

RESEARCH REPORT DOCUMENTATION PAGE

1. Report No. ND 94-07	2. Report Date December 2001	3. Contract No. N/A	4. Project No. IM-8-094(005)331
5. Title and Subtitle Optical Camera In Edge Drains		6. Report Type Work Plan <input type="checkbox"/> Construction <input type="checkbox"/> Evaluation <input type="checkbox"/> <u>Final</u> <input checked="" type="checkbox"/>	7. Project No. 8. Project No. 9. Project No. 10. Project No.
11. Author(s)/Principle Investigator(s) Curt Dunn, Tom Bold, Mike Marquart			
12. Performing Organization Name and Address NDDOT M+R <input checked="" type="checkbox"/> North Dakota DOT NDDOT OTHER* <input type="checkbox"/> Materials and Research Division NDSU <input type="checkbox"/> 300 Airport Road UND <input type="checkbox"/> Bismarck ND 58504-6005 UGPTI <input type="checkbox"/> OTHER* <input type="checkbox"/> *see supplementary notes		13. Sponsoring Agency Name and Address North Dakota DOT Materials and Research Division 300 Airport Road Bismarck ND 58504-6005	
14. Supplementary Notes			
15. Abstract Purpose and Need Along with proper surface drainage practices, provisions are needed to provide proper subsurface drainage for the removal of water from underneath the road surface. The North Dakota Department of Transportation (NDDOT), along with many other states, have utilized longitudinal underdrains (edge drains) to collect and dispose of water from the underlying pavement structure directly beneath the roadbed to eliminate moisture related pavement distress. Objective In order to evaluate the effectiveness and long-term operation of these edge drains, an optical camera was obtained to observe the interior of the edge drain piping. In performing the annual inspection of the edge drain systems, an evaluation of the optical camera system was also conducted to determine its performance and usefulness as a diagnostic tool for other applications. Scope The NDDOT has set aside a select group of edge drains along a portion of interstate in North Dakota as an experimental study. The experimental project is located on I-94 (eastbound) in Cass County. This study will monitor the performance and effectiveness of the edge drain system by use of the optical camera annually with a final report in the fifth year. Items evaluated are: -Amount of fines being carried into the edge drains -Flushing capability of the fines -Condition of the drain pipes Summary In general the edge drains appear to be functioning properly with little internal restriction from collected sediment or other foreign material. The edge drain systems evaluated show that 26 of the 38 (68.4%) had no change or a decrease in the amount of sediment observed. The evaluation history indicates that most increases in observed sediment occurred in the first two years of service and continues to decrease in amount. Of those systems indicating an increase in sediment, it should be noted that the increase is generally small and is not presenting any performance problems. Other items such as the intrusion of rodents into the drain system, punctures and/or protrusions in the pipes, plant roots, and sags in the pipes; although degrading the overall condition of the edge drain system, do not appear to be presenting any problems. The clogging of concrete headwall outlets with hay and other matter may create performance problems. Grass clippings should be removed for optimum operation of the edge drain systems. The source of the damage to the rodent screens appears to be NDDOT mowers. Edge drain concrete headwalls used on current projects utilize a different rodent screen design. This new design is less susceptible to the type of damage observed on this project. The condition of the rodent screens should be monitored and repairs performed as required. The optical camera system used to inspect the edge drains continues to work well with little or no difficulty in operation. Since acquired by the NDDOT, the camera system has been utilized by Materials and Research Division personnel for the evaluation of experimental projects. District personnel from around the state have used it to evaluate newly constructed pavement edge drain systems, slide area drainage systems, roadway culverts, and storm drainage systems. Materials and Research personnel have performed general maintenance on the camera system. Maintenance operations consist of general cleaning and lubrication of camera head contacts and fittings. Miniature light bulbs, which act as the light source for the camera in the absence of natural light, are replaced when they have been damaged or fail. Replacement bulbs, (approximately \$1.70 per bulb), are somewhat difficult to replace; however, using proper tools, this operation also is performed by Materials and Research personnel. Color-coded tape was applied to the 300' cable to indicate the position of the camera when "snaking" the camera through a pipe. Due to the adverse conditions (water, grit, etc.) in which the camera operates, this tape must occasionally be replaced. Recommendations: The condition of the headwall area is critical to the performance of the edge drain systems. The headwall should be kept clear of grass clippings and other debris. Damaged rodent screens should be repaired to prevent rodents from entering the edge drain system. The optical camera system has been very reliable, and easy to operate. District personnel continue to use it regularly to inspect new construction of drainage systems. The camera has proven to be a valuable inspection and diagnostic tool.			
16. Key Words Drainage Pipes Plastic	17. Distribution Statement No restrictions. This document is available to the public from: North Dakota Department of Transportation Materials and Research Division: 300 Airport Road Bismarck ND 58504-6005 Office: (701) 328-6900		18. No. of Pages 31 19. File type/Size Pdf / 0.8 mb

**NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION**

**MATERIALS AND RESEARCH
DIVISION**

Experimental Study ND 94-07

**Scoping Edge Drains with
an Optical Camera**

Final Report

Project IM-8-094(005)331

December, 2001

Prepared by
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

BISMARCK, NORTH DAKOTA
Website: <http://www.discovernd.com/dot/>

DIRECTOR
Dave Sprynczynatyk

MATERIALS AND RESEARCH DIVISION
Ron Horner

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

EXPERIMENTAL PROJECT REPORT

EXPERIMENTAL PROJECT	EXPERIMENTAL PROJECT NO.					CONSTRUCTION PROJ NO	LOCATION					
	1	STATE ND	YEAR 94	-	NUMBER 07	IM-8-094(005)331 8	Cass County 28					
SHORT TITLE	EVALUATION FUNDING						NEEP NO.	PROPRIETARY FEATURE?				
	48	1 X HP&R		3	DEMONSTRATION		<input type="checkbox"/>	Yes				
	2	CONSTRUCTION		4	IMPLEMENTATION		49	51 X No				
THIS FORM	DATE MO. YR.				REPORTING							
	140	1	2	-	2	0	0	1				
					1	INITIAL	2	ANNUAL				
							3	X FINAL				
KEY WORDS	KEY WORD 1				KEY WORD 2							
	145 DRAINAGE				167 PIPES							
	KEY WORD 3				KEY WORD 4							
	189 Plastic				211							
	UNIQUE WORD				PROPRIETARY FEATURE NAME							
	233				255							
CHRONOLOGY	Date Work Plan Approved		Date Feature Constructed:		Evaluation Scheduled Until:		Evaluation Extended Until:		Date Evaluation Terminated:			
	02-94		09-94		09-99				12-2001			
	277		281		285		289		293			
QUANTITY AND COST	QUANTITY OF UNITS				UNITS				UNIT COST (Dollars, Cents)			
	<input type="text" value="01"/>				1 X LIN. FT 5 TON 2 SY 6 LBS 3 SY-IN 7 EACH 4 CY 8 LUMP SUM				<input type="text" value="30000.0"/>			
	297				305				306			
AVAILABLE EVALUATION REPORTS	X CONSTRUCTION				X PERFORMANCE				X FINAL			
	315											
EVALUATION	CONSTRUCTION PROBLEMS					PERFORMANCE						
	1	NONE				1	EXCELLENT					
	2 X	SLIGHT				2	GOOD					
	3	MODERATE				3	SATISFACTORY					
	4	SIGNIFICANT				4	MARGINAL					
318	5	SEVERE				5	UNSATISFACTORY					
APPLICATION	1 ADOPTED AS PRIMARY STD.		4 PENDING		(Explain in remarks if 3, 4, 5, or 6 is checked)							
	2 PERMITTED ALTERNATIVE		5 REJECTED									
320	3 ADOPTED CONDITIONALLY		6 NOT CONSTRUCTED									
REMARKS	321 In general the edge drains are in good condition both structurally and internally. The sediment material that has occurred in most of the edge drains, in the first two years of service is continuing to decrease in amount and is not presenting any performance problems. Proper maintenance of the headwall is necessary to keep the system operating. The optical camera system has been very reliable and is an invaluable tool to evaluate drain systems.700											

Experimental Study ND 94-07

**Scoping Edge Drains with
an Optical Camera**

FINAL REPORT

Project IM-8-094(005)331

November 1999

Written by
Curt Dunn/Tom Bold

Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

TABLE OF CONTENTS

Objective	1
Scope	1
Location	2
Design	3
Construction	3
Evaluation	4
Summary	19
Recommendations	20
Appendix A: Construction Plans	A-1
Appendix B: Standard Specification	B-1

SCOPING EDGE DRAINS WITH AN OPTICAL CAMERA

Objective

Along with proper surface drainage practices, provisions are needed to provide proper subsurface drainage for the removal of water from underneath the road surface. The North Dakota Department of Transportation (NDDOT), along with many other states, have utilized longitudinal underdrains (edge drains) to collect and dispose of water from the underlying pavement structure directly beneath the roadbed to eliminate moisture related pavement distress. In order to evaluate the effectiveness and long term operation of these edge drains, an optical camera was obtained to observe the interior of the edge drain piping. In performing the annual inspection of the edge drain systems, an evaluation of the optical camera system was also conducted to determine its performance and usefulness as a diagnostic tool for other applications.

Scope

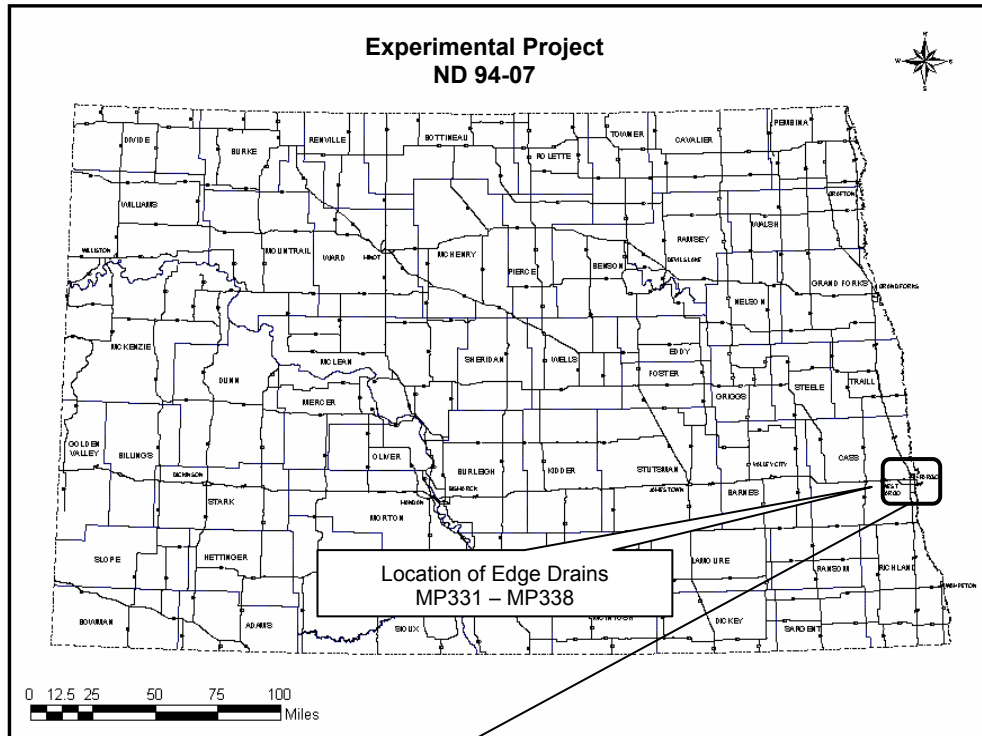
The NDDOT has set aside a select group of edge drains along a portion of interstate in North Dakota as an experimental study. This study will monitor the performance and effectiveness of the edge drain system by use of the optical camera.

Items evaluated are:

- Amount of fines being carried into the edge drains
- Flushing capability of the fines
- Condition of the drain pipes

Location

Experimental project ND 94-07 is located on I-94 (eastbound) in Cass County. It was constructed in conjunction with project # IM-8-094(005)331, (MP331.042 to MP 338.630), from the Casselton Interchange to the Mapleton Interchange. The points of interest related to the edge drain inspection are located between Mile Points 331 and 338.



Design

According to the plans, the edge drains were to run parallel to the roadway for a distance of 250' (please refer to Appendix A). The pipe then turns perpendicular to the roadway drains into the existing ditch. The other end of the drain pipe is capped to prevent foreign objects from entering the pipe.

Construction

The main contractor for project IM-8-094(005)331 was Progressive Contractors Incorporated (PCI). The construction and installation of the edge drains was subcontracted to Weisz & Sons, based out of Bismarck, North Dakota.

The Materials and Research evaluation team visited the project site on November 3, 1994. A random inspection of the system to evaluate the condition of the drain pipes after the installation of the edge drain system was conducted.

The installation of the edge drains conformed to Section 714 of the North Dakota Department of Transportation Supplemental Specifications. A copy of this specification is included in appendix B.

An alteration was made in the field so that the edge drains would run continually along the roadway at 500' intervals with lateral outlet pipes on each end. This practice may prove to be an advantage for maintenance.

Evaluation

To conduct this inspection, a color flexiprobe inspection system manufactured by Pearpoint Inc. was used, consisting of a P217 color optical camera, a color monitoring unit, and a 300' rod/cable dispenser. Photo 1



Photo 1: View of the P217 color optical camera.

Photo 1 depicts the P217 color optical camera. The diameter of the camera is about 1½". This enables the camera to enter into pipes that are small in diameter, such as the 4" edge drain pipes. It can also be used on larger diameter pipes when equipped with skids. This camera is equipped with several small lights that make a ring around the camera lens. The camera is designed to give high quality pictures with a minimum of light.

The evaluation team conducted the fifth annual inspection of the edge drain system on October 19th and 20th, 1999. The weather conditions during the inspection were dry and sunny with high winds on the 20th.

Table 1, (page 5), shows the selected station points where edge drains were inspected, along with a brief description indicating the absence or presence of fines and the general condition of the drain pipe in question. The evaluation results are shown for the years 1995 through 2001.

Please note that at each station there are two outlet pipes side by side. The table makes reference to an east (E) outlet pipe and a west (W) outlet pipe. The station number is followed by a 'Rt' or a 'Lt'. This indicates whether the station point is on the right side of the roadway or the left side (median side) of the roadway.

Table 1.

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
865+60Rt W	1995	Clear	Pipe blocked at 140' by guardrail post. Detected some gravel in pipe. No indication of water in the pipe.
	1996	Some sediment in low areas.	Pipe blocked at 140' by guardrail post. Functioning Properly.
	1997	Some sediment in low areas.	Pipe blocked at 140' by guardrail post. Functioning Properly.
	1998	Very little sediment	Pipe blocked at 140' by guardrail post. Some ponding at the outlet pipe. Functioning Properly.
	1999	Some sediment	Pipe blocked at 140' by guardrail post. Pipe and headwall damp. Functioning Properly.
865+60Rt E	1995	Clear	Functioning Properly.
	1996	Some sediment @ 40'-80'.	Functioning Properly.
	1997	Some sediment in low areas.	Functioning Properly. Some water ponded near the outlet.
	1998	Very little sediment	Functioning Properly. Some ponding at the outlet pipe.
	1999	Some sediment	Pipe and headwall damp. Back edge of headwall slightly lower than front, possible damming of water. Functioning Properly.

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
880+50Lt W	1995	Detected some sediment 120' into pipe.	Functioning Properly.
	1996	Clear	Functioning Properly, except for a mouse nest lodged in pipe.
	1997	Clear	Functioning Properly, some evidence of a mouse nest. Rodents still present in the pipe.
	1998	Clear	Functioning Properly, no evidence of any rodents or rodent nests.
	1999	Clear	Pipe and headwall damp. Headwall clean, some grass behind rodent screen.
880+50Lt E	1995	Clear	Water standing in pipe at 240'.
	1996	Clear	Pipe dry and evidence of drainage in the past.
	1997	Clear	Functioning Properly. Pipe is dry. Some small dents in bottom of pipe.
	1998	Clear	Functioning Properly. Some ponding around the outlet pipe.
	1999	Clear	Water up to 1 ½" deep in pipe near radius. Some grass behind rodent screen.
980+50Rt W	1995	Clear	Functioning Properly. No indication of water in the pipe.
	1996	Detected some sediment.	Functioning Properly.
	1997	Very little sediment detected.	Functioning Properly. Encountered a rodent nest.
	1998	Clear	Functioning Properly. Some ponding.
	1999	Clear	¾" water in pipe. Headwall dry and clean.
980+50Rt E	1995	Clear	At 115' pipe appears restricted, pipe squeezed together. Able to pass camera thru.
	1996	Clear	Mouse nest at 20', cannot penetrate it.
	1997	Some sediment caked on sides of pipe.	Functioning Properly. Encountered a rodent nest. Evidence of flow lines suggests pipe was flowing 1/3 to ½ full at one time.
	1998	Clear	Functioning Properly. No evidence of any rodent nest previously detected last year.
	1999	Clear	½" water in pipe. Headwall dry, rodent nest in pipe.

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
996+00Rt W	1995	Detected some sediment (maybe dirt) @ 240.	Pipe has 1½" of water in it. Optical camera was not pushed all the way through due to obstruction.
	1996	Clear	Pipe is dry and appears to have been draining, however, prior condition still exists.
	1997	Very little sediment detected.	Functioning Properly.
	1998	Very little sediment detected.	Functioning Properly. Some ponding in low areas.
	1999	Some sediment	Pipe dry. Headwall clean and dry.
996+00Rt E	1995	Clear	Functioning Properly.
	1996	Detected some sediment in bottom around the radius of the pipe	Pipe is draining. Evidence in spots of water being 1/3 to ½ full at one time due to dried sediment stuck to the walls of the pipe.
	1997	.Clear	Functioning Properly. Evidence of flow lines suggests pipe was flowing 1/3 to ½ full at one time.
	1998	Clear	Functioning Properly.
	1999	Sediment 1 st 80 feet	Pipe is wet with vegetation (roots). Headwall clean and dry.
1001+00Lt W	1995	Clear	Detected ponding water from 70 to 100 feet into the pipe.
	1996	Detected some sediment	Functioning Properly. Pipe is dry and has been draining.
	1997	Very little sediment present.	Functioning Properly. Evidence of roots from foliage directly above the edge drains.
	1998	Very little sediment present.	Functioning Properly. Evidence of roots from foliage directly above the edge drains.
	1999	Small aggregate & sediment in 1 st 90 feet (sag in pipe)	Water up to 2" deep in pipe. Headwall clean and dry. No roots.
1001+00Lt E	1995	Clear	Functioning Properly.
	1996	Detected some sediment	Evidence of pipe being ½ full of water at one time. Mouse nest at 20'.
	1997	Some sediment in isolated areas.	Functioning Properly.
	1998	Clear	Functioning Properly.

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
	1999	Very little sediment	Some water in pipe, some vegetation. Headwall clean and dry, cracking.
1018+00Rt W	1995	Detected some sediment in pipe	Functioning properly, except for ponding water (1/3 full) for about 15 ft.
	1996	Detected some dirt or sediment on sidewalls.	Pipe was not draining completely due to a dirt lump lodged in pipe.
	1997	Some sediment present.	Encountered a clump of dirt at 40', otherwise Functioning Properly
	1998	Very little sediment	Clump of dirt washed out. Functioning Properly.
	1999	Very little sediment	Some water in pipe. Headwall clean and dry, stained by soils or damming.
1018+00Rt E	1995	Clear	Functioning Properly.
	1996	Detected some sediment	Pipe is dry and there is evidence that it has been draining.
	1997	Very little sediment present.	Functioning Properly.
	1998	Very little sediment present	Functioning Properly.
	1999	Very little sediment	Water in pipe, low area. Headwall clean and dry. Mower tire damaged rodent screen, rodent nest present at radius.
1018+ 00Lt W	1995	Clear	Ponding water due to sags in pipe.
	1996	Clear	Functioning Properly. Pipe is dry and has been draining.
	1997	Did not evaluate.	Did not evaluate.
	1998	Clear	Functioning Properly.
	1999	Unidentifiable scum floating in pipe, very little sediment.	Water up to 2" in pipe. Low area in pipe after radius for 85'. Headwall covered with grass clippings. Back of headwall appears lower than front, possible damming of water.
1018+00Lt E	1995	Clear	Standing water sometimes ½ full.
	1996	Clear	About 65' into edge drain a small puncture is present in the bottom of the pipe.
	1997	Did not evaluate.	Did not evaluate.
	1998	Clear	Functioning Properly. Puncture @ 65'

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
	1999	Unidentifiable scum floating in pipe, very little sediment.	Water up to 2" in pipe. Low area in pipe @ 60'. Puncture @ 65'. Headwall covered with grass clippings. Back of headwall appears lower than front, possible damming of water.
1033+00Rt W	1995	Clear	Functioning Properly.
	1996	Sediment build-up on pipe walls.	Functioning Properly. Pipe is dry and has been draining
	1997	Some sediment build-up on pipe walls.	Functioning Properly. Evidence of roots from foliage directly above the edge drains.
	1998	Very little sediment	Functioning Properly. Evidence of roots from foliage directly above the edge drains.
	1999	Some sediment	Pipe is damp. Headwall has some grass clippings, but dry. Headwall was chipped by mower. No evidence of foliage or roots.
1033+00Rt E	1995	Clear	At 150', pipe partially collapsed and not passable.
	1996	Clear	Functioning Properly up to 150' then could not pass with camera. Pipe is dry. Evidence in spots of water being a 1/3 to 1/2 full at one time
	1997	Some sediment present.	Functioning Properly. Evidence of roots from foliage directly above the edge drains. At 150', pipe partially collapsed and not passable.
	1998	Clear	Functioning Properly. Evidence of roots from foliage directly above the edge drains. Rodent nest present. At 150', pipe impassable.
	1999	Clear	Headwall has some grass, but dry. Rodent screen damaged by mower tire, no evidence of rodents. No evidence of roots. Pipe impassable.
1033+00Lt W	1995	Clear	Functioning Properly.
	1996	Clear	Functioning Properly. Pipe is dry and has been draining.
	1997	Some sediment build-up on the pipe walls	Functioning Properly. Evidence of roots from foliage directly above the edge drains. Some ponding water.
	1998	Very little sediment present	Functioning Properly. Evidence of roots from foliage directly above the edge drains.

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
	1999	Some sediment	Pipe is damp, not draining. Bumps in pipe from 60 - 100'. Headwall has some grass, but dry.
1033+00Lt E	1995	Clear	Functioning Properly.
	1996	Some sediment caked on bottom of pipe.	Pipe is draining. Has two small punctures on the bottom of the pipe. Punctures.
	1997	Some sediment present.	Functioning Properly. Evidence of roots from foliage directly above the edge drains. Punctures
	1998	Very little sediment present	Functioning Properly. Evidence of roots from foliage directly above the edge drains.
	1999	Some sediment present	Pipe is dry. Headwall clean and dry. Punctures
1038+00Lt W	1995	Clear	Pipe has several ponding areas.
	1996	Clear	Bottom of pipe from inlet to 120' has many punctures in it.
	1997	Some sediment present	No change.
	1998	Some sediment present	No change.
	1999	Some sediment present	Pipe is damp, 1/4" water. Headwall clean and dry. Occasional bumps in pipe.
1038+00Lt E	1995	Clear	Functioning Properly.
	1996	Detected lots of sediment on the bottom of the pipe	Functioning Properly. Pipe is dry and has been draining.
	1997	Detected lots of sediment lying on the bottom of the pipe.	Functioning Properly. Has a few punctures in the bottom of the pipe.
	1998	Very little sediment present	Functioning Properly. Has a few punctures in the bottom of the pipe.
	1999	Sediment increases with length of pipe.	Pipe is damp, 1/4" water. Headwall clean and dry. Occasional bumps in pipe. Punctures
1038+00Rt W	1995	Clear	Functioning Properly.
	1996	Detected some sediment	Functioning Properly. Some ponding of water.
	1997	.Some sediment build-up on the pipe walls.	Functioning Properly. Some ponding of water.
	1998	Very little sediment	Functioning Properly. Some ponding of water.

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
	1999	Some sediment present	Pipe is damp, up to 1/4" water. Headwall clean and dry. Rodent screen damaged, rodent nest in radius. Bump in pipe at 30' with aggregate protruding.
1038+00Rt E	1995	Clear	Functioning Properly.
	1996	Detected lots of sediment.	Functioning Properly. Pipe is dry. Evidence of pipe being 1/2 full of water at one time.
	1997	Some sediment build-up on the pipe walls.	Functioning Properly. Some ponding of water.
	1998	Very little sediment present	Functioning Properly. Some ponding of water
	1999	Sediment increases with length of pipe.	Pipe is damp, 1/4" water. Headwall clean and dry.
1048+00Rt W	1995	Clear	Standing water for about 100', about 1/3 full at times.
	1996	Detected some sediment.	Functioning Properly. Some ponding of water.
	1997	Some sediment build-up on the pipe walls.	Functioning Properly. Some ponding of water.
	1998	Very little sediment	Functioning Properly.
	1999	Some sediment, small aggregate	Pipe is dry. Headwall dry with grass clippings. Bumps in pipe.
1048+00Rt E	1995	Small amount of sediment in pipe	Functioning Properly.
	1996	Detected some sediment.	Functioning Properly. Some ponding of water.
	1997	Some sediment build-up on the pipe walls.	Functioning Properly. Some ponding of water.
	1998	Very little sediment present	Functioning Properly.
	1999	Some sediment	Pipe is damp, 1/4" water. Headwall dry with grass clippings.
1048+00Lt W	1995	Clear	Functioning Properly.
	1996	Detected lots of sediment.	Pipe is dry and has been draining. Detected some punctures on the bottom of the pipe.
	1997	Some sediment, however, not as much as last year.	Functioning Properly. Evidence of roots from foliage directly above the edge drains. Some ponding water. Punctures.
	1998	Very little sediment present	Functioning Properly. Punctures

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
	1999	Some sediment, small aggregate	Pipe is dry. Headwall dry with grass clippings. Bumps in pipe. Punctures
1048+00Lt E	1995	Clear	Functioning Properly. No indication of water in the pipe.
	1996	Detected some sediment.	Pipe is dry and has been draining. Detected some punctures on the bottom of the pipe.
	1997	Very little sediment present.	Functioning Properly. Evidence of roots from foliage directly above the edge drains. Some ponding and punctures.
	1998	Very little sediment present.	Functioning Properly. Evidence of roots from foliage directly above the edge drains. Some ponding and punctures.
	1999	Some sediment	Pipe is damp, ¼" water. Headwall dry with grass clippings. Punctures.
1053+00Lt W	1995	Clear	Functioning Properly
	1996	Clear	Functioning Properly. Pipe is dry. Evidence of pipe being ½ full of water at one time.
	1997	Some sediment build-up on the pipe walls and laying on bottom.	Functioning Properly. Some ponding of water.
	1998	Some sediment build-up on the pipe walls and laying on bottom.	Functioning Properly
	1999	Some sediment	Pipe is damp. Headwall dry with grass clippings.
1053+00Lt E	1995	Clear	A lot of water standing in pipe. In places ½ full of water.
	1996	Clear	Pipe is dry and has been draining. Detected some punctures on the bottom of the pipe.
	1997	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water. Evidence by flow lines that pipe was flowing 1/3 full at one time.
	1998	Some sediment detected	Functioning Properly. Punctures.
	1999	Some sediment	Pipe is damp. Headwall dry with grass clippings.
1053+00Rt W	1995	Some sediment in pipe.	Pipe has several sags. In some areas the pipe is ½ full of water

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
	1996	Detected lots of sediment.	Functioning Properly. Pipe is dry and has been draining.
	1997	Detected lots of sediment caked on sides and laying on bottom of pipe.	Functioning Properly. Some ponding of water.
	1998	Some sediment present. Not as much as last year.	Functioning Properly.
	1999	Sediment build-up for 200'	Pipe is damp, 1/4" water. Headwall is dry with grass clippings. Bumps in pipe.
1053+00Rt E	1995	Some sediment in pipe. In one portion, a lot of sediment has accumulated.	Functioning Properly No indication of water in the pipe.
	1996	Detected lots of sediment.	Functioning Properly. Pipe is dry and has been draining.
	1997	Some sediment detected.	Functioning Properly. Some ponding of water.
	1998	Some sediment detected.	Functioning Properly. Some ponding of water.
	1999	Some sediment	Pipe is damp. Headwall dry with grass clippings.
1090+00Rt W	1995	Clear	Functioning Properly
	1996	Detected some sediment.	Pipe is dry and has been draining.
	1997	Some sediment caked on sides.	Functioning Properly
	1998	Small amount of sediment caked on sides.	Functioning Properly
	1999	Very little sediment	Pipe is damp, 1/4" water. Headwall is dry with grass clippings.
1090+00Rt E	1995	Clear	Functioning Properly
	1996	Detected some sediment.	Pipe is dry and has been draining. Mouse nest lodged in the pipe.
	1997	Some sediment caked on sides.	Some ponding. @ 120' detected possible class 2 trench material in pipe for about 20'.
	1998	Small amount of sediment caked on sides.	Some ponding. @ 120' detected possible class 2 trench material in pipe for about 20'.
	1999	Fine sediment and small aggregate @ 105 - 120'	Pipe is damp. Headwall is dry with grass clippings. Smaller material washed out.

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
1120+00Lt W	1995	Some sediment in pipe	Functioning Properly
	1996	Detected some sediment	Functioning Properly. Pipe is dry. Evidence of pipe being 3/4 full of water at one time.
	1997	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water.
	1998	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water.
	1999	No sediment	Pipe is damp. Headwall dry with grass clippings.
1120+00Lt E	1995	Clear	Functioning Properly. No indication of water in pipe.
	1996	Detected some sediment.	Functioning Properly. Pipe is dry. Evidence of pipe being 1/3 full of water at one time.
	1997	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water.
	1998	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water.
	1999	Clear	Pipe is damp. Headwall dry with grass clippings. Rodent screen damaged, rodent nest in pipe.
1160+00Rt W	1995	Clear	Functioning Properly. Some ponding.
	1996	Detected some sediment.	Functioning Properly. Pipe is dry. Evidence of pipe being 1/3 full of water at one time.
	1997	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water.
	1998	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water.
	1999	Clear	Pipe is damp. Headwall dry with grass clippings. Rodent screen damaged, no evidence of rodents.
1160+00Rt E	1995	Some sediment in pipe	Functioning Properly
	1996	Detected some sediment.	Pipe is dry. Evidence of pipe being 1/3 full of water at one time. Detected a puncture in one area.
	1997	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water. Detected a puncture in one area

STATION	YEAR	PRESENCE OF FINES	GENERAL CONDITION OF EDGE DRAINS
	1998	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water. Detected a puncture in one area
	1999	Clear	Pipe is damp. Headwall dry with grass clippings. Detected a puncture in one area
1202+50Lt W	1995	Clear	Functioning Properly
	1996	Detected some sediment.	Pipe is dry and has been draining. Detected many punctures on the bottom of the pipe.
	1997	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water. Punctures on the bottom of the pipe.
	1998	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water. Punctures on the bottom of the pipe.
	1999	Clear	Pipe is damp. Headwall dry with grass clippings. Rodent screen damaged, no evidence of rodents. Punctures on the bottom of the pipe.
1202+50Lt E	1995	Clear	Functioning Properly
	1996	Detected some sediment.	Pipe is dry and has been draining. Detected a puncture in one area.
	1997	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water. Detected a puncture in one area.
	1998	Small amount of sediment caked on sides of pipe.	Functioning Properly. Some ponding of water. Detected a puncture in one area.
	1999	Clear	Pipe is damp. Headwall dry with grass clippings. Rodent screen damaged, no evidence of rodents. Detected a puncture in one area.

Prior Annual Evaluation Information

Nearly all of the edge drains, at some point in the evaluation period, have accumulated some degree of sediment. As previously shown in Table 1, many of the edge drains scoped were experiencing little or no sediment problems during the first year of operation. As time proceeded, however, sediment began to appear. During the fourth evaluation, much of the sediment present during previous evaluations appears to have either washed out or had become stuck to the sides of the perforated pipe. Exact location of this sediment was not

previously determined; therefore it is difficult to determine if this is the same sediment in the same location.

A small amount of sediment material was extracted from one of the edge drains earlier in an evaluation period. This material was tested and found to have a PH level of 8.66. This would classify the material to be slightly alkaline in nature. The water and sediment draining from beneath the roadway has had no negative effect on vegetation surrounding the edge drain headwall. No further PH testing has been conducted.

The general physical condition of the edge drain system continues to be excellent and performs well considering isolated areas where protrusions, punctures or sags (ponding) are present. The protrusions and/or punctures do not seem to be increasing in number or size and at this time are not affecting the performance of the edge drains. It is quite possible that the protrusions or punctures were formed during construction along with the sags in the pipes. During the initial observations with the optical camera the protrusions may have gone undetected because of the large amounts of water draining through the pipes at the time. In some cases, where ponding was prevalent earlier, the area is dry. The water has either evaporated or has slowly percolated through the pipes. During wet times the sags in the pipes may decrease the capacity; however, the sags do not appear to be filling up with sediment or other foreign material.

The intrusion of rodents continues to be a problem; however, the nests appear to break-up and eventually wash out of the system.

Another condition that was detected during last years evaluation was the presence of plant roots growing through the edge drains. Although still present, the roots are very small in size and do not pose a threat to the edge drain system.

An item that needs to continue to be stressed is maintenance of the headwalls. Headwalls that have long weeds and grass around them and near the rodent screens have the potential to cause damming at the exit of the drains decreasing the capacity of the drainage system and potentially retaining sediment within the pipes.

Fifth Annual Evaluation

As previously mentioned, the weather during the fifth annual evaluation was favorable. As a result of these conditions, the drain pipes were not actively draining water, although evidence of past drainage was observed.

The fifth annual evaluation (visual) indicated that 12 of the 38 (31.6%) drains have an increase in sediment, 20 of the 38 (52.6%) had no change, and 6 of the 38 (15.8%) had a decrease in the observed sediment. It should be noted that these were visual observations and the amount of increase or decrease cannot be quantified.

The overall condition of the each edge drain system, (pipe, headwall, etc.) was also evaluated. Photo 2 provides a view of one of the headwall systems evaluated.



Photo 2: Typical Headwall-Painted for Ease of Location and Identification of Damage

After evaluation, the back edge of each headwall was painted for identification purpose. Any physical damage, (cracks, chips, etc.) was spot painted. Damage to any rodent screen was repaired. Note the location of chips in the headwall as indicated by the spot painting on Photo 2. Observations indicated that the condition of 3 of the 38 (7.9%) edge drain systems improved, 16 of the 38 (42.1%) had no change, and 19 of the 38 saw a degradation in their condition since last year's evaluation. The degraded conditions included; 19 of the 38 (50.0%) edge drain headwalls contained grass clippings, 7 of the 38 (15.8%) had damaged rodent screens, and 4 of the 38 (10.5%) had evidence of rodent nests at various locations within the drain pipes.

Mowers appear to be causing damage to the rodent screens. This raises the potential for intrusion of rodents into the edge drain systems. Rodent nests could introduce restrictions within the system and lead to collection of sediment. Damage is limited to the bending of the screens and is easily repaired utilizing hand tools.

Seventh Annual Evaluation

The seventh annual evaluation was conducted after the fall mowing operation. This aids in the evaluation of the drainage system. The same drain systems were observed using an optical camera as were observed in the fifth annual evaluation. Comparing the data, the seventh annual evaluation has not changed much from the fifth annual evaluation. Sediment found in the pipes will change a little from year to year depending on annual rainfall and speed of water discharge. Headwall damage has not increased and grass clippings are still found in the outlet troughs. Fewer rodent nests were found during this evaluation.

The Pearpoint optical camera system worked very well in observing the internal edge drain system. Performing regular maintenance is all that is needed to ensure optimum performance. Photo 3 shows what is observed on the optical camera monitor. If you look past the reflection on the screen, aggregate can be seen in the drain pipe.



Photo 3: Aggregate blockage in drain pipe.

Summary

In general the edge drains appear to be functioning properly with little internal restriction from collected sediment or other foreign material. The edge drain systems evaluated show that 26 of the 38 (68.4%) had no change or a decrease in the amount of sediment observed. The evaluation history indicates that most increases in observed sediment occurred in the first two years of service and continues to decrease in amount. Of those systems indicating an increase in sediment, it should be noted that the increase is generally small and is not presenting any performance problems.

Other items such as the intrusion of rodents into the drain system, punctures and/or protrusions in the pipes, plant roots, and sags in the pipes; although degrading the overall condition of the edge drain system, do not appear to be presenting any problems.

The clogging of concrete headwall outlets with hay and other matter may create performance problems. Grass clippings should be removed for optimum operation of the edge drain systems.

The source of the damage to the rodent screens appears to be NDDOT mowers. Edge drain concrete headwalls used on current projects utilize a different rodent screen design. This new design is less susceptible to the type of damage observed on this

project. The condition of the rodent screens should be monitored and repairs performed as required.

The optical camera system used to inspect the edge drains continues to work well with little or no difficulty in operation. Since acquired by the NDDOT, the camera system has been utilized by Materials and Research Division personnel for the evaluation of experimental projects. District personnel from around the state have used it to evaluate newly constructed pavement edge drain systems, slide area drainage systems, roadway culverts, and storm drainage systems.

General maintenance on the camera system has been performed by Materials and Research personnel. Maintenance operations consist of general cleaning and lubrication of camera head contacts and fittings. Miniature light bulbs, which act as the light source for the camera in the absence of natural light, are replaced when they have been damaged or fail. Replacement bulbs, (approximately \$1.70 per bulb), are somewhat difficult to replace; however, using proper tools, this operation also is performed by Materials and Research personnel. Color coded tape was applied to the 300' cable to indicate the position of the camera when "snaking" the camera through a pipe. Due to the adverse conditions (water, grit, etc.) in which the camera operates, this tape must occasionally be replaced.

Recommendations:

The condition of the headwall area is critical to the performance of the edge drain systems. The headwall should be kept clear of grass clippings and other debris. Damaged rodent screens should be repaired to prevent rodents from entering the edge drain system.

The optical camera system has been very reliable, and easy to operate. District personnel continue to use it regularly to inspect new construction of drainage systems. The camera has proven to be a valuable inspection and diagnostic tool.

Appendix A

DESIGN DATA			
Traffic	Average Daily		Est. Trucks
Current 1994	Pass. 3,455	Trucks 700	Total 4,155
Forecast 2014	Pass. 5,080	Trucks 1,050	Total 6,130
Minimum Sight Dist. for	Design Speed		70 MPH
Stopping	625 FT		
Full Control of Access			
No Point of Access Other than at Interchange Ramps			

N7311

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

IN CASS COUNTY

FEDERAL AID PROJECT IN-8-094(005)331

PCC RECYCLING & SPS-2 EXPERIMENTAL SECTIONS

FEDERAL REGION	STATE	PROJECT NO.	SHEET NO.
8	ND	IN-8-094(005)331	1

GOVERNING SPECIFICATIONS:

Standard Specifications adopted by the North Dakota Department of Transportation September 1993 Standard Drawings currently in effect and other Contract Provisions submitted hereto.

LENGTH OF PROJECT

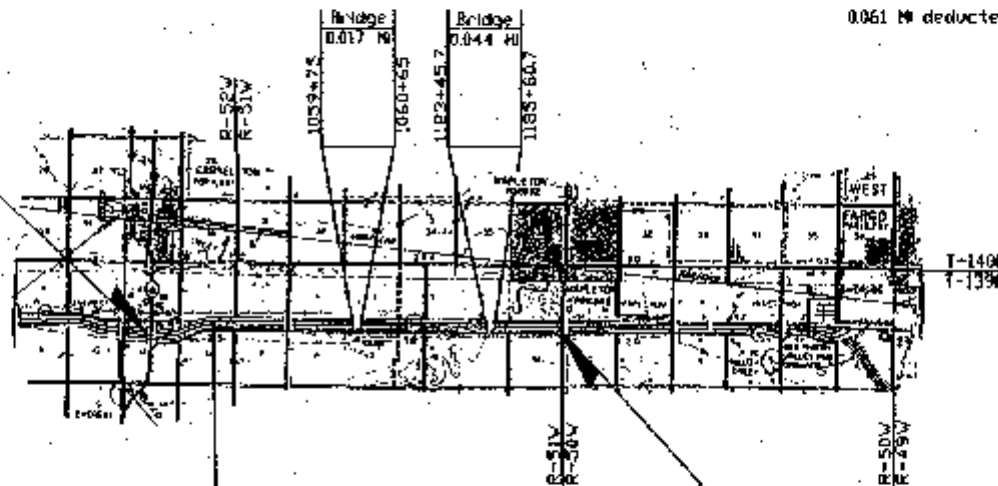
Miles-Gross	Miles-Net
7.518	7.449

0.061 M deducted for bridges.



A-2

BEGIN Sta. 855+48.4
Section 11, Twp 139 N,
Rge 52 W



EQUATION
916+85.7 Blk=
916+94.4 Ahd

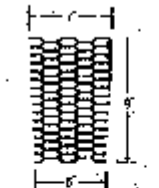
END Sta. 1250+11.8
Section 12, Twp 139 N,
Rge 51 W

PAVING SECTION	<i>Brain Power</i>
URBAN SECTION	
TRAFFIC SECTION	<i>Greg Skiffell</i>
RURAL SECTION	
RECOMMEND APPROVAL	<i>2-1 1994</i>
DESIGN ENGINEER	<i>David K. P. Lee</i>

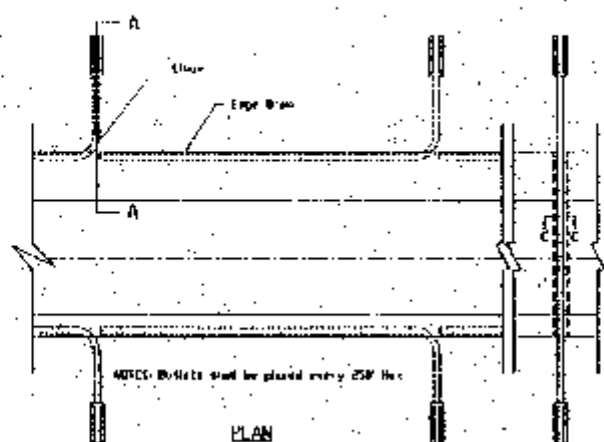
U.S. DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION	APPROVED DATE <i>2-1-94</i>	
APPROVED	<i>Ray Zink</i> DIRECTOR OF HIGHWAYS AND ENGINEERING	
DIVISION ADMINISTRATOR	DATE	NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

STANDARD DRAWING	SCALE	DESIGN AND PROJECT NO.	SHEET
D	N.P.	14-B-894 (900/931)	1

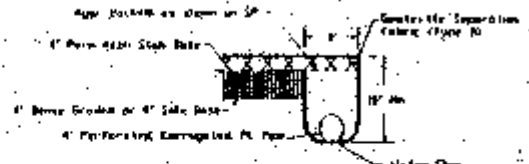
PAVEMENT EDGE DRAIN THROUGH CURB AND GUTTER
 HEADWALL AND TYPICAL DETAILS



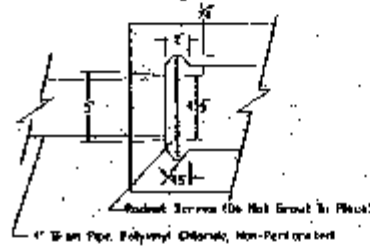
ROADWAY SCREEN
 3x3 Gal. Hardware Cloth 30x1
 (Wire or Coated)



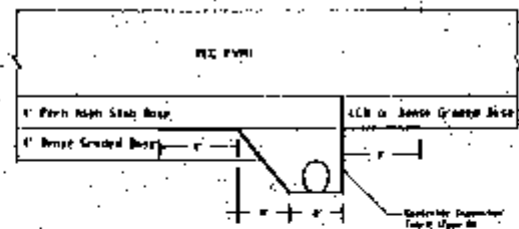
PLAN



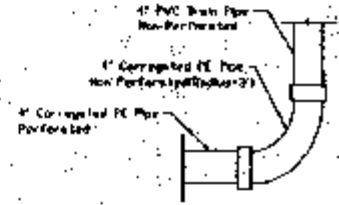
DEBURATED CORRUGATED POLYETHYLENE PIPE FRENCH DETAIL



4" PIPE HOLE DETAIL

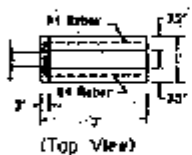


DETAIL C-C
 TRANSVERSE INTERSECTOR DRAIN DETAIL
 Sta. 882+85.9 and Sta. 972+16.1

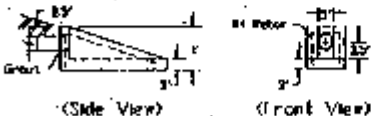


INTERSECTION DETAIL

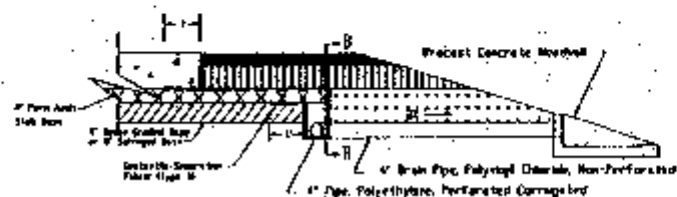
A-3



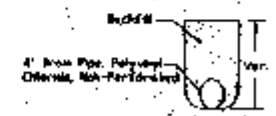
(Top View)



PRECAST CONCRETE HEADWALL



TYPICAL SECTION A-A



DETAIL CUT B-B

NOTE: All dimensions shown for concrete headwall are minimum dimensions.

Appendix B

The first lift above the reinforcement fabric shall have a minimum lift of 12 inches before compaction. Small dozer equipment or front end loaders with low ground pressures shall be used to spread the cover material.

709.04 METHOD OF MEASUREMENT.

Page 346

04-21-95

Add the following to Section 709.04:

D. Geotextile Reinforcement Fabric. The reinforcement fabric shall be measured by the actual surface area covered to the nearest square yard. No allowance will be made for overlaps.

709.05 BASIS OF PAYMENT.

Page 346

04-21-95

02-16-96

Delete the Pay Items in Section 709.05 and add the following:

Pay Item	Unit
Geotextile Fabric Type ____	Square Yard

714 CULVERTS, STORM DRAINS AND UNDERDRAINS.

Page 347

03-17-95

Delete the title of Section 714 and insert the following:

**SECTION 714
CULVERTS, STORM DRAINS, EDGE DRAINS, AND UNDERDRAINS**

714.01 DESCRIPTION.

Page 347

03-17-95

Delete Section 714.01 in its entirety and insert the following:

This work consists of installing culverts, storm drains, edge drains, and underdrains designed to intercept and carry off surface or underground water.

Culverts, storm drains, edge drains, and underdrains of the various types and sizes specified will, at times, be referred to as pipe or conduit in these Specifications.

714.02 MATERIALS.

Page 348

07-29-94

06-16-95

Delete item "Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts" in Section 714.02 A and insert the following:

"Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts, Underdrains, and Storm Drains"

714.02 MATERIALS.

Page 348

03-17-95

02-16-96

Add the following to Section 714.02:

E. Edge Drains.

Materials shall meet the following:

Item	Section
Perforated, Corrugated, P.E. Pipe	830.03 A.5
PVC Discharge Pipe	830.03 A.4
Geotextile Fabric	858
Trench Backfill	
Permeable Trench Backfill Cl.2	816.03
Permeable Base Aggr. Cl.7	816.03
Size 4 or 5 Concrete Aggregate*	816.02
Concrete Sand*	816.01
Class 43 Chips*	816.03

* Sieve analysis only.

Delete the first paragraph of Section 714.03 A. 6. in its entirety and replace with the following:

6. **Backfilling for Pipe Installed in Embankments.** After installing the pipe on the required bedding, suitable backfill shall be placed along each side of the pipe in layers not exceeding 12 inches. Each layer shall be compacted to the required density. If a specified density is not required, compaction shall be according to Section 203.02 I.

Add the following to Section 714.03:

- E. **Edge Drains.** Edge Drains shall be constructed along the pavement edge as shown on the Plans. The drains shall be outletted at approximate intervals of 250 feet and at low points in the flow line of the edge drain.

The drains shall be placed by a machine trencher capable of cutting the trench, lining the trench with a geotextile fabric, and laying the pipe in a continuous operation. The drains shall be placed at a minimum grade of 0.2%. Laser grade control will be required on the trenching machine whenever the pipe grades do not follow the pavement grades at a constant depth. The trenching equipment shall be designed and operated so the excavated material does not fall back into the trench. The excavated trench material shall be disposed of by the contractor.

The trench backfill shall be compacted with a vibratory shoe compactor narrower than the trench, but not more than 2 inches less than the trench width. The trench backfill shall be compacted adequately to ensure that additional settlement will not occur.

When edge drains are installed adjacent to a permeable base material, the trench shall be wrapped with a Type D2 geotextile separation fabric. The fabric shall be pinned directly below the flow line of the permeable base material so the flow of water to the drain is not impeded. Concrete sand will not be used for trench backfill on projects using a permeable base material.

When edge drains are installed on a project with a non-permeable base material, the PE pipe shall be enclosed in a geotextile fabric sock. The Contractor may elect to use a Type D3 or Type D4 geotextile separation fabric for the sock.

Edge drains that outlet to the ditch shall be constructed concurrently with the longitudinal edge drains and laid at right angles to the roadway centerline. The discharge pipe shall be a PVC pipe laid at a minimum grade of 2%. The connection to the edge drain pipe shall be made with a non-perforated PE pipe placed with a 3-foot radius. Two drains coming together at a low point shall be connected to separate discharge pipes. The discharge trenches shall be constructed similar to the drains, but shall be backfilled with the existing soil. Headwalls shall be installed a minimum of 6 inches above the ditch grade. The discharge pipe shall be inserted and coupled to the headwall with grout. The uppermost point of the headwall shall be placed flush with the roadway inslope. The inslope shall be shaped to conform to the sides and toe of the headwall. The headwall and rodent screen shall be installed at the same time the outlet pipe is installed.

Each headwall shall be provided with a rodent screen that fits snugly into the headwall so mice and other rodents are unable to enter the drain. The rodent screens must be removable, the Contractor will not be permitted to grout the screens into place.

Edge drains that outlet to a storm sewer system shall be coupled to the inlet by use of grout, rubber or plastic gaskets, or by a gasket joint inserted into a thermoplastic coupling cast into the inlet. The connections to the storm sewer shall be made concurrently with the installation of the drain. The cost of the connections to the storm sewer shall be incidental to the cost of the edge drains.

Ends of the drainage line where outlets are not required shall be capped.

All joints shall be connected securely according to the manufacturer's recommendations.

Construction equipment will not be allowed on the edge drain until it is properly protected.