DIVISION 300

SUBGRADE PREPARATION

DIVISION 300 - SUBGRADE PREPARATION

301.00 **CHECKLISTS** (See Division 200)

302.00 BASE COURSE AND SUBGRADE INSPECTION

The Construction Technician will inspect and control fine grading and subgrade preparation as required by the plans and contract provisions. Grade stakes for trimming, if required, will usually be set by a construction survey party. The Project Manager and/or the construction technician will check the design gradation and proportions. The construction technician will stake and inspect the quality, quantity, and placement of aggregates and binder materials. If gravel aggregates are produced at a screening plant, inspection may be required at the plant and a scale inspection may be required.

The Construction Technician should be able to determine all project transitions and the complete roadway layout. He/she should anticipate that the prime contractor will need "paving hubs" once the grading contractor has the grade within 75-90 mm (3 – 3 ½ inches) of the final grade. The "paving hubs" once placed should clearly define the roadway. If any points do not fit as anticipated, the Construction Technician should check the point(s) with the survey crew and, if necessary, the Project Manager.

Fly Ash

Liberal use of fly ash is recommended to dry and stabilize unsuitable soil on critical projects.

When purchasing fly ash, the price to be paid for the fly ash should be from the invoice the contractor receives from the source of the fly ash. It is not our intent that the contractor purchases and stockpiles fly ash, marks up the price, and then invoices it to us.

303.00 SUBGRADE PREPARATION AND SHOULDER SUBGRADE PREPARATION

(See SSHC Section 302)

303.01 CONSTRUCTION METHODS

Since the performance of these items is accomplished to prepare the subgrade to support rigid or flexible pavement, and since the performance of either type of pavement is strongly affected by the moisture and density conditions of the subgrade at the time of placement of the pavement, the inspection of work under this subsection is of the highest importance. While staying within the Specification moisture and density limits, the following points should be kept in mind:

- In order to achieve high subgrade strength for flexible pavements, soils should have high densities and low moisture contents.
- In order to avoid differential swell in subgrade below rigid pavements, soils should have lower densities and higher moisture contents.
- In order to avoid roughness due to differential heave, subgrade soils should have uniform moisture and densities.

Studies have shown that a wide range of moistures and densities may be found in subgrades thought to be uniformly compacted to the satisfaction of the construction inspectors. It is believed that this lack of uniformity may to some extent be due to the tendency to take samples in locations thought to be representative (thus actually being a median condition) rather than taking samples at random locations. *See Materials Sampling Guide* for directions on how to sample the subgrade.

@ Another problem which may result in improper moisture and density control is the erroneous identification of the soil type. A review of the Materials and Research "Earthwork Engineering Guide" is recommended.

Settlement of shoulder pavement relative to the driving lanes and a resulting maintenance operation to eliminate a drop-off condition is quite common. Extra care in compaction of subgrade adjacent to the pavement edge is necessary to alleviate this problem area.

The item of work "Subgrade Preparation" is designated as the procedure to be followed in preparing the grade on projects where the surfacing will be constructed.

It is particularly important to test the portion of the roadbed which will underlie the outer edges of the surfacing. Frequently, this portion of the roadbed will be found to be high in moisture content and have less than satisfactory density due to freezing and thawing or lack of traffic compaction. If the moisture or density of this outer portion is less than satisfactory, difficulty may be experienced in properly constructing and compacting the overlying pavement.

This work provides for adjusting grade lines, scarifying, drying, shaping and compacting of the upper 150 mm (6 inches) of the roadbed ahead of surface or base construction. The moisture and density requirements will be shown in the plans.

The Specifications require that the correction of failures below the upper 150 mm (6 inches) of the subgrade will be performed on an "Extra Work" basis.

After the operations of Subgrade Preparation, Shoulder Subgrade Preparation and Subgrade Trimming are completed, the Project Manager should arrange to measure the cross sections of the trimmed subgrade surfaces. The measurements should be taken at 600 mm (2 feet) intervals across the subgrade from side to side and the results recorded in the inspector's notebook. The sections should be taken with a tight string line stretched across the top of the forms or across the reference lines and measurements made to the nearest 3 mm (1/8 inch) from the cord to the subgrade. In some cases it may be advantageous to perform this checking by instrument which is an acceptable method.

At the beginning of the operation checks should be made to assure that the equipment is in proper adjustment and the operating ability is such as to produce the desired template. As a minimum, after having checked the beginning operation, the template should be checked each 300 m (1000 feet) and the results recorded in a field book. In the case of urban work, or when the performance of the work is such that it is questionable, the frequency of checks should be substantially increased to assure the correctness of the grade. The contractor should be informed of any areas that will need correction before subsequent operations proceed.

The Specifications provide a maximum trimming tolerance from the staked elevation when preparing the subgrade for placement of asphaltic concrete or a combination of base and asphaltic concrete or armor coat. There are no specified trimming tolerances when preparing the subgrade for placement of foundation courses or concrete pavement. However, there are "contractor self-imposed tolerances" due to thickness tolerances of the subsequent surface structure. Thus, due to the nature of the specifications, the tolerances imposed by the contractor should in reality be even more rigid than those specified for flexible pavement.

Subgrade preparation is not accepted until the overlying pavement has been placed. Any damage to the subgrade prior to placement of the overlying pavement shall be corrected by the contractor at no additional cost to the Department.

Prime Coat (*SSHC Section 517*)

The special provisions or plans may require the application of a prime coat after the trimming operation has been completed. The Project Manager may desire a prime coat due to actual job conditions when one has not been provided for. The District Engineer may be consulted for advice and for procedure when a prime coat is needed and has not been provided for in the project documents.

Subgrade Preparation After Removal of Existing Approach Slabs

SSHC Subsection 603.05, Paragraph 8 states that "the work of preparation of the subgrade under the pavement approaches shall not be measured and paid for directly but shall be considered subsidiary to the concrete pavement." This is intended to apply to approach slabs placed on new subgrade and not to the existing subgrade found after the removal of existing approach slabs.

When existing approach slabs are removed and the existing subgrade must be corrected, corrective work at depths greater than 150 mm (6 inches) shall be paid for as "extra work" (as per *SSHC Subsection 302.05*, Paragraph 5).

303.02 METHOD OF MEASUREMENT

Note in the *SSHC Subsection 302.04* that when measured by the square meter, the area is the plan quantity for the overlying paved surface. When measured by the station, each shoulder is measured separately without regard to width (100 m or 100 foot stations).

304.00 SUBGRADE STABILIZATION (*SSHC Section 303*)

304.01 DESCRIPTION

The principal function of subgrade stabilization is to provide a stable grade for subsequent construction.

304.02 MATERIAL REQUIREMENTS

@ See the Materials and Research Sampling Guide for sampling and testing requirements.

Obtaining Materials From Local Pits

In general, the contractor must obtain all off site pits and close them with the landowner. The Department no longer tracks site releases for contractor provided pits.

304.03 EQUIPMENT

The inspector should carefully check the contractor's equipment and calibrations. Pay quantities and other important measurements may be based on some of the equipment and we need to make certain that they conform to the requirements of the Specifications and the special provisions.

304.04 CONSTRUCTION METHODS

This item consists of the stabilization of non-cohesive sand by the addition of a natural soil binder material. In order to insure satisfactory performance of the overlying pavement, especially if it is of the flexible type, the following points should be kept in mind:

1. Silt clay soils exhibit poorer support for pavement if they exist as thin layers over pervious sands than if they comprise the full depth of the subgrade. For this reason, the placement of a thin soil binder layer over the sand should be prohibited.

2. The minimum amount of soil binder required to support construction operations should be used. An excessive amount of binder causes the mixture layer to act as a silt-clay layer as in 1 above.

3. Thorough mixing of sand and soil binder is conducive to good performance.

4. A stabilized subgrade will allow paving equipment to travel over sandy areas.

305.00 EARTH SHOULDER CONSTRUCTION (*SSHC Section 304*)

305.01 DESCRIPTION

Shoulder construction when included in the plans and contract shall be constructed in accordance with *SSHC Section 304*. Very often there are also special provisions included in the contract that pertain to specific problems anticipated in the shoulder construction of the project. The inspector and Project Manager should be certain that the special provision requirements are followed.

305.02 CONSTRUCTION METHODS

I. Signs, delineators, mailboxes and guardrail will usually need to be removed from the areas where the contractor is required to perform this item of work. Department maintenance forces may be required to move the signs, delineators, and guardrail. There generally will be instructions in the contract stating the disposition of the delineators and guardrail and who is responsible for the relocation. The mailboxes should be moved by the owner. It is a good policy to discuss the anticipated conflicts affecting mail deliveries with the postmaster for the area before actual construction begins. The Project Manager or inspector will have to contact the mailbox owners and coordinate the relocation of these mailboxes so that inconveniences will be held to a minimum for all parties involved. The Department's or contractor's employees should not move these mailboxes except with the permission of the owners. If the owners will not cooperate, the postmaster for the area should be contacted.

II. Safety and protection of the highway user is a prime concern. The Standard Plans require plastic barrels if the drop-off at the edge of the traveled way is more than 50 mm (2 inches).

Certified flaggers are required when the normal flow of traffic must be interrupted. All slow equipment as defined in the Nebraska Rules of the Road shall display the slow moving vehicle emblem and have strobe or flashing yellow beacons. The contractor must erect and maintain all the required signs and barricades in the correct positions to protect and warn the motorists. The Project Manager should take photographs and video tape the construction zone to document conditions.

III. The inspector shall take sufficient measurements and make sufficient observations to confirm that the shoulders have been constructed in reasonably close conformity with the typical section and the material requirements specified. These conforming checks shall be recorded in a bound field notebook. One check per 1.0 km (1/2 mile) highway centerline distance shall be the minimum number of checks required.

IV. The time limitations imposed by the Specifications in Table 304 and
@ Subsection 304.03 on placing the shoulders should be enforced. The tally of days (internal) charged against the shouldering must be shown on the weekly working day report.

305.03 METHOD OF MEASUREMENT

Plan stationing may be used for computing shoulder construction except in cases where apparent errors in stationing are discovered and the correct stationing is to be used.

Calibration of water measuring equipment is discussed in the *SSHC Section 205*.

Note in the *SSHC Subsection 304.04* that shoulders are measured by the station and each shoulder is measured separately without regard to width and depth.

306.00 FOUNDATION COURSE

306.01 DESCRIPTION

The principal functions of a foundation course are:

1. To provide a means of distributing water, which leaks through cracks and joints, in a uniform manner throughout the subgrade, thus avoiding differential swell and frost heave.

2. To prevent pumping at joints, cracks, and edges.

3. To strengthen support under joints, thus avoiding faulting.

4. To provide uniform support for the entire slab, thus reducing cracking.

For these reasons, the construction of foundation course deserves close inspection.

SSHC Section 307 describes foundation courses. All types require the use of mineral aggregate for foundation course, fine sand and water and all must be mixed in a twin pugmill mixer.

306.02 MATERIAL REQUIREMENTS

Generally all borrow pits are the contractor's responsibility to obtain and close.

306.03 CONSTRUCTION METHODS

Preparation of Subgrade

See plans and specifications for material requirements. Sampling procedures in the *Materials Sampling Guide* shall be followed.

Subgrade preparation will normally be accomplished under a contract item in *SSHC Section 302*. However, it is important that the moisture and density conditions specified under the subgrade preparation item be maintained until the foundation course is laid. Obtaining the moisture and density conditions is required by *SSHC Subsection 302.01*.

Mixing, Laying and Compacting

SSHC Subsection 307.03 require that the mineral aggregates and the pulverized soil binder be mixed in an approved pugmill. The purpose of this requirement is to produce a uniform and intimate mixture of the binder, water and aggregates and to make it possible to place this mixture, spread it and compact it to a firm foundation, without incorporating additional material from the subgrade. Accordingly, hauling should not be permitted when moisture conditions in the subgrade are such as to cause ruts and the resulting contamination of the base course material.

Uniformity of thickness of the compacted layer is very important. Since the Specifications require trimming of the subgrade and the base course by the use of automated electronically controlled equipment, accurate thickness control must be demanded.

Proper control of moisture content is significant for two reasons:

1. Uniformity of moisture content at the proper level aids in obtaining uniform density, meeting requirements.

2. Uniform moisture content, thoroughly distributed throughout the binder and aggregate mass, aids in the development of the necessary cohesion.

In the laydown of foundation course, it is best to lay the full thickness in one layer, when feasible. If there is only one layer, slippage between layers, a common problem in granular base courses, will be avoided.

After completion of the trimming operation, cross sections should be taken on the surface of the soil aggregate base course at 600 mm (2 feet) transverse intervals and at 300 m (1000 ft) longitudinal intervals matching the locations of the cross sections taken on the subgrade and recorded in the field book.

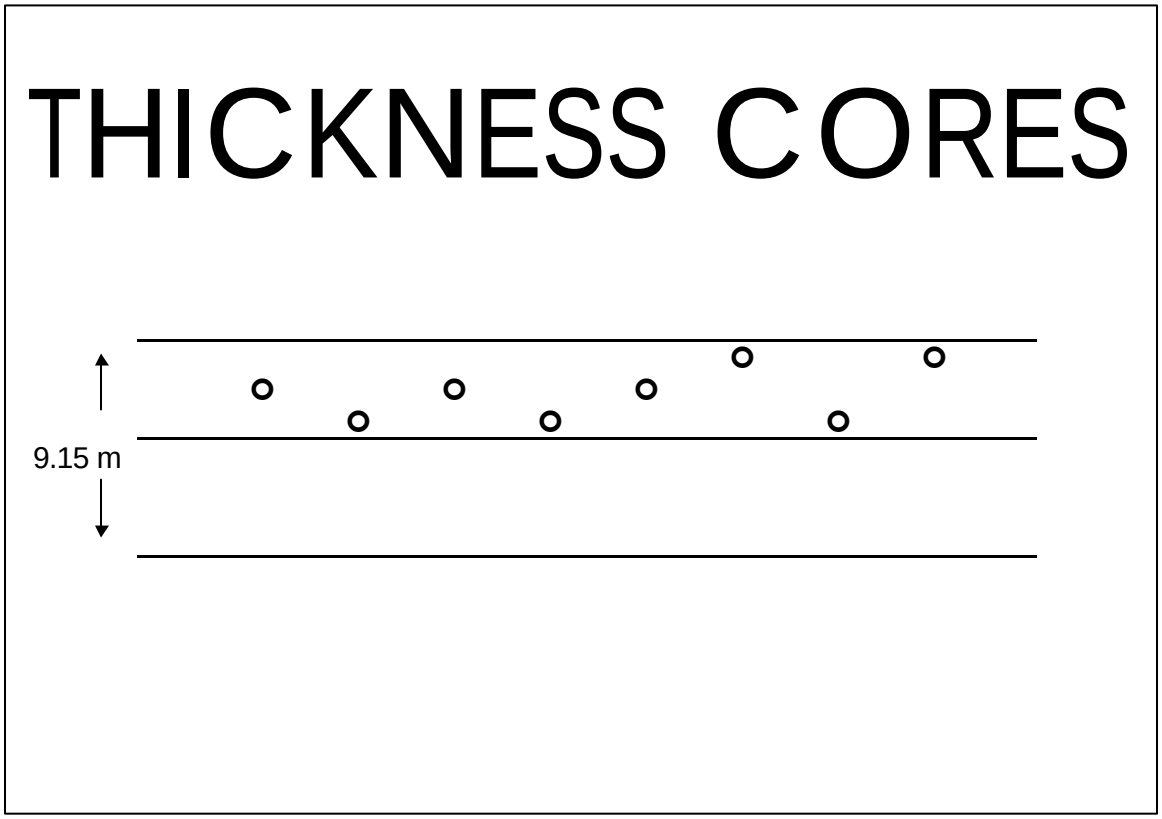
The Materials and Tests "*Materials Sampling Guide*" requires that density tests be made a 300 m (1000 foot) intervals or closer. At the time the density tests are made, following the trimming operation, the thickness of the soil aggregate base shall be carefully measured and recorded as documentation that the thickness requirements have been met. The thickness measurements shall be considered to represent only that width constructed and trimmed in a single operation. If any of these measurements show a deficiency from planned thickness of 12.5 mm (1/2 inch) or more and if payment is to be made by the square meter, additional measurements shall be made to define the extent of the soil aggregate base course shortage.

If a measurement shows a deficiency in thickness, a check measurement shall be taken 3 m (10 foot) either side of this location parallel to the centerline of roadway. If both check measurements fall within the 12.5 mm (1/2 inch) tolerance permitted, no deficiency is to be considered. If one or both are deficient in thickness, further checking shall be made at 15 m (50 foot) intervals from the original measurement and parallel to the centerline of roadway until a thickness within the tolerance is found in one or both directions as the case may be. Between this point and the location 15 m (50 foot) back, determine the point within 3 m (10 foot) at which the soil aggregate base course is within the tolerance permitted. If both categories of deficiency occur, the same procedure shall be used to determine the beginning and ending points of the two categories. The width of the deficiency shall be considered to be the full width constructed and trimmed in that particular operation.

Measurements for determining the thickness should be made at a maximum spacing of 150 m (500 feet) directly behind the trimming operation. This will prevent the priming of any deficient section that the contractor has the option to remove or that must be removed and replaced in accordance with the specifications.

The Project Manager shall enter all measurements and locations where made in a field notebook. In some cases a sketch may be necessary to clarify a nonpay area. Deductions in the pay quantity of the soil aggregate base course are to be computed and made by the field Project Manager.

The following examples shows measurements taken in a 150 m (500 foot) section where a thickness deficiency has occurred.



Measurement No.	Location	Actual Thickness	Specified Thickness
1	1 m Lt. cl Sta. 1001+50	81 mm	100 mm
2	1001+40	93 mm	100 mm
3	1001+60	79 mm	100 mm
4	1002+00	75 mm	100 mm
5	1002+50	79 mm	100 mm
6	1003+00	100 mm	100 mm
7	1002+90	91 mm	100 mm
8	1002+80	84 mm	100 mm

Limits of deficient area in the category of 12 mm to 25 mm deficient equal Station 1001+40 to Station 1002+90.

Non Pay Square Meters Soil Aggregate Base Course (Contractor's Option)

$150\ m \times 9.15\ m = 1350\ m^2$

Portland Cement Treated Foundation Course Requirements:

The time schedules given in the specifications should be strictly enforced. Once hydration of the cement is started, the process continues and cementing characteristics of the cement will be lost if aggregate and cement are not quickly compacted to their final orientation within the foundation course.

Compaction operations should be completed as quickly as possible. If rolling continues for too long a period, the bonds which the portland cement is trying to establish are broken in the upper part of the layer.

Prime coat application, which serves to some extent as protection against the infiltration of moisture, should not be delayed. If moisture penetrates the portland cement treated foundation course and enters the subgrade, a very serious problem can result.

Maintenance of the Compacted Base Course and Prime Coat

Prime coats should be applied as soon as possible after laydown and compaction procedures are completed, to protect against soaking of the base course by rainfall. The second laydown of a base course almost always is inferior to the first, especially if drying operations on the subgrade have been made necessary as a result of rainfall percolating through an unprotected base course.

The specifications provide that after the base course has been compacted to the required density and shaped to the typical cross section, the base course and prime coat shall be maintained by the contractor until subsequent construction has been completed.

306.04 BASIS OF PAYMENT

If the foundation course is to be paid for by the megagram (ton), deductions should be made for excess water.

Foundation course measured by the m^2 (square yard) is not directly measured but is the quantity of overlying pavement. (See *SSHC Subsection 307.04*)

307.00 ROCK OR AGGREGATE SURFACING (*SSHC Section 310*)

307.01 DESCRIPTION

This work consists of placing aggregate for a wearing course on an approved roadbed or on a newly built earth grade or on detours temporarily in use during construction. The aggregate surfacing shall be spread to meet the requirements shown in the plans or as directed by the Project Manager.

307.02 MATERIAL REQUIREMENTS

I. Setting Up the Field Testing Laboratory - Usually aggregate tests on construction projects are carried on in conjunction with other phases of the contract work and in that case the inspector may use the testing facilities provided for that work. The following equipment should be available to the aggregate inspector:

1 - 15 m (50 foot) tape
1 - Handaxe
1 - Grain Scale and pan or equivalent
1 - Set of sieves, 4.75 mm (No. 4) and 2.00 mm (No. 10) (including pan and lid)
1 - Shaker
1 - Splitter
2 - Aggregate drying pans
1 - Gasoline stove or hotplate
1 - Shovel or aggregate probe

II. Sampling and Testing - Aggregates shall be sampled, tested or submitted for testing in accordance with the Materials and Tests "*Materials Sampling Guide*". The inspector should read and become familiar with *SSHC Sections 310 and 1033*, and the special provisions of the contract.

The inspector will be responsible for sampling and testing of aggregate on the project. In some cases, when aggregate is supplied by a large producer, the District Engineer will have an inspector available at the pit site to test the material before it is shipped. However, even though some testing is done at the source, testing will be required on the project in order to calculate the payment to the contractor (*SSHC Subsection 310.05*).

307.03 EQUIPMENT

The inspector should inspect the contractor's equipment before starting. Each truck should be carefully measured and the capacity computed by the inspector. These capacities, truck numbers, etc., should be recorded in a field notebook. The measurement and capacities are reported to the District Engineer on a DR Form 101. (A sample of DR Form 101 is included on *Appendix 1*). For additional information in regard to the measurement of trucks, (see Subsection 103.04 in this manual.)

The specifications provide that the contractor shall secure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful

prosecution of the work. District Offices have current copies of the laws and load limits and questions concerning legal loads should be directed to the District Offices.

The Project Manager and inspector shall also be familiar with and see that the contractor adheres to the provisions of *SSHC Subsection 105.11*, Restrictions on Moving and Use of Heavy Equipment.

The load capacity for which the truck is licensed is indicated on a sticker pasted on the license plate and should be checked against the license certificate carried in the cab. Mass capacity will vary according to the number of single or tandem axles and will be specified for the truck's gross mass.

All trucks used on the project in connection with the performance of the work are required to be licensed in Nebraska regardless of the fact that they may be properly licensed in some other state. Trucks used only in hauling equipment or materials from outside the state to the project are covered by reciprocity and may not be required to be licensed in Nebraska.

Violations should be called to the contractor's attention. In the event that the contractor does not take steps to comply, the Project Manager shall immediately advise the District Engineer by letter with a copy to the contractor. Letters reporting violations shall include the name and address of the owner, make, type and license numbers of the vehicles and an explanation of the violation involved. This information will be referred to the proper authorities for investigation.

307.04 CONSTRUCTION METHODS

Hauling and Distributing Materials

I. Hauling Materials. No more than two different truck box capacities will be permitted unless approved by the Project Manager. No hauling shall be permitted when weather or roads are such that hauling causes excessive rutting. When aggregate for detours is required, it is advisable to go over the detour road with the District Construction Engineer to see what road defects need correction before the aggregate is placed.

II. Staking for the Distribution of Materials - In order that the contractor may know where on the road to place aggregate, stakes should be set along the shoulder which is to receive the aggregate at the load distance spacing. If it should occur that it is not desirable to place aggregate continuously, two stakes driven vertical should be set at the beginning and ending of each series of loads, two stakes driven to form a "X" may be used to mark each tenth load. One load should be spread between each pair of stakes, and instructions should be issued to the contractor to leave a small gap between loads so that you may be sure that all loads are placed as staked. When trucks of more than one capacity are used, stakes shall be set for each size in sections rather than intermingling the different sizes. One size usually takes the long haul and the other the short. Consult the plan for the width and depth of the aggregate to be placed.

When placing aggregate on a newly graded project, the number of loads staked in any given distance shall be checked against the project station reference stakes. When placing aggregate on an unreferenced detour, the number of loads per kilometer (mile) staked should be checked against the number of cubic meters (cubic yards) required per kilometer (mile).

III. Inspection Costs - In order to avoid excessive inspection costs, particularly on other than high production operations, it may be necessary to control the placement and inspection operations as follows:

1. When a single aggregate, or separate aggregate materials are being deposited on both long and short haul sections, or on separate sections of the project, one inspector located at the short haul placement point may observe and inspect the loads destined for the other, or longer haul sections.

2. The inspector staking and inspecting the delivery of the aggregates may also take necessary material samples and check the gradation of the aggregate.

3. If the material placement rate is so low as to create uneconomical and wasteful inspection costs, the headquarters or District Office should be contacted for special instructions.

307.05 METHOD OF MEASUREMENT

Rock or aggregate for surfacing will be measured by the cubic meter (cubic yard) in trucks with "struck loads". This measurement will be made at the point of delivery. Refer to Section 105 of this manual for a more complete discussion.

307.06 BASIS OF PAYMENT (*SSHC Subsection 310.05*)

This material is now paid for according to *SSHC* Table 310.01. If there is a deduction it will be computed and deducted from the contract unit price and that lot must be shown as a contingency item on the estimate with the computed unit price.

Maintenance of temporary surfacing is paid for with equipment rental pay items.

CONVERSION FACTORS	
To Convert Tons of Material to Cubic Yards	Divide By
Crushed Sand Gravel	1.20 Tn/CY
Fine Aggregate for Concrete	1.30 Tn/CY
Coarse Aggregate (Limestone) for Concrete	1.25 Tn/CY
Sand-Gravel for Concrete; Surfacing Gravel or Crushed Rock	1.35 Tn/CY
Crushed Rock for Base Course	1.25 Tn/CY
Crushed Rock for Base Course Screenings	1.25 Tn/CY
Mineral Filler and Soil Binder	0.85 Tn/CY
To Convert Megagrams of Material to Cubic Meters	Divide By
Crushed Sand Gravel	1.30 Mg/m^3
Fine Aggregate for Concrete	1.54 Mg/m^3
Coarse Aggregate (Limestone) for Concrete	1.48 Mg/m^3
Sand-Gravel for Concrete; Surfacing Gravel or Crushed Rock	1.60 Mg/m^3
Crushed Rock for Base Course	1.48 Mg/m^3
Crushed Rock for Base Course Screenings	1.48 Mg/m^3
Mineral Filler and Soil Binder	1.06 Mg/m^3

Road Gravel Requirements

English Version

Width	Sq.	1/2" Depth			3/4" Depth			1" Depth			1 1/2" Depth			2" Depth			2 1/2" Depth			3" Depth		
of	Yds.	1 cu.yd.	Cu. Yds.		1 cu.yd.	Cu. Yds.		1 cu.yd.	Cu. Yds.		1 cu.yd.	Cu. Yds.		1 cu.yd.	Cu. Yds.		1 cu.yd.	Cu. Yds.		1 cu.yd.	Cu. Yds.	
Road-	Per	Covers	Per	Per	Covers	Per	Per	Covers	Per	Per	Covers	Per	Per	Covers	Per	Per	Covers	Per	Per	Covers	Per	Per
way	Mile	Lin. Ft.	Sta.	Mile	Lin. Ft.	Sta.	Mile	Lin. Ft.	Sta.	Mile	Lin. Ft.	Sta.	Mile	Lin. Ft.	Sta.	Mile	Lin. Ft.	Sta.	Mile	Lin. Ft.	Sta.	Mile
9'	5280.0	72.00	1.39	73.33	48.00	2.08	110.00	36.00	2.78	146.67	24.00	4.17	220.00	18.00	5.56	293.33	14.40	6.94	366.67	12.00	8.33	440.00
10'	5866.7	64.80	1.54	81.48	43.20	2.31	122.22	32.40	3.09	162.96	21.60	4.63	244.44	16.20	6.17	325.93	12.96	7.72	407.41	10.80	9.26	488.89
11'	6453.3	58.91	1.70	89.63	39.27	2.55	134.44	29.45	3.40	179.26	19.64	5.09	268.89	14.73	6.79	358.52	11.78	8.49	448.15	9.82	10.19	537.78
12'	7040.0	54.00	1.85	97.78	36.00	2.78	146.67	27.00	3.70	195.56	18.00	5.56	293.33	13.50	7.41	391.11	10.80	9.26	488.89	9.00	11.11	586.67
13'	7626.7	49.85	2.01	105.93	33.23	3.01	158.89	24.92	4.01	211.85	16.62	6.02	317.78	12.46	8.02	423.70	9.97	10.03	529.63	8.31	12.04	635.56
14'	8213.3	46.29	2.16	114.07	30.86	3.24	171.11	23.14	4.32	228.15	15.43	6.48	342.22	11.57	8.64	456.30	9.26	10.80	570.37	7.72	12.96	684.44
15'	8800.0	43.20	2.31	122.22	28.80	3.47	183.33	21.60	4.63	244.44	14.40	6.94	366.67	10.80	9.26	488.89	8.64	11.57	611.11	7.20	13.89	733.33
16'	9386.7	40.50	2.47	130.37	27.00	3.70	195.56	20.25	4.94	260.74	13.50	7.41	391.11	10.13	9.88	521.48	8.10	12.35	651.85	6.75	14.81	782.22
17'	9973.3	38.12	2.62	138.52	25.41	3.94	207.78	19.06	5.25	277.04	12.71	7.87	415.56	9.53	10.49	554.07	7.62	13.12	692.59	6.35	15.74	831.11
18'	10560.0	36.00	2.78	146.67	24.00	4.17	220.00	18.00	5.56	293.33	12.00	8.33	440.00	9.00	11.11	586.67	7.20	13.89	733.33	6.00	16.67	880.00
19'	11146.7	34.11	2.93	154.81	22.74	4.40	232.22	17.05	5.86	309.63	11.37	8.80	464.44	8.53	11.73	619.26	6.82	14.66	774.07	5.69	17.59	928.89
20'	11733.3	32.40	3.09	162.96	21.60	4.63	244.44	16.20	6.17	325.93	10.80	9.26	488.89	8.10	12.35	651.85	6.48	15.43	814.81	5.40	18.52	977.78
21'	12320.0	30.86	3.24	171.11	20.57	4.86	256.67	15.43	6.48	342.22	10.29	9.72	513.33	7.72	12.96	684.44	6.17	16.20	855.56	5.14	19.44	1026.67
22'	12906.7	29.45	3.40	179.26	19.63	5.09	268.89	14.73	6.79	358.52	9.82	10.19	537.78	7.36	13.58	717.04	5.89	16.98	896.30	4.91	20.37	1075.56
23'	13493.3	28.17	3.55	187.41	18.78	5.32	281.11	14.09	7.10	374.81	9.39	10.65	562.22	7.04	14.20	749.63	5.63	17.75	937.04	4.70	21.30	1124.44
24'	14080.0	27.00	3.70	195.56	18.00	5.56	293.33	13.50	7.41	391.11	9.00	11.11	586.67	6.75	14.81	782.22	5.40	18.52	977.78	4.50	22.22	1173.33
25'	14666.7	25.92	3.86	203.70	17.28	5.79	305.56	12.96	7.72	407.41	8.64	11.57	611.11	6.48	15.43	814.81	5.18	19.29	1018.52	4.32	23.15	1222.22
26'	15253.3	24.92	4.01	211.85	16.61	6.02	317.78	12.46	8.02	423.70	8.31	12.04	635.56	6.23	16.05	847.41	4.98	20.06	1059.26	4.15	24.07	1271.11
27'	15840.0	24.00	4.17	220.00	16.00	6.25	330.00	12.00	8.33	440.00	8.00	12.50	660.00	6.00	16.67	880.00	4.80	20.83	1100.00	4.00	25.00	1320.00
28'	16426.7	23.14	4.32	228.15	15.43	6.48	342.22	11.57	8.64	456.30	7.71	12.96	684.44	5.79	17.28	912.59	4.63	21.60	1140.74	3.86	25.93	1368.89
29'	17013.3	22.34	4.48	236.30	14.89	6.71	354.44	11.17	8.95	472.59	7.45	13.43	708.89	5.59	17.90	945.19	4.47	22.38	1181.48	3.73	26.85	1417.78
30'	17600.0	21.60	4.63	244.44	14.40	6.94	366.67	10.80	9.26	488.89	7.20	13.89	733.33	5.40	18.52	977.78	4.32	23.15	1222.22	3.60	27.78	1466.67

CHAPTER NOTES:

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