W.A. Meneley Consultants Ltd.
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December 4, 1988

0094-054

Mr. Mart Cram, P.Eng.
Saskatchewan Water Corporation
P.O. Bag 1000
Outlook, Saskatchewan
S0l 2N0

Hydrogeologic Assessment of the
Hillcrest Irrigation Project

Dear Mart:

This letter accompanies our evaluation of the Hillcrest Irrigation Project which was carried out at your request.

If you have any questions concerning the interpretation of our findings please contact Les Henry directly as I will be out of the country until February 6, 1989.

Yours sincerely

W.A. Meneley, P.Eng.

WAM/wp
attachments

ASSOCIATION OF PROFESSIONAL ENGINEERS
OF SASKATCHEWAN
CERTIFICATE OF AUTHORIZATION
W.A. MENELEY CONSULTANTS LTD.
NUMBER 297
PERMISSION TO CONSULT HELD BY:

DISCIPLINE	SASK. REG. No.	SIGNATURE
Geological	1673	

HYDROGEOLOGIC ASSESSMENT OF THE HILLCREST IRRIGATION PROJECT

by

J.L. Henry, P. Ag., E.A. Christiansen, P. Eng.
and W.A. Meneley, P. Eng.

0094-054 December 5, 1988

Table of Contents

Appendices

Illustrations

HYDROGEOLOGIC ASSESSMENT OF THE HILLCREST IRRIGATION PROJECT

by

J.L. Henry, P. Ag., E.A. Christiansen, P.Eng.
and W.A. Meneley, P. Eng.

1.0 AREA OF STUDY AND TERMS OF REFERENCE

The original communication requesting a proposal for this study (Wiens to Meneley, May 20, 1988) showed the area of study to be:

Section 35-32-04-W3rd M

North 1/2 36-32-04-W3rd M

All of sections 1 and 2 33-04-W3rd M

SW 11-33-04-W3rd M

Section 12-33-04-W3rd M

East 1/2 13-33-04-W3rd M

Section 7-33-03-W3rd M

Based on those locations a two phase program of evaluation was proposed. Phase I was a preliminary reconnaissance of hydrogeologic and soil conditions on the project, and Phase II was a groundwater survey with preparation of a hydrogeologic cross section based on existing information. It was recognized that a third phase involving exploration drilling or installation of monitoring wells might be required, but this could not be predicted until the first two phases were completed.

At the time of obtaining authority to proceed (Cram to Meneley, July 12, 1988) additional parcels of land were added to the project. These parcels were:

SE 22-33-04-W3rd M
and
Two quarter section pivots in section 23-33-04-W3rd M

The pivots in section 23 would be situated to take best advantage of available terrain. They would include

portions of all four quarters but would be predominantly in the south half of the section.

The addition of these new parcels of land, along with information from Phase I, required that more detailed information be obtained. The original lands were predominantly above 1800 feet elevation, whereas the new lands added were predominantly below 1775 feet elevation. The SE 22-33-04-W3rd M was almost all below 1750 feet elevation and a portion was below 1725 feet elevation.

Thus, a third phase was instituted, which involved hydraulic rotary drilling to a suitable geologic datum, and test hole augering to document the near surface stratigraphy.

2.0 METHODS OF INVESTIGATION AND INFORMATION UTILIZED

2.1 Phases I and II

Phases I and II involved procurement and analysis of all available hydrogeology and related soils information. This included all the documents listed in the references section plus soil investigation reports obtained from the files of the Saskatchewan Water Corporation. The availability of a recent water well survey in the area (Remenda, 1987) meant that only four wells had to be sampled for this study.

In addition, on July 1, 1988 preliminary field inspection was carried out by J. L. Henry and E. A. Christiansen. This inspection was based on the original parcels of land and did not include SE 22 and Section 23-33-04W3 M.

Based on existing information and reconnaissance field inspection, a preliminary geologic cross section was prepared (Drawing 0121-001-01, E.A. Christiansen Consulting Ltd.). This preliminary drawing was used as a guide to direct test hole drilling and is not included with this report.

2.2 Phase III

Phase III involved the drilling of one deep test hole (Dundurn 01) to a suitable geologic datum using hydraulic rotary drilling equipment and standard techniques thereto (Sauer and Beckie, 1975; Hogg and Henry, 1985). This information was used to establish the base of exploration for subsequent test hole augering to the top of the Floral Formation.

One piezometer was installed using hydraulic rotary equipment and two piezometers were installed using the auger. These installations utilized 2" PVC 10 slot screen connected to 2" PVC schedule 40 casing. They were packed with fracsand and sealed with cement or barite.

3.0 RESULTS AND RECOMMENDATIONS

3.1 Results

Examination of existing hydrogeology and soils information established that all lands except SE 22 and Section 23-33-04-W3 were at elevations well above the piezometric surface of aquifers within the area. The very few saline conditions that are encountered within the southern land parcels are associated with slow drainage of sloughs and evaporite rings forming around these sloughs. Thus, surface drainage will be an important consideration in the irrigation of these lands.

Detailed test hole drilling on SE 22 and Section 23-33-04-W3 established the existence of a bedrock aquifer which is the Ardkenneth member of the Bearpaw Formation and in which both Jacob Willms and Dan Willms currently have producing wells. The piezometric surface of that aquifer is 1727' (J. Willms, 28/08/81).

In addition, the test hole drilling and piezometer construction program established that a glacial aquifer (Test Hole Dundurn 01, Appendix A) was present with a piezometric surface of 1736 feet above sea level. Cross section A - A' (Figure 1) and cross section B - B' (Figure 2) showed the position of these aquifers relative to the parcels of land under consideration.

Based on the information assembled to this stage, it was considered not feasible to proceed with irrigation of SE 22-33-04-W3 because a large portion of that quarter section occurs below the piezometric surface of the known aquifer systems. Based on detailed studies elsewhere, irrigation of such a hydrogeologic environment will cause soil salinization (Henry et al, 1988).

The rotary test hole drilling program also established the base of exploration for test hole augering as the top of the Floral Formation. Fifteen auger test holes were completed on Section 23 and N 1/2 14 and SE 22-33-04-W3. The detailed logs of the augering program are in Appendix A and cross section C - C' (Figure 3) illustrates the findings of the test hole augering.

The test hole augering showed the existence of sandy material on top of the till. It also showed that the existing topography is a good reflection of the Floral Formation surface. The very sharp texture break between sand and glacial till of the Floral surface will control the flow patterns of any excess irrigation water applied.

Thus, any excess water applied will infiltrate downward to the till surface and then tend to migrate laterally in a downslope direction. This water will tend to accumulate beneath the topographic depressions, causing waterlogging and salinization.

3.2 Recommendations

1. That irrigation proceed on all parcels outlined except SE 22-33-04-W3rd M.

2. That the question of surface drainage be addressed throughout the project. This is particulary crucial in the southern portion of the project where the topography is a rolling moraine with numerous undrained depressions. Drainage of these depressions will be required to ensure the long term viability of the project.

3. That careful monitoring be conducted in the irrigation of Section 23 and NW 14-33-04-W3rd M. One piezometer currently exists within the sand on top of the till (Test Hole Dundurn No. 06), and this and other piezometers installed as part of this project should be monitored on a weekly basis throughout the growing season and a monthly basis throughout the rest of the year. We recommend that the operator (Dan Willms) be provided with the equipment and recording forms and carry out this monitoring. Additional shallow piezometers may be required to monitor shallow water tables.

4. To avoid excessive migration of water at the till surface, the irrigation should be carefully scheduled to avoid over-irrigation.

4.0 REFERENCES

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ELLIS, J.G., ACTON, D.F. and MOSS, H.C., 1970. The soils of the Rosetown map area (720/16), Saskatchewan. Ext. Pub. 202, University of Saskatchewan, Saskatoon.

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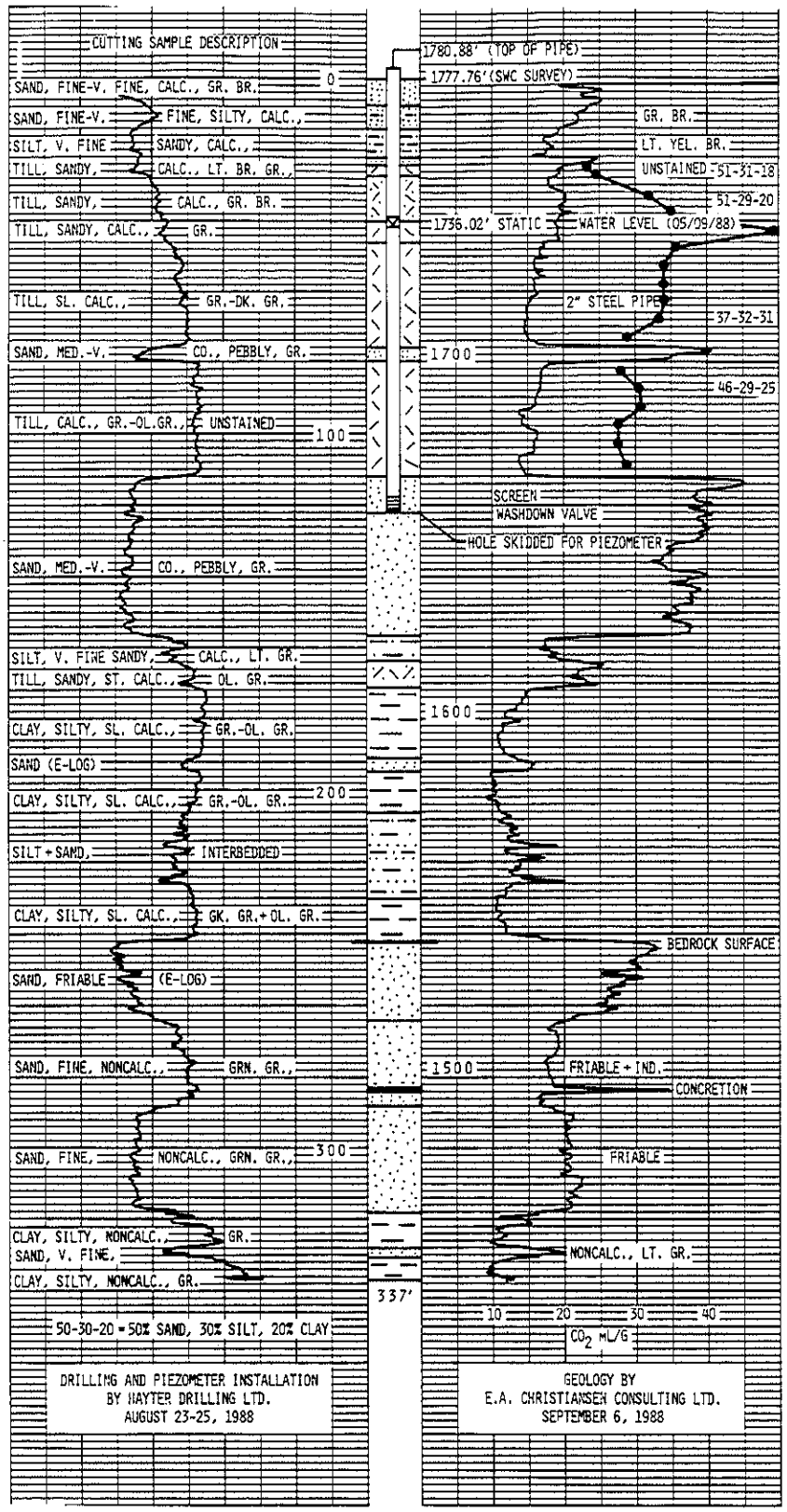
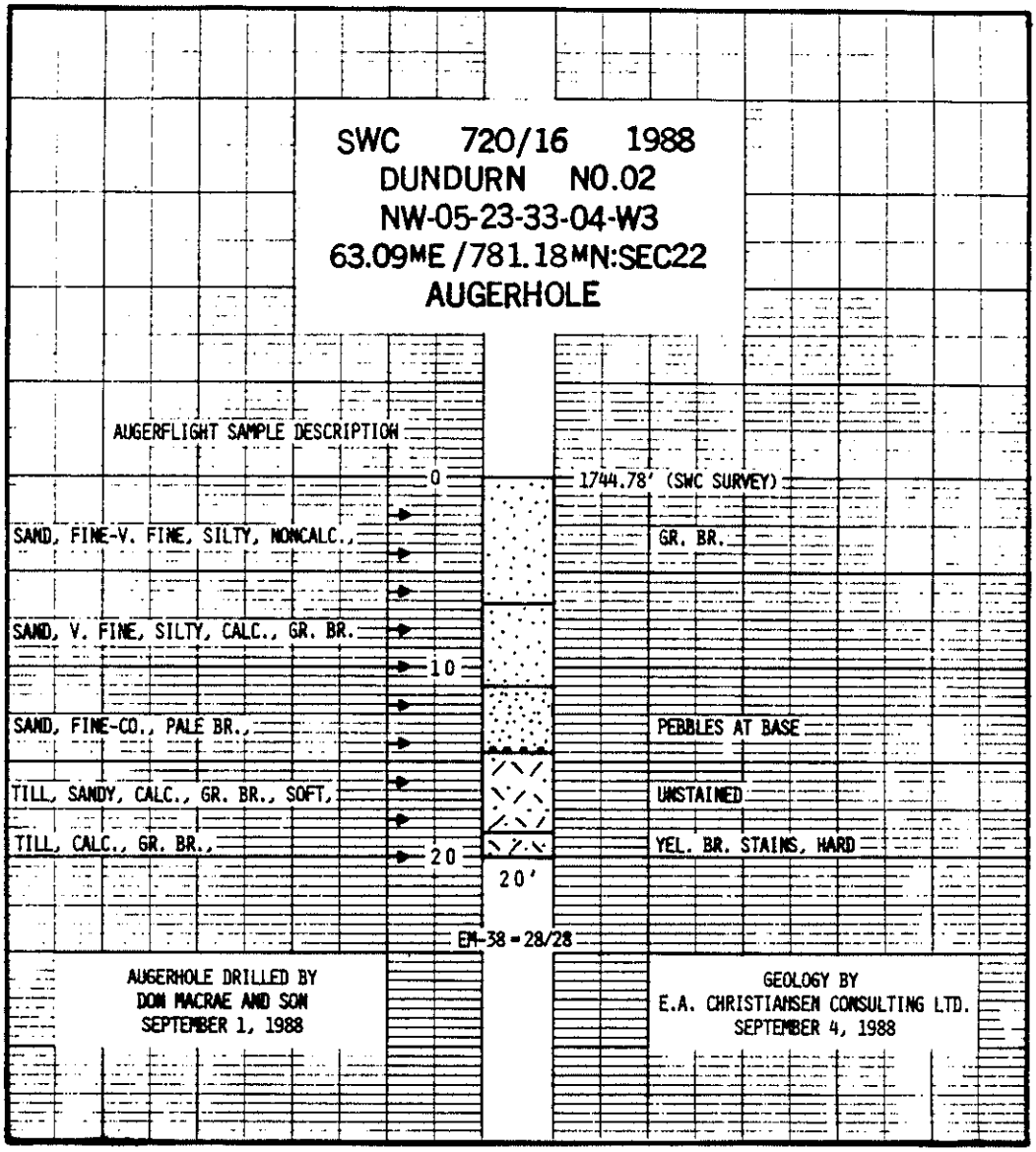


SWC 720/16 1988
DUNDURN NO.01
SE-11-23-33-04-W3
627.02ME/864.65MN:SEC22
TESTHOLE & PIEZOMETER

ELEVATION 1777.76 FT.
SURVEY
SP COND MUD 1.2 mS/cm
SP COND WATER 1.2 mS/cm
SP 10 MV R 10 OHMS

E. A. Christiansen Consulting Ltd.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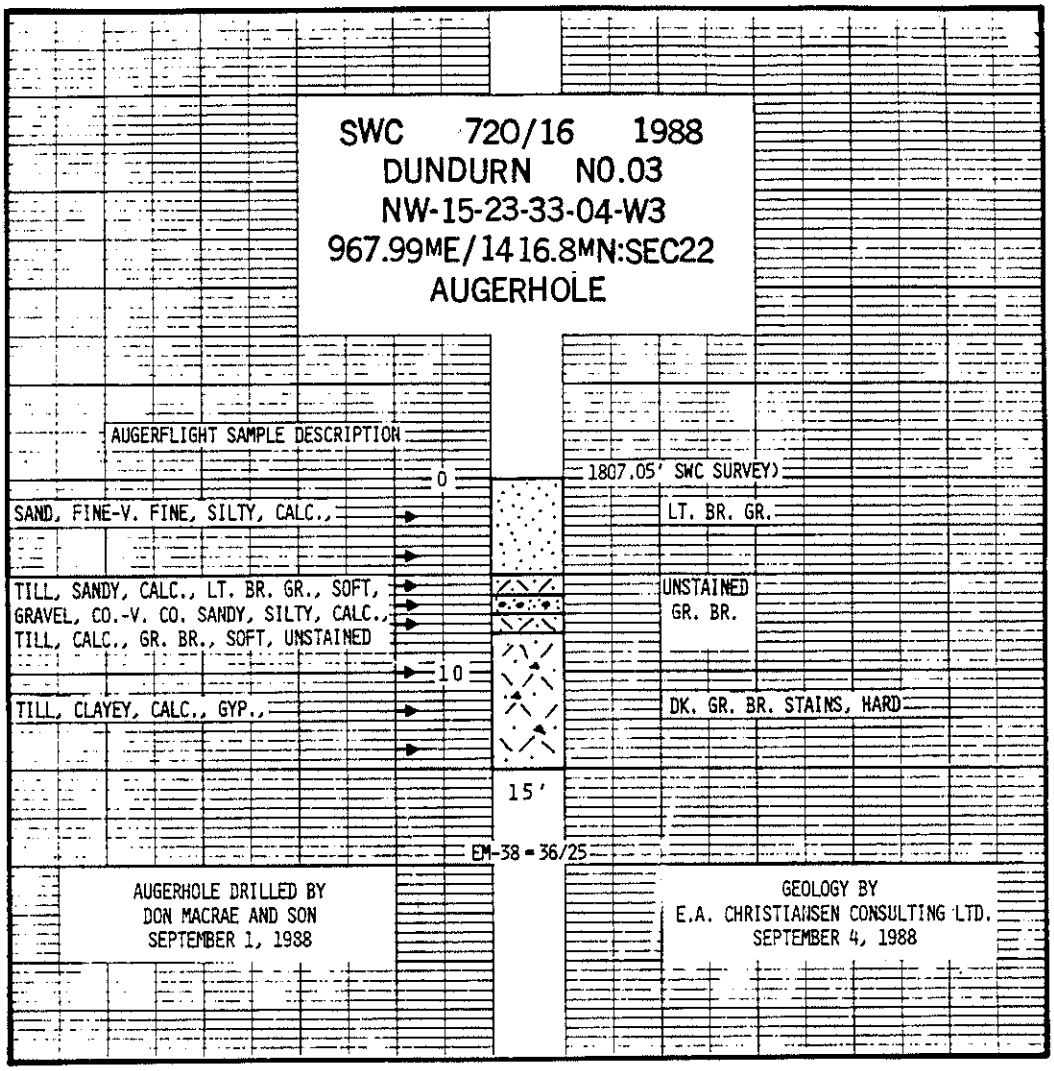
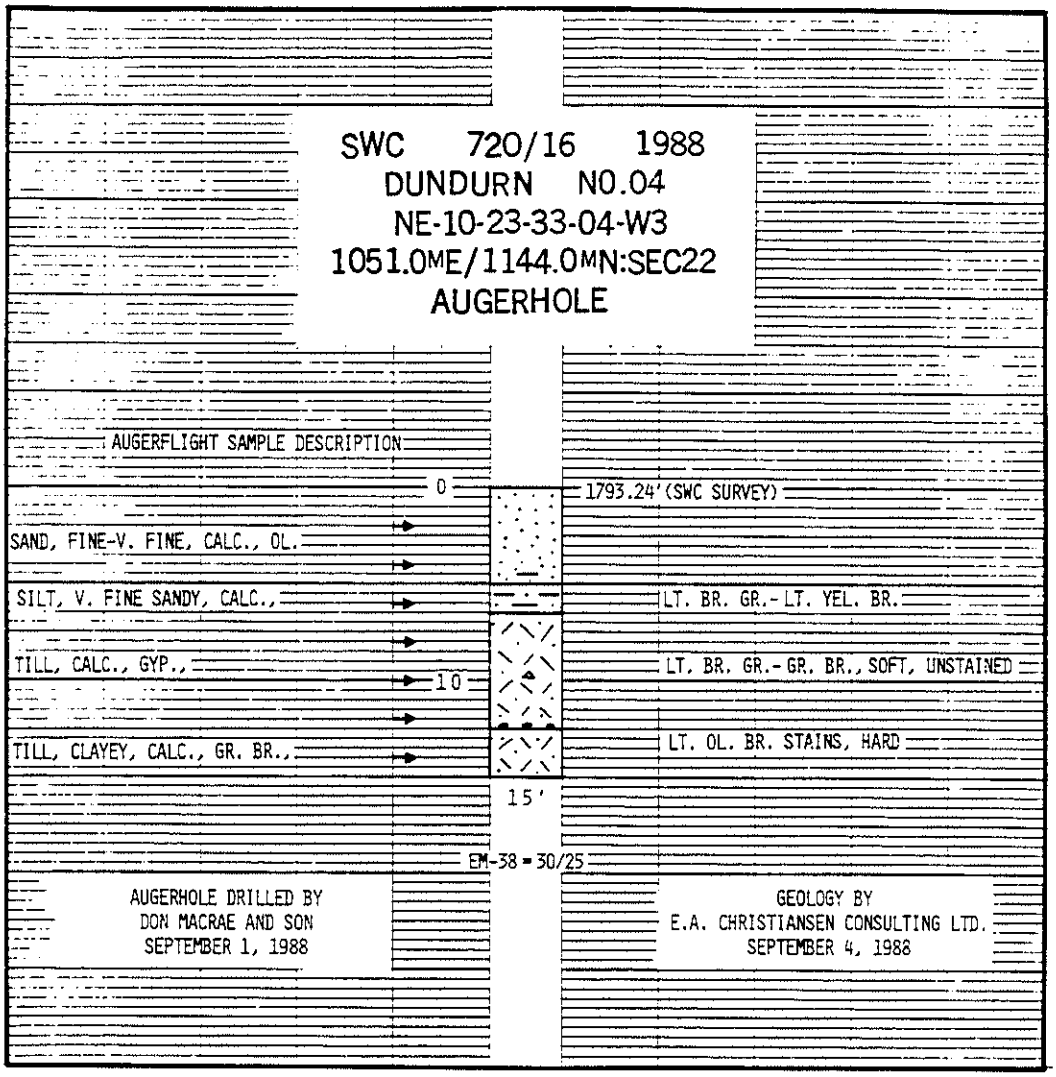
DUNDURN NO.02
NW-05-23-33-04-W3
63.09ME /781.18MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
10
20
SAND, FINE-V. FINE, SILTY, NONCALC.,
SAND, V. FINE, SILTY, CALC., GR. BR.
SAND, FINE-CO., PALE BR.,
TILL, SANDY, CALC., GR. BR., SOFT,
TILL, CALC., GR. BR.,
1744.78' (SWC SURVEY)
GR. BR.
PEBBLES AT BASE
UNSTAINED
YEL. BR. STAINS, HARD
20'
EM-38 = 28/28
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988


SWC 720/16 1988
DUNDURN NO.03
NW-15-23-33-04-W3
967.99ME/1416.8MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
SAND, FINE-V. FINE, SILTY, CALC.,
TILL, SANDY, CALC., LT. BR. GR., SOFT,
GRAVEL, CO.-V. CO. SANDY, SILTY, CALC.,
TILL, CALC., GR. BR., SOFT, UNSTAINED
10
TILL, CLAYEY, CALC., GYP.,
15'
EM-38 = 36/25
1807.05' SWC SURVEY)
LT. BR. GR.
UNSTAINED
GR. BR.
DK. GR. BR. STAINS, HARD
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988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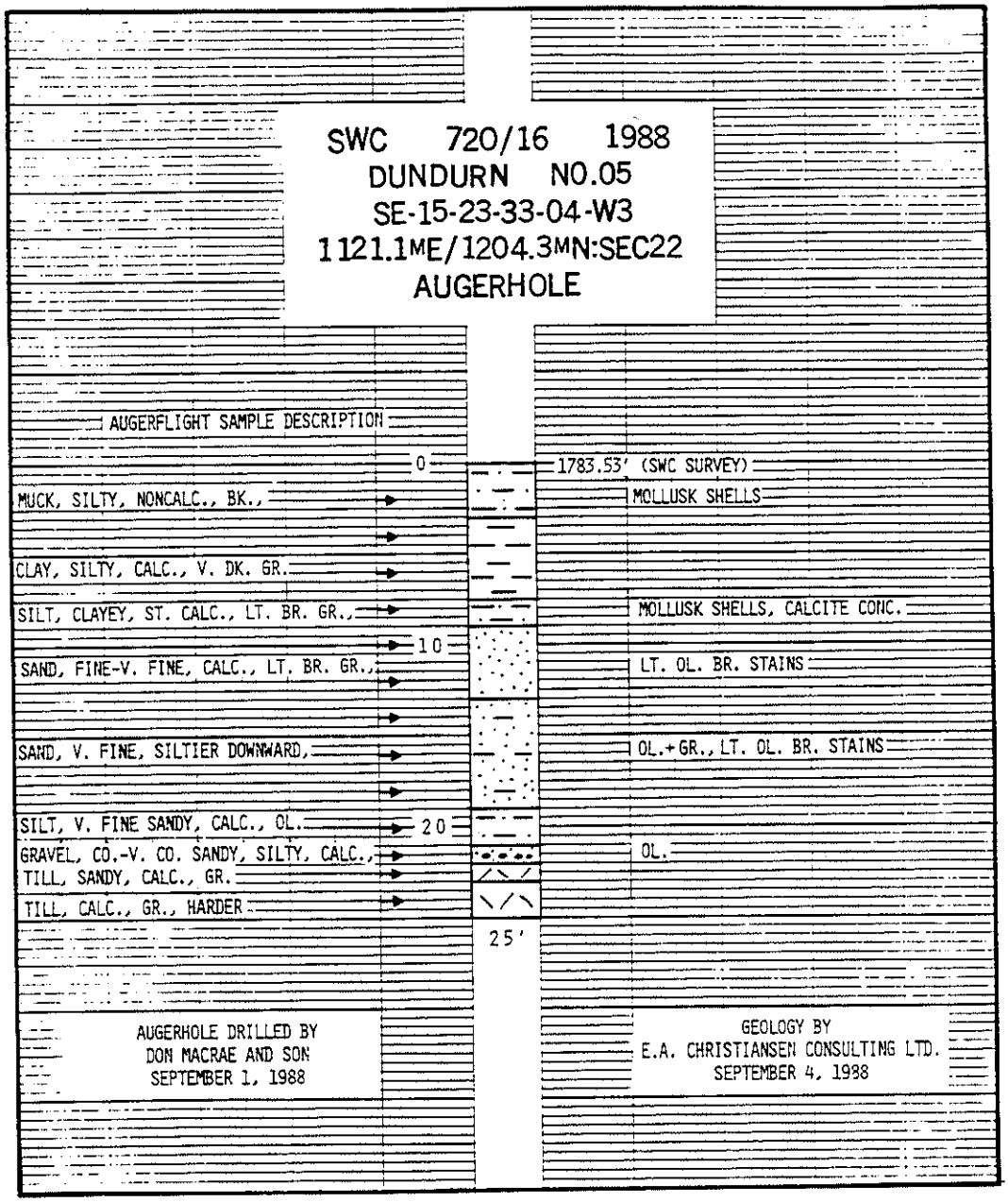
NE-10-23-33-04-W3
1051.0ME/1144.0MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
1793.24' (SWC SURVEY)
SAND, FINE-V. FINE, CALC., OL.
SILT, V. FINE SANDY, CALC.,
LT. BR. GR.-LT. YEL. BR.
TILL, CALC., GYP.,
LT. BR. GR.-GR. BR., SOFT, UNSTAINED
10
TILL, CLAYEY, CALC., GR. BR.,
LT. OL. BR. STAINS, HARD
15'
EM-38 = 30/25
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988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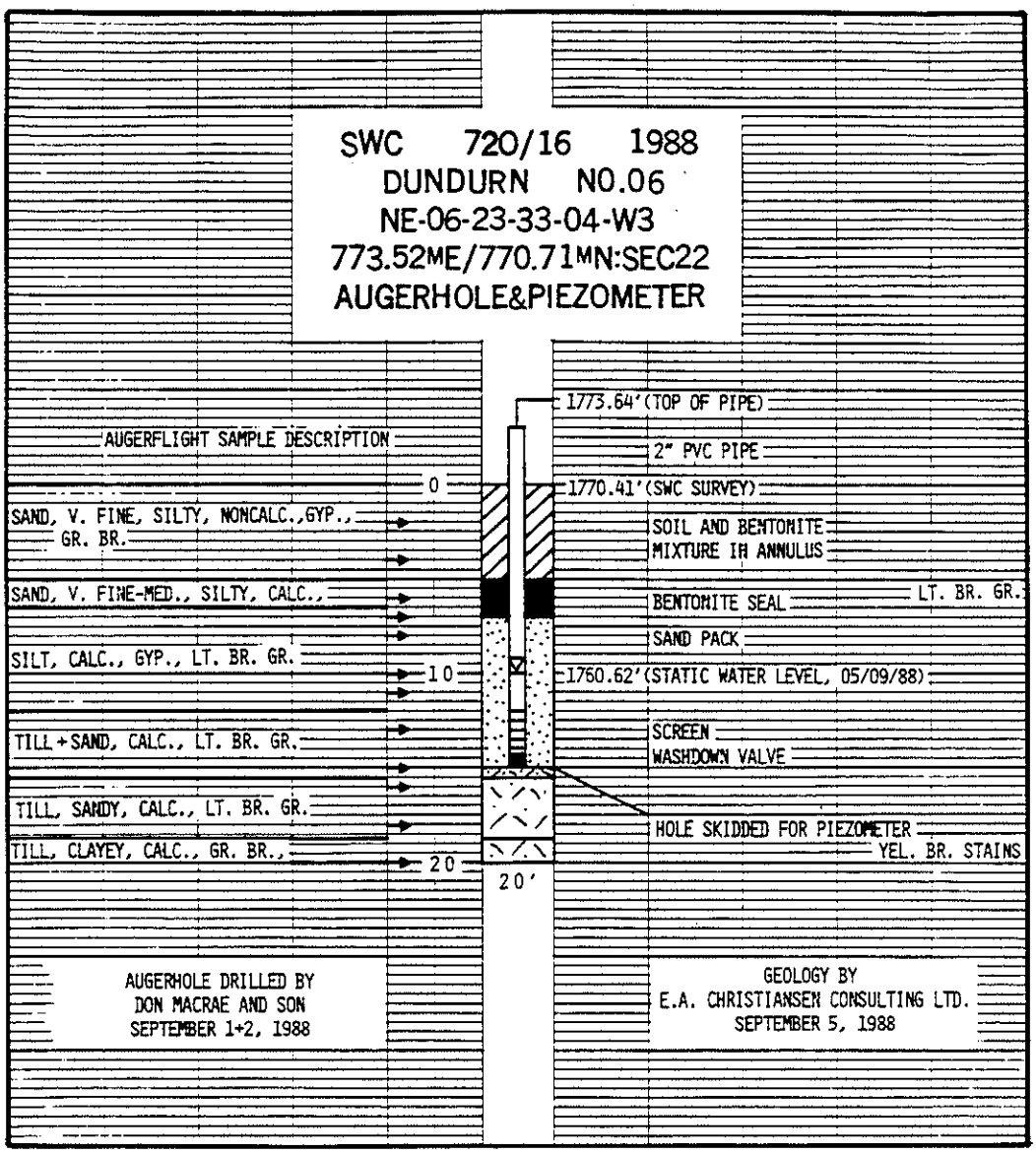
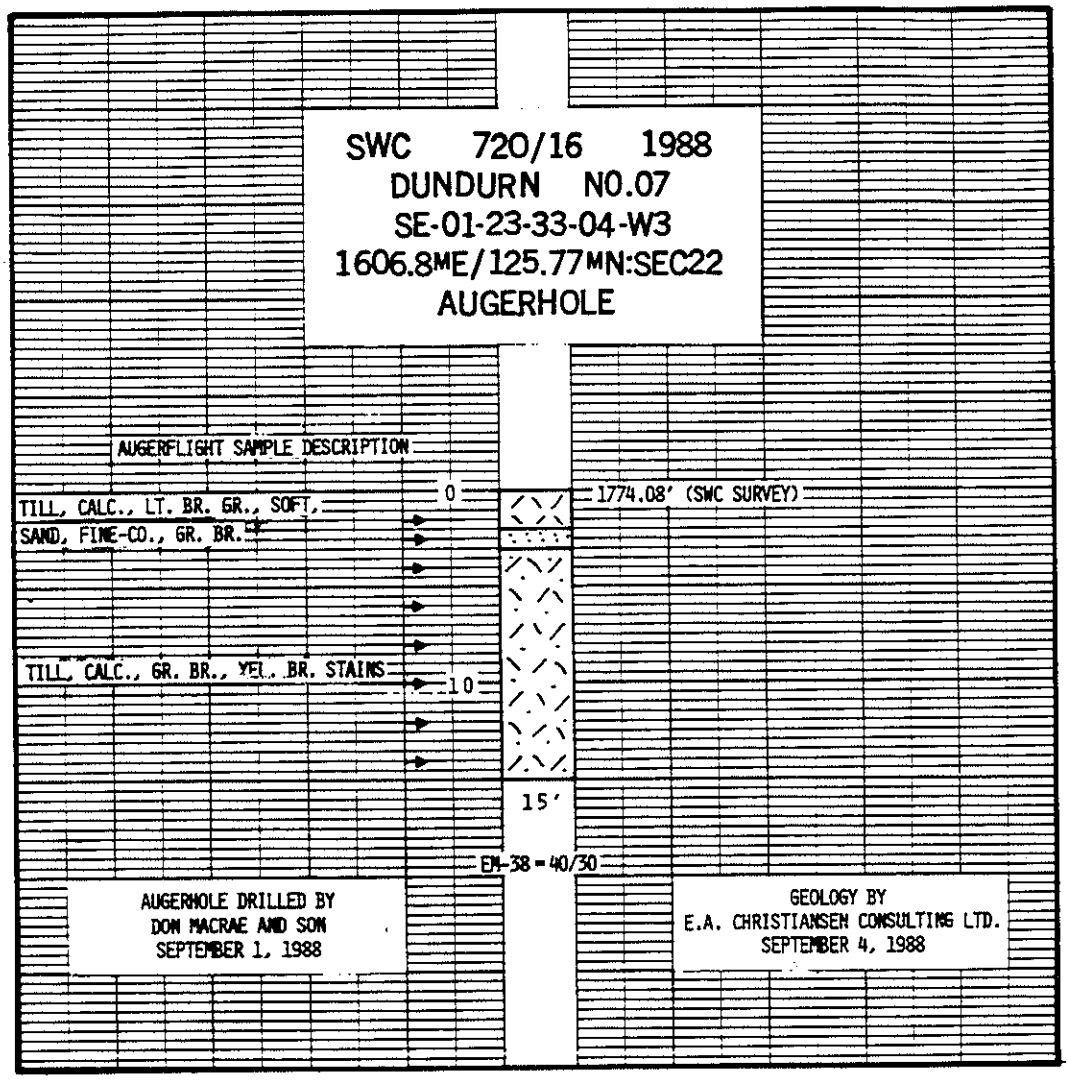
DUNDURN NO.05
SE-15-23-33-04-W3
1121.1ME/1204.3MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
MUCK, SILTY, NONCALC., BK.,
CLAY, SILTY, CALC., V. DK. GR.
SILT, CLAYEY, ST. CALC., LT. BR. GR.,
10
SAND, FINE-V. FINE, CALC., LT. BR. GR.,
SAND, V. FINE, SILTIER DOWNWARD,
SILT, V. FINE SANDY, CALC., OL.
20
GRAVEL, CO.-V. CO. SANDY, SILTY, CALC.,
TILL, SANDY, CALC., GR.
TILL, CALC., GR., HARDER
25'
1783.53' (SWC SURVEY)
MOLLUSK SHELLS
MOLLUSK SHELLS, CALCITE CONC.
LT. OL. BR. STAINS
OL.+GR., LT. OL. BR. STAINS
OL.
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988


SWC 720/16 1988
DUNDURN NO.06
NE-06-23-33-04-W3
773.52ME/770.71MN:SEC22
AUGERHOLE&PIEZOMETER
AUGERFLIGHT SAMPLE DESCRIPTION
0
SAND, V. FINE, SILTY, NONCALC.,GYP., GR. BR.
SAND, V. FINE-MED., SILTY, CALC.,
SILT, CALC., GYP., LT. BR. GR.
10
TILL+SAND, CALC., LT. BR. GR.
TILL, SANDY, CALC., LT. BR. GR.
TILL, CLAYEY, CALC., GR. BR.,
20
20'
1773.64'(TOP OF PIPE)
2" PVC PIPE
1770.41'(SWC SURVEY)
SOIL AND BENTONITE MIXTURE IN ANNULUS
BENTONITE SEAL
LT. BR. GR.
SAND PACK
1760.62'(STATIC WATER LEVEL, 05/09/88)
SCREEN
WASHDOWN VALVE
HOLE SKIDDED FOR PIEZOMETER
YEL. BR. STAINS
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1+2, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 5, 1988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DUNDURN N0.07
SE-01-23-33-04-W3
1606.8ME/125.77MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
TILL, CALC., LT. BR. GR., SOFT,
SAND, FINE-CO., GR. BR.
TILL, CALC., GR. BR., YEL. BR. STAINS
0
10
1774.08' (SWC SURVEY)
15'
EM-38 = 40/30
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
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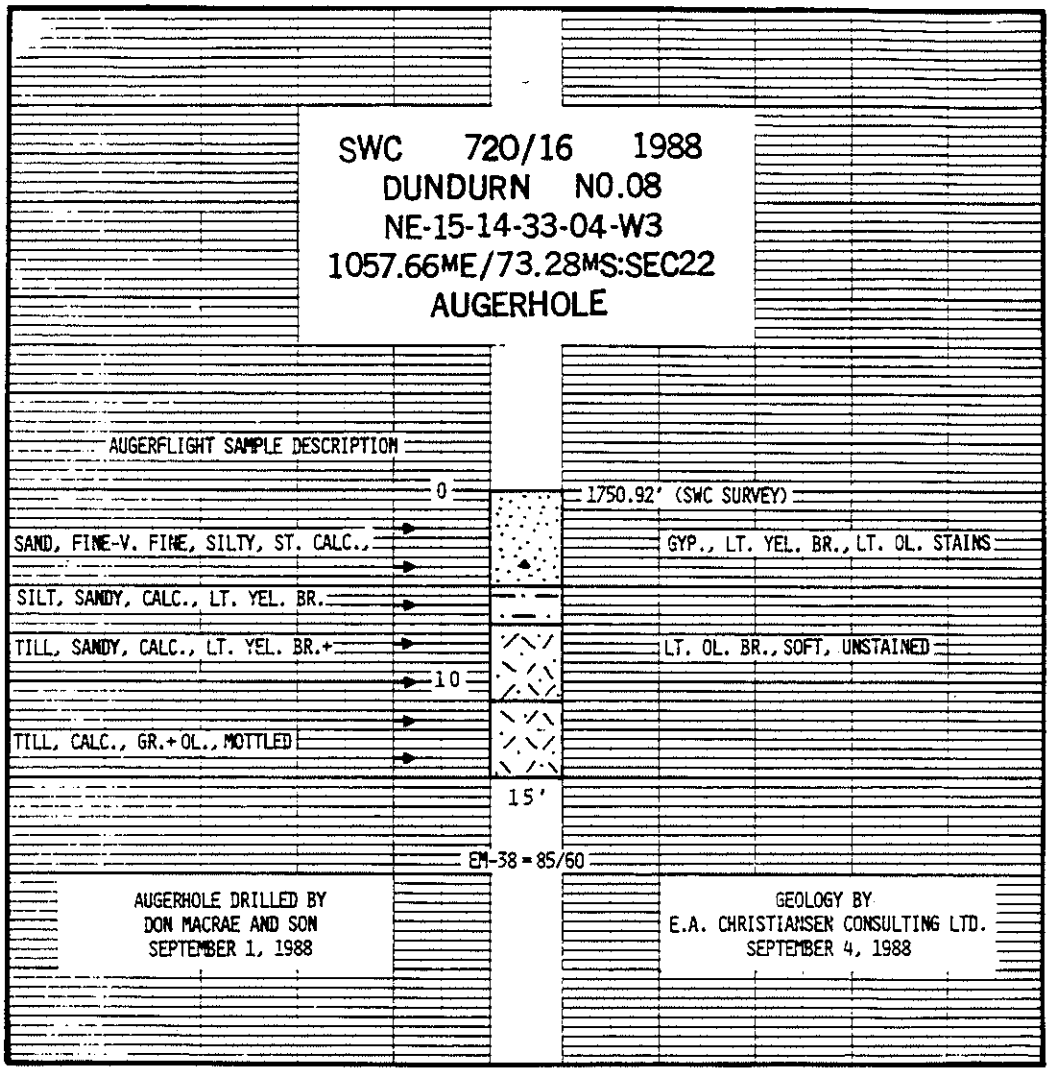
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988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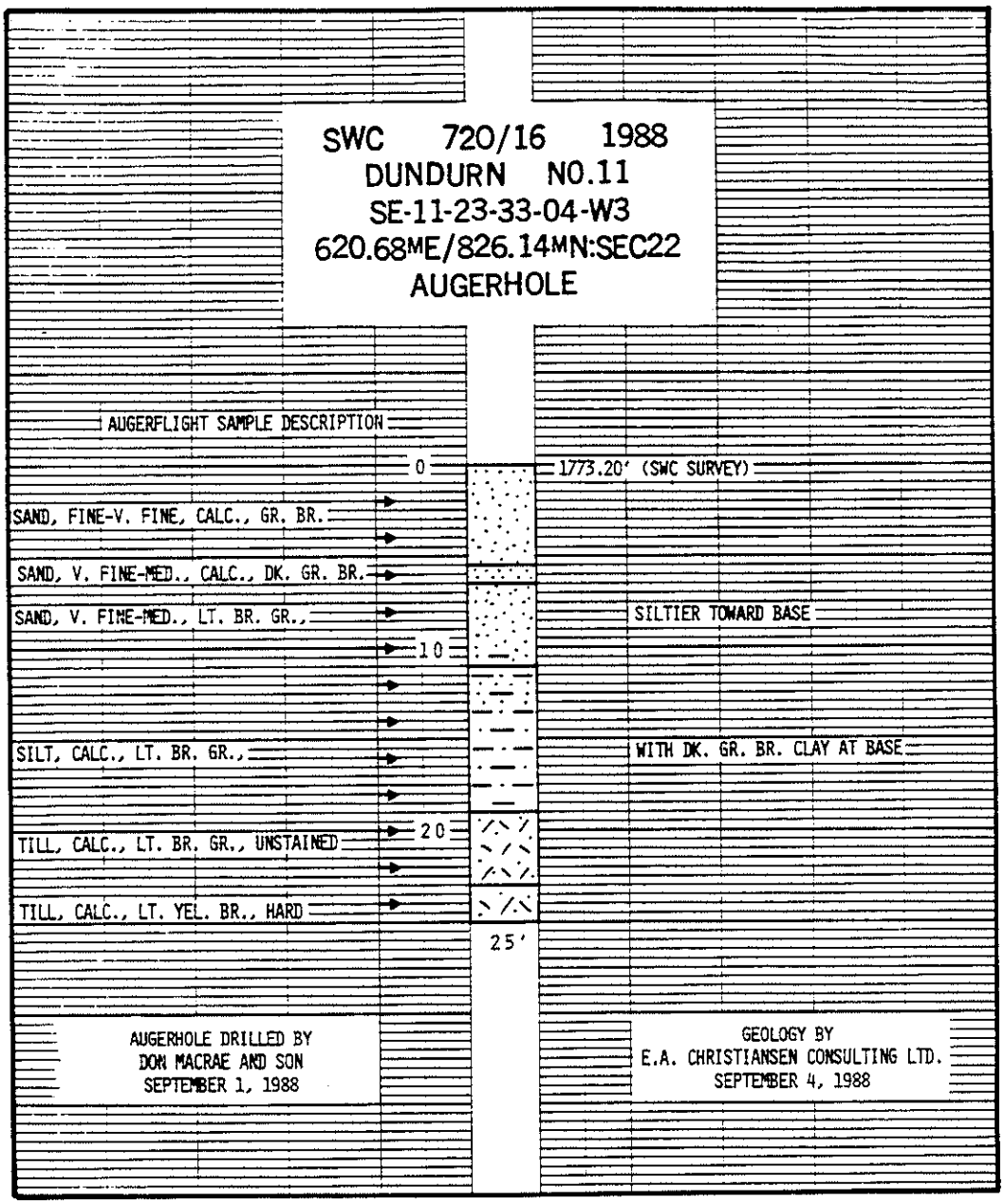
DUNDURN NO.08
NE-15-14-33-04-W3
1057.66ME/73.28MS:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
1750.92' (SWC SURVEY)
SAND, FINE-V. FINE, SILTY, ST. CALC.,
GYP., LT. YEL. BR., LT. OL. STAINS
SILT, SANDY, CALC., LT. YEL. BR.
TILL, SANDY, CALC., LT. YEL. BR.+
LT. OL. BR., SOFT, UNSTAINED
10
TILL, CALC., GR.+OL., MOTTLED
15'
EM-38 = 85/60
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988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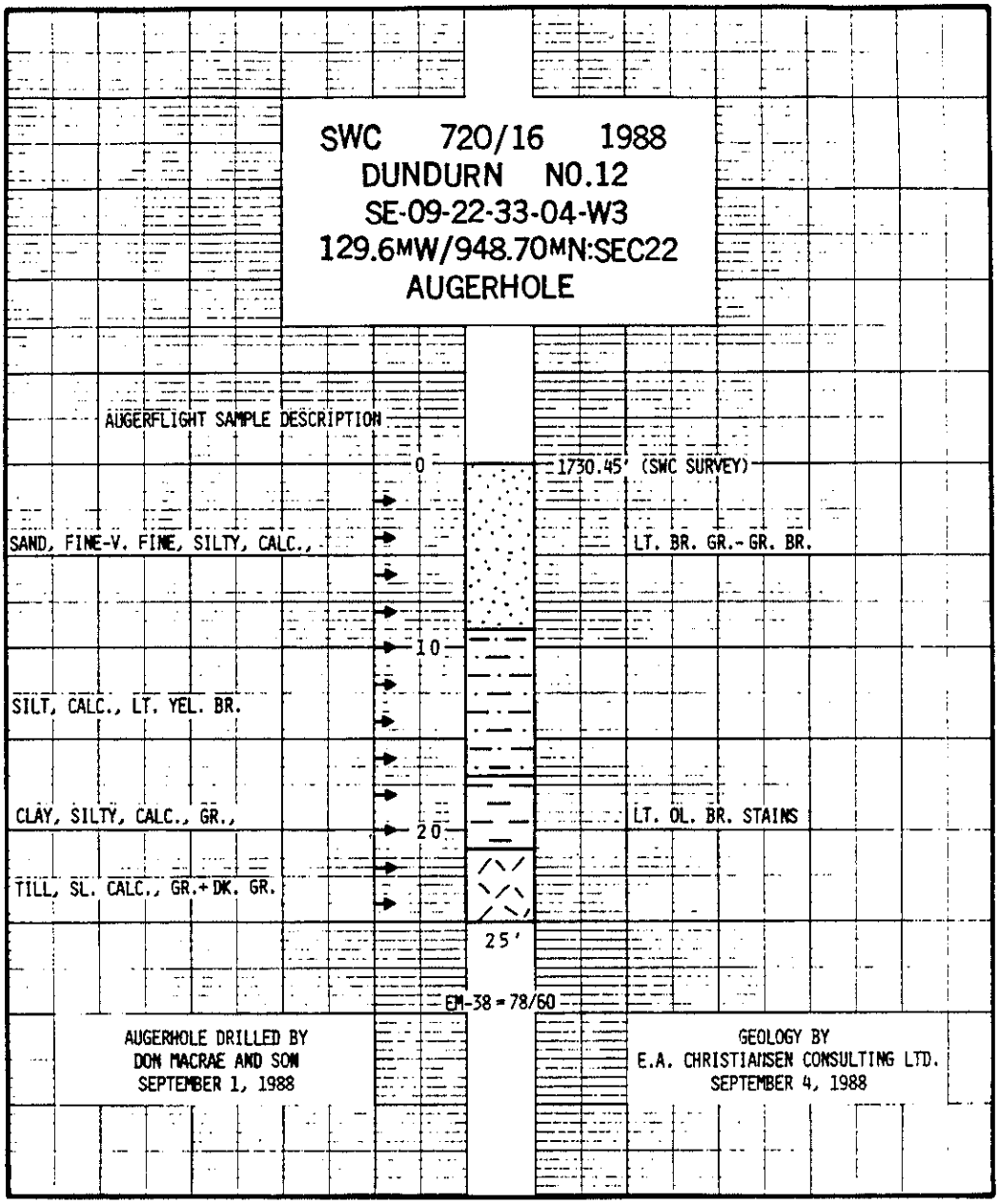
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
1773.20' (SWC SURVEY)
SAND, FINE-V. FINE, CALC., GR. BR.
SAND, V. FINE-MED., CALC., DK. GR. BR.
SAND, V. FINE-MED., LT. BR. GR.,
SILTIER TOWARD BASE
10
SILT, CALC., LT. BR. GR.,
WITH DK. GR. BR. CLAY AT BASE
20
TILL, CALC., LT. BR. GR., UNSTAINED
TILL, CALC., LT. YEL. BR., HARD
25'
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988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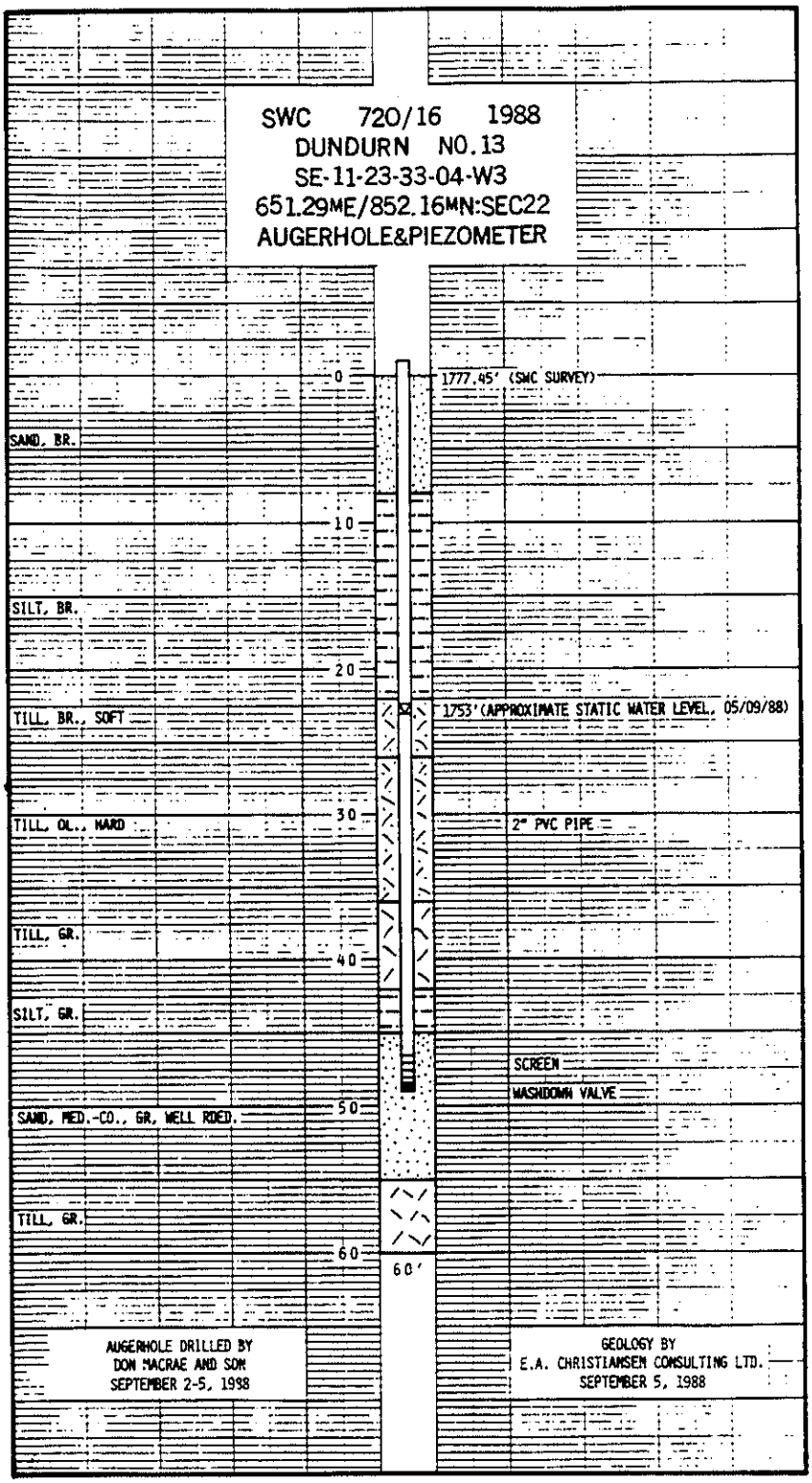
DUNDURN NO.12
SE-09-22-33-04-W3
129.6MW/948.70MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
1730.45' (SWC SURVEY)
SAND, FINE-V. FINE, SILTY, CALC., LT. BR. GR.-GR. BR.
10
SILT, CALC., LT. YEL. BR.
CLAY, SILTY, CALC., GR., LT. OL. BR. STAINS
20
TILL, SL. CALC., GR.+DK. GR.
25'
EM-38 = 78/60
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 1, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988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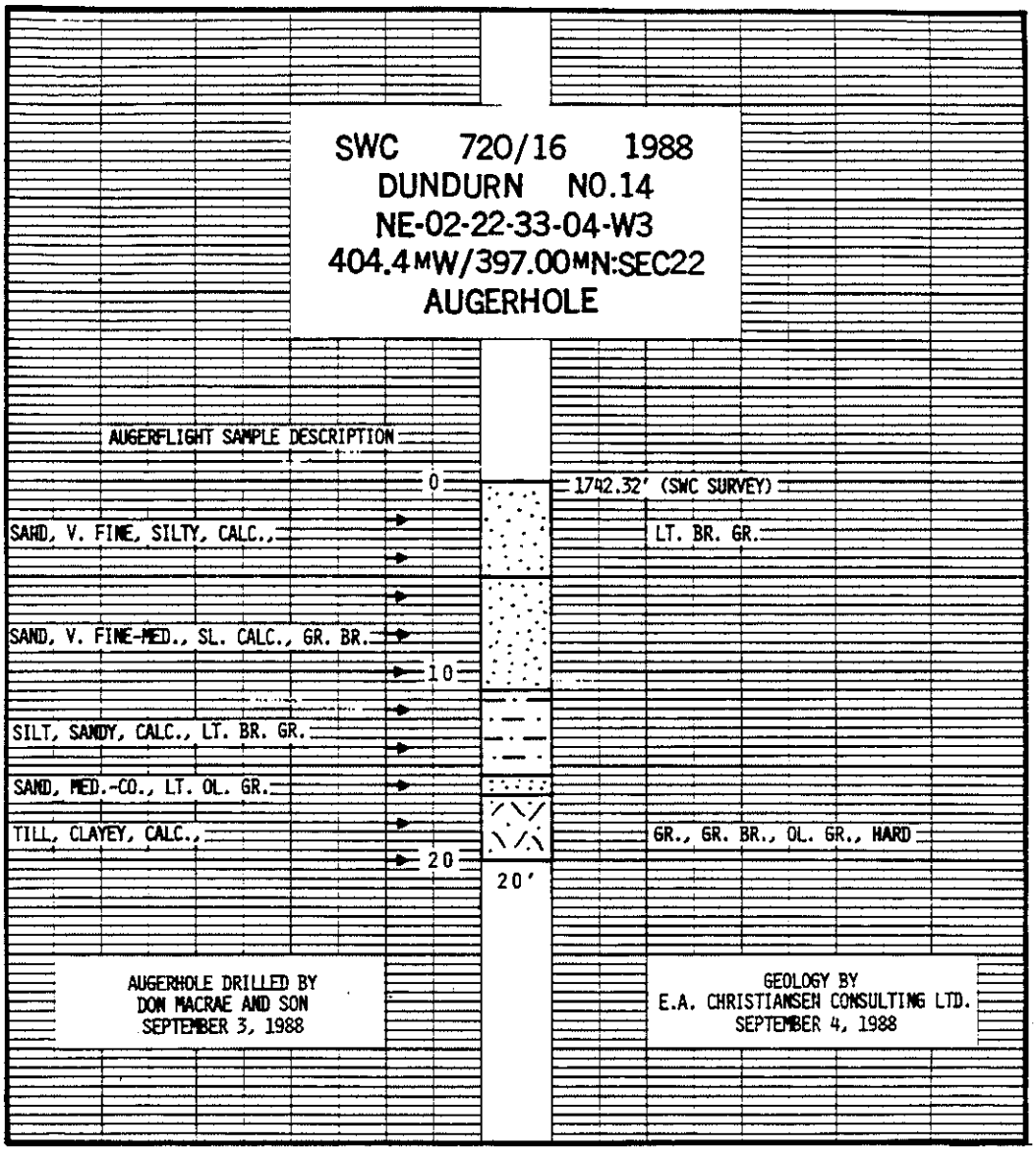
DUNDURN NO.13
SE-11-23-33-04-W3
651.29ME/852.16MN:SEC22
AUGERHOLE&PIEZOMETER
0
1777.45' (SWC SURVEY)
SAND, BR.
10
SILT, BR.
20
1753'(APPROXIMATE STATIC WATER LEVEL, 05/09/88)
TILL, BR., SOFT
2" PVC PIPE
30
TILL, OL., HARD
TILL, GR.
40
SILT, GR.
SCREEN
WASHDOWN VALVE
SAND, MED.-CO., GR, WELL RDED.
50
TILL, GR.
60
60'
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 2-5, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 5, 1988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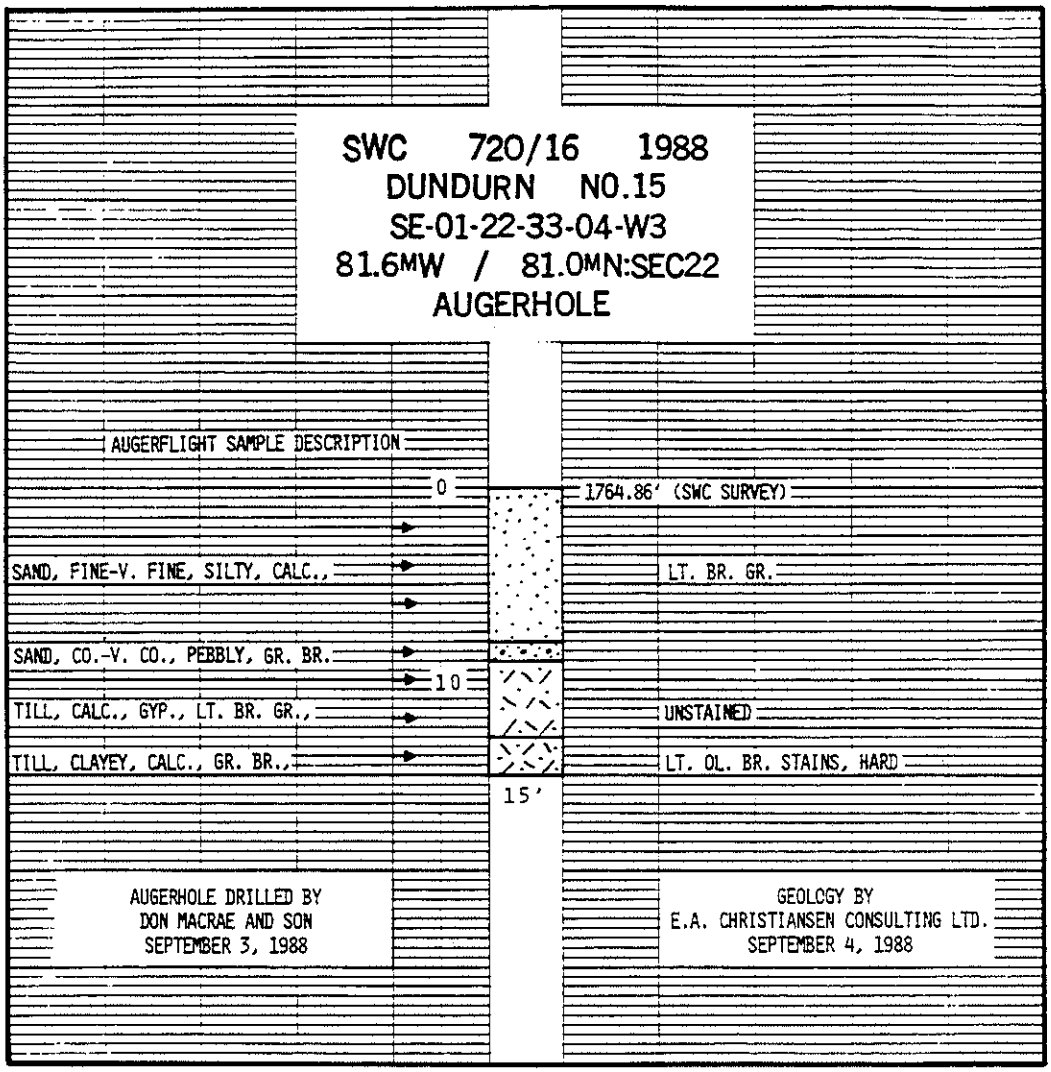
DUNDURN NO.14
NE-02-22-33-04-W3
404.4 MW/397.00 MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
SAND, V. FINE, SILTY, CALC.,
SAND, V. FINE-MED., SL. CALC., GR. BR.
10
SILT, SANDY, CALC., LT. BR. GR.
SAND, MED.-CO., LT. OL. GR.
TILL, CLAYEY, CALC.,
20
20'
1742.32' (SWC SURVEY)
LT. BR. GR.
GR., GR. BR., OL. GR., HARD
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 3, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988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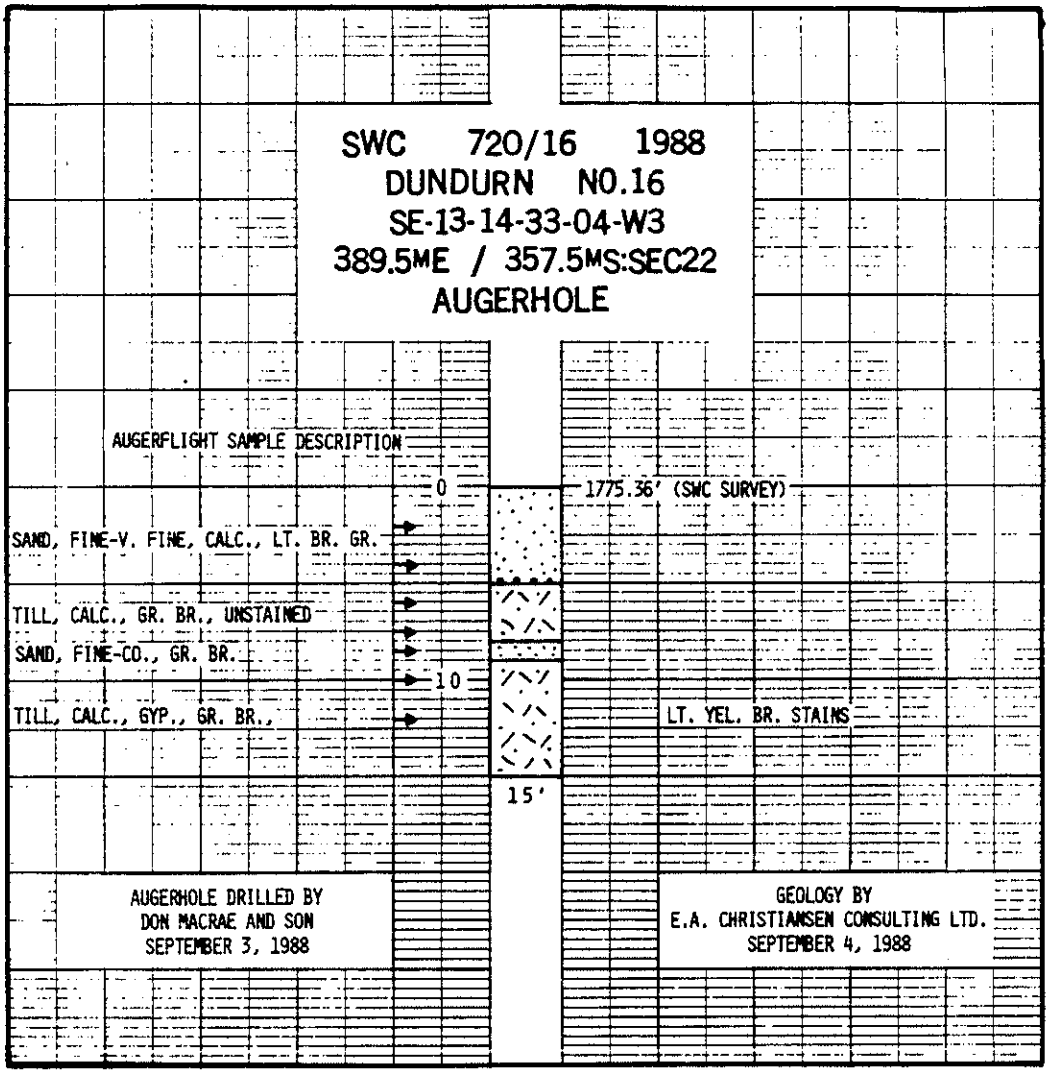
DUNDURN NO.15
SE-01-22-33-04-W3
81.6MW / 81.0MN:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
1764.86' (SWC SURVEY)
SAND, FINE-V. FINE, SILTY, CALC.,
LT. BR. GR.
SAND, CO.-V. CO., PEBBLY, GR. BR.
10
TILL, CALC., GYP., LT. BR. GR.,
UNSTAINED
TILL, CLAYEY, CALC., GR. BR.,
LT. OL. BR. STAINS, HARD
15'
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 3, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988


SWC 720/16 1988
DUNDURN NO.16
SE-13-14-33-04-W3
389.5ME / 357.5MS:SEC22
AUGERHOLE
AUGERFLIGHT SAMPLE DESCRIPTION
0
1775.36' (SWC SURVEY)
SAND, FINE-V. FINE, CALC., LT. BR. GR.
TILL, CALC., GR. BR., UNSTAINED
SAND, FINE-CO., GR. BR.
10
TILL, CALC., GYP., GR. BR.,
LT. YEL. BR. STAINS
15'
AUGERHOLE DRILLED BY
DON MACRAE AND SON
SEPTEMBER 3, 1988
GEOLOGY BY
E.A. CHRISTIANSEN CONSULTING LTD.
SEPTEMBER 4, 1988

SASKATCHEWAN SOIL TESTING LABORATORY

Date: 07-09-88 SPECIAL ANALYSIS

CHRISTIANxI8-01731/01747 xxxE. A. CHRISTIANSEN CONSULTINGxxx

Lab Number	Client Identification	CO2 EQUIV ml/gm
I8-01731	DUNDURN #1 20-25	23.54
I8-01732	DUNDURN #1 25-30	24.47
I8-01733	DUNDURN #1 30-35	31.88
I8-01734	DUNDURN #1 35-40	35.03
I8-01735	DUNDURN #1 40-45	49.68
I8-01736	DUNDURN #1 45-50	35.40
I8-01737	DUNDURN #1 50-55	33.92
I8-01738	DUNDURN #1 55-60	33.74
I8-01739	DUNDURN #1 60-65	33.74
I8-01740	DUNDURN #1 65-70	33.36
I8-01741	DUNDURN #1 70-75	29.10
I8-01742	DUNDURN #1 80-85	27.80
I8-01743	DUNDURN #1 85-90	30.40
I8-01744	DUNDURN #1 90-95	30.77
I8-01745	DUNDURN #1 95-100	27.62
I8-01746	DUNDURN #1 100-105	27.43
I8-01747	DUNDURN #1 105-110	28.92

Comment:

xxxEndxxx

SASKATCHEWAN SOIL TESTING LABORATORY

Date: 06-09-88 FERTILITY ANALYSIS

CHRISTIANxI8-01731/01747 xxxE. A. CHRISTIANSEN CONSULTINGxxx

Lab Number	Client Identification	pH	Conduct ms/cm
I8-01731	DUNDURN #1 20-25	8.0	1.0
I8-01732	DUNDURN #1 25-30	7.8	1.5
I8-01733	DUNDURN #1 30-35	7.8	1.5
I8-01734	DUNDURN #1 35-40	8.0	1.3
I8-01735	DUNDURN #1 40-45	8.1	0.9
I8-01736	DUNDURN #1 45-50	8.1	1.1
I8-01737	DUNDURN #1 50-55	8.0	1.1
I8-01738	DUNDURN #1 55-60	8.1	1.1
I8-01739	DUNDURN #1 60-65	8.1	1.1
I8-01740	DUNDURN #1 65-70	8.1	1.2
I8-01741	DUNDURN #1 70-75	8.1	1.1
I8-01742	DUNDURN #1 80-85	8.2	1.0
I8-01743	DUNDURN #1 85-90	8.2	1.0
I8-01744	DUNDURN #1 90-95	8.2	1.0
I8-01745	DUNDURN #1 95-100	8.3	1.0
I8-01746	DUNDURN #1 100-105	8.2	1.0
I8-01747	DUNDURN #1 105-110	8.3	1.0

Comment:

xxxEndxxx

SASKATCHEWAN SOIL TESTING LABORATORY

Date: 06-09-88 MECHANICAL ANALYSIS

$CHRISTIANxI8-01731/01743 xxxE. A. CHRISTIANSEN CONSULTINGxxx

Lab Number	Client Identification	Sand percent	Silt percent	Clay percent
I8-01731	DUNDURN #1 20-25	50.8	30.9	18.3
I8-01733	DUNDURN #1 30-35	51.0	28.5	20.5
I8-01740	DUNDURN #1 65-70	37.2	32.2	30.6
I8-01743	DUNDURN #1 85-90	45.8	29.3	25.0

SASKATCHEWAN SOIL TESTING LABORATORY

Date: 31-08-88 WATER ANALYSIS

CHRISTIANxW8-00132/00133 xxxE. A. CHRISTIANSEN CONSULT.xxx

Lab #	Client Identification	T.D.S.	pH	COND. (mS/cm)	CONCENTRATION OF IONS (ug/mL) Na+	Ca++	Mg++	K+	Cl-	SO4=	HCO3-	S.A.R.
W8-00132	DUNDURN #1P SAMPLE #1	1178	8.0	1.8	172	149	72	11	14	681	495	2.9
W8-00133	DUNDURN #1P SAMPLE #2	1088	8.2	1.7	162	113	61	10	14	620	429	3.1

SASKATCHEWAN SOIL TESTING LABORATORY

Date: 08-09-88 WATER ANALYSIS

CHRISTIANxW8-00155/00156 xxxE. A. CHRISTIANSEN CONSULTINGxxx

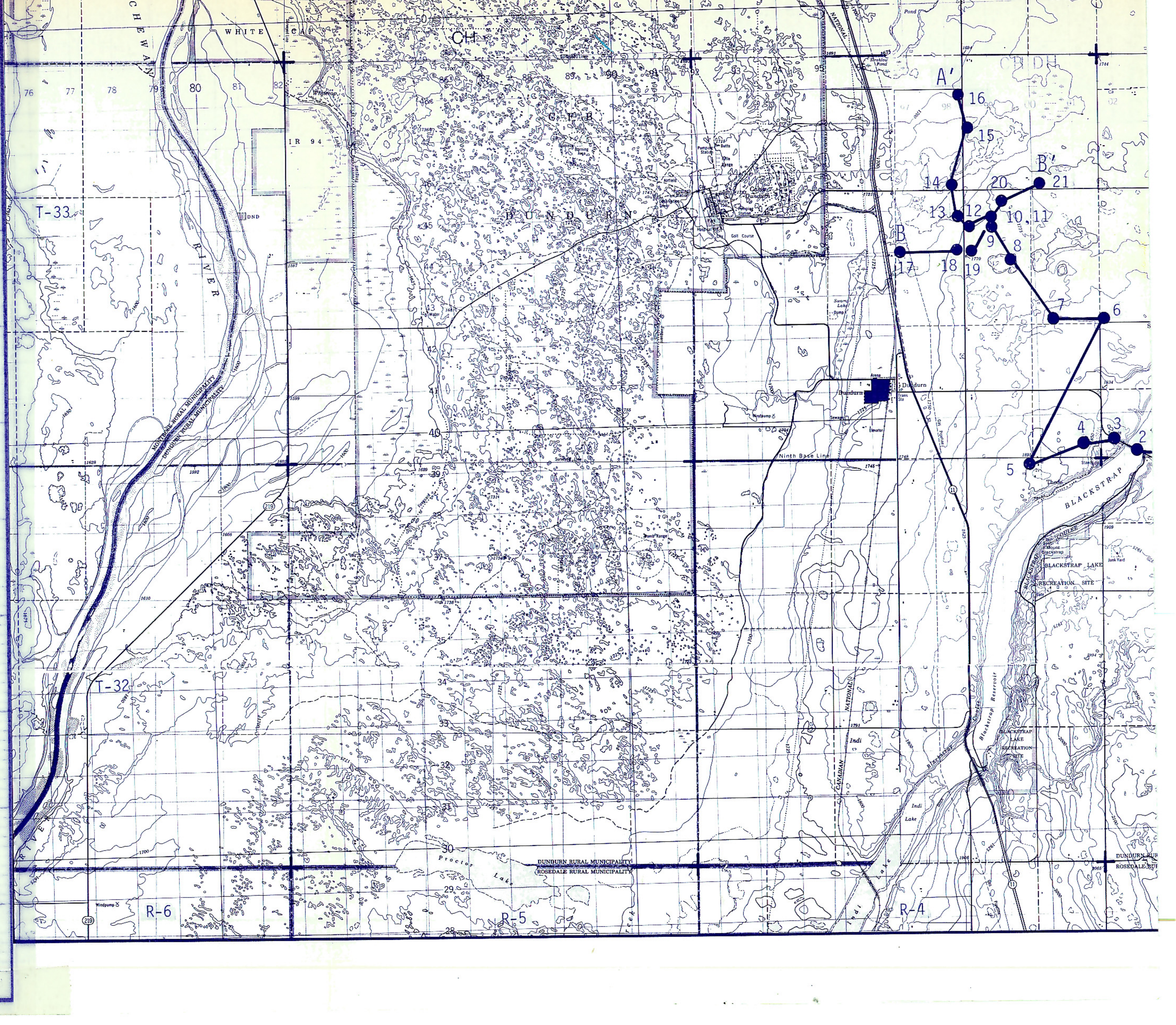
Lab #	Client Identification	T.D.S.	pH	COND. (mS/cm)	CONCENTRATION OF IONS (ug/mL) Na+	Ca++	Mg++	K+	Cl-	SO4=	HCO3-	S.A.R.
W8-00155	DUNDURN #13	1510	7.9	2.4	76	350	139	16	12	1235	386	0.9
W8-00156	DUNDURN #06P	1568	8.1	2.4	215	213	157	6	12	1143	416	2.7

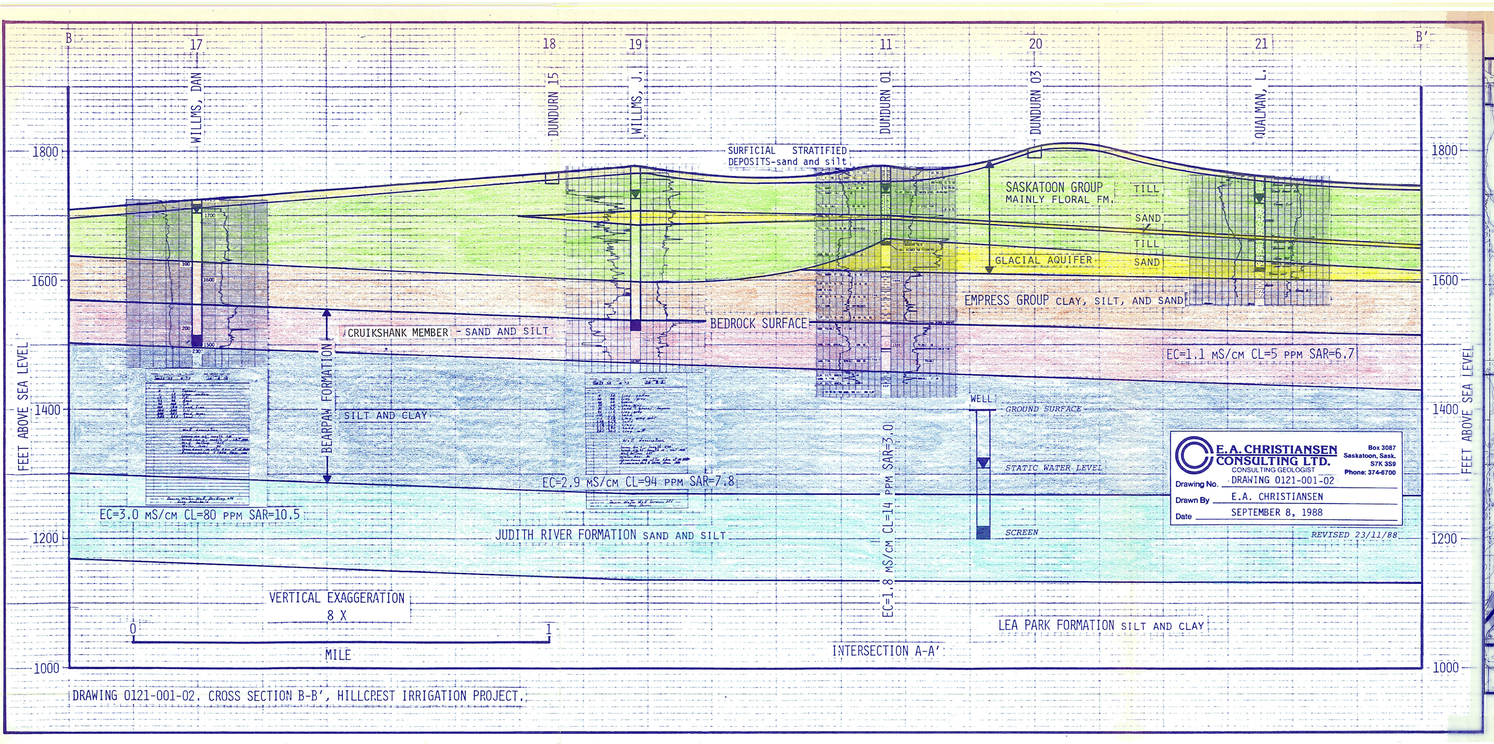
Analyses of water samples from farm wells

LAB #	CLIENT IDENTIFICATION	T.D.S.	pH	COND. mS/cm	CONCENTRATION OF IONS (ug/ml) Na+	Ca++	Mg++	K+	Cl-	SO4=	HCO3-	S.A.R.
W8-00112	Well No. 1	1901	8.00	3.0	545	124	49	11	80	1120	588	10.5
W8-00113	Well No. 2	1830	8.00	2.9	455	154	64	8	94	1057	591	7.8
W8-00116	Well No. 3	2829	7.05	4.4	658	336	189	13	59	2364	576	7.1
W8-00137	Well No. 4	678	8.10	1.1	190	36	15	4	5	210	431	6.7

WELL NO.	OWNER	LOCATION	DEPTH feet	STATIC LEVEL (ft)
1	Dan Willms	SW 04-22-33-04-W3	225	21
2	Jacob Willms	SE 04-23-33-04-W3	255	47
3	W. Falk	SW 04-18-33-03-W3	86	68
4	L. Qualman	SW 01-27-33-04-W3	148	42

DRAWING 0121-001-01. CROSS SECTION A-A', HILLCREST IRRIGATION PROJECT.





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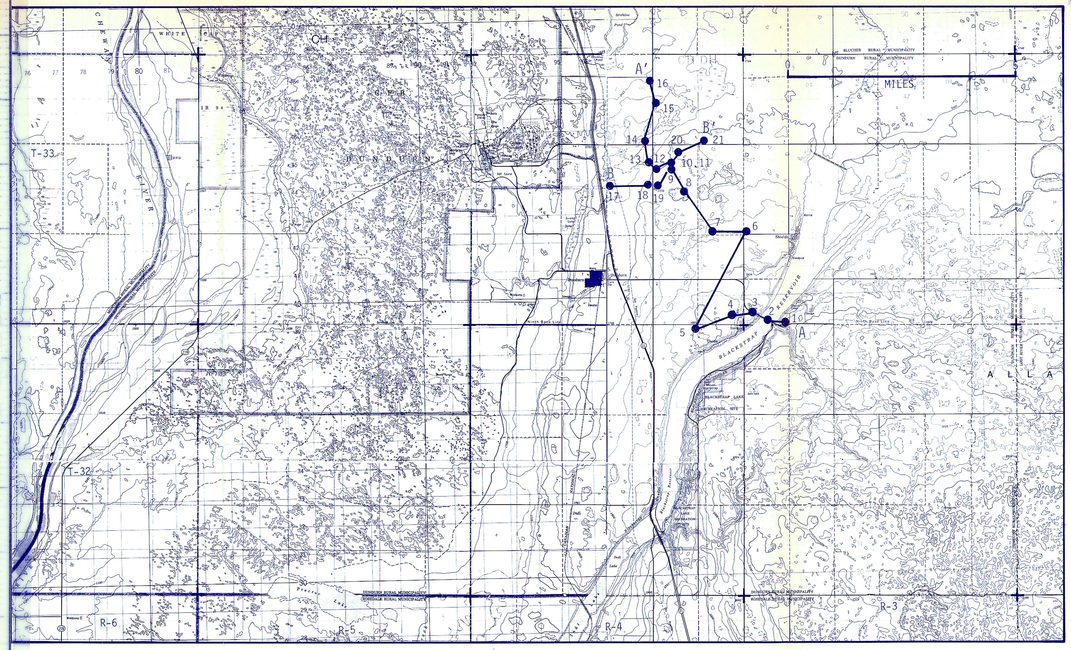

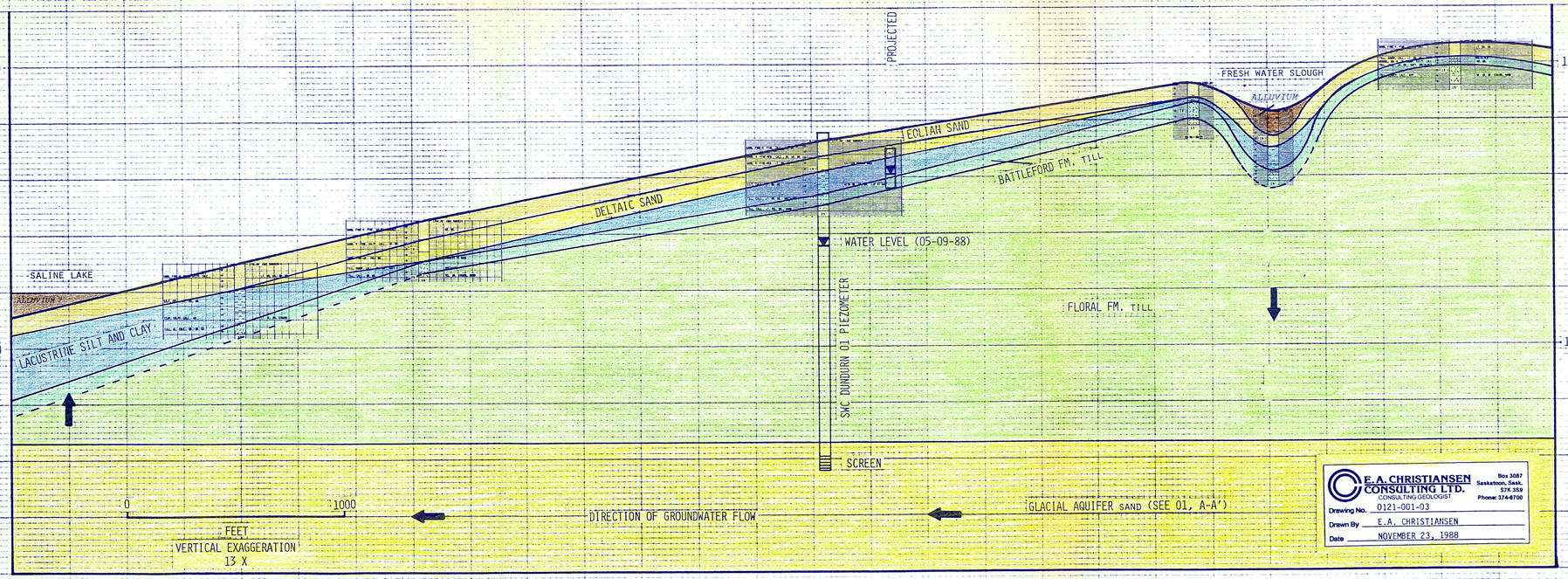

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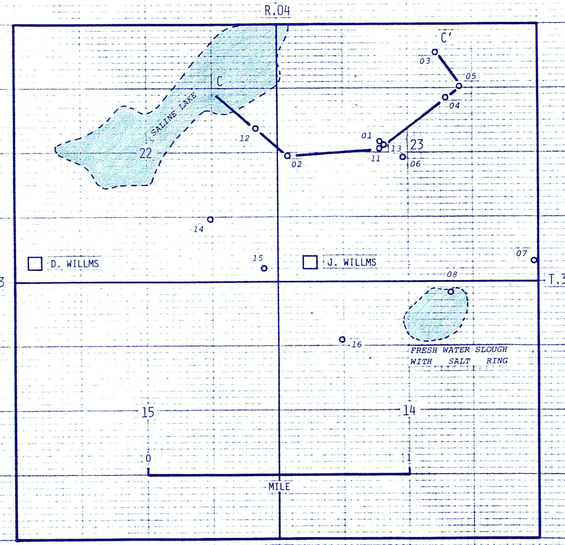
Drawing No. 0121-001-03
Drawn By E.A. CHRISTIANSEN
Date NOVEMBER 23, 1988

DRAWING 0121-001-03. CROSS SECTION C-C', HILLCREST IRRIGATION PROJECT.



LOCATION MAP