STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	1	34

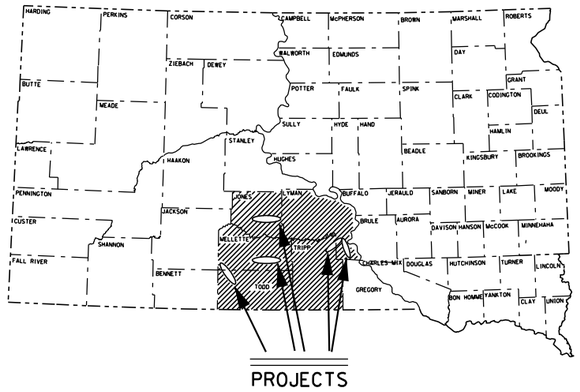
Plotting Date: 01/26/2015

Revised 01-26-2015 JDH

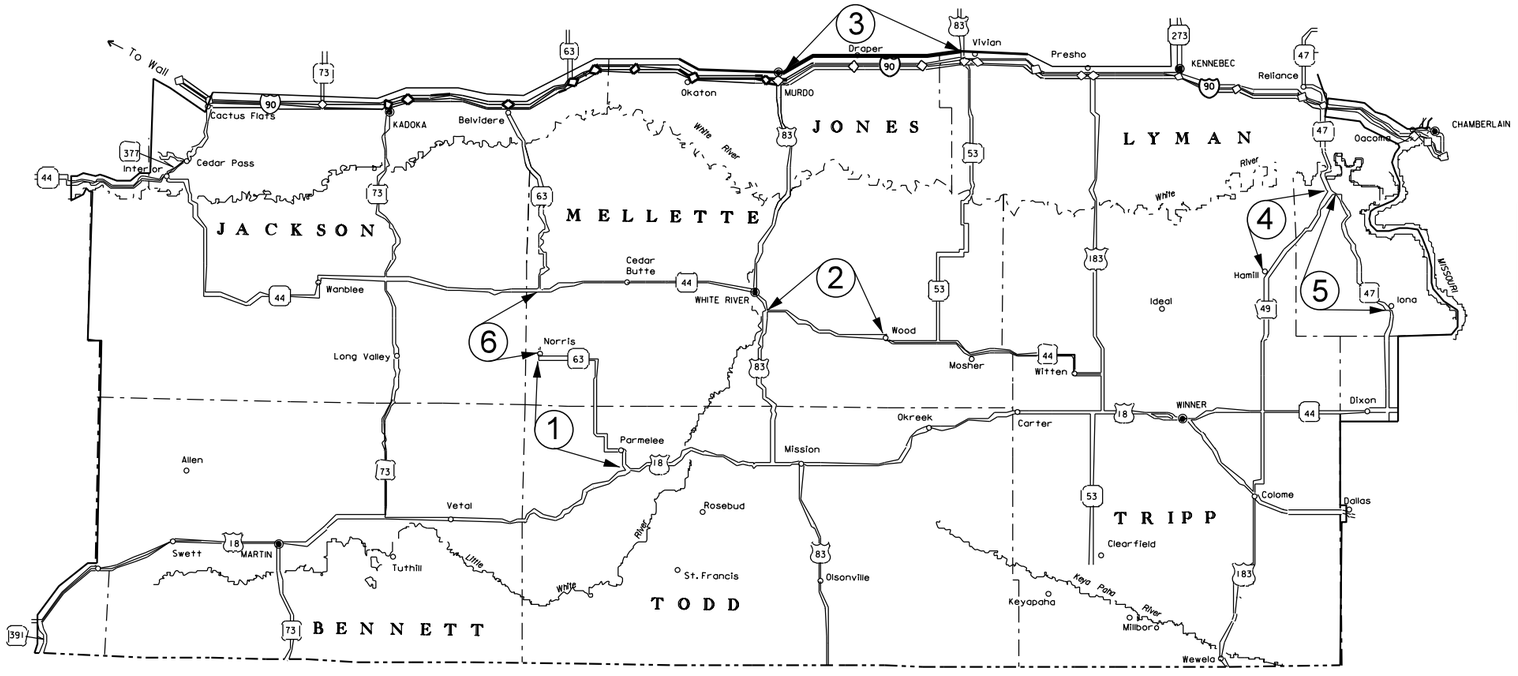
STATE OF SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION
PLANS FOR PROPOSED
PROJECTS P 0033(20) & P 6063(03)
SD HIGHWAYS 44, 47, 49, 63, & 248
JONES, LYMAN, MELLETTE, TODD, & TRIPP COUNTIES

ASPHALT SURFACE TREATMENT

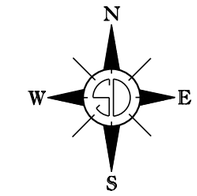
PCN 048C & 0573



PROJECTS



PROJECT HIGHWAY SEGMENTS



INDEX OF SHEETS

Project P 0033(20)

ROUTE 1- SD 63 - MRM 26.71 + 0.000 TO MRM 47.69 + 0.000
ROUTE 2 - SD 44 - MRM 200.74 + 0.000 TO MRM 215.00 + 0.125
ROUTE 3 - SD 248 - MRM 205.35 + 0.177 TO MRM 225.00 + 0.089
ROUTE 4 - SD 49 - MRM 41.10 + 0.368 TO MRM 53.52 + 0.000
ROUTE 5 - SD 47 - MRM 42.00 + 0.030 TO MRM 57.89 + 0.084

Project P 6063 (03)

ROUTE 6 - Norris Road from Norris to Corn Creek

STORM WATER PERMIT
NO PERMIT REQUIRED

11

PLOT SCALE - 1:15369.8

PLOTTED FROM - TRW1INT23

PLOT NAME - 21

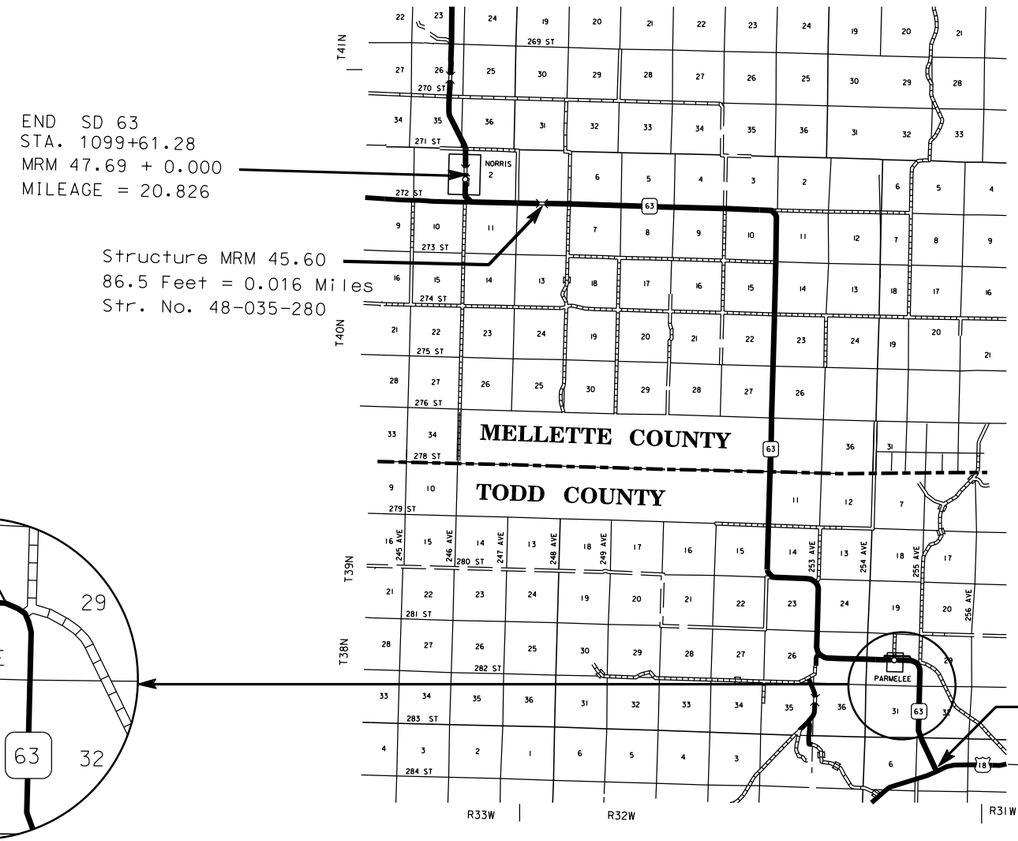
FILE - ...\WORKING\048CLAYOUT.DGN

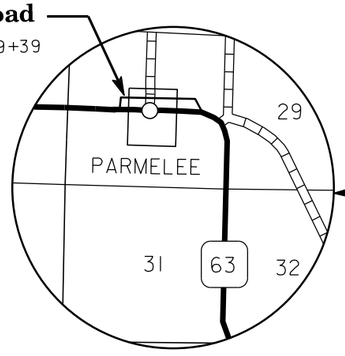
STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	2	34

Plotting Date: 01/26/2015

Revised 01-26-2015 JDH

PROJECT LAYOUT
ASPHALT SURFACE TREATMENT
SD 63 – MELLETTE & TODD COUNTIES
ROUTE #1



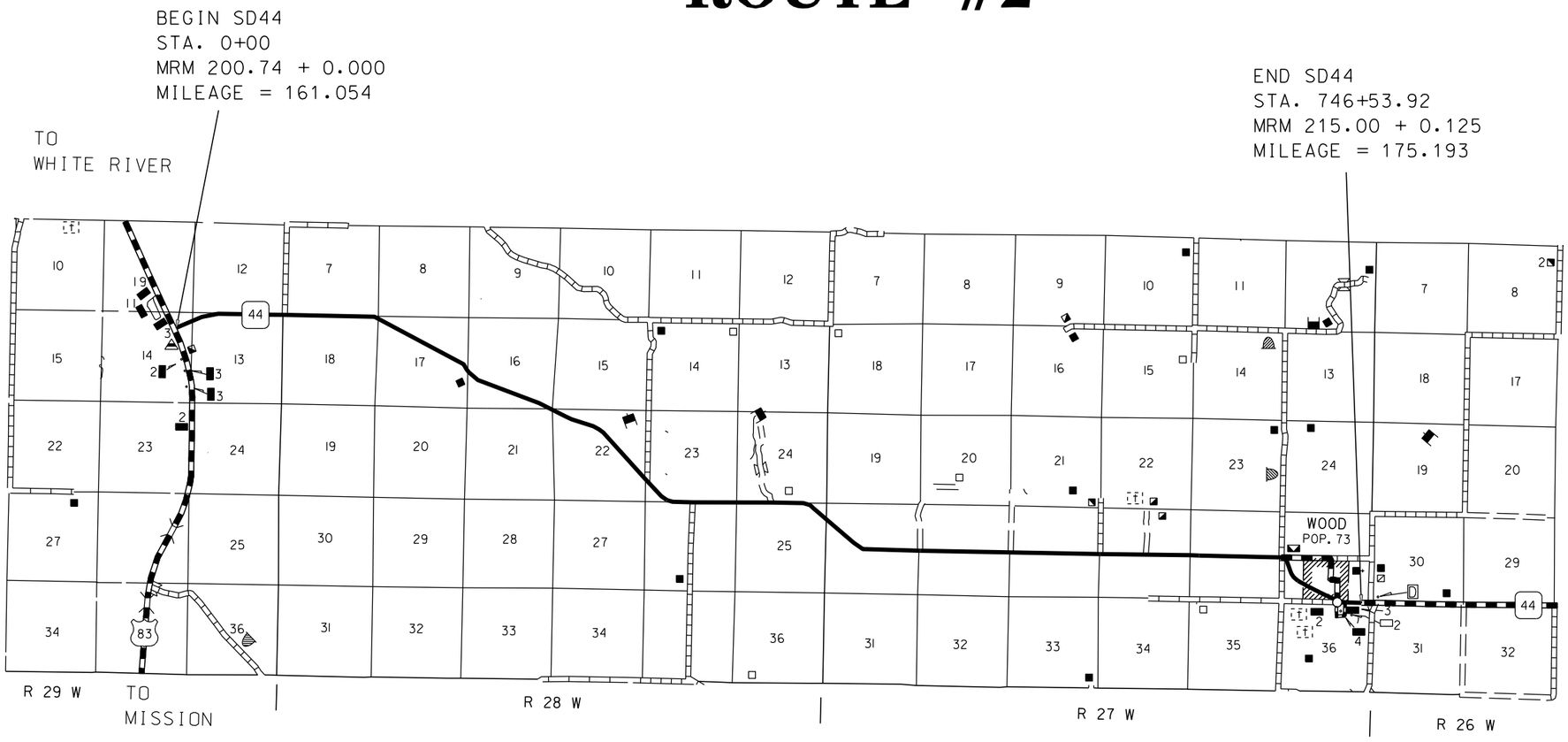


GROSS LENGTH: 111,281.28 FT = 21.076 MILES
LENGTH OF EXCEPTIONS: 86.50 FT = 0.016 MILES
NET LENGTH: 111,194.78 FT = 21.060 MILES

DESIGN DESIGNATION

ADT (2013)	380
ADT (2033)	571
DHV	69
D	5.1%
T DHV	11.2%
T ADT	26.5%
V	55 MPH

PROJECT LAYOUT
ASPHALT SURFACE TREATMENT
SD44 – MELLETTE COUNTY
ROUTE #2



DESIGN DESIGNATION

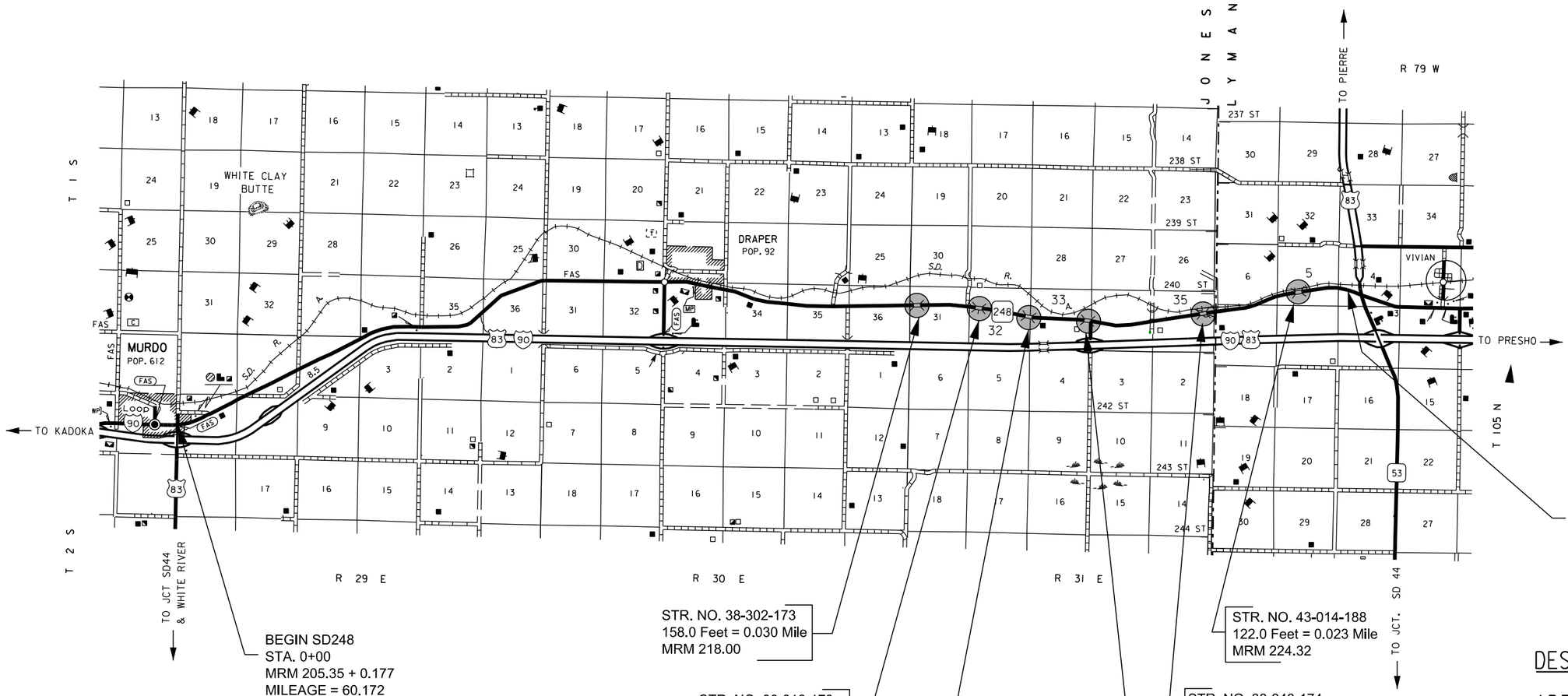
ADT (2013)	230
ADT (2023)	328
DHV	39.7
D	51%
T DHV	4.7%
T ADT	10.4%

GROSS LENGTH:	74,653.92 FT = 14.139 MILES
LENGTH OF EXCEPTIONS:	0.00 FT = 0.00 MILES
NET LENGTH:	74,653.92 FT = 14.139 MILES

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	4	34

Plotting Date: 01/16/2015

PROJECT LAYOUT
ASPHALT SURFACE TREATMENT
SD 248 – JONES & LYMAN COUNTIES
ROUTE #3



GROSS LENGTH:	103,287.36 FT = 19.562 MILES
LENGTH OF EXCEPTIONS:	876.00 FT = 0.166 MILES
NET LENGTH:	102,411.36 FT = 19.396 MILES

DESIGN DESIGNATION

ADT (2013)	179
ADT (2033)	211
DHV	35.8
D	51%
T DHV	7.2%
T ADT	3.3%
V	55 MPH

PLOT SCALE - 1:15369.8

PLOT NAME - 4

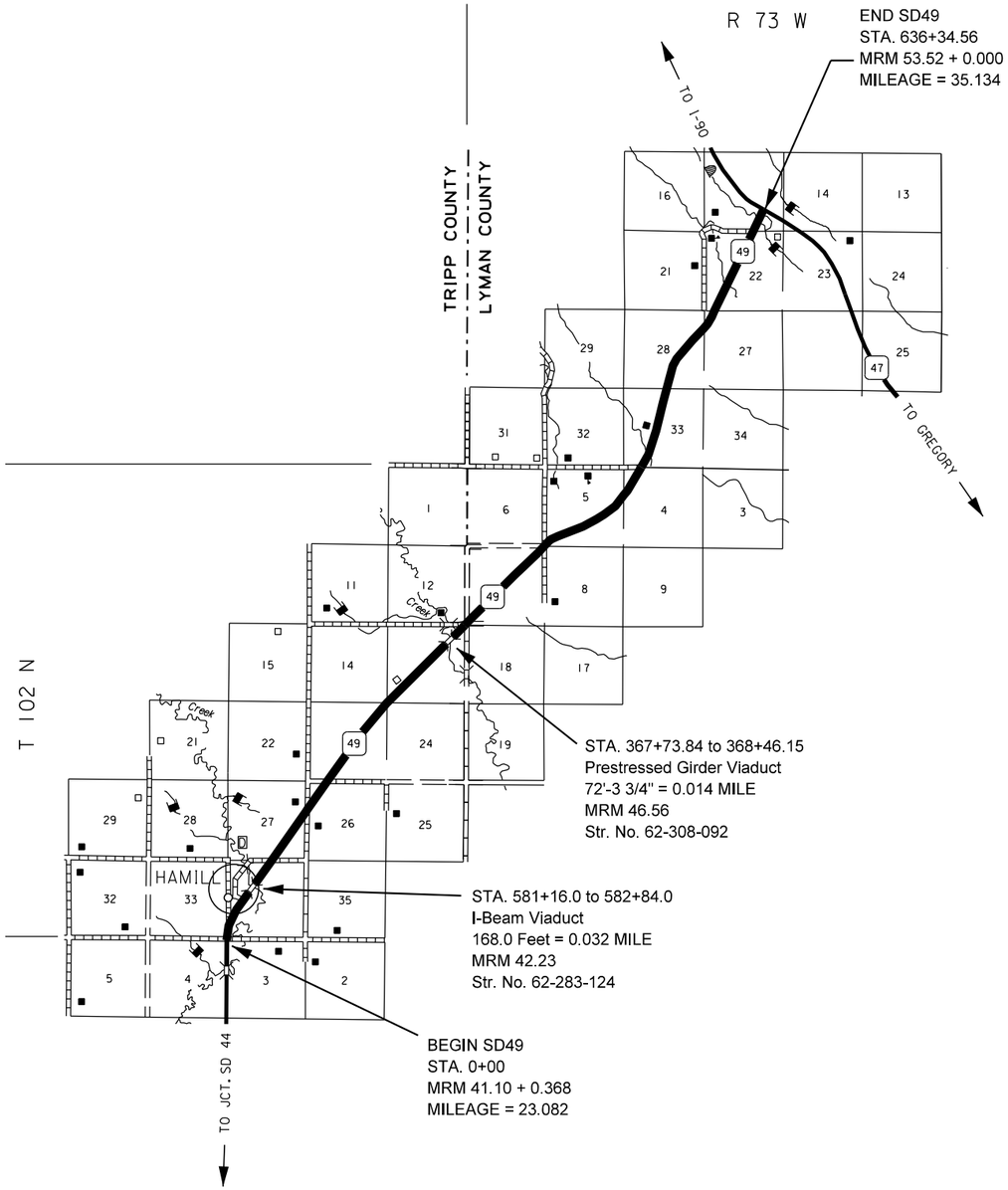
FILE - ...\WORKING\048CLAYOUT.DGN

PLOTTED FROM - TRW1NT23

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	5	34

Plotting Date: 01/16/2015

PROJECT LAYOUT
ASPHALT SURFACE TREATMENT
SD 49 – TRIPP & LYMAN COUNTIES
ROUTE #4



GROSS LENGTH: 63,634.56 FT = 12.052 MILES
LENGTH OF EXCEPTIONS: 240.31 FT = 0.046 MILES
NET LENGTH: 63,394.25 FT = 12.006 MILES

DESIGN DESIGNATION

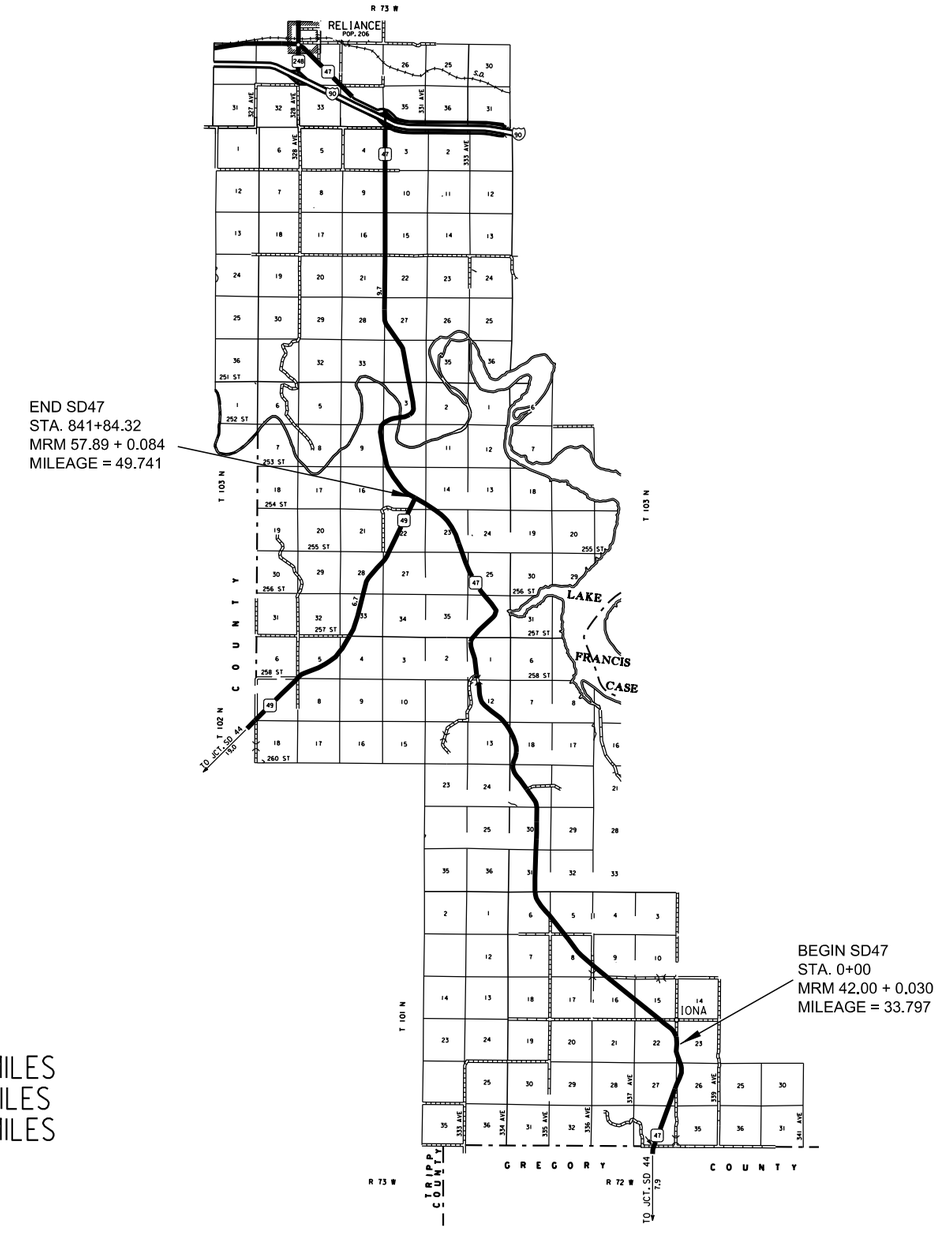
ADT (2013)	360
ADT (2033)	503
DHV	60.9
D	51%
T DHV	10.1%
T ADT	22.1%
V	65 MPH

PLOT SCALE - 1.15369.8
PLOTTED FROM - TRW1INT23
PLOT NAME - 27
FILE - ...\WORKING\048CLAYOUT.DGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	6	34

Plotting Date: 01/16/2015

PROJECT LAYOUT
ASPHALT SURFACE TREATMENT
SD 47 – LYMAN COUNTY
ROUTE #5



GROSS LENGTH: 84,184.32 FT = 15.944 MILES
LENGTH OF EXCEPTIONS: 0.00 FT = 0.00 MILES
NET LENGTH: 84,184.32 FT = 15.944 MILES

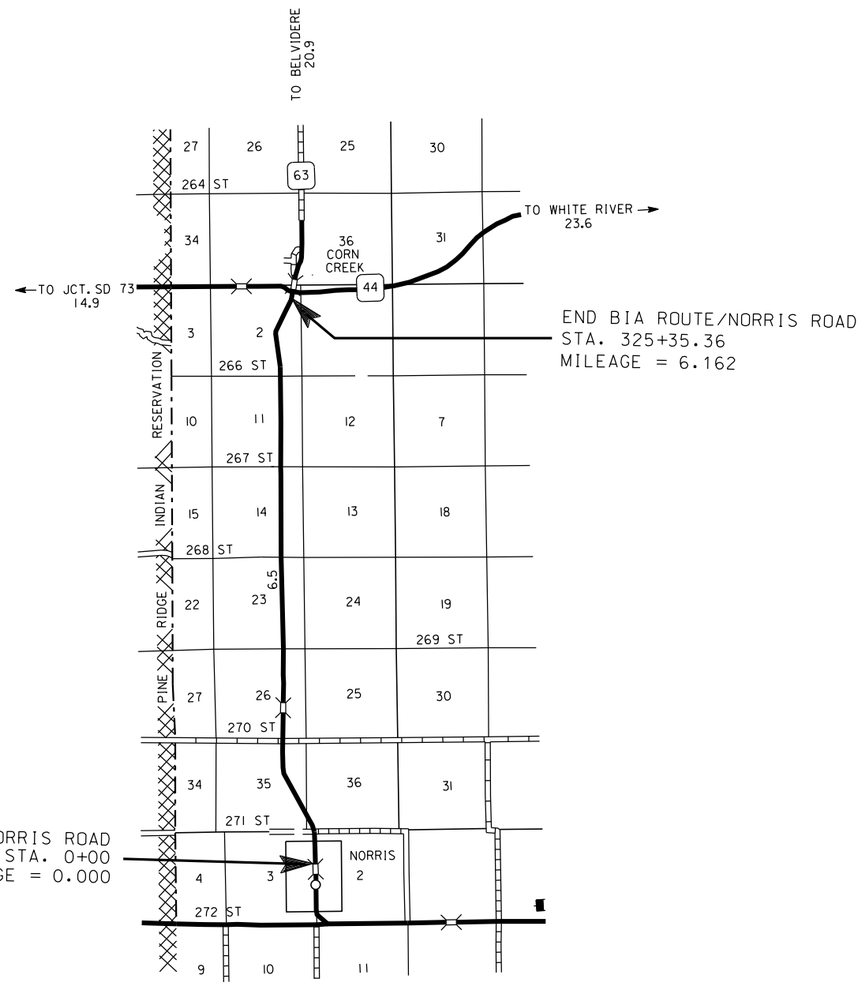
DESIGN DESIGNATION

ADT (2013)	305
ADT (2033)	509
DHV	61.9
D	51%
T DHV	10.1%
T ADT	22.1%
V	65 MPH

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	7	34

Plotting Date: 01/16/2015

PROJECT LAYOUT
ASPHALT SURFACE TREATMENT
NORRIS ROAD – MELLETTE COUNTY ROUTE #6



GROSS LENGTH: 32,535.36 FT = 6.162 MILES
LENGTH OF EXCEPTIONS: 0.00 FT = 0.00 MILES
NET LENGTH: 32,535.36 FT = 6.162 MILES

DESIGN DESIGNATION

ADT (2013)	179
ADT (2033)	211
DHV	35.8
D	51%
T DHV	3.3%
T ADT	7.2%
V	55 MPH

PLOT SCALE - 1.15369.8
PLOTTED FROM - TRWIINT23
PLOT NAME - 2
FILE - ...\WORKING\048CLAYOUT.DGN

ESTIMATE OF QUANTITIES AND ENVIRONMENTAL COMMITMENTS

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	8	34

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ESTIMATE OF 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 and the variation in 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 those actually used even though they may vary significantly from plans estimates.

ESTIMATE OF QUANTITIES

P 0033(20), PCN 048C

Bid Item Number	Item	Quantity	Unit
009E0010	Mobilization	Lump Sum	LS
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	300.7	Ton
330E3000	Sand for Fog Seal	10.0	Ton
360E0020	AE150S Asphalt for Surface Treatment	1,222.8	Ton
360E1200	Modified Cover Aggregate	2,732.5	Ton
360E1200	Modified Cover Aggregate	2,151.4	Ton
360E1200	Modified Cover Aggregate	1,920.3	Ton
360E1200	Modified Cover Aggregate	2,617.2	Ton
360E1200	Modified Cover Aggregate	1,620.1	Ton
633E1300	Pavement Marking Paint, White	2,789.0	Gal
633E1305	Pavement Marking Paint, Yellow	991.0	Gal
634E0010	Flagging	1,045	Hour
634E0020	Pilot Car	245	Hour
634E0100	Traffic Control	4,266	Unit
634E0120	Traffic Control, Miscellaneous	Lump Sum	LS
634E0630	Temporary Pavement Marking	165.0	Mile

P 6063 (03), PCN 0573

Bid Item Number	Item	Quantity	Unit
009E0010	Mobilization	Lump Sum	LS
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	23.8	Ton
330E3000	Sand for Fog Seal	5.0	Ton
360E0020	AE150S Asphalt for Surface Treatment	119.8	Ton
360E1200	Modified Cover Aggregate	1,084.5	Ton
633E1300	Pavement Marking Paint, White	208.0	Gal
633E1305	Pavement Marking Paint, Yellow	74.0	Gal
634E0010	Flagging	78	Hour
634E0020	Pilot Car	18	Hour
634E0100	Traffic Control	758	Unit
634E0120	Traffic Control, Miscellaneous	Lump Sum	LS
634E0630	Temporary Pavement Marking	12.3	Mile

SPECIFICATIONS

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

ESTIMATE OF QUANTITIES AND ENVIRONMENTAL COMMITMENTS

ENVIRONMENTAL COMMITMENTS

An Environmental Commitment is a measure that SDDOT commits to implement in order to avoid, minimize, and/or mitigate a real or potential environmental impact. Environmental commitments to various agencies and the public have been made to secure approval of this project. An agency mentioned below with permitting authority can influence a project if perceived environmental impacts have not been adequately addressed. Unless otherwise designated, the Contractor's primary contact regarding matters associated with these commitments will be the Project Engineer. These environmental commitments are not subject to change without prior written approval from the SDDOT Environmental Office. The environmental commitments associated with this project are as follows:

COMMITMENT B: FEDERALLY THREATENED, ENDANGERED, AND PROTECTED SPECIES

COMMITMENT B2: WHOOPING CRANE

The Whooping Crane is a spring and fall migratory bird in South Dakota that is about 5 feet tall and typically stops on wetlands, rivers, and agricultural lands along their migration route. An adult Whooping Crane is white with a red crown and a long, dark, pointed bill. Immature Whooping Cranes are cinnamon brown. While in flight, their long necks are kept straight and their long dark legs trail behind. Adult Whooping Cranes' black wing tips are visible during flight.

Action Taken/Required:

Harassment or other measures to cause the Whooping Crane to leave the site is a violation of the Endangered Species Act. If a Whooping Crane is sighted roosting in the vicinity of the project, borrow pit, or staging site associated with the project, cease construction activities in the affected area until the Whooping Crane departs and contact the Project Engineer. The Project Engineer will contact the Environmental Office so that the sighting can be reported to USFWS.

COMMITMENT B4: BALD EAGLE

Bald eagles are known to occur in this area.

Action Taken/Required:

If a nest is observed within one mile of the project site, notify the Project Engineer immediately so that he/she can consult with the Environmental Office for an appropriate course of action.

COMMITMENT E: STORM WATER

Construction activities constitute less than 1 acre of disturbance.

Action Taken/Required:

At a minimum and regardless of project size, appropriate erosion and sediment control measures must be installed to control the discharge of pollutants from the construction site.

COMMITMENT H: WASTE DISPOSAL SITE

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

Action Taken/Required:

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.

ESTIMATE OF QUANTITIES AND ENVIRONMENTAL COMMITMENTS

COMMITMENT I: HISTORICAL PRESERVATION OFFICE CLEARANCES

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.

Action Taken/Required:

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.

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.

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SCOPE OF WORK

The work required for this project includes, but is not limited to, the following items, not listed in order of execution.

PCN 048C

1. Asphalt Surface Treatment on SD63 from MRM 26.71, junction of SD63 and US18, northwest 21.1 miles to MRM 47.69.
2. Asphalt Surface Treatment on SD44 from MRM 200.74, Junction of SD44 & SD83 south of White River, east 14.1 miles to MRM 215.12, east of Wood.
3. Asphalt Surface Treatment on SD248 from MRM 205.52, east edge of Murdo, east 19.6 miles to MRM 225.09, end of concrete pavement west of SD83.
4. Asphalt Surface Treatment on SD49 from MRM 41.47, junction of SD49 & 263rd ST, northeast 12.0 miles to MRM 53.52, junction of SD49 & SD47.
5. Asphalt Surface Treatment on SD47 from MRM 42.03, just south of Iona, north 15.9 miles to MRM 58.00, just north of Junction of SD49 & SD47.

PCN 0573

1. Asphalt Surface Treatment on Norris Road from MRM 47.69 on SD63, north to junction of SD63 & SD44, at Corn Creek.

2. The project work on the Norris Road is being completed under agreement with Mellette County and Rosebud Sioux Tribe.

Work activities will be conducted during daylight hours only.

The Contractor shall modify the sequence of operation during the application of the asphalt surface treatment if any unforeseen circumstances arise that affect the installation or quality of the asphalt surface treatment. Circumstances that may affect the installation include, but are not limited to, weather, 24 hour temperatures, and traffic. These modifications shall be accomplished by the Contractor at no expense to the State and to the satisfaction of the Engineer.

ENGINEER NOTIFICATION

The Contractor is required to notify the Area Engineer at least 10 days prior to beginning asphalt surface treatment operations.

BRIDGE ENDS AND APPROACH SLABS

Asphalt surface treatment shall not be placed on any bridge and/or bridge approach slabs. Any emulsion or cover aggregate found to be on bridges or approach slabs after final brooming shall be removed by the Contractor as directed by the Engineer at no cost to the Department.

Cover aggregate material shall not be broomed under any guardrail, 3 cable guardrail, or into any drop inlets along the project.

All joints at bridge ends including asphalt plug joints and strip seal glands along the project shall be masked and/or protected the entire length prior to Asphalt Surface Treatment operations. This protection shall remain in place until completion of the fog seal and any final brooming operations. The protection shall then be removed and any loose material cleaned out of each of the gland areas. Any damage to the glands caused by the asphalt surface treatment operations shall be repaired at no expense to the State. All costs related to this work shall be incidental to the various contract items.

MODIFIED COVER AGGREGATE

Aggregate for Modified Cover Aggregate shall conform to the following gradation requirements:

Passing a 3/8 Inch Sieve	100%
Passing a No. 4 Sieve	0-75%
Passing a No. 8 Sieve	0-30%
Passing a No. 40 Sieve	0-6%
Passing a No. 200 Sieve	0-3.0%

Aggregate may be crushed or uncrushed.

All other requirements of the Specifications Section 881.2 for Type 1B Cover Aggregate shall apply.

After the aggregate stockpile has been produced, the Contractor shall submit an aggregate sample to the asphalt supplier a minimum of 14 days prior to starting the project to allow time to evaluate the compatibility and design of the surface treatment. A copy of the test results shall be submitted to the Engineer and Bituminous Engineer for approval prior to starting the asphalt surface treatment work.

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

FOG SEAL

The fog seal shall be placed following the completion of the chip seal. Prior to the application of the fog seal the Contractor will be required to broom the chip seal. In addition, the rumble strips shall be thoroughly broomed clean prior to the application of the fog seal. A CSS-1h or SS-1h emulsion shall be used for the fog seal application. A water-to-emulsion rate of 1:1 should be used for the Fog Seal application.

The Contractor shall fog seal the entire asphalt concrete surface including sluff.

The Contractor shall plan the fog seal operation to allow adequate cure time for the fog seal and to minimize/eliminate the need to apply blotting sand to the fog seal.

If adequate cure time for the Fog Seal is not available, to facilitate traffic, the Contractor shall be allowed to place a minimum sufficient amount of blotting sand on the fog seal to allow traffic to cross the uncured portion of the fog seal, as permitted by the Engineer.

Blotting sand for Fog Seal is only intended to be placed for accesses to businesses, intersection crossings, and as determined by the Engineer to facilitate traffic movements. Blotting sand will not be placed to accelerate the Contractor's schedule.

Blotting sand that is applied shall be broomed off the surface of the roadway once the fog seal has sufficiently cured as determined by the Engineer.

Blotting sand for fog seal shall conform to Specification Section 879.1.B.

Prior to hauling, Blotting Sand shall be screened to minimize segregation, eliminate oversize, and effectively breakup or discard material bonded into chunks.

All costs for supplying, hauling, placing, and brooming the blotting sand shall be incidental to the contract unit price per ton for "Sand for Fog Seal".

TRAFFIC CONTROL

The sign tabulation units were calculated allowing one lane closure setup to be paid on each roadway segment. The traffic control signs will be paid once, regardless of the number of times moved within each roadway segment. If the Contractor elects to use additional lane closures, with approval from the Engineer, no additional payment will be made.

All traffic control sign fixed locations shall be set in the field by the Contractor and verified by the Engineer prior to installation.

Fixed location signing placed more than two days prior to the start of construction shall be covered until the time of construction. The covers shall be a hard cover and no plastic bags or soft covers will be allowed. The covers must be approved by the Engineer prior to installation. The cost of materials, labor and equipment necessary to complete this work shall be incidental to other contract items. No separate payment will be made.

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.

Storage of vehicles and equipment shall be outside the clear zone 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 sites in a minimum number of vehicles necessary to perform the work.

Indiscriminate driving and parking of vehicles within the right-of-way will not be permitted. Any damage to the 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 State, and to the satisfaction of the Engineer.

The Contractor shall provide documentation that all breakaway sign supports comply with FHWA NCHRP 350 or MASH crash-worthy requirements. The contractor shall provide post installation details at the preconstruction meeting for all steel post breakaway sign support assemblies.

The Contractor shall furnish, install, and maintain "REDUCE SPEED LOOSE GRAVEL NEXT X MILES" signs upon the start of surface treatment operations at each end of the project. These signs shall be installed as shown on the "Fixed Location Sign Layout" sheets in these plans. These signs shall be removed after the fog seal has been completed.

If operations exist where the traveling public will be delayed at a flagging station more than 5 minutes, it is required that the flaggers and pilot car operators all have radio or telephone contact with one another. This equipment is to be used to assist with Traffic movement in the event that an emergency vehicle such as ambulance, police or fire vehicles need to pass through the project in an expedient manner.

Until completion of initial brooming, additional flagger(s) and FLAGGER symbol sign(s) shall be provided to alert the traveling public entering completed portions of the project to the potential of airborne chips. These flaggers shall be located at the nearest reasonable State Highway junction, in which the traveling public may consider an alternate State Highway route. Location of these advance warning flaggers shall be determined at the preconstruction meeting.

The flagger(s) shall provide each motorist with a printed notice on the Contractor's letterhead similar to the one shown. Cost of the notice shall be incidental to various contract items.

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"CONTRACTOR'S LETTERHEAD"

THIS HIGHWAY IS BEING RESURFACED WITH A CHIP SEAL COAT.

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

The bottom of signs on portable or temporary supports shall not be less than seven feet above the pavement in urban areas and one foot above the pavement in rural areas. Portable sign supports may be used as long as the duration is less than 3 days. If the duration is more than 3 days, the signs shall meet the minimum mounting heights of 5 foot for rural areas and 7 foot for urban areas.

The Contractor shall furnish, install and maintain "TRUCK CROSSING" signs. The location for this pair of signs will be determined on construction. Payment for these signs will be based on the contract unit price per unit for Traffic Control and will be paid for once on the contract.

TEMPORARY PAVEMENT MARKING

Temporary pavement markings shall be as per the Specifications. Temporary pavement marking will be measured once for the asphalt surface treatment and once for the fog seal on each route, for a total of two applications.

All costs for each application of the temporary pavement marking; including labor, material, maintenance, etc. shall be incidental to the contract unit price per mile for "Temporary Pavement Marking".

The Contractor will be allowed to use "Do Not Pass" and "Pass With Care" fixed support signs for a period of two (2) weeks to mark no passing zones or roads with an average daily traffic of 2500 vehicles or less. Cost for furnishing, installing, and removing the "Do Not Pass" and "Pass With Care" signs shall be incidental to the contract unit price per mile for "Temporary Pavement Marking".

No temporary pavement marking paint will be allowed on the asphalt surface treatment or fog seal applications.

At the end of each day the temporary pavement markings shall be in place and visible. No separate payment will be made at the end of the next day for remarking a stretch that was not evened up with surface treatment on the previous day.

Flagger symbol signs (W20-7) and flaggers, or a shadow vehicle with rotating yellow lights or strobe lights shall be positioned on the roadway shoulder in advance of workers for both directions of traffic during the installation of temporary road markers. The traffic control device used shall be moved to provide proper warning of the work operation. A ROAD WORK AHEAD (W20-1), a Workers symbol sign (W21-1) or a BE PREPARED TO STOP (W3-4) warning sign shall be mounted on the rear of the shadow vehicle. The method of traffic control used by the Contractor for this work shall be approved by the Engineer.

EXISTING PAVEMENT CONDITIONS AND TRAFFIC VOLUMES

The existing pavement conditions for each highway segment are listed in the table below.

ROUTE	EXISTING PAVEMENT CONDITION
SD63 MRM 26.71 to MRM 47.69	Slight porous and oxidized
SD44 MRM 200.74 to MRM 215.12	Slightly pocked, porous, and oxidized
SD248 MRM 205.52 to MRM 225.09	Slightly porous and oxidized
SD49 MRM 41.47 to MRM 53.52	Slightly pocked, porous, and oxidized
SD47 MRM 42.03 to MRM 57.97	Slightly pocked, porous, and oxidized
BIA Route/Norris Road – Norris north to junction of SD63/SD44 @ Corn Creek	Smooth, non-porous

Recessed in-lane rumble strips are currently in place for the stop signs located at the following locations - SD63 – MRM 26.7, SD44 – MRM 200.8, and SD49 – MRM 53.5. The Contractor shall apply Asphalt Surface Treatment through these locations as part of this contract work. The SDDOT Winner Area Office will evaluate the effectiveness of the in-lane rumble strips and will regrind the rumble strips, if needed.

The traffic volumes are shown on the project layout sheet for each highway segment.

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PERMANENT PAVEMENT MARKING PAINT

The Contractor shall advise the Engineer a minimum of 2 weeks prior to the application of the permanent pavement marking to allow the State to check and mark the location of no passing zones. All materials shall be applied as per manufacturer's recommendations.

Application of permanent pavement marking paint shall be completed within 14 days following completion of fog seal and be no more than 21 days following the completion of the asphalt surface treatment.

For each working day the application of permanent pavement marking paint remains uncompleted after the 14 calendar days, the Contractor will be assessed $250 liquidated damages.

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 Contractor will be required to repaint all existing pavement marking including centerline, edge line, lane lines, word messages, turn arrows, stop bars, railroad crossings, pedestrian crossings, etc. This list is approximate. The Contractor will be required to inventory and mark, with appropriate colored tabs, the extent and location of the existing word messages, turn arrows, stop bars, railroad crossings, pedestrian crossings, etc. before the markings are obliterated. The Engineer will be provided a copy of the pavement marking inventory. Additional quantities are included in the estimate of quantities to paint the additional pavement marking. The cost of the tabs shall be incidental to the contract unit prices for the various items.

Existing Pavement Markings
SD44 - MRM 200.8 - 2 Turn Lane Arrows
SD49 - MRM 53.5 - 2 Turn Lane Arrows
SD47 - MRM 57.8 - 2 Turn Lane Arrows

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 compatibility of the aggregate and asphalt. It is the Contractor's responsibility to verify the aggregate and asphalt compatibility with their asphalt oil supplier prior to bidding the contract. Compatibility will be verified by the SDDOT Bituminous Engineer during the mix design approval process. No reimbursement for modifications of aggregate or asphalt oil will be made to the Contractor if the mix design components are discovered to be incompatible after the award of the contract.

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 Treatments Report. The asphalt surface treatment 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.

In addition to the above data, the Contractor will submit with the design of the asphalt surface treatment a sample of each aggregate and emulsion for use by the Engineer for verifying the test results. The design may be verified by the Department.

The mix design shall be submitted to the Engineer at least one week prior to the start of construction.

Appendix C Volume II. Guidelines for Design of Chip Seals are reproduced below:

Volume II. Guidelines for Design of Chip Seals

Introduction

This volume presents 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 application rates are presented. An example design problem, illustrating the design procedure in a step-by-step manner, is also presented.

Aggregate Chips

Aggregate Type

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.

ASPHALT FOR SURFACE TREATMENT MIX DESIGN (CONTINUED)

Aggregate Gradation

The aggregate gradation plays a key role in the design, construction and performance of chip seals. The gradation requirements shown in this Design Procedure are for information only and Modified Cover Aggregate is specified in the plans. The ideal gradation comprises the following characteristics:

* The 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 (⅜ 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 is also provided in the table.

Table II-1. Recommended aggregate gradations for chip seal designs.

Sieve Size	Cover Aggregate Percent Passing
9.52 mm (⅜ in)	100
4.75 mm (No. 4)	50 95%
2.36 mm (No. 8)	0 – 30%
0.425 mm (No.40)	0 – 6%
0.075 mm (No. 200)	0 – 3.0%

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. The Flakiness Index is a measure of the percentage, by weight, of flat 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.

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)

ASPHALT FOR SURFACE TREATMENT MIX DESIGN (CONTINUED)

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 thicker 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 (¾ in), 12.5 mm (½ in), 9.5 mm (⅜ in), 6.3 mm (¼ 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).

ASPHALT FOR SURFACE TREATMENT MIX DESIGN (CONTINUED)

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 wheel path after traffic has reoriented the chips on their flattest side. It is determined from the median particle size and flakiness index using the following equation:

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

where:

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

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 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 0.09 l/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.

ASPHALT FOR SURFACE TREATMENT MIX DESIGN (CONTINUED)

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 wheel paths.

Table II-3. Recommended traffic correction factor.

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 computed using the following equation:

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

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 oxidized	+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:

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

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.

ASPHALT FOR SURFACE TREATMENT MIX DESIGN (CONTINUED)

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 snowplow 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 wheel path. 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-2 emulsion with a residual asphalt content of 66.5 percent will be used as the binder. Determine the emulsion and aggregate application rates 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 (½ in)	100
9.52 mm (⅜ in)	95
6.35 mm (¼ 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 (½ to ⅜ in)	54.2	12.3
9.5 to 6.3 mm (⅜ to ¼ in)	123.3	43.5
6.3 to 4.75 mm (¼ in to No. 4)	184.4	89.5
Total	361.9	145.3

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

ASPHALT FOR SURFACE TREATMENT MIX DESIGN (CONTINUED)

$$FI = \frac{Weight\ of\ Flat\ Chips}{Weight\ of\ Sample} = \frac{145.3}{361.9 + 145.3} = 0.286 = 28.6\ percent$$

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:

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

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 shown in Table II-7.

ASPHALT FOR SURFACE TREATMENT MIX DESIGN (CONTINUED)

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:

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

Step 6. Determine the voids in the loose aggregate.

The voids in the loose aggregate (V) is determined using Equation II-2 as follows:

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

Step 7. Determine the aggregate application rate.

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

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

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:

$$B = \frac{2.244 \times H \times T \times V + S + A}{R}$$
$$= \frac{2.244 \times 0.157 \times 0.60 \times 0.44 + 0.06 + 0.00}{0.665} = 0.23\ gal.yd^2$$

$$B = \frac{2.244 \times M \times T \times V + S + A}{R}$$
$$= \frac{2.244 \times 0.23 \times 0.60 \times 0.44 + 0.06 + 0.00}{0.665} = 0.30\ gal.yd^2$$

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

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RATES OF MATERIALS

The Estimate of Quantities is based on the following quantities of material per mile.

PROJECT P 0033(20), PCN 048C

SD63 - MRM 26.71 TO MRM 36.13 (Station 0+00 to 497+53) Exception = 0 feet:

AE150S Asphalt for Surface Treatment at the rate of 14.9 tons applied 23 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 134.9 tons applied 23 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.5 tons applied 28 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

SD63 – Parmalee Service Road - MRM 29.10 TO MRM 29.35 (Station 126+19 to 139+39) Exception = 0 feet:

AE150S Asphalt for Surface Treatment at the rate of 15.6 tons applied 24 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 140.8 tons applied 24 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.0 tons applied 24 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

SD63 – MRM 36.13 TO MRM 47.69 (Station 497+53 to 1099+61) Exception = 86.5 feet:

AE150S Asphalt for Surface Treatment at the rate of 13.6 tons applied 21 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 123.2 tons applied 21 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.1 tons applied 25 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

SD44 MRM 200.74 to MRM 215.12 (Station 0+00 to 746+54) Exception = 0 feet:

AE150S Asphalt for Surface Treatment at the rate of 14.9 tons applied 23 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 134.9 tons applied 23 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.7 tons applied 30 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

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SD248 – MRM 205.52 to MRM 225.09 (Station 0+00 to 1032+87) Exceptions = 876 feet:

AE150S Asphalt for Surface Treatment at the rate of 14.9 tons applied 23 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 134.9 tons applied 23 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.7 tons applied 30 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

SD49 - MRM 41.47 TO MRM 53.52 (Station 0+00.0 to 636+35) Exception = 240.3 feet:

AE150S Asphalt for Surface Treatment at the rate of 14.9 tons applied 23 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 134.9 tons applied 23 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.7 tons applied 30 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

SD47 - MRM 42.03 TO MRM 57.97 (Station 0+00 to 841+84) Exception = 0 feet:

AE150S Asphalt for Surface Treatment at the rate of 14.9 tons applied 23 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 134.9 tons applied 23 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.7 tons applied 30 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

PROJECT P 6063(03), PCN 0573

Norris Road – Norris to SD 44 Junction (Station 0+00 to 325+35) Exception = 0 feet:

AE150S Asphalt for Surface Treatment at the rate of 19.4 tons applied 30 feet wide (Rate = 0.26 gallon per square yard).

Modified Cover Aggregate at the rate of 176.0 tons applied 30 feet wide (Rate = 20 pounds per square yard).

SS-1h or CSS-1h Asphalt for Fog Seal at the rate of 3.7 tons applied 30 feet wide (Rate = 0.05 gallon per square yard). The oil applied shall be dependent on the type of aggregate used.

Revised 02-03-2015 JDH

TABLE OF QUANTITIES BY ROUTE (FOR INFORMATION ONLY) PCN 048C

BID ITEM NUMBER	ITEM	SD63	SD44	SD248	SD49	SD47	TOTAL	UNIT
009E0010	Mobilization	Lump Sum	Lump Sum	Lump Sum	Lump Sum	Lump Sum	**Lump Sum**	**LS**
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	69.7	53.3	72.6	44.9	60.2	**300.7**	**Ton**
330E3000	Sand for Fog Seal	2.0	2.0	2.0	2.0	2.0	**10.0**	**Ton**
360E0020	AE 150S Asphalt for Surface Treatment	301.9	212.2	289.2	179.0	240.5	**1222.8**	**Ton**
360E1200	Modified Cover Aggregate – SD63	2732.5					**2732.5**	**Ton**
360E1200	Modified Cover Aggregate – SD44		1920.3				**1920.3**	**Ton**
360E1200	Modified Cover Aggregate – SD248			2617.2			**2617.2**	**Ton**
360E1200	Modified Cover Aggregate – SD49				1620.1		**1620.1**	**Ton**
360E1200	Modified Cover Aggregate – SD47					2151.4	**2151.4**	**Ton**
633E1300	Pavement Marking Paint, White	704	478	661	407	539	**2789**	**Gal**
633E1305	Pavement Marking Paint, Yellow	250	170	235	145	191	**991**	**Gal**
634E0010	Flagging	265	180	250	150	200	**1045**	**Hour**
634E0020	Pilot Car	60	40	60	35	50	**245**	**Hour**
634E0100	Traffic Control	1081	1013	860	656	656	**4266**	**Unit**
634E0120	Traffic Control, Miscellaneous	Lump Sum	Lump Sum	Lump Sum	Lump Sum	Lump Sum	**Lump Sum**	**LS**
634E0630	Temporary Pavement Marking	41.652	28.278	39.124	24.104	31.888	**165.046**	**Mile**

TABLE OF ADDITIONAL QUANTITIES (FOR INFORMATION ONLY) PCN 048C

BID ITEM NUMBER	ITEM	JCT OF US18/SD63	Parmalee Service Road	Norris Shoulders	JCT OF US18/SD44	Wood Radii	Murdo Shoulders	JCT OF SD47/SD49	UNIT
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	0.1	1.1	0.1	0.3	0.1	0.1	0.6	**Ton**
360E0020	AE 150S Asphalt for Surface Treatment	0.6	5.8	0.0	1.4	0.0	0.0	2.8	**Ton**
360E1200	Modified Cover Aggregate	5.6	52.6	0.0	12.5	0.0	0.0	25.0	**Ton**

The above quantities are included in the Estimate of Quantities.

ITEMIZED LIST OF TRAFFIC CONTROL – PCN 048C

SIGN CODE	DESCRIPTION	SIGN SIZE	UNITS PER SIGN	SD 63		SD 44		SD 248		SD 49		SD 47	
				NUMBER	UNITS	NUMBER	UNITS	NUMBER	UNITS	NUMBER	UNITS	NUMBER	UNITS
W3-4	BE PREPARED TO STOP	48" x 48"	34	1	34	1	34	1	34	1	34	1	34
W8-6	TRUCK CROSSING	48" x 48"	34	2	68	2	68	2	68	2	68	2	68
W20-1	ROAD WORK AHEAD	48" x 48"	34	12	408	10	340	7	238	3	102	3	102
W20-4	ONE LANE ROAD AHEAD	48" x 48"	34	2	68	2	68	2	68	2	68	2	68
W20-7	FLAGGER (symbol)	48" x 48"	34	4	136	4	136	4	136	4	136	4	136
W21-1	WORKERS (symbol)	48" x 48"	34	1	34	1	34	1	34	1	34	1	34
W21-2	FRESH OIL	36" x 36"	27	2	54	2	54	2	54	2	54	2	54
G20-1	ROAD WORK NEXT __ MILES	36" x 18"	17	2	34	2	34	2	34	2	34	2	34
G20-2	END ROAD WORK	36" x 18"	17	11	187	11	187	8	136	4	68	4	68
SPECIAL	REDUCE SPEED LOOSE GRAVEL NEXT XX MILES	36" x 48"	29	2	58	2	58	2	58	2	58	2	58
TOTAL UNITS					1081		1013		860		656		656

Standard traffic control signs, not listed in the above table, ordered by the Engineer will be paid at that sign's respective "unit per sign" value as listed in the Department's complete Standard Sign List. A copy of the Standard Sign list is available upon request from the Winner Area Office.

Revised 01-26-2015 JDH

TABLE OF QUANTITIES BY ROUTE (FOR INFORMATION ONLY) PCN 0573

BID ITEM NUMBER	ITEM	TOTAL	UNIT
009E0010	Mobilization	**Lump Sum**	**LS**
330E0300	SS-1h or CSS-1h Asphalt for Fog Seal	**23.8**	**Ton**
330E3000	Sand for Flush Seal	**5.0**	**Ton**
360E0020	AE 150S Asphalt for Surface Treatment	**119.8**	**Ton**
360E1200	Modified Cover Aggregate – Norris Road	**1084.5**	**Ton**
633E1300	Pavement Marking Paint, White	**208**	**Gal**
633E1305	Pavement Marking Paint, Yellow	**74**	**Gal**
634E0010	Flagging	**78**	**Hour**
634E0020	Pilot Car	**18**	**Hour**
634E0100	Traffic Control	**758**	**Unit**
634E0120	Traffic Control, Miscellaneous	**Lump Sum**	**LS**
634E0630	Temporary Pavement Marking	**12.324**	**Mile**

ITEMIZED LIST FOR TRAFFIC CONTROL – PCN 0573

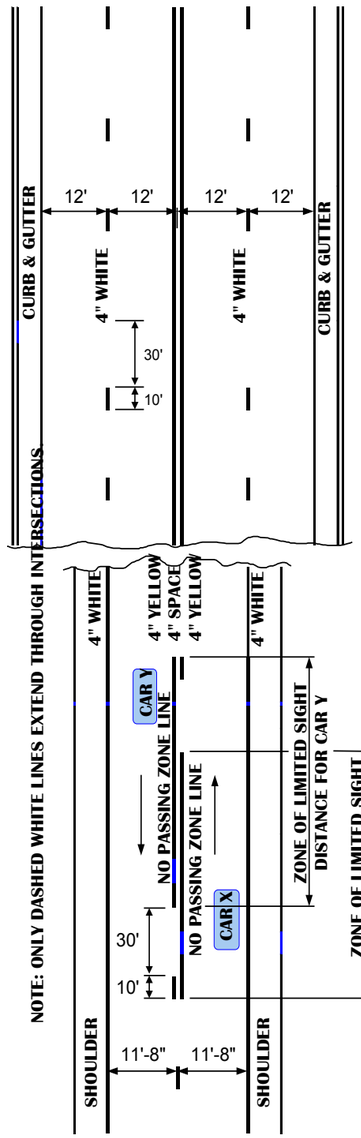
SIGN CODE	DESCRIPTION	NUMBER	SIGN SIZE	UNITS PER SIGN	UNITS
W3-4	BE PREPARED TO STOP	1	48" x 48"	34	34
W8-6	TRUCK CROSSING	2	48" x 48"	34	68
W20-1	ROAD WORK AHEAD	5	48" x 48"	34	170
W20-4	ONE LANE ROAD AHEAD	2	48" x 48"	34	68
W20-7	FLAGGER (symbol)	4	48" x 48"	34	136
W21-1	WORKERS (symbol)	1	48" x 48"	34	34
W21-2	FRESH OIL	2	36" x 36"	27	54
G20-1	ROAD WORK NEXT __ MILES	2	36" x 18"	17	34
G20-2	END ROAD WORK	6	36" x 18"	17	102
SPECIAL	REDUCE SPEED LOOSE GRAVEL NEXT XX MILES	2	36" x 48"	29	58
				TOTAL UNITS	**758**

Standard traffic control signs, not listed in the above table, ordered by the Engineer will be paid at that sign's respective "unit per sign" value as listed in the Department's complete Standard Sign List. A copy of the Standard Sign list is available upon request from the Winner Area Office.

STATE OF SOUTH DAKOTA	PROJECT	SHEET NO.	TOTAL SHEETS
	P 0033(20), P 6063(03)	25	34

FURNISHING AND APPLYING PAVEMENT MARKING PAINT

UNDIVIDED ROADWAY



1. Pavement marking paint and glass beads will be furnished and applied by the Contractor. Material shall meet the requirements of Section 980 and 981 of the Specifications. The bead application rate shall be 8 pounds per gallon of paint.

2. Construction requirements, methods of measurement and basis of payment shall conform to the requirements of Section 633 of the Specifications and the Supplemental Specifications.

3. Approximate paint application rates shall be as follows:

Four Lane Roadway (Rates for one line)	**Two Lane Roadway**
Solid Yellow Centerline Rate = 16.90 Gals./Pass-Mile	Yellow Centerline (Includes No Passing Zones) Rate = 12± Gals./Pass-Mile
Dashed White Laneline Rate = 4.60 Gals./Pass-Mile	Solid White Edgeline (Rate for one line) Rate = 16.90 Gals./Pass-Mile
Solid White Edgeline (Not applicable in curb & gutter section) Rate = 16.90 Gals./Pass-Mile	

4. Typical pavement marking as shown on this sheet shall be applied throughout the entire length of undivided roadway.

5. Exact location of NO PASSING ZONE lines will be determined in the field by the Engineer. A dash of white paint will mark the beginning and end of all no passing zones. NO PASSING ZONE signs and the ending post in fence lines, if present, shall not be used as the beginning and ending of NO PASSING ZONE lines.

6. Traffic Control shall be incidental to the cost of application. The striper and advance or trailing warning vehicle shall be equipped with flashing amber lights or advance warning arrow panel.

ESTIMATED QUANTITIES

PAVEMENT MARKING PAINT	PCN 048C	PCN 0573	
WHITE	2789	208	Gal.
YELLOW	991	74	Gal.
TOTAL	3780	282	Gal.

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	26	34

Plotting Date: 01/16/2015

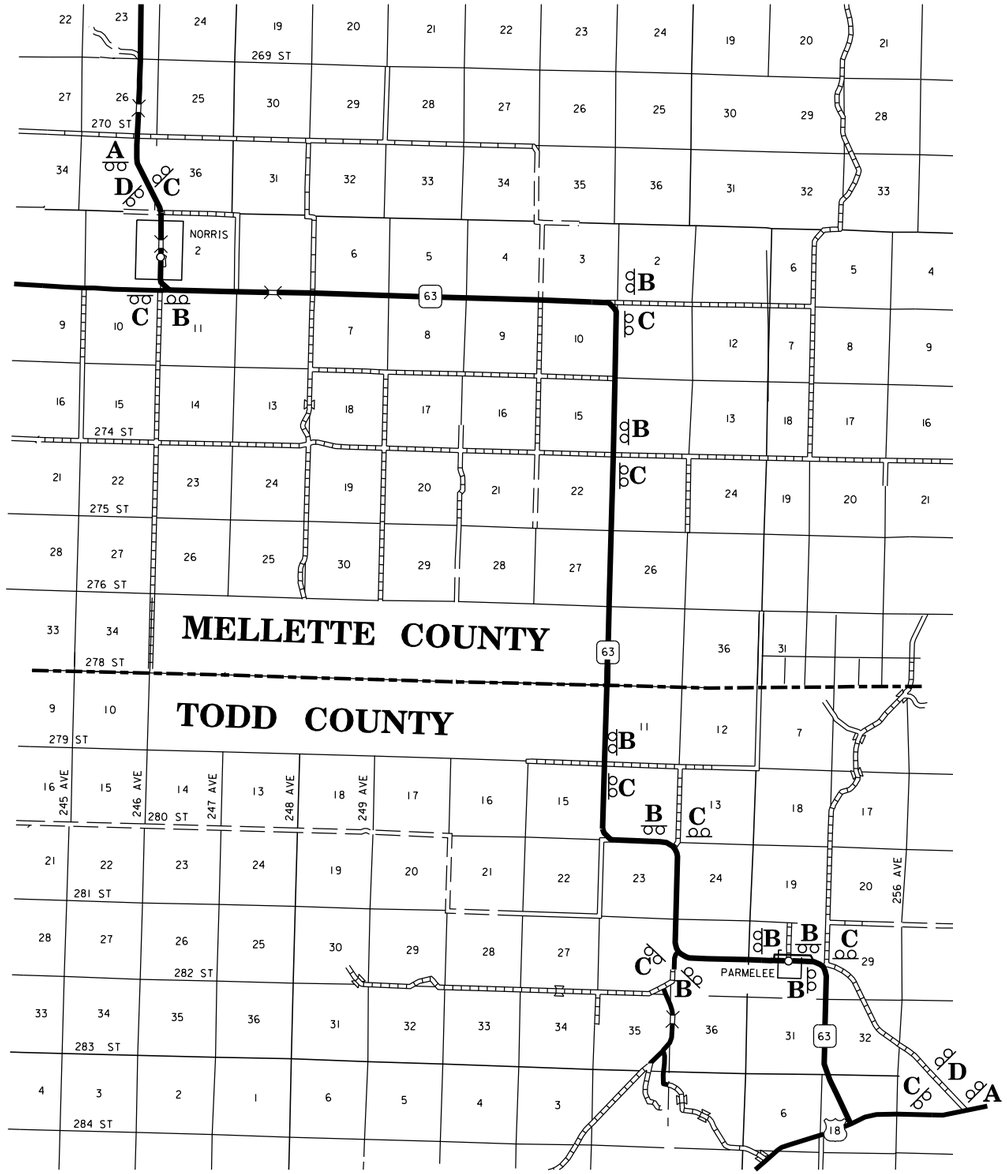
FIXED LOCATION SIGNS
SD 63 – MELLETTE AND TODD COUNTIES
ROUTE #1

A = ROAD WORK NEXT 21 MILES
G20-1
(48"X24")

B = ROAD WORK AHEAD
W 20-1
(48"X48")

C = END ROAD WORK
G20-2
(36"x18")

D = REDUCE SPEED LOOSE GRAVEL NEXT 21 MILES
"SPECIAL"
(36"x48")



NOTES:

SIGN LOCATIONS WILL BE VERIFIED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION

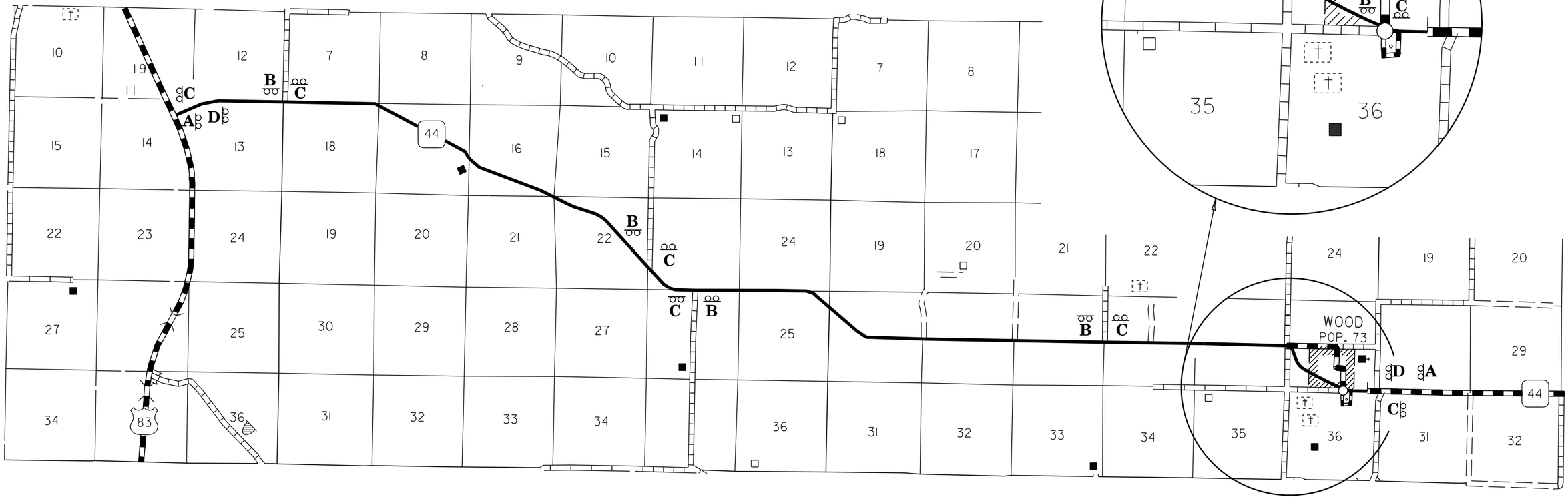
FIXED LOCATION SIGNS TO REMAIN IN PLACE UNTIL THE COMPLETION OF THE PERMANENT PAVEMENT MARKINGS.

PLOT SCALE - 1.15369.8
PLOT NAME - 10
PLOTTED FROM - TRW1INT23
FILE - ...\WORKING\048CLAYOUT.DGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	27	34

Plotting Date: 01/16/2015

FIXED LOCATION SIGNS
SD44 – MELLETTE COUNTY
ROUTE #2



NOTES:

SIGN LOCATIONS WILL BE VERIFIED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION

FIXED LOCATION SIGNS TO REMAIN IN PLACE UNTIL THE COMPLETION OF THE PERMANENT PAVEMENT MARKINGS.

A = ROAD WORK NEXT 19 MILES — G20-1 (48"X24")

B = ROAD WORK AHEAD — W 20-1 (48"X48")

C = END ROAD WORK — G20-2 (36"x18")

D = REDUCE SPEED LOOSE GRAVEL NEXT 17 MILES — "SPECIAL" (36"x48")

PLOT SCALE - 1:15369.8

PLOTTED FROM - TRWLINT23

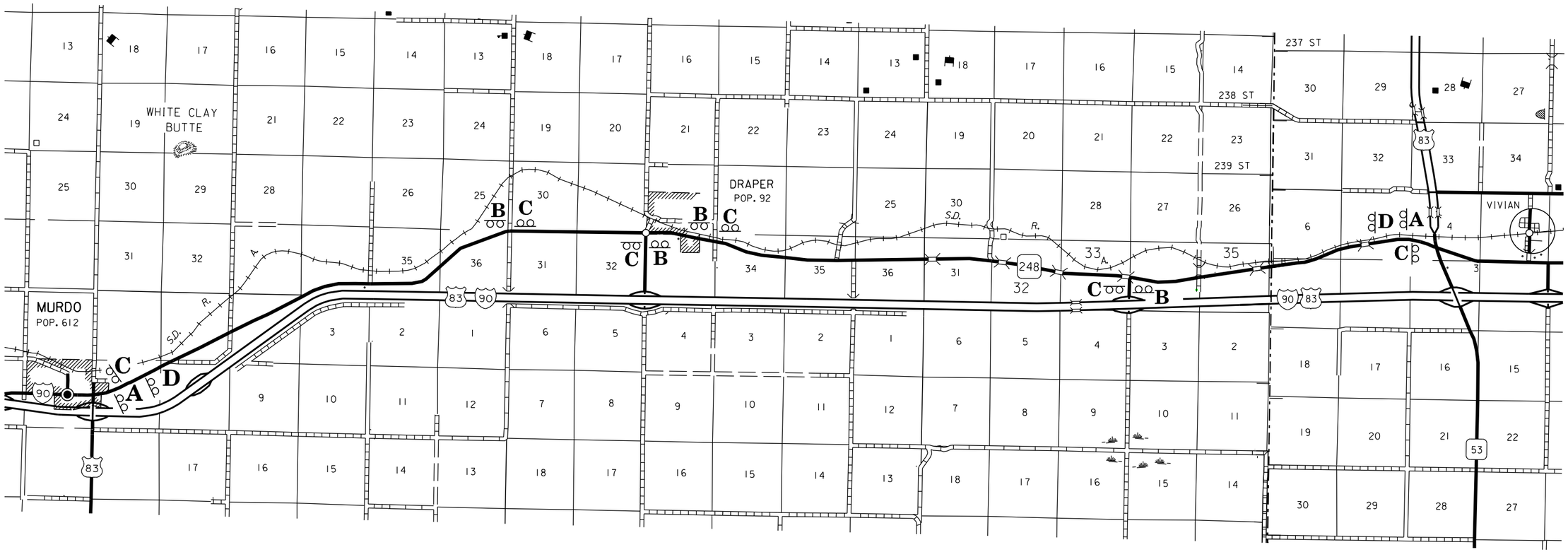
PLOT NAME - 18

FILE - ...\WORKING\048CLAYOUT.DGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	28	34

Plotting Date: 01/16/2015

FIXED LOCATION SIGNS
SD 248 – JONES AND LYMAN COUNTIES
ROUTE #3



NOTES:

SIGN LOCATIONS WILL BE VERIFIED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION

FIXED LOCATION SIGNS TO REMAIN IN PLACE UNTIL THE COMPLETION OF THE PERMANENT PAVEMENT MARKINGS.

A = ROAD WORK NEXT 19 MILES
G20-1 (48"X24")

B = ROAD WORK AHEAD
W 20-1 (48"x48")

C = END ROAD WORK
G20-2 (36"x18")

D = REDUCE SPEED LOOSE GRAVEL NEXT 19 MILES
"SPECIAL" (36"x48")

PLOT SCALE - 1:15369.8

PLOTTED FROM - TRWIN123

PLOT NAME - 8

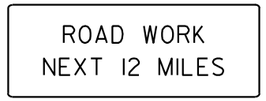
FILE - ...\WORKING\248CLAYOUT.DGN

STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 0063(03)	29	34

Plotting Date: 01/16/2015

FIXED LOCATION SIGNS
SD 49 – TRIPP & LYMAN COUNTIES
ROUTE #4

A =

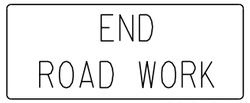


G20-1
(48"X24")

B =

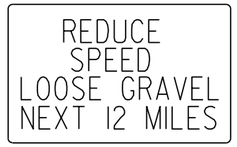
W 20-1
(48"X48")

C =

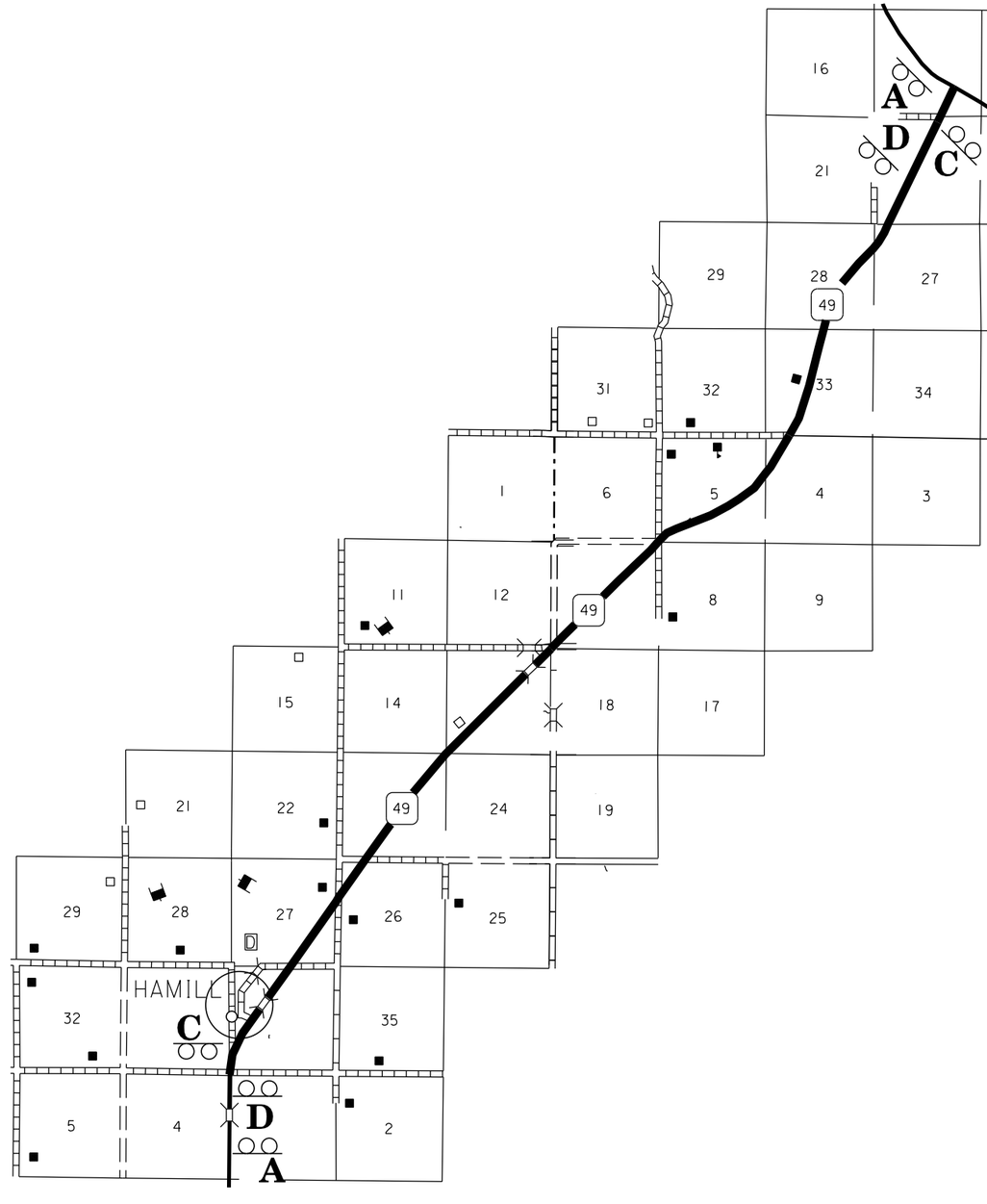


G20-2
(36"X18")

D =



"SPECIAL"
(36"X48")



NOTES:

SIGN LOCATIONS WILL BE VERIFIED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION

FIXED LOCATION SIGNS TO REMAIN IN PLACE UNTIL THE COMPLETION OF THE PERMANENT PAVEMENT MARKINGS.

PLOT SCALE - 1:15369.8

PLOTTED FROM - TRWLINT23

PLOT NAME - 16

FILE - ...\WORKING\048CLAYOUT.DGN

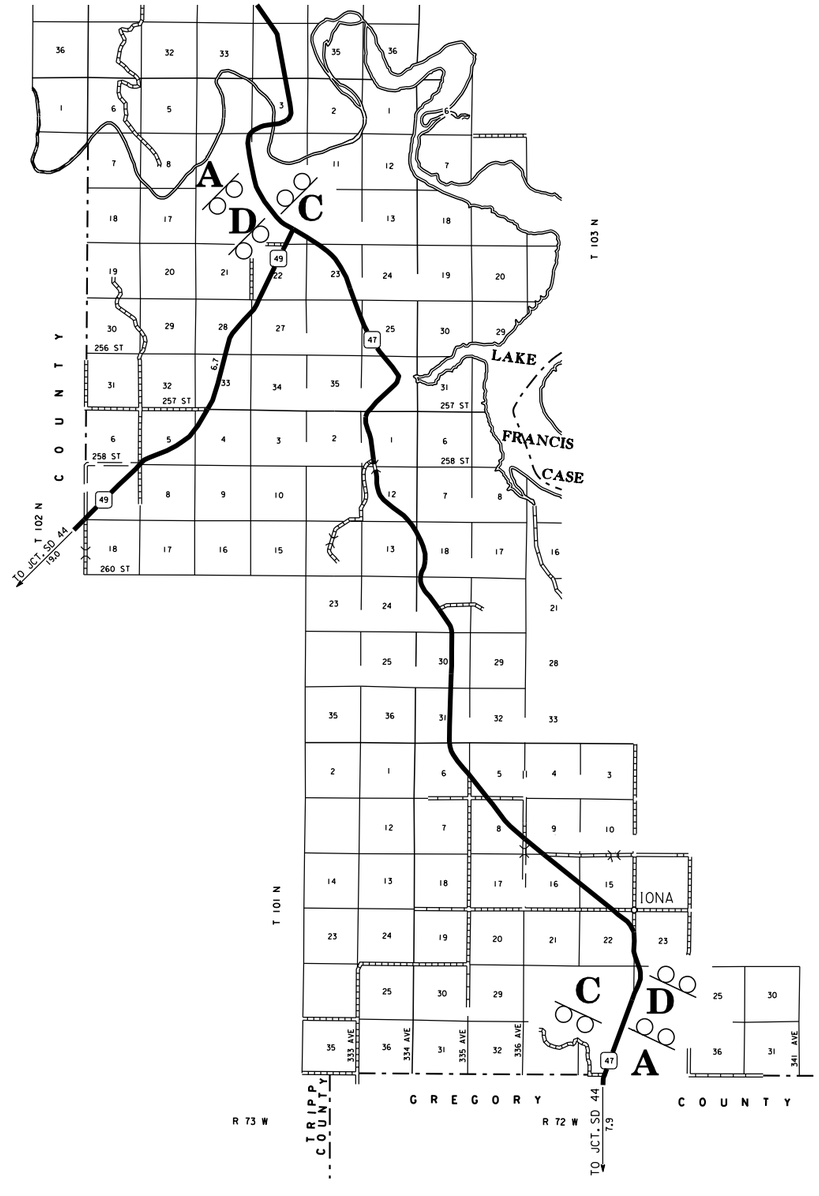
FIXED LOCATION SIGNS
SD 47 – LYMAN COUNTY
ROUTE #5

A = ROAD WORK NEXT 14 MILES
G20-1
(48"X24")

B = ROAD WORK AHEAD
W 20-1
(48"x48")

C = END ROAD WORK
G20-2
(36"x18")

D = REDUCE SPEED LOOSE GRAVEL NEXT 14 MILES
"SPECIAL"
(36"x48")



NOTES:

SIGN LOCATIONS WILL BE VERIFIED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION

FIXED LOCATION SIGNS TO REMAIN IN PLACE UNTIL THE COMPLETION OF THE PERMANENT PAVEMENT MARKINGS.

PLOT SCALE - 1.15369.8

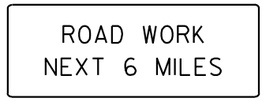
PLOTTED FROM - TRW1INT23

PLOT NAME - 14

FILE - ...\WORKING\048CLAYOUT.DGN

FIXED LOCATION SIGNS
NORRIS ROAD – MELLETTE COUNTY
ROUTE #6

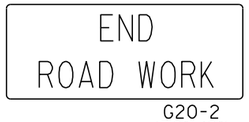
A =



G20-1
(48"X24")

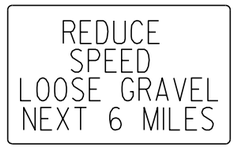
B =

C =

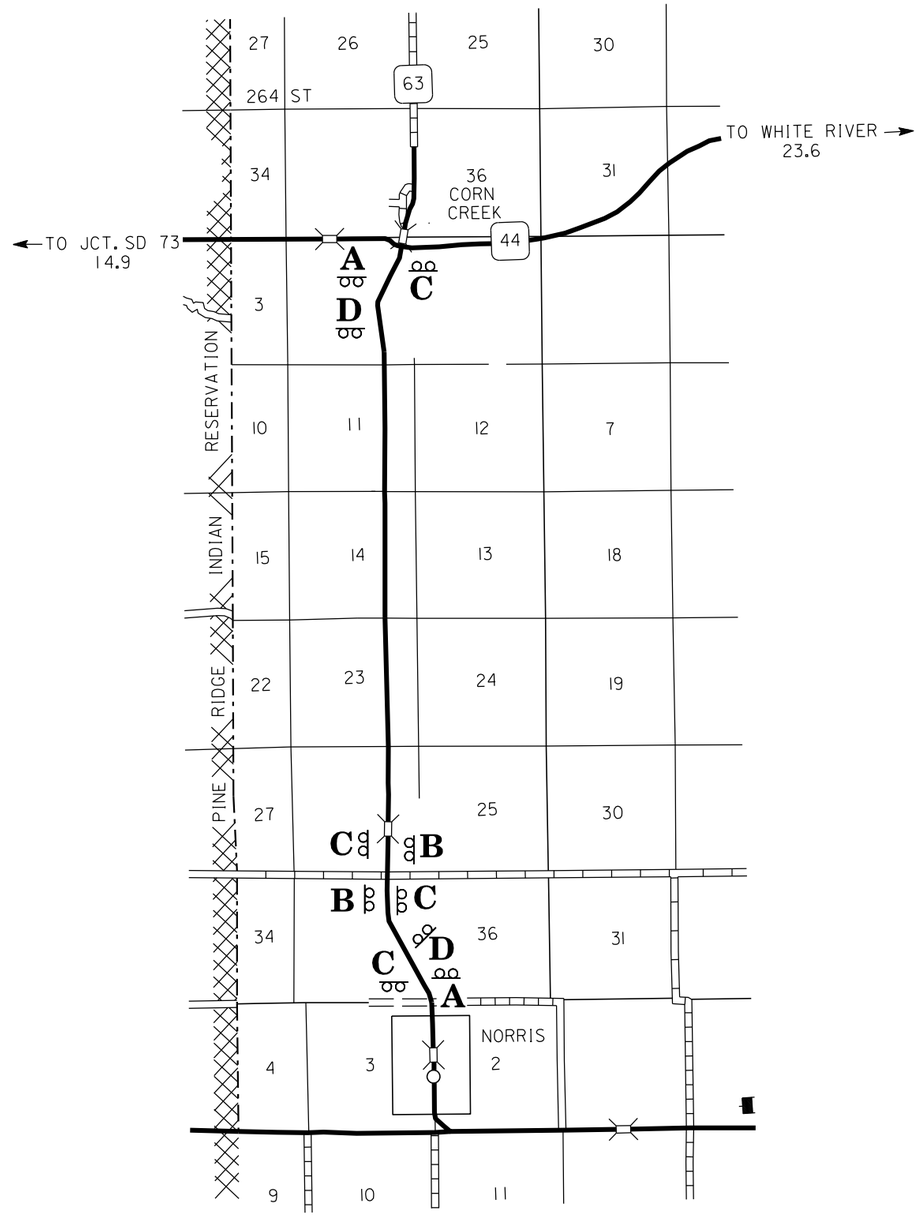


G20-2
(36"X18")

D =



"SPECIAL"
(36"X48")

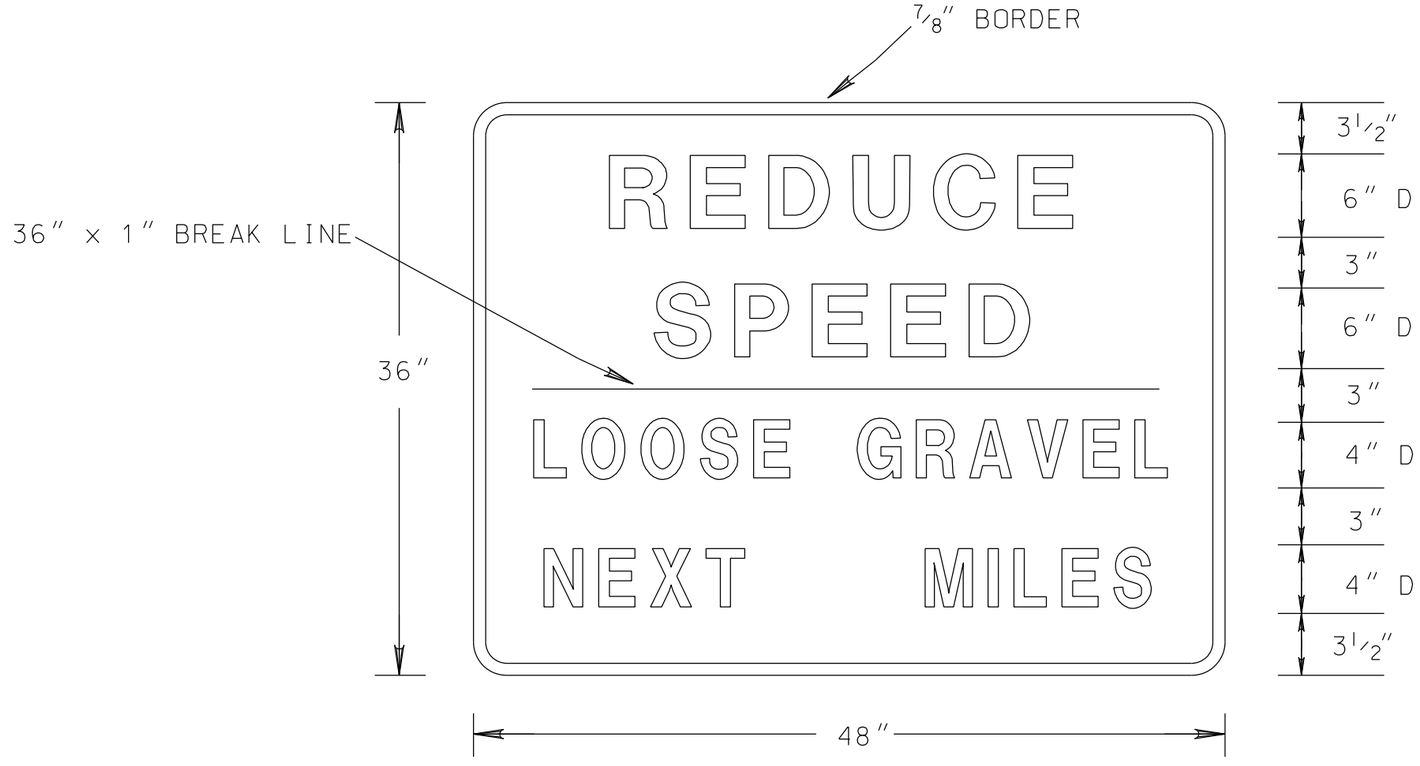


NOTES:

SIGN LOCATIONS WILL BE VERIFIED IN THE FIELD BY THE ENGINEER PRIOR TO INSTALLATION

FIXED LOCATION SIGNS TO REMAIN IN PLACE UNTIL THE COMPLETION OF THE PERMANENT PAVEMENT MARKINGS.

SPECIAL SIGN DETAIL



LEGEND - BLACK (NON-REFLECTORIZED)
BACKGROUND - ORANGE (ASTM D4956 TYPE XI SHEETING)
SIGN BLANK - 0.100" ALUMINUM

NOTE: QUANTITY IS INCLUDED AS SPECIAL SIGN IN THE SIGN TABULATION.

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.

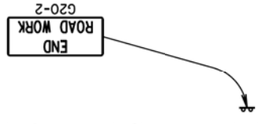
The ROAD WORK AHEAD and the END ROAD WORK signs may be omitted for short duration operations (1 hour or less).

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.

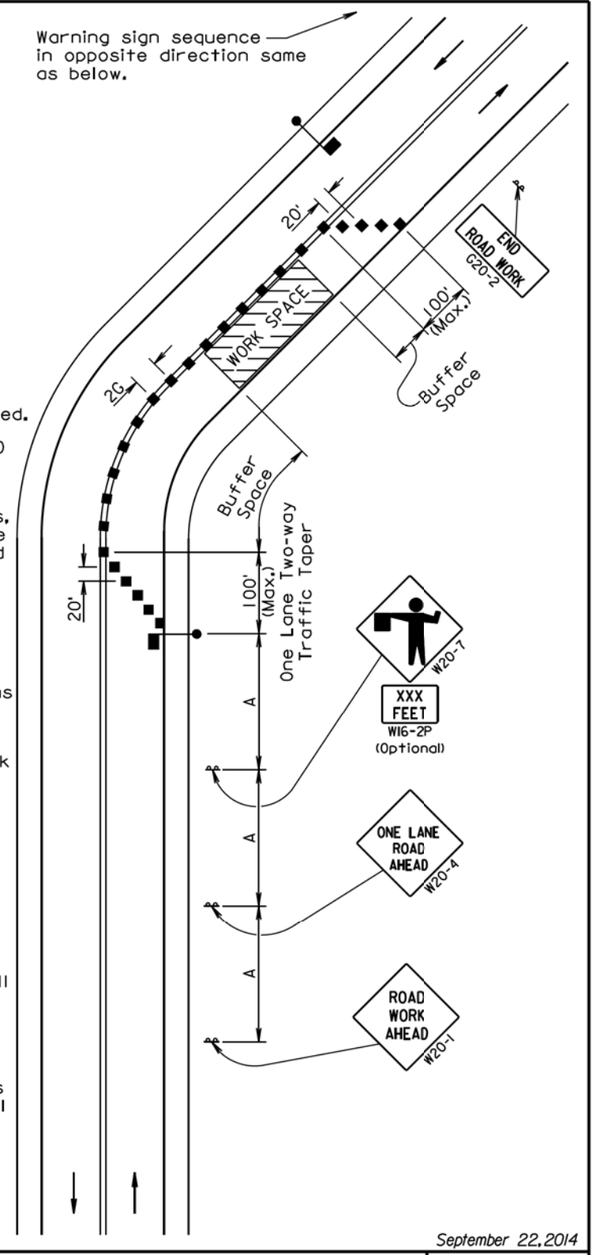
Channelizing devices are not required along the centerline adjacent to work area when pilot cars are utilized for escorting traffic through the work area.



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

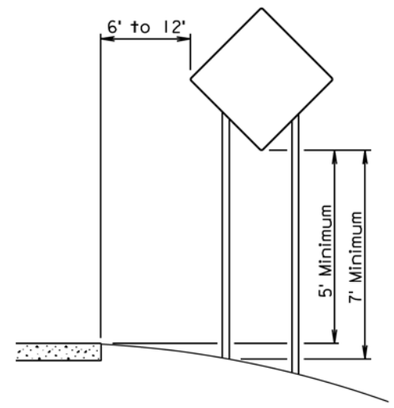
The buffer space should be extended so that the two-way traffic taper is placed before a horizontal or vertical curve to provide adequate sight distance for the flagger and queue of stopped vehicles.

The length of A may be adjusted to fit field conditions.

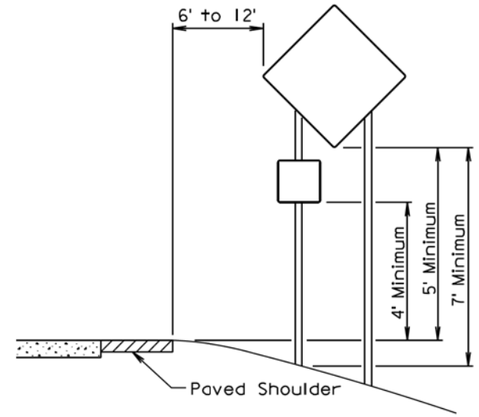


September 22,2014

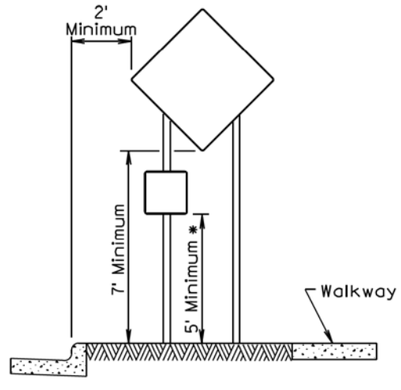
Published Date: 4th Qtr. 2014	SDDOT	GUIDES FOR TRAFFIC CONTROL DEVICES LANE CLOSURE WITH FLAGGER PROVIDED	PLATE NUMBER 634.23
			Sheet 1 of 1



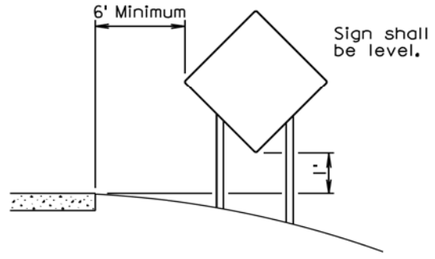
RURAL DISTRICT



RURAL DISTRICT WITH SUPPLEMENTAL PLATE



URBAN DISTRICT



RURAL DISTRICT
3 DAY MAXIMUM
(Not applicable to regulatory signs)

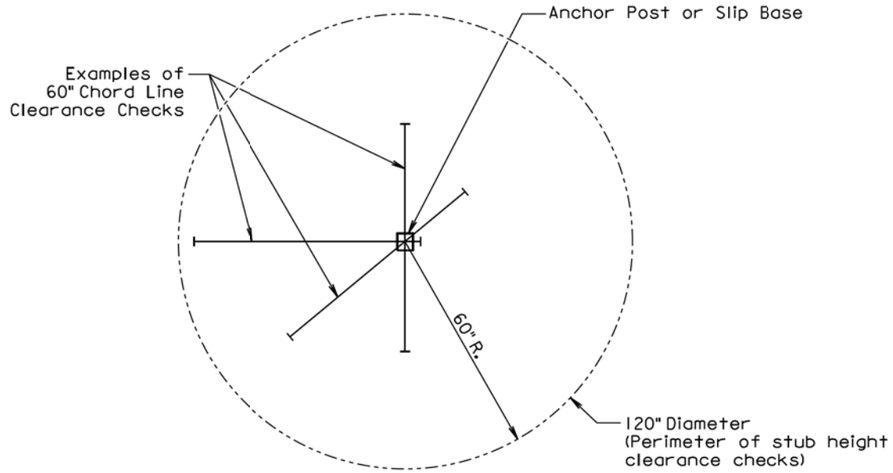
* If the bottom of supplemental plate is mounted lower than 7 feet above a pedestrian walkway, the supplemental plate should not project more than 4" into the pedestrian facility.

September 22,2014

Published Date: 4th Qtr. 2014	SDDOT	CRASHWORTHY SIGN SUPPORTS (Typical Construction Signing)	PLATE NUMBER 634.85
			Sheet 1 of 1

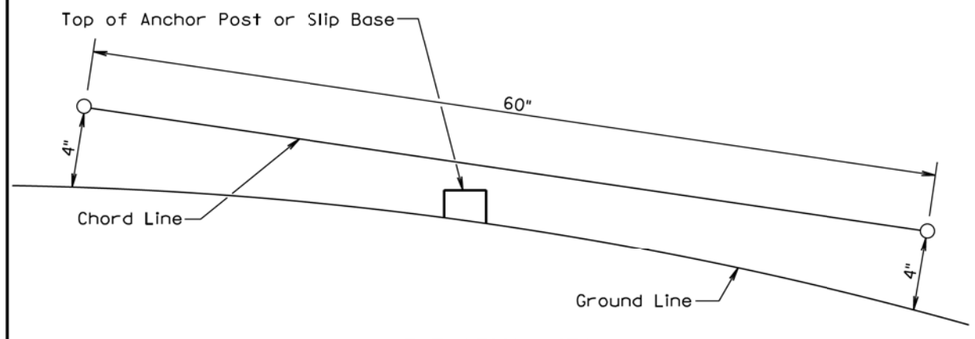
STATE OF SOUTH DAKOTA	PROJECT	SHEET	TOTAL SHEETS
	P 0033(20), P 6063(03)	34	34

Plotting Date: 01/16/2015



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: 4th Qtr. 2014	**SDDOT**	***BREAKAWAY SUPPORT STUB CLEARANCE***	***PLATE NUMBER*** 634.99
			Sheet 1 of 1

Plot Scale - 1:200

- Plotted From - tvvi1n23

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