STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

TRANSPORTATION RESEARCH DIVISION
BUREAU OF PLANNING

DATE: FEBRUARY 2001

EXPERIMENTAL CONSTRUCTION (99-8)

Experimental Use of Geogrids
As An Alternative To Gravel Placement

Interim Report - First Year

INTRODUCTION

With the ongoing demand for improved infrastructure, the Maine Department of Transportation (MDOT) continues to identify and evaluate new and innovative construction methods and materials. The Department's Capital Highway Improvement Program (CHIP) attempts to reduce construction costs by utilizing existing roadway base and pavement materials. In the fall of 1998, MDOT began construction of a project that incorporated this philosophy and an experimental feature of geogrids to minimize the need for additional base gravel materials.

PROJECT LOCATION/DESCRIPTION

This project is located on Route(s) #6-15 in Big Squaw Township, Piscataquis County (see attached location map). This 5.94-kilometer section of roadway was originally identified to receive a standard 16 mm maintenance mulch overlay. After further review and several discussions concerning the significant distortion (crown) of the existing roadway and the high volume of heavy truck traffic, it was determined that this section was an excellent candidate for the CHIP process.

The experimental feature of this project consists of 11 sections of varying length encompassing the entire project length. The primary focus of this research was to determine if placement of a geogrid product could minimize the need for additional base gravel materials.

As this research evolved, it became apparent that not only could MDOT evaluate the effectiveness of geogrids, but also conduct an analysis on each of the construction procedures utilized within this project.

MDOT's Geotechnical group played a significant role in selecting the geogrid product used in the research portion of this project and in establishing the overall research strategy. The geogrid product is Biaxial GeoGrid BX1200 (SS-2), manufactured by The Tensar Corporation of Morrow, Georgia (see attached Product Specification Sheet).

Table I presents the section locations, treatment and final average gravel and pavement depths.

TABLE I

Section Number	Location (mm)	Treatment	Final Gravel Depth (mm)	Final Pavement Depth
1	0+100 - 0+220	Undercut	650	110
2	0+220 - 0+600	Geogrid	685	115
3	0+600 - 0+700	Control	750	115
4	0+700 - 2+770	Reclaim	685	115
5	2+770 - 3+270	Geogrid	700	95
6	3+270 - 3+390	Control	640	110
7	3+390 - 3+520	Geogrid	540	115
8	3+520 - 5+120	Reclaim	590	110
9	5+120 - 5+320	Geogrid	680	120
10	5+320 - 5+400	Undercut	420	165
11	5+400 - 6+040	Reclaim	650	115

CONSTRUCTION PROCEDURES

Preliminary Falling Weight Deflectometer (FWD) data was collected in June 1998, at the project level for design considerations. This evaluation included FWD testing at 150-meter intervals and 25 pavement, base and subgrade explorations using power augers randomly located along the project. This data was then combined with traffic information and analyzed using DARWin 3.01 software to develop needed gravel and pavement thicknesses for the project's construction. These thicknesses were developed for a 15-year design life.

Construction of the 5.94-kilometer project began in mid-September 1998. This late season start did not allow sufficient time to complete the entire project. However, all of the pavement reclamation and base material work was completed, and the 65 mm Superpave binder coarse was applied and left exposed for the winter season of 1998-1999.

With the exception of the two undercut sections, pavement was reclaimed the entire project length using a "Wirtgen Pavement Reclaimer". This reclamation process consisted of "full depth" reclaiming of the existing pavement layer, plus approximately 25 mm of the existing gravel base. Pavement depths varied from 60 mm to 125 mm.

During the grinding process, it was noted that the reclaimed material had a very poor quality and became muddied with rainfall. Quality of this material was improved by applying 75 to 100 millimeters of gravel to the existing pavement before grinding.

In late January 1999, maintenance personnel identified two areas of pavement failure within the project and a decision was made to restrict heavy loads from traveling along the constructed section. This "posting" was implemented using the MDOT's standard posting procedure which limits gross vehicle weights to 23,000 pounds except when air temperatures fall below 32 degrees Fahrenheit and water is not present at roadway cracks. This posting minimized any additional failures and overall, the project performed adequately.

In early spring, 1999, additional FWD testing was performed on the binder coarse to determine if the total pavement depth of 105 millimeters would sufficiently support future traffic weight and volume. Several areas of minor deficiency were identified and treated with additional pavement at the time of wearing surface placement.

Final pavement depths for the project consisted of 65 millimeters of Superpave 19 mm binder course, and Superpave 12.5 mm surface course at depths ranging from 30 to 100 millimeters (see attached Typical).

A summary of each construction procedure follows:

Undercut Sections

In the two undercut sections (1 and 10), existing roadway materials were excavated at varying depths between 300 and 600 millimeters. As anticipated, ledge was encountered in several areas of section #1. Gravel and pavement materials were reintroduced at a depth of between 760 and 800 millimeters for section #1, and a depth of between 550 and 585 millimeters for section #10. As stated above, FWD testing in the spring of 1999 identified deficient loading capacities in several areas including section #10. To correct this deficiency, an additional 50 mm of wearing surface was placed.

Geogrid Sections

In the four-geogrid sections (2, 5, 7 and 9), existing pavement material and 25 mm of gravel base material were ground in-place and leveled to grade using a grader to eliminate excessive crown. Two rolls of geogrid product, each measuring 4 meters in width and approximately 50 meters in length were then placed on top of the grindings full roadway width. Construction of each geogrid section was completed using this 50-meter interval to minimize traffic interruptions.

Adjoining sides and ends of the geogrid product were overlapped and attached using "tie connectors". These "ties" were rated at 75 pounds tensile strength. After initial application, it was determined that a single "tie" did not supply adequate strength and two connectors were used at each tie location.

Both lanes of traffic were stopped during this process, until a single lane width layer of gravel of varying depth (300 mm minimum) could be placed over the longitudinal seam at the center of the roadway. Once single lane traffic flow was reestablished, the left and right side of the geogrid was covered to a total width of 7.3 meters. Some "pushing" or "waving" of the geogrid product was noted during gravel application (see attached photos). This movement was not considered critical but it did create concern with respect to ease of application.

Control Sections

The two Control sections (3 and 6) were constructed in the same manner as the geogrid sections, with the exclusion of the geogrid product and its associated procedures.

Reclaim Sections

Construction of the three Reclaimed sections (4, 8 and 11) included the reclamation of the existing pavement layer and 25 mm of the existing gravel base material. Gravel was added at depths of 75 to 100 millimeters where necessary as stated above. This material was then leveled to grade and pavement layers applied.

Field Inspection Summary

On September 12, 2000, approximately one year after project completion, the first annual visual evaluation was completed. This inspection identified a minimal amount of cracking within the 11 designated sections. Overall, each section was determined to be in very good condition. The most significant concern identified during this inspection was the pavement edge/gravel shoulder interface. Several areas exhibited a "drop-off" from the pavement edge with significant edge cracking developing. This was reported to the Maintenance and Operations forces responsible for this roadway and corrective action was taken in the form of additional gravel being applied to these areas. Also identified during this evaluation was a "texture difference" or raveling of the pavement at the center of the southbound lane from station 0+100 to 1+582. After discussions with the Paving Inspector for the project, this condition was identified as what is commonly referred to as the "Blaw-Knox Streak". This condition exists because of aggregate segregation at the center of the Blaw-Knox paver. This was corrected for the remainder of the project by removing one of the reversing augers inside the paver.

Table II summarizes the cracking identified during this evaluation.

TABLE II
Cracking Summary - Fall 2000

Section	Center Joint Cracking/Raveling (Linear Meters)	Transverse (# Of Cracks)	Longitudinal (Linear Meters)	Load Associated (Linear Meters)		
				I	M	S
#1 (Undercut)	-	-	-	-	-	-
#2 (Geogrid)	-	-	-	-	-	-
#3 (Control)	-	-	-	-	-	-
#4 (Reclaim)	18	2.25	3	1	-	-
#5 (Geogrid)	-	-	-	-	-	-
#6 (Control)	-	-	-	-	-	-
#7 (Geogrid)	-	-	-	-	-	-
#8 (Reclaim)	-	1.00	-	-	-	-
#9 (Geogrid)	-	-	-	-	-	-
#10 (Undercut)	-	-	-	-	-	-
#11 (Reclaim)	-	1.00	-	-	-	-

In addition to the visual evaluation, each section was analyzed using the Department's FWD and ARAN test vehicles. MDOT's rolling dipstick was also utilized to evaluate culvert movement at eight culvert locations along the project. Each of these testing devices also collected data in early spring, 2000 to evaluate the projects strength, roughness and rutting characteristics during spring thaw conditions. Below is a brief summary of testing procedures and results for each device.

Falling Weight Deflectometer

On September 22, 2000, FWD testing was completed in each of the 11 sections. Four drops, each generating approximately 9000 pounds of force, were used at each test location (see attached photo). Deflection measurements were recorded and this data was then analyzed using DARWin 3.01 software. Overall Subgrade Modulus, Pavement Modulus and Effective Existing Structural Numbers were then developed for each section. These values were computed using a minimum of 10 test points per section.

Table III (attached) compares the Subgrade Modulus; Pavement Modulus and Effective Existing Structural Number values developed using FWD data collected in September 1999, after project completion and data collected in September 2000. With the exception of Section 1, results of the September 2000 testing indicated an increase in Pavement Modulus and Effective Structural Number readings. This "strengthening" has been identified in several other research projects and can, in all likelihood, be attributed to the densification of roadway materials under heavy traffic loads. It is anticipated that this increasing in strength will slow significantly in future years.

September 2000 and April 2000 data was also analyzed as described above. Comparisons indicated the Pavement Modulus values in the four Geogrid sections decreased in strength an average of 32.7 percent. The two undercut sections decreased 33.5 percent; the three reclaim sections decreased 38.8 percent and the two control sections decreased by 44.6 percent. Although the results of this portion of the analysis are primarily inconclusive, it is interesting to note the difference in decreased strength of the Geogrid sections and the control sections. The Subgrade Modulus values also indicated that the Geogrid sections weakened by lesser amounts when compared to the other treatments. Results of this analysis are summarized in Table IV (attached).

ARAN Roughness and Rutting

The ARAN collected a complete series of project data late in the fall of 2000. Roughness and rutting data was compared to data collected in the fall of 1999 in an effort to track deterioration. With the exception of Section 7 that fell into the "comfortable ride at 55 mph/88 kph" category, roughness readings remained in the category "comfortable ride at 65 mph/105 kph". Roughness is presented as International Roughness Index (IRI) in metric units. Figure I (attached) presents the range of IRI values and a verbal description of each. Roughness data is summarized in the attached Table V.

Fall 2000 rutting data actually indicated a decrease in rut depths when compared to the fall of 1999 data in all sections except Section 2 and Section 8. It is important to note, the ARAN measures rut depths in millimeters and even the slightest deviation in positioning of the vehicle during data collection can skew the results. It is anticipated that this data will become more valuable in future evaluations when more prominent rutting develops. Table VI (attached) summarizes the 1999 and 2000 rut data.

Analysis was also completed on spring 2000 data for both roughness and rutting. Roughness measurements from the spring of 2000 indicated a slightly less desirable reading than the readings collected in September 2000. Sections 2, 3, 4, 5, 6 and 10 remained in the "comfortable ride at 65 mph/105 kph" category. The remaining sections were categorized as "comfortable ride at 55 mph/88 kph". These results are summarized in Table VII (attached).

Overall, the comparison of spring and fall rut data was inclusive. Spring rut depths were actually less in all sections with the exception of sections 2 and 10. This data is summarized in Table VIII (attached).

Rolling Dipstick

As detailed in the Construction report for this project, the Department's "Rolling Dipstick was utilized in an effort to monitor vertical movement of eight cross culverts along the project (see attached photo). Data was collected in March 2000 and again in September 2000 as part of the annual evaluation process. Comparisons of IRI readings were made for fall 1999 and fall 2000, and spring and fall 2000. Overall, IRI readings displayed minimal change from 1999 to 2000 with the exception of culvert #4 located in one of the geogrid sections at station 3+432. The end of the culvert at this location appears to have lifted near the edge of the northbound travel way. Table IX (attached) summarizes this comparison.

The spring-fall comparison indicated significant movement occurred at each culvert. Interestingly, Culvert #4, which displayed significant movement in the fall 1999-fall 2000 comparison, displayed the least amount of movement (32 percent) for this evaluation. This data is summarized in Table X.

SUMMARY/FUTURE EVALUATIONS

This project was completed in mid July 1999, using limited design criteria and limited resources. The urgency of needed repairs necessitated a minimal turnaround time from design to completion.

Overall, data collected during the 2000 season indicated no obvious advantages to either of the treatments used on this project. It is anticipated that future years of data collection will better indicate the best treatment selection for this type of roadway.

The next field evaluation is scheduled for the fall of 2001. Data will be collected in the same manner as collected in the fall of 2000, summarized and presented in the form of the second year interim report.

Prepared by:
Stephen Colson
Transportation Planning Analyst

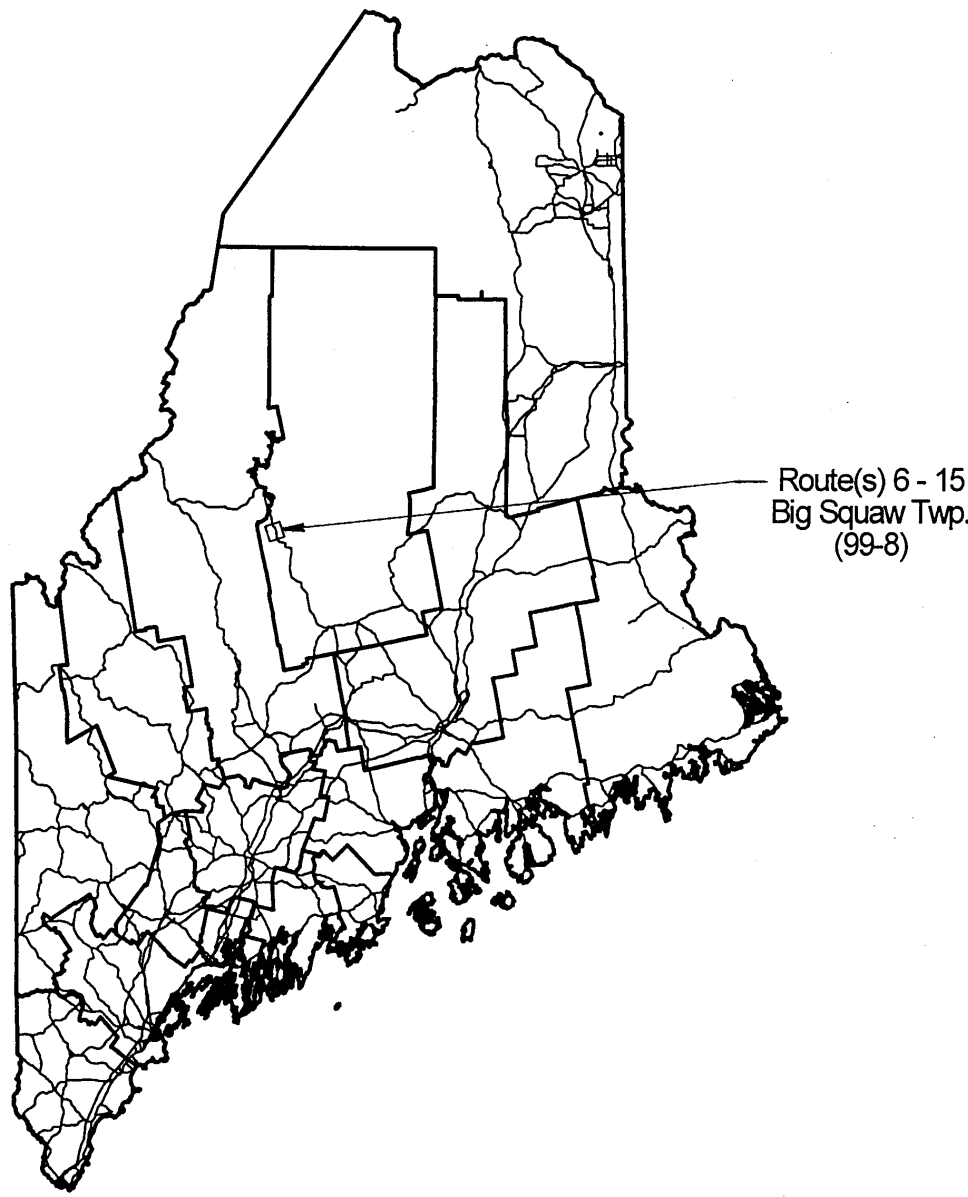
Reviewed by:
Dale Peabody
Transportation Research Engineer

Distribution B

Other Available Documents

Construction Report - December 1999

Use of GeoGrids - Project Location



BIAXIAL GEOGRID BX1200 (SS-2)

The geogrid shall be a regular grid structure formed by biaxially drawing a continuous sheet of select polypropylene material and shall have aperture geometry and rib and junction cross-sections sufficient to permit significant mechanical interlock with the material being reinforced. The geogrid shall have high flexural rigidity and high tensile modulus in relation to the material being reinforced and shall also have high continuity of tensile strength through all ribs and junctions of the grid structure. The geogrid shall maintain its reinforcement and interlock capabilities under repeated dynamic loads while in service and shall also be resistant to ultraviolet degradation, to damage under normal construction practices and to all forms of biological or chemical degradation normally encountered in the material being reinforced.

The geogrid shall also conform in all respects to the property requirements listed below.

PROPERTY	TEST METHOD	UNITS	VALUE
Interlock			
• aperture size[1]	I.D. Calipered[2]		
- MD		in	1.0 (nom)
- CMD		in	1.3 (nom)
• open area	COE Method[3]	%	70 (min)
• thickness	ASTM D 1777-64		
- ribs		in	0.05 (nom)
- junctions		in	0.16 (nom)
Reinforcement			
• flexural rigidity - MD	ASTM D1388-64[4]	mg-cm	750,000 (min)
• tensile modulus -MD	GRI GG1-87[5]	lb/ft	18,500 (min)
• junction strength - MD	GRI GG2-87[6]	lb/ft	1,080 (min)
• junction efficiency	GRI GG2-87[6]	%	90 (min)
Material			
• polypropylene	ASTM D 4101 Group 1/Class 1/Grade 2	%	98 (min)
• carbon black	ASTM 4218	%	0.5 (min)
Dimensions			
• roll length		ft	164
• roll width		ft	9.8 & 13.1
• roll weight		lb	102 & 135

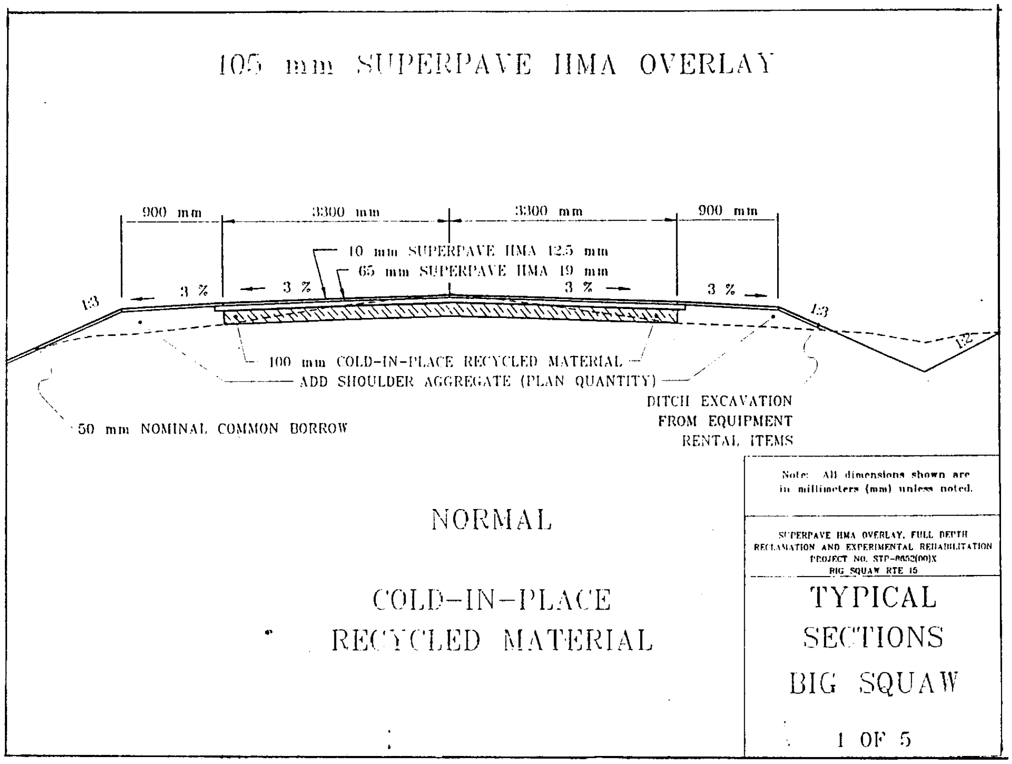
Notes:

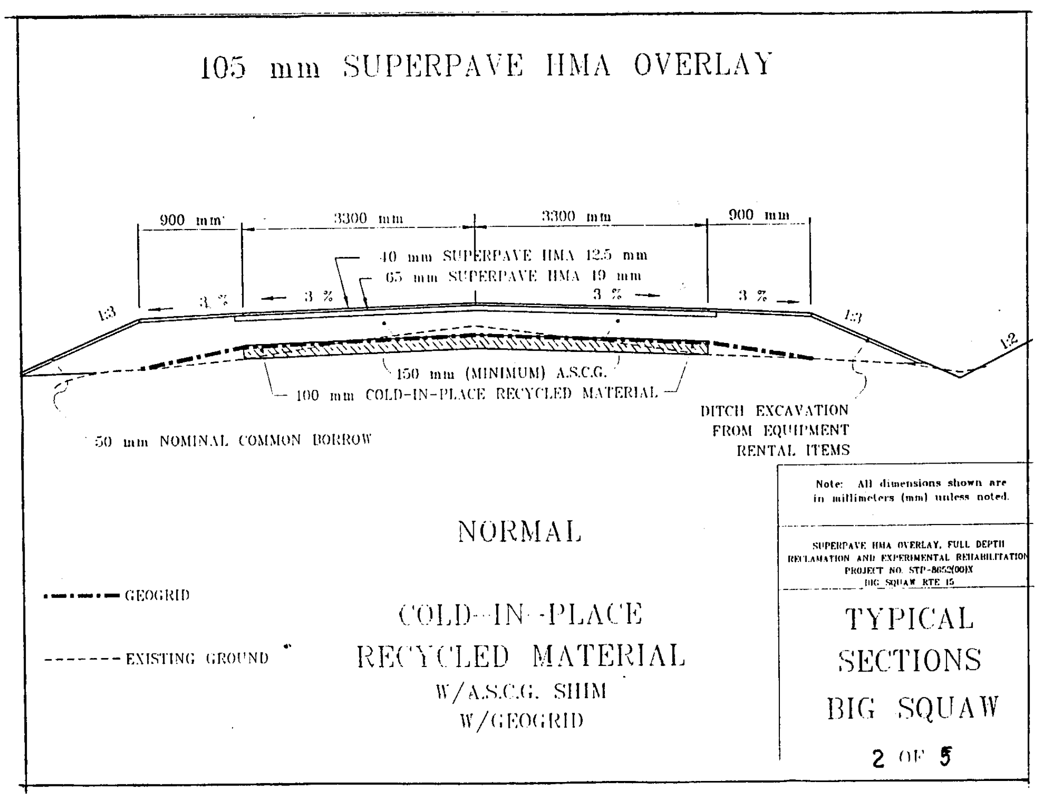
1. MD dimension is along roll length. CMD dimension is across roll width.
2. Maximum inside dimension in each principal direction measured by calipers.
3. Percent open area measured without magnification by Corps of Engineers method as specified in CW 02215 Civil Works Construction Guide, November 1977.
4. ASTM D 1388-64 modified to account for wide specimen testing as described in Tensar test method TTM-5.0 "Stiffness of Geosynthetics".
5. Secant modulus at 2% elongation measured by Geosynthetic Research Institute test method GG1-87 "Geogrid Tensile Strength". No offset allowances are made in calculating secant modulus.
6. Geogrid junction strength and junction efficiency measured by Geosynthetic Research Institute test method GG2-87 "Geogrid Junction Strength".

The Tensar Corporation
1210 Citizens Parkway
Morrow, GA 30260
1-800-845-4453

MATERIAL PROPERTY DATA SHEET
BX1200
October 27, 1993

Typical Cross Section Details

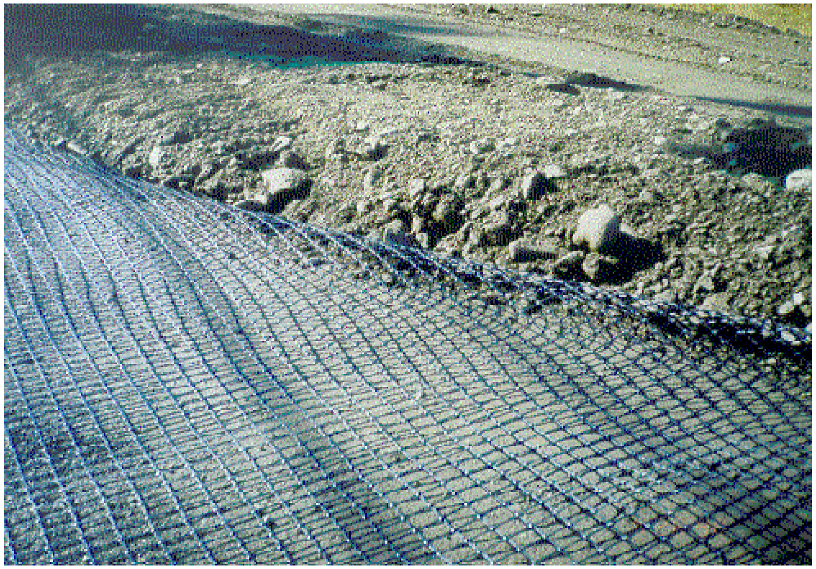




Geogrid Placement 50-meter length - full roadway width

Pushing or Waving of Geogrid Material

Variable Depth Gravel Placement



Close-up of “Waving” Grid

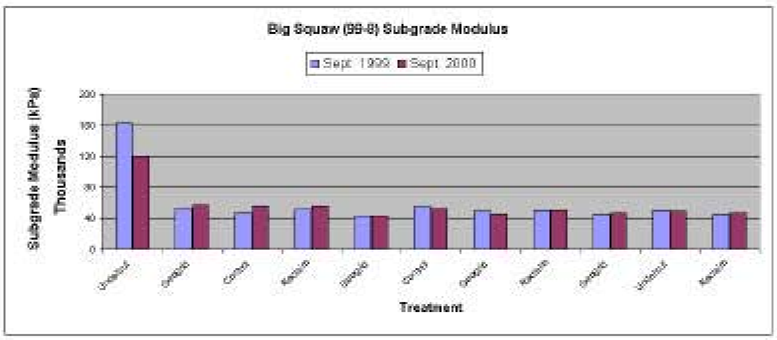
Falling Weight Deflectometer

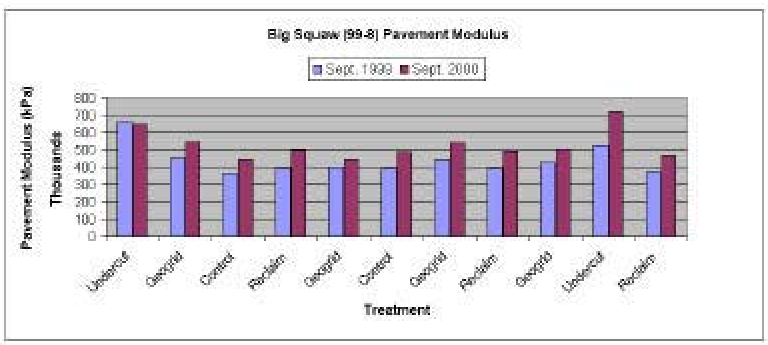
Rolling Dipstick

TABLE III

Big Squaw - Route #15 (99-8)
FWD Analysis
Sept. 1999/Sept. 2000

				September, 1999 Construction Complete			September, 2000 1 Year Evaluation			Percent Change 1999 to 2000		
Section Location	Treatment	Average AC Depth (mm)	Average Total Depth (mm)	Subgrade Mr (kPa)	Pavement Modulus (kPa)	Effective Existing SN	Subgrade Mr (kPa)	Pavement Modulus (kPa)	Effective Existing SN	Subgrade Mr	Pavement Modulus	Effective Existing SN
0+100 - 0+220	Undercut	110	760	163064	658346	159	120349	642962	157	-26.20	-2.34	-1.26
0+220 - 0+600	Geogrid	115	800	52273	448042	147	57420	546419	157	9.85	21.96	6.80
0+600-0+700	Control	115	865	47305	366081	149	56368	445187	159	19.16	21.61	6.71
0+700 - 2+770	Reclaim	115	800	51199	389413	140	55552	497300	152	8.50	27.71	8.57
2+770 - 3+270	Geogrid	95	795	43596	399903	141	43600	446052	146	0.01	11.57	3.55
3+270 - 3+390	Control	110	750	54539	392367	132	52606	483008	141	-3.54	23.10	6.82
3+390 - 3+520	Geogrid	115	655	49332	445664	120	45341	538150	128	-8.09	20.75	6.67
3+520 - 5+120	Reclaim	110	700	50822	390489	123	49742	488167	132	-2.13	25.01	7.32
5+120 - 5+320	Geogrid	120	800	45496	426052	144	47208	502440	153	3.76	17.93	6.25
5+320 - 5+400	Undercut	165	585	50564	524946	113	49382	717667	126	-2.34	36.71	11.50
5+400 - 6+040	Reclaim	115	765	45781	371220	132	46646	466068	142	1.89	25.55	7.58





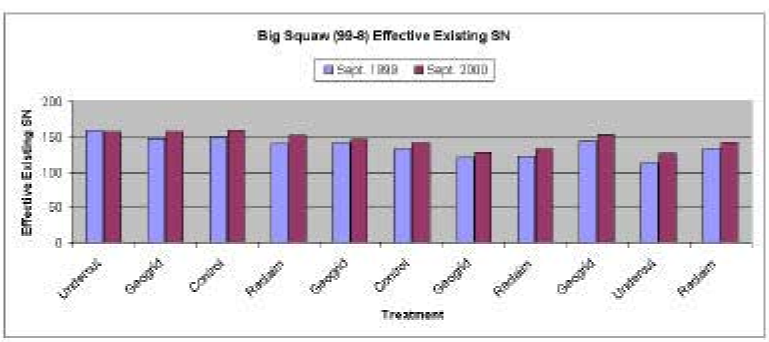
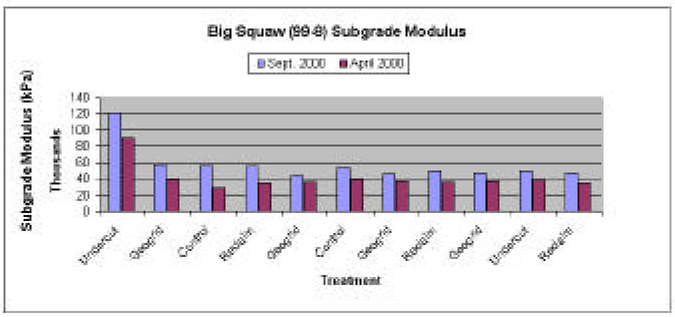
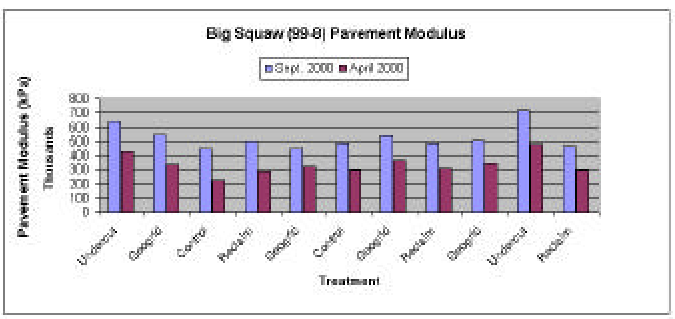


TABLE IV

Big Squaw - Route #15 (99-8)
FWD Analysis
April 2000/September 2000

				September, 2000			April, 2000			Percent Change September to April		
Section Location	Treatment	Average AC Depth (mm)	Average Total Depth (mm)	Subgrade Mr (kPa)	Pavement Modulus (kPa)	Effective Existing SN	Subgrade Mr (kPa)	Pavement Modulus (kPa)	Effective Existing SN	Subgrade Mr	Pavement Modulus	Effective Existing SN
0+100 - 0+220	Undercut	110	780	120349	642962	157	91096	424093	137	-24.31	-34.04	-12.74
0+220 - 0+600	Geogrid	115	800	57420	546419	157	38635	334536	133	-32.72	-38.78	-15.29
0+600-0+700	Control	115	865	56368	445187	159	29160	223975	126	-48.27	-49.69	-20.75
0+700 - 2+770	Reclaim	115	800	55552	497300	152	34141	286733	127	-38.54	-42.34	-16.45
2+770 - 3+270	Geogrid	95	795	43600	446052	146	35636	320267	131	-18.27	-28.20	-10.27
3+270 - 3+390	Control	110	750	52606	483008	141	38510	292673	120	-26.80	-39.41	-14.89
3+390 - 3+520	Geogrid	115	655	45341	538150	128	37099	366438	112	-18.18	-31.91	-12.50
3+520 - 5+120	Reclaim	110	700	49742	488167	132	35773	305012	113	-28.08	-37.52	-14.39
5+120 - 5+320	Geogrid	120	800	47208	502440	153	37190	342618	134	-21.22	-31.81	-12.42
5+320 - 5+400	Undercut	165	585	49382	717667	126	37343	481703	110	-24.38	-32.88	-12.70
5+400 - 6+040	Reclaim	115	785	46646	468068	142	34065	296020	122	-26.97	-36.49	-14.08





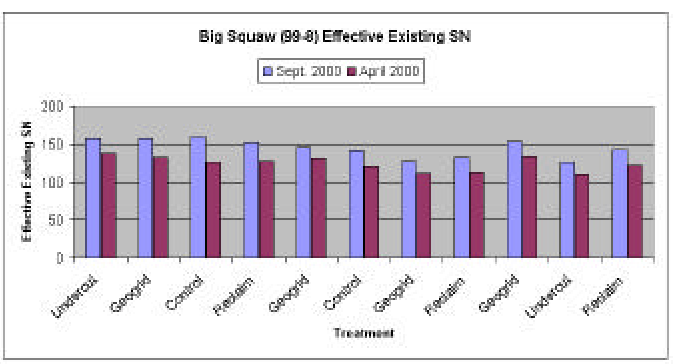


TABLE V

Big Squaw - Route #15 (99-8)
IRI Readings (By Section)
Sept.1999 - Sept. 2000

Section Number	Section Location	Treatment	IRI (Sept. 1999) (Meters/Kilometer)	IRI (Sept. 2000) (Meters/Kilometer)
1	0+100 - 0+220	Undercut	1.24	1.16
2	0+220 - 0+600	Geogrid	1.09	1.17
3	0+600-0+700	Control	1.05	1.06
4	0+700 - 2+770	Reclaim	1.10	1.24
5	2+770 - 3+270	Geogrid	1.07	1.23
6	3+270 - 3+390	Control	0.85	1.15
7	3+390 - 3+520	Geogrid	1.10	1.63
8	3+520 - 5+120	Reclaim	1.08	1.31
9	5+120 - 5+320	Geogrid	1.16	1.32
10	5+320 - 5+400	Undercut	1.12	1.18
11	5+400 - 6+040	Reclaim	1.23	1.37

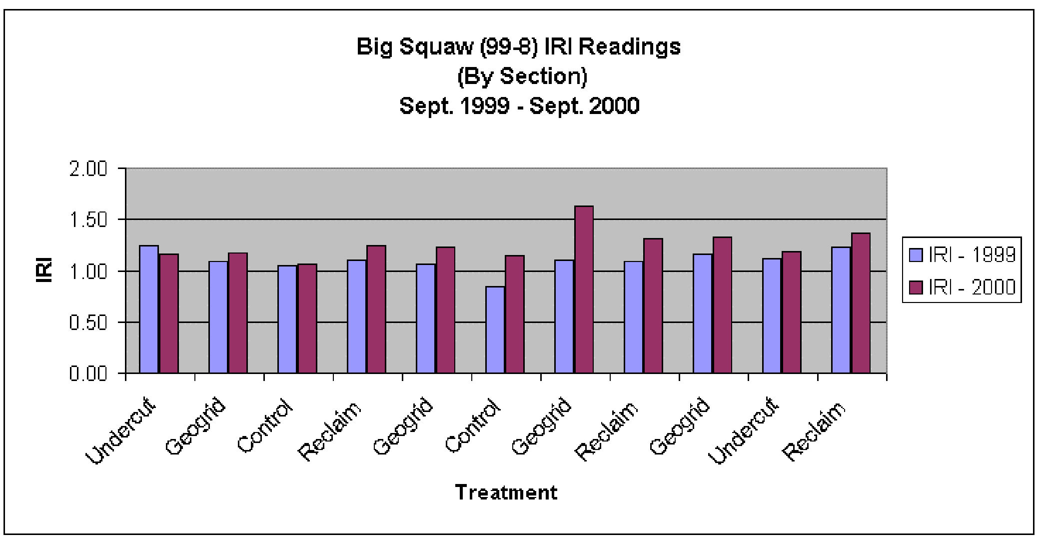


TABLE VI

Big Squaw Route #15 (99-8)
Average Rut Depths (By Section)
1999-2000

Section Number	Section Location	Treatment	Average Rut Depth Sept. 1999 (Millimeters)	Average Rut Depth Sept. 2000 (Millimeters)	Change	Percent Change
1	0+100 - 0+220	Undercut	3.7	3.38	0.32	-8.65
2	0+220 - 0+600	Geogrid	3.57	3.58	-0.01	0.28
3	0+600-0+700	Control	3.44	3.2	0.24	-6.98
4	0+700 - 2+770	Reclaim	3.61	3.54	0.07	-1.94
5	2+770 - 3+270	Geogrid	3.68	3.43	0.25	-6.79
6	3+270 - 3+390	Control	3.75	3.3	0.45	-12.00
7	3+390 - 3+520	Geogrid	3.88	3.75	0.13	-3.35
8	3+520 - 5+120	Reclaim	3.66	3.71	-0.05	1.37
9	5+120 - 5+320	Geogrid	3.56	3.53	0.03	-0.84
10	5+320 - 5+400	Undercut	3.83	3.13	0.7	-18.28
11	5+400 - 6+040	Reclaim	3.64	3.49	0.15	-4.12

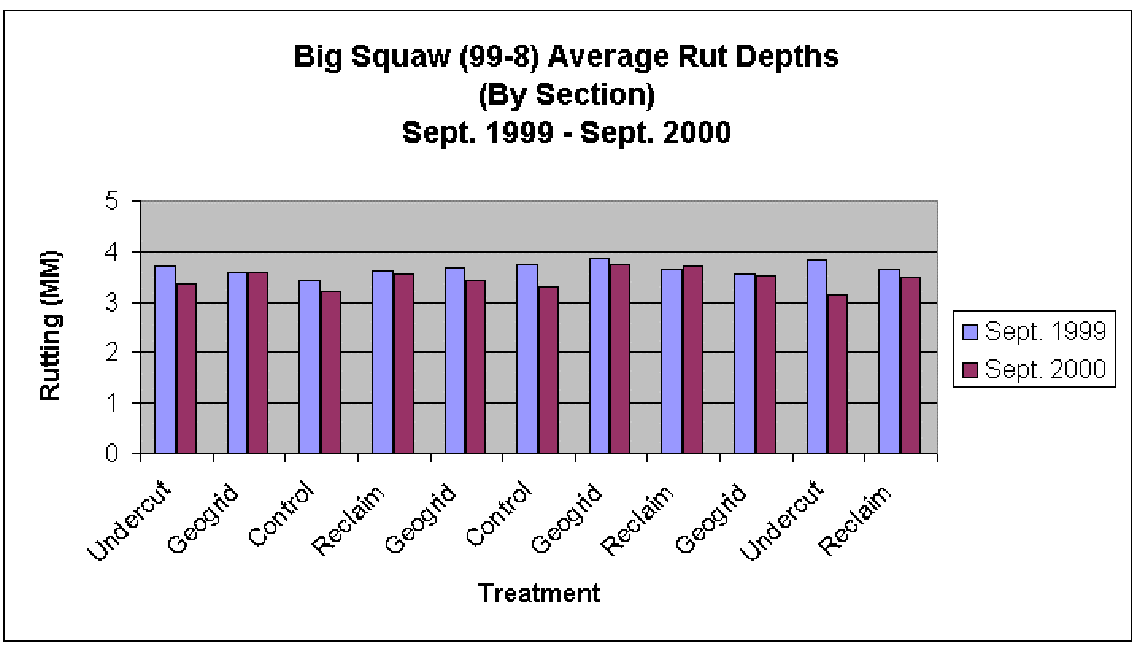


TABLE VII

Big Squaw - Route #15 (99-8)
IRI Readings (By Section)
April 2000 - Sept. 2000

Section Number	Section Location	Treatment	IRI (April 2000) (Meters/Kilometer)	IRI (Sept. 2000) (Meters/Kilometer)
1	0+100 - 0+220	Undercut	1.72	1.16
2	0+220 - 0+600	Geogrid	1.49	1.17
3	0+600-0+700	Control	1.54	1.06
4	0+700 - 2+770	Reclaim	1.56	1.24
5	2+770 - 3+270	Geogrid	1.47	1.23
6	3+270 - 3+390	Control	1.44	1.15
7	3+390 - 3+520	Geogrid	1.88	1.63
8	3+520 - 5+120	Reclaim	1.66	1.31
9	5+120 - 5+320	Geogrid	1.58	1.32
10	5+320 - 5+400	Undercut	1.53	1.18
11	5+400 - 6+040	Reclaim	1.71	1.37

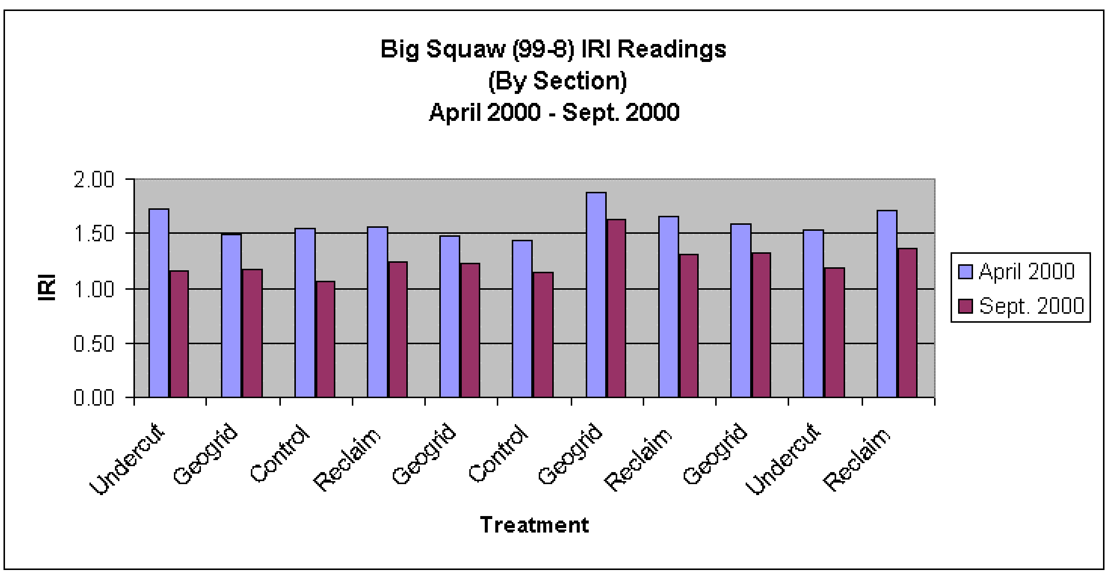


TABLE VIII

Big Squaw Route #15 (99-8)
Average Rut Depths (By Section)
April 2000 - Sept. 2000

Section Number	Section Location	Treatment	Average Rut Depth April 2000 (Millimeters)	Average Rut Depth Sept. 2000 (Millimeters)	Change	Percent Change
1	0+100 - 0+220	Undercut	3.46	3.38	0.08	-2.31
2	0+220 - 0+600	Geogrid	3.4	3.58	-0.18	5.29
3	0+600-0+700	Control	3.2	3.2	0	0.00
4	0+700 - 2+770	Reclaim	3.38	3.54	-0.16	4.73
5	2+770 - 3+270	Geogrid	3.03	3.43	-0.4	13.20
6	3+270 - 3+390	Control	3.15	3.3	-0.15	4.76
7	3+390 - 3+520	Geogrid	3.53	3.75	-0.22	6.23
8	3+520 - 5+120	Reclaim	3.16	3.71	-0.55	17.41
9	5+120 - 5+320	Geogrid	3.21	3.53	-0.32	9.97
10	5+320 - 5+400	Undercut	3.25	3.13	0.12	-3.69
11	5+400 - 6+040	Reclaim	3.23	3.49	-0.26	8.05

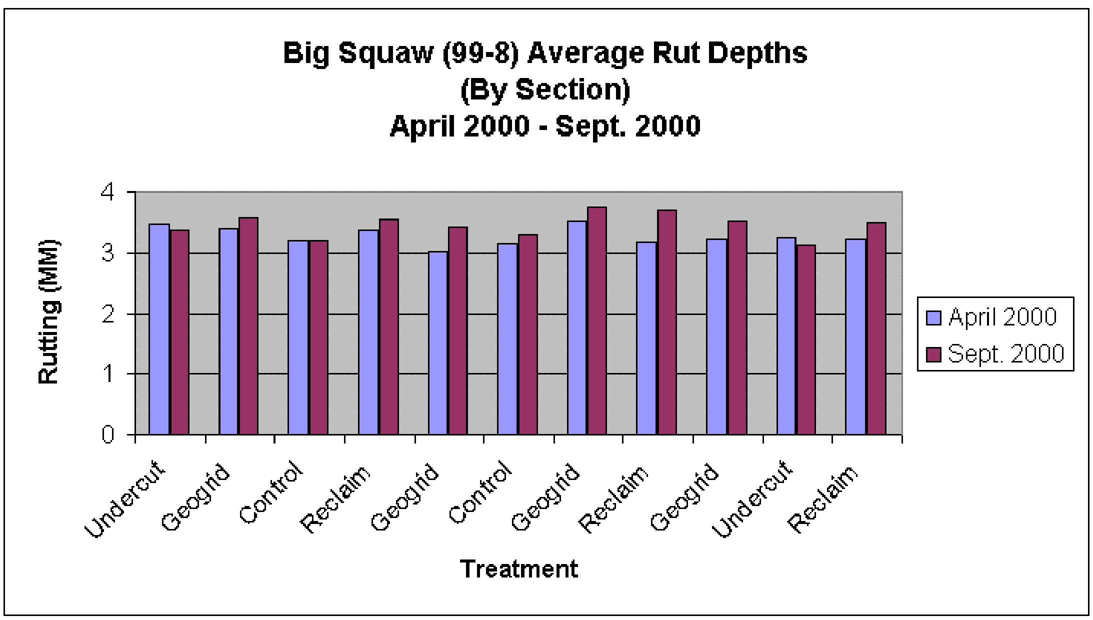


TABLE IX

Big Squaw - Route #15 (99-8)
Rolling Dipstick (Sept. 1999 - Sept. 2000)
International Roughness Index (IRI)
(CULVERTS)

Culvert Location	Treatment	Average IRI Sept. 1999 (Meters/Kilometer)	Average IRI Sept. 2000 (Meters/Kilometer)
2+314	Reclaim	0.7	0.87
2+957	Geogrid	0.86	0.87
3+110	Geogrid	1.15	1.3
3+432	Geogrid	2	3.09
4+221	Reclaim	0.71	0.79
5+162	Geogrid	0.74	0.92
5+349	Control	1.12	1.06
5+459	Reclaim	1.08	1.06

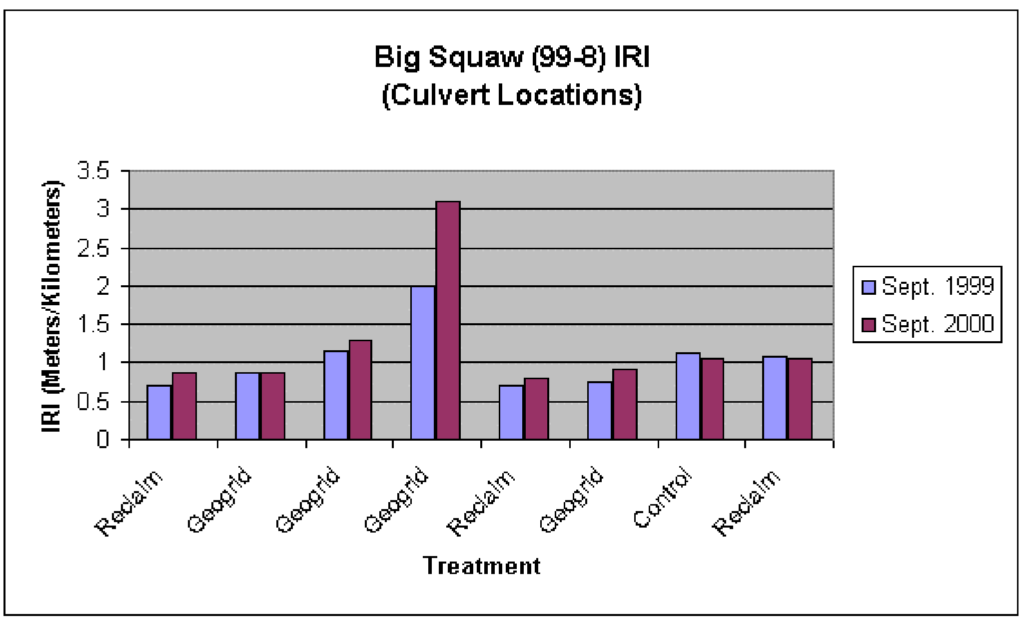


TABLE X

Big Squaw - Route #15 (99-8)
Rolling Dipstick (March 2000 - Sept. 2000)
International Roughness Index (IRI)
(CULVERTS)

Culvert Location	Treatment	Average IRI March 2000 (Meters/Kilometer)	Average IRI Sept. 2000 (Meters/Kilometer)	Percent Change Sept. - March
2+314	Reclaim	4.66	0.87	435.63
2+957	Geogrid	2.18	0.87	150.57
3+110	Geogrid	3.06	1.3	135.38
3+432	Geogrid	4.08	3.09	32.04
4+221	Reclaim	1.73	0.79	118.99
5+162	Geogrid	3.99	0.92	333.70
5+349	Control	2.97	1.06	180.19
5+459	Reclaim	2.71	1.06	155.66