FOR BIDDING PURPOSES ONLY

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	P 6175(02) P 6465(02) P 6169(07)	1	16

Plotting Date: 3/5/14
Revised Date: mm/dd/yy
Initials: TLW

STATE OF SOUTH DAKOTA

DEPARTMENT OF TRANSPORTATION

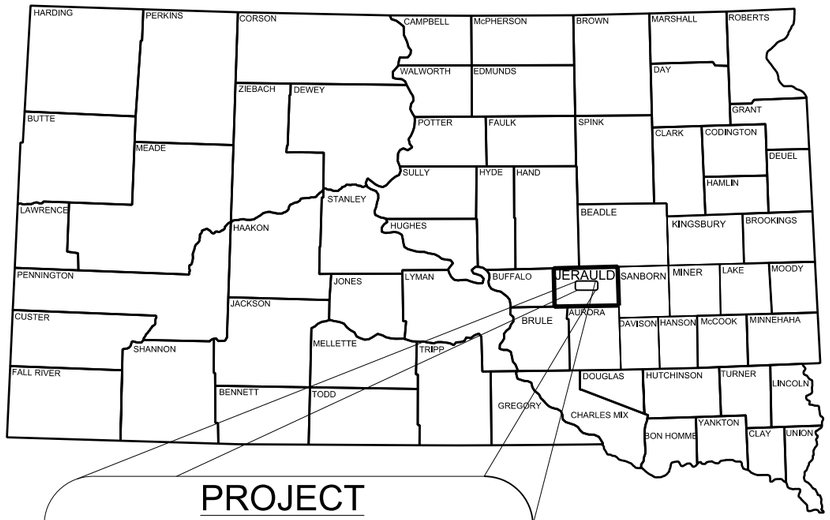
PLANS FOR PROPOSED

P 6175(02), P 6465(02) & P 6169(07)

JERAULD COUNTY

ASPHALT SURFACE TREATMENT

PCN 04AA, 04AK & 04AJ



PROJECT

From 50' North of 10th St.
North 6.6 Miles on 382nd Ave. to 221st St.

From SD34 at Wessington Springs
S 7.3 miles on 383 Ave. to 236 St.

From SD34 8 miles W of Wessington Springs
S 10.6 miles on 373 Ave. to 238 St.

DESIGN DESIGNATION P 6175(02)

ADT (2007)	190
ADT (2027)	265
DHV	40
D	50%
T DHV	2.4%
T*ADT	5.2%

DESIGN DESIGNATION P 6465(02)

ADT (2007)	495
ADT (2027)	690
DHV	100
D	50%
T DHV	2.4%
T*ADT	5.2%

DESIGN DESIGNATION P 6169(07)

ADT (2007)	215
ADT (2027)	300
DHV	45
D	50%
T DHV	2.4%
T*ADT	5.2%

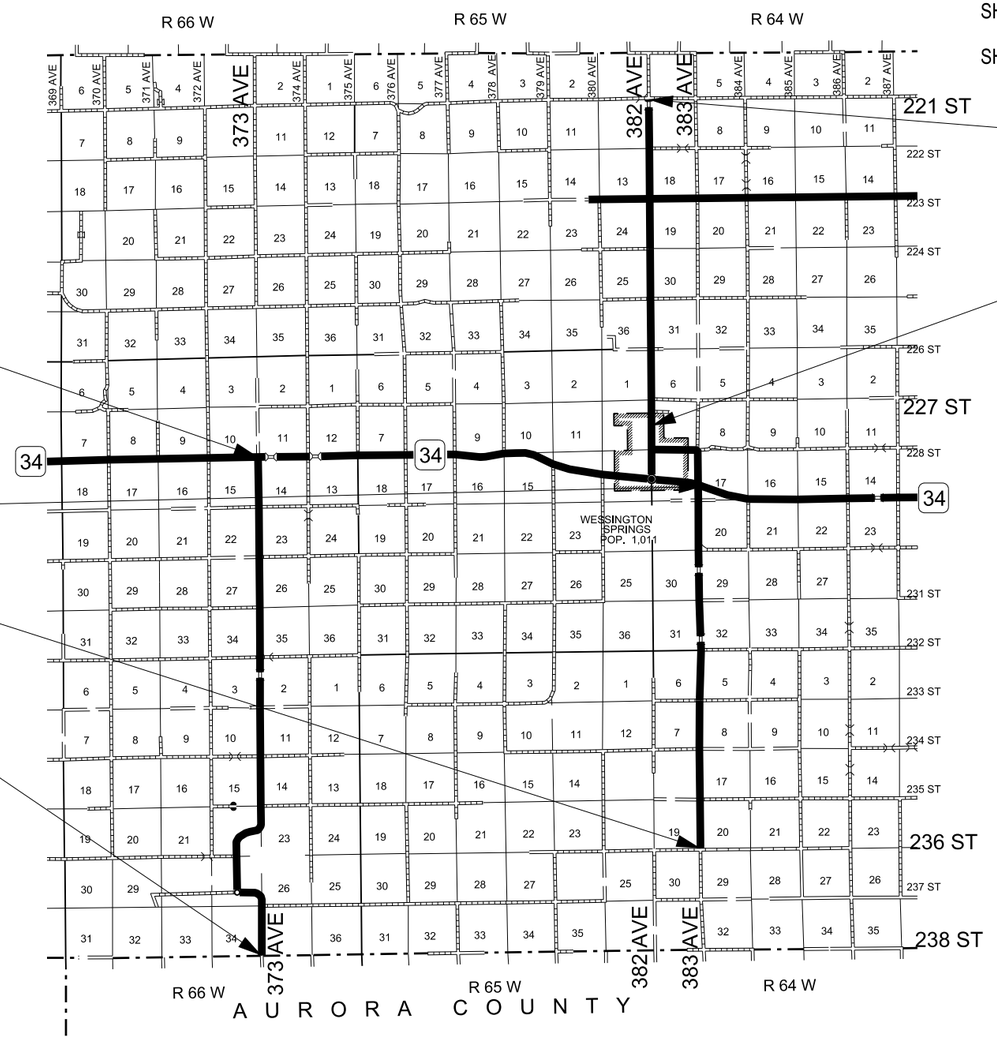
Storm Water Permit (none required)

End Project 6169(07)
STA. 559+68 at SD34 8 miles West of Wessington Springs on 373rd Avenue

End Project 6465 (02)
STA. 386+00 at SD34 8 miles West of Wessington Springs on 383rd Avenue

Start Project 6465 (02)
STA. 0+00 at 236th Street South 7.3 miles on 383rd Avenue

Start Project 6169(07)
STA. 0+00 at 238th Street on 373rd Avenue



End Project 6175 (02)
STA. 348+48 at 221st Street on 382nd Avenue

Start Project 6175 (02)
STA. 0+00 at 50' North of 10th Street on 383nd Avenue

REGISTERED PROFESSIONAL ENGINEER
Reg. No. 5820
TLW GILLEN
SOUTH DAKOTA

INDEX OF SHEETS

PLANS S13-P585, 586, 587

Survey by: Brosz Engineering, Inc. Pierre, SD

Plans by: Brosz Engineering, Inc. Pierre, SD

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ESTIMATE OF QUANTITIES & NOTES

FOR BIDDING PURPOSES ONLY

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	2	16

Plotting Date: 3/6/2014
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ESTIMATE OF QUANTITIES

P 6175(02), PCN 04AA
from 50' North of 10th Street 6.6 miles North on 382nd Ave. to 221 St.

BID ITEM NUMBER	ITEM	QUANTITY	UNIT
009E0010	Mobilization	Lump Sum	LS
120E0100	Unclassified Excavation, Digouts	26	CuYd
320E2000	Maintenance Patching	53.0	Ton
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	29.7	Ton
360E1200	Modified Cover Aggregate	1300.9	Ton
633E1300	Pavement Marking Paint, White	297	Gal
633E1305	Pavement Marking Paint, Yellow	93	Gal
634E0010	Flagging	250	Hour
634E0020	Pilot Car	60	Hour
634E0100	Traffic Control	784	Unit
634E0120	Traffic Control, Miscellaneous	Lump Sum	LS
634E0630	Temporary Pavement Marking	13.2	Mile
900E1200	MC-3000 Asphalt for Surface Treatment	137.9	Ton

P 6465(02), PCN 04AK
from SD34 at Wessington Springs south 7.3 miles on 383 Ave. to 236 St.

BID ITEM NUMBER	ITEM	QUANTITY	UNIT
009E0010	Mobilization	Lump Sum	LS
320E2000	Maintenance Patching	10.0	Ton
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	32.9	Ton
350E0010	Asphalt Concrete Crack Sealing	32,791	Lb
360E0042	CRS-2P Asphalt for Surface Treatment	139.4	Ton
360E1200	Modified Cover Aggregate	1027.8	Ton
633E1300	Pavement Marking Paint, White	329	Gal
633E1305	Pavement Marking Paint, Yellow	88	Gal
634E0010	Flagging	400	Hour
634E0020	Pilot Car	100	Hour
634E0100	Traffic Control	784	Unit
634E0120	Traffic Control, Miscellaneous	Lump Sum	LS
634E0630	Temporary Pavement Marking	14.6	Mile

P 6169(07), PCN 04AJ
from SD34 8 miles W of Wessington Springs south 10.6 miles on 373 Ave. to 238 St.

BID ITEM NUMBER	ITEM	QUANTITY	UNIT
009E0010	Mobilization	Lump Sum	LS
120E0100	Unclassified Excavation, Digouts	5	CuYd
320E2000	Maintenance Patching	1053.0	Ton
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	47.7	Ton
350E0010	Asphalt Concrete Crack Sealing	23,203	Lb
360E0042	CRS-2P Asphalt for Surface Treatment	202.5	Ton
360E1200	Modified Cover Aggregate	1492.5	Ton
633E1300	Pavement Marking Paint, White	478	Gal
633E1305	Pavement Marking Paint, Yellow	291	Gal
634E0010	Flagging	300	Hour
634E0020	Pilot Car	75	Hour
634E0100	Traffic Control	784	Unit
634E0120	Traffic Control, Miscellaneous	Lump Sum	LS
634E0630	Temporary Pavement Marking	21.2	Mile

SPECIFICATIONS

Standard Specifications for Roads & Bridges, 2004 Edition and Required Provisions, Supplemental Specifications and/or Special Provisions as included in the Proposal.

WASTE DISPOSAL SITE

The Contractor shall furnish a site(s) for the disposal of construction and/or demolition debris generated by this project.

Construction and/or demolition debris may not be disposed of within the State ROW.

The waste disposal site(s) shall be managed and reclaimed in accordance with the following from the General Permit for Highway, Road, and Railway Construction/Demolition Debris Disposal Under the South Dakota Waste Management Program issued by the Department of Environment and Natural Resources.

The waste disposal site(s) shall not be located in a wetland, within 200 feet of surface water, or in an area that adversely affects wildlife, recreation, aesthetic value of an area, or any threatened or endangered species, as approved by the Project Engineer.

If the waste disposal site(s) is located such that it is within view of any ROW, the following additional requirements shall apply:

1. Construction and/or demolition debris consisting of concrete, asphalt concrete, or other similar materials shall be buried in a trench completely separate from wood debris. The final cover over the construction and/or demolition debris shall consist of a minimum of 1 foot of soil capable of supporting vegetation. Waste disposal sites provided outside of the State ROW shall be seeded in accordance with Natural Resources Conservation Service recommendations. The seeding recommendations may be obtained through the appropriate County NRCS Office. The Contractor shall control the access to waste disposal sites not within the State ROW through the use of fences, gates, and placement of a sign or signs at the entrance to the site stating "No Dumping Allowed".

2. Concrete and asphalt concrete debris may be stockpiled within view of the ROW for a period of time not to exceed the duration of the project. Prior to project completion, the waste shall be removed from view of the ROW or buried and the waste disposal site reclaimed as noted above.

The above requirements will not apply to waste disposal sites that are covered by an individual solid waste permit as specified in SDCL 34A-6-58, SDCL 34A-6-1.13, and ARSD 74:27:10:06.

Failure to comply with the requirements stated above may result in civil penalties in accordance with South Dakota Solid Waste Law, SDCL 34A-6-1.31.

All costs associated with furnishing waste disposal site(s), disposing of waste, maintaining control of access (fence, gates, and signs), and reclamation of the waste disposal site(s) shall be incidental to the various contract items.

HISTORICAL PRESERVATION OFFICE CLEARANCES

This commitment is required for all projects where there are earth disturbing activities due to borrow sites, waste disposal sites, staging areas, or plant sites.

The SDDOT has obtained concurrence with the State Historical Preservation Office (SHPO or THPO) for all work included within the project limits and all designated option borrow sites provided within the plans.

All earth disturbing activities not designated within the plans require review of cultural resources impacts. This work includes, but is not limited to: staging areas, borrow sites, waste disposal sites, and all material processing sites.

FOR BIDDING PURPOSES ONLY

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	3	16

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ESTIMATE OF QUANTITIES & NOTES

The Contractor shall arrange and pay for a cultural resource survey and/or records search. The Contractor has the option to contact the state Archaeological Research Center (ARC) at 605-394-1936 or another qualified archaeologist, to obtain either a records search or a cultural resources survey. A record search might be sufficient for review; however, a cultural resources survey may need to be conducted by a qualified archaeologist.

The Contractor shall provide ARC with the following: a topographical map or aerial view on which the site is clearly outlined, site dimensions, project number, and PCN. If applicable, provide evidence that the site has been previously disturbed by farming, mining, or construction activities with a landowner statement that artifacts have not been found on the site.

The Contractor shall submit the records search or cultural resources survey report and if the location of the site is within the current geographical or historic boundaries of any South Dakota reservation to SDDOT Environmental Engineer, 700 East Broadway Avenue, Pierre, SD 57501-2586 (605-773-3180). SDDOT will submit the information to the appropriate SHPO/THPO. Allow **30 Days** from the date this information is submitted to the Environmental Engineer for SHPO/THPO review.

If evidence for cultural resources is uncovered during project construction activities, then such activities shall cease and the Project Engineer shall be immediately notified. The Project Engineer will contact the SDDOT Environmental Engineer in order to determine an appropriate course of action.

SHPO/THPO review does not relieve the Contractor of the responsibility for obtaining any additional permits and clearances for staging areas, borrow sites, waste disposal sites, or material processing sites that affect wetlands, threatened and endangered species, or waterways. The Contractor shall provide the required permits and clearances to the Project Engineer at the preconstruction meeting.

SHOULDER WORK

Prior to construction, Jerauld County employees will inspect shoulders for excess vegetation and spray if necessary. It will be the Contractor's responsibility to notify the County a minimum of 30 days prior to commencing work on the project. The County assumes no responsibility for the effectiveness of the herbicide applied. Contact person for Jerauld County is Highway Superintendent Walt Hein at 605-539-9671.

Vegetation and accumulated material on and adjacent to the roadway shall be removed by the Contractor to the satisfaction of the engineer prior to asphalt surface treatment. This work is considered incidental to other contract items and separate measurement and payment will not be made.

EXISTING PAVEMENT CONDITIONS AND TRAFFIC VOLUMES

The existing pavement conditions for each project are listed below. The descriptions are from the McLeod procedure for seal coat design. The traffic volumes are also shown.

Project	Surface Condition	Traffic Volume ADT
P 6175(02) PCN 04AA	Slightly pocked, porous & oxidized	190
P 6465(02) PCN 04AK	Slightly pocked, porous & oxidized	495
P 6169(07) PCN 04AJ	Slightly pocked, porous & oxidized	215

SEQUENCE OF OPERATIONS

The following sequence of operations will be followed on a per project basis unless an alternate sequence is submitted in writing to and approved by the engineer at least two weeks prior to the requested change.

1. Install fixed location traffic control devices.
2. Install temporary traffic control devices as needed for each type of work.
3. Complete digouts, maintenance patching, rut filling and asphalt concrete composite as determined by the Engineer.
4. Complete crack sealing.
5. Place temporary pavement marking tabs not more than 24 hours prior to asphalt surface treatment application.
6. Apply asphalt surface treatment. The Contractor shall begin sealing operations at the farthest point from the stockpile site and work towards the stockpile site to eliminate unnecessary driving and turning on the fresh seal.
7. Remove plastic covers on tabs after asphalt surface treatment application.
8. Broom asphalt treated areas.
9. Apply fog seal.
10. Remove plastic covers on tabs after fog seal application.
11. Apply permanent pavement marking paint.
12. Remove temporary traffic control devices.

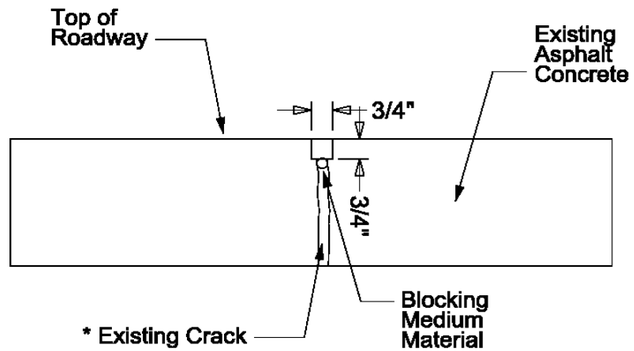
ESTIMATED QUANTITIES

The quantities of asphalt for surface treatment and cover aggregate are based on the rates shown in the Rates of Materials. This is only an estimate. The actual application rates of materials will be determined by mix design as stated in these plans. The mix design rates may vary from the estimated rates stated in the Rates of Materials depending on the aggregate source, gradation and flakiness index. The application rates may also be adjusted in the field due to results of gradations, flakiness index and differing surface conditions. Pay quantities will be based off the actual target rates the inspectors use even though they may vary significantly from plans estimates.

Reclamation of the waste disposal site(s) shall be incidental to the various contract items.

BLOCKING MEDIUM MATERIAL

All costs for furnishing and placing the blocking medium material for asphalt concrete crack sealing shall be incidental to the contract unit price per pound for Asphalt Concrete Crack Sealing. The Contractor shall have backer rod/blocking medium material available for use on the project during crack sealing.



*** The blocking medium material shall be used in cracks that are 3/8" or more in width.**

FOR BIDDING PURPOSES ONLY

ESTIMATE OF QUANTITIES & NOTES

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	4	16

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ASPHALT CRACK SEALING

Sealant shall conform to the requirements of D6690 Type VI as per the SDDOT Standard Specifications for Roads and Bridges, 2004 edition, *Section 350*.

All cracks not previously routed and sealed will require routing, cleaning, sealing and blotting the sealant as per the specifications. The typical reservoir dimension after routing will be 3/4" x 3/4". All cracks shall be covered with toilet paper or another acceptable material after installation to prevent traffic from sticking to and pulling sealant out of the crack.

Cracks previously routed and sealed shall be cleaned by blowing compressed air into the crack. The crack shall then be filled with sealant and covered with toilet paper.

Project 04AA shall not be crack sealed.
Project 04AJ shall not be crack sealed from Station 0+00 to Station 190+08

UNCLASSIFIED EXCAVATION, DIGOUTS

Unclassified Excavation, Digouts will include all excavation and removal of unsatisfactory asphalt concrete material. The Contractor's attention is drawn to the intent of the work involved. Many areas are cracked, rutted or depressed in some manner. If the existing material is tight in place it shall not be disturbed just cleaned, tacked and leveled. Unstable (loose) material will be removed. The depth may vary but is anticipated to never exceed 4 inches in depth. If in a location where the sub surface material appears unstable below the 4 inch depth the Engineer will inspect the site and provide direction for the repair.

Asphalt concrete will be placed in the excavated area and compacted to provide a level top. In areas where the dig out area is more than 3 inches in depth the asphalt concrete will be placed in two equal lifts.

The quantity will be measured and paid for per cubic yard of the removed volume. Asphalt Concrete will be paid for at the contract unit price for Maintenance Patching. Traffic will be maintained and controlled by the contractor through the dig out and leveling locations.

The tables included in these plans have identified the areas found on the initial survey that will require repair or leveling. The Contractor shall inspect the project to become familiar with the repair areas and to verify the intent of work involved as directed in the plans.

TABLE OF UNCLASSIFIED EXCAVATION, DIGOUTS

P 6175(02), PCN 04AA

Description	Station	Lt	Rt	feet Length	feet Width	Sq. Yd. Area
Wheel rutting	11+05	8'		55	5	30.6
Pothole	19+55	8'		20	4	8.9
Breakup	23+85		12'	25	3	8.3
Pothole	28+25		8'	2	2	0.4
Patch	38+71	6'		2	5	1.1
Pothole	39+56		8'	2	2	0.4
Pothole	49+95	2'		2	2	0.4
Breakup	68+71		12'	6	2	1.3
Pothole	70+90		12'	3	3	1.0
Wheel rutting	76+94	8'		60	4	26.7
Pot Hole	91+01	8'		4	4	1.8
Wheel rutting	91+75	8'		12	4	5.3
Wheel rutting	100+21	6'		40	6	26.7
Wheel rutting	100+21	2'		15	3	5.0
Pothole	128+25		10'	6	6	4.0
Pothole	146+25		12'	3	3	1.0
Pothole	160+90		12'	40	4	17.8
Wheel rutting	182+03	12'		32	6	21.3
Pothole	203+35		10'	3	3	1.0
Pothole	229+20	7'		12	5	6.7
Breakup	256+10		11'	80	3	26.7
Pothole	267+29	7'		5	5	2.8
Breakup	273+23	10'		5	2	1.1
Breakup	299+30		12'	55	3	18.3
Pothole	342+20	10'		2	2	0.4
Breakup	336+37	10'		15	4	6.7
Breakup	340+15			15	5	8.3
				Total Area (Sq.Yd.) to repair =		234.1
		Volume (Cu. Yd.) to repair at a depth of 4" =				26.0

Asphalt Patch 4" Depth = 53 Tons

P 6169(07), PCN 04AJ

Description	Station	Lt	Rt	feet Length	feet Width	Sq. Yd. Area
Wheel rutting	15+22		6'	110	6	73.3
Wheel rutting	30+77	6'		12	6	8.0
Wheel rutting	60+20	CL		70	6	46.7
Wheel rutting	90+11		Full	40	12	53.3
Wheel rutting	91+38		Full	50	12	66.7
Wheel rutting	97+02		6'	151	6	100.7
Wheel rutting	110+10		6'	448	6	298.7
Wheel rutting	113+17		6'	55	6	36.7
Wheel rutting	116+72	6'		160	6	106.7
Wheel rutting	116+72		6'	160	6	106.7
Wheel rutting	125+35		Full	75	12	100.0
Wheel rutting	126+98		Full	50	12	66.7
Wheel rutting	137+79	8'		15	6	10.0
Wheel rutting	147+18		10'	25	6	16.7
Wheel rutting	153+68		10'	320	6	213.3
Wheel rutting	163+73	CL		70	5	38.9
Wheel rutting	184+95		4'	130	8	115.6
				Total Area (Sq.Yd.) to level =		1458.4

Asphalt Concrete for leveling wheel ruts = 81.0 Tons
Asphalt Concrete thin lift overlay = 972.0 Tons

The rate for the thin lift overlay is 135 tons for each 12' lane mile.

FOR BIDDING PURPOSES ONLY

ESTIMATE OF QUANTITIES & NOTES

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MAINTENANCE PATCHING

Prior to the Asphalt Surface Treatment being placed the Contractor shall remove any digouts; repair any surface deformations, pot holes, edge breakups, wheel ruts or irregularities by removing the unstable material and place hot mix asphalt concrete in the repair area. The repair shall restore the driving surface to a smooth and stable condition. The repair areas will be inspected and accepted by the Engineer prior to the placement of the Asphalt Surface Treatment.

The Contractor is to present, at the preconstruction meeting, the method or methods to be employed to level the wheel ruts and fill the digout locations. The Contractor shall use a rut box, paver or other methods to be approved by the area office to provide a level surface prior to compacting the asphalt concrete placed in the wheel ruts.

The quantities included in the plans are an estimate. The existing surfacing is anticipated to have additional breakup areas once the frost goes out in the spring. The quantities to repair the new areas not shown in the tables will be added on construction as approved by the County and directed by the Engineer.

On project 04AJ from station 0+00 to station 190+08 (Aurora Co. line to Jct.235th St), the intent is to fix the surface deformations, fill the wheel ruts that are ¾ inch or deeper and place a thin lift (skin patch) 24' wide overlay. The estimated rate is 135 tons of Class E, Type 2 per 12' wide lane mile for the overlay.

Payment for Maintenance Patching will be by the ton. The Asphalt Concrete furnished by the contractor for Maintenance Patching shall meet the requirements for Asphalt Concrete Composite,
Class E, Type 2. A copy of the mix design is to be submitted a minimum of two weeks prior to placement of the Maintenance Patching material. Acceptable PG Binders include: PG 58-28 or PG 64-22.

TEMPORARY PAVEMENT MARKING

Paint will not be allowed for Temporary Pavement Marking.

Prior to asphalt surface treatment the Contractor shall install night visible temporary road markers with double covers at equal 40' spacing for the temporary pavement marking as per section 634.3, C.2. of the Standard Specifications. The contractor shall install DO NOT PASS signs at the beginning of all No Passing Zones and PASS WITH CARE signs at the end of all No Passing Zones. The number of DO NOT PASS signs are estimated to be 49 and the number of PASS WITH CARE signs are estimated to be 33 on this contract.

The temporary road markers shall have secure covers. If the covers become detached, prior to sealing, the temporary road marker shall be replaced with a new marker. Any markers that are non-reflective shall be cleaned or replaced.

The Contractor shall remove and dispose of the temporary road markers after the Permanent Pavement Marking has been applied. Method of removal shall be non-destructive to the road surface and shall result in the marker being separated from the adhesive (the adhesive shall remain on the road surface and the marker is discarded) or the marker shall be cut in such a manner that no more than a ¼" of the vertical portion of the marker remains on the road surface. Removal shall be accomplished within seven days of completion of the Permanent Pavement Marking.

Flagger symbol signs and flaggers or shadow vehicle with rotating amber or strobe lights shall be positioned on the roadway shoulder in advance of the workers in both directions of traffic during the installation and removal of the temporary road markers.

The traffic control shall be moved intermittently to provide proper warning of the work operation. A ROAD WORK AHEAD (W20-1), FLAGGER Symbol (W20-7a) or BE PREPARED TO STOP (W20-7b) shall be mounted on the rear of the shadow vehicle.

The method of traffic control used for this operation shall be approved by the engineer.

The cost for the traffic control to remove and install the temporary road markers shall be incidental to the contract unit price for Temporary Pavement Marking per mile.

GENERAL MAINTENANCE OF TRAFFIC

Work activities shall be conducted during daylight hours only. During nights, weekends and other nonworking hours, all materials and equipment shall be removed from the roadway. Storage of vehicles and equipment shall be outside the clear zone area a minimum of 30 feet from the driving lanes and as near as possible to the right-of-way line.

Contractor's employees should mobilize at a location off the right-of-way and arrive at the work site in a minimum number of vehicles necessary to do the work. Indiscriminate driving and parking of vehicles within the right-of-way will not be permitted. Any damage to vegetation, surfacing, embankment, delineators and existing signs resulting from such indiscriminate use shall be repaired and/or restored by the contractor, at no expense to the owner and to the satisfaction of the Engineer.

Removing, relocating, covering, salvaging and resetting of existing traffic control devices, including delineation, shall be the responsibility of the Contractor. Cost for this work shall be incidental to the contract unit prices for the various items unless otherwise specified in the plans. Any delineators and signs damaged or lost shall be replaced by the Contractor at no cost to the State or County.

The Contractor shall provide documentation that all breakaway sign supports comply with FHWA NCHRP Report 350 or MASH crashworthy requirements. The Contractor shall provide installation details at the pre-construction meeting for all breakaway sign support assemblies.
The actual workspace for the chip seal shall be limited to two mile segments. A sufficient buffer space shall be installed so as not to cause congestion at the workspace. The traveling public shall not have to wait longer than 15 minutes at the flagger station. The pilot car shall travel no faster than 20 mph on the fresh seal.

The Contractor shall furnish any flagging required. Only SDDOT certified flaggers will be allowed. Flaggers shall have their certification cards with them at all times when they are flagging.

In addition to the traffic control shown in the layouts contained in these plans, the Contractor shall provide additional flagger(s) and flagger symbol sign(s) at major intersections during daylight hours after the asphalt surface treatment has been applied and prior to the initial brooming being completed.

The Contractor shall furnish, install and maintain TRUCK CROSSING signs. The TRUCK CROSSING signs shall be displayed at all times when haul vehicles are hauling material. When hauling conditions no longer exist, the signs shall be covered or removed from view. The exact number and location shall be determined on construction. Payment for additional signs will be based on the contract unit price per unit for Traffic Control.

Flagger(s) shall provide each motorist with a printed notice on the Contractor's letterhead similar to the one shown. Cost for the notice shall be incidental to the contract unit prices for the various items.

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Initials:	RMW		

ESTIMATE OF QUANTITIES & NOTES

"CONTRACTOR'S LETTERHEAD"

THIS ROADWAY IS BEING RESURFACED WITH A CHIP SEAL APPLICATION.

THIS TYPE OF CONSTRUCTION HAS THE POTIENTIAL OF CAUSING VEHICLE DAMAGE SUCH AS CHIPPED WINDSHIELDS AND BROKEN HEADLIGHTS DUE TO ROCKS BEING THROWN BY HIGH SPEED ONCOMING TRAFFIC.

YOU MAY WISH TO CONSIDER TAKING AN ALTERNATE ROUTE. IF YOU PROCEED, KEEP TO THE RIGHT AND DRIVE 40 MPH OR LESS. ANOTHER FLAGGER AND A PILOT CAR WILL BE ESCORTING YOU AROUND THE SEAL COAT APPLICATION AREA.

THANK YOU!

Sufficient traffic control devices have been included in these plans to sign one workspace on each project. If the Contractor elects to work on additional sites simultaneously, the cost for additional traffic control devices shall be incidental to the Contract unit price per unit for Traffic Control.

MODIFIED COVER AGGREGATE

Cover aggregate shall conform to the requirements of Section 881 of the SDDOT Standard Specifications for Type 2A Cover Aggregates except:

The Aggregate shall be Modified Cover Aggregate, Quartzite material and conform to the following gradation requirements:

Passing a 3/8" sieve	100 %
Passing a No. 4 sieve	0-60 %
Passing a No. 8 sieve	0-18 %
Passing a No. 40 sieve	0-4 %
Passing a No. 200 sieve	0-1.3 %

Delete foot note 1 and replace with:

100% of the material retained on the No. 4 sieve shall have two or more fractured faces produced by crushing. The Flakiness Index shall be a maximum of 30 percent.

Quality tests on the Modified Cover Aggregate for abrasion and soundness are required by specification. The Contractor shall notify the Area Office prior to sampling and a representative from the Area Office shall witness all sampling of aggregates to be submitted to the Central Testing Laboratory for Quality testing. Satisfactory test results for the Modified Cover Aggregate shall be obtained prior to its use on the Project.

At least 50% of the aggregate shall be stockpiled at each stockpile site at least one week prior to work beginning on that project. This is to allow the Area Office time to run tests on the material and enter the results into the mix design spread sheets.

Asphalt for Surface Treatment shall be CRS-2P for Project 04AK and 04AJ.

Asphalt for Surface Treatment shall be MC-3000 for Project 04AA.

ASPHALT FOR SURFACE TREATMENT

The asphalt for surface treatment that is delivered for use on this contract shall be used in the order it is received. Storage of asphalt for surface treatment shall only be allowed at the end of the work day. The material that is placed in storage shall be the first material used the following day."

ASPHALT FOR FOG SEAL

An SS-1h or CSS-1h emulsion shall be used for Fog Seal. The material will be blended 1/2 water and 1/2 oil for a diluted solution applied at a rate of 0.15 gallons per square yard (0.075 undiluted gallons per square yard). The water will not be paid for separately.

The Fog Seal will be applied after waiting a minimum of 96 hours but no more than 7 calendar days after the completion of the Asphalt Surface Treatment.

Prior to applying the fog seal the entire surface shall be broomed from the center outward to the edge of the shoulder. This will be considered incidental to the item SS-1h or CSS-1h Asphalt for Fog Seal.

PERMANENT PAVEMENT MARKING PAINT

Permanent pavement markings shall be furnished and applied by the Contractor in accordance with Section 633 of the Standard Specifications, the details in these plans and as per manufacturer's recommendations.

The application of Permanent Pavement Marking Paint may begin 7 calendar days following completion of final surfacing and shall be completed within 14 calendar days following completion of final surfacing when DO NOT PASS and PASS WITH CARE signs are used to mark No Passing Zones.

The Contractor shall be required to repaint all existing pavement markings including centerline and edge lines. The Contractor will be required to inventory and mark, with appropriate colored tabs, the extent and location of the existing before the markings are obliterated. The cost of the tabs shall be incidental to the contract unit prices for the various items.

For each working day the application of permanent pavement marking paint remains uncompleted after the previously stated time requirements, the Contractor will be assessed liquidated damages at the rate of $250.00 per day. This provision applies up to the Contract Completion Date, as extended. After the completion date, liquidated damages will be assessed in accordance with section 8.7, until the Permanent Pavement Marking is completed, even though the project may be open to traffic.

The approximate paint application rates shall be as follows:

Dashed Yellow Centerline 6.2 gallons per mile
Solid Yellow Centerline 22.5 gallons per mile
Solid White 4" Edgeline 22.5 gallons per mile

The rate of application of glass beads shall be 8 lbs per gallon of paint.

PROJECT	Length	Pavement Marking Paint White	Yellow
P 6175(02), PCN 04AA			
Solid Yellow Centerline	12,617 L.F.		54 gallons
Dashed Centerline	32,582 L.F.		39 gallons
Solid White Edgeline	69,690 L.F.	297 gallons	
P 6465(02), PCN 04AK			
Solid Yellow Centerline	10,137 L.F.		44 gallons
Dashed Centerline	37,241 L.F.		44 gallons
Solid White Edgeline	77,200 L.F.	329 gallons	
P 6169(07), PCN 04AJ			
Solid Yellow Centerline	56,381 L.F.		241 gallons
Dashed Centerline	42,476 L.F.		50 gallons
Solid White Edgeline	112,000L.F.	478 gallons	
	TOTAL	1104 gallons	472 gallons

FOR BIDDING PURPOSES ONLY

ESTIMATE OF QUANTITIES & NOTES

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	7	16

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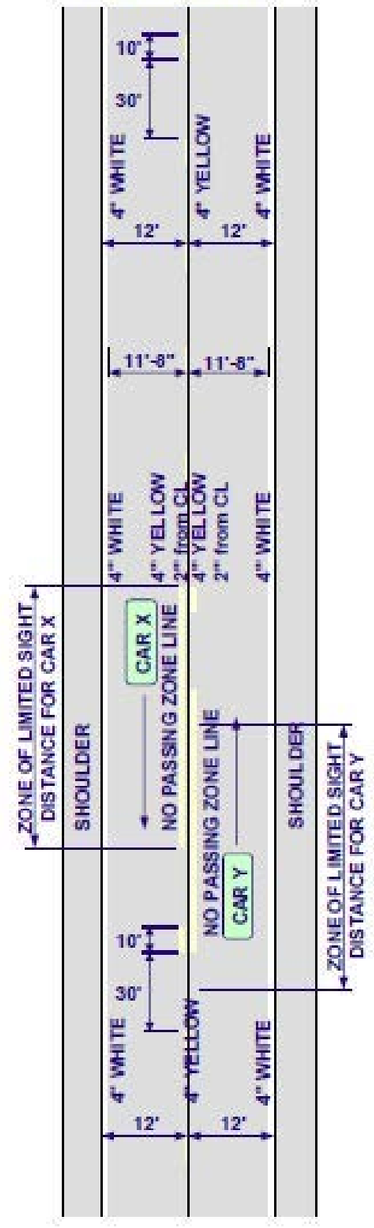
Initials: RMW

PAVEMENT MARKING

TWO LANE ROADWAY



FOR BIDDING PURPOSES ONLY

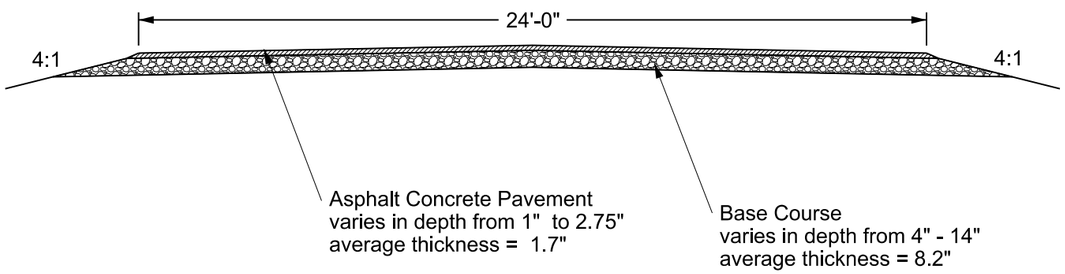
STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	P 6175(02); P6465(02) P6169(07)	8	16

Plotting Date: 3/3/14
Revised Date: mm/dd/yy
Initials: RMW

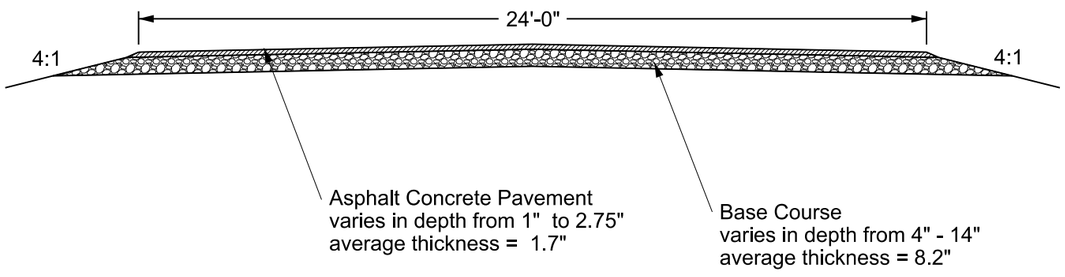
Typical Section

Existing Conditions

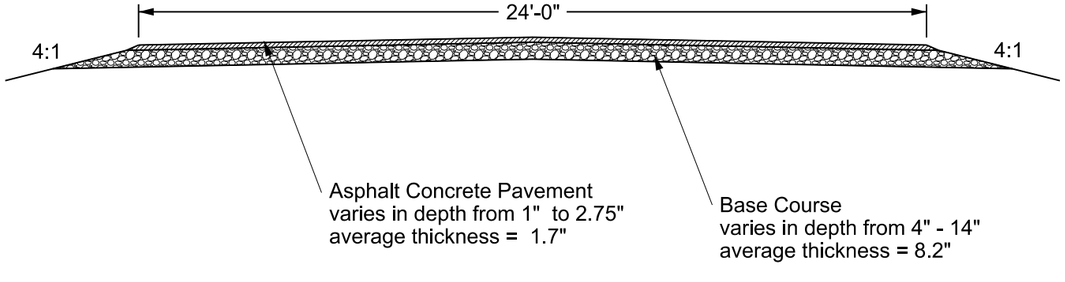
P 6175(02) - PCN 04AA
Sta. 0+00 to 348+48



P 6465(02) - PCN 04AK
Sta. 0+00 to 385+44



P 6169(07) - PCN 04AJ
Sta. 0+00 to 559+68



RATES OF MATERIALS

JERAULD COUNTY

P 6175(02), PCN 04AA

The Estimate of Quantities is based on the following quantities of materials per mile (project length = 6.6 miles).

Sta. 0+00 to 348+48

MC-3000 Asphalt for Surface Treatment at the rate of 20.9 tons applied 24 feet wide
(Rate = 0.35 gallons per square yard). 137.9 TON

Modified Cover Aggregate, (Type 2A) at the rate of 197.1 tons applied 24 feet wide
(Rate = 28 pounds per square yard). 1300.9 TON

SS-1h or CSS-1h for Fog Seal at a rate of 4.5 tons applied 24 feet wide
(Rate = 0.075 gallons per square yard). 29.7 TON

P 6465(02), PCN 04AK

The Estimate of Quantities is based on the following quantities of materials per mile (project length = 7.3 miles).

Sta. 0+00 to 385+44

CRS-2P Asphalt for Surface Treatment at the rate of 19.1 tons applied 24 feet wide
(Rate = 0.32 gallons per square yard). 139.4 TON

Modified Cover Aggregate, (Type 2A) at the rate of 140.8 tons applied 24 feet wide
(Rate = 20 pounds per square yard). 1027.8 TON

SS-1h or CSS-1h for Fog Seal at a rate of 4.5 tons applied 24 feet wide
(Rate = 0.075 gallons per square yard). 32.9 TON

P 6169(07), PCN 04AJ

The Estimate of Quantities is based on the following quantities of materials per mile (project length = 10.6 miles).

Sta. 0+00 to 559+68

CRS-2P Asphalt for Surface Treatment at the rate of 19.1 tons applied 24 feet wide
(Rate = 0.32 gallons per square yard). 202.5 TON

Modified Cover Aggregate, (Type 2A) at the rate of 140.8 tons applied 24 feet wide
(Rate = 20 pounds per square yard). 1492.5 TON

SS-1h or CSS-1h for Fog Seal at a rate of 4.5 tons applied 24 feet wide
(Rate = 0.075 gallons per square yard). 47.7 TON

FOR BIDDING PURPOSES ONLY

ASPHALT SURFACE TREATMENT MIX DESIGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	9	16

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ASPHALT FOR SURFACE TREATMENT MIX DESIGN

After the aggregate stockpiles have been produced, the Contractor shall submit samples of the aggregates to the asphalt supplier, prior to construction, to determine a mix design and verify the compatibility of the aggregate and asphalt.

The asphalt surface treatment will be designed in accordance with the Modified McLeod Design Procedure found in Volume II of Appendix C of the Preventive Maintenance Surface Treatment Report that has been reproduced and is included in these plans. The asphalt surface treatment mix design will be prepared by qualified personnel experienced in asphalt surface treatment design.

The surface design will be based on the traffic volume(s) and pavement conditions contained in the plans. The final application rate for the asphalt binder and cover aggregate will be determined after the source of the material is known and field adjustments are made. The design will include the following information.

1) Aggregate gradation.
2) Bulk specific gravity of the aggregate.
3) Loose unit weight of the aggregate.
4) Asphalt type and rate of application.
5) Aggregate rate of application.

The Contractor shall submit a sample of aggregate and asphalt for surface treatment for use by the engineer for verifying test results. The Mix design shall be submitted at least two weeks prior to construction.

Introduction

The following notes represent the guidelines for the design of chip seals. The guidelines first cover some general information regarding the aggregate chips and the asphalt emulsion. The guidelines then address the specific material properties that are used in the recommended design procedure. Finally, the design equations for the aggregate and emulsion asphalt application rates are presented. An example design problem, illustrating the design procedure in a step-by-step manner, is also presented.

Aggregate Chips

Three aggregate types—quartzite, limestone, and natural aggregates—are commonly used throughout the state. Quartzite is more common in the eastern part of the state, whereas limestone is more common in the western part of the state. Natural aggregates are found in the central as well as the northeast portion of the state. Other aggregate types, such as river gravel and granite, have been used for chip seals but are not common.

The selection of the aggregate type should be based on the availability and cost of aggregates in the area. The performance of chip seals with specific aggregate types should also be considered in the selection. On specialized applications, such as for high-volume roadways, additional considerations may need to be taken into account. For example, crushed aggregate can provide improved retention and durability characteristics.

Aggregate Shape

The ideal shape for aggregate chips is cubical and angular, as opposed to flat and rounded. Flat particles tend to orient on their flattest side under traffic loadings and can become completely covered with emulsion and create a bleeding problem. In addition, these completely embedded chips prevent proper embedment of chips that lie on top of the embedded chips, resulting in continued chip loss. With cubical aggregates, the chip height is essentially the same regardless of its orientation, resulting in more uniform chip embedment.

Angular or crushed aggregate particles are preferred over rounded particles. Rounded aggregates are more susceptible to rolling and displacement under traffic, especially in locations of stopping or turning traffic. Angular particles tend to lock together and provide better long-term retention and stability.

Aggregate Gradation

- Aggregate chips should be similarly sized. A one-size aggregate provides a more uniform thickness and a more consistent and proper embedment of the chips, which improves the retention and performance of the chip seal. Similarly sized chips also help improve the surface friction and drainage capabilities of the chip seal.

- The aggregate bands should not be too wide. Allowing a wide range of aggregate retained on a particular sieve will result in widely varying gradations and differing performance. A tight gradation band ensures consistency and uniformity of the chip seal.

- The gradation should limit the amount of fines (material passing the 0.075 mm (No. 200) sieve). Fine materials create dust and can be a safety hazard for passing vehicles. Furthermore, fine materials absorb emulsion and can affect the bonding characteristics and performance of the chip seal.

To better account for these ideal properties, the aggregate gradations in table II-1 are recommended for all roadways. The maximum aggregate size is 9.52 mm (3/8 in). The gradation also forces the majority of the aggregate to a small range to create a more uniform chip seal. The gradation also addresses the amount of fines by limiting the material passing the 0.075 mm (No. 200) sieve to one percent. The recommended gradation for sections using a second choke stone layer are also provided in the table.

Table II-1 Recommended aggregate gradations for chip seal designs

	Percent Passing	
Sieve Sizes	**Aggregate Chips**	**Choke Stone**
12.7 mm (1/2 in)	100	100
9.52 mm (3/8 in)	90 - 100	100
6.35 mm (1/4 in)	40 - 70	100
4.75 mm (No. 4)	0 - 15	85 – 100
2.36 mm (No. 8)	0 - 5	10 – 40
1.18 mm (No. 16)	-	0 – 10
0.300 mm (No. 50)	-	0 – 5
0.075 mm (No. 200)	0 - 1	0 – 1

Flat and Elongated Particles (Flakiness Index)

Like small particles, flat and elongated particles can become completely embedded in the emulsion and thus prevent larger aggregate particles from achieving proper embedment. The flakiness index—determined in accordance with the Central Federal Lands Highway Division (CFLHD) DFT-508, *Standard Method of Determining the Flakiness Index and Average Least Dimension of Aggregates*—should be performed to limit the amount of flat and elongated particles. For most applications, the Flakiness Index should be limited to 30 percent (i.e., the weight of flat and elongated particles should not exceed 30 percent of the total aggregate weight). For special applications such as high-volume roadways, the limit should be tightened to 20 or 25 percent.

Asphalt Emulsion

Emulsification is a process in which two otherwise incompatible materials are blended together. In the case of asphalt emulsion, the two incompatible materials are asphalt and water. An asphalt emulsion consists of asphalt particles dispersed in water, which is stabilized using a chemical solution (also known as an emulsifier). Upon application, the water and asphalt separate, a process referred to as “breaking” of the emulsion. The water then evaporates leaving the asphalt as the bonding agent.

FOR BIDDING PURPOSES ONLY

ASPHALT SURFACE TREATMENT MIX DESIGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	10	16

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Emulsion Classification

Asphalt emulsions are classified into three categories—anionic, cationic, and nonionic—referring to the electrical charge of the emulsifier surrounding the asphalt particles. Anionic emulsions have a negative electrical charge surrounding the asphalt particles, and cationic emulsions have a positive charge. Because opposite electrical charges attract, anionic emulsions should be used with aggregates that have a positive charge (such as limestone and natural aggregates). Likewise, cationic emulsions should be used with aggregates that have a negative charge (such as quartzite).

Emulsions are further identified based on how quickly they revert back to asphalt cement. The following terms are used to classify the emulsion grades:

- Rapid-setting (RS)
- Medium-setting (MS)
- Slow-setting (SS)
- Quick-setting (QS)

The grades indicate the speed at which the emulsion will become unstable and "break" coming into contact with the aggregate. An RS emulsion breaks very quickly and has little or no ability to mix with an aggregate. An MS emulsion will mix with coarse aggregate but not fine aggregate. SS and QS emulsions are designed to mix with fine aggregates.

High-float emulsions (designated) as HF) allow a ticket film of asphalt material on the aggregate, which enhances the bonding and retention. They are designated as such because they pass the Float Test (ASTM D139 or AASHTO T50). High-float emulsions are recommended for use with dusty aggregates (greater than 2 percent fines).

Numbers are used in the classification to indicate the relative viscosity of the emulsion. Lower numbers indicate a lower viscosity or more fluid material (i.e. an MS-2 is more viscous than an MS-1). Letters are also sometimes used following the designation: "h" indicates a harder base asphalt, "s" indicates a softer base asphalt, and "P" indicates a polymer-modified asphalt.

Table II-2 shows the classifications for asphalt emulsion. Standard specifications are available for anionic asphalt emulsions (ASTM D977 or AASHTO M140) and for cationic asphalt emulsions (ASTM D2397 or AASHTO M208).

Table II-2 Classifications of asphalt emulsions

Anionic Asphalt Emulsions	Cationic Asphalt Emulsions
RS-1	CRS-1
RS-2	CRS-2
HFRS-2	--
MS-1	--
MS-2	CMS-2
MS-2h	CMS-2h
HFMS-1	--
HFMS-2	--
HFMS-2h	--
HFMS-2s	--
SS-1	CSS-1
SS-1h	CSS-1h

Chip Seal Design

Chip seals should be designed so that the proposed materials are of sufficient quality and have the desired properties to provide the expected performance. Proper design also ensures that the proper application rates are being used. The design procedure presented herein is a modified version of the McLeod design procedure (McLeod 1969) and is currently being used by the Minnesota Department of Transportation (Janisch and Gaillard 1998).

The procedure is based on two basic principles:

- The aggregate application rate is designed to provide a chip seal that is one stone thick (i.e., there should be a single layer of uniformly sized chips) with minimal excess.
- The voids in the aggregate are designed to be 70 percent filled with asphalt cement for good performance (i.e., the chips should be 70 percent embedded).

Emulsion Properties

Residual Asphalt Content

A portion of an asphalt emulsion consists of water, which evaporates as the binder breaks. The amount of asphalt cement that remains after breaking is referred to as the residual asphalt content. It is important to consider the residual asphalt content because it represents the amount of material that is available for bonding to the aggregate. In general, the residual asphalt content is about 65 to 70 percent (i.e., 65 to 70 percent of an asphalt emulsion consists of asphalt cement).

As mentioned, the objective of this design procedure is to achieve 70 percent embedment of the average-sized aggregate. To accomplish this, the emulsion must be at the top of the average-sized aggregate before curing. If only 70 percent of the aggregate is covered initially, the asphalt height will be about 30 percent too low after curing.

Aggregate Properties

Median Particle Size

The median particle size is the theoretical size through which 50 percent of the material passes. It is determined from the gradation chart using the following sieve sizes: 25.0 mm (1 in), 19.0 mm (3/4 in), 12.5 mm (1/2 in), 9.5 mm (3/8 in), 6.3 mm (1/4 in), 4.75 mm (No. 4), 2.36 mm (No. 8), 1.18 mm (No. 16), 0.300 mm (No. 50), and 0.075 mm (No. 200).

Flakiness Index

The Flakiness Index is a measure of the percentage, by weight, of flat particles. It is determined by testing a sample of aggregate particles for their ability to fit through a slotted plate. The test is conducted in accordance with the Central Federal Lands Highway Division (CFLHD) DFT-508, *Standard Method of Determining the Flakiness Index and Average Least Dimension of Aggregates*. The weight of the material passing the slots is divided by the total weight of the aggregate sample to determine the percent of flat particles or Flakiness Index.

Average Least Dimension

The average least dimension represents a reduction of the median particle size after accounting for the amount of flat particles. It represents the chip seal thickness in the wheelpath after traffic has reoriented the chip on their flattest side. It is determined from the median particle size and flakiness index using the following equation:

$$H = \frac{M}{1.139285 + 0.011506 \times FI} \qquad \text{(Eq. II-1)}$$

where:

H = Average least dimension, in.
M = Median particle size, in.
FI = Flakiness index, percent.

FOR BIDDING PURPOSES ONLY

ASPHALT SURFACE TREATMENT MIX DESIGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	11	16

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Loose Unit Weight

The loose unit weight is required in order to determine the voids in the aggregate in a loose condition. The voids represent the available space for the asphalt binder after placement and rolling. The loose unit weight is a function of the gradation, shape, and specific gravity of the aggregate. It should be determined in accordance with ASTM C29.

Bulk Specific Gravity

Bulk specific gravity represents the weight of aggregate as compared to the weight of water. Different aggregate types have different unit weights or specific gravities. This factor affects the application rate of the aggregate chips because a heavier aggregate will require more weight of chips (or a higher application rate) than a lighter aggregate to cover the same area. Bulk specific gravities for aggregates typically range from 2.40 to 3.00. Natural aggregates are generally about 2.40, and quartzite and limestone aggregates are generally around 2.60.

Voids in the Loose Aggregate

The voids in the loose aggregate represent the voids after the aggregate chips are placed on the pavement. It is based on the loose unit weight and can be determined using the following equation:

$$V = 1 - \frac{W}{62.4G} \qquad \text{(Eq. II-2)}$$

where:

V= Voids in the loose aggregate
W= Loose unit weight of the aggregate chips, lb/ft^3
G= Bulk specific gravity of the aggregate

For one-sized chips, this factor will typically be around 50 percent. Rolling will reduce the amount of voids, typically to around 30 percent. Traffic will further reduce the amount of voids to around 20 percent.

Aggregate Absorption

Aggregates, especially porous aggregates, will absorb a portion of the asphalt emulsion. This will affect the amount of asphalt binder that is available for bonding with the aggregate chips. To ensure that enough binder remains, this factor must be taken into account when designing the emulsion application rate. An absorption correction factor of $0.091/m^2$ ($0.02\ gal/yd^2$) is recommended for aggregates with absorption greater than 1.5 percent. Quartzite is generally not too absorptive and will not require an adjustment. Some limestone and natural aggregates, however, may require an adjustment to the emulsion application rate.

Other Design Properties

Traffic Volume

The traffic volume will influence the amount of asphalt binder that is required to provide sufficient embedment of the aggregate chips. All other factors equal, roadways with higher traffic volumes will require less asphalt binder. This may appear to be the opposite of what is typically expected. However, consider that traffic causes a reorientation of the chips until they eventually lie on their flattest side. More traffic thus results in a greater probability that the chips will be laying on their flattest side and will result in a thinner chip seal. Less traffic will result in a thicker chip seal and will thus require more asphalt binder to achieve sufficient embedment. Table II-3 provides the recommended traffic correction factor to be used in determining the emulsion application rate. Failure to account for this factor will result in bleeding in the wheelpaths.

Table II-3 Recommended traffic correction factors

Traffic (ADT)	Traffic Factor
< 100	0.85
100 – 500	0.75
500 – 1000	0.70
1000 – 2000	0.65
>2000	0.60

Traffic Whip-Off

A portion of the aggregate chips will get thrown off the roadway before final curing and embedment under traffic has occurred. This is accounted for in the procedure using a traffic whip-off factor. The factor is based on the traffic volume and traffic speed of the roadway. Low-volume, residential streets will have about a 5 percent loss, whereas the loss on high-volume, high-speed roadways will be around 10 percent. The factor can be computer using the following equation:

$$E = 1 + \frac{P}{100} \qquad \text{(Eq. II-3)}$$

where:

E = Traffic whip-off factor.
P = Expected loss of aggregate chips, percent.

Thus, an expected loss of 10 percent results in a traffic whip-off factor of 1.10.

Existing Pavement Condition

The surface condition of the existing pavement will greatly influence the amount of asphalt emulsion that is required. A dry, porous pavement will absorb a tremendous amount of asphalt binder and thus affect the emulsion application rate. Conversely, a new pavement (or a pavement with bleeding on the surface) will absorb much less binder. The varying condition is accounted for in the design procedure by the surface correction factor. The recommended value, based on the pavement surface texture, is provided in table II-4.

The same application rate cannot be used for all roadways with varying conditions. Similarly, the surface condition should be monitored during placement, and the application rate adjusted as needed to address areas of differing condition.

Table II-4 Recommended surface correction factors

Existing Pavement Surface Texture	Surface Correction Factor, gal/yd^2
Black, flushed asphalt	-0.01 to -0.06
Smooth, non-porous	0.00
Slightly porous and oxidize	+0.03
Slightly pocked, porous, and oxidized	+0.06
Badly pocked, porous, and oxidized	+0.09

Design Equations

Once the inputs are determined, the application rates can be calculated using the McLeod design equations. The equations for aggregate and emulsion application rates are presented below.

Aggregate Application Rate

The following equation is used to determine the aggregate application rate:

$$C = 46.8 \times (1-0.4V) \times H \times G \times E \qquad \text{(Eq. II-4)}$$

where:

C = Chip application rate, lbs/yd^2
V = Voids in loose aggregate
H = Average least dimension, in.
G = Bulk specific gravity
E = Traffic whip-off factor

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ASPHALT SURFACE TREATMENT MIX DESIGN

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Emulsion Application Rate

The emulsion application rate is determined using the following equation:

$$B = \frac{2.244 \times H \times T \times V + S + A}{R} \qquad \text{(Eq. II-5)}$$

where:

B = Binder application rate, gal/yd^2
H = Average least dimension, in.
T = Traffic correction factor.
V = Voids in loose aggregate
S = Surface correction factor.
A = Aggregate absorption factor, gal/yd^2
R = Residual asphalt content of binder

Minnesota performs an additional calculation of the emulsion application rate to account for snow plow damage (Janisch and Gaillard 1998). The emulsion application rate is recalculated using the median particle SIZE INSTEAD OF THE AVERAGE LEAST DIMENSION. This new emulsion rate provides the required rate if the chips are not reoriented, and thus is more representative of the rate required outside the wheelpath. The average of the two rates is then used as the starting point in the field. Minnesota has found that if this additional calculation is not performed, insufficient binder is applied in non-traffic areas, and snow plows shave off the chips (Janisch and Gaillard 1998).

Example Design Problem

A 68 kg (150 lb) sample of quartzite aggregate has been submitted for design. The roadway has traffic levels of 2,125 vehicles per day. The pavement surface is slightly pocked, porous, and oxidized. A CRS-2P emulsion with a residual asphalt content of 66.5 percent will be used as the binder. Determine the emulsion and aggregate application rate for this project.

Step 1. Determine the aggregate gradation, bulk specific gravity, and percent absorption

Laboratory testing of the aggregate revealed the gradation as shown in table II-5. Testing in accordance with AASHTO T 84-94 indicates a bulk specific gravity of the aggregate of 2.61. The aggregate absorption based on AASHTO T 84-94 is 0.55 percent, so no correction is needed.

Table II-5 Gradation results for design project

Sieve Size	Percent Passing
12.7 mm (1/2 in)	100
9.52 mm (3/8 in)	95
6.35 mm (1/4 in)	62
4.75 mm (No. 4)	12
2.36 mm (No. 8)	3.2
0.075 mm (No. 200)	1.3

Step 2. Determine the mean particle size

The median particle size (M) is determined by plotting the gradation results and reading off the size at which 50 percent of the particles pass. The median particle size represents the theoretical size at which half the stones are larger and half are smaller. For the given gradation, the median particle size is determined to be 5.8 mm (0.23 in).

Step 3. Determine the flakiness index

To determine the flakiness index, the aggregate particles are fitted through slots. The results of this testing is shown in table II-6.

Table II-6 Results of flakiness index test

Size Fraction	Weight Retained On Slot, grams	Weight Passing Slot, grams
12.5 to 9.5 mm (1/2 to 3/8 in)	54.2	12.3
9.5 to 6.3 mm (3/8 to ¼ in)	123.3	43.5
6.3 to 4.75 mm (1/4 in to No.4)	184.4	89.5
Total	**361.9**	**145.3**

Using these results, the flakiness index (FI) is determined as follows:

$$FI = \frac{\text{Weight of Flat Chips}}{\text{Weight of Sample}} = \frac{145.3}{361.9+145.3} = 0.286$$

$$= 28.6\ \%$$

Step 4. Determine the average least dimension

The average least dimension (H) is the expected thickness of the chip seal after the chips have been reoriented on their flattest side from traffic. It is determined using equation II-2 as follows:

$$H = \frac{M}{1.139285 + 0.011506 \times FI} = \frac{0.23\ in}{1.139285 + 0.011506 \times 28.6} = 0.157in$$

Step 5. Determine the loose weight of the aggregate

A metal cylinder with a volume of 0.014 m^3 (0.50 ft^3) was loosely filled with aggregate and weighed. This process was repeated three times, the results of which are show in table II-7.

Table II-7 Results of loose unit weight testing

Test Number	Weight of Aggregate, kg (lbs)
1	20.57 (45.25)
2	20.60 (45.32)
3	20.59 (45.29)
Average	**20.59 (45.29)**

The loose unit weight (W) is then determined as follows:

$$W = \frac{\text{Weight of Aggregate}}{\text{Volume of Cylinder}} = \frac{45.29 lbs}{0.50\ ft^3} = 90.58\ lbs/ft^3$$

Step 6. Determine the voids in the loose aggregate

The voids in the loose aggregate (V) is determined using equation II-3 as follows:

$$V = 1 - \frac{W}{62.4G} = 1 - \frac{90.58\ lbs/ft^3}{62.4\ lbs/ft^3 \times 2.61} = 0.44$$

Step 7. Determine the aggregate application rate

With the inputs determined above, equation II-4 is used to determine the aggregate application rate (C):

$$C = 46.8 (1 - 0.4 \times V) \times H \times G \times E$$
$$= 46.8 (1 - 0.4 \times 0.44) \times 0.157 \times 2.61 \times 1.10 = 17.3\ lbs/yd^2$$

FOR BIDDING PURPOSES ONLY

ASPHALT SURFACE TREATMENT MIX DESIGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO	TOTAL SHEETS
	P 6175(02); P 6465(02); P 6169(07)	13	16

Plotting Date: 3/5/2014
Revised Date: mm/dd/yyyy
Initials: RMW

Step 8. Determine the emulsion application rate

The emulsion application rate is determined using equation II-5. The calculation is performed twice—once for the wheel path areas (using the average least dimension) and again for the non-wheel path areas (using the median particle size). These calculations are shown below:

$$B = \frac{2.244 \times H \times T \times V + S + A}{R}$$

$$= \frac{2.244 \times 0.157 \times 0.60 \times 0.44 + 0.06 + 0.00}{0.665} = 0.23 \text{ gal/yd}^2$$

$$B = \frac{2.244 \times M \times T \times V + S + A}{R}$$

$$= \frac{2.244 \times 0.230 \times 0.60 \times 0.44 + 0.06 + 0.00}{0.665} = 0.30 \text{ gal/yd}^2$$

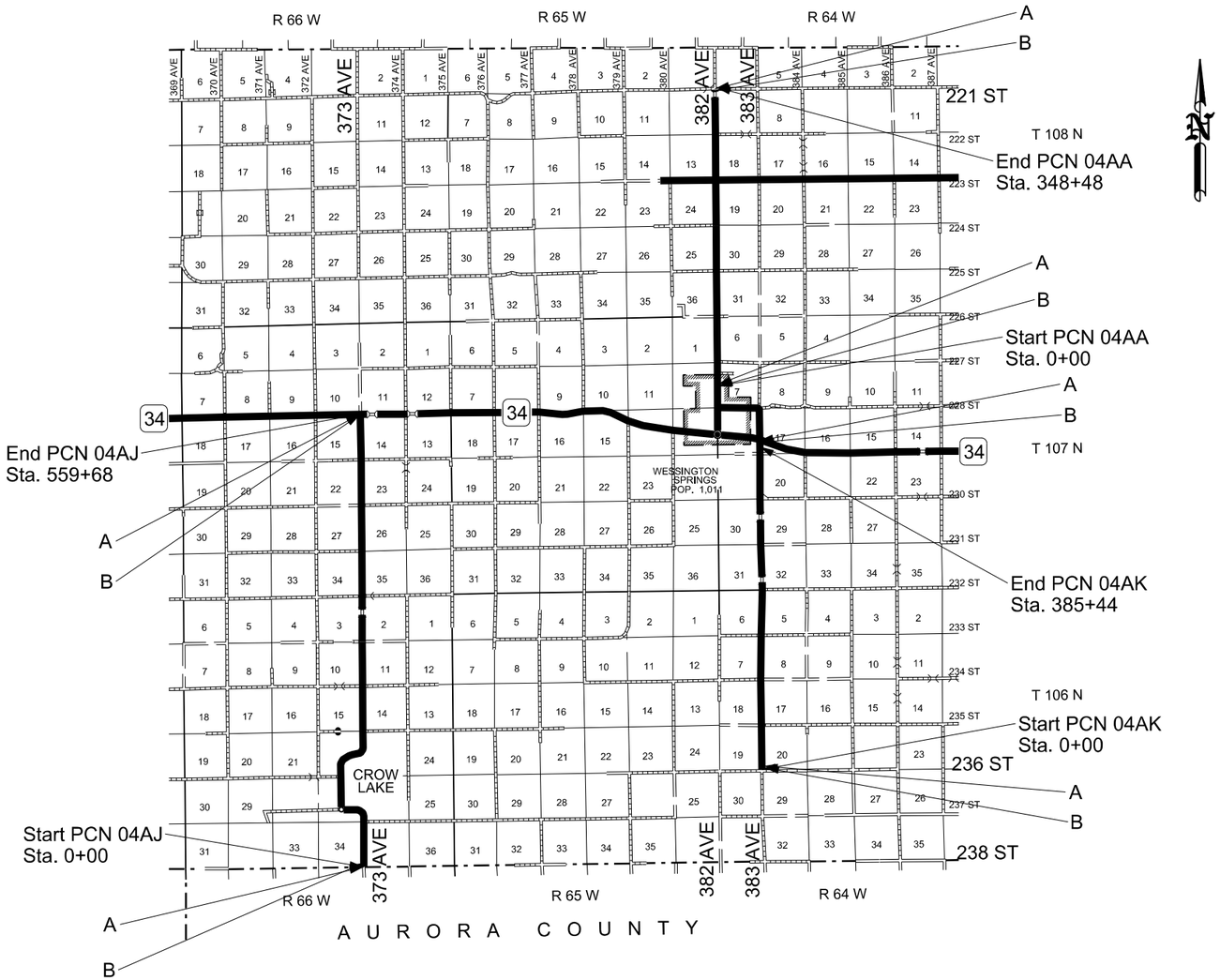
The average of the two results (0.27 gal/yd^2) is used as the starting point in the field.

FOR BIDDING PURPOSES ONLY

TRAFFIC CONTROL

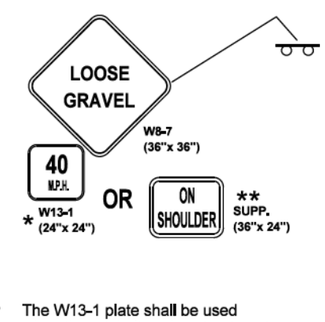
STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	P 6175(02); P 6465(02) P6169(07)	14	16

Plotting Date: 2/5/14
Revised Date: mm/dd/yy
Initials: RMW



ITEMIZED LIST FOR TRAFFIC CONTROL FOR EACH PROJECT

SIGN CODE	SIGN SIZE	DESCRIPTION	NUMBER REQUIRED	UNITS PER SIGN	UNITS
G20-1	48" x 24"	ROAD WORK NEXT ## MILES	2	24	48
G20-2	36" x 18"	END ROAD WORK	2	17	34
W3-4	48" x 48"	BE PREPARED TO STOP	2	34	68
W8-6	48" x 48"	TRUCK CROSSING	2	34	68
W8-7	36" x 36"	LOOSE GRAVEL	4	27	108
W8-11	48" x 48"	UNEVEN LANES	2	34	68
W13-1P	24" x 24"	ADVISORY SPEED PLAQUE	4	16	64
W20-1	48" x 48"	ROAD WORK #### FT. OR AHEAD	2	34	68
W20-4	48" x 48"	ONE LANE ROAD #### FT. OR AHEAD	2	34	68
W20-7a	48" x 48"	FLAGGER	4	34	136
W21-2	36" x 36"	FRESH OIL	2	27	54
				TOTAL UNITS	784



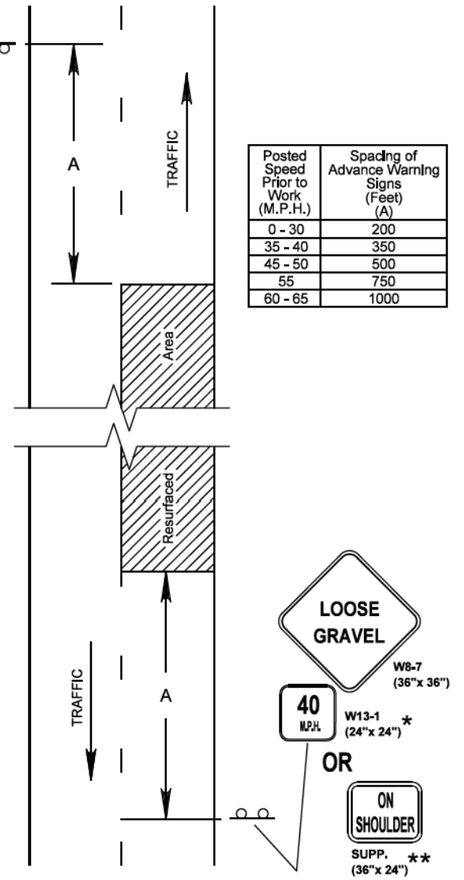
* The W13-1 plate shall be used when the asphalt surface treatment is applied to the mainline.

** The Supplemental plate shall be used when the asphalt surface treatment is applied only to the shoulders.

NOTES:

The Contractor shall provide an additional Flagger at each urban intersection to control side-street traffic whenever the work activities create a hazard or whenever traffic must be restricted from the work area (fresh seal).

Install additional W8-7, LOOSE GRAVEL, signs at 5 mile intervals throughout the entire length of the loose aggregate area and at affected major intersections, edge of towns, etc.



Posted Speed Prior to Work (M.P.H.)	Spacing of Advance Warning Signs (Feet) (A)
0 - 30	200
35 - 40	350
45 - 50	500
55	750
60 - 65	1000

Notes:

All Fixed Location signs shall remain in place until the permanent pavement marking is complete.

All Fixed Location signs shall be placed 200' to 300' from intersection. Exact location to be approved by the Engineer.

Construction signs shall not obscure existing signs and must be installed a minimum of 200' from an existing sign.

A
ROAD WORK NEXT 7 MILES
G20–1 (48" X 24")
PCN 04AA
PCN 04AK

A
ROAD WORK NEXT 11 MILES
G20–1 (48" X 24")
PCN 04AJ

B
END ROAD WORK
G20–2 (36" X 18")
PCN 04AA
PCN 04AK
PCN 04AJ

FIXED LOCATION SIGNS
(GROUND MOUNTED SUPPORTS)
JERAULD COUNTY
P 6175(02), PCN 04AA
P 6465(02), PCN 04AK
P 6169(07), PCN 04AJ

GUIDES FOR TRAFFIC CONTROL DEVICES

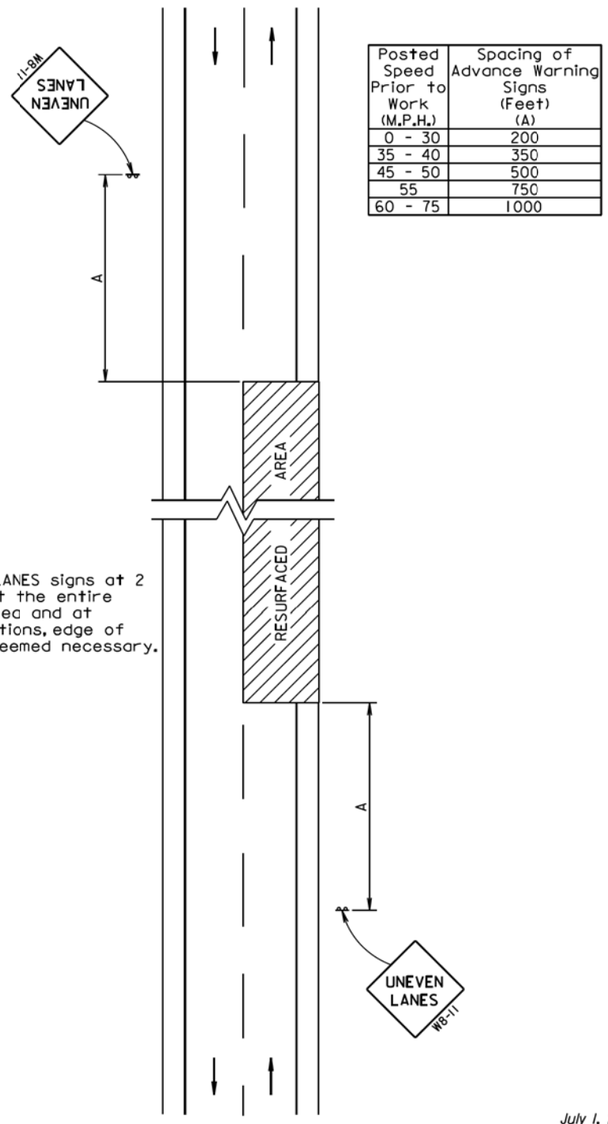
Typical Application - Traffic Control Devices to be used on an undivided highway, Asphalt Surface Treatment, when operations have created a driving surface of loose aggregate.

FOR BIDDING PURPOSES ONLY

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	P 6175(02); P 6465(02) P 6169(07)	15	16

Plotting Date: 2/5/14
Revised Date: mm/dd/yy
Initials: RMW

Posted Speed Prior to Work (M.P.H.)	Spacing of Advance Warning Signs (Feet) (A)
0 - 30	200
35 - 40	350
45 - 50	500
55	750
60 - 75	1000



Install additional UNEVEN LANES signs at 2 mile intervals throughout the entire length of the uneven area and at affected major intersections, edge of towns, and other sites deemed necessary.

July 1, 2005

Published Date: 1st Qtr. 2014	SDDOT	GUIDES FOR TRAFFIC CONTROL DEVICES UNEVEN ROAD SURFACE	PLATE NUMBER 634.22 Sheet 1 of 1

Posted Speed Prior to Work (M.P.H.)	Spacing of Advance Warning Signs (Feet) (A)	Spacing of Channelizing Devices (Feet) (G)
0 - 30	200	25
35 - 40	350	25
45 - 50	500	50
55	750	50
60 - 65	1000	50

Flagger

Channelizing Device

For low-volume traffic situations with short work zones on straight roadways where the flagger is visible to road users approaching from both directions, a single flagger may be used.

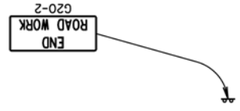
The ROAD WORK AHEAD and the END ROAD WORK signs may be omitted for short duration operations (1 hour or less).

For tack and/or flush seal operations, when flaggers are not being used, the FRESH OIL sign (W21-2) shall be displayed in advance of the liquid asphalt areas.

Flashing warning lights and/or flags may be used to call attention to the advance warning signs.

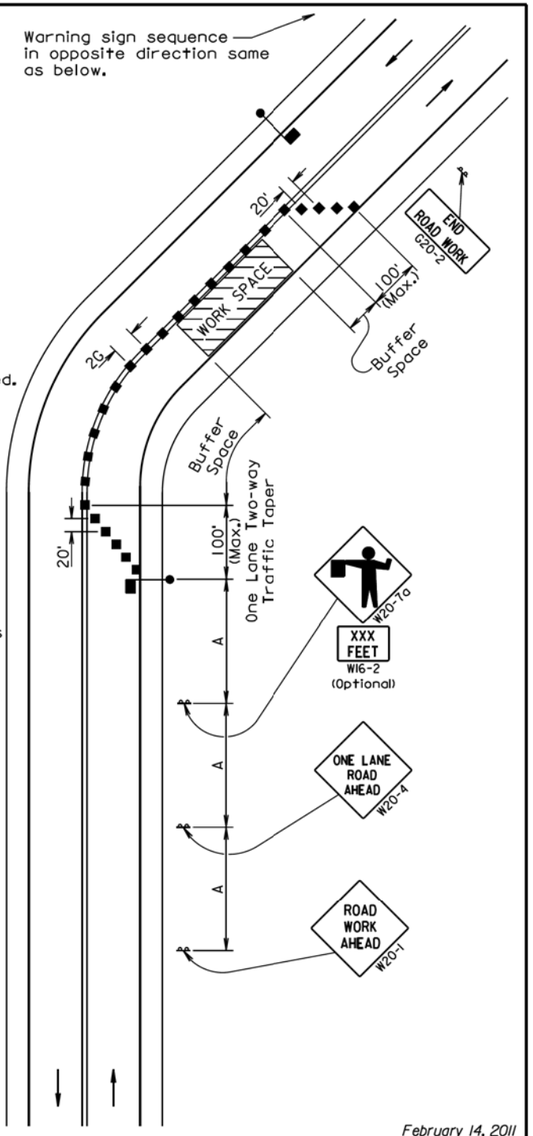
The channelizing devices shall be drums or 42" cones.

Channelizing devices are not required along the centerline adjacent to work area when pilot cars are utilized for escorting traffic through the work area.



Channelizing devices and flaggers shall be used at intersecting roads to control intersecting road traffic as required.

The buffer space should be extended so that the two-way traffic taper is placed before a horizontal or vertical curve to provide adequate sight distance for the flagger and queue of stopped vehicles.



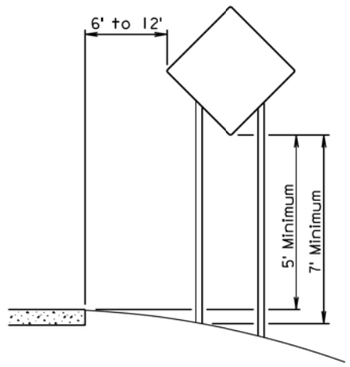
February 14, 2011

Published Date: 1st Qtr. 2014	SDDOT	GUIDES FOR TRAFFIC CONTROL DEVICES LANE CLOSURE WITH FLAGGER PROVIDED	PLATE NUMBER 634.23 Sheet 1 of 1

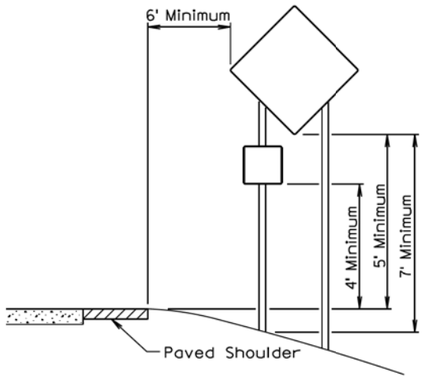
FOR BIDDING PURPOSES ONLY

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	P 6175(02); P 6465(02) P 6169(07)	16	16

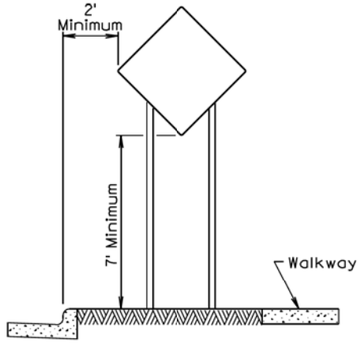
Plotting Date: 2/5/14
Revised Date: mm/dd/yy
Initials: RMW



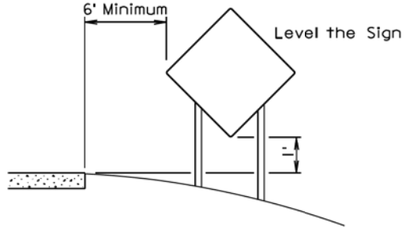
RURAL DISTRICT



RURAL DISTRICT WITH SUPPLEMENTAL PLATE



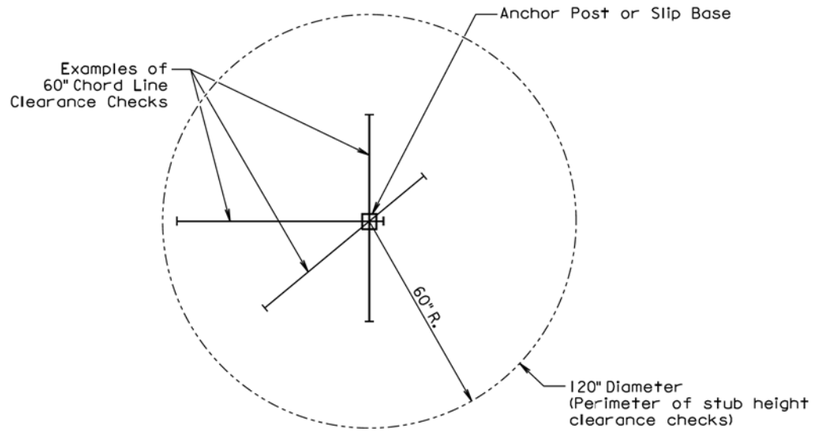
URBAN DISTRICT



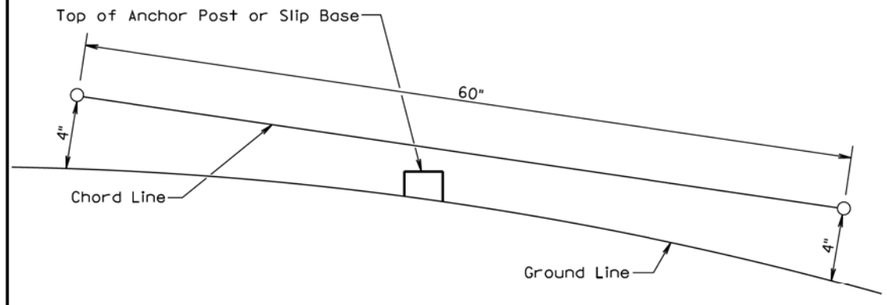
RURAL DISTRICT 3 DAY MAXIMUM

February 14, 2011

Published Date: 1st Qtr. 2014	SDDOT	CRASHWORTHY SIGN SUPPORTS (Typical Construction Signing)	PLATE NUMBER 634.85
			Sheet 1 of 1



PLAN VIEW
(Examples of stub height clearance checks)



ELEVATION VIEW

GENERAL NOTES:

The top of anchor posts and slip bases SHALL NOT extend above a 60" chord line within a 120" diameter circle around the post with ends 4" above the ground.

At locations where there is curb and gutter adjacent to the breakaway sign support, the stub height shall be a maximum of 4" above the ground line at the localized area adjacent to the breakaway support stub.

The 4" stub height clearance is not necessary for U-channel lap splices where the support is designed to yield (bend) at the base.

July 1, 2005

Published Date: 1st Qtr. 2014	SDDOT	BREAKAWAY SUPPORT STUB CLEARANCE	PLATE NUMBER 634.99
			Sheet 1 of 1