill"). Entries for Fill are made under the heading "Embankment" on the Earthwork Quantities Sheet. Calculate the Fill volume by using the same method used to quantify the Cut, i.e., Average End Area. The Fill is the material in the area above the old ground up to the subgrade. Again, remember to note the total amount of Fill on the line labeled "Fill" on each cross section.

The Cut and Fill information will be transferred to the Earthwork Summary Sheet including any Rock or Muck excavation if involved. This is where the final earthwork quantities will be computed (e.g. Item 203.1, 203.2, 203.4, etc.).

Figure 8-4 shows an example of the typical Earthwork Summary Sheet. (There may not be an entry for every line shown in the example. Similarly, the example may not show a line that is needed for the particular project. The example should not be taken literally as shown, so it can be modified to account for specific project needs.)

FIGURE 8-3

New Hampshire Dept. of Transportation			Sheet 1 of 2			
EARTHWORK QUANTITIES						
ANYWHERE			99999			
Town			State Project No.			
Computed by	J. Hardiman		Date		Jan - 1 - 2000	
Checked by	S. Hardiman		Date		Jan - 1 - 2000	
K ₂₀ = 64.516			SCALE (1:100)			
EXCAVATION			EMBANKMENT			
Station	in ²	m ³	X-sect Sheet Total	in ²	m ³	X-sect Sheet Total
16+20.00	0.23			0.00		
		27.7			6.5	
16+40.00	0.20			0.10		
		34.2			15.5	
16+60.00	0.33			0.14		
		58.1			9.0	
16+80.00	0.57			0.00		
		11.6			0	
16+83.15	0.57	(area assumed same as Sta. 16+80)		0.00		
BRIDGE LOCATION STA. 16+83.15 TO 16+98.45						
16+98.45	0.37	(area assumed same as Sta. 17+00)		0.00		
		3.7	135.3		0	31.0
17+00.00	0.37			0.00		
		42.6			5.8	
17+20.00	0.29			0.09		
		36.1			14.2	
17+40.00	0.27			0.13		
		31.0			19.4	
INTERSECTION OF MILLIKEN DRIVE WITH NH RTE. 11 STA. 17+47						
17+60.00	0.21			0.17		
		25.8			23.9	
17+80.00	0.19			0.20		
			135.5			63.3
<p>This is a suggested format for an Earthwork Quantities sheet. Quantities for Rock or Muck excavation can also be calculated using this sheet.</p> <p>The "K" value is from the Highway Design Manual, Volume 2.</p> <p>Using this "K" value, determine the volume between sections m3 by multiplying the K value by the sum of the end areas (in2).</p>						

EARTHWORK COMPUTATIONS

NOTE: THE PURPOSE OF THIS TABLE IS TO SIMPLIFY CALCULATION OF EARTHWORK QUANTITIES. IT SHOULD BE REMEMBERED THAT THE "K" FACTORS SHOWN WERE DERIVED ASSUMING THE EQUIPMENT USED TO MEASURE THE AREAS GAVE RESULTS IN SQUARE INCHES. (K's SHOWN ARE FOR 1:100)

Enter table with "L", distance between cross sections (linear meters)

Read "K" factor for distance between sections.

Volume (m³) = K x Sum of end areas (square inches).

CROSS SECTION SCALE:
1:100 (2 meter x 2 meter grid)
1:50 ("K"/4)

L	40	39	38	37	36	35	34	33
K	129.032	125.806	122.580	119.355	116.129	112.903	109.677	106.451
L	32	31	30	29	28	27	26	25
K	103.226	100.000	96.774	93.548	90.322	87.097	83.871	80.645
L	24	23	22	21	20	19	18	17
K	77.419	74.193	70.968	67.742	64.516	61.290	58.064	54.839
L	16	15	14	13	12	11	10	9
K	51.613	48.387	45.161	41.935	38.710	35.484	32.258	29.032
L	8	7	6	5	4	3	2	1
K	25.806	22.581	19.355	16.129	12.903	9.677	6.451	3.226

TABLE 8-1

FIGURE 8-4

Project: _____ Fed. No. _____ State No. _____
Preliminary Final

1.	Common Excavation in Sections, Including Boulders and Pavement		
2.	Common Excavation Not In Sections (Bituminous Pavement)		
3.	Common Excavation for Wetland Creation, Including Boulders		
4.	Drive and Approach Excavation, Including Boulders		

5.	Common Excavation in Sections, Excl. Bldrs. & Conc. Pvmt. [1-(22+23)]		
6.	Common Excavation for Wetland Creation (3 - 24)		
7.	Muck Excavation in Sections (Not Item 203.4).		
8.	Topsoil Removed Beneath Fill Sections		
9.	Unsuitable Material Removed Beneath Fill Sections		
10.	Drive and Approach Excavation (4 - 26)		
11.	Total Common Excavation (Sum of 5 thru 10)		
	COMMON EXCAVATION FOR ESTIMATE	ITEM 203.1	
12.	Muck Excavation (See Item 203.4)		
	MUCK EXCAVATION FOR ESTIMATE	ITEM 203.4	
13.	Wetland Soils Removed For Mitigation (Cuts and Fills) (See Item 203.49)		
	WETLAND SOILS FOR MITIGATION FOR ESTIMATE	ITEM 203.49	
14.	Rehandling Surcharge Material		
	REHANDLING SURCHARGE MAT'L FOR ESTIMATE	ITEM 203.7	
15.	Unclassified Channel Excavation, Roadway (See Item 207.3)		
16.	Unclassified Channel Excavation, Bridge (See Item 207.3)		
17.	Common Bridge Excavation (Item 504.1) (From Bridge Quantities)		
18.	Common Channel Excav., Roadway (See Item 207.1) (From Drainage Quants.)		
19.	Common Channel Excav., Bridge (See Item 207.1) (From Bridge Quants.)		
=====			
20.	Rock Excavation in Sections (Solid)		
21.	Rock Excavation for Wetland Creation (Solid)		
22.	Boulders in Sections (1 x ___%)		
23.	Concrete Pavement in Sections		
24.	Boulders in Common Excavation for Wetland Creation (3 x ___%)		
25.	Drive and Approach Excavation (Solid Rock)		
26.	Drive and Approach Excavation (Boulders) (4 x _____%)		
27.	Rock Overbreakage		
28.	Rock Not Covered by Sections (Surface Bldrs, Headers, Foundations, etc.)		
29.	Total Rock Excavation (Item 203.2) (Sum of 20 thru 28)		
	ROCK EXCAVATION FOR ESTIMATE	ITEM 203.2	
30.	Rock Structure Excavation (See Item 206.2)		
31.	Rock Bridge Excavation (See Item 504.2, 504.21 or 504.24) (From Bridge Quants.)		

32.	Rock Channel Excavation, Roadway (See Item 207.2) (From Drainage Quantities)		
33.	Rock Channel Excavation, Bridge (See Item 207.2) (From Drainage Quants.)		
=====			
34.	Sections Fill		
35.	Topsoil Replacement (8)		
36.	Unsuitable Material Replacement (9)		
37.	Muck Replacement (7 or 12)		
38.	Drive and Approach Fill		
39.	Wetland Soil Replacement (13)		
40.	Fill for Rock Cut Earth Berms		
41.	Replace Embankment Settlement with Fill Material		
42.	Embankment-In-Place (Item 203.6) (Sum of 34 thru 41)		
	EMBANKMENT-IN-PLACE FOR ESTIMATE	ITEM 203.6	

Computed By: _____ Date: _____ Revised By: _____ Date: _____
 Checked By: _____ Date: _____ Checked By: _____ Date: _____

**NOTE: Do not show italicized matter on Earthwork Summary for the Plans*

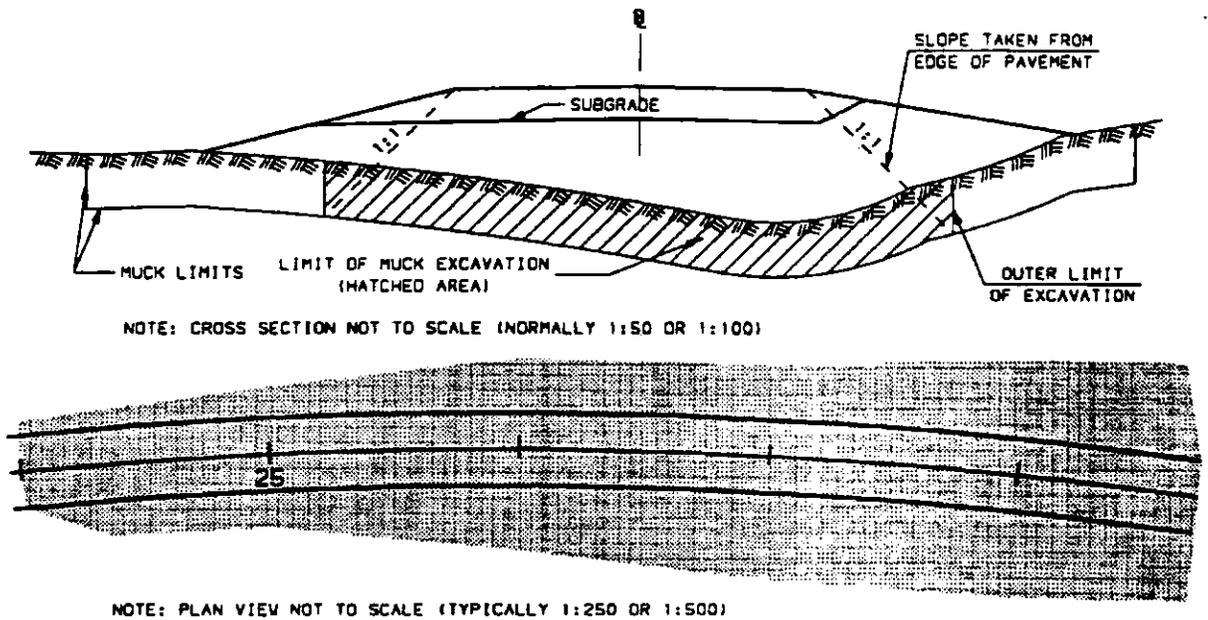
EARTHWORK SUMMARY SHEET

The following are the directions for compiling the Earthwork Summary Sheet. The directions may include information that is not relevant to the project. They may also not include information that is needed. Use engineering judgment to decided what should be shown on the Earthwork Summary for the plans. Add and delete lines as needed.

1. **Common Excavation in Sections, Including Boulders and Pavement** Compute this quantity on the Earthwork Quantities Sheets using the "Average-End-Area" method of volumetric computation. This quantity represents the sum of the volumes measured on the cross section sheets that are entered on the sheet in the line labeled "Common Excavation". This is not the quantity that is paid as Item 203.1 - Common Excavation. This work includes any boulders or concrete pavement that would be in the measured cross sectional area that are not paid under Item 203.1.
2. **Common Excavation Not In Sections (Bituminous Pavement)** This quantity represents excavation to remove existing bituminous pavement not shown in the cross sections.
3. **Common Excavation for Wetland Creation, Including Boulders** This work seldom falls completely within the roadway cross sections. This quantity separates wetland construction from roadway construction, and may be computed by the Average-End-Area method if cross sectional information for the site is available. A grading plan could be used instead of cross sections, as long as an acceptable method of three dimensional measurement is used.
4. **Drive and Approach Excavation, Including Boulders** Simplify this calculation as much as possible, due to its small percentage in the total Common Excavation. Assume cross sections along the drive or approach center line and use the Average-End-Area method to calculate the quantity, or use and acceptable method of three dimensional measurement if using a grading plan. Do not include this quantity in the volume shown on the cross section sheets in the line labeled "Common Excavation".
5. **Common Excavation in Sections, Excluding Boulders and Concrete Pavement** This calculation excludes material that is not paid as Common Excavation that may be in the measured cross sectional area (e.g., boulders, concrete pavement). The resultant quantity is part of the total quantity paid as Item 203.1.

6. **Common Excavation for Wetland Creation** This calculation excludes material that is not paid as Common Excavation in the excavation for the wetland that may be in the measured cross sectional area (e.g., boulders, concrete pavement, etc.). The resultant quantity is part of the total quantity paid as Item 203.1.
7. **Muck Excavation in Sections (Not Item 203.4)** The decision to pay for the removal of this material as either Item 203.1 - Common Excavation or Item 203.4 - Muck Excavation may be influenced by the construction activities involved. Generally, if the volume encountered is more than 2000 m³ or the average depth is more than 1 m, it can be paid as Item 203.4 - Muck Excavation. Coordinate with the District Construction Engineer to determine the preferred payment item. If this line is used, do not use line 12. (The scale of the section shown in Figure 8-5 is assumed to be 1:100 to illustrate the example calculation.)

FIGURE 8-5

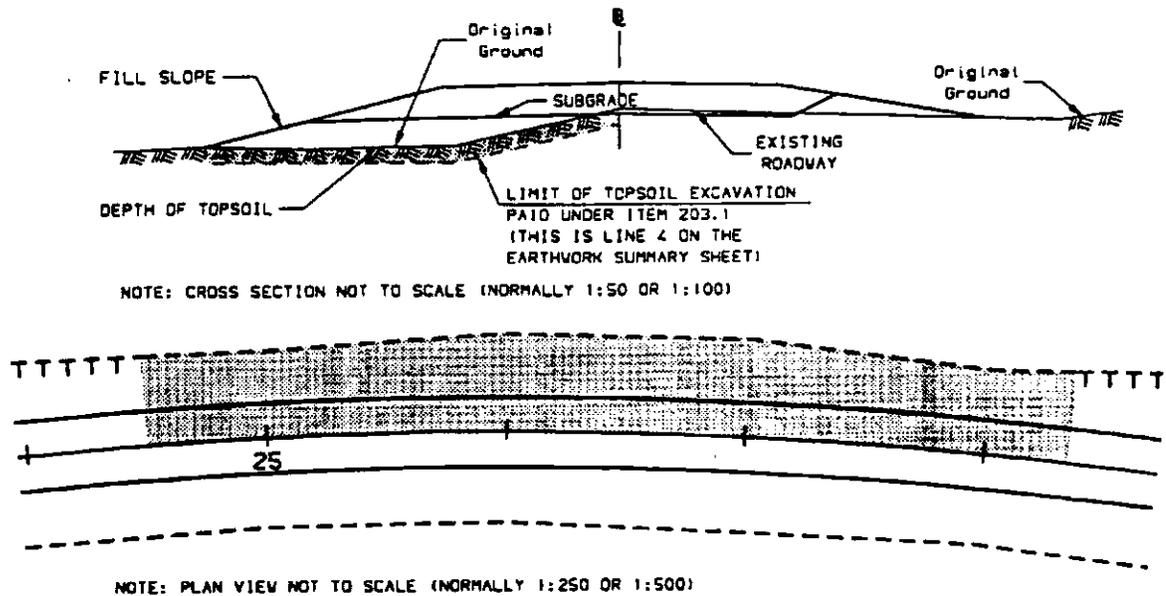


<u>STATION</u>	<u>LENGTH</u>	<u>AREA(in²)</u>	<u>SUM OF AREA(in²)</u>	<u>K (Pg. 9)</u>	<u>VOLUME(m³)</u>
+80		0.63			
	20		1.62	64.516	104.5
25+00		0.99			
	20		2.42	64.516	156.1
+20		1.43			
	20		3.00	64.516	193.5
+40		1.57			
	20		3.29	64.516	212.2
+60		1.72			
	14		3.59	45.161	162.1
+74		1.87			
				TOTAL =	828.4 m ³

8. **Topsoil Removed Beneath Fill Sections** Compute by multiplying the area of fields and woods (plan view) within fill slopes by the depth of Topsoil recommended in the Geotechnical Report. Include only those areas proposed to be filled, not necessarily the limits of the fill slope lines (see Figure 8-6).

FIGURE 8-6

(The scale of Figures 8-6 is assumed to be 1:500.)

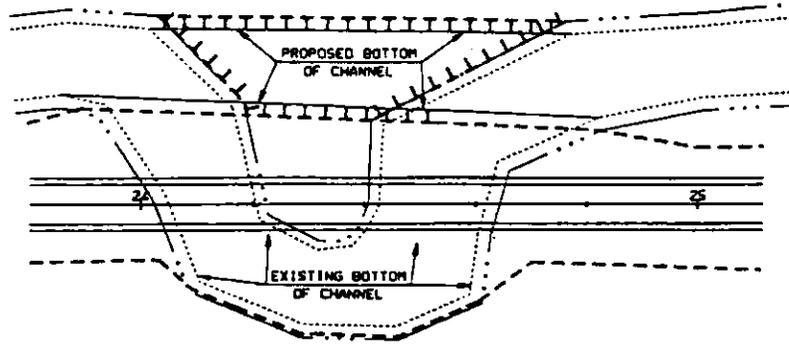


$$\text{Volume} = (3.17 \text{ in}^2 \times 161.29 \frac{\text{m}^2}{\text{in}^2}) \times 0.3 \text{ m deep} = 153.4 \text{ m}^3$$

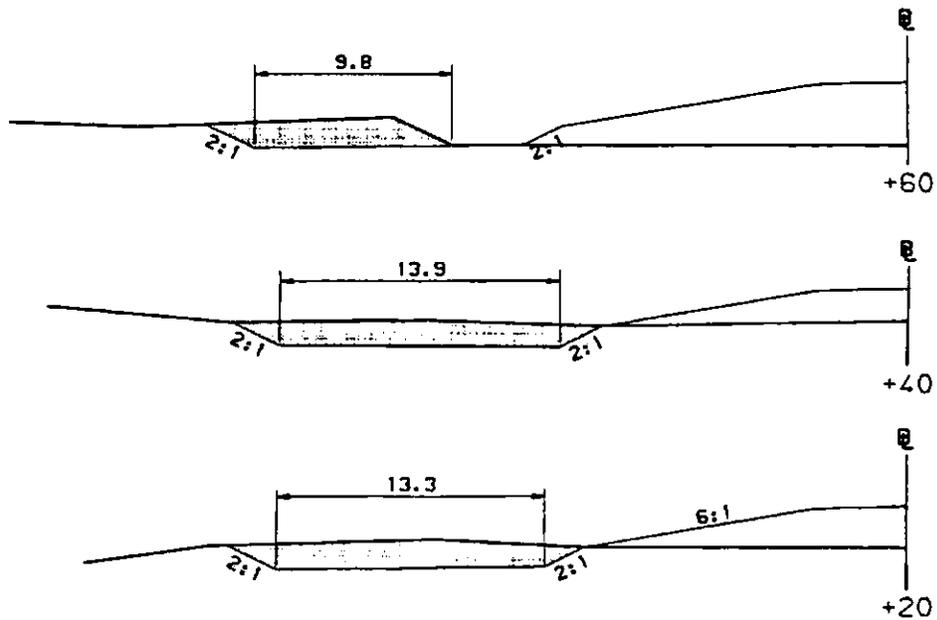
9. **Unsuitable Material Removed Beneath Fill Sections** This line is used to quantify excavated material that is unacceptable as a base for fill material (i.e., stump dumps, silt deposits, marine clays, etc.). The Geotechnical Report will describe the location of this material, its depth, and recommended excavation limits. Compute this quantity by multiplying the area of the material by the depth noted in the Geotechnical Report.
10. **Drive and Approach Excavation** This calculation excludes material i.e., boulders, concrete pavement, etc., that may be in the measured drive or approach area that is not paid as Common Excavation. This quantity should not be part of the volume entered on the cross section sheets in the line labeled "Common Excavation".
11. **Total Common Excavation** This is the total volume of excavation that is paid under Item 203.1 - Common Excavation.
12. **Muck Excavation (Item 203.4)** Using this line results in the payment of this excavation under Item 203.4 - Muck Excavation. Generally, if the volume encountered is more than 2000 m³ or the average depth is greater than 1 m, it should be paid as Item 203.4 - Muck Excavation. If this line is used, do not use line 7.
13. **Wetland Soils Removed for Mitigation (Cuts and Fills) (Item 203.49)** This line is used when a source of Wetland Soils suitable for mitigation is noted in the Geotechnical Report or by specific Environmental determination and will be used in a mitigation site. This quantity includes Wetland Soils removed from cut and fill sections.
14. **Rehandling Surcharge Material** Rehandling surcharge material consists of removing and redepositing the surplus surcharge material that has been used to displace or consolidate certain material below the specified sections of fill. The quantity is computed as the volume of material placed above subgrade minus any anticipated settlement. The expected settlement is normally recommended in the Geotechnical Report as part of the recommendation to surcharge the material.

15. **Unclassified Channel Excavation, Roadway (Item 207.3)** This item is used if classification of the material is not known, i.e., common, rock, muck. Compute for channels that have a bottom width of 3.0 meters or more. (This item may also be used for excavation of detention ponds and vegetated treatment swales. This quantity will appear on the Drainage Summary. (See the example below). The scale of the cross sections shown in Figure 8-7 is assumed to be 1:100. ($K_{20} = 64.516$)

FIGURE 8-7



NOTE: PLAN VIEW NOT TO SCALE (NORMALLY 1:250 OR 1:500)



NOTE: CROSS SECTIONS NOT TO SCALE (NORMALLY 1:50 OR 1:100)

<u>STATION</u>	<u>LENGTH</u> <u>VOLUME(m³)</u>	<u>AREA(in²)</u>	<u>SUM OF END AREAS (in²)</u>	<u>K(Pg. 9)</u>	
24+08		0.00			
	12		3.24	38.710	125.4
+20		3.24			
	20		6.42	64.516	414.2
+40		3.18			
	20		5.43	64.516	350.3
+60		2.25			
	18		2.25	58.064	130.6
+78		0.00			
Total =					1020.5 m ³

16. **Unclassified Channel Excavation, Bridge (Item 207.3)** If Unclassified Channel Excavation is paid for in the Bridge items, the quantity is repeated here for informational purposes.
17. **Common Bridge Excavation (Item 504.1)** If Common Bridge Excavation is paid for in the Bridge items, it is repeated here for information.
18. **Common Channel Excavation, Roadway (Item 207.1)** Compute for channels that have a bottom width of 3.0 meters or more. (This item may also be used for excavation of detention ponds and vegetated treatment swales). This item is used if classification of the material is known to be common. This item will appear on the Drainage Summary. The calculation would be similar to the example shown in Line 15.
19. **Common Channel Excavation, Bridge (Item 207.1)** If Common Channel Excavation is paid for in the Bridge items, the quantity is repeated here for informational purposes.
-
20. **Rock Excavation in Sections (Solid)** This quantity is the sum of all the solid rock areas measured on the cross sections.

Rock excavation usually includes presplitting if the rock is 3 m or more in depth above the subgrade, measured along the slope and the designed slope is 1:2 (H:V) or steeper. If presplitting is not required, a certain amount of overbreakage will be allowed (Specification 203.4.8) and included on the Summary. Compute, but do not show on the cross sections, 600 mm beyond the rock face above the subgrade for overbreakage as a pay item. No overbreakage is allowed or paid for if presplitting is required.

The Bureau of Materials and Research's *Research Geologist* will provide the presplitting hole spacing. The designer will compute the pay quantities linear meters of hole, as follows:

- Measure the depth from top of rock along the designed rock slope to subgrade at 10 m intervals and average the depth between the 10 m intervals.
- Multiply the number of holes in the 10 m section by the average depth. Repeat the process for the length of the face to be presplit.

If the rock cut is more than 10 m deep, a shelf may be needed. Add 1.2 m of depth to allow for the drilling overlap at the shelf. Extra drilled holes without explosives are added by using a percentage recommended by the Bureau of Materials and Research.

21. **Rock Excavation for Wetland Creation (Solid)** This work usually falls outside of the roadway cross sections. This line separates wetland construction from roadway construction and is computed by the Average-End-Area method if cross sectional information is available, or by any acceptable method of three dimensional measurement if a grading plan is used. Coordinate the limits of this excavation with the wetland Designer. This quantity should also include rock excavation for large stormwater detention basins not shown on the cross sections.

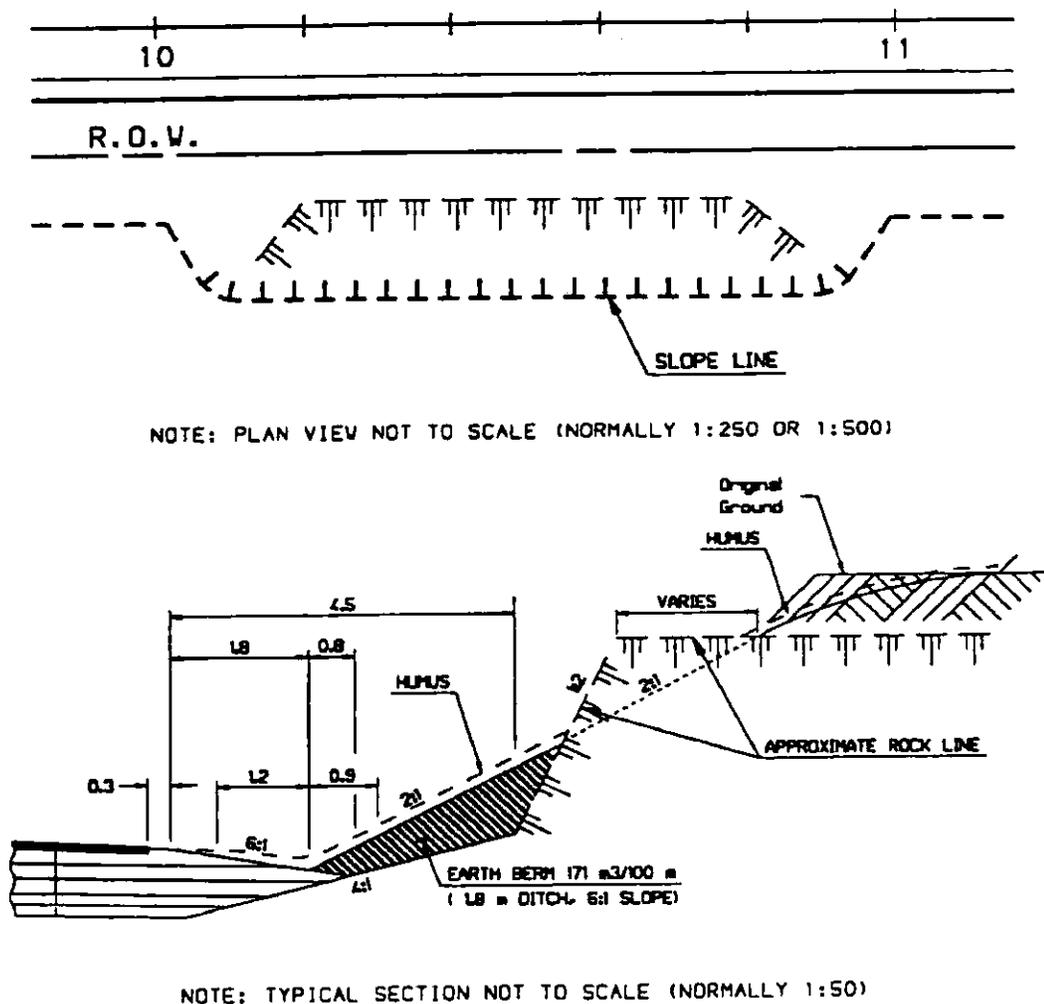
22. **Boulders in Sections** Compute this quantity by multiplying the volume of excavation in Line 1 by the "percentage of boulders in common excavation" recommended in the Geotechnical Report.
 23. **Concrete Pavement in Sections** This quantity represents the quantity of Concrete Pavement present in the excavation. Refer to the old project's typical sections for the dimensions to compute this quantity.
 24. **Boulders in Common Excavation for Wetland Creation** Compute this quantity by multiplying the quantity in Line 3 by the "percentage of boulders in common excavation" recommended in the Geotechnical Report.
 25. **Drive and Approach Excavation (Solid Rock)** Simplify this calculation as much as possible, due to its small percentage in the total Rock Excavation. Assume cross sections along the drive or approach center line and use the Average-End-Area method to calculate the quantity, or use an acceptable method of three dimensional measurement if using a grading plan. Do not include this quantity in the volume entered on the cross section sheets in the line labeled "Rock Excavation".
 26. **Drive and Approach Excavation (Boulders)** Compute this quantity by multiplying the quantity in Line 4 by the "percentage of boulders in common excavation" recommended in the Geotechnical Report.
 27. **Rock Overbreakage** See *Standard Specifications* Section 203.4.8. If Presplitting is paid for, no measurement for overbreakage will be allowed. When overbreakage is measured and allowed, it will be measured 600 mm horizontally beyond the required slope lines. No allowance for overbreakage will be made below the subgrade elevation.
 28. **Rock not Covered by Sections** This quantity includes surface boulders and the removal of existing stone or masonry structures not accounted for in the cross sectional information.
 29. **Total Rock Excavation (Item 203.2)** This is the total volume of excavation that is paid as Item 203.2 - Rock Excavation.
 30. **Rock Structure Excavation (Item 206.2)** This quantity is solid rock excavation for structure installation (i.e. ditches, catch basins, culverts, headwalls, retaining walls, drainage swales). Make sure to cross reference this quantity with the Total from the Drainage Summary.
 31. **Rock Bridge Excavation (Item 504.2, 504.21 or 504.24)** This excavation is performed for the construction of bridge piers and abutments. The quantity should be provided by the Bridge Designer and is shown here for informational purposes.
 32. **Rock Channel Excavation, Roadway (Item 207.2)** Compute for channels that have a bottom width of 3.0 meters or more. (This item may also be used for excavation of detention ponds and vegetated treatment swales.) This line is used if classification of the material is known to be rock. This item will appear on the Drainage Summary. The calculation would be similar to the example shown in Line 15.
 33. **Rock Channel Excavation, Bridge (Item 207.2)** This quantity is provided by the bridge Designer when the classification of the material is known to be rock, and is repeated here for informational purposes.
-
34. **Sections Fill** Compute this quantity using the "Average-End-Area" method of volumetric computation. This quantity represents the sum of the fill volumes measured on the cross section sheets in the line labeled "Fill".
 35. **Topsoil Replacement** This quantity is used to fill the excavation performed to save the Topsoil removed beneath the fill sections and is the quantity shown in Line 8.
 36. **Unsuitable Material Replacement** This quantity is used to fill the excavation that was performed to remove unsuitable material beneath fill sections and is the quantity shown in Line 9.
 37. **Muck Replacement** This quantity is used to fill excavation performed to remove Muck and is the quantity shown in either Line 7 or Line 12.
 38. **Drive and Approach Fill** Simplify this calculation as much as possible, due to its small percentage in the total Embankment-In-Place. Assume cross sections along the drive or approach center line and use the Average-End-Area method to calculate the quantity, or use an acceptable method of three dimensional

measurement if using a grading plan. Do not include this quantity in the volume that is entered on the cross section sheets in the line labeled "Fill".

39. **Wetland Soil Replacement** This quantity is used to fill the excavation that was performed to save identified Wetland Soils, and is the "Fill" part of the quantity shown in Line 13.
40. **Fill for Rock Cut Earth Berms** This quantity is the volume of fill material needed to construct the earth berm at the bottom of a rock cut as shown on the typical sections included in the plans and the example in Fig. 8-8. Compute this volume by applying the constant shown on the typical. In the example the berm is constructed from Sta. 10+20 to Sta. 10+80.

$$\text{Volume} = 60 \text{ m} \times \frac{171 \text{ m}^3}{100 \text{ m}} = 102.6 \text{ m}^3$$

FIGURE 8-8



41. **Replace Embankment Settlement with Fill Material** This quantity is used only when the settlement is not replaced by an aggregate base course, e.g., Item 304.1 - Sand. The approximate settlement is recommended in the Geotechnical Report.

42. Embankment-In-Place (Item 203.6) This volume is the quantity that is paid as Item 203.6 - Embankment In Place.

Item 203.3 - Unclassified Excavation

Use this item for excavation performed in compliance with *Standard Specification* Section 203 when the nature of the material is unknown. Unless the nature of the material is found to be unsuitable, it can be used within roadway embankments.

Item 203.5 - Borrow

The item for borrow is included in a contract when information is unavailable to calculate a reasonably accurate estimate for the final pay quantity Item 203.6 - Embankment - In - Place. Refer to the previous NHDOT Highway Design Manual, which is on file in the NHDOT Library in the Bureau of Transportation Planning.

Item 203.52 - Impervious Material

Define the location of the work. Computations should include a dimensioned sketch. If the computation involves measuring an area from a cross section sheet, set up calculations the same way Earthwork Quantities are (Items 203.1, 203.6, etc.)

Item 203.6 - Embankment - In - Place

The quantity for this item is a final pay quantity and is derived from calculation on the Earthwork Summary Sheet. The basis of the quantity is normally the amount of Fill material needed to create embankments. For computation guidance, see the Item 203.1 computations.

Item 206.1 & 206.2 - Structure Excavation

See the *Standard Specifications* Section 206.1.1, and Appendices 8-2 and 8-3 for a description of when to use this item. Designate each location by station, draw a sketch, and show dimensions as part of the calculation.

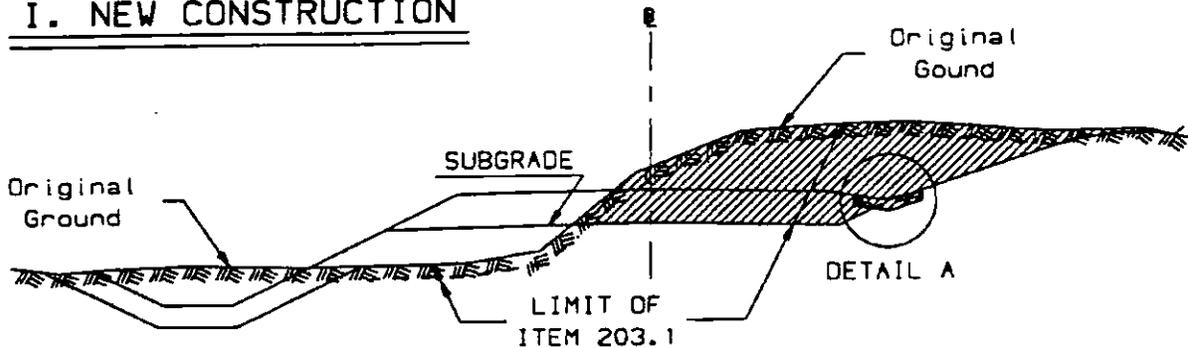
Roadway ditches which are not adjoining roadway excavation and are to be paid under "Structure Excavation", can be computed the same way that roadway excavation quantities are computed ,i.e., Average-End-Area. See *Standard Specifications* Section 206.4 for excavation limits. An example of Structure Excavation can be found under the computations for Items 603 & 604.

Figure 8-9 shows an example of when to pay for roadway ditch excavation. Additional information that describes payment for excavation can be found in the *Standard Specifications* Section 206.

FIGURE 8-9

ROADWAY AND DITCH EXCAVATION PAY LIMITS
FOR FURTHER INFORMATION, SEE STANDARDS SPECIFICATIONS SECTION 206. AND 203.5.1

I. NEW CONSTRUCTION



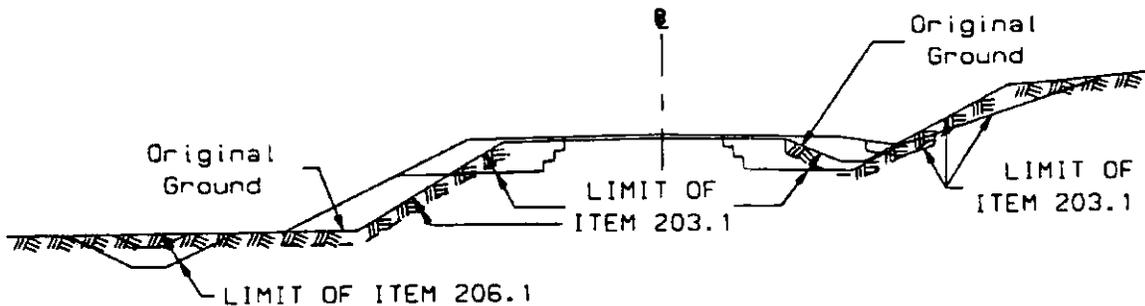
SHADED AREA WILL BE PAID AS ITEM 206.1 (THE DITCH IS NOT ADJACENT TO THE ROADWAY EXCAVATION; IT IS A SEPARATE EXCAVATION)



HATCHED AREA WILL BE PAID AS ITEM 203.1 (THE DITCH IS PART OF THE EXCAVATION FOR THE ROADWAY TYPICAL)

DETAIL A

II. RECONSTRUCTION



Item 206.19 - Common Structure Excavation Exploratory

Include this item in a contract with an estimated quantity when it is suspected that, for example, underground utilities are not accurately known and it is necessary to verify that the improvements are constructible.

SECTION 207 - CHANNEL EXCAVATION

Show a dimensioned sketch of the channel profile and cross sections to illustrate computations. This quantity is usually computed by the Average-End-Area method. See the Item 203.1 computations for an example of this calculation.

SECTION 209 - GRANULAR BACKFILL

Granular Backfill is used for several purposes, e.g., bedding for drainage pipes in rock and unsuitable material, bedding for pipes larger than 1200 mm diameter (See *Standard Specifications* Section 603.3.2), bedding for sidewalks, retaining walls, etc. It may, at times, be necessary to specify Granular backfill (Sand), Granular backfill (Gravel), or Granular Backfill (Bridge) (see *Standard Specifications* Section 209.2.1). For an example of this computation, see the Division 500 computations.

SECTION 214 - FINE GRADING

Although this work includes final grading beyond the limits of the pavement (See *Standard Specifications* Section 214.1.1) the equivalent calculation is based on a measured pavement surface. Therefore, calculate the total area of the new pavement. Estimate the cost by multiplying the area by \$ 1.00 to \$1.25 per square meter depending on the type and size of the project, using the higher price for urban jobs or phased construction projects. When no quantity for this item is included in the contract, this work will be subsidiary. This item is normally shown in the Incidental Summary.

DIVISION 300 - BASE COURSES

SECTION 304 - AGGREGATE BASE COURSES

There are several methods for calculation of base course material quantities. The Designer will determine which method will produce an acceptable level of accuracy in a reasonable amount of time. USE GOOD JUDGMENT.

The first method the Designer may use is that the "Applied Constant Method". The NHDOT requires that the volumetric constant per 100 m of roadway be shown on the Typical Sections of Improvement for base course materials. To calculate these quantities, simply apply the appropriate constants to the lengths of roadway they represent. Where roadway width varies, show a sketch with the quantity calculations.

The limitation with this method is the Constants shown on the "typicals" are for a normal crown condition only. The Applied Constant Method of computation may not be the best method for computing base course quantities depending on the number of horizontal curves and curve length. This method produces its best results when used in an urban typical, since

the volume of base course materials on the high side of a superelevated curve does not vary greatly through transition sections.

The Designer may also use a computer program (CAD/D) to determine base course material quantities. This method will usually produce more accurate results than the Applied Constant Method when computing volumes along an alignment that has many curves. There are, however, two (2) limitations that should be evaluated before using this method.

The first limitation is the time required to set up the program. The difference in the results obtained from this method compared to the Applied Constant Method may not be worth the effort. Simple alignments with uniform templates are usually not good candidates for this method.

The second limitation with this method is the difficulty in adjusting the computer generated information to account for changes in the template when the road crosses an intersection or bridge. This often results in the adjustment of the quantities by hand calculations. If the project has many intersections or bridges, it may be quicker to do all the calculations by hand.

Remember that neither of these methods will account for the quantity of the material within the radius area at an intersection. To compute this volume, measure the area in the radius and multiply it by the depth of material noted on the typical.

Do not deduct the volume occupied by a curb (See *Standard Specifications* Section 609.5.2). Provide a station to station reference for the lengths of the shoulders with different sideslopes. Show a separate computation for areas that need extra sand as recommended in the Geotechnical Report. Set up this computation as follows (Base Course Material constants are assumed):

Roadway (Main Line) (EP to EP) Sta. 16+00 to 89+90 = 7390 m

$$\begin{aligned}
 304.1 \text{ Sand} &= 148 \text{ m}^3/100 \text{ m} \times 7390 \text{ m} = 10\,937.2 \text{ m}^3 \\
 304.2 \text{ Gravel} &= 148 \text{ m}^3/100 \text{ m} \times 7390 \text{ m} = 10\,937.2 \text{ m}^3 \\
 304.3 \text{ Crushed Gravel} &= 148 \text{ m}^3/100 \text{ m} \times 7390 \text{ m} = 10\,937.2 \text{ m}^3
 \end{aligned}$$

LOCATION	Length of Fill (m)			Length of Cut (m)	
	2:1	4:1	6:1	Earth	Rock
Sta. 16+00 to 26+25, Lt.			1025		
Sta. 16+00 to 17+80, Rt.		180			
Sta. 17+80 to 25+80, Rt.	800				
Sta. 26+25 to 34+25, Lt.				800	
etc. etc.	etc.	etc.	etc.	etc.	etc.
Length of Sideslope (m)	2280	425	10 000	1425	640

Sideslope Volumes:

Sand	2:1	2280 m	x	62	m ³ /100 m	=	1413.6 m ³
	4:1	425 m	x	105	m ³ /100 m	=	446.3 m ³
	6:1	10 000 m	x	120	m ³ /100 m	=	12 000.0 m ³
Earth		1425 m	x	58	m ³ /100 m	=	826.5 m ³
Rock		640 m	x	68	m ³ /100 m	=	435.2 m ³
							<u>15 121.6 m³</u>

$$\text{Item 304.1 - Sand Volume} = 10\,937.2 \text{ m}^3 + 15\,121.6 \text{ m}^3 = 20\,058.8 \text{ m}^3$$

The volumes for Item 304.2 - Gravel and Item 304.3 - Crushed Gravel would be computed similarly. An example calculation for Item 304.35 - Crushed Gravel for Drives can be found in the Section 403 computations.

SECTION 306 - RECLAIMED STABILIZED BASE

The computations for this item will be broken down into specific areas. Payment is determined by computed areas, by using dimensioned sketches, or by using a station to station reference. For example:

Main Line	Sta. 30+50 to 32+85, Rt. (7.2 m wide)
	235 m x 7.2 m = 1692.0 m ²

Samson Drive Planimetered (1:500 scale)

$$6.35 \text{ in}^2 \times \frac{161.29 \text{ m}^2}{1 \text{ in}^2} = 1024.2 \text{ m}^2$$

$$\text{Item 306 - Reclaimed Area} = 1692.0 \text{ m}^2 + 1024.2 \text{ m}^2 = 2716.2 \text{ m}^2$$

DIVISION 400 - PAVEMENTS

SECTION 403 - HOT BITUMINOUS PAVEMENT

Item 403.11 - Hot Bituminous Pavement, Machine Method

Break down the computations into areas of roadway, drives and approaches, parking areas, side streets, etc. Show quantities for base, binder, and wearing course pavements to provide Construction personnel with quantities to check pavement yields as placement occurs. Also, separate quantities of night paving from daytime paving.

Calculate the extra width required for an asphalt curb by a station to station reference. In granite curb areas, the limit of machine method pavement calculations will be 300 mm *in front* of the curb for the binder and base courses of pavement. Compute hand method pavement (Item 403.12) in curbed areas to complete the paving operation of base and binder courses in front of the curb. (See *Standard Specification* Section 609.5.3). Show a dimensioned sketch to clarify the basis of computations, i.e., tapers, dimensions, radii, etc. Application rates are shown on the typical sections. Check the joint detail if the pavement

includes a base course. The binder and wearing courses have a slightly different width to eliminate a vertical joint through the different pavement courses. Calculation of the mass of pavement involves using a constant (0.061 t/m²/25 mm for all pavement course types):

Example: Roadway 140 mm deep (Sta. 34+50 to 46+50) = 1200 m

$$\begin{aligned} \text{Base} & \quad 65 \text{ mm} \times \frac{0.061 \text{ t/m}^2}{25 \text{ mm}} \times 1200 \text{ m} \times 7.5 \text{ m} & = & \quad 1427.40 \text{ t} \\ \text{Binder} & \quad 50 \text{ mm} \times \frac{0.061 \text{ t/m}^2}{25 \text{ mm}} \times 1200 \text{ m} \times 7.35 \text{ m} & = & \quad 1076.04 \text{ t} \\ \text{Wearing} & \quad 25 \text{ mm} \times \frac{0.061 \text{ t/m}^2}{25 \text{ mm}} \times 1200 \text{ m} \times 7.20 \text{ m} & = & \quad 527.04 \text{ t} \end{aligned}$$

Parking Area 50 mm Deep (Planimetered Area) (Scale 1:500)

$$\text{Wearing} \quad 4.75 \text{ in}^2 \times \frac{161.29 \text{ m}^2}{1 \text{ in}^2} \times \frac{0.061 \text{ t/m}^2}{25 \text{ mm}} \times 50 \text{ mm} = 93.47 \text{ t}$$

Item 403.12 - Hot Bituminous Pavement, Hand Method

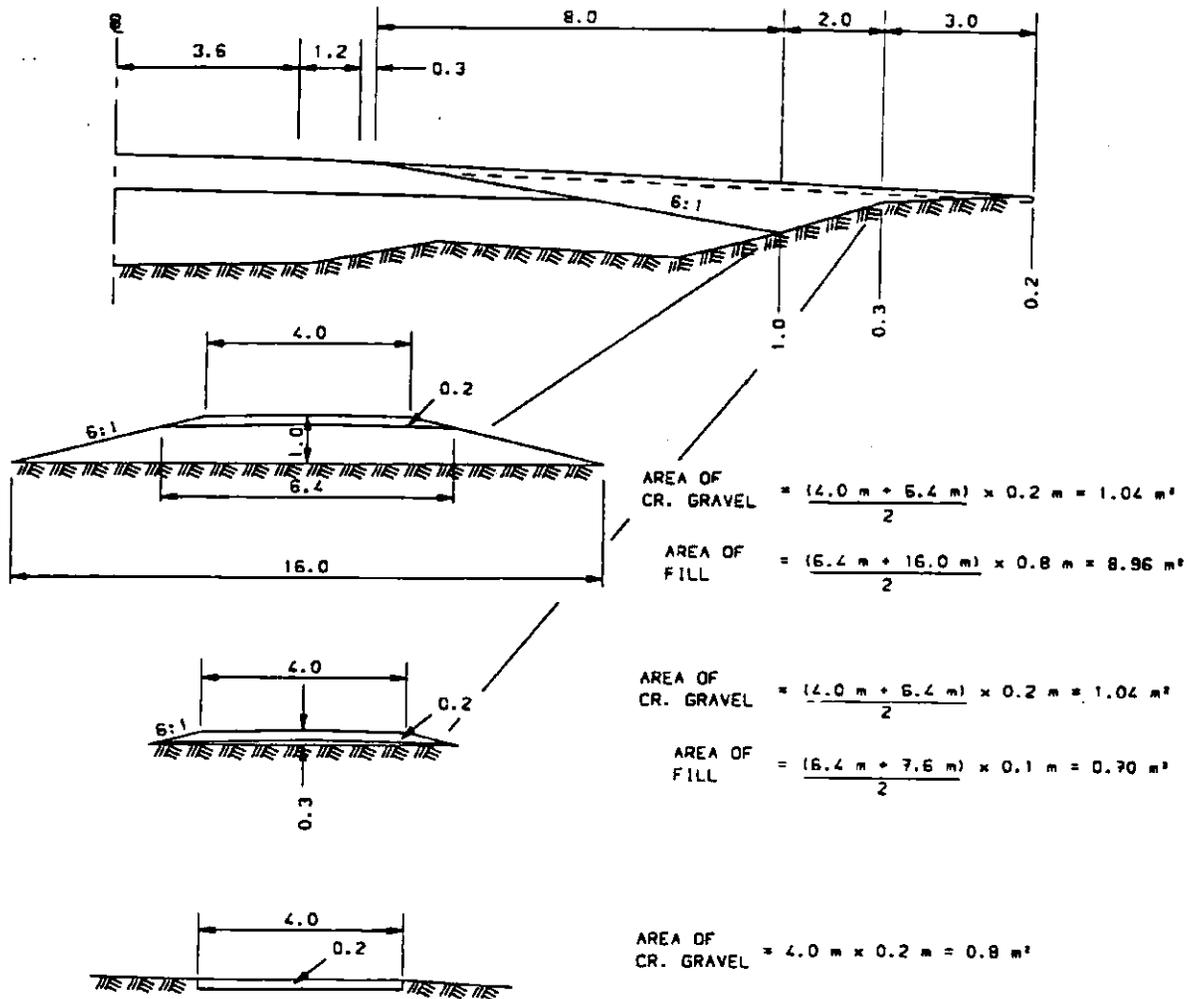
Hand method pavement is always used in driveway construction unless otherwise noted. Below is an example computation for the pavement quantities, including computations for drive excavation and fill. (A typical residential drive has 50 mm of pavement; a commercial drive has 75 mm).

Example: Sta. 4+25, Rt. Const. Paved Drive (FIGURE 8-10)

Embankment in Place

$$\begin{aligned} \text{Volume} & = \left[\frac{(0 \text{ m}^2 + 8.96 \text{ m}^2)}{2} \times 8 \text{ m} \right] + \left[\frac{(8.96 \text{ m}^2 + 0.70 \text{ m}^2)}{2} \times 2 \text{ m} \right] + \\ & \quad \left[\frac{(0.70 \text{ m}^2 + 0 \text{ m}^2)}{2} \times 3 \text{ m} \right] \\ & = 46.6 \text{ m}^3 \end{aligned}$$

FIGURE 8-10



Crushed Gravel

$$\text{Volume} = \left[\frac{(1.04 \text{ m}^2 + 1.04 \text{ m}^2)}{2} \times 10.0 \text{ m} \right] + \left[\frac{(1.04 \text{ m}^2 + 0.80 \text{ m}^2)}{2} \times 3.0 \text{ m} \right] = 13.2 \text{ m}^3$$

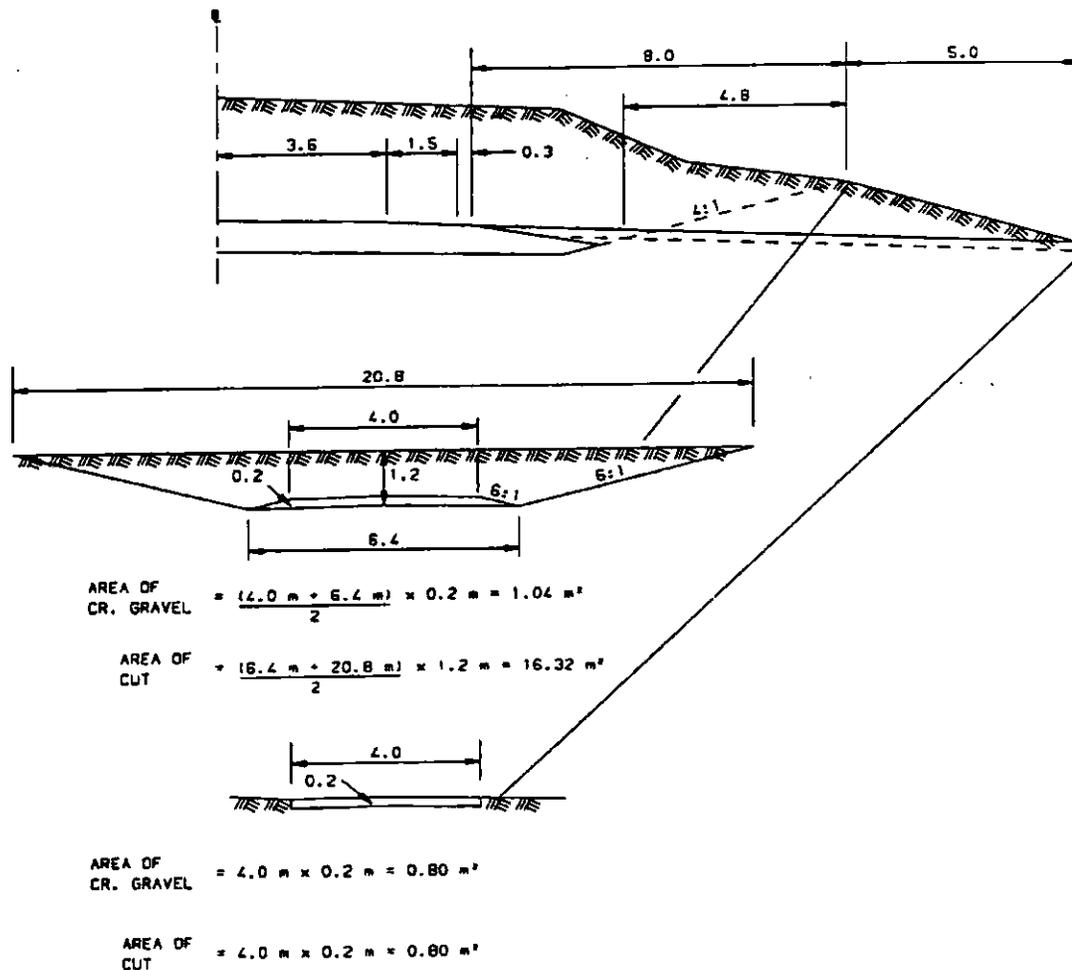
Hot Bituminous Pavement (Hand Method.) (1:250 Plan) (50 mm Deep)

Measure the area on the plan view to get the surface area of the drive.

$$\text{Wearing: } 0.60 \text{ in}^2 \times \frac{40.32 \text{ m}^2}{1 \text{ in}^2} \times \frac{0.061 \text{ t/m}^2}{25 \text{ mm}} \times 50 \text{ mm} = 2.95 \text{ t}$$

Example: Sta. 3+15, Rt. Construct Paved Drive (See Figure 8 - 11)

FIGURE 8-11



Common Excavation

$$\text{Volume} = \left[\frac{(0 \text{ m}^2 + 16.32 \text{ m}^2)}{2} \times 4.8 \text{ m} \right] + \left[\frac{(16.32 \text{ m}^2 + 0.80 \text{ m}^2)}{2} \times 5.0 \text{ m} \right] = 82.0 \text{ m}^3$$

Crushed Gravel

$$\text{Volume} = \left[\frac{(1.04 \text{ m}^2 + 1.04 \text{ m}^2)}{2} \times 8.0 \text{ m} \right] + \left[\frac{(1.04 \text{ m}^2 + 0.80 \text{ m}^2)}{2} \times 5.0 \text{ m} \right] = 12.9 \text{ m}^3$$

Hot Bituminous Pavement (Hand Method.) (1:250 Plan) (50 mm Deep)

Compute the drive area on the plan for drive surface.

$$\text{Wearing: } 0.50 \text{ in}^2 \times \frac{40.32 \text{ m}^2}{1 \text{ in}^2} \times \frac{0.061 \text{ t/m}^2}{25 \text{ mm}} \times 50 \text{ mm} = 2.46 \text{ t}$$

Separate pavement quantities into base, binder and wearing courses.

	BASE (t)	BINDER (t)	WEARING (t)	TOTAL (t)
Roadway (MACHINE)	1427.40	1076.04	527.04	3030.48
Parking (MACHINE)	-	-	93.47	93.47
Drives (HAND)	-	-	5.41	5.41
Totals	1427.40	1076.04	625.92	3129.36

Item 403.11 Total = 3030.48 + 93.47 = 3123.95 t

Item 403.12 Total = 5.41 t

The Drive and Approach excavation quantity and Drive and Approach embankment quantity are shown on the Earthwork Summary Sheet (see the Item 203.1 computations for the Earthwork Summary Sheet.) Unpaved drive aprons can be planimeted for quantity computation.

LOCATION	EXCAVATION	EMBANKMENT	ITEM 304.35 - CRUSHED GRAVEL FOR DRIVES
3+15, Rt.	82.0 m ³	-	12.9 m ³
4+25, Rt.	-	46.6 m ³	13.2 m ³
Totals	82.0 m ³	46.6 m ³	26.1 m ³

Show computations for any temporary pavement by a station to station reference and by phase, detours, temporary widenings, and other areas needed for traffic control during construction. Removal of temporary pavement is subsidiary to Item 403.11. Separate calculations should also be made for other paving items such as those containing crumb rubber, or for those involving different classes of wear, etc.

SECTION 410 - BITUMINOUS SURFACE TREATMENT

These items are generally used to pay for preparing a finished surface on a low volume, low speed roadway, e.g., town owned roadways. They are rarely, if ever, used otherwise. An exception are the items for Emulsified Asphalt for Tack Coat which are used between consecutive courses of pavement. In this case, the Tack Coat is subsidiary to the pavement items (see the *Standard Specifications* Section 401.5.2). Therefore, there is usually no need to compute this quantity.

SECTION 411 - PLANT MIX SURFACE TREATMENT

List the areas by a station to station reference. Make note of average length, width and assumed depth of wheel ruts, shoulder work, etc. to arrive at the appropriate quantity.

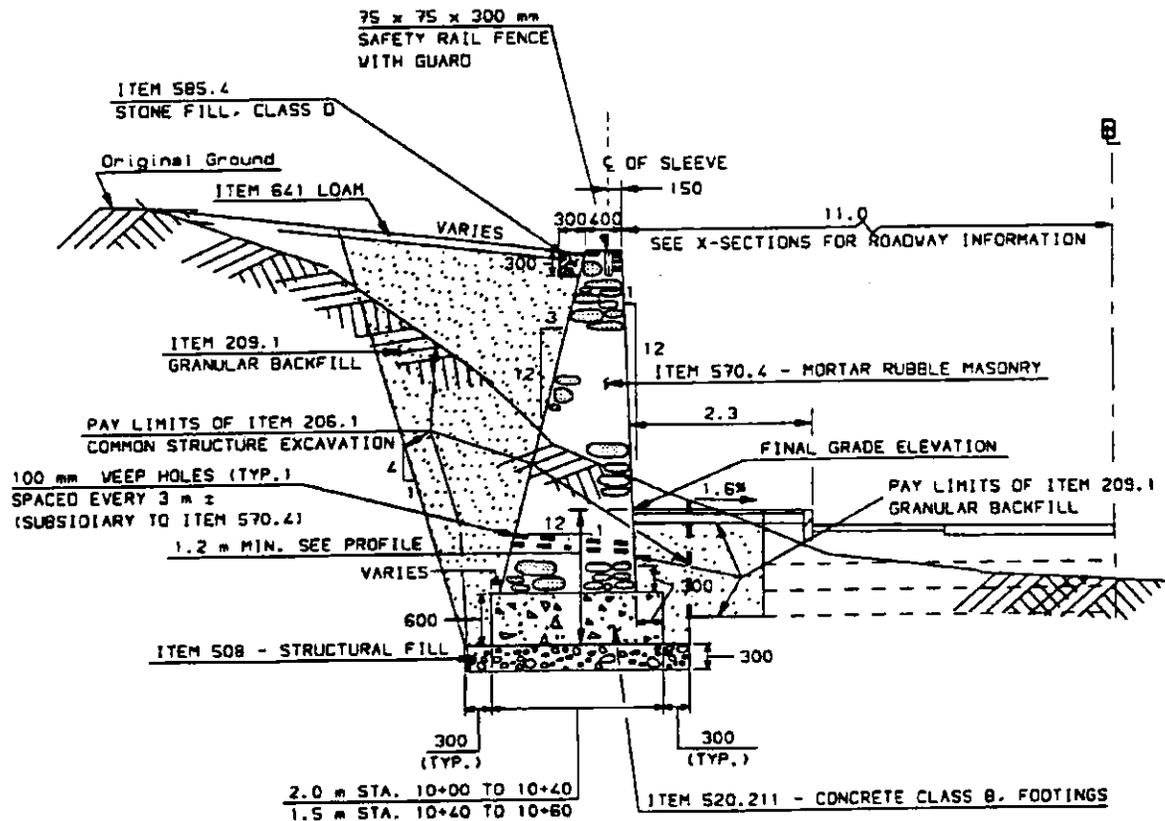
SECTION 417 - COLD PLANING OF BITUMINOUS SURFACES

Areas of cold planing are broken down the same way that hot bituminous pavement areas are. Compute each occurrence by plan area or scaled/computed dimensions. For example:

Construct Approach Detail (Beginning and End of Project)
Sta. 79+00.0 to 79+15.5 (Beg. of Project)
Area = 15.5 m long x 9.6 m wide = 148.8 m²

DIVISION 500 - STRUCTURES

FIGURE 8-12



There are several items that the Designer will need to calculate when designing a structure e.g., Mortar Rubble Masonry, Concrete, Reinforcing Steel (Roadway), Granular Backfill, Common Structure Excavation, Structural Fill, Stone Fill, Safety Fence and Handrails, etc. The following is an example of the calculations for the retaining wall design shown in Figure 8 - 12.

Item 209.1 - Granular Backfill (m³)

In Figure 8-12, notice that there are two areas that show Granular Backfill. There is the area in front of the wall under the sidewalk, and an area behind the wall. For the example, the area in front of the wall will be called Area "A" and the area behind the wall Area "B". The computations will be done by Average - End - Area method. (Assumed Scale 1:50) (K_{20} for 1:50 is K_{20} for 1:100 divided by 4 ($64.516/4 = 16.129$). (See the notes on Table 8-1).

AREA "A"					
STATION	LENGTH (m)	AREA (in ²)	SUM OF AREAS (in ²)	K (Pg. 9)	VOLUME (m ³)
10+00		1.05			
	20		2.10	16.129	33.9
10+20		1.05			
	20		2.10	16.129	33.9
10+40		1.05			
	20		2.10	16.129	33.9
10+60		1.05			

AREA "B"					
STATION	LENGTH (m)	AREA (in ²)	SUM OF AREAS (in ²)	K (Pg. 9)	VOLUME (m ³)
10+00		3.26			
	20		7.69	16.129	124.0
10+20		4.43			
	20		7.56	16.129	121.9
10+40		3.13			
	20		4.81	16.129	77.6
10+60		1.68			

TOTAL = 425.2 m³

Item 206.1 - Common Structure Excavation

The limits of Common Structure Excavation are described in Figure 8-12. The detail shows a thick dashed line in front of the wall that separates Common Excavation from Common Structure Excavation (Common Structure Excavation is used to pay for the excavation for the retaining wall). An Average-End-Area calculation can be done: (Scale 1:50) ($K_{20} = 64.516/4 = 16.129$).

STATION	LENGTH (m)	AREA (in ²)	SUM OF AREAS (in ²)	K(Pg. 9)	VOLUME (m ³)
10+00		4.18			
	20		9.86	16.129	159.0
10+20		5.68			
	20		9.69	16.129	156.3
10+40		4.01			
	20		6.16	16.129	99.4
10+60		2.15			

TOTAL = 414.7 m³

Item 520.211 - Concrete Class B, Footings (m³)

The footing has a constant width of 2.0 m from 10+00 to 10+40, then a constant width of 1.5 m from 10+40 to 10+60

Volume From 10+00 to 10+40:

$$= 40 \text{ m long} \times 2.0 \text{ m wide} \times 0.3 \text{ m deep}$$

$$= 24.0 \text{ m}^3$$

Volume From 10+40 to 10+60:

$$= 20 \text{ m long} \times 1.5 \text{ m wide} \times 0.3 \text{ m deep}$$

$$\text{Volume} = 9.0 \text{ m}^3$$

$$\text{Volume} = 24.0 \text{ m}^3 + 9.0 \text{ m}^3 = 33.0 \text{ m}^3$$

Item 508. - Structural Fill (m³)

Structural fill is used to stabilize the retaining wall footing. The structural fill has a constant width of 2.6 m from Sta. 10+00 to 10+40, then 2.1 m from Sta. 10+40 to 10+60.

Volume from 10+00 to 10+40:

$$= 40 \text{ m long} \times 2.6 \text{ m wide} \times 0.3 \text{ m deep} = 31.2 \text{ m}^3$$

Volume from 10+40 to 10+60

$$= 20 \text{ m long} \times 2.1 \text{ m wide} \times 0.3 \text{ m deep} = 12.6 \text{ m}^3$$

$$\text{Volume} = 31.2 \text{ m}^3 + 12.6 \text{ m}^3 = 43.8 \text{ m}^3$$

Item 570.4 - Mortar Rubble Masonry (m³)

Mortar rubble masonry (MRM) is the material the wall is made from. This item can be calculated using an Average-End-Area computation. (Scale 1:50) ($K_{20} = 64.516/4 = 16.129$)

STATION	LENGTH (m)	AREA (in ²)	SUM OF AREAS (in ²)	K (Pg. 9)	Volume (m ³)
10+00		1.89			
	20		4.46	16.129	71.93
10+20		2.57			
	20		4.38	16.129	70.65
10+40		1.81			
	20		2.78	16.129	44.84
10+60		0.97			
TOTAL =					187.42 m³

Item 585.4 - Stone Fill Class D (m³)

The detail shows Stone Fill Class D in back of the wall near the surface to promote drainage. (Scale 1:50)(K₂₀ = 1.62 $\frac{\text{m}^2}{\text{in}^2}$: See page 1).

$$\text{Volume} = (0.05 \text{ in}^2 \times \frac{1.61 \text{ m}^2}{\text{in}^2}) \times 60 \text{ m} = 4.8 \text{ m}^3$$

Item 606.6311 - Safety Rail with Guard, Steel (m)

Normally, there will be a handrail or safety rail installed at the top of a retaining wall if it is in a location accessible to pedestrians.

$$\text{Length} = 60.0 \text{ m}$$

SECTION 520 - CONCRETE

Locate and dimension a sketch of the structure to provide backup for the computations. If concrete is used when constructing drainage, i.e., headwalls, energy dissipater, etc., show the computations under a section entitled "Drainage." All computations should show the different classes of concrete, i.e., Footings, Above Footing, etc. Refer to the sample computation in the retaining wall example Figure 8-12.

SECTION 544 - REINFORCING STEEL

Keep the quantity of roadway reinforcing steel separate from the bridge quantities. Reinforcing steel is typically encountered when constructing energy dissipaters, concrete headwalls, retaining walls, steps, sign bases, etc. Bridge Design usually will provide reinforcing steel configuration and quantities with their retaining wall designs, and also review the layout of reinforcing and its quantity for energy dissipater designs. The quantity of reinforcing steel for headwalls is found on the Standard Plans.

SECTION 570 - STONE MASONRY

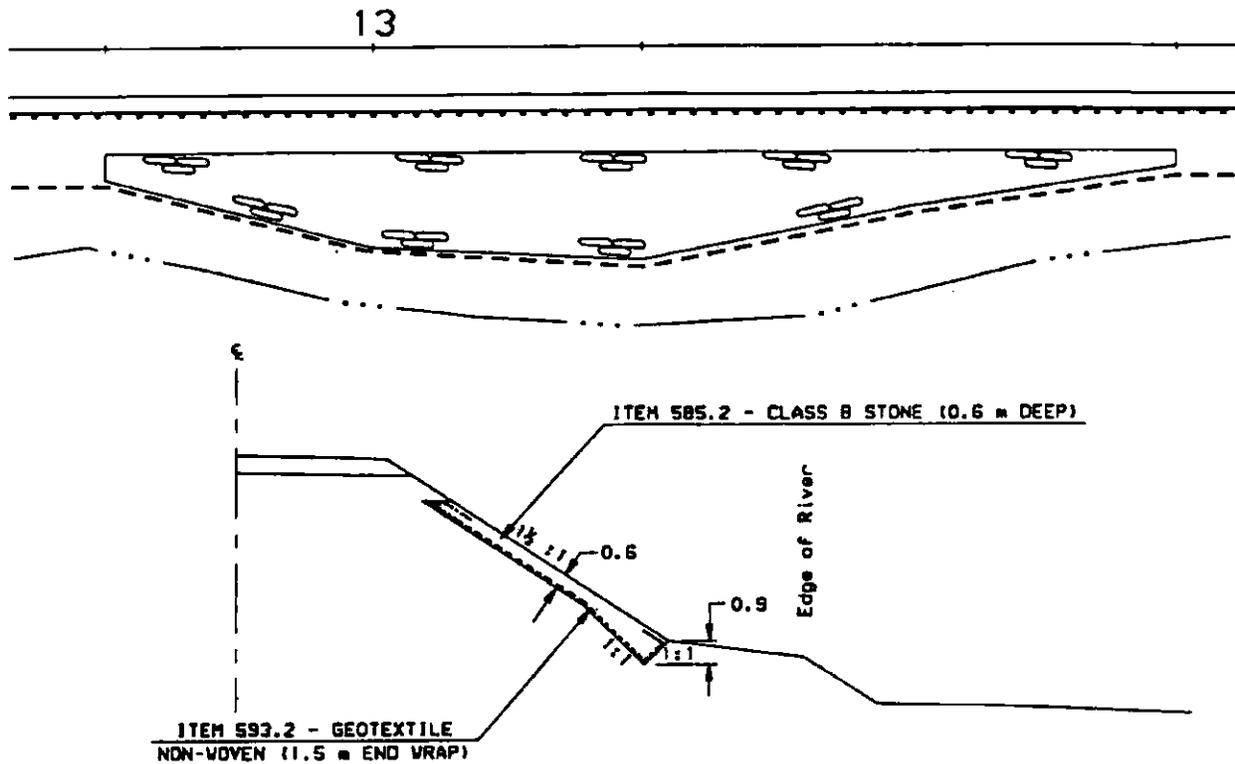
Locate and dimension a sketch the structure to provide backup for computations. The quantity of MRM for headwalls is in the Standard Plans. Show a tabulation of the quantity from each drainage note to provide a total quantity for the project estimate. Cross reference the quantity of MRM for a retaining wall with the quantity shown on the drainage summary. (Refer to the sample computation in the retaining wall example Figure 8-12).

SECTION 585 - STONE FILL

Computing stone quantities for slope protection is usually done using the Average-End-Area Method. Locate and dimension a sketch of the area requiring the stone fill. Tabulate the slope lengths at 20 meter intervals using the layout shown in the example (See Figure 8-13). Locate areas of stone fill by station to station reference for slope protection or as part of inlet and/or outlet protection at a drainage structure. Drainage notes should include the length, width, and depth of the stone fill treatment. Note the class of stone that is used. Each class may require a different type of geotextile fabric, which is explained in the Item 593

calculation. The calculation that follows is for the example plan shown in Fig. 8-13. (Scale 1:100, $K_{20} = 64.516$)

FIGURE 8-13



Sta. 12+80 to 13+60, RT. Class B Stone 0.6 m thick.

STATION	LENGTH (m)	AREA (in ²)	SUM OF AREAS (in ²)	K (Pg. 9)	VOLUME (m ³)
+80		0.25			
	20		1.16	64.516	74.8
13+00		0.91			
	20		2.02	64.516	130.3
+20		1.11			
	20		1.64	64.516	105.8
+40		0.53			
	20		0.68	64.516	43.9
+60		0.15			
Total =					354.8

SECTION 593 - GEOTEXTILE

(This Section is not covered in the *Standard Specifications*.) Recommendations for the type of geotextile will be included in the Geotechnical Report. The specification for Non-Woven Geotextile is available from the Specifications Engineer in the Bureau of Highway Design. Specifications for Woven Geotextile are provided by the Bureau of Materials and Research.

The type of geotextile to be used in is dependent upon the class of stone or material placed over it. Generally, Low-Strength Geotextiles are used under Stone Fill Class C. Medium-Strength Geotextiles are used under Stone Fill Class B; similarly, High-Strength Geotextiles are used under Stone Fill Class A.

When more than one type of Stone Fill is needed on a project, it may make sense to use the highest strength Geotextile needed exclusively on the project to control costs. For example, using Medium-Strength Geotextile under a small quantity of Stone Fill Class C due to a large amount of Stone Fill Class B on the project.

In the computation below, the longitudinal length of geotextile is the distance it extends between stations. The width of geotextile is measured (laterally) along the length of the slope as measured from the cross sections. Include the length of "end wrap" as recommended in the Geotechnical Report. (See Fig. 14-13 for a pictorial description of the "end wrap"; in this case, it is 1.5 m). If geotextile is part of a drainage note, reference the drainage note and list the quantity here for tabulation. Do not include the overlap of successive rolls in the length of geotextile.

Example: Sta. 12+80 to 13+60, RT. (Const. Non-Woven Geotextile (1.5 m Wrap))

STATION	LENGTH	SLOPE WIDTH (m)	AVE. WIDTH (m)	AREA (m ²)
+80		3.0 + (1.5 x 2 for end wrap) = 6.0		
	20		9.75	195.0
13+00		10.5 + (1.5 x 2 for end wrap) = 13.5		
	20		14.25	285.0
+20		12.0 + (1.5 x 2 for end wrap) = 15.0		
	20		12.00	240.0
+40		6.0 + (1.5 x 2 for end wrap) = 9.0		
	20		6.75	135.0
+60		1.5 + (1.5 x 2 for end wrap) = 4.5		
				855.0 m ²

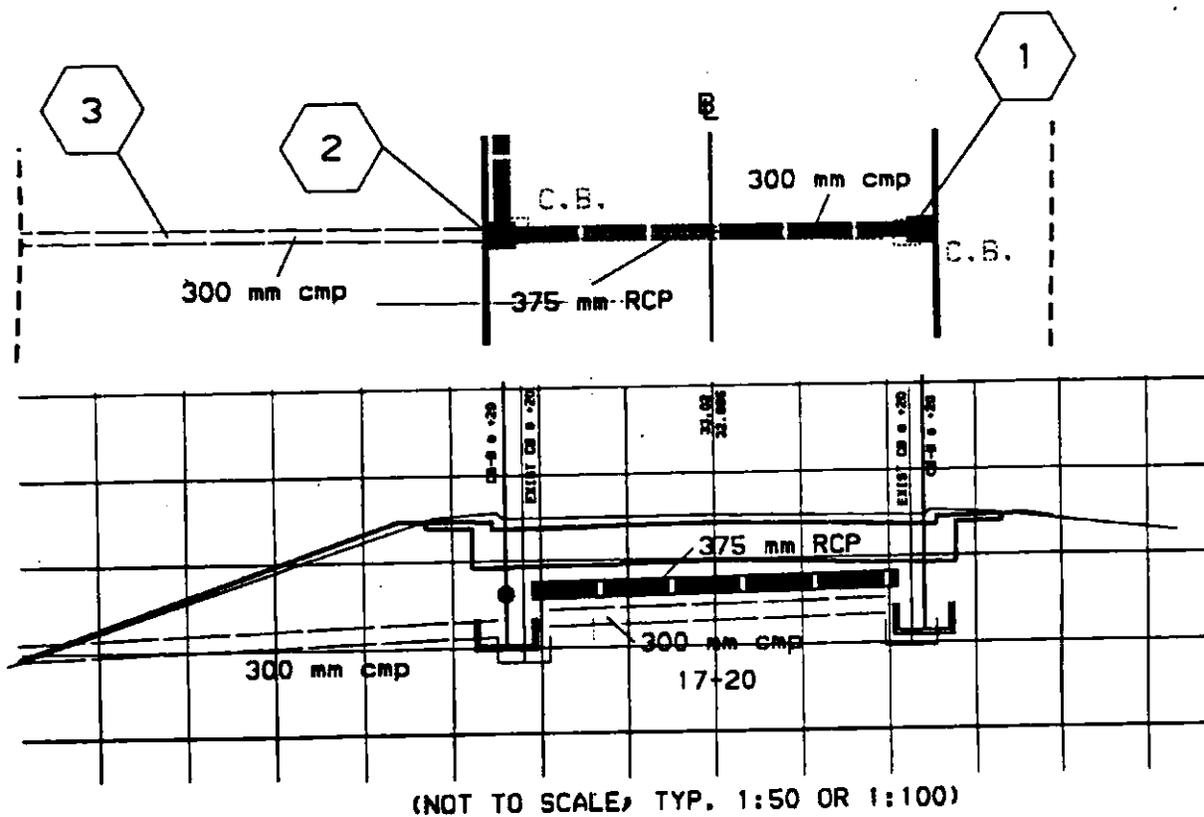
DIVISION 600 - INCIDENTAL CONSTRUCTION

SECTION 603 - CULVERTS & STORM DRAINS.

SECTION 604 - CATCH BASINS, DROP INLETS, AND MANHOLES

Refer to the specific installation by construction note and number. Compute all the items payable under the noted work and include in a section of the Quantities Workbook entitled *Drainage*. A number of items will be cross referenced to this section (Item 209.1, 570.4, 520, etc.). Consider Figure 8-14:

FIGURE 8-14



- 1 STA. 17+20.0, LT. 4.80 m TO RT. 4.80 m
 REMOVE 7.7 m x 300 mm Exist. CMP
 REMOVE EXIST. CB, @ + 20.1 RT. 4.47 m (SUBSID.)
 CONST. 8.4 m x 375 mm RCP Class III
 CONST. CB-B @ + 20.0 RT. 4.80 m
 375 mm INV OUT = 31.270 m
 Grate Elev = 32.750 m

- 2 STA. 17+40.0, LT. 4.80 m TO 17+20.0, LT. 4.80 m
REMOVE 1.0 m x 300 mm CMP (SUBSID.)
REMOVE CB @ +20.1, LT. 4.48 m (SUBSID.)
CONST. 18.8 m x 375 mm RCP, CLASS III
CONST. CB-B @ +20.00 LT. 4.80 m
375 mm INV IN = 31.125 m
375 mm INV OUT = 31.050 m
Grate Elev = 32.550 m

- 3 STA. 17+20.0, LT. 4.40 TO LT. 14.40
REMOVE EXIST. 10.0 m x 300 mm CMP

In this example, a new 375 mm RCP is being installed above an existing 300 mm CMP. The Contractor is required to remove the 300 mm CMP, according to the drainage note. The removal will be paid for under Item 202.41 - Removal of Existing Pipe, 0 - 600 mm, because an additional operation is necessary to remove the existing pipe (i.e., it is not necessary to remove the existing pipe to install the new one above it).

There are situations where this is not the case. If the new pipe was below the existing pipe, the excavation for the new pipe would require the Contractor to remove the existing pipe. Therefore, the removal would be subsidiary to the construction of the new pipe. (See *Standard Specifications* Section 206 for trench width limits for C.B.'s, D.I.'s, M.H.'s and pipes.) If the pipe or drainage structure to be removed is within the limits described, the removal is subsidiary.

The Designer must use judgment in deciding if removal of drainage is paid for or is subsidiary. There are situations where part of a pipe or drainage structure is within (paid) excavation limits and another part is not.

In this example, Note 2 (See Figure 8-14), 1.0 m x 300 mm CMP is removed subsidiary since it is within the limits of excavation for the new drainage structure. The remaining 10.0 m is paid for as Item 202.41 since it is beyond the point of excavation for new drainage.

In Drainage Note 1, the quantities will be:

- Item 603.00204 = 8.40 m
- Item 604.12 = 1.00 unit (2.5 m deep)
- Item 202.41 = 7.7 m x 300 mm CMP
- Remove exist CB at +20.1, Lt. 4.47 m (SUBSID.) (within new CB)

In Drainage Note 2, the quantities will be:

- Item 603.00204 = 18.82 m
- Item 604.12 = 1.00 unit (2.5 m deep)
- Remove 1.0 m x 300 mm CMP (SUBSID.) (within new CB)
- Remove exist CB-B, +20.1 Lt. 4.48 (SUBSID.) (within new CB)

In Drainage Note 3. the quantities will be:

Item 202.41 = 10.0 m (Outside limits of excavation for the pavement structure and not within the trench for pipe)

There may be other items (i.e. MRM, common structure excavation, stone fill) that are required in a drainage note. Each of these items should be accounted for within the drainage quantities shown in the Quantities Workbook. Consider the following example:

16 STA 82+95.0, LT. 4.50 m TO STA 83+05.0, LT. 9.50 m
 CONST. 11.0 m x 375 mm RCP, CLASS III
 CONST. CB-B @ +95.0, Lt. 4.50 m
 375 mm INV. IN = 81.129
 375 mm INV. OUT = 81.053
 GRATE ELEV = 83.253
 CONST. PC-4 HEADWALL @ +95.0, LT. 8.40 m
 INV @ HDR = 80.424
 CONST. 1.2 x 4.0 m OUTLET DITCH
 CONST. STONE FILL, CLASS C AT OUTLET (1.2 x 4 x 0.3 m)
 ON A LOW STRENGTH NON-WOVEN GEOTEXTILE (SEE
 DRAINAGE DETAILS)

Typical quantity computations would be as follows:

Item 604.12 - Catch Basin Type B

Top Grate Elev.	83.253 m
- Depth of Grate (From Std. No. DR-1, Pl. No. 2)	0.203 m
	83.050 m
 Sump Elev. = 81.053 (Inv. out) - 1.000 m (Sump depth)	 80.053 m
	2.997 m

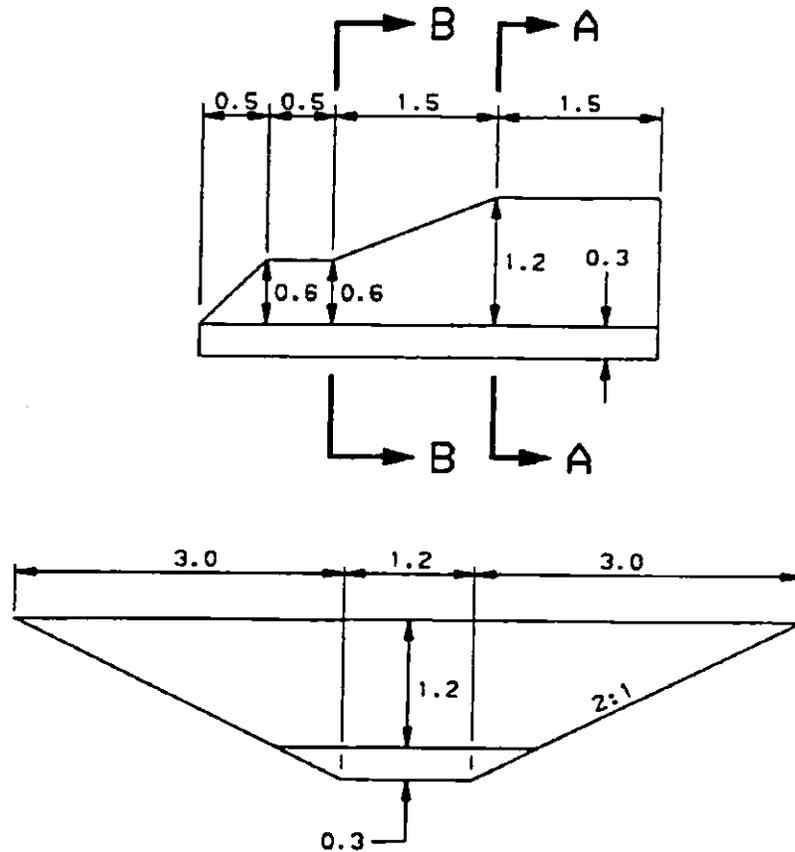
No. of Units = $2.997 \text{ m} \times \frac{1 \text{ Unit}}{2.5 \text{ m}} = 1.20 \text{ Units}$

Item 603.00204 - 375 mm RCP, Class III

Normally, pipe lengths are calculated measuring the distance between the center of drainage structures and subtracting the radius of each structure from the measured length. In this example, there is only one structure, therefore, subtract 0.6 m from the scaled length. (If this pipe were on a steep grade such as a 2:1, use the Slope Correction Factor to calculate the correct length.)

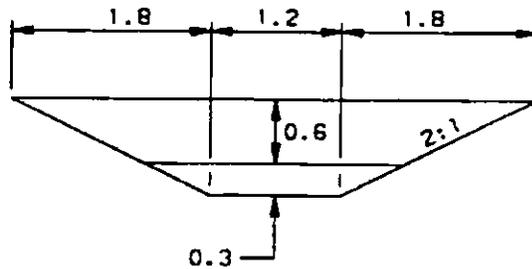
Length = 11.61 m - 0.60 m = 11.01 m

FIGURE 8-15



AREA OF COMMON STR. EX. = $\frac{(7.2 \text{ m} + 1.2 \text{ m}) \times 1.5 \text{ m}}{2} = 6.3 \text{ m}^2$

SECTION A-A



AREA OF COMMON STR. EX. = $\frac{(4.8 \text{ m} + 1.2 \text{ m}) \times 0.9 \text{ m}}{2} = 2.7 \text{ m}^2$

SECTION B-B

Item 585.3 - Stone Fill, Class C

The outlet in this example has a flat bottom. (See Figure 8-15)

$$\text{Volume} = \left[\frac{(2.4 \text{ m} + 1.2 \text{ m})}{2} \right] \times 4 \text{ m} \times 0.3 \text{ m} = 2.2 \text{ m}^3$$

Item 206.1 - Common Structure Excavation

See the *Standard Specifications* Section 206.1.1 for a description of when this item applies. For example, the calculations would be as follows:

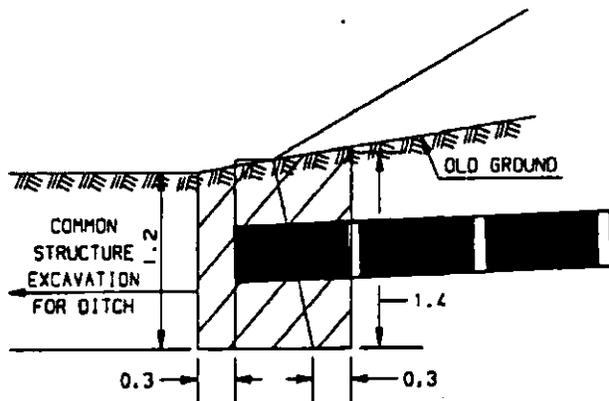
For Ditch (See Figure 8-15):

$$\text{Vol.} = \left[\frac{(0 \text{ m}^2 + 2.7 \text{ m}^2)}{2} \times 0.5 \text{ m} \right] + \left[\frac{(2.7 \text{ m}^2 + 2.7 \text{ m}^2)}{2} \times 0.5 \right] + \left[\frac{(2.7 \text{ m}^2 + 6.3 \text{ m}^2)}{2} \times 1.5 \text{ m} \right] + \left[\frac{(6.3 \text{ m}^2 + 6.3 \text{ m}^2)}{2} \times 1.5 \text{ m} \right]$$

$$\text{Volume} = 0.7 \text{ m}^3 + 1.4 \text{ m}^3 + 6.8 \text{ m}^3 + 9.5 \text{ m}^3 = 18.4 \text{ m}^3$$

For Headwall (See Figure 8-16):

FIGURE 8-16



From Standard Plan No. HW-1A, Plate No. 1

$$\text{Volume} = \frac{0.398 \text{ m}^3}{100 \text{ mm}} \times \frac{(1200 \text{ mm} + 1400 \text{ mm})}{2}$$

$$\text{Volume} = 5.2 \text{ m}^3$$

For CB :

$$\text{Volume} = \pi r^2 h = \pi [(0.725 \text{ m}) + (0.3 \text{ m})]^2 (2.997 - 2.700) = 1.0 \text{ m}^3$$

$$\text{Volume} = 18.4 \text{ m}^3 + 5.2 \text{ m}^3 + 1.0 \text{ m}^3 = 24.6 \text{ m}^3$$

Item 570.4 - Mortar Rubble Masonry - (For PC-4 Headwall)

See Standard Plan No. HW-1A, Plate No. 1

$$\text{Volume} = 1.01 \text{ m}^3$$

Item 593.21 -Low Strength Geotextile, Non-woven

Usually, the detail will show a length of geotextile that is wrapped into the stone to anchor it in place. The total length of the "end wrap" (one side) is assumed to be 300 mm for Stone Fill, Class C.

$$\text{Area} = 4.0 \text{ m long} \times (1.2 \text{ m wide} + 0.3 \text{ m (2) end wrap}) = 7.2 \text{ m}^2$$

SECTION 606 - GUARDRAIL

Permanent Location:

Locate the barrier by a station to station reference. Show, or make reference to, the warrant calculations used to determine the length of need. Adjust the length of the barrier to correspond to a standard manufactured length (e.g. 3.810 m for guardrail, 6.0 m for precast concrete median barrier). Tabulate backup computations as they will appear on the Summary Sheet. Summarize as shown in the following table:

Ref. No.	Location	Appropriate Item				
		Beam Guardrail	Terminal Unit G-2 (3.810 m)	Terminal Unit- ELT (11.43 m)	Concrete Barrier	Reset Guardrail
1	23+50.00 to 25+78.60, Rt.	213.36 m	1	1		
2	25+50.00 to 27+25.26, Lt.		1	1		160.02 m
3	44+20.00 to 46+51.00, Lt.				231.0 m	
	Total	213.36 m	2	2	231.0 m*	160.02 m

* Approach end of barrier is flared 15:1 in order to end the barrier outside of the 9.0 m clear zone.

Temporary Locations:

A tabulation of locations for temporary guardrail or portable concrete barrier should be set up to simplify the computation for each item. During various phases of the Traffic Control Plan (TCP) there will be specific quantities of barrier used on a temporary basis to separate work areas from traffic. Show the length of each barrier required for each phase of the TCP. For example:

Phase	Location	Temporary Guardrail (m)	Portable Concrete Barrier (m)	Number of End Treatments (Unit)
Ia	10+50.0 Rt. to 20+85.0 Rt.		1035.0	Approach End Flared*
Ib	16+00.0 Lt. to 19+60.0 Lt.		360.0	1 Impact Attenuator
Ic	22+50.0 Rt. to 32+85.0 Rt.		1,035.0	Approach End Flared*
II	17+00.0 Lt. to 26+90.0 LT.		990.0	1 Impact Attenuators
IIIa	30+00.0 Rt. to 36+15.0 Rt.		615.0	Approach End Flared*
IIIb	18+50.0 Lt. to 21+85.0 Lt.		335.0	Both Ends Flared*
IV	26+00.00 to 45+08.81 Lt. & Rt.	3771.90**		4 ELTs

*The barrier is flared 15:1 in order to end the barrier outside of the 9.0 m Clear Zone.

**This length does not include the length of the (temporary) end treatments which are paid under a separate item.

In the table above, there are 3 areas of the project under construction in Phase I requiring a total of 2430.0 m of portable concrete barrier. Phase II requires 990.0 m and Phase III, 950.0 m. The TCP requires the portable concrete barrier in Phase I to be completely removed before Phase II or Phase III is started on this project. Since by Standard Specification 606.4.4.2 once the portable concert barrier is delivered to the project, relocation of it on the project will not be measured for payment; the quantity total for Item 606.417 would be 2430.0 m.

Remember that guardrail is the preferred temporary barrier during the winter months to simplify snow removal operations.

Item 606.95 - Temporary Traffic Control Barrier

Specifying this item in a contract is a common method for establishing the minimum criteria for temporary barrier while allowing the Contractor to use available materials. This item allows the Contractor the option of using either guardrail or portable concrete barrier (or approved equal) on a temporary basis. The length of temporary traffic control barrier specified under the item *includes the end treatment* and is, therefore, not paid separately. If portable concrete barrier is used, this may include an impact attenuator.

SECTION 607 - FENCES

Tabulate the locations of a fence by a station to station reference for each roadway including the number and location of post assemblies, i.e. corner, gate, etc. Separate fenced areas within project into Main Line, Ramp A, Ramp B, etc. See the *Standard Specifications* for the required locations of post assemblies. See Chapter 10 of the Highway Design Manual for fencing of ROW.

Main Line (Woven wire)

Sta. 10+60.0 to 13+50.0	290.0 m	2 post assemblies (at least 1 every 180 m; so 0 & 145 m)
Sta. 13+50.0 to 13+62.0	1 gate	2 post assemblies (gate)
Sta. 13+62.0 to 13+90.0	<u>28.0 m</u>	<u>1 post assembly (end)</u>
Total =	318.0 m	5 post assemblies

Ramp A (Chain link)

Sta. 6+00.5 to 11+50.5	<u>550.0 m</u>	5 post assemblies (at least 1 every 150 m; so 0, 137.5 m, <u>275.0 m, 412.5 m & 550.0 m</u>)
Total =	550.0 m	5 post assemblies

SECTION 608 - SIDEWALKS

Tabulate the location of sidewalks and islands by a station to station reference. Deduct the width of the curb from the width used to compute the surface area of the sidewalk. Generally, sidewalks are constructed with either 50 mm of hot bituminous pavement or 100 mm of Portland cement concrete. Concrete traffic islands (shown on the Sidewalk Summary), are usually built with 150 mm of Portland cement concrete. High speed facility

ramp gores are constructed with 200 mm concrete and are also paid under Section 608. The Sidewalk Summary will include 608 and 209 items. Identify each location. For example:

Item 608.105 - 50 mm Bituminous Sidewalk (1.5 m Wide)

$$25+25.05 \text{ to } 25+63.05 \text{ Rt. } (38.00 \text{ m} \times 1.375 \text{ m}) = 52.25 \text{ m}^2$$

Item 209.4 - Granular Backfill (Gravel), (Bedding for sidewalk)

$$25+25.00 \text{ to } 25+63.00 \text{ Rt. } (52.25 \text{ m}^2 \times 0.1 \text{ m}) = 5.2 \text{ m}^3$$

Islands should also be located by a station to station reference and can be computed by plan area for irregular shaped island, or computed by length x width. For example:

Item 608.215 - 150 mm Concrete Sidewalk

308+50.65 to 308+84.65 Lt. (Planimetered - scale 1:500)

$$1.05 \text{ in}^2 \times \frac{161.29 \text{ m}^2}{1 \text{ in}^2} = 169.35 \text{ m}^2$$

Item 209.4 - Granular Backfill (Gravel)

$$169.4 \text{ m}^2 \times 0.1 \text{ m} = 16.9 \text{ m}^3$$

SECTION 609 - CURBS

List the curb computations as depicted in the example below. Measure the lengths of curb with a station to station reference. Sharp radii can be computed mathematically or scaled from the plan.

Vertical granite curb with a radius of 6.0 m or less is paid under Item 609.02 - Curved Granite Curb. Slope curb with a radius between 0.6 to 4.5 m is paid under Item 609.22 - Straight Granite Slope Curb with Radial Joints. Granite slope curb with a radius less than 0.6 m is paid under Item 609.23 - Curved Granite Slope Curb.

Reuse of any existing granite curbing on the project should be calculated first. Field inspect the existing granite curb to determine how much is reusable. Consider the construction phasing when calculating reset granite curb. Construction phasing may not allow removal of existing granite curb that at first is planned to be reset.

After determining what existing curb can be reused, calculate the length as Item 609.5. When all the reset curb is used, continue with new curb. Do not use reset curb in areas with a radius 6.0 m or less. Use new curb. Any reusable existing curb not used on the project will be removed and will be paid under Item 202.6 - Curb Removal for Storage. See the Item 202.6 computation section for an example.

Mark No.	Location	Curb Radius	Computation	Length
G1-1	3+40.05 to 4+09.05, Rt.			69.00 m
G1-2	4+09.00 to 4+24.00, Rt.	R = 15 m @ 90°	$\pi \times 30 \text{ m} \times 90/360 =$	23.56 m
G1-3	4+16.25 to 4+24.25, Rt.	R = 8 m @ 90°	$\pi \times 16 \text{ m} \times 90/360 =$	12.57 m
G1-4	5+02.20 to 5+17.20, Lt.	R=15 m @ 138°	$\pi \times 30 \text{ m} \times 138/360 =$	36.12 m
G1-5	5+18.00 to 5+54.00, Lt.			36.00 m
			Total =	177.25 m

SECTION 614 - ELECTRICAL CONDUIT

Tabulate conduit runs by a station to station reference, from pull box (or power source at the beginning of a run) to pull box. Normally, *molded* pull boxes are used for lighting in grassed or sidewalk areas and *concrete* pull boxes for lighting in paved areas and for traffic signals. Verify the type of pull boxes that should be used with Design Services for lighting designs and the Bureau of Traffic for signal designs.

On all projects where Public Service of NH (PSNH) is involved in supplying power for traffic control signals and/or lighting, 75 mm Steel Conduit will be included in the contract for conduit sweeps between utility poles and conduit installations (usually a general note on the General Notes sheet is included as follows:)

“Both ends of conduit runs carrying a PSNH secondary cable shall utilize 75 mm galvanized steel 90° sweeps (vertical to horizontal) approved for electrical cables and a 3 m horizontal section connected by threaded couplings. 75 mm PVC conduit may be used for the intermediate section. All conduit runs that are entirely steel conduit shall be grounded.”

Design Services supplies the lighting design which is the basis for all the lighting quantities. Each conduit sweep is computed as 1 m in length at each entrance or exit at power sources and pull boxes (i.e., measure conduit installations from center to center of pull box adding 2 m for sweeps).

Typically, the conduit and pull box quantities for lighting installations is shown on the same summary as the quantities for traffic signal installation. This is known as the Traffic Signal and Lighting Summary. However, if the lighting design is complex (as it may be for interstate interchanges) consider separating the lighting and traffic signal quantities into their own summaries. The layout used for computations will be similar to the layout used on the summary sheet. For example:

Ref. No.	Ref. Line for Conduit	Location	625.22 Light Pole Base Type B (Each)	614.523 Molded Pull Box (m)	614.70814 75 mm PVC Conduit. Sch. 40 (m)	614.3081 75 mm Steel Conduit (m)
A		6+50.0, Lt. 11.00 m (Power Source)				
B	A-B	6+50.0, Lt. 11.00 m to 6+50.0, Lt. 6.00 m		1		7.00
C	B-C	6+50.0, Lt. 6.00 m to 6+90.0, Lt. 6.00 m		1	34.00	8.00
D	C-D	6+90.0, Lt. 6.00 m to 6+90.0, Lt. 8.00 m	1		2.00	
E	C-E	6+90.0, Lt. 6.00 m to 7+40.0, Lt. 6.00 m		1	44.00	8.00
F	E-F	7+40.0, Lt. 6.00 m to 7+40.0, Lt. 8.00 m	1		2.00	
Total =			2	3	82.00	23.00

SECTION 615 - TRAFFIC SIGNS

There are several different types of signs. Sign layout, including dimensions, lettering, and post types required are provided by the Bureau of Traffic. The different types are as follows:

Type A: Extruded aluminum plank signs with retroreflective sheeting background and retroreflective demountable copy. This type of sign is generally used when the sign height is greater than 1.5 meters or the width is greater than 3.6 meters. This type of sign can be mounted on 100 mm tubes, steel I-beams or on an overhead sign structure. If mounted on tubes or I-beams, the mounts are included in the sign cost. Normally, a Type A sign is mounted using I-beams (when not mounted on an overhead sign structure). A typical example of a Type A sign is an exit sign or other guide sign.

Type B: Flat sheet aluminum with retroreflective sheeting background with retroreflective demountable copy. This type of sign has a maximum height of 1.5 meters, a maximum width of 3.6 meters and is typically mounted on 100 mm tubes or steel U-channel posts. If mounted on tubes or U-channel posts, the cost of the mounts are included in the cost of sign. Type B signs are usually mounted on 100 mm tubes. A typical example of a Type B sign is a smaller guide sign that does not meet Type A sign requirements.

Type C: Flat sheet aluminum with permanently mounted copy. In most cases a Type C sign is mounted on 100 mm tubes when on an Interstate and on U-channel posts in all other cases. Mounts are included in the sign cost. Some typical examples of Type C signs are regulatory and warning signs along with other smaller guide signs.

Type AA, BB, or CC signs are as described above, however, are not supplied with the mounts. To compute traffic sign quantities, categorize each type of sign and list, by station and offset, under that category. Tabulate by item number.

For overhead sign structures, provide their location by station and offset and show sign area. The Bureau of Bridge Design will usually provide estimated quantities for the bases (e.g., concrete, reinforcing steel, etc.). The Bureau of Traffic will provide a cost for full or cantilevered sign structures. Provide funding in the contract for shop inspection of an overhead sign structure. Use \$1500 to \$2000 for a single structure and \$1000 each for multiple structures. Contact Bridge Design to discuss cost estimates. (See the Estimate Guidelines in Chapter 13 for additional information.)

Compile the sign quantities on the sign text layout sheets provided by the Bureau of Traffic, and summarize them in the *Quantity Workbook*.

SECTION 616 - TRAFFIC SIGNALS

Summarize under the Traffic Signal and Lighting Summary. Note the location of the mast arm foundation by station and offset.

SECTION 618 - UNIFORMED OFFICERS AND FLAGGERS

Determine how long (in weeks) it will take to construct the project. The calculation should include work hours/day, work days per week and the number of flaggers and/or uniformed officers anticipated (with or without vehicle). Review the total number of hours for each with the District Construction Engineer. The quantity for Flaggers (Item 618.7) is shown in the Estimate as a total number of *hours*. The cost for Uniformed Officers (Item 618.6) is shown in the Estimate as a *dollar amount*.

SECTION 619 - MAINTENANCE OF TRAFFIC

Maintenance of Traffic is paid as a unit item. The purpose of this item is to provide a safe and passable traffic accommodation for the traveling public within the project limits. This includes dust control and Construction Signs and Warning Devices.

The list of Construction Signs and Warning Devices is provided by the Bureau of Traffic and reviewed/modified by the Bureau of Construction. The permanent (typically post mounted) signs included in this list are shown in the summaries. The operational controls are listed to define a cost estimate that is required by the *Manual of Uniform Traffic Control Devices* (MUTCD) but are not shown in the summaries. Operational construction signs and warning devices are determined by the Contractor based on the needs of the daily work operations.

When estimating the cost for Item 619.1 - Maintenance of Traffic, keep in mind that the cost for the construction signs and warning devices provided by the Bureau of Traffic is based on the cost of *new* signs and warning devices. This cost should be adjusted down to reflect the fact that most Contractors will erect signs and warning devices from their used inventory. Add to this the cost of other work that is included as part of this item as defined by the Standard Specification. Reference past projects of similar type for examples of cost.

Item 619.25 - Portable Changeable Message Sign (U)

Portable Changeable Message Signs are paid by the unit. The basis for this quantity is the number of units needed for the length of the project (two (2) signs during the project would be two (2) units).

Item 619.253 - Portable Changeable Message Sign (Unit/Week)

Portable Changeable Message Signs (Unit/Week) are paid by the unit. The basis of this quantity is different than it is for Item 619.25. The quantity is calculated by taking the number of signs need and multiplying it by the number of weeks they are need (two (2) signs needed for ten (10) weeks would be twenty (20) units).

SECTION 621 - DELINEATORS

Tabulate delineators by the item showing locations by a station to station and offset reference, the required spacing and quantity. Delineators are usually summarized in the Incidental Items summary. Delineator spacing along a roadway will be set by establishing the spacing through curves along the alignment, then setting the spacing along the tangent sections. Delineator spacing is found on Standard No. DL-1. For example:

PC to PT	RADIUS	PLAN SPACING	ITEM 621.3
28+20.000 to 33+81.250 Lt. & Rt.	650 m	561.250 m x $\frac{1 \text{ Del.}}{40 \text{ m}}$	14 x 2 sides = 28

If the curve is at the top of a 2:1 fill slope, beam guardrail delineators are also needed.

RADIUS	SPACING	ITEM 621.2
650	561.250 m x $\frac{1 \text{ Post}}{1.905 \text{ m}}$ x $\frac{1 \text{ Del.}}{14 \text{ Posts}}$	21

Now calculate the first, second, and third delineator spacing before and after the curve. Be sure to remember that the maximum delineator spacing will be 80 m. Similar computation layouts should be used when calculating other delineator items. Delineators for temporary barrier including guardrail are subsidiary to the barrier. Post mounted delineators are not required along sidewalks. Delineators for permanent barrier including guardrail are paid separately.

SECTION 622 - MARKERS AND BOUNDS

Item 622.1 - Steel Witness Markers

Witness markers are used to locate ditch line drainage structures, ends of culverts, slope drains and underdrains. Witness markers are not placed at the ends of culverts that are 900 mm and larger in diameter. For example:

Sta. 103+50 Rt. Und. Out.	1
Sta. 103+75 Lt. CB	1
Sta. 104+90 Lt. & Rt. (300 mm culvert)	2
Total =	<u>4</u>

Item 622.2, 4, 5 - Bounds

Bounds are set on Right-of-Way lines, at the beginning and ending of the project, at the beginning and ending of (horizontal) curves, at the beginning and ending of spirals, at angle points and spaced no further than 300 m on tangents. Do not place bounds on property lines or on existing right-of-way lines. If the station or offset to an angle point is not definitely known, show the station and offset as plus or minus. The majority of the bounds that are set are concrete bounds. Stone bounds are used when bounding non-State Right-of-Way for cities and towns. A typical bound compilation is shown below. (If bounds are summarized in their own summary box, Right-of-Way flagging can be eliminated on the construction plans). For example:

Location	Item 622.2 Concrete bounds	Item 622.4 Stone bounds	Item 622.5 Reset bounds
Main Line			
Sta. 10+00.00 Lt. & Rt. 15.00 m	2	-	-
Sta. 13+00.00 Lt. 15.00 m	1	-	-
Town Road			
Sta. 3+65 Rt. 12.00 m	-	1	-
Sta. 4+60 Lt. 10.85 m	-	-	1
Total	3	1	1

SECTION 625 - LIGHT POLE BASES

Tabulate light pole base locations by station and offset. Separate by roads, ramps, etc. This item will usually be included in the Traffic Signal and Lighting Summary. For example:

Location	Item 625.2
66+50 Rt. 8.4	1
68+76 Lt. 8.4	1
77+38 Lt. 10.2	1
Total	3

SECTION 628 - SAWED PAVEMENTS

Pavement cuts can be made with a pavement saw, or can be done with a cutting wheel on the back of a piece of heavy equipment like a grader. Generally, longitudinal cuts that will be overlaid with pavement can be done with a wheel, and are considered subsidiary to the pavement items. All concrete pavement cuts, longitudinal bituminous pavement cuts that will not be overlaid later, transverse cuts and driveway cuts are done with a saw and paid under Section 628. Show the item totals in the Incidental Items summary.

Location	628.1	628.2	628.3
37+50 Pave. Match (Asph.)		8.2 m	
50+00 Match concrete drive (Conc.)	6.1 m		
9+50 Side St. Asph. over Concrete			7.5 m
Total	6.1 m	8.2 m	7.5 m

SECTION 632 - RETROREFLECTIVE PAVEMENT MARKINGS

Retroreflective Pavement Markings include pavement markings applied during construction phasing and applied as the final markings upon completion of the project. The designer should review not only the final Pavement Marking Layout supplied by the Bureau of Traffic, but also any Construction Traffic Control Phasing to determine a reasonable estimate for this quantity. Tabulate the locations and types of markings at each location.

PAVEMENT MARKINGS UPON COMPLETION (From Pavement Marking Plans)

Main Line 10+00.0 to 13+65.0, Lt. & Rt. Item 632.0110 - (100 mm Paint Line)
 100 mm SSL (W) (Edge) 2 Lines x 365.0 m = 730.0 m
 100 mm SBL (Y)(Centerline) 365.0 m x 3 m Line = 91.3 m
 12 m Length

Town Road 1+50.0 to 3+00.0 Item 632.0110 - (100 mm Paint Line)
 100 mm SSL(W) (Edge) 2 lines x 150.0 m = 300.0 m
 100 mm DSL (Y)(Centerline) 2 lines x 150.0 m = 300.0 m

Town Road Stop Line Item 632.0130 - (300 mm Paint Line)
 300 mm SSL (W) 1 line x 3.6 m lane width = 3.6 m

Location	632.0110 (100 mm Line) (m)		632.0130 (300 mm Line) (m)
	(W)	(Y)	(W)
Main Line	730.0 + 91.3 = 821.3		
Town Road	300.0 + 300.0 = 600.0		3.6
Sub-Total	1421.3		3.6

PAVEMENT MARKINGS DUE TO CONSTRUCTION PHASING (Developed for TCP)

Main Line (Phase 2) 10+00.0 to 13+65.0, Lt. & Rt. Item 632.0110 - (100 mm Paint Line)
 100 mm SSL (W) (Edge) 2 Lines x 365.0 = 730.0 m
 100 mm DSL (Y)(Centerline) 2 Lines x 365.0 = 730.0 m

Town Road Stop Line Item 632.0130 - (300 mm Paint Line)
 300 mm SSL (W) 1 line x 3.6 m lane width = 3.6 m

Detour (Phase 1) 10+85.0 to 12+85.5, Lt. & Rt. Item 632.0110 - (100 mm Paint Line)
 100 mm DSL (W) (Edge) 2 lines x 200.5 m = 401.0 m
 100 mm DSL (Y) (Centerline) 2 lines x 200.5 m = 401.0 m

Location	632.0110 (100 mm Line) (m)		632.0130 (300 mm Line) (m)
	(W)	(Y)	(W)
Main Line	730.0 + 730.0 = 1460.0		
Town Road			3.6
Detour Phase 1	401.0 + 401.0 = 802.0		
Sub-Total	2262.0		3.6

Item 632.0110 Total = 1421.3 m + 2262.0 m = 3683.3 m

Item 632.0130 Total = 3.6 m + 3.6 m = 7.2 m

The TCP may require the designer to consider using other types of roadway delineation along with painted lines to highlight the traveled way. For example, locations where vehicular traffic is close to pedestrian traffic may require special delineation (i.e., raised pavement markers, tubular markers, etc.). Any additional delineation will be paid under its appropriate item number.

Item 632.9XX - Obliterate Pavement Marking

Compile the quantity of markings to be obliterated, using a chart similar to the one used for applying pavement markings. Describe locations where the pavement markings are no longer applicable. Tabulate by station, as necessary, to clarify computations. Include breakdown of TCP phasing to assist in the determination of the quantity.

If an existing pavement marking will be used after the construction is finished, blackout tape can be used to obliterate the marking during construction. After construction is finished, the tape is removed, restoring the pavement marking. If blackout tape will be required, it must be specified in the contract documents (i.e., the plans, Prosecution of Work, etc.). Payment is still made as Obliterate Pavement Marking.

SECTION 641 - LOAM

List each area by a station to station reference. Compute using a dimensioned sketch or measure the plan area. Loam is usually used in areas that are aesthetically sensitive, e.g., in front of homes and businesses, around parks and playgrounds, and under sod. The majority of other landscaping areas will receive humus, except wetland areas which receive wetland humus. List each area by a station to station reference.

Route 66		
85+60.0 to 86+10.0 Rt.	(50.0 m x 5.0 m x 0.1 m)	= 25.00 m ³
Plummer Road		
Island (1:500 Scale)	(2.65 in ² x $\frac{161.29 \text{ m}^2}{\text{in}^2}$ x 0.1 m)	= 42.74 m ³
Sod Area		
8+00.0 to 8+40.0 Lt.	(40.0 m x 0.2 m x 0.1 m)	= <u>0.80 m³</u>
		Total = 68.54 m ³

Loamed areas will be tabulated in a separate summary with the Total carried to the Landscaping and Slope Protection Summary.

SECTION 642 - LIMESTONE

Limestone is used in all loam and humus areas. According to the *Standard Specifications*, the rate is based upon the pH of the soil. Since the pH of the soil is unknown to the Designer, use the average of 4.50 t/ha. Be aware that some special landscaping areas do not receive limestone (e.g., wetland humus areas). For example:

$$\text{Loam: } 365 \text{ m}^2 \times \frac{1 \text{ ha}}{10\,000 \text{ m}^2} \times \frac{4.50 \text{ t}}{1 \text{ ha}} = 0.164 \text{ t}$$

$$\begin{array}{rcl} \text{Humus: } 811 \text{ m}^2 \times \frac{1 \text{ ha}}{10\,000 \text{ m}^2} \times \frac{4.50 \text{ t}}{1 \text{ ha}} & = & 0.365 \text{ t} \\ & & \hline \text{Total} & = & 0.529 \text{ t} \end{array}$$

SECTION 643 - FERTILIZER FOR GRASSES

Fertilizer is used in all loam and humus areas. Since the condition of the soil is unknown to the Designer, use the application rate for a 10-10-10 fertilizer. Be aware that some special landscaping areas do not receive fertilizer, e.g., wetland humus areas.

For example:

$$\begin{array}{rcl} \text{Loam: } 365 \text{ m}^2 \times \frac{9.8 \text{ kg}}{100 \text{ m}^2} & = & 36 \text{ kg} \\ \text{Humus: } 811 \text{ m}^2 \times \frac{9.8 \text{ kg}}{100 \text{ m}^2} & = & 79 \text{ kg} \\ \text{Total} & = & \hline & & 115 \text{ kg} \end{array}$$

If the calculated quantity for fertilizer (for initial application or refertilization) is more than 250 kg, pay this quantity by the ton. Refertilization is generally used on multi-construction season projects that require more than one (1) construction season where the seeding is done in one construction season for all or part of the project, but completion is not until a subsequent construction season.

SECTION 644 - GRASS SEED

All loam, humus, and wetland humus areas are seeded. Each type of area gets a different type of seed. Consult the *Standard Specifications* or Special Provisions for the proper seed mix. Apply the various types of seed at the rates specified. Compute each seed type separately. Also, separate out each use because the quantities can be summarized under landscaping, or slope protection, or both. For example:

Item 644.15 - Park Seed Type 15 (Used in loam areas.)

$$\text{Loam } 1000 \text{ m}^2 \times \frac{1 \text{ ha}}{10\,000 \text{ m}^2} \times \frac{135 \text{ kg}}{\text{ha}} = 14 \text{ kg}$$

Item 644.44 - Slope Seed Type 44 (Used in humus areas.)

$$\text{Humus } 2400 \text{ m}^2 \times \frac{1 \text{ ha}}{10\,000 \text{ m}^2} \times \frac{90 \text{ kg}}{\text{ha}} = 22 \text{ kg}$$

Item 644.6 - Crownvetch (Used in addition to Slope Seed Type 44 to stabilize slopes 3:1 and steeper.)

$$\text{Steep Slopes } 14\,000 \text{ m}^2 \times \frac{1 \text{ ha}}{10\,000 \text{ m}^2} \times \frac{11.2 \text{ kg}}{\text{ha}} = 16 \text{ kg}$$

There are other special purpose seeds not referenced in the *Standard Specifications*. The Specifications Engineer can supply the special provisions for these items. Consult with the Roadside Development Section of Highway Design for guidance in the application of these special seeds.

SECTION 645 - EROSION CONTROL

Item 645.11, 645.111 - Mulch

Mulch is used to trap moisture and hold seed in place until the grass is established. Use the loam and humus areas to compute this quantity. Separate calculations will be used when special mulch is used for erosion control. Tackifiers are normally used to help keep the mulch in place. Some landscaping areas do not receive mulch (e.g., sod and wetland humus areas).

Loam Areas	990 m ²
Humus Areas	2430 m ²
	<hr/> 3420 m ² or 0.342 ha

Item 645.21 - Slope Stabilization (2:1 or Flatter)

The products under this item are used to help stabilize slopes where high runoff velocities would cause a problem with grass establishment and is recommended by Materials and Research in their Geotechnical Request. The typical method of measurement is to digitize the area to be covered and apply the appropriate Slope Correction Factor (if needed). Another method would be to estimate an average slope length between stations, and compute the quantity as the sum of areas between stations. For example:

	Plan Area (m ²)	Slope Correction Factor	Actual Area (m ²)
16+00.0 to 18+75.0 Rt. (2:1 Slope)	990.0	1.12	1108.8
17+25.5 to 19+30.5 Lt. (4:1 Slope)	492.0	1.03	506.8
		Total =	1615.6

Item 645.22 - Slope Stabilization (Steeper than 2:1)

The products under this item are also used to help stabilize slopes where high runoff velocities would cause a problem with grass establishment but, since the slope angle is steeper, the potential for a more severe problem is greater if not addressed. This quantity is measured similarly to the way Item 645.21 is calculated.

Item 645.23 - Channel Stabilization, Low Velocity, and

Item 645.24 - Channel Stabilization, High Velocity

These items represent two groups of products that are designed to establish grass in channels and ditches. Usually, a recommendation to stabilize a ditch or channel will be in the Geotechnical Report. These products are generally used in locations that are aesthetically sensitive and are intended to be an alternative erosion control measure to stone fill. To compute this quantity, measure the wetted perimeter of the ditch and multiply that by the length of ditch that is covered by the channel stabilization. For example:

$$\begin{aligned}
 &6:1 \text{ Ditch Wetted Perimeter (From Typical)} = 1.2 \text{ m} + 0.9 \text{ m} = 2.1 \text{ m} \\
 &\text{Sta. } 32+50.0 \text{ to } 34+63.0, \text{ Rt. (6:1 Ditch)} = 213 \text{ m long} \times 2.1 \text{ m wide} = 447.3 \text{ m}^2 \\
 &\text{Sta. } 31+50.2 \text{ to } 32+65.20, \text{ Lt. (6:1 Ditch)} = 115 \text{ m long} \times 2.1 \text{ m wide} = \underline{241.5 \text{ m}^2} \\
 &\text{Total} = 688.8 \text{ m}^2
 \end{aligned}$$

Item 645.25 - Permanent Stabilization

A recommendation to use Permanent Stabilization will be in the Geotechnical Report. This item is reserved for those products from the Approved Products List that are intended to have an extended life, and will be supplemented with grasses as the soil stabilization method. Good judgment should be used when specifying this item, since it is more expensive than stone fill. It is generally used when stone fill would be aesthetically unacceptable. The method of measurement is the same for this item as it would be for Item 645.21 on slopes or for Item 645.23 in ditches.

Item 645.51 - Hay Bales for Temporary Erosion Control

The actual number of hay bales used will depend upon the Stormwater Management Plan and the erosion control devices selected by the Contractor's Consultant. Estimate the number of hay bales per the "EROSION CONTROL" detail sheet in Appendix 8-4. Separate the various types of protection, e.g., "A", "B", "C", and "D". Also, consider the stages of construction. Consult with the Bureau of Construction to verify the types of protection likely to be used and their locations. Show the total on the summary. A hay bale is assumed to be 0.75 m long. For example:

Type A

$$\begin{aligned} &\text{Sta. 17+50.0 to 23+00.0, Rt.} = 550 \text{ m} \\ &550 \text{ m} \times \frac{1 \text{ bale}}{0.75 \text{ m}} = 734 \text{ bales} \end{aligned}$$

$$\begin{aligned} &\text{Sta. 26+00.0 to 29+50.0} = 350 \text{ m} \\ &900 \text{ m} \times \frac{1 \text{ bale}}{0.75 \text{ m}} = 1200 \text{ bales} \end{aligned}$$

Type C

$$\begin{aligned} &\text{Sta. 23+00.0 to 26+00.0, Rt.} = 300 \text{ m} \\ &300 \text{ m} \times \frac{2 \text{ bales}}{6 \text{ m}} = 100 \text{ bales} \end{aligned}$$

$$\text{Total} = \underline{\underline{2034 \text{ bales}}}$$

Item 645.531, 645.532 - Silt Fence

The actual length of silt fence used will depend upon the Stormwater Management plan and the erosion control devices selected by the Contractor's Consultant. List location where fence may be required by a station to station reference. Generally, place silt fence along all wetlands and fill slopes steeper than 4:1. A remarks column should be used to point out requirements for temporary detours or other uses for silt fence required during phases of the Traffic Control Plan. For example:

Main Line

$$\begin{aligned} &36+50.3 \text{ to } 43+85.3 \text{ Rt.} \quad 735.0 \text{ m} \\ &36+50.5 \text{ to } 42+50.5 \text{ Lt.} \quad 600.0 \text{ m} \end{aligned}$$

Detour

$$\begin{aligned} &37+00.5 \text{ to } 39+85.5, \text{ Rt.} \quad \underline{285.0 \text{ m}} \\ &\text{Total} = 1620.0 \text{ m} \end{aligned}$$

Item 645.71 - Monitoring Erosion and Sediment Control

Determine the number of weeks that monitoring would be required to construct the project from beginning to completion. Then determine the number of hours per week that monitoring will be necessary, based on the requirements in the *Standard Specifications* (a good assumption to start with is 4 hours/week). Computations should show how the quantity was derived i.e., hours/week, number of weeks, etc. Review this quantity with the District Construction Engineer. The total quantity is usually shown in the Incidental Items summary.

SECTION 646 - TURF ESTABLISHMENT

This item is usually used on projects where it is undesirable to specify separate items to establish grass or where the treatment is straight forward and similar throughout the project as is the case with 4R-type projects. Consult with the District Construction Engineer to see if this item is preferred.

SECTION 647 - HUMUS

All grassed areas (except those areas receiving loam or wetland soils) receive humus (normally 90 mm deep). The typical method of measurement is to digitize the area to be covered and apply the appropriate Slope Correction Factor (if needed). Another method would be to estimate an average slope length between stations, and compute the quantity as the sum of areas between stations. Separate special intermixed or wetland humus areas as required. For example: (use the 2:1 slope correction factor of 1.12, since the example is assumed to be on a 2:1 slope).

$$\text{Planimetered } 6.27 \text{ in}^2 \times \frac{161.29 \text{ m}^2}{1 \text{ in}^2} \times 1.12 = 1132.64 \text{ m}^2$$

$$\text{Total} = 1132.64 \text{ m}^2 \times 0.09 \text{ m} = 101.9 \text{ m}^3$$

SECTION 648 - SOD

Sod is used in developed areas to quickly and more comparatively match adjacent landscaped areas. Sometimes the areas to receive sod are stipulated by ROW agreement. Sod is more costly than loam/seed or turf establishment; therefore, carefully evaluate the area before specifying it's use. Sod areas will also need loam, limestone, and fertilizer (paid under their respective items). Describe the sod areas with a station to station reference. Areas can be scaled or the area can be planimetered. For example:

Sta. 38+25 to 39+75, Rt. (behind sidewalk)

$$150.0 \text{ m long} \times 2.0 \text{ m wide} = 300.0 \text{ m}^2$$

Sta. 31+60 Lt. (Island)

$$1.45 \text{ in}^2 \times \frac{161.29 \text{ m}^2}{\text{in}^2} = \underline{233.9 \text{ m}^2}$$

$$\text{Total} = 533.9 \text{ m}^2$$

SECTION 670 - SPECIAL ITEMS

Item 670.066 - Mailbox Post Assemblies

List the mailbox locations by approximate station and offset.

Main Line		
64+35.0 Rt.		1
66+65.3 Lt.		1
67+10.5 Rt.		1
South Street		
26+60.0 Rt.		1
26+80.0 Lt.		1
	Total	<u>5</u>

Item 670.101 - Temporary Lighting

Temporary lighting is paid in either of two (2) ways. When the Contractor provides it, it is paid as a unit (Item 670.101). When it is arranged for by the Contractor through the local power company, it is paid for as "extra work", i.e., a fixed dollar amount is included in the contract under Item 1008.1. (See section 109.04 from additional information regarding extra work.) The Utility Coordinator will determine which Temporary Lighting item to use, and its final cost.

Item 670.045 - Construct and Remove Detour

This unit item eliminates the need to measure the quantity of materials used and the excavation required to construct and remove detours (or temporary widenings) on a project. This item includes earthwork and aggregate base courses. The Designer should still compute excavation, fill, and aggregate base course quantities, since they are the basis of the cost of the unit item. Other items required to complete the detour such as drainage, pavement, and guardrail are paid separately and are identified as temporary in the item description.

SECTION 692 - MOBILIZATION

Use on all projects unless otherwise directed. Computation is based as a percentage of the contract item sub-total (*including bridge items*). A dollar amount is shown in the estimate. Historically, bid amounts for Mobilization vary widely, sometimes from less than 1% of the contract item sub-total to as much as 10% or more. Generally, the higher the construction cost, the lower the percentage used in the calculation which normally ranges from 3% to 8%. Round the dollar amount to next higher \$1000. Coordinate with the Senior Consultant Supervisor or the Chief of Final Design to establish this cost on the P.S. & E. Estimate.

SECTION 693 - TRAINING PROGRAMS

On-the-Job Training is accounted for as a fixed dollar amount of within the Contract. At the beginning of each fiscal year (October), the Labor Compliance Section of the Bureau of Human Resources produces a list of the recommended number of trainees for Federal Aid construction projects that will advertise. If a project is scheduled to include this item in the

Contract, the number of trainees required to meet On-the-Job training goals is on this list. Contact the Final Design Group Leader or Consultant Supervisor for this list.

SECTION 698 - FIELD FACILITIES

Item 698.11, 12, 13 - Field Office Type A, B, C

Highway Design will coordinate with the Bureau of Construction to determine which type of Field Office, if any, is appropriate for the project. A separate item is included if NHDOT supplies the field office (e.g., a building owned by the State that will be removed). The cost of this unit item is estimated using the Weighted Average Unit Prices report (available from Records Section).

Item 698.2 - Physical Testing Laboratory

Highway Design will also coordinate with the Bureau of Construction to determine whether a Physical Testing Laboratory is needed. The cost of this unit item is estimated using the Weighted Average Unit Prices.

SECTION 699 - TEMPORARY PROJECT WATER POLLUTION CONTROL (SOIL EROSION)

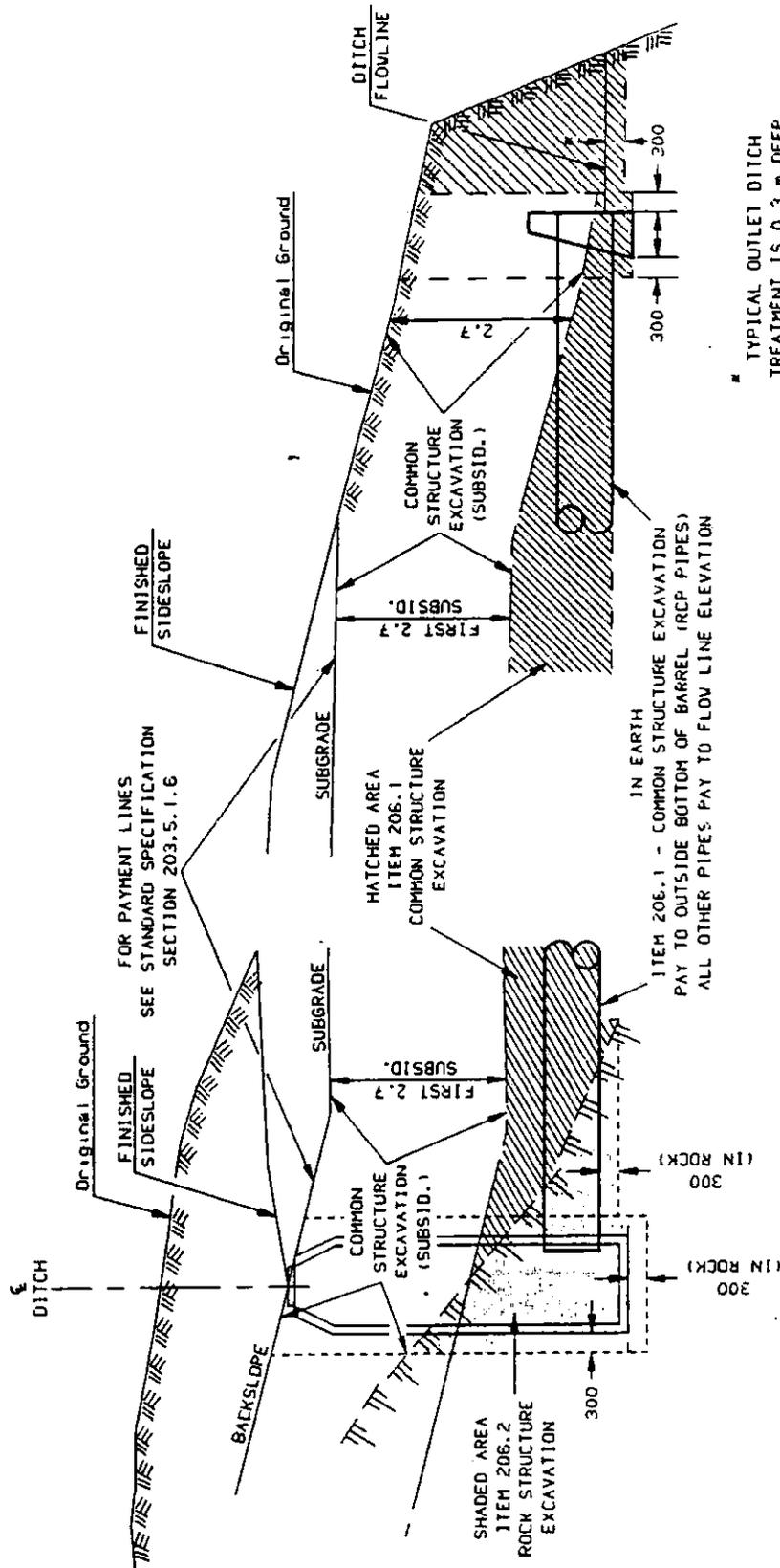
Item 699 - Temporary Project Water Pollution Control

Temporary Project Water Pollution Control consists of temporary control measures as shown on the plans or required during the life of the contract to control water pollution. This will usually include the use of hay bales, silt fence, pipes, earth berms, filter fabrics, slope drains, grasses, etc. A contract usually includes Item 699 in conjunction with Item 645.51 and 645.531, so a cost per unit for these items can be fixed under their respective items but paid for under Item 699. The final cost of this item is dependent upon the extent of the pollution control needed, and is driven by experience. Contact the Chief of Final Design or the Consultant Supervisor for guidance in setting a dollar amount for this item. Round the dollar amount to the next higher \$1000.

APPENDIX LIST

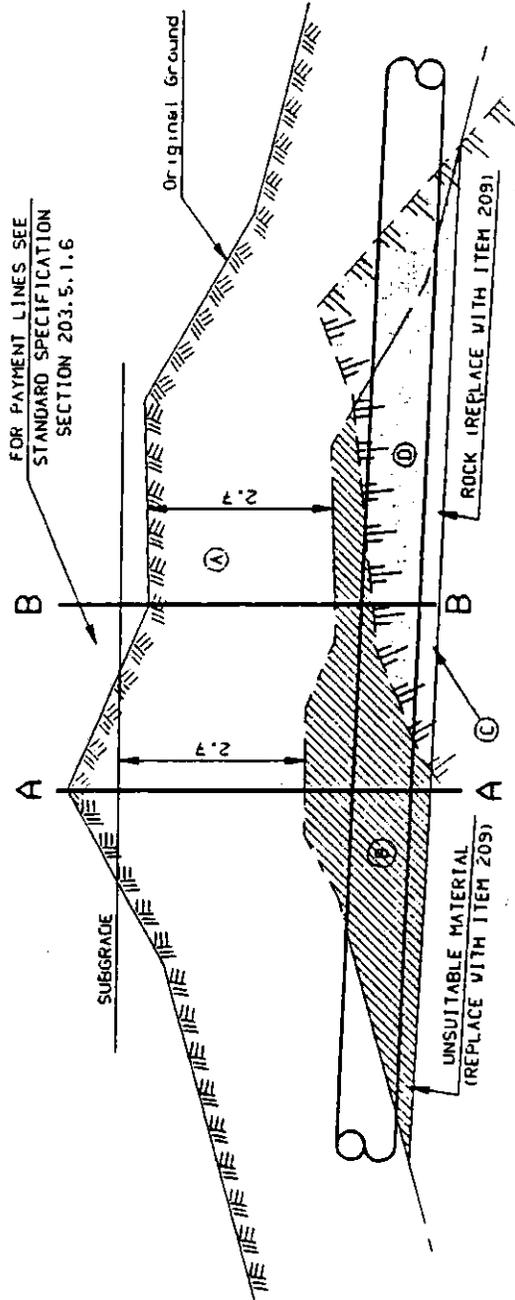
- 8-1 Highway Design Calculation Sheet
- 8-2 Common Structure Excavation Diagram for a Closed Drainage System
- 8-3 Common Structure Excavation Diagram for a Culvert
- 8-4 Erosion Control Detail Sheet

APPENDIX 8-2



TYPICAL OUTLET DITCH
TREATMENT IS 0.3 m DEEP
STONE FILL CLASS C
(DEPTH MAY VARY)

APPENDIX 8-3



FOR PAYMENT LINES SEE
STANDARD SPECIFICATION
SECTION 203.5.1.6

Original Ground

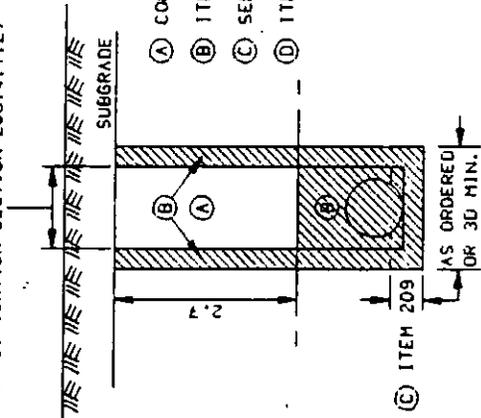
SUBGRADE

UNSUITABLE MATERIAL
(REPLACE WITH ITEM 209)

ROCK (REPLACE WITH ITEM 209)

SECTION IN UNSUITABLE MATERIAL
(FOR WIDTH, SEE STANDARD
SPECIFICATION SECTION 206.4.1.2)

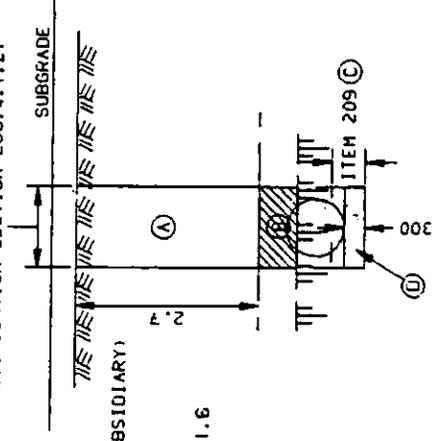
SECTION IN ROCK
(FOR WIDTH, SEE STANDARD
SPECIFICATION SECTION 206.4.1.2)



SUBGRADE

(C) ITEM 209

AS ORDERED
OR 30 MIN.



SUBGRADE

(C) ITEM 209

300

- (A) COMMON STRUCTURE EXCAVATION (0 - 2.7 m SUBSIDIARY)
- (B) ITEM 206.1 - COMMON STRUCTURE EXCAVATION
- (C) SEE STANDARD SPECIFICATION SECTION 603.3.1.6
- (D) ITEM 206.2 - ROCK STRUCTURE EXCAVATION

SECTION A-A

SECTION B-B

